SPECTRAL SAMPLING TOOLS FOR VEGETATION BIOPHYSICAL PARAMETERS (BP) AND FLUX MEASUREMENTS IN EUROPE: THE NEW EUROPEAN ES0903 COST ACTION

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The estimate of carbon sequestration by terrestrial ecosystems and the prediction of the global change impact on the ecosystem carbon balance are urgent needs required by international agreements. To support the development of this knowledge, a deep insight into processes that regulate carbon exchanges between terrestrial ecosystems and the atmosphere is fundamental (Baldocchi et al., 2001). Flux towers remain a primary tool for understanding ecosystem carbon fluxes within the global flux networks. International initiatives such as SpecNet are developing to fill the temporal and spatial gap between ecosystem measurements and remote sensing by means of scale-appropriate optical measurements (Gamon et al, 2006). The linkage of ecosystem fluxes measured with the eddy covariance technique, biophysical parameters measurements and remotely sensed information can be considered as the most promising method for scaling up ground observations (Gianelle et al, 2009).

In this framework, a new EU COST Action project is starting in Europe (February 2010-2014; http://w3.cost.esf.org/index.php?id=205&action_number=ES0903). Up to now, 9 European countries are participating to the Action. The COST Action project is open: researchers from European Cost Countries, but also from Near-Neighbour and non-COST countries can participate to the Action and, in some cases, can obtain some specific national funding (Australia, New Zealand, South Africa). This paper illustrates the Action objectives, focusing on the Action main activities, and giving some examples of the COST spectral optical sampling approach.

At present, a full integration of remote sensing information and ecosystem level carbon fluxes has not been achieved, although several international initiatives have been developing in the last years with this objective (e.g. SpecNet, http://spectralnetwork.net/).

Recognizing the importance of plant phenology and of the linkage between remote sensing and eddy covariance, the international flux (Fluxnet) and the European networks (CARBOEUROPE-IP project) recently suggested continuous measurements in the standard measurement protocol, which is also highlighted by Huemmrich et al. (1999).

According to the highlighted scientific questions and problems, the objectives of ES0903 are i) to analyse the state of the art of the optical sampling research in Europe, ii) to standardize tools and methods in the optical sampling measurements, iii) to focus on the fluxes and biomass estimation problems as an input to the technological world for development of new sensors and iiii) to involve the scientific instruments industries in designing and testing a common multi-band reflectance sensor for ground optical measurements in the European flux network.

The COST Action ES0903 is focusing on 4 main Working Groups: Networking, Intercomparison, New Instruments and Upscaling.

Network

In order to build up a diffuse European spectral sampling network, European scientists currently working in the optical sampling of fluxes are invited to participate to the COST Action. A complete list regarding the optical sampling activities carried out within the different research teams (Both EU and non-EU) will be prepared during the first year of the activities. The list will include: i) researchers involved in the activities ii) BP investigated (biomass, LAI, water content, nitrogen content, chlorophyll content, green to total biomass ratio, etc) and detailed protocols (tools adopted, sampling spatial organisation, laboratory measurements iii) optical sampling adopted tools (spectroradiometers, aircraft sensors, satellite sensors) and protocols iv) data years collection, dates, frequency of data collection (continuous, episodical measurements, summer or all year round measurements), available metadata, data public availability v) relevant publications of the research teams vi) future activities planned by the research teams

FIG 1: the COST ES0903 network (as in December 2009). The COST Action projects are open and any country can join the network at any time.

Comparisons
One of the main limitations of the optical approach is related to data and sensor intercalibration and intercomparison issues. Despite the recognised need for calibrated and comparable spectral information, spectral datasets collected from proximal remote sensing methodologies are often non-comparable due to a range of factors, notably: different instruments with varying spectral resolutions and radiometric sensitivities; varying foreoptics which give rise to differing “spot sizes” and hence variations in field-of-view (FIG. 2); preference by different research groups to use different measurement methodologies including bi-conical, cos-conical, dual- or single- sensor head systems; and lack of appropriate metadata on the above characteristics and antecedent environmental conditions during measurement sequences.

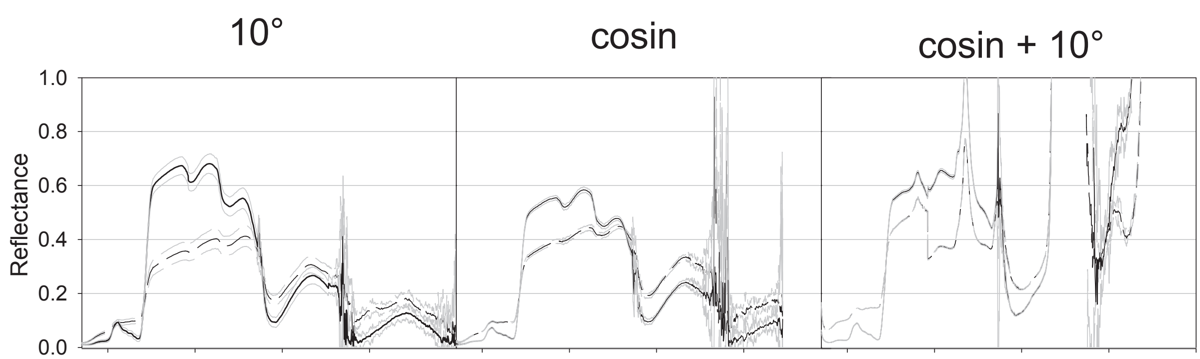

FIG 2: Grassland reflectance (mean and standard deviation) measured at Monte Bondone (Italy) at the beginning (dotted line) and at the end (solid line) of the vegetative period with 3 different methods: 10° foreoptics vs. reference panel, cosine radiance vs. irradiance and 10° foreoptics vs. cosin irradiance. Measurements were carried out using a ASDI Fieldspec spectroradiometer.

Instruments

According to all the aforementioned aspects related to the advanced optical sampling networks, the use of a new (or upgraded) standardised narrow-band multispectral low cost instrument for continuous measurements over a wide range of ecosystems within the eddy covariance flux network is particularly important. At the moment, only a limited number of instruments with similar characteristics are available on the market (e.g Skye, Cropscan, etc.; see FIG 3) and their performances need to be improved to meet the scientific community needs. The standard instrument would provide a common tool for the eddy covariance network and would form the basis of a baseline, traceable, and reliable standard from which reproducible optical measurements could be made. In addition, the instrument use would be of interest across different networks, related to ecosystem modelling, global change observations, phenology monitoring, soil science, and fire risk studies, for example. The Action will be an important input for the industries involved in the spectroradiometry field. The integration between research and technology is expected to boost the optical sampling instrumentation standard of the optical sensing network

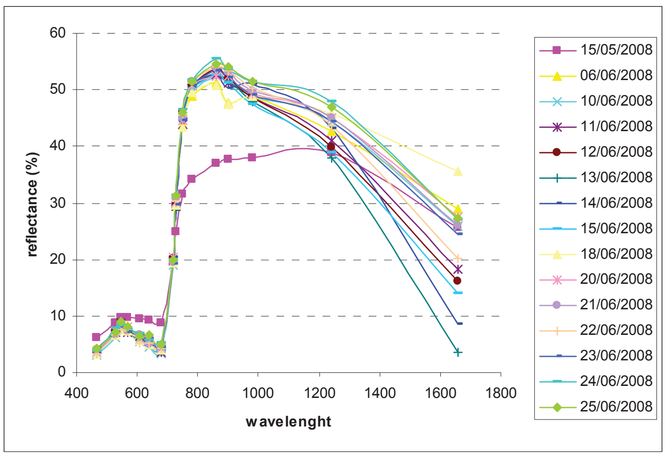

FIG 3: Cropscan MSR 16 daily measurements (10 AM) at Monte Bondone (Italy). MSR 16 allows to acquire 16 bands reflectances values in the VIS-NIR domain on a continuous basis.

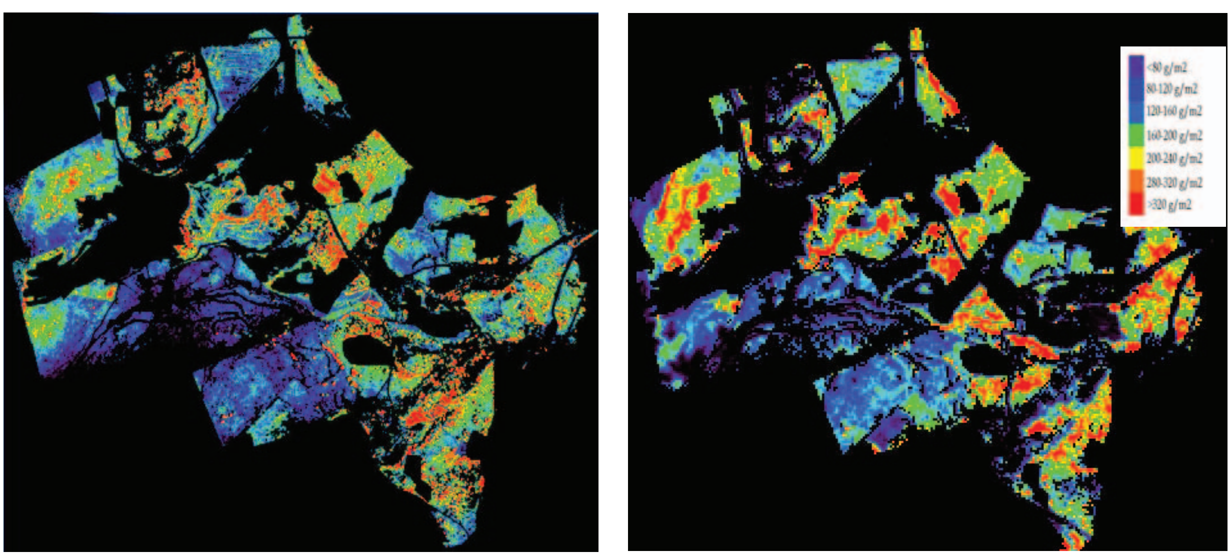

FIG 4: Grassland biomass maps of the Viote del Monte Bondone area obtained from a ASPIS sensor image (left; 1 m spatial resolution) and a SPOT image (right, 10 m spatial resolution).

Upscaling

Mapping vegetation biophysical parameters is fundamental to understanding ecosystem functioning. Considerable time and expense are commonly spent measuring these variables which need to be scaled up from ecosystem to landscape level to monitor productivity, carbon stocks and fluxes. (FIG. 4) In this framework, site level measurements will be compared with remote sensing products in order to investigate possible strategies to spatialise the point measurements, involving physiological indices models (Photochemical Reflectance Index) or the integration of spectral vegetation indices into more complex biogeochemical models.

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