Electric fields at the magnetopause

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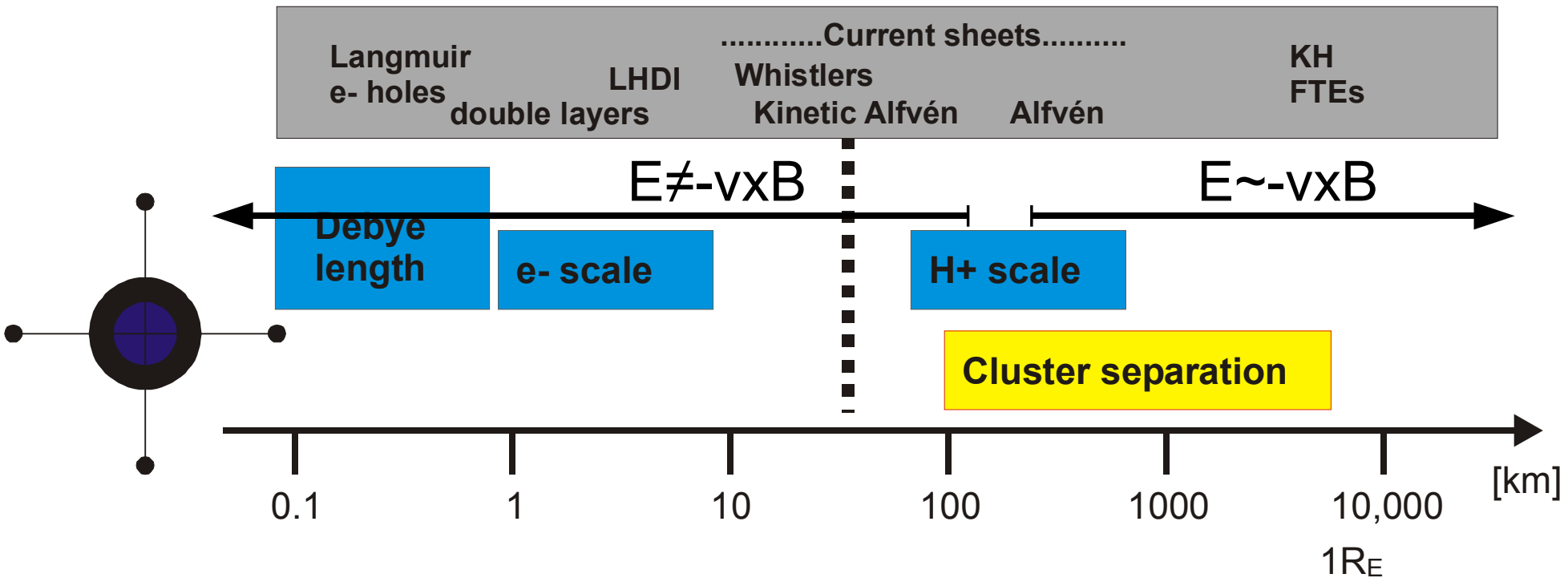
Outline

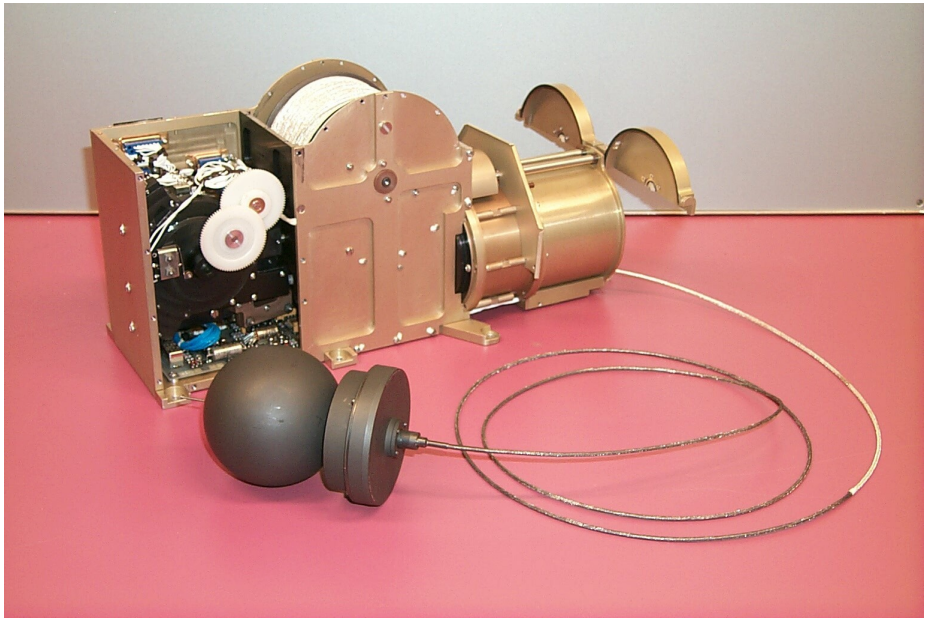
We encourage the use of electric field data!

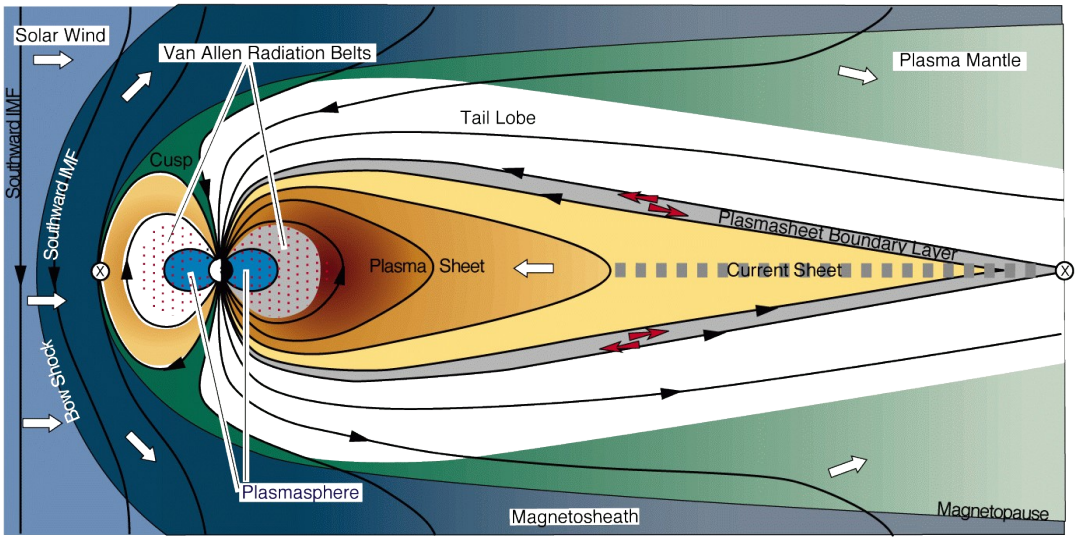
Plasma = charged particles, B, E

- ✔ Chapman – Ferraro current
- ✔ Magnetic reconnection
- ✔ Flux transfer events (FTEs)
- ✔ Plasma waves
- ✔ Anomalous collisions

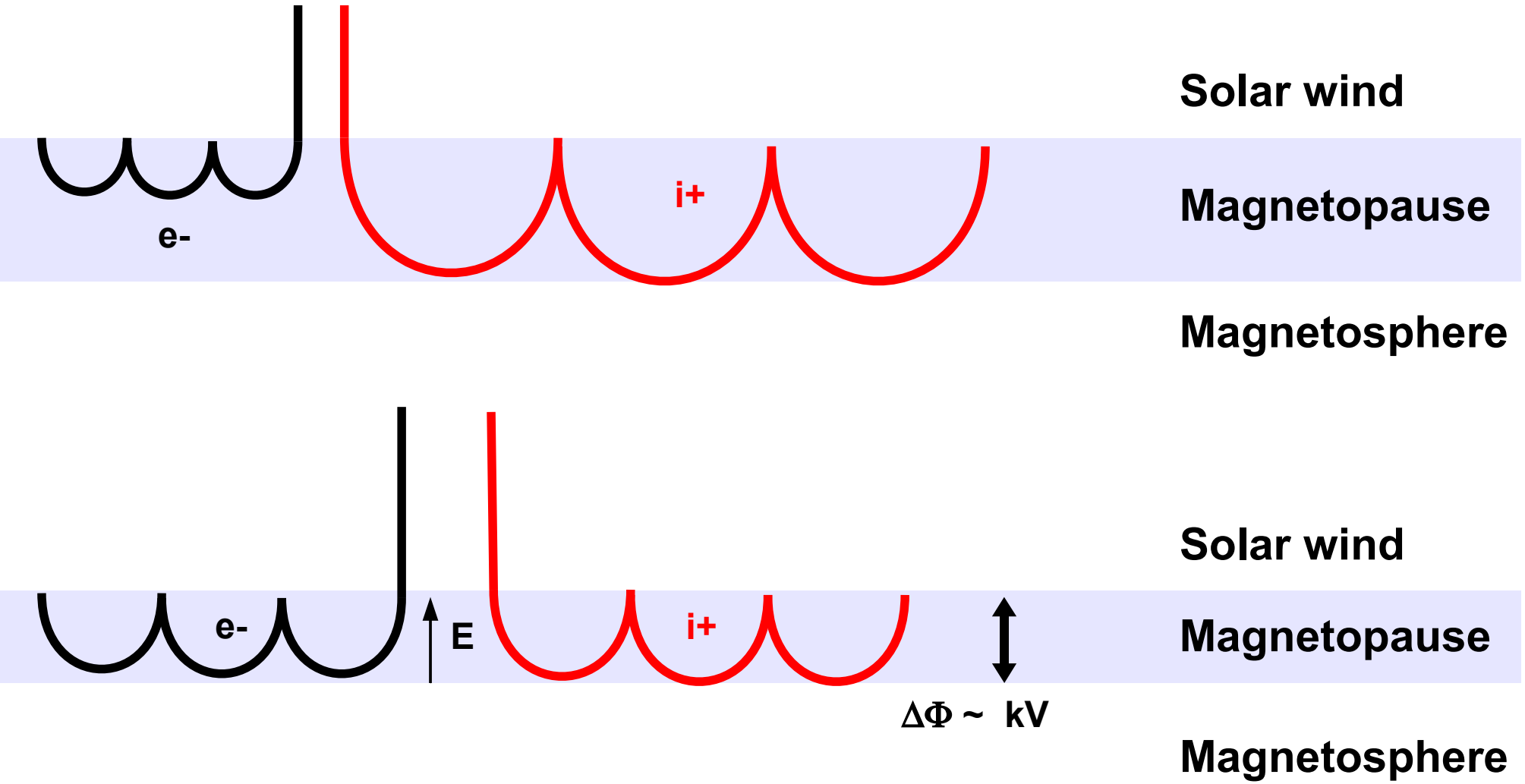
Micro scales ⟷ Macro scales



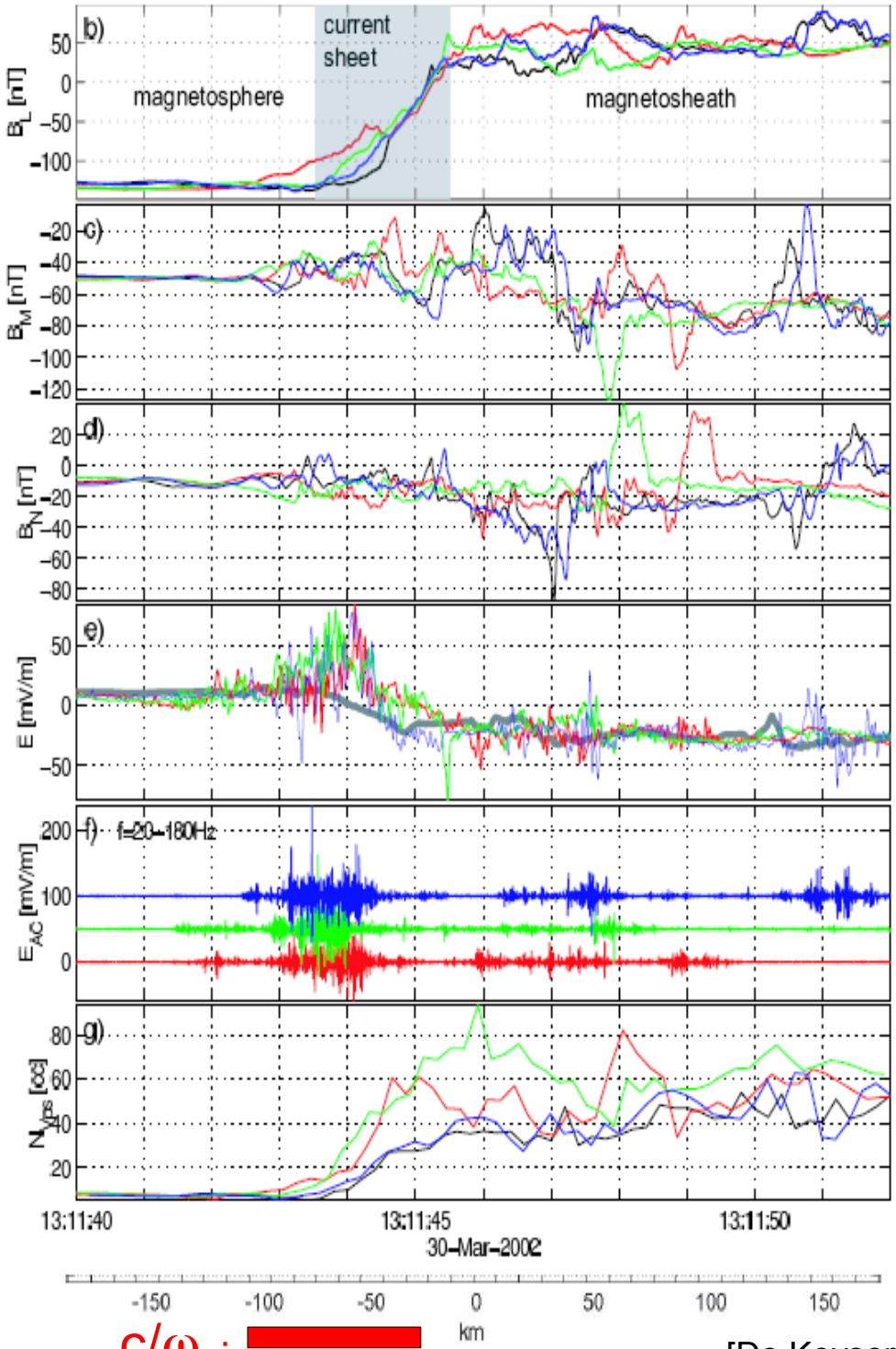


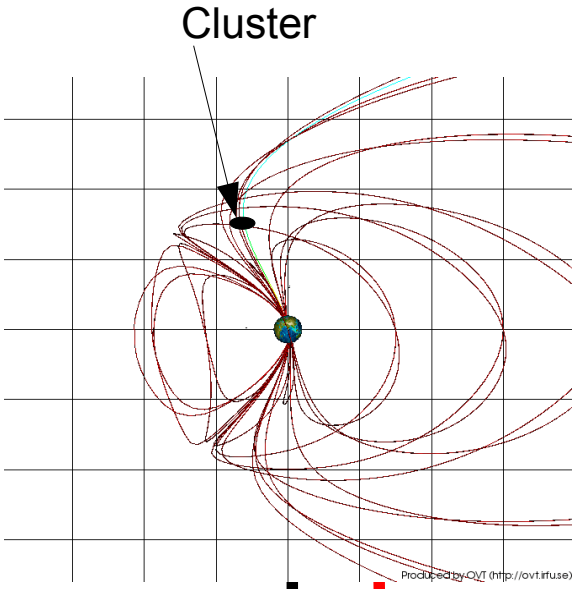


Chapman-Ferraro current

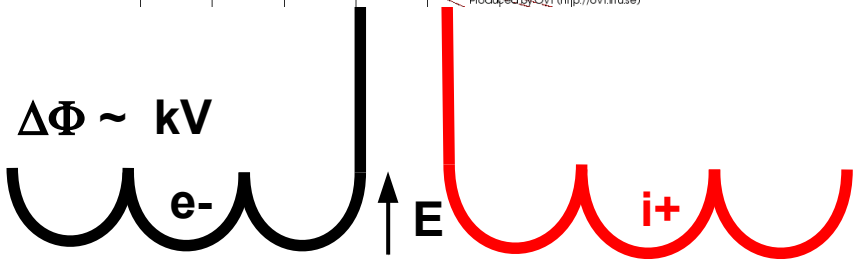


Magnetopause current layer





E



δE Plasma waves

n **Steep density gradients**
seen in satellite potential

[De Keyser et al,2005]

Magnetic reconnection

Generalized Ohms law and Cluster

$$\mathbf{E} = -\mathbf{v}\times\mathbf{B} + \frac{1}{ne}(\mathbf{j}\times\mathbf{B}) - \frac{1}{ne}\nabla\mathbf{p}_e + \frac{m}{ne^2}d_t\mathbf{j} + \eta\mathbf{j}$$

$$\mathbf{E}_{||} = -\frac{1}{ne}\nabla\mathbf{p}_e + \frac{m}{ne^2}d_t\mathbf{j} + \eta\mathbf{j}$$

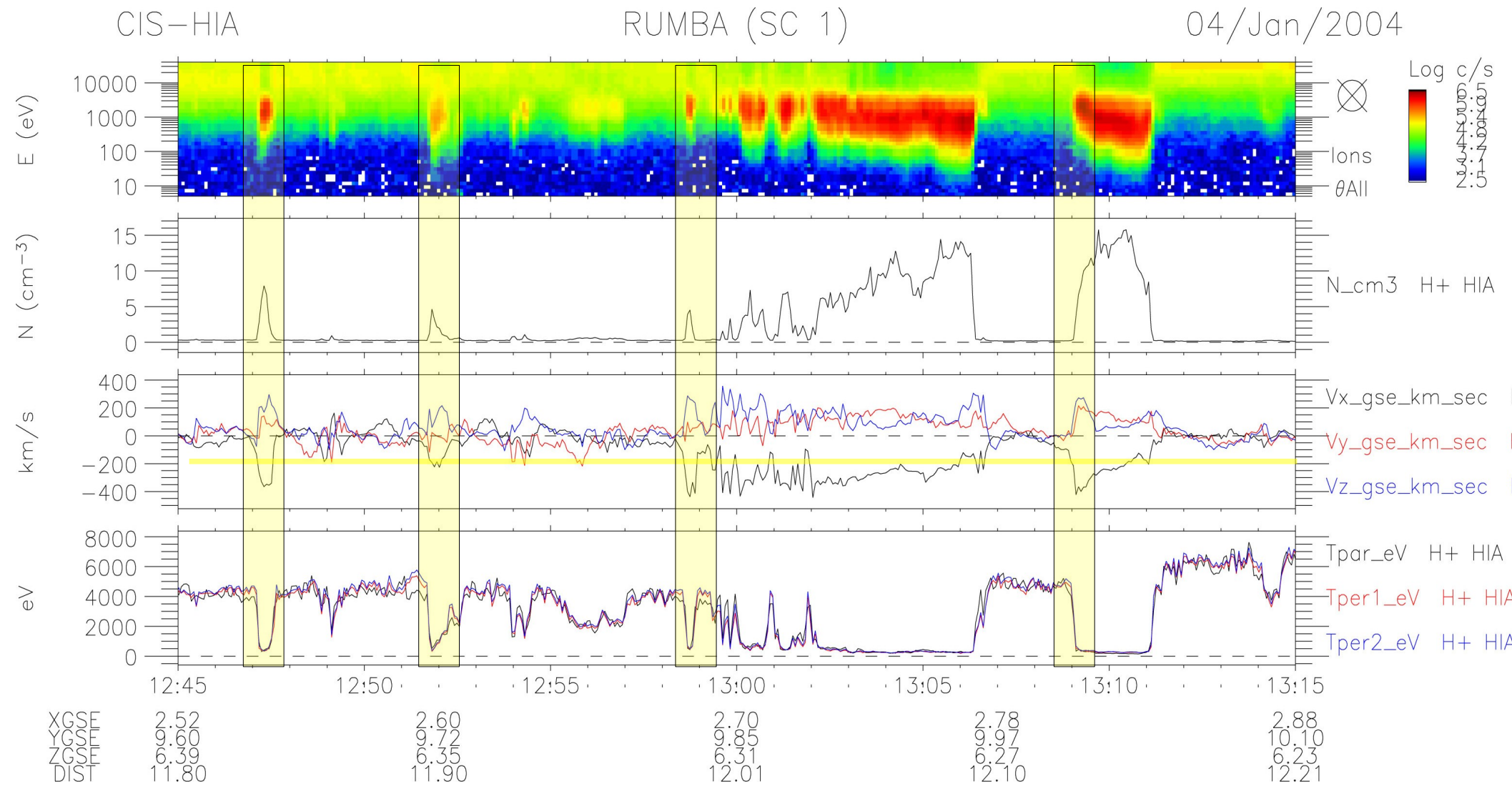
At spin resolution

- **B** 3D[FGM], **E** [EFW,EDI], **n** [CIS, PEACE, WHISPER], $\mathbf{p}_e$ [PEACE], **v** [CIS], **j** [PEACE+CIS, curlometer]

At high time resolution (5 S/s and higher)

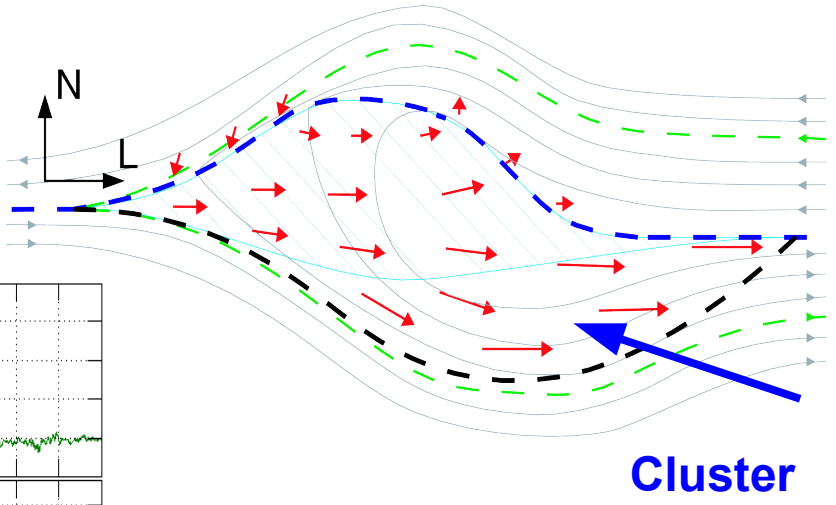
- **B** 3D[FGM,STAFF], **E** [EFW,EDI], sometimes **n** [WBD]
- **n** satellite potential [EFW]
- **j** [curlometer, planar current sheet assumption]
- $\mathbf{T}_e$
- **v**

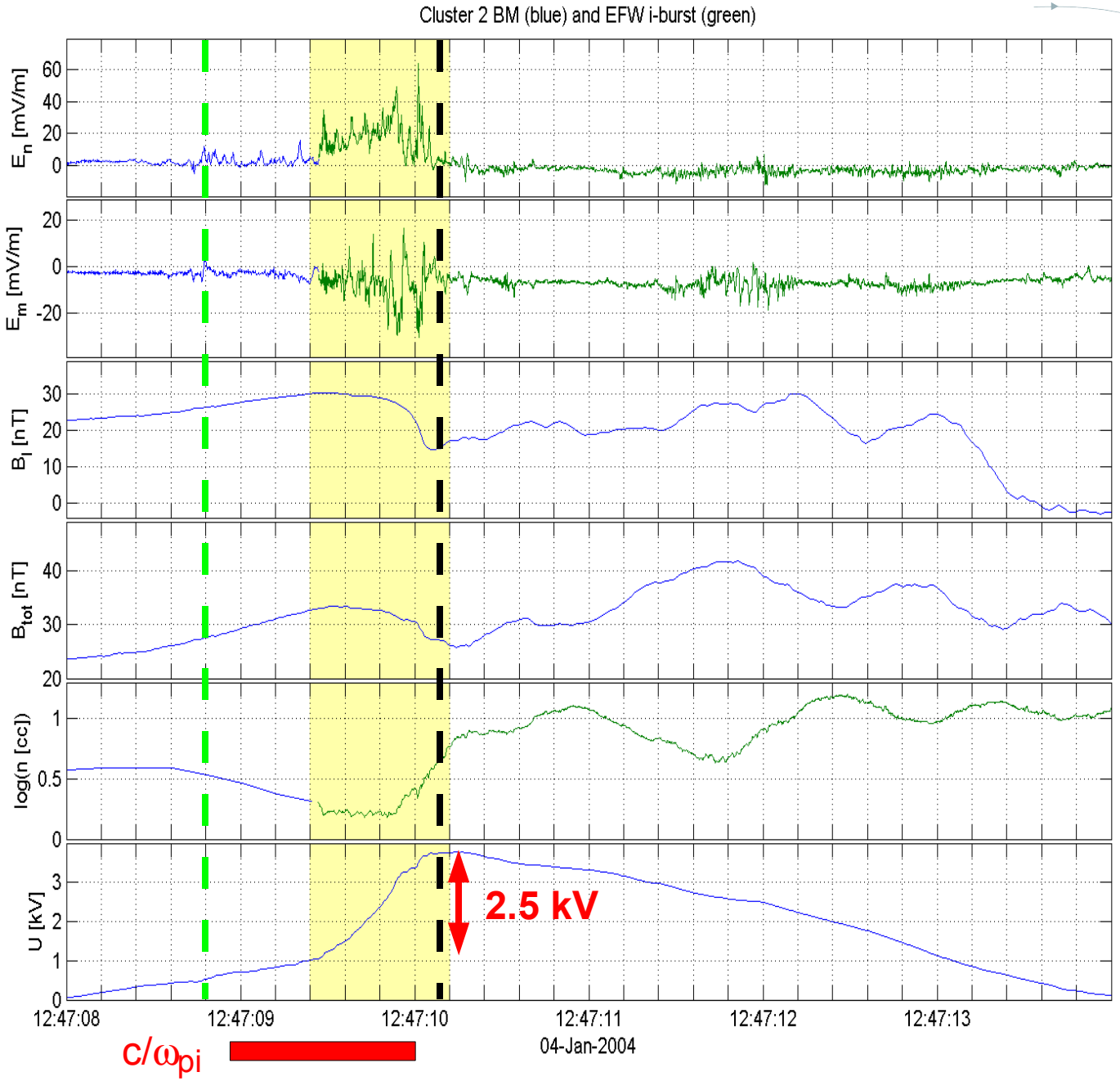
Flux Transfer events (FTEs)



Poster today!

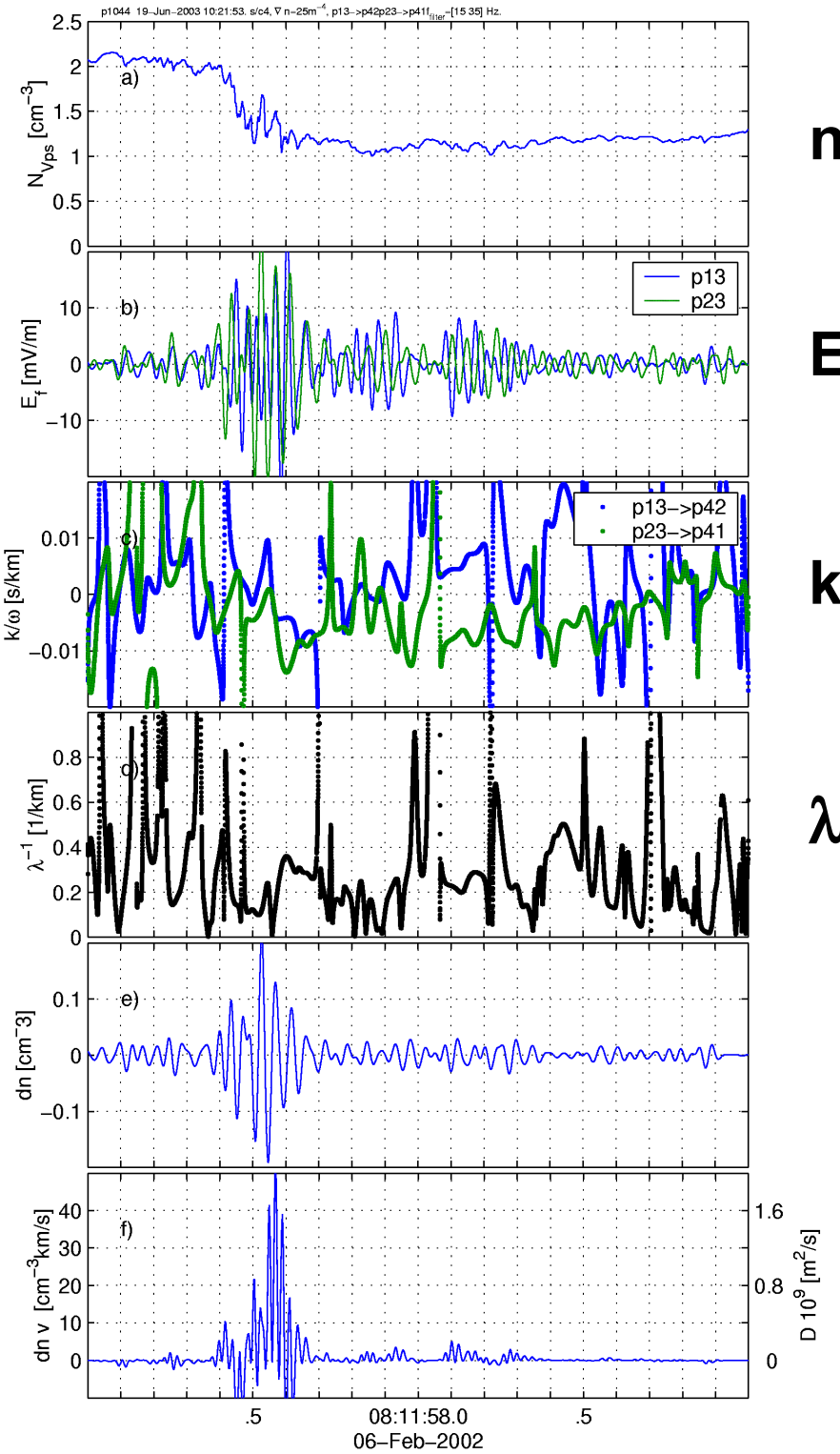
FTE, E field structure





- ✔ L ≤ ion gyroradius
- ✔ Strong E. $E/B_0 \sim V_A$
- ✔ Strong $j_{||} \sim 0.3 \mu A/m^2$
- ✔ Density gradient
- ✔ Large potential jump
- ✔ dt < 1s

Plasma waves

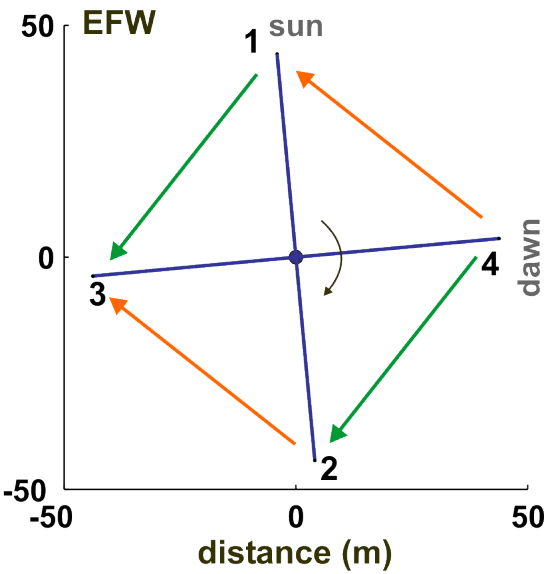


n

E

k/ω

λ



- ✓ Wave-particle interaction often through electrostatic waves
- ✓ E.g., lower hybrid, ion/electron acoustic, solitary waves
- ✓ Using internal burst one can estimate the phase speed of waves for which $\omega/k<400$km/s
- ✓ Example – drift lower hybrid waves
- ✓ $k\rho_e \sim 1$
- ✓ low coherence

[Vaivads et al,2004]

Anomalous collisions

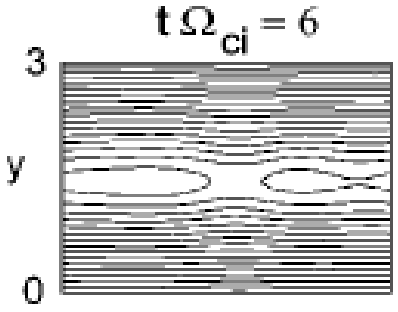
Momentum equation derived from the Vlasov equation separating AC and DC scales

$$nm(\partial_t \mathbf{u} + \mathbf{u}\nabla\mathbf{u}) - nq(\mathbf{E} + \mathbf{u} \times \mathbf{B}) + \nabla \cdot \mathbf{p} = \underbrace{q(< \delta n\, \delta\mathbf{E} > + < \delta\mathbf{j} \times \delta\mathbf{B} >)}_{\eta \mathbf{j}}$$

Anomalous collision frequency

$$\nu_y^{\text{eff}} = \frac{q}{nmv_y}(< \delta n\, \delta E_y > + < \delta\mathbf{j} \times \delta\mathbf{B} > |_y)$$

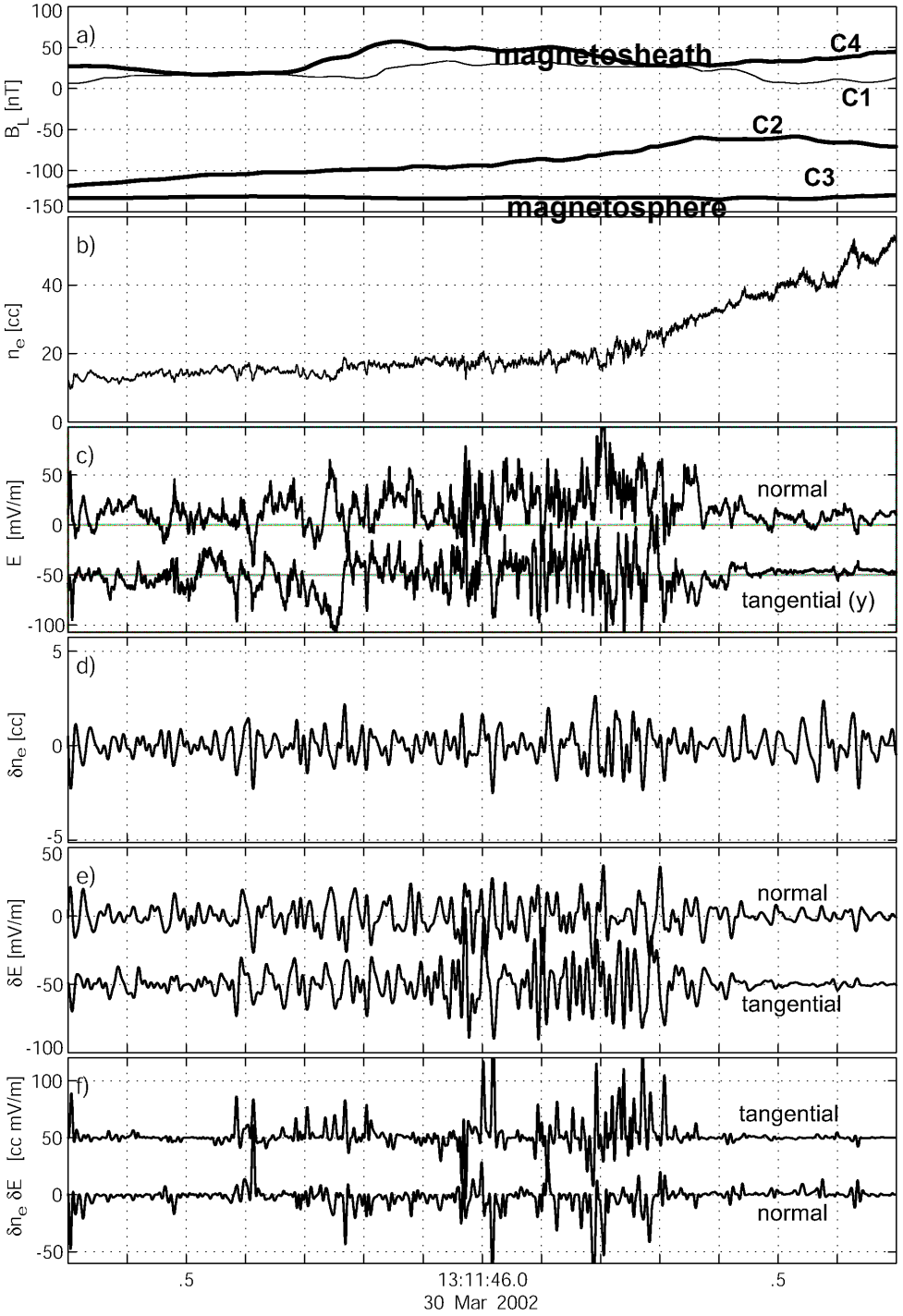
The first (and second?) term can be measured experimentally in space!



Lower hybrid drift waves lead to the thinning of the current sheet and onset of the reconnection.

[Scholer et al., 2004]

Anomalous resistivity, Cluster observations



[Sillin et al., 2005]

Current sheet

Density gradient

LHD waves

Anomalous resistivity $\nu \sim f_{LH}$

Summary

We encourage the use of electric field data!

Plasma = charged particles, B, E

- ✔ Chapman – Ferraro current
  Strong E fields, potential jump, density gradient within 1s
- ✔ Magnetic reconnection
  Generalized Ohms Law
- ✔ Flux transfer events (FTEs)
  Strong E fields, potential jump 2.5kV, density gradient within 1s
- ✔ Plasma waves
  Wave-particle interaction often through electrostatic waves.
  e.g. Lower hybrid waves. Can measure phase velocities < 400 km/s.
- ✔ Anomalous collisions