SPACESTORM

Empirical model for plasma sheet electrons: Initial results, THEMIS data

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GEM 2015 Workshop, Snowmass CO, USA, 15-19 June 2015

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Boundary conditions for Inner Magnetosphere Particle Transport and Acceleration Model

Previous studies:
we set the model **boundary at 10 R_E** and use the **kappa electron distribution** function. Parameters of the kappa distribution function: **number density *n* and temperature *T*** in the plasma sheet given by the empirical model derived from Geotail data by *Tsyganenko and Mukai* [2003].

In IMPTAM simulation, the **electron *n* is assumed to be the same as that for ions** in the TM03 model, but **Te/Ti = 0.2** is taken into account (*Kaufmann et al.* [2005], *Wang et al.* [2012]).

Applying this model for boundary conditions has a number of **limitations**:

(1) Model was derived from Geotail data for ions (limited detector energy range <40keV).

(2) ratio Te/Ti can vary during disturbed conditions.

(3) at distances closer than 10 Re, the correlation between Ti and Te might not exist at all and no certain ratio can be determined (*A. Runov*, 2015, private communication).

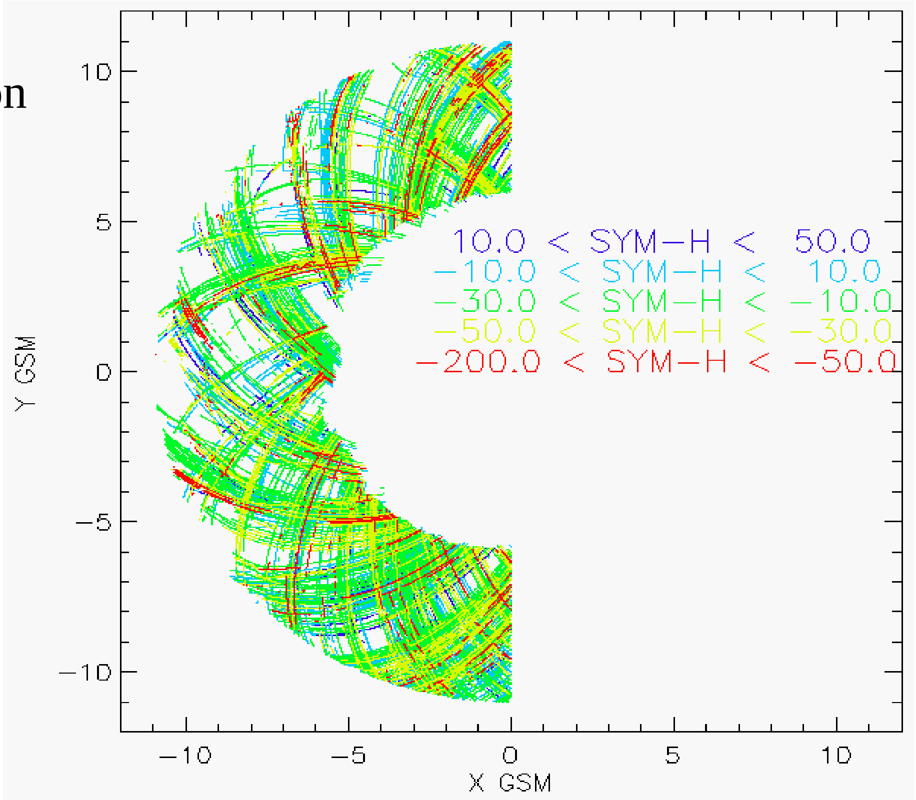
(4) simple $\sin^2$ MLT dependence.

Revision of boundary conditions in the plasma sheet using THEMIS data

THEMIS data for ions and electrons used:
ESA (a few eV up to 25 (30) keV) and **SST** (25 keV- few MeVs).

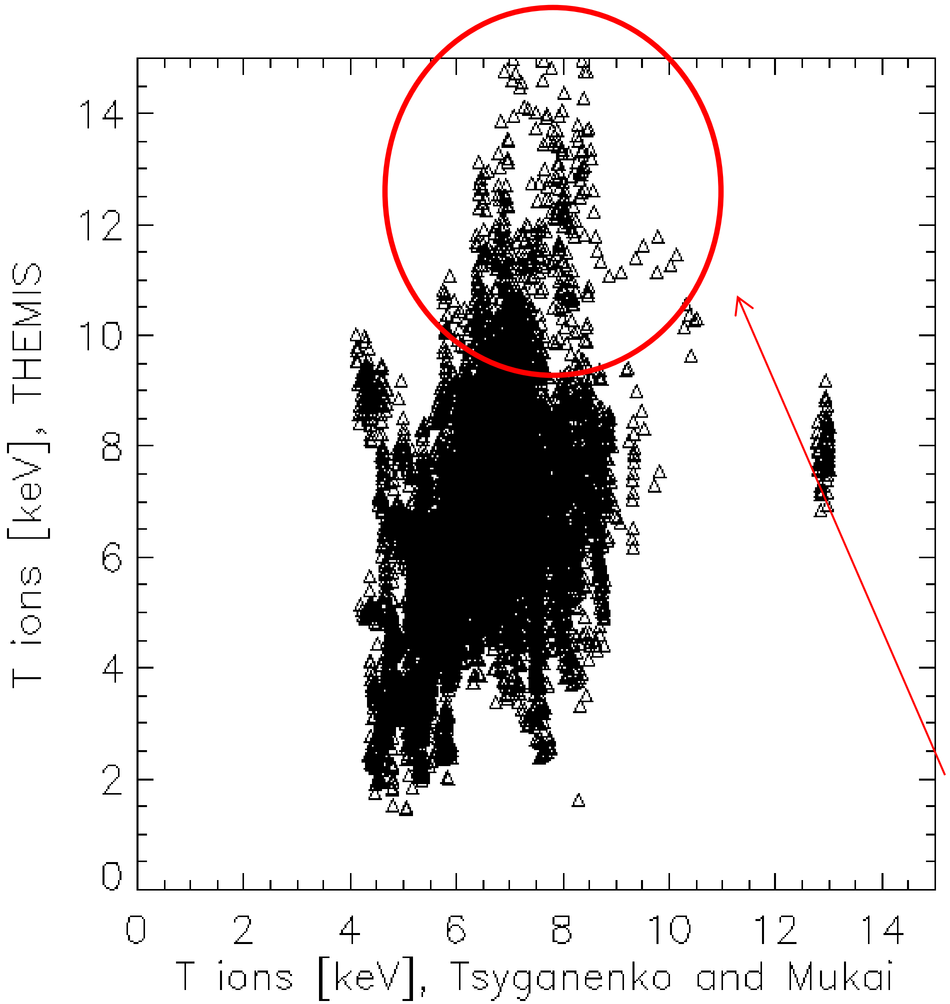
Data for **storm periods**: All the periods with SYM-H<-50nT and one day before and one day after these periods for 2007-2013. The quiet periods before the storms are also in our database.

Then we computed the **plasma moments** using last calibration procedures. After synchronization of the solar wind data with THEMIS plasma moments we got ~66,000 datapoints at 1.5 min resoluton.



Comparison of ion temperatures from THEMIS data and *Tsyganenko and Mukai* [2003] model

Subset of the data with R=10-10.5 R_E used.



Correlation is very low (CC = 0.22) in comparison with high correlation obtained for such comparison in TM03 paper (CC=0.7).

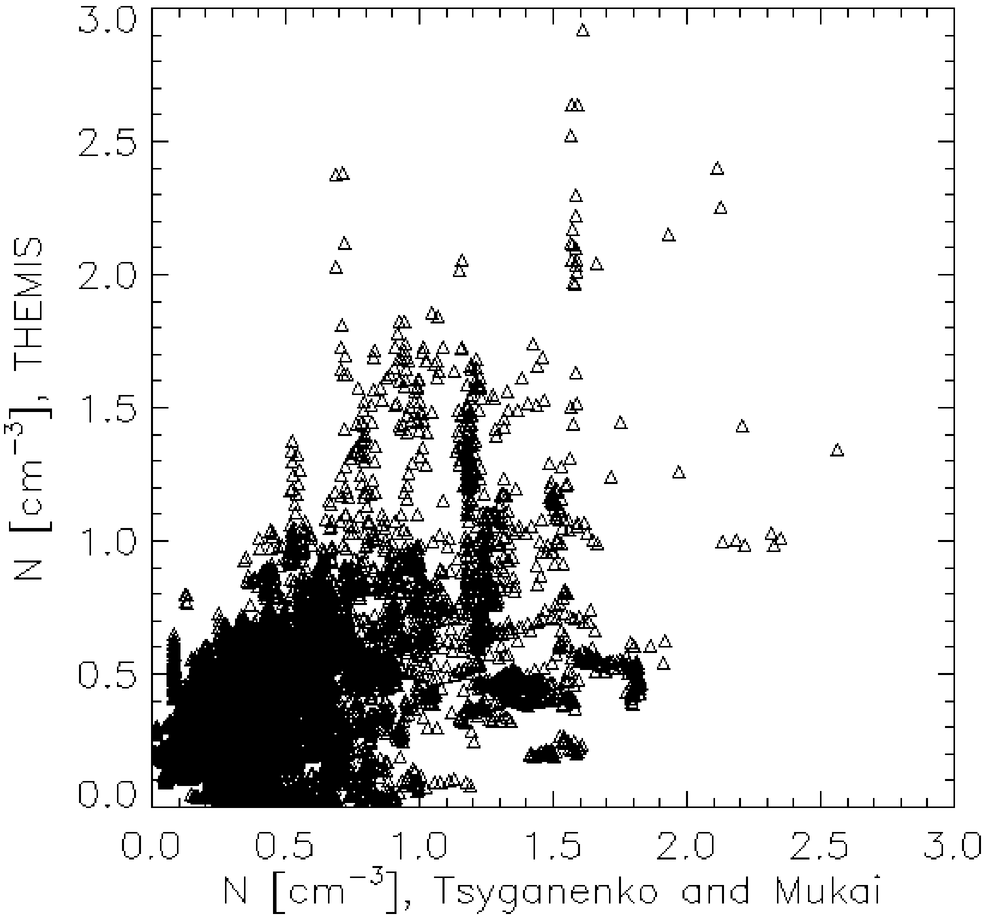
Due to limited range of radial distances in our comparison while the whole range of the Geotail (R=10-50 R_E) was used in TM03 model.

However, the points mostly fit the TM03 dependence confirming high quality of the THEMIS plasma data.

TM03 might systematically underestimate Ti for high-temperature part of the distribution due to limited energy range of Geotail spectormeter

Comparison of number densities of electrons from THEMIS data and of ions from *Tsyganenko and Mukai* [2003] model

Subset of the data with R=10-10.5 R_E is used.



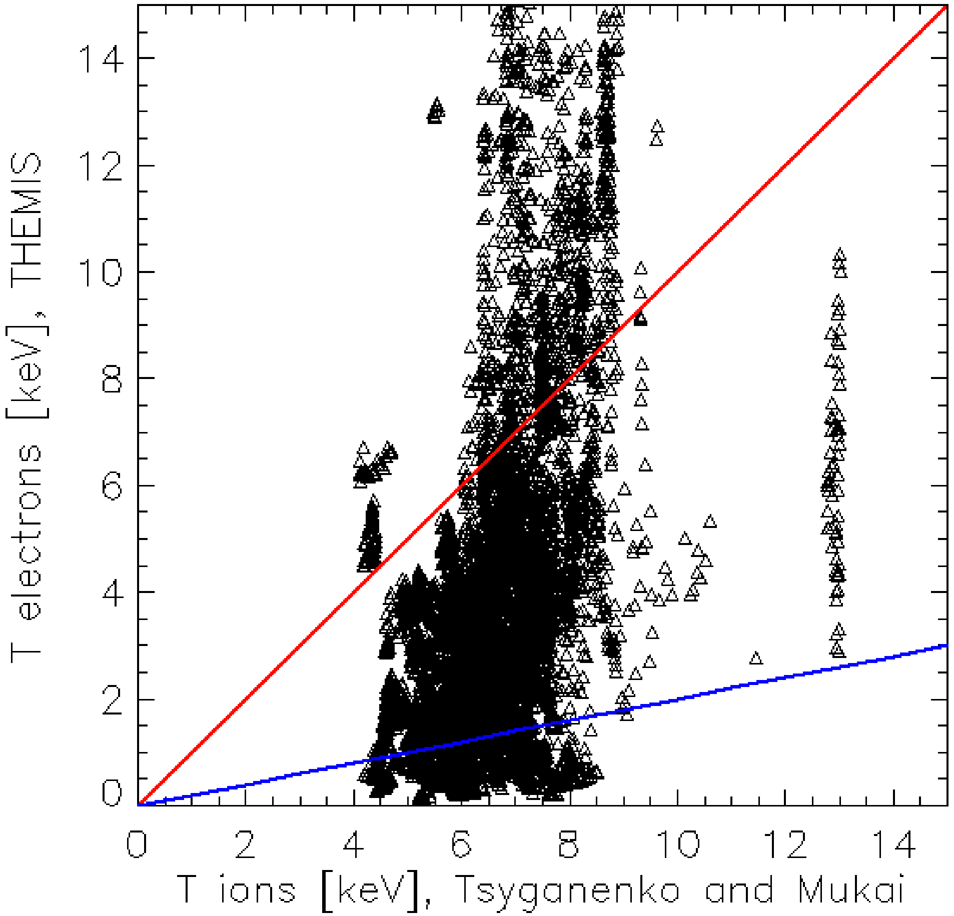
The correlation is 0.49 (close to 0.56 by TM03) in spite of limited range of the radial distances.

The TM03 equation for number density for ions can be used for electrons for IMPTAM simulation.

However, we are working towards improving the model for Ne.

Comparison of temperatures of electrons from THEMIS data and of ions from *Tsyganenko and Mukai* [2003] model

Subset of the data with R=10-10.5 R_E is used.



Red line: Te=Ti

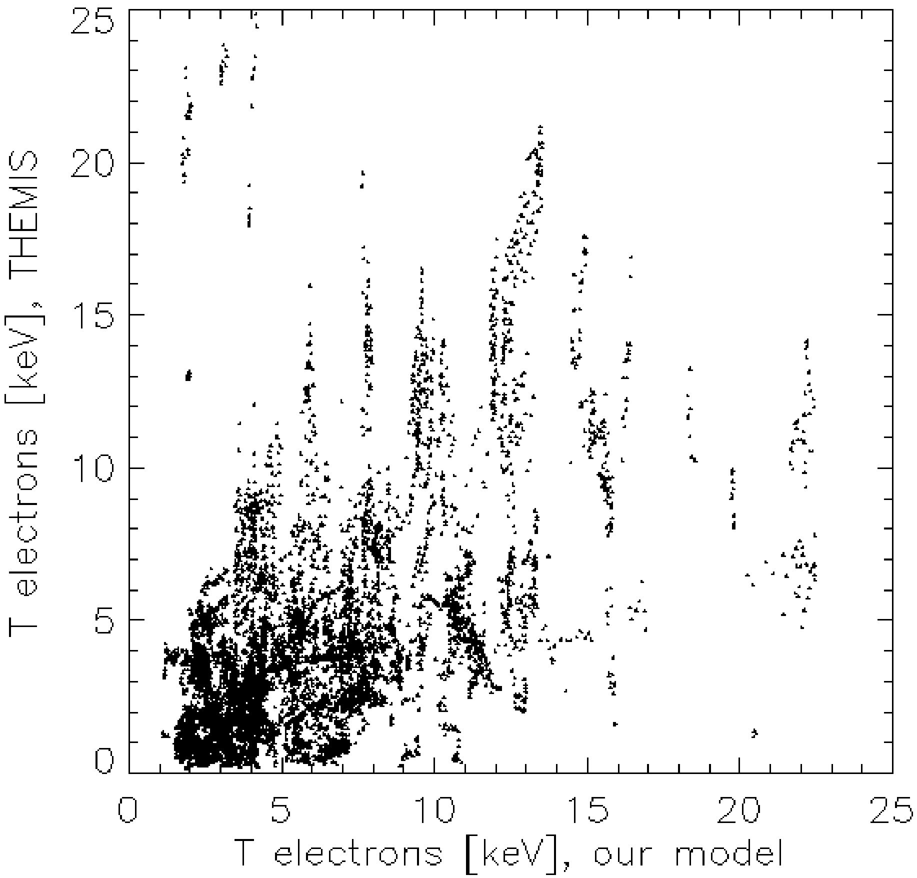
Blue line: Te=Ti/5

If the relation Te=Ti/5 would have been valid in this region, the points would be distributed along blue line.

TM03 ion temperature shows **almost no correlation** with measured electron temperature.

Similar to *Runov* [2015] (private communication): there is **no correlation between Ti and Te at geocentric distances closer than R=12Re.**

Empirical model for electron temperature at 6-11 R_e



It was found that only **solar wind velocity** shows prominent correlation with electron temperature for at 6-11 R_E.

Model depending on R, Ψ, and V_{sw}, where R is the radial distance, Ψ is the azimuthal angle from midnight in radians,

$$\Psi = arctg\left(-\frac{Y_{GSM}}{X_{GSM}}\right)$$

and V_{sw} is the solar wind velocity.

R and V_{sw} are normalized by 10 R_E and 500km/s.

The **correlation coefficient** for the whole range of distances R= 6-11 R_E is **0.54.**

$$T_e = \begin{bmatrix} 2.84 - 2.90R - 0.0045\Psi + 0.00501\Psi^2 - 0.00386\Psi^2 R + \\ \left(2.34R - 0.00183\Psi^2\right)Vsw \end{bmatrix}^{2.5}$$

Example for February 28 –March 3, 2013 storm