Helmholtz Climate Initiative

Regional Climate Change

Evaluation of Regional Atmospheric Simulations with TERENO Pre-Alpine Observations (TP4)

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Objective

Since October 2011, all three major measurement sites of the Pre-Alpine Terrestrial Environmental Observatory (TERENO) are in full operation with online data transfer. Beside of the high frequency eddy flux measurements, meteorological observations are derived with a 10 minute interval. The new data provides great temporal and promises good comparability on the scale of regional atmospheric modeling. This study presents a first comparison between the TERENO Pre-Alpine station measurements and simulations with the Advanced Weather Research and Forecast model WRF-ARW.

Study Site and Measurement Equipment

The Pre-Alpine observatory encompasses the Ammer river catchment. Three measurement facilities (Fendt, Rottenbuch, and Graswang) are installed over grassland with an north to south elevation gradient from 600 to 860 m.a.s.l. The Graswang location represents a complex alpine valley terrain.

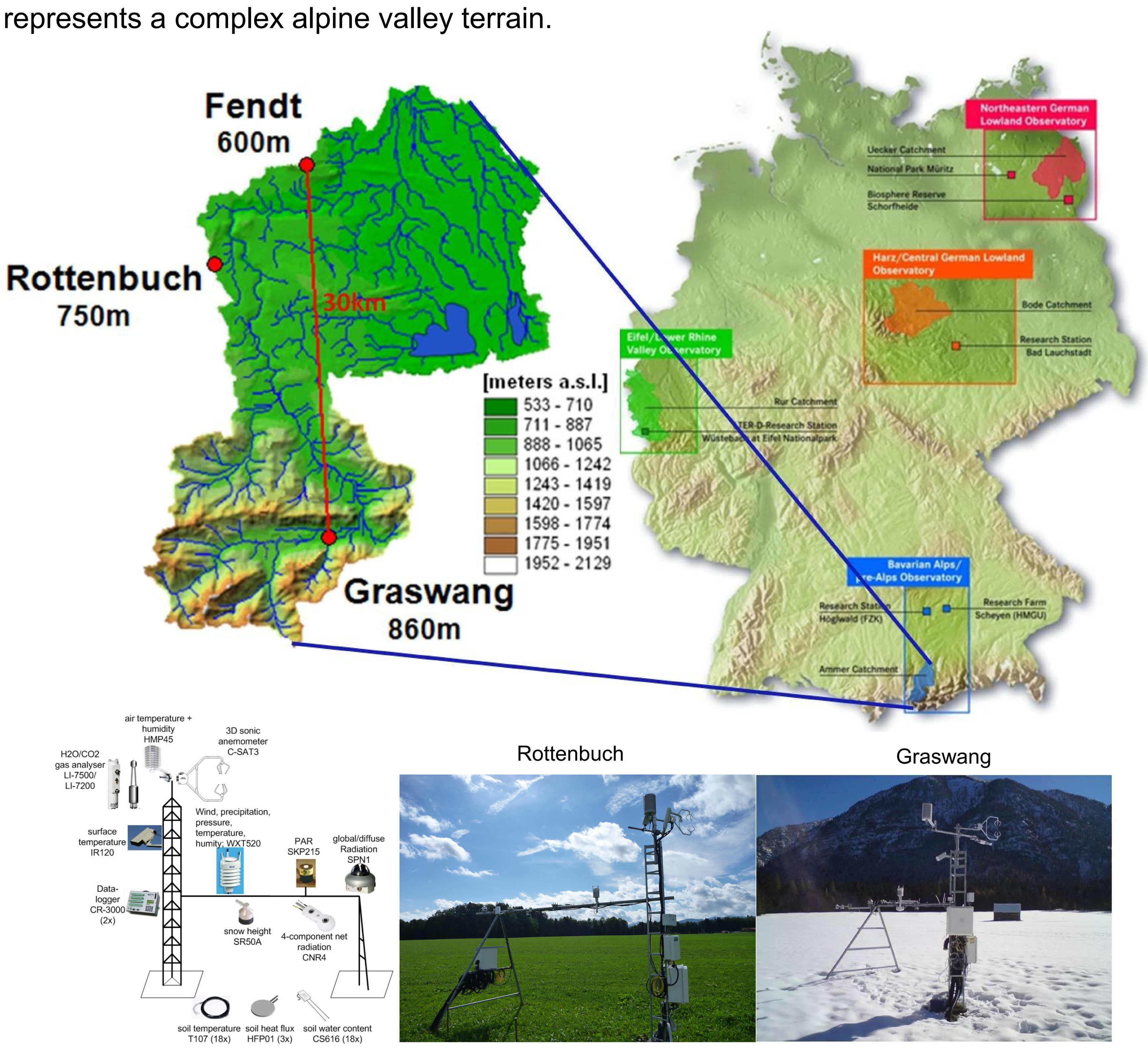

Fig. 1: TERENO Pre-Alpine extent and measurement site configuration

Sensors

• Temperature:	Vaisala HMP45 (±0.2K)
• Pressure:	Vaisala WX7 520 (±0.5 hPa)
• Shortwave radiation:	Kipp & Zonen CNR 4 (±10%)
• Relative humidity:	Vaisala HMP 45 (±1%)

The measurements are recorded with an interval of one minute and 10 minute mean values are computed by the data logger. Due to the 3 weeks cold period in early 2012 with temperatures below -25 °C the power supply for the logger devices failed at Graswang and Rottenbuch.

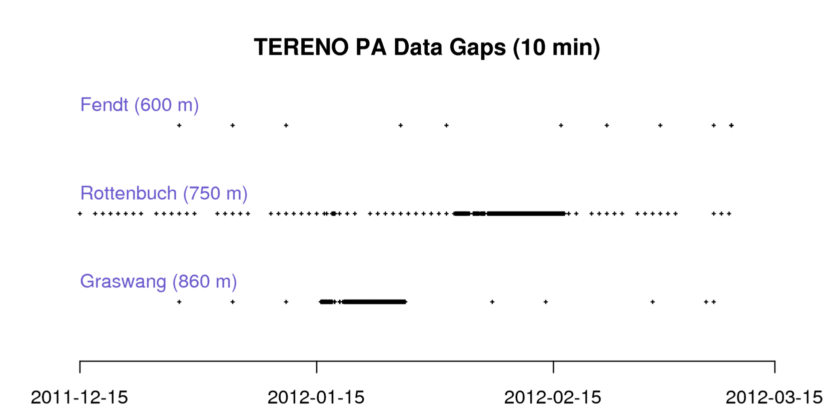

Fig. 2: Data gaps: one point equals a 10 minutes lack

Regional Atmospheric Simulations

The WRF-ARW simulations depict a series of dynamically downscaled predictions of the Global Forecasting System (GFS) of NOAA. The model is set up with 3 nested domains and 42 vertical layers. Every day, a 72 hour prediction is computed. Soil moisture and temperature, and snow variables are initialized from the WRF-ARW forecast of the previous day.

Setup Domain 3
- Goddard SW RAD
- Goddard LW RAD
- Grell-Devenyi CU
- Goddard GCE MP

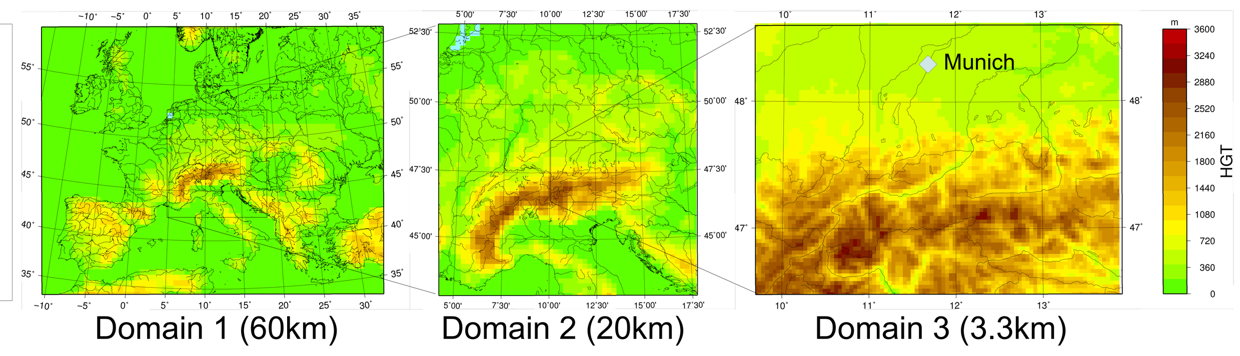

Fig. 3: WRF model domain configuration

Preliminary Results

Figure 4 compares the time series for 2m-temperature, air pressure, short wave radiation, and relative humidity. The colors red, blue, and orange depict the forecasts for day 1, day 2 and day 3. The baseline triangle marks the station reference. The point, square, and downward triangle symbols represent the different domains.

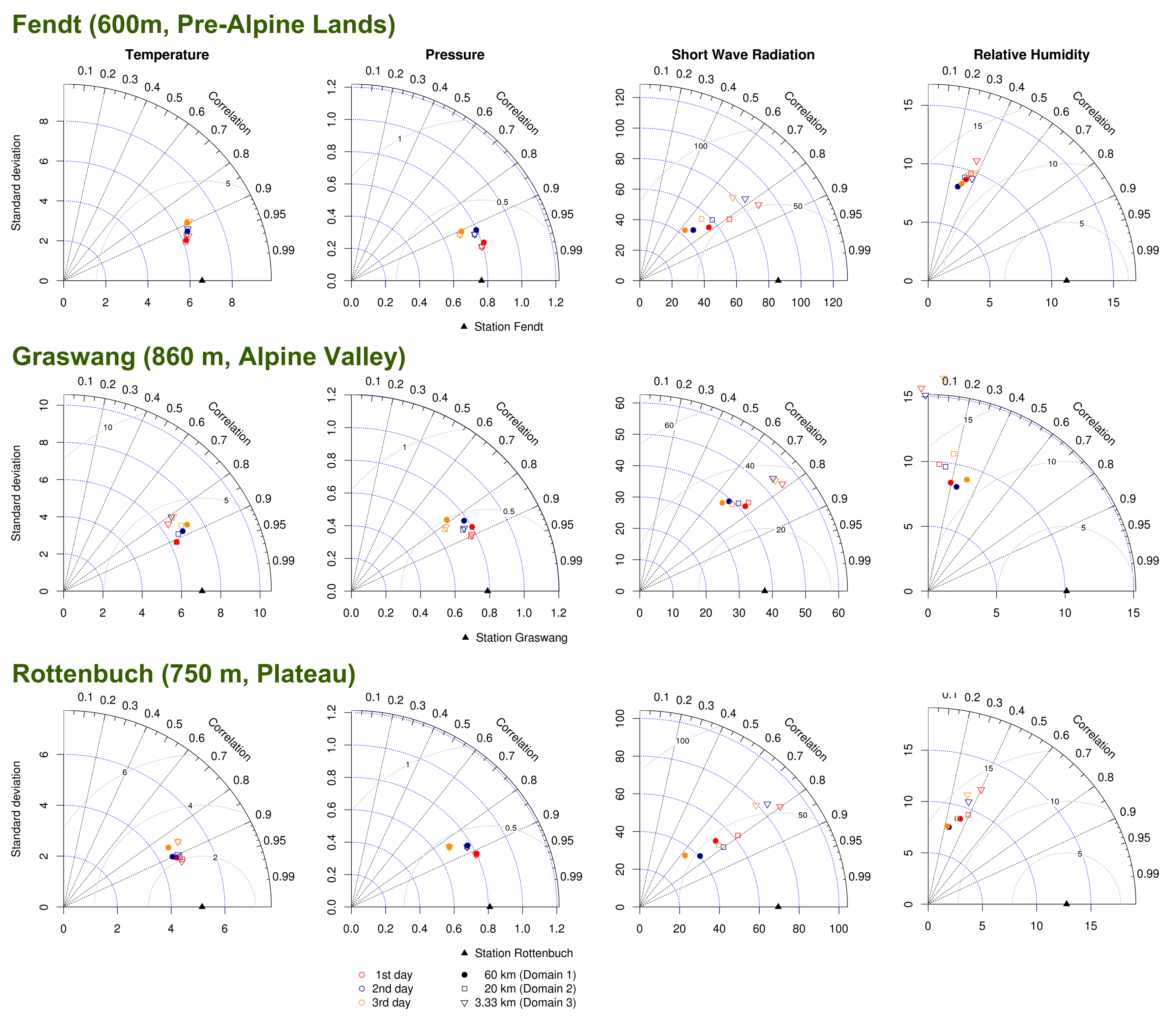

Fig.4: Taylor diagram comparison of regional atmospheric model and TERENO Pre-Alpine observations, 2011-12-15 to 2012-03-13 (90 days) for the sites Fendt, Graswang, and Rottenbuch

Temperature:	Better for short forecasts; not always improving with increasing resolution
Pressure :	Better for short forecasts; 20km resolution equal to 3.3km
Radiation:	Decreasing skill with inc. forecast time; improvement with inc. resolution
Humidity:	Weak coherence; in general improvement with increased resolution
Fendt:	3.3km run resembles the station characteristics best
Graswang:	3.3km run fails except for pressure; best results obtained with 20km
Rottenbuch:	Similar to Fendt, increasing resolution improves the skill

Conclusion and Outlook

In general, the dynamical downscaling with the WRF-ARW model yields an improved representation of the atmospheric state near the surface. For Fendt and Rottenbuch the skill improves with increasing domain resolution. However, for Graswang better results are achieved with the coarser domains. We assume that the special features of this narrow mountain valley are not yet resolved by the finest regional domain. A further increment in spatial resolution could be a solution.

In 2012, further climate stations and precipitation gauges will be mounted throughout the Pre-Alpine observatory. Additional measurement facilities will be established in mountainous environments.
Moreover, the regional atmospheric model driving will be extended from the GFS forecasts to global analysis and reanalysis products. In a further step, the comparison should also address the benefits of fully two-way coupled models like WRF-Hydro, and WRF-HMS.