

Ionospheric effects in very long distant HF radio wave propagation

A.V. Zalizovski

Institute of Radio Astronomy, NAS, Ukraine.

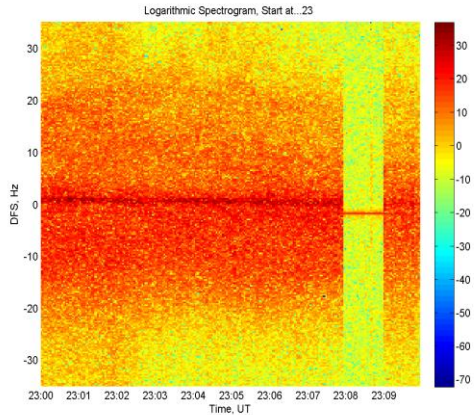
Chervonopraporna str., 4. Kharkiv



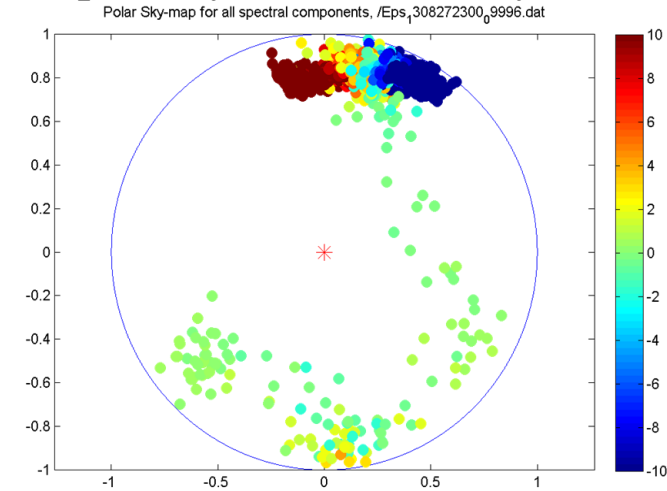
HF band – 3...30 MHz

Techniques for spectral, time-frequency, and angular, selection of spatial modes of HF signals

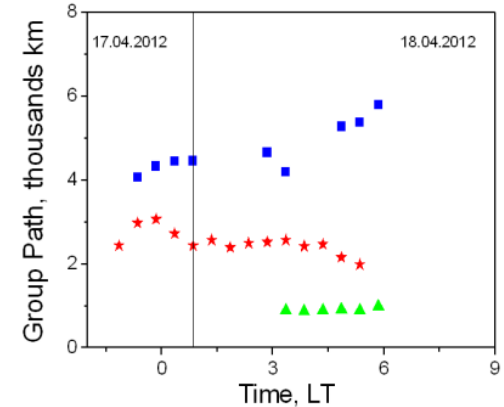
Spectrogram



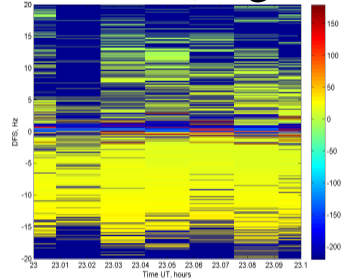
Map of sky of received sky waves



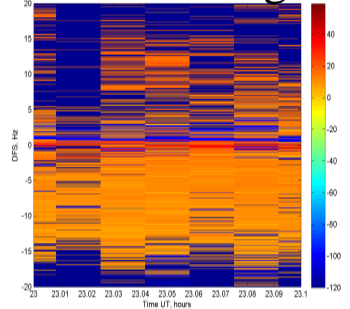
Group paths of spatial modes



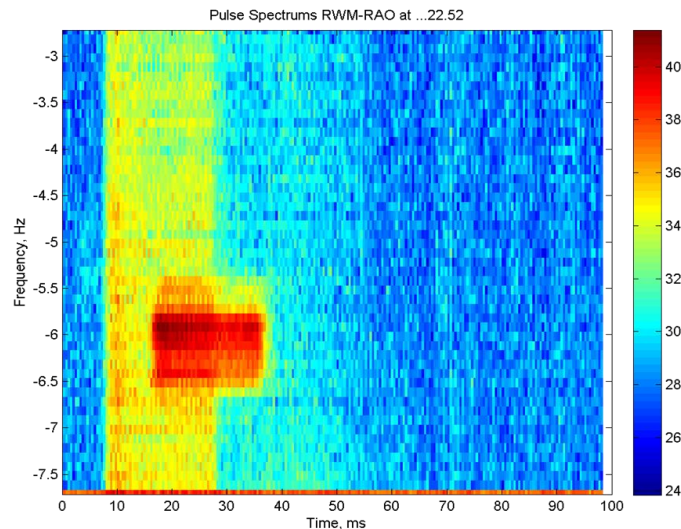
Azimuth diagram



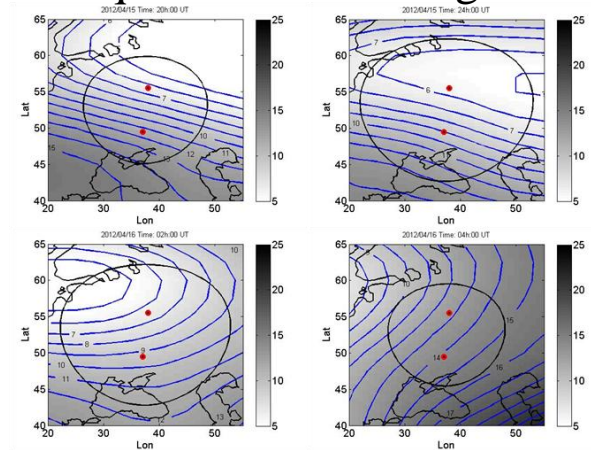
Elevation diagram



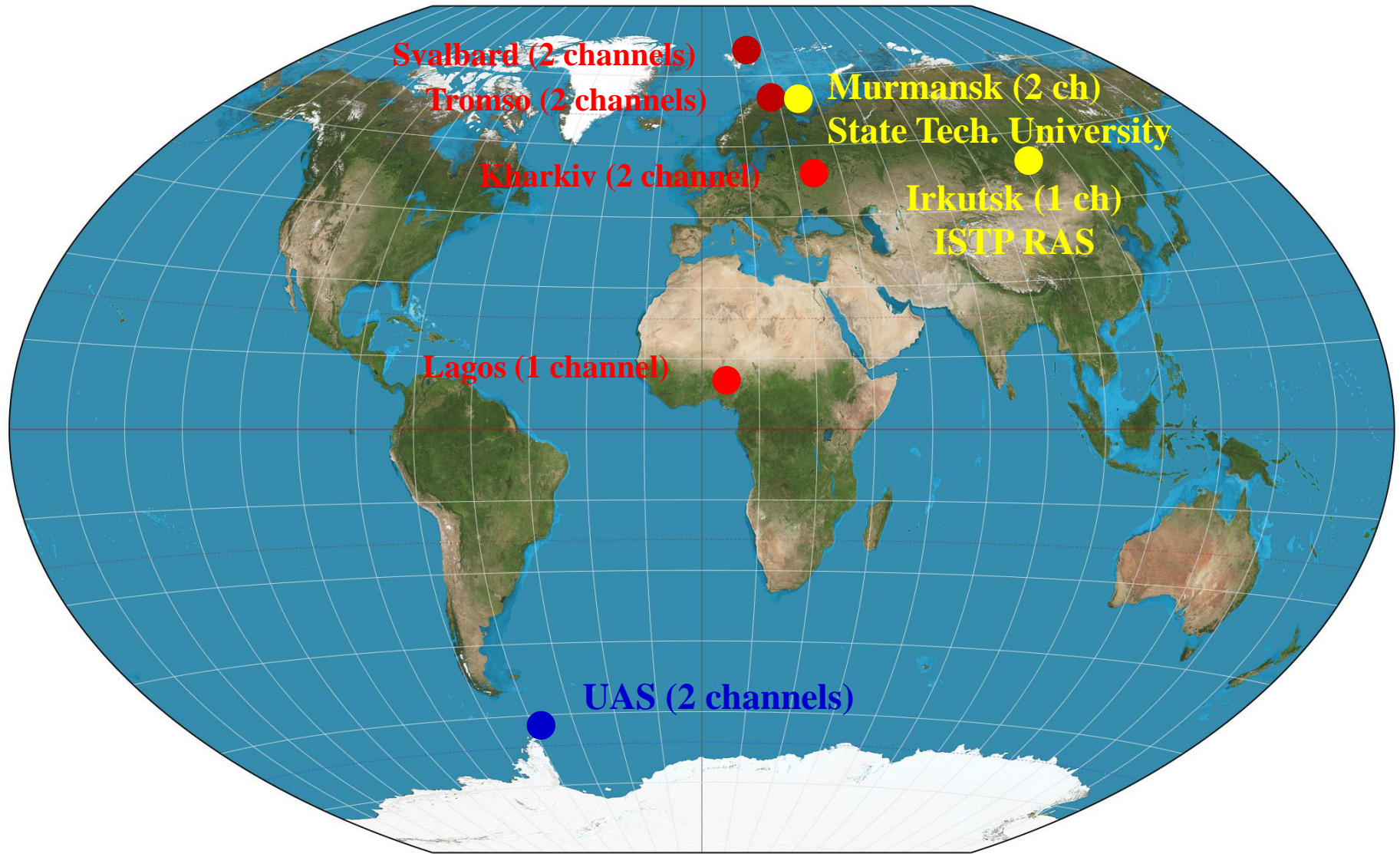
Time-frequency selection



Maps of reflection points of oblique back scatter signals



Network of the HF receivers

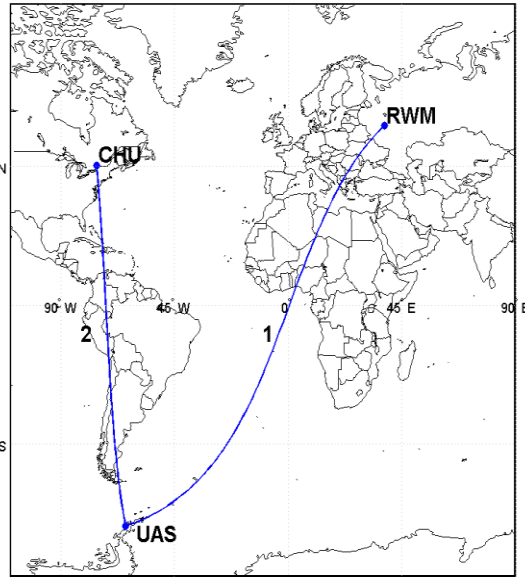


● Internet-controlled

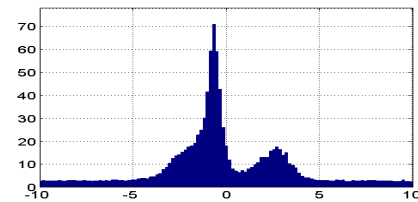
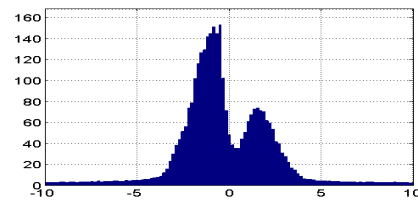
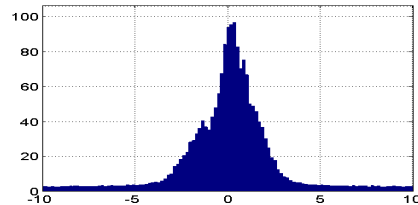
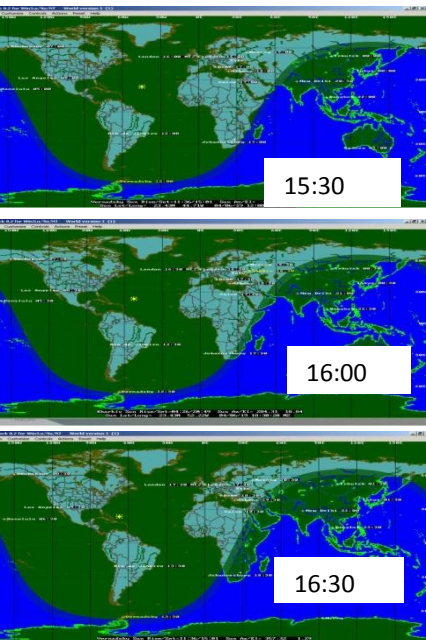
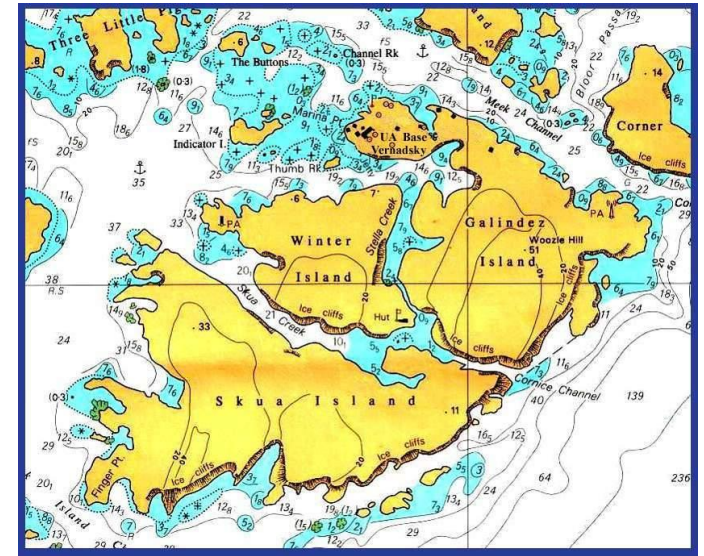
● Manually-controlled

● Partner instruments

First spectral results of very long-distance radio wave propagation that were got by signals of time service station



Argentine Islands Archipelago



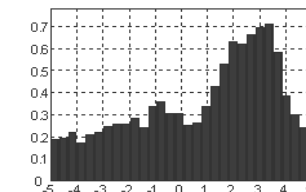
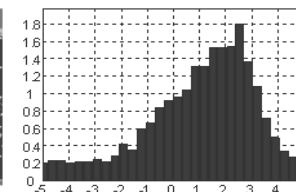
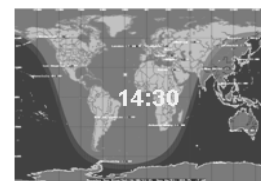
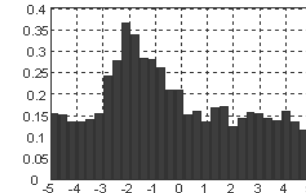
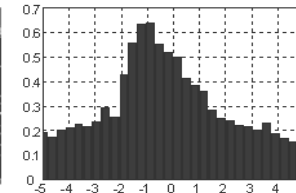
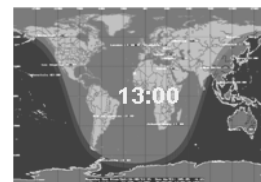
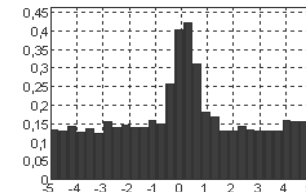
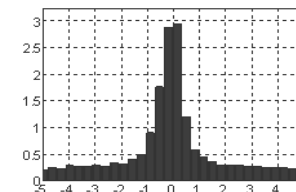
Geographic coordinates:
65.25° S, 64.27° W

Geomagnetic coordinates (CGM) :
50.1° S, 9.3° E



Effects around the antipode point of transmitters

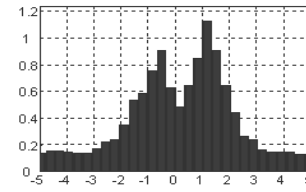
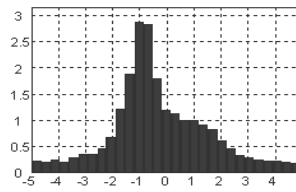
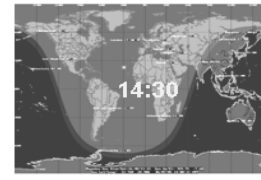
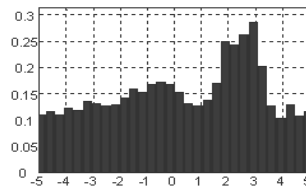
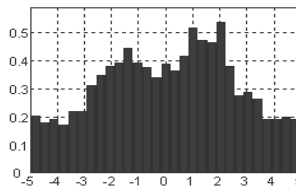
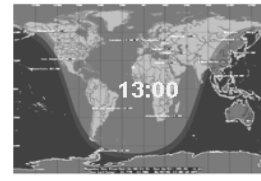
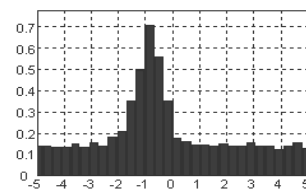
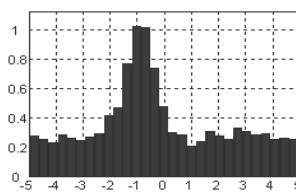
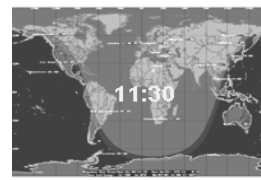
Иркутск – УАС, 04.07.2006



9,3 МГц

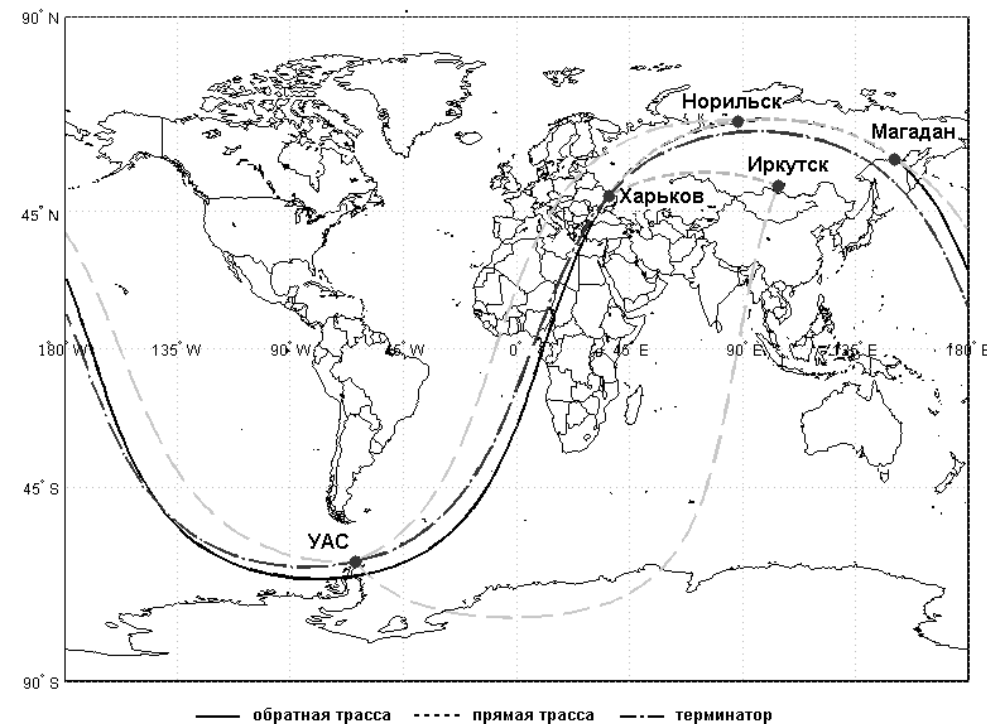
12,3 МГц

Магадан – УАС, 04.07.2006

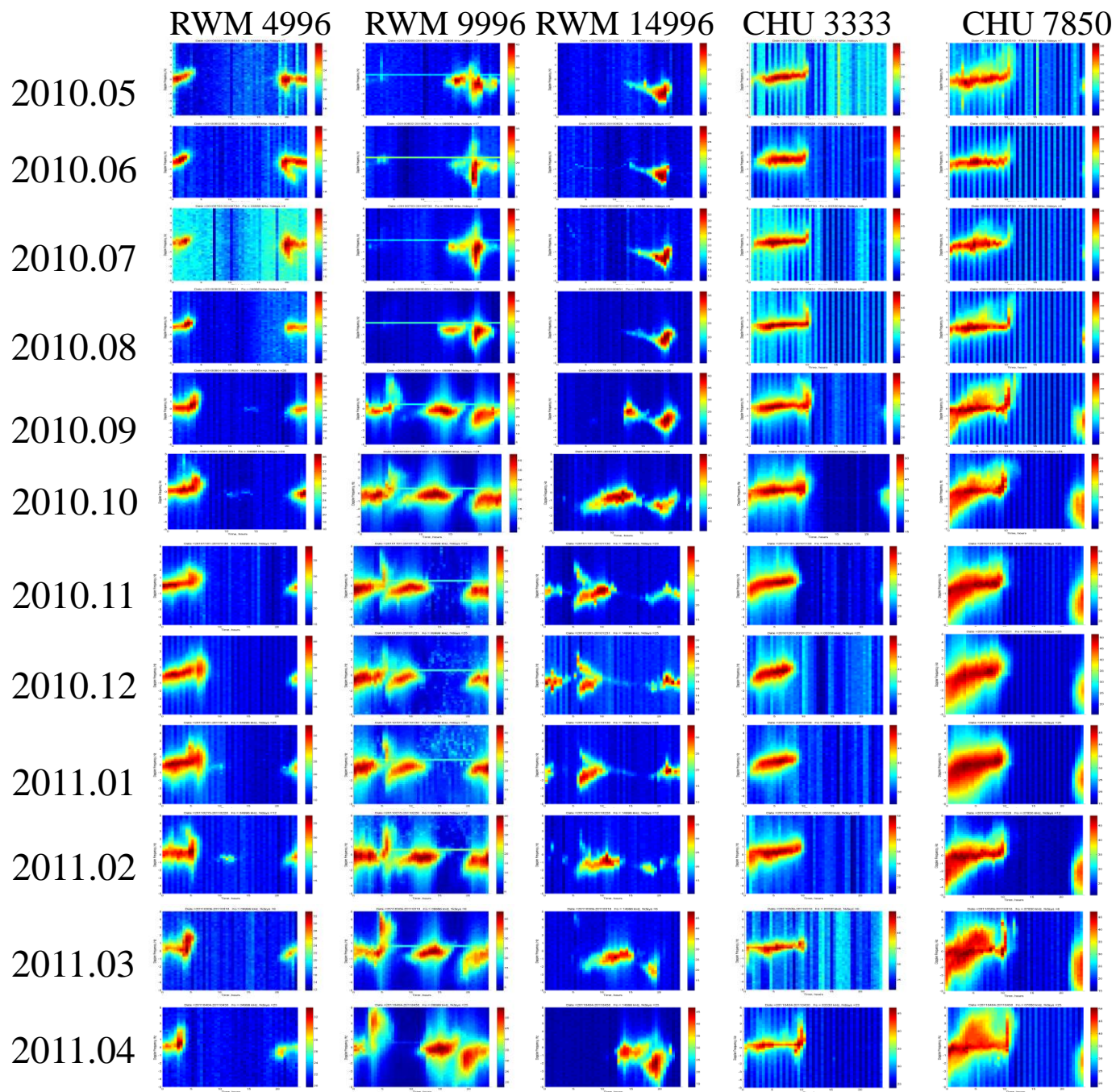
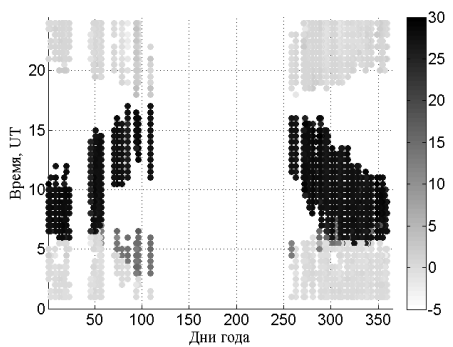
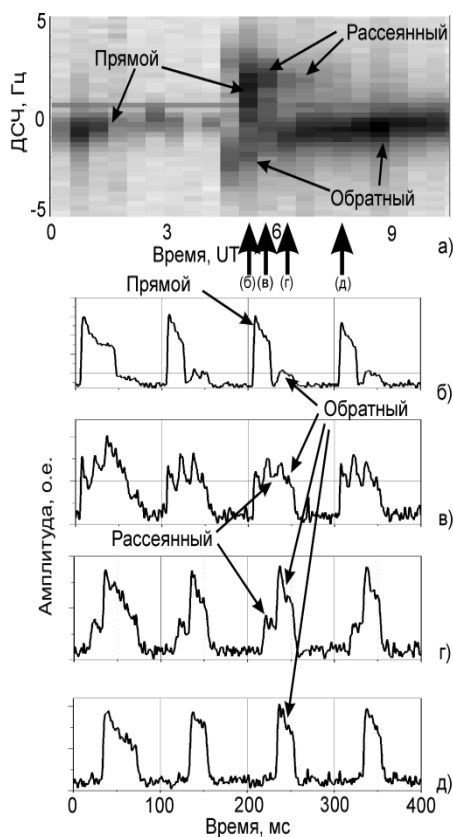


8,3 МГц

11 МГц



Daily and seasonal variations of HF signal parameters on very long distant radio paths



Interannual variability RWM - UAS 9996 kHz,

2010

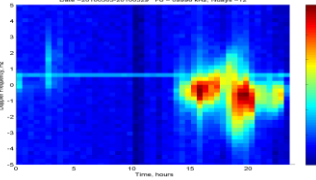
May

June

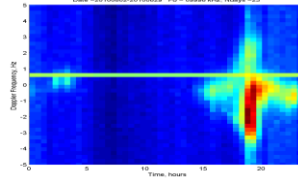
July

August

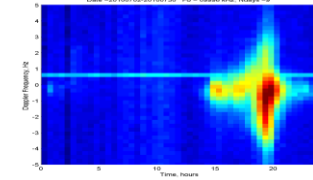
September



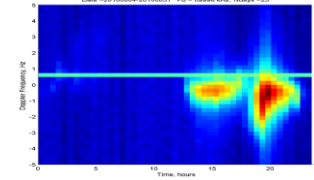
73.9, 13.61



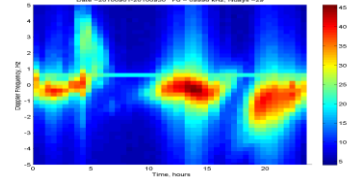
72.6, 12.27



79.9, 8.74

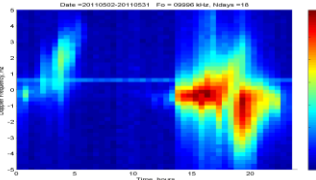


79.7, 12.23

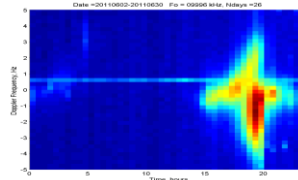


81.1, 8.77

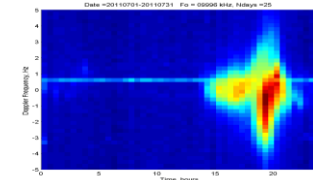
2011



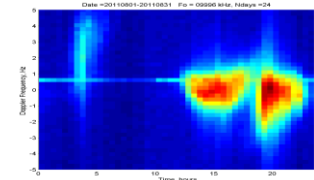
95.7, 14.48



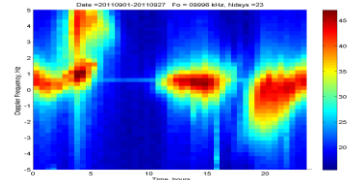
95.8, 14.07



94.3, 14.16



101.8, 11.45



134.5, 19.30

CHU - UAS, 07850 kHz

2010

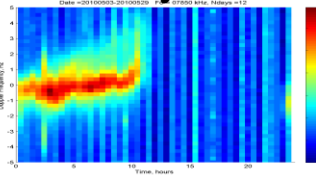
May

June

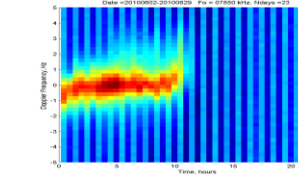
July

August

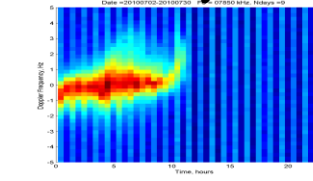
September



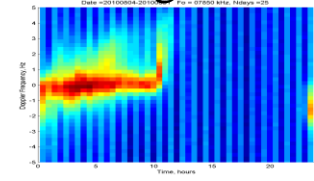
73.9, 13.61



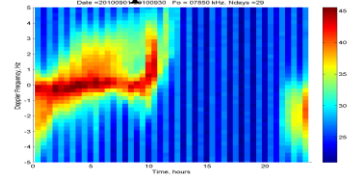
72.6, 12.27



79.9, 8.74

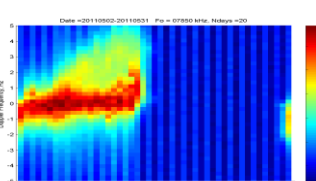


79.7, 12.23

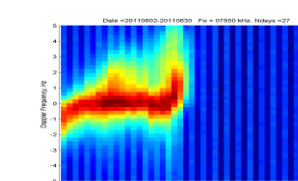


81.1, 8.77

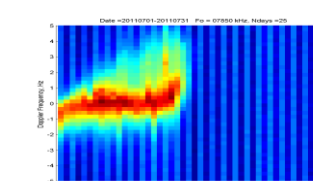
2011



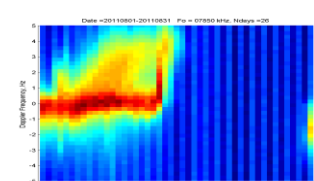
95.7, 14.48



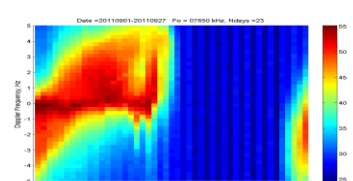
95.8, 14.07



94.3, 14.16



101.8, 11.45

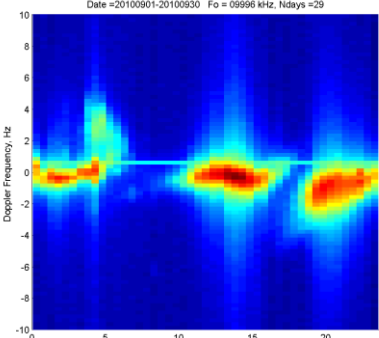


134.5, 19.30

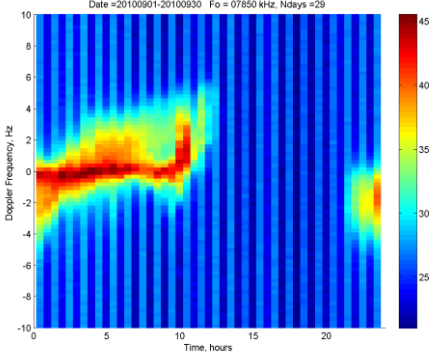
Interannual variability

September
spectrograms

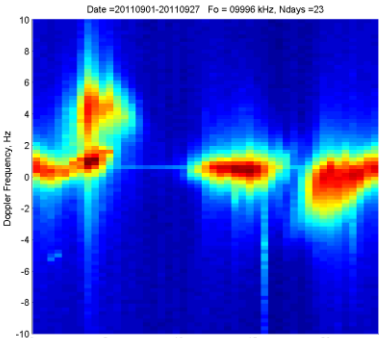
2010



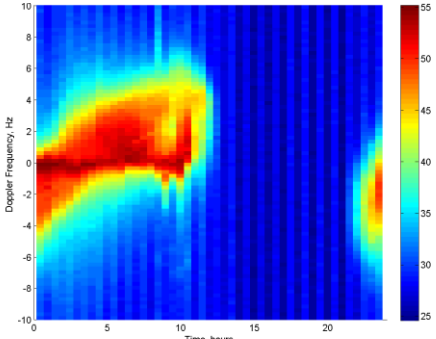
F10.7 Amp
81.1, 8.77



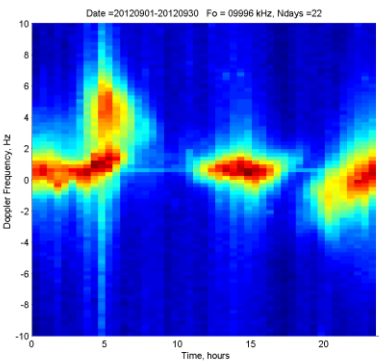
2011



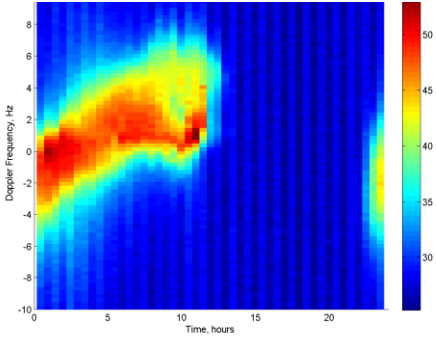
134.5, 19.30



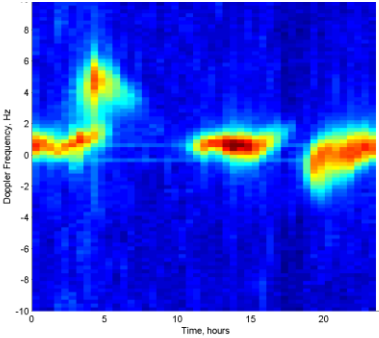
2012



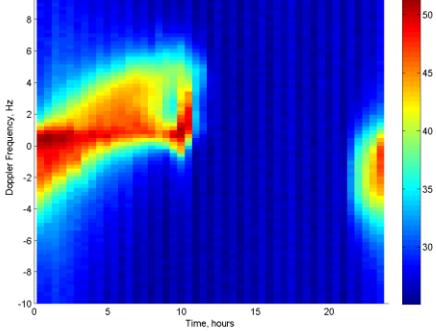
123.2, 13.07



2013



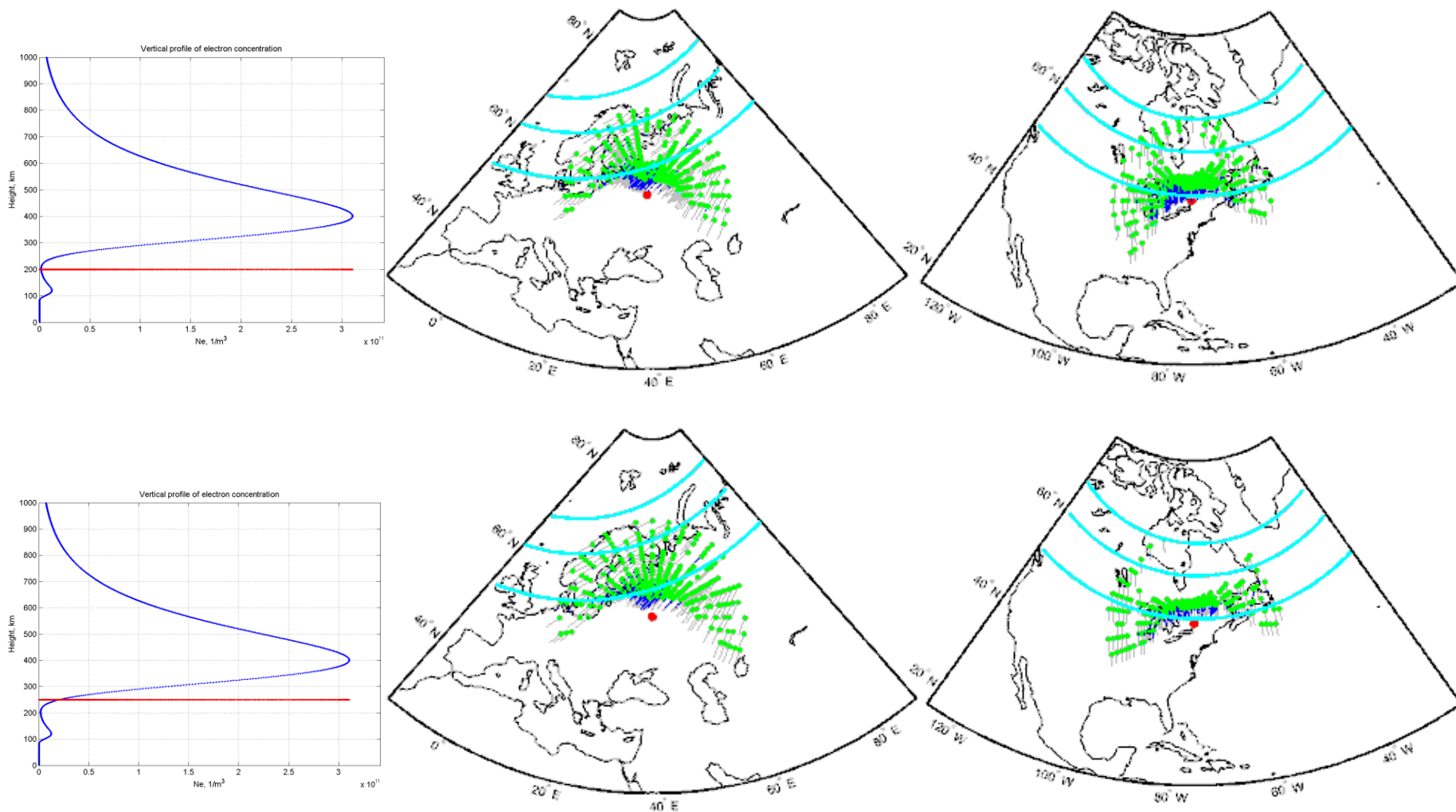
102.7, 9.57



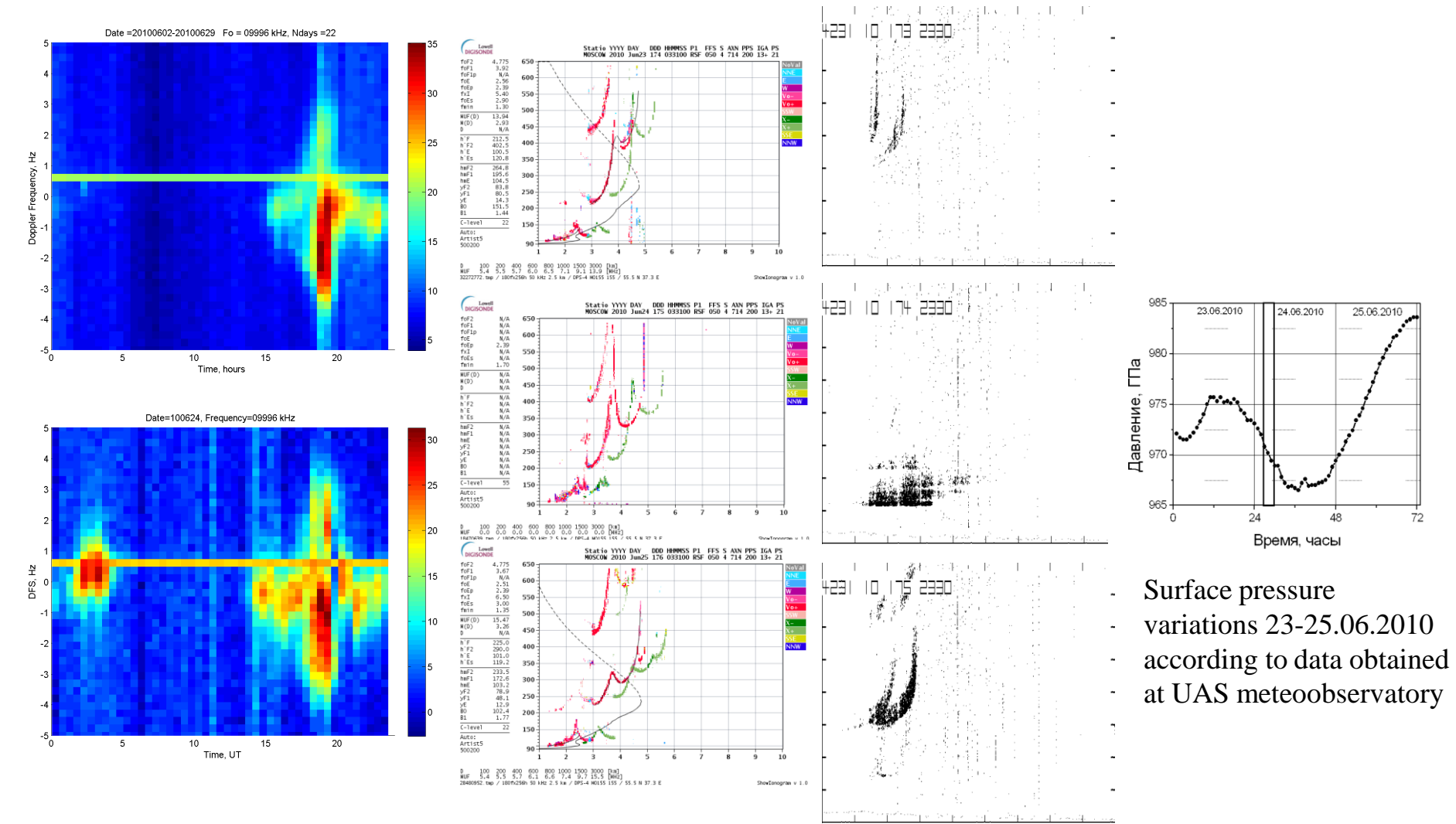
Results of modeling of interlayer waveguide exciting by aspect-scattered signals

RWM, 9996 kHz

CHU, 7850 kHz



Impact of Es of tropospheric origin on the very-long distant propagation of HF radio signals



Daily logarithmic spectrograms of signals on RWM-UAS radio line.
a) month-averaged daily spectrogram calculated without 24.06.2010,
b) Daily for the 24.06.2010.

Ionograms over the RWM station received on 23.06.2010, 24.06.2010, and 25.06.2010 03:30 UT

Ionograms over UAS received on 23.06.2010, 24.06.2010 , and 25.06.2010 at 03:30 UT

Surface pressure variations 23-25.06.2010 according to data obtained at UAS meteorobservatory

Doppler HF monitoring is powerful technique for diagnostics of the ionospheric irregularities



Thank you!