South Atlantic Anomaly influence to JEM-EUSO measurements

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South Atlantic Anomaly (SAA)

- two different effects (?)

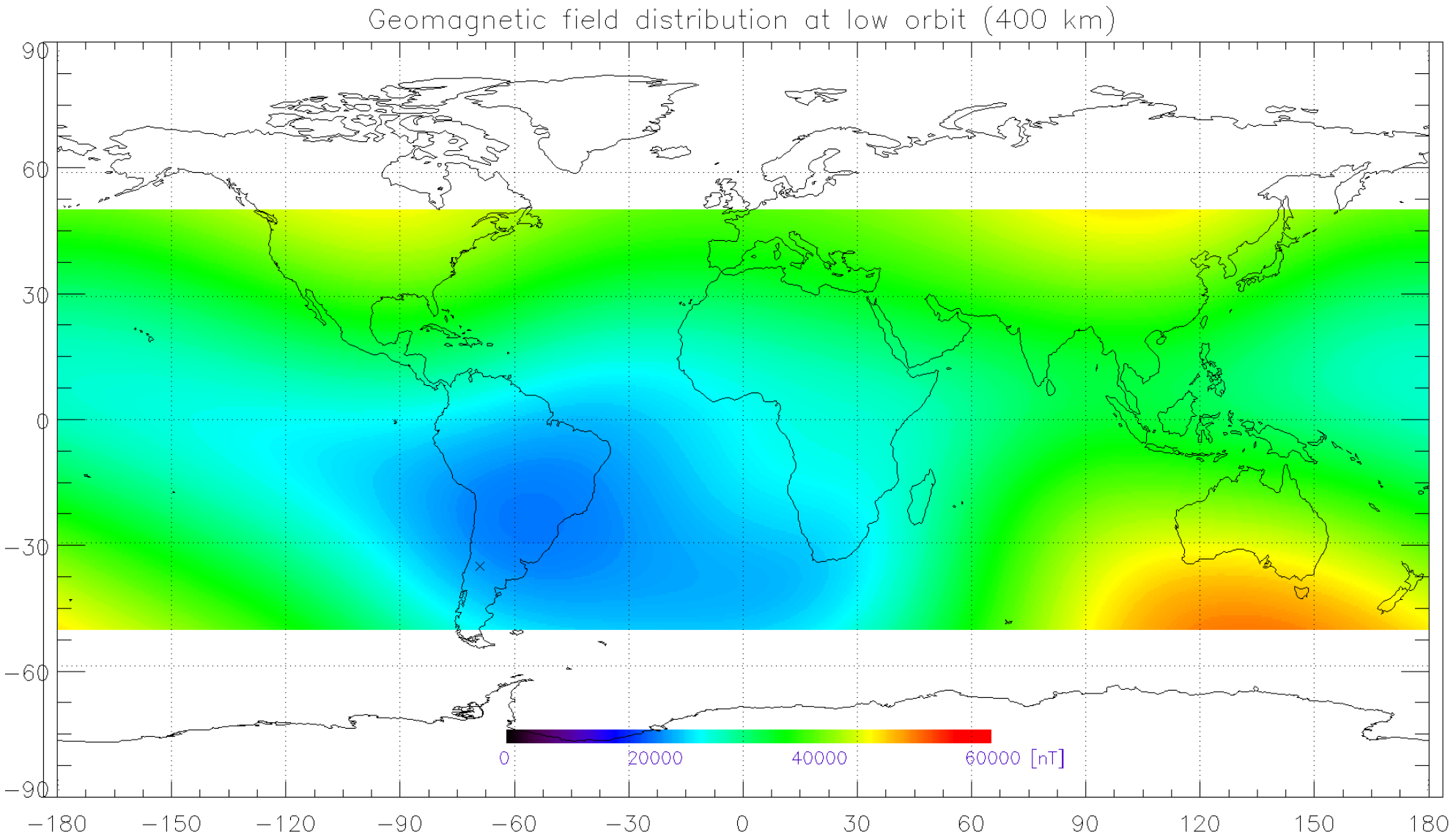
a) production of higher UV background in atmosphere
b) trapped particles (e^-) influence to lens, creating additional UV background in SAA

- not yet recognized major effect(s) ?

Previous simple estimation of SAA influence
- based on evaluation of total geomagnetic field (IGRF) and Tatiana 1 measurements

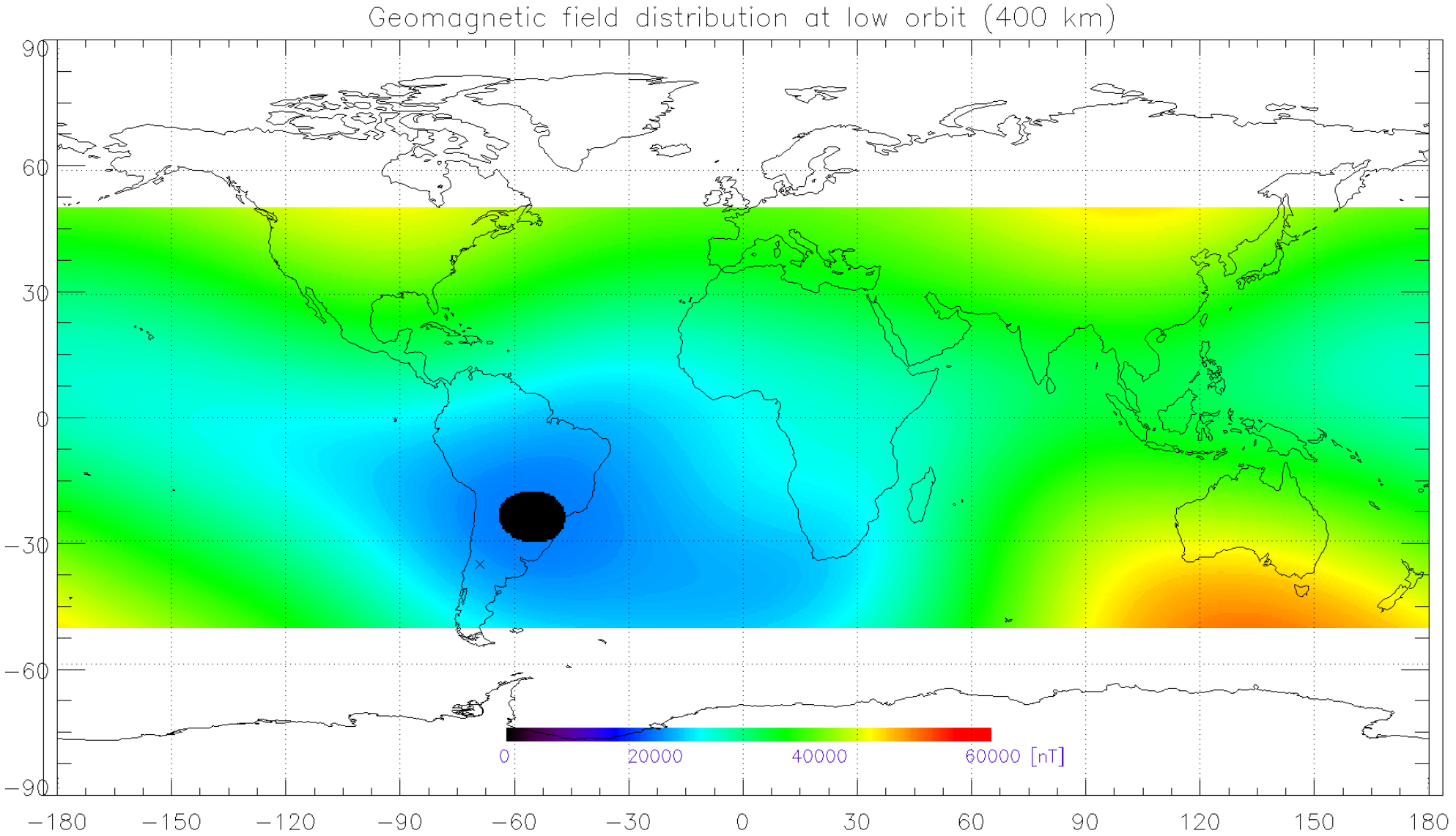
SAA effect on JEM-EUSO operational efficiency

- IGRF field model – total magnetic field in *nT*



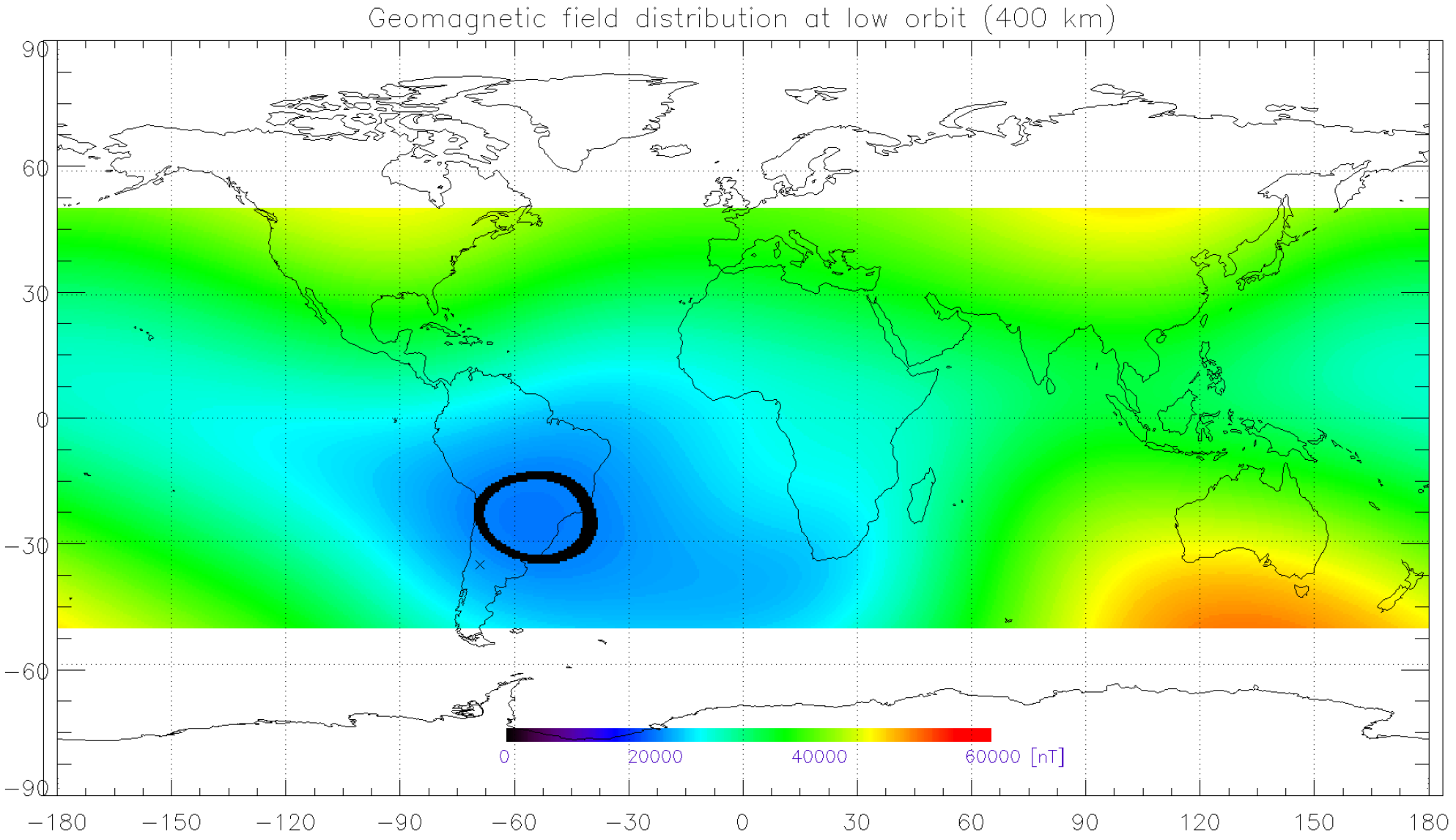
SAA effect on JEM-EUSO operational efficiency

- IGRF field model – total magnetic field in *nT* :: *black circle area with* $B_{total} < 19500\ nT$



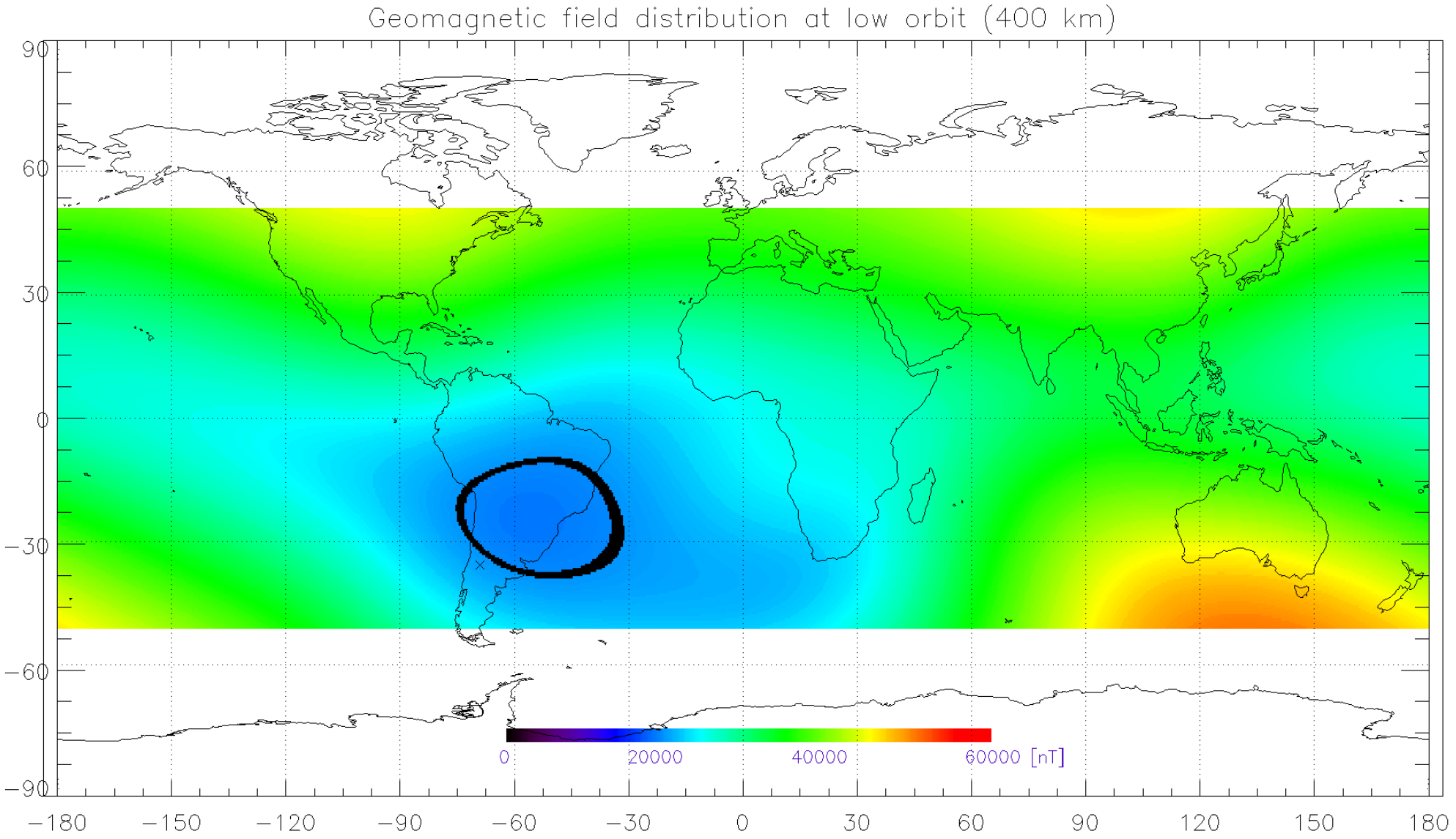
SAA effect on JEM-EUSO operational efficiency

- IGRF field model – total magnetic field in *nT* :: *black circle area with* $B_{total} < 20000\ nT$



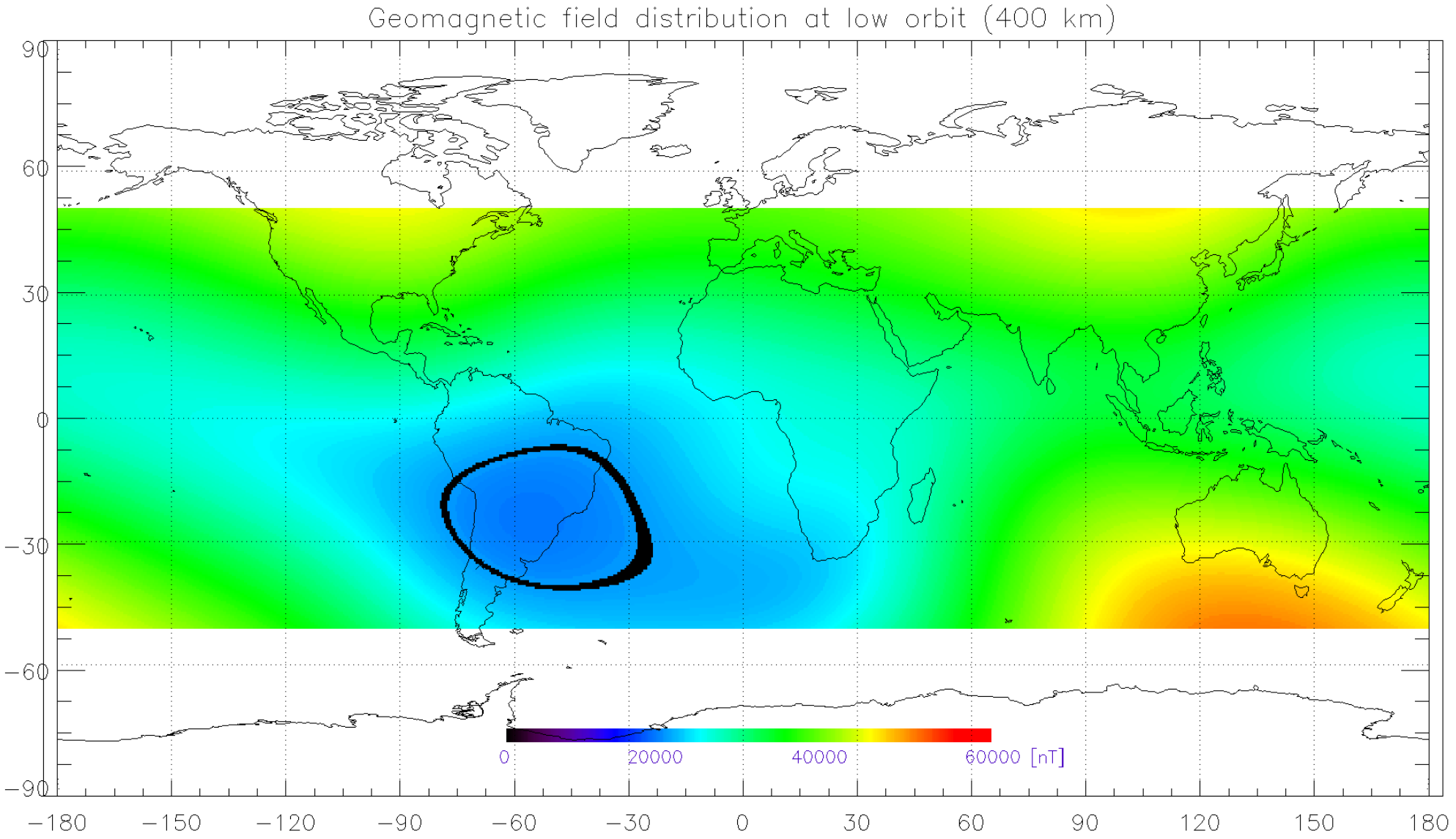
SAA effect on JEM-EUSO operational efficiency

- IGRF field model – total magnetic field in *nT* :: *black circle area with* $B_{total} < 20500$ *nT*



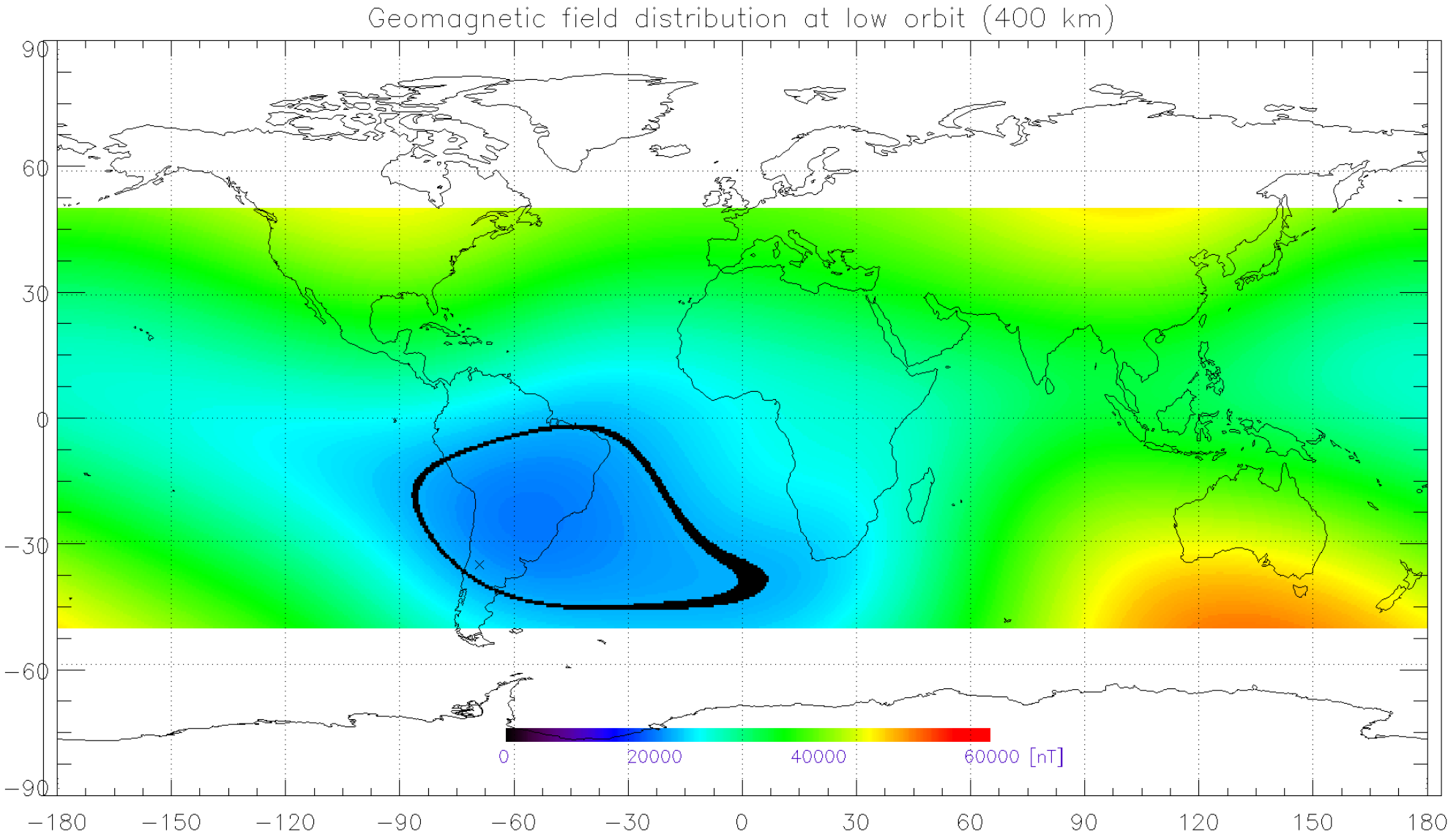
SAA effect on JEM-EUSO operational efficiency

- IGRF field model – total magnetic field in *nT* :: *black circle area with* $B_{total} < 21000\ nT$



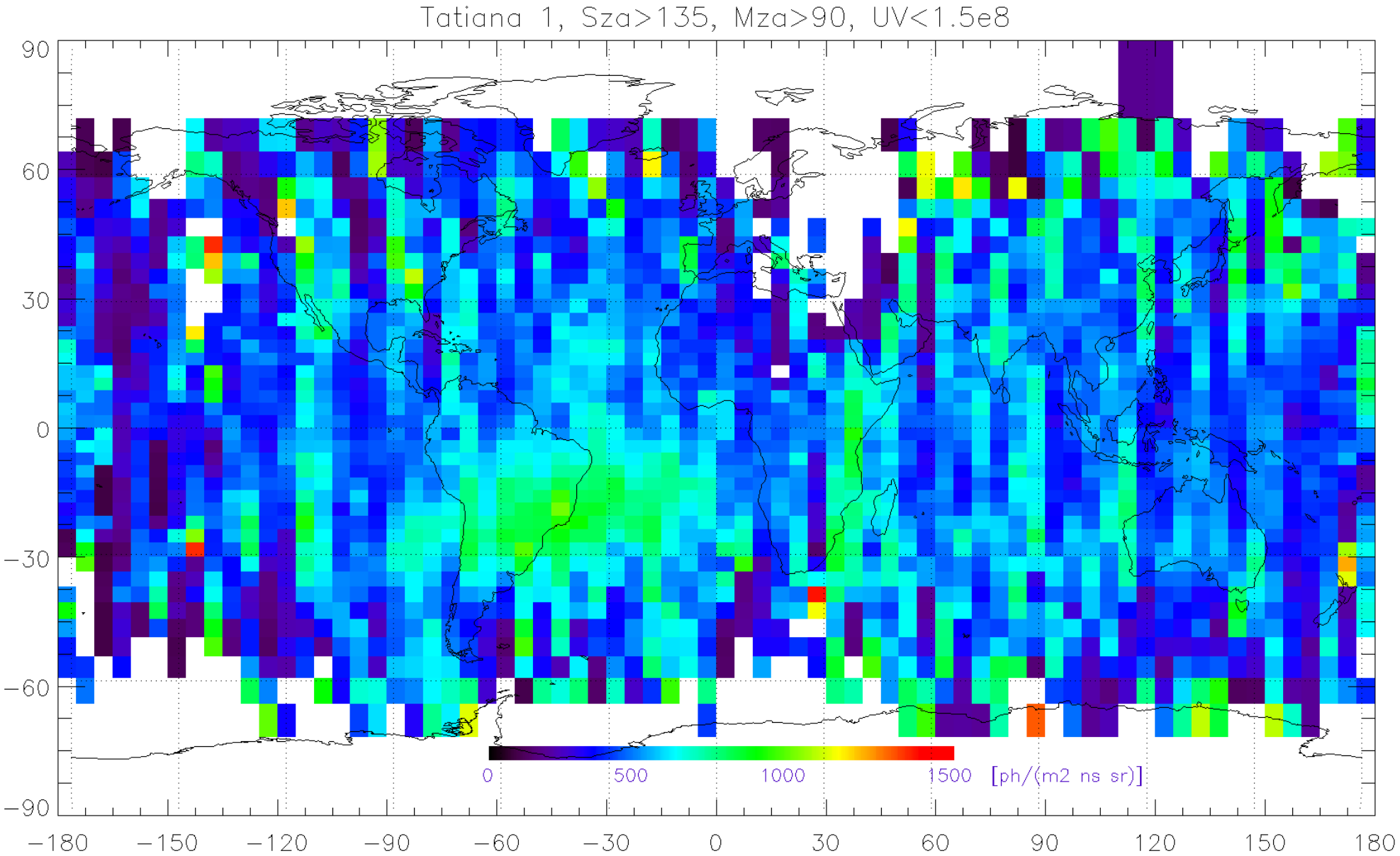
SAA effect on JEM-EUSO operational efficiency

- IGRF field model – total magnetic field in *nT* :: *black circle area with* $B_{total} < 22000\ nT$



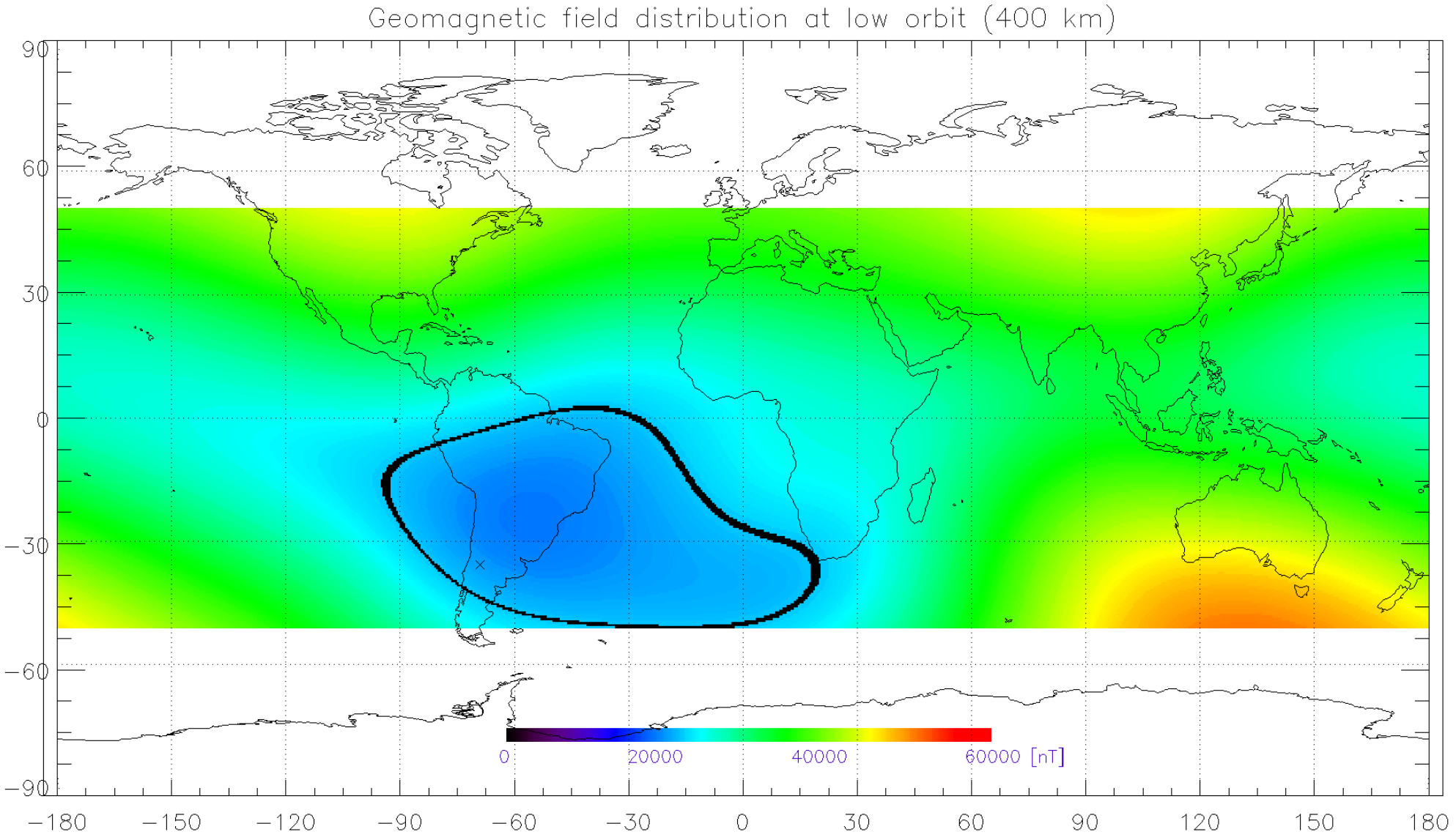
SAA effect on JEM-EUSO operational efficiency

Tatiana 1 UV BG measurements



SAA effect on JEM-EUSO operational efficiency

- IGRF field model – total magnetic field in *nT* :: *black circle area with* $B_{total} < 23000\ nT$



SAA effect on JEM-EUSO operational efficiency

- To which energies / particles we (instrument) are sensitive?

- If effect is due to additional/higher UV BG created in SAA – then Tatiana 1 can be used to bordering region
- If influence of trapped particles to detector is same/similar as for Tatianas – same as previous point, but this is probably not case
- Conservative estimation – we are not measure inside SAA, measurements inside SAA are excluded

SAA effect on JEM-EUSO operational efficiency

B_{total} < 19500 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	19.22
1500	20.42	20.38
2000	21.43	21.38
5000	26.07	26.02
10000	32.21	32.14
15000	34.81	34.73
30000	34.84	34.77

B_{total} < 20000 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	19.04
1500	20.42	20.19
2000	21.43	21.18
5000	26.07	25.78
10000	32.21	31.84
15000	34.81	34.41
30000	34.84	34.44

B_{total} < 20500 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	18.85
1500	20.42	19.99
2000	21.43	20.97
5000	26.07	25.52
10000	32.21	31.52
15000	34.81	34.06
30000	34.84	34.10

B_{total} < 21000 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	18.63
1500	20.42	19.75
2000	21.43	20.73
5000	26.07	25.23
10000	32.21	31.16
15000	34.81	33.67
30000	34.84	33.70

B_{total} < 21500 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	18.38
1500	20.42	19.49
2000	21.43	20.46
5000	26.07	24.90
10000	32.21	30.75
15000	34.81	33.22
30000	34.84	33.26

B_{total} < 22000 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	18.04
1500	20.42	19.13
2000	21.43	20.07
5000	26.07	24.44
10000	32.21	30.18
15000	34.81	32.61
30000	34.84	32.64

B_{total} < 22500 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	17.70
1500	20.42	18.77
2000	21.43	19.69
5000	26.07	23.97
10000	32.21	29.60
15000	34.81	32.00
30000	34.84	32.03

B_{total} < 23000 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	17.36
1500	20.42	18.41
2000	21.43	19.32
5000	26.07	23.52
10000	32.21	29.04
15000	34.81	31.39
30000	34.84	31.42

B_{total} < 24000 nT

$I_{Allowed}$ [ph/(m^2 ns sr)]	$I_{SUN} + I_{BG} + I_{MOON}$ [%]	$I_{SUN} + I_{BG} + I_{MOON} + I_{SAA}$ [%]
1000	19.26	16.77
1500	20.42	17.79
2000	21.43	18.66
5000	26.07	22.73
10000	32.21	28.07
15000	34.81	30.33
30000	34.84	30.36

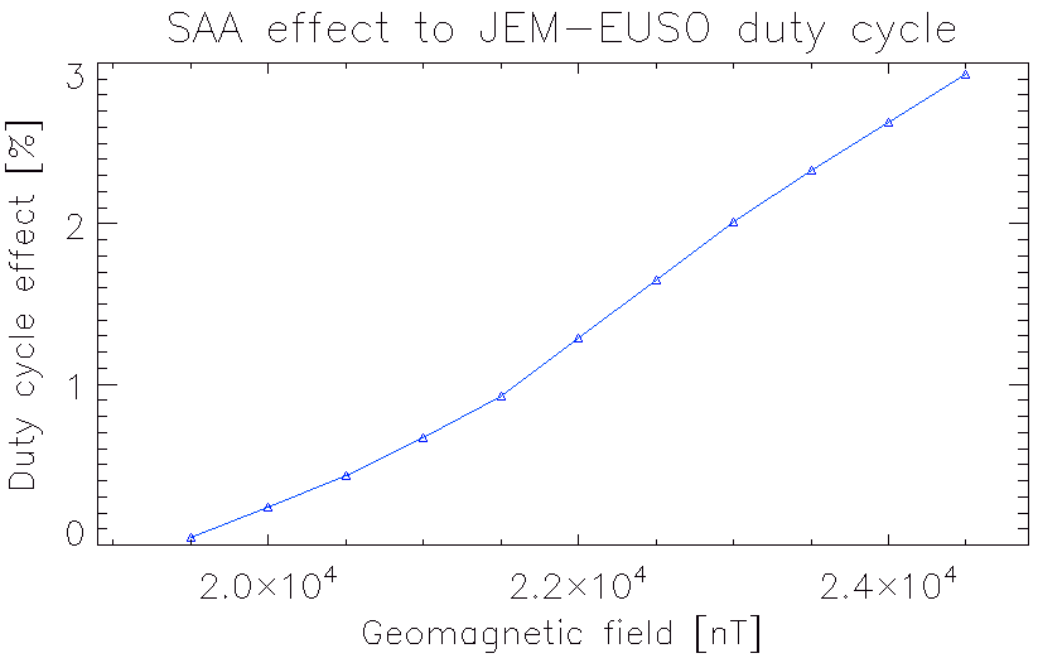
SAA effect on JEM-EUSO operational efficiency

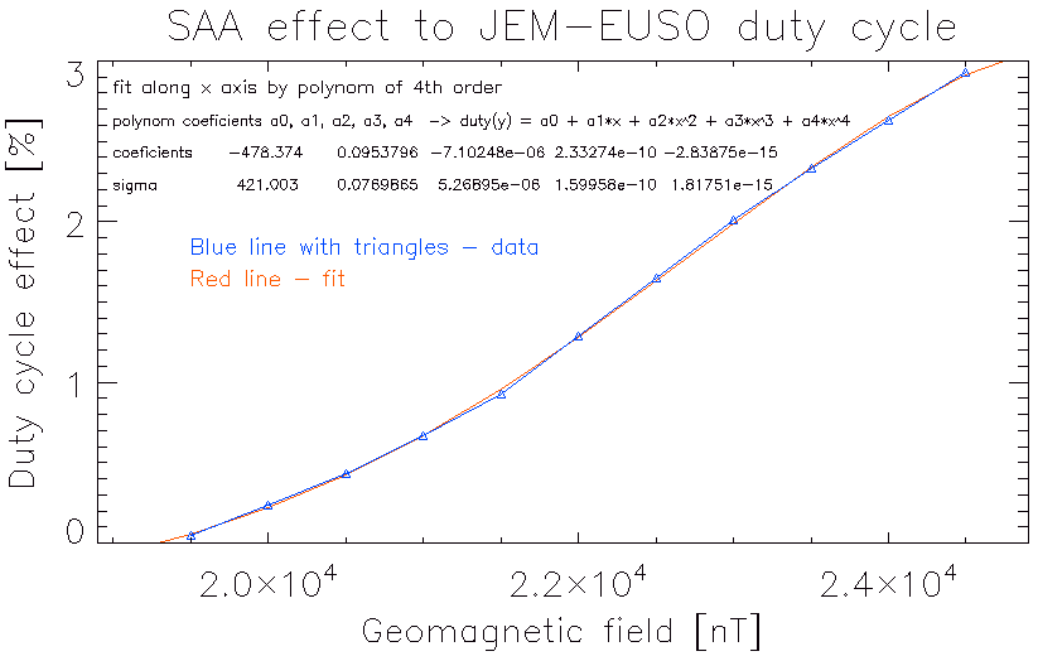
- From Tatiana 1

21000 – 21500 nT

0.67% - 0.93%

- We need to check less conservative criteria





SAA effect on JEM-EUSO operational efficiency

Conclusion for SAA effect to DC from simple approach

- Conservative estimation of South Atlantic Anomaly effect to JEM-ESUO operational efficiency lead to reduction of allowed time of measurements by 0.7%-0.9%.

- To verify SAA effect we need to know/estimate to which particles (energies) we are sensitive

  - **Galactic cosmic rays?**

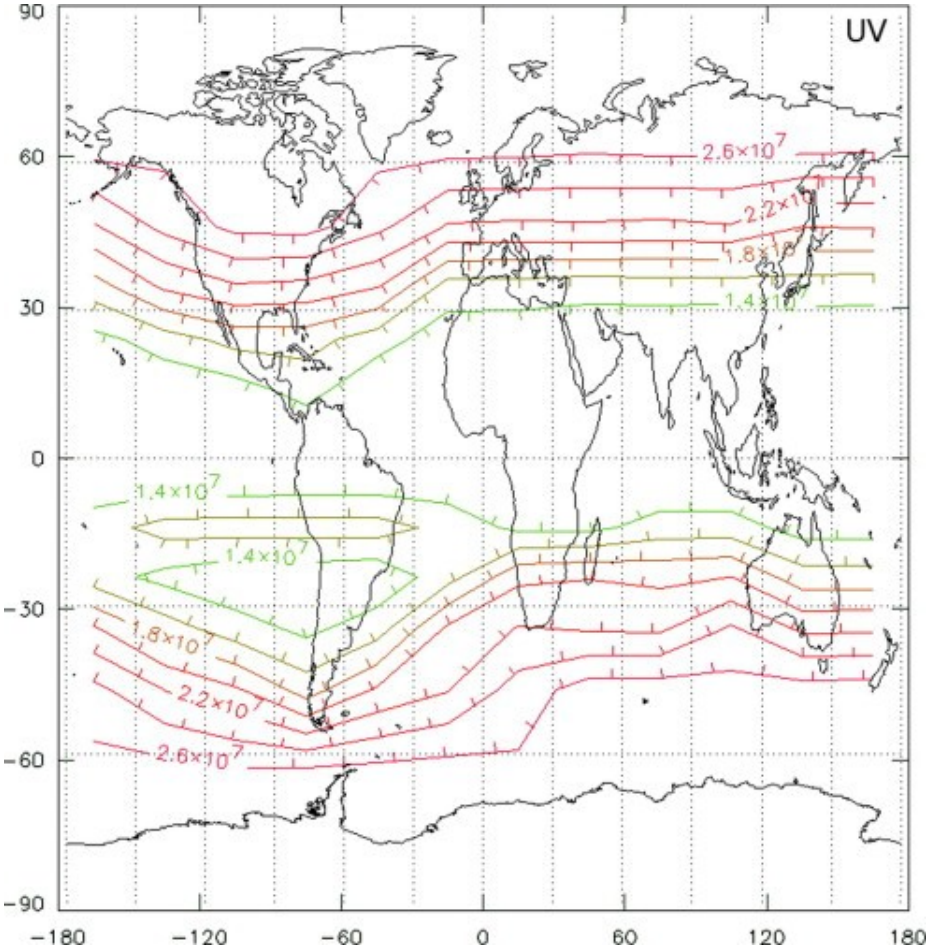
Galactic cosmic rays

- Hypothesis: GCR create additional UV BG

  - was already tested in article in Advances in Space Research [1] for all Earth surface except SAA

  - now simulation also for SAA

  - even we think that this will be not main/big effect, we provide simulation in SAA



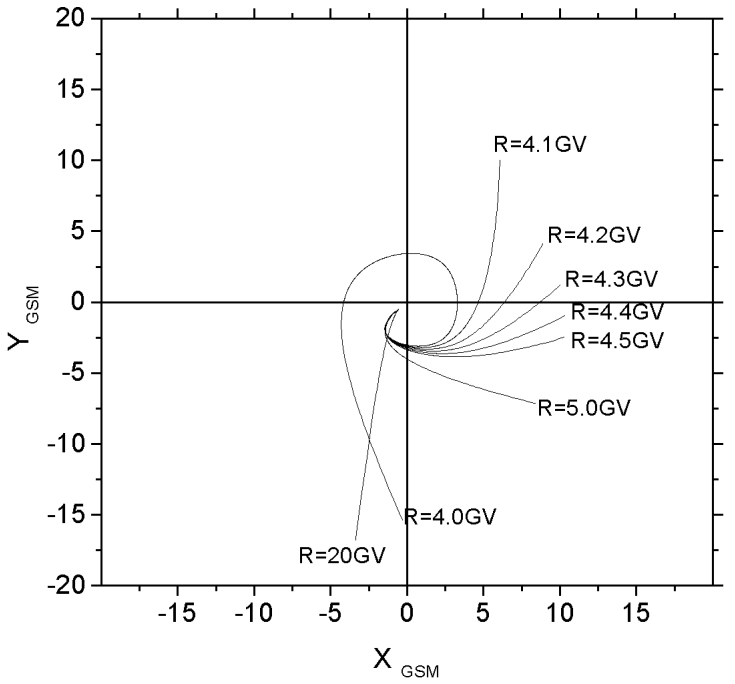
UV light intensity at the top of the atmosphere for albedo 100%. For albedo 0% UV light in 300–400 nm (number of photons in (m2 s sr)−1) will have half values.

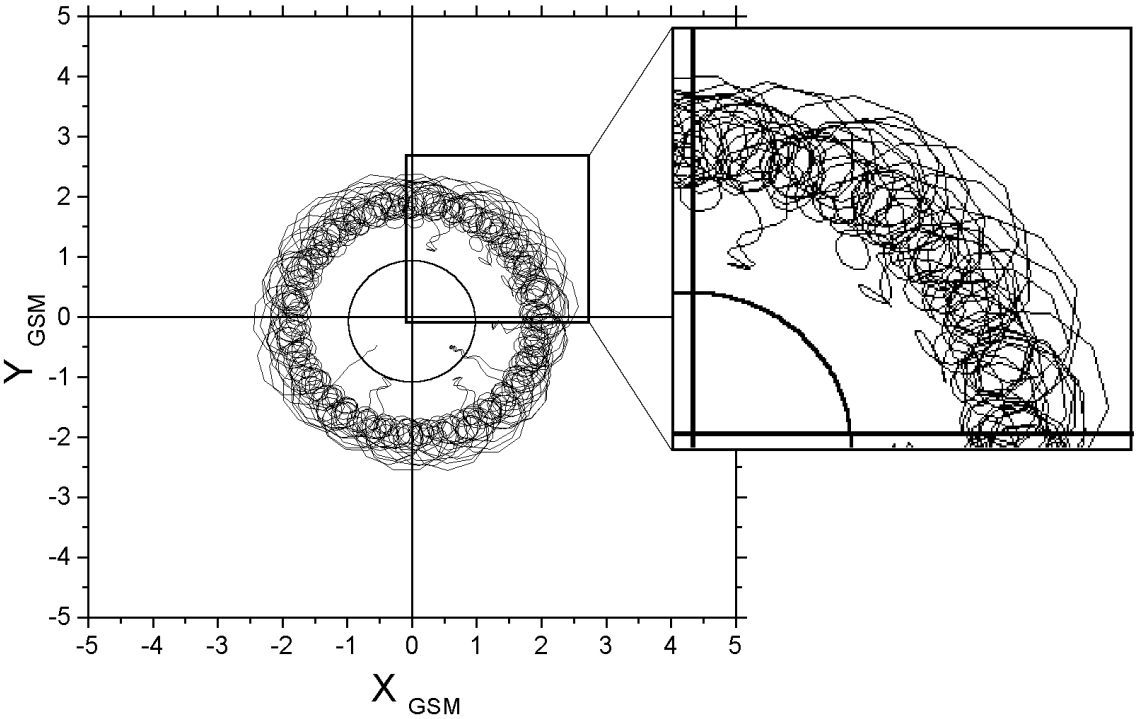
[1] Distribution of secondary particles intensities over Earth's surface: Effect of the geomagnetic field, Advances in Space Research, 50, 7,986-996, 2012

Galactic cosmic rays

Simulation

- for every point (geographical place) on latitude "line" crossing a SAA and we evaluate
  - 576 directions
  - for every directions 20 000 energies
  - ~10 million trajectories for one point



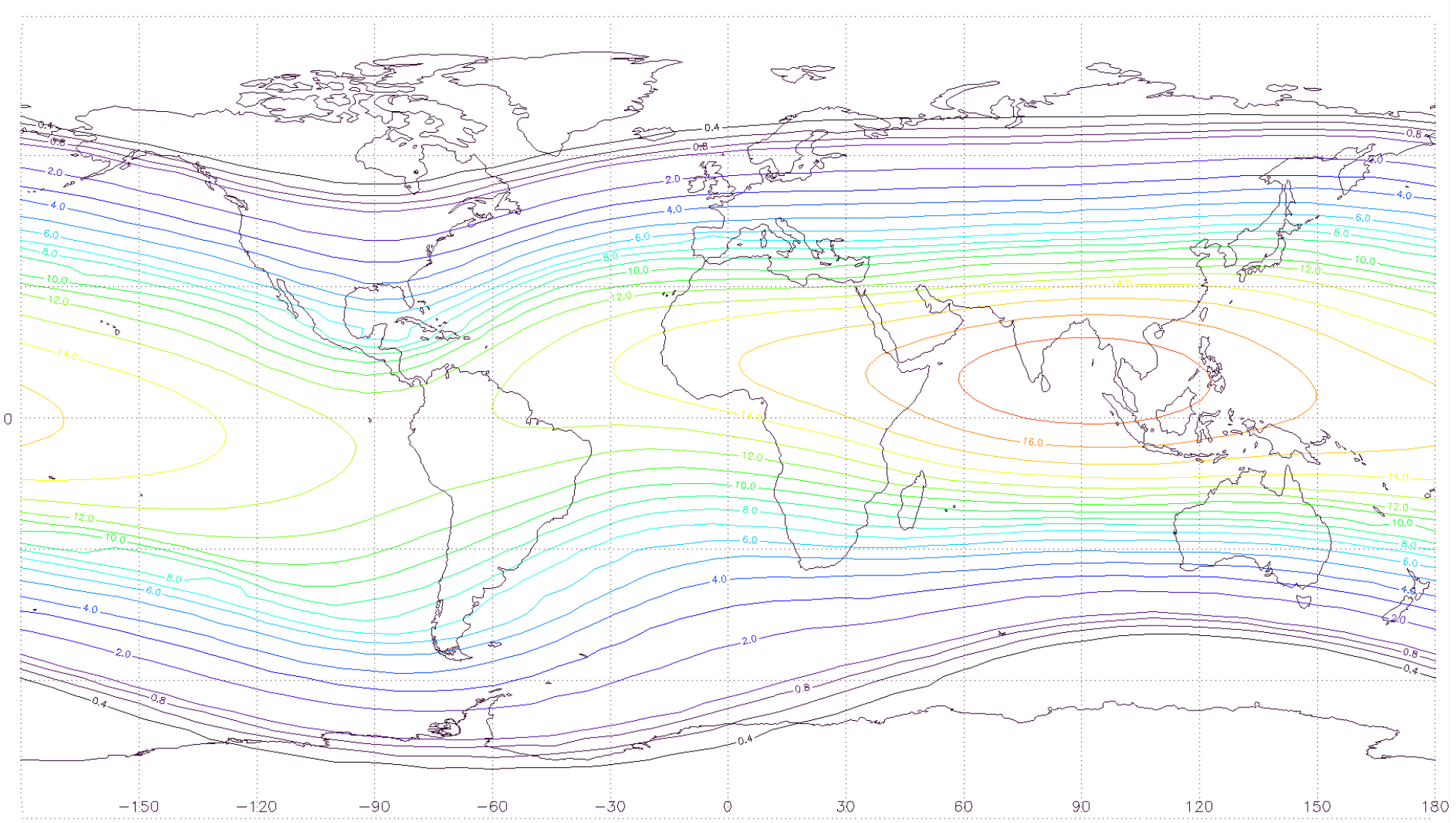


- longitudes 0 and 300 degrees

- Model **GeoMag**

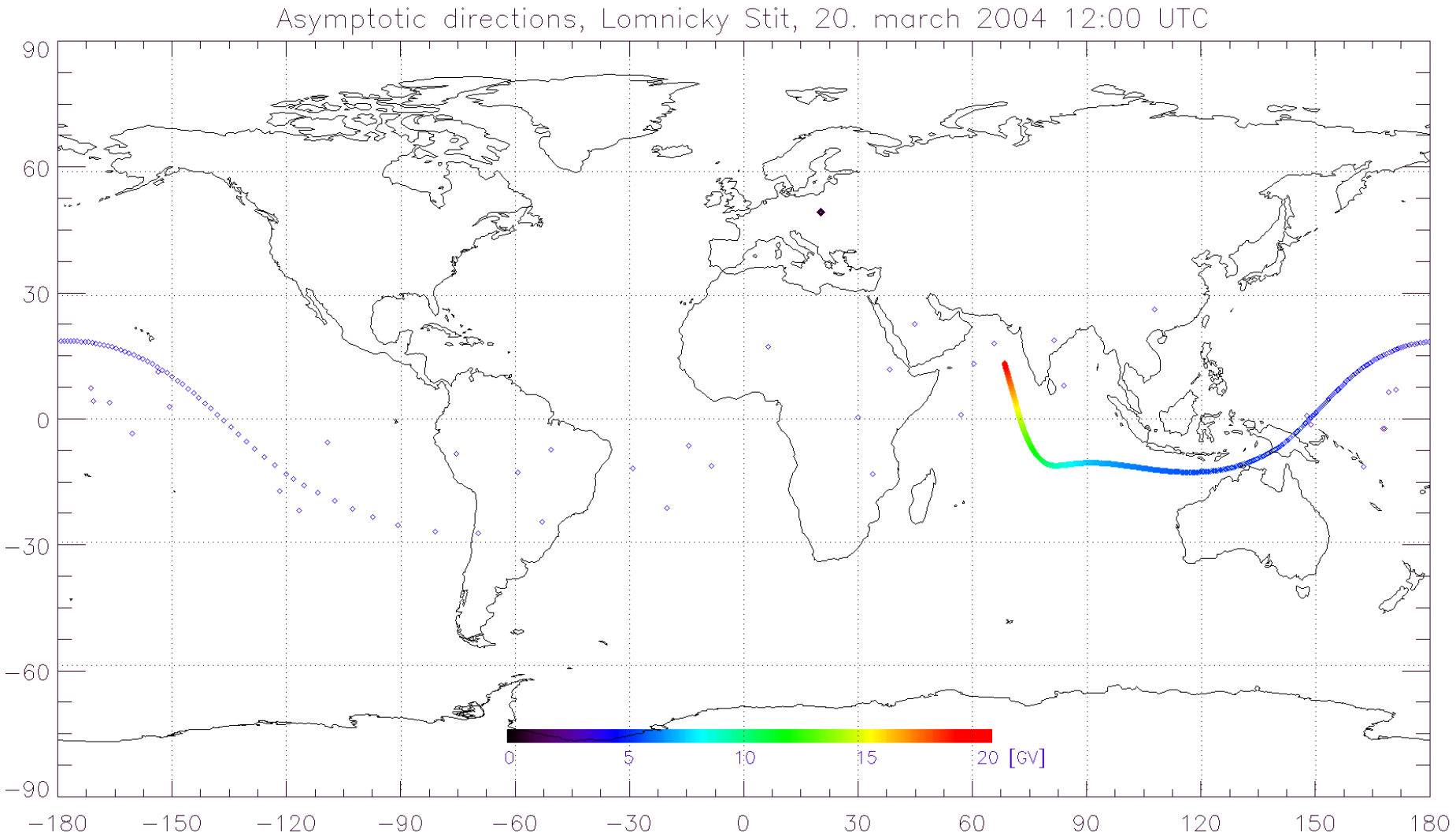
www.geomagsphere.org

Vertical cutoff rigidities



www.geomagsphere.org

Vertical cutoff rigidities



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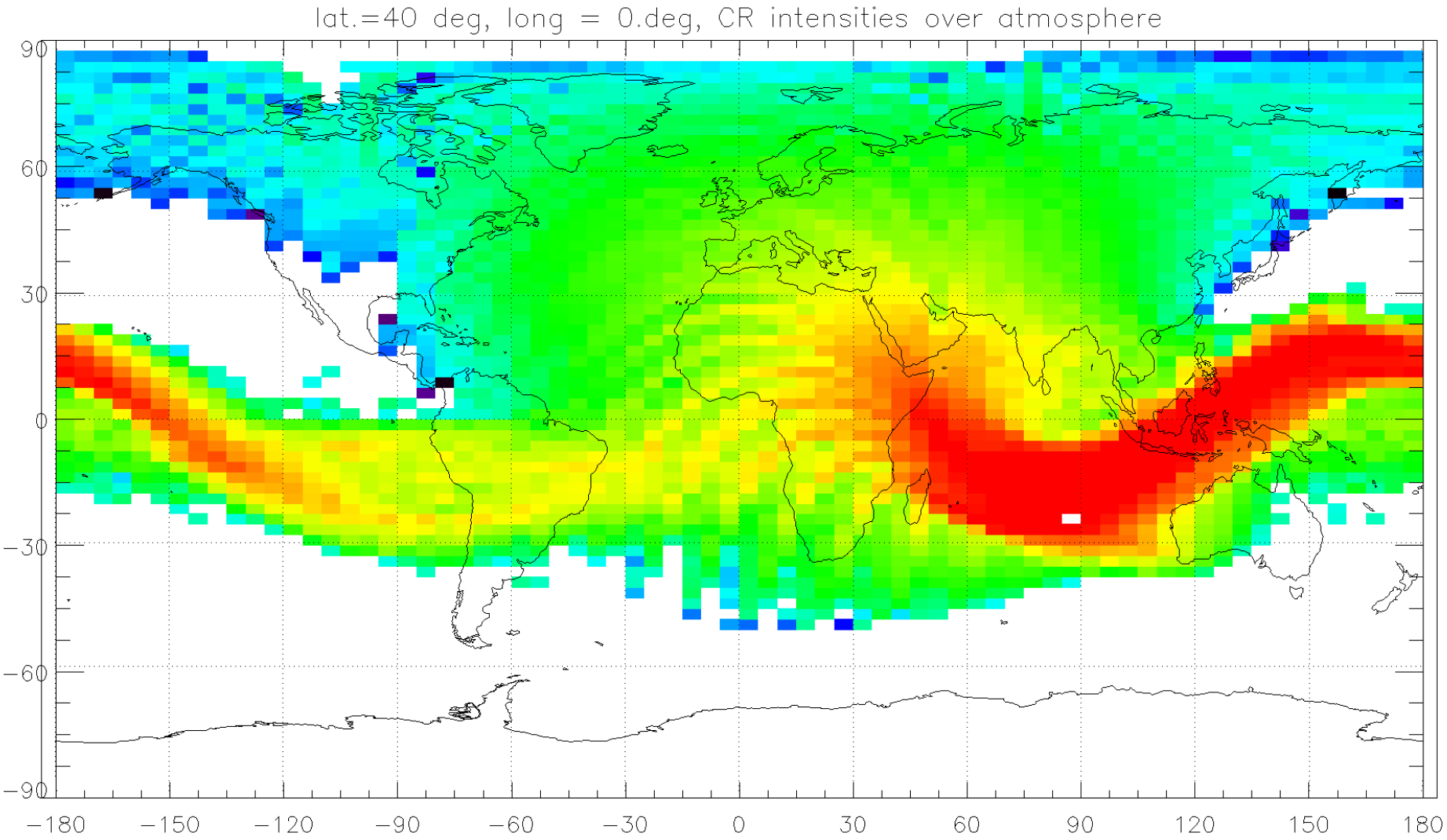
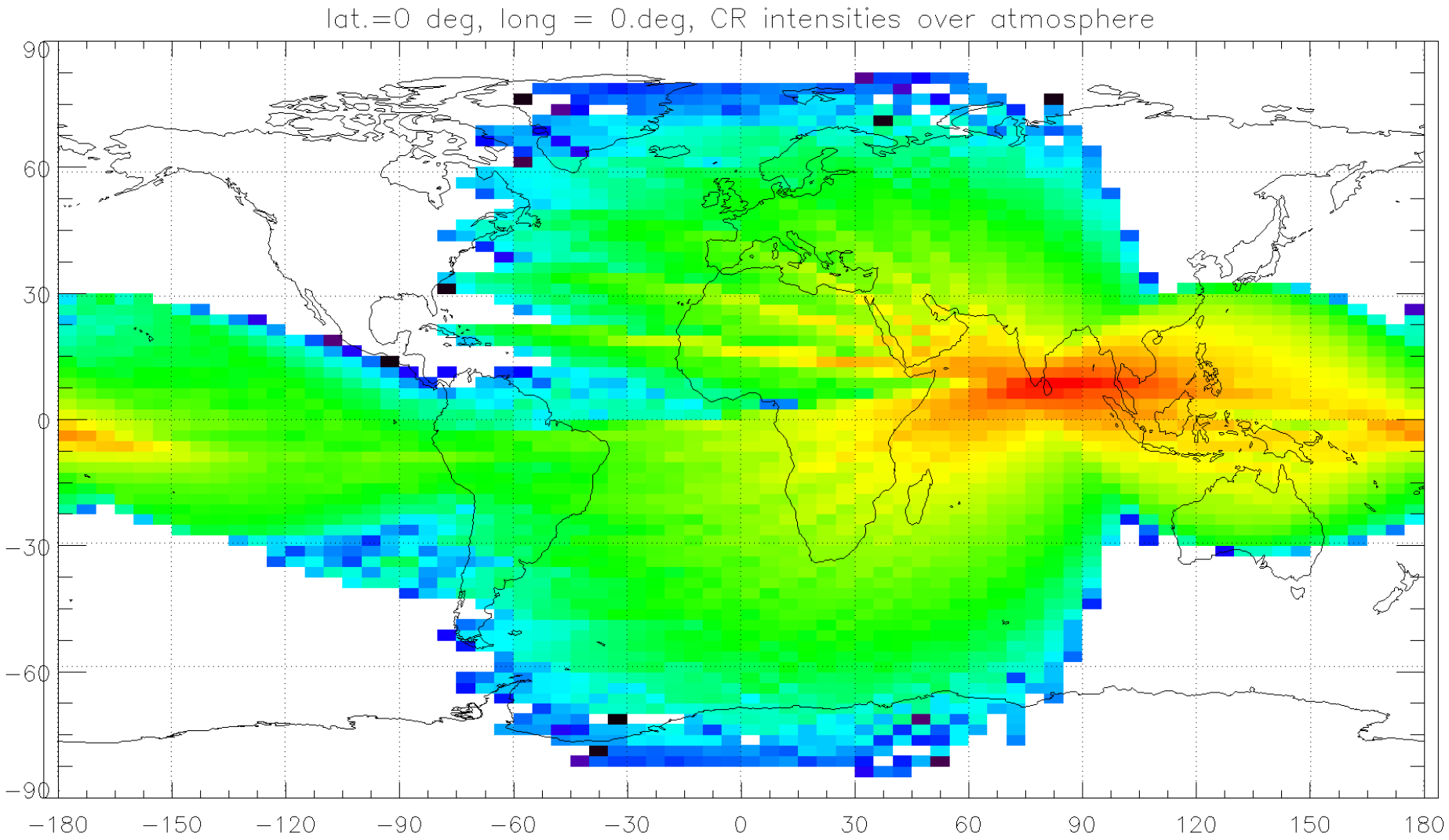
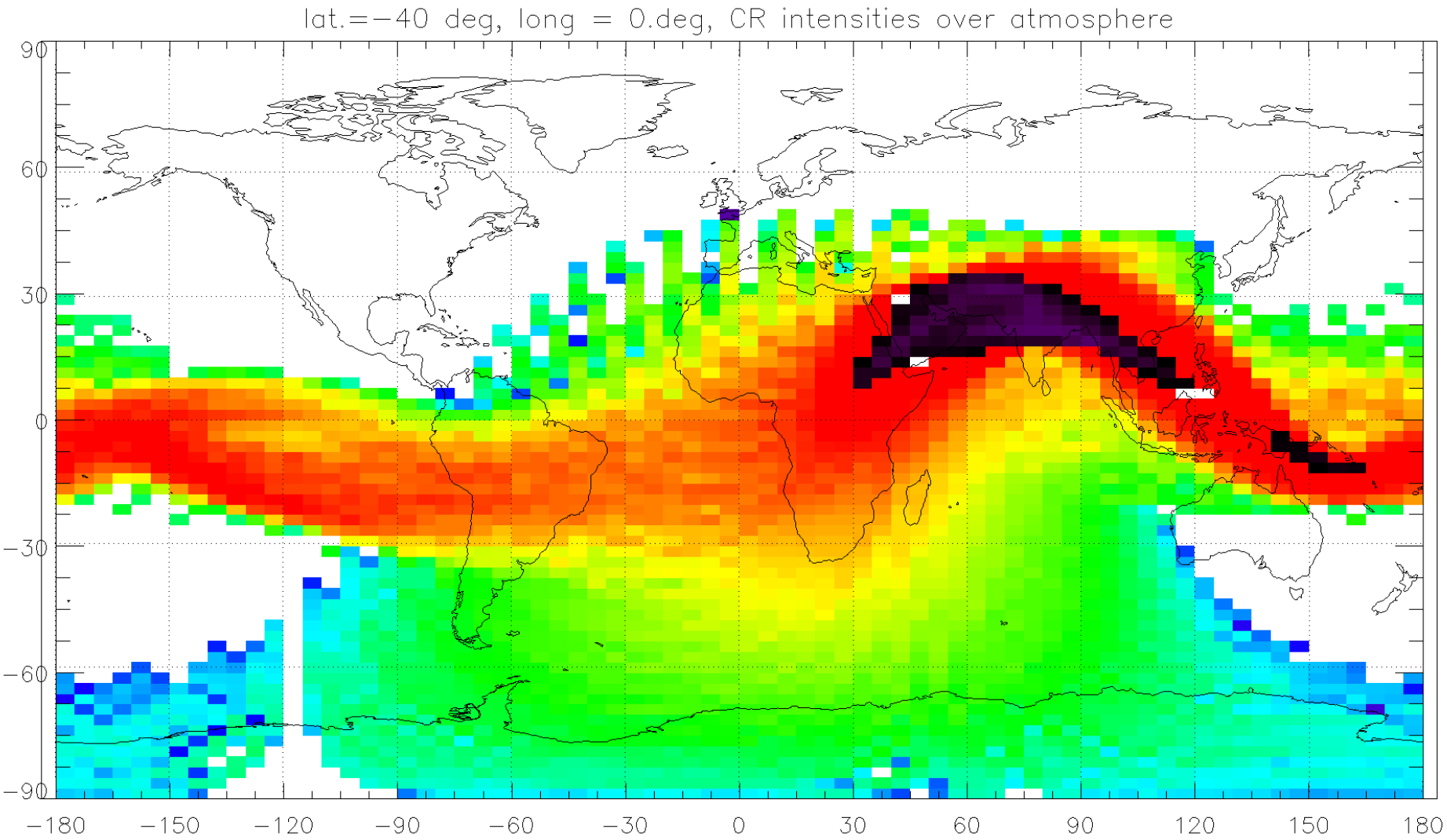
Asymptotic cone example : lat/lon :: 40/0 deg.



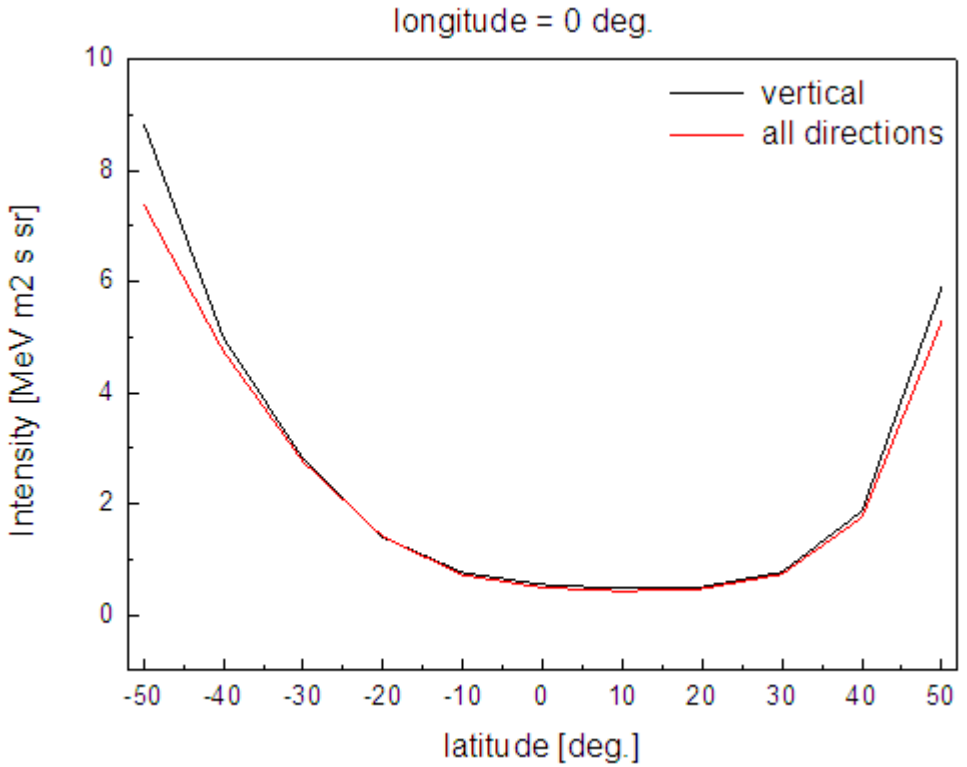
Asymptotic cone example : lat/lon :: 0/0 deg.

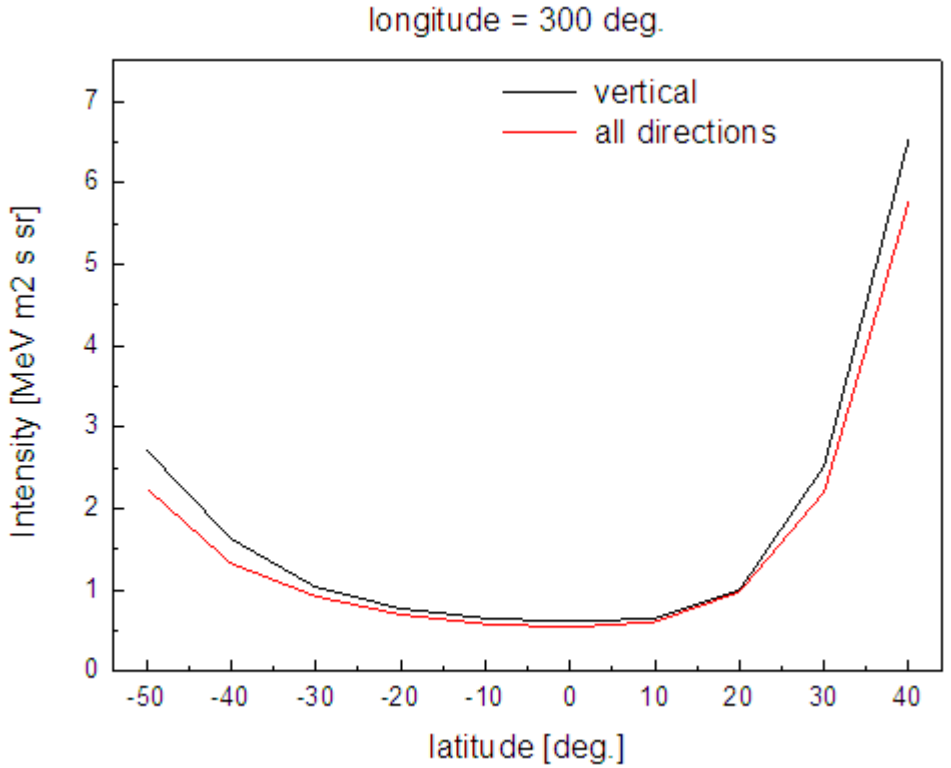


Asymptotic cone example : lat/lon :: -40/0 deg.



Vertical vs. All directions





Conclusion : Not reasonable influence from GCR

- Airglow UV BG production is higher in SAA - previous AURIC presentation
- dynamical : intensity change in time and border of SAA change

Trapped particles : e^-

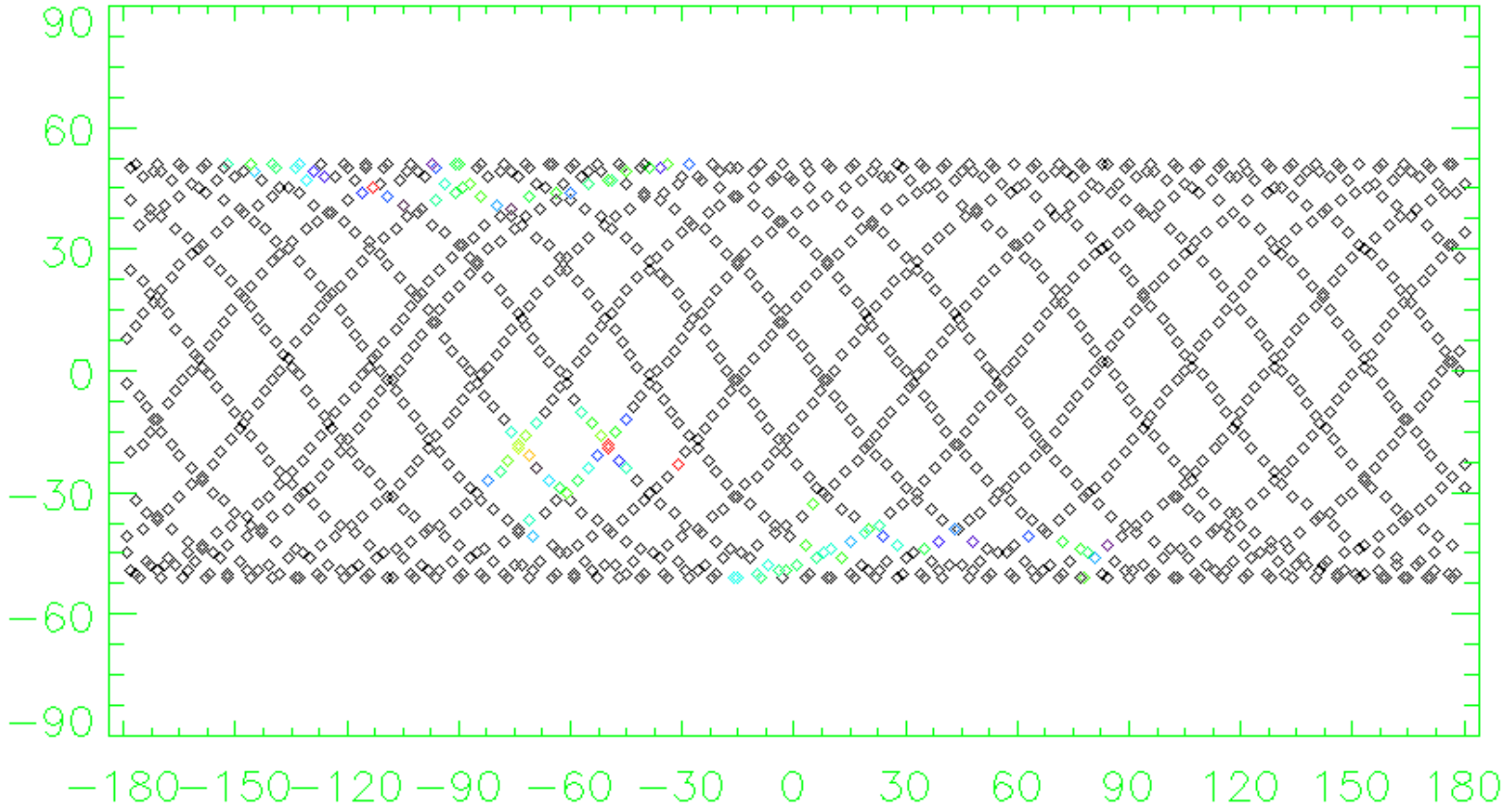
Trapped electrons influence

- SPENVIS model : producing a data (trapped e- intensities) for generated/selected orbit

- effect of those e- to lenses : how many UV photons are crearted ? > Fluka ?

- because possibly major (16% !) not yet known effect crosscheck is welcomed

SPENVIS : generated ISS like orbit



SPENVIS : traped electrons along orbit for 1 month