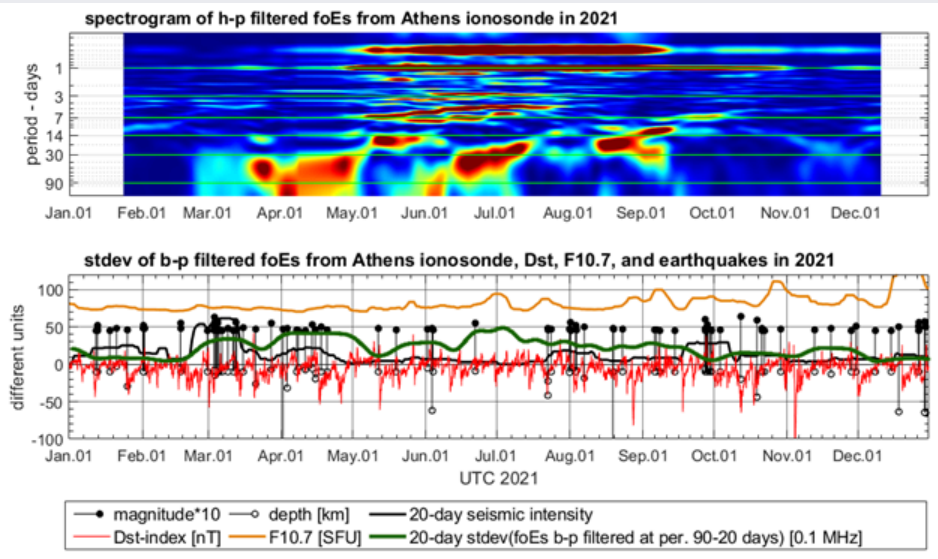
PITHIA-NRF TNA Success story: **SIDSEA** (**S**ensitivity of **I**onospheric **D**isturbance detection by **S**warm in time of strong **E**arthquakes in **A**egean region)

The earthquakes result from tectonic processes, which generate the so-called Lithosphere-Atmosphere-Ionosphere Coupling (LAIC). The tectonic plate boundaries are weak zones of the Earth's crust, where various chemical and physical processes contribute to LAIC. These are processes affecting the ionosphere from below, but their imprints in the ionosphere are mixed with those coming from different processes from above, related to the solar forcing and magnetic field variations. Acoustic Gravity Waves (AGW) occur in close time proximity to the largest crustal movements, whereas Electric Field Modifications (EFM) can last for days, and moreover, can be precursory to the largest mainshocks.

Thanks to the Trans National Access (TNA) programme of PITHIA-NRF, two groups of researchers from the UWM and from the NOA had the opportunity to work together in the framework of the SIDSEA project. SIDSEA investigated the sensitivity of various frequencies of the ionospheric observations' spectrum to the seismic activity. The data analysis performed for the SIDSEA project was focused on the Aegean Sea and over two years of moderate to strong seismic activity in 2020-2021. The project employed ionospheric observations from the Athens Digisonde AT138, TEC from co-located ground-based GNSS receivers and electron density from the in-situ observations collected by the Swarm satellites in the topside ionosphere. The Fourier-based band-pass filtering method was applied to all data-series, after preliminary inspection of the spectrograms and initial assessment of these spectral bands, which showed a higher degree of correlation with seismic sources in comparison to respective correlation with solar or geomagnetic variations. It was observed that the use of long time series can help in the discussion on the evolution of LAIC processes . The variability of ionospheric characteristics appears to be different at different frequencies, which exhibit various sensitivity to seismic, solar-driven and magnetospheric factors. The sensitivity levels at analyzed over-diurnal periods suggested rather EFM channel of LAIC, as AGW channel is better detectable at much shorter wavelengths. The results of band-pass ionospheric data filtering in the Aegean Sea focused on LAIC are preliminary, but indicate the possibility of detection of relatively weak signals, which can be important in the observation of LAIC.



Discussions held during this TNA project shown that the use of high-level data products such as the power spectral density, can efficiently support phenomenological studies and advanced ionospheric modelling. Furthermore, the data quality is critical for the reliability of the results obtained from data processing and modelling efforts. These ideas have been developed to the successful DISPEC proposal submitted to the European Commission and funded in the framework of the Horizon Europe programme. The results directly obtained from the TNA SIDSEA project are submitted for publication to the Earth, Planets and Space.

References:

- *DISPEC - SCIENTIFIC EXPLOITATION OF SPACE DATA FOR IMPROVED IONOSPHERIC SPECIFICATION*, https://cordis.europa.eu/project/id/101135002
- *Jarmołowski, W., Wielgosz P. and Belehaki A., Sensitivity of band-pass filtered in situ LEO and ground-based ionosphere observations to lithosphere-atmosphere-ionosphere coupling over the Aegean Sea. Earth, Planets and Space Journal, submitted, 30.04.2024*

https://pithia-nrf.eu

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