

Contrasting seasonal changes in temperature, precipitation and snow cover in the Alps over the last century

Martin Ménégoz, Julien Beaumet, Hubert Gallée, Xavier Fettweis, Nicolas Jourdain, Juliette Blanchet, Samuel Morin, Bruno Wilhelm, Sandrien Anquetin, Delphine Six, Christian Vincent



Atelier neige
CEN, 29/01/2020

Photo: NASA

MAR, 7km, forced with different reanalysis datasets -> ERA20C and ERA5
Two articles to investigate climate trends in the Alps:

<https://doi.org/10.5194/hess-2019-690>

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1 **Contrasting seasonal changes in total and intense precipitation in the**
2 **European Alps from 1903 to 2010**

3
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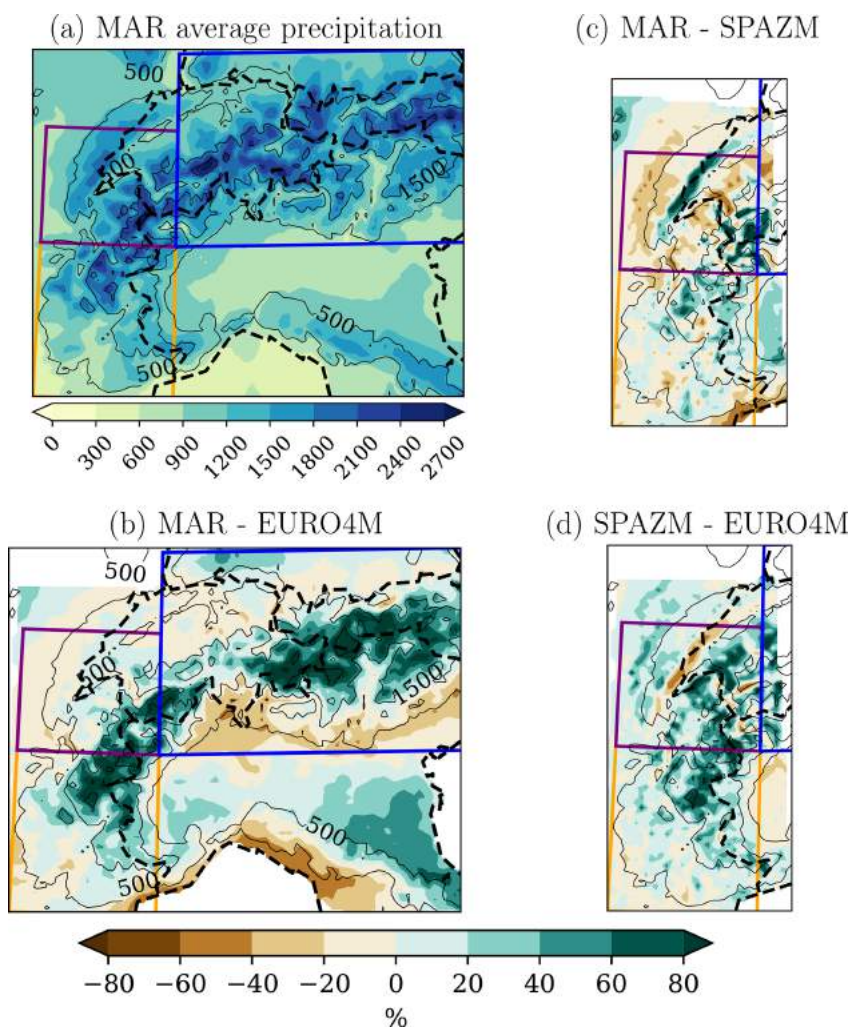
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**Twentieth century temperature and snow cover changes in the
French Alps using a high-resolution regional climate model and
reanalyses**

Julien Beaumet¹, Martin Ménégoz¹, Hubert Gallée¹, Xavier Fettweis², Samuel Morin³, Delphine Six¹,
Christian Vincent¹, Bruno Wilhelm¹, and Sandrine Anquetin¹

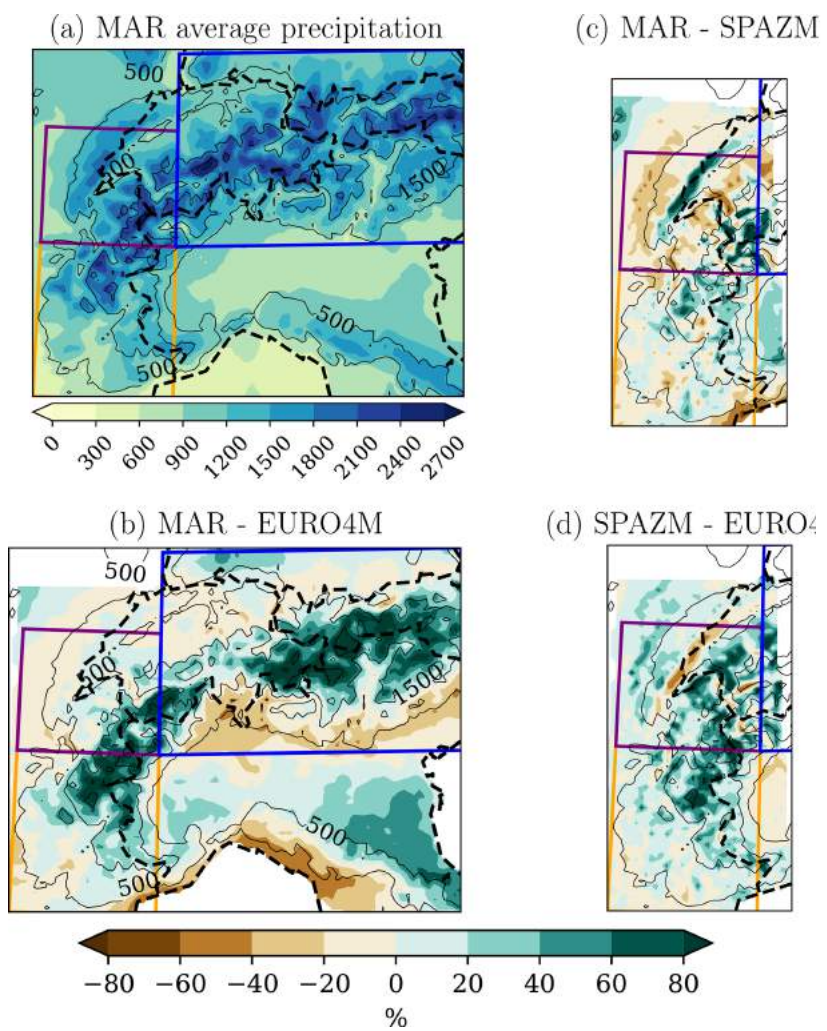
(In revision for REC)

Precipitation

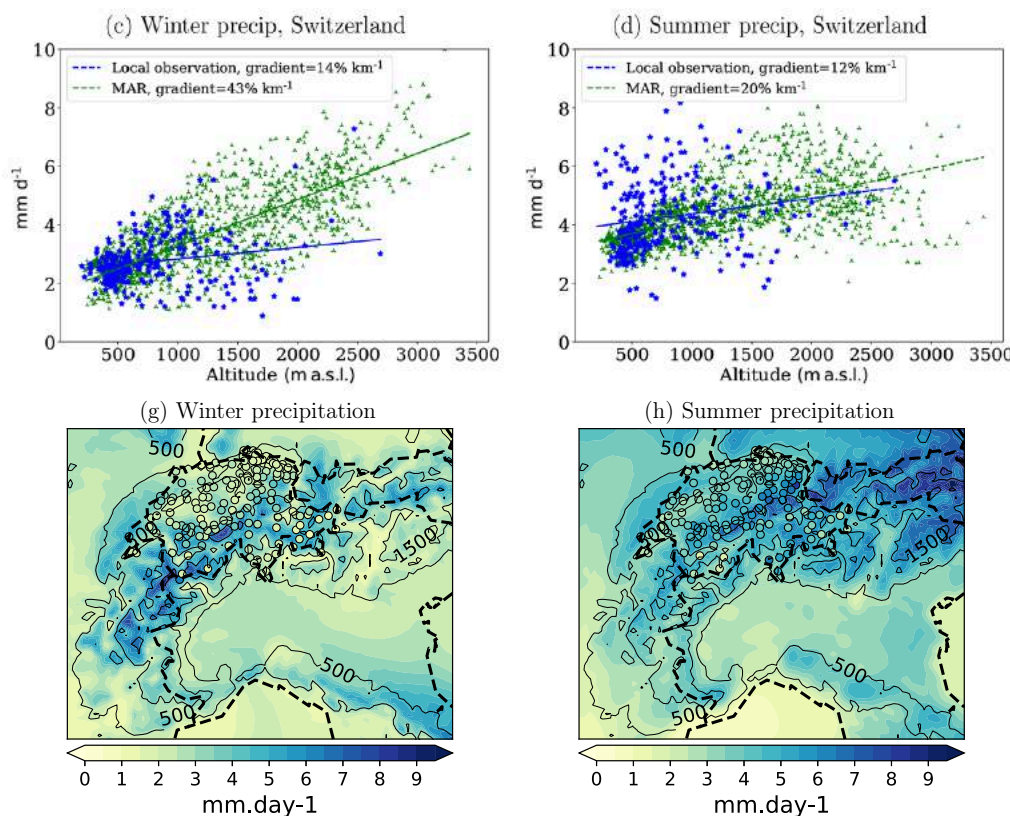


Annual mean of precipitation (a, mm)
over 1971-2008: MAR and differences
(%) with observational datasets

Precipitation



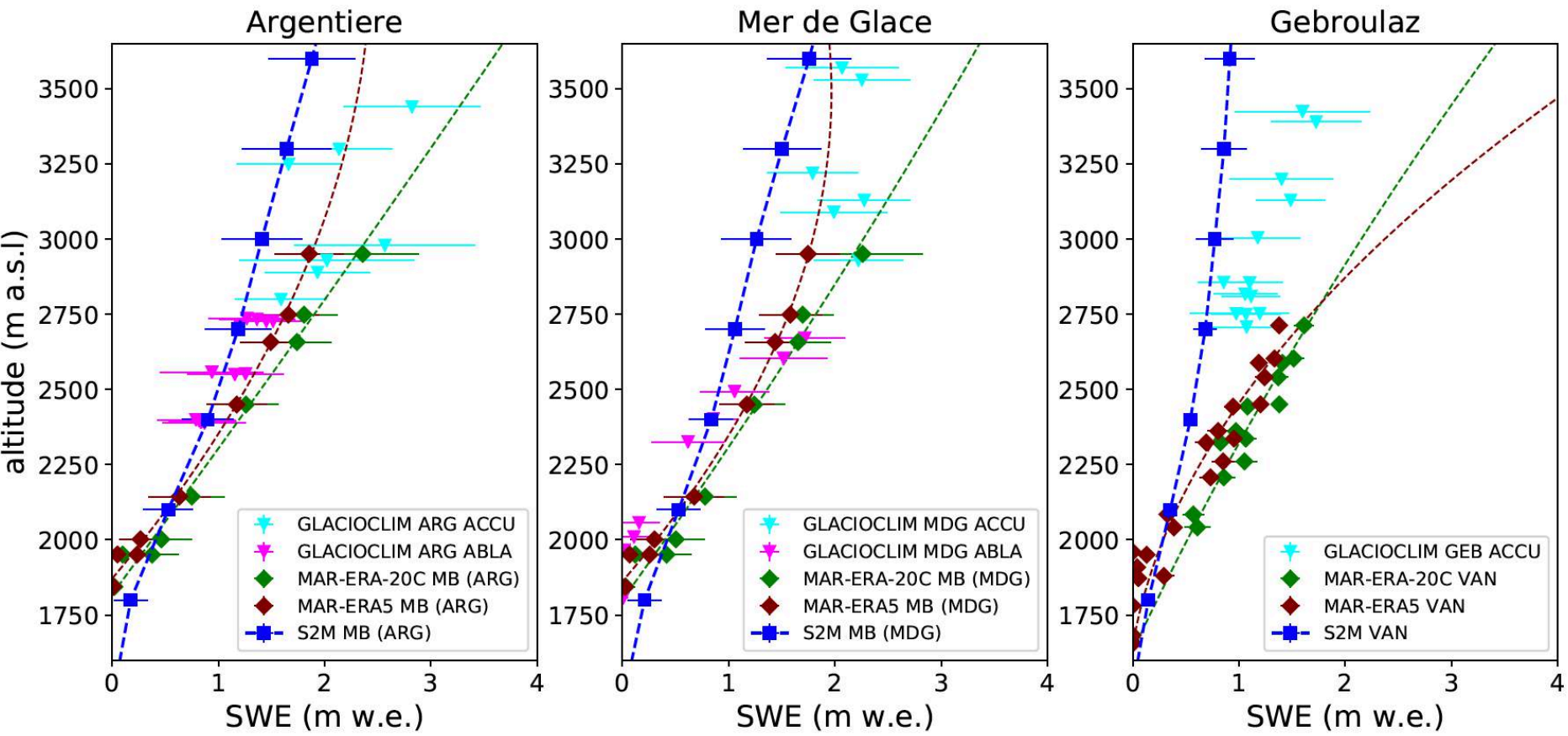
Annual mean of precipitation (a, mm) over 1971-2008: MAR and differences (%) with observational datasets



Precipitation over 1971-2008: vertical gradient (top) and seasonal mean (MAR and Swiss stations)

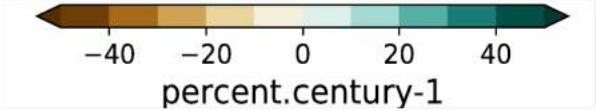
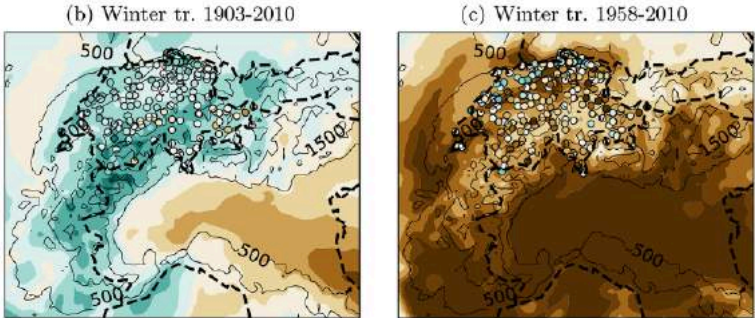
Snow accumulation

Late Spring SWE (1993-2010)

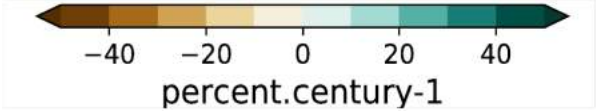
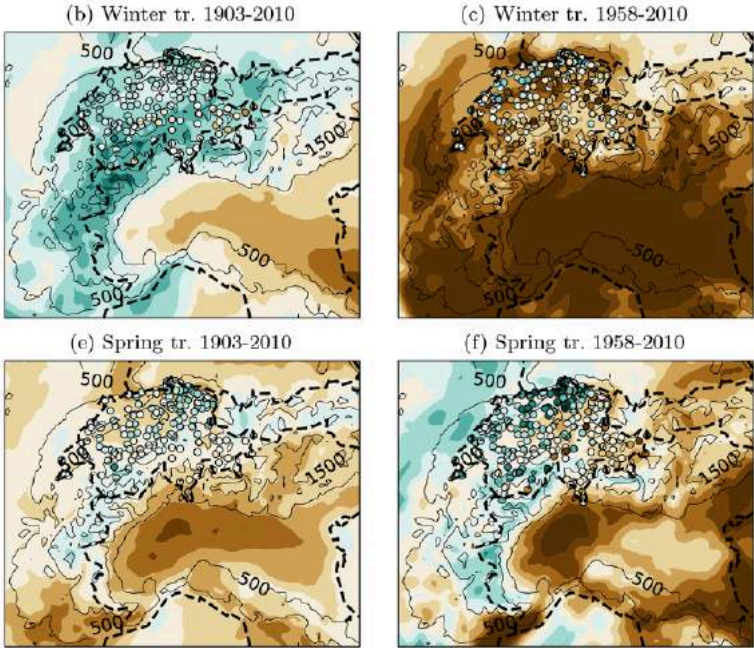


Late spring mean snow accumulation over 1993-2010 Glacioclim, S2M and MAR

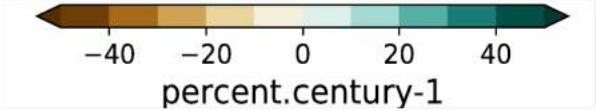
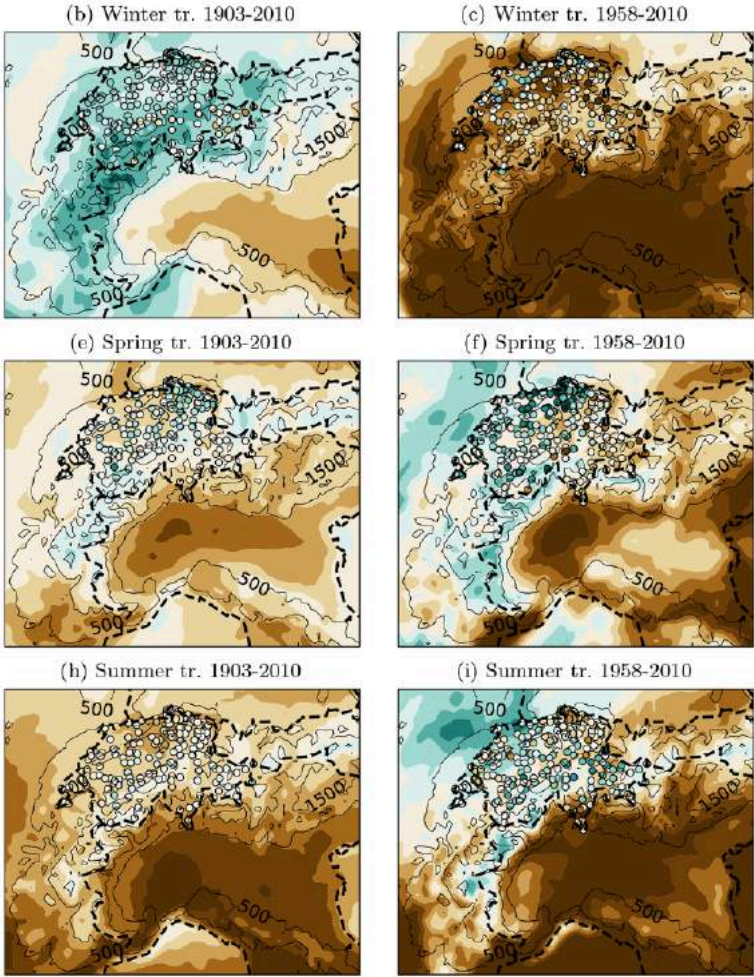
Seasonal trends of
mean precipitation



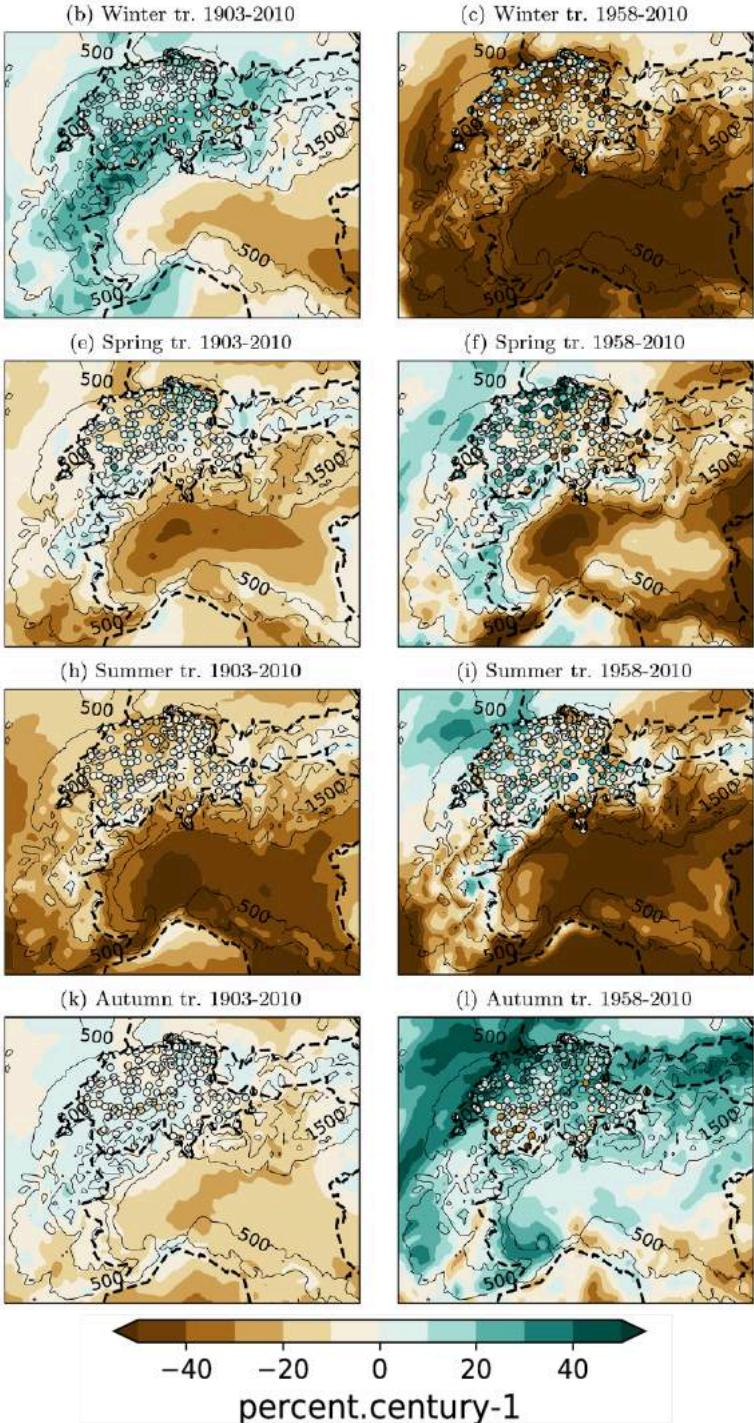
Seasonal trends of mean precipitation



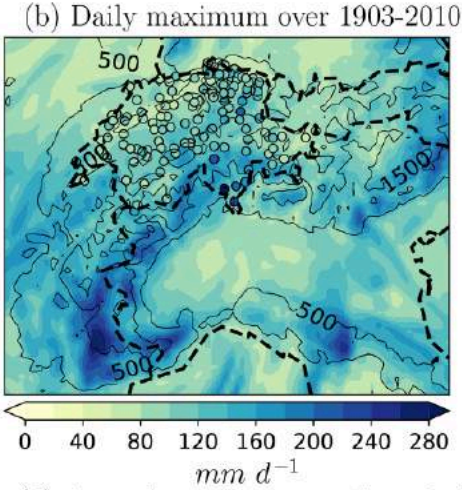
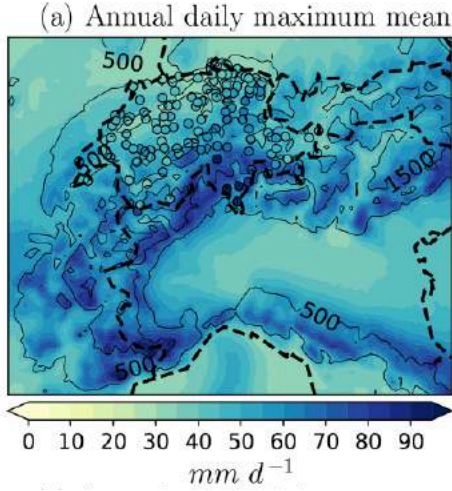
Seasonal trends of
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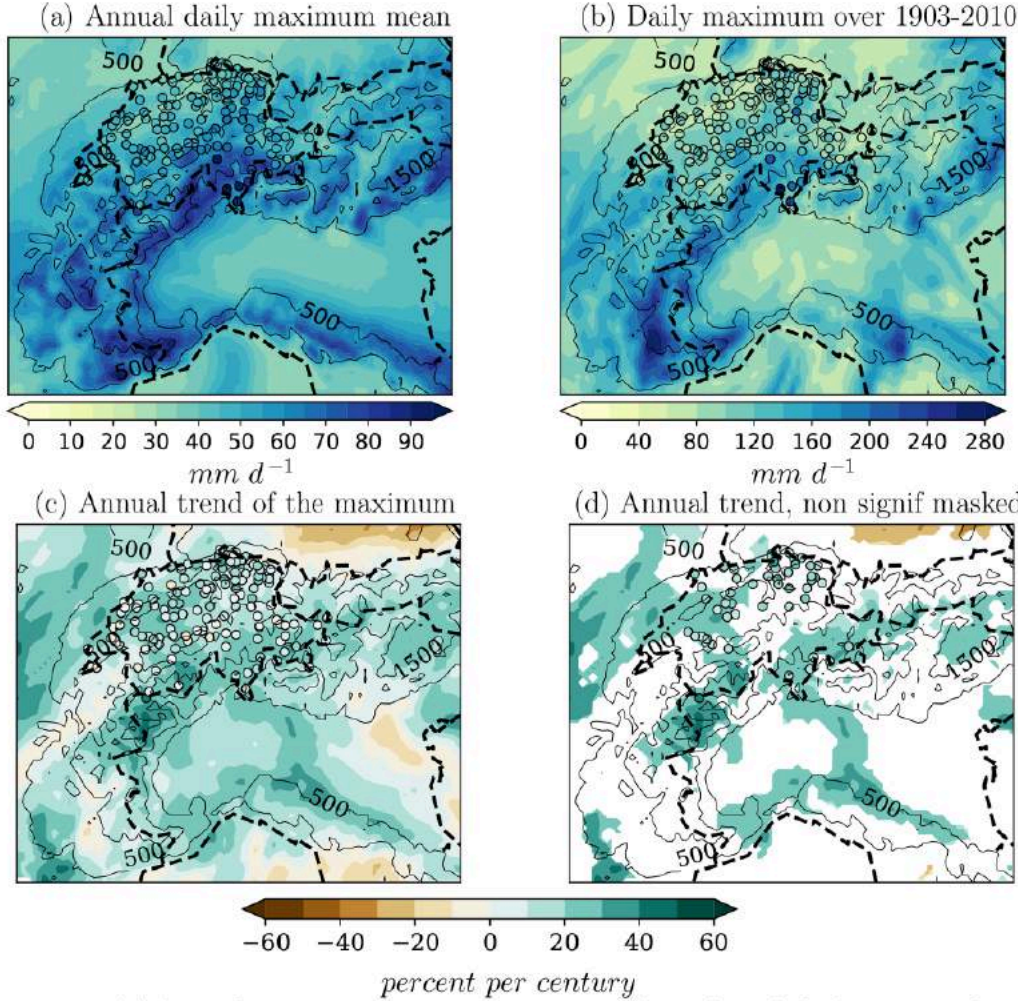
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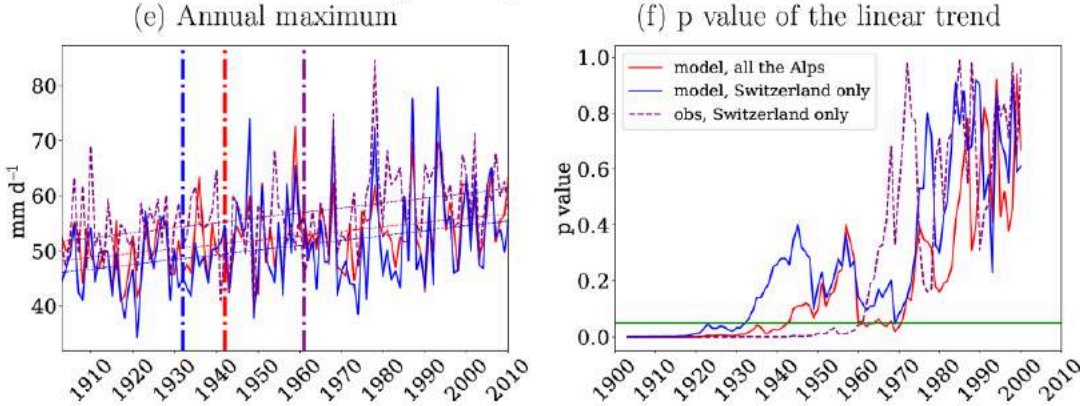
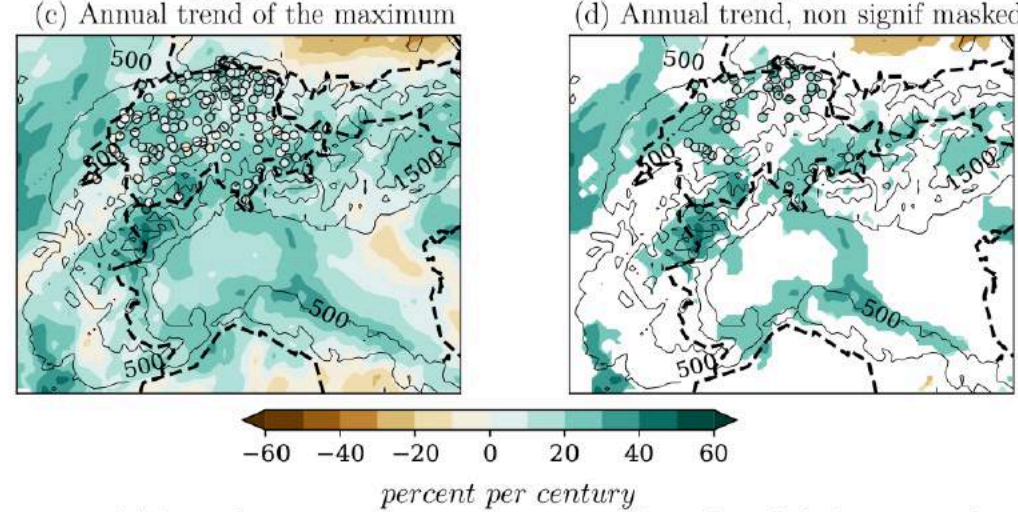
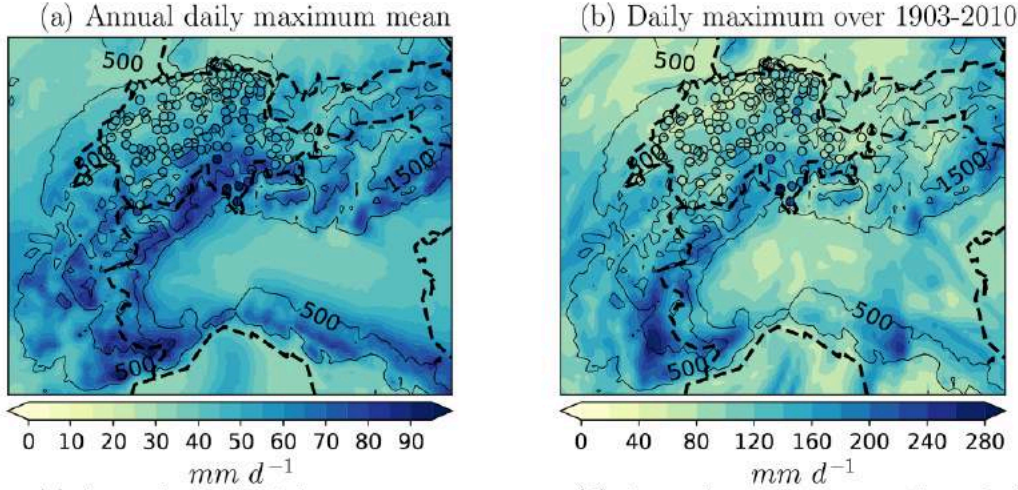
Annual trend of intense precipitation (Rx1day)



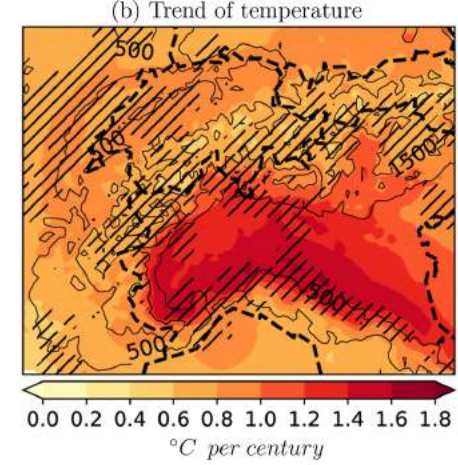
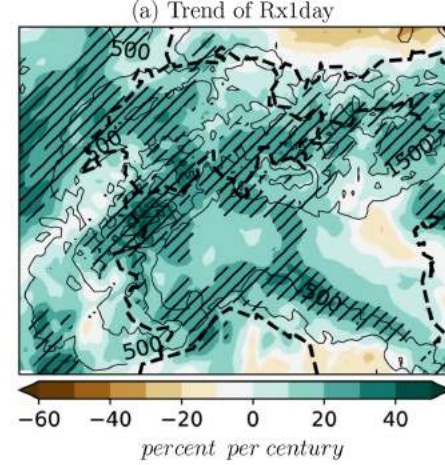
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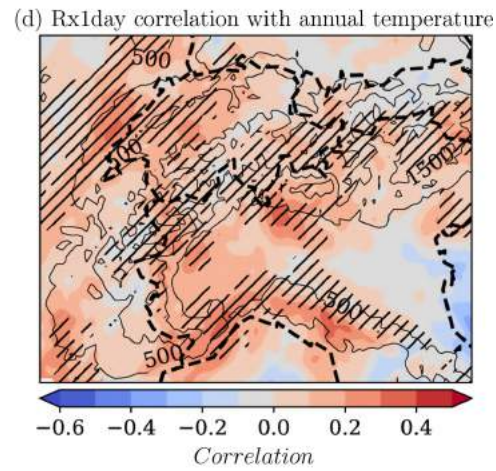
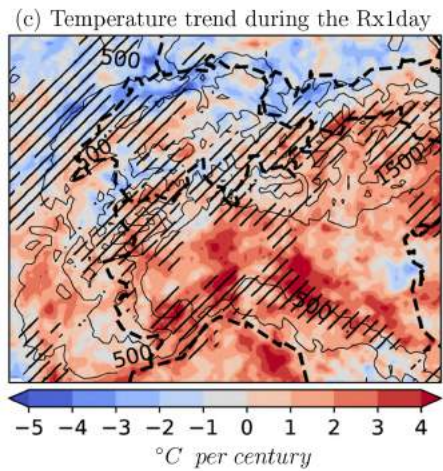
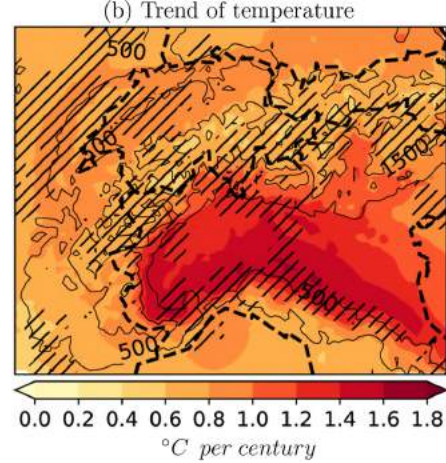
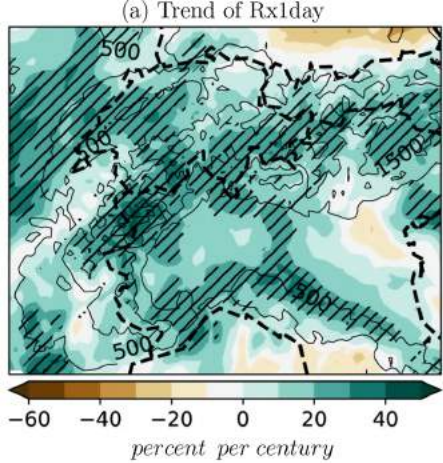
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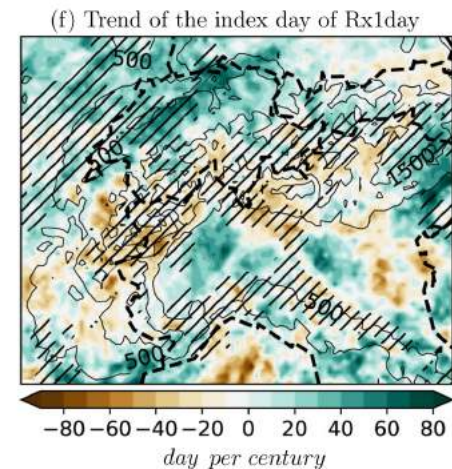
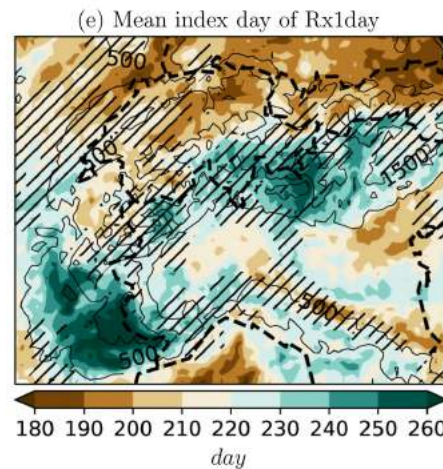
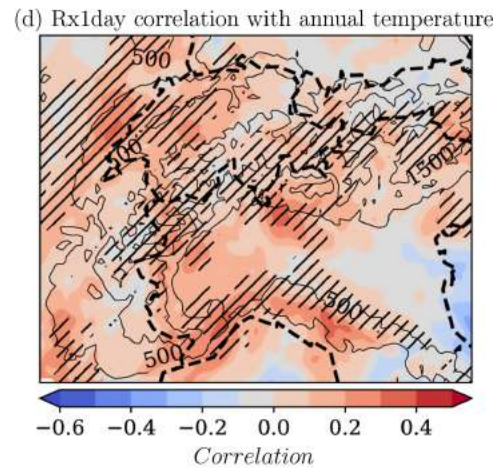
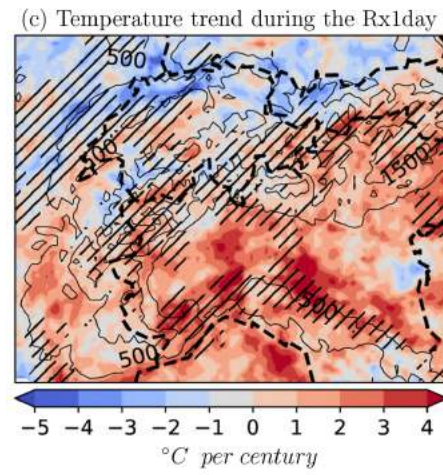
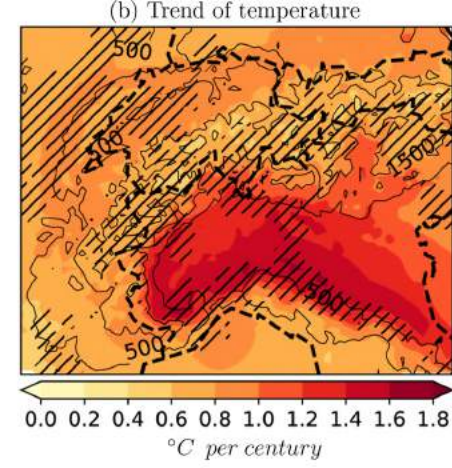
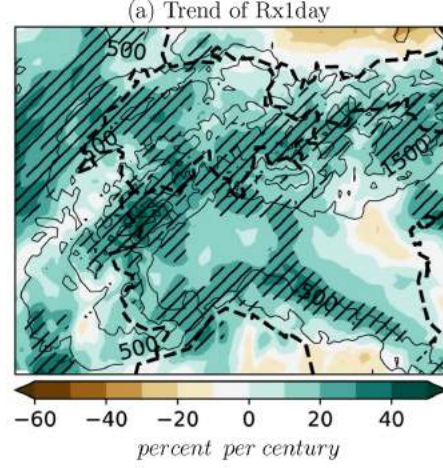
Rx1day trend versus temperature trend



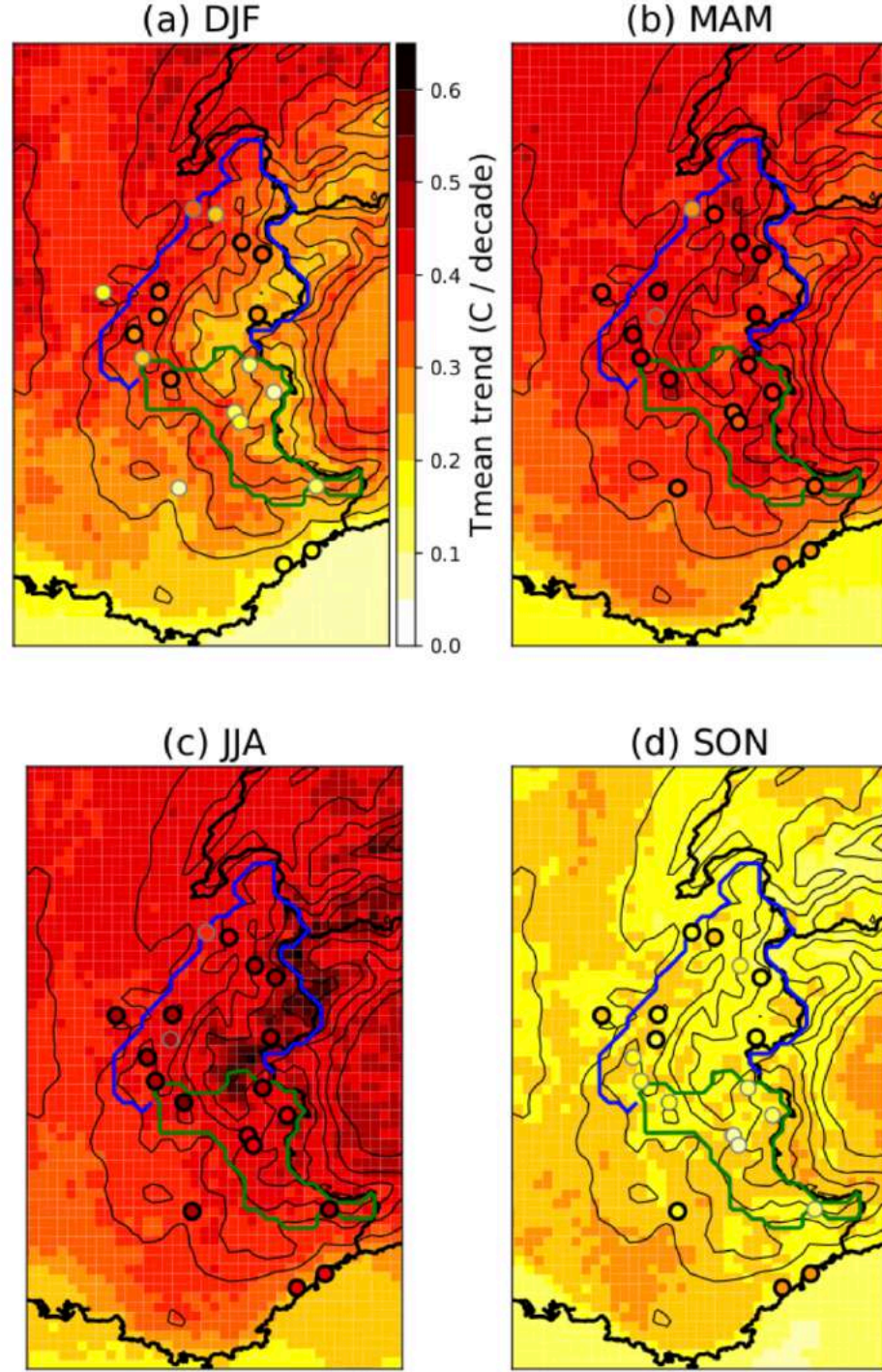
Rx1day trend versus temperature trend



Rx1day trend versus temperature trend



Temperature trend 1959-2010
MAR (shading) and Météo-
France stations (dots)



Temperature trend

MAR:

Southern Alps -> orange

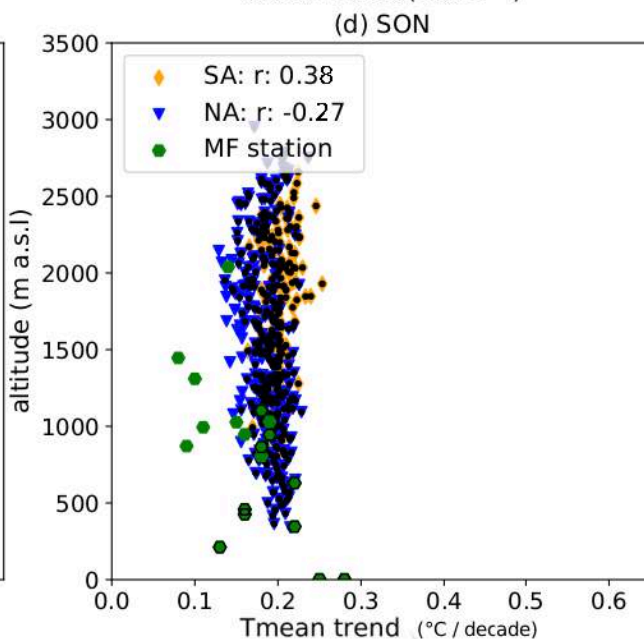
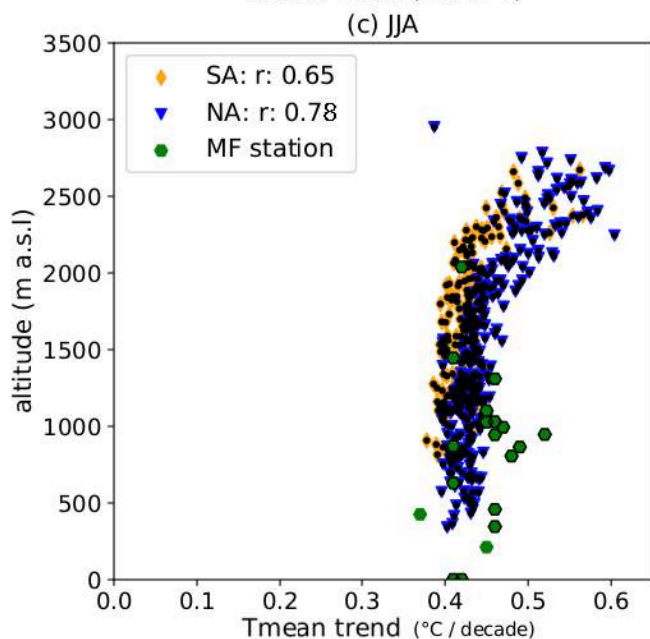
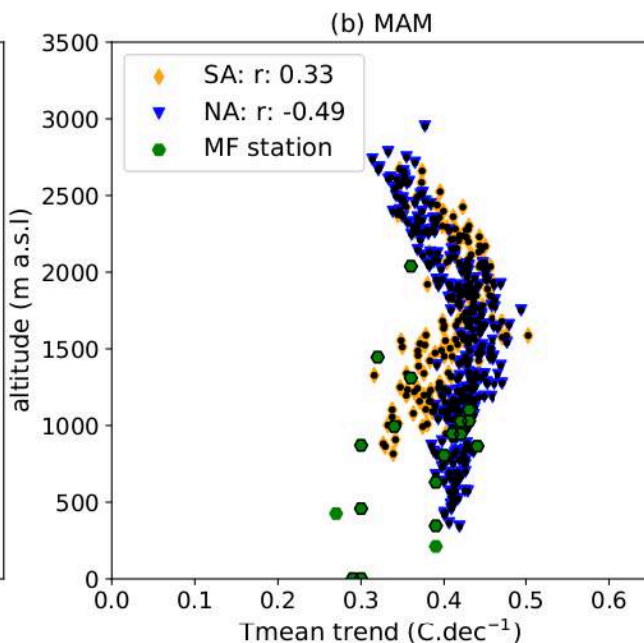
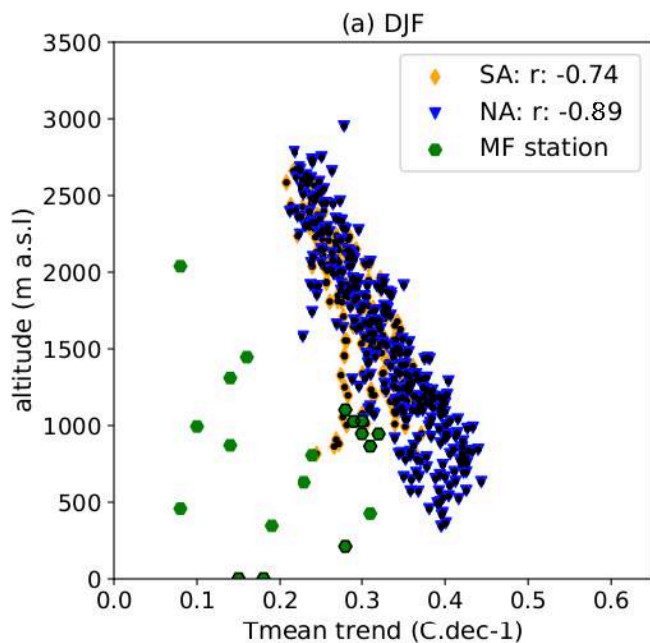
Northern Alps -> blue

Meteo-France:

Stations -> green

a)

MAR-ERA-20C Tmean trend 1959-2010



Take-home messages:

- ✓ Downscaling ECMWF reanalysis with MAR at 7km
- ✓ Accurate representation of precipitation in mountainous areas (vertical gradient)
- ✓ Contrasted seasonal trends of mean precipitation; drastic drying in the Southern plains (20% to 40% per century)
- ✓ General increase in intense precipitation (up to 40% per century for the Rx1day)
- ✓ Positive trend in Rx1day where it is correlated with annual temperature
- ✓ Contrasted Temperature trends:
 - > summer 0.4 to 0.5°C/decade, more intense at high elevation
 - > spring and winter: 0.3°C to 0.4°C/decade, more intense at intermediate altitude, depending on the snow albedo feedback
 - > less pronounced in autumn (0.2°C/decade)
- ✓ MAR – LMDZ : toward common models?