

# **Impact of space weather on ionospheric scintillation**

**Shepeliev V. , Lytvynenko O.**

*Institute of Radio Astronomy, Kharkov-Odessa, Ukraine*

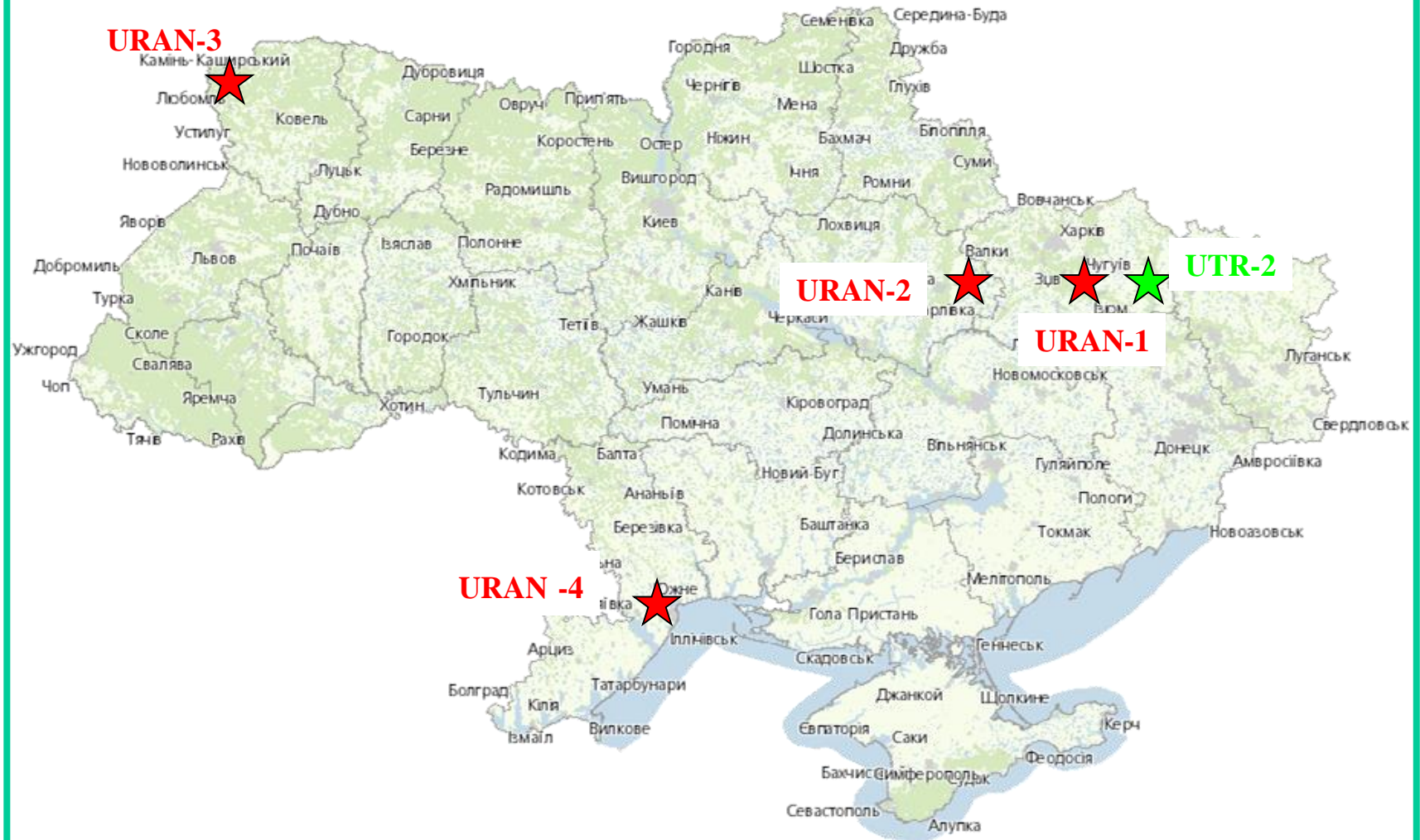
Solar Influences on the Magnetosphere, Ionosphere and Atmosphere  
Primorsko, Bulgaria, 13 ÷ 17 September, 2021

# UTR-2





# Ukrainian Radio Astronomical Network

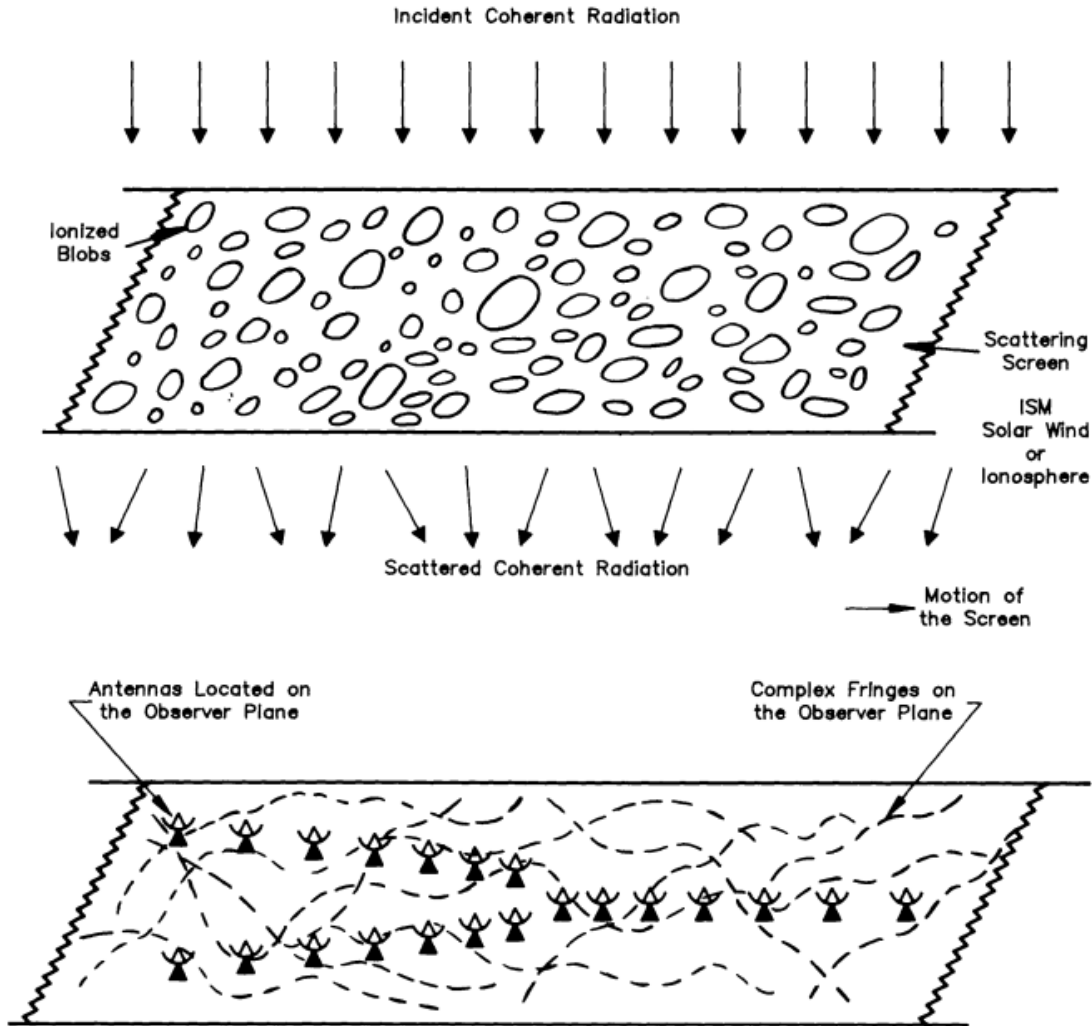




A Distant Point Source

K. R. ANANTHARAMAIAH<sup>†</sup>,  
T. J. CORNWELL, AND RAMESH NARAYAN<sup>‡</sup>

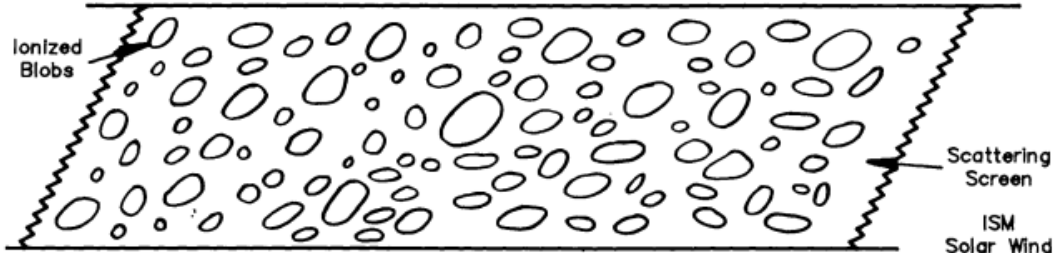
1989ASPC...6..415A





A Distant Point Source

Incident Coherent Radiation

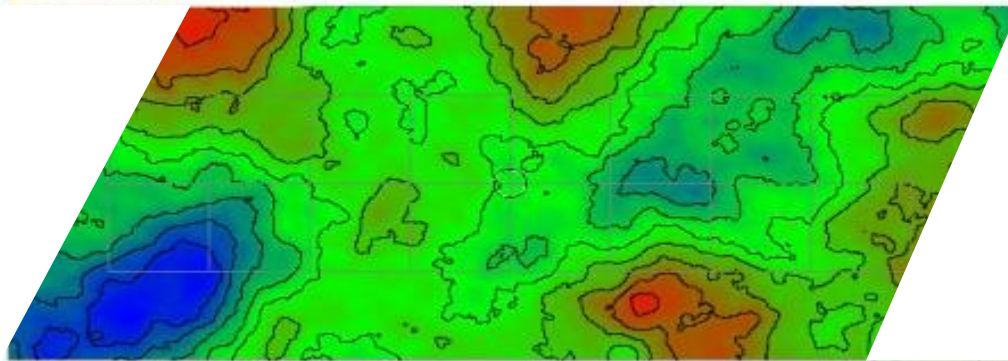


ISM  
Solar Wind  
or  
Ionosphere

Scattered Coherent Radiation



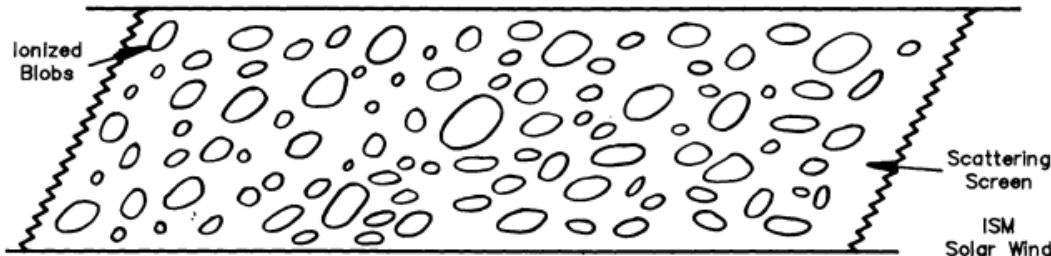
→ Motion of the Screen





A Distant Point Source

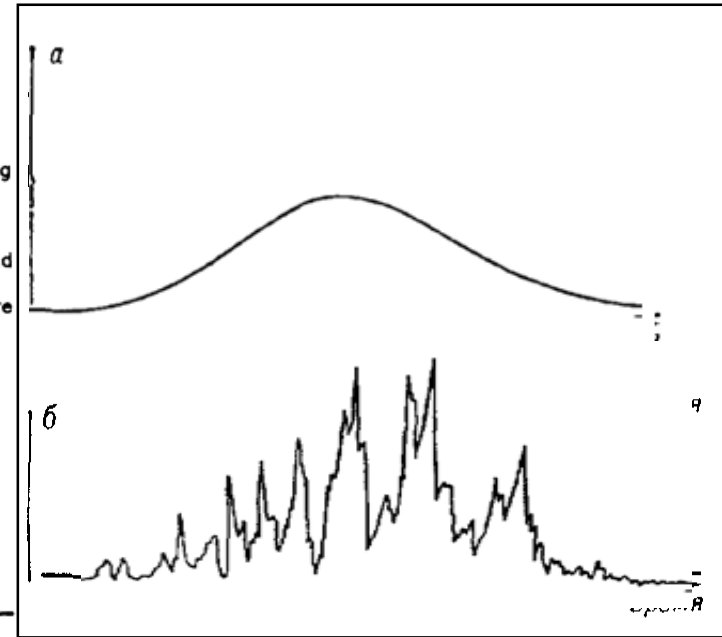
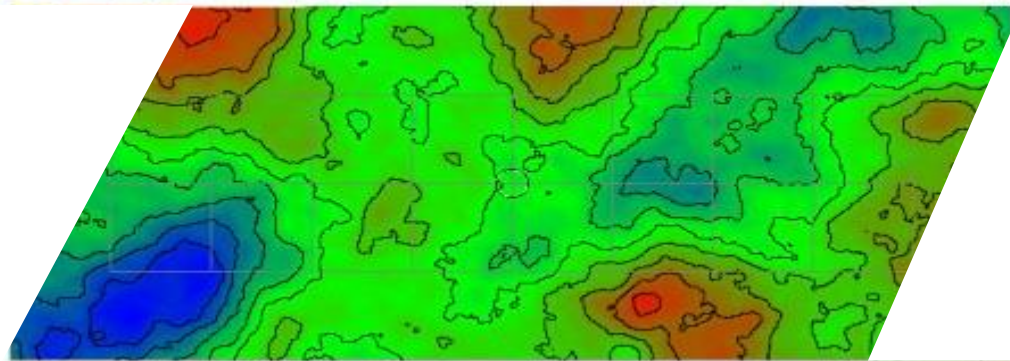
Incident Coherent Radiation



Scattered Coherent Radiation



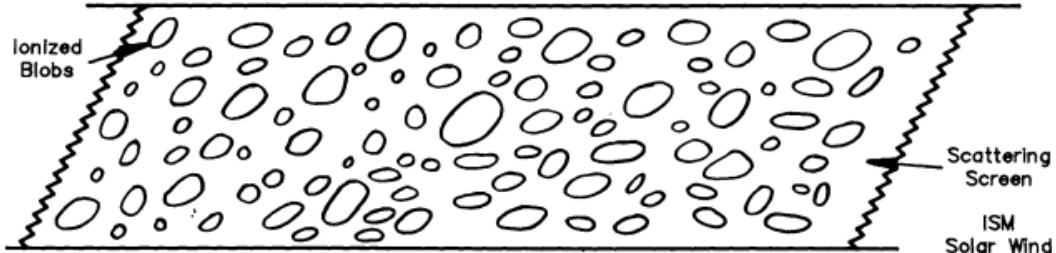
Motion of the Screen





A Distant Point Source

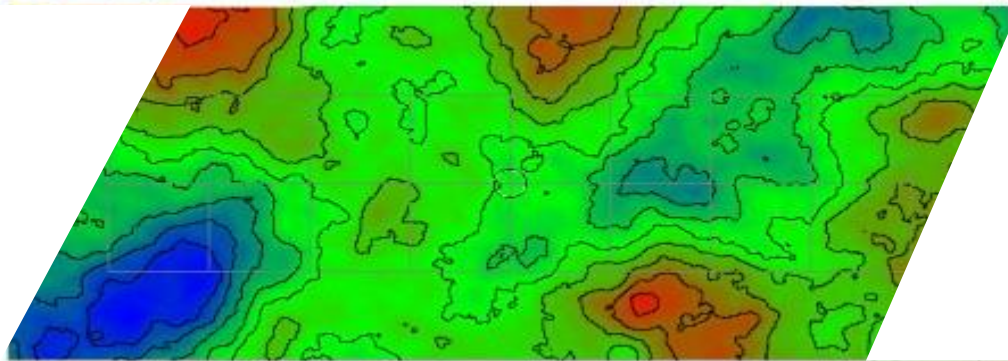
Incident Coherent Radiation



Scattered Coherent Radiation



→ Motion of the Screen

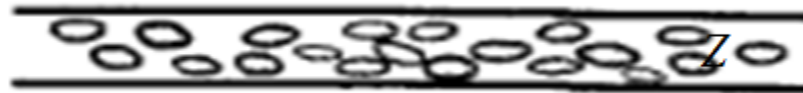




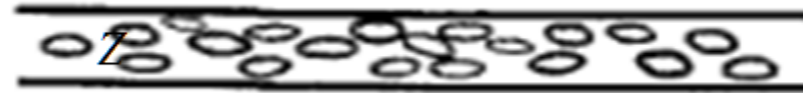


A Distant Point Source

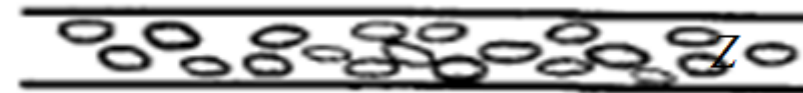
Incident Coherent Radiation



Interstellar medium



Solar wind



Ionosphere





# Interstellar plasma

$0.1 - 0.3 \text{ cm}^{-3}$

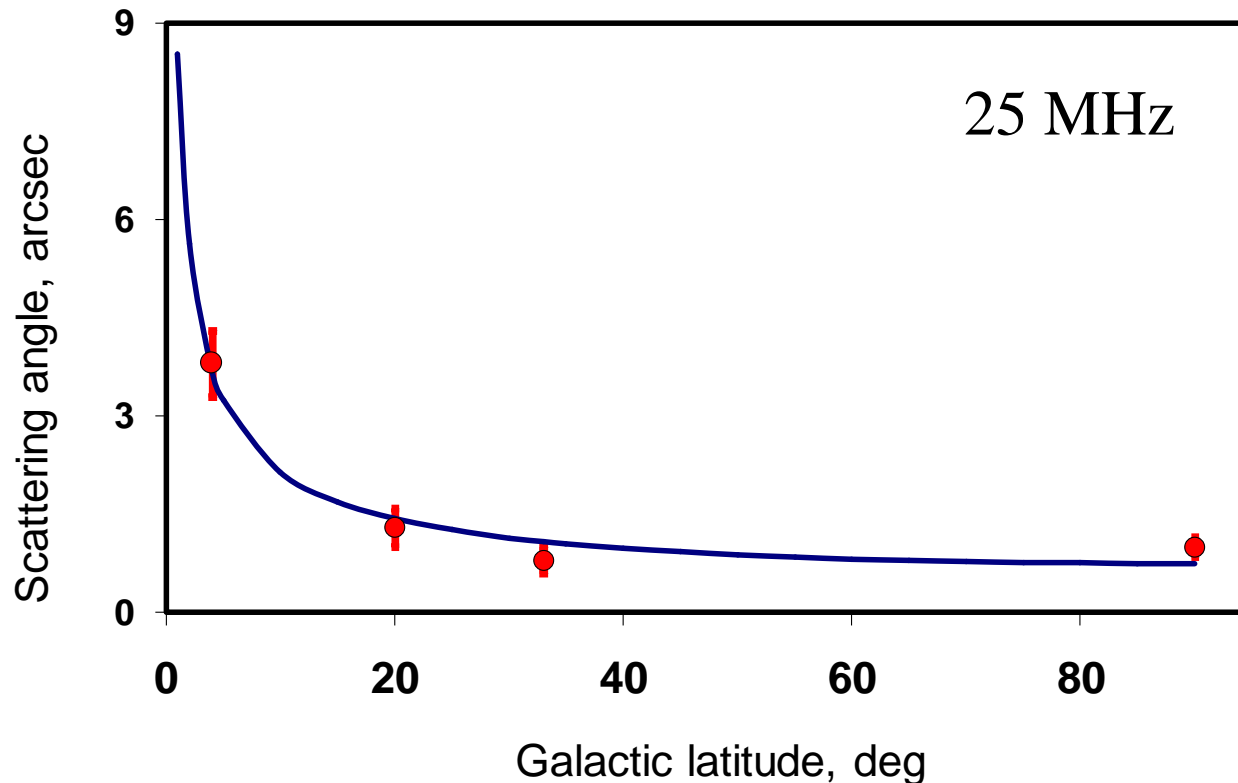
strong scintillation mode

main effect - scattering

$$\theta_s \cong 20(10\lambda)^{2.2} (\sin b)^{-0.6}$$

Shishov, V.I. *Astronomy Reports*, V. 45, 2001

$\theta_s \sim 0''.8 \div 9''$



## scattering in action



# Interstellar plasma

$0.1 - 0.3 \text{ cm}^{-3}$

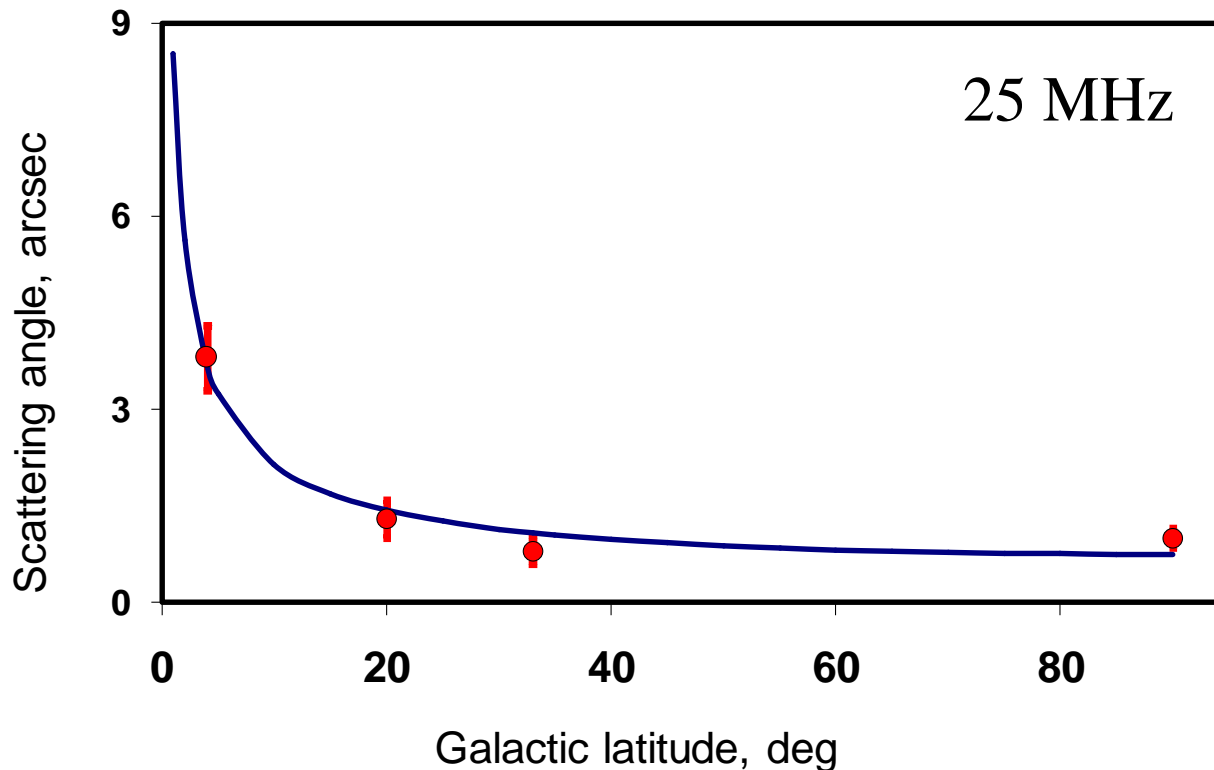
strong scintillation

main effect - scattering

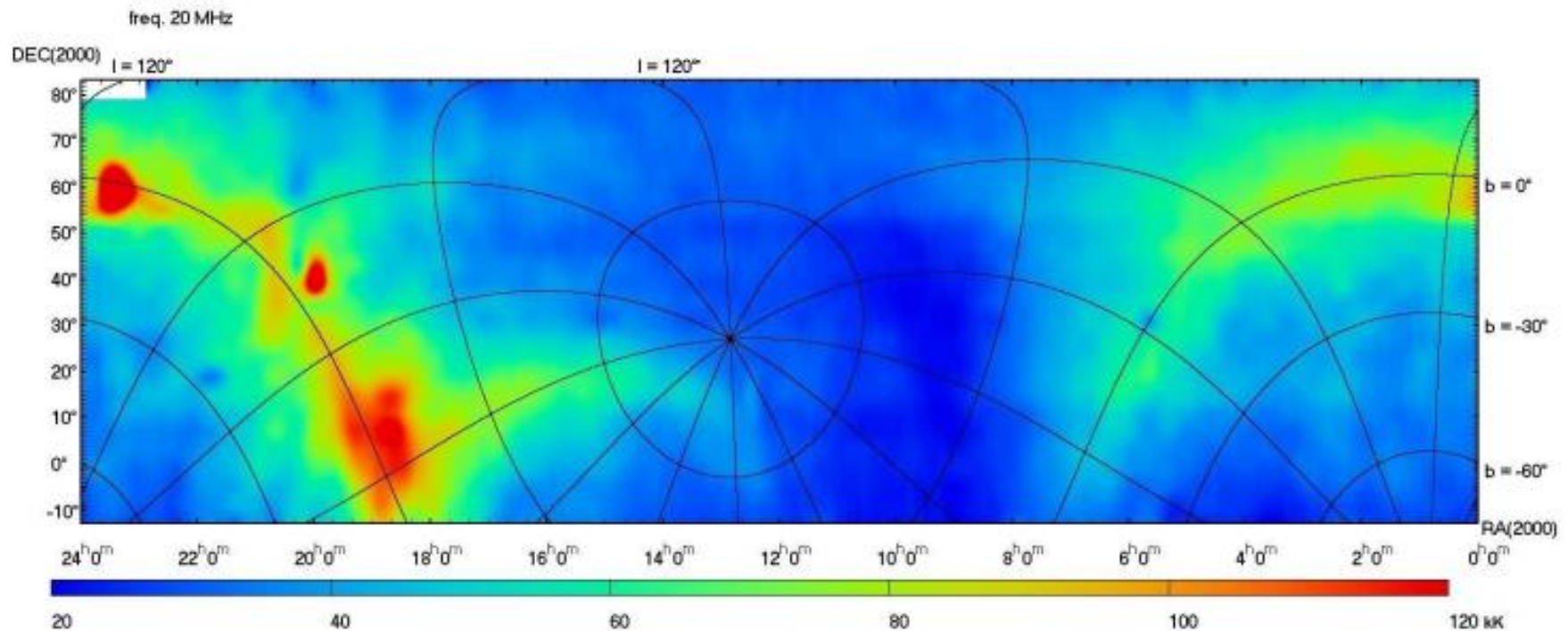
$$\theta_s \cong 20(10\lambda)^{2.2} (\sin b)^{-0.6}$$

Shishov, V.I. *Astronomy Reports*, V. 45, 2001

$\theta_s \sim 0''.8 \div 9''$

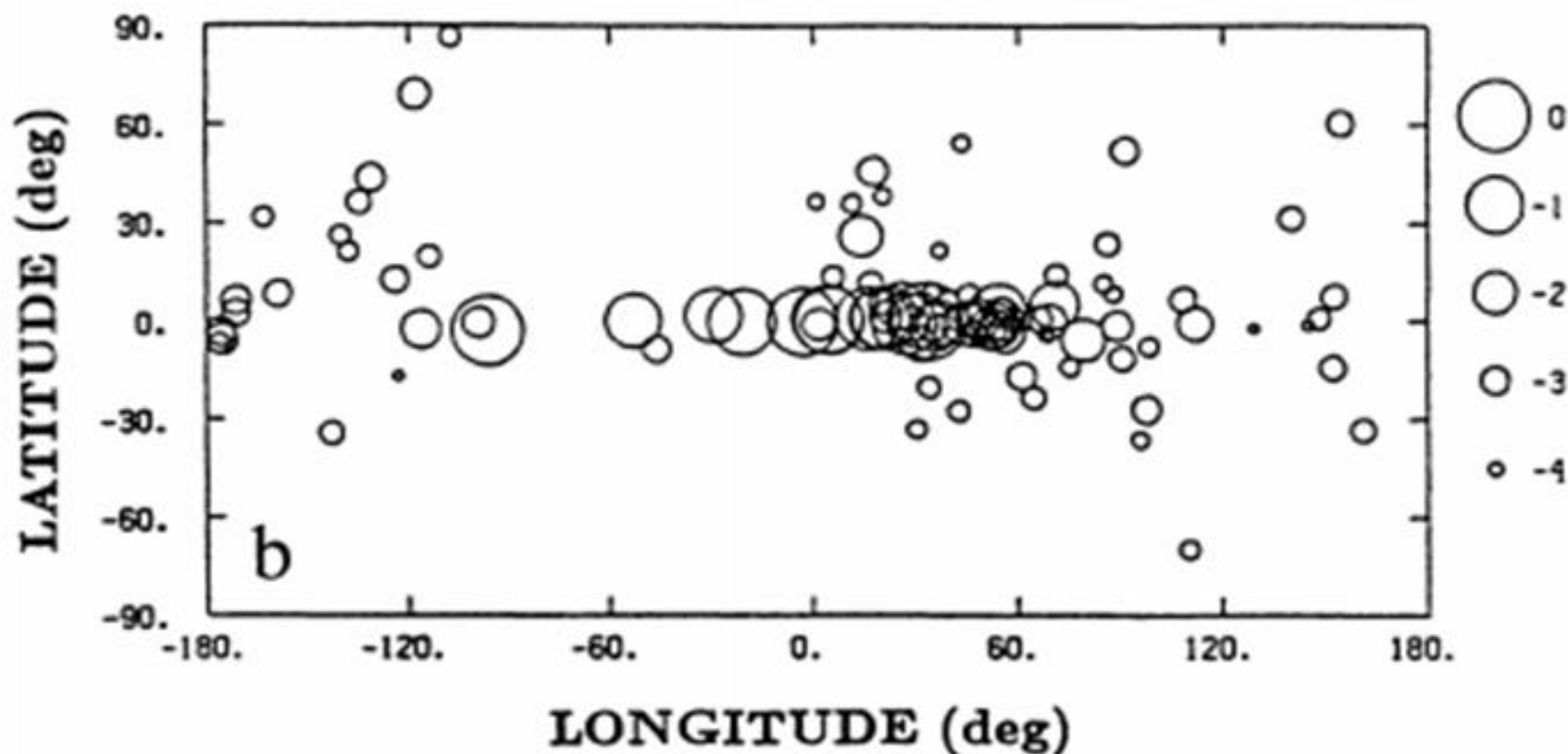


# Galactic background at 20 MHz



**Fig. 18** The large-scale brightness temperature map of Northern sky at 20 MHz. Map was produced with observations from one of the NS sections of UTR-2 and entire URAN-2 radio telescope. Half-power bandwidth ( $\alpha^\circ \times \delta^\circ$ ) was  $\sim 11^\circ \times 7^\circ$  near the zenith direction of  $\sim 50^\circ$ . Map is represented in equatorial coordinates superimposed on galactic coordinates with angular step of  $30^\circ$ .



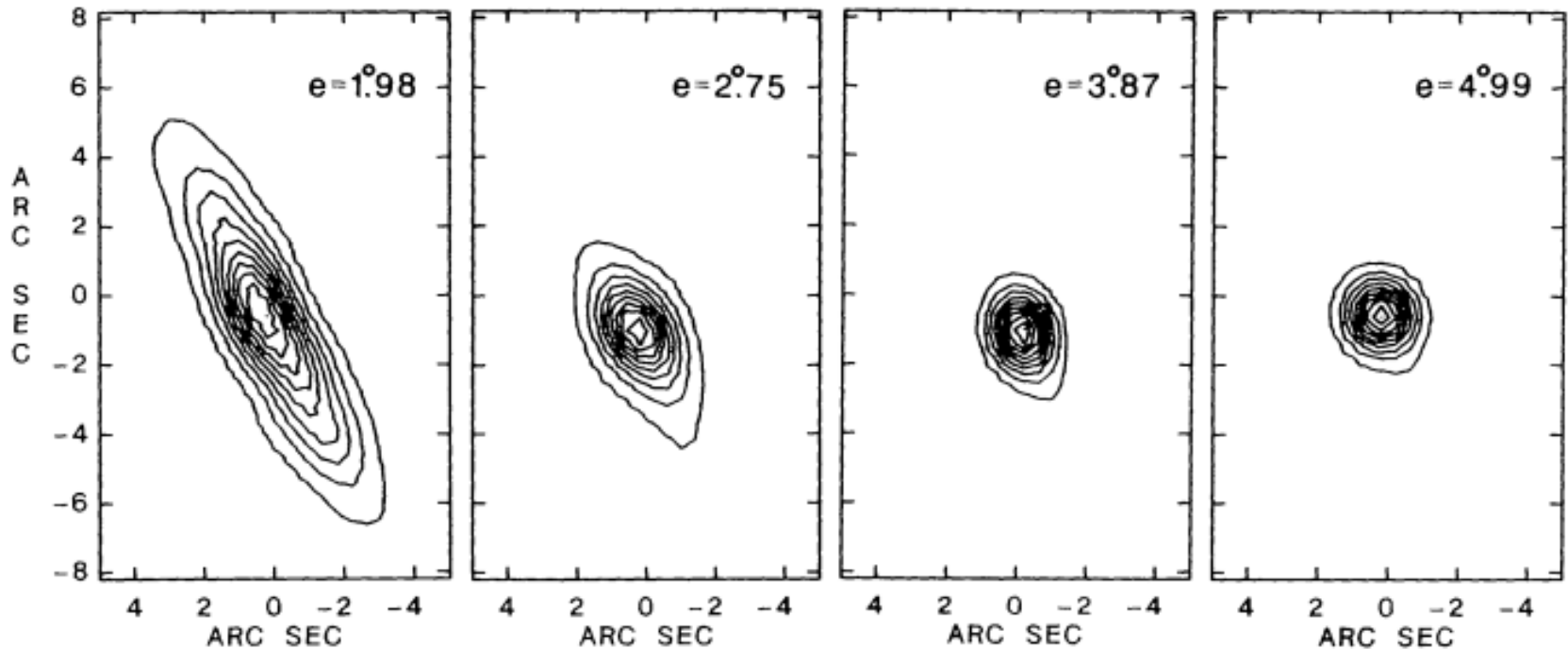


Plots (from Cordes et al 1988b) of the line-of-sight-averaged  $C_N^2$  values versus (a) distance from the Earth and (b) galactic coordinates. Plot (a) shows the erratic and increasing scattering at low latitudes and great distances, and (b) demonstrates that these increases are strongest toward the inner part of the galactic disk. The origin of the localized, strongly enhanced “turbulence” is actively being sought.

# Interplanetary medium

$$n_e \sim 10 \text{ cm}^{-3}$$

$$z \sim 1 \text{ a.u.}$$

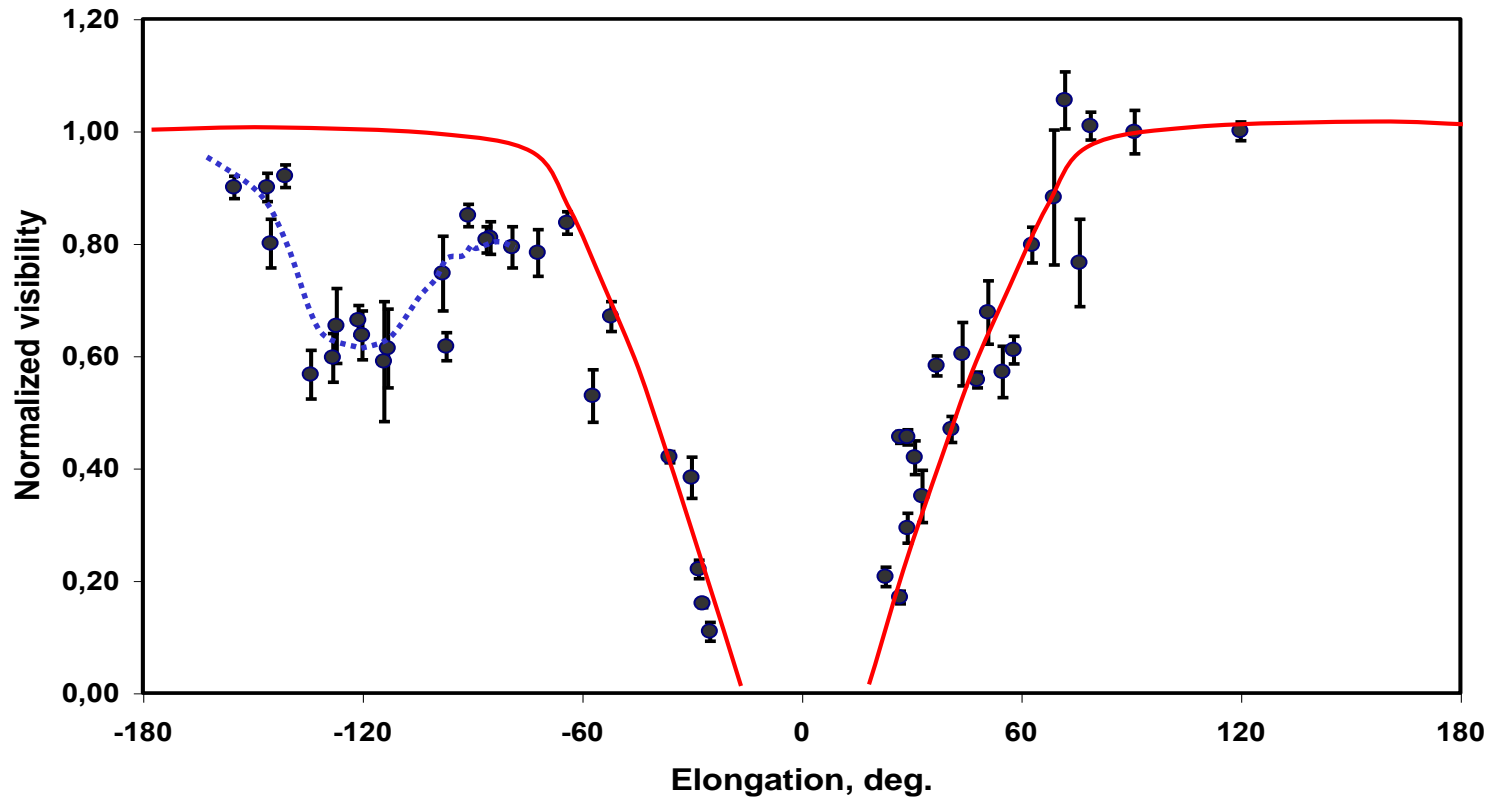


images of 3C 279 made at  $\lambda 20\text{cm}$  when the source was at different angular distances from the Sun. The elongation is shown for each frame.

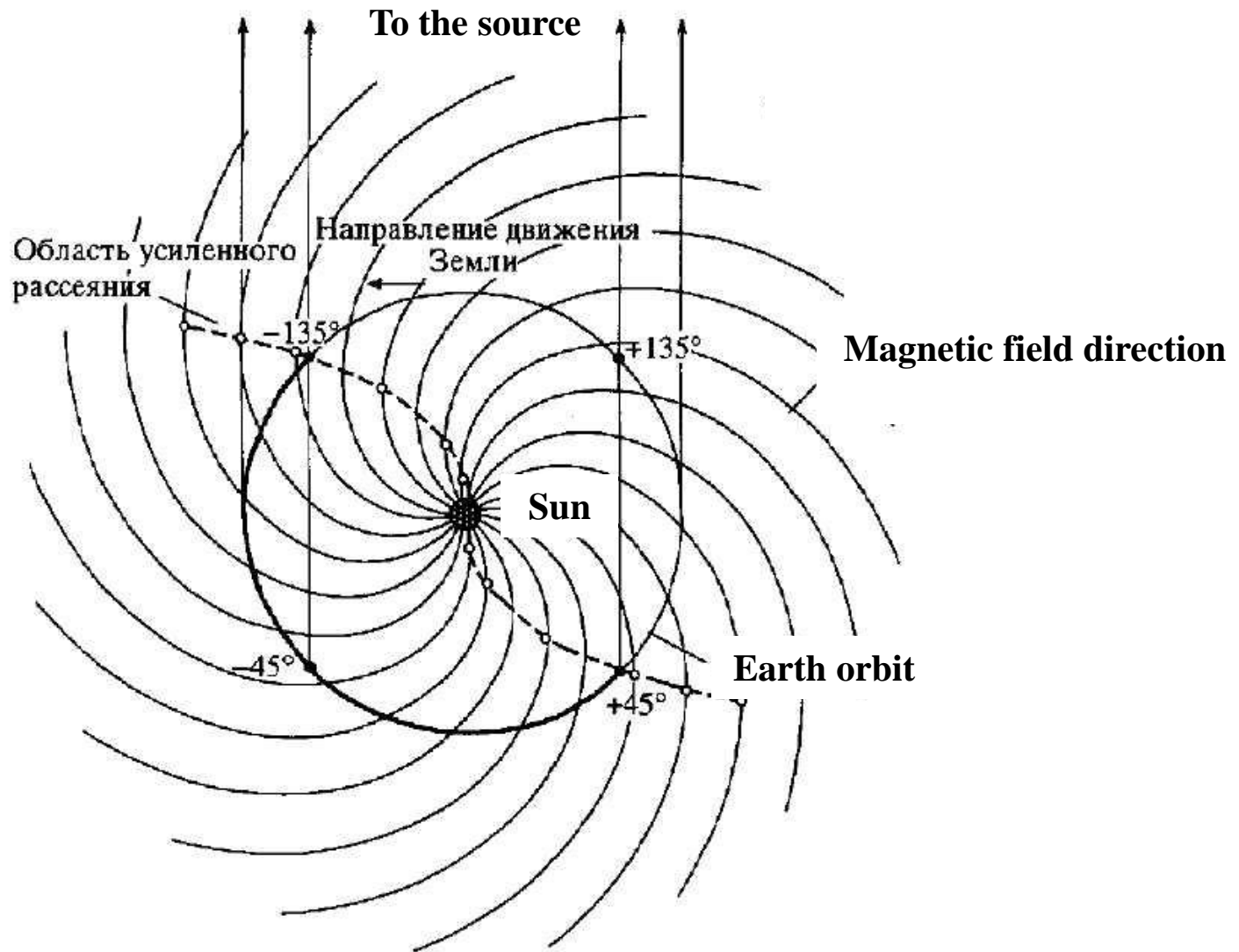
K. R. ANANTHARAMAIAH<sup>†</sup>,  
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1989ASPC...6..415A

# Interplanetary medium



*Braude et al. Astronomy Reports, V39, #5, 1995*



*Braude et al. Astronomy Reports, V39, #5, 1995*

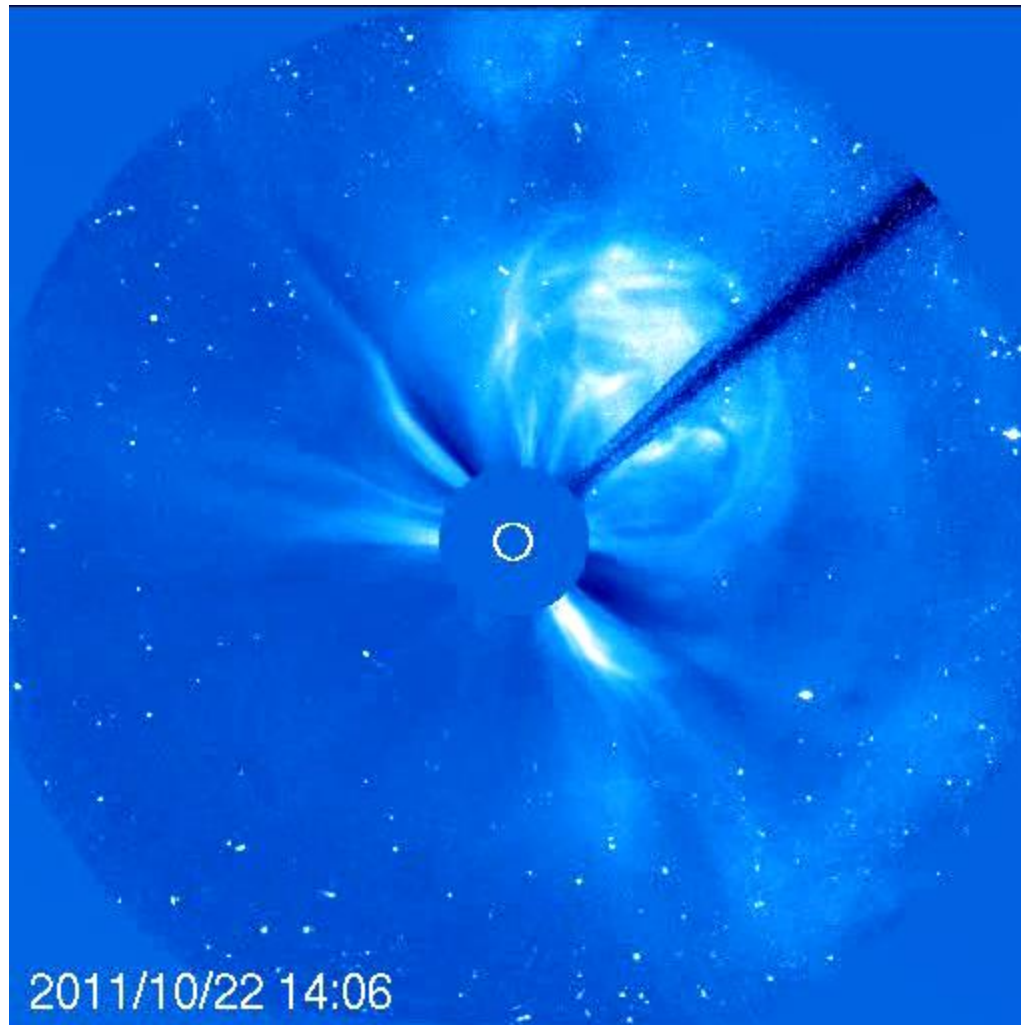


# **Observations of ionosphere and solar wind turbulence at low frequencies using interferometers URAN**

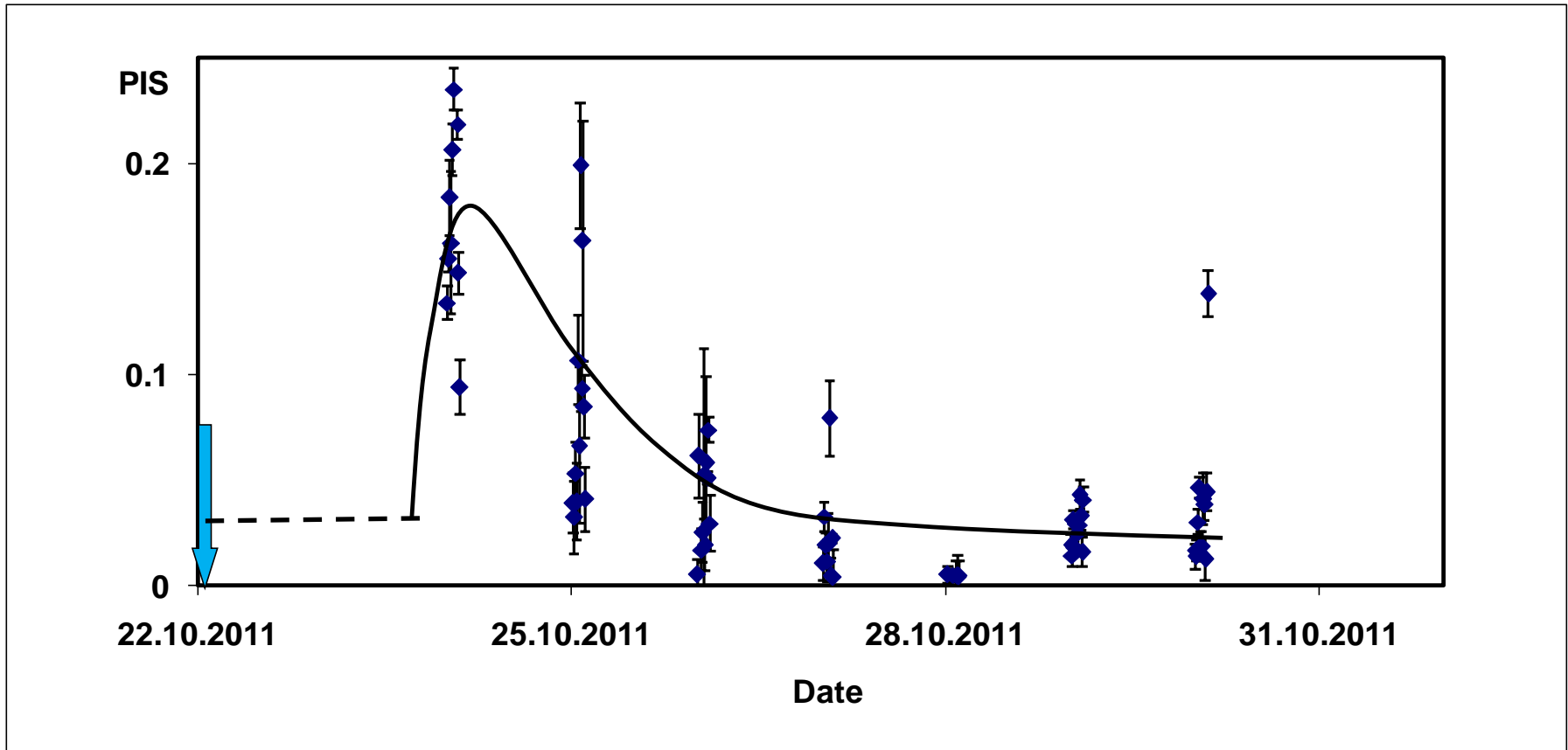
**Shepeliev V. , Lytvynenko O.**

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Solar Influences on the Magnetosphere, Ionosphere and Atmosphere  
Primorsko, Bulgaria, 2 ÷ 9 June, 2019

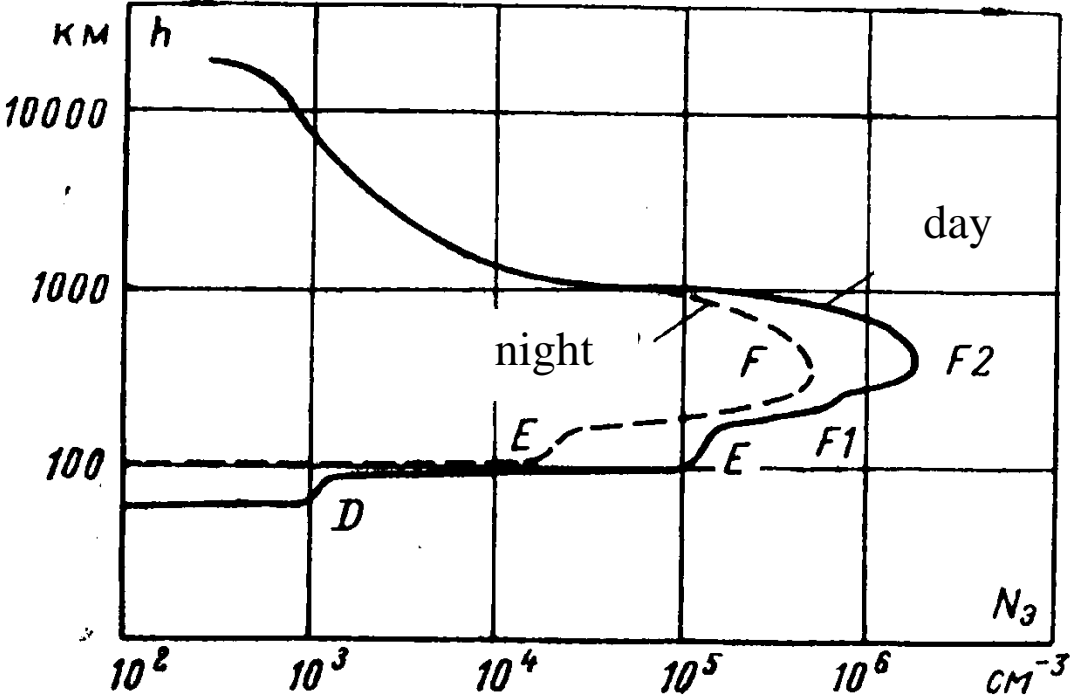


Solar Influences on the Magnetosphere, Ionosphere and Atmosphere  
Primorsko, Bulgaria, 2 ÷ 9 June, 2019



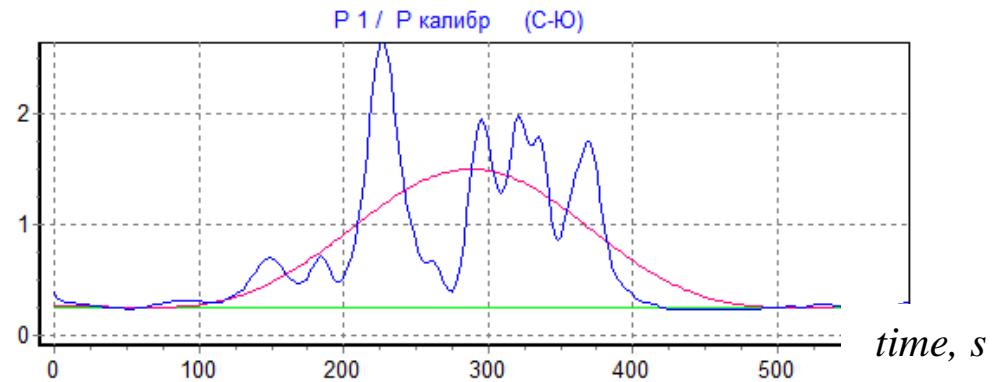
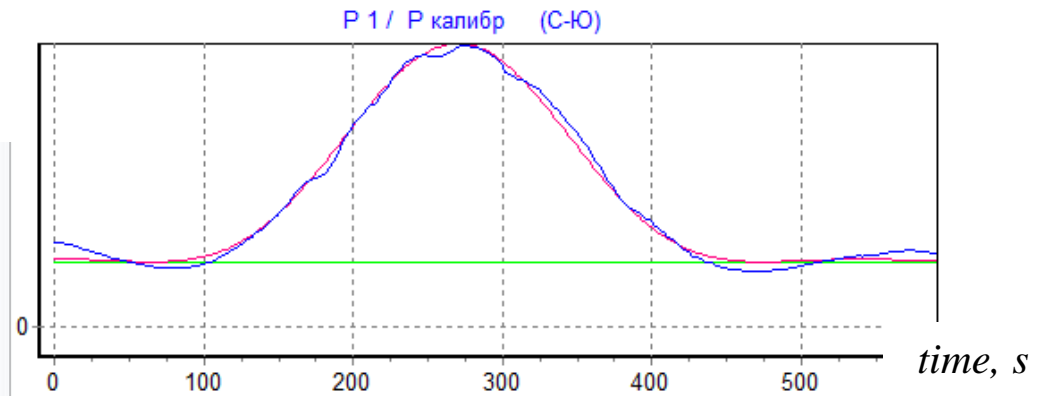
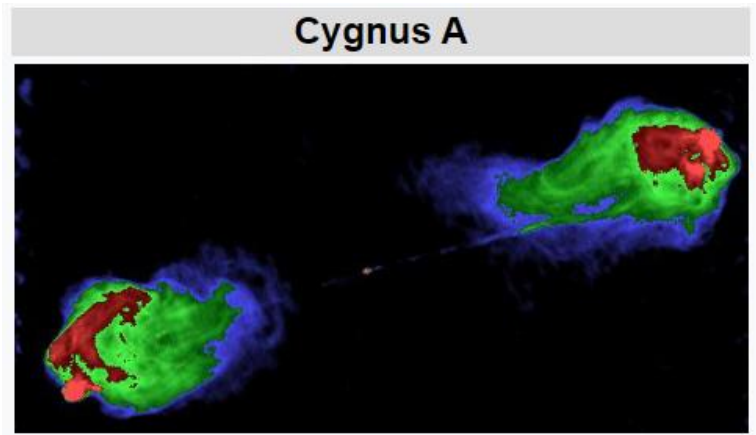
Solar Influences on the Magnetosphere, Ionosphere and Atmosphere  
Primorsko, Bulgaria, 2 ÷ 9 June, 2019

# Ionosphere





# Ionospheric scintillation of Signus A at 25 MHz UTR-2



**S. L. Rashkovsky // Radiophysics and Quantum Electronics, 2004, V. 47(9) - P. 631-645**

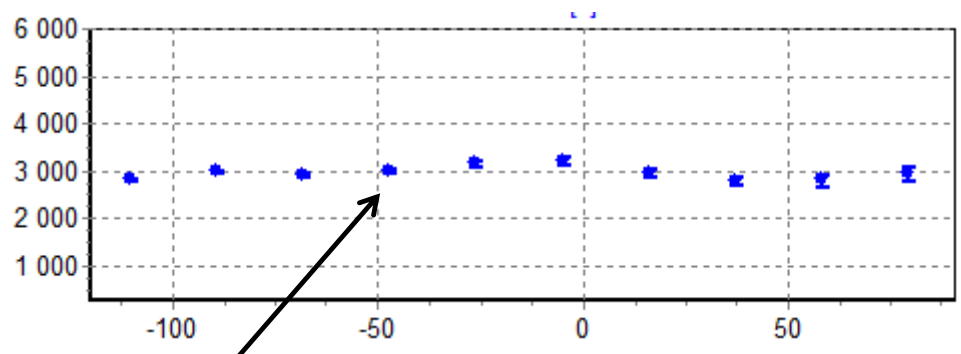
**O. A. Lytvynenko, S. K. Panishko // Odessa Astronomical Publications. 2015. – Vol. 28. – No 2. – P. 235-237.**

**S. K. Panishko, O. A. Lytvynenko // Odessa Astronomical Publications. – 2019. – Vol. 32. – P. 103-104.**

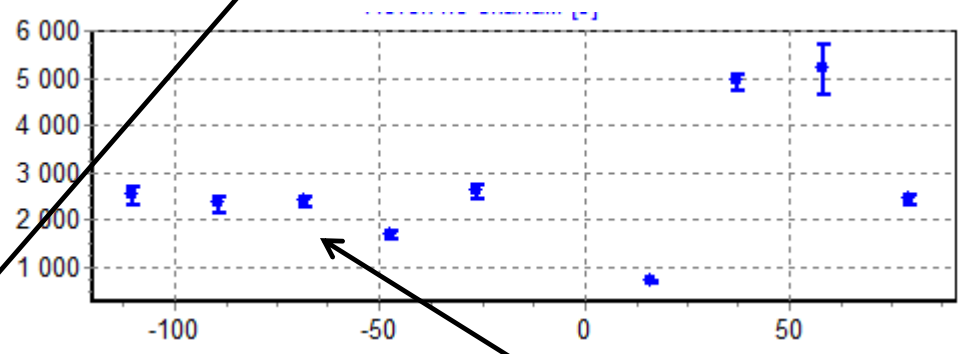
**O. A. Lytvynenko, S. K. Panishko // Odessa Astronomical Publications. – 2020. – Vol. 33. – P. 72-74.**

**V. G. Derevyagin, R. O. Kravetz, O. A. Lytvynenko, S. K. Panishko // Proceedings of Eleventh Workshop «Solar influences on the magnetosphere, ionosphere and atmosphere», Primorsko, Bulgaria, June 3-7. – 2019. – P. 84-88**

Flax, Jy

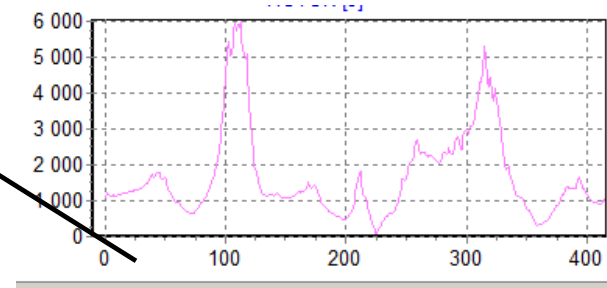
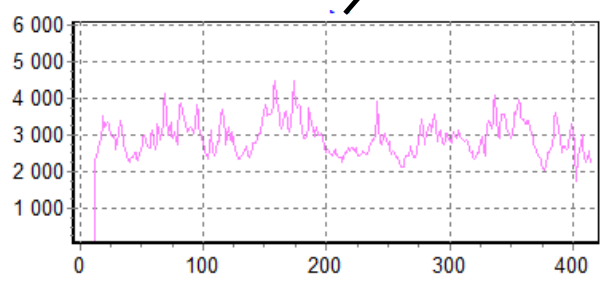


Time, min



$m=0.15$

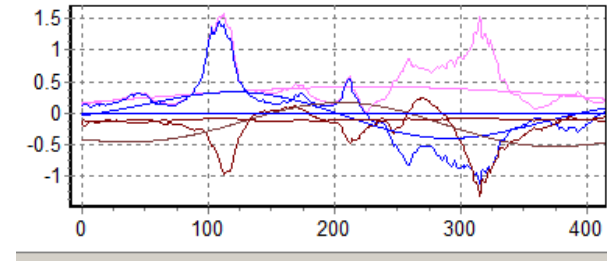
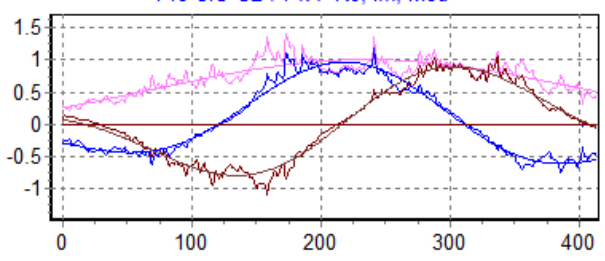
$m=0.73$



Time, sec

Pro ClO\*3B / Pk : Re, Im, Mod

Pro ClO\*3B / Pk : Re, Im, Mod



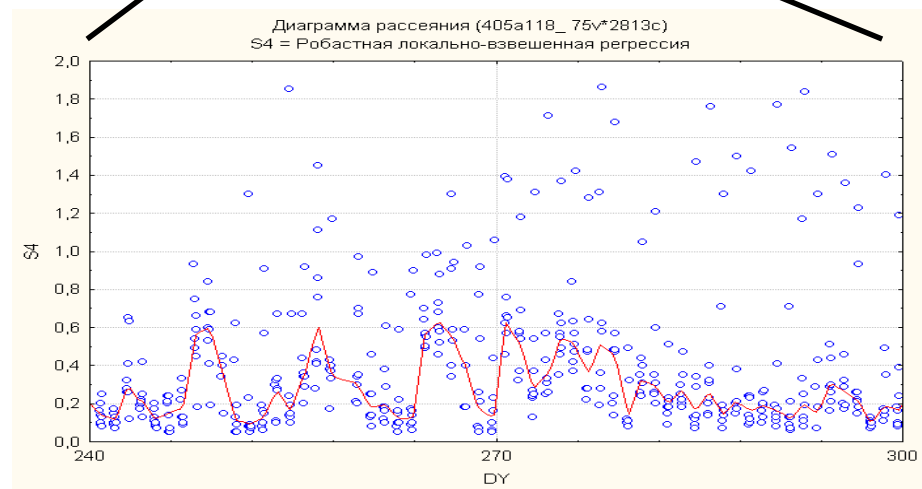
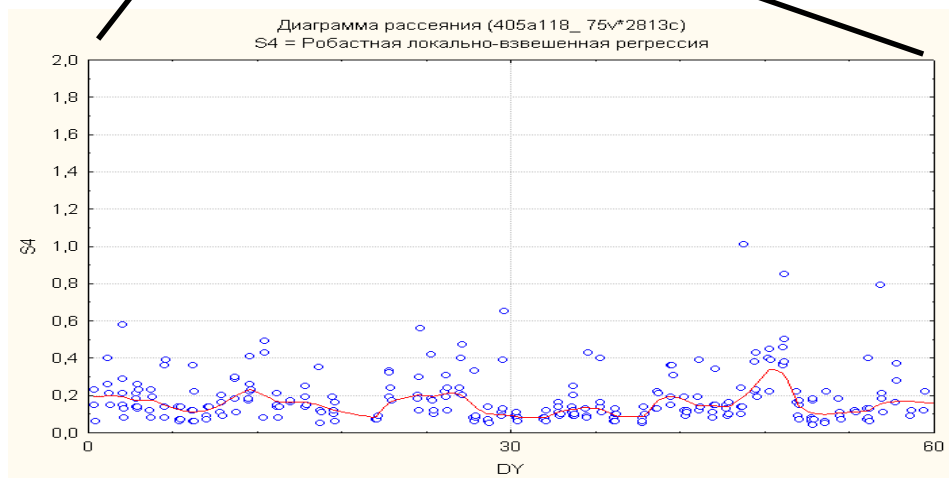
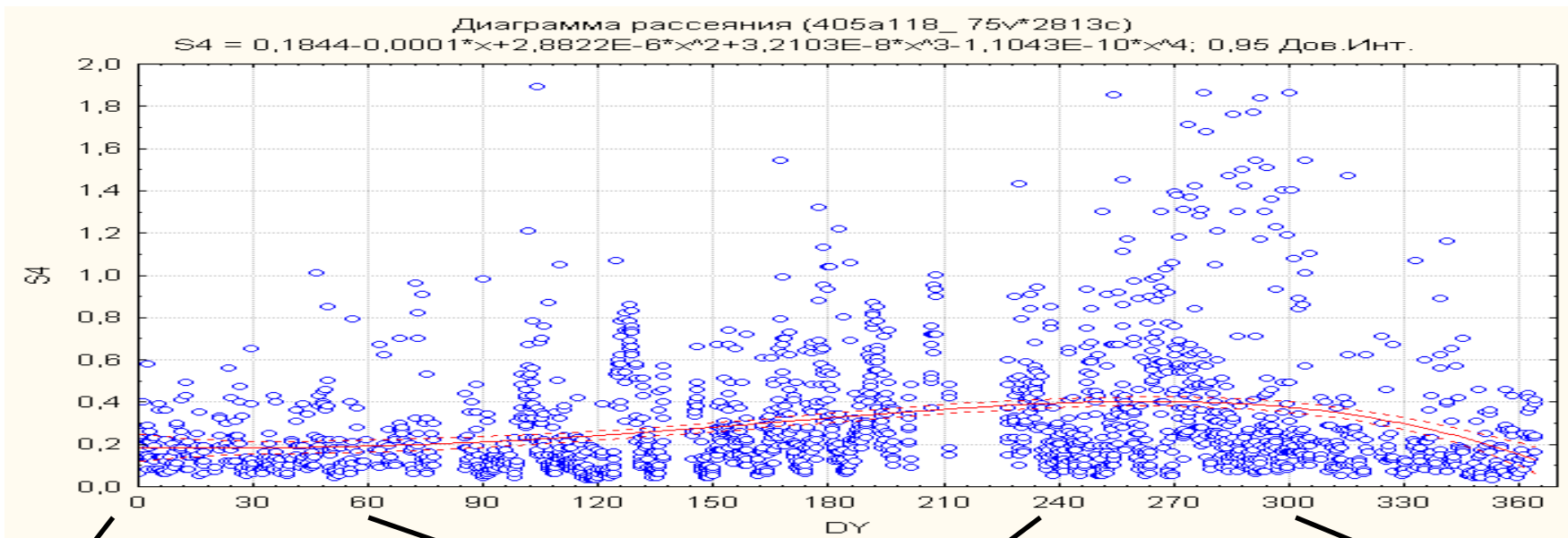
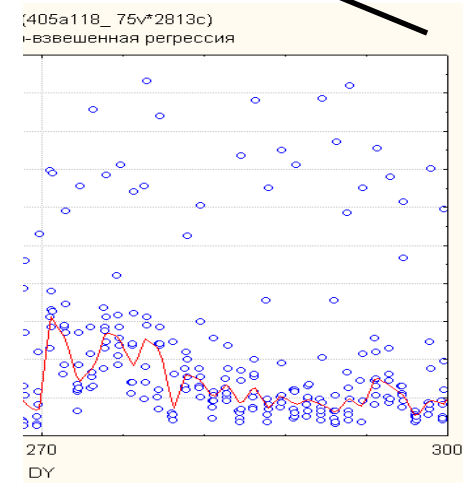
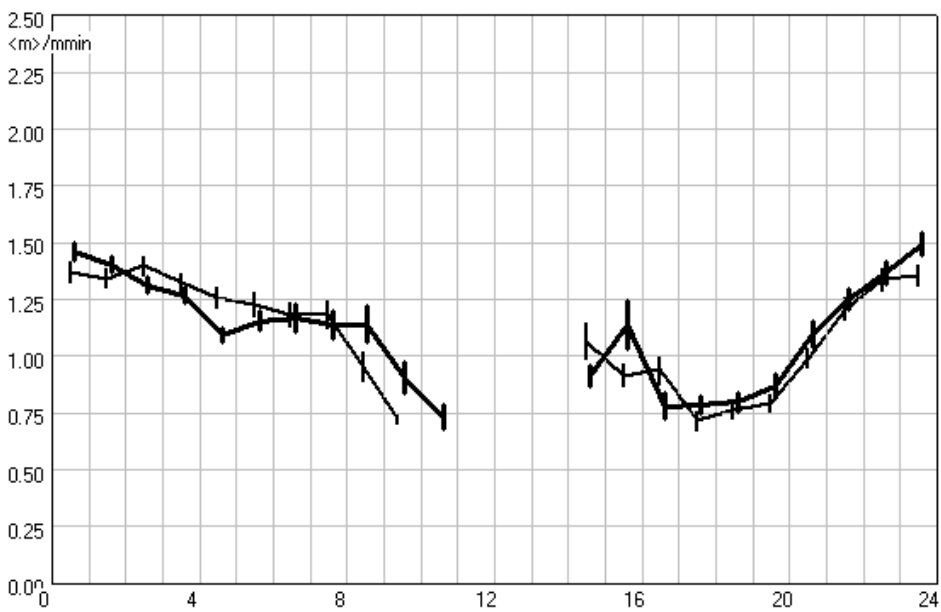
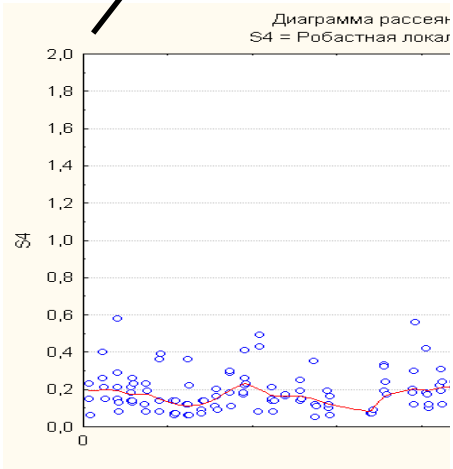
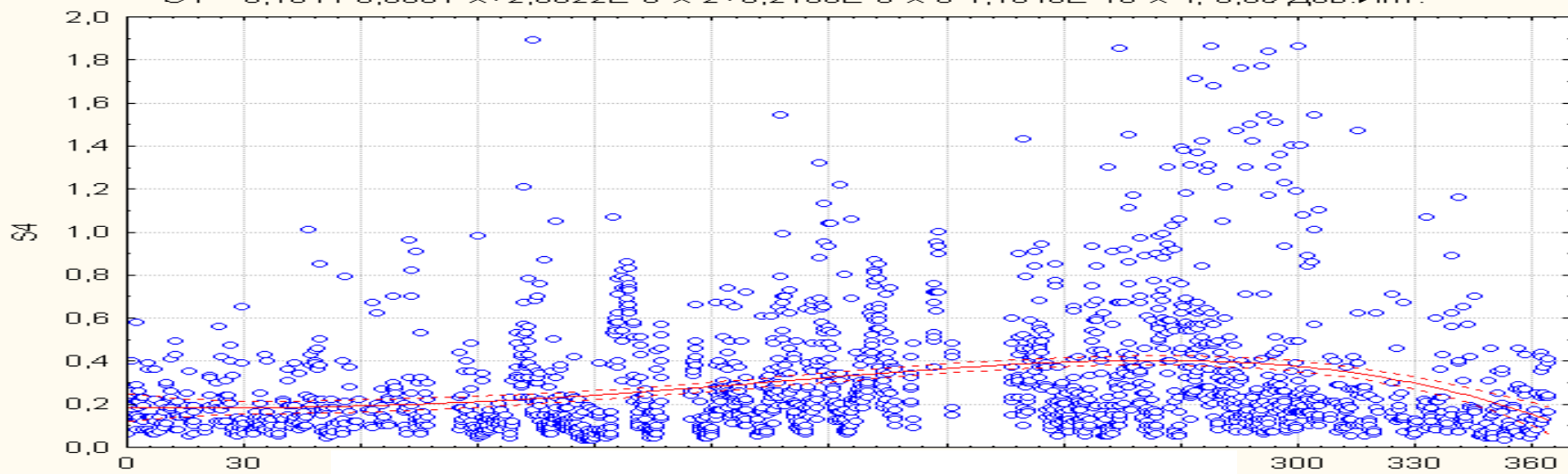
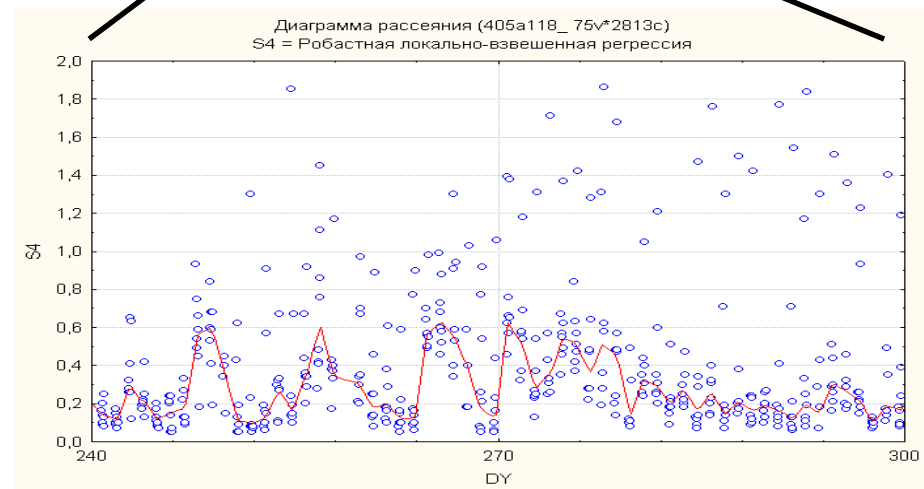
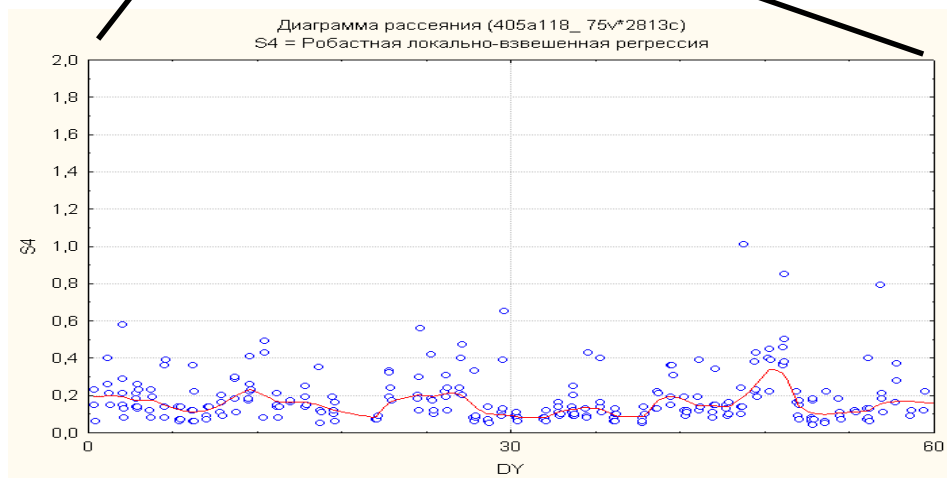
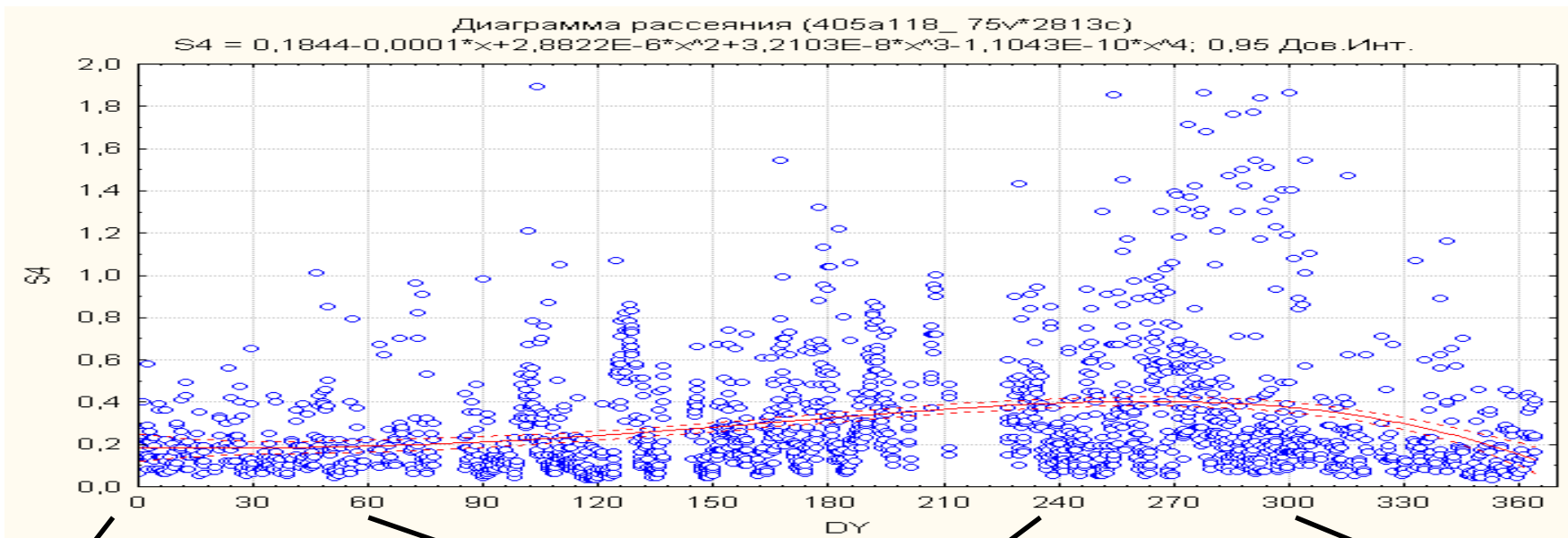
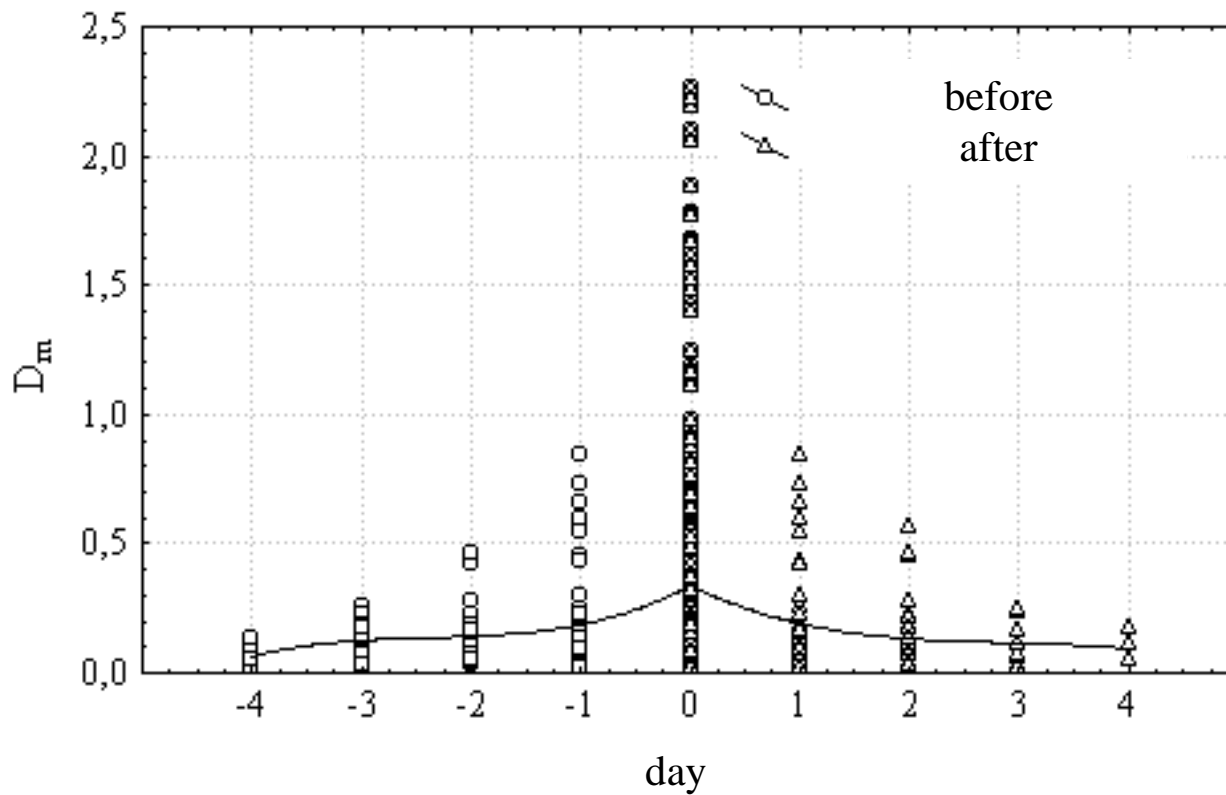


Диаграмма рассеяния (405a118\_75v\*2813с)  
 $S4 = 0,1844 - 0,0001 * x + 2,8822E-6 * x^2 + 3,2103E-8 * x^3 - 1,1043E-10 * x^4$ ; 0,95 Дов.Инт.





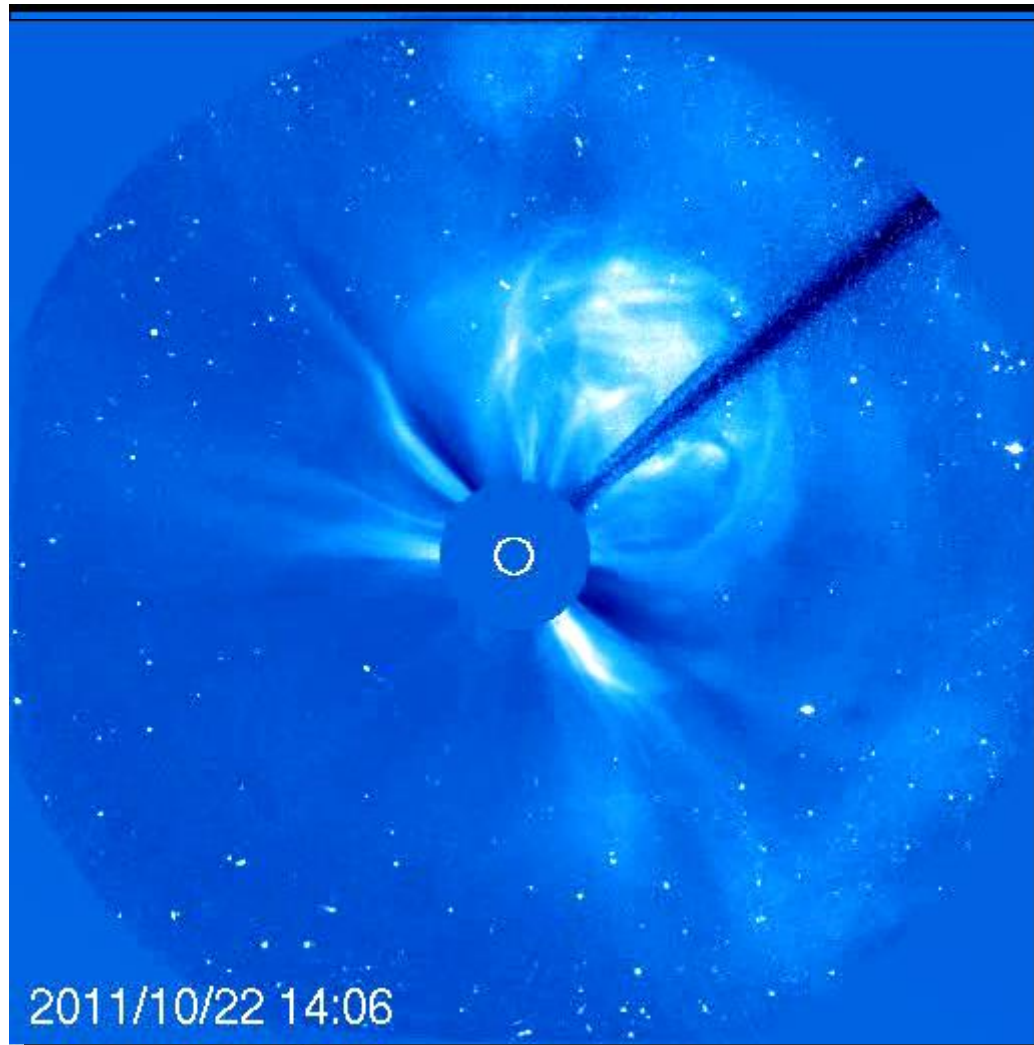




. Distortion index versus time before and after troposphere front

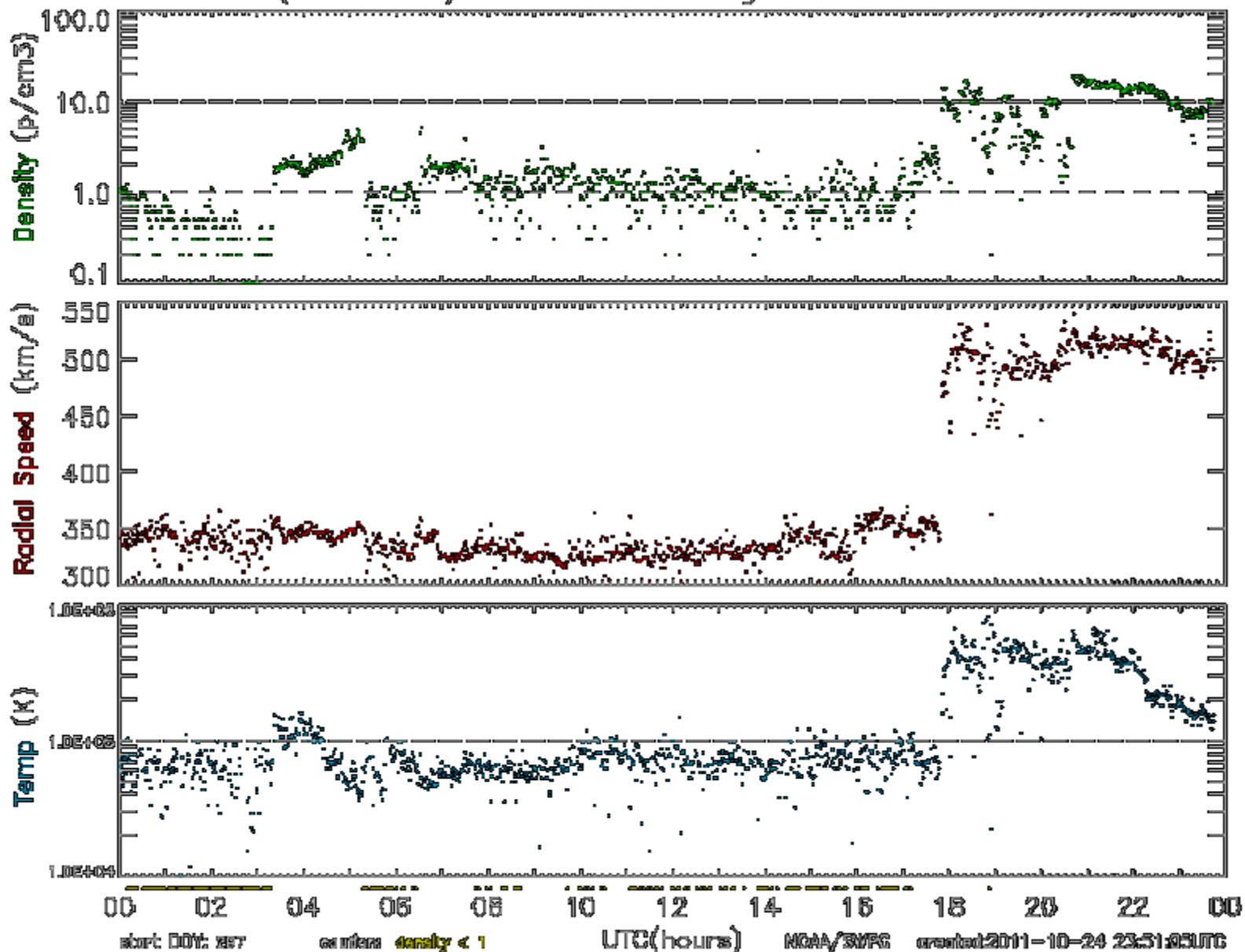
**ВЛИЯНИЕ МЕТЕОРОЛОГИЧЕСКИХ УСЛОВИЙ НА КАЧЕСТВО РАДИОАСТРОНОМИЧЕСКИХ  
НАБЛЮДЕНИЙ В ДЕКАМЕТРОВОМ ДИАПАЗОНЕ ВОЛН**

**О. А. Литвиненко, С. А. Подольский**



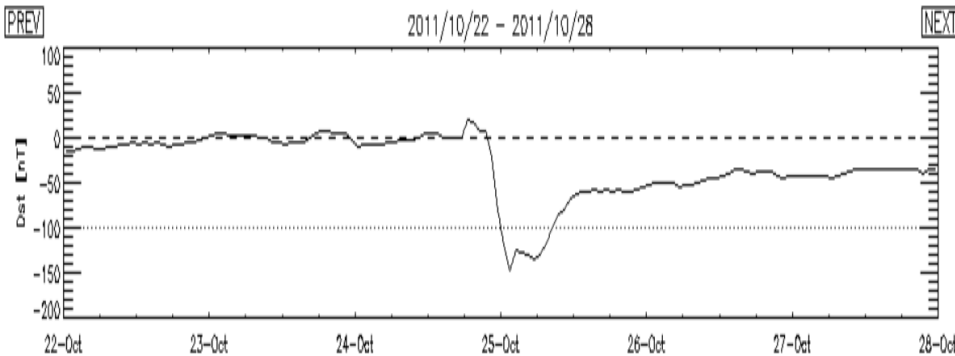
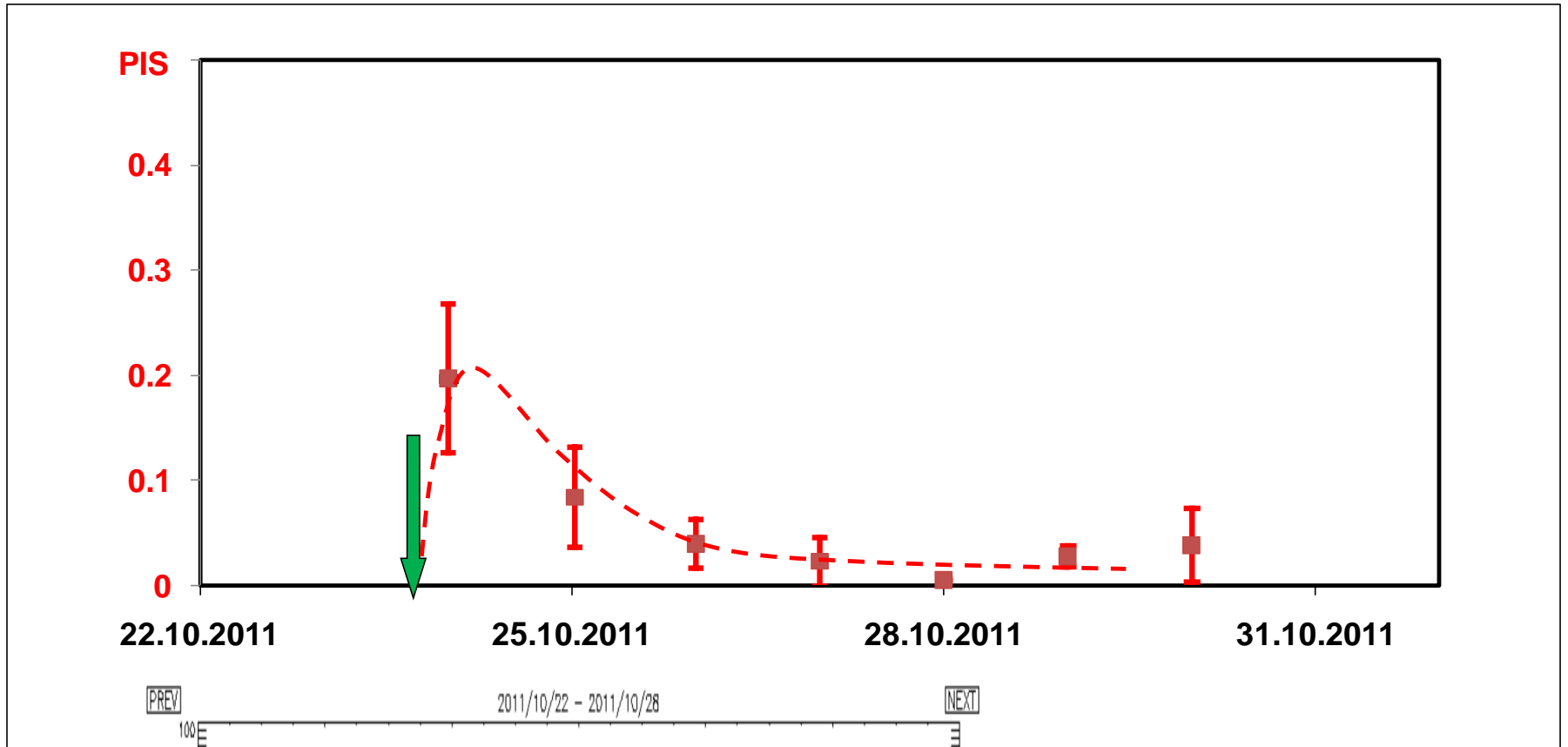
ACE RTSW (Estimated) SWEFAM

Begin: 2011-10-24 00:00:00UTC

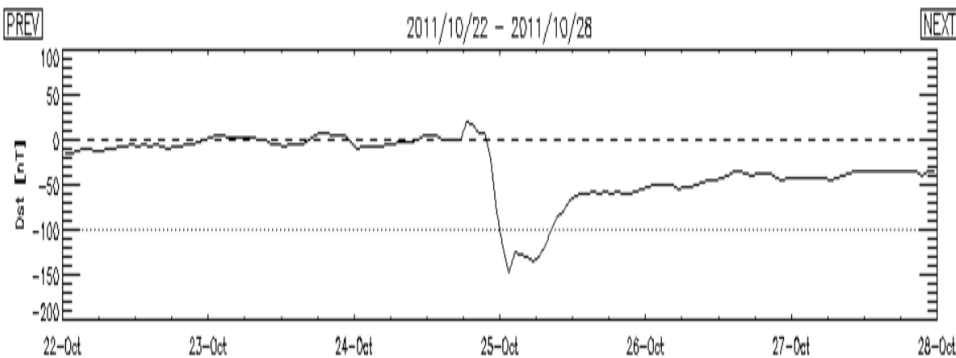
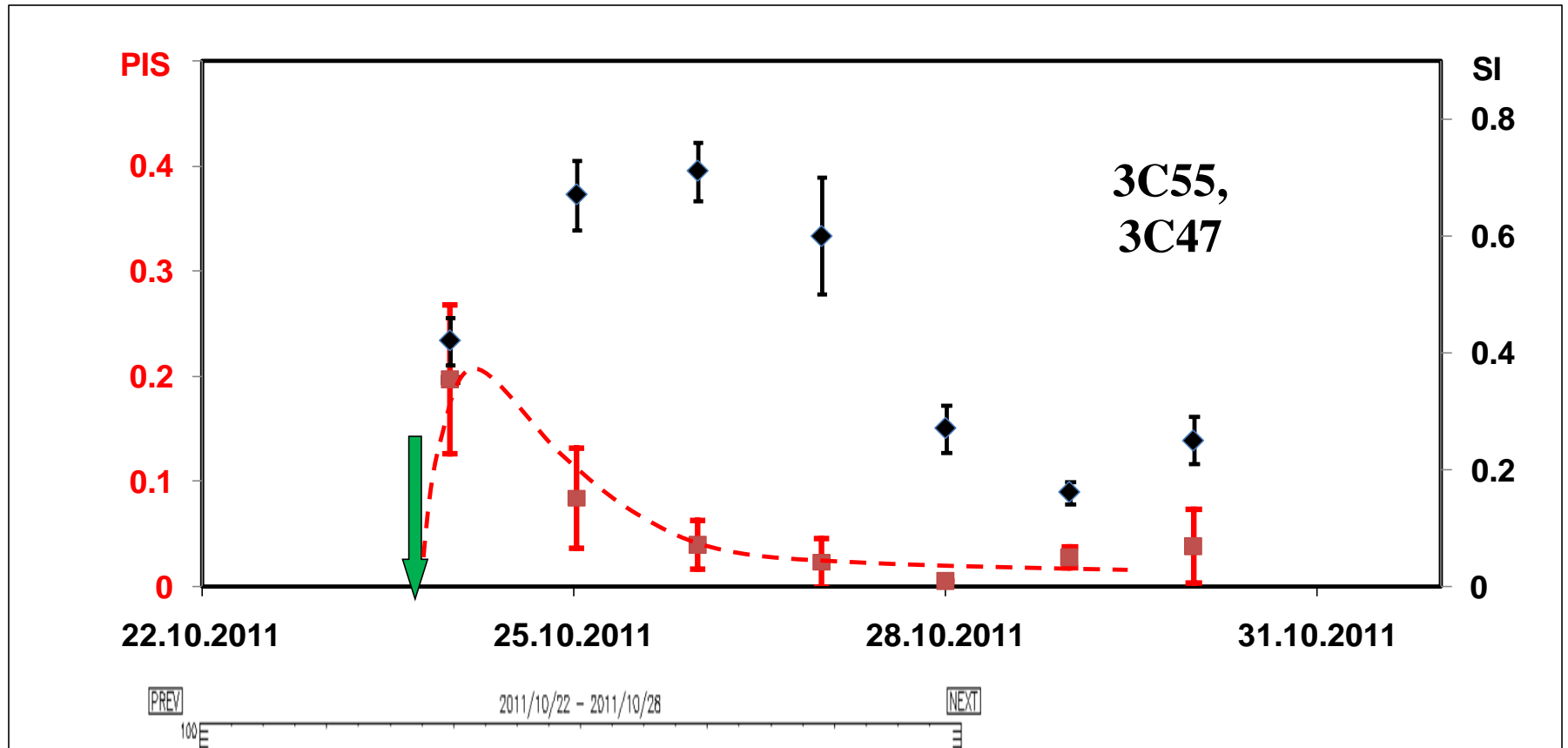


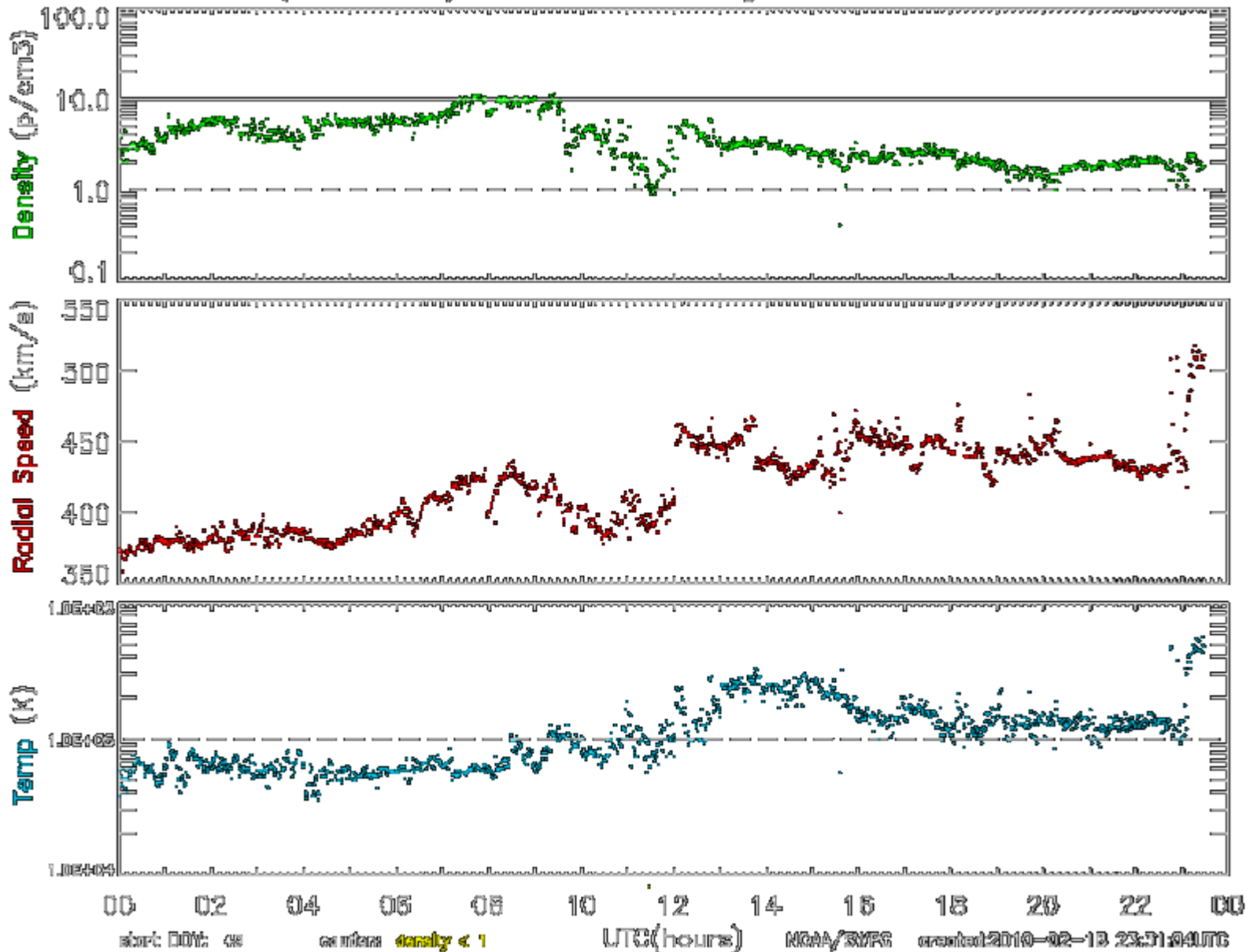
ACE  
Plasma / B Field

# Interplanetary scintillation



# Interplanetary + ionospheric scintillation





ACE  
Plasma / B Field



# Interplanetary scintillation



# Interplanetary + ionospheric scintillation

