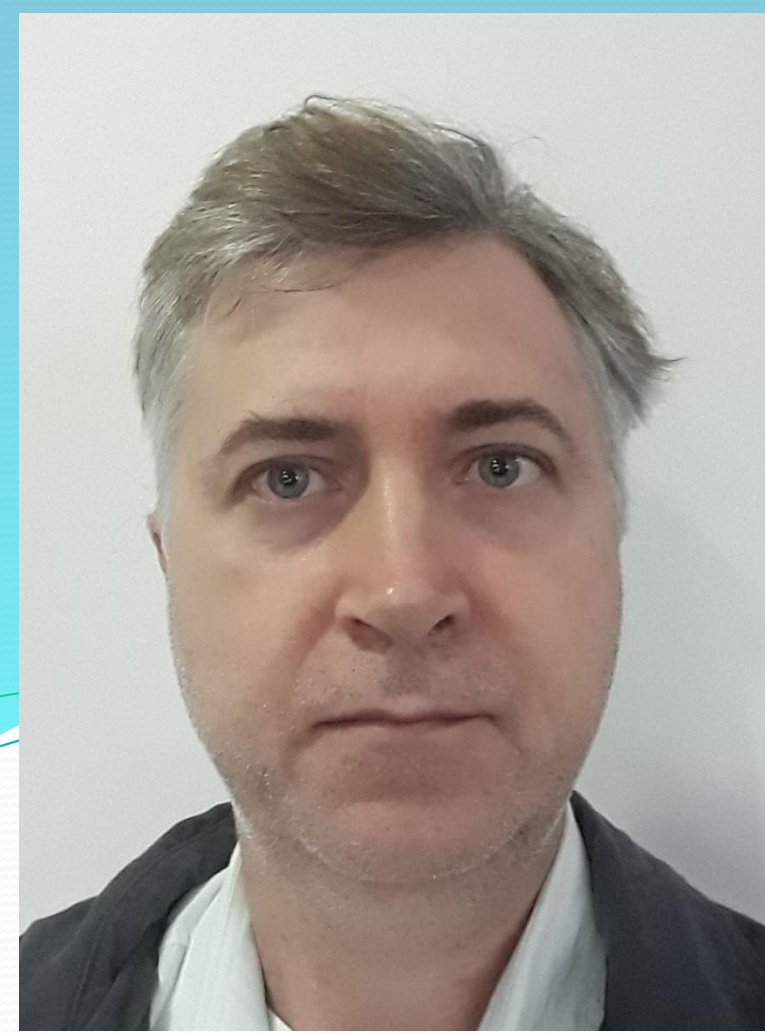


Evaluation Accessing the contribution of Advanced Technology Microwave Sounder (ATMS) in the Brazilian Numerical Modeling and Data Assimilation System



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The recent discontinuation of the Advanced Microwave Sounding Unit (AMSU-A) in the NOAA series satellites (NOAA-15, 18, and 19) gives the (I) **Advanced Technology Microwave Sounder (ATMS)** sensor greater relevance in the process of assimilating microwave radiance data, and this fact is the motivation of this study. Therefore, understanding and studying the impact of assimilating ATMS sensor radiance channels becomes essential for developing a more realistic numerical weather forecast, especially in extreme atmospheric conditions such as storms, cyclones, and hurricanes. Thus, this work presents results on the impact of ATMS sensor data assimilation on the numerical forecast of (II) **Melissa hurricane**, which reached category five on October 27, 2025, in the Caribbean Sea, Central America. The (III) **Numerical Modeling and Data Assimilation System (SMNA)** is used in this study. Different experiments were conducted to explore the radiance channels available in the ATMS sensor and assess their contribution to the improvement of the predictability of the Melissa hurricane. The (IV) **impact of radiance data assimilation from ATMS** into the CPTEC/INPE, Brazil, is investigated and discussed in this work.

(I) ATMS sensor: technical details

The Advanced Technology Microwave Sounder (ATMS) flies aboard the Joint Polar Satellite System (JPSS) series: **Suomi NPP**, **NOAA-20**, and **NOAA-21**. With 22 microwave channels, ATMS integrates capabilities similar to AMSU-A and MHS (Microwave Humidity Sounder), enabling precise atmospheric temperature and humidity profiling.

ATMS Channel Classification

Temperature Channels (Oxygen Band: 50–60 GHz)

Channels 4–15

→ Atmospheric temperature profiling (lower troposphere to lower stratosphere)

Moisture Channels (Water Vapor Band: ~183 GHz)

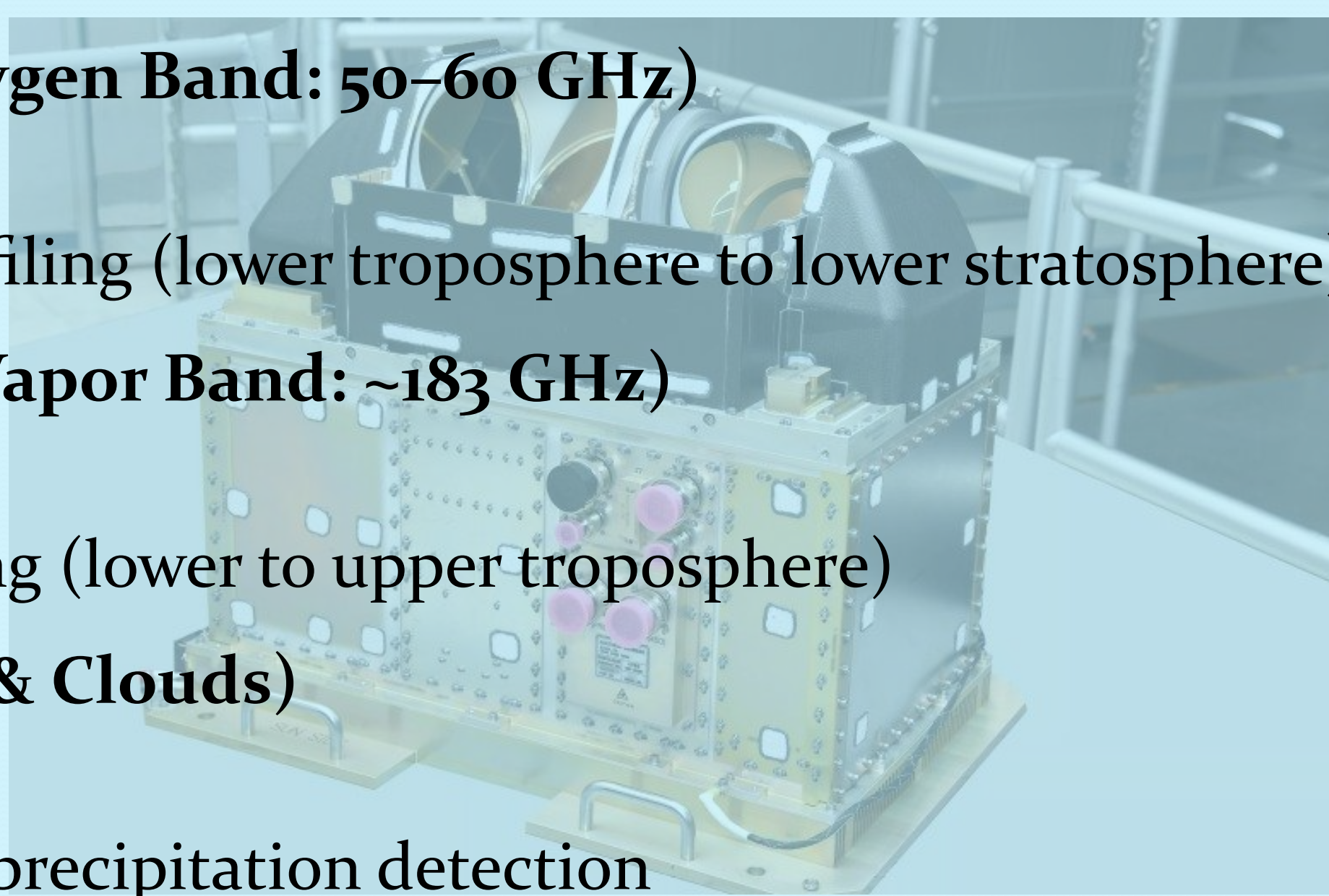
Channels 17–22

→ Atmospheric humidity profiling (lower to upper troposphere)

Window Channels (Surface & Clouds)

Channels 1, 2, 3 and 16

→ Surface emission, clouds, and precipitation detection



(II) Melissa hurricane: event characterization

Hurricane Melissa formed over the Caribbean Sea from a tropical disturbance under favorable conditions, including warm sea surface temperatures, high moisture, and low vertical wind shear. The system gradually organized as convection intensified around a developing low-pressure center, leading to the formation of a tropical cyclone. Ocean heat content in the region supported its further development and intensification as it moved across the Caribbean.

The period of strongest intensification occurred between 25 and 29 October 2025, when the cyclone reached its peak wind speeds (see **Figure 1 (a)**) due to enhanced deep convection and a well-established warm core structure (see **Figure 1 (b)**).

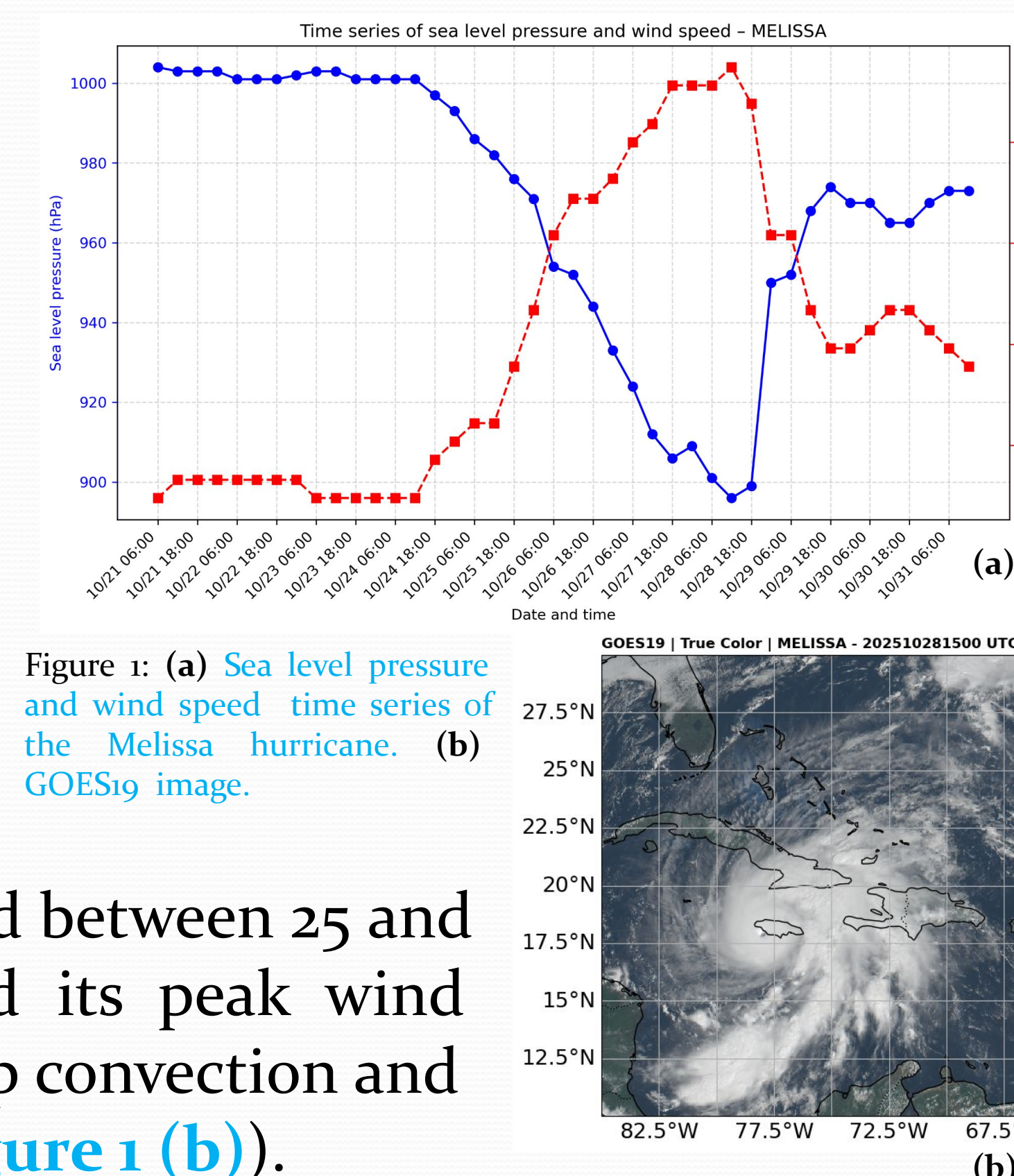
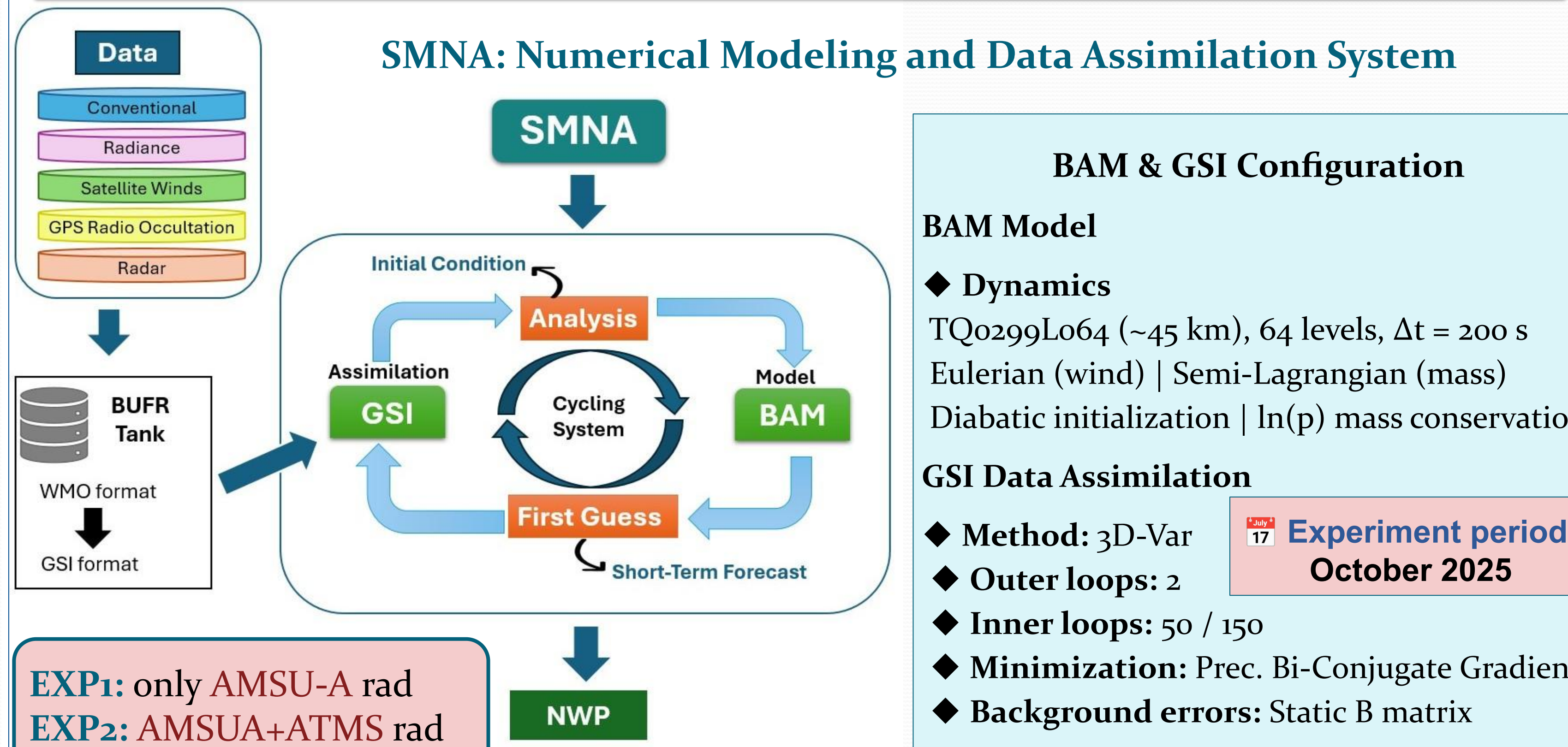


Figure 1: (a) Sea level pressure and wind speed time series of the Melissa hurricane. (b) GOES-19 image.

(III) SMNA: configuration and experiment designer



Additional data: AMSU-A radiances (MetOp satellites), Atmospheric Motion Vectors (AMV) from geostationary and polar-orbiting satellites, GNSS radio occultation data, and in situ observations from dropsondes, radiosondes, and pilot balloons.

AMSU-A		ATMS	
Sat.	Channels	Sat.	Channels
MetOp-B	7–13	NPP	5–14
MetOp-C	7, 9–13	NOAA-20	5–14
		NOAA-21	6–14

(IV) Preliminary results: impact of the radiance data assimilation from ATMS

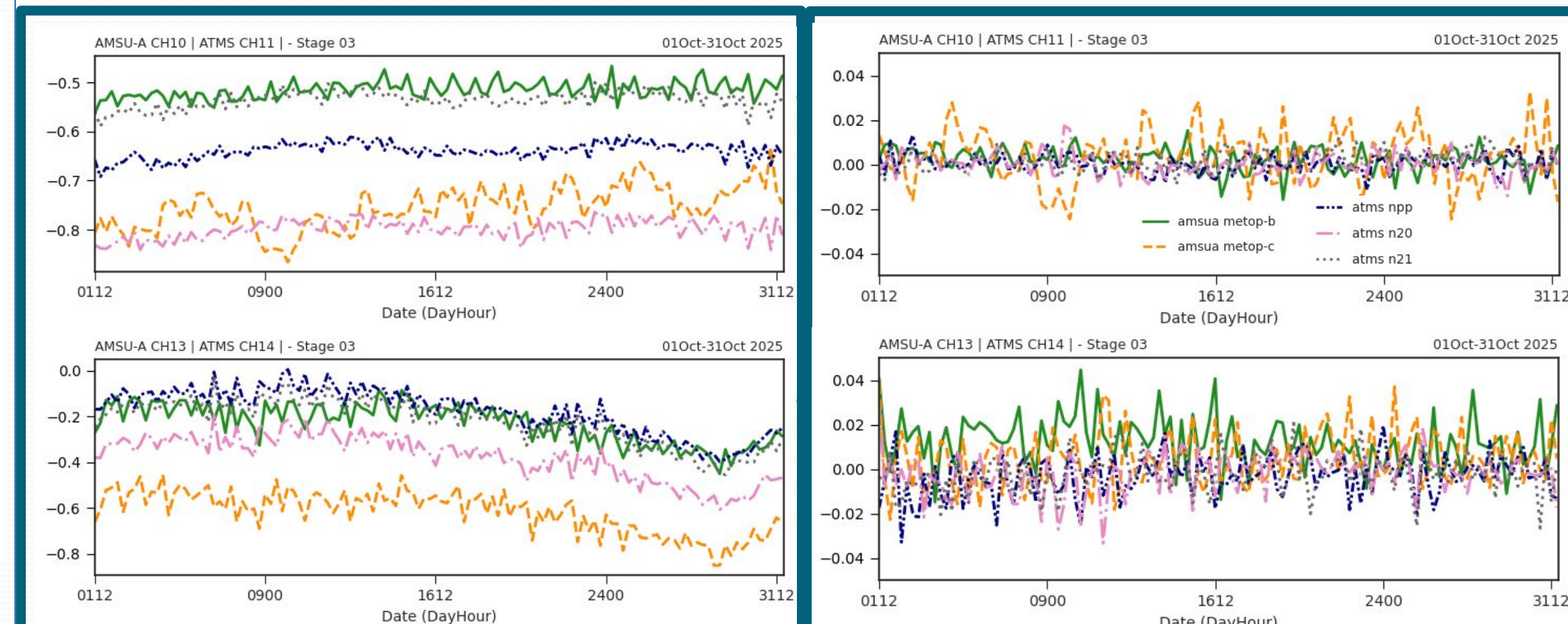


Figure 2: O-A global mean before bias correction, channels 10 and 13 of the AMSU-A and channels 11 and 14 from the ATMS (EXP2).

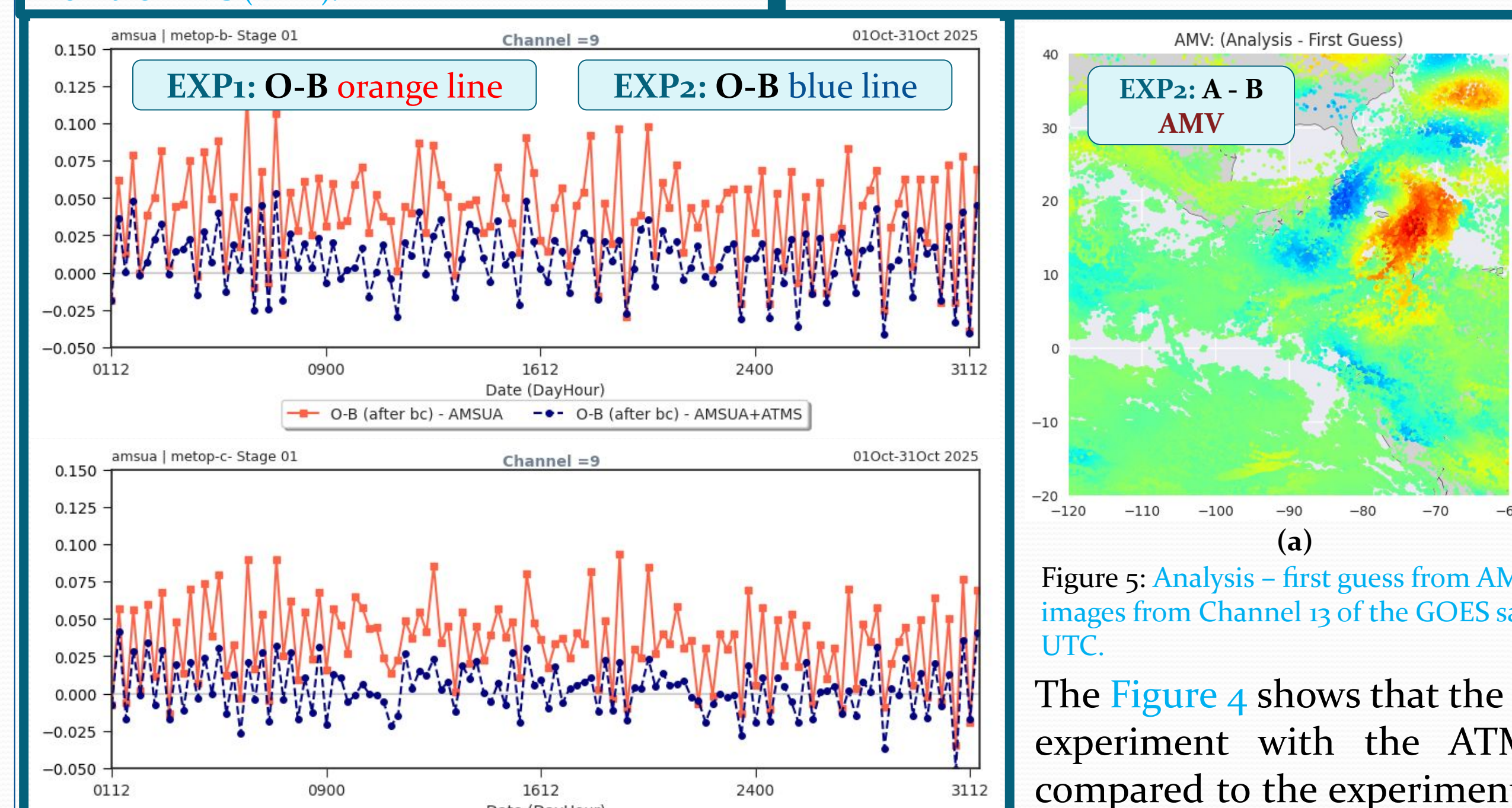


Figure 4: O-B global mean in channel 9 of the AMSUA sensor in EXP1 (orange line) and EXP2 (blue line). Up and down plots are of the, respectively, AMSU-A Metop-B and AMSU-A Metop-C data time series.

The **Figure 2** show the global mean (O-A) differences for Metop-B, NPP, and NOAA-21 are closer to zero than for Metop-C and NOAA-20 radiances. In **Figure 3**, after the bias correction, is possible see of that ~57.29 GHz channels from the mid - stratosphere (CH 10 and 11) show lower variability in the global mean (O-A), while the upper stratosphere exhibits larger variation around zero (CH 13 and 14).

▷ O-B = Obs - First guess;
▷ O-A = Obs - Analysis.

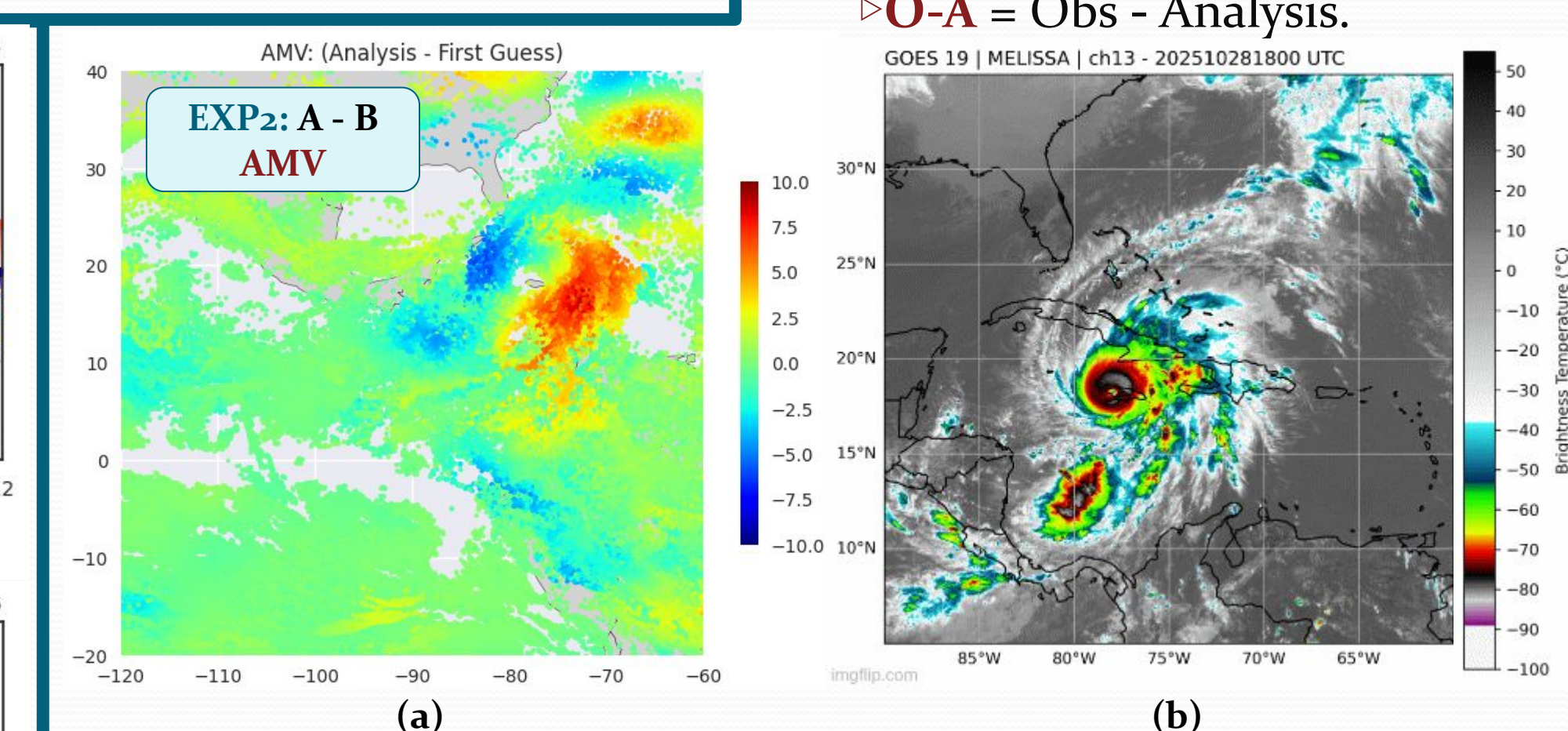


Figure 5: Analysis - first guess from AMV observations obtained in EXP2 (a panel) and images from Channel 13 of the GOES satellite (b panel) valid for 28 October 2025 at 18 UTC.

The **Figure 4** shows that the global mean (O-B) time series in the experiment with the ATMS sensor exhibits a lower bias compared to the experiment without ATMS, indicating that the sensor's assimilation had a positive impact in assimilation process. Radiance observations impact multiple atmospheric model variables in data assimilation, and maintaining their database is crucial for improving forecasts of extreme events, such as Melissa hurricane. **Figure 5** shows that the difference between the analysis and the first guess over the Caribbean Sea on 28 October at 18 UTC highlights the recirculation region of Hurricane Melissa and identifies areas of wind acceleration and deceleration in the numerical model representation of the atmosphere.

Conclusion:

The results reported here are the first using the ATMS data in this center, and they are essential for establishing a consistent radiance database for the assimilation process in the new Brazilian climate prediction model being developed by CPTEC/INPE and partners, the Model for Ocean-laNd-Atmosphere Prediction (MONAN), in phase of implementation and test.

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MONAN (Model for Ocean-laNd-Atmosphere predictionN) Program



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