Flying a Spacecraft through a Lunar Magnetic Anomaly Measurement Requirements as Defined by Fully Kinetic Modelling

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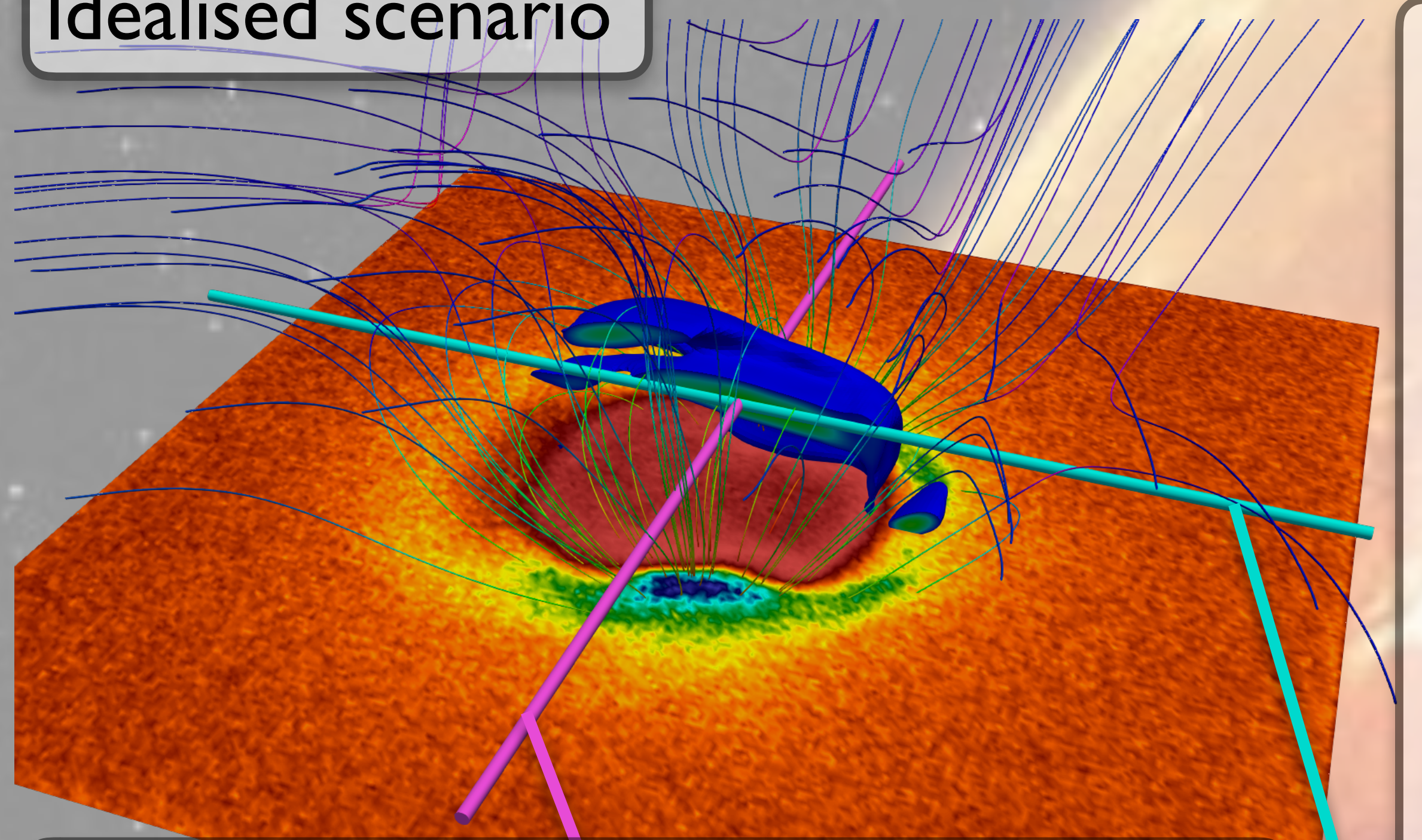
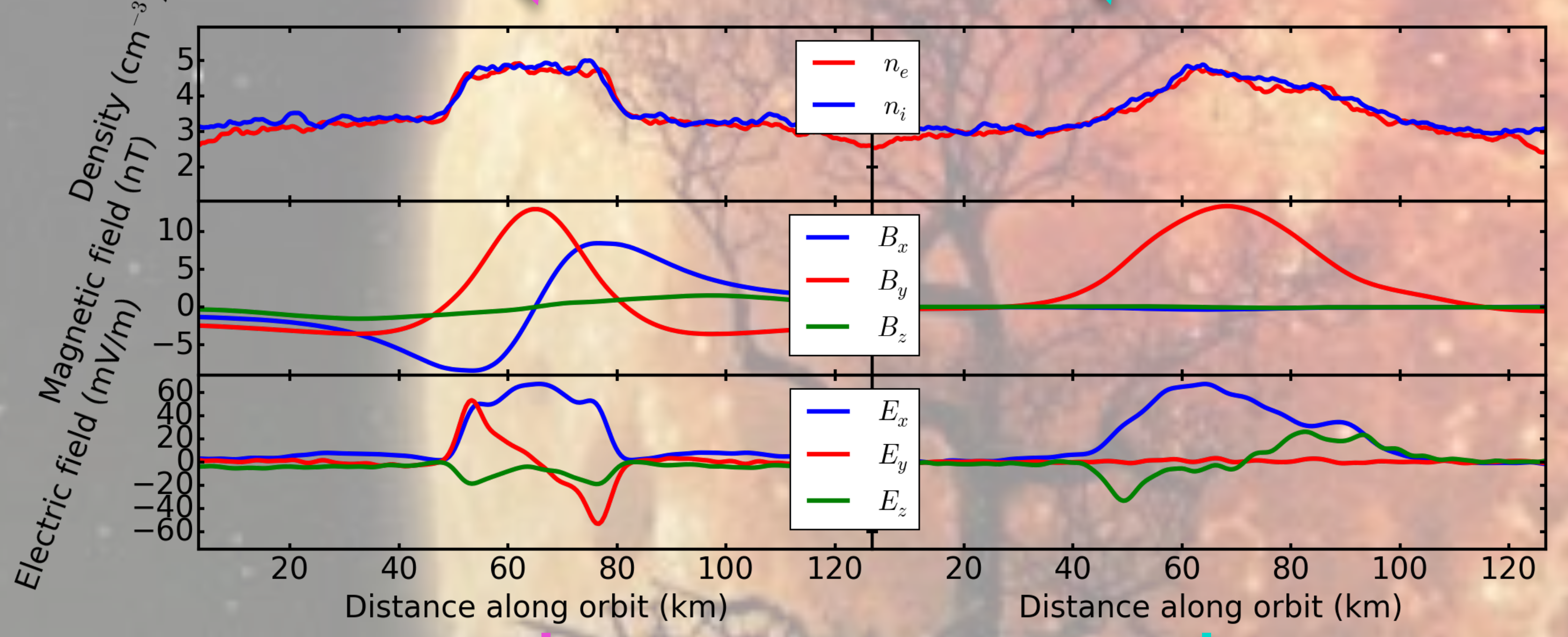
Idealised scenario

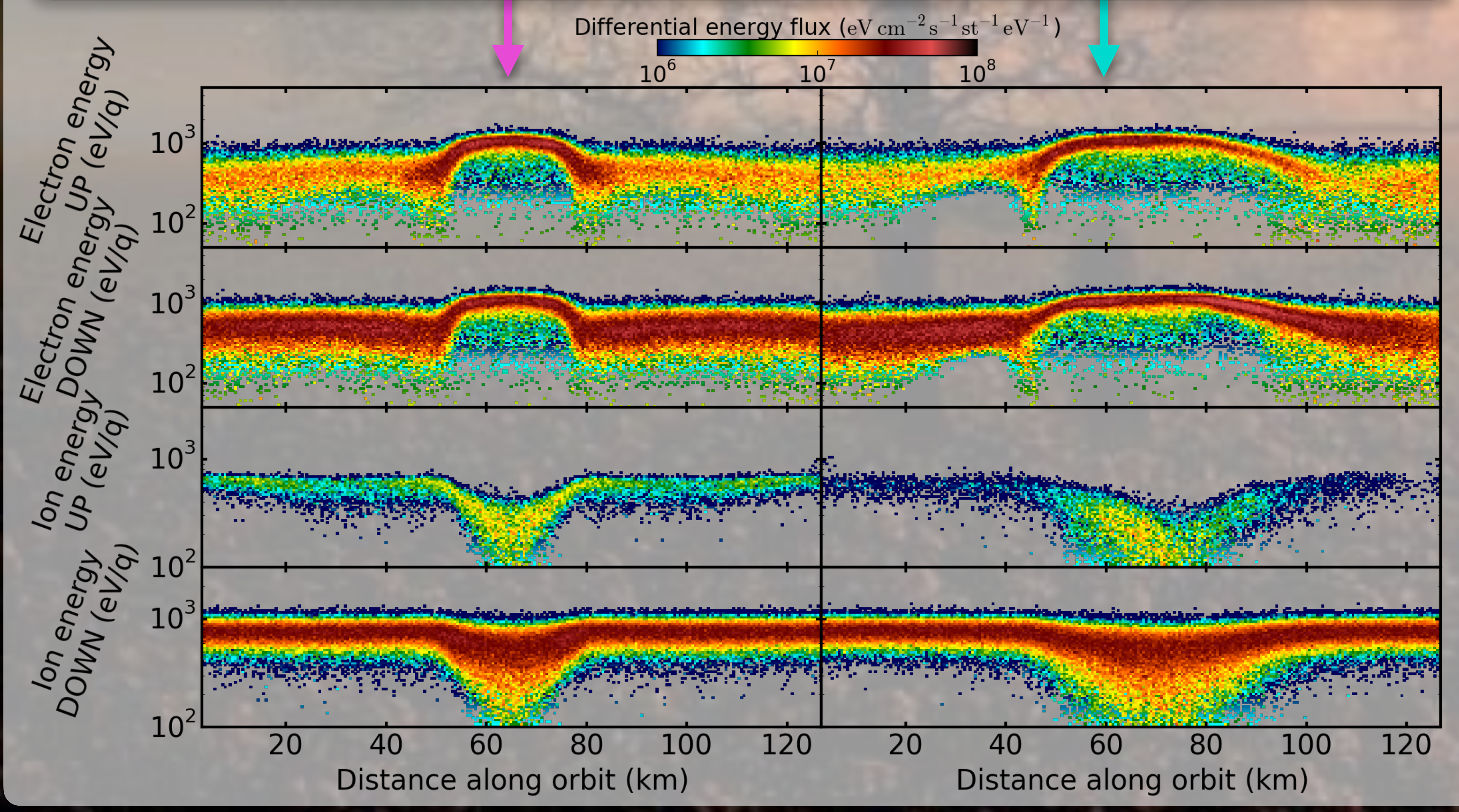


Solar wind protons penetrate deeper into magnetic anomaly regions as compared to electrons due to their difference in inertia. This leads to substantial electrostatic fields, capable of partially deflecting/reflecting the impinging solar wind plasma. A mini-magnetosphere has formed.

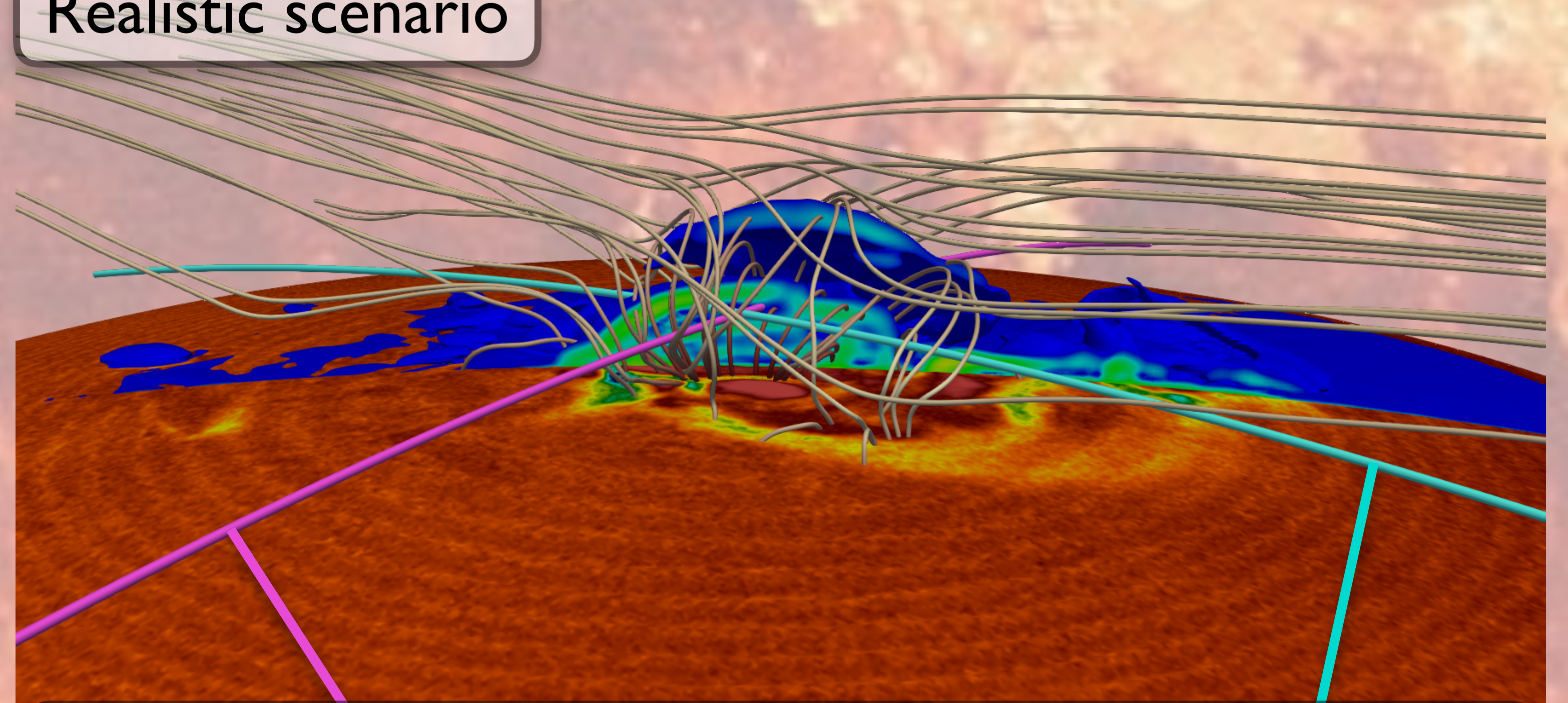
A horizontal dipole centred 13 km below the absorbing lunar surface (Deca et al. 2015, 2016).



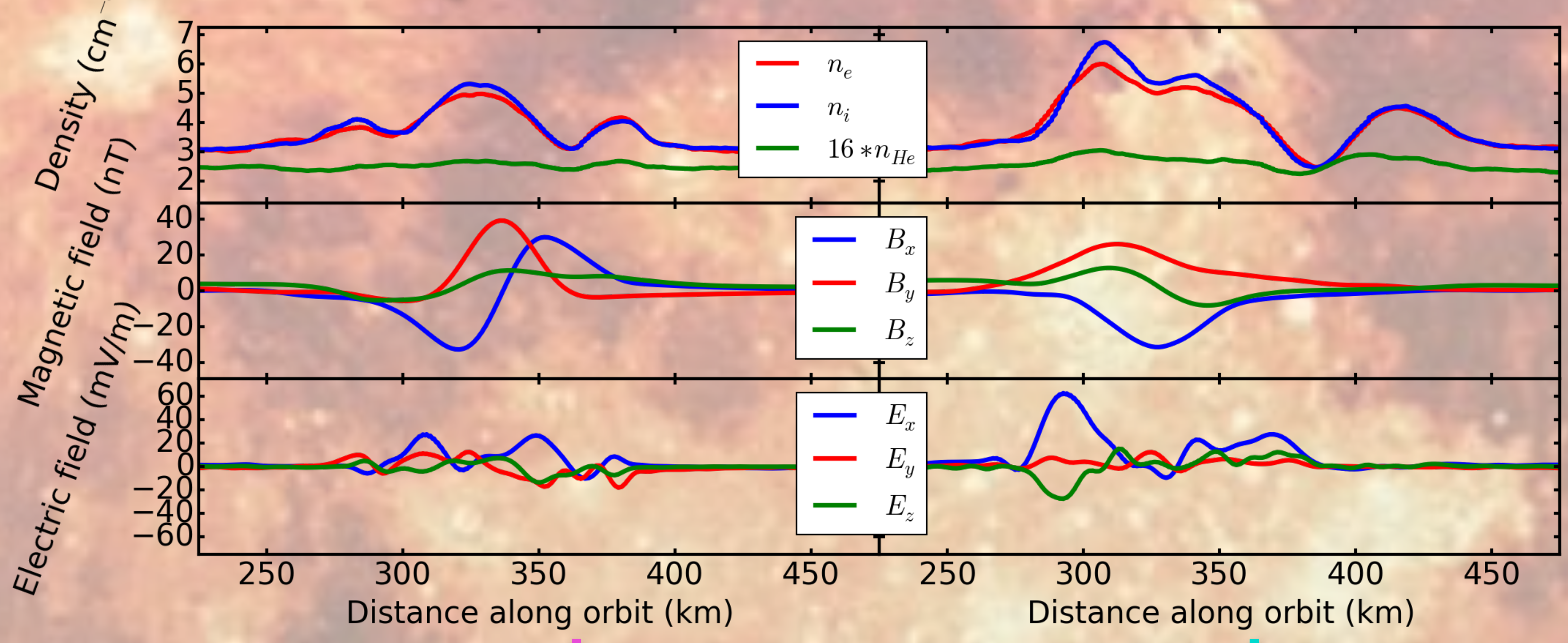
Profiles along a polar (left panels) and equatorial orbit (right panels) show the rapidly varying electromagnetic fields/density (above) and particle energy distributions (below) a spacecraft would encounter along its trajectory at 15 km above the lunar surface. Note that high-cadence observations are required to capture the fine-scale structures of the interaction [Deca & Divin 2016].



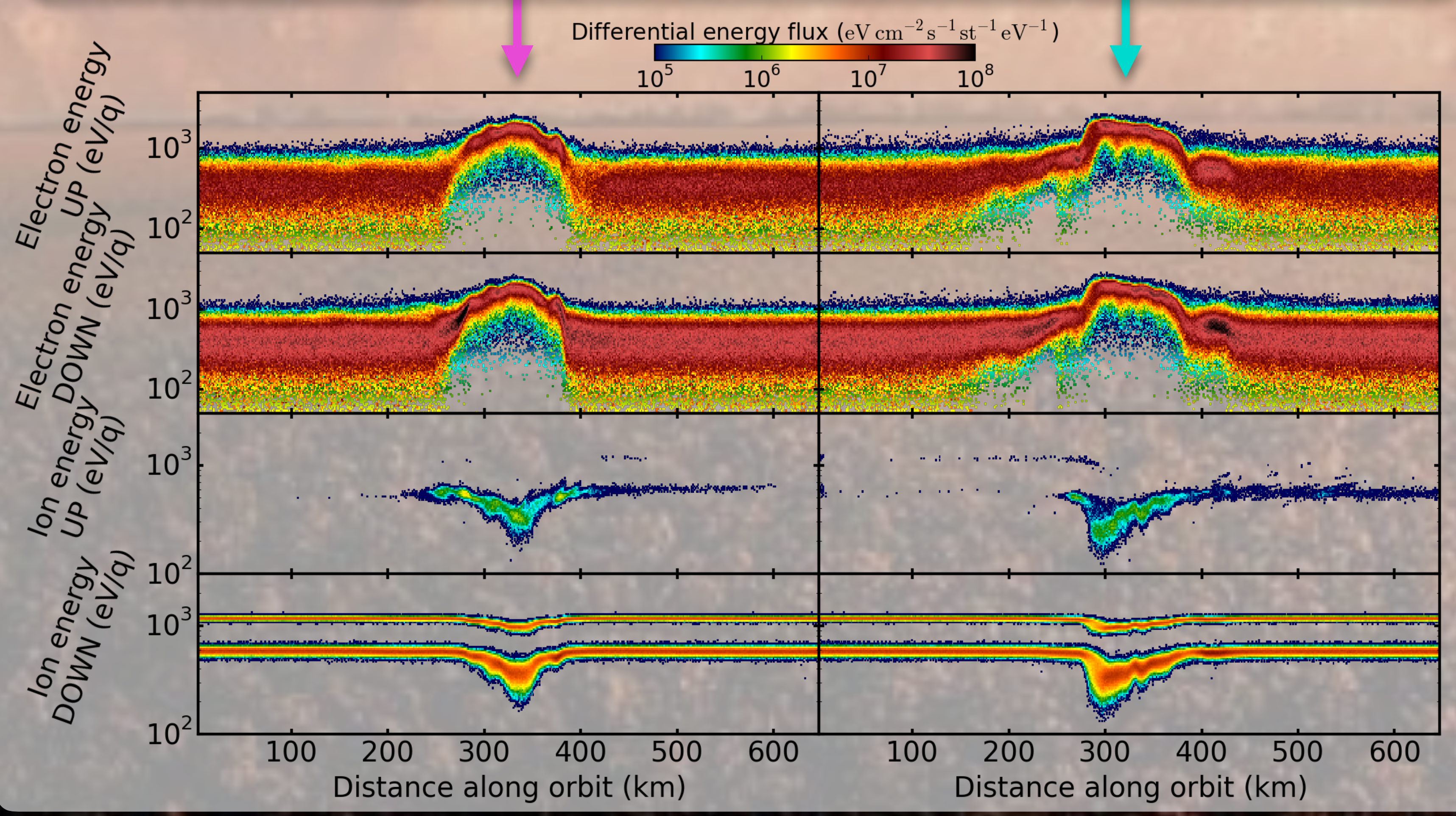
Realistic scenario



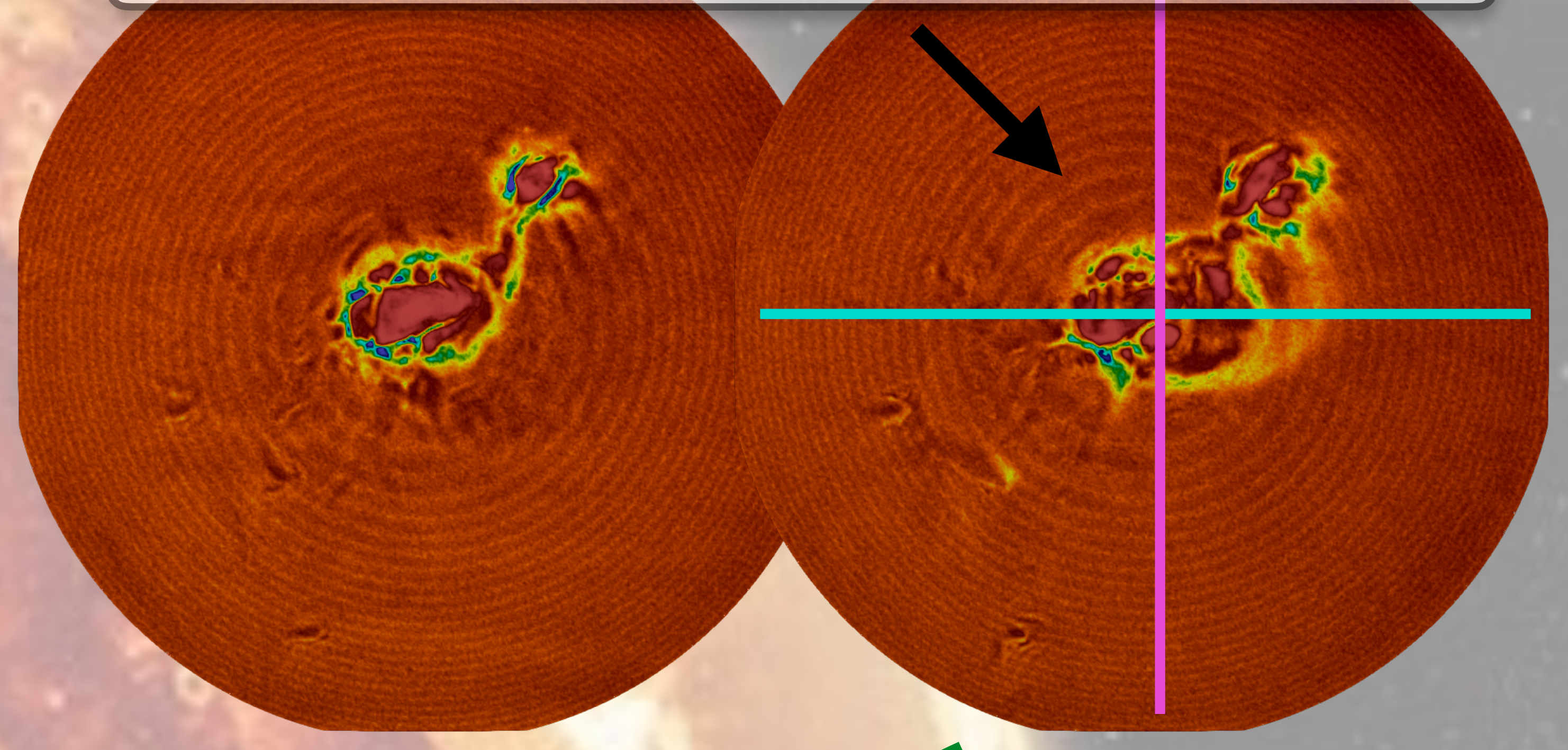
The Reiner Gamma magnetic topology, simulated with iPic3D (Markidis et al. 2012) using the Tsunakawa et al. (2014, 2015) model.



The Reiner Gamma magnetic topology consists of two quasi-dipolar components. Flying through the interaction region, hence, reveals similarities with the idealised scenario. Comparing with a pure electron/proton solar wind plasma, we find that adding 5% He^{2+}-particles to the simulation has a negligible effect on the overall structure of the electromagnetic fields [Deca et al., in preparation].

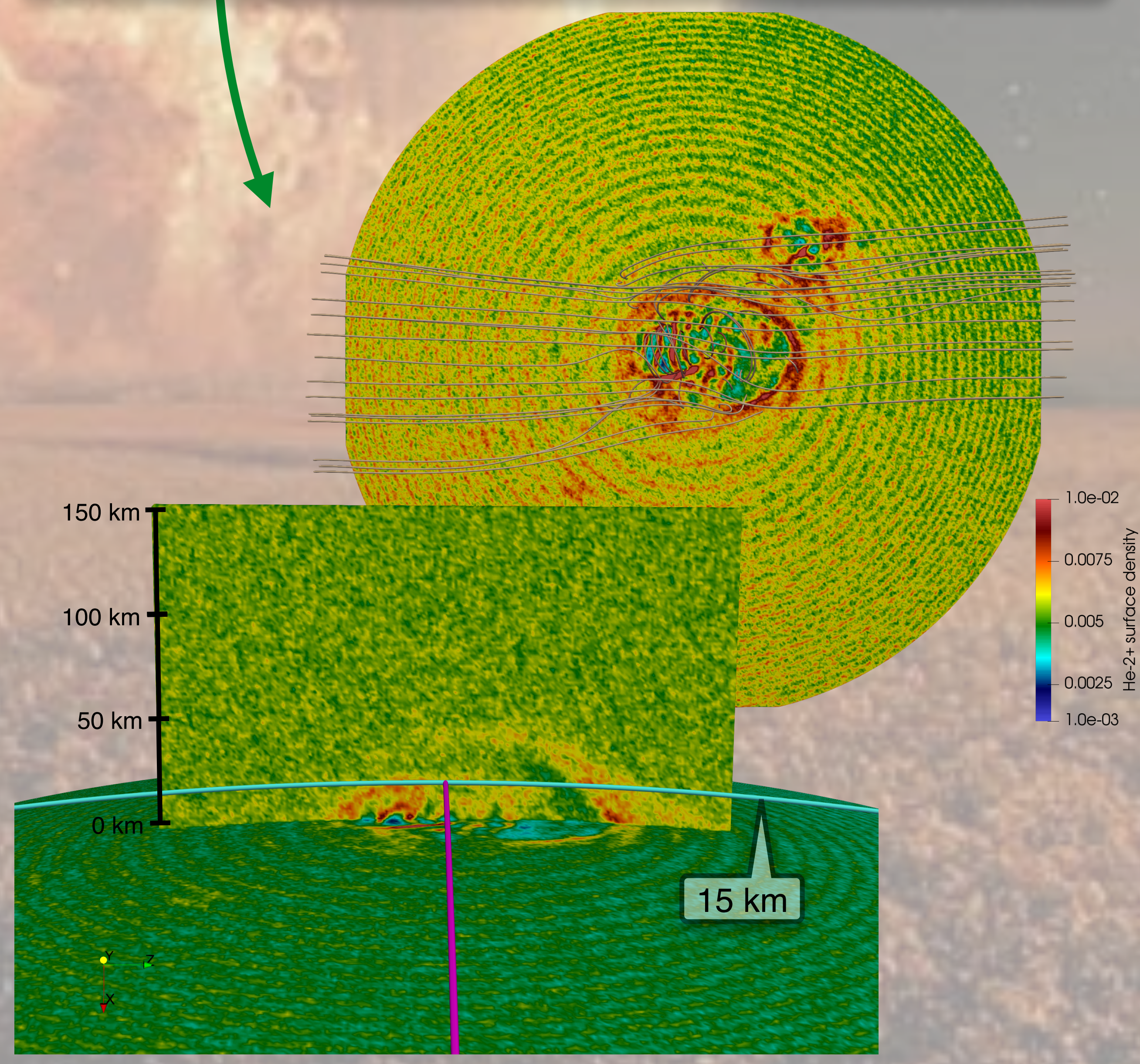


Solar wind normal (left) and at 45° incidence (right) to surface.



The solar wind speed and direction are the determining factors that shape the surface weathering pattern. Above two examples. Integrating over all incident solar wind angles and magnitudes is required to evaluate possible correlations with lunar swirls [Deca et al., under review]. The interplanetary magnetic field direction might only become important for lunar anomalies that have comparable magnetic field magnitudes as the impinging solar wind.

To first order, the He^{2+} distributions agree with the solar wind proton profiles (below). Due to their higher mass, however, only few particles are re/deflected by charge-separation electric field above the magnetic topology.



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