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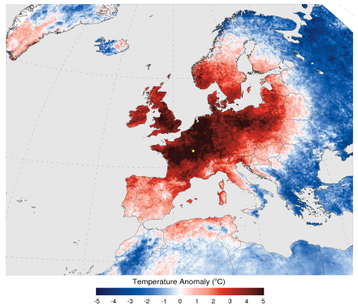
Determining the atmospheric moisture budget to analyse droughts processes and predictability

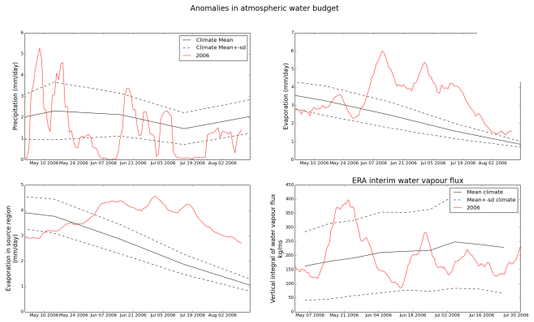
Classifying Droughts

The idea of this research is to determine the anomalies in the atmospheric moisture budget during droughts. Apart from diagnosing the anomalies in precipitation, evaporation and moisture flux, a moisture tracking model is used to determine the (evaporation) origin of precipitation that falls. This approach is explored here for the July 2006 Western European drought, but will be used to diagnose droughts globally, with the **aim of improving predictability**.
Using ensembles of seasonal predictions, the role of the land surface in initialising and maintaining droughts is explored, both for the local and up-wind land surface.

Case: Europe July 2006 Drought

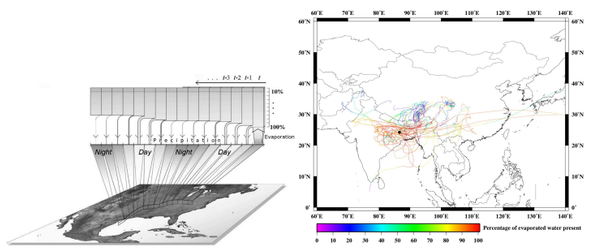


Source: wikipedia



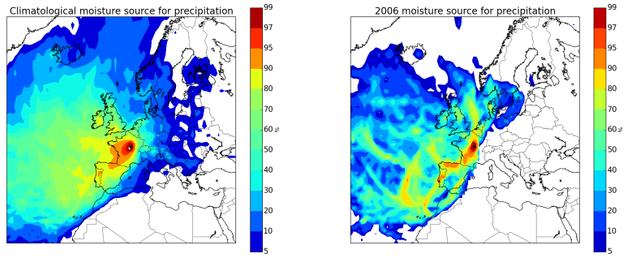
Moisture budget anomalies in eastern France (GLDAS)

Moisture Tracking



Precipitation is tracked back through the atmosphere to its previous evaporation location, using a moisture tracking scheme that is forced with ERA-interim q,u,v,w,E and P. During this back-trajectory, the moisture balance is continuously made and allocated (left panel). The sum of all individual trajectories (right panel) is a pdf of the previous evaporation location (below).

Moisture Sources



Pdf's of the evaporation location of the precipitation falling in eastern France (black dot), the average for June-July from 1979-2014 (left panel) and for June-July 2006 (right panel).
The shading is in percentage of the precipitation in the target point, so the global sum equals the total June-July precipitation in the target point.

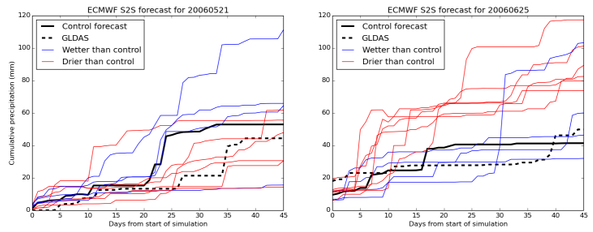
Seasonal Prediction

Using the ensemble members of the atmospheric model seasonal forecast output from the S2S-archive (http://www.s2sprediction.net), which all have different soil moisture and SST initialisation, the forecasts in the May-June 2006 period are analysed. The moisture conditions (day 1 evaporation):

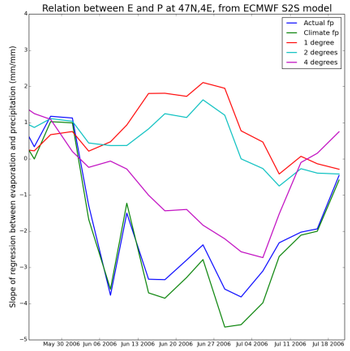
- locally around the precipitation location (1, 2 and 4 degree environment)
- upwind in the climatological and actual 2006 moisture origins

are compared to the precipitation forecast (day 45). The initial state is also compared to GLDAS data to determine whether errors in the initialisation are related to errors in the forecast.

Influence of Initial State

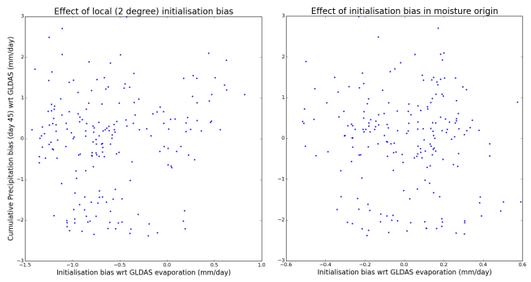


The ECMWF S2S ensemble members are sorted wrt initial state (evaporation on day 1) in the climatological moisture source. The effect of this initial state on the precipitation in eastern France varies throughout the drought period. When the drier initialisation generates more precipitation, this is due to a small number of days with a lot of rain. When the wetter initialisation produces more precipitation, it is distributed more gradually in time.



Linear regression between initial state and simulated precipitation (day 45) throughout the 2006 drought. Before the onset of the drought, wetter initialisations lead to more precipitation. During the drought, moisture locally leads to more precipitation (moisture budget or precipitation triggering?), while moister land surfaces upwind lead to less precipitation (triggering of thunderstorms?).

Effect of Bias in Initial State



The effect of initialisation on the bias compared to GLDAS seems to be small.

Conclusion

Moist land surface conditions in the source regions seems normally to lead to more precipitation. During the drought period it leads to **less precipitation**.
No relation was found between correct land surface initialisation and the precipitation forecast.