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Energetic particle precipitation and mesospheric odd hydrogen

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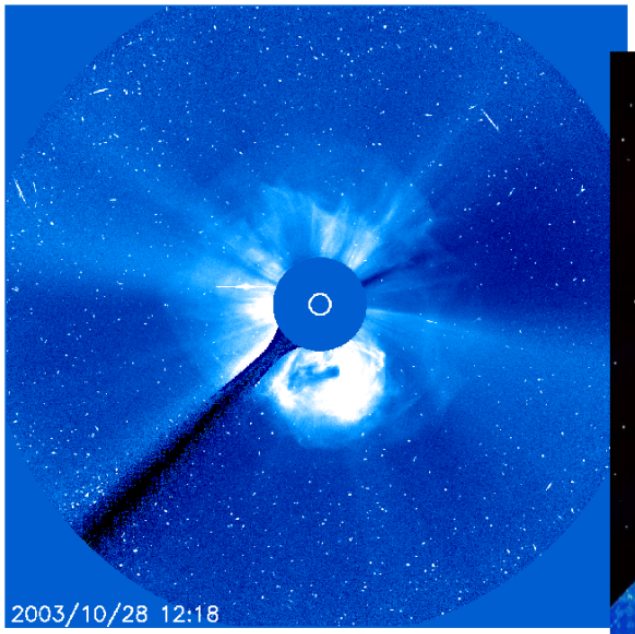
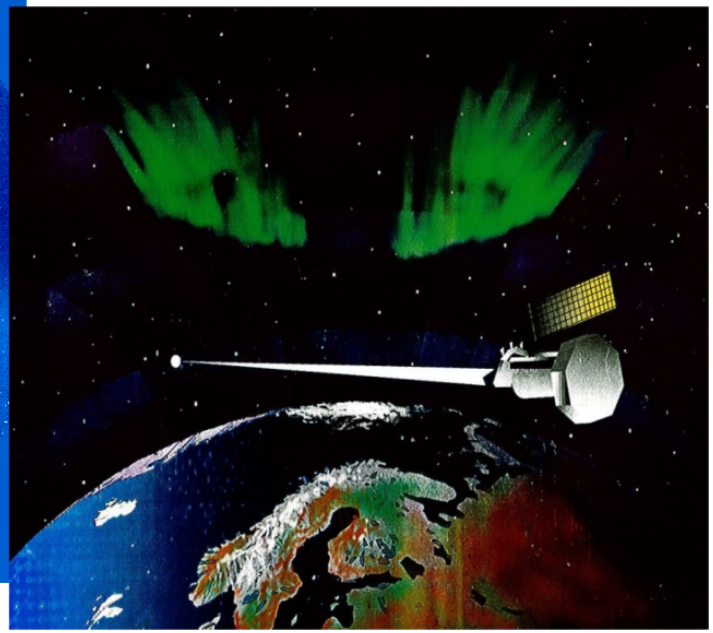
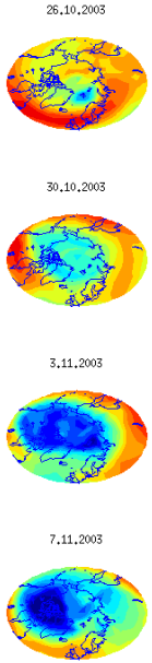
Energetic particle precipitation (EPP)



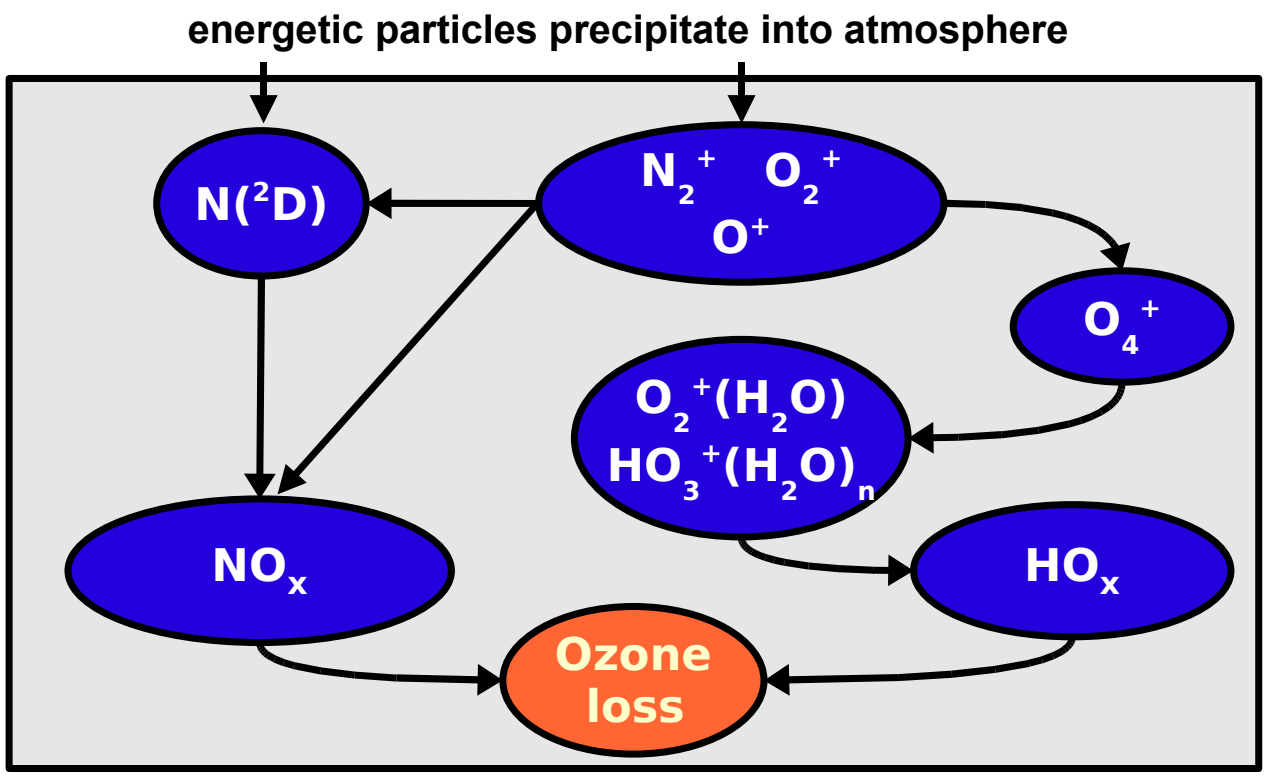




Earth's magnetic field directs charged particles into polar regions

EPP affects both ionosphere and middle atmosphere

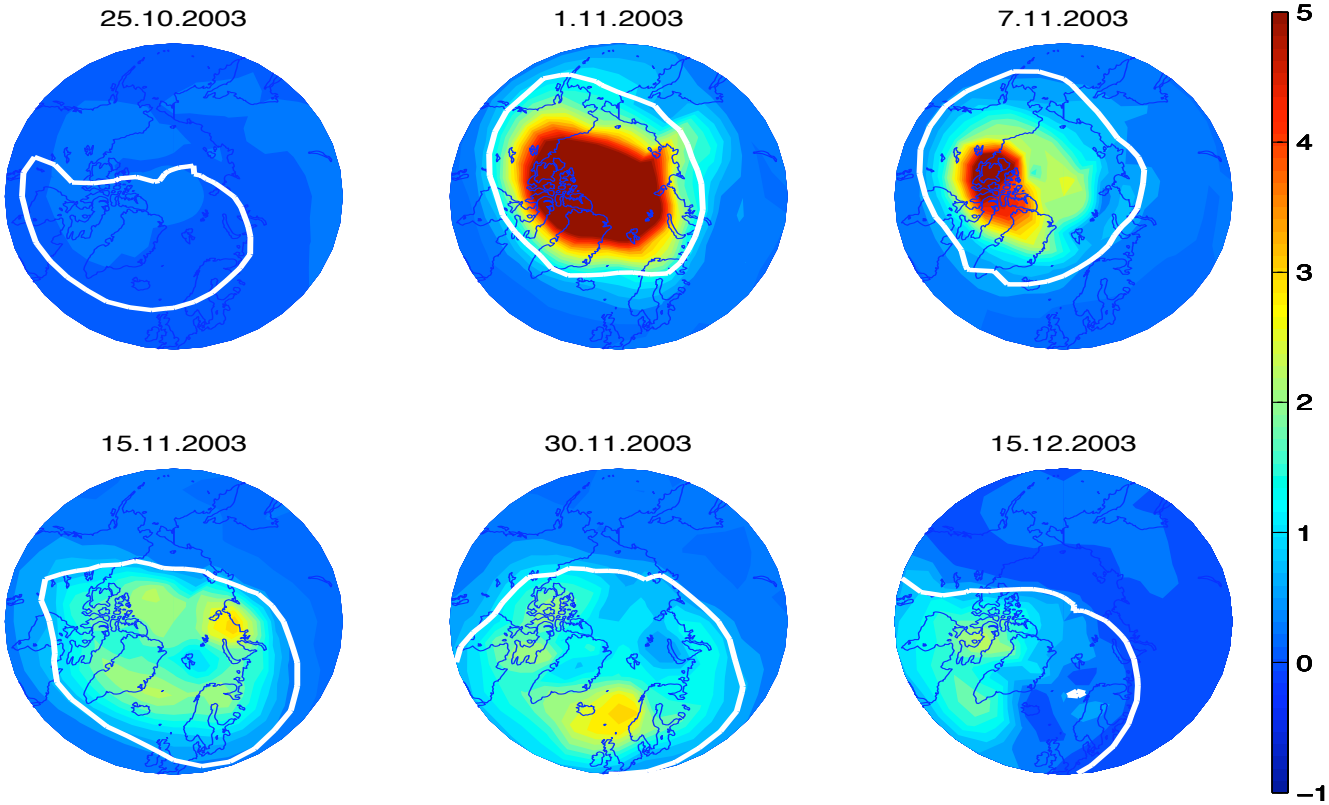
Atmospheric effects of EPP



Ozone connects to temperature and dynamics

Influence of polar vortex

HNO_3 (ppbv) at 45 km, Oct–Dec 2003



FinROSE chemistry-transport model

Mesospheric odd hydrogen: indicator of EPP

- Night-time HO_x ($= H + OH + HO_2$) concentration is relatively low.
  $\Longrightarrow$ It can be enhanced by moderate EPP forcing.

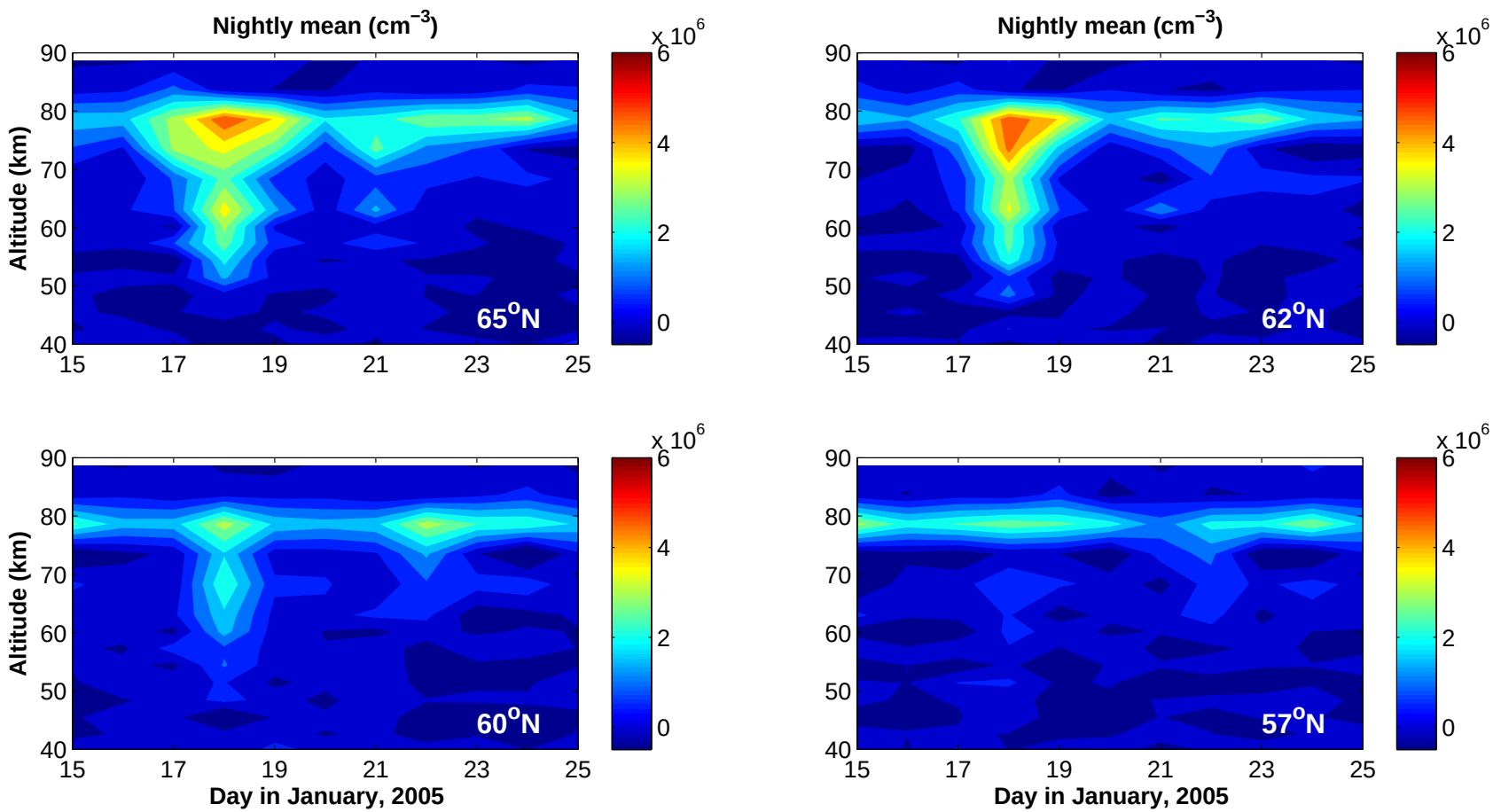
- HO_x has a relatively short chemical lifetime (hours).
  $\Longrightarrow$ Returns quickly to normal values after EPP forcing stops.

Odd hydrogen responds quickly
to increases and decreases of EPP forcing

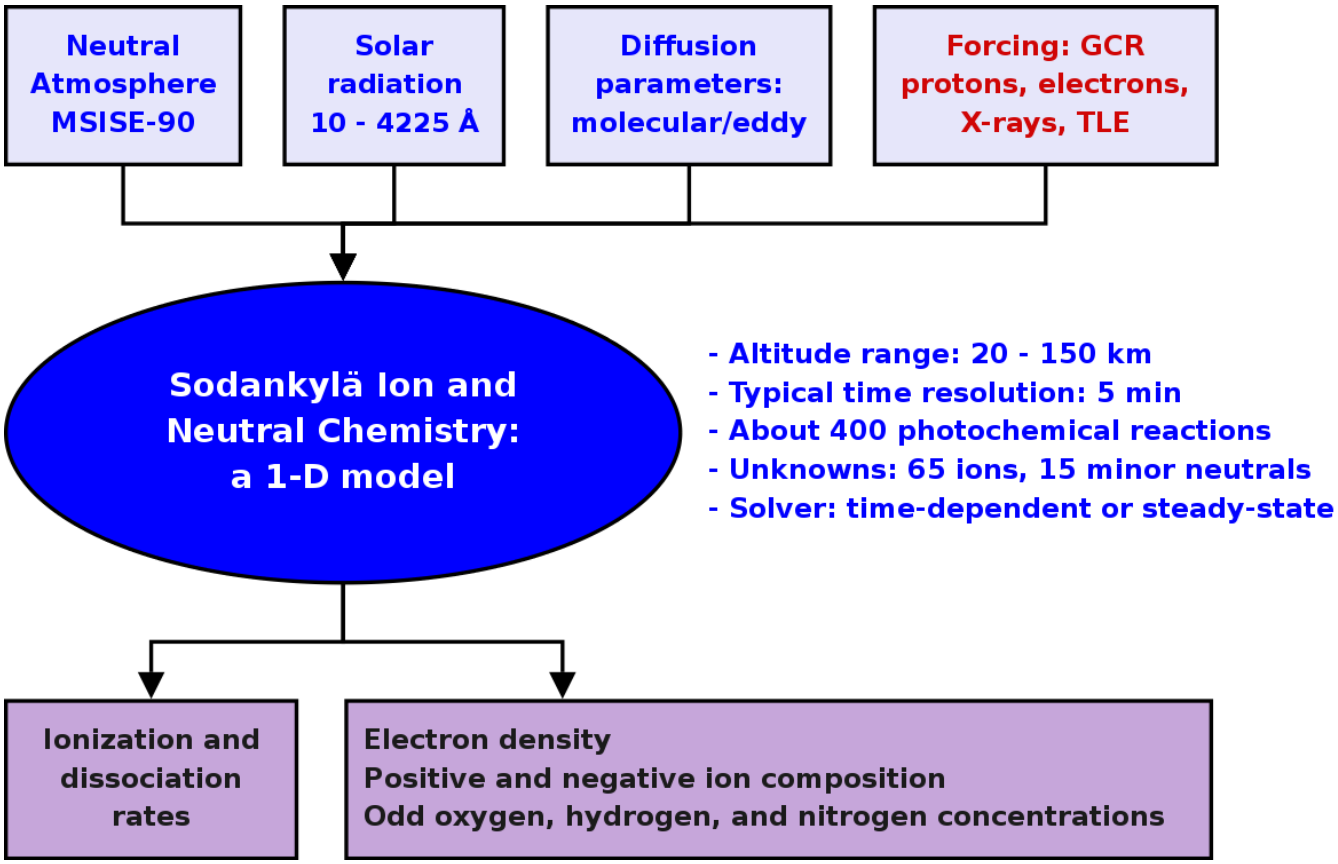
- HO_x data are available from the MLS/Aura instrument, providing observations of mesospheric changes during EPP.

MLS/Aura – mesospheric OH during EPP

Solar proton event of January 2005

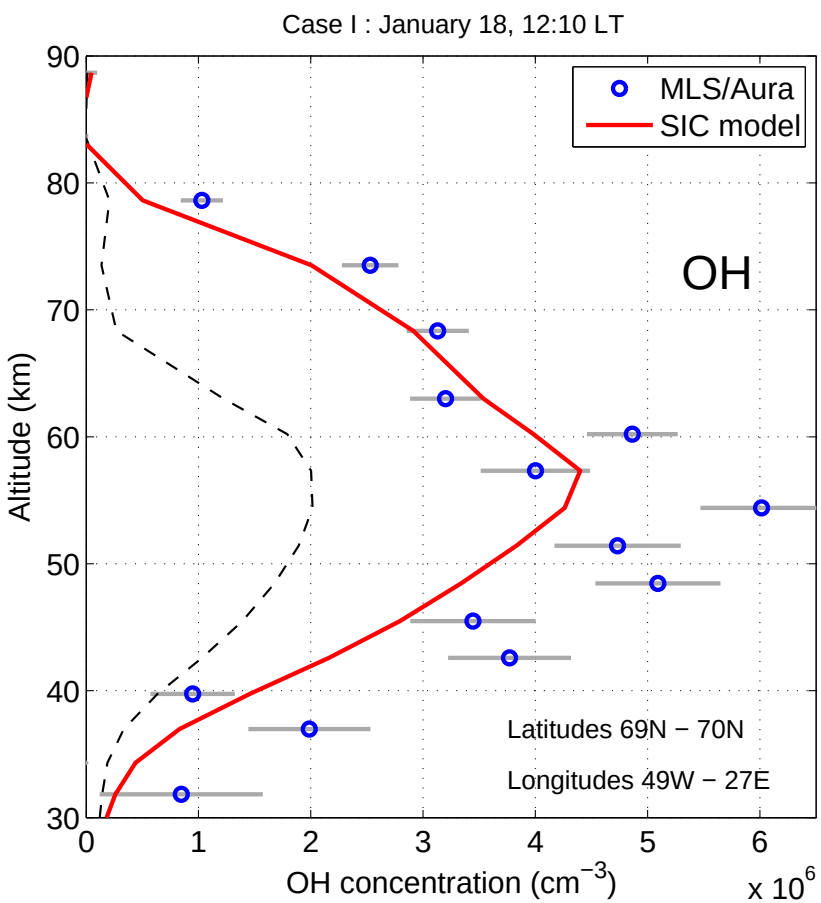


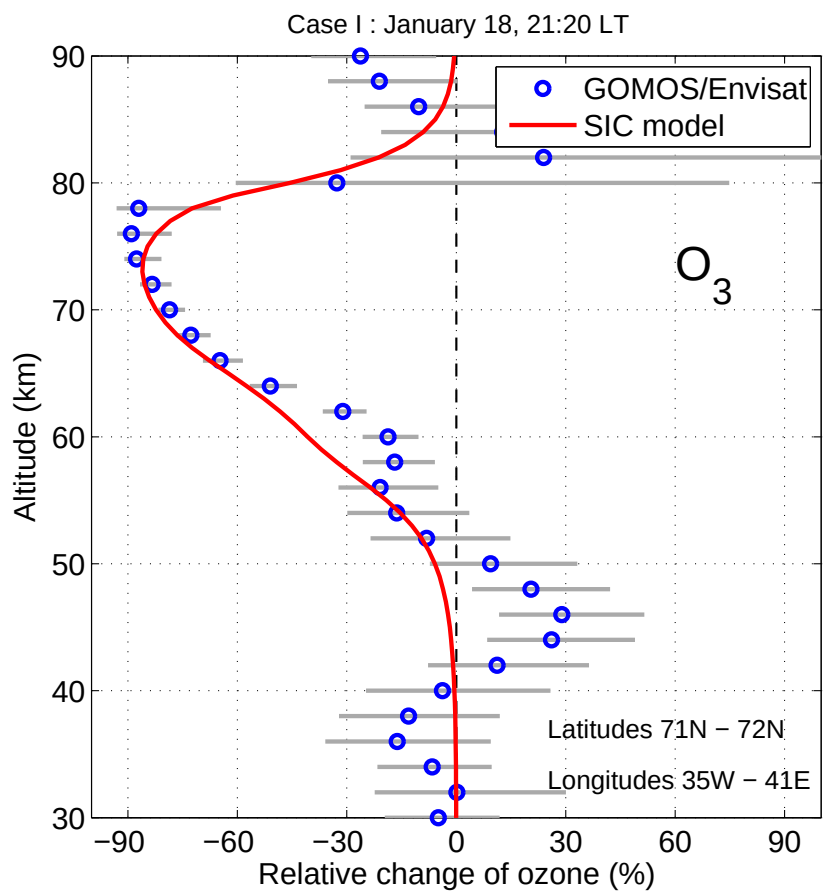
SIC model – Ion chemistry and odd hydrogen



OH production – SIC vs. MLS/Aura

Solar proton event of January 2005





OH: spatio-temporal proxy for EPP?

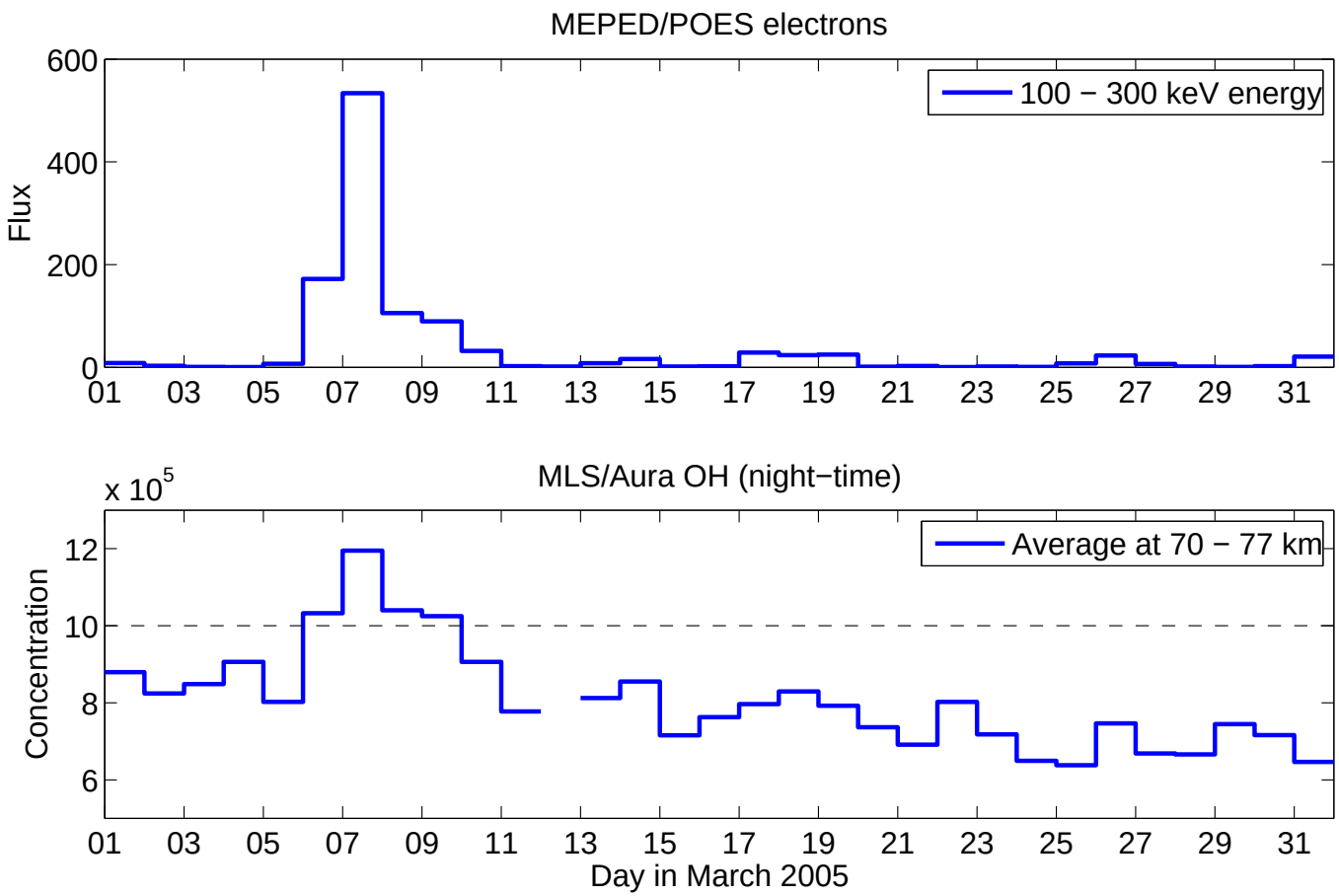
- Strong solar proton events: YES
  - effects cover the polar cap regions
  - events last for several days
  - proton flux observations are easy

- Electron precipitation: MAYBE
  - effects cover restricted latitude bands
  - magnitude and duration are very variable
  - electron flux observations are difficult

OH proxy would have great value in characterizing electron precipitation

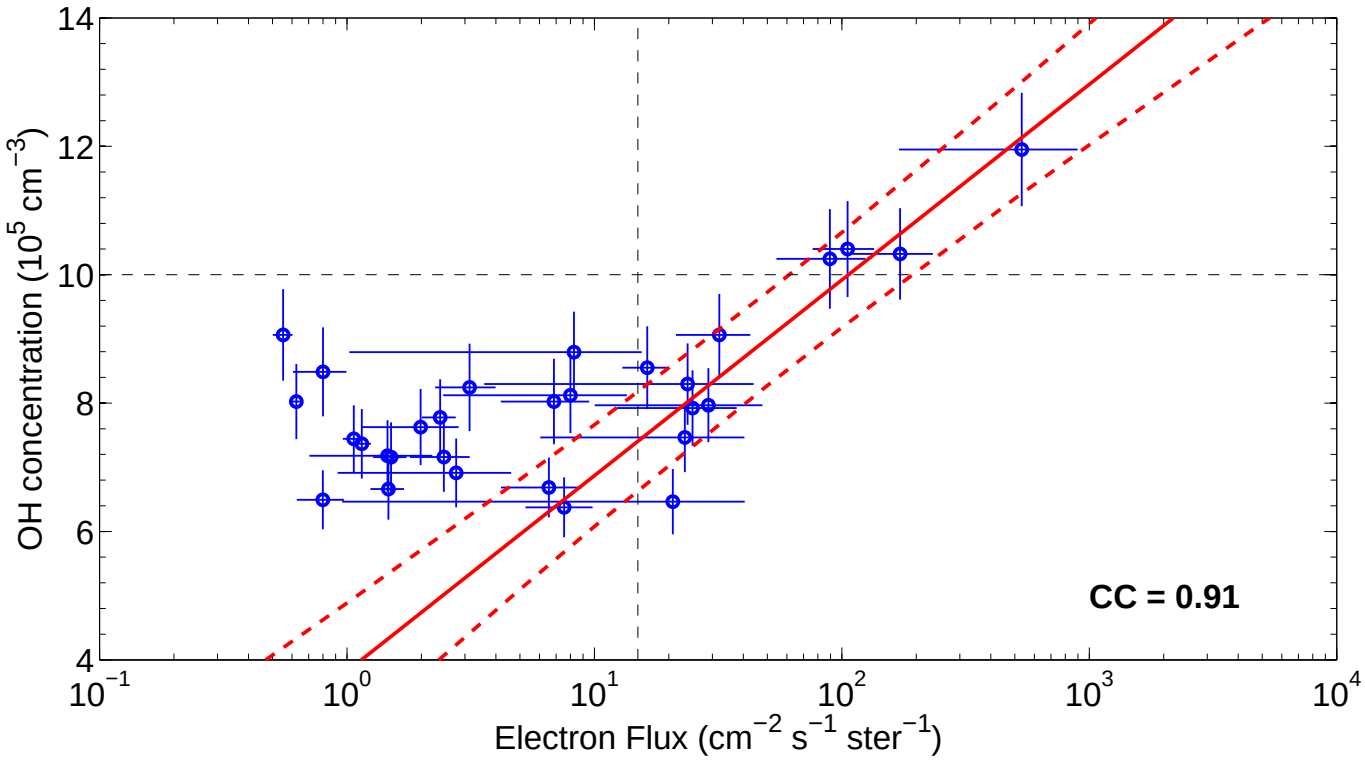
Observations in March 2005

Magnetic latitudes 55 – 65°S



Correlation: electron flux vs. OH concentration

March 2005, magnetic latitudes 55 – 65°S



High electron fluxes are seen in OH concentration

Summary

- Energetic particle precipitation (EPP) produces odd hydrogen in the mesosphere
- MLS/Aura can detect the changes in HO_x caused by EPP
- HO_xbehaviour can be modelled if ion chemistry is taken into account
- MLS/Aura observations can help in characterisation of the magnitude and spatio-temporal extent of EPP
- For more details, see
  Verronen et al., *Geophys. Res. Lett.*, *33*, L24811, 2006
  Verronen et al., *Ann. Geophys.*, *25*, 2203–2215, 2007