

# Dayside Kinetic Processes in Global Solar Wind-Magnetosphere Interaction

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**Research area:** SWMI, GSM    **Term:** 2016-2020

*a venue for joint modeling and experimental efforts*

## 1 Topic

Kinetic processes in the **foreshock**, **bow shock**, **magnetosheath**, and **magnetopause** generate structures and dynamics that can have effects in the whole **magnetosphere-ionosphere** system.

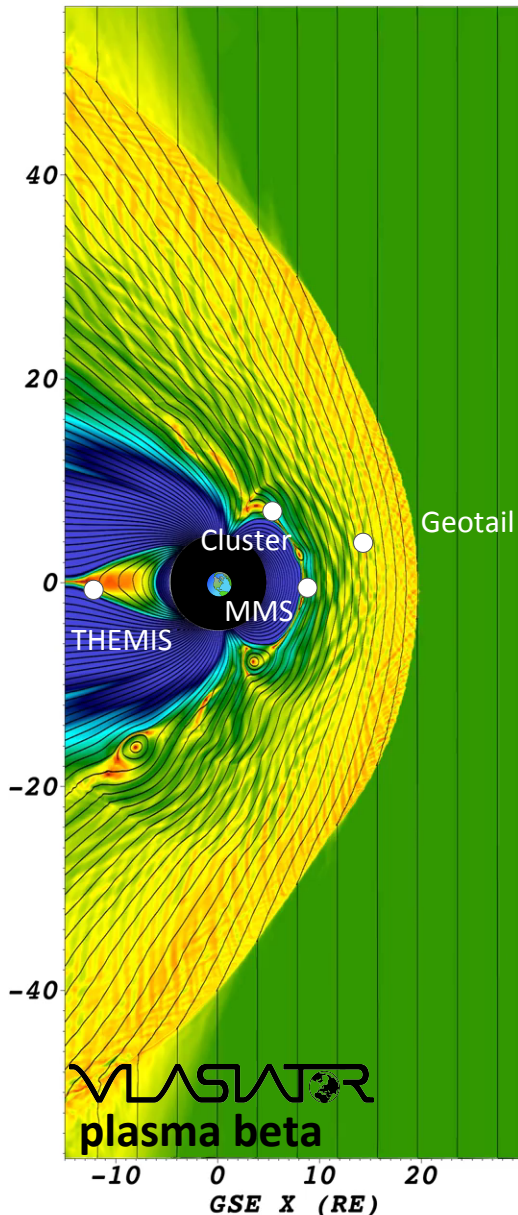
## 2 Timeliness

### Novel global kinetic models

- coupled MHD-PICs
- several hybrid-PICs
- hybrid-Vlasov model
- ...

### Unprecedented observations

- MMS
- HSO coordinated conjunctions: THEMIS, VAP, Geotail, Cluster, ground-based observatories,...
- statistics



# Focus Group goals and deliverables: where are we?

**Database of conjunctions**  
for validation of current and future global kinetic models

**Modeling challenges: model-model-obs. comparisons**  
a short time interval with constant SW conditions  
for a spacecraft conjunction from the 1st MMS magnetopause season

**Events**



events of interest from the MMS era  
(storms/SW discontinuities)

**Statistics**



a set of SW conditions and  
validation against obs. statistics

## Preparation

- optimal data acquisition during MMS 25Re apogee dayside phase (2017-2018)
- modeling for upcoming dayside missions (THOR, SMILE)

## Lead discussions on

- how to make data from large kinetic models easily accessible to the community
- how to achieve kinetic effects in operational space weather models

# Aims

## for the first Dayside Modeling Challenge

- **Collect** coordinated in situ and remote observations to assess the dynamics of the magnetospheric system and for model validation
- **Quantify** agreement/disagreement between datasets and models
- **Determine** reasons for data/model, model/model, and data/data differences
  - development of model
  - development of observatories
- **Advance** our understanding of multi-scale plasma processes and their role in SW-magnetosphere interaction

# Update on the search of candidate events

## 1. Primary challenge event:

2015-11-18 01:50-03:00 UT purely southward IMF event, MMS-Geotail magnetopause conjunction with SuperDARN radar observations, presented at the 2016 Summer Workshop

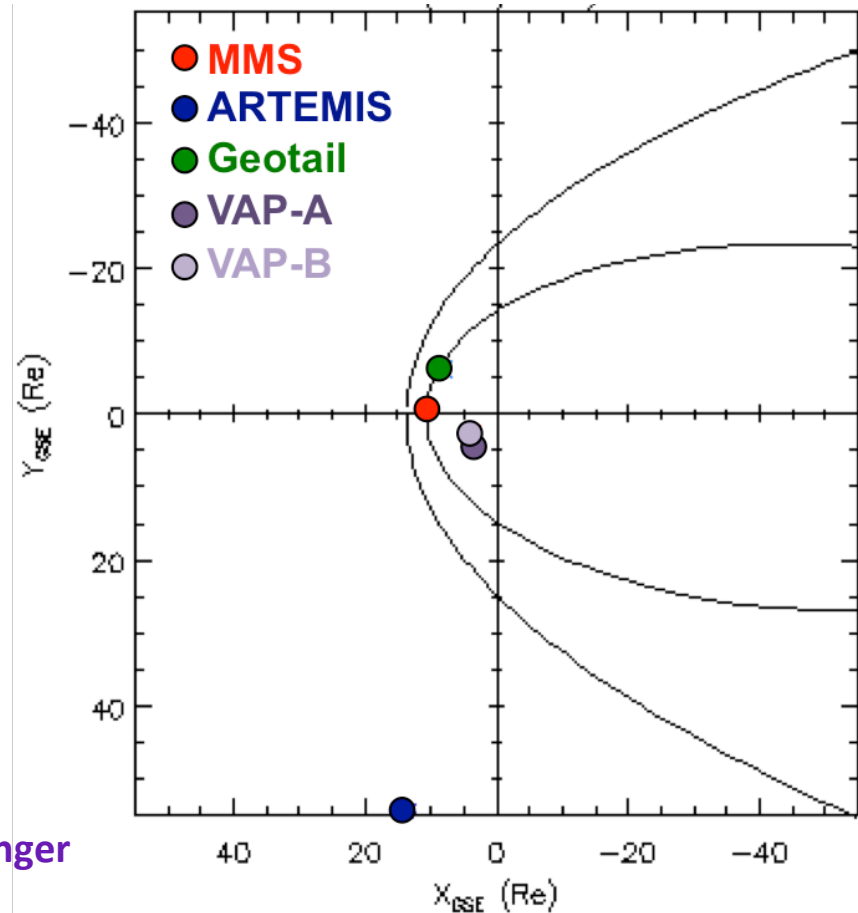
- We have searched the first MMS dayside season, and haven't found other such southward IMF events that would merit to be put up for a vote.
- To be considered part of the challenge, we expect you to have results for this event before you move on to any secondary/follow-up events. This will ensure that we'll have enough comparable simulations.

## 2. Secondary challenge events:

- Significant IMF By component: two candidate events (**vote**)
  - 2015-10-02 presented in the 2016 Summer Workshop
  - 2016-01-09
- Quasi-radial IMF: two candidate events (**vote**)
  - 2015-11-30
  - 2016-01-04
- Note 1: We have identified one potential Parker spiral type event (2015-12-04), but the  $B_z$  was mainly northward. We **welcome community comments and input on this IMF geometry**.
- Note 2: We have not been able to find a clean northward IMF event requested in the Summer Workshop. We will continue to look for one during the second MMS dayside season and **welcome community input**.

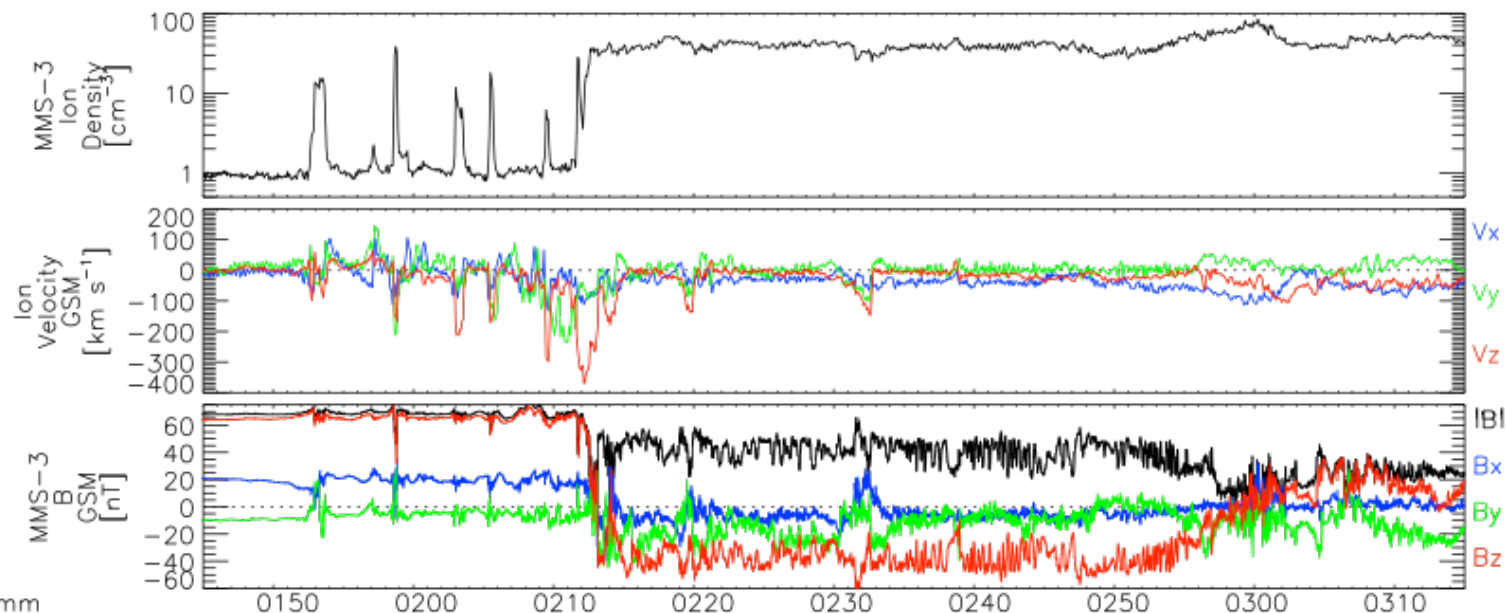
# Primary challenge event: 2015-11-18 southward IMF 01:50-03:00 UT

- ARTEMIS/ACE/Wind SW observations
  - $V_{SW} \sim 370\text{km/s}$
  - $n_{SW} \sim 8\text{ cm}^{-3}$
  - IMF  $\sim [0, 0, -6]\text{ nT}$
  - exact timing of discontinuities requires further analysis: **Rishi Mistry**
- MMS-Geotail magnetopause conjunction
  - both observe southward reconnection jets
  - X-line estimated to be at  $Z_{GSM} \sim +2R_E$  due to dipole tilt [Kitamura et al., JGR 2016]
  - MMS parallel electric fields: **Rick Wilder**
  - MSH mirror mode activity: **Matthew Argall**
- Magnetospheric conditions
  - ULF waves (ground mags, VAP): **Mike Hartinger**
  - cold ions, TEC maps: **Brian Walsh**
- SuperDARN radar data
  - dawnward flow enhancements: **Toshi Nishimura**



# Primary challenge event: 2015-11-18 southward IMF

- MMS observations:  
preliminary analysis
  - some **5+** FTEs during this event
  - properties could be used for metrics
  - further FTE analysis: **Heli Hietala, Marit Oieroset, Steve Petrinec**
  - further analysis needed to produce boundary conditions for local reconnection models: **volunteers?**
- Observational THEMIS statistics  
**Andrew Dimmock**
  - this type of large southward IMF events ( $B_z \sim -5$  nT) are quite rare
    - not possible to produce maps of the equatorial magnetosheath properties
  - Some **individual intervals** can be pulled out to improve the obs coverage



# Discussion on metrics

- potential metrics for obs-model comparisons:
  - location of the magnetopause (based on MMS and Geotail crossings)
    - adds to previous GEM challenge performed with MHD models
    - synergy with CCMC-LWS space weather activities
  - location of the X-line  
(northward of the sc, estimated to be at  $Z_{\text{GSM}} \sim 2R_E$ )
  - thickness of the current sheet at MMS
  - properties of the FTEs (including their periodicity)
    - MMS local observations
    - ground-based observations (e.g., estimated speed)
  - magnetosheath magnetic field power spectrum
  - properties of the magnetosheath mirror mode waves
- potential metrics for model-model comparisons:
  - match moments of the plasma distributions
  - how much the global solutions differ for the models that do meet ‘minimum requirements’ in obs-model comparisons
  - comparing phenomena in smaller-than-Earth (hybrid-PIC) models after they have been scaled such that the modeled magnetopause location matches observations
- potential metrics for comparing different observations:
  - FACs from in situ and remote observations
  - FTE characteristics from in situ and remote observations