INVESTIGATION OF SOLAR ECLIPSE EFFECTS

IN THE UPPER IONOSPHERE

USING DEMETER DATA

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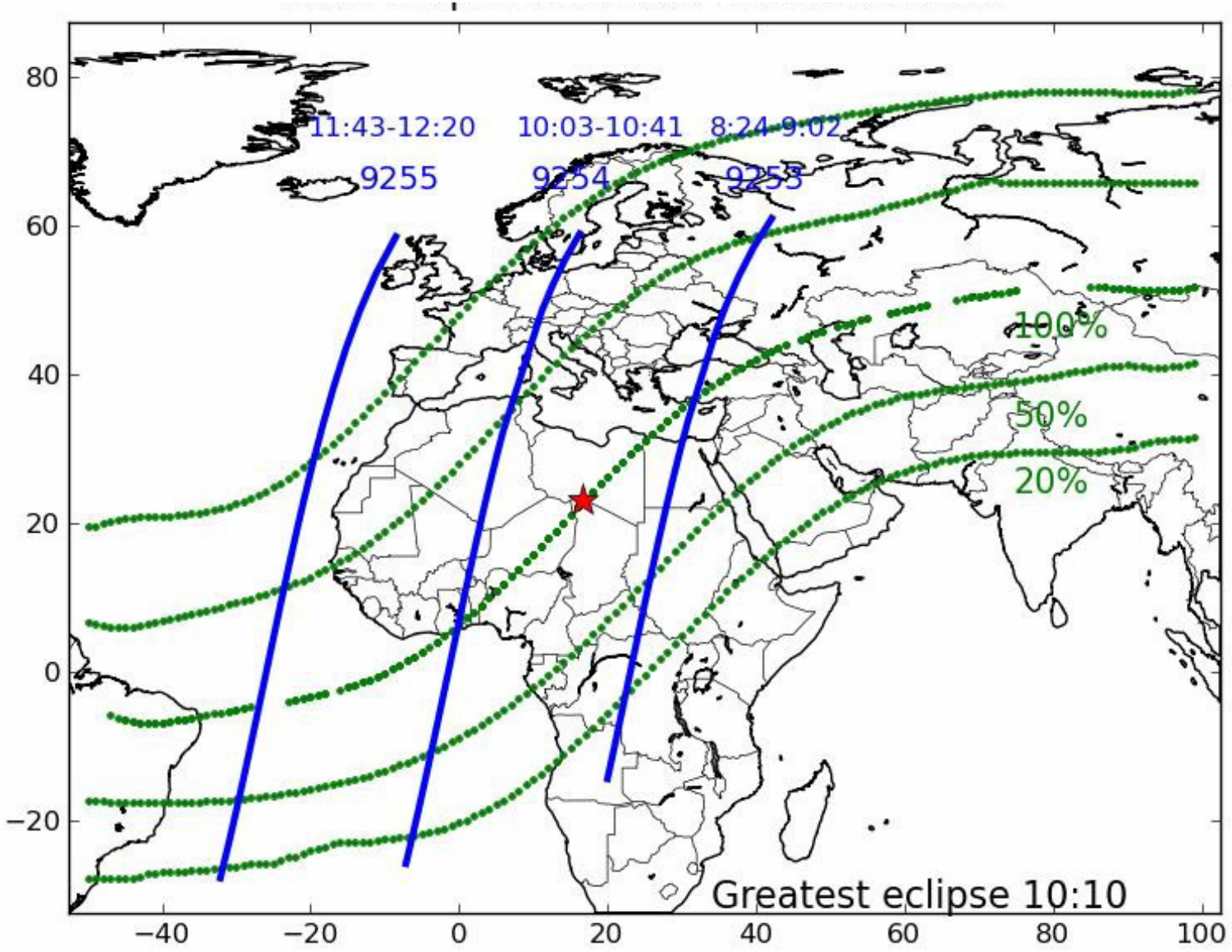
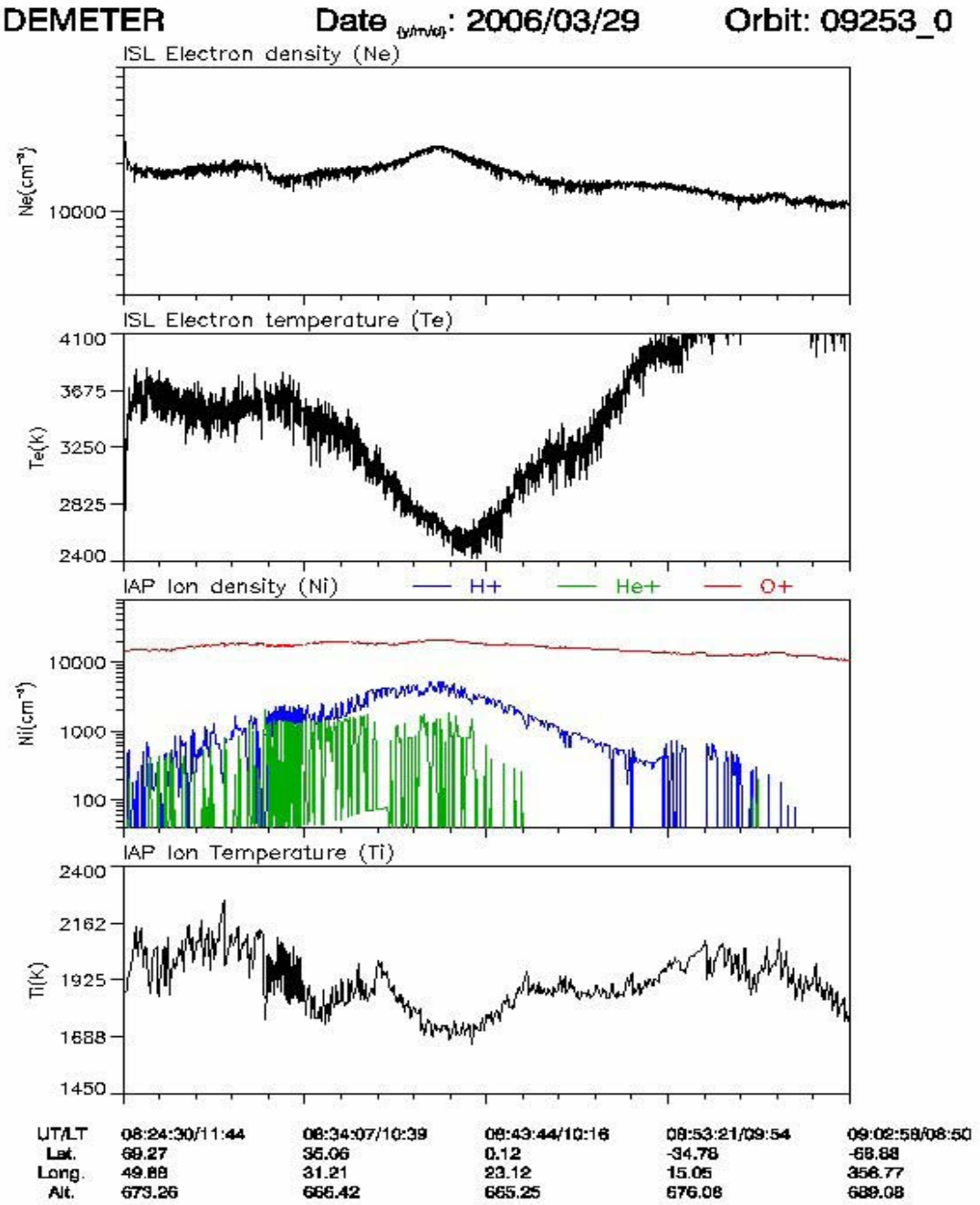
OVERVIEW

1- Motivation
   - new observations of solar eclipse effects in the top-side ionosphere by DEMETER
   - quantitative analysis of ionosphere processes
   - validation of ionospheric models and interest for other studies
2- The 2006 Eclipse over Africa
3- The « Reference Ionosphere »
4- Analysis of DEMETER observations
5- Numerical simulation with SAMI2 and results
6- Comparison between observations and model results and interpretation
7- Other eclipses during the DEMETER life time
8- Conclusion

THE MARCH 29, 2006 SOLAR ECLIPSE OVER AFRICA




DEMETER
Date (y/m/d): 2006/03/29
Orbit: 09253_0
ISL Electron density (Ne)
Ne(cm⁻³)
10000
ISL Electron temperature (Te)
Te(K)
4100
3675
3250
2825
2400
IAP Ion density (Ni)
H+
He+
O+
Ni(cm⁻³)
10000
1000
100
IAP Ion Temperature (Ti)
Ti(K)
2400
2162
1925
1688
1450
UT/LT 08:24:30/11:44 08:34:07/10:39 08:43:44/10:16 08:53:21/09:54 09:02:58/08:50
Lat. 69.27 35.06 0.12 -34.78 -68.88
Long. 49.88 31.21 23.12 15.05 356.77
Alt. 673.26 666.42 665.25 676.08 689.08

THE « REFERENCE IONOSPHERE »

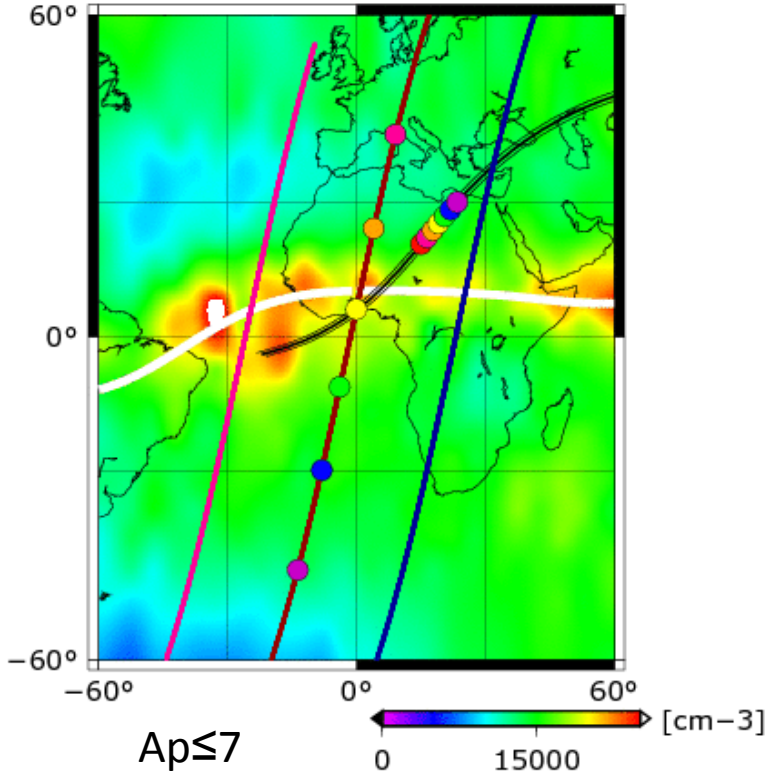
1- The need for a « Reference Ionosphere »

2- Ionospheric variability
- solar flux, long term variation
- seasonal variations
- magnetic activity
- geographical effects (SAA, wave 4 modulation…)

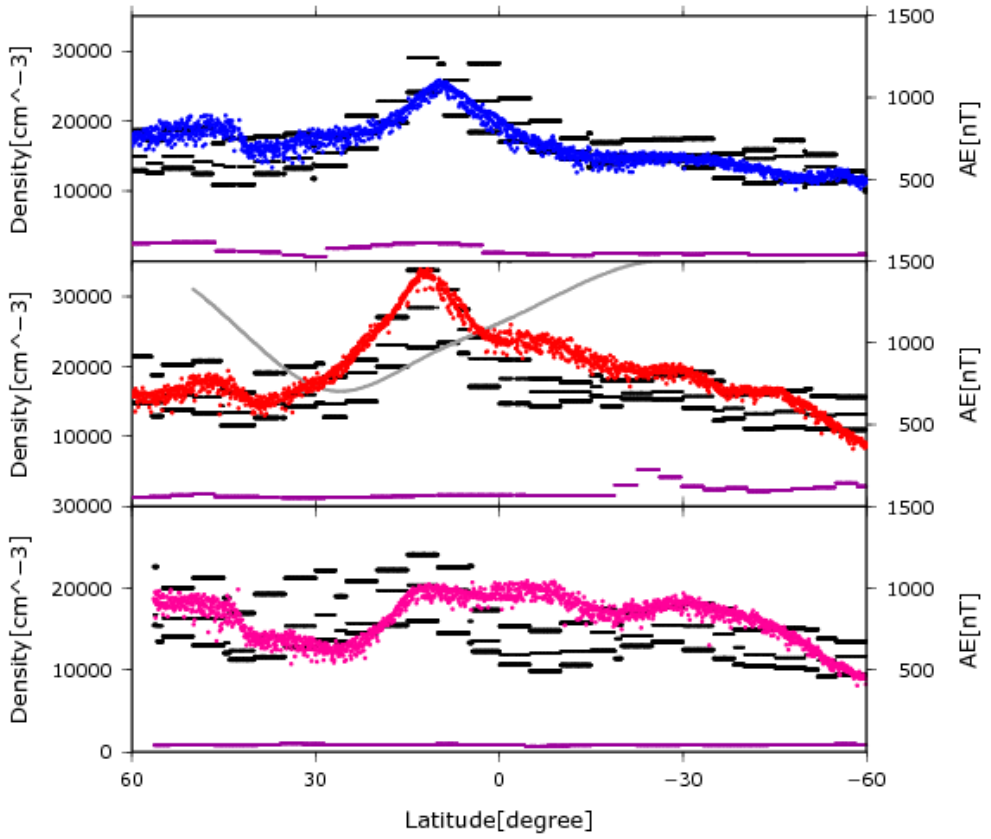
3- Methods to determine the Reference Ionosphere and selection for the 2006 eclipse case.
- « same orbits » with descending nodes within ~ 5° from the eclipse orbit on March 28 and 30, 2006
- « neighbour orbits » with a ~ 15° shift in longitude
- « similar orbits » statistical method over a long period

ELECTRON DENSITY VARIABILITY

Ne(3year median 2006 to 2008)



Ne(3year median(2006to2008) and rawdata)

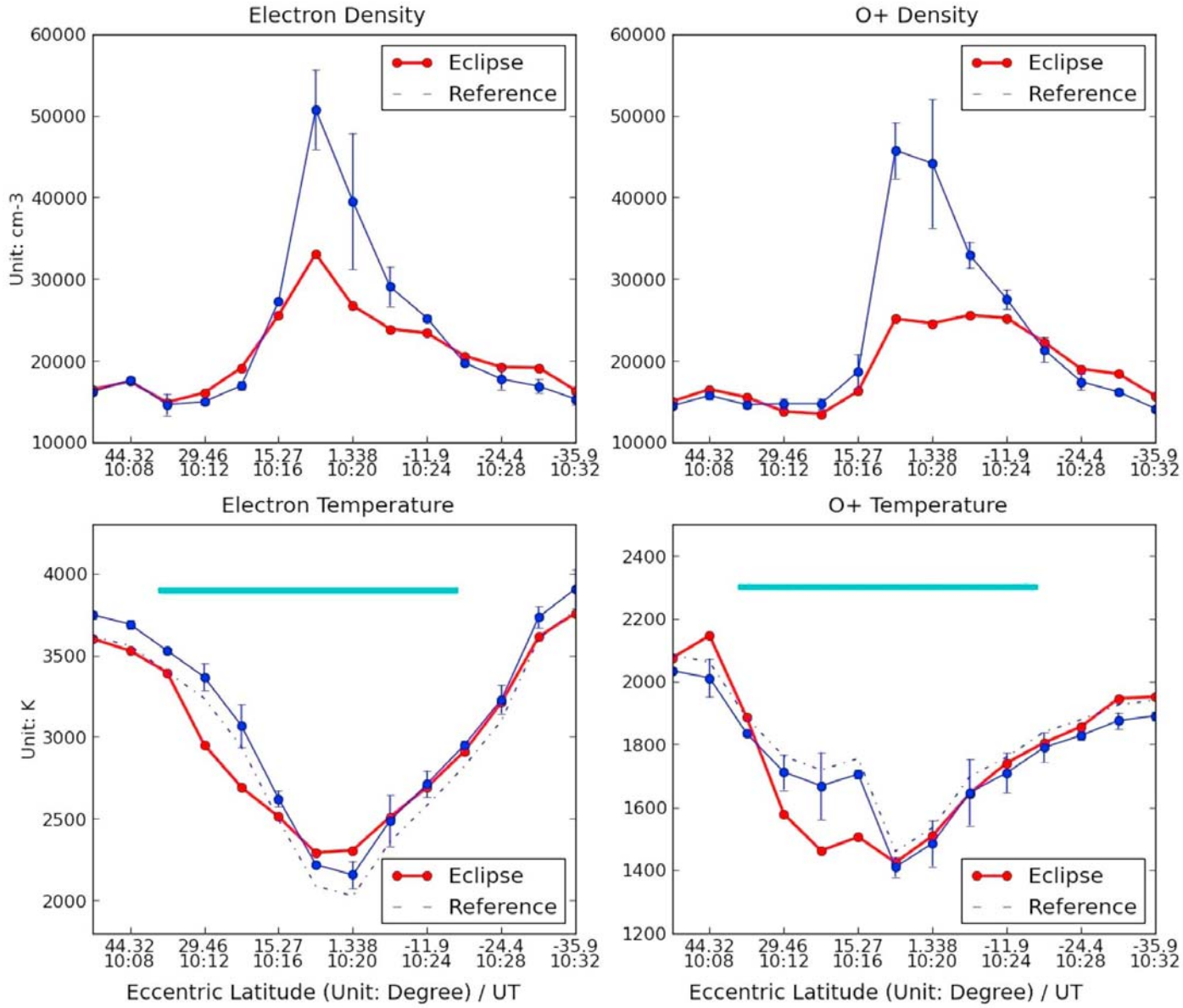


March 29,2006 08:24□09:02

March 29,2006 10:03□10:41

March 29,2006 11:43□12:20

DEMETER RESULTS



NUMERICAL MODELING

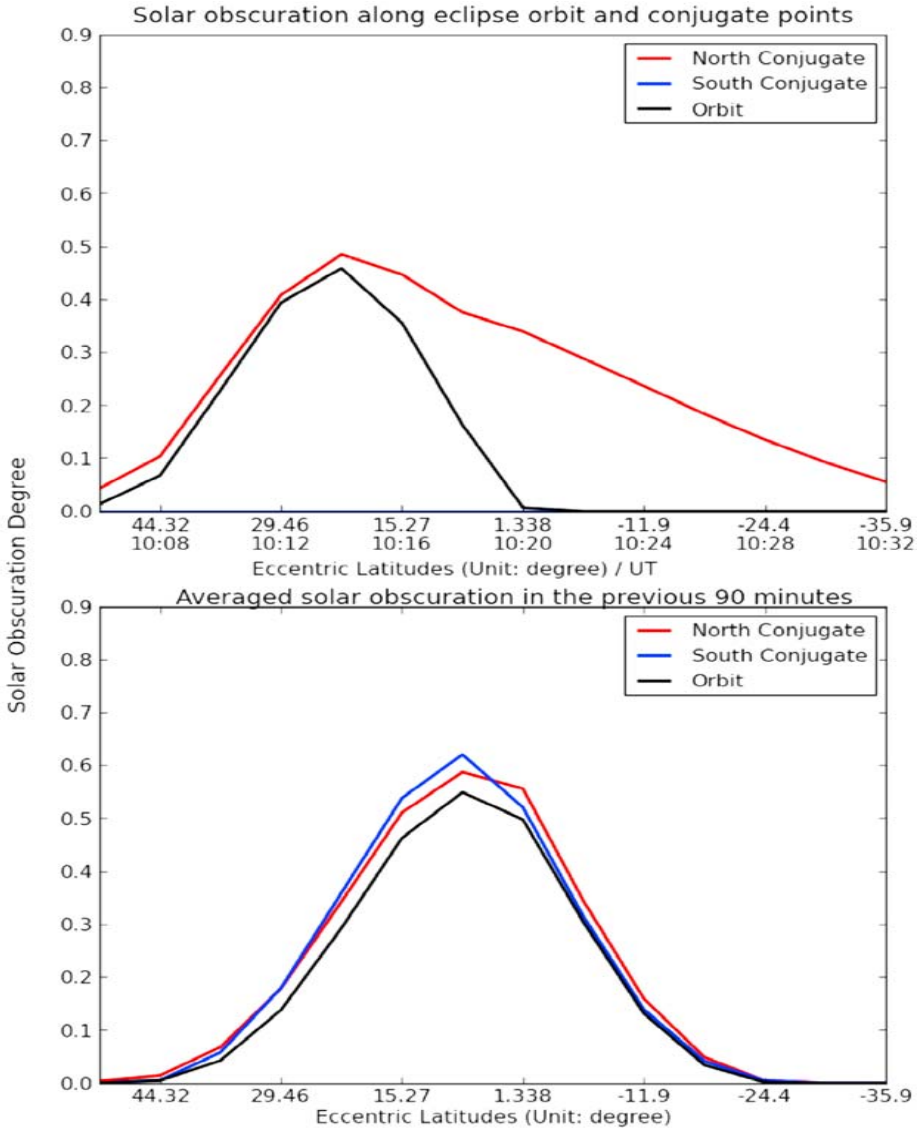
1- The SAMI2 model, advantages and limitations

- 2D inter-hemispheric model in a geomagnetic plane
- boundary conditions at ~ 85 km
  local photochemical equilibrium
- takes into account the effects of
  - electric field E
  - thermospheric winds W
- difficulty in defining the correct E and W for the eclipse day
- lack of transport perpendicular to the geomagnetic plane

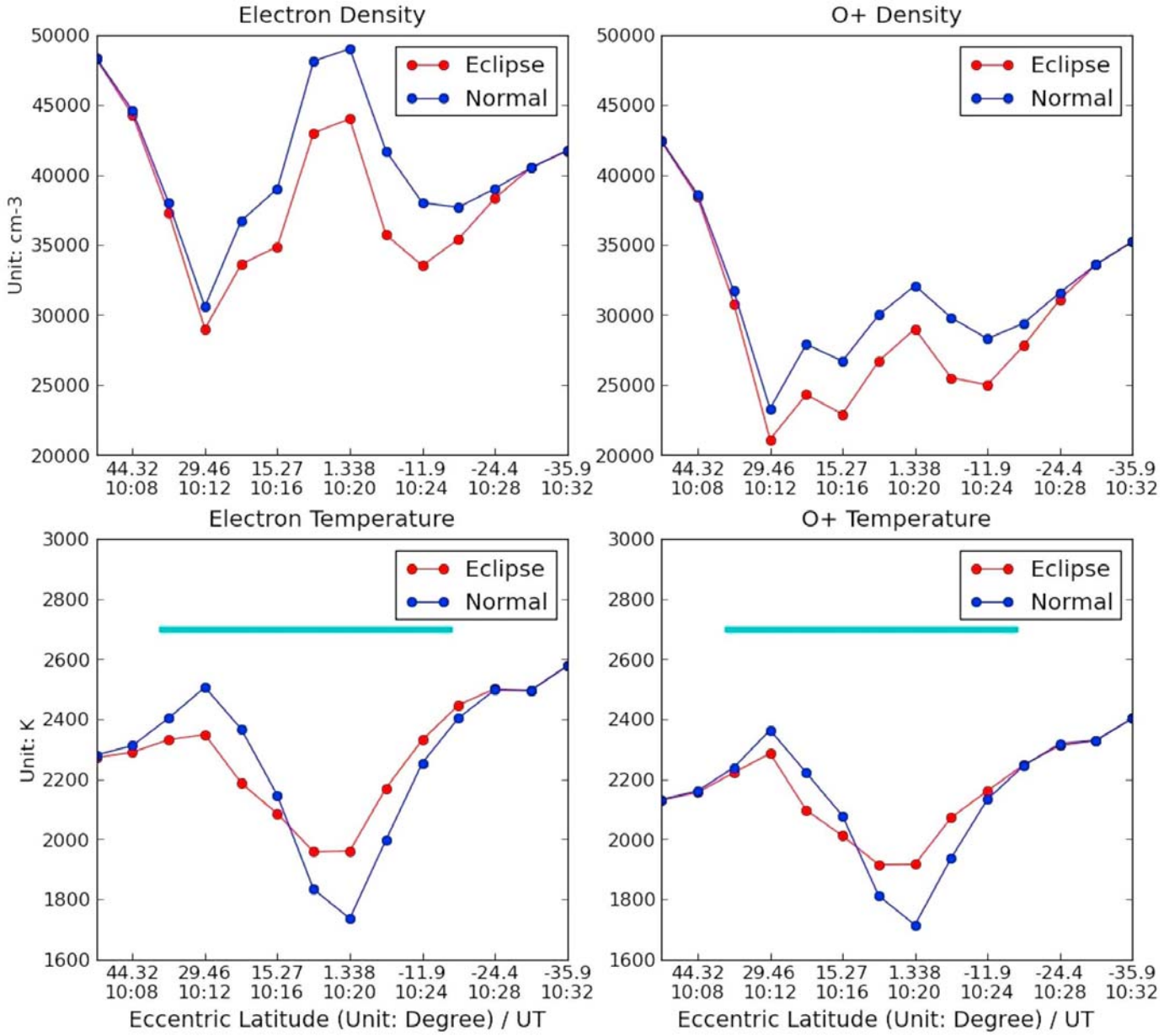
2- Representation of eclipse effects

- obscuration
- time/space variations of the photo-ionization

VARIATION OF THE SOLAR UV FLUX
THE OBSCURATION PARAMETER



MODEL RESULTS



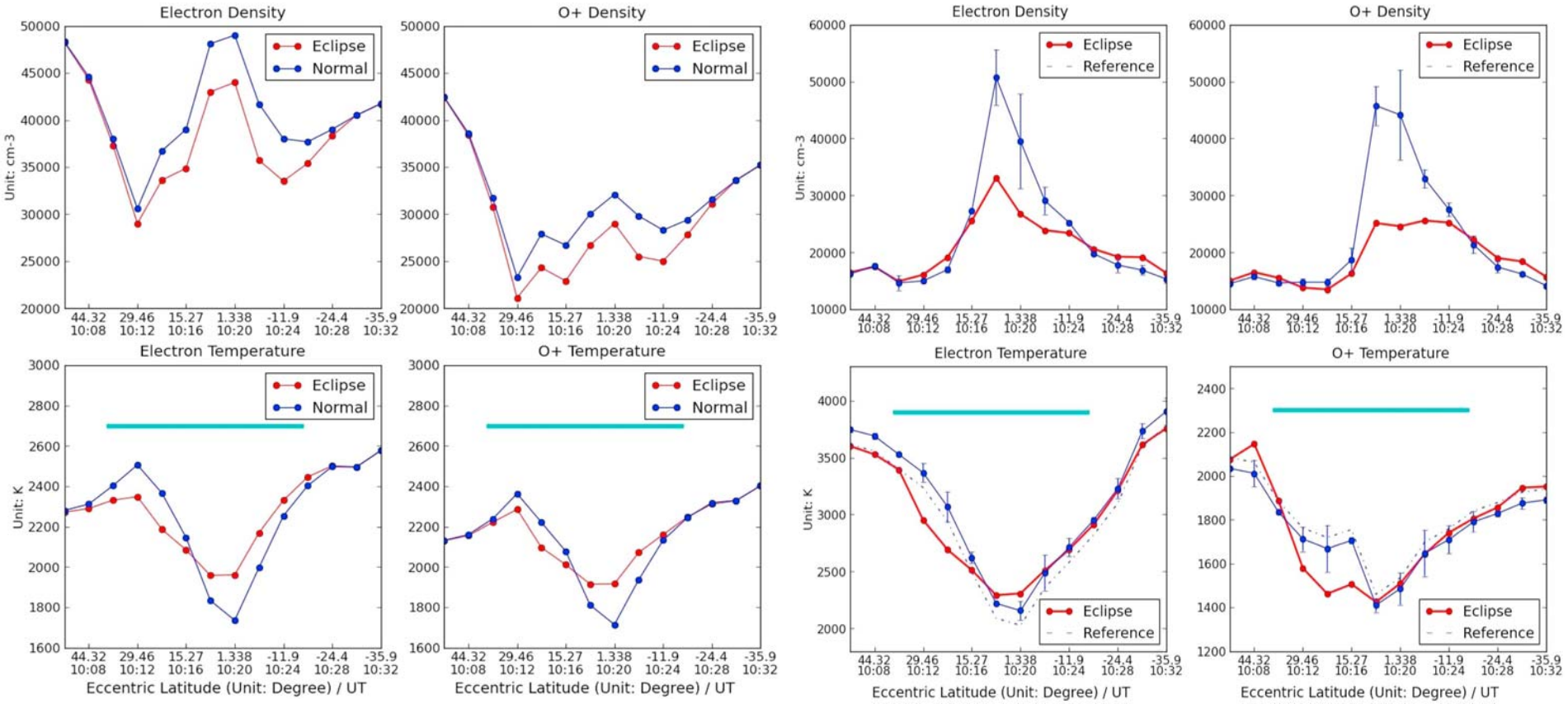
INTERPRETATION

1- Comparison between observations and model results

2- Fast effects: thermal equilibrium

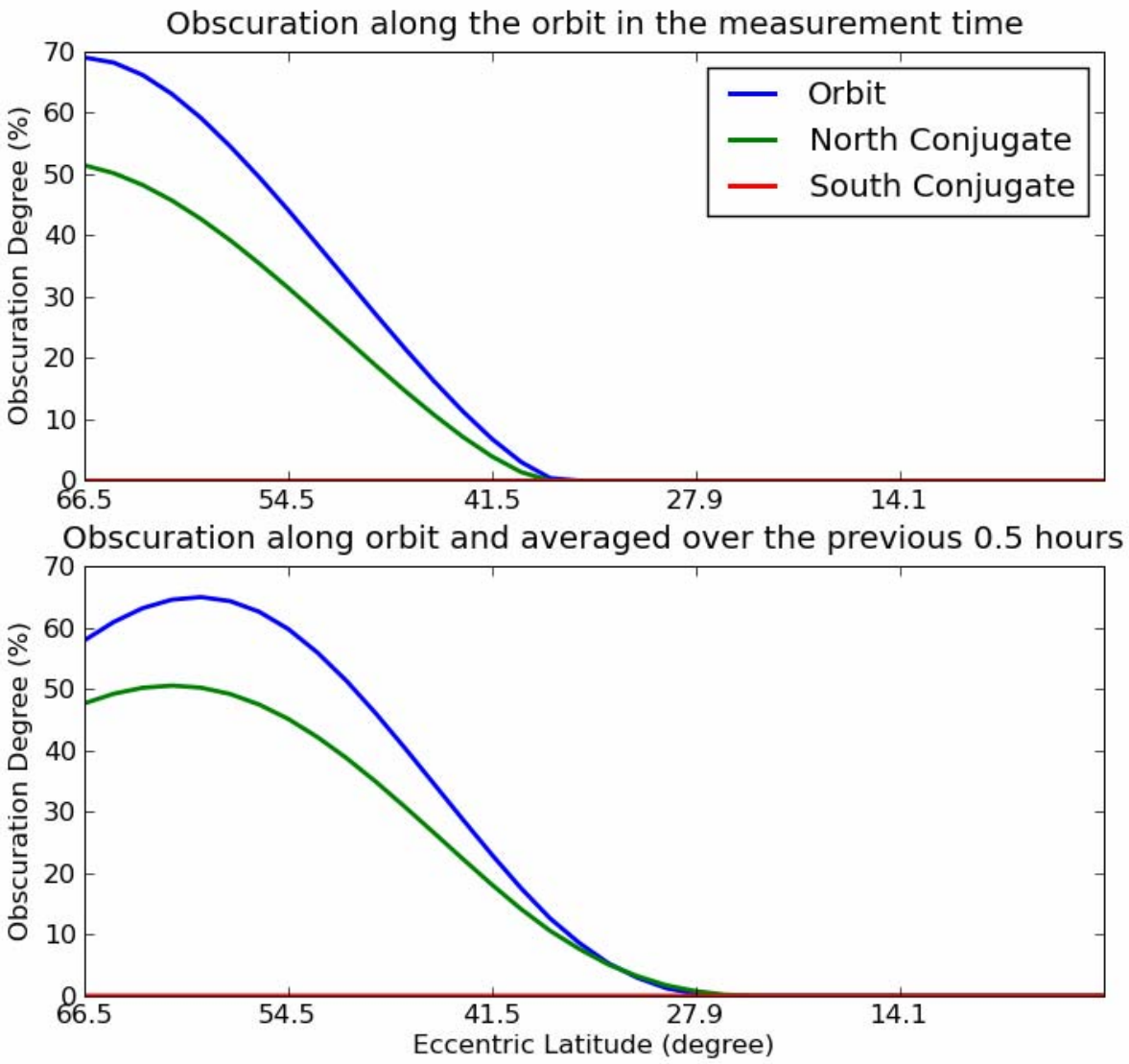
3- Slow effects: plasma transport along field lines

4- Unexpected effects: coupling between fast and slow effects



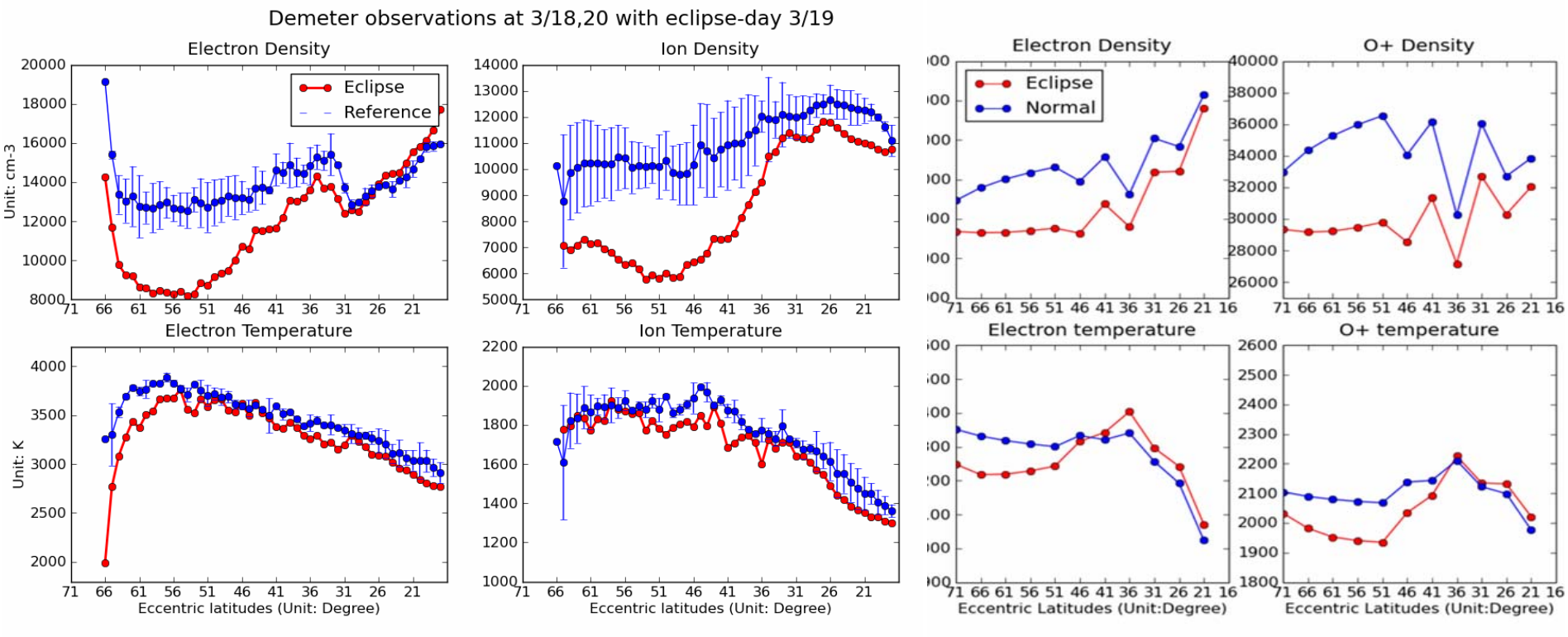
OTHER ECLIPSES AND ON-GOING STUDIES

- The Mongolia/China 2007 eclipse
    - high latitude eclipse
-The Japan 2009 Eclipse
    - see next talk by M. Kamogawa


Obscuration along the orbit in the measurement time
Obscuration Degree (%)
70
60
50
40
30
20
10
0
66.5
54.5
41.5
27.9
14.1
Orbit
North Conjugate
South Conjugate
Obscuration along orbit and averaged over the previous 0.5 hours
Obscuration Degree (%)
70
60
50
40
30
20
10
0
66.5
54.5
41.5
27.9
14.1
Eccentric Latitude (degree)

The 2007 MONGOLIA/CHINA ECLIPSE

Preliminary results



CONCLUSIONS

- Very good agreement between DEMETER data and model
- Identification and understanding of the driving processes
- Possible improvements and future works
    - the « Reference Ionosphere »
    - taking into account the real ionospheric conditions (E, W)
- Interest for other studies
    - improved understanding of ionospheric processes
    - help to quantitatively interpret ionospheric disturbances (gravity waves, effects of seismic activity, …)