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Interactive Comment

Interactive comment on "EUROSPEC: at the interface between remote sensing and ecosystem CO_2 flux measurements in Europe" *by* A. Porcar-Castell et al.

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The paper represents a review of achievements and conclusions derived from the EUROSPEC COST activity, and contains relevant recommendations for implementation of networks of proximal optical measurements in flux towers to complement/validate satellite data in the context of global carbon cycle research.

The content of the paper can probably be taken as a reference in the field, particularly due to the useful recommendations provided towards the implementation of a network of optical spectral measurements, operated in continuous mode in association with flux tower sites and other ecological monitoring sites, serving then as a tool for the validation of modelling approaches and other type of observations, particularly satellite data. The review character of this contribution makes this paper quite relevant and of general interest.

The structure of the paper is adequate and in general it is quite well written. The main aspects in the paper are the identification and description of the sources of variability in the measurements and the derived recommendations. Three sources of variability are described, but one source of variability which is only indirectly addressed, and which is critical for this type of measurements, is the temporal stability in the measurements and temporal stability in calibration. Issues such as the heating of instruments along a diurnal cycle can bias the measurements, as well as long-term drifts in instrument behaviour of instrument calibration. Given the experience of the authors during EUROSPEC and related studies, it would be adequate to show more explicitly (maybe through a new dedicated Section 3.2.4) how relevant are such stability effects, quantifying the changes experienced. Temperature-controlled equipment is complex and expensive, and guidelines can be provided on when such temperature stability becomes more critical and when other simple methods can be used, giving guidelines about the amount of error that would be expected. At the same time, it would be adequate to indicate the different stability effects on absolute terms and on relative inter-band calibration (i.e., for multispectral sensors, indicate which bands or spectral ranges are more sensible to instabilities). Some indication about the frequency needed for cross-calibration of instruments, typical order of magnitude of the accuracy in radiometric calibration achieved for these types of instruments, typical temporal drift of calibration, etc. can be details than can provide more quantitative information useful for the readers.

Section 3.2.3 is named “Field-of-view heterogeneity”, which seems to be related to the heterogeneity of observations inside the field of view of the instrument. In fact, the description is not about surface heterogeneity within the field-of-view, which is unavoidable at all observation scales and depends very much on the objective of the measurements. What is addressed in Section 3.2.3 corresponds in fact to two different issues: (a) the knowledge of the actual instantaneous field-of-view (optical) of the instrument, related to the PSF/MTF and related optical characterization, basically given by a 2D response function over the observation area; and (b) the case of sensors having focal-plane separation of spectral bands (either by the spatial disposition of detector in the focal plane, or by aberrations in the optical acquisition of the signal), causing that the instantaneous field-of-view is different for each spectral band. The first aspect (a) can be compensated by a dedicated laboratory characterization of the instrument for any kind of design, while the second aspect (b) requires a proper design of the instrument. Implications are different and have different impact on the data processing and interpretation.

An aspect which is not discussed in the paper, and that becomes essential to analyse scaling issues from single flux tower measurements to spatially continuous remote sensing data, is the role of spatial statistics and statistical sampling issues. Ground sampling following statistical basis is essential to properly formalize a mean value for the averaged measurement and the associated statistical error, which depends on the sampling strategy followed. The opportunity to use UAVs in such ground sampling provides a method to follow different possible statistical sampling procedures of the ground area (tower footprint) or the remote sensing pixel. Some comment about statistical background should be included when analysing upscaling aspects in Section 3.4.

Box 1 is particularly relevant, but some potential changes can be implemented: (a) Change "high signal to noise" by "High signal-to-noise ratio" (b) Change "Ideal cosine directional response function" by "Optimal cosine directional response function" (the ideal one is probably not achievable) (c) The "Low temperature-sensitivity" condition probably means thermal stability in the measurements (for a temperature sensor one would like to have high temperature sensitivity!) (d) "Operating temperature range matching the wide thermal distribution of terrestrial plant species" means in fact the

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range of environmental conditions, but probably for a given site the overall range is more limited than the overall range when all potential sites are considered together. No necessarily every single instrument will operate in the full range of conditions. This can be clarified.

In Table 1, for SFOV it is stated "Need for temperature control to derive radiometric quantities in absolute units", but in fact the temperature control does not guarantee calibration in absolute units. Here reference should be to consistent time series of measurements, but not necessarily absolute units, which imply calibration to a reference. The same is true for DFOV given as "Need to temperature control to derive both radiometric quantities in absolute units and reflectance ratios". Difference between absolute units (calibration to a reference) and temperature control for stability (consistency in calibration) should be clarified.

Also in Table 1, it is stated that hyperspectral systems have "Option to process the data with radiative transfer models", but this is true for all data type, multispectral or hyperspectral, and not exclusive of hyperspectral.

In page 13078, lines 22-23 it is stated that "Spectral measurements can be classified into multispectral or hyperspectral depending on the number of bands." In fact, the number of bands is a bad criteria to classify sensors, and has been misleading sometimes. Better refer to spectral resolution versus spectral range covered, contiguous spectral coverage versus discrete coverage, etc.

Figure 2 is not particularly appropriate. As it is, it looks like multispectral data (discrete data) is a subset of the continuous sampling (same Gaussian response, but different number of Gaussians). In fact, discrete cases tend to be wide filters that show a response far from a Gaussian. The continuous case shown corresponds typically to a spectrometer, but the discrete case looks like the case where some bands of the spectrometers are used (i-e, case of MERIS or OLCI). The general case, however, is not the one illustrated in the figure.

Some other minor editorial aspects:

Page 13071, line 21: change "carbon cycle" by "terrestrial components of the carbon cycle", or "terrestrial carbon balance" or more directly "GPP". The problem comes from the fact that carbon cycle includes other temporal and spatial scales and contains also carbon exchanges in oceans, etc., just to be more precise.

Page 13074, line 20: change "recent technological and technical advances" by "recent technical advances"

Page 13078, line 12: change "down-welling and up-welling reflectance" by "down-welling and up-welling radiances"

Page 13080, line 22: change "in situ field measurements to measure. . ." to avoid word repetition.

Page 13081, line 1: change "at or off-nadir" (not clear the meaning, should be "at nadir or off-nadir" ?)

Page 13083, line 21: change "Because the situation where the same sensor is used in all sites is not. . ." by "Because the use of the same type of sensor in all sites is not. . ."

Page 13084, line 25: change "instrument readout" by "instrument readout time"

Page 13085, line 14: change "angular-dependent time degradation" by "angular-dependent time degradation at such wavelengths".

Page 13086, line 7: change "the response across that area is the same at all points" by "the response across that area is the same for all points inside the given FOV".

Page 13086, lines 14-15: change "Even when less optically complex spectrometers, measuring only across the VNIR region are considered, the Earth Surface. . ." by "Even when less optically complex spectrometers are considered, for instance measuring only across the VNIR region, the Earth Surface. . ."

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Page 13087, line 13: change “science and industry was suggested” by “science and industry was suggested, particularly to produce prototypes for new instruments”

Page 13094, line 22: change “resolution” by “resolutions” (plural)

Page 13095, line 13: change “Network” by “network” (no need for capital)

Page 13095, line 25: change “Tools” by “tool” (no need for capital)

Page 13096, line 3: change “Networking” by “networking” (no need for capital)

Page 13097, line 1: change “has” by “have”

Page 13098, line 24: here the word “drones” is used, when previously they were referred as UAVs or RPAs. Better use a consistent wording or clarify differences, if any, between drones and UAVs.

Page 13099, line 5: change “community” by “communities”

Figure caption of figure 2: change “spectra” by spectral”.

In Table 1, Configuration hemispherical-conical: change “Small Sampling area” by “Small sampling area”.

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