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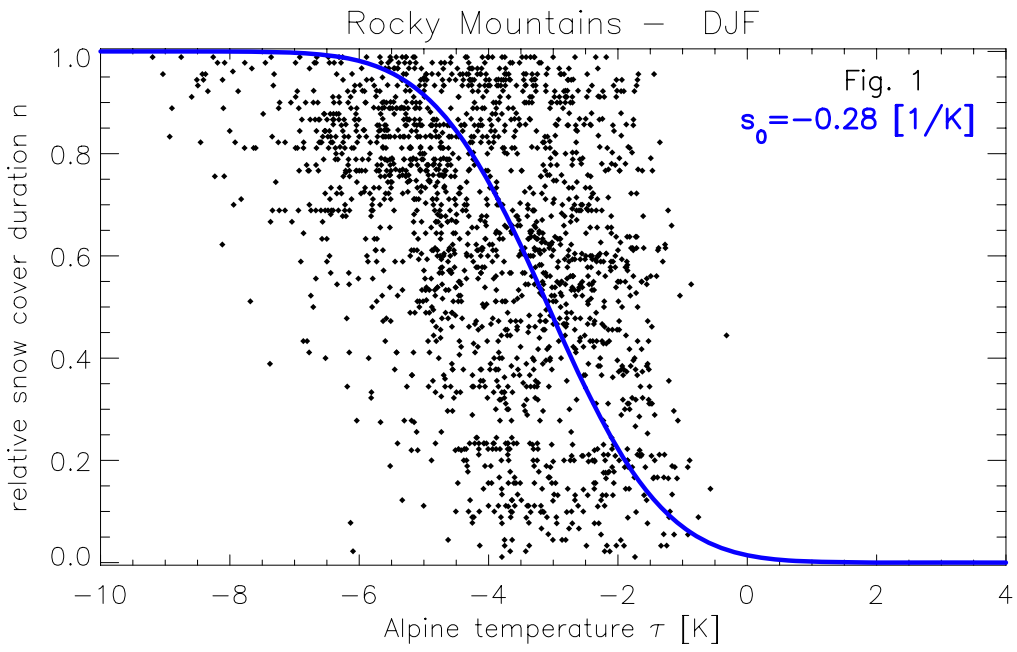
Sensitivity of snow cover duration to regional temperature in the Rocky Mountains[2)]

The number of days with snow cover at 674 SNOTEL (SNOpack TELemetry) stations in the U.S. Rocky Mountains for the years 1961 to 2002 has been investigated with respect to the mean temperature of the region. The data were provided by Dr. Poulos (NCAR).

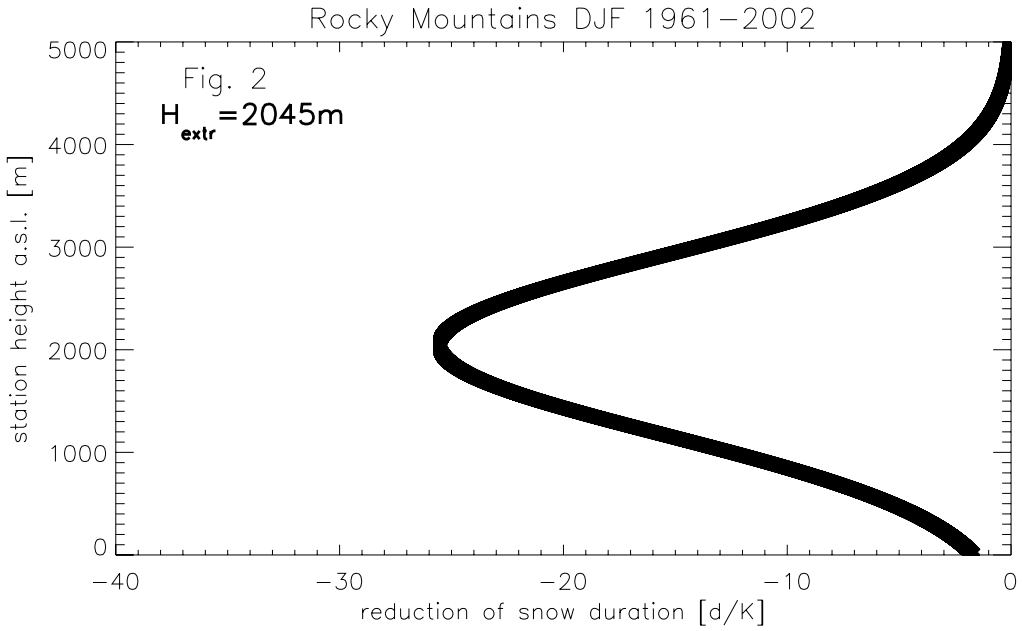
We measure the snow cover duration as the relative number *n* of days during the winter season (DJF) at which a snow cover of at least 12.5 cm snow water equivalent has been observed (thresholds different from 12.5 cm have also been investigated). We consider *n* a function of station height *H* and temperature *T*. The latter is determined as regional winter average over the area of the Rocky Mountains, 100°-118°E and 32°-48°N, from the CRU (Climate Research Unit) dataset as provided by Mitchell and Jones (2005). The functional relation *n(H,T)* is gained through a statistical model which consists in fitting a logistic curve to the observed data. It was originally developed for Austria (Hantel et al., 2000) and recently applied to the European Alps.

Purpose of this research is to estimate the sensitivity of the snow duration to temperature (Fig. 1). The regional temperature is sufficiently close to what a climate model should predict for large-scale temperature development representative for the winter season of the western part of North America. The sensitivity *s* is defined as the partial derivative of *n* with respect to *T* for constant *H*. We expect small sensitivities for stations both at low levels ("never snow") and at very high levels ("always snow"). At intermediate levels *s* should reach a negative extremum, referred to as s_0.



We find a maximum sensitivity s_0 = -(0.28±0.03) 1/K for the area of the Rocky Mountains in elevations around 2.050 m during winter. Since a climate shift of 1 K would be within the natural seasonal fluctuations, the sensitivity implies that a rise of the mean regional temperature of 1 K has the potential to reduce the duration of snow cover by 28%. Given a maximum of 91 snow cover days (= 100%) in winter a reduction of 28% would correspond to a reduction of almost 27 days per degree warming in elevations of maximum sensitivity (Fig. 2). Above and below about 2050 m the sensitivity is gradually getting smaller.

For comparison: The sensitivity for snow heights of 5 cm is s_0 = -(0.34±0.04) 1/K for Austria and s_0 = -(0.30±0.06) 1/K for Switzerland (Wielke et al., 2004), located at levels around 600 to 800 m.



The theory behind the statistical model suggests that our results are insensitive to possible climate mean trends; s_0 depends primarily upon the natural fluctuations of regional temperature which causes short snow duration in warm winters and long duration in cold winters, in accord with general experience. The novel aspect of this study is that the sensitivity is closely related to the variance of these temperature fluctuations.

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