Energetic Electron Precipitation during Slot Region Filling Events

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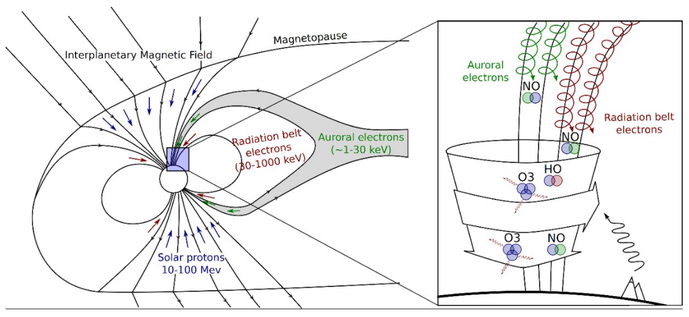
Motivation

Precipitating auroral and radiation belt electrons are considered an important part of the natural forcing of the climate system.

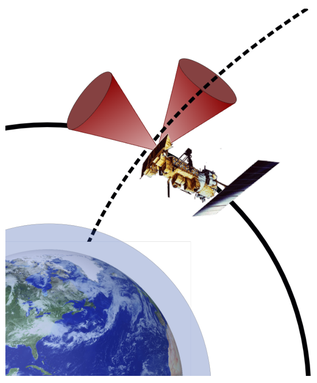


Ionization rates due to Medium Energy Electrons (MEE) (>30 keV)?

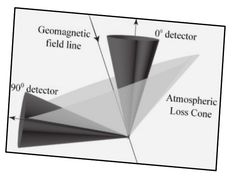
The slot region marks the equatorward boundary of the energetic electron precipitation (EEP). There are, however, numerous reports where energetic electrons cross these boundaries and fill the slot region. The ensuing EEP will occur long after the geomagnetic activity subsides. This is a missing energy input in current EEP estimates scaled by geomagnetic indices.

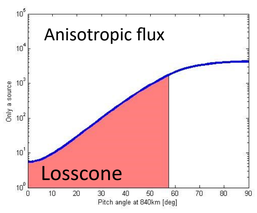
Data and Methods

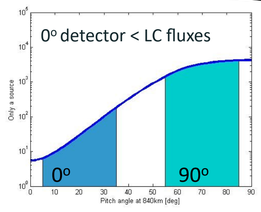
NOOA/POES MEPED



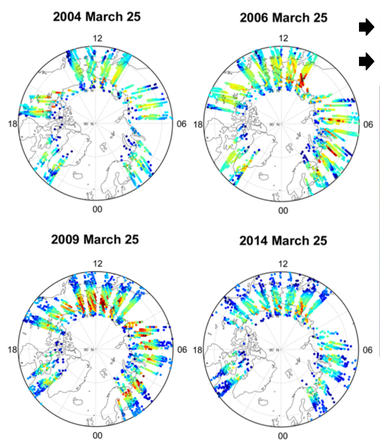
- Low energy proton corrections
- Energy channels: >43 keV, >114 keV, >292 keV
- Applies flux measurements from both telescopes together with theory of pitch angle diffusion by wave-particle interaction to construct the bounce loss cone (BLC) fluxes



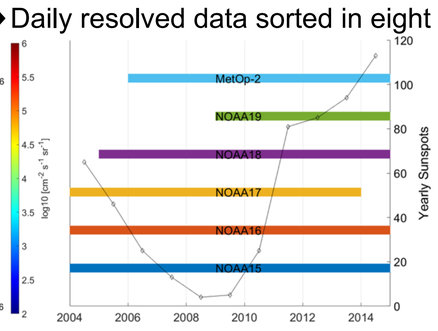




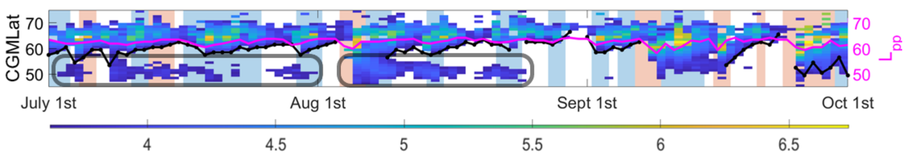
Nesse Tyssøy et al. (2016), Energetic electron precipitation into the middle atmosphere—Constructing the loss cone fluxes from MEPED POES, doi:10.1002/2016JA022752.



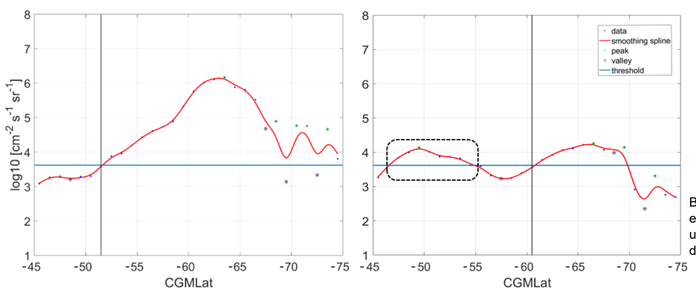
- Data over a full solar cycle
- Daily resolved data sorted in eight MLT sectors



Identification of slot region filling events

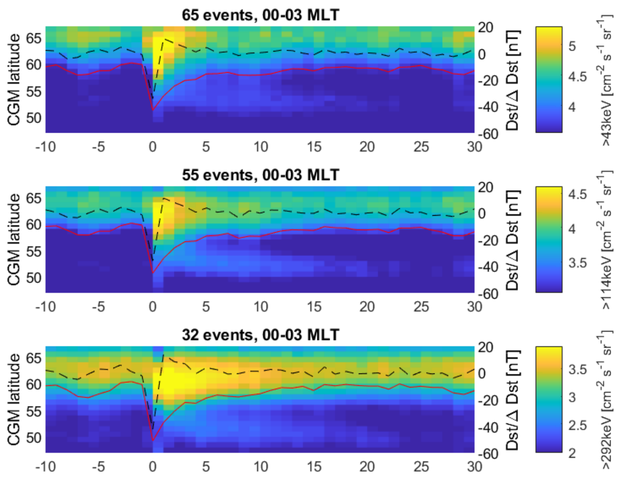


Plasmapause location, L_{pp}: Kp-parameterized plasmapause model by Moldwin et al. (2002).
Equatorward boundary determined by Babu et al. (2022):



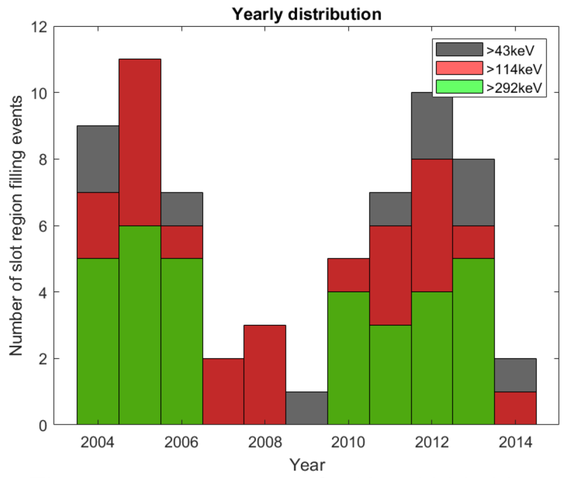
Babu et al. (2022). Determining latitudinal extent of energetic electron precipitation using MEPED on-board NOAA/POES. doi:10.1029/2022JA030489

Potential slot region filling events:
Equatorward boundary - Lpp > mean difference + standard deviation
Single days and solar proton events are disquarded
Onset day largets Dst drop

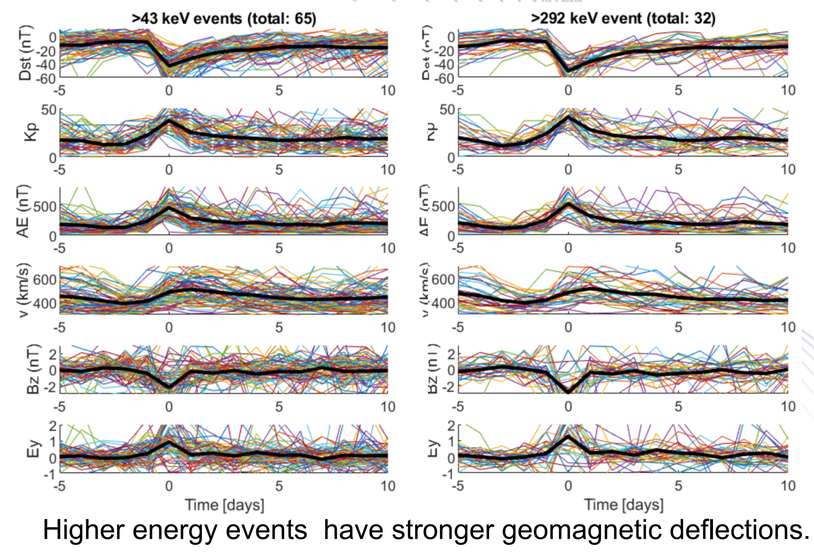


The occurrence rate of >292 keV slot region filling events is about half of the >43 keV slot region filling events.

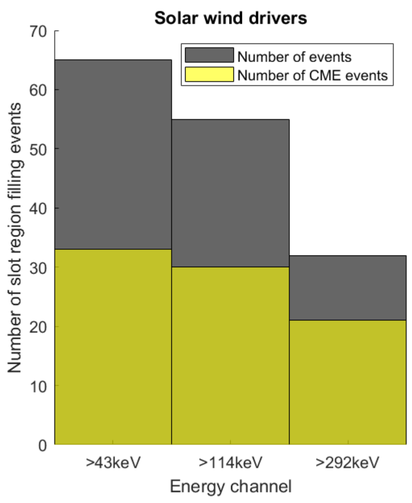
Dependency on Solar Wind and Geomagnetic Activity :



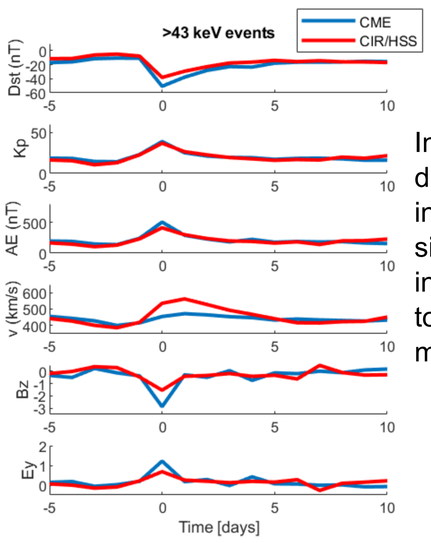
The occurrence rates of >43, >114 keV, and >292 keV events are found to be strongly energy and solar cycle dependent.



Higher energy events have stronger geomagnetic deflections. Solar wind parameters reveal a calm period before the event.

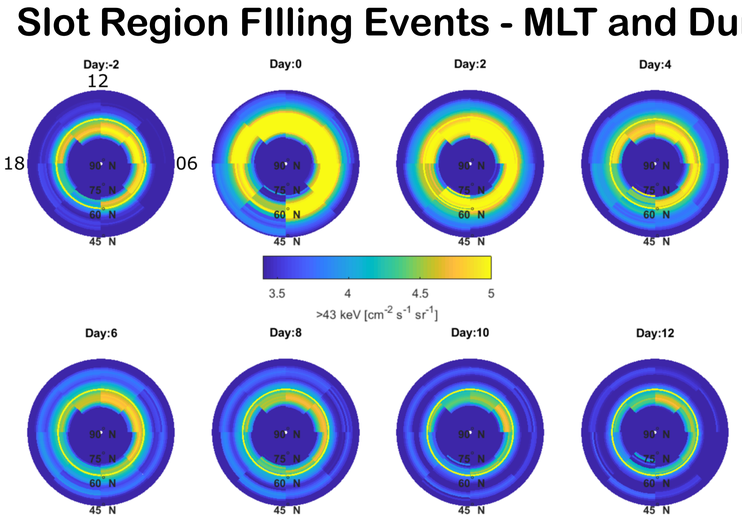


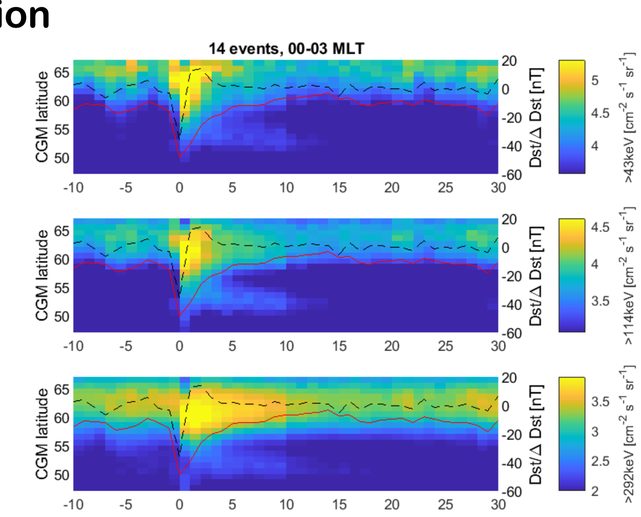
Higher energy events are more likely to be associated with CMEs.



Independent of the solar wind drivers, the geomagnetic indices are similar. This similarity is particularly evident in the Kp index, which is known to be strongly correlated with magnetospheric convection.

Slot Region FIlling Events - MLT and Duration

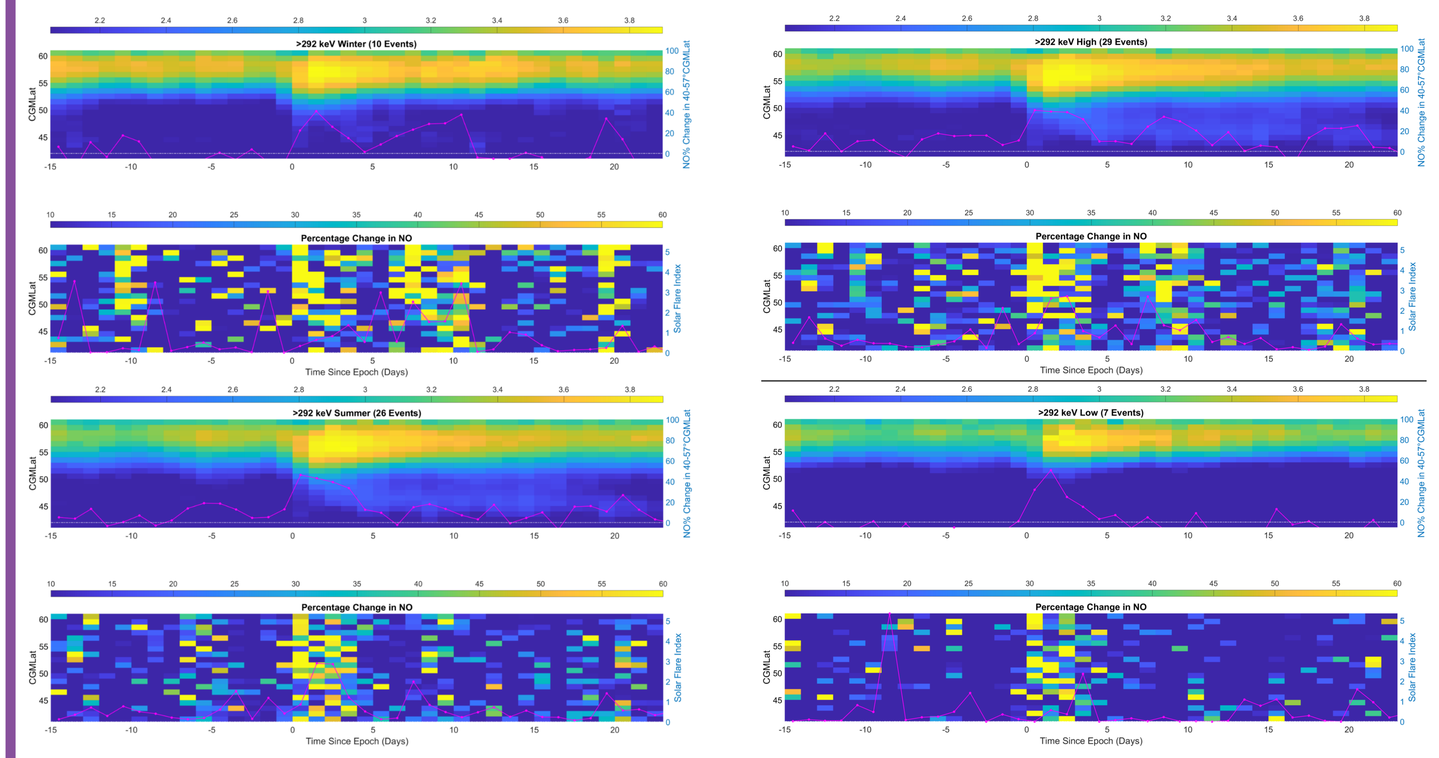




The slot region reforms more efficiently closer to the plasmapause, which creates a double EEP band. The slot region precipitation pattern is consistent with pitch angle scattering into the loss cone from plasmaspheric hiss and lightning-induced whistler mode waves.

The maximum flux level below 57°CGM latitude (L< 3), was reduced to 25% after 13, 14 and 17 day for the >43 keV,'>114 keV, and >292 keV fluxes. The corresponding e-folding decay rates are 9, 10, and 12 days consistent with previous studies.

Atmospheric Effects of Slot Region Energetic Electron Precipitation



Concurrent with slot region filling events, the MIPAS/Envisat NO density shows an increase at <55° CGMlatitudes. The NO density increases during both summer and winter at low latitudes associated with slot region filling events.

This demonstrates the importance of including slot region EEP when assessing the EEP impact on the atmosphere!