



Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Verkeer en Waterstaat

Seamless prediction illustrated with EC-Earth

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G.J. van Oldenborgh (KNMI), T.
Semmler (MetEireann), B.
Wouters (KNMI), K. Wyser
(SMHI), F. Doblas-Reyes (IC3)
and EC-Earth consortium



EC-Earth consortium



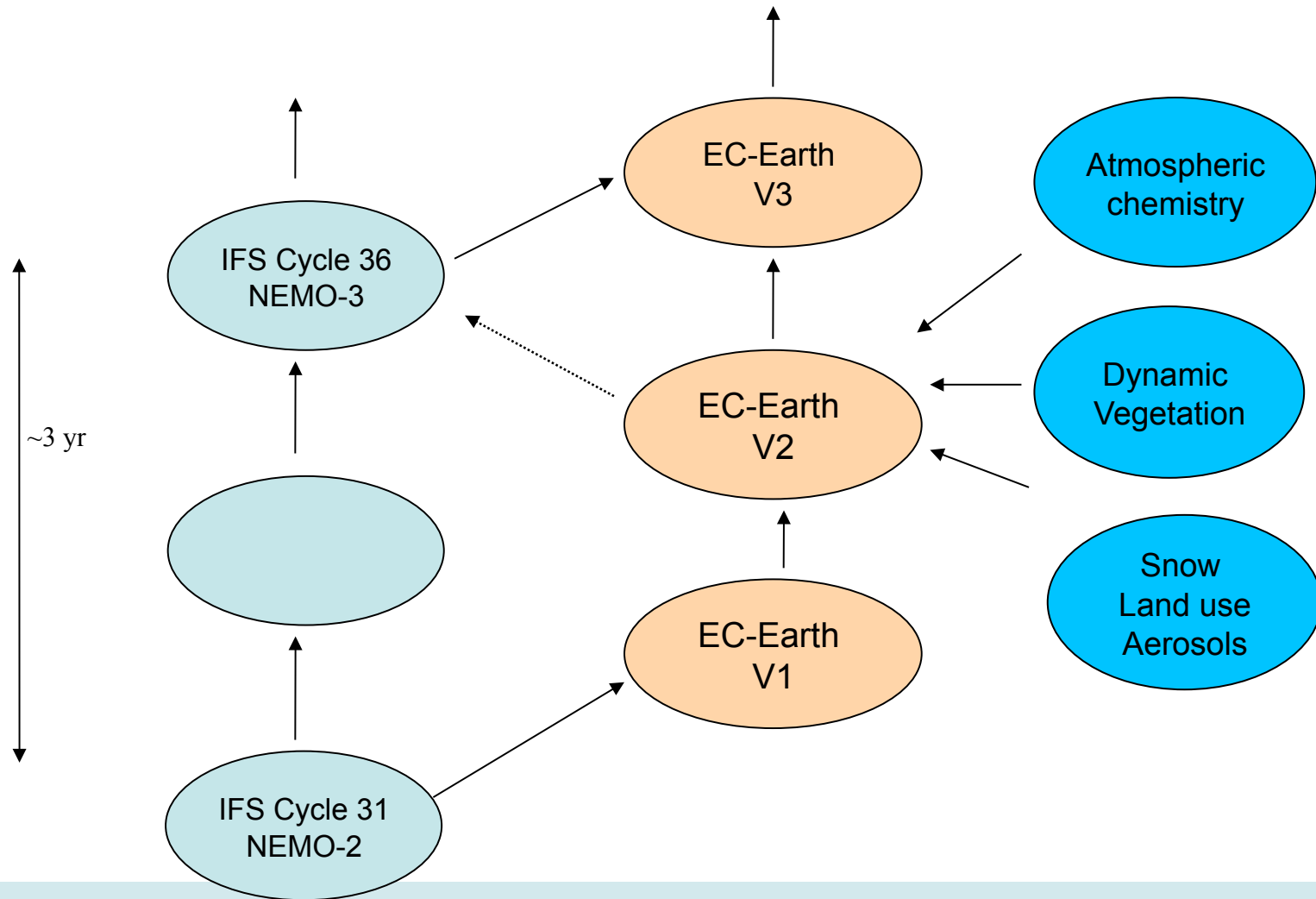
Steering group: W. Hazeleger (KNMI, chair), C. Jones (SMHI), J. Hesselbjerg, Christensen (DMI), R. McGrath (Met Eireann), P. Viterbo (IM), E. C. Rodriguez (AEMET) observer E. Kallen (ECMWF), NEMO-representative



ECMWF

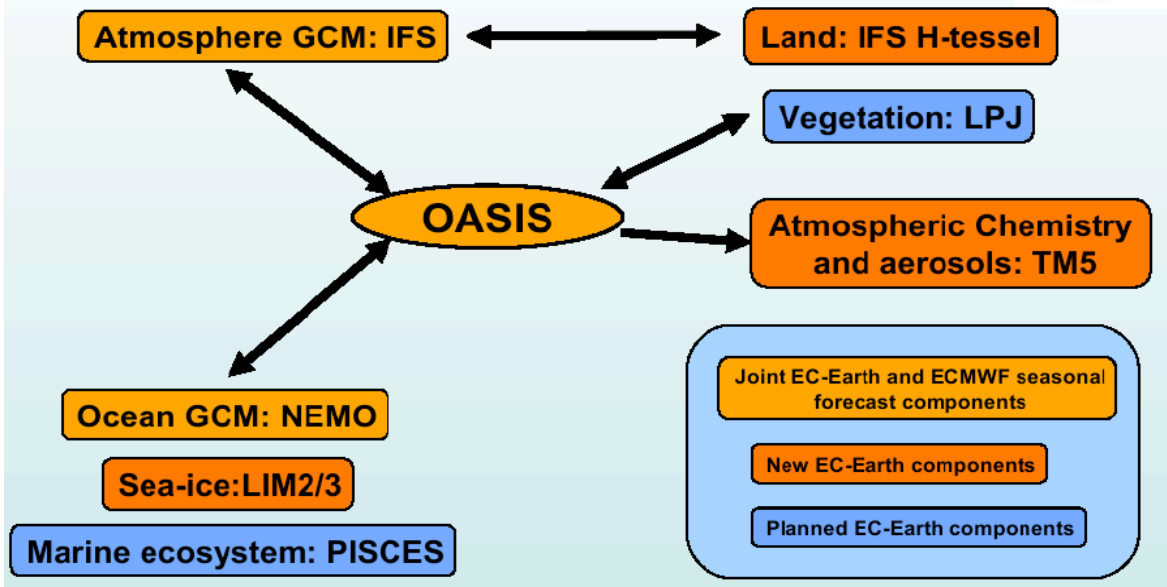
EC-Earth

Univ/institutes





EC-EARTH components

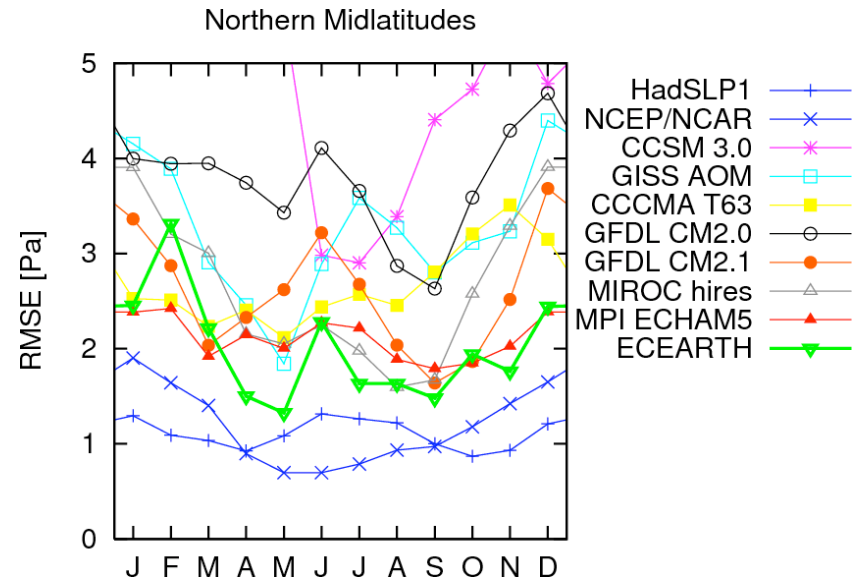
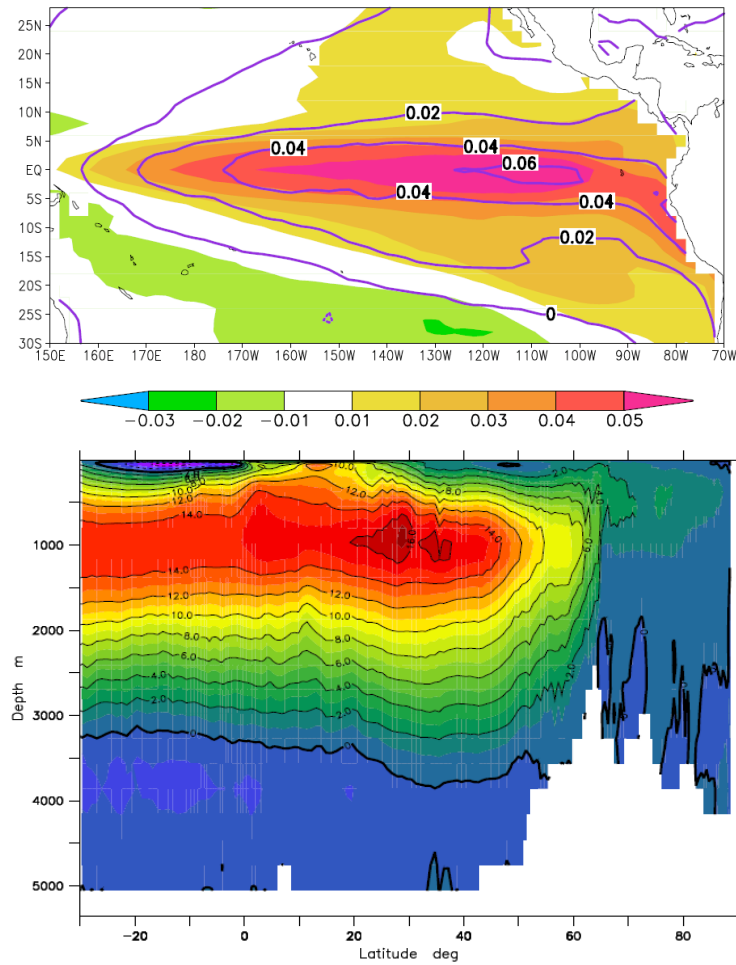


ECMWFs IFS c31r1+
atmosphere: T159 L62
(runs up to T799)

NEMO V2 Ocean:
1 degree L42, with
equatorial refinement
and tripolar grid
(runs up to 0.25 deg)



EC-Earth at a glance...



Hazeleger et al. Clim Dyn 2011 (minor rev)



Seasonal predictions

7 month, 5 member ensemble, start dates Feb, May, Aug, Nov.,
1981-2005

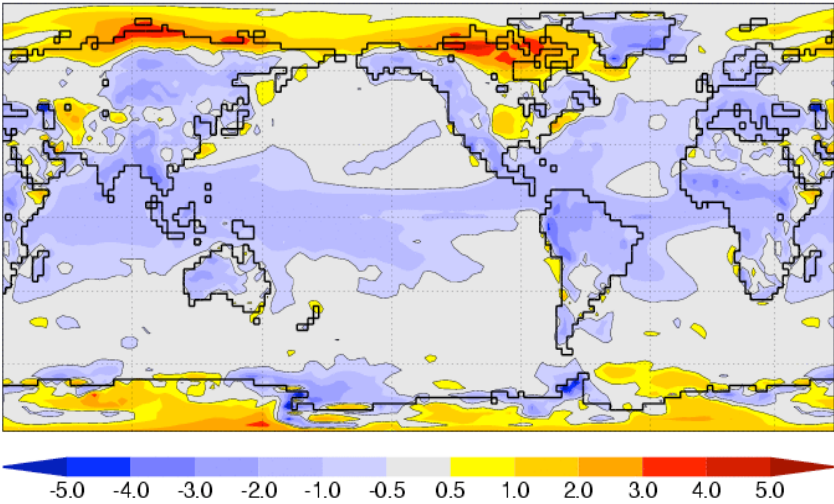
Initialization

1. ERA40/ERAInt atmosphere and land, NEMOVAR-ORAS4 ocean (3-D Var, XBTs, hydrography, SST, altimetry; 5 members), DFS4.3-NEMO/LIM sea ice.
2. Perturbations atmosphere: singular vectors
3. Perturbations ocean: 5 members of NEMOVAR (ORA-S4; representing observational error)

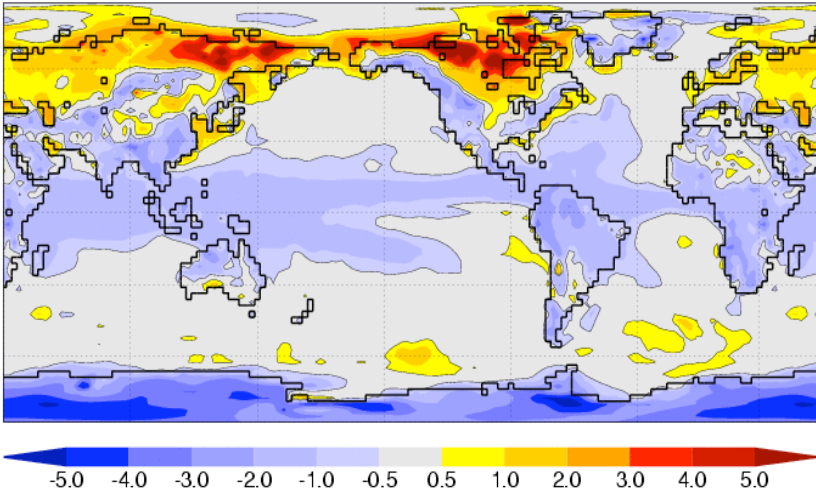


Seasonal predictions: bias after 1 month

May



Nov



Bias of first month near-surface air temperature re-forecasts wrt ERA40/Int over 1976-2005 → Informs model development.

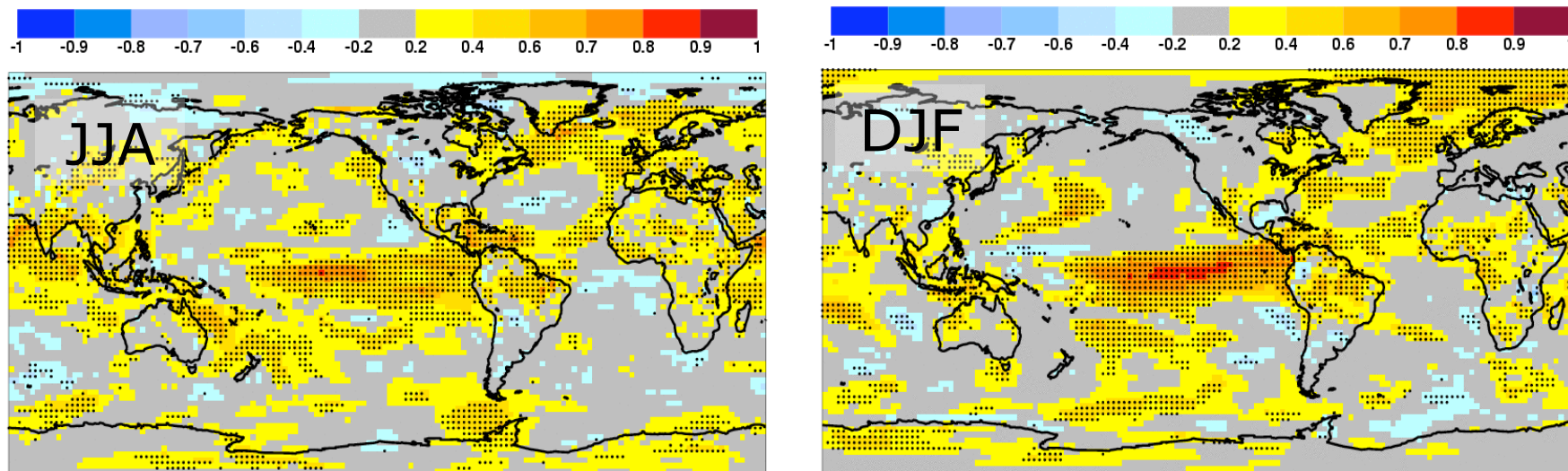


Annual predictions

13 month, 5 member ensemble, start dates May, Nov., 1976-2005



Annual predictions: correlation skill (7 month lead time)



Ensemble-mean correlation of EC-Earth near-surface air temperature re-forecasts wrt ERA40/Int over 1976-2005. Dots for values statistically significant with 95% conf.

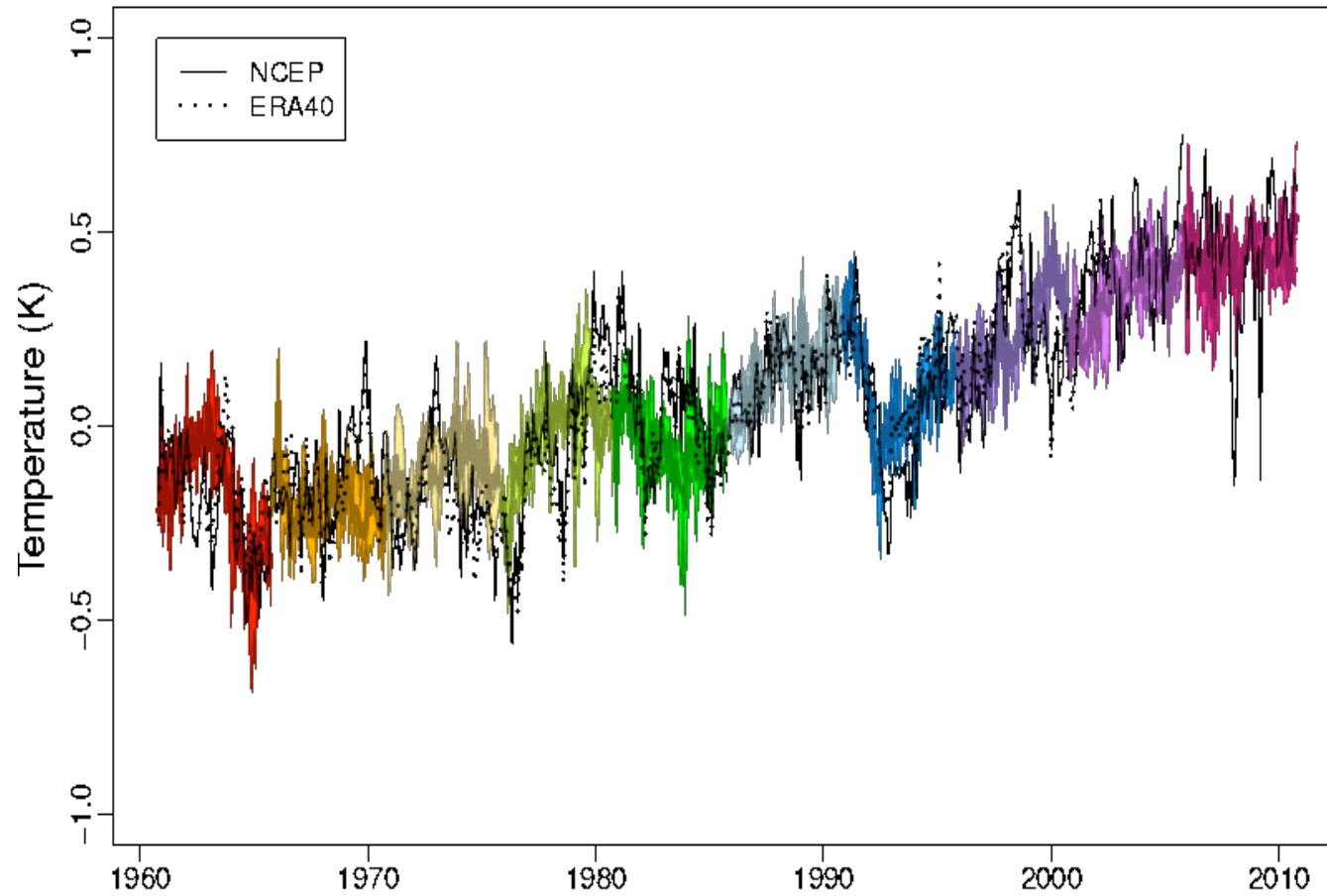


Decadal predictions

10 years, 10 member ensemble, start date Nov, 1960, 1965, 1970,
...,2005



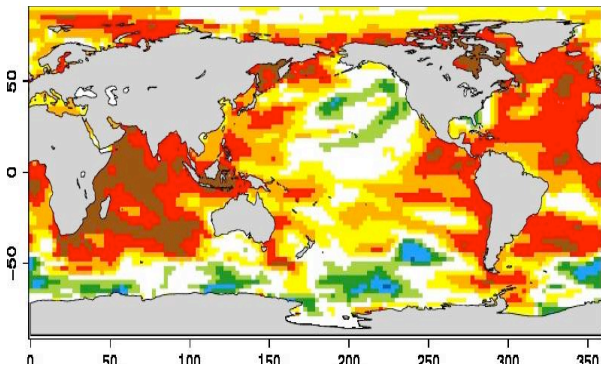
EC-Earth hindcasts, drift corrected



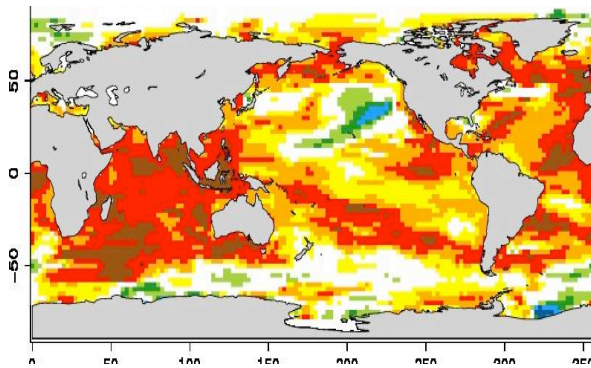


Decadal prediction skill: anomaly correlation SST (2-5 yr)

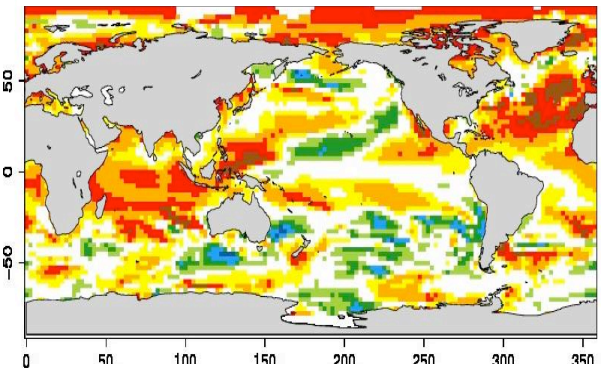
CERFACS



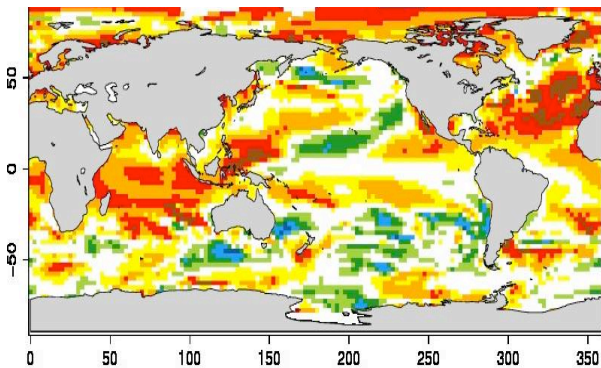
UKMO



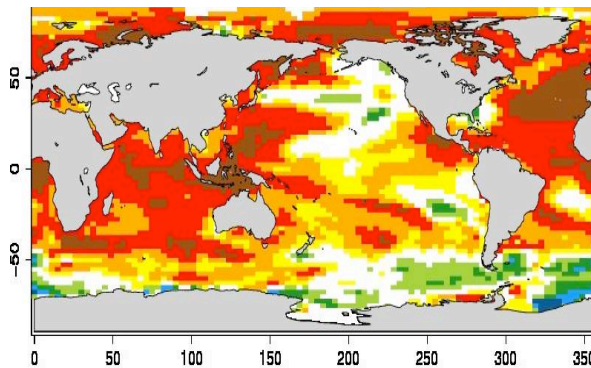
IFM-GEOMAR



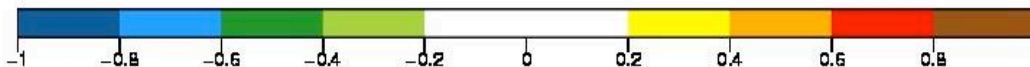
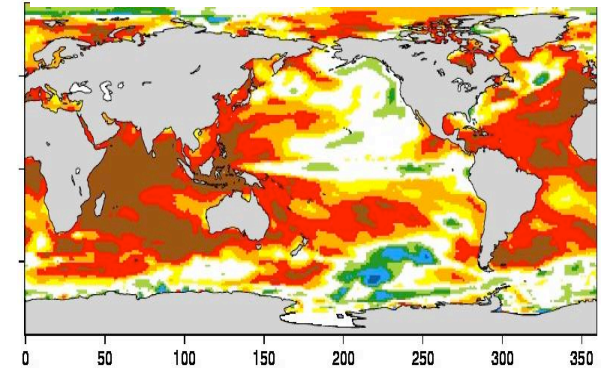
ECMWF



DePreSys



EC-Earth

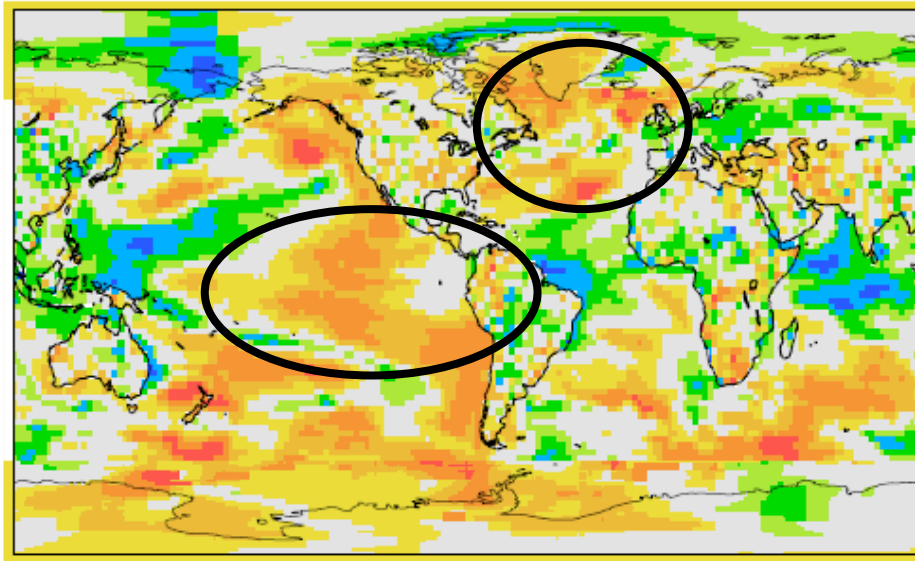


SST ensemble-mean correlation (lead: 2-5 year average; 1960-2005) wrt ERSST.

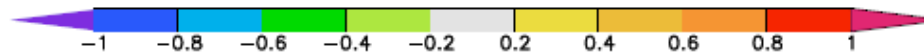
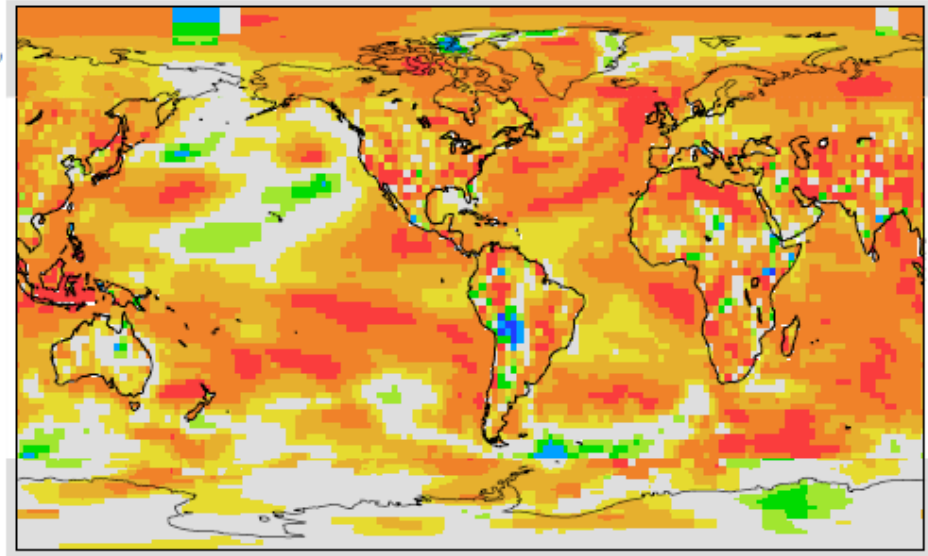


Skill dominated by trend!

Skill without trends: years 2–5



Total skill: years 2–5



Trend, defined by regression on global mean CO₂ concentrations removed (nb this is not the CMIP5 ensemble, this ensemble did not include volcanic forcing)



Historical and climate scenario simulations

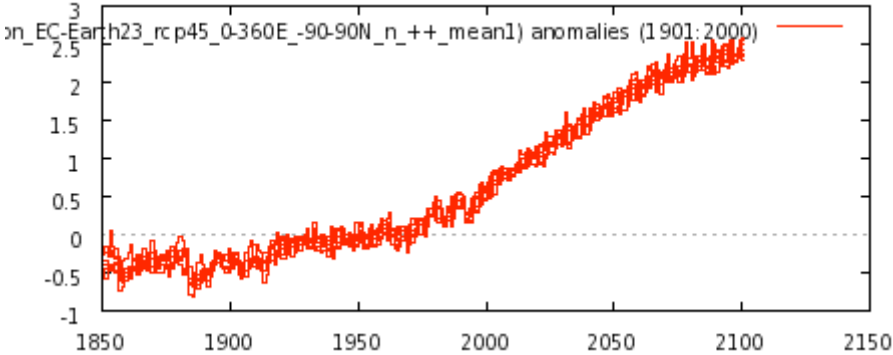
- 1850-2005: 16 members with prescribed GHG and aerosol concentrations, volcanic aerosols and land use.
Initialized from a range of start dates from a preindustrial spinup
- 2005-2100: RCP 2.6, 4.5, 8.5.
Initialized from end historical simulations.

	Ensemble #	Completed	In progress	Not started or unknown
Pre-industrial	1	1	-	-
Historical	16	15	1	0
RCP4.5	14	10	1	3
RCP8.5	13	8	2	3
AMIP	#	#	#	#
Decadal (full field)	10	10	-	-
Decadal (anomaly)	8-10	2	2	4-6

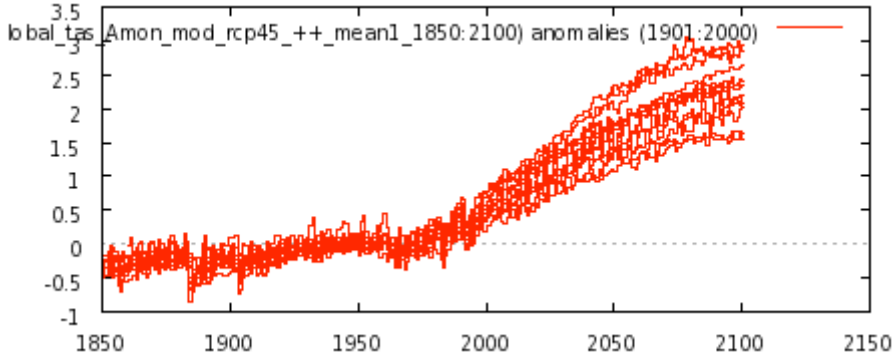
Nb different HPC platforms by 10 partners



Historical and RCP 4.5 global mean 2-meter temperature



EC-Earth V2.3 (7 members, another 9 to process)

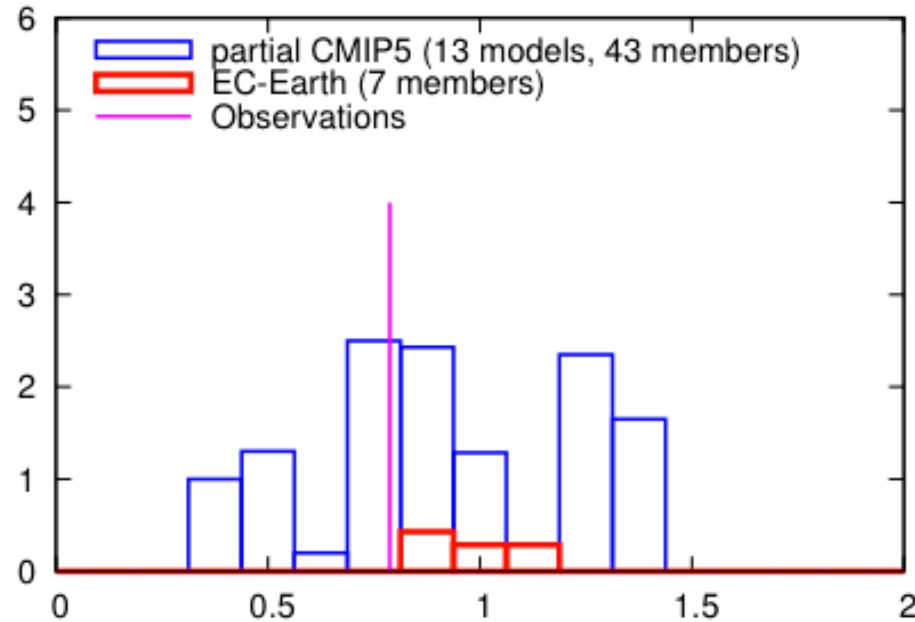


12 CMIP5 models, including EC-Earth



Trends in EC-Earth and CMIP5 vs observations

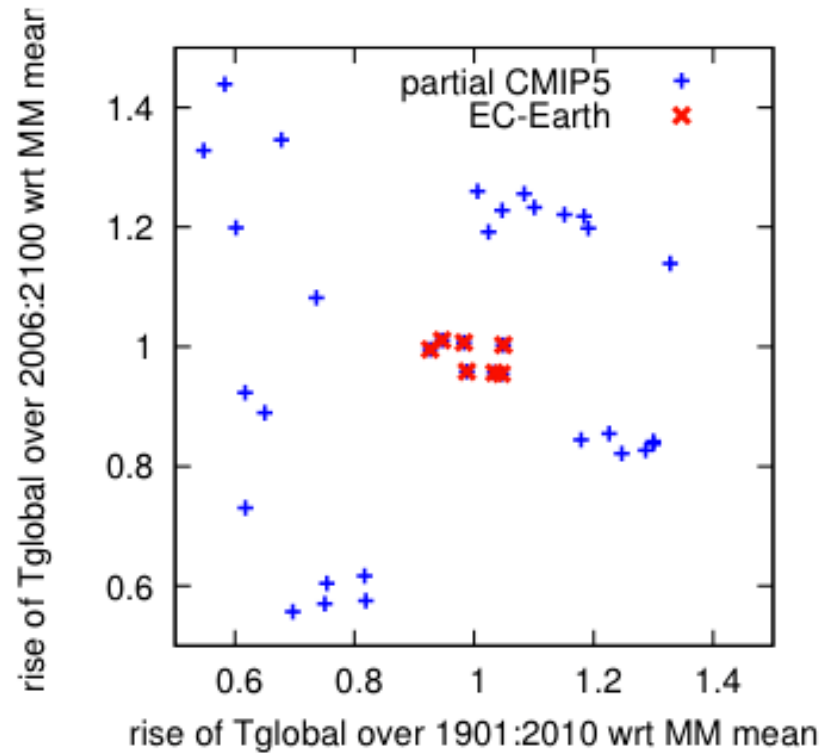
Annual mean CMIP and OBS vs CMIP5 MM mean 1950:2010



CMIP5 multimodel mean has slightly larger trend than observed. Idem dito for EC-Earth



Trend deviation in historical period vs future scenario



No relation & clouds of model ensembles are found → model uncertainty large



Developments

- 1) Higher resolution: T799 atmosphere – 0.25 deg ocean, T799 and higher AMIP → resolving synoptics relevant to society
- 2) New components: atmospheric chemistry (TM5), dynamic vegetation (LPJ-GUESS), ocean biogeochemistry (PISCES)
- 3) Couple to Integrated Assessment Model (IMAGE)
 - 1) Land use scenarios
 - 2) Emission policies (e.g. air quality vs GHG)
 - 3) Coupled feedbacks (e.g. via crop damages)



Conclusions and outlook

Seamless prediction strategy works (but not too strictly defined)

Model development, e.g. via initial biases

Near term prediction skill in EC-Earth:

ENSO skill at seasonal time scales

Skill in (externally forced) trend on multiannual time scales

→ attention for radiative forcing needed (aerosols)

Some skill in PDV and AMO up to 5 years

Historical and future scenarios:

EC-Earth similar to multi-model mean with slightly too high trends

Good circulation characteristics

More info: <http://ecearth.knmi.nl>



Status Core CMIP5 runs (Oct 18, 2011)

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AMIP	#	#	#	#
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NB run at different HPC platforms by 10 different partners



Seamless prediction from seasons to decades

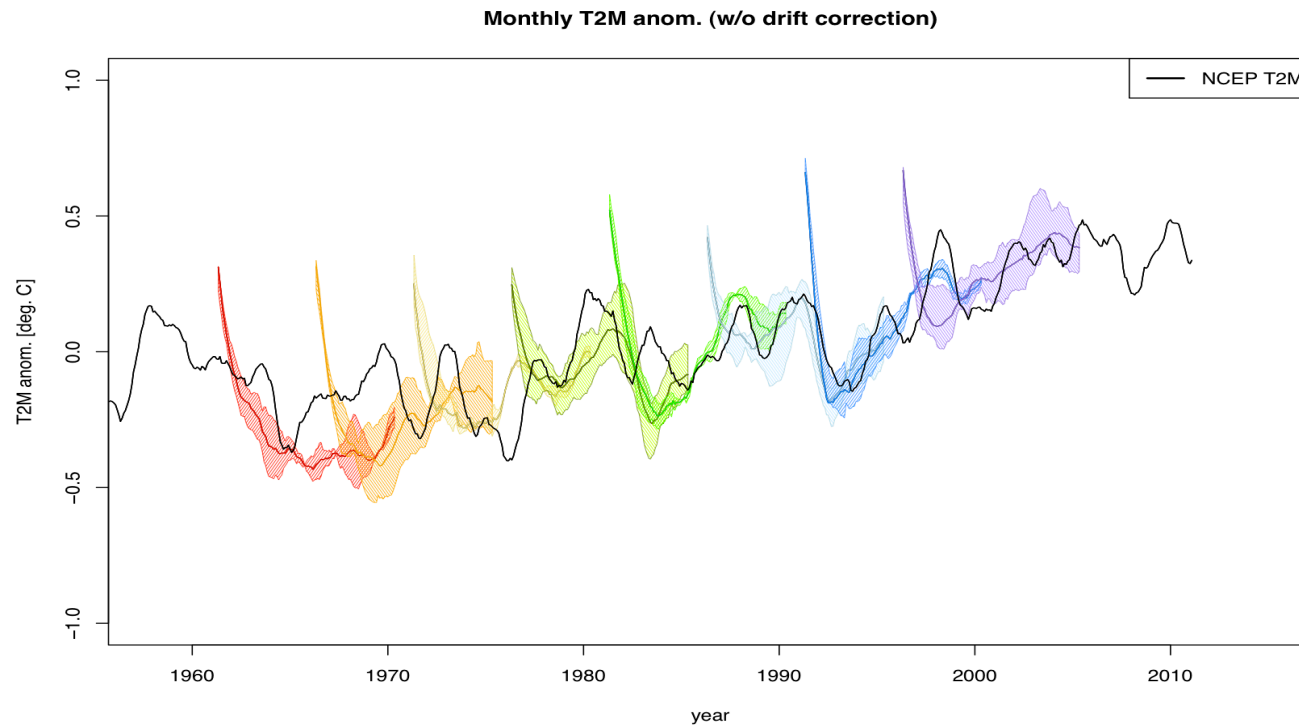
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 - Annual predictions: 13 month, 5 member ensemble, start dates May, Nov., 1976-2005
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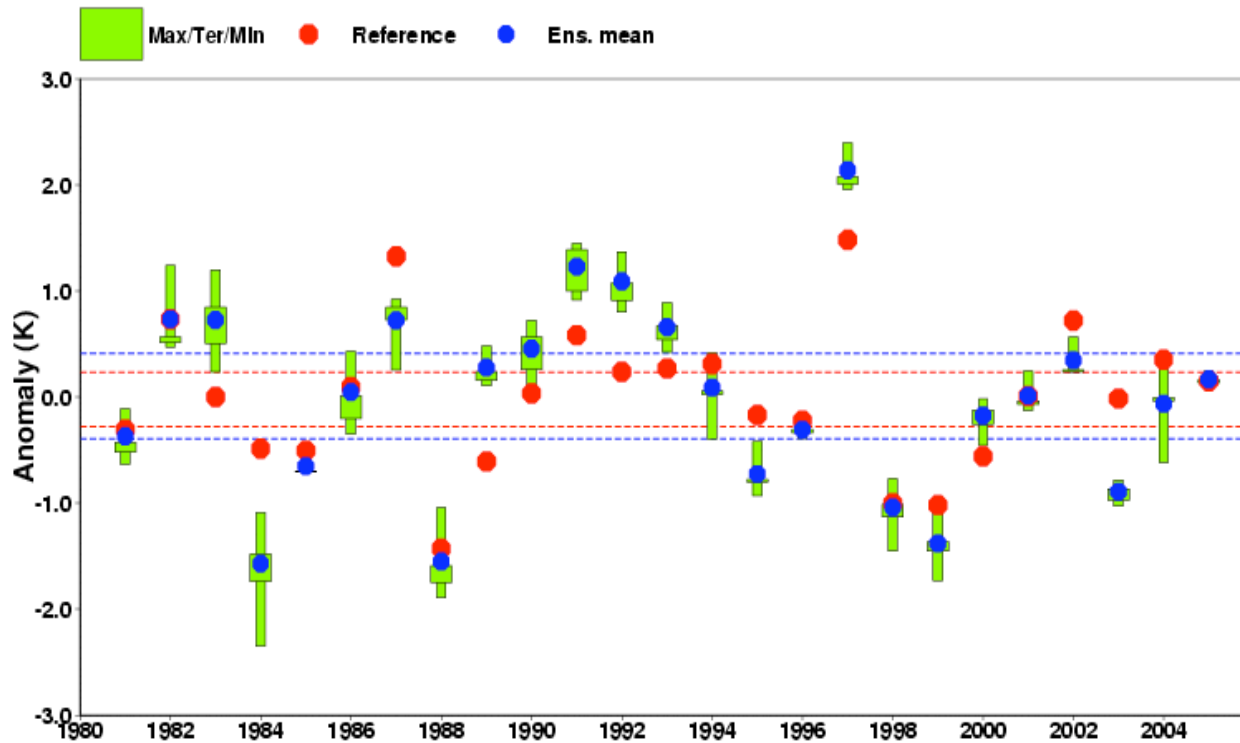
EC-Earth hindcasts (full initialisation)

12 month running mean Global mean Ts anomaly relative to 1960-2010 mean





Seasonal predictions: ENSO



EC-Earth

Ratio sd: 1.34

Corr: 0.82

RPSSd: 0.48

ECMWF System 3

Ratio sd: 0.84

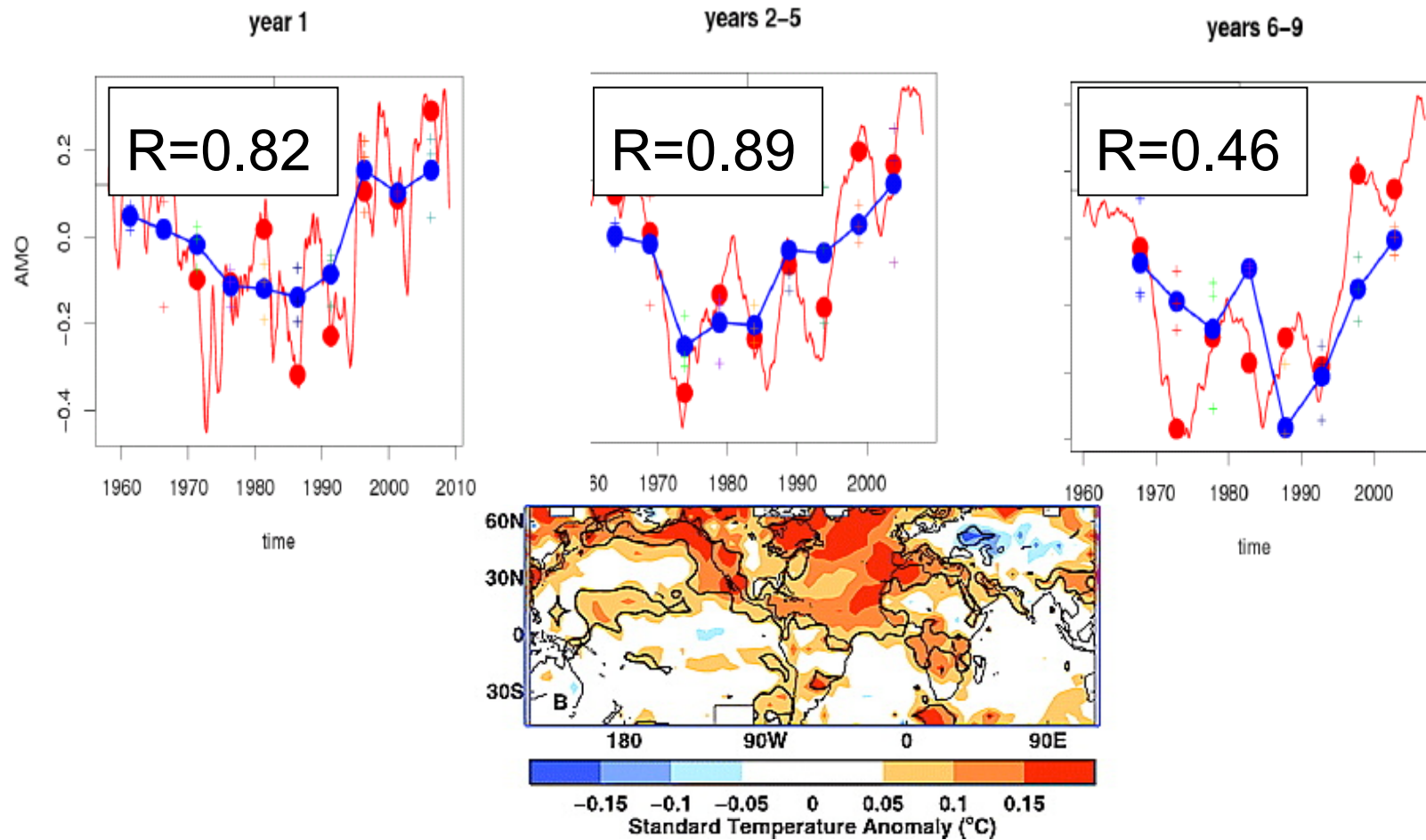
Corr: 0.86

RPSSd: 0.68

Niño3.4 time series for ERA40/Int (red dots), ensemble range (green box-and-whisker) and ensemble mean (blue dots) 2-4 month (JJA) re-forecasts over 1981-2005.

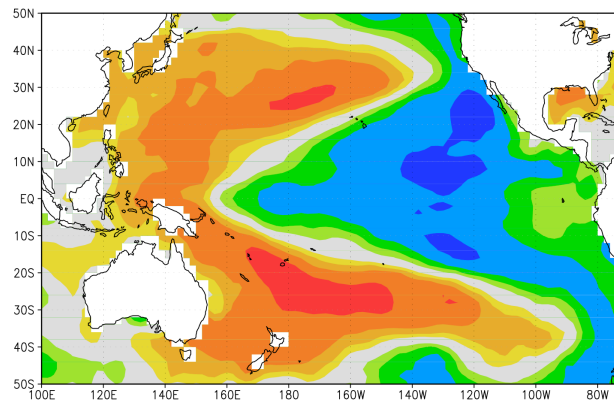
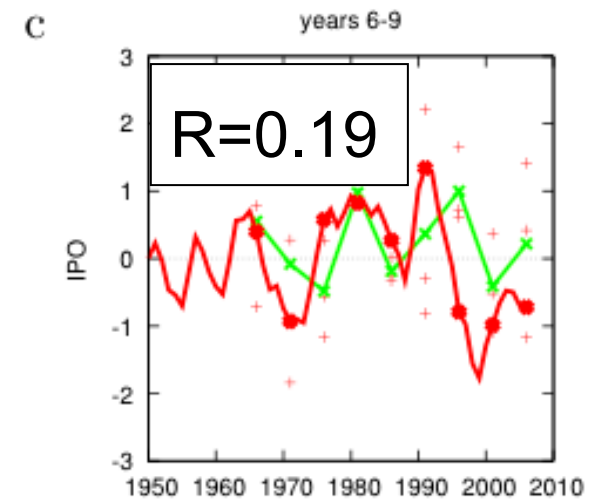
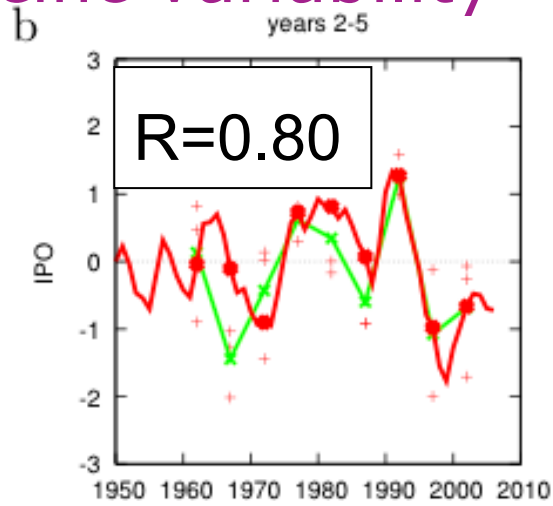
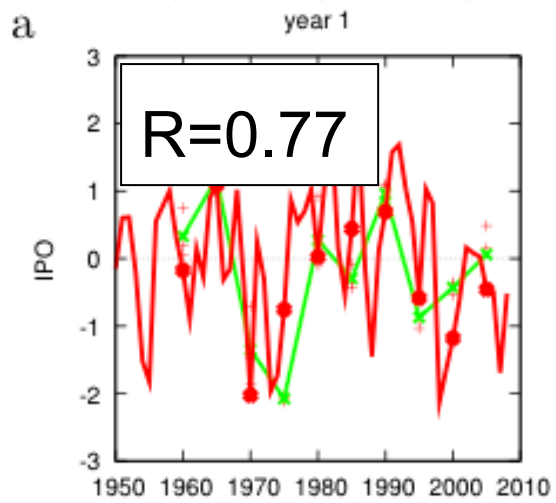


Predictions of Atlantic Multidecadal Oscillation





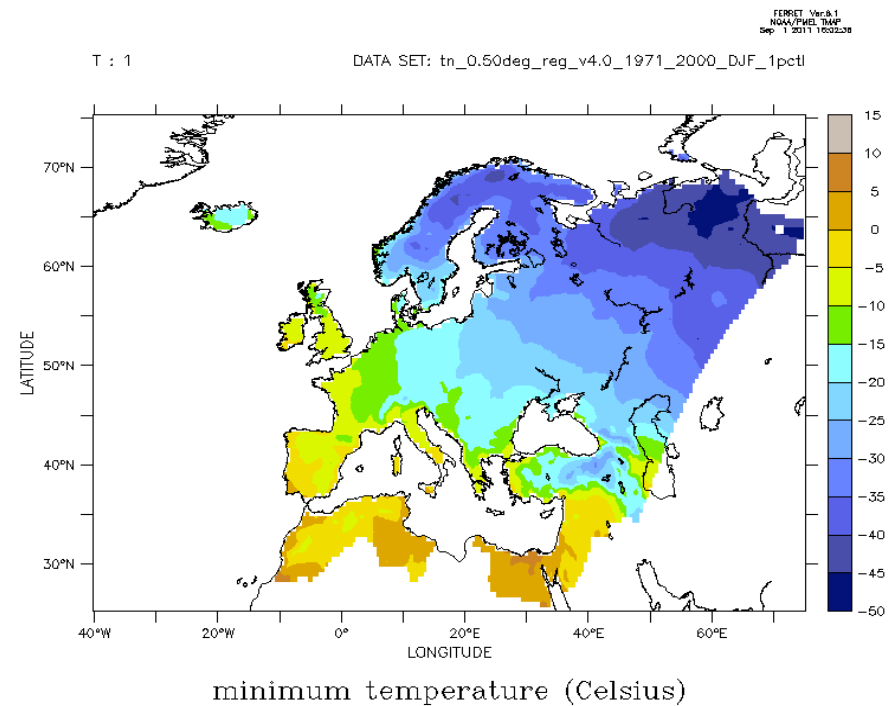
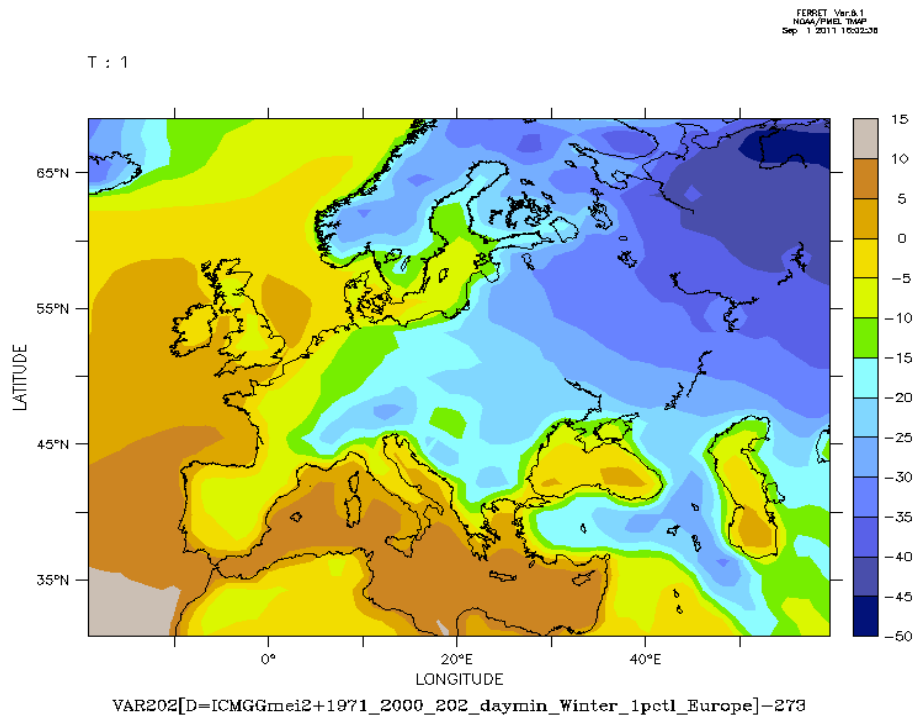
Predictions of Pacific variability





Extreme events in Europe

1 % percentile DJF 1971-2000 from historical simulation and from E-OBS





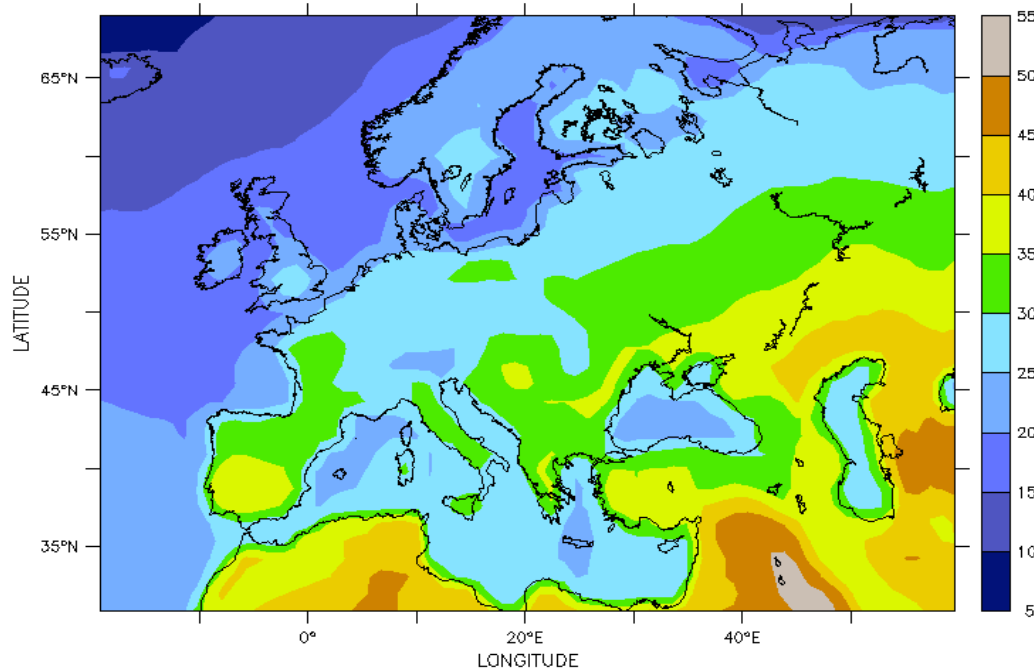
Extreme events in Europe



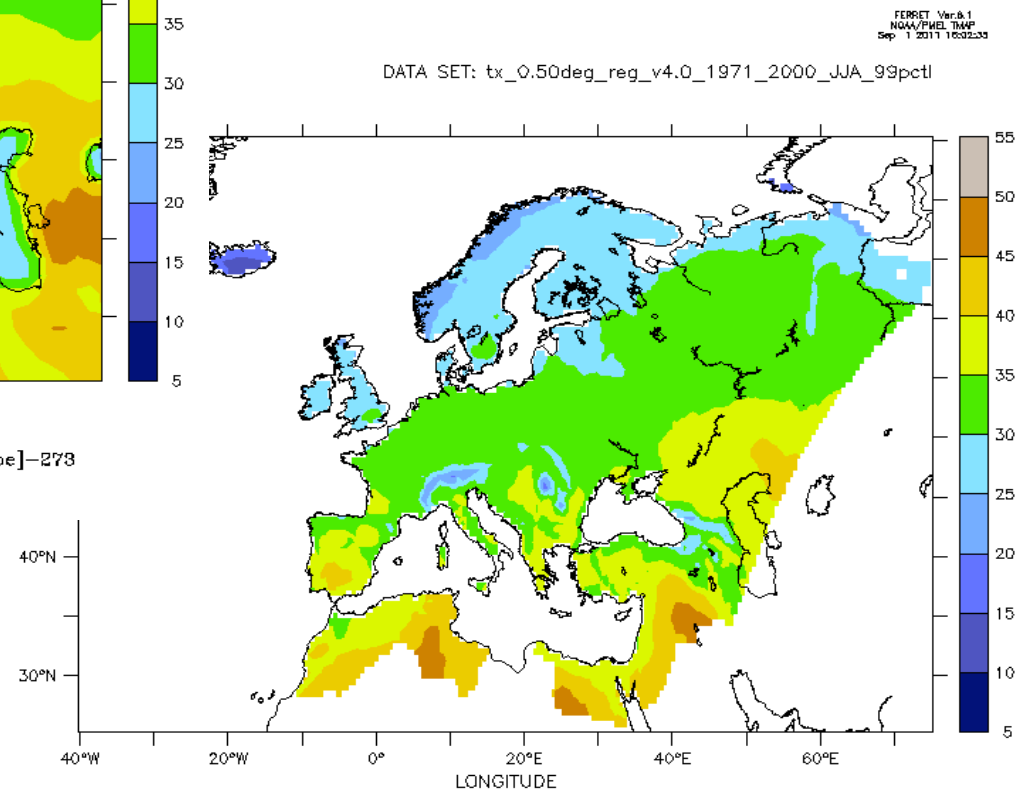
99 % percentile JJA 1971-2000 from mei2 industrial simulation and from E-OBS

FERRET Ver.8.1
NOAA/PIREL TRMF
Sep 1 2011 16:02:33

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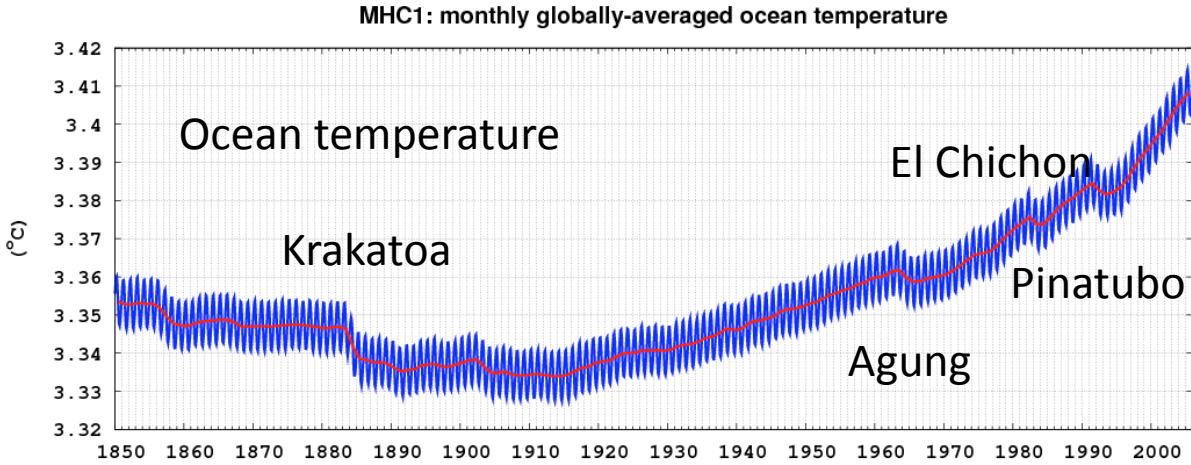
VAR201[D=ICMGGmei2+1971_2000_201_daymax_Summer_99pct1_Europe]-273



maximum temperature (Celsius)

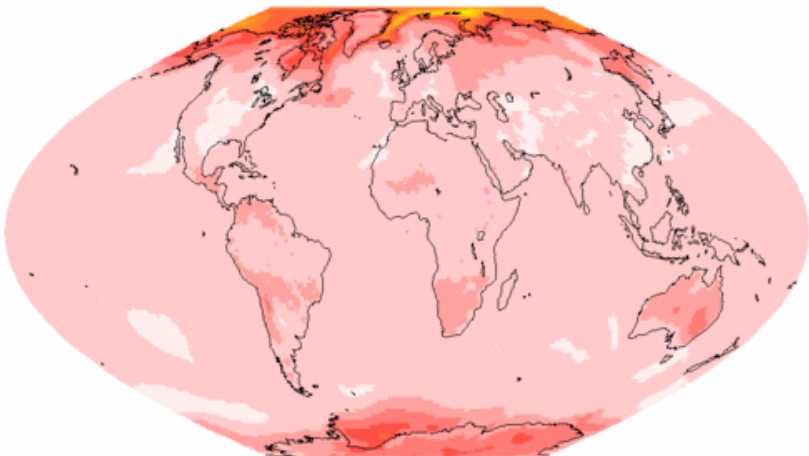


CMIP5 historical and RCP simulations

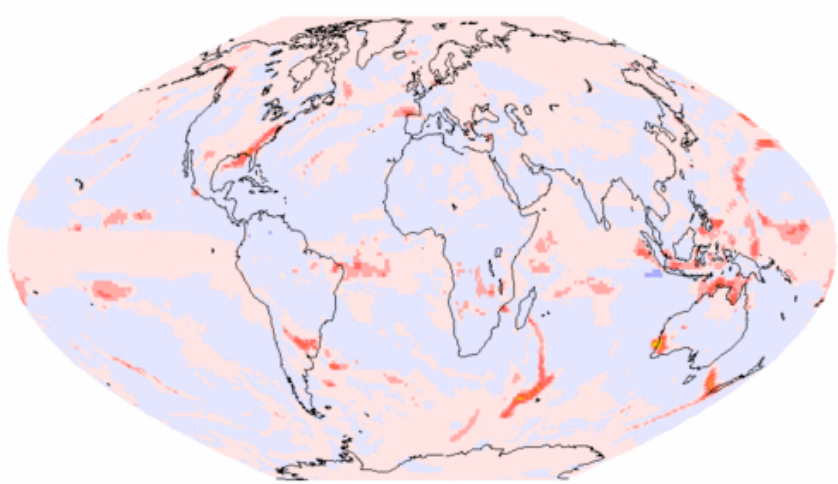




CMIP5 projections



T2M trend rcp45 deg/dec.



TP trend rcp45 mm/day/dec

21st century trends, RCP 4.5