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1-2 PLENARY: UPDATES FROM SPACEBORNE IMAGING SPECTROSCOPY MISSIONS

THE FLUORESCENCE EXPLORER (FLEX) MISSION: IMAGING SPECTROSCOPY IN VERY HIGH SPECTRAL RESOLUTION

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Abstract

The FLuorescence EXplorer (FLEX) mission was selected in 2015, by the European Space Agency, as the 8th ESA Earth Explorer, to be launched in 2025. The key scientific objective of the mission is the quantitative mapping of actual photosynthetic activity of terrestrial ecosystems, at a global scale and with a spatial resolution adequate to resolve land processes associated to vegetation dynamics. To accomplish such objective, the FLEX satellite carries the Fluorescence Imaging Spectrometer (FLORIS). FLEX will fly in tandem with Copernicus Sentinel-3 (same orbit at 815 km, 27 days repeat cycle). Together with FLORIS, the OLCI and SLSTR instruments on Sentinel-3 provide all the necessary information to retrieve the emitted vegetation fluorescence, including compensation for atmospheric effects and the derivation of the additional biophysical information needed to map the spatial and temporal dynamics of vegetation photosynthesis from such global measurements.

The FLORIS instrument provides images with a 150 km swath and 300 m pixel size. By using two combined imaging spectrometers, FLORIS will measure the radiance between 500 and 780 nm with a spectral sampling of 0.093 nm (HR spectrometer) and 0.6 nm (LR spectrometer), with high spectral resolution of 0.3 nm in particular at the Oxygen-A (755-780 nm) and -B bands (677-697 nm). It will also cover the photochemical reflectance features between 500 and 600 nm, the variable chlorophyll absorption from 600 to 677 nm, and the red-edge from 697 to 755 nm. The specific information provided by the FLORIS instrument includes the full-spectrum of fluorescence emission in the range 650-780 nm, to account for dynamical changes in the shape of fluorescence emission spectrum induced by stress factors, and the spectral variability in surface reflectance in the 500-600 nm spectral range indicative of chemical adaptations in regulated heat dissipation, to estimate the amount of energy dissipated by non-radiative processes.

FLEX will provide validated ready-to-use high-level science products that can be directly used by vegetation dynamical models, climate models and applications. Efforts are put in place to guarantee proper Cal/Val activities and dedicated validation networks. The FLEX Level-2 products are already provided in the same geographical grid as Sentinel-2 products to facilitate multi-mission data exploitation strategies. Usage of common global multi-resolution spatial grids for high-level L3/L4 products maximizes the inter-operability of FLEX products in global data assimilation approaches and multiple applications. Particular efforts are in place to provide each product with realistic and properly estimated uncertainties, and also to propagate the derived uncertainties from the original satellite data until the final high-level products.

Most of the technical issues, spectral and radiometric corrections and retrieval strategies, are common to other imaging spectroscopy missions, but some effects have to be taken more carefully given the very high spectral resolution. Atmospheric corrections and compensation for spectral distortions are specially challenging in the case of FLEX, because the information used in FLEX is just coming from such little spikes in surface apparent reflectance which are taken as noise and spectrally smoothed in other imaging spectroscopy missions.

The legacy of FLEX for imaging spectroscopy will benefit from the lesson learned about characterization of such atmospheric effects and spectral correction methods, but also from the developments of new leaf/canopy radiative transfer models, coupling structural, biochemical and physiological effects, and new techniques for the

retrievals of new vegetation products from such spectral observations. The End-to-End mission simulation tools, and the advances in dedicated Cal/Val activities with robust statistical approaches developed for FLEX, will also be beneficial for future imaging spectroscopy missions.