Wave-like oscillations within sporadic E layer and stratospheric temperature. Are there common oscillation domains?

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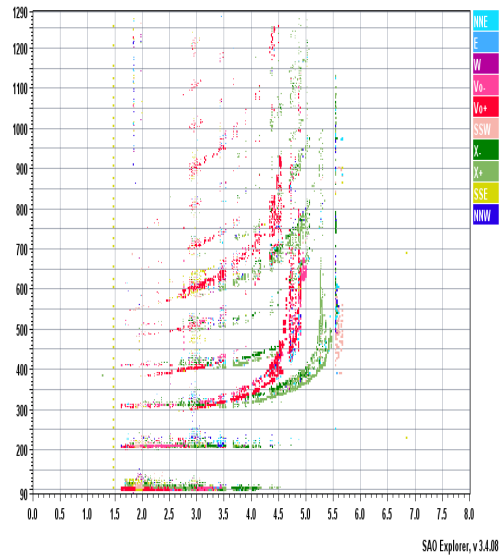
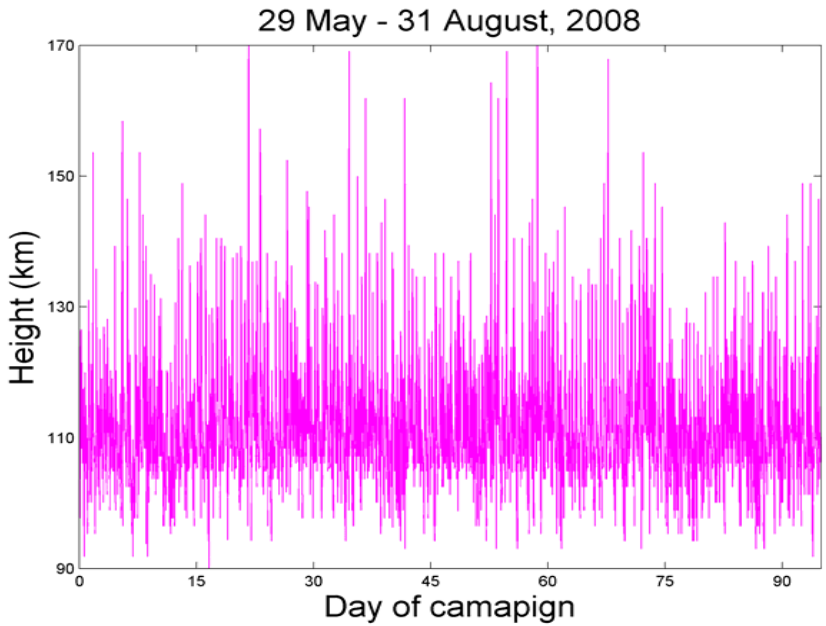
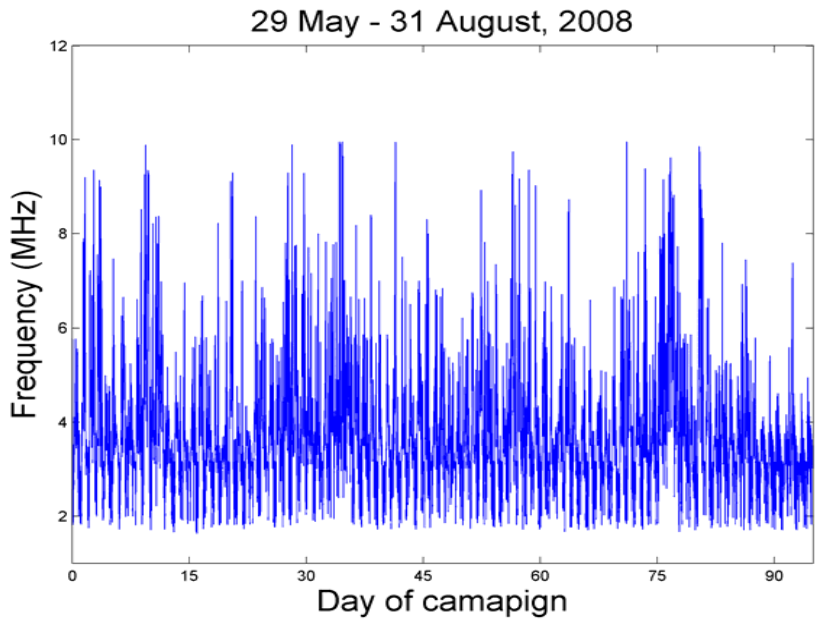
Data: Time series of height (hEs), critical frequency (foEs) of Sporadic and stratospheric temperature at levels 10hPa, 20hPa and 30hPa

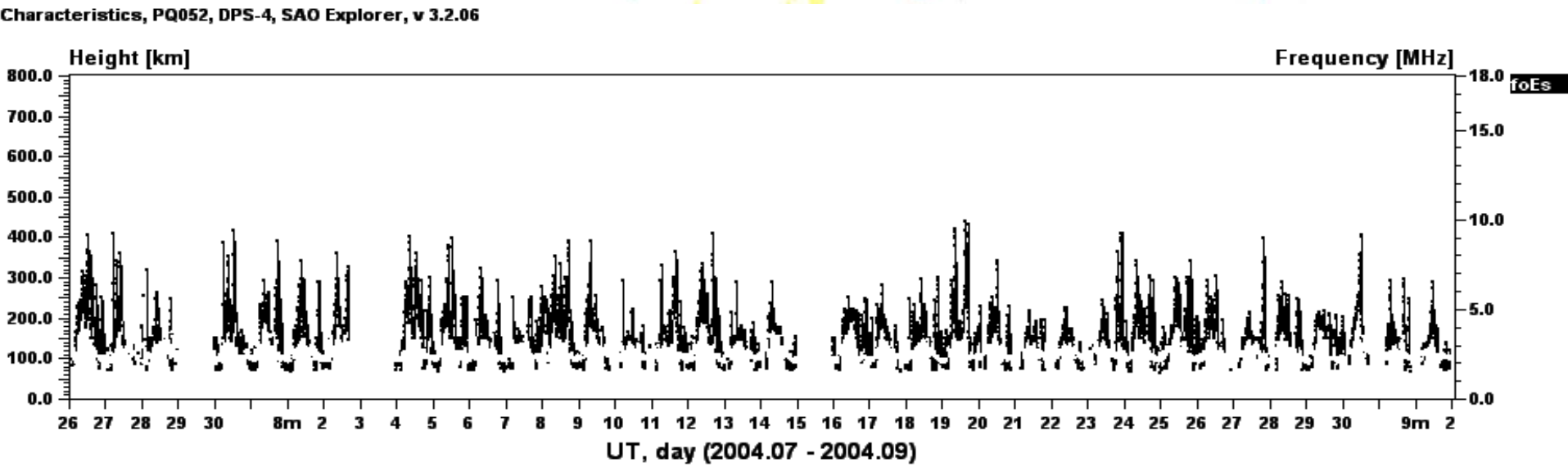
DPS 4 - Průhonice Observatory	Campaign 2004	Campaign 2006	Campaign 2008
Date	27 July –1 September	30 May – 27 August	29 May – 31 August
Ionogram	5 minutes	15 minutes	15 minutes
Temperature			
10 hPa level 20 hPa level 30 hPa level	daily	daily	daily





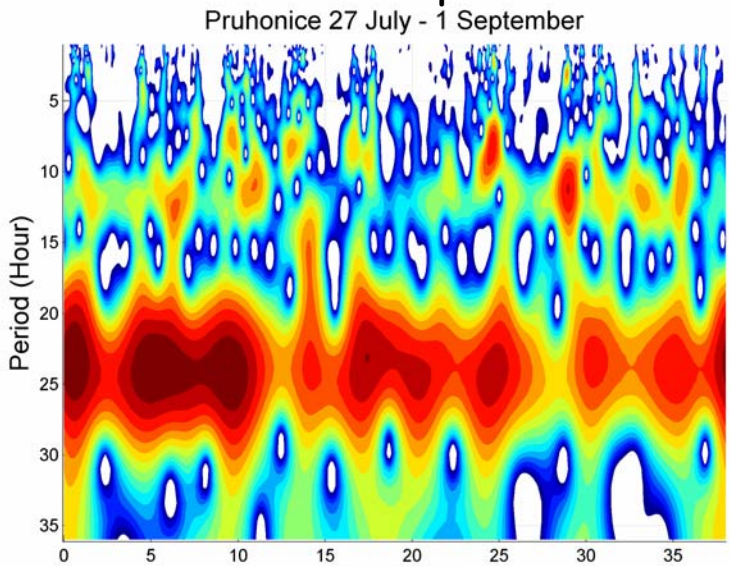


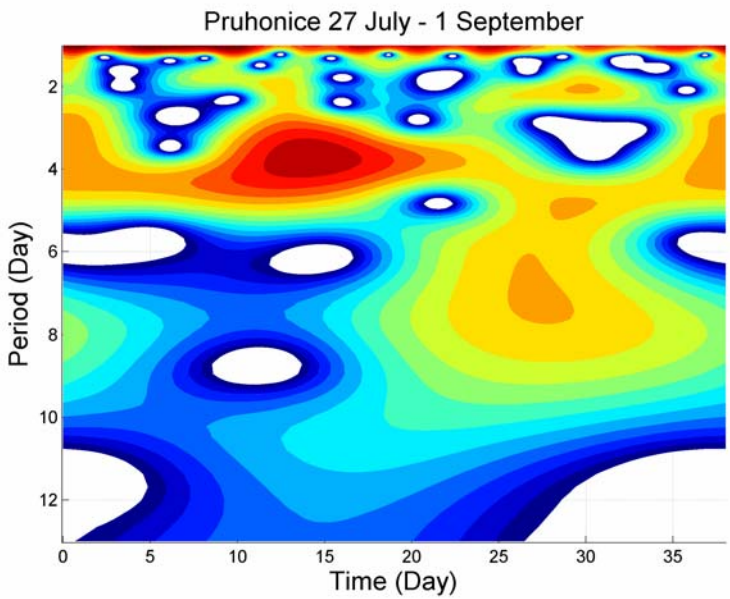
Summary: The present study concerns variability of the wave activity in the sporadic E layer plasma. Within oscillations in height (hEs) and critical frequency (foEs) of sporadic E layer together with the temperature in the lower laying neutral atmosphere we search for the wave-like oscillations over a wide period range of hours to several days, covering tidal and planetary oscillation domain. In order to detect modulation of the E layer plasma wave-like oscillation by planetary waves from lower laying atmosphere we analyse oscillation in the neutral atmosphere temperature at the level of 10hPa.
Special campaigns were performed during summer time when the sporadic E layer occurence is highest (data were collected since 2004 till 2008). Critical frequencies foEs and layer heights hEs were analysed by mean of Wavelet Transform. Variability in height and critical frequency of sporadic E layer shows significant periodicities over a wide period range of hours to several days, covering tidal and planetary oscillation domain. Detail analyses of the 24-oscillation mode additionally reveals significant Period modulation of the central period in the planetary domain. Results are consistent for all analysed data sets (foEs and layer heights hEs).Wavelet based analysis of the wave activity within Es layer is completed by the stratospheric temperature measurements at 30 hPa, 20 hPa and 10 hPa.



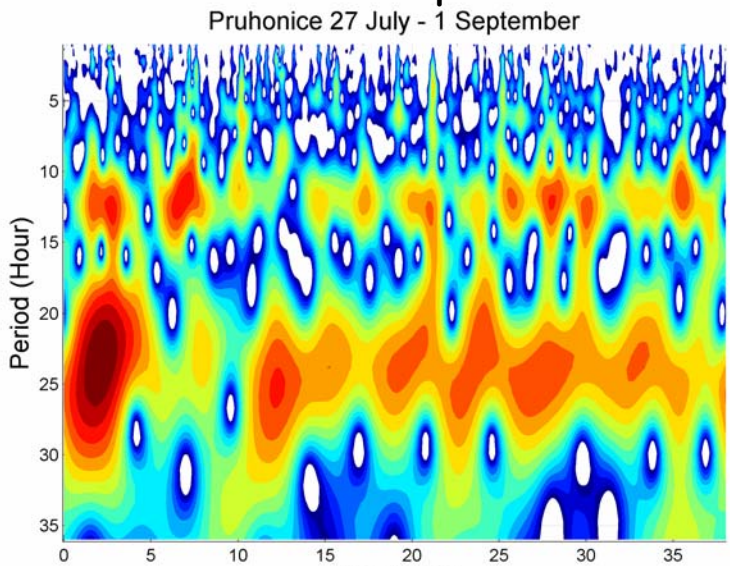
Campaign 2004

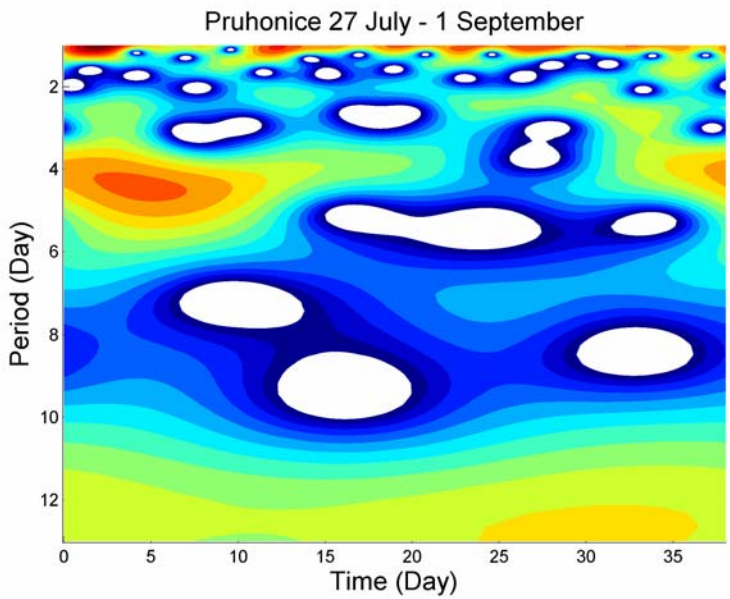
Wavelet Power Spectrum - foEs





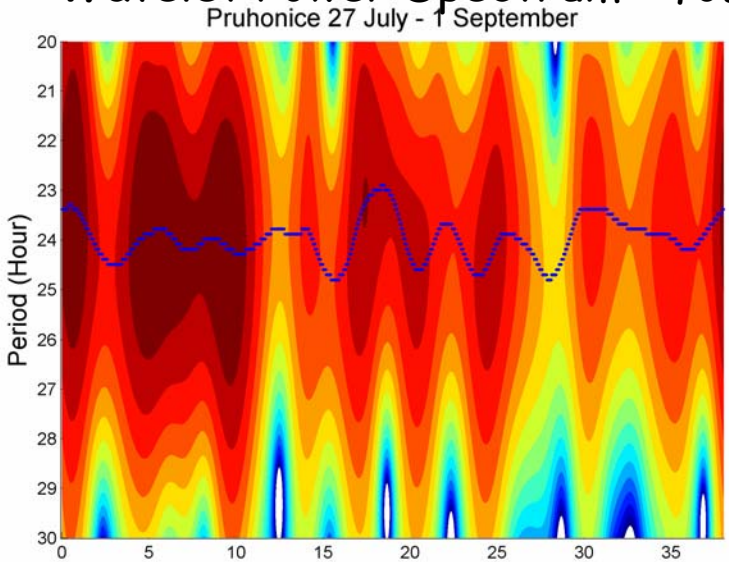
Wavelet Power Spectrum - hEs

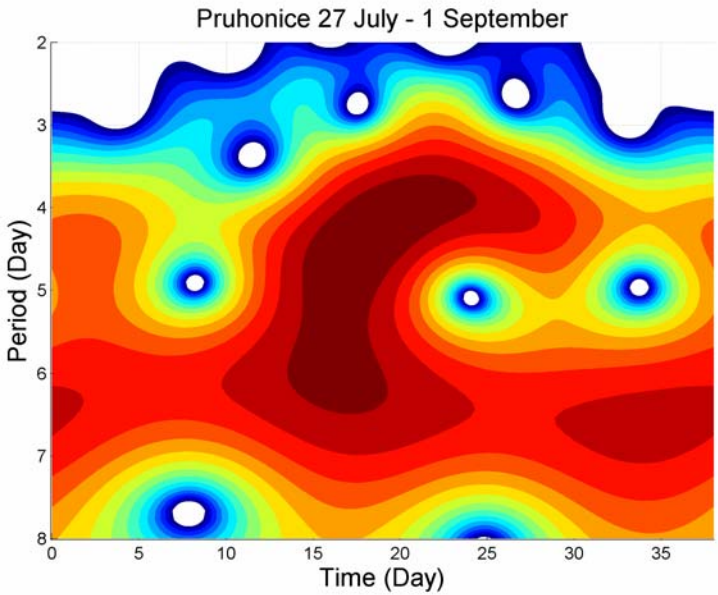




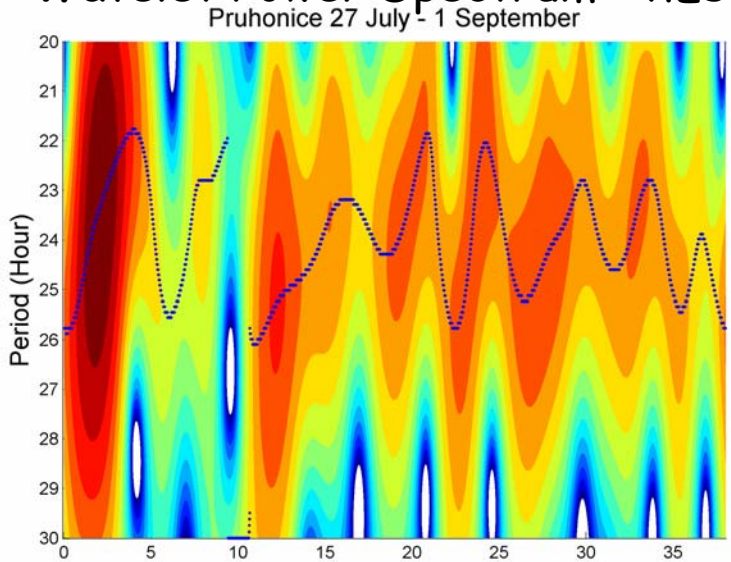
Campaign 2004 – 24-hour oscillation mode

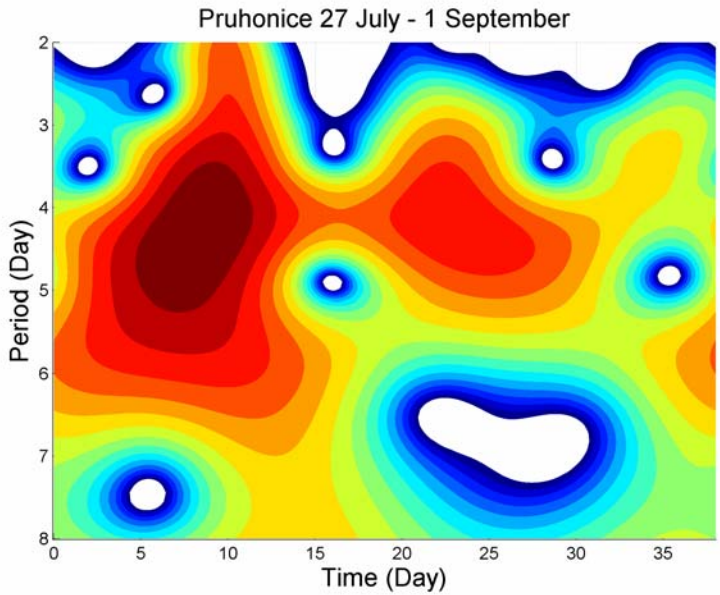
Wavelet Power Spectrum - foEs



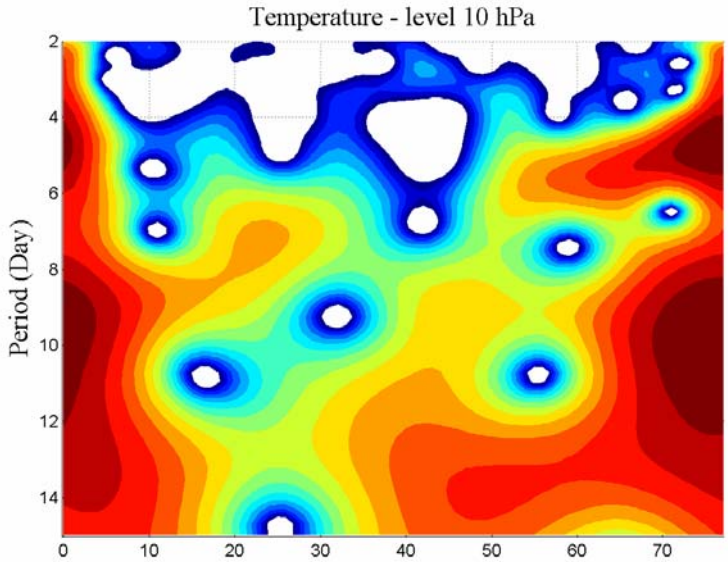


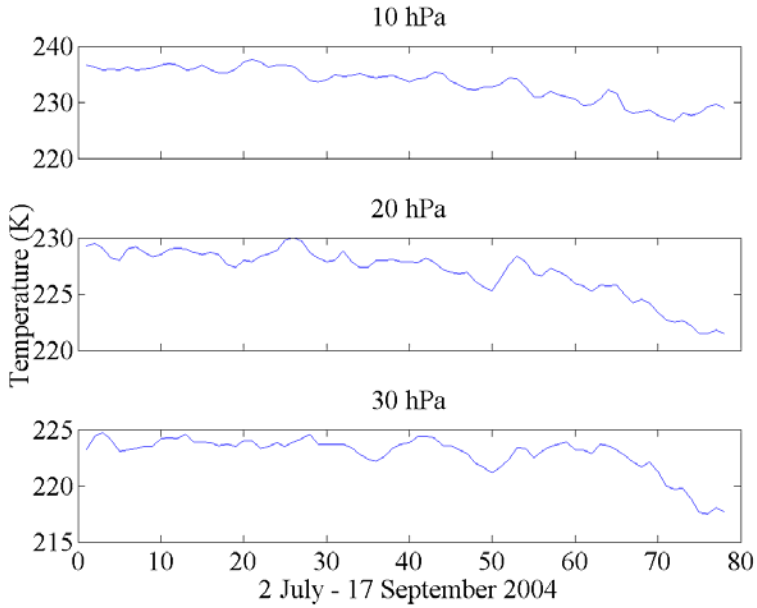
Wavelet Power Spectrum - hEs

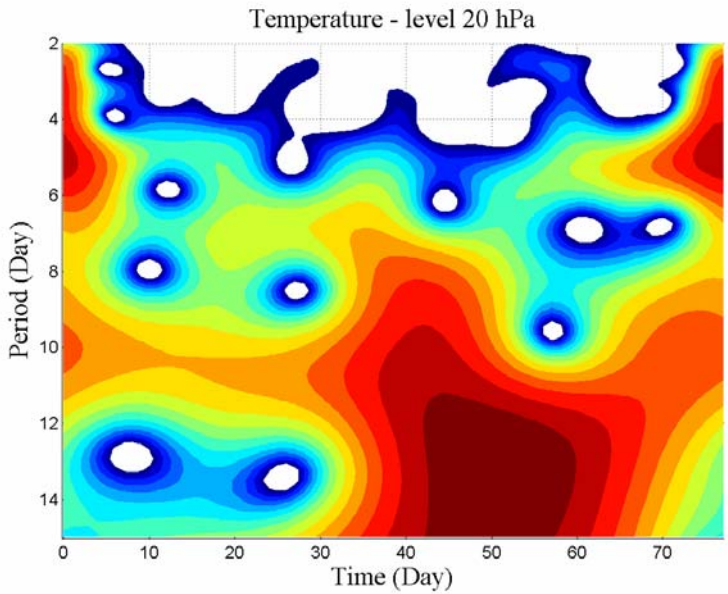


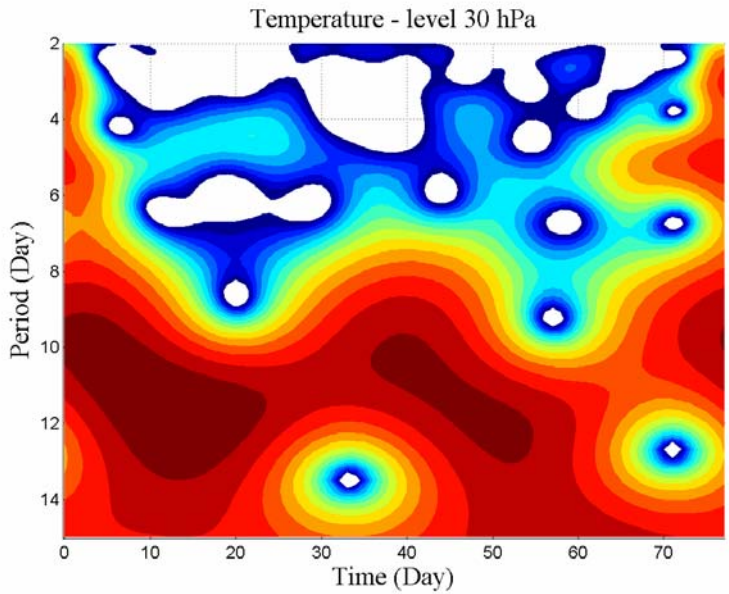


Stratospheric Temperature 2004



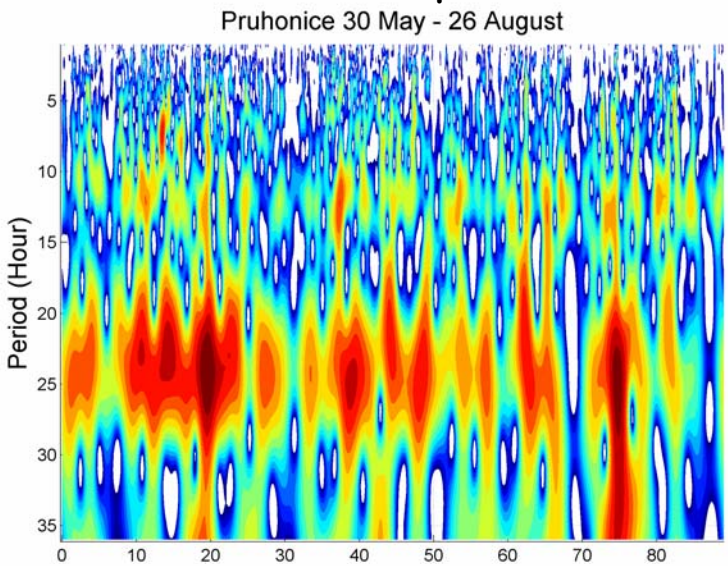


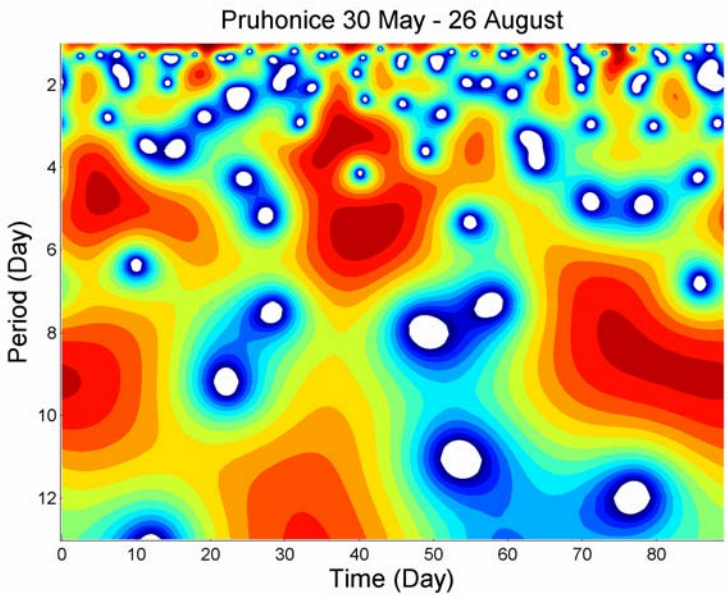




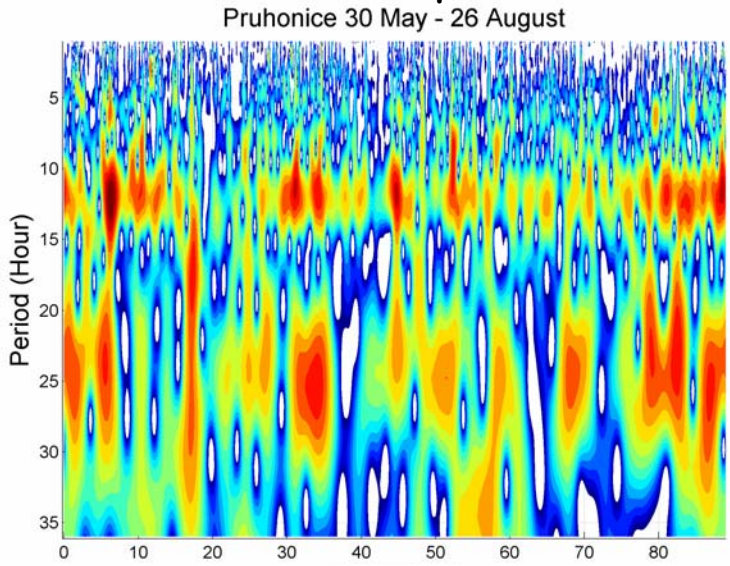
Campaign 2006

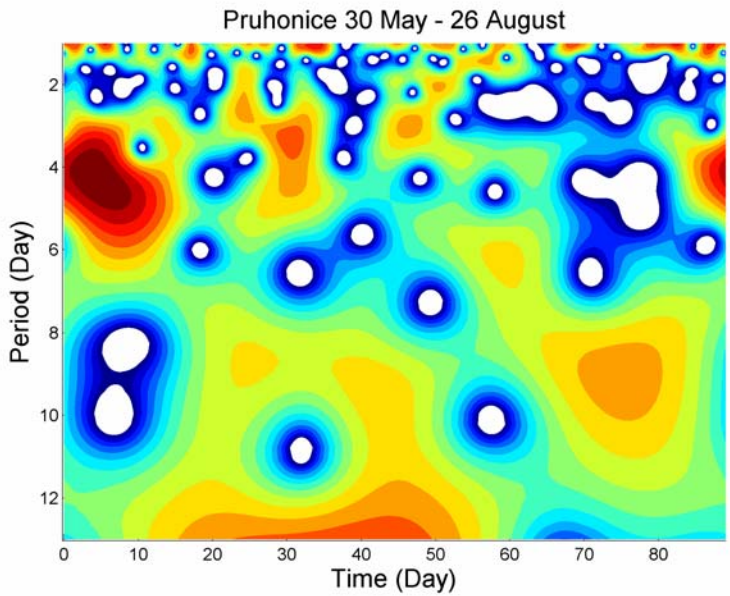
Wavelet Power Spectrum - foEs





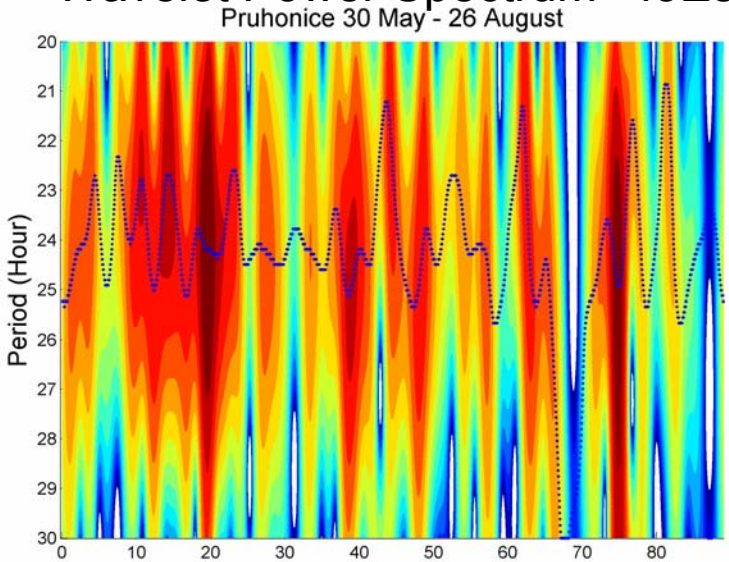
Wavelet Power Spectrum - hEs

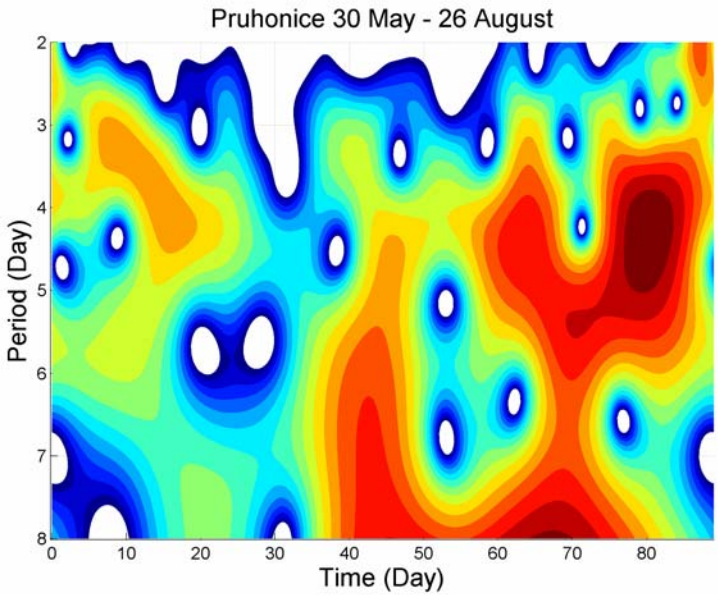




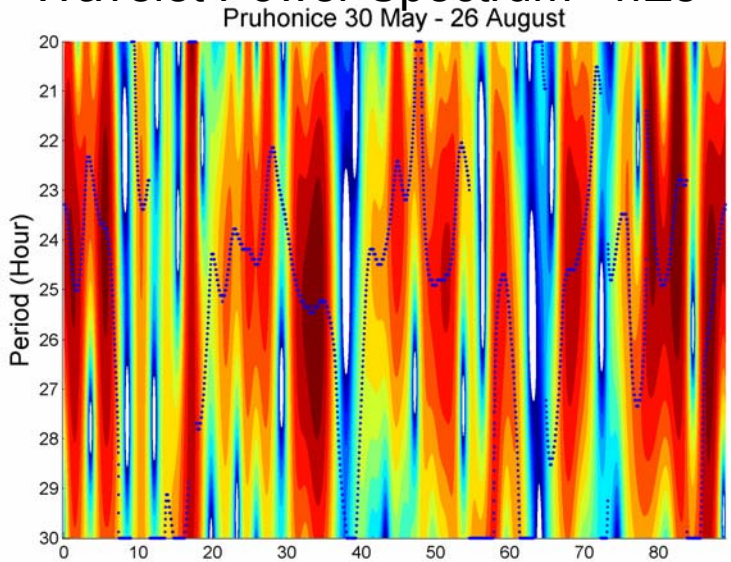
Campaign 2006 – 24-hour oscillation mode

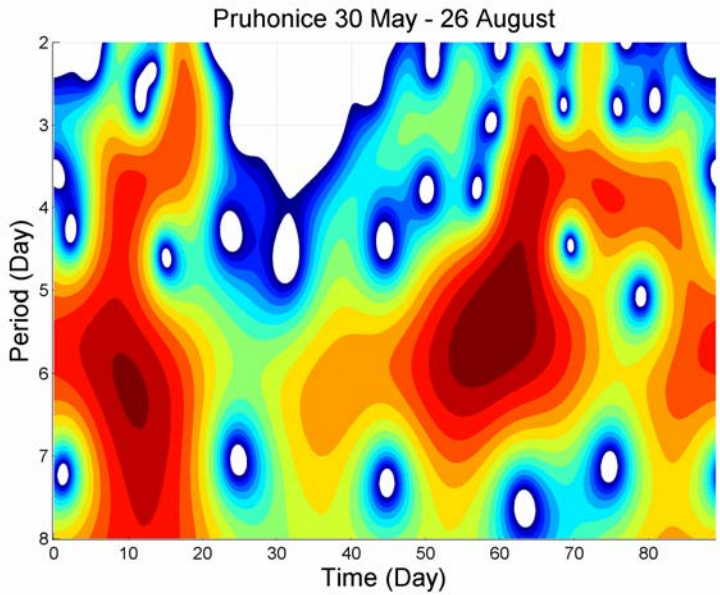
Wavelet Power Spectrum - foEs



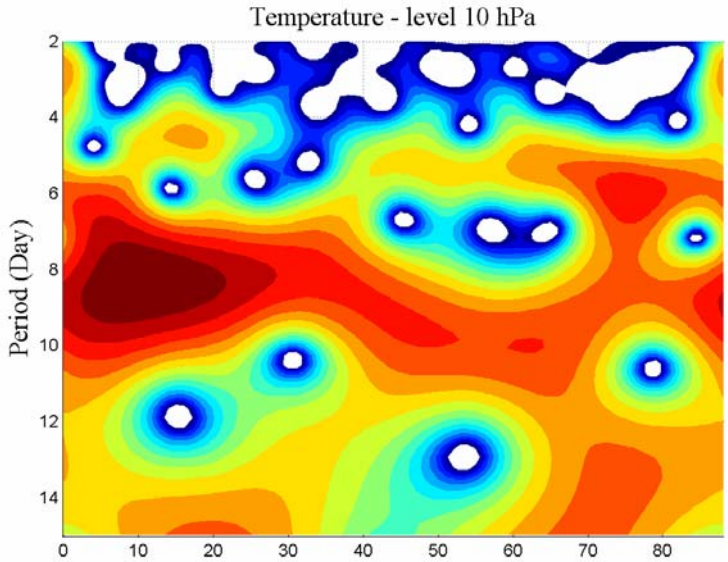


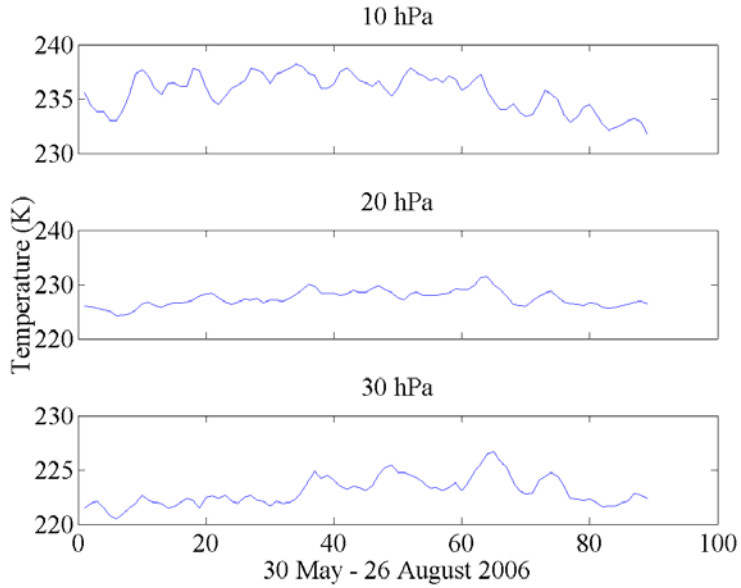
Wavelet Power Spectrum - hEs

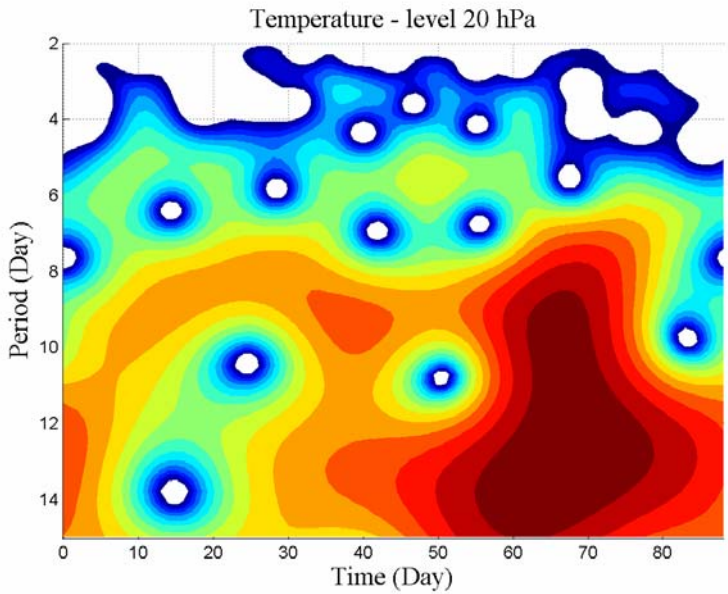


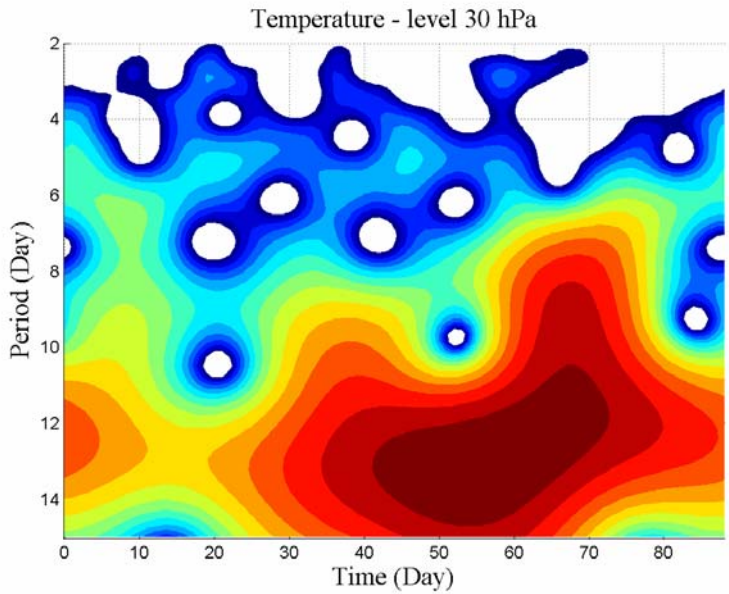


Stratospheric Temperature 2006

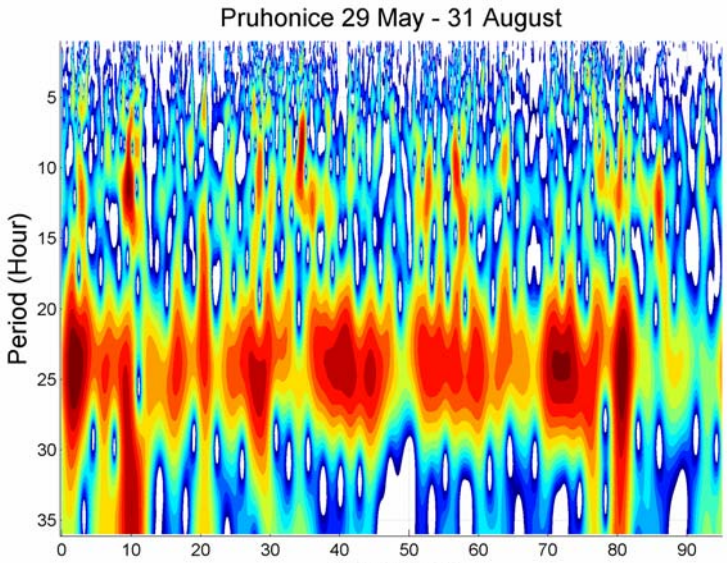


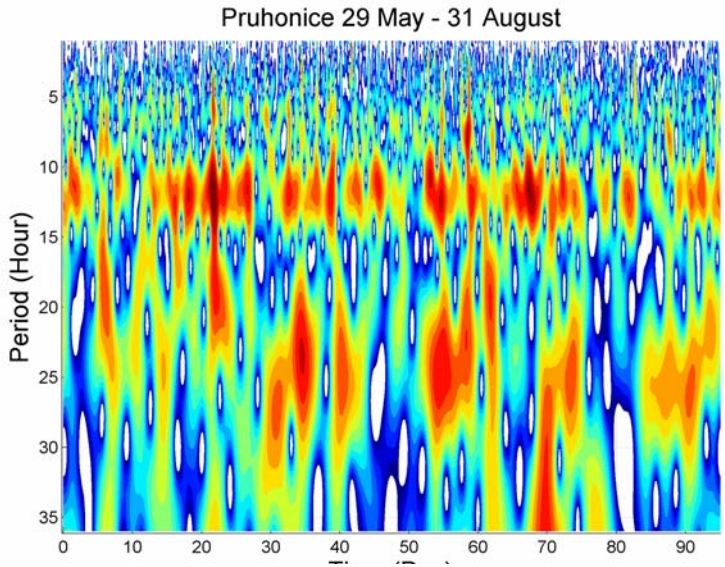


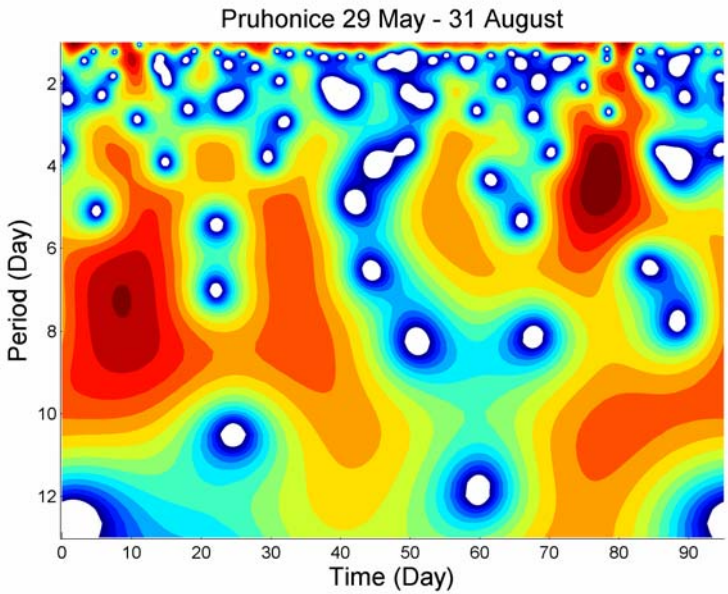


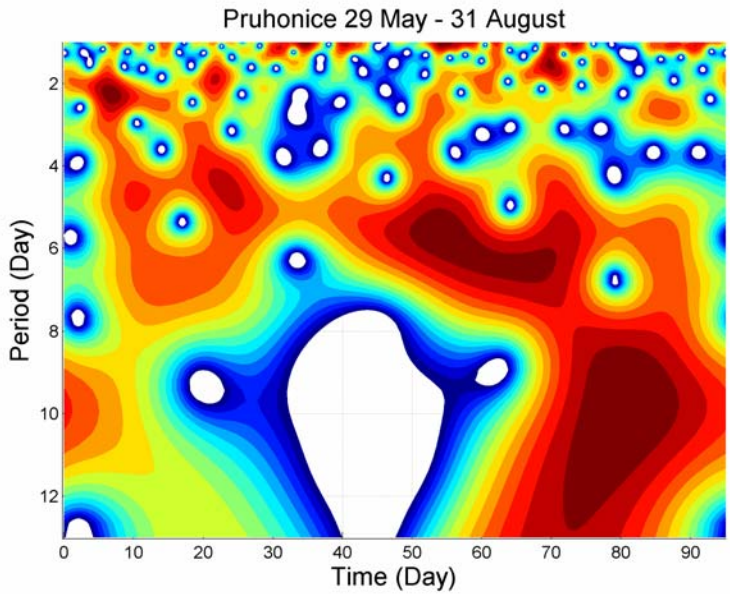


Campaign 2008



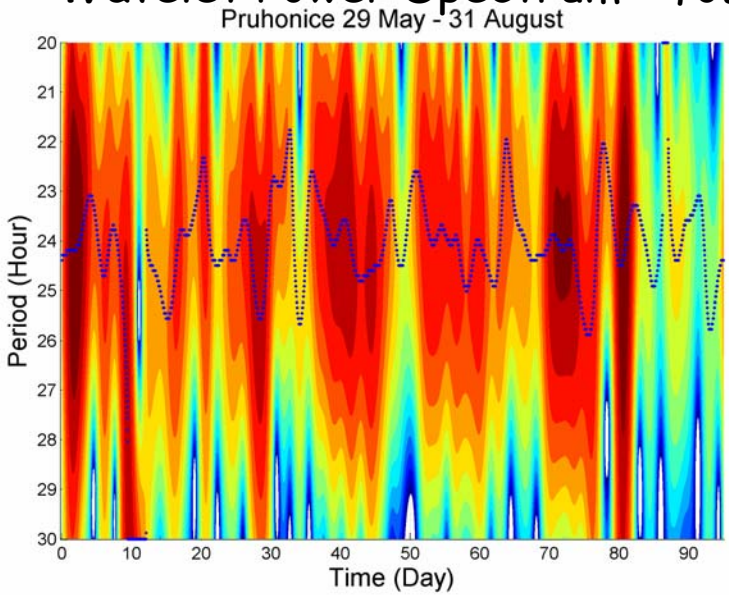




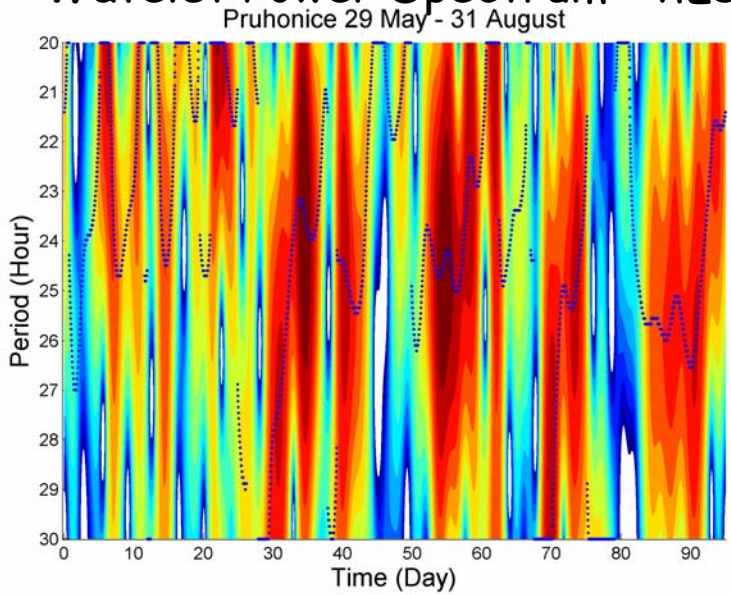


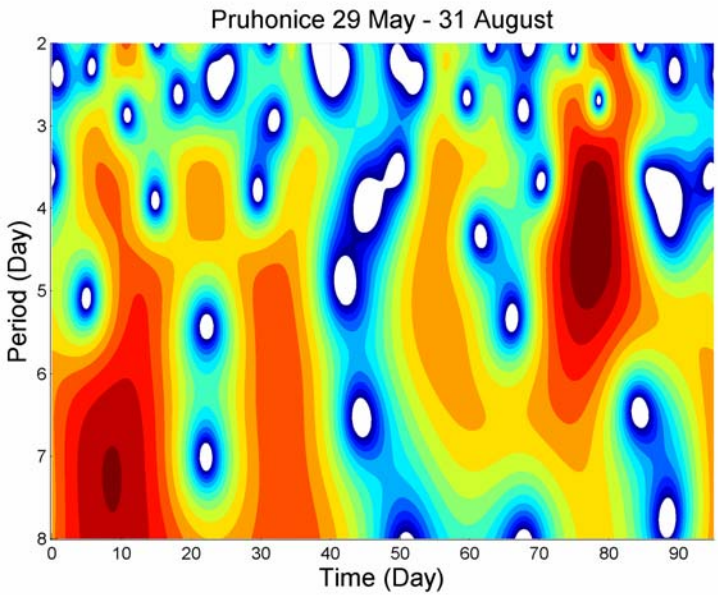
Campaign 2008 – 24-hour oscillation mode

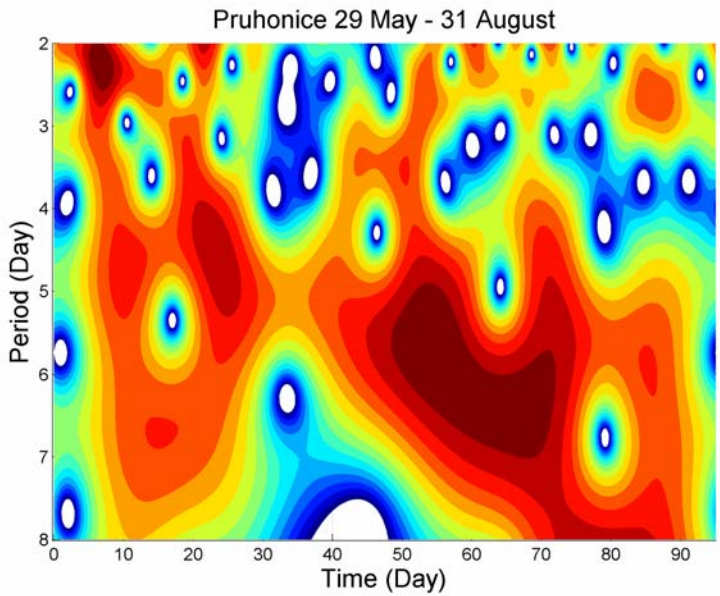
Wavelet Power Spectrum - foEs



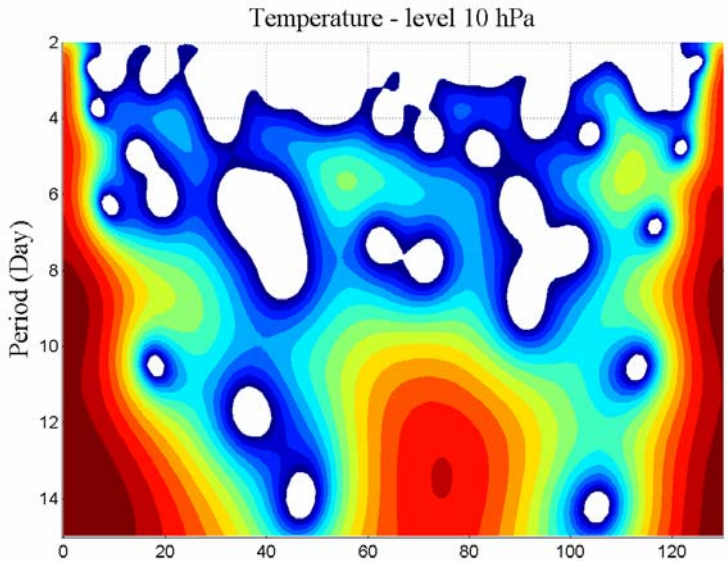
Wavelet Power Spectrum - hEs

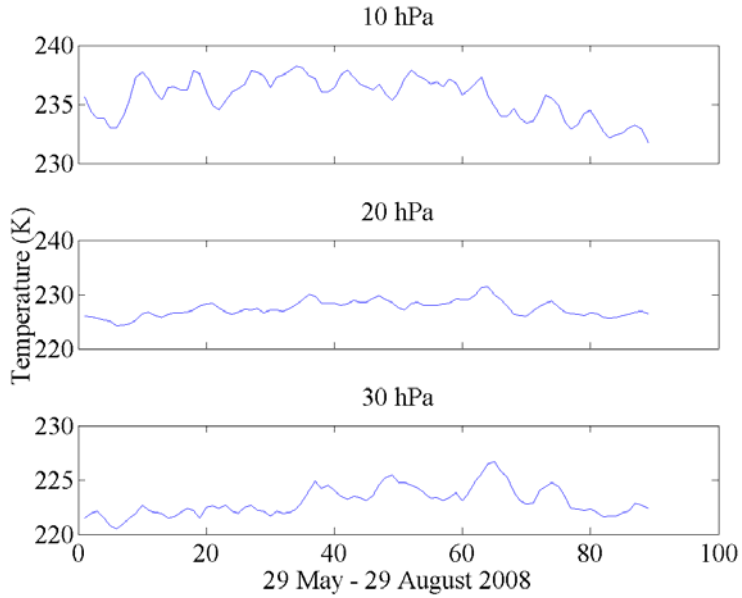


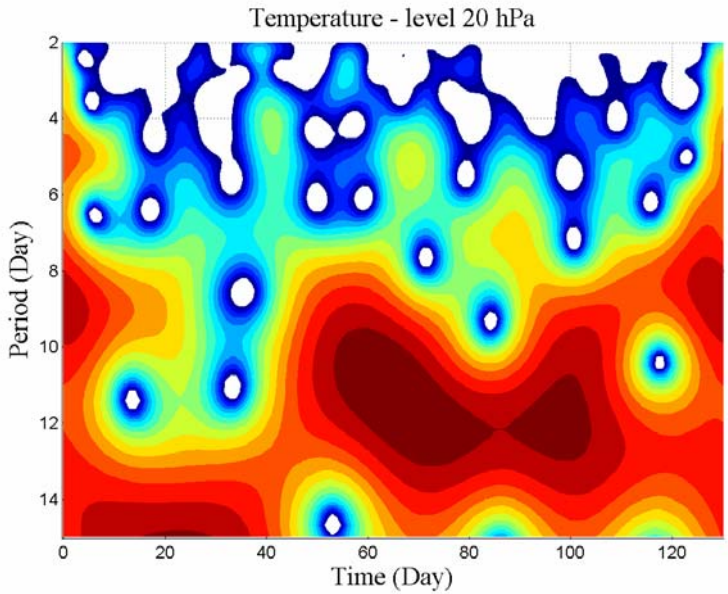


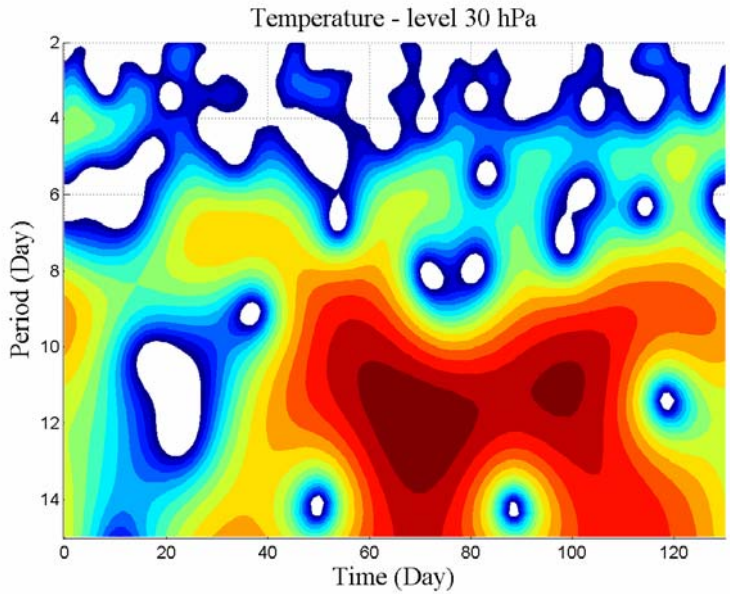


Stratospheric Temperature 2008









Results:

In general, there are no common wave bursts, that occur at the same time within time series of Es parameters and temperatures. However, there are some corresponding domains that may be link together as we are analysing data from different/distant atmospheric regions – stratosphere vs. mesosphere and lower thermosphere.

Campaign 2004 – within foEs and hEs oscillations and stratospheric temperature, there is almost no common domain. Slight increase of the oscillation energy can be found at period of 4 days.

Campaign 2006 – wavelet power spectra reveals common increase of the energy at periods around 4 days, 6 days and 7 days

Campaign 2008 – as in previous, similar oscillation domains are detected within wavelet power spectra of Sporadic E layer parameters and stratospheric temperature.

The fact, that we do not see good agreement also for the campaign 2004 may be caused by the data availability (foEs and hEs is shortest special campaign).

Acknowledgement:

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References

Beard, A.G., Michell, N.J., Williams, P.J.S., Kunitake, M., 1999. Non-linear interactions between tides and planetary waves resulting in periodic tidal variability. Journal of Atmospheric and Solar-Terrestrial Physics, 61, 363-376.

Bourdillon, A., Haldoupis, C., Delloue, J., 1995. High-frequency Doppler radar observations of magnetic aspect sensitive irregularities in the midlatitude E region ionosphere. Journal of Geophysical Research, 100, No. A11, 21,503-21,521.

Forbes, M.J., 1994. Tidal and Planetary Waves. The Upper Mesosphere and Lower Thermosphere: A Review of Experiment and Theory, Geophysical Monograph 87, edited by R.M. Johnson and T.L. Killeen, AGU, Washington, D.C., 67-87.

Haldoupis, C., Pancheva, D., Michell, N.J., 2004. A study of tidal and planetary wave periodicities present in midlatitude sporadic E layers. Journal of Geophysical Research, 109, Art. No. A02302.

Laštovička, J., 2006. Forcing of the ionosphere by waves from below. Journal of Atmospheric and Solar-Terrestrial Physics, 68, 479-497.

Laštovička, J., Fišer, V., Pancheva, D., 1994. Long-term trends in planetary wave activity (2-15 days) at 80-100 km inferred from radio wave absorption. Journal of Atmospheric and Solar-Terrestrial Physics, 56, 893-899.

Mallat, S., 1998. A Wavelet Tour of Signal Processing. Academic Press, San Diego.

Mathews, J. D., 1998. Sporadic E: current views and recent progress. Journal of Atmospheric and Solar-Terrestrial Physics, 60(4), 413-435.

Pancheva, D., Haldoupis, C., Meek, C.E., Manson, A.H., Mitchell, N.J., 2003. Evidence of a role for modulated atmospheric tides in the dependence of sporadic E layers on planetary waves. Journal of Geophysical Research, 108, Art. No. 1176

Pancheva, D., Beard, A.G., Mitchell, N.J., Muller, H.G., 2000. Nonlinear interactions between planetary waves in the mesosphere/lower-thermosphere region. Journal of Geophysical Research, 105, 157-170.

Šauli, P., Bourdillon, A., 2008. Height and critical frequency variations of the sporadic-E layer at midlatitudes. Journal of Atmospheric and Terrestrial Physics, 70 (15), 1904-1910.

Tsunoda, R.T., Cosgrove, R.B., Ogawa, T., 2004. Azimuth-dependent E-s layer instability: A missing link found Journal of Geophysical Research,109 (A12), Art. No. A12303.

Whitehead, J.D., 1989. Recent work on mid-latitude and equatorial sporadic E. Journal of Atmospheric and Terrestrial Physics, 51, 401-424.