AllSky VIS/IR assimilation activities at GeoSphere Austria

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Promoting Innovation.

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1 April 2025

next sTOP…

Assimilation of SEVIRI VIS0.6 in AROME-Austria

AROME-Austria model details

	Details
Model Version	AROME CY48T1_op1
Assimilation method	3D-Var
Framework	OOPS
Resolution	2.5 km
Levels	90
Assimilation window	-90min - +90min
Area / centered over	600x432 /Alpine region
LBC Model	IFS HRES
RTTOV (radiative transfer model)	RTTOV v12.2, BRDF atlas

Table 1: AROME-Austria model setup

Introduction

Traditional clear-sky assimilation limitation:

- Conventional clear-sky data assimilation methods typically consider only observations from cloud-free regions, excluding crucial data from areas affected by clouds or storms.
- This results in underrepresentation of key atmospheric phenomena such as cloud dynamics, precipitation, and storms, leading to less accurate forecasts.

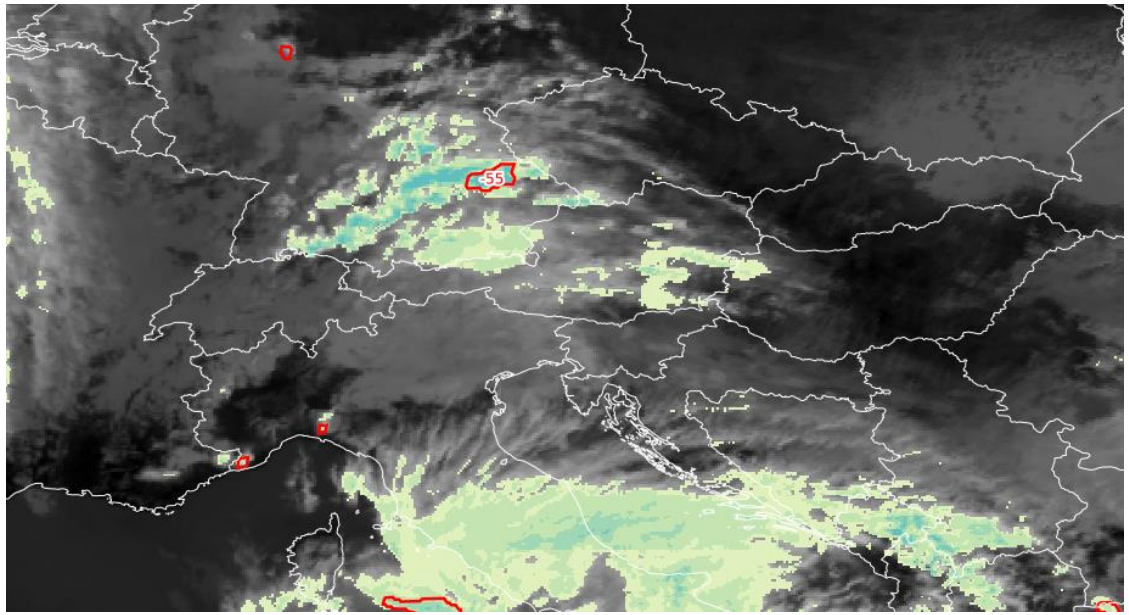


Fig. 1 : MSG SEVIRI IR10.8 µm + other products sandwiched, 8th May 2023, 12:00 UTC.
Courtesy: EUMETVIEW

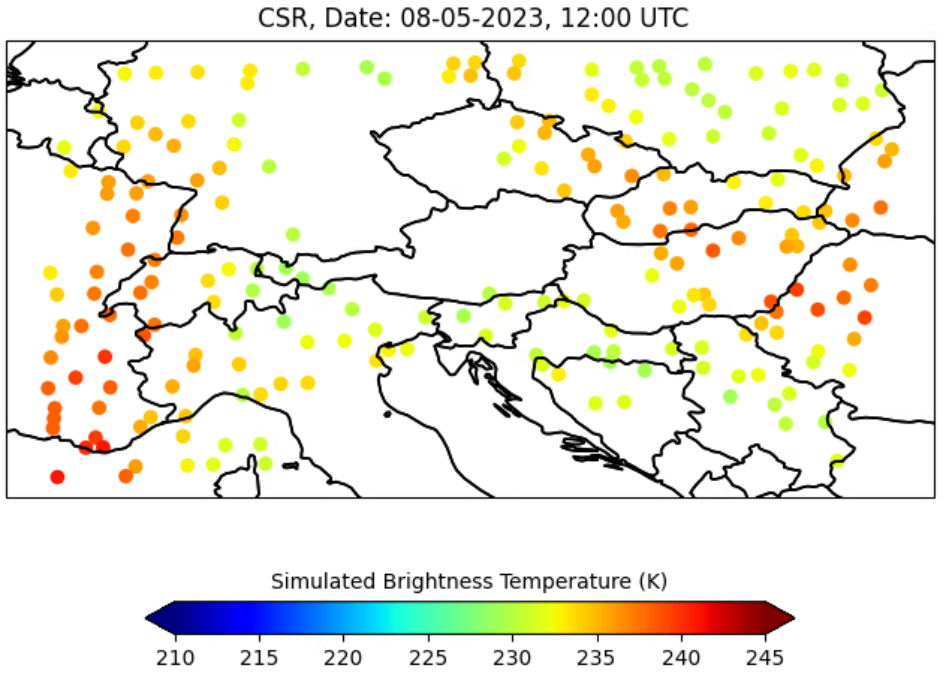


Fig 2: WV6.2 µm channel from MSG SEVIRI

Motivation

- **Water vapor channel observations**:

Capture deep convection, mid- and upper-level clouds, and cloud top height, improving the representation of atmospheric moisture and cloud dynamics.

- **Visible channel observations**:

Detect water clouds beneath cirrus and low stratus, enhancing the understanding of cloud layers that block infrared measurements.

- **Data assimilation integration**:

Combining water vapor and visible channel observations reduces ambiguities, providing a more accurate initial atmospheric state and improving model forecasts, particularly in complex cloud conditions.

Let‘s see (what is) VISIBLE…

VIS reflectances 0.6 µm

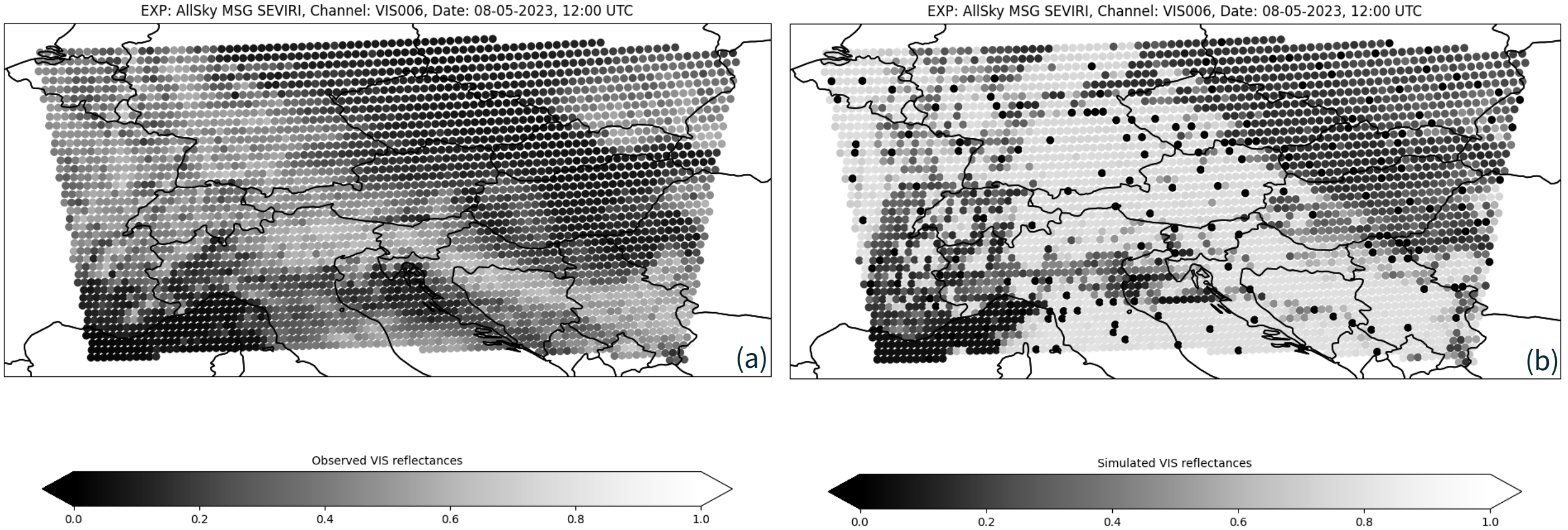


Fig 3: VIS0.6 µm channel from MSG SEVIRI

VIS reflectances 0.8 µm

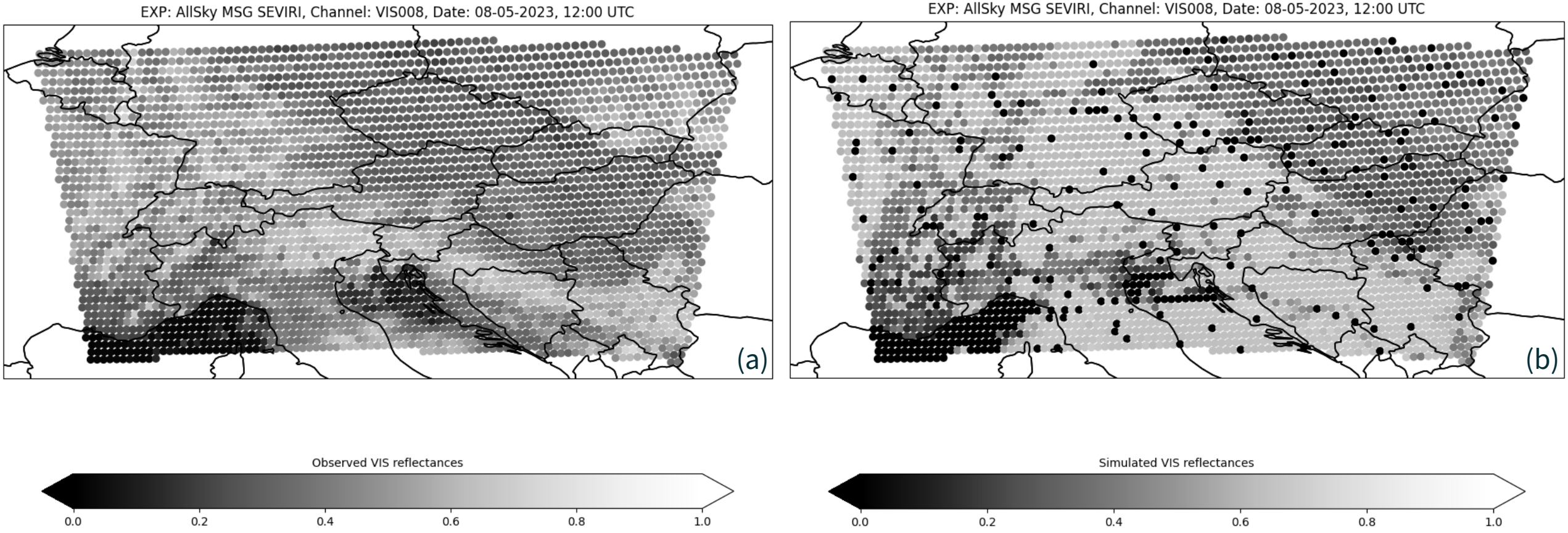


Fig 4: VIS0.8 µm channel from MSG SEVIRI

First guess departure from VIS0.6 µm simulation

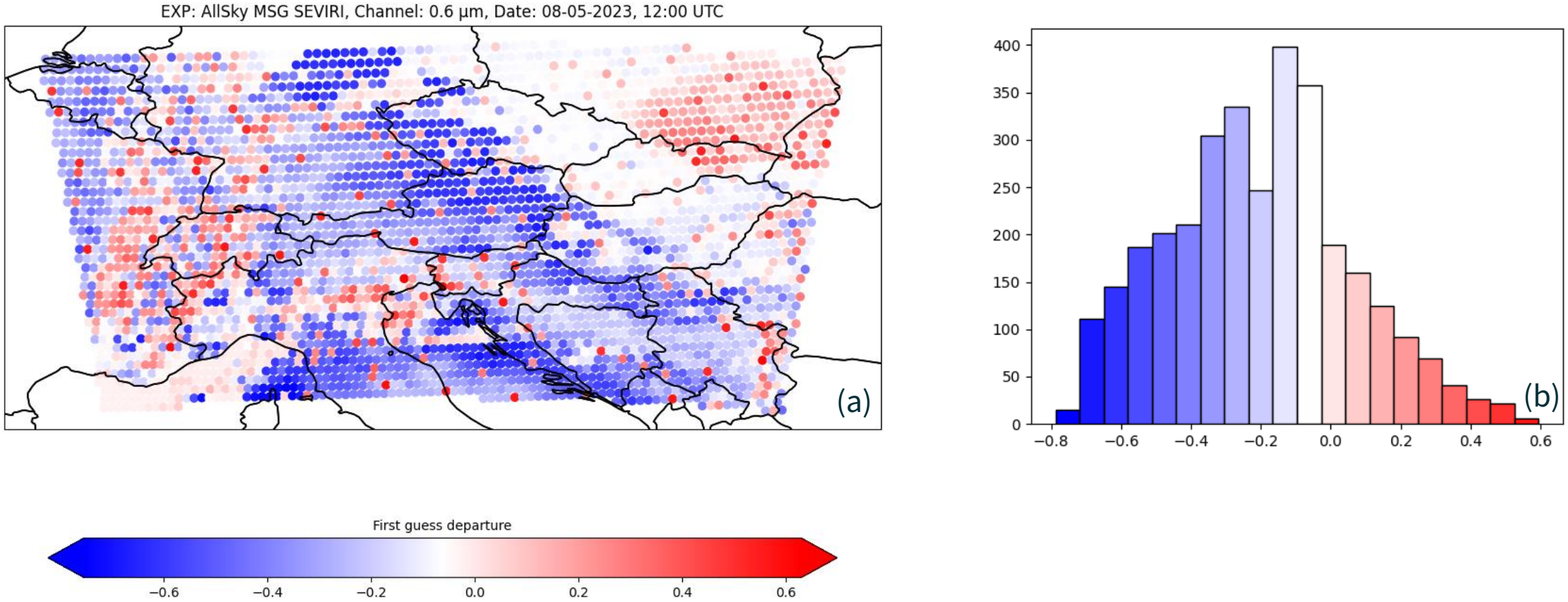


Fig 5: Distribution of first guess departures and stats

Issue in VIS minimization in the adjoint model code.

Moving to AllSky IR ...

AllSky IR assimilation

Using
MSG SEVIRI

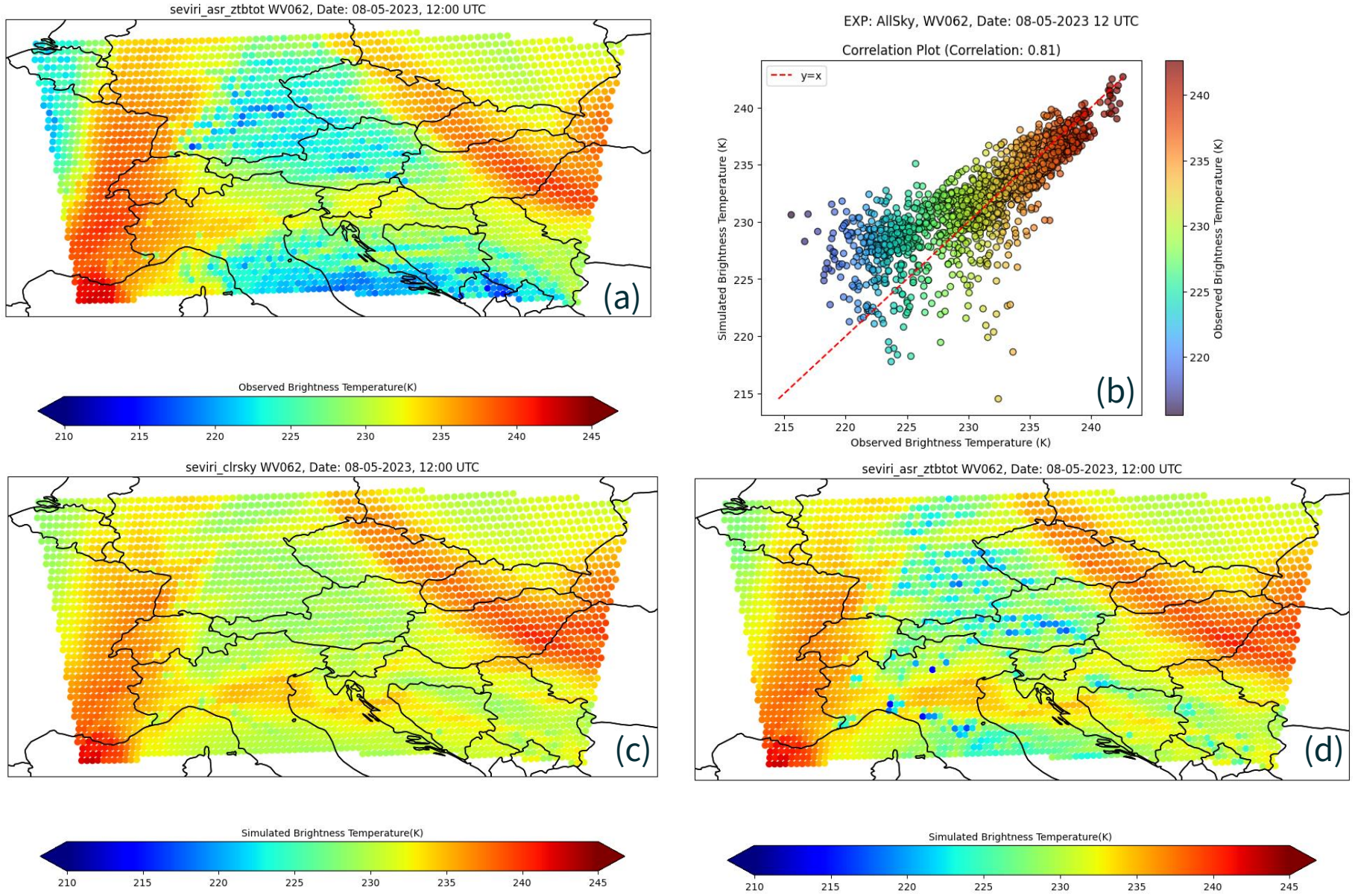


Fig 6: WV6.2 µm channel from MSG SEVIRI

Observation error model

the cloud property itself. We developed a new parameter called the cloud effect average (C_A):

$$C_A = (|C_M| + |C_O|)/2,$$

where C_M and C_O are cloud effect on model and observation, respectively, written by

$$C_M = B - B_{clr},$$
$$C_O = O - B_{clr},$$

O and B are observed and simulated BTs, respectively. B_{clr} is clear-sky background BT when the cloud-scattering calculation is switched off in RTTOV. C_A increases as observation and all-sky

(Grabbed from *Okamato et al.*2013)

Thus if errors are treated correctly, all-sky observations can be assimilated successfully under the assumption of Gaussianity on which assimilation systems are based.

Cloud Amount, Stage=screening

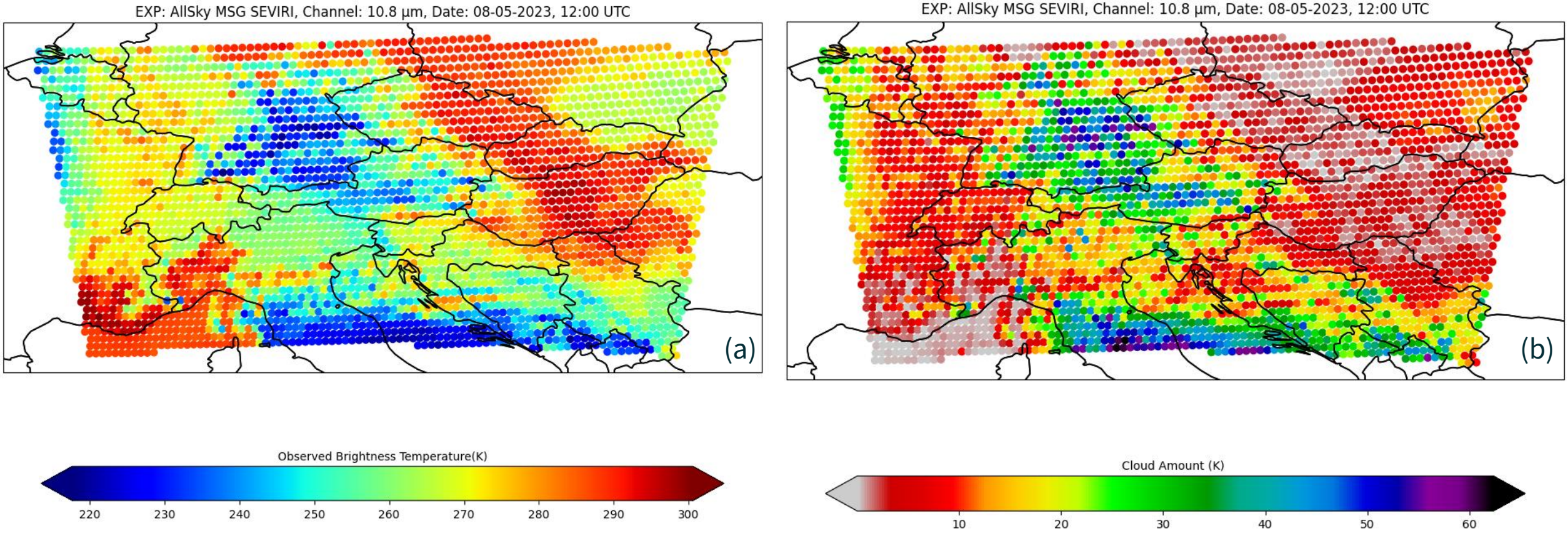
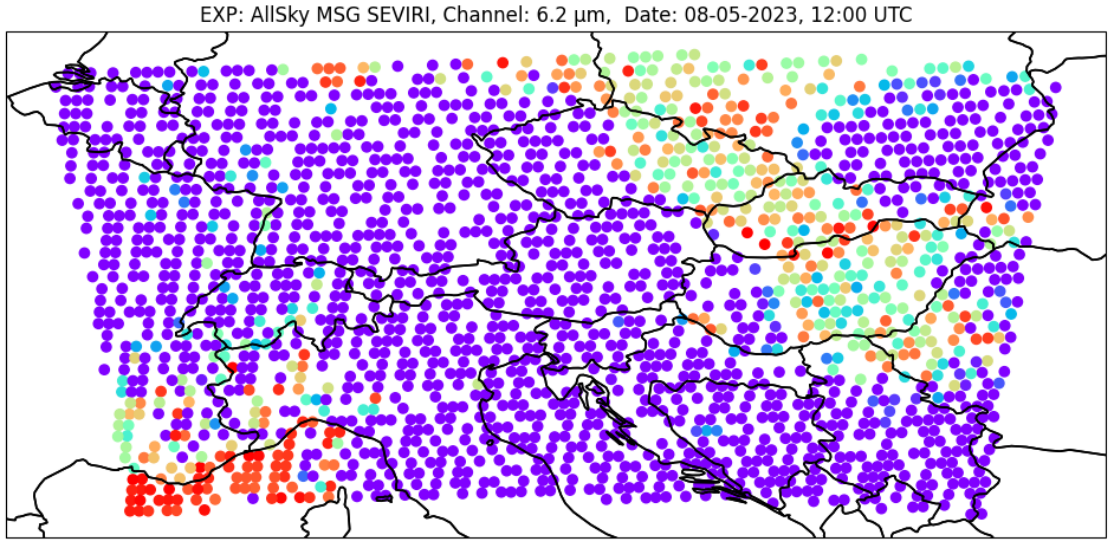
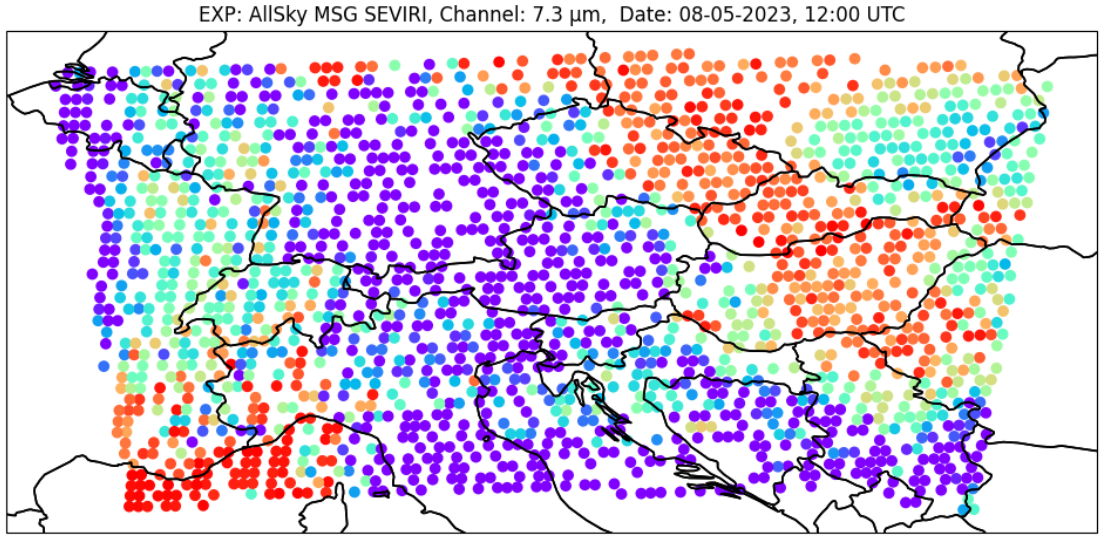
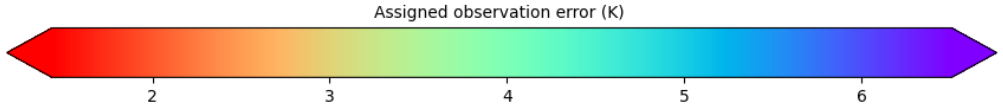


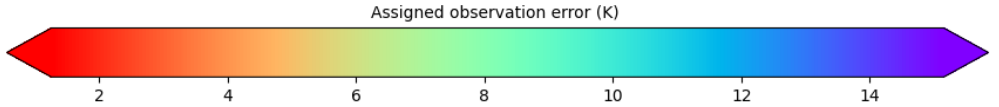
Fig 7: (a)Observations and (b)Cloud amount from the window channel.

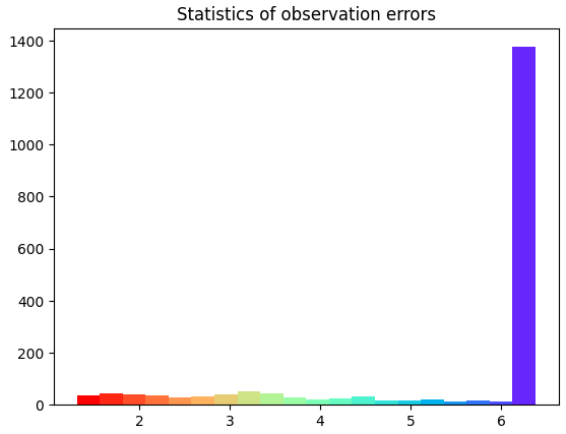
AllSky IR assimilation - dynamic observation errors





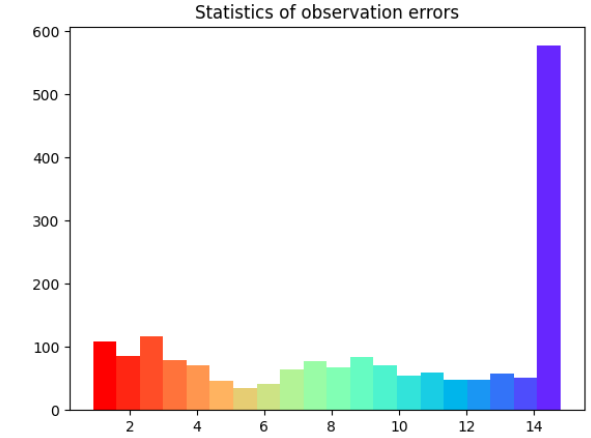






(a)

Fig 8: Observation errors for WV channels in MSG SEVIRI, following works of Geer and Bauer 2011, Okamoto et al. 2014



(b)

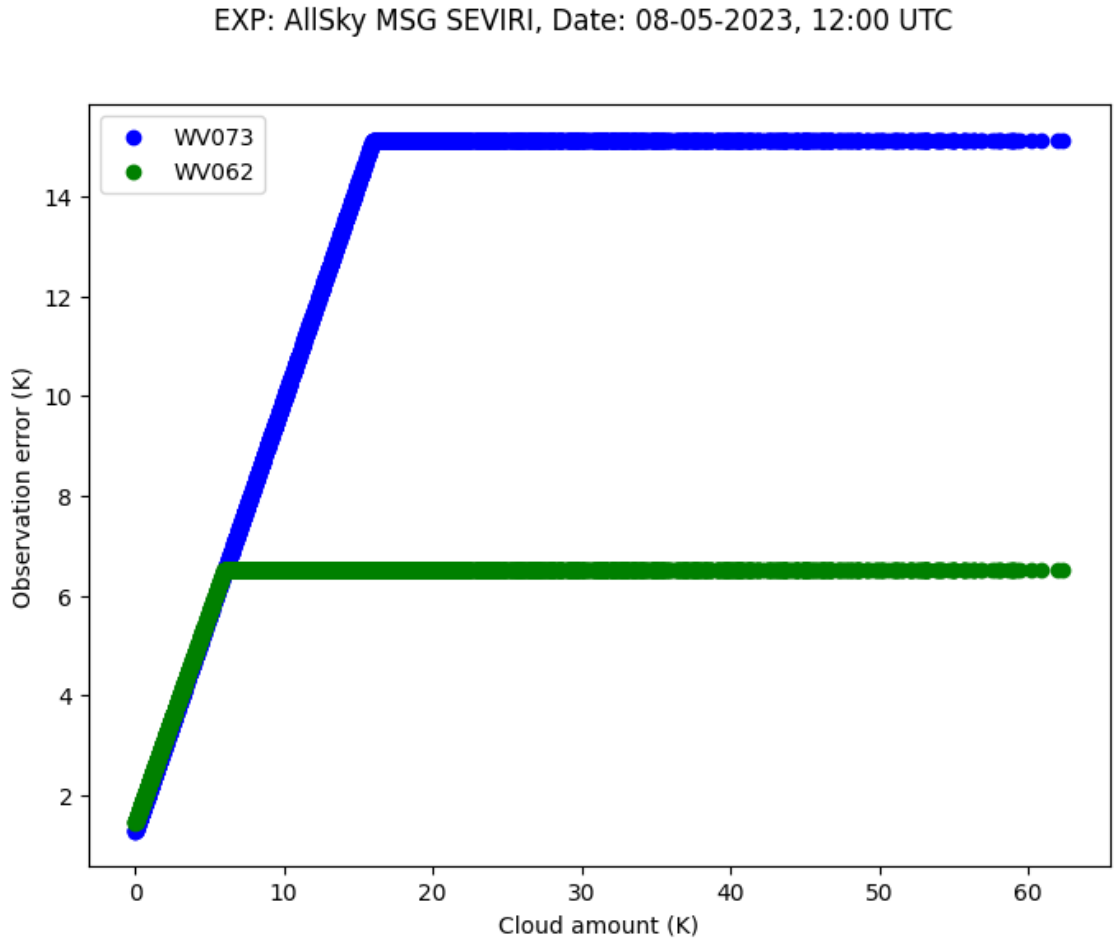
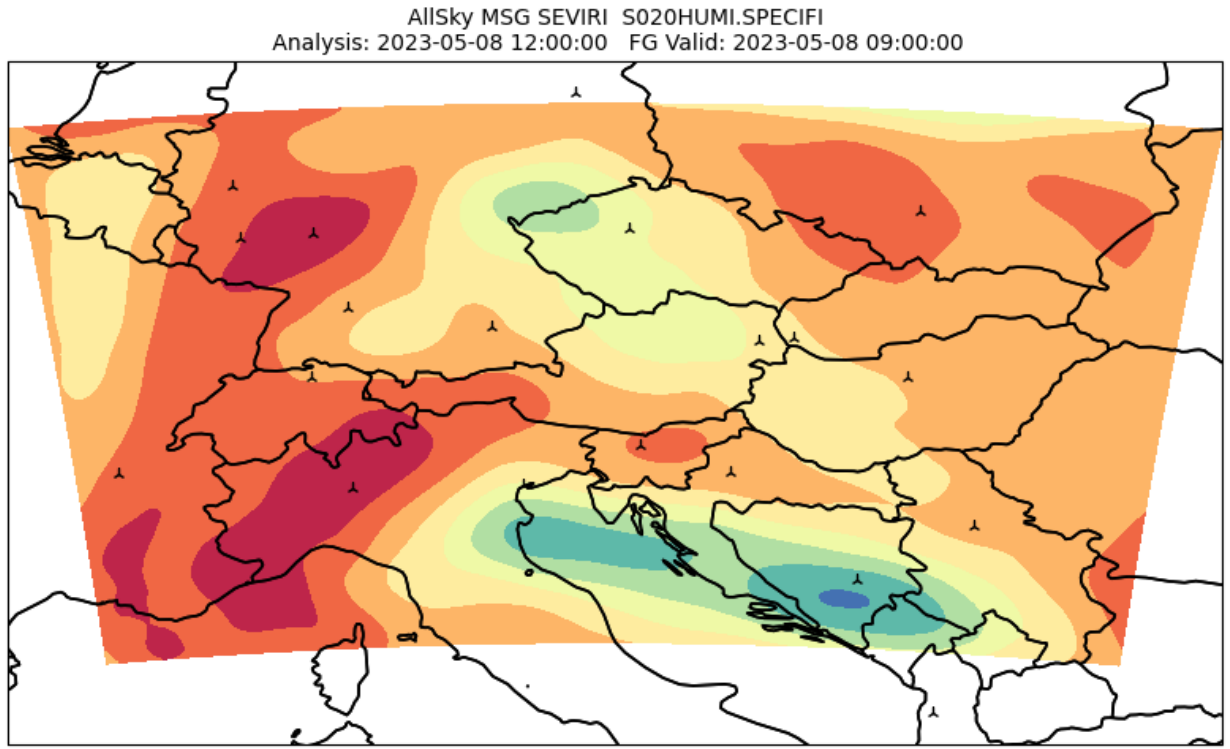
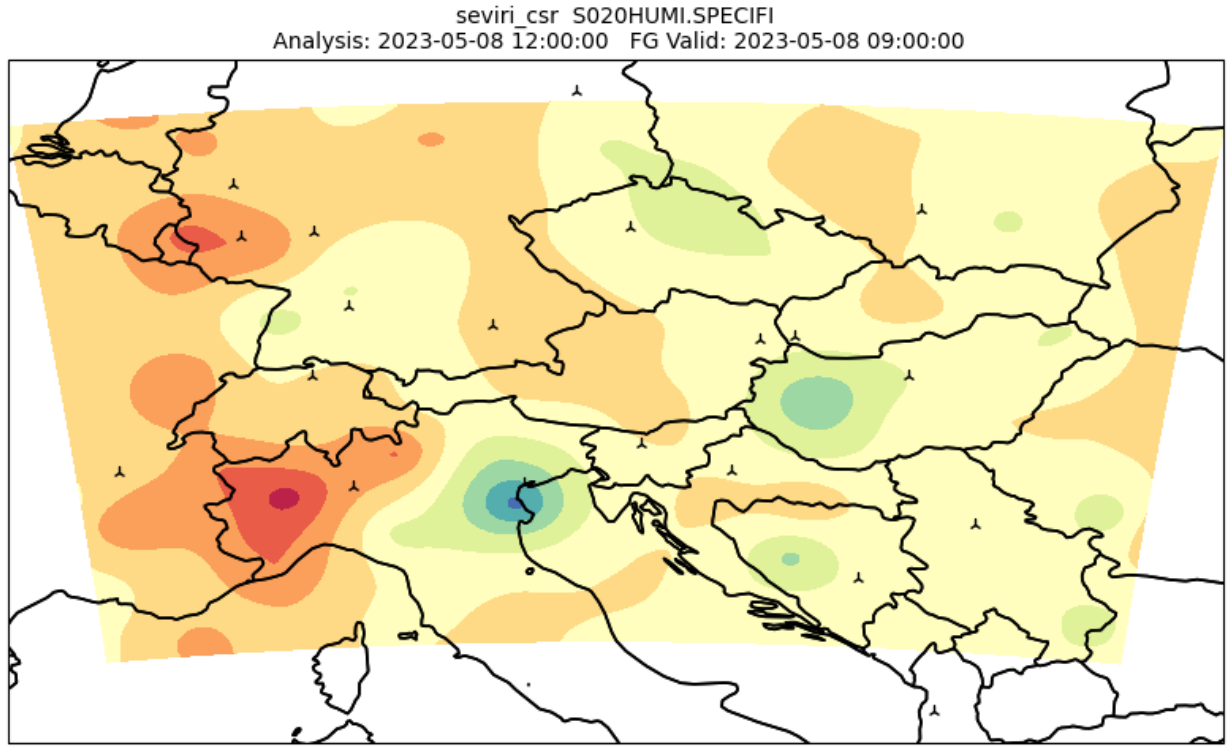


Fig 9: Assigned observation errors for WV channels in MSG SEVIRI based on calculated cloud amount.

AllSky IR assimilation – analysis increment



(a)



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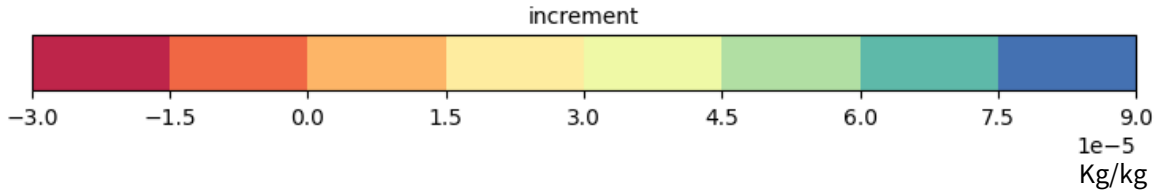

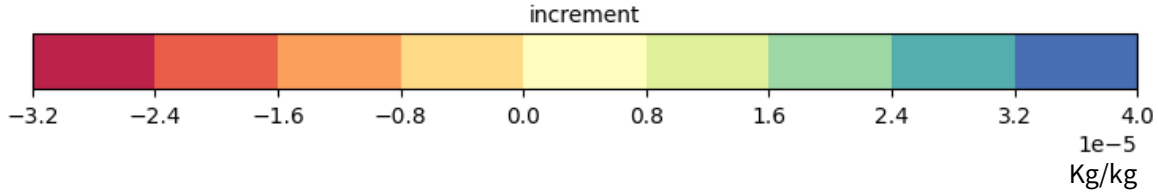

Fig 10: Analysis increments in AllSky vs Clear-Sky, peaking at WV6.2 µm

MeteoSat Third Generation (MTG): Flexible Combined Imager (FCI)

The Art:

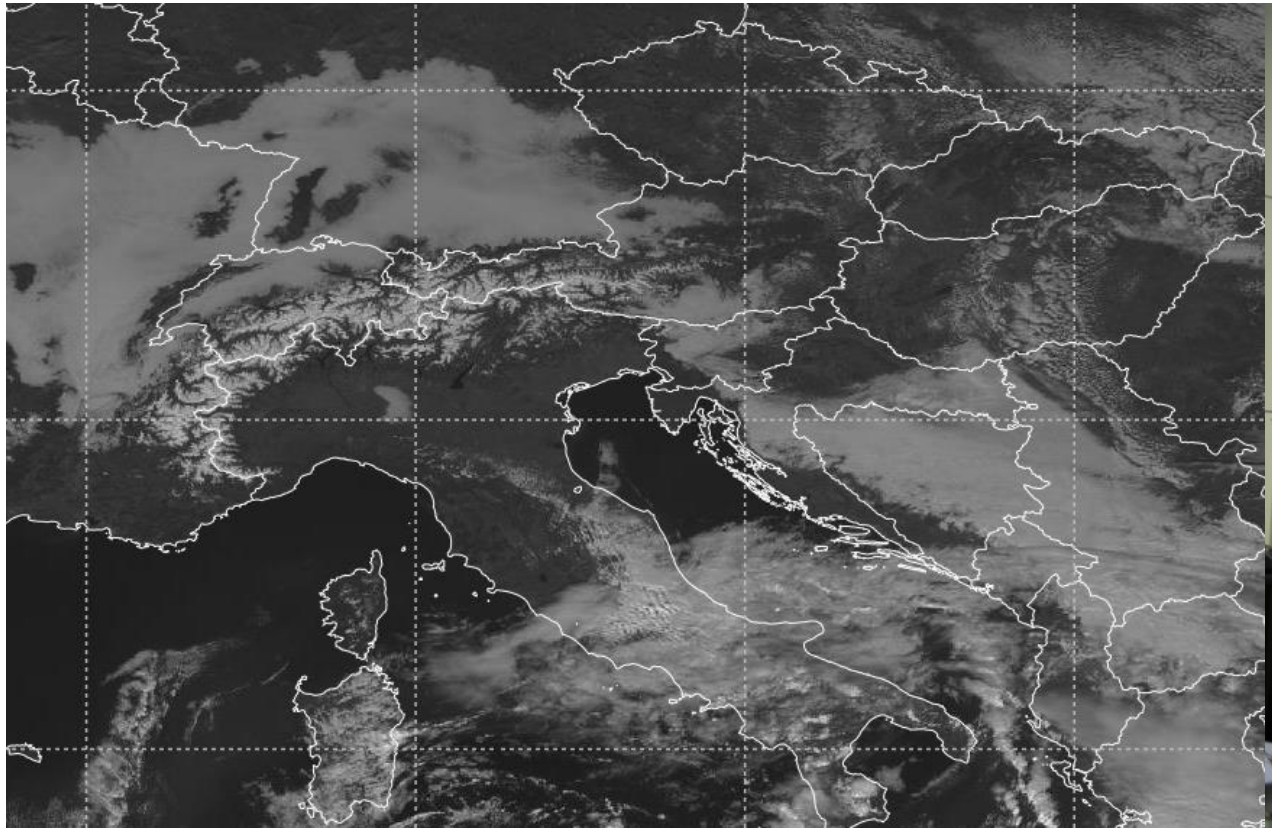

Fig 11: VIS0.6 µm snapshot from 3 Feb 2025, 12 UTC. *Courtesy: EUMETVIEW*

The Artist:

Fig 12: MTG FCI instrument at the test centre. *Courtesy: ESA*

Conclusion

- AllSky IR assimilation has demonstrated effective integration with MSG SEVIRI water vapor channels, utilizing a cloud-dependent observation error model.

- The assimilation of MSG SEVIRI VIS channels is currently under development, though progress has been delayed due to technical challenges.

Next steps:

- The objective is to integrate both VIS and IR channels from MSG SEVIRI in a unified assimilation framework once the necessary technical advancements and testing are completed (2025).

- Future plans involve transitioning to the MTG FCI, integrating its water vapor and visible channels into our AllSky data assimilation framework, 1km ensemble, and utilizing these advanced observations to enhance the operational model (2026/2027).

GeoSphere Austria

DANKE

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NaN values in RTTOV-MFASIS simulation

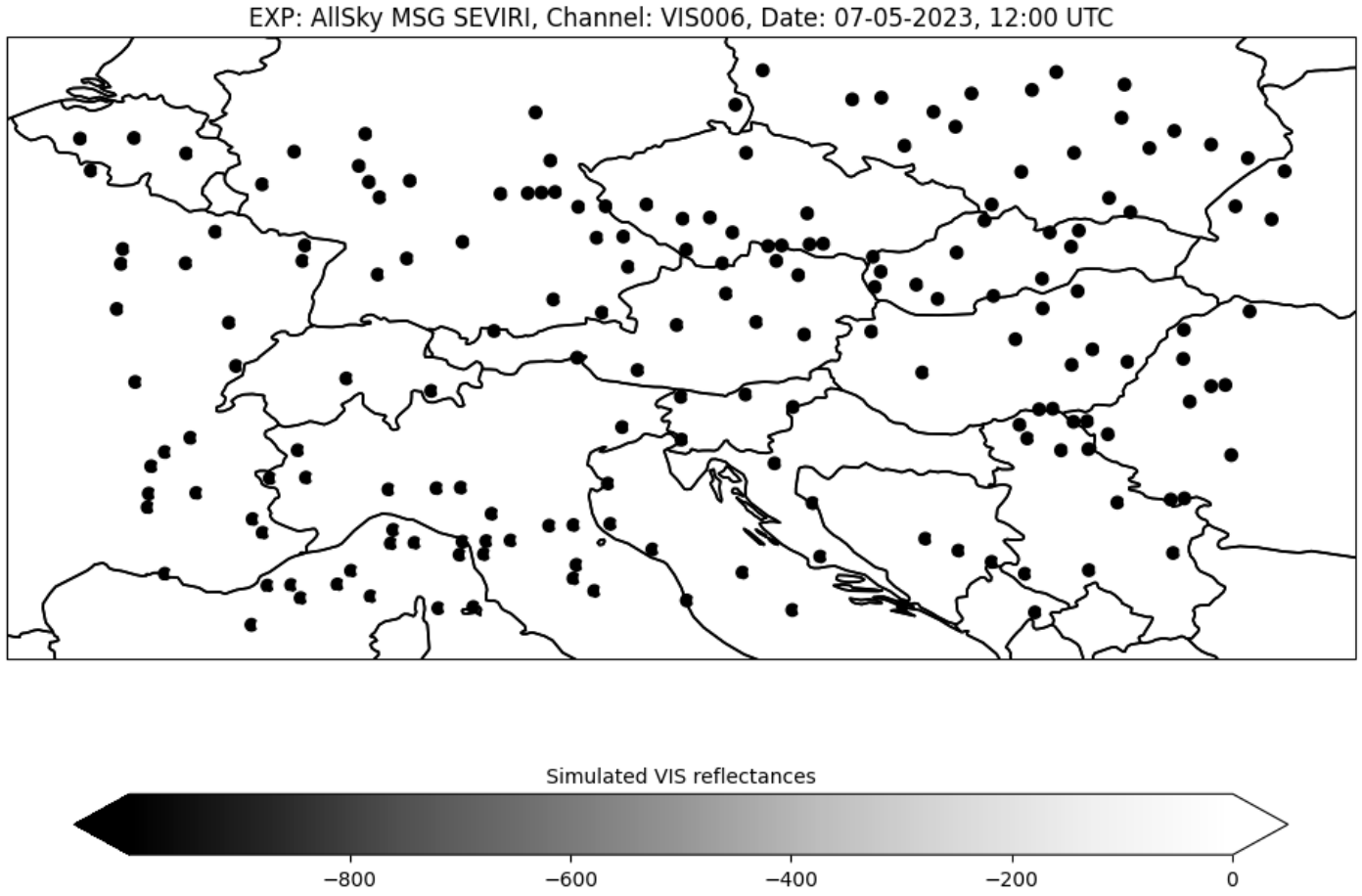
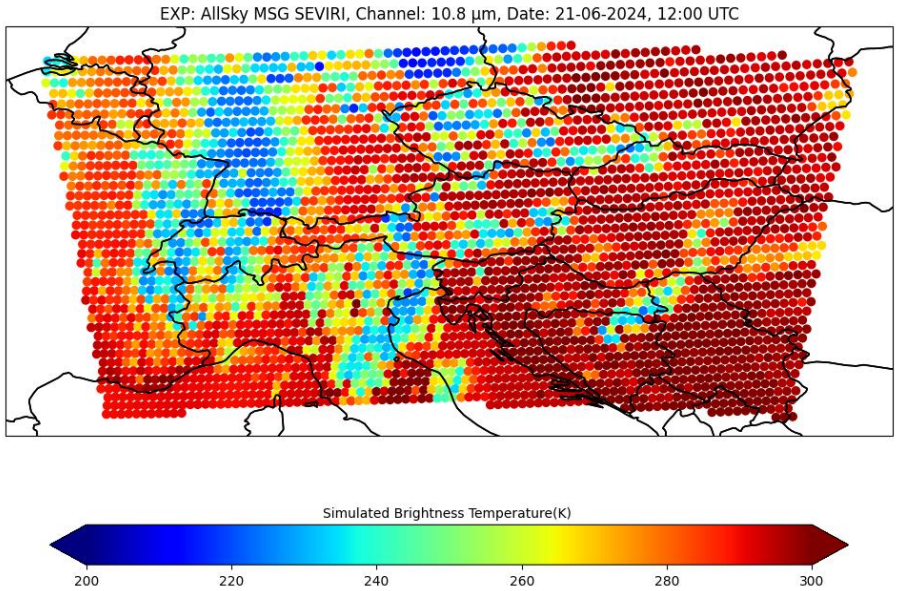
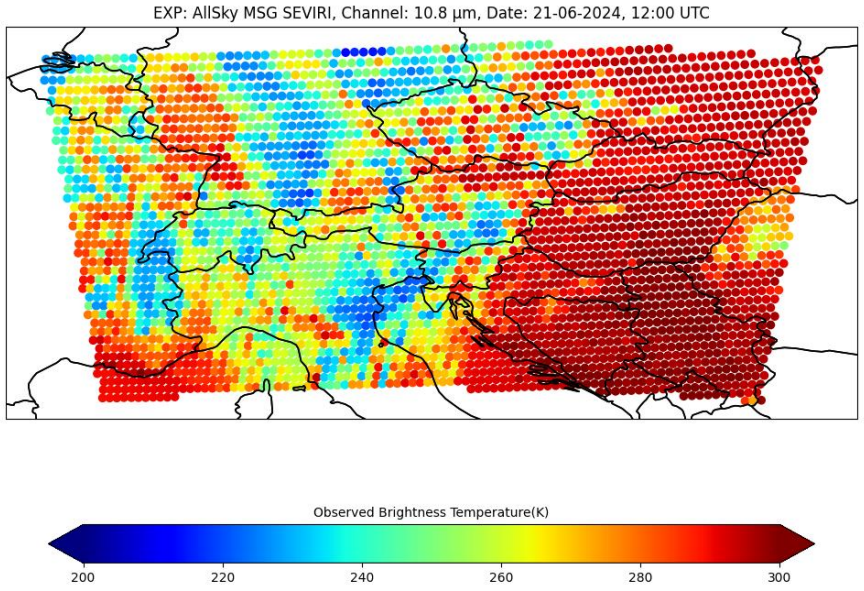
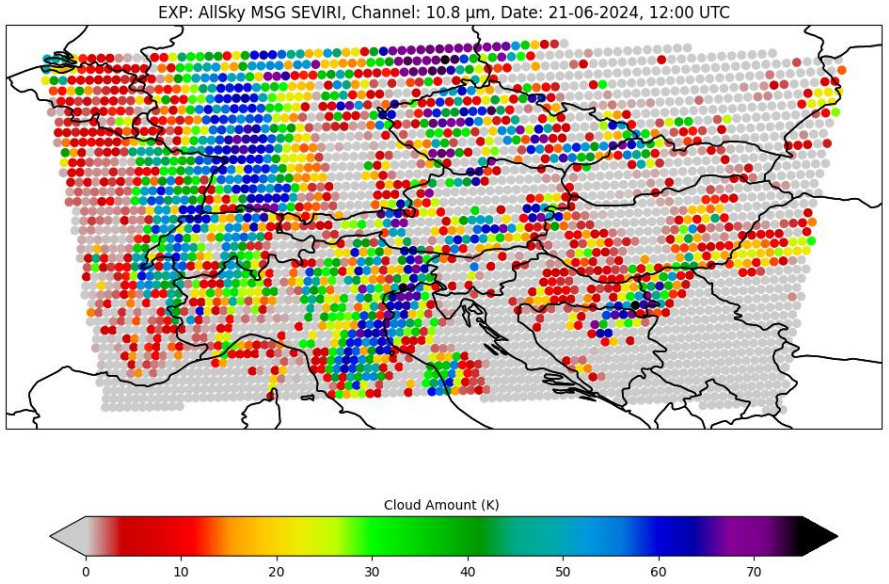


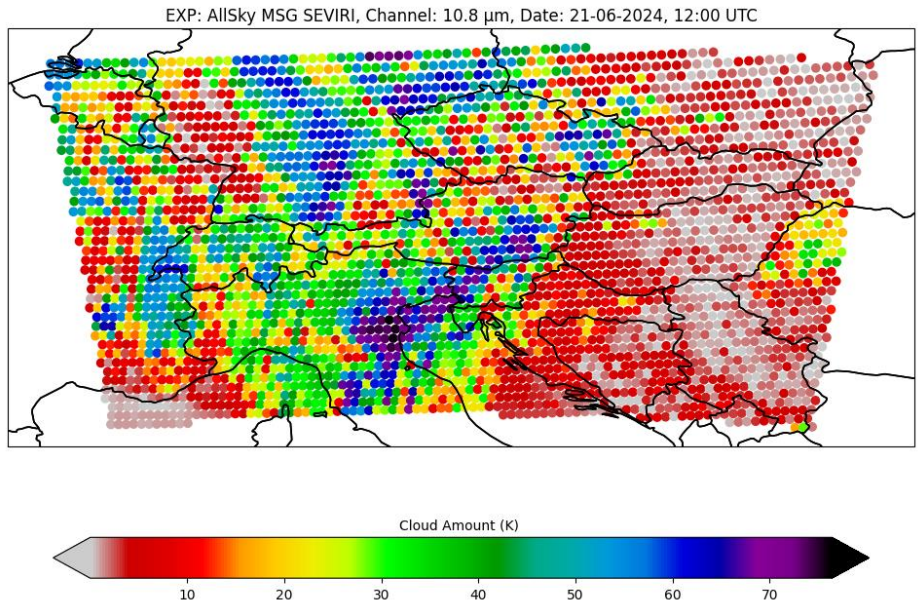
Fig 5: VIS0.6 µm channel from MSG SEVIRI - NaN values in simulation

Cloud amounts from model and observations









GeoSphere Austria NWP operational/pre-operational system

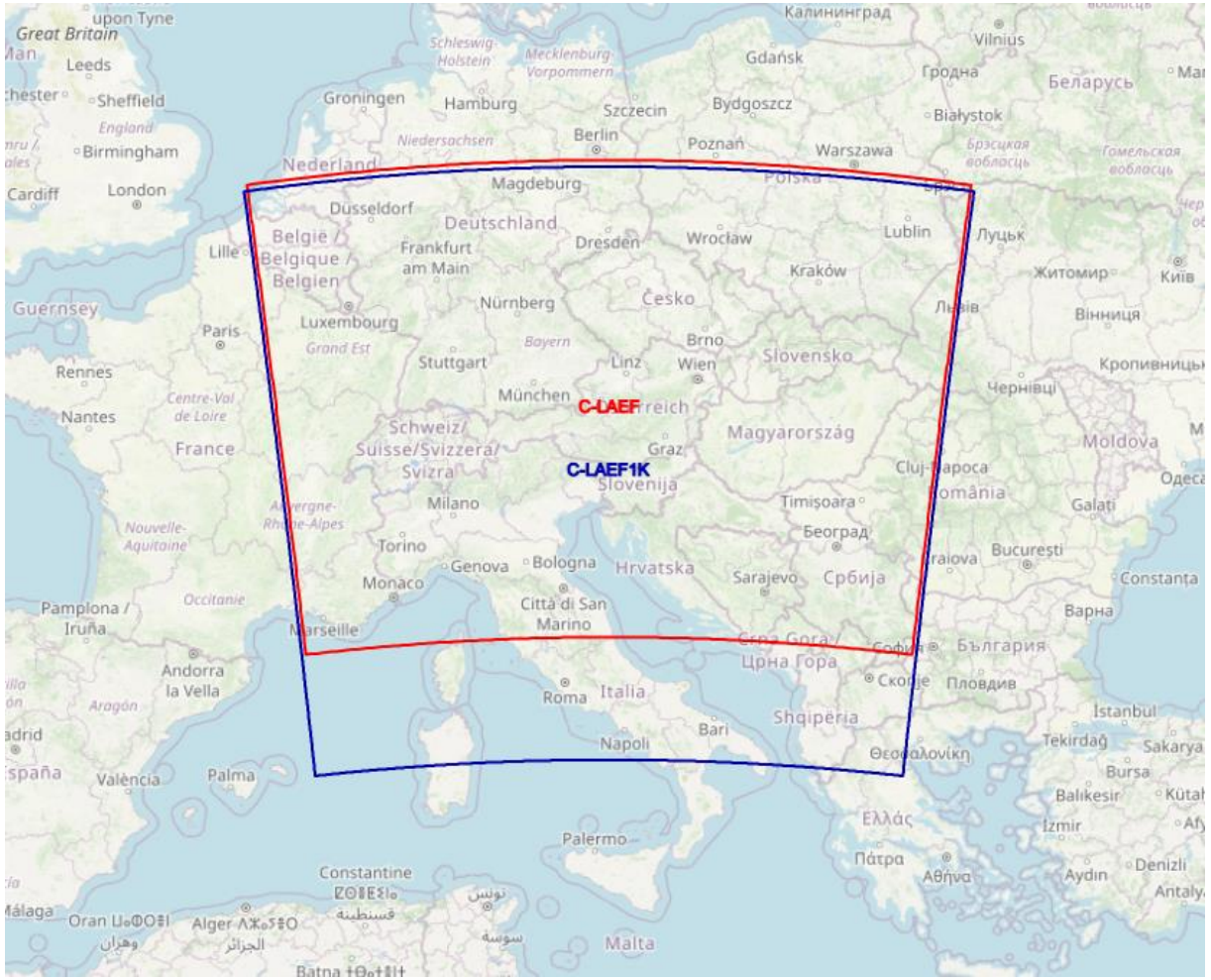


Fig. 1 : Model domain(s)

System	Details
AROME-Austria	2.5km/L90 8x / day +60h
C-LAEF	16 pert. + 1 ctrl 2.5km/L90 8x/day 2x/day +60h
C-LAEF 1k (pre-operational)	C-LAEF control + 16 pert. Member 1km/90L, 8 x / day, lagged mode +60h

Table 1 : Model domain configuration(s)