Improvement of ECMWF Monthly Precipitation Forecasts over France using an Analog Method

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1. Context

Water resource forecasting (water levels, river flow and water temperature) is an important need of the electricity sector, as it impacts two essential components of the system : hydropower production and thermal plants cooling. The annual and interannual variability of water resource is high. Hence, accurate forecasts are necessary from hours (security and flood alerts) to one year ahead (optimal management of the reservoirs).
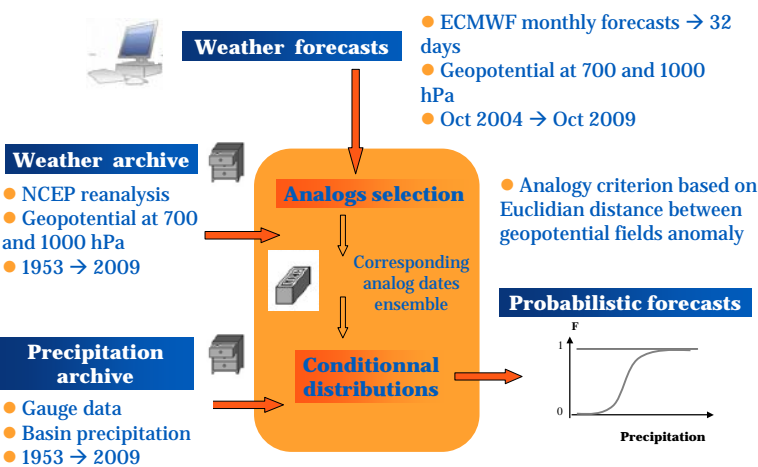

Water resource : a strong interannual variability & a forecasting challenge
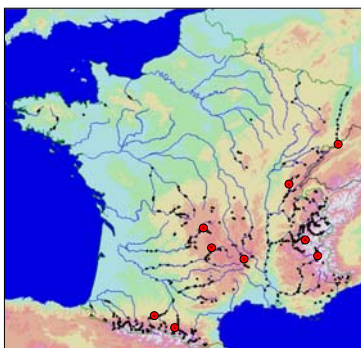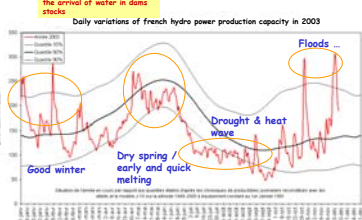
Local precipitations forecasts at the scale of the basin are necessary to allow optimal operation of hydraulic power plants and reservoirs. The actual operational process provides precipitation forecasts up to 7 days. The goal, here, is to extend this period to the upcoming 32 days. We used ECMWF monthly forecasts from October 2004 to October 2009 (262 forecasts, each consisting in 50 members ensemble forecasts).

2. Analog method

- ECMWF monthly forecasts → 32 days
- Geopotential at 700 and 1000 hPa
- Oct 2004 → Oct 2009

Weather archive
- NCEP reanalysis
- Geopotential at 700 and 1000 hPa
- 1953 → 2009

Precipitation archive
- Gauge data
- Basin precipitation
- 1953 → 2009

- Analogy criterion based on Euclidian distance between geopotential fields anomaly

Outputs of the method are, for each forecast date :
50 selected analogs x 50 members ensemble → 2500 monthly precipitation analogs forecasts (d+1 → d+32)

## 3. Results : Analog Vs Raw Forecasts

Change in RMSE :
- **(+)** RMSE(clim) > RMSE(analog forecasts)
- **(-)** RMSE(clim) < RMSE(analog forecasts)

**orange** — Improvement of analog forecasts compared to raw forecasts

Basin	RAW Precipitations Forecast				Analog Precipitations Forecast			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
1	+	-	-	-	+	=	-	-
2	+	+	-	-	+	+	+	+
3	+	+	-	-	+	-	-	-
4	+	-	-	-	+	+	+	+
5	+	+	=	-	+	+	+	+
6	+	+	-	-	+	-	-	-
7	+	-	-	-	+	-	-	-
8	+	=	-	-	+	+	+	=
9	+	=	-	-	+	+	+	+

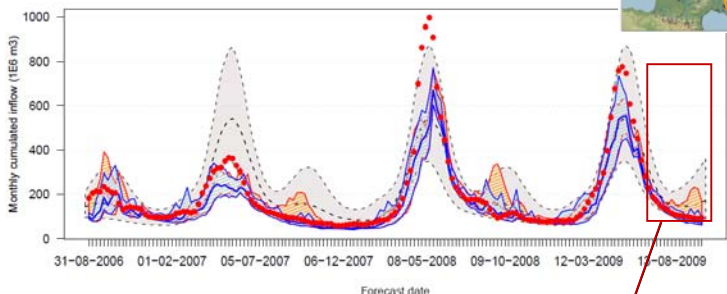→ **In almost all cases, the analog method improves the results from the deterministic point of view**
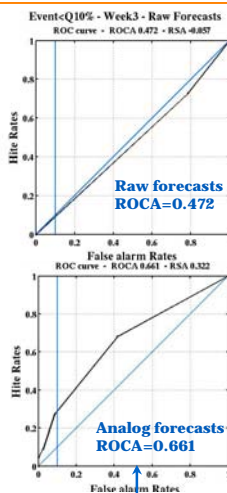
ROC, week 3, basin #2

Change in ROC skill score : difference between the ROCSS obtained using analog and raw forecasts for weeks 1 to 4. The improvement is clear !
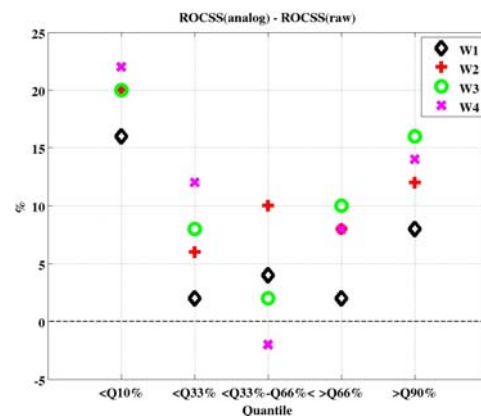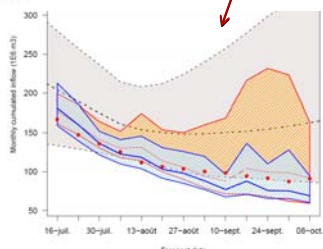

4. Application

Forecasted monthly cumulated inflows at Serre-Ponçon reservoir.

80% confidence interval inflow forecast calculated with
- Grey: inflow climatology
- Orange: precipitation climatology
- Blue: ECMWF/analogs monthly forecast
- Red: observed inflow

5. Conclusions

- The electricity sector is one of the most important users of weather, water and climate data and forecasts. Downscaling techniques can help in adapting the gridded model forecasts to the relevant user 's space and time scales. The continuity and linkages between decision processes at different time scales clearly ask for seamless approaches in weather and climate forecasting for the energy sector.

- Analog approach is attractive in practical applications for water resource management and advanced flood warning systems. This method presents **significant performances,** is **cheap** and **quick.**

- Moreover, we have identified ways to **further improve the model** by:
  - testing of different similarity criterions between two patterns
  - optimizing the choice of predictors used to characterise weather conditions.

- The analog predictions were used to forecast monthly cumulated inflows at Serre-Ponçon reservoir. Analog forecasts do a much better job than the classical approach, based on climatology ! This is in particular the case in autumns 2007 and 2009 (very low inflows observed). Other basins and the whole period (2004-2009) are under investigation.

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