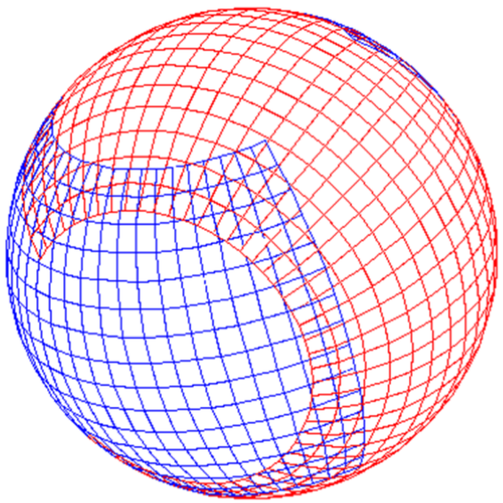
WG3: Simulations - Summary

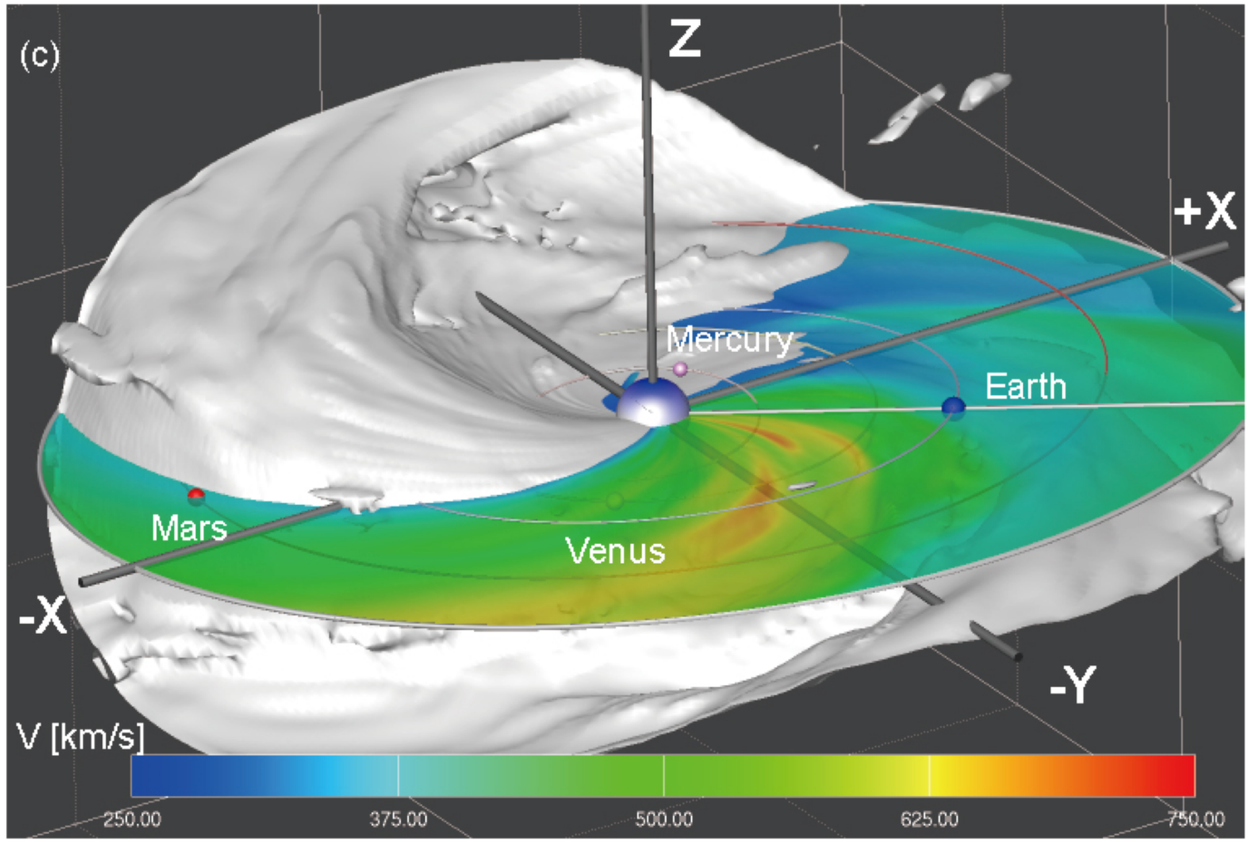
- Invited talk by Shiota-san on new Japanese space weather modeling project.
- Contributions by
  - Gonzalez-Dominguez (Niembro-Hernandez),
  - Fang Shen (Wang Yuming),
  - Enriquez Rivera,
  - Mishra (Nandita),
  - Lugaz
- <u>One important caveat</u>:
  - relatively simple simulations starting in the heliosphere (ENLIL) are now run in real-time.
  - more realistic simulations with simplified CME “initiation” mechanisms can be run few months after an event (H3DMHD, SWMF or MAS w/ out-of-equilibrium FRs).
  - for the most advanced simulations, where realistic initiation mechanisms and realistic physics are important, most researchers are still focusing on events from SC23.

Solar wind MHD model: SUSANOO-SW

- Numerical domain in
  25 Rs ≦ r ≦ 425 Rs (~ 2 au)
- Yinyang Grid
  (202 × 68 × 192 × 2)
- Inner boundary
  solar wind map
  rotating and time-
  dependent
- Planets are revolving



Heliographic inertial coordinate
Solar wind map on the ecliptic plane



Colors: velocity on ecliptic plane
White surface: neutral sheet (Shiota + 2014)

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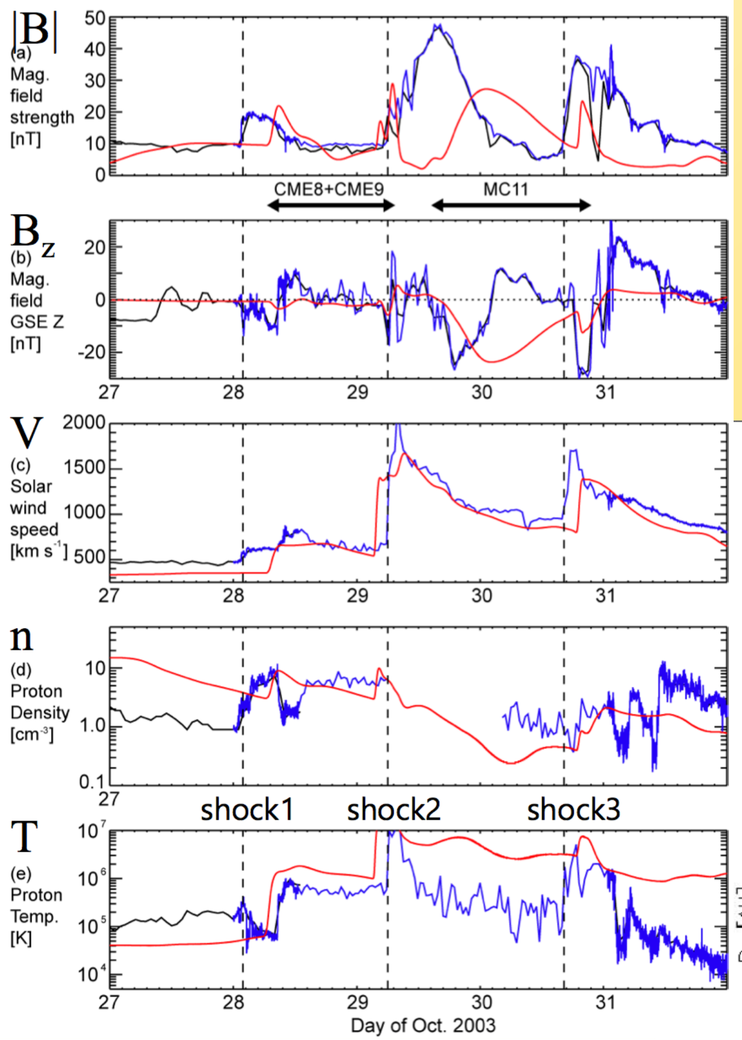
Comparison with in situ measurement

MHD
OMNI
ACE (Skoug+ 2004)

- Solar wind profile at the Earth position is compared with in situ measurements.
- The results reproduce well the profiles of solar wind speed and B_z strength following shock 2.



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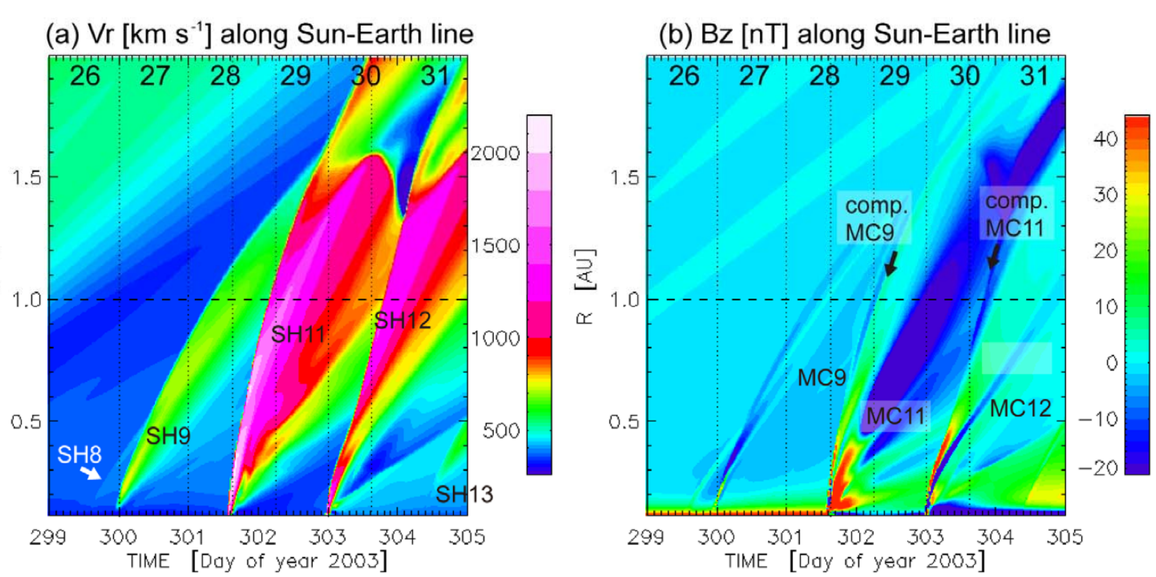
CME-CME Interaction

A preceding CME can be compressed by a following CME



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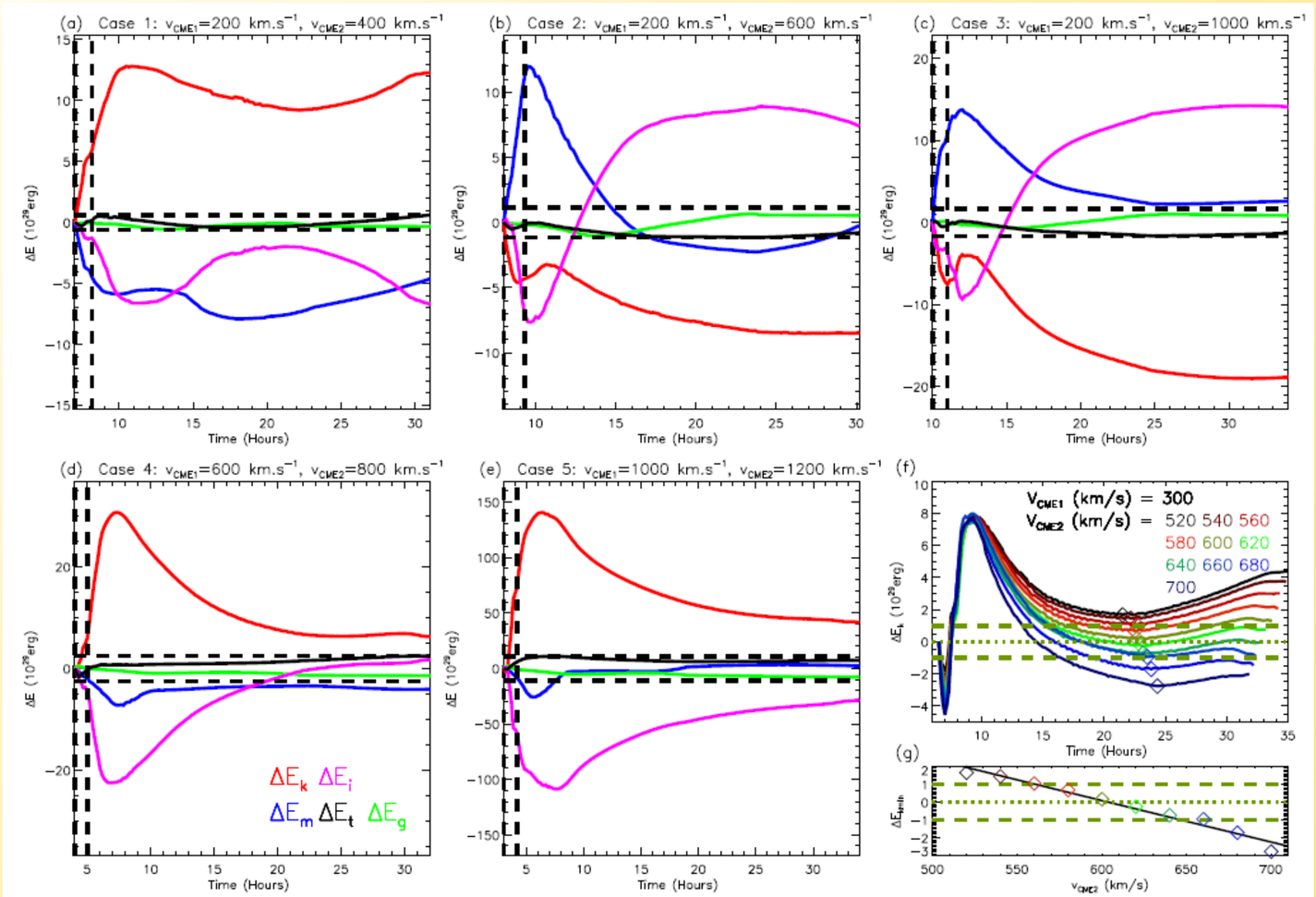
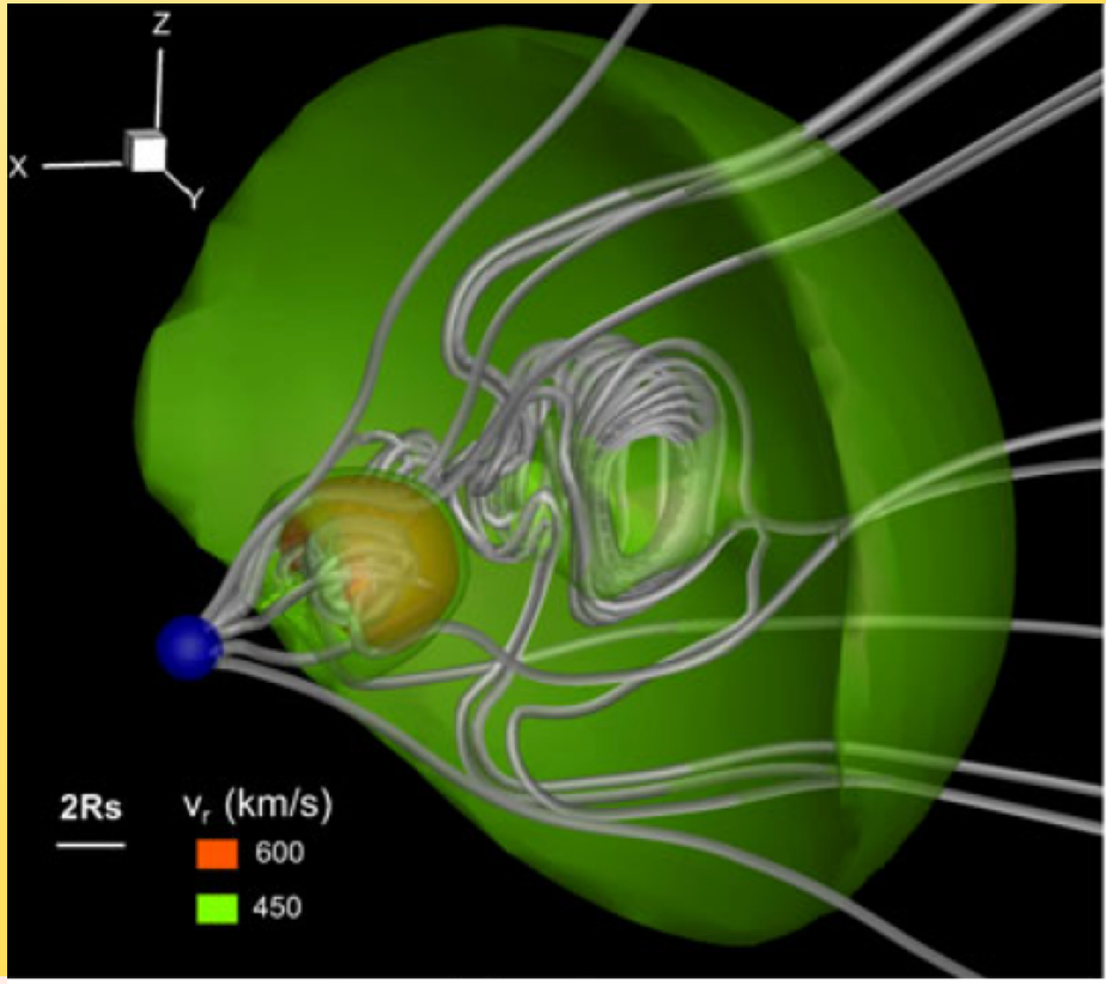
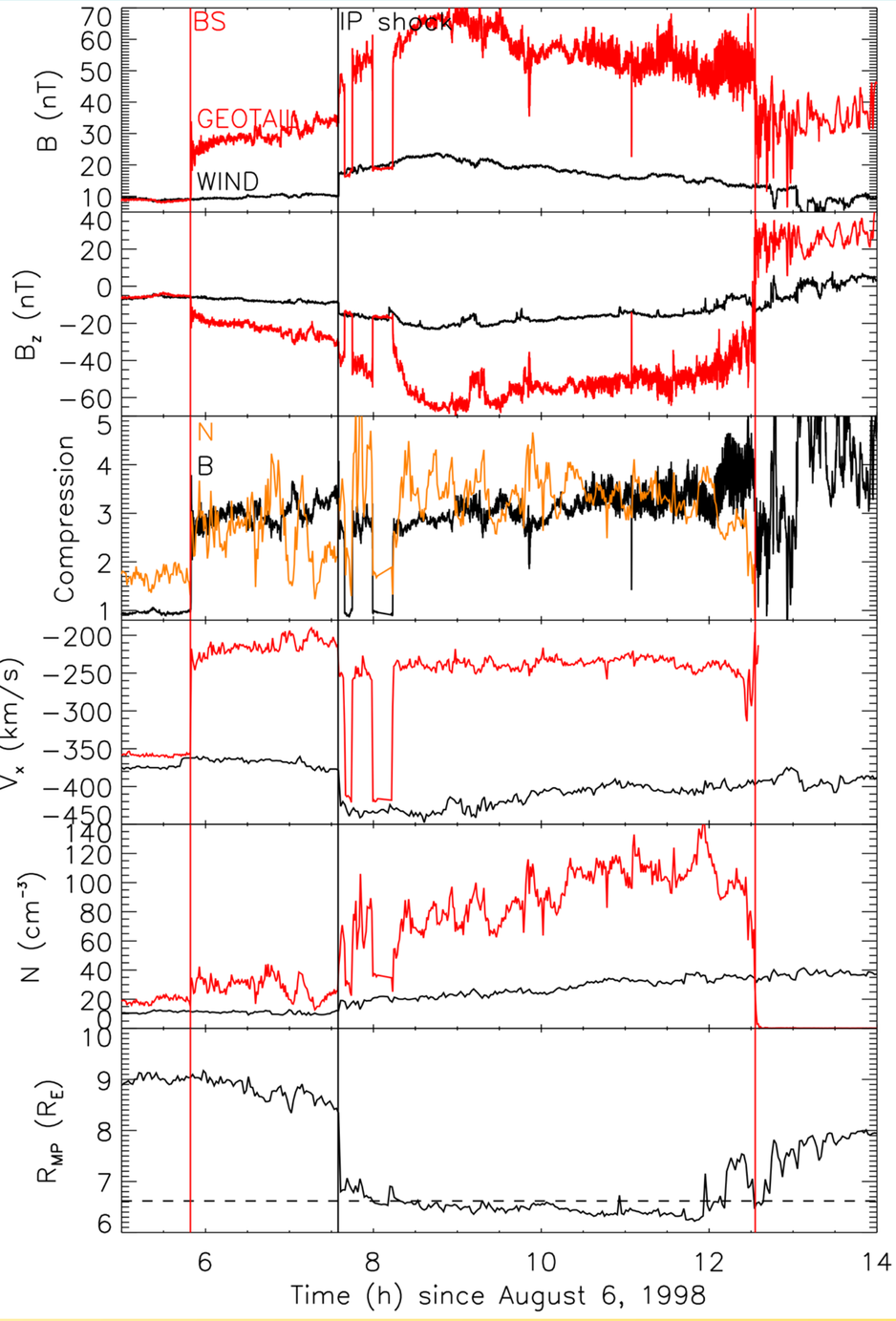
Simulations of multiple/interacting CMEs

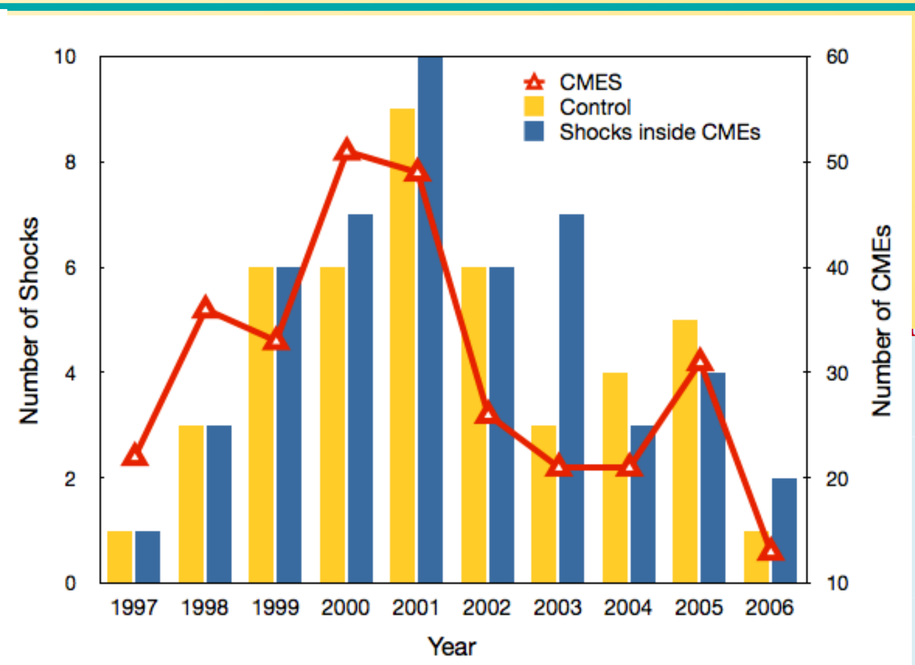


see talk by F. Shen (given by Y. Wang)

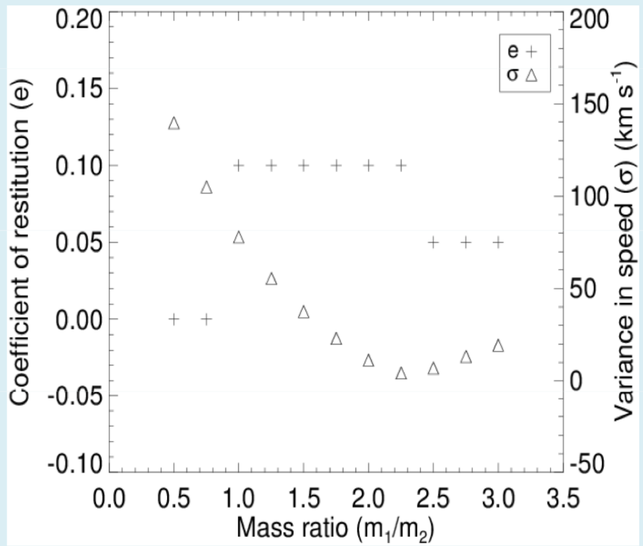


CME-CME interaction: non-simulation





We found e = 0.1 for σ = 9 km/s
Collision close to perfectly inelastic
Total kinetic energy of the system decreased by 6.7%



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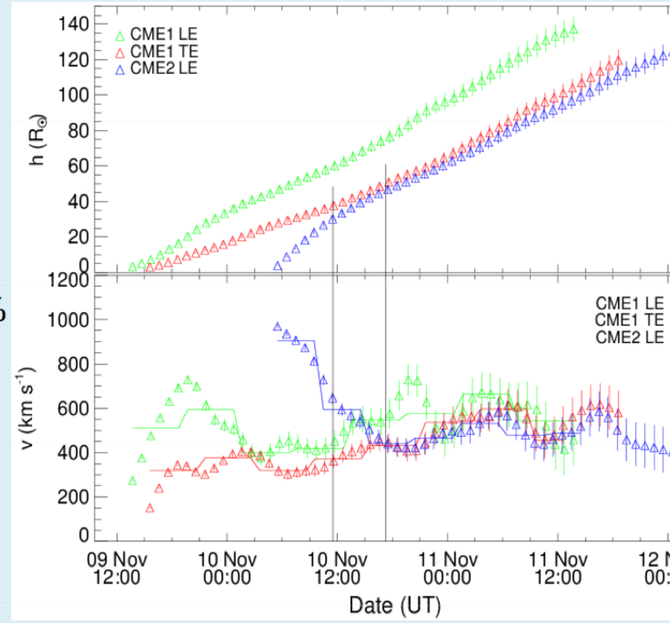
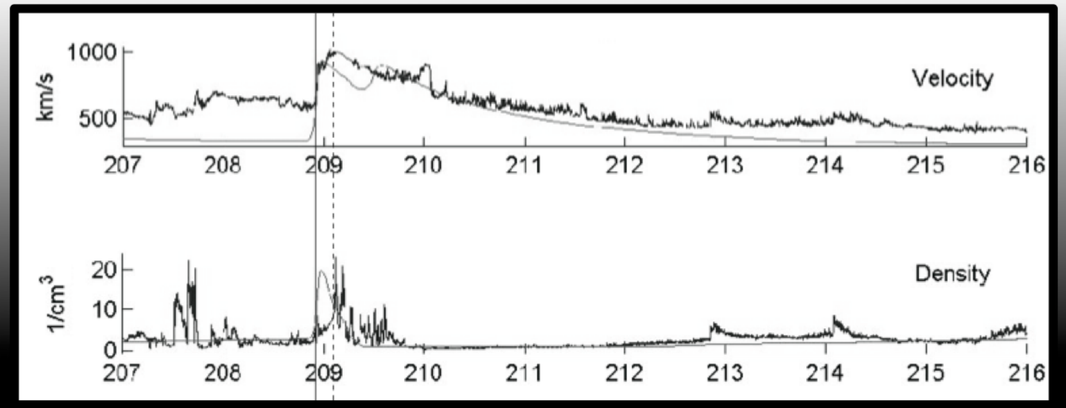
3D Reconstruction in HI FOV using HM method (Lugaz et al. 2009)

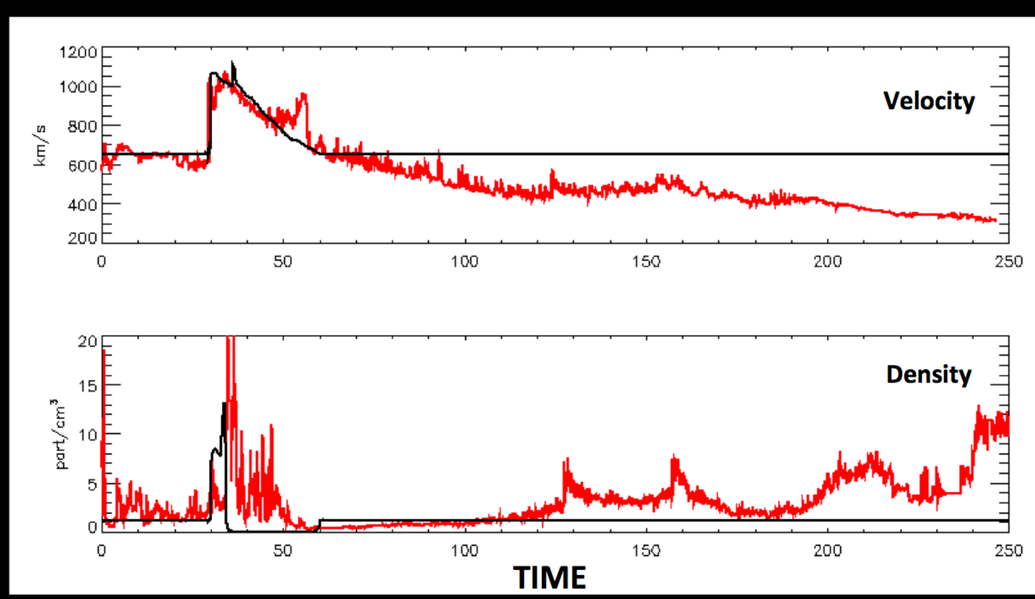


From observation M_1/M_2=2.05; however we have varied the ratio between 0.5 to 3.0, and examined t effect on our calculation. In each case collision remains perfectly inelastic.

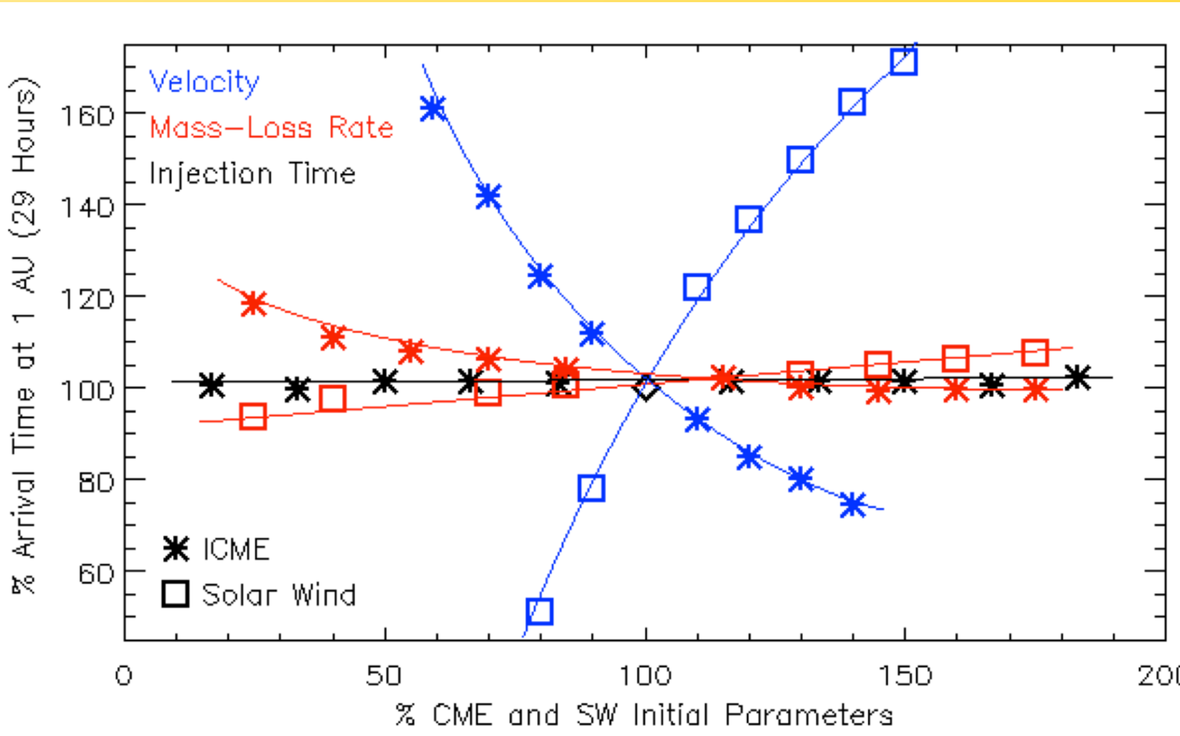
Parametric studies of CME propagation in HD simulations



ENLIL



YGUAZÚ



Forbush decrease and GLE events

1. Calculation of FD min & bkg spectrum

- Obtain the force–field parameter $\Delta\phi$ and then *J(P)*

- Parameterization of *J(P)*: J_{gal} J_{For}

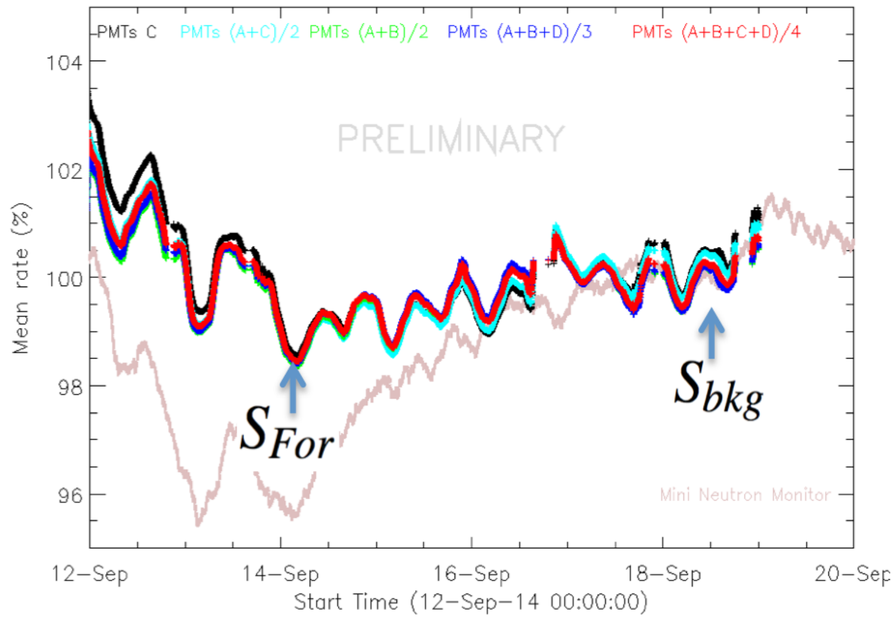
$$J(P) = J_0(P_0^a + P^a)^{(\gamma_1-\gamma_2)/a} P^{\gamma_2}$$

2. Counting rate: S_{bkg} S_{For}

$$S(\theta) = \int_{P_{cut}}^{\infty} J(P,t) A_{Eff}(P,\theta) dP$$

3. Fractional decrement

$$(S_{bkg} - S_{For})/S_{bkg}$$



On September 14, 2014 HAWC registered a double-step FD

Conclusions - Future

- Simulations have really reached the point where very different simulations are used for different goals:
  - Real-time forecasting: ENLIL, STELab
  - Providing environment for analyses of real events: STELab, ENLIL, H3DMHD
  - Understanding causes of eruption: complex initiation mechanism, as much realistic physics as possible — beyond ISEST goals?
  - CME-CME interaction: Most advanced domain where people are using simulations + data analysis (remote + in-situ) to learn new things.
- Is there something ISEST wants to focus on?
- Next year: individual progress can be expected: STELab, PSI, CAS/USTC, Michigan.
- For coordinated work, 1-2 event(s) should be chosen - in coordination with other WGs (1 isolated, 1 multiple?). ISEST-simulation campaign events.
- 2013 March 15, 2015 March 15; 2015 June 22?
- What is importance of solar initiation? How to determine orientation at 0.1 AU?