

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

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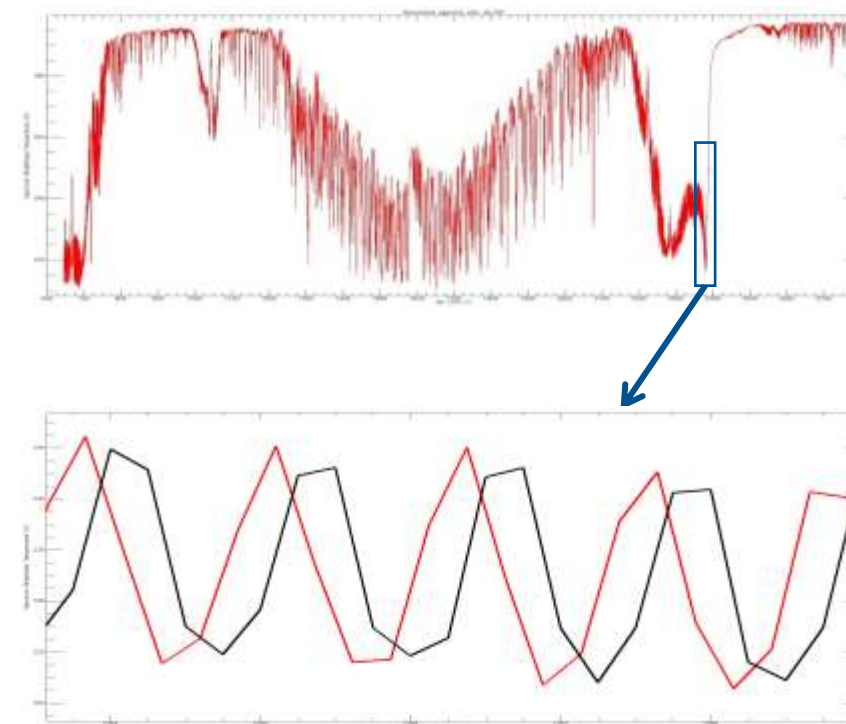
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IASI CONFERENCE - NANCY
02-06/12/2024

THE IASI SPECTRAL CALIBRATION

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

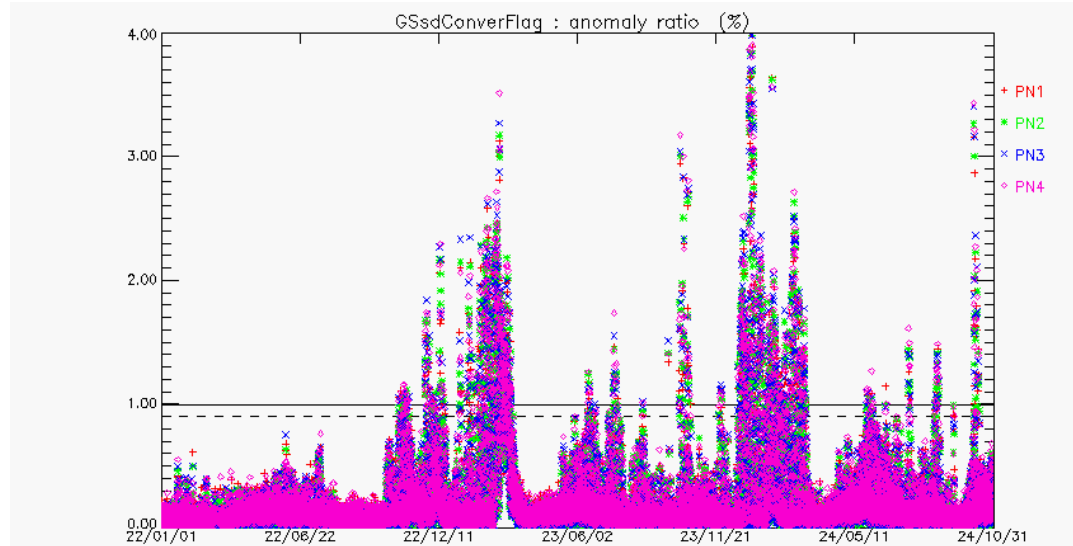
- Per pixel spectral shifts are computed using an iterative scheme which locates the position of the correlation maximum between lines combs of the measured spectrum and a reference spectrum in a particular spectral window (CO_2 around 2370cm^{-1}).
- The average spectral shift is then calculated for 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.



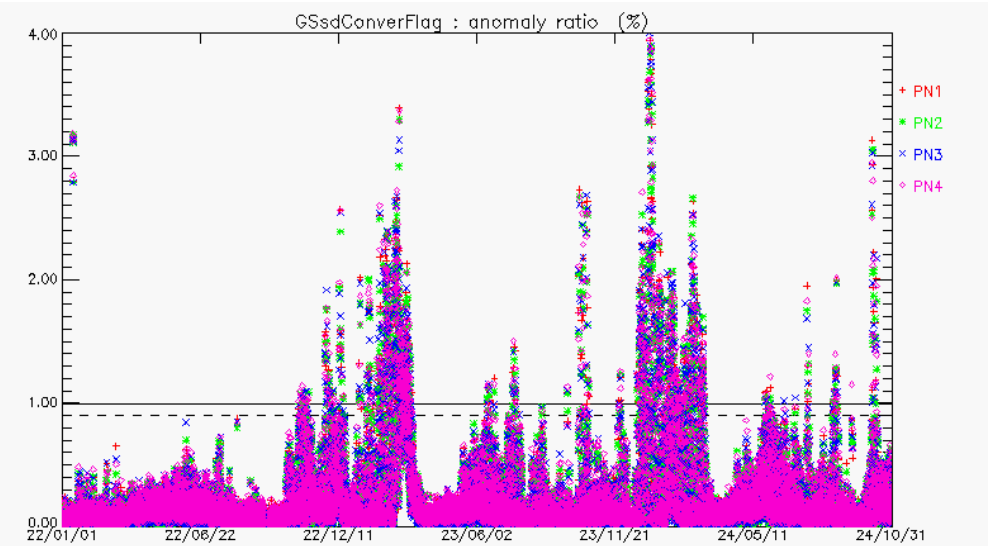
TIMELINE OF THE ANOMALY

THE SPECTRAL
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ON IASI-B AND IASI-C

IASI-B
01/01/2022 – 31/10/2024



IASI-C
01/01/2022 – 31/10/2024



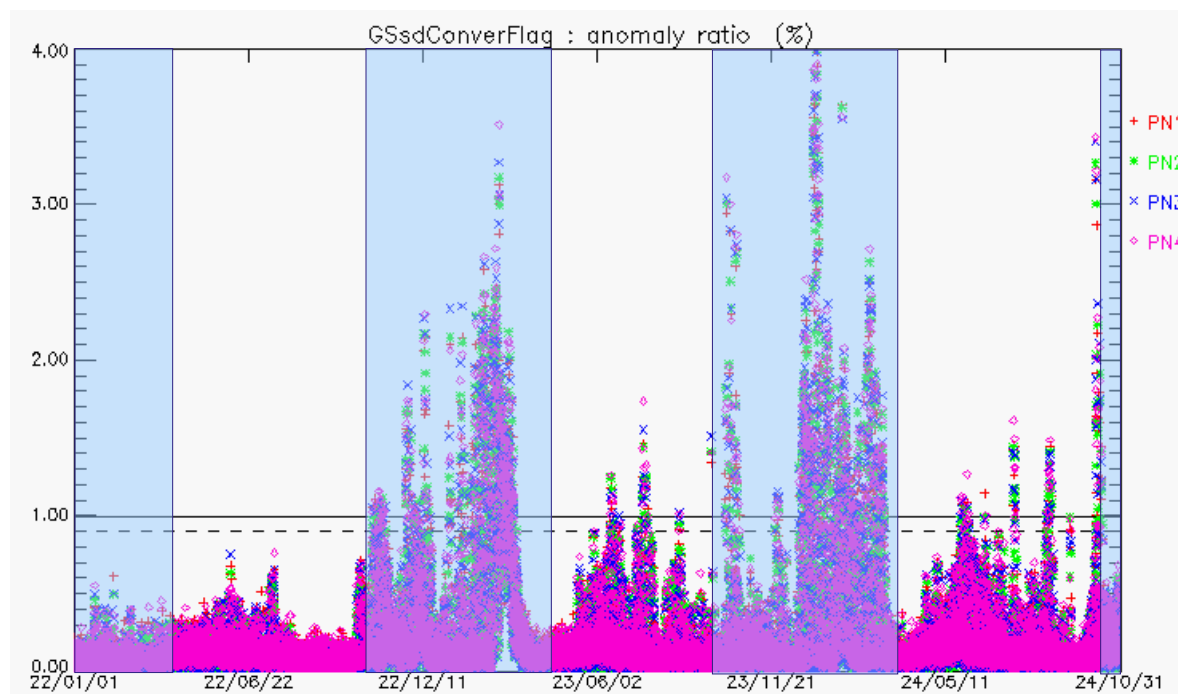
- Starting January 2022 the algorithm reports an elevated non-convergence ratio for all pixels of both IASI-B and IASI-C.
- A possible problem in ground processing was quickly excluded.
- Past simultaneous events: September 2019 and January 2021, but they were isolated and brief.
- **No effect on the 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

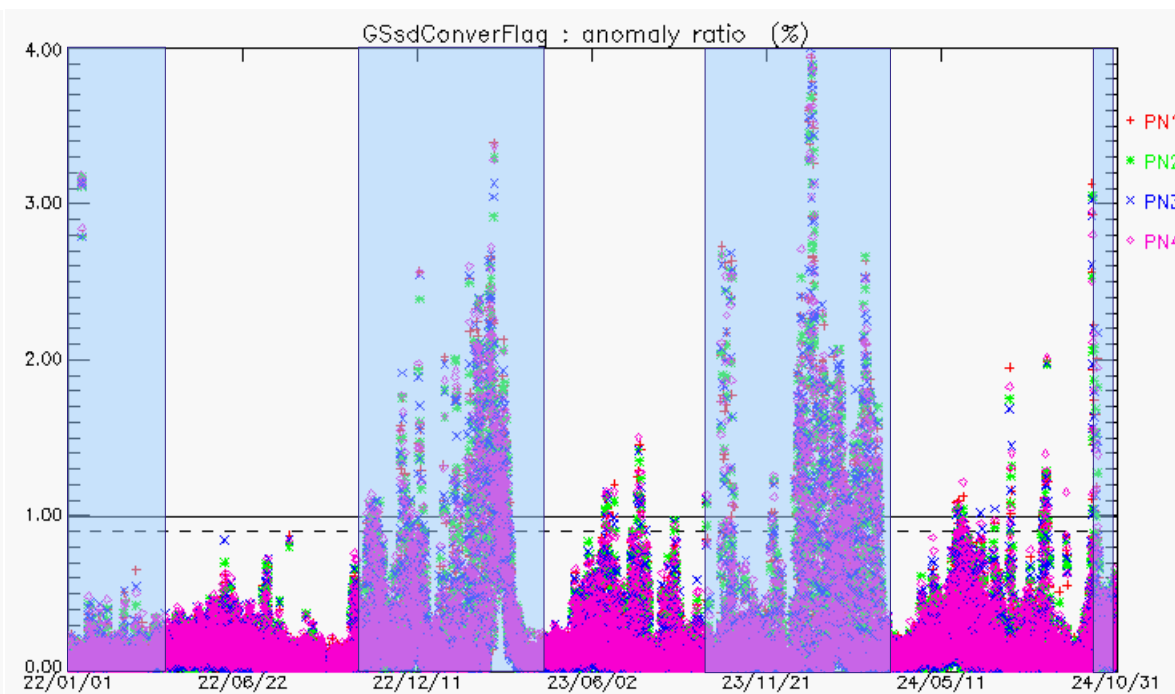
THE SPECTRAL
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- Both instruments are synchronized -> the possible root cause is geophysical.
- The anomaly exhibits a seasonal trend, being stronger from (roughly) [October to April](#).

IASI-B



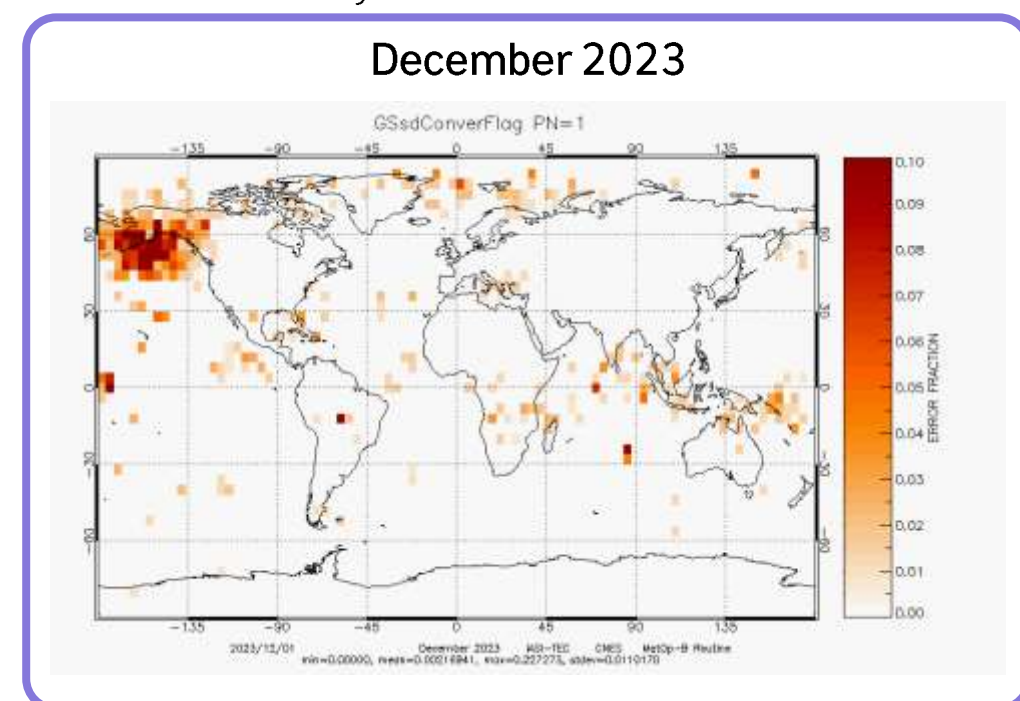
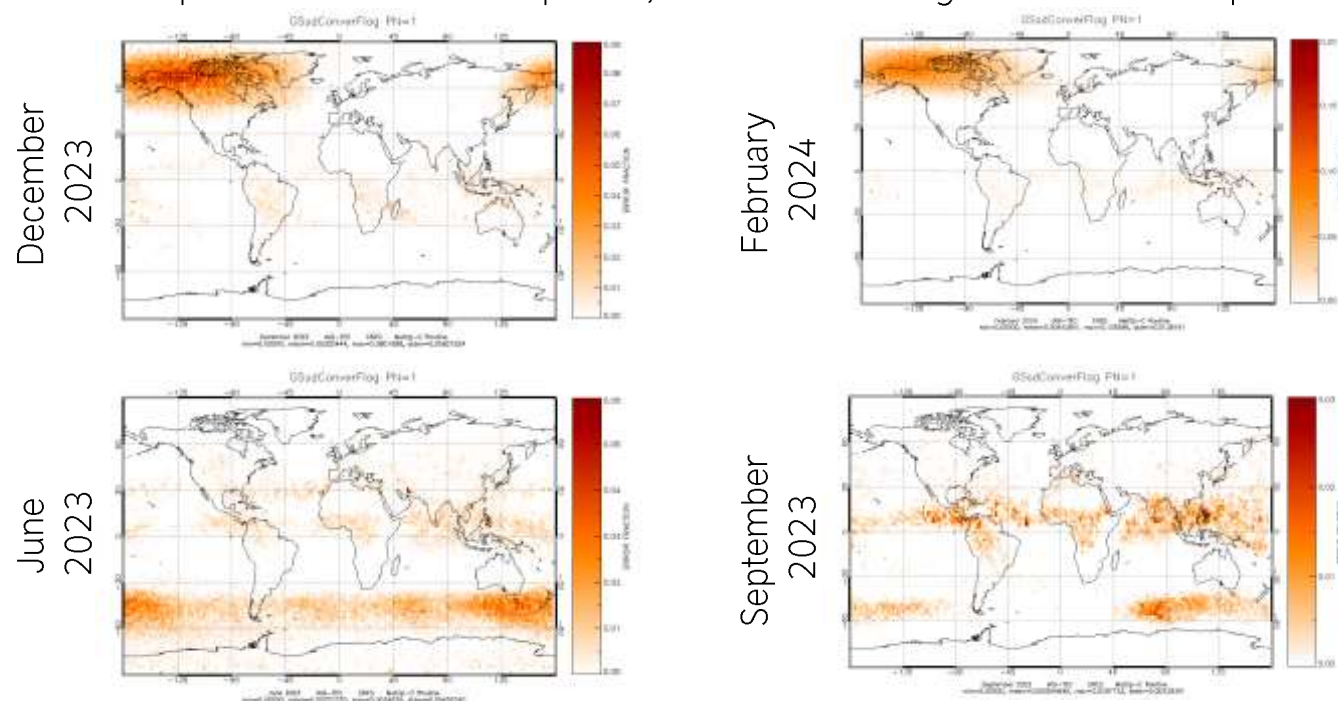
IASI-C



GEOLOCATION

THE SPECTRAL
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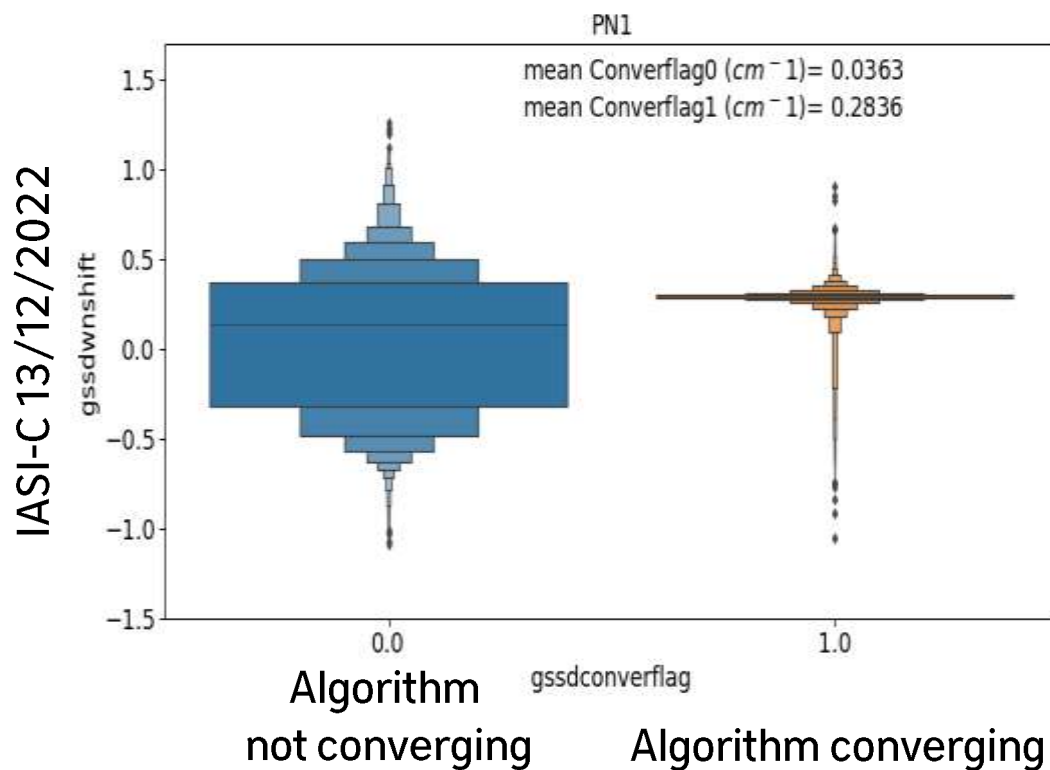
- The geolocation of the non-convergence flags indicates that the anomaly is located around the North Pole from October to April (shallower spectral lines around the poles).
- For the reminder of the year, the anomaly is located around the South Pole.
- In transition periods the anomaly is also frequently observed in mid-latitudes.
- A comparison to a reference period, shows that the signal around the equator is not linked to the anomaly.



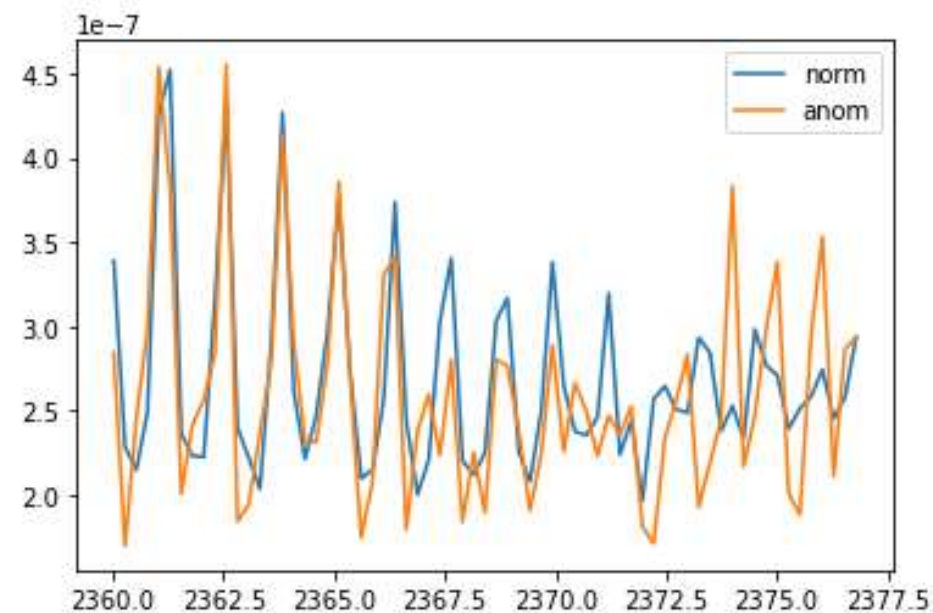
ROUGH SPECTRAL SHIFTS

THE SPECTRAL
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- 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.



L0 uncalibrated spectral window (average)



PROBABLE CAUSES

THE SPECTRAL
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EXCLUDED SCENARIOS

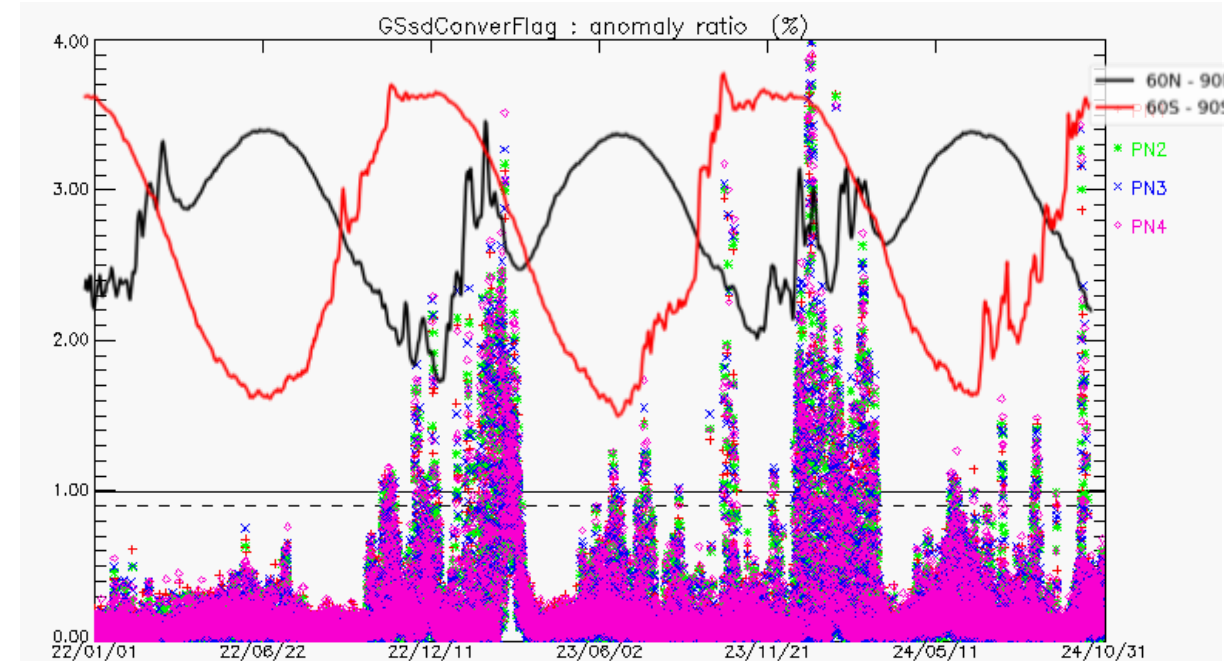
- Triggering of an algorithm threshold due to the gradual increase of CO₂: investigations do not back up this assumption.
- Solar activity: discussed but has been deemed improbable.
- ENSO: no evident correlation.

PROBABLE CAUSES

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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

PROBABLE CAUSES

THE SPECTRAL
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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.



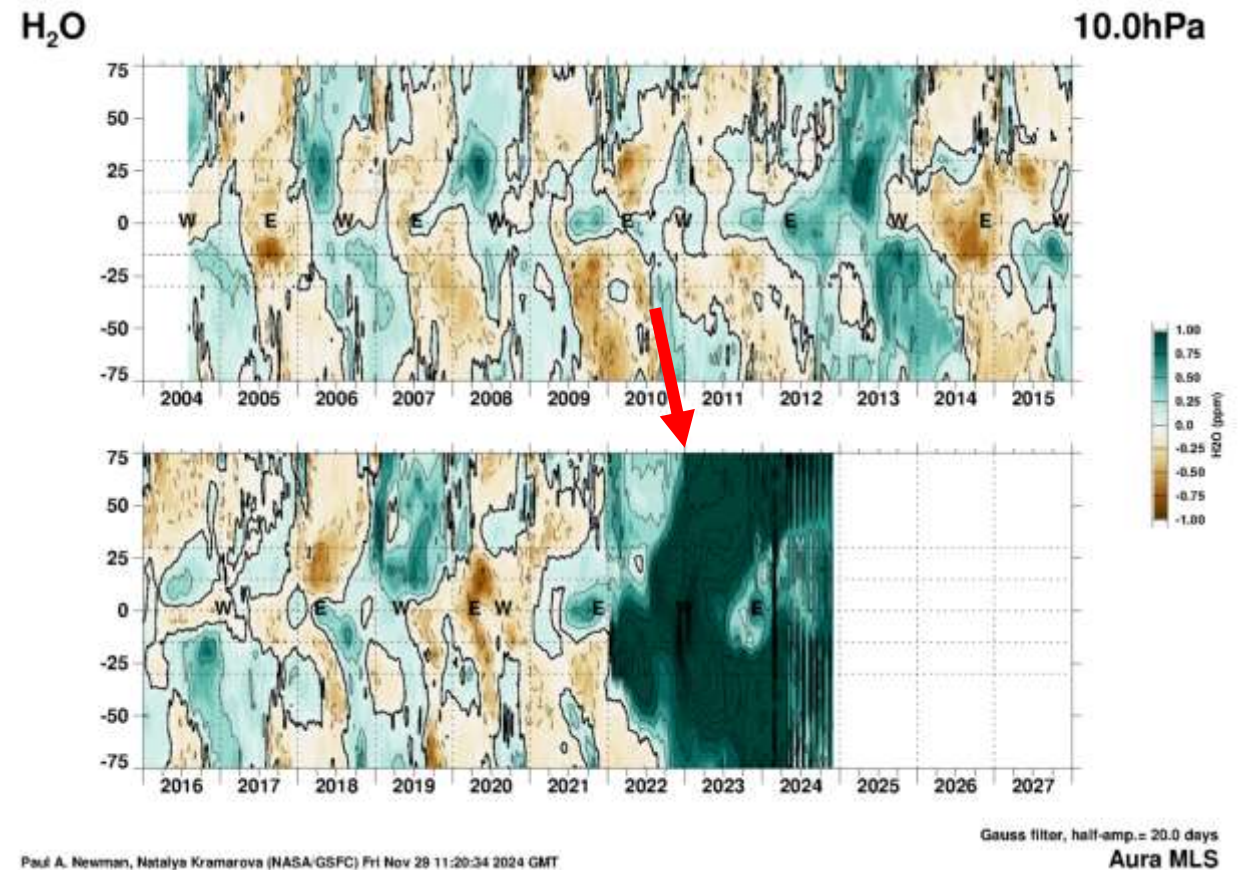
Image:
Tonga Geological Services / ZUMA Press / Zuma / RÉA

PROBABLE CAUSES

THE SPECTRAL
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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.