

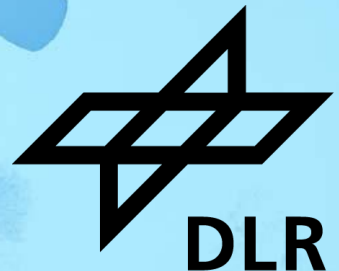
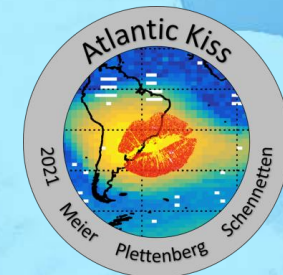
BETWEEN SEA LEVEL AND THE ISS: RADIATION MEASUREMENTS IN THE SAA REGION AT FLIGHT ALTITUDES

Matthias M. Meier^{1,↗}, Thomas Berger¹, Thomas Jahn², Daniel Matthiä¹, Mona C. Plettenberg^{1,↗},
Markus Scheibinger², Kai Schennetten^{1,↗}, Michael Wirtz¹

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

↗DLR Flight Crew

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



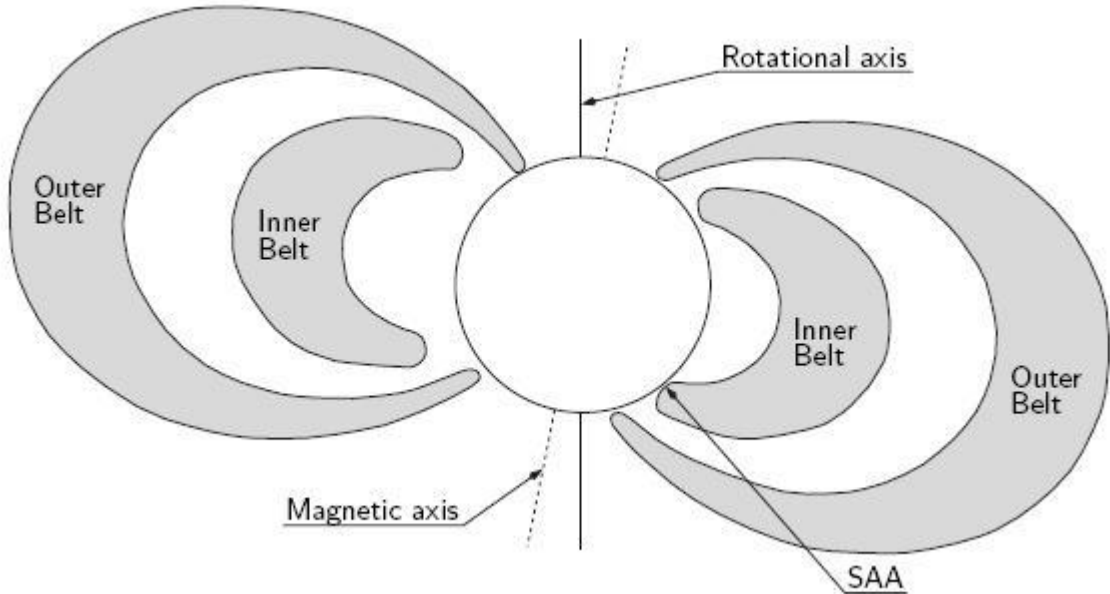
Overview



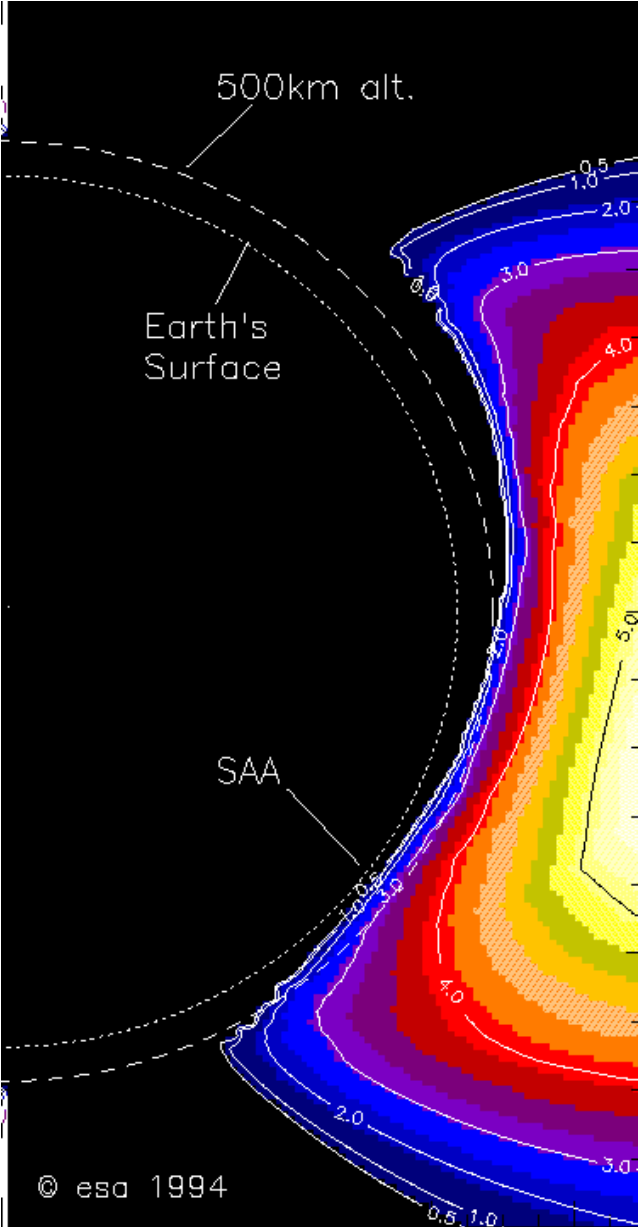
- ▶ Introduction
- ▶ Method
- ▶ Atlantic Kiss – Mission Impossible
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- ▶ **Introduction**
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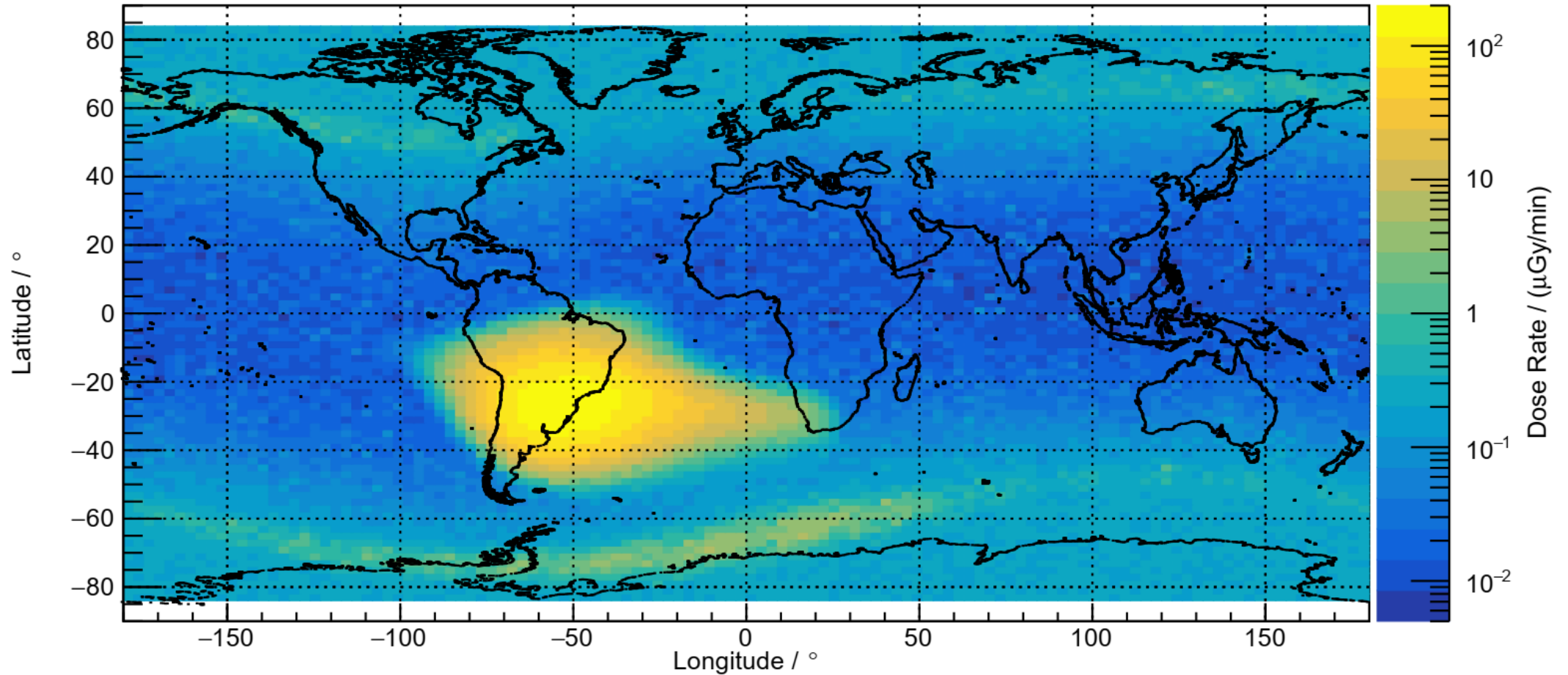
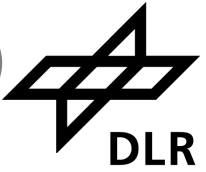
South Atlantic Anomaly



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?



Reports about the South Atlantic Anomaly (SAA)

A screenshot of a web browser displaying an article from the website 'wissenschaft.de'. The browser's address bar shows the URL 'https://www.wissenschaft.de/allgemein/bruechiger-schild/'. Below the address bar, there are navigation links for 'DLR Intranet', 'DLR Portal', and 'DLR Webpostkorb'. The website's header features the 'wissenschaft.de' logo and navigation links for 'bdw+', 'Themenbereiche', 'Bilder|Videos', 'Rubriken', and 'Lexikon'. The main text of the article discusses the South Atlantic Anomaly (SAA) as a critical zone in the Earth's magnetic field, where the magnetic field is significantly weaker. It mentions that the Concorde had to fly at a lower altitude (15 km) over this region. It also states that a passenger on a long-haul flight from Frankfurt to Buenos Aires receives approximately 1000 times more radiation than on a flight to Tokyo. The text ends with an ellipsis.

https://www.wissenschaft.de/allgemein/bruechiger-schild/

DLR Intranet | DLR Portal | DLR Webpostkorb

wissenschaft.de bdw+ Themenbereiche Bilder|Videos Rubriken Lexikon

Kritische Zonen sind die Schwachstellen im irdischen Magnetschild: die Pole und der Südatlantik. Dort muss die Concorde inzwischen ihre übliche Flughöhe von 15 Kilometern verlassen. Im Unterschallverkehr gibt es dagegen noch keine Auflagen, obwohl ein Passagier auf einem Langstreckenflug von Frankfurt nach Buenos Aires etwa 1000-mal so viel Strahlung abbekommt wie auf einem Flug nach Tokio. Wenn das Magnetfeld weiter an Kraft verliert, wird irgendwann jeder Kompass ...

(Source: Klaus Jacob, Brüchiger Schild, Bild der Wissenschaft, 10/2002)

Reports about the South Atlantic Anomaly (SAA)



HELMHOLTZ CENTRE POTSDAM
**GFZ GERMAN RESEARCH CENTRE
FOR GEOSCIENCES**

Geomagnetic South Atlantic Anomaly probably no evidence of reversing Earth's magnetic field

04/25/2018 Created by ak

SHARE 

...

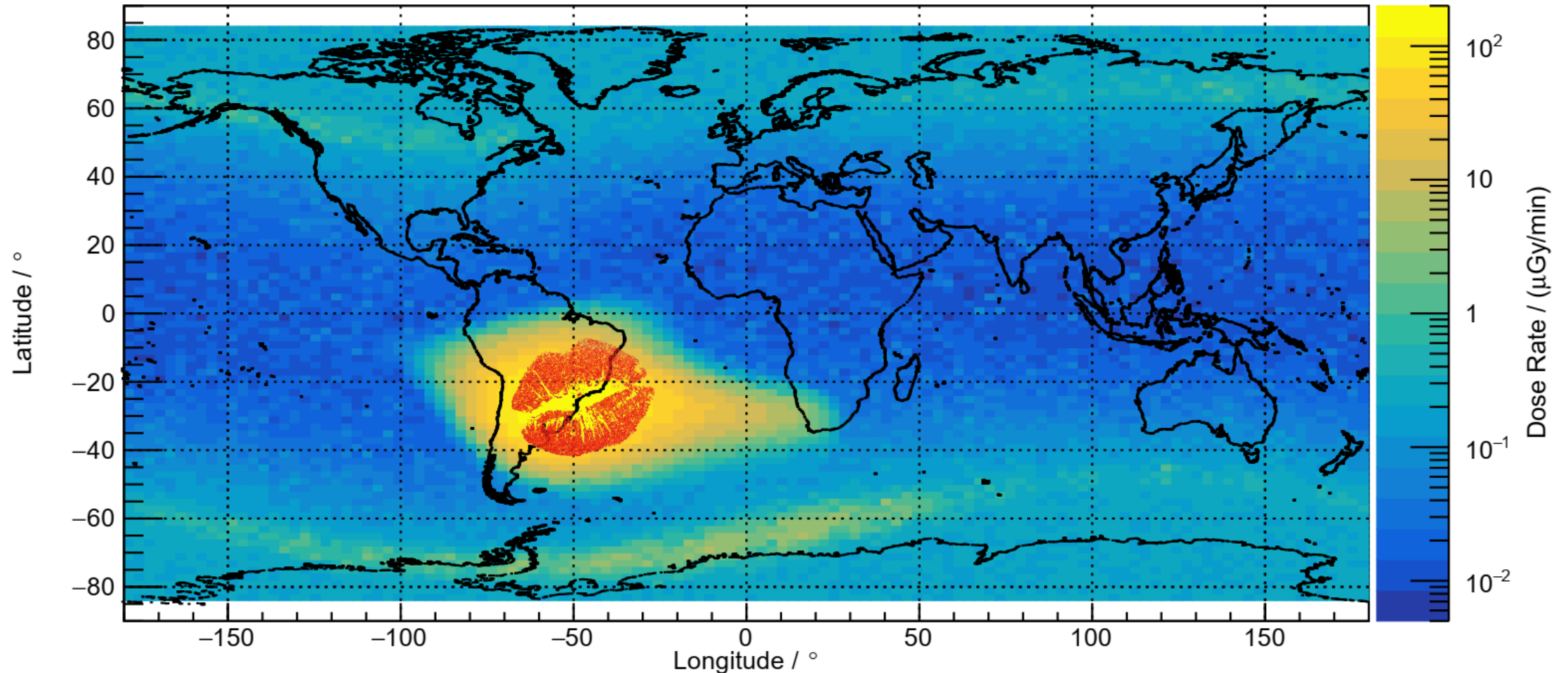
The area of the South Atlantic Anomaly is characterized by a significant reduction in the strength of Earth's magnetic field compared with areas at similar geographic latitudes. Here, protection from harmful radiation from space is reduced. This leads, for example, to a higher rate of satellite communication blackouts or higher doses of radiation for passengers of long-distance flights.

...

(Source: Monika Korte, GFZ German Research Centre for Geosciences, 4/2018)

South Atlantic Anomaly (SAA)

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



Overview



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- 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.

 **AGU** PUBLICATIONS

Space Weather

RESEARCH ARTICLE

10.1002/2013SW001022

Key Points:

- Numerical model calculating radiation exposure in aviation
- Model validation with experimental data

Numerical calculation of the radiation exposure from galactic cosmic rays at aviation altitudes with the PANDOCA core model

Daniel Matthiä¹, Matthias M. Meier¹, and Günther Reitz¹

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



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

$$\dot{H}_N$$



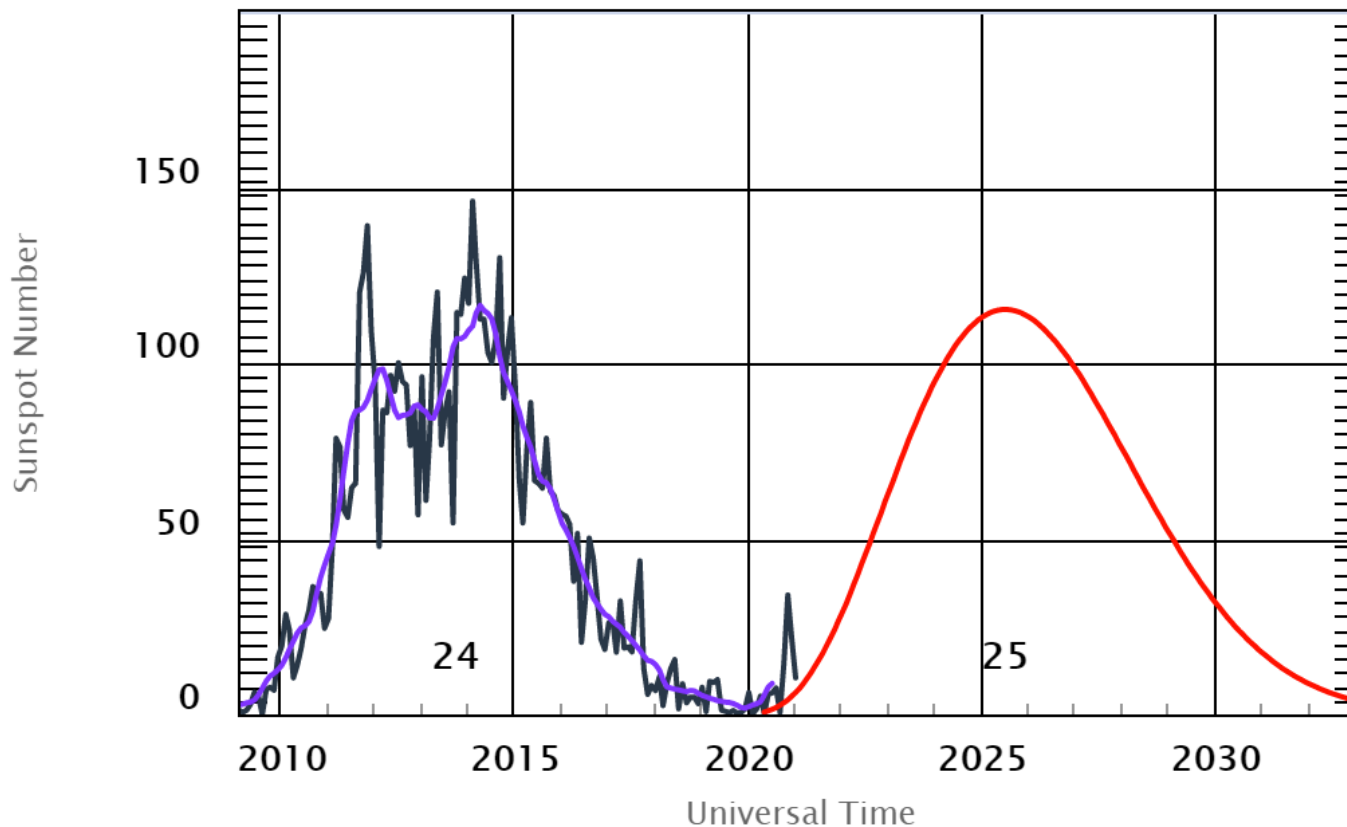
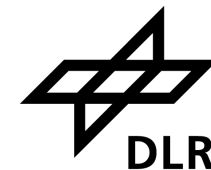
REM-Counter: sensitive to neutrons

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



Liulin: sensitive to charged particles

ISES Solar Cycle Sunspot Number Progression

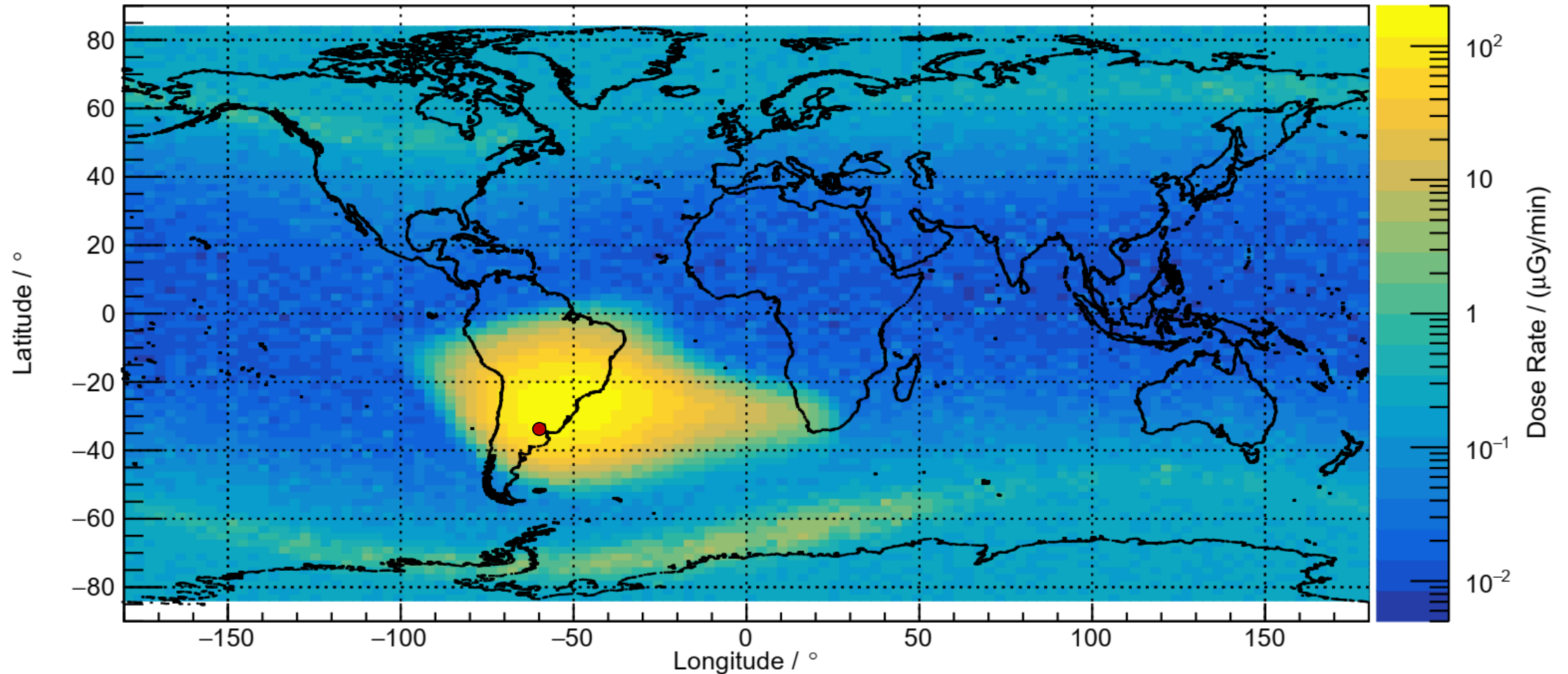


◆ Monthly Values — Smoothed Monthly Values — Predicted Values

Space Weather Prediction Center

Source: NOAA

South Atlantic Anomaly: Measuring Flight to Buenos Aires



Measuring Flight to Buenos Aires: Scheduled 2. June 2020



Overview

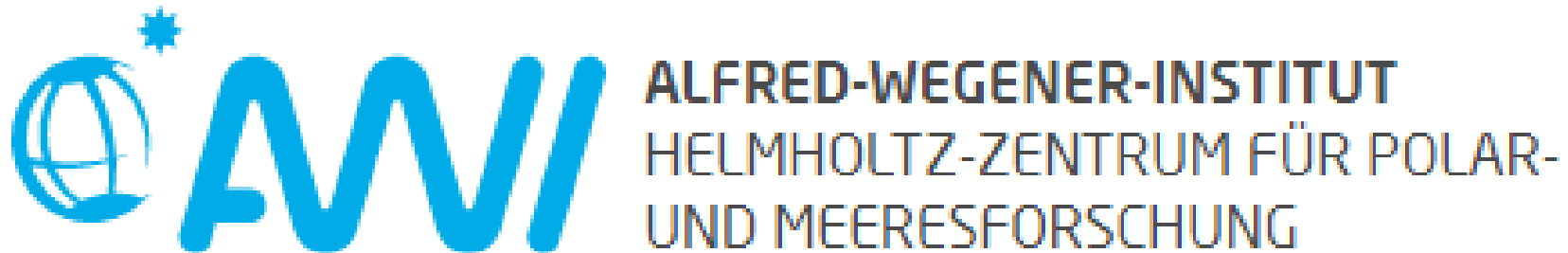


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Atlantic Kiss – Mission Impossible



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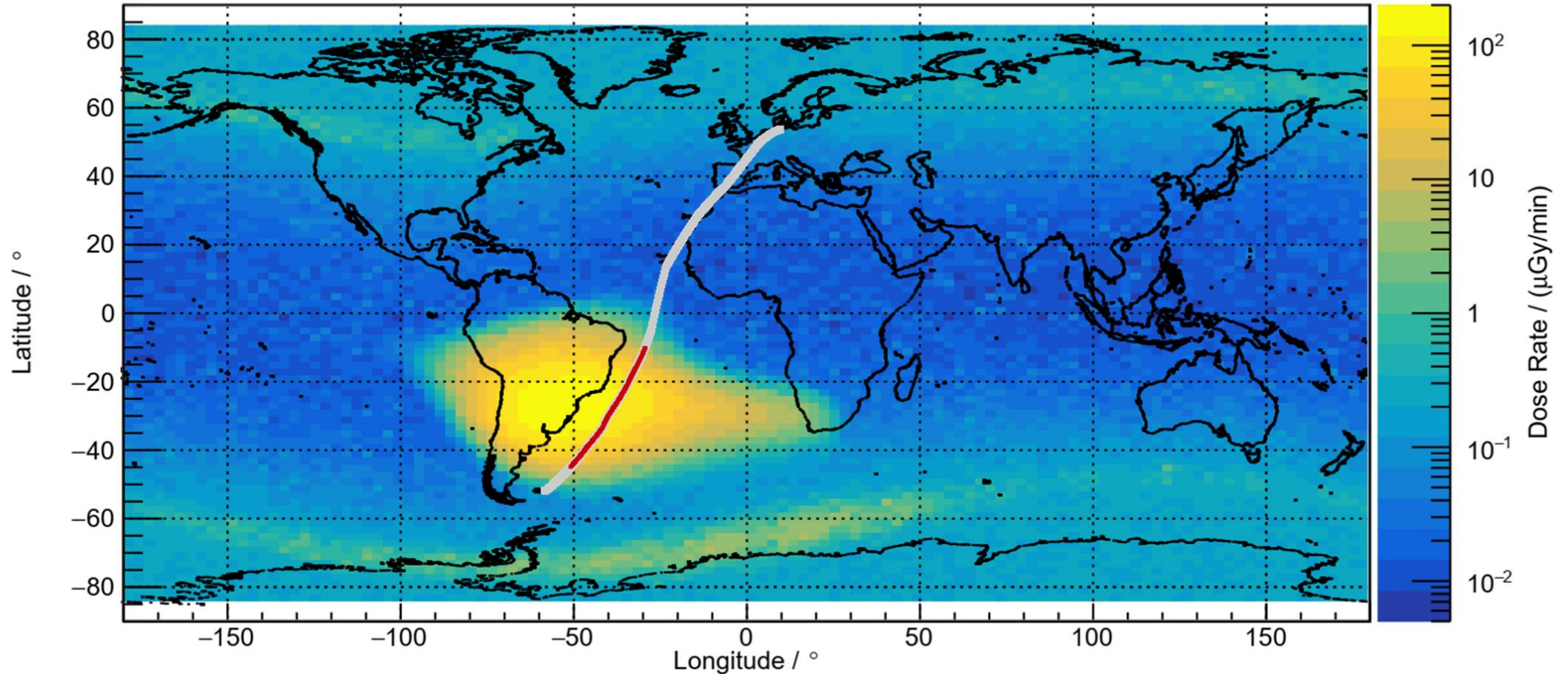
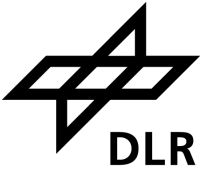
[🏠 Newsroom](#) > [Releases](#) > [Record Flight: Lufthansa Takes Off With Antarctica Researcher...](#)

29.01.2021

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

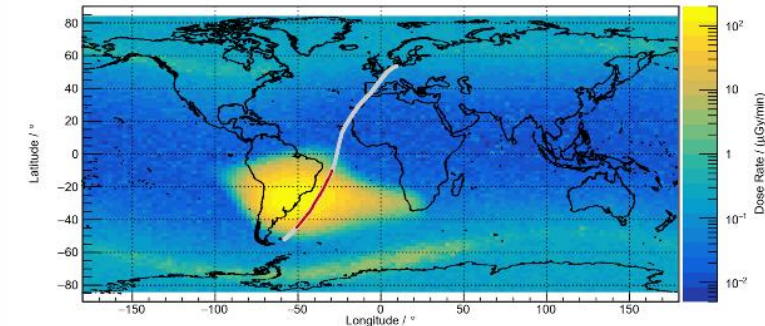
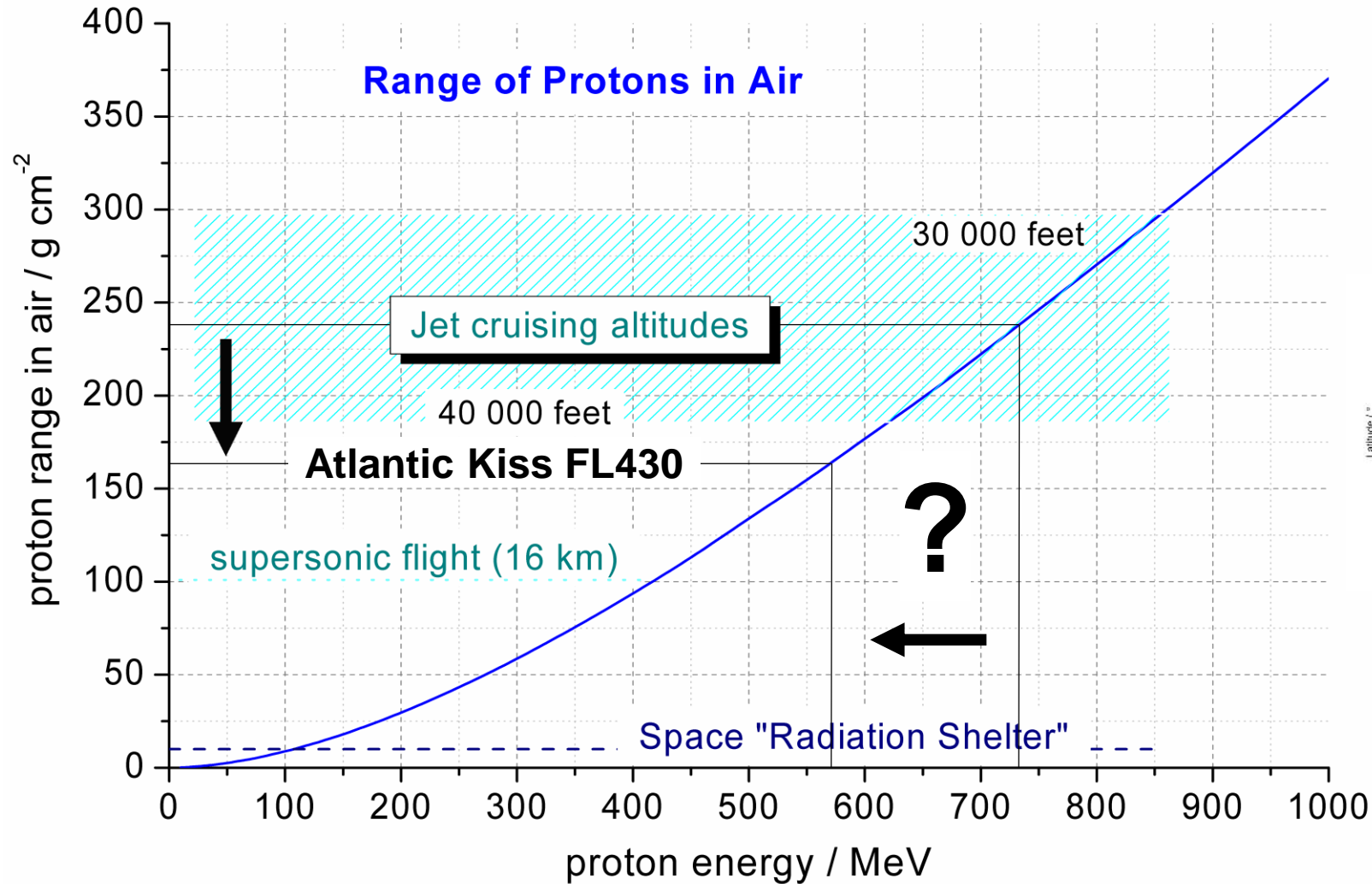
Longest non-stop Lufthansa flight on Sunday on behalf of the Alfred Wegener Institute

Atlantic Kiss – Flight Route to MPN



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

Atmospheric Shielding: Range of Protons



Atlantic Kiss – Mission Impossible



- 27.1.2021 Begin of the mission planning with Lufthansa and AWI.
- 22.2.2021 Special travel permit by the DLR pandemic crisis management team.
- 7.3.2021 Begin of the self isolation of the DLR-Crew (Meier, Plettenberg, Schennetten).
- 14.3.2021 Integration of the LH- and DLR-Crew in the mission process of the AWI and begin of the quarantine in Bremerhaven.
- 30.3.2021 Flight from Hamburg (HAM, Germany) to Mount Pleasant (MPN, East Falkland).

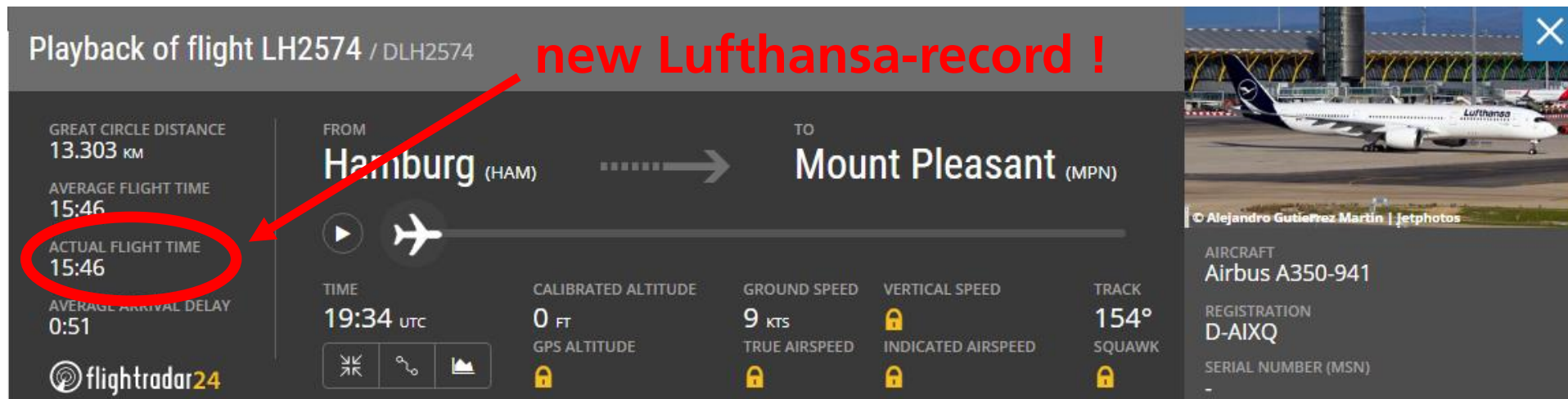
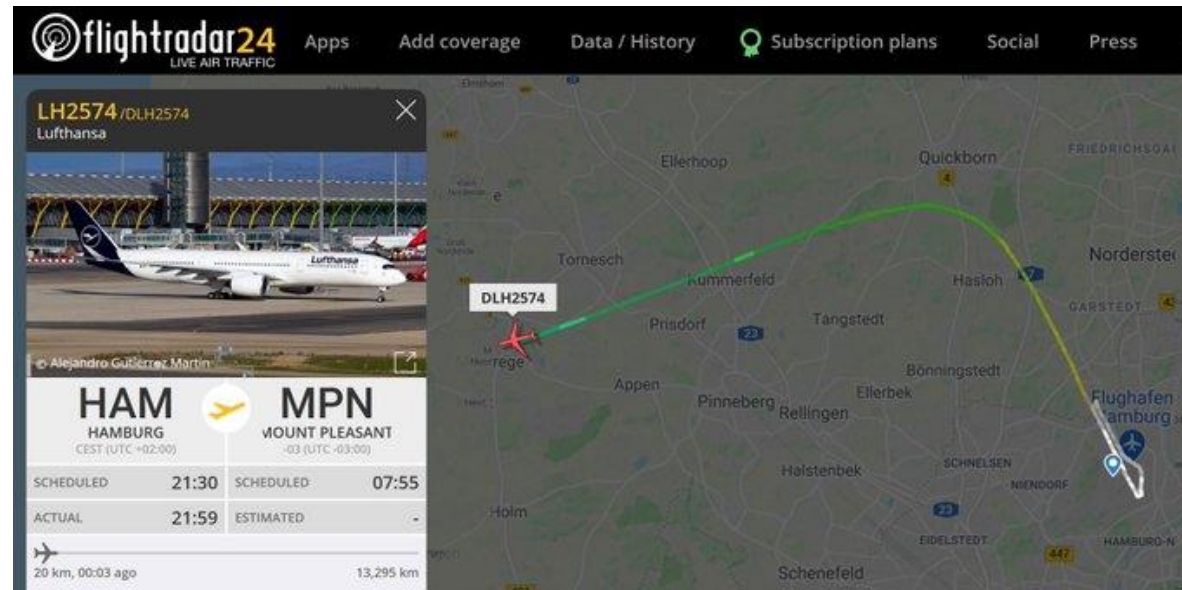
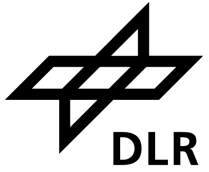
Atlantic Kiss: 16 Days in Quarantine for 16 Hours Freedom



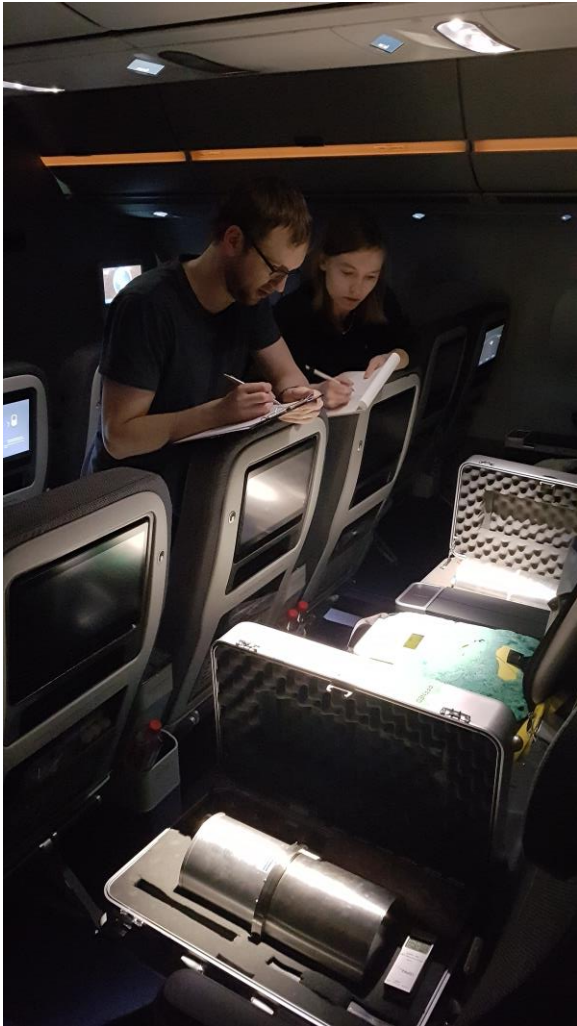
Atlantic Kiss: Here We Go...



Atlantic Kiss: HAM - MPN



Atlantic Kiss: HAM - MPN



flightradar24 LIVE AIR TRAFFIC

LH2574/DLH2574
Lufthansa

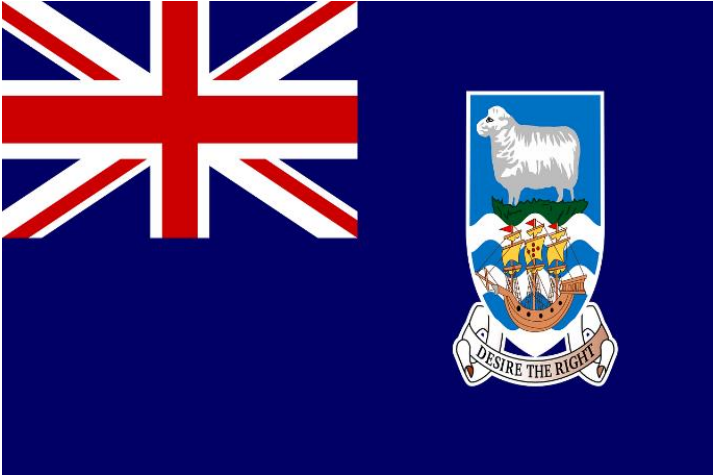
HAM HAMBURG
CEST (UTC +02:00)

MPN MOUNT PLEASANT
-03 (UTC -03:00)

SCHEDULED	21:30	SCHEDULED	07:55
ACTUAL	21:59	ESTIMATED	08:46

13,123 km, 15:23 ago 181 km, in 00:23

Quarantine 2.0: Stanley, Falkland

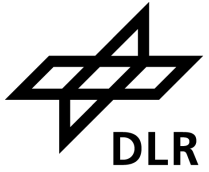


Overview

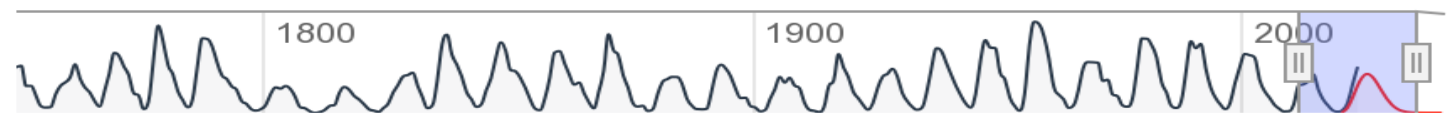
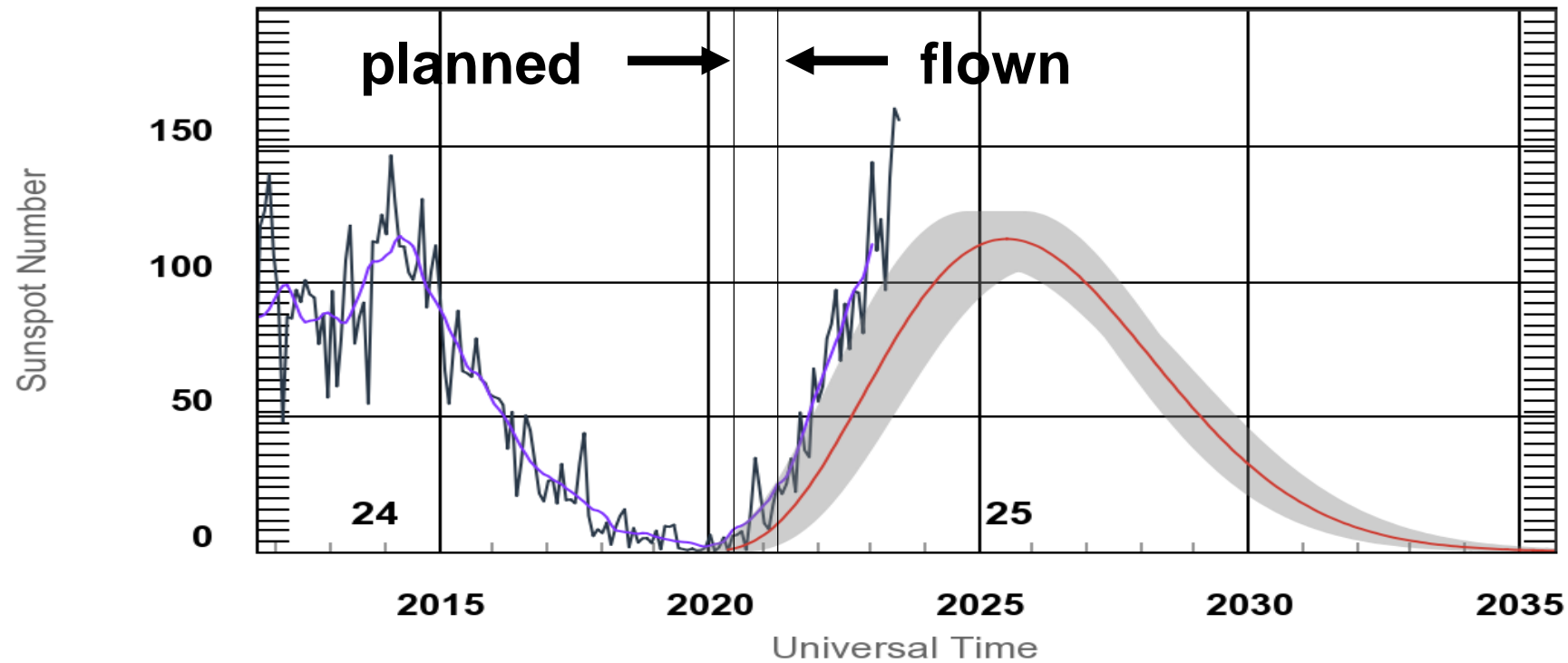


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ISES Solar Cycle Sunspot Number Progression



Zoom:

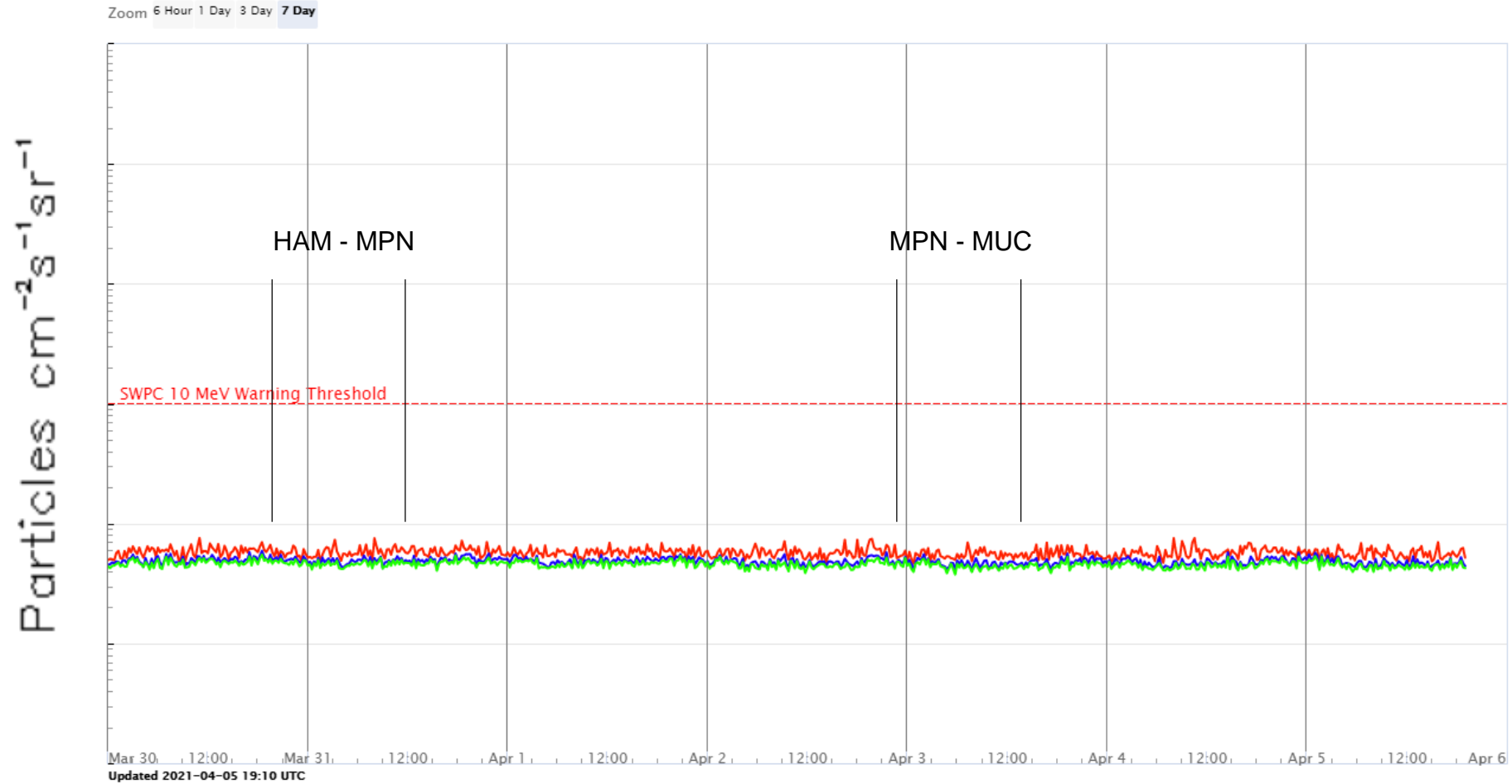
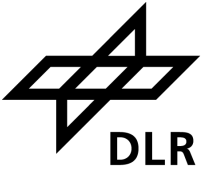


- ◆ Monthly Values
- Smoothed Monthly Values
- Predicted Values
- Predicted Range

Space Weather Prediction Center

Source: NOAA

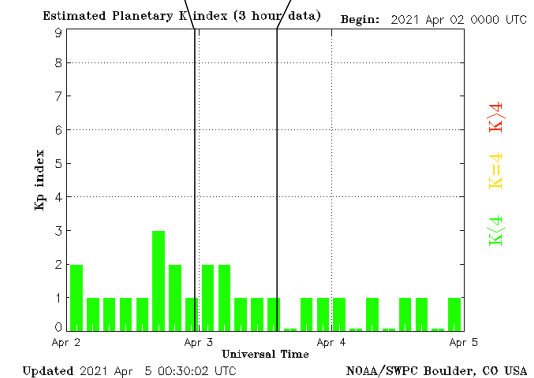
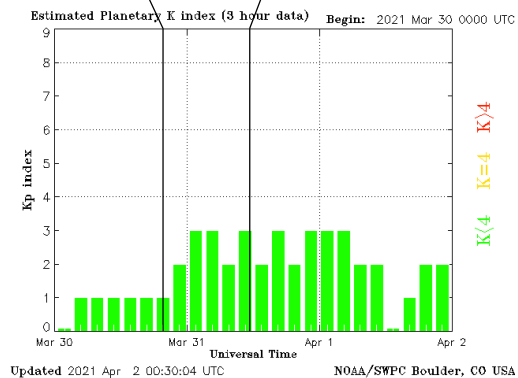
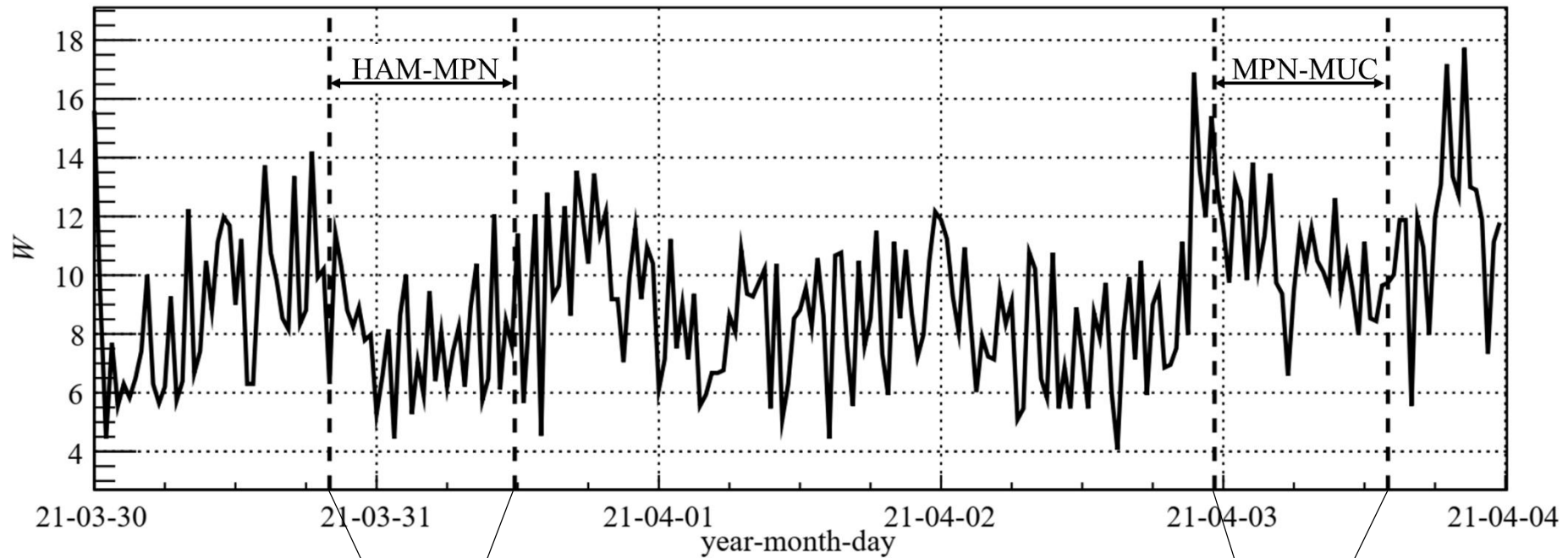
Atlantic Kiss: Space Weather Conditions 1



Source: NOAA

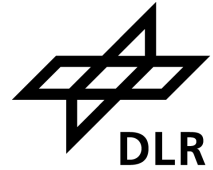
(integrated proton flux >10 MeV, >50 MeV & >100 MeV)

Atlantic Kiss: Space Weather Conditions 2

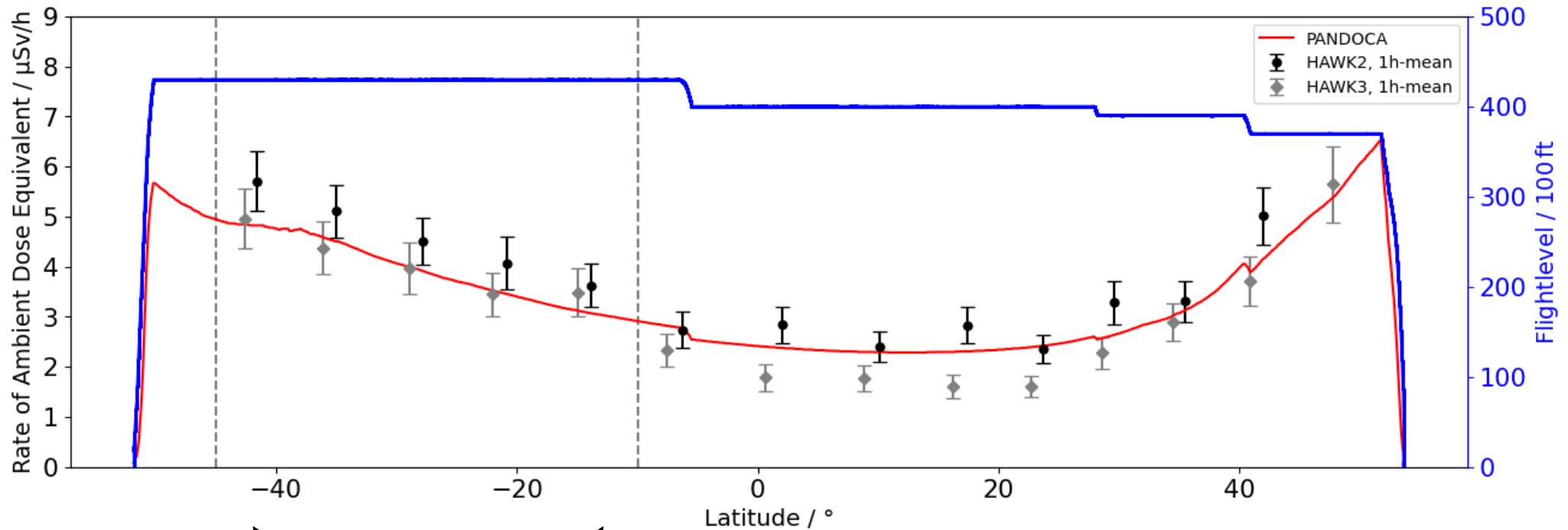


Source: NOAA

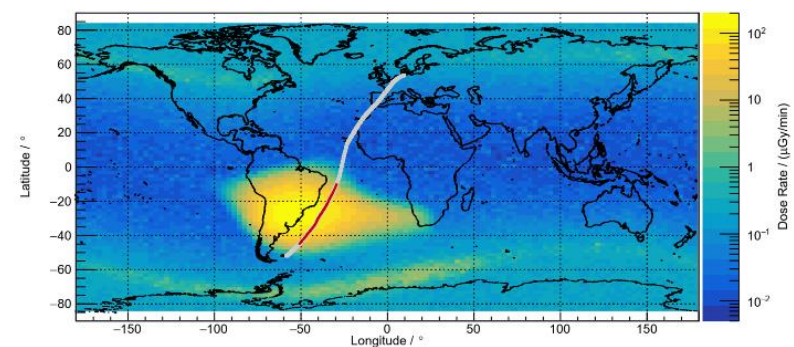
HAWK: Ambient Dose Equivalent



S ← N



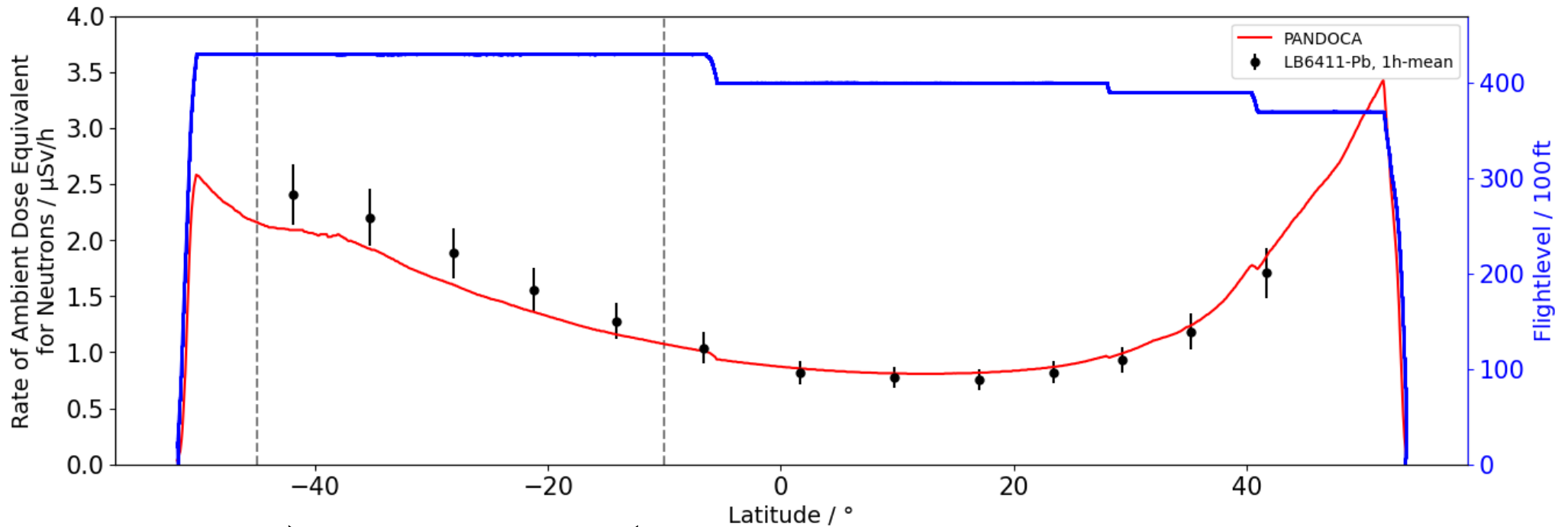
SAA - region



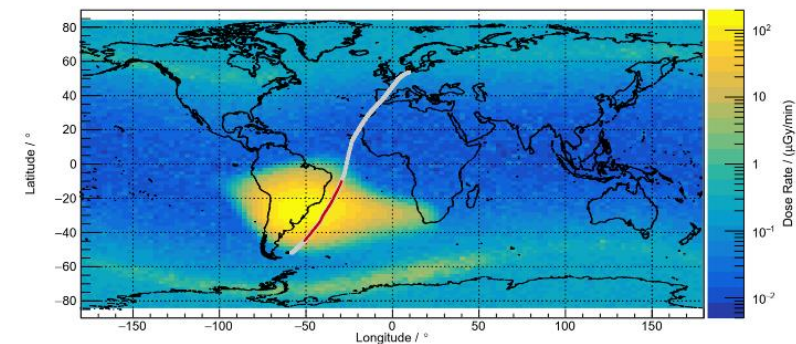
REM-Counter: Neutron Component



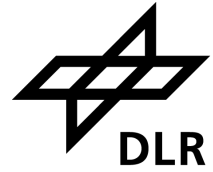
S ← N



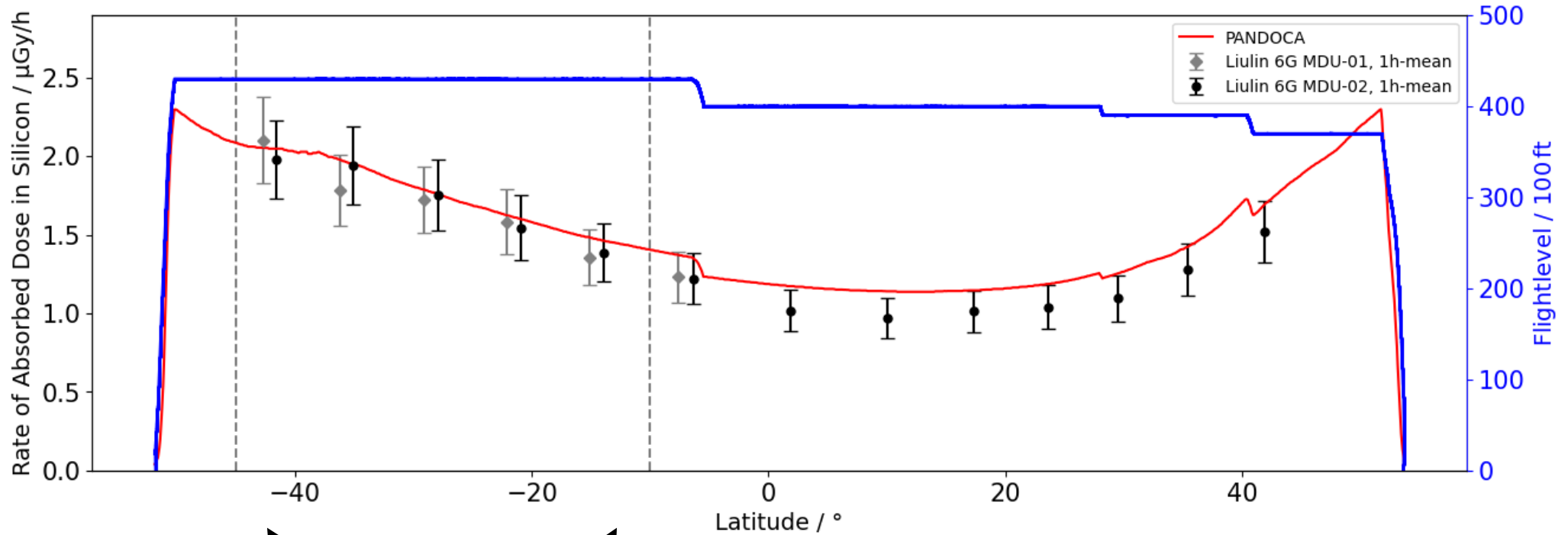
SAA - region



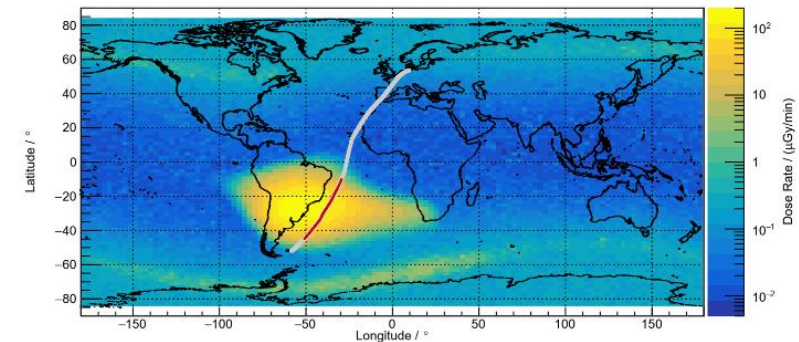
Liulin: Absorbed Dose in Silicon



S ← N



SAA - region

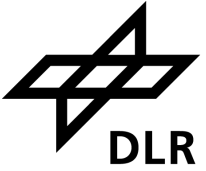


Overview

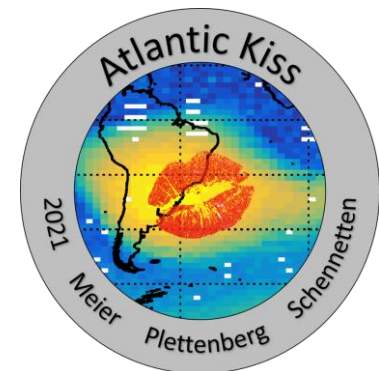


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Summary



- 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.



Acknowledgement

We gratefully acknowledge the support of our mission Atlantic Kiss by Dr. Eberhard Kohlberg (AWI) and the marvelous Crew of LH2574/LH2575.

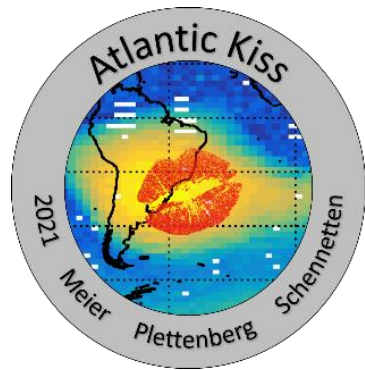


Capt. Thomas Jahn & Dr. Eberhard Kohlberg

Further Information on
<https://www.dlr.de/me//desktopdefault.aspx/tabid-18297/>



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

Matthias M. Meier ¹✉, Thomas Berger ¹, Thomas Jahn², Daniel Matthiä ¹,
Mona C. Plettenberg ¹, Markus Scheibinger², Kai Schennetten ¹ & Michael Wirtz ¹



A photograph showing the wing and tail of a white airplane flying over a dark ocean under a clear blue sky. The wing is the central focus, extending from the right side towards the left. The tail fin is visible at the end of the wing on the left. The ocean below is dark and textured, and the sky is a deep, clear blue.

Behind the Paper

Does the SAA Affect Radiation Exposure at Flight Altitudes?

Behind the scenes of an unusual flight to the Falkland Islands to measure the exposure to cosmic radiation across the South Atlantic Ocean.

Published Jun 20, 2023

 **Mona Plettenberg**
PhD Student, German Aerospace Center (DLR)

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<https://healthcommunity.nature.com/posts/does-the-saa-affect-radiation-exposure-at-flight-altitudes>