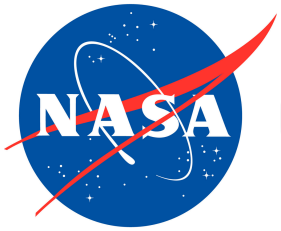
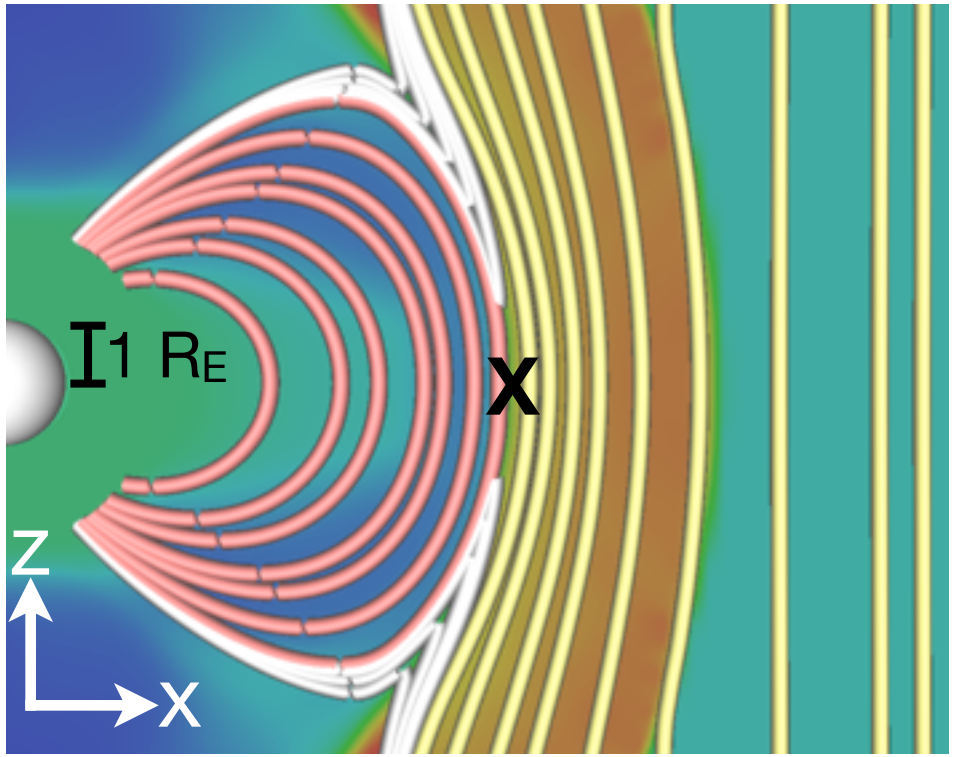


A Student's Perspective on NASA's Community Coordinated Modeling Center

Colin Komar
West Virginia University
2014 CCMC Workshop
Annapolis, MD
April 2, 2014

Dayside Magnetopause Reconnection

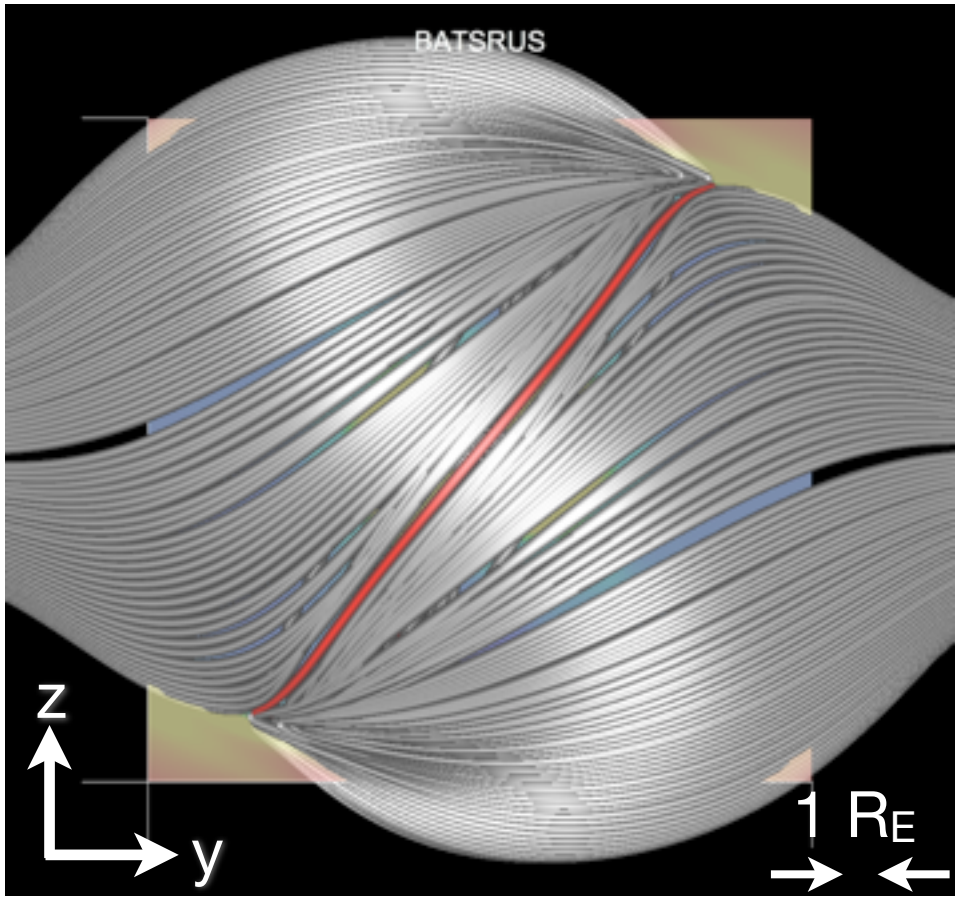
- For southward IMF, reconnection occurs at subsolar point
- All four magnetic topologies are separated at subsolar point
  - Magnetic separator (**X**)
- Reconnection occurs at separator



[Space Weather Explorer]

Dayside Magnetopause Reconnection

- For southward IMF, reconnection occurs at subsolar point
- All four magnetic topologies are separated at subsolar point
  - Magnetic separator (**X**)
- Reconnection occurs at separator
  - Separators can be defined for arbitrary clock angle
  - Finding separators is important for locating reconnection at the dayside magnetopause



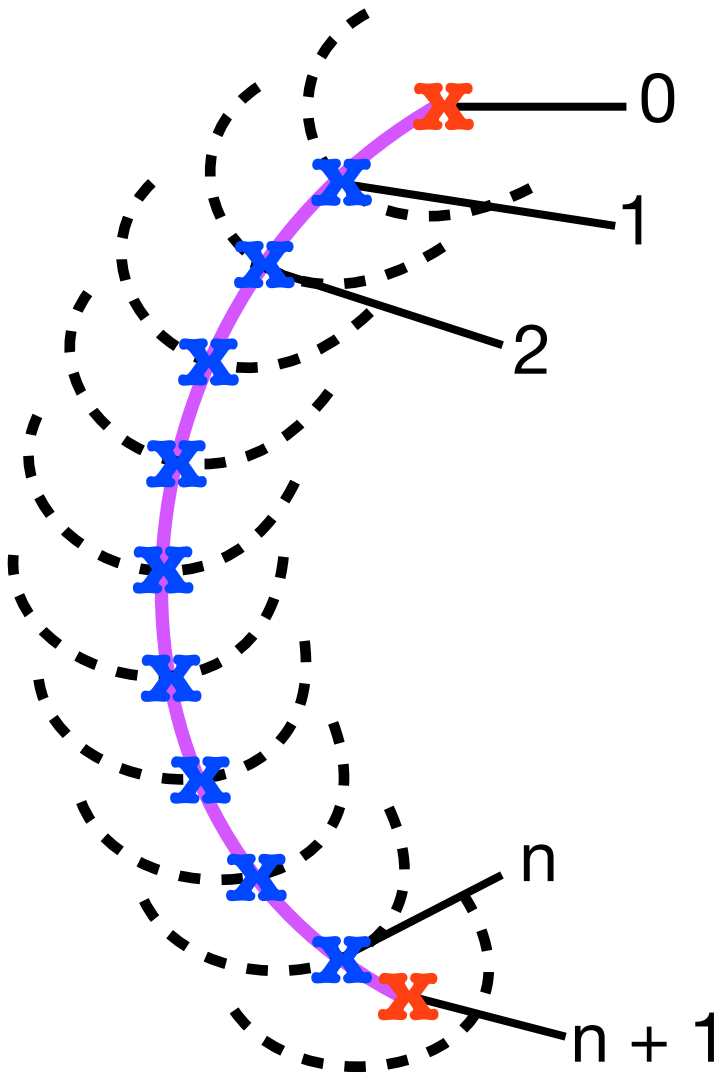
Separator for $\theta_{IMF} = 90°$ global magnetospheric MHD simulation

[Space Weather Explorer]

A New Method to Trace Separators

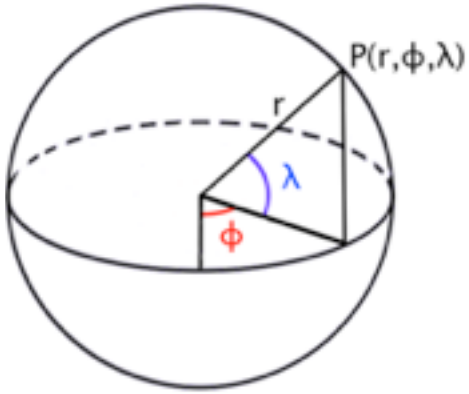
- We developed a simple and efficient method to locate **separators** (Komar et al., JGR, 2013)

1) Start at a known location on the separator: **X**
2) Center hemisphere at this location
3) Calculate topology of field lines piercing the hemisphere's surface
4) Find topological merging point on hemisphere: **X**
5) Center new hemisphere at **X**
6) Repeat 3) - 5) until known stopping point within a hemisphere
7) Connect points to trace separator

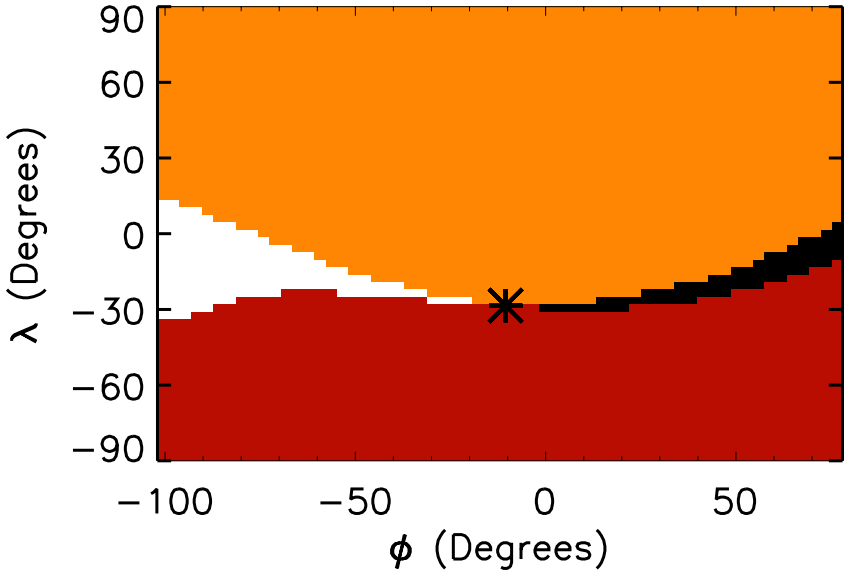


Finding the Separator on a Hemisphere

- Perform a bi-directional trace of magnetic field lines piercing hemisphere to determine magnetic topology
  - Closed: **Red**
  - Open: **Orange**
  - Northern: White
  - Southern: **Black**
- Approximate merging point of four topologies (asterisk)
- Computationally efficient: field lines are traced on surfaces of hemispheres



Spherical coordinates



Example topology map for $\theta_{IMF} = 30°$ at **r** = (3.16, 1.87, 8.01) R_E. [KAMELEON]

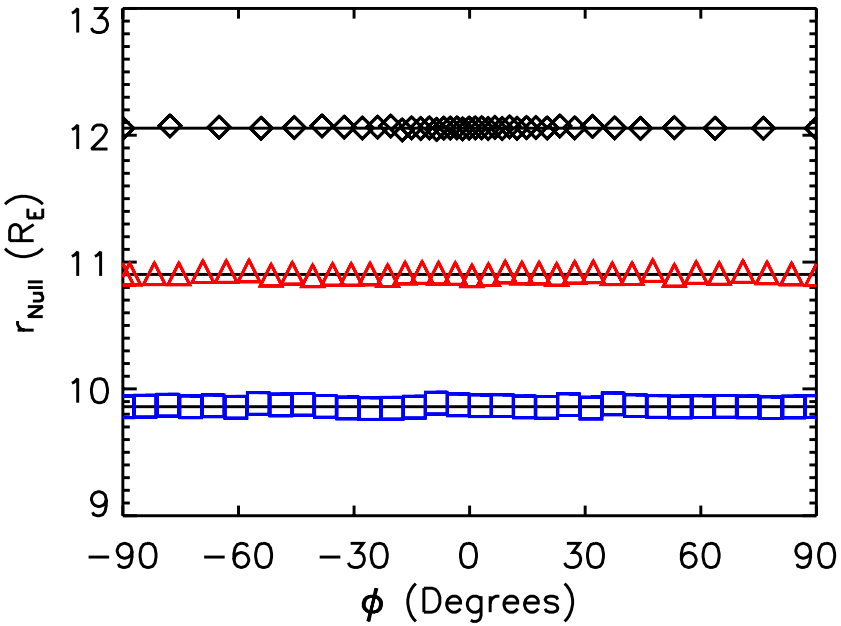
Method Verification

- Find separators in vacuum superposition:

$$\mathbf{B} = \mathbf{B}_{Dipole} + \mathbf{B}_{IMF}$$

  - Vacuum superposition has analytic solutions for separators (Yeh, 1976; Hu et al., 2009)

Our method accurately traces separators!

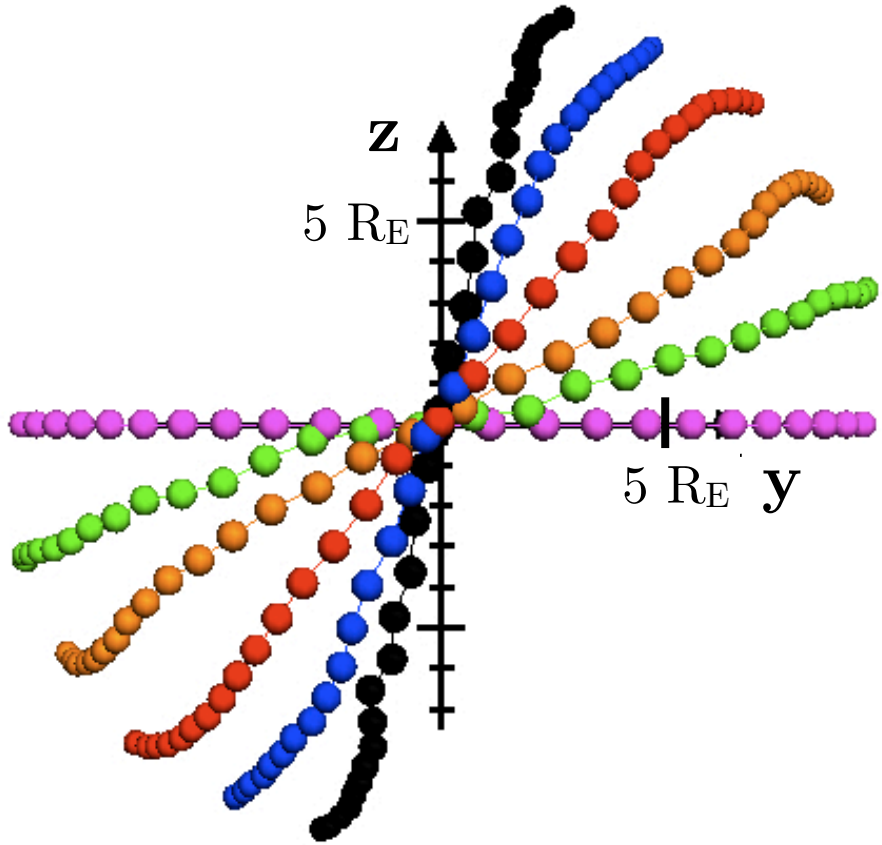


Separators in vacuum superposition for θ_{IMF} = **30°**, **90°**, **150°**.

Separator Clock Angle Dependence

- Traced separators in global resistive MHD simulations for different IMF clock angles (BATS-R-US)
  - **30°**, **60°**, **90°**, **120°**, **150°**, **180°**

Our method traces entire separator for any IMF orientation!



One Year Later…

(1) Locate magnetopause (top plot, green) from current maximum (Nemecek et al., 2011)

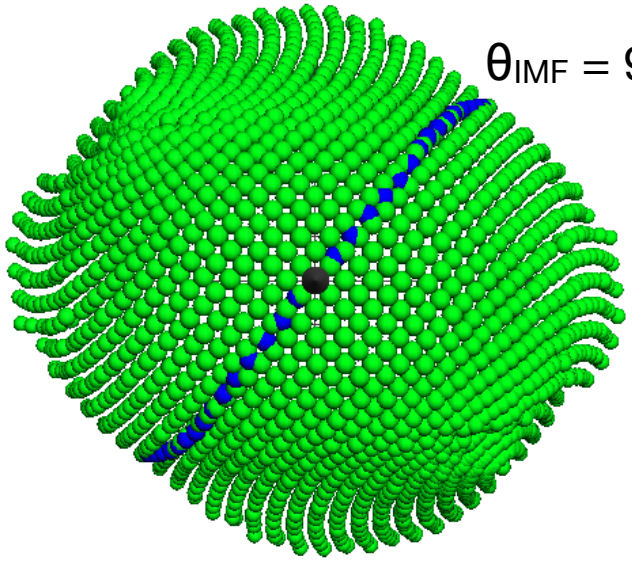
(2) Find magnetopause normal and sample plasma properties

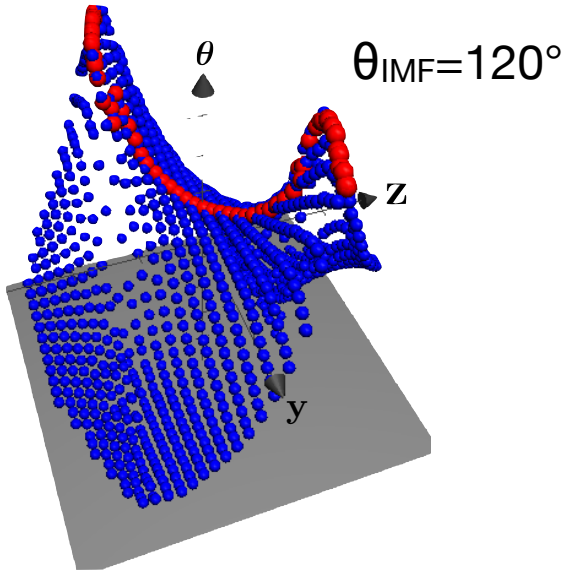
(3) Calculate reconnection model at each point

(4) Find each reconnection model's prediction via each model's maximized quantity

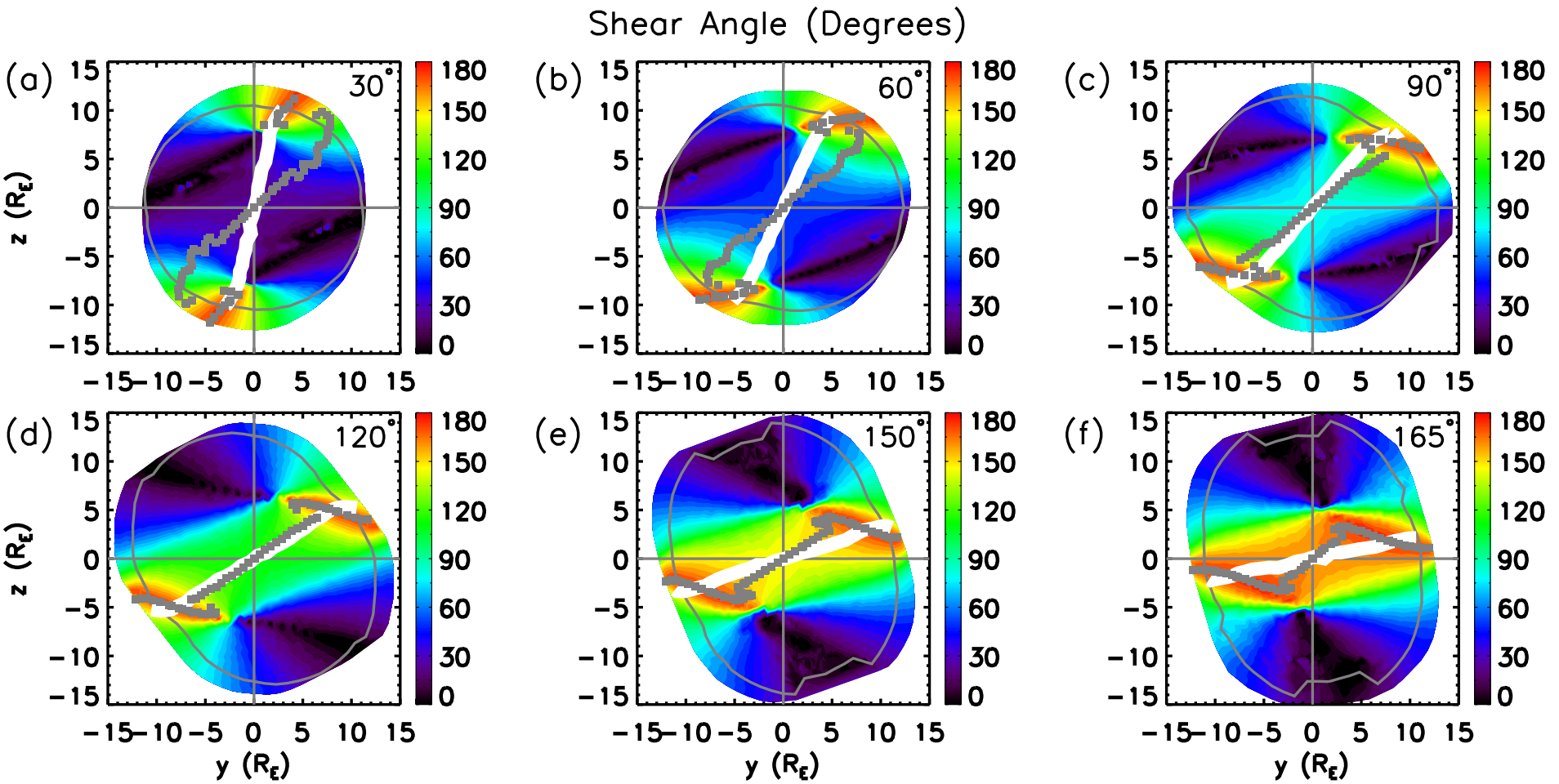
- We use image processing techniques to detect "ridges" (Lindeberg, 1993, 1998)

(5) Compare with magnetic separator





One Year Later… (cont.)



Perform a comparative analysis of reconnection location models at Earth's dayside magnetopause (Komar et al., in prep.)

Summary

- CCMC has enabled us to study three-dimensional magnetic reconnection at the dayside magnetopause
  - Locate magnetic separators in global resistive MHD simulations (BATS-R-US)
  - Use robust image processing techniques to compare predictions of dayside reconnection location models with magnetic separators for a variety of solar wind and magnetospheric conditions
- Implications for
  - Space Weather forecasting and geoeffectiveness of IMF with arbitrary strength and direction
  - NASA's upcoming Magnetospheric MultiScale Mission

Acknowledgments

- CCMC resources have led to two successful research projects
  - Runs on Request Service
  - On-line visualization, Space Weather Explorer, KAMELEON software
  - Simulation support
- Travel support to 2013 GEM Summer Workshop (CCMC/NSF)
- Work with CCMC will comprise at least two chapters (~40%) to my Ph. D. dissertation
- Additional thanks
  - Collaborators: Paul Cassak, John Dorelli, Ray Fermo, Alex Glocer, and Masha Kuznetsova
  - CCMC Staff: Anna Chulaki, Marlo Maddox, Anne Michelle Mendoza, and Lutz Rastaetter
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