CLIMATIC TRENDS FOR THE LAST 45 WINTERS IN A FRENCH ALPS REGION

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Abstract :
The three numerical models SAFRAN-CROCUS-MEPRA, usually applied by Météo-France for operational avalanche forecasting, is here used for retrospective weather and snow climate analyses during the 1958/2004 winter period, using all available observed information and the newly reanalysed atmospheric data of the ECMRWF (European Centre for Medium-Range Weather Forecasts) called "ERA-40".
In this presentation, we shall describe some general results over the French Alps, then focus on a region. Thus will be described trends concerning temperature, precipitation, snow depths, and the avalanche favourable meteorological conditions too.

Keywords : *climatic trends, French Alps, snow cover, avalanches.*

1. INTRODUCTION

Since the early 1990s, Météo-France has used, for its operational avalanche forecasting, an automatic system of three numerical models : SAFRAN, CROCUS and MEPRA. These models simulates meteorological parameters, snow cover stratigraphy and avalanche risks respectively, at various elevations, aspects and slopes.
In the French Alps, the lack of sufficient amount of directly observed long-term snow data does not allow to know precisely the long-term trend of all these parameters. The SAFRAN-CROCUS-MEPRA model chain, here used for retrospective weather climate and snow analyses, provides such trends during the 1958/2004 winter period.

2. METHOD

The first model SAFRAN model chain is here supplied with guess-fields values issued from the newly reanalysed atmospheric data ERA-40 of the ECMRWF (European Centre for Medium-Range Weather Forecasts), and with all available observed and kept information in the French Alps.
Thus, SAFRAN simulates meteorological parameters at ground level for each day in the past between 1958 and 2004. The second model, CROCUS, simulates then the snow cover stratigraphies which follow, and the third one, MEPRA, the corresponding avalanche risks.
These results coming from numerical models have been validated by a comparison between temperature and precipitation in twenty-one places provided in the one hand by SAFRAN, on the other hand straight by human observations.
Concerning the avalanche activity, no simple parameter can be analysed. We here chose a relevant meteorological factor for natural avalanche triggering : the episodes with snowfalls water equivalent in 3 days >=80 mm in a massif.

3.RESULTS

3.1 Climatologic point of view

The forty-six winters long period allows having relevant means about air temperature, total and snow precipitations, snow cover winter-mean depth and duration for various elevations, aspects and slopes for all the schematised massifs of the French Alps (publication under way). But, we here present results only for flat in a region (part of département of Isère).

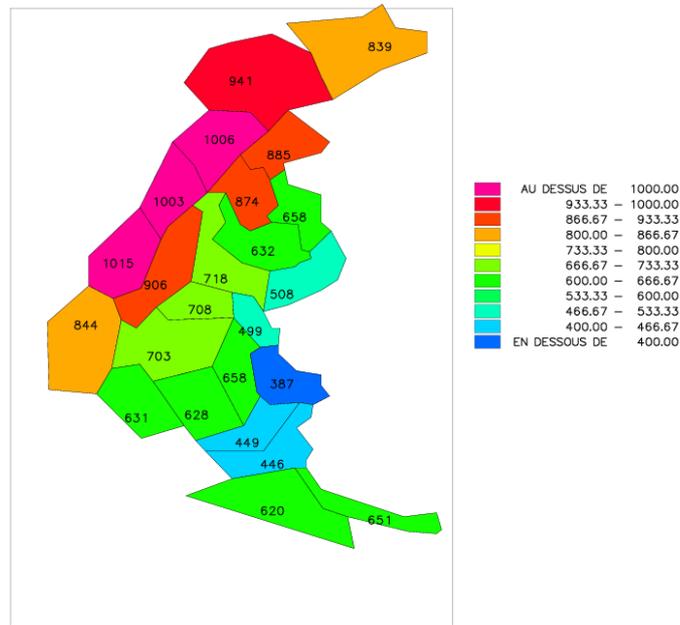ALPS : SAFRAN mean winter precipitation in mm
within the 1958–2002 period

Figure 1 : SAFRAN mean winter precipitation (1958-2002 period) in the French Alps
massifs at 1800 m a.s.l.

Precipitation and snow parameters in the French Alps are characterised by a marked declining gradient
from the northwest foothills to the southeastern interior massifs.

The long-term series we got also show a large year-to-year variability of all these parameters.

3.2 Trend point of view

- During the simulated period 1958-2002, the winter air period has been rising in the order of
magnitude by about 1°C, mainly since the middle of the 1980 years. However, variations are large at
varying altitudes and for different seasons. This warming is more pronounced at medium altitudes than
higher, and in the Prealps than in inner massifs. However, there is everywhere a large year-to-year
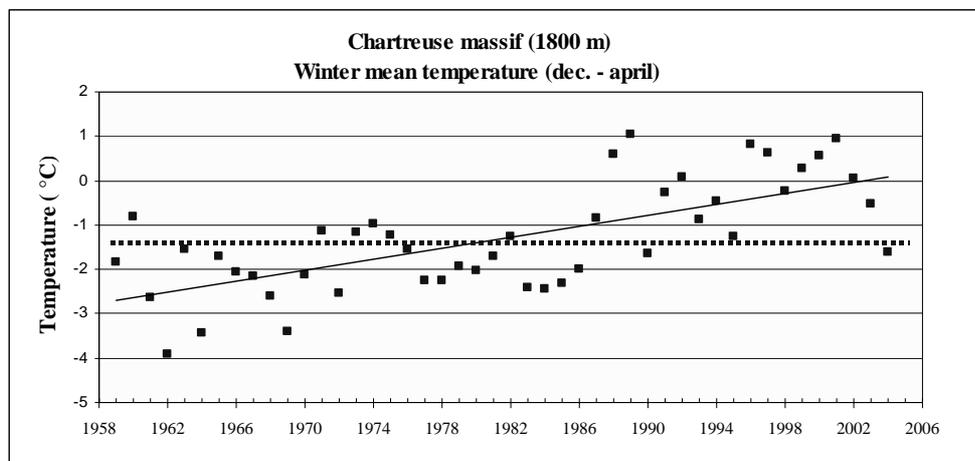variability with regard to the smoothed trend lines.

Figure 2 : Winter mean temperature (december-april) from 1958-1959 winter
to 2003-2004 winter for Chartreuse massif at 1800 m a.s.l.

- Precipitation trends are rather diverse, making it hard to detect clear tendencies. As a general trend to winter precipitation is slightly rising (2 to 3 mm per year). Year-to-year variability is big but trends remain uniform at varying elevations. Snow precipitations trend to follow temperature increasing with decreasing snow falls below 2000 m.
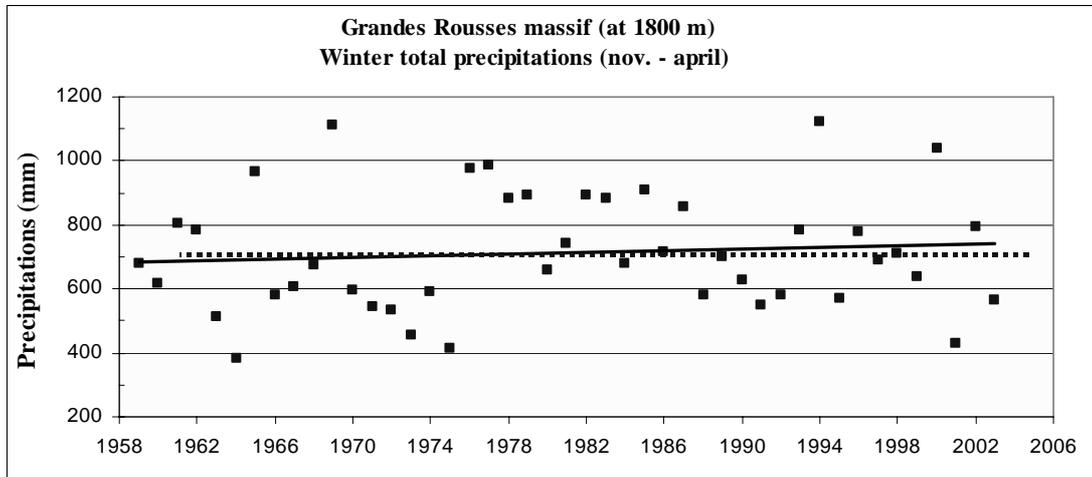

Figure 3 : Winter (nov.-april) total precipitations (rain and snow) from 1958-1959 winter to 2003-2004 winter for Grandes Rousses massif at 1800 m a.s.l.

- Snow depths are clearly decreasing at medium elevations (up to 1800 m a.s.l.), slightly decreasing above 1800 m and up to 2100 m, and without clear trend at higher elevations.
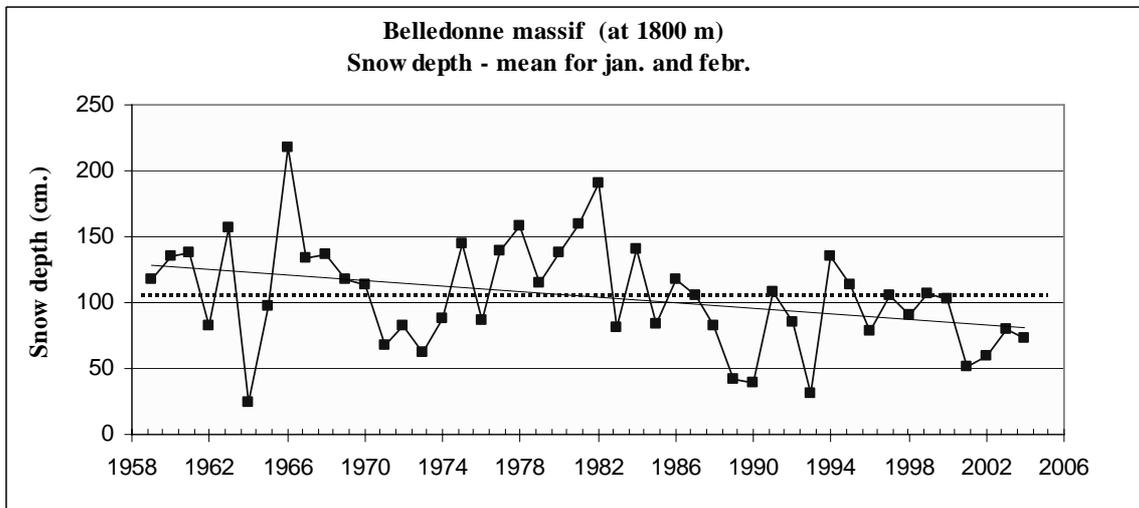

Figure 4 : Winter (jan.-febr.) snow depth from 1958-1959 winter to 2003-2004 winter for Belledonne massif at 1800 m a.s.l.

- About natural avalanche activity, the chosen parameter (number of episodes with snowfalls water equivalent in 3 days >=80 mm in Grandes Rousses massif) shows no significant trend between 1958-1959 winter and 2003-2004 winter.
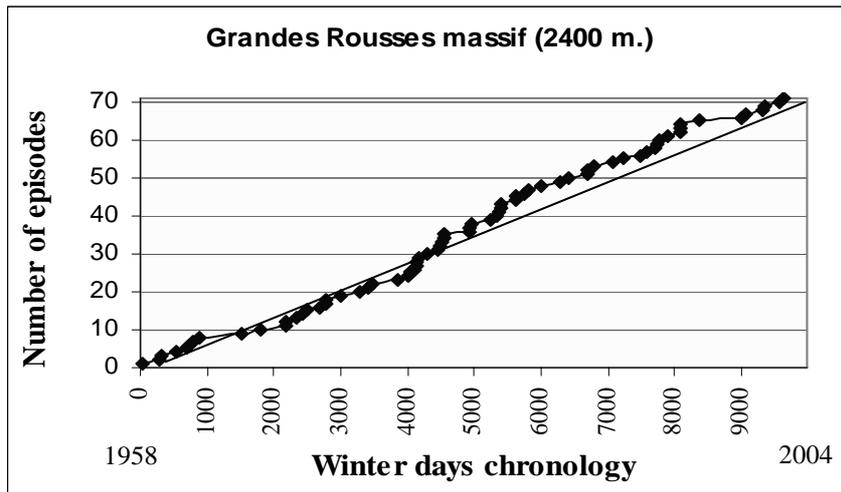
Figure 5 : Cumulative number of episodes with snowfalls water equivalent in 3 days >=80 mm
in Grandes Rousses massif at 2400 m a.s.l.
between 1958-1959 winter and 2003-2004 winter (nov.-may)

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