Finnish Meteorological Institute

Earth Observation Unit

effects of precipitating radiation belt electrons on the mesosph
hydroxyl and ozone:
Towards better understanding Sun - Earth connection

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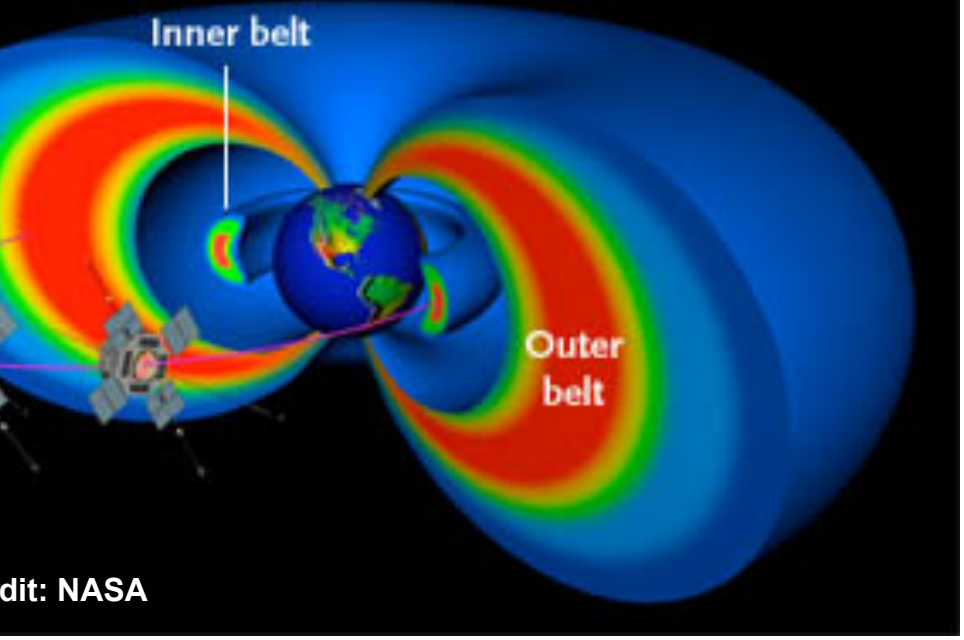
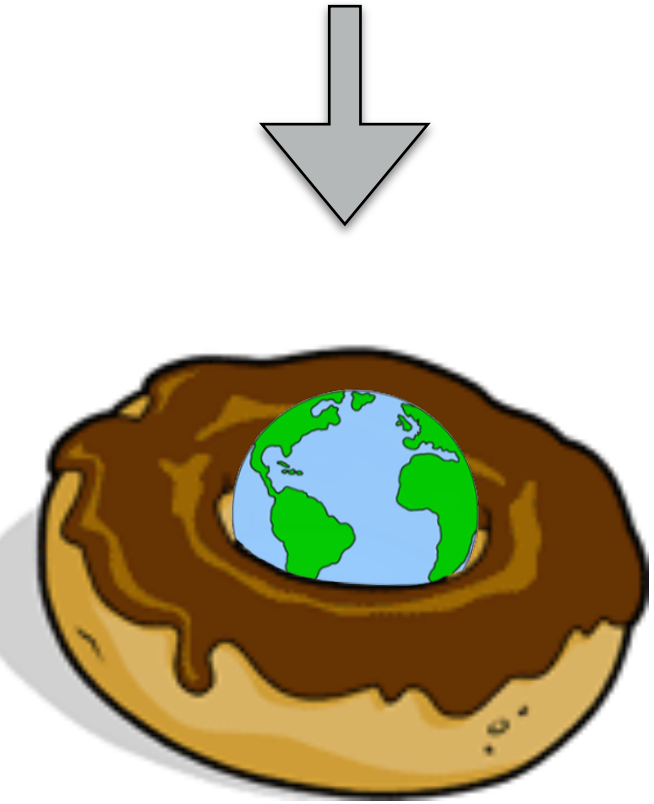
- The three men responsible for success of Explorer 1, America's satellite, launched in 1958.
- They found first evidence for radiation belts using data from a co ray detector.
- After 56 years there are still questions about the physics conne to the radiation belts.



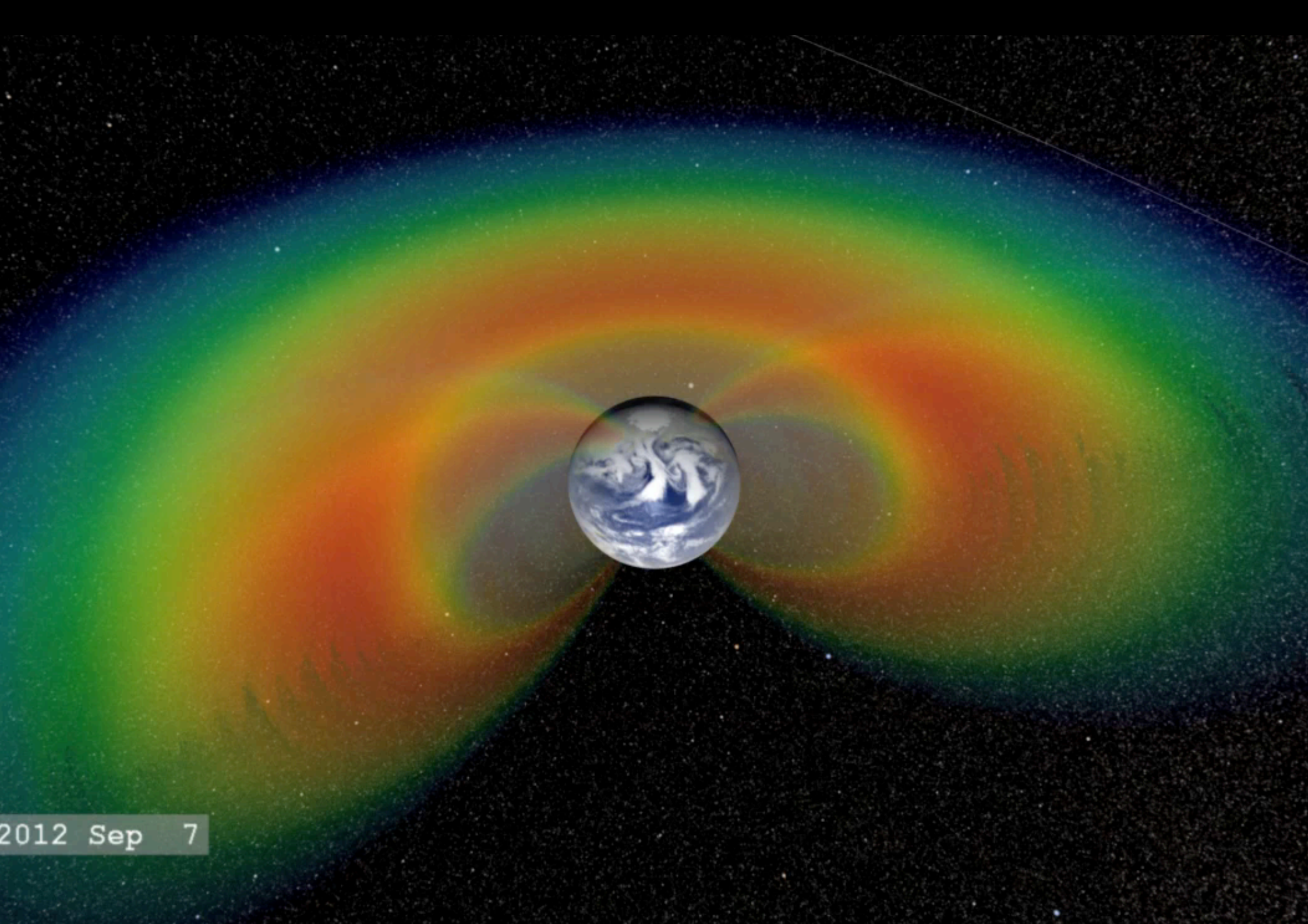
- 'layer' of high energy particles trapped by Ea

  magnetic field
- two giant donuts with the Earth in the cente

  of the "donut" hole



- the inner belt - 1,200 km to 6,500 km
- the outer belt -13,000 km to 40,000 km
- separated by a slot
- the outer belt is much stronger
- the radiation belts are highly variable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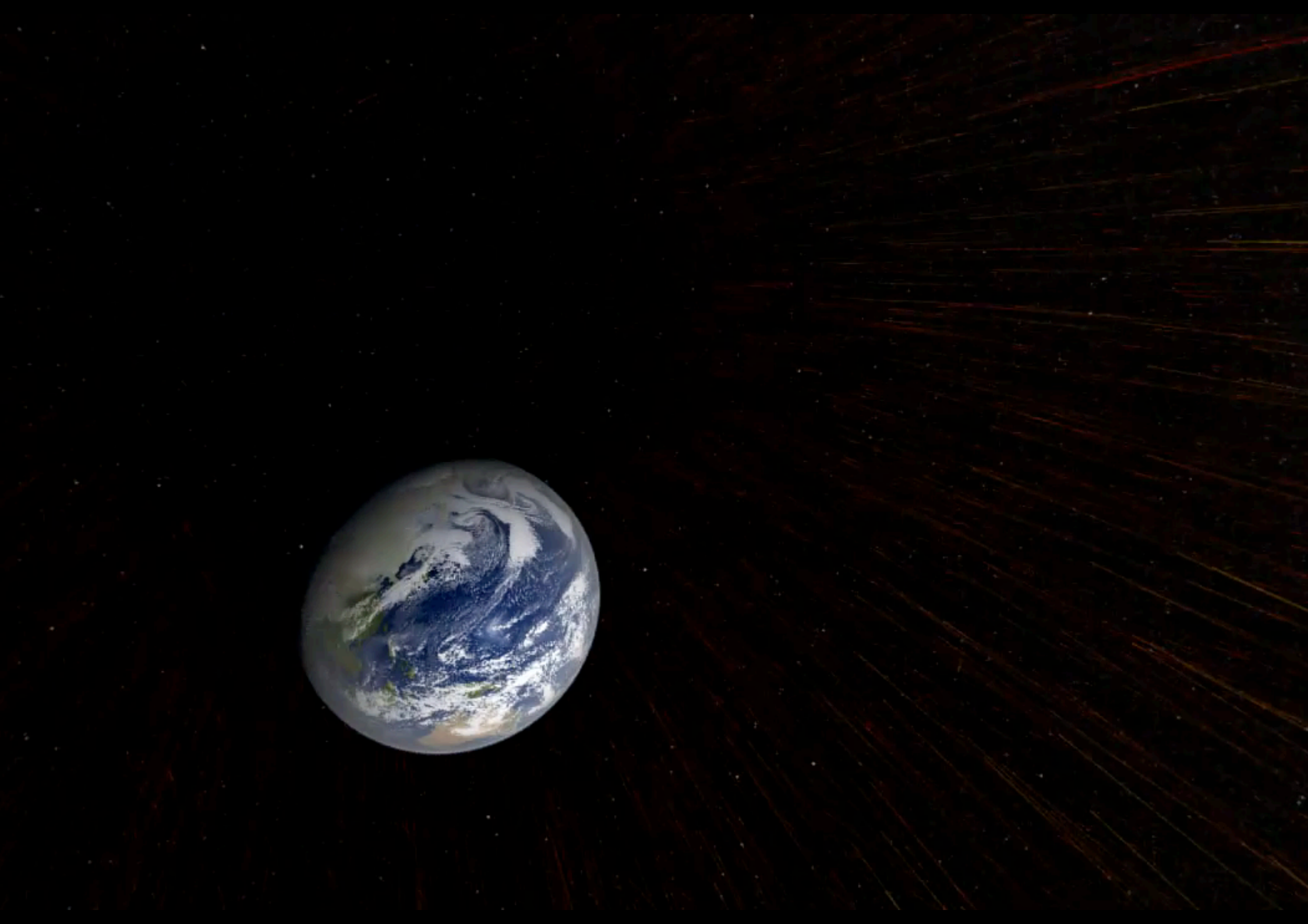
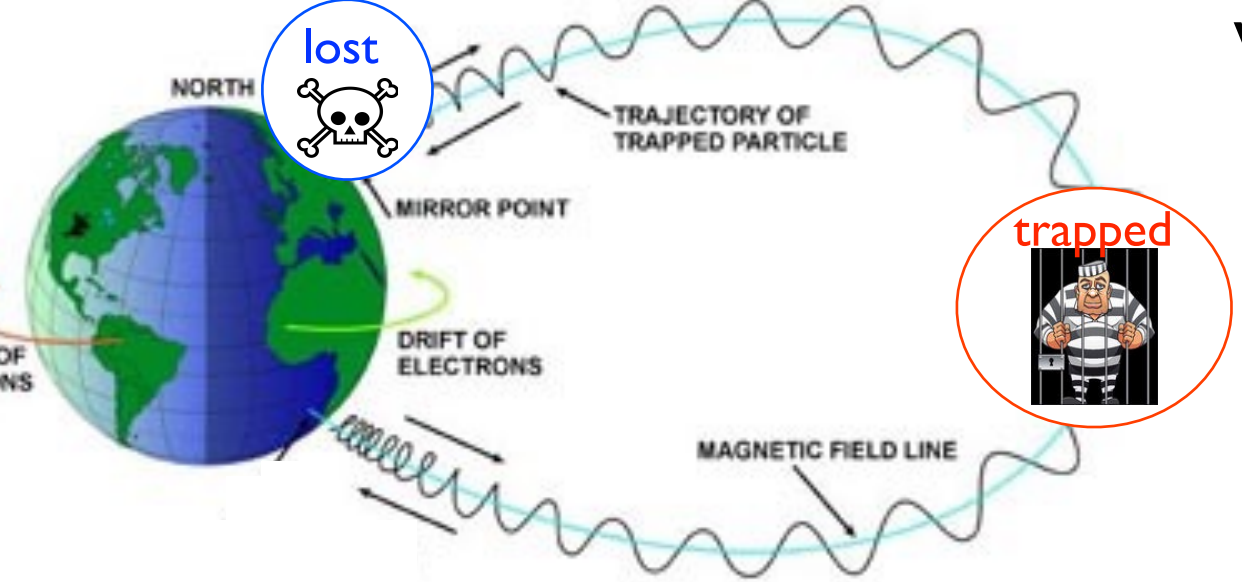


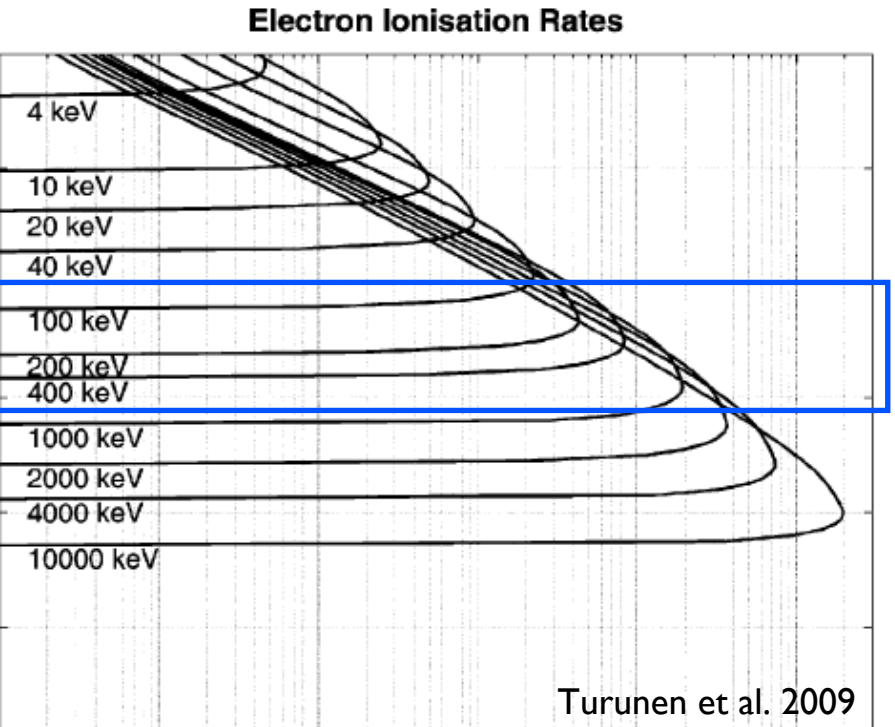


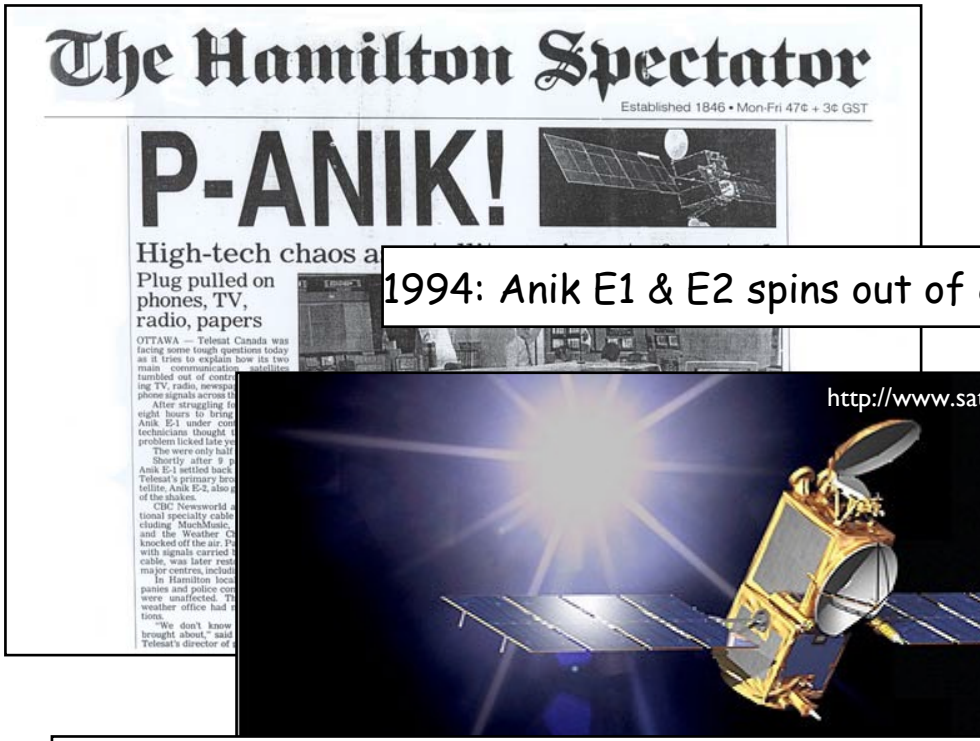
What do they do all day long?

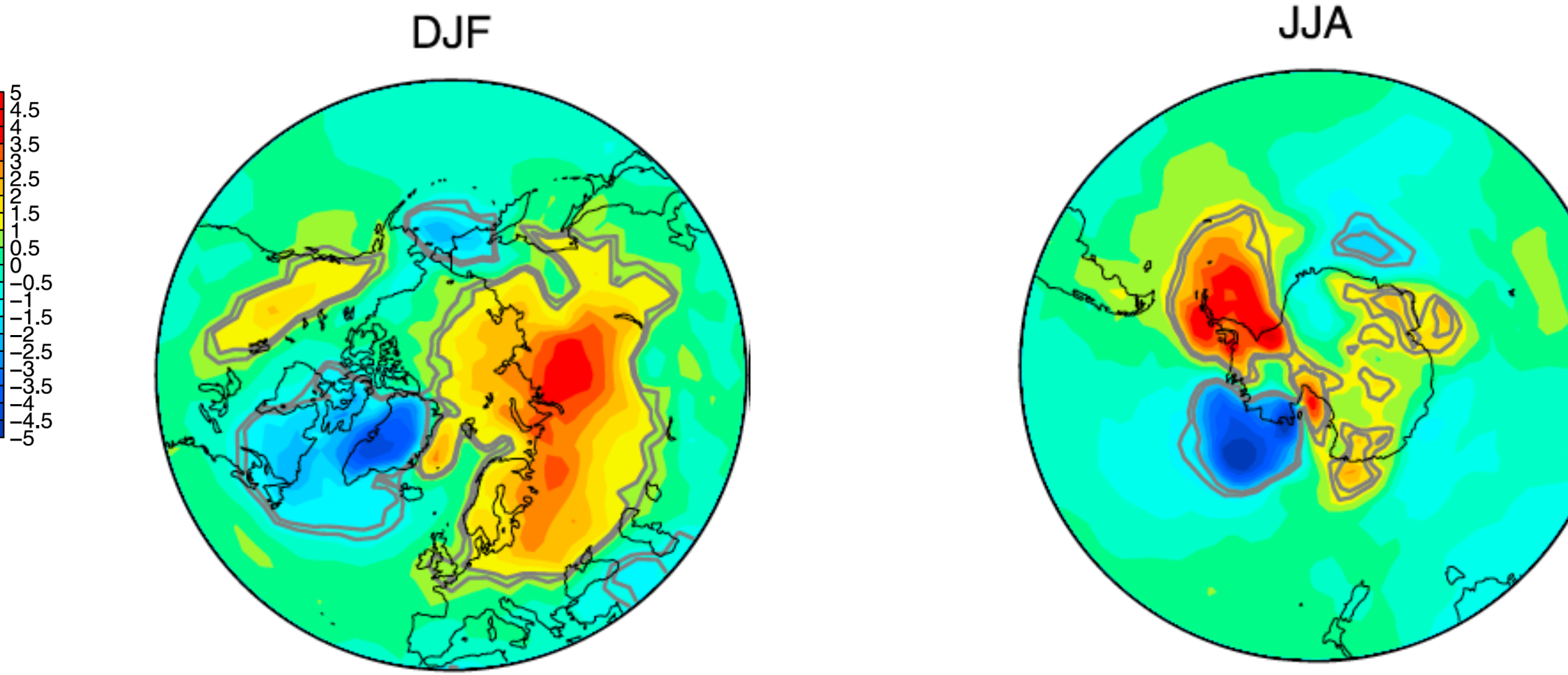
- gyrate around the filed line (million times
- bounce between the poles (1 ride / secc
- drift around the Earth (1 hour)

"Attack of the Killer Electrons"

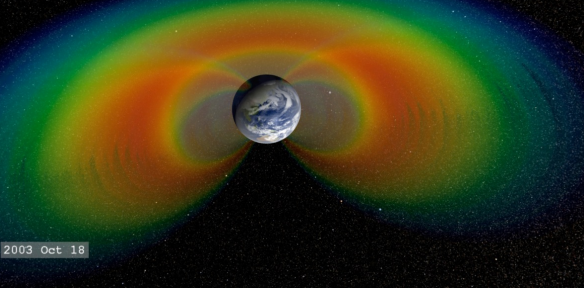
opulation…

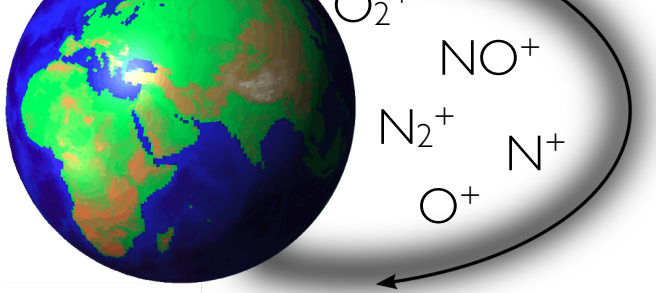




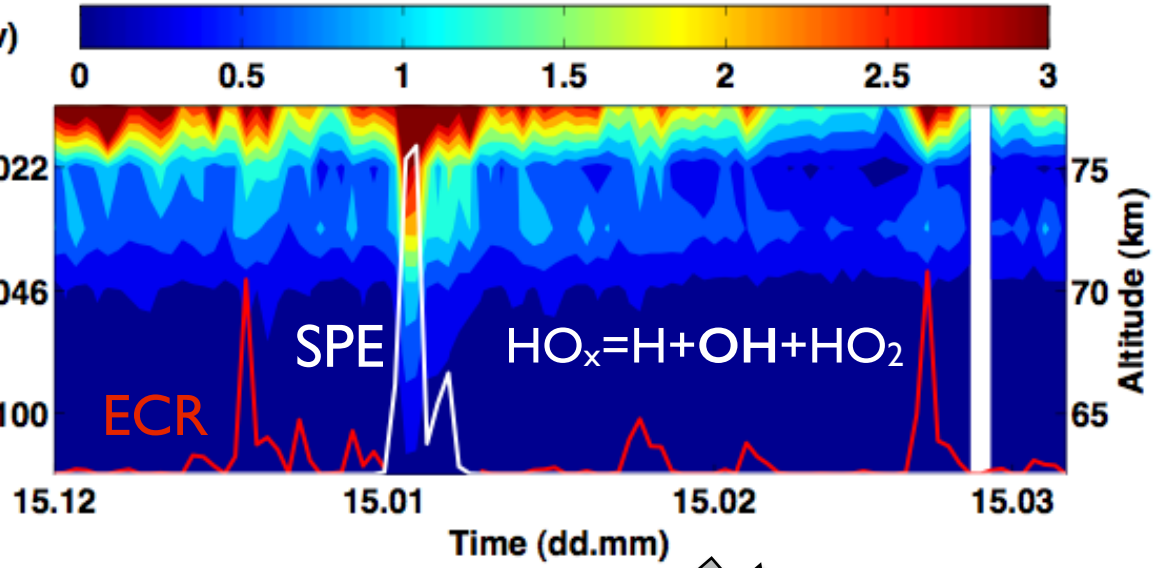


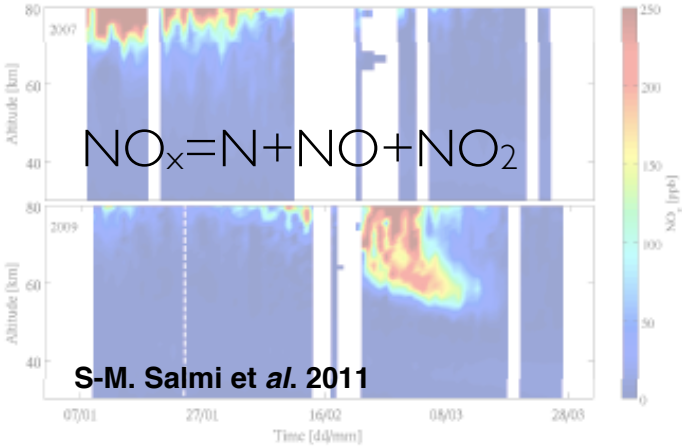
- ~50 years of data (ERA-40 and ECMWF)
- statistically significant differences in winter- time polar surface air temperature
- **±4.5 K changes in both hemispheres**

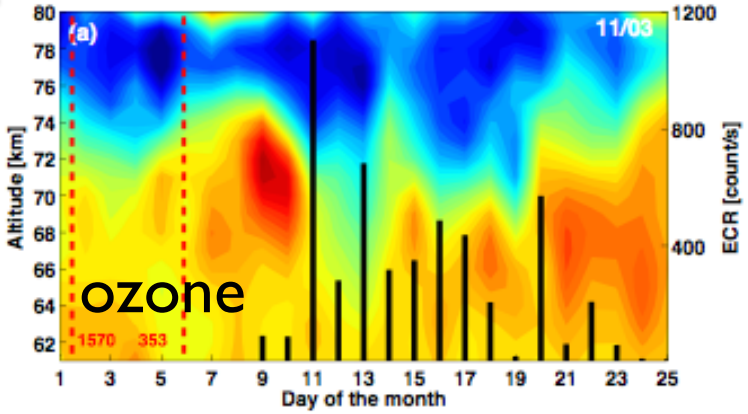




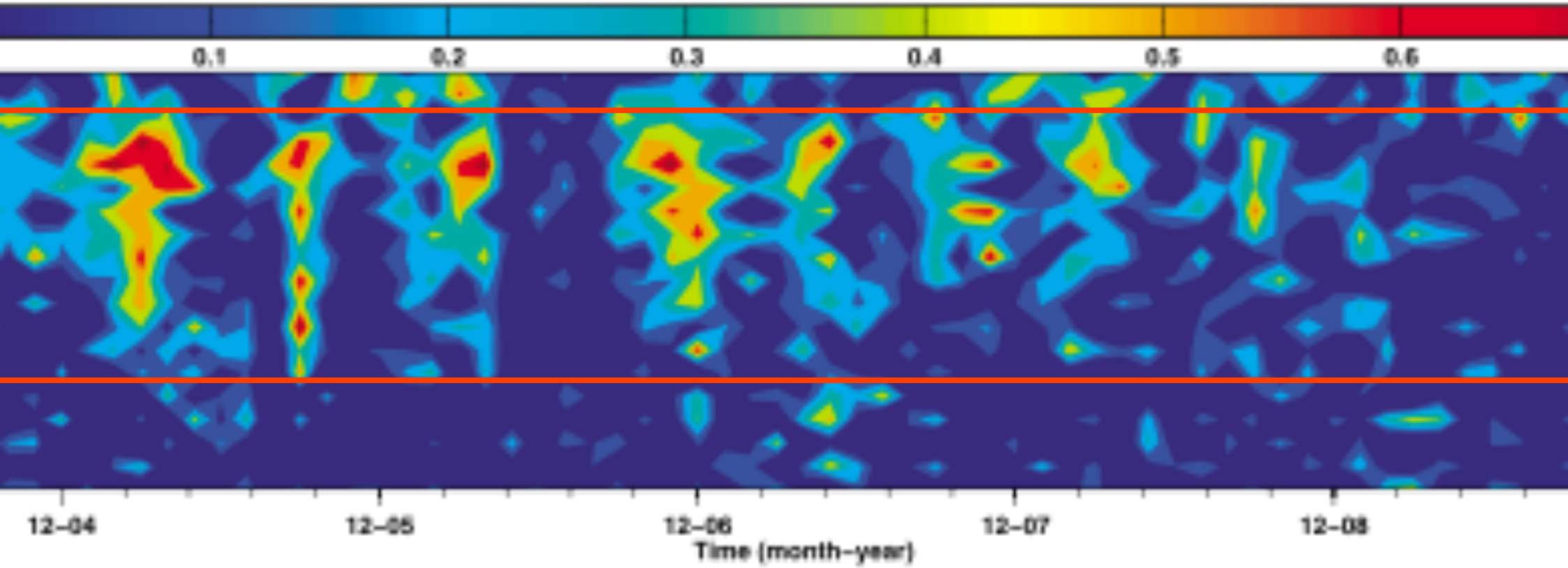
- increased ionisatio
- enhanced HO_x ar
- mesospheric ozor
- effect on climate





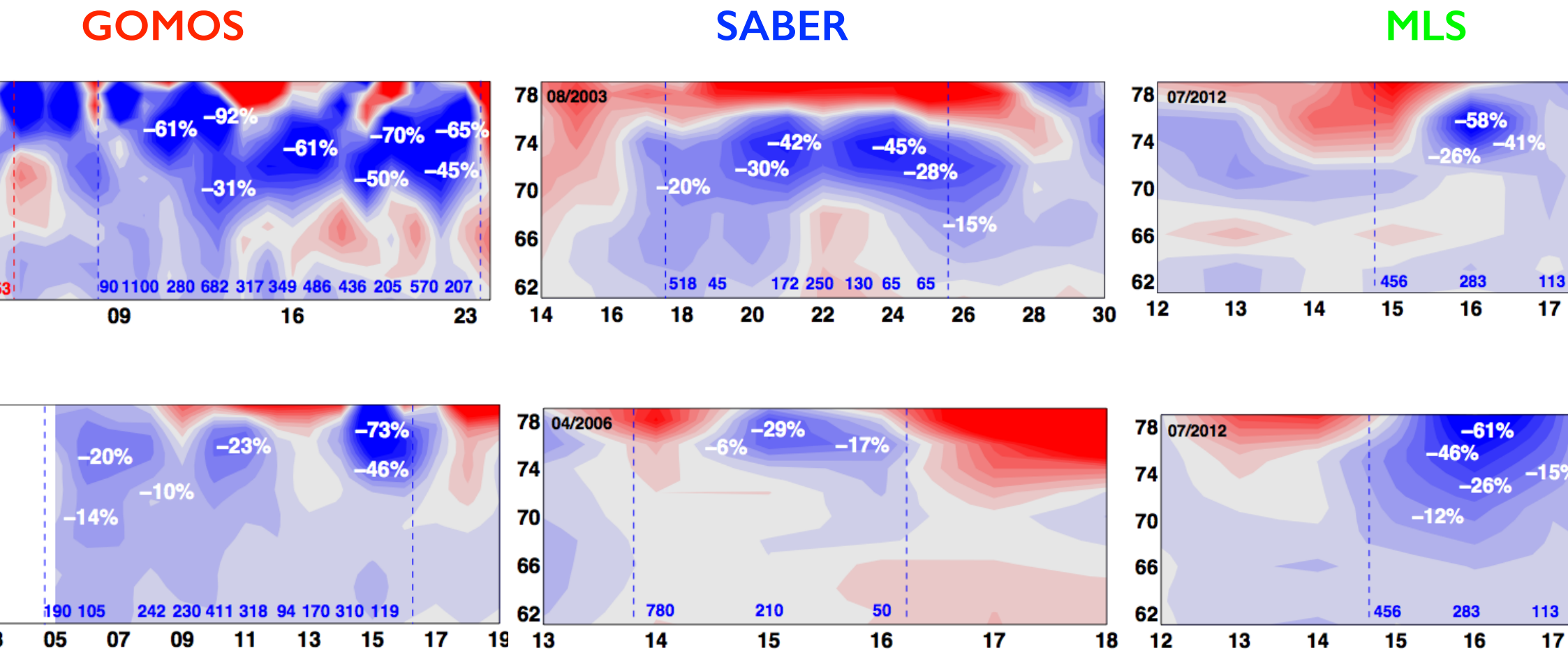


Correlation between OH and energetic electrons



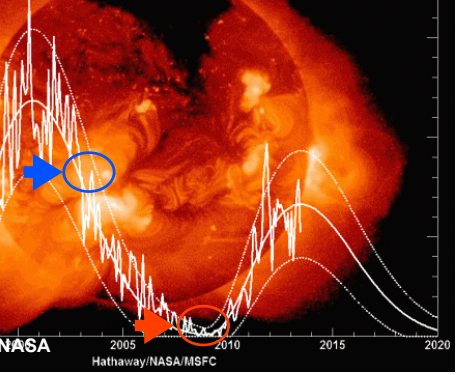
- precipitating electrons significantly affect mesospheric hydroxyl during 35% of the time
- the effect is observed down to about 52 km altitude
- the correlation decreases as we move towards the solar minimum in 2009

What about the ozone?

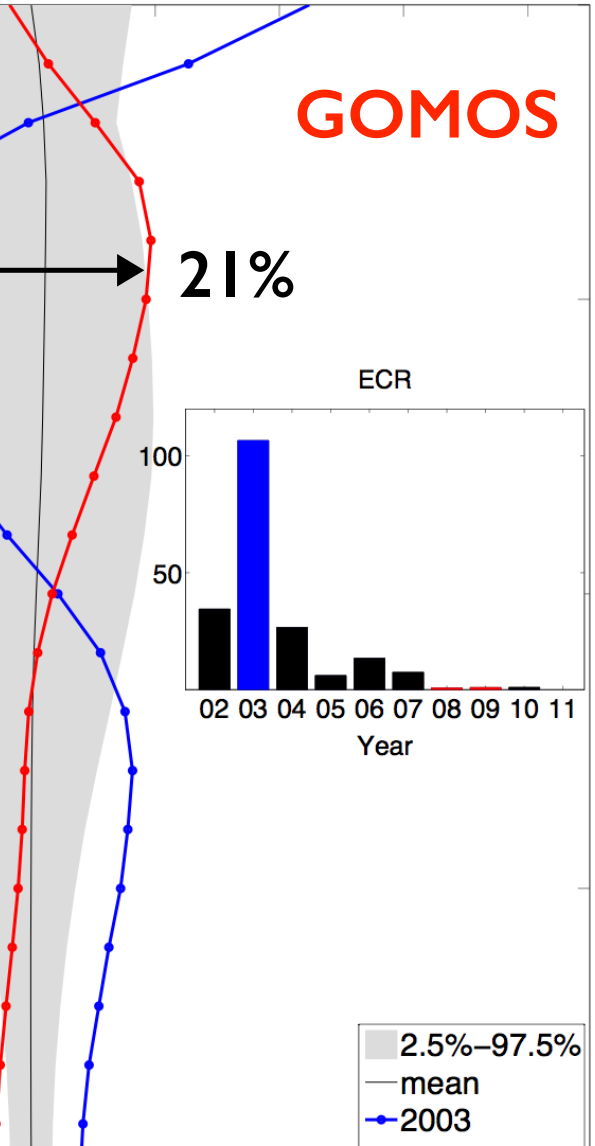


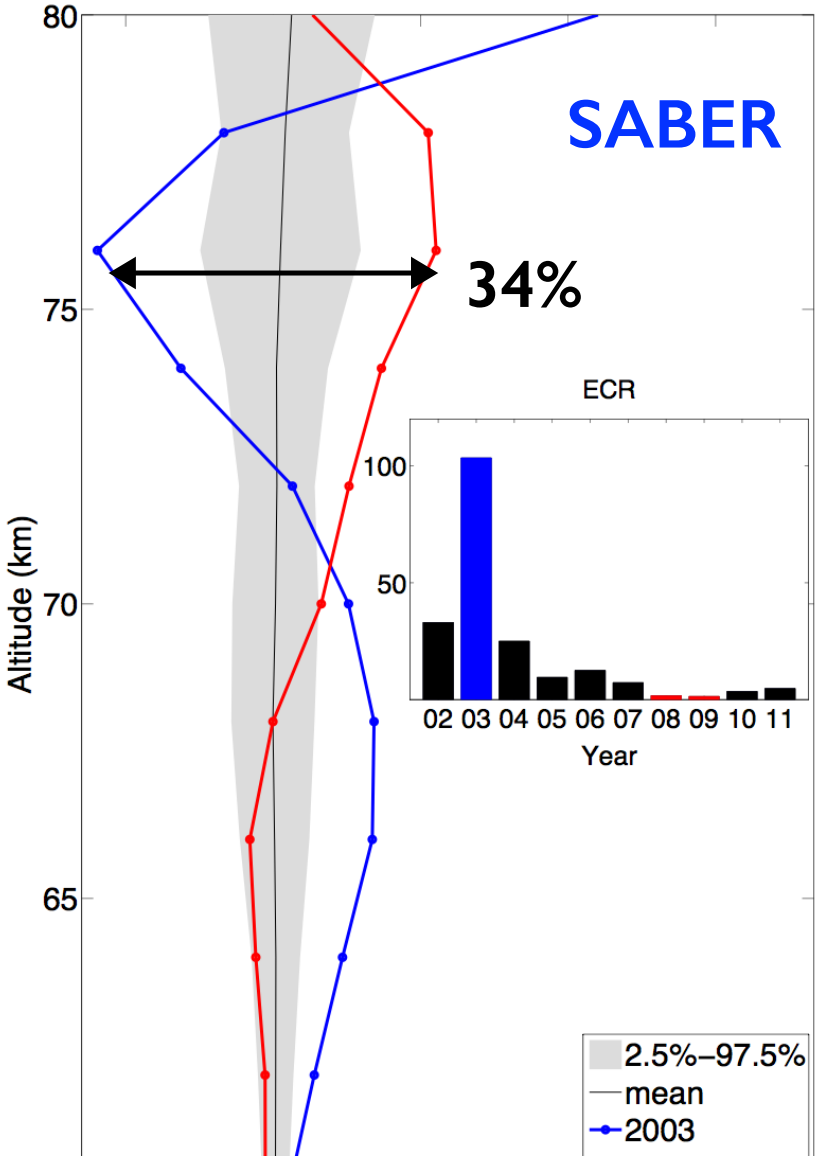
Global Ozone Monitoring by Occultation of Stars (GOMOS/Envisat)

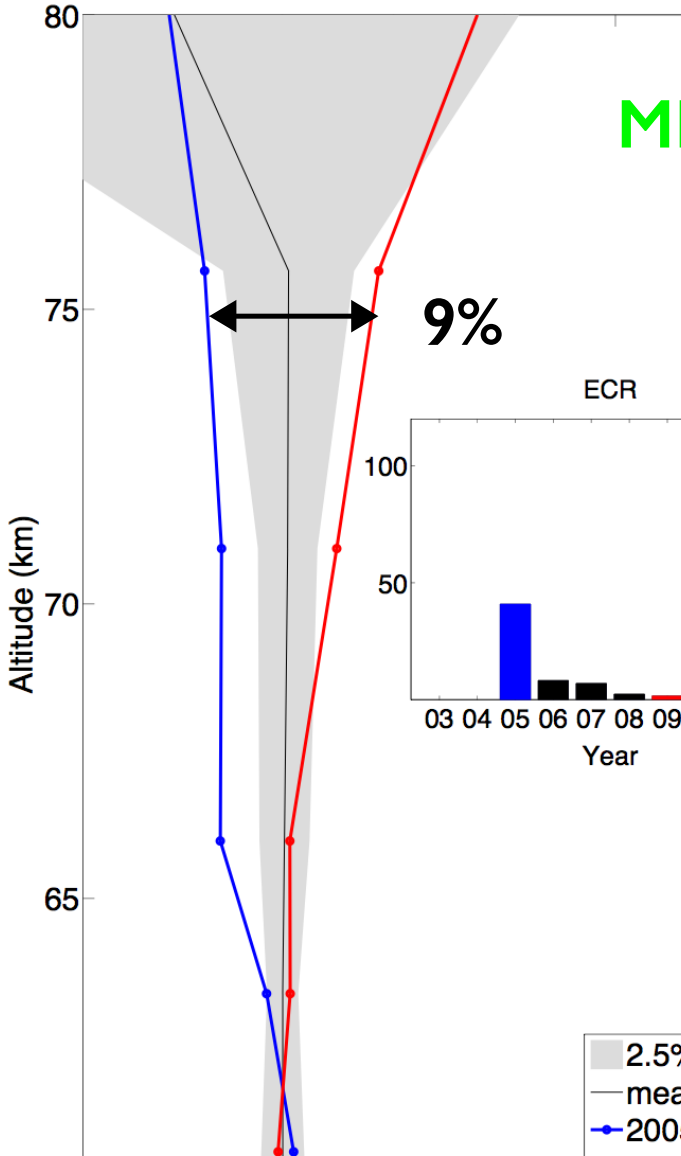
Sounding of the Atmosphere using Broadband Emission Radiometry (SABE

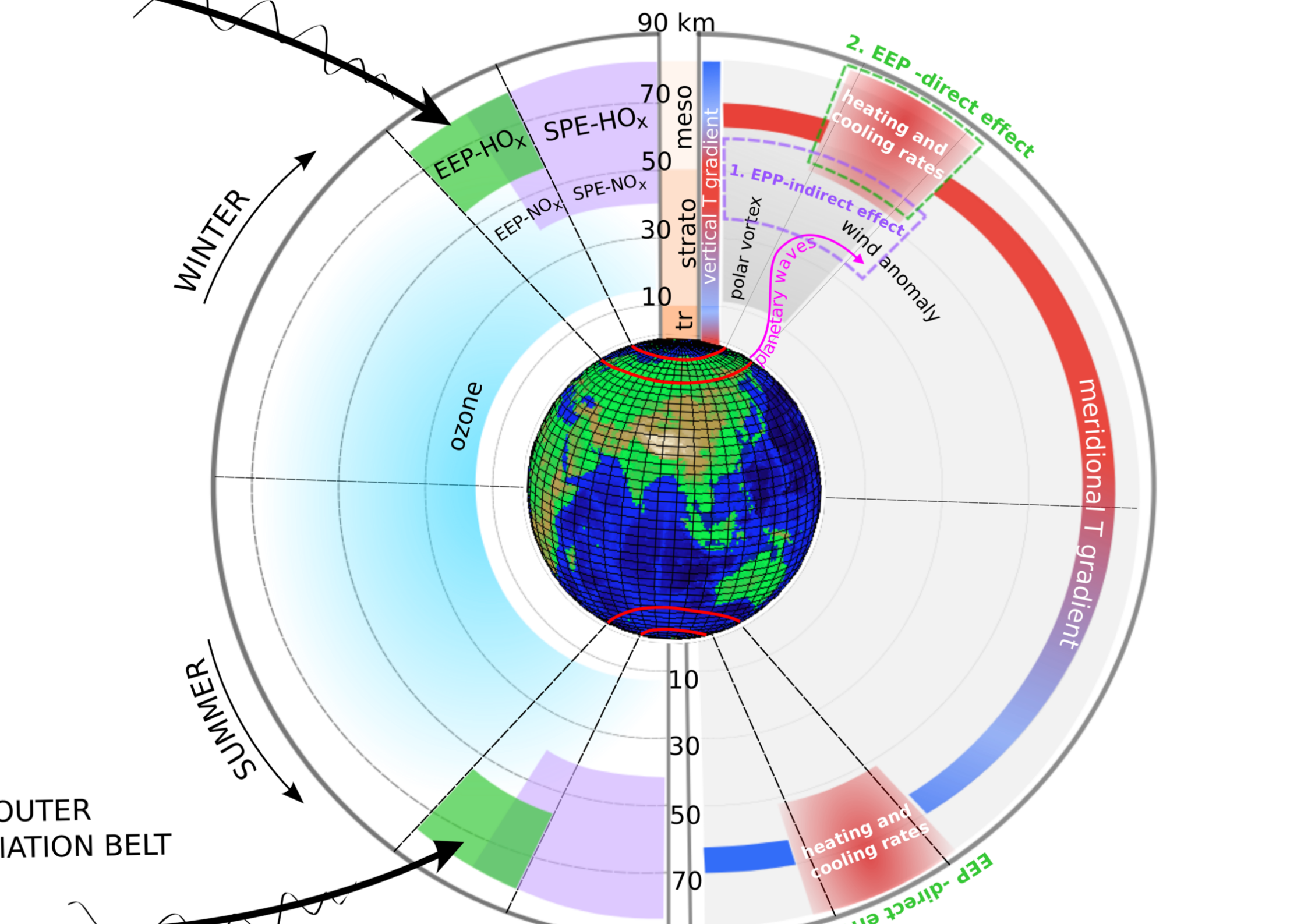


Effect of energetic electron precipitation on a longer timescales








90 km
70
50
30
10
meso
strato
tr
vertical T gradient
EEP-HOx
SPE-HOx
EEP-NOx
SPE-NOx
WINTER
SUMMER
ozone
polar vortex
planetary waves
wind anomaly
1. EPP-indirect effect
2. EEP -direct effect
heating and cooling rates
meridional T gradient
heating and cooling rates
EEP -direct effect
OUTER
IATION BELT

Thank you for your attention!