Attributing the wet Winter season 2013/14 in Southern UK and Northern France using circulation analogues statistics

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Event

- Average precipitation over 2 station composits (figure 1).
  (1) 14 stations in south-eastern UK (data: Met Office)
  (2) 31 stations in north-western France (data: Météo France)
- High seasonal precipitation sums (Kendon and McCarthy, 2015) in the Winter season 2013/14 (01/12/2013-28/02/2014), shown as purple triangles in figures 3 and 4.

Sea level pressure analogues

- NCEP reanalysis data (Kalnay et al., 1996)
- North Atlantic region
- Distance to measure the similarity of slp anomaly fields:
  (1) Eudlidean
  (2) Mahalanobis
- Sampling periods
  (1) 1973–2012, taken as factual.
  (2) 1952–1991, taken as counter-factual.
- 20 analogue dates for each simulated day (figure 2).

Precipitation simulations

- Daily composite average precipitation from analogue dates averaged over the season.
- Sampling from the 20 analogues of each day using:
  (1) Random selection
  (2) weighted by rank
  (3) weighted by distance
- 500 realisations for each sampling period and sampling method.

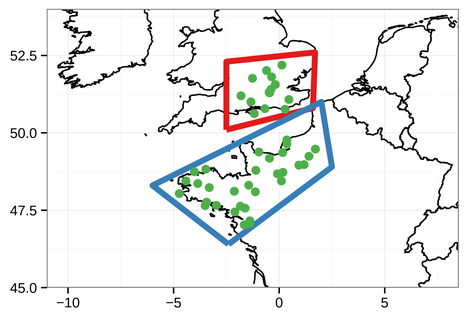

Figure 1: Station composits: 14 stations in the "Southern England" composite (red rectangle), 31 stations in the "Northern France" composite (blue rectangle)

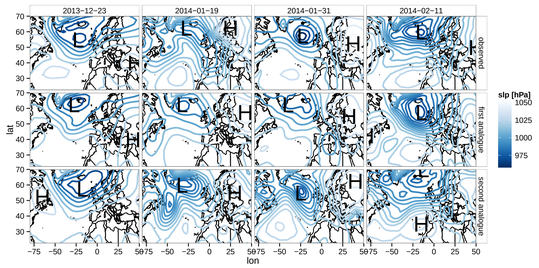

Figure 2: The 20 closest situations (analogues) in terms of sea level pressure anomalies over the North Atlantic region are selected from a data base period. The figure shows the the sea level pressure maps and the first two analogues in terms of Euclidean distance for 4 selected days.

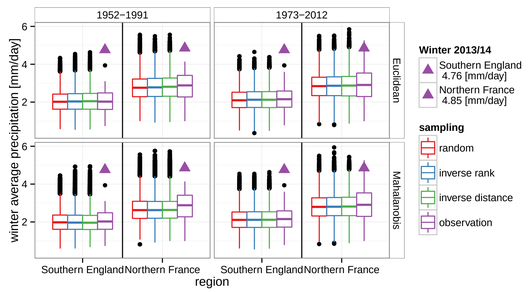

Figure 3: Simulations of the two sampling periods with the two distances and the three sampling methods (red, blue, green) for the two regions. Purple: distribution of observed Winter precipitation during the simulated period.

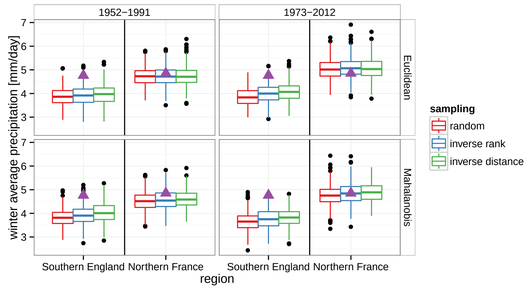

Figure 4: Same as figure 3 but simulating Winter 2013/14. Purple triangle: observed precipitation. For Northern France the event has a high probability given the Circulation. For Southern England the simulated precipitation is more dependent on the sampling method in experiment 1.

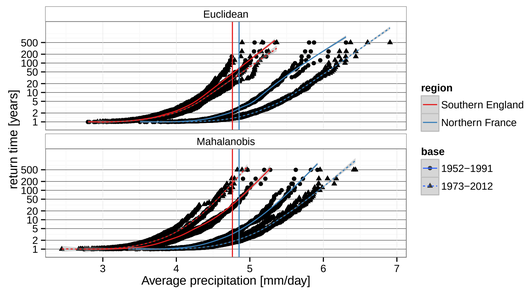

Figure 5: Empirical return times of simulated winter precipitation given Winter 2013/14 like circulation. Vertical lines: observed value for Winter 2013/14. France: consistently lower return times for a given value using the recent sampling period. England: Highly dependant on distance and sampling.

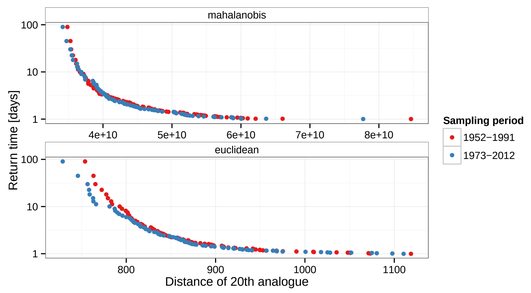

Figure 6: Empirical return times of the distance of the 20th analogue. Smaller return values correspond to more similar sea level pressure anomalies.

Experiment 1

- Simulate all Winter seasons in the sampling periods.

Results

- Simulations tend to have a low bias with Mahalanobis distance.
- The observed distributions are quite well reproduces with Euclidean distance.
- Little differences between sampling methods.
- Winter 2013/14 precipitation is the highest observed in the record in Southern England and second highest in Northern France. (figure 3)

Experiment 2

- Simulate the Winter season 2013/14

Results

- Higher precipitation values for distance weighted sampling. (figure 4)
- France: The return time in factual simulation is half the counter-factual one. (figure 5)
- England: Highly distance dependent return time differences.
- The probability to find analogues with lower than average distances is 2.2% (Mahalanobis) to 3.6% (Euclidean) higher for sampling period 2. (figure 6)

Conclusions

- Slight increase in the probability of Winter 2013/14 like circulation.
- The uncertainties due to the chosen distance and the chosen sampling weights can be huge when simulating an event with low conditional probability. (England composite)
- Consistent increase in precipitation given the circulation for the Northern France composite, likely linked to climate change.

Kalnay, E. et al. (1996). The NCEP/NCAR 40-year reanalysis project. *Bulletin of the American Meteorological Society*, 77(3):437–471.
Kendon, M. and McCarthy, M. (2015). The uk's wet and stormy winter of 2013/2014. *Weather*, 70:40–47.
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