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Towards IASI-NG radiance assimilation for mineral dusts

1st evaluation of the OSSE framework

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1 - Desert aerosols

- Dusts are primary aerosols, emitted directly into the atmosphere, driven mainly by wind saltation. The main places of emission are deserts (Figure 1), and the diameters of these dusts range from 0.2 to 20 μm .
- Good forecast of dust fields is important for weather and climate, with direct and indirect effects on radiative impact. Also for human activities, with effects on air quality, energy and civil aviation

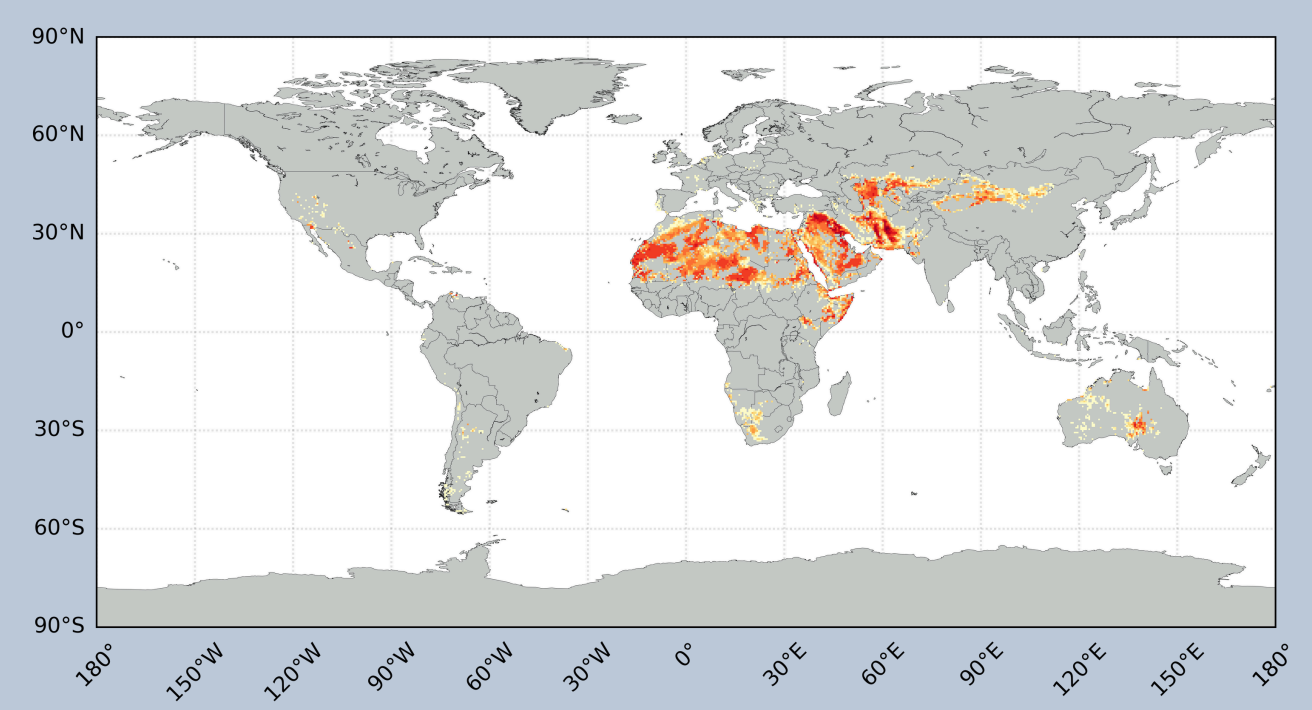


Figure 1: Cumulative emission of desert aerosol in MOCAGE in August 2025

2 - Infrared sensors

IASI & IASI-NG:

- IASI & IASI-NG (New Generation) are a hyperspectral infrared (IR) sensor developed by Thalès Alenia Space for IASI and Airbus Defence and Space for IASI-NG under contract from CNES.
- IASI-NG is intended to replace IASI, but with improved performance:
 - Radiometric noise divided by 2
 - Spectral resolution doubled

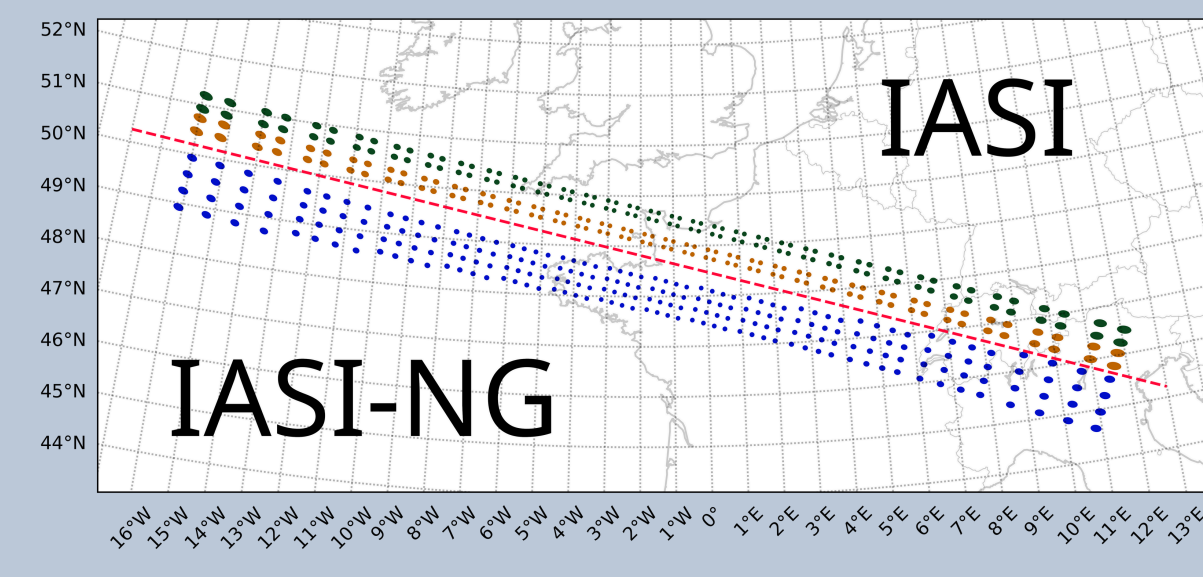


Figure 2: Example of pixel footprints of one IASI-NG swath (blue) and two IASI swaths (orange and green)

3 - Models

Mocage:

- MOCAGE (Modèle de Chimie Atmosphérique de Grande Echelle) is developed and used by Météo-France to model the chemical composition (including aerosols) of the atmosphere and its transport over time. It is an offline chemistry transport model.
- MOCAGE can use the French ARPEGE model (Action de Recherche Petite Echelle Grande Echelle) for all physical data such as temperature, pressure, winds, etc.
- We use the MOCAGE configuration with a resolution of $0.5^\circ \times 0.5^\circ$ on 60 levels.

CAMS-Global:

- CAMS global (or IFS-COMPO) is a transport chemistry model developed and improved by ECMWF.
- We use its 'daily global analyses and forecasts' configuration, which gives us data at a spatial resolution of $0.4^\circ \times 0.4^\circ \times 137$ levels.

4 - Aims

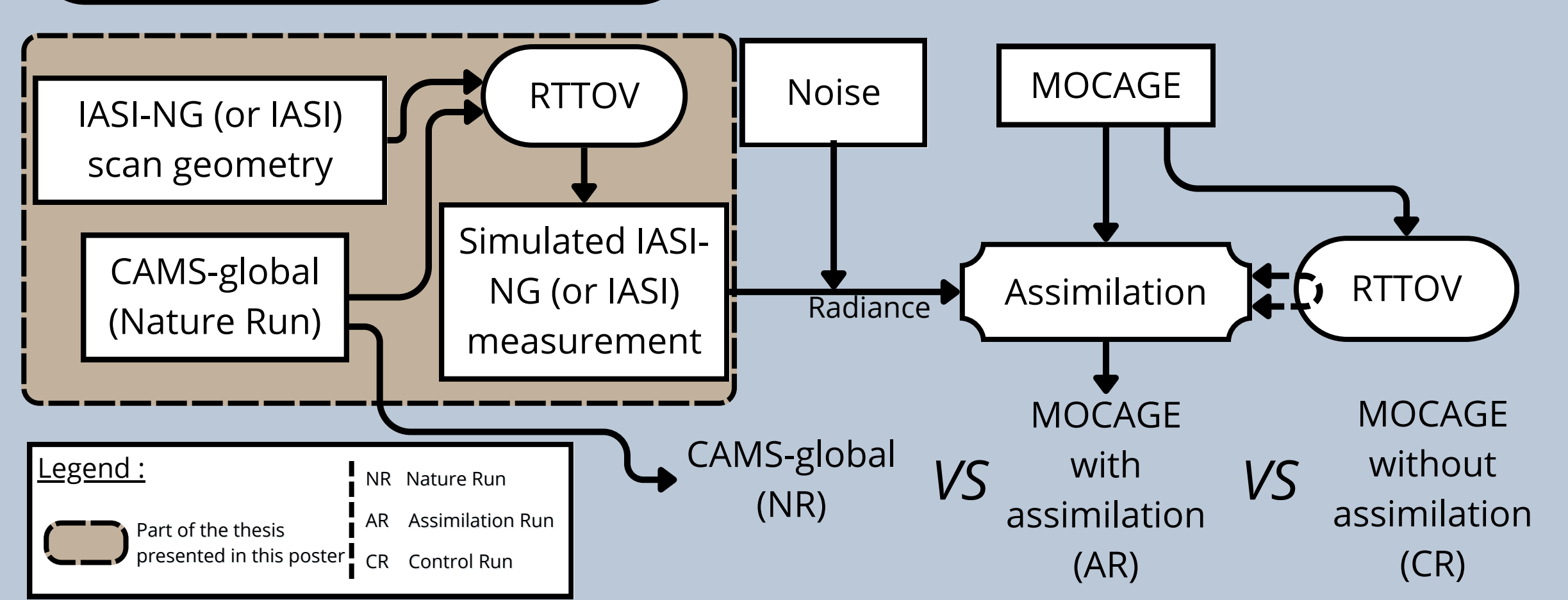
Aim of the PhD thesis:

Improving the representation of desert aerosols in MOCAGE by assimilating IASI-NG radiance data

Aims of the poster:

- See whether the improved performance of IASI-NG allows for better diagnosis of the presence, concentration and vertical distribution of desert aerosols
- Quantified if IASI and IASI-NG can detect significant differences between two models

5 - The PhD thesis summary



6 - Observation simulations

RTTOV:

- RTTOV (Radiative Transfer for TOVS) was created and is regularly updated by EUMETSAT's SAF (Satellite Application Facility) Numerical Forecasting.
- It can be used to quickly simulate IASI and IASI-NG spectra (and other sensors) from meteorological data (temperature, pressure, etc.), chemical data (aerosol and gas concentration, etc.), surface data and measurement angles.

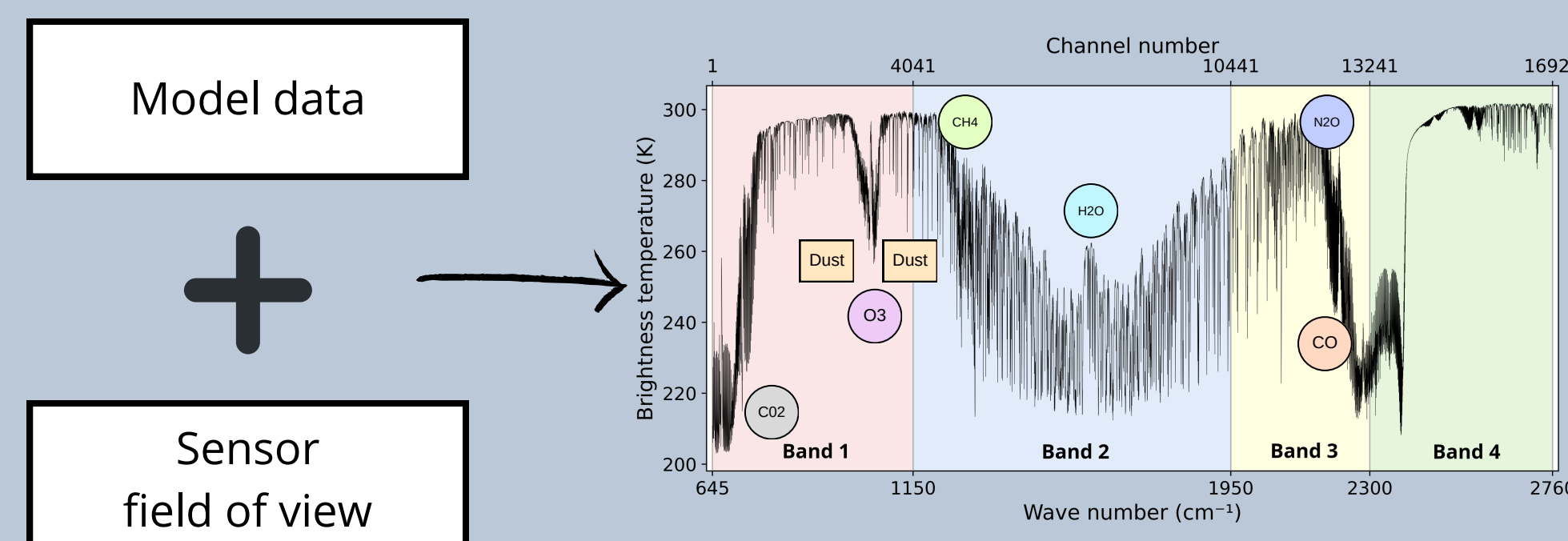


Figure 3: Example of a IASI-NG spectrum simulated by RTTOV

7 - Observation classification

CADS:

- CADS (Cloud and Aerosol Detection Software) is developed by EUMETSAT NWP-SAF (Satellite Application Facility).
- We only use the Aerosol part, which allows infrared satellite measurements to be classified into several categories

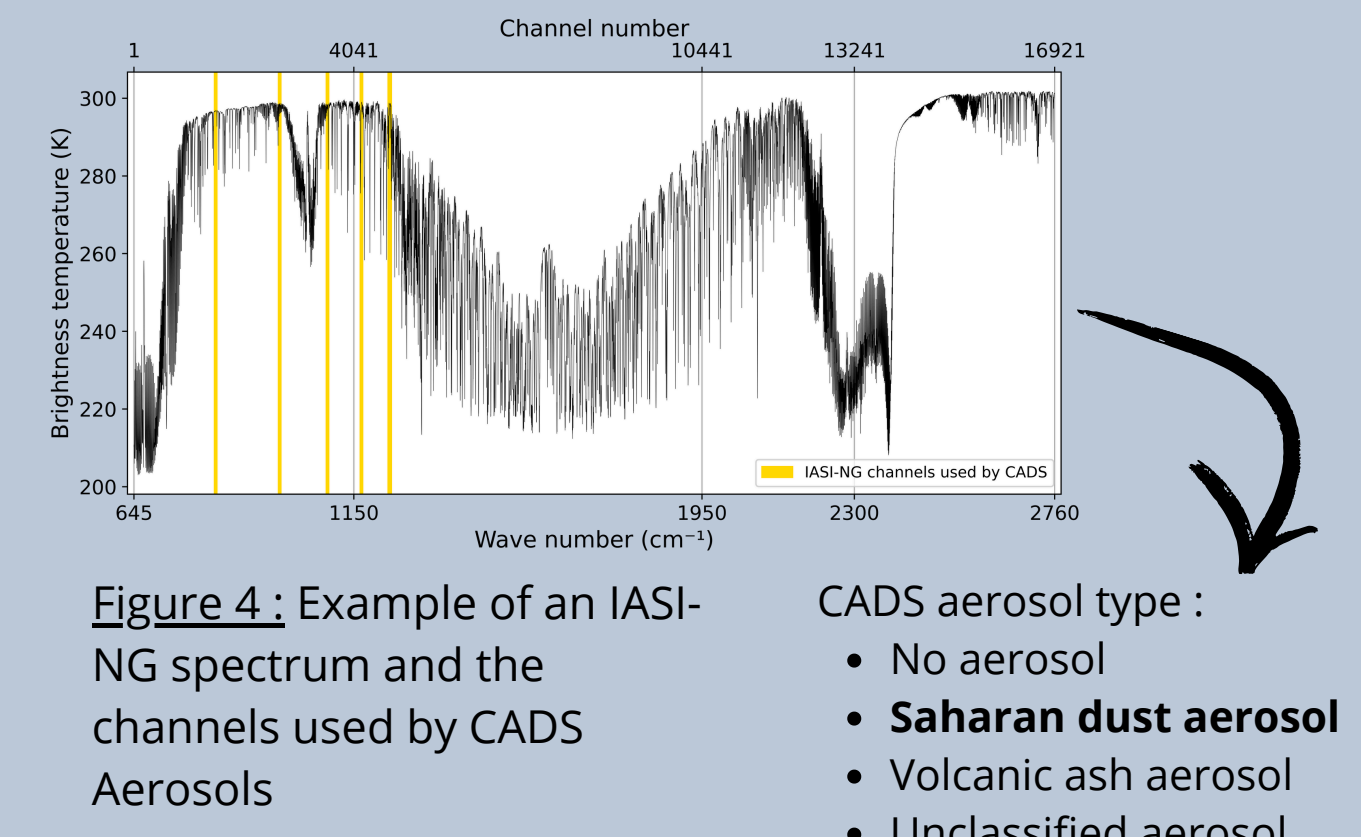


Figure 4: Example of an IASI-NG spectrum and the channels used by CADS
Aerosols

8 - Comparison between Nature Run and Control Run

Simulations from	CAMS-Global (Nature Run)		MOCAGE (Control Run)	
A) Model data Dust total column on 24/18/2024 at 9 p.m. ($\text{kg}\cdot\text{m}^{-2}$)				
Sensor	IASI	IASI-NG	IASI	IASI-NG
B) CADS results				
C) Spectral differences (CAMS) - (MOCAGE) Brightness temperature (K)				

- Significant difference between CAMS and MOCAGE for a desert aerosol plume but it's a typical difference range between modelling and reality

Real observation

IASI

Legend:

- A) Comparison in the observation space
- B) Comparison in the classification space
- C) Comparison in the spectral space

- Significant differences between CADS results for CAMS and MOCAGE compared to reality, due to simulation without taking clouds into account
- Significant difference in brightness temperatures between IASI and IASI-NG, suggesting that IASI-NG may be better at detecting desert aerosols

9 - Conclusion

- The differences between the Nature Run (CAMS-Global) and the Control Run (MOCAGE) are present but not extreme
- CADS permet bien de détecter la présence des aérosols désertiques même depuis des observations simulées
- IASI-NG would be better than IASI at restoring the amount of desert aerosols

10 - Outlook

- Study in greater detail the sensitivity of IASI-NG to desert aerosols in order to optimise pixel classification
- Continue the OSSE study with the assimilation of simulated IASI-NG radiances into MOCAGE and assess the impact (AR vs NR, CR vs NR)
- Once the real IASI-NG data is available, assimilate it directly