Study of Ion Upflow during Substorm using ESR 32 m (Folke)

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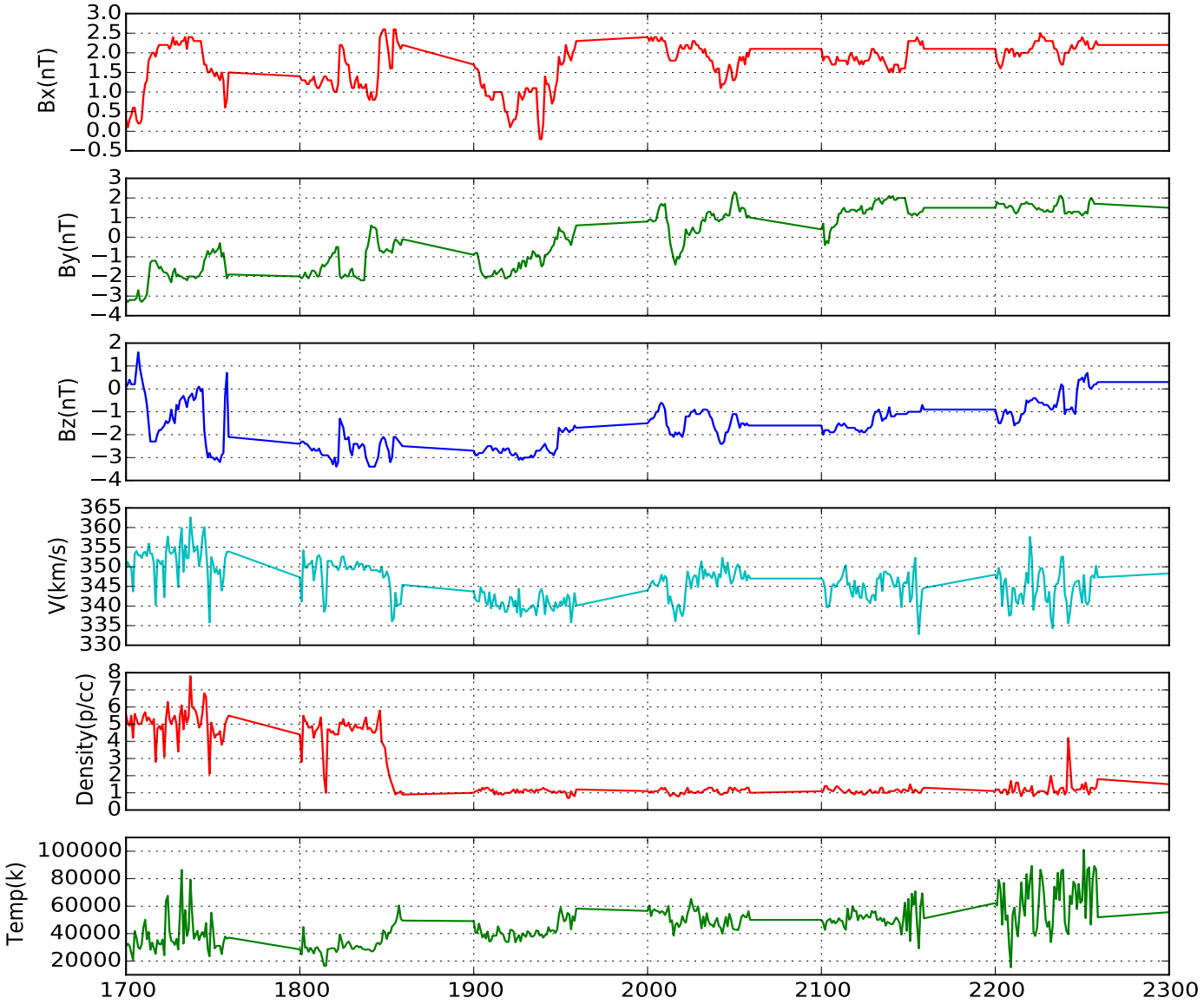
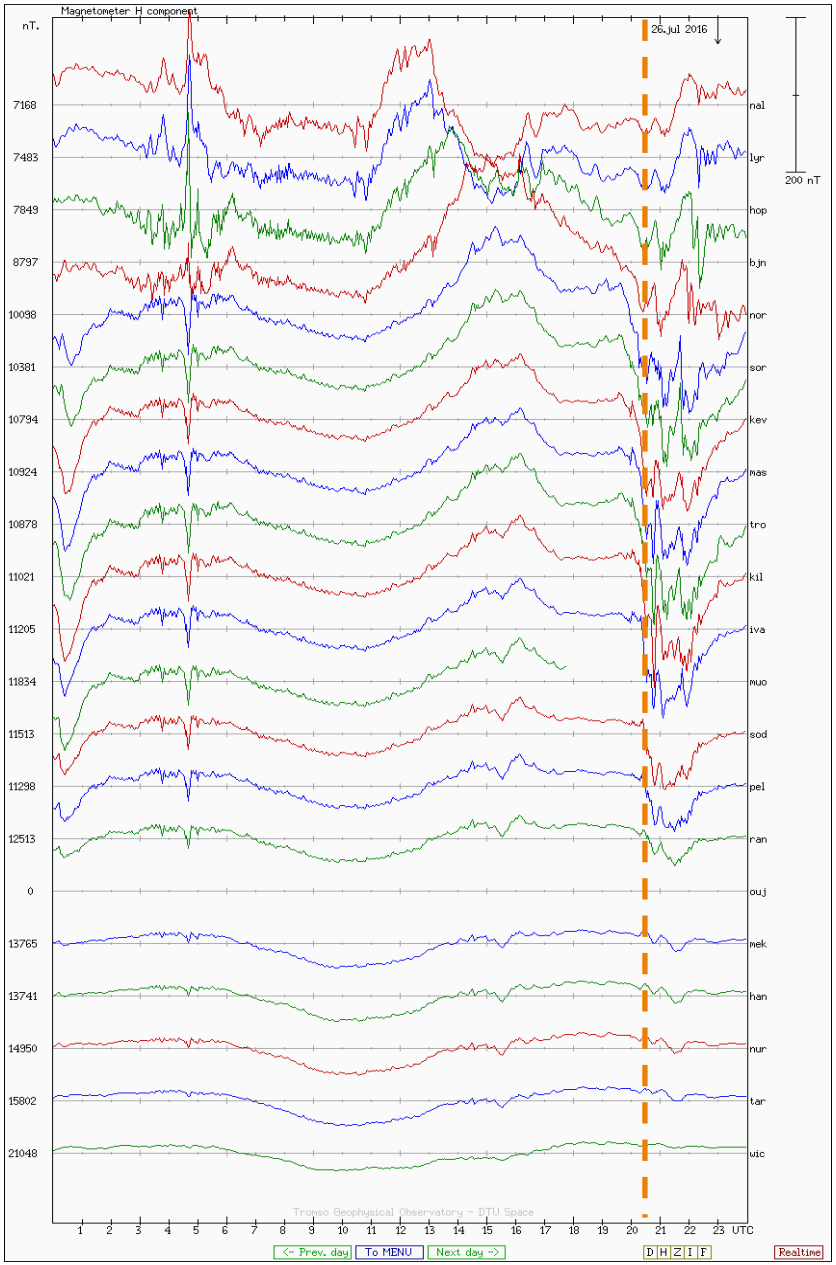
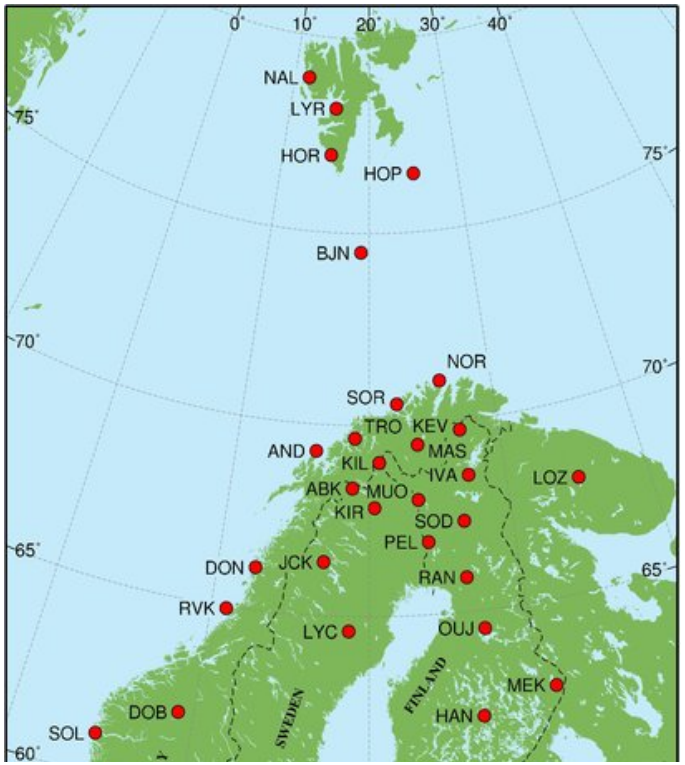
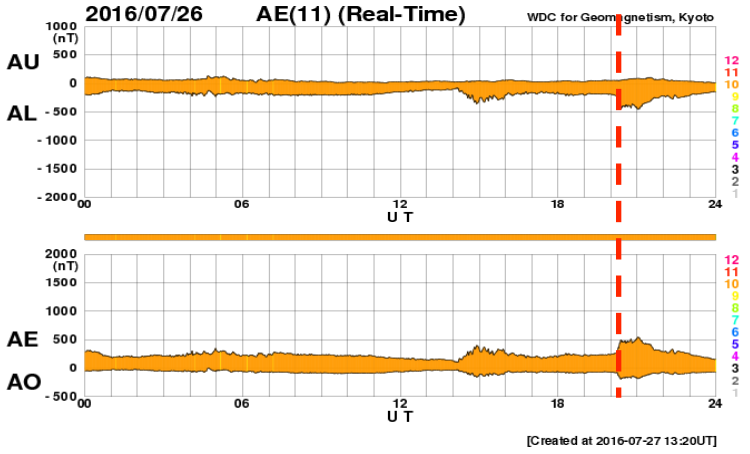
Solar Wind Conditions from ACE on July 26th, 2016



H Component of Ground Magnetometer and AE Index







Background to Ion Outflow

Ion outflow originates from dayside cusp and night side aurora region

[Yu and Ridley, 2013]

Auroral Bulk Upflow

Type-I

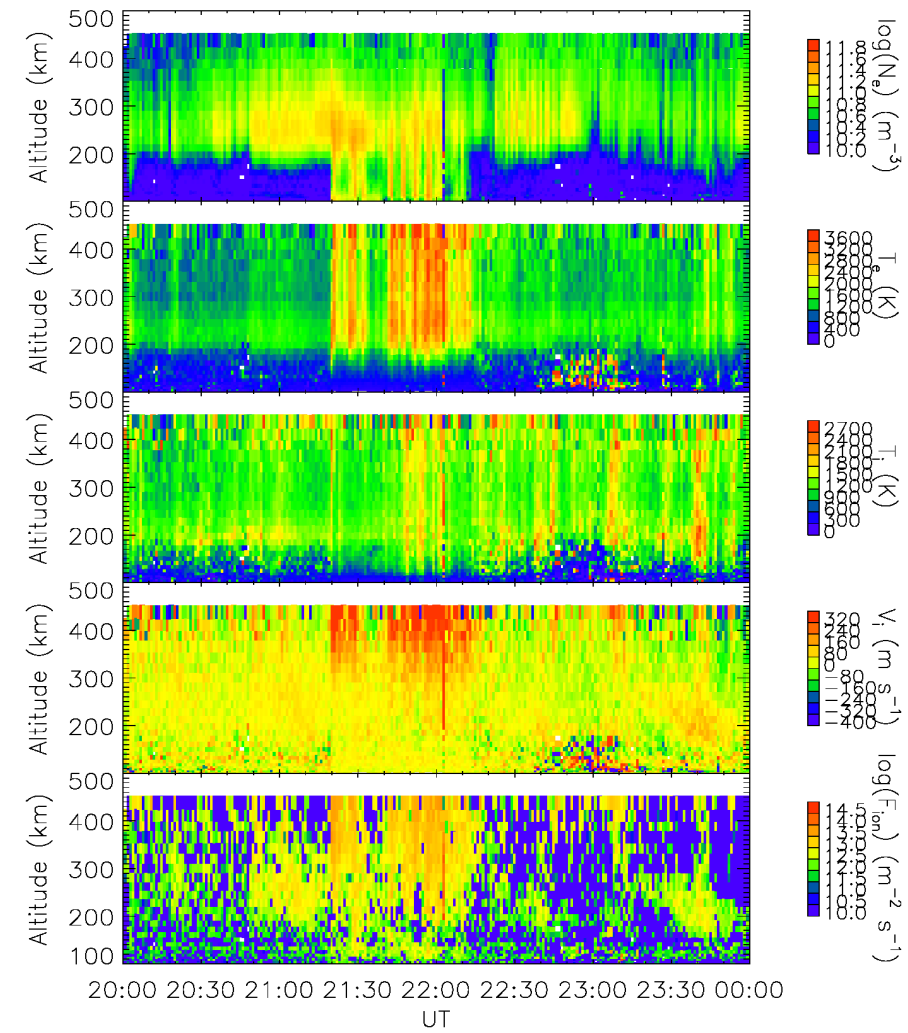
- High convection electric field
- Strong Joule heating
- No auroral precipitation

Type-II

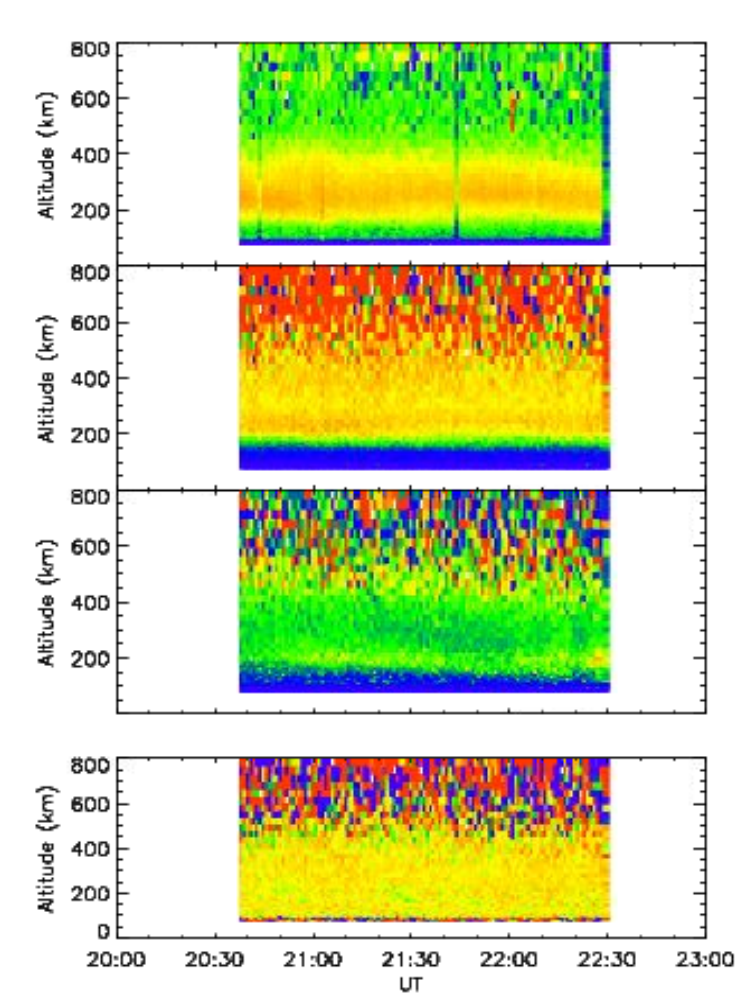
- FAV > 500 ms^{-1}
- $F_{ion} > 10^{13}\ m^{-2}s^{-1}$
- Strong T_e in the F-region
- No evidence of significant ion heating

Wahlund and Opgenoorth (1989) ; Wahlund et al. (1992)

Result: Comparison between 15/03/07 and 26/07/16 event



Our Observation



Conclusions

NO ION UPFLOW OBSERVED

Thanks

Questions!

Problem Derivation

- Momentum Equation;

$$\rho \frac{d\vec{V}}{dt} = \rho\vec{g} - \nabla P + \rho_q \vec{E} + \vec{j} \times \vec{B}$$

- Ambipolar electric field;

$$E_{\parallel} = -\frac{1}{eN_e} \nabla_{\parallel} (N_e K_B T_e)$$

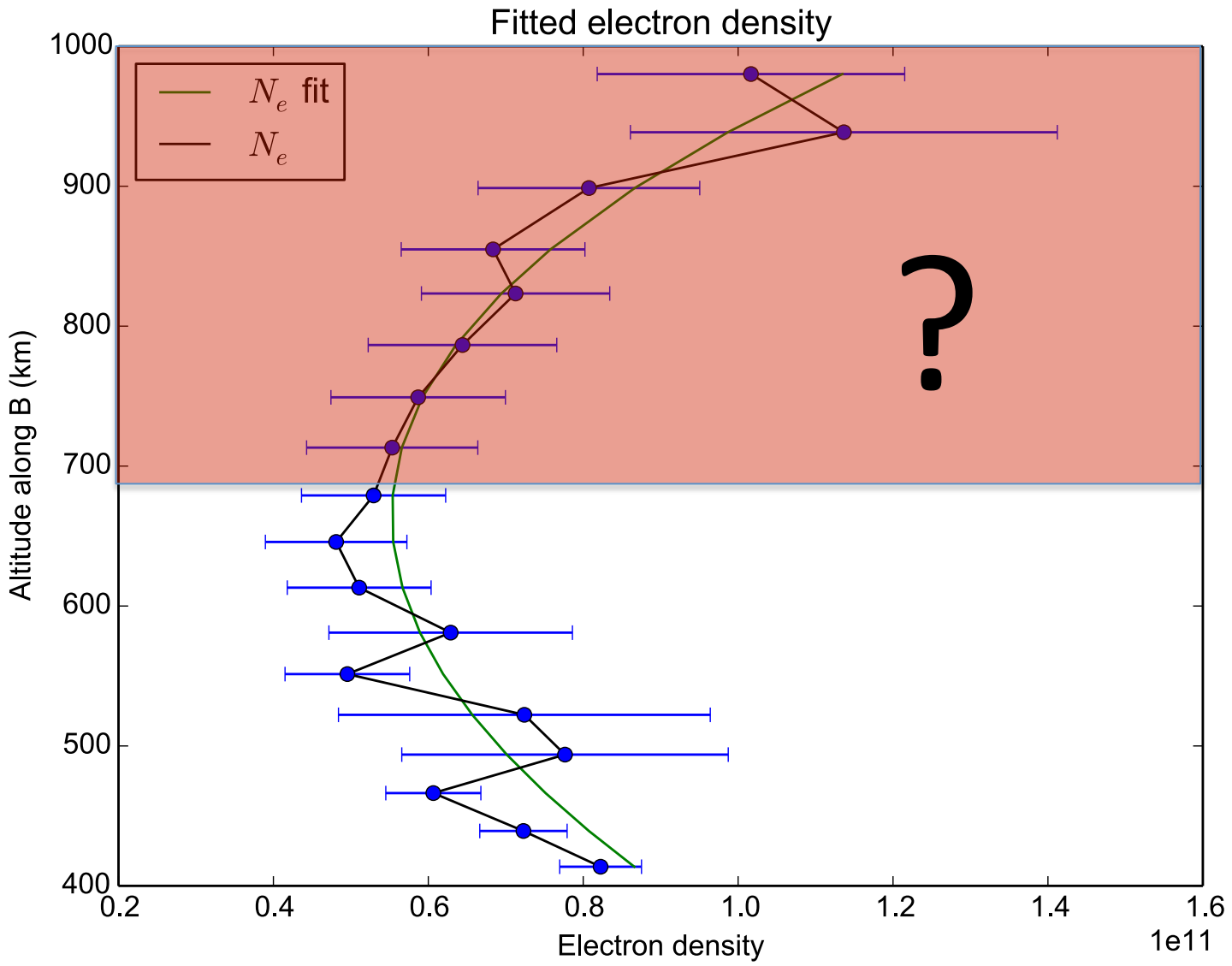
- State of Equilibrium;

$$0 = -m_i N_i g - \nabla_{\parallel} (N_i K_B T_i) + eN_i E_{\parallel}$$

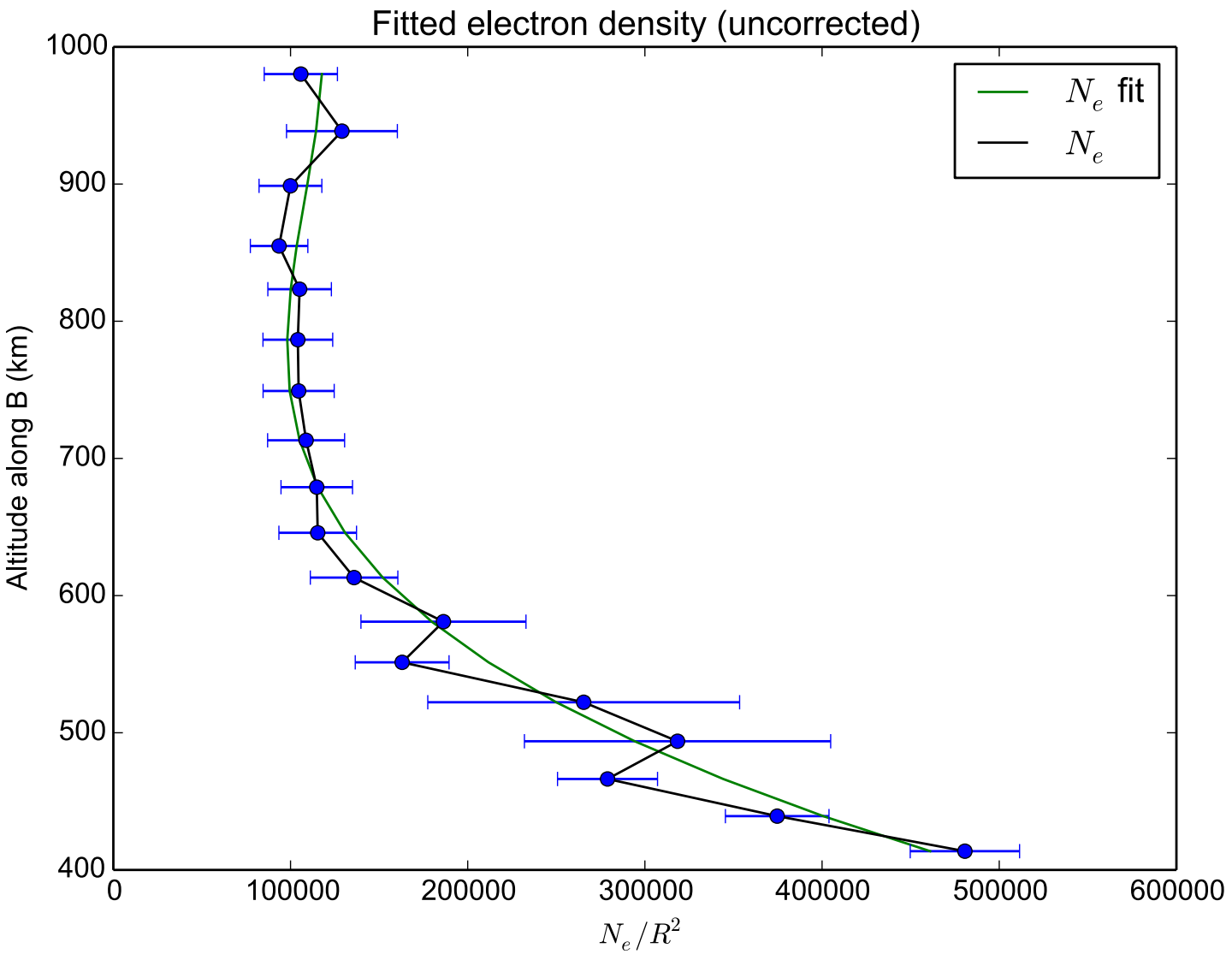
$$= -m_i N_e g - \nabla_{\parallel} (N_e K_B T_i) - \nabla_{\parallel} (N_e K_B T_e)$$

$$\frac{\partial}{\partial s} (N_e K_B (T_i + T_e)) = -m_i g N_e$$

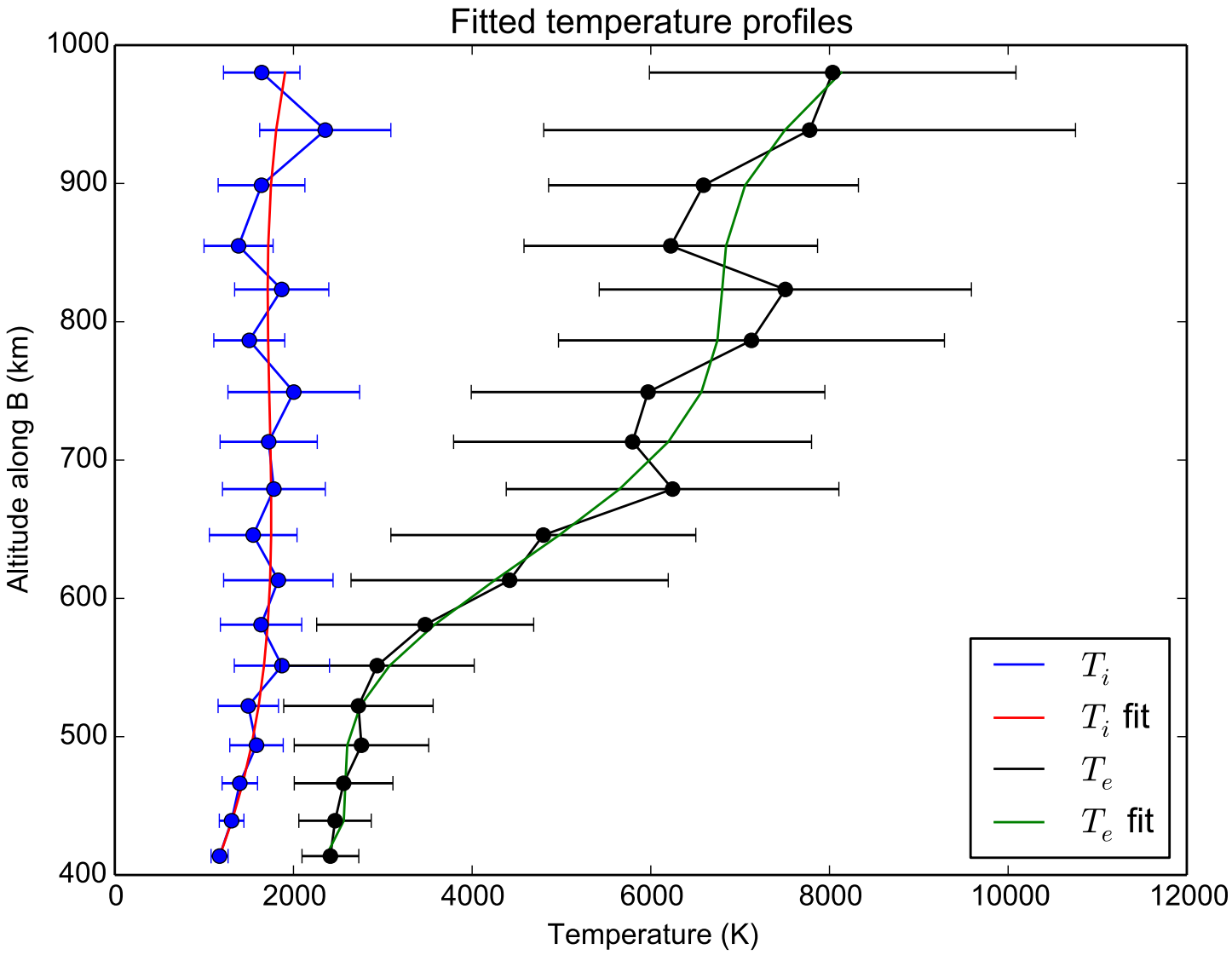
Polynomial Fitting for $N_e(s)$



Removal of R^2 Dependency

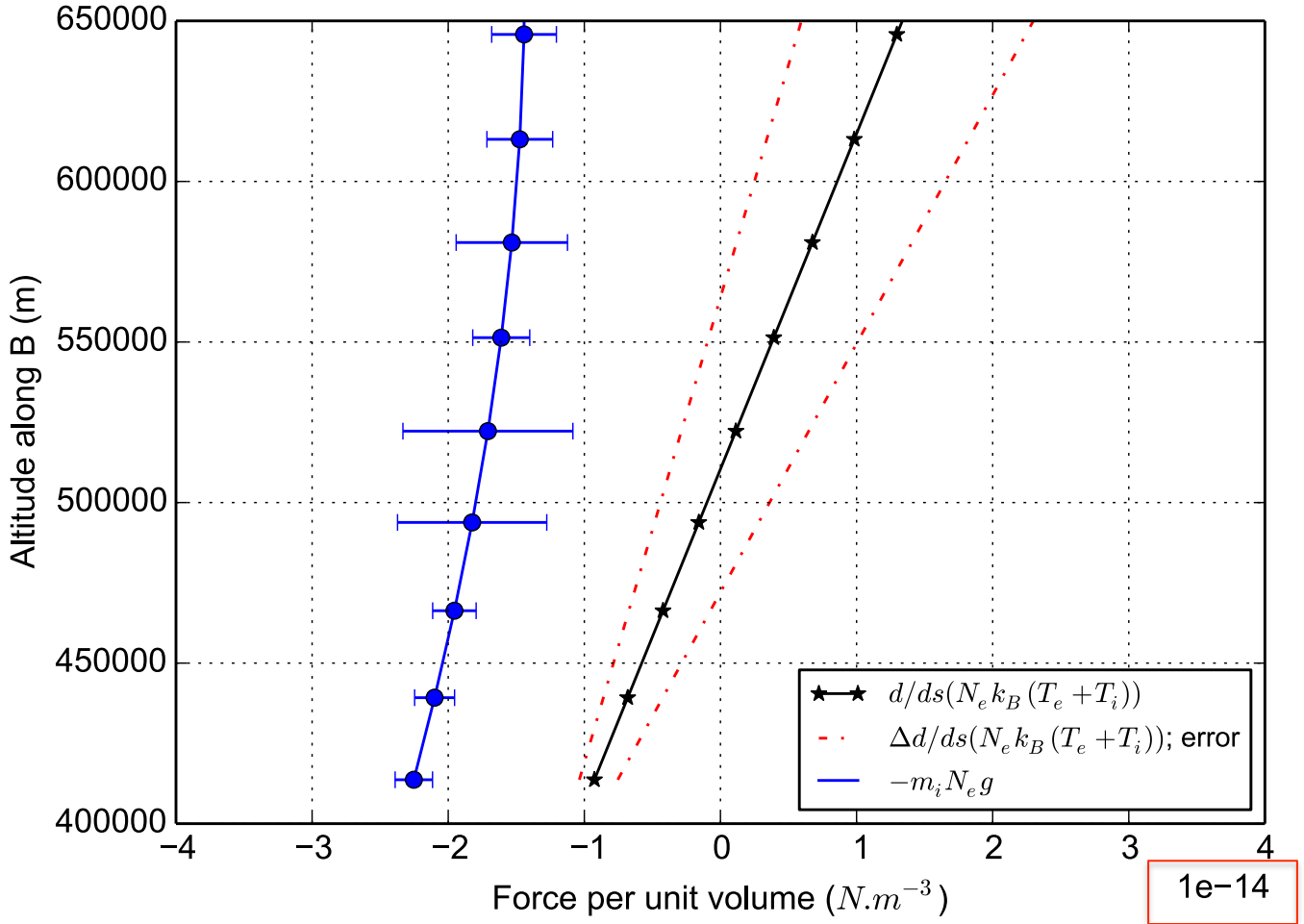


Polynomial Fitting of Temperatures

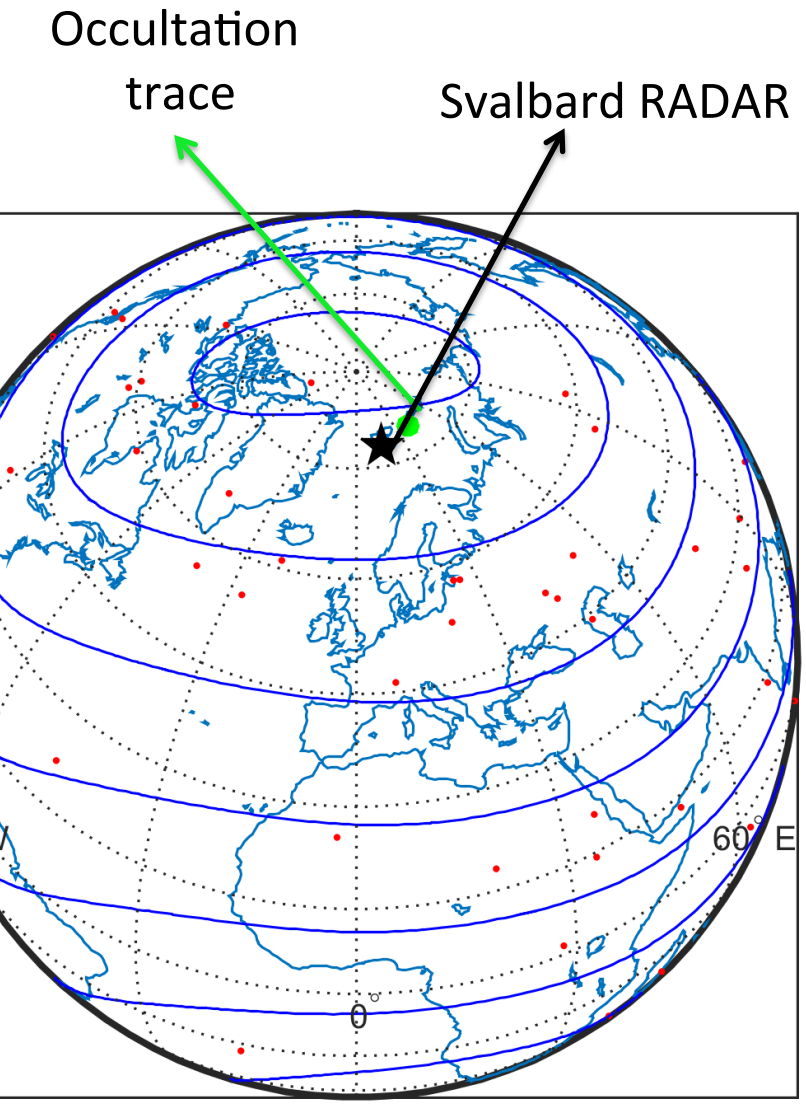


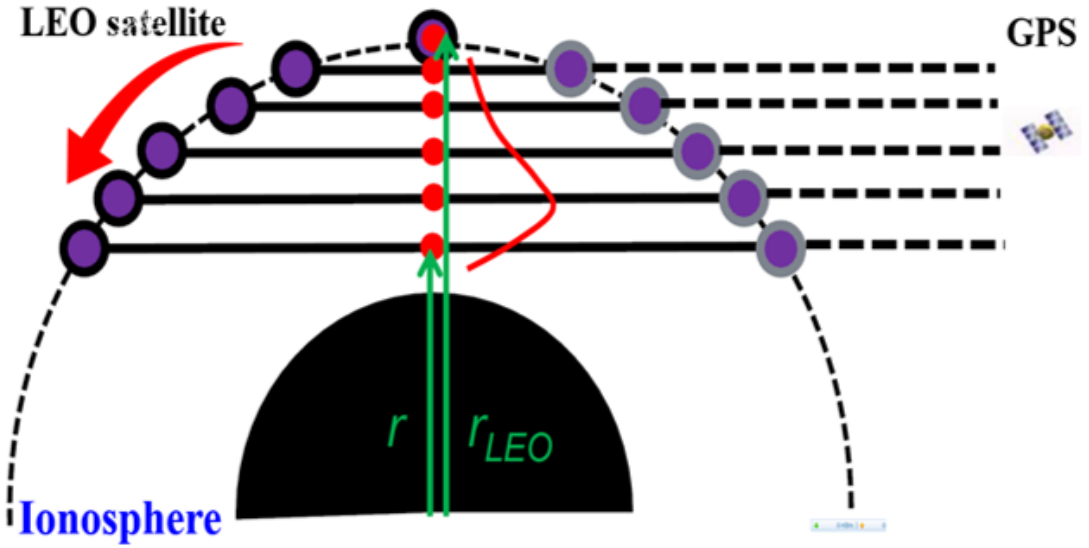
Comparison of Force Density Balance

$$\frac{\partial}{\partial s}(N_e K_B (T_i + T_e)) = -m_i g N_e$$



“COSMIC Background”

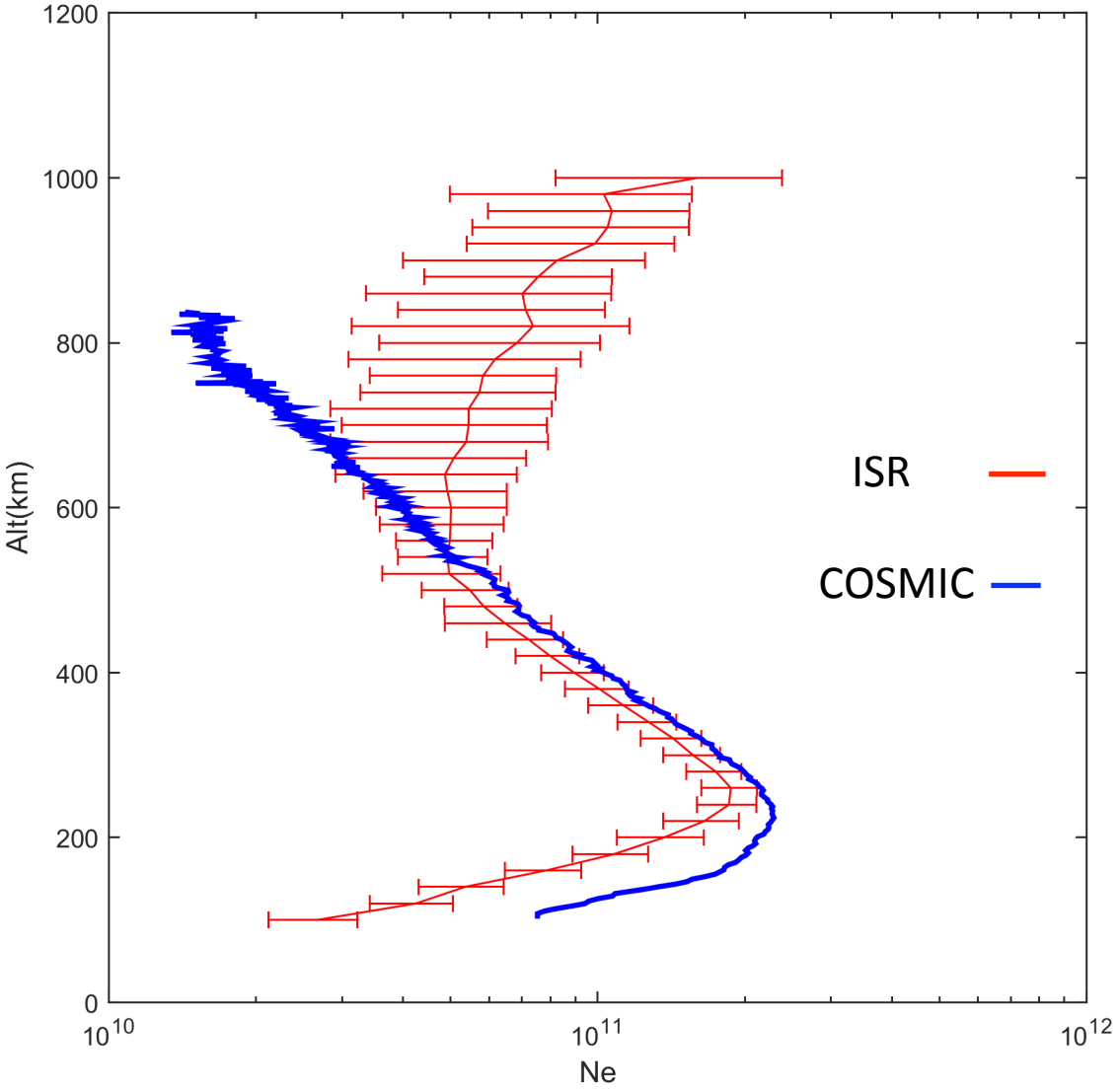




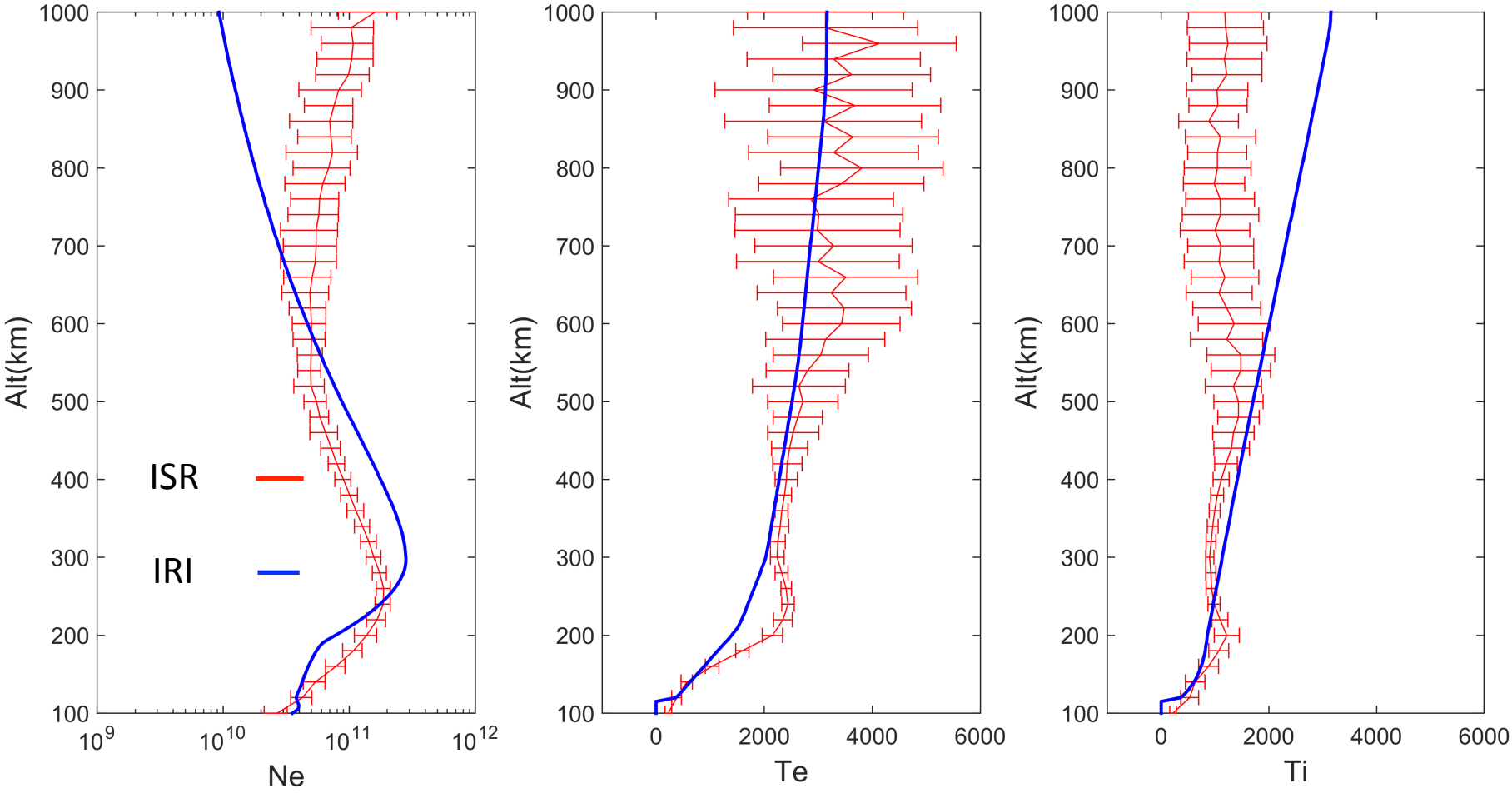
$$TEC_{OB}(r_P) = \left(\int_{r_P}^{r_{GPS}} + \int_{r_P}^{r_{LEO}}\right) \frac{r n_e(r)}{\sqrt{r^2 - r_P}} dr$$

$$N_e(r) = -\frac{1}{\pi}\int_r^{r_{LEO}} \frac{dTEC_0(p)/dp}{\sqrt{p^2 - r^2}} dp$$

Comparison between ISR and COSMIC Measurements



Comparison of ISR Measurement and IRI Model



Conclusions

- ESR 32 m (Folke) has been used to study ion upflow.
- No ion upflow has been observed during on 26/07/16 between 20:30 to 22:30 UT.
- This allowed us to examine quiet ionosphere equilibrium : hydrostatic pressure and ambipolar electric field.
- Data was used to verify COSMIC measurement and IRI model.
- Given more time, another data set containing ion upflow would be analyzed to show comparisons.