THE RELEVANCE OF THE SPACE WEATHER EVENTS OF MAY 2024 FOR RADIATION PROTECTION IN AVIATION

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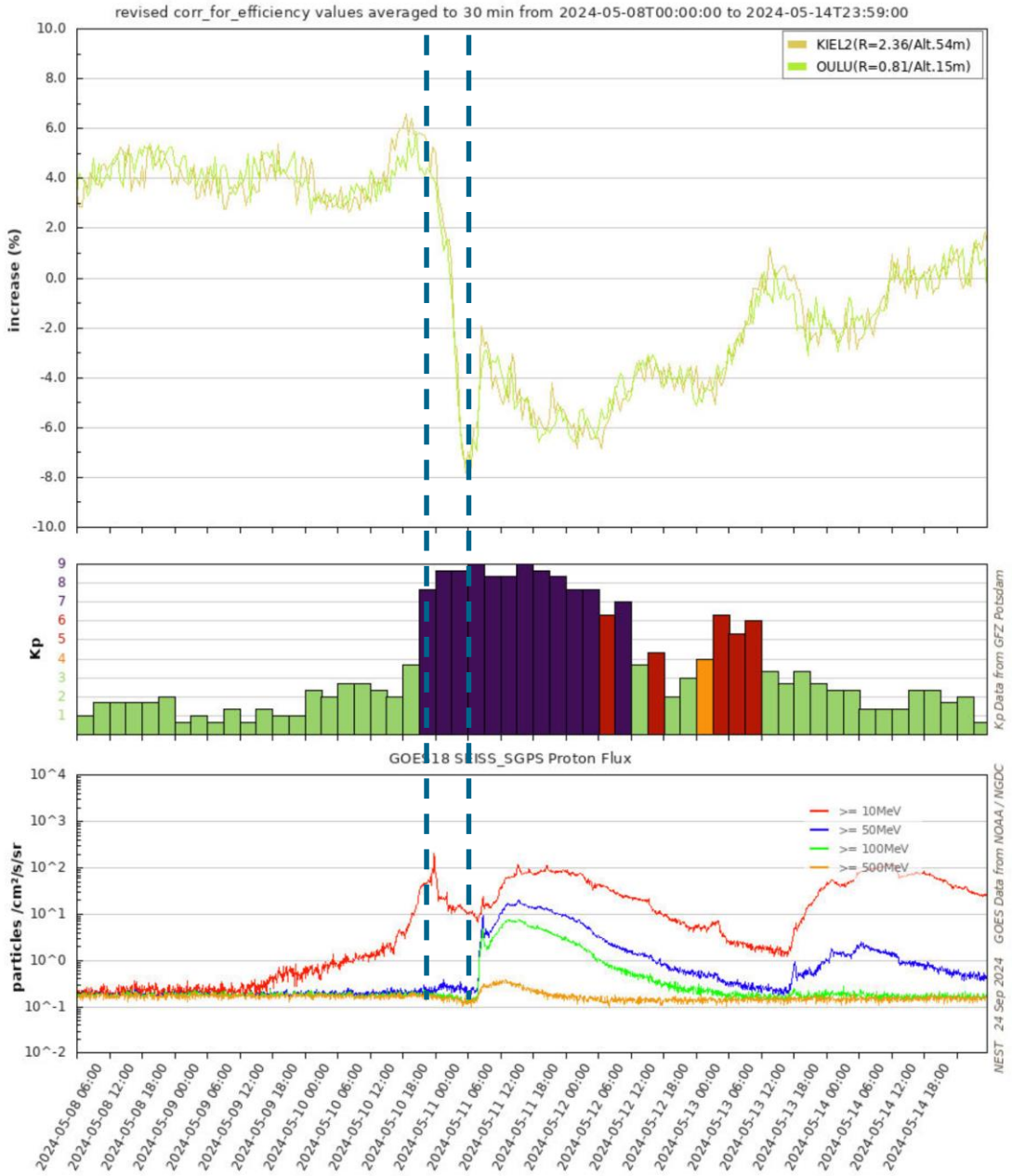
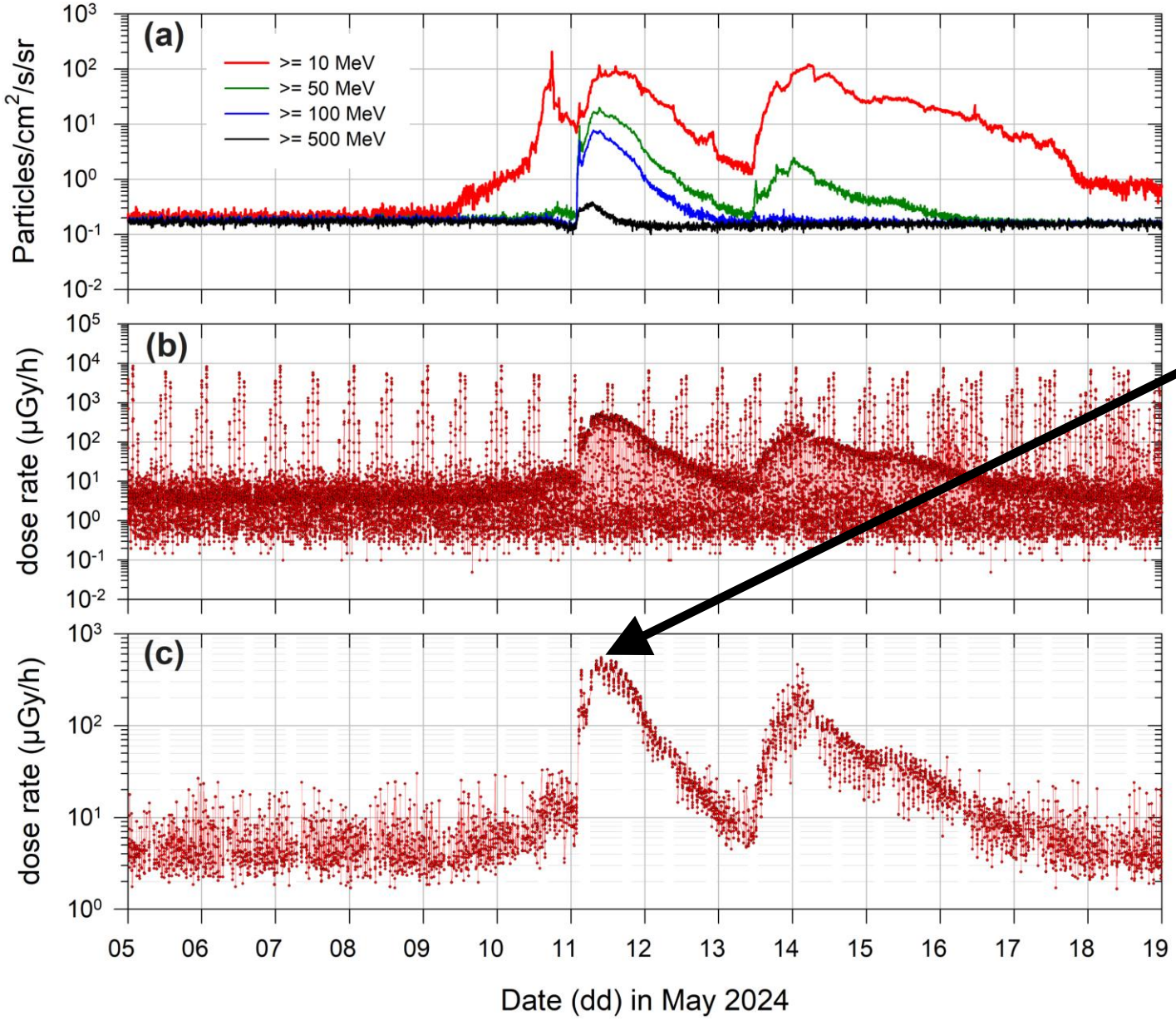
Space Weather Events of May 2024



- X-ray flares (M & X) and CMEs of 8 May
- Increase in proton flux
- Geomagnetic storm of 10 May
- Decrease in neutron monitor count rates (Forbush decrease)
- Ground Level Enhancement (GLE)
  - Sources: NMDB.eu (KIEL, OULU NMs), Kp GFZ, GOES SWPC/NOAA

Radiation Exposure in LEO: RAMIS Measurements



- RAMIS radiation detector
- Eu:CROPIS ~600km

~548 µGy/h in silicon

→ ~870 µSv/h

More about the RAMIS radiation detector: next talk by Maximilian Radenhäuser

Radiation Exposure in Aviation

- Increase compared to ground level due to cosmic radiation
  - Galactic cosmic rays and solar high energetic particles
- Legal regulation for aircrew in many countries (occupationally exposed)
- Transatlantic flight 50 - 100 µSv (mean natural exposure Germany: 2 mSv/a)
- Solar Particles: additional dose rates of up to several mSv/h cannot be excluded

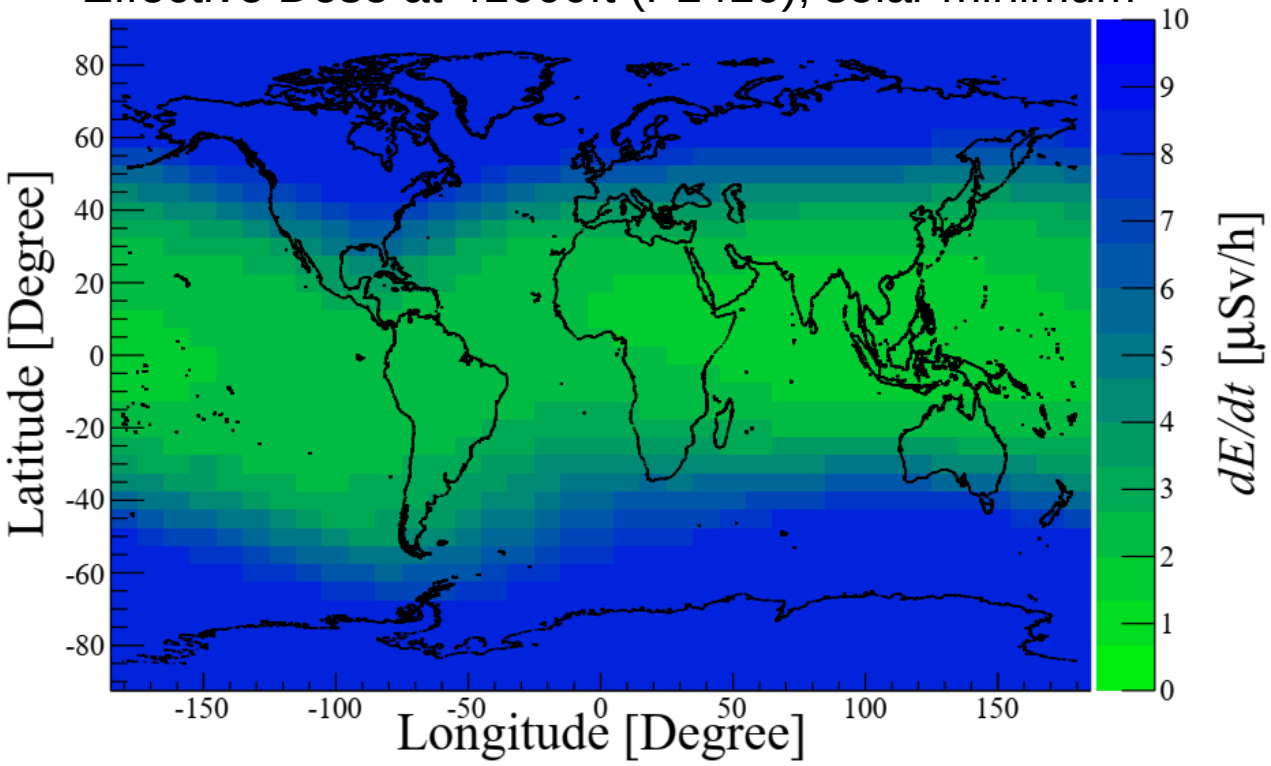
Radiation Exposure in Aviation: PANDOCA - Model

- Transport calculations through the atmosphere: particle fluxes → dose
- Protective mechanisms: altitude, geomagnetic shielding, solar cycle
- Accredited in Germany by the Federal Office of Civil Aviation

- May 2024 events:
  - FRA – LAX (Great circle)
  - 3 altitudes (FL380/400/430)

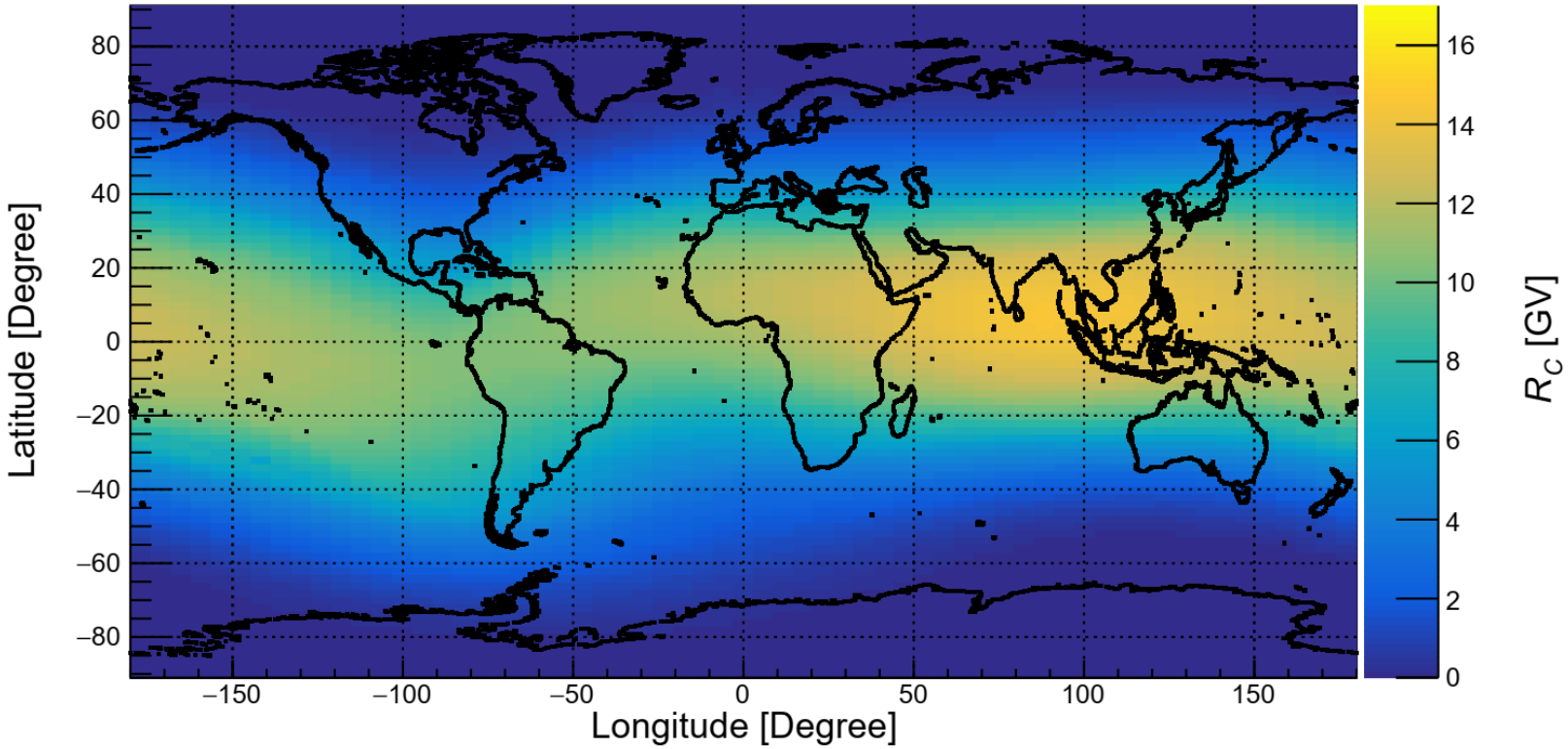
1. Magnetic shielding
2. Forbush decrease
3. GLE

Effective Dose at 41000ft (FL410), solar minimum



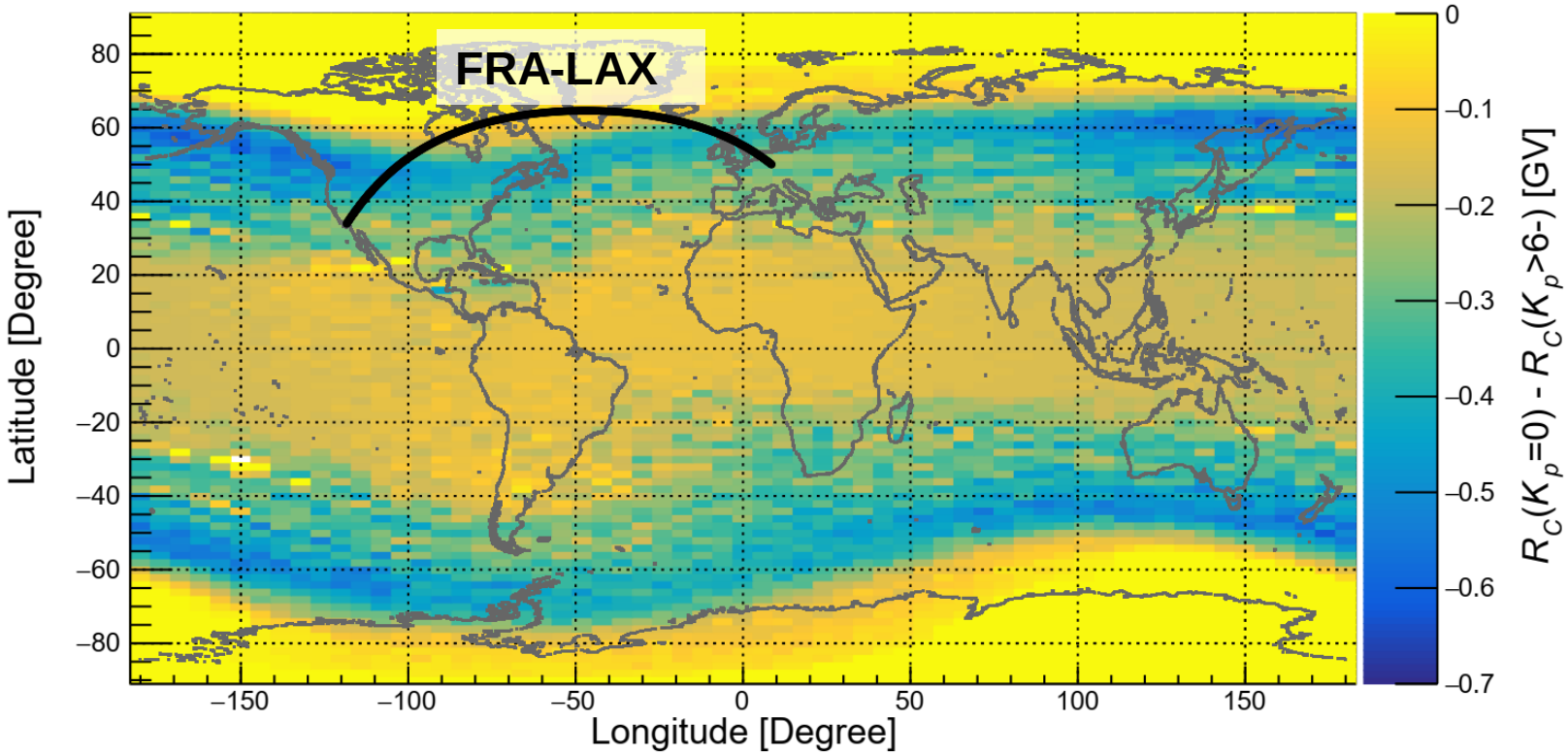
Results: Reduction in Geomagnetic Shielding

- Geomagnetic cut-off rigidity $R_c \approx 0 – 16$ GV



Results: Reduction in Geomagnetic Shielding

- Geomagnetic cut-off rigidity $R_c \approx 0 – 16$ GV
- $\Delta R_c < 0.7$ GV

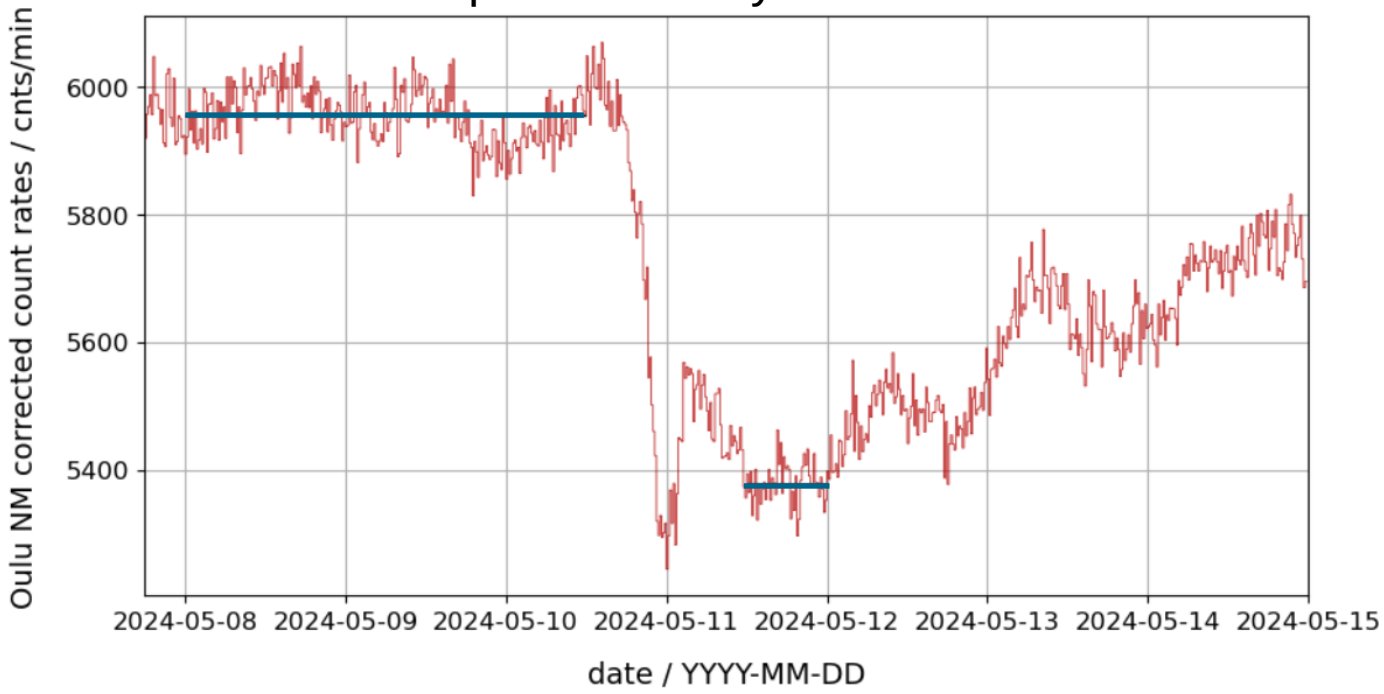


- FRA-LAX:

Dose + 0.5% - 0.6%

Results: Reduction in GCRs – Forbush Decrease

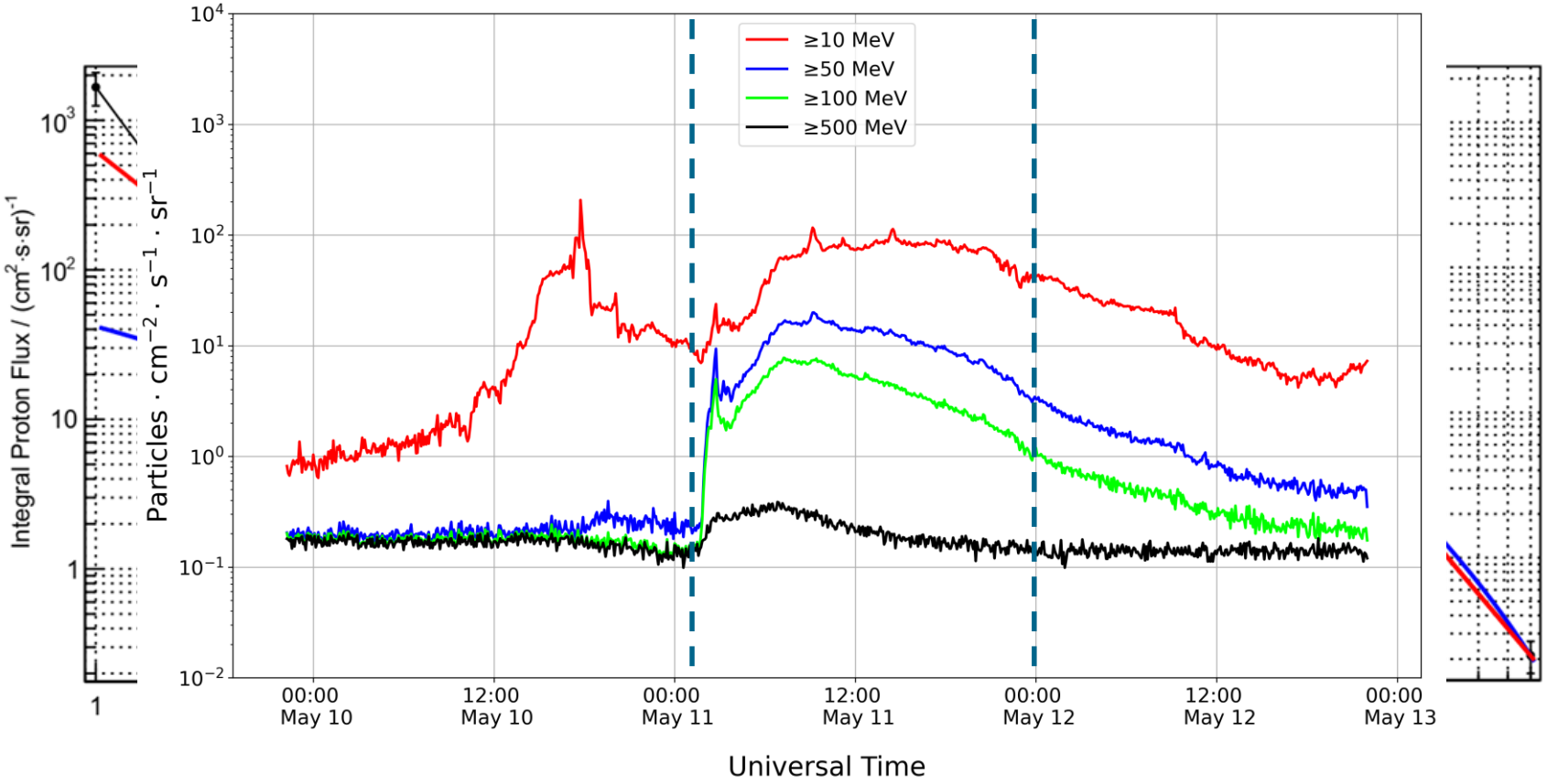
https://cosmicrays.oulu.fi/



- Intensity before and after the events from Oulu NM count rates
- Reduction in flight dose on the order of 23%

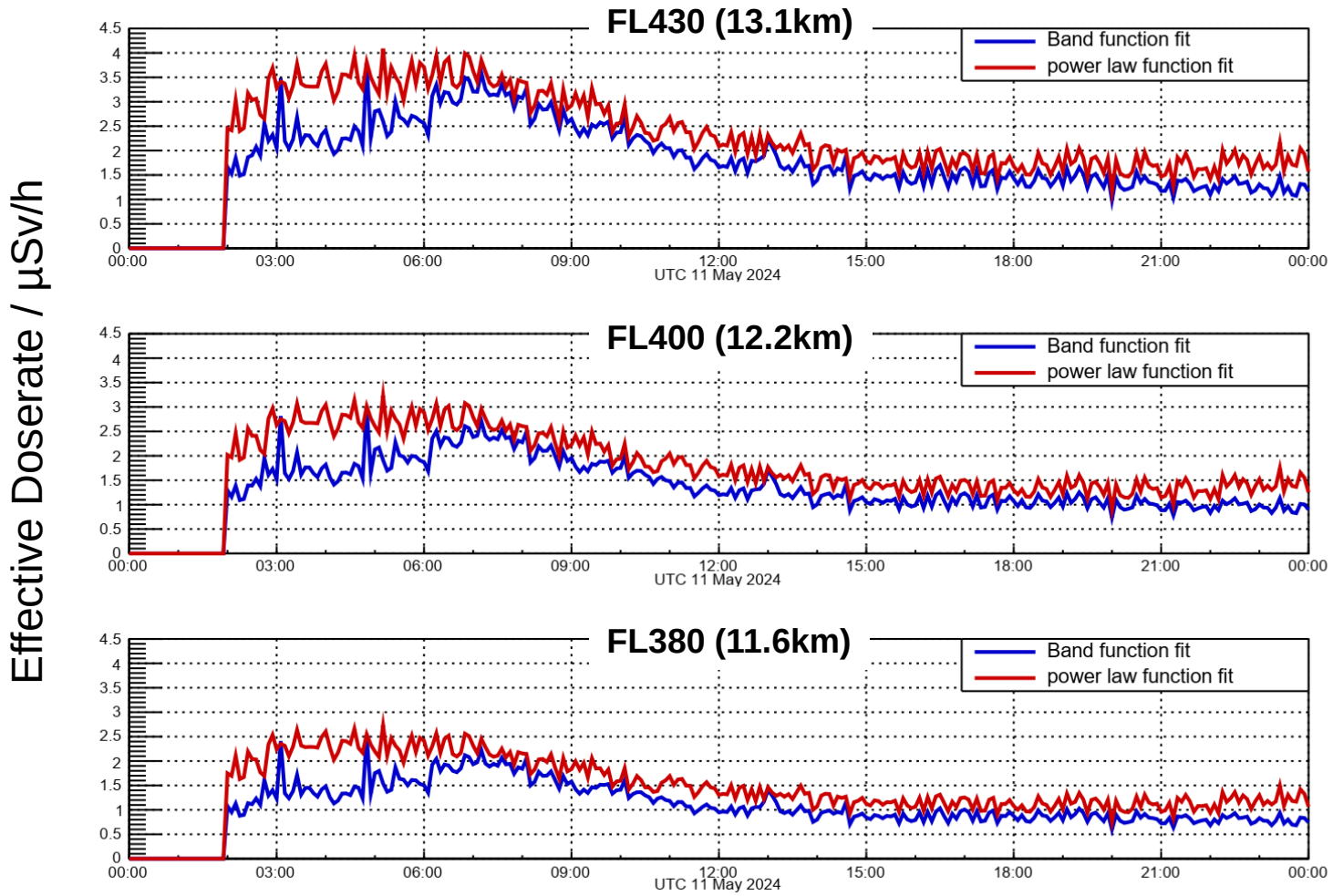
	FL430	FL400	FL380
Pre-Event	66.4 µSv	58.5 µSv	53.0 µSv
Forbush Event	50.7 µSv	45.0 µSv	41.1 µSv
Relative difference	-23.6%	-23.1%	-22.5%
Absolute difference	-15.7 µSv	-13.5 µSv	-11.9 µSv

Results: Increase in Radiation Exposure due to SEPs



- Fitting of integral proton spectra with power law function and Band-function
- Energy spectrum from 10 MeV to 10 GeV as input for PANDOCA

Results: Increase in Radiation Exposure due to SEPs



additional 2 µSv/h to 4 µSv/h
@ FL380 to FL430

10h integral:

15 µSv to 32 µSv

Increase of 30% to 50%

	Total Effective Dose due to SEP		
	FL430	**FL400**	**FL380**
Band Function Fit	25 µSv	19 µSv	15 µSv
Power Law Fit	32 µSv	25 µSv	21 µSv

Summary

- Overlapping effects: geomagnetic disturbance, Forbush Decrease and Ground Level Enhancement due to energetic particles in May 2024

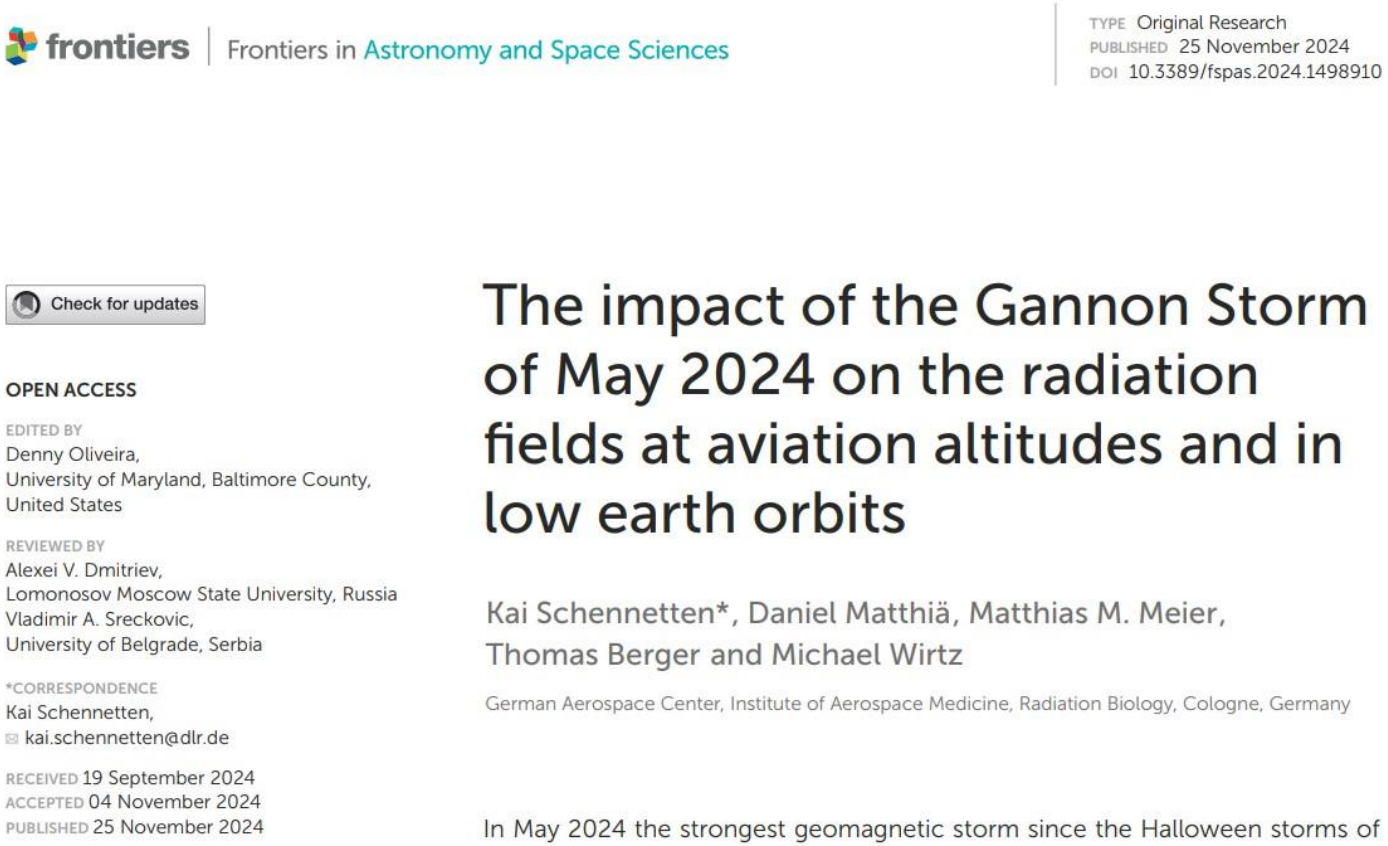
- Effects on the radiation exposure in aviation:
  - Reduction in geomagnetic shielding: **Increase of <1%**
  - Forbush Decrease: **Reduction of ≈ 20%**
  - Energetic Particles / GLE: **Increase of < 30% - 50%**

Summary

- All effects on the radiation exposure in aviation combined:

  Increase of ~15% - 25% @ FL430

Dose rate @600km: 870µSv/h
SEP dose rate @FL430: ~4µSv/h



frontiers | Frontiers in Astronomy and Space Sciences

TYPE Original Research
PUBLISHED 25 November 2024
DOI 10.3389/fspas.2024.1498910

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RECEIVED 19 September 2024
ACCEPTED 04 November 2024
PUBLISHED 25 November 2024

The impact of the Gannon Storm of May 2024 on the radiation fields at aviation altitudes and in low earth orbits

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In May 2024 the strongest geomagnetic storm since the Halloween storms of