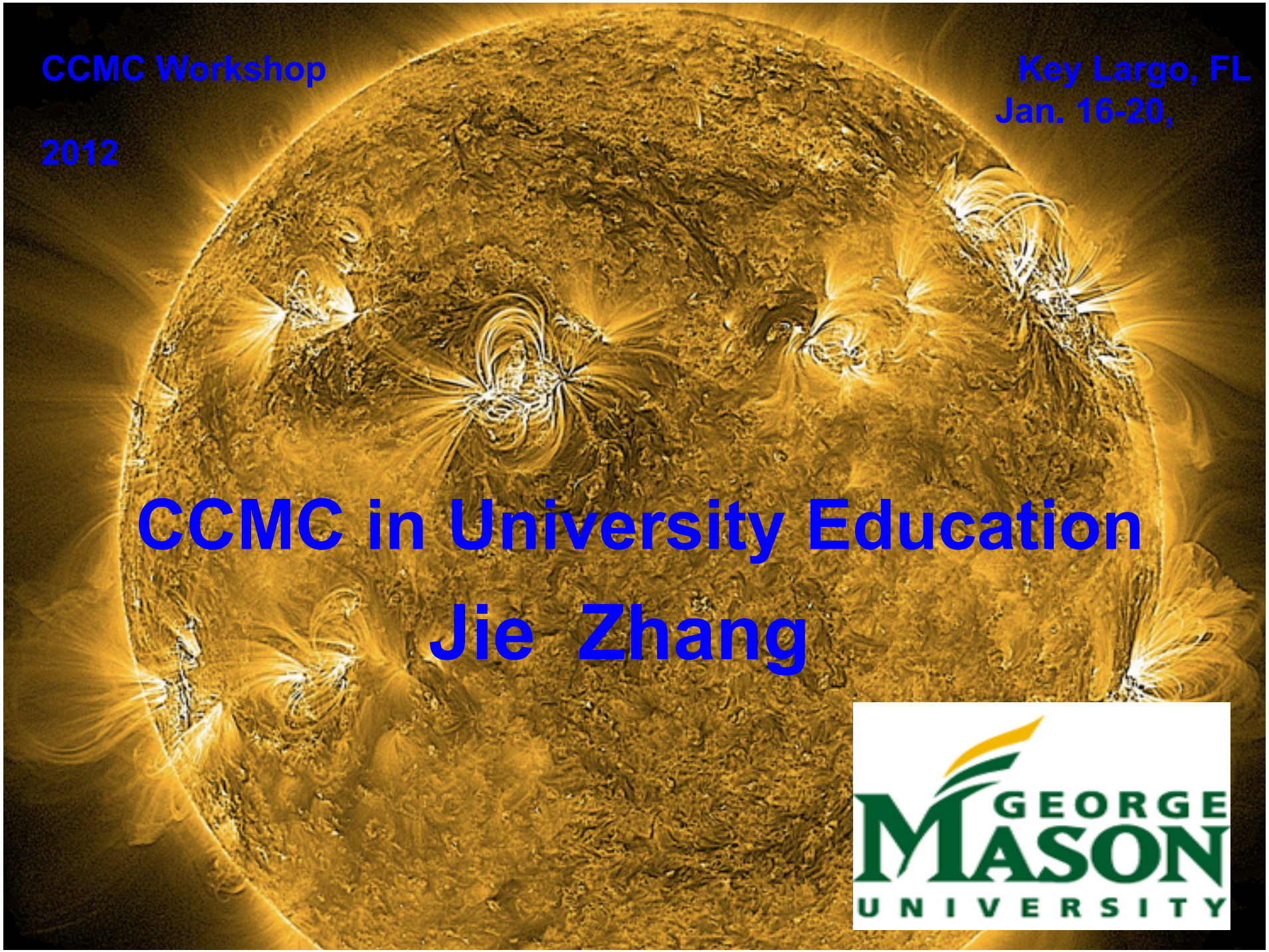
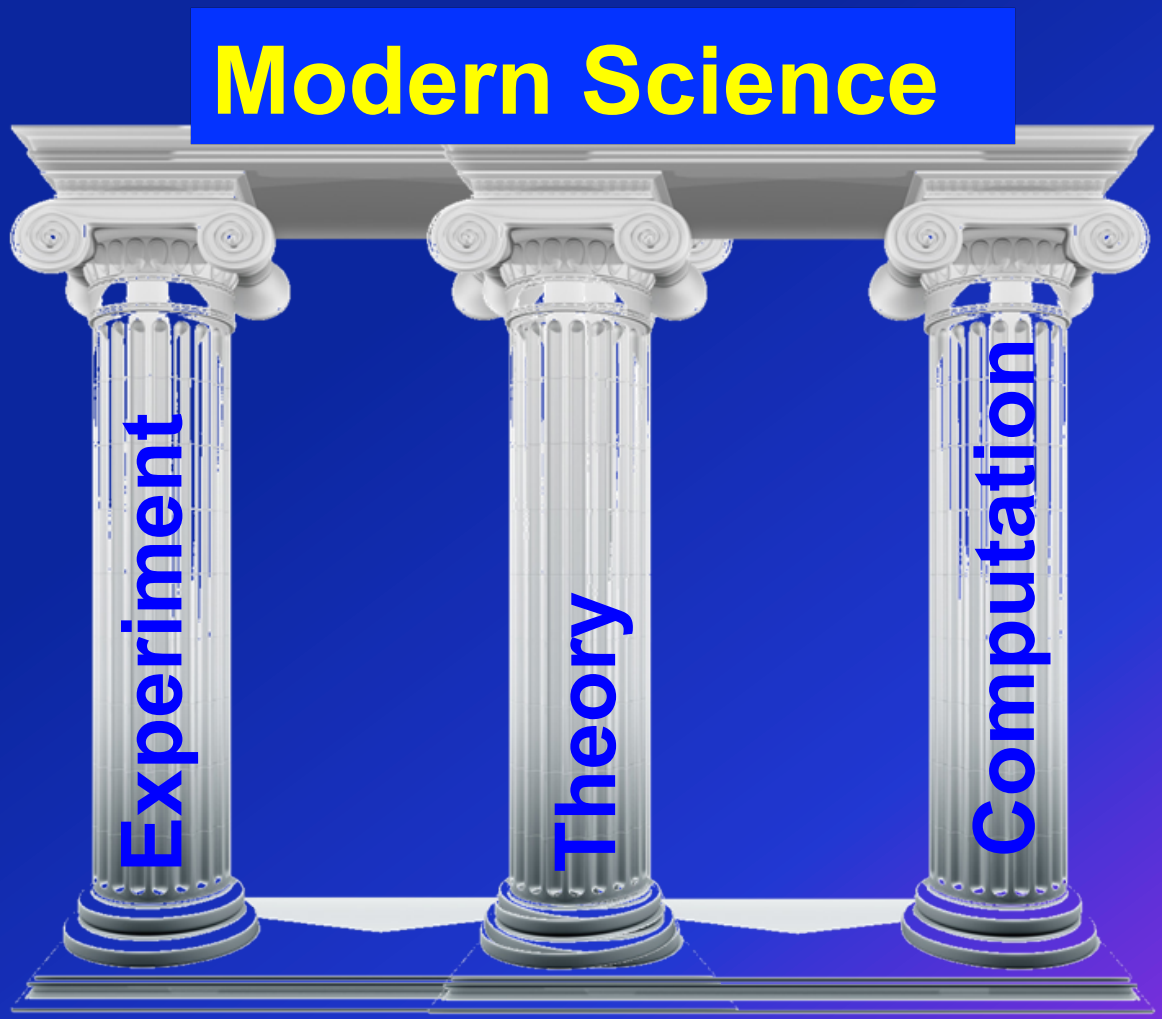

CCMC Workshop
2012
Key Largo, FL
Jan. 16-20,
CCMC in University Education
Jie Zhang
GEORGE
MASON
UNIVERSITY

Outline

1. The Three Pillars
2. GMU Space Weather Program
3. GMU Space Weather Course and CCMC
4. University Education and CCMC

The Three Pillars



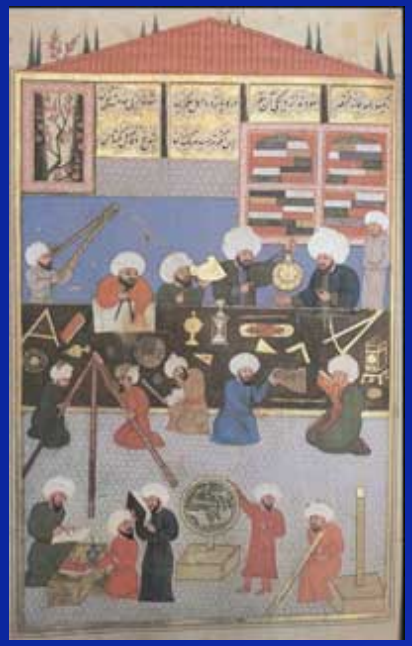
Why Computing for Science?

1. “Experimental science is the queen of sciences”
– Roger Bacon (1214 ?- 1294?, English Philosopher)

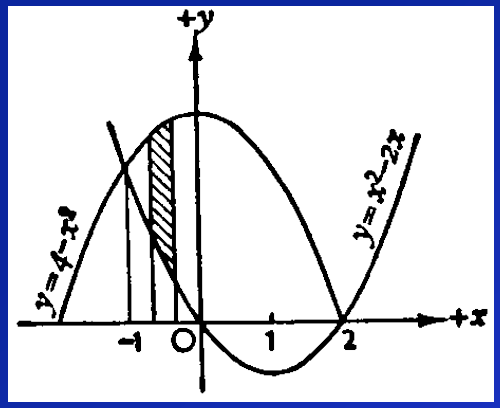
2. “Math is the queen of sciences”
– Carl Friedrich Gauss (1777 – 1855, German Mathematician)

3. “The purpose of computing is insight, not numbers”
– Richard Wesley Hamming (1915 – 1998, American Mathematician)

Why Computing for Science?



Experiment
(~ before 1600)



Math and
Theory
(After ~1600)

Computing
(After ~2000)

The goal is to gain insight

GMU Space Weather Program

Emphasize the balance of the three pillars

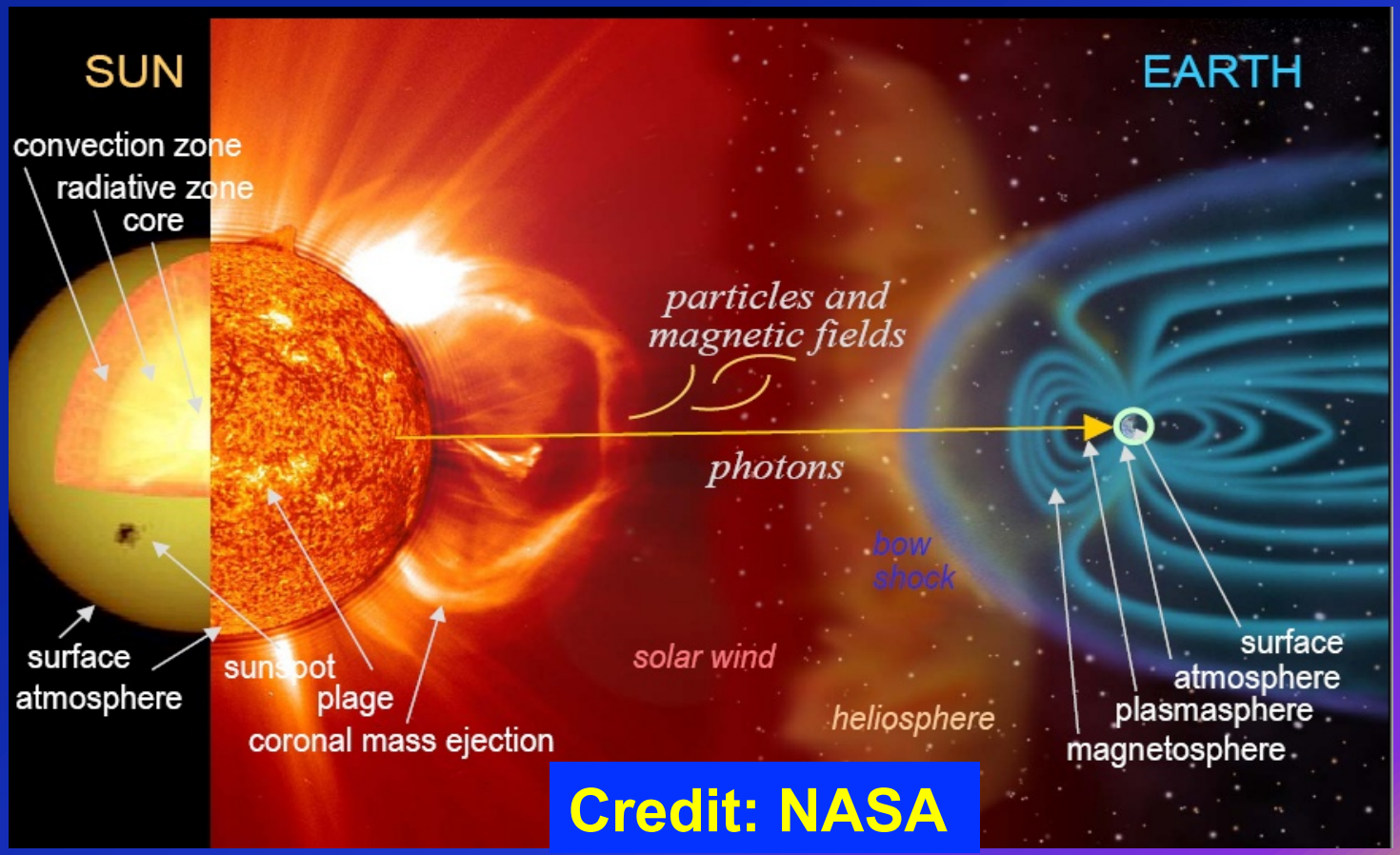
- The creation of SPACS: School of Physics, Astronomy and Computational Sciences in the College of Science in 2010
  - In 2005, the creation of the Department of Computational and Data Sciences

- Two PHD programs for Space Weather Students
  - PHD in Physical Sciences
  - PHD in Computational Sciences and Informatics

GMU Space Weather Program

Emphasize a systems approach

- Space weather science is truly of multi-disciplinary



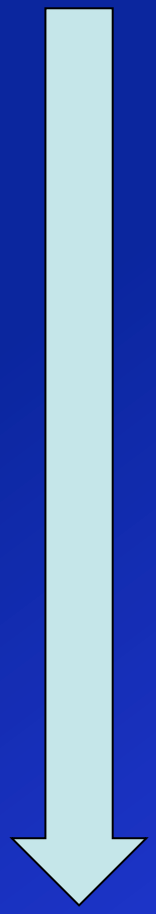
GMU Space Weather Program

Faculty:

Art Poland
Ken Dere
Jie Zhang
Dusan Odstrcil
Bob Weigel

Bob Meier
Dieter Bilitza
Phil Richards
Michael Summers

Sun



Earth

Students:

Curtis, Brian
Chintzoglou, Georgious
Colaninno, Robin (NRL)
Dandenault, Pat (NRL)
Hess Webber, Shea
Hess, Phillip
Karna, Nishu
Kunkel, Valbona (NRL)
Kercher, Andrew
Veibell, Victoir

Whitehouse, Paul (GSFC)

Graduated:

Forjan, Gary
Olmedo, Oscar (NRC Fellowship)
Poomvises, Watanachak
Evens, Rebekah (NPP)

Space Weather Course

- 2005 Fall, “Introduction to Space Weather” was first taught under CSI769 (a topic course)
- 2007 Spring, formally approved by the university as CSI 662
- 2009 Fall, as CSI 662 and PHYS 660
- 2012 Spring, the 4th time I teach “Introduction to Space Weather”

Space Weather Course

To develop a new science course, one needs

(1) A good textbook (the basic theory)

(2) Well designed projects (data analysis, computer models)

Space Weather Course

Textbooks Used

- "Space Physics: An Introduction to Plasma and Particles in the Heliosphere and Magnetosphere", May-Britt Kallenrode (2004)
- "Introduction to Space Environment", Thomas F. Tascione (1994)

- "Physics of Space Environment", Tamas I. Gombosi (1998)
- "Physics of the Solar Corona", Markus J. Aschwanden (2006)
- "Physics of the Earth's Space Environment", Gerd W. Prolss (2002)

And several other supplement books, including on rudimentary space weather concepts and on plasma physics

- "Space Weather, Environment and Societies", Lilensten & Bornarel (2006)
- "An Introduction to Space Weather", Mark Moldwin (2008)
- "The Sun from Space", Kenneth R. Lang (2009)

Space Weather Course

(Recent) Space weather books explored

- "Space Weather: Physics and Effects", Volker Bothmer and Ioannis A. Daglis (2007)
- "Understanding Space Weather and the Physics Behind it", Delores Knipp (2011)
- "Heliophysics: Plasma Physics of the Local Cosmos", Carolus J. Schrijver & George L. Siscoe (2009)
- "Heliophysics: Space Storms and Radiation: Causes and Effects", Carolus J. Schrijver & George L. Siscoe (2010)
- "Heliophysics: Evolving Solar Activty and the Climates of Space and Earth", Carolus J. Schrijver & George L. Siscoe (2010)

Space Weather Course - CCMC

Project (2009): The Chain of Sun-to-Earth Activities of an Intense Geomagnetic Storm

One requirement is to request model runs on at least one CCME model and discuss the model results. Students ran

- **"PFSS" model**
- **"MAS" model**
- **"BATS-R-US" magnetosphere model**
- **"AbbyNormal" model**
- **"CTIP" model**
- **"GAIM" model**

"Space Plasma Physics" class by Robert Weigel (Fall 2011)

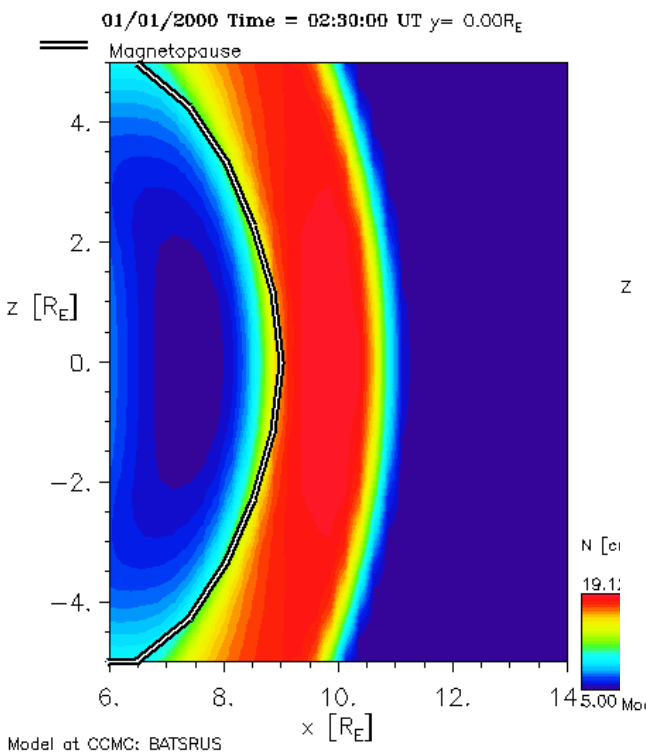
•compare the magnetopause from CCMC Education runs to discontinuities. Goal was to make connection between simulation data and theory covered in lectures and text.

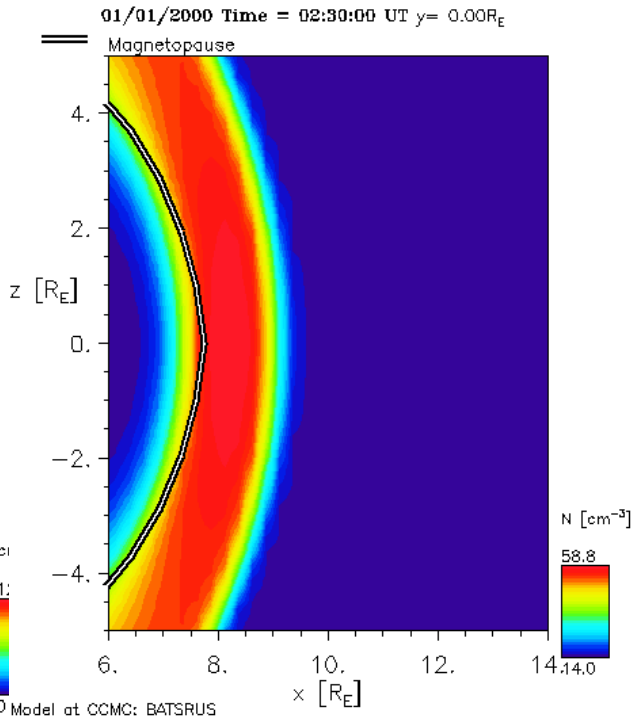
• plasma properties between X = 6-12 R_E, Y=0, Z=0 line. Bz = -5 nT for all cases, varying N and Vx.

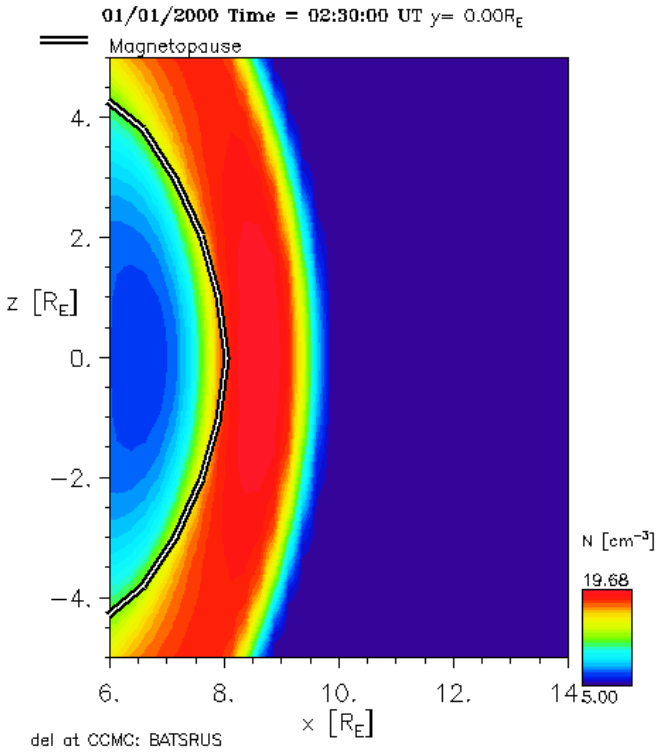
Requested Analysis for Project

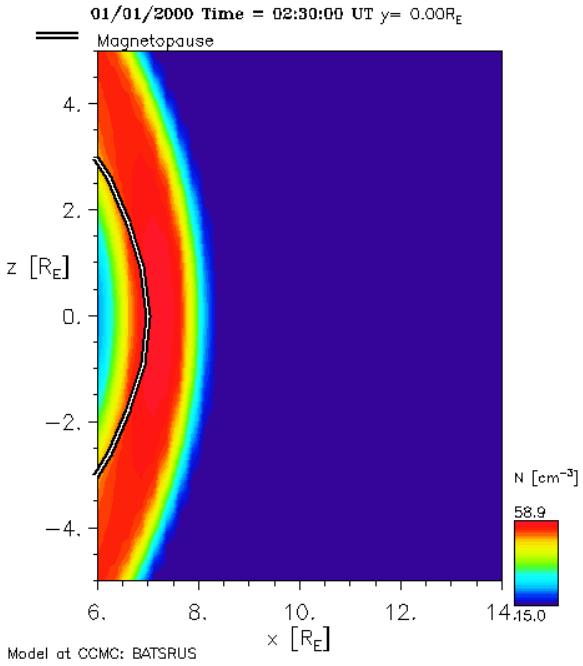
•Draw boundary of magnetopause based on MHD runs and comparison with ideal tangential discontinuity

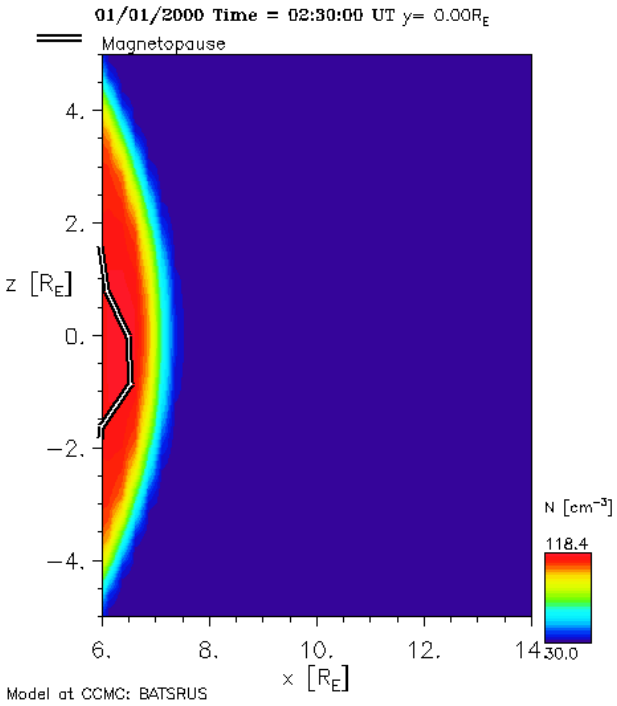
•Compare dependence of boundary on upstream Vx and N





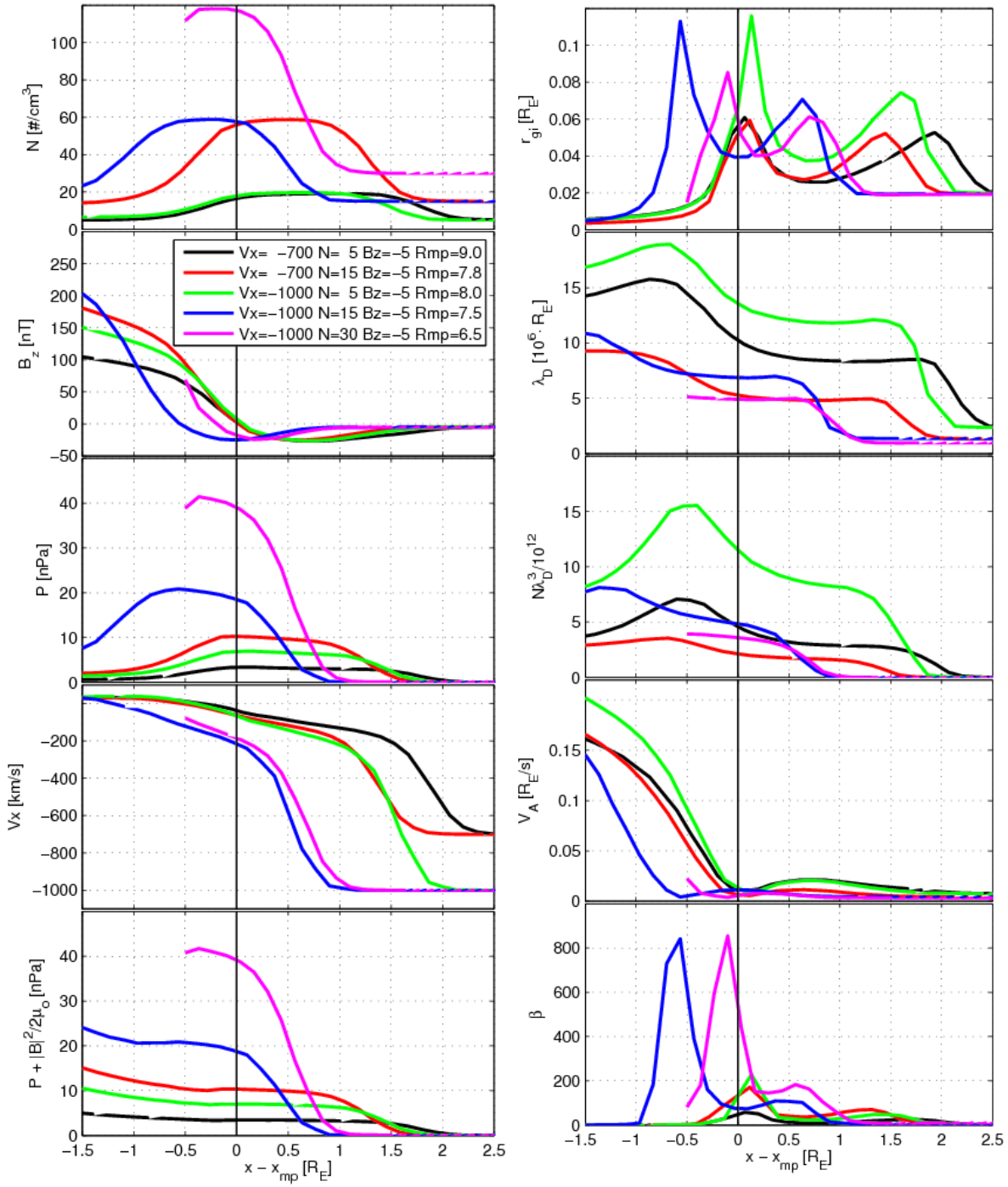






Case	Vx [km/s]	N [#/cm^3]
I	-700	5
II	-700	15
III	-1000	5
IV	-1000	15
V	-1000	30

Typical results



University Education - CCMC

CCMC is invaluable in university education

- Projects in formal classes
  - Easy to run – web based
  - Visualization tools
  - Extremely useful in reinforcing the student learning
  - Not possible to do in any traditional way
    - An Instructor has no/limited knowledge in simulation, or limited to one kind of models
    - Not “convenient” to contact developers

University Education - CCMC

CCMC is invaluable in university education

- Student research training
- Student thesis and dissertation

University Education - CCMC

Plans in the Future

- **Design multiple solid CCMC-based projects for my "Space Weather" class in Spring 2012**
- **Undergraduate course in space science; not only limited to graduate students**
  - **No such course in the university undergraduate curriculum**
  - **Existing astronomy courses are just so "astro"**

University Education - CCMC

Feedback:

- **Continue the good work!!!**
- **Enrich the educational page**
  - **Appropriate projects for graduate students, undergraduate students, and high school students, respectively.**
- **Bring real data together with the model results**
- **Make simulation "BLACK BOX" more transparent to students, e.g., some level of explanation and documentation**

The End