Comparing reanalysis products and observations

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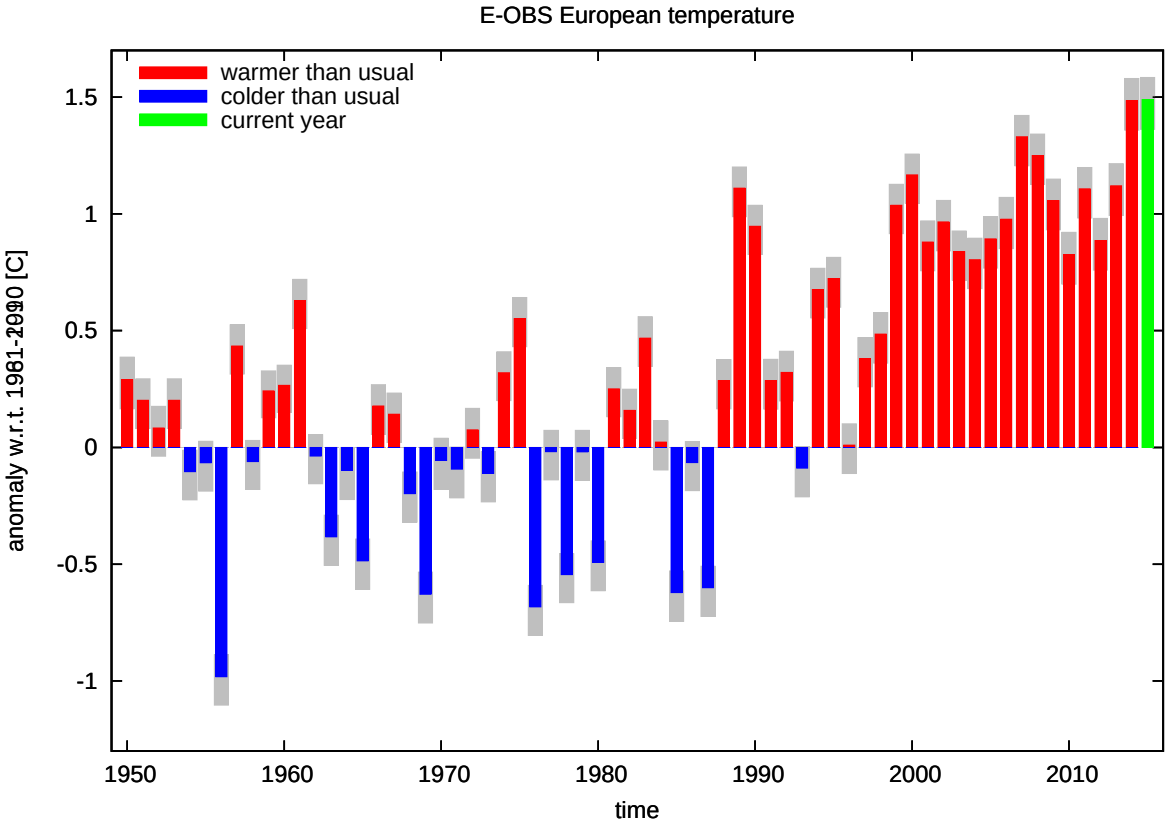
UERRA
Uncertainties in Ensembles of Regional ReAnalyses

Royal Netherlands Meteorological Institute (KNMI)

2015: joint warmest year for Europe

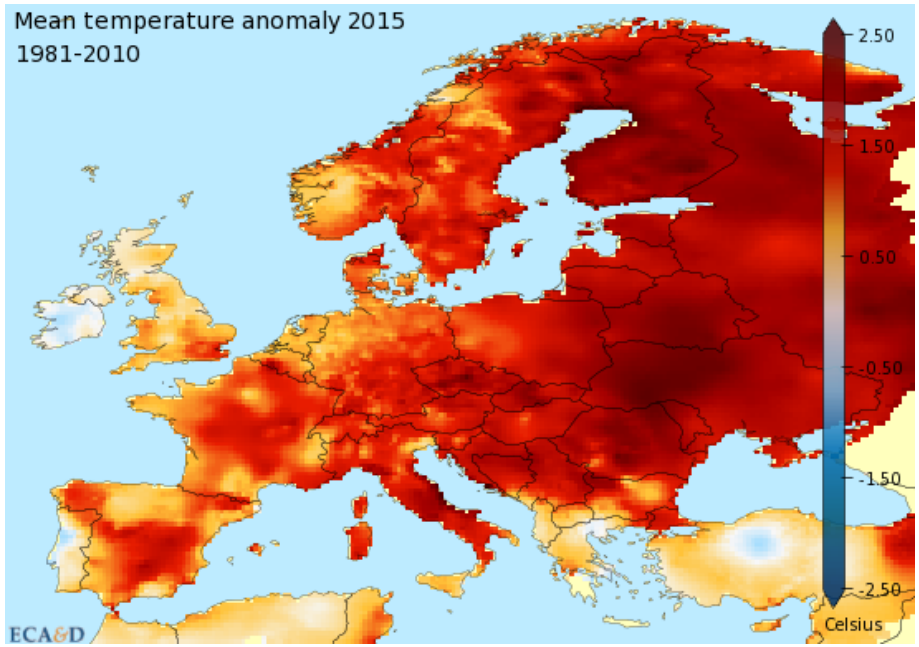


Average annual temperature for Europe w.r.t. 1981-2010

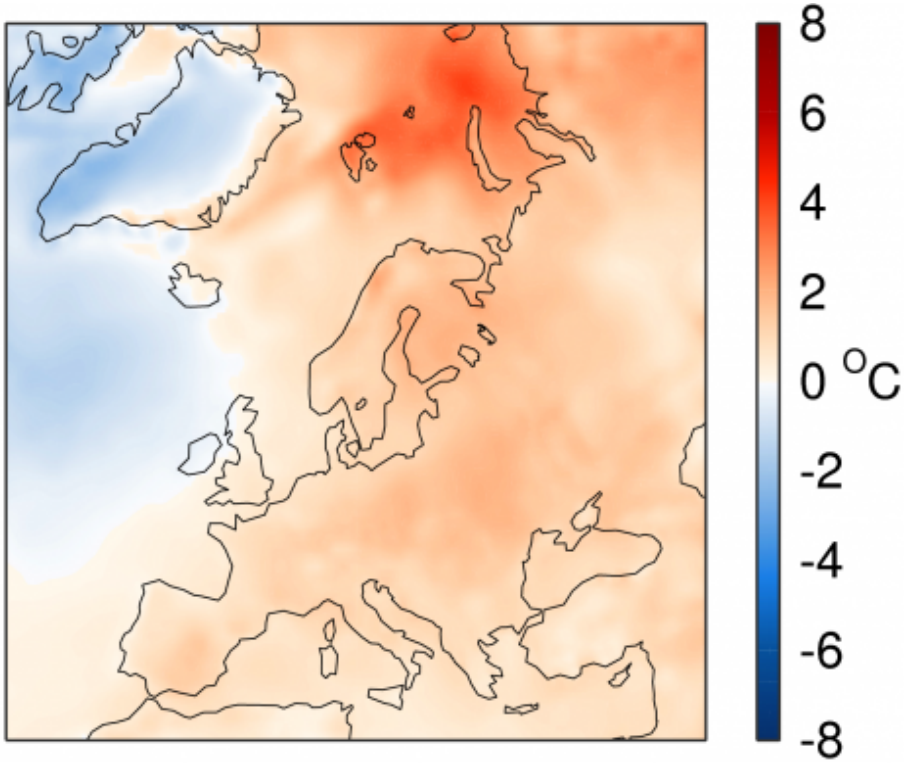
- 2015 temperature only *just* over the 2014 value
- December has been extremely warm
- replacing December with its 1981-2010 climatology would set the 2015 temperature at the 3rd place

Temperature assessment

Can observation-based assessments still compete with reanalysis?



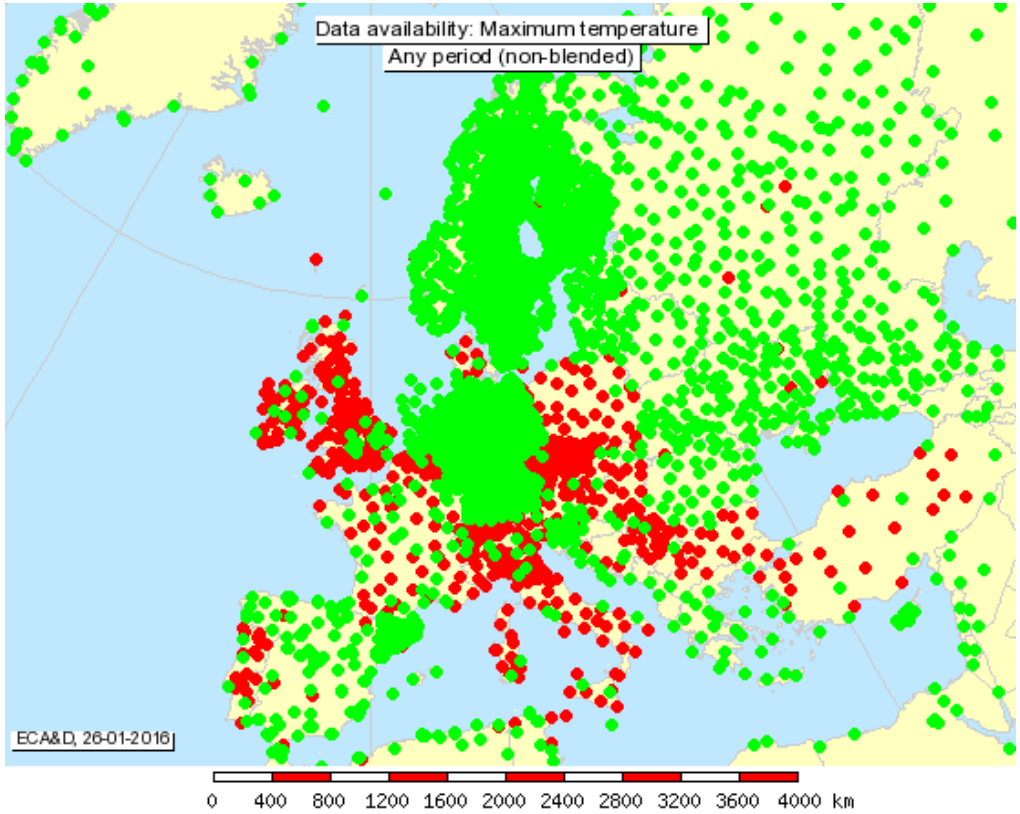
E-OBS based 2015 anomalous temperature

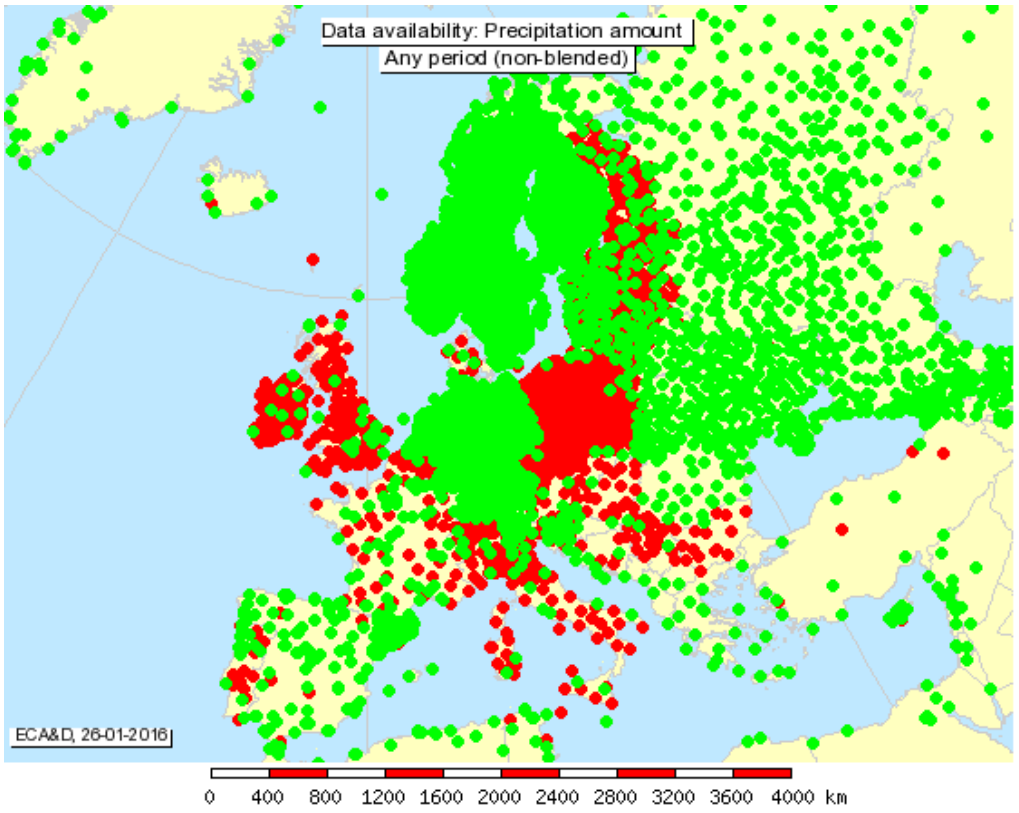


ECMWF based 2015 anomalous temperature

E-OBS and ECMWF agree in that Europe in 2015 was only *just* warmer than 2014

Data sets used



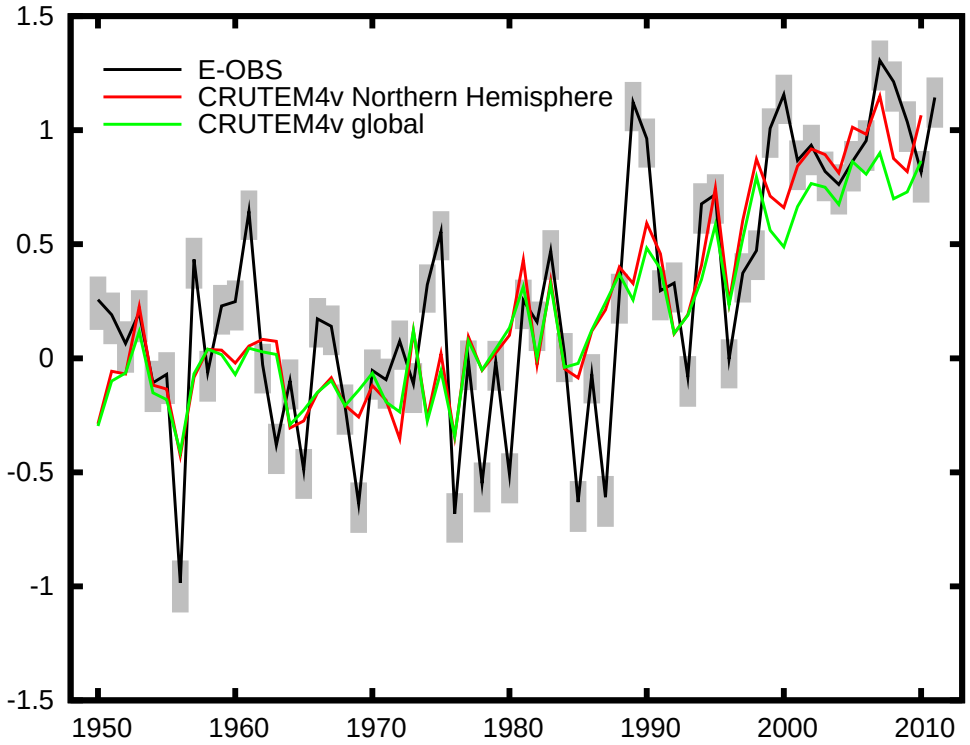


- amount of stations used for E-OBS $\gg$ reanalysis
- for many countries: (manual) rain gauge network included

http://www.ecad.eu

Approach

- calculate European averaged temperature
- regrid reanalysis to E-OBS grid
- compare statistics of extreme events



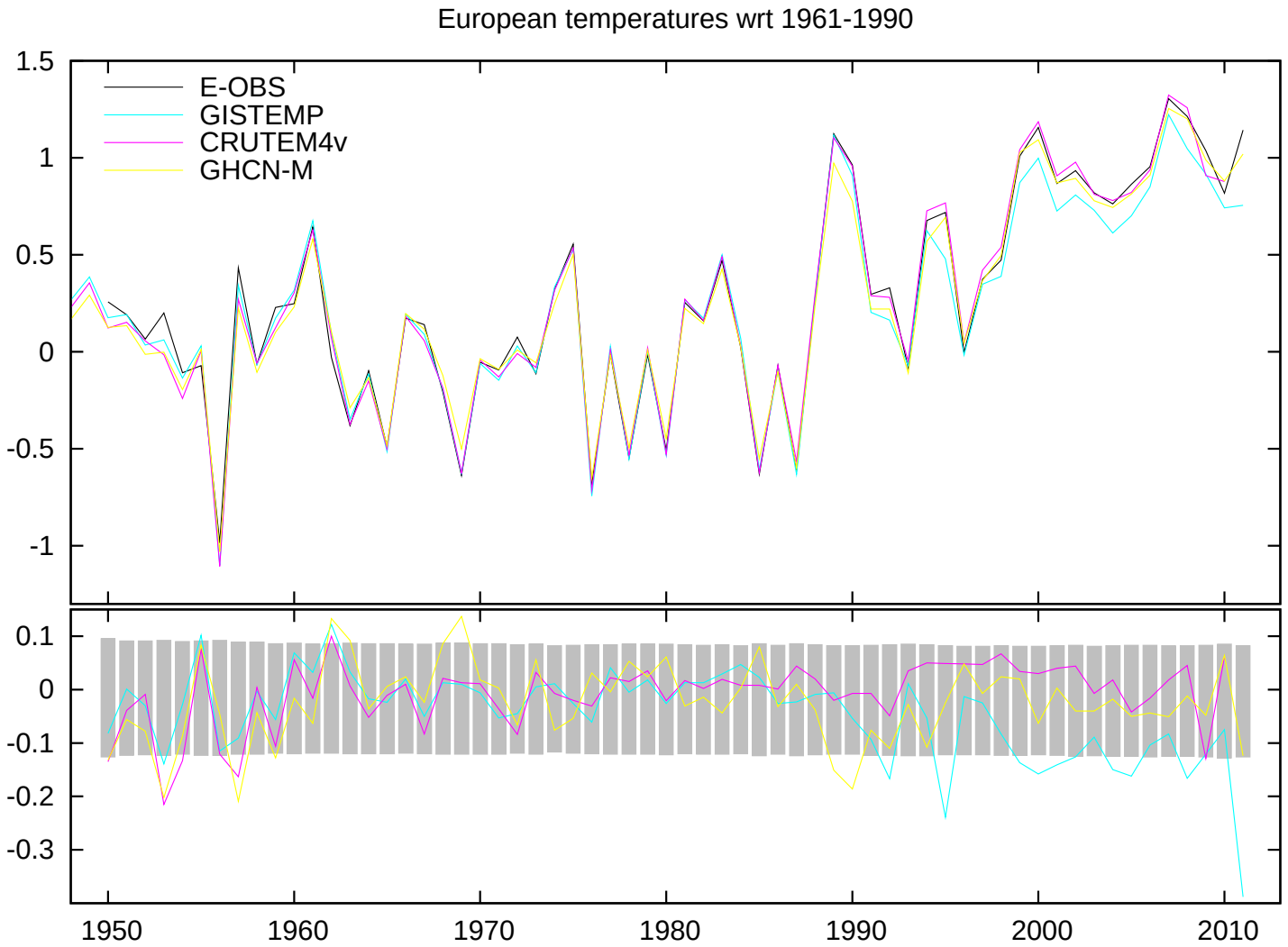
relevance: is Europe warming faster than the globe?

Approach

- use E-OBS $0.5° \times 0.5°$ tg grid
- define Europe: $12°$W-$45°$E / $30°$N-$75°$N + Iceland
- any missing data: replace with 1961-1990 CRU TS data
- estimate uncertainty
  - due to gridding
  - due to inclusion of inhomogeneous data
  - due to urbanization

van der Schrier et al. (2013), Chrysanthou et al. (2014)

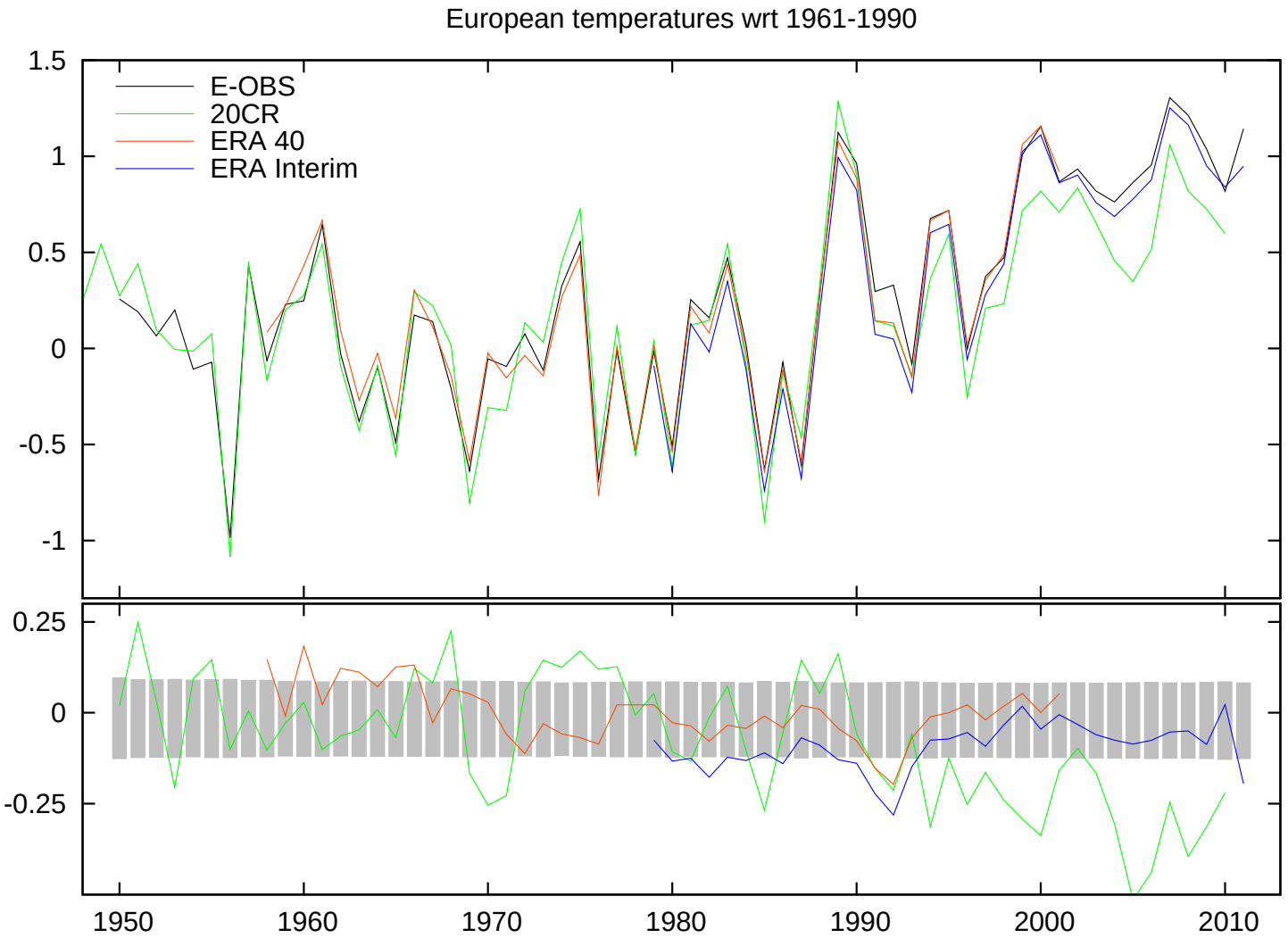
Comparison with other observations



E-OBS, GISSTEMP, CRUTEM4v, GHCN-M

van der Schrier et al. (2013)

Comparison with reanalysis

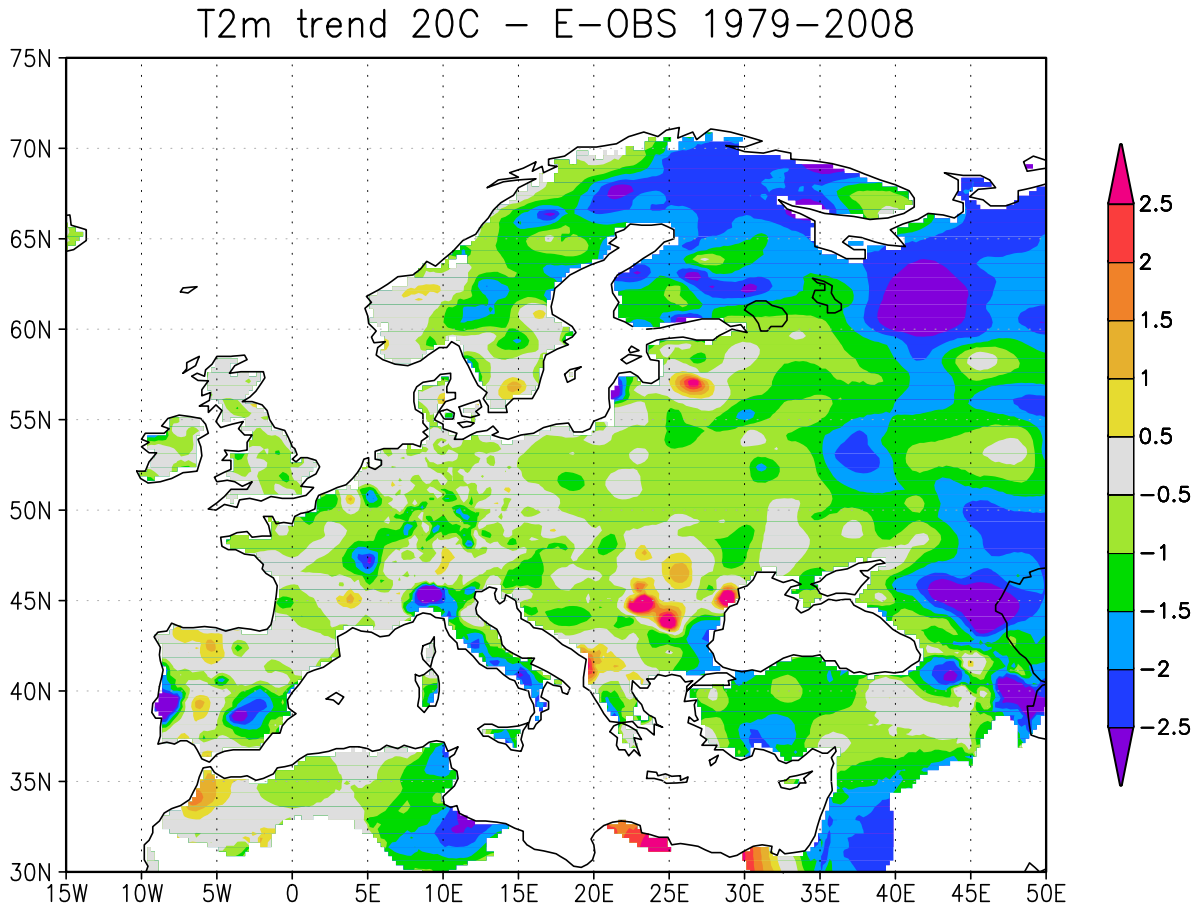


E-OBS, 20th Century Reanalysis, ERA-40, ERA Interim

van der Schrier et al. (2013)

What's happening to 20CR?

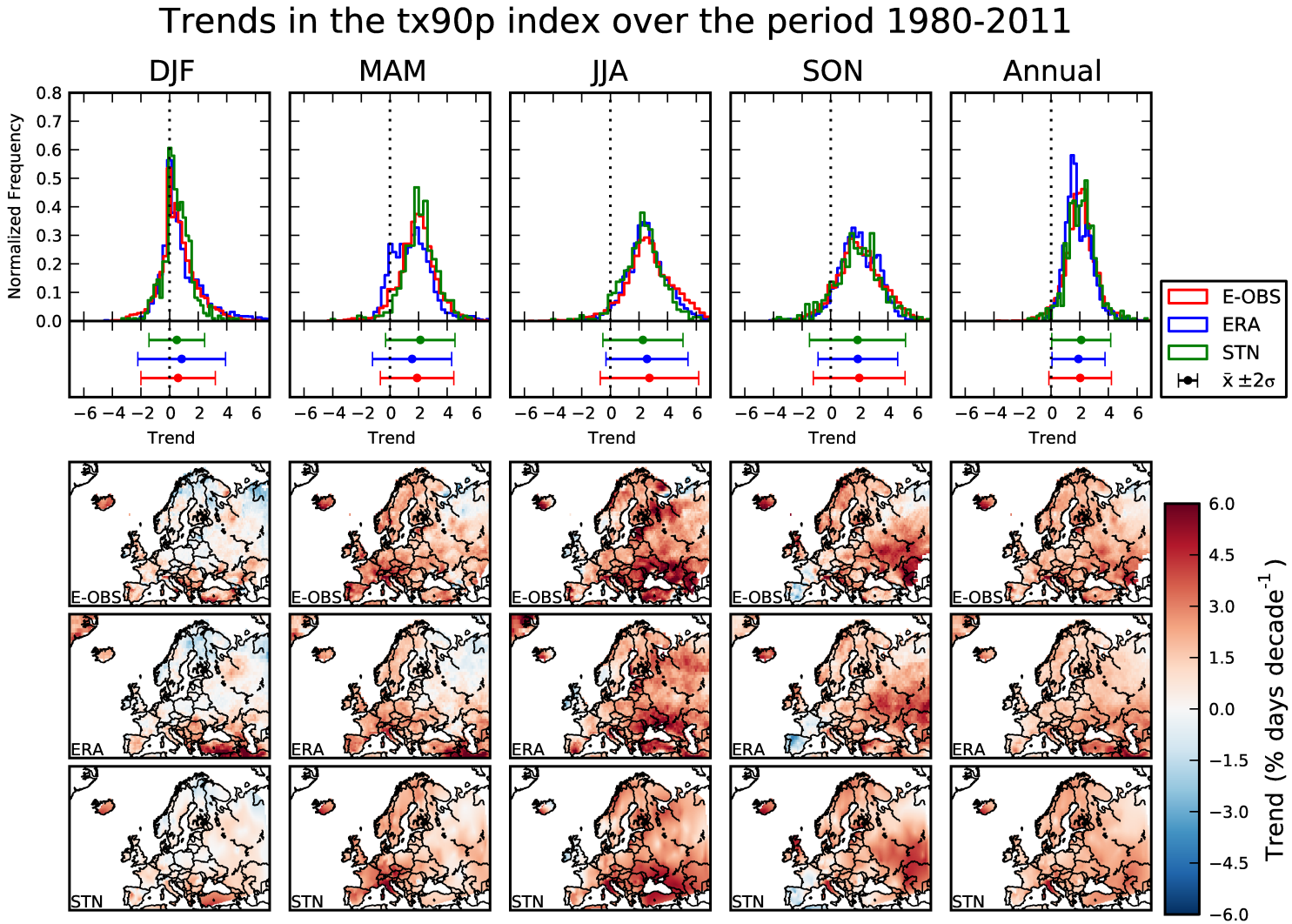
- 20CR apparently fails to capture warming trend
- 20CR is driven by surface pressure obs. and observed SSTs
- maritime areas - warming is captured by the SSTs
- continental areas - warming is missing



Difference in trends between the 20th Century Reanalysis and E-OBS (annual, 1979-2008).

van der Schrier et al. (2013)

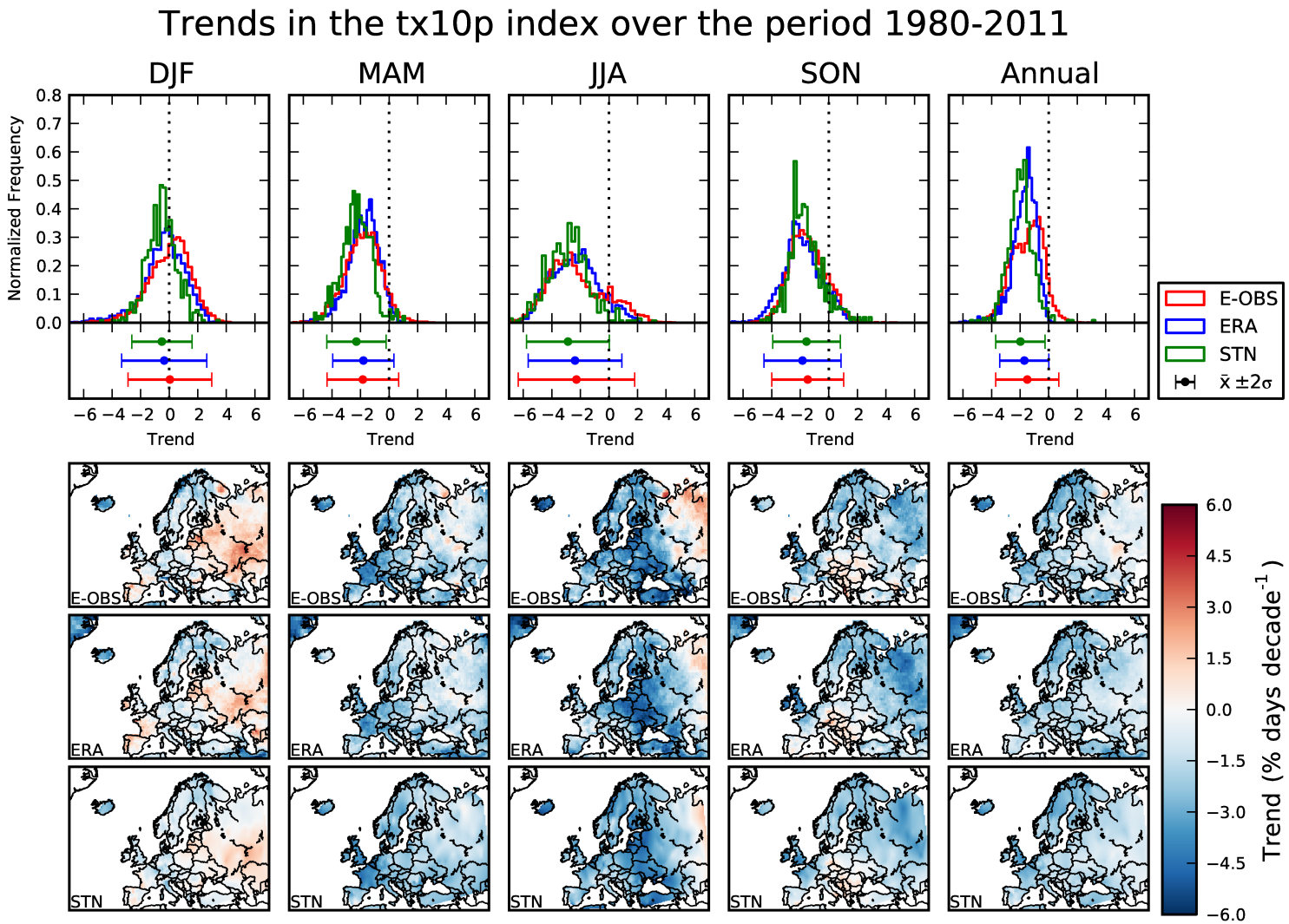
Warm temperature extremes



E-OBS, ERA Interim, interpolated station data

Cornes and Jones (2013)

Cold temperature extremes

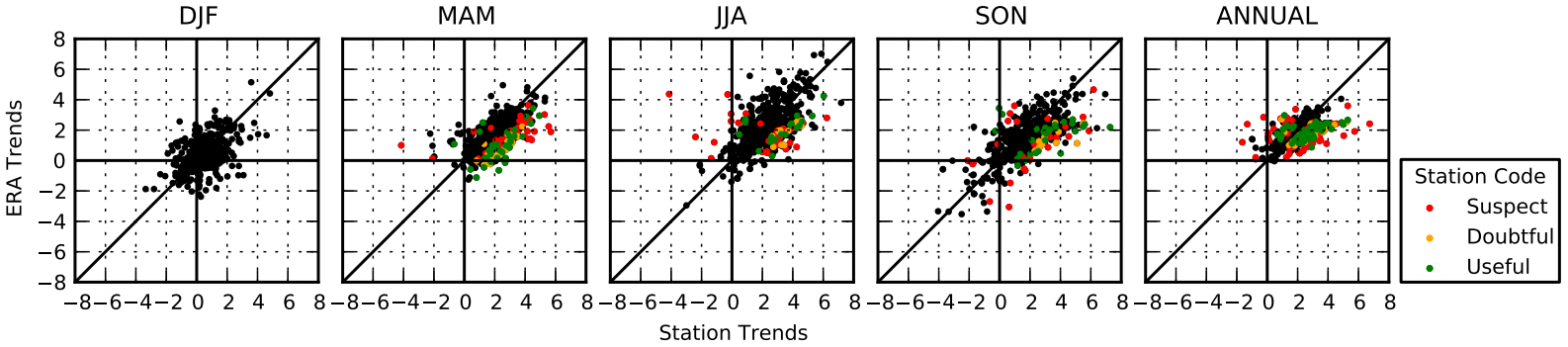


E-OBS, ERA Interim, interpolated station data

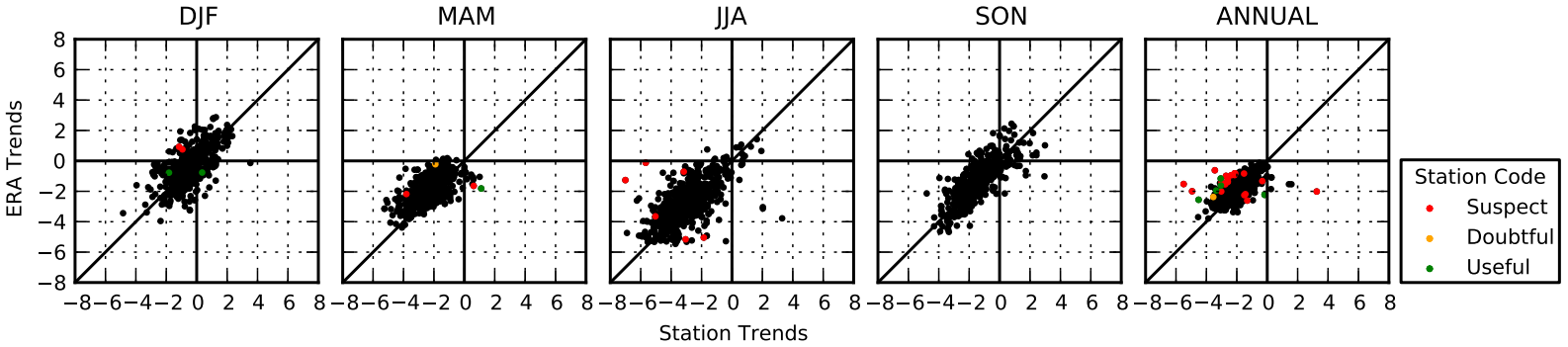
Cornes and Jones (2013)

Trends

(a) tx90p



(b) tx10p



ECA&D station trends vs. ERA Interim (interpolated to station location)

Cornes and Jones (2013)

Precipitation-related comparisons

Compare E-OBS, ERA Interim, 20th Century Reanalysis and NCEP/NCAR reanalysis using:

- Standardized Precipitation Index (SPI)
  - area percentage of Europe under severely dry (wet) conditions
  - ....found a bug in the program.....
- Hydroclimatic Intensity index (HY-INT)
  - HY-INT: intensity of hydrologic cycle (rather than actual precipitation)
- 'standard' ETCCDI indices
  - number of rainy days (RR1)
  - number of very heavy precipitation days (R20mm)

HY-INT: what is it?

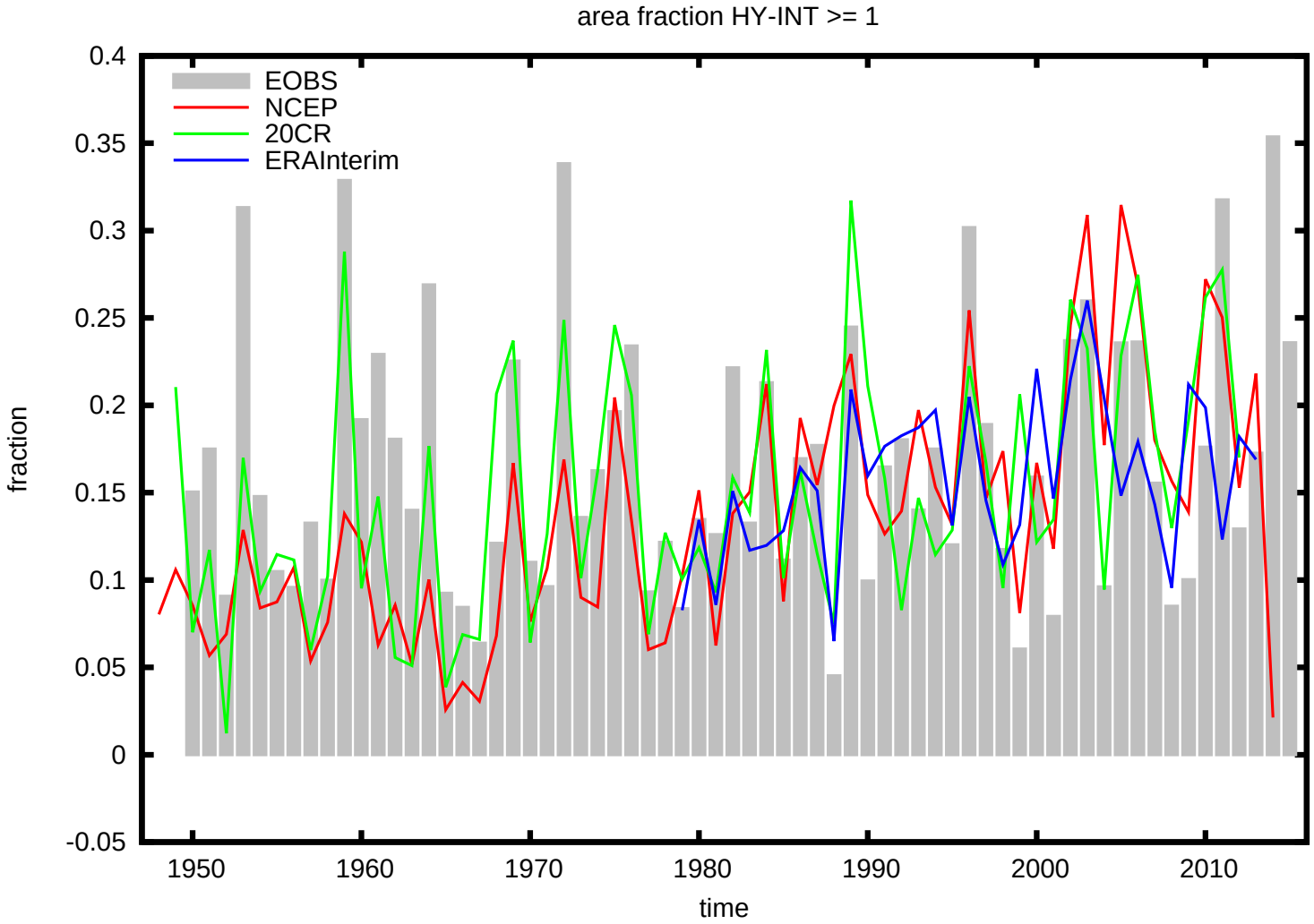
HY-INT is a measure for hydroclimatic intensity
'integrates metrics of precipitation intensity and dry spell length'

$$\text{HY-INT} = \text{INT} \times \text{DSL}$$

where
INT = intensity during wet days ($\sim$ SDII)
and
DSL = *mean* dry spell length (not quite CDD)

HY-INT is normalized with the standard deviation over 1981-2010 Giorgi et al. (2011)

HY-INT

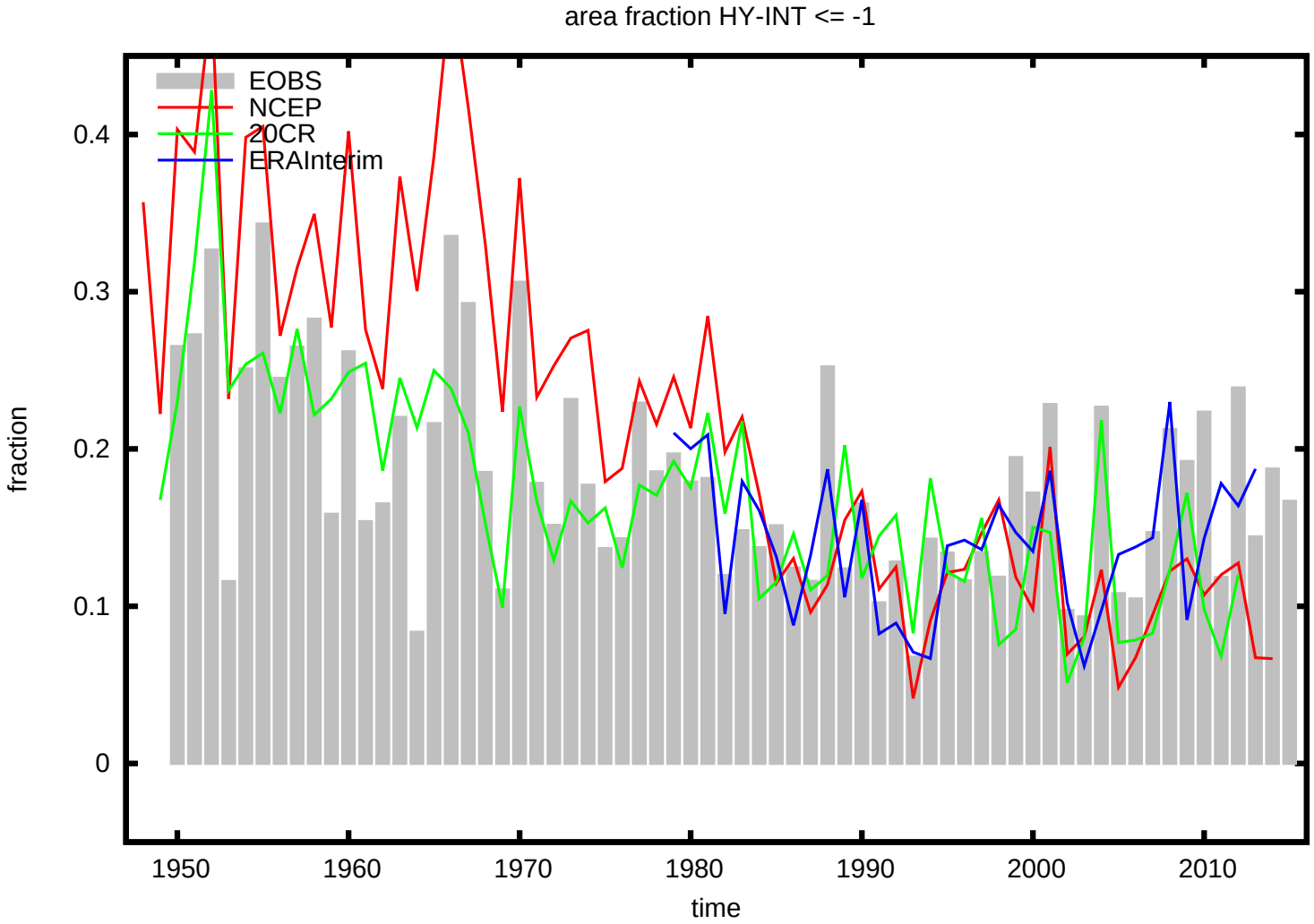


(long dry spells & much rain on rainy days)

fraction of Europe with HY-INT ≥ 1.0 (annual)

Photiadou et al. (in preparation)

HY-INT

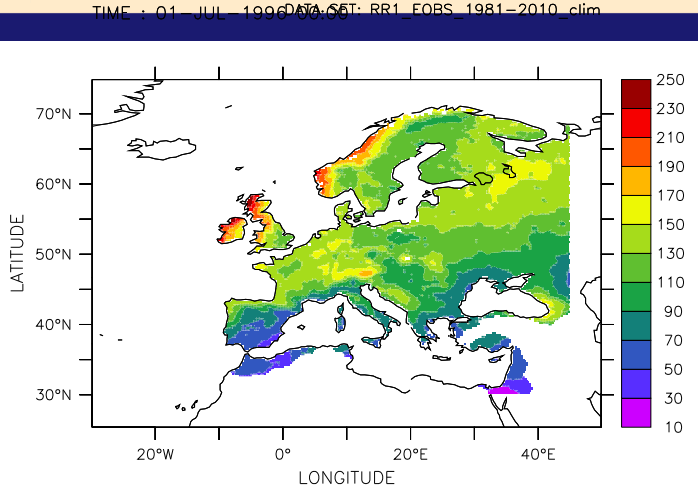


(short dry spells & drizzle on rainy days)

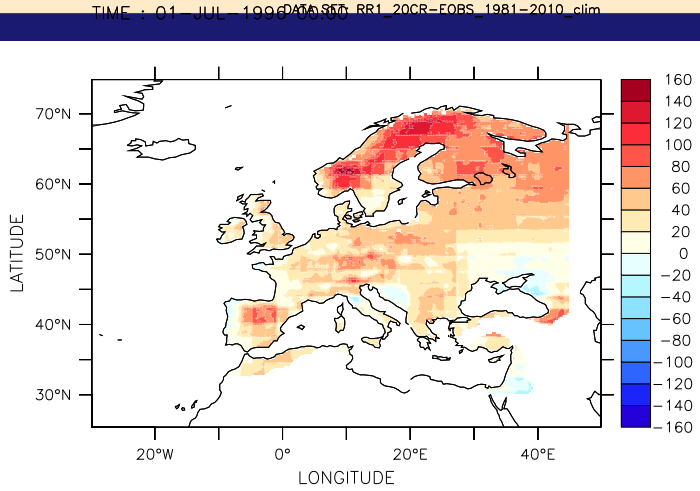
fraction of Europe with HY-INT ≤ -1.0 (annual)

Photiadou et al. (in preparation)

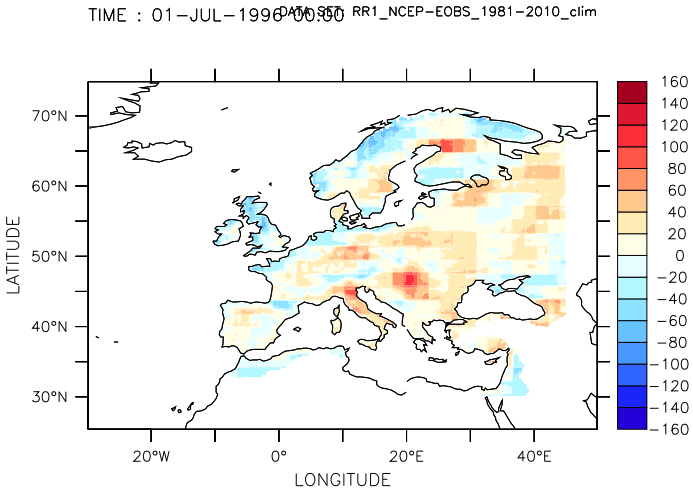
Climatology: RR1



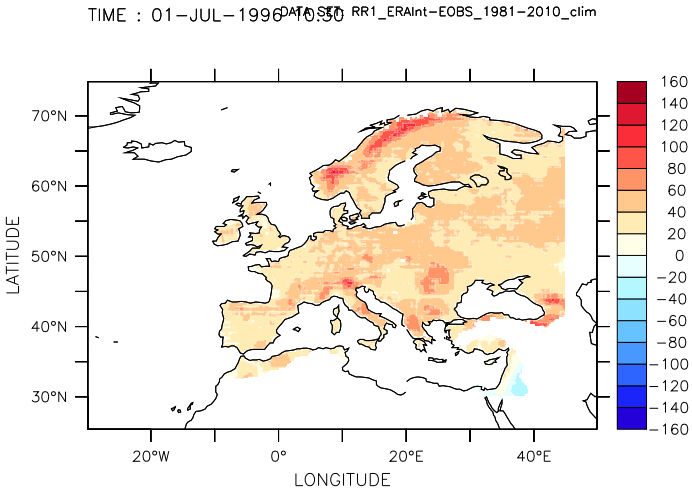
EOBS



20CR−EOBS



NCEP−EOBS

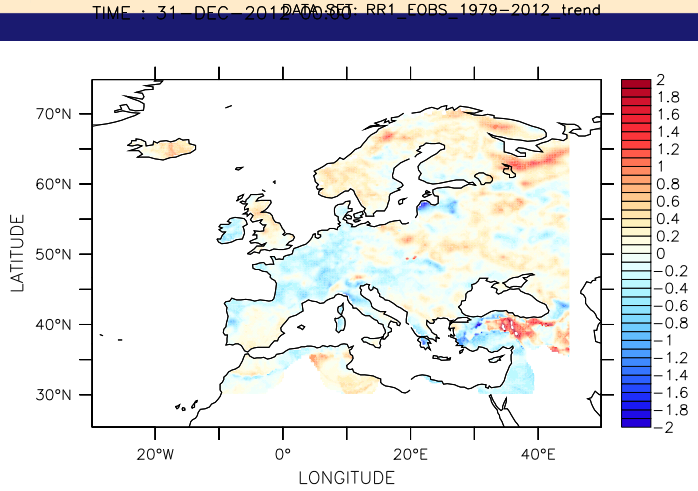


ERAInt−EOBS

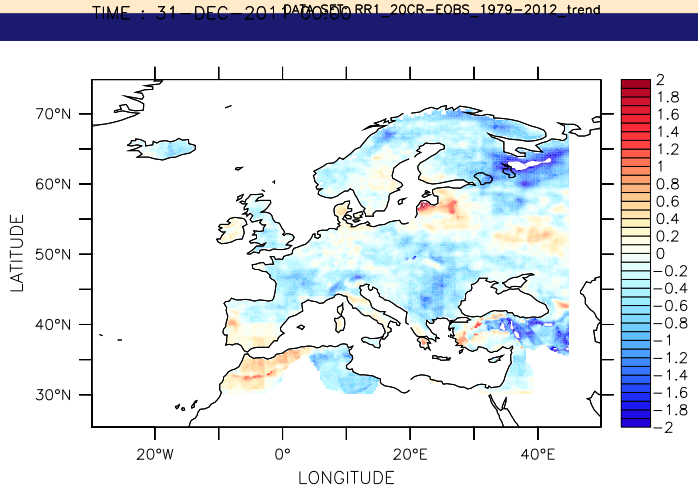
Climatology (1981-2010) annual number of rainy days (RR1).

Photiadou et al. (in preparation)

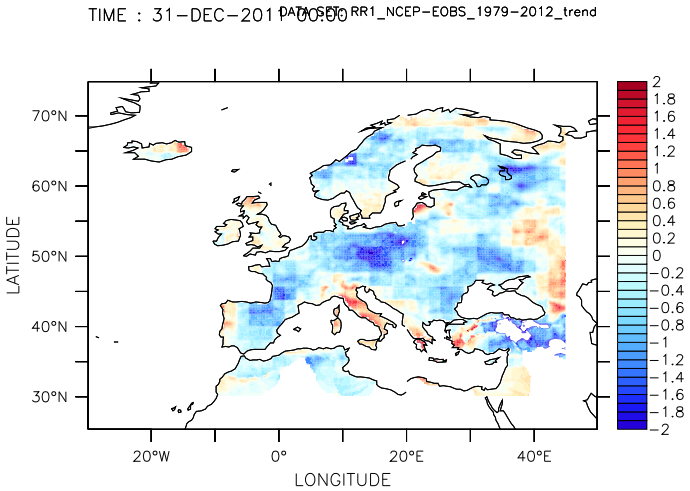
Trends: RR1



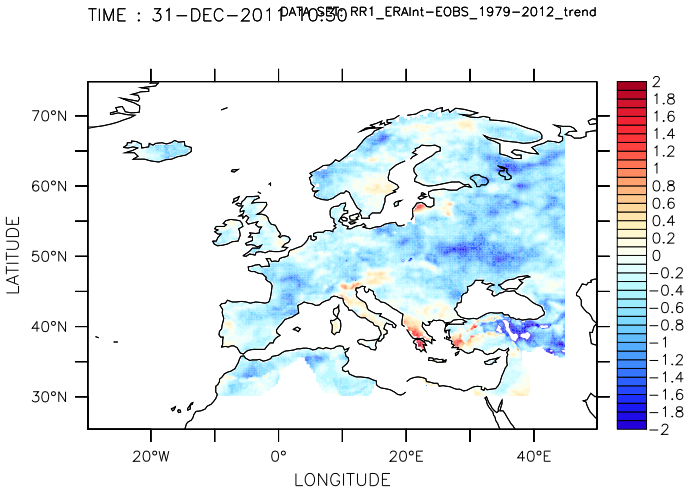
EOBS



20CR-EOBS



NCEP-EOBS

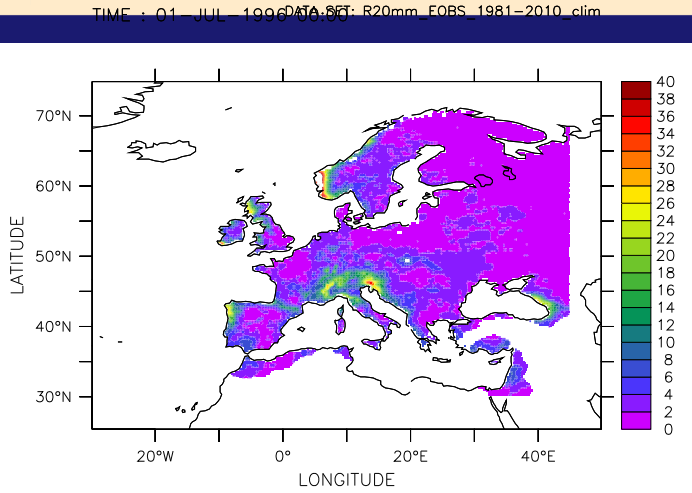


ERAInt-EOBS

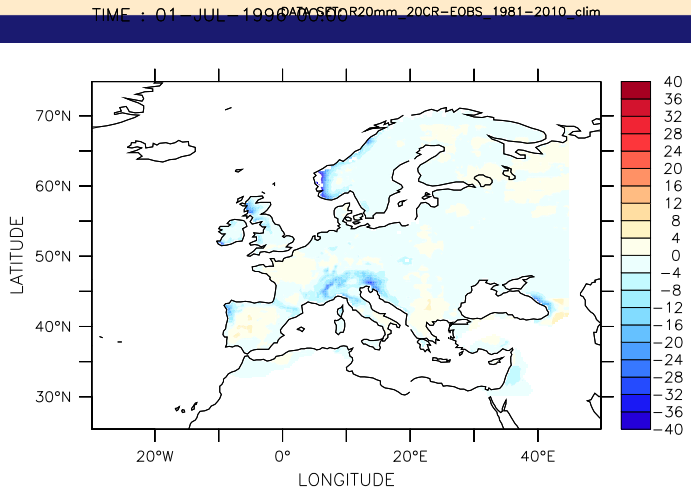
Trends (1979-2012) annual number of rainy days (RR1).

Photiadou et al. (in preparation)

Climatology: R20mm



EOBS



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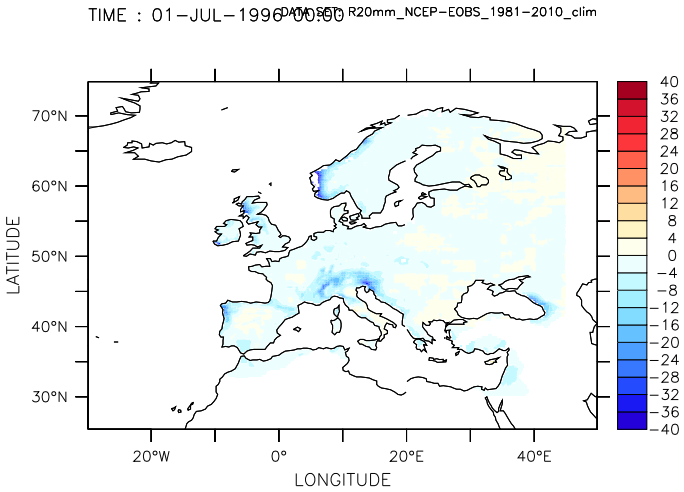
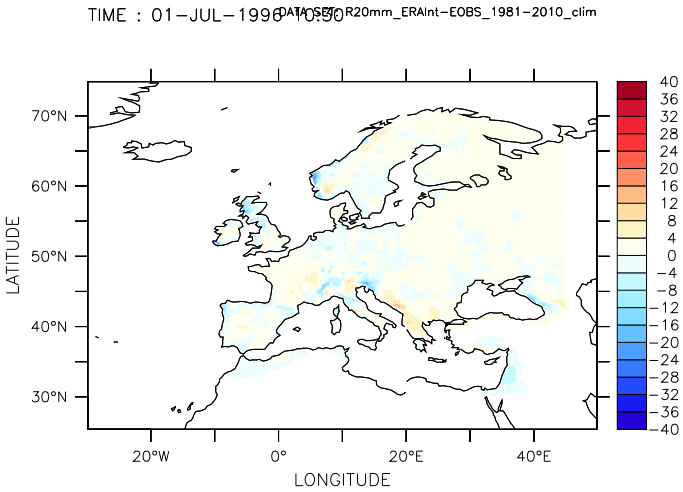


NCEP−EOBS

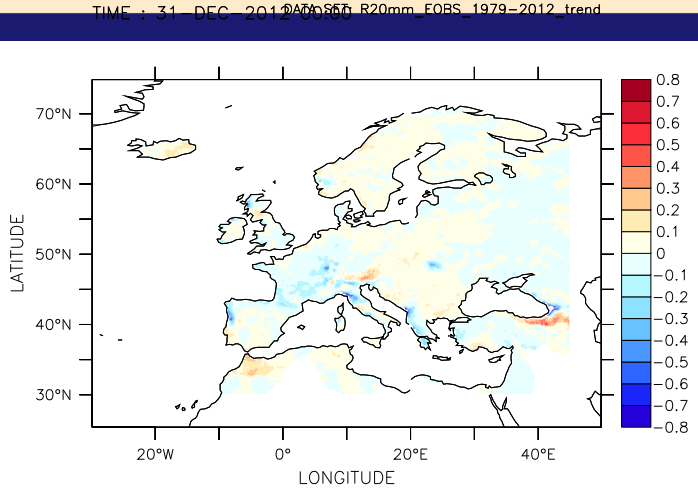


ERAInt−EOBS

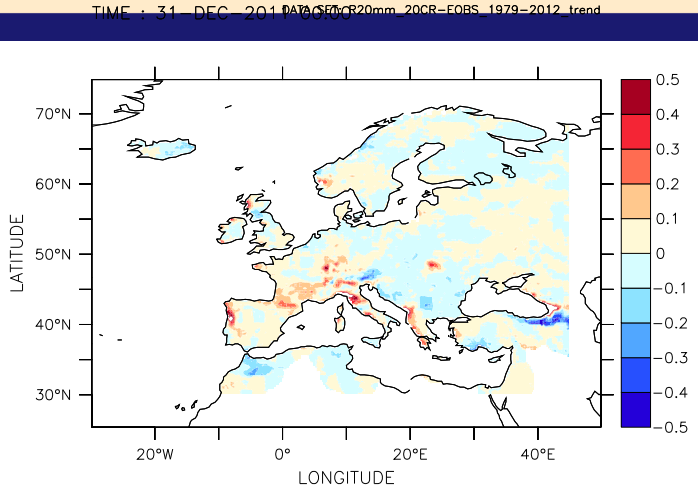
Climatology (1981-2010) very heavy precip. days (R20mm - annual)

Photiadou et al. (in preparation)

Trends: R20mm



EOBS



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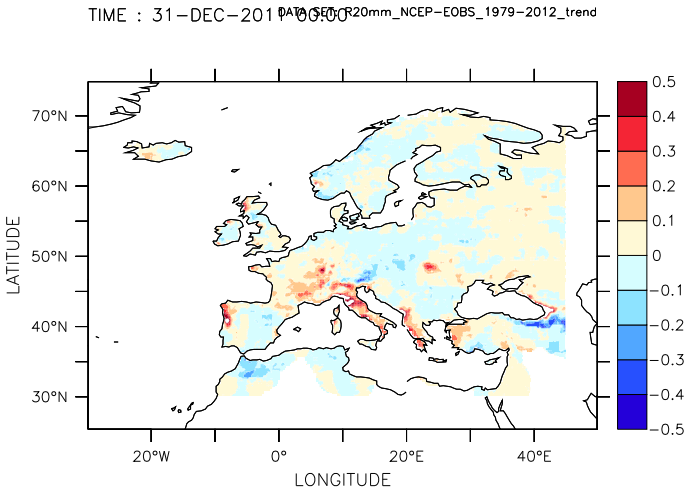
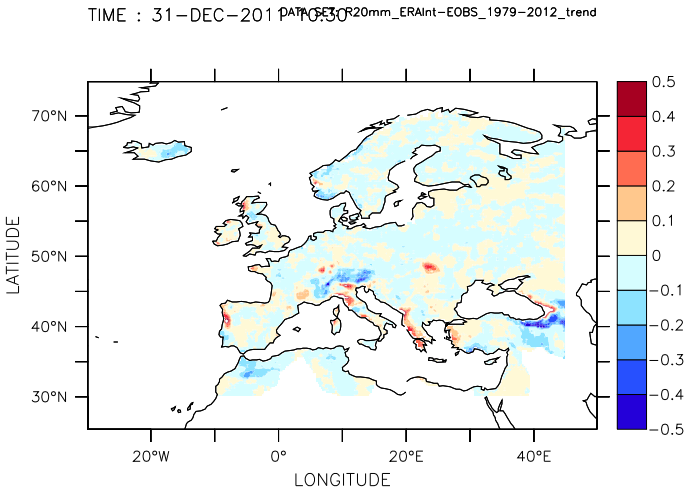


NCEP−EOBS



ERAInt−EOBS

Trends (1979-2012) very heavy precip. days (R20mm - annual)

Photiadou et al. (in preparation)

Conclusions

Temperature

- averaged over Europe: ERA 40 and ERA Interim match quite well
- trends in temperature extremes (TX90p/TN90p etc.): ERA Interim reproduces E-OBS trends
- warming trend seems to be missing in 20th Century Reanalysis - mostly in continental Europe

Precipitation

- 20th Century Reanalysis - NCEP/NCAR - ERA Interim compared with E-OBS
- averaged over Europe: general trend in HY-INT is present, but correlation is low
- climatology of RR1 and R20mm very different (RR1 overestimated in reanalysis, R20mm underestimated)
- trends in RR1 and R20mm underestimated