The Influence of El Niño and La Niña on Winter Climate Conditions at 138 Ski Resorts in Western North America

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INTRODUCTION

Observations suggest that the winter weather experienced by ski resorts varies considerably from year-to-year. Despite this variation, factors like the presence of El Niño and La Niña may play a role in influencing snowfall amounts and temperature trends over a particular winter season. Being able to predict how El Niño and La Niña influence snowfall and winter temperatures could be very beneficial to the operation of ski resorts.

OBJECTIVES

This research examines the effect El Niño and La Niña have on the climate conditions at 138 ski resorts in western North America. This research uses **ClimateWNA** to produce high quality interpolated climate data based on historical records for the mid-slope elevation of the ski resorts studied (Wang, Hamann, Spittlehouse, and Murdock, 2012). This data was then statistically analyzed with standardized Southern Oscillation Index (SOI) data (Trenberth, 1984) available from the National Center for Atmospheric Research (NCAR, 2014) to calculate correlation coefficients. The correlation output was grouped based on statistical significance and then mapped to identify possible spatial patterns.

METHODS

1) Using the historical data found in **ClimateWNA**, monthly values for snowfall and degree days < 0°C (a measure of winter season coldness) were generated for the mid-slope elevation of the 138 ski resorts for the primary ski season months of December, January, February, and March. From this data, composite values were computed by summing the four months analyzed for each of the two variables with the December value coming from the previous year.

2) Correlation and regression analysis was used to measure the cause and effect relationship between the two climate dependent variables and the summed composite of the monthly standardized Southern Oscillation Index (SOI) for the same four months. Correlation coefficients were determined by analyzing the observations for the time period 1935 to 2012.

3) The correlation coefficients for the 138 resorts and two climate variables analyzed were then mapped using ARCGIS geographic information system software to display possible spatial patterns across the study area. Different map symbols were used to identify whether the correlation coefficient was positive or negative, and whether it fell within four levels of statistical significance: $P \geq 0.01$, $P < 0.01$, $P < 0.001$, and $P < 0.0001$. Correlation coefficients with probability values equal to $P \geq 0.01$ were considered not significant on the map.

RESULTS

The **Figures** below show the generated maps for the correlation analysis output for the variables snowfall and degree days < 0°C for the 138 ski resorts studied.

DISCUSSION

Snowfall was found to be higher during La Niña events and lower with El Niño events for a number of resorts above 42° North latitude. Further, the strength of these correlations mostly decreased with distance from the coast. Resorts in New Mexico and Arizona generally had more snowfall with El Niño and less snowfall with La Niña.

For the variable degree days < 0°C, resorts located in British Columbia, Alberta, Washington, and coastal south Oregon generally had warmer than usual winters during El Niño events and colder winters when positive SOI values suggested the occurrence of La Niña. A single resort, Ski Apache in New Mexico showed the opposite trend.

The results obtained here match previous research investigating the relationship between El Niño and La Niña and the climate of western North America (Clark et al., 2001; D'Aleo, 2002; Castello and Shelton, 2004; Larkin and Harrison, 2005; Mote, 2006).

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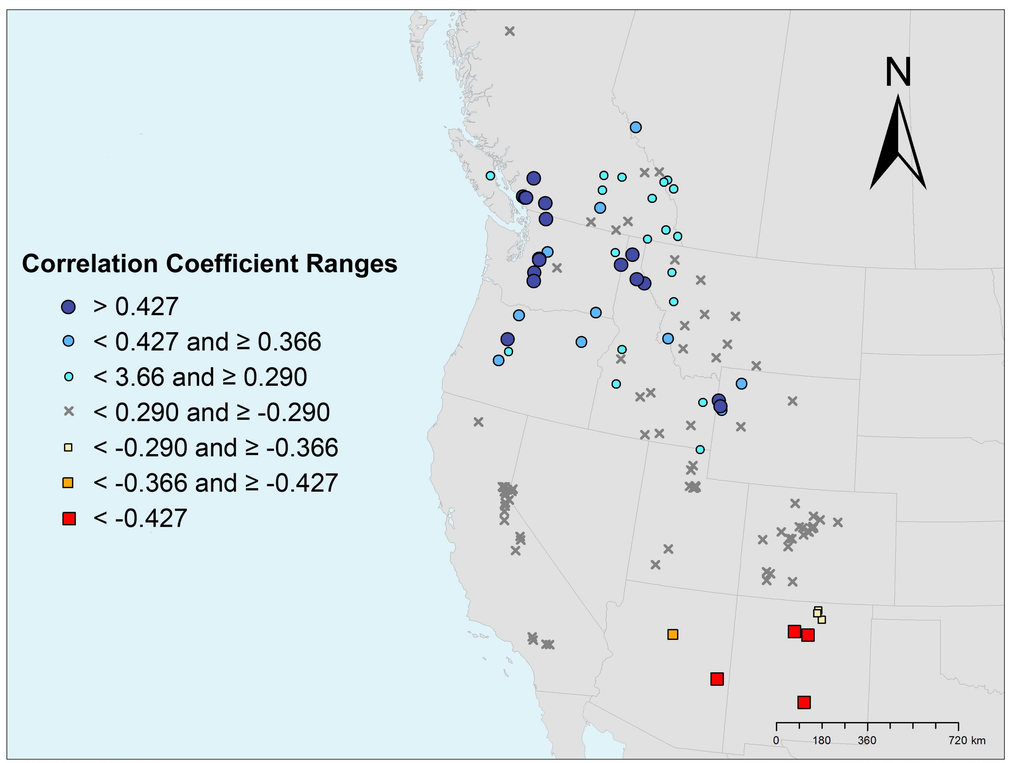
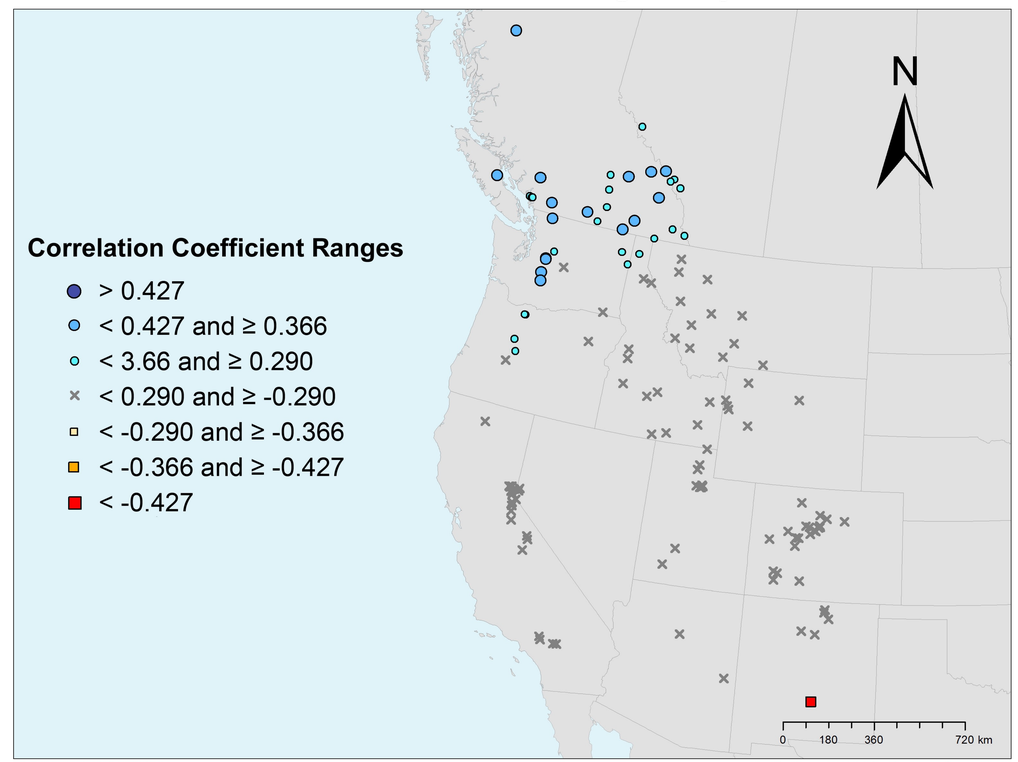
Correlation Coefficients for Snowfall



ESRI DATA AND MAPS
Basemap used: North American Elevation 1-km Resolution. 3rd ed. National Atlas of the US

Projection: GCS_North_American_1983
This map was created on July 14, 2014

Correlation Coefficients for Degree Days < 0°C



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