Verification of wind speed and radiation in regional reanalyses

Michael Borsche, Andrea Kaiser-Weiss, Frank Kaspar, (DWD)

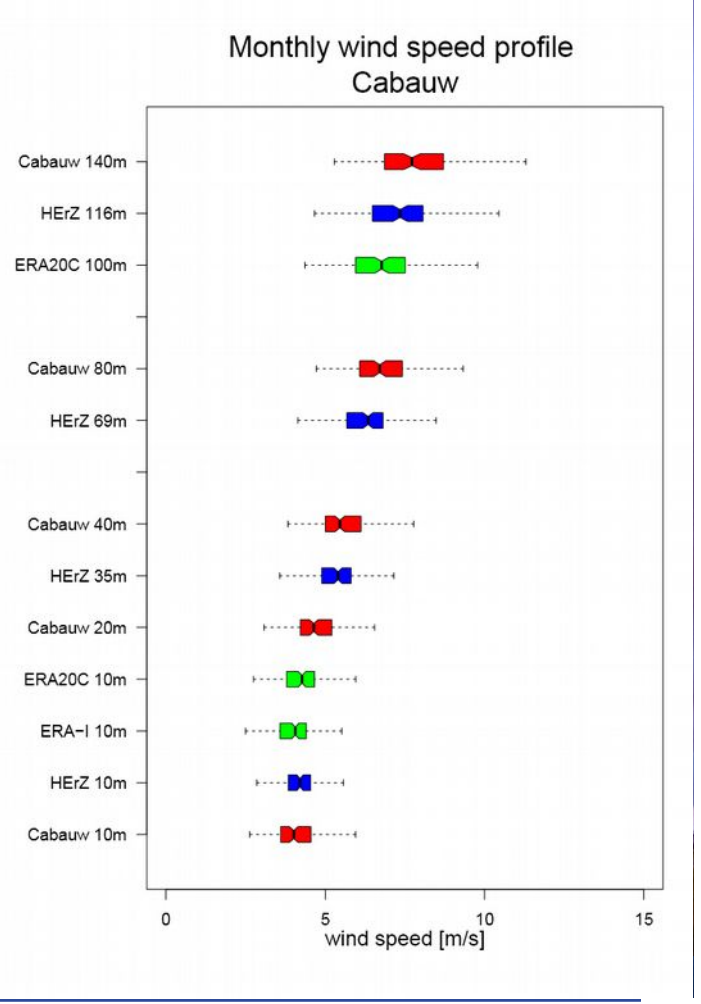
UERRA GA-4, 22 Nov 2016, Reading, UK

Summary of DWD contributions to WP3 in 2016

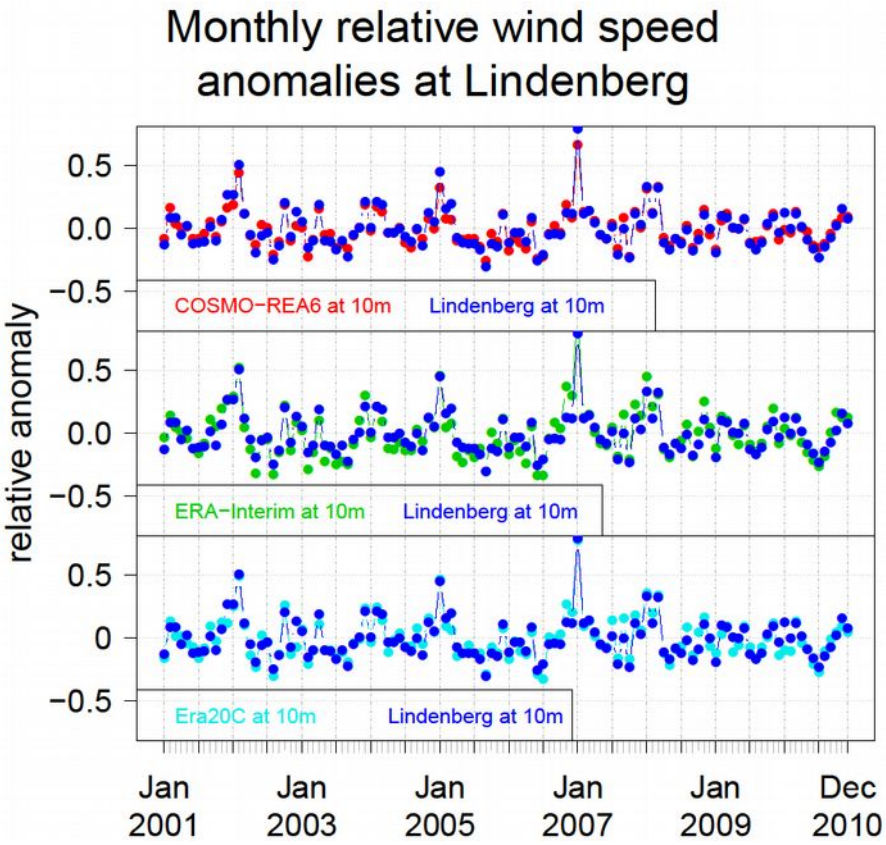
- D3.5: Preliminary report of assessment of regional reanalyses – first results
  - Method B: Comparison against station observations
    - Comparison against tower observations: wind speed
    - Using COSMO-REA6 reanalysis
  - Method D: Comparison against satellite data: CM SAF SARAH SIS
    - Comparison against CM SAF SIS (global radiation)
    - Using COSMO-REA6, HARMONIE, ALADIN reanalyses
    - Handling grib2
    - Handling lambert projection

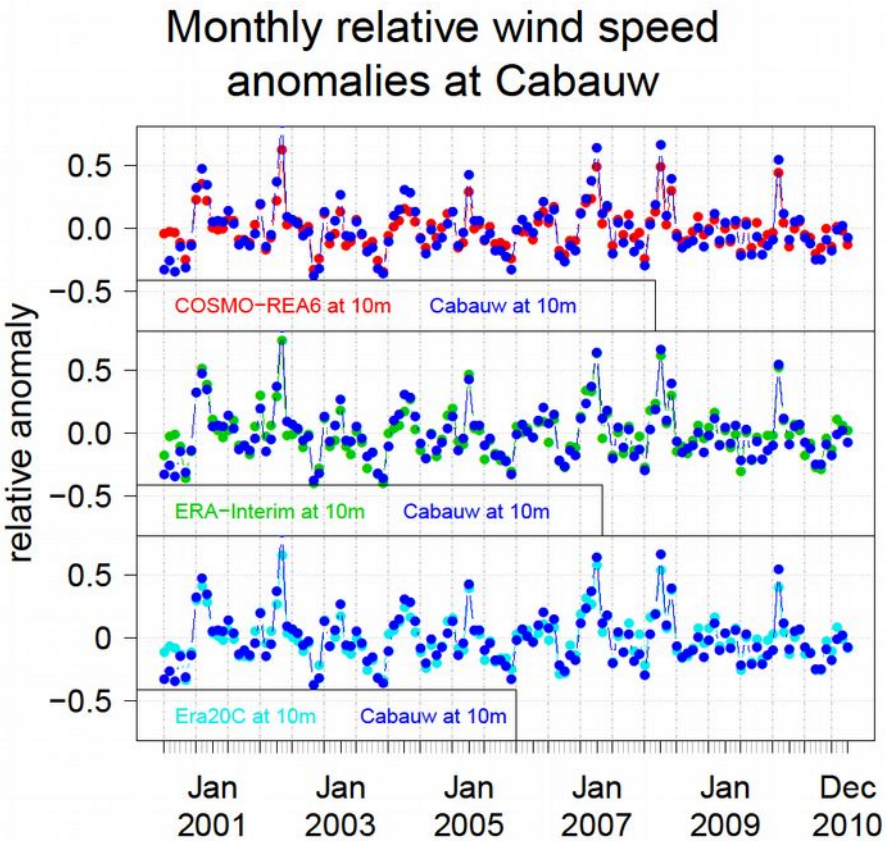
Comparison against wind speed of tower measurements

- Using COSMO-REA6 reanalysis
- Lindenberg, Northern Germany
  data from DWD
- Cabauw, The Netherlands
  data from Cesar site
- FINO 1 and FINO 2 scientific platforms in the North and Baltic Sea
  data from BSH
- Results published in Borsche et al., 2016 (published on Monday)

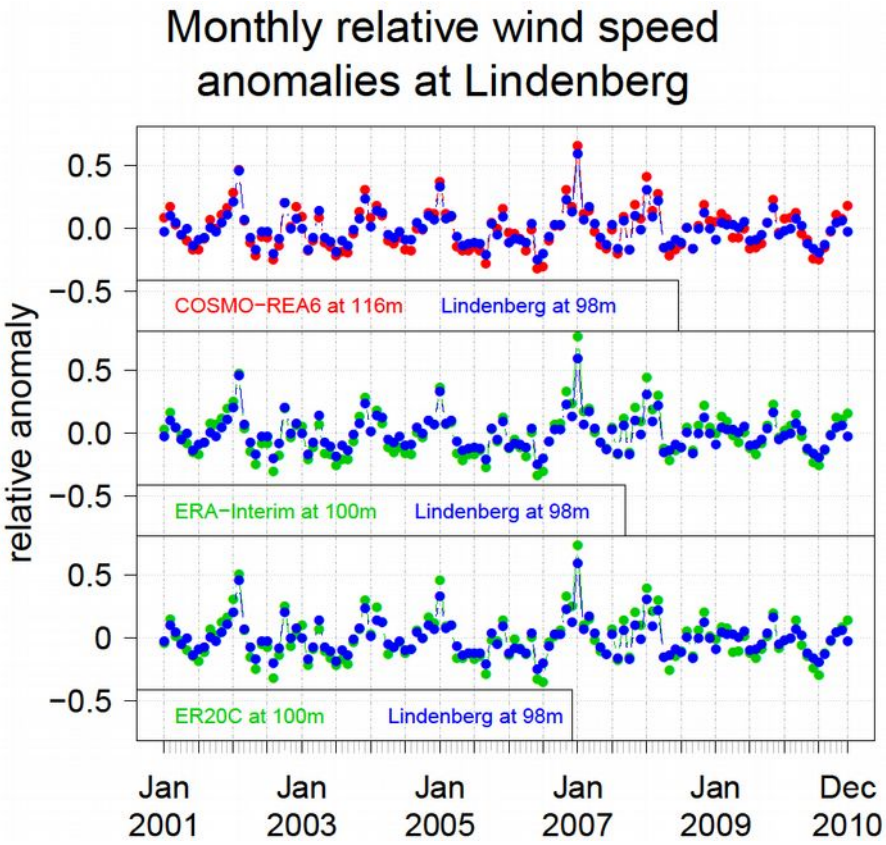


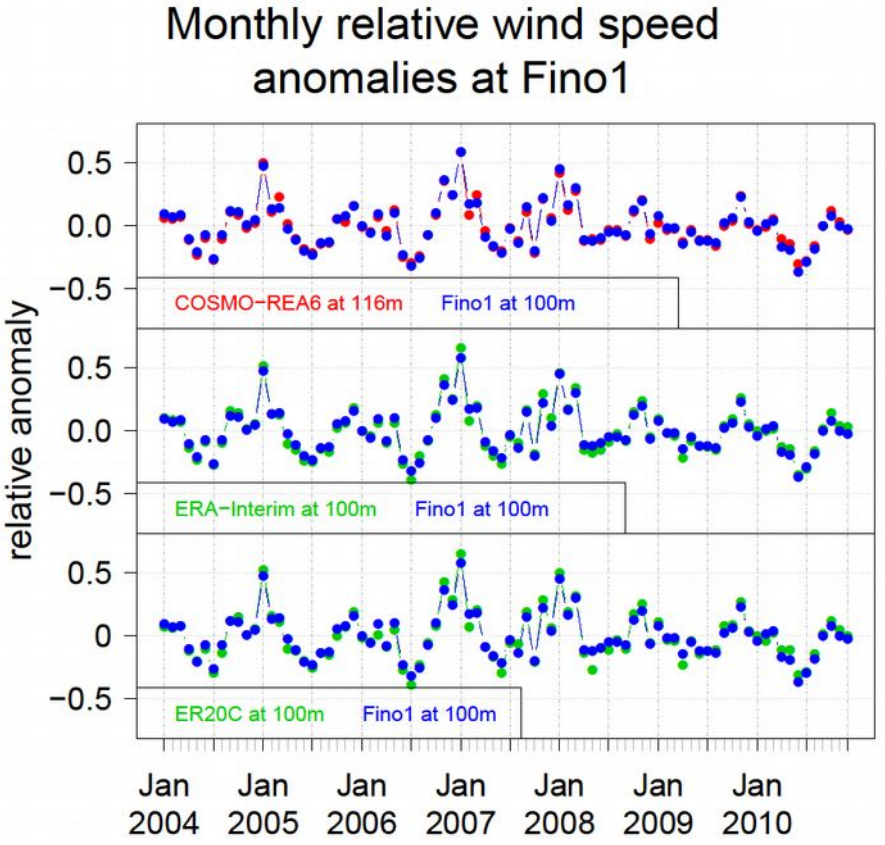
Monthly anomaly at 10m



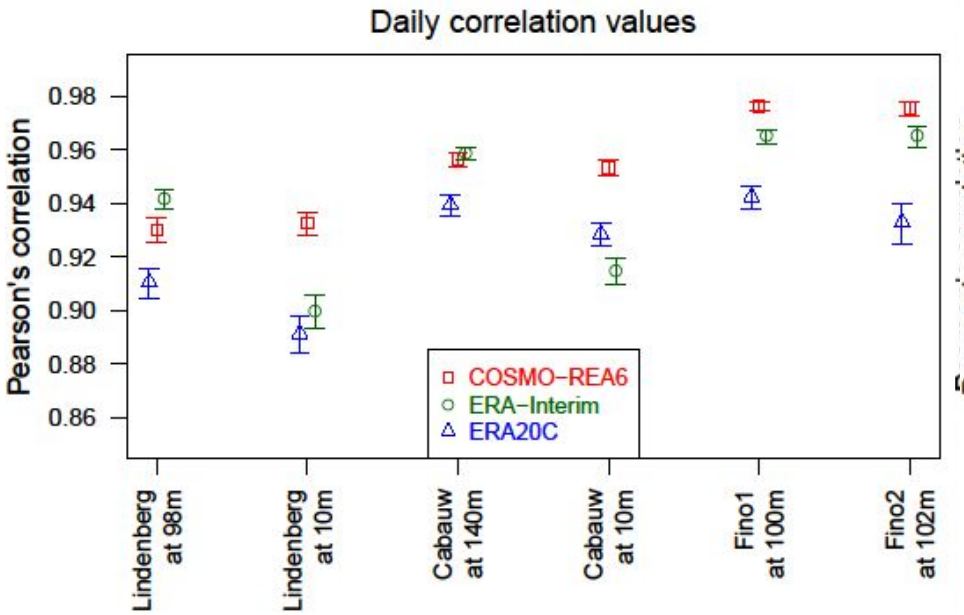


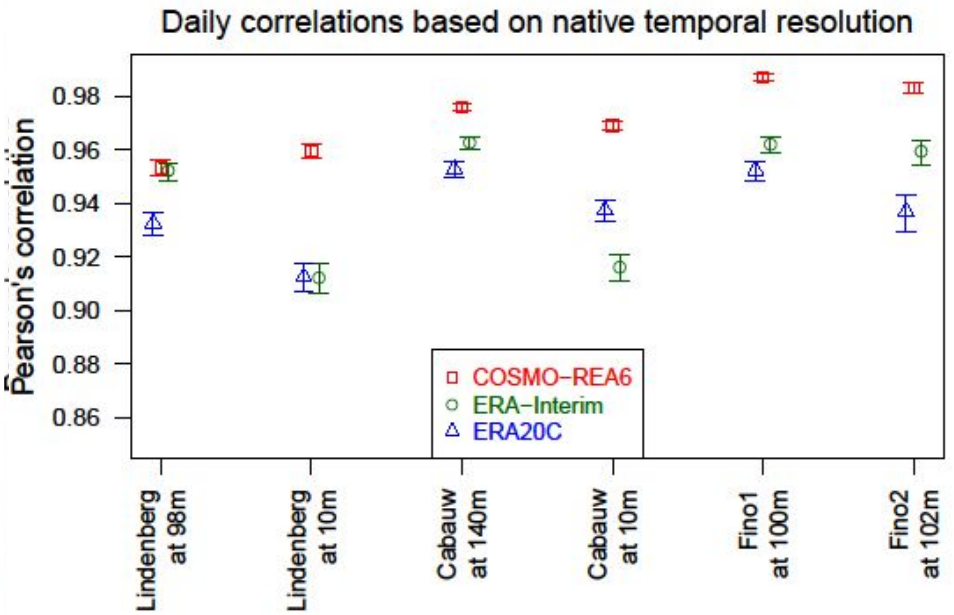
Monthly anomaly at 100m



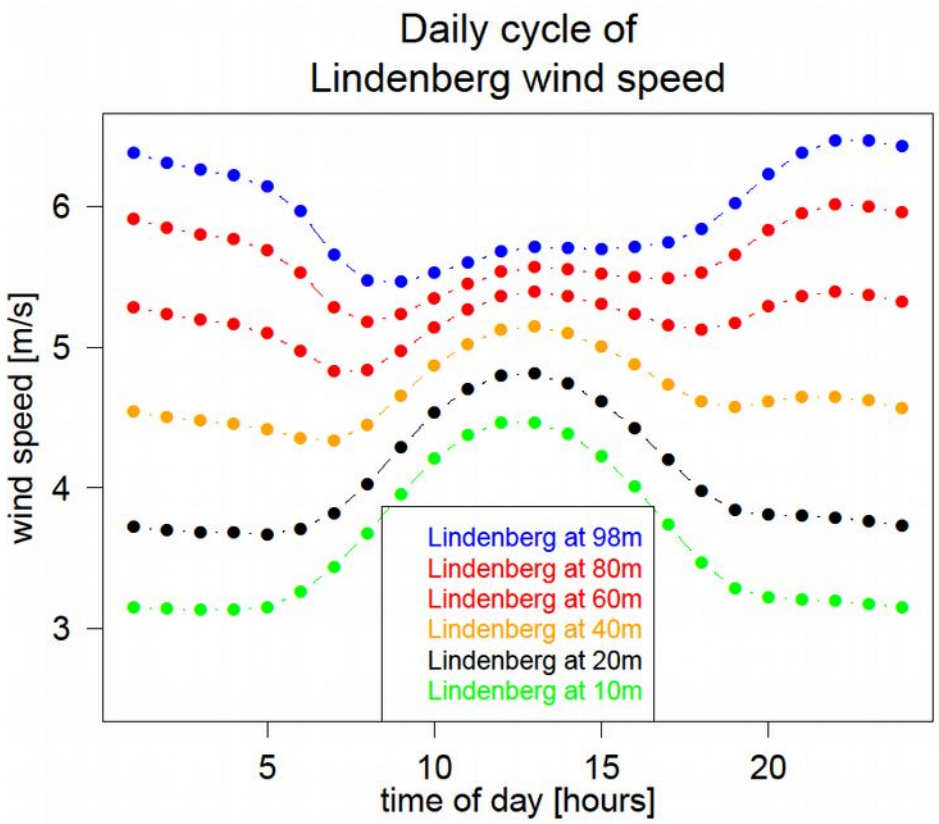


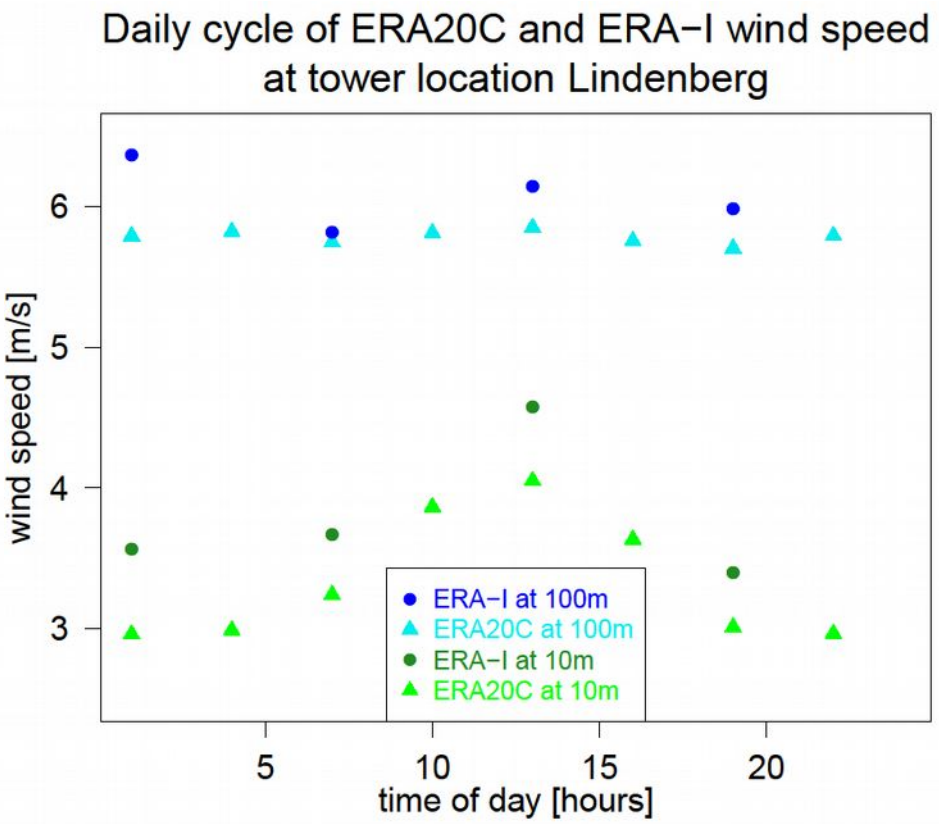
Correlation at 10m and 100m





Daily cycle of wind speed



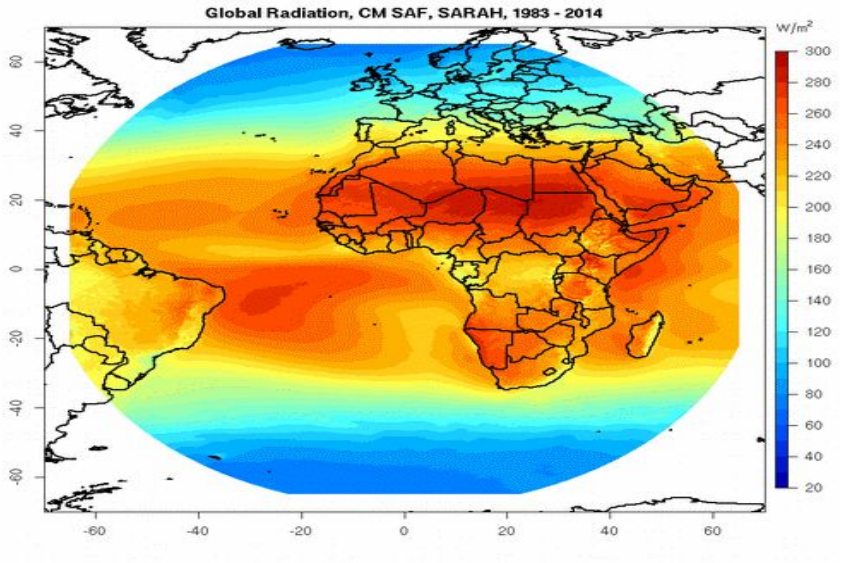


Comparison of global radiation against satellite data

- Comparison against satellite data: CM SAF SARAH SIS
- Using COSMO-REA6, HARMONIE, ALADIN reanalyses

Surface Solar Radiation Dataset – Heliosat (SARAH)

- **Variables**
  - Global irradiance (SIS)
  - Surface Direct Irradiance (DNI, SID)
  - Effective cloud albedo (CAL)
- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: instant and hourly means, daily means, monthly means
- **Coverage**
  - Spatial: METEOSAT-Prime Full disk
  - Temporal: 1983 to 2015



- **Satellites / Instruments**
  - METEOSAT 2 to 10 (MVIRI / SEVIRI)

Evaluation method

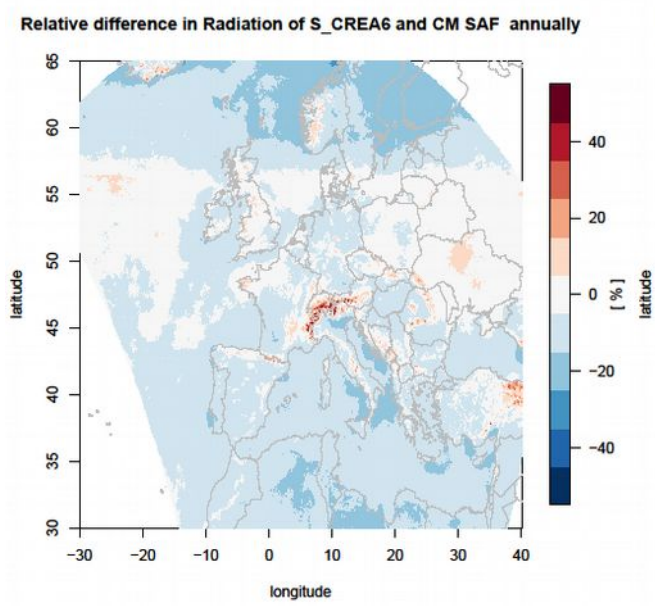
- Common grid of 0.1° spatial resolution (COSMO-REA6, CM SAF, HARMONIE, ALADIN)
- Common spatial coverage (domain)
- Common temporal coverage: 2008 (as of now)

Technical remarks

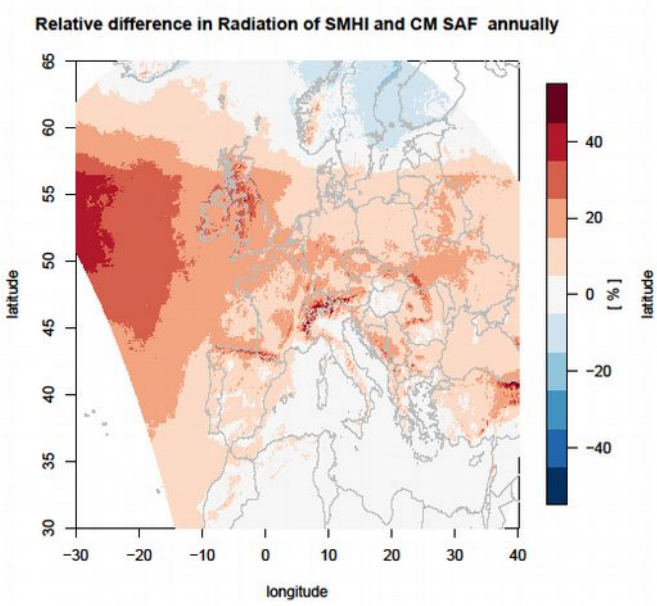
- Downloaded HARMONIE global radiation from MARS
  - Remapping grib2 files into netCDF format with CDOs
- Downloaded ALADIN global radiation from ECFS
  - Remapping grib1 files into netCDF format with CDOs
  - No issue with lambert conformal projection

Annual relative bias

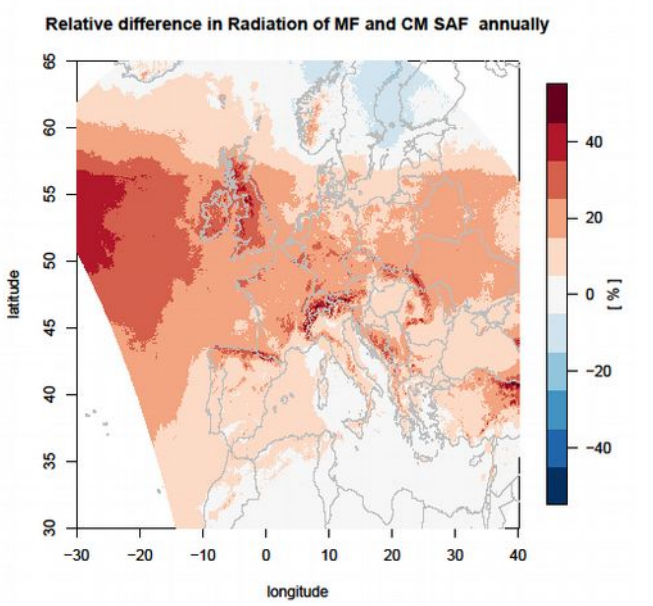
COSMO-REA6



HARMONIE

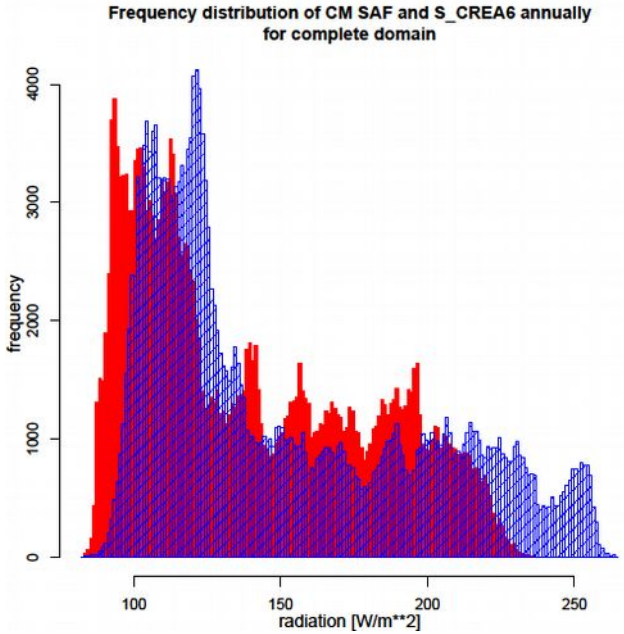


ALADIN

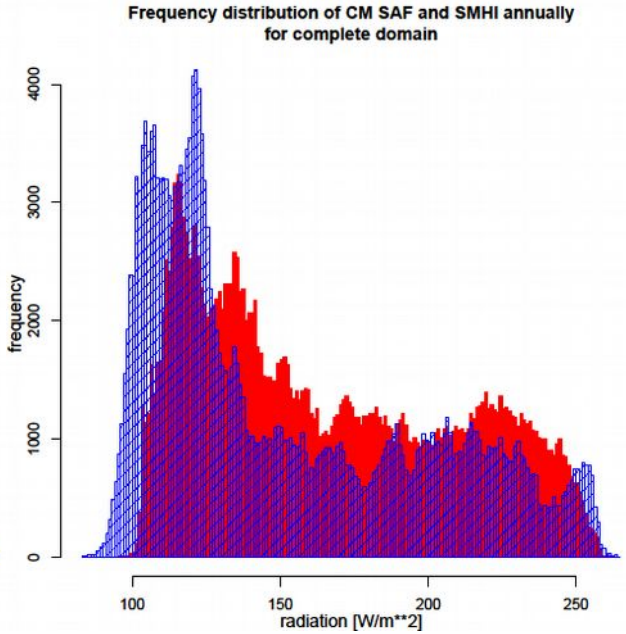


Annual frequency distribution

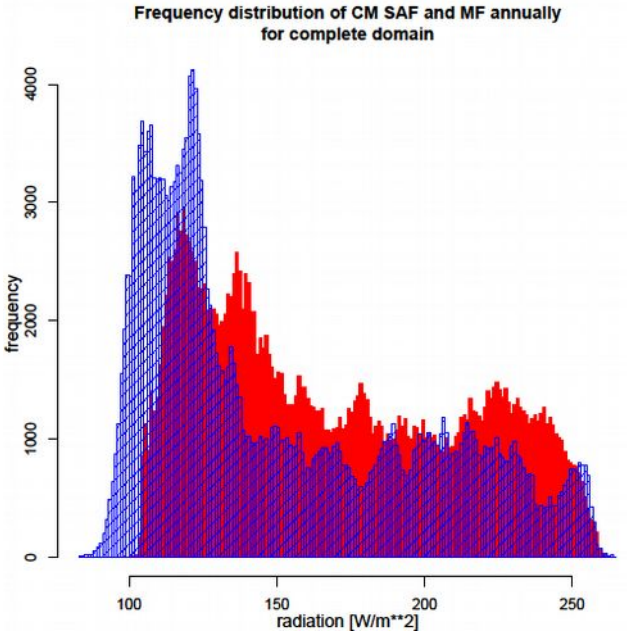
COSMO-REA6



HARMONIE

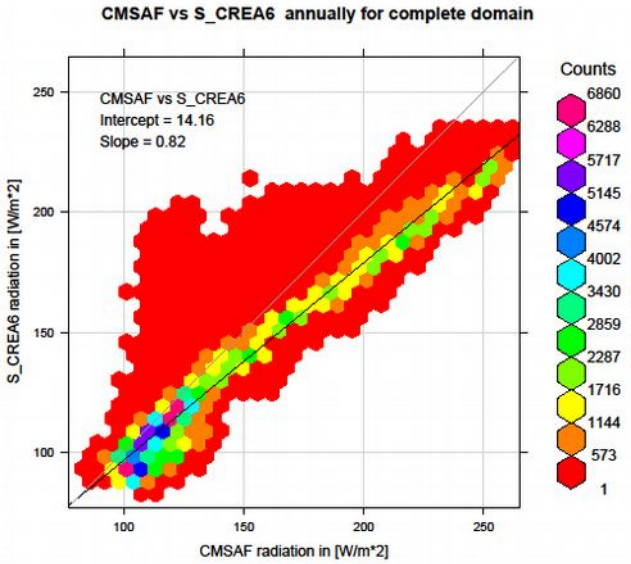


ALADIN

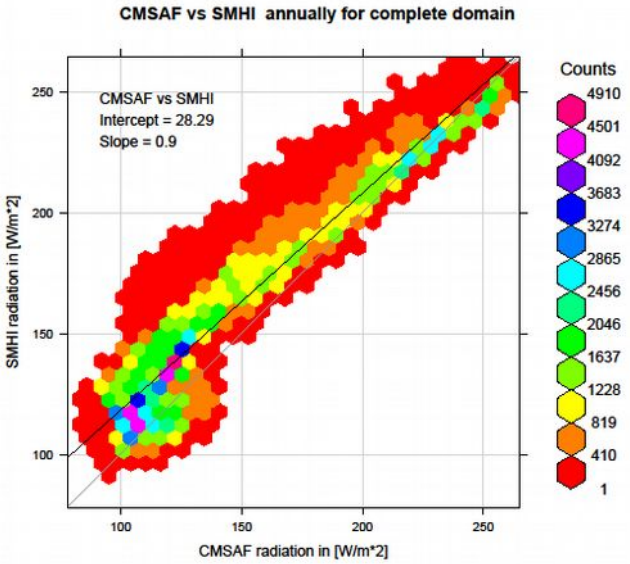


Annual distribution

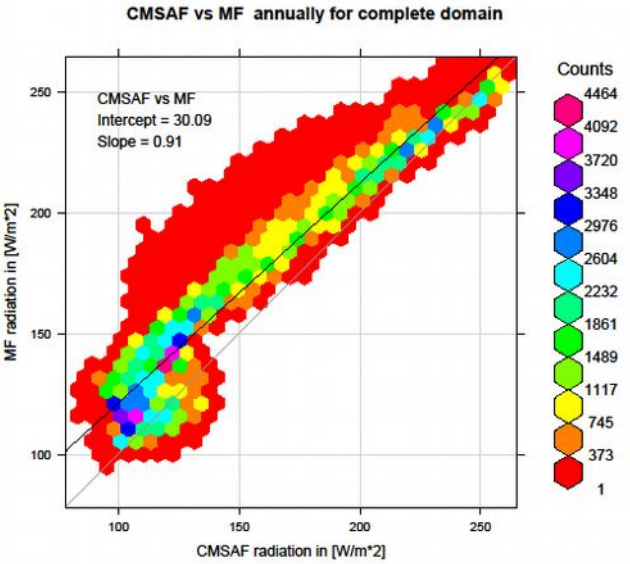
COSMO-REA6



HARMONIE

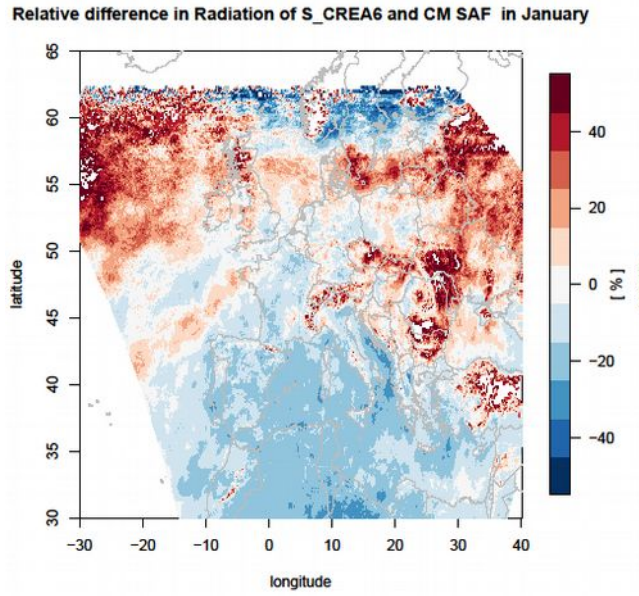


ALADIN

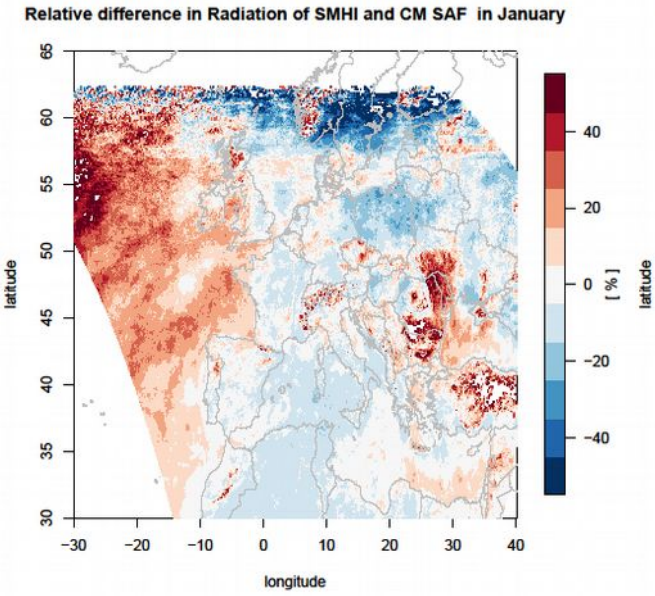


Comparison in January – relative

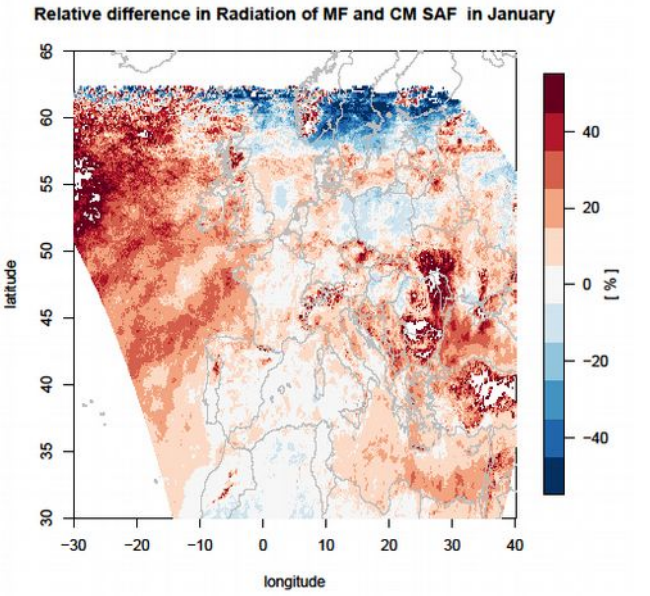
COSMO-REA6



HARMONIE

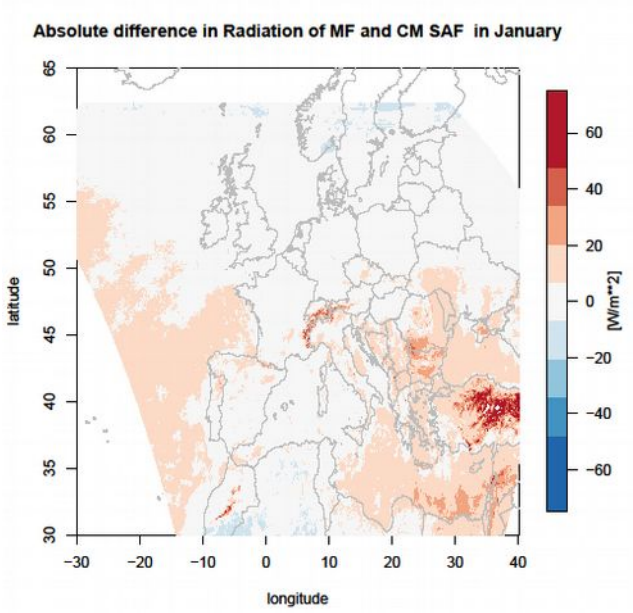


ALADIN

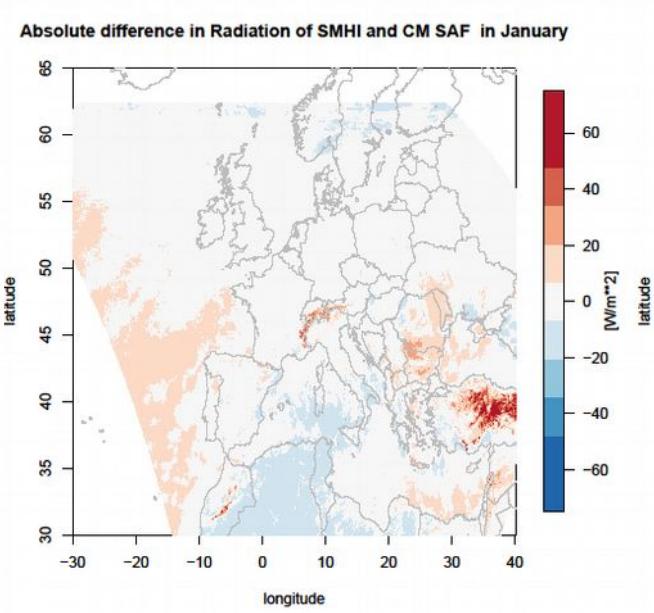


Comparison in January – absolute

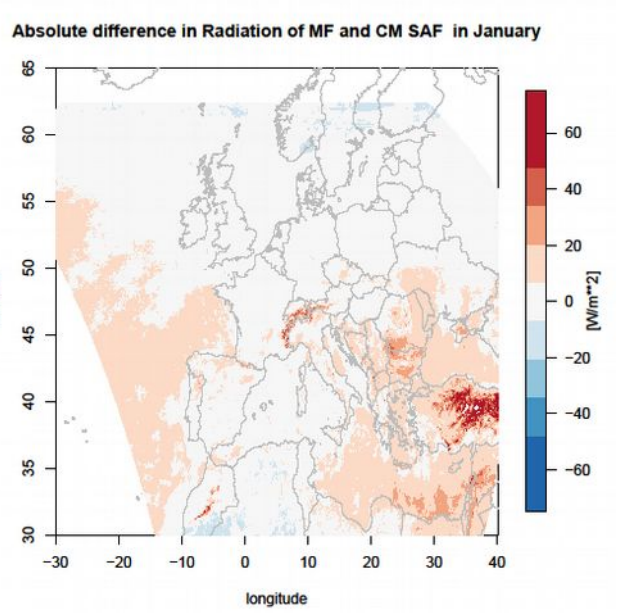
COSMO-REA6



HARMONIE

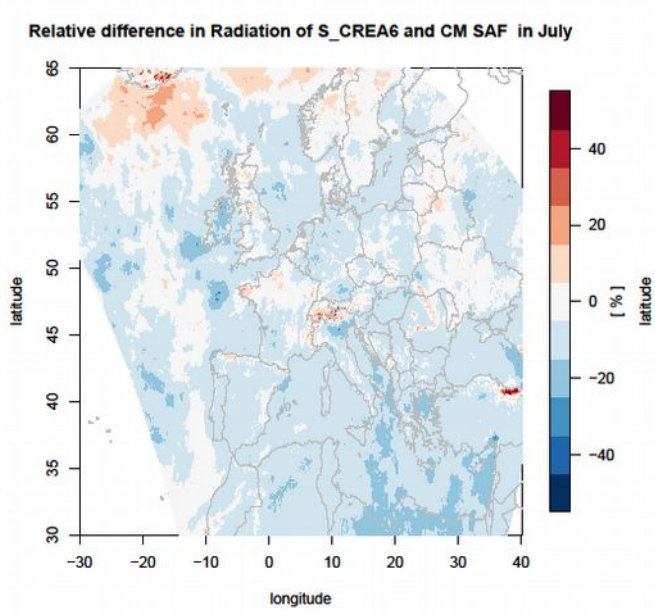


ALADIN

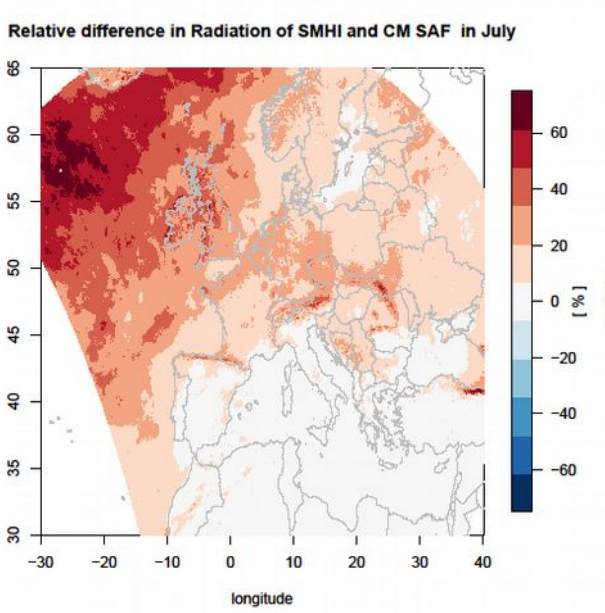


Comparison in July– relative

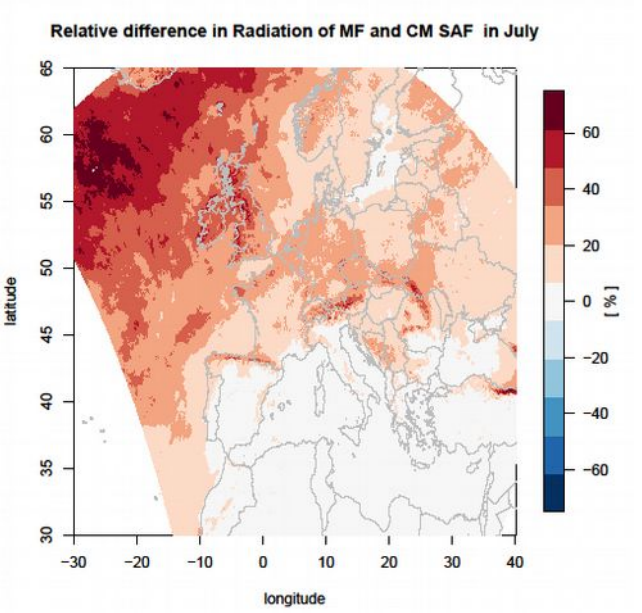
COSMO-REA6



HARMONIE

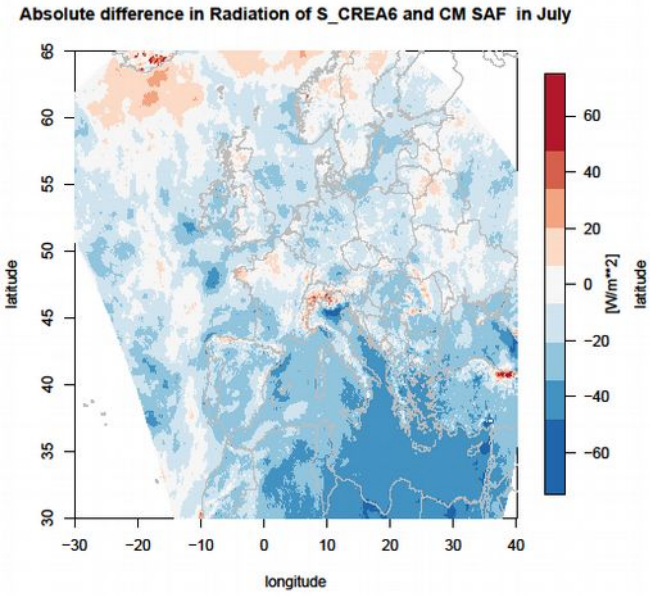


ALADIN

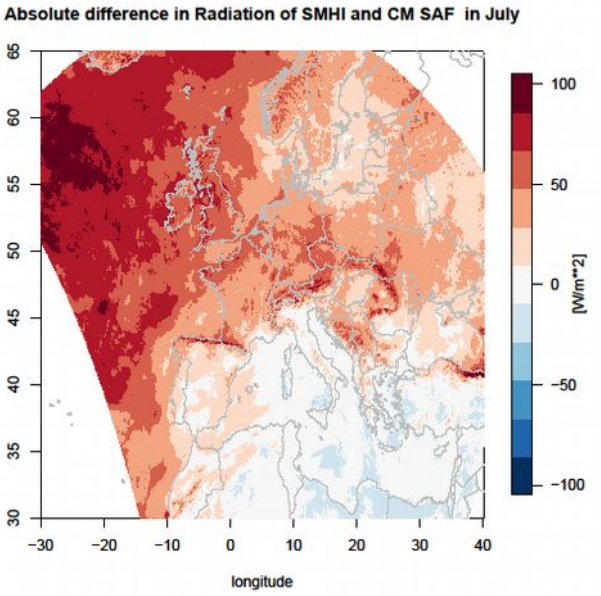


Comparison in July– absolute

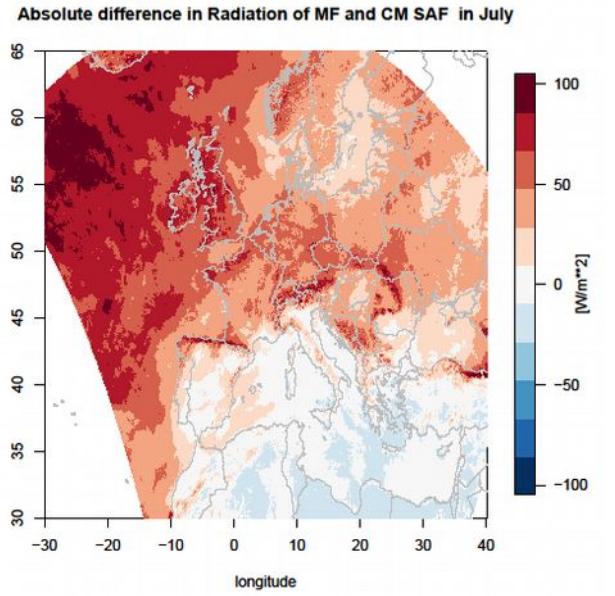
COSMO-REA6



HARMONIE

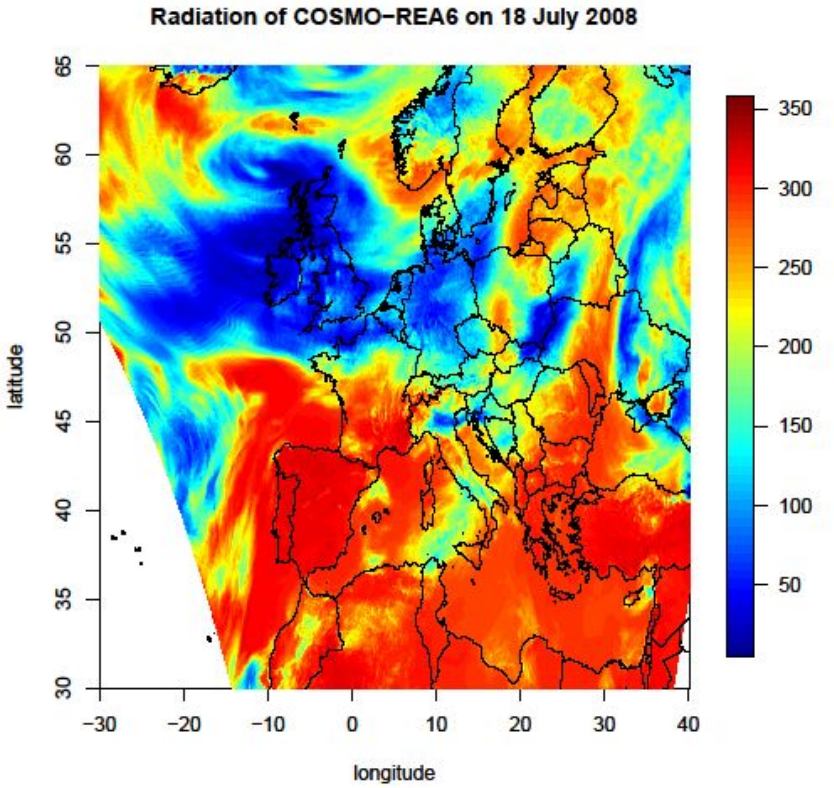


ALADIN

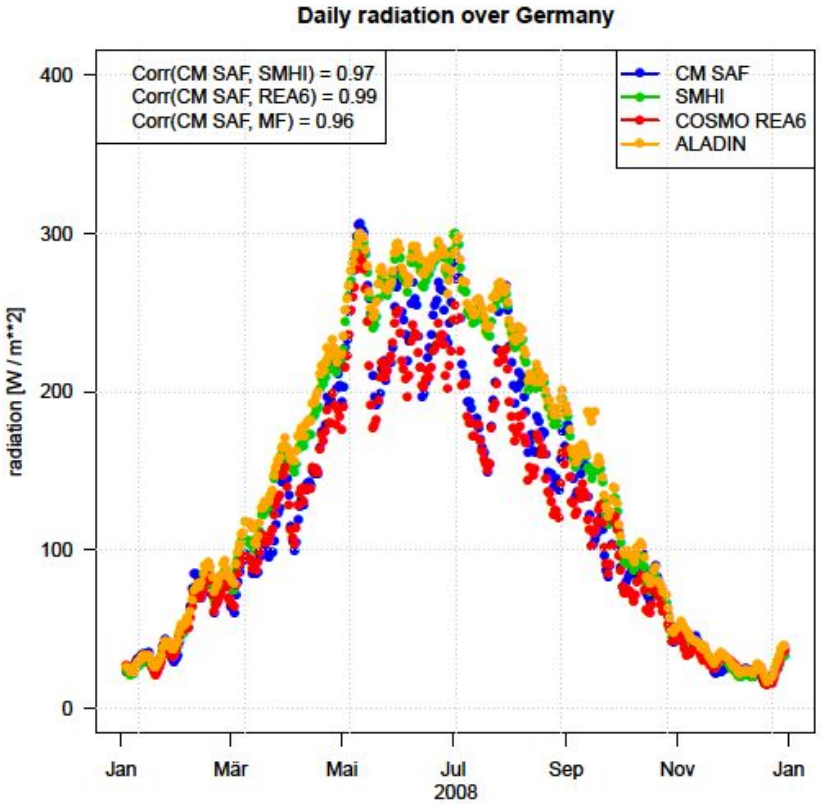


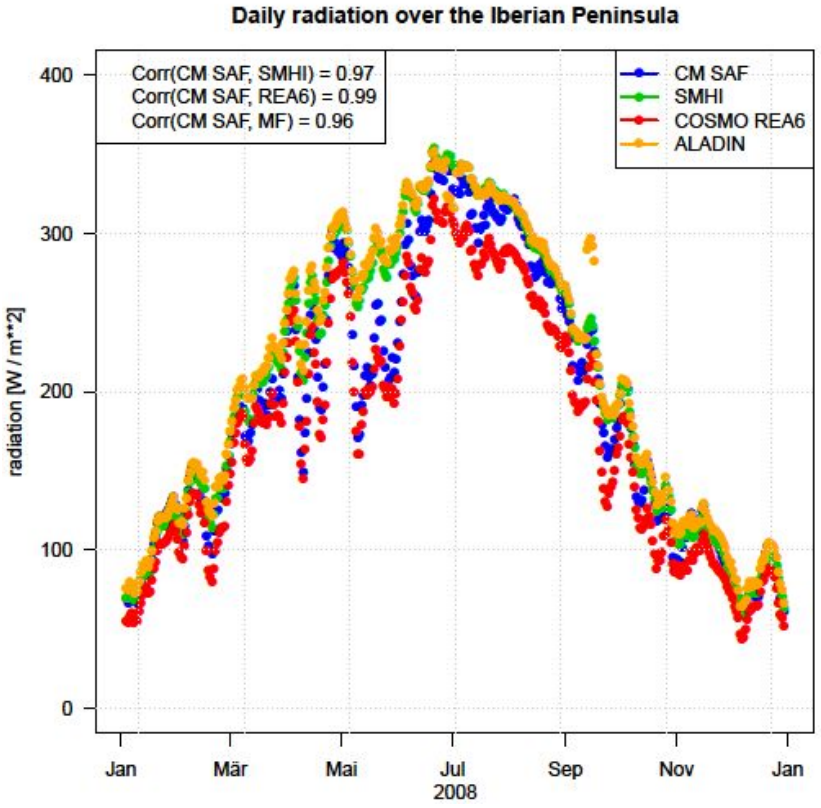
Daily means

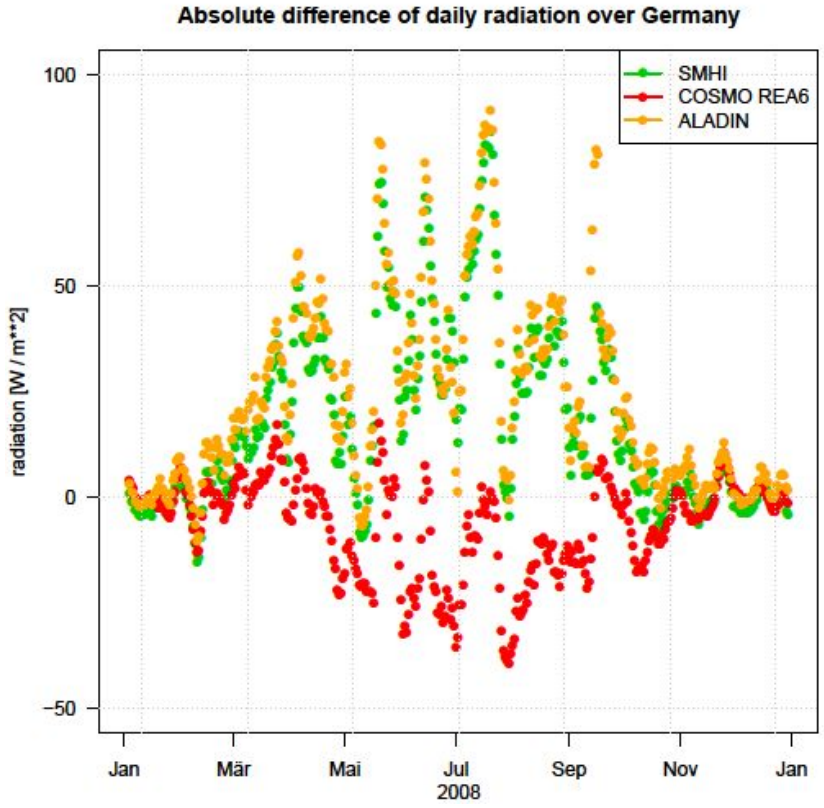
- Fair comparison with other RRAs in mind:
  use daily means
- Area mean over Germany and Iberian Peninsula

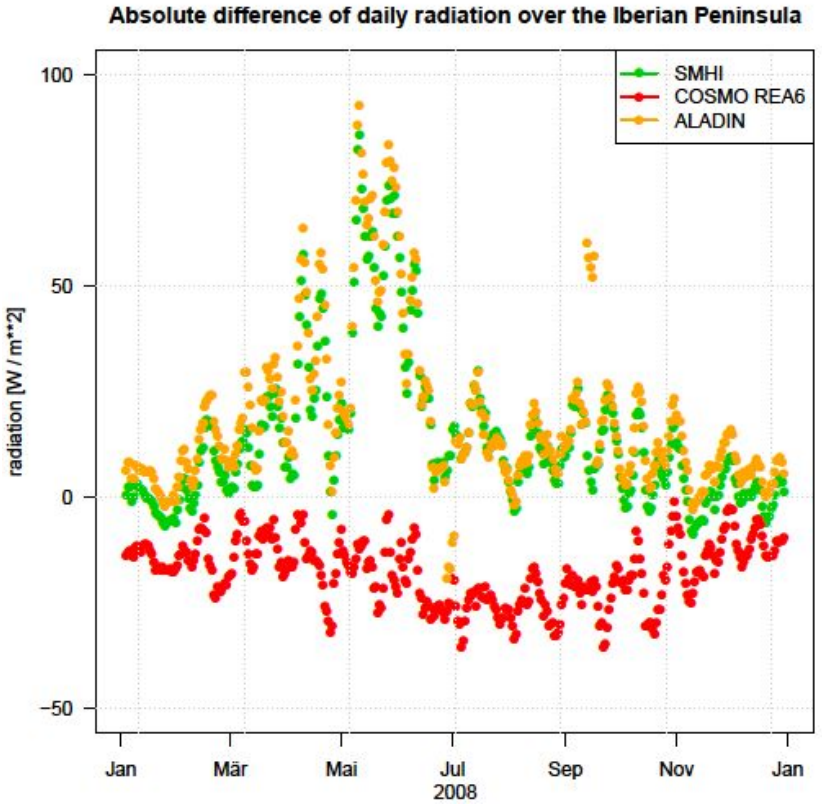


Annual cycle of daily means






Absolute difference of daily radiation over Germany
SMHI
COSMO REA6
ALADIN
radiation [W / m**2]
100
50
0
−50
Jan
Mär
Mai
Jul
2008
Sep
Nov
Jan


Absolute difference of daily radiation over the Iberian Peninsula
SMHI
COSMO REA6
ALADIN
radiation [W / m**2]
100
50
0
−50
Jan
Mär
Mai
Jul
2008
Sep
Nov
Jan

Summary

- Validation of reanalyses has been extended to HARMONIE and ALADIN
  - Grib2 format and lambert projection have been dealt with
- By comparison against CM SAF SARAH SIS it has been shown:
  - COSMO-REA6 global radiation has an annual negative bias of ~11% over land areas
  - HARMONIE and ALADIN global radiation have an annual positive bias of ~10% and ~15%, respectively, over land areas
  - HARMONIE and ALADIN show a distinct positive bias (up to 50% in summer) over the North Atlantic
- Correlation of daily values over Germany and the Iberian Peninsula are very high amounting up to 0.99

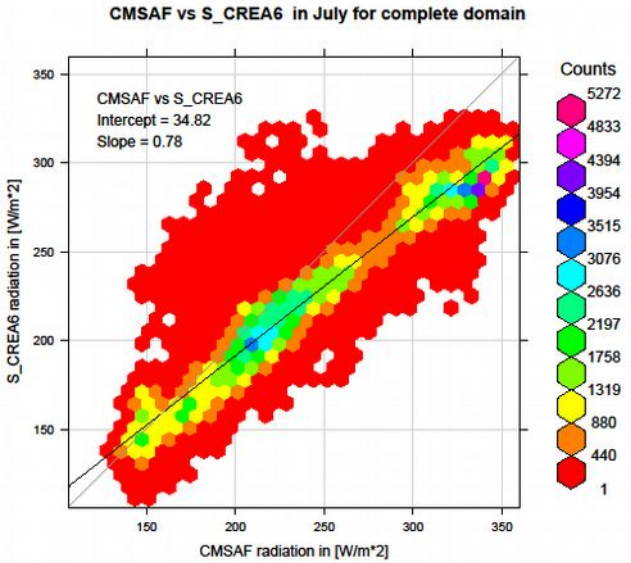
Outlook and future work

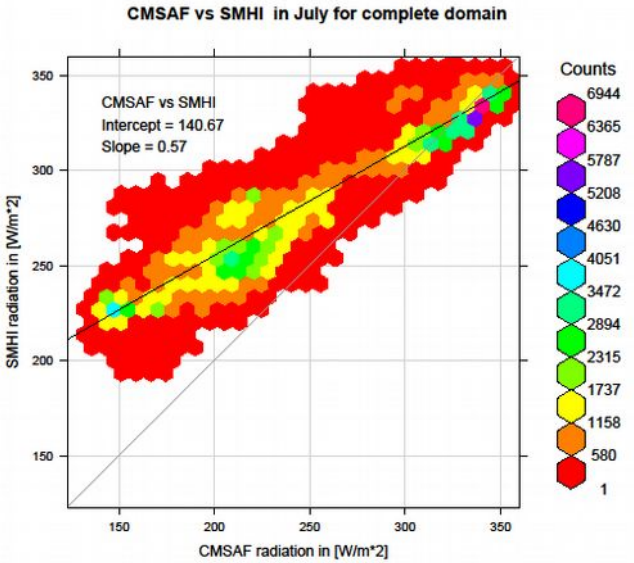
- Investigate extreme wind speeds
- Include more reanalyses into this study
  - ERA-Interim
  - Regional reanalysis by the MetOffice
- Investigate snow covered areas
  - Possibly include HelioMont over the alpine region
- Investigate uncertainties induced by cloud cover

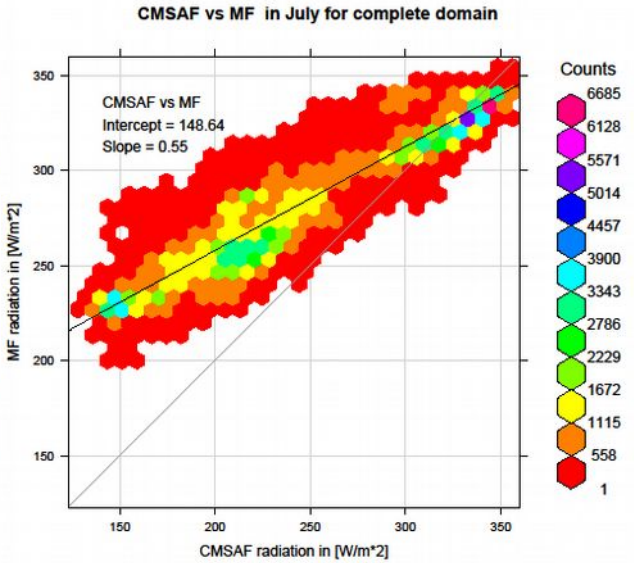
Thank you for your attention

Comparison in July– complete

COSMO-REA6 HARMONIE ALADIN

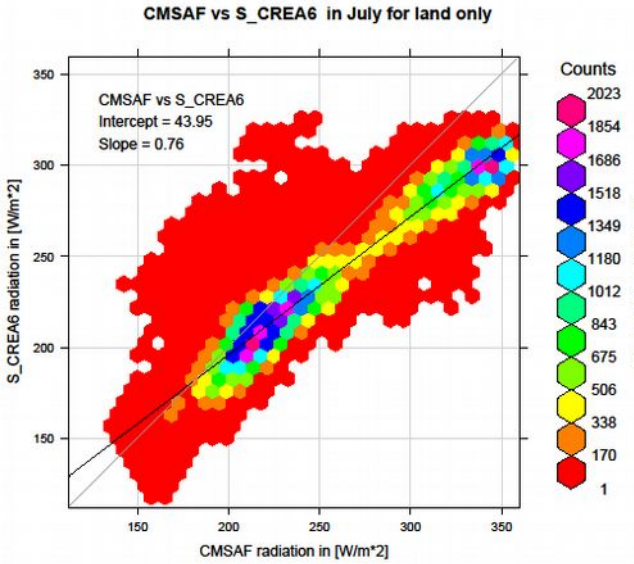




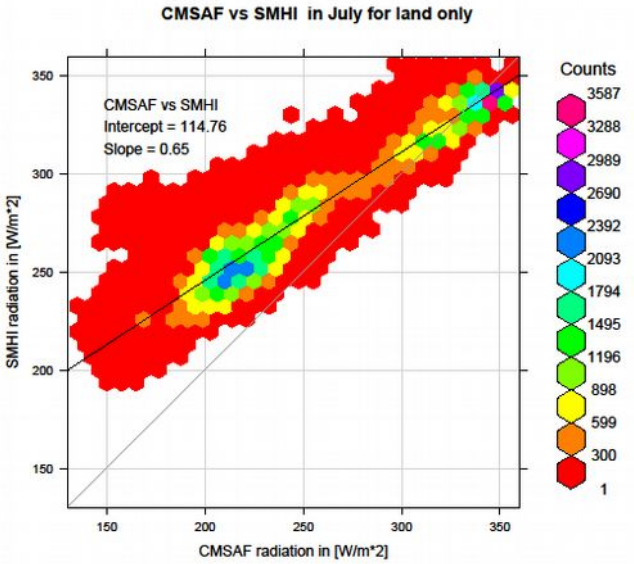


Comparison in July– land only

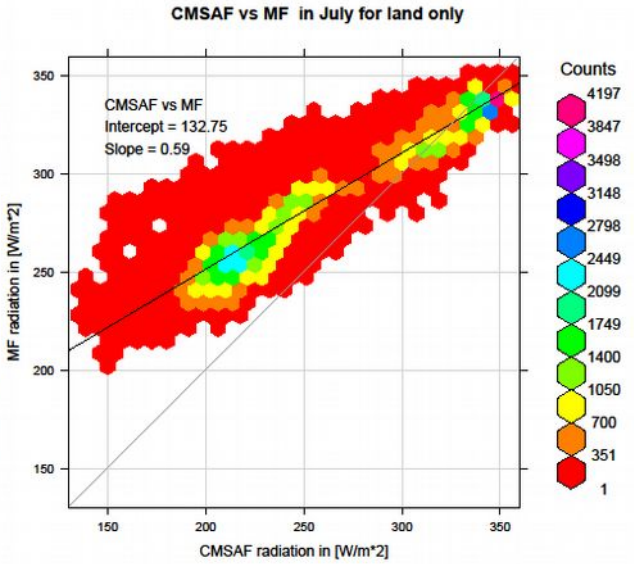
COSMO-REA6



HARMONIE

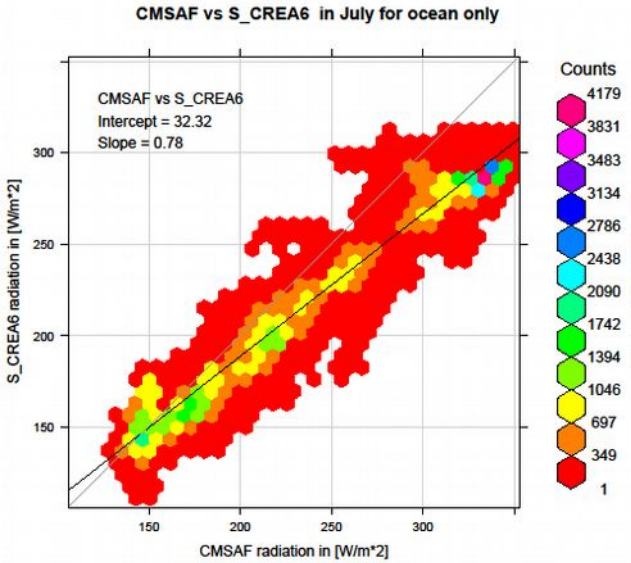


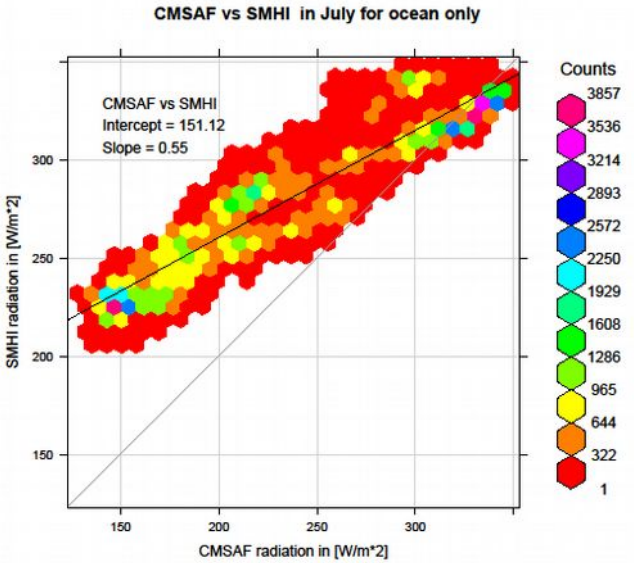
ALADIN

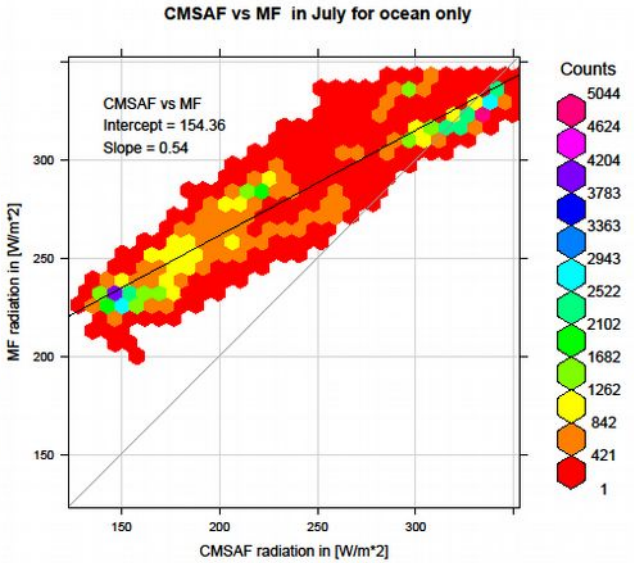


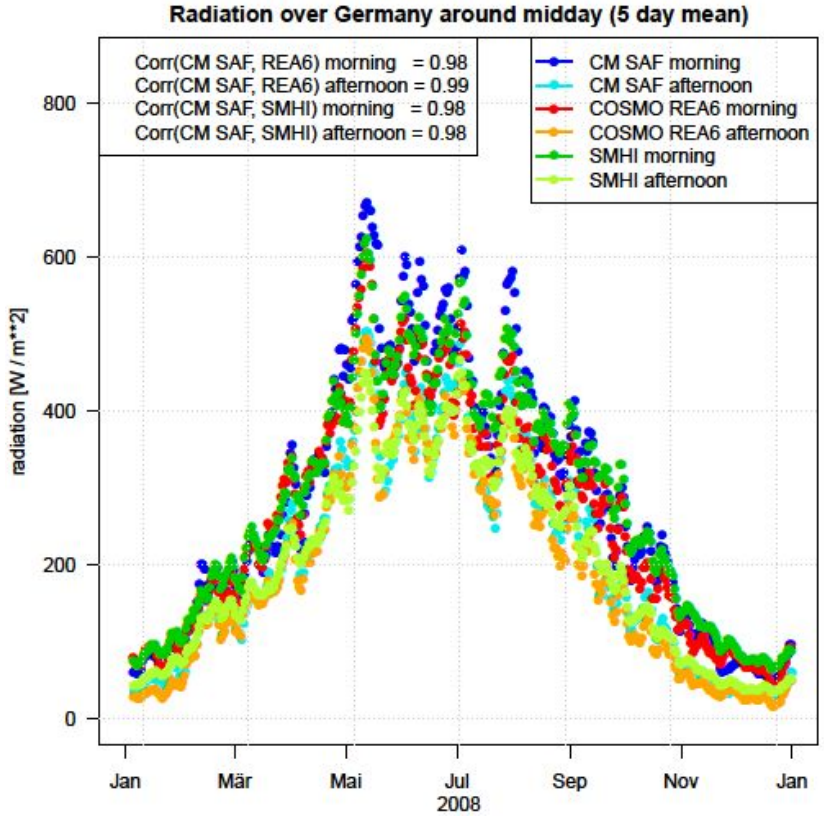
Comparison in July– ocean only

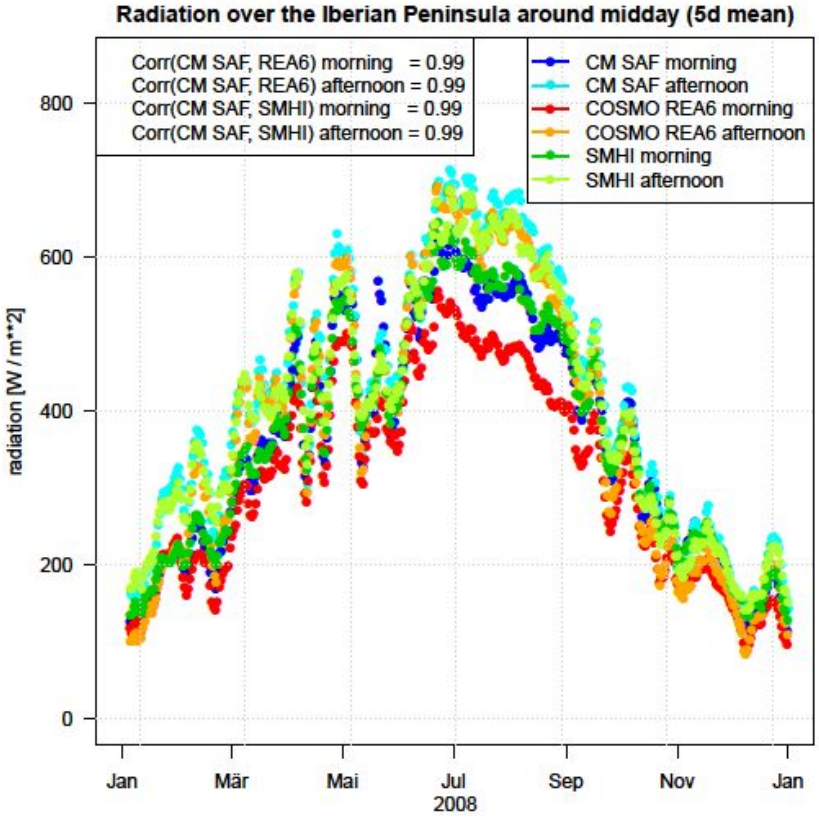
COSMO-REA6 HARMONIE ALADIN

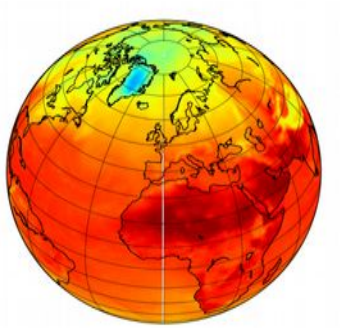




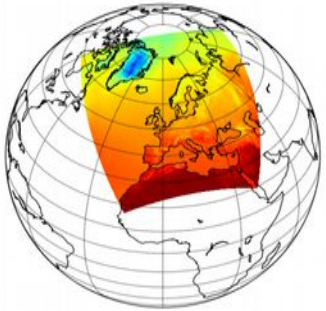



Radiation over Germany around midday (5 day mean)
Corr(CM SAF, REA6) morning = 0.98
Corr(CM SAF, REA6) afternoon = 0.99
Corr(CM SAF, SMHI) morning = 0.98
Corr(CM SAF, SMHI) afternoon = 0.98
CM SAF morning
CM SAF afternoon
COSMO REA6 morning
COSMO REA6 afternoon
SMHI morning
SMHI afternoon
radiation [W / m**2]
0
200
400
600
800
Jan
Mär
Mai
Jul
2008
Sep
Nov
Jan


Radiation over the Iberian Peninsula around midday (5d mean)
Corr(CM SAF, REA6) morning = 0.99
Corr(CM SAF, REA6) afternoon = 0.99
Corr(CM SAF, SMHI) morning = 0.99
Corr(CM SAF, SMHI) afternoon = 0.99
CM SAF morning
CM SAF afternoon
COSMO REA6 morning
COSMO REA6 afternoon
SMHI morning
SMHI afternoon
radiation [W / m**2]
0
200
400
600
800
Jan
Mär
Mai
Jul
2008
Sep
Nov
Jan



+



ERA-Interim LBC Observations

3D regional reanalysis

Observations as complete as possible or improving

NWP model and analysis system remain fixed

Reanalysis quality remains the same or improving

1961 → **2014**

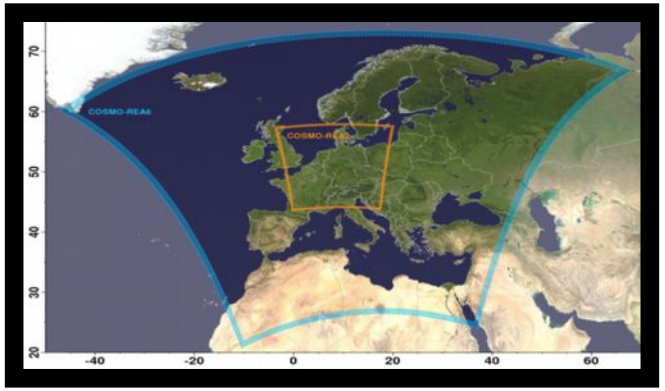
SMHI Variational 3D-VAR with a large scale constraint added from ERA-Interim

HARMONIE - Hirlam Aladin Regional/Mesoscale Operational NWP In Europe

@11 km from 1961 - 2014 deterministic including two ensemble members 2006 - 2010

COSMO-REA6: 1995-2014 @ 6.2km

- **Model**
  - COSMO-EU v4.25
  - 40 layer up to 23 km
  - grid = double resol. of CORDEX-EUR11
- **Boundary conditions**
  - ERA-Interim 3 hourly LBC
  - Snow, SST, Soil Moisture Analyses (off-line)
- **Observations**
  - Nudging of radiosondes, aircraft-, windprofiler-, synop-, ship-, and DRIBU-obs



Bollmeyer**, C., Keller, J. D., Ohlwein, C., Wahl, S., Crewell, S., Friederichs, P., Hense, A., Keune, J., Kneifel, S., Pscheidt I., Redl, S., and Steinke, S.: Towards a high-resolution regional reanalysis for the European CORDEX domain, Q. J. R. Meteorol. Soc., doi: 10.1002/qj2486, **2014