

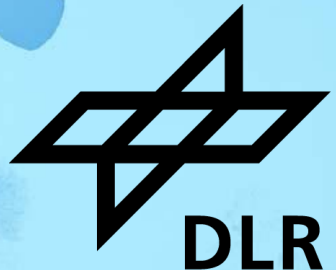
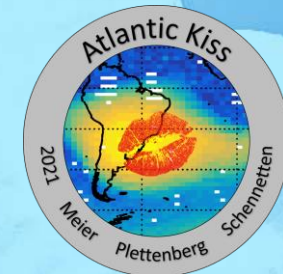
BETWEEN SEA LEVEL AND THE ISS: RADIATION MEASUREMENTS IN THE SAA REGION AT FLIGHT ALTITUDES II

Matthias M. Meier¹, Thomas Berger¹, Thomas Jahn^{2,†}, Moritz Kasemann¹, Karel Marsalek¹,
Daniel Matthiä¹, Kai Schennetten¹

¹German Aerospace Center, Institute of Aerospace Medicine, Radiation Biology, Cologne, Germany

[†]Flight Crew

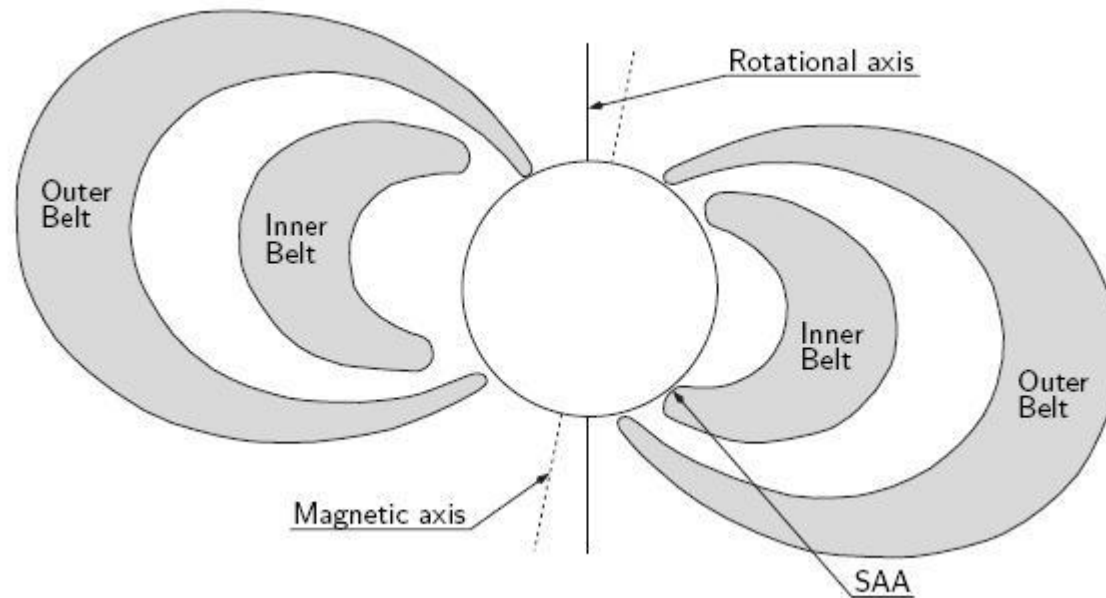
²Lufthansa German Airlines, Lufthansa Basis, Frankfurt/Main, Germany



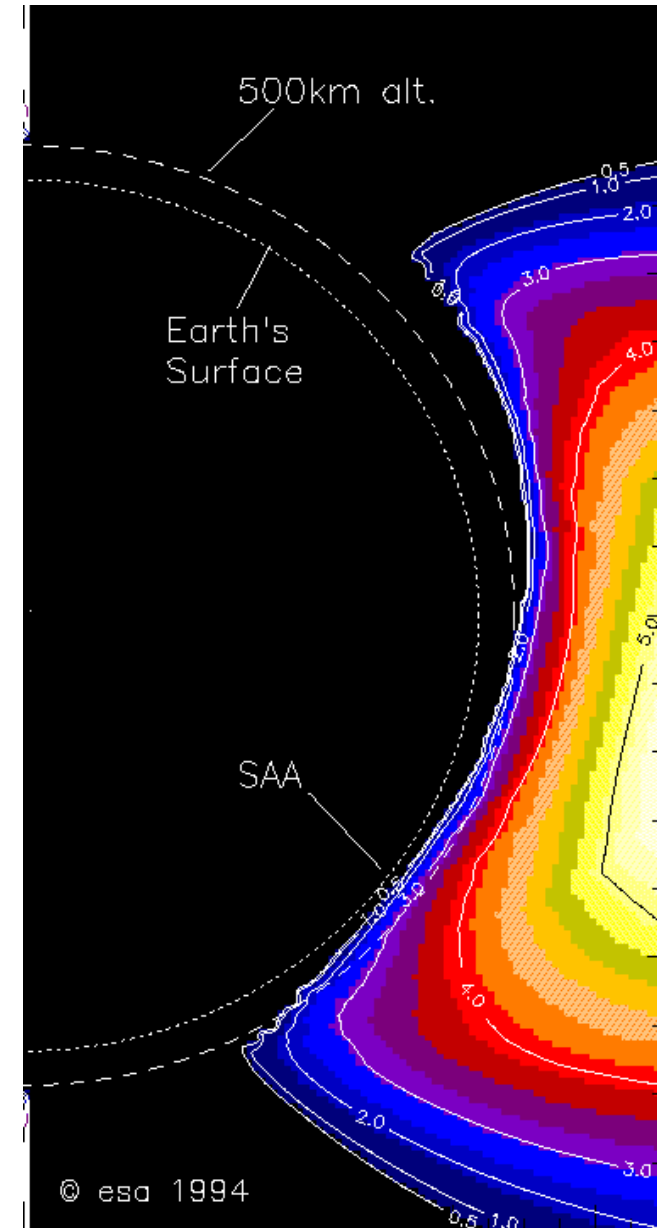
- ▶ Introduction
- ▶ Atlantic Kiss – Mission Impossible 2021
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- ▶ Atlantic Kiss – Mission Impossible 2021
- ▶ Back to the Falkland Islands 2025
- ▶ Summary

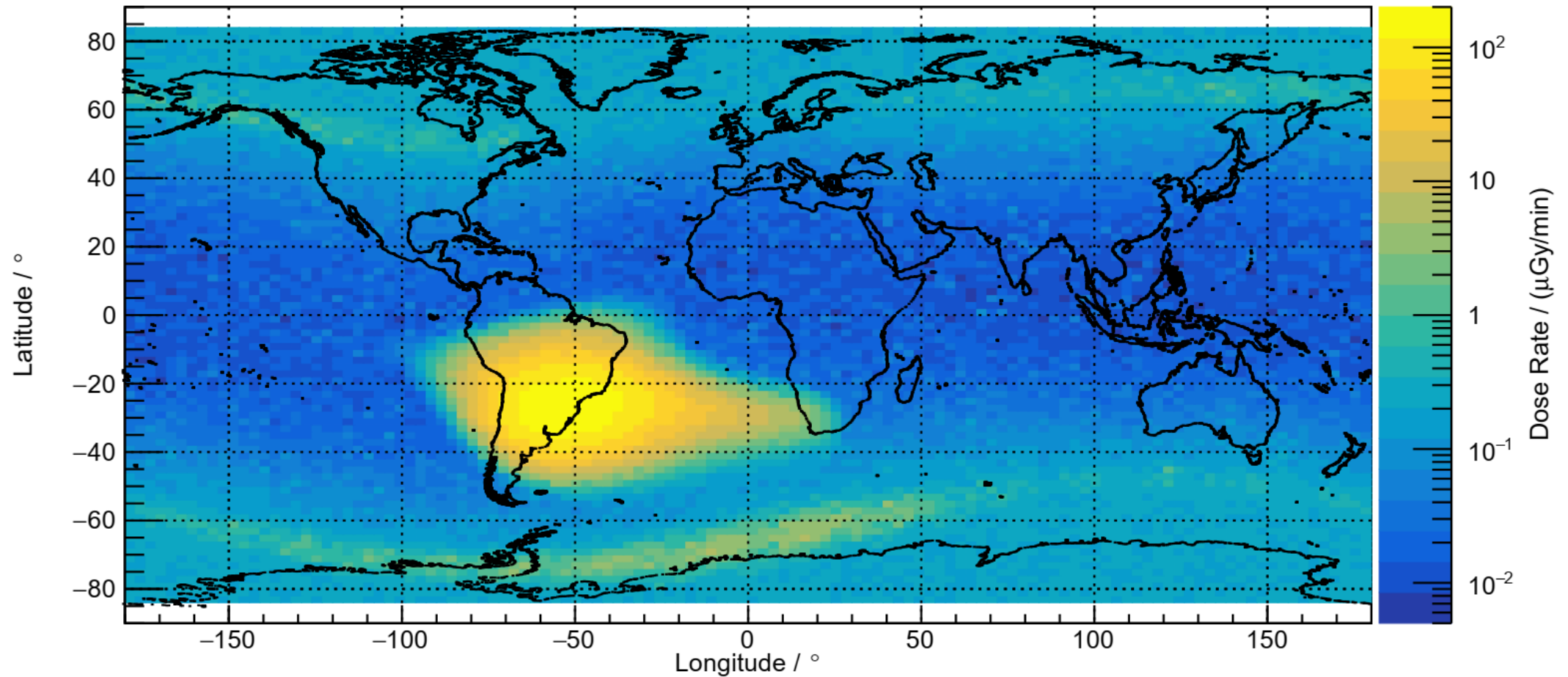
South Atlantic Anomaly



Source: ESA



South Atlantic Anomaly: RAMIS@ Eu:CROPIS (DLR, 600 km)



(data integrated March/April 2021)

Effects of the South Atlantic Anomaly (SAA)



Observations:

Damage to electronic components, e.g., laptops, in Low Earth Orbits.

Highly increased radiation exposure of space crews in LEOs.

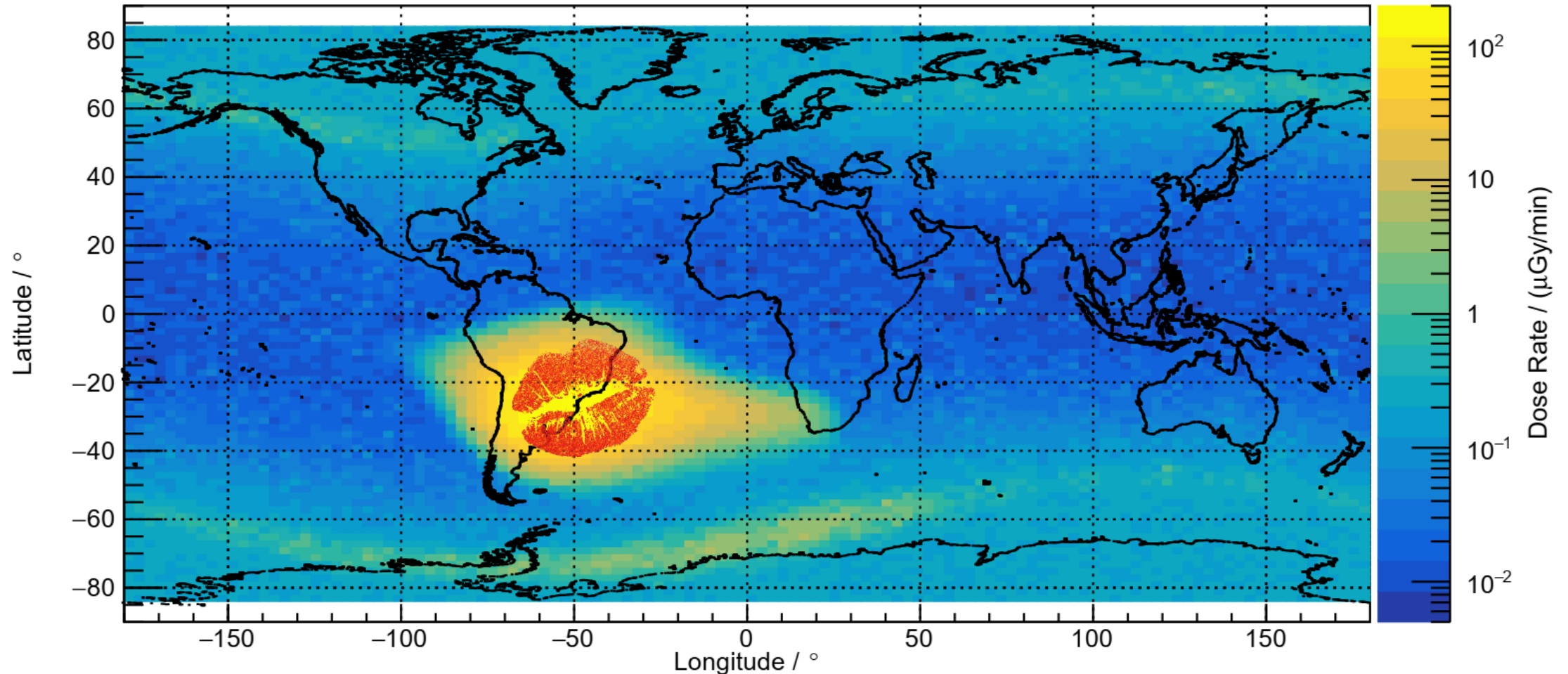
Question (posed by rumors):

Are there any radiation-related effects at aviation altitudes as well?

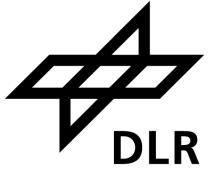
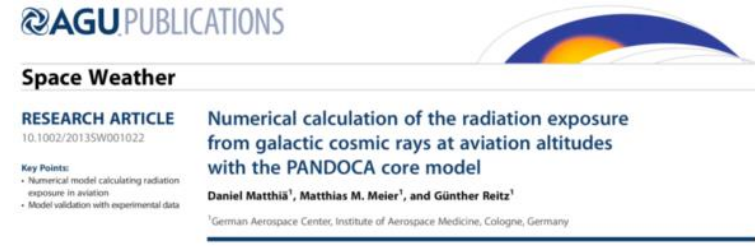


South Atlantic Anomaly (SAA)

Does the SAA really affect the radiation field at flight altitudes, i.e., is there really an „Atlantic Kiss“?



Method



- Question: How can we find out if there is an additional radiation contribution from the SAA at flight altitudes?
- Answer: Comparison of measurements with PANDOCA model calculations.
- PANDOCA is a model to assess radiation exposure at flight altitudes. Agreement with measuring data is better than some 10%.
- PANDOCA does not include any radiation contribution from the SAA, i.e., a significant deviation between measurements and model calculations would be indicative of an additional radiation component.

Measuring Instruments

$$\dot{H} * (10)$$



HAWK: sensitive to all particles

$$\dot{H}_N$$



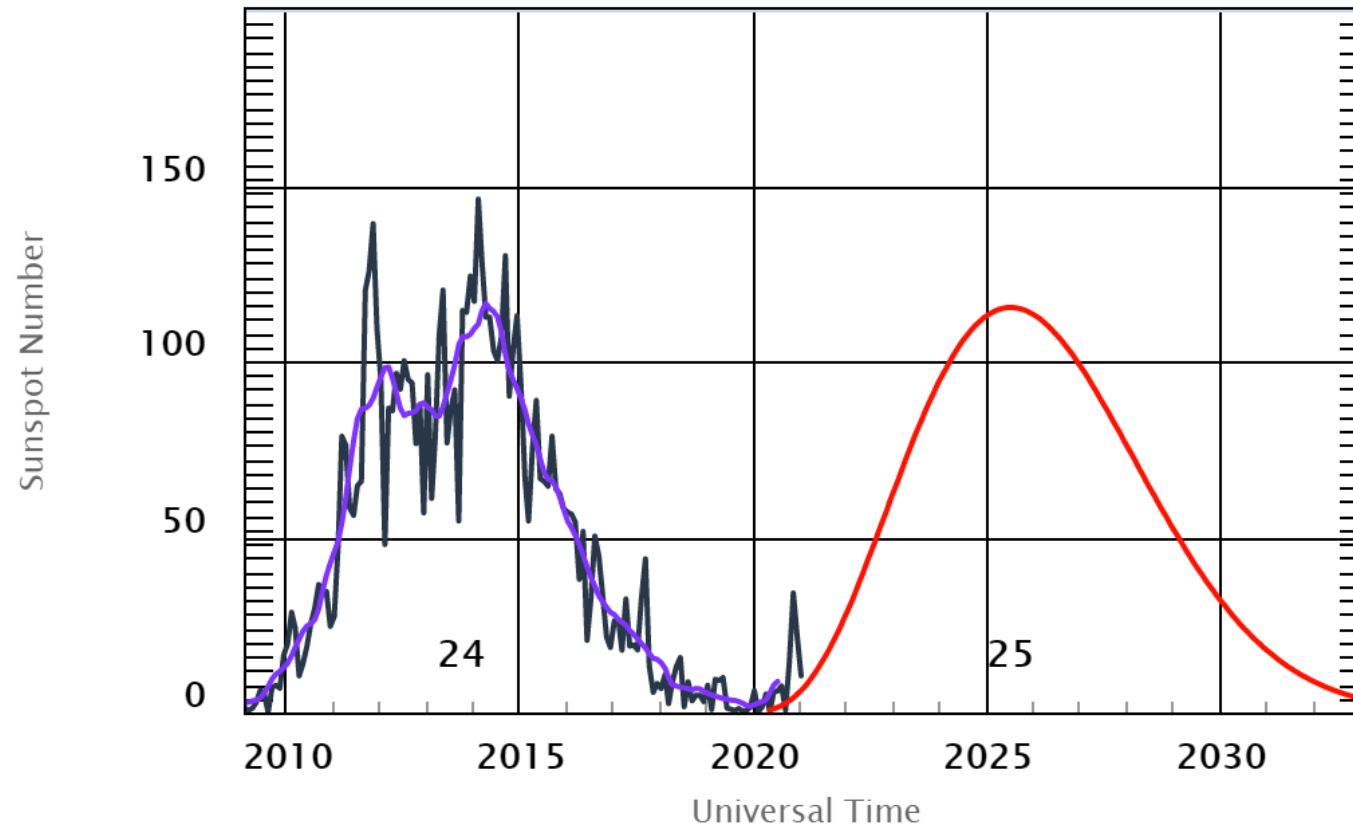
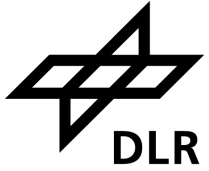
REM-Counter: sensitive to neutrons

$$\dot{D}_{Si}$$



Liulin & M-42: sensitive to charged particles

ISES Solar Cycle Sunspot Number Progression

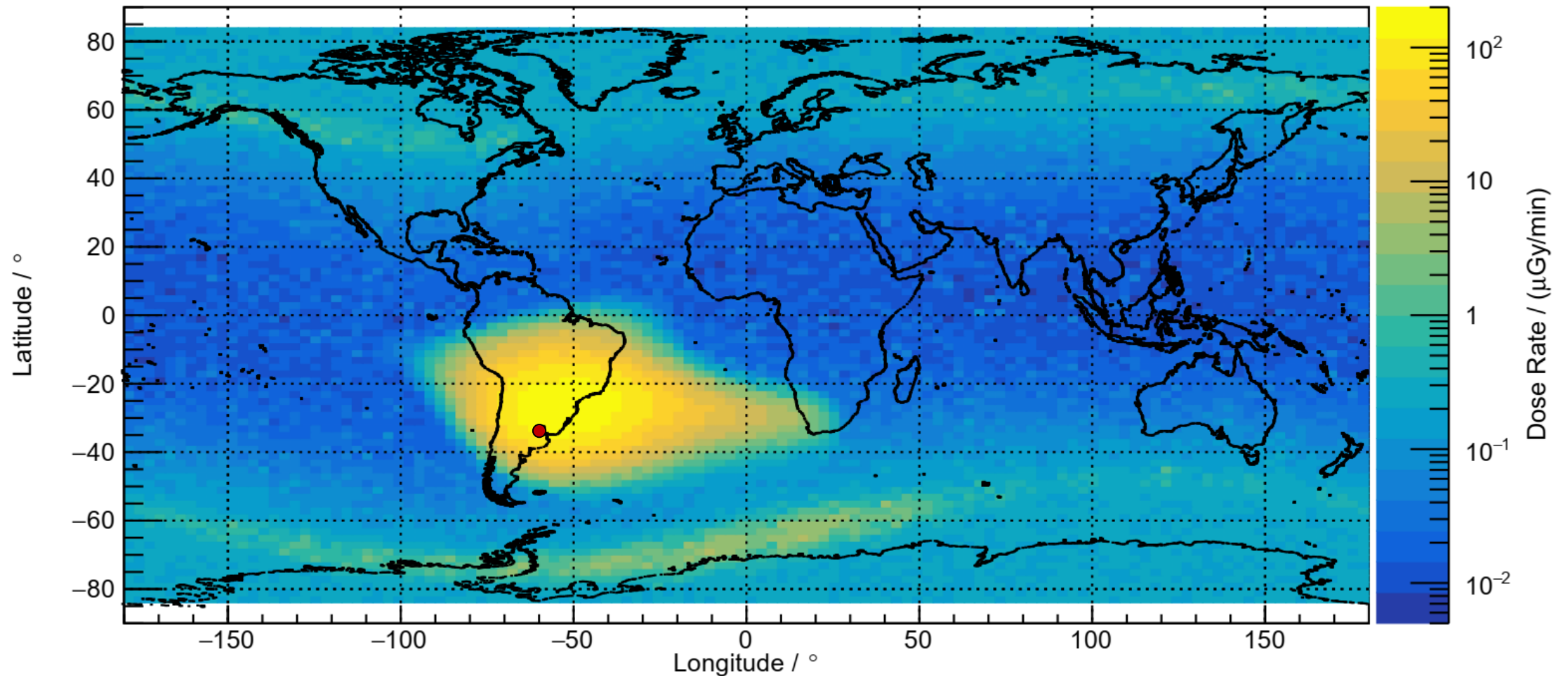


Source: NOAA

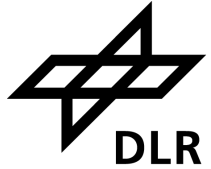
◆ Monthly Values — Smoothed Monthly Values — Predicted Values

Space Weather Prediction Center

South Atlantic Anomaly: Measuring Flight to Buenos Aires



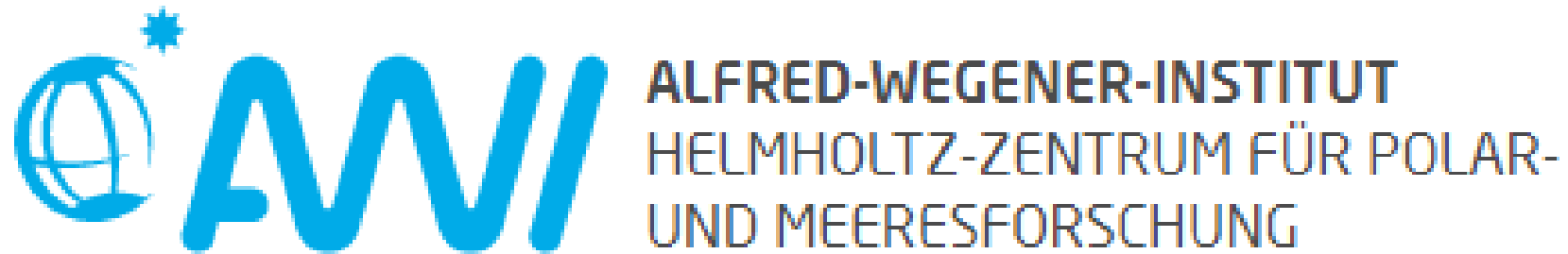
Measuring Flight to Buenos Aires: Scheduled 2. June 2020



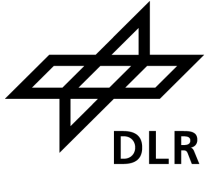
- ▶ Introduction
- ▶ **Atlantic Kiss – Mission Impossible 2021**
- ▶ Back to the Falkland Islands 2025
- ▶ Summary

Atlantic Kiss – Mission Impossible

Other German research institutes had problems with the SARS-CoV-2 pandemic as well:



Atlantic Kiss – Mission Impossible



A bright idea to solve this nasty little problem:



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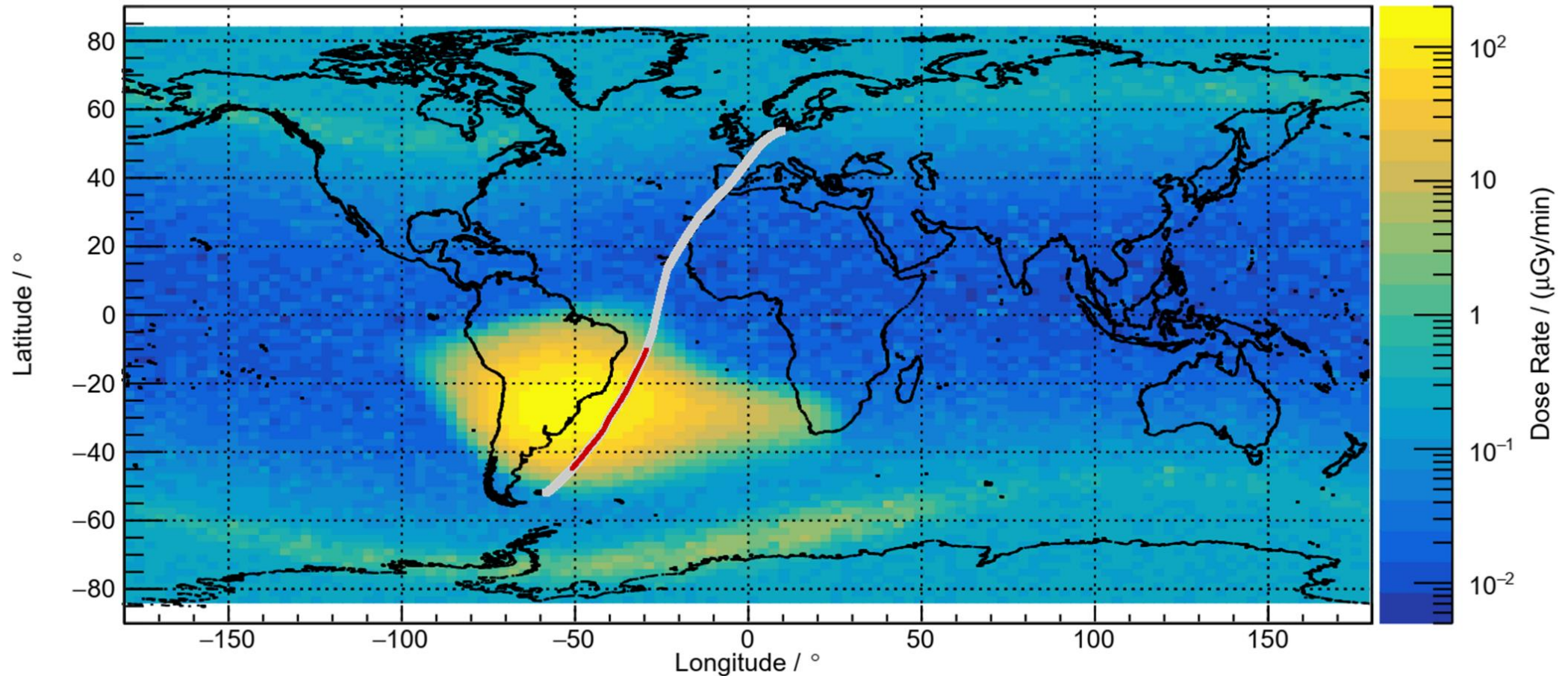
[🏠 Newsroom](#) > [Releases](#) > [Record Flight: Lufthansa Takes Off With Antarctica Researcher...](#)

29.01.2021

Record flight: Lufthansa takes off with Antarctica researchers on its 13,700-kilometer journey

Longest non-stop Lufthansa flight on Sunday on behalf of the Alfred Wegener Institute

Atlantic Kiss – Flight Route to MPN

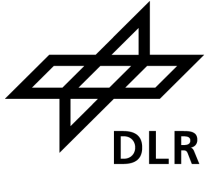


Flight @ FL430 through the geographic region of the SAA (red line).

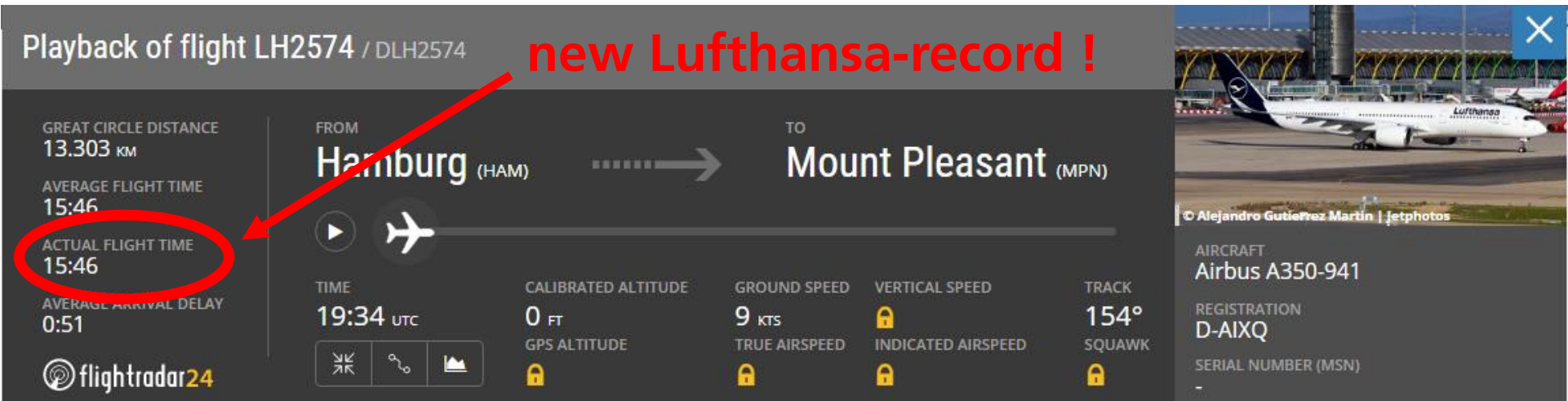
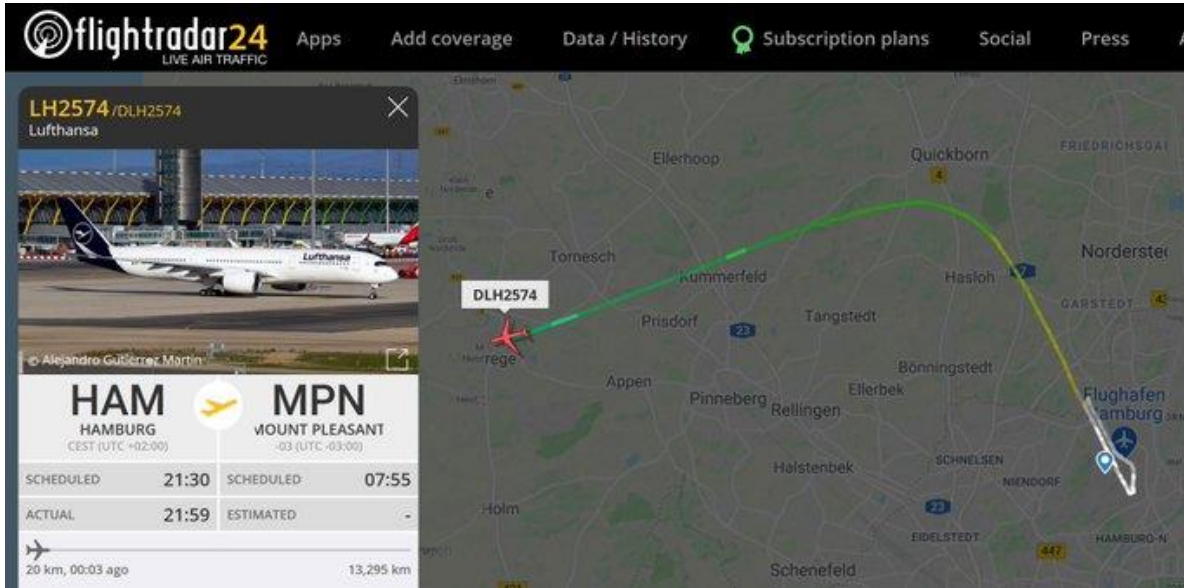
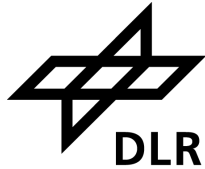
Atlantic Kiss: 16 Days in Quarantine for 16 Hours Freedom



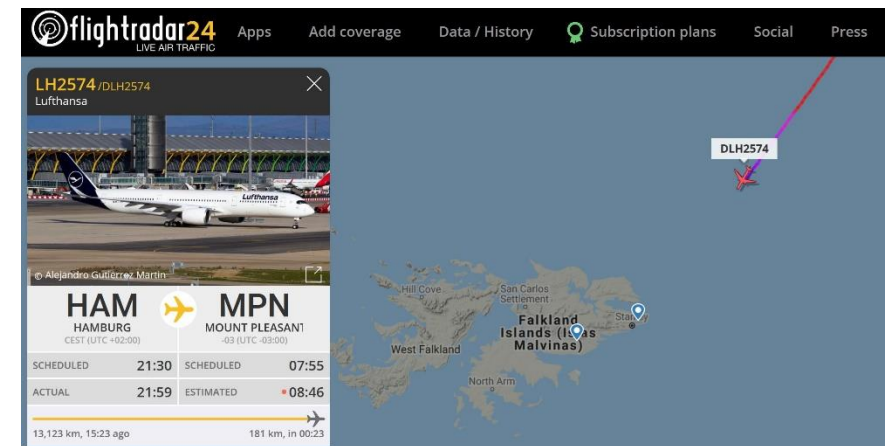
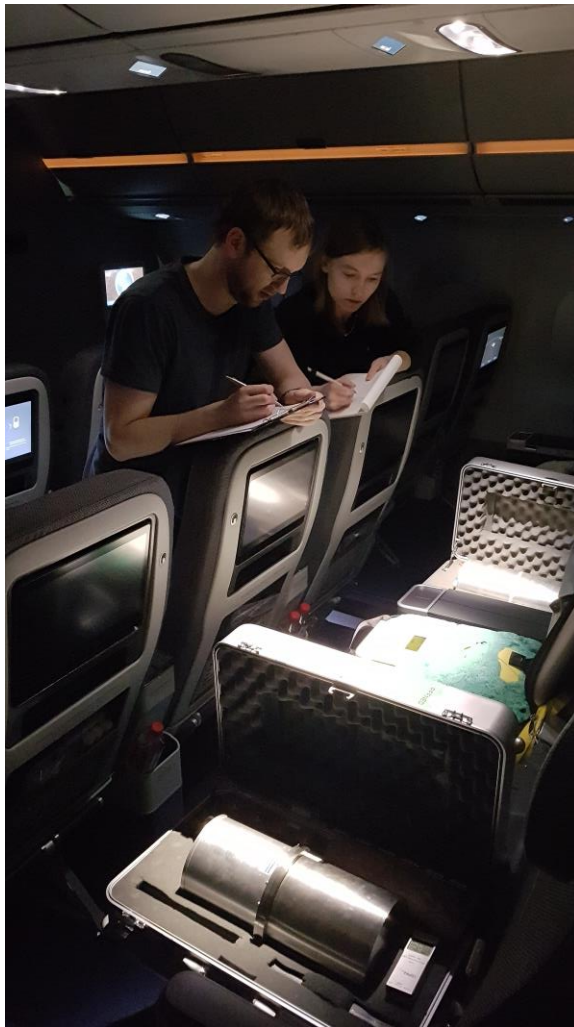
Atlantic Kiss: Here We Go...



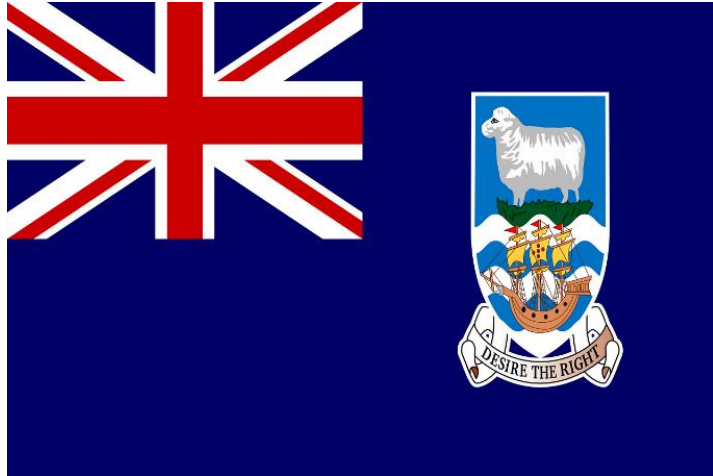
Atlantic Kiss: HAM - MPN



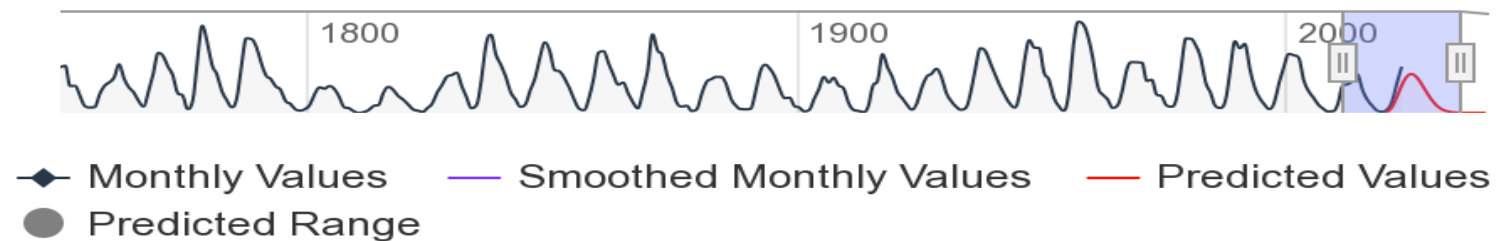
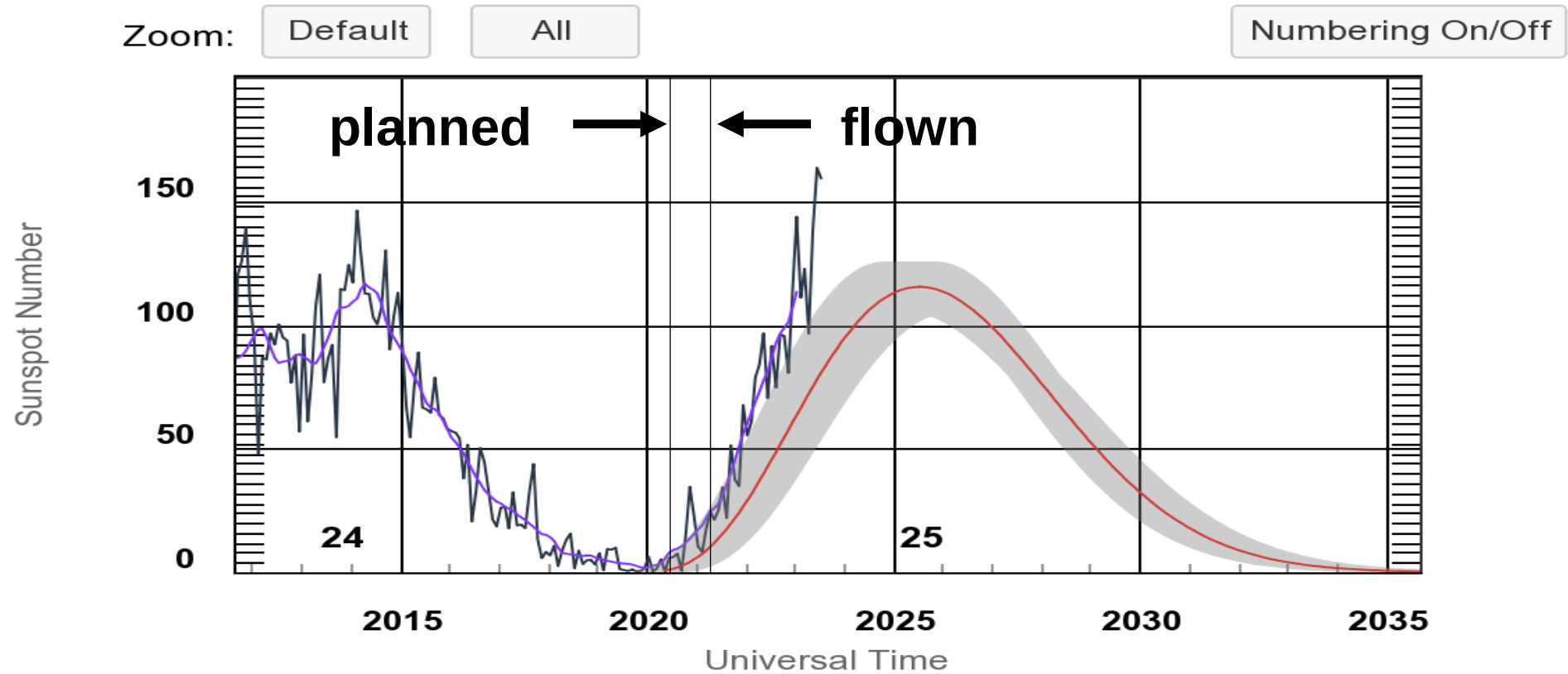
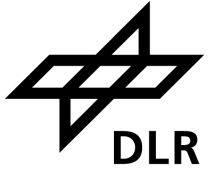
Atlantic Kiss: HAM - MPN



Quarantine 2.0: Stanley, Falkland



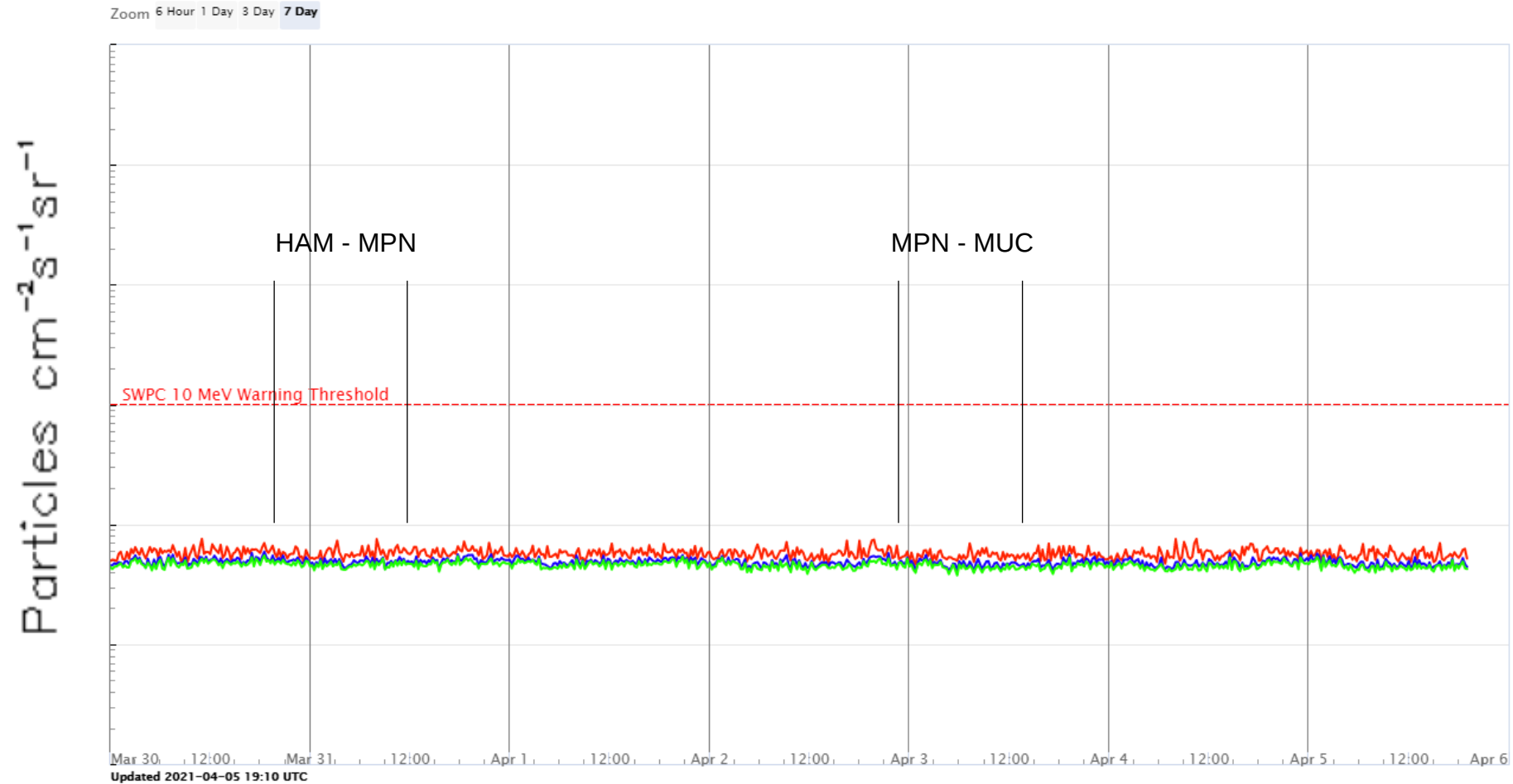
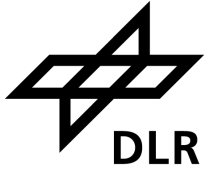
ISES Solar Cycle Sunspot Number Progression



Space Weather Prediction Center

Source: NOAA

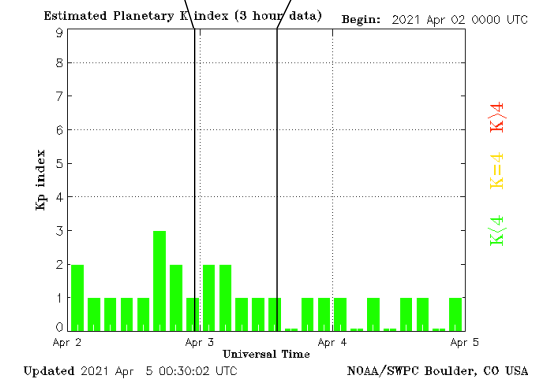
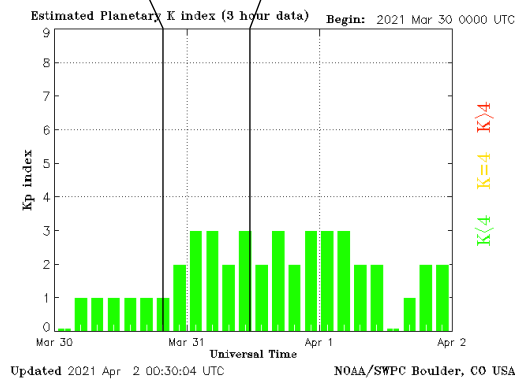
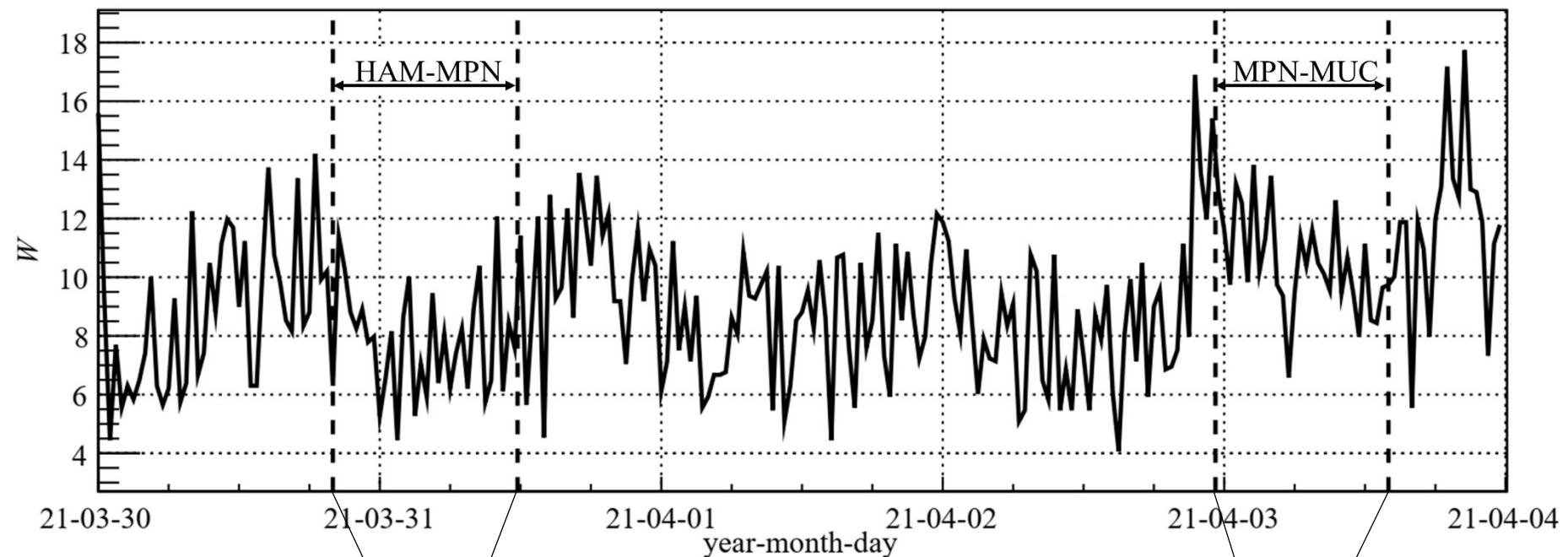
Atlantic Kiss: Space Weather Conditions 1



Source: NOAA

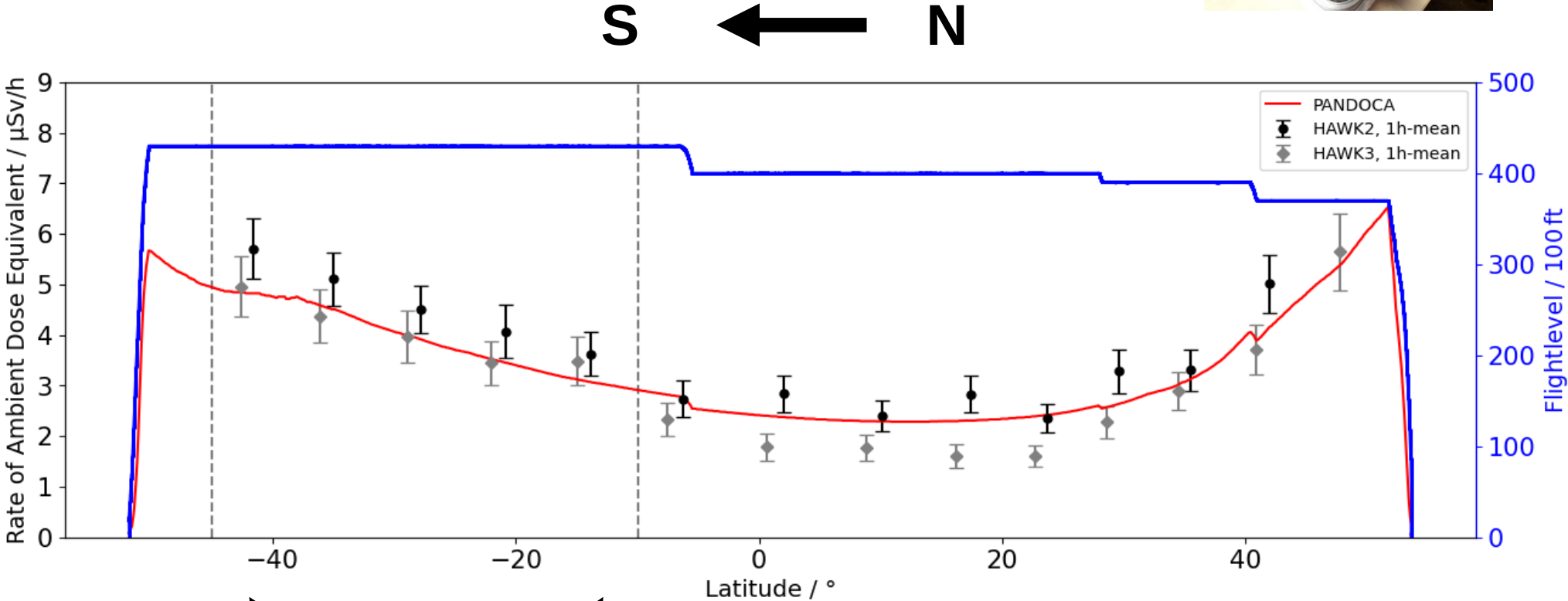
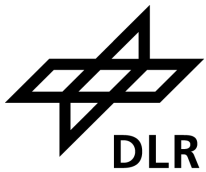
(integrated proton flux >10 MeV, >50 MeV & >100 MeV)

Atlantic Kiss: Space Weather Conditions 2

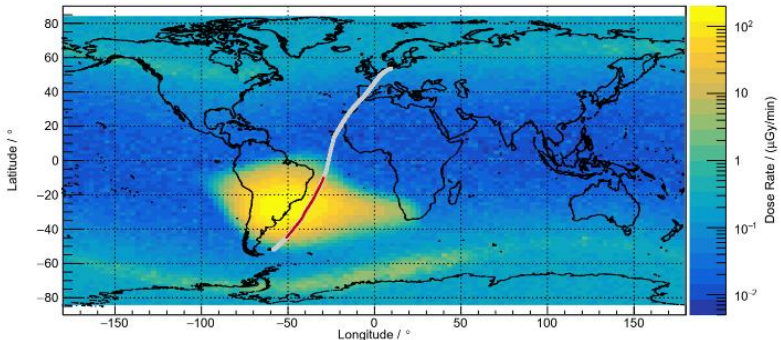


Source: NOAA

HAWK: Ambient Dose Equivalent



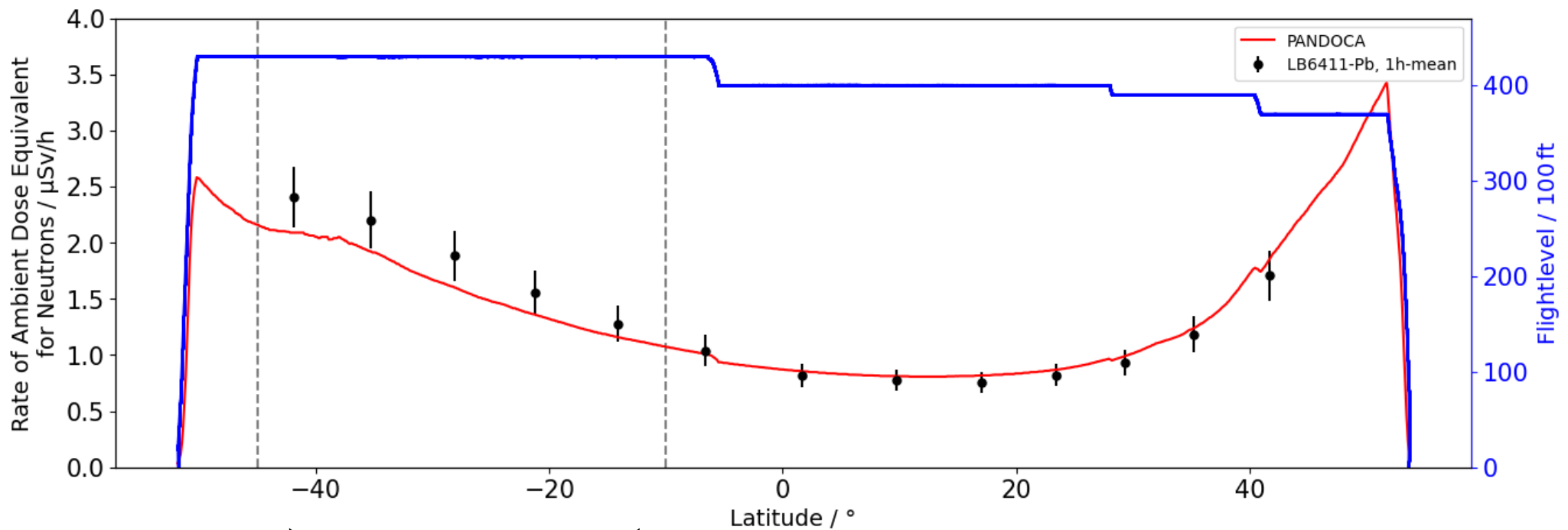
SAA - region



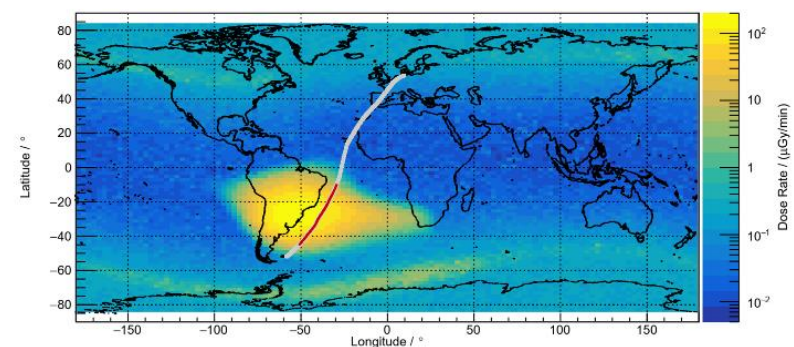
REM-Counter: Neutron Component



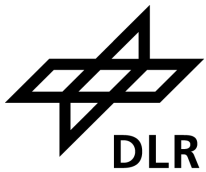
S ← N



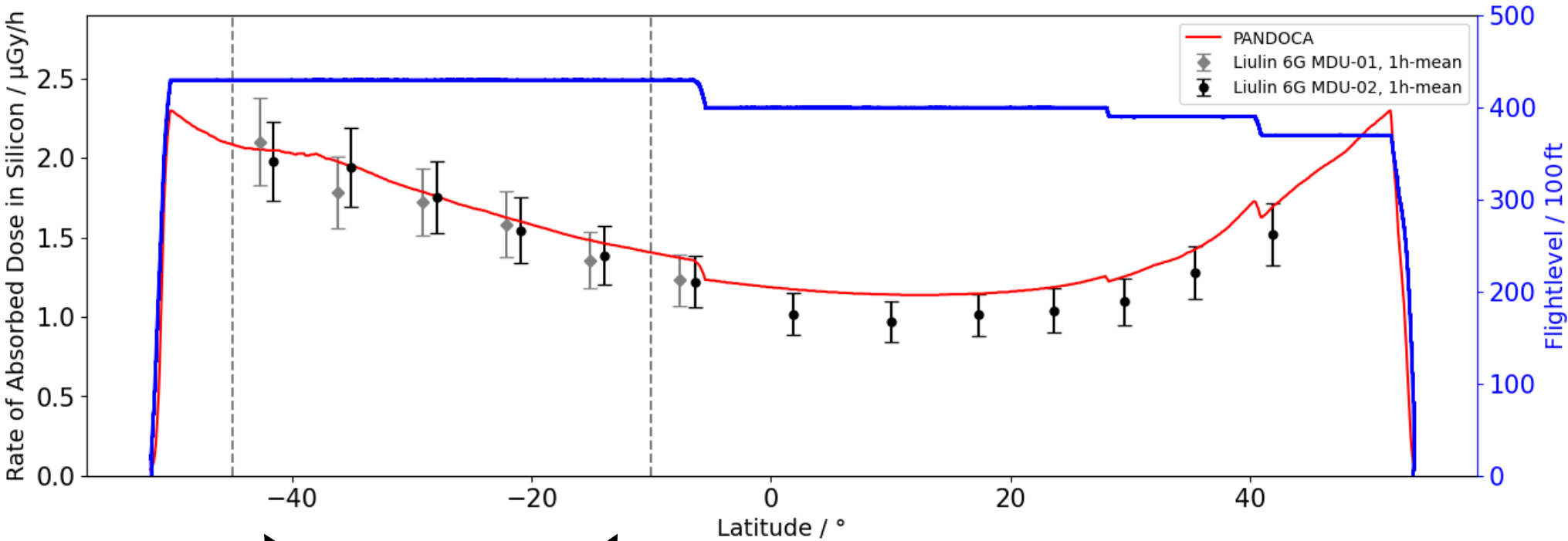
SAA - region



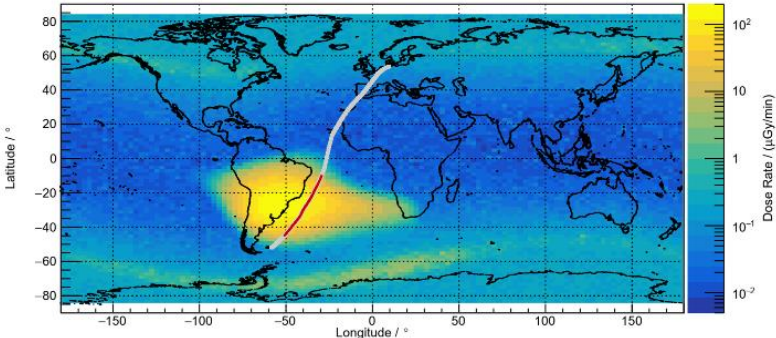
Liulin: Absorbed Dose in Silicon



S ← N



SAA - region

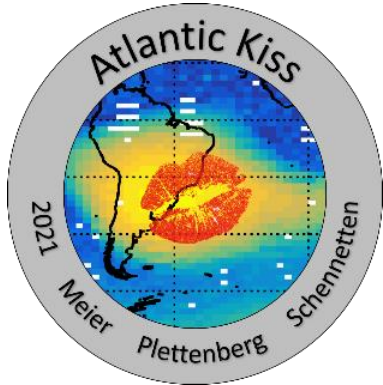


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OPEN Impact of the South Atlantic Anomaly on radiation exposure at flight altitudes during solar minimum

Matthias M. Meier¹✉, Thomas Berger¹, Thomas Jahn², Daniel Matthiä¹,
Mona C. Plettenberg¹, Markus Scheibinger², Kai Schennetten¹ & Michael Wirtz¹



- ▶ Introduction
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- ▶ Summary

Back to the Falkland Islands 2025



Another exchange of personnel by AWI:

Flight from Munich to Mount Pleasant on 11 March 2025.

However, no direct participation by DLR possible this time.



Transport of an M-42 semiconductor detector by Cpt.

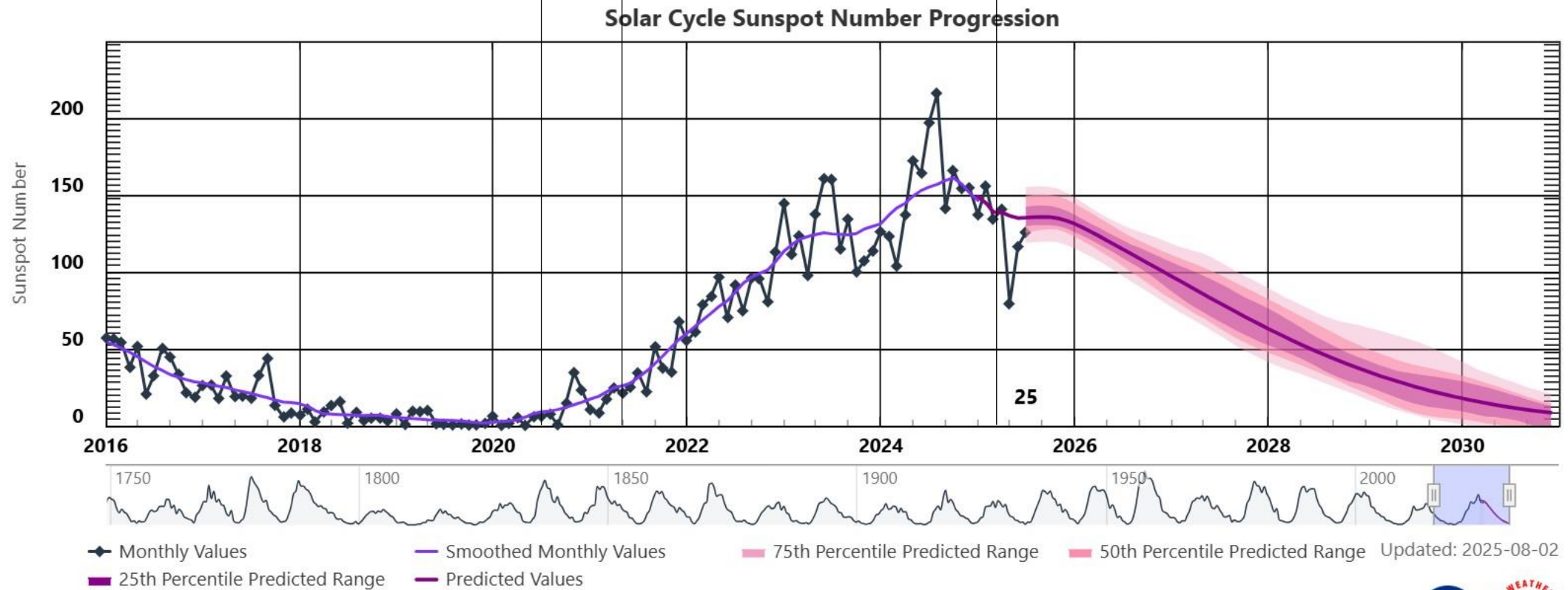


Progression of Solar Cycle 25

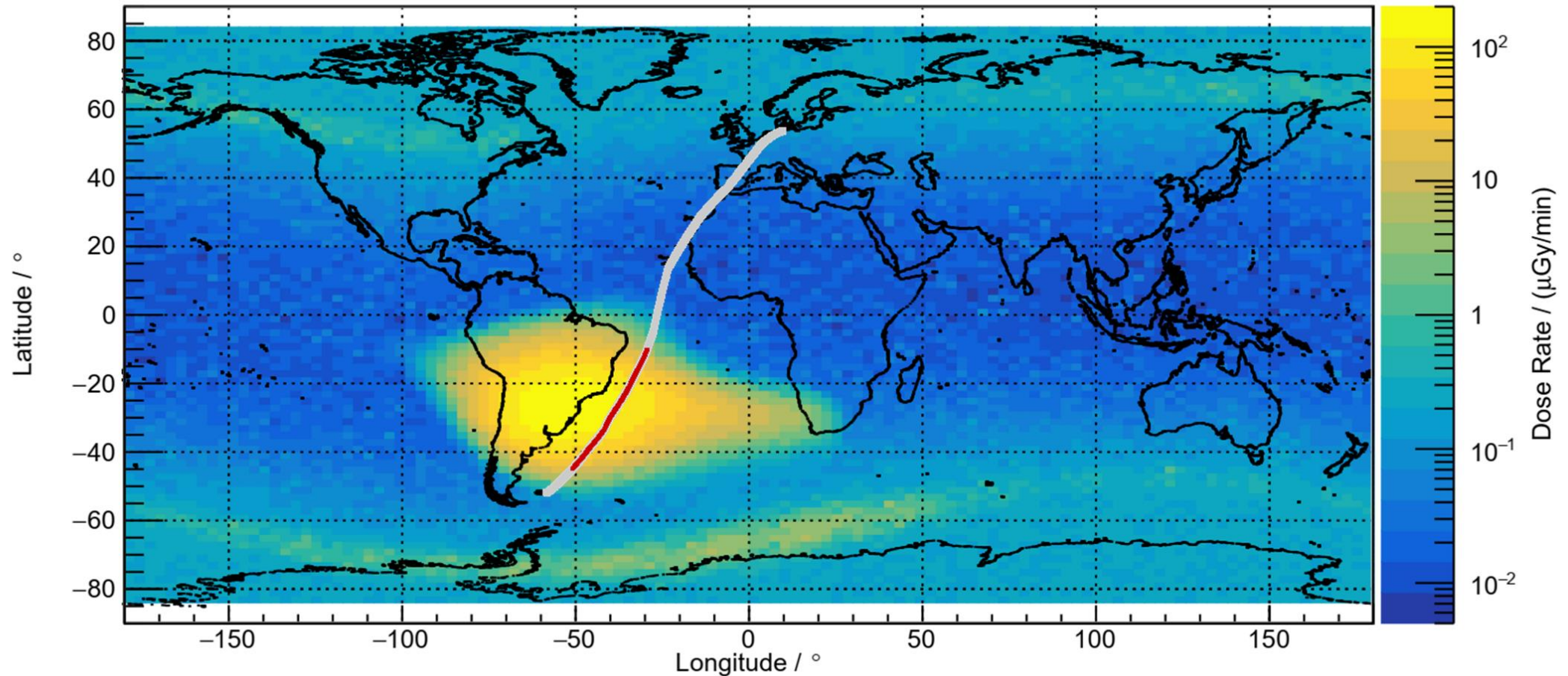
Atlantic Kiss planned →

← AK flown

← AK follow-up flown



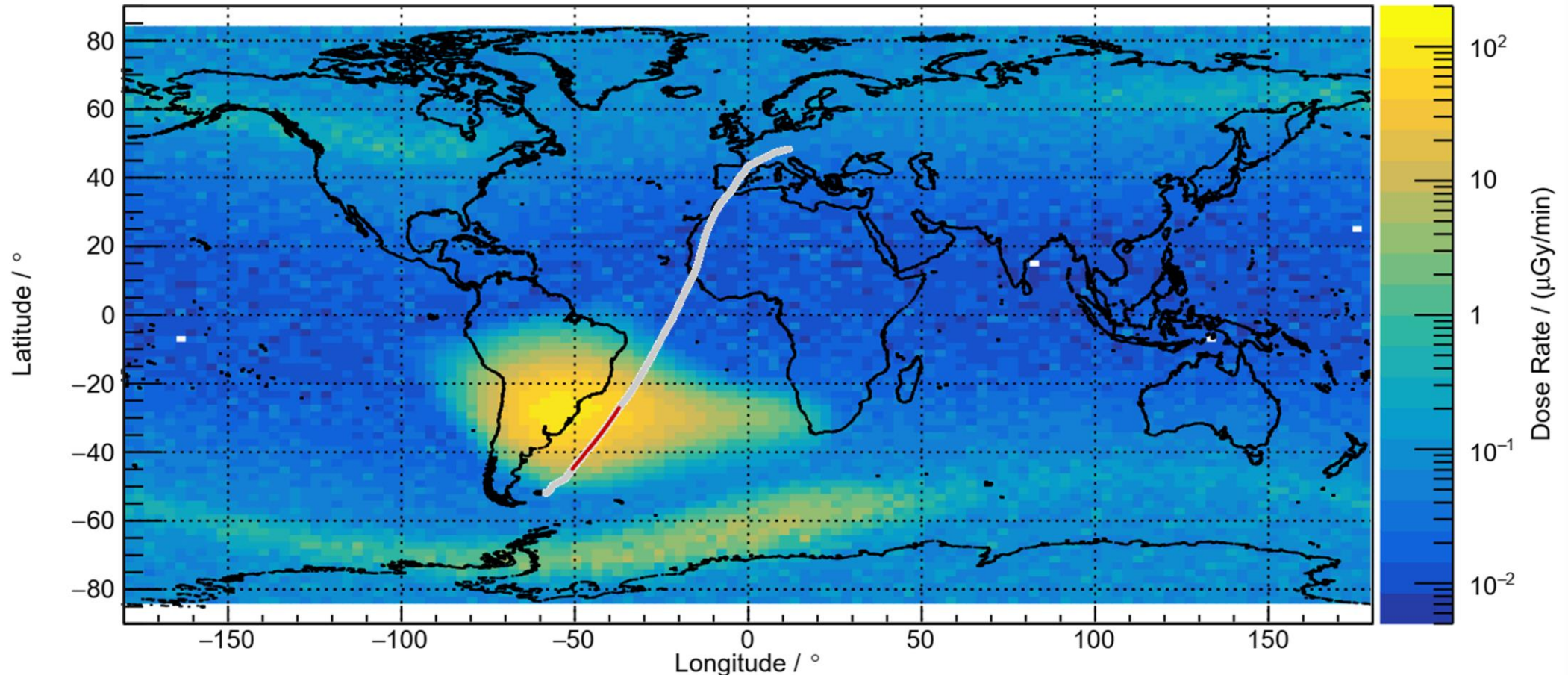
Atlantic Kiss – Flight Route to MPN (solar Minimum)



Flight @ FL430 through the geographic region of the SAA (red line).

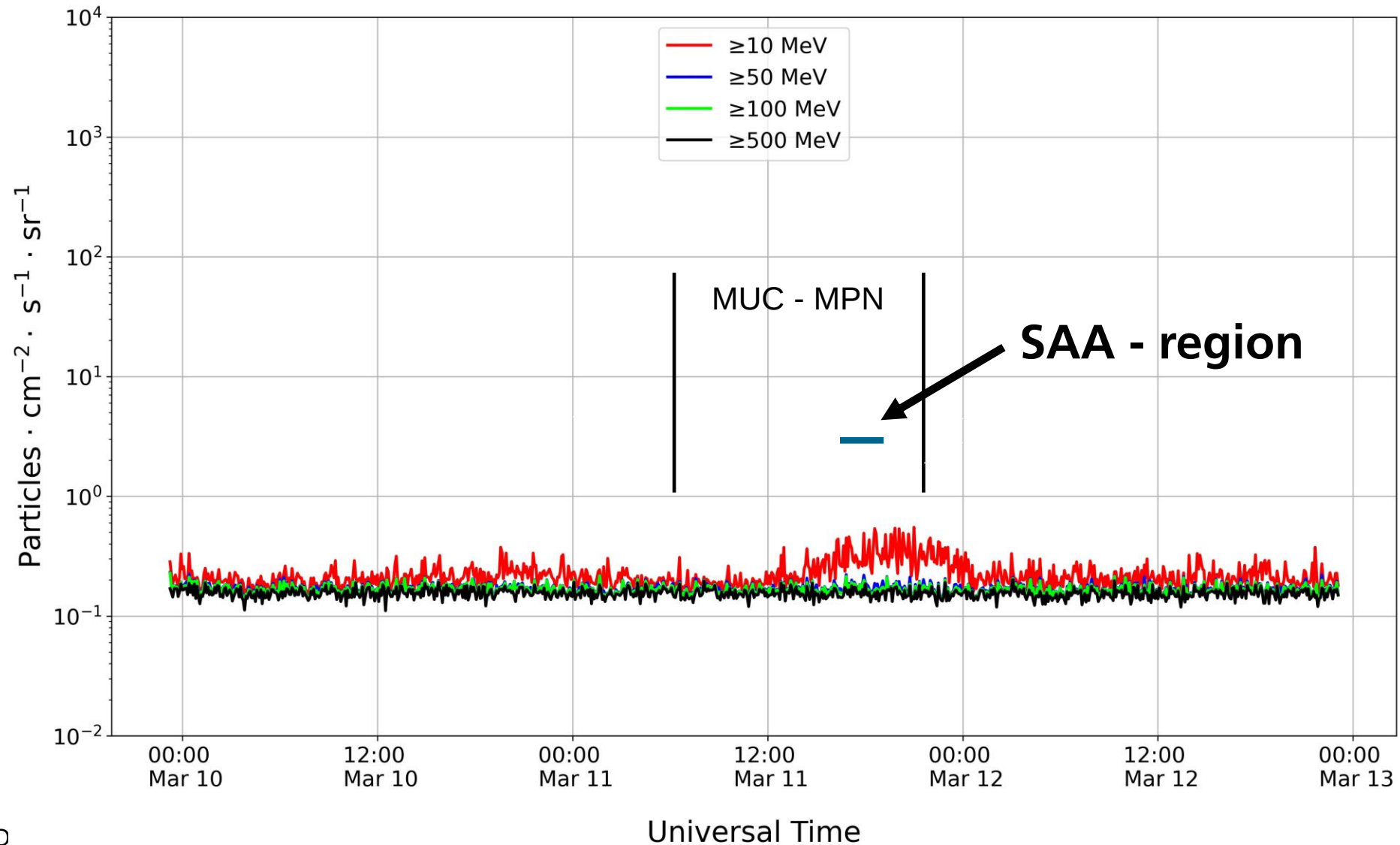
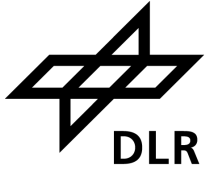
Atlantic Kiss follow-up – Flight Route to MPN (sol. Max.)

2025



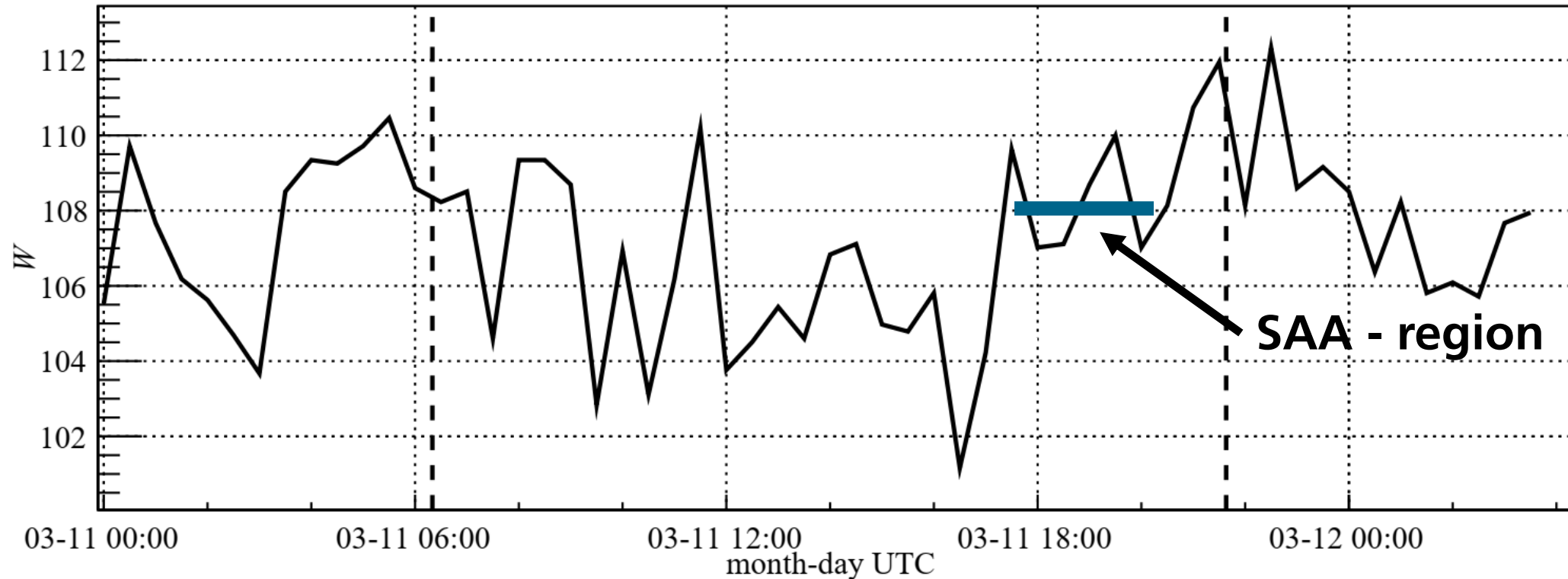
Flight @ FL430 through the geographic region of the SAA (red line).

Atlantic Kiss follow-up flight: Space Weather Conditions 1



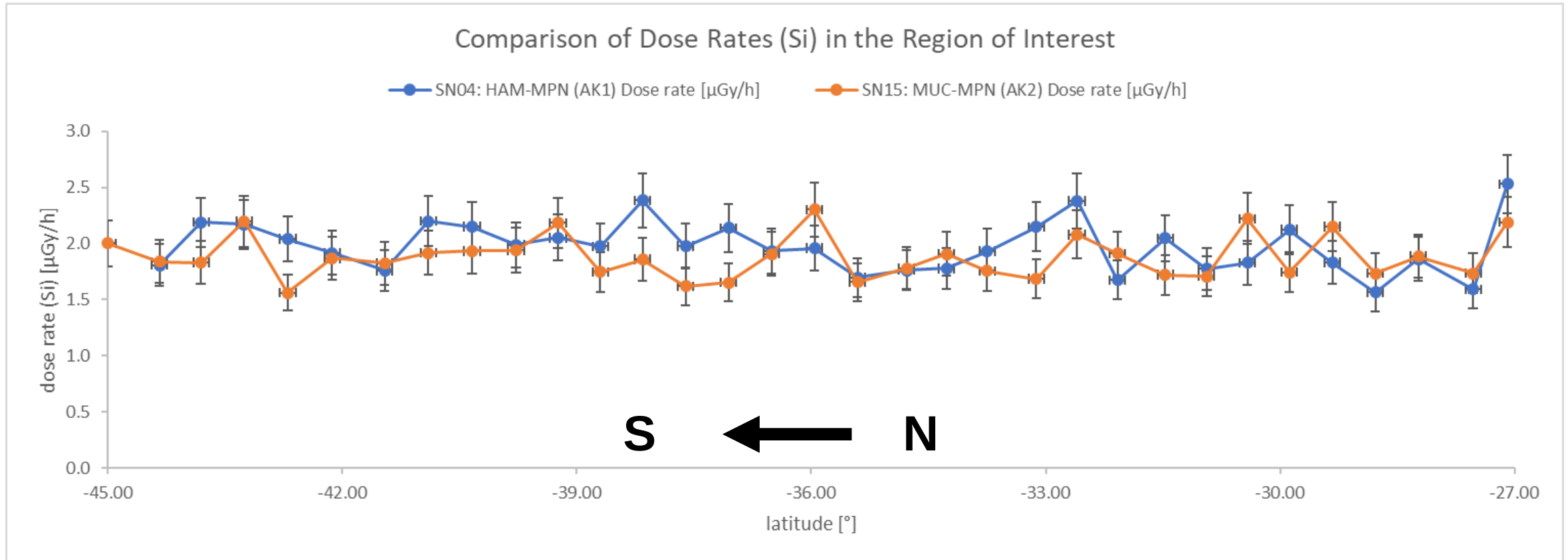
Source: NO

Atlantic Kiss follow-up flight: Space Weather Conditions 2



Magnetospheric conditions: $K_p < 3$ ($K_{p_{\max}} = 3-$, within the SAA - region $K_p = 1+$ & $2-$)

M-42: Absorbed Dose in Silicon

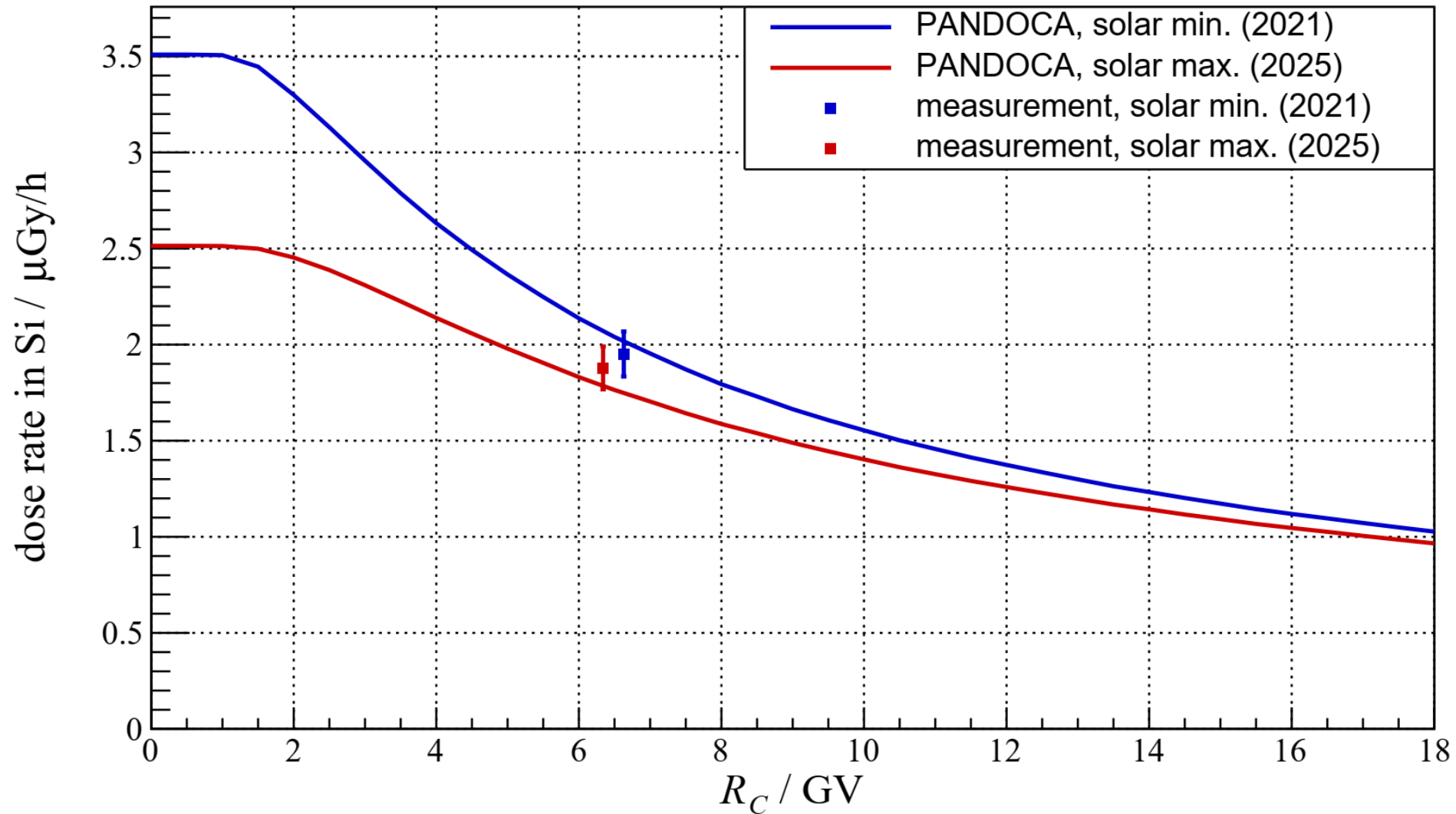


Mean values:

Atlantic Kiss: $1.97 \pm 0.12 \mu\text{Gy/h}$

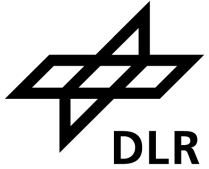
follow-up flight: $1.88 \pm 0.11 \mu\text{Gy/h}$

M-42: Absorbed Dose in Silicon

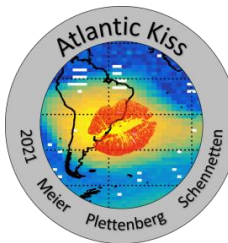


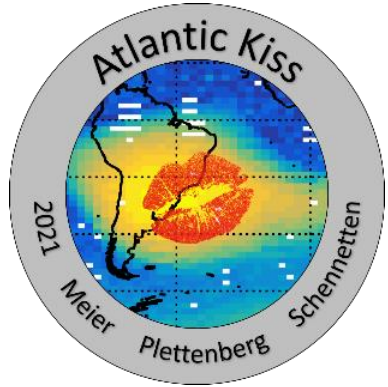
- ▶ Introduction
- ▶ Atlantic Kiss – Mission Impossible 2021
- ▶ Back to the Falkland Islands 2025
- ▶ **Summary**

Summary



- The South Atlantic Anomaly causes higher radiation exposure and increased damage to electronic devices in Low Earth Orbits.
- Rumors spread that even at flight altitudes radiation exposure were highly increased.
- The flight mission Atlantic Kiss was planned to comprehensively investigate the radiation exposure at flight altitudes and was performed under extraordinary circumstances during the SARS-CoV-2 pandemic.
- No indication of increased radiation exposure at FL430 was found.
- In a follow-up flight in March 2025 during the solar maximum of cycle 25, no indication of increased radiation exposure at FL430 could be observed either.





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Impact of the South Atlantic Anomaly on radiation exposure at flight altitudes during solar minimum

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