PREDICTING CLIMATE CHANGE IMPACTS ON PRECIPITATION FOR WESTERN NORTH AMERICA

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Abstract

Global Circulation Models (GCMs) are used to create projections of possible future climate characteristics under global climate change scenarios. Future local and regional precipitation scenarios can be developed by downscaling synoptic CGM data. Daily 500-mb geopotential heights from the Canadian Centre for Climate Modelling and Analysis's CGCM2 are used to represent future (2020-2050) synoptics and are compared to daily historical (1960-1990) 500-mb geopotential height reanalysis data. The comparisons are made based on manually classified synoptic patterns identified by Changnon et al. (1993. *Mon. Weather Rev.* **121**: 633-647). Multiple linear regression models are used to link the historical synoptic pattern frequencies and precipitation amounts for 372 weather stations across western North America,. The station-specific models are then used to forecast future precipitation amounts per weather station based on synoptic pattern frequencies forecast by the CGCM2 climate change forcing scenario. Spatial and temporal variations in precipitation are explored to determine monthly, seasonal and annual trends in climate change impacts on precipitation in western North America. The resulting precipitation scenarios demonstrate a decrease in precipitation from 10 to 30% on an annual basis for much of the south and western regions of the study area. Seasonal forecasts show variations of the same regions with decreases in precipitation and select regions with increases in future precipitation. A major advancement of this analysis was the application of synoptic pattern downscaling to summer precipitation scenarios for western North America.

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List of Abbreviations

GCM	Global Circulation Model
CCCma	Canadian Centre for Climate Modelling and Analysis
CGCM1	CCCma's first generation coupled global circulation model
CGCM2	CCCma's second generation coupled global circulation model
CGCM	Coupled (Atmosphere-Ocean) Global Circulation Model
GHG	Green House Gases
GHG+A	Green House Gases including Aerosols
mb	millibar , 1 millibar = 1 hPa
$1xCO_2$	Atmospheric carbon dioxide concentration pre-1990 levels
$2xCO_2$	Atmospheric carbon dioxide concentration when 1990 levels have doubled, to occur at approximately 2050
IPCC	Intergovernmental Panel on Climate Change
SRES	IPCC Special Report on Emission Scenarios
DR	Ridge synoptic pattern
NWM	Meridional northwest synoptic pattern
NWW	West-northwest synoptic pattern
NWZ	Zonal synoptic pattern
SWC	Cutoff synoptic pattern
SWS	Split-flow synoptic pattern
SWT	Trough synoptic pattern
UNC	Unclassified synoptic pattern
NAM	North American Monsoon
DJF	Winter - December, January, February
MAM	Spring - March, April, May
JJA	Summer - June, July, August
SON	Fall - September, October, November
UNFCCC	United Nations Framework Convention on Climate Change
NAM	North American Monsoon
MCS	Mesoscale Convective System
CMIP	Coupled Model Inter-comparison Project
GISS	Goddard Institute for Space Studies
GFDL	Geophysical Fluid Dynamics Laboratory
CIT	California Institute of Technology
NCDC	National Climatic Data Centre
NCEP/NCAR	National Center for Environmental Prediction / National Center for Atmospheric Research
GrADS	Grid Analysis and Display System
GIS	Geographic Information System
ESRI	Environmental Systems Research Institute
AML	Arc Macro Language
KS	Kolmogorov-Smirnov test
NWP	Numerical Weather Prediction Model

Chapter 1

Overview

1.1 Introduction

There is an increasing demand for a better understanding of the possible future outcomes of global climate change. Global Circulation Models (GCMs) are used to create projections of future anthropogenic climate change and can be used as a tool to demonstrate future climate characteristics (Houghton et al., 2001). GCM modeled historical temperatures are quite accurate and therefore GCM forecasts of future temperatures are considered to be reasonably dependable. However, GCM forecasts of historical precipitation are unreliable and hence modeled future precipitation is not considered an accurate representation of future conditions (Byrne et al., 1999; Felzer and Heard, 1999; Wilby et al., 1999; Hay et al., 2000; Wilby and Wigley, 2000). Future precipitation will likely be affected by global climate change; therefore some means of quantifying changes in precipitation, other than GCM modeled precipitation, is needed to develop future climate change impact scenarios. GCM simulations of synoptic scale circulation has been found to accurately represent observed historical conditions (McFarlane et al., 1992; Johns et al., 1997; Byrne et al., 1999; Flato et al., 2000; Lapp et al., 2002; Pavan et al., 2004) and there is a relatively strong statistical association between synoptic scale pattern classification and seasonal precipitation for fall, winter and spring. These relationships may be used to determine future seasonal precipitation using classification schemes for GCM-based forecasts of future synoptic patterns (Cavazos and Hewitson, 2002; Lapp et al., 2002).

Winter precipitation is synoptically driven, while summer precipitation is primarily convective (Houghton et al., 2001). The work undertaken in this thesis hypothesized that synoptic downscaling and classification schemes would permit a more accurate winter precipitation forecast in western North America than direct GCM forecasted precipitation could. Work completed in this thesis also found that late spring and summer convective precipitation relates to "unclassified" synoptic patterns (i.e. days on which no meaningful continental synoptic pattern was observed). This resulted in the ability to quantify the occurrence of convective type precipitation over western North America for use in future precipitation forecasts.

Seven dominant synoptic patterns for western North America for the winter seasons (October-March) of 1950-1985 were defined by Changnon et al. (1993) (Figure 1.1). These seven synoptic patterns were determined to control the spatial distribution and amount of winter precipitation in the Rocky Mountain States of the United States. Byrne et al. (1999) and Lapp et al. (2002) discovered that these synoptic patterns also controlled precipitation and spring runoff in the Canadian Rockies and the southern Canadian prairies. Therefore, based on the previous analyses of upper-level airflow and precipitation over the western United States and over western Canada, the seven synoptic patterns described by Changnon et al. can be used to classify daily 500 mb geopotential heights for all of western North America.

This thesis investigates the possible changes in future precipitation for western North America under global climate change. The methodology is based on previous studies by Changnon et al. (1993), Byrne et al. (1999), and Lapp et al. (2002) and links historical synoptic pattern frequencies to precipitation in order to model future precipitation scenarios on different spatial and temporal scales. The goal of this thesis is to gain a better knowledge of monthly, seasonal, and annual climatic variability and synoptically driven precipitation, with a focus on global climate change. Such precipitation scenarios are fundamental for determining the impact of climate change on water resources, and for developing adaptation strategies necessary for stakeholders in almost all sectors of the economy and society.

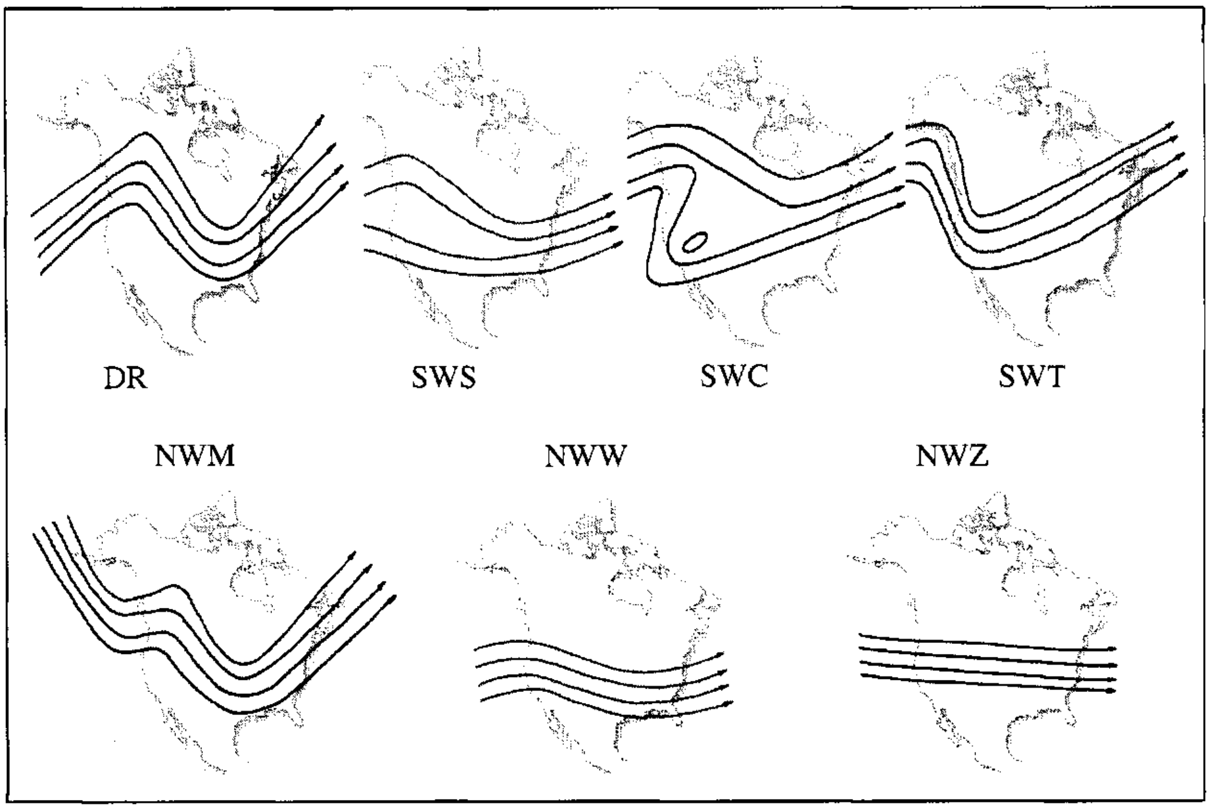


Figure 1.1 The seven dominant 500 mb synoptic patterns identified by Changnon et al. (1993) to govern winter precipitation in the western United States. Lines of flow represent upper-level atmospheric winds occurring along the greatest pressure differences, otherwise referred to as the jet stream. The ridge (DR) pattern is usually associated with dry anomalies across the western North America region. The split-flow (SWS) pattern, the cutoff (SWC) pattern, and the trough (SWT) pattern are associated with wet anomalies across the southern North America region. The meridional northwest (NWM), the west-northwest (NWW) pattern, and the zonal (NWZ) pattern are associated with wet anomalies across the northern regions of western North America.

1.2 Objectives

The objective of this thesis is to develop future precipitation scenarios for western North America under forecast global climate change. There are four sub-objectives that address this overall objective:

1) Determine and describe relationships that reflect historical synoptic upper airflow pattern-precipitation efficacy;
2) Examine monthly, seasonal, and annual synoptic pattern frequencies, and the relationship of pattern frequencies to precipitation for a large number of climate stations in western North America;
3) Evaluate changes in future synoptic pattern frequencies as classified from GCM based 500-mb geopotential heights;
4) Determine mean monthly, seasonal and annual precipitation changes for western North America.

1.3 Thesis Format

This thesis is organized as follows:

Chapter 1 - Overview and Introduction

Chapter 2 - Literature Review

Chapter 3 - Forecasting Precipitation for Western North America for the Fall, Winter and Spring Seasons

Chapter 4 - Forecasting Variation in Summer Precipitation for Western North America

Chapter 5 - Spatial Variation in Annual Precipitation for Western North America Under Forecast Climate Change

Chapter 6 - Conclusion, Summary and Recommendations

Chapter 2

Literature Review

2.1 Introduction

The following literature review discusses topics and information required as background for this thesis, as well as published literature relevant to the research methods adopted for this study.

2.2 Global Climate

2.2.1 Climate Variability and Climate Change

The Earth's climate is a dynamic system always undergoing change. However, it is important to recognize the difference between natural climate variability and global climate change. The Intergovernmental Panel on Climate Change (IPCC) defines climate variability as variations in the mean state or other statistics of the climate, including standard deviations and the occurrence of extremes, on all temporal and spatial scales beyond that of individual weather events (Houghton et al., 2001). Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability) (Houghton et al., 2001). Climate change, however, refers to a statistically significant variation in either the mean state of the climate or in its variability persisting for an extended period of time, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (Houghton et al., 2001). The IPCC in *Climate Change 2001:*

The Scientific Basis also notes that the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as:

> *"a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".*

The UNFCCC thus makes a distinction between climate change that can be attributed to human activities altering the atmospheric composition, and climate variability that can be attributed to natural causes (Houghton et al., 2001).

2.2.2 Anthropogenic Climate Change

Scientific literature provides strong support for human induced climate warming. Stott et al. (2000) found that natural forcing alone could not account for the warming observed over the last three decades. Increases in global mean surface air temperatures (i.e. 0.6 ± 0.2°C from 1860 to 2000) cannot be explained by anthropogenic forcings alone for the period from 1910 to 1945, but anthropogenic forcings are absolutely necessary to reproduce the warming that has occurred since 1976 (Zwiers and Weaver, 2000). The observed temperature trends during the 1950-1999 period were consistent with simulations that included anthropogenic forcing from increasing atmospheric greenhouse gases and sulfate aerosols (Karoly et al., 2003). Therefore, it could be concluded that the overall pattern of observed near-surface temperature change in the 20th century is caused by a combination of natural and anthropogenic forcing.

Although both natural and anthropogenic influences may have contributed to recent global warming, there is little doubt that increasing global temperatures can be related to increasing greenhouse gas (GHG) concentrations in the atmosphere

(Hengeveld, 2000). Carbon Dioxide (CO_2), Nitrous Oxide (N_2O), and Methane (CH_4), for example, play a role in retaining heat in the lower troposphere. Measurements of paleo-environmental CO_2 concentrations from ocean sediment and ice-cores reflect the relationship between CO_2 concentrations and global temperatures (Lee et al., 1998; Petit et al., 1999; Brostrom, 2004). Figures 2.1 and 2.2 demonstrate that increased levels of atmospheric CO_2 are related to increased mean annual temperatures in the Northern Hemisphere, especially in the 1990s. GHG increases in the atmosphere are mainly due to fossil fuel consumption by anthropogenic activities. This provides evidence that human induced climate change will continue as long as anthropogenic loadings of GHG to the atmosphere continues.

Possible impacts of global climate change are numerous and difficult to determine. One method of forecasting future impacts of anthropogenic climate change is to use global circulation models (GCMs), which are capable of numerically simulating components of the atmosphere and ocean's circulation. GCMs provide a means of understanding and projecting how GHG and aerosols might affect a system as dynamic as the earth's climate. These methods will be discussed further in section 2.5.

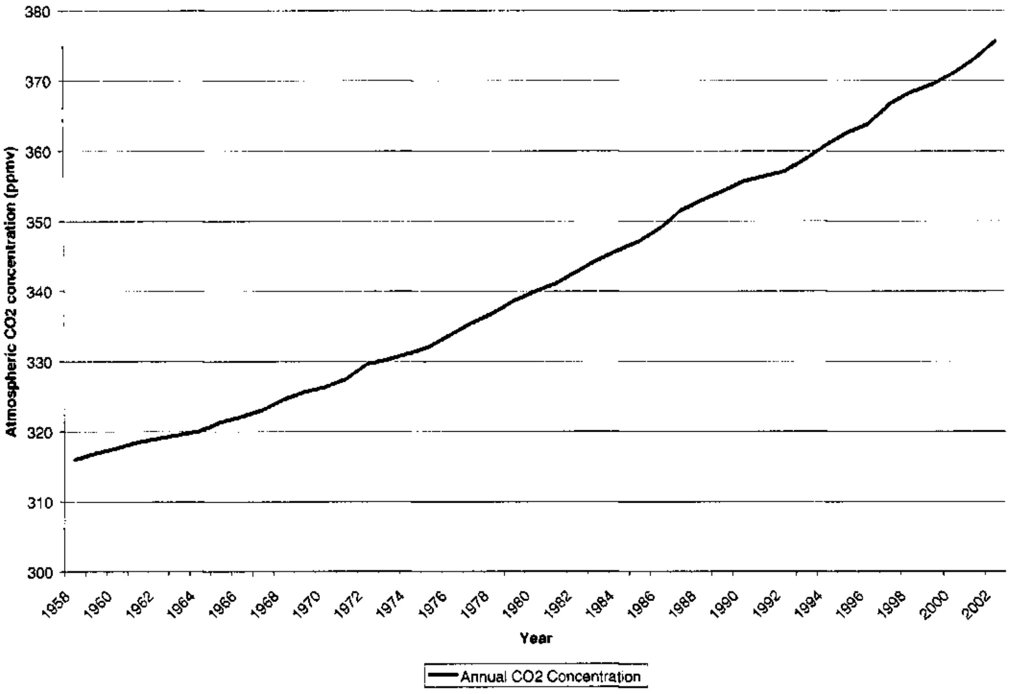


Figure 2.1 Observed atmospheric CO_2 concentration (ppmv) from 1958 to 2003 at the Mauna Loa Observatory, Hawaii (Data acquired from Keeling et al., 2004).

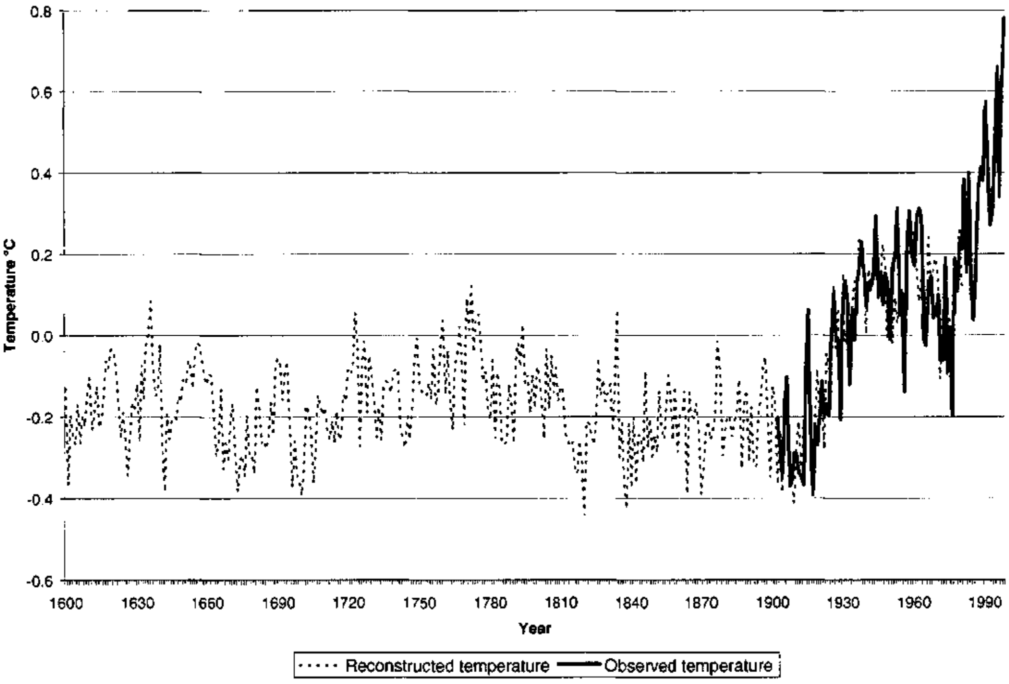


Figure 2.2 Northern Hemisphere mean annual temperatures from 1600-1998. Recorded temperatures begin in 1902 and show the rising temperatures particularly from 1990 onward). Reconstructed temperatures are based on the calibration of multiproxy data networks by the dominant patterns of temperature variability in the instrumental record (Data acquired from Mann et al., 1998).

2.3 Atmospheric Circulation

2.3.1 Air Masses, Fronts and Gradients

Atmospheric circulation plays a key role in governing other climatic variables such as temperature, precipitation and upper level and surface winds (Trenberth, 1995). It is therefore necessary to understand the circulation of the atmosphere and its relationship to key variables that may be affected by global climate change. The general circulation of the atmosphere is caused by the unequal heating of the earth's surface due to differences in incoming solar radiation and outgoing long wave radiation. The net gain of energy at the tropics is balanced by the net loss of energy at the North and South poles, creating hotter air at the equator and colder air at the poles (Ahrens, 2000). Surface air flows from the poles to the equator causing a general transport of warm air towards the poles and cool air towards the equator. This flow is caused by the pressure gradient force, which is the force that causes the air to move in the direction of higher pressure to lower pressure. When the surface air reaches the equator, it is lifted vertically through the processes of convection and convergence (Pidwirny, 2004). When the air reaches the top of the troposphere, it begins to flow horizontally as upper-level airflow, now traveling from the equator to the poles. At the poles, the air in the upper atmosphere then descends to the earth's surface to complete the cycle of flow which creates atmospheric circulation on a global level.

Temperature and pressure gradients, the lifting of air at the equator and the sinking of air at the poles, in combination with the coriolis force (the force caused by the earth's rotation that deflects to the right in the northern hemisphere and to the left in the southern hemisphere) also cause the trade winds near the equator and the prevailing westerly winds in the mid latitudes. In the Northern Hemisphere, the northward traveling mild westerly winds encounter the cold polar easterly winds moving south from the North Pole. The cold air in the north is the polar airmass and the warmer air to the south is a tropical airmass. An airmass is distinguished by having similar temperatures, pressure and moisture content within a large body of air. In North America, there are seven main airmasses that can control moisture, pressure and winds over the continent. Each airmass is characterized by its source region, polar for airmasses originating in the polar latitudes, tropical for airmasses originating in warm regions to the south, continental for airmasses originating over land -which are usually dry, and maritime for airmasses originating over oceans –which are usually moist. Airmasses do not readily mix due to their contrasting temperatures, and are separated by a temperature and pressure gradient called a front. This gradient surface in the Northern Hemisphere is called the polar front and lies in the boundary between the polar airmass and the tropical airmass. Along the polar front, surface air converges, rises, and as a result storms develop. Of critical importance to this thesis is the location of the westerly winds along the boundary of the polar air mass. These winds are the conveyor belt on which synoptic storms form and travel. These large scale interactions are the focus of discussion below.

2.3.2 The Jet Stream and Synoptic Climatology

The jet stream is a colloquial term for the geostrophic winds. Geostrophic winds are winds that theoretically blow at a constant speed in a straight path parallel to isobars, or lines of equal pressure, in the atmosphere. The jet stream is typically thousands of kilometers long, a few hundred kilometers wide, and only a few kilometers thick (DAS, 1999). Jet streams are usually found somewhere between 10-15 km above the earth's surface. In the northern hemisphere, the polar jet stream flows from west to east and is positioned where there is the strongest surface temperature contrast (Pidwirny, 2004). Thus, the polar jet stream forms along the polar front where there exists a boundary between warmer subtropical air located to the south of the jet stream and colder polar air located to the north. The sudden change in temperature between the polar airmass and the tropical airmass produces a steep pressure gradient that intensifies the upper-level wind speeds and combine with coriolis deflection to create the geostrophic winds (i.e. the jet stream) (Ahrens, 2000). On a 500 millibar pressure chart, the jet stream would be characterized by the area of concentrated pressure contours. The jet stream is the strongest during the winter where the temperature difference between high and low latitudes are the greatest. High and low pressure systems, as well as the fronts associated with the highs and lows, are carried along the jet stream. Small scale pressure systems influence weather on a scale of thousands of square kilometers. The largest scale pressure systems typically dominate weather on a sub continental to continental scale. These large-scale interactions between the jet stream and fronts are said to occur on a synoptic scale.

Synoptic circulations include the winds along the jet stream and the storm systems tractored by the westerly winds. General atmospheric circulation and synoptic scale interactions between airmasses can be strongly linked to climatic variables such as temperature and precipitation. Synoptic circulation plays an important role in the hydrologic cycle (Trenberth, 1995) and the location of the jet stream and related embedded storms are a critical factor in the spatial and temporal distribution of synoptic-scale precipitation. Any shift in the jet stream position due to climate change influences could potentially impact future synoptic precipitation; a concern if the polar airmass were to weaken under forecast climate warming and shift the jet stream's location and subsequent pattern of flow. Changes in jet stream pattern frequencies could also significantly alter the distribution of synoptic-scale precipitation on spatial and temporal scales.

2.4 Precipitation

The hydrologic cycle provides a direct connection between the atmosphere and the land surface. Water is cycled through the land, atmosphere and oceans as part of six components: precipitation, infiltration, evaporation, transpiration, surface runoff and groundwater flow (Viessman and Lewis, 2003). Precipitation is one of the most important components of the hydrologic cycle (Flato et al., 2000).

Precipitation depends on the uplift of humid air (DAS, 1999). Rising air expands and cools to the dewpoint temperature (the temperature at which relative humidity reaches 100%); moisture in the parcel of air condenses and forms cloud droplets around condensation nuclei (aerosol particles in the atmosphere that attract water droplets) (DAS, 1999). Coalescence occurs when drops of water collide and merge due to turbulent mixing of air, and as heavier droplets fall (Mason, 1975). Precipitation can also begin as ice crystals that collect and adhere to form snowflakes, a process called aggregation (Ahrens, 2000). If the falling snow passes through the freezing level into warmer air, the flakes may melt and collapse into rain drops, or if the surface air temperature is below freezing, precipitation may reach the surface as snow (DAS, 1999).

The processes that result in upward motions of air that generate clouds and precipitation are discussed below.

2.4.1 Synoptic Precipitation

Synoptic precipitation is derived from upper level air circulation interactions with surface conditions. Synoptic precipitation can be of three types: convergent, orographic, or frontal precipitation. Convergence is an atmospheric condition that exists when there is a net inflow of surface air into a region along the horizontal and air is forced to rise. Large scale convergence can lift a layer of air on the scale of hundreds of kilometers wide (DAS, 1999). Vertical motions of air associated with convergence are fairly weak resulting in nimbostratus clouds – cloud layers of sufficient thickness to permit precipitation processes to mature, resulting in low intensity, long duration precipitation events. Orographic precipitation occurs when air is lifted and cooled below dewpoint over a topographical feature, such as a mountain range or plateau. Frontal precipitation occurs due to uplift along stationary and mobile fronts separating air masses of different temperatures and density (DAS, 1999). For example, as a cold front advances onto warmer air, the lighter warm air is lifted ahead of the cold front, producing vertical movement of air, condensing moisture into clouds with vertical development and producing showers of precipitation. In the case of an advancing warm front, the less dense warm air rises overtop of the colder air ahead of the front. As the warm air rises, it cools and moisture condenses to produce clouds and light showers. Warm fronts tend to move more slowly than cold fronts, therefore clouds and precipitation along a warm front are typically light but more widespread than precipitation along a cold front (DAS, 1999).

Convergent, orographic and frontal synoptic types of precipitation are the principal kinds of precipitation in the extra-tropics, except for precipitation over continents in the summer which is mainly convective precipitation (Houghton et al., 2001).

Synoptic precipitation dominates throughout the fall, winter and spring seasons in North America when the geostrophic winds are strong. Many studies have examined the linkages of atmospheric circulation over North America and related synoptic circulation to precipitation (Rowson et al., 1992; Changnon et al., 1993; Latif and Barnett, 1994; Moore and McKendry, 1996; Cavazos, 1997; Konrad, 1997; Cayan et al., 1998; Byrne et al., 1999; Cavazos and Hewitson, 2002; Lapp et al., 2002). For example, Rowson et al. (1992) found that synoptic conditions played a large part in low pressure storm systems and precipitation in southwestern North America. Changnon et al. (1993) found seven synoptic patterns that dominated precipitation in October-March in the Rocky Mountain States of the United States. Konrad (1997) related 14 synoptic features to heavy rainfall events over the interior southeastern United Sates. Cavazos (1997) examined how large scale circulation influences winter rainfall events in northeastern Mexico. Cayan et al. (1998) investigated how regional and decadal precipitation anomalies relate to atmospheric circulation over western North America and found that the location of strong low pressure areas affects how much seasonal precipitation a region receives and Cavazos and Hewitson (2002) determined that for 15 sample locations all around the globe, synoptic 500 mb circulation was the number one predictor for winter precipitation.

2.4.2 Convective Precipitation

Convection is a process that refers to vertical atmospheric motions. Convective processes are responsible for most of the precipitation in the tropics and middle latitude continents in summer (Houghton et al., 2001). Summer heat from the sun warms surface parcels of air that rise and cool. If a layer of unstable air exists aloft, continued vertical development is likely to generate precipitation producing cumulonimbus, or thunderstorm clouds (DAS, 1999). Strong and Smith (2001) summarize the necessary conditions for thunderstorm activity to be: unstable air aloft of sufficient depth, relatively high humidity near ground level and a lifting process or trigger to start the air in vertical motion.

Early convective studies (Kung, 1967; Kung, 1969; Kung and Tsui, 1975) suggested that synoptic scale flow and downstream convective storms could be linked. This linkage hypothesis was based on the idea that an exchange of energy between all scales in the atmosphere exists because of potential and kinetic energy sources and sinks. The results of Kung's work indicated that the downscale effect of large-scale atmospheric flow transferring kinetic energy to the convective storm environment to be significant, especially in the pre-storm environment (Strong and Smith, 2001). Therefore, synoptic scale atmospheric motion may have an impact in providing energy to convective storms. In addition to energy transfers between atmospheric scales, it has been found that thunderstorms on the Canadian prairies were guided by the arrangement of the upper-level winds (Paul, 1982).

It is important to note that though convective precipitation may occur due to interactions between surface and synoptic climatic variables, it is not necessarily true that convective precipitation occurs only with the existence of synoptic interaction. For example, Knupp et al. (1998) found that a small meso-scale convective system (MCS) in Alabama formed in the complete absence of a discernable synoptic-scale influence.

North American summer precipitation is mainly due to convective processes (Houghton et al., 2001) and many other studies have looked into how summer convection produces precipitation events (Knupp et al., 1998; Higgins et al., 1999; Wallace et al., 1999; Brinkop, 2001; Zeng et al., 2001; Bordoni et al., 2004; Koster, 2004). Wallace et al. (1999) determined that the occurrence of convective activity in the Phoenix, AZ region largely depended on complicated precursor conditions including the diurnal amplitude of dewpoint temperature changes indicative of moisture levels in the boundary layer, though these findings were concluded to be subtle and not much use to the forecaster. The most useful findings were that local information on temperature, winds and moisture profiles are necessary for assessing the potential for thunderstorm activity in the central Arizona region and may be applicable to thunderstorm forecasting in many regions of the interior west of the United States (Wallace et al., 1999). An in-depth analysis on a specific convective storm determined that the main conditions under which the summer convective storm occurred were an unstable environment, weak synoptic forcing, and weak wind shear (Knupp et al., 1998). Knupp et al.'s findings showed that the storm formed under a *synoptically benign* environment, leading to the conclusion that surface heat flux was likely the initiator for convection. Likewise, Zeng et al. (2001) explored the microphysics behind a heavy convective precipitation storm, and found that rapid updrafts caused by surface heating were intensified by latent heat released by freezing precipitation. They also concluded that though the microphysical processes producing convective precipitation storms have been studied continuously since the first radar observations were possible, many questions still remain (Zeng et al., 2001). Convective activity, by nature, is much more difficult to forecast precipitation amounts for, as compared to large scale winter stratiform systems. Strong and Smith (2001) admit that the science of predicting summer thunderstorms is far from perfect, and new methods of forecasting long-term future summer precipitation would be beneficial to climatologists, planners, stakeholders, etc. in all sectors of society and the economy.

2.4.3 North American Monsoon

The North American Monsoon (NAM) is a regional scale atmospheric circulation that develops during the summer months over large areas of the southwestern United States and northwestern Mexico and causes a pronounced increase in rainfall over an otherwise very arid region (Bordoni et al., 2004). The NAM is typified by a seasonal reversal of pressure and wind patterns, from offshore to onshore winds (Ahrens, 2000). The associated circulation systems of the NAM are a major component of warm season precipitation regimes in the United States (Higgins et al., 1999). As much as 50-70 percent of the annual rainfall across the southwestern United States results from thunderstorms generated during the summer monsoon season (Ellis et al., 2004).

This thesis recognizes that the North American Monsoon plays a role in producing summer precipitation in the American Southwest, though the NAM could potentially be a weak point in this study since general atmospheric circulation and precipitation changes were the central focus and no explicit linkage was made to the regional monsoon circulation. However, the precipitation forecast model employed uses historically recorded precipitation that had been influenced by localized monsoonal circulation. Thus any future summer precipitation forecasts for the Southwest region would include historical monsoons and related precipitation.

2.5 Global Circulation Models

Climate models are tools used to simulate past and present climates and to develop future climate scenarios. Designed first for studying climate processes and natural climate variability, climate models are now widely used for investigating the climatic consequences of increased atmospheric concentrations of greenhouse gases and other atmospheric pollutants (McKendry et al., 1995; Houghton et al., 2001). To project the response of the climate to anthropogenic forcing, models of varying complexity represent each component or coupled combination of components of the climate system, such as atmospheric, land surface and oceanic components.

2.5.1 Coupled Global Circulation Models

A coupled general circulation model (CGCM) is an atmospheric circulation model coupled to an ocean circulation model. Both atmosphere and ocean models represent the full three dimensional circulation of both the atmosphere and the ocean including the ocean's role in sequestering and redistributing heat and freshwater over a range of temporal scales (Flato et al., 2000). Previous global circulation models (GCMs) focused mainly on atmospheric circulation with input parameters of specified ocean temperatures or a mixed layer ocean (Boer et al., 1992; McFarlane et al., 1992). A CGCM however, uses information about the state of the atmosphere and the ocean adjacent to or at the sea surface, to compute exchanges of heat, moisture and momentum between the atmosphere and ocean components (Houghton et al., 2001). The atmosphere component can include many vertical levels with inputs such as a moisture variable, clouds and cloud optical properties, a convective scheme (transfer processes, precipitation and latent heat), surface energy and surface hydrology, terrestrial radiative properties, and may also contain a simple 'slab' ocean with or without the effects of sea-ice (McFarlane et al., 1992; Roeckner et al., 1999; Stouffer and Manabe, 1999; Boer at al., 2000a; Flato et al., 2000; Gordon et al., 2000; Kim et al., 2002). The ocean component of a CGCM also includes many vertical layers with realistic bottom topography, as well as ocean mixing parameters, and has a sea-ice model that typically has a finer resolution than its atmosphere counterpart (Johns et al., 1997; Roeckner et al., 1999; Stouffer and Manabe, 1999; Flato et al., 2000; Kim et al., 2002). The atmospheric and oceanic components interact with each other by exchanging heat, freshwater, and momentum fluxes usually once per day (Stouffer and Manabe, 1999; Kim et al., 2002). When atmosphere and ocean components are coupled, the resulting climate will often drift away from a realistic state (Broccoli 2005, *pers. comm.*). CGCMs can include a flux adjustment to account for imbalances between atmosphere-ocean heat fluxes. Some recent CGCMs however, do not include this flux adjustment. As stated in the Coupled Model Intercomparison Project (CMIP) (Covey et al., 2003), the new generation of non-flux-adjusted GCMs and the flux-adjusted GCMs both simulate an overall level of natural internal climate variability that is within the bounds set by observations (Covey et al., 2003). CMIP evaluated eighteen coupled global circulation models that are being used both to detect anthropogenic effects in the climate record of the past century and to project the influence of human production of greenhouse gases and aerosols on future climates. Some of the CGCMs used in CMIP and most commonly found in the literature include: GISS(Russell) from the Goddard Institute for Space Studies (GISS) (Russell et al., 1995; Russell and Rind, 1999), GFDL_R30_c from the Geophysical Fluid Dynamics Laboratory (GFDL) (Delworth et al., 2002, Dixon et al., 2003), ECHAM4+OPYC3 from the Max Planck Institute for Meteorology (Roeckner et al., 1996), HadCM2 and HadCM3 from the Hadley Centre for Climate Prediction and Research (Hadley Centre) (Johns et al., 1997; Felzer and Heard, 1999; Gordon et al., 2000) and CGCM1 and CGCM2 from the Canadian Centre for Climate Modelling and Analysis (CCCma) (Doherty and Mearns, 1999; Boer et al., 2000a; Boer et al., 2000b; Flato et al., 2000; Kim et al., 2002; Kim at al., 2003). The CMIP results suggest that coupled GCM control runs are nearly as accurate as observational uncertainty allows them to be (Covey et al., 2003).

Discussion here forward using the acronym GCM is referring to coupled global circulation models unless otherwise explicitly stated.

2.5.2 CGCM Forcing Scenarios

Coupled Global Circulation Models use control runs to equilibrate to historical conditions and greenhouse gas (GHG) and/or aerosol forcing scenarios for future climate projections. GCM runs can include different rates of GHG and aerosol (GHG+A) loadings into the atmosphere, basing the loading rates on emissions that are the product of complex dynamic systems determined by driving forces such as demographic development, socio-economic development, and technological change (Nakicenovic and Swart, 2000). Demographic development is the growth in the number of individuals of a population, and in this case, world population. Socio-economic development refers to development involving both social and economic factors. Lastly, GCM GHG+A loading rates can depend on technological advancements or changes in the set of feasible production possibilities related to technology. Previous GCM runs were based on the Intergovernmental Panel on Climate Change (IPCC) IS92 forcing scenarios, which used the title 1xCO2 as baseline atmospheric Carbon Dioxide (CO_2) concentrations and the title of 2xCO2 for the rate of change in CO_2 concentrations if a doubling of atmospheric CO_2 occurred by approximately the year 2050 (CCCma) . Since the IS92 scenarios, the IPCC updated the previous GHG+A loadings to produce more realistic future emission scenarios. The IPCC's Special Report on Emissions Scenarios (SRES) GHG+A loadings increase at differing rates depending on human driving forces summarized in Houghton et al. (2001). Four SRES "storylines" (A1, A2, B1, B2) were developed to describe the relationships between emission driving forces and their evolution into the future. Each storyline represents different demographic, social, economic, technological, and environmental developments and are explained in the Summary for Policy Makers Special Report on Emission Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change (Nakicenovic and Swart, 2000). The A1 storyline and scenario family describes a future world of very rapid economic growth, low population growth rate, and the rapid introduction of new and more fuel and emission efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A2 storyline describes a very heterogeneous world with the underlying theme of self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in rapid population growth. Economic development is primarily regionally oriented and per capita economic growth and technological changes are more fragmented and slower than in other storylines. The B1 storyline describes a convergent world with the same slow population growth as the A1 storyline, but has rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives. The B2 storyline describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. B2 involves a world with moderate population growth, intermediate levels of economic development, and less rapid but more diverse technological change than the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels (Nakicenovic and Swart, 2000).

The A1, B1, A2, and B2 SRES storylines are used in GCM modeled future climates. The outputs of GCMs are modeled datasets that can usually be downloaded with permission from the GCM's modeling centre or by contacting the scientists directly. Commonly used GCM output includes: temperature, wind speed, solar flux, soil moisture, specific humidity, geopotential heights, and precipitation.

Global Circulation Models are powerful tools in the science of climate change. GCMs allow for possible future outcomes of climate change to be explored on many levels, with options to focus on one or many possible impacts. According to the IPCC, GCMs are the "...only credible tools currently available for simulating the physical processes that determine global climate" (Houghton et al., 2001).

2.5.3 Global Circulation Model and GCM Output Used in This Study

The Canadian Centre for Climate Modelling and Analysis' (CCCma) second generation coupled global circulation model (CGCM2) was selected as the GCM for use in this thesis. The CCCma's website (www.cccma.bc.ec.gc.ca) has CGCM2 output readily available for downloading. The CGCM2 is an updated version of CGCM1, an atmospheric circulation model coupled with an ocean circulation model. The CGCM2 is comprised of atmosphere, ocean, sea ice, and land surface components (Kim et al., 2002). CGCM2 differs from the CCCma's CGCM1 only in its representation of ocean mixing and sea ice dynamics (Flato and Boer, 2001). However, the greenhouse gas and aerosol forcing scenarios differ between the first and second generation models. The CGCM1's future output data was based on the Intergovernmental Panel on Climate Change (IPCC) "IS92a" forcing scenario, where greenhouse gases and aerosols (GHG+A), were to increase at an equal rate of 1% per year for the period of 1990-2100 starting at 1990 levels (Houghton et al., 1996). The updated CGCM2's output is produced using more realistic future emission scenarios from the IPCC Special Report on Emissions Scenarios (SRES) greenhouse gases and aerosols forcing scenarios (Houghton et al., 2001). The data used for this study is a "business as usual" GHG+A emissions scenario (IPCC SRES "A2"), where population growth and economic development are assumed to increase at a similar rate as they are at present but there will be slightly lower GHG emissions than the IS92a scenario, and slightly lower aerosol loadings (CCCma). Although the IS92a GHG+A and the IPCC SRES A2 forcing scenarios differ in their rates of GHG and aerosol loadings, the forcing scenarios for CGCM1 and CGCM2 would likely not be significantly different (Flato, 2004, *pers. comm.*). In this thesis, the CGCM2 500 mb geopotential heights were not validated against observed geopotential heights as validation was completed in previous studies for the 500 mb geopotential heights from the CGCM1 (Lapp et al., 2002; Byrne et al., 1999).

2.6 Downscaling

2.6.1 Downscaling Rationale

Climate change studies often use Global Circulation Model (GCM) output to represent climatic variables under forecast climate change scenarios (Zorita and von Storch, 1999). The inherent problem associated with GCM output, however, lies in the spatial resolution of the GCM. GCM generated output has a very large spatial resolution with grid sizes of 50,000 to 100,000 or more km^2, which is much larger than most climate change impact study areas existing on regional scales (Hay et al., 2000; Wilby and Wigley, 2000). In addition to the GCM grid being too coarse to deal with important sub-grid scale processes, especially with regards to the hydrologic cycle, GCM output has been found to be unreliable at individual grid and sub-grid scales (Von Storch et al., 1993; Baldwin et al., 1999, Byrne et al., 1999; Felzer and Heard, 1999; Wilby et al., 1999). To overcome this problem, downscaling techniques, the ‘scaling down’ from large-scale to small scale, have emerged as a method of relating large-scale atmospheric climatic variables to small-scale surface processes. Though GCMs have been found to poorly represent sub-grid scale processes, such as precipitation and processes involving clouds (Wilby and Wigley, 2000; Allen and Ingram, 2002), GCMs represent atmospheric circulation quite well. Downscaling methods therefore assume that suitable relationships between large-scale circulation and sub-grid scale variables exist and that these relationships will continue to be valid in the future. Circulation is well represented by GCMs, hence climatologists assume that climate change scenarios produced by downscaling methodologies from GCM circulation will be more reliable and of a finer resolution than raw GCM output of the same variable (Wilby and Wigley, 2000). Precipitation characteristics, for example, are better reproduced by downscaled results than by direct GCM output (Trigo and Palutikof, 2001).

2.6.2 Hydrological Downscaling Applications

Downscaling has been effectively used in both streamflow and snowpack modelling, where upper-level atmospheric circulation is related to surface runoff and hydrologic processes. Bergstrom et al. (2001) assessed climate change impacts on runoff in Sweden using GCM air temperatures and precipitation downscaling and hydrologic models. McCabe (1996) used observed 700 mb pressure-height anomalies to identify relationships between winter atmospheric circulation and variability in annual streamflow in the western United States. Miller et al. (1999) also explored streamflow in the southwestern U.S. using a meso-scale atmospheric simulation model, including numerous surface-scale models to downscale GCM data to streamflow. A simplified approach to GCM downscaling was also used to simulate precipitation. Another study, by Hay et al. (2000), estimated streamflow for three mountainous river basins in the western U.S. using GCM downscaled output used as input into a precipitation-runoff model.

With regards to winter atmospheric downscaling in the western United Sates, Cayan (1996) investigated high and low snow water equivalents associated with atmospheric circulation patterns and found that anomalously low snow water equivalents were associated with a particular winter circulation pattern. Changnon et al. (1993) also related snowpack in the Rocky Mountain States of the United States to specific 500 mb synoptic patterns, and found that seven synoptic patterns dominated winter precipitation from 1960-1985. Based on Changnon et al. (1993), two other studies (Byrne at al., 1999; Lapp et al., 2002) also linked synoptic circulation patterns to snow runoff and winter precipitation and used the linkages to forecast future runoff and precipitation under climate change scenarios in Rocky Mountain regions of Canada and the United States. Specifically in Canada, Moore and McKendry (1996) explored 500 mb upper-level atmospheric circulation patterns and snowpack in British Columbia and found that shifts in snowpack anomaly patterns coincided with shifts in atmospheric circulation and changes in frequencies of synoptic circulation types.

2.6.3 Precipitation Downscaling

Specific relationships between precipitation and synoptic-scale atmospheric circulation have also been determined through the use of downscaling methods. Wet and dry winter precipitation conditions in the Eastern Mediterranean were found to be associated with distinct 500 mb upper-level airflow patterns (Krichak et al., 2000). In northeastern Mexico and southeastern Texas, downscaling techniques were found to be successful at reproducing large precipitation events and adequately identified rainfall events according to large-scale controls that could be used in climate change assessments (Cavazos, 1997). Cavazos and Hewitson (2002) also found geopotential heights at mid-tropospheric levels to be one of the most relevant controls of daily precipitation for 15 locations around the globe. The study also found that 500 mb geopotential heights are the number one predictor of daily winter precipitation and could therefore be used in downscaling methodologies from large-scale synoptic circulations to smaller-scale winter precipitation events.

2.6.4 Map Patterns and Downscaling

The use of map patterns have been used as one method of relating synoptic circulation patterns to precipitation for downscaling purposes. Map patterns of geopotential heights, for example maps of the 500 mb pressure-surface, have played a fundamental part in understanding how atmospheric circulation can affect surface climatic variables (California Institute of Technology (CIT), 1943; Elliot 1951; Lamb, 1972; Changnon et al., 1993; Hughes et al., 1993; Yarnal and Frakes, 1997; Cayan et al., 1998). These map patterns are used directly in synoptic downscaling by weighting the surface weather variables, such as precipitation, with relative frequencies of the synoptic map pattern. Climate change impacts may then be determined by the change in frequencies of the synoptic map patterns from past observed conditions to modeled future climate conditions.

2.6.5 Downscaling Procedures

Synoptic typing or synoptic classification procedures used in downscaling applications can be either objective or subjective. Objective classification (also referred to as automated classification) of map patterns involves a statistical determination of dominant map patterns through the use of computer-based statistical models fitted to present observations (Zorita and von Storch, 1999). Objective methods include, for example, correlation-based methods (Lund, 1963; Kirchhofer, 1973; Kaufmann et al., 1999), artificial neural networks (Cavazos, 1997; Trigo and Palitikof, 2001), cluster analysis (McCabe and Wolock, 1999), and many other statistical downscaling models (Miller et al., 1999; Hay et al., 2000). Statistical classification is a quick way to downscale, in the sense that time spent on the initial classification can then be duplicated or adjusted within minutes to a few hours (Frakes and Yarnal, 1997).

Subjective classification involves manually classifying map patterns by visually placing similar map patterns in synoptic pattern groups (Carleton, 1987). Manual classifications are conceptually straightforward and are useful to non-climatologists (Yarnal and Frakes, 1997). Through direct contact with the map patterns, the classifier develops an understanding of the climatological patterns that would not be possible with the use of statistical downscaling methods (Frakes and Yarnal, 1997).

Objective or computer-assisted classification is common in the literature (Key and Crane, 1986; Blair, 1998; Huth, 1996; Mearns et al., 1999; Wilby and Wigley, 2000, Huth and Kysely, 2000; Busuioc, et al., 2001), though objective or statistical downscaling has its limitations. Objective classification methods produce patterns that are sensitive to the imposed boundaries, the input grid point density, and the statistical method used, as well as the subjectivity in determining the map pattern types (Key and Crane, 1986). Unlike manual classification methods, map patterns generated by statistical classifications have not been controlled by the investigator (Frakes and Yarnal, 1997) and could potentially be patterns that do not represent actual or meaningful synoptic conditions. For example, classifying synoptic patterns statistically may 'force' a pattern into a category into which it may be more statistically close to but may not actually be synoptically meaningful. Manual classification methods, on the other hand, are extremely labour intensive and difficult to replicate (Yarnal and Frakes, 1997), but have the advantage of incorporating a level of synoptic experience into the classification scheme (Carleton, 1987) and may allow for patterns that do not 'fit' into one or another category to be placed into an 'unclassified' group.

2.6.6 Downscaling Method Used in This Study

For use in this thesis, a manual classification method was adopted to provide the opportunity to become familiar with the synoptic data and to ensure appropriate, meaningful meteorological synoptic patterns were utilized (i.e. synoptic patterns associated with precipitation or else unclassified patterns). Synoptic map patterns found to control the spatial distribution and amount of winter precipitation in the Rocky Mountain States of the United States by Changnon et al. (1993) were adopted as the synoptic map patterns for use in this thesis (Figure 1.1, Chapter 1). Changnon et al.'s (1993) patterns and methodology for downscaling winter synoptic circulation patterns were used by Byrne et al. (1999) and by Lapp et al. (2002) to relate synoptic patterns to spring runoff and precipitation in the Canadian Rockies and the Canadian prairies respectively. Changnon et al.'s synoptic patterns have been used with success in the western U.S. and Canada, therefore this classification is adopted in this thesis.

The 500 mb synoptic upper level airflow from the Canadian Centre for Climate Change and Analysis' (CCCma) second generation coupled circulation model (CGCM2) and the NCEP/NCAR reanalysis 500 mb pressure heights were classified according to Changnon et al.'s dominant synoptic patterns and downscaled from a Northern

Hemisphere window to a North American window, then statistically linked to daily precipitation by means of correlations and step-wise linear regression.

Chapter 3

Forecasting Precipitation for Western North America for the Fall, Winter and Spring Seasons

3.1 Introduction

Global Circulation Models (GCMs) are used to project future anthropogenic climate change and can be used as a tool to explore future climate characteristics (Houghton et al., 1996; Houghton et al., 2001). GCM modeled future temperatures are considered to be quite dependable. However, it has been found that GCM forecasted precipitation is unreliable (Von Storch et al., 1993; Byrne et al., 1999; Felzer and Heard, 1999; Wilby et al., 1999; Wilby and Wigley, 2000). Future precipitation will likely be affected by global climate change; therefore a different method of quantifying changes in precipitation, other than direct GCM precipitation output, is needed to develop future climate change impact scenarios. One method used to determine future precipitation is to link atmospheric upper level airflow (synoptic) patterns to precipitation events (Changnon et al., 1993; Houghton et al., 2001; Lapp et al., 2002). The frequency and duration of atmospheric circulation patterns influences the spatial and temporal distribution of precipitation (Yarnal and Diaz,1986; Trenberth, 1990; Latif and Barnett, 1994; Byrne et al., 1999; Cavazos and Hewitson, 2002; Lapp et al., 2002).

Many studies have used synoptic variability and statistical analyses over broad geographic areas to forecast future precipitation for North America (CIT, 1943), The British Isles (Lamb, 1972), western North America (Changnon et al., 1993), British Columbia, Washington State and the adjacent eastern pacific (Moore and McKendry, 1996), New Zealand and surrounding Pacific waters (Kidson and Thompson, 1998), Europe (Krichak et al., 2000), Iberian Peninsula (Trigo and Palutokof, 2001), and a series of regional analyses were carried out by Cavazos and Hewitson (2002).

Downscaling techniques have emerged as a means of relating large-scale GCM output to small-scale surface variables, such as precipitation (Wilby and Wigley, 2000). The downscaling method applied in this study was manual classification. The benefits of this approach were discussed in Frakes and Yarnal (1997); Byrne et al., (1999); and Lapp et al., (2002), and are reviewed in section 2.6 of this thesis.

Seven dominant synoptic patterns for western North America for the winter (October-March) seasons of 1950-1985 were defined by Changnon et al. (1993). Changnon et al. reported that these patterns controlled the spatial distribution and amount of winter (October-March) precipitation in the Rocky Mountain States of the USA. Byrne et al. (1999) and Lapp et al. (2002) discovered that these synoptic patterns also control precipitation and spring runoff in the southern Canadian Rockies and the Canadian prairies. In this analysis, the geographic window was extended to include western North America from Alaska to southern Arizona and California (Figure 3.1).

CGCM2 500 mb output is used to represent future synoptic conditions under global climate change scenarios. Byrne et al. (1999) used the Canadian Climate Centre (CCC) Global Circulation Model output (McFarlane, 1992). Lapp et al. (2002) used the Canadian Centre for Climate Modelling and Analysis' (CCCma) first generation coupled global circulation model (CGCM1) for historical and future synoptic conditions, with excellent results. In this study, the CCCma's second generation coupled global circulation model (CGCM2) 500 mb geopotential height output for the A2 greenhouse gas and aerosol forcing scenario was used.

3.2 Objectives

The objectives of this chapter are to:

1. Develop estimates of spatial and seasonal properties of precipitation characteristics over western North America under forecast climate warming for the fall (September, October, November – SON), winter (December, January, February – DJF) and spring (March-April-May –MAM);
2. Compare historical and future precipitation properties to determine regional precipitation disparities expected by 2020-50.

To meet these objectives, a series of data sets were assembled and integrated by a research team that included McKechnie, Nicole Rabe and Anita Shepherd as follows:

i. Daily synoptic classification of the historical NCEP/NCAR upper air data and for the CGCM2 upper level circulation patterns (Rabe, McKechnie, Shepherd);

ii. Grouping of the daily historical and future synoptic classification data by month (Rabe and McKechnie);

iii. Developing statistical linkages between historical synoptic classification data and precipitation data (Rabe and McKechnie);

iv. Forecasting future monthly and seasonal precipitation for the period 2020-50 using the relationships in iii above (McKechnie and Rabe);

v. A comparison of historic and future precipitation characteristics for 372 stations in western North America (McKechnie);

vi. Spatial and seasonal analyses of the forecast changes in precipitation for Fall, Winter and Spring (McKechnie).

3.3 Study Area

The analysis was undertaken for weather stations located in Alberta, British Columbia, the Northwest Territories, Saskatchewan, and the Yukon Territory, in Canada; and Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming in the United States (Figure 3.1).

3.4 Datasets

3.4.1 Historical Time Period

The historical time period is defined as 1960-1990 for the purposes of this study. However, an explanation of how months were grouped into seasons is necessary to clarify how the historical 30 year period was assembled. For example, December of 1960 is part of the 1961 winter (DJF) season. As well, since the fall (SON) season leads into the winter season, SON of 1960 is grouped into 1961. Consequently, the period ends in August 1990. The end result is that the actual 30 year historical period is from 1961-1990, but will be referred to as 1960-1990 herein. The historical upper air data was acquired from the National Center for Environmental Prediction / National Centre for Atmospheric Research (NCEP/NCAR) reanalysis project (Kalnay et al., 1996). The data used for this research was the 6 hourly 500 mb geopotential heights. The atmospheric window was based on a grid size of 2.5° by 2.5° degrees, and the spatial extent of the window included all of North America (boundaries 15-80°N and 60-160°W).

Observed daily precipitation data was acquired for the historical period from the National Climatic Data Centre (NCDC) (EarthInfo Inc. 2003) for stations shown in Figure 3.2. Climate stations were selected for western North American if they had a complete daily coverage for 1960-1990.

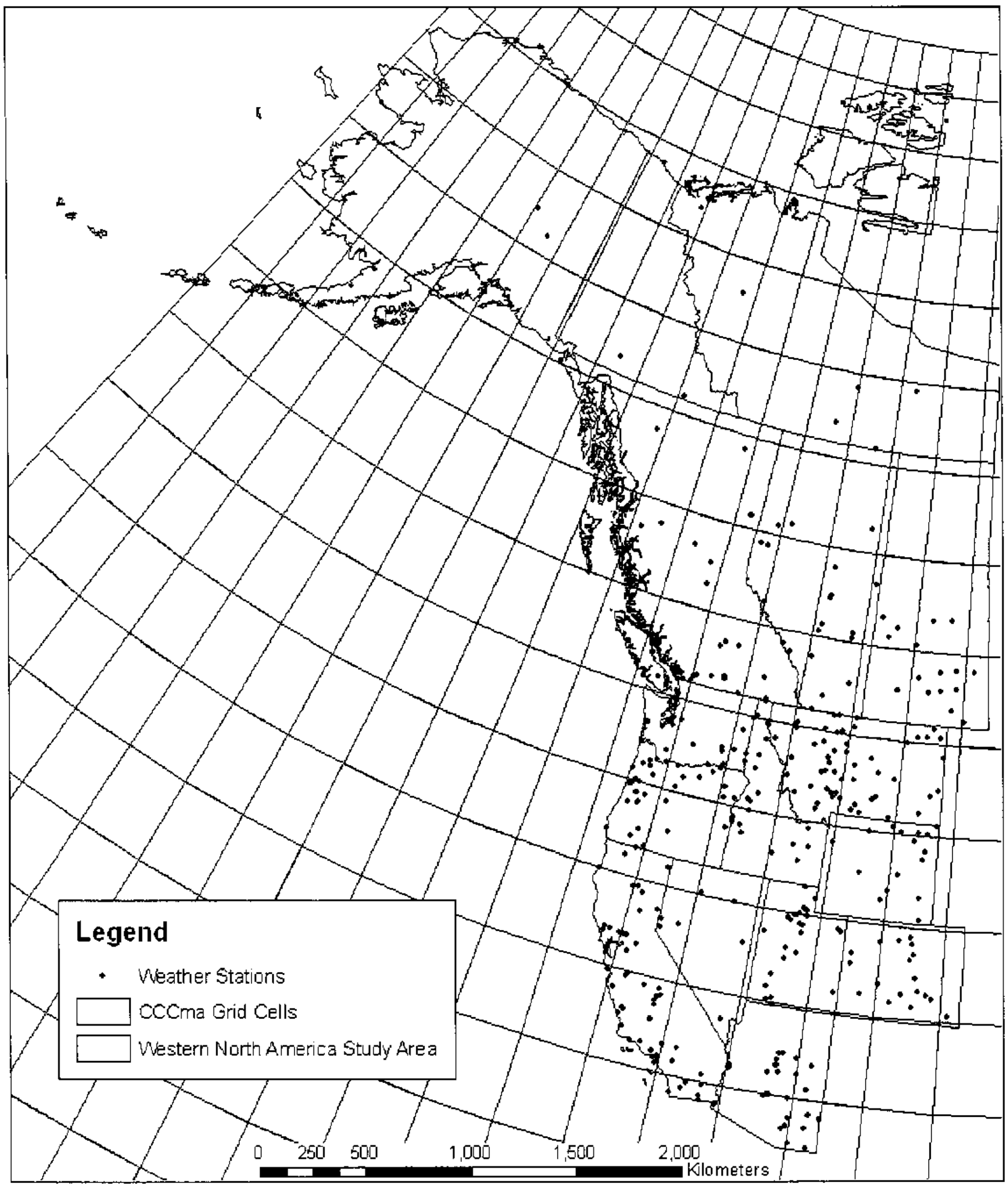


Figure 3.1 Weather stations used in the precipitation analysis with the shaded areas representing the western North American study region and the unshaded grid cells representing the Canadian Centre for Climate Modelling and Analysis (CCCma) 3.75° x 3.75° grid cells used in the CGCM2 downscaling process.

3.4.2 Future Time Period

The future time period is defined as 2020-2050. However, as stated above in the historical data section, the actual 30 year future period is from 2021-2050 but will be referred to as 2020-2050 for the purposes of this study. The Canadian Centre for Climate Modelling and Analysis (CCCma) second generation coupled global circulation model (CGCM2) "A2" daily 500 mb geopotential heights were selected to represent the synoptics conditions for the future period. CGCM2 is an updated version of CGCM1, an atmospheric circulation model coupled with an ocean circulation model (Kim et al., 2002). The CGCM1's future data was based on the Intergovernmental Panel on Climate Change (IPCC) "IS92a" forcing scenario, where greenhouse gases and aerosols (GHG+A) were to increase at an equal rate of 1% per year for the period of 1990-2100 starting at 1990 levels (Houghton et al., 1996). The CGCM2 data is based on the more realistic IPCC Special Report on Emissions Scenarios (SRES) greenhouse gases and aerosols forcing scenarios (Houghton et al., 2001). The data used in this paper is the "business as usual" GHG+A emissions scenario (IPCC SRES "A2") where population growth and economic development are assumed to increase at a similar rate as they are at present but there will be slightly lower GHG emissions than the IS92a scenario, and slightly lower aerosol loadings (CCCma, 2004).

The CGCM2 "A2" daily 500 mb geopotential heights were downloaded for the years 2020-2050. The area of interest was a North American window of 18 rows by 31 columns of grid cells (grid cell size approximately 3.75° by 3.75°, boundaries 16.70–79.78° N and 52.5–165.0° W).

3.5 Methodology

3.5.1 Methods for Historical Period

Grid Analysis and Display System (GrADS) software was used to display the daily 500 mb geopotential height surfaces for the years 1960-1990. The daily elevation fields were displayed at the 100 m and 30 m contour intervals to be downscaled into synoptic patterns using established methodologies (Byrne et al,. 1999; Lapp et al., 2002). Each daily elevation field was visually inspected for the location of the principal westerly jet, defined as the zone of highest wind velocity. The core of the westerly jet is characterized by the greatest density of contours representing the steep elevation gradient occurring between the Continental Polar and the Continental Tropical Airmasses. The daily patterns displayed over North America in GrADS were compared to each of the seven synoptic patterns defined by Changnon et al. (1993). Daily patterns which did not resemble any of the seven patterns were labeled 'unclassified'. The average frequencies of synoptic patterns per month are presented in Appendix A, Table A1. Unclassified days were infrequent in the late fall and winter months (October, November, December, January, February, March) occurring on average 1.12 times per season. However, unclassified days occurred with increasing frequency in April, May, June and September (occurring on average 10.69 times per year). The effect of unclassified patterns on synoptically controlled climate variables, such as precipitation, is considered to be negligible during the winter season (Lapp et al., 2002). This is not unexpected given unclassified days are rare during the period October through March. Unclassified days were not significant in producing precipitation for the winter months, though to address the issue of unclassified patterns occurring with greater frequency in the spring (April and May) and in early fall (September), days with unclassified synoptic patterns were included in the regression model (described below).

In total, 372 weather stations in western Canada and the western United States were identified as having complete precipitation records for the historical period 1960-1990 (Figure 3.1).

3.5.2 Methods for Future Period

Arc Macro Language (AML) program routines developed by Lapp et al. (2002) were refined to import the daily CGCM2 500 mb geopotential heights for the years 2020-2050 into ESRI's Geographic Information Sstem (GIS) program, ArcInfo for visual classification. The daily geopotential heights were analyzed at 30m elevation contour intervals and classified according to the seven synoptic patterns defined by Changnon et al. (1993), as described above. Synoptic pattern frequencies resulting from the classification formed the basis for the precipitation forecast model.

3.5.3 Precipitation Forecast Model

Stepwise linear regression was utilized to link monthly precipitation accumulations at each of the 372 stations and synoptic pattern frequency statistics on a month by month basis for Fall (SON), Winter (DJF) and Spring (MAM). No intercept stepwise multiple linear regression was used, based on the assumption that precipitation is related to one of, or a combination of the seven synoptic patterns, as well as unclassified days. To determine which synoptic pattern or which combination of synoptic patterns produce precipitation at each of the 372 weather stations, the pattern frequencies were set as the independent variables, in other words, the predictors for monthly precipitation. A forecast model for future precipitation was developed from the results of the regression using the formula:

$$\mathbf{P_t = C_{dr}F_{dr}+C_{sws}F_{sws}+C_{swc}F_{swc}+C_{swt}F_{swt}+C_{nwm}F_{nwm}+C_{nww}F_{nww}+C_{nwz}F_{nwz}+C_{unc}F_{unc}} \qquad (3.1)$$

Where $\mathbf{P_t}$ is the forecasted precipitation for time step t (monthly or seasonal)
$\mathbf{C_x}$ are the regression coefficients linking each pattern to P_t
$\mathbf{F_x}$ are the synoptic pattern frequencies

The stepwise regression model applied to each station per month was selected using one or a combination of synoptic patterns based on the highest R^2. The R^2 value is a measure of the proportion of the dependent variable (precipitation) that can be attributed to the combined effects of the independent variables (synoptic patterns). Figures illustrated the spatial distribution of the R^2 values for the study area are included here and tables of R^2 values per station and by season are presented in Appendix A, Table A3, A4, A5, and A6.

3.5.4 Statistical Analysis

A series of analyses were carried out to determine how seasonal precipitation characteristics may have changed. The ratio of future/historical total seasonal (DJF, MAM, SON) precipitation for each station was calculated and an interpolated surface was created in a GIS using the Ordinary Kriging method in ESRI's ArcMap. Kriging was selected as the interpolation method because it interpolates based on general spatial characteristics of the data itself. Kriging also produced few artifacts and had the capability to create predictive standard error maps for the precipitation surfaces. R^2 values were also interpolated via Kriging in a GIS and mapped to provide a spatial representation of the statistical relationships between precipitation and synoptic pattern frequencies.

For each of the 372 weather stations, differences in the distributional structure of seasonal precipitation were examined by carrying out separate Kolmogorov-Smirnov (KS) tests. The KS test is a non-parametric goodness of fit test that can be used to determine if two distributions (not means) are statistically different from one another (i.e. if two samples are from the same or different populations). Climate stations where the KS test identified statistically significant ($p<0.05$) distribution differences in precipitation profiles are indicated by a green star on all maps as appropriate. The reader should note that in regions where green stars do not match with increases or decreases in precipitation, the apparent discrepancy is a function of the KS test being a measure of precipitation distributional characteristics and was performed separately from the interpolation (Kriging) used to create the precipitation ratio maps.

Predictive error maps of the interpolated ratio surfaces were created on a seasonal basis. The predictive error was less than 0.25 (ratio) for all interpolated precipitation ratio layers, and is less than 0.15 for the annual map (predictive standard error maps are presented in Appendix A, Figures A.1a, A.1b, A.1c, A.1d, A.1e). Changes in variance between historical and future precipitation were also determined for the historical and future 30 year periods for all stations, and the ratios of precipitation variance were mapped.

3.6 Results

R^2 maps of one representative month per season (October for Fall, January for Winter and April for Spring) are presented in Figures 3.2a, 3.2b, 3.2c. The remaining Fall, Winter and Spring monthly R^2 maps are presented in the Appendix (Figures A.2a, A.2b, A.2c, A.2d, A.2e, A.2f, A.2g, A.2h). The precipitation forecast model represents the central provinces and states well with R^2 values ranging from 0.6 - 0.9 in October, and 0.7 - 0.9 in January and April. The American Southwest however, shows lower R^2, likely because of very low precipitation and high relative error.

The analysis of precipitation uses a future to historical precipitation ratio to estimate comparative impacts of climate change on precipitation over the study region. Maps of the precipitation ratios for all stations are presented in Figures 3.3a, 3.3b, 3.3c, 3.4a, 3.4b, 3.4c, subject to several constraints. The results in northern regions are less dependable given there are few climate stations in a large geographic area. Further, in smaller geographic regions where substantial change is observed, there may be less validity to the regional prediction given the localized nature of the change.

The analysis predicts fall (SON) precipitation for 2020-2050 will decline in the southwestern States of the US and in the coastal regions of Alaska and in coastal and northern British Columbia (Figure 3.3a). Regions that will have a decrease of up to 50% in precipitation in the fall occur in Arizona, including the Sonoran Desert, and southern regions of Colorado, Utah, Nevada and California. Localized regions of up to 50% drying will also occur in southeastern Montana and northeastern Wyoming, as well as southeastern Oregon, northeastern California and northwestern Nevada. Areas of increased precipitation of up to 50% for the fall occur in central Saskatchewan and east central Alberta.

The winter (DJF) season for 2020-2050 will have a general drying in southern British Columbia, all of Washington, Oregon, California, Idaho, most of Nevada, northwestern Utah, central Wyoming and eastern Colorado, as well as central Alaska (Figure 3.3b). Washington and the coastal and Cascade regions of Oregon, and northwestern California will experience significant decreases in precipitation of up to 50% in the winter season. Precipitation may increase up to 30% in the western Northwest Territories, northeastern British Columbia, and northeastern Alberta.

The spring (MAM) season for 2020-2050 will have a general drying in British Columbia, southern Alberta, interior Washington, Oregon, California, northern Idaho, western Montana, southern Nevada, most of Utah, Wyoming, Colorado, and Arizona (Figure 3.3c). The Kootenay region of British Columbia, and east central and south eastern Wyoming, Colorado, and the Sonoran Desert in Arizona and southern California will experience a significant decrease in precipitation of up to 50% in the winter season. No regions of Western North America will experience an increase in precipitation in the future in the spring.

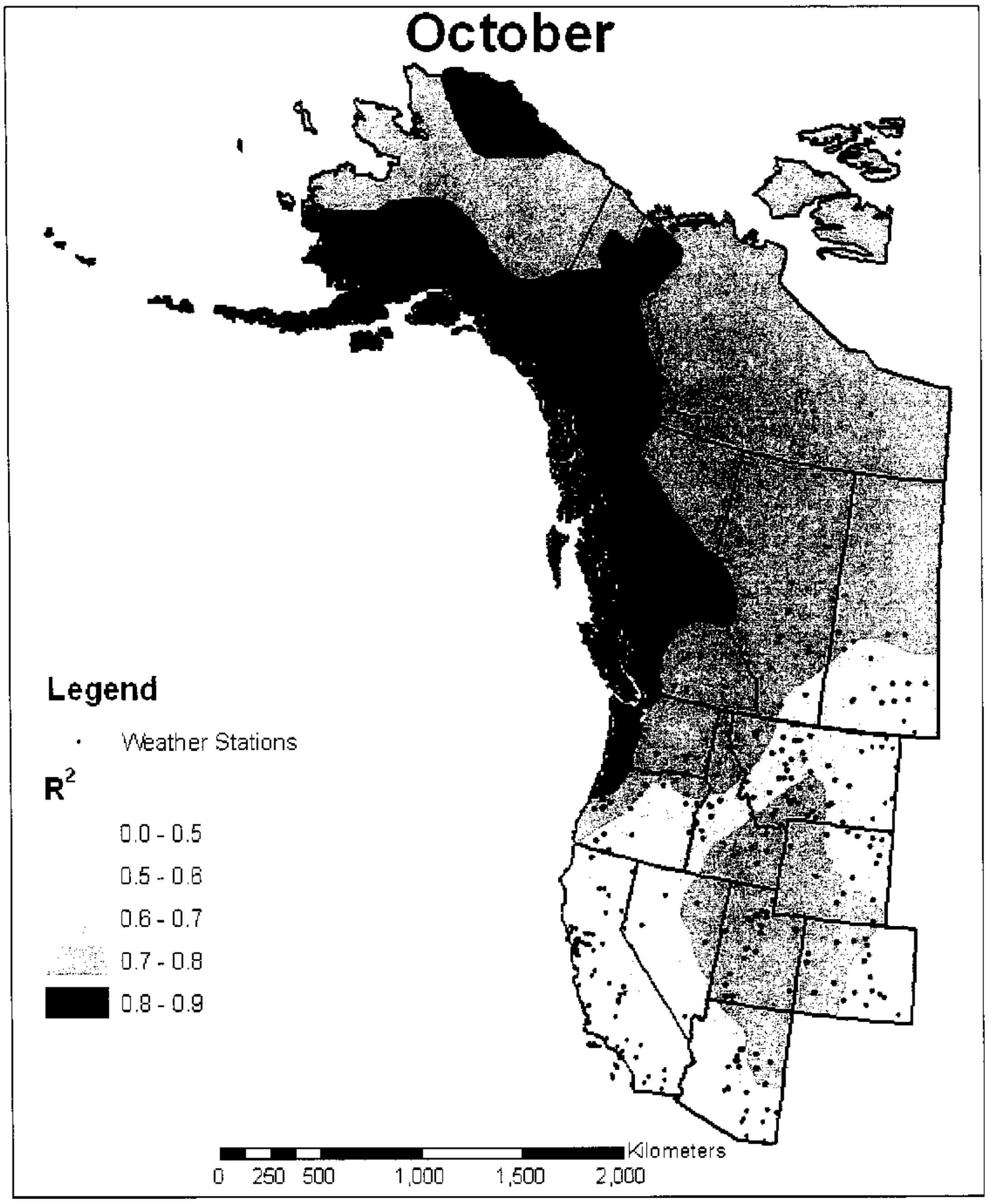


Figure 3.2a Fall (October) spatial representation of R^2 values.

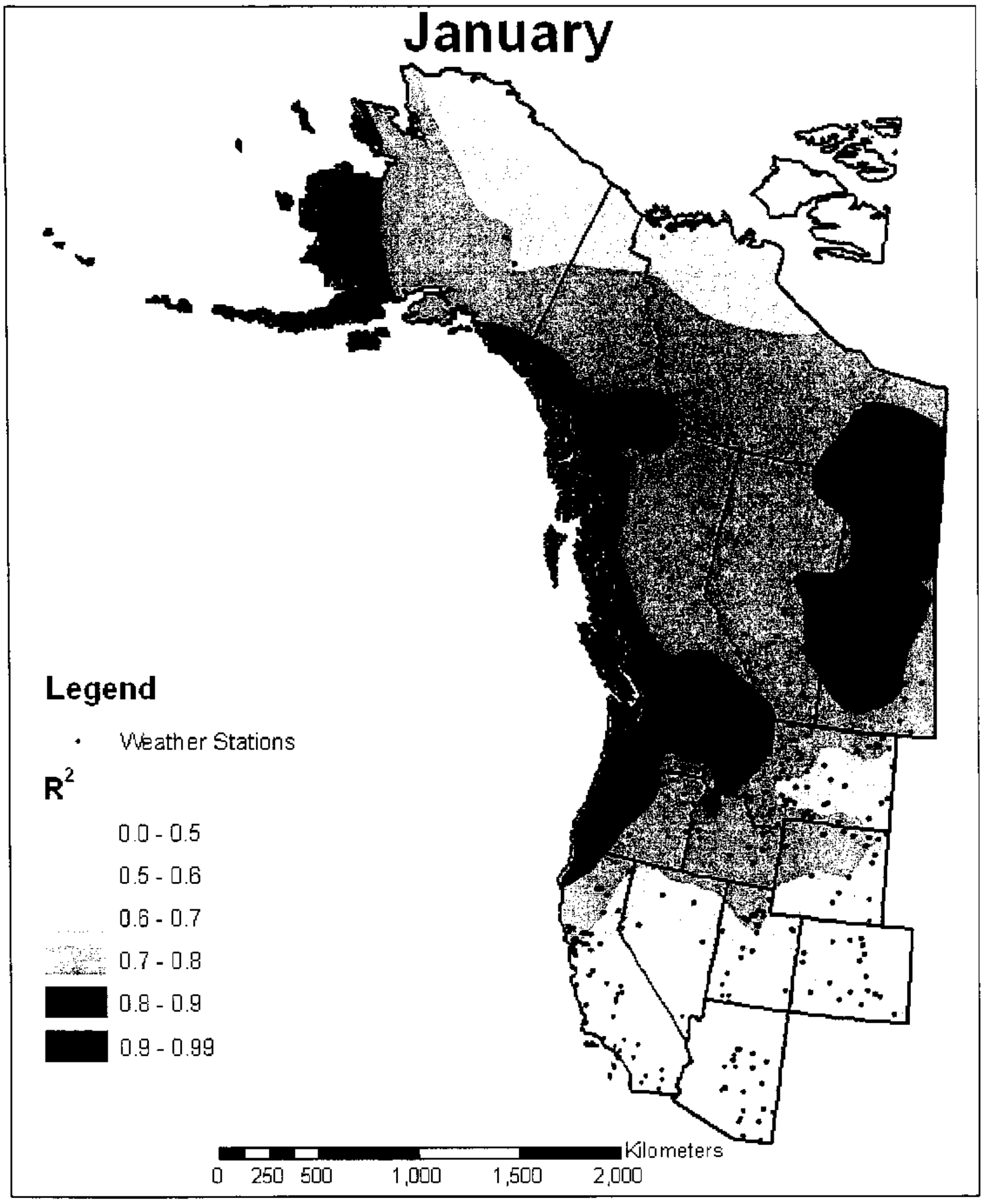


Figure 3.2b Winter (January) spatial representation of R^2 values.

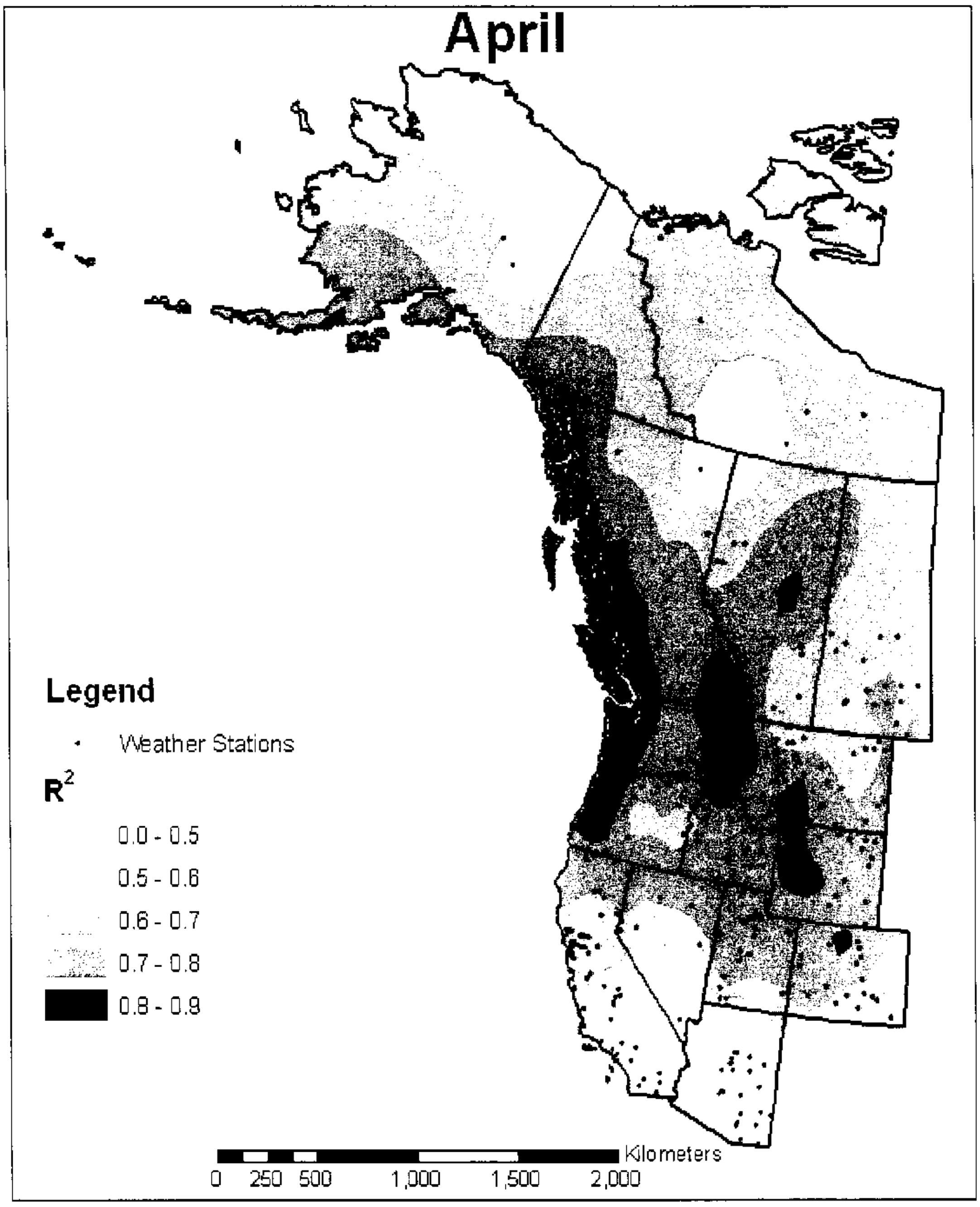


Figure 3.2c Spring (April) spatial representation of R^2 values.

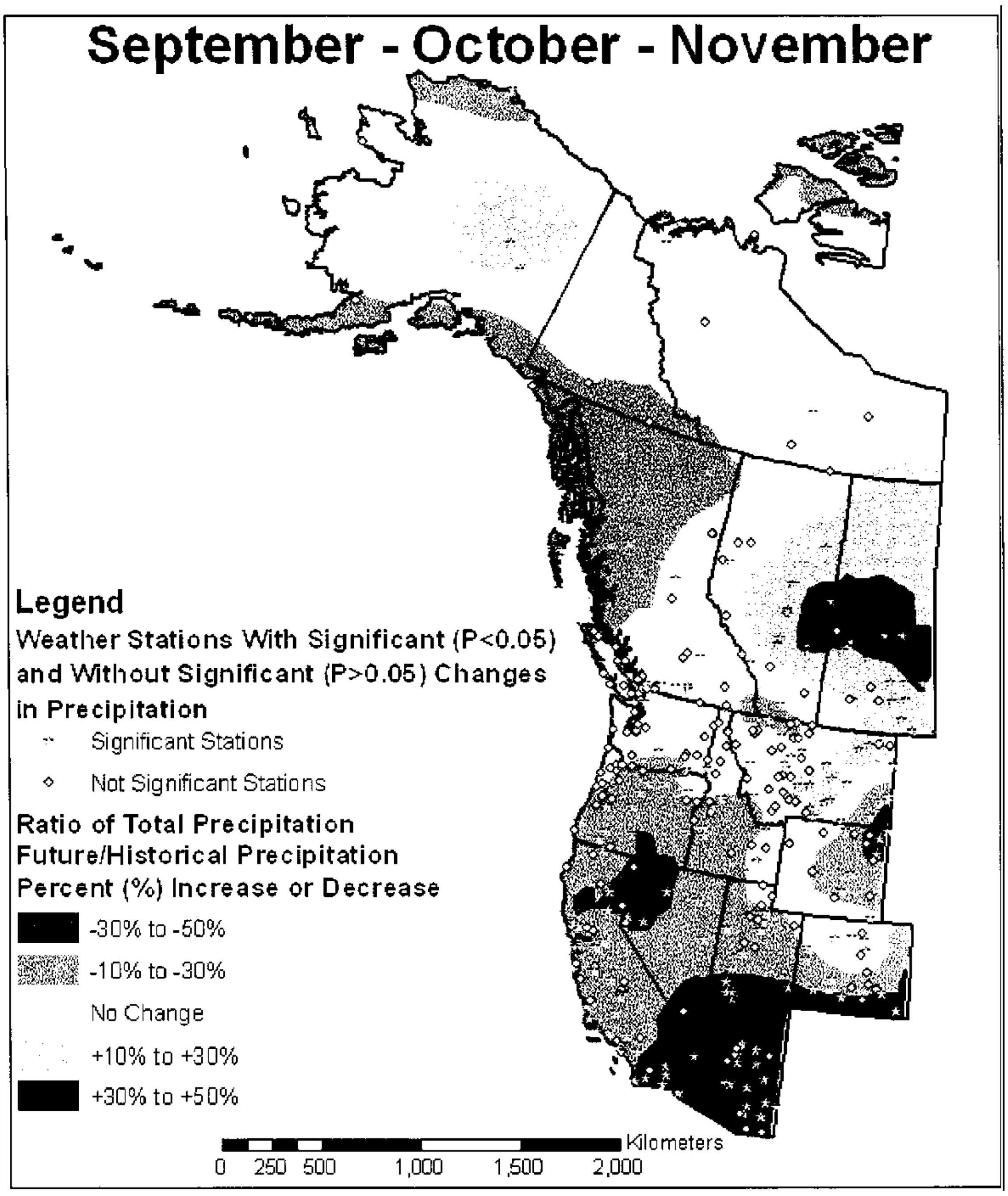


Figure 3.3a Fall (September, October, November) spatial distribution of increasing and decreasing precipitation under forecast climate change in western North America. Green stars represent weather stations showing a statistically significant (based on a KS test) change in precipitation distribution between historical and future periods.

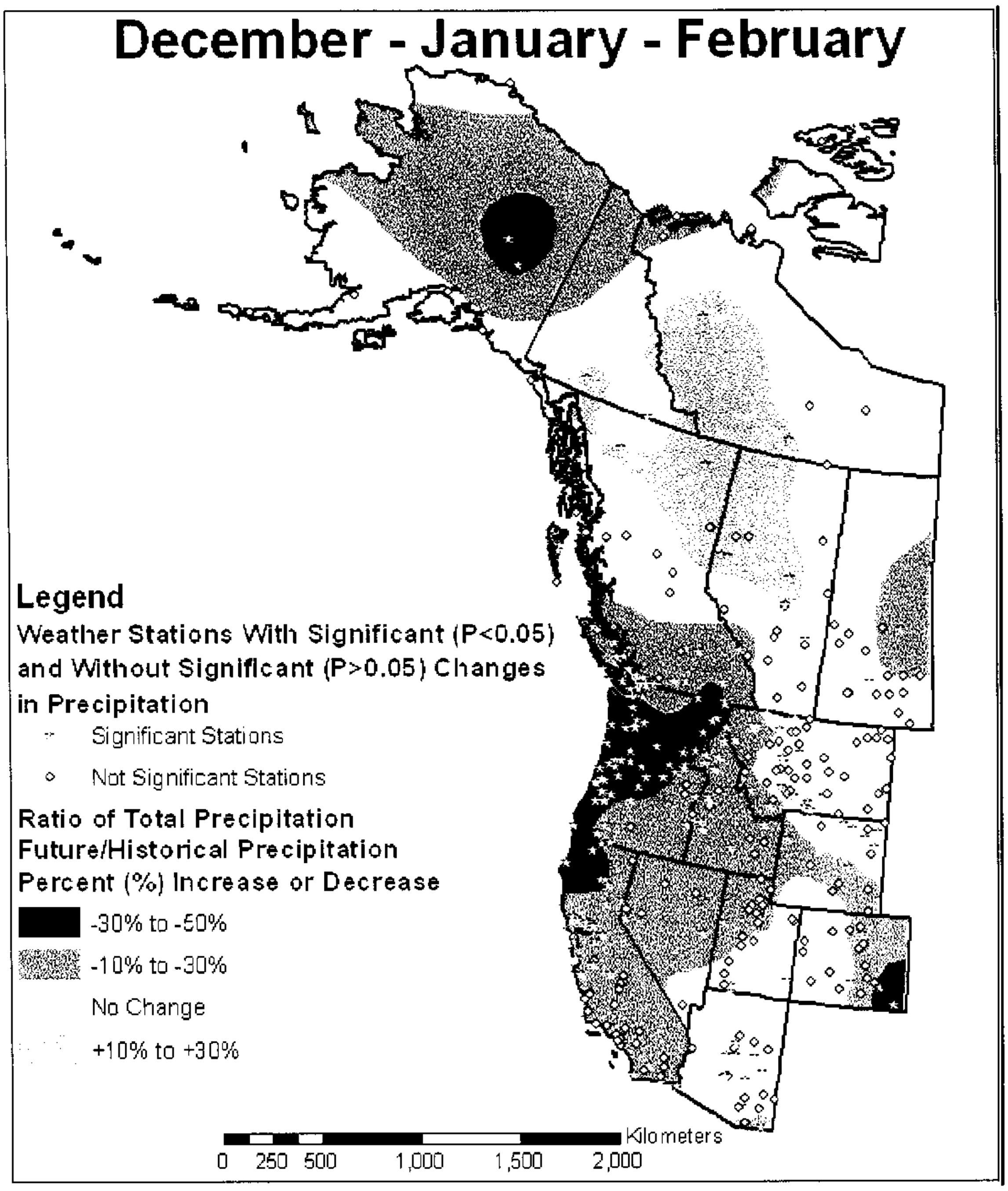


Figure 3.3b Winter (December, January, February) spatial distribution of increasing and decreasing precipitation under forecast climate change in western North America. Green stars represent weather stations showing a statistically significant (based on a KS test) change in precipitation distribution between historical and future periods.

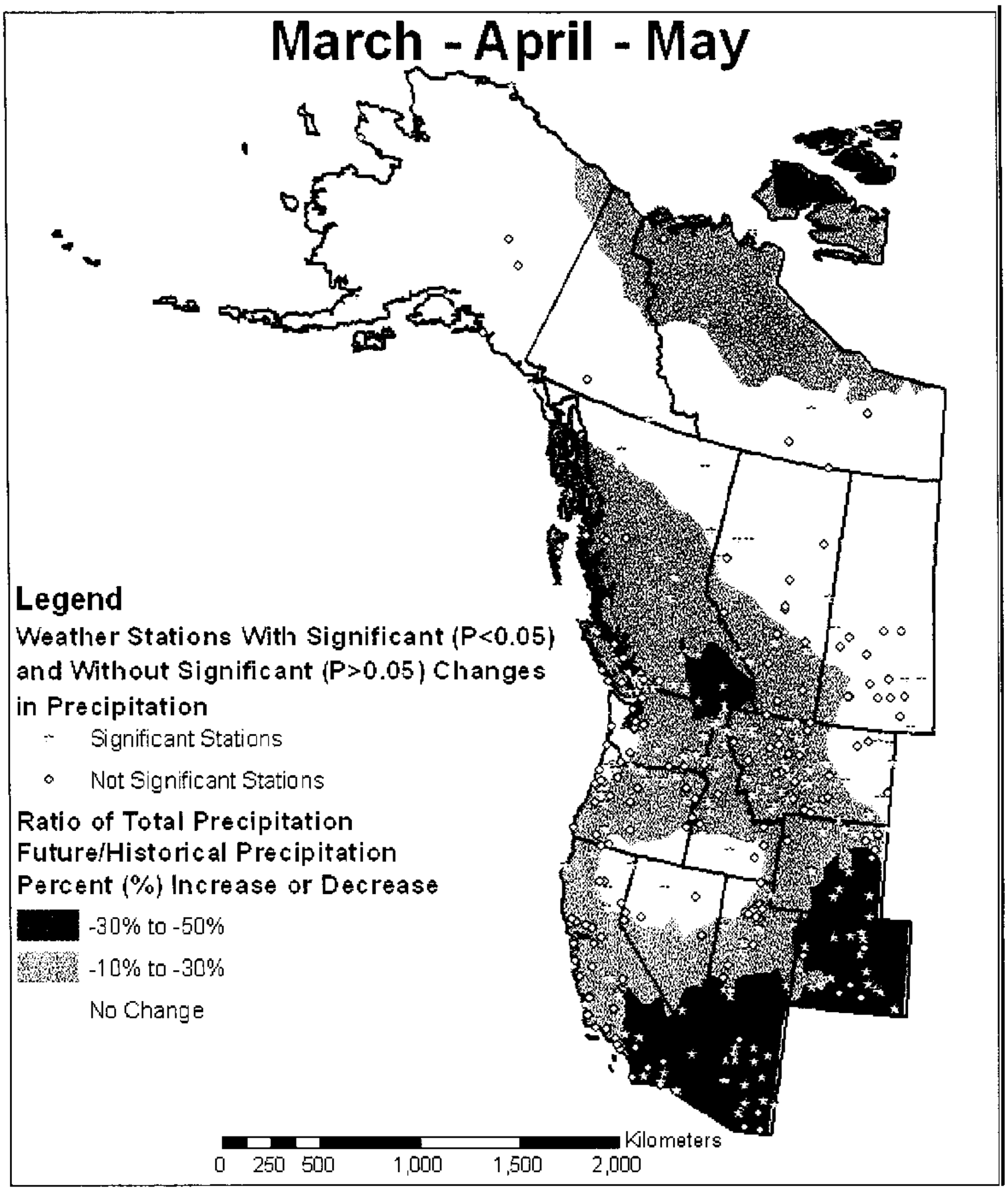


Figure 3.3c Spring (March, April, May) spatial distribution of increasing and decreasing precipitation under forecast climate change in western North America. Green stars represent weather stations showing a statistically significant (based on a KS test) change in precipitation distribution between historical and future periods.

To further explore the spatial and seasonal properties of precipitation characteristics over western North America under forecast climate warming, variances in historical and future precipitation were compared with the same techniques used for the seasonal mean precipitation ratios. However, the results of the precipitation variance forecasts differ from the IPCC's forecast of amplified extreme precipitation events (Houghton et al., 2001). The results in this thesis mainly show decreases in variance throughout the fall, winter and spring, rather than the IPCC forecast of increases in precipitation variance in the future. The maps of precipitation variance for the fall, winter and spring are presented in Appendix A, Figures A.3a, A.3b, A.3c, and A.3d.

The reader is cautioned that the variance in precipitation in this thesis may not be the true variance since the regression model (Equation 3.1) may restrict the variance. The regression maps are thus presented in the Appendix, rather than the results section. The following is a brief summary of the mapped precipitation variance for 2020-2050 (Figures A.3a, A.3b, A.3c, A.3d).

The fall (SON) changes in variance of precipitation show a severe decrease in variance of greater than 50% for most of the western US states and southern Alberta and Saskatchewan (Figure A.3a). Most of western North America shows a decreasing trend in variance of precipitation, the exception being Alaska, which shows an increase in variance – subject to previously expressed concerns regarding data validity in the north.

Future winter (DJF) variance in precipitation decreases over the entire study region by 50% or more (Figure A.3b). In general, there will be less variation in precipitation amounts in winter in the future.

There is a greater range of changes in precipitation variance in the spring (MAM) for 2020-2050 (Figure A.3c). Decrease in variance of greater than 50% occurs in California, Arizona, Colorado, southern Utah, and southwestern coastal Oregon as well as in southern Alberta, southeastern British Columbia and part of northeastern Montana. Increases in variance in precipitation occur in northern Saskatchewan and northeastern Alberta.

3.7 Discussion

The climate change impacts on fall, winter and spring precipitation are substantial. The creation of future precipitation scenarios in this study could allow for more efficient planning in all sectors and applications of agriculture, food, finance, and health (Palmer et al., 2004). The costs and adaptations needed for changing water supplies, the probable need to modify infrastructure, and the economic impacts of developing irrigation systems and diversions to accommodate seasonal water requirements demonstrate the need to understand potential future precipitation changes. Much depends on winter precipitation and snow accumulation in many mountainous regions of western North America; and tourism and recreational resorts based on skiing or snowmobiling. Winter snowpack is also fundamental in determining the amount of snow melt runoff that supplies rivers and streams with seasonal flows. Spring precipitation is also important in providing water supplies to downstream locations and for water storage for summer dry periods. Fall precipitation events can establish early winter snowpack accumulation or could hinder agriculture harvest times.

The above discussion provides some insight into the climate change impacts of shifting fall, winter and spring precipitation regimes. The results presented in the previous section for the fall, winter, and spring however, though important to consider on an individual seasonal basis will be better interpreted once precipitation has been evaluated on an annual basis. Therefore, further discussion pertaining to the results for fall, winter and spring will be explored in greater detail in Chapter 5. Chapter 5 discusses the potential climate change impacts of varying annual and seasonal future precipitation by region: The Prairie Provinces, Coastal British Columbia and Alaska, the Northern Region, the Pacific Northwest, Mountainous Regions, and the American Southwest.

3.8 Summary

Global circulation model synoptic circulation output was used to explore future changes in precipitation amounts and precipitation variance influenced by climate change in western North America for fall, winter and spring. Historical synoptic data was linked to historical precipitation and was used in a precipitation forecast model using step-wise linear regression. The model predicts the greatest consequence of climate change on future fall, winter and spring precipitation to be a decrease in seasonal precipitation for regions of the south western United States. Planners and stakeholders in this region should take note of the potential impact of decreased water supplies and water shortages that are likely to occur in the future.

Chapter 4

Forecasting Variation in Summer Precipitation for Western North America

4.1 Introduction

Downscaling techniques have rarely been applied to long-term summer precipitation forecasts. Summer precipitation is mainly convective; and the nature of convective storms make it is especially difficult to forecast for daily or weekly periods, and for precipitation amounts (Houghton et al., 2001).

Convective precipitation occurs due to the vertical movement of air in the atmosphere and only develops under the right combination of atmospheric conditions. Unstable air aloft of sufficient depth, relatively high humidity near ground level and a lifting agent or trigger combine to create vertical air motion (Strong and Smith, 2001). It is possible to forecast convection through the use of numerical weather prediction (NWP) models (complex physical processes represented by mathematical formulations run on supercomputers) to provide predictions on many atmospheric variables, including temperature, pressure, wind, precipitation and vertical temperature variability (DAS, 1999). NWP models are typically used to forecast meso-scale convective occurrences on scales of a few days, but the forecasts are limited due to the fact that convection simulated by the NWP models is still a rather inexact science (Strong and Smith, 2001).

Global Circulation Models (GCMs) are capable of forecasting climatic variables years into the future. Conventional thinking in the meteorological community considers there are minimal linkages between synoptic scale meteorology and convective activity in summer over the study region, and hence most studies in recent decades have focused on defining downscaling linkages during the fall, winter and spring, when synoptic gradients are well established (Rowson et al., 1992; Changnon et al., 1993; von Storch et al., 1993; Latif and Barnett, 1994; McCabe,1996; Moore and McKendry, 1996; Cavazos, 1997; Konrad, 1997; Cayan et al., 1998; Byrne et al., 1999; Wilby and Wigley, 2000; Trigo and Palutikof, 2001; Cavazos and Hewitson, 2002; Lapp et al., 2002). However, some studies reported there were synoptic influences on convective scale activity (Kung, 1967; Kung, 1969; Kung and Tsui, 1975). Discussion in Chapter 2 (Knupp et al., 1998) suggested convective storms form under a synoptically benign environment. In this analysis, a synoptically benign environment is defined by the unclassified days – days on which no meaningful synoptic pattern is discernable in the analysis window. Local stagnant air subject to little mixing and hence rapid local heat flux under intense summer radiation is the likely initiator for convection. Therefore, it is possible to consider the use of a GCM as a tool in long-term summer convective precipitation forecasting by inclusion of the unclassified days as a synoptic class. In this study, the Canadian Centre for Climate Modelling and Analysis' (CCCma) CGCM2 500 mb geopotential height output was used to represent future summer (June, July, August - JJA) atmospheric conditions, to be applied in downscaling methodology similar to Chapter 3.

4.2 Objectives

The objective of this chapter is to develop estimates of long-term future (2020-2050) summer (JJA) temporal and spatial precipitation characteristics over western North America under forecast climate warming.

To meet these objectives, the following data sets were created and assembled by McKechnie and Shepherd:

i. A daily synoptic classification of the historical summer NCEP/NCAR upper air data and for the CGCM2 upper level circulation patterns (Shepherd and McKechnie);

ii. A grouping of the daily historical and future summer synoptic classification data by month (McKechnie);

iii. Statistical linkages between historical synoptic classification data and precipitation data (McKechnie);

iv. A forecast of future monthly and summer season precipitation for the period 2020-50 using the relationships in (iii) and through the use of a simple synoptic regression model that included "unclassified" synoptic days;

v. A comparison of historic and future precipitation characteristics for 372 stations in western North America (McKechnie);

vi. Spatial and seasonal analyses of the forecast changes in precipitation for summer (McKechnie).

4.3 Study Area

Weather stations for this study are located in Alberta, British Columbia, the Northwest Territories, Saskatchewan, and the Yukon Territory, in Canada; and Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming in the United States (Chapter 3, Figure 3.1).

4.4 Datasets

4.4.1 Historical Data

As in Chapter 3, historical upper 500 mb airflow data was acquired from the National Centers for Environmental Prediction / National Centre for Atmospheric Research (NCEP/NCAR) reanalysis project (Kalnay et al.,1996) for the 1960-1990 period. Observed daily precipitation data was acquired for the historical period from the National Climatic Data Centre (NCDC) (EarthInfo Inc. 2003). In total, 372 weather stations in western Canada and the western United States were identified as having complete precipitation records for the historical period 1960-1990. These stations were selected to represent precipitation conditions for western North America (Figure 3.1).

4.4.2 Future Data

Chapter 3 describes the future data used for summer synoptic classification. The Canadian Centre for Climate Modelling and Analysis (CCCma) second generation coupled global circulation model (CGCM2) “A2” daily 500 mb geopotential heights were selected to represent the future time period. The CGCM2 daily 500 mb geopotential heights were downloaded for the years 2020-2050.

4.5 Methodology

The same methodology as applied in Chapter 3 to fall, winter and spring was applied to summer (JJA). Historical (1960-1990) daily geopotential heights were manually classified according to Changnon et al.’s (1993) seven synoptics patterns (Figure 1.1). The average frequencies of synoptic patterns per month are presented in

Appendix A, Table A1, to illustrate the total pattern frequencies used in the methodology. Though unclassified days were not significant in producing precipitation for the winter months, it was found that when days with unclassified synoptic patterns were included in the regression model (Equation 3.1), unclassified days were significant predictors of precipitation in April, May, June, July, August, and September for some climate stations. Therefore, synoptic downscaling could be applied to spring and summer precipitation scenarios. Precipitation, assumed to be convective in nature, was quite likely to occur on days where there was no recognizable synoptic pattern. Unclassified synoptic patterns (i.e. an absence of pattern) should be considered the eighth synoptic class.

Stepwise linear regression (no-intercept) was used to link monthly precipitation accumulations at each of the 372 stations and synoptic pattern frequency statistics, including unclassified patterns, on a month by month basis for the summer (JJA). To determine which synoptic pattern or which combination of synoptic patterns produce precipitation at each of the 372 weather stations, the pattern frequencies were set as the independent variables. The regression model selected for each station was based on the highest R^2 (Appendix A, Table A6). It is important to note that although R^2 values are not consistently as high as for the fall, winter and spring, this study presents a new, less complicated means of forecasting summer precipitation.

Future (2020-2050) daily CGCM2 geopotential heights were manually classified according to Changnon et al.'s (1993) seven synoptics patterns (Figure 1.1) and the unclassified pattern as an eighth pattern (absence of pattern) using a Geographic Information System (GIS). The analysis is the same as described for Equation 3.1.

As in Chapter 3, the ratio of future/historical total seasonal precipitation per station was calculated and an interpolated surface was created in a Geographic Information System (GIS) using the Ordinary Kriging method in ESRI's ArcMap. An interpolated R^2 map was also created using Kriging to show the spatial extents of R^2 values.

Significant changes in precipitation distributions per station between the historical and future time periods were determined using the Kolmogorov-Smirnov (KS) test. The significance results of the KS test per station were mapped over the summer precipitation layer to demonstrate where statistically significant ($p<0.05$) increases and decreases in precipitation will exist in the future due to climate change impacts. The KS test determines if historical summer precipitation and future summer precipitation are significantly different in distribution properties. Climate stations where the KS test predicted significant increases or decreases in precipitation are indicated by a green star, and are subject to the constraints discussed in Chapter 3.

Variances in historical and future precipitation were determined for the historical and future 30 year periods. Ratios of future/historical precipitation variance per station were calculated and interpolated surfaces were created in a GIS using the Kriging method in ESRI's ArcMap. Variance ratios were mapped for a summer evaluation of spatial variations in changes in precipitation variance.

4.6 Results

The July R^2 map is presented as Figure 4.1 as the representative month for the summer season. June and August are presented in the Appendix (Figures A.2e, A.2f). The precipitation forecast model well represents the Canadian provinces, the Pacific Northwest States, and Wyoming, Colorado, Utah and Arizona with R^2 values ranging from 0.6 – 0.9, while the region surrounding the American Southwest especially California, (likely because of very low precipitation) show lower R^2.

Figure 4.2 illustrates the results of the precipitation ratio changes for summer for western North America. There are regions of increasing or decreasing summer precipitation expected by 2020-2050 under forecast climate warming. The summer (JJA) for 2020-2050 will have a general drying in northern Canada: the Yukon, Northwest Territories, the majority of central and northern Saskatchewan, eastern and northern Alberta, and the extreme northern region of British Columbia. Regions of California, Nevada, Arizona, and Colorado will also experience up to a 30% decrease in future summer precipitation (Figure 4.2). However, nearly the entire state of Washington, Idaho and Montana will experience significant increases in precipitation of up to 30% in the summer. Other regions that may have an increase of summer precipitation of up to 30% are: northern Nevada, northern California and southern Oregon, as well as northern Wyoming. Southeastern Saskatchewan and a small southern coastal region of California may also receive more summer precipitation in the future than historically.

To further explore the summer precipitation characteristics over western North America under forecast climate warming, Figure A.3d in Appendix A was created to demonstrate the spatial properties of precipitation variance. The reader is cautioned that the variance in precipitation may not be the true variance due to restrictions in the regression model (Equation 3.1). The IPCC forecasts an amplification of extreme precipitation events in both Canada and the USA (Houghton et al., 2001), while the variance forecasts in this analysis found decreasing variability in precipitation extremes. The following is a brief summary of summer precipitation variance for the 2020-2050 period (Figure A.3d).

Future summer variance in precipitation decreases by 10 to 50% for Alaska, the Yukon, the Northwest Territories and most of Saskatchewan (Appendix A, Figure A.4). Southern Washington, eastern Oregon, northern California and Nevada, southern Idaho, most of Utah and Arizona, and southeastern Colorado will also experience less variance in precipitation in the summer in the future. Increases in variance in future summer precipitation occurs in coastal British Columbia, Washington and Oregon, as well as central interior British Columbia and central Alberta. Other regions of increased variance of 50% or more are southeastern Saskatchewan, and much of Montana and Wyoming.

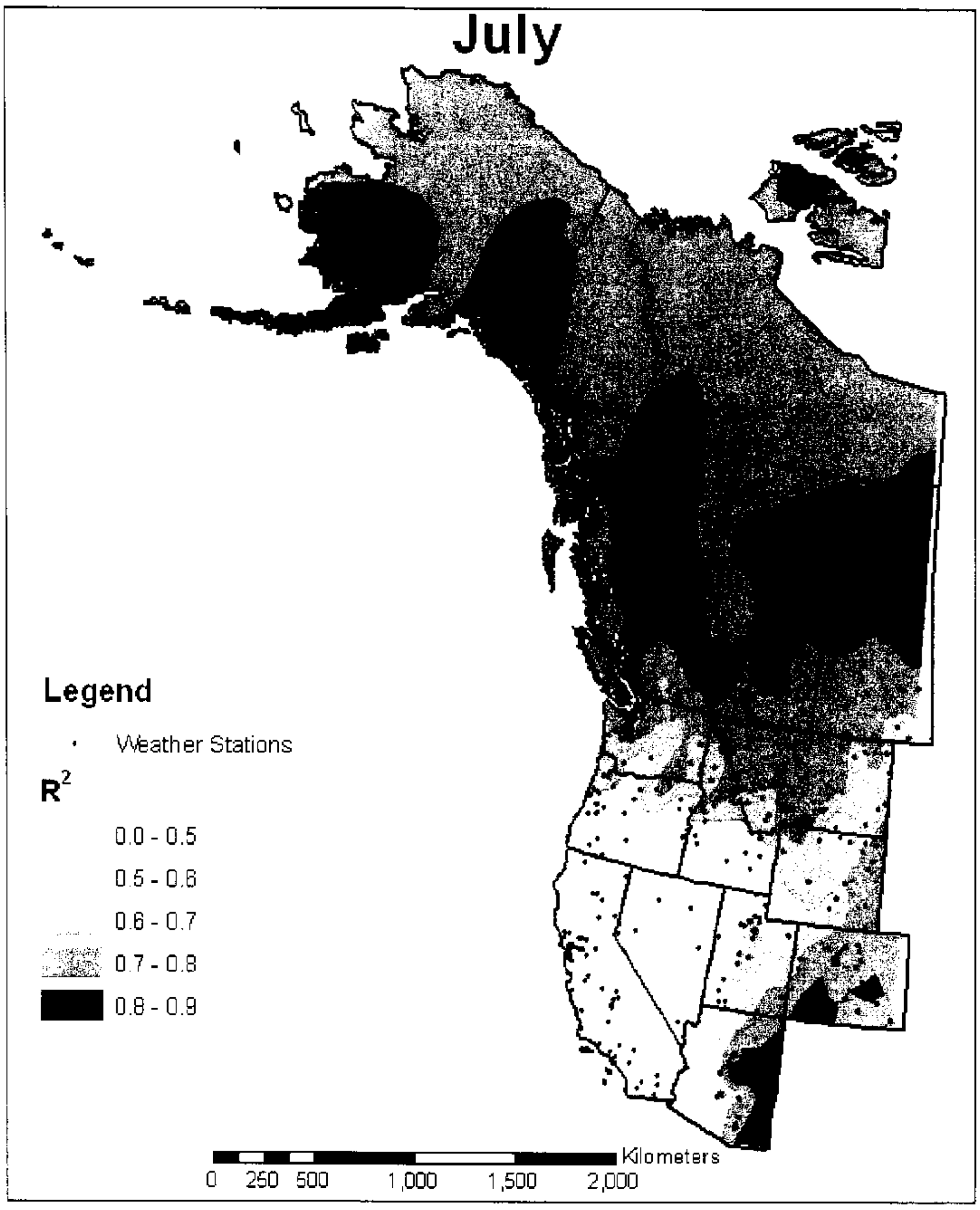


Figure 4.1 Summer (July) spatial representation of R^2 values.

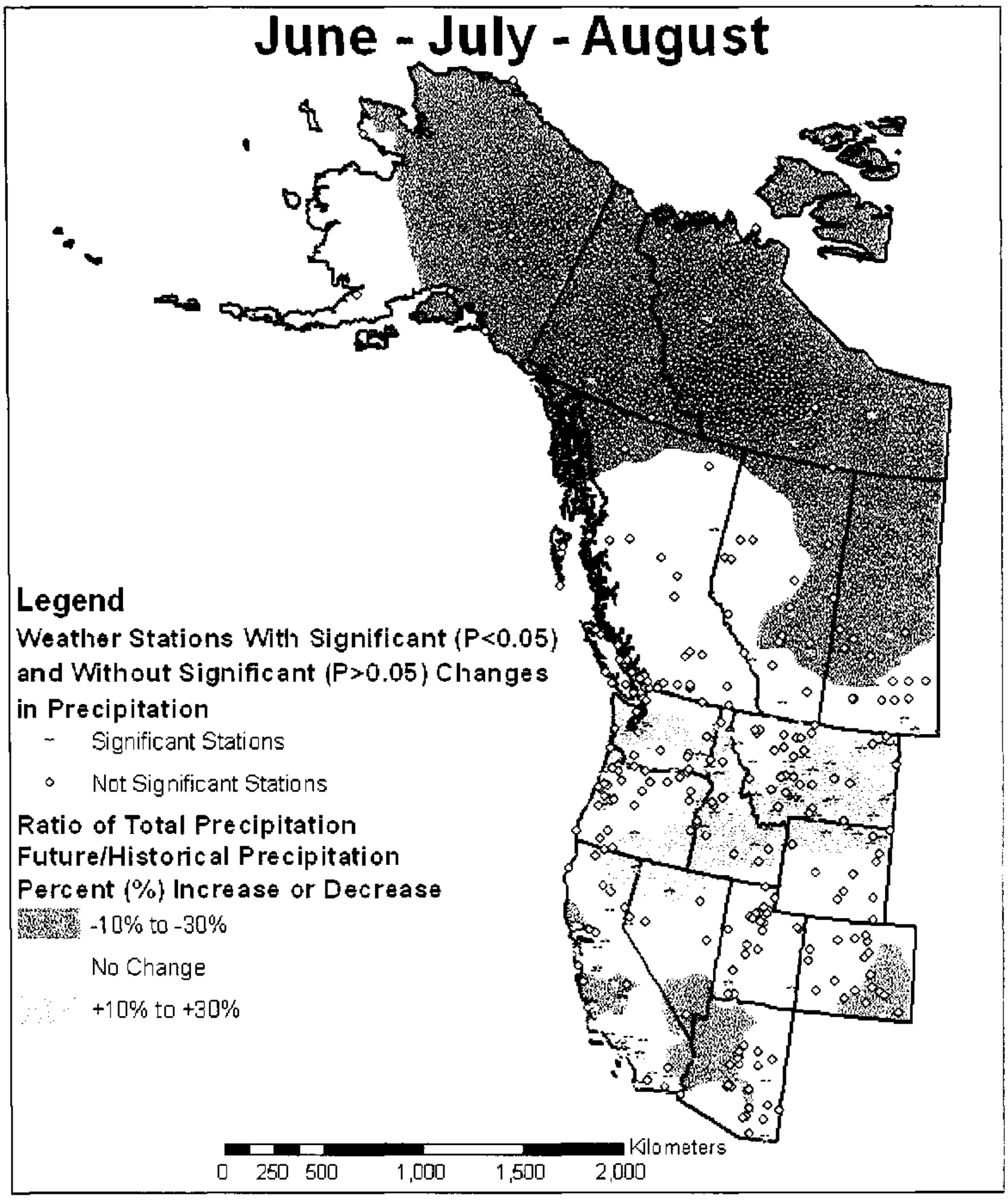


Figure 4.2 Summer (June, July, August) spatial distribution of increasing and decreasing precipitation under forecast climate change in western North America. Green stars represent weather stations showing a statistically significant (based on a KS test) change in precipitation distribution between historical and future periods.

4.7 Discussion

A major advancement of the work undertaken in this thesis was the application of synoptic pattern downscaling to summer precipitation scenarios for western North America. The addition of the unclassified synoptic days as an eighth synoptic pattern made it possible to use a downscaling approach to forecast future summer precipitation scenarios. The development of summer precipitation scenarios for 2020-2050 then made it feasible to combine the results from Chapter 3, fall, winter and spring, as well as Chapter 4's summer seasonal forecasts to create future precipitation scenarios on an annual basis.

Summer precipitation changes are of great importance to many sectors of the economy, and to the environment. Droughts or intense summer storms could impact infrastructure, irrigation systems, thus agriculture in general. Summer months provide growing time for crops that are very much dependent on certain water requirements, both amount of and timing of precipitation.

This brief discussion provides some insight into the climate change impacts of changing summer precipitation regimes, though further discussion pertaining to the results for summer will be explored in greater detail in Chapter 5 once the summer precipitation scenarios have been added to the fall, winter and spring forecasts. Chapter 5 discusses the potential climate change impacts of varying seasonal and annual future precipitation on a regional basis: The Prairie Provinces, Coastal British Columbia and Alaska, the Northern Region, the Pacific Northwest, Mountainous Regions, and the American Southwest.

4.8 Summary

Global circulation model synoptic circulation output was used as a method of exploring future changes in summer precipitation amounts and precipitation variance influenced by climate change in western North America. The use of a GCM in long-term summer convective precipitation forecasting was considered possible by the inclusion of unclassified days as an additional synoptic class to the seven synoptic patterns defined by Changnon et al. (1993). Historical synoptic 500 mb data was linked to historical precipitation for use in a precipitation forecast model using step-wise linear regression. The model predicts the greatest consequence of climate change on summer precipitation to be a decrease in seasonal precipitation for the northern regions of western North America and an increase in summer precipitation in the interior northern United States, especially Idaho and Montana. Planners and stakeholders in northern regions forecasted to be drier should take note of possible impacts on water supplies. The regions forecasted to experience an increase in summer precipitation should be warned of potentially intensified summer convective storms and possible flooding. Crop-rich agricultural regions may want to consider the impact of hail-producing storms that can form in intense convective environments (Zeng et al., 2001).

Chapter 5

Spatial Variation in Seasonal and Annual Precipitation Under Forecast Climate Change for Western North America

5.1 Introduction

The objective of this chapter is to combine results from Chapters 3 and 4 to assess the spatial change in the mean and variance of seasonal and annual precipitation for western North America under climate change. A further analysis investigates change on a regional basis.

5.2 Datasets

Historical (1960-90) and Future (2020-50) datasets were employed as explained in Chapters 3 and 4. Fall, winter, spring and summer precipitation totals were used for the annual analysis.

5.3 Methodology

Output developed in Chapter 3 for fall, winter and spring precipitation, and in Chapter 4 for summer precipitation was combined to produce future climate change affected precipitation forecasts on an annual basis. Average monthly synoptic pattern frequencies and average annual and seasonal pattern frequencies are presented in Appendix A, Table A1 and Table A2 respectively, to represent the actual pattern frequency totals used in Chapter 3 and 4 methodology. The ratios of future/historical total annual precipitation per station were calculated and an interpolated surface was created in a GIS using the Ordinary Kriging method in ESRI's. The annual ratios were mapped and statistically significant ($P<0.05$) changes in distributional characteristics in precipitation for all 372 climate stations were determined using the Kolmogorov-Smirnov (KS) test and significant increases and decreases are indicated by a green star on the ratio maps.

Ratios of precipitation variance for all stations was calculated and mapped to provide an annual assessment of spatial changes in precipitation variance as forecast by the CGCM2.

5.4 Results

Ratios of increasing or decreasing annual precipitation over western North America expected by 2020-2050 under forecast climate warming are provided in Figure 5.1, and the annual variance ratios are presented in the Appendix as Figure A.3e. The seasonal precipitation ratio maps from chapters 3 and 4 are included here as Figure 5.2, and the seasonal precipitation variance maps from chapters 3 and 4 are included in Appendix A, Figure A.3f. R^2 maps were created on a monthly basis for Chapters 3 and 4, though an R^2 map for an annual illustration of spatial R^2 values was not feasible since R^2s would have been averaged, thus losing significance.

The majority of weather stations in the western and southern regions of western North America will have a decrease of 10-30% in annual precipitation during the years 2020-2050. The spatial extent of the drying covers western and southern British Columbia, Washington, Oregon, California, Nevada, Utah, Colorado and central and southern Wyoming. The rest of the study area, including Alaska, the Yukon, the

Northwest Territories, northeastern British Columbia, Alberta, Saskatchewan, Montana, eastern Idaho, and northern Wyoming, demonstrates minimal change in annual precipitation with the exception of extreme southeast Saskatchewan and northeast Montana, which show an increase of 10-30% in annual precipitation.

Annual precipitation variance characteristics over western North America under forecast climate warming are presented in Figure A.3e. Annual precipitation variance will increase by over 50% for British Columbia, Alberta, Saskatchewan and portions of Idaho, Montana and Wyoming. Future annual variance in precipitation decreases by greater than 50% in California, the southern tip of Nevada and western Arizona.

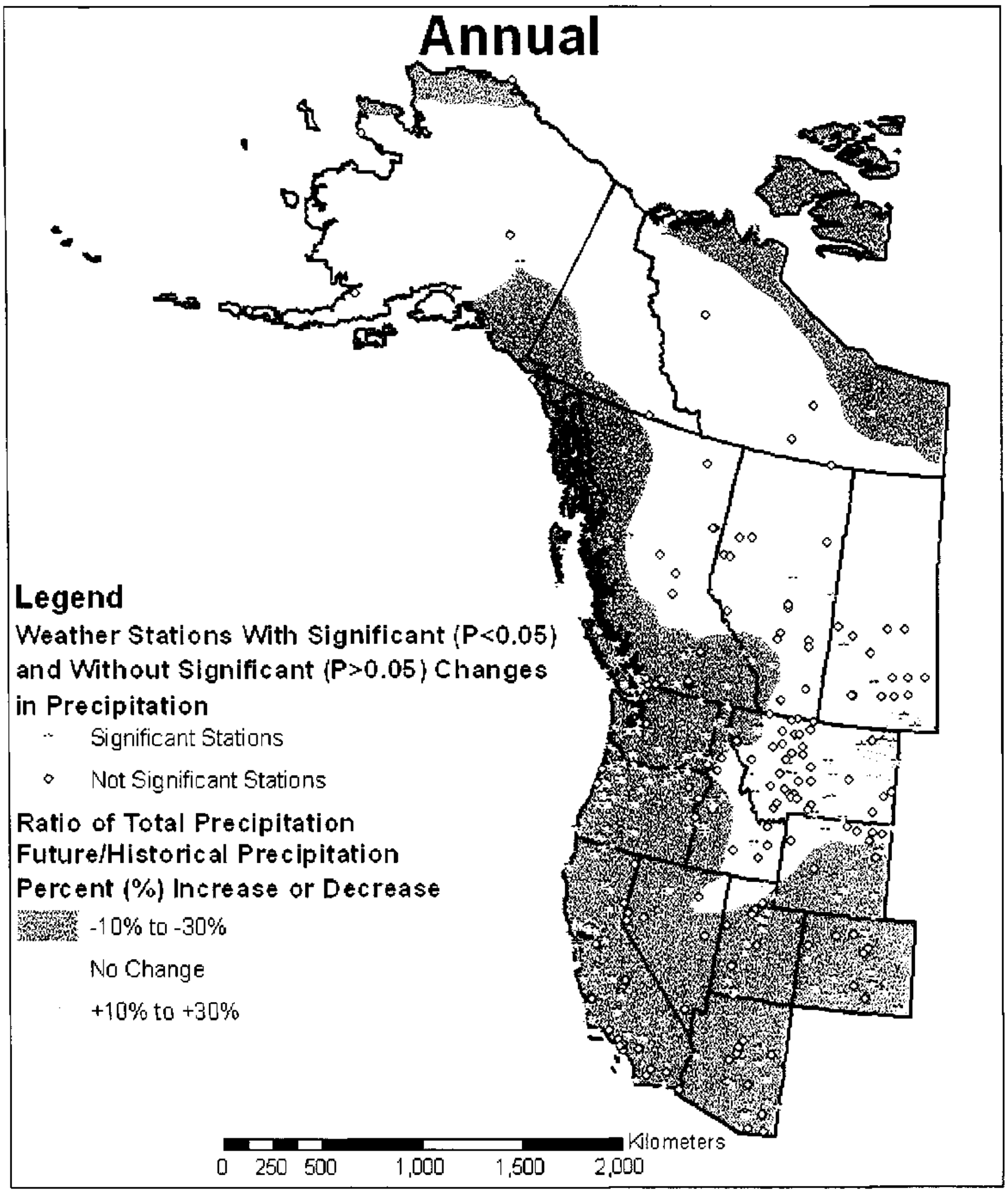
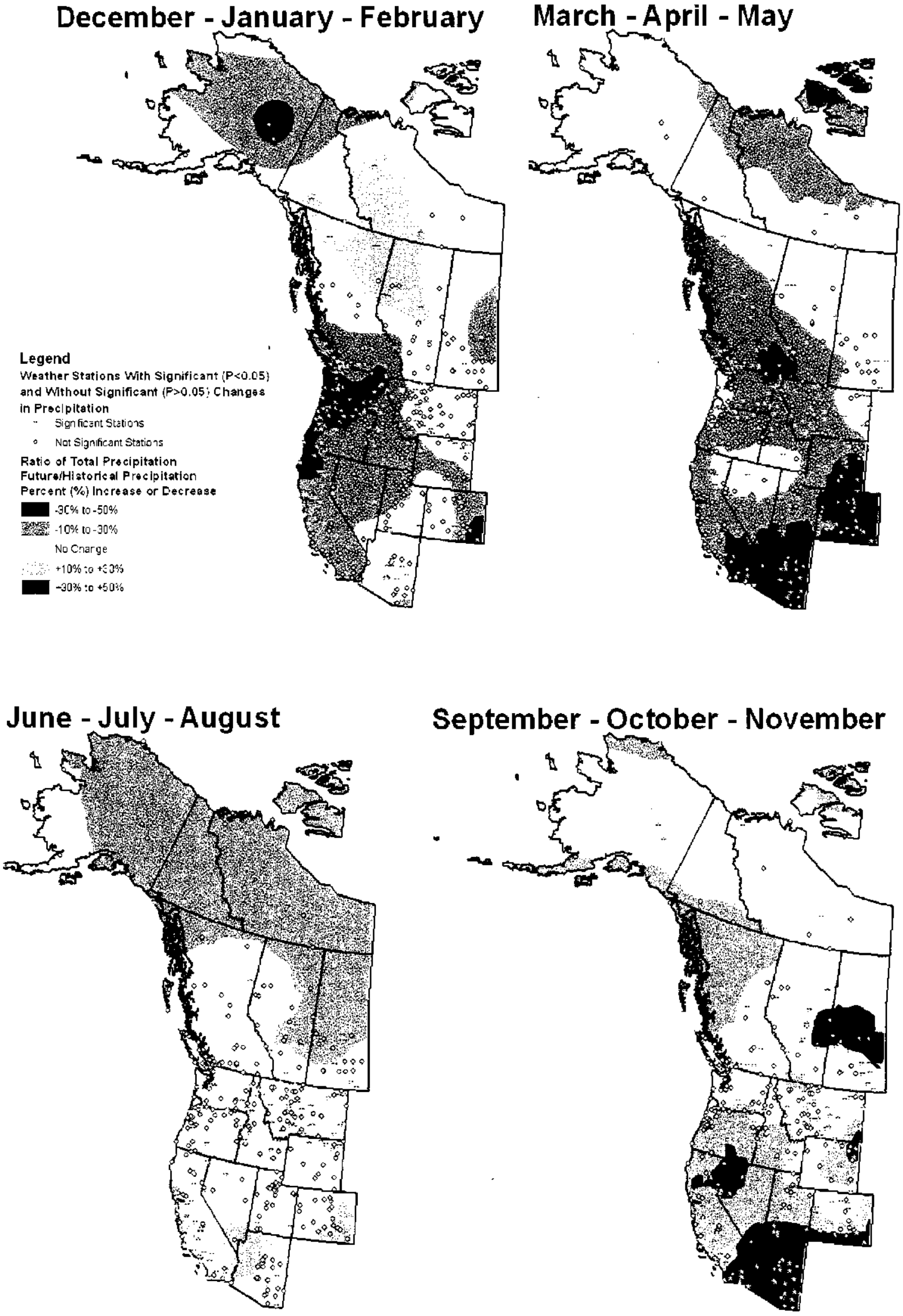


Figure 5.1 Annual spatial distribution of precipitation under forecast climate change in western North America. Green stars represent weather stations showing a statistically significant (based on a KS test) change in precipitation distribution between historical and future periods.



Figures 5.2 Seasonal precipitation ratio maps.

5.5 Discussion

Synoptic circulation and the position of the jet stream play a critical role in the spatial and temporal distribution of synoptic-scale precipitation over western North America. A shift in the jet stream position due to climate change influences (represented by synoptic pattern frequency changes) impact future seasonal and annual precipitation (Appendix A, Table A2). The creation of future precipitation scenarios, as in this study, could allow for more efficient planning in all sectors and applications of agriculture, food, finance, and health (Palmer et al., 2004). To discuss the potential climate change impacts of varying annual and seasonal future precipitation, a discussion by region is presented: The Prairie Provinces, Coastal British Columbia and Alaska, the Northern Region, the Pacific Northwest, Mountainous Regions, and the American Southwest.

The Prairie Provinces - Alberta and Saskatchewan - show increases in precipitation during the fall, and no change to modest decrease in the winter and spring. Decreased precipitation on the prairies in winter and spring would result in decreased streamflow runoff and lower soil moisture conditions (Wu et al., 2004) which would potentially reduce the amount of summer precipitation in a productive agricultural area (Koster et al., 2004). Increases in precipitation in the fall could also hamper harvesting season in a crop-rich region (Palmer et al., 2004). The variance in precipitation for fall, winter and spring is forecasted to decrease for the Prairie Provinces. This could result in less difference between minimum and maximum precipitation extremes. This reduced variability in precipitation may be beneficial in the sense that there could be a reduction in the severity of winter storms, heavy precipitation and hazardous blizzard conditions.

During the summer, the southeastern region of Saskatchewan will receive more precipitation in the future, while the rest of the Prairies show no change. Climate change appears to have little impact on summer precipitation in the Prairie Provinces at first glance, but the water balance will likely be adversely affected because of rising temperatures. Warmer temperatures increase the rate of evaporation, thus decreasing the amount of available moisture for plant and crop growth, and decreasing potential runoff to prairie streams (Gleick, 1999). If agricultural regions such as the Canadian prairies were to receive less precipitation than historically 'normal', plant growth and crop yields would be affected, potentially limiting food production and upsetting an agriculturally dependent economy.

Coastal Northern British Columbia and Alaska display a decrease in fall precipitation, no change in the winter, and a decrease in the spring. Decreasing precipitation in coastal regions may impact vegetation zones, species diversity and forest species distributions (Shafer et al., 2001). Some Pacific Northwest tree species are already shifting their range northward and upslope (Shafer et al., 2001), likely because of the need for cooler temperatures and more precipitation. The rest of the Northern Region, including interior Alaska, the Yukon and Northwest Territories mainly show minimal change in precipitation throughout the fall, winter and spring seasons, with some localized increases and decreases driven by one or two weather stations that are subject to suspicion. Summer precipitation is forecasted to either decrease, as in the case of Alaska and northern coastal British Columbia, or to change very little. Even if there is little to no change in precipitation in forested regions, the impact of increasing temperatures will likely cause coastal and northern regions to be drier. Dry forests are more susceptible to intense forest fires which cause regeneration of post-burn forests with invasive species more suited to hotter, drier climates rather than with indigenous species (Viers, 1981).

The Pacific Northwest Region of Southern British Columbia, Washington and Oregon will experience 10 to 30% less precipitation in the winter and spring. Less precipitation stored as snowpack in these regions may have future implications on water resources; streams and rivers fed by snowmelt may have reduced flow in the future (Moore and McKendry, 1996; Gleik, 1999; Wolock and McCabe, 1999; Lapp et al., 2005). An increase in future temperatures due to climate warming could cause early snowmelt and trigger a significant shift in the seasonal pattern of snowmelt, streamflow and flooding potential (Gleick, 1999; Leung and Wigmosta, 1999). It may seem that the forecasted increase in summer precipitation in the Pacific Northwest may help low flow issues, however, it is not likely that more summer season precipitation would compensate for winter snowpack deficits and related spring runoff.

Mountainous Regions of Colorado, Wyoming, Idaho and western Montana show a decrease in precipitation for winter and spring. These states are the headwaters of important US river systems that supply water to many downstream States, especially portions of the Great Plains. The regions of Colorado, Wyoming, Idaho and western Montana exhibiting a decrease in future precipitation should be concerned with future water management strategies. Water managers in these regions should rethink water storage systems and diversions to ensure a reliable water supply exists for dry years and for downstream communities and agriculture, as current rainfall is not sufficient to support existing food production (Ojima et al., 1999).

The summer precipitation in Idaho and Montana is forecasted to increase. This increase in summer precipitation, combined with warmer temperatures, may result in higher water vapor content in the atmosphere, thus increasing the likelihood of severe thunderstorms (Byrne, 2004). The potential increase in severe thunderstorm occurrences is even more likely to occur in Montana and Wyoming, where there is in an increase in precipitation variance during the summer months in addition to forecasted wetter summer conditions.

The American Southwest: Utah, Arizona, Nevada and California will experience a decrease in precipitation in the fall and spring, with regions of the southwest experiencing decreases of up to 50%. The Southwest States of California and Nevada will also experience less precipitation in the winter months. This should be worrisome for California, where brush fires and fire damage are already problematic and are likely to increase with climate change and changing climate variability (Dresler at al., 1998).

The American Southwest will likely suffer even greater local water shortages than at present, especially in regions where freshwater is diverted from rivers hundreds of kilometers away to supply cities and agricultural practices. Winter and spring precipitation over the headwaters of the Colorado River, a primary source of water for this region and for Nevada and southern California, will seriously decline. Declining Colorado River flows will impact many diversion systems and communities.

The summer precipitation forecast does not show an improvement over the fall, winter and spring for the southwestern States. Though the southern coastal region of California shows an increase in summer precipitation, (potentially a monsoonal effect, discussed below) the rest of the American Southwest is likely to experience warmer temperatures, more evaporation and less precipitation. Less precipitation in the future will likely impede groundwater recharge; a concern in particular for communities already dependent on groundwater as a primary source of freshwater. Summer precipitation variance in the American southwest is also forecasted to increase in a small portion of Arizona and Nevada (the reader should take note of the low density of weather stations in AZ and NV). Increased summer precipitation variance may produce an increase in summer storms and flash flooding in dry areas such as Arizona. Increased precipitation intensity or higher frequencies of precipitation events could exacerbate problems in sewer overflows, storm water drainage, soil stability and potential mudslides if intense storms and flash flooding were to increase (Byrne, 2004).

The North American Monsoon (NAM) could also affect summer precipitation in the American Southwest. As explained in Chapter 2, the NAM is a seasonal and regional surface circulation affecting summer precipitation in the Southwestern States. As much as 50-70 percent of the annual rainfall across the southwestern United States results from thunderstorms generated during the summer monsoon season (Ellis et al., 2004). The NAM could potentially be a weak point in this study. General atmospheric circulation and precipitation changes were the central focus of this thesis. No explicit linkage was made to the regional monsoon circulation. One study (Carleton, 1987), however, found that synoptic circulation and synoptic patterns affected precipitation in the American Southwest during the summer monsoon. Carleton (1987) classified 500 mb synoptic types and found 11 circulation types that describe the summer monsoon, which relate to Arizona summer rainfall. Therefore, it is likely that the synoptic precipitation forecast model applied herein implicitly accounts for NAM linkages to synoptic circulation.

Changes in future precipitation, either increasing or decreasing, may have many other impacts on ecosystems, human health, cities, industry and the economy throughout western North America. Geographic ranges of ecoregions may have already shifted northward and/or upward in elevation, and in some cases, have contracted (Parmesan and Galbraith, 2004). Aerosols in the air and dust storms could increase under dry future conditions, affecting visibility and respiratory health (Chan and Loh, 2002). Drier conditions could increase erosion potential as well, since moisture deficits may limit vegetation growth that would otherwise hold soil in place. Recreational activities and eco-tourism may also be impacted by a reduction in precipitation in certain seasons in western North America. Water sports and boating require lake and reservoir levels to be high (WTO, 2003). Winter activities such as those in alpine resorts thrive off of skiing and snowmobiling and are wholly dependant on seasonal snow accumulation. Also, nature-based and winter tourism in mountainous regions of western North America are dependent on the quality of a destination's natural surroundings. Climate-induced changes in precipitation may affect flora and fauna, glacier retreat, and increase potential damage to forests by fire and influence the quality of the tourist experience (WTO, 2003).

Industries such as mining, oil sands, oil and gas, agriculture and other industrial activities or industrial plants that require water for operation would be adversely affected by water use restrictions levied under times of water shortage. Hydropower production would also be limited if there were decreases in the water supply necessary to fill reservoirs and operate turbines (Kniazkov, 2005).

The discussion and exploration of climate change impacts on precipitation and future water supplies in western North America help the public and policymakers understand the potential consequences of climate change in their region. These climate change scenarios developed for the next 20 to 50 years aid in the preparation to safeguard ecosystems, water supplies, the economy and society.

5.7 Summary

The results from the seasonal (SON, DJF, MAM, JJA) future precipitation analyses were combined to provide insight as to how climate change may impact the annual spatial and temporal distribution of precipitation and precipitation variance. Example weather stations were selected to represent regions and to better illustrate how future precipitation may change over the seasons. Discussion focused on regional analyses of potential precipitation climate change impacts and the results offer precipitation scenarios that will ultimately be necessary for not only future water resources and watershed management, but for applications in all sectors of the economy and society.

Chapter 6

Conclusions

6.1 Summary

The objective of this thesis was to investigate the possible changes in future precipitation for western North America under global climate change. A manual downscaling technique using synoptic (upper-level atmospheric airflow) patterns was adopted based on methods developed in previous studies (Changnon et al., 1993; Byrne et al., 1999; Lapp et al., 2002). Daily historical (1960-1990) 500-mb geopotential height NCEP/NCAR reanalysis data was visually classified into seven (eight including unclassified) synoptic patterns defined by Changnon et al. (1993). Future (2020-2050) daily 500-mb geopotential heights from the Canadian Centre for Climate Modelling and Analysis's second generation coupled global circulation model (CGCM2) were visually classified using Geographic Information System (GIS) algorithms. The historical pattern and precipitation linkages were used in a step-wise linear regression model to forecast future precipitation amounts for 372 weather stations over western North America. Future precipitation was compared to historical precipitation to develop estimates of future precipitation distribution changes. Maps of ratio precipitation and precipitation variance were created and discussed for annual and seasonal conditions. The analysis predicted the greatest consequence of climate change on future precipitation to be a decrease in annual precipitation for much of the western United States. The seasonal spatial distribution of precipitation is impacted as well, with regions of the southern United States, especially California and the American Southwest, forecasted to receive less seasonal precipitation in future. Forecasting long-term future summer precipitation using downscaling techniques was a novel accomplishment and may provide a less complicated means of creating summer climate change precipitation scenarios.

Gaining new insight on climate change impacted seasonal and annual precipitation is beneficial to all sectors and applications of agriculture, food, finance, water resources and human and ecosystem health.

6.2 Recommendations

Future applications of the precipitation scenarios created in this study are numerous. Future temperature forecasts and the future precipitation forecasts developed in this study could be combined for use in impacts and adaptations studies for drought susceptibility and water management. As well, the combination of temperature and precipitation data from this study could be applied to evapo-transpiration, which would be very beneficial for agriculture, habitat, and ecology applications. Furthermore, many sector-specific studies, from oil sands to ecosystem management could benefit from understanding potential precipitation changes. Precipitation forecasts could also aid in severe weather forecasting and climate extreme studies.

The daily synoptic pattern frequency data produced in this study could be further analyzed for persistence of synoptic patterns. This could be used to determine if the duration and persistence of a certain pattern has an impact on precipitation events. Further, the sequence or flow from one pattern to another could be a factor in the occurrence of specific precipitation events (sustained precipitation or intense events) in western North America.

The western North American window could also be expanded to include the central US and Canada: Manitoba, New Mexico, the Dakotas, Nebraska, Kansas, Oklahoma and Texas, which would cover the Great Plains and give insight into future problems associated with climate change in a more extensive region.

References

Adams, D.K. and A.C. Comrie. 1997. The North American Monsoon. *Bull. Am. Meteorol. Soc.* **78**(10):2197-2213.

Ahrens, C.D. 2000. Meteorology Today -6th ed. Brooks/Cole, Pacific Grove, CA.

Allen, M.R. and W.J. Ingram. 2002. Constraints on future changes in climate and the hydrological cycle. *Nature.* **419**: 224-232.

Arora, V.K. 2001. Streamflow simulations for continental-scale river basins in a global atmosphere general circulation model. *Adv. Water Resour.* **24**: 775-791.

Arritt, R.W., D.C. Goering, C.J. Anderson. 2000. The North American monsoon system in the Hadley Centre coupled ocean-atmosphere GCM. *Geophys. Res. Lett.* **27**(4): 565-568.

Baldwin, C.K., F.H. Wagner, U. Lall. 1999. Water-resources climate-change scenarios in the Rocky Mountain/Great Basin region guided by historical climatic variability analysis. Published in: Potential Consequences of Climate Variability and Change to Water Resources of the United States, D.B. Adams (Ed), American Water Resources Association, Herndon, Virginia, TPS-99-1, pp. 281-284.

Bergström S., B. Carlsson, M. Gardelin, G. Linström, A. Pettersson, M. Rummukainen. 2001. Climate change impacts on runoff in Sweden – assessments by global climate models, dynamical downscaling and hydrological modeling. *Climate Res.* **16**: 101-112.

Blair, D. 1998. The Kirchhofer technique of synoptic typing revisited. *Int. J. Climatol.* **18**: 1625-1635.

Boer, G.J., G. Flato, D. Ramsden. 2000a. A transient climate change simulation with greehouse gas and aerosol forcing: projected climate to the twenty-first century. *Clim. Dyn.* **16**: 427-450.

Boer, G.J., G. Flato, M.C. Reader, D. Ramsden. 2000b. A transient climate change simulation with greenhouse gas and aerosol forcing: experimental design and comparison with the instrumental record for the twentieth century. *Clim. Dyn.* **16**: 405-425.

Boer, G.J., N.A. McFarlane, M. Lazare. 1992. Greenhouse gas-induced climate change simulated with the CCC Second-Generation General Circulation Model. *J. Climate.* **5**: 1045-1077.

Bordoni, S., P.E. Ciesielski, R.H. Johnson, B.D. McNoldy, B. Stevens. 2004. The low-level circulation of the North American Monsoon as revealed by QuikSCAT. *Geophys. Research Letters.* **31**: L10109, doi:10.1029/2004GL020009

Brinkop, S. 2001. Change of convective activity and extreme events in a transient climate change simulation. DLR-Institut fuer Physik der Atmosphaere, Report No. 142.

Broccoli, A.J. 2005. Personal communication. Associate Professor, Department of Environmental Sciences and Acting Director, Center for Environmental Prediction, Rutgers University, New Brunswick, NJ.

Brostrom, G. 2004. The dynamics of the North Atlantic carbon cycle and its relation to the temperature of the winter mixed layer. *Tellus B.* **56**(1): 72-84.

Busuioc, A., D. Chen, C. Hellström. 2001. Performance of statistical downscaling models in GCM validation and regional climate change estimates: application for Swedish precipitation. *Int. J. Climatol.* **21**: 557-578.

Byrne, J.M. 2004. CWN (Canadian Water Network). Online: www.cwn-rce.ca

Byrne, J.M., A. Berg, I. Townshend. 1999. Linking observed and general circulation model upper air circulation patterns to current and future snow runoff for the Rocky Mountains. *Water Resour. Res.* **35**(12): 3793-3802.

Carleton, A.M. 1987. Summer circulation climate of the American Southwest, 1945-1984. *Ann. Assoc. Am. Geographers.* **77**(4): 619-634.

Cavazos, T. 1997. Downscaling large-scale circulation to local winter rainfall in North-Eastern Mexico. *Int. J. Climatol.* **17**: 1069-1082.

Cavazos, T. and B. Hewitson. 2002. Relative performance of empirical predictors of daily precipitation. In Rizzoli, A.E., A.J. Jakeman (Eds.), Integrated Assessment and Decision Support, Proceedings of the First Biennial Meeting of the International Environmental Modelling and Software Society, 2: 349-354, iEMSs, June 2002.

Cayan, D.R., 1996. Climate variability and snowpack in the western U.S. *J. Climate.* **9**(5): 928-948.

Cayan, D.R., D.H. Peterson. 1990. The influence of north Pacific atmospheric circulations on streamflow in the West. *Geophys. Mono.* **55**: 375-397.

Cayan, D.R., M.D. Dettinger, H.F., Diaz, and N.E. Graham. 1998. Decadal variability of precipitation over western North America. *J. Climate.* **11**: 3148-3166.

CCCma (Canadian Centre for Climate Modelling and Analysis). Online: www.cccma.bc.ec.gc.ca

Chan, M. and C. Loh. 2002. Air pollution and health: a briefing paper. Civic Exchange, Hong Kong.

Changnon D., T.B. McKee, N.J. Doeskin. 1993. Annual snowpack patterns across the Rockies: long term trends and associated 500-mb synoptic patterns. *Mon. Weather Rev.* **121**: 633-647.

Ciret, C., A. Henderson-Sellers. 1998. Sensitivity of ecosystem models to the spatial resolution of the NCAR community climate model CCM2. *Clim. Dyn.* **14**: 409-429.

CIT: California Institute of Technology. 1943. Synoptic weather types of North America, technical paper. Meteorol. Dep. Calif. 161pp.

Covey, C., K.M. AchutaRao, U. Cubasch, P. Jones, S.J. Lambert, M.E. Mann, T.J. Phillips, and K.E. Taylor. 2003. An Overview of Results from the Coupled Model Intercomparison Project (CMIP). *Global and Planetary Change.* **37**: 103-133.

DAS (Department of Atmospheric Sciences), University of Illinois Urbana-Champaign. 1999. Weather World 2010 (WW2010) Educational CD-ROM, 2nd Edition.

Delworth, T.L., R.S. Stouffer, K.W. Dixon, M.J. Spelman, T.R. Knutson, A.J. Broccoli, P.J. Kushner, and R.T. Wetherald. 2002. Simulation of climate variability and change by the GFDL R30 coupled model. *Clim. Dyn.* **19**: 555-574.

Dixon, K.W., T.L. Delworth, T.R. Knutson, M.J. Spelman, and R.J. Stouffer. 2003. A comparison of climate change simulations produced by two GFDL coupled climate models. *Global and Planetary Change*, **37**, 81-102.

Doherty, R., L.O. Mearns. 1999. A comparison of simulation of current climate from two coupled atmosphere-ocean global circulation models against observations and evaluation of their future climates. *Report to the National Institute for Global*

Environmental Change (NIGEC). Boulder, CO: ESIG/NCAR. Online: www.esig.ucar.edu/doherty/index.html

Dresler, P.V., M.C. MacCracken, J.M. Melillo, A. Janetos. 1998. National assessment of the potential consequences of climate variability and change for the United States. *Water Resources.* **112**:16-24.

EarthInfo Inc. 2003. National Climatic Data Center - Global Historical Climatology Network data on CD-Rom.

Elliot, R.D. 1951. Extended range forecasting by weather types. In T.F. Malone (ed.), Compendium of Meteorology. Am. Meteorol. Soc., Boston Mass. 834-840.

Ellis, A.W., E.M. Saffell, and T.W. Hawkins. 2004. A Method for Defining Monsoon Onset and Demise in the Southwestern USA. *Int. J. Climatol.* **24**: 247-265.

Felzer, B. and P. Heard. 1999. Precipitation differences amongst GCMs used for the U.S. National Assessment. *J. Am. Water Resour. Assoc.* **35**(6): 1327-1339.

Flato, G.M. 2004. Personal communication. Research Scientist, Canadian Centre for Climate Modelling and Analysis, Victoria, BC.

Flato, G.M., G.J. Boer. 2001. Warming asymmetry in climate change simulations. *Geophys. Res. Lett.* **28**(1): 195-198.

Flato, G.M., G.J. Boer, W.G. Lee, N.A. MacFarlane, D. Ramsden, M.C. Reader, A.J. Weaver. 2000. The Canadian Centre for Climate Modeling and Analysis global coupled model and its climate. *Clim. Dyn.* **16**: 451-467.

Frakes, B., B. Yarnal. 1997. A procedure for blending manual and correlation-based synoptic classifications. *Int. J. Climatol.* **17**: 1381-1396.

Frei, C., C. Schar, D. Luthi, H.C. Davies. 1998. Heavy precipitation processes in a warmer climate. *Geophys. Res. Lett.* **25**(9): 1431-1434.

Gleick, P.H. 1999. Introduction: Studies from the water sector of the National Assessment. *J. Am. Water Resour. Assoc.* **35**(6): 1297-1300.

Gordon, C., C. Cooper, C.A. Senior, H. Banks, J.M. Gregory, T.C. Johns, J.F.B. Mitchell, R.A. Wood. 2000. The simulation of SST, sea ice extent and ocean heat transports in a version of the Hadley Centre coupled model without flux adjustments. *Clim. Dyn.* **16**: 147-168.

Hay, L.E., R.L. Wilby, G.H. Leavesley. 2000. A comparison of delta change and downscaled GCM scenarios for three mountainous basins in the United States. *J. Am. Water Res. Assoc.* **36**(2): 387-397.

Hengeveld, H.G. 2000. Projections for Canada's climate future – a discussion of recent simulations with the Canadian Climate Model. Meteorological Service of Canada, Minister of Public Works and Government Services Canada.

Higgins, R.W., Y. Chen, A.V. Douglas. 1999. Interannual variability of the North American warm season precipitation regime. *J. Climate.* **12**: 653-680.

Houghton, J. T., L.G. Meira Filho, B.A. Callandar, N. Harris, A. Kattenburg and K. Maskell (Eds.). 1996. Climate Change 1995: The Science of Climate Change. Contribution to the Working Group I to the Second Assessment Report of the IPCC. Cambridge University Press, UK. Pp. 572.

Houghton, J. T., Y. Ding, D.J. Griggs, M. Noguer, P. J. van der Linden, D. Xiaosu (Eds.). 2001. Climate Change 2001: the Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, UK. pp 944

Hughes, J.P., D.P. Lettenmaier and P. Guttorp. 1993. A stochastic approach for assessing the effect of changes in synoptic circulation patterns on gauge precipitation. *Water Resour. Res.* **29**(10): 3303-3315.

Huth, R., J. Kysely. 2000. Constructing site-specific climate change scenarios on a monthly scale using statistical downscaling. *Theor. Appl. Climatol.* **66**: 13-27.

Huth, R. 1996. An intercomparison of computer-assisted circulation classification methods. *Int. J. Climatol.* **16**: 893-922.

Johns, T.C., R.E. Carnell, J.F. Crossley, J.M. Gregory, J.F.B. Mitchell, C.A. Senior, S.F.B. Tett, and R.A. Wood. 1997. The second Hadley Centre coupled ocean-atmosphere GCM: model description, spinup and validation. *Clim. Dyn.* **13**: 103-134.

Kalnay, E., M. Kanamitsu, R. Kistler, W. Collins, D. Deaven, L. Gandin, M. Iredell, S. Saha, G. White, J. Woollen, Y. Zhu, A. Leetmaa, B. Reynolds, M. Chelliah, W. Ebisuzaki, W. Higgins, J. Janowiak, K.C. Mo, C. Ropelewski, J. Wang, R. Jenne and D. Joseph . 1996. The NCEP/NCAR 40-year reanalysis project. *Bull. Am. Meteorol. Soc.* **77**: 437-471.

Karoly, D.J., K. Braganza, P.A. Stott, J.M. Arblaster, G.A. Meehl, A.J. Broccoli, K.W. Dixon. 2003. Detection of a Human Influence on North American Climate. *Science*. **302**(5648): 1200-1203.

Kaufmann, R.K., S.E. Snell, S. Gopal, and R. Dezzani. 1999. The significance of synoptic patterns identified by the Kirchhofer technique: a Monte Carlo approach. *Int. J. Climatol.* **19**: 619-626.

Keeling, C.D., T.P. Whorf, and the Carbon Dioxide Research Group. 2004. Atmospheric CO2 concentrations (ppmv) derived from in situ air samples collected at Mauna Loa Observatory, Hawaii. Scripps Institution of Oceanography (SIO) University of California, La Jolla, California USA.

Key, J. and R.G. Crane. 1986. A comparison of synoptic classification schemes based on 'objective' procedures. *J. Climatol.* **6**: 375-388.

Kidson, J.W., C.S. Thompson. 1998. A comparison of statistical and model-based downscaling techniques fro estimating local climate variations. *J. Climate.* **11**: 735-753.

Kim, S.J., G.M. Flato, G.J. Boer, N.A. McFarlane. 2002. A coupled climate model simulation of the Last Glacial Maximum, Part 1: transient multi-decadal response. *Clim. Dyn.* **19**: 515-537.

Kim, S.J., G.M. Flato, G.J. Boer. 2003. A coupled climate model simulation of the Last Glacial Maximum, Part 2: Approach to equilibrium. *Clim. Dyn.* **20**: 635–661.

Kirchhofer, W. 1973. Classification of European 500mb patterns, Arbeitsbericht der schweizerischen meteorologischn zentralanstalt. **43**. Geneva, Switzerland.

Kniazkov, M. 2005. Shrunken US lake a barometer of five-year drought. *Globe and Mail*, Tuesday January 4, 2005: A9.

Knupp, K.R., B. Geerts, and S.J. Goodman. 1998. Analysis of a small, vigorous mesoscale convective system in a low-shear environment, part 1: formation, radar echo structure, and lightning behaviour. *Mon. Wether Rev.* **126**: 1812-1836.

Konrad, C.E. 1997. Synoptic-scale features associated with warm season heavy rainfall over the interior southeastern United States. *Weather Forecast.* **12**(1): 557-571.

Koster, R.D., P.A. Dirmeyer, Z. Guo, G. Bonan, E. Chan, P. Cox, C.T. Gordon, S. Kanae, E. Kowalczyk, D. Lawrence, P. Liu, C. Lu, S. Malyshev, B. McAvaney, K. Mitchell, D. Mocko, T. Oki, K. Oleson, A. Pitman, Y.C. Sud, C.M. Taylor, D. Verseghy, R. Vasic, Y. Xue, and T. Yamada. 2004. Regions of strong coupling between soil moisture and precipitation. *Science*. **305**: 1138-1140.

Krichak, S.O., M. Tsidulko, and P. Alpert. 2000. Monthly synoptic patterns associated with wet/dry conditions in the eastern Mediterranean. *Theor. Appl. Climatol.* **65**: 215-229.

Kung, E.C. 1967. Diurnal and long-term variations of the kinetic energy generation and dissipation for a five year period. *Mon. Weather Rev.* **95**: 593-606.

Kung, E.C. 1969. Further study on the kinetic energy balance. *Mon. Weather Rev.* **97**: 573-581.

Kung, E.C., and T.L. Tsui. 1975. Subsynoptic-scale kinetic energy balance in the storm area. *J. Atmos. Sci.* **32**: 729-740.

Lamb, H. H. 1972. British Isles weather types and a register of the daily sequence of circulation patterns 1861-1971.

Lapp S., J. Byrne, S. Kienzle, I. Townshend. 2002. Linking global circulation model synoptics and precipitation for western North America. *Int. J. Climatol.* **22**: 1807-1817.

Lapp, S., J. Byrne, I. Townshend and S. Kienzle. 2005. Climate Warming Impacts on Snowpack Accumulation in an Alpine Watershed: A GIS Based Modeling Approach. *Int. J. Climatol.*, in press.

Latif, M. and T.P. Barnett. 1994. Causes of decadal climate variability over the North Pacific and North America. *Science*. **266**(5185): 634-637.

Lee, K., R. Wanninkhof, T. Takahashi, S.C. Doney, and R.A. Feely. 1998. Low interannual variability in recent oceanic uptake of atmospheric carbon dioxide. *Nature*. **396**(6707): 155–159.

Lueng, L.R. and M.S. Wigmosta. 1999. Potential climate change impacts on mountain watersheds in the Pacific Northwest. *J. Am. Water Resour. Assoc.* **35**(6): 1463-1471.

Lund, I.A. 1963. Map-pattern classification by statistical methods. *J. Appl. Meteorol.* **2**: 56-65.

Mann, M.E., R.S. Bradley, M.K. Hughes. 1998. Global-Scale Temperature Patterns and Climate Forcing Over the Past Six Centuries. *Nature*. **392**: 779-787.

Mason, B.J. 1975. Clouds, Rain and Rainmaking. Cambridge University Press, New York.

McCabe, G.J. 1996. Effects of winter atmospheric circulation on temporal and spatial variability in annual streamflow in the western United States. *Hydrolog. Sci. J.* **41**(6): 873-887.

McCabe, G.J., D.M. Wolock. 1999. General-circulation-model simulations of future snowpack in the western United States. *J. Am. Water Resour. Assoc.* **35**(6): 1473-1483.

McFarlane, N.A., G.J. Boer, J-P. Blanchet, M. Lazare. 1992. The Canadian Climate Centre Second-Generation general circulation model and its equilibrium climate. *J. Climate*. **5**: 1013-1044.

McKendry, I.G., D.G. Steyn, G. McBean. 1995. Validation of synoptic circulation patterns simulated by the Canadian Climate Centre General Circulation Model for Western North America. *Atmos. Ocean.* **33**(4): 809-825.

Mearns, L.O., I. Bogardi, F. Girogi, I. Matyasovszky, M. Palecki. 1999. Comparison of climate change scenarios generated from regional climate model experiments and statistical downscaling. *J. Geophys. Res.* **104**(D6): 6603-6621.

Miller, N.L., J. Kim, R.K. Hartman, J. Farrara. 1999. Downscaled climate and streamflow study of the southwestern United States. *J. Am. Water Resour. Assoc.* **35**(6): 1525-1537.

Moore, R.D., I.G. McKendry. 1996. Spring snowpack anomaly patterns and winter climatic variability, British Columbia, Canada. *Water Resour. Res.* **32**(3): 623-632.

Nakicenovic, N. and R. Swart, (eds.). 2000. Special Report on Emissions Scenarios. Cambridge University Press, Cambridge, United Kingdom, 612 pp.

Ojima, D., L. Garcia, E. Elgaali, K. Miller, T.G.F. Kittel, J. Lackett. 1999. Potential climate change impacts on water resources on the Great Plains. *J. Am. Water Resour. Assoc.* **35**(6): 1443-1453.

Palmer, T., F. Doblas-Reyes, R. Hagedorn. 2004. DEMETER: A Multi-Model Ensemble System for Reliable Seasonal to Interannual Prediction. 1st International CLIVAR (Climate Variability and Predictability) Science Conference, Baltimore, Maryland: June 21-25.

Parmesan, C. and H. Galbraith. 2004. Observed impacts of global climate change in the US. Pew Center on Global Climate Change, Arlington, VA.

Paul, A.H. 1982. The thunderstorm hazards on the Canadian prairies. *Geoforum.* **13**(4): 275-288.

Pavan, V., S. Marchesi, A. Morgillo, C. Cacciamani, and F. Doblas-Reyes. 2004. Seasonal predictability for winter precipitation and surface temperature over northern Italy. *Geophys. Res. Abstr.* **6**.

Petit, J.R., J. Jouzel, D. Raynaud, N.I. Barkov, J.-M. Barnola, I. Basile, M. Benders, J. Chappellaz, M. Davis, G. Delayque, M. Delmotte, V.M. Kotlyakov, M. Legrand, V.Y. Lipenkov, C. Lorius, L. Pépin, C. Ritz, E. Saltzman, and M. Stievenard. 1999. Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. *Nature.* **399**: 429-436.

Pidwirny, M. 2004. Fundamentals of Physical Geography: Online Textbook. Online: physicalgeography.net. Department of Geography, Okanagan University College Kelowna, B.C.

Roeckner, E., L. Bengtsson, J. Feichter, J. Lelieveld, H. Rodhe. 1999. Transient climate change simulations with a coupled atmosphere-ocean GCM including the tropospheric sulfur cycle. *J. Climate.* **12**: 3004-3032.

Rowson, D.R. and S.J. Collucci. 1992. Synoptic climatology of thermal low-pressure systems over southwestern North America. *Int. J. Climatol.* **12**: 529-545.

Russell, G.L., J.R. Miller, and D. Rind. 1995. A coupled atmosphere-ocean model for transient climate change studies. *Atmos. Ocean.* **33**: 683-730.

Russell, G.L., and D. Rind. 1999. Response to CO_2 transient increase in the GISS coupled model: Regional coolings in a warming climate. *J. Climate.* **12**: 531-539.

Shafer, S.L., P.J. Bartlein, and R.S. Thompson. 2001. Potential changes in the distributions of western North America tree and shrub taxa under future climate scenarios. *Ecosystems*. **4**: 200-215.

Stott, P.A., S.F.B. Tett, G.S. Jones, M.R. Allen, J.F.B. Mitchell, G.J. Jenkins. 2000. External Control of 20th Century Temperature by Natural and Anthropogenic Forcings. *Science*. **290**(5499): 2133-2137.

Stouffer, R.J., S. Manabe. 1999. Response of a coupled ocean-atmosphere model to increasing atmospheric carbon dioxide: sensitivity to the rate of increase. *J. Climate*. **12**: 2224-2237.

Strong, G.S. and C.D. Smith. 2001. Assessment and prediction of prairie severe thunderstorm weather phenomena. Public Safety and Emergency Preparedness Canada, Her Majesty the Queen in Right of Canada (2001).

Trenberth, K.E. 1990. Recent observed interdecadal climate changes in the northern hemisphere. *Bull. Am. Meteorol. Soc.* **71**: 993-998.

Trenberth, K.E. 1995. Atmospheric circulation climate changes. *Clim. Change*. **31**: 427-453.

Trigo, R.M., J.P. Palutikof. 2001. Precipitation scenarios over Iberia: a comparison between direct GCM output and different downscaling techniques. *J. Climate*. **14**: 4422-4446.

Veirs, S. D. 1981. Coast redwood forest stand dynamics, succession status, and the role of fire. Pages 119-141 In (J. E. Means ed.) Proceedings of forest succession and stand development in the northwest. Oregon State Univ., Corvallis.

Viessman, W. Jr., G.L. Lewis. 2003. Introduction to hydrology. Pearson Education, Inc. Upper Saddle River, NJ.

Von Storch, H., E. Zorita, U. Cubasch. 1993. Downscaling of global climate change estimates to regional scales: an application to Iberian rainfall in wintertime. *J. Climate*. **6**: 1161-1171.

Wallace, C.E., R.A. Maddox, K.W. Howard. 1999. Summertime convective storm environments in central Arizona: local observations. *Weather and Forecasting*. **14**: 994-1006.

Wilby, R.L., L.E. Hay, G.H. Leavesley. 1999. A comparison of downscaled and raw GCM output: implications for climate change in the San Juan River basin, Colorado. *J. Hydrology*. **225**: 67-91.

Wilby, R.L., T.M.L. Wigley. 2000. Precipitation predictors for downscaling: observed and general circulation model relationships. *Int. J. Climatol.* **20**: 641-661.

WTO –World Tourism Organization. 2003. Proceedings of the 1st International Conference on Climate Change and Tourism. Djerba, Tunisia. April 9-11, 2003.

Wu, W., R.E. Dickinson, H.Wang, Y. Liu, M. Shaikh, Y. Dai, Y. Tian, and L. Zhou. 2004. Covariabilities of spring soil moisture and summer precipitation in US. *J. of Geophys. Res. - Atmospheres*, revised.

Yarnal, B., H. F. Diaz. 1986. Relationships between extremes of the Southern Oscillation and the winter climate of the Anglo-American Pacific coast. *J. Climatol.*, **6**: 197-219.

Yarnal, B., B. Frakes. 1997. Using synoptic climatology to define representative discharge events. *Int. J. Climatol.* **17**: 323-341.

Zeng, Z, S.E. Yutter, R.A. Houze Jr. 2001. Microphysics of the rapid development of heavy convective precipitation. *Mon. Weather Rev.* **129**: 1882-1904.

Zorita, E., and H. von Storch. 1999. The analog method as a simple statistical downscaling technique: comparison with more complicated methods. *J. Climate.* **12**: 2474-2489.

Zwiers, F.W., A.J. Weaver. 2000. Climate change: the causes of 20th century warming. *Science.* **290**: 2081-2083.

Appendix A

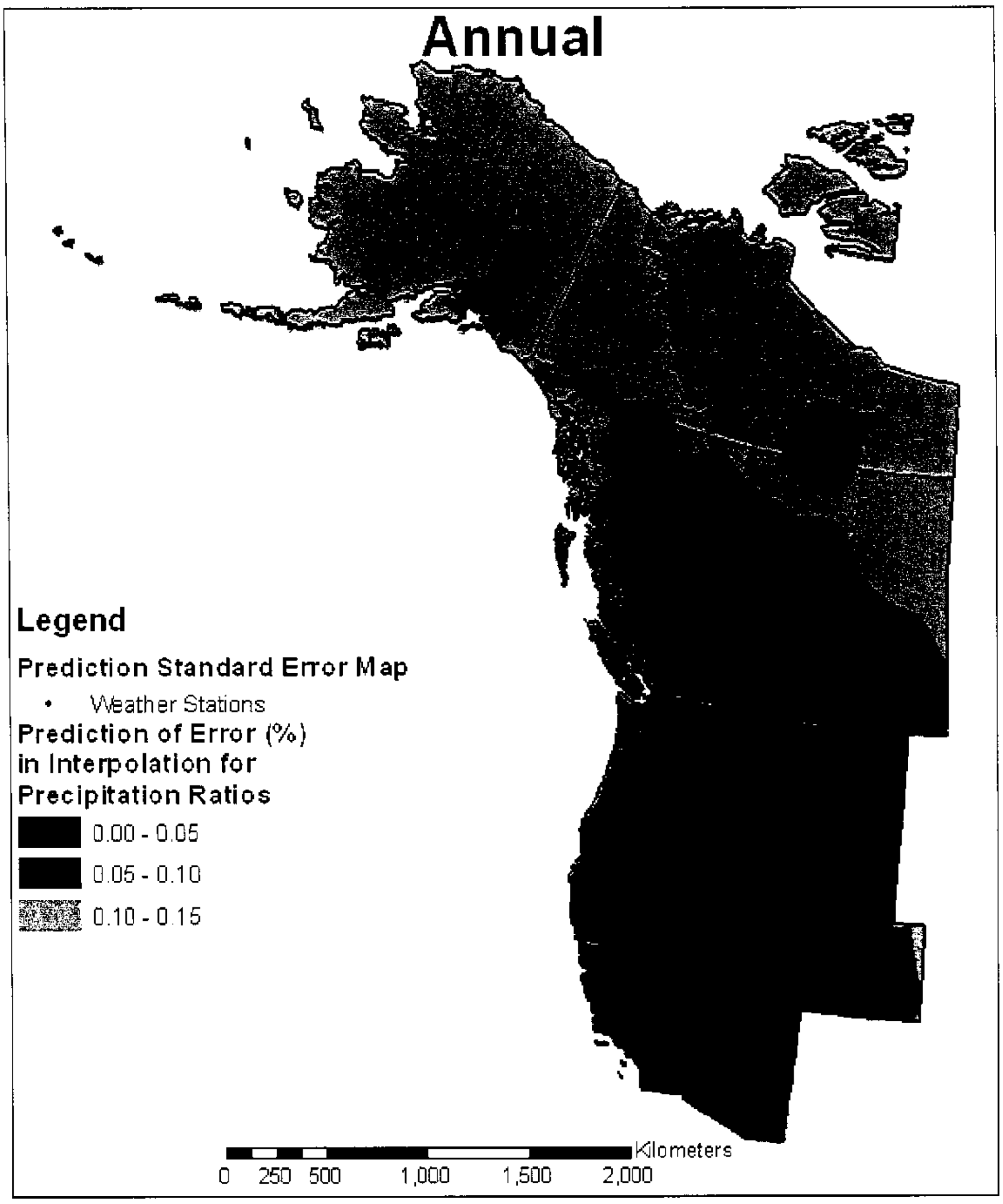


Figure A.1a Prediction standard error of the annual precipitation ratio interpolation.

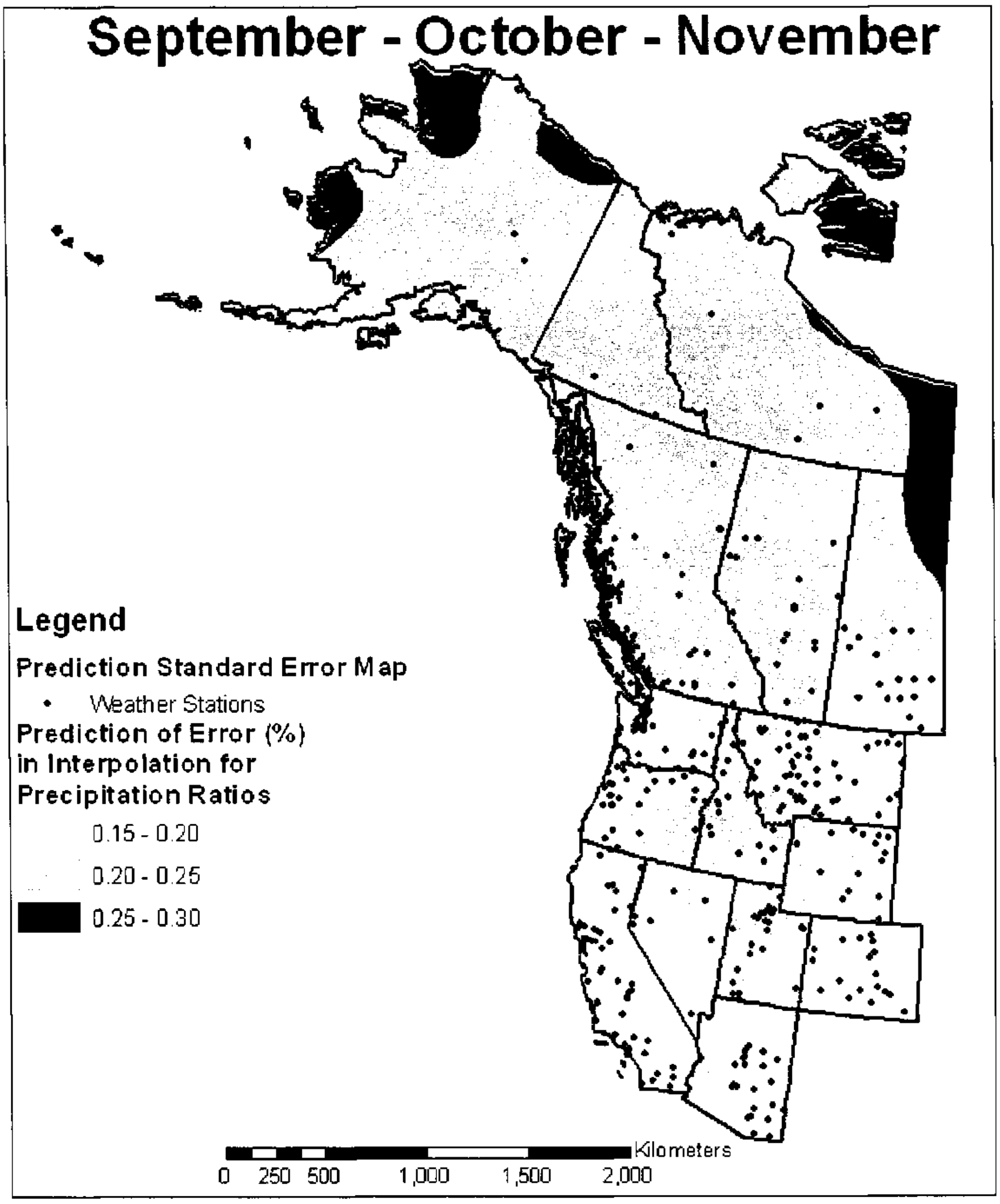


Figure A.1b Prediction standard error of the Fall (September, October, November) precipitation ratio interpolation.

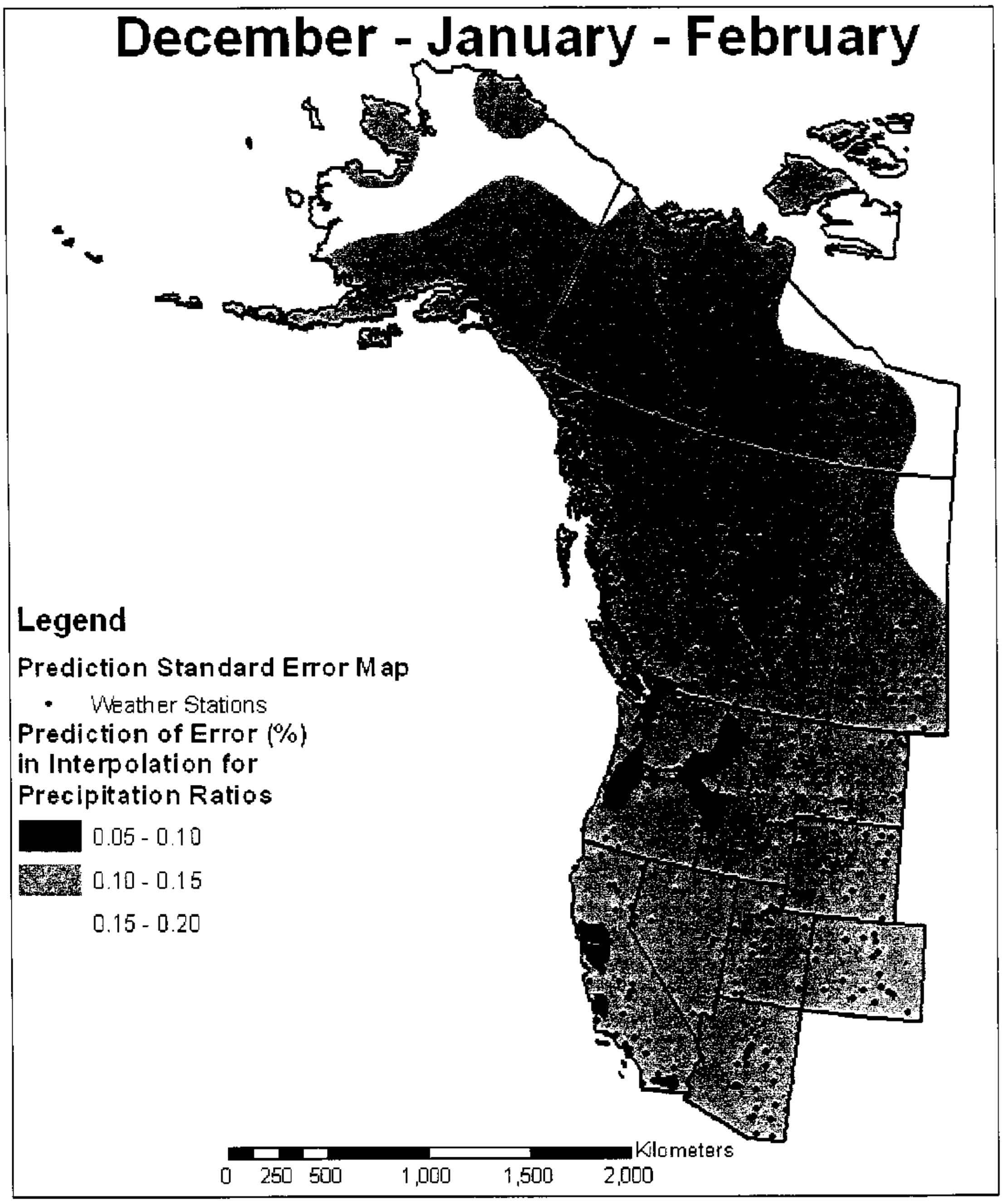


Figure A.1c Prediction standard error of the winter (December, January, February) precipitation ratio interpolation.

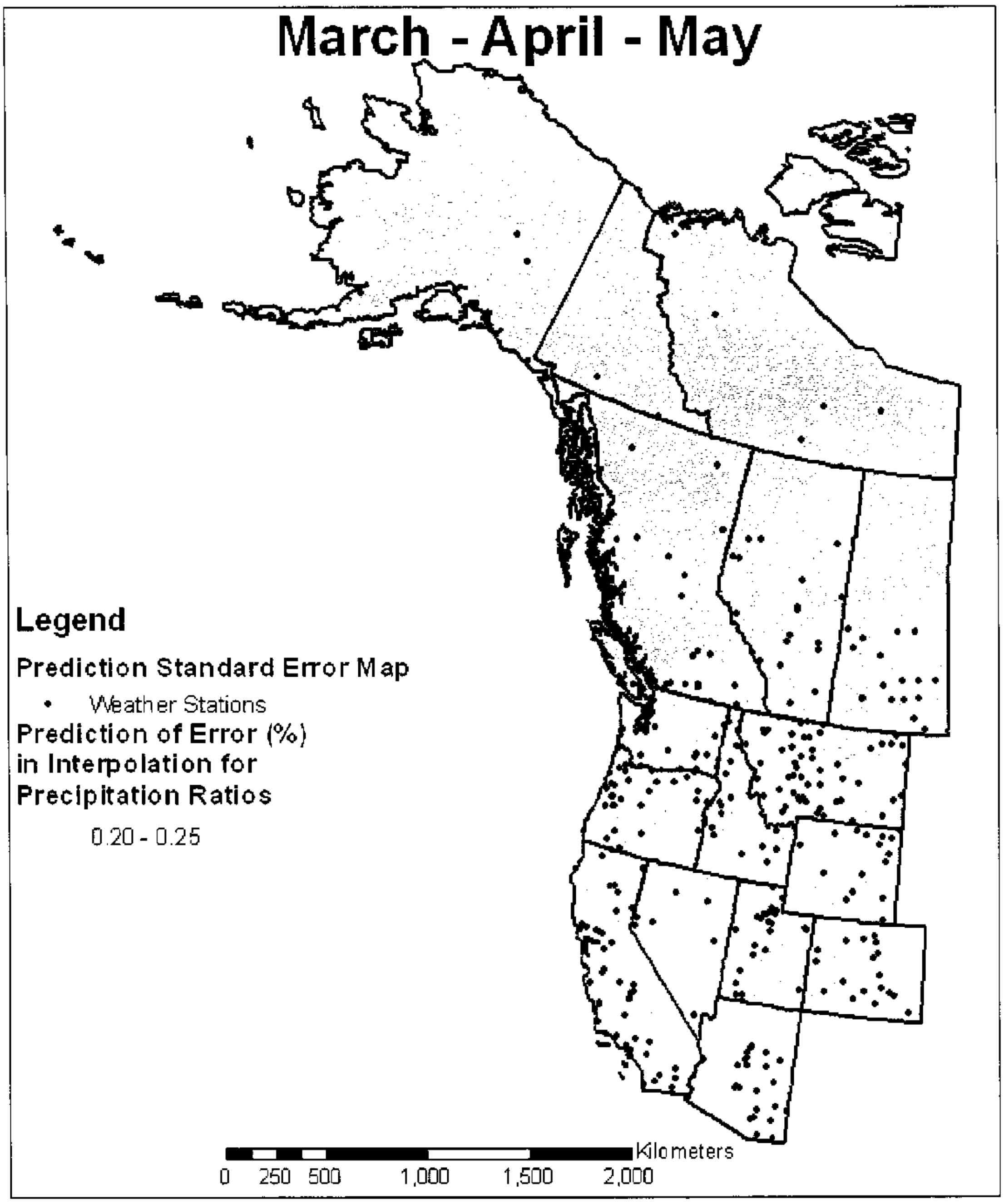


Figure A.1d Prediction standard error of the Spring (March, April, May) precipitation ratio interpolation.

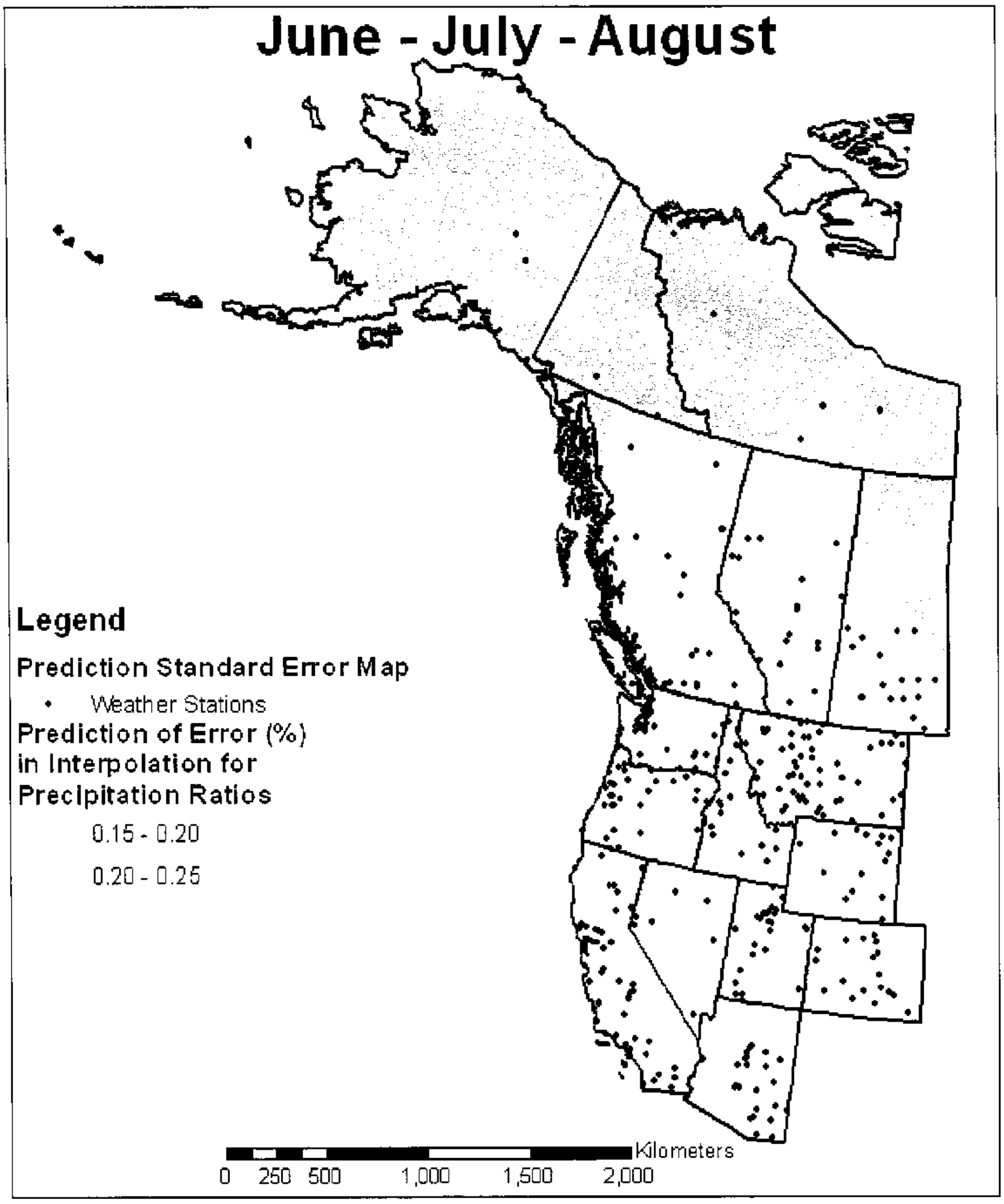


Figure A.1e Prediction standard error of the Summer (June, July, August) precipitation ratio interpolation.

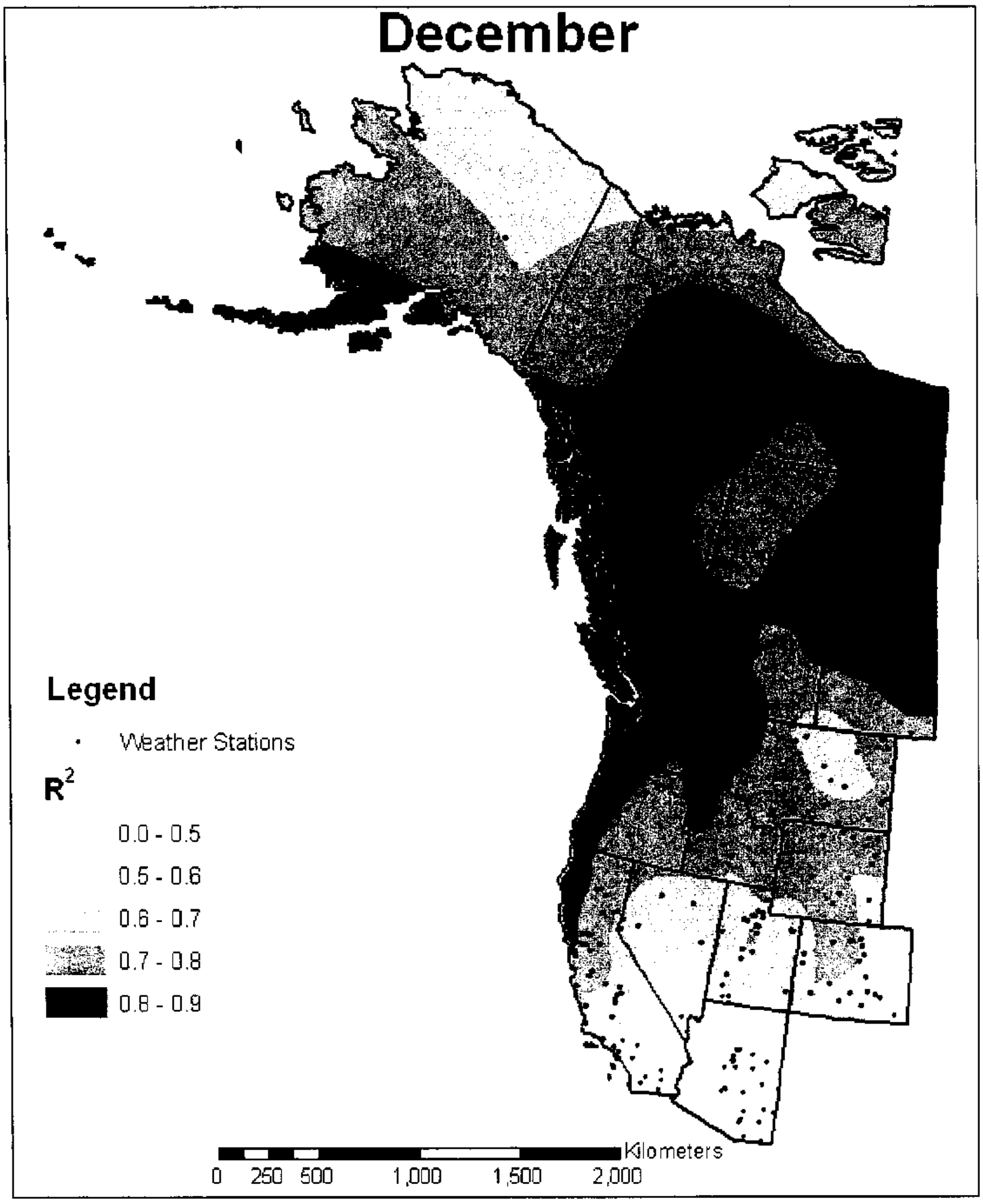


Figure A.2a R^2 Map showing the fit of the precipitation forecast and regression model for December.

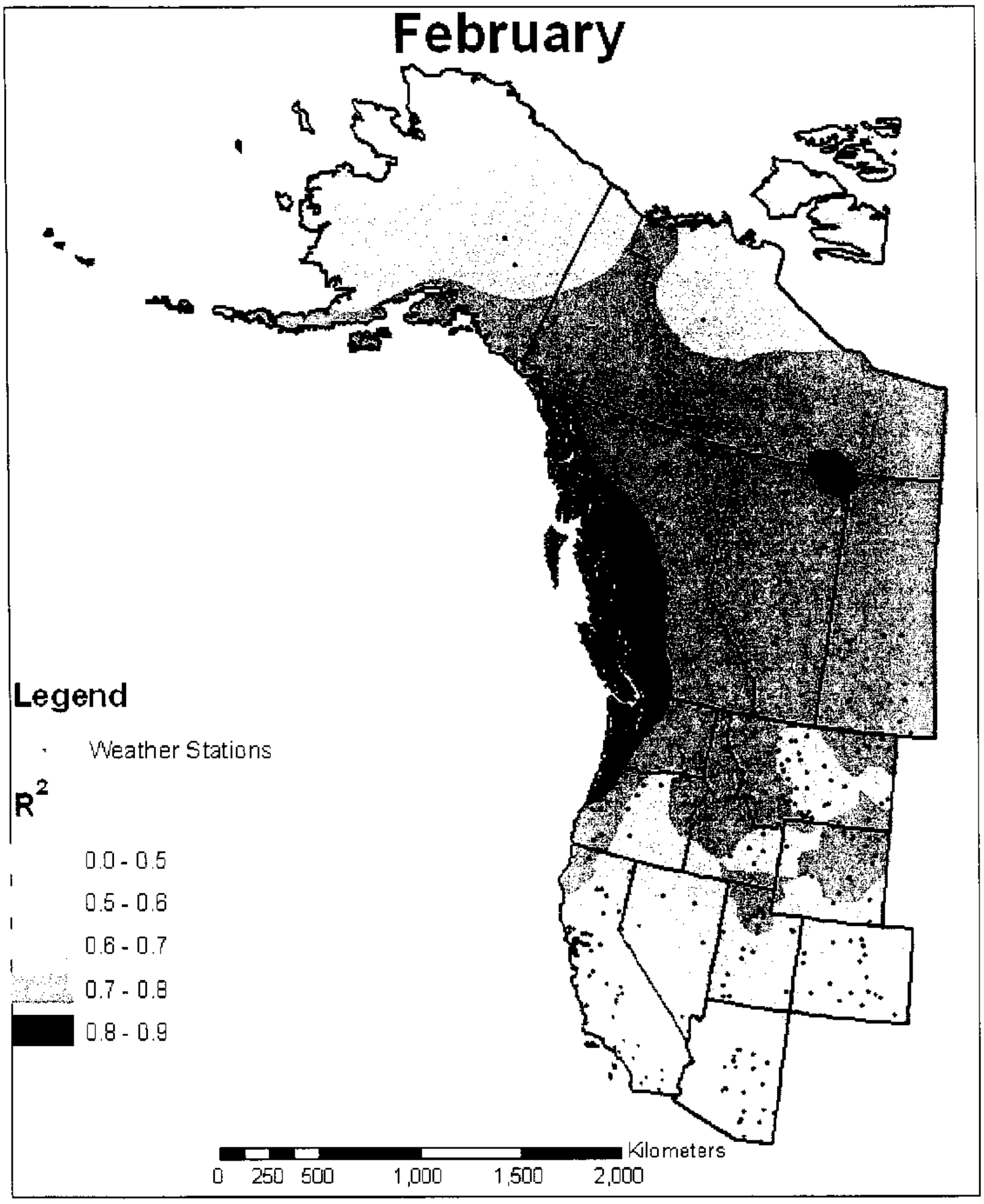


Figure A.2b R^2 Map showing the fit of the precipitation forecast and regression model for February.

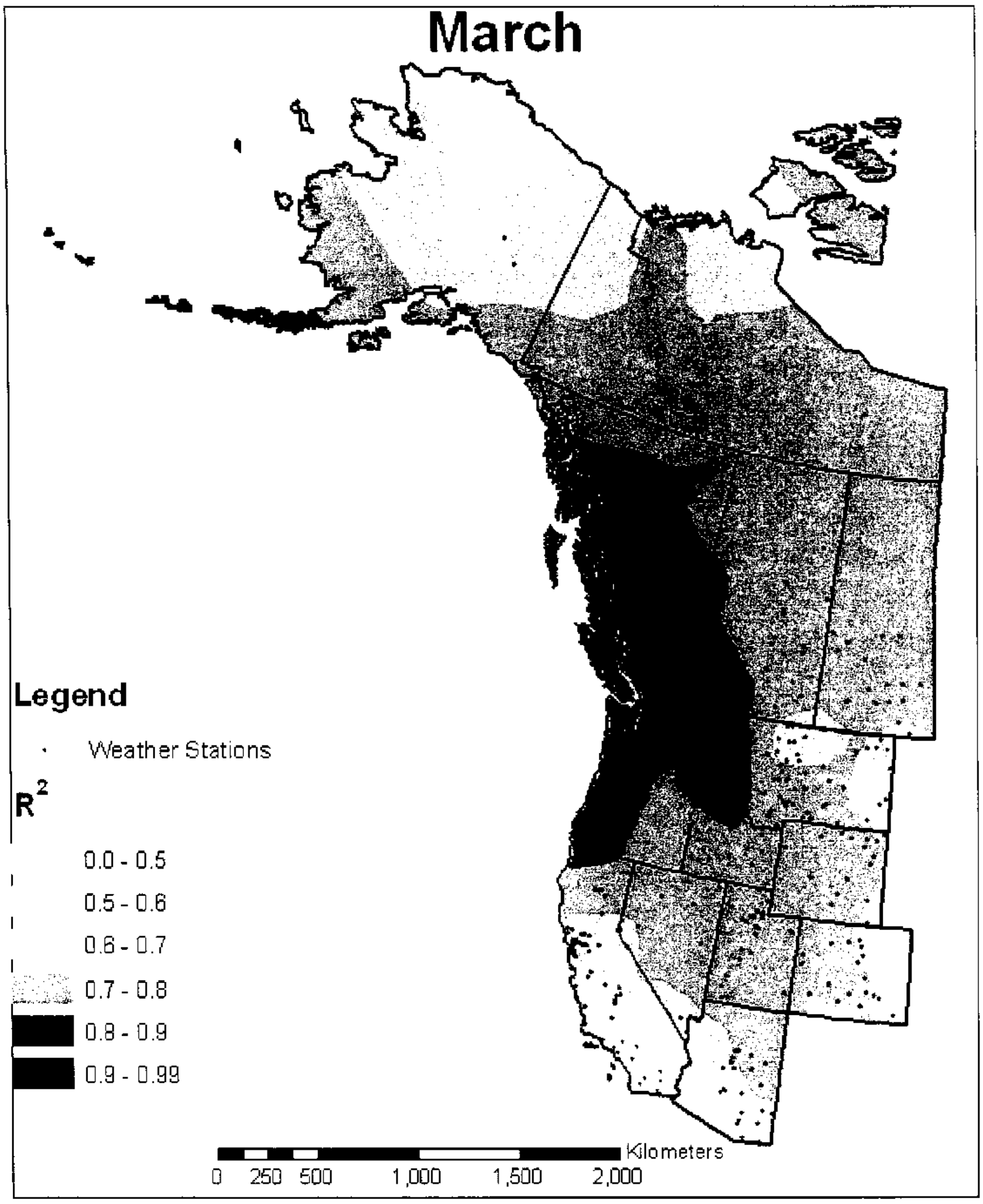


Figure A.2c R^2 Map showing the fit of the precipitation forecast and regression model for March.

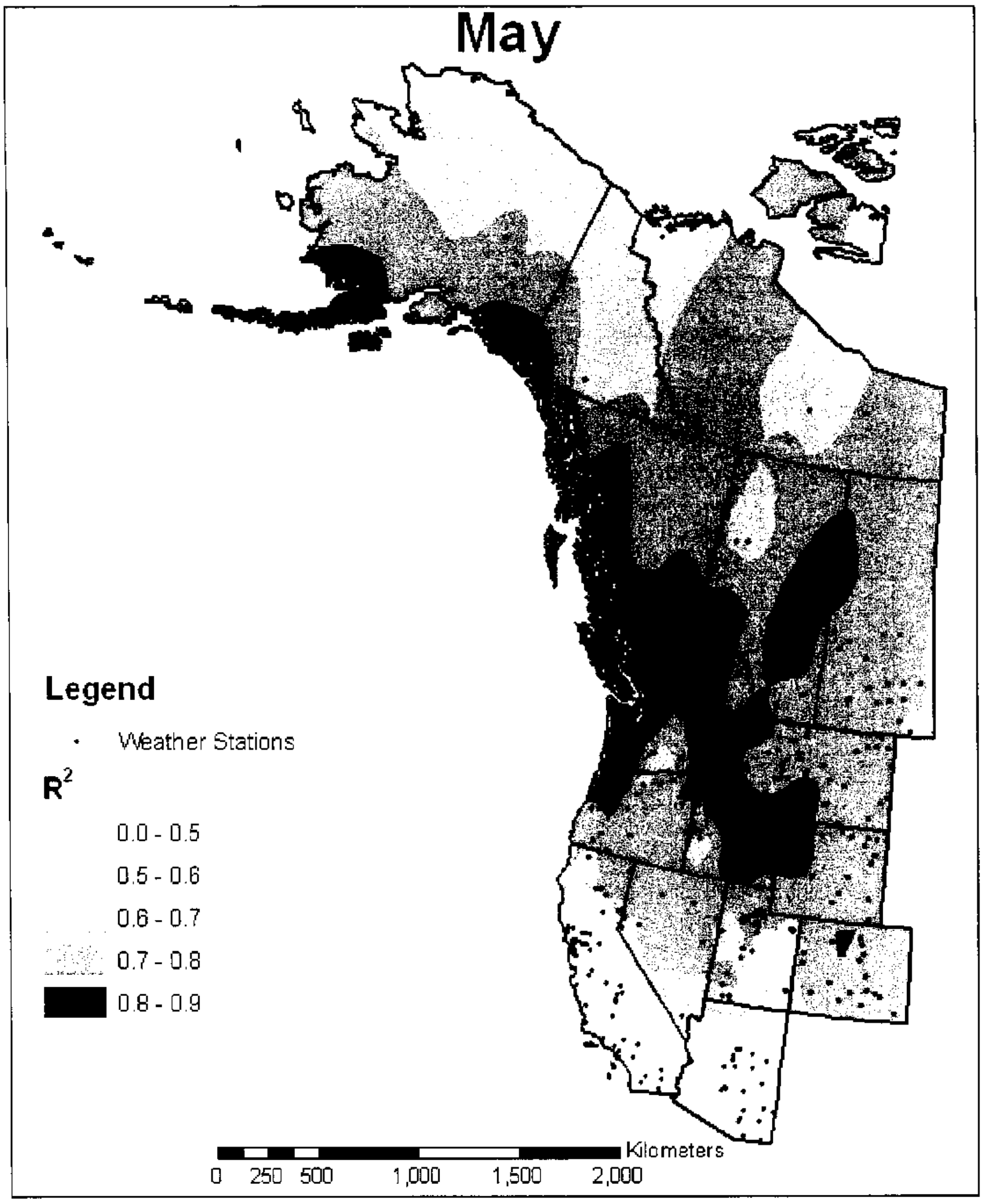


Figure A.2d R^2 Map showing the fit of the precipitation forecast and regression model for May.

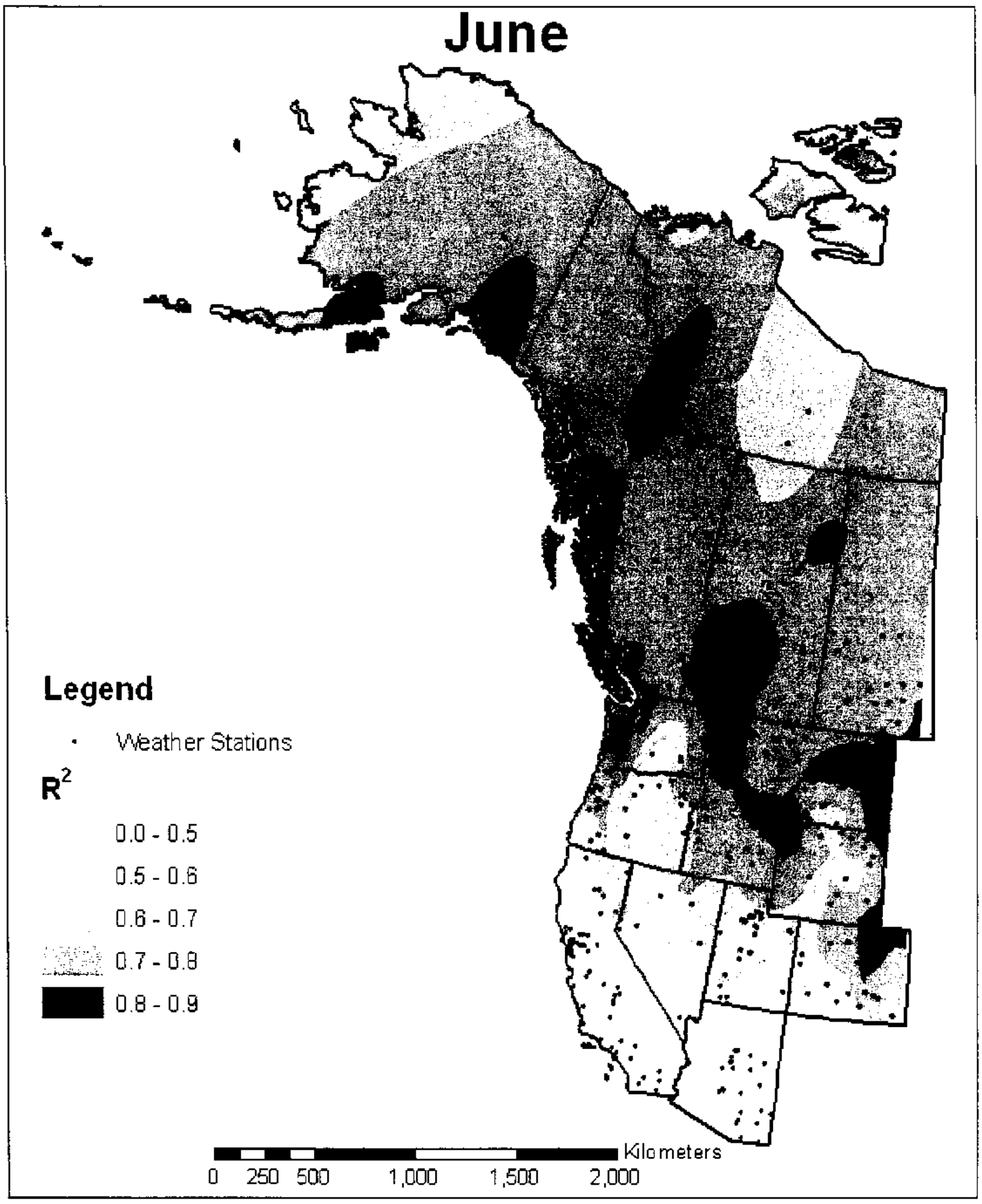


Figure A.2e R^2 Map showing the fit of the precipitation forecast and regression model for June.

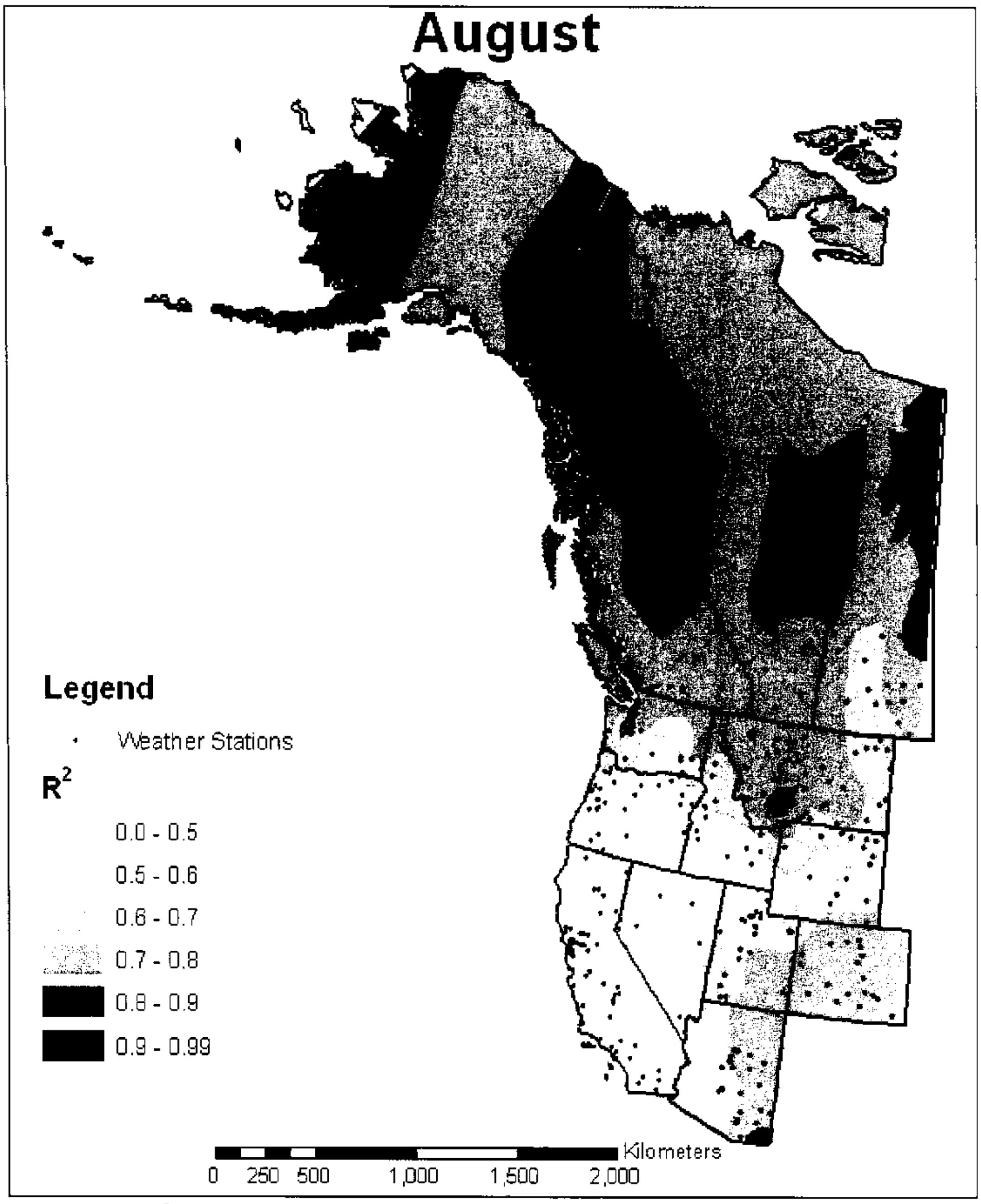


Figure A.2f R^2 Map showing the fit of the precipitation forecast and regression model for August.

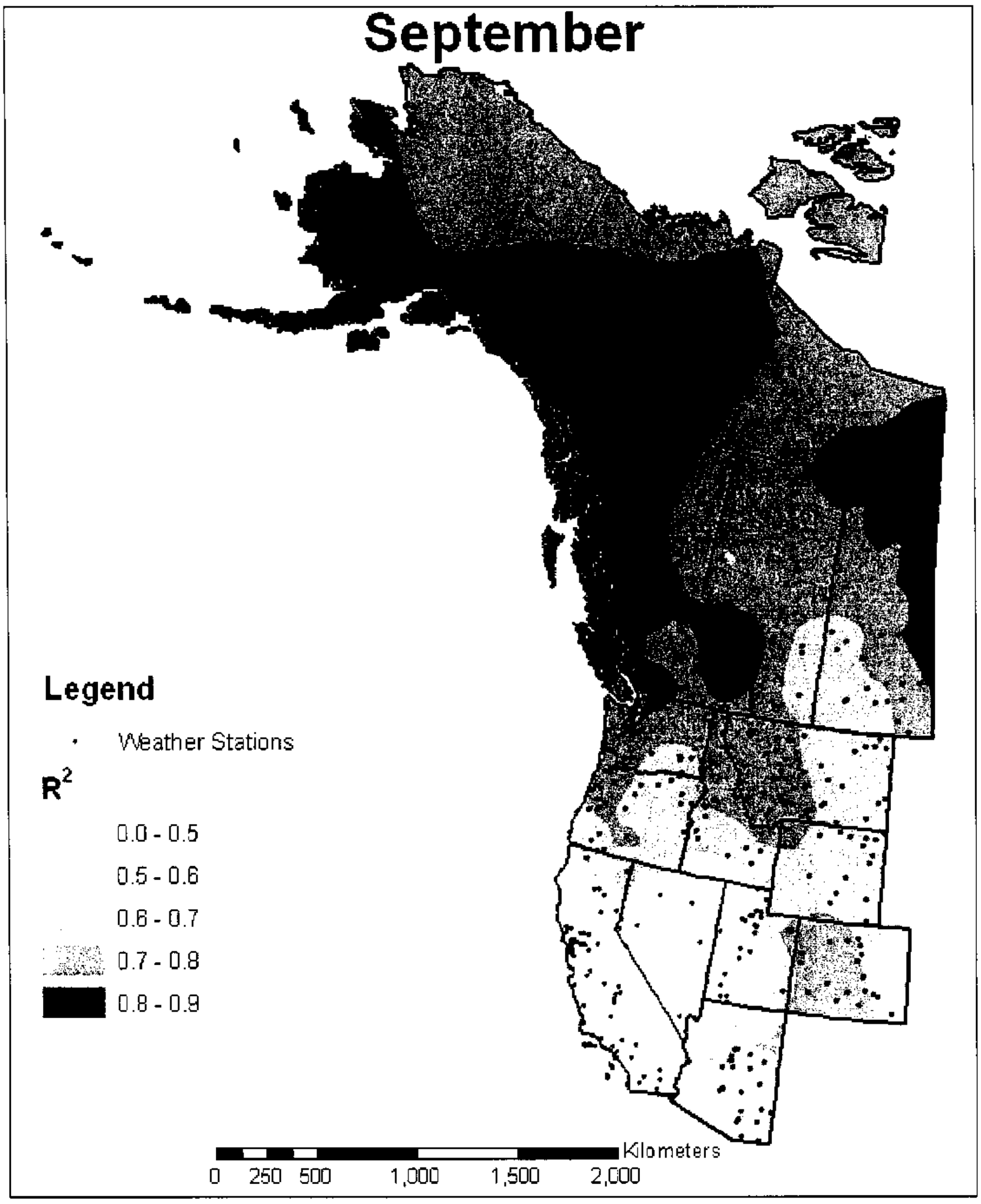


Figure A.2g R^2 Map showing the fit of the precipitation forecast and regression model for September.

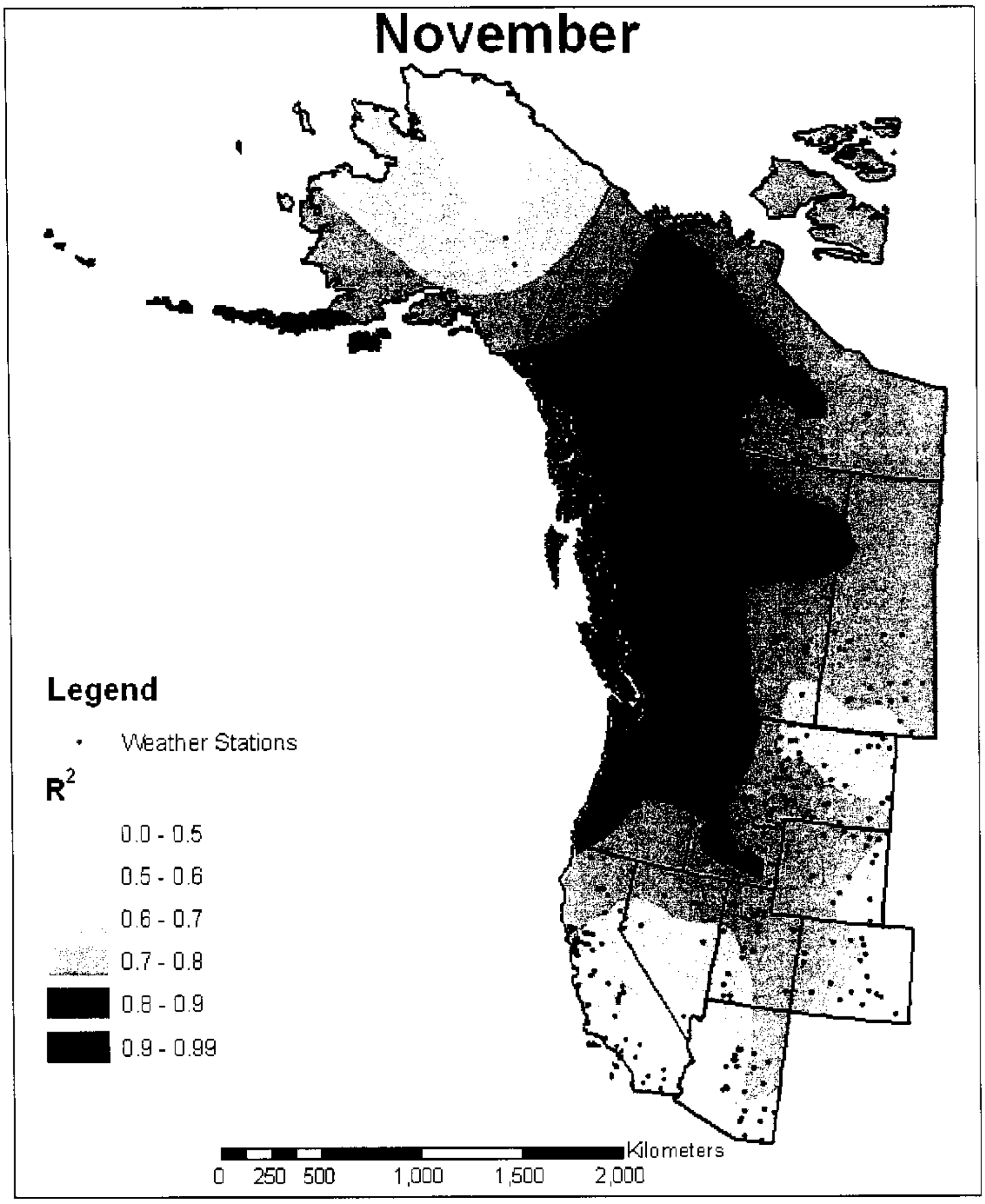
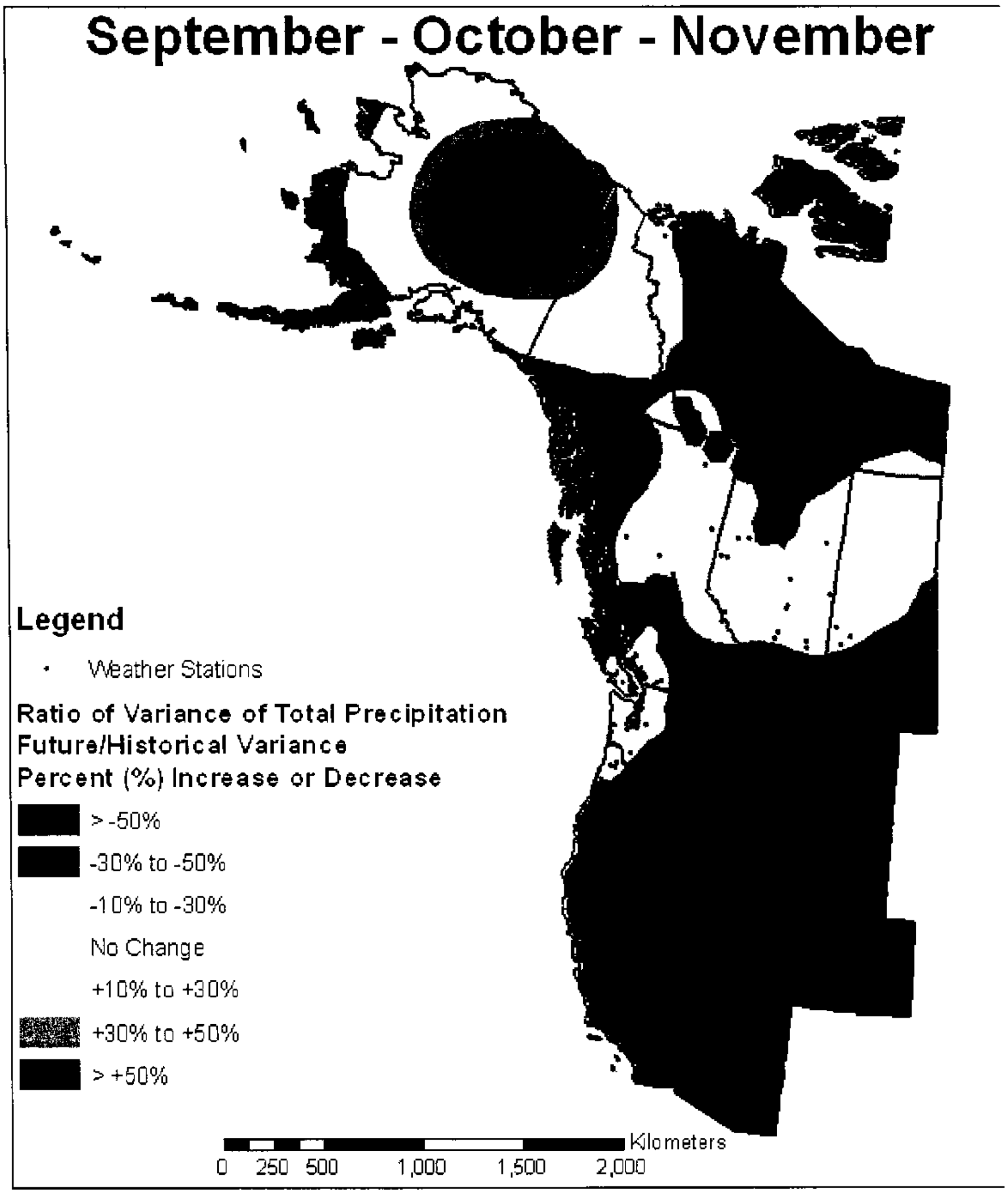
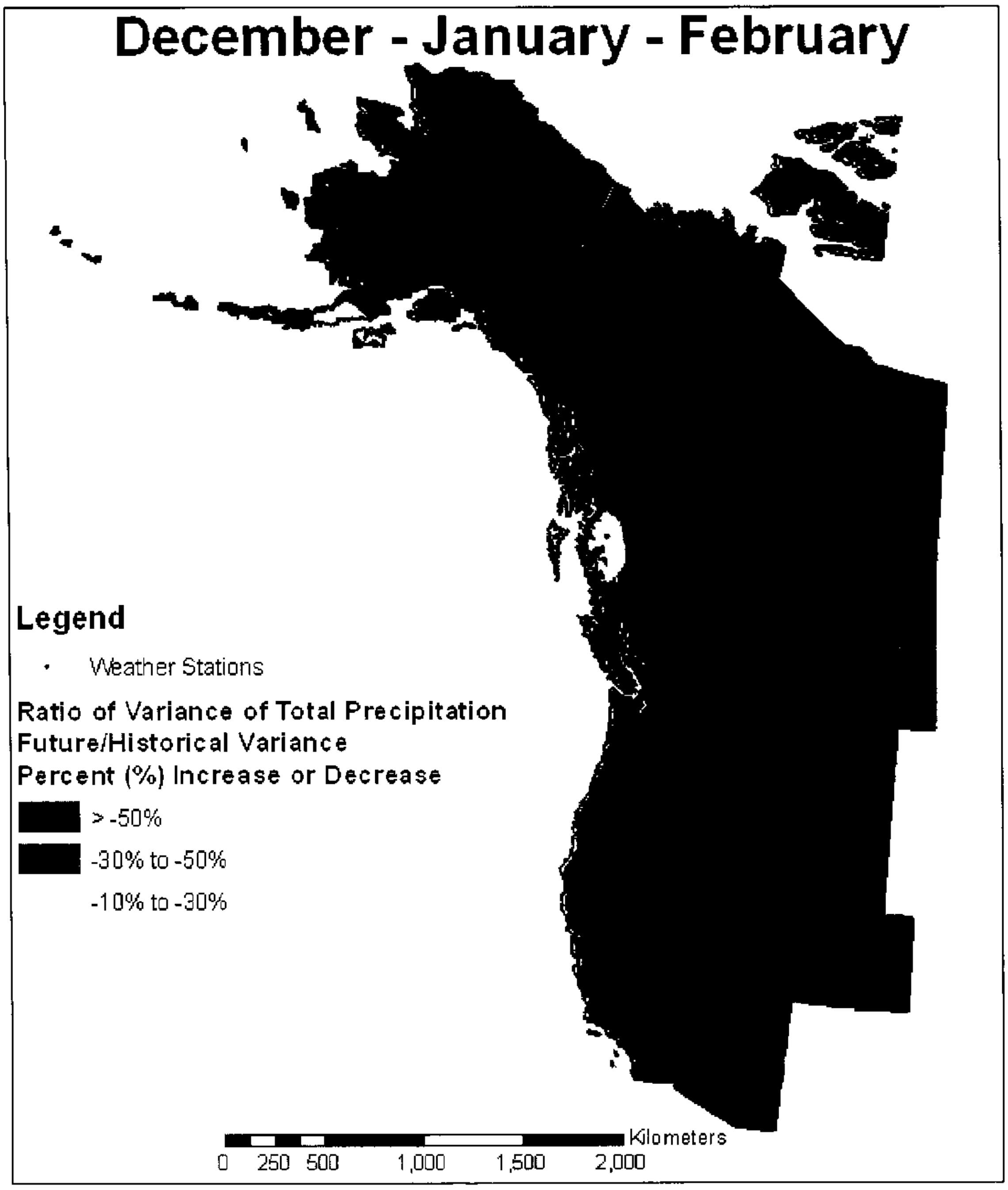


Figure A.2h R^2 Map showing the fit of the precipitation forecast and regression model for November.

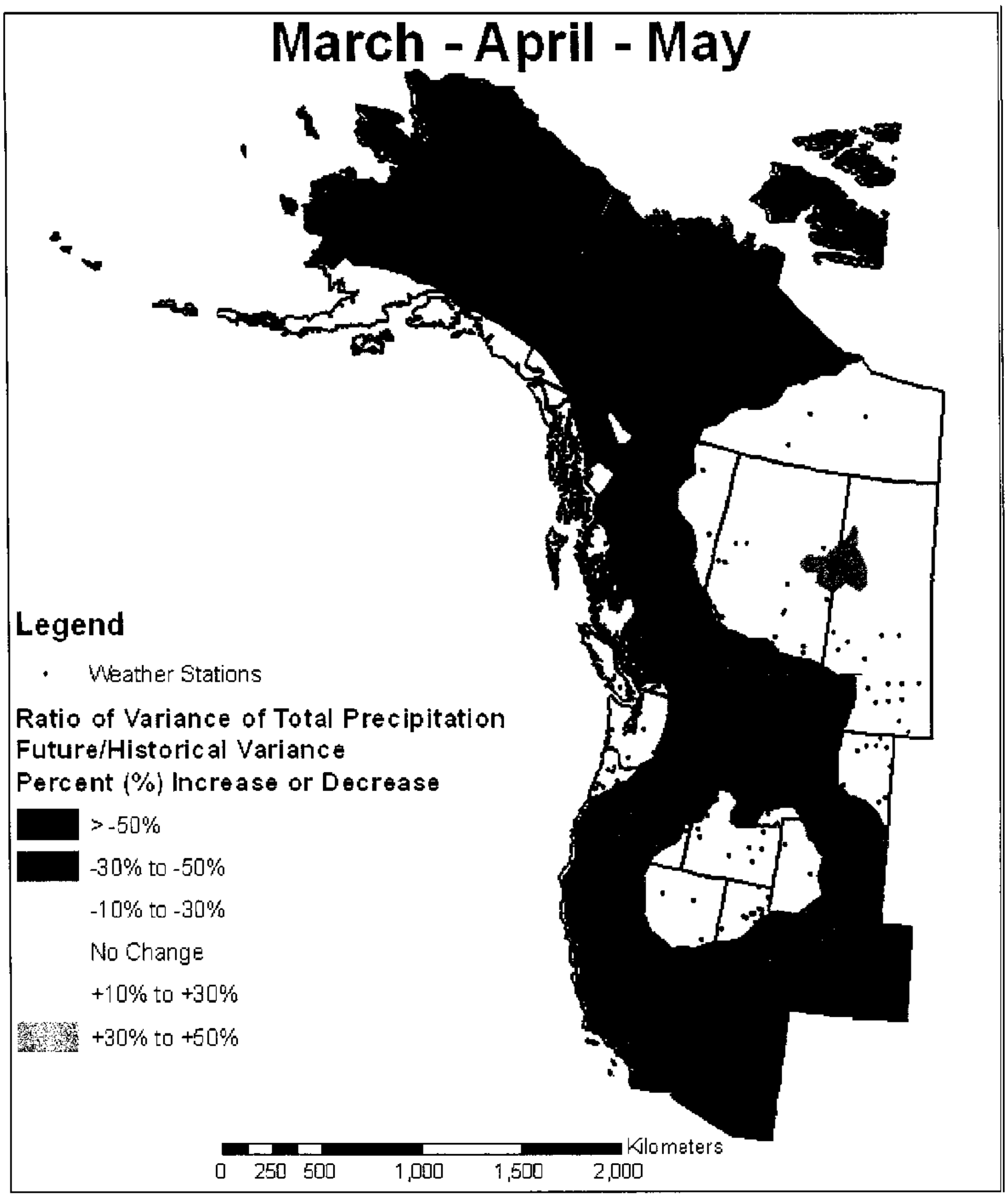


A.3a Fall (September, October, November) spatial distribution of future seasonal precipitation variance under forecast climate change in western North America.

****Note: the two stations in Alaska creating the greater than 50% increase in variance are subject to the constraints discussed in section 3.6.**



A.3b Winter (December, January, February) spatial distribution of future seasonal precipitation variance under forecast climate change in western North America.



A.3c Spring (March, April, May) spatial distribution of future seasonal precipitation variance under forecast climate change in western North America.

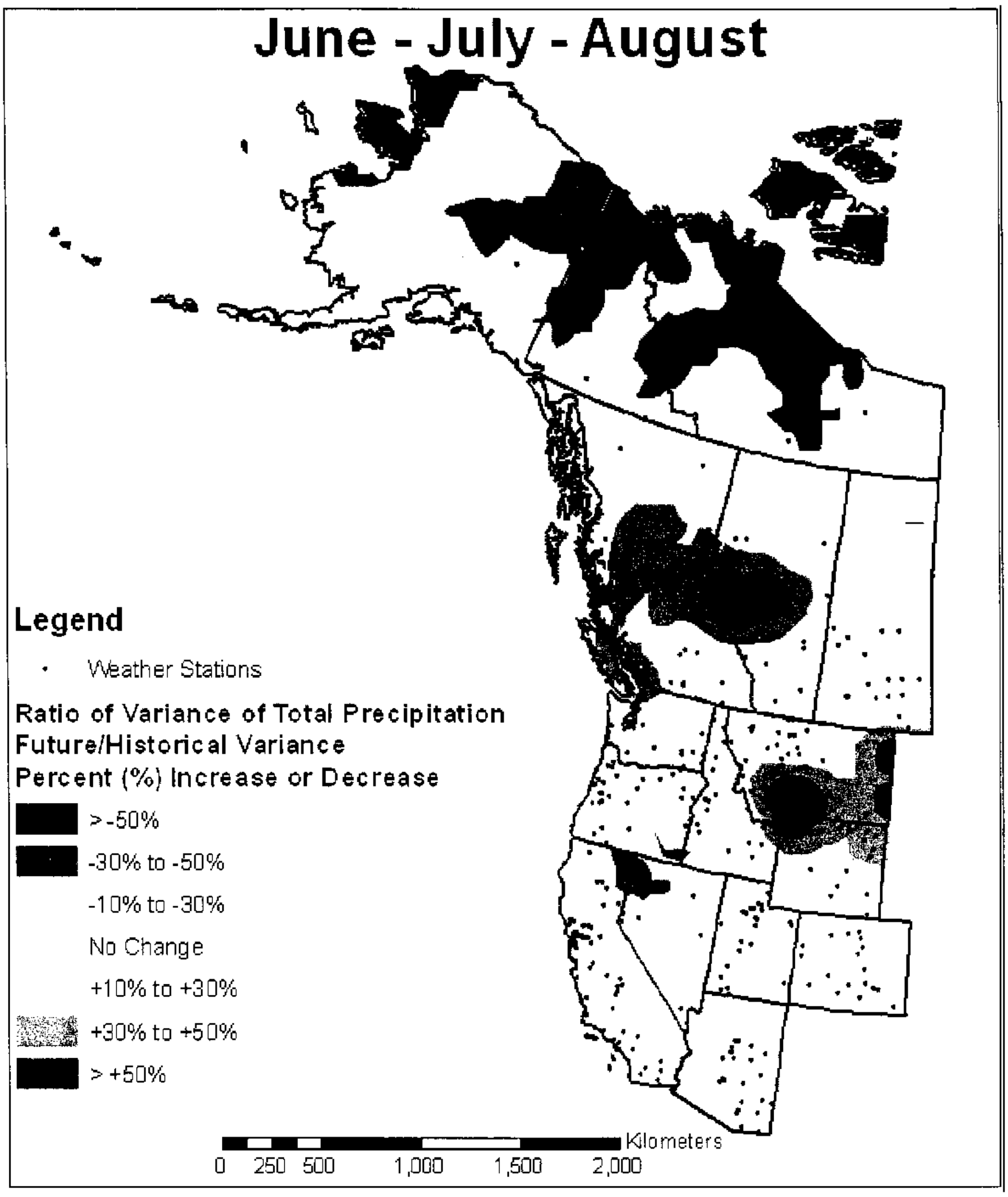


Figure A.3d Summer (June, July, August) spatial distribution of future seasonal precipitation variance under forecast climate change in western North America.

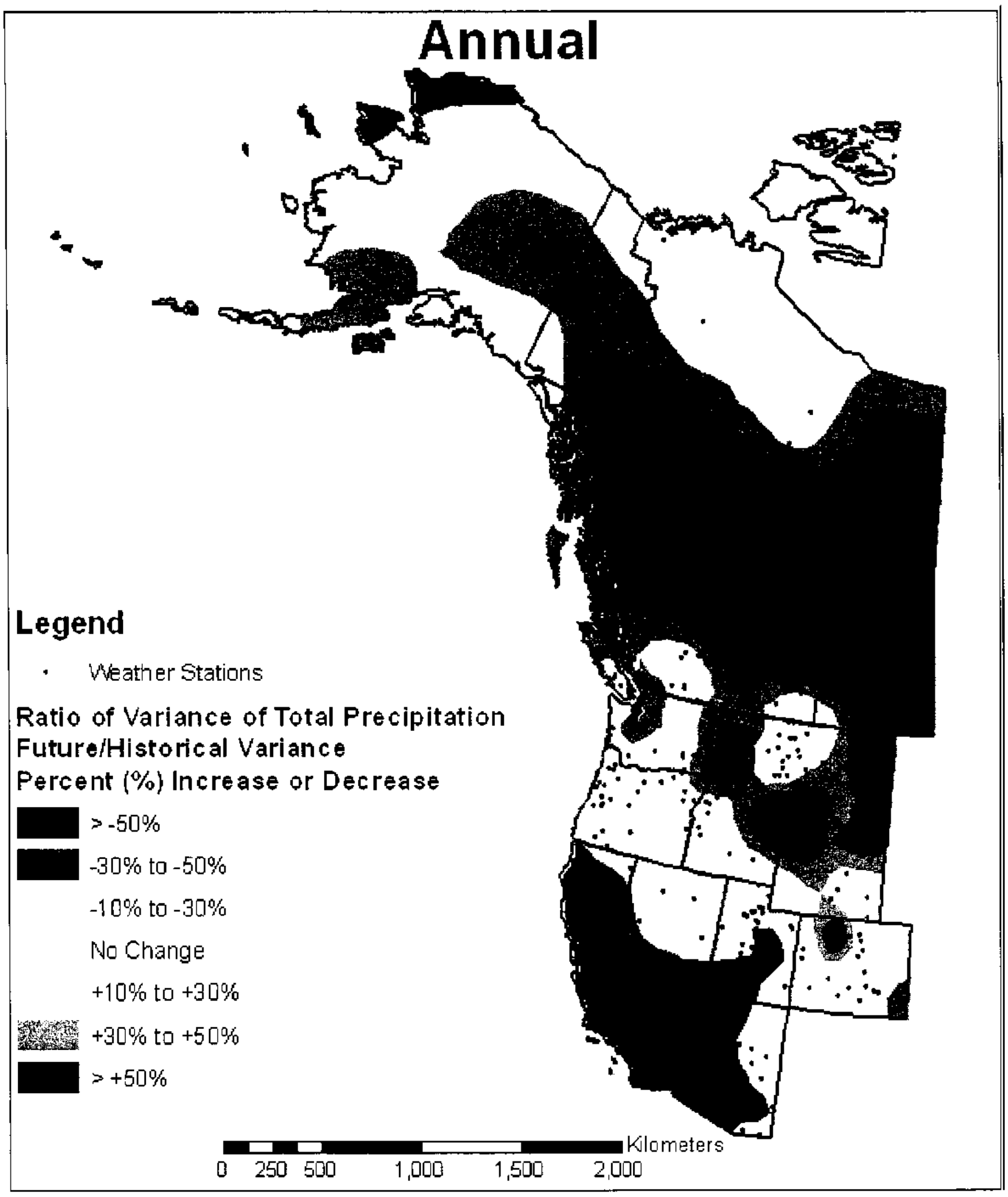
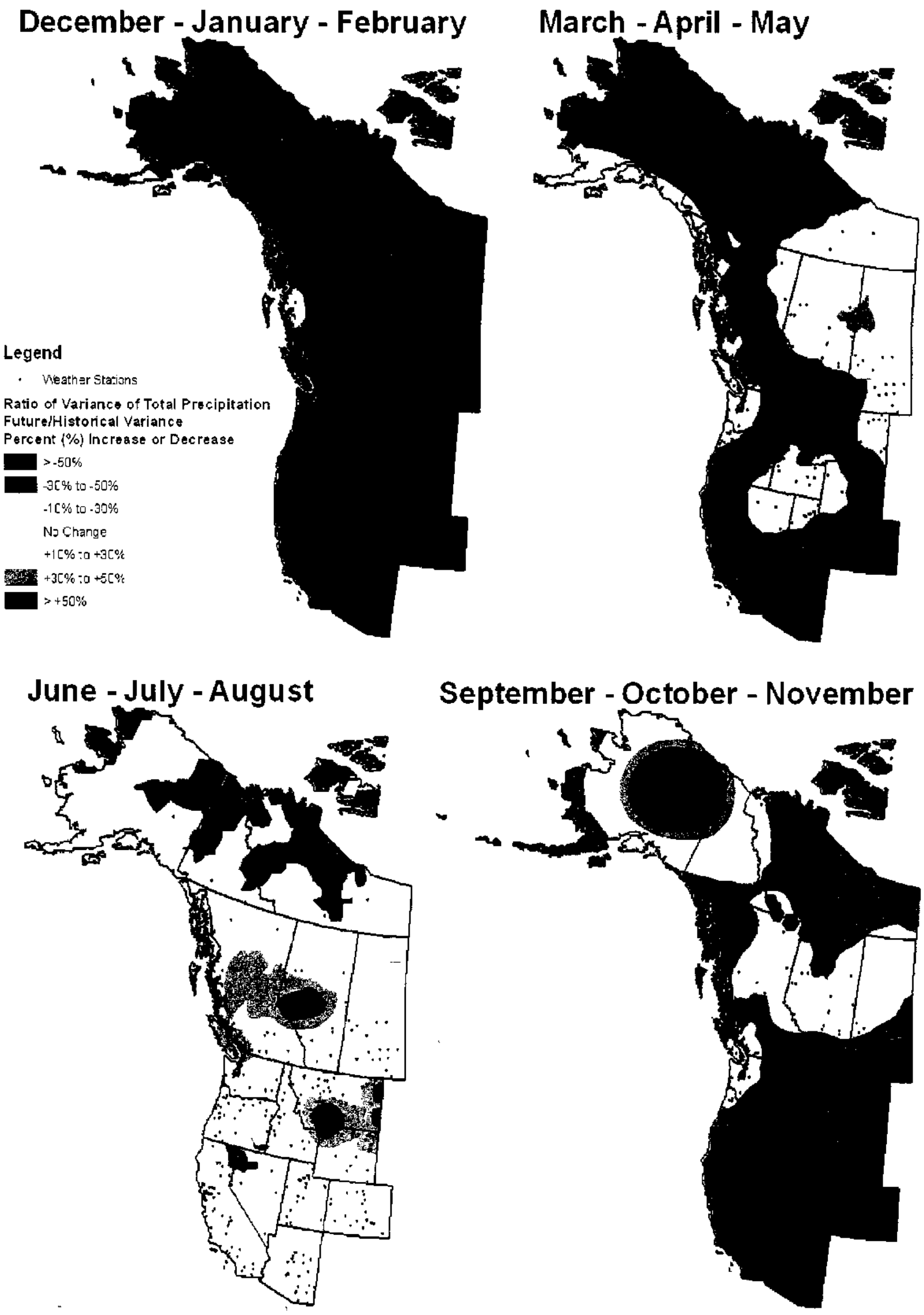


Figure A.3e Annual spatial distribution of precipitation variance under forecast climate change in western North America.



Figures A.3f Seasonal precipitation variance ratio maps.

Table A1. Month by month average frequency over 30 years of Changnon et al.'s (1993) seven synoptic patterns with the addition of unclassifieds as an eighth pattern. Shaded cells denote the historical (1960-1990) period, while unshaded cells denote the future (2020-2050) time period. The sum column is the total number of days per month.

MONTH	SWC	SWS	NWW	SWT	NWZ	DR	NWM	UNC	Sum
Jan	5.5	1.0	7.2	9.2	0.9	3.8	3.1	0.4	31
	3.1	1.0	3.2	12.7	1.2	5.6	2.2	2.0	31
Feb	4.5	1.9	6.3	7.2	0.5	3.8	2.9	1.2	28
	2.6	1.2	5.4	10.1	1.3	4.3	1.8	1.3	28
Mar	6.6	2.0	6.6	8.2	0.5	2.2	3.5	1.4	31
	2.5	2.1	4.4	12.1	1.3	4.2	2.6	1.8	31
Apr	2.9	1.3	4.0	2.8	0.5	6.4	2.8	9.3	30
	2.3	1.0	4.4	10.1	0.6	5.7	2.7	3.3	30
May	2.1	0.9	3.7	2.8	0.7	6.5	1.6	12.7	31
	3.2	1.2	5.2	9.2	1.3	4.8	2.6	3.5	31
Jun	2.2	0.7	3.8	2.4	0.9	7.0	1.3	11.6	30
	1.3	1.7	5.2	5.1	1.2	5.5	1.5	8.2	30
Jul	3.0	1.8	4.2	2.8	0.9	6.3	0.2	11.8	31
	2.4	2.3	3.0	4.4	1.0	4.6	1.8	11.5	31
Aug	5.1	2.0	3.0	3.1	0.7	6.6	0.6	9.9	31
	1.8	1.6	3.4	4.5	1.6	5.5	1.5	11.1	31
Sep	2.7	0.6	3.4	2.9	0.6	8.7	2.0	9.1	30
	0.7	1.9	5.1	8.9	2.8	1.8	1.9	7.5	31
Oct	5.7	0.9	7.2	4.7	1.4	4.4	4.5	2.2	31
	0.8	0.4	7.5	15.5	2.5	1.6	2.0	0.7	31
Nov	6.0	1.0	7.5	6.2	1.2	3.3	4.0	0.8	30
	1.6	0.7	6.6	13.5	1.3	2.8	2.8	0.7	30
Dec	5.0	1.6	7.4	9.4	0.4	3.0	3.5	0.7	31
	1.8	0.9	5.2	12.5	1.4	5.7	1.7	1.8	31

Table A2. Average synoptic pattern frequencies and T-test results for equality of means between historical (1960-1990) and future (2020-2050) annual and seasonal (SON, DJF, MAM, JJA) pattern occurrences. Italics/bold frequencies represent a significant difference (P <0.05) between historical (shaded) and future (unshaded) pattern frequencies.

	SWC	SWS	NWW	SWT	NWZ	DR	NWM	UNC
ANNUAL	***51.23***	15.77	64.30	***61.60***	***9.20***	***62.03***	29.93	***71.20***
	24.07	16.00	58.40	***118.37***	***17.33***	***51.97***	25.10	***52.73***
SON	***14.27***	2.47	18.03	***13.80***	***3.27***	***16.50***	***10.50***	***12.17***
	3.10	3.00	19.17	***37.90***	***6.63***	***6.17***	***6.70***	***8.33***
DJF	***14.48***	4.32	***20.23***	***24.87***	***1.77***	***10.26***	***9.19***	***2.23***
	7.32	3.03	***13.35***	***34.13***	***3.68***	***15.06***	***5.58***	***4.94***
MAM	***11.67***	4.30	14.33	***13.77***	***1.63***	15.03	7.90	***23.37***
	7.97	4.23	14.03	***31.40***	***3.13***	14.70	7.93	***8.60***
JJA	***10.33***	4.53	11.03	***8.33***	2.47	***19.90***	***2.03***	33.37
	5.43	5.63	11.60	***13.97***	3.83	***15.67***	***4.83***	31.03

*note: Pattern frequencies apply in a closed system (i.e. a change in one pattern frequency is offset by a change in one or a few other frequencies)

Table A3. R^2 values for each weather station for the Fall (September, October, November) months. The number of independent variables represent the number of precipitation-linked synoptic patterns used in the regression model, while Pattern1, 2, 3, 4, and 5 show the synoptic patterns that are statistically linked to precipitation at each given station.

Station Name	State/ Province	Month	R^2	Number of Independent Variables	Independent Variables used in Regression Model				
					Pattern1	Pattern2	Pattern3	Pattern4	Pattern5
ALDER 17 S	MT	9	0.76	3	UNC	NWW	NWM		
		10	0.83	3	SWC	NWZ	NWM		
		11	0.73	2	SWC	NWW			
ALSEA F H FALL CREEK	OR	9	0.74	2	UNC	SWT			
		10	0.82	3	NWW	NWZ	NWM		
		11	0.92	3	NWW	NWZ	NWM		
ALTENBERN	CO	9	0.76	2	UNC	NWM			
		10	0.72	2	SWC	SWT			
		11	0.78	3	SWC	SWT	NWZ		
ANACORTES	WA	9	0.81	3	UNC	SWS	SWT		
		10	0.85	3	SWC	NWW	NWZ		
		11	0.92	3	SWC	NWW	NWZ		
ASH MOUNTAIN	CA	9	0.37	1	UNC				
		10	0.71	3	SWT	NWZ	NWM		
		11	0.74	3	SWC	NWW	NWZ		
ASTORIA WSO AIRPORT	OR	9	0.81	2	UNC	SWT			
		10	0.84	3	NWW	NWZ	NWM		
		11	0.94	4	SWC	NWW	NWZ	NWM	
BAKER 1 E	MT	9	0.64	2	NWM	DR			
		10	0.41	1	NWM				
		11	0.71	1	SWC				
BAKER FCWOS	OR	9	0.64	2	UNC	NWW			
		10	0.71	2	NWZ	NWM			
		11	0.78	3	NWW	SWT	NWM		
BAKERSFIELD WSO ARPT	CA	9	0.29	1	UNC				
		10	0.35	1	NWM				
		11	0.56	2	NWM	SWS			
BEAVER CREEK RANGER STN	AZ	9	0.68	3	UNC	SWS	NWM		
		10	0.66	1	SWC				
		11	0.69	2	SWC	NWZ			
BELGRADE AIRPORT	MT	9	0.78	3	UNC	NWW	NWM		
		10	0.78	3	SWC	NWW	NWZ		
		11	0.76	2	SWC	NWW			
BEND	OR	9	0.61	1	UNC				
		10	0.62	2	SWC	NWZ			
		11	0.71	2	NWZ	NWM			
BILLINGS WSO	MT	9	0.68	3	SWT	NWZ	SWC		
		10	0.7	2	SWC	SWT			
		11	0.8	2	SWC	SWT			
BLAINE	WA	9	0.71	2	UNC	SWT			

		10	0.85	2	NWW	NWZ			
		11	0.94	4	SWC	NWW	NWZ	NWM	
BOISE WSFO AIRPORT	ID	9	0.67	2	UNC	NWM			
		10	0.76	3	SWC	NWZ	NWM		
		11	0.89	3	NWW	NWZ	NWM		
BONNEVILLE DAM	OR	9	0.77	2	UNC	SWT			
		10	0.89	3	NWW	NWZ	NWM		
		11	0.91	3	NWW	NWZ	NWM		
BORREGO DESERT PARK	CA	9	0.39	2	UNC	SWS			
		10	0.43	1	SWS				
		11	0.47	1	SWC				
BOZEMAN 12 NE	MT	9	0.78	3	UNC	NWW	SWC		
		10	0.76	3	NWW	SWT	NWZ		
		11	0.89	3	SWC	NWW	SWT		
BOZEMAN MONTANA ST UNIV	MT	9	0.77	3	UNC	NWW	NWM		
		10	0.82	3	SWC	NWW	NWZ		
		11	0.79	2	SWC	NWW			
BREDETTE	MT	9	0.59	1	UNC				
		10	0.58	2	SWT	NWM			
		11	0.71	2	SWC	NWW			
BROADUS	MT	9	0.62	2	NWM	DR			
		10	0.46	2	SWC	NWW			
		11	0.76	2	SWC	SWT			
BUTTE FAA ARPT	MT	9	0.69	2	UNC	SWC			
		10	0.62	2	SWT	NWZ			
		11	0.78	2	SWC	NWW			
CABINET GORGE	ID	9	0.76	3	UNC	SWT	SWC		
		10	0.77	2	NWW	NWZ			
		11	0.91	3	NWW	NWZ	NWM		
CALEXICO 2 NE	CA	9	0.28	1	DR				
		10	0.41	1	SWC				
		11	0.31	1	NWM				
CALISTOGA	CA	9	0.61	2	UNC	NWM			
		10	0.35	1	SWC				
		11	0.71	3	NWW	NWZ	NWM		
CALLAO	UT	9	0.44	1	SWC				
		10	0.6	2	SWT	NWM			
		11	0.62	2	SWT	SWS			
CAMP PARDEE	CA	9	0.41	2	UNC	NWM			
		10	0.55	2	SWT	NWM			
		11	0.7	2	SWC	NWW			
CANELO 1 NW	AZ	9	0.73	3	SWS	SWT	DR		
		10	0.56	2	SWC	NWW			
		11	0.65	1	SWC				
CANOGA PARK PIERCE COLLEGE	CA	9	0.37	2	UNC	SWS			

		10	0.31	1	SWT				
		11	0.43	1	SWC				
CANYON FERRY DAM	MT	9	0.70	2	UNC	SWC			
		10	0.64	2	NWZ	NWM			
		11	0.81	2	SWT	NWM			
CARSON CITY	NV	9	0.51	2	UNC	SWC			
		10	0.67	2	SWC	NWM			
		11	0.59	2	NWW	NWZ			
CASCADE 1 NW	ID	9	0.68	2	UNC	NWM			
		10	0.53	2	SWC	NWZ			
		11	0.81	3	NWW	NWZ	NWM		
CASCADE 20 SSE	MT	9	0.80	3	UNC	NWM	SWC		
		10	0.67	2	SWT	NWZ			
		11	0.77	2	SWT	NWM			
CASCADE 5 S	MT	9	0.81	3	UNC	NWM	SWC		
		10	0.57	2	SWT	NWZ			
		11	0.8	2	SWC	SWT			
CASPER WSO AP	WY	9	0.63	2	NWM	DR			
		10	0.73	2	SWC	SWS			
		11	0.74	2	SWC	SWT			
CEDAR CITY AP	UT	9	0.47	1	DR				
		10	0.78	2	SWC	SWT			
		11	0.64	1	SWC				
CEDAR LAKE	WA	9	0.86	2	UNC	SWT			
		10	0.86	3	SWC	NWW	NWZ		
		11	0.93	4	SWC	NWW	NWZ	NWM	
CEDARVILLE	CA	9	0.60	2	UNC	NWM			
		10	0.45	2	DR	NWZ			
		11	0.76	2	NWW	NWM			
CENTER 4 SSW	CO	9	0.86	3	UNC	NWM	SWC		
		10	0.66	1	SWC				
		11	0.54	1	SWC				
CHESTER	CA	9	0.61	2	UNC	NWM			
		10	0.45	2	SWC	NWM			
		11	0.69	2	NWW	NWM			
CHEYENNE WSFO AP	WY	9	0.62	2	DR	SWC			
		10	0.74	3	SWC	NWZ	SWS		
		11	0.53	1	SWT				
CHIMACUM 4 S	WA	9	0.77	2	UNC	SWT			
		10	0.65	2	NWW	NWZ			
		11	0.86	3	SWC	NWW	NWM		
CHOTEAU AIRPORT	MT	9	0.66	2	UNC	SWC			
		10	0.53	1	NWZ				
		11	0.49	1	NWM				
CITY CREEK WATER PLANT	UT	9	0.56	2	UNC	SWC			
		10	0.86	3	SWC	SWT	NWM		
		11	0.81	2	SWC	NWW			
CLEARMONT 5	WY	9	0.68	2	UNC	SWC			

SW									
		10	0.64	2	SWC	SWT			
		11	0.77	2	SWC	DR			
COCHETOPA CREEK	CO	9	0.74	2	UNC	SWC			
		10	0.66	2	SWC	NWZ			
		11	0.75	2	SWC	SWT			
COLONY	WY	9	0.69	2	NWM	DR			
		10	0.57	2	SWC	NWM			
		11	0.75	3	SWC	NWW	NWZ		
COLORADO SPRINGS WSO AP	CO	9	0.67	2	UNC	SWC			
		10	0.65	2	SWC	NWZ			
		11	0.57	1	SWT				
COPCO NO 1 DAM	CA	9	0.71	2	UNC	NWM			
		10	0.76	3	SWC	NWZ	NWM		
		11	0.74	2	NWW	NWM			
CORDES	AZ	9	0.68	3	UNC	NWW	SWS		
		10	0.6	1	SWC				
		11	0.65	2	SWC	NWZ			
CORVALLIS STATE UNIV	OR	9	0.77	2	UNC	SWT			
		10	0.8	3	NWW	NWZ	NWM		
		11	0.92	3	NWW	NWZ	NWM		
COTTAGE GROVE DAM	OR	9	0.77	2	UNC	SWT			
		10	0.85	4	SWC	NWW	NWZ	NWM	
		11	0.88	3	NWW	NWZ	NWM		
COUGAR 6 E	WA	9	0.77	2	UNC	SWT			
		10	0.86	3	NWW	NWZ	NWM		
		11	0.91	3	NWW	NWZ	NWM		
CRESTON	MT	9	0.82	3	UNC	NWM	SWC		
		10	0.84	3	SWC	NWW	NWZ		
		11	0.84	3	NWW	SWT	NWM		
CUYAMACA	CA	9	0.40	1	UNC				
		10	0.56	2	SWC	SWT			
		11	0.65	2	SWC	NWZ			
DALLESPORT FCWOS AP	WA	9	0.65	2	UNC	NWM			
		10	0.61	2	NWZ	NWM			
		11	0.85	3	NWW	NWZ	NWM		
DAVIS 2 WSW EXP FARM	CA	9	0.30	1	NWM				
		10	0.32	1	SWS				
		11	0.66	2	NWZ	NWM			
DEER CREEK DAM	UT	9	0.65	2	UNC	NWM			
		10	0.79	2	SWC	NWZ			
		11	0.8	3	SWC	NWW	NWZ		
DENVER WSFO AP	CO	9	0.70	2	SWT	SWC			
		10	0.69	2	SWC	NWZ			
		11	0.76	2	SWT	SWS			

DEVILS TOWER 2	WY	9	0.69	2	NWM	DR			
		10	0.62	2	SWC	NWM			
		11	0.7	2	SWC	SWT			
DORENA DAM	OR	9	0.76	2	UNC	NWM			
		10	0.86	4	SWC	NWW	NWZ	NWM	
		11	0.89	3	NWW	NWZ	NWM		
DOUGLAS FCWOS	AZ	9	0.68	3	SWS	NWM	DR		
		10	0.4	1	SWC				
		11	0.61	1	SWC				
DUBOIS EXPERIMENT STN	ID	9	0.72	3	UNC	SWS	SWC		
		10	0.8	3	SWC	NWM	SWS		
		11	0.71	2	NWW	NWM			
DUNCAN	AZ	9	0.70	3	UNC	NWM	DR		
		10	0.72	1	SWC				
		11	0.61	1	SWC				
ECHO DAM	UT	9	0.58	2	UNC	SWC			
		10	0.86	3	SWC	SWT	NWZ		
		11	0.8	3	NWW	SWT	NWZ		
ELK RIVER 1 S	ID	9	0.75	3	UNC	SWT	NWM		
		10	0.82	3	NWW	NWZ	NWM		
		11	0.91	4	NWW	SWT	NWZ	NWM	
ELKO FCWOS	NV	9	0.46	1	UNC				
		10	0.79	2	SWC	NWZ			
		11	0.78	3	SWC	NWW	NWZ		
ELKTON 3 SW	OR	9	0.64	2	UNC	NWM			
		10	0.76	3	NWW	NWZ	NWM		
		11	0.86	3	NWW	NWZ	NWM		
ELY WSO AIRPORT	NV	9	0.50	2	UNC	SWC			
		10	0.69	2	SWT	NWM			
		11	0.66	2	SWC	NWW			
EMBLEM	WY	9	0.58	2	NWM	DR			
		10	0.54	2	SWC	SWT			
		11	0.64	2	SWC	NWW			
EMMETT 2 E	ID	9	0.53	2	UNC	SWC			
		10	0.78	3	SWC	NWZ	NWM		
		11	0.83	3	NWW	NWZ	NWM		
EUGENE WSO AIRPORT	OR	9	0.77	2	UNC	SWT			
		10	0.77	3	SWC	DR	NWZ		
		11	0.89	3	NWW	NWZ	NWM		
EUREKA WFO WOODLEY IS	CA	9	0.59	2	UNC	NWM			
		10	0.76	3	SWC	NWZ	NWM		
		11	0.8	3	NWW	NWZ	NWM		
FALLON EXPERIMENT STN	NV	9	0.39	1	DR				
		10	0.66	1	SWC				
		11	0.67	2	NWZ	NWM			

FERN RIDGE DAM	OR	9	0.74	2	UNC	SWT			
		10	0.77	3	DR	NWZ	NWM		
		11	0.9	3	NWW	NWZ	NWM		
FILLMORE	UT	9	0.54	2	UNC	SWC			
		10	0.84	3	SWC	SWT	NWM		
		11	0.69	2	NWW	SWT			
FISHTAIL	MT	9	0.68	2	SWT	SWC			
		10	0.7	2	SWC	SWT			
		11	0.82	2	SWC	SWT			
FLAGSTAFF WSO AP	AZ	9	0.67	3	UNC	SWS	SWC		
		10	0.7	1	SWC				
		11	0.74	2	SWC	NWZ			
FLATWILLOW 4 ENE	MT	9	0.56	2	UNC	SWT			
		10	0.75	3	SWC	SWT	NWM		
		11	0.69	2	SWC	SWT			
FORT BENTON	MT	9	0.71	2	UNC	SWC			
		10	0.78	3	SWC	NWZ	NWM		
		11	0.7	2	SWC	SWT			
FORT JONES RANGER STN	CA	9	0.57	2	UNC	NWM			
		10	0.52	2	SWT	NWM			
		11	0.74	3	NWW	NWZ	NWM		
FORT LOGAN 4 ESE	MT	9	0.77	2	UNC	SWC			
		10	0.73	3	NWW	NWZ	NWM		
		11	0.73	2	SWT	NWM			
FOWLER 1 SE	CO	9	0.66	2	UNC	SWC			
		10	0.58	2	SWC	NWZ			
		11	0.69	2	SWT	SWS			
FRESNO YOSEMITE INTL	CA	9	0.29	1	UNC				
		10	0.57	2	NWM	SWS			
		11	0.62	2	SWC	NWM			
GALATA 16 SSW	MT	9	0.73	2	UNC	SWC			
		10	0.63	2	SWT	NWZ			
		11	0.54	1	SWC				
GIBSON DAM	MT	9	0.80	3	UNC	NWM	SWC		
		10	0.6	2	NWW	NWZ			
		11	0.63	1	SWT				
GILDFORD	MT	9	0.69	2	UNC	SWC			
		10	0.66	2	SWT	NWM			
		11	0.57	1	NWW				
GILLETTE 9 ESE	WY	9	0.69	2	UNC	SWC			
		10	0.66	2	SWT	NWM			
		11	0.77	2	SWC	NWW			
GLASGOW INTERNATL AP	MT	9	0.50	1	UNC				
		10	0.69	3	SWT	NWZ	NWM		
		11	0.67	2	SWC	SWT			
GOLD BEACH RANGER STN	OR	9	0.60	1	UNC				

		10	0.76	3	SWC	NWZ	NWM		
		11	0.88	3	NWW	NWZ	NWM		
GOLDBUTTE 7 N	MT	9	0.77	3	UNC	NWM	SWC		
		10	0.65	2	NWW	NWZ			
		11	0.54	1	SWT				
GRAND JUNCTION WSO AP	CO	9	0.71	3	UNC	NWM	SWC		
		10	0.65	1	SWC				
		11	0.75	3	SWC	SWT	SWS		
GRAND LAKE 1 NW	CO	9	0.74	3	NWM	DR	NWZ		
		10	0.75	3	SWC	SWT	SWS		
		11	0.77	2	NWW	SWT			
GRANT GROVE	CA	9	0.37	1	UNC				
		10	0.69	2	SWT	NWM			
		11	0.76	3	NWW	NWZ	NWM		
GRANTSVILLE 2 W	UT	9	0.61	2	UNC	SWC			
		10	0.78	2	SWC	NWM			
		11	0.68	2	SWC	NWW			
GRATON	CA	9	0.55	2	UNC	NWM			
		10	0.51	2	SWC	NWZ			
		11	0.75	3	NWW	NWZ	NWM		
GREAT FALLS AIRPORT	MT	9	0.76	2	UNC	SWC			
		10	0.64	2	SWC	NWZ			
		11	0.72	2	SWC	SWT			
HALFWAY	OR	9	0.62	2	UNC	NWM			
		10	0.71	3	SWT	NWZ	NWM		
		11	0.83	2	NWW	NWM			
HAMILTON	MT	9	0.81	3	UNC	NWW	SWC		
		10	0.61	2	NWW	NWZ			
		11	0.71	2	NWW	NWM			
HARLOWTON	MT	9	0.77	3	UNC	NWW	SWC		
		10	0.67	2	SWT	NWM			
		11	0.74	2	SWC	SWT			
HASKINS DAM	OR	9	0.70	2	UNC	SWT			
		10	0.82	3	NWW	NWZ	NWM		
		11	0.89	3	NWW	NWZ	NWM		
HATTON 9 SE	WA	9	0.66	2	UNC	NWM			
		10	0.7	2	NWZ	NWM			
		11	0.87	3	NWW	NWZ	NWM		
HAYFIELD PUMPING PLANT	CA	9	0.17	1	DR				
		10	0.38	1	SWC				
		11	0.38	1	SWC				
HEALDSBURG	CA	9	0.51	2	UNC	NWM			
		10	0.52	2	SWC	NWM			
		11	0.7	2	NWZ	NWM			
HEBER RANGER STN	AZ	9	0.70	3	UNC	SWS	NWM		

		10	0.83	1	SWC				
		11	0.78	2	SWC	NWZ			
HELENA WSO	MT	9	0.73	2	UNC	SWC			
		10	0.65	2	SWT	NWZ			
		11	0.76	3	SWC	NWW	NWZ		
HEPPNER	OR	9	0.64	2	UNC	SWC			
		10	0.7	2	SWC	NWM			
		11	0.86	3	NWW	SWT	NWM		
HERON 2 NW	MT	9	0.68	2	UNC	SWC			
		10	0.8	2	NWW	NWZ			
		11	0.9	3	NWW	NWZ	NWM		
HILLSBORO	OR	9	0.76	2	UNC	SWT			
		10	0.83	3	NWW	NWZ	NWM		
		11	0.91	3	NWW	NWZ	NWM		
HOQUIAM FCWOS AP	WA	9	0.80	2	UNC	SWT			
		10	0.85	3	NWW	NWZ	NWM		
		11	0.91	3	NWW	SWT	NWM		
HUNGRY HORSE DAM	MT	9	0.83	4	UNC	NWW	NWM	SWC	
		10	0.85	3	SWC	NWW	NWZ		
		11	0.87	3	NWW	NWZ	NWM		
HUNTLEY EXPERIMENT STN	MT	9	0.65	3	UNC	SWT	NWZ		
		10	0.68	2	SWC	SWT			
		11	0.68	2	SWC	SWT			
IDAHO FALLS 46 W	ID	9	0.71	3	SWS	NWM	NWZ		
		10	0.75	2	SWC	NWM			
		11	0.79	2	NWW	NWZ			
IDAHO FALLS FAA ARPT	ID	9	0.65	2	UNC	NWM			
		10	0.78	3	SWC	SWT	NWM		
		11	0.82	2	NWW	NWZ			
IMPERIAL	CA	9	0.28	1	DR				
		10	0.48	1	SWS				
		11	0.34	1	SWC				
INGOMAR 14 NE	MT	9	0.54	2	UNC	NWM			
		10	0.55	2	DR	SWT			
		11	0.65	2	SWC	NWW			
IRVING	AZ	9	0.74	3	UNC	SWS	NWM		
		10	0.73	1	SWC				
		11	0.71	2	SWC	NWZ			
JENSEN	UT	9	0.72	3	UNC	NWM	SWC		
		10	0.75	2	SWC	SWT			
		11	0.71	2	SWC	NWZ			
KAHLOTUS 5 SSW	WA	9	0.68	2	UNC	NWM			
		10	0.7	2	NWZ	NWM			
		11	0.86	3	NWW	NWZ	NWM		
KALISPELL WSO AIRPORT	MT	9	0.78	3	UNC	NWM	SWC		
		10	0.83	3	SWC	NWW	NWZ		

		11	0.83	3	NWW	SWT	NWZ		
KANAB	UT	9	0.62	4	UNC	SWS			
		10	0.74	2	SWC	SWS			
		11	0.66	1	SWC				
KASSLER	CO	9	0.74	3	NWM	DR	SWC		
		10	0.67	2	NWZ	SWS			
		11	0.74	2	SWT	SWS			
KENO	OR	9	0.69	2	UNC	NWM			
		10	0.55	2	SWC	NWZ			
		11	0.78	3	NWW	NWZ	NWM		
KENT	OR	9	0.65	3	UNC	SWS	SWC		
		10	0.65	2	SWC	NWM			
		11	0.83	2	NWW	NWM			
LACROSSE	WA	9	0.68	3	UNC	SWT	SWC		
		10	0.73	2	SWT	NWM			
		11	0.9	3	NWW	NWZ	NWM		
LANDER WSO AP	WY	9	0.57	2	SWT	SWC			
		10	0.74	2	SWC	SWT			
		11	0.68	1	SWC				
LAS VEGAS WSO AIRPORT	NV	9	0.59	2	SWS	DR			
		10	0.59	1	SWC				
		11	0.55	2	SWC	SWS			
LAVEEN 3 SSE	AZ	9	0.50	2	SWT	DR			
		10	0.53	1	SWC				
		11	0.63	2	SWT	NWZ			
LEABURG 1 SW	OR	9	0.72	2	UNC	SWT			
		10	0.8	3	NWW	NWZ	NWM		
		11	0.92	3	NWW	NWZ	NWM		
LEMON COVE	CA	9	0.31	1	UNC				
		10	0.64	2	SWC	NWM			
		11	0.65	2	SWT	NWM			
LENNEP 6 WSW	MT	9	0.83	3	UNC	NWW	SWC		
		10	0.71	2	SWT	NWZ			
		11	0.79	2	SWT	NWM			
LEO 6 SW	WY	9	0.66	2	NWM	SWC			
		10	0.69	2	SWC	DR			
		11	0.74	2	SWC	SWT			
LEWISTON WSO AP	ID	9	0.73	2	UNC	SWT			
		10	0.8	3	SWC	NWZ	NWM		
		11	0.82	3	NWW	SWT	NWM		
LINDSAY	CA	9	0.33	1	UNC				
		10	0.6	2	SWC	NWM			
		11	0.65	2	SWT	NWM			
LIVINGSTON FCWOS	MT	9	0.78	3	UNC	NWW	SWC		
		10	0.8	3	SWC	NWW	NWZ		
		11	0.61	1	SWT				
LONG BEACH WSCMO	CA	9	0.53	2	UNC	SWS			
		10	0.38	1	SWT				

		11	0.49	1	SWC				
LONGMONT 2 ESE	CO	9	0.60	2	SWT	SWC			
		10	0.65	2	NWZ	SWS			
		11	0.6	1	SWT				
LOS ANGELES DOWNTOWN	CA	9	0.39	2	SWS	SWC			
		10	0.39	1	SWT				
		11	0.45	1	NWM				
LOS ANGELES WSO ARPT	CA	9	0.54	2	UNC	SWS			
		10	0.41	1	SWC				
		11	0.47	1	NWM				
LOS BANOS	CA	9	0.30	1	SWS				
		10	0.57	2	NWZ	SWS			
		11	0.65	3	NWZ	NWM	SWS		
LOS BANOS ARBURUA RCH	CA	9	0.18	1	UNC				
		10	0.63	2	SWT	SWS			
		11	0.64	3	NWZ	NWM	SWS		
LOWER HAY CREEK	OR	9	0.61	2	UNC	SWC			
		10	0.7	3	SWC	NWZ	NWM		
		11	0.78	2	NWW	NWM			
LUSTRE 4 NNW	MT	9	0.47	1	UNC				
		10	0.46	1	SWT				
		11	0.61	2	NWW	SWT			
MAC KENZIE	MT	9	0.66	2	NWM	DR			
		10	0.39	1	NWM				
		11	0.63	1	SWC				
MALHEUR BRANCH EXP STN	OR	9	0.63	2	UNC	NWM			
		10	0.62	2	SWC	NWM			
		11	0.76	2	NWW	NWM			
MANTI	UT	9	0.58	2	UNC	SWC			
		10	0.8	2	SWC	SWT			
		11	0.74	2	SWC	SWT			
MANZANITA LAKE	CA	9	0.66	2	UNC	NWM			
		10	0.58	2	SWC	NWM			
		11	0.76	3	NWW	NWZ	NWM		
MC MILLIN RESERVOIR	WA	9	0.80	2	UNC	SWT			
		10	0.86	3	NWW	NWZ	NWM		
		11	0.93	3	NWW	NWZ	NWM		
MCCALL	ID	9	0.68	2	UNC	SWC			
		10	0.63	2	NWZ	NWM			
		11	0.83	3	NWW	NWZ	NWM		
MCNARY DAM	WA	9	0.57	2	UNC	SWC			
		10	0.68	2	SWC	NWM			
		11	0.81	2	SWT	NWM			
MEDFORD WSO AP	OR	9	0.62	2	UNC	NWM			
		10	0.55	2	SWC	DR			

		11	0.77	2	NWW	NWM			
MEDICINE LAKE 3 SE	MT	9	0.75	3	UNC	NWW	NWM		
		10	0.37	1	NWW				
		11	0.64	2	SWC	NWW			
MESA EXPERIMENT FARM	AZ	9	0.42	1	DR				
		10	0.7	1	SWC				
		11	0.71	2	SWC	NWZ			
MIAMI	AZ	9	0.67	5	NWW	SWS	NWM		
		10	0.74	1	SWC				
		11	0.76	1	SWC				
MILTON FREEWATER	OR	9	0.61	2	UNC	NWM			
		10	0.73	3	DR	SWT	NWM		
		11	0.89	4	SWC	NWW	NWZ	NWM	
MINERSVILLE	UT	9	0.49	1	UNC				
		10	0.78	2	SWC	SWT			
		11	0.58	1	SWC				
MISSOULA WSO AP	MT	9	0.80	3	UNC	NWM	SWC		
		10	0.68	2	SWT	NWZ			
		11	0.81	2	SWT	NWM			
MOCCASIN EXPERIMENT STN	MT	9	0.71	2	UNC	SWC			
		10	0.71	2	SWT	NWM			
		11	0.76	2	SWC	SWT			
MONTEZUMA CASTLE N M	AZ	9	0.64	3	UNC	SWS	SWT		
		10	0.66	1	SWC				
		11	0.56	1	SWC				
MONTICELLO	UT	9	0.64	2	UNC	SWC			
		10	0.79	1	SWC				
		11	0.82	4	SWC	SWT	NWZ	NWM	
MORAN 5 WNW	WY	9	0.77	4	UNC	SWS	SWT	SWC	
		10	0.8	3	SWC	SWT	NWZ		
		11	0.85	2	NWW	NWZ			
MORGAN POWER AND LIGHT	UT	9	0.61	2	UNC	SWC			
		10	0.81	3	SWC	SWT	NWZ		
		11	0.84	3	SWC	NWW	NWZ		
MORRO BAY FIRE DEPT	CA	9	0.30	1	UNC				
		10	0.55	2	SWC	NWM			
		11	0.69	3	SWC	NWZ	NWM		
MOSCOW UNIV OF IDAHO	ID	9	0.68	2	UNC	NWM			
		10	0.81	4	SWC	NWW	NWZ	NWM	
		11	0.86	3	NWW	NWZ	NWM		
MOUNT VERNON 3 WNW	WA	9	0.82	3	UNC	NWW	SWT		
		10	0.81	2	NWW	SWT			

		11	0.91	4	SWC	NWW	SWT	NWZ	
MYSTIC LAKE	MT	9	0.78	3	UNC	SWT	SWC		
		10	0.77	3	SWC	SWT	NWZ		
		11	0.8	2	SWC	NWW			
NEW MEADOWS RANGER STN	ID	9	0.75	3	UNC	NWW	NWM		
		10	0.61	2	NWZ	NWM			
		11	0.77	2	NWW	NWM			
NEWPORT	WA	9	0.76	3	UNC	SWT	SWC		
		10	0.66	2	NWW	NWM			
		11	0.9	3	NWW	NWZ	NWM		
NEZPERCE	ID	9	0.78	3	UNC	SWT	NWM		
		10	0.84	3	NWW	NWZ	NWM		
		11	0.87	4	SWC	NWW	SWT	NWM	
NILAND	CA	9	0.21	1	DR				
		10	0.26	1	SWS				
		11	0.44	1	SWC				
OAK CITY	UT	9	0.60	2	UNC	SWC			
		10	0.78	2	SWC	SWT			
		11	0.75	2	SWC	NWW			
OJAI	CA	9	0.18	1	UNC				
		10	0.34	1	NWM				
		11	0.51	1	NWM				
OLYMPIA WSO AP	WA	9	0.78	2	UNC	SWT			
		10	0.8	3	NWW	NWZ	NWM		
		11	0.91	3	NWW	NWZ	NWM		
ONTARIO CAA AIRPORT	OR	9	0.59	2	UNC	NWM			
		10	0.6	2	NWZ	NWM			
		11	0.75	2	NWW	NWM			
ORACLE 2 SE	AZ	9	0.67	2	NWM	DR			
		10	0.67	1	SWC				
		11	0.76	2	SWC	SWT			
ORDERVILLE	UT	9	0.53	1	DR				
		10	0.77	3	SWC	SWT	SWS		
		11	0.67	2	SWC	NWZ			
OTIS 2 NE	OR	9	0.78	2	UNC	SWT			
		10	0.88	4	SWC	NWW	NWZ	NWM	
		11	0.95	4	NWW	SWT	NWZ	NWM	
OWYHEE DAM	OR	9	0.60	2	UNC	NWW			
		10	0.65	2	SWC	NWM			
		11	0.76	2	NWW	NWM			
PALMDALE	CA	9	0.29	1	DR				
		10	0.24	1	SWT				
		11	0.41	1	NWM				
PALOMA	CA	9	0.40	2	UNC	NWM			
		10	0.64	1	SWC				
		11	0.66	3	NWW	NWZ	NWM		
PARKER RESERVOIR	CA	9	0.60	2	UNC	SWS			
		10	0.33	1	SWC				

		11	0.49	1	SWC				
PASO ROBLES	CA	9	0.22	1	UNC				
		10	0.59	2	SWC	NWM			
		11	0.69	3	NWZ	NWM	SWS		
PASO ROBLES FCWOS	CA	9	0.22	1	UNC				
		10	0.51	2	SWT	SWS			
		11	0.71	3	NWZ	NWM	SWS		
PENDLETON WSO AIRPORT	OR	9	0.68	2	UNC	NWM			
		10	0.77	3	SWC	NWZ	NWM		
		11	0.86	3	NWW	NWZ	NWM		
PETRIFIED FOREST N P	AZ	9	0.66	3	UNC	SWS	SWT		
		10	0.78	1	SWC				
		11	0.75	2	SWC	SWT			
PHOENIX WSO AP	AZ	9	0.37	1	NWW				
		10	0.53	1	SWC				
		11	0.65	2	SWC	NWZ			
POCATELLO WSO AP	ID	9	0.59	2	UNC	NWM			
		10	0.72	2	SWC	SWT			
		11	0.84	3	SWC	NWW	NWZ		
PORTERVILLE	CA	9	0.30	1	UNC				
		10	0.5	1	SWC				
		11	0.64	2	SWC	SWT			
PORTHILL	ID	9	0.78	2	UNC	SWC			
		10	0.77	3	SWC	NWW	NWZ		
		11	0.89	3	NWW	NWZ	NWM		
PORTLAND WSFO	OR	9	0.75	2	UNC	NWM			
		10	0.87	3	NWW	NWZ	NWM		
		11	0.92	3	NWW	NWZ	NWM		
PRIEST RIVER EXP STN	ID	9	0.76	2	UNC	SWT			
		10	0.76	3	NWW	NWZ	NWM		
		11	0.9	3	NWW	NWZ	NWM		
PROSPECT 2 SW	OR	9	0.66	2	UNC	NWM			
		10	0.75	3	SWC	NWZ	NWM		
		11	0.84	3	NWW	NWZ	NWM		
PUEBLO WSO AP	CO	9	0.67	2	UNC	SWC			
		10	0.68	2	SWC	NWZ			
		11	0.72	2	SWT	SWS			
PUYALLUP 2 W EXP STN	WA	9	0.80	2	UNC	SWT			
		10	0.82	3	NWW	NWZ	NWM		
		11	0.92	3	NWW	NWZ	NWM		
RAWLINS AP	WY	9	0.67	2	UNC	SWC			
		10	0.65	2	SWC	SWT			
		11	0.66	2	SWC	SWT			
RED LODGE 2 N	MT	9	0.70	3	UNC	SWT	SWC		
		10	0.78	2	SWC	SWT			
		11	0.84	2	SWC	SWT			

REDSTONE	MT	9	0.60	2	UNC	NWW			
		10	0.56	2	SWT	NWM			
		11	0.38	1	NWW				
RENO WSFO AIRPORT	NV	9	0.46	2	UNC	SWC			
		10	0.61	2	SWC	NWM			
		11	0.63	2	NWW	NWZ			
REX 1 S	OR	9	0.81	2	UNC	SWT			
		10	0.84	3	NWW	NWZ	NWM		
		11	0.92	3	NWW	NWZ	NWM		
RICHFIELD	ID	9	0.57	2	UNC	SWC			
		10	0.7	2	SWC	NWZ			
		11	0.8	2	NWW	NWZ			
RICHMOND	UT	9	0.62	2	UNC	SWC			
		10	0.84	4	SWC	SWT	NWM	SWS	
		11	0.78	3	SWC	NWW	NWZ		
RICHMOND CA	CA	9	0.44	2	UNC	NWM			
		10	0.54	2	SWC	SWS			
		11	0.71	3	SWT	NWZ	NWM		
RIVERSIDE CITRUS EXP STN	CA	9	0.44	1	SWS				
		10	0.36	1	SWT				
		11	0.52	2	SWC	NWZ			
ROCHELLE 3 E	WY	9	0.58	2	DR	SWC			
		10	0.66	2	SWC	SWT			
		11	0.72	2	SWC	SWT			
ROCKY FORD 2 SE	CO	9	0.64	2	DR	SWC			
		10	0.62	2	SWC	NWW			
		11	0.66	2	SWT	SWS			
ROY 8 NE	MT	9	0.50	1	UNC				
		10	0.69	2	SWT	NWM			
		11	0.57	2	SWC	SWT			
SACRAMENTO FAA ARPT	CA	9	0.34	1	SWC				
		10	0.33	1	SWS				
		11	0.62	2	SWT	NWM			
SAFFORD AGRICULTRL CTR	AZ	9	0.56	2	NWM	DR			
		10	0.65	1	SWC				
		11	0.58	1	SWC				
SALT LAKE CITY NWSFO	UT	9	0.52	2	UNC	SWC			
		10	0.78	2	SWC	SWT			
		11	0.84	3	SWC	NWW	SWT		
SALTAIR SALT PLANT	UT	9	0.56	2	UNC	SWC			
		10	0.75	2	SWC	SWT			
		11	0.73	2	NWW	SWT			
SAN DIEGO WSO AIRPORT	CA	9	0.39	2	UNC	SWS			
		10	0.49	2	SWT	SWS			
		11	0.57	2	SWC	NWZ			
SAN	CA	9	0.53	2	UNC	NWM			

FRANCISCO MISSION DOLORES		10	0.54	1	SWC				
		11	0.71	3	NWZ	NWM	SWS		
SAN FRANCISCO WSO AP	CA	9	0.47	2	UNC	NWM			
		10	0.46	1	SWC				
		11	0.7	2	NWZ	NWM			
SANTA BARBARA MUNI AP	CA	9	0.38	2	UNC	SWS			
		10	0.4	1	NWM				
		11	0.48	1	SWC				
SANTA CRUZ	CA	9	0.48	2	UNC	SWS			
		10	0.72	2	SWC	NWZ			
		11	0.72	3	NWZ	NWM	SWS		
SANTA MARIA WSO ARPT	CA	9	0.27	1	UNC				
		10	0.45	2	NWM	SWS			
		11	0.7	3	NWZ	NWM	SWS		
SCOTTS MILLS 9 SE	OR	9	0.79	2	UNC	NWM			
		10	0.87	3	NWW	NWZ	NWM		
		11	0.93	3	NWW	NWZ	NWM		
SEATTLE TCOMA WSCMO AP	WA	9	0.78	2	UNC	SWT			
		10	0.79	3	NWW	NWZ	NWM		
		11	0.94	4	SWC	NWW	NWZ	NWM	
SEDONA RS	AZ	9	0.67	3	UNC	SWS	SWT		
		10	0.68	1	SWC				
		11	0.7	2	SWC	NWZ			
SHERIDAN WSO AP	WY	9	0.76	3	UNC	DR	SWC		
		10	0.68	2	SWC	SWT			
		11	0.8	2	SWC	NWW			
SHONKIN 7 S	MT	9	0.69	2	UNC	SWC			
		10	0.76	3	SWT	NWZ	NWM		
		11	0.8	2	SWC	SWT			
SIDNEY	MT	9	0.65	2	UNC	SWT			
		10	0.34	1	SWT				
		11	0.72	2	SWC	SWT			
SIMPSON 6 NW	MT	9	0.56	2	UNC	SWC			
		10	0.59	2	SWT	NWM			
		11	0.6	2	SWC	NWW			
SPANISH FORK PWR HOUSE	UT	9	0.59	2	UNC	SWC			
		10	0.74	2	SWC	NWZ			
		11	0.82	2	SWC	NWW			
SPOKANE WSO AIRPORT	WA	9	0.73	2	UNC	NWM			
		10	0.71	3	SWT	NWZ	NWM		
		11	0.86	3	NWW	NWZ	NWM		

SPRINGFIELD 7 WSW	CO	9	0.64	2	DR	SWC			
		10	0.48	1	SWC				
		11	0.58	2	SWC	SWS			
STOCKTON WSO	CA	9	0.40	2	SWS	NWM			
		10	0.62	2	SWT	NWM			
		11	0.6	2	SWT	NWM			
STRAWBERRY VALLEY	CA	9	0.52	2	UNC	NWM			
		10	0.35	1	SWC				
		11	0.75	3	NWW	NWZ	NWM		
SUMMER LAKE 1 S	OR	9	0.80	3	UNC	SWT	NWM		
		10	0.35	1	DR				
		11	0.7	2	NWW	NWM			
SUMMIT	OR	9	0.78	2	UNC	SWT			
		10	0.85	3	NWW	NWZ	NWM		
		11	0.92	3	NWW	NWZ	NWM		
SUNBURST 8 E	MT	9	0.83	3	UNC	NWM	SWC		
		10	0.62	2	DR	NWZ			
		11	0.62	2	SWC	SWT			
TELLURIDE 4 WNW	CO	9	0.83	3	UNC	SWT	SWC		
		10	0.8	2	SWC	NWZ			
		11	0.81	2	SWC	NWW			
THOMPSON FALLS POWER HOUSE	MT	9	0.77	3	UNC	NWW	NWM		
		10	0.76	2	NWW	NWZ			
		11	0.89	3	NWW	NWZ	NWM		
TIBER DAM	MT	9	0.69	2	UNC	SWC			
		10	0.6	2	NWZ	NWM			
		11	0.57	2	SWC	SWT			
TIDEWATER 2 SW	OR	9	0.75	2	UNC	SWT			
		10	0.85	3	NWW	NWZ	NWM		
		11	0.93	3	NWW	NWZ	NWM		
TIMPANOGOS CAVE	UT	9	0.66	2	UNC	SWC			
		10	0.84	3	SWC	SWT	NWM		
		11	0.83	3	SWC	NWW	NWZ		
TOOELE	UT	9	0.60	2	UNC	SWC			
		10	0.75	2	SWC	SWT			
		11	0.76	2	SWC	NWW			
TRIDENT	MT	9	0.71	3	UNC	NWW	NWM		
		10	0.77	3	SWC	NWZ	NWM		
		11	0.69	2	SWT	NWM			
TUCSON MAGNETIC OBSY	AZ	9	0.59	2	UNC	SWS			
		10	0.51	1	SWC				
		11	0.7	1	SWC				
TUCSON WBO	AZ	9	0.62	2	SWT	DR			
		10	0.49	1	SWC				

		11	0.65	2	SWC	NWW			
UNION EXPERIMENT STN	OR	9	0.73	3	UNC	NWW	SWT		
		10	0.78	3	SWT	NWZ	NWM		
		11	0.85	3	SWC	NWW	SWT		
UPTON 13 SW	WY	9	0.66	2	NWM	DR			
		10	0.68	2	SWC	NWM			
		11	0.57	2	SWC	NWW			
VALIER	MT	9	0.75	3	UNC	NWM	SWC		
		10	0.61	2	SWT	NWZ			
		11	0.75	2	SWC	SWT			
VERNAL AIRPORT	UT	9	0.79	3	UNC	NWM	SWC		
		10	0.76	3	SWC	SWT	NWM		
		11	0.76	3	SWC	NWZ	SWS		
VICTORVILLE PUMP PLANT	CA	9	0.27	1	SWS				
		10	0.35	1	SWC				
		11	0.52	2	SWC	NWZ			
VINTON	CA	9	0.62	3	UNC	SWS	SWC		
		10	0.38	1	NWM				
		11	0.64	1	NWW				
VIRGINIA CITY	MT	9	0.75	3	UNC	NWW	NWZ		
		10	0.66	2	SWC	NWW			
		11	0.72	2	NWW	NWM			
VOLTA POWER HOUSE	CA	9	0.56	2	UNC	NWM			
		10	0.71	2	SWC	NWZ			
		11	0.76	3	NWW	NWZ	NWM		
WALLA WALLA FAA AIRPORT	WA	9	0.65	2	UNC	SWT			
		10	0.74	2	SWC	NWM			
		11	0.92	4	SWC	NWW	NWZ	NWM	
WALLACE WOODLAND PARK	ID	9	0.73	3	UNC	SWT	SWC		
		10	0.8	2	NWW	NWZ			
		11	0.92	3	NWW	NWZ	NWM		
WALNUT CANYON NATL MONUMENT	AZ	9	0.77	3	UNC	SWS	NWM		
		10	0.75	1	SWC				
		11	0.71	2	SWC	NWZ			
WALSENBURG	CO	9	0.76	2	DR	SWC			
		10	0.63	2	SWC	NWZ			
		11	0.74	2	SWT	SWS			
WANSHIP DAM	UT	9	0.67	2	UNC	SWC			
		10	0.85	3	SWC	SWT	NWZ		
		11	0.86	3	SWC	NWW	NWZ		
WARREN	ID	9	0.73	2	UNC	SWC			
		10	0.66	2	NWW	NWM			
		11	0.82	3	NWW	SWT	NWM		
WATERDALE	CO	9	0.68	3	UNC	NWM	SWC		
		10	0.67	2	SWC	NWZ			

		11	0.65	1	SWT				
WESTCLIFFE	CO	9	0.79	3	UNC	SWT	SWC		
		10	0.76	2	SWC	NWZ			
		11	0.6	2	SWC	NWW			
WESTON 1 E	WY	9	0.57	2	UNC	SWC			
		10	0.58	2	SWC	NWW			
		11	0.62	2	NWW	SWT			
WHEATLAND 4 N	WY	9	0.65	2	NWM	SWC			
		10	0.72	3	SWC	DR	NWZ		
		11	0.43	1	SWT				
WHITERIVER 1 SW	AZ	9	0.73	3	UNC	SWS	NWM		
		10	0.72	1	SWC				
		11	0.8	1	SWC				
WILLCOX	AZ	9	0.66	3	SWS	NWM	DR		
		10	0.58	1	SWC				
		11	0.66	1	SWC				
WINNEMUCCA WB CITY	NV	9	0.58	2	UNC	SWC			
		10	0.79	2	SWC	NWZ			
		11	0.72	2	SWC	NWW			
WINSLOW WSO AP	AZ	9	0.70	3	UNC	SWS	NWM		
		10	0.7	1	SWC				
		11	0.63	1	SWC				
WINTERS	CA	9	0.28	1	NWM				
		10	0.49	2	SWC	SWS			
		11	0.66	2	NWZ	NWM			
WISDOM	MT	9	0.71	2	UNC	SWC			
		10	0.64	2	NWZ	NWM			
		11	0.77	2	SWC	NWW			
WOODRUFF	UT	9	0.60	2	UNC	SWC			
		10	0.78	2	SWC	SWT			
		11	0.77	3	SWC	NWW	NWZ		
WYOLA 1 SW	MT	9	0.68	2	UNC	SWC			
		10	0.71	2	SWC	SWT			
		11	0.86	3	SWC	NWW	SWT		
YAKIMA WSO AP	WA	9	0.61	2	UNC	NWM			
		10	0.6	2	SWT	NWM			
		11	0.79	3	NWW	NWZ	NWM		
YAMPA	CO	9	0.81	4	UNC	SWT	NWZ	SWC	
		10	0.79	3	SWC	SWT	SWS		
		11	0.83	2	NWW	SWT			
YUMA VALLEY	AZ	9	0.53	2	NWW	DR			
		10	0.45	1	SWC				
		11	0.33	1	SWC				
YUMA WSO AP	AZ	9	0.31	1	DR				
		10	0.33	1	SWC				
		11	0.3	1	SWC				
ZION NATIONAL PARK	UT	9	0.58	2	UNC	SWC			

		10	0.68	1	SWC				
		11	0.67	1	SWC				
ABBOTSFORD A	BC	9	0.79	2	UNC	SWT			
		10	0.81	2	NWW	NWZ			
		11	0.95	4	NWW	NWM	SWC	NWZ	
AGASSIZ CDA	BC	9	0.81	2	UNC	SWT			
		10	0.85	3	NWW	NWM	NWZ		
		11	0.93	3	NWW	NWM	SWC		
ALERT BAY	BC	9	0.88	3	UNC	SWT	DR		
		10	0.9	3	NWW	NWM	NWZ		
		11	0.8	2	NWW	SWC			
ANCHORAGE WSCMO AP	AK	9	0.80	2	UNC	SWC			
		10	0.88	5	SWC	DR	SWT	NWM	NWZ
		11	0.69	2	DR	SWT			
ANNETTE WSO AIRPORT	AK	9	0.89	2	UNC	DR			
		10	0.93	4	SWC	DR	NWW	NWM	
		11	0.88	4	DR	NWW	SWT	SWS	
ATHABASCA 2	AB	9	0.74	3	UNC	NWW	SWT		
		10	0.76	3	SWT	DR	NWZ		
		11	0.84	3	NWW	NWM	NWZ		
BALDONNEL	BC	9	0.70	3	UNC	SWT	SWC		
		10	0.79	3	NWW	SWC	NWZ		
		11	0.83	2	NWW	NWM			
BANFF	AB	9	0.88	4	UNC	NWW	NWM	SWC	
		10	0.79	2	NWW	SWC			
		11	0.79	2	NWW	NWM			
BARROW WSO AIRPORT	AK	9	0.68	2	UNC	SWC			
		10	0.85	2	SWC	NWW			
		11	0.56	1	NWM				
BEAVERLODGE CDA	AB	9	0.71	2	UNC	SWT			
		10	0.81	3	NWW	SWC	NWZ		
		11	0.73	2	NWW	NWM			
BIG DELTA FAA/AMOS AP	AK	9	0.85	5	UNC	NWM	DR		
		10	0.73	2	SWC	NWW			
		11	0.66	2	NWW	SWT			
BROWNFIELD	AB	9	0.59	2	UNC	SWT			
		10	0.76	2	SWT	NWZ			
		11	0.82	3	NWM	SWC	SWT		
BURNABY CAPITOL HILL	BC	9	0.79	2	UNC	SWT			
		10	0.79	2	NWW	NWZ			
		11	0.93	4	NWW	NWM	SWC	SWT	
BURNABY MTN TERMINAL	BC	9	0.78	2	UNC	SWT			
		10	0.83	2	NWW	NWZ			
		11	0.91	3	NWW	SWC	SWT		
CALGARY INT'L A	AB	9	0.78	3	UNC	NWM	SWC		
		10	0.75	3	SWC	SWT	DR		

		11	0.65	1	NWM				
CAPE PARRY A	NT	9	0.80	3	UNC	SWT	DR		
		10	0.81	3	NWW	NWM	SWC		
		11	0.73	2	SWT	NWM			
CAPE ST JAMES	BC	9	0.87	3	UNC	NWW	DR		
		10	0.92	4	NWW	NWM	SWC	DR	
		11	0.93	5	NWW	SWC	SWT	DR	SWS
CARWAY	AB	9	0.73	3	UNC	NWM	SWC		
		10	0.67	2	SWC	SWT			
		11	0.81	2	SWC	SWT			
CHATHAM POINT	BC	9	0.81	2	UNC	SWT			
		10	0.89	3	NWW	NWM	NWZ		
		11	0.9	3	NWW	SWC	SWT		
COLD BAY WSO AIRPORT	AK	9	0.88	4	UNC	NWW	NWM	SWC	
		10	0.84	3	NWW	SWT	NWM		
		11	0.82	2	SWC	SWT			
COLD LAKE A	AB	9	0.81	3	NWW	SWT	DR		
		10	0.71	2	SWT	NWZ			
		11	0.79	2	NWM	SWT			
COMOX A	BC	9	0.78	2	UNC	SWT			
		10	0.88	3	NWW	NWM	NWZ		
		11	0.86	3	NWW	NWM	SWT		
CORDOVA FAA AP	AK	9	0.90	3	UNC	DR	SWC		
		10	0.91	4	SWC	DR	SWT	NWM	
		11	0.77	2	SWC	DR			
CORONATION A	AB	9	0.65	3	UNC	NWW	NWZ		
		10	0.78	2	SWT	NWZ			
		11	0.8	2	NWM	SWT			
COURTENAY GRANTHAM	BC	9	0.83	2	UNC	SWT			
		10	0.86	3	NWW	NWM	NWZ		
		11	0.87	3	NWW	NWM	SWC		
COWICHAN LAKE FORESTRY	BC	9	0.76	2	UNC	SWT			
		10	0.83	3	NWW	NWM	NWZ		
		11	0.83	2	NWW	SWC			
CRESTON	BC	9	0.79	2	UNC	SWC			
		10	0.78	3	NWW	SWT	NWZ		
		11	0.9	3	NWW	NWM	NWZ		
DEASE LAKE	BC	9	0.91	3	UNC	DR	SWC		
		10	0.75	2	NWW	SWC			
		11	0.79	2	NWW	SWC			
DUVAL	SK	9	0.75	3	UNC	NWM	DR		
		10	0.61	2	SWT	NWZ			
		11	0.65	2	SWT	NWM			
EAGLE BAY	BC	9	0.84	3	UNC	NWW	SWT		
		10	0.83	3	NWW	SWT	NWZ		
		11	0.91	4	NWW	NWM	SWT	NWZ	
EDMONTON CITY CENTRE A	AB	9	0.78	3	UNC	NWW	NWZ		

		10	0.7	2	SWC	NWZ			
		11	0.75	3	NWW	SWC	NWZ		
EDMONTON NAMAO A	AB	9	0.74	2	UNC	NWW			
		10	0.75	3	SWC	SWT	NWZ		
		11	0.66	2	NWM	SWC			
ESTEVAN A	SK	9	0.78	3	UNC	NWW	NWM		
		10	0.57	2	NWW	SWT			
		11	0.8	2	NWW	SWC			
FAIRBANKS WSO AIRPORT	AK	9	0.77	3	UNC	SWT	NWM		
		10	0.78	3	SWC	NWW	NWM		
		11	0.53	1	SWT				
FAIRVIEW	AB	9	0.74	3	UNC	NWW	NWM		
		10	0.71	2	NWW	SWC			
		11	0.85	3	NWW	SWC	SWS		
FORT MCMURRAY A	AB	9	0.75	2	UNC	SWT			
		10	0.79	3	NWW	SWC	NWZ		
		11	0.84	3	NWW	NWM	SWT		
FORT NELSON A	BC	9	0.78	3	UNC	NWW	NWM		
		10	0.67	3	NWW	NWM	SWC		
		11	0.81	2	NWW	SWC			
FORT RELIANCE	NT	9	0.79	3	UNC	SWT	DR		
		10	0.79	3	NWW	NWM	SWC		
		11	0.71	2	SWT	SWC			
FORT SMITH A	NT	9	0.86	3	UNC	SWT	DR		
		10	0.65	2	NWW	SWC			
		11	0.78	2	SWT	NWW			
FORT ST JAMES	BC	9	0.81	3	UNC	SWT	DR		
		10	0.88	3	NWW	SWC	NWZ		
		11	0.87	3	NWW	SWC	SWT		
FORT ST JOHN A	BC	9	0.67	2	UNC	SWT			
		10	0.77	3	NWW	SWC	NWZ		
		11	0.85	3	NWW	NWM	SWC		
GRAND FORKS	BC	9	0.75	2	UNC	SWC			
		10	0.78	3	NWW	SWT	NWZ		
		11	0.91	3	NWW	NWM	NWZ		
GRANDE PRAIRIE A	AB	9	0.65	2	UNC	SWT			
		10	0.84	3	NWW	SWC	NWZ		
		11	0.77	3	NWW	NWM	SWT		
HAY RIVER A	NT	9	0.74	2	SWT	DR			
		10	0.65	2	NWW	SWC			
		11	0.68	2	NWW	NWM			
HEFFLEY CREEK	BC	9	0.71	2	UNC	SWC			
		10	0.69	2	NWW	NWM			
		11	0.84	2	SWC	SWT			
HOPE A	BC	9	0.86	3	UNC	NWW	SWT		
		10	0.84	3	NWW	NWM	NWZ		
		11	0.86	2	NWW	SWT			
INDIAN HEAD CDA	SK	9	0.77	3	UNC	NWW	SWC		

		10	0.65	2	SWT	NWZ			
		11	0.71	2	NWW	NWM			
INUVIK A	NT	9	0.77	3	UNC	DR	SWC		
		10	0.84	3	NWW	NWM	SWC		
		11	0.91	4	SWT	NWW	DR	SWS	
JASPER	AB	9	0.85	2	UNC	SWT			
		10	0.88	4	NWW	NWM	SWC	SWS	
		11	0.87	3	NWW	NWM	SWT		
KAMLOOPS A	BC	9	0.74	2	UNC	SWC			
		10	0.74	2	NWW	SWT			
		11	0.84	2	NWM	SWT			
KASLO	BC	9	0.86	3	UNC	SWT	SWC		
		10	0.81	3	NWW	SWC	NWZ		
		11	0.95	3	NWW	NWM	NWZ		
KELLIHER	SK	9	0.72	2	UNC	SWC			
		10	0.69	2	SWT	NWZ			
		11	0.72	2	SWT	NWM			
KING SALMON WSO AP	AK	9	0.85	4	UNC	NWM	DR	SWC	
		10	0.84	3	SWC	NWW	SWT		
		11	0.81	3	SWC	DR	SWT		
LACOMBE CDA	AB	9	0.78	3	UNC	NWZ	SWC		
		10	0.71	3	SWC	SWT	NWZ		
		11	0.7	2	NWM	SWT			
LAKE LOUISE	AB	9	0.83	3	UNC	NWW	SWT		
		10	0.75	2	NWW	NWZ			
		11	0.84	3	NWW	NWM	SWC		
LETHBRIDGE A	AB	9	0.68	2	UNC	SWC			
		10	0.64	2	SWC	SWT			
		11	0.69	2	SWC	NWZ			
LOST RIVER	SK	9	0.81	3	UNC	SWT	DR		
		10	0.78	3	SWT	NWZ	DR		
		11	0.81	2	SWC	NWM			
MERRY ISLAND	BC	9	0.75	2	UNC	SWT			
		10	0.9	3	NWW	NWM	NWZ		
		11	0.89	3	NWW	NWM	SWT		
MOOSE JAW A	SK	9	0.59	2	SWT	DR			
		10	0.58	2	NWZ	SWC			
		11	0.72	2	NWW	NWM			
MOULD BAY A	NT	9	0.75	3	UNC	NWM	SWC		
		10	0.76	2	NWW	SWC			
		11	0.76	2	SWT	NWW			
NOME WSO AIRPORT	AK	9	0.84	2	UNC	NWM			
		10	0.74	2	SWC	NWW			
		11	0.63	1	SWT				
NORMAN WELLS A	NT	9	0.84	3	UNC	DR	SWC		
		10	0.77	2	SWT	NWM			
		11	0.82	2	NWW	SWC			
NORTH BATTLEFORD A	SK	9	0.58	2	UNC	SWT			
		10	0.7	2	NWW	NWZ			

		11	0.71	2	SWC	NWM			
PACHENA POINT	BC	9	0.84	3	UNC	NWW	SWT		
		10	0.89	3	NWW	NWM	NWZ		
		11	0.93	3	NWW	NWM	SWT		
PEACE RIVER A	AB	9	0.68	2	UNC	NWW			
		10	0.72	2	NWW	SWC			
		11	0.89	4	NWW	NWM	SWC	SWS	
PENTICTON A	BC	9	0.77	2	UNC	NWM			
		10	0.63	2	SWT	NWZ			
		11	0.86	3	NWW	NWM	NWZ		
PITT POLDER	BC	9	0.82	2	UNC	SWT			
		10	0.85	3	NWW	NWM	NWZ		
		11	0.92	3	NWW	NWM	SWT		
PORT HARDY A	BC	9	0.84	3	UNC	SWT	DR		
		10	0.93	3	NWW	NWM	NWZ		
		11	0.85	2	NWW	SWC			
POWELL RIVER	BC	9	0.83	2	UNC	SWT			
		10	0.88	3	NWW	NWM	NWZ		
		11	0.88	3	NWW	NWM	SWC		
PRINCE ALBERT A	SK	9	0.77	3	NWW	SWS	NWM		
		10	0.71	2	SWT	NWZ			
		11	0.76	2	SWT	NWM			
PRINCE GEORGE A	BC	9	0.83	3	UNC	NWM	DR		
		10	0.83	2	NWW	SWC			
		11	0.84	3	NWW	SWC	SWT		
PRINCE RUPERT MONT CIRC	BC	9	0.89	3	UNC	SWT	DR		
		10	0.91	4	NWW	NWM	SWC	DR	
		11	0.9	4	NWW	SWC	SWT	DR	
PRINCETON A	BC	9	0.85	3	UNC	SWS	NWM		
		10	0.72	2	NWW	NWZ			
		11	0.8	3	NWW	NWM	SWC		
QUESNEL A	BC	9	0.82	5	UNC	NWW	NWM		
		10	0.79	2	NWW	SWC			
		11	0.83	3	NWW	SWC	SWT		
RED DEER A	AB	9	0.77	3	UNC	NWW	SWC		
		10	0.71	2	SWT	NWZ			
		11	0.77	2	NWM	SWT			
REGINA A	SK	9	0.71	3	UNC	NWW	NWM		
		10	0.6	2	SWT	NWZ			
		11	0.7	2	SWT	NWM			
SANDSPIT A	BC	9	0.90	4	UNC	NWW	SWS	DR	
		10	0.87	3	NWW	NWM	SWC		
		11	0.91	3	NWW	SWC	DR		
SARDIS	BC	9	0.83	2	UNC	SWT			
		10	0.85	3	NWW	NWM	NWZ		
		11	0.93	3	NWW	NWM	SWC		
SASKATOON A	SK	9	0.80	4	UNC	NWW	SWS	NWM	
		10	0.67	2	SWT	NWZ			
		11	0.72	2	SWT	NWM			

SCOTT CDA	SK	9	0.58	2	UNC	SWT			
		10	0.71	2	NWW	NWZ			
		11	0.76	3	NWW	NWZ	SWC		
SEYMOUR FALLS	BC	9	0.85	3	UNC	NWW	SWT		
		10	0.84	3	NWW	NWM	NWZ		
		11	0.91	3	NWW	NWM	SWC		
SMITHERS A	BC	9	0.93	5	UNC	NWW	NWM	DR	SWC
		10	0.88	3	NWW	NWM	SWC		
		11	0.81	2	NWW	SWC			
SUFFIELD A	AB	9	0.60	2	UNC	NWM			
		10	0.7	3	NWM	SWT	NWZ		
		11	0.61	2	NWW	SWC			
SUMMERLAND CDA	BC	9	0.77	3	UNC	SWS	NWM		
		10	0.63	2	NWM	SWT			
		11	0.84	5	NWW	NWM	NWZ		
SWIFT CURRENT A	SK	9	0.63	2	UNC	SWC			
		10	0.6	2	SWT	NWZ			
		11	0.77	2	SWT	NWM			
SWIFT CURRENT CDA	SK	9	0.65	3	SWT	DR	SWC		
		10	0.65	2	NWZ	SWS			
		11	0.77	2	SWT	NWM			
TERRACE A	BC	9	0.91	2	NWW	DR			
		10	0.92	4	NWW	NWM	SWC	DR	
		11	0.84	3	NWW	SWC	DR		
TLELL	BC	9	0.90	4	UNC	SWS	SWT	DR	
		10	0.92	4	NWW	NWM	SWC	DR	
		11	0.93	3	NWW	SWC	DR		
TOFINO A	BC	9	0.85	3	UNC	SWT	DR		
		10	0.87	3	NWW	NWM	NWZ		
		11	0.91	3	NWW	SWC	SWT		
TUGASKE	SK	9	0.63	2	NWM	DR			
		10	0.59	2	NWZ	SWC			
		11	0.72	2	SWT	NWM			
TUKTOYAKTUK	NT	9	0.78	2	UNC	SWC			
		10	0.76	2	SWT	NWM			
		11	0.73	2	SWT	DR			
VANCOUVER INT'L A	BC	9	0.80	2	UNC	SWT			
		10	0.85	3	NWW	NWM	NWZ		
		11	0.9	3	NWW	NWM	SWC		
VANCOUVER UBC	BC	9	0.80	2	UNC	SWT			
		10	0.82	2	NWW	NWZ			
		11	0.9	3	NWW	NWM	SWC		
VICTORIA INT'L A	BC	9	0.73	2	UNC	SWT			
		10	0.85	3	NWW	NWM	NWZ		
		11	0.87	3	NWW	NWM	NWZ		
WASECA	SK	9	0.60	2	SWT	DR			
		10	0.67	2	NWW	NWZ			

		11	0.72	2	SWC	NWM			
WATSON LAKE A	YT	9	0.90	5	UNC	NWW	SWS	SWT	DR
		10	0.87	3	SWT	DR	SWC		
		11	0.87	2	SWC	NWW			
WEYBURN	SK	9	0.77	3	UNC	NWW	NWM		
		10	0.55	1	SWT				
		11	0.78	2	NWW	SWC			
WHITEHORSE A	YT	9	0.88	4	UNC	NWW	SWS	SWC	
		10	0.81	4	SWT	DR	SWC	NWM	
		11	0.84	2	SWC	NWW			
YAKUTAT WSO AIRPORT	AK	9	0.85	3	UNC	DR	SWC		
		10	0.9	4	DR	NWW	SWT	NWM	
		11	0.88	3	DR	NWW	SWS		
YELLOWKNIFE A	NT	9	0.77	3	UNC	SWT	DR		
		10	0.85	3	SWT	NWW	SWC		
		11	0.89	4	SWT	NWW	NWM	SWS	
YORKTON A	SK	9	0.82	3	UNC	NWW	NWM		
		10	0.67	2	SWT	NWM			
		11	0.81	3	NWW	SWC	NWM		

Table A4. R^2 values for each weather station for the Winter (December, January, February) months. The number of independent variables represent the number of precipitation-linked synoptic patterns used in the regression model, while Pattern1, 2, 3, 4, and 5 show the synoptic patterns that are statistically linked to precipitation at each given station.

Station Name	State/ Province	Month	R^2	Number of Independent Variables	Independent Variables used in Regression Model				
					Pattern1	Pattern2	Pattern3	Pattern4	Pattern5
ALDER 17 S	MT	12	0.90	3	DR	NWW	SWT		
		1	0.68	2	SWC	DR			
		2	0.62	1	NWW				
ALSEA F H FALL CREEK	OR	12	0.92	3	SWC	NWW	NWM		
		1	0.92	4	NWW	SWT	NWZ	NWM	
		2	0.88	3	SWC	NWW	NWM		
ALTENBERN	CO	12	0.67	2	NWW	SWT			
		1	0.61	1	SWT				
		2	0.58	2	SWC	NWW			
ANACORTES	WA	12	0.90	5	SWC	NWW	NWM		
	WA	1	0.81	3	NWW	SWT	NWM		
	WA	2	0.87	3	SWC	NWW	NWM		
ASH MOUNTAIN	CA	12	0.61	1	NWW				
		1	0.57	1	SWT				
		2	0.60	1	NWW				
ASTORIA WSO AIRPORT	OR	12	0.90	2	NWW	SWT			
		1	0.89	2	NWW	NWM			
		2	0.85	3	SWC	NWW	NWM		
BAKER 1 E	MT	12	0.69	2	SWT	NWM			
		1	0.64	2	DR	SWT			
		2	0.64	2	NWW	SWT			
BAKER FCWOS	OR	12	0.76	1	NWW				
		1	0.76	2	NWW	SWT			
		2	0.83	3	DR	NWW	SWT		
BAKERSFIELD WSO ARPT	CA	12	0.79	4	DR	SWT	NWZ	SWS	
		1	0.59	2	SWT	SWS			
		2	0.50	1	NWW				
BEAVER CREEK RANGER STN	AZ	12	0.55	1	SWT				
		1	0.60	2	SWT	SWS			
		2	0.59	2	DR	NWW			
BELGRADE AIRPORT	MT	12	0.84	2	NWW	SWT			
		1	0.72	2	SWC	SWT			
		2	0.65	1	NWW				
BEND	OR	12	0.69	1	NWW				
		1	0.82	2	NWW	SWT			
		2	0.53	1	NWW				
BILLINGS WSO	MT	12	0.77	2	SWT	SWS			

		1	0.63	1	SWT				
		2	0.75	2	SWC	NWW			
BLAINE	WA	12	0.87	2	NWW	SWT			
		1	0.89	3	SWC	NWW	NWM		
		2	0.86	3	SWC	NWW	NWM		
BOISE WSFO AIRPORT	ID	12	0.78	1	NWW				
		1	0.78	2	NWW	SWT			
		2	0.70	1	NWW				
BONNEVILLE DAM	OR	12	0.91	3	SWC	NWW	NWM		
		1	0.90	2	NWW	NWM			
		2	0.87	3	SWC	NWW	NWM		
BORREGO DESERT PARK	CA	12	0.45	1	SWT				
		1	0.39	1	SWT				
		2	0.45	2	DR	NWZ			
BOZEMAN 12 NE	MT	12	0.88	2	NWW	SWT			
		1	0.84	2	NWW	SWT			
		2	0.87	2	NWW	SWT			
BOZEMAN MONTANA ST UNIV	MT	12	0.85	2	NWW	SWT			
		1	0.81	2	NWW	SWT			
		2	0.78	2	NWW	NWM			
BREDETTE	MT	12	0.81	2	NWW	SWT			
		1	0.79	3	SWT	NWZ	NWM		
		2	0.75	2	NWW	SWT			
BROADUS	MT	12	0.79	2	SWT	NWM			
		1	0.64	2	NWW	SWT			
		2	0.73	1	NWW				
BUTTE FAA ARPT	MT	12	0.81	2	NWW	SWT			
		1	0.72	3	SWT	NWZ	NWM		
		2	0.75	2	SWC	NWW			
CABINET GORGE	ID	12	0.92	3	SWC	NWW	NWM		
		1	0.84	2	NWW	SWT			
		2	0.84	3	NWW	NWZ	NWM		
CALEXICO 2 NE	CA	12	0.27	1	SWC				
		1	0.31	1	SWT				
		2	0.31	1	SWS				
CALISTOGA	CA	12	0.81	2	NWW	NWM			
		1	0.72	2	NWW	SWT			
		2	0.61	1	NWW				
CALLAO	UT	12	0.55	1	NWW				
		1	0.58	2	NWW	SWT			
		2	0.46	1	NWW				
CAMP PARDEE	CA	12	0.69	1	NWW				
		1	0.68	2	NWW	SWT			
		2	0.70	1	NWW				

CANELO 1 NW	AZ	12	0.38	1	SWT				
		1	0.63	2	SWC	SWS			
		2	0.67	3	DR	NWW	SWS		
CANOGA PARK PIERCE COLLEGE	CA	12	0.58	1	SWC				
		1	0.41	1	SWT				
		2	0.46	1	NWW				
CANYON FERRY DAM	MT	12	0.73	2	NWW	SWT			
		1	0.60	1	SWT				
		2	0.72	2	NWW	SWT			
CARSON CITY	NV	12	0.59	1	NWW				
		1	0.52	1	SWT				
		2	0.47	1	NWW				
CASCADE 1 NW	ID	12	0.78	2	NWW	NWM			
		1	0.87	4	NWW	SWT	NWZ	NWM	
		2	0.81	2	NWW	NWM			
CASCADE 20 SSE	MT	12	0.76	1	SWT				
		1	0.64	2	SWT	NWZ			
		2	0.72	2	NWW	SWT			
CASCADE 5 S	MT	12	0.80	1	SWT				
		1	0.82	3	DR	SWT	NWZ		
		2	0.72	2	NWW	SWT			
CASPER WSO AP	WY	12	0.57	2	SWC	NWW			
		1	0.74	2	SWC	NWM			
		2	0.84	5	SWC	DR	SWT		
CEDAR CITY AP	UT	12	0.74	2	SWC	SWT			
		1	0.50	1	SWT				
		2	0.72	2	SWC	NWW			
CEDAR LAKE	WA	12	0.90	2	NWW	SWT			
		1	0.89	3	NWW	SWT	NWM		
		2	0.87	3	NWW	SWT	NWM		
CEDARVILLE	CA	12	0.74	1	NWW				
		1	0.66	2	NWW	SWT			
		2	0.68	1	NWW				
CENTER 4 SSW	CO	12	0.52	1	SWT				
		1	0.62	1	SWC				
		2	0.67	2	DR	SWT			
CHESTER	CA	12	0.78	2	NWW	NWM			
		1	0.72	2	NWW	NWM			
		2	0.65	1	NWW				
CHEYENNE WSFO AP	WY	12	0.65	2	SWC	SWT			
		1	0.45	1	SWT				
		2	0.65	2	SWC	NWW			
CHIMACUM 4 S	WA	12	0.88	4	SWC	DR	NWW	NWM	
		1	0.79	2	NWW	NWM			
		2	0.83	3	SWC	NWW	NWM		

CHOTEAU AIRPORT	MT	12	0.77	2	SWT	NWM			
		1	0.75	3	SWT	NWZ	NWM		
		2	0.34	1	NWW				
CITY CREEK WATER PLANT	UT	12	0.79	3	DR	NWW	SWT		
		1	0.86	3	NWW	SWT	NWM		
		2	0.83	4	DR	NWW	SWT	SWS	
CLEARMONT 5 SW	WY	12	0.78	2	SWT	NWM			
		1	0.69	2	SWT	NWZ			
		2	0.83	2	DR	SWT			
COCHETOPA CREEK	CO	12	0.68	2	NWW	SWT			
		1	0.69	1	SWT				
		2	0.70	3	DR	NWW	SWT		
COLONY	WY	12	0.72	2	NWW	SWT			
		1	0.59	2	DR	SWT			
		2	0.73	2	DR	NWW			
COLORADO SPRINGS WSO AP	CO	12	0.75	2	SWT	NWZ			
		1	0.67	2	SWC	SWS			
		2	0.50	1	SWC				
COPCO NO 1 DAM	CA	12	0.82	1	NWW				
		1	0.85	3	NWW	NWZ	NWM		
		2	0.66	1	NWW				
CORDES	AZ	12	0.43	1	SWT				
		1	0.50	1	SWT				
		2	0.52	2	DR	NWZ			
CORVALLIS STATE UNIV	OR	12	0.88	2	NWW	NWM			
		1	0.89	3	NWW	SWT	NWM		
		2	0.82	2	SWC	NWW			
COTTAGE GROVE DAM	OR	12	0.90	2	NWW	NWM			
		1	0.91	3	NWW	NWZ	NWM		
		2	0.77	2	SWC	NWW			
COUGAR 6 E	WA	12	0.92	3	SWC	NWW	NWM		
		1	0.90	3	NWW	NWZ	NWM		
		2	0.88	3	SWC	NWW	NWM		
CRESTON	MT	12	0.84	2	NWW	NWM			
		1	0.82	3	DR	NWW	SWT		
		2	0.90	3	DR	NWW	NWM		
CUYAMACA	CA	12	0.54	1	SWT				
		1	0.50	1	SWT				
		2	0.44	1	NWW				
DALLESPORT FCWOS AP	WA	12	0.79	2	NWW	NWM			
		1	0.83	2	NWW	NWM			
		2	0.61	1	NWW				
DAVIS 2 WSW EXP FARM	CA	12	0.80	1	NWW				

		1	0.71	2	NWW	SWT			
		2	0.60	1	NWW				
DEER CREEK DAM	UT	12	0.66	1	NWW				
		1	0.52	1	SWT				
		2	0.66	2	DR	NWW			
DENVER WSFO AP	CO	12	0.62	2	SWC	SWT			
		1	0.75	1	SWC				
		2	0.77	3	SWC	DR	SWT		
DEVILS TOWER 2	WY	12	0.89	3	SWC	NWW	SWT		
		1	0.79	3	DR	NWW	SWT		
		2	0.80	2	DR	SWT			
DORENA DAM	OR	12	0.90	2	NWW	NWM			
		1	0.92	4	NWW	SWT	NWZ	NWM	
		2	0.82	3	SWC	NWW	NWM		
DOUGLAS FCWOS	AZ	12	0.44	1	SWC				
		1	0.75	3	DR	SWT	SWS		
		2	0.65	2	DR	SWS			
DUBOIS EXPERIMENT STN	ID	12	0.81	2	NWW	NWZ			
		1	0.66	2	NWW	NWM			
		2	0.59	1	NWW				
DUNCAN	AZ	12	0.61	2	SWT	SWS			
		1	0.67	2	DR	SWT			
		2	0.67	2	DR	SWS			
ECHO DAM	UT	12	0.65	1	NWW				
		1	0.64	2	SWT	NWZ			
		2	0.73	2	DR	NWW			
ELK RIVER 1 S	ID	12	0.89	3	SWC	NWW	NWM		
		1	0.90	4	NWW	SWT	NWZ	NWM	
		2	0.81	2	NWW	SWT			
ELKO FCWOS	NV	12	0.64	1	NWW				
		1	0.68	2	NWW	SWT			
		2	0.80	2	NWW	SWS			
ELKTON 3 SW	OR	12	0.88	2	NWW	NWM			
		1	0.93	3	NWW	NWZ	NWM		
		2	0.80	2	SWC	NWW			
ELY WSO AIRPORT	NV	12	0.62	1	NWW				
		1	0.65	2	NWW	SWT			
		2	0.64	2	SWC	NWW			
EMBLEM	WY	12	0.50	1	SWT				
		1	0.65	2	NWW	SWT			
		2	0.53	1	NWW				
EMMETT 2 E	ID	12	0.89	2	NWW	SWS			
		1	0.75	2	NWW	NWM			
		2	0.70	1	NWW				
EUGENE WSO AIRPORT	OR	12	0.86	2	NWW	NWM			

		1	0.91	3	NWW	NWZ	NWM		
		2	0.77	2	SWC	NWW			
EUREKA WFO WOODLEY IS	CA	12	0.85	1	NWW				
		1	0.84	2	NWW	NWM			
		2	0.83	2	SWC	NWW			
FALLON EXPERIMENT STN	NV	12	0.56	1	NWW				
		1	0.66	2	SWT	NWM			
		2	0.51	1	NWW				
FERN RIDGE DAM	OR	12	0.87	2	NWW	NWM			
		1	0.93	4	NWW	SWT	NWZ	NWM	
		2	0.78	2	SWC	NWW			
FILLMORE	UT	12	0.74	2	NWW	SWT			
		1	0.76	2	NWW	SWT			
		2	0.76	2	SWC	NWW			
FISHTAIL	MT	12	0.73	1	SWT				
		1	0.66	1	SWT				
		2	0.62	2	NWW	SWT			
FLAGSTAFF WSO AP	AZ	12	0.63	1	SWT				
		1	0.63	1	SWT				
		2	0.58	2	SWC	NWW			
FLATWILLOW 4 ENE	MT	12	0.68	1	SWT				
		1	0.55	1	SWT				
		2	0.62	1	NWW				
FORT BENTON	MT	12	0.73	2	SWT	NWM			
		1	0.77	3	SWT	NWZ	NWM		
		2	0.74	3	DR	NWW	SWT		
FORT JONES RANGER STN	CA	12	0.79	1	NWW				
		1	0.84	3	NWW	NWZ	NWM		
		2	0.66	1	NWW				
FORT LOGAN 4 ESE	MT	12	0.71	2	NWW	SWT			
		1	0.61	2	SWT	NWM			
		2	0.61	1	NWW				
FOWLER 1 SE	CO	12	0.46	1	SWT				
		1	0.70	2	SWC	NWW			
		2	0.47	1	SWC				
FRESNO YOSEMITE INTL	CA	12	0.80	3	SWC	NWM	SWS		
		1	0.58	2	NWW	NWM			
		2	0.54	1	NWW				
GALATA 16 SSW	MT	12	0.73	2	SWT	SWS			
		1	0.69	2	NWW	SWT			
		2	0.61	1	NWW				
GIBSON DAM	MT	12	0.68	2	NWW	NWM			
		1	0.85	3	NWW	SWT	NWZ		

		2	0.71	2	NWW	SWT			
GILDFORD	MT	12	0.52	1	SWT				
		1	0.72	3	SWC	NWW	SWT		
		2	0.57	1	NWW				
GILLETTE 9 ESE	WY	12	0.82	2	NWW	SWT			
		1	0.83	2	DR	SWT			
		2	0.76	4	DR	SWT			
GLASGOW INTERNATL AP	MT	12	0.73	2	NWW	SWT			
		1	0.75	3	SWT	NWZ	NWM		
		2	0.81	2	NWW	SWT			
GOLD BEACH RANGER STN	OR	12	0.90	3	SWC	NWW	NWM		
		1	0.89	3	NWW	NWZ	NWM		
		2	0.80	2	SWC	NWW			
GOLDBUTTE 7 N	MT	12	0.62	1	SWT				
		1	0.65	2	NWW	SWT			
		2	0.80	3	DR	NWW	SWT		
GRAND JUNCTION WSO AP	CO	12	0.71	2	NWW	SWT			
		1	0.80	2	NWW	SWT			
		2	0.60	2	SWC	NWW			
GRAND LAKE 1 NW	CO	12	0.87	3	DR	NWW	SWT		
		1	0.73	1	SWT				
		2	0.71	1	NWW				
GRANT GROVE	CA	12	0.60	1	NWW				
		1	0.52	1	SWT				
		2	0.59	1	NWW				
GRANTSVILLE 2 W	UT	12	0.64	1	NWW				
		1	0.66	2	SWT	NWM			
		2	0.69	2	SWC	NWW			
GRATON	CA	12	0.82	2	NWW	NWM			
		1	0.75	2	NWW	SWT			
		2	0.69	1	NWW				
GREAT FALLS AIRPORT	MT	12	0.82	2	SWT	SWS			
		1	0.83	2	SWT	NWZ			
		2	0.72	2	SWC	NWW			
HALFWAY	OR	12	0.83	2	NWW	SWT			
		1	0.84	2	NWW	NWM			
		2	0.85	3	NWW	NWM	SWS		
HAMILTON	MT	12	0.62	1	NWW				
		1	0.81	3	NWW	SWT	NWZ		
		2	0.75	1	NWW				
HARLOWTON	MT	12	0.64	2	SWT	SWS			
		1	0.67	2	SWT	NWZ			
		2	0.59	1	NWW				
HASKINS DAM	OR	12	0.92	4	SWC	DR	NWW	NWM	

		1	0.89	2	NWW	NWM			
		2	0.86	3	SWC	NWW	NWM		
HATTON 9 SE	WA	12	0.78	1	NWW				
		1	0.80	2	NWW	NWM			
		2	0.67	2	SWC	NWW			
HAYFIELD PUMPING PLANT	CA	12	0.45	1	SWC				
		1	0.39	1	NWW				
		2	0.48	2	DR	NWZ			
HEALDSBURG	CA	12	0.82	2	NWW	NWM			
		1	0.72	2	NWW	SWT			
		2	0.65	1	NWW				
HEBER RANGER STN	AZ	12	0.55	1	SWT				
		1	0.65	1	SWT				
		2	0.64	3	SWC	NWW	SWS		
HELENA WSO	MT	12	0.76	2	NWW	SWT			
		1	0.71	3	SWT	NWZ	NWM		
		2	0.74	2	NWW	SWT			
HEPPNER	OR	12	0.82	2	NWW	NWM			
		1	0.81	3	DR	NWW	NWM		
		2	0.72	2	SWC	NWW			
HERON 2 NW	MT	12	0.91	3	SWC	NWW	NWM		
		1	0.90	4	NWW	SWT	NWZ	NWM	
		2	0.86	3	NWW	NWZ	NWM		
HILLSBORO	OR	12	0.91	3	SWC	NWW	NWM		
		1	0.90	3	NWW	SWT	NWM		
		2	0.79	2	SWC	NWW			
HOQUIAM FCWOS AP	WA	12	0.94	5	SWC	NWW	NWM		
		1	0.90	3	NWW	SWT	NWM		
		2	0.89	3	SWC	NWW	NWM		
HUNGRY HORSE DAM	MT	12	0.87	3	SWC	NWW	NWM		
		1	0.92	4	NWW	SWT	NWZ	NWM	
		2	0.84	2	NWW	NWM			
HUNTLEY EXPERIMENT STN	MT	12	0.71	1	SWT				
		1	0.67	2	NWW	SWT			
		2	0.62	1	NWW				
IDAHO FALLS 46 W	ID	12	0.58	1	NWW				
		1	0.67	1	SWT				
		2	0.62	1	NWW				
IDAHO FALLS FAA ARPT	ID	12	0.86	3	DR	NWW	SWT		
		1	0.76	2	NWW	SWT			
		2	0.67	1	NWW				
IMPERIAL	CA	12	0.32	1	SWC				
		1	0.35	1	SWT				
		2	0.44	2	SWC	DR			

INGOMAR 14 NE	MT	12	0.56	1	SWT				
		1	0.61	2	NWW	SWT			
		2	0.72	1	NWW				
IRVING	AZ	12	0.56	1	SWT				
		1	0.57	1	SWT				
		2	0.58	2	DR	NWZ			
JENSEN	UT	12	0.52	1	SWT				
		1	0.57	1	SWT				
		2	0.58	2	SWC	NWW			
KAHLOTUS 5 SSW	WA	12	0.75	1	NWW				
		1	0.80	2	NWW	NWM			
		2	0.58	1	NWW				
KALISPELL WSO AIRPORT	MT	12	0.82	2	NWW	NWM			
		1	0.86	3	NWW	SWT	NWM		
		2	0.89	4	DR	NWW	NWZ	NWM	
KANAB	UT	12	0.41	1	SWT				
		1	0.47	1	SWT				
		2	0.55	2	DR	NWW			
KASSLER	CO	12	0.70	2	NWW	SWT			
		1	0.72	1	SWC				
		2	0.73	2	DR	SWT			
KENO	OR	12	0.72	1	NWW				
		1	0.76	2	NWW	SWT			
		2	0.67	1	NWW				
KENT	OR	12	0.74	1	NWW				
		1	0.84	2	NWW	NWM			
		2	0.59	1	NWW				
LACROSSE	WA	12	0.86	2	NWW	NWM			
		1	0.82	2	NWW	NWM			
		2	0.73	2	NWW	SWT			
LANDER WSO AP	WY	12	0.70	1	SWT				
		1	0.66	1	SWC				
		2	0.64	2	SWC	SWT			
LAS VEGAS WSO AIRPORT	NV	12	0.50	2	SWC	NWM			
		1	0.37	1	SWT				
		2	0.51	2	DR	NWZ			
LAVEEN 3 SSE	AZ	12	0.49	1	SWT				
		1	0.47	1	SWT				
		2	0.60	2	DR	SWS			
LEABURG 1 SW	OR	12	0.92	2	NWW	NWM			
		1	0.93	3	NWW	SWT	NWM		
		2	0.84	3	SWC	NWW	NWM		
LEMON COVE	CA	12	0.63	1	NWW				
		1	0.56	1	SWT				
		2	0.58	1	NWW				
LENNEP 6 WSW	MT	12	0.71	2	NWW	SWT			
		1	0.70	2	NWW	SWT			

		2	0.81	2	SWC	NWW			
LEO 6 SW	WY	12	0.88	3	SWC	DR	SWT		
		1	0.71	2	SWC	NWW			
		2	0.74	2	SWT	SWS			
LEWISTON WSO AP	ID	12	0.77	2	NWW	NWM			
		1	0.72	2	NWW	SWT			
		2	0.79	1	NWW				
LINDSAY	CA	12	0.60	1	NWW				
		1	0.54	1	SWT				
		2	0.57	1	NWW				
LIVINGSTON FCWOS	MT	12	0.86	2	NWW	SWT			
		1	0.50	1	SWC				
		2	0.63	1	NWW				
LONG BEACH WSCMO	CA	12	0.61	2	SWC	NWM			
		1	0.42	1	SWT				
		2	0.55	2	DR	NWW			
LONGMONT 2 ESE	CO	12	0.60	1	SWC				
		1	0.70	2	SWC	SWT			
		2	0.69	2	SWC	DR			
LOS ANGELES DOWNTOWN	CA	12	0.66	3	SWC	DR	NWM		
		1	0.41	1	SWT				
		2	0.48	1	NWW				
LOS ANGELES WSO ARPT	CA	12	0.62	2	SWC	NWM			
		1	0.45	1	SWT				
		2	0.47	1	NWW				
LOS BANOS	CA	12	0.70	1	NWW				
		1	0.64	2	NWW	SWT			
		2	0.62	1	NWW				
LOS BANOS ARBURUA RCH	CA	12	0.73	2	SWC	NWW			
		1	0.65	2	NWW	SWT			
		2	0.54	1	NWW				
LOWER HAY CREEK	OR	12	0.79	2	NWW	NWM			
		1	0.85	2	NWW	NWM			
		2	0.52	1	NWW				
LUSTRE 4 NNW	MT	12	0.74	2	NWW	SWT			
		1	0.76	3	SWT	NWZ	NWM		
		2	0.78	2	NWW	SWS			
MAC KENZIE	MT	12	0.66	1	SWT				
		1	0.65	2	DR	SWT			
		2	0.65	1	NWW				
MALHEUR BRANCH EXP STN	OR	12	0.87	3	NWW	NWZ	SWS		
		1	0.76	2	NWW	NWM			
		2	0.75	1	NWW				

MANTI	UT	12	0.72	2	NWW	SWT			
		1	0.66	1	SWT				
		2	0.57	1	NWW				
MANZANITA LAKE	CA	12	0.75	1	NWW				
		1	0.72	2	NWW	NWM			
		2	0.72	1	NWW				
MC MILLIN RESERVOIR	WA	12	0.93	5	SWC	NWW	NWM		
		1	0.89	2	NWW	NWM			
		2	0.85	2	NWW	NWM			
MCCALL	ID	12	0.84	2	NWW	NWM			
		1	0.87	3	NWW	SWT	NWM		
		2	0.84	2	NWW	NWM			
MCNARY DAM	WA	12	0.73	1	NWW				
		1	0.77	2	NWW	NWM			
		2	0.63	2	DR	NWW			
MEDFORD WSO AP	OR	12	0.79	2	NWW	NWM			
		1	0.79	2	NWW	SWT			
		2	0.64	1	NWW				
MEDICINE LAKE 3 SE	MT	12	0.72	2	SWT	NWM			
		1	0.65	2	NWZ	NWM			
		2	0.57	1	NWW				
MESA EXPERIMENT FARM	AZ	12	0.47	1	SWT				
		1	0.58	2	SWT	SWS			
		2	0.60	2	SWC	DR			
MIAMI	AZ	12	0.50	1	SWT				
		1	0.64	1	SWT				
		2	0.61	2	DR	NWM			
MILTON FREEWATER	OR	12	0.84	2	NWW	SWT			
		1	0.75	2	NWW	NWM			
		2	0.73	2	SWC	NWW			
MINERSVILLE	UT	12	0.59	1	SWT				
		1	0.62	2	NWW	SWT			
		2	0.76	2	SWC	NWW			
MISSOULA WSO AP	MT	12	0.83	2	NWW	NWM			
		1	0.83	3	NWW	SWT	NWZ		
		2	0.83	2	NWW	SWT			
MOCCASIN EXPERIMENT STN	MT	12	0.71	2	SWT	SWS			
		1	0.69	2	NWW	SWT			
		2	0.69	2	SWC	NWW			
MONTEZUMA CASTLE N M	AZ	12	0.47	1	SWT				
		1	0.61	2	SWT	SWS			
		2	0.47	1	NWW				
MONTICELLO	UT	12	0.59	1	SWT				

		1	0.52	1	SWT				
		2	0.61	2	SWC	DR			
MORAN 5 WNW	WY	12	0.80	2	NWW	NWM			
		1	0.92	4	NWW	SWT	NWZ	NWM	
		2	0.81	2	NWW	SWT			
MORGAN POWER AND LIGHT	UT	12	0.64	1	NWW				
		1	0.79	3	NWW	SWT	NWZ		
		2	0.68	2	NWW	SWS			
MORRO BAY FIRE DEPT	CA	12	0.75	2	SWC	NWM			
		1	0.49	1	SWT				
		2	0.52	1	NWW				
MOSCOW UNIV OF IDAHO	ID	12	0.84	2	NWW	SWT			
		1	0.79	2	NWW	NWM			
		2	0.79	2	NWW	NWM			
MOUNT VERNON 3 WNW	WA	12	0.90	3	SWC	SWT	NWM		
		1	0.80	3	NWW	SWT	NWM		
		2	0.90	4	SWC	NWW	SWT	NWM	
MYSTIC LAKE	MT	12	0.77	2	NWW	SWT			
		1	0.80	3	SWT	NWZ	NWM		
		2	0.77	2	NWW	SWT			
NEW MEADOWS RANGER STN	ID	12	0.81	2	NWW	NWM			
		1	0.81	2	NWW	SWT			
		2	0.81	2	NWW	NWM			
NEWPORT	WA	12	0.92	3	SWC	NWW	NWM		
		1	0.87	3	NWW	NWZ	NWM		
		2	0.80	3	SWC	NWW	NWM		
NEZPERCE	ID	12	0.85	2	NWW	NWM			
		1	0.82	2	NWW	SWT			
		2	0.92	3	DR	NWW	SWT		
NILAND	CA	12	0.33	1	SWT				
		1	0.34	1	NWW				
		2	0.44	2	DR	NWZ			
OAK CITY	UT	12	0.74	2	NWW	SWT			
		1	0.75	2	NWW	SWT			
		2	0.71	2	SWC	NWW			
OJAI	CA	12	0.65	3	SWC	DR	NWW		
		1	0.42	1	SWT				
		2	0.49	1	NWW				
OLYMPIA WSO AP	WA	12	0.92	3	SWC	NWW	NWM		
		1	0.89	2	NWW	NWM			
		2	0.88	3	SWC	NWW	NWM		
ONTARIO CAA AIRPORT	OR	12	0.82	3	NWW	NWZ	SWS		
		1	0.76	2	NWW	NWM			

		2	0.73	1	NWW				
ORACLE 2 SE	AZ	12	0.66	2	SWT	SWS			
		1	0.66	2	SWT	SWS			
		2	0.66	2	DR	NWW			
ORDERVILLE	UT	12	0.41	1	SWT				
		1	0.47	1	SWT				
		2	0.55	2	DR	NWW			
OTIS 2 NE	OR	12	0.88	2	NWW	SWT			
		1	0.92	3	NWW	SWT	NWM		
		2	0.89	3	SWC	NWW	NWM		
OWYHEE DAM	OR	12	0.81	2	NWW	SWS			
		1	0.73	2	NWW	NWM			
		2	0.67	1	NWW				
PALMDALE	CA	12	0.46	1	SWC				
		1	0.44	1	SWT				
		2	0.44	1	NWW				
PALOMA	CA	12	0.77	2	SWC	NWW			
		1	0.63	2	NWW	SWT			
		2	0.61	2	NWW	SWS			
PARKER RESERVOIR	CA	12	0.34	1	SWC				
		1	0.30	1	SWT				
		2	0.35	1	NWW				
PASO ROBLES	CA	12	0.55	1	NWW				
		1	0.54	1	SWT				
		2	0.52	1	NWW				
PASO ROBLES FCWOS	CA	12	0.63	2	SWC	NWW			
		1	0.52	1	SWT				
		2	0.51	1	NWW				
PENDLETON WSO AIRPORT	OR	12	0.78	2	NWW	SWT			
		1	0.75	2	NWW	NWM			
		2	0.74	1	NWW				
PETRIFIED FOREST N P	AZ	12	0.60	2	SWT	SWS			
		1	0.67	3	DR	SWT	SWS		
		2	0.73	3	DR	NWM	SWS		
PHOENIX WSO AP	AZ	12	0.52	1	SWT				
		1	0.52	1	SWT				
		2	0.64	2	DR	SWS			
POCATELLO WSO AP	ID	12	0.72	1	NWW				
		1	0.76	2	NWW	SWT			
		2	0.72	1	NWW				
PORTERVILLE	CA	12	0.58	1	NWW				
		1	0.52	1	SWT				
		2	0.56	1	NWW				
PORTHILL	ID	12	0.90	3	SWC	NWW	NWM		
		1	0.89	4	NWW	SWT	NWZ	NWM	
		2	0.82	2	NWW	NWM			

PORTLAND WSFO	OR	12	0.90	3	SWC	NWW	NWM		
		1	0.87	2	NWW	NWM			
		2	0.83	2	SWC	NWW			
PRIEST RIVER EXP STN	ID	12	0.91	3	SWC	NWW	NWM		
		1	0.87	3	NWW	NWZ	NWM		
		2	0.86	3	SWC	NWW	NWM		
PROSPECT 2 SW	OR	12	0.81	1	NWW				
		1	0.90	4	NWW	SWT	NWZ	NWM	
		2	0.77	2	SWC	NWW			
PUEBLO WSO AP	CO	12	0.68	1	SWT				
		1	0.70	2	SWC	NWW			
		2	0.52	1	SWC				
PUYALLUP 2 W EXP STN	WA	12	0.94	3	SWC	NWW	NWM		
		1	0.90	2	NWW	NWM			
		2	0.86	3	SWC	NWW	NWM		
RAWLINS AP	WY	12	0.86	2	NWW	SWT			
		1	0.64	1	SWT				
		2	0.75	2	SWC	NWW			
RED LODGE 2 N	MT	12	0.81	1	SWT				
		1	0.79	3	DR	SWT	NWZ		
		2	0.73	2	DR	SWT			
REDSTONE	MT	12	0.65	1	SWT				
		1	0.59	2	NWZ	NWM			
		2	0.57	1	NWW				
RENO WSFO AIRPORT	NV	12	0.61	1	NWW				
		1	0.62	1	SWT				
		2	0.52	1	NWW				
REX 1 S	OR	12	0.89	2	NWW	NWM			
		1	0.90	3	NWW	SWT	NWM		
		2	0.79	2	SWC	NWW			
RICHFIELD	ID	12	0.67	1	NWW				
		1	0.73	2	NWW	SWT			
		2	0.65	1	NWW				
RICHMOND	UT	12	0.77	2	NWW	SWT			
		1	0.77	2	NWW	SWT			
		2	0.77	2	SWC	NWW			
RICHMOND CA	CA	12	0.81	2	NWW	NWM			
		1	0.69	2	NWW	SWT			
		2	0.69	2	NWW	SWS			
RIVERSIDE CITRUS EXP STN	CA	12	0.56	2	SWC	NWM			
		1	0.46	1	SWT				
		2	0.44	1	NWW				
ROCHELLE 3 E	WY	12	0.78	2	NWW	SWT			
		1	0.76	2	SWT	NWZ			
		2	0.69	3	SWC	DR	NWW		

ROCKY FORD 2 SE	CO	12	0.63	2	SWC	SWT			
		1	0.60	2	SWC	SWS			
		2	0.70	3	SWC	NWW	NWZ		
ROY 8 NE	MT	12	0.59	1	SWT				
		1	0.57	1	SWT				
		2	0.64	2	NWW	NWM			
SACRAMENTO FAA ARPT	CA	12	0.79	1	NWW				
		1	0.69	2	NWW	SWT			
		2	0.64	1	NWW				
SAFFORD AGRICULTRL CTR	AZ	12	0.44	1	SWT				
		1	0.56	2	SWC	SWS			
		2	0.67	2	DR	SWS			
SALT LAKE CITY NWSFO	UT	12	0.67	1	NWW				
		1	0.76	2	NWW	SWT			
		2	0.77	3	SWC	NWW	SWS		
SALTAIR SALT PLANT	UT	12	0.66	1	NWW				
		1	0.78	3	NWW	SWT	SWS		
		2	0.76	3	SWC	NWW	SWS		
SAN DIEGO WSO AIRPORT	CA	12	0.61	2	SWC	NWM			
		1	0.46	1	SWT				
		2	0.53	2	SWC	NWW			
SAN FRANCISCO MISSION DOLORES	CA	12	0.80	2	NWW	NWZ			
		1	0.74	2	NWW	SWT			
		2	0.71	2	NWW	SWS			
SAN FRANCISCO WSO AP	CA	12	0.84	3	SWC	NWW	NWM		
		1	0.70	2	NWW	SWT			
		2	0.63	1	NWW				
SANTA BARBARA MUNI AP	CA	12	0.71	3	SWC	DR	NWW		
		1	0.47	1	SWT				
		2	0.51	1	NWW				
SANTA CRUZ	CA	12	0.69	1	NWW				
		1	0.66	2	NWW	SWT			
		2	0.72	2	NWW	SWS			
SANTA MARIA WSO ARPT	CA	12	0.71	2	SWC	NWW			
		1	0.47	1	SWT				
		2	0.51	1	NWW				
SCOTTS MILLS 9 SE	OR	12	0.91	3	SWC	NWW	NWM		
		1	0.91	3	NWW	NWZ	NWM		
		2	0.87	3	SWC	NWW	NWM		

SEATTLE TCOMA WSCMO AP	WA	12	0.91	3	SWC	NWW	NWM		
		1	0.88	2	NWW	NWM			
		2	0.84	2	NWW	NWM			
SEDONA RS	AZ	12	0.54	1	SWT				
		1	0.63	2	SWT	SWS			
		2	0.59	2	SWC	DR			
SHERIDAN WSO AP	WY	12	0.79	1	SWT				
		1	0.75	1	SWT				
		2	0.80	3	DR	NWW	SWT		
SHONKIN 7 S	MT	12	0.75	1	SWT				
		1	0.86	3	DR	SWT	NWZ		
		2	0.86	3	SWC	DR	SWT		
SIDNEY	MT	12	0.78	2	NWW	SWT			
		1	0.66	2	NWW	SWT			
		2	0.74	1	NWW				
SIMPSON 6 NW	MT	12	0.58	1	SWT				
		1	0.66	2	SWT	NWM			
		2	0.61	1	NWW				
SPANISH FORK PWR HOUSE	UT	12	0.74	2	NWW	NWZ			
		1	0.76	2	NWW	SWT			
		2	0.77	3	SWC	NWW	SWS		
SPOKANE WSO AIRPORT	WA	12	0.85	2	NWW	NWM			
		1	0.87	3	NWW	SWT	NWM		
		2	0.75	2	NWW	SWT			
SPRINGFIELD 7 WSW	CO	12	0.55	1	SWC				
		1	0.65	2	SWC	NWW			
		2	0.69	1	SWC				
STOCKTON WSO	CA	12	0.81	4	SWC	DR	NWW	NWM	
		1	0.65	2	NWW	SWT			
		2	0.64	1	NWW				
STRAWBERRY VALLEY	CA	12	0.74	1	NWW				
		1	0.74	2	NWW	SWT			
		2	0.67	1	NWW				
SUMMER LAKE 1 S	OR	12	0.56	1	NWW				
		1	0.72	2	NWW	SWT			
		2	0.56	1	NWW				
SUMMIT	OR	12	0.93	4	SWC	DR	NWW	NWM	
		1	0.90	3	NWW	SWT	NWM		
		2	0.87	3	SWC	NWW	NWM		
SUNBURST 8 E	MT	12	0.75	2	NWW	SWT			
		1	0.83	3	DR	SWT	NWZ		
		2	0.67	2	NWW	SWT			
TELLURIDE 4 WNW	CO	12	0.80	2	NWW	SWT			

		1	0.74	1	SWT				
		2	0.76	3	SWC	DR	NWW		
THOMPSON FALLS POWER HOUSE	MT	12	0.87	3	SWC	NWW	NWM		
		1	0.89	4	NWW	SWT	NWZ	NWM	
		2	0.81	2	NWW	SWT			
TIBER DAM	MT	12	0.55	1	SWT				
		1	0.66	2	NWW	SWT			
		2	0.66	2	DR	NWW			
TIDEWATER 2 SW	OR	12	0.89	2	NWW	SWT			
		1	0.91	3	NWW	SWT	NWM		
		2	0.90	3	SWC	NWW	SWT		
TIMPANOGOS CAVE	UT	12	0.81	3	DR	NWW	SWT		
		1	0.69	2	SWT	NWM			
		2	0.80	3	DR	NWW	SWS		
TOOELE	UT	12	0.77	2	NWW	SWT			
		1	0.75	2	SWT	SWS			
		2	0.78	2	SWC	NWW			
TRIDENT	MT	12	0.58	1	SWT				
		1	0.51	1	SWT				
		2	0.50	2	NWW	NWM			
TUCSON MAGNETIC OBSY	AZ	12	0.52	2	SWT	SWS			
		1	0.60	2	SWT	SWS			
		2	0.57	1	DR				
TUCSON WBO	AZ	12	0.53	2	SWT	SWS			
		1	0.61	2	SWC	DR			
		2	0.65	2	DR	SWS			
UNION EXPERIMENT STN	OR	12	0.80	2	NWW	SWT			
		1	0.68	2	NWW	SWT			
		2	0.73	2	DR	NWW			
UPTON 13 SW	WY	12	0.72	3	NWW	SWT	NWM		
		1	0.43	1	SWT				
		2	0.70	3	SWC	DR	NWW		
VALIER	MT	12	0.71	2	NWW	NWM			
		1	0.72	2	NWW	NWZ			
		2	0.57	1	NWW				
VERNAL AIRPORT	UT	12	0.61	2	NWW	SWT			
		1	0.57	1	SWT				
		2	0.64	2	SWC	NWW			
VICTORVILLE PUMP PLANT	CA	12	0.51	2	SWC	SWS			
		1	0.39	1	SWT				
		2	0.38	1	NWW				
VINTON	CA	12	0.72	1	NWW				
		1	0.55	2	NWW	SWT			

		2	0.54	1	NWW				
VIRGINIA CITY	MT	12	0.83	2	NWW	SWT			
		1	0.73	2	NWW	SWT			
		2	0.79	2	NWW	NWM			
VOLTA POWER HOUSE	CA	12	0.82	2	NWW	NWM			
		1	0.75	2	NWW	NWM			
		2	0.74	1	NWW				
WALLA WALLA FAA AIRPORT	WA	12	0.83	2	NWW	NWM			
		1	0.83	2	NWW	NWM			
		2	0.83	3	NWW	NWM	SWS		
WALLACE WOODLAND PARK	ID	12	0.92	3	SWC	NWW	NWM		
		1	0.87	4	NWW	SWT	NWZ	NWM	
		2	0.82	2	NWW	SWT			
WALNUT CANYON NATL MONUMENT	AZ	12	0.66	2	DR	SWT			
		1	0.65	2	SWT	SWS			
		2	0.61	2	SWC	NWW			
WALSENBURG	CO	12	0.70	2	NWW	SWT			
		1	0.85	2	SWC	NWW			
		2	0.70	2	SWC	SWT			
WANSHIP DAM	UT	12	0.65	1	NWW				
		1	0.66	1	SWT				
		2	0.74	2	DR	NWW			
WARREN	ID	12	0.79	2	NWW	NWM			
		1	0.77	3	NWW	SWT	NWZ		
		2	0.89	3	NWW	SWT	NWZ		
WATERDALE	CO	12	0.62	1	SWT				
		1	0.61	1	SWT				
		2	0.62	2	SWC	NWW			
WESTCLIFFE	CO	12	0.73	1	SWT				
		1	0.71	2	SWC	NWW			
		2	0.71	2	SWC	SWT			
WESTON 1 E	WY	12	0.79	2	NWW	SWT			
		1	0.73	2	NWW	SWT			
		2	0.64	4	DR	SWT			
WHEATLAND 4 N	WY	12	0.51	1	NWW				
		1	0.48	1	SWT				
		2	0.58	2	SWC	NWW			
WHITERIVER 1 SW	AZ	12	0.60	2	SWT	SWS			
		1	0.72	2	SWT	SWS			
		2	0.61	2	DR	NWM			
WILLCOX	AZ	12	0.51	2	SWT	SWS			
		1	0.61	2	DR	SWT			
		2	0.68	2	DR	SWS			
WINNEMUCCA	NV	12	0.67	1	NWW				

WB CITY									
		1	0.70	2	NWW	SWT			
		2	0.68	1	NWW				
WINSLOW WSO AP	AZ	12	0.52	1	SWT				
		1	0.53	1	SWT				
		2	0.66	2	DR	SWS			
WINTERS	CA	12	0.77	1	NWW				
		1	0.70	2	NWW	SWT			
		2	0.55	1	NWW				
WISDOM	MT	12	0.75	2	NWW	NWM			
		1	0.78	2	NWW	SWT			
		2	0.75	1	NWW				
WOODRUFF	UT	12	0.65	2	NWW	SWT			
		1	0.54	1	SWT				
		2	0.62	1	NWW				
WYOLA 1 SW	MT	12	0.82	2	NWW	SWT			
		1	0.83	3	DR	SWT	NWZ		
		2	0.73	2	SWC	NWW			
YAKIMA WSO AP	WA	12	0.79	1	NWW				
		1	0.73	2	NWW	NWM			
		2	0.58	1	NWW				
YAMPA	CO	12	0.84	2	NWW	SWT			
		1	0.79	2	NWW	SWT			
		2	0.73	2	SWC	NWW			
YUMA VALLEY	AZ	12	0.34	1	SWC				
		1	0.40	1	SWT				
		2	0.56	2	NWZ	SWS			
YUMA WSO AP	AZ	12	0.36	1	SWT				
		1	0.39	1	SWT				
		2	0.63	3	SWC	DR	NWZ		
ZION NATIONAL PARK	UT	12	0.58	2	SWC	SWT			
		1	0.53	1	SWT				
		2	0.59	2	DR	NWW			
ABBOTSFORD A	BC	12	0.83	2	NWW	SWT			
		1	0.88	3	NWW	NWM	SWC		
		2	0.81	2	NWW	NWM			
AGASSIZ CDA	BC	12	0.80	2	NWW	SWT			
		1	0.85	3	NWW	NWM	SWT		
		2	0.85	3	NWW	NWM	SWC		
ALERT BAY	BC	12	0.88	3	NWW	SWC	SWT		
		1	0.86	4	NWW	NWM	SWT	DR	
		2	0.89	4	NWM	SWC	SWT	DR	
ANCHORAGE WSCMO AP	AK	12	0.82	2	SWT	SWS			
		1	0.63	2	SWC	DR			
		2	0.81	3	DR	NWW	SWT		
ANNETTE WSO AIRPORT	AK	12	0.92	3	DR	NWW	SWT		

		1	0.91	4	SWC	DR	NWW	NWM	
		2	0.84	2	DR	SWT			
ATHABASCA 2	AB	12	0.83	2	SWT	DR			
		1	0.82	2	SWT	DR			
		2	0.78	2	NWW	SWT			
BALDONNEL	BC	12	0.76	2	SWT	DR			
		1	0.74	1	SWT				
		2	0.69	2	NWW	NWM			
BANFF	AB	12	0.75	2	NWM	SWC			
		1	0.67	2	SWT	NWZ			
		2	0.54	1	NWW				
BARROW WSO AIRPORT	AK	12	0.61	1	SWT				
		1	0.53	2	SWC	DR			
		2	0.60	2	NWW	SWT			
BEAVERLODGE CDA	AB	12	0.74	3	NWM	SWT	DR		
		1	0.71	1	SWT				
		2	0.69	2	NWW	SWT			
BIG DELTA FAA/AMOS AP	AK	12	0.66	1	SWC				
		1	0.66	1	SWC				
		2	0.60	2	SWC	SWT			
BROWNFIELD	AB	12	0.82	2	SWT	DR			
		1	0.80	1	SWT				
		2	0.88	2	NWW	SWT			
BURNABY CAPITOL HILL	BC	12	0.83	2	NWW	SWT			
		1	0.84	3	NWW	NWM	SWT		
		2	0.85	3	NWW	NWM	SWC		
BURNABY MTN TERMINAL	BC	12	0.91	5	NWW	NWM	SWC		
		1	0.86	3	NWW	NWM	SWT		
		2	0.85	3	NWW	NWM	SWC		
CALGARY INT'L A	AB	12	0.72	1	SWT				
		1	0.73	2	SWT	NWZ			
		2	0.74	2	NWW	SWT			
CAPE PARRY A	NT	12	0.68	2	SWT	NWW			
		1	0.58	1	SWT				
		2	0.55	1	NWW				
CAPE ST JAMES	BC	12	0.93	2	NWW	SWT			
		1	0.92	6	NWW	NWM	SWC	DR	
		2	0.92	4	NWM	SWT	DR	NWZ	
CARWAY	AB	12	0.79	1	SWT				
		1	0.83	3	SWT	DR	NWZ		
		2	0.73	2	NWW	SWT			
CHATHAM POINT	BC	12	0.91	4	NWW	NWM	SWC	SWT	
		1	0.89	3	NWW	NWM	SWC		
		2	0.85	3	NWW	NWM	SWC		
COLD BAY WSO AIRPORT	AK	12	0.84	3	SWC	SWT	SWS		

		1	0.89	4	SWC	DR	SWT	NWZ	
		2	0.77	2	SWC	SWT			
COLD LAKE A	AB	12	0.76	2	SWT	SWS			
		1	0.82	2	NWW	SWT			
		2	0.73	2	NWW	SWT			
COMOX A	BC	12	0.88	2	NWW	SWT			
		1	0.85	4	NWW	NWM	SWC	DR	
		2	0.83	3	NWW	NWM	SWC		
CORDOVA FAA AP	AK	12	0.76	3	SWC	DR	NWW		
		1	0.87	3	SWC	DR	SWS		
		2	0.76	2	DR	SWT			
CORONATION A	AB	12	0.82	3	NWM	SWC	SWT		
		1	0.83	2	SWT	NWZ			
		2	0.82	2	NWW	SWT			
COURTENAY GRANTHAM	BC	12	0.89	2	NWW	SWT			
		1	0.83	3	NWW	NWM	DR		
		2	0.82	3	NWW	NWM	SWC		
COWICHAN LAKE FORESTRY	BC	12	0.86	2	NWW	SWT			
		1	0.81	2	NWW	NWM			
		2	0.81	3	NWW	NWM	SWC		
CRESTON	BC	12	0.91	3	NWW	NWM	SWC		
		1	0.90	3	NWW	NWM	SWT		
		2	0.80	2	NWW	NWM			
DEASE LAKE	BC	12	0.85	2	SWT	DR			
		1	0.77	2	SWC	SWT			
		2	0.70	2	NWW	SWT			
DUVAL	SK	12	0.86	3	NWW	SWT	SWS		
		1	0.77	2	NWW	SWT			
		2	0.87	4	NWW	SWT	NWZ	SWC	
EAGLE BAY	BC	12	0.90	3	NWM	SWC	SWT		
		1	0.86	3	NWW	NWM	SWT		
		2	0.84	3	NWW	SWC	SWT		
EDMONTON CITY CENTRE A	AB	12	0.84	5	NWM	SWC	DR		
		1	0.77	1	SWT				
		2	0.81	2	NWW	SWT			
EDMONTON NAMAO A	AB	12	0.84	3	NWM	SWT	DR		
		1	0.78	1	SWT				
		2	0.75	2	NWW	SWT			
ESTEVAN A	SK	12	0.76	2	NWW	SWT			
		1	0.82	4	SWT	NWZ	NWM	DR	
		2	0.80	3	NWW	SWT	NWZ		
FAIRBANKS WSO AIRPORT	AK	12	0.70	3	SWC	DR	NWM		
		1	0.74	2	SWC	SWT			
		2	0.52	2	DR	SWT			
FAIRVIEW	AB	12	0.73	2	SWT	DR			

		1	0.81	2	SWT	DR			
		2	0.70	3	NWW	NWM	SWC		
FORT MCMURRAY A	AB	12	0.83	3	NWW	SWT	DR		
		1	0.76	2	NWW	SWT			
		2	0.79	4	NWW	SWC	SWT	NWZ	
FORT NELSON A	BC	12	0.81	2	SWT	DR			
		1	0.77	2	SWT	DR			
		2	0.77	2	NWW	SWT			
FORT RELIANCE	NT	12	0.84	4	SWT	NWW	DR	SWS	
		1	0.84	3	NWW	SWC	DR		
		2	0.74	2	SWT	DR			
FORT SMITH A	NT	12	0.79	2	SWT	NWW			
		1	0.83	3	SWT	SWC	DR		
		2	0.88	3	SWT	SWC	NWZ		
FORT ST JAMES	BC	12	0.86	3	SWC	SWT	DR		
		1	0.78	2	NWW	SWT			
		2	0.80	2	NWW	NWM			
FORT ST JOHN A	BC	12	0.78	2	SWT	DR			
		1	0.76	1	SWT				
		2	0.66	2	NWW	NWM			
GRAND FORKS	BC	12	0.94	5	NWW	NWM	SWC		
		1	0.88	3	NWW	NWM	SWT		
		2	0.77	3	NWW	NWM	SWS		
GRANDE PRAIRIE A	AB	12	0.78	3	NWM	SWT	DR		
		1	0.73	1	SWT				
		2	0.72	2	NWW	SWT			
HAY RIVER A	NT	12	0.78	3	SWT	DR	SWS		
		1	0.77	2	SWT	DR			
		2	0.85	3	SWT	SWC	DR		
HEFFLEY CREEK	BC	12	0.88	4	NWM	SWC	SWT	SWS	
		1	0.82	3	NWW	NWM	SWT		
		2	0.73	3	SWT	DR	SWS		
HOPE A	BC	12	0.77	2	NWW	SWT			
		1	0.75	2	NWW	SWT			
		2	0.89	4	NWW	NWM	SWC	NWZ	
INDIAN HEAD CDA	SK	12	0.83	2	NWW	SWT			
		1	0.75	2	NWW	SWT			
		2	0.83	4	NWW	SWT	NWZ	SWC	
INUVIK A	NT	12	0.81	3	NWW	NWM	SWC		
		1	0.71	2	SWT	DR			
		2	0.82	3	SWT	NWW	DR		
JASPER	AB	12	0.81	5	NWM	SWC	DR		
		1	0.66	1	SWT				
		2	0.71	2	NWW	SWT			
KAMLOOPS A	BC	12	0.82	3	NWM	SWT	SWS		

		1	0.77	3	NWW	NWM	SWT		
		2	0.72	2	NWW	SWT			
KASLO	BC	12	0.87	3	NWW	NWM	SWC		
		1	0.90	3	NWW	NWM	SWT		
		2	0.84	3	NWW	NWM	SWC		
KELLIHER	SK	12	0.82	5	NWZ	SWC	NWM		
		1	0.86	4	NWW	SWT	NWZ	NWM	
		2	0.86	3	SWT	NWZ	SWC		
KING SALMON WSO AP	AK	12	0.84	2	SWT	SWS			
		1	0.90	4	SWC	DR	NWM	NWZ	
		2	0.64	2	DR	SWT			
LACOMBE CDA	AB	12	0.75	4	NWM	SWC			
		1	0.75	1	SWT				
		2	0.78	2	NWW	SWT			
LAKE LOUISE	AB	12	0.87	4	NWM	SWC			
		1	0.78	2	NWW	SWT			
		2	0.78	3	NWW	NWM	NWZ		
LETHBRIDGE A	AB	12	0.82	2	NWM	SWT			
		1	0.78	2	NWW	SWT			
		2	0.77	2	NWW	SWT			
LOST RIVER	SK	12	0.89	3	NWW	SWT	SWS		
		1	0.83	5	NWW	SWC	NWM		
		2	0.67	2	SWC	NWM			
MERRY ISLAND	BC	12	0.91	3	NWW	NWM	SWC		
		1	0.90	4	NWW	NWM	SWT	DR	
		2	0.81	3	NWW	SWC	SWT		
MOOSE JAW A	SK	12	0.74	2	NWW	SWT			
		1	0.79	3	NWW	SWT	NWM		
		2	0.84	3	NWW	SWT	NWZ		
MOULD BAY A	NT	12	0.67	2	SWT	SWC			
		1	0.46	2	SWT	DR			
		2	0.54	2	NWW	SWS			
NOME WSO AIRPORT	AK	12	0.72	2	SWC	NWW			
		1	0.86	3	SWC	DR	SWT		
		2	0.53	2	DR	SWT			
NORMAN WELLS A	NT	12	0.90	5	SWT	SWC	DR	SWS	
		1	0.70	2	SWC	DR			
		2	0.57	2	SWT	SWC			
NORTH BATTLEFORD A	SK	12	0.87	3	NWW	NWM	DR		
		1	0.86	4	SWT	NWZ	NWM	DR	
		2	0.71	2	SWT	SWC			
PACHENA POINT	BC	12	0.87	2	NWW	SWT			
		1	0.89	3	NWW	NWM	SWC		
		2	0.85	3	NWW	NWM	SWC		
PEACE RIVER A	AB	12	0.81	3	NWM	SWC	DR		
		1	0.78	2	SWT	DR			
		2	0.65	2	NWW	SWT			

PENTICTON A	BC	12	0.82	2	NWW	SWT			
		1	0.84	4	NWW	NWM	SWT	DR	
		2	0.68	1	NWW				
PITT POLDER	BC	12	0.83	2	NWW	SWT			
		1	0.85	3	NWW	NWM	SWT		
		2	0.89	4	NWW	NWM	SWC	SWT	
PORT HARDY A	BC	12	0.84	3	NWW	SWT	DR		
		1	0.86	5	NWW	NWM	SWC		
		2	0.91	4	NWM	SWC	SWT	DR	
POWELL RIVER	BC	12	0.88	2	NWW	SWT			
		1	0.81	2	NWW	SWT			
		2	0.85	4	NWW	NWM	SWC	DR	
PRINCE ALBERT A	SK	12	0.83	2	NWW	SWT			
		1	0.81	3	NWW	SWT	NWM		
		2	0.77	2	SWT	SWC			
PRINCE GEORGE A	BC	12	0.84	2	SWT	DR			
		1	0.76	2	NWW	SWT			
		2	0.81	2	NWW	SWT			
PRINCE RUPERT MONT CIRC	BC	12	0.85	3	SWC	SWT	DR		
		1	0.90	3	NWW	NWM	SWC		
		2	0.92	4	NWM	SWT	DR	NWZ	
PRINCETON A	BC	12	0.86	5	NWW	NWM	SWC		
		1	0.88	4	NWW	NWM	DR	NWZ	
		2	0.81	2	NWW	SWT			
QUESNEL A	BC	12	0.89	4	NWM	SWC	SWT	DR	
		1	0.71	1	SWT				
		2	0.81	2	NWW	SWT			
RED DEER A	AB	12	0.76	4	NWM	SWC			
		1	0.77	1	SWT				
		2	0.80	2	NWW	SWT			
REGINA A	SK	12	0.85	3	NWW	SWT	SWS		
		1	0.88	8	NWZ	SWC	NWM	DR	
		2	0.75	2	NWW	SWT			
SANDSPIT A	BC	12	0.93	3	NWW	SWC	SWT		
		1	0.90	4	NWW	NWM	SWC	DR	
		2	0.82	5	NWM	SWC	DR		
SARDIS	BC	12	0.83	2	NWW	SWT			
		1	0.88	3	NWW	NWM	SWT		
		2	0.85	2	NWW	NWM			
SASKATOON A	SK	12	0.86	3	SWT	SWC	NWM		
		1	0.87	4	SWT	NWZ	NWM	DR	
		2	0.71	2	NWW	SWT			
SCOTT CDA	SK	12	0.84	3	NWW	NWM	DR		
		1	0.85	4	SWT	NWZ	NWM	DR	
		2	0.73	2	NWW	SWT			
SEYMOUR FALLS	BC	12	0.82	2	NWW	SWT			

		1	0.85	3	NWW	NWM	SWC		
		2	0.85	3	NWW	NWM	SWC		
SMITHERS A	BC	12	0.85	2	SWT	DR			
		1	0.74	2	NWW	SWT			
		2	0.89	3	NWW	NWM	SWT		
SUFFIELD A	AB	12	0.79	2	NWW	SWT			
		1	0.74	2	SWT	NWZ			
		2	0.76	2	NWW	SWT			
SUMMERLAND CDA	BC	12	0.77	2	NWW	SWT			
		1	0.86	4	NWW	NWM	SWT	DR	
		2	0.73	3	NWW	SWT	SWS		
SWIFT CURRENT A	SK	12	0.73	2	NWW	SWT			
		1	0.86	4	SWT	NWZ	NWM	DR	
		2	0.86	3	NWW	SWT	NWZ		
SWIFT CURRENT CDA	SK	12	0.73	2	NWW	SWT			
		1	0.88	4	SWT	NWZ	NWM	DR	
		2	0.85	3	NWW	SWT	NWZ		
TERRACE A	BC	12	0.85	3	SWT	DR	SWS		
		1	0.83	2	NWW	SWC			
		2	0.84	3	NWW	NWM	SWT		
TLELL	BC	12	0.90	2	NWW	SWT			
		1	0.92	4	NWW	NWM	SWC	DR	
		2	0.88	3	NWM	SWT	DR		
TOFINO A	BC	12	0.88	5	NWW	NWM	SWC		
		1	0.89	3	NWW	NWM	SWC		
		2	0.86	3	NWW	NWM	SWC		
TUGASKE	SK	12	0.80	2	SWC	NWM			
		1	0.88	5	NWW	SWT	NWZ	NWM	DR
		2	0.81	3	NWW	SWT	SWC		
TUKTOYAKTUK	NT	12	0.58	1	NWW				
		1	0.53	1	SWC				
		2	0.72	2	SWT	DR			
VANCOUVER INT'L A	BC	12	0.91	5	NWW	NWM	SWC		
		1	0.91	4	NWW	NWM	SWC	DR	
		2	0.85	3	NWW	NWM	SWC		
VANCOUVER UBC	BC	12	0.91	5	NWW	NWM	SWC		
		1	0.89	4	NWW	NWM	SWT	DR	
		2	0.84	3	NWW	NWM	SWC		
VICTORIA INT'L A	BC	12	0.85	2	NWW	SWT			
		1	0.83	2	NWW	NWM			
		2	0.86	3	NWW	NWM	SWC		
WASECA	SK	12	0.85	3	NWW	NWM	DR		
		1	0.87	4	SWT	NWZ	NWM	DR	
		2	0.76	2	NWW	SWT			
WATSON LAKE A	YT	12	0.84	5	DR	SWC	NWM		

		1	0.87	4	SWT	DR	SWC	NWW	
		2	0.78	3	SWT	SWC	NWM		
WEYBURN	SK	12	0.83	2	NWW	SWT			
		1	0.70	2	NWW	SWT			
		2	0.86	3	NWW	SWT	NWZ		
WHITEHORSE A	YT	12	0.77	2	SWT	DR			
		1	0.77	2	SWT	DR			
		2	0.84	4	SWT	NWW	NWM	NWZ	
YAKUTAT WSO AIRPORT	AK	12	0.82	3	SWC	DR	SWT		
		1	0.88	3	SWC	DR	SWS		
		2	0.83	3	SWC	DR	SWT		
YELLOWKNIFE A	NT	12	0.80	2	SWT	NWW			
		1	0.74	2	SWT	DR			
		2	0.76	3	NWM	SWC	DR		
YORKTON A	SK	12	0.83	2	NWW	SWT			
		1	0.66	2	NWW	SWT			
		2	0.70	2	SWT	SWC			

Table A5. R^2 values for each weather station for the Spring (March, April, May) months. The number of independent variables represent the number of precipitation-linked synoptic patterns used in the regression model, while Pattern1, 2, 3, 4, and 5 show the synoptic patterns that are statistically linked to precipitation at each given station.

Station Name	State/ Province	Month	R^2	Number of Independent Variables	Independent Variables used in Regression Model				
					Pattern1	Pattern2	Pattern3	Pattern4	Pattern5
ALDER 17 S	MT	3	0.63	2	SWC	SWT			
		4	0.72	2	UNC	NWW			
		5	0.88	2	UNC	SWS			
ALSEA F H FALL CREEK	OR	3	0.91	4	DR	NWW	SWT	NWM	
		4	0.86	3	UNC	SWT	DR		
		5	0.85	3	UNC	NWW	DR		
ALTENBERN	CO	3	0.86	4	SWC	SWT	NWZ	SWS	
		4	0.76	3	UNC	NWM	SWC		
		5	0.67	1	UNC				
ANACORTES	WA	3	0.90	3	SWC	NWW	NWM		
		4	0.92	4	UNC	NWW	NWM	SWC	
		5	0.88	4	UNC	NWW	SWT	DR	
ASH MOUNTAIN	CA	3	0.78	3	SWC	NWW	SWS		
		4	0.60	1	UNC				
		5	0.58	1	UNC				
ASTORIA WSO AIRPORT	OR	3	0.93	4	DR	NWW	SWT	NWM	
		4	0.90	6	UNC	SWS	SWT	DR	
		5	0.87	3	UNC	NWW	DR		
BAKER 1 E	MT	3	0.56	1	SWT				
		4	0.77	3	UNC	SWS	SWT		
		5	0.74	2	UNC	NWW			
BAKER FCWOS	OR	3	0.84	3	NWW	SWT	NWM		
		4	0.60	1	UNC				
		5	0.80	1	UNC				
BAKERSFIELD WSO ARPT	CA	3	0.71	2	SWC	SWS			
		4	0.55	1	UNC				
		5	0.23	1	SWT				
BEAVER CREEK RANGER STN	AZ	3	0.76	2	SWC	SWS			
		4	0.53	2	UNC	SWC			
		5	0.39	1	UNC				
BELGRADE AIRPORT	MT	3	0.73	1	SWC				
		4	0.85	4	UNC	NWM	NWZ	SWC	
		5	0.86	2	UNC	SWS			
BEND	OR	3	0.80	2	NWW	SWT			
		4	0.60	1	UNC				
		5	0.72	3	UNC	SWS	SWT		
BILLINGS WSO	MT	3	0.83	3	SWC	NWW	NWM		
		4	0.74	2	NWW	SWT			
		5	0.76	1	UNC				
BLAINE	WA	3	0.92	4	DR	NWW	SWT	NWM	
		4	0.87	3	UNC	NWW	SWC		
		5	0.89	4	UNC	NWW	DR	NWZ	
BOISE WSFO	ID	3	0.79	2	SWC	NWW			

AIRPORT		4	0.83	3	UNC	SWS	SWC		
		5	0.59	1	UNC				
BONNEVILLE DAM	OR	3	0.93	3	NWW	SWT	NWM		
		4	0.87	2	UNC	SWT	DR		
		5	0.91	5	NWW	SWS	SWT	NWM	DR
BORREGO DESERT PARK	CA	3	0.36	1	SWC				
		4	0.47	2	UNC	SWT			
		5	0.21	1	UNC				
BOZEMAN 12 NE	MT	3	0.89	3	NWW	SWT	NWM		
		4	0.89	4	UNC	NWW	SWS	NWM	
		5	0.91	3	UNC	NWW	SWS		
BOZEMAN MONTANA ST UNIV	MT	3	0.84	4	SWC	NWW	SWT	NWM	
		4	0.91	4	UNC	NWM	NWZ	SWC	
		5	0.89	3	UNC	NWW	SWS		
BREDETTE	MT	3	0.63	2	NWW	SWT			
		4	0.70	2	NWW	SWT			
		5	0.80	2	NWW	SWC			
BROADUS	MT	3	0.62	2	SWC	NWW			
		4	0.69	2	UNC	SWT			
		5	0.75	2	UNC	NWW			
BUTTE FAA ARPT	MT	3	0.81	2	NWW	SWT			
		4	0.76	2	UNC	SWT			
		5	0.81	1	UNC				
CABINET GORGE	ID	3	0.87	3	NWW	SWT	NWM		
		4	0.83	3	UNC	NWW	SWS		
		5	0.84	2	UNC	NWW			
CALEXICO 2 NE	CA	3	0.27	1	SWC				
		4	0.20	1	UNC				
		5	0.16	1	UNC				
CALISTOGA	CA	3	0.66	2	NWW	SWT			
		4	0.65	1	UNC				
		5	0.31	1	UNC				
CALLAO	UT	3	0.70	2	SWC	SWS			
		4	0.70	2	UNC	SWS			
		5	0.59	1	UNC				
CAMP PARDEE	CA	3	0.76	3	NWW	SWT	SWS		
		4	0.64	1	UNC				
		5	0.48	1	UNC				
CANELO 1 NW	AZ	3	0.60	2	SWC	SWS			
		4	0.39	1	UNC				
		5	0.58	2	DR	SWC			
CANOGA PARK PIERCE COLLEGE	CA	3	0.51	2	SWC	NWZ			
		4	0.37	1	UNC				
		5	0.16	1	SWT				
CANYON FERRY DAM	MT	3	0.61	1	SWT				
		4	0.81	2	UNC	SWT			
		5	0.79	1	UNC				
CARSON CITY	NV	3	0.64	2	NWW	NWM			
		4	0.65	1	UNC				

		5	0.57	2	SWT	SWC			
CASCADE 1 NW	ID	3	0.87	3	NWW	SWT	NWM		
		4	0.72	2	UNC	DR			
		5	0.86	3	UNC	SWS	SWT		
CASCADE 20 SSE	MT	3	0.82	3	SWC	NWW	SWT		
		4	0.84	4	UNC	SWT	NWM	NWZ	
		5	0.76	1	UNC				
CASCADE 5 S	MT	3	0.72	3	SWC	NWW	SWS		
		4	0.74	2	UNC	NWW			
		5	0.78	1	UNC				
CASPER WSO AP	WY	3	0.81	3	SWC	NWW	SWT		
		4	0.81	4	UNC	SWS	NWM	SWC	
		5	0.73	2	UNC	SWC			
CEDAR CITY AP	UT	3	0.83	2	SWC	SWS			
		4	0.81	4	UNC	SWS	NWM	SWC	
		5	0.76	3	UNC	SWT	SWC		
CEDAR LAKE	WA	3	0.96	4	SWC	NWW	SWT	NWM	
		4	0.93	4	UNC	NWW	SWT	DR	
		5	0.91	3	UNC	NWW	DR		
CEDARVILLE	CA	3	0.86	3	SWC	NWW	NWM		
		4	0.83	3	UNC	SWS	SWT		
		5	0.78	2	SWT	SWC			
CENTER 4 SSW	CO	3	0.73	2	SWT	SWS			
		4	0.57	2	DR	SWC			
		5	0.69	1	UNC				
CHESTER	CA	3	0.71	2	NWW	SWT			
		4	0.66	1	UNC				
		5	0.70	1	UNC				
CHEYENNE WSFO AP	WY	3	0.67	2	SWC	NWW			
		4	0.73	2	UNC	SWC			
		5	0.83	1	UNC				
CHIMACUM 4 S	WA	3	0.90	3	NWW	SWT	NWM		
		4	0.85	3	UNC	NWW	SWT		
		5	0.87	3	UNC	NWW	DR		
CHOTEAU AIRPORT	MT	3	0.61	2	DR	SWT			
		4	0.74	2	UNC	SWT			
		5	0.76	1	UNC				
CITY CREEK WATER PLANT	UT	3	0.87	3	SWC	NWW	NWM		
		4	0.85	4	UNC	NWW	SWS	SWT	
		5	0.68	1	UNC				
CLEARMONT 5 SW	WY	3	0.68	2	NWW	SWT			
		4	0.78	3	UNC	NWM	NWZ		
		5	0.76	2	UNC	SWC			
COCHETOPA CREEK	CO	3	0.81	3	NWW	SWT	SWS		
		4	0.72	2	NWM	DR			
		5	0.75	1	UNC				
COLONY	WY	3	0.62	2	NWW	SWT			
		4	0.74	3	UNC	NWM	NWZ		
		5	0.62	1	UNC				
COLORADO SPRINGS WSO AP	CO	3	0.77	2	SWC	SWT			
		4	0.69	2	UNC	DR			

		5	0.77	2	UNC	DR			
COPCO NO 1 DAM	CA	3	0.87	3	SWC	NWW	NWM		
		4	0.76	2	UNC	SWT			
		5	0.77	2	UNC	SWT			
CORDES	AZ	3	0.66	1	SWC				
		4	0.35	1	UNC				
		5	0.40	1	UNC				
CORVALLIS STATE UNIV	OR	3	0.90	4	DR	NWW	SWT	NWM	
		4	0.89	3	UNC	SWS	DR		
		5	0.80	3	UNC	NWW	SWS		
COTTAGE GROVE DAM	OR	3	0.91	4	DR	NWW	SWT	NWM	
		4	0.92	3	UNC	SWT	DR		
		5	0.88	5	UNC	NWW	SWS	SWT	DR
COUGAR 6 E	WA	3	0.95	4	DR	NWW	SWT	NWM	
		4	0.89	4	UNC	NWW	SWS	DR	
		5	0.86	4	UNC	NWW	DR	NWZ	
CRESTON	MT	3	0.74	2	NWW	SWT			
		4	0.84	3	UNC	NWM	DR		
		5	0.87	2	UNC	SWT			
CUYAMACA	CA	3	0.62	1	SWC				
		4	0.64	1	UNC				
		5	0.53	1	SWT				
DALLESPORT FCWOS AP	WA	3	0.79	2	NWW	SWT			
		4	0.69	2	UNC	DR			
		5	0.63	2	UNC	SWT			
DAVIS 2 WSW EXP FARM	CA	3	0.67	3	NWW	SWT	SWS		
		4	0.48	1	UNC				
		5	0.35	1	UNC				
DEER CREEK DAM	UT	3	0.68	2	SWC	NWW			
		4	0.82	3	UNC	SWS	SWT		
		5	0.71	2	UNC	NWM			
DENVER WSFO AP	CO	3	0.66	2	SWC	NWW			
		4	0.72	3	NWW	SWS	SWT		
		5	0.76	2	UNC	DR			
DEVILS TOWER 2	WY	3	0.77	2	NWW	SWT			
		4	0.74	3	UNC	NWW	SWS		
		5	0.76	3	UNC	NWW	SWC		
DORENA DAM	OR	3	0.90	3	NWW	SWT	NWM		
		4	0.92	3	UNC	SWT	DR		
		5	0.86	4	UNC	NWW	SWS	SWT	
DOUGLAS FCWOS	AZ	3	0.66	2	SWC	SWS			
		4	0.32	1	DR				
		5	0.42	1	DR				
DUBOIS EXPERIMENT STN	ID	3	0.75	2	NWW	SWT			
		4	0.70	3	UNC	NWZ	SWC		
		5	0.84	3	UNC	SWS	SWT		
DUNCAN	AZ	3	0.69	2	SWC	SWS			

		4	0.35	1	UNC				
		5	0.45	1	UNC				
ECHO DAM	UT	3	0.85	3	SWC	NWW	SWS		
		4	0.82	3	UNC	SWS	SWT		
		5	0.76	2	UNC	SWT			
ELK RIVER 1 S	ID	3	0.93	4	DR	NWW	SWT	NWM	
		4	0.84	3	UNC	SWT	DR		
		5	0.91	3	UNC	NWW	SWT		
ELKO FCWOS	NV	3	0.65	2	NWW	SWT			
		4	0.74	2	UNC	SWC			
		5	0.83	3	SWS	SWT	SWC		
ELKTON 3 SW	OR	3	0.89	4	DR	NWW	SWT	NWM	
		4	0.82	2	UNC	SWT			
		5	0.74	2	UNC	DR			
ELY WSO AIRPORT	NV	3	0.83	2	SWC	SWS			
		4	0.69	2	UNC	SWC			
		5	0.75	2	UNC	SWT			
EMBLEM	WY	3	0.80	4	SWC	NWW	NWZ	NWM	
		4	0.73	3	UNC	NWW	SWC		
		5	0.72	1	UNC				
EMMETT 2 E	ID	3	0.77	2	NWW	SWT			
		4	0.74	2	UNC	SWC			
		5	0.68	2	UNC	SWT			
EUGENE WSO AIRPORT	OR	3	0.86	3	NWW	SWT	NWM		
		4	0.84	2	UNC	DR			
		5	0.81	3	UNC	NWW	DR		
EUREKA WFO WOODLEY IS	CA	3	0.84	3	SWC	NWW	NWM		
		4	0.75	2	UNC	SWT			
		5	0.74	1	UNC				
FALLON EXPERIMENT STN	NV	3	0.69	2	SWT	SWS			
		4	0.53	2	UNC	SWC			
		5	0.78	4	SWS	SWT	NWM	SWC	
FERN RIDGE DAM	OR	3	0.88	3	NWW	SWT	NWM		
		4	0.84	2	UNC	SWS			
		5	0.83	3	UNC	NWW	DR		
FILLMORE	UT	3	0.89	4	SWC	DR	SWT	SWS	
		4	0.73	2	SWT	DR			
		5	0.67	2	UNC	NWM			
FISHTAIL	MT	3	0.73	2	SWC	NWM			
		4	0.78	3	UNC	SWT	NWZ		
		5	0.81	1	UNC				
FLAGSTAFF WSO AP	AZ	3	0.77	2	SWC	SWS			
		4	0.62	2	UNC	SWC			
		5	0.63	2	UNC	SWC			
FLATWILLOW 4 ENE	MT	3	0.74	5	SWC	NWW	NWM		
		4	0.75	2	NWW	SWT			
		5	0.79	2	UNC	NWW			
FORT BENTON	MT	3	0.54	1	SWT				
		4	0.70	2	NWW	SWT			

		5	0.78	2	UNC	NWW			
FORT JONES RANGER STN	CA	3	0.76	2	NWW	NWM			
		4	0.68	2	UNC	SWT			
		5	0.59	1	UNC				
FORT LOGAN 4 ESE	MT	3	0.75	2	SWC	NWW			
		4	0.77	5	UNC	NWM	NWZ		
		5	0.74	1	UNC				
FOWLER 1 SE	CO	3	0.69	2	SWC	DR			
		4	0.57	2	UNC	DR			
		5	0.70	1	UNC				
FRESNO YOSEMITE INTL	CA	3	0.68	2	SWC	SWT			
		4	0.56	1	UNC				
		5	0.37	1	UNC				
GALATA 16 SSW	MT	3	0.54	2	SWC	NWW			
		4	0.69	3	UNC	NWW	SWT		
		5	0.81	2	UNC	NWW			
GIBSON DAM	MT	3	0.70	2	DR	SWT			
		4	0.78	3	UNC	SWT	NWZ		
		5	0.71	1	UNC				
GILDFORD	MT	3	0.49	1	SWT				
		4	0.63	2	UNC	NWW			
		5	0.72	2	UNC	NWW			
GILLETTE 9 ESE	WY	3	0.79	2	NWW	SWT			
		4	0.70	2	UNC	NWW			
		5	0.75	3	UNC	NWW	SWC		
GLASGOW INTERNATL AP	MT	3	0.78	2	NWW	SWT			
		4	0.63	1	NWW				
		5	0.81	3	UNC	NWW	SWC		
GOLD BEACH RANGER STN	OR	3	0.88	4	DR	NWW	SWT	NWM	
		4	0.78	2	UNC	NWW			
		5	0.72	3	UNC	SWS	DR		
GOLDBUTTE 7 N	MT	3	0.68	3	NWW	SWT	SWS		
		4	0.66	2	UNC	NWW			
		5	0.83	2	UNC	NWW			
GRAND JUNCTION WSO AP	CO	3	0.74	2	SWC	SWT			
		4	0.64	2	NWW	SWS			
		5	0.77	3	UNC	NWM	DR		
GRAND LAKE 1 NW	CO	3	0.79	3	SWC	NWW	SWT		
		4	0.89	4	UNC	NWM	NWZ	SWC	
		5	0.81	2	UNC	DR			
GRANT GROVE	CA	3	0.75	2	SWC	SWT			
		4	0.59	1	UNC				
		5	0.63	1	UNC				
GRANTSVILLE 2 W	UT	3	0.85	3	SWC	NWM	SWS		
		4	0.77	3	UNC	SWS	SWT		
		5	0.75	2	UNC	SWT			
GRATON	CA	3	0.65	2	NWW	SWT			
		4	0.70	1	UNC				

		5	0.25	1	UNC				
GREAT FALLS AIRPORT	MT	3	0.78	2	NWW	SWT			
		4	0.70	2	UNC	SWT			
		5	0.82	1	UNC				
HALFWAY	OR	3	0.75	2	NWW	SWT			
		4	0.72	2	UNC	DR			
		5	0.76	2	UNC	SWT			
HAMILTON	MT	3	0.76	2	NWW	SWT			
		4	0.75	2	UNC	SWT			
		5	0.82	1	UNC				
HARLOWTON	MT	3	0.65	2	SWC	NWW			
		4	0.82	3	UNC	NWM	NWZ		
		5	0.84	3	UNC	NWW	SWS		
HASKINS DAM	OR	3	0.91	4	DR	NWW	SWT	NWM	
		4	0.83	3	UNC	SWS	DR		
		5	0.81	3	UNC	NWW	DR		
HATTON 9 SE	WA	3	0.82	3	NWW	NWM	SWS		
		4	0.75	2	UNC	DR			
		5	0.82	3	UNC	SWT	NWM		
HAYFIELD PUMPING PLANT	CA	3	0.30	1	SWC				
		4	0.26	1	UNC				
		5	0.25	1	SWS				
HEALDSBURG	CA	3	0.64	2	NWW	SWT			
		4	0.66	1	UNC				
		5	0.25	1	UNC				
HEBER RANGER STN	AZ	3	0.80	2	SWC	NWZ			
		4	0.68	3	UNC	NWM	SWC		
		5	0.45	1	DR				
HELENA WSO	MT	3	0.77	3	SWC	NWW	SWT		
		4	0.76	2	UNC	SWT			
		5	0.71	1	UNC				
HEPPNER	OR	3	0.79	2	NWW	SWT			
		4	0.71	1	UNC				
		5	0.77	1	UNC				
HERON 2 NW	MT	3	0.86	3	NWW	SWT	NWM		
		4	0.82	3	UNC	NWW	DR		
		5	0.85	2	UNC	NWW			
HILLSBORO	OR	3	0.91	4	DR	NWW	SWT	NWM	
		4	0.87	3	UNC	SWS	DR		
		5	0.81	2	UNC	NWW			
HOQUIAM FCWOS AP	WA	3	0.93	4	NWW	SWT	NWZ	NWM	
		4	0.87	5	UNC	SWT	DR		
		5	0.86	3	UNC	NWW	DR		
HUNGRY HORSE DAM	MT	3	0.87	3	NWW	SWT	NWM		
		4	0.87	6	UNC	SWT	NWM	DR	
		5	0.90	2	UNC	NWW			
HUNTLEY EXPERIMENT STN	MT	3	0.62	2	SWC	NWW			
		4	0.77	2	NWW	SWT			
		5	0.80	2	UNC	NWW			
IDAHO FALLS 46	ID	3	0.78	3	NWW	SWT	SWS		

W									
		4	0.67	2	UNC	SWT			
		5	0.93	4	UNC	SWS	SWT	SWC	
IDAHO FALLS FAA ARPT	ID	3	0.82	3	NWW	SWT	SWS		
		4	0.71	2	UNC	SWT			
		5	0.81	2	UNC	SWS			
IMPERIAL	CA	3	0.32	1	SWC				
		4	0.18	1	UNC				
INGOMAR 14 NE	MT	3	0.68	2	NWW	SWT			
		4	0.65	2	NWW	SWS			
		5	0.80	2	UNC	NWW			
IRVING	AZ	3	0.72	2	SWC	SWS			
		4	0.52	1	UNC				
		5	0.44	1	UNC				
JENSEN	UT	3	0.76	2	SWC	NWZ			
		4	0.76	2	UNC	SWC			
		5	0.72	2	UNC	NWM			
KAHLOTUS 5 SSW	WA	3	0.81	3	NWW	NWM	SWS		
		4	0.73	2	UNC	DR			
		5	0.76	2	UNC	SWT			
KALISPELL WSO AIRPORT	MT	3	0.78	2	NWW	SWT			
		4	0.86	3	UNC	NWM	DR		
		5	0.84	1	UNC				
KANAB	UT	3	0.74	2	SWC	SWS			
		4	0.42	1	UNC				
		5	0.63	2	UNC	SWC			
KASSLER	CO	3	0.68	2	SWC	SWT			
		4	0.81	3	UNC	SWS	SWC		
		5	0.77	2	UNC	DR			
KENO	OR	3	0.83	2	NWW	SWT			
		4	0.72	2	UNC	SWT			
		5	0.76	2	UNC	SWT			
KENT	OR	3	0.79	2	NWW	SWT			
		4	0.78	1	UNC				
		5	0.74	2	UNC	SWT			
LACROSSE	WA	3	0.80	3	NWW	SWT	SWS		
		4	0.74	2	UNC	DR			
		5	0.83	2	UNC	SWT			
LANDER WSO AP	WY	3	0.68	2	SWC	NWM			
		4	0.86	4	UNC	SWS	NWM	SWC	
		5	0.79	2	UNC	SWC			
LAS VEGAS WSO AIRPORT	NV	3	0.66	1	SWC				
		4	0.17	1	SWT				
		5	0.56	1	SWC				
LAVEEN 3 SSE	AZ	3	0.58	2	SWC	NWZ			
		4	0.39	2	UNC	NWZ			
		5	0.21	1	NWM				
LEABURG 1 SW	OR	3	0.90	3	NWW	SWT	NWM		
		4	0.92	3	UNC	SWT	DR		
		5	0.84	2	UNC	NWW			
LEMON COVE	CA	3	0.62	1	SWC				
		4	0.52	1	UNC				

		5	0.38	1	SWT				
LENNEP 6 WSW	MT	3	0.75	2	NWW	SWT			
		4	0.74	2	UNC	SWT			
		5	0.89	3	UNC	NWW	SWS		
LEO 6 SW	WY	3	0.85	3	SWC	NWW	NWM		
		4	0.81	4	UNC	SWS	SWT	SWC	
		5	0.75	1	UNC				
LEWISTON WSO AP	ID	3	0.85	4	DR	NWW	SWT	NWM	
		4	0.75	2	UNC	DR			
		5	0.86	3	UNC	NWW	SWT		
LINDSAY	CA	3	0.65	2	SWC	NWZ			
		4	0.51	1	UNC				
		5	0.40	1	SWT				
LIVINGSTON FCWOS	MT	3	0.79	3	NWW	SWT	SWS		
		4	0.84	3	UNC	SWT	NWZ		
		5	0.86	3	UNC	NWW	SWS		
LONG BEACH WSCMO	CA	3	0.55	2	SWC	NWZ			
		4	0.43	1	UNC				
		5	0.21	1	SWT				
LONGMONT 2 ESE	CO	3	0.55	2	SWC	DR			
		4	0.73	3	UNC	SWS	SWC		
		5	0.66	1	UNC				
LOS ANGELES DOWNTOWN	CA	3	0.65	2	SWC	NWZ			
		4	0.43	1	UNC				
		5	0.16	1	SWT				
LOS ANGELES WSO ARPT	CA	3	0.63	2	SWC	NWZ			
		4	0.41	1	UNC				
		5	0.16	1	SWT				
LOS BANOS	CA	3	0.57	2	SWC	SWS			
		4	0.59	1	UNC				
		5	0.32	1	UNC				
LOS BANOS ARBURUA RCH	CA	3	0.57	2	SWC	SWS			
		4	0.56	1	UNC				
		5	0.32	1	SWT				
LOWER HAY CREEK	OR	3	0.73	2	NWW	SWT			
		4	0.70	1	UNC				
		5	0.70	2	UNC	SWT			
LUSTRE 4 NNW	MT	3	0.73	2	SWT	NWM			
		4	0.61	2	NWW	NWM			
		5	0.75	3	UNC	NWW	SWC		
MAC KENZIE	MT	3	0.63	2	NWW	SWT			
		4	0.79	3	UNC	SWS	SWT		
		5	0.74	2	UNC	NWW			
MALHEUR BRANCH EXP STN	OR	3	0.66	2	NWW	SWS			
		4	0.60	2	UNC	SWC			
		5	0.74	2	UNC	SWT			
MANTI	UT	3	0.76	3	SWC	NWW	SWS		

		4	0.81	3	UNC	SWT	DR		
		5	0.67	1	UNC				
MANZANITA LAKE	CA	3	0.80	2	NWW	SWT			
		4	0.76	2	UNC	SWT			
		5	0.82	3	UNC	SWS	SWT		
MC MILLIN RESERVOIR	WA	3	0.93	3	NWW	SWT	NWM		
		4	0.91	5	UNC	SWT	DR		
		5	0.90	4	UNC	NWW	SWT	DR	
MCCALL	ID	3	0.90	3	NWW	SWT	NWM		
		4	0.77	2	UNC	SWC			
		5	0.88	2	UNC	SWT			
MCNARY DAM	WA	3	0.76	2	NWW	SWT			
		4	0.67	1	UNC				
		5	0.65	2	UNC	SWT			
MEDFORD WSO AP	OR	3	0.80	2	NWW	SWT			
		4	0.80	2	UNC	SWT			
		5	0.76	1	UNC				
MEDICINE LAKE 3 SE	MT	3	0.64	2	NWW	SWT			
		4	0.74	2	UNC	SWT			
		5	0.74	2	NWZ	SWC			
MESA EXPERIMENT FARM	AZ	3	0.63	2	SWC	NWZ			
		4	0.33	1	UNC				
		5	0.28	1	UNC				
MIAMI	AZ	3	0.73	2	SWC	NWZ			
		4	0.57	1	UNC				
		5	0.36	1	DR				
MILTON FREEWATER	OR	3	0.83	4	NWW	SWT	NWZ	SWS	
		4	0.82	2	UNC	DR			
		5	0.73	2	UNC	SWT			
MINERSVILLE	UT	3	0.83	3	SWC	SWT	SWS		
		4	0.82	4	UNC	NWM	NWZ	SWC	
		5	0.72	2	UNC	SWT			
MISSOULA WSO AP	MT	3	0.82	2	NWW	SWT			
		4	0.85	4	UNC	SWT	DR	NWZ	
		5	0.73	1	UNC				
MOCCASIN EXPERIMENT STN	MT	3	0.81	3	SWC	NWW	SWT		
		4	0.87	4	UNC	NWW	NWM	NWZ	
		5	0.77	1	UNC				
MONTEZUMA CASTLE N M	AZ	3	0.73	2	SWC	SWS			
		4	0.46	2	UNC	SWC			
		5	0.32	1	UNC				
MONTICELLO	UT	3	0.77	2	SWC	SWS			
		4	0.71	3	NWW	NWM	SWC		
		5	0.61	1	UNC				
MORAN 5 WNW	WY	3	0.81	2	NWW	SWT			
		4	0.85	3	UNC	SWT	DR		

		5	0.92	3	UNC	NWW	SWS		
MORGAN POWER AND LIGHT	UT	3	0.85	5	SWC	NWW	NWM		
		4	0.81	3	UNC	SWS	SWT		
		5	0.76	3	UNC	SWT	NWM		
MORRO BAY FIRE DEPT	CA	3	0.66	2	SWT	SWS			
		4	0.60	1	UNC				
		5	0.34	1	UNC				
MOSCOW UNIV OF IDAHO	ID	3	0.90	4	SWC	NWW	SWT	NWM	
		4	0.84	2	UNC	DR			
		5	0.87	1	UNC				
MOUNT VERNON 3 WNW	WA	3	0.90	3	SWC	NWW	NWM		
		4	0.93	4	UNC	NWW	NWM	SWC	
		5	0.89	3	UNC	NWW	SWT		
MYSTIC LAKE	MT	3	0.82	3	SWC	NWW	SWT		
		4	0.76	3	UNC	SWS	SWT		
		5	0.87	1	UNC				
NEW MEADOWS RANGER STN	ID	3	0.86	3	NWW	SWT	NWM		
		4	0.78	3	UNC	NWZ	SWC		
		5	0.81	2	UNC	NWW			
NEWPORT	WA	3	0.85	3	NWW	SWT	NWM		
		4	0.81	2	UNC	DR			
		5	0.87	2	UNC	NWZ			
NEZPERCE	ID	3	0.90	4	DR	NWW	SWT	NWM	
		4	0.89	3	UNC	SWT	DR		
		5	0.90	2	UNC	SWT			
NILAND	CA	3	0.21	1	SWS				
		4	0.18	1	SWT				
OAK CITY	UT	3	0.81	3	SWC	NWW	SWS		
		4	0.81	3	UNC	NWM	SWC		
		5	0.71	2	UNC	NWM			
OJAI	CA	3	0.62	2	SWC	NWZ			
		4	0.45	1	UNC				
		5	0.24	1	SWT				
OLYMPIA WSO AP	WA	3	0.93	4	DR	NWW	SWT	NWM	
		4	0.89	5	UNC	SWT	DR		
		5	0.82	3	NWW	SWT	DR		
ONTARIO CAA AIRPORT	OR	3	0.63	2	NWW	SWT			
		4	0.62	2	UNC	SWC			
		5	0.73	2	UNC	SWT			
ORACLE 2 SE	AZ	3	0.62	2	SWC	SWS			
		4	0.49	1	UNC				
		5	0.43	1	UNC				
ORDERVILLE	UT	3	0.72	2	SWC	SWS			
		4	0.50	2	UNC	SWC			
		5	0.66	1	UNC				
OTIS 2 NE	OR	3	0.90	4	DR	NWW	SWT	NWM	
		4	0.91	3	UNC	SWT	DR		
		5	0.86	3	UNC	NWW	DR		
OWYHEE DAM	OR	3	0.70	2	SWC	NWW			
		4	0.69	2	UNC	SWC			

		5	0.78	3	UNC	SWS	SWT		
PALMDALE	CA	3	0.48	1	SWC				
		4	0.37	1	UNC				
		5	0.20	1	SWT				
PALOMA	CA	3	0.65	2	SWT	SWS			
		4	0.67	1	UNC				
		5	0.47	1	UNC				
PARKER RESERVOIR	CA	3	0.55	1	SWC				
		4	0.21	1	UNC				
		5	0.36	1	UNC				
PASO ROBLES	CA	3	0.67	2	SWT	SWS			
		4	0.57	1	UNC				
		5	0.29	1	SWT				
PASO ROBLES FCWOS	CA	3	0.66	2	SWT	SWS			
		4	0.56	1	UNC				
		5	0.24	1	SWT				
PENDLETON WSO AIRPORT	OR	3	0.81	3	NWW	SWT	SWS		
		4	0.76	2	UNC	DR			
		5	0.76	2	UNC	SWT			
PETRIFIED FOREST N P	AZ	3	0.82	3	SWC	NWW	SWS		
		4	0.31	1	DR				
		5	0.47	1	DR				
PHOENIX WSO AP	AZ	3	0.52	1	SWC				
		4	0.34	1	UNC				
		5	0.20	1	UNC				
POCATELLO WSO AP	ID	3	0.80	2	SWC	NWW			
		4	0.80	2	UNC	SWT			
		5	0.84	2	UNC	SWS			
PORTERVILLE	CA	3	0.71	2	SWC	NWZ			
		4	0.51	1	UNC				
		5	0.34	1	UNC				
PORTHILL	ID	3	0.88	3	NWW	SWT	NWM		
		4	0.93	4	UNC	NWM	DR	NWZ	
		5	0.79	1	UNC				
PORTLAND WSFO	OR	3	0.91	4	DR	NWW	SWT	NWM	
		4	0.89	3	UNC	SWT	DR		
		5	0.86	2	UNC	NWW			
PRIEST RIVER EXP STN	ID	3	0.91	4	DR	NWW	SWT	NWM	
		4	0.86	2	UNC	DR			
		5	0.84	2	UNC	NWW			
PROSPECT 2 SW	OR	3	0.87	3	NWW	SWT	NWM		
		4	0.91	4	UNC	SWT	DR	NWZ	
		5	0.73	1	UNC				
PUEBLO WSO AP	CO	3	0.72	2	SWC	DR			
		4	0.61	2	UNC	DR			
		5	0.79	2	UNC	DR			
PUYALLUP 2 W EXP STN	WA	3	0.93	3	NWW	SWT	NWM		
		4	0.90	5	UNC	SWT	DR		

		5	0.86	3	UNC	NWW	DR		
RAWLINS AP	WY	3	0.81	3	SWC	NWW	NWM		
		4	0.72	2	NWW	SWS			
		5	0.75	1	UNC				
RED LODGE 2 N	MT	3	0.80	3	SWC	NWW	SWT		
		4	0.83	4	NWW	SWT	NWM	NWZ	
		5	0.82	1	UNC				
REDSTONE	MT	3	0.66	2	NWW	SWT			
		4	0.72	2	NWW	SWT			
		5	0.77	3	UNC	NWW	SWC		
RENO WSFO AIRPORT	NV	3	0.65	2	SWT	NWZ			
		4	0.74	1	UNC				
		5	0.55	2	UNC	SWS			
REX 1 S	OR	3	0.90	4	DR	NWW	SWT	NWM	
		4	0.87	3	UNC	SWS	DR		
		5	0.85	3	UNC	NWW	DR		
RICHFIELD	ID	3	0.76	2	NWW	SWT			
		4	0.69	2	UNC	SWC			
		5	0.90	6	NWW	SWS	SWT	SWC	
RICHMOND	UT	3	0.81	3	SWC	NWW	NWM		
		4	0.84	3	UNC	SWS	SWT		
		5	0.76	2	UNC	SWS			
RICHMOND CA	CA	3	0.68	3	NWW	SWT	SWS		
		4	0.62	1	UNC				
		5	0.25	1	UNC				
RIVERSIDE CITRUS EXP STN	CA	3	0.66	2	SWC	NWZ			
		4	0.45	1	UNC				
		5	0.30	1	SWT				
ROCHELLE 3 E	WY	3	0.76	2	SWC	NWW			
		4	0.77	3	UNC	SWT	SWC		
		5	0.78	2	UNC	SWC			
ROCKY FORD 2 SE	CO	3	0.67	1	SWC				
		4	0.66	2	UNC	DR			
		5	0.80	2	UNC	SWT			
ROY 8 NE	MT	3	0.74	2	NWW	SWT			
		4	0.70	2	NWW	NWM			
		5	0.78	2	UNC	NWW			
SACRAMENTO FAA ARPT	CA	3	0.66	3	NWW	SWT	SWS		
		4	0.66	1	UNC				
		5	0.40	1	UNC				
SAFFORD AGRICULTRL CTR	AZ	3	0.68	2	SWC	SWS			
		4	0.30	1	UNC				
		5	0.37	1	DR				
SALT LAKE CITY NWSFO	UT	3	0.85	3	SWC	NWW	NWM		
		4	0.84	4	UNC	SWS	SWT	NWZ	
		5	0.74	2	UNC	NWW			
SALTAIR SALT PLANT	UT	3	0.86	3	SWC	NWW	SWS		
		4	0.81	4	UNC	SWS	SWT	NWZ	
		5	0.70	1	UNC				

SAN DIEGO WSO AIRPORT	CA	3	0.53	1	SWC				
		4	0.52	1	UNC				
		5	0.39	1	SWT				
SAN FRANCISCO MISSION DOLORES	CA	3	0.71	3	NWW	SWT	SWS		
		4	0.62	1	UNC				
		5	0.32	1	UNC				
SAN FRANCISCO WSO AP	CA	3	0.71	3	NWW	SWT	SWS		
		4	0.60	1	UNC				
		5	0.38	1	UNC				
SANTA BARBARA MUNI AP	CA	3	0.61	2	SWC	NWZ			
		4	0.45	1	UNC				
		5	0.24	1	SWT				
SANTA CRUZ	CA	3	0.73	3	NWW	SWT	SWS		
		4	0.64	1	UNC				
		5	0.30	1	UNC				
SANTA MARIA WSO ARPT	CA	3	0.65	2	SWT	SWS			
		4	0.58	1	UNC				
		5	0.28	1	SWT				
SCOTTS MILLS 9 SE	OR	3	0.93	4	DR	NWW	SWT	NWM	
		4	0.91	3	UNC	SWT	DR		
		5	0.89	4	UNC	NWW	SWT	DR	
SEATTLE TCOMA WSCMO AP	WA	3	0.93	3	NWW	SWT	NWM		
		4	0.87	5	UNC	SWT	DR		
		5	0.78	2	UNC	NWW			
SEDONA RS	AZ	3	0.68	1	SWC				
		4	0.54	2	UNC	SWC			
		5	0.58	2	UNC	SWC			
SHERIDAN WSO AP	WY	3	0.77	2	NWW	SWT			
		4	0.75	3	UNC	SWS	SWT		
		5	0.79	1	UNC				
SHONKIN 7 S	MT	3	0.74	3	SWC	NWW	SWT		
		4	0.83	3	NWW	SWS	NWM		
		5	0.75	2	UNC	NWW			
SIDNEY	MT	3	0.64	2	NWW	SWT			
		4	0.75	2	NWW	SWT			
		5	0.71	2	NWW	SWC			
SIMPSON 6 NW	MT	3	0.67	3	NWW	SWT	SWS		
		4	0.53	1	NWW				
		5	0.71	2	UNC	NWW			
SPANISH FORK PWR HOUSE	UT	3	0.89	4	SWC	NWW	SWT	SWS	
		4	0.79	3	UNC	NWW	SWS		
		5	0.65	1	UNC				
SPOKANE WSO AIRPORT	WA	3	0.89	3	NWW	SWT	NWM		
		4	0.78	2	UNC	DR			
		5	0.87	2	UNC	NWW			

SPRINGFIELD 7 WSW	CO	3	0.64	1	SWC				
		4	0.61	2	UNC	SWC			
		5	0.72	1	UNC				
STOCKTON WSO	CA	3	0.68	3	NWW	SWT	SWS		
		4	0.70	1	UNC				
		5	0.35	1	UNC				
STRAWBERRY VALLEY	CA	3	0.70	2	NWW	SWT			
		4	0.63	1	UNC				
		5	0.59	1	UNC				
SUMMER LAKE 1 S	OR	3	0.73	2	NWW	NWM			
		4	0.68	2	UNC	DR			
		5	0.76	2	UNC	SWT			
SUMMIT	OR	3	0.92	4	DR	NWW	SWT	NWM	
		4	0.87	3	UNC	SWT	DR		
		5	0.83	3	UNC	NWW	DR		
SUNBURST 8 E	MT	3	0.69	3	SWC	NWW	NWZ		
		4	0.68	2	UNC	NWW			
		5	0.84	1	UNC				
TELLURIDE 4 WNW	CO	3	0.80	3	SWC	SWT	SWS		
		4	0.89	6	UNC	NWM	NWZ	SWC	
		5	0.81	2	UNC	NWM			
THOMPSON FALLS POWER HOUSE	MT	3	0.92	4	DR	NWW	SWT	NWM	
		4	0.75	2	NWW	SWT			
		5	0.82	1	UNC				
TIBER DAM	MT	3	0.46	2	SWC	NWW			
		4	0.63	2	UNC	NWW			
		5	0.82	2	UNC	NWW			
TIDEWATER 2 SW	OR	3	0.92	4	DR	NWW	SWT	NWM	
		4	0.88	3	UNC	SWT	DR		
		5	0.85	3	UNC	NWW	DR		
TIMPANOGOS CAVE	UT	3	0.62	2	SWC	SWS			
		4	0.69	2	UNC	SWC			
		5	0.73	2	UNC	SWT			
TOOELE	UT	3	0.91	3	SWC	NWW	SWS		
		4	0.82	4	UNC	SWS	SWT	NWZ	
		5	0.80	3	UNC	SWT	SWC		
TRIDENT	MT	3	0.65	2	NWW	SWT			
		4	0.80	3	UNC	SWT	NWZ		
		5	0.85	2	UNC	SWS			
TUCSON MAGNETIC OBSY	AZ	3	0.70	2	SWC	SWS			
		4	0.56	2	UNC	SWT			
		5	0.34	1	UNC				
TUCSON WBO	AZ	3	0.73	2	SWC	SWS			
		4	0.55	2	UNC	SWC			
		5	0.46	1	DR				
UNION EXPERIMENT STN	OR	3	0.81	3	NWW	SWT	NWM		
		4	0.79	2	UNC	DR			

		5	0.87	2	UNC	SWT			
UPTON 13 SW	WY	3	0.71	3	SWC	NWW	NWZ		
		4	0.81	4	UNC	SWT	NWZ	SWC	
		5	0.77	3	UNC	NWM	SWC		
VALIER	MT	3	0.57	2	NWW	SWT			
		4	0.64	2	NWW	SWT			
		5	0.80	1	UNC				
VERNAL AIRPORT	UT	3	0.74	3	SWC	NWZ	SWS		
		4	0.74	2	UNC	SWC			
		5	0.66	2	UNC	NWM			
VICTORVILLE PUMP PLANT	CA	3	0.41	1	SWC				
		4	0.39	1	UNC				
		5	0.31	1	UNC				
VINTON	CA	3	0.69	2	NWW	NWM			
		4	0.74	2	UNC	SWT			
		5	0.80	6	SWS	SWT	NWM	SWC	
VIRGINIA CITY	MT	3	0.75	3	SWT	NWM	SWS		
		4	0.83	4	UNC	NWW	SWS	SWT	
		5	0.85	2	UNC	SWS			
VOLTA POWER HOUSE	CA	3	0.74	2	NWW	SWT			
		4	0.75	1	UNC				
		5	0.69	2	UNC	SWT			
WALLA WALLA FAA AIRPORT	WA	3	0.80	2	NWW	SWT			
		4	0.81	2	UNC	DR			
		5	0.83	3	UNC	SWT	SWC		
WALLACE WOODLAND PARK	ID	3	0.93	4	DR	NWW	SWT	NWM	
		4	0.86	3	UNC	NWW	NWM		
		5	0.84	2	UNC	NWW			
WALNUT CANYON NATL MONUMENT	AZ	3	0.72	2	SWC	SWS			
		4	0.56	2	SWT	SWC			
		5	0.53	2	UNC	NWM			
WALSENBURG	CO	3	0.73	3	SWC	NWW	SWT		
		4	0.65	2	SWT	DR			
		5	0.77	2	UNC	DR			
WANSHIP DAM	UT	3	0.87	3	SWC	NWW	NWM		
		4	0.79	3	UNC	NWW	SWS		
		5	0.79	3	UNC	SWT	NWM		
WARREN	ID	3	0.86	3	NWW	SWT	NWM		
		4	0.89	3	UNC	SWS	SWT		
		5	0.88	2	UNC	SWT			
WATERDALE	CO	3	0.55	2	NWW	SWT			
		4	0.72	2	UNC	SWC			
		5	0.72	1	UNC				
WESTCLIFFE	CO	3	0.73	2	SWT	SWS			
		4	0.70	2	SWT	DR			
		5	0.80	3	UNC	NWW	DR		
WESTON 1 E	WY	3	0.70	2	NWW	SWT			
		4	0.75	3	UNC	NWM	SWC		
		5	0.71	2	UNC	NWW			

WHEATLAND 4 N	WY	3	0.57	2	SWC	DR			
		4	0.75	3	UNC	NWZ	SWC		
		5	0.78	2	UNC	NWM			
WHITERIVER 1 SW	AZ	3	0.75	2	SWC	SWS			
		4	0.49	1	UNC				
		5	0.37	1	DR				
WILLCOX	AZ	3	0.60	2	SWC	SWS			
		4	0.37	1	DR				
		5	0.40	1	DR				
WINNEMUCCA WB CITY	NV	3	0.77	2	NWW	SWT			
		4	0.73	2	UNC	SWC			
		5	0.63	2	UNC	SWS			
WINSLOW WSO AP	AZ	3	0.74	2	SWC	SWS			
		4	0.52	2	UNC	SWC			
		5	0.32	1	UNC				
WINTERS	CA	3	0.67	3	NWW	SWT	SWS		
		4	0.51	1	UNC				
		5	0.33	1	UNC				
WISDOM	MT	3	0.87	3	NWW	SWT	NWM		
		4	0.79	2	UNC	SWC			
		5	0.81	1	UNC				
WOODRUFF	UT	3	0.64	2	SWC	SWT			
		4	0.74	3	UNC	NWW	SWS		
		5	0.74	1	UNC				
WYOLA 1 SW	MT	3	0.77	2	NWW	SWT			
		4	0.76	3	UNC	NWW	SWS		
		5	0.78	1	UNC				
YAKIMA WSO AP	WA	3	0.67	2	NWW	NWM			
		4	0.63	1	UNC				
		5	0.65	1	UNC				
YAMPA	CO	3	0.77	2	SWC	NWW			
		4	0.83	3	SWT	NWM	DR		
		5	0.82	1	UNC				
YUMA VALLEY	AZ	3	0.32	1	SWC				
		4	0.29	1	UNC				
		5	0.16	1	DR				
YUMA WSO AP	AZ	3	0.43	1	SWC				
		4	0.33	2	SWT	NWZ			
		5	0.26	1	SWC				
ZION NATIONAL PARK	UT	3	0.69	2	SWC	SWS			
		4	0.62	2	UNC	SWC			
		5	0.61	1	UNC				
ABBOTSFORD A	BC	3	0.96	5	NWW	NWM	SWC	SWT	DR
		4	0.93	4	UNC	NWW	SWT	DR	
		5	0.87	3	NWW	SWT	DR		
AGASSIZ CDA	BC	3	0.89	3	NWW	NWM	SWT		
		4	0.90	3	NWW	SWT	DR		
		5	0.89	4	UNC	NWW	SWT	DR	
ALERT BAY	BC	3	0.88	3	NWW	NWM	SWC		
		4	0.89	5	UNC	SWT	DR		
		5	0.84	3	UNC	NWW	DR		
ANCHORAGE	AK	3	0.55	2	SWC	SWT			

WSCMO AP		4	0.70	2	UNC	SWT			
		5	0.70	2	UNC	SWT			
ANNETTE WSO AIRPORT	AK	3	0.89	4	SWC	DR	NWW	NWM	
		4	0.84	4	UNC	NWW	SWS	DR	
		5	0.84	3	UNC	NWM	DR		
ATHABASCA 2	AB	3	0.79	2	NWW	SWT			
		4	0.82	4	SWS	NWM	DR	SWC	
		5	0.82	3	NWW	DR	SWC		
BALDONNEL	BC	3	0.79	3	NWW	NWM	SWT		
		4	0.65	2	UNC	DR			
		5	0.75	2	UNC	NWW			
BANFF	AB	3	0.78	3	NWW	NWM	SWT		
		4	0.85	3	UNC	NWW	DR		
		5	0.75	1	UNC				
BARROW WSO AIRPORT	AK	3	0.49	1	NWM				
		4	0.47	2	SWS	SWT			
		5	0.53	2	UNC	DR			
BEAVERLODGE CDA	AB	3	0.84	3	NWW	NWM	SWT		
		4	0.59	2	NWW	SWC			
		5	0.69	2	UNC	NWW			
BIG DELTA FAA/AMOS AP	AK	3	0.62	2	SWT	NWM			
		4	0.37	1	UNC				
		5	0.70	2	UNC	NWW			
BROWNFIELD	AB	3	0.78	2	NWW	SWT			
		4	0.69	2	NWW	NWM			
		5	0.81	2	UNC	NWW			
BURNABY CAPITOL HILL	BC	3	0.92	3	NWW	NWM	SWT		
		4	0.87	3	UNC	NWW	DR		
		5	0.87	3	UNC	NWW	NWZ		
BURNABY MTN TERMINAL	BC	3	0.94	4	NWW	NWM	SWC	SWT	
		4	0.85	3	UNC	NWW	DR		
		5	0.86	3	UNC	NWW	NWZ		
CALGARY INT'L A	AB	3	0.76	2	NWW	SWT			
		4	0.70	2	UNC	NWW			
		5	0.82	2	UNC	NWW			
CAPE PARRY A	NT	3	0.55	2	SWT	NWW			
		4	0.71	2	UNC	NWM			
		5	0.76	1	UNC				
CAPE ST JAMES	BC	3	0.90	4	NWW	NWM	SWC	DR	
		4	0.86	3	UNC	NWW	SWC		
		5	0.83	2	UNC	DR			
CARWAY	AB	3	0.69	2	NWW	SWT			
		4	0.63	2	NWW	SWT			
		5	0.82	1	UNC				
CHATHAM POINT	BC	3	0.93	4	NWW	NWM	SWT	SWS	
		4	0.89	5	UNC	SWT	DR		
		5	0.82	3	UNC	NWW	DR		
COLD BAY WSO AIRPORT	AK	3	0.84	2	SWC	SWT			

		4	0.77	2	UNC	NWM			
		5	0.82	2	UNC	SWC			
COLD LAKE A	AB	3	0.76	2	NWW	SWT			
		4	0.70	2	NWW	SWS			
		5	0.90	4	NWW	SWT	NWZ	SWC	
COMOX A	BC	3	0.94	5	NWW	NWM	SWT	DR	NWZ
		4	0.84	2	UNC	DR			
		5	0.82	3	UNC	NWW	NWZ		
CORDOVA FAA AP	AK	3	0.84	3	SWC	DR	SWT		
		4	0.76	2	UNC	NWM			
		5	0.88	3	UNC	SWT	SWC		
CORONATION A	AB	3	0.77	2	NWW	SWT			
		4	0.72	2	UNC	NWW			
		5	0.83	2	UNC	NWW			
COURTENAY GRANTHAM	BC	3	0.93	4	NWW	NWM	SWT	NWZ	
		4	0.86	2	UNC	DR			
		5	0.76	2	UNC	NWZ			
COWICHAN LAKE FORESTRY	BC	3	0.95	4	NWW	NWM	SWT	NWZ	
		4	0.84	3	UNC	NWW	DR		
		5	0.77	2	NWW	DR			
CRESTON	BC	3	0.83	3	NWW	NWM	SWT		
		4	0.88	3	UNC	NWW	DR		
		5	0.77	1	UNC				
DEASE LAKE	BC	3	0.82	4	NWW	NWM	SWC	SWT	
		4	0.61	1	NWW				
		5	0.83	1	UNC				
DUVAL	SK	3	0.77	2	NWW	SWT			
		4	0.75	2	NWM	DR			
		5	0.71	2	UNC	NWW			
EAGLE BAY	BC	3	0.90	3	NWW	NWM	SWC		
		4	0.82	2	UNC	DR			
		5	0.90	2	UNC	NWW			
EDMONTON CITY CENTRE A	AB	3	0.71	2	NWW	SWT			
		4	0.81	3	SWS	SWT	DR		
		5	0.83	4	UNC	NWW	NWM	SWC	
EDMONTON NAMAO A	AB	3	0.70	2	NWW	SWT			
		4	0.89	4	NWW	SWS	NWM	DR	
		5	0.81	4	UNC	NWW	NWM	SWC	
ESTEVAN A	SK	3	0.72	2	NWW	SWT			
		4	0.76	2	UNC	SWT			
		5	0.65	2	UNC	SWC			
FAIRBANKS WSO AIRPORT	AK	3	0.59	1	NWM				
		4	0.63	2	NWW	SWT			
		5	0.74	2	UNC	NWW			
FAIRVIEW	AB	3	0.74	3	NWW	NWM	SWT		
		4	0.63	2	UNC	DR			
		5	0.67	2	NWW	SWT			
FORT MCMURRAY A	AB	3	0.76	2	NWW	SWT			
		4	0.81	3	UNC	DR	SWC		
		5	0.83	2	NWW	DR			

FORT NELSON A	BC	3	0.82	3	NWW	NWM	SWT		
		4	0.46	1	NWW				
		5	0.75	2	UNC	NWW			
FORT RELIANCE	NT	3	0.67	3	SWC	DR	SWS		
		4	0.66	1	NWW				
		5	0.74	2	UNC	SWT			
FORT SMITH A	NT	3	0.80	4	SWT	NWW	DR	SWS	
		4	0.66	1	NWW				
		5	0.75	3	UNC	NWW	DR		
FORT ST JAMES	BC	3	0.86	3	NWW	NWM	SWT		
		4	0.68	2	NWW	DR			
		5	0.77	2	UNC	NWW			
FORT ST JOHN A	BC	3	0.73	3	NWW	NWM	SWT		
		4	0.69	3	NWW	SWS	SWC		
		5	0.72	2	UNC	NWW			
GRAND FORKS	BC	3	0.80	3	NWW	SWT	SWS		
		4	0.86	2	UNC	DR			
		5	0.82	1	UNC				
GRANDE PRAIRIE A	AB	3	0.81	2	NWW	SWT			
		4	0.64	2	NWW	SWS			
		5	0.76	2	UNC	NWW			
HAY RIVER A	NT	3	0.83	3	SWT	NWW	DR		
		4	0.55	1	NWW				
		5	0.73	2	UNC	SWT			
HEFFLEY CREEK	BC	3	0.76	2	NWW	SWT			
		4	0.71	2	UNC	DR			
		5	0.84	2	UNC	NWW			
HOPE A	BC	3	0.87	3	NWW	SWC	SWT		
		4	0.82	2	NWW	DR			
		5	0.87	4	UNC	NWW	DR	NWZ	
INDIAN HEAD CDA	SK	3	0.63	2	NWW	SWT			
		4	0.67	2	UNC	NWM			
		5	0.73	5	NWW	DR	SWC		
INUVIK A	NT	3	0.85	3	NWM	SWC	DR		
		4	0.65	2	SWT	DR			
		5	0.58	1	UNC				
JASPER	AB	3	0.77	2	NWW	NWM			
		4	0.81	3	NWW	SWT	DR		
		5	0.87	3	UNC	NWW	SWC		
KAMLOOPS A	BC	3	0.80	2	NWW	SWT			
		4	0.61	1	UNC				
		5	0.81	2	UNC	NWW			
KASLO	BC	3	0.89	3	NWW	NWM	SWT		
		4	0.91	3	UNC	NWW	DR		
		5	0.81	2	UNC	NWW			
KELLIHER	SK	3	0.82	2	NWW	SWT			
		4	0.66	2	UNC	NWM			
		5	0.75	2	UNC	NWW			
KING SALMON WSO AP	AK	3	0.82	3	SWC	SWT	NWM		
		4	0.81	2	UNC	SWT			
		5	0.87	4	UNC	NWW	SWT	SWC	
LACOMBE CDA	AB	3	0.84	2	NWW	SWT			
		4	0.60	2	UNC	SWT			

		5	0.80	2	UNC	NWW			
LAKE LOUISE	AB	3	0.78	2	NWW	NWM			
		4	0.71	2	UNC	NWW			
		5	0.76	2	UNC	NWZ			
LETHBRIDGE A	AB	3	0.78	2	NWW	SWT			
		4	0.59	1	NWW				
		5	0.76	1	UNC				
LOST RIVER	SK	3	0.78	2	NWW	SWT			
		4	0.69	2	NWW	NWM			
		5	0.74	2	NWW	DR			
MERRY ISLAND	BC	3	0.91	4	NWW	NWM	SWT	SWS	
		4	0.87	2	UNC	DR			
		5	0.84	3	UNC	NWW	DR		
MOOSE JAW A	SK	3	0.75	2	NWW	SWT			
		4	0.73	2	NWW	NWM			
		5	0.76	3	UNC	NWW	SWC		
MOULD BAY A	NT	3	0.81	2	NWW	SWC			
		4	0.49	1	UNC				
		5	0.74	2	UNC	DR			
NOME WSO AIRPORT	AK	3	0.69	2	SWC	SWT			
		4	0.57	2	NWW	NWM			
		5	0.71	2	UNC	SWC			
NORMAN WELLS A	NT	3	0.67	4	NWM	SWC			
		4	0.65	2	SWT	DR			
		5	0.80	2	UNC	NWW			
NORTH BATTLEFORD A	SK	3	0.81	3	NWW	SWT	DR		
		4	0.53	1	NWW				
		5	0.77	2	UNC	NWW			
PACHENA POINT	BC	3	0.91	4	NWW	NWM	SWT	DR	
		4	0.86	4	UNC	NWW	SWS	DR	
		5	0.86	4	UNC	NWW	DR	NWZ	
PEACE RIVER A	AB	3	0.77	3	NWW	NWM	SWT		
		4	0.71	2	SWS	DR			
		5	0.63	2	NWW	SWT			
PENTICTON A	BC	3	0.78	3	NWW	SWT	SWS		
		4	0.73	2	UNC	DR			
		5	0.83	1	UNC				
PITT POLDER	BC	3	0.90	3	NWW	NWM	SWT		
		4	0.87	3	UNC	NWW	DR		
		5	0.87	3	UNC	NWW	NWZ		
PORT HARDY A	BC	3	0.90	4	NWW	NWM	SWC	SWT	
		4	0.87	3	NWW	SWT	DR		
		5	0.87	2	NWW	DR			
POWELL RIVER	BC	3	0.90	4	NWW	NWM	SWT	DR	
		4	0.87	3	UNC	SWT	DR		
		5	0.86	3	UNC	NWW	DR		
PRINCE ALBERT A	SK	3	0.76	3	NWW	SWT	DR		
		4	0.65	2	NWM	DR			
		5	0.71	1	NWW				
PRINCE GEORGE A	BC	3	0.86	4	NWW	NWM	SWC	SWT	
		4	0.89	3	NWW	NWM	SWC		

		5	0.88	4	UNC	NWW	DR	NWZ	
PRINCE RUPERT MONT CIRC	BC	3	0.87	3	NWW	NWM	SWC		
		4	0.86	3	NWW	SWT	DR		
		5	0.86	3	UNC	NWM	DR		
PRINCETON A	BC	3	0.65	2	NWW	SWT			
		4	0.62	2	UNC	DR			
		5	0.76	1	UNC				
QUESNEL A	BC	3	0.85	3	NWW	SWC	SWT		
		4	0.74	2	NWW	SWC			
		5	0.86	2	UNC	DR			
RED DEER A	AB	3	0.80	2	NWW	SWT			
		4	0.72	3	UNC	NWW	NWM		
		5	0.85	2	UNC	NWW			
REGINA A	SK	3	0.79	3	NWW	SWT	SWC		
		4	0.72	3	NWW	SWS	NWM		
		5	0.76	3	UNC	NWW	SWC		
SANDSPIT A	BC	3	0.89	4	NWW	SWT	DR	SWS	
		4	0.82	2	UNC	DR			
		5	0.84	3	UNC	NWW	DR		
SARDIS	BC	3	0.91	3	NWW	NWM	SWT		
		4	0.90	4	UNC	NWW	SWT	DR	
		5	0.93	5	UNC	NWW	SWT	DR	NWZ
SASKATOON A	SK	3	0.78	2	NWW	SWT			
		4	0.60	2	NWW	NWM			
		5	0.76	2	UNC	NWW			
SCOTT CDA	SK	3	0.81	3	NWW	SWT	NWM		
		4	0.52	1	NWW				
		5	0.80	2	UNC	NWW			
SEYMOUR FALLS	BC	3	0.92	3	NWW	NWM	SWT		
		4	0.85	3	UNC	NWW	DR		
		5	0.81	3	UNC	NWW	DR		
SMITHERS A	BC	3	0.80	3	NWW	SWT	DR		
		4	0.84	3	SWT	DR	SWC		
		5	0.80	2	UNC	NWZ			
SUFFIELD A	AB	3	0.75	2	NWW	SWT			
		4	0.64	2	UNC	NWW			
		5	0.78	2	UNC	NWW			
SUMMERLAND CDA	BC	3	0.79	3	NWW	SWT	SWS		
		4	0.73	2	UNC	DR			
		5	0.81	1	UNC				
SWIFT CURRENT A	SK	3	0.72	2	NWW	SWT			
		4	0.70	2	NWW	NWM			
		5	0.75	2	UNC	NWW			
SWIFT CURRENT CDA	SK	3	0.76	2	NWW	SWT			
		4	0.68	2	NWW	NWM			
		5	0.75	2	UNC	NWW			
TERRACE A	BC	3	0.84	3	NWW	SWC	DR		
		4	0.78	2	SWT	DR			
		5	0.85	3	UNC	NWM	NWZ		
TLELL	BC	3	0.91	4	NWW	SWT	DR	SWS	
		4	0.85	2	UNC	DR			
		5	0.86	3	UNC	NWW	DR		

TOFINO A	BC	3	0.91	4	NWW	SWT	DR	SWS	
		4	0.83	3	UNC	NWW	DR		
		5	0.77	2	NWW	DR			
TUGASKE	SK	3	0.82	4	NWW	SWT	NWZ	SWC	
		4	0.74	3	NWW	SWS	NWM		
		5	0.74	2	UNC	NWW			
TUKTOYAKTUK	NT	3	0.64	3	SWC	DR	NWZ		
		4	0.51	1	UNC				
		5	0.43	1	UNC				
VANCOUVER INT'L A	BC	3	0.94	4	NWW	NWM	SWT	SWS	
		4	0.83	2	UNC	DR			
		5	0.84	3	UNC	NWW	NWZ		
VANCOUVER UBC	BC	3	0.92	3	NWW	NWM	SWT		
		4	0.84	2	UNC	DR			
		5	0.82	2	UNC	NWW			
VICTORIA INT'L A	BC	3	0.89	3	NWW	NWM	SWT		
		4	0.84	5	UNC	SWT	DR		
		5	0.82	2	UNC	NWZ			
WASECA	SK	3	0.77	2	NWW	SWT			
		4	0.67	1	NWW				
		5	0.67	2	NWW	SWT			
WATSON LAKE A	YT	3	0.80	3	SWT	DR	NWM		
		4	0.72	2	SWT	DR			
		5	0.69	2	UNC	SWT			
WEYBURN	SK	3	0.66	2	NWW	SWT			
		4	0.65	2	UNC	NWW			
		5	0.69	4	NWW	SWC			
WHITEHORSE A	YT	3	0.59	4	NWW	NWM			
		4	0.74	2	NWW	SWT			
		5	0.63	2	UNC	NWZ			
YAKUTAT WSO AIRPORT	AK	3	0.88	3	SWC	DR	SWT		
		4	0.81	2	UNC	DR			
		5	0.91	4	UNC	NWM	DR	SWC	
YELLOWKNIFE A	NT	3	0.83	4	SWT	NWW	DR	SWS	
		4	0.72	2	NWW	SWC			
		5	0.57	1	UNC				
YORKTON A	SK	3	0.81	2	NWW	SWT			
		4	0.67	2	UNC	NWM			
		5	0.76	2	UNC	NWW			

Table A6. R^2 values for each weather station for the Summer (June, July, August) months. The number of independent variables represent the number of precipitation-linked synoptic patterns used in the regression model, while Pattern1, 2, 3, 4, and 5 show the synoptic patterns that are statistically linked to precipitation at each given station.

tation Name	State/ Province	Month	R^2	Number of Independent Variables	Independent Variables used in Regression Model				
					Pattern1	Pattern2	Pattern3	Pattern4	Pattern5
ALDER 17 S	MT	6	0.87	3	NWW	SWS	SWT		
		7	0.70	4	SWS	UNC			
		8	0.89	4	NWW	SWC	SWT	NWM	
ALSEA F H FALL CREEK	OR	6	0.77	2	UNC	NWZ			
		7	0.58	1	SWT				
		8	0.54	1	SWT				
ALTENBERN	CO	6	0.61	2	NWW	SWT			
		7	0.78	3	NWW	UNC	NWZ		
		8	0.73	2	UNC	DR			
ANACORTES	WA	6	0.83	2	UNC	SWT			
		7	0.77	2	SWC	SWT			
		8	0.59	1	SWT				
ASH MOUNTAIN	CA	6	0.27	1	NWW				
		7	0.31	1	NWZ				
		8	0.17	1	NWZ				
ASTORIA WSO AIRPORT	OR	6	0.80	2	UNC	NWZ			
		7	0.67	2	UNC	SWT			
		8	0.68	2	SWT	NWM			
BAKER 1 E	MT	6	0.78	4	NWW	SWT			
		7	0.72	2	UNC	SWT			
		8	0.69	5	SWS	SWT	NWM		
BAKER FCWOS	OR	6	0.65	1	UNC				
		7	0.44	1	SWT				
		8	0.53	2	SWS	UNC			
BAKERSFIELD WSO ARPT	CA	6	0.18	1	NWM				
		7	0.18	1	SWS				
		8	0.19	1	NWM				
BEAVER CREEK RANGER STN	AZ	6	0.37	1	NWW				
		7	0.81	2	NWW	NWZ			
		8	0.80	3	NWW	UNC	DR		
BELGRADE AIRPORT	MT	6	0.74	2	NWW	SWT			
		7	0.63	2	SWT	DR			
		8	0.85	4	SWS	SWC	SWT	NWM	
BEND	OR	6	0.60	2	UNC	SWT			
		7	0.42	1	SWS				
		8	0.44	1	UNC				
BILLINGS WSO	MT	6	0.64	2	NWW	SWT			
		7	0.73	3	NWW	SWC	NWM		
		8	0.76	3	SWS	SWT	NWM		
BLAINE	WA	6	0.82	2	UNC	NWZ			

		7	0.82	2	SWC	SWT			
		8	0.74	1	SWT				
BOISE WSFO AIRPORT	ID	6	0.73	2	NWW	SWT			
		7	0.41	1	UNC				
		8	0.47	1	UNC				
BONNEVILLE DAM	OR	6	0.78	2	UNC	NWZ			
		7	0.55	2	UNC	SWT			
		8	0.70	2	SWT	NWM			
BORREGO DESERT PARK	CA	6	0.13	1	UNC				
		7	0.38	1	UNC				
		8	0.24	1	SWC				
BOZEMAN 12 NE	MT	6	0.89	3	UNC	NWW	SWT		
		7	0.75	3	SWS	SWC	SWT		
		8	0.83	3	SWC	SWT	NWM		
BOZEMAN MONTANA ST UNIV	MT	6	0.81	2	NWW	SWT			
		7	0.69	2	NWW	SWT			
		8	0.88	4	SWC	SWT	NWM	DR	
BREDETTE	MT	6	0.80	2	NWW	SWT			
		7	0.68	4	SWS	UNC			
		8	0.57	2	NWW	SWT			
BROADUS	MT	6	0.83	2	NWW	SWT			
		7	0.70	2	NWW	UNC			
		8	0.65	2	SWT	DR			
BUTTE FAA ARPT	MT	6	0.78	2	NWW	SWT			
		7	0.67	2	SWS	SWC			
		8	0.79	5	SWC	SWT	NWM		
CABINET GORGE	ID	6	0.76	1	UNC				
		7	0.65	2	SWC	SWT			
		8	0.71	3	SWS	SWT	NWZ		
CALEXICO 2 NE	CA	6	0.14	1	NWM				
		7	0.24	1	UNC				
		8	0.34	2	NWM	DR			
CALISTOGA	CA	6	0.27	1	SWC				
		7	0.21	1	NWZ				
		8	0.30	2	SWC	NWM			
CALLAO	UT	6	0.51	1	SWT				
		7	0.45	1	NWW				
		8	0.62	2	SWS	SWC			
CAMP PARDEE	CA	6	0.23	1	SWT				
		8	0.19	1	SWT				
CANELO 1 NW	AZ	6	0.58	2	SWT	DR			
		7	0.87	4	UNC	SWT	NWZ	DR	
		8	0.84	3	NWW	UNC	SWC		
CANOGA PARK PIERCE COLLEGE	CA	6	0.19	1	NWM				
		7	0.13	1	NWZ				

		8	0.33	1	NWM				
CANYON FERRY DAM	MT	6	0.76	2	UNC	SWC			
		7	0.70	2	SWS	SWC			
		8	0.79	3	SWC	SWT	NWM		
CARSON CITY	NV	6	0.43	1	SWC				
		7	0.52	1	UNC				
		8	0.42	1	SWC				
CASCADE 1 NW	ID	6	0.73	2	NWW	SWT			
		7	0.63	2	NWW	SWT			
		8	0.55	2	SWS	UNC			
CASCADE 20 SSE	MT	6	0.81	3	NWW	SWT	SWC		
		7	0.74	3	NWW	SWC	SWT		
		8	0.79	5	SWC	SWT	NWM		
CASCADE 5 S	MT	6	0.72	2	NWW	SWT			
		7	0.82	3	SWS	SWC	SWT		
		8	0.77	5	SWS	SWT	NWM		
CASPER WSO AP	WY	6	0.63	2	DR	SWC			
		7	0.75	2	NWW	NWZ			
		8	0.54	1	UNC				
CEDAR CITY AP	UT	6	0.68	2	NWW	SWT			
		7	0.50	1	UNC				
		8	0.63	2	UNC	DR			
CEDAR LAKE	WA	6	0.82	2	UNC	NWW			
		7	0.71	2	SWC	SWT			
		8	0.85	3	SWS	SWT	NWM		
CEDARVILLE	CA	6	0.53	2	NWW	SWT			
		7	0.49	2	SWT	DR			
		8	0.45	1	UNC				
CENTER 4 SSW	CO	6	0.55	2	DR	SWC			
		7	0.80	3	UNC	SWC	NWZ		
		8	0.80	2	UNC	DR			
CHESTER	CA	6	0.61	2	NWW	SWT			
		7	0.46	2	UNC	NWZ			
		8	0.31	1	SWC				
CHEYENNE WSFO AP	WY	6	0.90	4	SWS	NWM	DR	SWC	
		7	0.78	3	UNC	NWZ	DR		
		8	0.78	4	UNC	SWC	SWT	NWM	
CHIMACUM 4 S	WA	6	0.83	2	UNC	SWT			
		7	0.80	2	NWW	SWT			
		8	0.82	3	SWS	SWT	NWM		
CHOTEAU AIRPORT	MT	6	0.69	2	UNC	SWC			
		7	0.87	3	SWS	SWC	SWT		
		8	0.65	2	UNC	NWM			
CITY CREEK WATER PLANT	UT	6	0.70	2	NWW	SWT			
		7	0.60	2	NWW	UNC			
		8	0.61	2	SWS	SWC			
CLEARMONT 5 SW	WY	6	0.77	2	NWW	SWT			

		7	0.59	2	SWS	UNC			
		8	0.67	5	SWT	NWM	DR		
COCHETOPA CREEK	CO	6	0.59	2	NWW	DR			
		7	0.77	2	NWW	UNC			
		8	0.80	2	UNC	DR			
COLONY	WY	6	0.82	2	NWW	SWT			
		7	0.73	2	UNC	SWC			
		8	0.67	2	NWW	SWC			
COLORADO SPRINGS WSO AP	CO	6	0.76	3	SWS	NWM	DR		
		7	0.85	3	NWW	UNC	DR		
		8	0.81	3	SWS	UNC	DR		
COPCO NO 1 DAM	CA	6	0.69	2	UNC	SWT			
		7	0.26	1	UNC				
		8	0.37	1	SWS				
CORDES	AZ	6	0.30	1	NWW				
		7	0.81	3	UNC	NWZ	DR		
		8	0.68	2	SWS	UNC			
CORVALLIS STATE UNIV	OR	6	0.68	2	UNC	NWW			
		7	0.52	1	SWT				
		8	0.36	1	UNC				
COTTAGE GROVE DAM	OR	6	0.77	3	UNC	NWW	SWT		
		7	0.52	2	SWS	SWT			
		8	0.38	1	SWT				
COUGAR 6 E	WA	6	0.84	2	UNC	NWZ			
		7	0.59	1	SWT				
		8	0.72	2	SWT	NWM			
CRESTON	MT	6	0.82	2	UNC	SWC			
		7	0.80	3	SWS	SWC	SWT		
		8	0.72	2	SWS	SWT			
CUYAMACA	CA	6	0.27	1	NWW				
		7	0.37	1	NWZ				
		8	0.29	1	SWC				
DALLESPORT FCWOS AP	WA	6	0.46	1	UNC				
		7	0.47	1	SWT				
		8	0.40	1	UNC				
DAVIS 2 WSW EXP FARM	CA	6	0.25	1	SWC				
		7	0.13	1	SWT				
		8	0.32	1	SWS				
DEER CREEK DAM	UT	6	0.66	2	NWW	SWT			
		7	0.49	1	NWW				
		8	0.66	2	SWS	SWC			
DENVER WSFO AP	CO	6	0.83	3	NWW	DR	SWC		
		7	0.72	3	SWS	UNC	NWZ		
		8	0.67	1	UNC				
DEVILS TOWER	WY	6	0.83	2	NWW	SWT			

2		7	0.81	3	UNC	SWC	NWZ		
		8	0.71	3	SWT	NWM	DR		
DORENA DAM	OR	6	0.76	4	NWW	SWT			
		7	0.39	1	SWT				
		8	0.43	1	SWT				
DOUGLAS FCWOS	AZ	6	0.45	1	NWW				
		7	0.90	4	UNC	SWT	NWZ	DR	
		8	0.81	3	NWW	UNC	DR		
DUBOIS EXPERIMENT STN	ID	6	0.83	3	NWW	SWS	SWT		
		7	0.68	2	NWW	NWZ			
		8	0.59	2	UNC	SWC			
DUNCAN	AZ	6	0.40	1	DR				
		7	0.88	3	NWW	UNC	NWZ		
		8	0.81	3	NWW	UNC	DR		
ECHO DAM	UT	6	0.68	2	NWW	SWT			
		7	0.67	2	NWW	UNC			
		8	0.41	1	SWC				
ELK RIVER 1 S	ID	6	0.84	3	UNC	NWZ	SWC		
		7	0.66	3	SWS	SWC	SWT		
		8	0.81	3	SWS	SWT	NWM		
ELKO FCWOS	NV	6	0.69	2	NWW	SWT			
		7	0.60	4	SWS	DR			
		8	0.37	1	SWC				
ELKTON 3 SW	OR	6	0.67	2	UNC	NWZ			
		7	0.49	2	SWC	SWT			
		8	0.40	1	SWT				
ELY WSO AIRPORT	NV	6	0.69	2	SWT	SWC			
		7	0.59	2	SWS	UNC			
		8	0.64	1	SWC				
EMBLEM	WY	6	0.72	2	NWW	SWT			
		7	0.55	2	NWW	UNC			
		8	0.54	2	UNC	SWC			
EMMETT 2 E	ID	6	0.72	2	NWW	SWT			
		7	0.44	2	SWT	DR			
		8	0.34	1	UNC				
EUGENE WSO AIRPORT	OR	6	0.77	5	NWW	SWT	NWM		
		7	0.37	1	SWT				
		8	0.36	1	UNC				
EUREKA WFO WOODLEY IS	CA	6	0.52	1	UNC				
		7	0.42	1	SWT				
		8	0.30	1	SWT				
FALLON EXPERIMENT STN	NV	6	0.60	2	NWW	SWS			
		7	0.32	1	UNC				
		8	0.39	1	UNC				
FERN RIDGE	OR	6	0.68	2	UNC	NWZ			

DAM									
		7	0.41	1	SWT				
		8	0.34	1	SWT				
FILLMORE	UT	6	0.63	2	NWW	SWT			
		7	0.67	3	NWW	UNC	NWZ		
		8	0.72	2	SWS	SWC			
FISHTAIL	MT	6	0.70	3	SWT	NWM	DR		
		7	0.72	2	SWS	SWC			
		8	0.65	2	SWC	SWT			
FLAGSTAFF WSO AP	AZ	6	0.34	1	UNC				
		7	0.88	3	UNC	SWC	NWZ		
		8	0.76	2	NWW	DR			
FLATWILLOW 4 ENE	MT	6	0.80	3	UNC	SWT	NWM		
		7	0.75	2	SWS	UNC			
		8	0.83	3	SWC	SWT	NWM		
FORT BENTON	MT	6	0.69	2	UNC	SWC			
		7	0.82	2	SWC	SWT			
		8	0.72	5	SWC	SWT	NWM		
FORT JONES RANGER STN	CA	6	0.38	1	SWT				
		7	0.51	2	SWS	UNC			
		8	0.44	1	SWS				
FORT LOGAN 4 ESE	MT	6	0.77	3	NWW	SWT	SWC		
		7	0.79	5	SWS	SWC	SWT		
		8	0.73	5	SWC	SWT	NWM		
FOWLER 1 SE	CO	6	0.79	3	NWM	DR	SWC		
		7	0.87	3	SWS	UNC	DR		
		8	0.74	2	UNC	DR			
FRESNO YOSEMITE INTL	CA	6	0.33	1	NWW				
		7	0.16	1	UNC				
		8	0.25	1	NWZ				
GALATA 16 SSW	MT	6	0.67	2	UNC	SWC			
		7	0.76	3	SWS	SWC	SWT		
		8	0.74	3	SWS	SWT	NWM		
GIBSON DAM	MT	6	0.66	2	UNC	SWC			
		7	0.74	4	SWS	UNC	SWC	DR	
		8	0.72	3	UNC	SWC	NWM		
GILDFORD	MT	6	0.74	2	UNC	NWM			
		7	0.73	2	SWC	SWT			
		8	0.75	3	SWC	SWT	NWM		
GILLETTE 9 ESE	WY	6	0.72	2	NWW	SWT			
		7	0.73	2	NWW	UNC			
		8	0.65	3	SWS	UNC	NWM		
GLASGOW INTERNATL AP	MT	6	0.82	2	SWT	NWM			
		7	0.63	2	UNC	SWT			
		8	0.57	2	UNC	NWM			
GOLD BEACH RANGER STN	OR	6	0.69	2	UNC	NWZ			

		7	0.44	1	SWT				
		8	0.35	1	SWT				
GOLDBUTTE 7 N	MT	6	0.75	3	UNC	SWS	SWC		
		7	0.78	3	SWS	SWC	NWM		
		8	0.74	2	SWT	DR			
GRAND JUNCTION WSO AP	CO	6	0.55	2	NWW	SWC			
		7	0.70	3	NWW	SWT	NWZ		
		8	0.76	2	UNC	SWC			
GRAND LAKE 1 NW	CO	6	0.66	2	NWW	SWT			
		7	0.84	3	UNC	SWT	DR		
		8	0.76	2	UNC	SWC			
GRANT GROVE	CA	6	0.36	1	DR				
		7	0.32	1	DR				
		8	0.42	1	SWS				
GRANTSVILLE 2 W	UT	6	0.66	2	NWW	SWT			
		7	0.66	2	NWW	UNC			
		8	0.63	1	SWC				
GRATON	CA	6	0.29	1	SWC				
		7	0.15	1	NWZ				
		8	0.20	1	SWC				
GREAT FALLS AIRPORT	MT	6	0.73	2	UNC	SWC			
		7	0.77	3	SWS	SWC	SWT		
		8	0.73	3	SWT	NWM	DR		
HALFWAY	OR	6	0.74	3	UNC	NWW	SWT		
		7	0.78	3	SWT	NWM	NWZ		
		8	0.47	1	UNC				
HAMILTON	MT	6	0.79	2	UNC	SWC			
		7	0.70	2	NWW	SWT			
		8	0.80	5	NWW	UNC	SWC	NWM	
HARLOWTON	MT	6	0.78	3	SWT	NWM	DR		
		7	0.65	2	NWW	UNC			
		8	0.79	3	UNC	SWC	NWM		
HASKINS DAM	OR	6	0.83	2	UNC	NWZ			
		7	0.64	1	SWT				
		8	0.53	2	SWT	NWM			
HATTON 9 SE	WA	6	0.61	1	UNC				
		7	0.71	2	SWC	SWT			
		8	0.72	3	SWS	SWT	NWM		
HAYFIELD PUMPING PLANT	CA	6	0.16	1	UNC				
		7	0.41	2	UNC	SWT			
		8	0.33	1	SWC				
HEALDSBURG	CA	6	0.31	1	SWC				
		7	0.15	1	NWZ				
		8	0.21	1	SWC				
HEBER RANGER STN	AZ	6	0.27	1	UNC				

		7	0.89	5	SWS	UNC	SWC		
		8	0.75	2	UNC	DR			
HELENA WSO	MT	6	0.77	3	UNC	DR	SWC		
		7	0.66	2	SWC	SWT			
		8	0.76	3	SWC	SWT	NWM		
HEPPNER	OR	6	0.61	1	UNC				
		7	0.75	2	SWC	SWT			
		8	0.59	2	SWS	SWT			
HERON 2 NW	MT	6	0.84	3	UNC	NWW	SWT		
		7	0.65	2	SWC	SWT			
		8	0.64	2	SWS	SWT			
HILLSBORO	OR	6	0.70	2	UNC	NWZ			
		7	0.61	1	SWT				
		8	0.55	2	UNC	NWM			
HOQUIAM FCWOS AP	WA	6	0.81	2	UNC	NWZ			
		7	0.69	2	UNC	SWT			
		8	0.73	3	NWW	SWT	NWM		
HUNGRY HORSE DAM	MT	6	0.87	3	UNC	NWW	SWC		
		7	0.78	2	SWC	SWT			
		8	0.81	3	SWS	SWT	NWM		
HUNTLEY EXPERIMENT STN	MT	6	0.71	2	NWW	SWT			
		7	0.67	2	NWW	UNC			
		8	0.72	5	SWT	NWM	DR		
IDAHO FALLS 46 W	ID	6	0.69	2	NWW	SWT			
		7	0.40	1	DR				
		8	0.40	1	UNC				
IDAHO FALLS FAA ARPT	ID	6	0.72	2	NWW	SWT			
		7	0.52	1	NWW				
		8	0.65	2	UNC	SWC			
IMPERIAL	CA	7	0.17	1	UNC				
		8	0.31	1	NWM				
INGOMAR 14 NE	MT	6	0.80	3	NWW	SWT	SWC		
		7	0.70	2	UNC	SWC			
		8	0.77	3	SWS	NWM	DR		
IRVING	AZ	6	0.37	1	NWW				
		7	0.91	4	UNC	SWC	NWZ	DR	
		8	0.75	2	UNC	DR			
JENSEN	UT	6	0.59	2	NWW	SWC			
		7	0.52	2	NWW	NWZ			
		8	0.59	2	SWS	UNC			
KAHLOTUS 5 SSW	WA	6	0.69	2	UNC	SWC			
		7	0.66	2	SWC	SWT			
		8	0.69	3	SWS	SWT	NWM		
KALISPELL WSO AIRPORT	MT	6	0.78	2	UNC	SWC			
		7	0.71	2	SWS	SWT			
		8	0.74	2	SWS	SWT			

KANAB	UT	6	0.48	1	NWW				
		7	0.56	2	NWW	UNC			
		8	0.68	2	UNC	DR			
KASSLER	CO	6	0.89	5	NWW	SWS	DR	NWZ	SWC
		7	0.69	2	NWW	UNC			
		8	0.73	2	UNC	SWC			
KENO	OR	6	0.74	2	UNC	DR			
		7	0.37	1	UNC				
		8	0.31	1	UNC				
KENT	OR	6	0.59	1	UNC				
		7	0.68	3	SWS	SWC	DR		
		8	0.54	2	SWS	SWT			
LACROSSE	WA	6	0.81	3	UNC	NWW	SWT		
		7	0.73	1	SWT				
		8	0.72	3	SWS	SWT	NWM		
LANDER WSO AP	WY	6	0.68	3	NWW	SWT	SWC		
		7	0.68	4	NWW	NWZ			
		8	0.53	2	UNC	DR			
LAS VEGAS WSO AIRPORT	NV	6	0.28	1	SWT				
		7	0.26	1	UNC				
		8	0.55	2	UNC	SWT			
LAVEEN 3 SSE	AZ	6	0.39	1	SWC				
		7	0.68	2	NWW	NWZ			
		8	0.61	2	NWW	UNC			
LEABURG 1 SW	OR	6	0.62	1	UNC				
		7	0.62	2	SWC	SWT			
		8	0.56	1	SWT				
LEMON COVE	CA	6	0.16	1	DR				
		7	0.27	1	DR				
		8	0.15	1	SWS				
LENNEP 6 WSW	MT	6	0.77	2	UNC	SWC			
		7	0.80	4	NWW	UNC	SWC	NWM	
		8	0.85	4	SWC	SWT	NWM	DR	
LEO 6 SW	WY	6	0.78	2	DR	SWC			
		7	0.61	2	UNC	DR			
		8	0.57	1	UNC				
LEWISTON WSO AP	ID	6	0.78	2	NWW	SWT			
		7	0.56	1	SWT				
		8	0.67	4	SWS	SWT			
LINDSAY	CA	6	0.14	1	DR				
		7	0.35	1	DR				
		8	0.38	2	NWW	NWM			
LIVINGSTON FCWOS	MT	6	0.82	4	NWW	SWT			
		7	0.77	3	SWS	UNC	SWC		
		8	0.74	3	UNC	SWC	NWM		
LONG BEACH WSCMO	CA	6	0.29	1	SWT				
		7	0.15	1	NWZ				
		8	0.34	1	NWM				

LONGMONT 2 ESE	CO	6	0.82	3	NWW	DR	SWC		
		7	0.64	2	NWW	UNC			
		8	0.75	1	UNC				
LOS ANGELES DOWNTOWN	CA	6	0.16	1	NWM				
		7	0.13	1	NWZ				
		8	0.33	1	NWM				
LOS ANGELES WSO ARPT	CA	6	0.18	1	NWM				
		7	0.14	1	SWC				
		8	0.29	1	NWM				
LOS BANOS	CA	6	0.20	1	DR				
		7	0.15	1	SWT				
		8	0.17	1	SWS				
LOS BANOS ARBURUA RCH	CA	6	0.13	1	DR				
		7	0.14	1	NWZ				
		8	0.13	1	NWZ				
LOWER HAY CREEK	OR	6	0.54	1	UNC				
		7	0.62	2	SWC	SWT			
		8	0.42	1	SWT				
LUSTRE 4 NNW	MT	6	0.79	3	UNC	SWT	NWM		
		7	0.82	3	SWS	SWC	SWT		
		8	0.73	3	SWC	SWT	NWM		
MAC KENZIE	MT	6	0.84	4	NWW	SWT			
		7	0.63	2	NWW	UNC			
		8	0.75	3	SWS	UNC	NWM		
MALHEUR BRANCH EXP STN	OR	6	0.70	2	UNC	SWC			
		7	0.56	1	SWT				
		8	0.51	2	SWS	UNC			
MANTI	UT	6	0.64	2	NWW	SWC			
		7	0.73	3	SWS	UNC	NWZ		
		8	0.81	3	NWW	SWS	SWC		
MANZANITA LAKE	CA	6	0.65	3	UNC	SWS	SWT		
		7	0.31	1	SWT				
		8	0.31	1	UNC				
MC MILLIN RESERVOIR	WA	6	0.79	2	UNC	NWZ			
		7	0.73	2	UNC	SWT			
		8	0.64	2	SWS	SWT			
MCCALL	ID	6	0.72	2	UNC	SWT			
		7	0.64	2	NWW	NWZ			
		8	0.63	2	SWS	SWT			
MCNARY DAM	WA	6	0.63	2	UNC	NWZ			
		7	0.79	4	NWW	UNC	SWC	NWM	
		8	0.39	1	UNC				
MEDFORD WSO AP	OR	6	0.70	2	UNC	SWT			
		7	0.46	1	SWT				
		8	0.34	1	SWS				

MEDICINE LAKE 3 SE	MT	6	0.81	4	NWW	SWT			
		7	0.69	2	NWW	SWT			
		8	0.71	3	SWC	SWT	NWM		
MESA EXPERIMENT FARM	AZ	6	0.27	1	SWT				
		7	0.72	2	UNC	NWZ			
		8	0.52	1	UNC				
MIAMI	AZ	6	0.30	1	UNC				
		7	0.62	1	UNC				
		8	0.73	2	NWW	UNC			
MILTON FREEWATER	OR	6	0.73	2	UNC	NWZ			
		7	0.69	1	SWT				
		8	0.72	3	SWS	UNC	NWM		
MINERSVILLE	UT	6	0.65	2	NWW	SWT			
		7	0.58	2	UNC	NWZ			
		8	0.59	1	SWC				
MISSOULA WSO AP	MT	6	0.79	4	NWW	SWT			
		7	0.79	3	UNC	SWC	SWT		
		8	0.71	2	UNC	NWM			
MOCCASIN EXPERIMENT STN	MT	6	0.86	5	NWW	SWT	DR		
		7	0.86	4	SWS	UNC	SWC	NWM	
		8	0.80	3	UNC	SWC	NWM		
MONTEZUMA CASTLE N M	AZ	6	0.24	1	DR				
		7	0.80	2	SWC	NWZ			
		8	0.81	2	UNC	DR			
MONTICELLO	UT	6	0.53	2	NWW	DR			
		7	0.73	2	NWW	UNC			
		8	0.73	2	UNC	DR			
MORAN 5 WNW	WY	6	0.84	2	NWW	SWT			
		7	0.64	2	NWW	SWT			
		8	0.74	2	UNC	SWC			
MORGAN POWER AND LIGHT	UT	6	0.69	2	NWW	SWT			
		7	0.47	1	NWW				
		8	0.46	1	SWC				
MORRO BAY FIRE DEPT	CA	6	0.26	1	DR				
		7	0.33	1	SWC				
MOSCOW UNIV OF IDAHO	ID	6	0.78	3	UNC	NWW	SWC		
		7	0.66	2	SWC	SWT			
		8	0.52	1	UNC				
MOUNT VERNON 3 WNW	WA	6	0.86	2	UNC	SWT			
		7	0.83	2	SWC	SWT			
		8	0.75	2	SWS	SWT			
MYSTIC LAKE	MT	6	0.81	2	NWW	SWT			

		7	0.86	4	NWW	UNC	SWC	NWZ	
		8	0.75	2	UNC	SWC			
NEW MEADOWS RANGER STN	ID	6	0.68	1	UNC				
		7	0.72	2	SWT	NWZ			
		8	0.56	1	SWT				
NEWPORT	WA	6	0.79	2	UNC	NWW			
		7	0.82	3	SWC	SWT	NWM		
		8	0.77	3	SWS	SWT	NWM		
NEZPERCE	ID	6	0.83	3	UNC	NWW	SWT		
		7	0.70	2	SWC	SWT			
		8	0.72	3	SWS	SWT	NWM		
NILAND	CA	7	0.16	1	NWW				
		8	0.21	1	NWM				
OAK CITY	UT	6	0.63	2	NWW	SWT			
		7	0.64	2	NWW	NWZ			
		8	0.60	2	SWS	SWC			
OJAI	CA	6	0.29	1	SWT				
		7	0.18	1	SWS				
OLYMPIA WSO AP	WA	6	0.82	3	UNC	SWT	NWZ		
		7	0.70	2	UNC	SWT			
		8	0.57	2	SWT	NWM			
ONTARIO CAA AIRPORT	OR	6	0.67	2	NWW	SWT			
		7	0.45	1	SWT				
		8	0.40	1	UNC				
ORACLE 2 SE	AZ	6	0.39	1	NWW				
		7	0.83	3	UNC	NWZ	DR		
		8	0.78	2	UNC	SWC			
ORDERVILLE	UT	6	0.37	1	UNC				
		7	0.59	2	NWW	NWZ			
		8	0.71	2	UNC	DR			
OTIS 2 NE	OR	6	0.79	3	UNC	SWT	NWZ		
		7	0.69	2	SWT	NWZ			
		8	0.74	2	SWT	NWM			
OWYHEE DAM	OR	6	0.66	2	NWW	SWC			
		7	0.49	2	UNC	NWM			
		8	0.43	1	UNC				
PALMDALE	CA	6	0.20	1	NWW				
		7	0.21	1	NWW				
		8	0.29	1	NWM				
PALOMA	CA	6	0.23	1	DR				
		7	0.23	1	SWC				
		8	0.17	1	NWZ				
PARKER RESERVOIR	CA	6	0.15	1	NWM				
		7	0.36	1	NWW				
		8	0.37	1	SWC				
PASO ROBLES	CA	6	0.23	1	UNC				
		7	0.22	1	SWC				
		6	0.24	1	UNC				

PASO ROBLES FCWOS	CA	7	0.23	1	SWC				
PENDLETON WSO AIRPORT	OR	6	0.79	3	UNC	SWS	NWZ		
		7	0.72	2	SWC	SWT			
		8	0.37	1	UNC				
PETRIFIED FOREST N P	AZ	6	0.32	1	DR				
		7	0.88	4	UNC	SWC	NWZ	DR	
		8	0.79	2	UNC	DR			
PHOENIX WSO AP	AZ	6	0.21	1	NWM				
		7	0.54	2	NWW	NWZ			
		8	0.50	1	UNC				
POCATELLO WSO AP	ID	6	0.79	2	NWW	SWT			
		7	0.55	2	NWW	DR			
		8	0.50	2	SWC	SWT			
PORTERVILLE	CA	6	0.27	1	SWC				
		7	0.20	1	NWW				
		8	0.36	2	SWS	NWM			
PORTHILL	ID	6	0.85	3	UNC	NWW	SWT		
		7	0.75	3	SWC	SWT	NWZ		
		8	0.81	3	SWS	SWT	NWM		
PORTLAND WSFO	OR	6	0.79	3	UNC	SWT	NWZ		
		7	0.62	1	SWT				
		8	0.57	2	SWT	NWM			
PRIEST RIVER EXP STN	ID	6	0.81	2	UNC	SWC			
		7	0.77	3	SWC	SWT	NWM		
		8	0.78	3	SWS	SWT	NWM		
PROSPECT 2 SW	OR	6	0.69	4	NWW	SWT			
		7	0.35	1	SWS				
		8	0.37	1	UNC				
PUEBLO WSO AP	CO	6	0.73	1	DR				
		7	0.84	3	NWW	NWZ	DR		
		8	0.74	2	UNC	SWC			
PUYALLUP 2 W EXP STN	WA	6	0.77	2	UNC	NWZ			
		7	0.80	3	UNC	SWT	NWM		
		8	0.71	3	SWS	SWT	NWM		
RAWLINS AP	WY	6	0.69	4	NWW	SWT			
		7	0.55	1	UNC				
		8	0.75	2	SWS	UNC			
RED LODGE 2 N	MT	6	0.72	2	NWW	SWT			
		7	0.67	2	NWW	UNC			
		8	0.73	3	SWT	NWM	DR		
REDSTONE	MT	6	0.83	3	UNC	SWT	NWM		
		7	0.67	2	NWW	SWT			
		8	0.64	2	UNC	SWT			
RENO WSFO AIRPORT	NV	6	0.66	3	SWS	DR	SWC		
		7	0.56	1	DR				

		8	0.40	1	SWS				
REX 1 S	OR	6	0.74	2	UNC	NWZ			
		7	0.67	1	SWT				
		8	0.50	1	SWT				
RICHFIELD	ID	6	0.72	2	SWT	SWC			
		7	0.41	1	NWW				
		8	0.35	1	SWS				
RICHMOND	UT	6	0.70	2	NWW	SWT			
		7	0.51	2	NWW	NWZ			
		8	0.49	2	SWC	NWM			
RICHMOND CA	CA	6	0.22	1	SWT				
		7	0.15	1	NWZ				
		8	0.19	1	SWS				
RIVERSIDE CITRUS EXP STN	CA	6	0.42	1	NWM				
		7	0.17	1	UNC				
		8	0.25	1	NWM				
ROCHELLE 3 E	WY	6	0.74	2	NWM	DR			
		7	0.81	3	NWW	NWM	DR		
		8	0.56	1	UNC				
ROCKY FORD 2 SE	CO	6	0.71	2	DR	SWC			
		7	0.73	3	SWC	NWZ	DR		
		8	0.77	4	SWS	UNC	NWM	DR	
ROY 8 NE	MT	6	0.85	3	NWW	SWT	NWM		
		7	0.82	3	UNC	SWT	NWM		
		8	0.82	3	SWC	SWT	NWM		
SACRAMENTO FAA ARPT	CA	6	0.38	2	NWW	SWC			
		8	0.32	1	SWS				
		6	0.39	1	UNC				
SAFFORD AGRICULTRL CTR	AZ	7	0.86	3	NWW	UNC	NWZ		
		8	0.68	2	UNC	DR			
SALT LAKE CITY NWSFO	UT	6	0.66	2	NWW	SWT			
		7	0.54	2	NWW	UNC			
		8	0.47	1	SWC				
SALTAIR SALT PLANT	UT	6	0.70	2	NWW	SWT			
		7	0.62	2	NWW	DR			
		8	0.42	1	SWC				
SAN DIEGO WSO AIRPORT	CA	6	0.23	1	SWT				
		7	0.20	1	NWW				
		8	0.36	1	NWM				
SAN FRANCISCO MISSION DOLORES	CA	6	0.28	1	SWC				
		7	0.14	1	SWT				
		8	0.26	1	SWS				
SAN FRANCISCO	CA	6	0.25	1	SWT				

WSO AP		7	0.20	1	SWT				
		8	0.19	1	NWZ				
SANTA BARBARA MUNI AP	CA	6	0.18	1	SWT				
		7	0.16	1	SWC				
		8	0.13	1	SWC				
SANTA CRUZ	CA	6	0.32	1	SWC				
		7	0.14	1	NWZ				
		8	0.29	1	NWZ				
SANTA MARIA WSO ARPT	CA	6	0.28	1	SWT				
		7	0.26	1	SWT				
SCOTTS MILLS 9 SE	OR	6	0.75	2	UNC	NWZ			
		7	0.64	1	SWT				
		8	0.62	1	SWT				
SEATTLE TCOMA WSCMO AP	WA	6	0.78	3	UNC	SWT	NWZ		
		7	0.77	2	SWC	SWT			
		8	0.57	2	SWT	NWM			
SEDONA RS	AZ	6	0.27	1	NWW				
		7	0.77	2	SWT	DR			
		8	0.80	3	NWW	UNC	DR		
SHERIDAN WSO AP	WY	6	0.72	2	NWW	SWT			
		7	0.62	2	NWW	SWS			
		8	0.72	3	SWT	NWM	DR		
SHONKIN 7 S	MT	6	0.75	3	UNC	NWW	SWC		
		7	0.81	2	SWC	SWT			
		8	0.81	3	SWT	NWM	DR		
SIDNEY	MT	6	0.86	5	NWW	SWT	DR		
		7	0.62	2	NWW	DR			
		8	0.68	2	SWS	SWT			
SIMPSON 6 NW	MT	6	0.67	2	UNC	SWC			
		7	0.78	2	SWC	SWT			
		8	0.72	3	UNC	SWT	NWM		
SPANISH FORK PWR HOUSE	UT	6	0.64	2	NWW	SWT			
		7	0.61	2	UNC	NWZ			
		8	0.67	2	SWS	SWC			
SPOKANE WSO AIRPORT	WA	6	0.82	3	UNC	SWS	SWT		
		7	0.59	2	SWS	SWC			
		8	0.71	2	SWS	SWT			
SPRINGFIELD 7 WSW	CO	6	0.75	3	NWM	DR	SWC		
		7	0.76	3	UNC	SWC	DR		
		8	0.78	6	SWS	NWM	NWZ	DR	
STOCKTON WSO	CA	6	0.23	1	DR				
		7	0.12	1	SWT				
		8	0.27	1	NWZ				

STRAWBERRY VALLEY	CA	6	0.52	2	NWW	SWT			
		7	0.16	1	NWZ				
		8	0.26	1	SWS				
SUMMER LAKE 1 S	OR	6	0.60	2	NWW	DR			
		7	0.45	2	SWS	SWT			
		8	0.46	1	UNC				
SUMMIT	OR	6	0.77	2	UNC	NWZ			
		7	0.57	1	SWT				
		8	0.52	1	SWT				
SUNBURST 8 E	MT	6	0.77	3	UNC	NWW	SWC		
		7	0.79	3	SWS	SWC	NWM		
		8	0.71	2	SWT	DR			
TELLURIDE 4 WNW	CO	6	0.69	2	NWW	DR			
		7	0.89	3	NWW	UNC	NWZ		
		8	0.77	2	UNC	DR			
THOMPSON FALLS POWER HOUSE	MT	6	0.83	3	UNC	SWS	SWT		
		7	0.72	2	NWW	SWT			
		8	0.79	4	SWS	SWT	NWM	NWZ	
TIBER DAM	MT	6	0.72	2	UNC	SWC			
		7	0.74	2	SWC	SWT			
		8	0.75	5	SWT	NWM	DR		
TIDEWATER 2 SW	OR	6	0.77	2	UNC	NWZ			
		7	0.57	1	SWT				
		8	0.64	2	SWT	NWM			
TIMPANOGOS CAVE	UT	6	0.64	2	NWW	SWT			
		7	0.68	2	NWW	UNC			
		8	0.60	2	UNC	SWC			
TOOELE	UT	6	0.65	2	NWW	SWT			
		7	0.62	2	NWW	NWZ			
		8	0.49	1	SWC				
TRIDENT	MT	6	0.80	4	NWW	SWT			
		7	0.76	3	NWW	SWC	NWZ		
		8	0.86	3	SWC	SWT	NWM		
TUCSON MAGNETIC OBSY	AZ	6	0.30	1	NWW				
		7	0.80	3	NWW	NWZ	DR		
		8	0.77	2	UNC	SWC			
TUCSON WBO	AZ	6	0.42	2	NWW	SWT			
		7	0.77	3	UNC	SWC	NWZ		
		8	0.79	3	NWW	UNC	SWC		
UNION EXPERIMENT STN	OR	6	0.79	3	UNC	NWW	SWC		
		7	0.51	1	SWT				
		8	0.61	2	SWS	UNC			
UPTON 13 SW	WY	6	0.78	3	SWT	NWM	DR		
		7	0.68	2	NWW	UNC			

		8	0.62	2	NWW	DR			
VALIER	MT	6	0.76	3	UNC	NWM	SWC		
		7	0.72	3	SWS	SWC	SWT		
		8	0.68	3	SWS	UNC	NWM		
VERNAL AIRPORT	UT	6	0.66	2	NWW	SWC			
		7	0.50	1	NWW				
		8	0.73	3	NWW	SWS	DR		
VICTORVILLE PUMP PLANT	CA	6	0.18	1	NWW				
		7	0.21	1	NWW				
		8	0.31	1	DR				
VINTON	CA	6	0.77	3	SWS	SWT	DR		
		7	0.61	2	NWZ	DR			
		8	0.52	2	SWC	SWT			
VIRGINIA CITY	MT	6	0.90	4	UNC	NWW	SWS	SWT	
		7	0.72	2	SWS	UNC			
		8	0.89	3	SWS	SWC	SWT		
VOLTA POWER HOUSE	CA	6	0.61	2	UNC	SWT			
		7	0.20	1	SWT				
		8	0.26	1	SWT				
WALLA WALLA FAA AIRPORT	WA	6	0.69	2	UNC	NWZ			
		7	0.72	1	SWT				
		8	0.65	4	SWS	NWM			
WALLACE WOODLAND PARK	ID	6	0.83	3	UNC	NWW	SWT		
		7	0.73	2	NWW	SWT			
		8	0.69	2	NWW	SWT			
WALNUT CANYON NATL MONUMENT	AZ	6	0.27	1	UNC				
		7	0.83	3	UNC	SWT	DR		
		8	0.66	2	UNC	DR			
WALSENBURG	CO	6	0.73	2	DR	SWC			
		7	0.65	1	UNC				
		8	0.83	3	UNC	NWZ	DR		
WANSHIP DAM	UT	6	0.66	2	NWW	SWT			
		7	0.66	1	UNC				
		8	0.56	2	SWS	SWC			
WARREN	ID	6	0.77	3	UNC	DR	SWC		
		7	0.71	2	UNC	SWT			
		8	0.69	3	SWS	UNC	NWM		
WATERDALE	CO	6	0.90	3	NWW	DR	SWC		
		7	0.66	2	NWW	NWZ			
		8	0.81	3	UNC	SWT	DR		
WESTCLIFFE	CO	6	0.70	2	SWS	DR			
		7	0.81	2	UNC	DR			
		8	0.75	2	NWW	DR			
WESTON 1 E	WY	6	0.81	2	NWW	SWT			
		7	0.68	1	UNC				
		8	0.69	2	SWC	SWT			

WHEATLAND 4 N	WY	6	0.77	3	SWS	DR	SWC		
		7	0.79	3	NWW	NWZ	DR		
		8	0.66	2	UNC	DR			
WHITERIVER 1 SW	AZ	6	0.42	1	NWW				
		7	0.84	2	NWW	UNC			
		8	0.78	3	NWW	UNC	SWC		
WILLCOX	AZ	6	0.47	1	UNC				
		7	0.86	3	SWS	UNC	NWZ		
		8	0.82	3	NWW	UNC	DR		
WINNEMUCCA WB CITY	NV	6	0.70	3	NWW	SWS	SWT		
		7	0.35	1	NWW				
		8	0.49	1	UNC				
WINSLOW WSO AP	AZ	6	0.25	1	NWW				
		7	0.79	3	NWW	UNC	NWZ		
		8	0.71	1	UNC				
WINTERS	CA	6	0.31	1	SWC				
		7	0.14	1	SWT				
		8	0.40	3	NWW	SWS	NWZ		
WISDOM	MT	6	0.85	5	NWW	SWS	SWT		
		7	0.71	4	SWC	SWT			
		8	0.78	3	SWC	SWT	NWM		
WOODRUFF	UT	6	0.73	2	NWW	SWT			
		7	0.57	2	NWW	DR			
		8	0.48	1	SWC				
WYOLA 1 SW	MT	6	0.61	2	UNC	SWC			
		7	0.48	1	NWW				
		8	0.73	2	SWT	NWM			
YAKIMA WSO AP	WA	6	0.48	1	UNC				
		7	0.58	1	SWT				
		8	0.36	1	SWT				
YAMPA	CO	6	0.83	2	NWW	SWT			
		7	0.80	3	NWW	NWZ	DR		
		8	0.85	3	NWW	UNC	SWC		
YUMA VALLEY	AZ	6	0.16	1	SWS				
		7	0.14	1	NWW				
		8	0.34	1	NWM				
YUMA WSO AP	AZ	7	0.40	2	UNC	SWT			
		8	0.31	1	UNC				
ZION NATIONAL PARK	UT	6	0.34	1	NWW				
		7	0.60	2	NWW	SWC			
		8	0.77	3	UNC	SWC	SWT		
ABBOTSFORD A	BC	6	0.79	2	UNC	NWZ			
		7	0.83	4	NWW	SWS	SWT	NWM	
		8	0.74	2	SWS	SWT			
AGASSIZ CDA	BC	6	0.82	2	UNC	NWZ			
		7	0.72	2	SWC	SWT			
		8	0.82	2	SWS	SWT			

ALERT BAY	BC	6	0.82	2	UNC	NWM			
		7	0.77	2	UNC	SWT			
		8	0.81	2	UNC	SWT			
ANCHORAGE WSCMO AP	AK	6	0.75	2	UNC	SWT			
		7	0.77	2	NWW	UNC			
		8	0.68	2	UNC	DR			
ANNETTE WSO AIRPORT	AK	6	0.85	3	NWW	DR	SWC		
		7	0.83	3	NWW	UNC	DR		
		8	0.83	3	NWW	UNC	SWC		
ATHABASCA 2	AB	6	0.81	3	UNC	SWS	DR		
		7	0.85	3	UNC	SWT	DR		
		8	0.89	3	NWW	SWS	SWT		
BALDONNEL	BC	6	0.85	4	UNC	NWW	SWS	SWT	
		7	0.73	2	UNC	SWT			
		8	0.81	3	UNC	SWT	DR		
BANFF	AB	6	0.89	2	UNC	SWC			
		7	0.77	2	NWW	UNC			
		8	0.74	2	SWS	UNC			
BARROW WSO AIRPORT	AK	6	0.67	2	UNC	NWW			
		7	0.72	2	UNC	SWC			
		8	0.76	2	SWS	UNC			
BEAVERLODGE CDA	AB	6	0.70	2	UNC	SWT			
		7	0.79	2	UNC	SWT			
		8	0.78	3	SWS	SWC	SWT		
BIG DELTA FAA/AMOS AP	AK	6	0.81	2	NWW	DR			
		7	0.82	2	NWW	UNC			
		8	0.86	3	UNC	SWC	SWT		
BROWNFIELD	AB	6	0.76	2	UNC	SWC			
		7	0.78	2	UNC	SWC			
		8	0.75	3	NWW	SWC	SWT		
BURNABY CAPITOL HILL	BC	6	0.80	1	UNC				
		7	0.80	2	UNC	SWT			
		8	0.79	2	UNC	SWT			
BURNABY MTN TERMINAL	BC	6	0.80	1	UNC				
		7	0.78	2	UNC	SWT			
		8	0.79	2	SWS	SWT			
CALGARY INT'L A	AB	6	0.80	2	UNC	SWC			
		7	0.86	4	NWW	UNC	SWC	SWT	
		8	0.70	3	SWS	SWT	DR		
CAPE PARRY A	NT	6	0.72	3	SWS	SWT	NWM		
		7	0.79	4	NWW	SWC	NWM	DR	
		8	0.73	2	UNC	DR			
CAPE ST JAMES	BC	6	0.83	3	UNC	NWW	DR		
		7	0.72	1	UNC				
		8	0.83	3	NWW	SWT	DR		
CARWAY	AB	6	0.67	2	NWW	SWC			

		7	0.75	3	SWS	SWC	NWM		
		8	0.70	3	UNC	SWT	NWM		
CHATHAM POINT	BC	6	0.77	1	UNC				
		7	0.76	2	UNC	SWT			
		8	0.71	1	SWT				
COLD BAY WSO AIRPORT	AK	6	0.69	1	UNC				
		7	0.85	4	UNC	SWC	SWT	NWM	
		8	0.92	3	NWW	UNC	DR		
COLD LAKE A	AB	6	0.71	3	UNC	NWM	DR		
		7	0.88	3	UNC	SWT	DR		
		8	0.86	3	NWW	SWS	SWT		
COMOX A	BC	6	0.81	2	UNC	SWT			
		7	0.81	2	UNC	SWT			
		8	0.71	2	SWS	SWT			
CORDOVA FAA AP	AK	6	0.86	4	UNC	NWM	DR	SWC	
		7	0.88	4	NWW	UNC	SWC	DR	
		8	0.77	2	NWW	DR			
CORONATION A	AB	6	0.78	2	UNC	SWC			
		7	0.73	2	UNC	SWC			
		8	0.63	2	UNC	SWC			
COURTENAY GRANTHAM	BC	6	0.84	2	UNC	SWT			
		7	0.86	3	NWW	UNC	SWT		
		8	0.76	2	SWS	SWT			
COWICHAN LAKE FORESTRY	BC	6	0.81	1	UNC				
		7	0.71	2	UNC	SWT			
		8	0.71	2	SWS	SWT			
CRESTON	BC	6	0.85	3	UNC	NWW	SWC		
		7	0.77	2	SWC	SWT			
		8	0.82	3	SWS	SWT	DR		
DEASE LAKE	BC	6	0.79	2	UNC	DR			
		7	0.80	2	UNC	SWC			
		8	0.91	4	NWW	SWC	SWT	NWZ	
DUVAL	SK	6	0.81	3	UNC	SWS	NWM		
		7	0.70	2	NWW	SWC			
		8	0.76	3	NWW	UNC	SWT		
EAGLE BAY	BC	6	0.89	2	UNC	SWT			
		7	0.85	3	SWC	SWT	NWZ		
		8	0.70	2	SWS	SWT			
EDMONTON CITY CENTRE A	AB	6	0.74	2	UNC	SWC			
		7	0.77	2	NWW	UNC			
		8	0.79	2	NWW	SWT			
EDMONTON NAMAO A	AB	6	0.68	2	UNC	SWC			
		7	0.86	4	NWW	UNC	SWC	NWZ	
		8	0.79	2	NWW	SWT			
ESTEVAN A	SK	6	0.84	3	UNC	NWW	SWT		
		7	0.65	2	UNC	SWT			

		8	0.73	3	UNC	NWM	NWZ		
FAIRBANKS WSO AIRPORT	AK	6	0.77	2	UNC	SWC			
		7	0.82	3	NWW	NWZ	DR		
		8	0.75	2	UNC	DR			
FAIRVIEW	AB	6	0.77	3	UNC	SWS	DR		
		7	0.83	2	UNC	SWT			
		8	0.77	2	SWC	SWT			
FORT MCMURRAY A	AB	6	0.84	3	UNC	NWM	DR		
		7	0.85	2	UNC	DR			
		8	0.81	3	UNC	SWC	NWZ		
FORT NELSON A	BC	6	0.72	2	UNC	NWW			
		7	0.80	2	NWW	UNC			
		8	0.82	3	SWT	NWM	DR		
FORT RELIANCE	NT	6	0.75	4	UNC	SWT	DR	SWC	
		7	0.76	2	NWW	UNC			
		8	0.80	2	UNC	SWC			
FORT SMITH A	NT	6	0.72	2	NWW	SWT			
		7	0.79	2	UNC	DR			
		8	0.85	2	NWW	SWC			
FORT ST JAMES	BC	6	0.77	1	UNC				
		7	0.81	2	UNC	SWT			
		8	0.85	2	NWW	SWT			
FORT ST JOHN A	BC	6	0.83	4	UNC	NWW	SWS	SWT	
		7	0.77	2	SWT	DR			
		8	0.76	2	SWT	DR			
GRAND FORKS	BC	6	0.82	2	UNC	SWT			
		7	0.77	2	SWC	SWT			
		8	0.71	3	SWS	UNC	SWT		
GRANDE PRAIRIE A	AB	6	0.71	2	UNC	DR			
		7	0.79	2	UNC	SWT			
		8	0.75	2	UNC	SWT			
HAY RIVER A	NT	6	0.61	2	UNC	DR			
		7	0.77	3	NWW	UNC	DR		
		8	0.83	2	SWC	SWT			
HEFFLEY CREEK	BC	6	0.76	1	UNC				
		7	0.84	3	NWW	SWC	NWZ		
		8	0.77	3	SWS	UNC	SWT		
HOPE A	BC	6	0.77	2	UNC	NWW			
		7	0.64	2	NWW	SWT			
		8	0.79	2	SWS	SWT			
INDIAN HEAD CDA	SK	6	0.80	5	NWW	SWS	SWT		
		7	0.75	2	UNC	SWC			
		8	0.66	2	UNC	SWT			
INUVIK A	NT	6	0.73	3	UNC	SWS	NWM		
		7	0.75	2	UNC	DR			
		8	0.76	3	SWS	UNC	SWC		
JASPER	AB	6	0.84	2	UNC	SWT			
		7	0.75	2	NWW	SWT			

		8	0.80	2	UNC	SWT			
KAMLOOPS A	BC	6	0.81	1	UNC				
		7	0.79	3	UNC	SWC	NWZ		
		8	0.66	2	SWS	UNC			
KASLO	BC	6	0.85	3	UNC	NWZ	SWC		
		7	0.83	2	NWW	SWT			
		8	0.76	2	SWT	DR			
KELLIHER	SK	6	0.77	2	UNC	NWM			
		7	0.78	3	UNC	SWC	SWT		
		8	0.73	2	NWW	SWT			
KING SALMON WSO AP	AK	6	0.83	2	UNC	SWC			
		7	0.91	4	SWS	UNC	SWC	DR	
		8	0.93	3	NWW	UNC	DR		
LACOMBE CDA	AB	6	0.81	2	UNC	SWC			
		7	0.85	2	NWW	UNC			
		8	0.80	3	SWT	NWM	DR		
LAKE LOUISE	AB	6	0.86	3	UNC	DR	SWC		
		7	0.82	3	NWW	UNC	SWC		
		8	0.82	4	SWS	UNC	SWT	NWM	
LETHBRIDGE A	AB	6	0.73	2	NWW	SWC			
		7	0.78	5	SWC	SWT	NWM		
		8	0.72	3	SWS	UNC	NWM		
LOST RIVER	SK	6	0.75	2	UNC	SWC			
		7	0.84	3	UNC	SWT	DR		
		8	0.89	3	NWW	SWT	DR		
MERRY ISLAND	BC	6	0.86	2	UNC	SWT			
		7	0.86	4	NWW	SWS	UNC	SWT	
		8	0.74	2	SWS	SWT			
MOOSE JAW A	SK	6	0.80	3	UNC	NWM	SWC		
		7	0.73	2	NWW	UNC			
		8	0.67	2	SWT	DR			
MOULD BAY A	NT	6	0.70	3	SWT	NWM	DR		
		7	0.83	3	SWC	NWZ	DR		
		8	0.70	1	UNC				
NOME WSO AIRPORT	AK	6	0.64	2	UNC	SWT			
		7	0.77	2	UNC	SWC			
		8	0.86	2	UNC	SWC			
NORMAN WELLS A	NT	6	0.82	2	UNC	SWC			
		7	0.79	2	UNC	DR			
		8	0.72	2	UNC	DR			
NORTH BATTLEFORD A	SK	6	0.79	2	UNC	SWC			
		7	0.83	2	UNC	SWC			
		8	0.60	1	UNC				
PACHENA POINT	BC	6	0.82	2	UNC	NWW			
		7	0.72	2	UNC	SWT			
		8	0.74	2	NWW	SWT			
PEACE RIVER A	AB	6	0.71	2	UNC	DR			
		7	0.81	2	UNC	SWT			

		8	0.78	2	SWS	SWT			
PENTICTON A	BC	6	0.76	2	UNC	SWT			
		7	0.76	2	UNC	SWT			
		8	0.74	2	UNC	SWT			
PITT POLDER	BC	6	0.79	1	UNC				
		7	0.76	2	UNC	SWT			
		8	0.84	2	SWS	SWT			
PORT HARDY A	BC	6	0.82	2	UNC	NWM			
		7	0.80	2	UNC	SWT			
		8	0.79	2	UNC	SWT			
POWELL RIVER	BC	6	0.84	2	UNC	SWT			
		7	0.86	3	NWW	UNC	SWT		
		8	0.68	1	SWT				
PRINCE ALBERT A	SK	6	0.77	2	UNC	SWC			
		7	0.80	3	SWS	UNC	SWC		
		8	0.63	2	SWC	SWT			
PRINCE GEORGE A	BC	6	0.79	1	UNC				
		7	0.88	3	UNC	SWT	DR		
		8	0.94	4	NWW	SWS	UNC	SWT	
PRINCE RUPERT MONT CIRC	BC	6	0.81	2	NWW	DR			
		7	0.73	2	NWW	UNC			
		8	0.72	2	NWW	UNC			
PRINCETON A	BC	6	0.79	2	UNC	SWT			
		7	0.72	2	NWW	SWT			
		8	0.79	2	SWS	UNC			
QUESNEL A	BC	6	0.77	1	UNC				
		7	0.85	3	NWW	UNC	SWT		
		8	0.89	2	SWS	SWT			
RED DEER A	AB	6	0.83	2	UNC	SWC			
		7	0.87	3	NWW	UNC	SWC		
		8	0.83	6	SWS	SWT	NWM	DR	
		6	0.73	2	UNC	NWM			
REGINA A	SK	7	0.73	2	UNC	SWT			
		8	0.75	3	SWT	NWM	DR		
		6	0.82	3	UNC	NWW	DR		
SANDSPIT A	BC	7	0.69	2	UNC	SWT			
		8	0.81	2	SWT	DR			
SARDIS	BC	6	0.81	2	UNC	NWZ			
		7	0.79	2	NWW	SWT			
		8	0.82	2	SWS	SWT			
SASKATOON A	SK	6	0.80	3	UNC	SWS	SWC		
		7	0.73	2	UNC	SWC			
		8	0.66	2	NWW	UNC			
SCOTT CDA	SK	6	0.74	2	UNC	SWC			
		7	0.79	2	UNC	SWC			
		8	0.80	5	SWS	SWT	NWM		
SEYMOUR FALLS	BC	6	0.78	1	UNC				
		7	0.76	2	UNC	SWT			
		8	0.76	2	NWW	SWT			

SMITHERS A	BC	6	0.77	2	UNC	SWT			
		7	0.89	2	UNC	SWT			
		8	0.83	3	NWW	UNC	SWT		
SUFFIELD A	AB	6	0.71	2	UNC	SWC			
		7	0.81	3	UNC	SWC	SWT		
		8	0.78	3	SWS	UNC	NWZ		
SUMMERLAND CDA	BC	6	0.79	2	UNC	SWT			
		7	0.78	2	UNC	SWT			
		8	0.75	3	SWS	UNC	NWZ		
SWIFT CURRENT A	SK	6	0.74	2	UNC	SWC			
		7	0.70	2	NWW	DR			
		8	0.69	2	SWT	DR			
SWIFT CURRENT CDA	SK	6	0.73	2	UNC	SWC			
		7	0.70	2	NWW	UNC			
		8	0.68	2	SWT	DR			
TERRACE A	BC	6	0.84	3	UNC	NWW	DR		
		7	0.77	2	UNC	SWT			
		8	0.71	2	UNC	NWZ			
TLELL	BC	6	0.82	2	UNC	DR			
		7	0.77	2	UNC	DR			
		8	0.84	2	SWT	DR			
TOFINO A	BC	6	0.82	2	UNC	NWW			
		7	0.73	2	UNC	SWT			
		8	0.71	1	SWT				
TUGASKE	SK	6	0.75	2	UNC	SWC			
		7	0.73	2	UNC	SWC			
		8	0.66	2	SWT	DR			
TUKTOYAKTUK	NT	6	0.61	2	NWW	SWT			
		7	0.74	2	NWW	UNC			
		8	0.78	3	SWS	UNC	SWC		
VANCOUVER INT'L A	BC	6	0.78	1	UNC				
		7	0.80	2	UNC	SWT			
		8	0.80	2	SWS	SWT			
VANCOUVER UBC	BC	6	0.79	1	UNC				
		7	0.81	2	UNC	SWT			
		8	0.75	2	SWS	SWT			
VICTORIA INT'L A	BC	6	0.73	1	UNC				
		7	0.81	2	UNC	SWT			
		8	0.67	2	SWS	SWT			
WASECA	SK	6	0.79	2	UNC	SWC			
		7	0.86	4	UNC	SWC	SWT	DR	
		8	0.84	3	NWW	SWS	SWT		
WATSON LAKE A	YT	6	0.83	2	UNC	DR			
		7	0.82	3	NWW	UNC	NWZ		
		8	0.87	3	NWW	SWC	SWT		
WEYBURN	SK	6	0.75	3	UNC	SWT	NWM		
		7	0.62	2	NWW	NWZ			

		8	0.71	3	UNC	SWT	NWM		
WHITEHORSE A	YT	6	0.74	2	UNC	DR			
		7	0.74	2	NWW	UNC			
		8	0.81	3	SWC	SWT	DR		
YAKUTAT WSO AIRPORT	AK	6	0.77	2	DR	SWC			
		7	0.84	3	SWS	UNC	DR		
		8	0.84	3	NWW	SWC	DR		
YELLOWKNIFE	NT	6	0.61	2	UNC	SWC			
		7	0.70	3	NWW	UNC	NWZ		
		8	0.68	2	SWC	SWT			
YORKTON A	SK	6	0.79	3	UNC	NWW	SWS		
		7	0.79	3	NWW	UNC	SWC		
		8	0.79	2	NWW	SWT			