International Reference Ionosphere (IRI)
Workshop 2013 "IRI and GNSS"
Olsztyn, June 24 - 28, 2013

Formation of Weddell Sea and Yakutsk Anomalies in *foF*2 Diurnal Variations and Their Manifestation in the Topside Ionosphere

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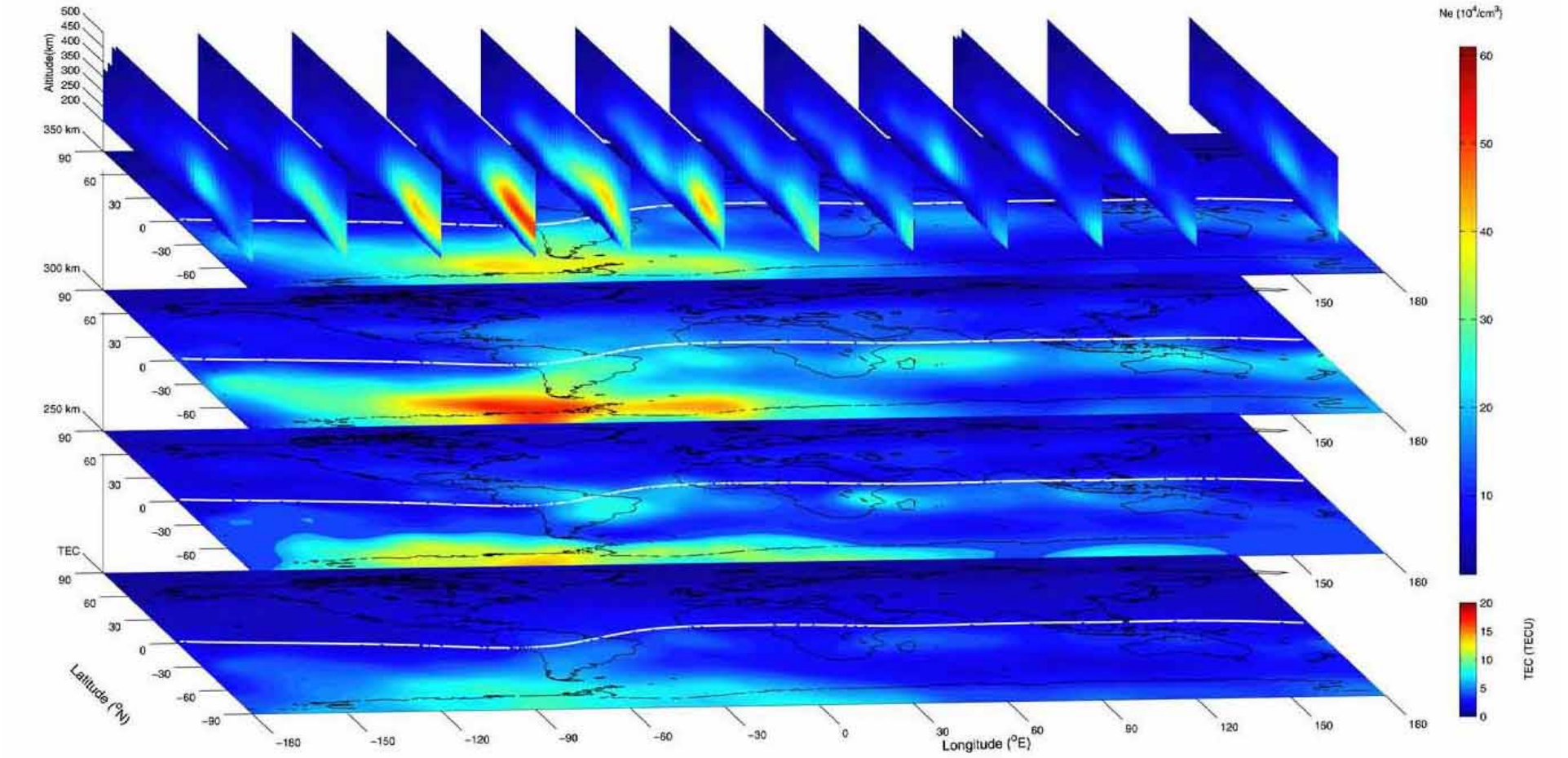
First 3D WSA structure

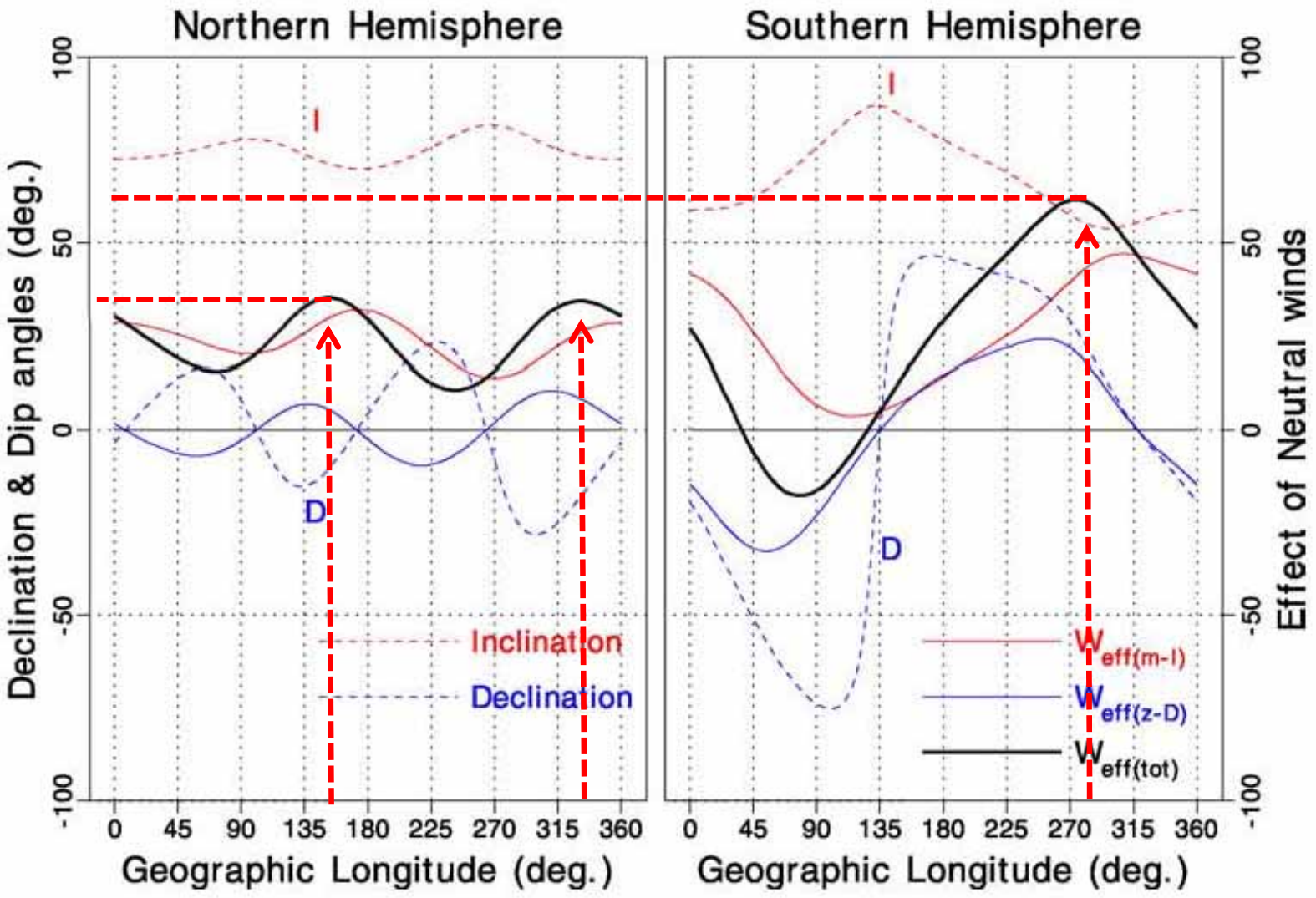


Lin et al., 2009

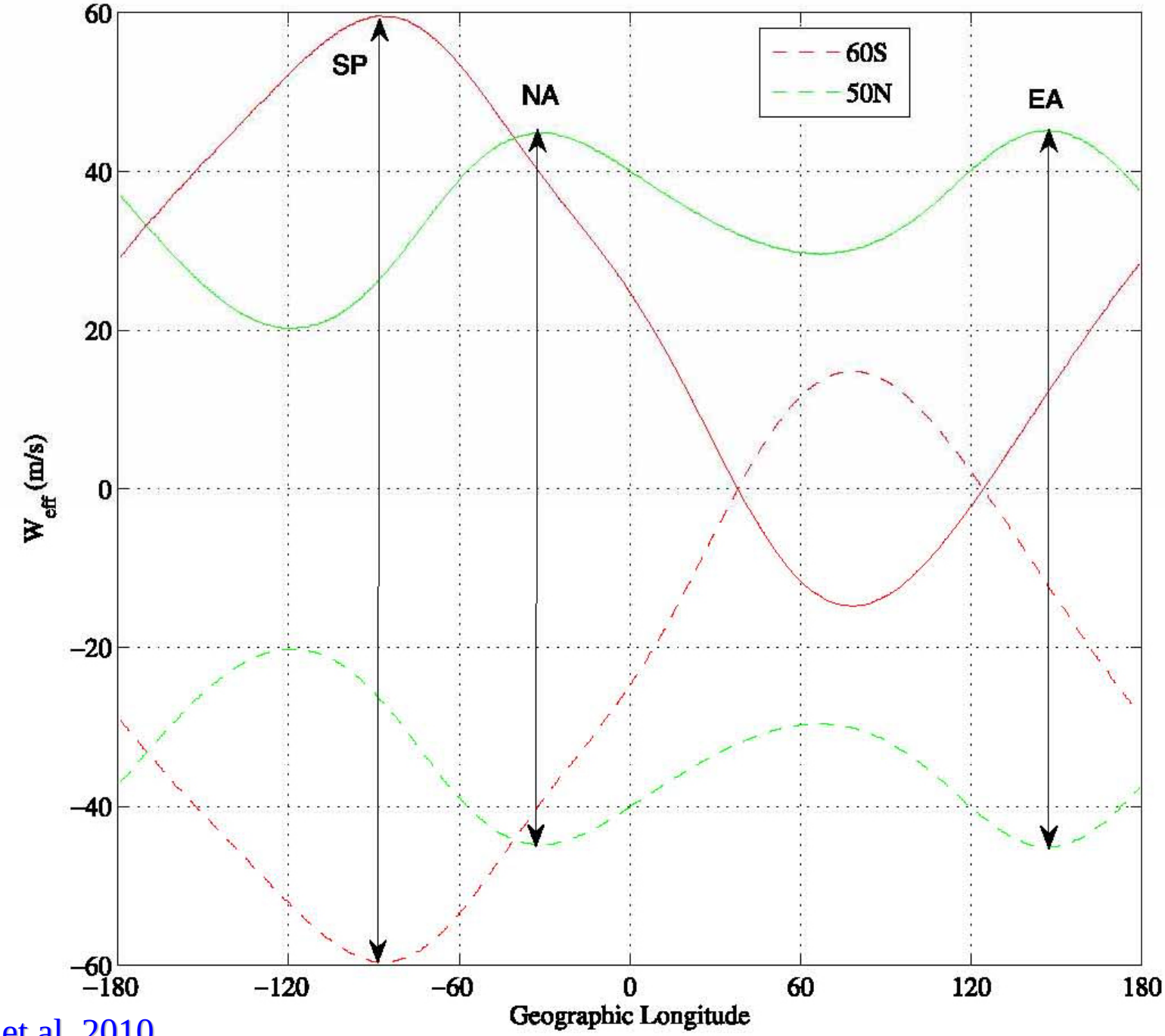
THE PREVIOUSLY PROPOSED FORMATION MECHANISMS OF WSA AND WSA-LIKE ANOMALIES

1. **Solar UV and EUV ionization and thermospheric wind [*Dudeney and Piggott*, 1978]**
2. **Plasma transport from the day side into the night side through the polar caps due to the magnetospheric convection [*Penndorf*, 1965] (formation of "tongue of ionization")**
3. **Declination, inclination, and the divergence of the geomagnetic field lines [*Horvath and Essex*, 2003; *Horvath*, 2006]**
4. **Big difference between the positions of geographic and geomagnetic poles [*Lin et al.*, 2009]**
5. **Horizontal plasma flows in the South Atlantic Magnetic Anomaly region [*Rastogi*, 1960, *Horvath and Lovell*, 2009a]**
6. **Plasma inflow from the plasmasphere [*Burns et al.*, 2008]**
7. **Close relationship with the EIA [*Burns et al.*, 2008; *Lin et al.*, 2009]**
8. **Soft particle precipitations [*Pavlov and Pavlova*, 2007, *Danilov et al.*, 2003]**
9. **Vertical E × B plasma drift [*Burns et al.*, 2009; *Horvath and Lovell*, 2009b]**

Effectiveness of neutral wind in vertical plasma transport



Jee et al.,2009

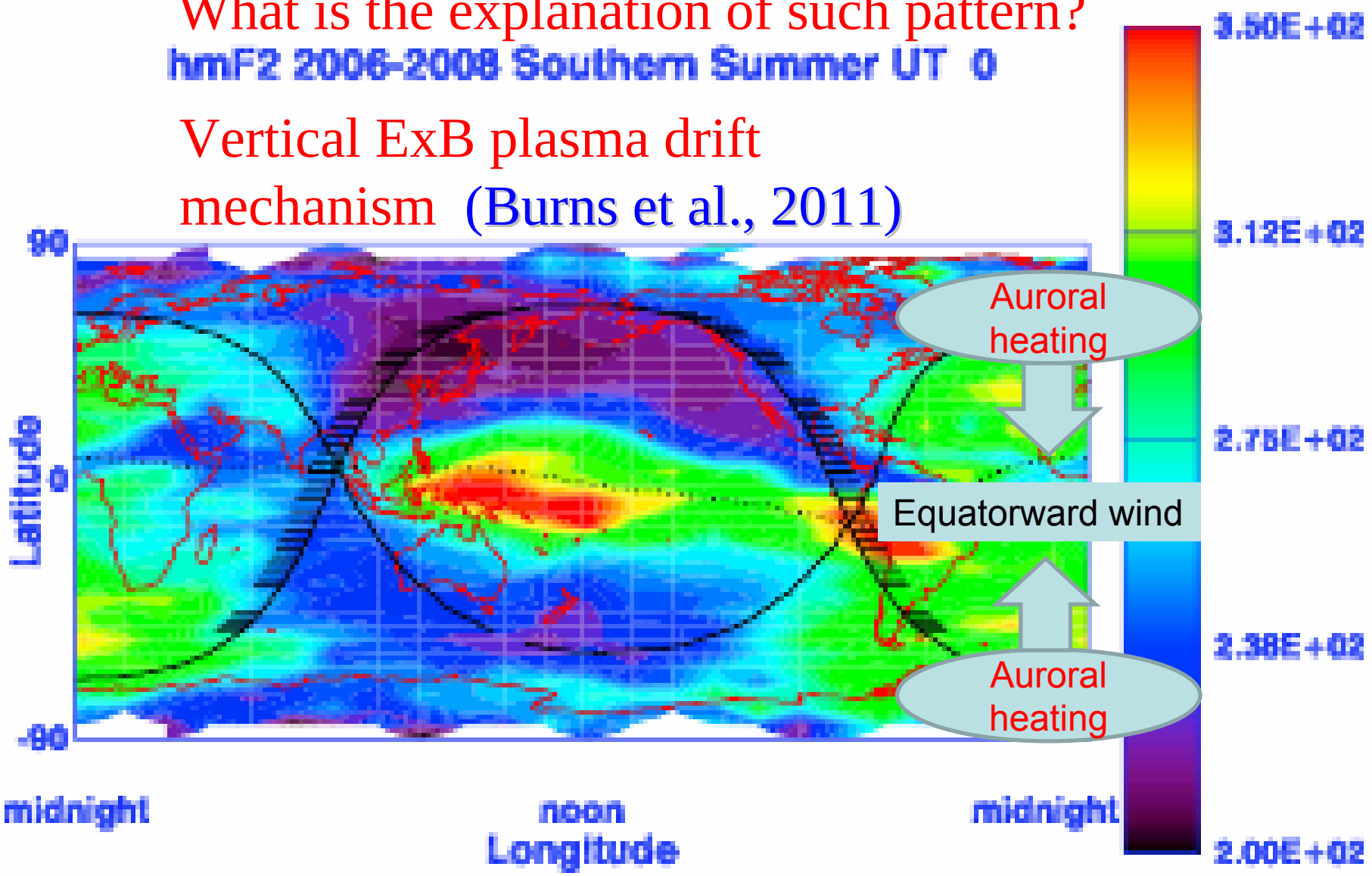


midnight

noon

H. Liu et al.,2010

What is the explanation of such pattern?



Our opinion: Upward vertical transport due to neutral wind

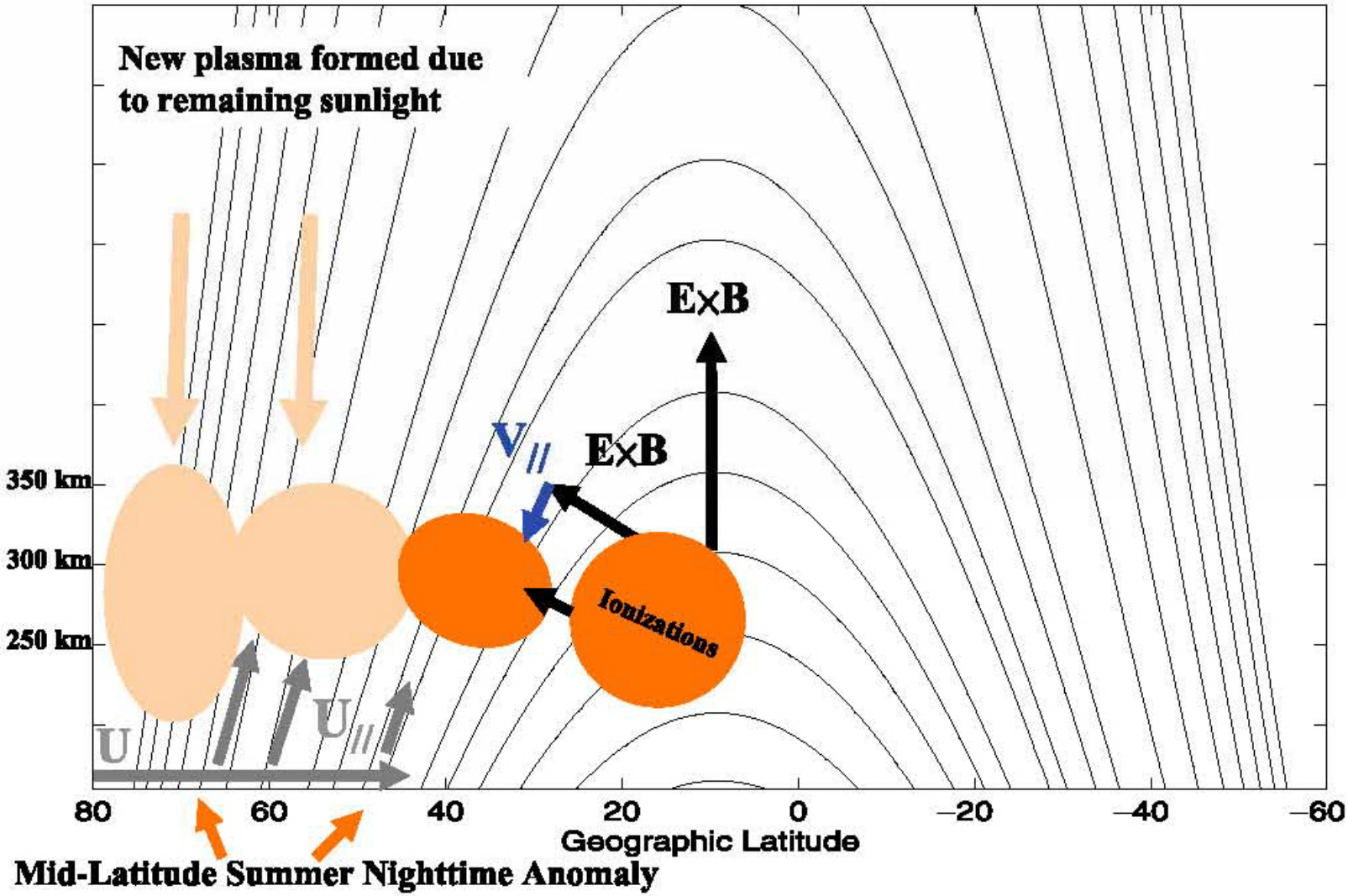


Figure 8. Schematic diagram shows the possible formation mechanism of the midlatitude summer anomaly. The longitude sector of this diagram is around the Northeast Asia sector (~135°E). It is noted that the geometry of the schematic does not reflect the realistic magnetic field line configuration.

Lin et al., 2010

SAMI-2

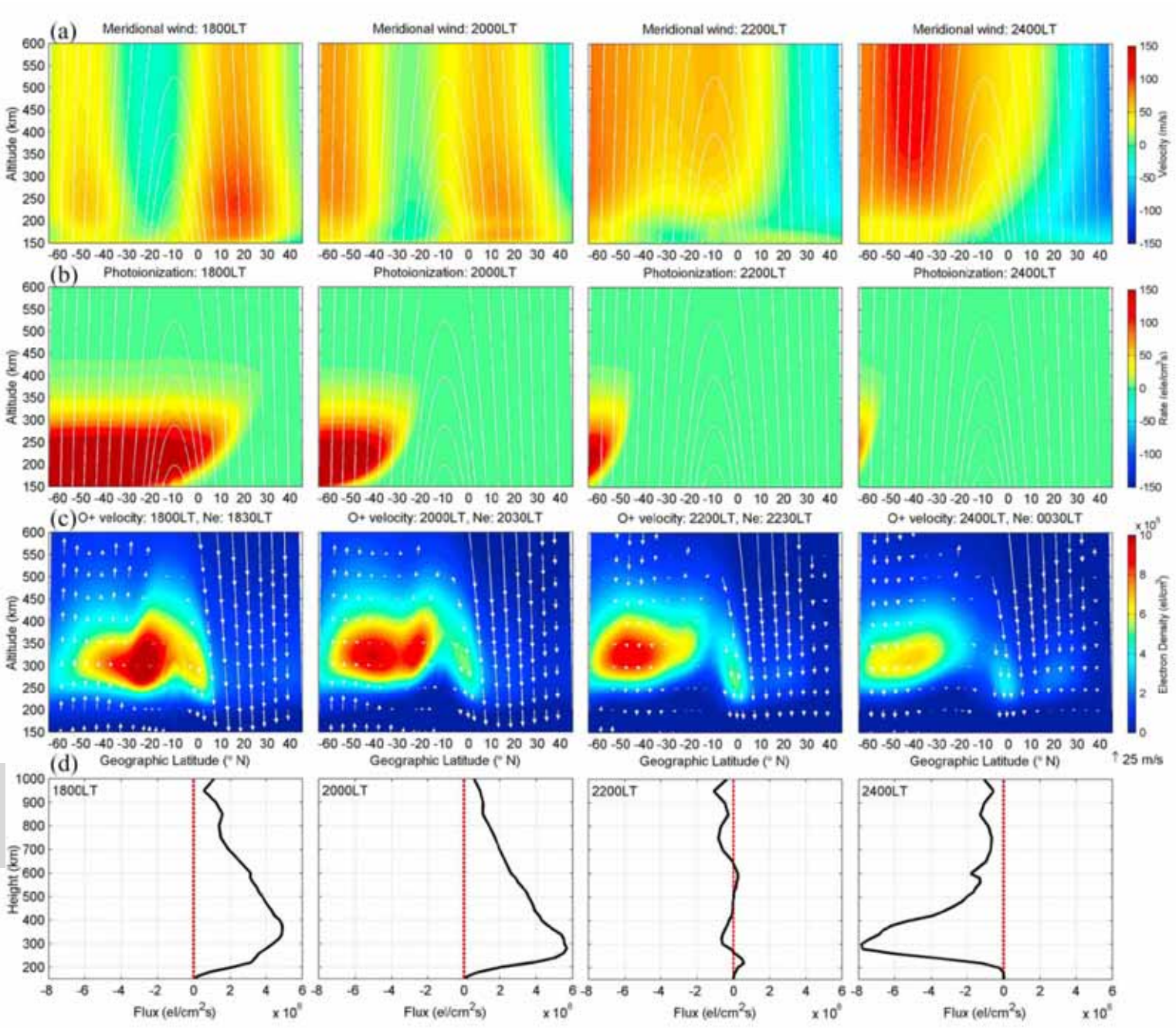
Meridional neutral wind

Photoioniztion displasement

Electron density

Very low latitudes of WSA

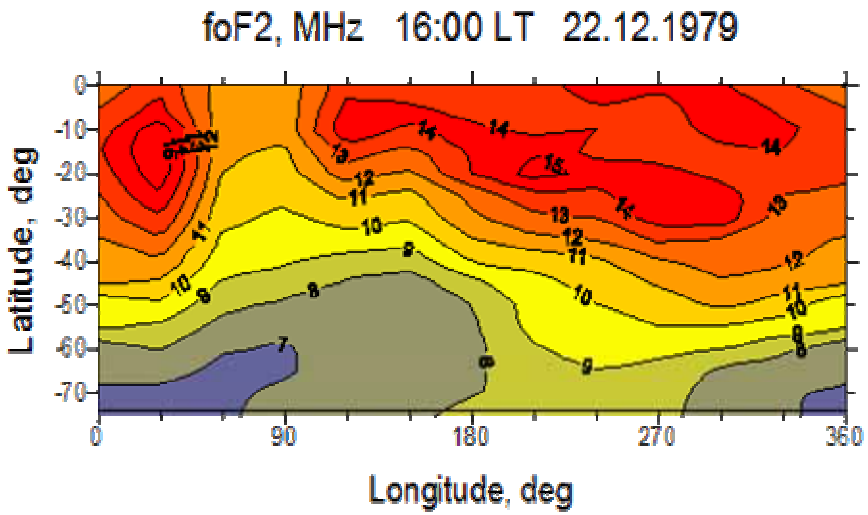
Plasmaspheric flux



Chen et al., 2011

foF2 Local Summer in the Southern Hemisphere

Intercosmos-19



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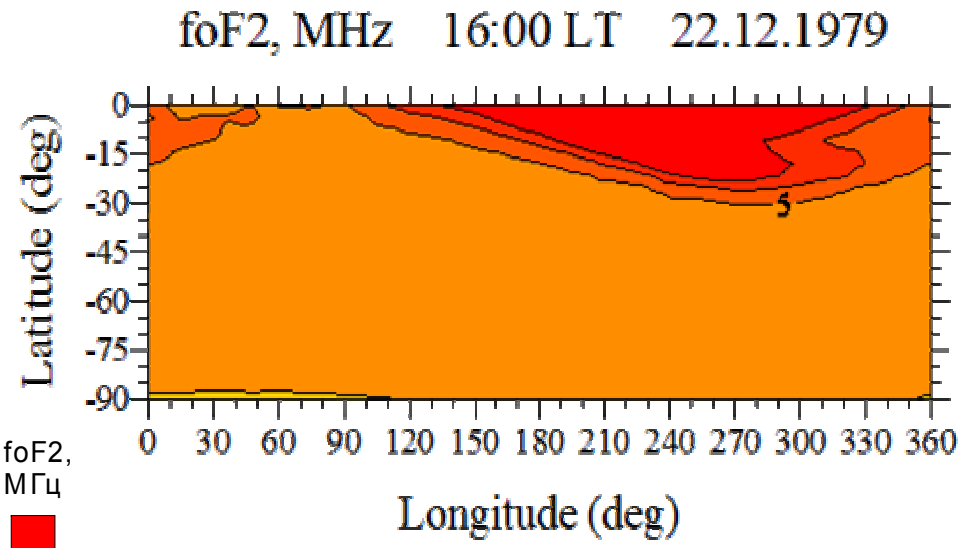
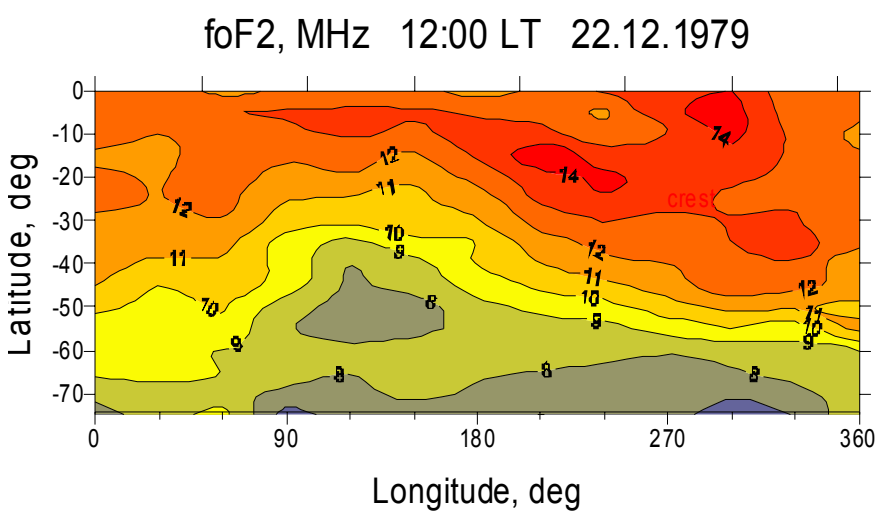
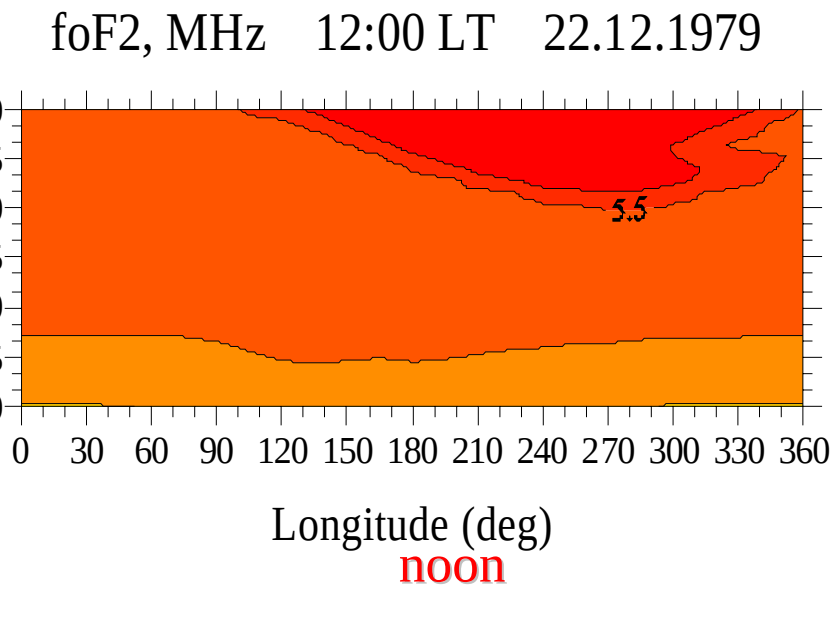


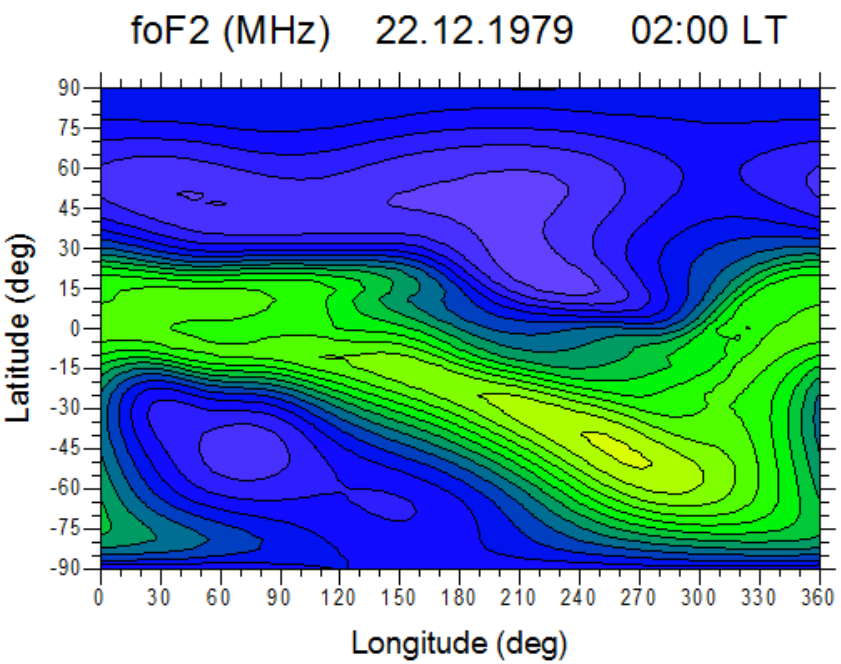


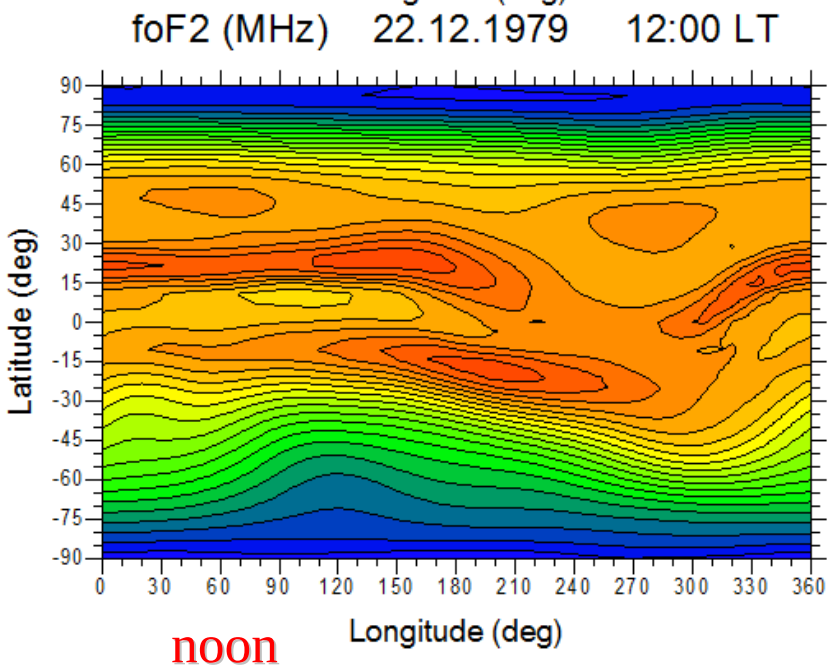
noon



noon

IRI





noon

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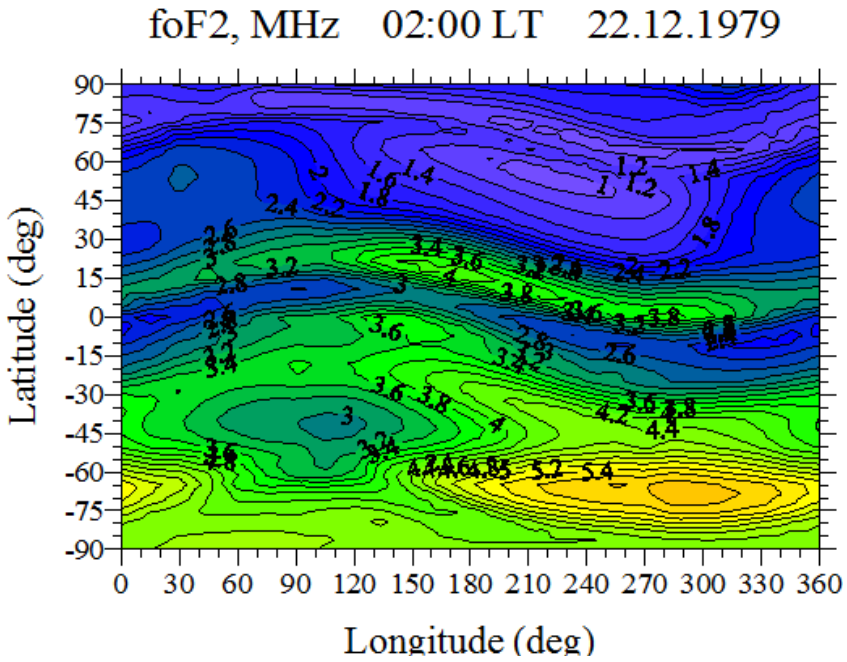
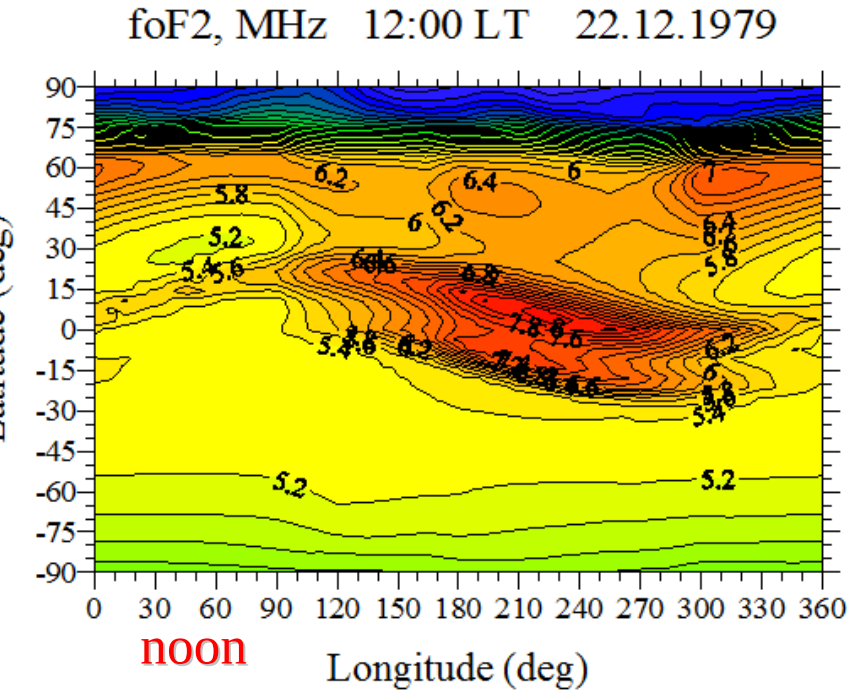
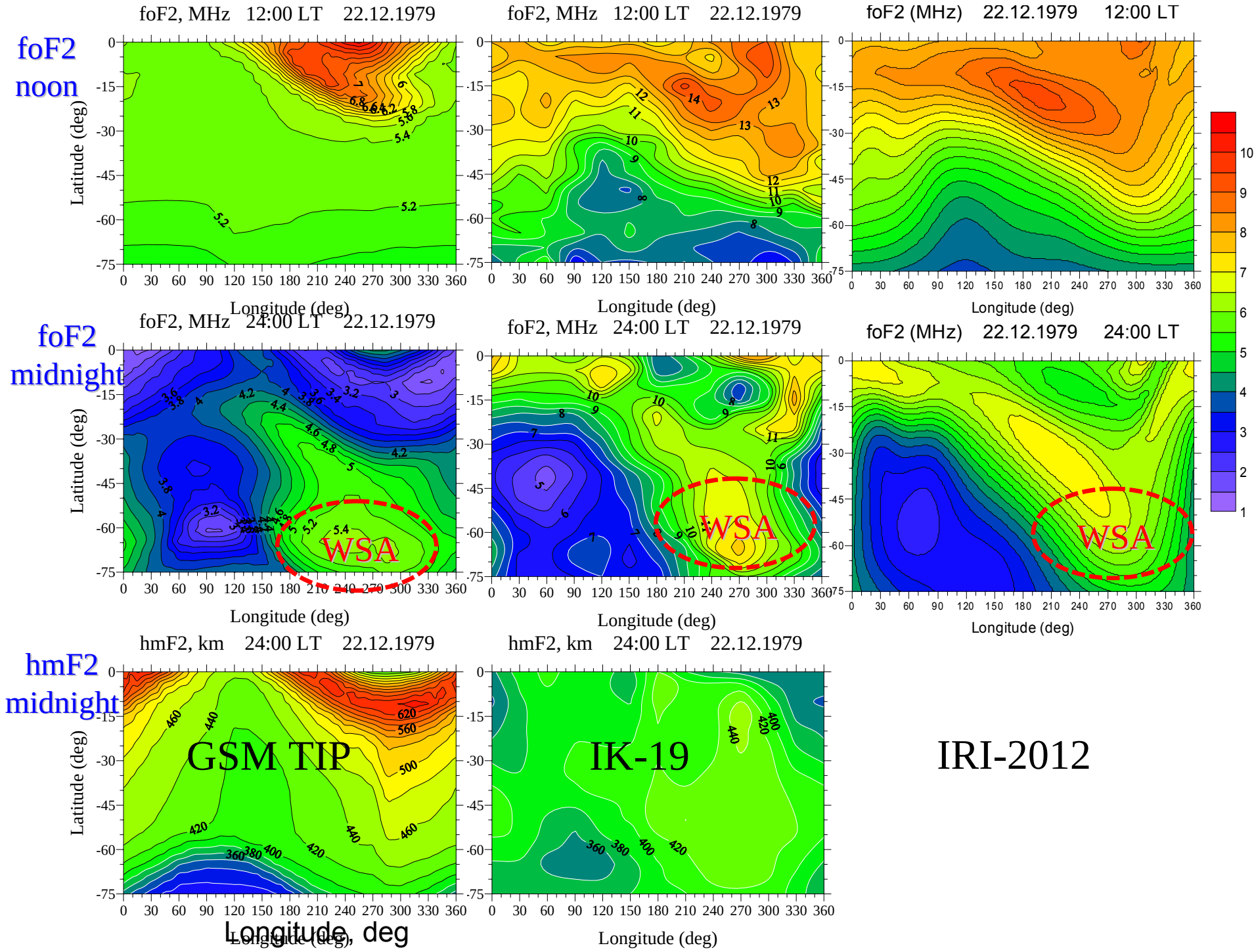




noon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WSA
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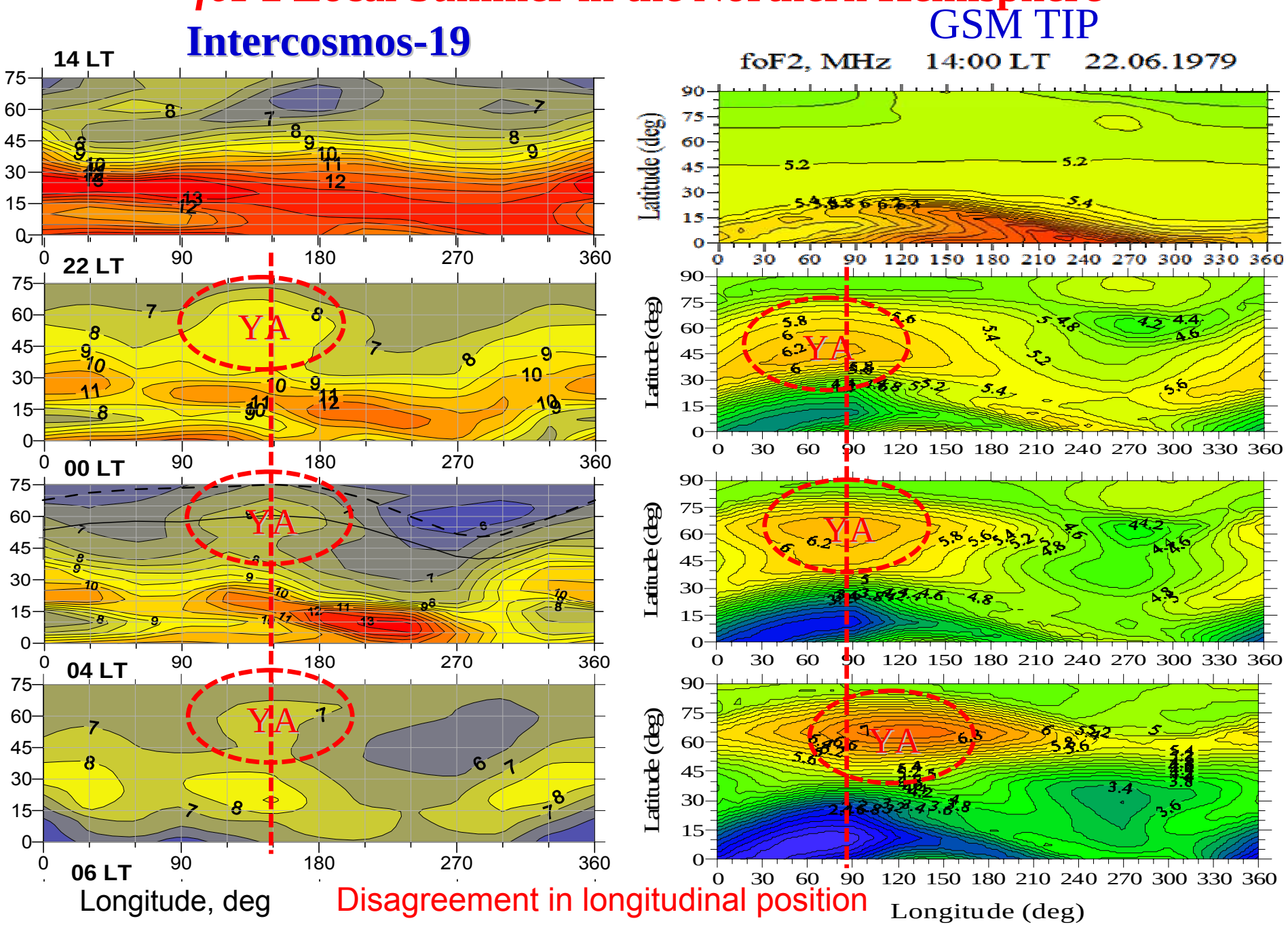
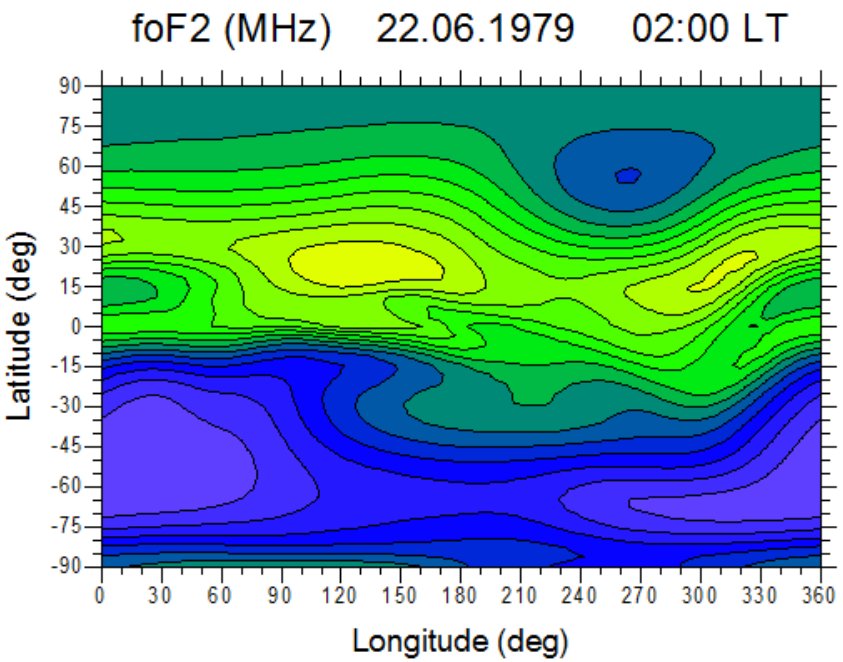
midnight
hmF2, km 24:00 LT 22.12.1979
hmF2, km 24:00 LT 22.12.1979
GSM TIP
IK-19
IRI-2012
Longitude, deg

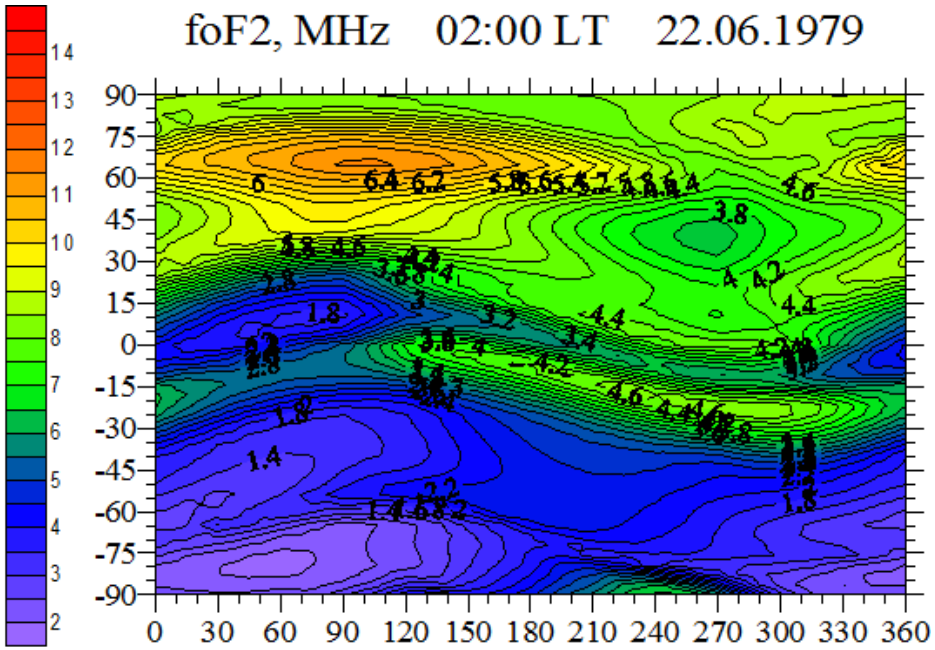
foF2 Local Summer in the Northern Hemisphere



IRI

GSM TIP





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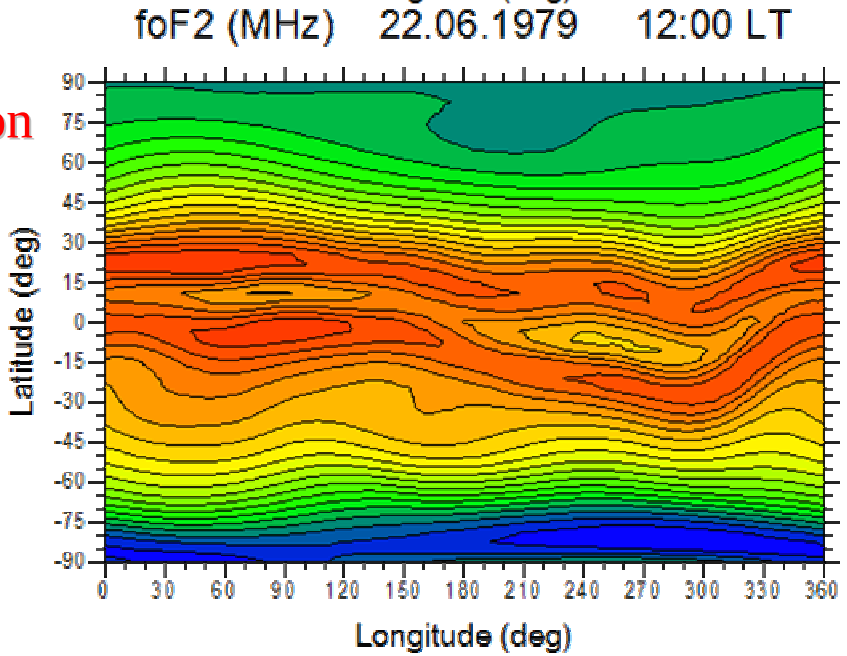

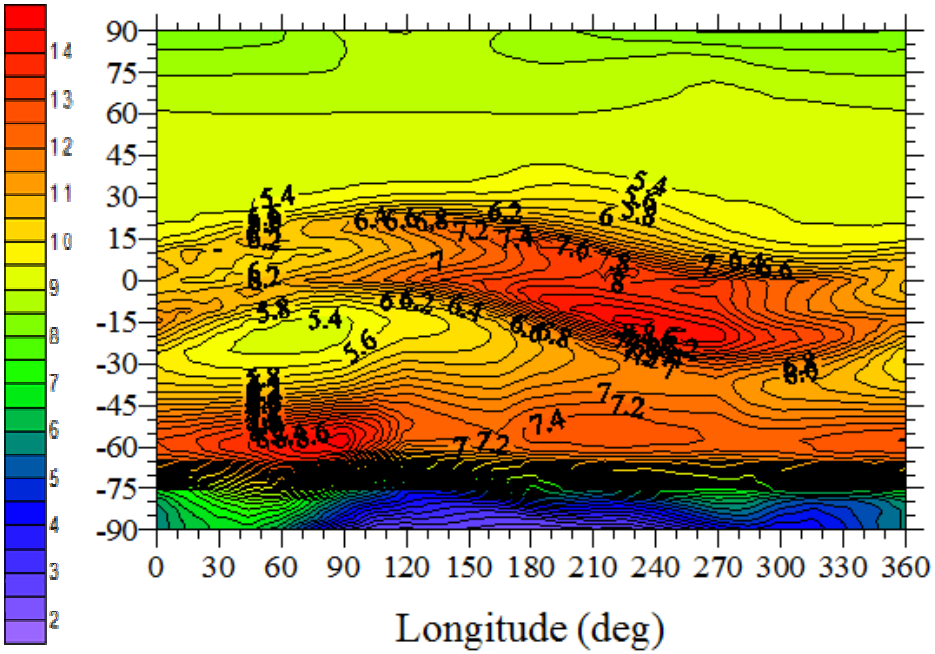

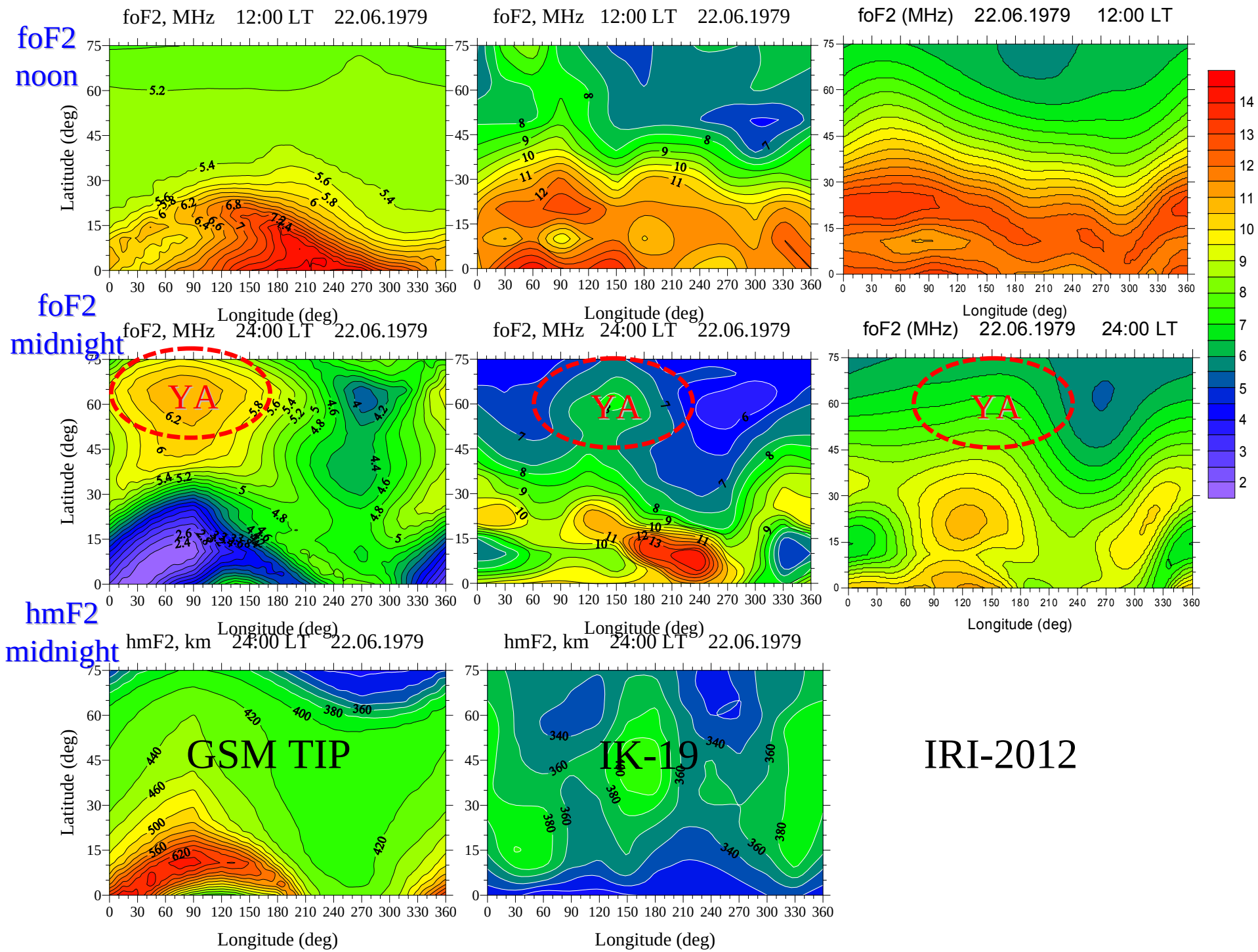
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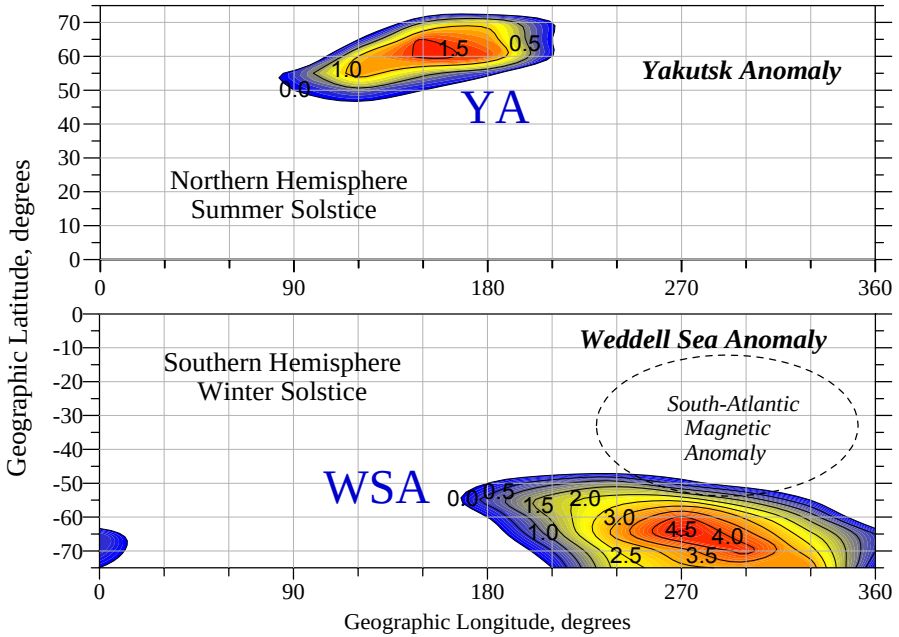
hmF2, km 24:00 LT 22.06.1979
hmF2, km 24:00 LT 22.06.1979
GSM TIP
IK-19
IRI-2012
Latitude (deg)
Longitude (deg)

Anomalies regions

IK-19



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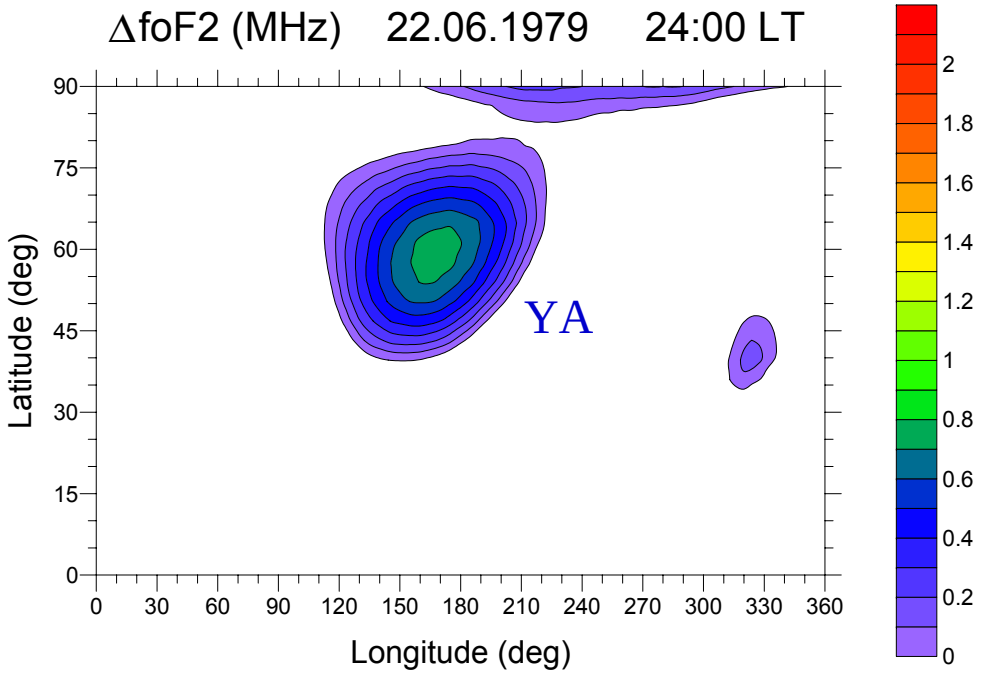

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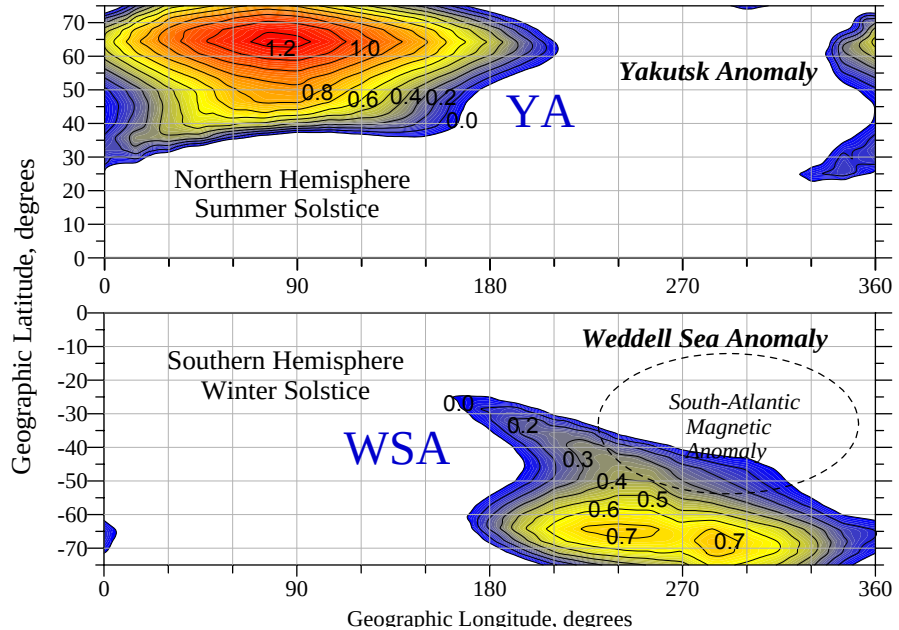
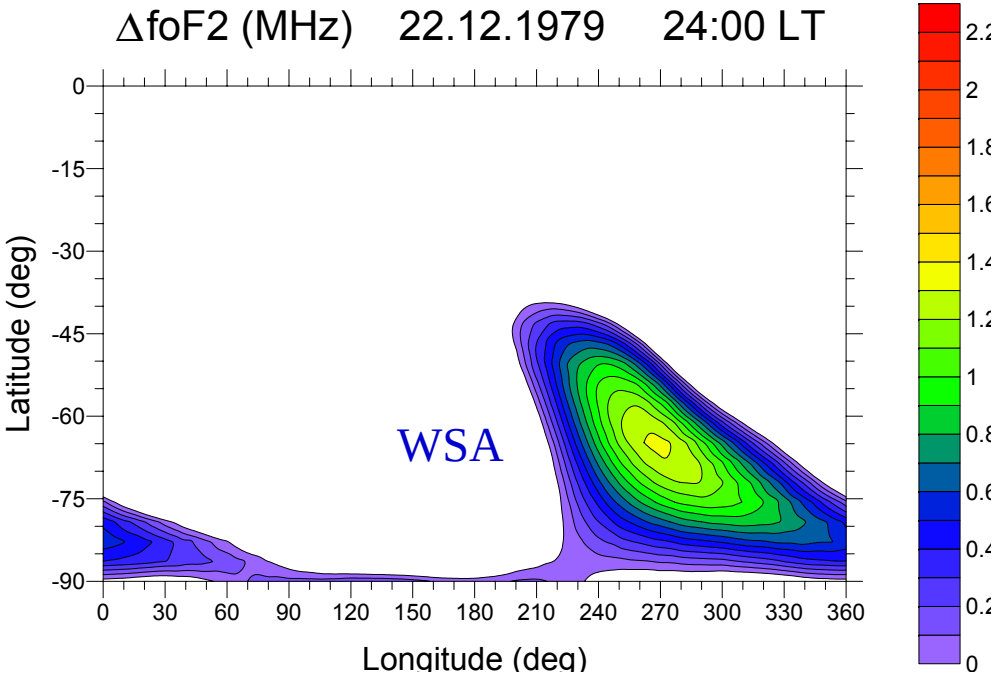
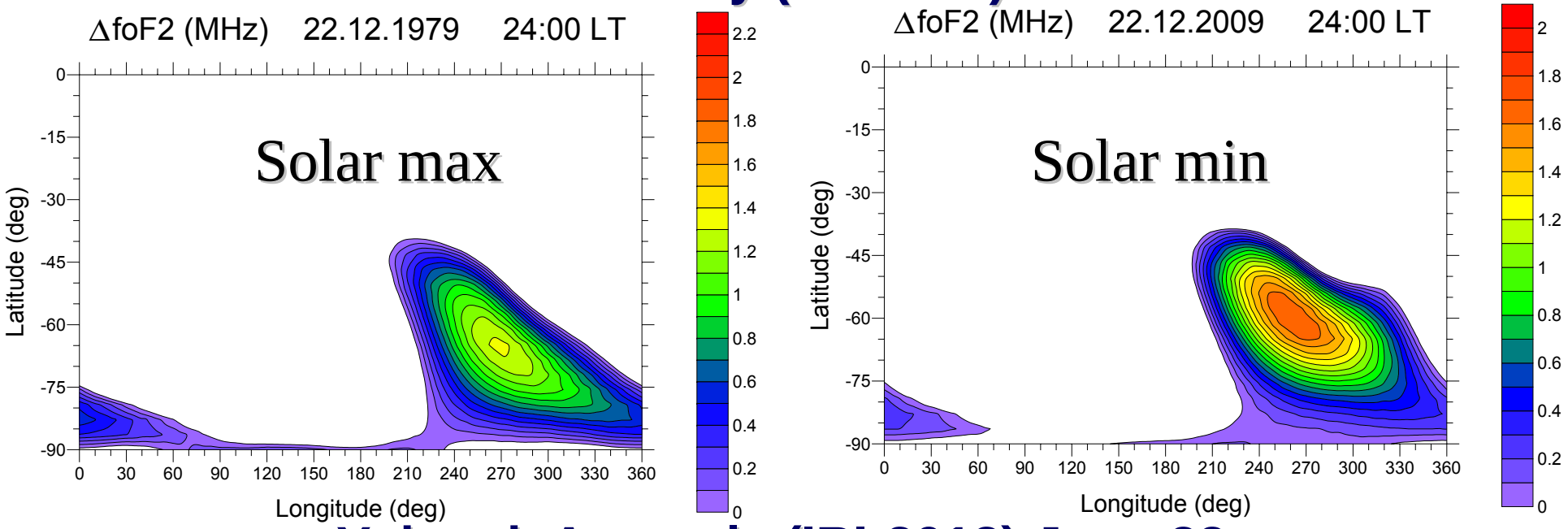
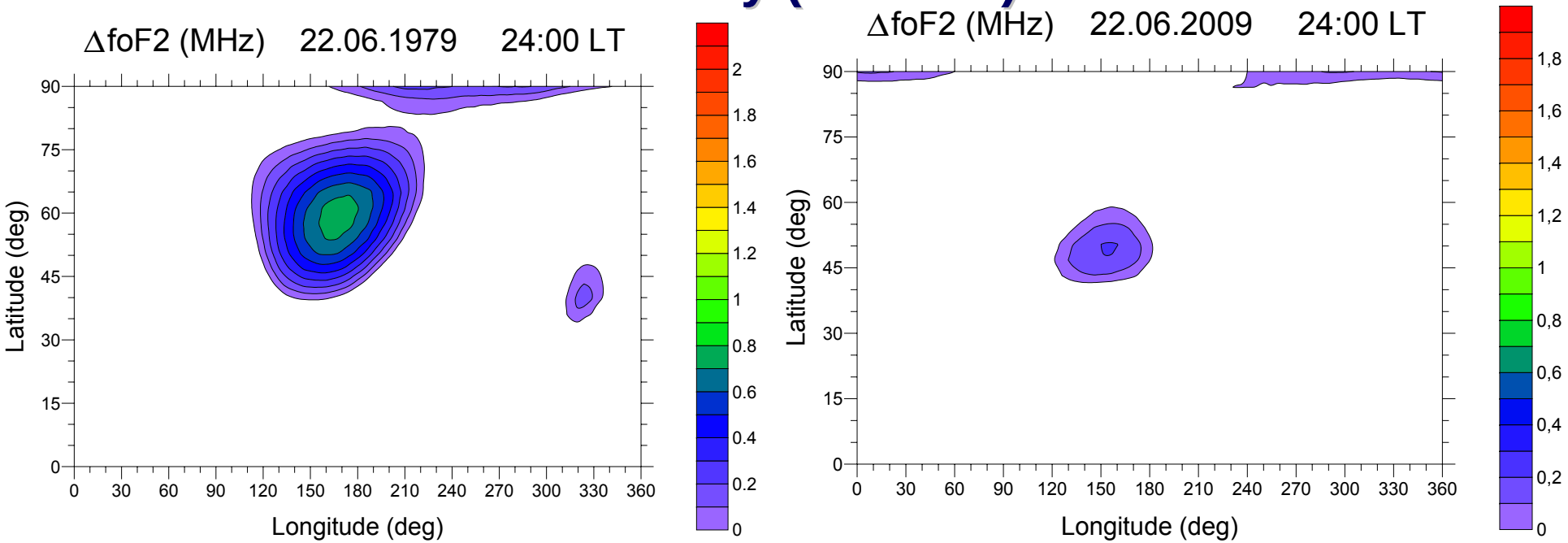




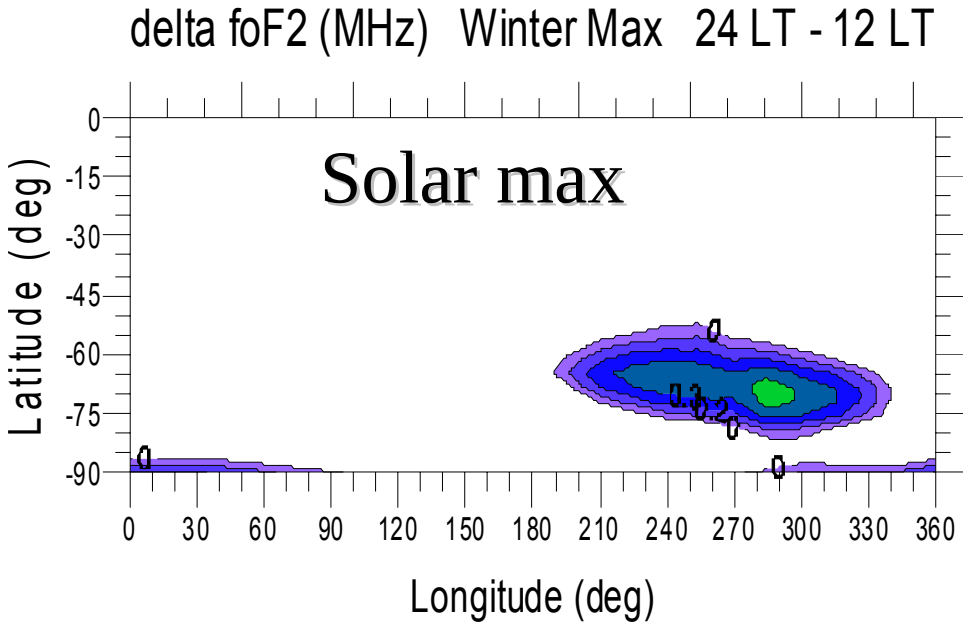
Weddell Sea Anomaly (IRI-2012) December 22

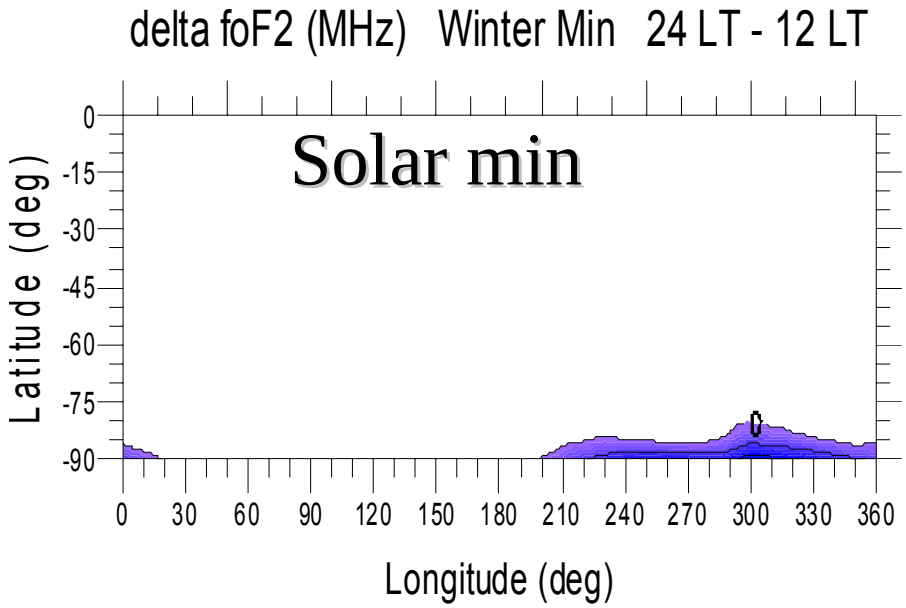


Yakutsk Anomaly (IRI-2012) June 22

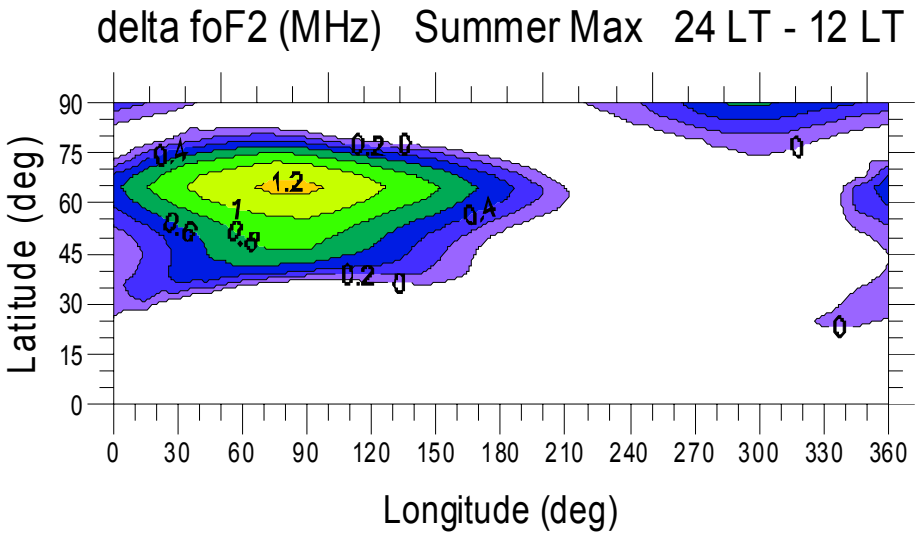


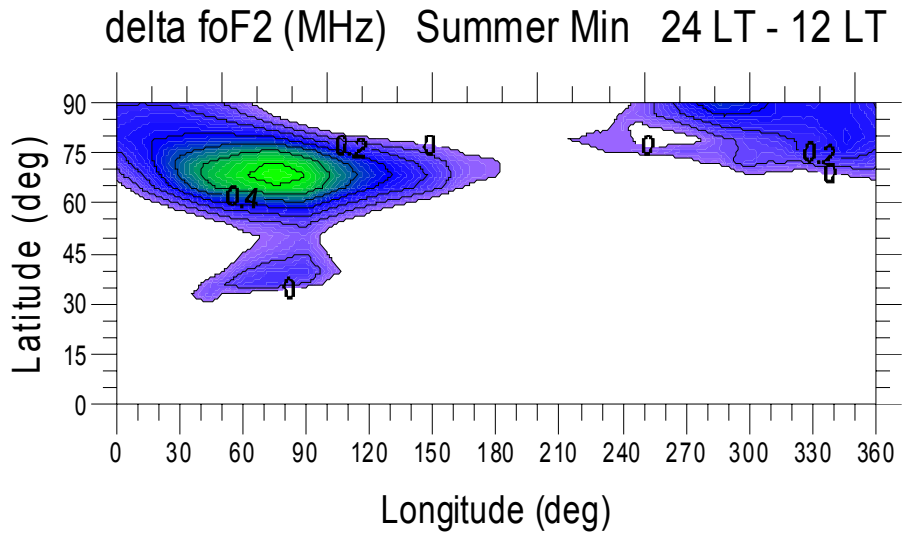
Weddell Sea Anomaly (GSM TIP) December 22



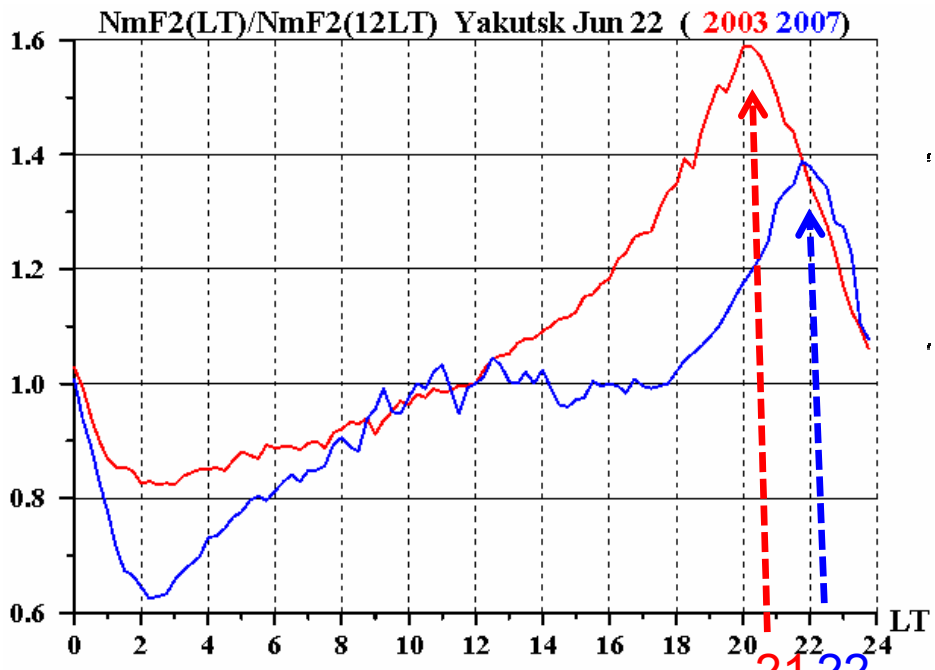


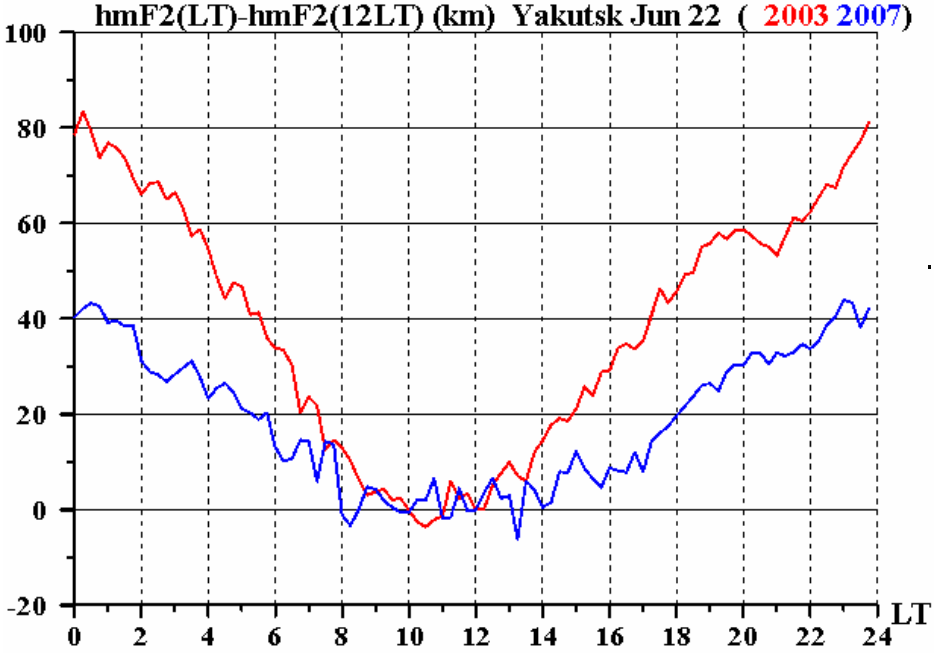
Yakutsk Anomaly (GSM TIP) June 22



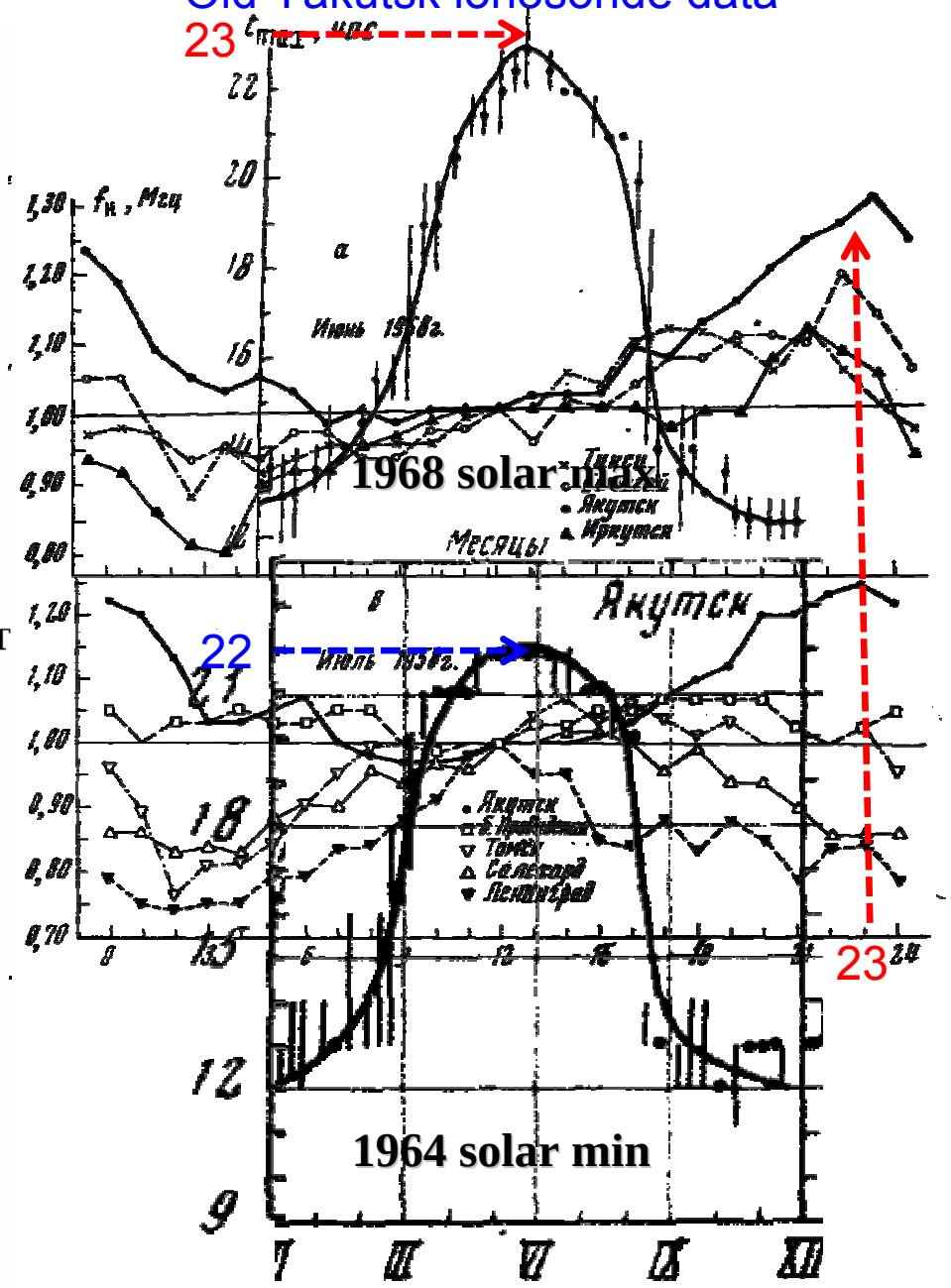


Yakutsk DPS-4 ionosonde data

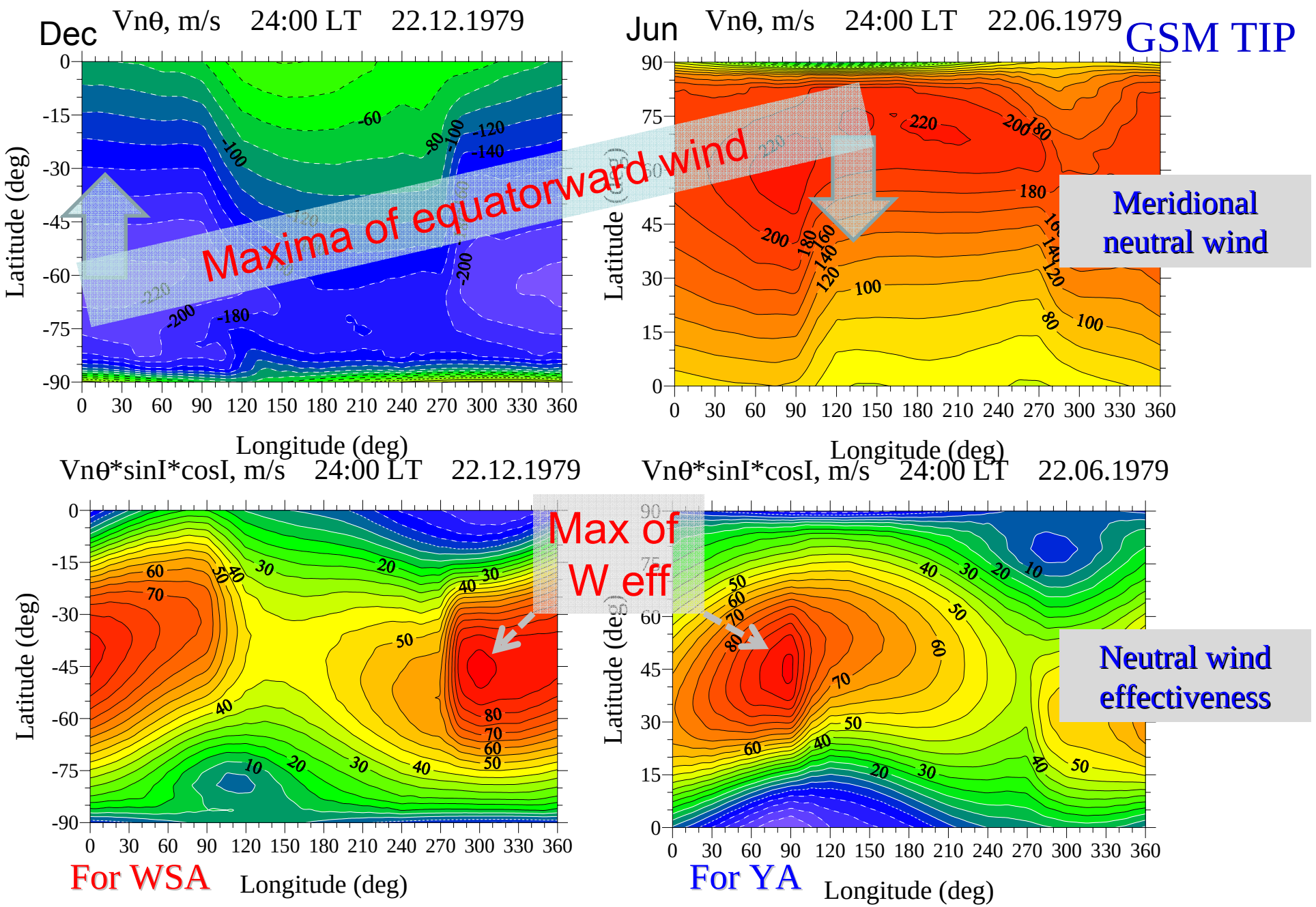




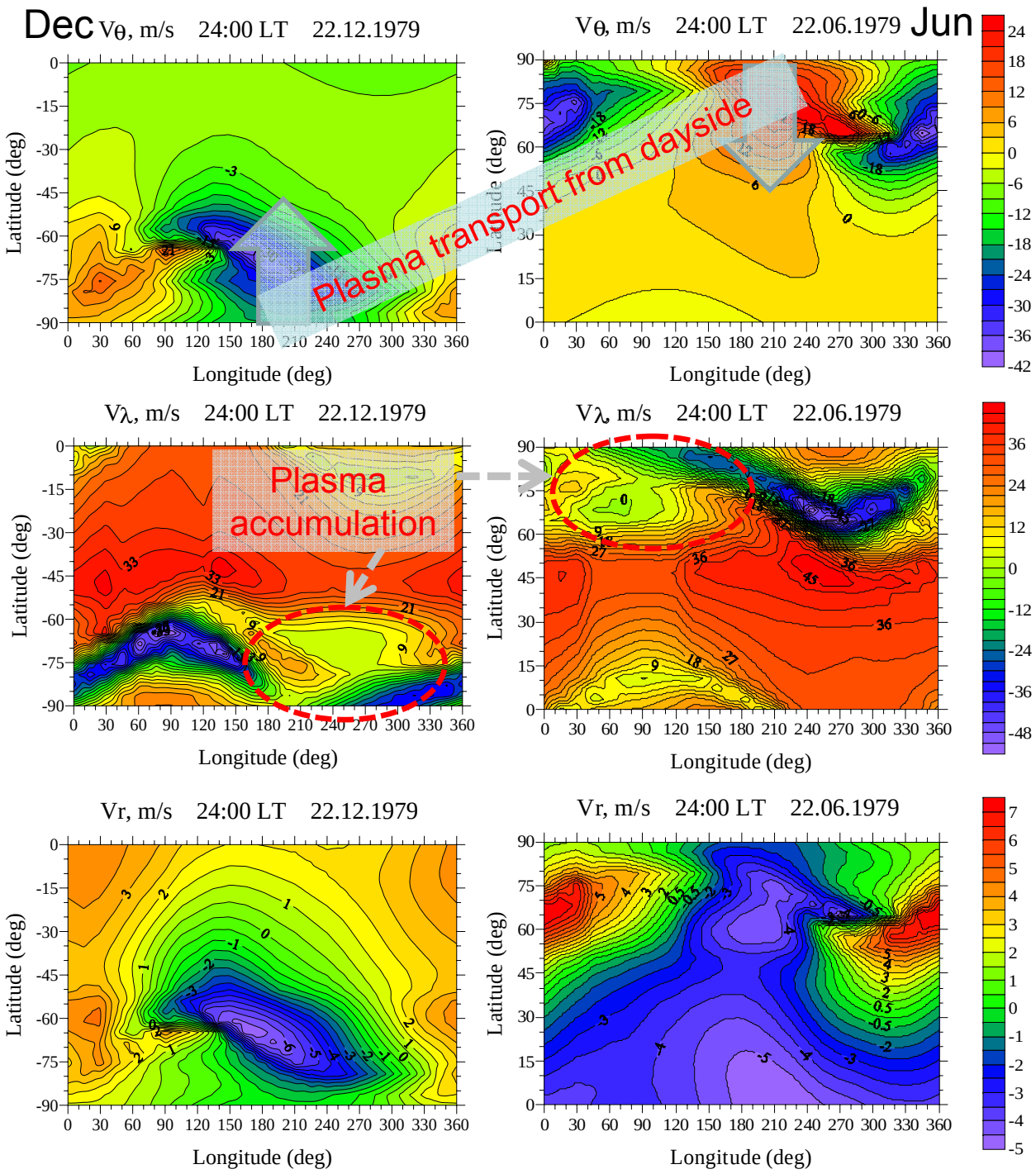
Old Yakutsk ionosonde data



Mamrukov et al., 1971



Meridional component of thermospheric wind velocity at height of 300 km positive in Southward direction and its contribution to the vertical plasma transport velocity.



Meridional ExB plasma drift velocity

Zonal ExB plasma drift velocity

Vertical ExB plasma drift velocity

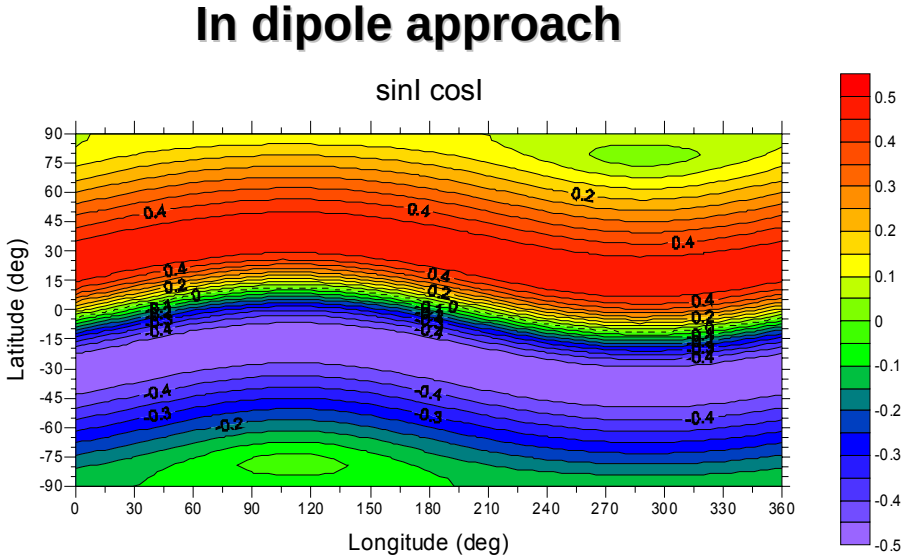
Southward, eastward and vertical components of electromagnetic plasma drift velocity at nighttime

The main reasons for the formation of the Weddell Sea Anomaly and Yakutsk Anomaly according to our understanding

1. **UV and EUV fluxes in local Summer are one of the main reasons of WSA and YA formation**

2. **The main source of thermospheric wind is the heating by the UV and EUV radiation on the dayside, the Joule heating and the heating by the precipitating auroral electrons on the nightside. The superposition of these sources generates the maximum in meridional equatorward wind on the nightside when the geomagnetic pole is located on the dayside. As a result the meridional wind velocity on the nightside have maximum at geographical meridian ~105° E.**

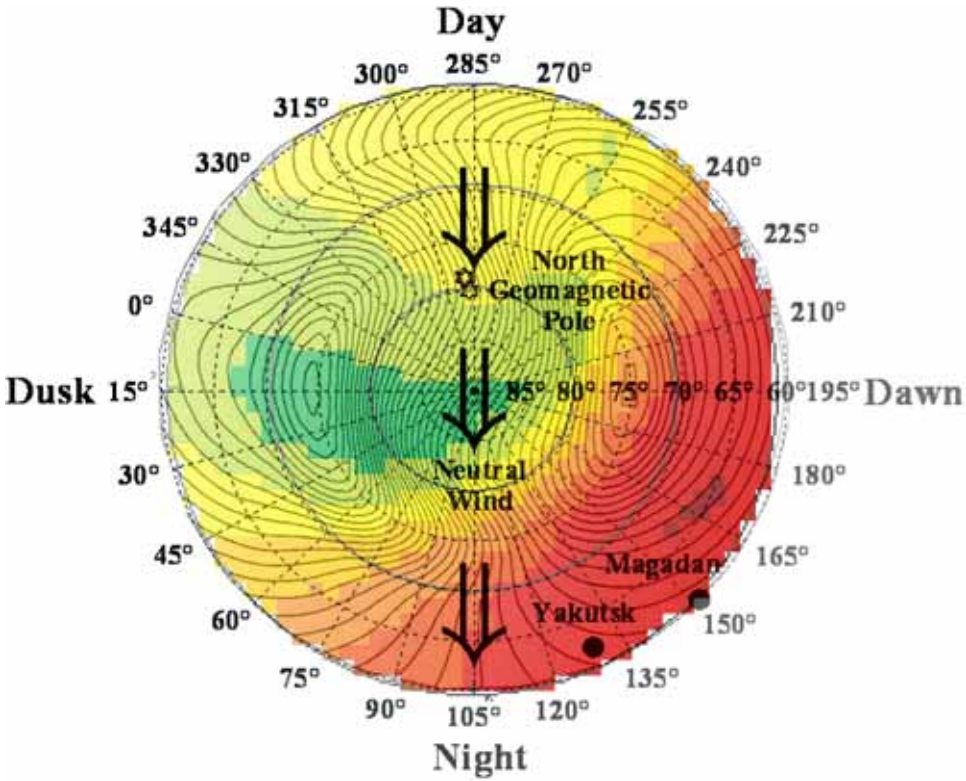
3. **The discrepancy between geographic and geomagnetic axies leads to that the effectiveness of the wind in the vertical plasma transport along the geomagnetic field lines is proportional to the *sinI*×*cosI* (*I* is the magnetic inclination), which is maximal on the longitude ~105° E in the Northern Hemisphere and on the longitude ~75° W in the Southern Hemisphere.**



4. The plasma at heights of the ionosphere F region in high latitudes drifts from the dayside to the nightside through the polar caps under the action of the magnetospheric convection electric field across geomagnetic field lines producing the tongue of ionization. It is shown that tongue of ionization have longitudinal variation with maxima near to WSA-like anomalies.

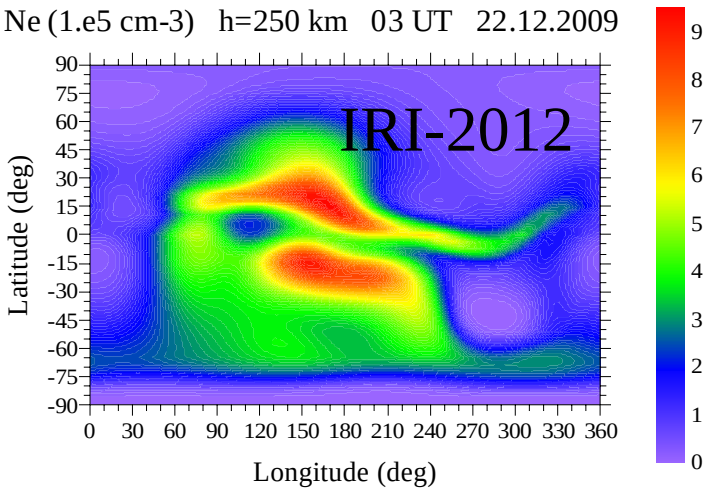
5. Plasma accumulation regions that formed near to WSA and YA by zonal ExB plasma drift can be additional mechanism for WSA and YA formation.

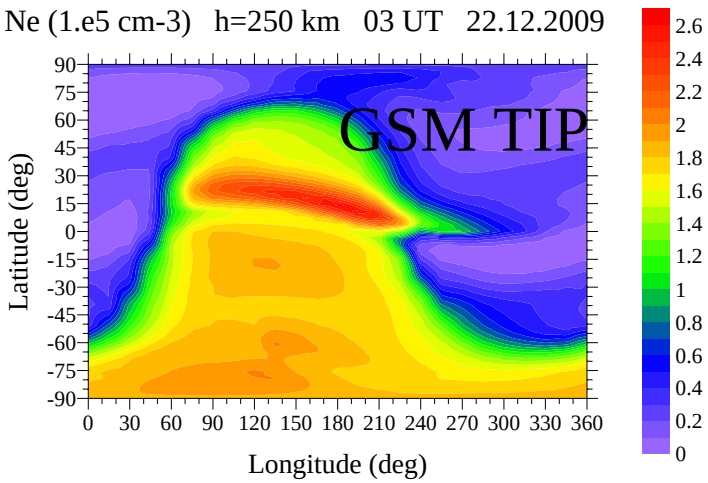
The scheme showing the basic formation mechanisms of the Yakutsk anomaly: a) the meridional wind (shown by arrows) from the day to night side over the North Pole that is maximal on the meridian passing through the geographic and geomagnetic poles, and b) the magnetospheric plasma convection (shown by isolines) from the day to night side across the polar cap that forms a tongue of ionization (in the color scale it ts shown the distribution of *foF*2).



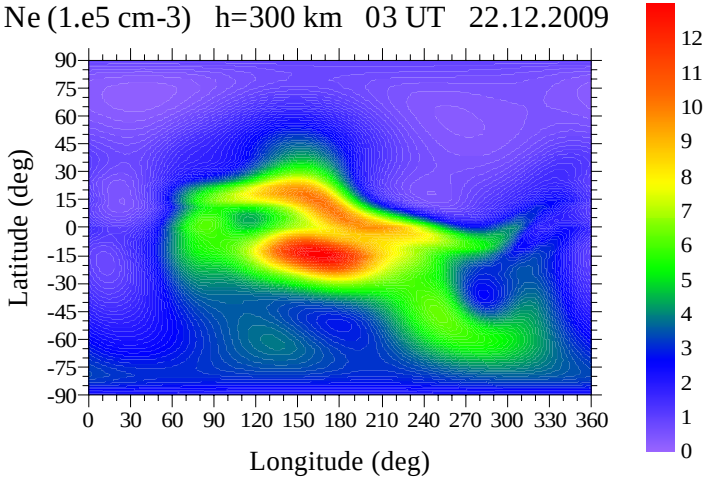
Ne

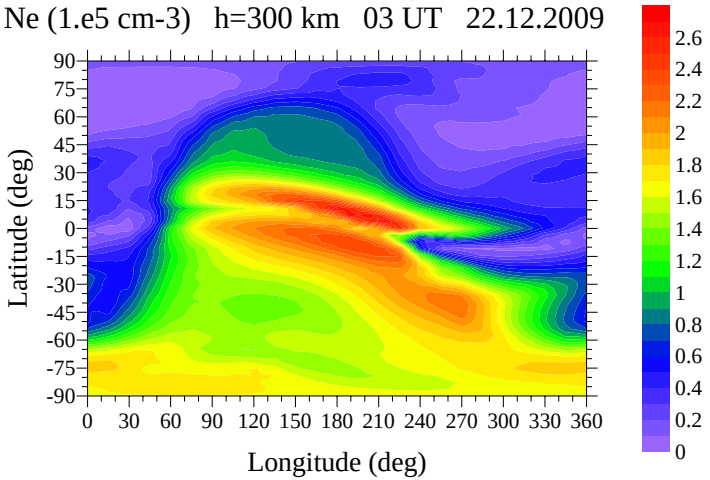
250 km



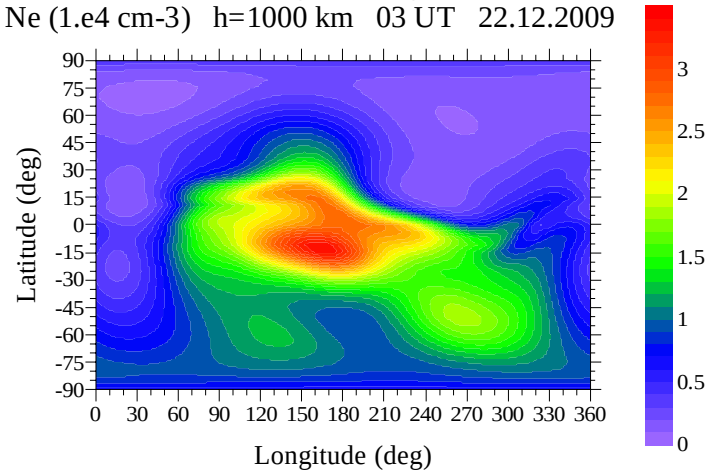


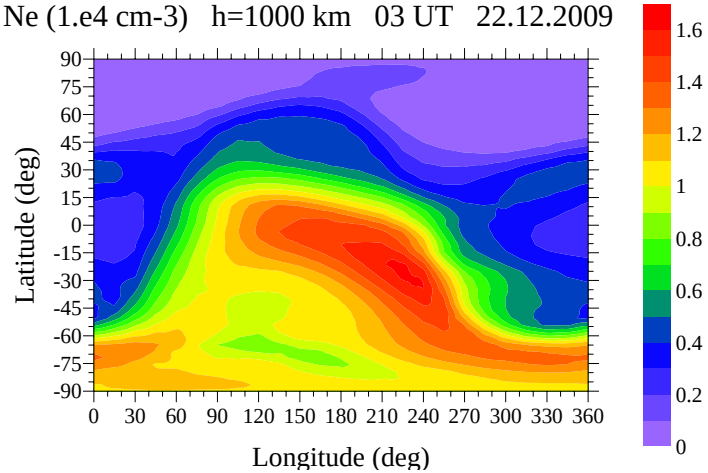
300 km



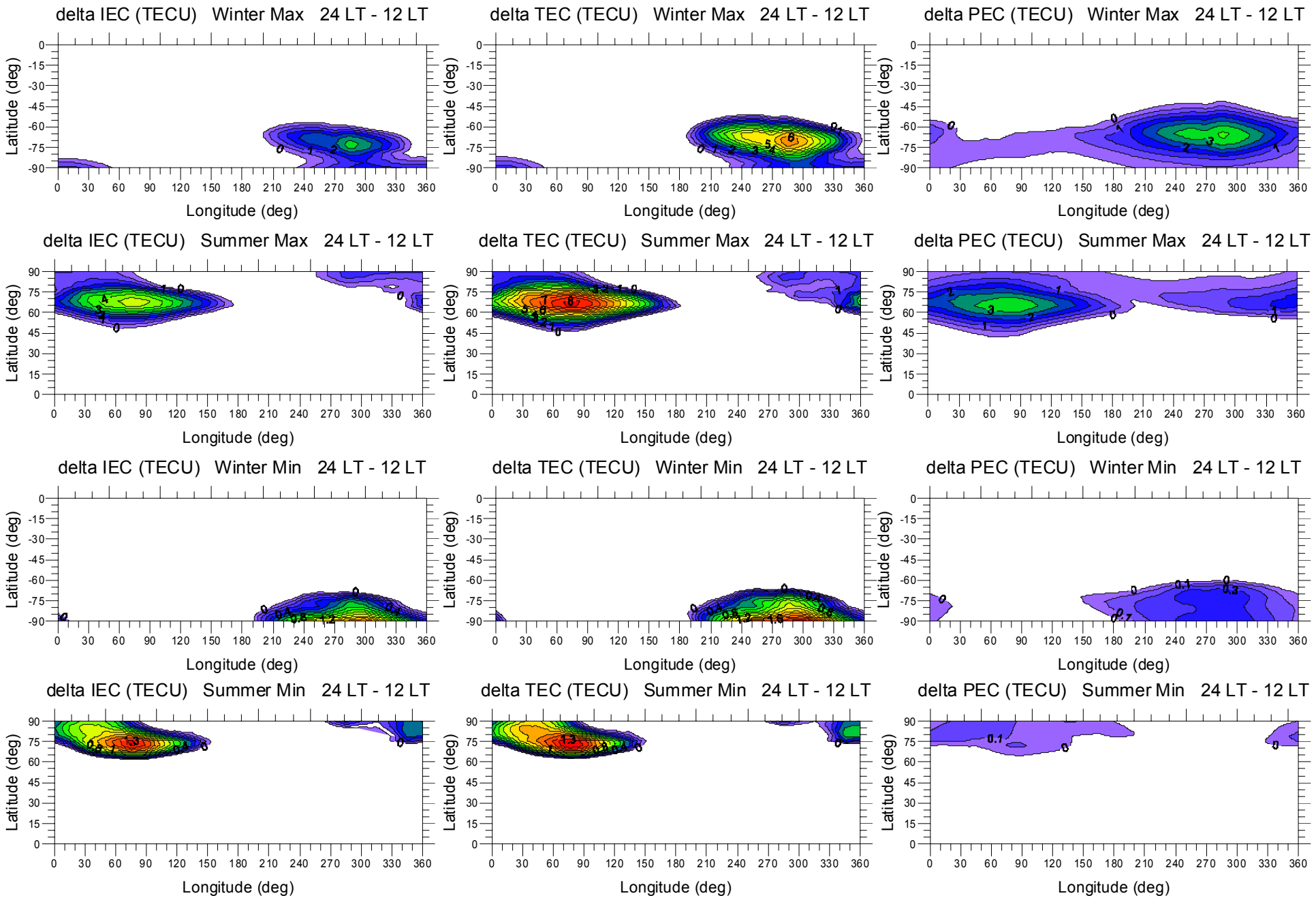


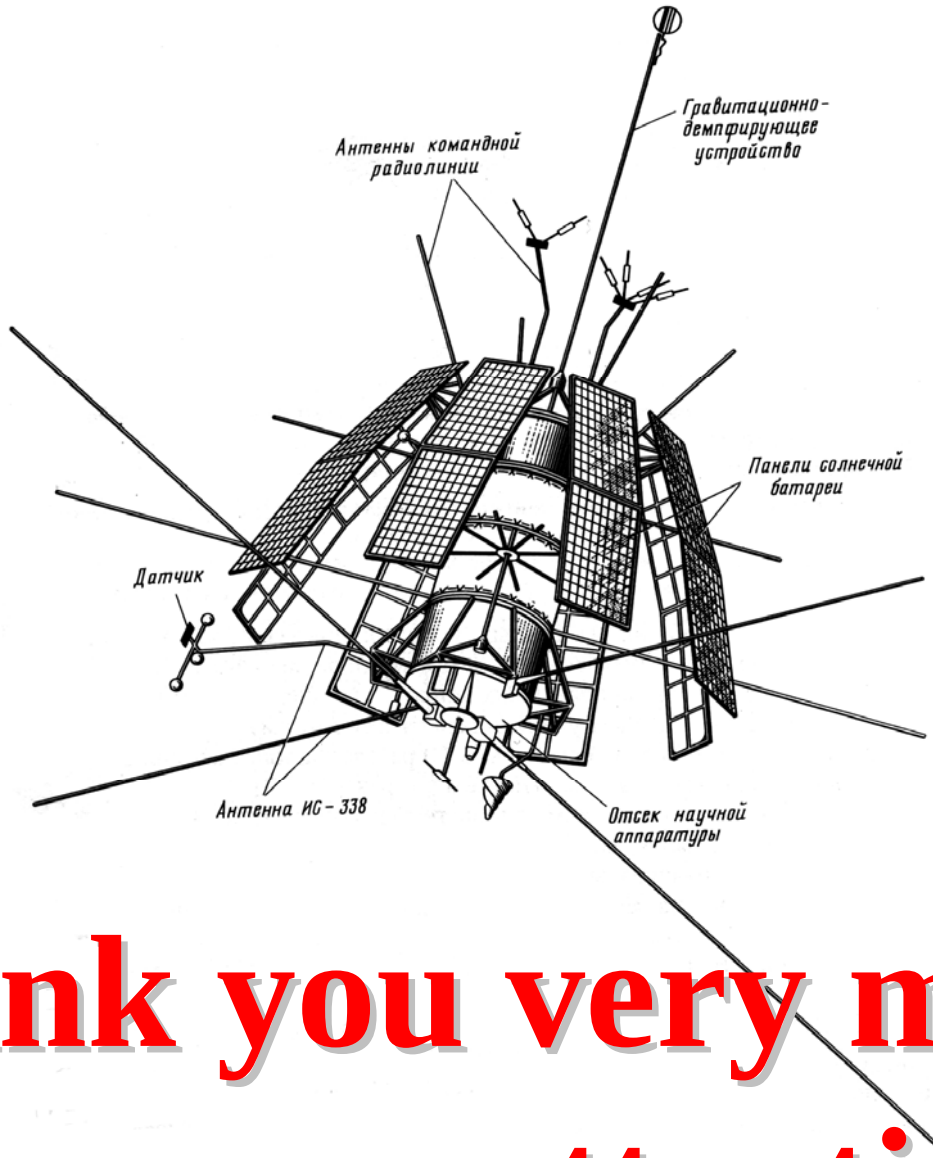
1000 km





Weddell Sea and Yakutsk Anomalies in IEC, TEC and PEC





Thank you very much for your attention