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Statistical analysis and trends of wet snow avalanches in the French Alps over the period 1959-2010

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Since an avalanche contains a significant proportion of wet snow, its characteristics and its behavior change significantly (heterogeneous and polydisperse). Even if on a steep given slope, wet snow avalanches are slow. They can flow over gentle slopes and reach the same extensions as dry avalanches. To highlight the link between climate warming and the proliferation of wet snow avlanches, we crossed two well-documented avalanche databases: the permanent avalanche chronicle (EPA) and the meteorological re-analyzes. For each avalanche referenced in EPA, a moisture index I is buit. It represents the ratio of the thickness of the wet snow layer to the total snow thickness, at the date of the avalanche on the concerned massif at 2400 m.a.s.l. The daily and annual proportion of avalanches exceeding a given threshold of I are calculated for each massif of the French alps. The statistical distribution of wet avalanches per massif is calculated over the period 1959-2009. The statistical quantities are also calculated over two successive periods of the same duration 1959-1984 and 1984-2009, and the annual evolution of the proportion of wet avalanches is studied using time-series tools to detect potential rupture or trends. This study showed that about 77% of avalanches on the French alpine massif mobilize dry snow. The probability of having an avalanche of a moisture index greater than 10 % in a given year is 0.2. This value varies from one massif to another. The analysis between the two successive periods showed a significant growth of wet avalanches on 20 massifs and a decrease on 3 massifs. The study of time-series confirmed these trends, which are of the inter-annual variability level.