Research Networking Programmes

Short Visit Grant ☒ or Exchange Visit Grant ☐

(please tick the relevant box)

Scientific Report

The scientific report (WORD or PDF file – maximum of eight A4 pages) should be submitted online within one month of the event. It will be published on the ESF website.

Proposal Title: Interpretation of thunderstorm-ionosphere coupling observed by ionosonde and VLF measurements.

Application Reference N°: 6924

1) Purpose of the visit

The thunderstorm – ionosphere coupling have been studied by ionograms obtained from the Digisonde DPS4D at Pruhonice, Czech Republic and ionosonde (VISRC2) at Nagycenk, Hungary during two campaigns in summer, 2013 and 2014. Thunderstorms passed through the territory of the ionosondes on 20th of June, 2013 and on 30th of July, 2014 and numerous sprites were captured above them. Ionograms were recorded in every minute and every two minutes in the two cases. Peaks appeared in the variation of ionospheric fmin values which occurred much more frequently and with higher amplitudes just in that time window which the sprite events grouped in. Moreover the lack of the sporadic E layer has been found in those hours. The purpose of the TEA-IS visit to Crete of V. Barta (Geodetic and Geophysical Insitute, Sopron, Hungary) was the collaboration with C. Haldoupis (University of Crete, Greece) who is a well-known expert of very low frequency (VLF) EM wave phenomena related to TLEs (Transient Luminous Events) as well as ionospheric plasma physics, mid-latitude sporadic E-layer and interaction of large scale atmospheric (tidal and planetary) waves with the ionosphere plasma. Further data analysis and tecniques were planned in order to investigate if there is a relationship between the thunderstorm lightning activity and the variation seen in sporadic E. Also we used other available ionosonde measurements during the rime of the thunderstorms of the event studies in order to test the present observation. Analysis of VLF data (Crete and/or Cyprus) was also considered in conjunction with ionosonde, TLE and lightning data.

2) Description of the work carried out during the visit

- The work started with an informal 4-hour seminar and discussions. I gave a presentation on the results of the papers in this field and our previous results. We discussed the results and the possible physical mechanisms and the following steps of the work.

- We searched for the sign of early/fast and LORE (long-recovery Early event) VLF perturbations during the period of the campaign on 20 of June, 2013. In the case of the second event study (30 of July, 2014) there was no data of the narrowband VLF receiver located on Crete and/or Cyprus. In the first case a couple of early/fast event were observed on the VLF signals continuously monitored by a receiver on Cyprus during the campaign related to the sprites and intense +CG lightning discharges wich show changes in the electron density of upper D-region. But there was no one-to-one association with the observed sprites. Although only one transmitter, which passing through the storm region (DHO), was working well in that period.

- I checked the variation of the foEs parameter five days later and five days before than the campaign on 20 of June. Usually the value of the foEs is low during the evening/night, but the disappearance was observed only that evening when the thunderstorm passed through the territory. I calculated the 10 days diurnal average foEs. It shows that the average foEs during the evening is low indeed, but not as low as in the case of the period of the campaign.

-I checked the foEs data of other ionosonde stations in Europe for the same periods of the two campaigns. The value of the foEs was low everywhere during the evening of 20 of June, but the lack of the sporadic E layer observed only in Pruhonice on the period of the campaign. The situation is similar in the second case (30, July, 2014). The value of the foEs is low in every ionosonde station in Europe during that evening, but only the ionosonde at Nagycenk observed the disappearance of the layer.

- Statistics of individual thunderstorms around Rome using intense (peak current > 200 kA) lightning data observed by LINET lightning detection network in 2009 were performed. We have checked the variation of foEs parameter and the VLF data of Crete for the periods of the thunderstorms. Taking into account the LINET data, 10 huge thunderstorms occurred in the vicinity of Rome (< 400 km) during the autumn and the winter of 2009. There were some LORE events in the VLF signals during November and December, 2009 but there were no any increase or decrease of the value of foEs related to these events. According to the statistics there is no clear correspondance between the intense lightnings during the thunderstorms and the variation of the foEs parameter.

3) Description of the main results obtained

I.) Results of the two events, taking into account the VLF data, the variation of the foEs parameter 5 days before and 5 days after the campaigns and the value of the foEs observed by the ionoseondes in Europe for the same periods: -Usually the value of the foEs is low during the evening, but the disappearance was observed only during those evenings when the thunderstorm passed through the territory. Consequently although the average value of the foEs parameter is low during the evening, there is an additional mechanism related to the thunderstorm which cause decrease in foEs indicating loss of the electron density of the sporadic E layer. This mechanism could be the following:
- Atmospheric gravity waves (AGWs) generated by thunderstorms can build up but also destroy a layer if it is in higher altitudes, above 100 - 110 km height. In this case the

sporadic E layers located around 110 km height, so the reduction in the value of foEs parameter could be related to AGWs.
- The electrons accelerated by the quasi-electrostatic (QE) field of the thunderstorm and/or by the electromagnetic impulses (EMPs) related to the most intense lightning discharges reaching the lower ionosphere can cause heating and ionisation in the upper D - lower E region. The absorption of the lower ionosphere increases due to this ionisation. Thus the electromagnetic waves transmitted by the ionosonde are absorbed in the D-region and they can not reach the height of the Sporadic E layer. They are not reflected from the sporadic E layer, so the layer disappears from our viewpoint, because we can not observe it.
- The accelerated electrons (by the EMPs) attach to the dust particles in the height of the E layer (95 - 120 km height) causing reduction in the electron density of the sporadic E layer.
II. Results of statistics of individual thunderstorms around Rome using intense (peak current > 200 kA) lightning data observed by LINET lightning detection network in 2009: According to the statistics, there is no clear correspondance between the intense lightnings during the thunderstorms and the variation of the foEs parameter.

Our main conclusion is that we need continuous LINET lightning data at least for one summer for further statistical analyses (Time series, spectral analysis, Superposed Epoch Analysis for individual thunderstorms) to disclose the connection between the thunderstorms/lightnings and the sporadic E layer.

4) Future collaboration with host institution (if applicable)

We keep in touch and we will discuss about the results of the further analyses by e-mail.

5) Projected publications / articles resulting or to result from the grant *(ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant)*

We will present the results in international conferences and we plan a common publication in a journal in the future depending on the results after analysing the data.

6) Other comments (if any)

(i) The spirit of collaboration between C. Haldoupis and me was really friendly.
(ii) I travelled from Sopron to Vienna International Airport by car and from Vienna to Iraklion by airplane. I have arrived to the Airport of Iraklion on 20th afternoon where Christos Haloupis waited for me and took me to my accomodation.
(iii) Christos Haldoupis throughout my visit looked after me perfectly, and thoughtfully.
(iv) I stayed in an apartment of Yannis Apartments in Amoudara, my accommodation was very comfortable and clean.
(v) When I came back from Iraklion I had to change airplane in Athens so I had to spend one night in Athens. I have arrived to Vienna international Airport on 3th of October. From Vienna to Sopron I travelled by train.

To ESF

Attn.

Blanche Facchini

European Science Foundation (ESF)

1 quai Lezay Marnesia

BP 90015

67080 Strasbourg Cedex

France

From Veronika Barta, Geodetic and Geophysical Institute, Research Centre for Astronomy and Earth Sciences, Sopron, Hungary

TEA-IS short visit grant, Reference Number: 6924

Sopron, October 14, 2014

Analysis of travel costs: Sopron – Heraklion – Sopron

1.)	Sopron to Vienna International Airport by car, -	3002 HUF (1 eu = 312 HUF) = 9,62 eu.
2.)	Airplane ticket, Wien – Herkalion, Heraklion – Athens, Athens – Wien, -	337,96 + 35 (Luggage cost) = 372, 96 eu
3.)	Airport – Athens – Airport return ticket –	= 14 eu
4.)	Vienna International Airport to Sopron by train –	4,40 + 15,40 = 19,80 eu
5.)	Local Public Transport in Heraklion –	8 * 1,50 + 5 * 1,10 = 13,50 + 5,50 = 17,50 eu
	TOTAL Travel expenses	= 433,88 eu

Dear Blanche Facchini,

This is the total cost of my travel from Sopron to Heraklion. I attached the receipts and the tickets to this letter.

Thank you in advance for your help.

Sincerely yours,

Veronika Barta
Geodetic and Geophysical Institute
Research Centre for Astronomy and Earth Sciences,
Sopron, Hungary