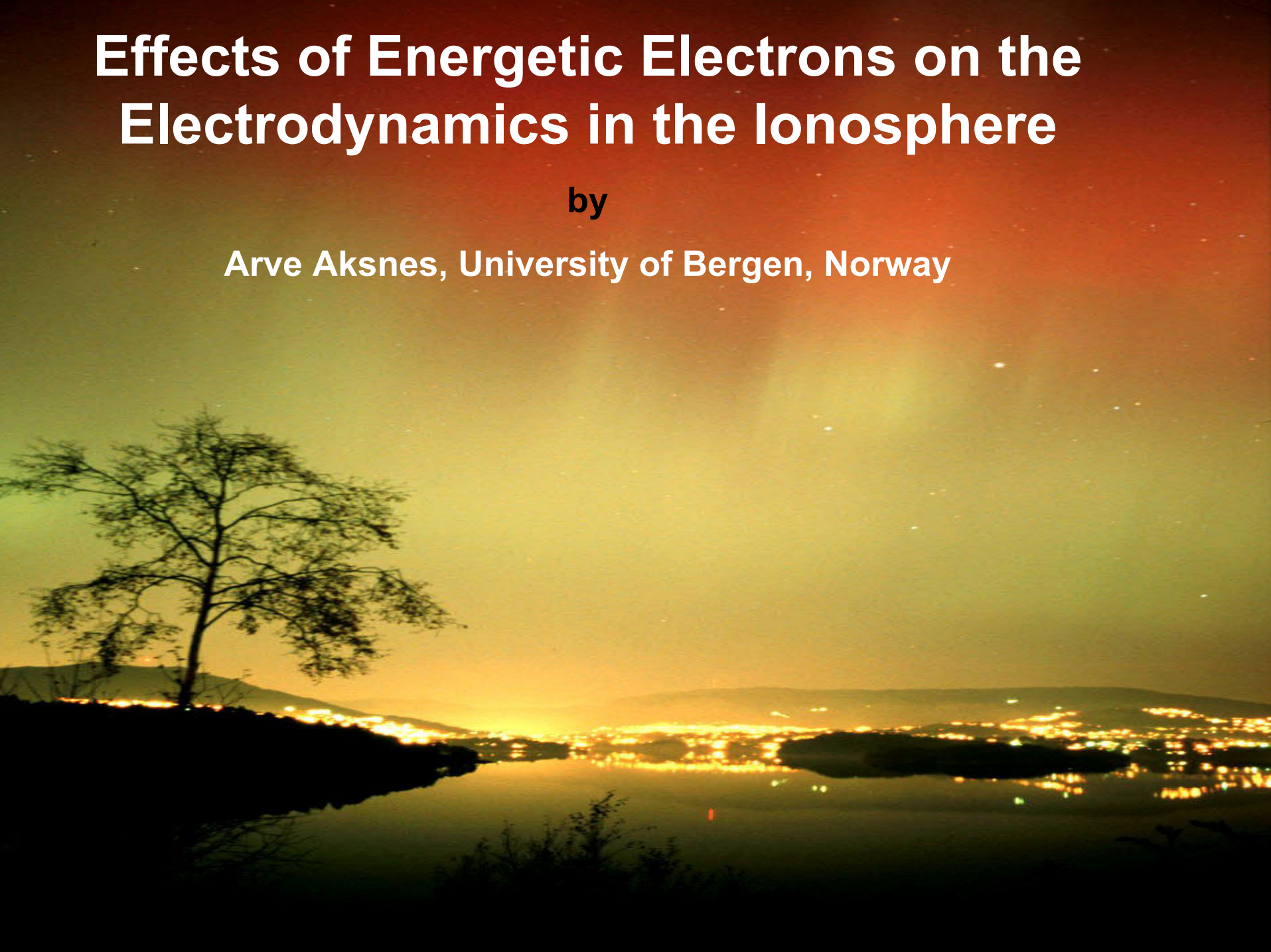
Effects of Energetic Electrons on the Electrodynamics in the Ionosphere

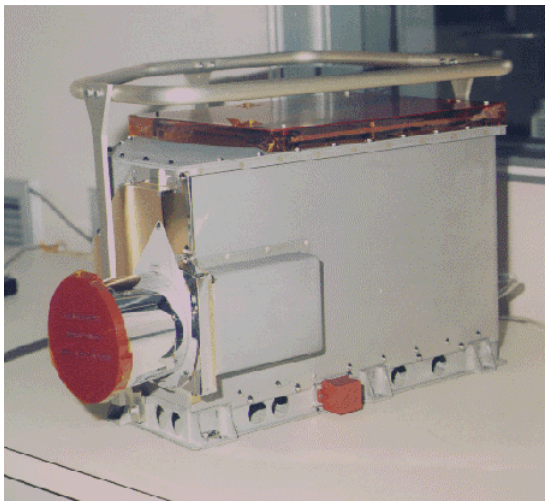
by

Arve Aksnes, University of Bergen, Norway



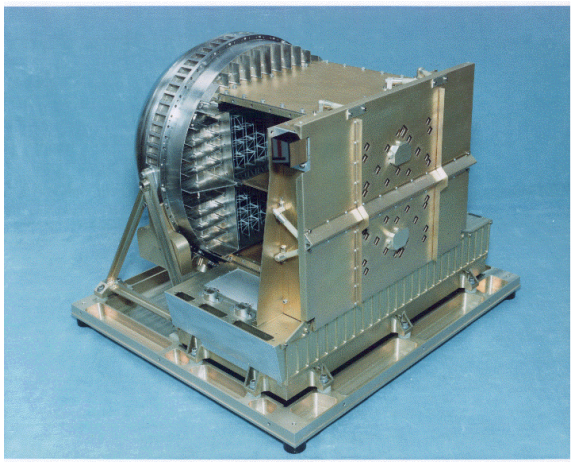
UVI

Measures UV-emissions

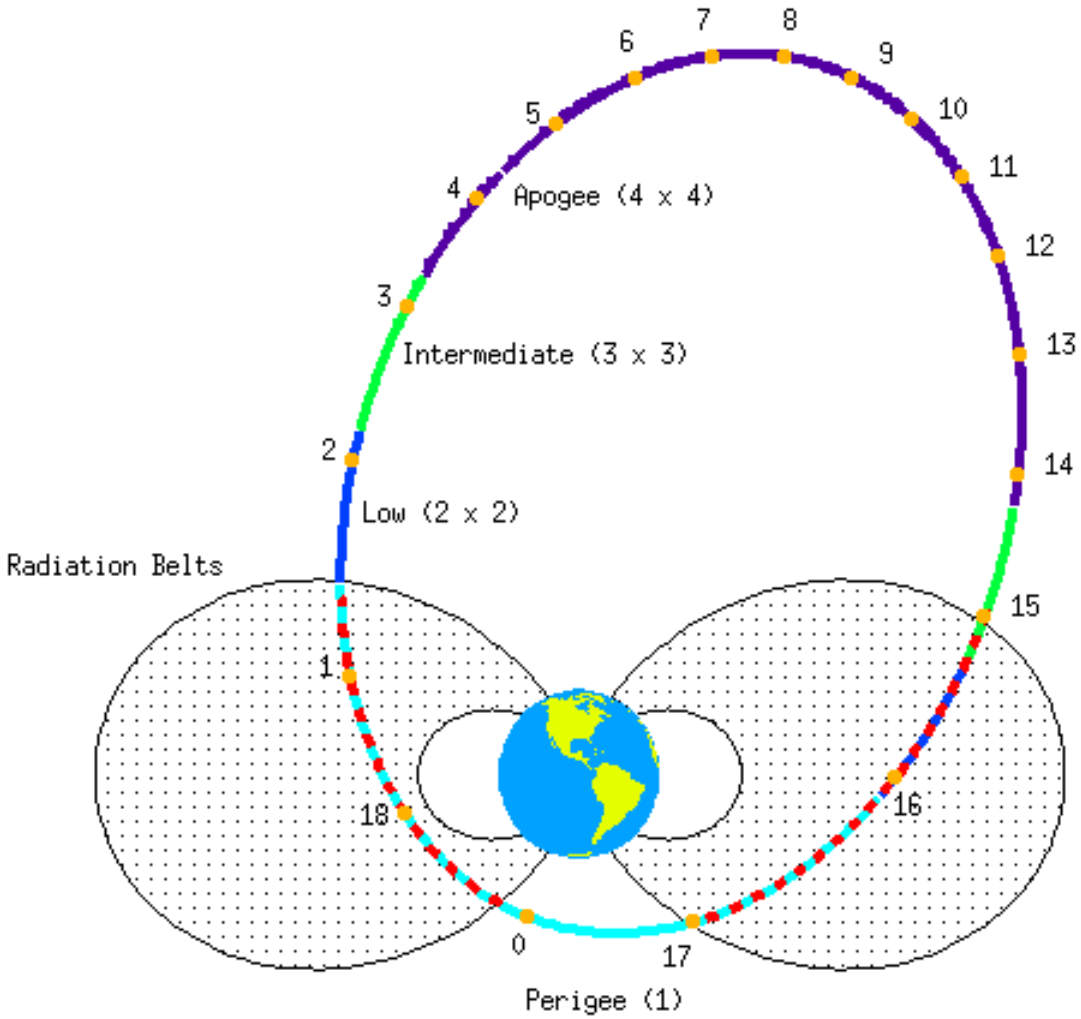


PIXIE

Measures X-rays

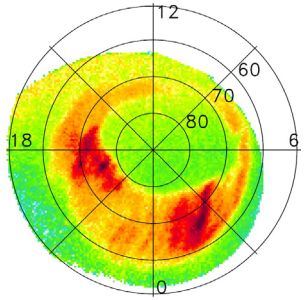


The Polar- satellite



UVI

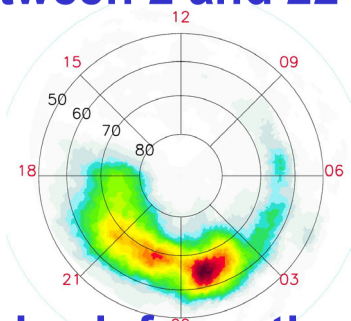
Measures UV-emissions between 140 and 180 nm



Provides information about electrons with energies 0.1-15 keV

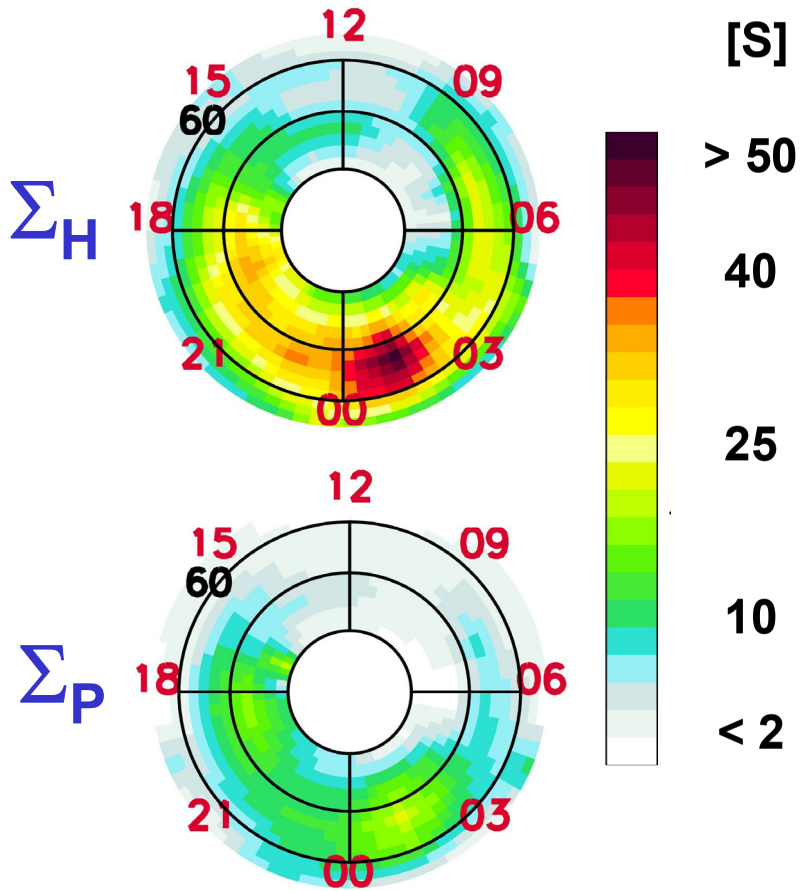
PIXIE

Measures X-ray photons between 2 and 22 keV



Provides information about electrons with energies 5-100 keV

Ionospheric Conductances



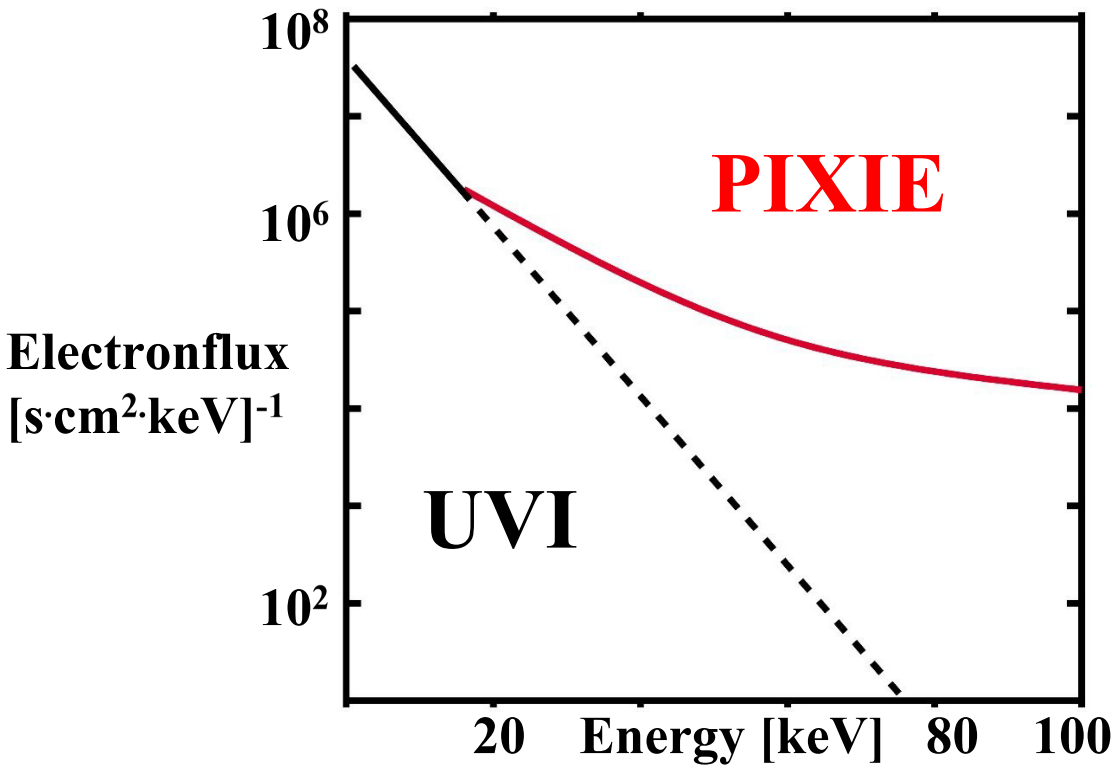
See **Aksnes et al., Annales Geophysicae, 20, 1181, 2002** for a description of the procedure to derive the conductances

Electron spectrum from UVI (0.1-15 keV)

$J_{exp} = 4.0 \cdot 10^{7} \cdot \exp(-E/5)$

Electron spectrum from PIXIE (5-100 keV)

$J_{exp} = 8.5 \cdot 10^{6} \cdot \exp(-E/10) + 8.0 \cdot 10^{4} \cdot \exp(-E/60)$



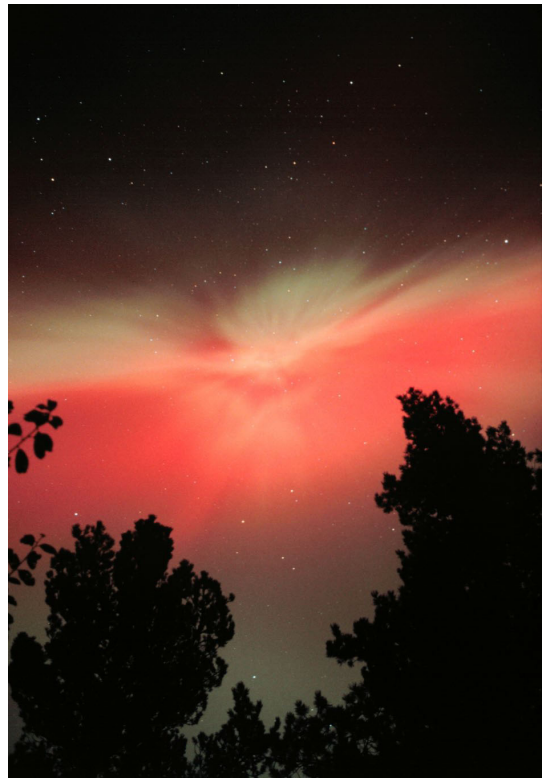
"Energetic electrons"

=

The extra electronflux at higher energies captured by PIXIE

AMIE is a computer code which combines all available data (from magnetometer stations, radars, satellites etc…) to provide instantaneous distributions of electrodynamical parameters.

First AMIE establishes a conductance distribution, which is then used to derive the other parameters like electric field, Joule heating, currents etc…

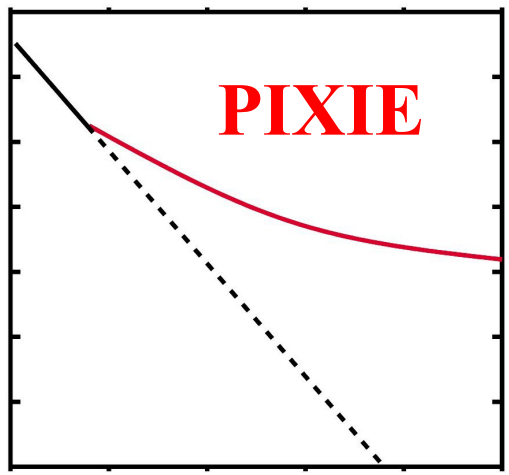


Methods to establish a global conductance map:

(1) Statistical conductance models

(2) Remote sensing of UV-emissions from space e.g. UVI measurements
The standard procedure today

(3) Remote sensing of both UV-emissions and X-rays from space; combined UVI and PIXIE data
New



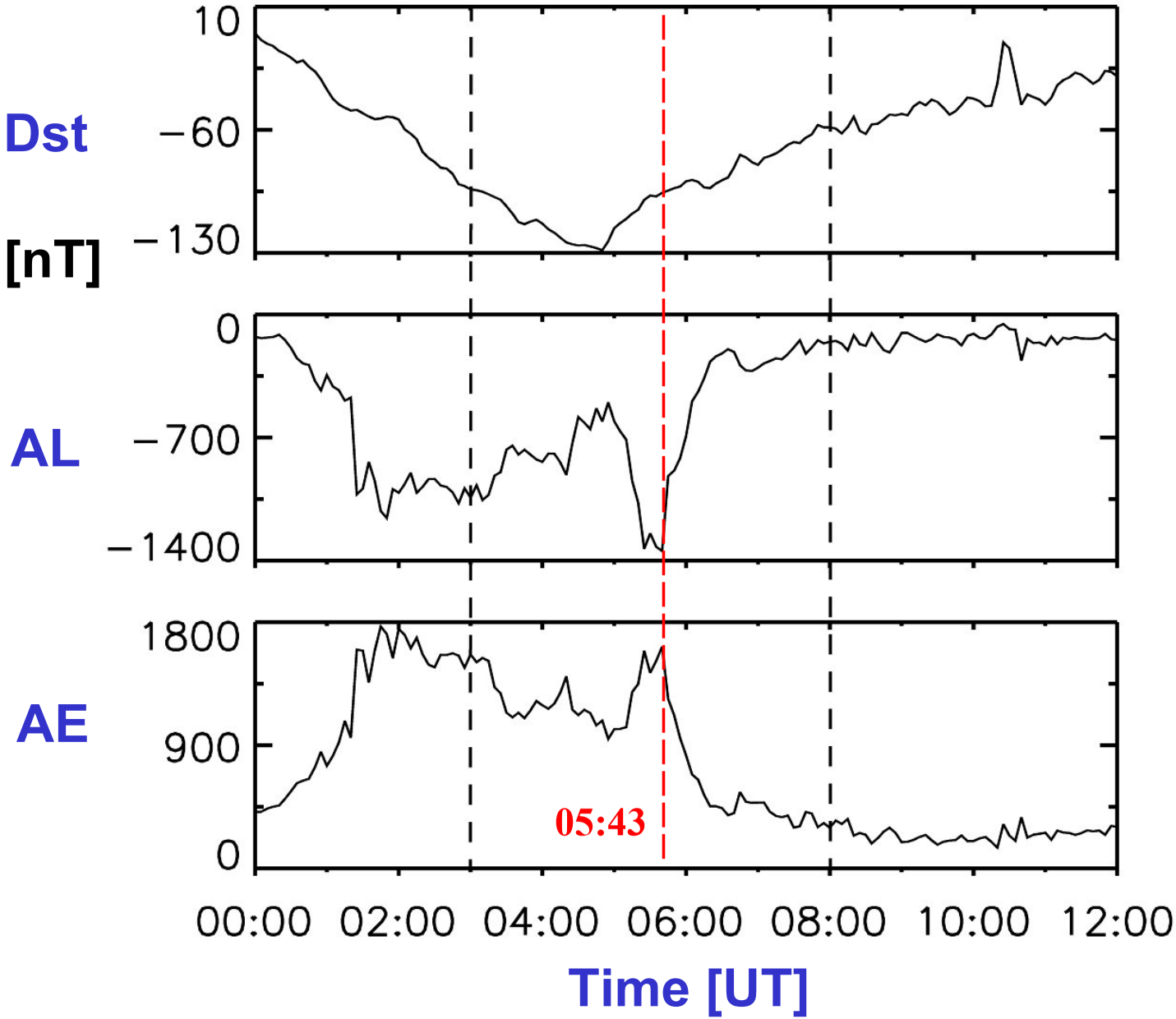
Effects of Energetic Electrons on the Electrodynamics in the Ionosphere

A. Aksnes (1), J. Stadsnes (1), G. Lu (2), N. Østgaard (3), G. A. Germany (4), R. R. Vondrak (5), T. J. Rosenberg (6), D. L. Detrick (6), M. Schulz(7)

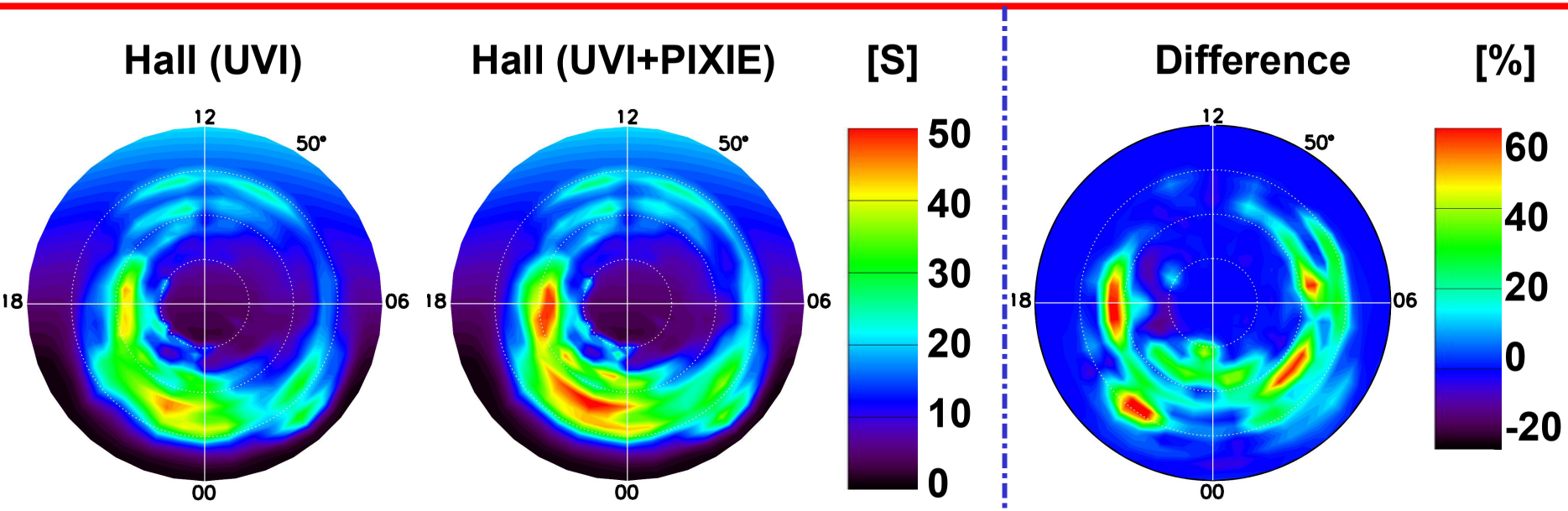
(1) University of Bergen, Norway
(2) HAO/NCAR, USA
(3) University of California, USA
(4) University of Alabama, USA
(5) NASA/Goddard Space Flight Center, USA
(6) University of Maryland, USA
(7) Lockheed Martin Advanced Technology Center, USA

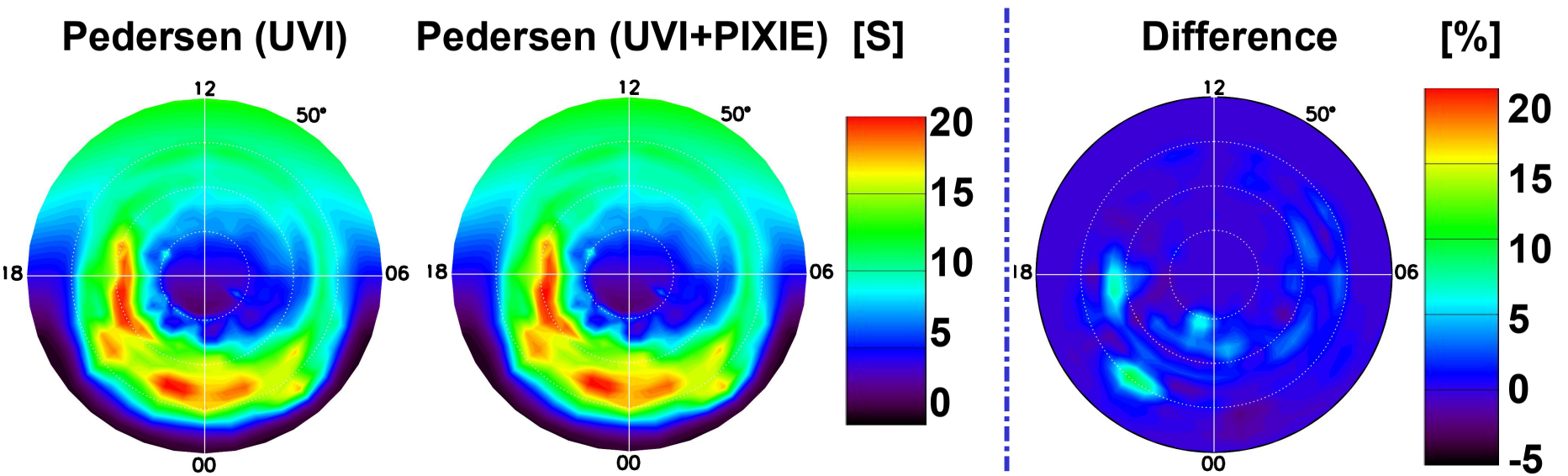
(July, 2003: Accepted for publication in Annales Geophysicae)

26/06/1998


Dst
[nT]
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−130
AL
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−700
−1400
AE
1800
900
0
05:43
00:00
02:00
04:00
06:00
08:00
10:00
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Time [UT]

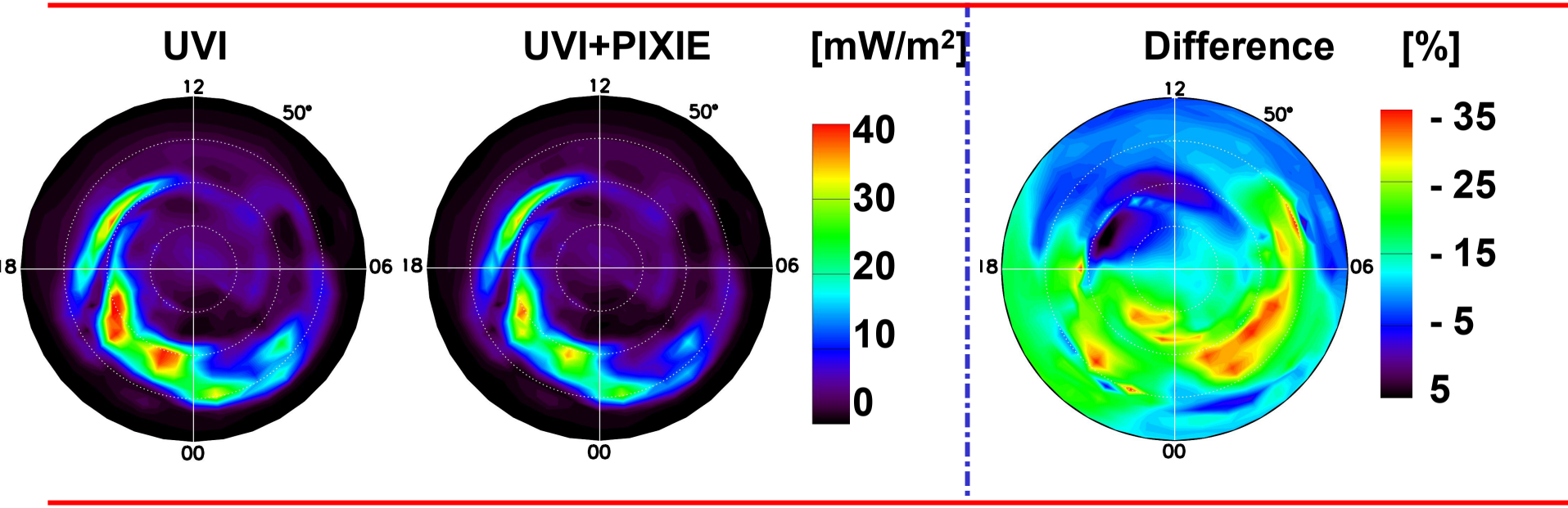
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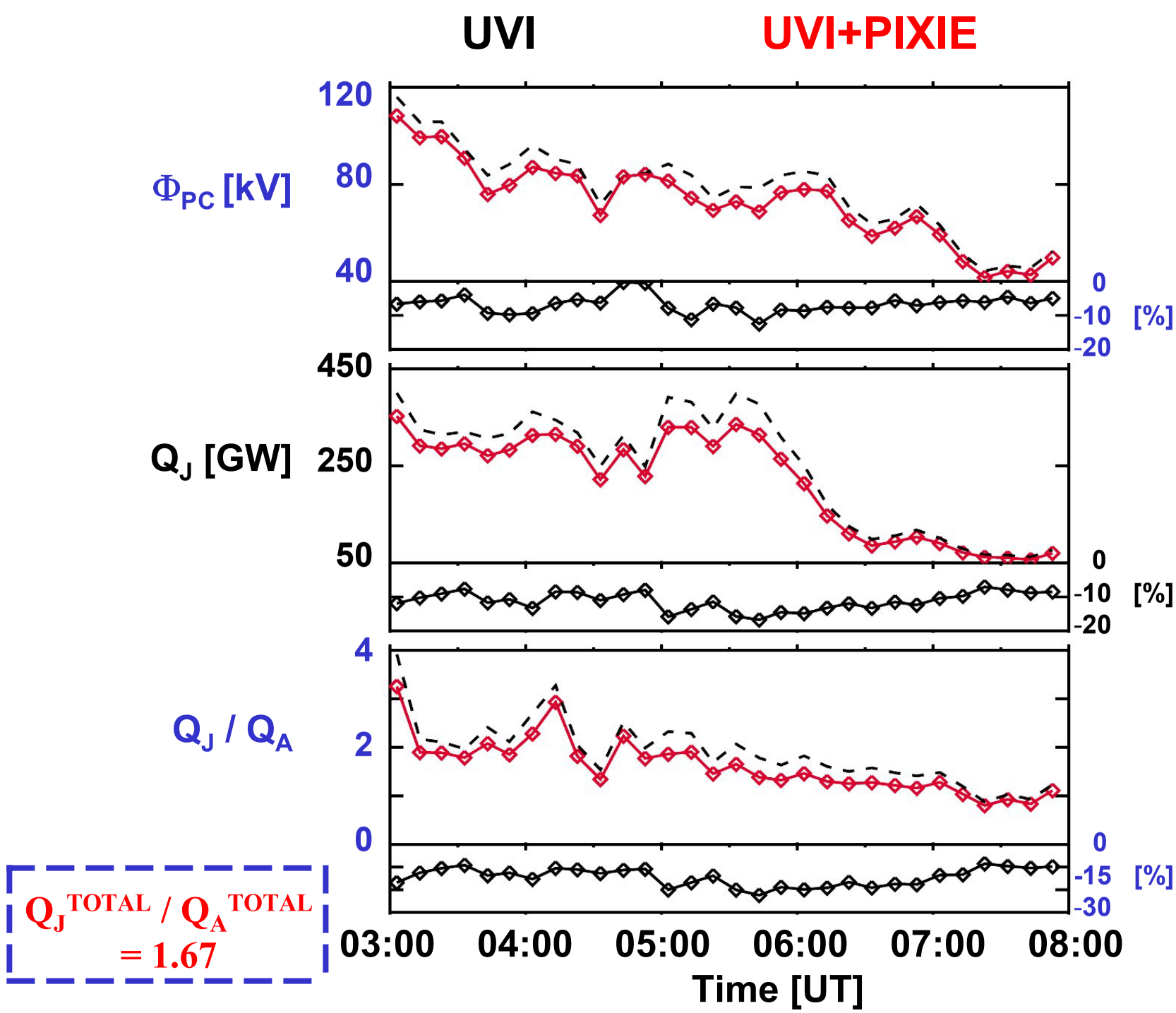




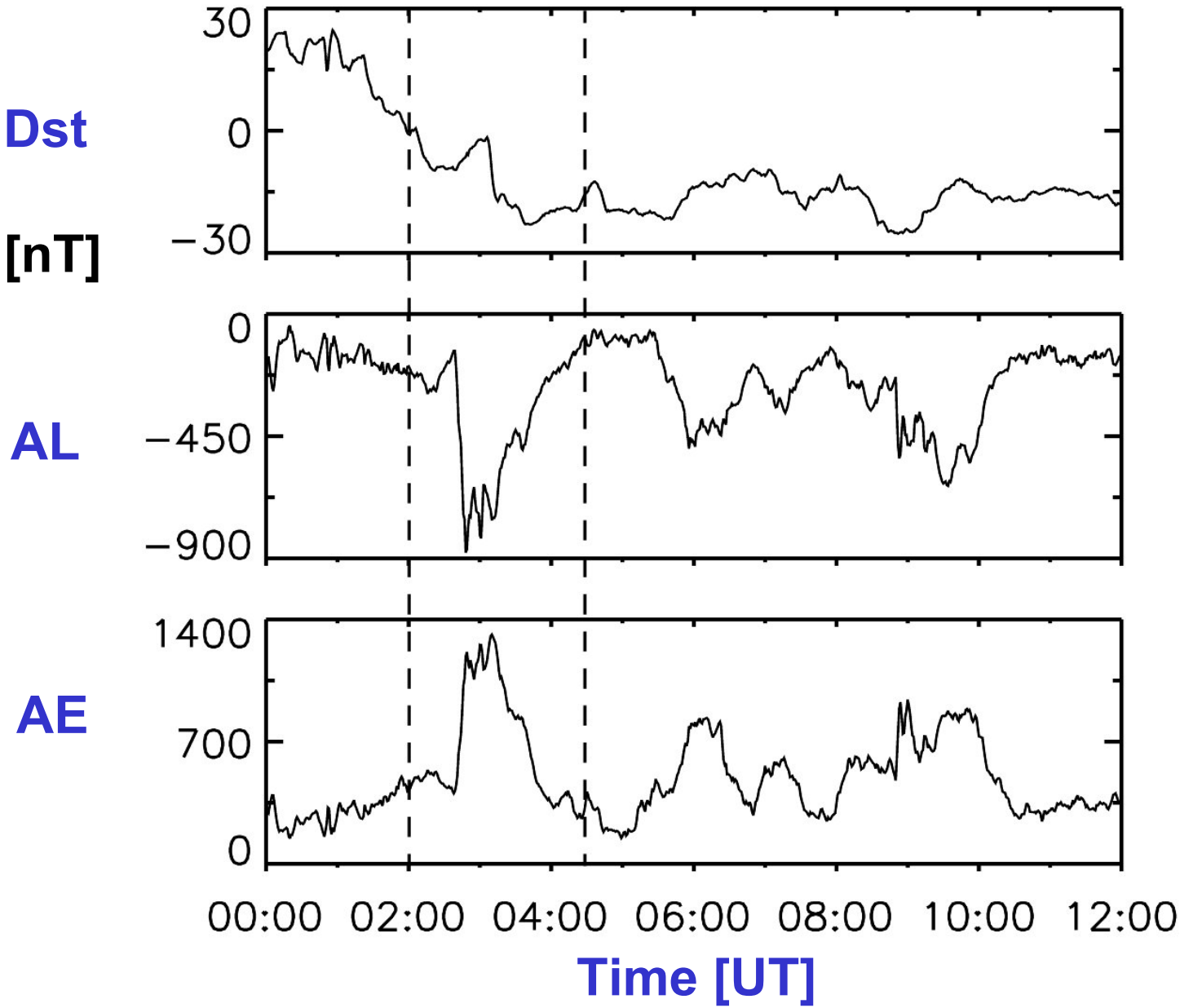
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Joule Heating $Q_J = \Sigma_P E^2$

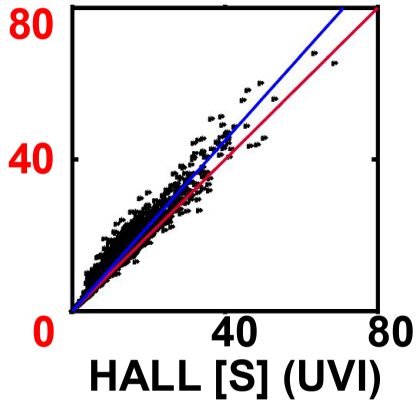



UVI
UVI+PIXIE
Φ_{PC} [kV]
120
80
40
0
-10
-20
[%]
Q_J [GW]
450
250
50
0
-10
-20
[%]
Q_J / Q_A
4
2
0
0
-15
-30
[%]
03:00
04:00
05:00
06:00
07:00
08:00
Time [UT]
Q_J^{TOTAL} / Q_A^{TOTAL} = 1.67

31/07/1997

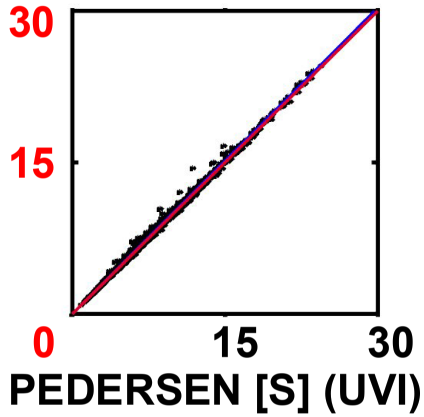

Dst
[nT]
30
0
−30
AL
0
−450
−900
AE
1400
700
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
Time [UT]

HALL [S]
(UVI+PIXIE)



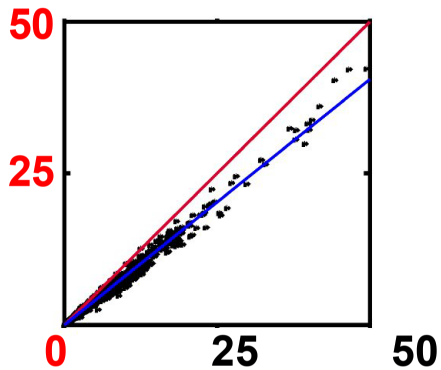
Σ_H (UVI+PIXIE)
=
$1.13 \cdot \Sigma_H$ (UVI)

PEDERSEN [S]
(UVI+PIXIE)

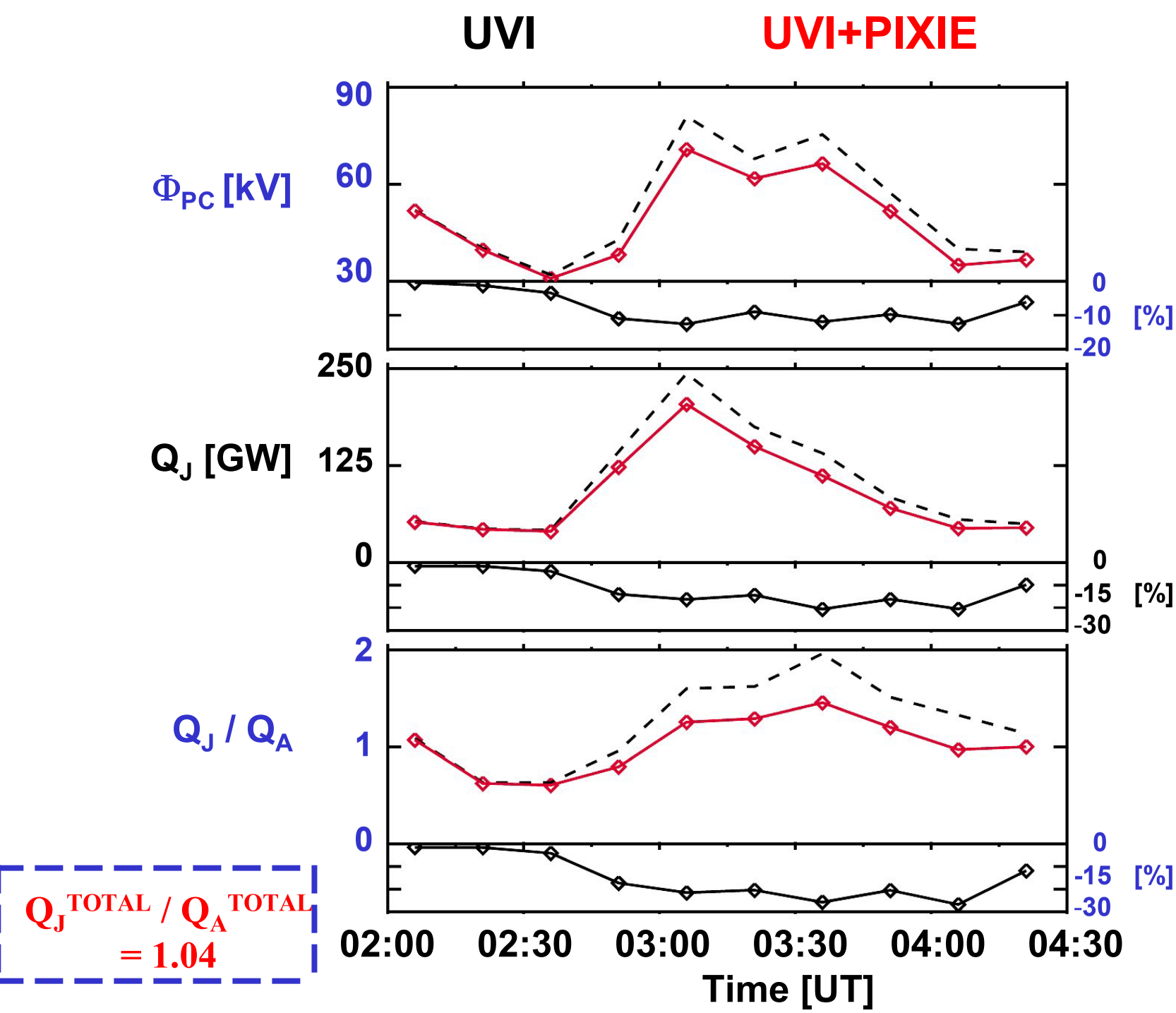


Σ_P (UVI+PIXIE)
~
Σ_P (UVI)

JOULE HEATING [mW/m^2]
(UVI+PIXIE)



Q_J (UVI+PIXIE)
=
$0.81 \cdot Q_J$ (UVI)

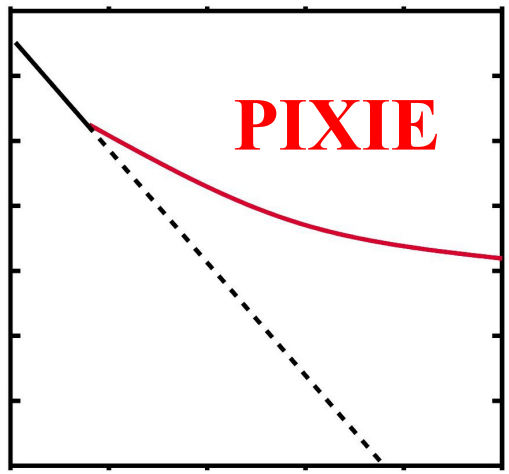

UVI
UVI+PIXIE
Φ_{PC} [kV]
90
60
30
0
-10
-20
[%]
Q_J [GW]
250
125
0
0
-15
-30
[%]
Q_J / Q_A
2
1
0
0
-15
-30
[%]
02:00
02:30
03:00
03:30
04:00
04:30
Time [UT]
Q_J^{TOTAL} / Q_A^{TOTAL} = 1.04

Summarize

- **The computer code AMIE**
  → Information about the electrodynamics in the ionosphere

- **Data from the UVI and PIXIE cameras onboard the Polar satellite**
  → Instantaneous global conductance maps during substorms

The X-ray camera PIXIE is the only instrument to provide global maps of the energetic electron precipitation up to 100 keV.



<u>Two AMIE-runs:</u>

- **(1) Only UVI data 0.1-15 keV + extrapolation to 100 keV**
- **(2) UVI+PIXIE data 0.1-100 keV**
  → Much better spectral characterization at higher energies

Results

- By including the PIXIE data in the AMIE procedure we estimate a larger Hall conductance, resulting in a smaller inferred electric field and therefore a lower value of the calculated Joule heating.

- The calculated ratio between Joule heating and energy flux by precipitating particles is sometimes almost 30 % smaller when including the PIXIE data.

- The results found in this study may indicate that the contribution from the auroral particle precipitation to the energy budget is especially important for substorm events occurring during non-storm periods.

Conclusion

- Energetic electrons (captured by PIXIE) can have a significant effect on electrodynamical parameters and must be accounted for when studying ionospheric electrodynamics