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GeoSphere Austria

1. Operational configurations at GeoSphere

Since last year only minor changes related to the operational system in Austria regarding 2m diagnostic tuning, bufrtemp activation, lake initialization and windfarm parametrisation were applied. However, we plan a major upgrade to a 1km scale C-LAEF in the years to come and first preparations are ongoing. This also includes testing of 3D-EnVar.

	C-LAEF	AROME-RUC
Model version	cy43t2bf11+	cy43t2bf11+
Resolution	2.5km	1.2km
domain	Alpine area 600x432GP	Austrian area 900x576GP
Members	16+1+1	deterministic
level	90 (5m-20hpa)	90 (5m-20hpa)
starting times	00,03,06,…,21	00,01,02,…,23
Forecast Range	60h/48h/3h	12h (05UTC+25h)
timestep	60s	30s
Output frequency	1h	1h3D /15min 2D
Orography	GMTED2010	SRTM 90m
Physiography	ECOCLIMAPI	ECOCLIMAPII
LBCs	IFS EPS/IFS HR	C-LAEF 2.5km det
coupling frequency	1h	1h
Surface Scheme	Surfex 8.0 FR	Surfex 8.0 FR
Initialisation	ENS 3D-Var+Jk+ENS OI(soil)/ 3D-Var+OI	3D-Var+OI+LHN/FDDA+IAU
cycling interval	3h	1h
window/Cutoff	+-90min/2h	-90min+30min/ 25min
B-Matrix	C-LAEF EDA climatologic	RUC-EDA climatologic+diff. of the day
Hardware	ECMWF ATOS/HPE Apollo 8600	HPE Apollo 8600

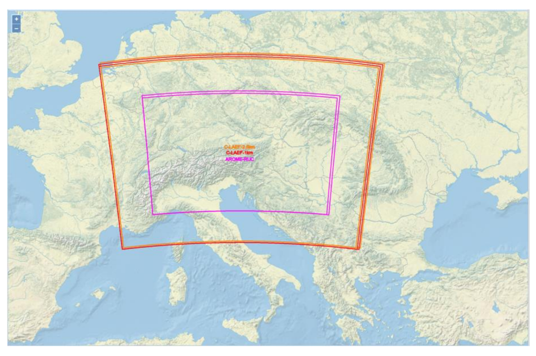


Fig.1: Operational domains including the planned 1km domain

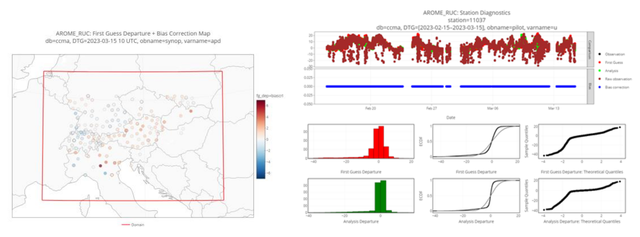


Fig.2: AROME-RUC OBSMON Installation GNSS fg-departures/ SODAR

B-Matrix and EnVar Tests

For the setup of a 1km C-LAEF version a new B-Matrix was calculated based on NMC method (90 differences +12h vs +36h) and new FESTAT-FA version from cy46t1. To use NMC-approach some slight modification of FESTAT code was necessary. Later an update with EDA method is planned. For this year we plan to run a period with C-LAEF-EnVar.

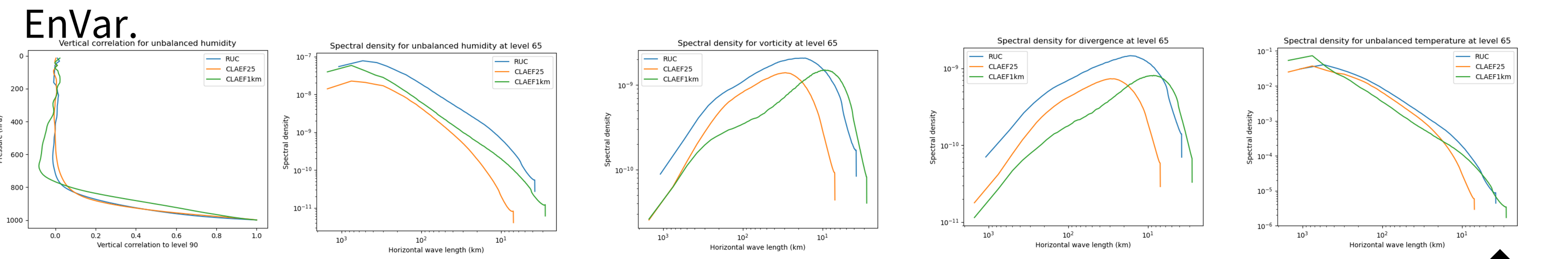


Fig.3: B-Matrix diagnostics CLAEF2.5km EDA, RUC 1.2km EDA and CLAEF1km NMC ⬆

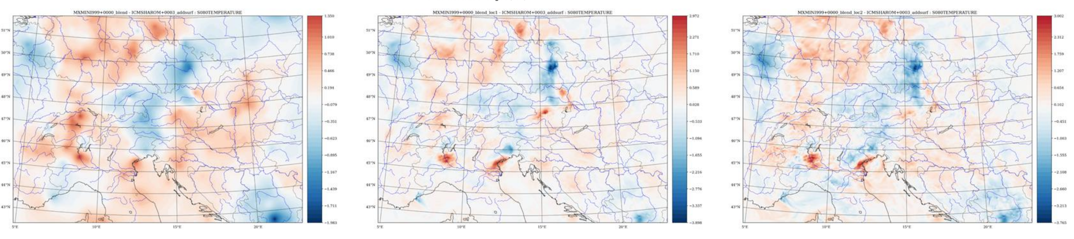


Fig.4: 3D-EnVar tests with cy46t1 increment 7th June 2022 09 UTC AROME 2.5km
OOPS 3D-Var, EnVar SP loc, EnVar GP loc 100km/0.2
⬅ *Obs: Synop, aircraft, MW satellite*

3. Windfarm parametrisation tests

The windfarm parametrization from cy48t2 Volker et al. 2015 (WF2) and Fitch et al. 2012 (WF1) were backphased to 46t1 and compiled on ECMWF HPC ATOS. Further the input database was updated and some small bugfixes applied regarding unnecessary memory usage and the correction of instantaneous power output as PEZDIAG5 field. The preprocessing was done for several AROME domains: 2.5km OPER, 1.25km Team-X, 500m Team-X and 200m Team-X. So far the Derecho case 18th August 2022 00UTC was run with 1.25km and 500m with WF1, WF2 and without WF as reference.

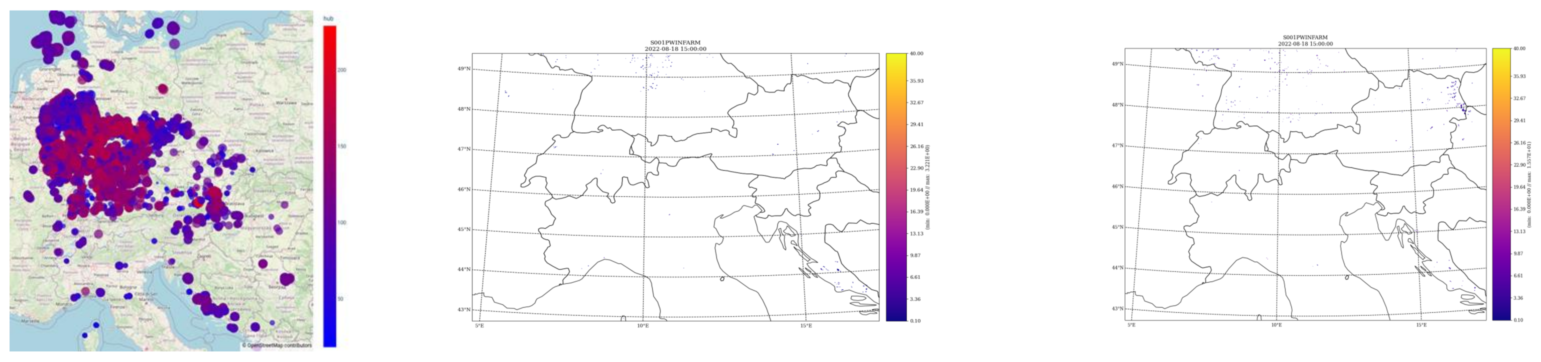


Fig.6: windfarm database for Central Europe based on opendata (about 15000 turbines) color indicates hub height and size of spots rotor diameter. Also type and altitude are known. Instantanous wind power/GP in MW
WF1 03UTC (left), WF1 15 UTC (middle), WF2 15UTC (right) AROME 500m

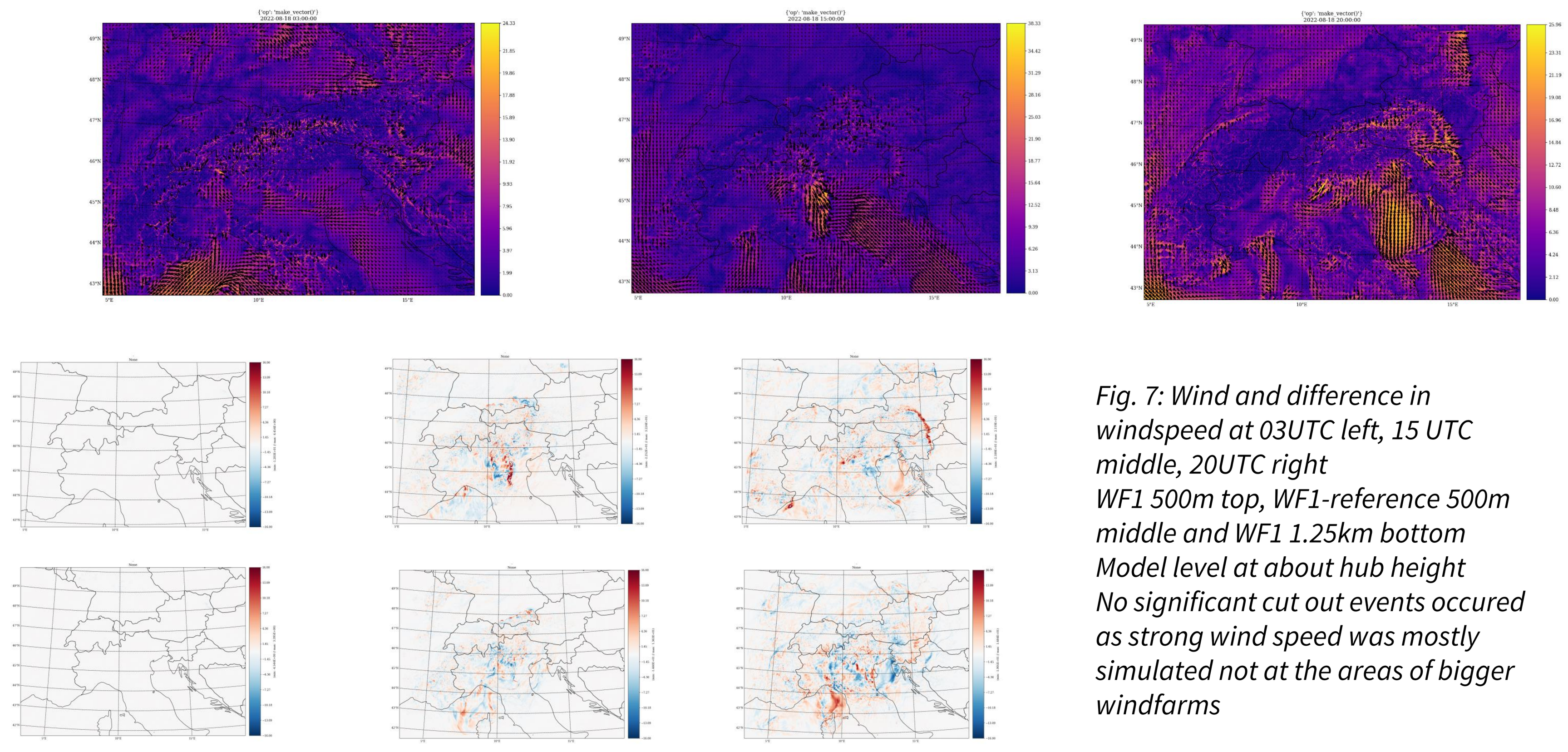


Fig. 7: Wind and difference in windspeed at 03UTC left, 15 UTC middle, 20UTC right
WF1 500m top, WF1-reference 500m middle and WF1 1.25km bottom
Model level at about hub height
No significant cut out events occured as strong wind speed was mostly simulated not at the areas of bigger windfarms

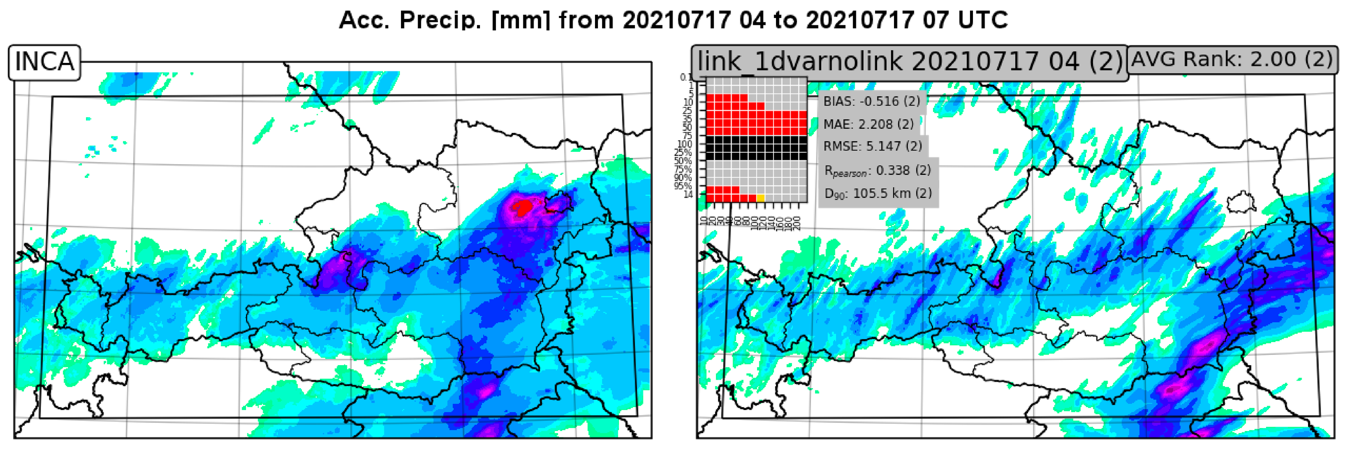
This work was partly done under the DE330 framework founded by the European Union

Preliminary Conclusions:
Even if the main features of change by WF1 and WF2 are similar, there are lots of differences in detail with strong impact on simulated power output. The main differences occur more at locations of high windspeed / active weather than the turbine locations itself. Higher resolution strongly affects the results on small scales.

LINK

The LINK project explores the feasibility of assimilating data from microwave links between cell phone towers into AROME using a 1D-VAR + 3D-VAR approach. Our project partner FH. St. Pölten uses machine learning to convert the signal attenuation data from microwave links into precipitation rates. For this purpose, a neural network was trained on microwave link data and GeoSphere's INCA analysis. The resulting data was initially assimilated as 100% RH observation at the links' mid points, which led to an overestimation of moisture and precipitation by AROME.

The 1D-VAR + 3D-VAR approach (Lopez et al., 2007) uses model physics and surface precipitation to estimate a best fit for a vertical profile from a selection of profiles from the first guess and then adjusts the humidity and temperature in the profile, which can then be assimilated as pseudo radiosonde containing, *RH*, *T*, or *q* observations.This spreads the assimilated moisture over a deeper layer and also allows drying above obsevations.



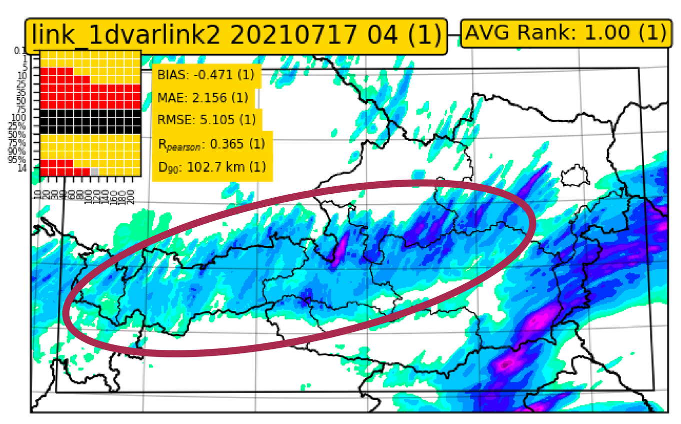
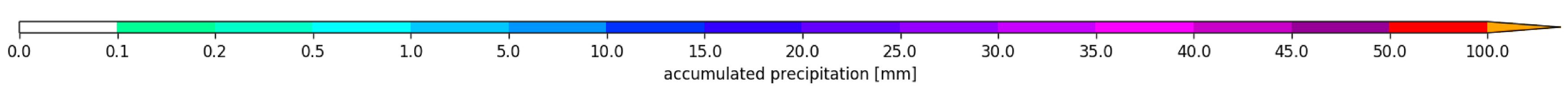


Figure 5: Verification of the first experiment using the 1D-VAR + 3D-VAR method showing two simulations without (nolink) and with (link) . The 3 hour accumulated precipitation forecast increases slightly when assimilating microwave link data.
Note that the observations were concentrated over the west of Austria in this case, thus not helping to capture the maximum over the northeast.



References

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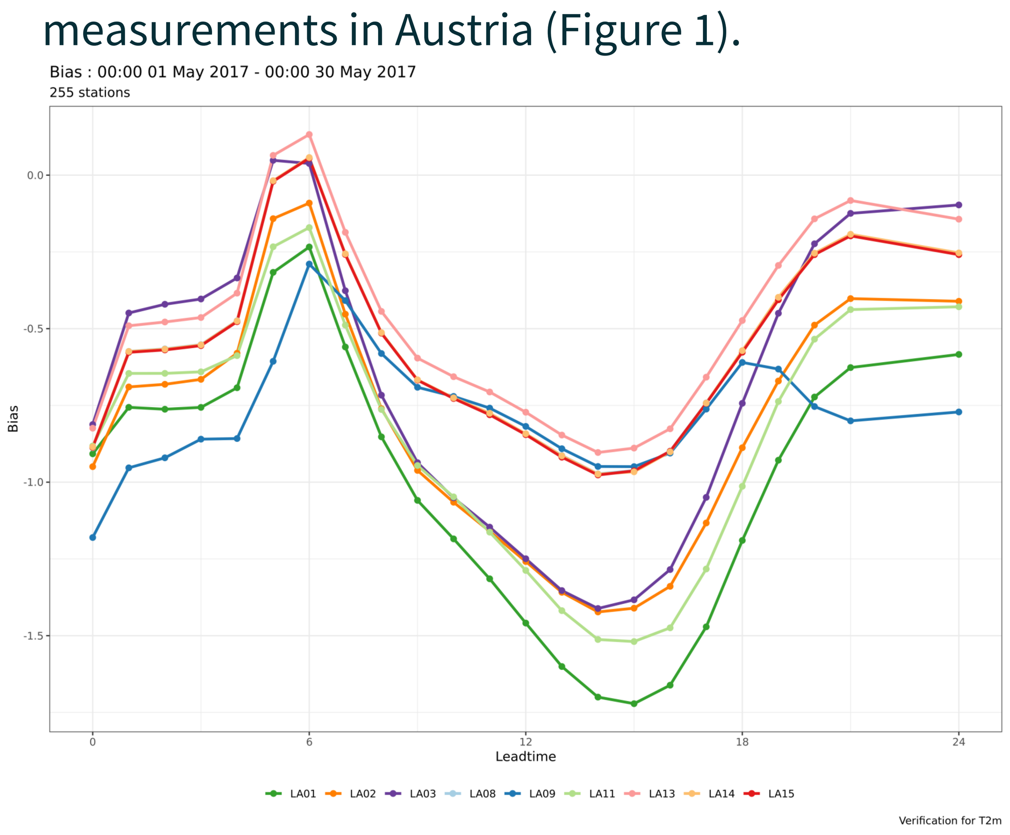
4. Patch-specific LAI assimilation in SURFEX

Hungarian colleagues showed the positive impact of LAI assimilation in AROME (Toth and Szintai, 2021). With this approach, the mean LAI for the grid cell is modified by the assimilation and the increment is applied to the patch-vegetation accordingly.

Due to improved measurement and analysis approaches for LAI based on Sentinel-2 and AI, we have a 500m-dataset with LAI values separated for broadleaf forests, needle leaf forests and grassland for Austria, provided by BOKU (University in Vienna). To use this data set in its full richness, LAI assimilation in SURFEX8.1 has been adapted to work separately for each patch (hard coded for NPATCH=12).

We tested the impact by assimilating LAI at the initial date (every day at 00UTC) and comparing the resulting AROME (CY43) T2M forecasts (up to +24hours) to station measurements in Austria (Figure 1).



	NPATCH	CPHOTO	ASSIM	Land Cover
LA01	1	NON	no	ECO II
LA02	12	NON	no	ECO II
LA03	12	NON	no	LISA/UA
LA08	12	NIT	mean LAI on 1km	ECO II
LA09	12	NIT	no	ECO II
LA11	12	NON	no	ECO I
LA13	12	NIT	mean LAI, local obs error	ECO II
LA14	12	NIT	mean LAI on 2.5km	ECO II
LA15	12	NIT	separate LAI	ECO II

Figure 8: Bias for 2m air temperature averaged over all available stations in Austria and for May 2017. LA14, LA15 and LA16 are overlapping.

Conclusion: A better representation of LAI improves T2M forecasts, and the patch-specific assimilation works. The resulting changes in LAI distribution compared to the original approach shows no additional positive impact on T2M on 2.5km, but we assume that this will change with increasing resolution of AROME in the future and a proper description of land cover will become even more relevant.

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