

Assimilation of ground-based radar reflectivity in AROME-France

Impact of 4DEnVar assimilation method and scale-dependent localisation

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AROME-France assimilation system

Current configuration:

- 3DEnVar hourly cycle
- Background error covariances from EDA (50 members, 3.2km, 90 vertical levels)
- Tuning of horizontal and vertical localisation

New possibilities:

- Add hydrometeor in control variable
- 4DEnVar without TL/AD version of the model
- Activate Scale Dependent Localisation (SDL)

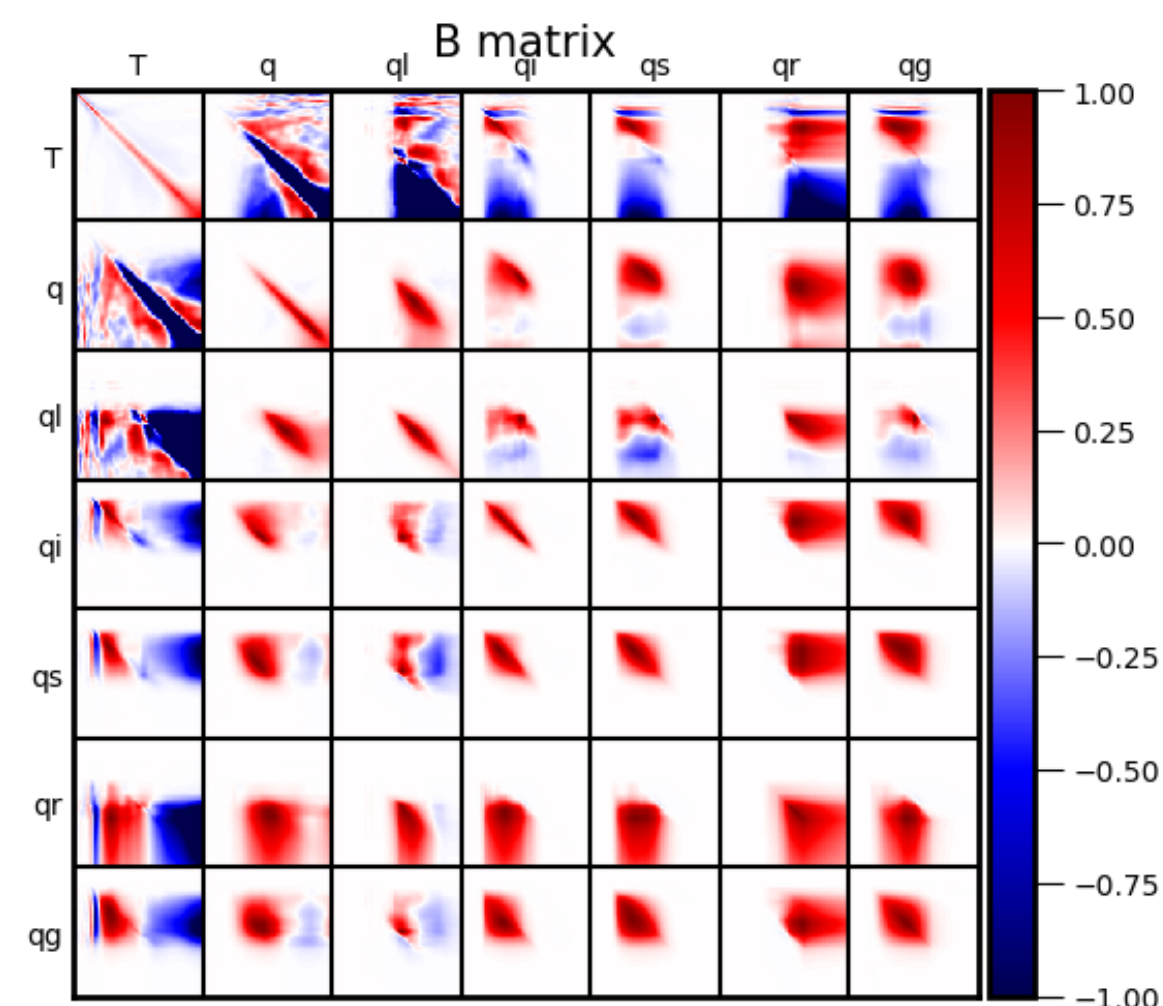


Figure 1 – Example of B matrix with hydrometeors in the control variable

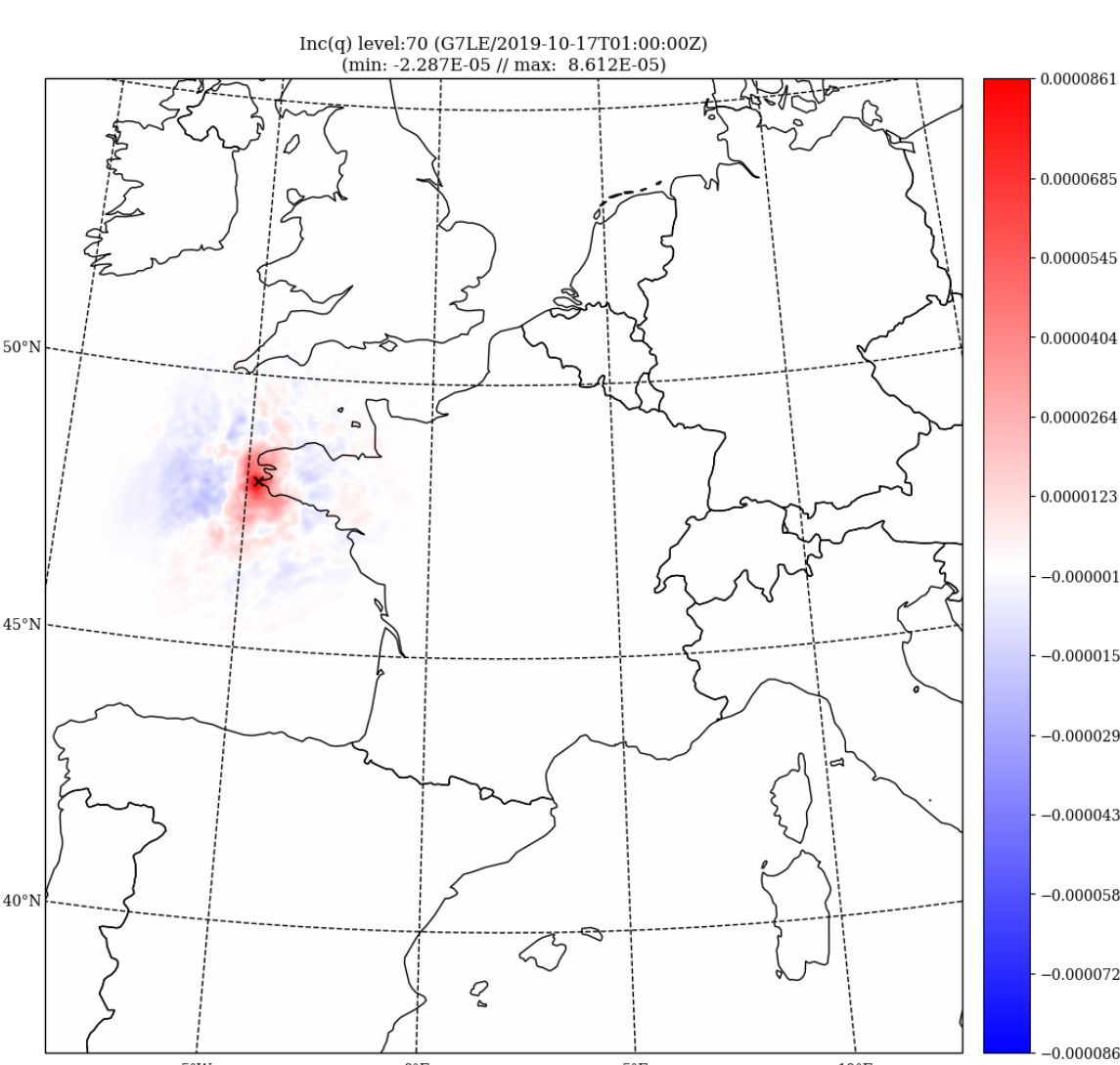
Radar reflectivity assimilation

In the previous AROME-France suite, assimilation of relative humidity pseudo-observations from Bayesian inversion [Wattrelot et al (2014)]. Development of TL/AD versions of the radar reflectivity observation operator and use of the hydrometeor in the control variable of the 3DEnVar assimilation system. Validation has been performed on three-months period and show improvements on scores versus radiosondes, IFS analysis and ground stations.

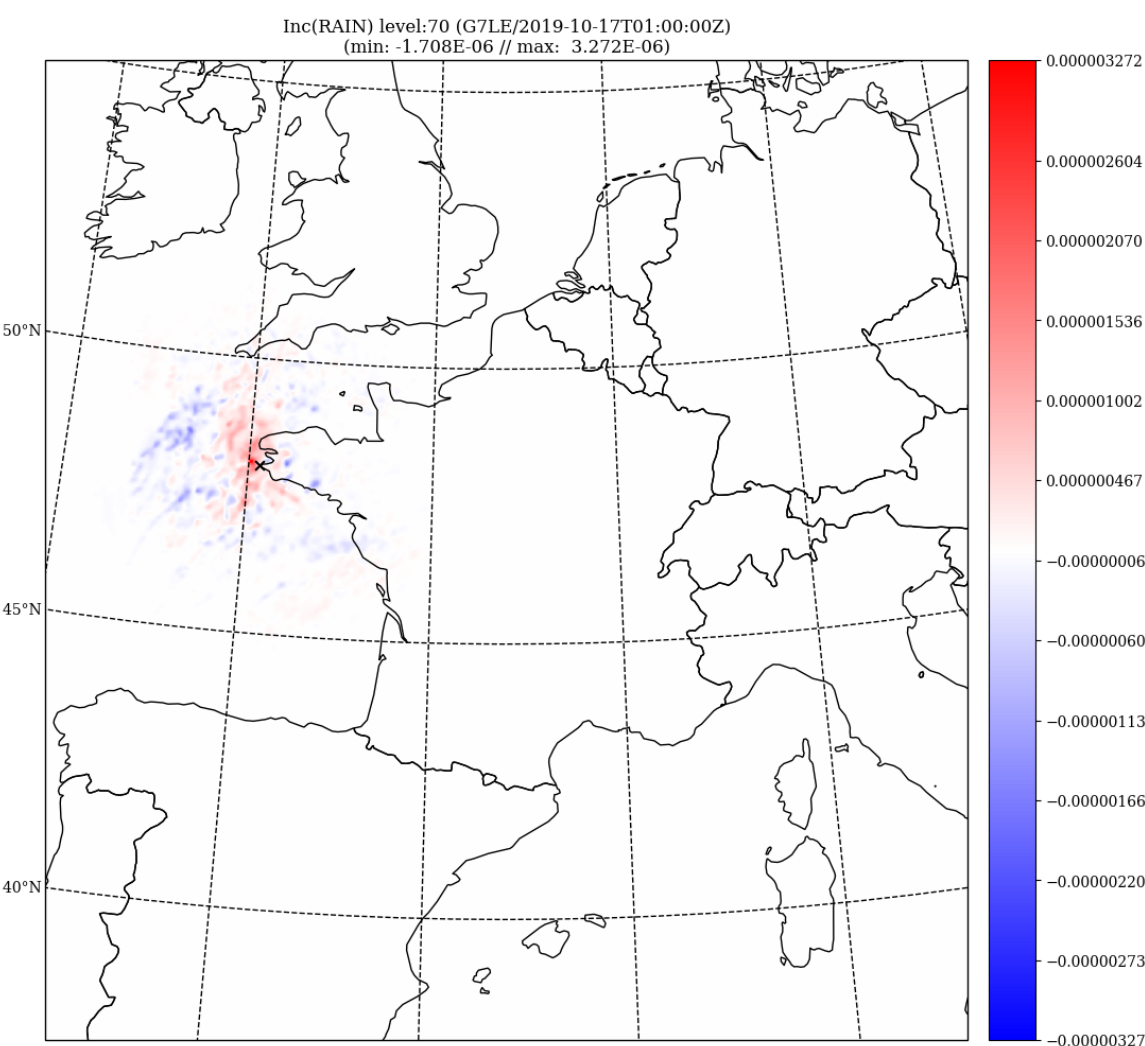
This method can be used in a 4DEnVar assimilation system. Tests are performed in hourly cycle with 15 minutes timeslots.

Assimilation of relative humidity

Increment of specific humidity



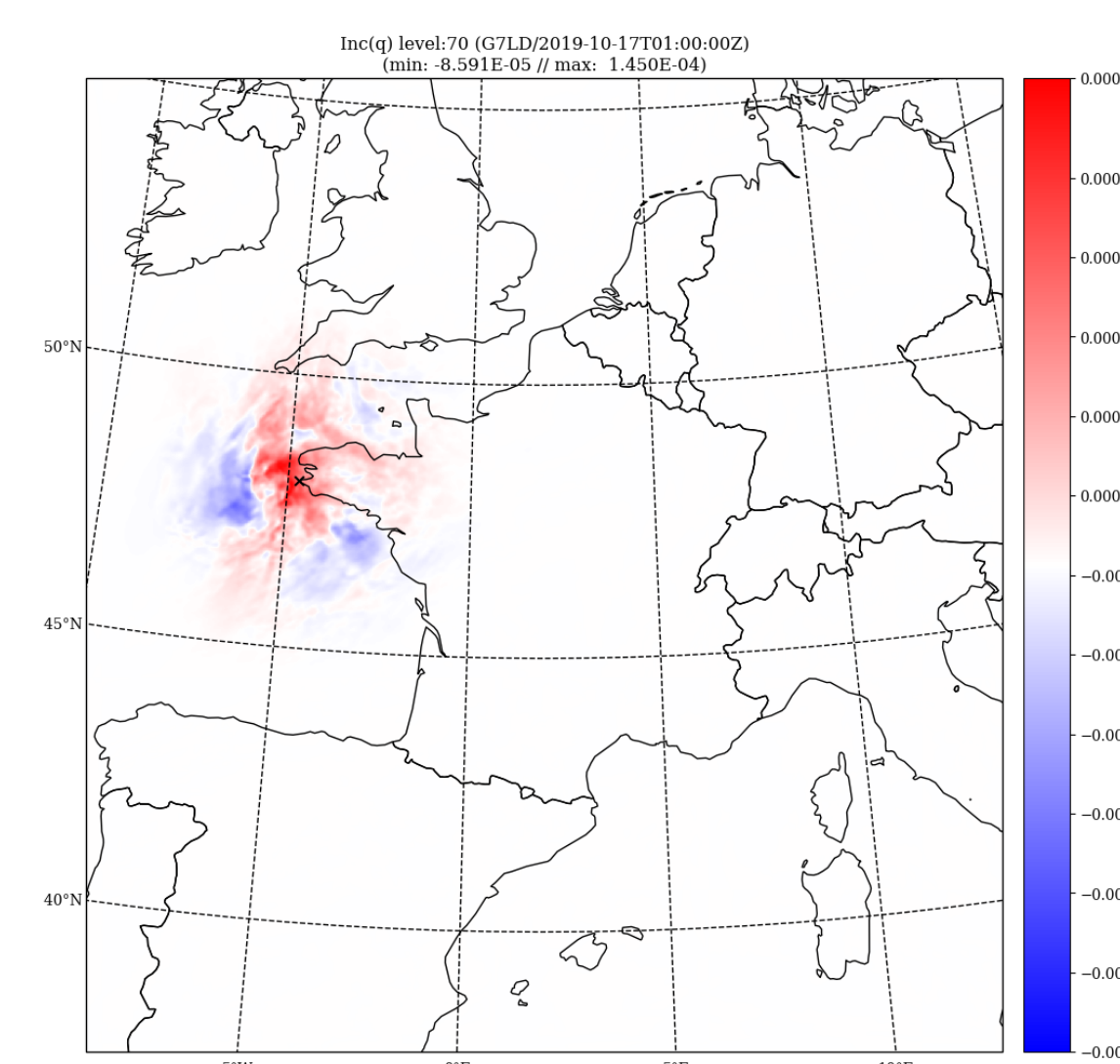
Cross covariances



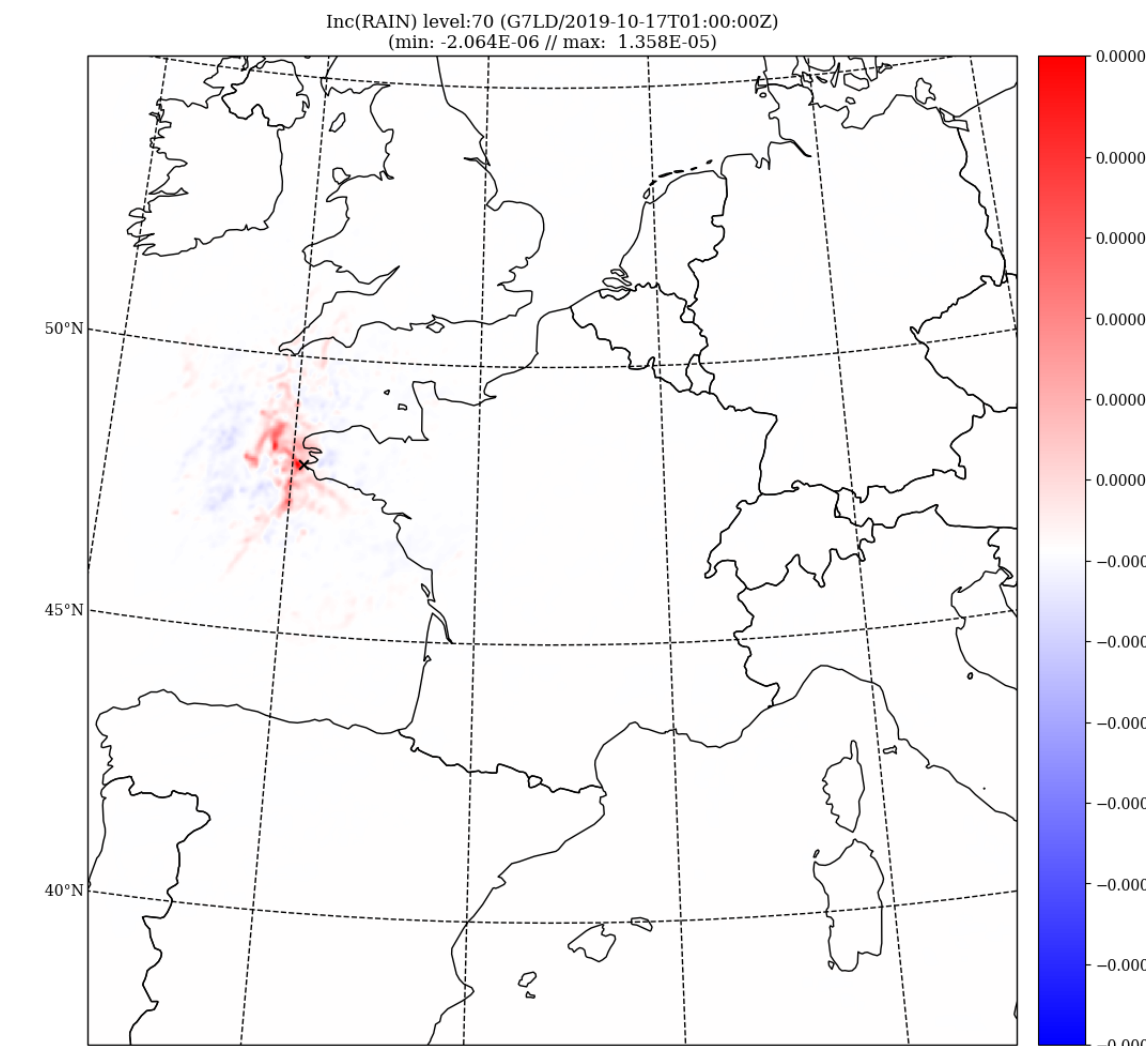
Increment of rain content

Assimilation of reflectivity

Increment of specific humidity



Cross covariances



Increment of rain content

Figure 2 – Example of single-observation assimilation

Scale-Dependent Localisation (SDL)

Localisation lengths should be adapted by parameter in 3DEnVar, more specially we should have shorter lengths for hydrometeors fields [Destouches et al, 2020]. Activation of SDL [Caron et al, 2019] allows to implicitly adapt localisation length to fields in the 3DEnVar assimilation system. Impact on forecast quality has been evaluated on a three-month experiment and scores are significantly improved.

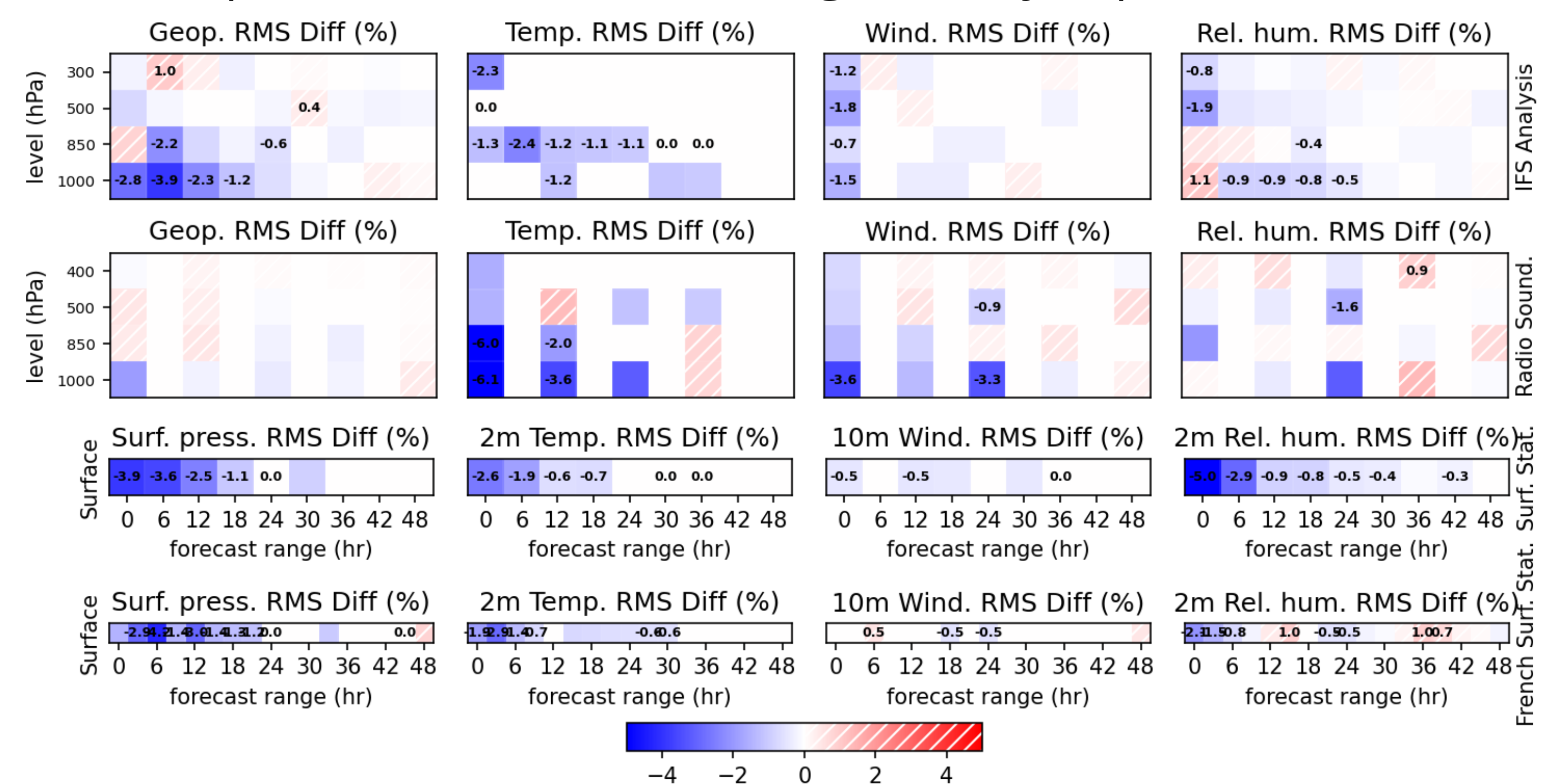


Figure 3 – Evaluation of SDL contribution. Scores over 3 month period.

4DEnVar assimilation scheme

4DEnVar has also been tested. A case study of a violent bow echo over Corsica has been evaluated.

4DEnVar + SDL configuration allow to better describe initiation of the convective area over Balearic islands and improve representation of violent wind gusts on a 13-hour forecast.

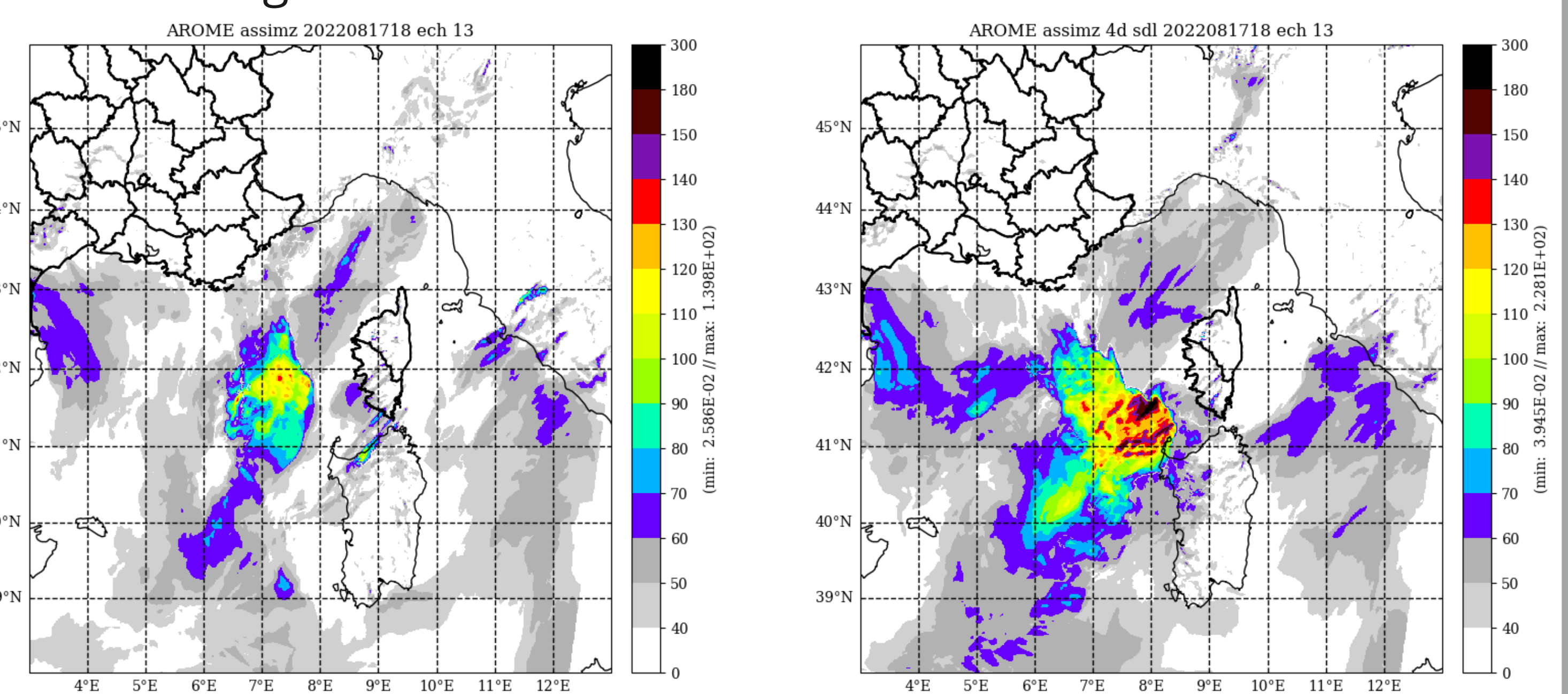


Figure 4 – Example of wind gust forecast in a bow echo case with 3DEnVar (left) and 4DEnVar+SDL (right).

Conclusion and perspectives

Ground-based radar reflectivity assimilation has been developed in the EnVar system with hydrometeors in the control variable. This assimilation system allows to use:

- Scale-Dependent Localisation (SDL). This method is highly beneficial when assimilating observations having impact on hydrometeors.
- 4DEnVar. It allows to assimilate observations every 15 minutes, which is beneficial to capture initiation of convective events, specially with ground-based radar observations.

These developments are part of the next Météo-France e-suite.

Bibliography

- [Caron et al (2019)] *Improving Background Error Covariances in a 3D Ensemble-Variational Data Assimilation System for Regional NWP*, Monthly Weather Review, 146, 3717-3733.
- [Destouches et al (2020)] *Estimating optimal localization for sampled background-error covariances of hydrometeor variables*, QJRM, 147:74-93.
- [Wattrelot et al (2014)] *Operational implementation of the 1D+3D-Var assimilation method of radar reflectivity data in the AROME model*, Monthly Weather Review, 142, 1852-1873.