



## Research Networking Programmes

### Short Visit Grant

### SCIENTIFIC REPORT

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**Proposal title:** Travel grant for ICOS-NEON Carbon training workshop 2014 in France

**Application reference N°:** 6848

#### 1. Purpose of the visit

The overall aim of the visit to Observatoire de Haute-Provence (OHP), France was to attend the 'ICOS-NEON greenhouse gas data training workshop' and learn about how to effectively handle and analyze 'big data'.

In my opinion, being familiar with and learning how to use the large amounts of data being created by networks such as *ICOS* and *NEON* effectively is an essential qualification for young researchers. More importantly, synthesis of those datasets will produce a huge collection of available data that will allow us to address new research questions that could not be addressed in the past. However, in order to make use of this remarkable capacity of new research perspectives in GHG studies proper tools, such as the ones that were taught at this workshop, are needed.

Also, as I am currently approaching the end of my PhD studies, I wanted to broaden my skill-set before taking the next career step. I believe that attendance in this workshop enabled me to maximize my employability and offered me new research ideas for my post-doctoral studies.

#### 2. Description of the work carried out during the visit

This workshop covered a variety of topics relevant to my studies and future career.

*06 Sept 2014*

Arrival to Marseille, France

*07 Sept 2014*

The visit started with taking a shuttle bus to the venue at Observatoire de Haute-Provence, St. Michele (Fig.1) which is situated in the southeast of France, about 100 km north of Marseille. The Observatory was established in 1937 and the first astronomical observations were made in 1943. This particular location for the station was chosen because of its highly favorable conditions for making astronomical observations.

The first workshop activities included introductions to the venue, introductions of the lecturers and a 'soapbox' introduction round by the participants.



**Fig.1.** Venue for the workshop at Observatoire de Haute-Provence, France

As the first assignment, teams of three people for projects had to be defined. The project comprised of putting together a convincing and clearly arranged project proposal to apply for funding for your project. The deadline for turning in the proposals was in 5 days.

*08 Sept 2014*

The first commitment of the day was turning in the titles for the project ideas. The project of me and my team members was entitled 'Estimating the role of environmental policy and outsourced manufacturing in national carbon budgets'.

The official workshop started with an introduction about OHP and its facilities by I. Xueref-Remy followed by opening talks by representatives from COOPEUS project (COOPERation EU-US), ICOS and NEON by H. Loescher and L. Powers.

The day continued with a lecture about 'Ecosystem measurements and the related uncertainty and frontiers' by B. Gielen and H. Loescher.

The second half of the day was dedicated to working on the project proposals. The proposals needed to clearly state the following: 1) concept, rationale 2) objectives 3) detailed work plan, potential pitfalls 4) budget 5) management, deliverables and collaborations.

Late at night J. Patris, an astronomer working at OHP, taught us about open sky astronomy and took us on a visit to one of the four telescopes at the observatory. This particular telescope was the second largest at the station with a diameter of 1.2 m.

*09 Sept 2014*

The entire day was devoted to hands-on work using the R software. The two topics covered were:

1. 'ATM: trend analysis' by M. Schmidt
2. 'ECO: data mining on land-atmosphere fluxes' by M. Mahecha and J. Zscheischler

The more specific exercises of topic 1 were based on the built-in atmospheric CO<sub>2</sub> data set from Mauna Loa in the R program. We learned how to decompose a time series with the STL method, i.e. Seasonal and Trend decomposition using Loess (locally weighted scatterplot smoothing). STL has several advantages over the classical decomposition method such as being able to handle any type of seasonality, not only monthly or quarterly data. Also, we got familiar with using the curve fitting routine 'ccgcrv' and its algorithm based on the Mauna Loa data on CO<sub>2</sub> and Mace Head and Schauinsland data on CH<sub>4</sub>. ccgcrv applies the standard ccg curve fitting routines to a time series data set. This curve fit consists of a function fit to the data where the function is a combination of a polynomial and annual harmonics. The residuals from this fit are then smoothed using a low pass filter.

The second topic of the day included learning about steps in data mining when dealing with land-atmosphere flux data. The aim of the exercise was to investigate extremes extending over large spatial and temporal scales. We learned about the importance of pre-processing of data, the required steps and different analysis methods (forward and backward assessment).

*10 Sept 2014*

Day 4 of the workshop started with a lecture by F. Vogel on 'Using isotope measurements for flux estimations'.

The day continued with field trips, first to take part in the launch of an ozone (O<sub>3</sub>) balloon followed by visits to the brand-new ICOS tower and the O3HP Oak Observatory.

Regular ozone sonde measurements at OHP started already in 1984 and are performed on a weekly basis. The ozone sondes are equipped with a GPS and a suit of meteorological probes providing concurrent pressure, temperature and relative humidity data. Balloons can measure the change in O<sub>3</sub> concentration to an altitude as high as 40 km and can provide as much as several days of continuous coverage. Launching of the ozone balloon at OHP can be seen on Fig.2.



**Fig.2.** Time series of balloon filling and launching for airborne measurements of ozone concentration in the atmosphere with a balloon at Observatoire de Haute-Provence, France

In July 2014 a new 100 m ICOS tower for measurements of atmospheric concentrations of greenhouse gases was inaugurated at OHP (Fig.3).



**Fig.3.** ICOS tower and infrastructure for measurements of atmospheric concentrations of greenhouse gases at three levels (10, 50 and 100 m) at Observatoire de Haute-Provence, France

The tower is equipped with state-of-the-art instruments at three levels (10, 50 and 100 m) and measures the following parameters:

1. Weather station (wind, temperature, humidity)
2. Picarro gas analyzer ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{H}_2\text{O}$ )
3. Online air sampling ( $\text{N}_2\text{O}$ ,  $\text{SF}_6$ ,  $\text{H}_2$  and  $\text{CO}_2$  isotopes)
4. Online particle sampling
5. Webcam (development of vegetation)

The tower supplements the environmental measures started with the O3HP.

The Oak Observatory O3HP is a platform built in 2010 dedicated to the observation of phenology and physiology of the white oak (*Quercus alba*) which is considered to be a good indicator species to study climate change impact on the Mediterranean forest. The experimental design of O3HP enables to study the effect of rain exclusion on the development of the white oak in relation to the predicted lower precipitation rates in the near future due to climate change.



**Fig.4.** Oak Observatory O3HP with the rain exclusion experiment and related measurements at Observatoire de Haute-Provence, France

The day ended with a lecture by A. Chabbi about ‘AnaEE – Infrastructure for Analysis and Experimentation on Ecosystems’.

*11 Sept 2014*

The day was dedicated to hands-on work with data using the R software. The two main topics covered were:

1. ‘ECO: data assimilation and Bayesian approach in ecosystem models’ by M. van Oijen
2. ‘Carbon cycle data assimilation system’ by P. Peylin

Within topic 1 we learned how to deal with uncertainty optimally, how to combine probability distributions and about Bayesian methods in the earth system sciences. More specifically we learned how to carry out Bayesian Calibration of the two parameters of the straight line: slope and intercept. This calibration method is called the Markov Chain Monte Carlo (MCMC) using the Metropolis algorithm. In addition, we were taught how to carry out a Bayesian Model Comparison (BMC) and Bayesian model averaging (BMA) using the MCMC on a data set comprising of two variables: biomass and leaf area index.

The second topic included learning about the typical data streams that are used in Carbon Cycle Data Assimilation Studies. Also, we were shown how to carry out sensitivity analysis and how to search for the optimal parameter values. Then, we discussed and analyzed the potential of atmospheric data to optimize ecosystem model parameters through the link of atmospheric transport models. Finally, we learned about global optimization, i.e. how to combine multiple data streams and about the strengths and weaknesses of optimizing surface fluxes with atmospheric CO<sub>2</sub> data (classical atmospheric inversion) or with the underlying ecosystem model parameters used to estimate the natural surface fluxes.

The remainder of the evening was spent on working on the project proposals.

*12 Sept 2014*

The day started with a lecture about 'Monitoring vegetation at the global scale from remote sensing observations' by F. Baret. In the following hands-on session we tried to retrieve leaf characteristics from the leaf reflectance measurements and canopy characteristics from canopy reflectance measurements using the Matlab software.

This was followed by a talk by P. Ciais on the topic of 'Key uncertainties in the C cycle and the role of atmospheric monitoring in the next decade'.

The third lecture of the day was on 'LIDAR applications for carbon monitoring: atmospheric transport and vegetation structure' given by P. DeCola. Additionally, we were given a brief overview of the LIDAR technology and made real-time measurements at OHP.

The rest of the evening was spent on finishing up the proposal presentations.

*13 Sept 2014*

The final assignment of the workshop was presenting the project proposals. Each team made a short and convincing 5 min presentation about their project idea which was followed by a 5 min Q/A round. Afterwards, the jury decided on the winning project and gave feedback on the strengths and weaknesses of each proposal.

The visit ended with a wrap-up of the workshop, filling in feedback forms and taking the shuttle bus back to Marseille, France.

*14 Sept 2014*

Departure to Tallinn, Estonia

### **3. Description of the main results obtained**

The most important outcomes from attending the 'ICOS-NEON greenhouse gas data training workshop' for me can be summarized under the following three subsections:

#### *Data mining, data assimilation and Bayesian modelling*

Being familiar with data mining, data assimilation and Bayesian approaches is a very useful tool when dealing with large amounts of data. This is a topic that I had no earlier experience with and therefore I consider this to be one of the most influential lessons learned during the workshop.

#### *Putting together a project proposal*

Gaining experience and getting helpful tips from experienced scientists on how to put together a solid and convincing project proposal is another main outcome of my visit. I learned how



important it is to have clearly defined and convincing objectives that are also feasible to be carried out within the given project period, how to best structure the work packages and how to allocate time and finances.

### *Networking*

During my visit I had the opportunity to meet many interesting people, widen my academic network and obtain numerous contacts for possible joint research projects in the future. Furthermore, I obtained new ideas relevant to my work and received information on potential positions for post-doctoral fellowships.

To conclude, this was a very exciting opportunity that allowed me to significantly expand my current skill set and my scientific network which will be of benefit during the last year of my PhD as well as in my future research career.

## **4. Future collaboration with host institution**

Although no fixed collaboration plans were established, this visit nevertheless provided me many contacts and a set of opportunities for future post-doctoral studies and also for prospective research collaborations. The expertise and experience of the researchers and experts involved in networks such as *ICOS* and *NEON* but also in all of the other research institutions represented at this workshop (LSCE/IPSL, INRA-EMMAH, Sigma Space Corporation, CEH-Edinburgh etc.) was impressive and therefore I am very hopeful that my visit will foster collaborations in the future.

## **5. Projected publications / articles resulting or to result from the grant**

Not applicable

## **6. Other comments**

None