ENLIL Progress and Plans Relevant to SEP Studies

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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

Various sets of cone parameters have been derived for this event period, including some from Hong Xie, some from Curt deKoning, and some from the CCMC/Space Weather Research Center.
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Outer ENLIL boundary at \textbf{5.3 AU}, plus multiple shock sources from multiple CMEs: Shock connection Radius shown.

\textbf{AUGUST 2010 case:} STB, STA GEO
August 2010 case
SEPMOD protons
results based on
ENLIL: includes
model ESP

AUGUST 2010 case:
STB , STA
GEO

AUGUST 2010 case:
STB , STA
GEO
Combined Display for GEO showing shock jumps
Combined Display for STA showing shock jumps
Combined Display for STB showing shock jumps
Details of individual shock sources
Example: The period covering most of July 2012, which included a dominant wide, fast CME aimed at STA.
Example: The period covering most of July 2012, which included a dominant wide, fast CME aimed at STA
Outer ENLIL boundary at 5.3 AU, plus multiple shock sources from multiple CMEs: Shock connection Radius shown.

JULY 2012 case: STB, STA GEO
July 2012 case
SEPMOD protons
results based on
ENLIL: includes
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July 2012 case
SEPMOD protons results based on ENLIL: includes model ESP
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!