Understanding the Origin and Transport of GLEs with Modern Observations

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GLE Factors

- GLEs are generally associated with eruptions from the western hemisphere
- GLEs are associated with \( \sim 2000 \text{ km/s} \) CMEs
- Ambient medium with relatively low Alfven speed (local, solar cycle)
- GLE sources need to be close to the ecliptic
  - Also the nose of the CME needs to be close to the ecliptic
Large Shock formation Height – less time the shock spends in high B region

The shock formation height is already at GLE release heights. The shock will take additional time to accelerate particles to higher energies.

At larger distances from the Sun, the shock becomes less efficient in accelerating particles because of the falling ambient magnetic field strength in the ambient medium.

\[
h_s = 2.55 + \frac{[(\lambda - 51)/35]^2}{2}
\]

Gopalswamy et al. 2013; Reames 2009
Sept. 1, 2014; 36 degrees  BTL

Preliminary

Vahe Petrosian
CORE PLUS HALO MODEL OF DIFFUSIVE SHOCK ACCELERATION
AND STOCHASTIC RE-ACCELERATION

Leon Kocharov

DHALO/DCORE=50,
D1,CORE(0.1 MeV)=2*10^6 km2/L.
Kocharov, T. Laitinen,
A. Afanasiev, R. Vainio,
K. Mursula, and J.M. Ryan

Fig. 1.— Particle acceleration and transport model. Shaded is the region of stochastic re-
acceleration of the shock accelerated particles. Effective depth of this region is consistent
with the proton energy spectrum and hence depends on the energy of resonant protons.
Prospects

• New gamma-ray data from Fermi will inform us about the location (acceleration sites?) of high energy particles at the Sun
  – Long Duration Gamma-ray Flares
  – Over-the-limb Flares

• Observations from PAMELA and AMS will bridge the gap between low-energy space-based measurements and ground-based.
  – Trajectory measurements inform us about the pitch angle distribution
  – Weakness is their orbit and narrow fields of view