Estimation of curvature radius of equatorial magnetic field line and its application in M-I mapping

Jun Liang[1], Eric Donovan[1], Emma Spanswick[1] , and V. Angelopoulos[2]

1. Department of Physics & Astronomy, University of Calgary, Calgary, Canada
2. IGPP/UCLA, Los Angeles.

GEM Mapping Session, June 18 2012

Why is the magnetic field-line curvature important

In the nightside tail, the magnetic field-line curvature is (***arguably the most important***) one of the controlling parameters that determine the pitch-angle scattering rate of energetic ions in the equatorial magnetosphere. [Sergeev et al., 1983].

Common threshold of strong/weak pitch angle scattering:

$R_c / \rho_i > 8$ Weak scattering

$R_c / \rho_i < 8$ Strong scattering

Methods to estimate R_c

$$R_c \approx \frac{B_z}{\partial B_x / \partial z}$$ at the equator

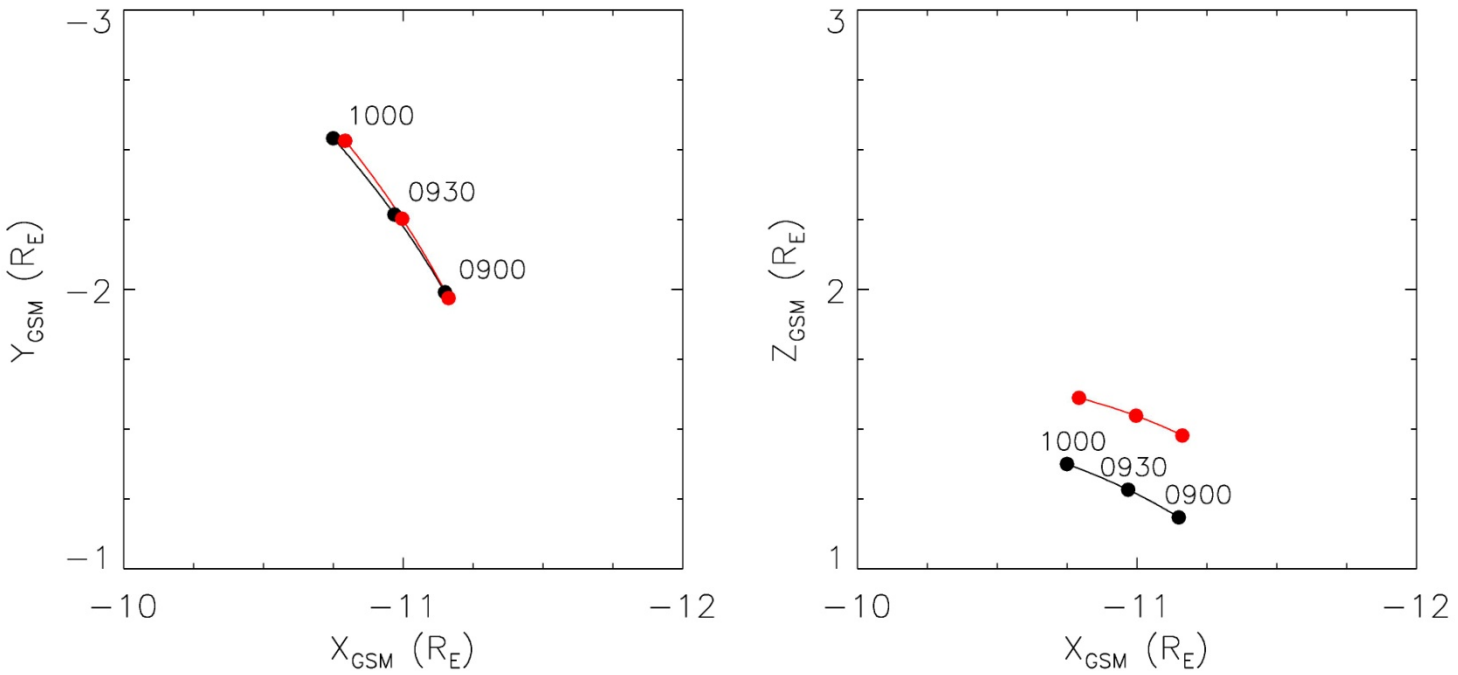
1.Single-satellite estimation [Sergeev et al., 1983]

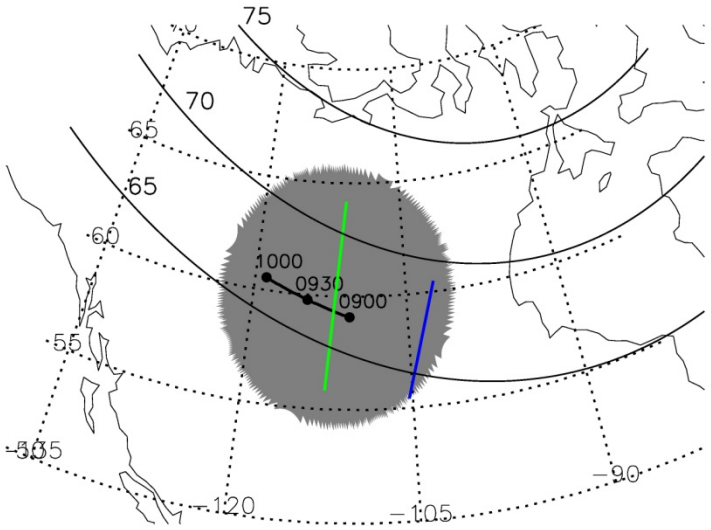
Assumption: $$\frac{\partial B_x}{\partial z} \approx \frac{\partial B_x}{\partial t} \cdot \frac{1}{v_z}$$

2. Multi-satellite estimation [Donovan et al., 2012; Liang et al., 2012]

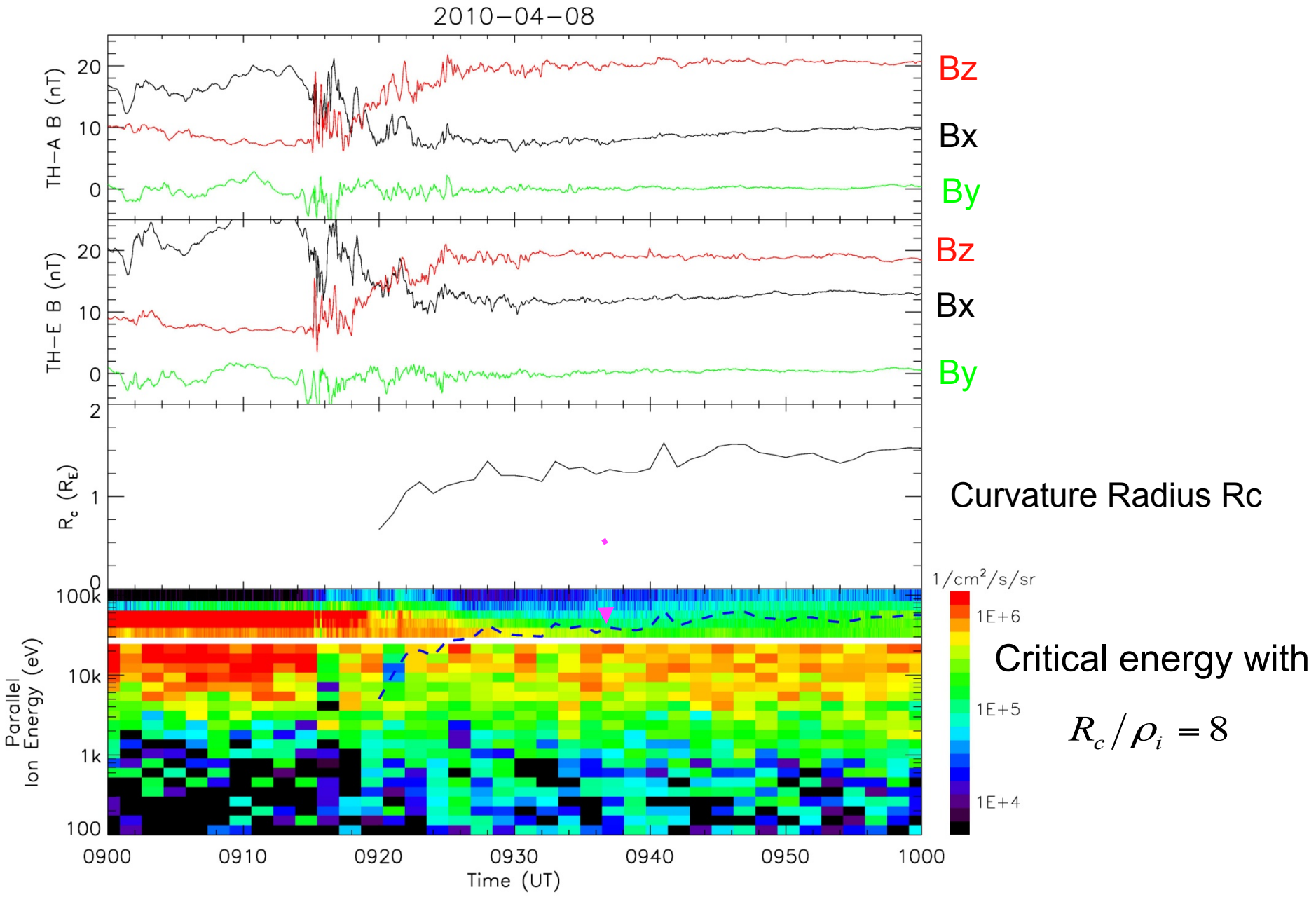
Requirement and assumption

$$Lc \geq \Delta Z >> \Delta X \qquad \frac{\partial B_x}{\partial z} >> \left|\frac{\partial B_x}{\partial x}\right| \sim \left|\frac{\partial B_z}{\partial z}\right|$$

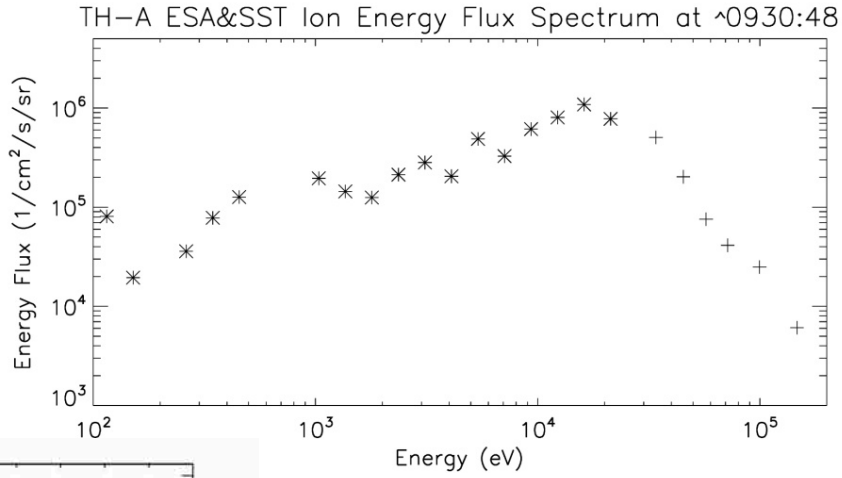


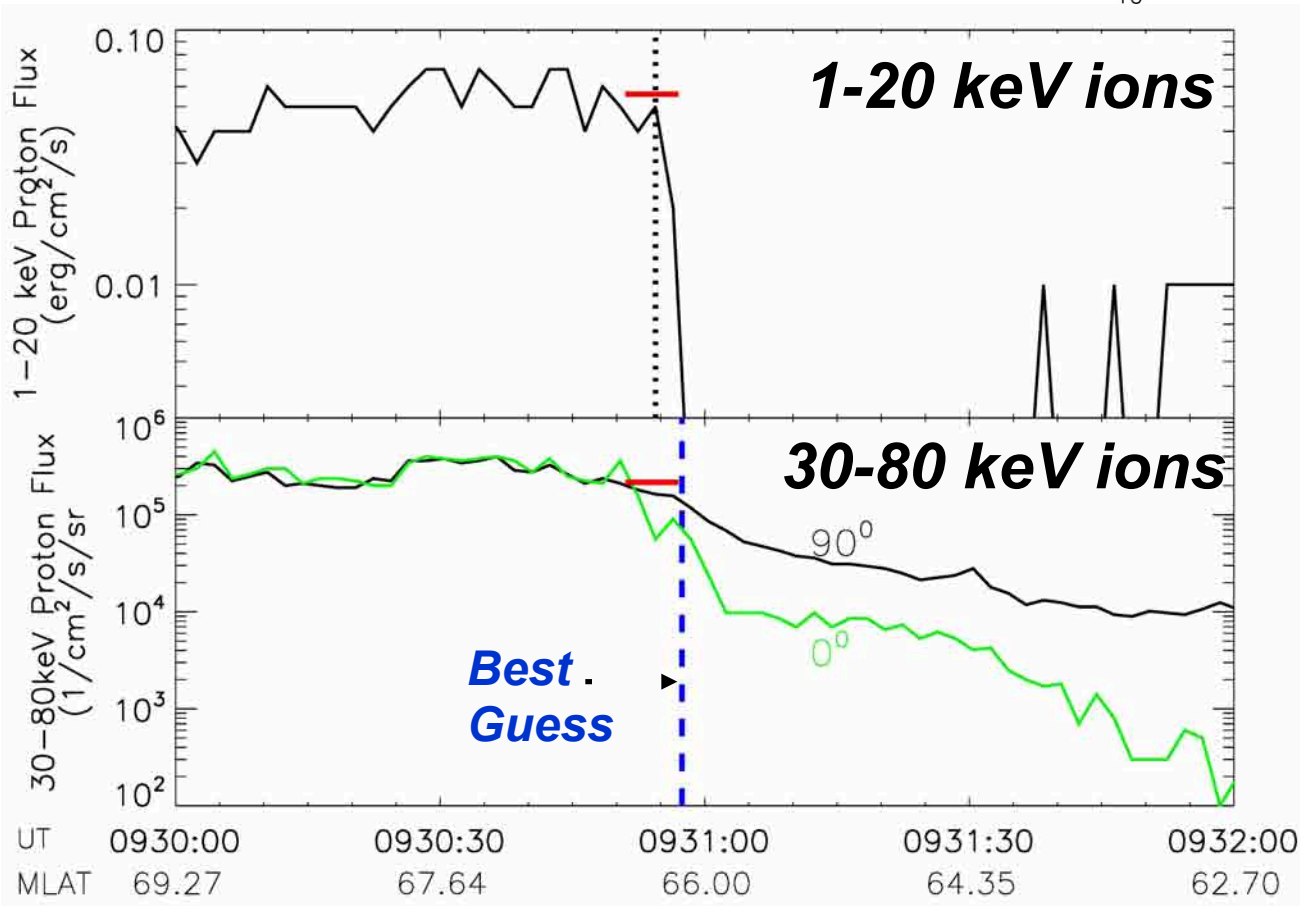


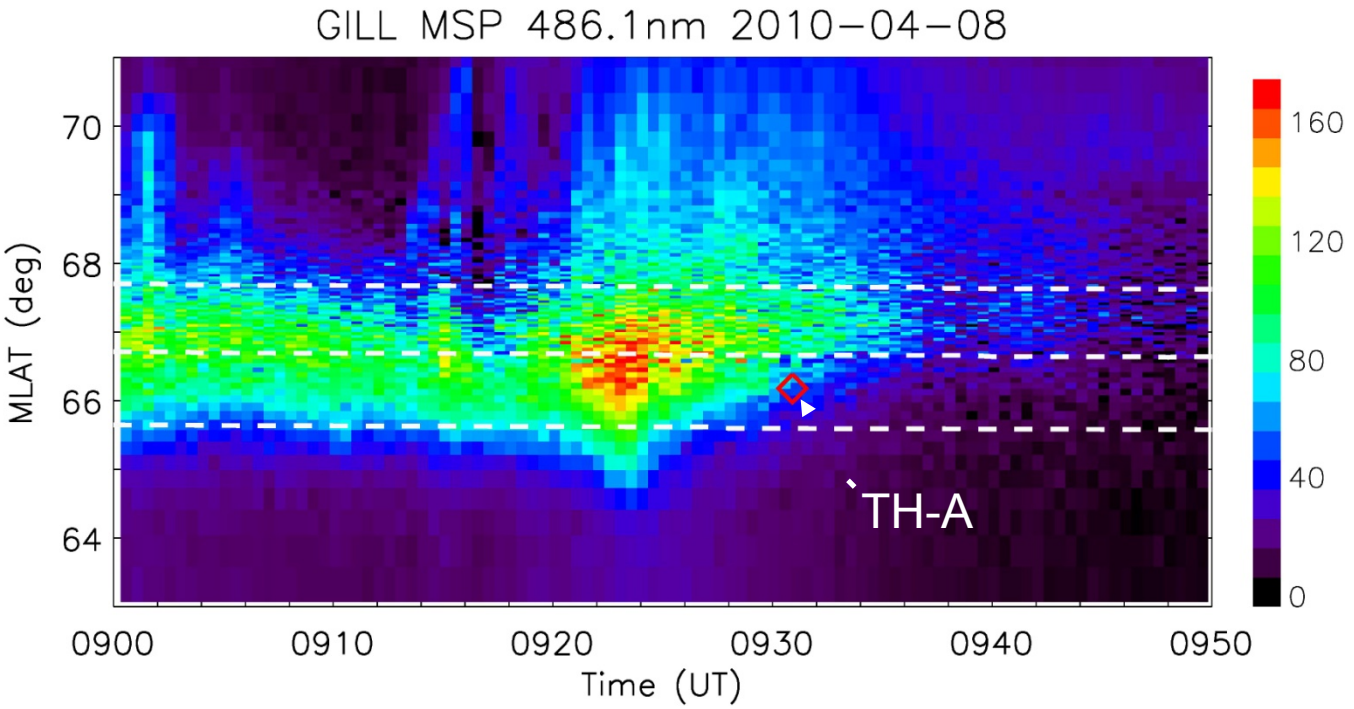
TH-A and E are dominantly separated in Z-distance (~1600 km).


2010−04−08
TH−A B (nT)
TH−E B (nT)
Bz
Bx
By
Bz
Bx
By
R_c (R_E)
Curvature Radius Rc
1/cm²/s/sr
1E+6
1E+5
1E+4
Parallel Ion Energy (eV)
100k
10k
1k
100
Critical energy with
$R_c / \rho_i = 8$
0900
0910
0920
0930
0940
0950
1000
Time (UT)

NOAA 19 observations and comparison with in-situ parallel fluxes.







Summary:

1. Using the in-situ calculated Rc one may deduce the PA scattering rate of ions in different energy ranges.
2. Together with the LEO particle and proton aurora measurements , the above information can be used to constrain the mapping of the in-situ probe, and to evaluate the accuracy of mapping based upon empirical field models.