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VLASIATOR

Proton precipitation in a hybrid-Vlasov simulation with southward interplanetary magnetic field driving: First 3D results

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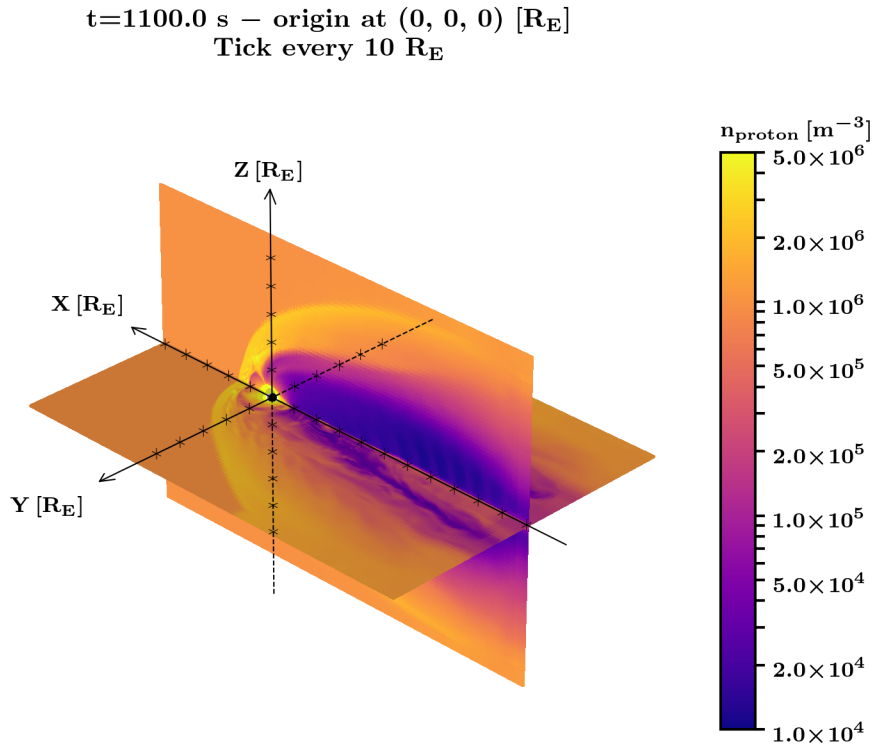
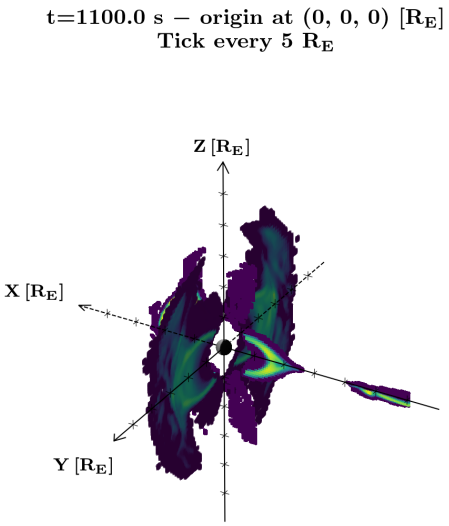
Vlasiator 6D run

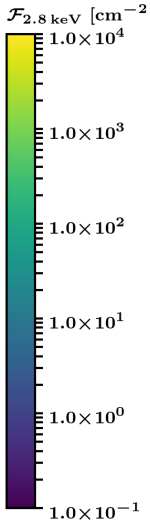
- Vlasiator is a hybrid-Vlasov model of near-Earth space (ions as velocity distributions, electrons as fluid)
  - Vlasov equation for ions
  - Maxwell's equations for electromagnetic fields
  - Closure with Ohm's law incl. Hall term and ∇P_e
- Same 6D run as described in the earlier talk by Minna Palmroth (EGU22-3573)
  - Southward IMF driving, 5 nT
  - $V_{SW} = 750$ km/s, $n_{SW} = 1$ cm^{-3}
  - Inner boundary at 4.7 R_E
  - Run duration: 1506 s
- **Objective:** Examine auroral ($E \lesssim 30$ keV) proton precipitation in this first 6D simulation

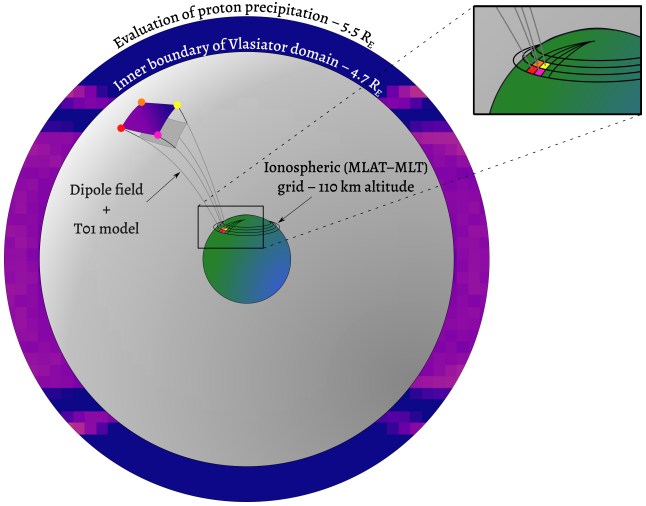


Precipitation data in Vlasiator

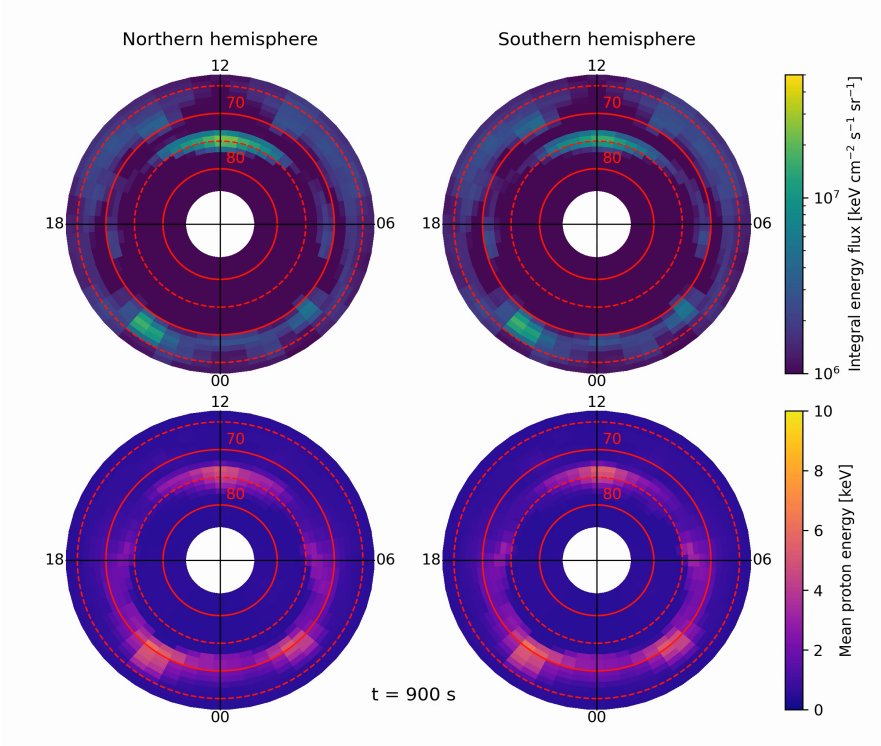
- From proton VDF, the **differential number flux** of precipitating protons is calculated (9 energy bins, 0.5–50 keV)
- The flux near the inner boundary is mapped to an ionosphere grid (MLAT–MLT) in both hemispheres
- From this differential flux, one can derive the **integral energy flux** and **mean precipitating energy**





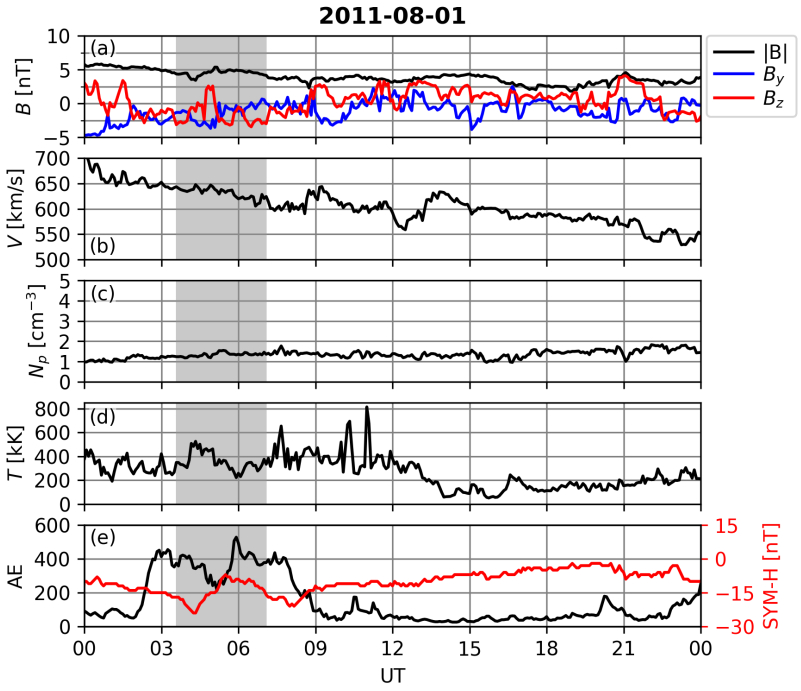


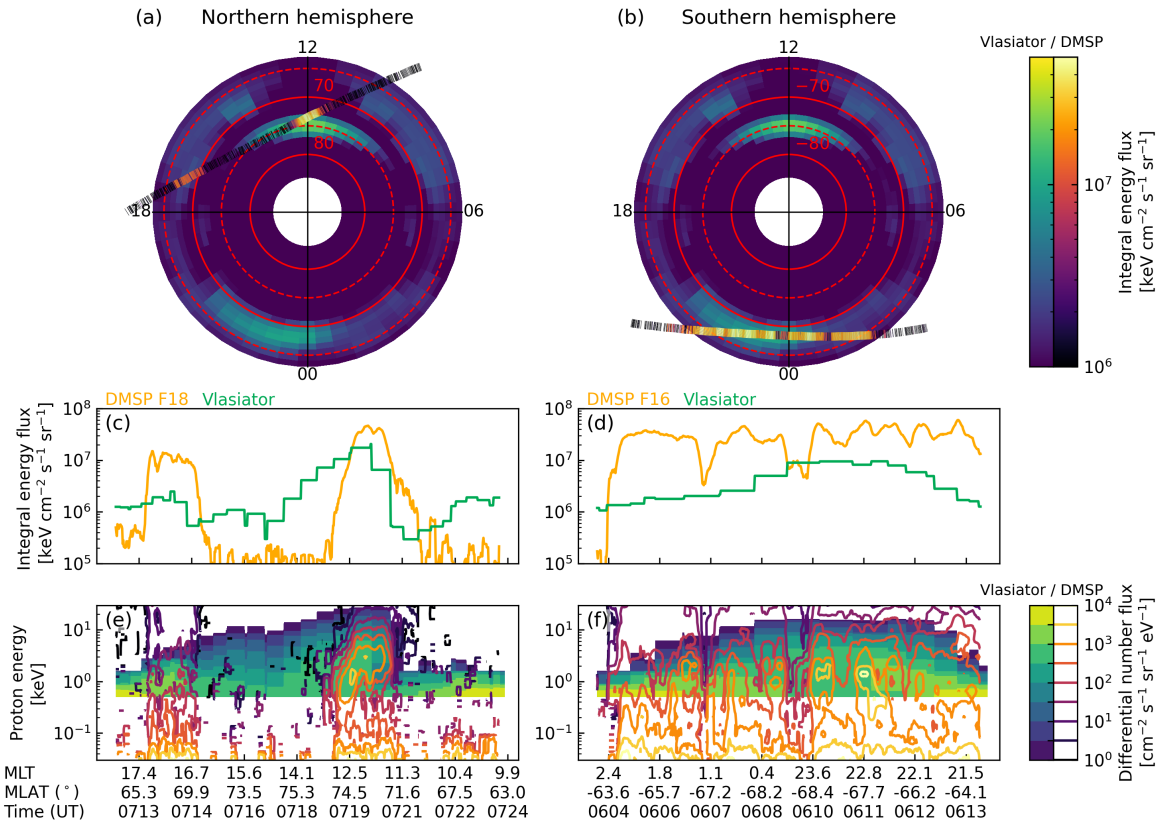
Global proton precipitation patterns



Comparison with satellite observations

- DMSP/SSJ observations during an event with comparable driving conditions





Key points and teaser

- First 3D simulation of auroral proton precipitation with Vlasiator (hybrid-Vlasov)
- Global precipitation patterns show interhemispheric symmetry on the nightside, not on the dayside
  - consistent with cusp precipitation being associated with flux transfer events transiting in it
- Comparison with DMSP observations indicate that the obtained fluxes are realistic

- Many analysis possibilities, e.g. keograms across MLT at selected MLATs
- Manuscript to be submitted soon!