Testing the Hybrid-3DEnVar for convective-scale NWP model AROME over Austria

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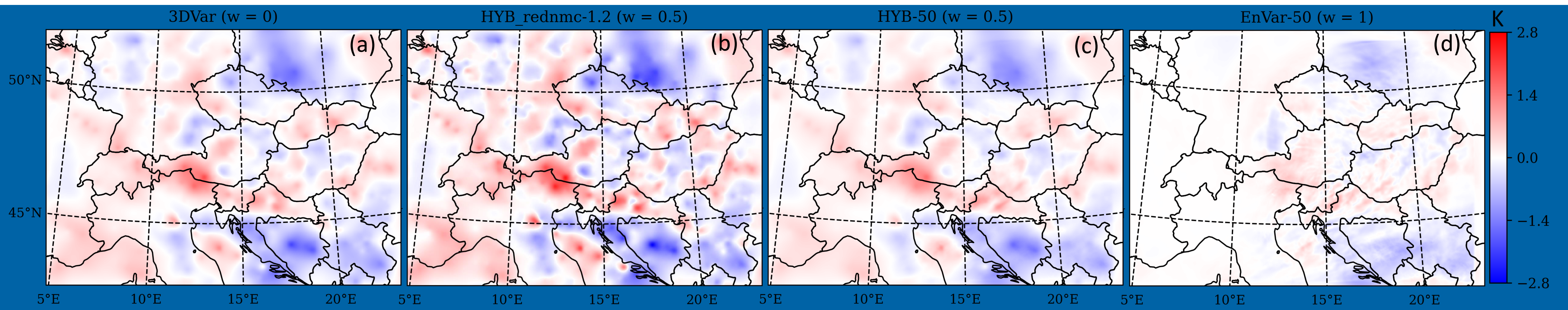
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Figure caption: Analysis increments at 250hPa from a) 3DVAR, b) HYB-50 with rednmc=1.2 , c) HYB-50 with rednmc=0.5, d) EnVar

Conclusions:

1. With the default settings, The static component of background covariances dominates Hybrid-EnVar. Changing the default rednmc (1.2) to the value used operationally by Geosphere (0.5) results in a more balanced weighting.

1. In our single testcase, both Hybrid and EnVar outperform 3DVAR.

2. VTS is an efficient approach to indirectly increase ensemble size, and shows promising potential.

1. Research questions

1. How to balance the static and ensemble components of the Hybrid-EnVar?

2. Is increasing ensemble size by Valid Time shift(VTS) ensemble approach beneficial?

2. Valid time shift (VTS) ensemble approach

1. VTS ensembles are initialized at the same time but are valid at different times. Rather than directly increasing ensemble size, VTS provides a low-cost way to increase the number of ensembles.

2. We apply 1 hour time shift to baseline ensembles to prepare VTS ensembles.

DA Experiment	Description	Aircraft assimilated/ Relative change in RMSD (%) against Radiosonde	Radiosonde assimilated/ Relative change in RMSD (%) against aircraft
3DVAR	Pure Climatological Background error covariance(BEC) Matrix (B_s)	+1.11	+0.90
EnVar-50	Pure Ensemble BEC (B_e)	-1.31	-0.30
HYB-50	50% weight to B_e	-1.16	-0.32
HYB-VTS-48	3×16 VTS ensembles with 50% weights to B_e	-0.94	-0.27
HYB-VTS-150	3×50 VTS ensembles with 50% weights to B_e	-0.98	-0.27

3. Approach

1. Hybrid-3DEnvar was tested Over Austria with 2.5km horizontal resolution.
2. 50 ensemble members from Convection-permitting Limited-Area Ensemble Forecasting (C-LAEF).
3. A locally driven convective summer day with weak pressure gradient force is chosen testcase to study.
4. Aircraft or radiosonde temperature is assimilated and verification is conducted against non-assimilated observation.
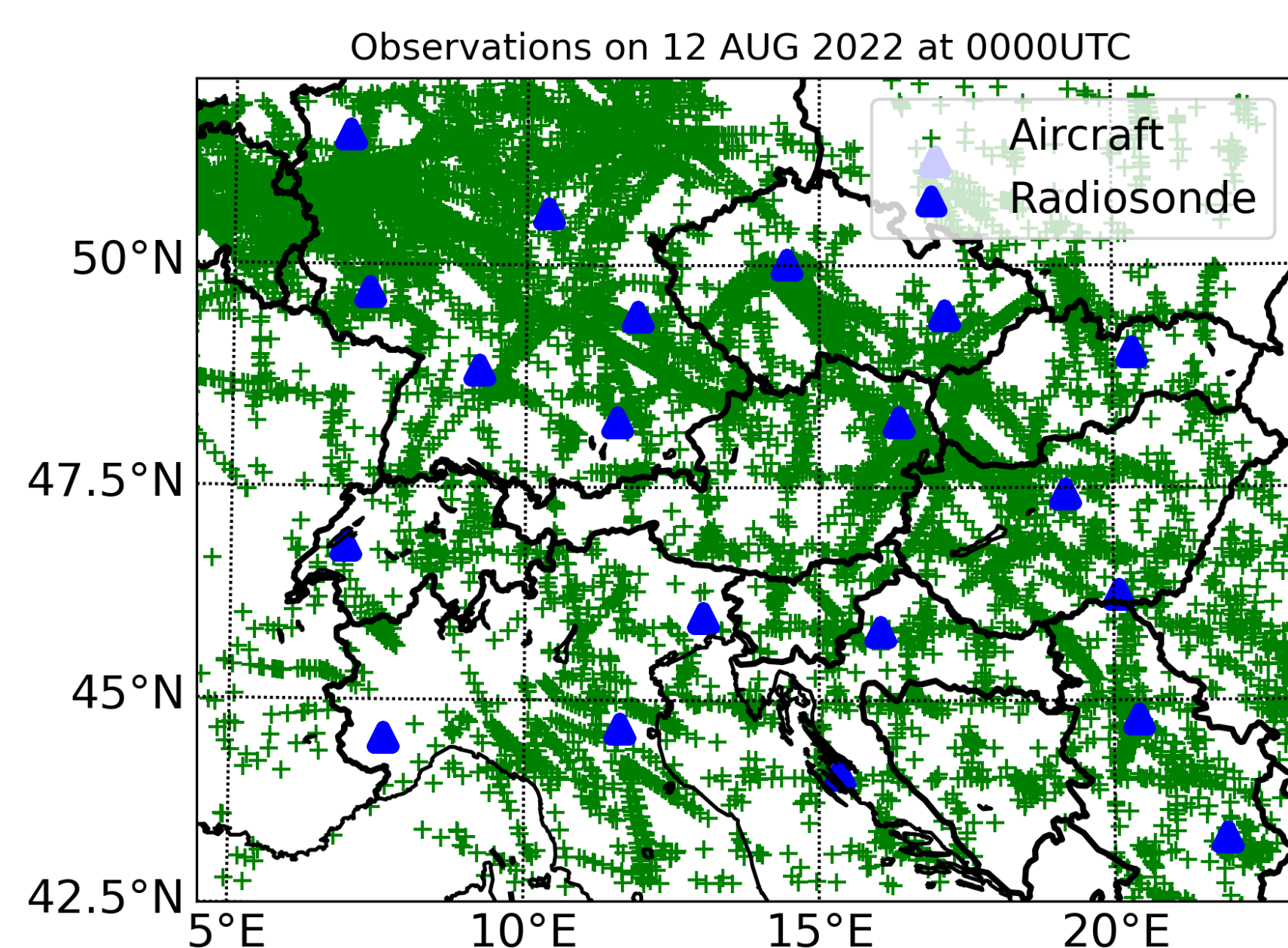
4. Increments at 500hPa from aircraft observations
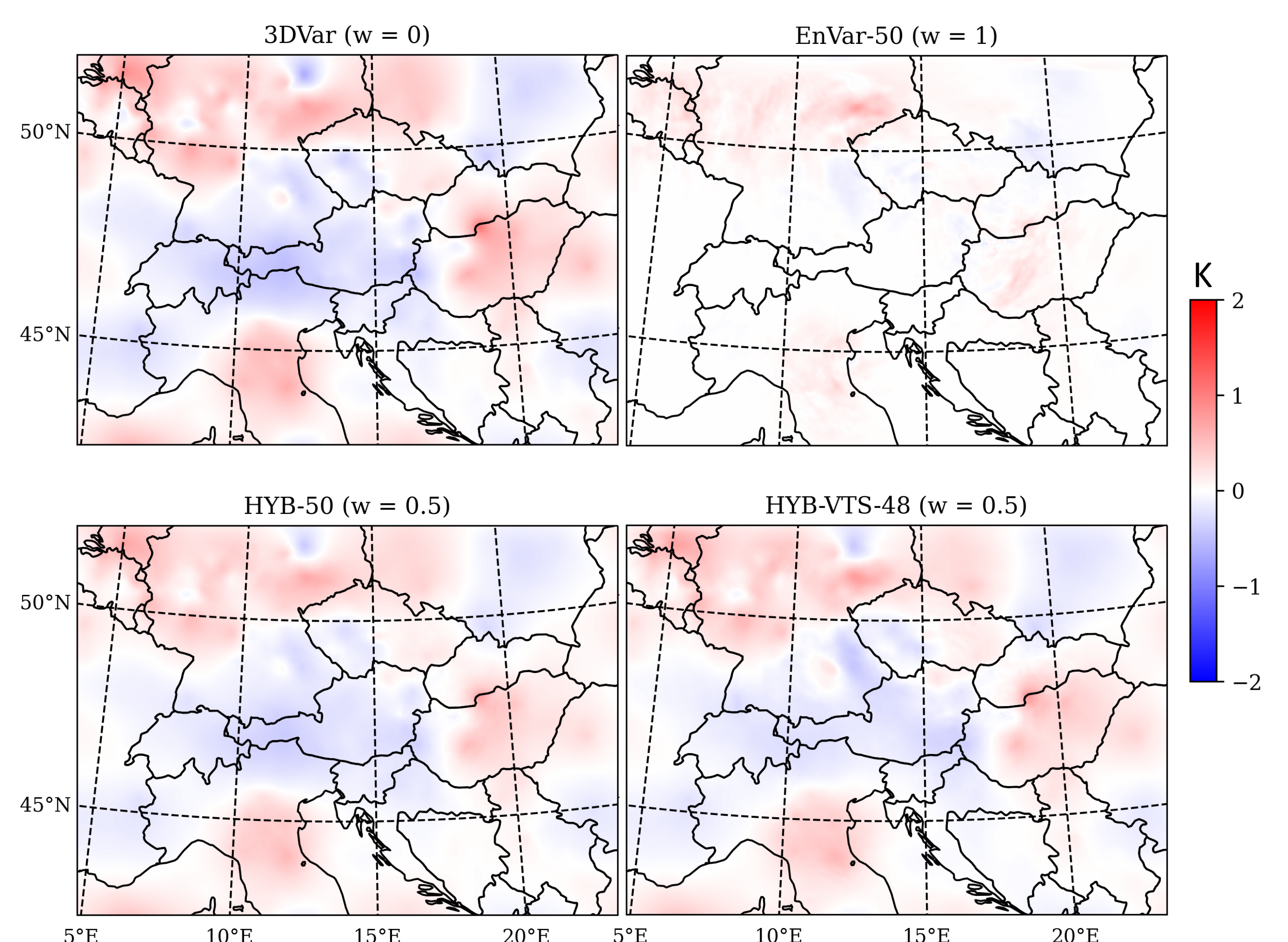
When calculated using independent radiosonde temperature observations, the % RMSD of analysis residuals of the HYB-VTS-48 is similar to that of the baseline HYB-50.

References

• Huang, B. and Wang, X., 2018. On the use of cost-effective valid-time-shifting (VTS) method to increase ensemble size in the GFS hybrid 4DEnVar system. *Monthly Weather Review*, 146(9), pp.2973-2998.

• Montmerle, T., Michel, Y., Arbogast, E., Ménétrier, B. and Brousseau, P., 2018. A 3D ensemble variational data assimilation scheme for the limited-area AROME model: Formulation and preliminary results. *Quarterly Journal of the Royal Meteorological Society*, 144(716), pp.2196-2215