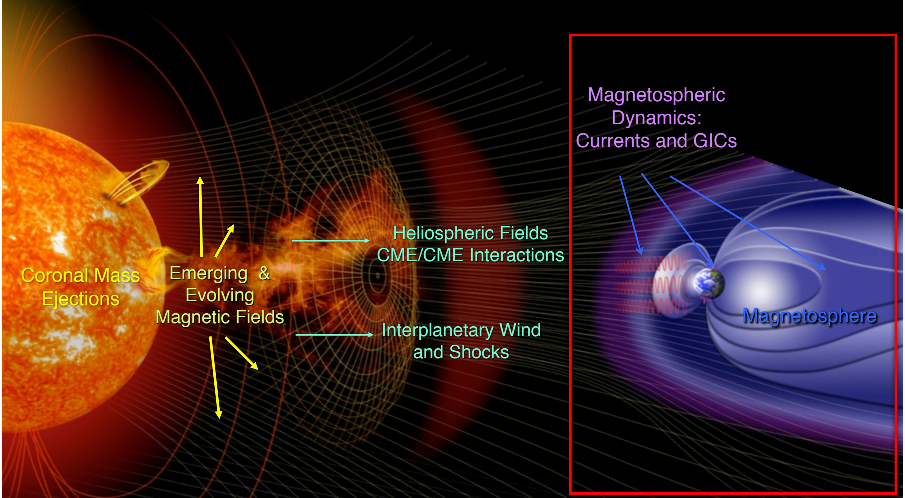
WP3 : Magnetospheric energy storage and release



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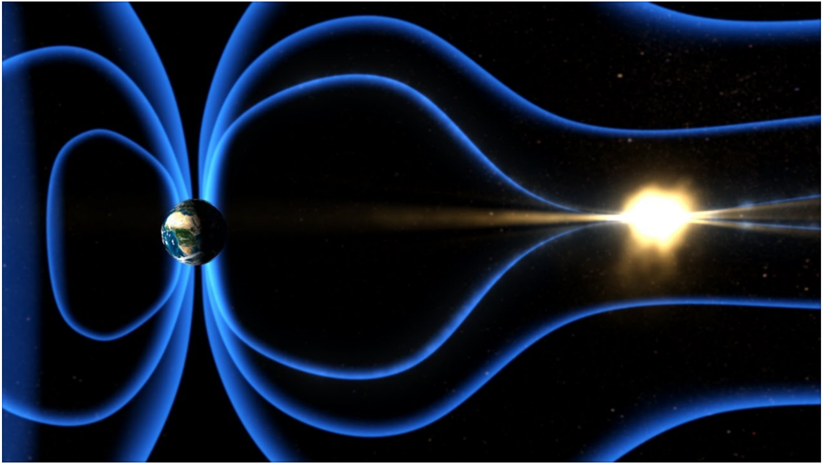
artist's impression

Overview

The Goals of WP3

1. Investigate the energy input into the magnetosphere as a function of upstream conditions.
2. To understand and quantify the different mechanisms of energy storage and release from normal-extreme-severe storm conditions.
3. Study the complex physical processes within the magnetotail which lead to impulsive/sudden energy release which are relevant for highly localised and extreme magnetic disturbances and spikes at the ground.
4. Use the results from 1-3 to suggest improvements to current space weather prediction frameworks with the goal to improve forecasting (lead time and magnitude) of GIC events.

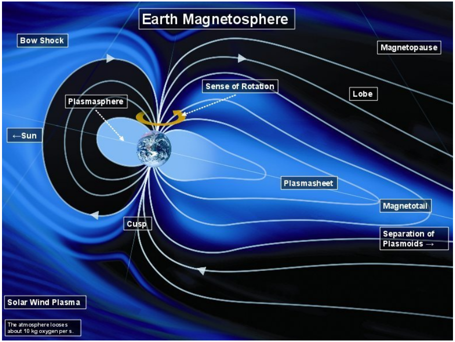
Energy Storage and Release



Credit: NASA

Energy: Input, Storage, Release, and Sudden Release

1. **Input:** Significant energy input occurs during southward IMF ($B_z < 0$) due to dayside magnetic reconnection.
2. **Storage:** Dayside magnetic flux transported tail-ward and stored in magnetotail lobes.
3. **Release:** Some dayside transported flux is convected Sunward from distant tail reconnection.
4. **Sudden release:** After prolonged $B_z < 0$, near Earth reconnection is initiated (trigger?) and an explosive energy release event occurs.



Relevance to Geomagnetically Induced Currents (GIC)

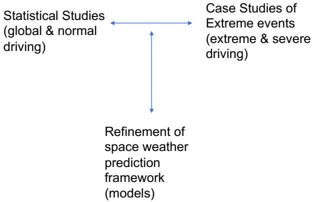
1. During "super" substorms, severe GIC events have been documented.
2. Severe events cause very large magnetic spikes ($\sim$ 1000 nT) which induce damaging GIC.
3. Predicting such events are very difficult as their triggering mechanisms are not fully understood.
4. The occurrence of these events depend on the pre-conditioned state of the system. i.e. the state of the magnetosphere from the initial loading to sudden release.

Important Questions

1. What is the required length of system pre-conditioning to trigger severe events?
2. What upstream events (for what pre-conditioned state) are most effective at triggering super substorms?
3. In the magnetotail, what physical descriptions (MHD vs kinetic) are required/relevant to triggering sudden energy release?
4. Can existing metrics be used for prediction of GIC during violent energy release, or do we need to develop additional indices?

Methods & Strategy

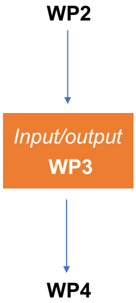
1. **Case studies:** Detailed examination of severe GIC events, what physical mechanisms were instrumental in each scenario.
2. **Statistics:** What physical mechanisms are important in the magnetotail, specifically for pre-conditioning the magnetosphere before extreme events.
3. **Models:** Based on 1-2, during what circumstances, locations, and for what physical scales do existing prediction models fail or perform poorly.
4. What improvements can we make?



Coupling to Other Work Packages

1. Results from WP2 will help determine the extremity of the upstream conditions which can be used to derive limits on GIC metrics during low-extreme-severe driving.
2. WP3 will provide WP4 will limits on dB/dt (and any other important metrics).

- Physical plasma and field parameters during severe solar storms and CME-CME interactions



- Temporal geomagnetic disturbance (dB/dt)

Thank you