On the predictability of the extreme summer 2003 over Europe

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- the summer (JJA) 2003 was the hottest summer in historical records over Central and Southern Europe
- very dry conditions over land
- quasi-barotropic atmospheric structure with positive geopotential anomaly in middle troposphere and heat low



## **Sources of seasonal predictability**

## Atmospheric predictability arises through slow fluctuations in the evolution of atmospheric boundary conditions.

#### **IMPORTANT FACTORS:**

- El Niño variability
- other tropical ocean temperatures
- climate change
- local land surface conditions

- $\rightarrow$  biggest single signal
- important, but multifaceted
- trends in midlatitudes
- e.g. soil moisture in 2003

#### **OTHER FACTORS:**

 ocean temperatures in mid latitudes - controversial

- snow cover
- sea ice anomalies
- atmospheric dynamic memory
- stratospheric influences

- not well known
- not well known
- approx. 1-2 months
- downward propagation of anomalies

## **Seasonal forecasting at ECMWF**



#### **Re-forecasts for JJA T2m over Southern Europe (land)**



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#### **Re-forecasts for JJA T2m over Southern Europe (land)**

## 1960-2005 re-forecasts detrended (1978-2005)



# Seasonal re-forecast of JJA 2003 with the operational system S3



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## Seasonal re-forecast of JJA 2003 with the operational system S3

#### total soil moisture





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## CY33R1 – an improved cycle of the atmospheric model



#### CY33R1 – an improved cycle of the atmospheric model



******	forecast
	(9 ensemble members)
	observed anomaly
	analysis climate
	model climate

hindcast period: 1991-2005

#### CY33R1 – an improved cycle of the atmospheric model



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#### total soil moisture anomalies





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#### Sensitivity to land surface parametrisation



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#### Sensitivity to parametrisation of convection



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#### **Sensitivity to radiation parametrisation**



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#### **Summary**

- Predictive skill for 2m temperature in summer over Southern Europe is relatively high, partly due to the warming trend
- Seasonal re-forecasts of JJA 2003 with the still operational model version (S3) showed no sign of an unusual warm summer
- Combined improved physical parameterization schemes (HTESSEL, convection, radiation) from NWP have remarkable positive impact on re-forecast near the surface and in the free atmosphere
- H-TESSEL is able to persist initial soil moisture anomaly into summer
- Interplay of local (atmosphere-land) and remote processes (largescale dynamics, convection over Sahel?)

Weisheimer, A., F. Doblas-Reyes, T. Jung and T. Palmer (2011): On the predictability of the extreme summer 2003 over Europe. *Geophys. Res. Lett.*, **38**, L05704, doi:10.1029/2010GL046455

#### Seasonal re-forecast of JJA 2003 with the uncoupled operational system



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#### total soil moisture anomalies



# SW surface radiation

















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