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NWP–model verification with VERA over complex terrain

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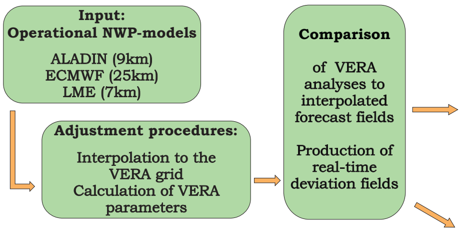
Operational model comparison

VERA (Vienna Enhanced Resolution Analysis; Steinacker et al. 2000, Steinacker et al. 2006) is a NWP-model-independent, real time analysis scheme, developed at the Department of Meteorology and Geophysics of the University of Vienna. Since 2003 a model comparison system has been embedded in the framework of VERAfem, a 2D version of VERA which produces surface fields on a regular grid with a resolution of 20km. Three NWP models, ALADIN-AUSTRIA, LME and ECMWF, are hourly, 3-hourly respectively, compared to the corresponding analysis.



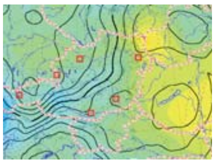


Fig. 1a

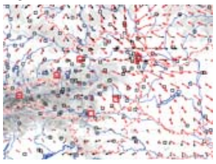


Fig. 1b

Fig. 1: Structure of the operational model comparison scheme which is embedded in the VERA system. Fig. 1a and Fig. 1b give examples of the graphical edition of the output fields. Coloured shades (above) describe difference fields (in this case MSL-pressure) overlaid with the single fields of analysis (solid lines) and forecast (dashed lines). Vector fields are drawn as depicted below.

The VERA-parameters ((equivalent) potential temperature, mean sea level pressure (direct model output and reduced by the standard-reduction-method from the lowest model layer), mixing ratio and wind speed) are calculated from the appropriate model output parameters. Interpolation of the model data to the VERA grid is done using Cressman Interpolation.

Statistical evaluation

The archived comparison data are evaluated by using various statistical methods. In doing so forecast quality is defined as the multitude of attributes that refer to either forecasts or observations (or analysis values) as well as to their relationship. Two statistical approaches which may complement each other are applied to the data: The “Measures Oriented” approach (MO) including general verification measures, and the “Distribution-Oriented” approach (DO) which is based on the two-dimensional, bivariate distribution of forecast and analysis values (Murphy and Winkler, 1987).

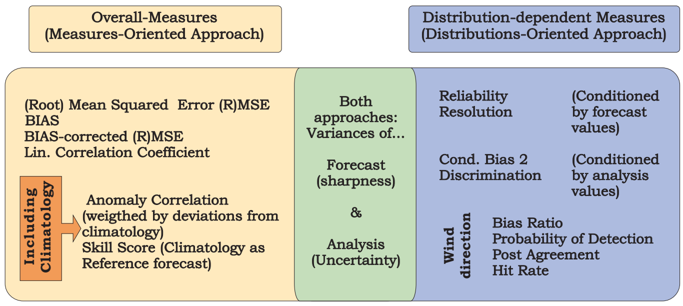


Fig. 2: Overview of the statistcial measures used for the evaluation of the model comparison data. The variances are of major importance as they belong to both, overall and distribution-dependent measures.

The VERA domain is divided into sections, called “climate regions”, and “points” with a dimension of 4 x 4 grid points within the Alpine Region. Data are temporally stratified by monthly periods, different times of day and selected cases of foehn and of thermally induced pressure structures in the Alps.

Results

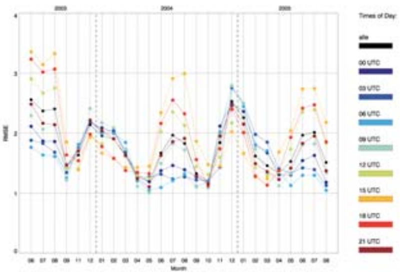


Fig. 3.1: Time series of monthly RMSE-values (RMSE of monthly cumulated data samples) of the MSL-pressure for ALADIN - VERA in hPa. Coloured lines represent different times of day, the black line the average for the whole day. The selected period is June 2003 - August 2005. The area of investigation spans the whole Alpine Region . Peaks during summer and winter are caused by the strong influence of thermally induced pressure systems in the Alps.

The results contain various information about the consistency between models and analysis as well as between the models among each other. Much emphasis is put on the influence of the Alpine mountain range on the deviations.

Fig.3.1 denotes the effect of thermally induced pressure systems. VERA strongly reproduces those cold-highs and heat-lows, whereas the forecast models tend to subpress them. The amount of deviation can be lowered if the model pressure is reduced employing the same standard reduction method as in VERA instead of using the MSL-pressure directly submitted by the model (Fig. 3.2).

In cases of south-foehn it can be observed that the pressure gradient over the Alps simulated by the forecast models is weaker and slightly shifted to the north in comparison to VERA (Fig. 3.3). These facts partly originate in different model topographies, which also cause diverse conditions of wind speed and wind direction in the different model forecasts at specific points in and around the Alpine mountain range (Fig.3.4.).

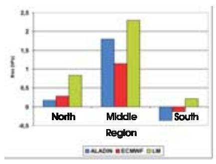


Fig 3.3.a

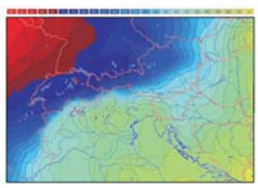


Fig 3.3.b

Fig 3.3.a: Bias of the model-reduced MSL-pressure in selected subregions (160 x 160km) north, over (”Middle”) and south of the Alps during cases of south foehn. The positive bias in the region ”Middle” indicates that the forecasted pressure gradient lies north of the analyzed one.

Fig 3.3.b: Mean deviation of the MSL-pressure between VERA and VERACLIM (climatological data based on the VERA method) for 97 cases of south foehn.

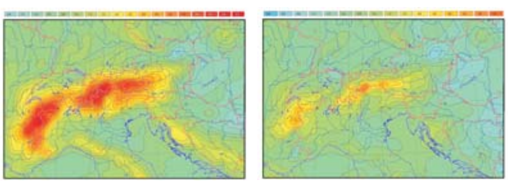


Fig 3.2: Mean pressure differences between LME and VERA in July 2005 at 15 UTC. On the left hand side the comparison is performed using the model-reduced pressure, whereas on the right hand side the model output of the lowest model level was reduced by a standard reduction method based on a polytropic assumption. Red colours denote positive biases (model minus VERA), bluish colours negative biases and greenish colours equality.

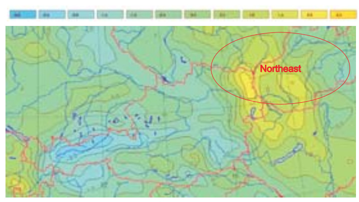


Fig 3.4.a

Fig 3.4.a: Mean deviation of the wind speed between ALADIN and ECMWF during south foehn. Yellow colours point out areas where the ALADIN - wind speed is higher than in the ECMWF forecasts, blue denotes stronger ECMWF - winds.

Fig 3.4.b: Distributions of the wind direction for ALADIN and VERA (left) and ECMWF and VERA (right) during south foehn in the region “Northeast” which is displayed in Fig. 3.4.a. The red areas denote the distribution of the forecasts, whereas the blue frames show the distribution of the analyzed values.

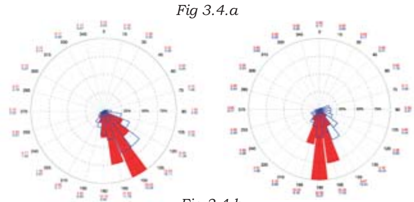


Fig 3.4.b

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References

Gorgas T., M. Dorninger, R. Steinacker, 2006: NWP-model verification with VERA over complex terrain. Proceedings of the 1st Scientific MAP D-PHASE Meeting, November 6-8, 2006. Available at the Department of Meteorology and Geophysics, University of Vienna.

Murphy, A. H. and R. L.Winkler, 1987, A General Framework for Forecast Verification, Monthly Weather Review, Vol. 115, 1330-1338.

Steinacker, R., C. Häberli, W. Pöttschacher, 2000, A Transparent Method for the Analysis and Quality Evaluation of Irregularly Distributed and Noisy Observational Data, Monthly Weather Review, Vol.128, No.7, 2303-2316.

Steinacker R., M. Ratheiser, B. Bica, B. Chimani, M. Dorninger, W. Gepp, C. Lotteraner, S. Schneider, S. Tschannett, 2006, A mesoscale data analysis and downscaling method over complex terrain, Monthly Weather Review, Vol. 134, No.10, 2758-2771.

VERA Homepage: www.univie.ac.at/img-wien/VERA/