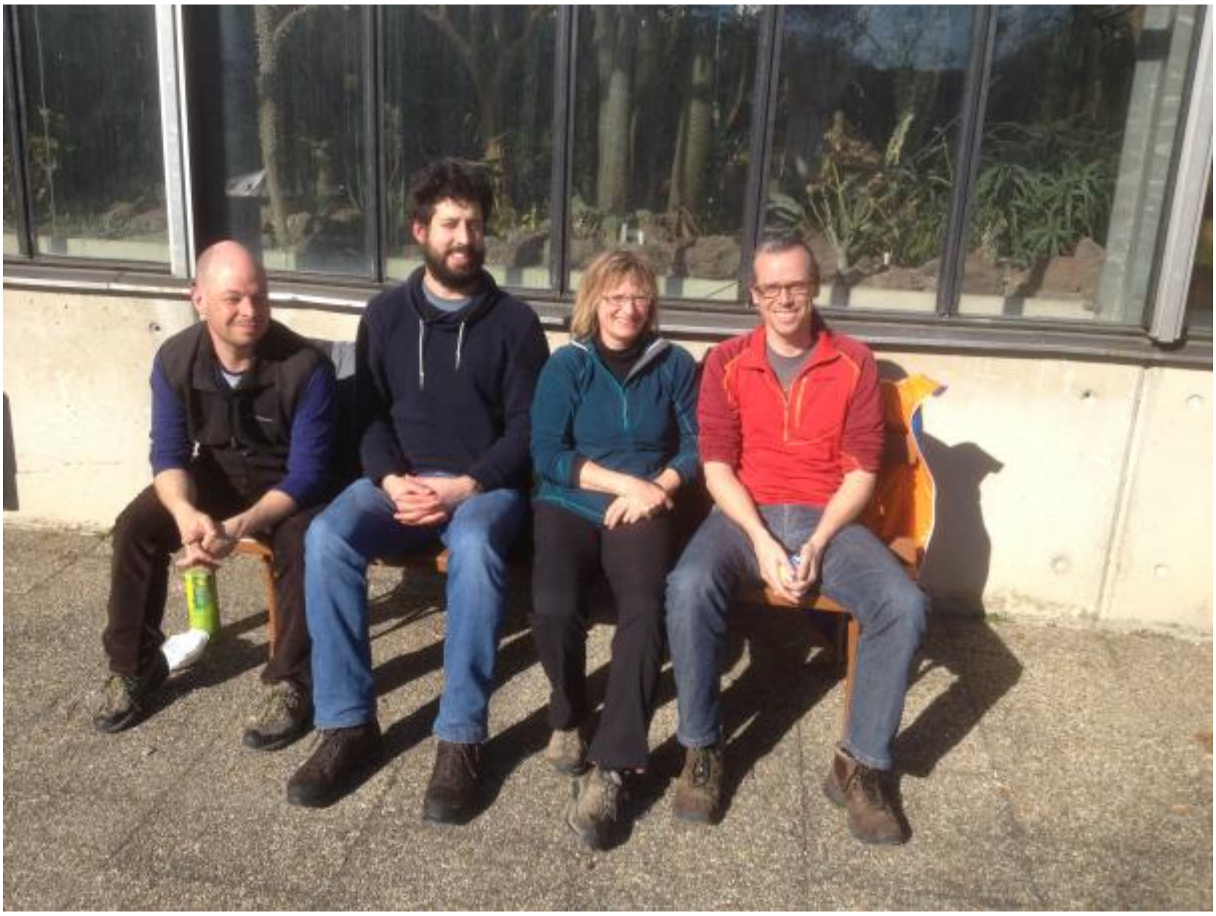
COST action OPTIMISE footprint modelling expert workshop

Place: University of Innsbruck

Dates: 13-17.02.2017

Participants: Natascha Kljun (Swansea Univ., UK), Enrico Tomelleri (EURAC, Italy), Georg Wohlfahrt (Univ. of Innsbruck, Austria), Tarek El-Madany (MPI Jena, Germany; not funded by COST)



(from left to right: Enrico Tomelleri, Tarek El-Madany, Natascha Kljun, Georg Wohlfahrt)

Rationale

One of the main themes of the COST action OPTIMISE is linking eddy covariance flux measurements of trace gases such as carbon dioxide or water vapour with proximal optical sensing data. The key difficulty in this context is a major difference between the flux footprint of eddy covariance measurements, that is the area from which the measured flux originates, and the footprint, more commonly termed field-of-view, of proximal sensing measurements. The footprint of eddy covariance flux measurements is typically much larger, on the scale of hundreds of meters, and variable in time, due to changing environmental conditions, the footprint of proximal sensing measurements in contrast is typically much smaller, on the scale of meters, and fixed. While these issues cannot be entirely avoided, they can be minimised by placing proximal sensing instruments in a way to ensure that the area that contributes most to the flux footprint is sampled.

The objective of this workshop was to develop a web-based tool that would allow OPTIMISE members and the entire scientific community to determine for any arbitrary flux site the optimal location for their proximal sensing instruments in a user-friendly fashion.

Approach

The eddy covariance flux footprint is calculated based on the model by Kljun et al. (2015). To this end the user has to upload a file with measurements of the necessary input variables measured at some site. The model then calculates a 'footprint climatology', that is the contribution of the area around the flux tower to the flux over extended periods of time (as defined by the length of the user-uploaded time series). This footprint climatology is then convolved with an unsupervised land cover classification based on Sentinel-2 remote sensing data. The key output here is then a graphical representation of which land cover type contributes most to the flux and where the pixels for optimal proximal sensor placement are located. Additional outputs include the data underlying the flux footprint climatology (for further processing by the user) as well as further graphical output highlighting the land cover distribution in the flux footprint.

Preliminary results

Figure 1 gives an impression of the Sentinel-2 data used for the unsupervised land cover classification, which is shown in Figure 2.

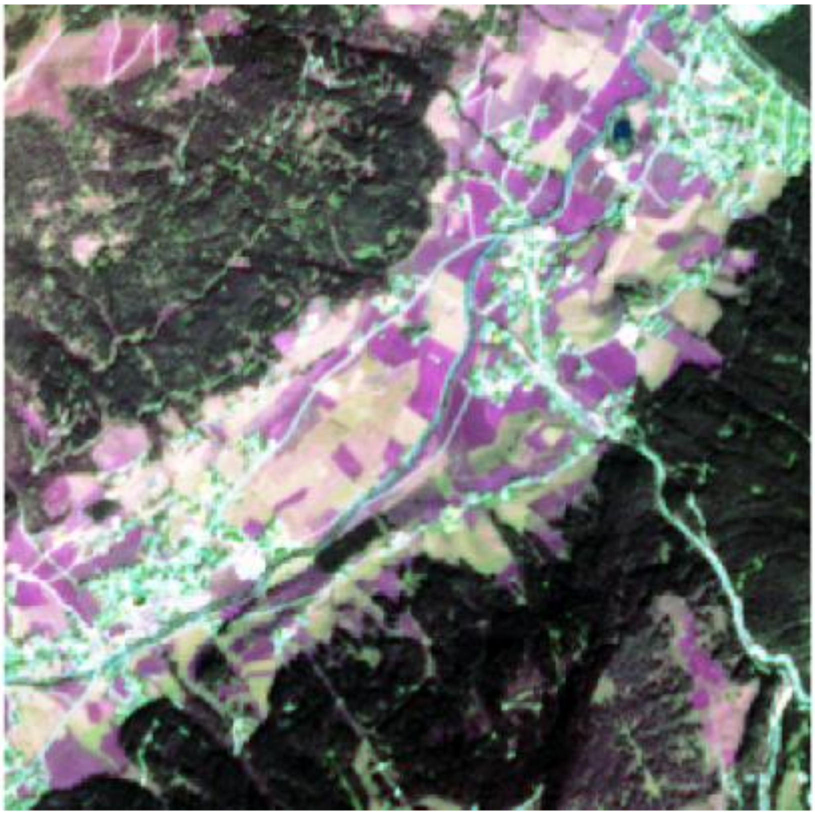


Figure 1 False-colour image based on Sentinel-2 bands 4, 3 and 2 for the area surrounding the AT-Neu flux tower (in the centre of the picture).

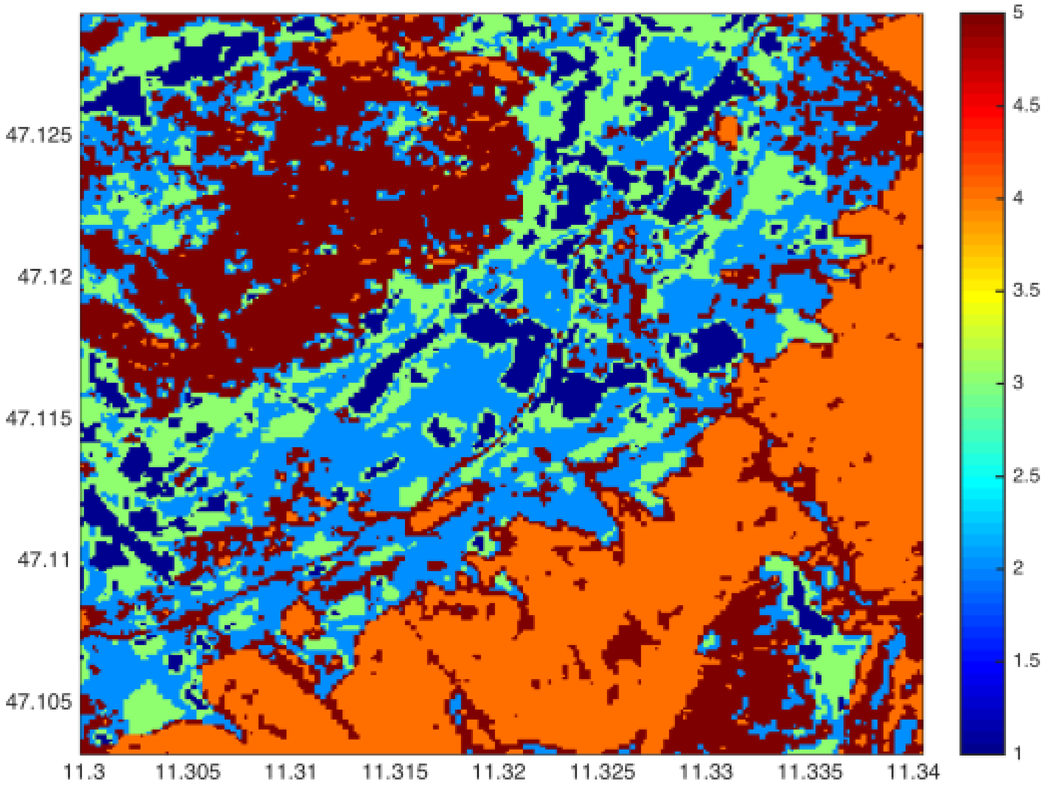


Figure 2 Results of unsupervised land cover classification (5 land cover types) for the scene shown in Figure 1.

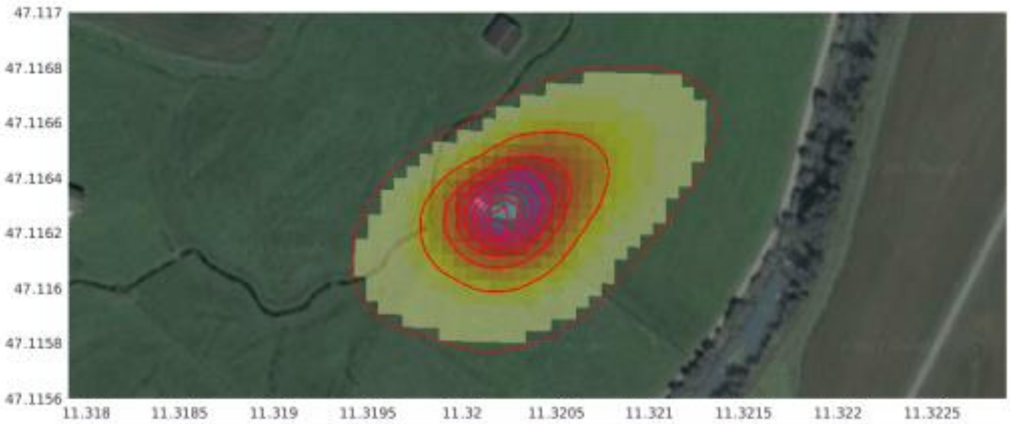


Figure 3 Flux footprint climatology (for May 2015) for the site AT-Neu. Contour lines and color-coding refer to different contributions to the total flux footprint climatology (outer contour line representing the 90 % contribution, the innermost contour line 10 %).

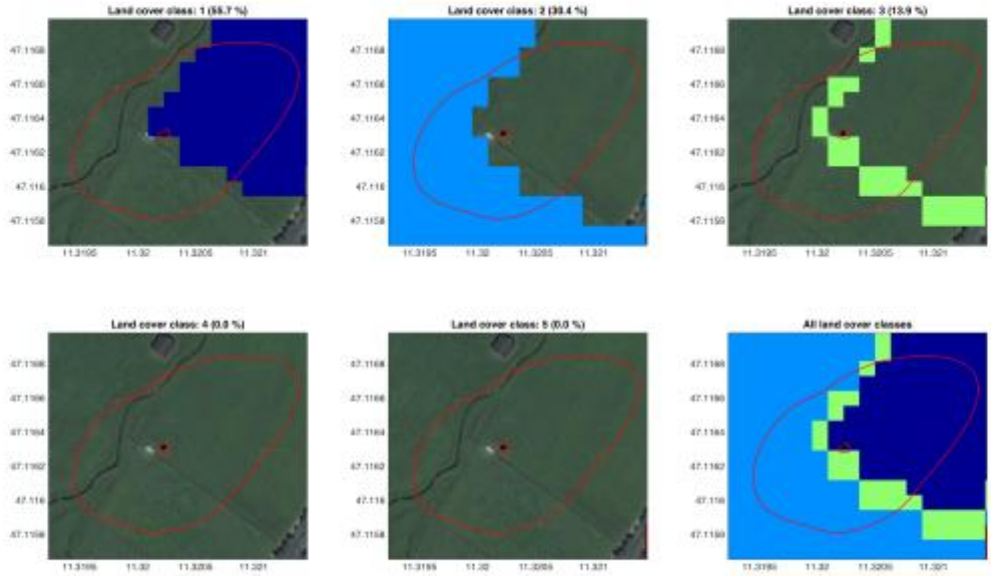


Figure 4 Footprint climatology (10 % and 90 % contour lines in red colour) around the AT-Neu flux tower (black) dot with the area taken up by the five land cover types (percentage within 90 % contour lines indicated in header).

The flux footprint climatology is shown in Figure 3. The contour lines indicate 10 % to 90 % contributions. The area enclosed by the 10 % contour line would be ideal for sensor placement.

The results of merging the land cover classification with the flux footprint climatology are shown in Figure 4. It can be seen that at the site AT-Neu there are two major land cover classes in the long-term flux footprint (classes #1 and #2). However, most of the flux footprint, as indicated by the 10 % contour line, comes from close to the flux tower. This area is shared between land cover class #1 and #3, as shown in more detail in Figure 5. Given that land cover class #1 is most representative for the overall (90 %) footprint, the optimal proximal sensor placement is in land cover class #1 within the 10 % contour line (Figure 5).

The same analyses have been carried out for a flux tower in a Mediterranean savannah in Spain and a coniferous forest in Sweden (not shown) in order to test the algorithms under a wide range of conditions.

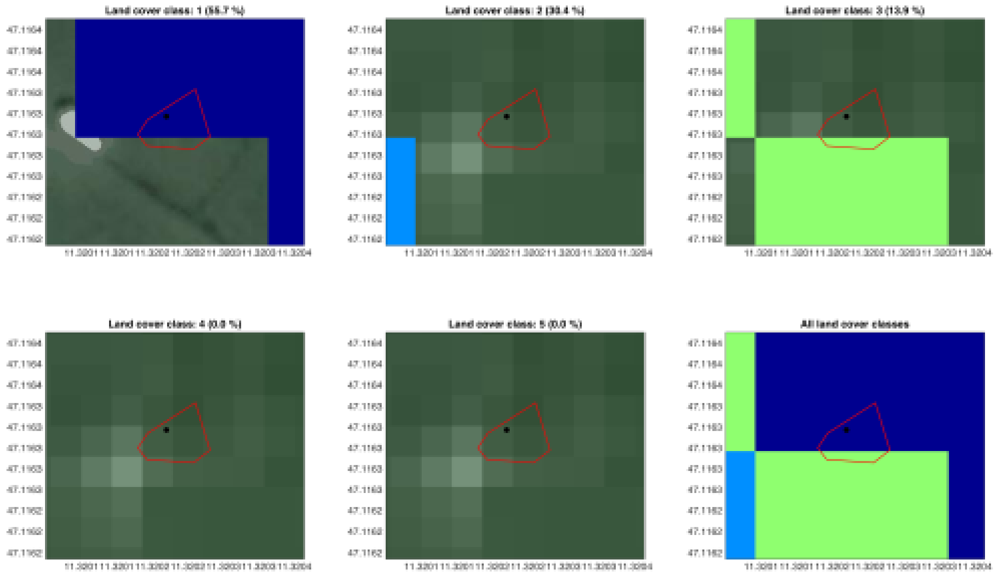


Figure 5 Zoom into Figure 4.

Outlook

At present, Sentinel-2 data are used in a static fashion due to difficulties with dynamically downloading and sub-setting Sentinel-2 data. This means that at present analyses can be carried out only for predefined sites, an issue which will be solved in the future. Tests using RGB data from Bing.maps, which would allow dynamic linking and subsetting, instead of Sentinel-2 are presently explored, also because of the better spatial resolution. Development and testing of the web interface is ongoing as well and will need to be continued into the future. Once extensively tested, the web tool and corresponding web link will be widely advertised and distributed.

Presentations during workshop

- Tomelleri Enrico: *From Ground to Satellite: on the Use of Hyper-Spectral UAV-borne Data for Linking Scales*
- El-Madany Tarek: *Footprints in Savannas – merging hyperspectral data and footprints to estimate spatial heterogeneity*
- Kljun Natascha: *Application of footprint models*
- Wohlfahrt Georg: *On linking flux measurements and proximal sensing*