

**November 09, 2024**

**Research trip report to the Sodankylä Geophysical Observatory, Finland, and the Institute of Atmospheric Physics CAS, Czechia**

Submitted by Claudia Martinez (ISEE, Nagoya University)

Period of stay: 29.07.2024 – 31.08.2024

Location: Sodankylä, Finland; Kühlungsborn, Germany; Prague, Czechia

I study plasma waves that are naturally present in the magnetosphere and their relation to radiation belt dynamics. Very low (VLF) and extremely low (ELF) frequency waves are known to be related to particle loss and acceleration. Through multi-point observations I investigate their properties and propagation using both ground and space measurements and simulations (ray tracing of waves). Thanks to the PBASE project I was able to have a long-term visit in Europe to discuss with colleagues on current and future projects around this work.

The visit started at the Institute of Atmospheric Physics, Czechia where I spent two weeks with their Space Physics group, led by my close collaborator O. Santolik. Most of the visit was focused on finalizing the implementation of a sferics and PLHR filter to existing PWING stations with D. Pisa. We are also working on a tool to visualize multiple PWING data simultaneously to handle statistics more quickly. I had substantial time to discuss the draft of two upcoming papers with O. Santolik, and in particular talked over how to address unusual results concerning ionospheric exit point characteristics and propagation of bursty-patches. During this time I also presented my recent results at a Colloquium for the institute on August 6. I also met with F. Nemec at Charles University, to discuss our ongoing collaboration and the participation of one of his students in the installation of a VLF receiver in Finland.

After Prague, I was invited to give another colloquium at the Leibniz Institute of Atmospheric Physics in Kühlungsborn, Germany by J. Chau. My presentation was on August 14, but my stay lasted a few days, which gave me a chance to learn more about the institute's research and how they use radars for remote sensing. I had multiple meetings with students and post-docs to discuss on their research topics, instruments, and current observations.

My last stop was the Sodankylä Geophysical Observatory, Finland. The main objective of this trip was the installation of an additional PWING receiver at Angeli in Northern Finland. The original idea was that this antenna would complete the first latitudinal chain of receivers combined with the KAN (since 2016) and OIJ stations (installed in 2022). Unfortunately, the KAN receiver was destroyed by a lightning strike and is currently out of service. However, ANG and OIJ data will still allow us to gather important information on latitudinal propagation of VLF waves, including bursty-patches, and the eventual effect of Energetic Electron Precipitation.

During the first part of the trip we successfully installed the receiver at ANG, checked the data and verified that it was working properly. For the second part, we addressed the issue of an eventual KAN replacement with our collaborator J. Manninen, as well as discuss future projects involving other receivers. We also reviewed a paper for submission and talked about plans to analyzed long term statistics of PWING stations to address VLF wave characteristics and origins/propagation of bursty-patches.



**Figure 1.** *New VLF receiver at Angeli, installed during this visit.*