Estimating the value of regional reanalyses from the UERRA intercomparison

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SMHI

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Mi

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Meteorologisk
institutt

Outline

1. General remarks
2. Evaluated parameters
3. Summary

1. General remarks on regional reanalyses

- Value of reanalysis most evident in data sparse areas
- Value is in coherence of parameters (wind, moisture, temperature, …)
- Regional reanalyses add value to the global reanalyses
- Evaluation results differ with region, month of year, temporal and spatial scale
- No single winner among our UERRA regional reanalyses
- Relative instead of absolute measures (e.g., based on percentiles) will score higher

How good? Product compares to ...?

... available reference data sets:

- Germany and Cabauw (wind)
- Europe where CM SAF data (radiation)
- Switzerland, where Heliomont data (radiation)
- Scandinavia, Alps, Romania (precipitation, climate indices)
- Europe covered by E-Obs, ECA&D (temperature, climate indices)

Note: Results (scores) depend on chosen area, and time of year.

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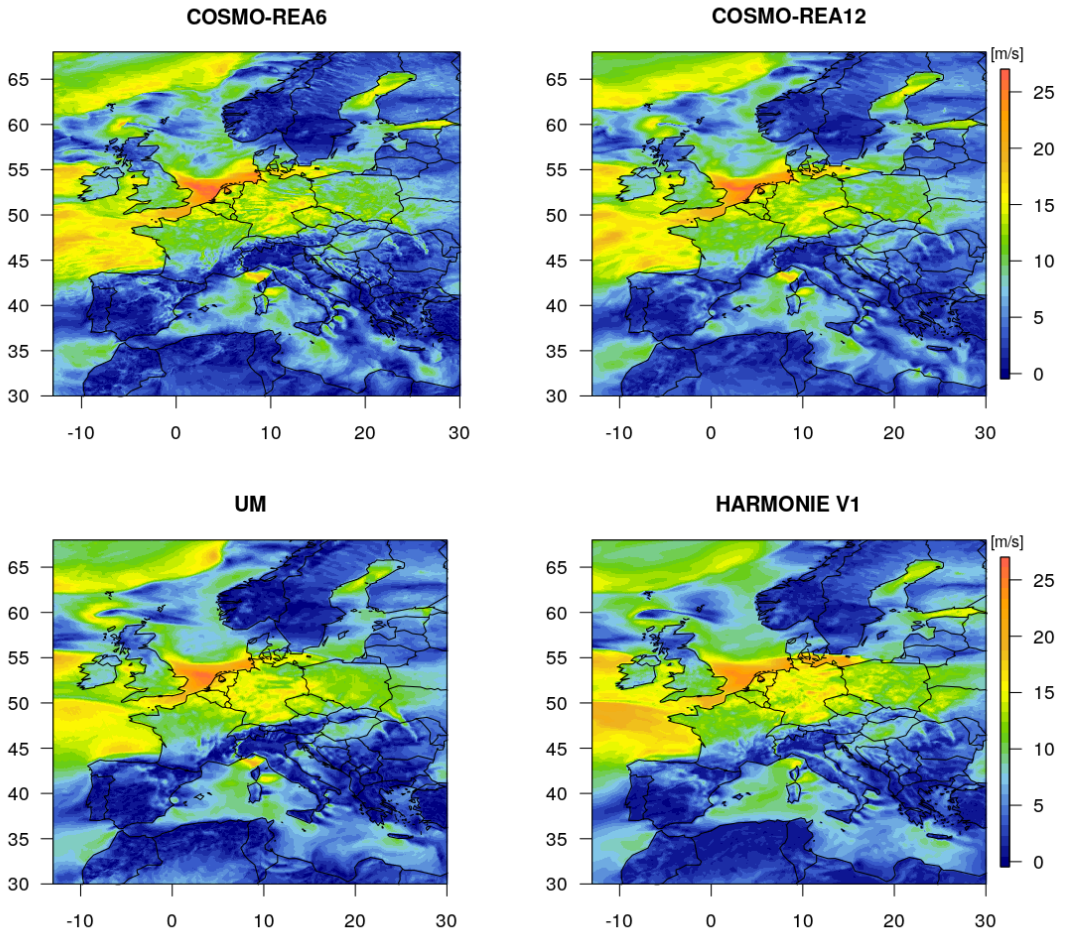
1. General remarks
2. Evaluated parameters
   - Wind
   - Radiation
   - Precipitation
   - Temperature
   - Climate indices
3. Summary

UERRA reanalyses exhibit similar synoptic features

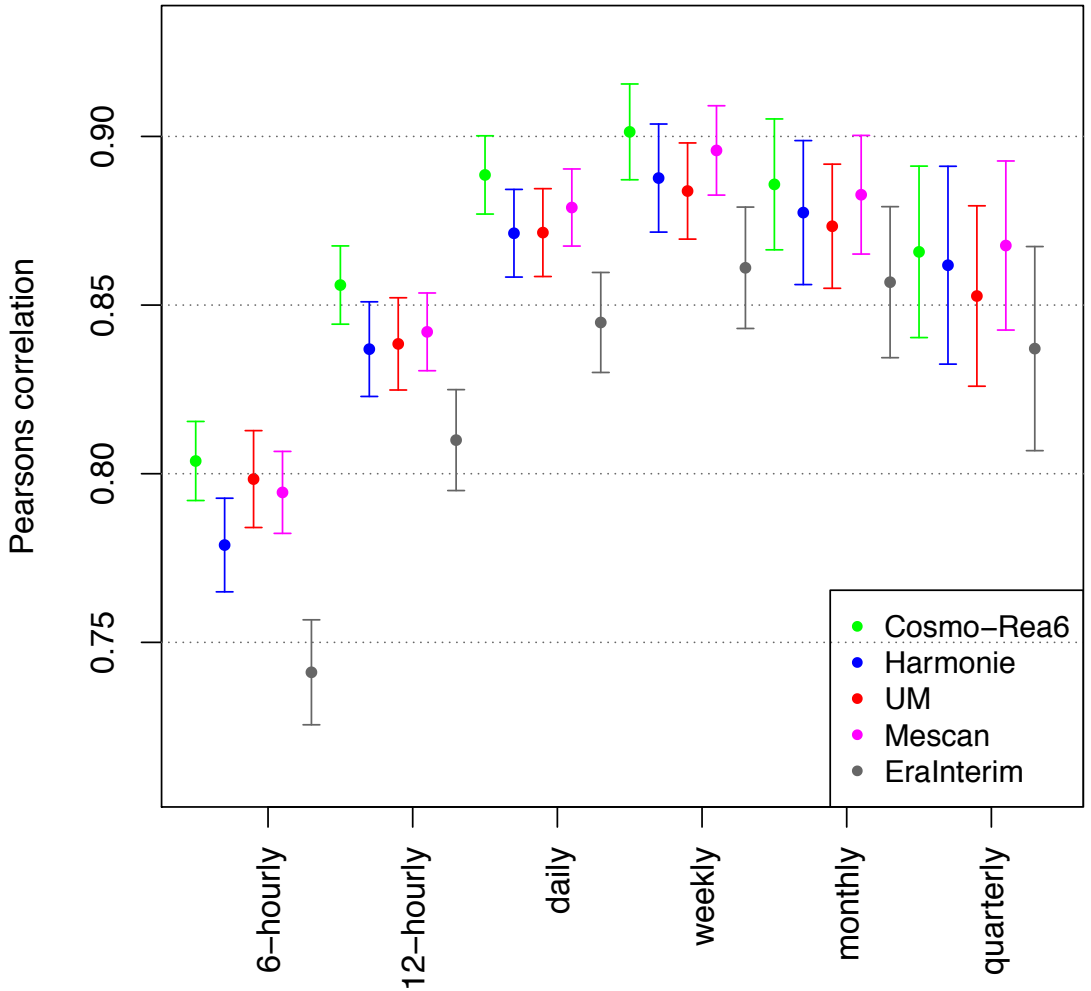
Wind speed in m/s, time slice showing smaller scale variability 19.1.2007 6 UTC



Deborah Niermann (DWD)

Regional reanalysis show added value over ERA-I

Correlation of 10m wind speed (from German stations) is higher for the regional reanalyses.



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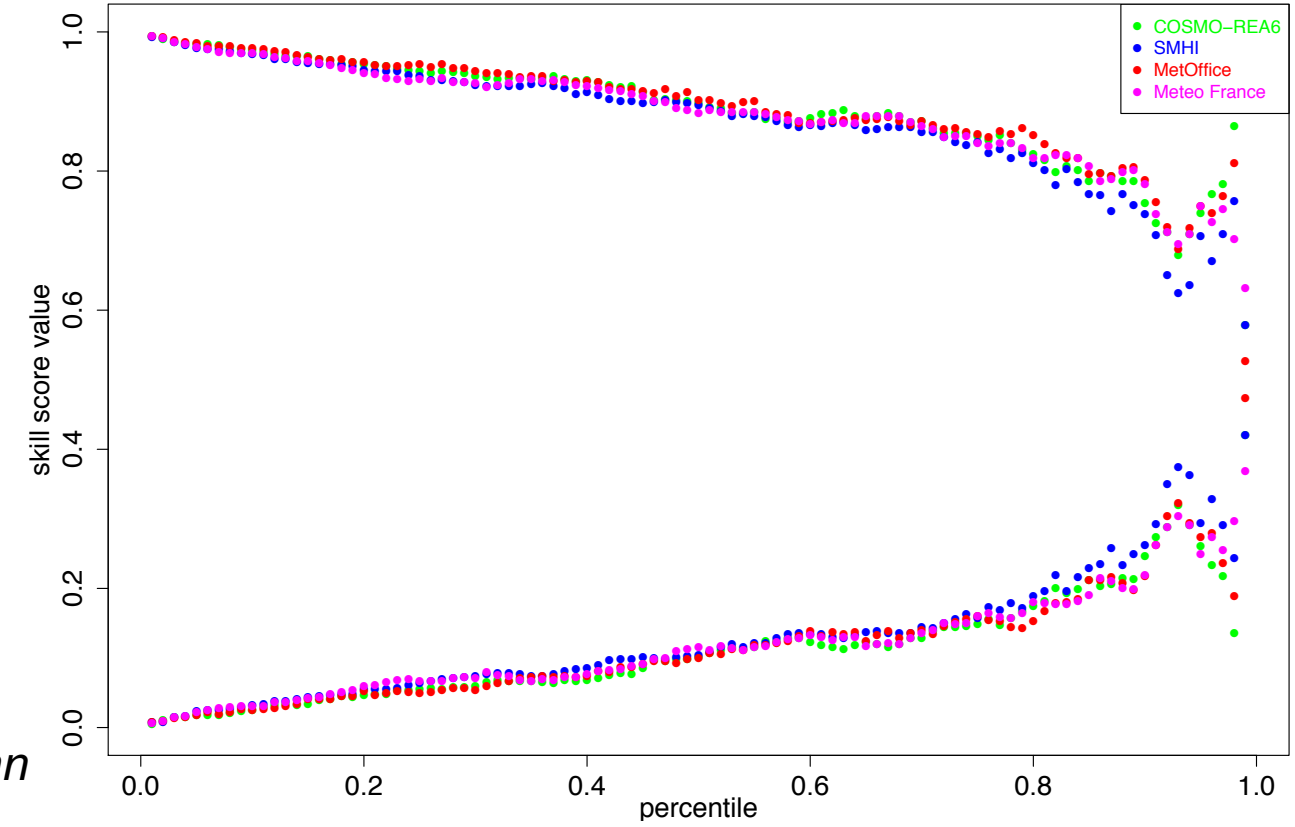
Relative scores can capture extremes

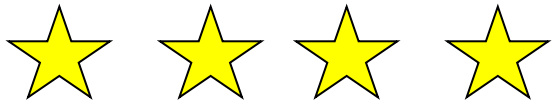
10m wind speed
contingency table

Deborah Niermann (DWD)

Hit rate vs False alarm ratio of daily means at Hannover

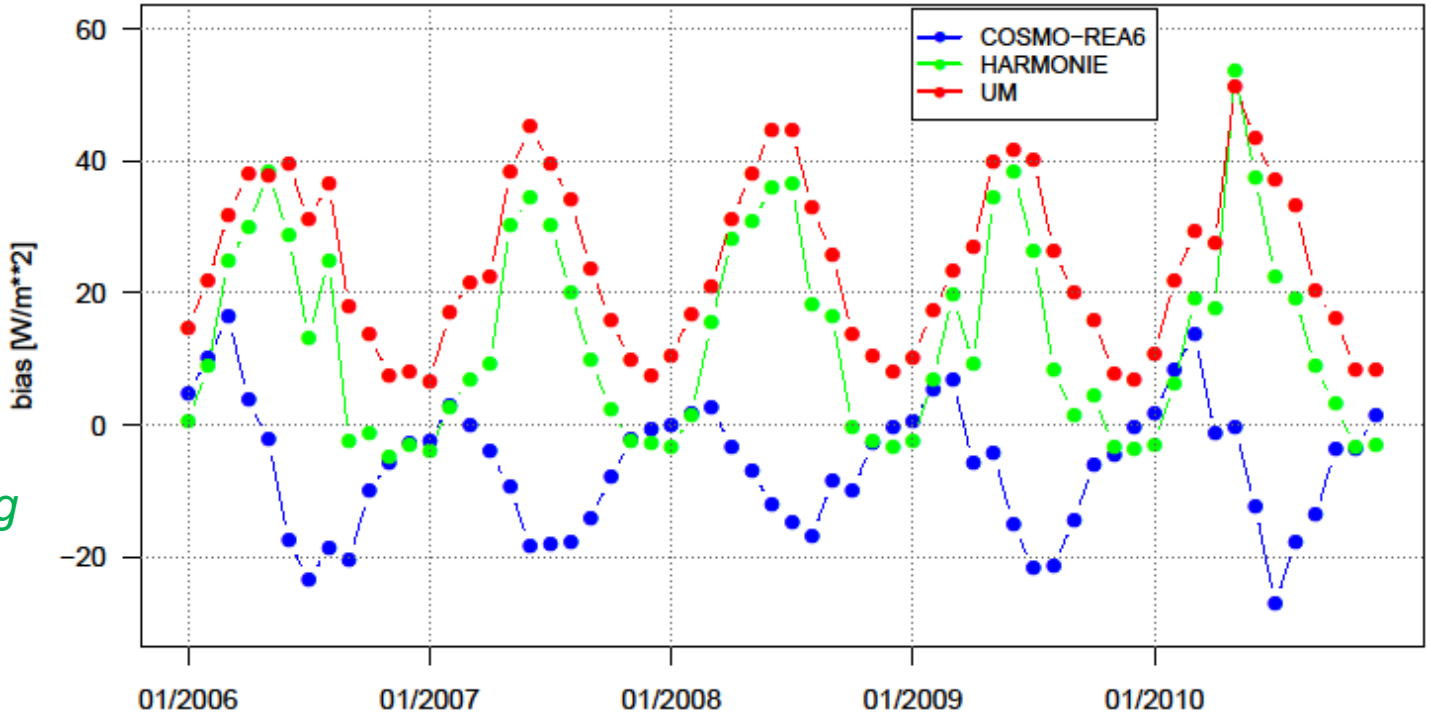


Summary for wind speed applications



- ➔ All regional reanalyses are an attractive data source for wind speed from 10m to 100m height at daily, monthly, annual and inter-annual scale, adding resolution and accuracy to the global reanalyses
- ➔ The correlations show a maximum peak at weekly time scale
- ➔ Care should be taken with the daily cycle from 50m height above ground and higher, there are limitations in temporal resolution of boundary layer changes.
- ➔ The bias depends on model system, wind speed (non-gaussian distribution !) and local effects

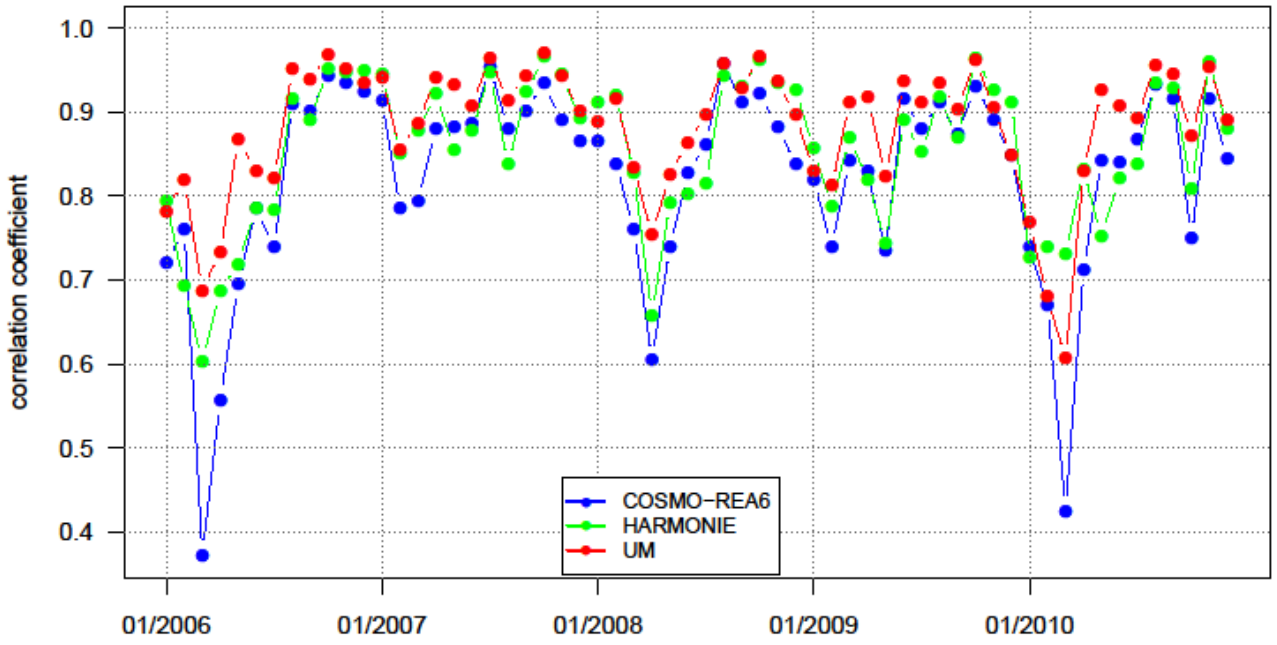
Radiation is heavily biased (depending on latitude, time of year, clouds, aerosols, …)



Solar incoming radiation
latitude band 45-55N
Michael Borsche (DWD)

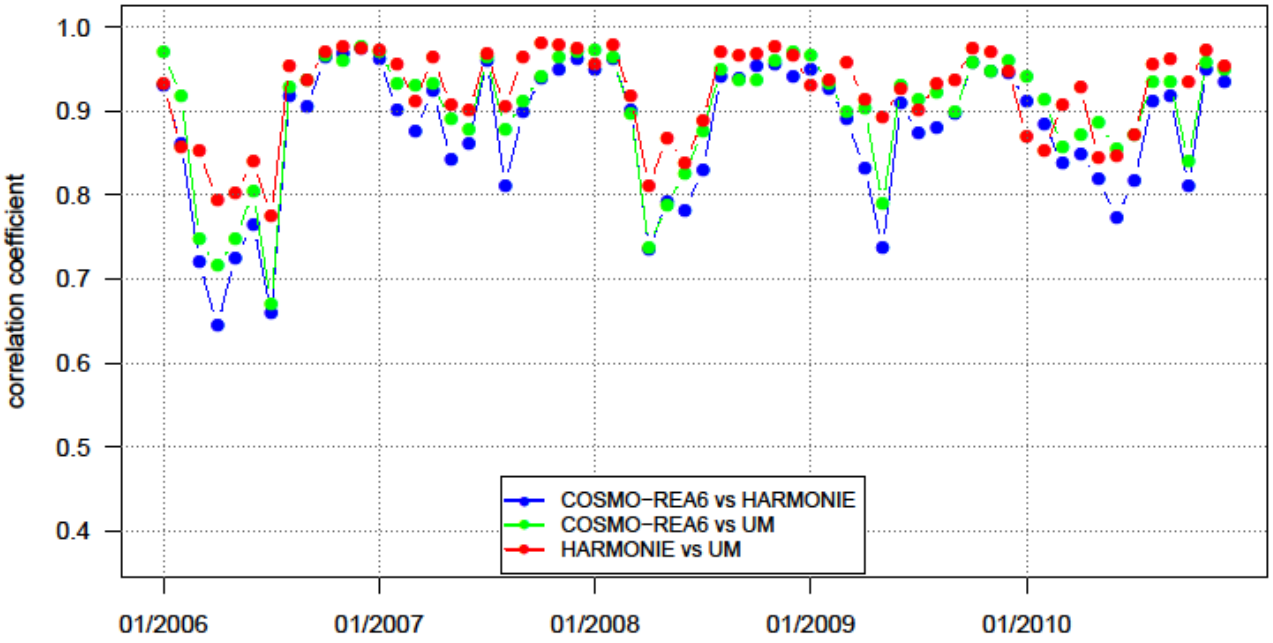
Monthly mean radiation - spatial correlation of regional reanalyses with SARAH-2

Some months with serious lack of correlation between regional reanalyses and satellite data Michael Borsche (DWD)



Monthly mean radiation - spatial correlation between regional reanalyses

Some months with less correlation between regional reanalyses
Michael Borsche (DWD)



Summary for radiation applications

- ➔ Model dependent bias, strongly dependent on region, month of year.
- ➔ Regional reanalysis fields are in some areas (e.g., far North, Alps) better than the CM SAF products

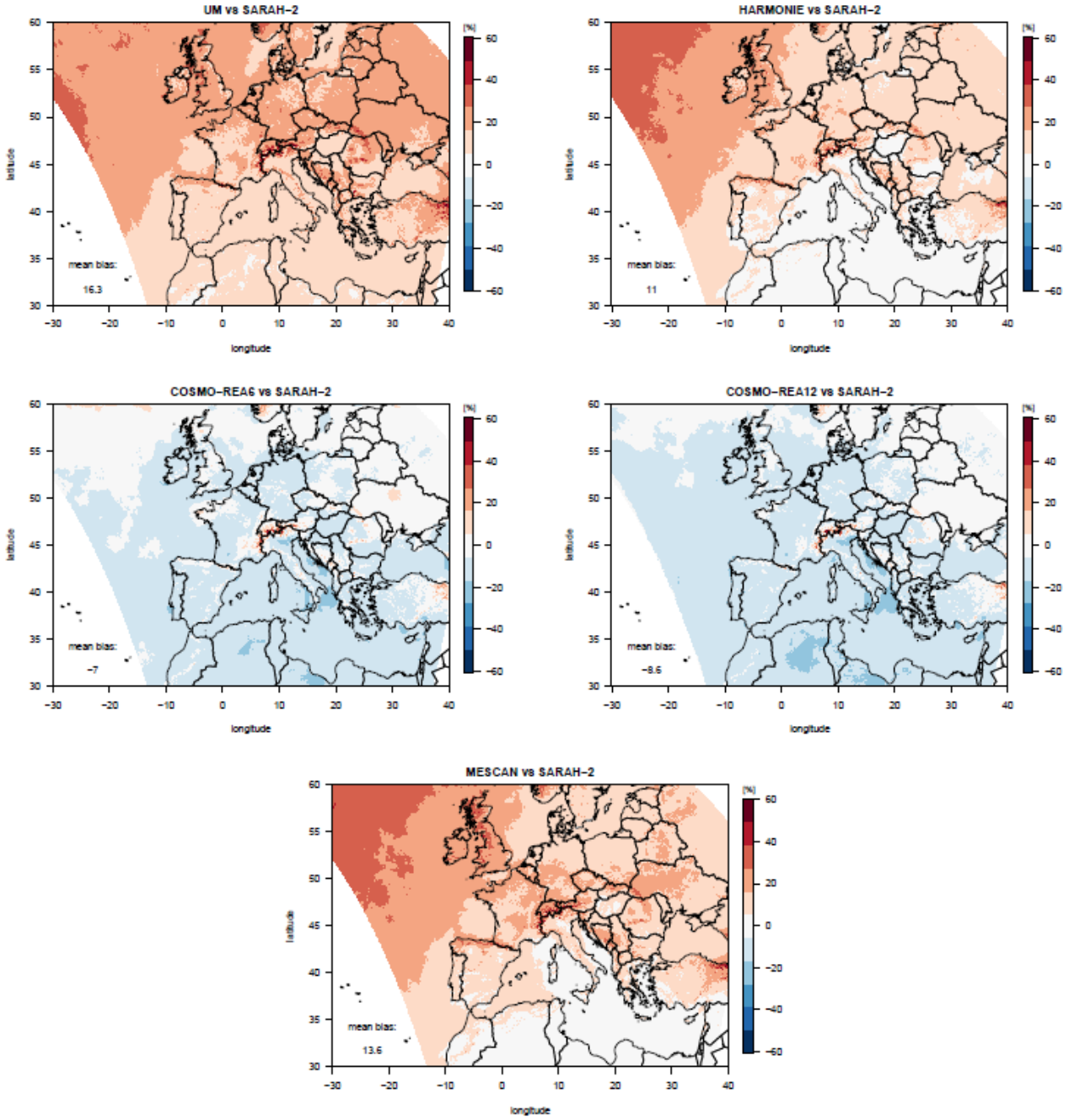


Figure 9: Daily mean percent bias of solar irradiance in 2008 between SARAH-2 and MESCAN, UM, COSMO-REA6, COSMO-REA12 and HARMONIE, respectively.

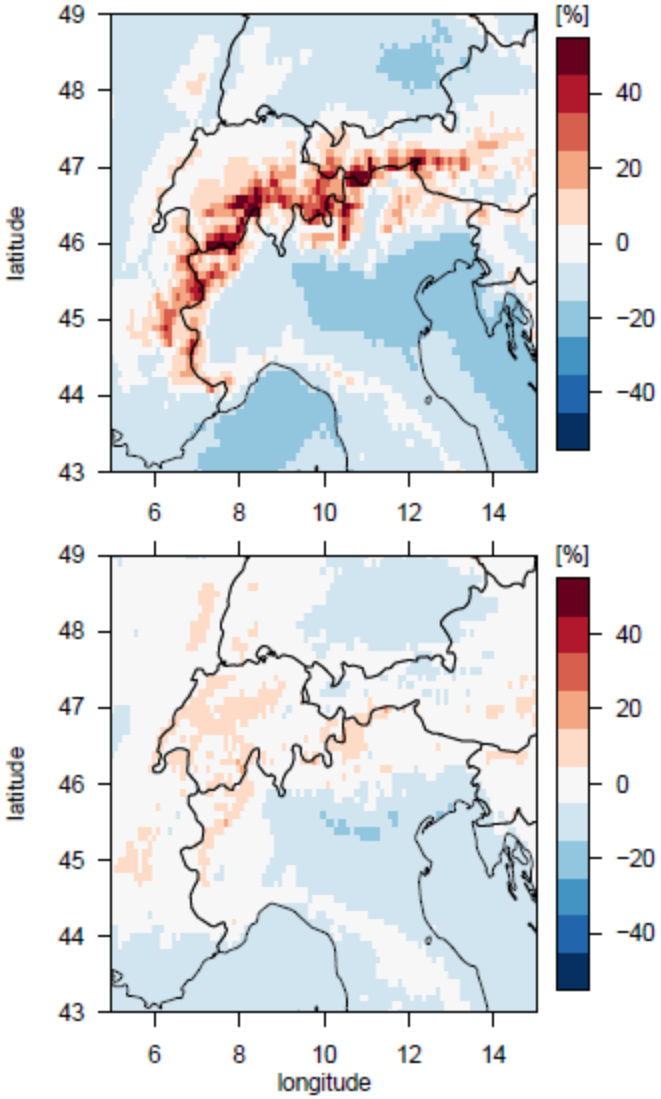
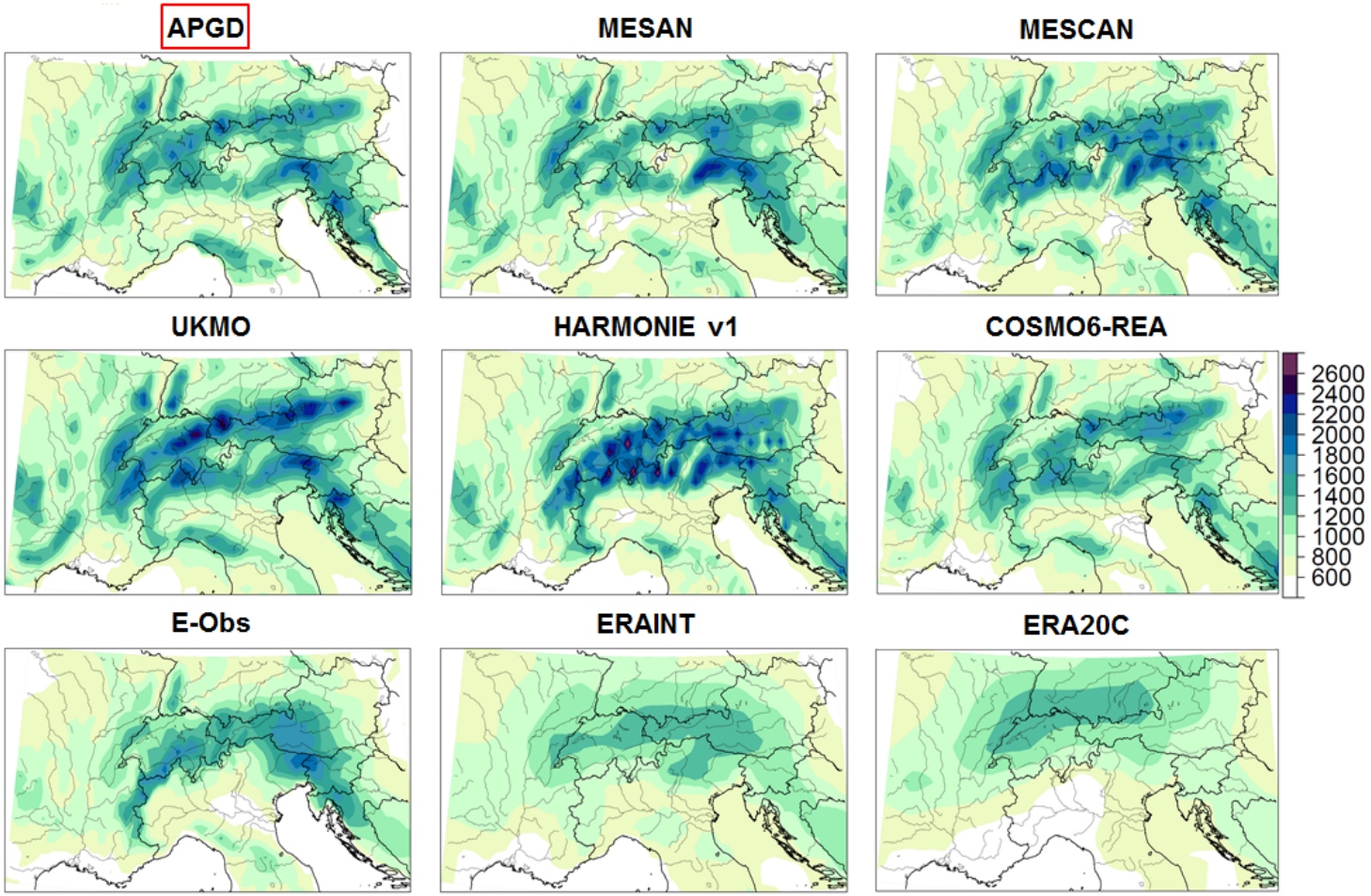


Figure 10: Monthly mean percent bias of COSMO-REA6 in 2008 over the Alpine region with reference data SARAH-2 (top) and HelioMont (bottom).

Precipitation: UERRA reanalyses show different climatological means

Mean annual precipitation (mm per year, 2006-2008). Datasets rescaled to 0.25° regular grid. Reference: APGD.



Francesco Isotta (MeteoSwiss)

Main results (Alpine Precipitation)

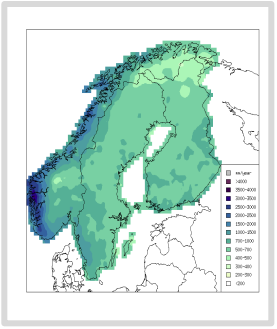
- Full regional reanalyses:
  - tendency to overestimate precipitation amounts and frequency, especially in complex terrain (Alps, Norway)
  - regional reanalysis shows better small scale structures and performance than observational gridded datasets in region of low station density (except wet-day frequency)
  - COSMO-REA6 and COSMO-ENS12 best performance.

- MeteoFrance downscaling data sets:
  - additional value in regions with dense station network
  - improvement especially for fraction of wet days

- Model error mostly bigger than uncertainty of the reference dataset (especially for days >10mm/d precipitation and global reanalyses)
- Scale dependent analyses: more information about the performance of the datasets depending on the application/scale of interest. Biggest differences from the reference and the lowest Brier skill score are found in complex topography, small catchment sizes and for higher precipitation amounts.
- Annual cycle is mostly well reproduced in all datasets.

Norwegian Meteorological Institute

Evaluation of daily precipitation
reference: Nordic (observational) Gridded Climate Dataset



Full regional reanalyses (RRAs):

precipitation fields have spatial structure similar to obs. gridded datasets (better than global RAs)

Overestimation of precipitation amounts and frequency, especially in complex terrain.

HARMONIE shows the best performances (dry area of Lapland in the north).

COSMO-ENS provides satisfactory results both on precipitation and of its uncertainty (Brier skill-score).

UKMO-ENS problem with precipitation amount (see UERRA report D2.14, Jermey et al.)

MeteoFrance downscaling data sets:

Additional value wrt RRAs, especially in regions with dense station network (prec and wet-day-freq better).

Local station density is the most important factor for quality of the post-processed precipitation fields.

The spatial structures are similar to the observational gridded datasets, though the downscaling datasets reach a very high detail of the precipitation pattern even in complex terrain.

MESCAN-SURFEX most detailed.

Generally: Most valuable contribution in data sparse regions. Largest differences found in complex topography, for higher precipitation amounts and in areas characterized by a sparse station network.

Annual cycle is mostly well reproduced in all datasets.

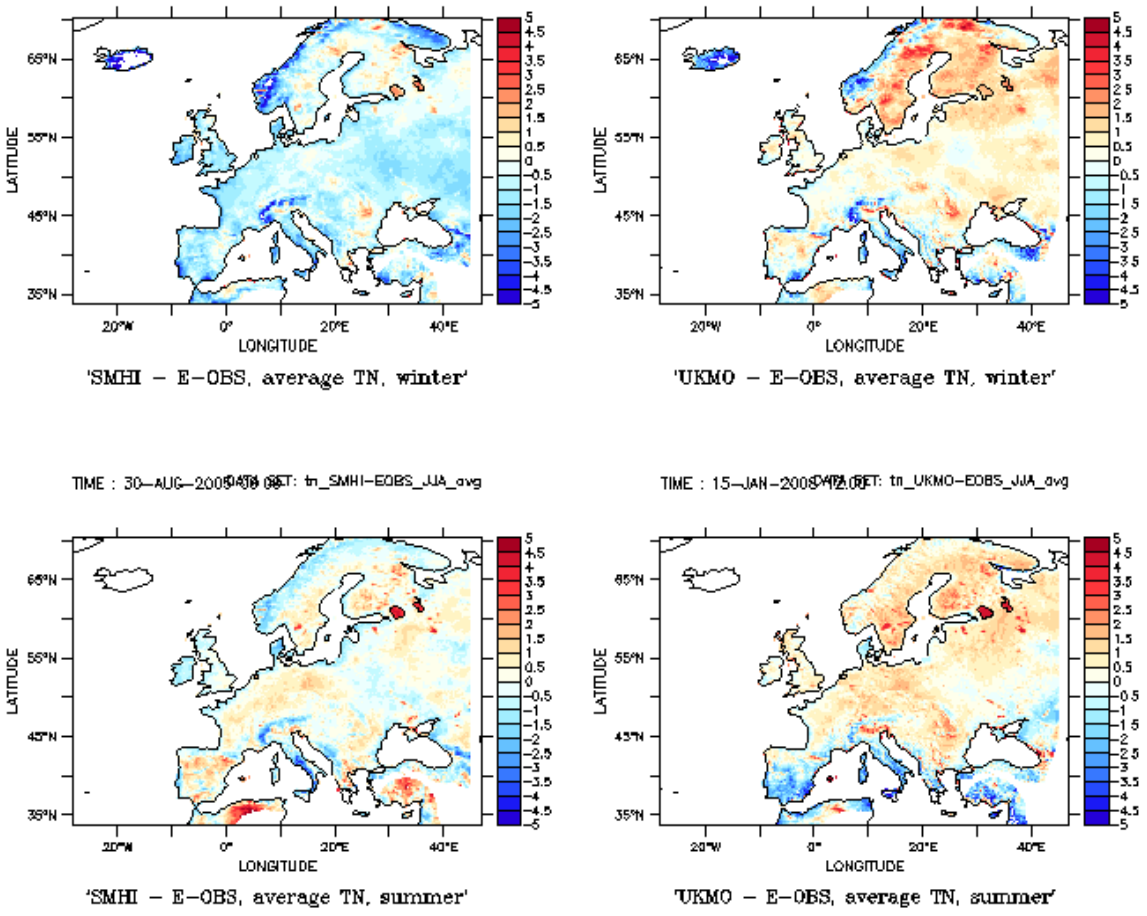
The spatial distribution of annual accumulated precipitation and the 95% quantile of daily precipitation are well reproduced by all datasets.

Summary for precipitation applications

- ➔ All regional reanalyses capture the spatial pattern of precipitation distribution
- ➔ There is a lot of small scale structure which is not easy to verify / falsify
- ➔ Different reanalysis vary in bias
- ➔ Annual cycle well reproduced
- ➔ Biggest differences from the reference and the lowest Brier skill score are found in complex topography, small catchment sizes and for higher precipitation amounts

Bias can be a problem (with consequences for climate indices)

Difference in winter (top) and summer (bottom) in **daily minimum temperature** between the SMHI reanalysis (left) and UKMO reanalysis (right) versus E-OBS.



Else van den Besselaar (KNMI)

Comparing E-OBS temperature against UERRA reanalysis

- tracing the variability

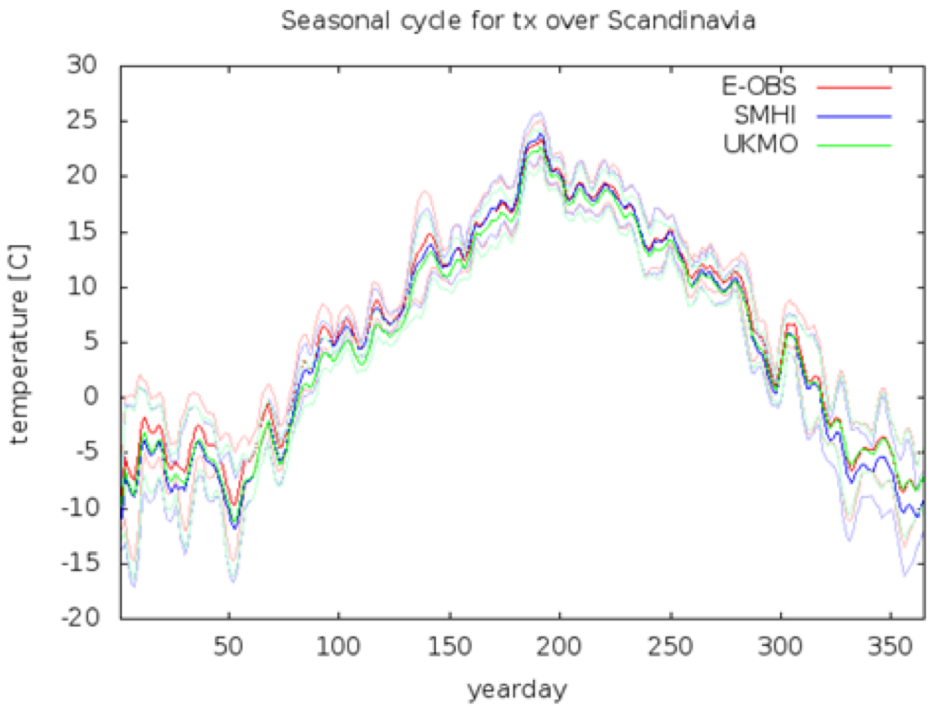
- bias problem:

cold extremes in winter are too cold

…while in summer, the warm extremes are too hot

- causing frost & summer days differences of up to 40 days/year

- spread in reanalysis too small to bridge the bias



Else van den Besselaar (KNMI)

Summary for temperature applications

- ➔ Regional means of temperature are good for use – as long as no thresholds are involved
- ➔ Long-term evaluation still missing

Summary for climate indices applications

(★)

- ➔ Model dependent bias, with consequences for climate indices
- ➔ Number of threshold exceedance critically dependent on bias
- ➔ Bias may depend on topography effects, or on (varying) resolution

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1. UERRA regional reanalyses capture synoptic features well and show added value over ERA-I.

3. Relative scores can capture extremes.

4. Regional reanalysis are recommended:
   - for wind speed applications (note daily cycle difficulty)
   - for radiation applications (note complicated bias)
   - for spatial distribution of precipitation (note absolute amounts differ between regional ranalyses)
   - for many situations, reanalysis temperatures are good alternatives to observations, but beware of extremes

5. Applications for any application involving thresholds (like climate indices) require careful treatment of bias.