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Renewable energy variability and availability from high resolution reanalyses

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The spatial and temporal volatility of renewable energy sources is one of the most challenging issues in the energy transition. Wind and solar energy productions are subject to the natural chaotic behavior of the atmosphere. With increasing renewable energies it becomes more and more difficult to ensure a balanced energy supply and demand. In order to minimize the problem it is crucial to know where, when and to what extent renewable energy can be generated. Atmospheric reanalyses provide all relevant meteorological quantities to estimate renewable energy in a gridded and consistent way. New regional high-resolution reanalyses allow detailed studies on the mesoscale which were not possible with the common global reanalyses. Thus, latest regional atmospheric reanalyses become more and more suitable to investigate the spatiotemporal variability and availability of renewable energy sources.

To investigate the above mentioned questions we use the high resolution reanalyses developed within the Hans-Ertel Centre for Weather Research. The high resolution reanalyses COSMO-REA6 (6 km horizontal resolution, 40 vertical layer) and COSMO-REA2 (2 km horizontal resolution, 50 vertical layer) are based on the operational German numerical weather prediction model COSMO. REA6 covers Europe and the Mediterranean region, REA2 is limited to Germany and its neighboring regions. The coarser reanalysis is available for two decades from 1995 to 2014 and the finer from 2007 to 2013. In both reanalyses a data assimilation (nudging) is used to couple the model- and observations to a best estimate of the true atmospheric flow.

As reanalyses provide best estimates of the true atmospheric flow, the evaluation starts with a quality assessment of the relevant quantities which are wind speed and global radiation. In this assessment the Baseline Surface Radiation Network (BSRN) and SYNOP observations of global radiation as well as wind speed in 10 m above ground are used. The comparison to observations shows deficits in the global radiation of the reanalyses data with different behavior for clear and cloudy sky. Therefore, a post-processing is applied. Using the updated COSMO-reanalyses data as input a wind and solar energy data set is produced. A reference photovoltaic module and a reference wind power plant are assumed to be installed at every single grid box. This data set provides the basis for the analysis of variability, availability and compensation potentials of renewable energies.