# ENLIL Progress and Plans Relevant to SEP Studies

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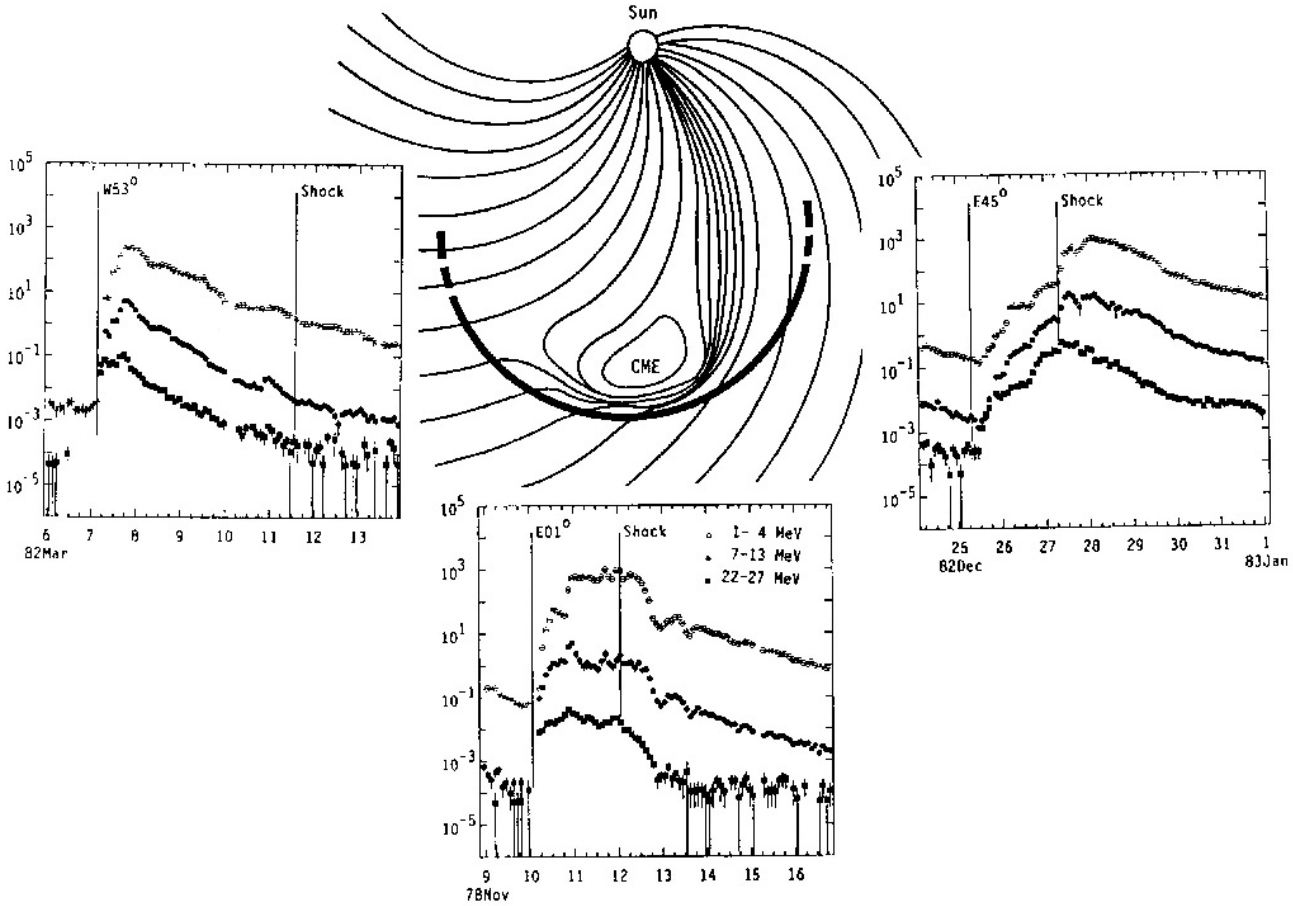
*ACE/STEREO/WIND* In-Situ Workshop
Caltech, May, 2014

# Still the goal: SEP sources and resulting distributions in the heliosphere



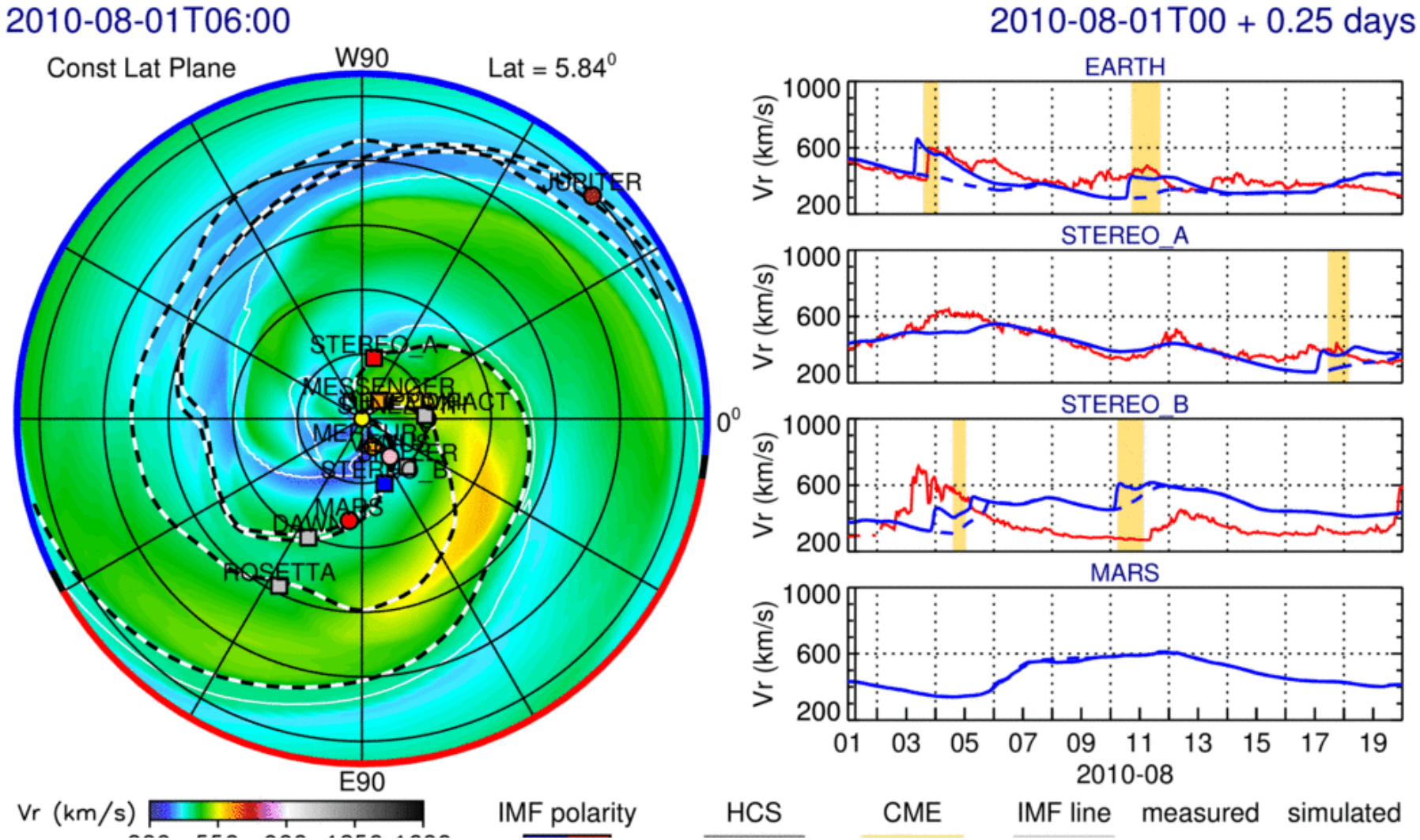

(from Reames, Space Science Rev., 1999, adapted from an original version by Cane and von Rosenvinge, 1988)

Key considerations in modeling gradual SEP events:

1. Underlying heliospheric conditions, including observer-connected field line geometry and propagating shock characteristics (can be addressed with WSA-ENLIL-cone)

2. The treatment of SEP injection at the shock source and SEP transport to the observer (addressable by various SEP event modeling codes)

# Example: The period covering most of August 2010, which included several CMEs

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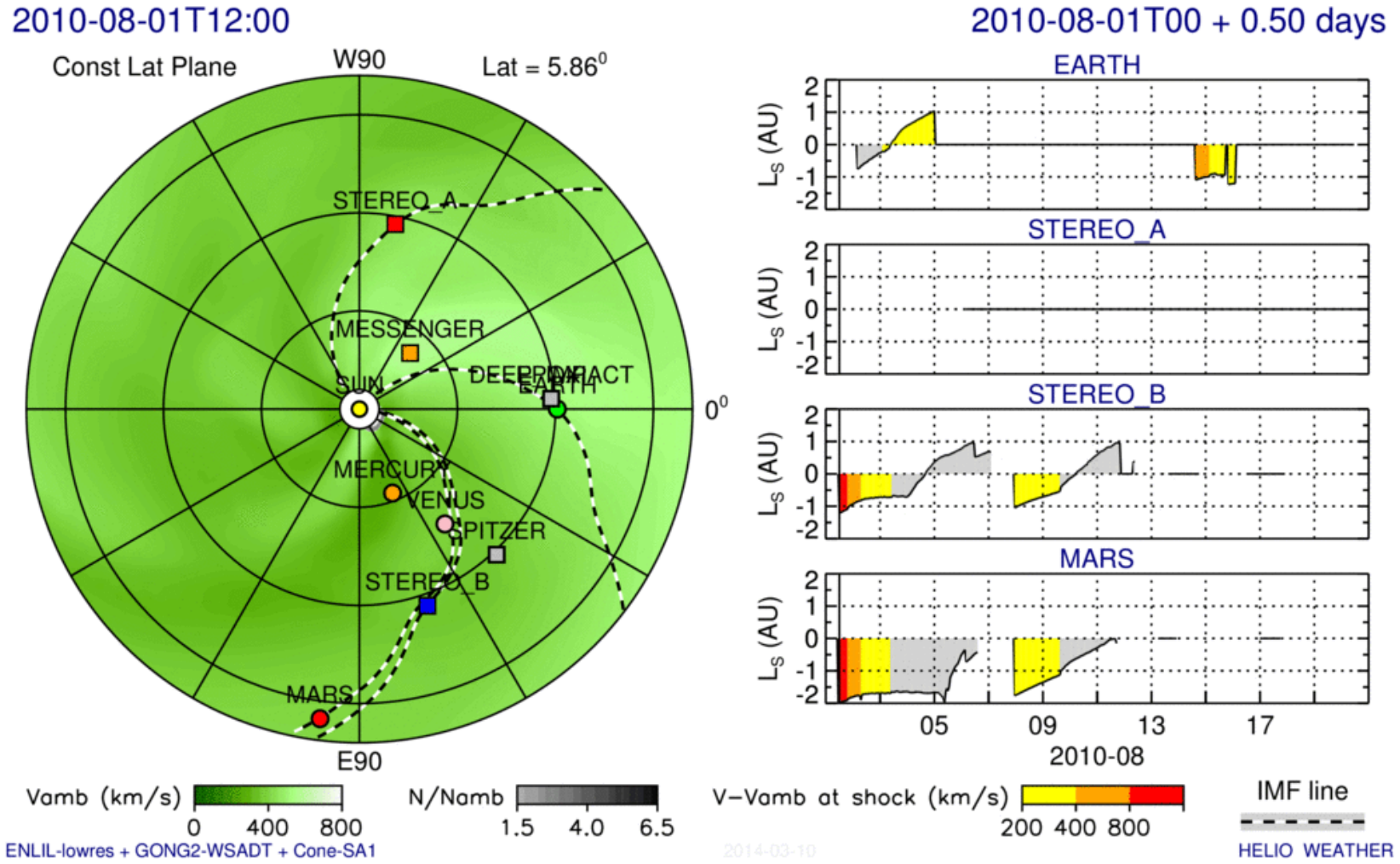


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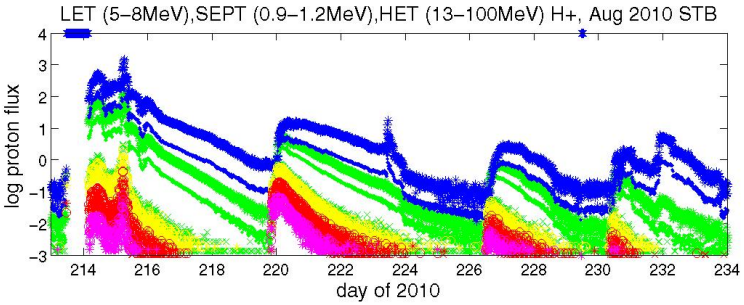
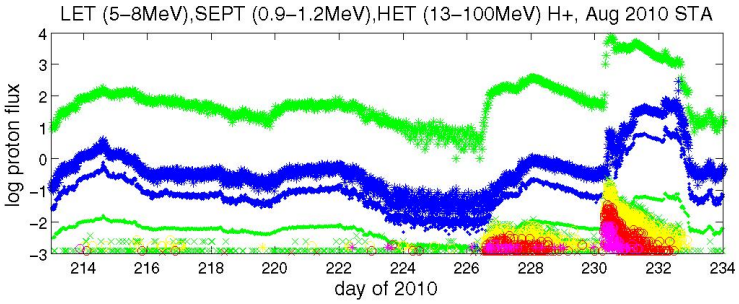
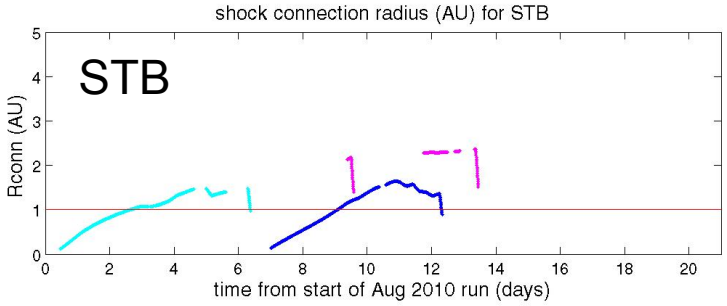
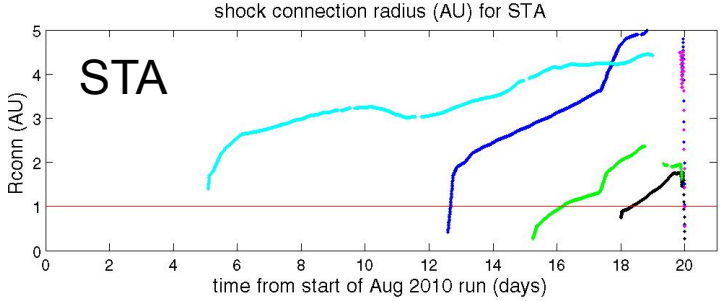
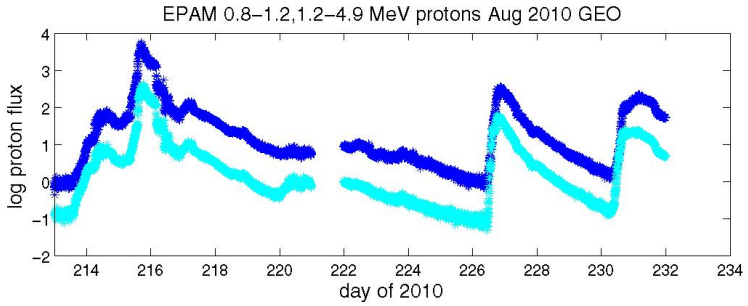


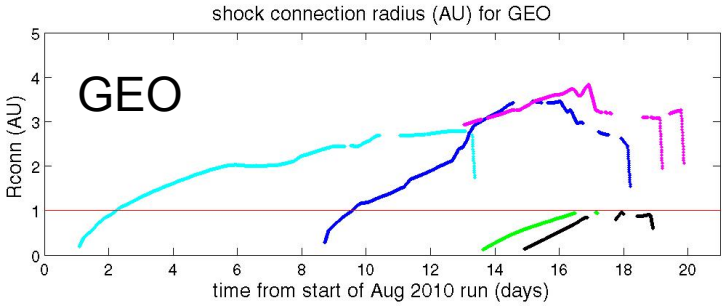



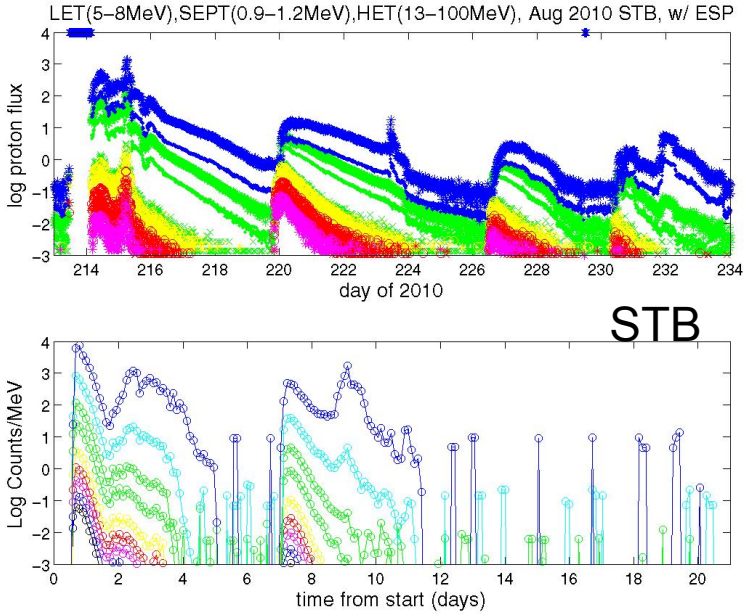



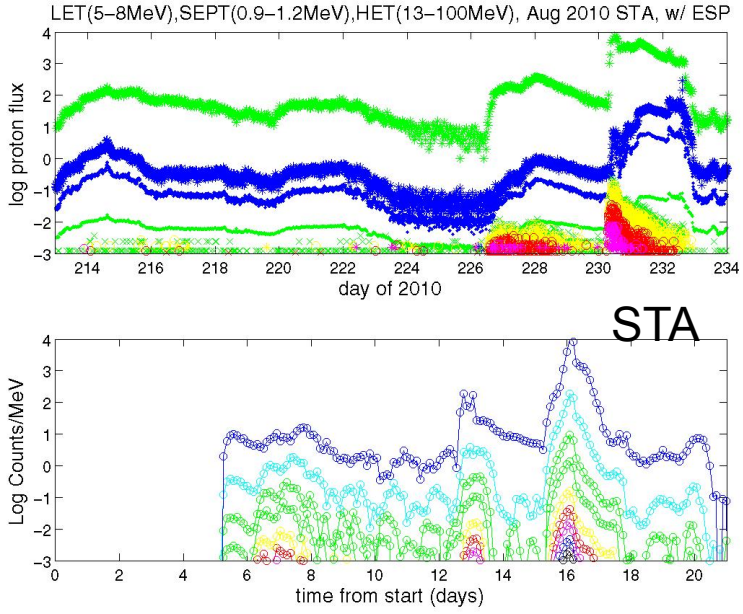

Outer ENLIL boundary at **5.3 AU**, plus multiple shock sources from multiple CMEs: Shock connection Radius shown.



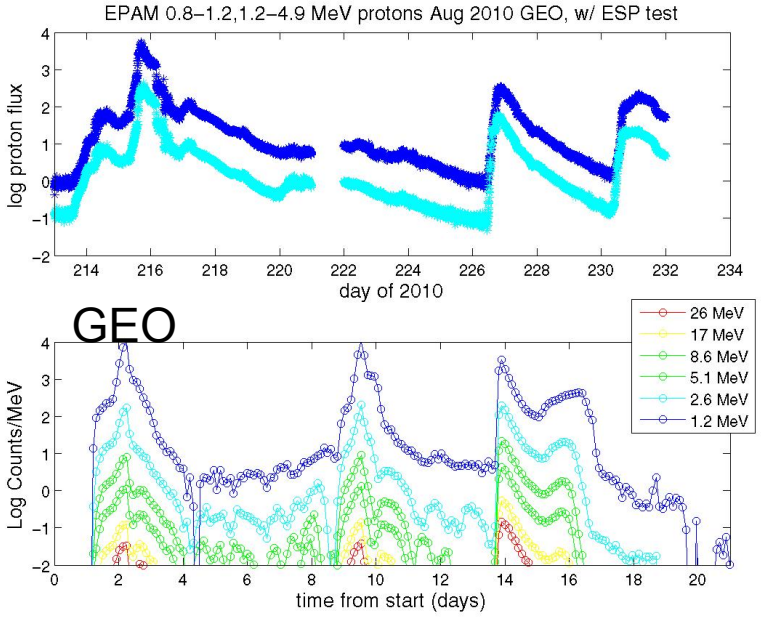




AUGUST 2010 case: STB , STA GEO




August 2010 case SEPMOD protons results based on ENLIL: includes model ESP

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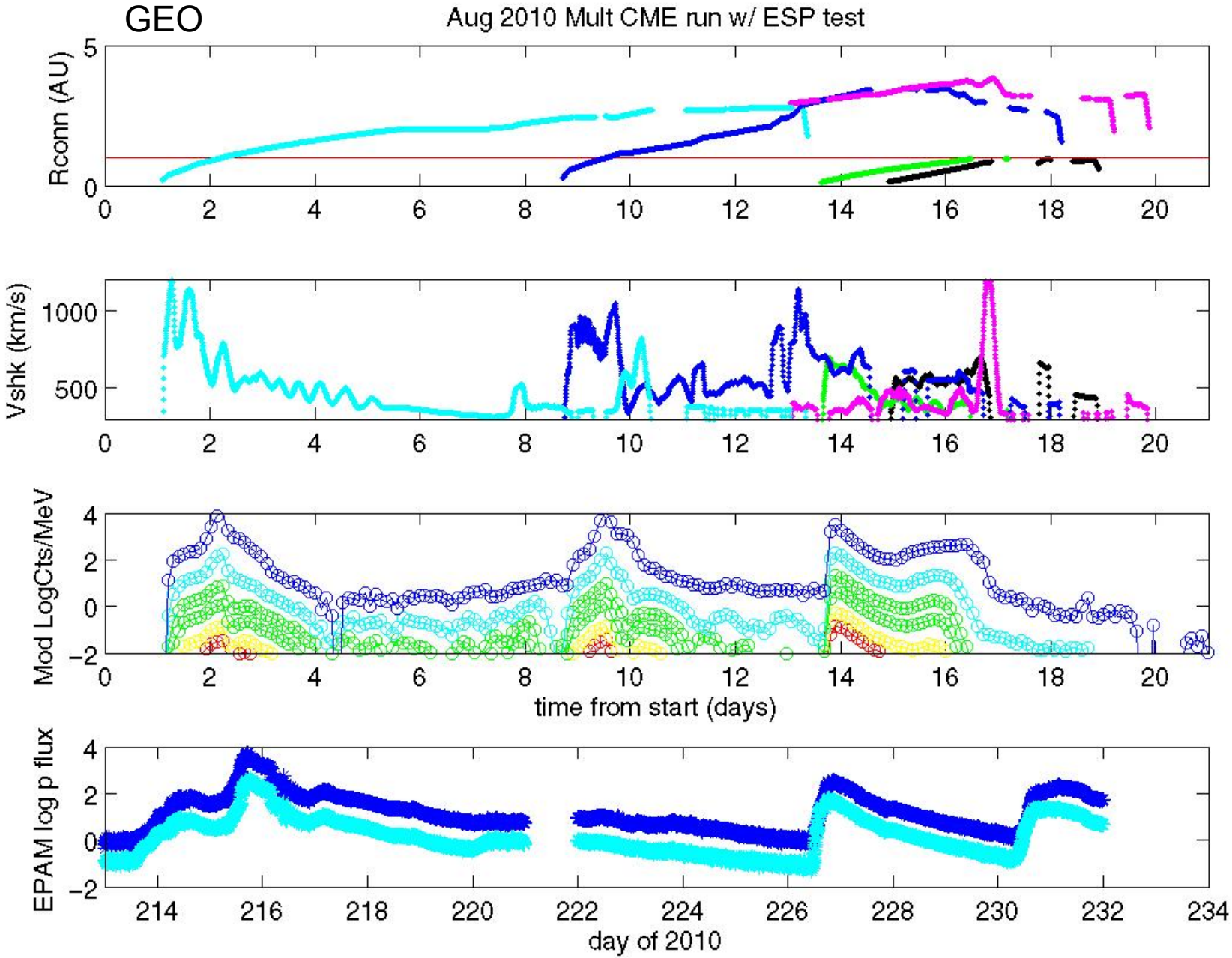
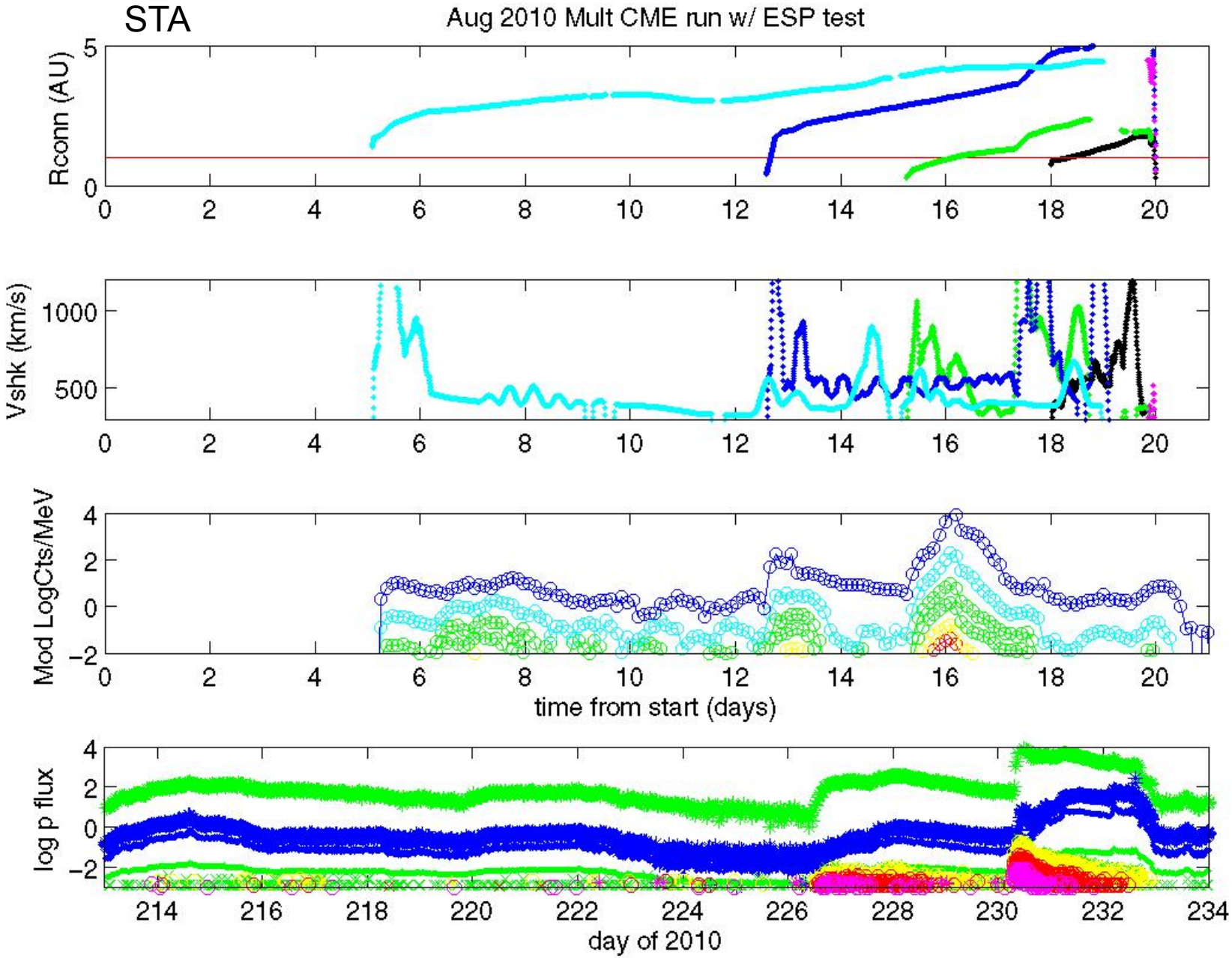
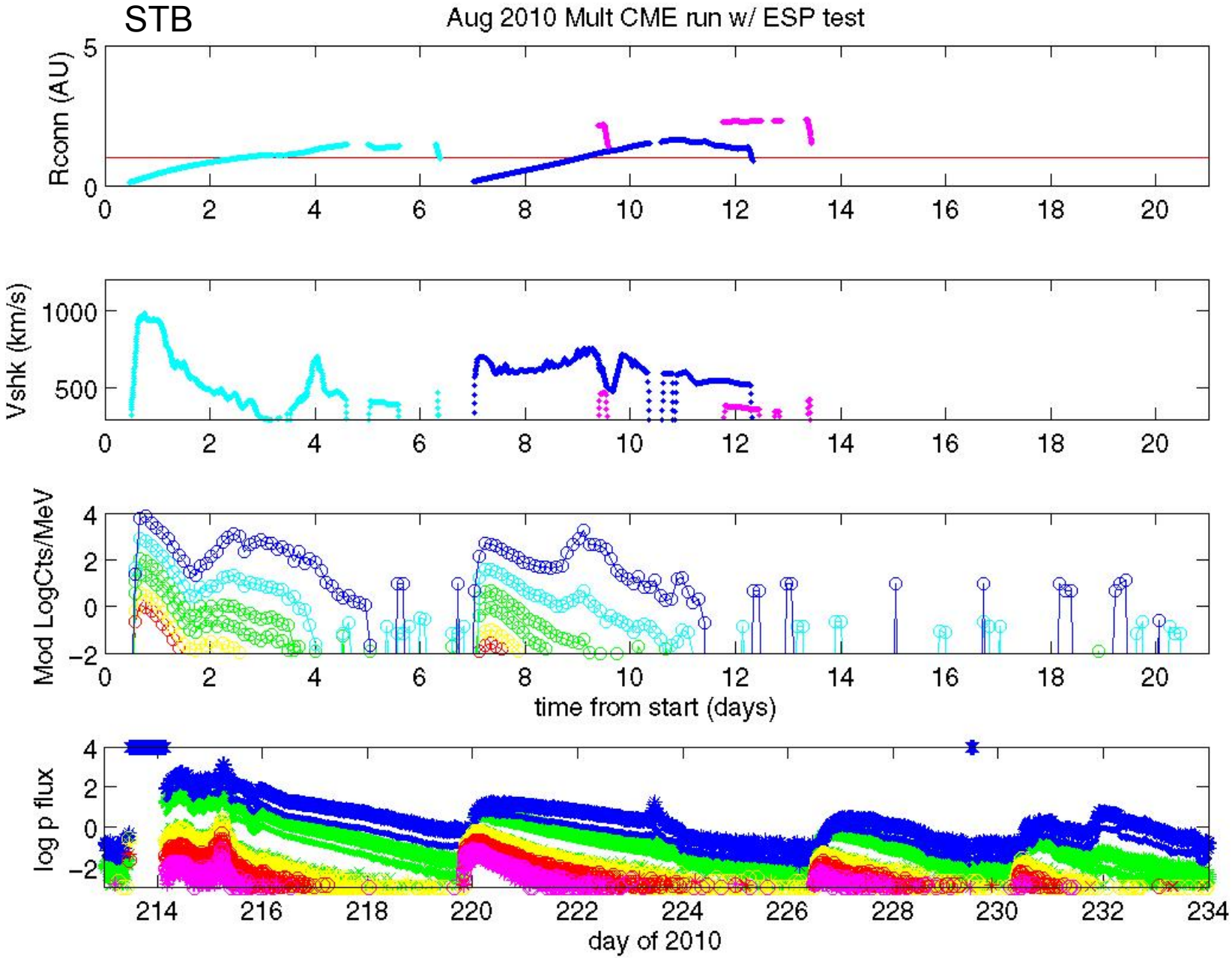



Combined Display for GEO showing shock jumps




Combined Display for STA showing shock jumps

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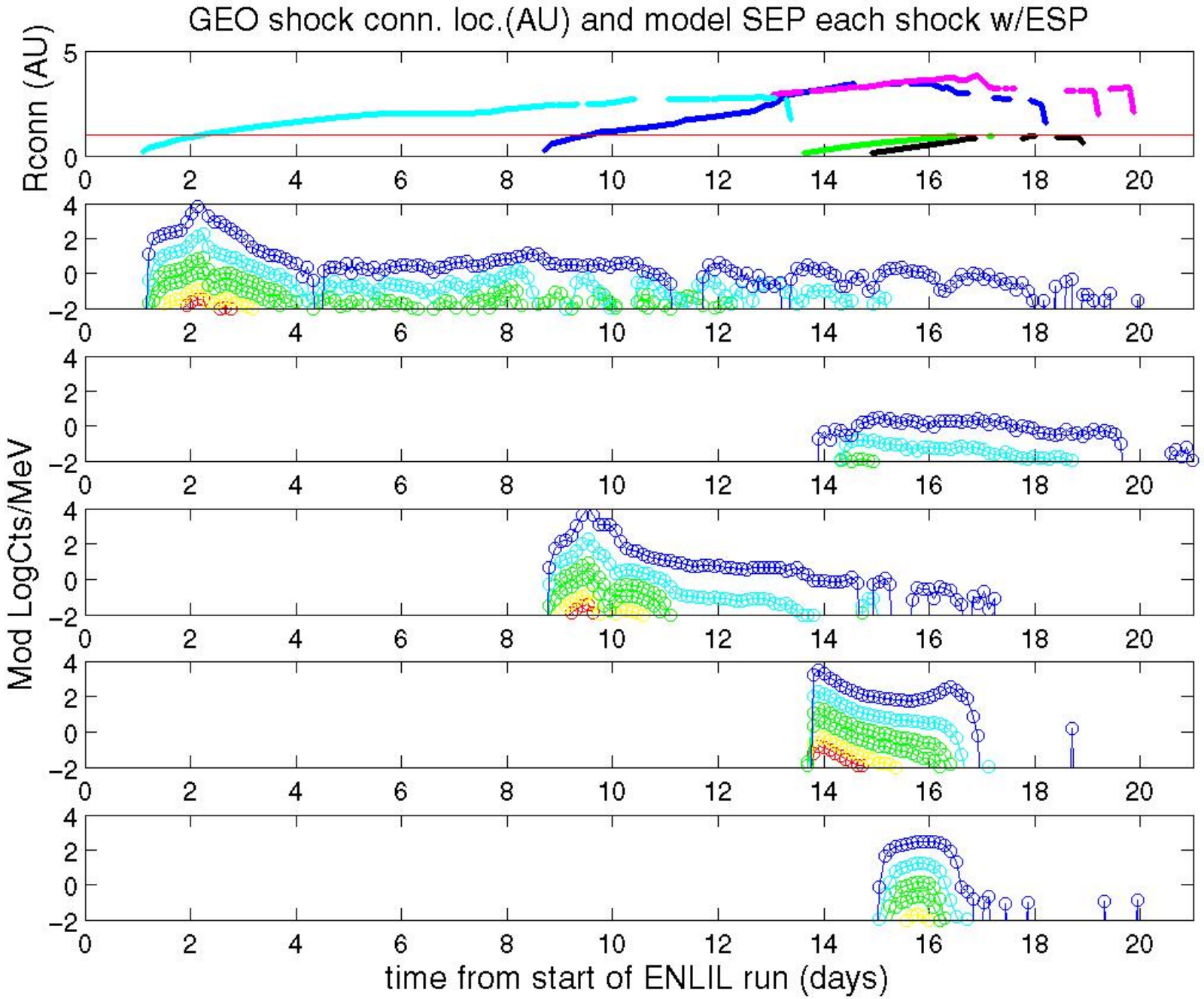
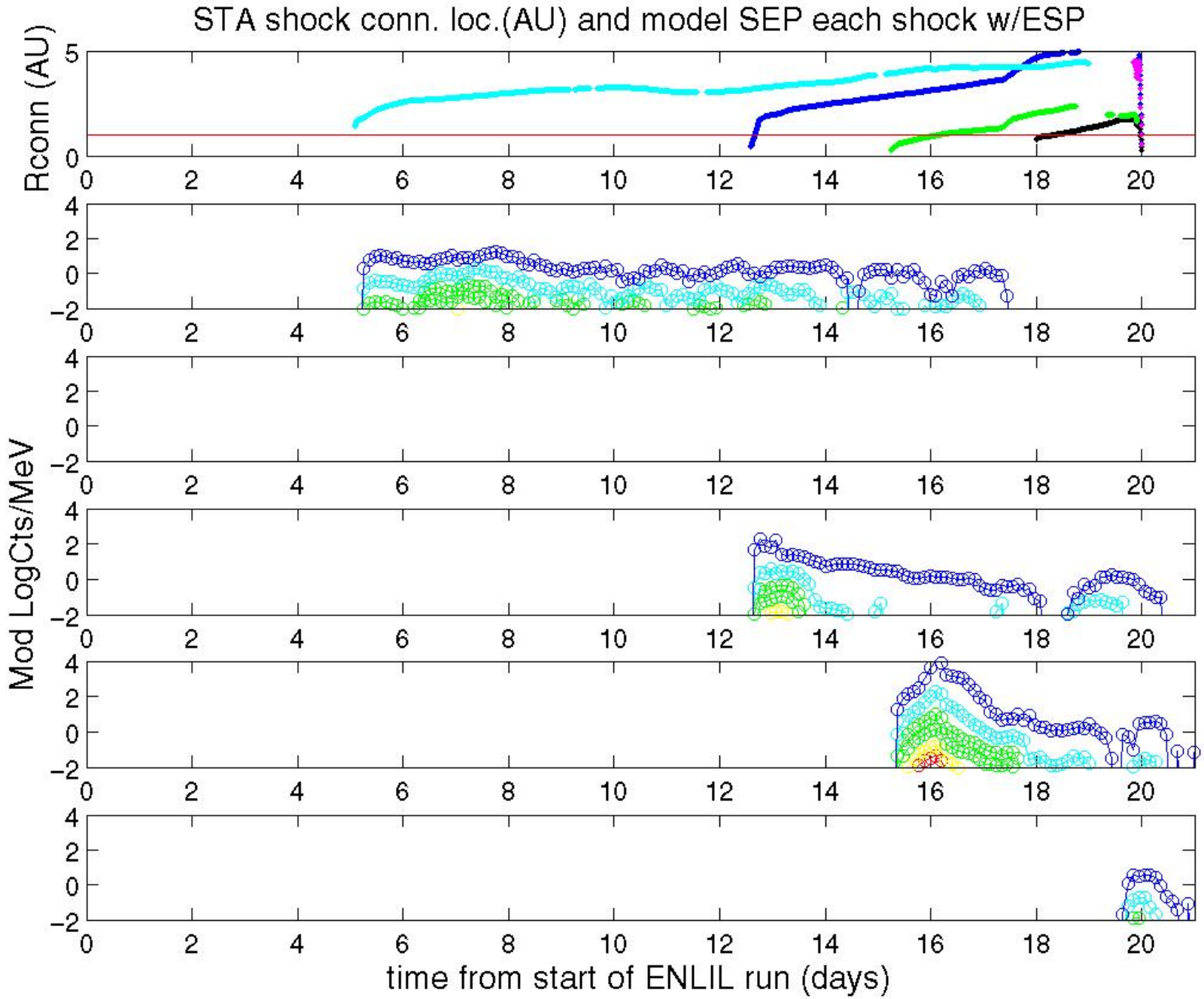
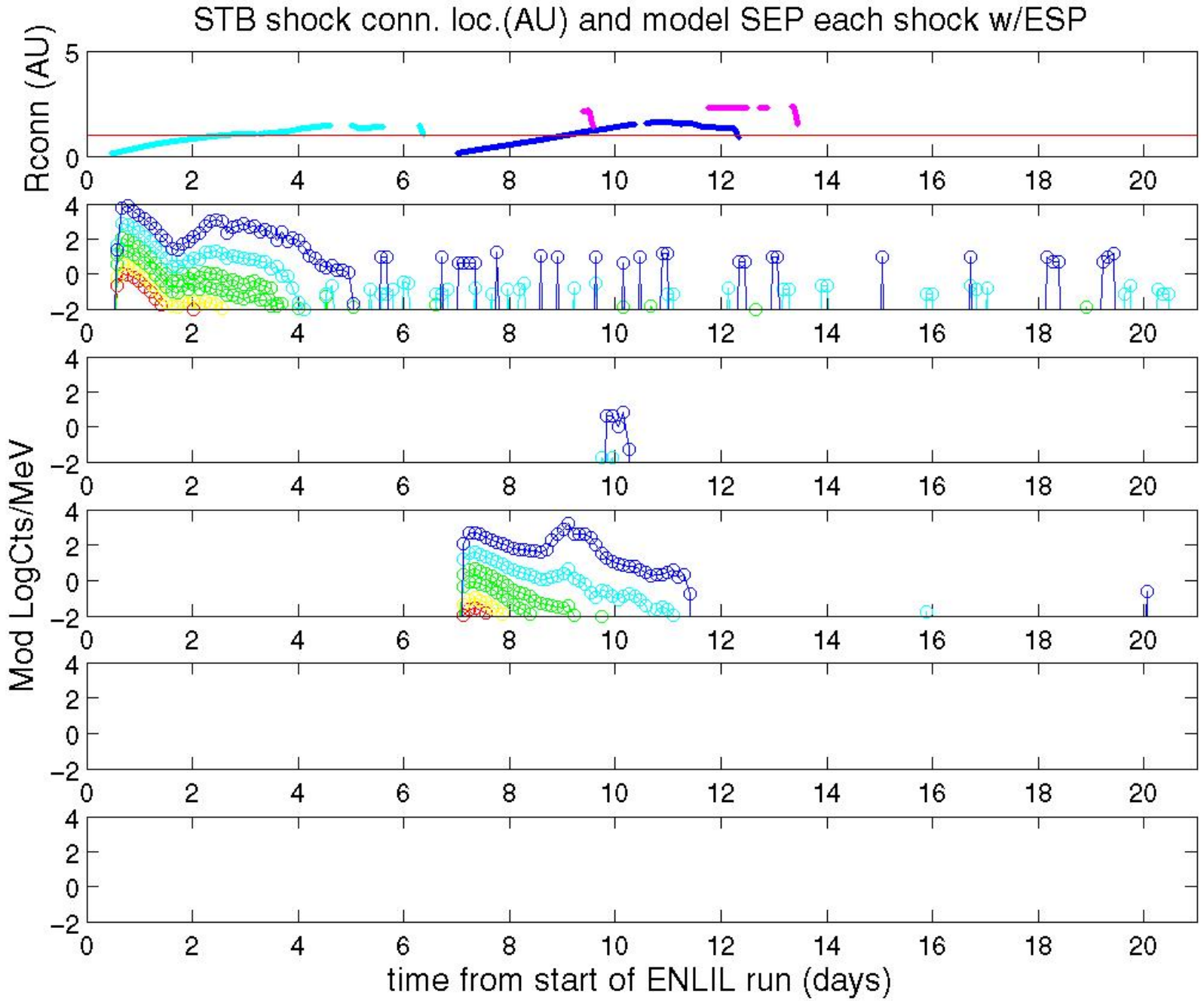



Details of individual shock sources


STA shock conn. loc.(AU) and model SEP each shock w/ESP
Rconn (AU)
Mod LogCts/MeV
time from start of ENLIL run (days)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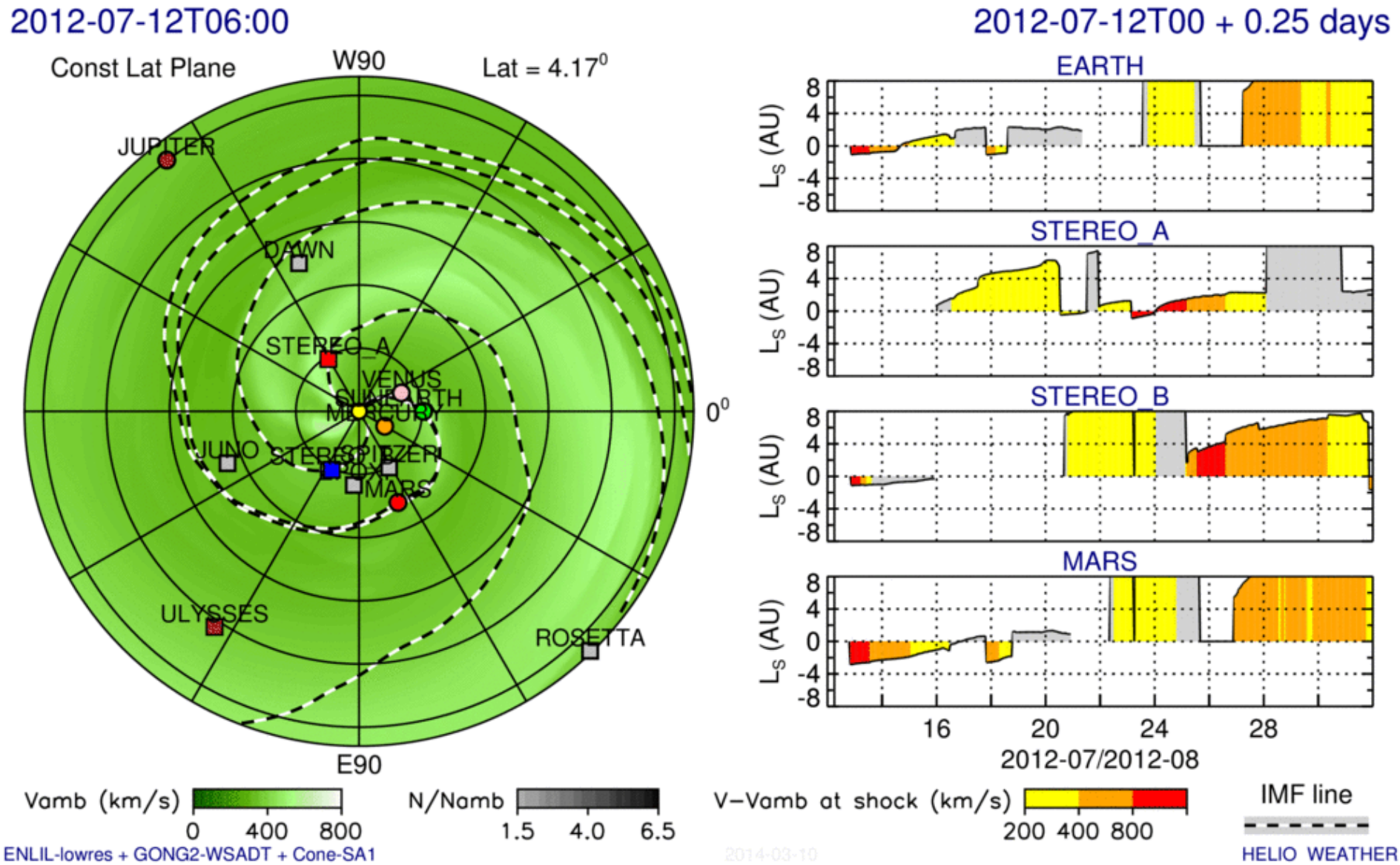
Example: The period covering most of July 2012, which included a dominant wide, fast CME aimed at STA




Parameters from CCMC/SWRC

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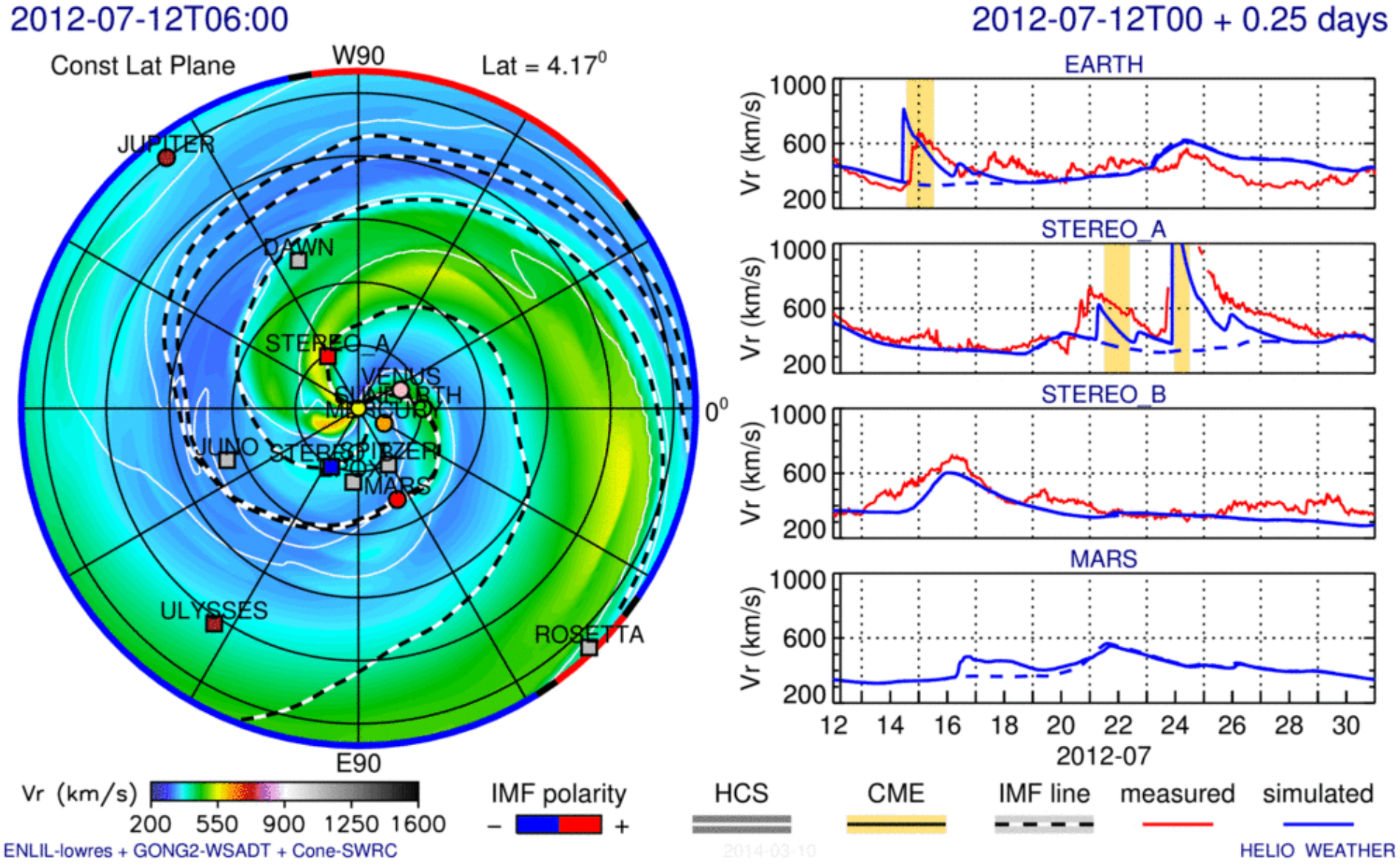

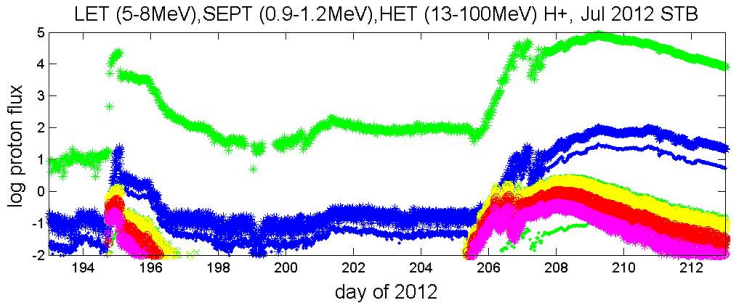


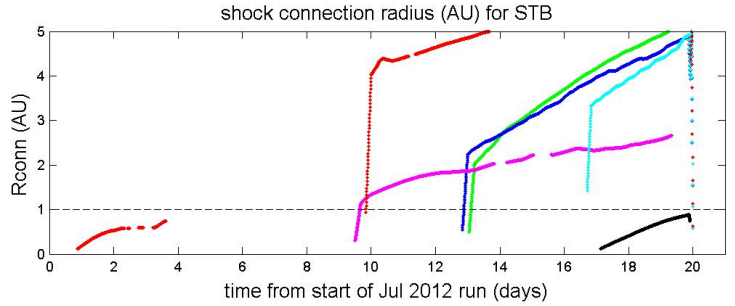


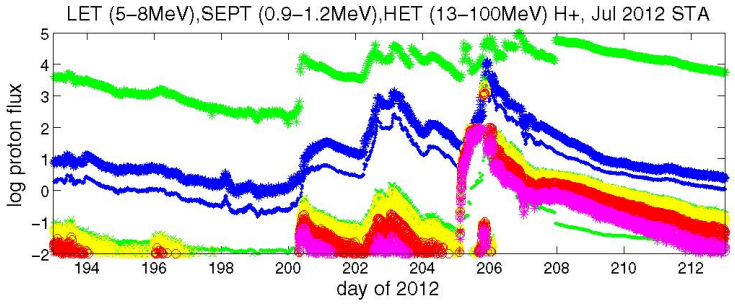


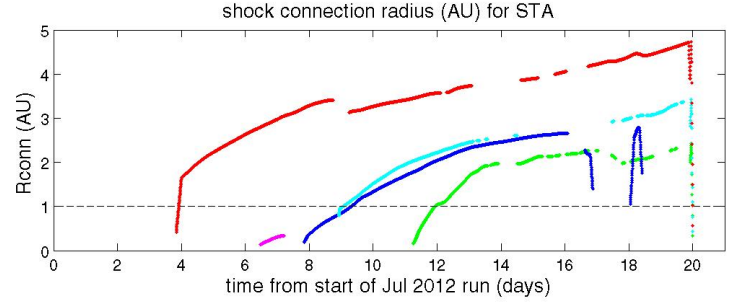


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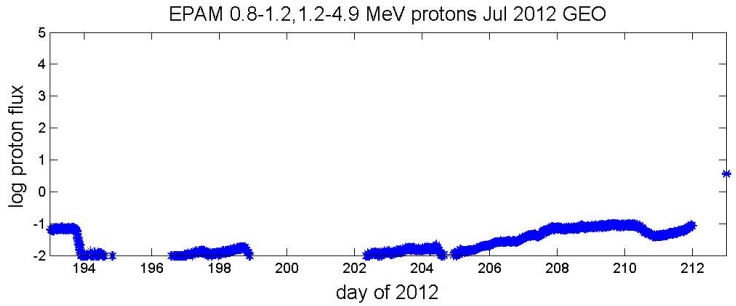
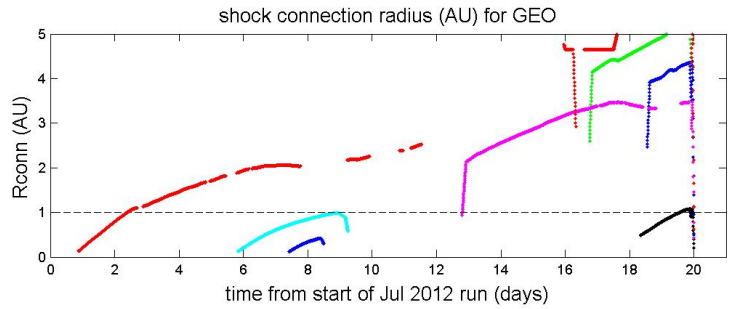
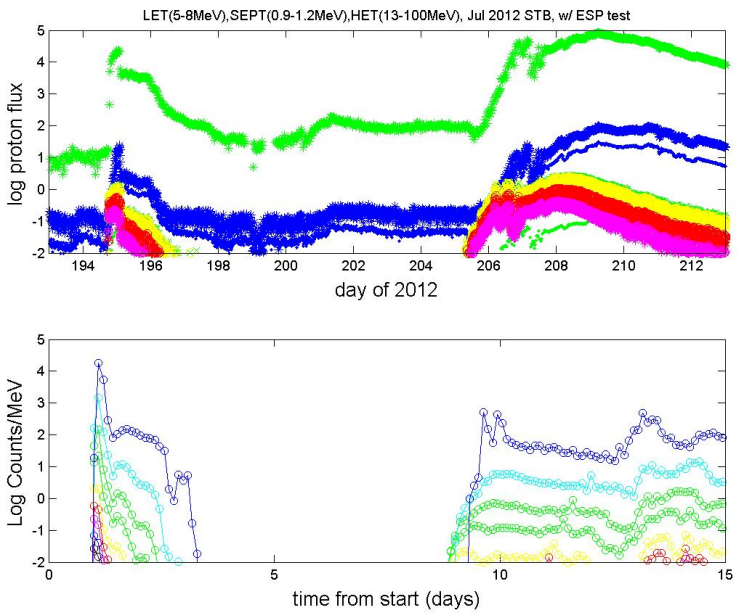
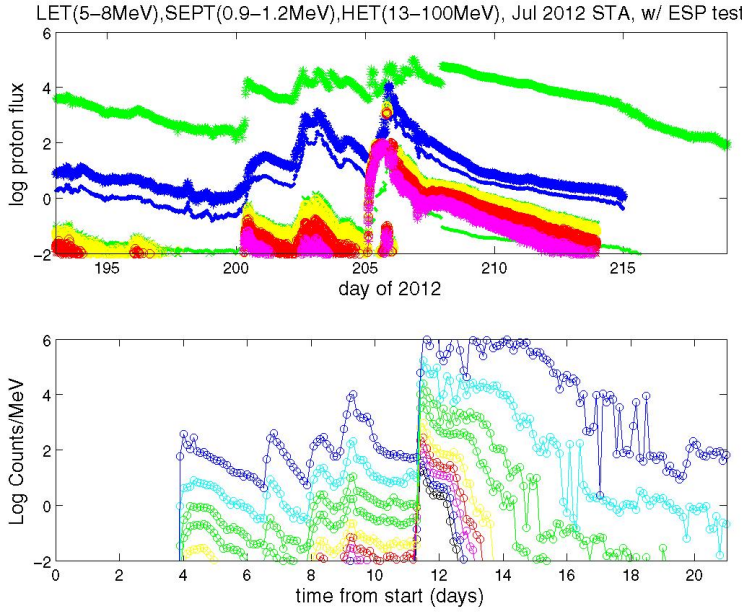



JULY 2012 case: STB , STA GEO

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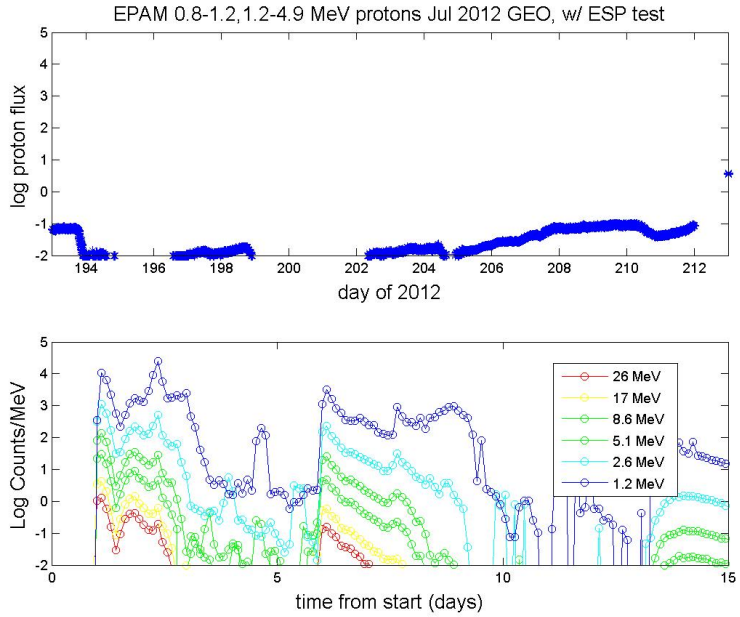


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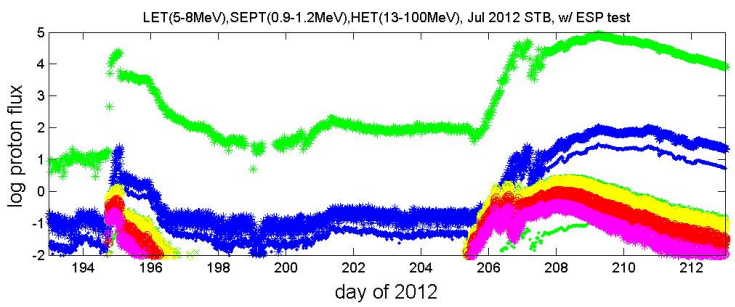


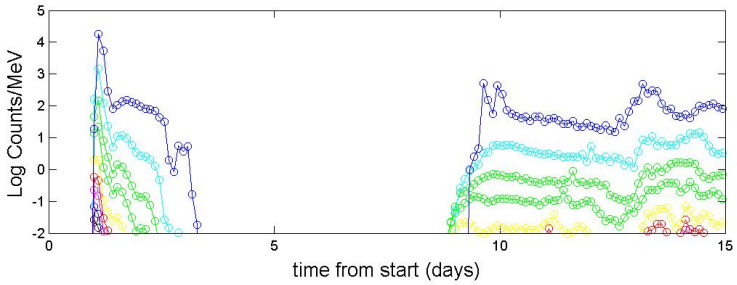


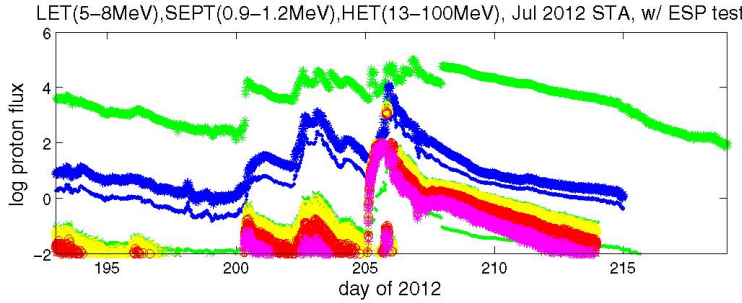


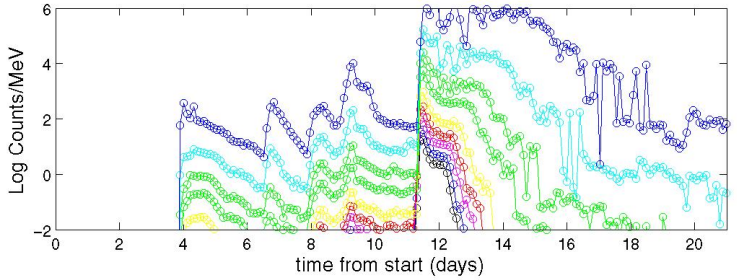


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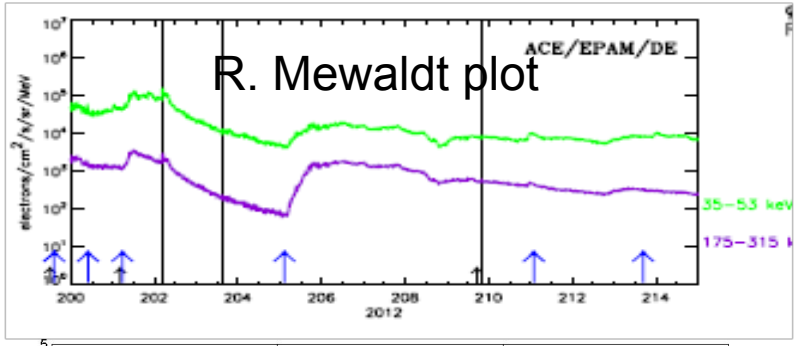
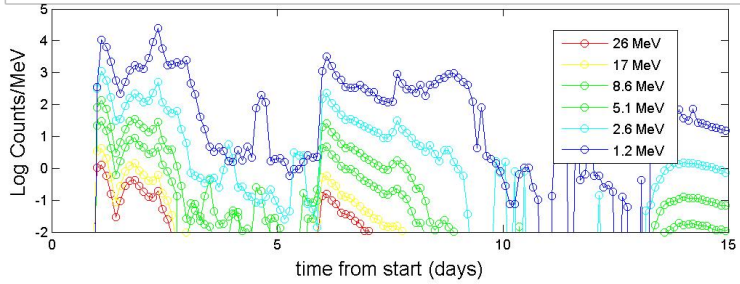


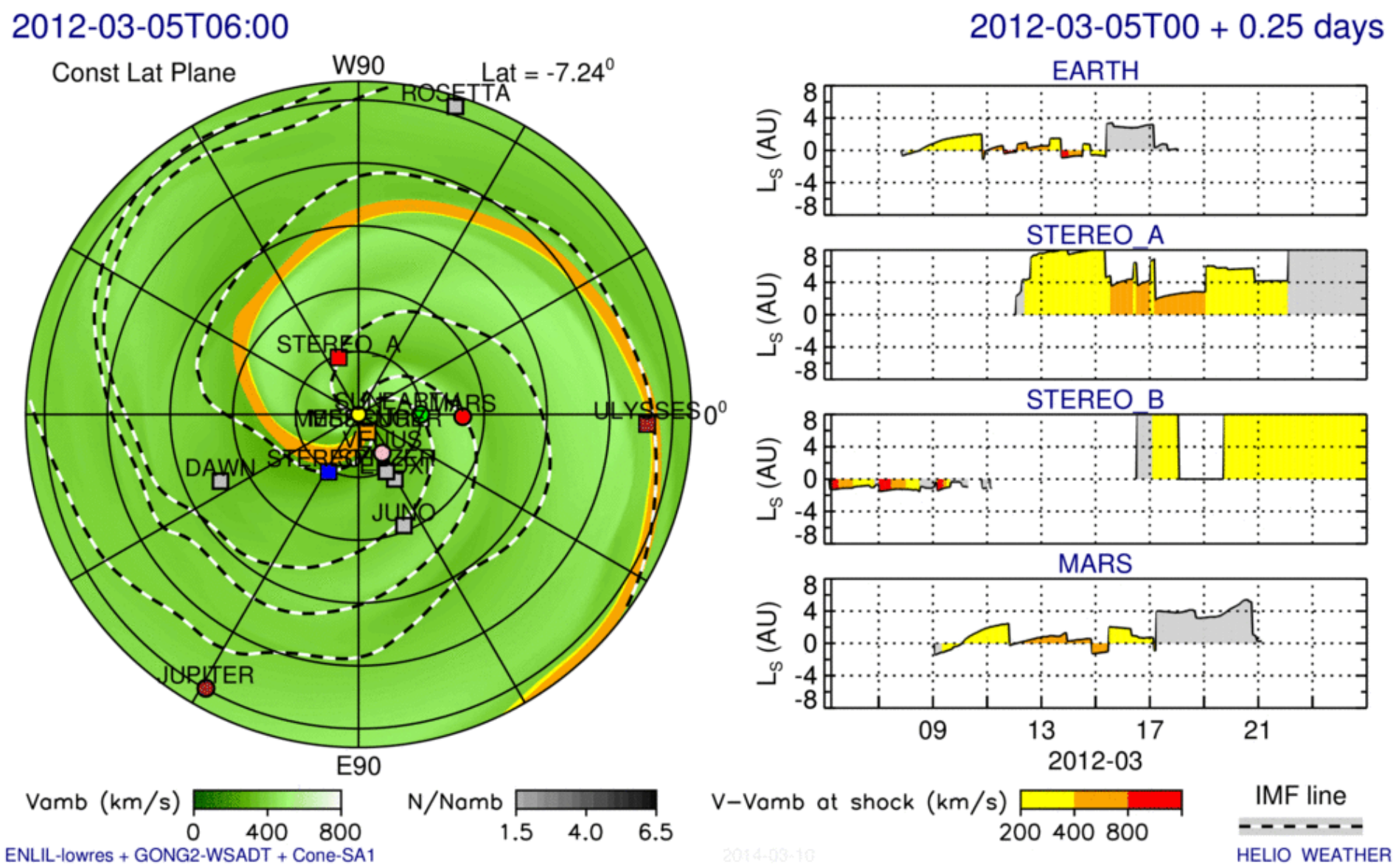

JULY 2012 case:
STB , STA
GEO

Some lessons learned:

-Outer boundary radius can be important

-Multiple shock sources need to be included in many cases

-SEP model results can be good only if the heliospheric model results are good!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ROSETTA
STEREO_A
EARTH
MARS
ULYSSES
0⁰
VENUS
DAWN
JUNO
JUPITER
E90
2012-03-05T00 + 0.25 days
EARTH
STEREO_A
STEREO_B
MARS
Ls (AU)
8
4
0
-4
-8
09
13
17
21
2012-03
Vamb (km/s)
0
400
800
N/Namb
1.5
4.0
6.5
V−Vamb at shock (km/s)
200
400
800
IMF line
ENLIL-lowres + GONG2-WSADT + Cone-SA1
HELIO WEATHER