STSM M Vorenhout

Overview of results obtained in Xanthi, Greece

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Short scientific report on results and activiteis during the STSM of M Vorenhout to University of Xanthi, Greece

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1. INTRODUCTION

The Short Term Scientific Mission (STSM) of Michel Vorenhout to the lab of Prof Kourtidis (University of Xanthi) took place in October 2017. This report gives an overview of activities performed and shows the main scientific results obtained during this 12 day mission.

The mission was approved by Dr Harm G. van der Geest, University of Amsterdam.

1.1. Aims of STSM

The mission had the following main aims:

1. Measure soil redox potential (Eh) at the host institution in Greece at high frequency in soils impacted by atmospheric electrical events.
2. Link the redox measurements to the running setup in which the atmospheric electric field (potential gradient, PG) is measured.
3. Interpretation of the obtained data on site.

The mission had the following secondary aims:

1. Enable scientific discussions between host and visiting researcher in order to deepen knowledge of visitor and host on the subject of Atmospheric Electricity and redox potential measurements in soils.
2. Here, own data will be presented to each other in order to deepen each other's knowledge and estimate if correlations are expected to really occur.
3. Education of M Vorenhout in the field of Atmospheric Electricity and the measurement thereof.

2. METHODS

2.1. Measure Eh in soils next to PG measurements

Four sturdy probes (Paleo Terra, Amsterdam, the Netherlands) with redox measurement tips at -1 and -21 cm below surface were placed in a created mudpit. Installation directly into the soil proved impossible due to the very low permeability of the soil. The mud pit was dug at 1.5 m from the metal fence around the local weather station/PG meter.
A recent Hypnos IV (Vorenhout, van der Geest, and Hunting 2011) (MVH Consult, Leiden, the Netherlands) was connected to the sturdy probes. Different cabling options were used, as explained here. For more details, see Chapter 3.
The first week, 16 to 23 October 2017, the four probes were connected via an extension wire. The extension wire was shielded, and the shield was grounded. Grounding was provided by the building's ground in the electrical circuit. This ground was located below the building (oral communication local staff @@Kostas???@@).

The extension cable had 4 spare wires, which were also connected to the Hypnos. This was done to see if the extension cable itself would pick up a signal, which would then only be attributed to the cable itself.

The second week, several trials were made to distinguish the influence of cabling and shielding. Two probes were connected to the Hypnos directly. The Hypnos was placed inside the fenced area under a Mesh shield (Faraday principle) that was grounded. The two remaining probes were connected via the same extension cable. This test was performed to see if a clear effect of the extension cable (eg picking up an Atmospheric Electricity signal) was visible in the data.

Measurements were taken in a 1 minute interval (the shortest possible with the Hypnos IV).

The setup was last modified on the final day of the mission. There, an additional single core wire was connected to a redox entry in the Hypnos. Measurement interval was scaled down to a 2 minutes interval. This setup was left on site in a working state.

2.2. Link results to local PG measurements

Local PG measurements have been performed for several years by Prof Kourtidis and coworkers (Kastelis and Kourtidis 2016). Measurements are taken at 1 second interval with a Campbell CS110 Electric Field meter. This device has an internal CR1000M that is linked via a RS232-Ethernet convertor to a locally running Loggernet setup. Data was downloaded in the second week, revealing data gaps, resulting in a continuous data set from October 22 2017 until the end of the mission.
Transformation of raw data PG was performed using supplied calibration values (pers comm Kourtidis).
The redox potential (Eh, the value against the standard hydrogen electrode) was obtained by adding a standard of 210mV (Eref) to the meaured potential (Em).

Data was averaged to 1 minute intervals by the CR1000 program. This averaged data was used in the analysis. Data for these two weeks of measurements were plotted as time series together with Eh data and weather data (mainly rainfall).

2.3. Secondary aims

The secondary aims were performed in between the experimental days.
First of all the host provided a short list of literature to read. This reading led to some discussions and of course personal education of M. Vorenhout. M. Vorenhout focused during the mission on improving knowledge on local versus global patterns in PG throughout UTC time.

Some of the literature studied included (Harrison 2004; Williams 2009; Lopes et al. 2017), and a textbook on Atmospheric Electricity (MacGorman and Rust 1998). Literature and several personal data sets were discussed throughout the mission.

Time was also spent on writing on part of a PostDoc proposal for Dr Ellard Hunting. The focus was put on a WP on a global measurement network of PG+Eh. For this, the obtained knowledge on the local PG setup proved very useful.

A new secondary aim occurred during the stay. In this case the measurements of PG revealed an interest in a small upgrade of the system and an exploration of possibilities. After a study of the current technical setup a possible upgrade was suggested, which can also include online read out of the data (www interface) with local and remote backup of PG and weather data, and online access to the redox potential data.
This work will be continued at MVH Consult and will be useful within WGV of the COST action ELECTRONET.

3. EXPERIMENTAL SETUP

3.1. Site details

The site has been described in detail in (Kastelis and Kourtidis 2016).

Photos of the site are shown in Figures 3.1 to 3.2

Figure 3.1:
Weather and PG station. Note the fence.

Figure 3.2:
The local CS110.

3.2. Probe details first week (Oct 16-Oct 23)

Table 3.1 Installation details for the probes. Depth in cm from soil surface. Rx: channel in Hypnos. Covered: covered by grounded metal plate. All probes on extension cable.

Probe number	Covered?	Depth (cm)	Rx	Remark
1.1		-1	1	
1.2		-21	2	
2.1		-1	3	
2.2		-21	4	
3.1	x	-1	5	
3.2	x	-21	6	
4.1	x	-1	7	
4.2	x	-21	8	
-		-	9	Single wire
-		-	10	Single wire
-		-	11	Single wire
-		-	12	Single wire
5		-20	13	Coax probe

Figure 3.3: *Probes placed in the mud inside the hole.*

Figure 3.4:
Applied shielding of two probes. Metal plate was connected to ground (green/yellow GND wire).

3.3. Probe details second week (Oct 23-Oct 27)

Table 3.2 Installation details for the probes. Depth in cm from soil surface. Rx: channel in Hypnos. Covered: covered by grounded metal plate as shown in Figure 3.4.

Probe number	Covered?	Depth (cm)	Rx	Remark
1.1		-1	1	
1.2		-21	2	
2.1		-1	3	
2.2		-21	4	
3.1	x	-1	5	
3.2	x	-21	6	
4.1	x	-1	7	
4.2	x	-21	8	
5		-20	13	Coax probe

Figure 3.5: *Setup in second week. Hypnos and junction boxes under grounded mesh wire. Reference located in bottom left (red top).*

Table 3.3 Final installation details for the probes. Depth in cm from soil surface. Rx: channel in Hypnos. Covered: covered by grounded metal plate as shown in Figure 3.4.

Probe number	Covered?	Depth (cm)	Rx	Remark
1.1		-1	1	
1.2		-21	2	
2.1		-1	3	
2.2		-21	4	
3.1		-1	5	
3.2		-21	6	
4.1		-1	7	
4.2		-21	8	
5		-20	13	Coax probe
Single wire		0	9	Single long wire on soil surface
Wire		-	10-12	Non connected wires

4. RESULTS AND DISCUSSION

4.1. Fair weather, non fair weather comparison

The results from the first week of measurements show a clear diurnal cycle in redox data following an initial decline in Eh values. This first decline is usually observed after placement of the sturdy probes in wet soils and this data is discarded from the discussion (Figure 4.1).
The occurrence of the diurnal pattern seems promising, and can maybe be related to the fair weather conditions in this period.
In this first week the soil was drying out slowly, going van very wet to nearly dry in the end. This drying out is shown in slowly or sudden increases in Eh in this period, clearly visible in probe 2 (Figure 4.2).
The second phase of the visit, with three short term setups took place during non-fair weather conditions. Some rain and intermittent cloud cover was present. During this second week no clear diurnal pattern was observed in Eh data. The thunderstorm that occurred in this second phase is clearly visible in the PG data (Figures 4.1, 4.2). The exact effect on Eh is unclear however. The large spikes in atmospheric potentials, both negative and positive in direction, are probably too fast to have a real effect on soil redox potential.

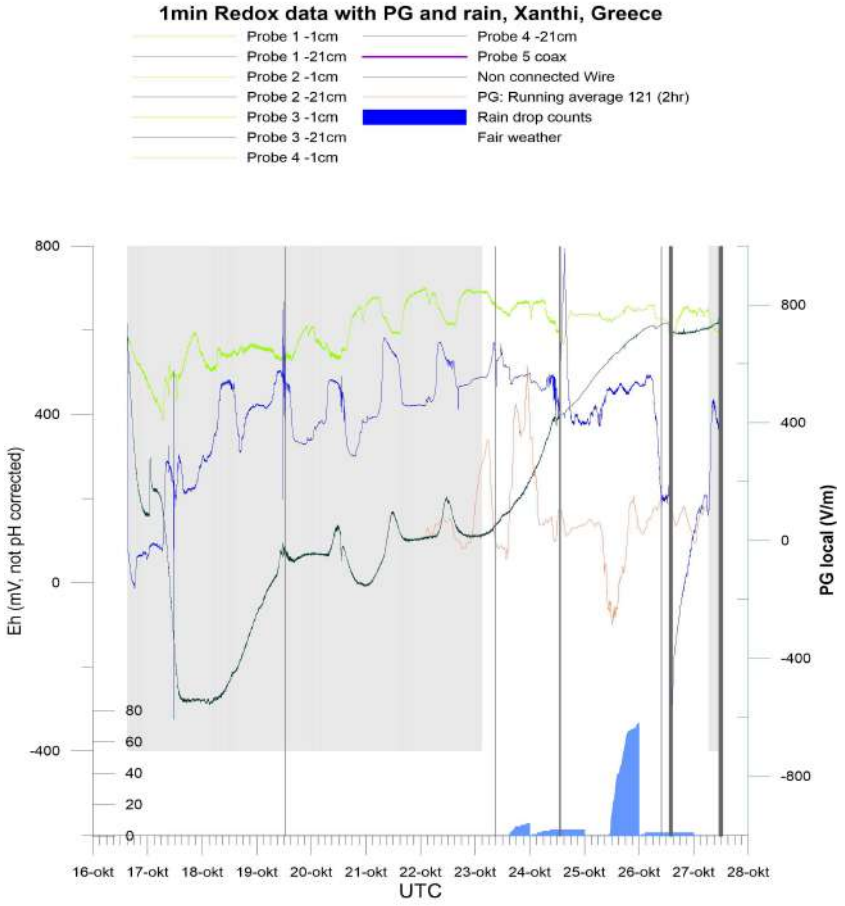

Figure 4.1:
Eh from probe 3. Note the daily variation in first period.

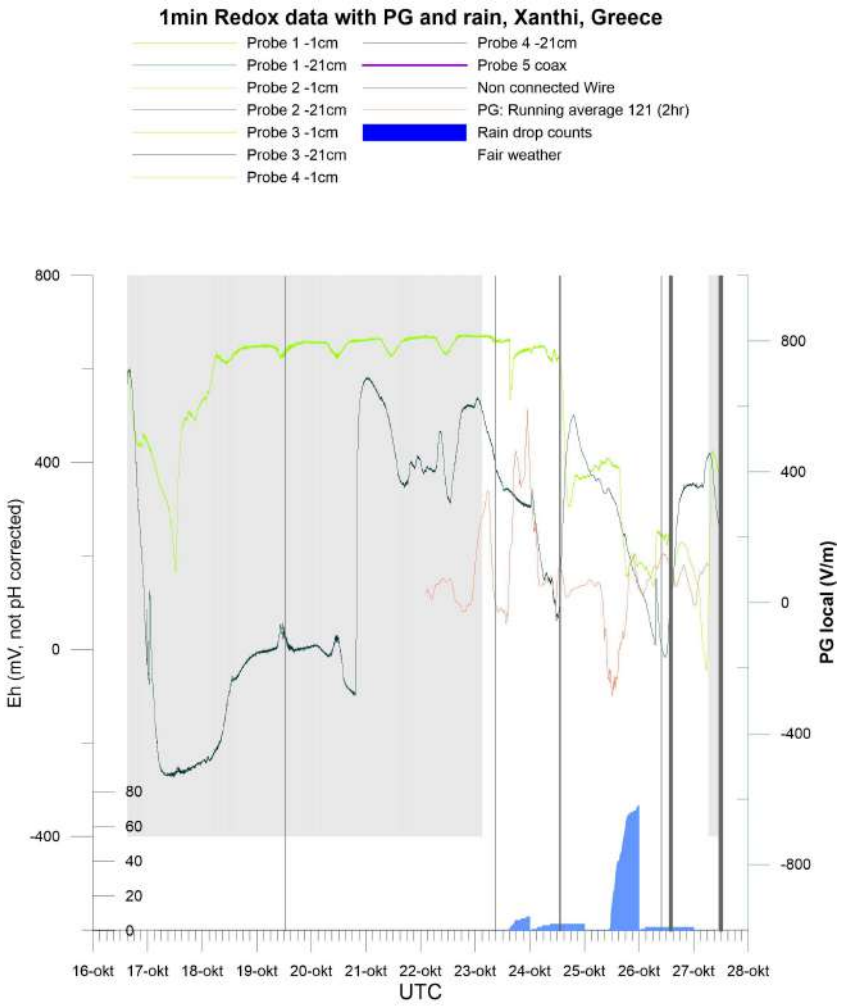

Figure 4.2:
Eh measured by probe 2. The -1cm sensor responds clearly to the drying of the mud.

4.2. *Cabling*

The effect of the actual cabling on the occurrence of a daily pattern in Eh cannot be ruled out. The diurnal pattern in the first week was also present in data taken from the non-connected cores in the extension cable (blue line in Figure 4.3).
The effect of the type of cable (PUR versus COAX) is unclear. The COAX probe did not show daily variation, but was also placed near the building in the first week. In that location, hardly any PG variation is expected due to the deformation of the PG field near the building. The weather in the second week was also not fair, with thunder and clouds. During this week no daily variation is found, and the COAX probe was moved along with the Hypnos to the fenced area. Each replacement was in oxidized (high Eh) soil and did not show any variation (Figure 4.3). Here longer time series are required.

The presence of a daily pattern in the non-connected cores during the first week led to the idea to connect a single long wire to a channel in the Hypnos. A single wire might act as a sensor for PG variation. This cable of appr 20m length (multi strand 0.5mm copper wire) was placed on the ground inside the fenced area. The Hypnos will measure the potential of that wire, and results can be compared to measurements taken from the probes. The wire was connected on the last day of the mission (Oct 27, 2017).

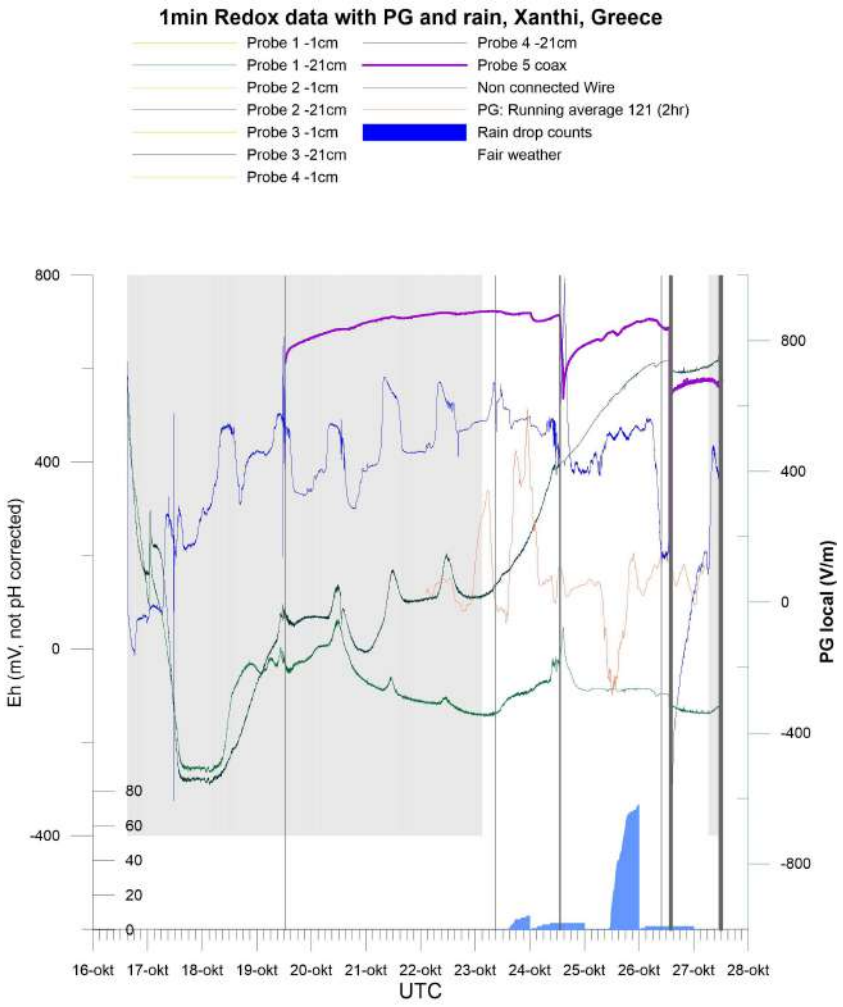

Figure 4.3:
Eh measured by sensors at -21 cm, one of the non-connected wires and the single COAX probe.

5. CONCLUSION AND THANKS

This Short Term Scientific Mission was too short to be able to catch all possible variations in weather type and Eh behaviour. It has however shown that measurements are well possible, and that the link between Eh and PG is possible (Hunting et al, subm). The Eh measurements will be continued on site, and when funding allows it, the results will be analyzed further within the scope of the COST action.

5.1. Thanks and ackknowledgements

This mission had not been possible without the help of Prof Kourtidis. Kostas, thanks a lot for the wonderful and intensive time at your lab. Hopefully we can continue this interesting work together.
I would also like to acknowledge the funding from COST action CA15211 "ElectroNet".

6. BIBLIOGRAPHY

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