Response of ionospheric sporadic structures over the Antarctic Peninsula (Akademik Vernadsky) on geomagnetic and meteorological activities

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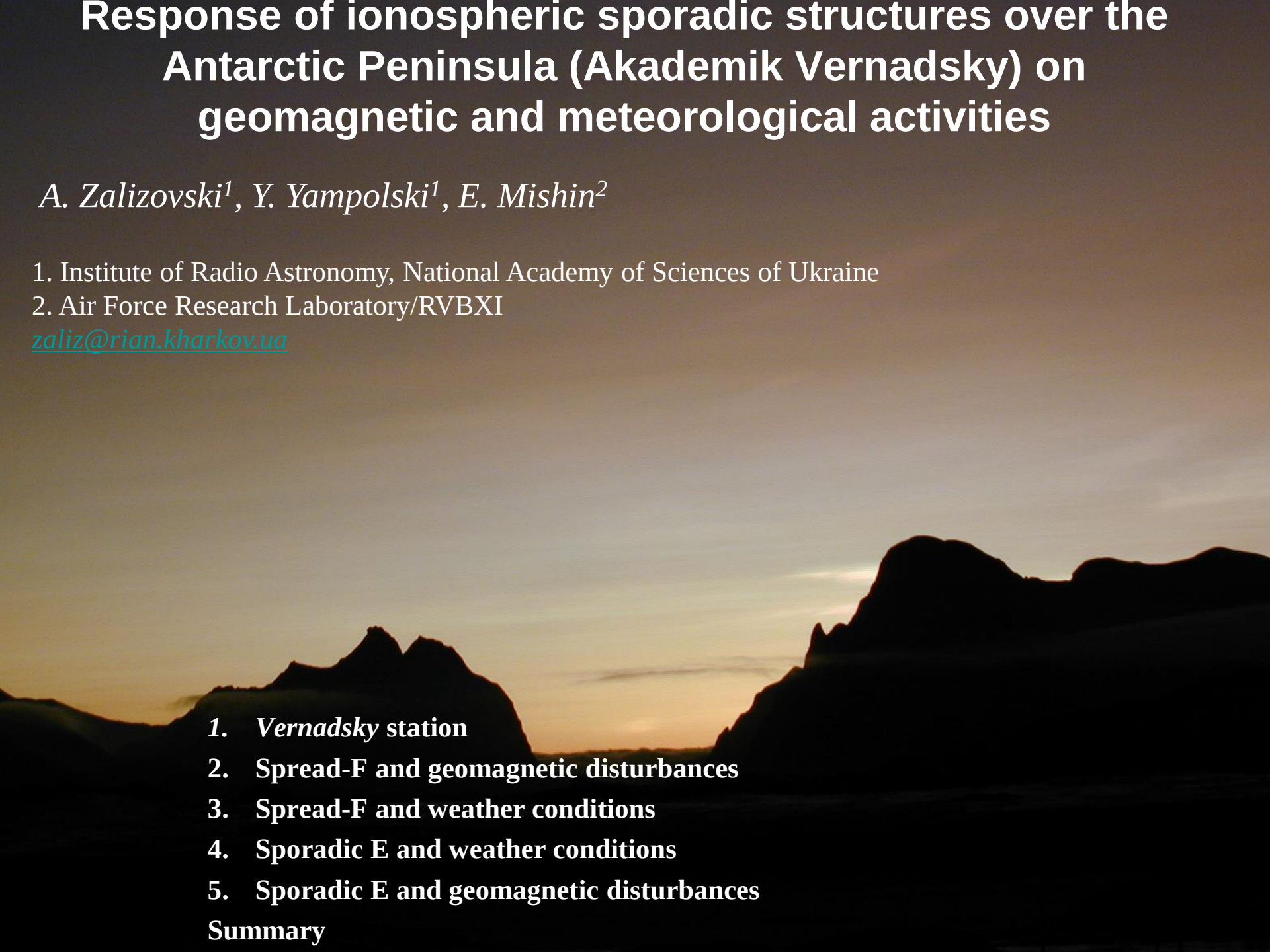
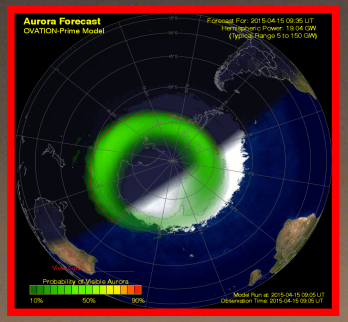


1. ***Vernadsky*** **station**
2. **Spread-F and geomagnetic disturbances**
3. **Spread-F and weather conditions**
4. **Sporadic E and weather conditions**
5. **Sporadic E and geomagnetic disturbances**

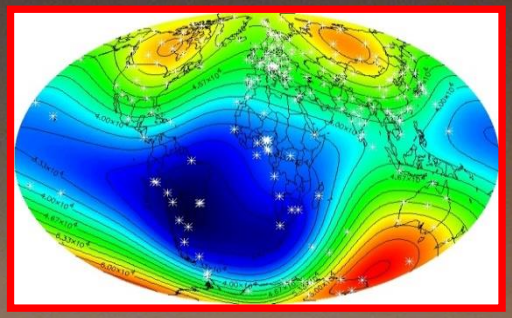
Summary

The Antarctic Peninsula region is a very suitable area for investigations of the troposphere-to-ionosphere energy transfer

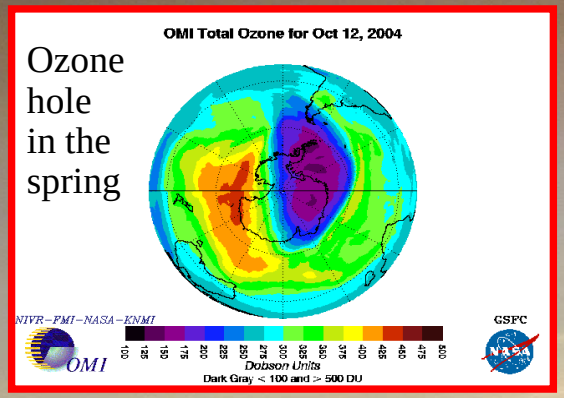
Biggest difference between geographic and geomagnetic latitudes, middle geomagnetic and high geographical



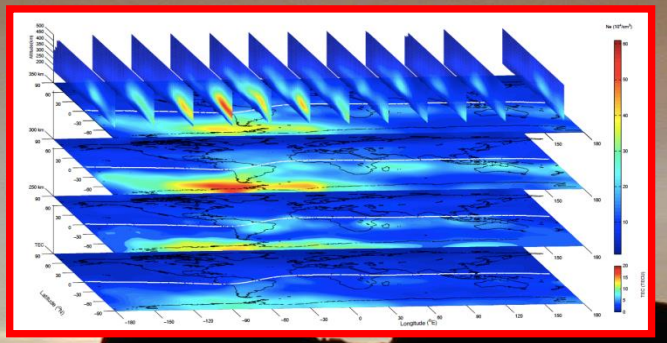
Magnetic anomaly (very low inclination)

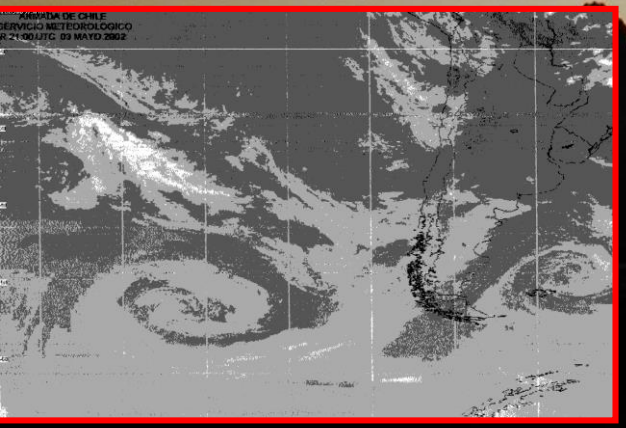


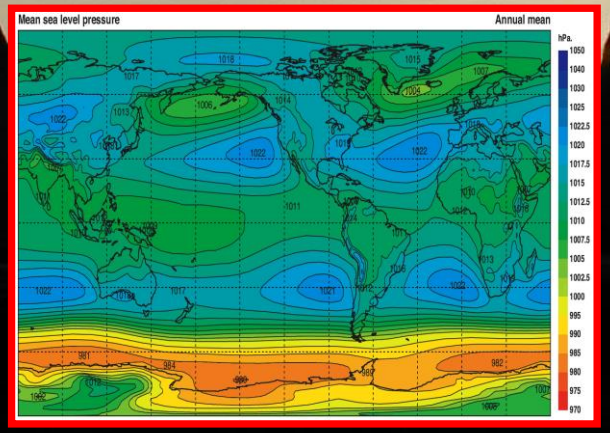
Ozone hole in the spring



Weddell sea anomaly

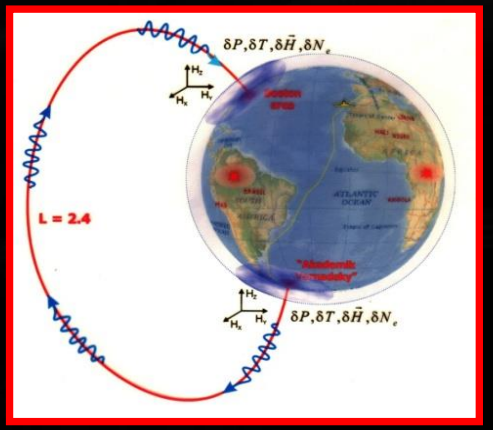






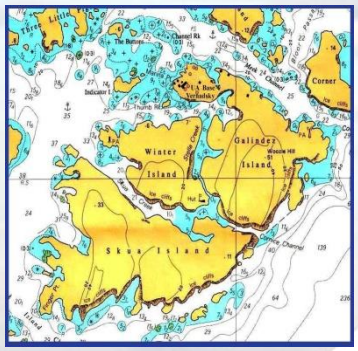
High cyclonic activity

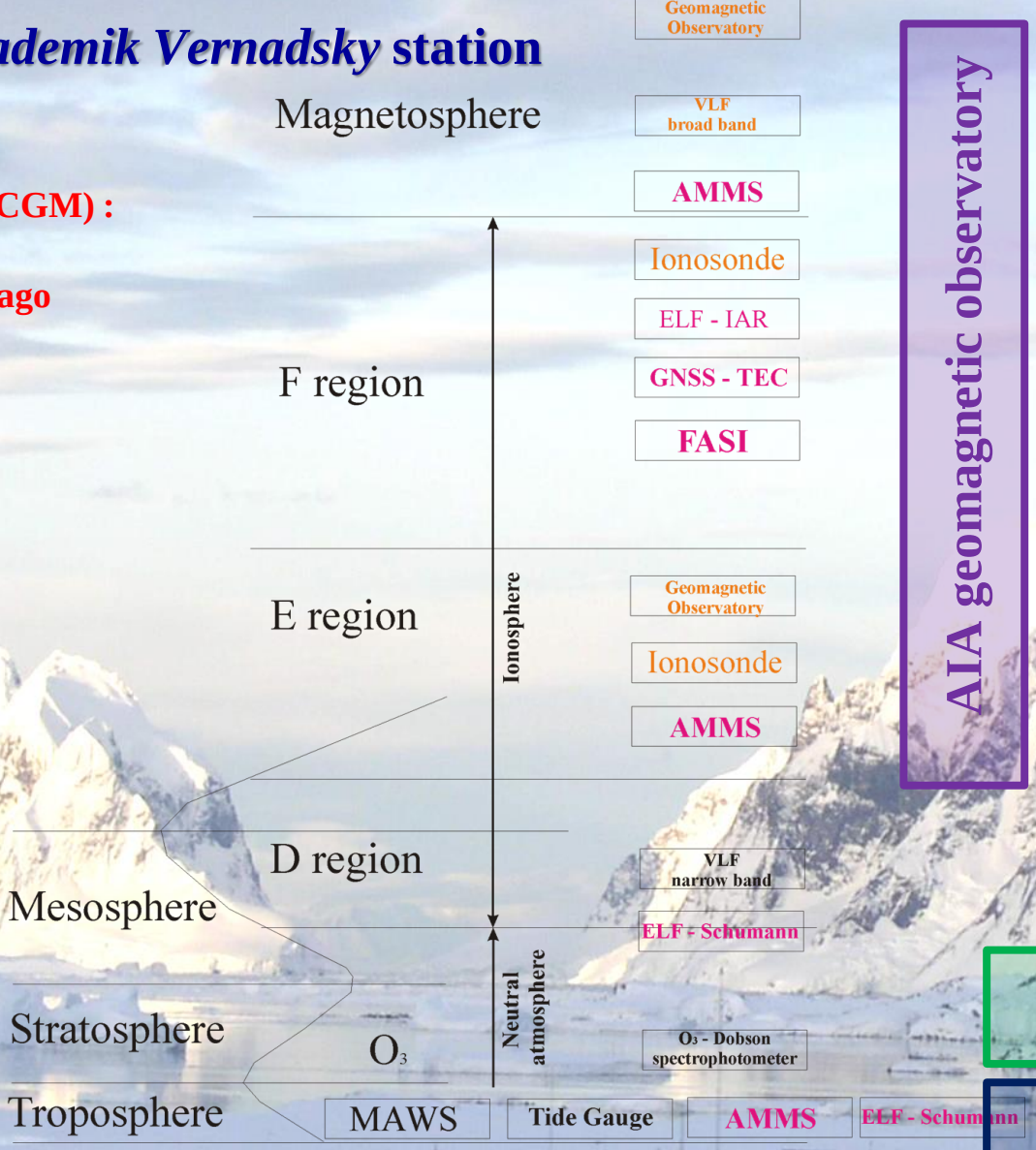
Magnetic conjugation with The US East Coast



Akademik Vernadsky station

Geographic coordinates:
65.25° S, 64.27° W
Geomagnetic coordinates (CGM) :
50° S, 9° E
Argentine Islands Archipelago





AIA geomagnetic observatory

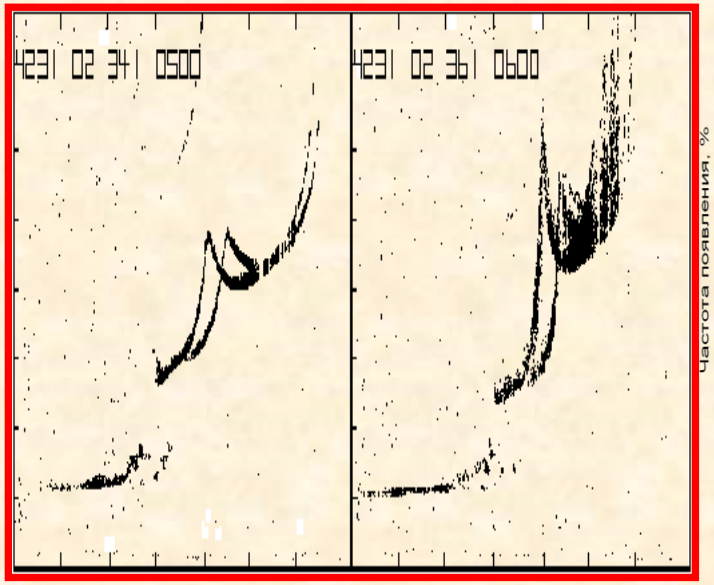
IONOSONDE

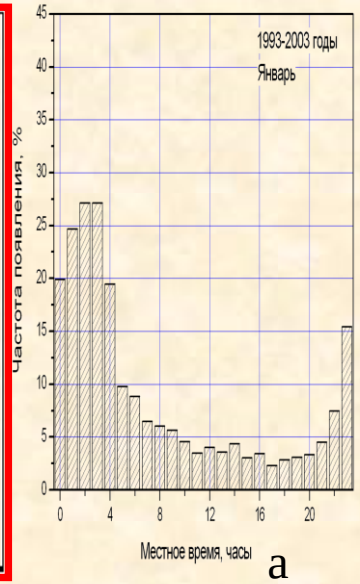
O_3 Dobson

Met office

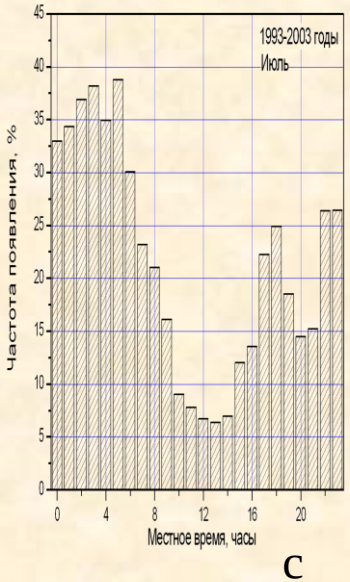
Analysis of long-term data sets obtained at Ukrainian Antarctic station *Akademik Vernadsky* (former UK *Faraday* base) has allowed detecting numerous facts suggesting the weather impact on the dynamics of middle and upper atmosphere above the Antarctic Peninsula.

Spread-F

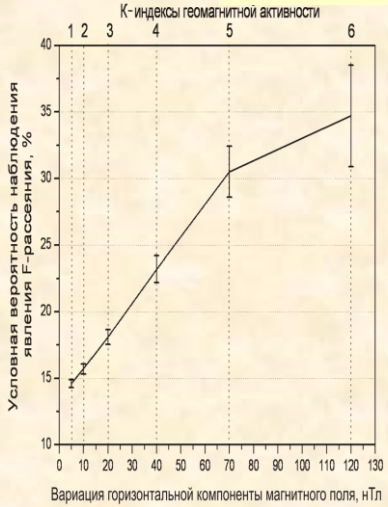




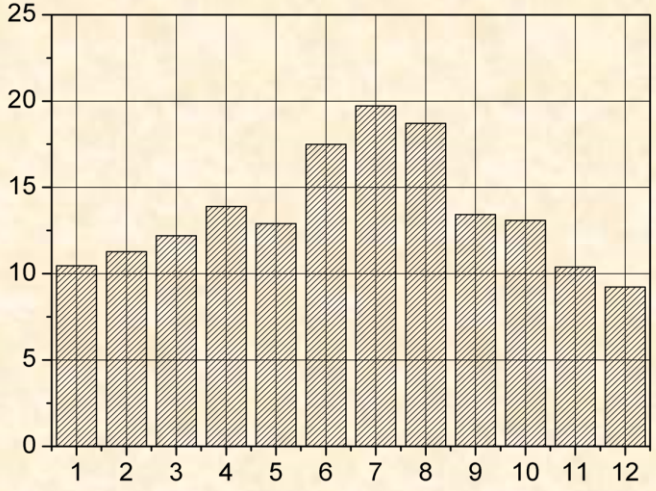
a



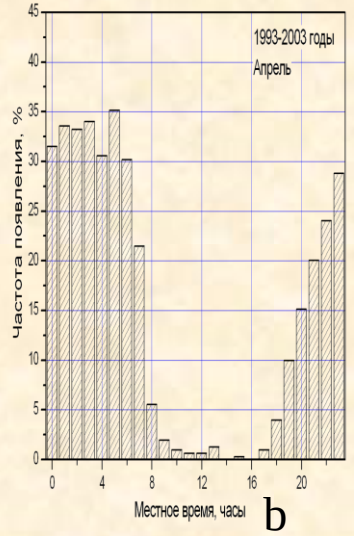
c



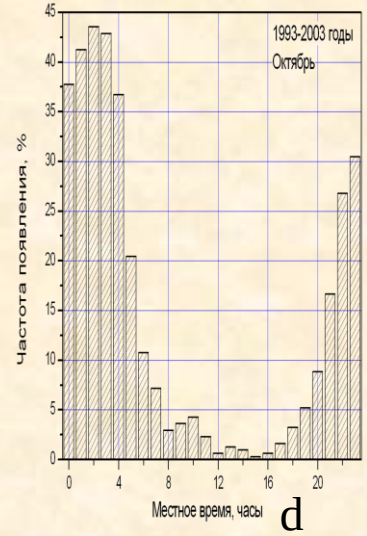
Dependence on geomagnetic activity



Seasonal variation of spread-F appearance

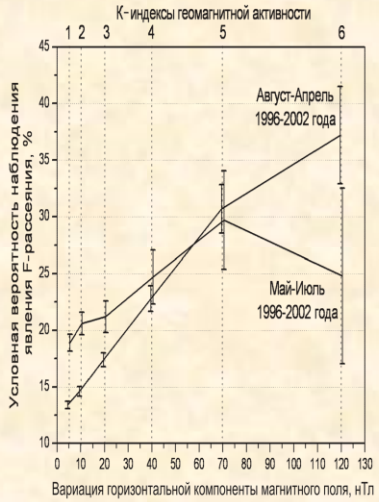


b



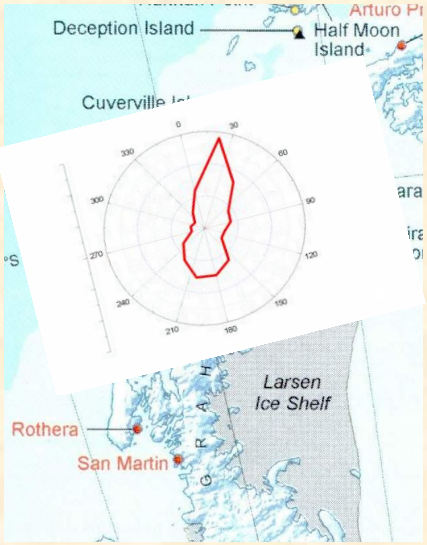
d

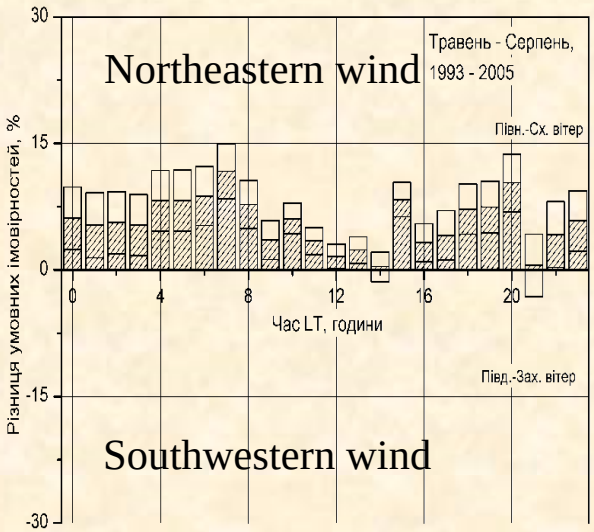
Diurnal variations of spread-F appearance in January (a), April (b), July (c), and October (d) according to 13-years data array.

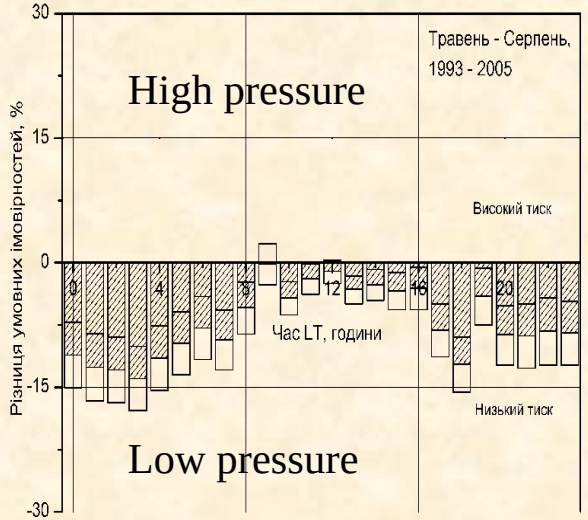


Dependence on geomagnetic activity at different seasons

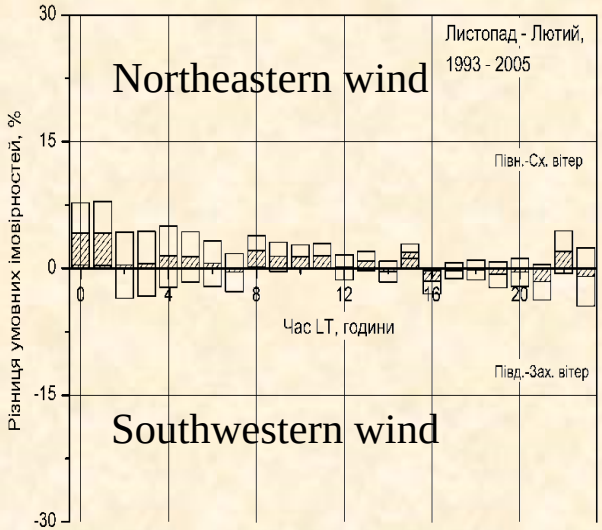
Response of spread-F on weather activity

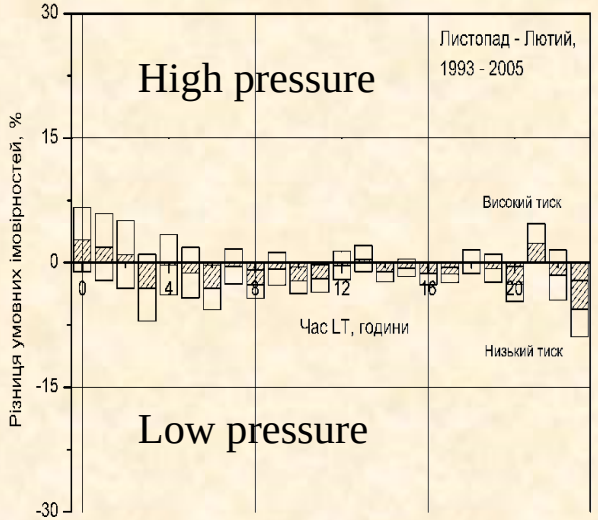






Winter





Summer

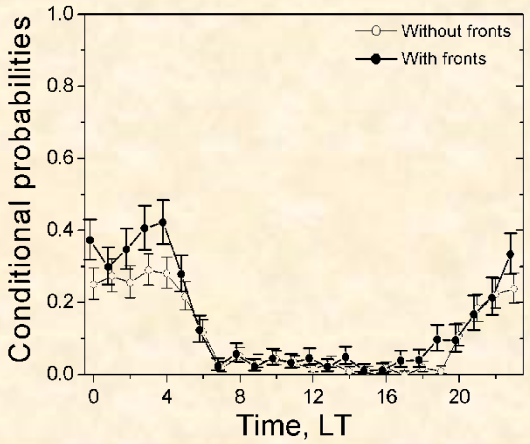
Zalizovski A.V., and Yu.M. Yampolski. The Spread-F Effect as an Indicator of Troposphere-Ionosphere Coupling. Radio Physics and Radio Astronomy, Vol.12 (1), 2007, p. 33-42 (in Russian).

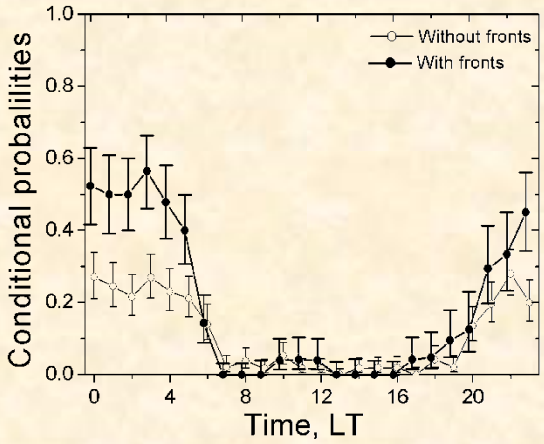
The role of ozone layer in the troposphere-to-ionosphere energy transfer

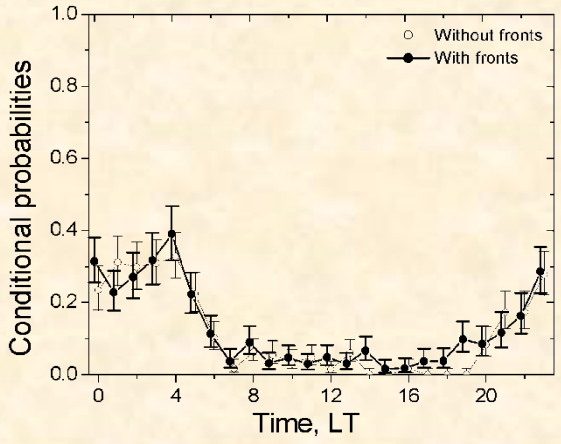
September 11 – October 5, 1995-2004

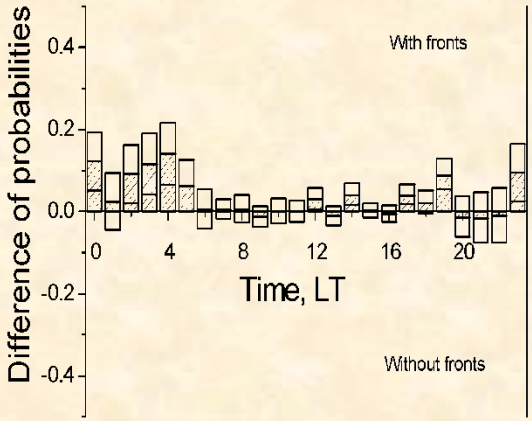
TOC < 180 D.U.

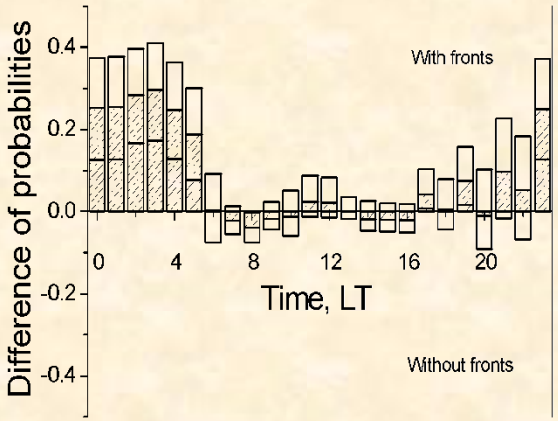
TOC > 180 D.U.

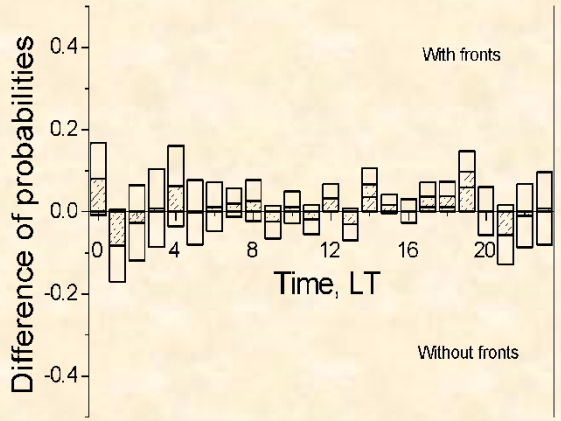








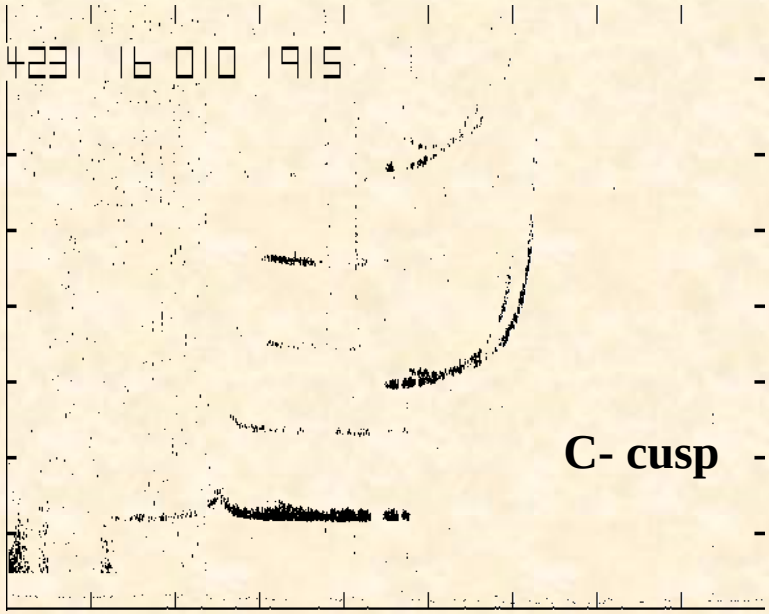




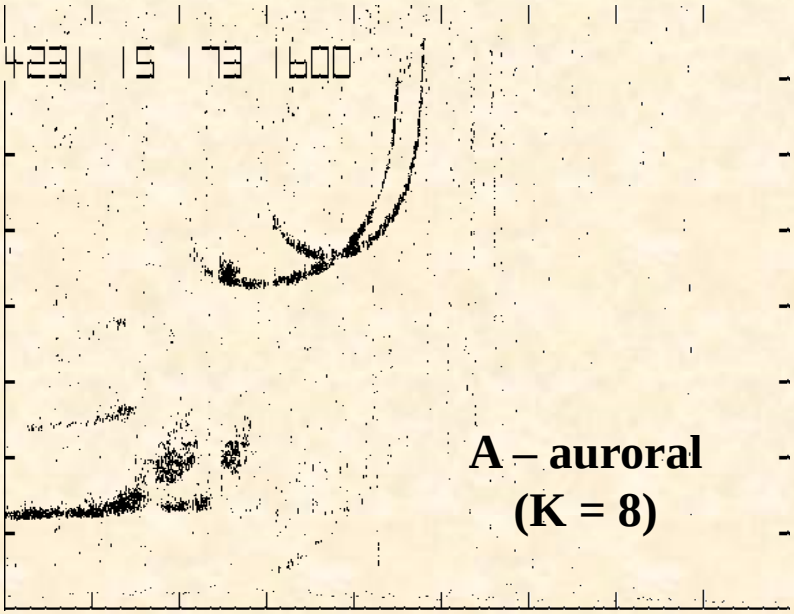
It has been found that under low ozone conditions (less then 180 D.U.) the conditional probability of the spread-F appearance increases in the presence of atmospheric fronts and reduces when they are absent. Under high ozone conditions (more then 180 D.U), statistical relationship between frontal activity and spread-F phenomenon disappears, i.e. the ozone layer plays a role of shield of troposphere-to-ionosphere energy transfer.

Zalizovski A.V. The role of the ozonosphere in the interaction between atmospheric layers as deduced from observation at the Antarctic base "Akademik Vernadsky". International Journal of Remote Sensing. – 2011. – 32(11). – P. 3187-3197. DOI: 10.1080/01431161.2010.541511.

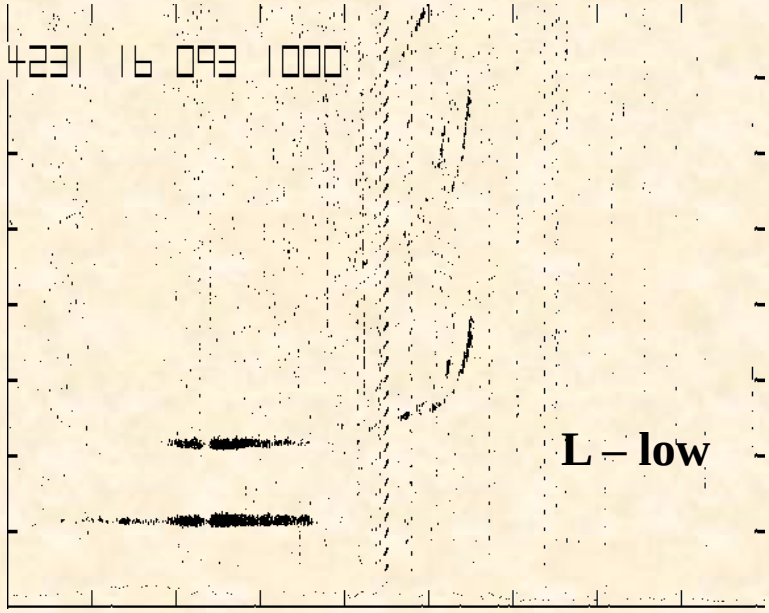
Examples of different types of Es over the Vernadsky station



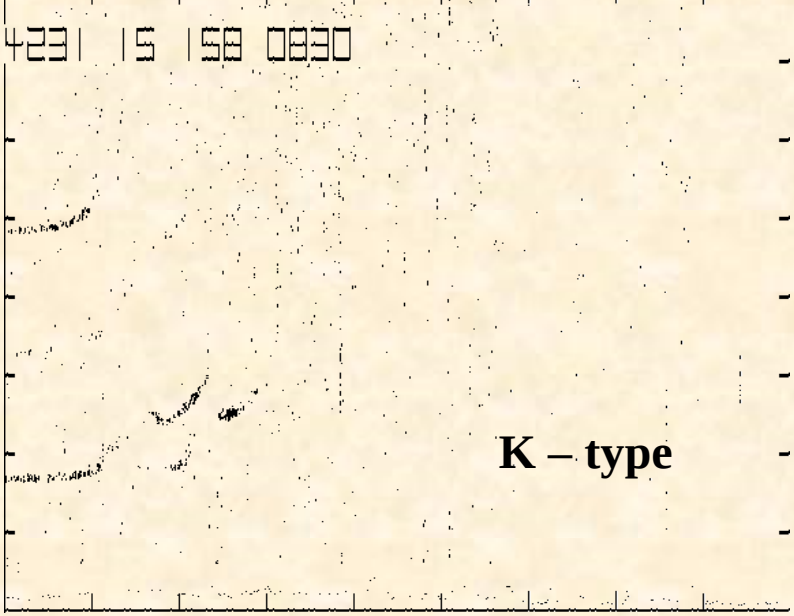
C- cusp



A – auroral
(K = 8)

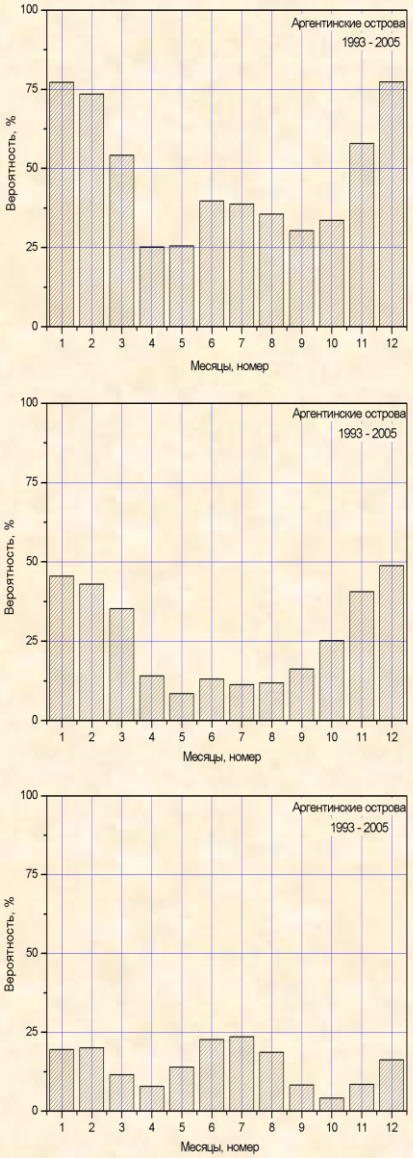


L – low

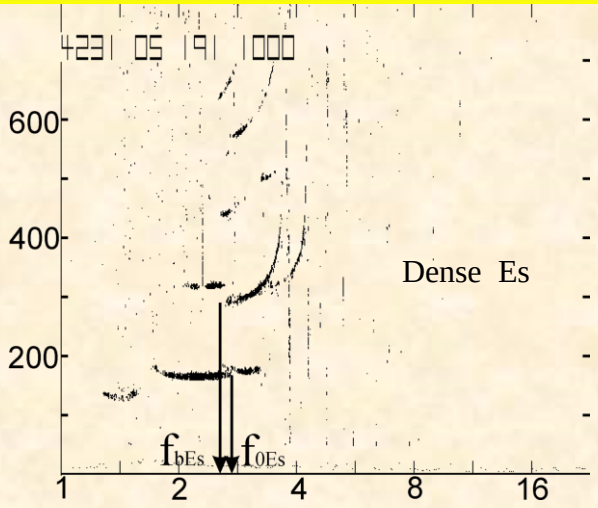


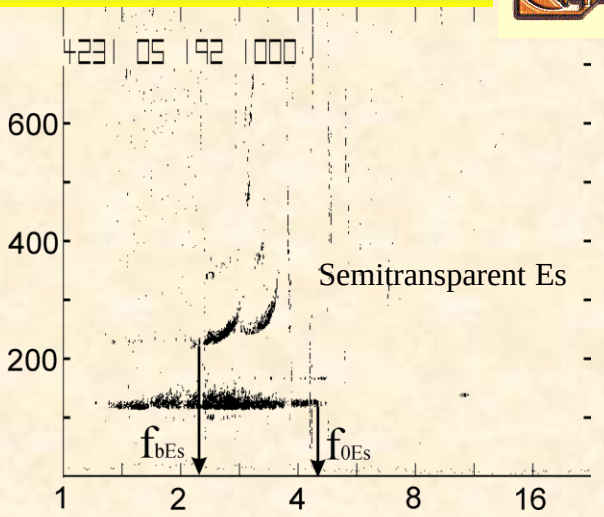
K – type

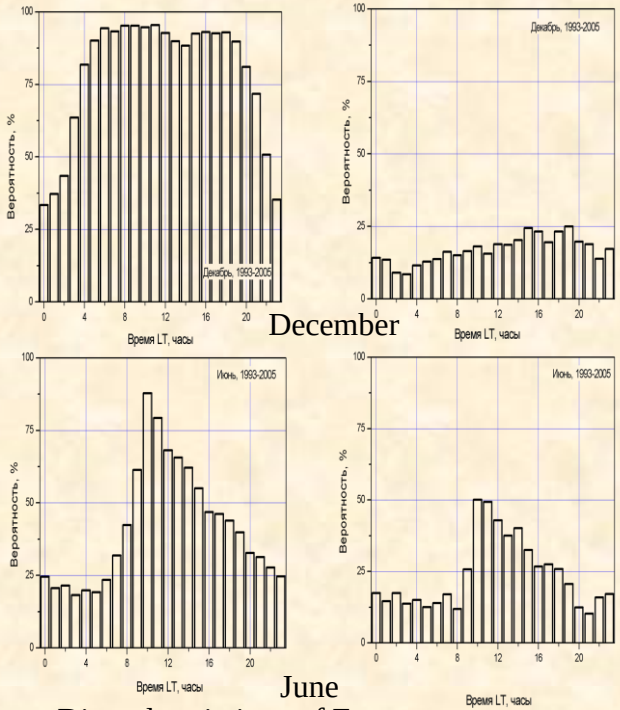
Sporadic E layers and their dependence on tropospheric weather



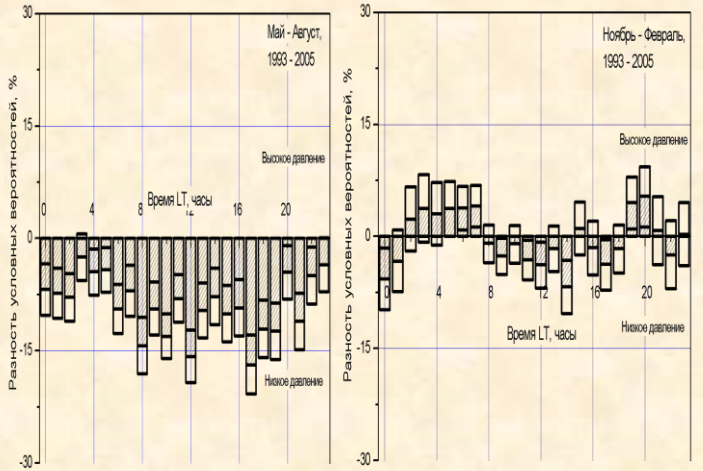
Seasonal variations of Es appearance:
а) all, б) dense, в) semitransparent







Diurnal variations of Es appearance at December and June (right panels for semitransparent)



a) b)

Difference of conditional probabilities of Es appearance under high and low surface pressure
a) May - August; b) November - February.

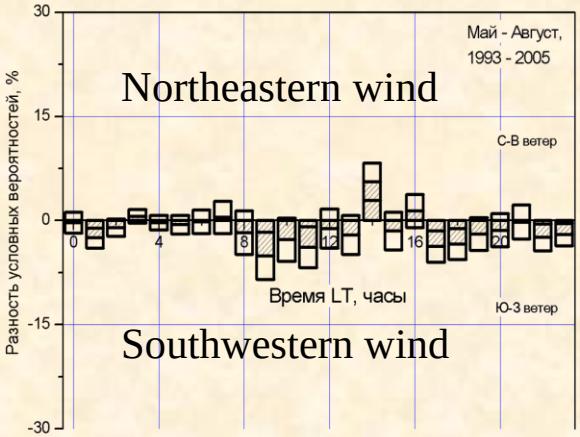
Sporadic E layers and their dependence on tropospheric weather

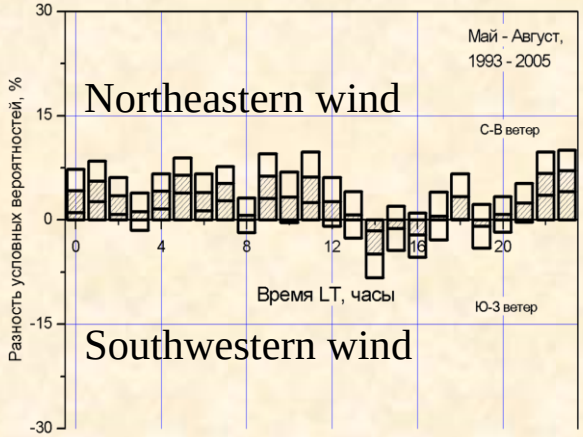
Winter

Dense layers

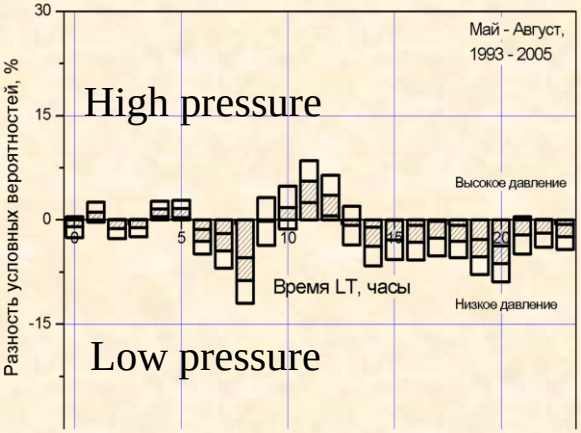
Semitransparent layers

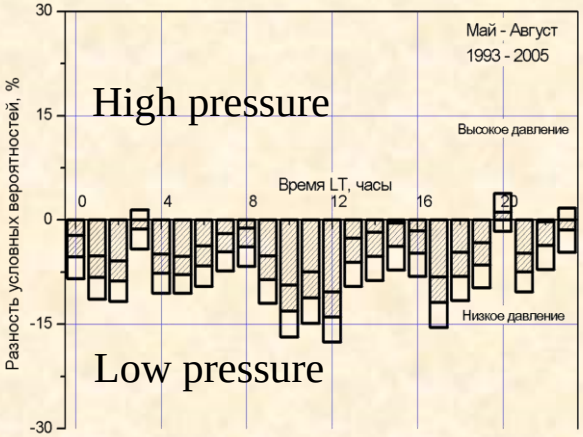
Surface Wind





Surface Pressure





A.V. Zalizovski. The Role of Tropospheric Processes in Forming the Sporadic Layers of E Ionospheric Region over the Antarctic Peninsula. Radio Physics and Radio Astronomy. – 2008. – Vol.13, # 1. – P. 26-38 (in Russian).

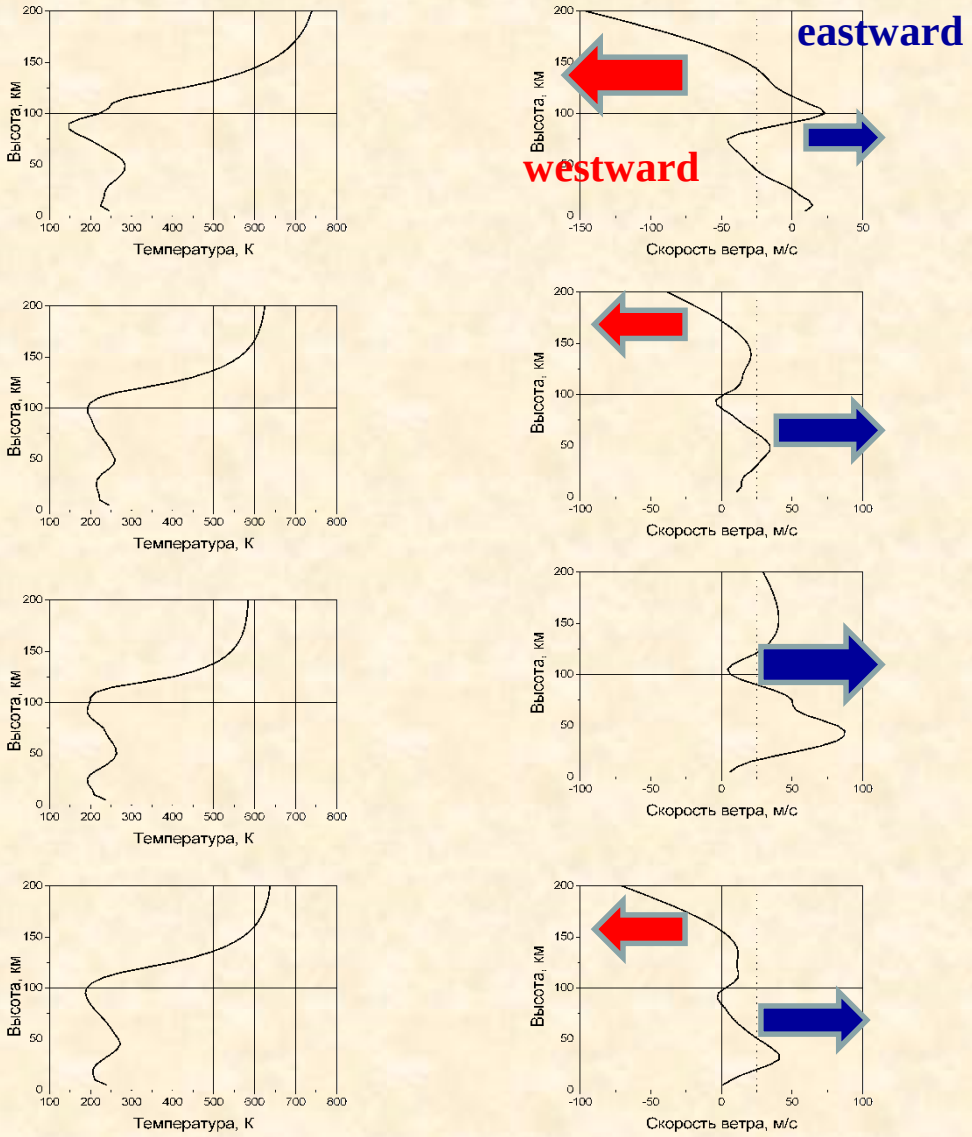
Modeling. Temperature and zonal wind profiles using NRL MSISE-00 for 65S 65W

$$N^2 = \frac{g}{T}\left(\frac{dT}{dz} + \frac{g}{C_P}\right); \qquad \Delta\omega = -\Delta V_x k_x$$

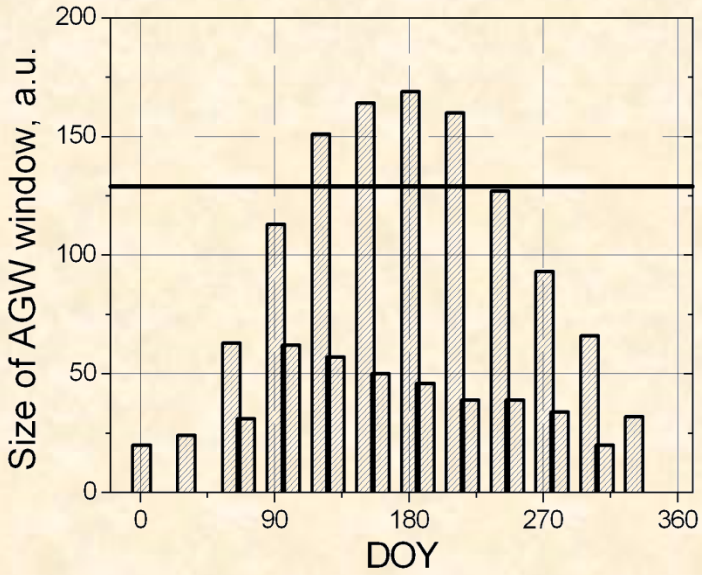
- **Local simulation of vertical propagation of AGW over the Antarctic Peninsula**
- **Vertical profiles of the temperature and horizontal winds of the middle and upper atmosphere from NRL MSISE-00**
- **Brunt-Vaisala frequency is taken as a function of the vertical temperature gradient and used as a free parameter.**
- **The seasonal variations in the statistical relation between processes in the lower and upper atmosphere can be explained by the respective changes in the vertical propagation conditions for atmospheric gravity waves.**

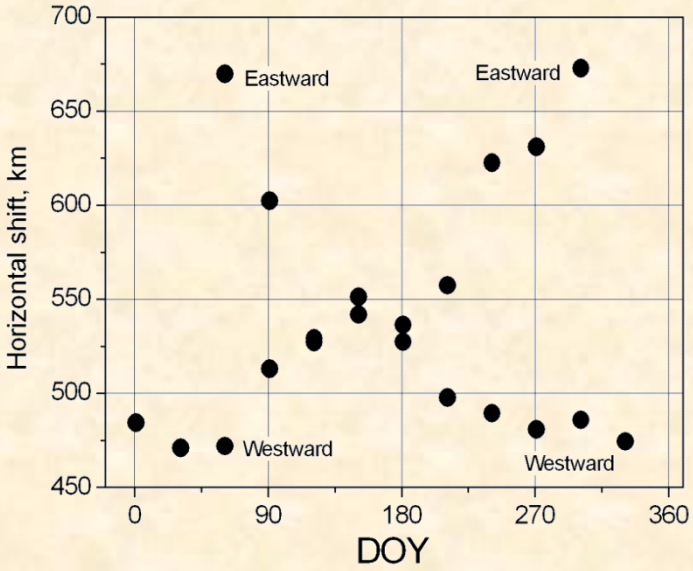
Temperature

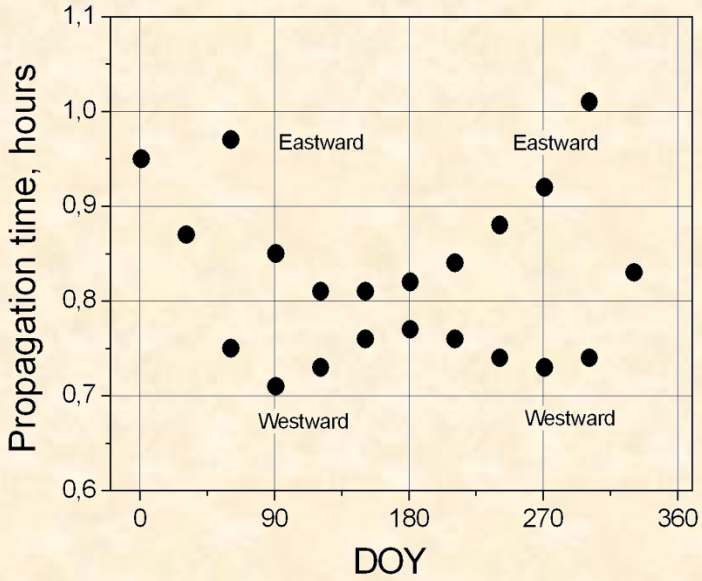
Zonal wind

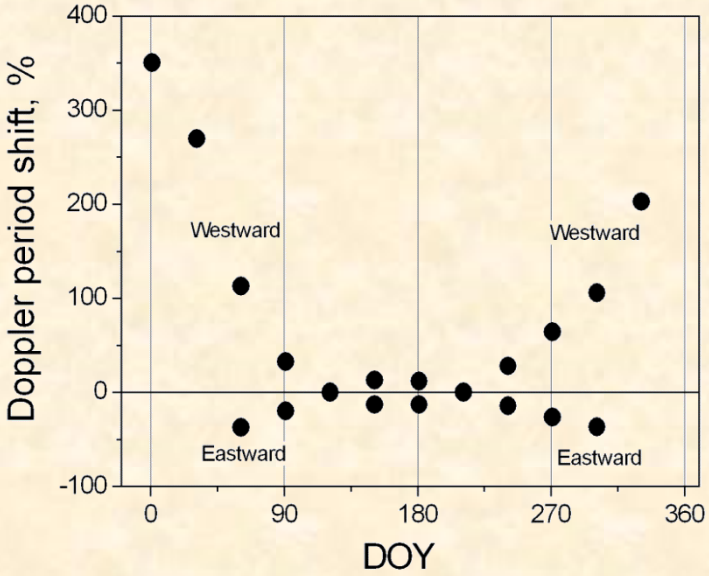


Modeling. Results for middle-scale AGW

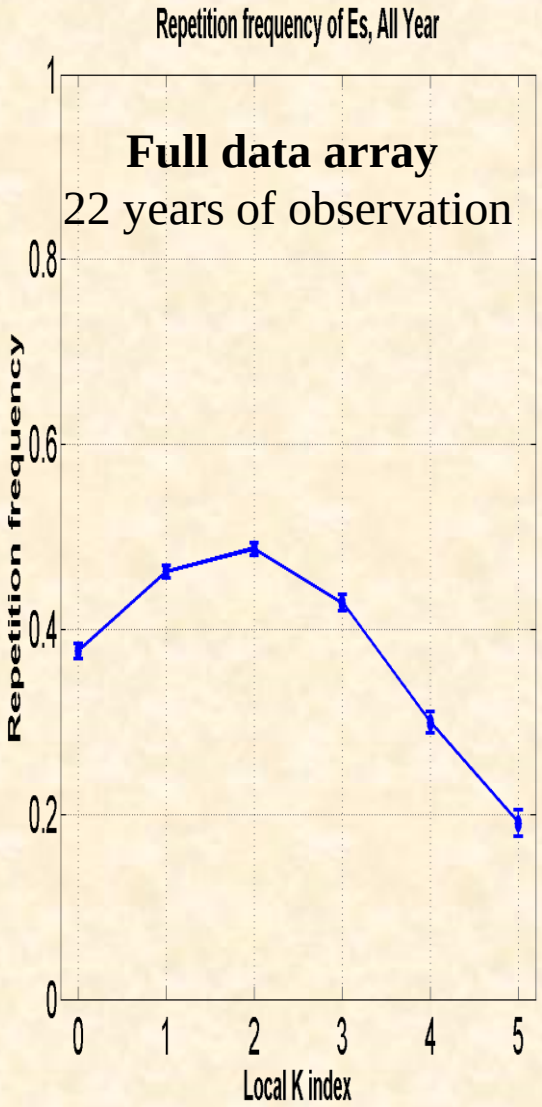


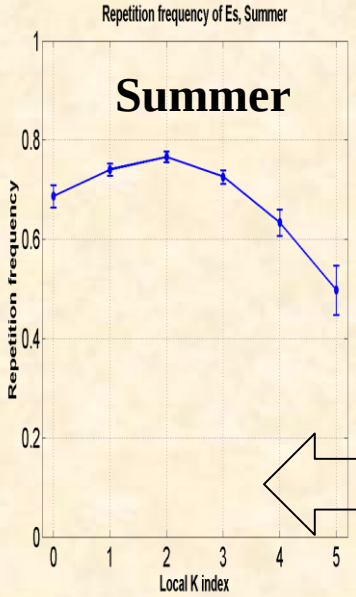


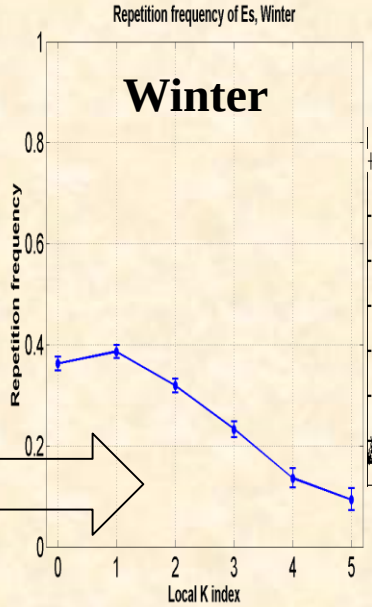


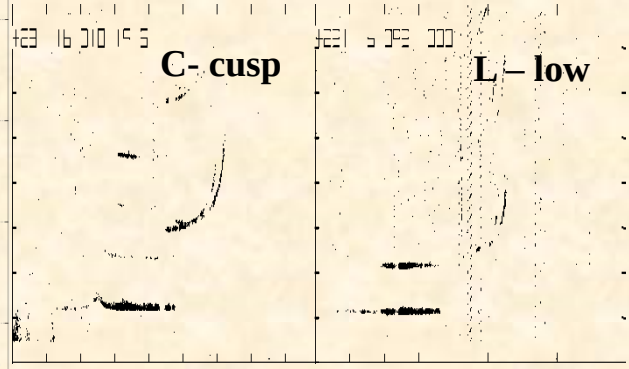


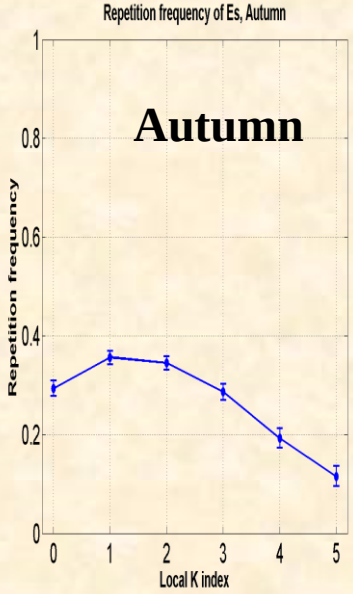
Response of ionospheric sporadic structures on geomagnetic activity

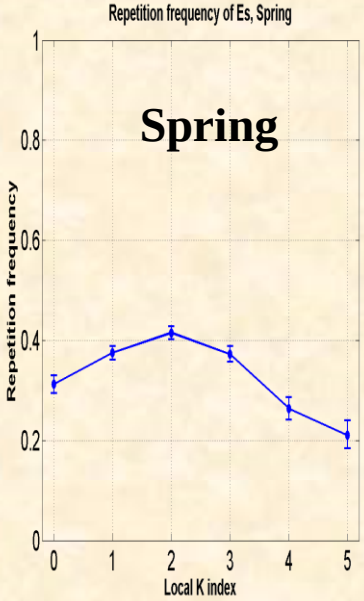


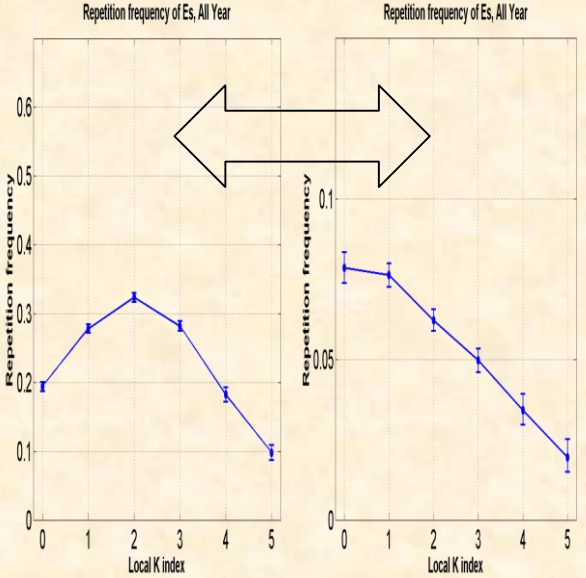




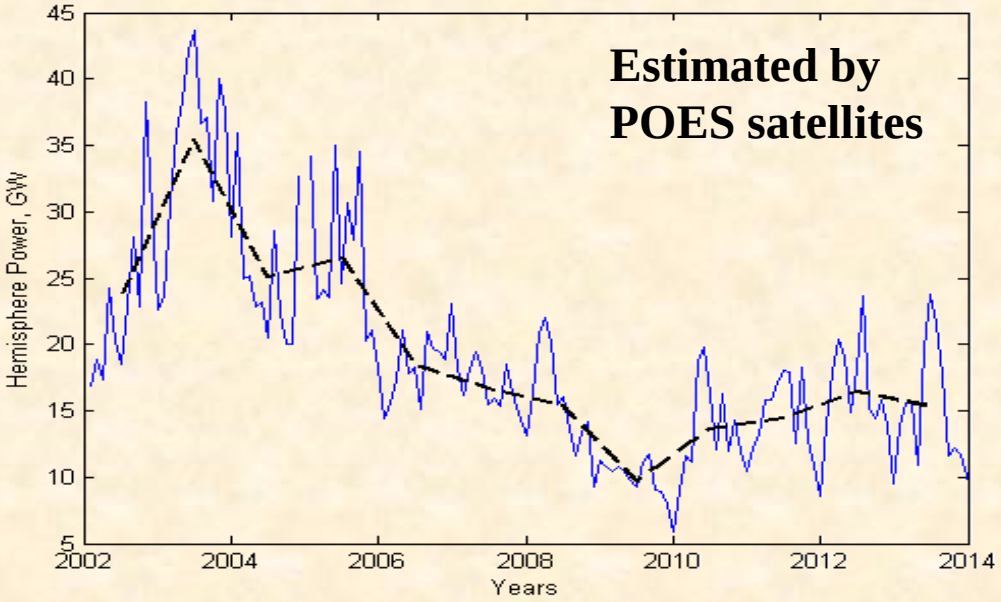


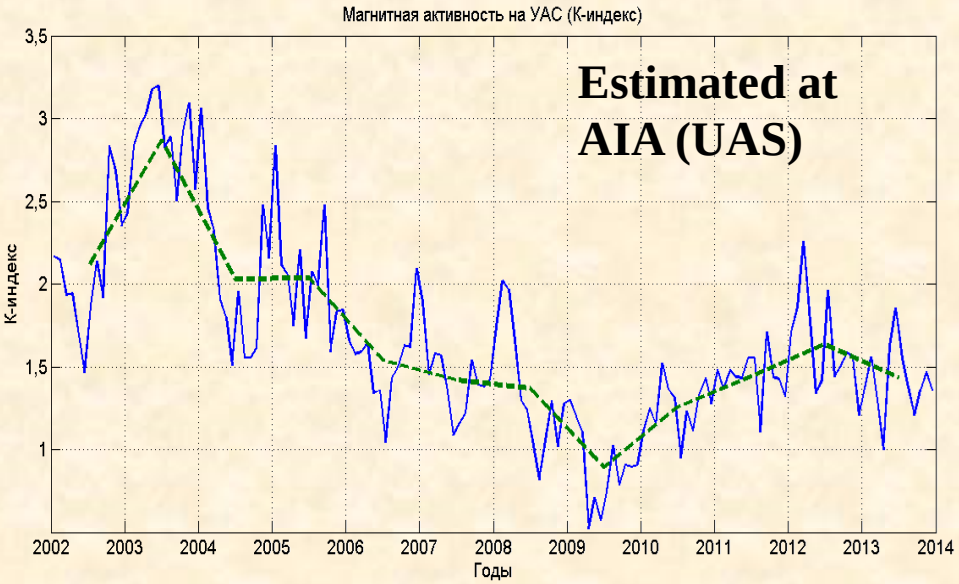


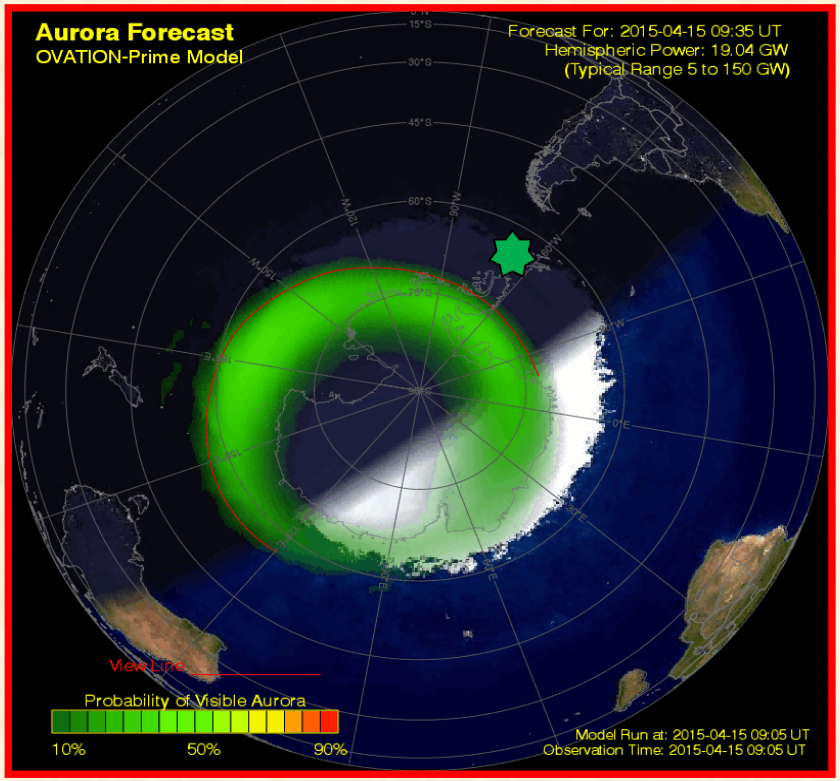




12-year variations of Hemisphere Power and local K-index







http://www.swpc.noaa.gov/

It looks like an optimal position and intensity of the auroral oval for the formation of Es above the maximum of the region E is exist for the location of *Vernadsky* station.

Summary

- As a result of analysis of more than 20-year experimental databases accumulated in Antarctica at *Akademik Vernadsky* station it was found that both Es and spread-F dependent on the tropospheric weather mostly at the winter time.
- The ozone layer plays a role of shield of troposphere-to-ionosphere energy transfer.
- The almost linear dependence of spread-F on the geomagnetic disturbances was found (not so clearly in the winter).
- The dependence of Es occurrence frequency on the local K-index demonstrates the non-linear character with the maximum at K = 2. At the winter time the maximum of Es occurrence shifts to local K = 0…1.
- The experimental results can be explained by propagation of atmospheric gravity waves (AGW) in the ionosphere. The seasonal variations in the effects could be associated with changes of intensities of troposheric and auroral sources of AGW and vertical profiles of temperature and horizontal winds that effect on AGW propagation conditions.


Thank you for your attention!