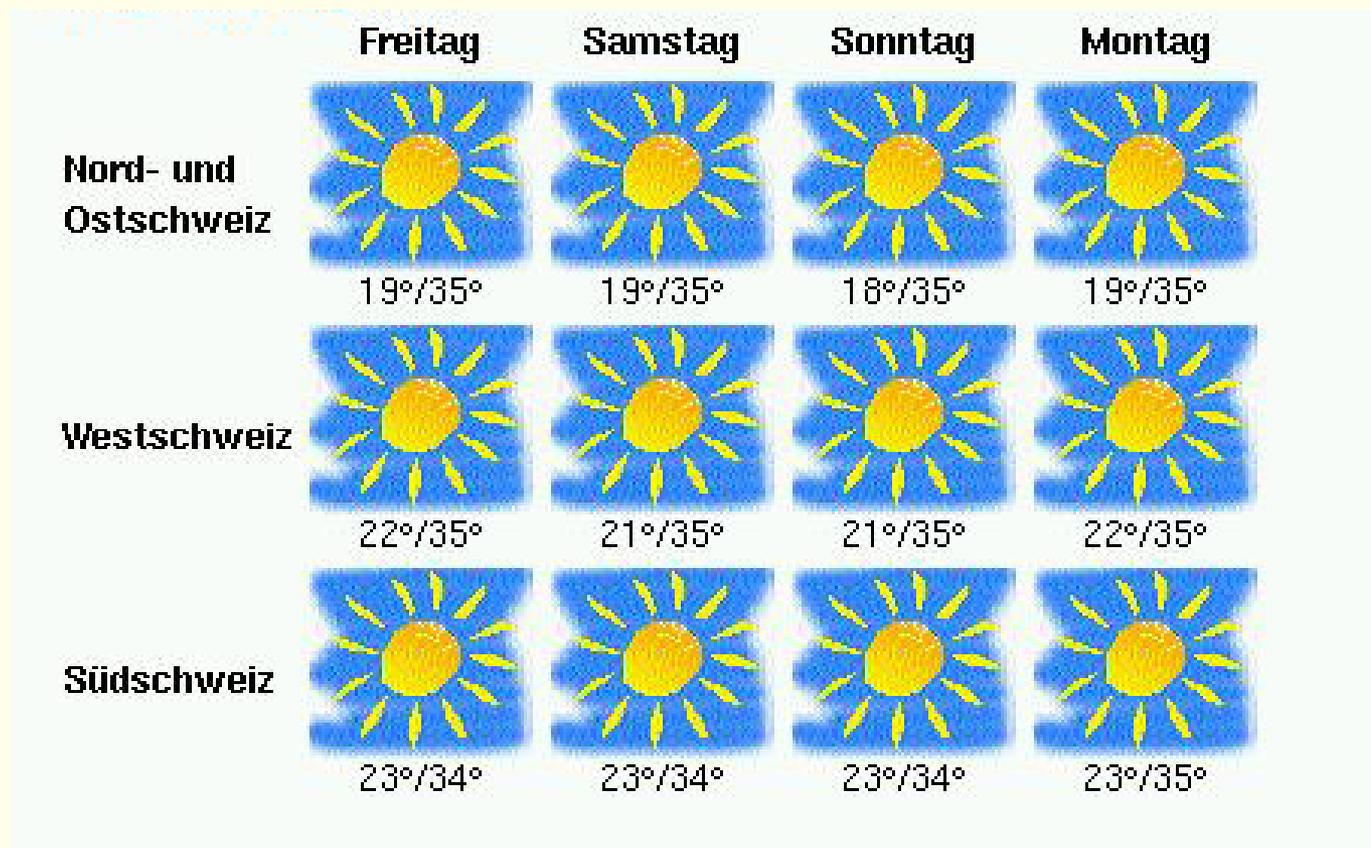


The contribution of the land surface to predictability in the ECMWF seasonal prediction system: The European summer 2003 case

Antje Weisheimer
ECMWF, seasonal forecasting section

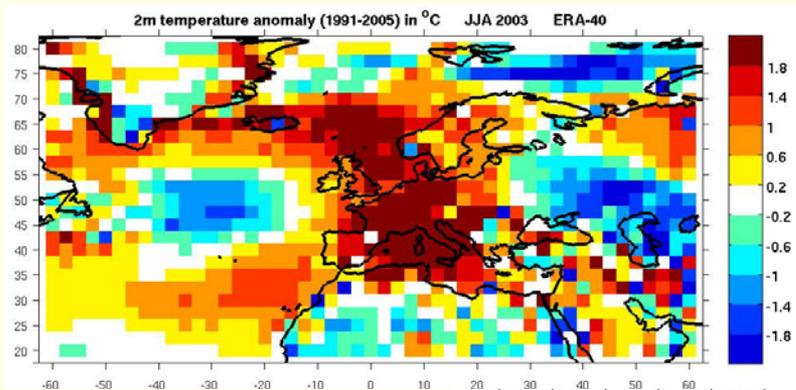
with thanks to
G. Balsamo, P. Bechtold, F. Doblas-Reyes, T. Jung,
M. Köhler, J.-J. Morcrette, T. Palmer

Medium-range weather forecast for a typical weekend in summer 2003

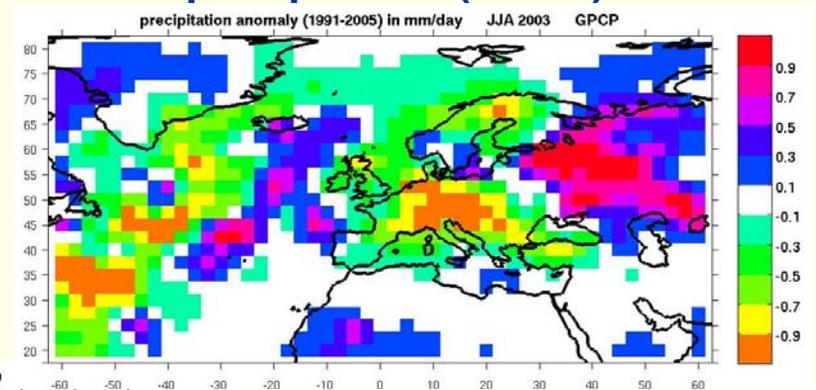


- the summer (JJA) 2003 was the hottest summer in historical records over Central and Southern Europe
- very dry conditions over land
- quasi-barotropic atmospheric structure with positive geopotential anomaly in middle troposphere (but heat low)

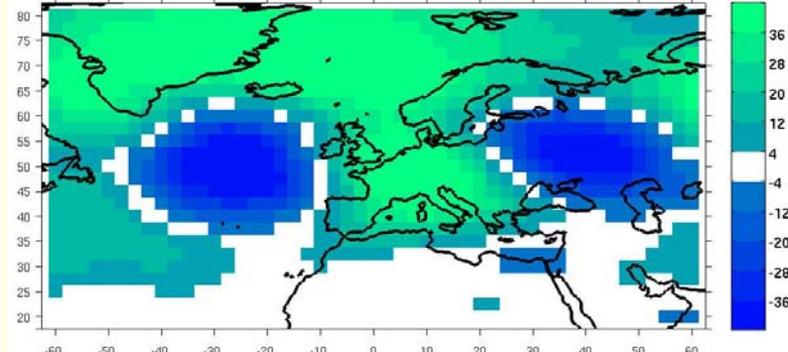
2m temp (ERA-40/oper.anal)



precipitation (GPCP)



Z500
(ERA-40/oper.anal)

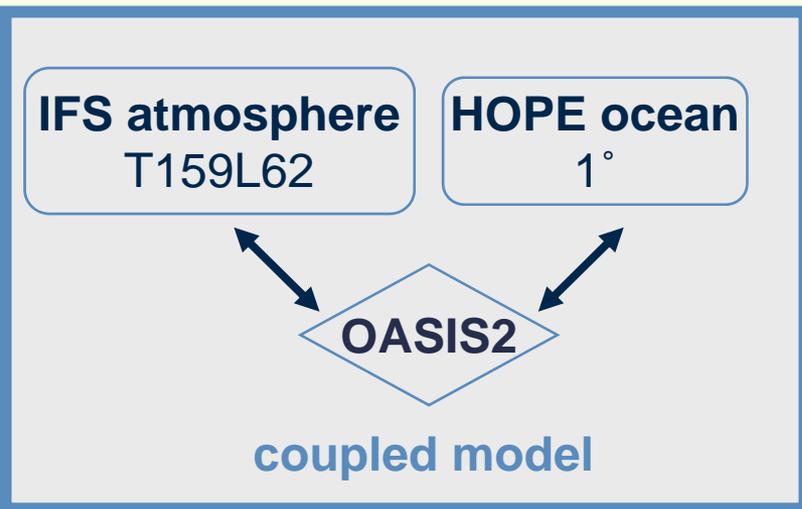


observed anomalies
wrt 1991-2005

Outline

- skill assessment in a set of seasonal hindcasts over Southern Europe
- JJA 2003 re-forecasts with our operational seasonal forecasting system CY31R1
- impact of HTESSSEL and other improvements in physical parameterization schemes in CY33R1

Seasonal forecasting at ECMWF:



Initialisation on 1st May:

- ERA-40/oper.analysis
- ocean re-analysis ORA-3

9 ensemble members by sampling:

- ocean analysis + SSTs
- singular vectors
- stochastic physics

Seasonal re-forecast

lead time:
2-4 months
(JJA)

sources of seasonal predictability

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

IMPORTANT FACTORS:

- El Niño variability → biggest single signal
- other tropical ocean temperatures - important, but multifaceted
- climate change - trends in mid latitudes
- local land surface conditions - e.g. soil moisture in 2003

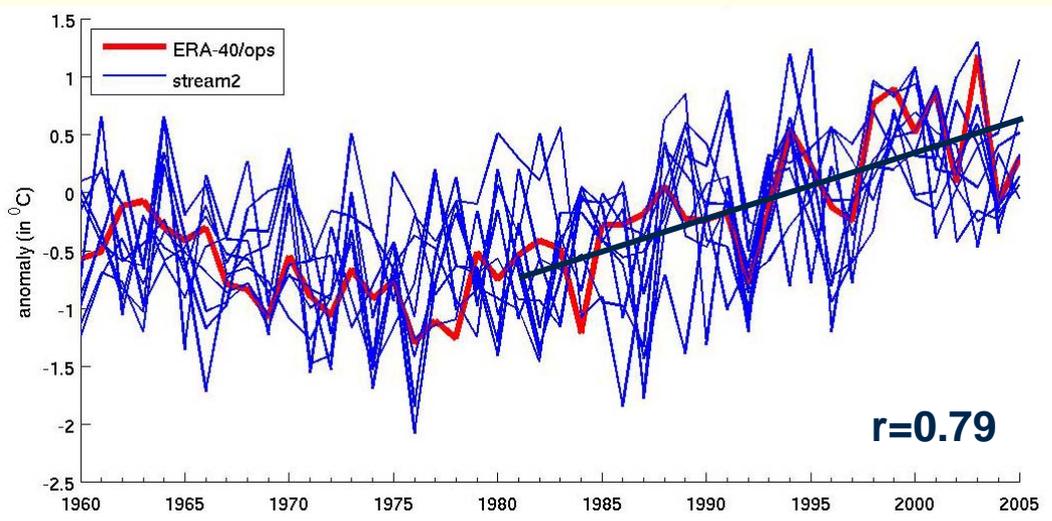
OTHER FACTORS:

- ocean temperatures in mid latitudes - controversial
- soil moisture/snow cover - not well known
- sea ice anomalies - not well known
- atmospheric dynamic memory - approx. 1-2 months
- stratospheric influences - downward propagation of anomalies

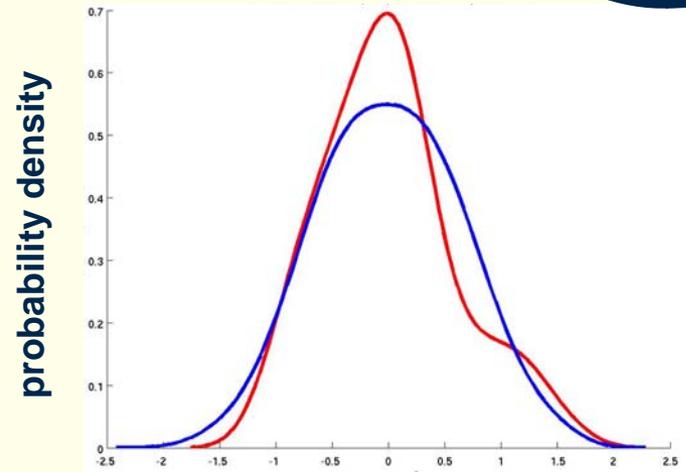
Operational/ENSEMBLES seasonal hindcasts for JJA T2m over Southern Europe (land)

CY31R1

1960-2005 hindcasts

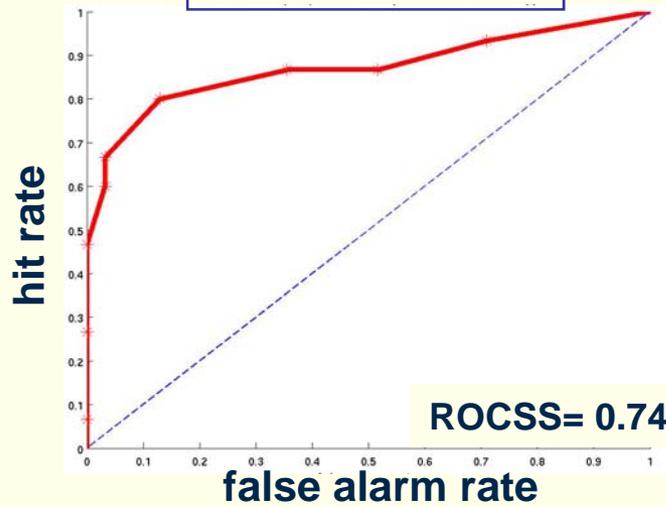


— analysis
— model



T2m anomaly

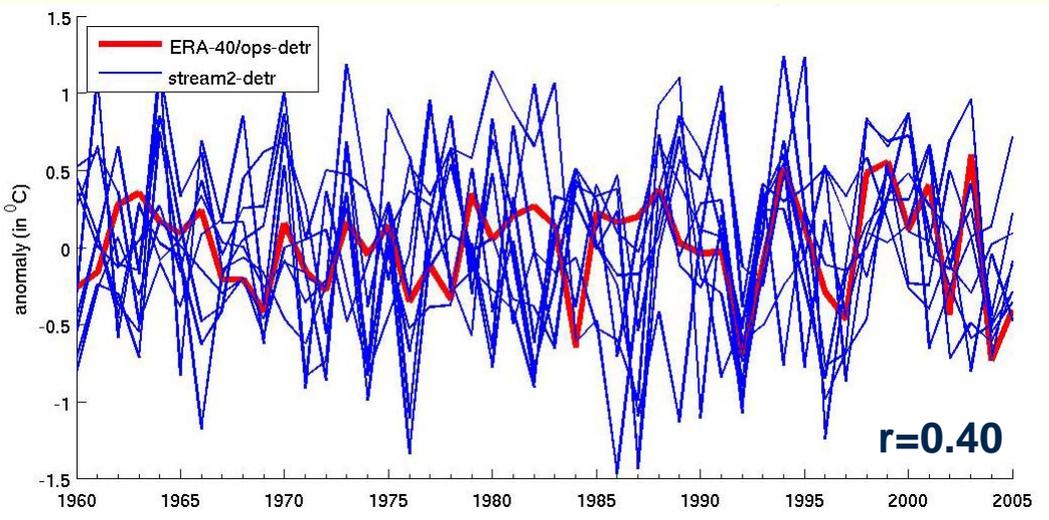
ROC diagrams
upper tercile



Operational/ENSEMBLES seasonal hindcasts for JJA T2m over Southern Europe (land)

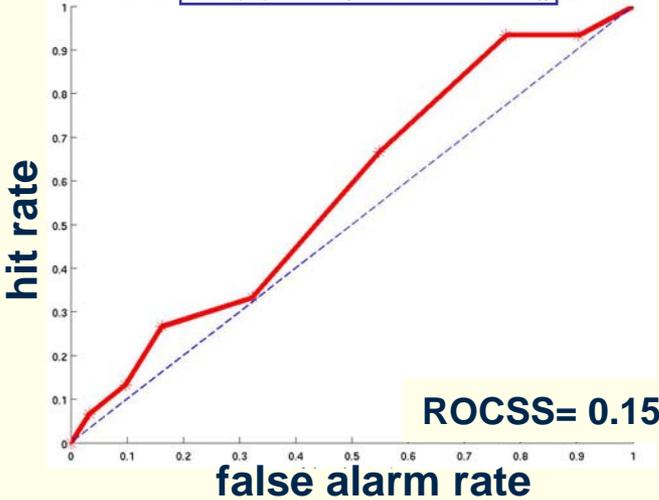
CY31R1

**1960-2005 hindcasts
detrended (1978-2005)**



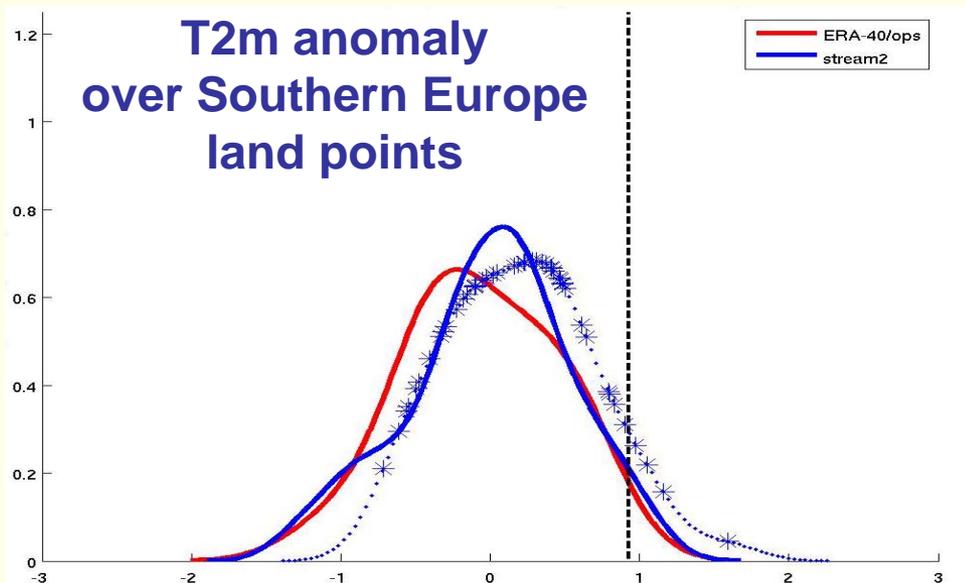
— analysis
— model

ROC diagrams
upper tercile



forecast for JJA 2003

CY31R1



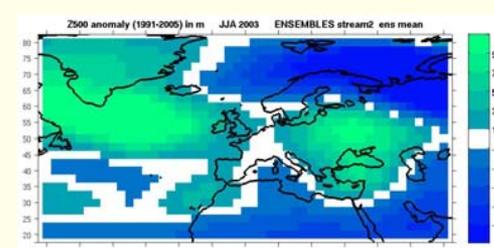
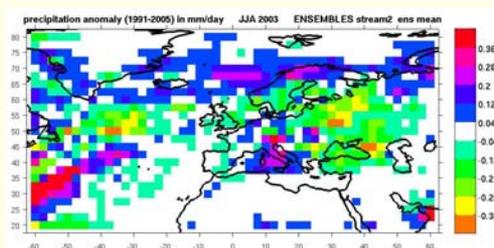
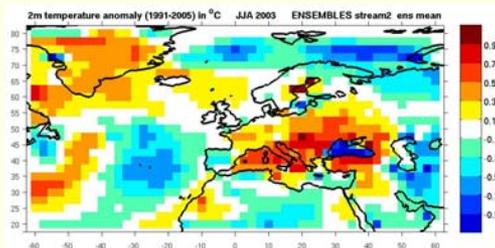
***** forecast
 (50 ensemble members)
 - - - - observed anomaly
 ——— analysis climate
 ——— model climate
 hindcast period: 1991-2005

2m Temp

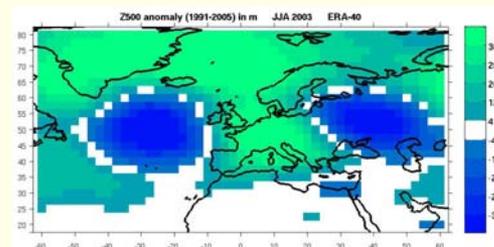
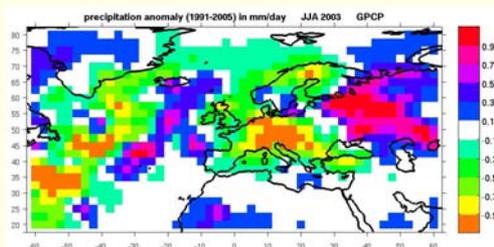
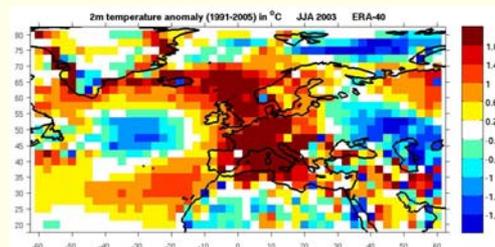
precipitation

Z500

model



obs

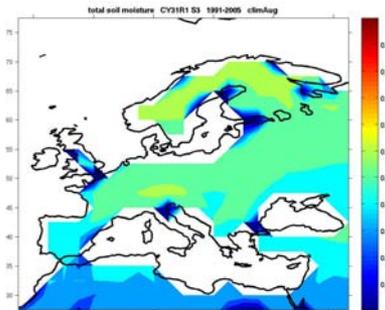
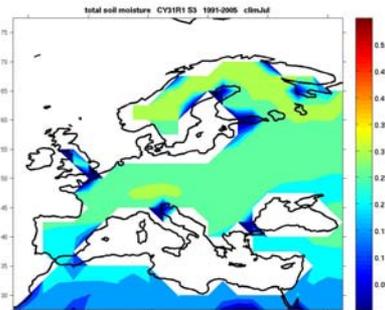
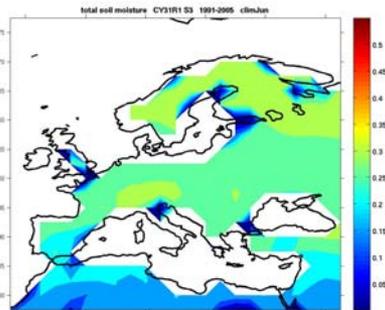
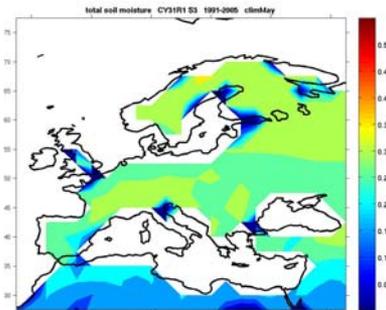


May climate

June climate

July climate

August climate

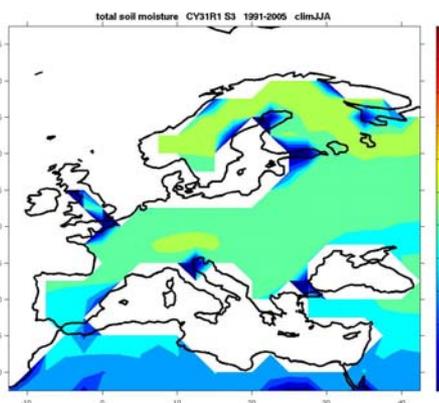


CY31R1 S3

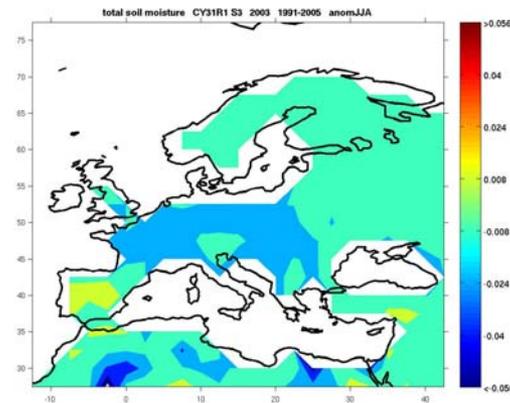
Total soil moisture

- climatology 1991-2005
- anomalies 2003

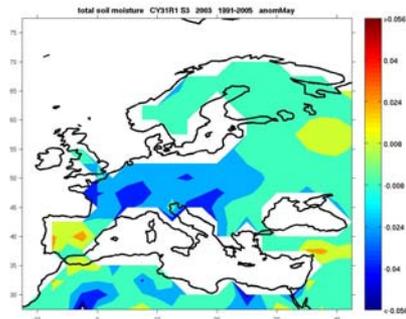
JJA climatology



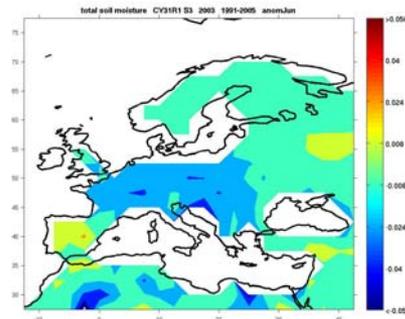
anomaly JJA 2003



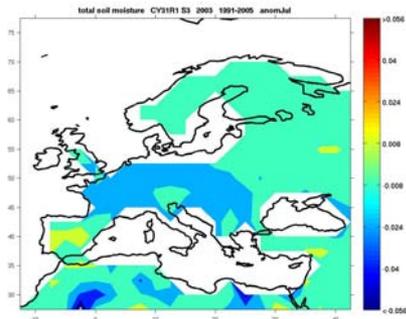
anomaly May 2003



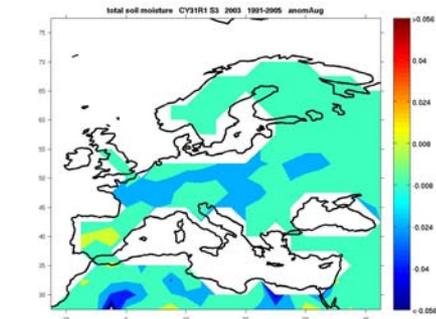
anomaly June 2003



anomaly July 2003



anomaly August 2003



CY33R1 - an improved cycle of the atmospheric model

land surface

new soil hydrology
H-TESSSEL

above PBL

vertical diffusion

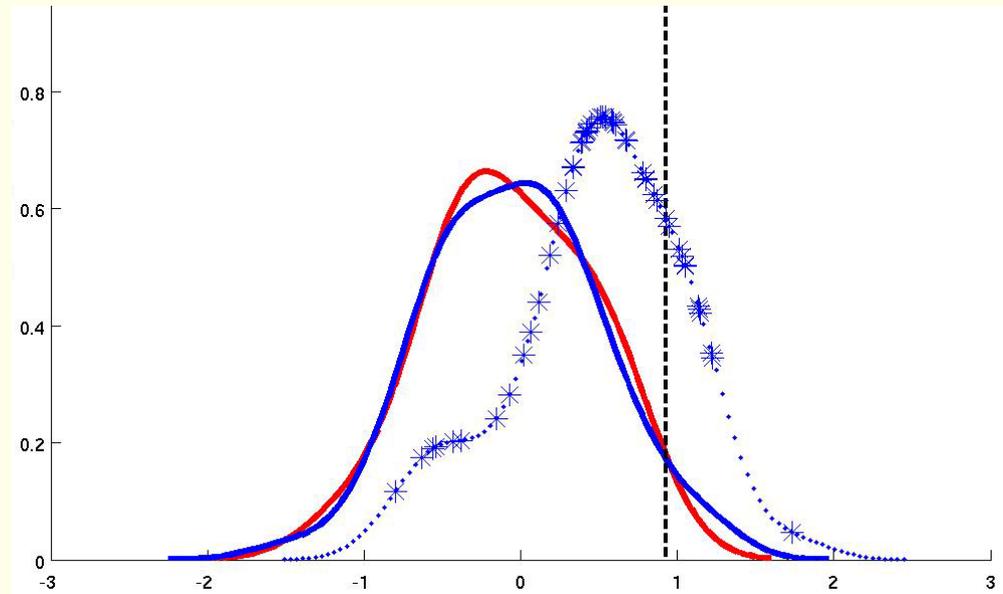
radiation

new SW scheme,
McICA cloud-radiation
interaction,
MODIS albedo

convective entrainment
→ more active scheme

convection

2m temperature
over Southern Europe (land)



***** forecast
(50 ensemble members)
- - - - observed anomaly
— analysis climate
— model climate

hindcast period: 1991-2005

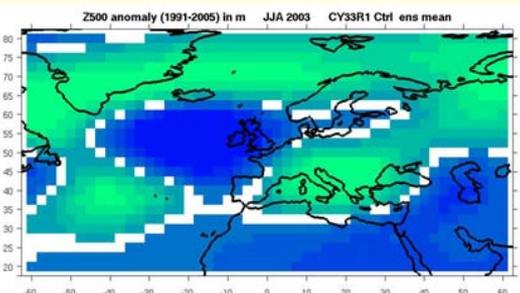
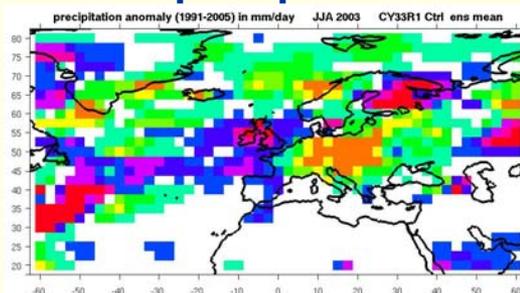
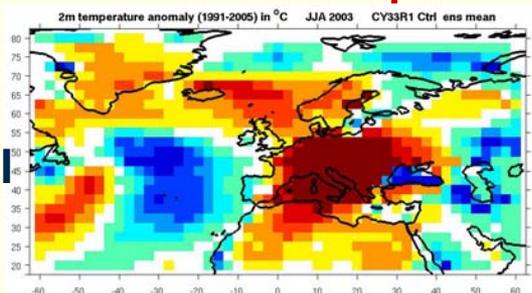
CY33R1 - an improved cycle of the atmospheric model

2m temp

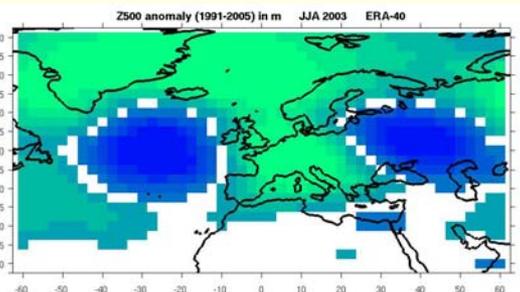
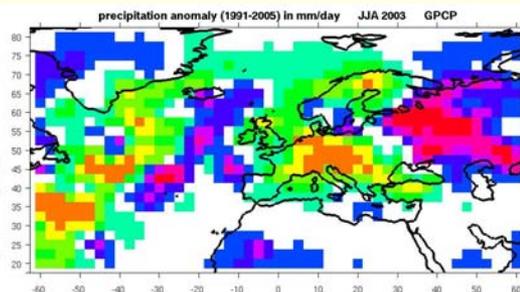
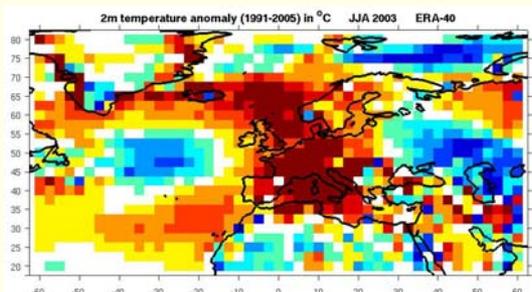
precipitation

Z500

model



obs



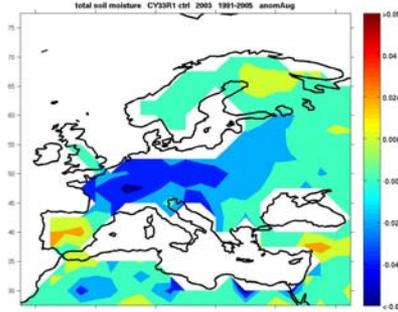
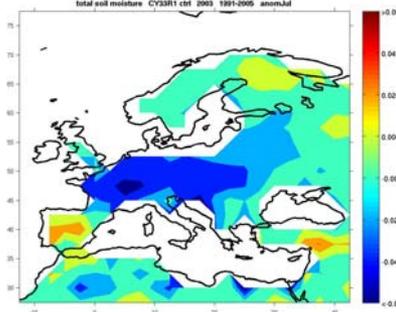
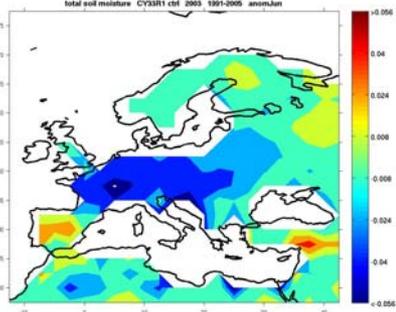
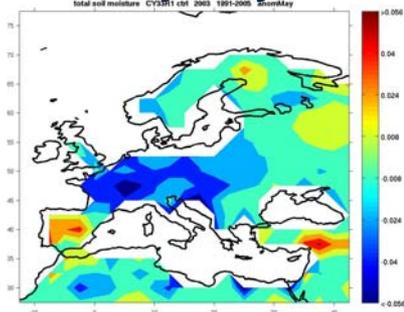
soil moisture anomalies

anomaly May 2003

anomaly June 2003

anomaly July 2003

anomaly August 2003



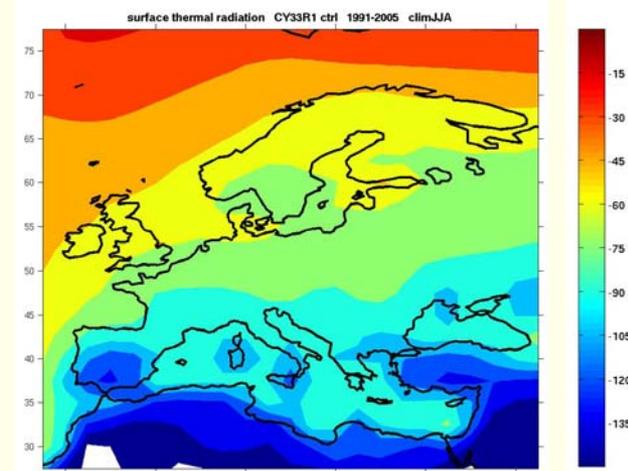
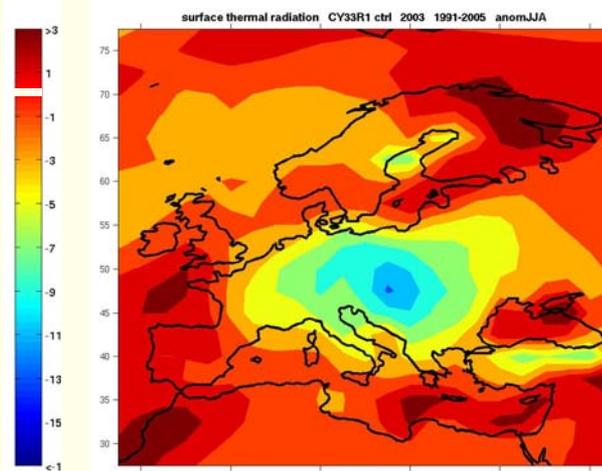
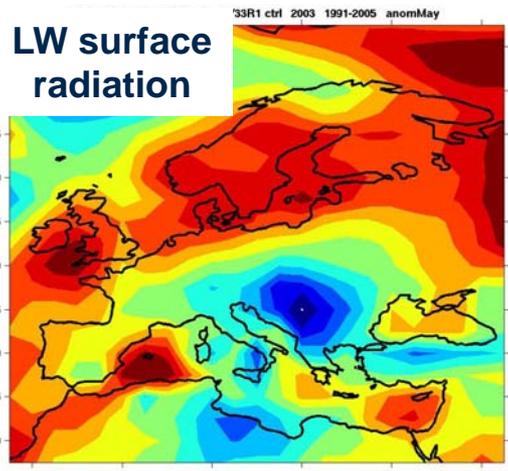
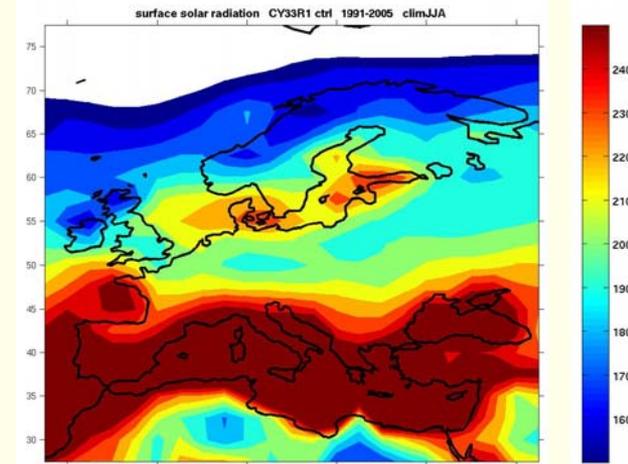
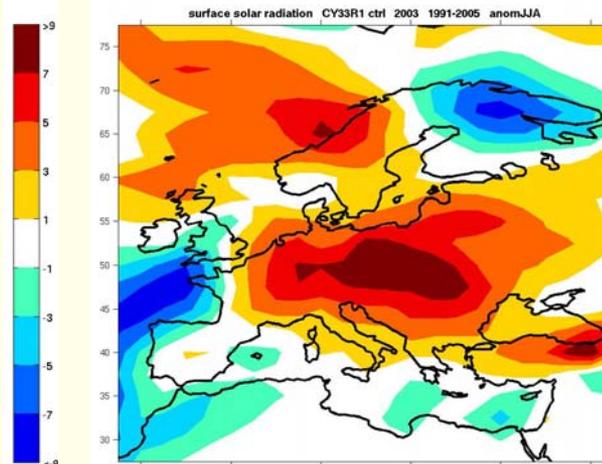
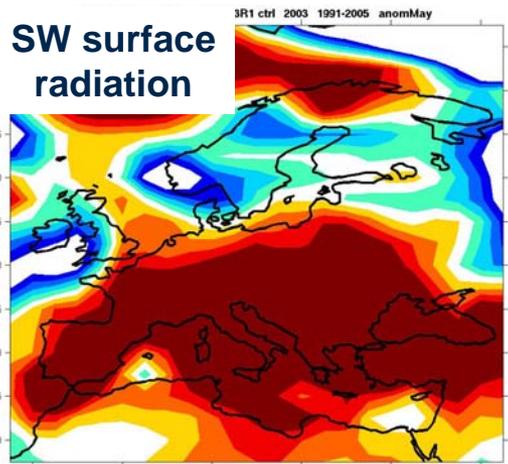
CY33R1 - an improved cycle of the atmospheric model

surface radiation

anomalies May 2003

anomalies JJA 2003

JJA climatologies



CY33R1 - an improved cycle of the atmospheric model

land surface

new soil hydrology
H-TESEL

above PBL

vertical diffusion

radiation

new SW scheme,
McICA cloud-radiation
interaction,
MODIS albedo

sensitivity experiments
by switching back
individual physics schemes
to their CY31R1 versions

convective entrainment
→ more active scheme

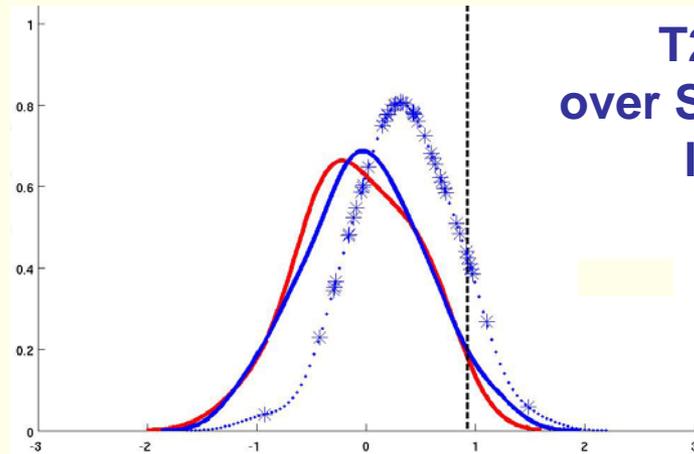
convection

Sensitivity study: Impact of physical parameterization schemes

land surface

CY33R1 with
HTESSEL → TESSEL

T2m anomaly
over Southern Europe
land points

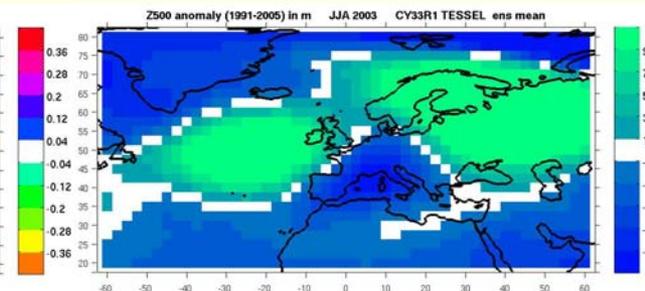
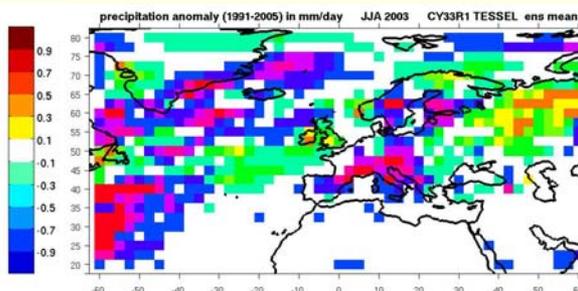
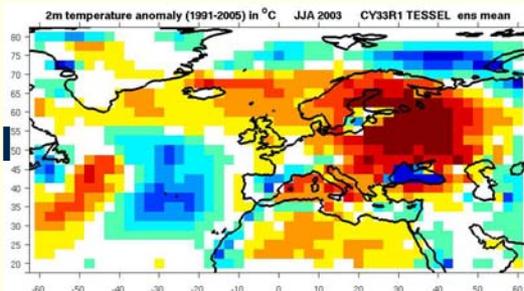


2m temp

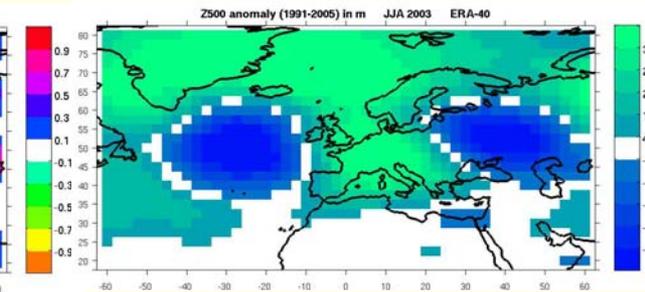
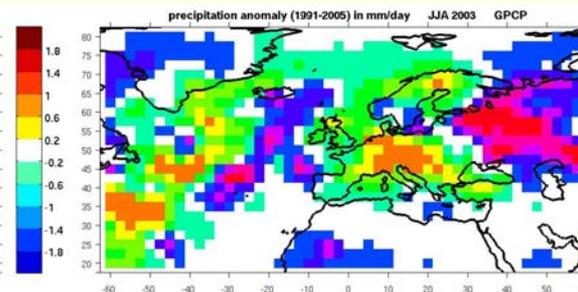
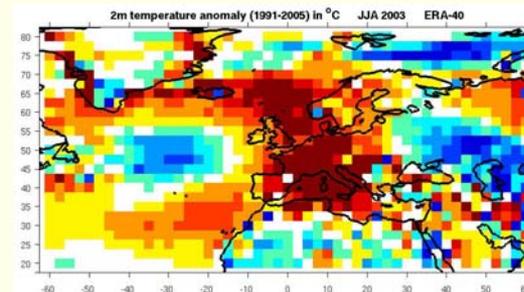
precipitation

Z500

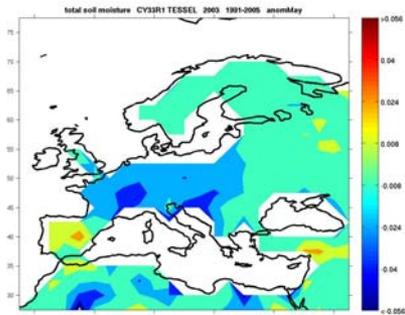
model



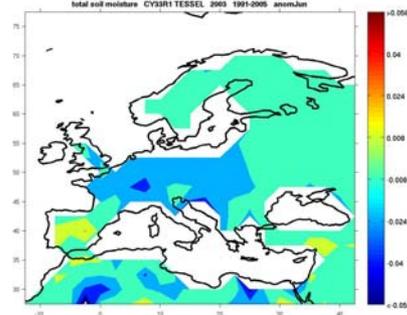
obs



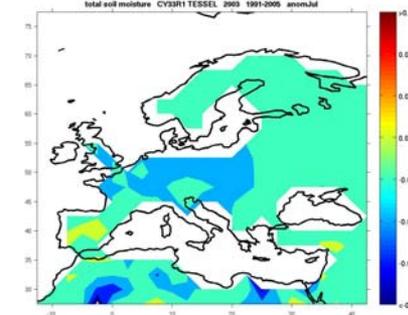
anomaly May 2003



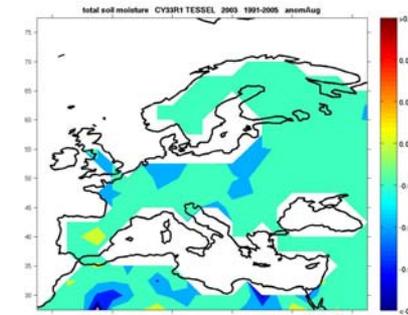
anomaly June 2003



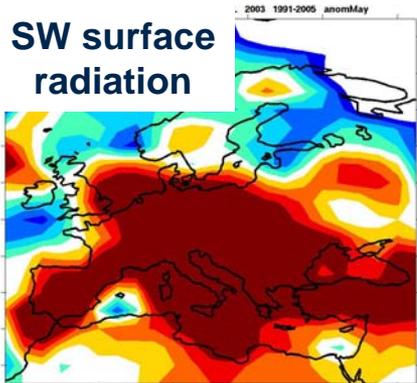
anomaly July 2003



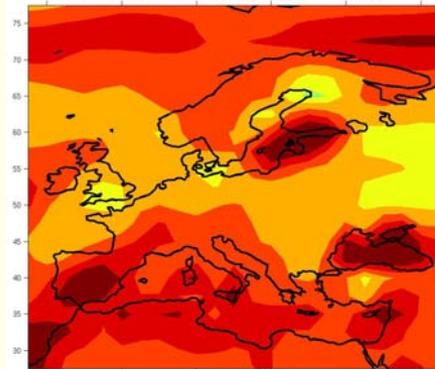
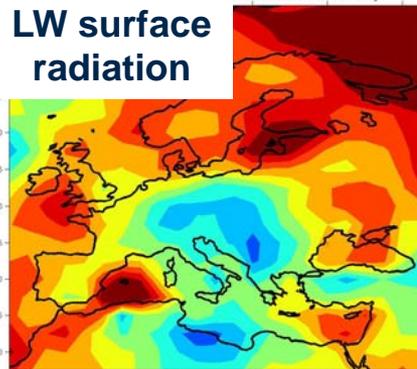
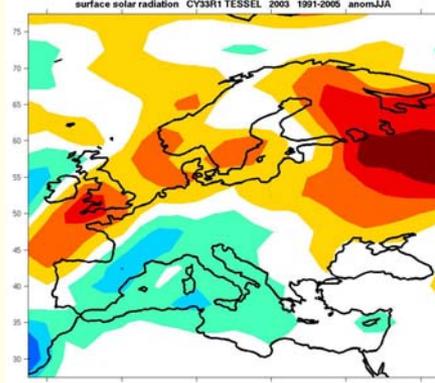
anomaly August 2003



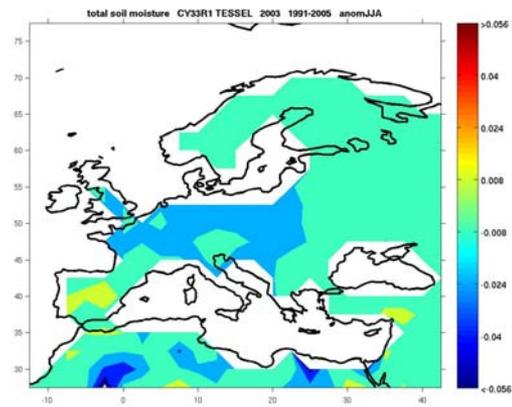
anomalies May 2003



anomalies JJA 2003



anomaly JJA 2003



CY33R1 TESSEL

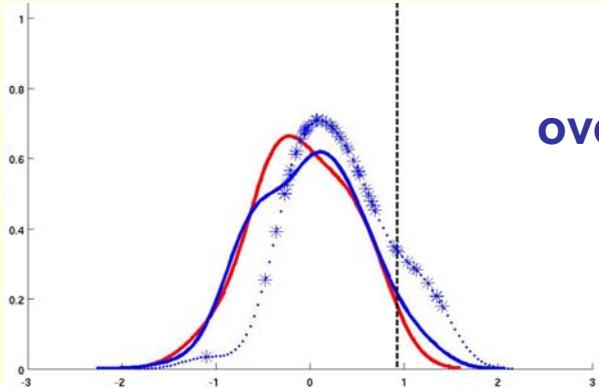
Total soil moisture & surface radiation

- climatology 1991-2005
- anomalies 2003

Impact of physical parameterization schemes

convection

CY33R1 with CY31R1 convection

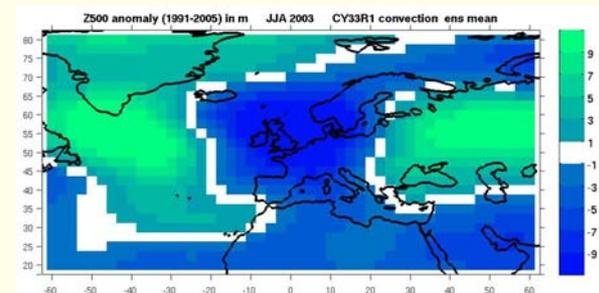
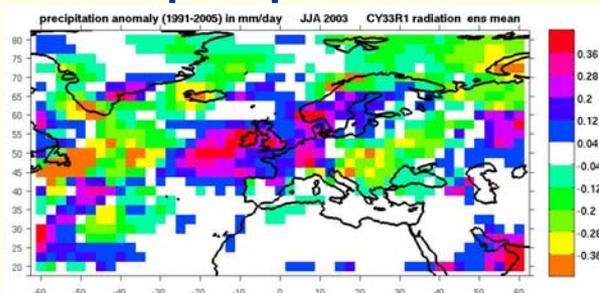
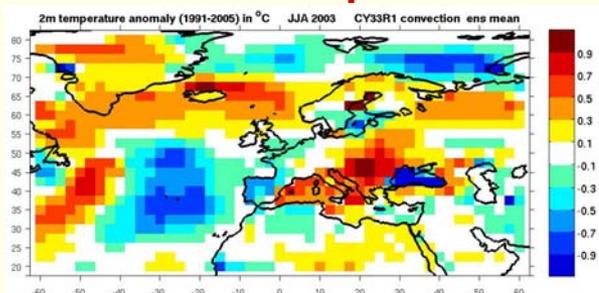


T2m anomaly over Southern Europe land points

2m temp

precipitation

Z500



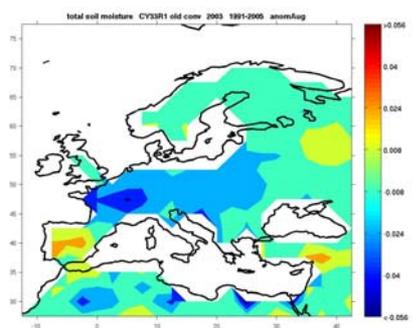
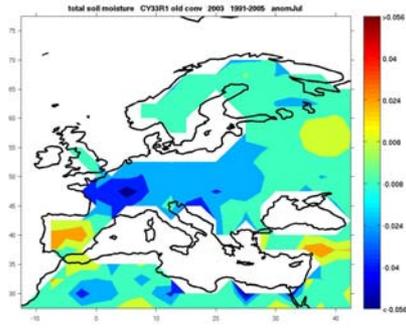
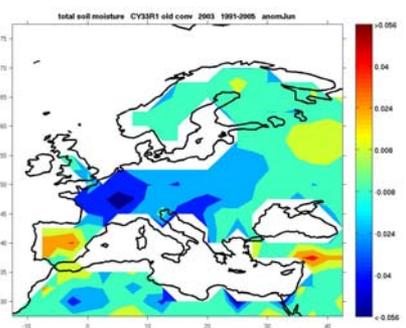
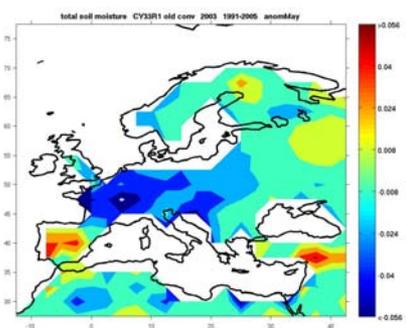
negative precipitation – soil moisture feedback?

anomaly May 2003

anomaly June 2003

anomaly July 2003

anomaly August 2003

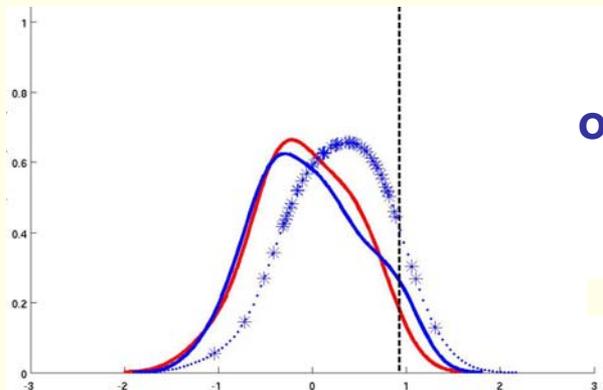


Impact of physical parameterization schemes

radiation

CY33R1 with
CY31R1 radiation

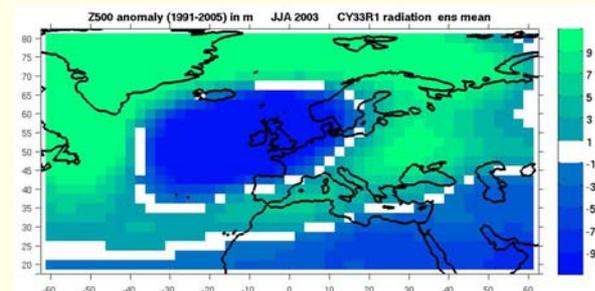
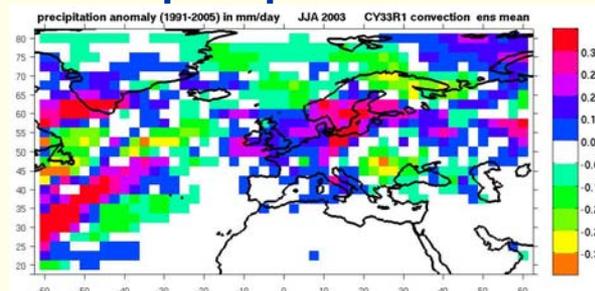
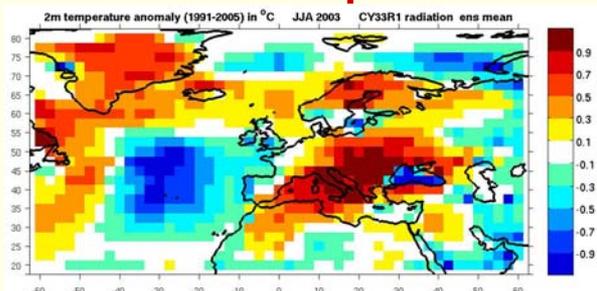
T2m anomaly
over Southern Europe
land points



2m temp

precipitation

Z500

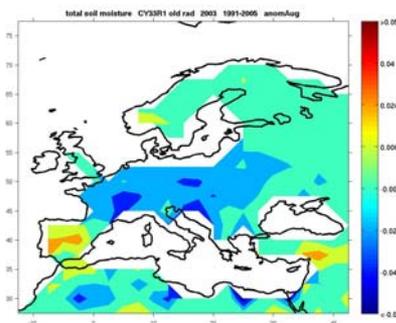
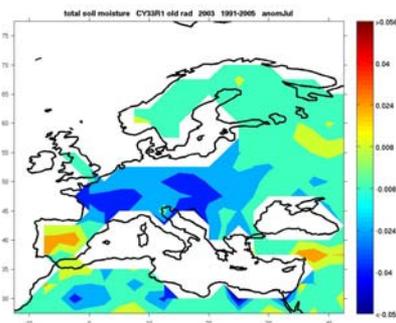
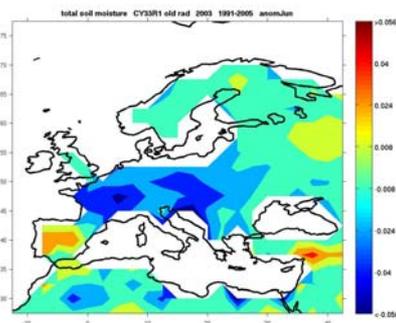
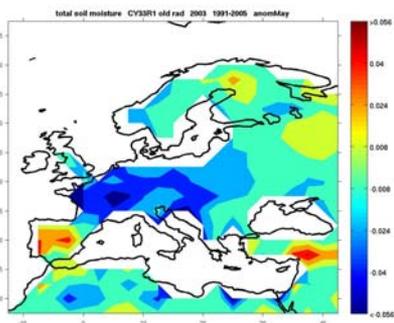


anomaly May 2003

anomaly June 2003

anomaly July 2003

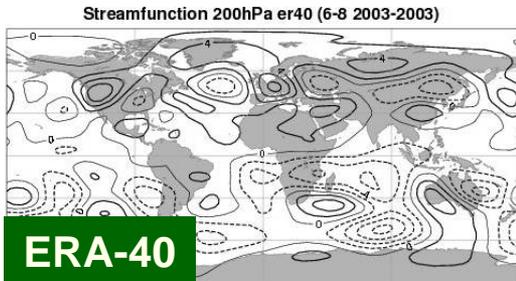
anomaly August 2003



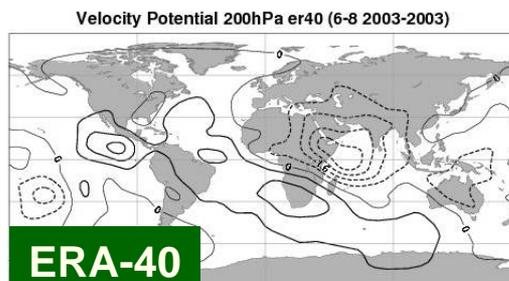
Remote impacts?

JJA 2003 anomalies

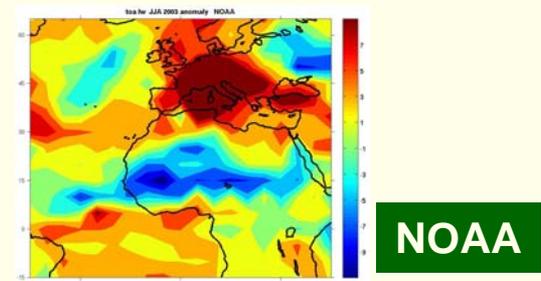
streamfunction_{200hPa}



vel. potential_{200hPa}



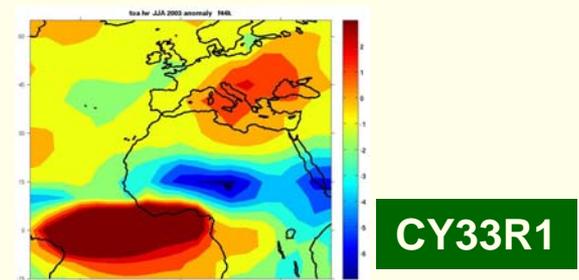
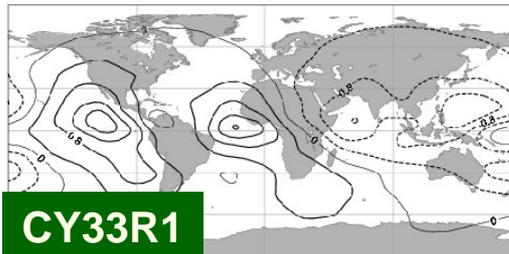
OLR



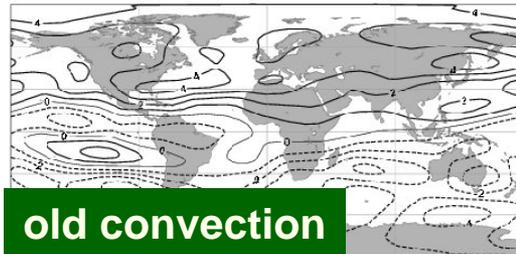
Streamfunction 200hPa f44k (6-8 2003-2003)



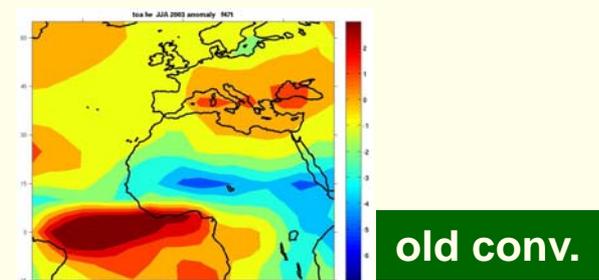
Velocity Potential 200hPa f44k (6-8 2003-2003)



Streamfunction 200hPa f47t (6-8 2003-2003)



Velocity Potential 200hPa f47t (6-8 2003-2003)



Summary

- **predictive skill for 2m temperature in summer over Southern Europe is relatively high**
- **a large part of the seasonal skill is due to the correct simulation of the warming trend over the last 30 years**
- **operational seasonal forecasts of JJA 2003 showed no sign of an unusual warm summer**
- **improved physical parameterization schemes (HTESSEL, convection, radiation) from NWP have remarkable positive impact on forecast near the surface and in the atmosphere**
- **land surface model persists soil moisture anomaly into summer**
- **interplay of local (atmosphere-land) and remote processes (large-scale dynamics, convection over Sahel?)**

But ...

Recently, a problem in the short-wave radiation calculation of the new (CY33R1) radiation scheme was discovered that can have an effect on all the results just presented.

Runs with a corrected version of the radiation code are under way.