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Tony van Eyken

Extended High Attitude Incoherent Scatter Radar Observations during the IPY

A P van Eyken
EISCAT Scientific Association



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Extended High Latitude Incoherent Scatter Radar Observations during the IPY

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*Thanks to Anja Strømme
and all the ISR scientists and operators*



Outline

- 1-year run at the ESR
- Operations at Poker Flat, Irkutsk, Millstone Hill, Sondrestrom, and SuperDARN
- Modelling
- Space debris, earthquake, and eclipse
- Databases, access, and displays
- What's next?



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1 March 2007 1630UT Ingemar Häggström starts the IPY run at the EISCAT Svalbard Radar

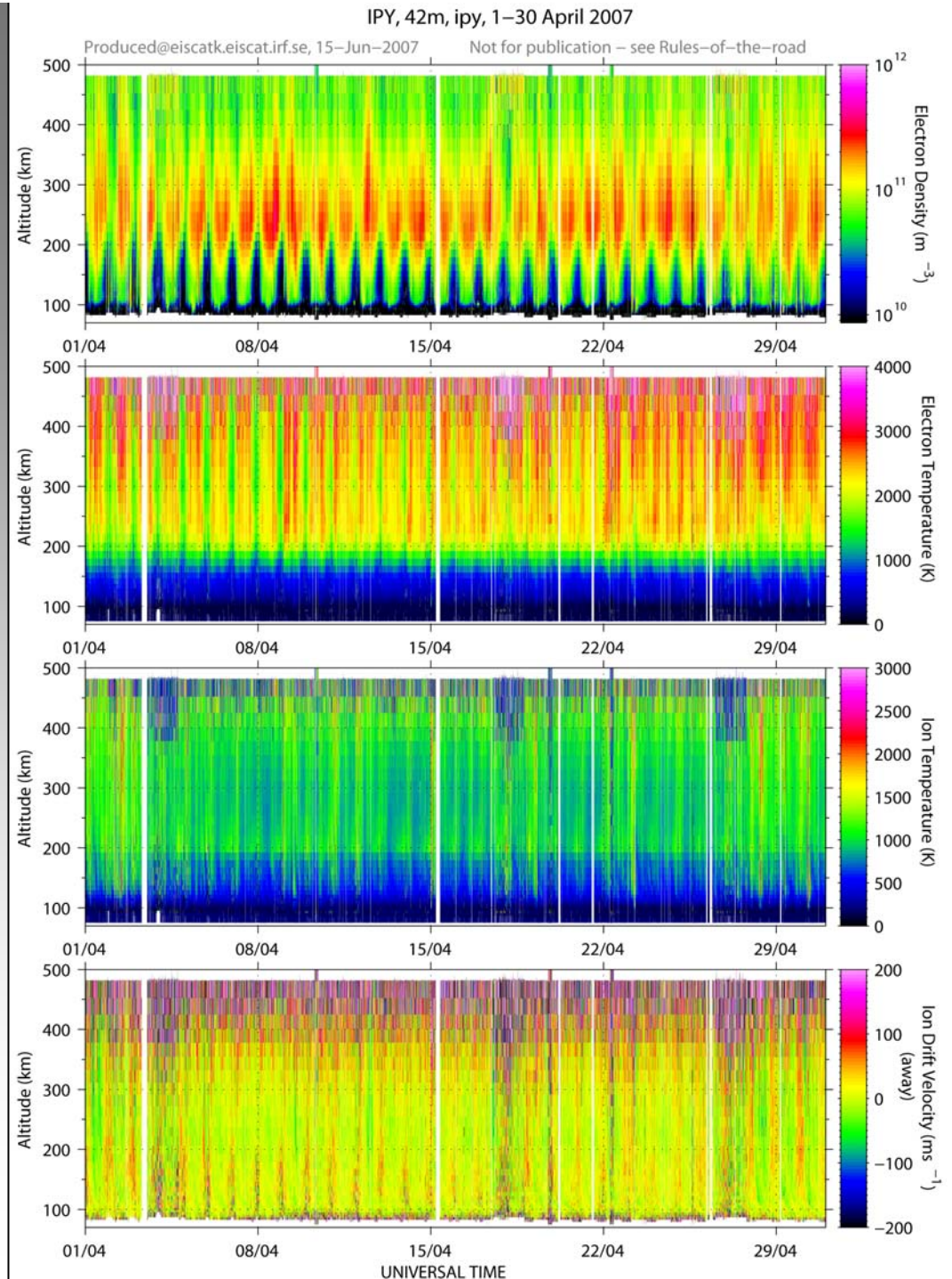




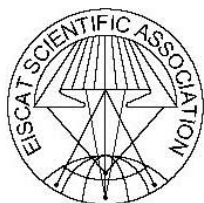
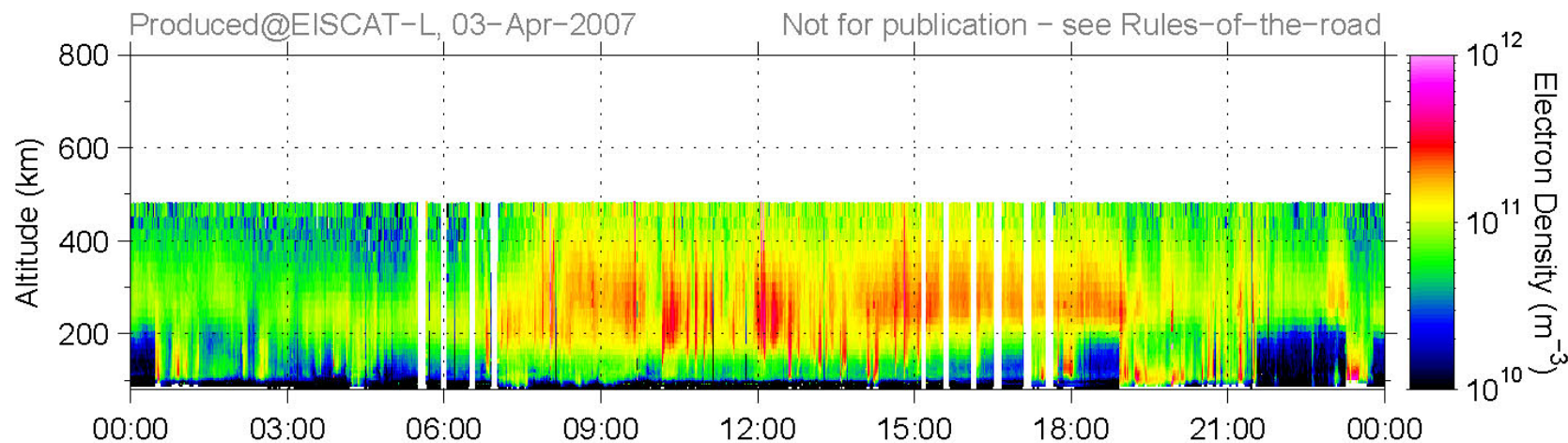
© EISCAT Scientific Association
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April 2008

- ESR
- Field aligned
- N_e , T_e , T_i , v_i



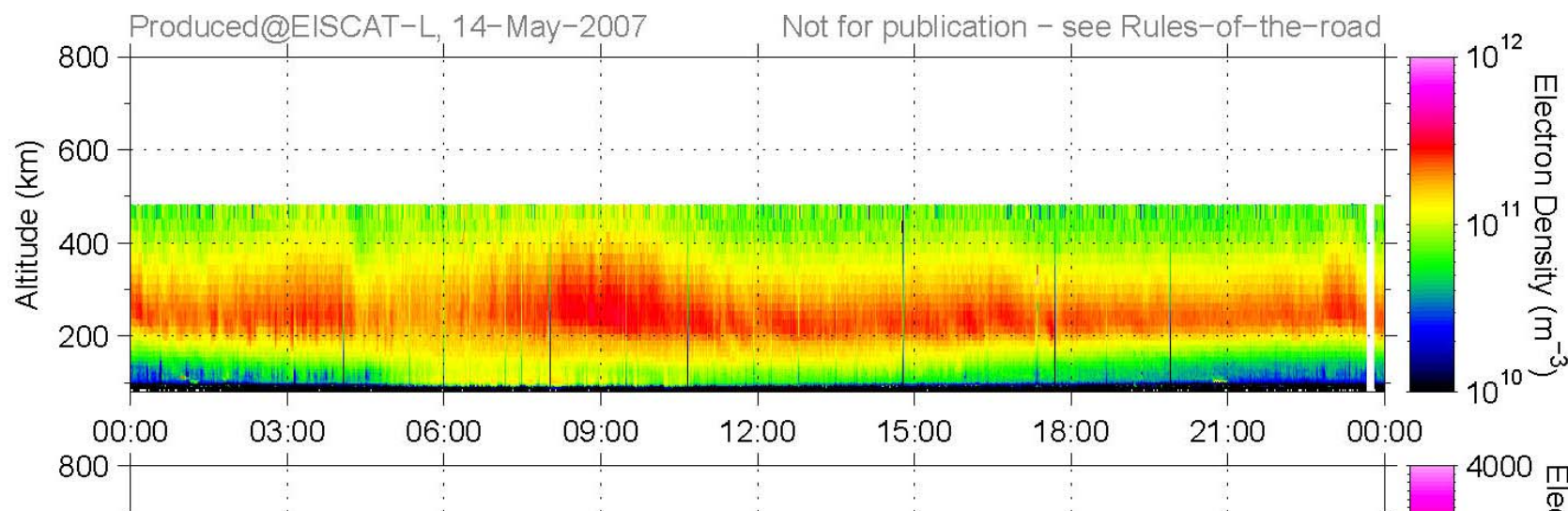
IPY, 42m, ipy, 2 April 2007



EISCAT Scientific Association

EISCAT SVALBARD RADAR

IPY, 42m, ipy, 13 May 2007





© EISCAT Scientific Association
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42m field-aligned antenna



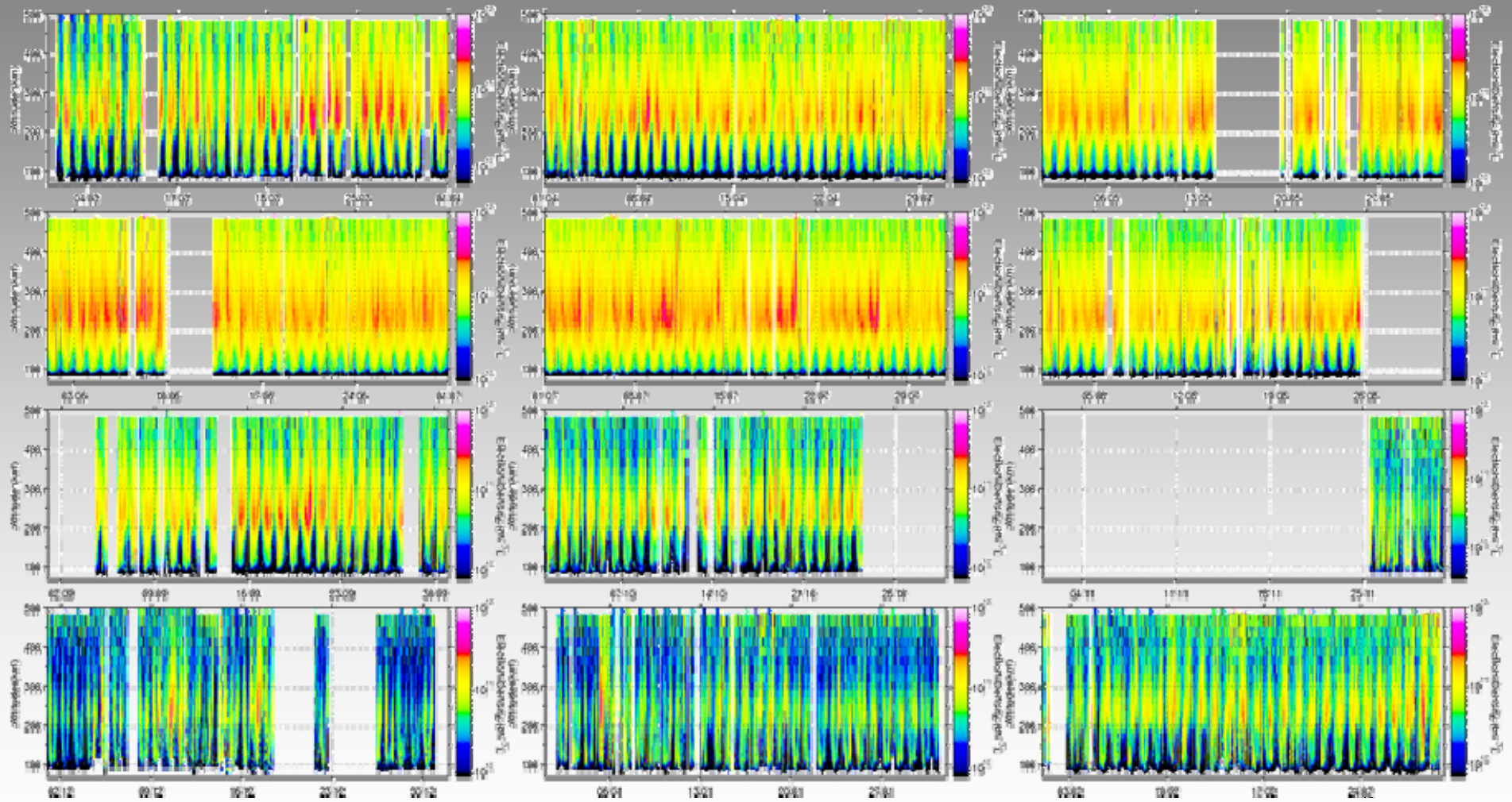


Photo: Martin Langeigen

1 MW from eight TV
transmitters



ESR: Spring, Summer, Autumn, Winter





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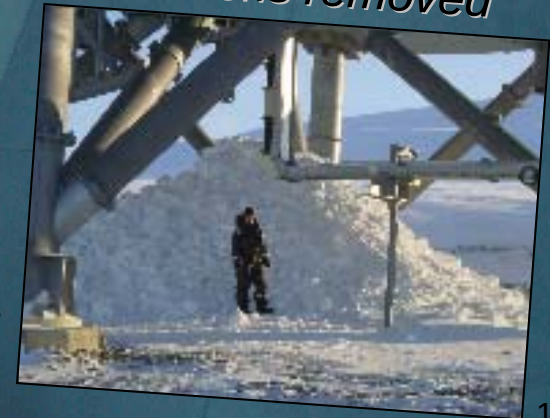
EISCAT Svalbard Radar



Snow removal is a constant chore



*Job done (for now)
~42 tons removed*





29 Feb 2008 2002UT
Martin Langteigen informs the power
plant that the IPY run completed





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IPY ISR coverage

EISCAT Svalbard Radar

EISCAT UHF

Poker Flat

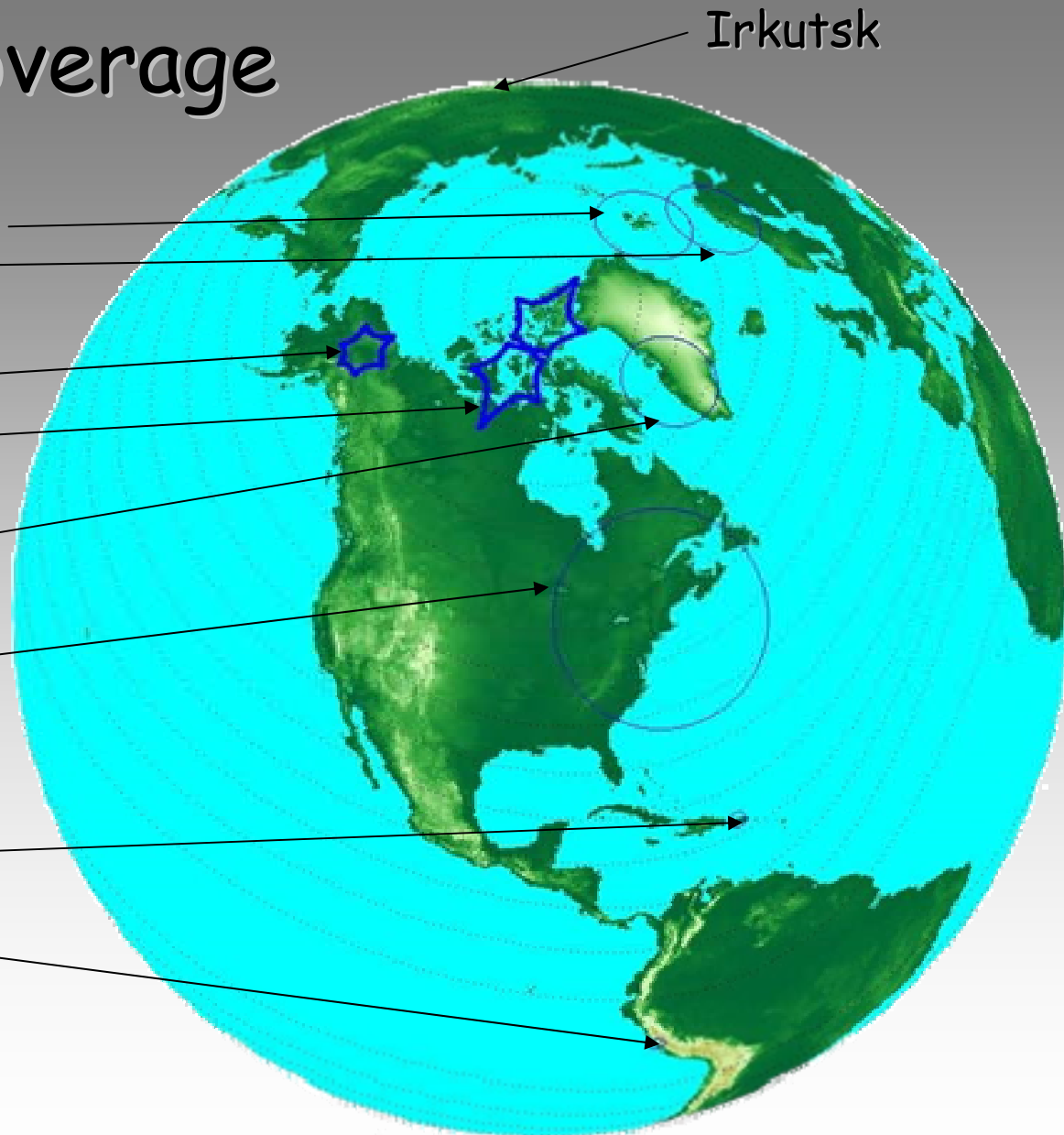
Resolute Bay

Sondrestrom

Millstone Hill

Arecibo

Jicamarca



Courtesy Craig Heinselman, SRI

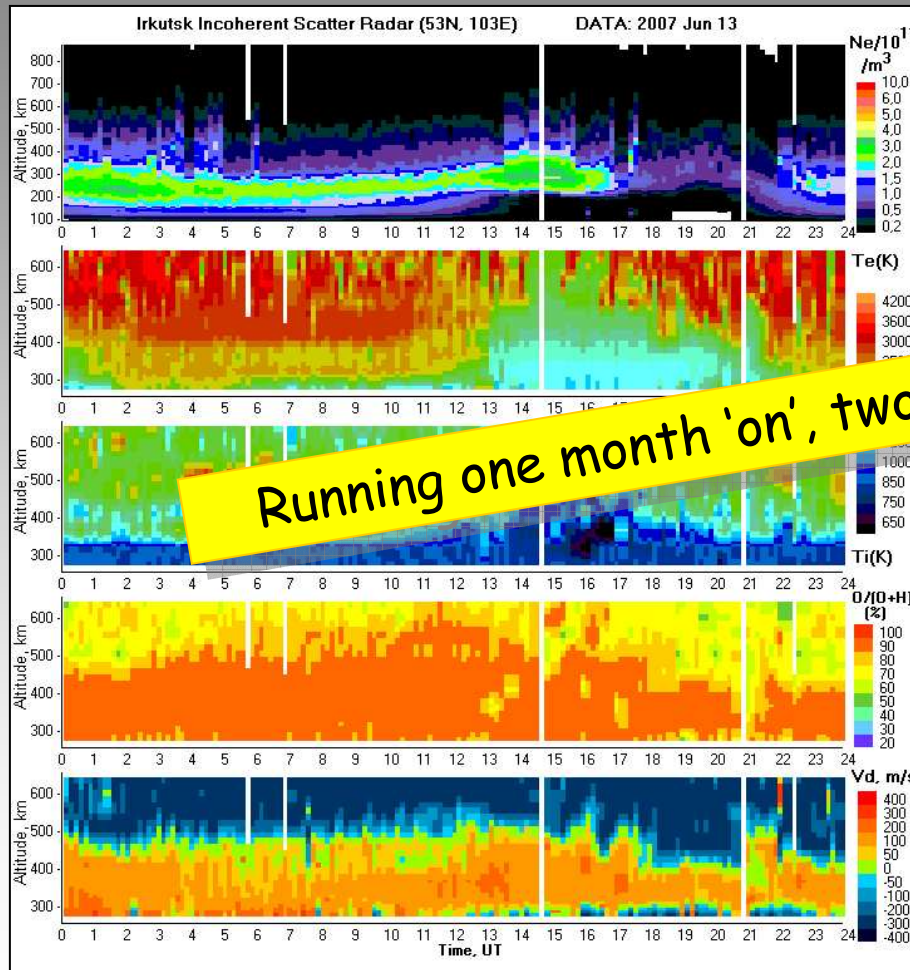


Irkutsk Radar

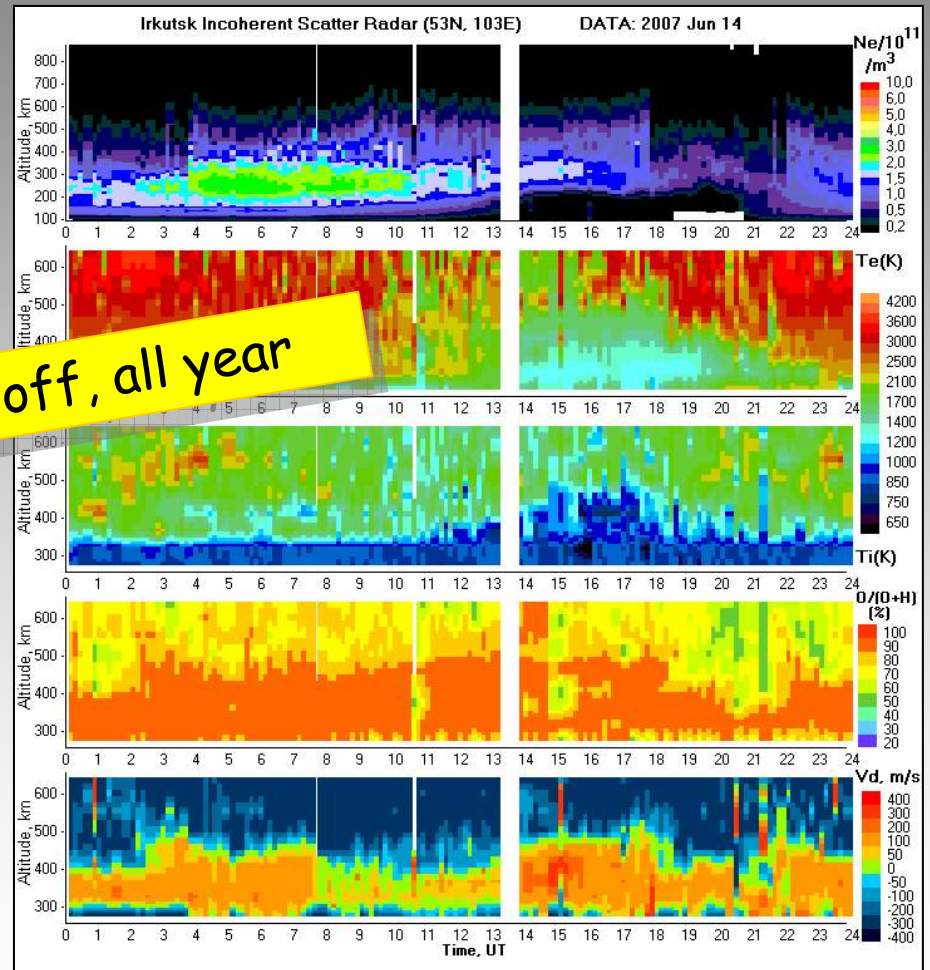




Irkutsk



Running one month 'on', two off, all year





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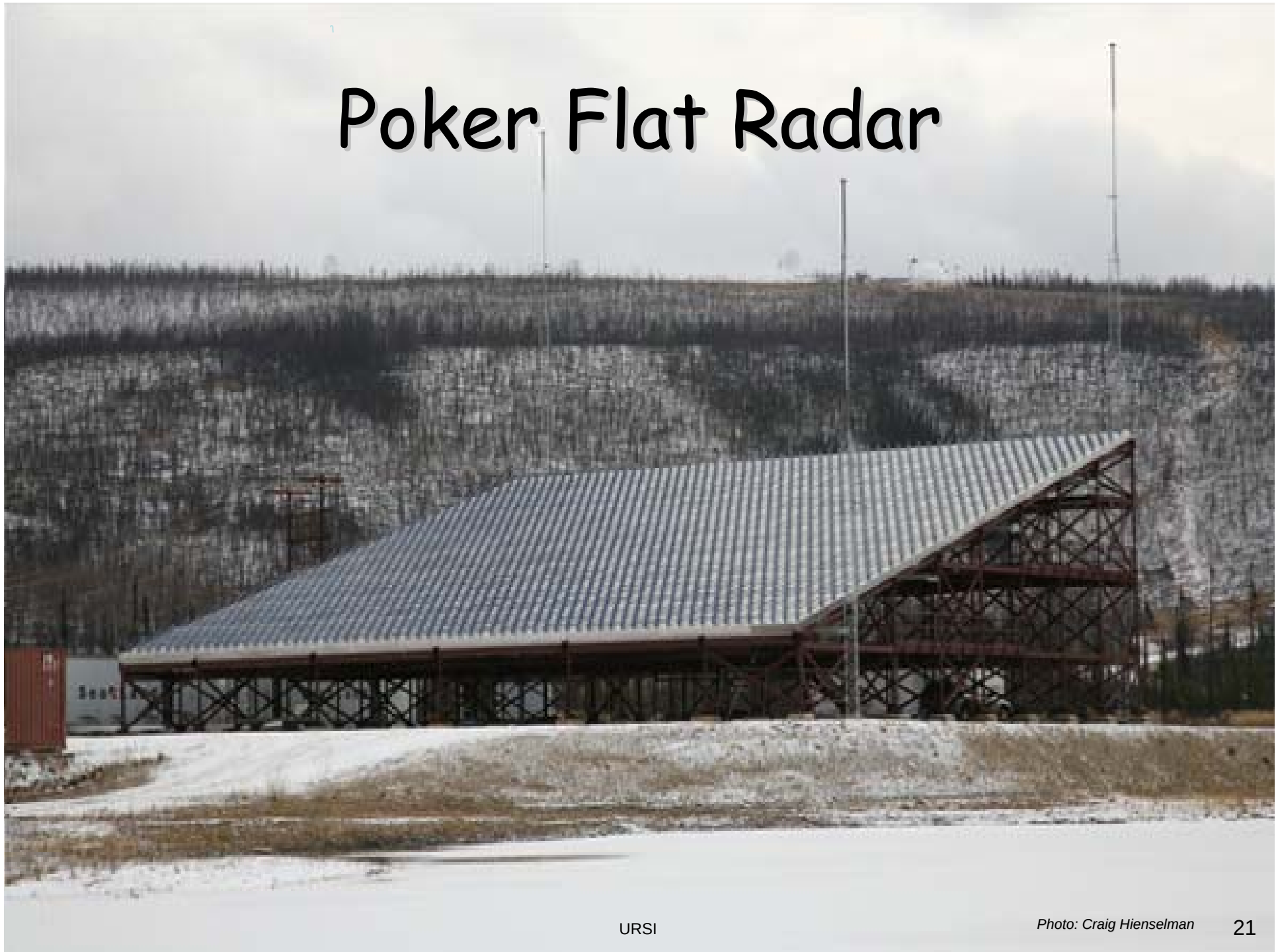
Millstone Hill Radar



URSI

Photo: Haystack Observatory, MIT

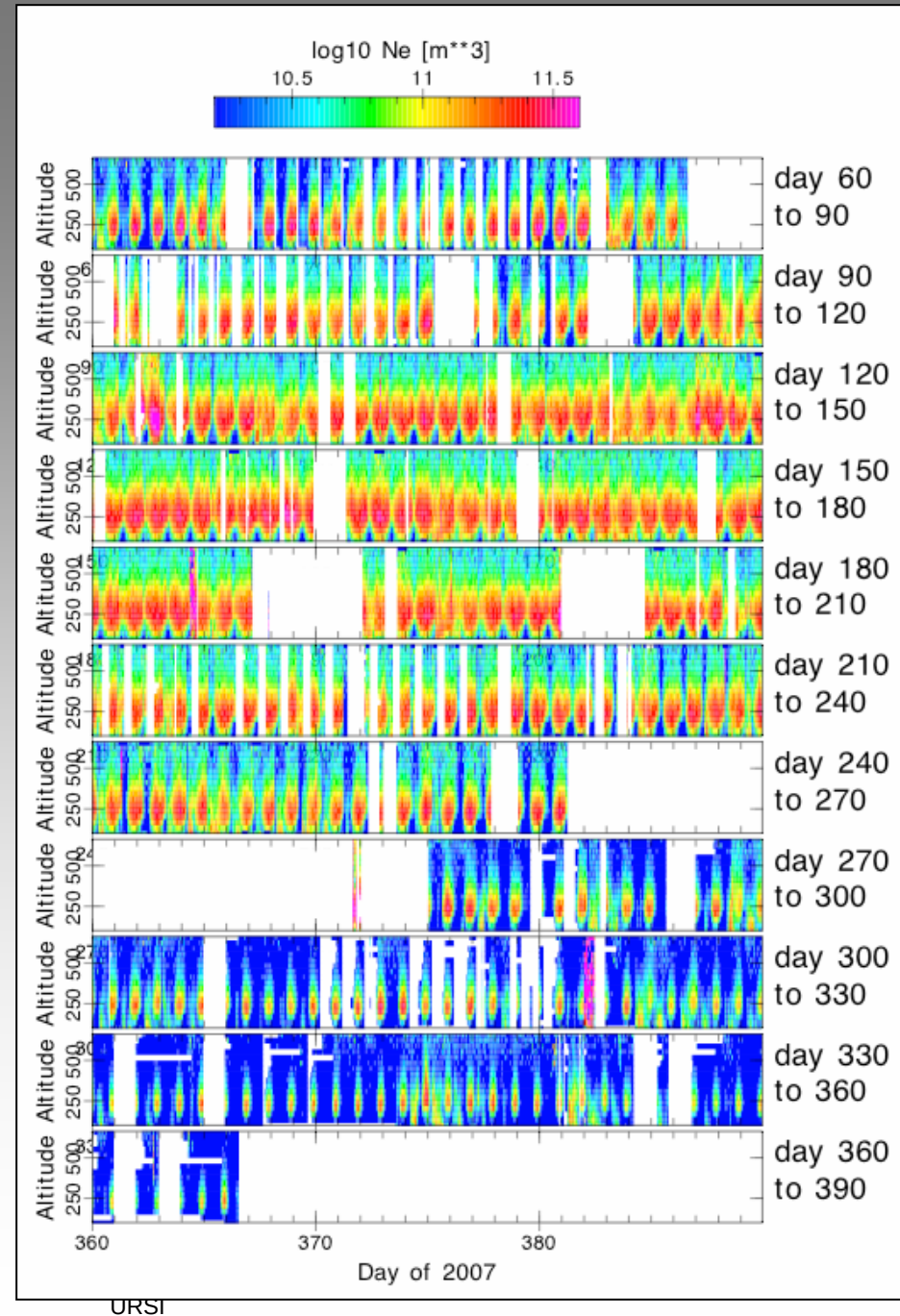
Poker Flat Radar





PFISR

Electron density
observations from
1 March 2007 to
7 January 2008





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Sondrestrom Radar



URSI

Photo: Craig Hienselman

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SuperDARN

Saskatoon

...different, complementary, views





IPY IS Radar Operations

- ESR operated field-aligned continuously
- Poker Flat Radar operates continuously
- ESR, Millstone Hill, and Sondrestrom run local scans one day every two weeks
- Irkutsk radar runs one month in every three
- Sondrestrom supports ESR during planned maintenance
- Profiles of electron density, electron and ion temperatures and line-of-sight velocity at least hourly
- Electron densities fully calibrated, typically using simultaneous plasma line measurements
- Bi-weekly combined observations also use scans to derive electric fields
- Longest ever ISR datasets emphasising quiet time variability and coupling from below
- **Most extensive, and most detailed, dataset describing the polar atmosphere ever collected**





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Supported by an ISSI Working Group

'Towards more effective physics-based and statistical models of the polar ionosphere'

- Capitalise on the unique opportunity represented by the huge increase in data availability during the International Polar Year (IPY) of 2007-9 to dramatically improve the quality of models and the underlying physical understanding, and in particular to develop their capabilities in now- and fore-casting.
- Two main threads, the first related directly to the development of the model-data comparison and model improvement, and the second related to understanding some of the important classes of phenomena revealed by the observational and modelling programs.
- Use the year-long ISR runs not just to validate the physics of high latitude ionospheric models, but also as input data for assimilation models.



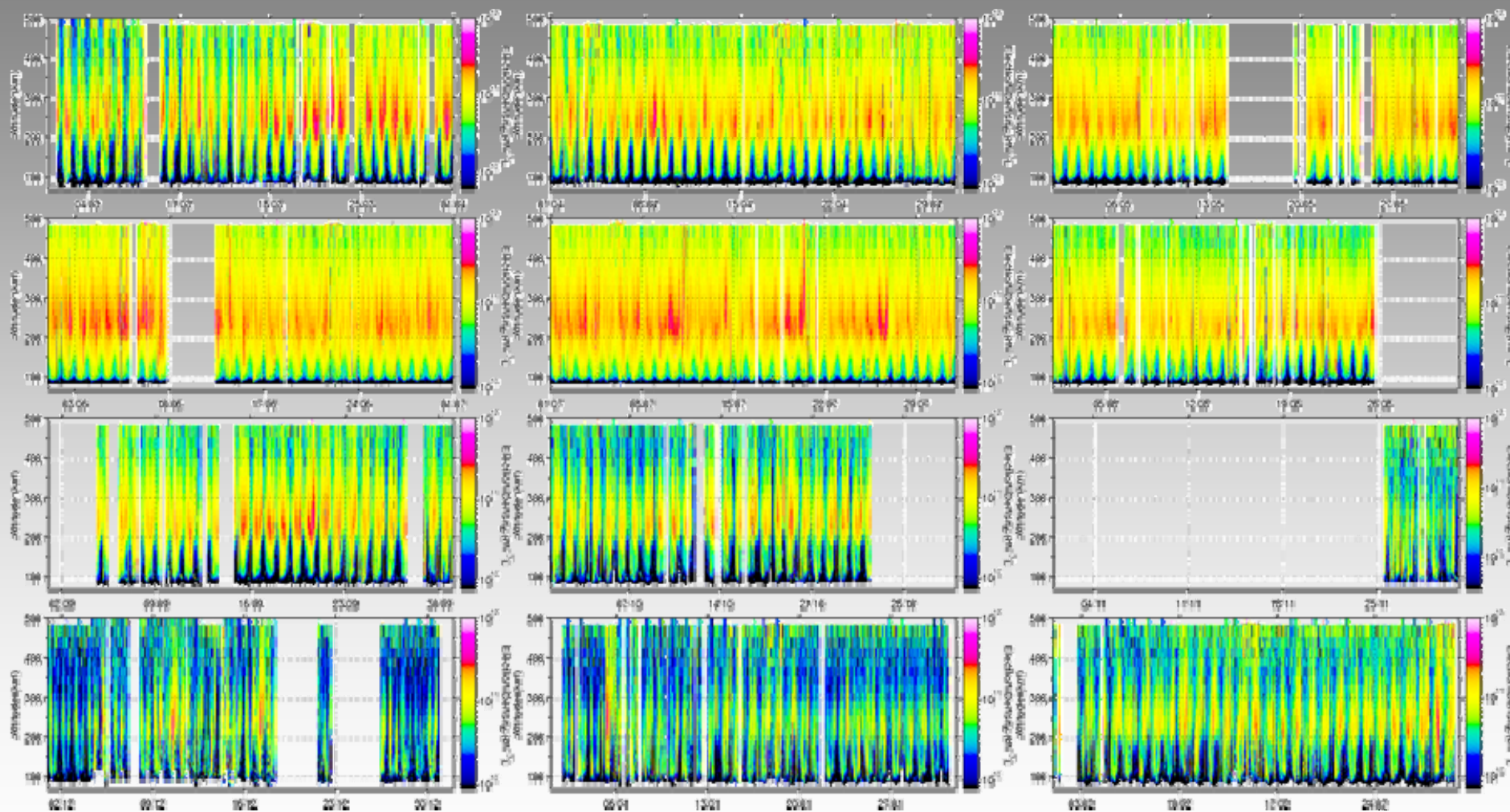
IPY: Modelling Campaign

Modeling Challenges

- Continuous model runs to capture:
 - Climate: Seasonal and diurnal
 - Weather: Days and hours
- Parameters
 - Electron density profiles
 - Ion temperature profiles
 - Electron temperatures profiles
- Separate atmospheric from magnetospheric drivers



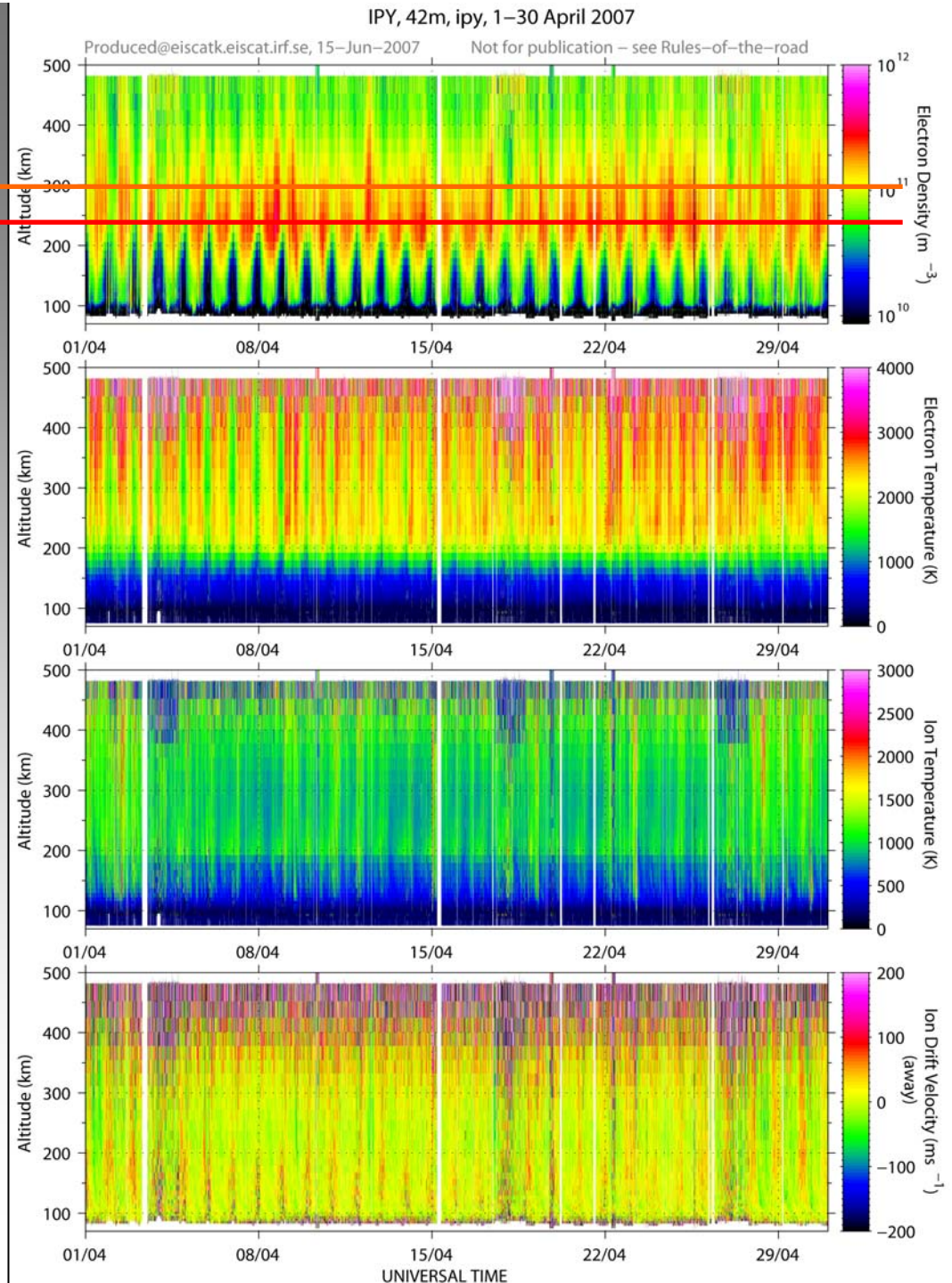
Spring, Summer, Autumn, Winter





April

- Red line is the approximate mean height of the observed F2 peak
- Orange line is the modellers' belief of where it should be
- Changing the temperature to take account of the reductions seen in the long term values by Millstone Hill accounts for most of the differences in altitude and peak density
- Climate modellers have suggested that doubling the amount of green-house gasses in the atmosphere would result in a reduction in the F2 peak altitude of about 40km





Modelling update

- The IPY ionospheric observations have yielded a unique high latitude database
- The PFISR and ESR data sets are complementary: auroral and polar cap coverage
- Ionospheric temperature is the major science focus for the modeling community
- New ISSI working group 'Bridging the gap between the middle and upper atmosphere'
Coordinator: P Hoffmann (Leibniz-Institute of Atmospheric Physics, Kühlungsborn)



Ionospheric temperatures

Ion temperature at 300 km

- Summer hotter by ~200K than winter
- $K_p > 3$ hotter by ~200K than $K_p < 1$
- Seen both at PFISR and ESR
- T_i is a parameter that distinguishes between weather and climate

Electron temperature at 300 km

- Dominated by solar heat source
- Geomagnetic-weather is second order!
- Both PFISR auroral and ESR polar see similar trends



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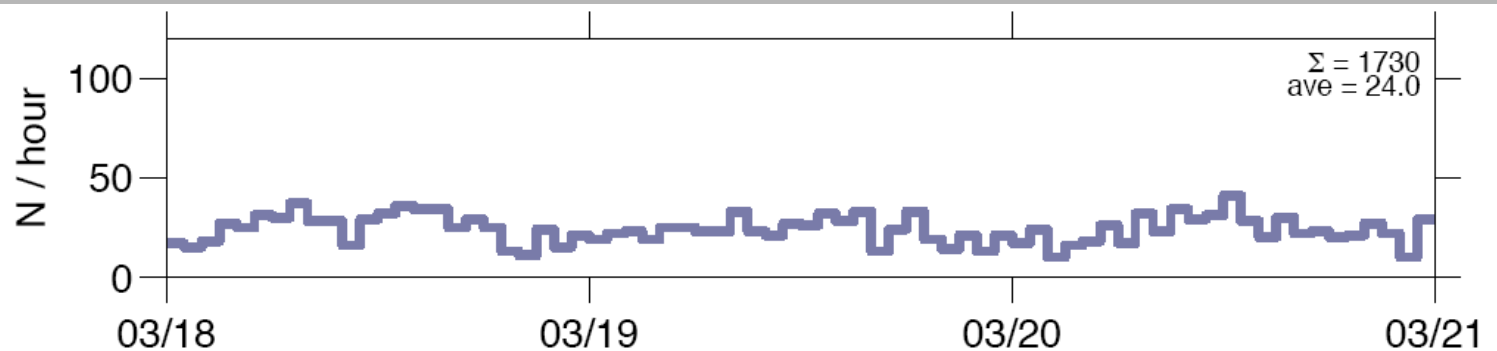


EISCAT: Space debris

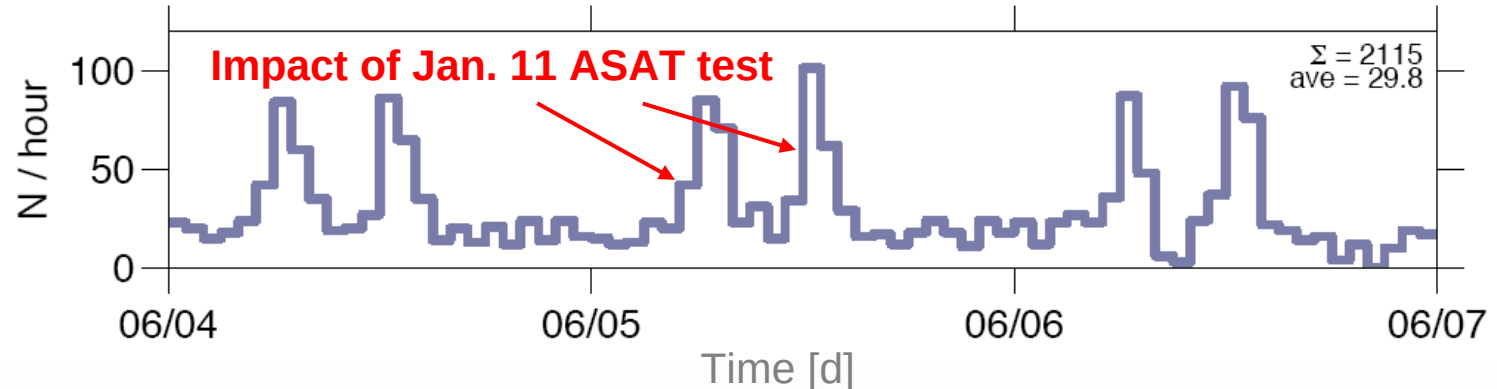
- Observations in 2005: UHF/Tromsø (675hours), ESR (24hours)
- Observations in 2006: UHF/Tromsø (378hours), ESR (138hours)
- Since March 13th 2007, continuous observations with the ESR as part of the IPY (International Polar Year)

EISCAT Svalbard Radar (ESR) results in March 2006 and June 2007

March 2006,
18th-21st

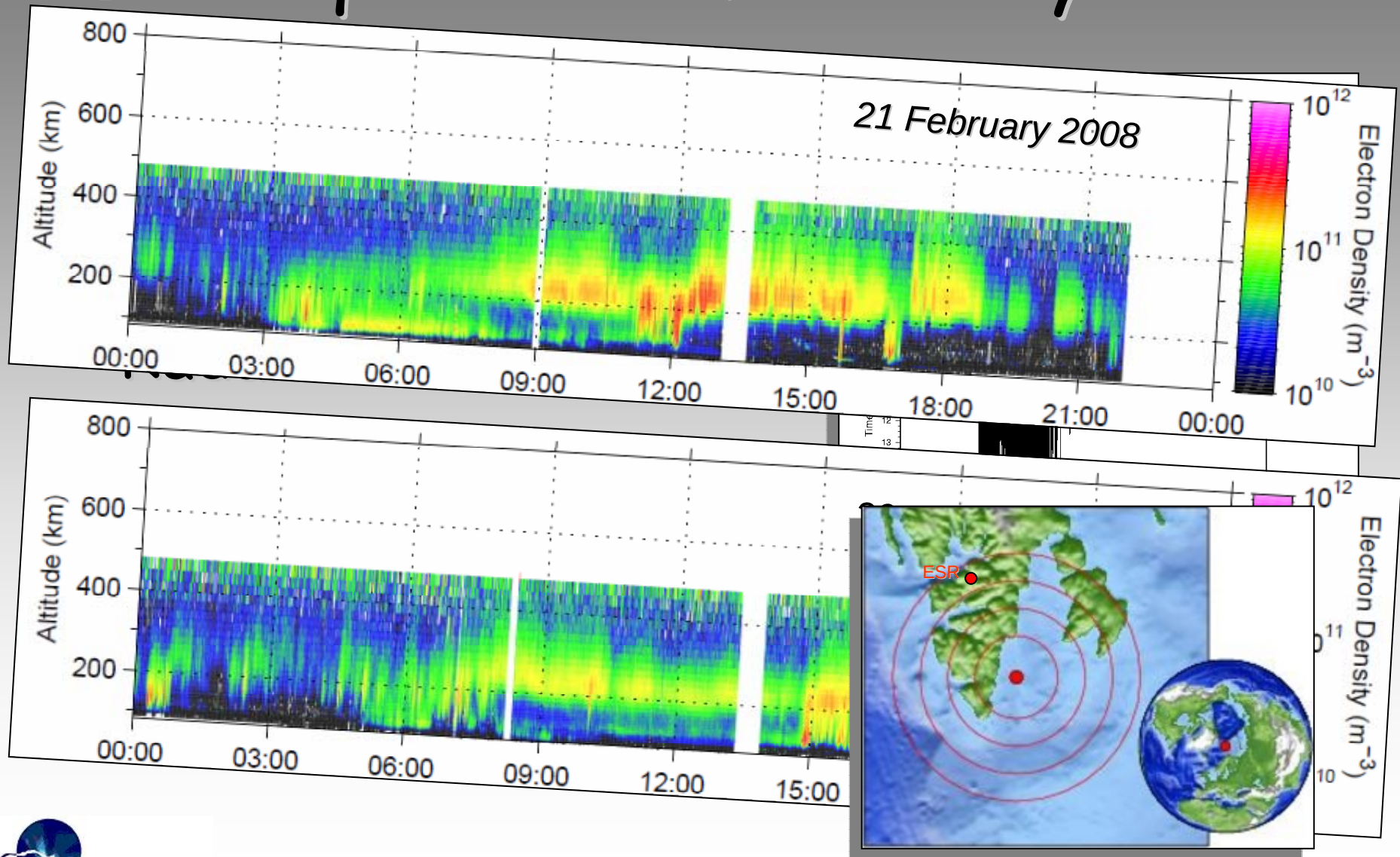


June 2007,
4th-7th





Earthquake: 21 February 2008



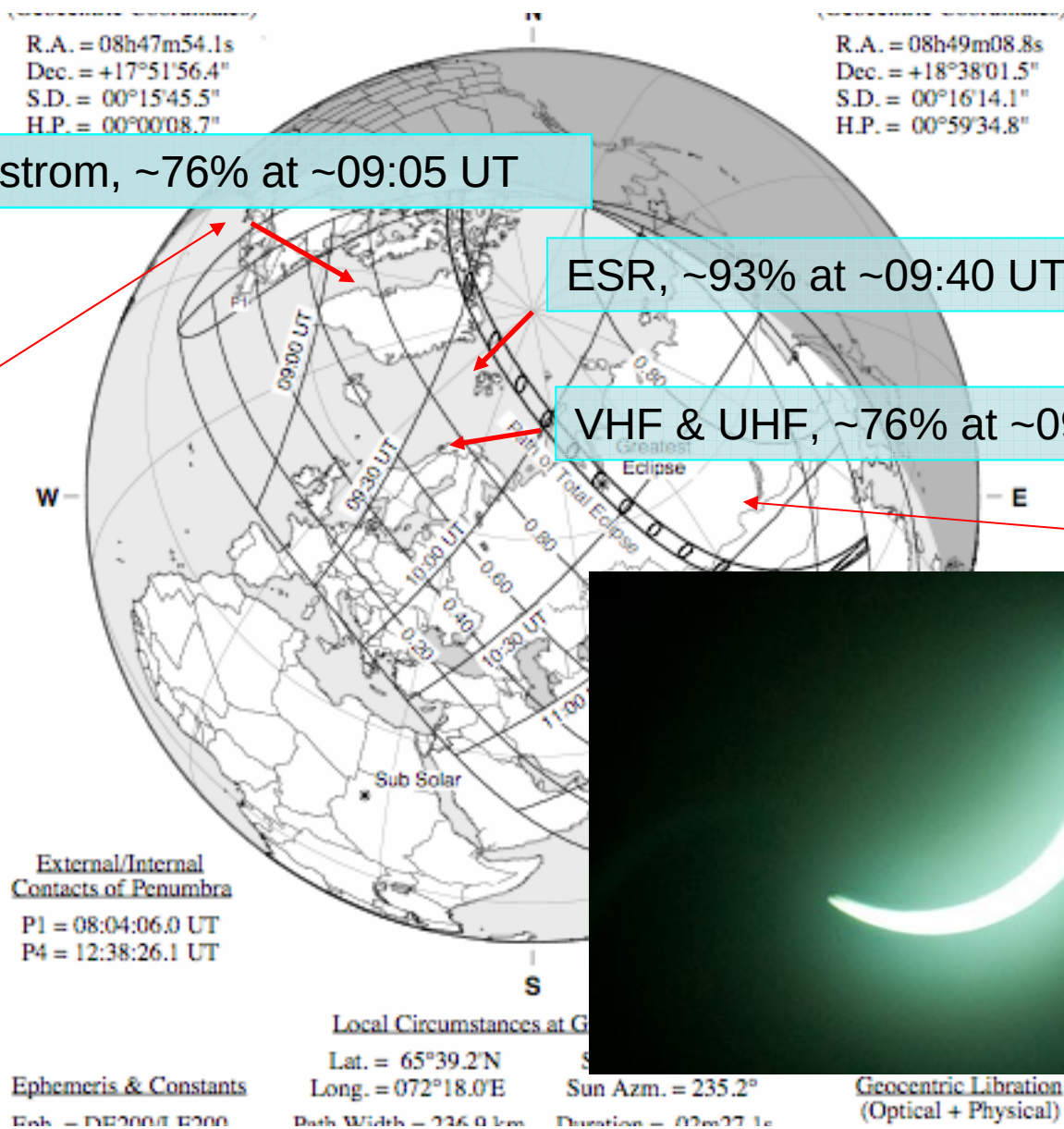


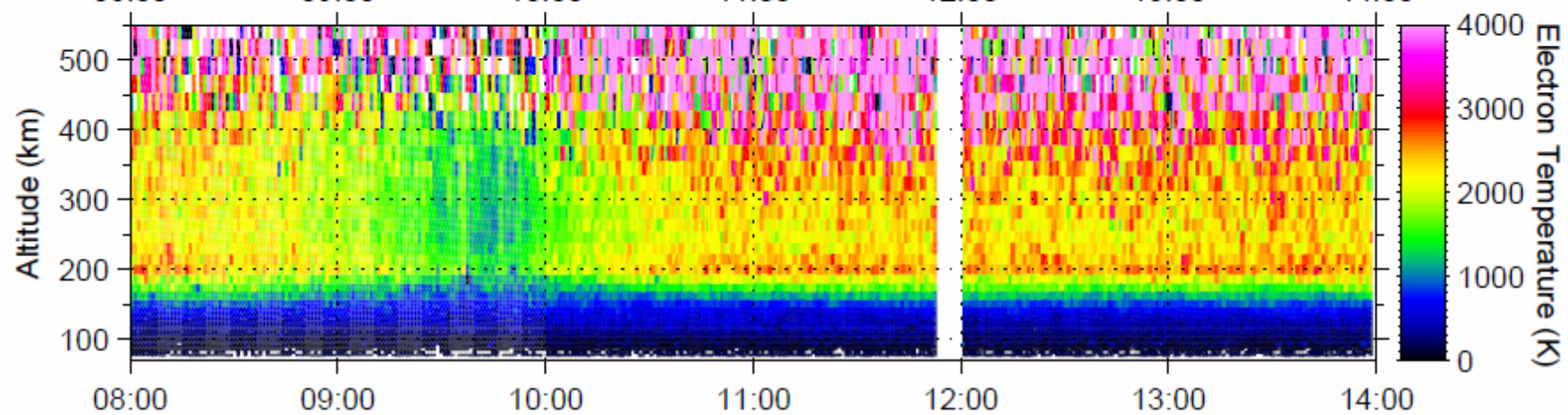
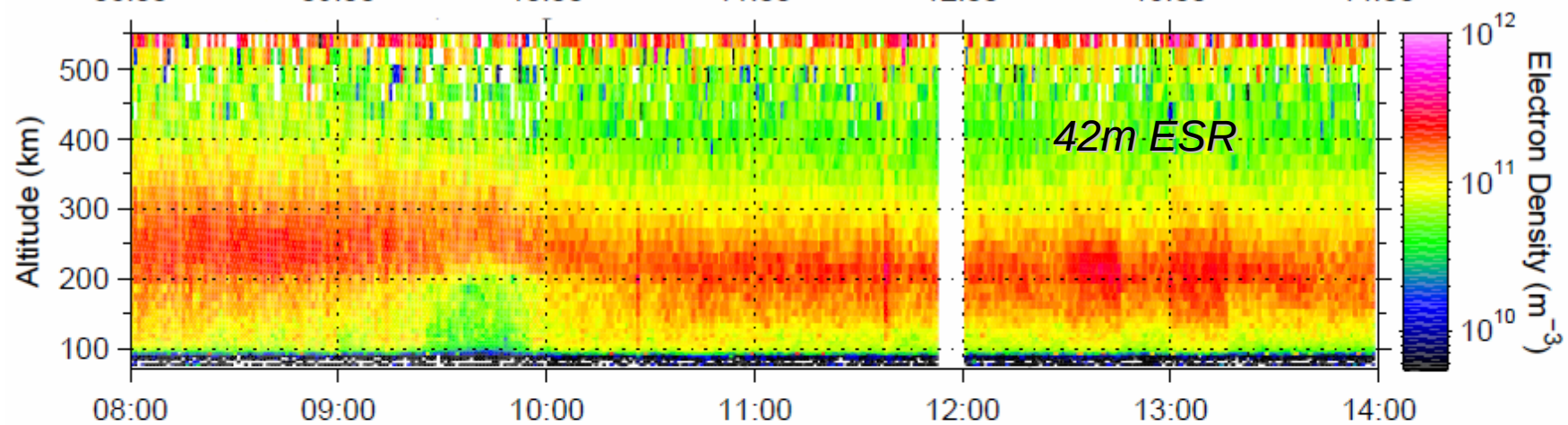
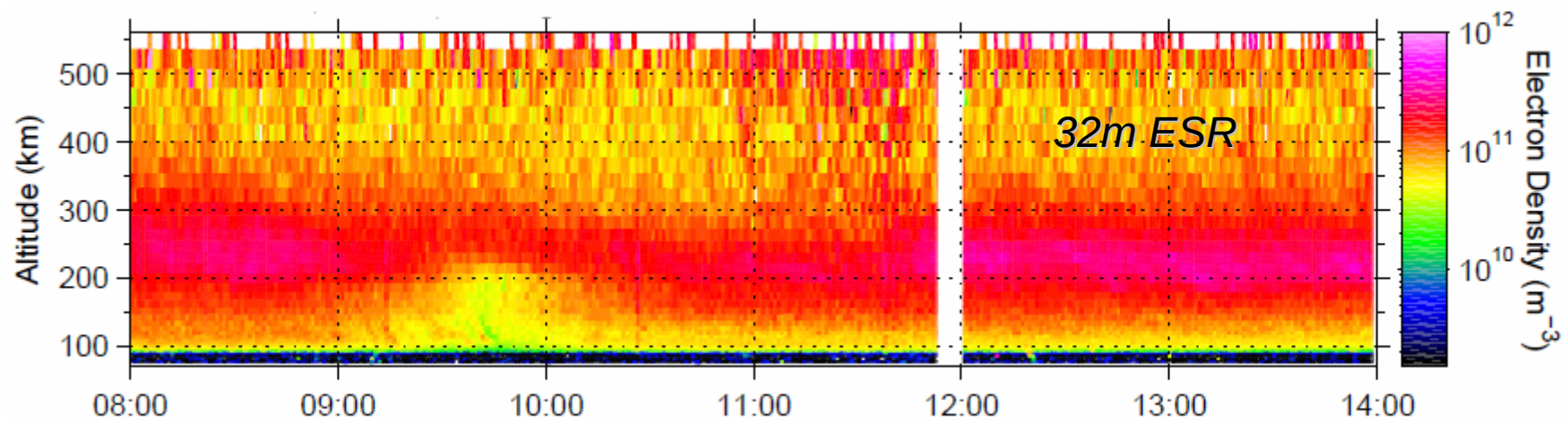
Eclipse 1 August 2008

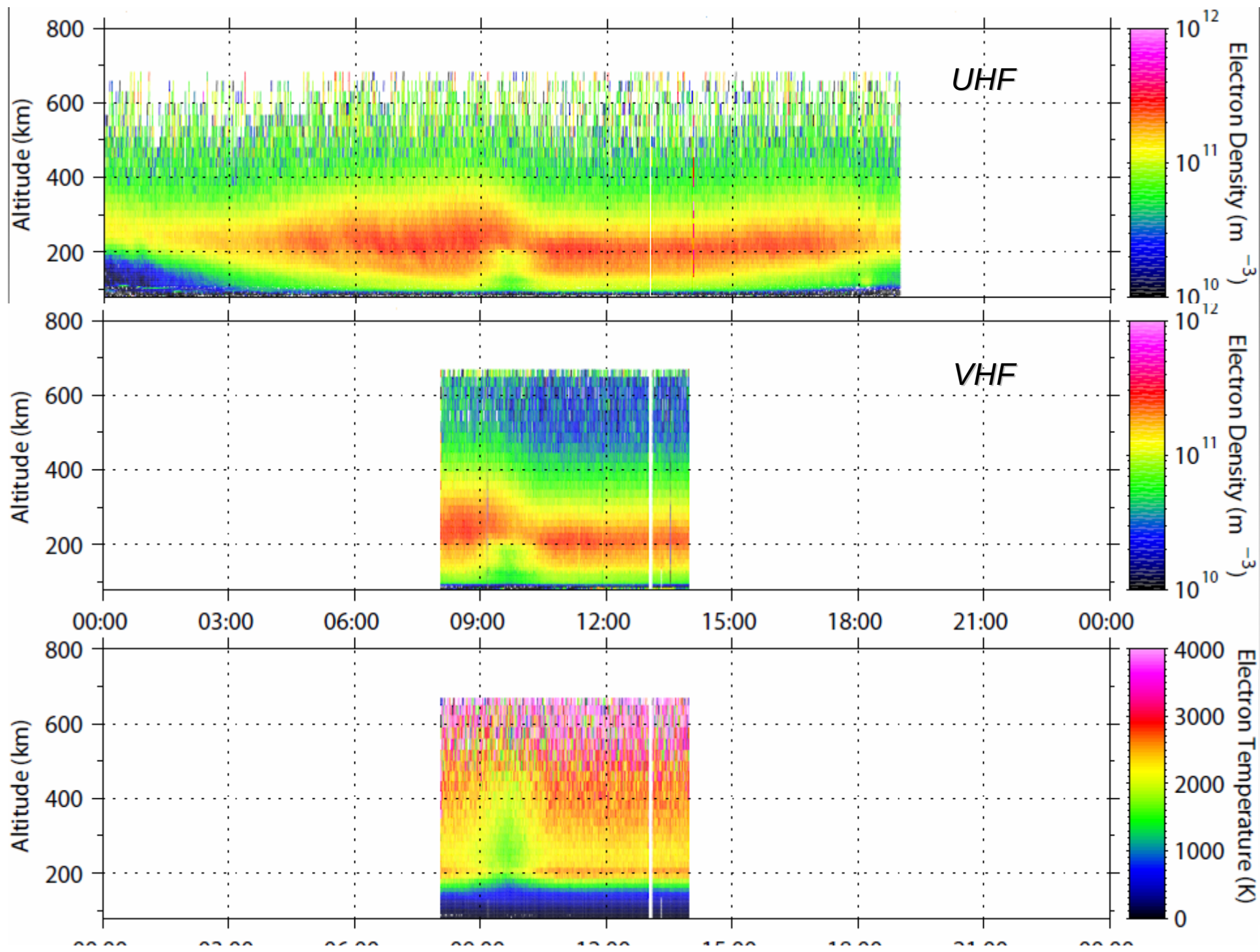
Sondrestrom, ~76% at ~09:05 UT

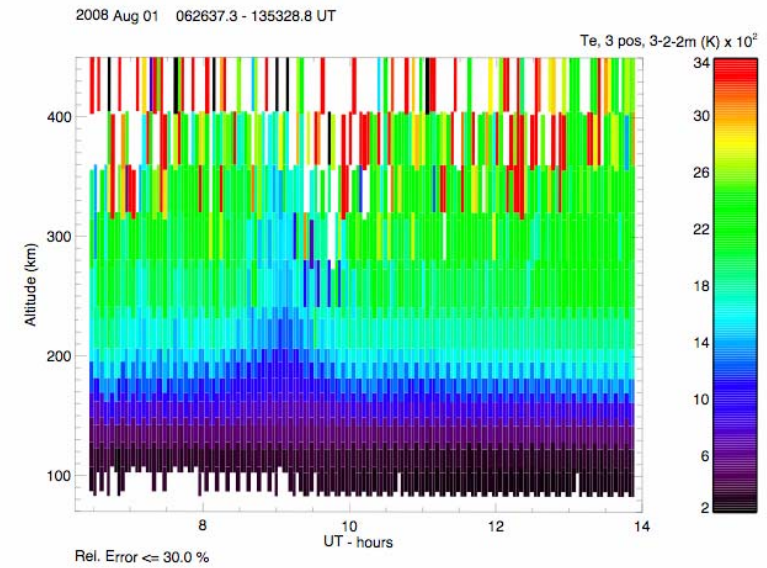
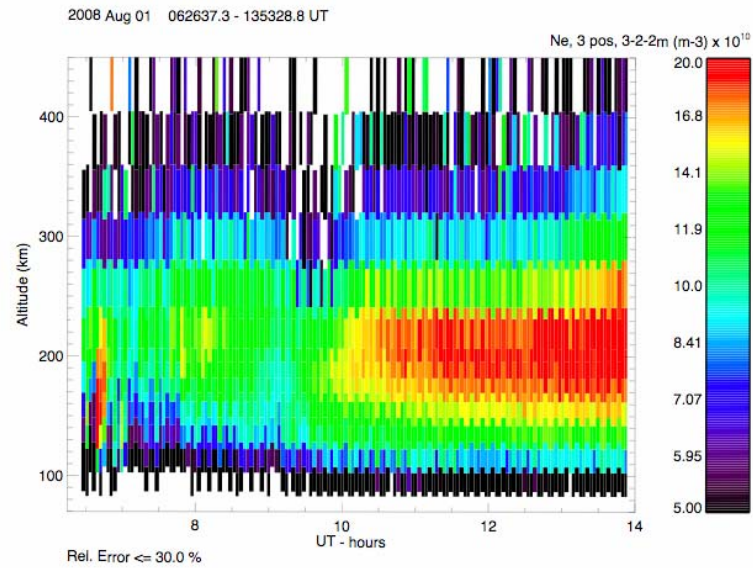
ESR, ~93% at ~09:40 UT

VHF & UHF, ~76% at ~09:40 UT





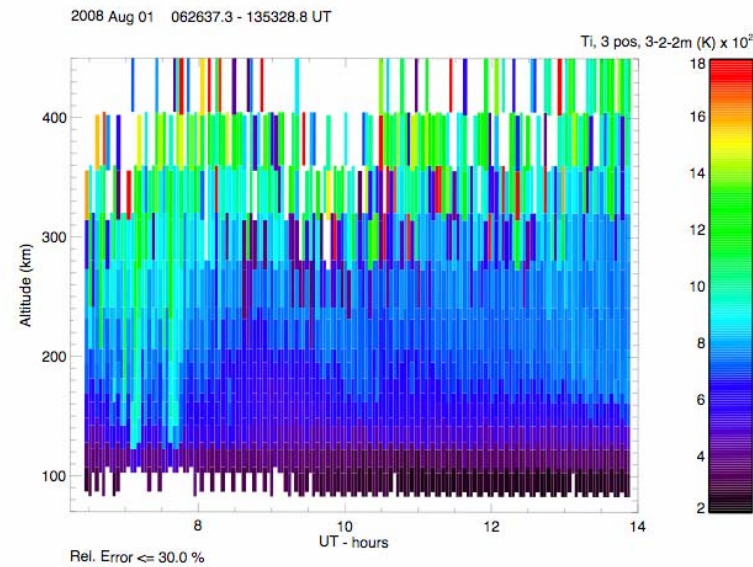




acport-56800-56807.ct1-1-sigma

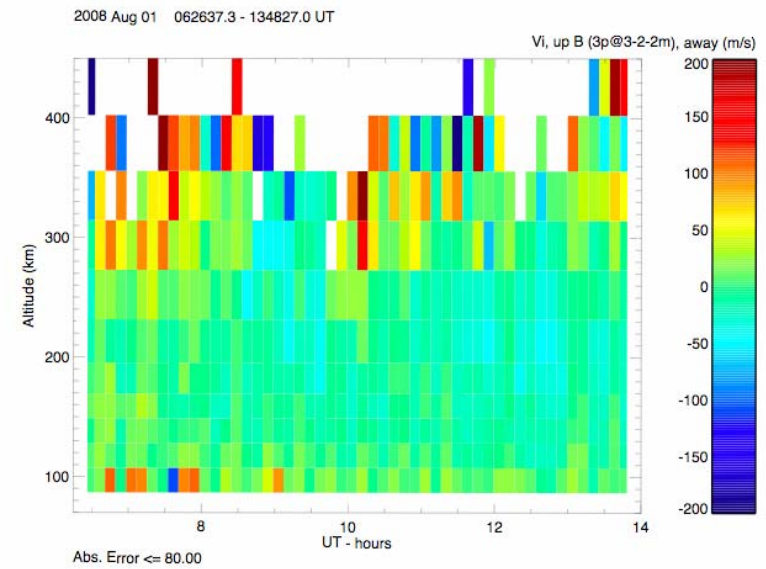
080801-0630-1400-te-3p.ps

Sondrestrom



acport-56800-56807.ct1-1-sigma

080801-0630-1400-ti-3p.ps



acport-56800-56807.ct1-1-sigma

080801-0630-1400-vi-upb.ps



IPY bi-weekly interval

Also running:

- Millstone Hill
- Irkutsk
- (PFISR)
- SuperDARN
- ...



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Data & data availability

- ISR data analysed in real time
- Data validated and calibrated using plasma line (this is the best calibrated incoherent scatter dataset ever)
- Analysed data freely available through distributed database within hours of data collection
- Raw data and additional products through PIs
- Modelling runs being added in compatible formats

Madrigal Database Access - Windows Internet Explorer

http://madrigal.haystack.mit.edu/cgi-bin/madrigal/accessData.cgi?newSite=1&user_fullname=Tony+van+Eyken&user_

File Edit View Favorites Tools Help

Google Go Bookmarks Check AutoFill Send to Settings

Madrigal Database Access

Back to [Millstone homepage](#)

Access Madrigal Data

Go to a different Madrigal site: Millstone

Simple Madrigal Data Access

This link allows you to print and plot local Millstone Madrigal data easily. Use the other three Madrigal interfaces to access more powerful capabilities, such as displaying derived parameters or searching over all Madrigal servers. Click [here](#) for a tutorial.

Browse for Individual Madrigal Experiments

Use this link to search available experiments. You can search either *all* Madrigal databases, or just the local Millstone database. You can choose which parameters to print, including derived parameters, and can filter the data using any parameter. Click [here](#) for a tutorial.

Global Madrigal Database Report

This link allows you to generate a report on multiple local Millstone experiments at once. Experiments can be filtered in a number of ways. Data from the local Madrigal database matching your criteria will be returned in a single report. Click [here](#) for a tutorial.

Plot Data from Instruments

This link allows you to create new plots from one or more instruments and/or Madrigal experiments versus time on a single web page. The data comes from the local Millstone database. Click [here](#) for a tutorial.

User: Tony van Eyken	Email: tony@eiscat.se	Affiliation: EISCAT	Click here to modify
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Use of the Madrigal Database is generally subject to the [CEDAR Database Rules-of-the-Road](#). Prior permission to access the data is not required. However, the user is required to establish early contact with any organization whose data are involved in the project to discuss the intended usage. Data are often subject to limitations which are not immediately evident to new users. Before they are formally submitted, draft copies of all reports and publications must be sent to the contact scientist at all data-supplying organizations along with

Internet 100%



Madrigal Experiment Listing - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Home Search Favorites Links

Station	Date	Time	Freq	Mode	Description
GO Mills	21.09.2005	0000	21.09.2005 2355	gps	World-wide Vertical Total Electron Content
GO Mills	21.09.2005	0805	21.09.2005 2352	mlh	ISWD 30 day run
GO EISCA	21.09.2005	0000	21.09.2005 0650	kir	tau2pl_ant
GO EISCA	21.09.2005	0001	22.09.2005 0000	lyr	steffe_ant
GO EISCA	21.09.2005	0000	21.09.2005 0650	sod	tau2pl_ant
GO EISCA	21.09.2005	0000	21.09.2005 0650	tro	tau2pl_ant
GO SRI	21.09.2005	0002	21.09.2005 2357	son	
GO JRO	21.09.2005	0500	22.09.2005 0500	ir	
GO Mills	22.09.2005	0000	22.09.2005 2355	gps	World-wide Vertical Total Electron Content
GO Mills	22.09.2005	0755	22.09.2005 2359	mlh	ISWD 30 day run
GO EISCA	22.09.2005	0710	22.09.2005 0000	kir	tau2pl_ant
GO EISCA	22.09.2005	0001	23.09.2005 0000	lyr	steffe_ant
GO EISCA	22.09.2005	0000	23.09.2005 2359	tro	tau2pl_ant
GO Mills	23.09.2005	0000	23.09.2005 2355	gps	World-wide Vertical Total Electron Content
GO Mills	23.09.2005	0801	23.09.2005 2359	mlh	ISWD 30 day run
GO EISCA	24.09.2005	0000	24.09.2005 0000	kir	tau2pl_ant
GO EISCA	24.09.2005	0001	24.09.2005 0000	lyr	steffe_ant
GO EISCA	24.09.2005	0000	24.09.2005 2359	tro	tau2pl_ant
GO SRI	24.09.2005	0002	24.09.2005 2355	son	
GO Mills	25.09.2005	0000	25.09.2005 2355	gps	World-wide Vertical Total Electron Content
GO Mills	25.09.2005	0803	25.09.2005 2359	mlh	ISWD 30 day run
GO EISCA	25.09.2005	0000	25.09.2005 2359	kir	tau2pl_ant
GO EISCA	25.09.2005	0001	26.09.2005 0000	lyr	steffe_ant
GO EISCA	25.09.2005	0000	25.09.2005 2359	tro	tau2pl_ant

**Available in popular formats, including flat ASCII files,
for free download**

Support program access, including support for VOs

Done Internet

**Data available in popular formats, including flat ASCII files,
for free download**

APIs support program access, including support for VOs

Distributed, free, data access system with extensive user and application programming interfaces. www.openmadrigal.org

VSTO Home - Windows Internet Explorer

http://www.vsto.org/home/home.htm

Google

Main Page - CedarWiki

VSTO Home

NCAR

Virtual Solar Terrestrial Observatory

Home Data Co

Welcome to the Virtual Solar

The Virtual Solar Terrestrial Observatory (VSTO) is a unified semantic environment for solar, terrestrial, and space physics (SSTSP), currently:

- Upper atmosphere data from the **CEDAR** (Coupling, Energetics and Dynamics) archive
- Corona data from the **MLSO** (Mauna Loa Solar Observatory) archive

Knowledge base from heterogeneous sources

VSTO Portal

VSTO Data Services

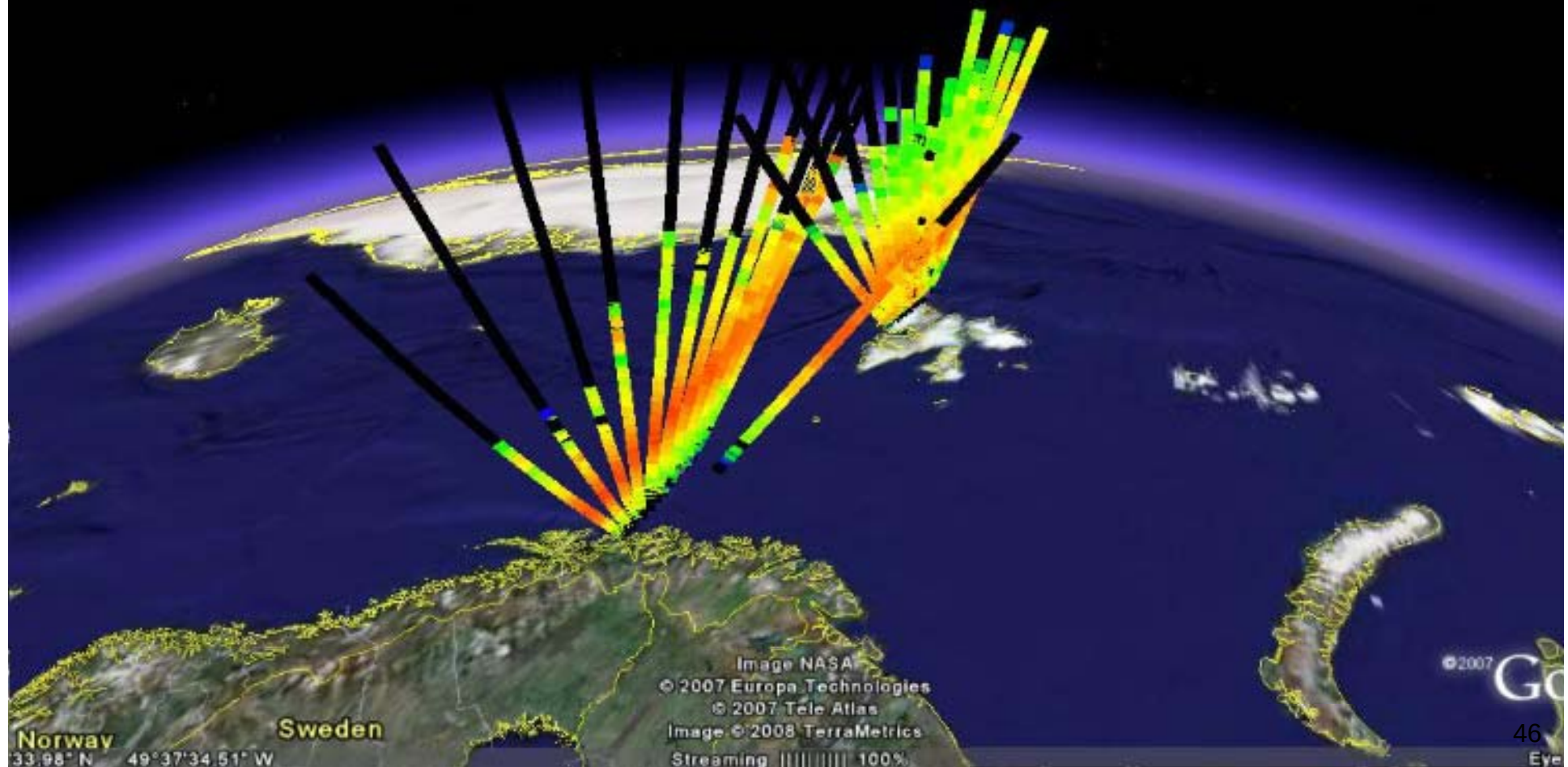
MLSO Data Services

Internet 100%

Courtesy of Y Ogawa and A Saito

21 SEP 2006 7:03am
21 SEP 2006 7:44am

Google Earth





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What happens after the IPY?

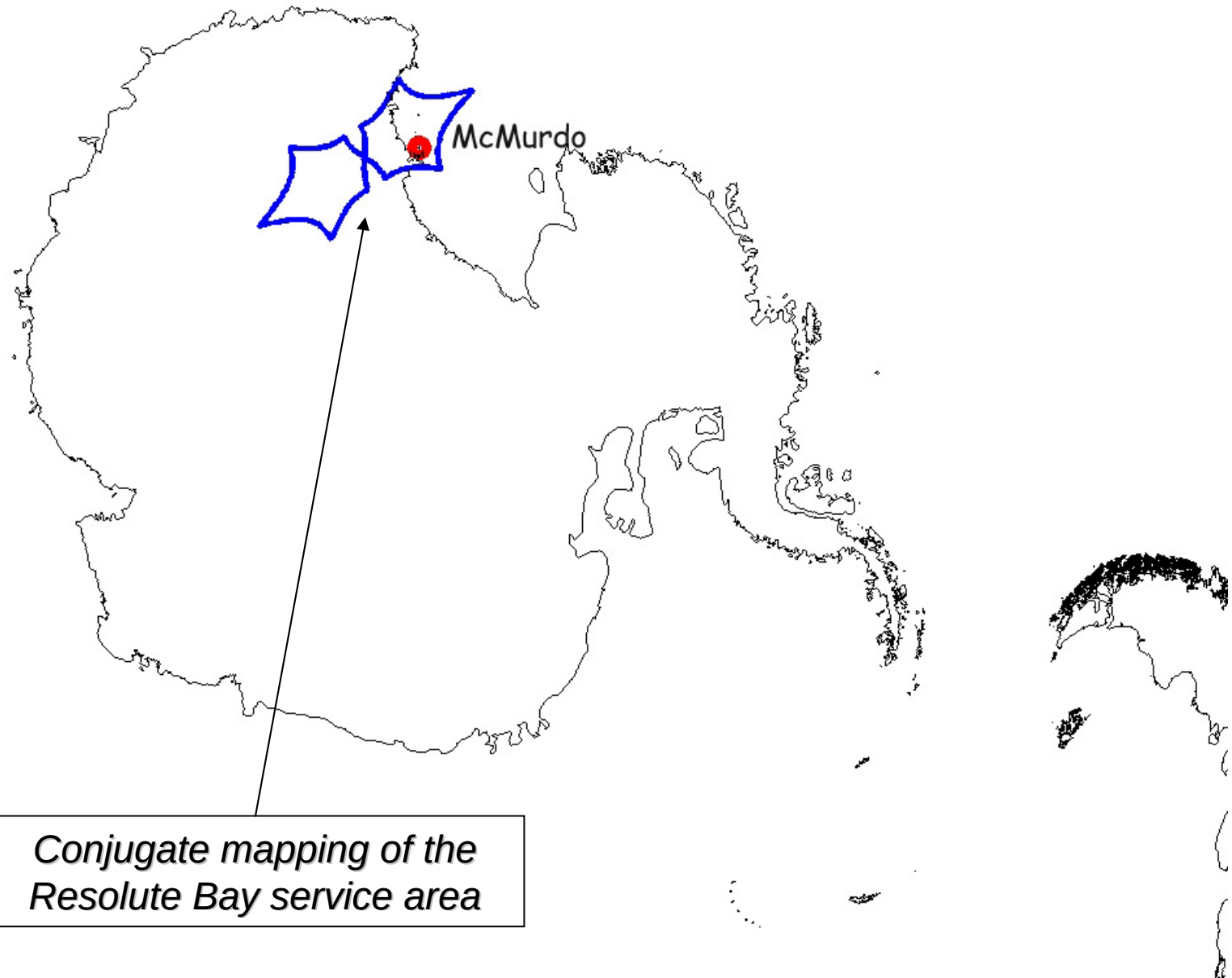
- Continuous ISR data is possible, practical, and useful
- Collected data will be the reference against which models and theories are tested for the next 50 years
- Studies and collaborations established under the drive of the IPY will continue and grow
- Thirst for high quality data drives demand for new, even better, and wider coverage



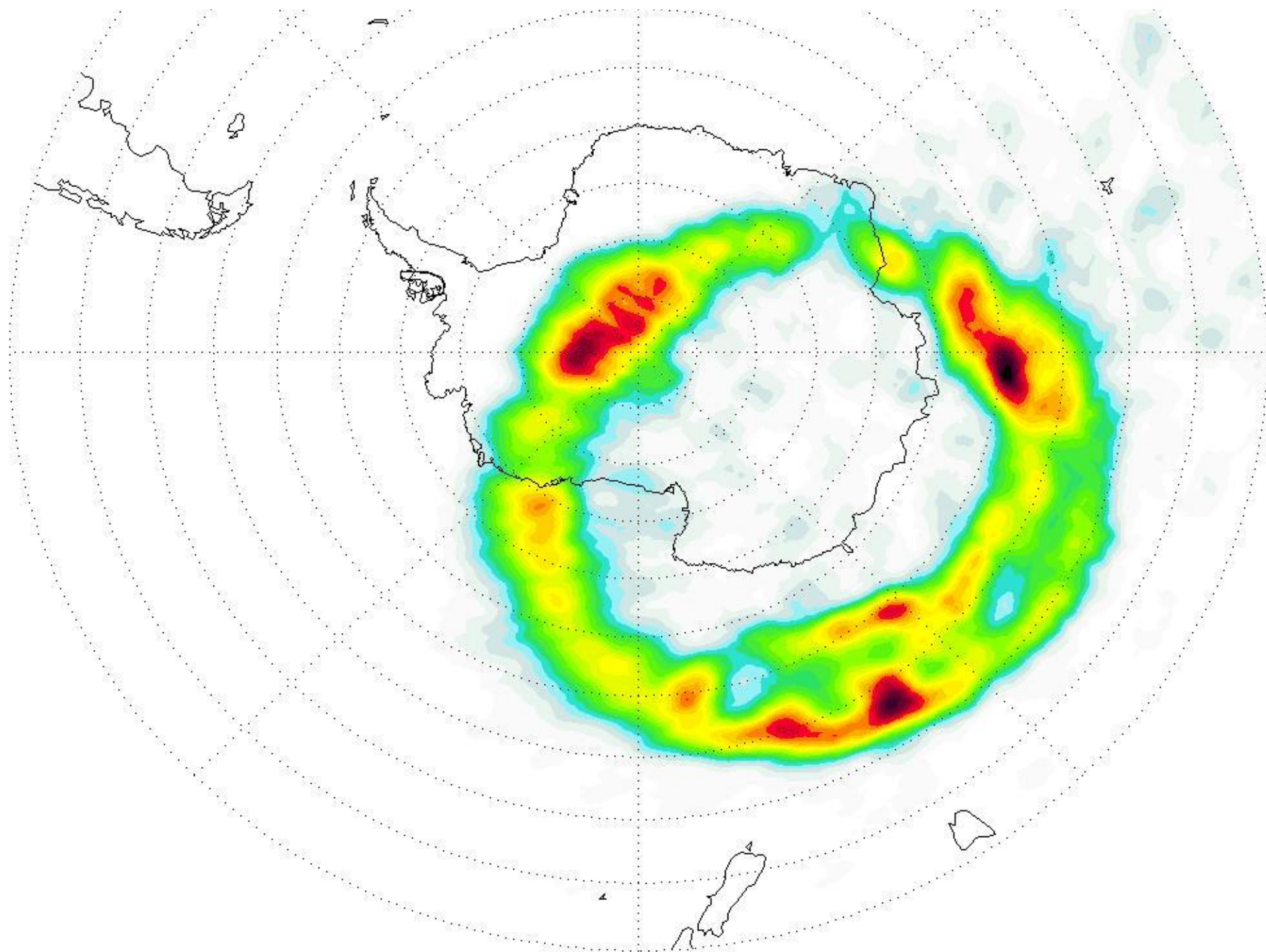
Momentum

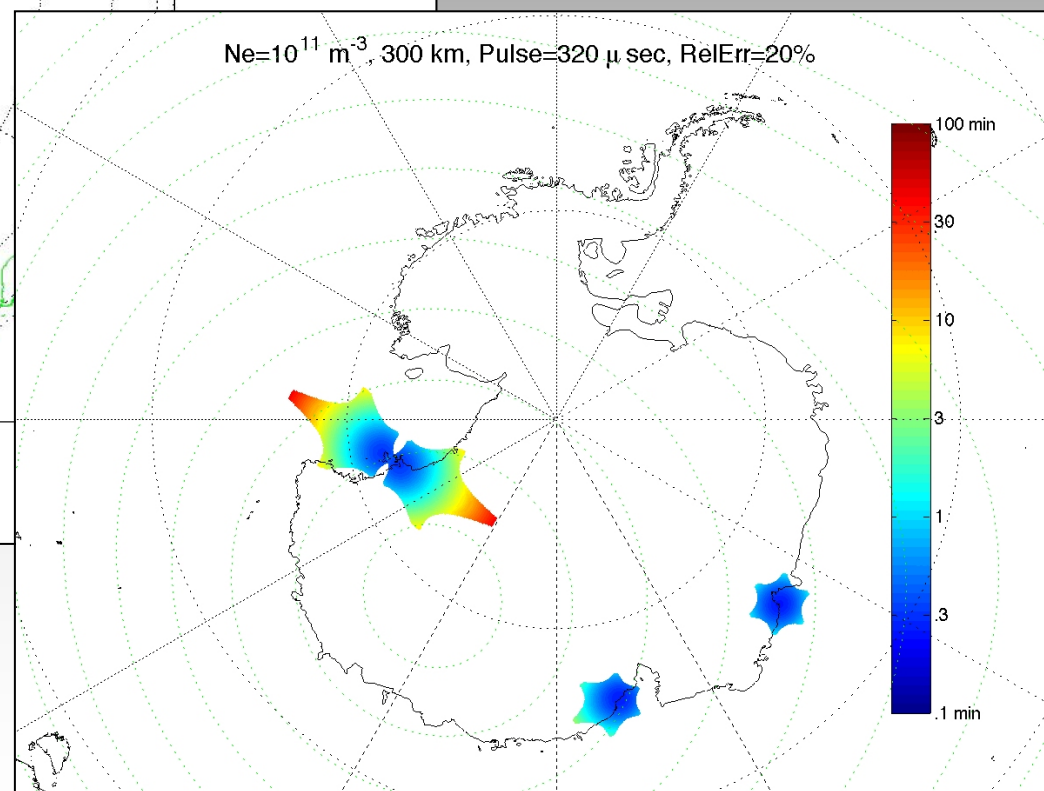
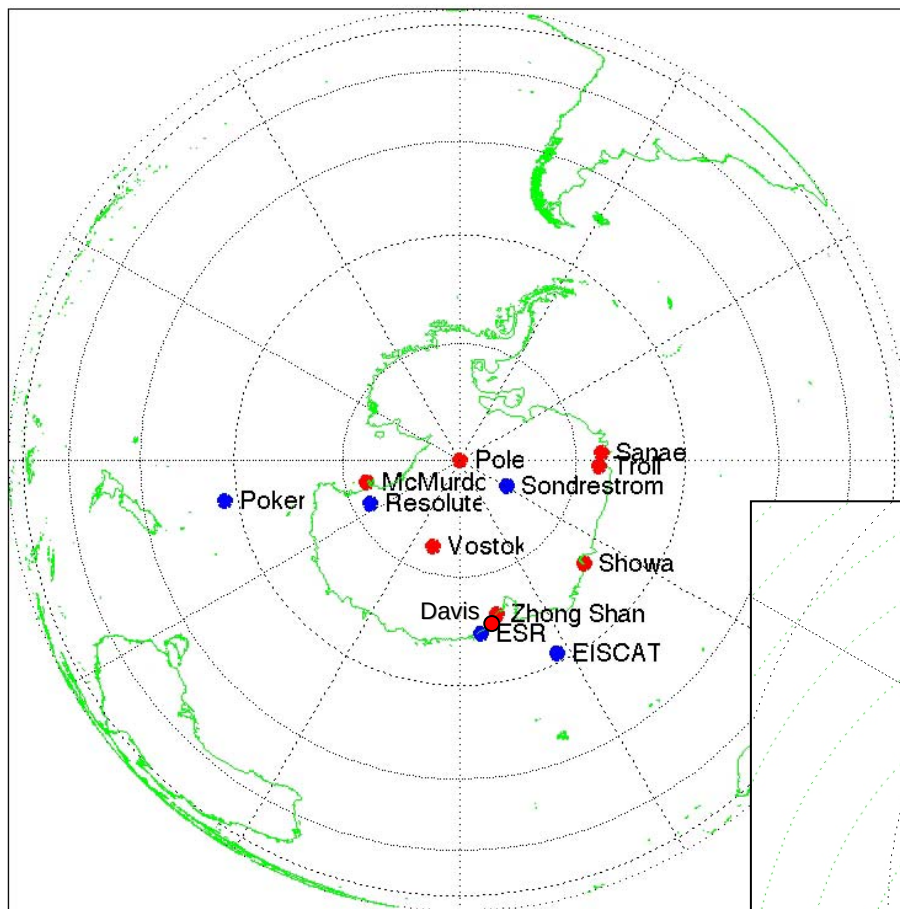
- PFISR still running... 17 months and rising!
- 2-weekly operations with EISCAT UHF tri-static, ESR, Sondrestrom, PFISR, ...
- Irkutsk
- ESFRI roadmap initiatives:
 - SIAEOS - Svalbard Integrated Arctic Earth Observing System
 - EISCAT_3D
- Conjugate questions
 - Antarctic ISR?
 - International workshop at URSI last week

An IS radar in Antarctica?



Craig Heinselman, SRI







Summary

- The high latitude ISR IPY dataset is unique, and should/will change the way we look at ISR data.
- Global features of the (northern) polar ionosphere can be studied by utilizing the chain of ISR around (and very soon in) the polar cap.
- Extending ISR measurements to Antarctica is a natural next step towards getting the complete picture of ionospheric dynamics and coupling from above, below, and between hemispheres.

Thank you for your attention!

