Using the regional reanalysis COSMO-REA6 for renewable energy applications

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The regional reanalysis COSMO-REA6 provides data from 1995 onwards, covering the European CORDEX domain. Because of the high spatial and temporal resolution (about 6km and an hourly time step) the data set exhibits a great potential in the field of renewable energy applications. One aspect of the German joint research project "Network of Experts" within the Ministry of Transport and Digital Infrastructure is the investigation of energy production by solar and wind with a focus on the transportation infrastructure. The aim is to use regional reanalysis data for this question. We will present estimations of data quality, concerning wind speed and global radiation. In order to highlight advantages and disadvantages of the COSMO-REA6 product we compare the reanalysis data with different data sources, including station observations from the German station network, a gridded data set and satellite based data.

Data

Observations:

- Station observations for wind gusts and global radiation are taken from the German station network, https://opendata.dwd.de/climate/

Reanalysis:

- COSMO-REA6 is available via https://opendata.dwd.de/climate_environment/REA/. More details at Bollmeyer et al., 2014.
- COSMO-REA6 provides 1-hourly variables for the CORDEX-EUR11 domain with 0.055° spatial resolution.
- Assimilated observations include conventional data like synop stations, ships, radiosondes, aircraft, but no remote sensing.

Satellite:

- Surface incoming shortwave radiation is taken from SARAH-2 records, provided by EUMETSAT CMSAF. The product may be ordered via www.cmsaf.eu.
- Spatial resolution is about 0.05° and temporal resolution is 30 min.

TRY:

- Test Reference Years (TRY) are generated as data set for technical climatology.
- TRY are available for 1995-2012 and with spatial resolution of 1km^2 and comprise 12 climate variables. More details at Krähenmann et al., 2016.

Results – Wind gust

- The model bias of wind gusts is higher than for mean wind speed.
- The correlation shows no significant drop from wind speed to wind gusts.
- For single test periods COSMO-REA6 shows good results in reproducing wind gusts for stormy time periods.
- At coastal stations the underestimation of frequency for high wind speeds is less pronounced, than for inland stations (Fig. 1).
- The seasonal variability shows significant reduced/increased values of correlation/MAE for the summer season (Fig. 2). Here the wind fields are often controlled by low scale convective situations, which can not be reproduced correctly by COSMO-REA6.

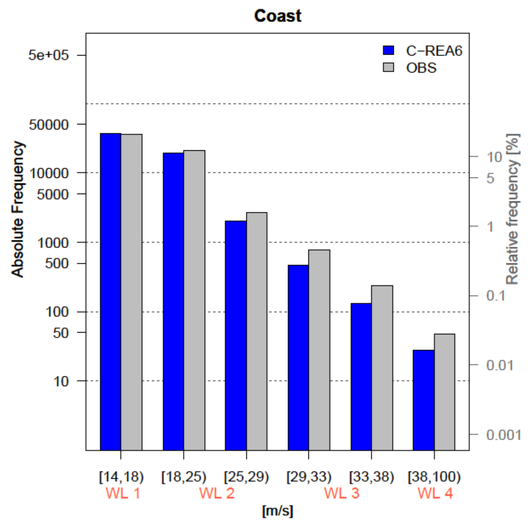

Fig. 1: Frequency of wind gusts for COSMO-REA6 and observations at stations near the coast for time period 1995-2015. The frequencies are computed for warning level (WL) 1-5.

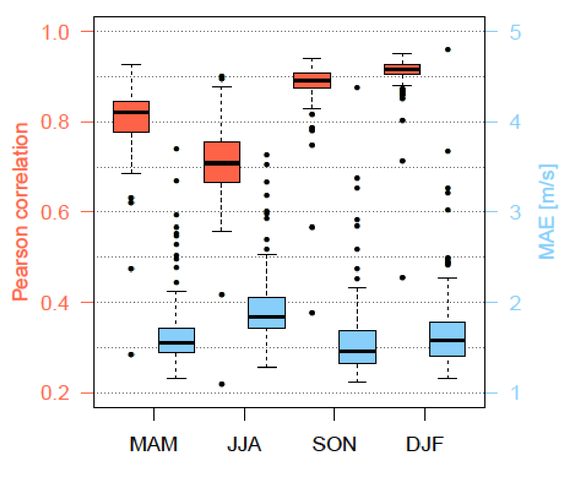

Fig. 2: Seasonal dependency of correlation and MAE for all station locations beneath 500m based on daily maximum values of wind gusts for COSMO-REA6 and station observation for time period 1995-2015.

Results – Global radiation

- Statistical evaluation of global radiation includes data set COSMO-REA6, TRY and SARAH-2.
- For the evaluation period 2008-2012 SARAH-2 and TRY show significant advantage, concerning correlation and mean absolute error (MAE) against COSMO-REA6 (Fig. 3).
- COSMO-REA6 shows significant lower bias, caused by compensation effects of two features: Overestimation of cloudy conditions and underestimation of clear sky conditions, see also Frank et al., 2018.

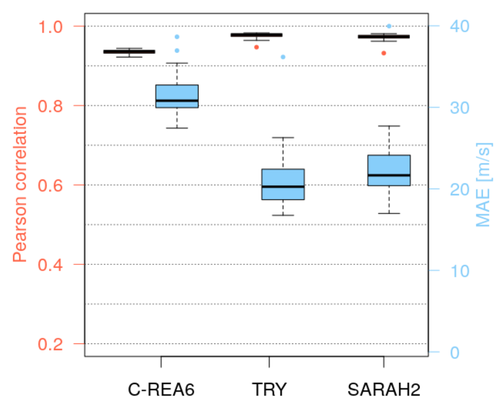

Fig. 3: Seasonal Pearson correlation and MAE for 38 station locations based on hourly mean global radiation for COSMO-REA6, TRY, SARAH-2 and station observation for time period 2008-2012.

- At the summer season (Fig. 4 top) COSMO-REA6 has shortcomings, concerning high cloud variability on small scales, while SARAH-2 and TRY show good representation of cloud contribution.
- In the winter season (Fig. 4 bottom), COSMO-REA6 can show advantages against SARAH-2 and TRY in case of snow cover and clear sky conditions. The latter ones show issues in distinguishing snow and clouds.

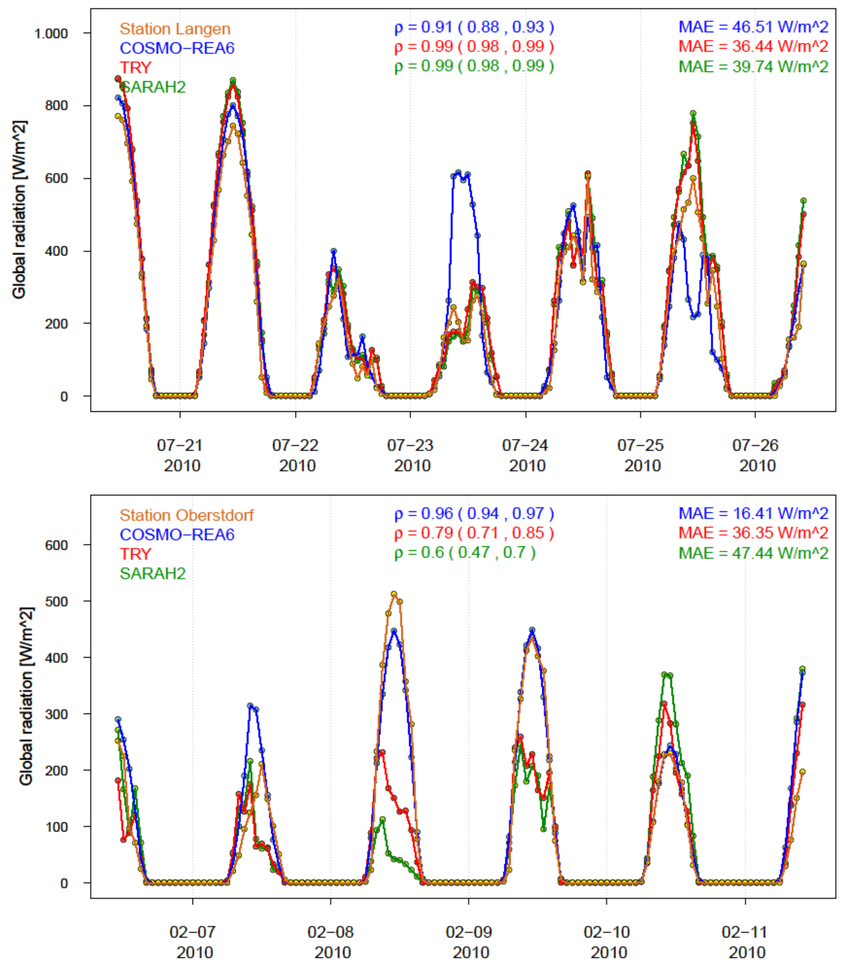

Fig. 4: Time series of global radiation for July 2010 at station Langen (top) and February 2010 at station Oberstdorf (bottom).

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References:

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