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The effects of El Niño and La Niña winters on snow and avalanche patterns in British Columbia, Canada and central Chile

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The occurrences of El Niño and La Niña affect global climate and atmospheric circulation to determine winter temperature and precipitation patterns. Both the winter temperatures and the associated precipitation patterns have effects on mountain snow deposition and snow avalanche occurrences. In this paper, approximately 25,000 avalanche occurrences collected over 30 winters were analyzed with respect to their relation to snowfall patterns contrasted for El Niño and La Niña winters for two avalanche areas in British Columbia (B.C.). In addition, snow and avalanche accident data from Chile were analyzed.

The paper is structured in four parts:

1. An index for strength of El Niño and La Niña winters was determined based on 61 years of Sea Surface Temperature (SST) data (1950 – 2010) using the definition given by Redmond (2005). The 61 values of the index were fitted to a probability density function and combined with sample statistics to give a single index of strength for each winter. Definitions for El Niño and La Niña winters (and strong events) were developed including return period for strong events.

2. Descriptions of snow climate and analysis of maximum snow on the ground during the winter were made for snow stations at Bear Pass (northwest, B.C.) , Kootenay Pass (southeast B.C) for correlation with the 30 years of avalanche occurrences at these sites (18,958 events at Bear Pass; 5575 events at Kootenay Pass). Corresponding snow data from two high mountain sites in central Chile were also analyzed.

3. Analysis of avalanche occurrences for Bear Pass and Kootenay Pass was made in relation to total snow received, the strength index for El Niño and La Niña winters, number and percentage of dry and wet avalanches and avalanche size. Statistical tests of significance for mean values and rank correlation analysis between variables were calculated.

4. Analyses of snow and avalanche accident data from the central Chilean Andes were made including correlation with the index of strength for El Niño / La Niña winters. The results suggest that snow and avalanche data have a pattern in Chile which is opposite to that in British Columbia. In B.C., La Niña winters produce the most snow and avalanche activity. In Chile, El Niño winters produce the most snow and, by inference, the most avalanches.

The results are believed to be the first comprehensive study exhibiting the effects of El Niño and La Niña winters on snow avalanche activity. In both B.C. and Chile, snow and avalanches affect major industries including mining, winter tourism and transportation. Since El Niño / La Niña winters can be predicted in advance, the information in this paper provides a partial framework for planning.