

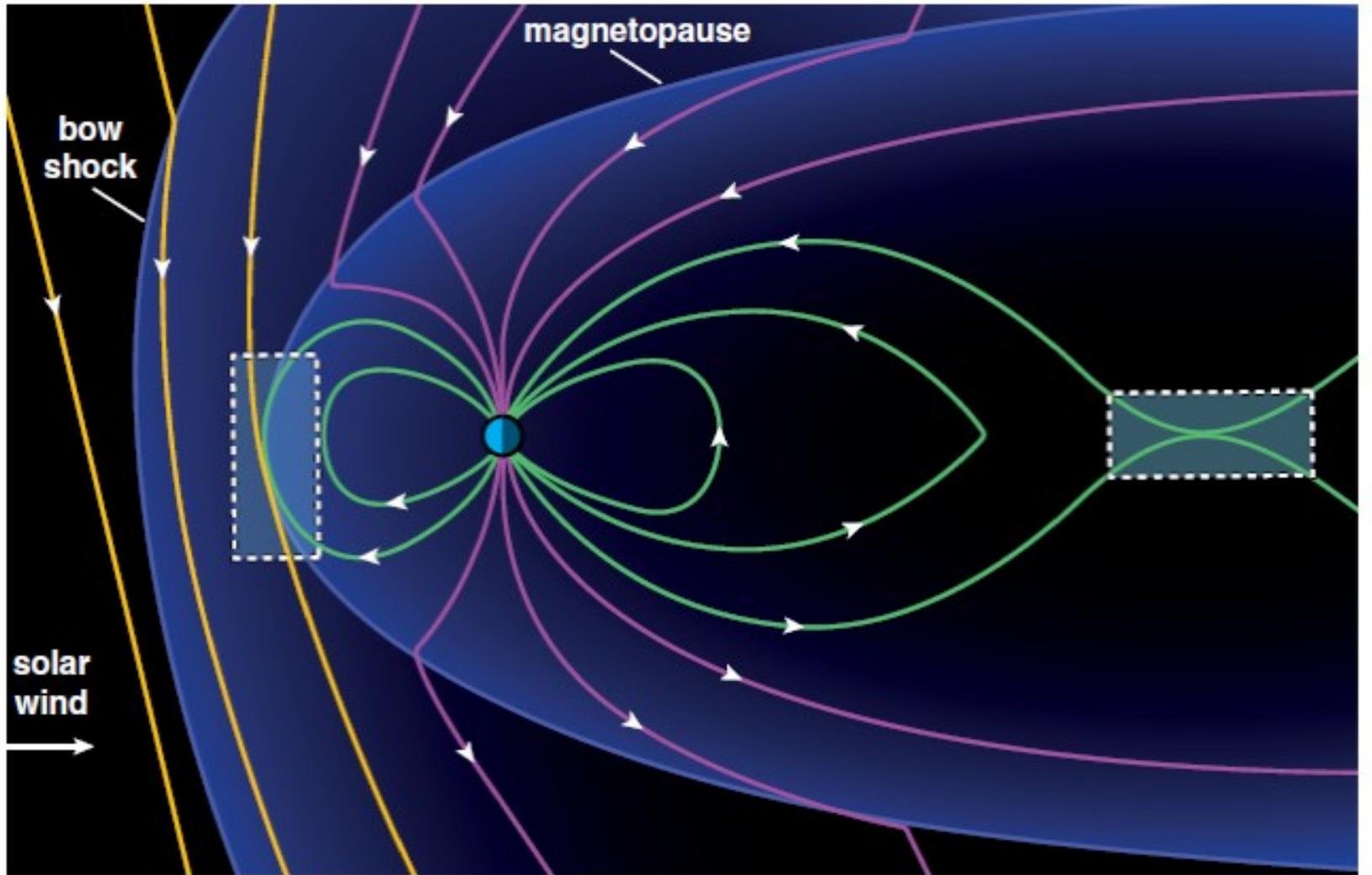
Magnetic Reconnection at the Earth's Magnetosphere

Walter D. Gonzalez

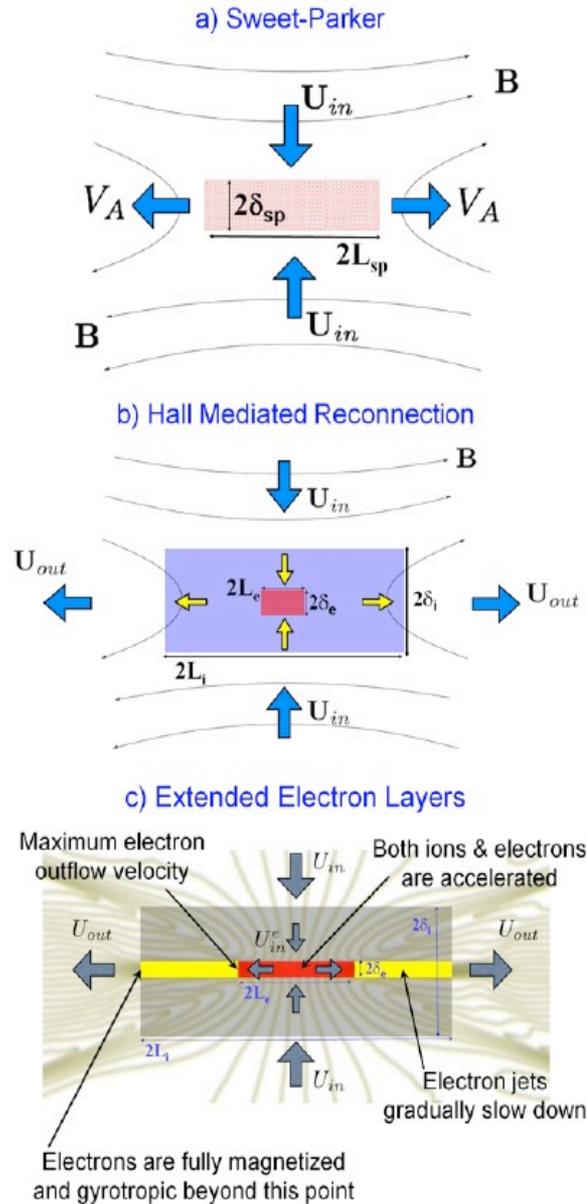
Joint Laboratory China-Brazil for Space Weather

ISSI-BEIJING FORUM

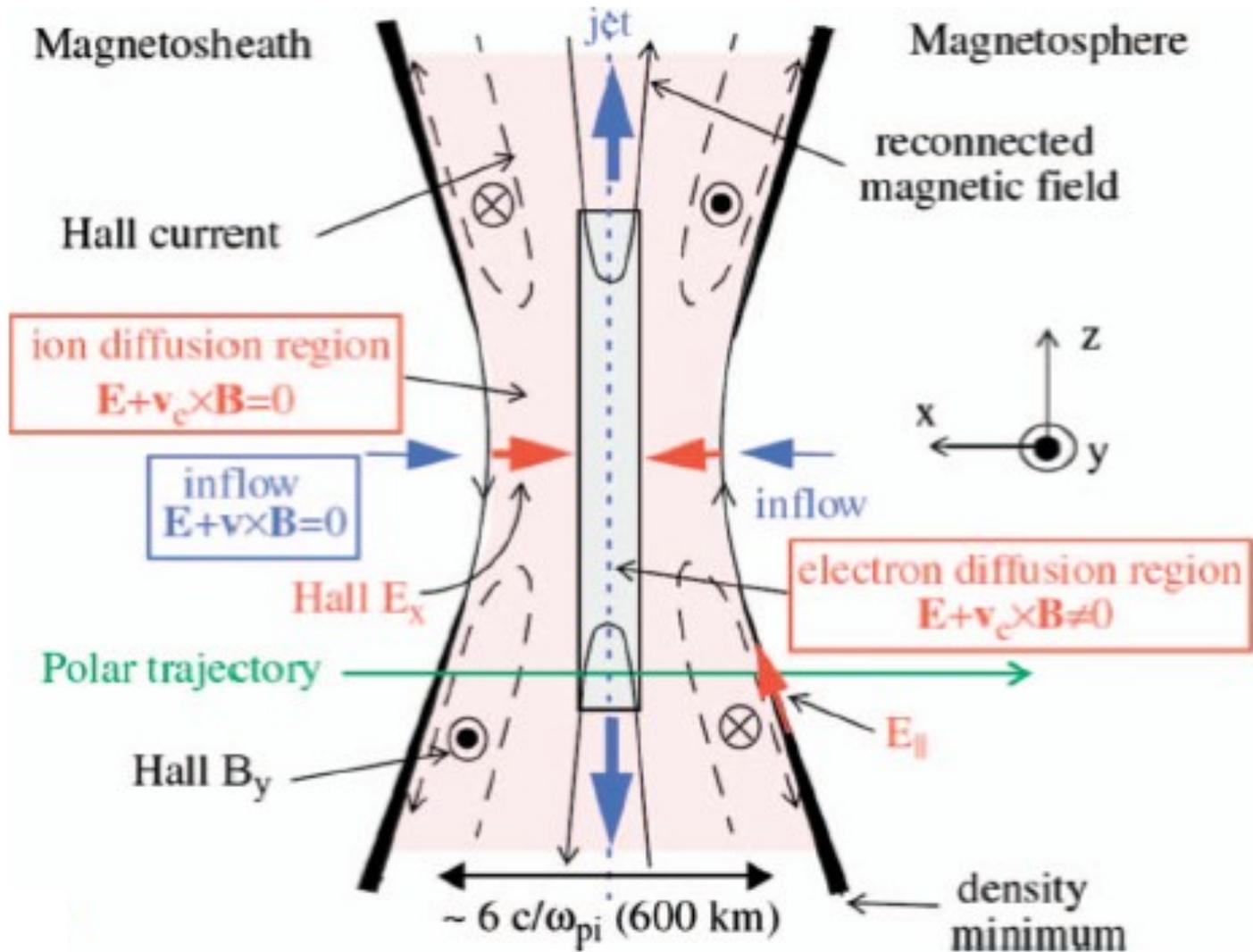
September 2019

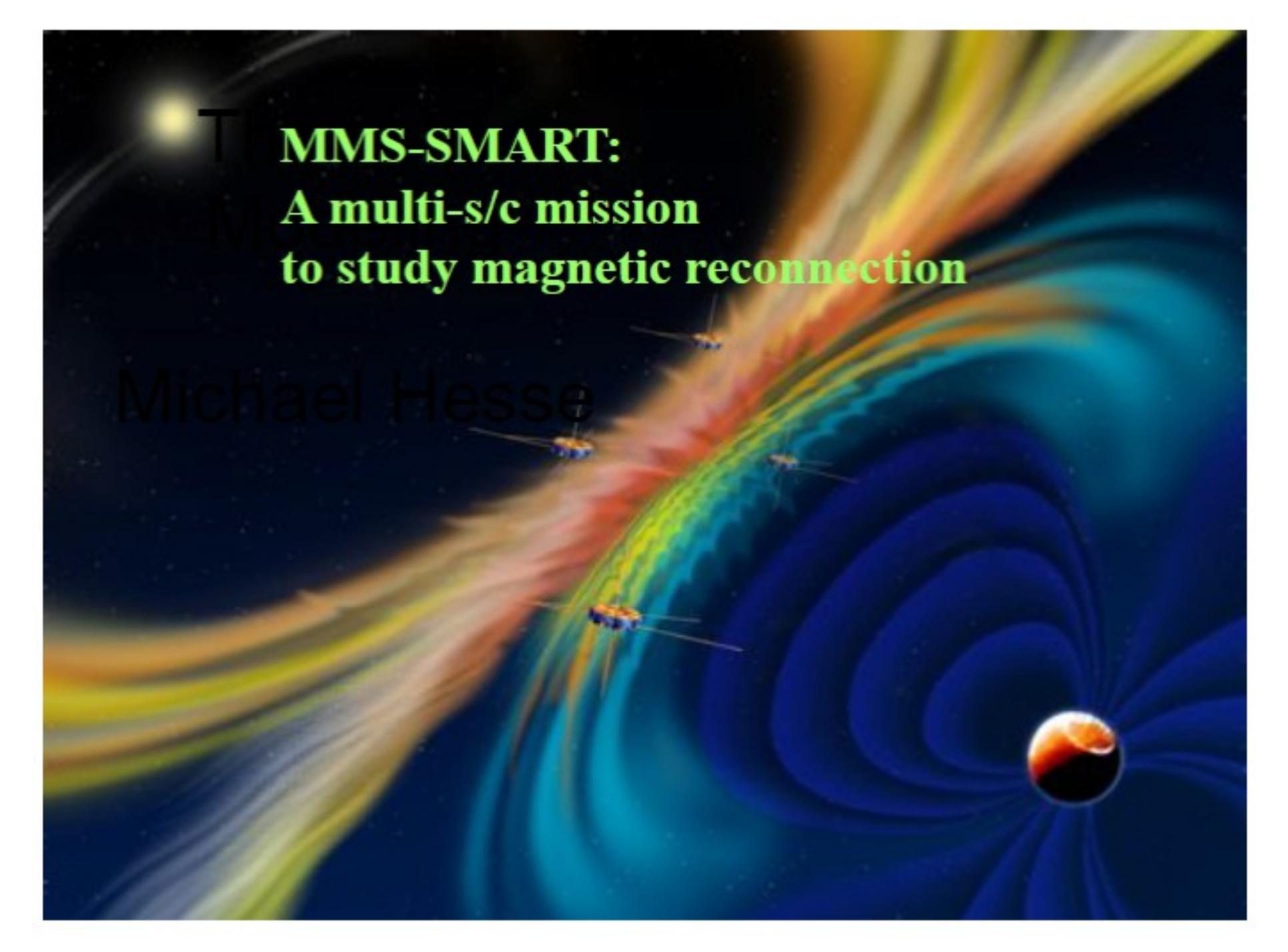


DIFFUSION REGION OF RECONNECTION



MAGNETOPAUSE HALL RECONNECTION

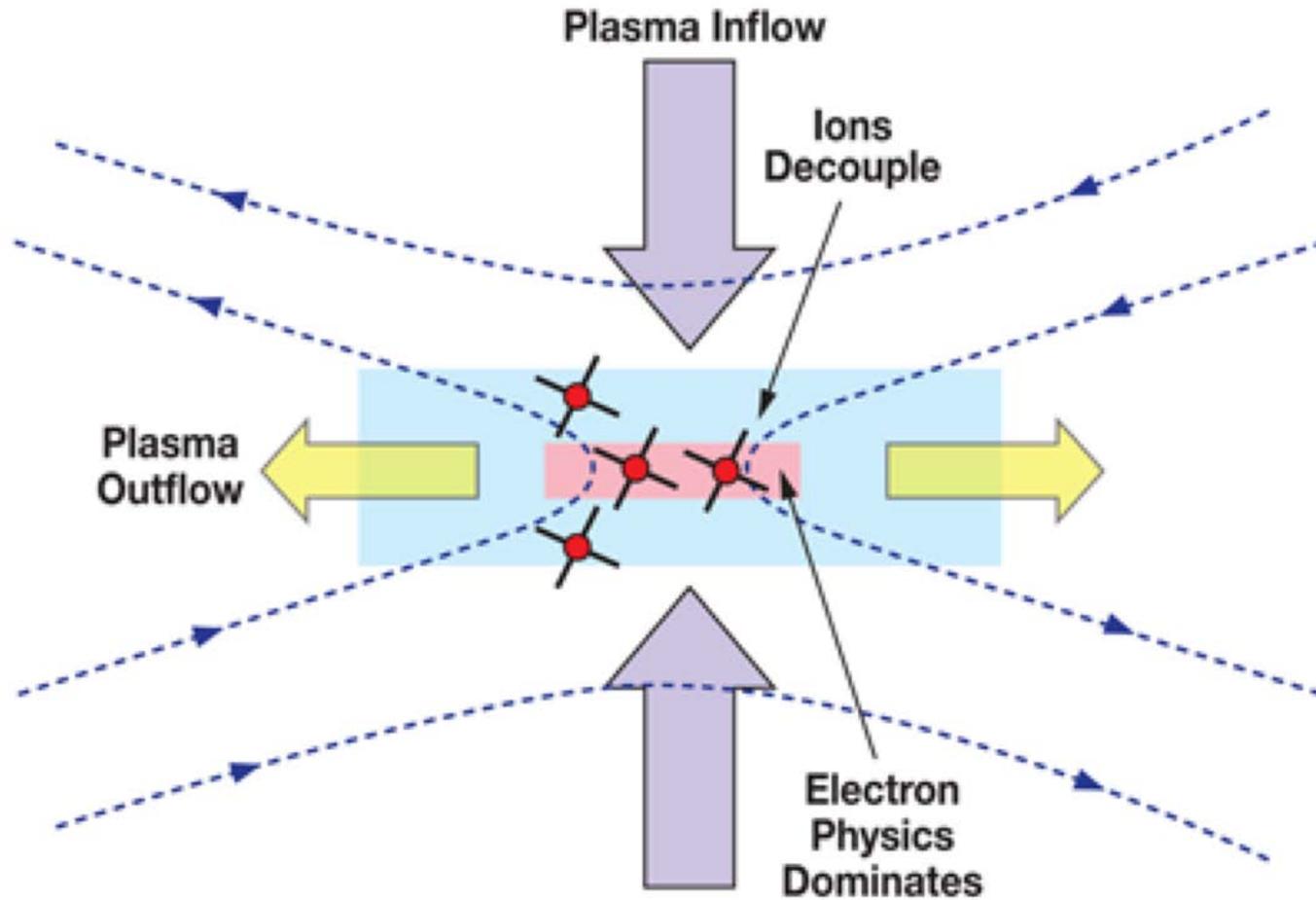


An artistic rendering of the Magnetospheric Multiscale (MMS) mission. The Earth is shown in the bottom right corner, with its magnetic field lines curving around it. A bright, multi-colored plasma jet (solar wind) is shown entering from the left, interacting with the magnetosphere. Four MMS spacecraft are positioned to study this interaction. The background is a dark space with a bright star in the top left.

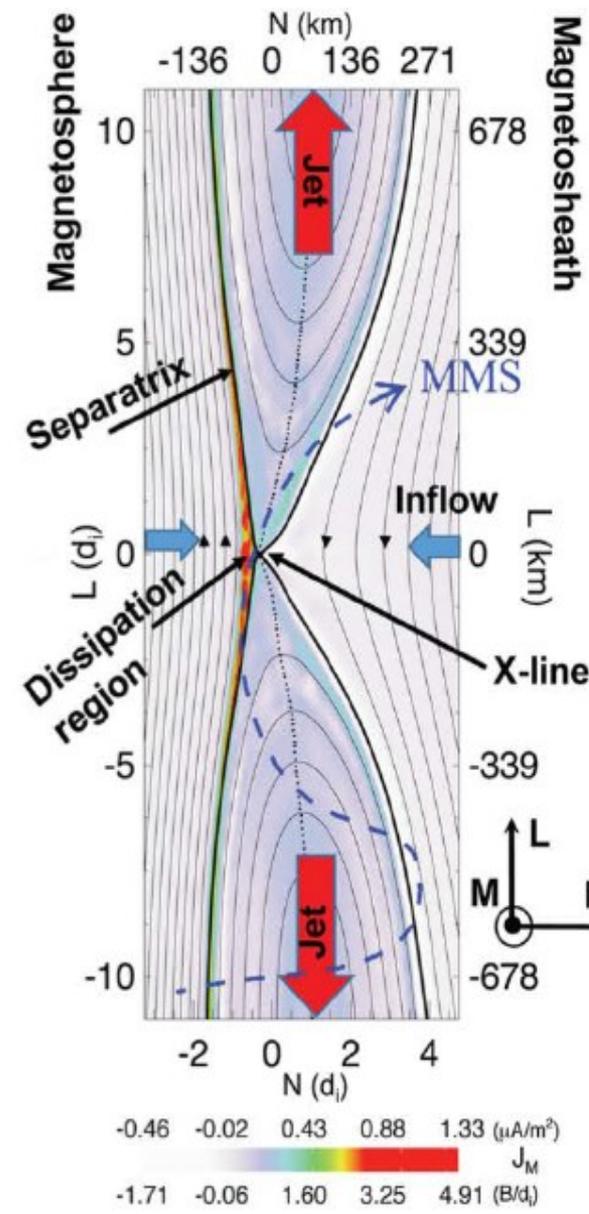
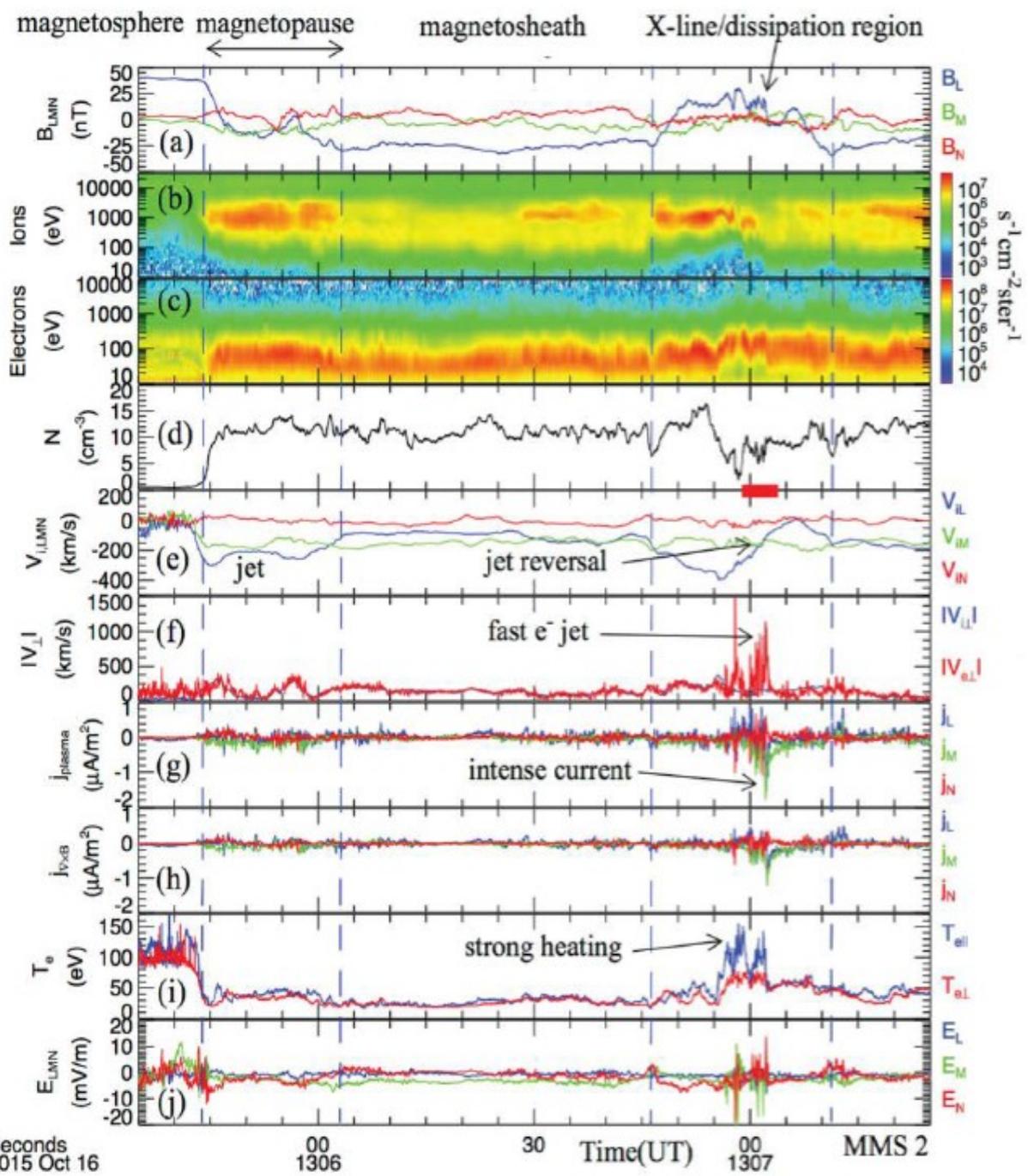
T **MMS-SMART:**
A multi-s/c mission
to study magnetic reconnection

Michael Hesse

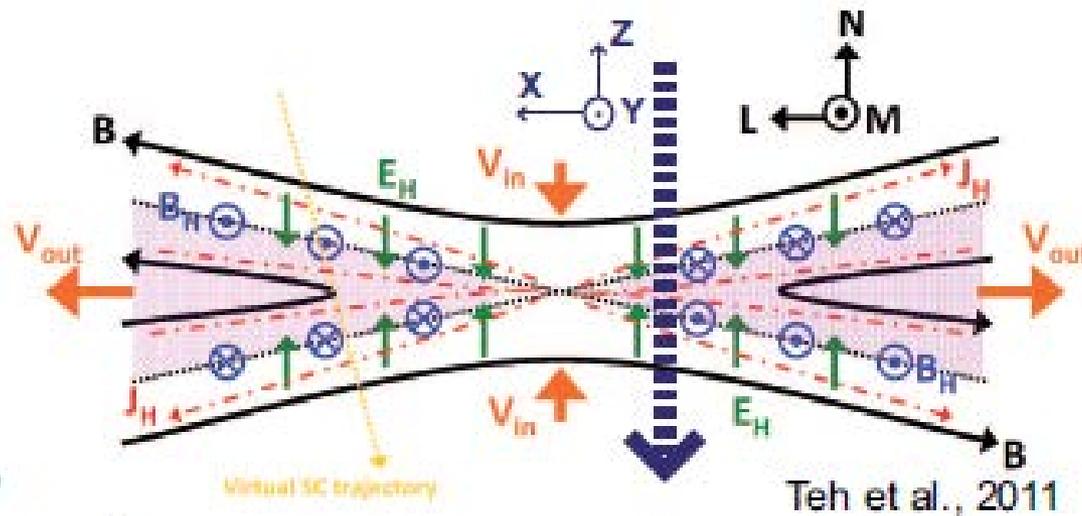
MMS SATELLITES



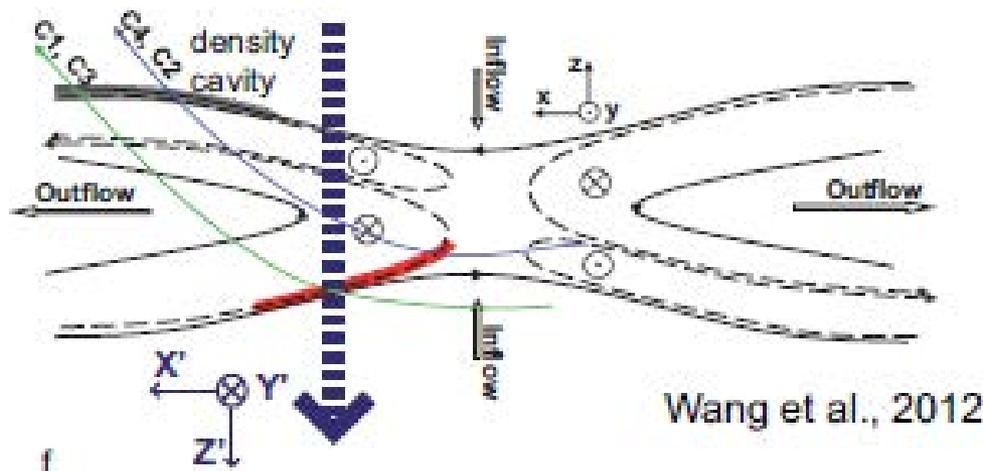
Burch et al.
2016
Magnetopause



DIFFUSION REGION AND SEPARATRICES AT THE RECONNECTING MAGNETOSPHERIC TAIL



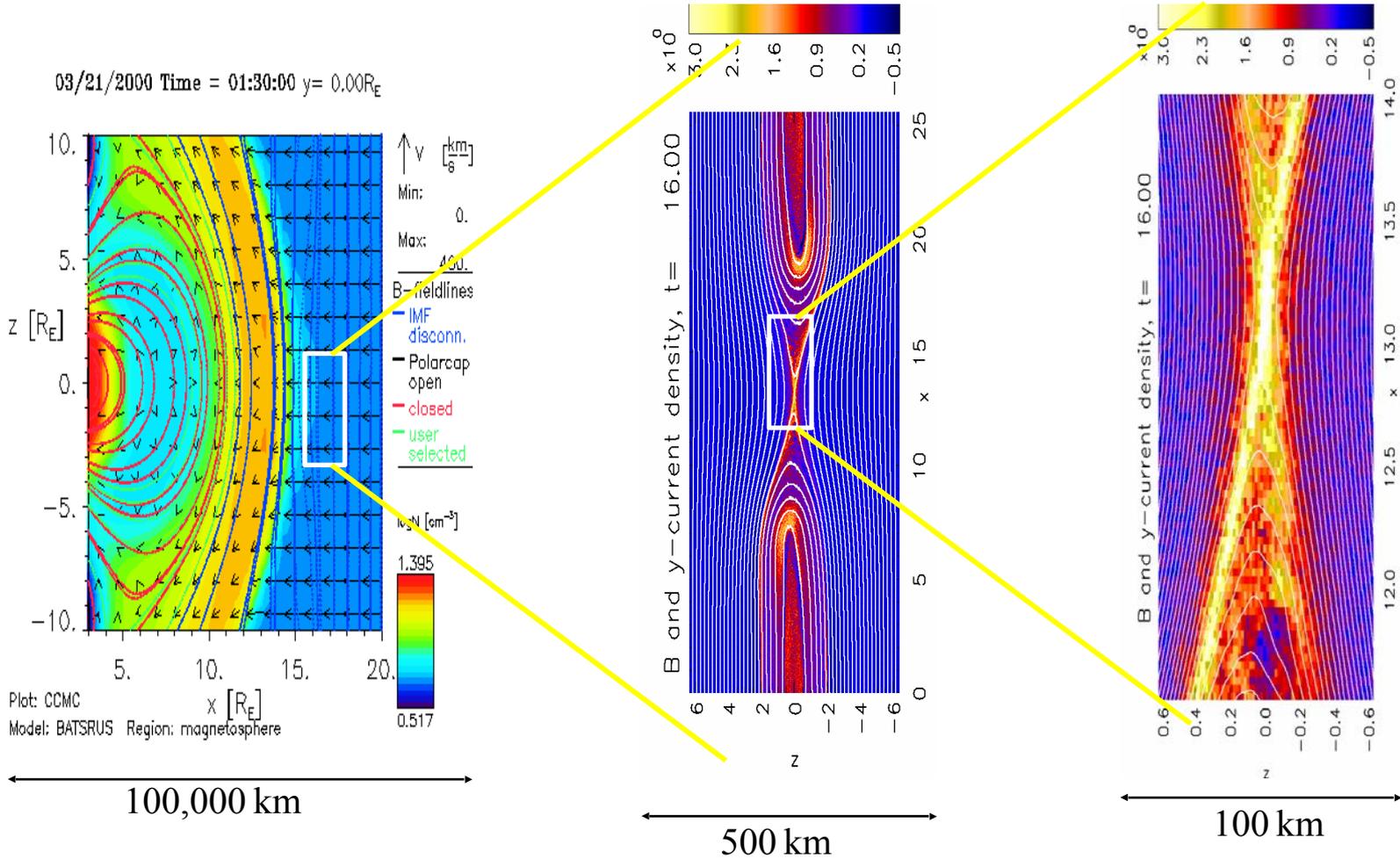
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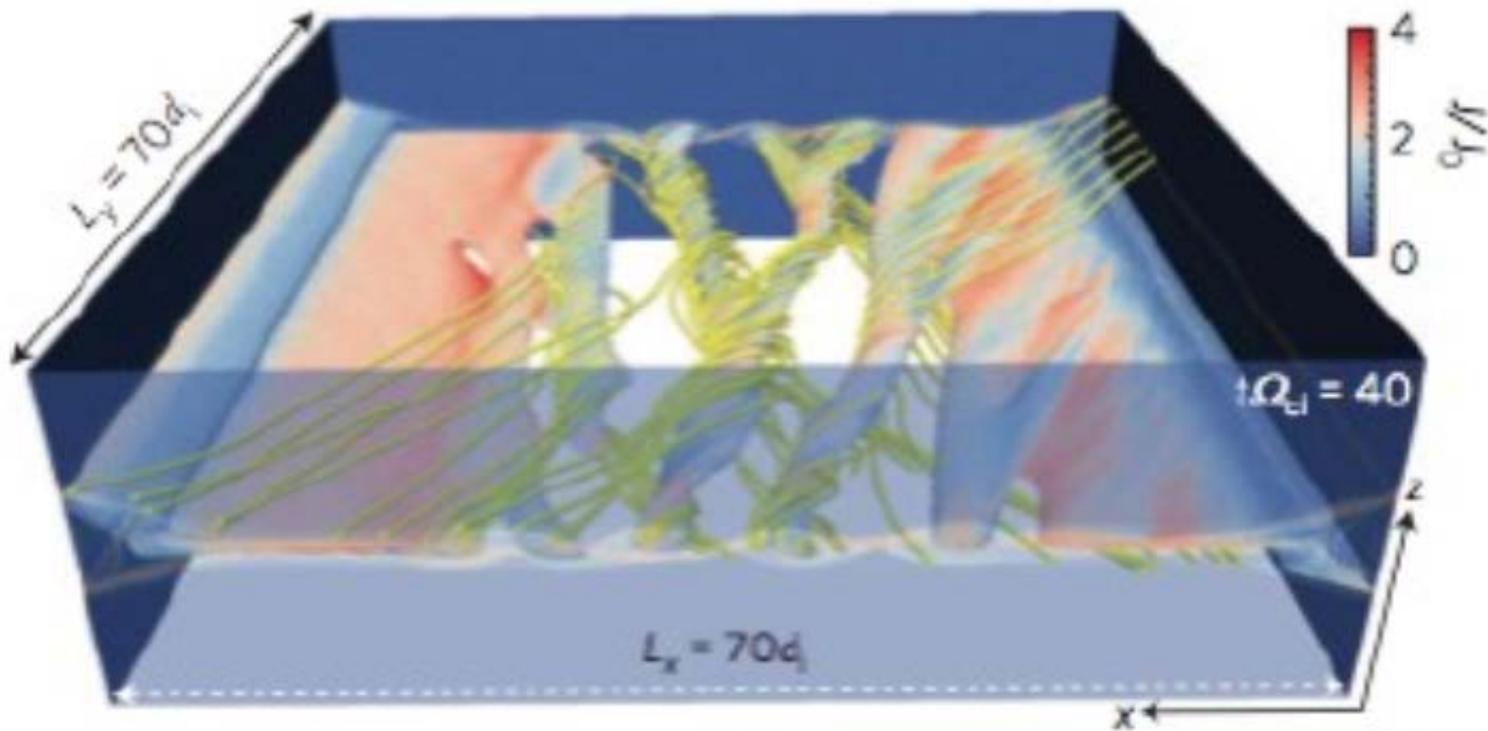
Magnetopause reconnection scales

From simulations:



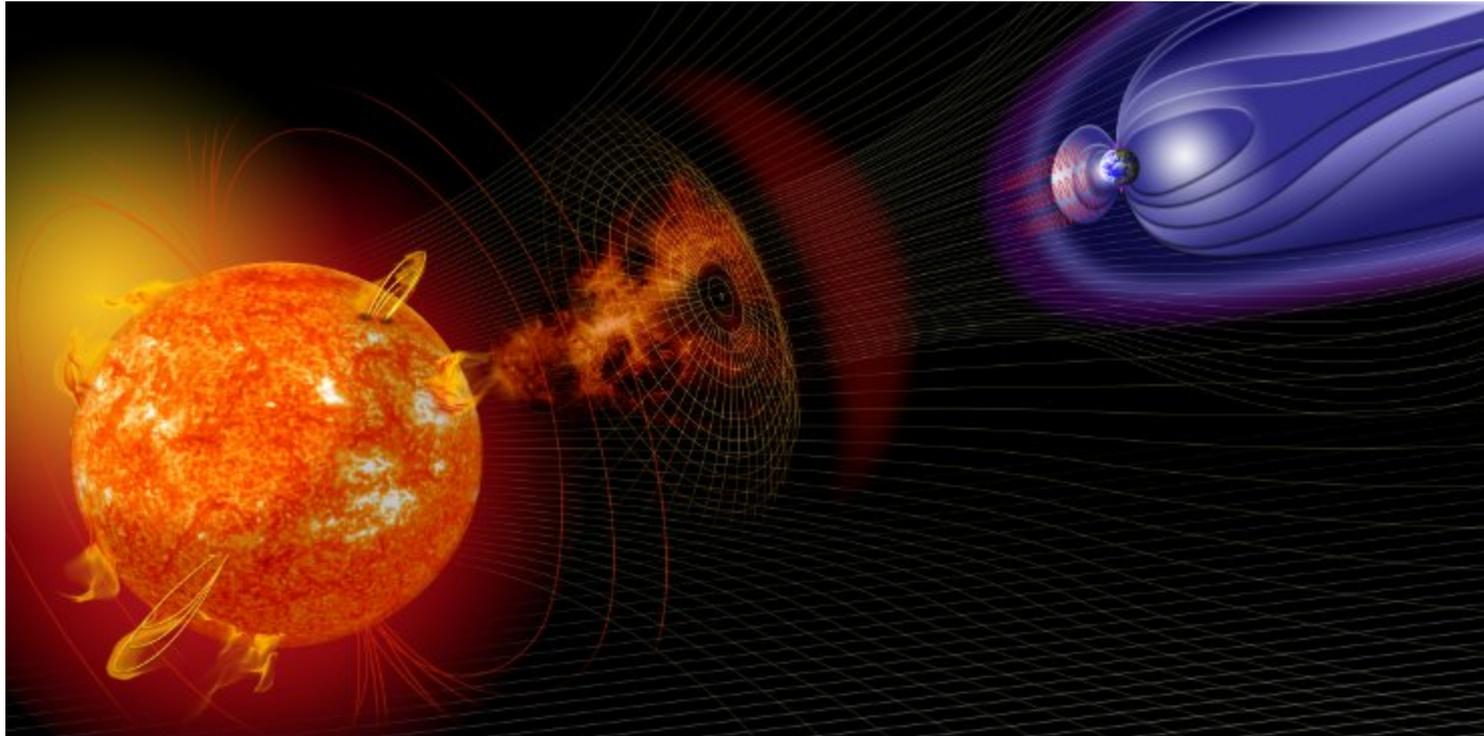
3D SIMULATION OF RECONNECTION AT THE MAGNETOPAUSE

Daughton et al, 2015



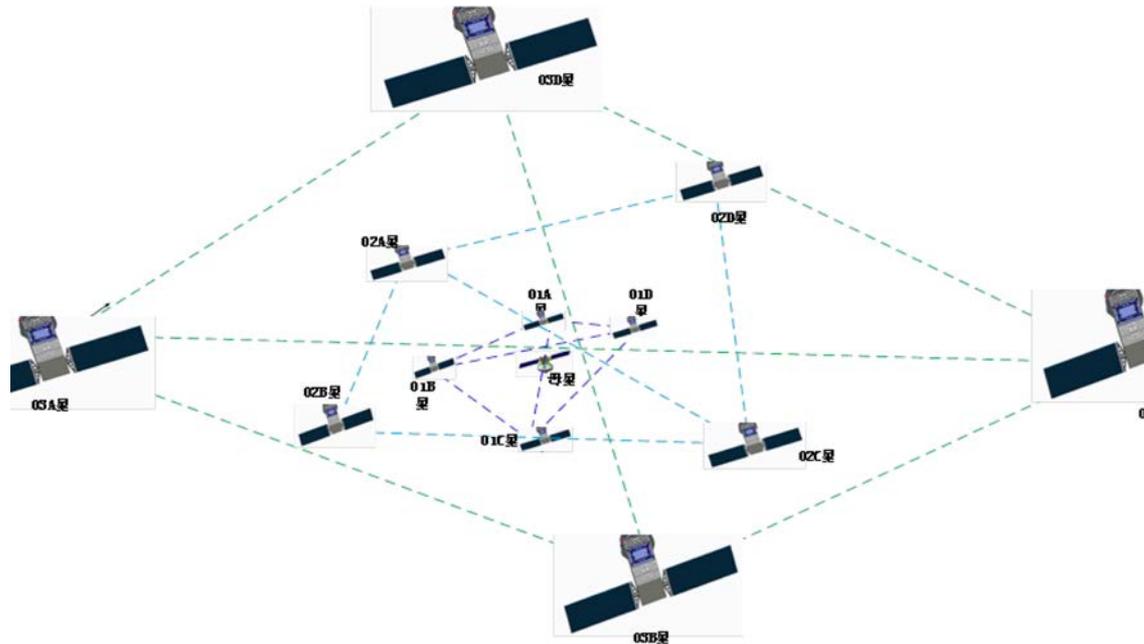
CROSS-SCALE RECONNECTION

SAME (MAGNETOSPHERIC RECONNECTION) MISSION

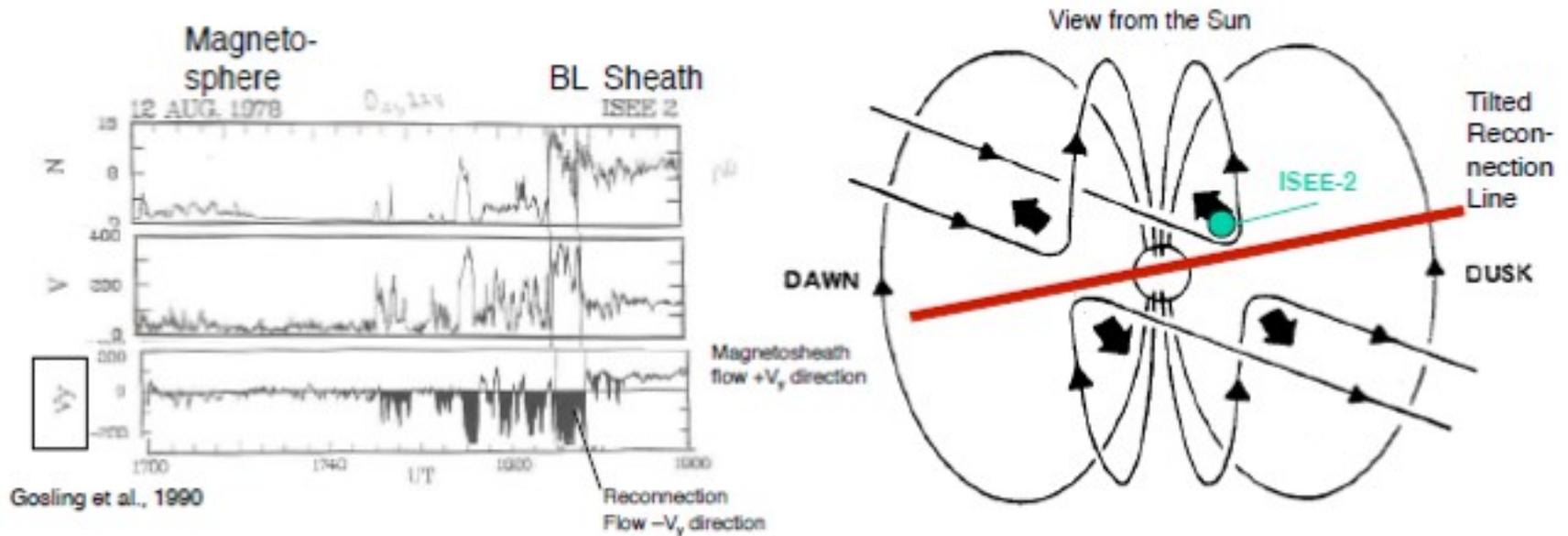


Satellite profile:

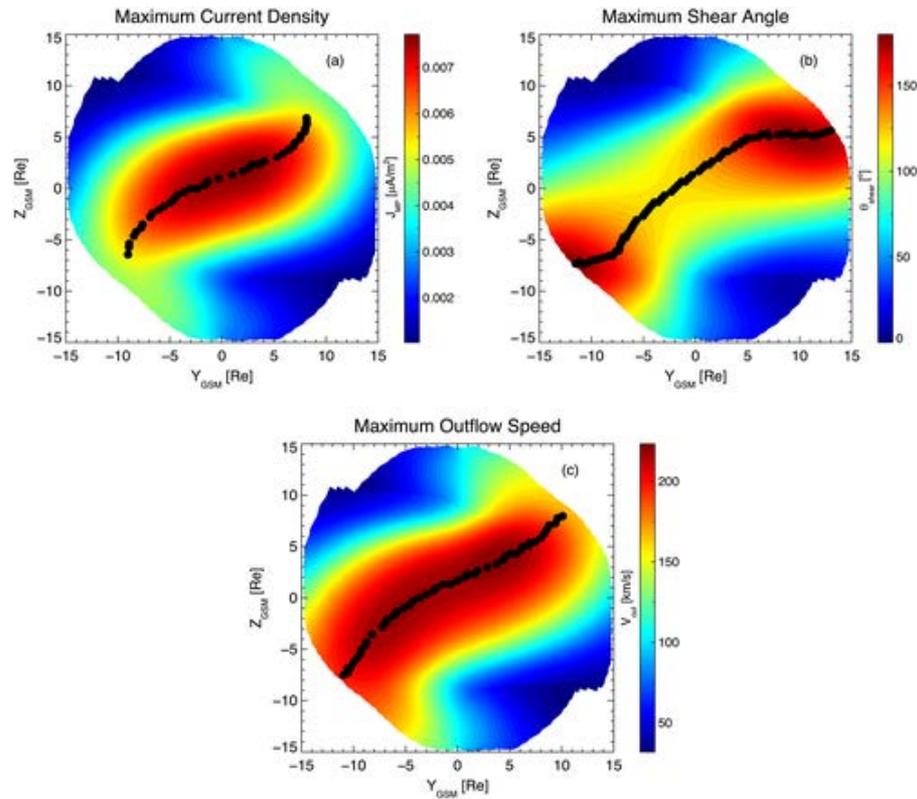
- 1) Mother-satellite+12 small satellite。
- 2) Three set of small satellite.
- 3) Each set includes four small satellite, with separation at the scales of 1-5km(electron scale) , 100km (ion scale), and 10000km(Macro-scale), with the option to adjust the macro-scale separation to even larger scale.



Flow Velocities (2): Component Reconnection



- “Flow Reversal Events” are purely a component reconnection phenomenon
- Observed for southward IMF when the IMF B_y is “Large”

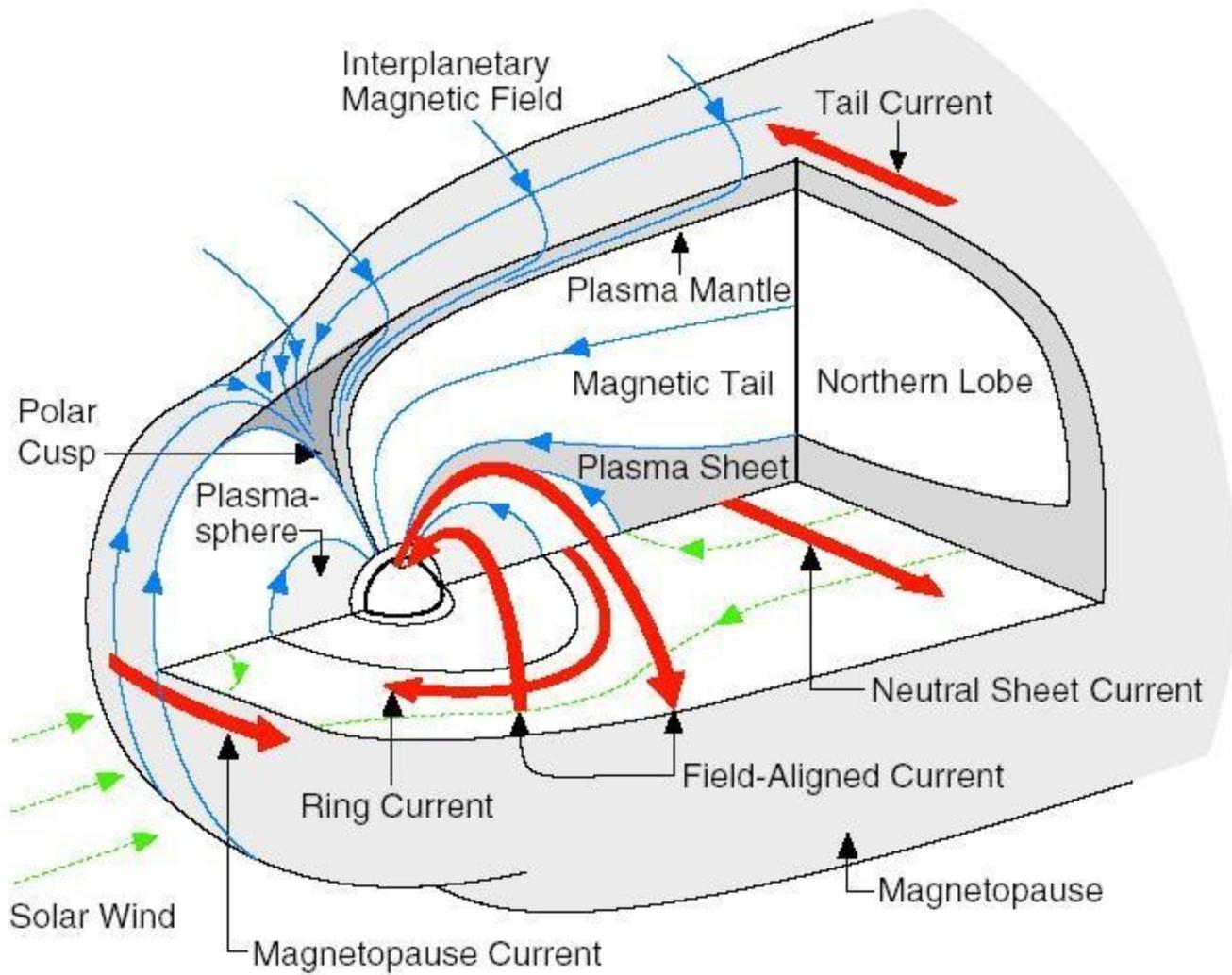


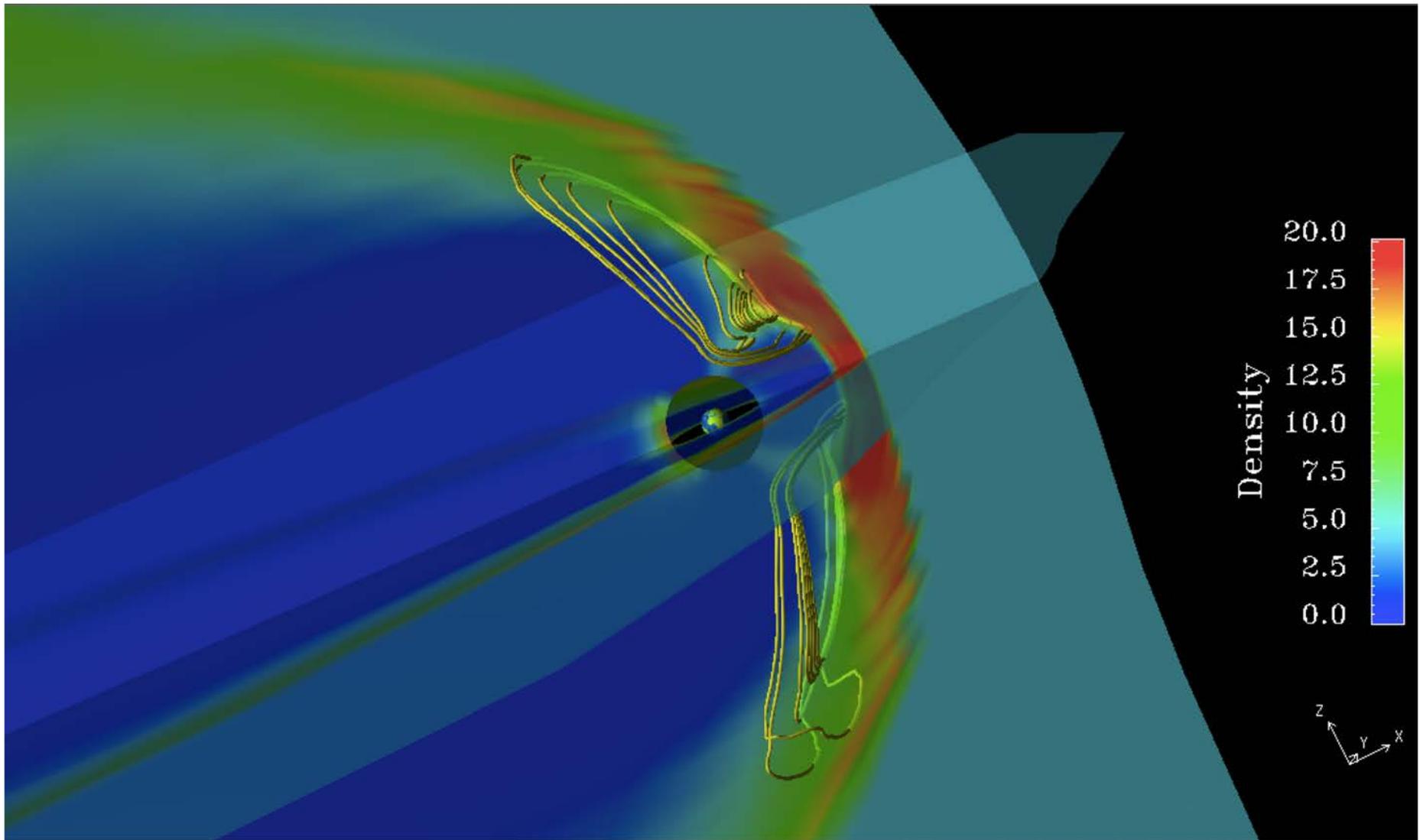
Souza et al. 2017

Color coded (a) magnetopause current density magnitude, (b) magnetic shear angle, and (c) asymmetric reconnection outflow velocity along the BATS-R-US dayside magnetopause boundary, as seen in the yz_{GSM} plane. Blank regions denote magnetopause locations where $x_{GSM} < 0$. Each black circle obeys a local maximum condition, as determined by the Lindeberg[1993, 1998] ridge-detection algorithm (see text for details). The collection of these points forms the X line location for this configuration. The IMF and Earth's dipole tilt conditions used as input for this BATS-R-US run are $(B_x, B_y, B_z) = (5.0, 5.0, -2.886)$ nT and $\psi = 0^\circ$.

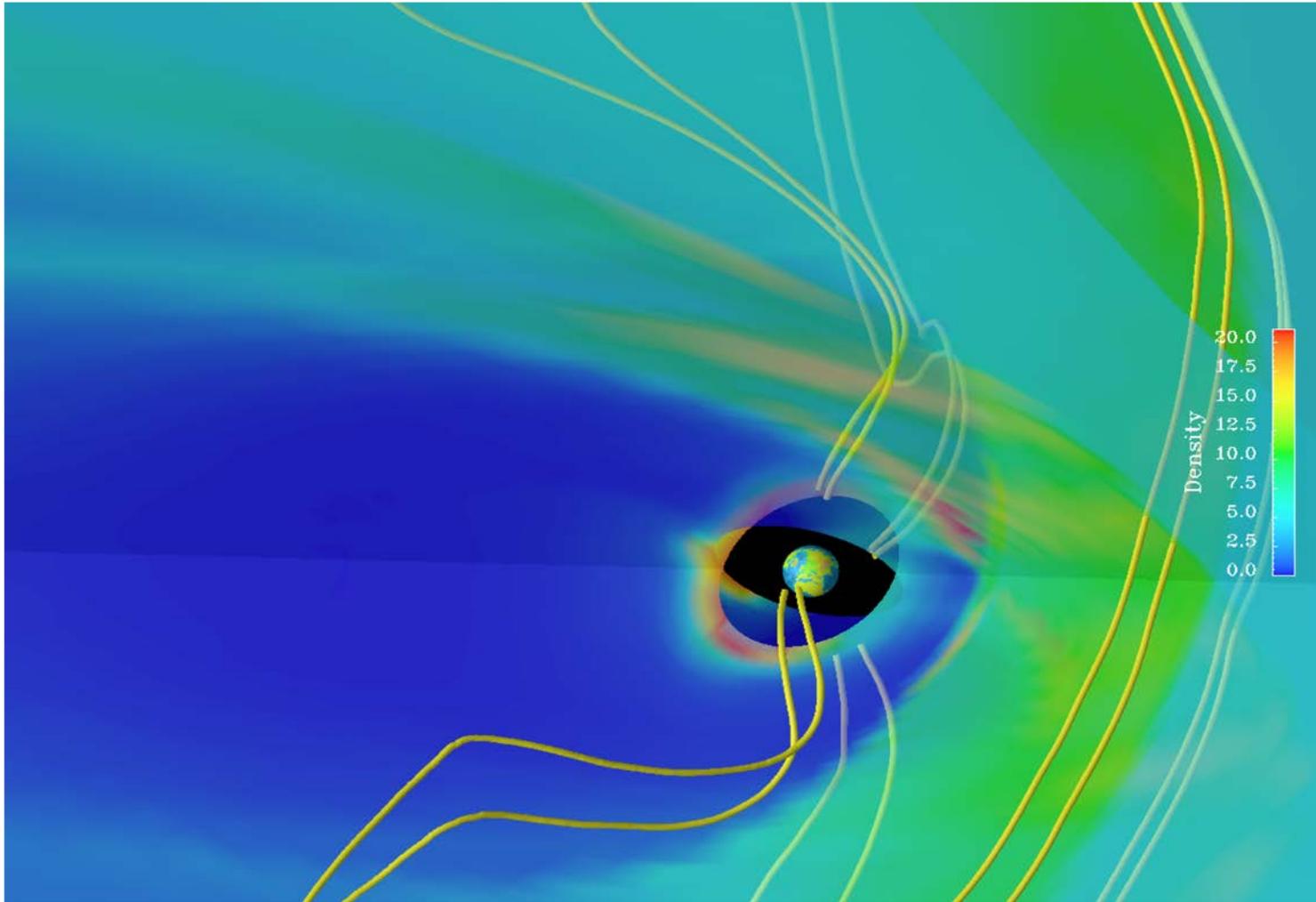
OPEN RESEARCH ISSUES IN MAGNETOSPHERIC RECONNECTION ASSOCIATED WITH THIS FORUM

- 1. Magnetopause Currents for High and Low Solar Wind - Plasma Beta values**
- 2. Role of boundary conditions for reconnection associated with large-scale solar wind-magnetosheath and ionospheric electric fields**
- 3. Role of interplanetary structures in magnetopause reconnection as a function of solar cycle phase**
- 4. Magnetospheric reconnection during extreme geomagnetic activity**

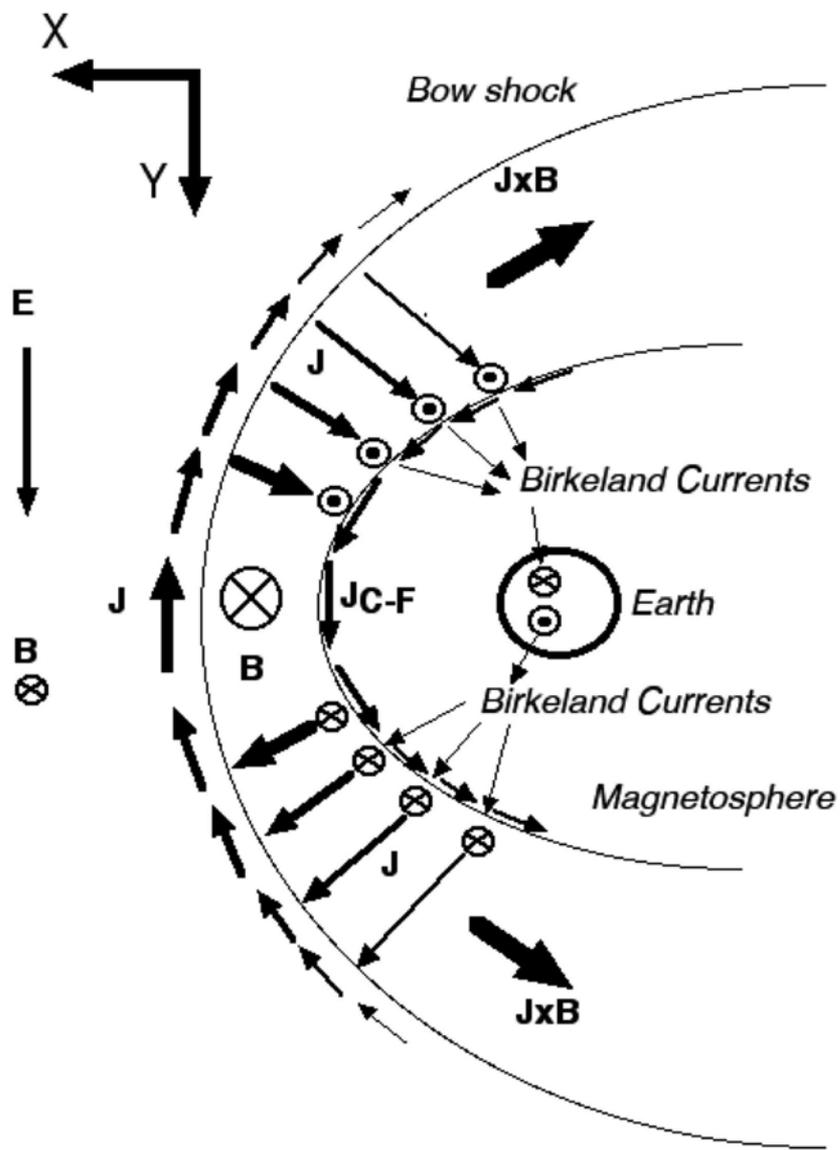




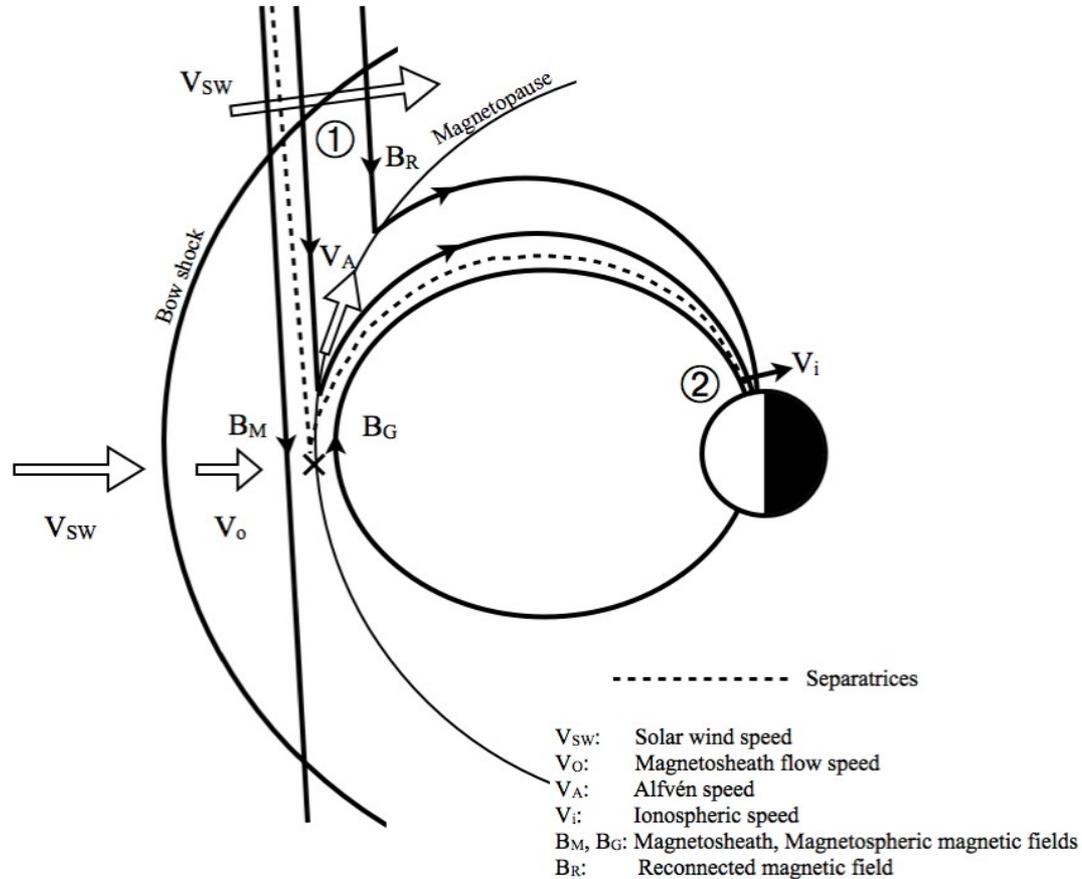
Current closure for moderate southward IMF (LFM global MHD code, Lopez 2016)



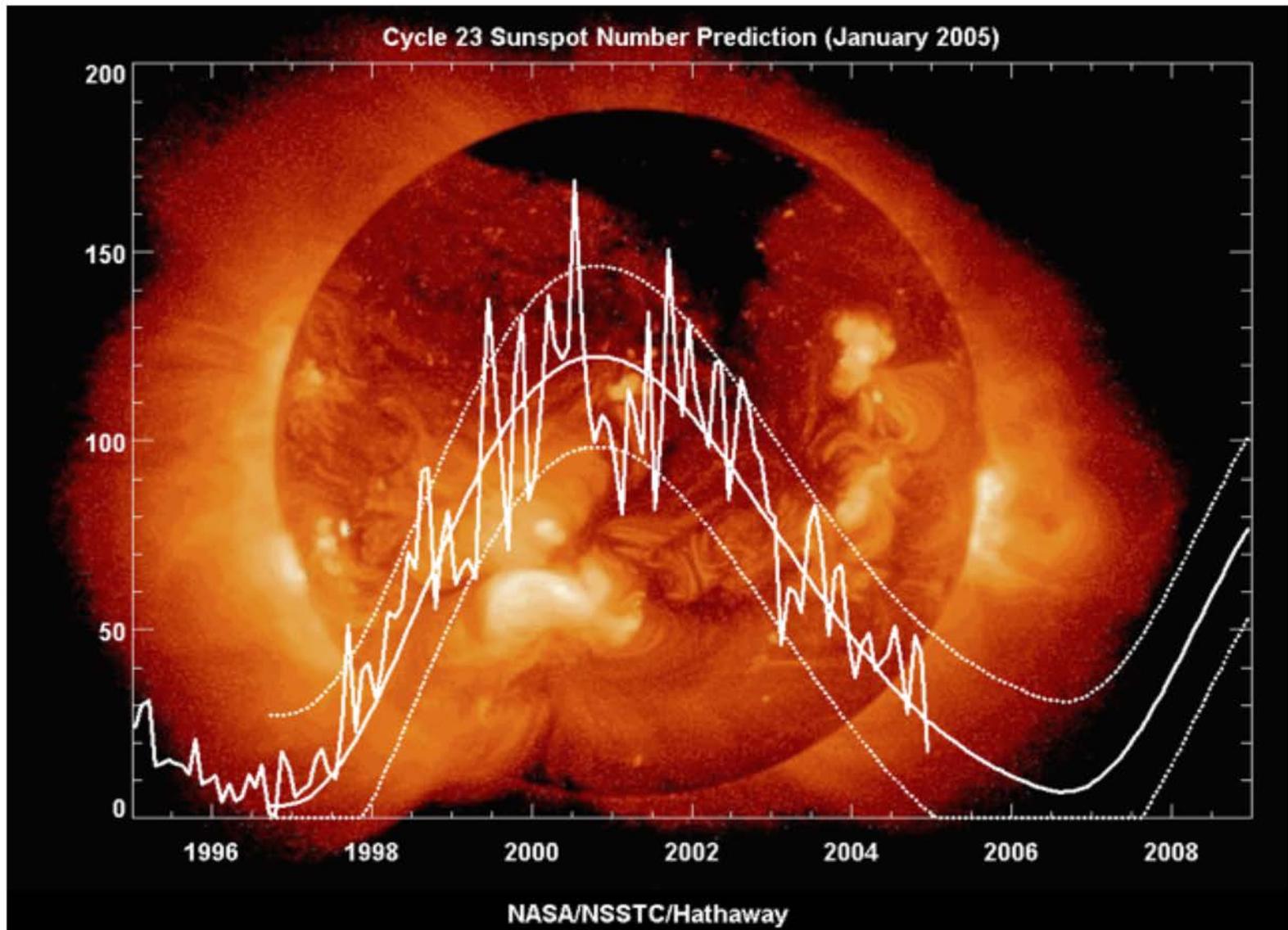
Current closure for large southward IMF with magnetosheath/Bow shock currents closing as Region-1 current through the ionosphere (LFM global MHD code, Lopez 2016)



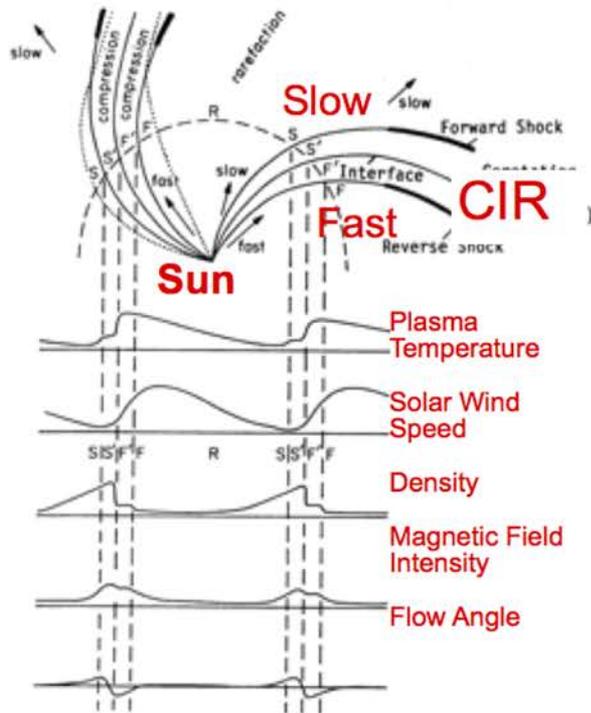
Global Boundary Conditions for Magnetopause Reconnection



SOLAR CYCLE



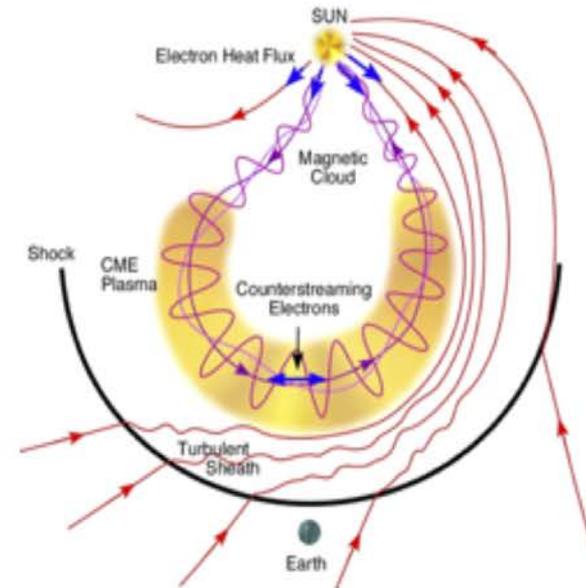
Corotating High-speed Streams



Individual streams recur at ~ 27 day solar rotation period;

Present throughout solar cycle, but most prominent during declining phase/ minimum.

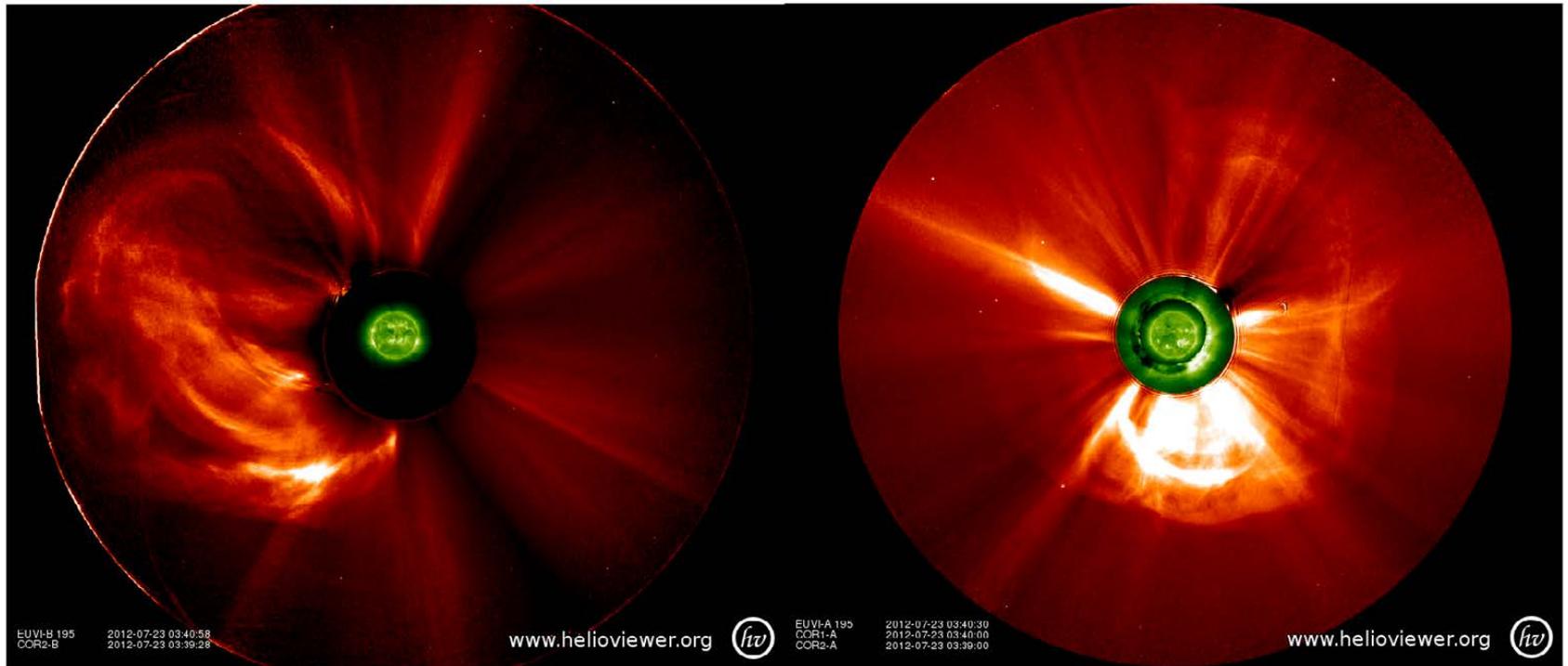
Interplanetary Coronal Mass Ejections (ICMEs)



Transient: ICME reaches Earth $\sim <1-4+$ days after CME at the Sun ($\sim 300 - >2000$ km/s);

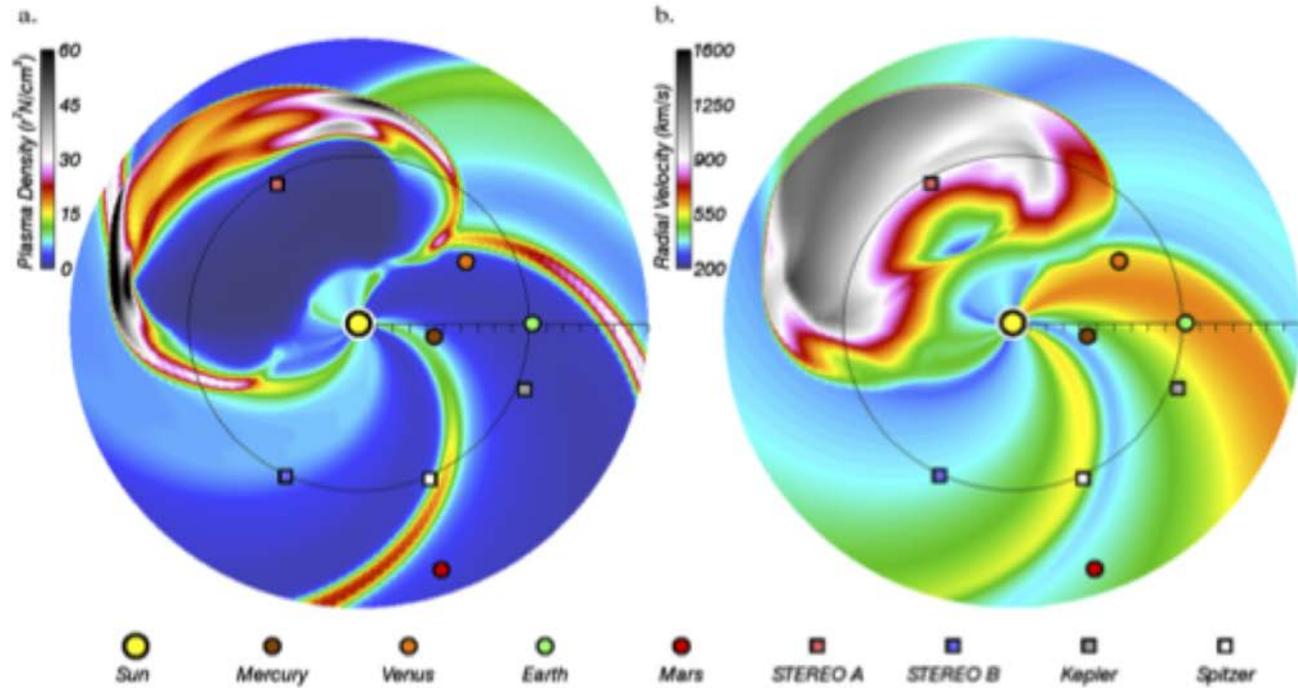
Shock formed ahead of fast ICMEs;
Sheath of compressed solar wind between shock, ICME;

STEREO A (right) and B (left) coronagraph images at about ± 120 degrees



July 23, 2012.

NOAA/Space Weather Prediction Center



Inner heliospheric model of a propagating CME for July 23, 2012. Solar wind density (left) and speed (right).

Solar wind Magnetosphere Ionosphere Link Explorer (SMILE)



Provide a **global view** of magnetosphere

Key Scientific Questions

- What are the fundamental modes of the dayside solar wind/magnetosphere interaction?
- What defines the substorm cycle?
- How do CME-driven storms arise, and what is their relationship to substorms?