Verification of wind speed and radiation in regional reanalyses

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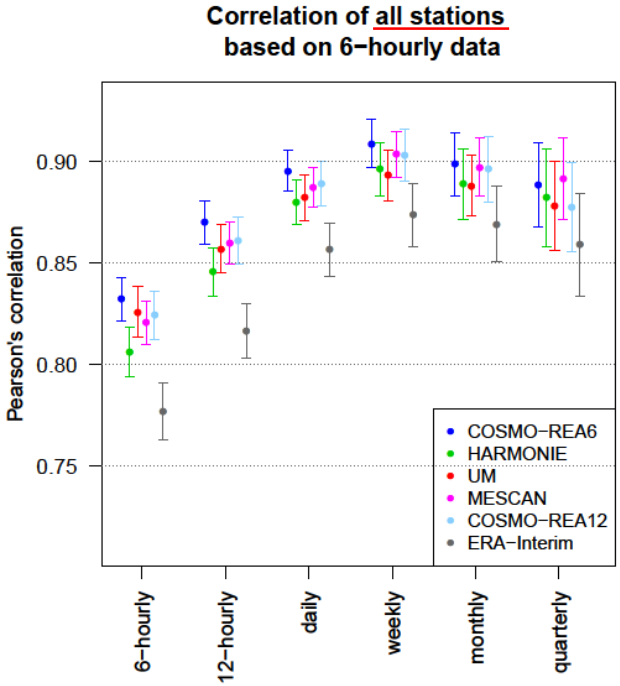
Summary of DWD contributions in 2017

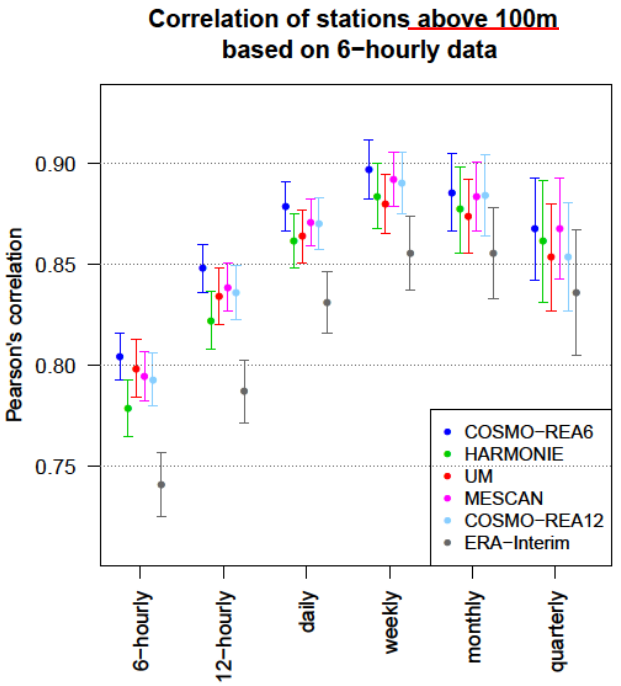
- Deliverable D3.6: Scientific report on assessment of regional reanalysis against independent data sets
  - Comparison against independent/dependent station measurements
    - Investigation of wind speed from 10m to 100m height
    - Including RRA products from UKMO, SMHI, MF and DWD/UB
    - Using COSMO-REA6, ERA-Interim and ERA-20C
    - Assessing uncertainty of UM and DWD ensembles
  - Comparison against satellite data
    - Expansion with new UERRA data sets from UM,MESCAN, COSMO-REA12
    - Using global radiation satellite data from (SARAH SIS and HelioMont)

Comparison of wind speed from RRA‘s against point measurements

- Use of station observations over Germany
- Use of independent mast measurements over Germany, Netherlands North and Baltic Sea

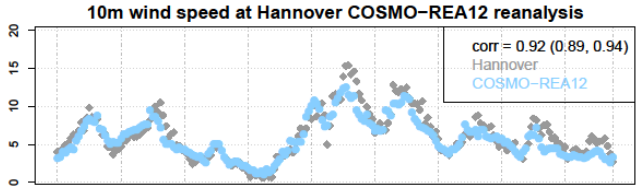
Time dependent correlation

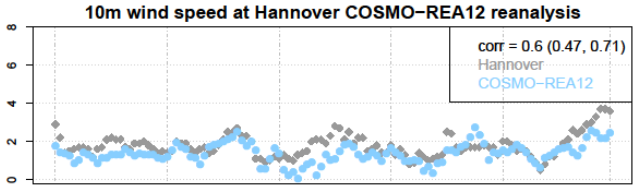


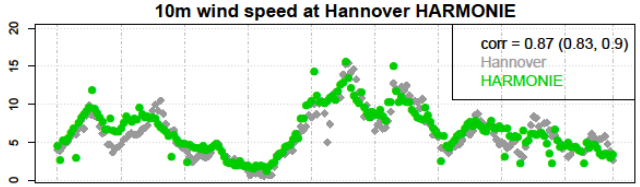


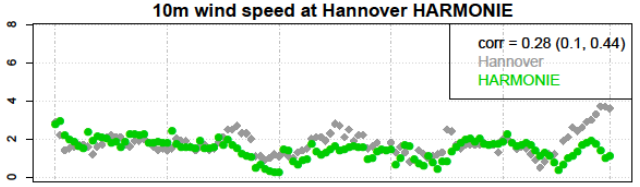
- Added value of regional reanalyses
- Peak when averaging over a few days
- COSMO assimilates 10m wind speed for stations beneath 100m height and UM beneath 500m height
- Distinction of quality between assimilated and non assimilated stations is not obvious (Kaiser-Weiss et al., 2015)

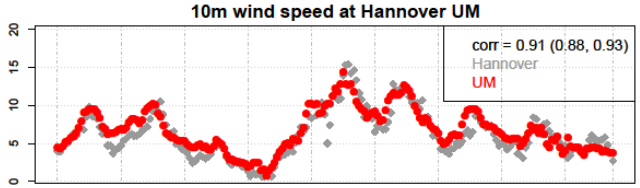
Various time periods

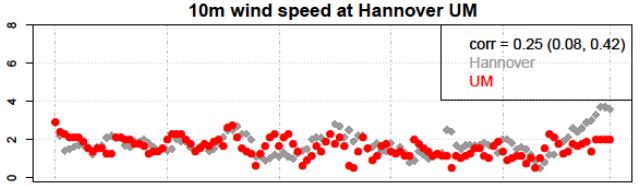


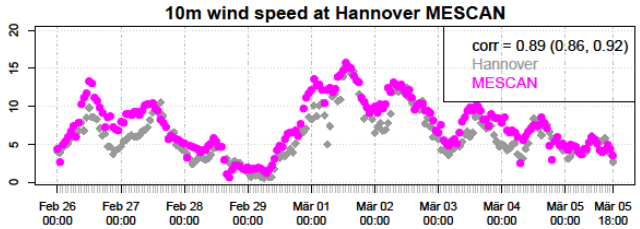


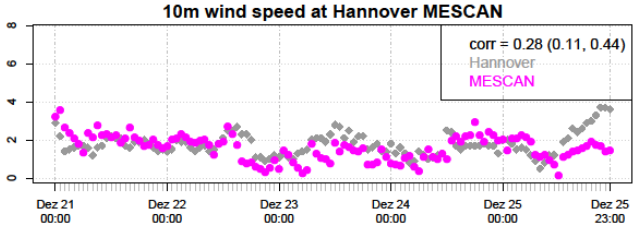






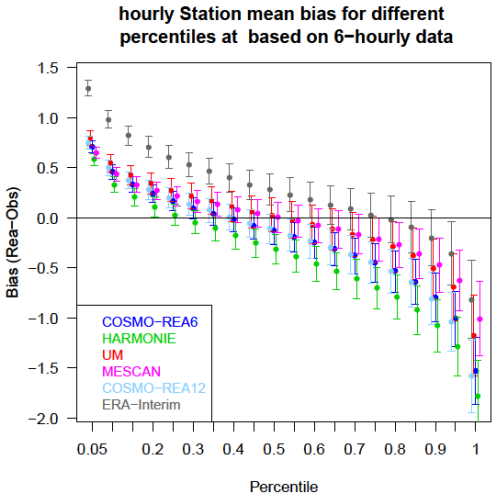


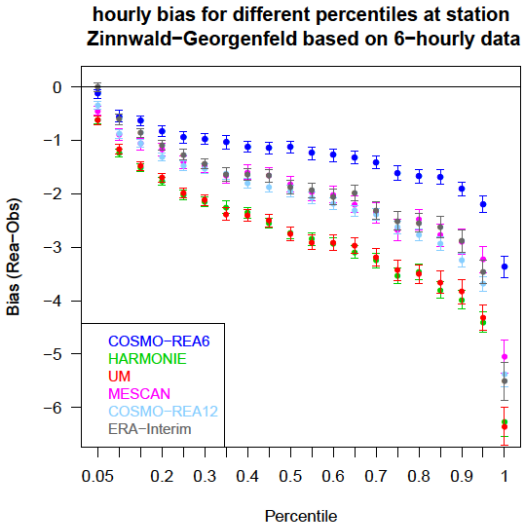


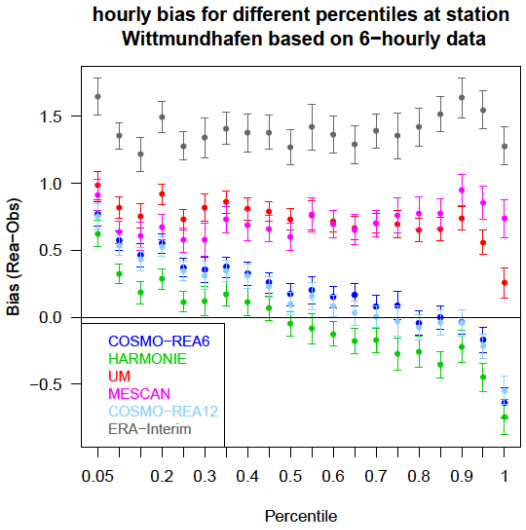


- Correlations of low wind periods are much smaller than for storm events
- Big improvements against EURO4M data sets

Dependency of wind bias





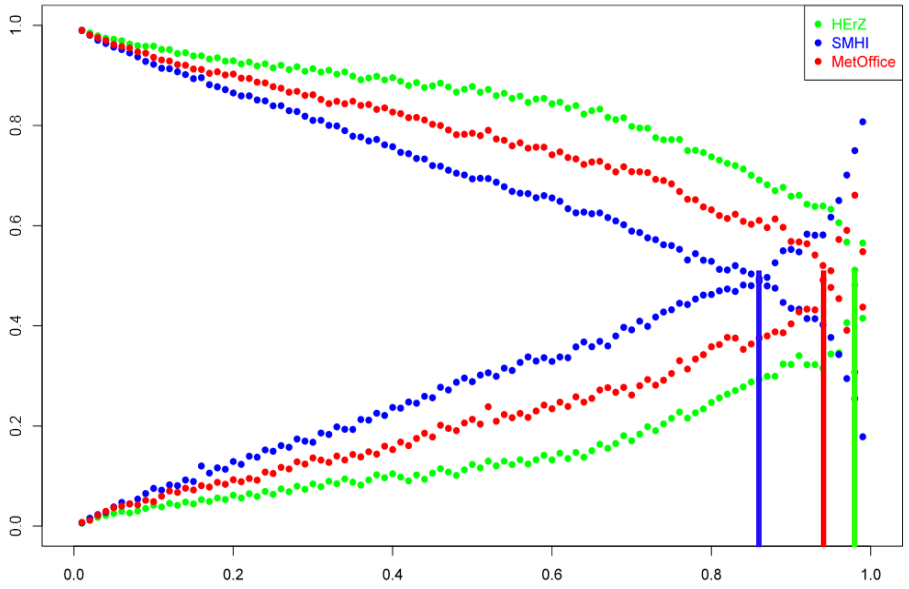


At locally influenced stations, the bias:

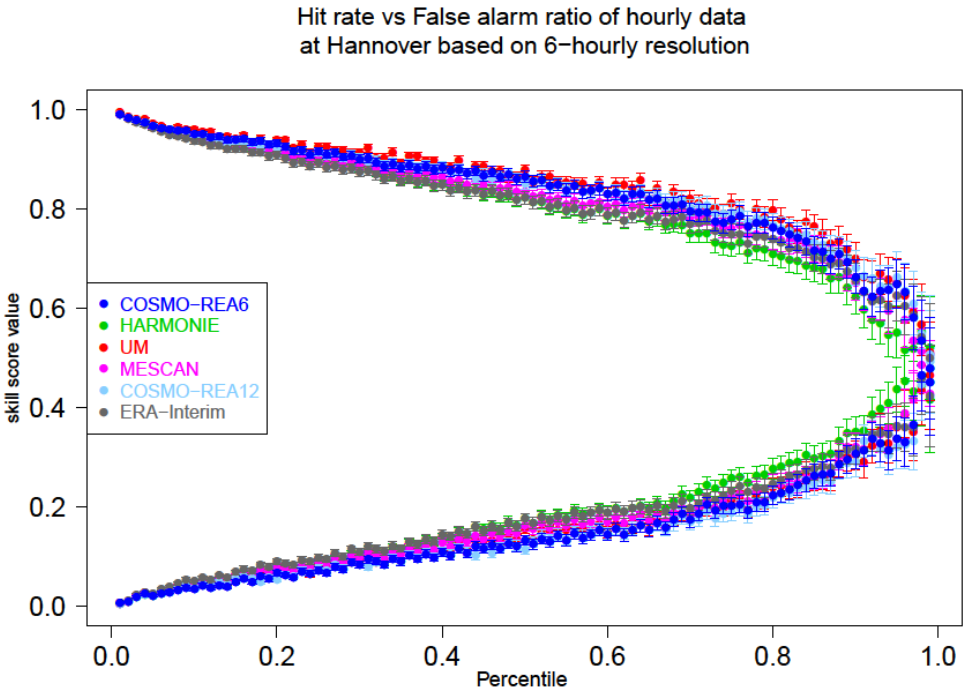
- ➔ At locally influenced stations, the bias:
  - = station dependent
  - = model dependent
  - = wind speed dependent
- ➔ Overestimation of low wind speeds and underestimation of high wind speeds
- ➔ Mean bias for station beneath 500m:
  - HARMONIE= 0.15±0.09
  - COSMO-ERA12=0.05±0.09
  - UM=0.29±0.11
  - MESCAN=0.22±0.1

Improvement towards EURO4M

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



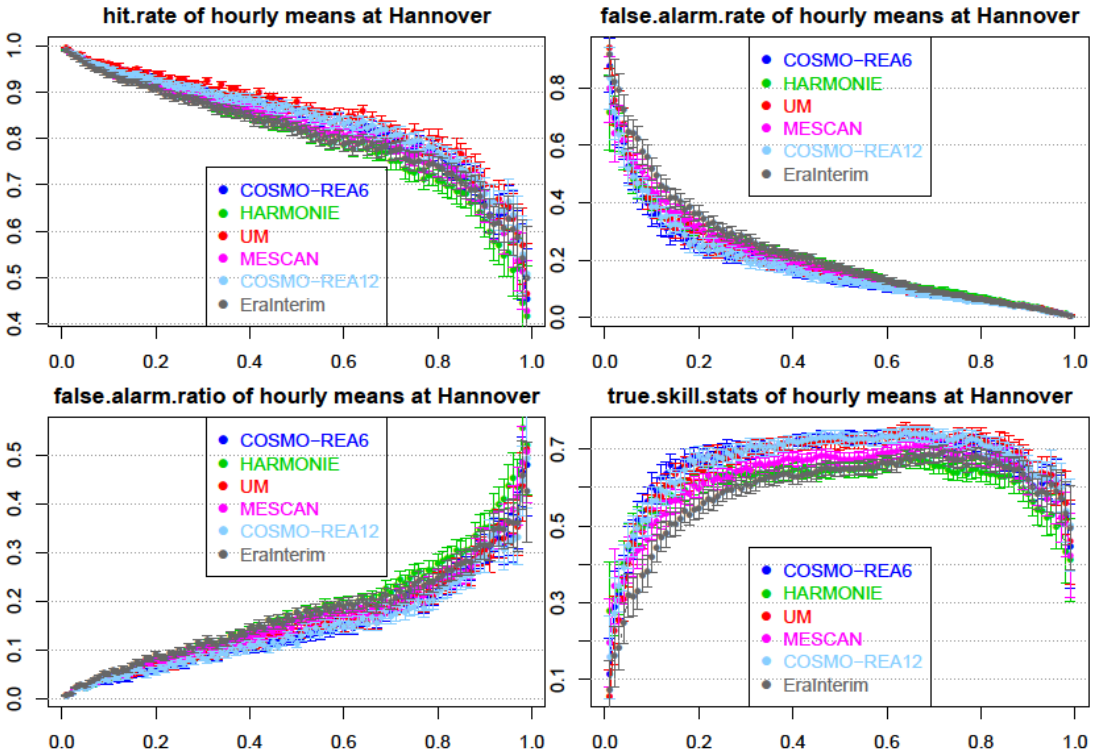
EURO4M



UERRA

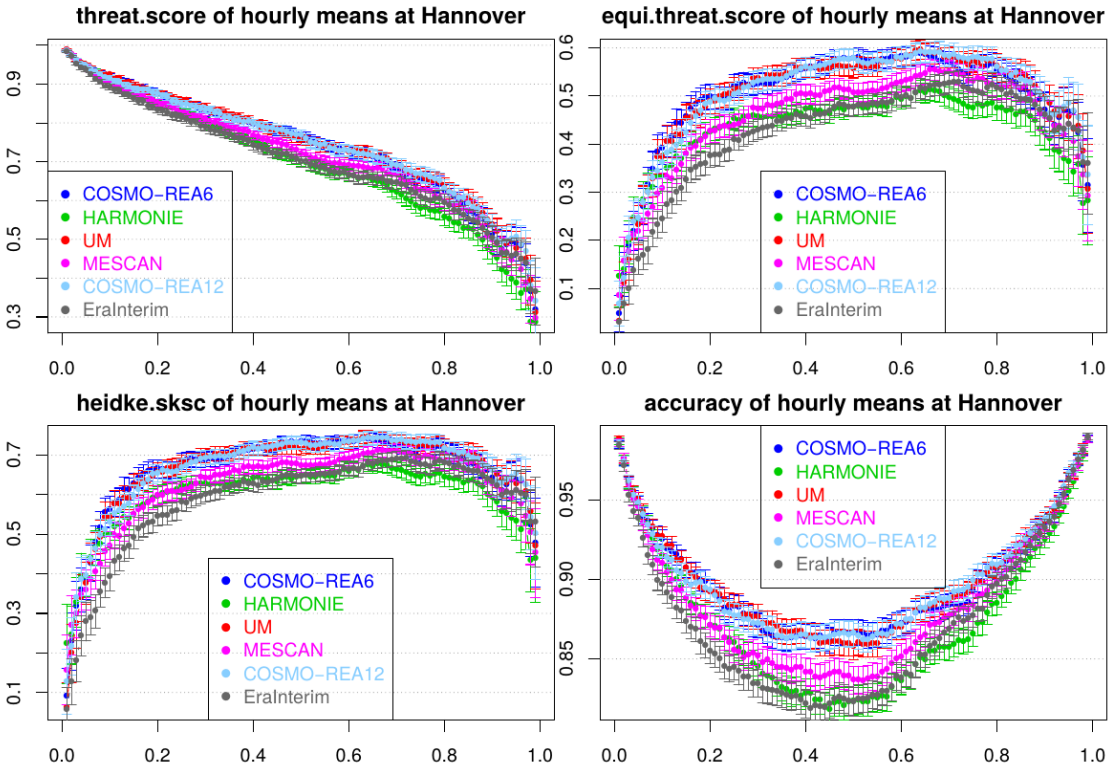
- Appropriate scores based on contingency table: Hit rate and false alarm ratio
- When HR and FAR cross, the model does not have skill anymore
- Only COSMO-REA6 has skill up to highest wind speeds for EURO4M
- All UERRA datasets show skill up to highest wind speeds

Evaluation of different scores



➔ For extreme events, the scores have to be independent of the base rate (symmetric extremal dependence index)

Evaluation of different scores



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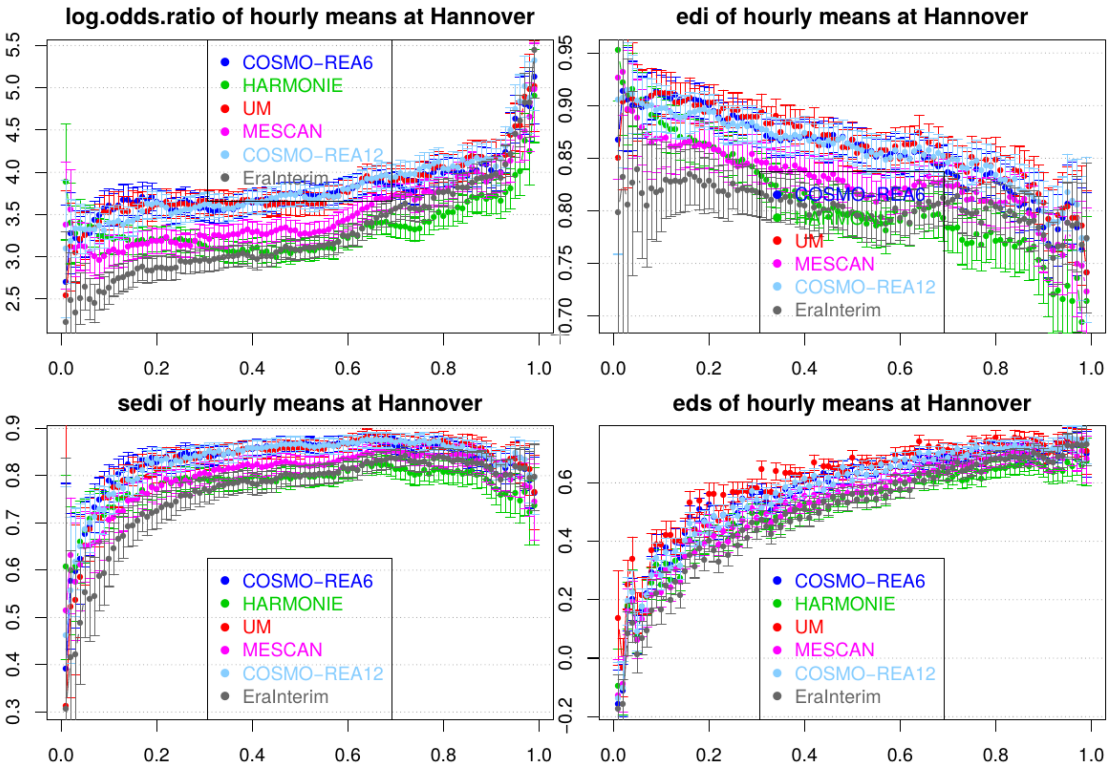

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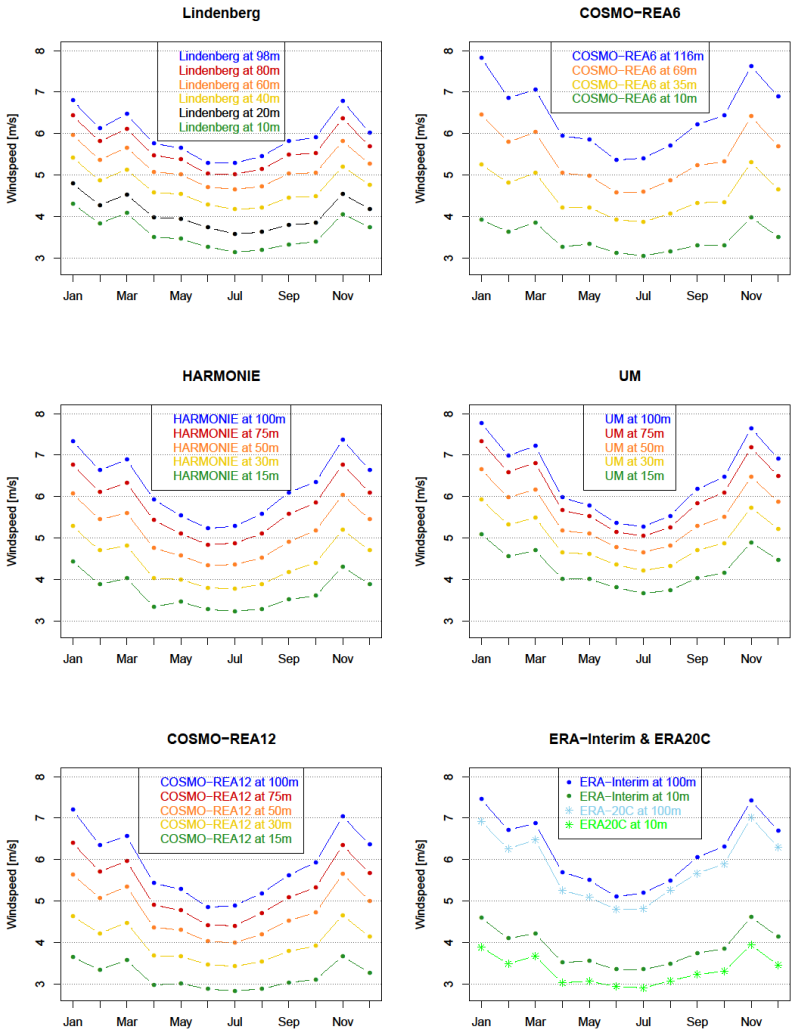
Wind speed up to 100m height

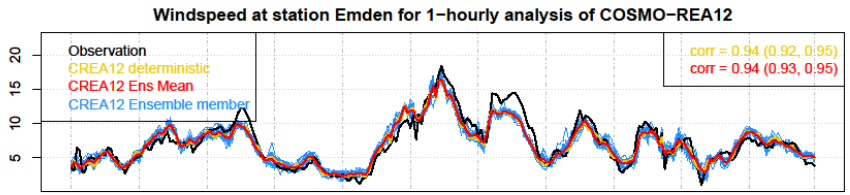


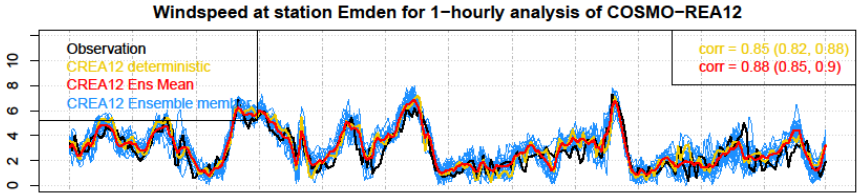
- Seasonal cycle is well reproduced at tower locations from 10m up to 100m height
- Annual variability increases with height
- Reproduction of daily cycle is more challenging (Borsche et al., 2016)

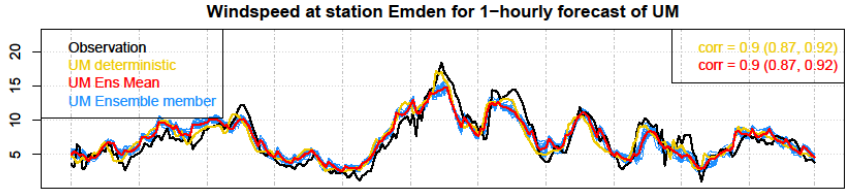
Analysis of reanalysis ensembles

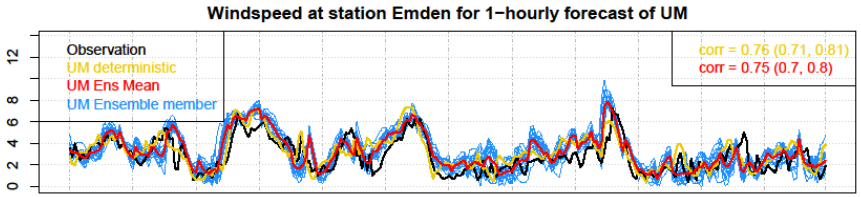
- Concepts of probabilistic forecast verification includes Brier Score, CRPS, rank histograms, reliability diagrams,…
- Here: Investigation of ensemble spread for user friendly uncertainty estimation
- Analysis includes 3 ensemble systems:
  - COSMO-REA12 ensemble with 20 members,
  - UM ensemble with 20 members
  - Multi model UERRA ensemble, consisting of the deterministic model runs from MESCAN, HARMONIE, UM and COSMO-REA12

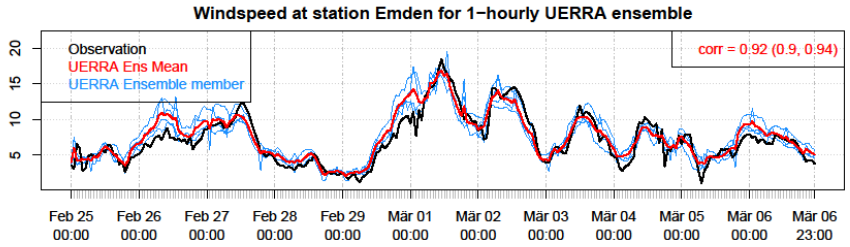
Seasonal variation of spread

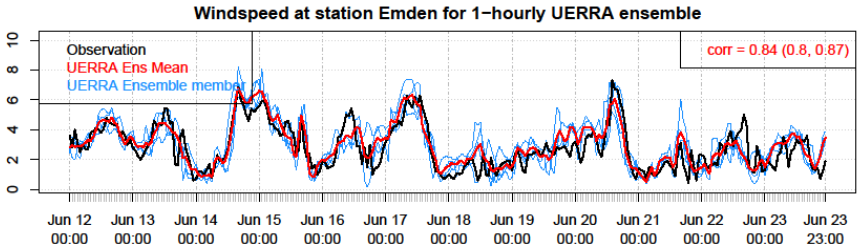










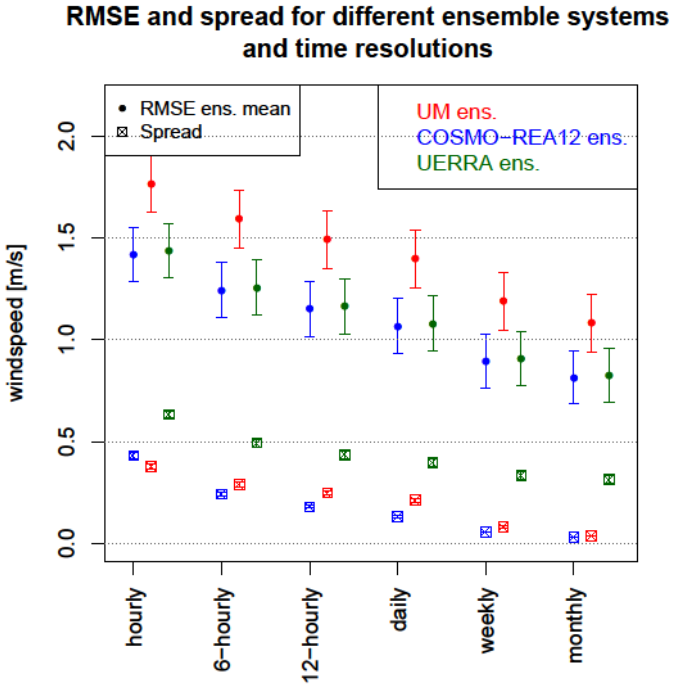


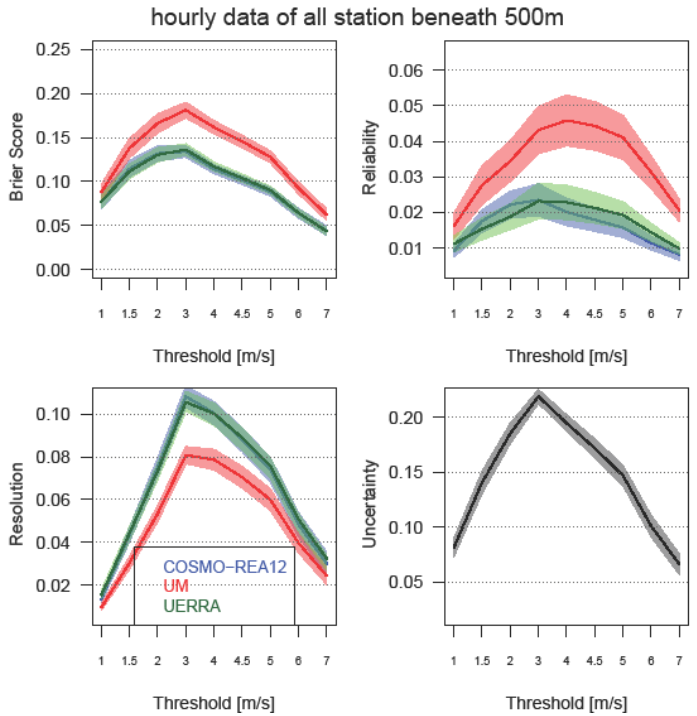
Winter

Summer

- Control and Ensemble mean are very similar for Crea12
- The spread increases in the summer season for UM and COSMO-REA12 ensemble

Analysis of spread



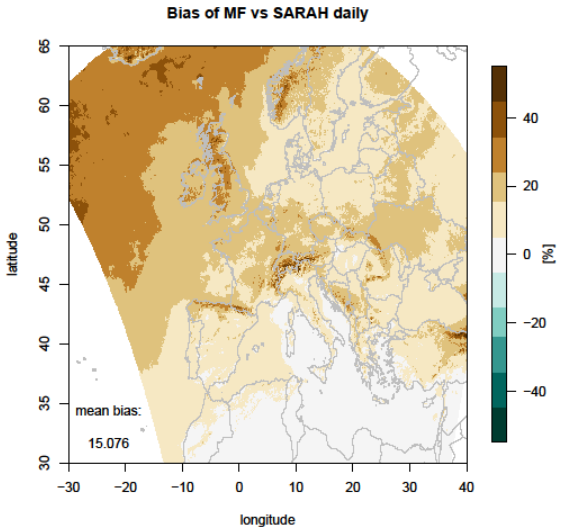


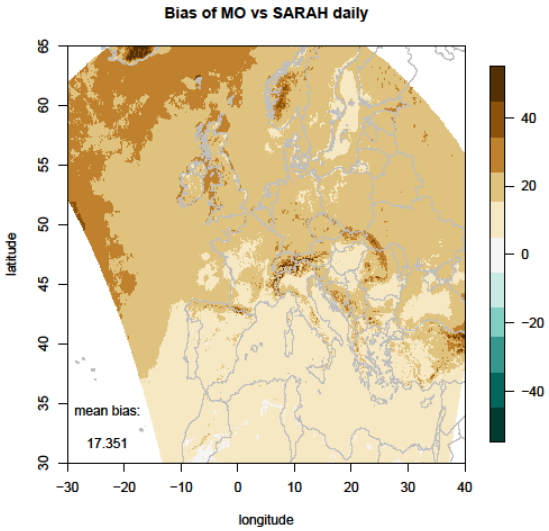
- The ensembles are underdispersive, considering 10m wind speed, but the spread represents uncertainty in model space only
- COSMO-REA12 shows a better resolution and reliability than UM

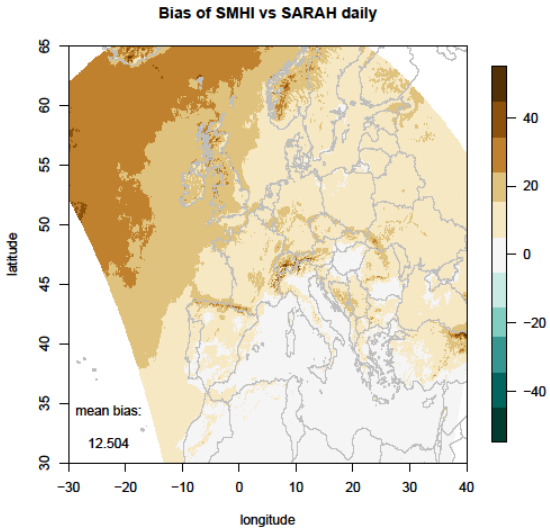
Comparison of global radiation from RRA's against satellite data

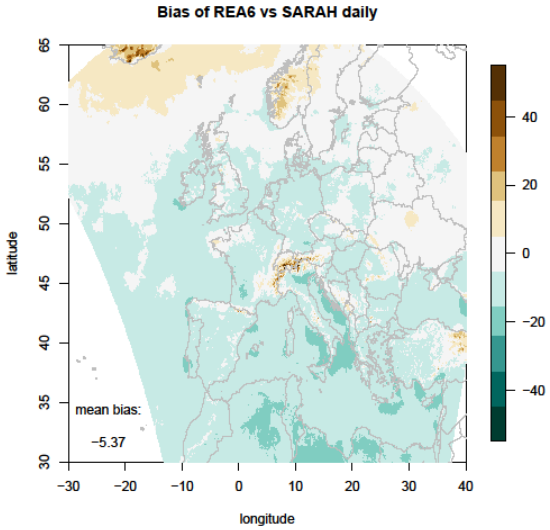
- Comparison against satellite data: CM SAF SARAH, HelioMont data from MeteoSwiss
- Using COSMO-REA12, HARMONIE, UM and MESCAN reanalyses
- All RRA's are remapped to regular grid of 0.1°
- Following pictures are Investigations for 2008 only

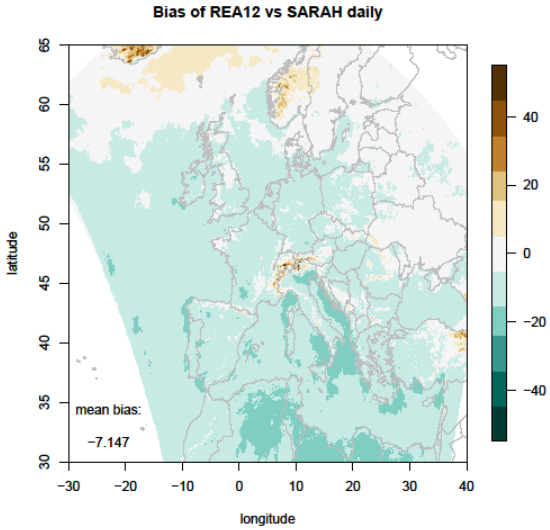
Daily Bias


Bias of MF vs SARAH daily
mean bias:
15.076
[%]
latitude
longitude

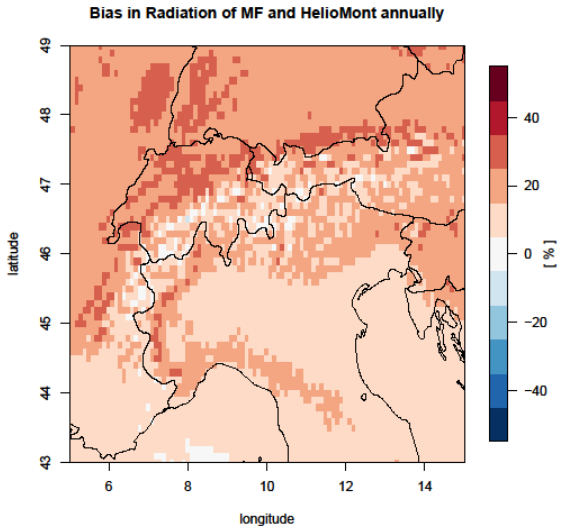

Bias of MO vs SARAH daily
mean bias:
17.351
latitude
longitude

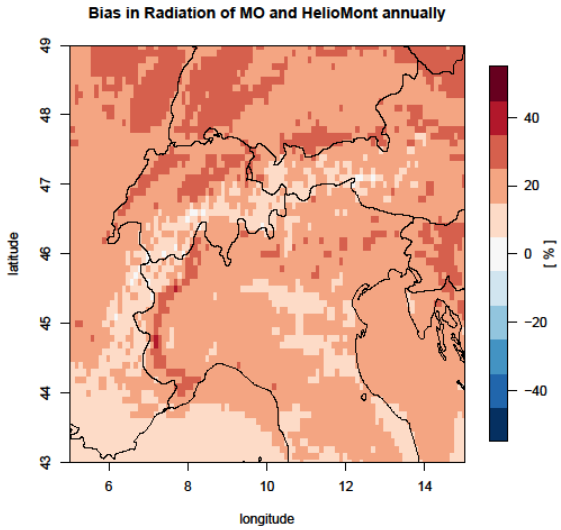

Bias of SMHI vs SARAH daily
mean bias:
12.504
latitude
longitude

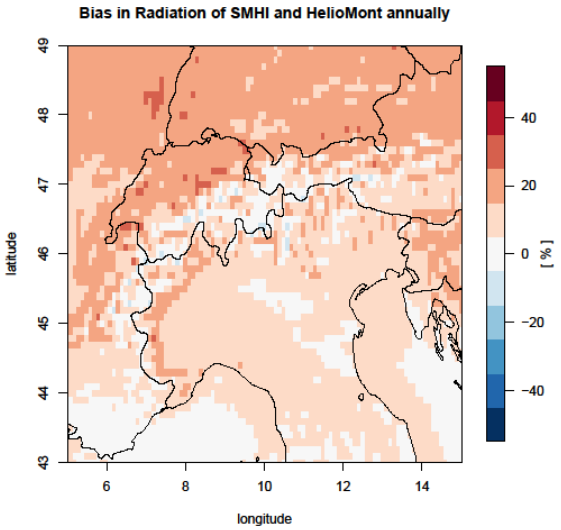

Bias of REA6 vs SARAH daily
mean bias:
−5.37
latitude
longitude

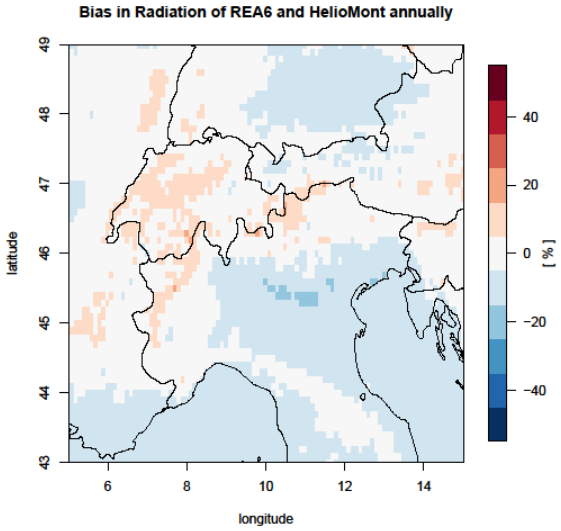

Bias of REA12 vs SARAH daily
mean bias:
−7.147
latitude
longitude

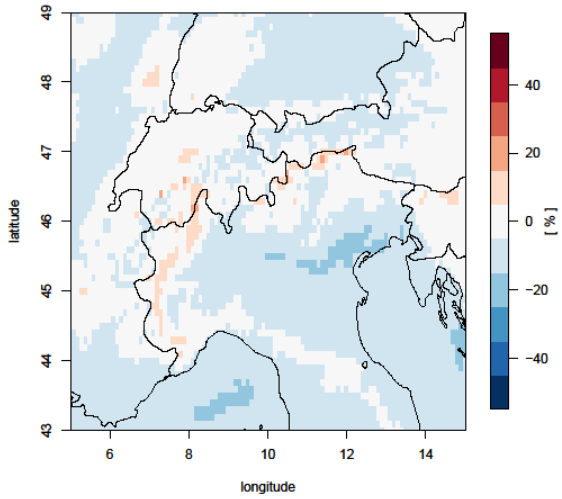
Zoom to specific area











Summary

- Validation of reanalyses has been extended to all regional reanalysis products of UERRA
- Comparison of windspeed against station observations show good correlations (peak at weekly scale) for all reanalyses
- Strong improvements for UM and HARMONIE according to EURO4M data sets
- The wind bias includes dependencies on model system, local effects and wind speed
- The ensembles UM and COSMO-REA12 show an increased spread for wind speed in the summer season
- By comparison against CM SAF SARAH SIS it has been shown:
  - COSMO-REA6 and REA12 global radiation has a daily negative bias of <8% over land areas
  - HARMONIE, MESCAN and UM global radiation have a daily positive bias of ~12-17%
- The comparison against Helios in the alpine region underlines that results not only depend on properties of model system but also on the quality of the reference data set