

# THE SPECTRAL CALIBRATION ALGORITHM CONVERGENCE ANOMALY ON IASI-B AND IASI-C: ANALYSIS AND RELATION TO GEOPHYSICAL EVENTS

D. KILYMIS<sup>1</sup>, C. BAQUE<sup>2</sup>, M. BOUILLON<sup>3</sup>, JEAN-CHRISTOPHE CALVEL<sup>4</sup>, M. FAILLOT<sup>1</sup>, E. JACQUETTE<sup>1</sup>,  
Y. KANGAH<sup>3</sup>, T. LALANNE<sup>5</sup>, O. VANDERMARCO<sup>1</sup>

<sup>1</sup>CNES, Centre spatial de Toulouse

<sup>2</sup>AKKA HT

<sup>3</sup>SPASCIA

<sup>4</sup>AKKODIS

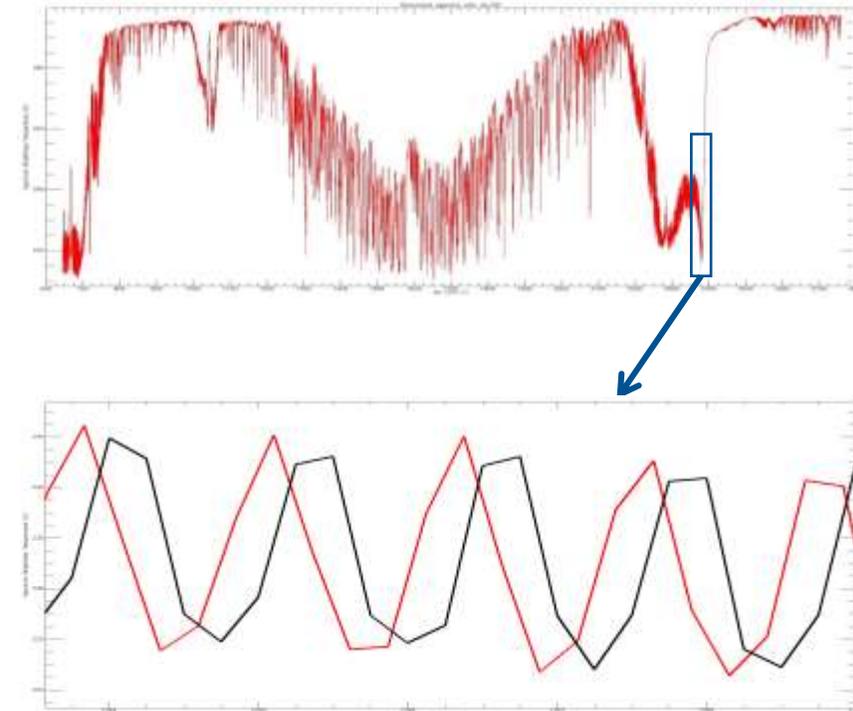
<sup>5</sup>NOVELTIS (currently at MAGELLIUM)

IASI CONFERENCE - NANCY  
**02-06/12/2024**

# THE IASI SPECTRAL CALIBRATION

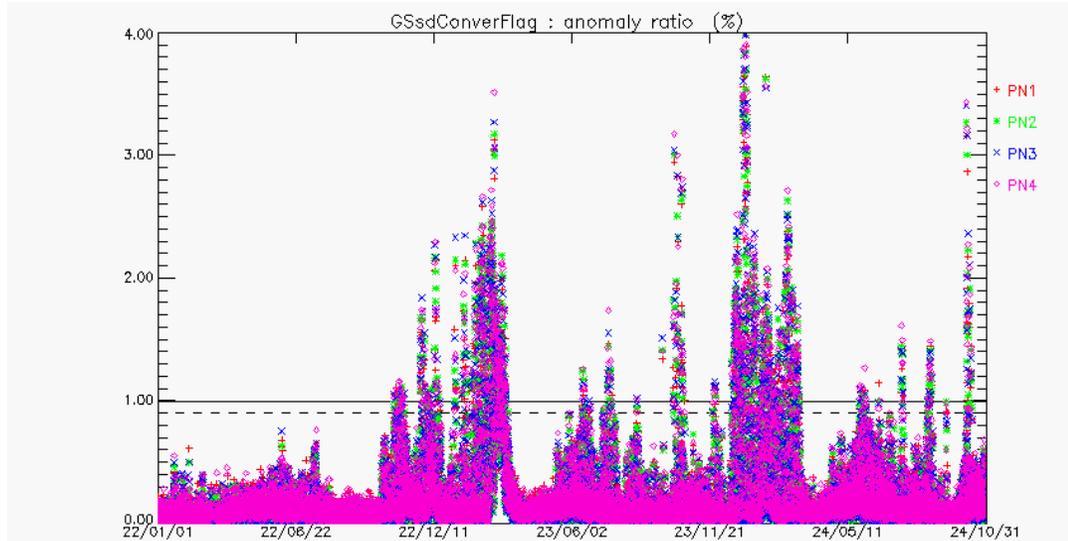
THE SPECTRAL  
CALIBRATION ALGORITHM  
CONVERGENCE ANOMALY  
ON IASI-B AND IASI-C

- Per pixel spectral shifts are computed using an iterative scheme which locates the position of the correlation maximum between lines combs of the measured spectrum and a reference spectrum in a particular spectral window ( $\text{CO}_2$  around  $2370\text{cm}^{-1}$ ).
- The average spectral shift is then calculated for each scan line.
- Filters before and after the calculation of the average spectral shift are used in order to reject inhomogeneous scenes, extreme shift values etc. This ensures the robustness of the chain.

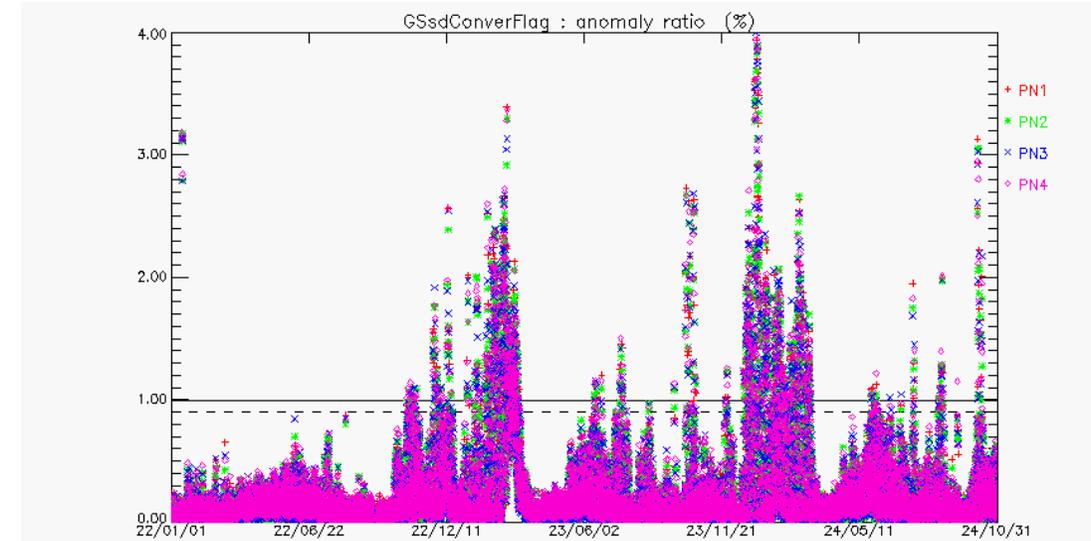


# TIMELINE OF THE ANOMALY

IASI-B  
01/01/2022 – 31/10/2024



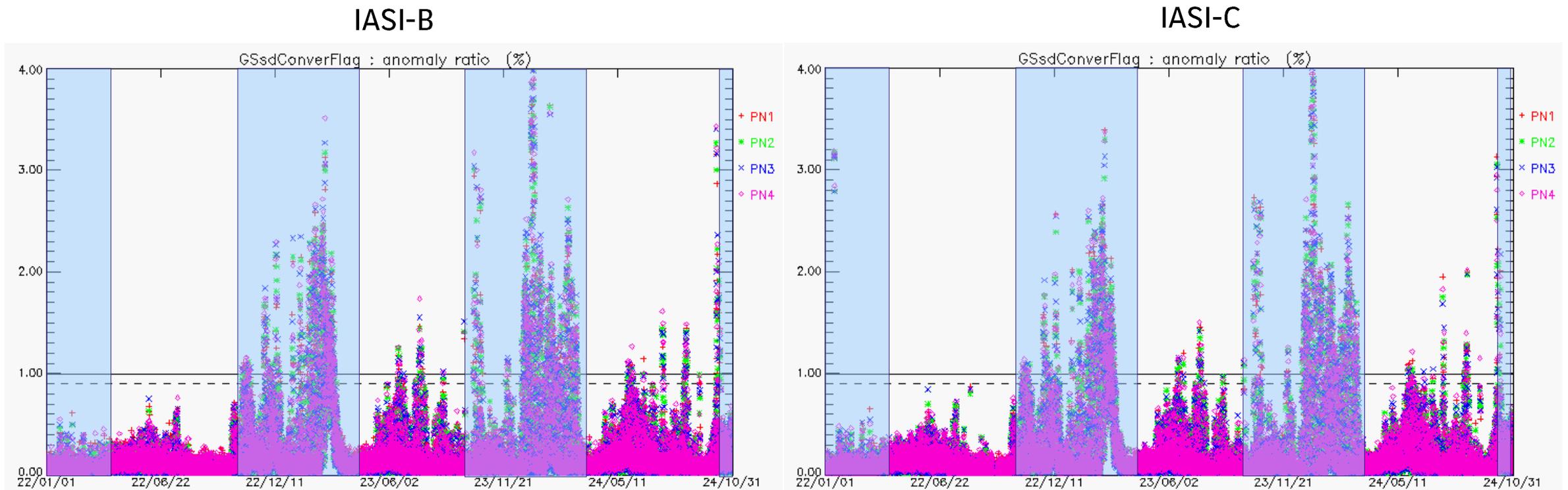
IASI-C  
01/01/2022 – 31/10/2024



- Starting January 2022 the algorithm reports an elevated non-convergence ratio for all pixels of both IASI-B and IASI-C.
- A possible problem in ground processing was quickly excluded.
- Past simultaneous events: September 2019 and January 2021, but they were isolated and brief.
- **No effect on the spectral calibration performance** as long as the algorithm converges for a few spectra per orbit. Maximum to this day is around 5% for a single orbit.
- The spectral calibration performance is confirmed by the monitoring the stability of the interferometric axis.

# SEASONALITY

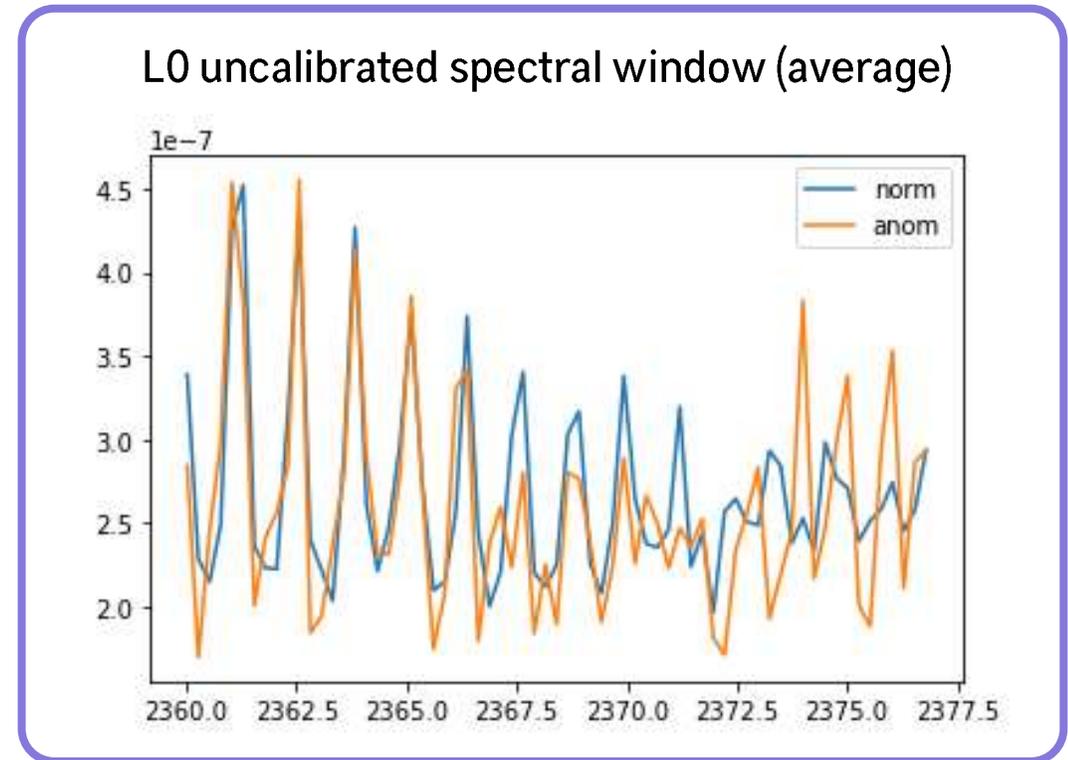
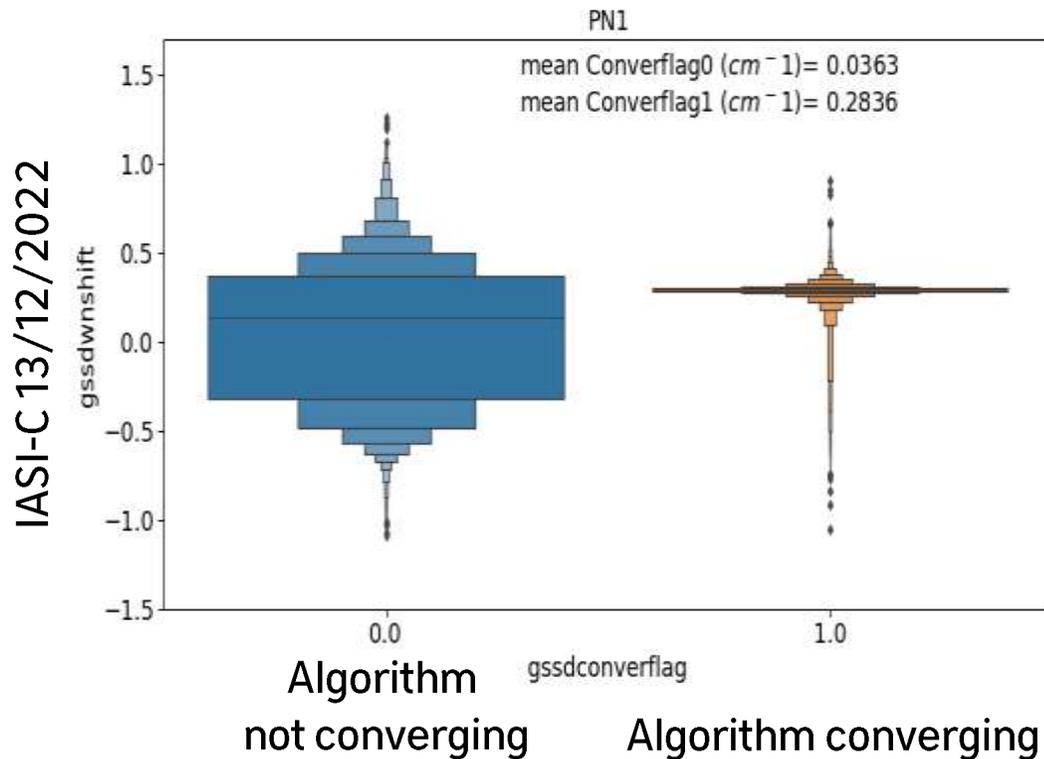
- Both instruments are synchronized -> the possible root cause is geophysical.
- The anomaly exhibits a seasonal trend, being stronger from (roughly) **October to April**.





# ROUGH SPECTRAL SHIFTS

- Rough spectral shifts: the shift values at the end of the iterations.
- They are much more variable when the spectral shifts determination algorithm reaches the limit number of iterations.
- This is an indication of the divergence of the iterative process.



# PROBABLE CAUSES

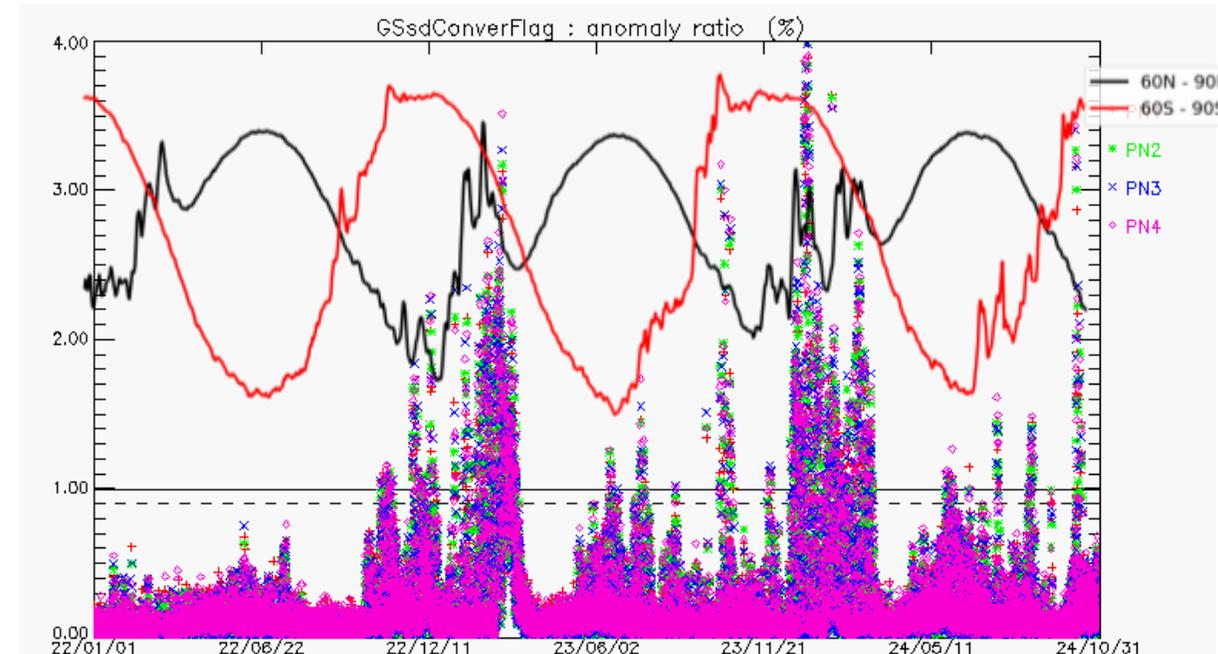
## EXCLUDED SCENARIOS

- Triggering of an algorithm threshold due to the gradual increase of CO<sub>2</sub>: investigations do not back up this assumption.
- Solar activity: discussed but has been deemed improbable.
- ENSO: no evident correlation.

# PROBABLE CAUSES

## CORRELATION TO THE EVOLUTION OF THE POLAR VORTEX

- Very strong correlation to the anomalies of the stratospheric temperature close to the poles.
- Analyses on EUMETSAT side point to the same direction.
- The North Pole anomaly events frequently start near the Bering Strait, could there be a link to the collapse of the polar vortex ?
- If these assumptions are true, why a similar anomaly has not been observed prior to January 2022 ?



Data : NASA Atmospheric Chemistry and Dynamics Laboratory  
[https://acd-ext.gsfc.nasa.gov/Data\\_services/met/ann\\_data.html](https://acd-ext.gsfc.nasa.gov/Data_services/met/ann_data.html)

# PROBABLE CAUSES

## CORRELATION TO THE ERUPTION OF THE HUNGA-TONGA HA'APAI VOLCANO

- Eruption on 15/01/2022, just 5 days prior to the first signs of the anomaly.
- Explosive volcano eruption at sea level, remarkable quantities of water vapor injected in the stratosphere.
- The stratospheric water vapor concentration is expected to return to normal levels only a few years after the eruption.
- The injection of water vapor at high altitude permitted the dispersion over the equator, reaching the poles in a few months.

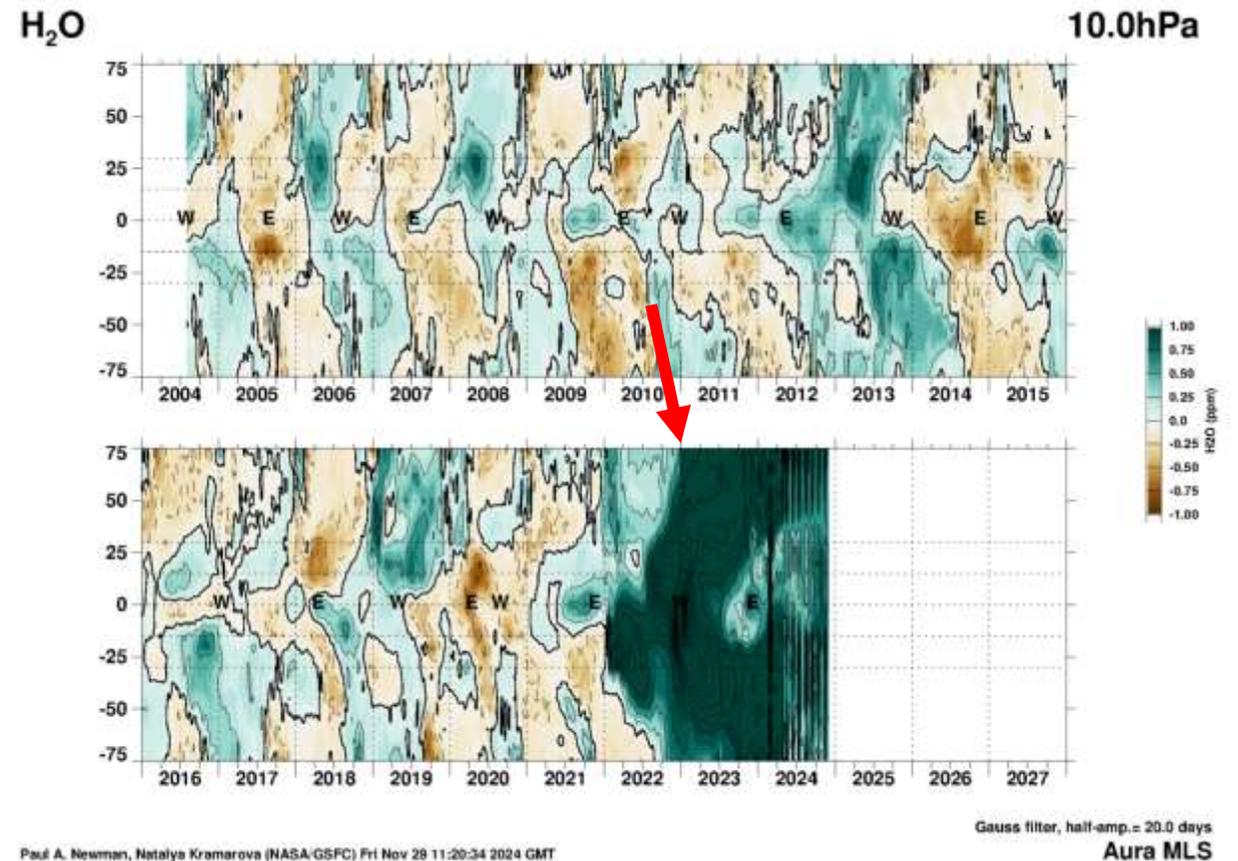


Image:  
Tonga Geological Services / ZUMA Press / Zuma / RÉA

# PROBABLE CAUSES

## CORRELATION TO THE ERUPTION OF THE HUNGA-TONGA HAA'PAI VOLCANO

- MLS data on humidity confirm the occurrence of remarkable quantities of water in the stratosphere for all latitudes.
- The increase of the water concentrations at northern high latitudes (red arrows) matches with the first strong signal of the anomaly (November 2022).



Water concentration at 10hPa, annual mean removed

# CONCLUSIONS

- The spectral calibration anomaly is simultaneously observed for both IASI instruments since January 2021.
- No impact on the instrument performance thanks to the robustness of the algorithm chain.
- The anomaly has a geophysical origin. It exhibits seasonality, switching between the North and South pole.
- Out of all probable causes, two scenarios seem plausible to this day:
  - Evolution of the polar vortex.
  - The eruption of the Hunga-Tonga Ha'apai volcano.
  - It is quite possible that the anomaly is a combination of the above two factors.
- Way forward:
  - Monitoring of the evolution of the anomaly is ensured by IASI TEC procedures.
  - No change in the parametrization of the algorithm: a modification of the algorithm filter would only reject at an earlier stage the non-converging spectra.
  - A more detailed study is to be launched in 2025.