Assessing the impact of Climate Change on continental surface hydrology and discharge in France

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METEO FRANCE
Toujours un temps d'avance

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

Introduction

The assessment of the **impacts of climate change on the water cycle** has become a very important issue, due to the public interest on climate change and to the economic and social importance of water resources. Furthermore, some regions of France, like the **Mediterranean region**, are specially vulnerable, due to the possibility of an intensification of the summer dry period and, at the same time, an increase in intense precipitation events (Cevennes) on a highly populated region. This work is done under the framework of the **CYPRIM project** (*Cyclogénèse et précipitations intenses en Méditerranée*) which has the objective to study the systems that produce intense precipitation on this region and to study their impacts and their future evolution.

References

1 . Boé, J. et al. **A simple statistical-dynamical downscaling scheme based on weather types and conditional resampling**. Journal of Geophysical Research 111, (2006).

2 . Boé, J., J. et al. **Statistical and dynamical downscaling of the Seine basin climate for hydro-meteorological studies**. International Journal of Climatology 27, 1643-1655 (2007).

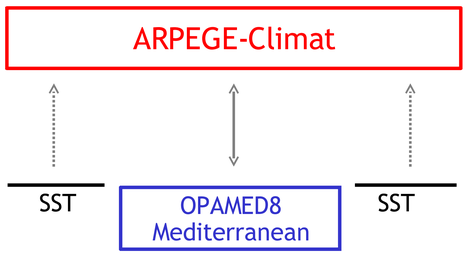
3 . Habets, F. et al. **The SAFRAN-ISBA-MODCOU hydrometeorological model applied over France**. Journal of Geophysical Research 113, D06113 (2008).

4 . Quintana-Seguí, P. et al. **Analysis of Near-Surface Atmospheric Variables: Validation of the SAFRAN Analysis over France**. Journal of Applied Meteorology and Climatology 47, 92-107 (2008).

5 . Somot, S. et al. **21st Century climate change scenario for the Mediterranean using a coupled Atmosphere-Ocean Regional Climate Model.** Global and Planetary Change In Press, Accepted Manuscript,

Climate

Atmosphere-Ocean Regional Climate Model



- A global atmosphere model is locally coupled with a regional ocean circulation model.
  - ARPEGE-Climate: Global spectral AGCM (50 km in the Mediterraean region).
  - OPAMED: Mediterranean Sea limited area OGCM (10 km).
- Emissions scenaro: SRES-A2 (beyond 2000).

Downscaling

Three methods

Statistical Downscaling | **Quantile Correction** | **Anomalies**

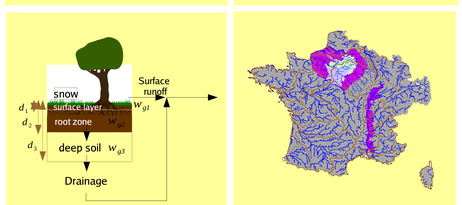
- Three methods used to test study the uncertainty
  - Statistical Downscaling: Multivariate and conditional resampling.
  - Quantile correction: A correction is found for each quantile for each variable separately.
  - Anomalies: For comparison with past studies.

Hydrology

Distributed model

ISBA 3-L
Surface scheme
Force-restore
8x8 km

MODCOU
Hydrological model
Routing and underground water

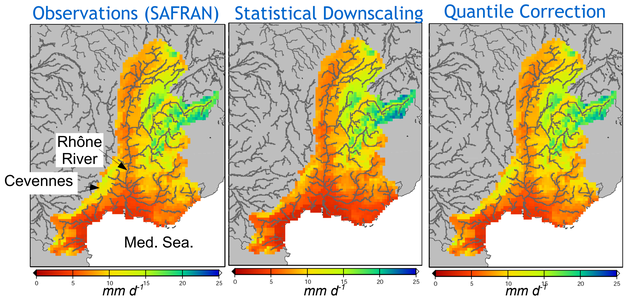


- ISBA: Surface scheme
  - 8 km resolution
  - Exponential profile of hydraulic conductivity
- MODCOU: Hydrogeological model
  - Routing to and within the river.
  - Aquifers for the Seine and Rhône rivers.
- The system calculates evaporation, soil wetness, runoff, river discharge (~ 900 gage stations in France), ...

Downscaling of Rainfall

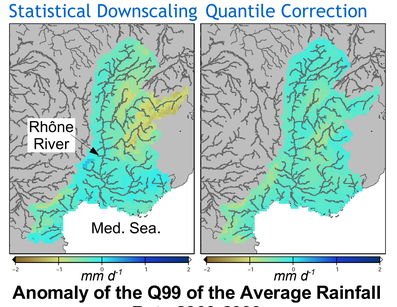
Average Rainfall Rate for the period 1970-2000

Observations (SAFRAN) | Statistical Downscaling | Quantile Correction



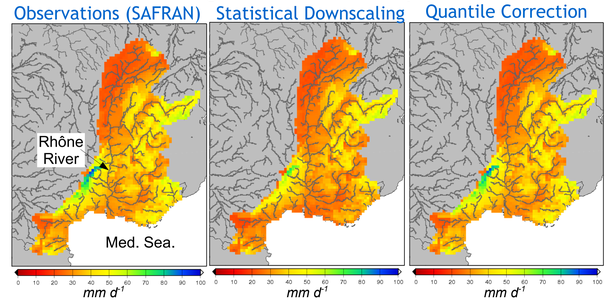
Anomaly of Average Rainfall Rate 2069-2099

Statistical Downscaling | Quantile Correction



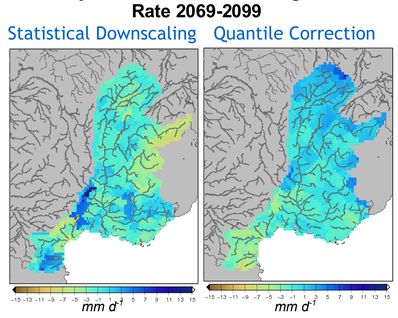
Q99 of the Average Rainfall Rate for the period 1970-2000

Observations (SAFRAN) | Statistical Downscaling | Quantile Correction



Anomaly of the Q99 of the Average Rainfall Rate 2069-2099

Statistical Downscaling | Quantile Correction



Area of study

The area depicted corresponds to the Mediterranean basin of France. The South East of France is a specially difficult area due to the variability of the Mediterranean climate.

Downscalings

The figures of Quantile Correction and the Observations are almost identical, as expected.

The statistical downscaling does not produce enough rain in general, but specially on the Cevennes mountains as it misses events of intense rainfall. The Cevennes are important as it is there were the episodes of intence precipitation and flash-floods are produced.

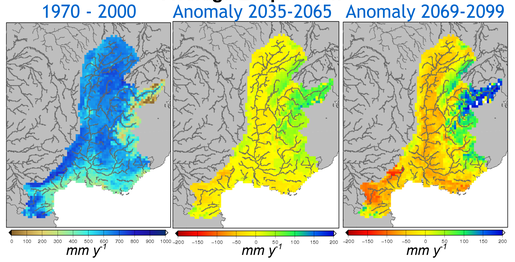
Both methods produce different patterns of anomaly, for both the mean and the Q99.

Hydrological Impact

Statistical Downscaling

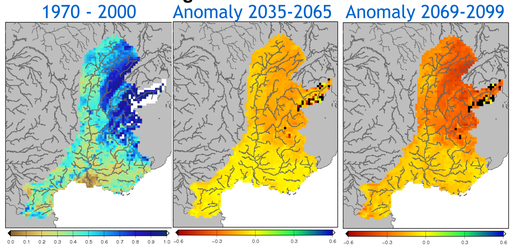
Average Evaporation

1970 - 2000 | Anomaly 2035-2065 | Anomaly 2069-2099



Average Soil Wetness Index

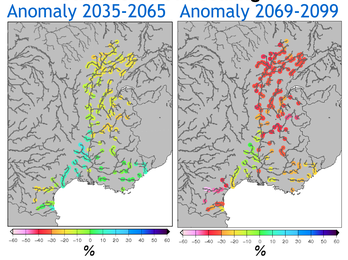
1970 - 2000 | Anomaly 2035-2065 | Anomaly 2069-2099



River discharge

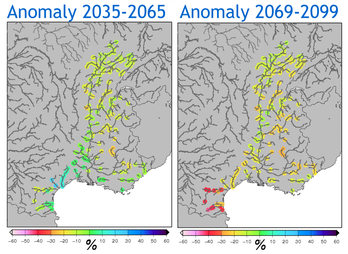
Statistical Downscaling

Anomaly 2035-2065 | Anomaly 2069-2099



Quantile Correction

Anomaly 2035-2065 | Anomaly 2069-2099



According to the statistical downscaling, the evaporation will diminish on the Mediterranean area due to the dryness of the soil

The hydrological model, when forced with both downscaling methods, shows a decrease of discharge for the end of the 21st century, but the differences of amplitude are important.

The amplitude of the difference between the two methods is probably enhanced due to threshold effects of the hydrological model.

Soil Wetness Index:

$$SWI = \frac{w_g - w_{wilt}}{w_{fc} - w_{wilt}}$$

Conclusions and Perspectives:

This poster shows a work in progress. In the following months, all the available data will be further analysed. The uncertainty related to the hydrological model will also be studied. These results will be compared to the other studies done under the umbrella of the CYPRIM project. `http://www.cnrm.meteo.fr/cyprim/`

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