

熱圏・電離圏変動のシミュレーションと 各種観測 との連携について

Collaboration between MTI simulations and observations

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日本における Mesosphere, Thermosphere, and Ionosphere (MTI) 分野での全球モデリングの進展

中層大気大循環モデル・九州大学

気象庁対流圏モデルの拡張

e.g., Miyahara et al. (1991), Miyoshi (1999)

大気全領域モデル・九州大学・東北大学

熱圏全域への拡張

e.g., Miyoshi and Fujiwara (2003)

大気圏・電離圏結合モデル・九州大学・東北大学・NICT

e.g., Jin et al. (2011)

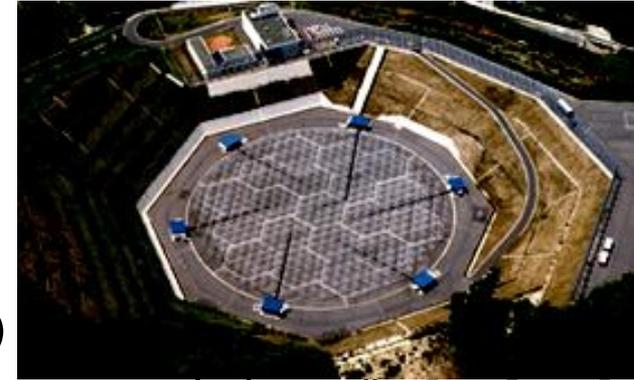
MTI分野での大型大気レーダー観測



EISCAT
(北欧)

<http://www.nipr.ac.jp/~eiscat/>

MU
(信楽)



<http://www.rish.kyoto-u.ac.jp/~mu/index.html>

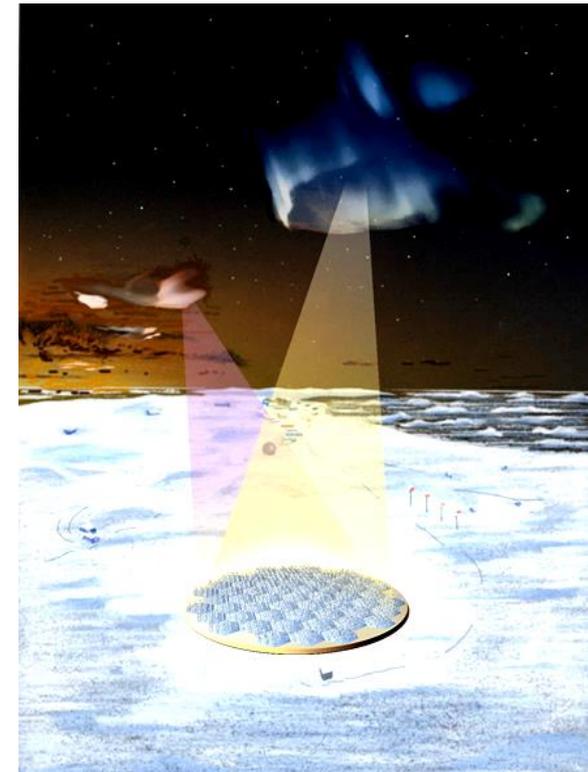


EAR
(インドネシア)

<http://www.rish.kyoto-u.ac.jp/ear/index.html>

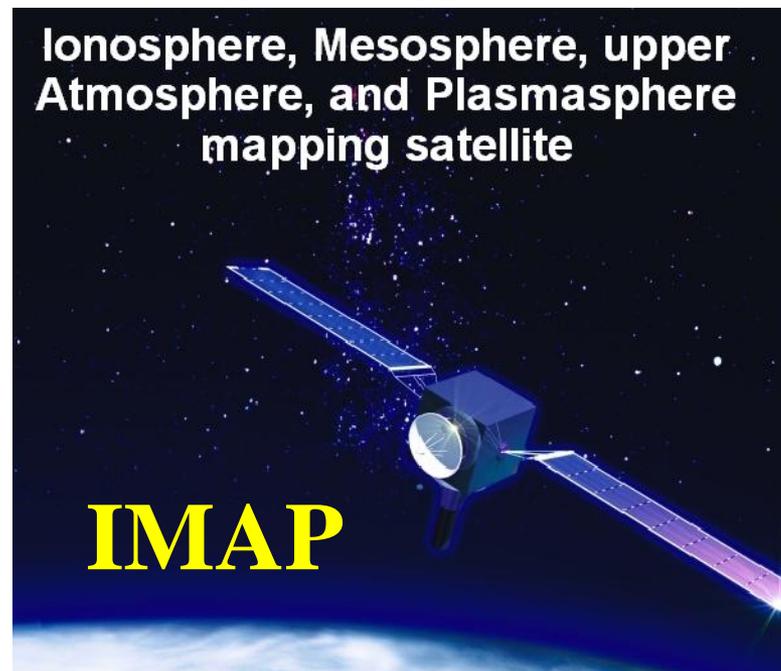
PANSY
(南極)

<http://pansy.nipr.ac.jp/index-j.html>



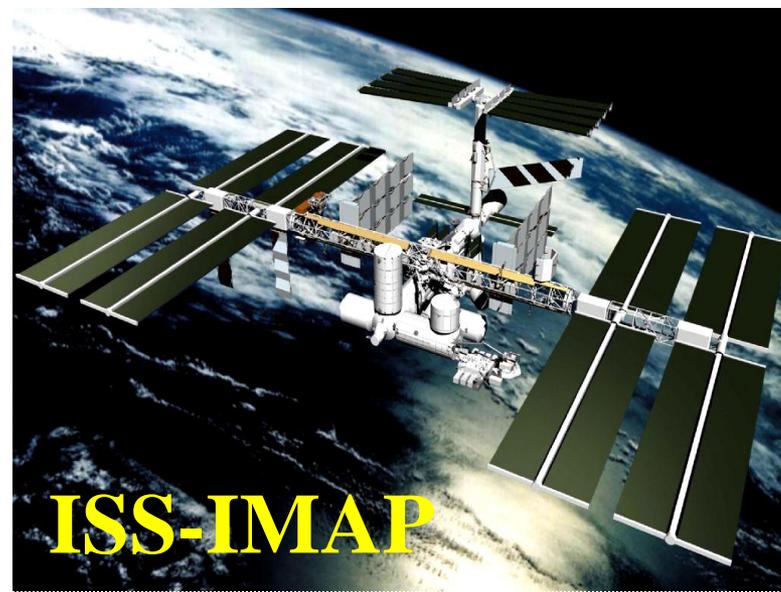
MTI分野での飛翔体観測

将来計画



国外でのプロジェクト

CHAMP
FORMOSAT
C/NOFS

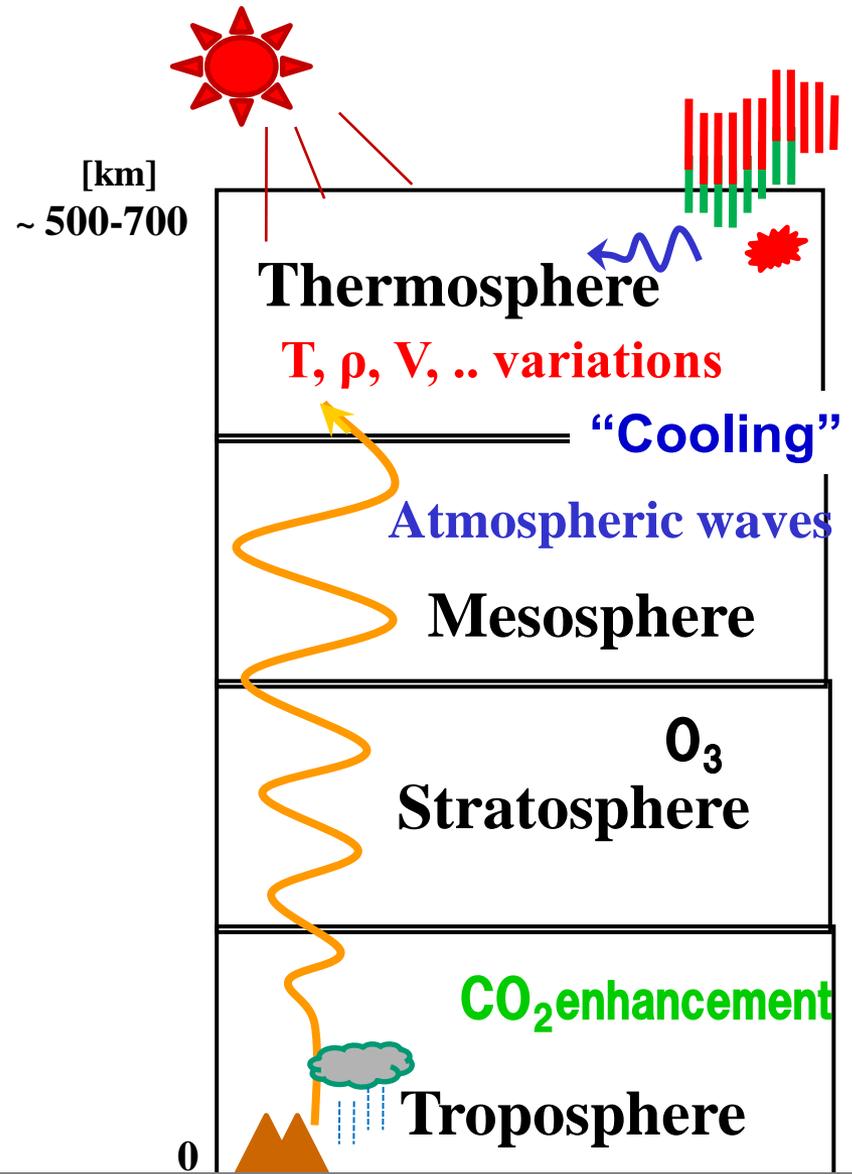


Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy (**GAIA**)

*Gaia, the goddess
of the mother earth,
was born from chaos*

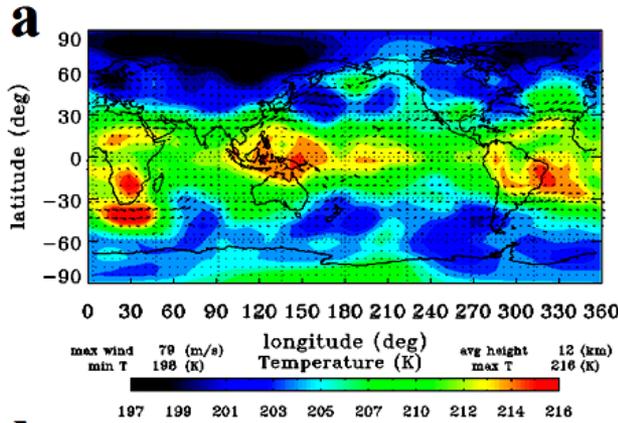


Antikemuseen,
www.theoi.com
Berlin

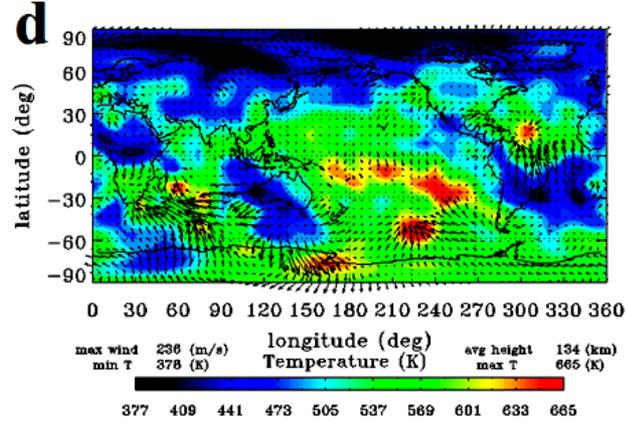


GCM simulation by Fujiwara et al. (IGA-book, 2011)

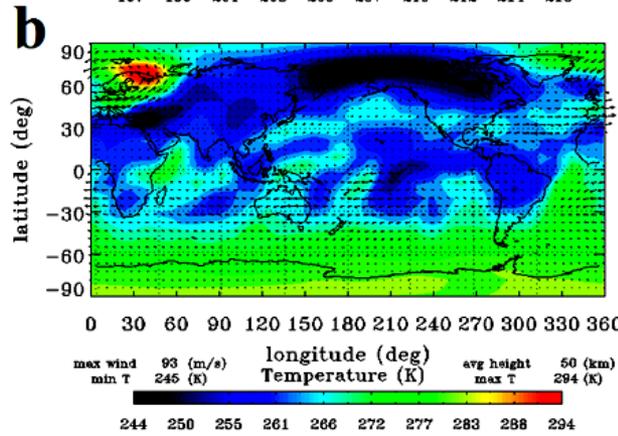
20 km



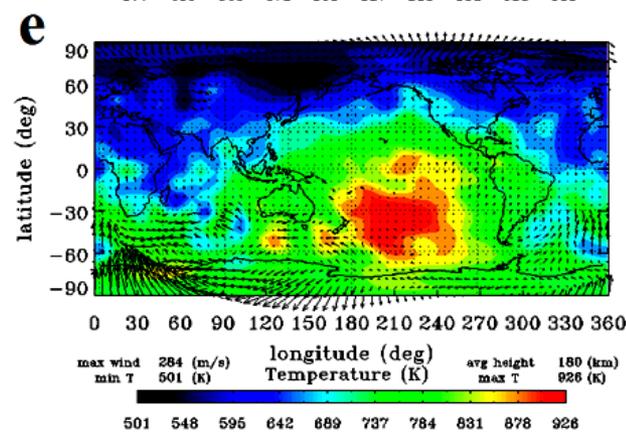
134 km



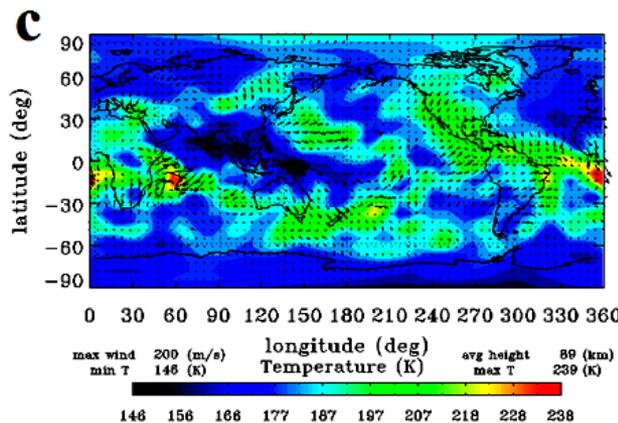
50 km



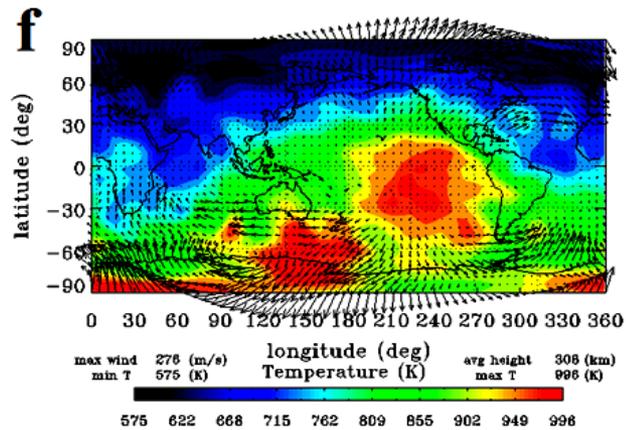
180 km



89 km



306 km



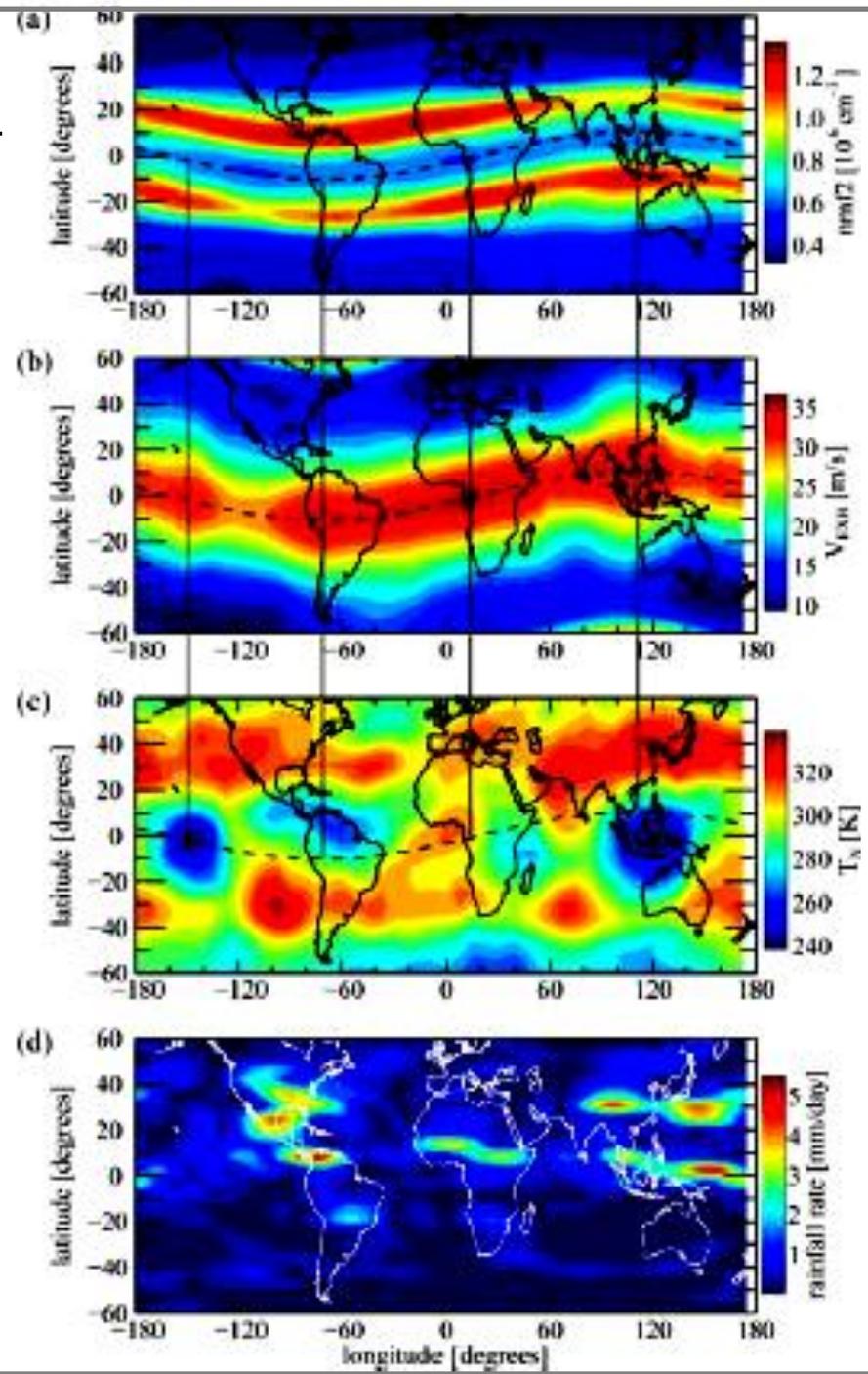
Example of the GAIA simulations

The first results from GAIA

30-day averaged variables in
September (15 LT)

- (a) Nmf2
- (b) Upward $\mathbf{E} \times \mathbf{B}$ velocity
at 300 km
- (c) Neutral temperature
at 110 km
- (d) Rain fall rate on the ground

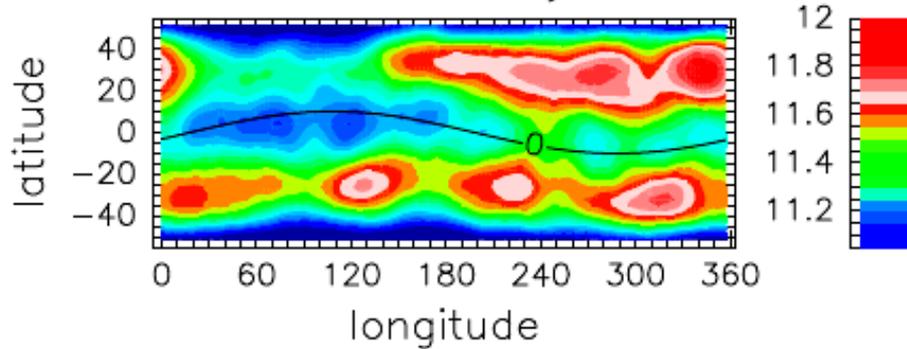
Jin et al. (JGR, 2011)



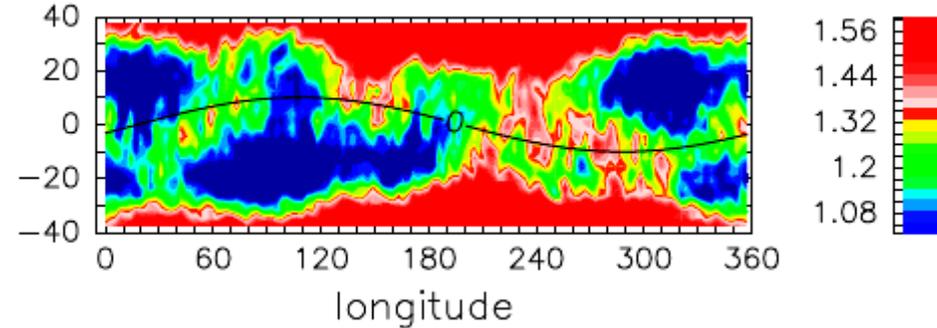
Example of the GAIA simulations (2)

Miyoshi et al. investigated the equatorial mass density anomaly (EMA) by using GAIA.

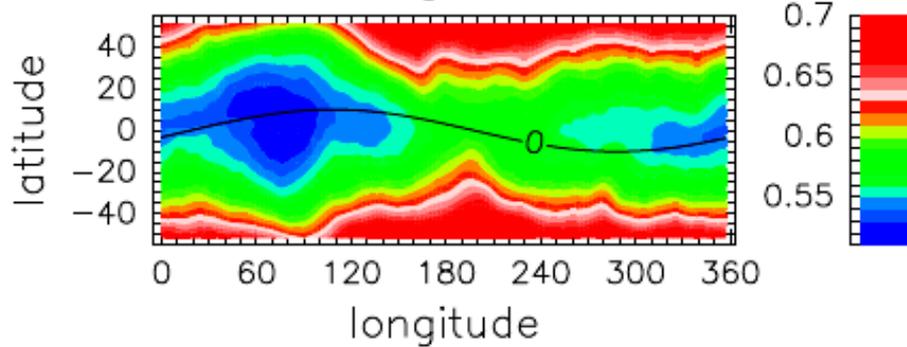
Neutral Density; 400km 10^{-12} km/m^3



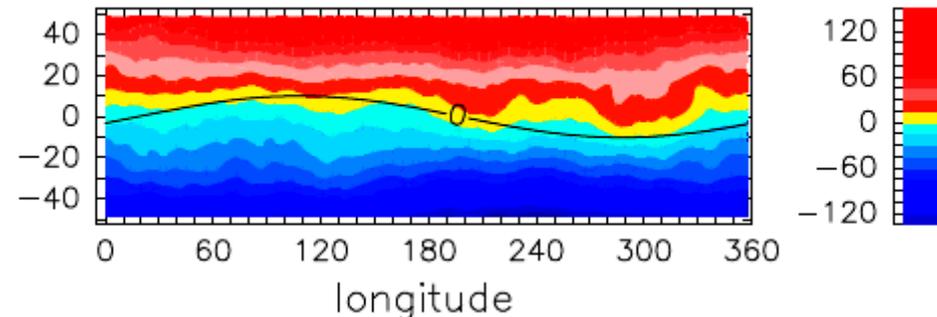
Vertical Wind (m/s); 300km



mean mixing ratio [O]; 300km



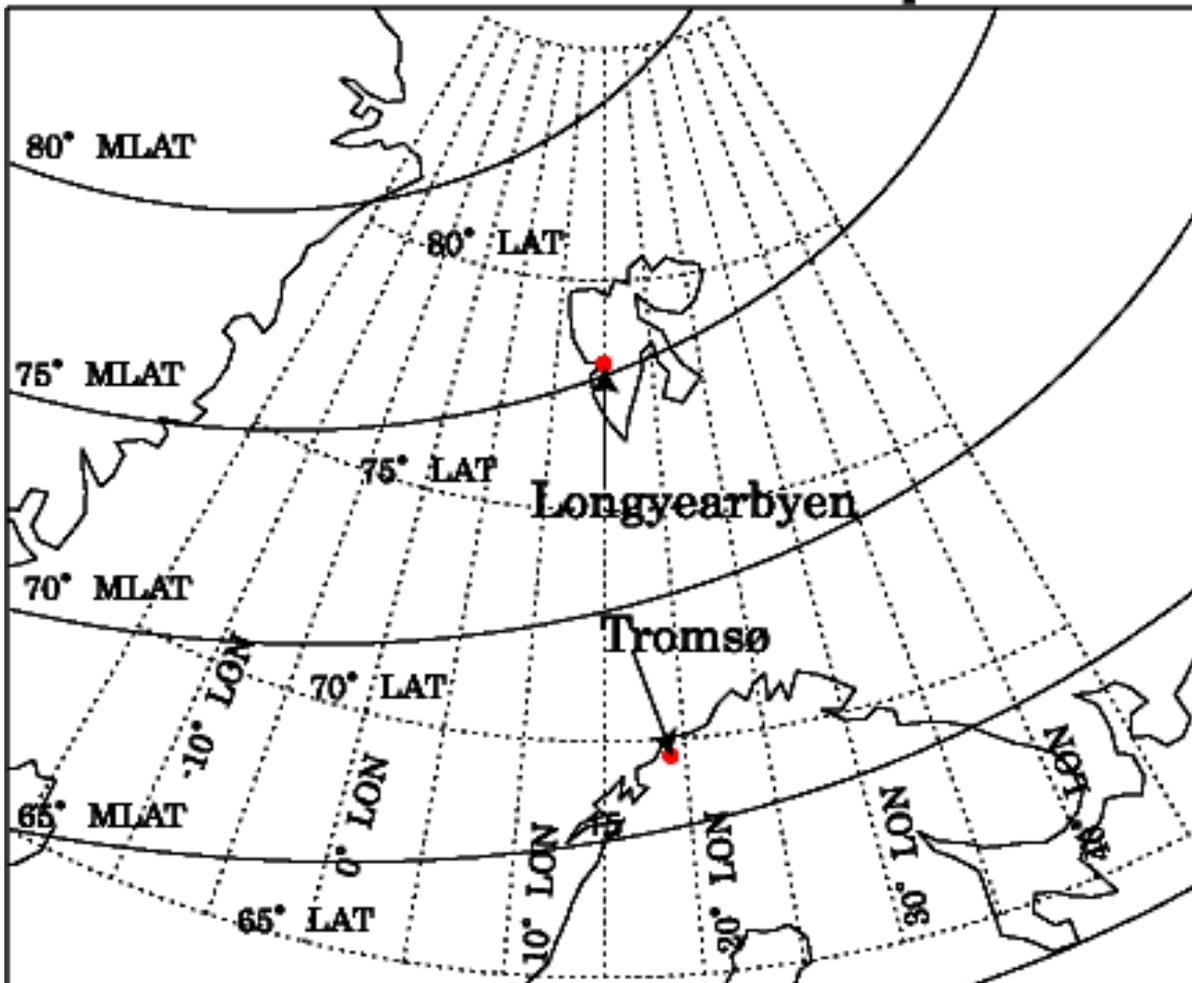
Meridional Wind (m/s) ; 400km



Miyoshi et al. (JGR, 2011)

EISCAT observations

EISCAT radar location map



Svalbard
Longyearbyen:

78.2°N, 16.1°E
(75.3°N geomag)

LT=UT+1hour

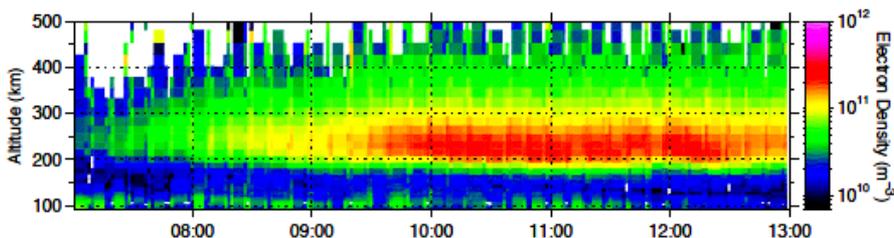
MLT=UT+3hour

Tromsø:

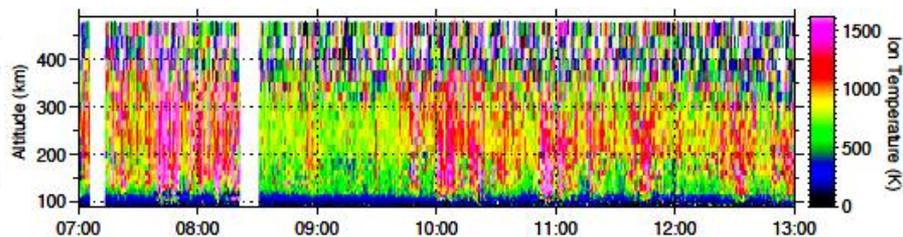
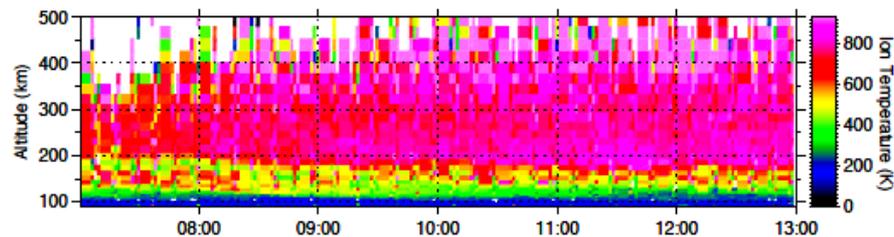
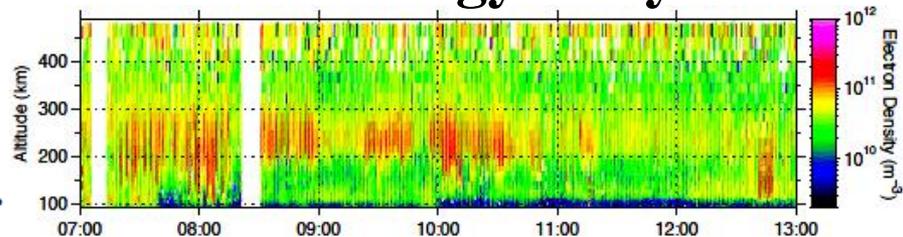
69.6°N, 19.2°E
(66.6°N geomag)

Observations on January 10, 2011

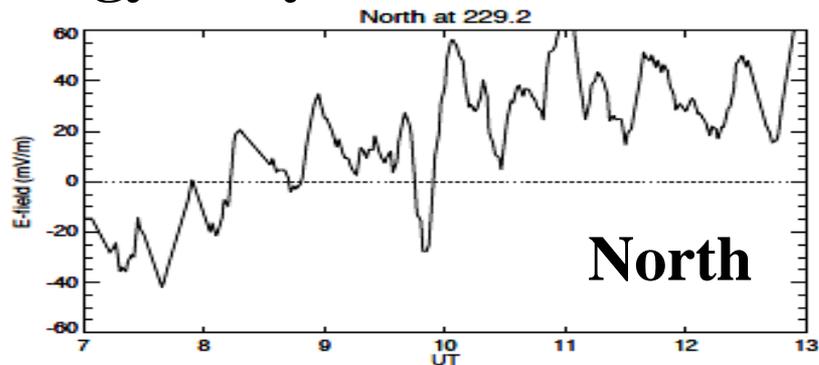
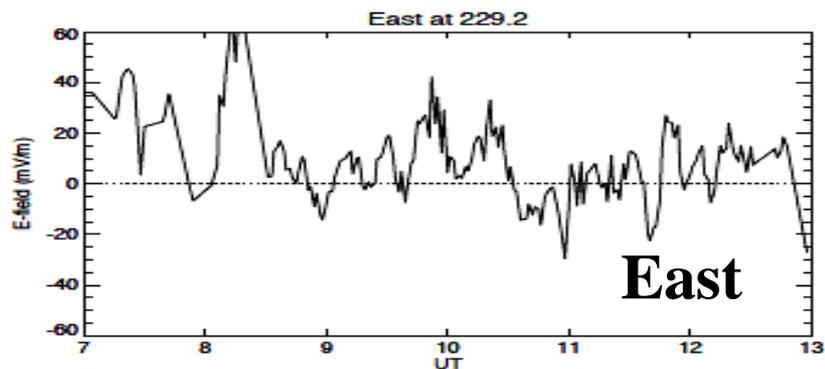
Tromsø



Longyearbyen



Electric field at Longyearbyen

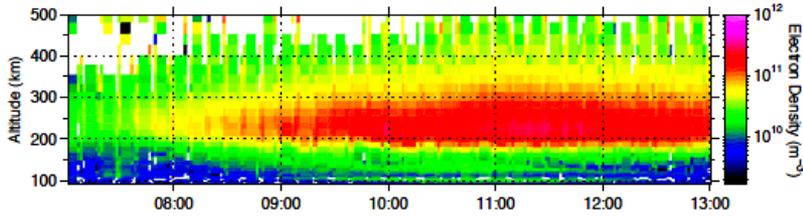


Observations on January 11, 2011

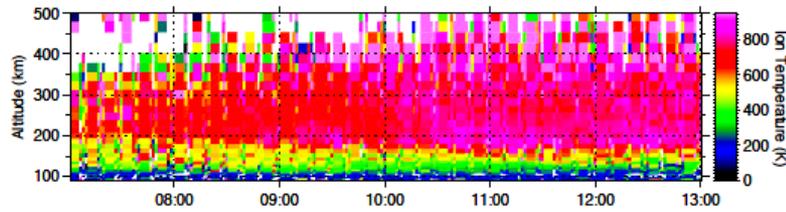
Jan 11, 2011

Tromsø

Ne



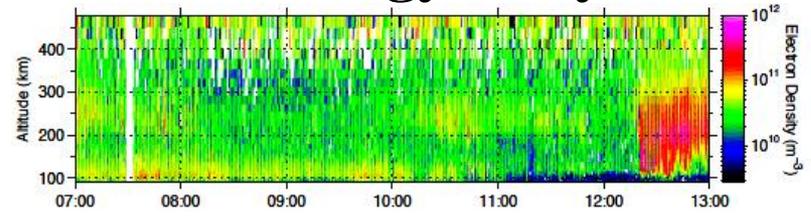
Ti



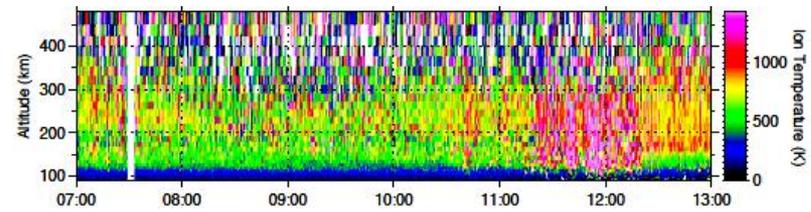
UT

Longyearbyen

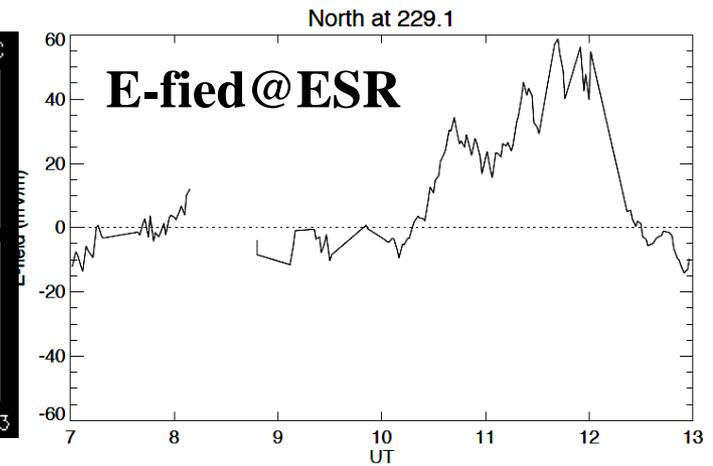
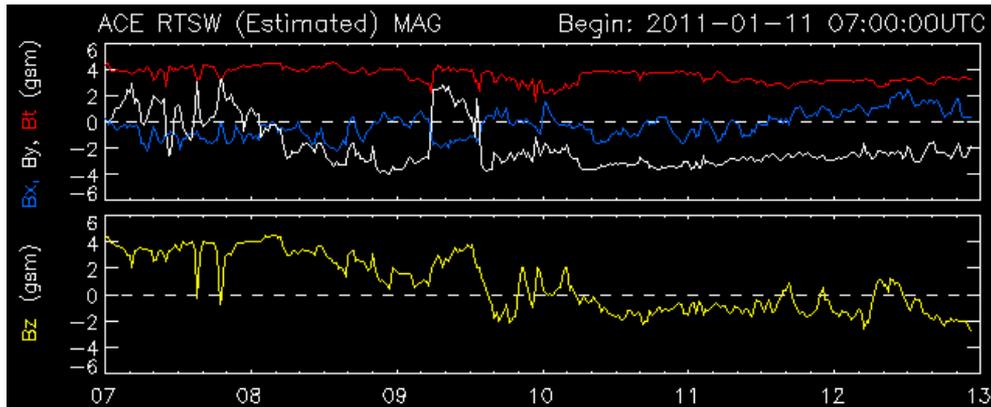
Ne



Ti

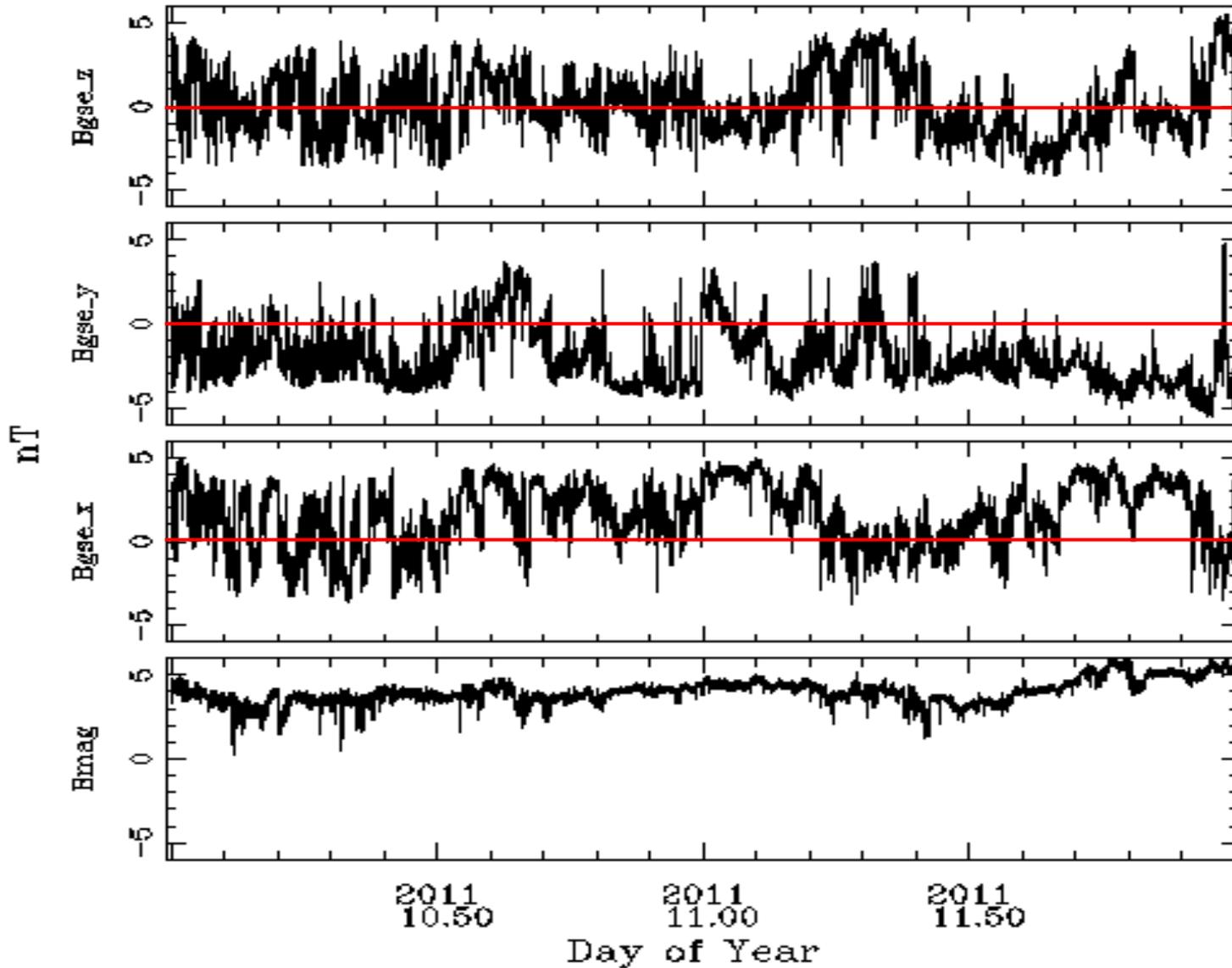


UT

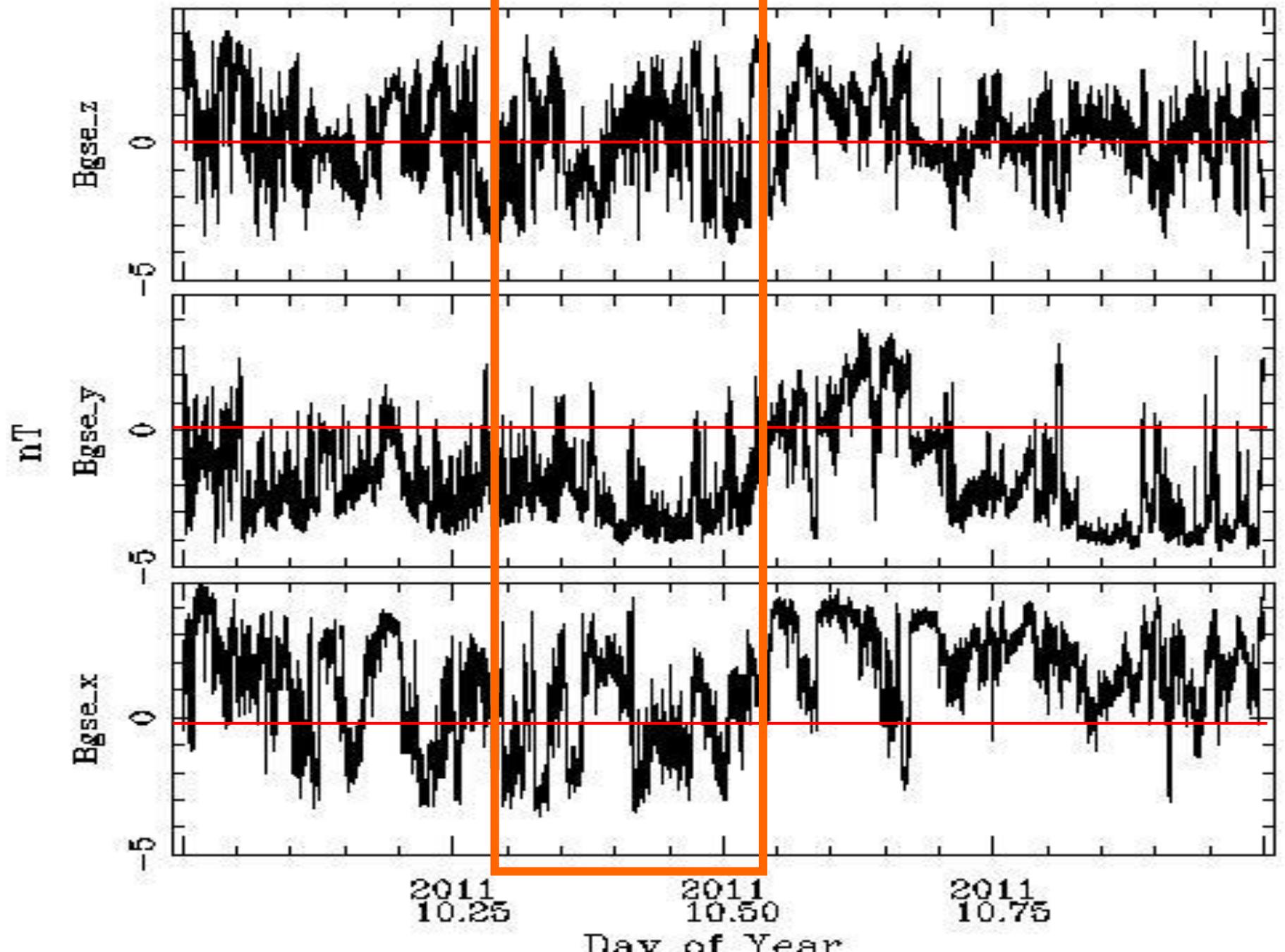


ACE Level 2 Data plot

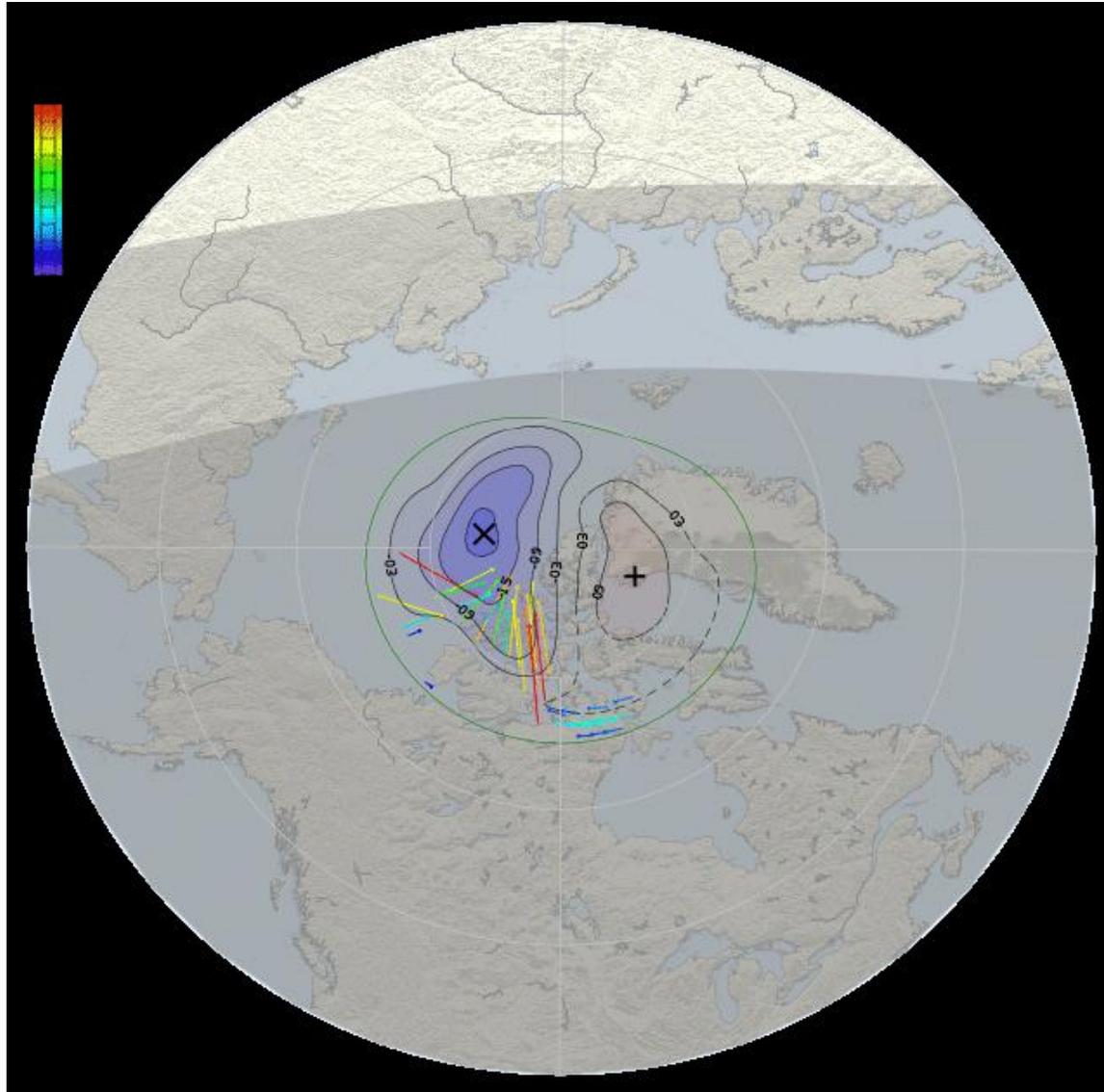
DOY .vs. Multiple Variables
1-second Averages



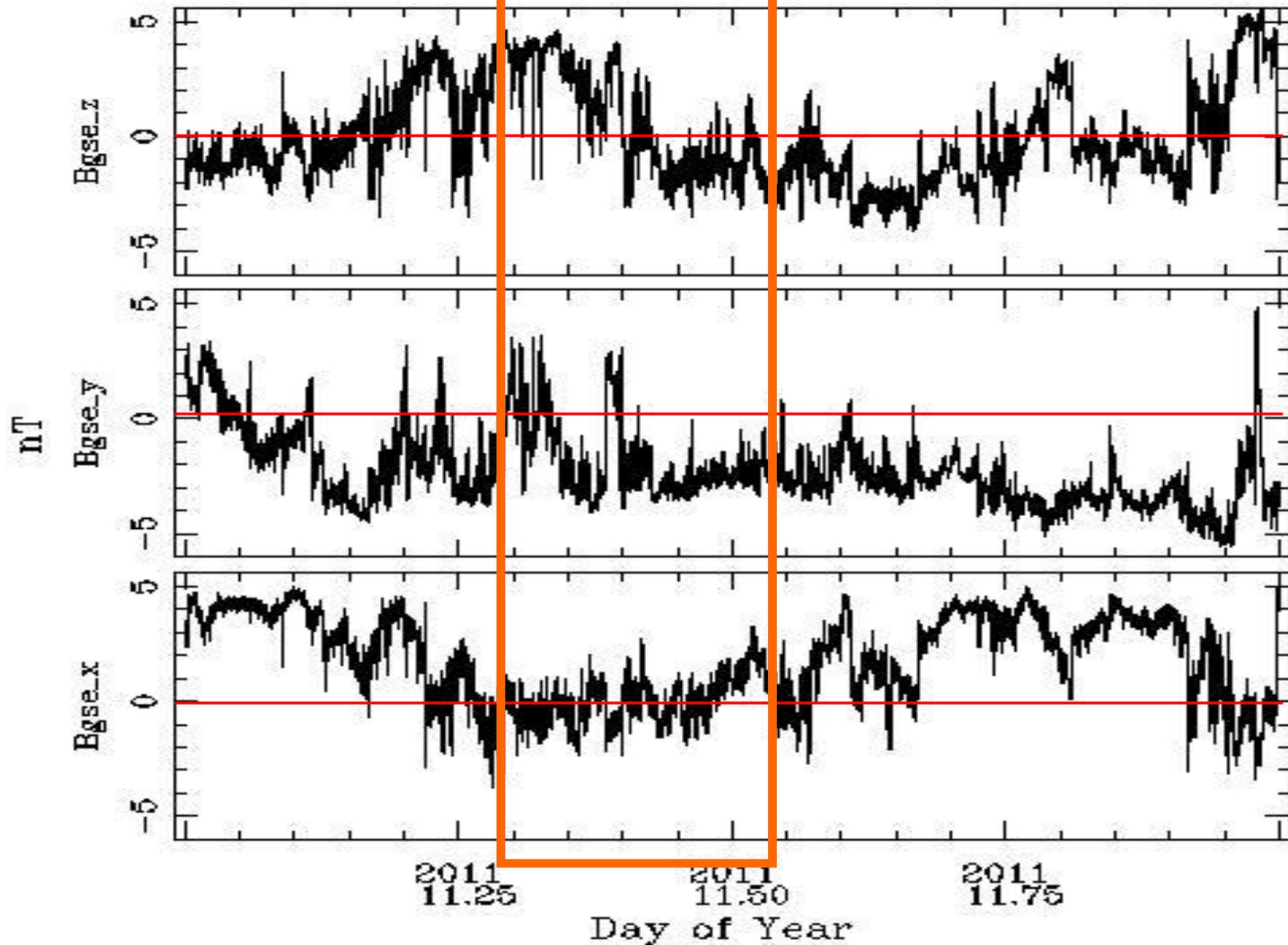
Jan 10



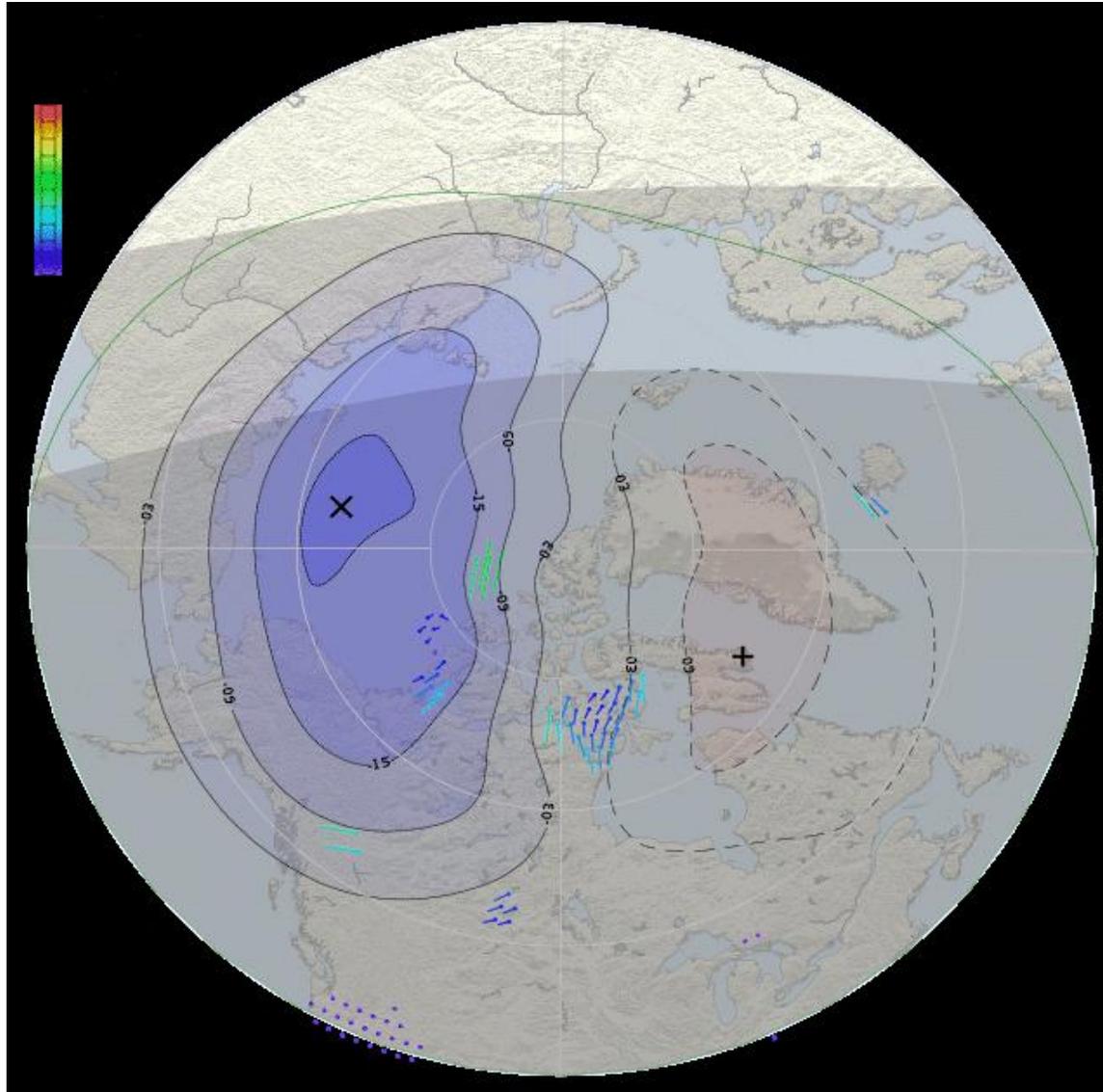
07:00-13:00 UT, January 10, 2011



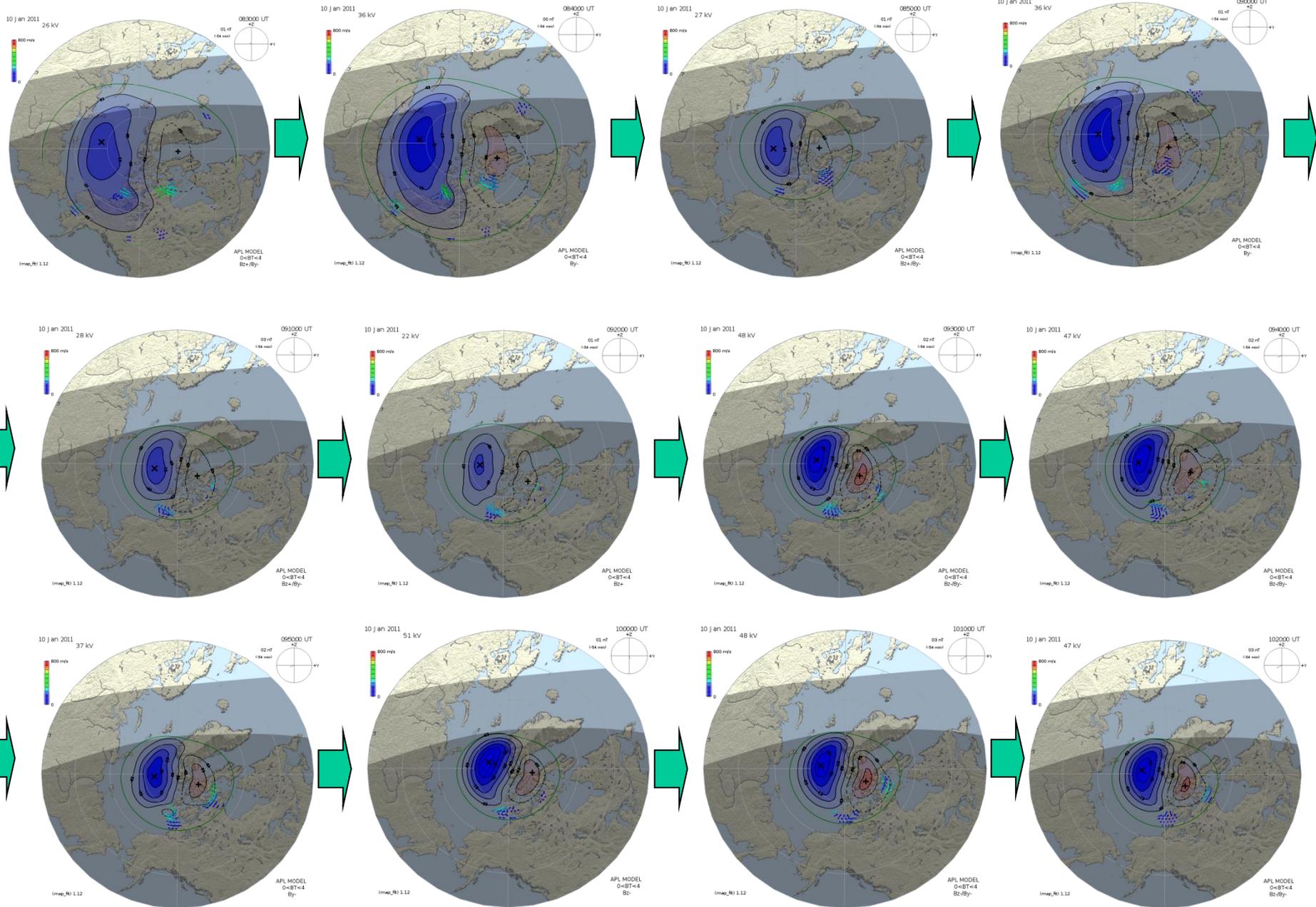
Jan 11



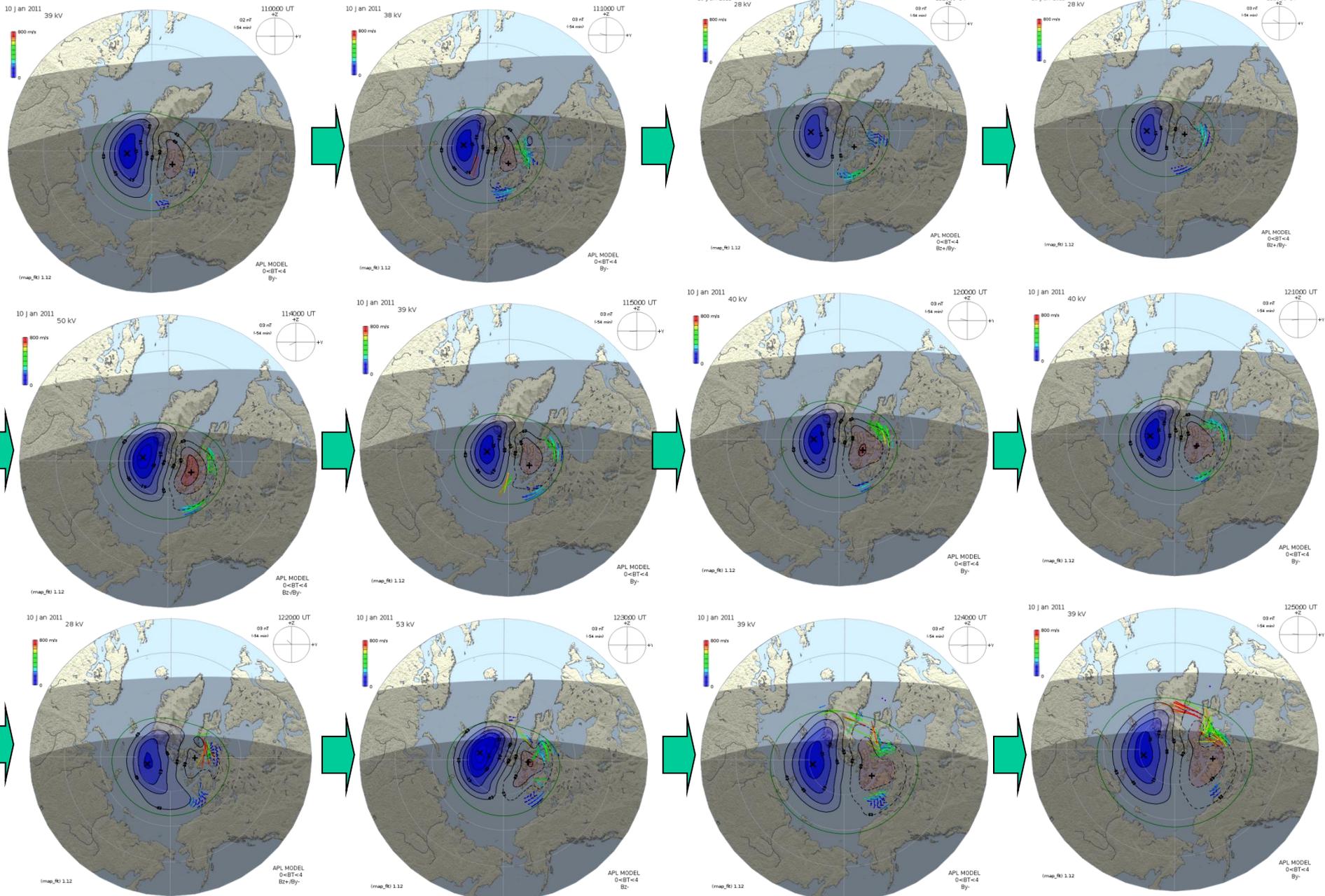
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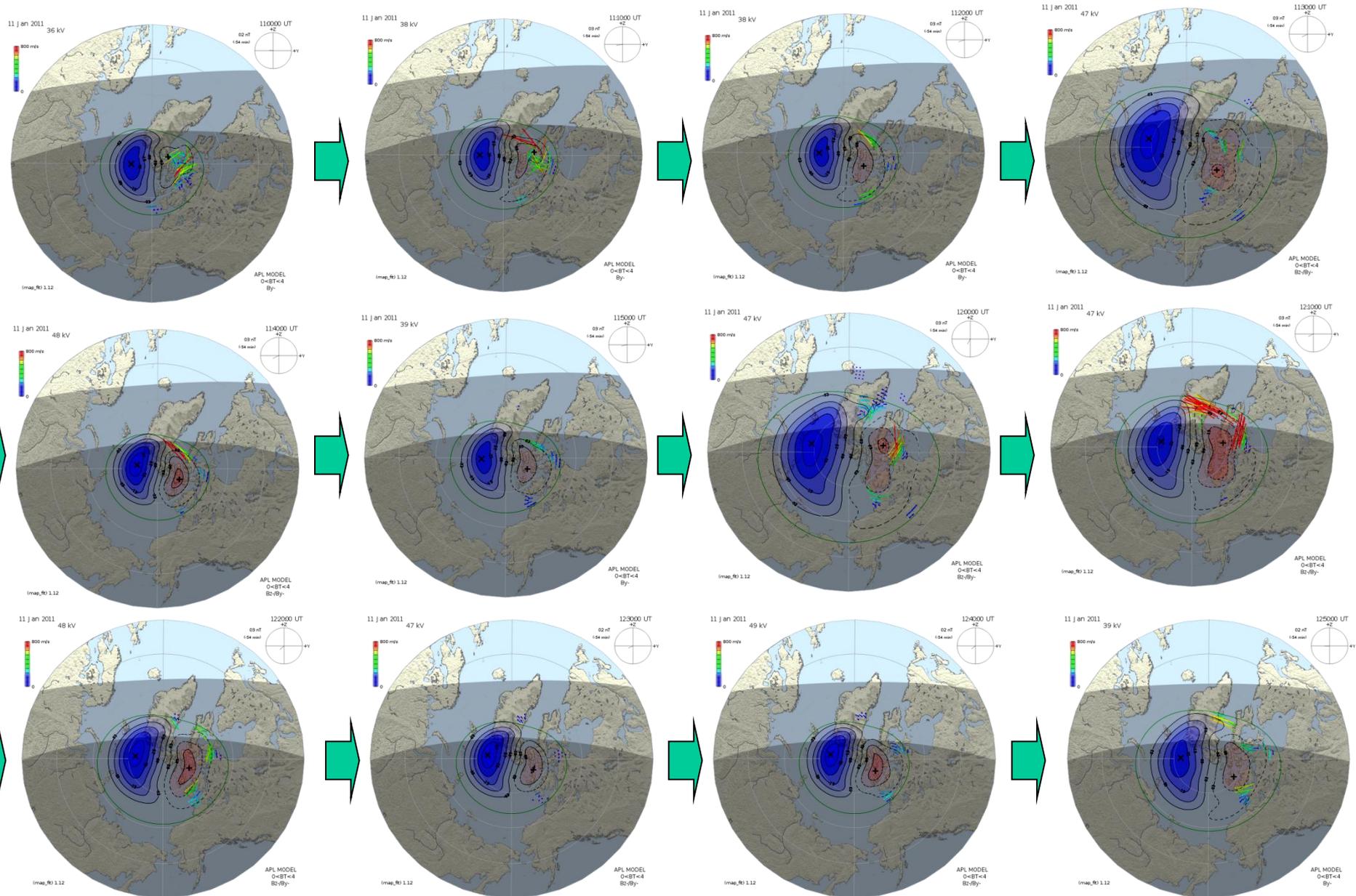
SuperDARN 8:30 ~ 10:20 UT, Feb 10, 2011



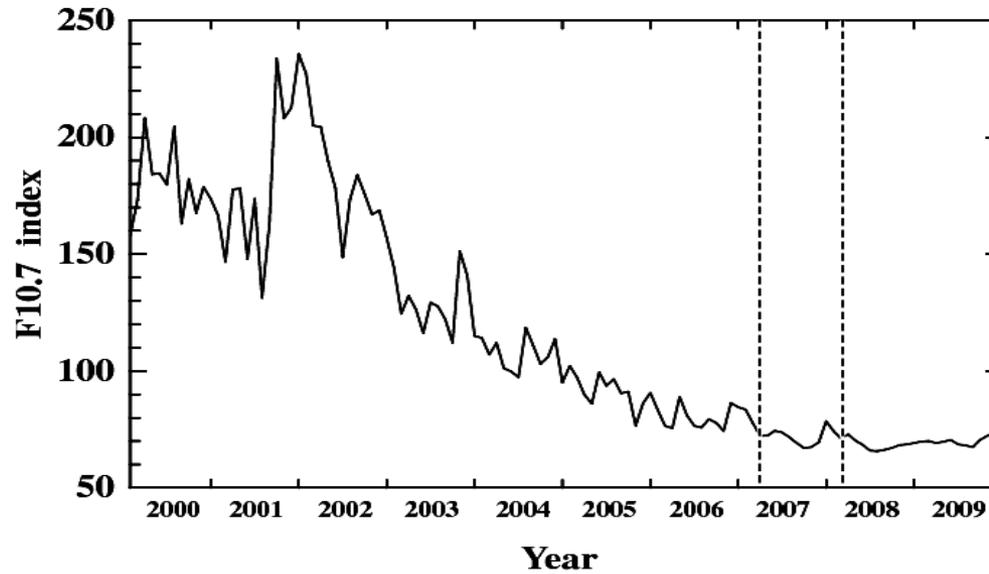
SuperDARN 11:00 ~ 12:50 UT, Jan 10, 2011



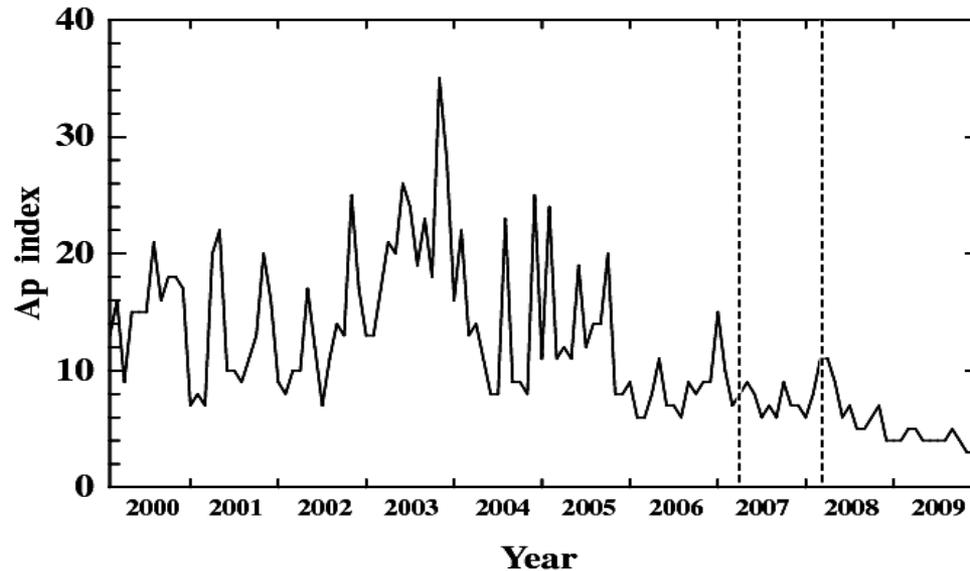
SuperDARN 11:00 ~ 12:50 UT, Jan 11, 2011



ESR data during the IPY observations (March 2007 ~ Feb 2008)

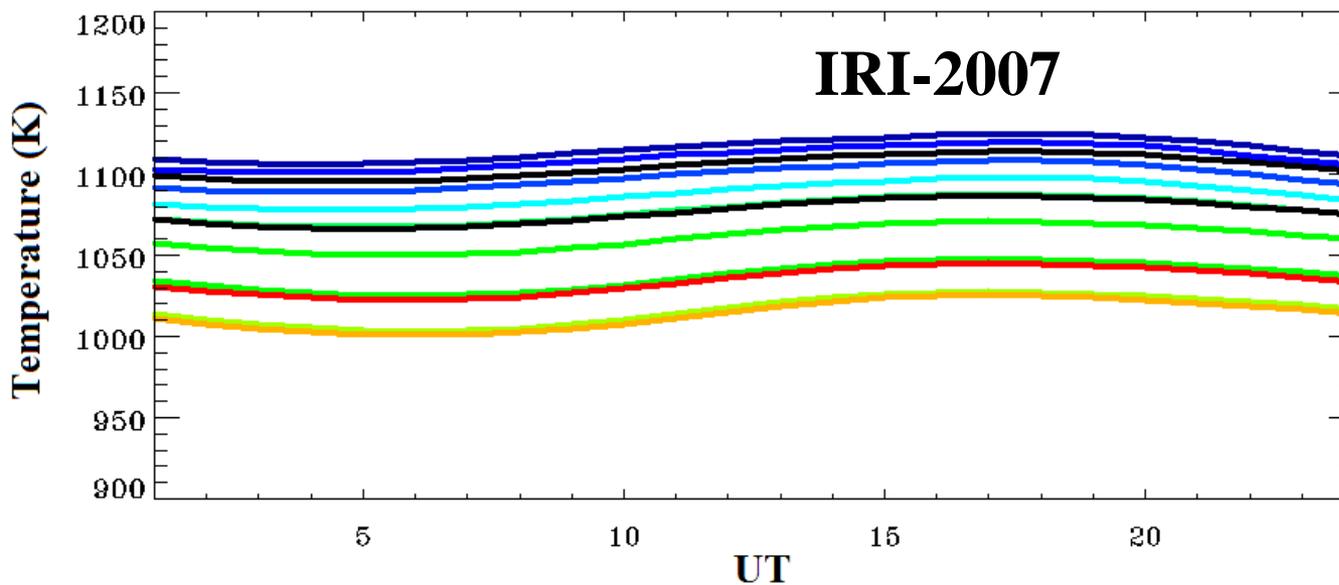
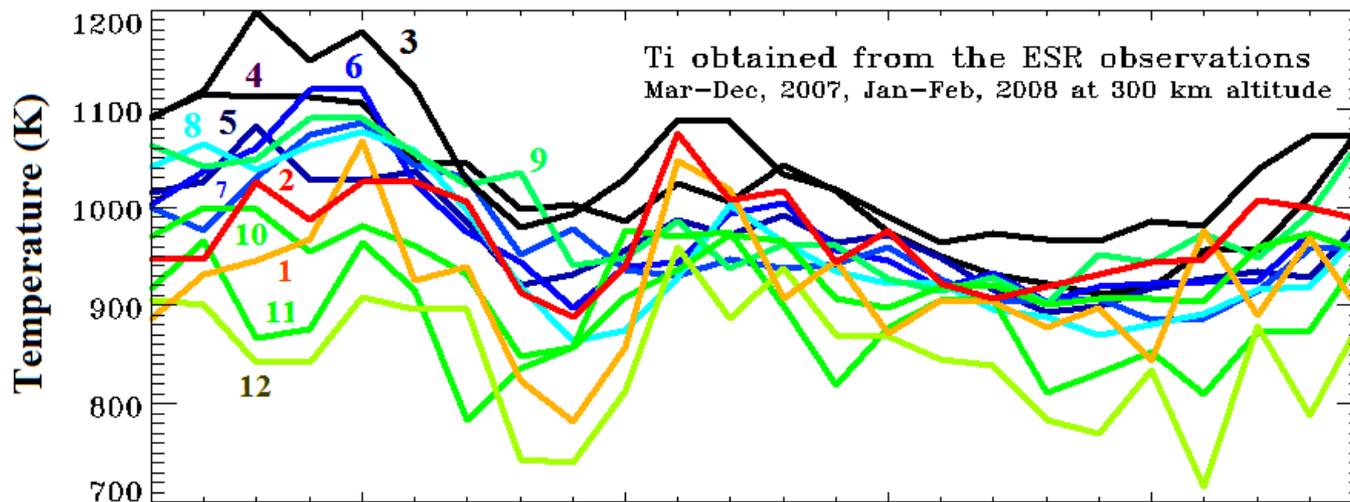


F10.7

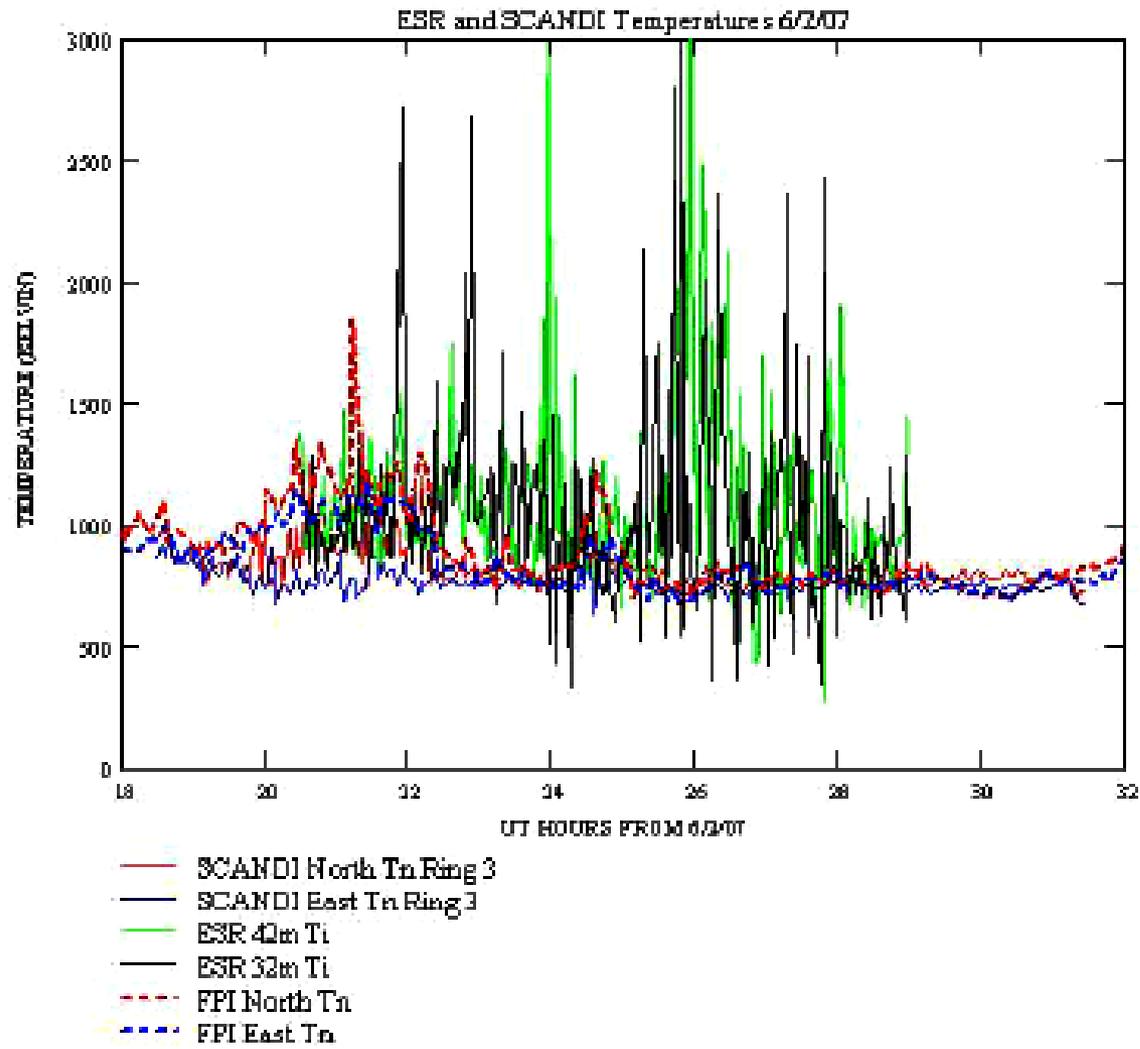


Ap

Monthly averaged ion temperature Mar 2007-Feb 2008



(Fujiwara et al., EPS, in press)

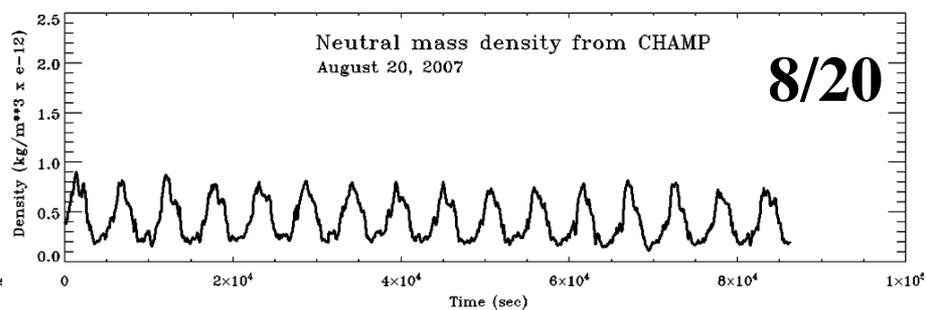
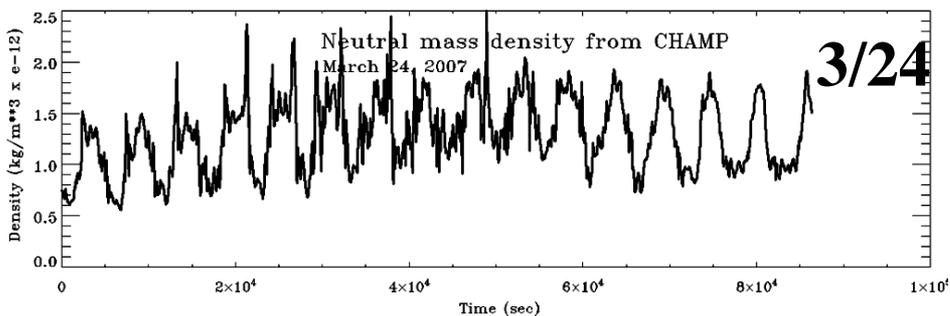
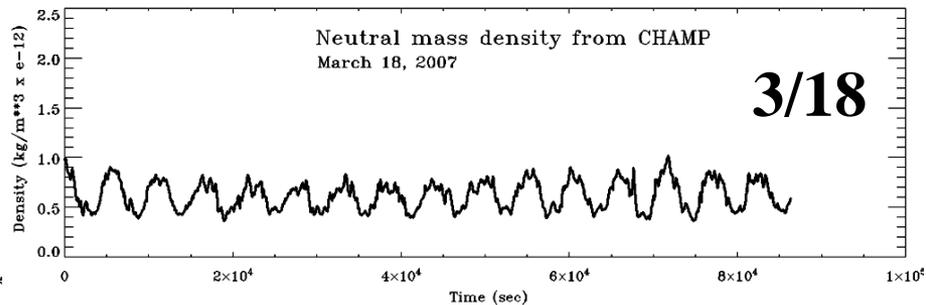
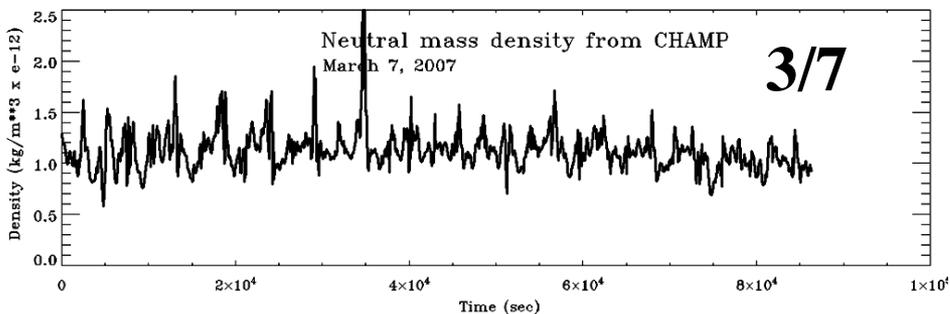


Aruliah et al.,
Ann Geophys, 2010.

The SCANDI neutral temperatures provide a lower boundary to the ion temperatures throughout the night, which provides independent confirmation that the SCANDI temperature analysis is consistent with energy conservation because T_i should equal T_n when there is no input of magnetospheric energy.

Fig. 17. Comparison of ion temperatures observed by the 2 ESR radars with the neutral temperatures observed by SCANDI on the night of 6–7 February 2007.

CHAMPによる24時間の質量密度計測例



まとめ

近年、中間圏・熱圏・電離圏(MTI)分野において、モデリング、レーダー観測、飛翔体観測が大いに進展している。これらの成果を有効利用することにより、総合的な研究(現象の全体像の理解)が可能になるものと考えられる。

例：人工衛星、EISCAT、SuperDARN、数値モデル、、、によって太陽風起源のエネルギーが超高層大気で消費されるまでの一連のプロセスを追いかけることができる。

様々な研究ツールが生み出す各種データを利用するにあたって、研究グループ間での情報共有は不可欠であり、またそのための有効手段の確立が重要である。

今後のシミュレーションデータの整備

北極研究・GRENE事業(大気上下結合グループ: 代表 中村卓司教授)において観測、GCMシミュレーション研究を実施予定。

その他、GCMシミュレーション関連プロジェクト(PANSY、ISS-IMAPなど)の中でデータを整備し、観測・再解析データ等と比較可能にすることを検討中。

*** 今回は紹介しなかったが、GAIAに気象再解析データを用いたシミュレーションが進められている(Jin et al., submitted to JGR)。**