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Spatial evaluation of high-resolution wind fields from empirical and dynamical modeling in hilly and mountainous terrain

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Empirical high-resolution (100 m $\times$ 100 m) surface wind fields were intercompared with data from the non-hydrostatic regional climate model COSMO-CLM (3 km resolution) and with wind field analysis data from the Integrated Nowcasting through Comprehensive Analysis (INCA) system (1 km resolution), using hourly temporal resolution (Schlager et al., 2018).

The empirical wind fields were generated, using the CALMET diagnostic model, for two regions with dense meteorological station networks: The WegenerNet Feldbach Region (FBR; Kirchengast et al., 2014) and its alpine sister network, the WegenerNet Johnsbachtal (JBT). The high-density WegenerNet FBR is located in southeastern Styria, Austria, a region predominated by a hilly terrain and limited differences in elevations. The network consists of 155 meteorological stations, located within an area of about 22 km $\times$ 16 km (one station per $\sim$2 km^2), observing temperature, humidity, precipitation, wind, soil moisture, and other parameters, at a temporal resolution of 5-minutes. The WegenerNet JBT is located in a mountainous region in northern Styria and contains 11 meteorological stations distributed over an area of about 16 km $\times$ 17 km and elevations ranging from about 600 m to 2200 m.

The focus of the presented work lies on evaluating spatial differences and displacements between the different datasets for thermally induced and strong wind events. For this intercomparison, a neighborhood-based spatial wind verification methodology, the so-called Wind Fractions Skill Score (WFSS), is used to estimate the modeling performances. Furthermore, gridpoint-based statistical error measures were calculated for the same evaluation events.

The spatial verification indicates a better statistical agreement for the hilly WegenerNet FBR than for the mountainous WegenerNet JBT. The results for the WegenerNet FBR show a better agreement between INCA and WegenerNet than between COSMO and WegenerNet wind fields, especially for large scales (neighborhoods). In particular, COSMO-CLM clearly underperforms in case of thermally induced wind events. For the JBT region, all spatial intercomparisons indicate little overlap at small neighborhood sizes. Considerable biases of wind vectors occur between INCA and WegenerNet as well as between COSMO and INCA. It is shown that COSMO-CLM, with a limited horizontal resolution of 3 km $\times$ 3 km and hence a too smooth orography, is not able to represent small-scale wind patterns.

References:

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