



## Scientific Report

The workshop/training course **“EddyUH: a software for eddy covariance flux calculation”** was held at the Kumpula Campus of University of Helsinki, Finland between 21<sup>st</sup> and 25<sup>th</sup> of January 2013. It was jointly organized by TTORCH. (funded by ESF), NORDFROST and the two Nordic Centres of Excellence DEFROST and CRAICC (funded by NordForsk). The workshop covered all aspects concerning eddy covariance (EC) technique, e.g. sensors, methods, post-processing, gap-filling. It consisted of lectures and practical work sessions, where the post-processing software EddyUH was used. The workshop hosted 18 participants from 8 different EU countries. Most of the participants were PhD students.

Special focus was given on post-processing protocol for water vapour, methane and nitrous oxide flux measurements, as well as on the extension of EC technique to aquatic ecosystems and urban areas.

The goal was in-line with one of the objective of TTORCH ESF Research Networking Programme, e.g. improving quality and consistency of non-CO<sub>2</sub> greenhouse gases measurements in Europe.

In particular, the following topics were covered:

- Introduction and theory of eddy covariance method.
- Extending EC technique to aquatic ecosystems and urban areas.
- EddyUH and rawdata post-processing (practical work and theory).
- Flux uncertainty and flux quality criteria.
- Flux gap-filling.
- Flux footprint.

All lectures given during the workshop are available on the webpage:

[http://www.atm.helsinki.fi/Eddy\\_Covariance/EddyUHcourse.php](http://www.atm.helsinki.fi/Eddy_Covariance/EddyUHcourse.php)

Most of lecturers were from the Micrometeorological group of University of Helsinki.

Prof. Anna Rutgersson from University of Uppsala was invited as guest lecturer. She is an international recognised expert on marine and lake ecosystems gas exchange dynamics.

Complete list of lecturers: Prof. Timo Vesala (University of Helsinki), Prof. Anna

Rutgersson(Uppsala University), Ullar Rannik (University of Helsinki), Olli Peltola (University of Helsinki), Sigrid Dengel (University of Helsinki), Annika Nordbo (University of Helsinki), Pasi Kolari (University of Helsinki), Ivan Mammarella (University of Helsinki).

A presentation session was also organized. The following participants gave a 20 min presentation, followed by a discussion session:

- M. Fischer, “The comparison of eddy covariance and Bowen ratio energy balance method for measuring the latent and sensible heat fluxes above high density poplar stand”
- L. Šigut, “Improvement of CO<sub>2</sub> eddy fluxes modelling in topographically complex terrain”

- D. Barantiev, “Boundary layer structure during sea breeze conditions at Ahtopol, Bulgaria”
- T. M. Ruuskanen, “Fluxes of Volatile Organic Compounds over Boreal Forest”
- A. Agueda Costafreda, “ Eddy covariance system and first measurements at the Ebre river Delta station ”
- M. Jammet, “Contrasting methane dynamics in a changing subarctic mire as seen by eddy covariance measurements”

The workshop/training course was overall successful, resulting in a very positive feedback from the participants

*1-Strongly disagree, 2-Disagree, 3-Unsure, 4-Agree, 5-Strongly agree*

OUTCOME	Average Rate
The course broadened my understanding of concepts and principles in the field	4.5
The course improved my ability to carry out original research in the field	4.5
The course taught me techniques directly applicable to my career	4.4
The material presented in the course was relevant to my research	4.4
LECTURES	Average Rate
The instructors' knowledge of the subjects was good.	4.9
The instructors explained the material well.	4.6
The instructors were prepared for the lectures.	4.8
The lectures were coordinated between instructors.	4.7
Lectures incorporated recent developments in the field.	4.7
The range of lectures captured the overall essentials of the field.	4.5
The level of the lectures was appropriate.	4.2
Instructors stimulated my intellectual curiosity.	4.4
PRACTICAL SESSION	Average Rate
The practical sessions were important for the learning process in the course	4.8
The use of EddyUH improved my understanding of the lectures.	4.5

The practical sessions were long enough.	4.2
The practical sessions were coordinated with the lectures.	4.5
OVERALL SATISFACTION	Average Rate
Overall, the course met my expectations.	4.8
The course was well organized.	4.8
The balance between lectures and hands-on sessions was optimal.	4.5
The course addressed my research needs.	4.2

The discussion sessions during the workshop were very fruitful. New methods and advancements for the standardization of the post-processing of EC flux data were presented and discussed (see, for instance, the lectures by Nordbo on urban flux measurements and Dengel on CH<sub>4</sub> flux gap-filling). Several joint studies/papers have been jointly planned between the lecturers and participants. Any future publications will acknowledge ESF for supporting such activities.

# Final programme

Monday 21.01.2013

14.00 – 14.30 Welcome and Introduction to the workshop (Ivan Mammarella)

14.30 – 15.15 Eddy covariance fluxes: basic concepts and background (Prof. Timo Vesala)

15.15 - 15.30 Coffee break

15.30 – 16.15 Eddy covariance fluxes: basic concepts and background (Prof. Timo Vesala)

16.15 -17.00 Downloading, installing and testing EddyUH on trainee's computers (Ivan Mammarella/Olli Peltola).

Tuesday 22.01.2013

09.15 – 10.30 EC system design, set-up and calibration (Sami Haapanala/Sigrid Dengel)

10.30 - 10.45 Coffee break

10.45 – 11.30 EC raw data post processing (Annika Nordbo)

11.45 – 12.45 Lunch

12.45 – 14.00 Practical work with EddyUH: Setup and run pre-processor (Olli Peltola/ Ivan Mammarella )

14.15-15.00 Energy and gas exchange in urban area. Experience from EC measurements in Helsinki, Finland (Leena Järvi)

15.00 - 15.15 Coffee break

15.30 – 16.15 Visit to SMEAR III urban measurement station in the University Campus (Leena Järvi & Annika Nordbo)

16.15 – 17.00 Practical work with EddyUH: spectral analysis and planar fit tools (Olli Peltola/ Ivan Mammarella)

Wednesday 23.01.2013

09.15 – 10.15 Flux corrections (Ivan Mammarella)

10.30 - 10.45 Coffee break

10.45 – 12.00 Energy and gas exchange in aquatic ecosystems ( Prof. Anna Rutgersson)

12.15 – 13.15 Lunch

13.30 – 15.15 Practical work with EddyUH: Lag times and transfer functions (Olli Peltola/ Ivan Mammarella)

15.15 - 15.30 Coffee break

15.30 - 17.00 Flux gap-filling methods(Pasi Kolari/ Sigrid Dengel)

Thursday 24.01.2013

09.15 – 10.30 Scientific presentations by the participants (20 min each)

10.30 - 10.45 Coffee break

10.45 – 12.00 Scientific presentations by the participants (20 min each)

12.15 – 13.15 Lunch

13.30 – 14.15 Flux uncertainty and quality criteria (Ivan Mammarella)

14.15 – 15.00 Practical work with EddyUH: calculate final flux values (Olli Peltola/ Ivan Mammarella)

15.00 - 15.15 Coffee break

15.30 – 16.30 Practical work with EddyUH continues ... (Olli Peltola/ Ivan Mammarella)

18.00 - workshop dinner downtown.

Friday 25.01.2013

09.15 – 10.30 Practical work with EddyUH (Olli Peltola/ Ivan Mammarella)

10.30 - 10.45 Coffee break

10.45 – 11.45 Footprints (Üllar Rannik)

11.45 – 12.15 Summary and conclusion of the course/workshop (Ivan Mammarella)

### **Presentations by the participants:**

- Milan Fischer “The comparison of eddy covariance and Bowen ratio energy balance method for measuring the latent and sensible heat fluxes above high density poplar stand”
- Ladislav ŠIGUT “Improvement of CO<sub>2</sub> eddy fluxes modelling in topographically complex terrain”
- D. Barantiev “Boundary layer structure during sea breeze conditions at Ahtopol, Bulgaria”

### Coffee break

- A. Agueda Costafreda, “ Eddy covariance system and first measurements at the Ebre river Delta station ”
- M. Jammet, “Contrasting methane dynamics in a changing subarctic mire as seen by eddy covariance measurements”
- T. M. Ruuskanen “Fluxes of Volatile Organic Compounds over Boreal Forest”

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