Polar wind flow from wake observations

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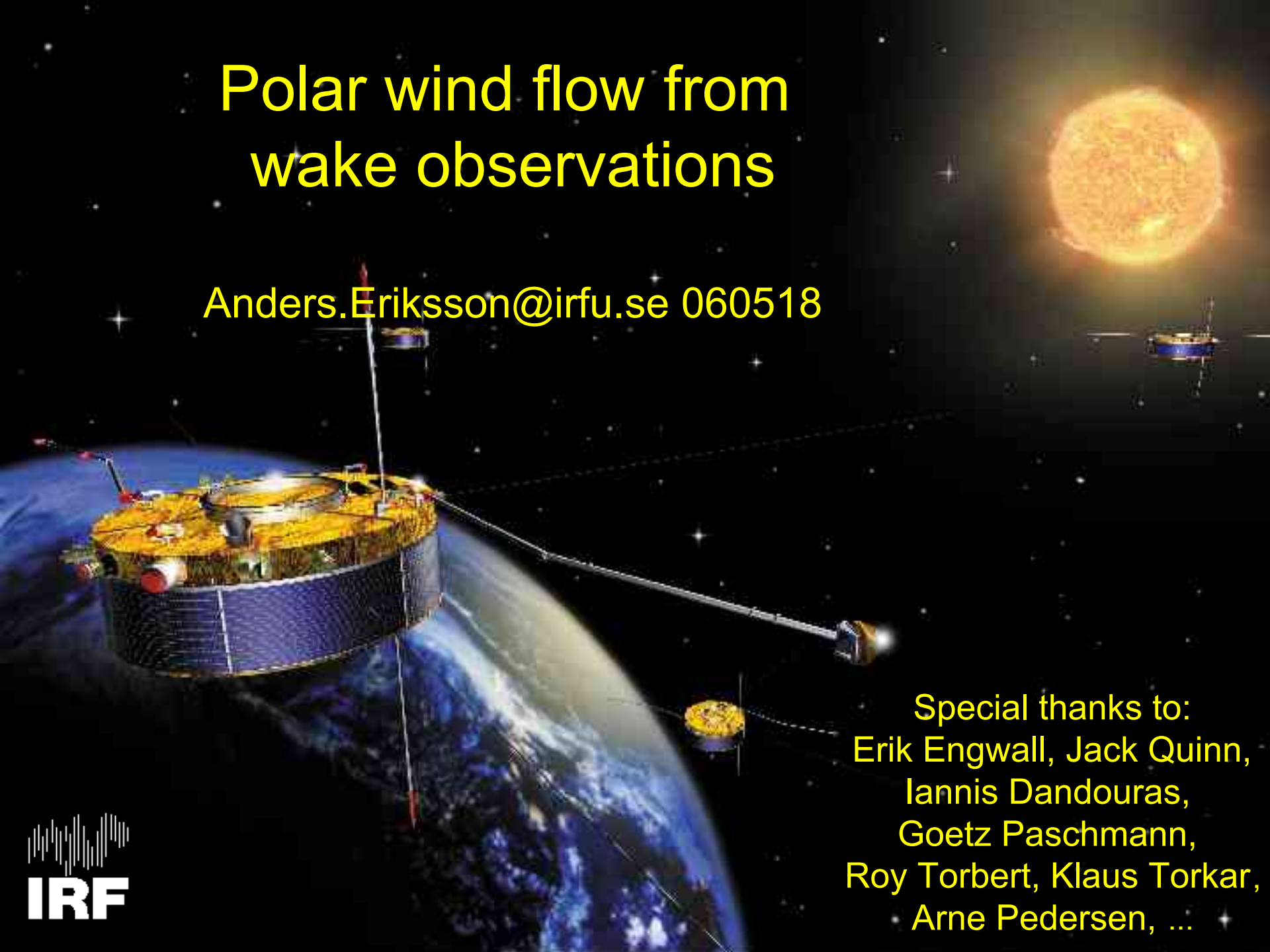

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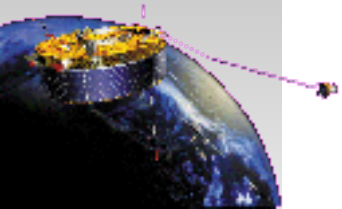
Arne Pedersen, ...

IRF

Wake and polar wind studies

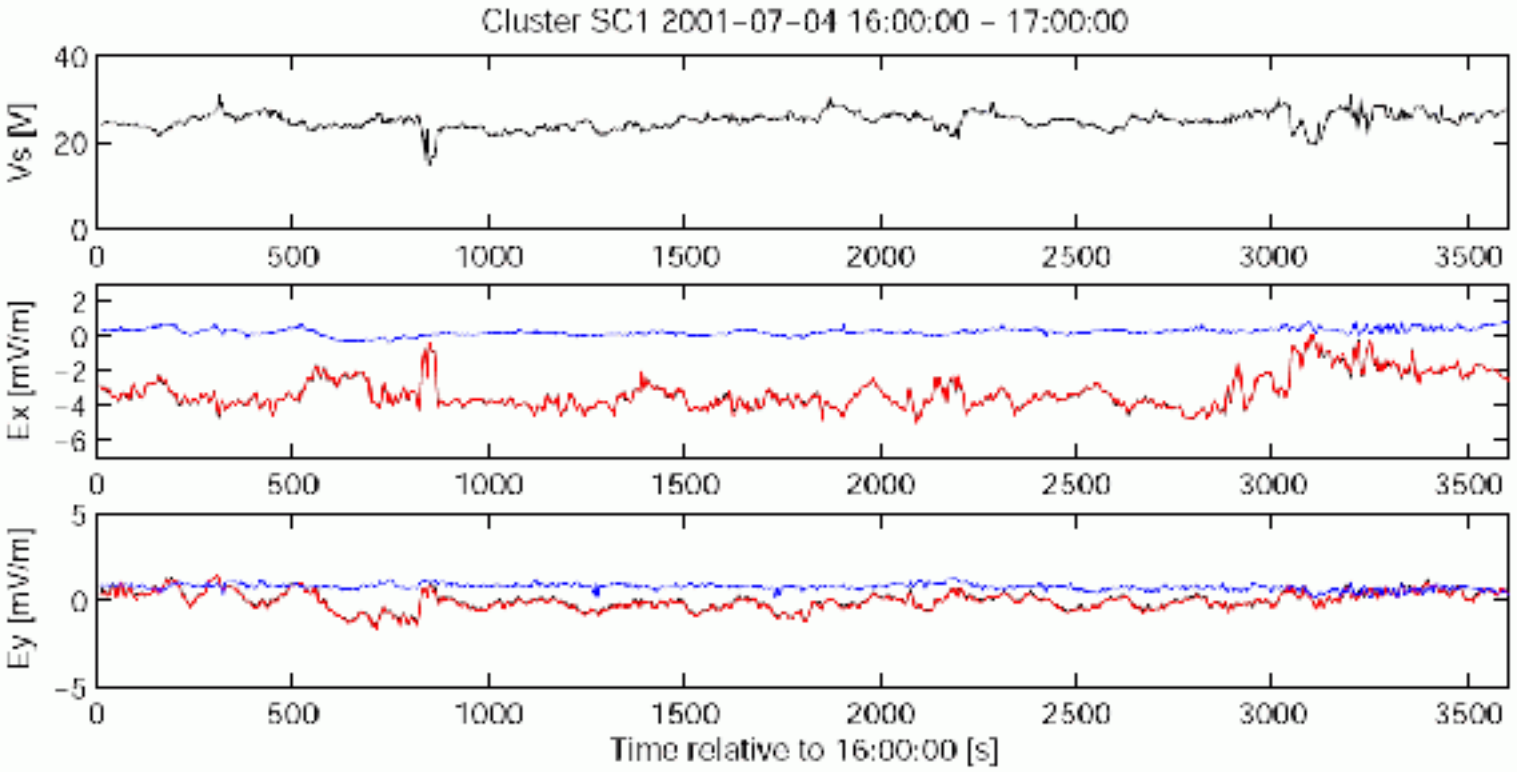
- Eriksson et al., Electric field measurements on Cluster: comparing the double-probe and electron drift techniques. Ann. Geophysicae, 24, 275-289 (2006)
- Engwall & Eriksson, Double-probe measurements in cold tenuous space plasma flows. *IEEE Trans. Plasma Sci.,* in press (2006)
- Engwall et al., Wake formation behind positively charged spacecraft in flowing tenuous plasmas. *Phys. Plasmas*, in press (2006)
- Engwall et al., Low-energy (order 10 eV) ion flow in the magnetotail lobes inferred from spacecraft wake observations. *Geophys. Res. Lett.,* 33, L06110 (2006)
- Engwall, *Cold magnetospheric plasma flows: properties and interaction with spacecraft*. Licentiate thesis, Uppsala University, March 2006

Wake shows polar wind

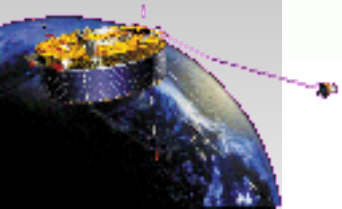


EFW-EDI discrepancies

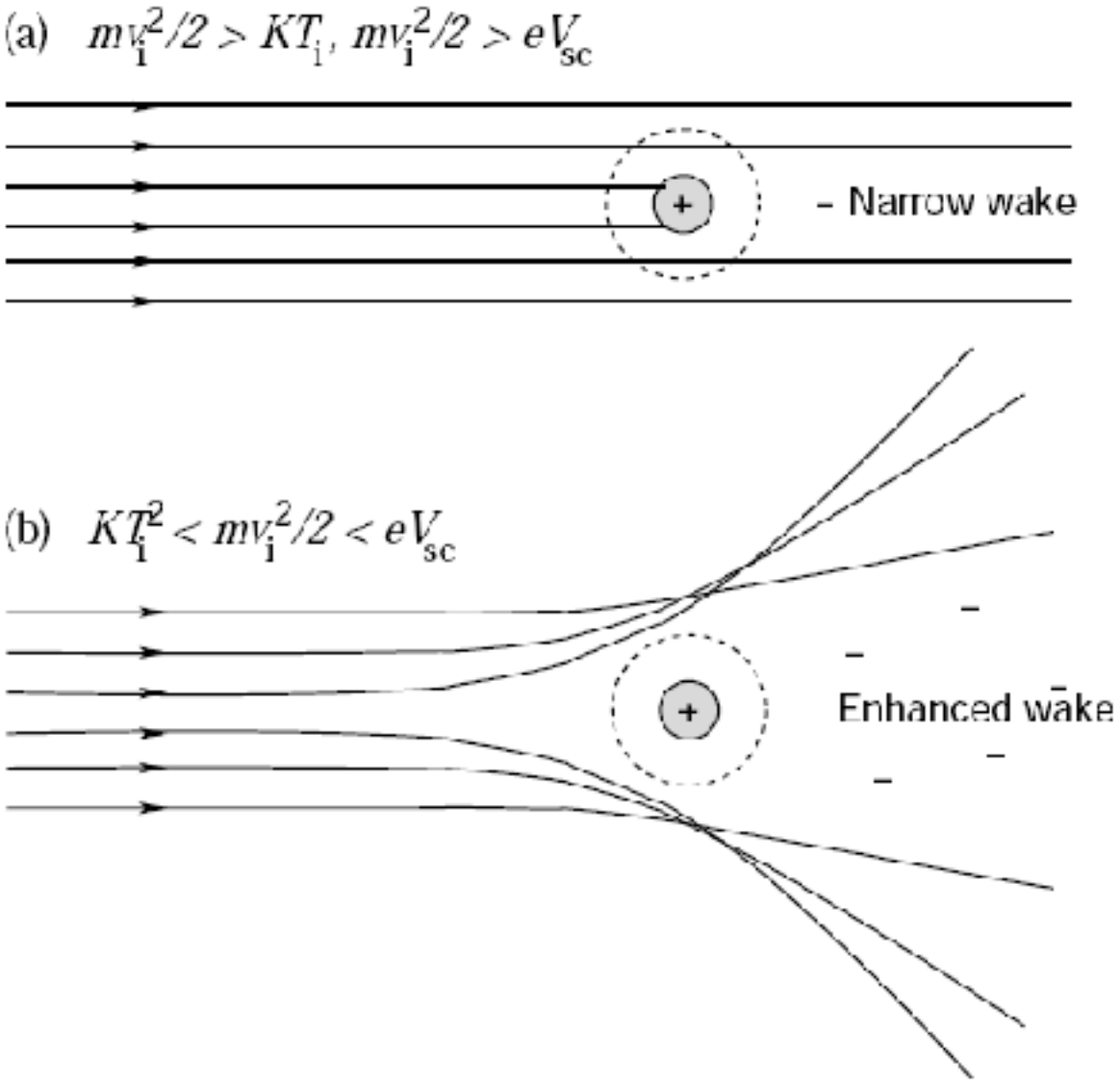
- Often observed in tail lobes/polar caps



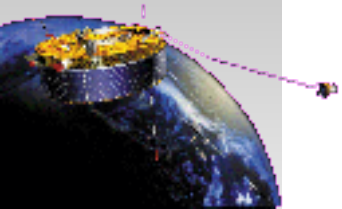
Wake shows polar wind



Large wake behind positive s/c

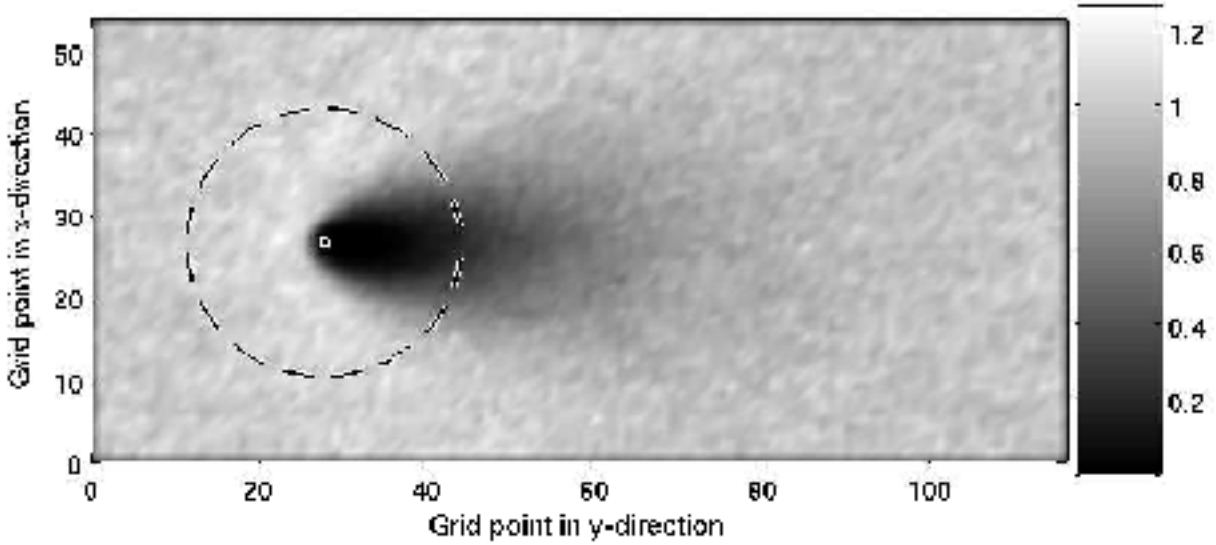


Wake shows polar wind

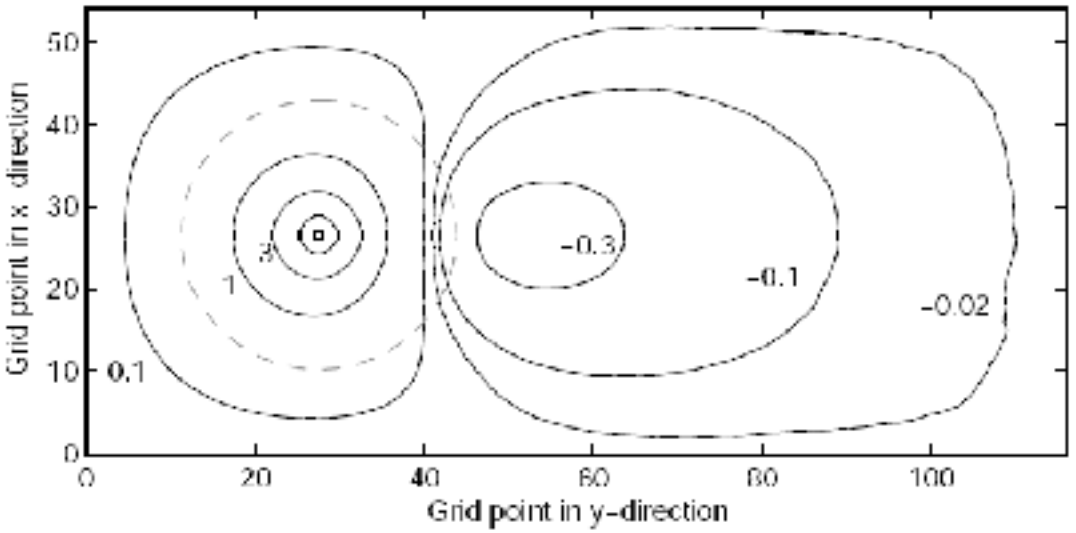


Simulations verify concept...

Wake shows polar wind



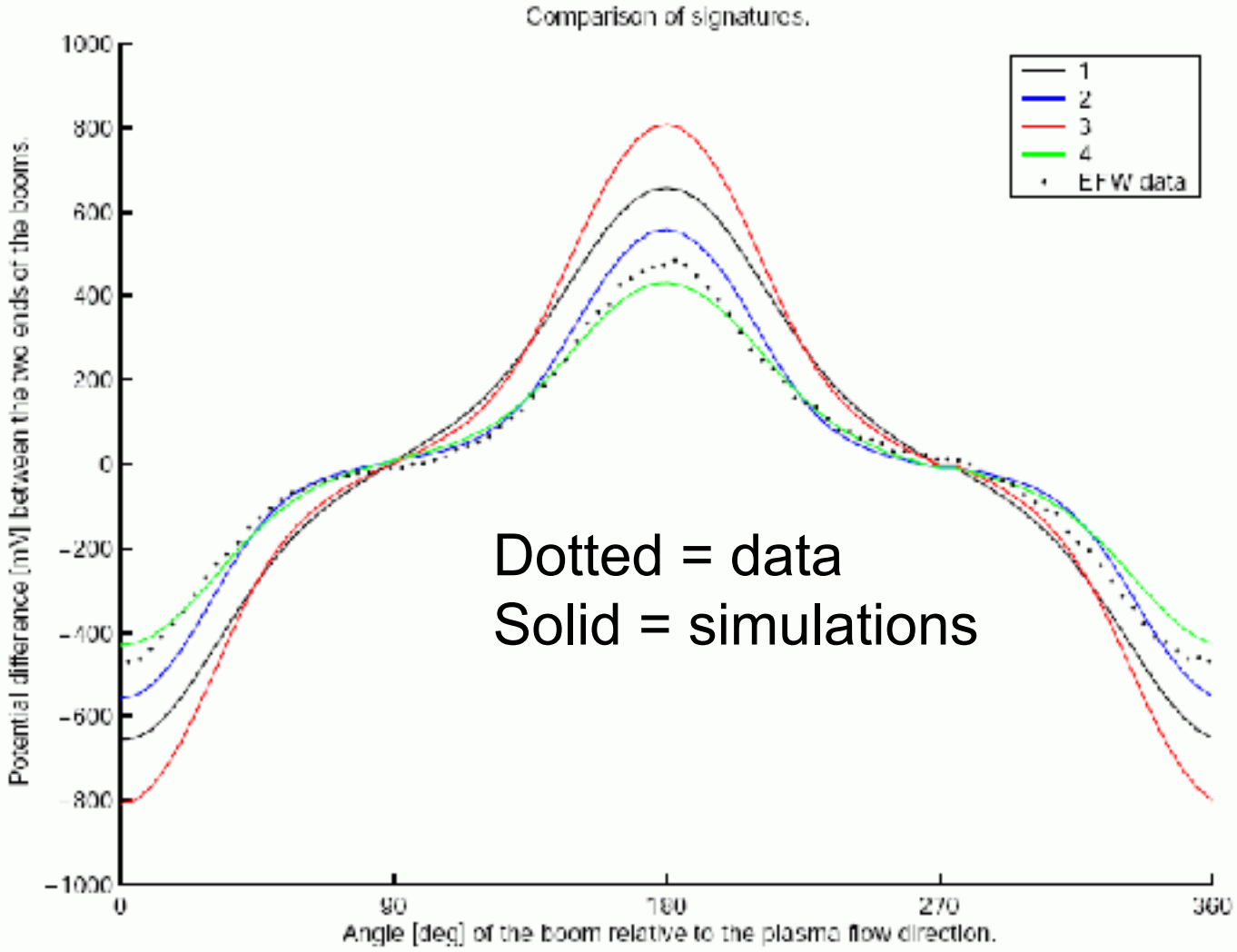
n/n_0



Potential [V]

... and reproduce wake spin signature.

Wake shows polar wind



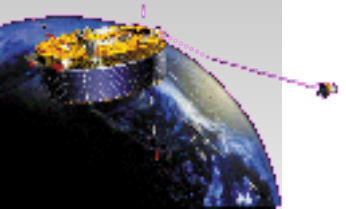
Simple model relates wake to flow

- Possible to invert to get parallel flow speed if wake is known
- EFW-EDI comparison gives wake...
- ... so we can now observe ions invisible to particle instruments!

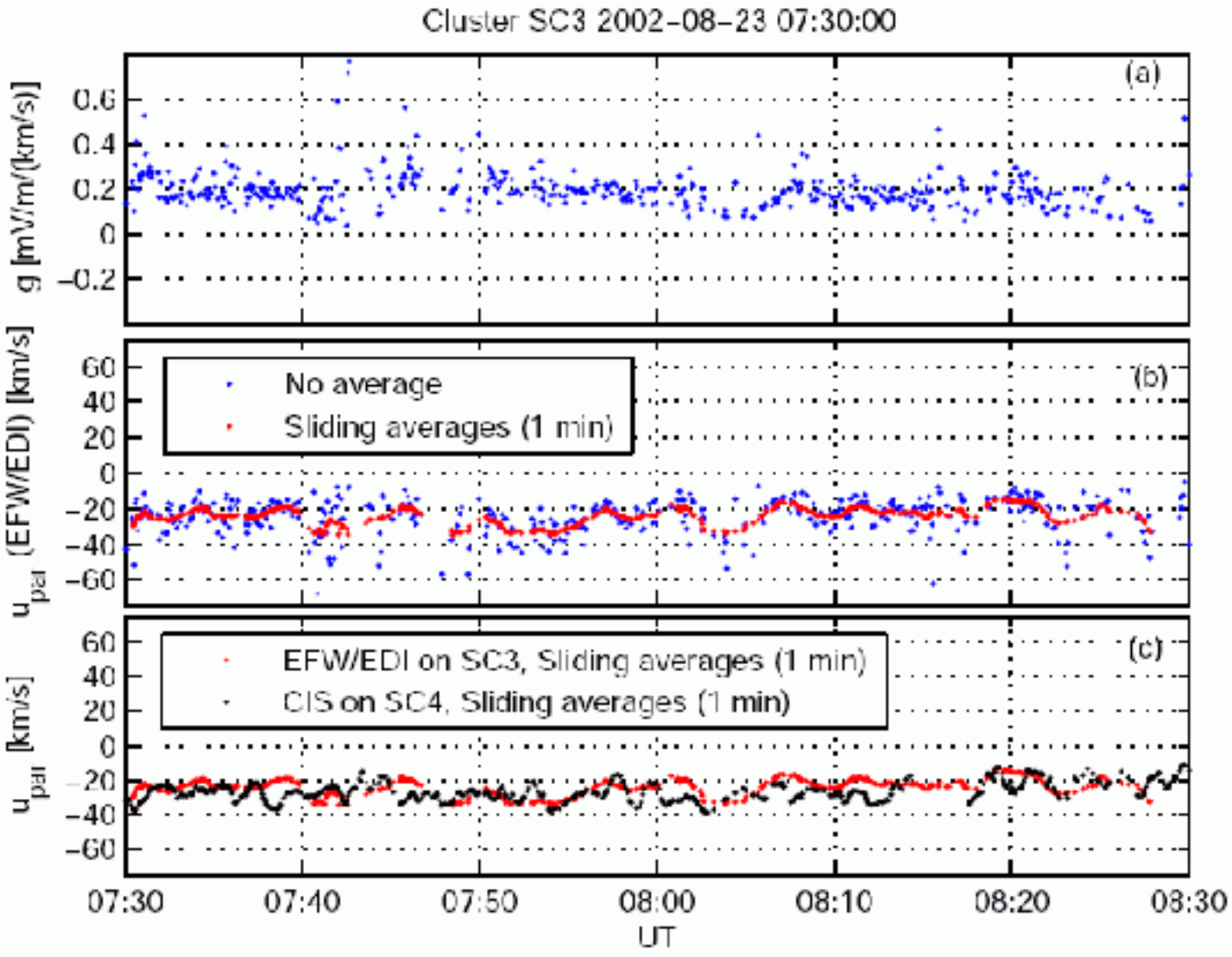
$$\mathbf{E}^{\mathrm{w}} = g\mathbf{u}_{\perp} + gu_{\parallel}\frac{\mathbf{B}}{B}$$

$$\begin{cases} g = \dfrac{(\mathbf{B}\times\mathbf{E}^{\mathrm{w}})_z}{E_z^{\mathrm{EDI}}} = \dfrac{B_x E_y^{\mathrm{w}} - B_y E_x^{\mathrm{w}}}{E_z^{\mathrm{EDI}}} \\ u_{\parallel} = \dfrac{B}{gB_c}\left(E_c^{\mathrm{w}} - gu_{\perp,c}\right) \end{cases}$$

Wake shows polar wind



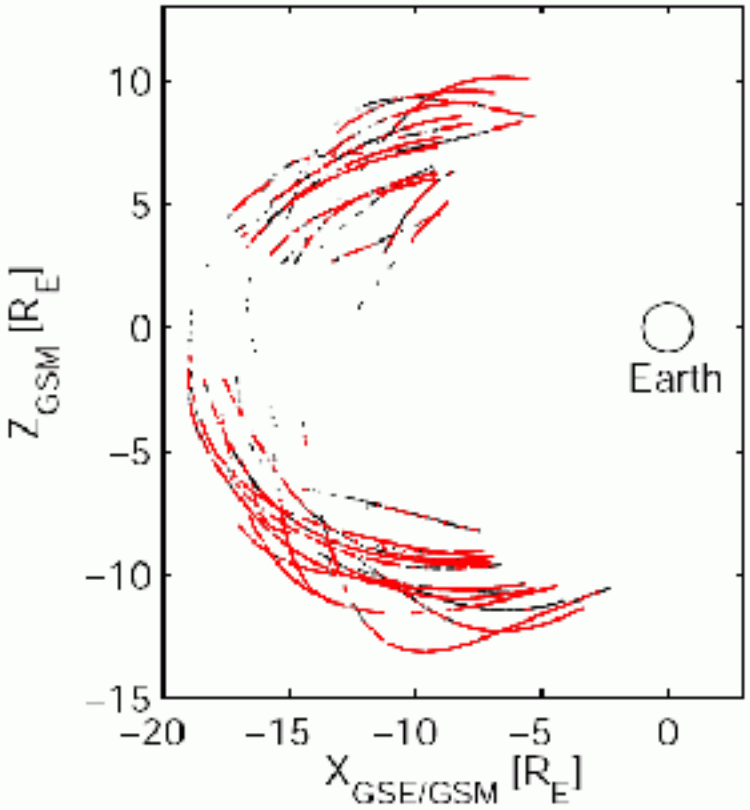
CIS comparison verifies method

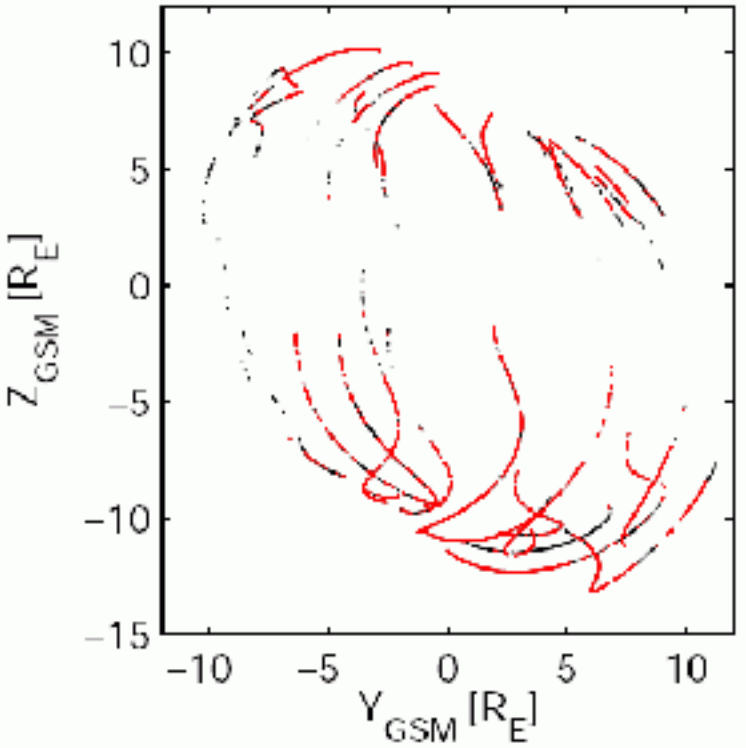


Wake shows polar wind

Initial statistics

- SC3, 3 months (autumn 2002), ~70 000 spins
- GSE X < -5
- Red = wake > 2 mV/m, black = no wake

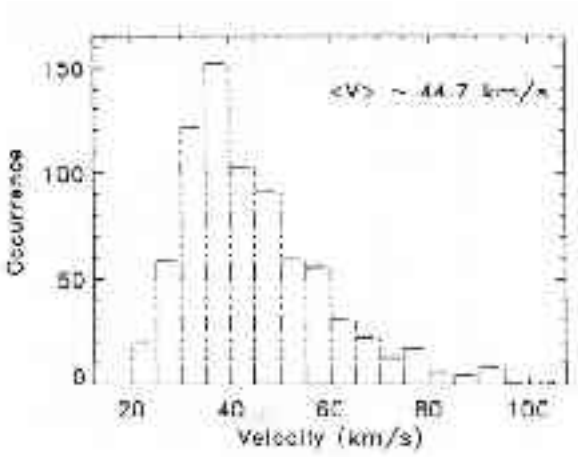


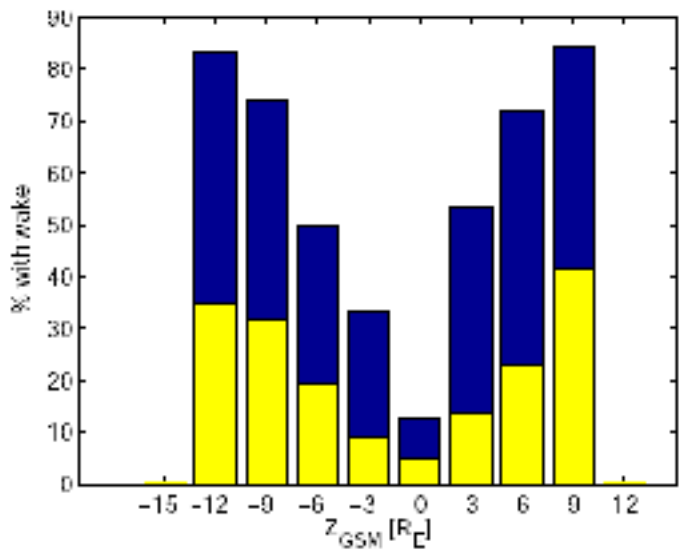


Wake shows polar wind

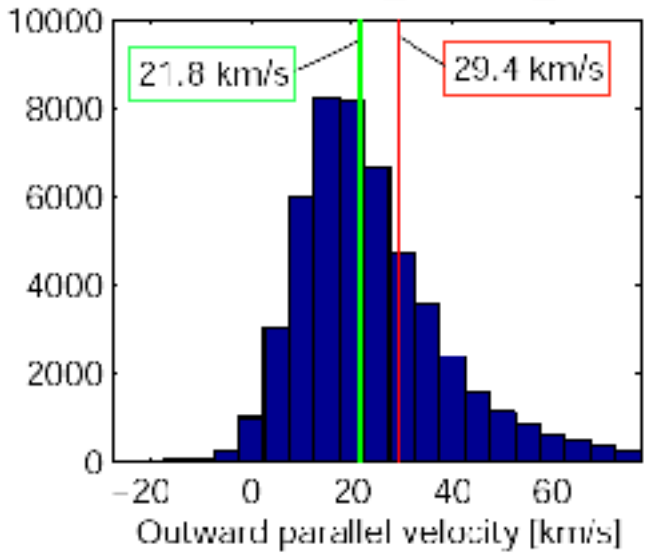
Flow statistics

- Comparison to Su et al., POLAR, 1998 (top right; they miss most of the fun despite PSI and all...)





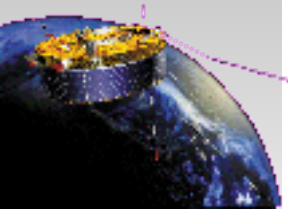
(a)



(b)

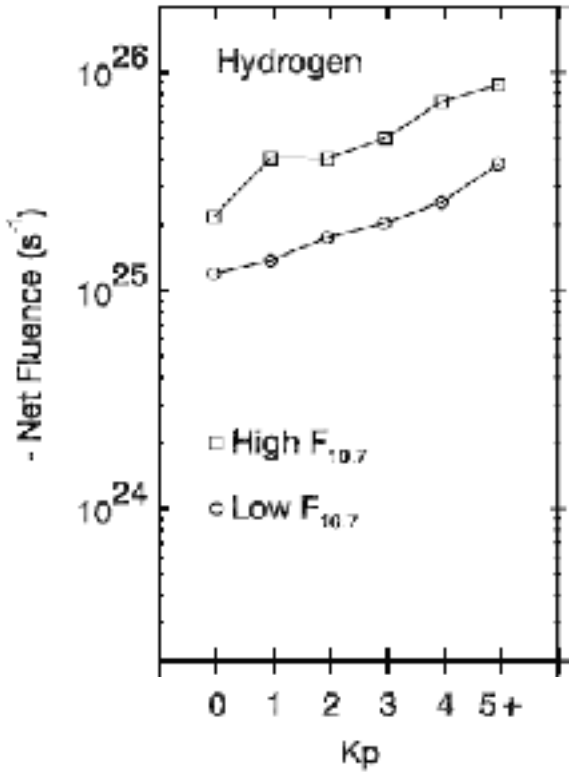
Figure 6.2: (a) Fraction of all events where cold ions have been detected as a function of Z_{GSM} using two different criteria: 1. $\mathbf{E}^{w} > 2$ mV/m (yellow and blue), and 2. $\mathbf{E}^{w} > 2$ mV/m, and $v_{\parallel} > 25$ km/s (yellow). (b) The outward velocity distribution along the magnetic field. The mean (red line) and median (green line) values are displayed.

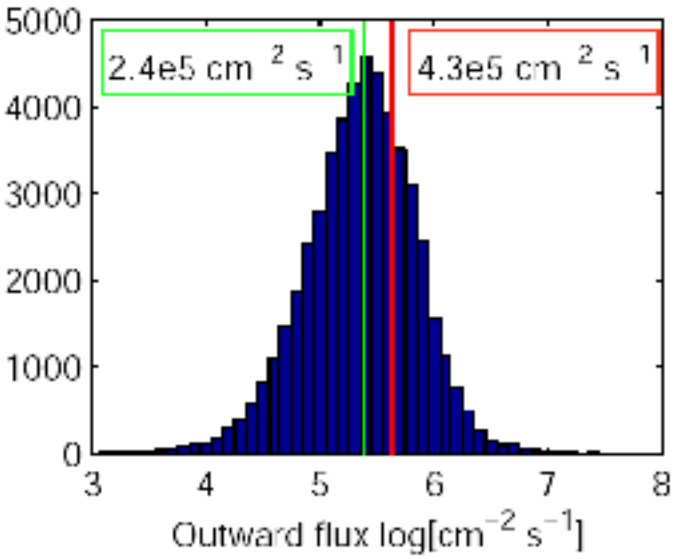
Wake shows polar wind

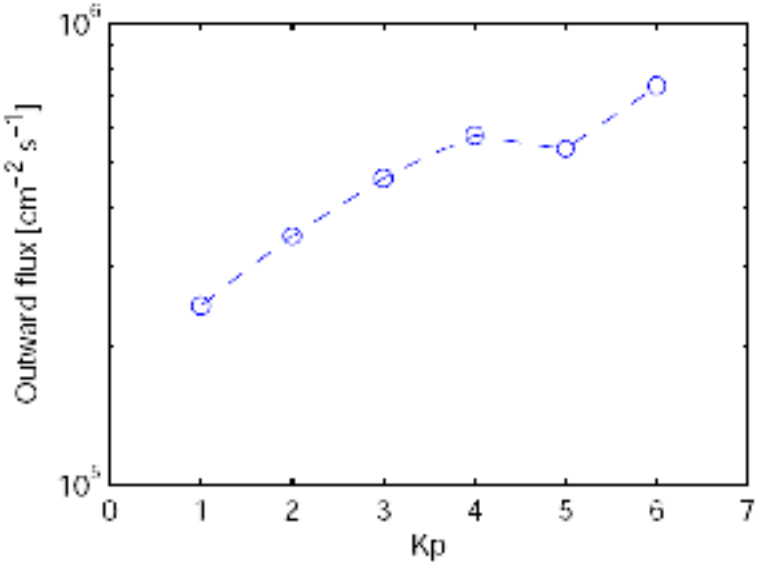


Flux statistics

- Depends on Vsc density calibration
- Comparison to Akebono results (Cully et al., 2003) →
- Great potential for further use!







Wake shows polar wind