INLAND WATER CONSTITUENT RETRIEVAL WITH THE APEX IMAGING SPECTROMETER

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APEX (Airborne Prism EXperiment) is a flexible airborne imaging spectrometer mission simulator and calibrator for existing and upcoming or future space missions. It is operating between 380 and 2500 nm in 313 freely configurable bands, up to 534 bands in full spectral mode. Besides general applications development and research, the system is foreseen to carry out experiments for e.g. ESA Sentinels II and III, the evaluated Explorers FLEX (Fluorescent Explorer) and TRAQ (Tropospheric Composition and Air Quality), the German national initiative ENMAP (Advanced Hyperspectral Mission), and the South African MSMI (Multi Sensor Micro satellite Imager) among others [1]. The first APEX test flights have been performed in June 2009 and it is expected that APEX will be operationally available to the user community in 2010. Several data exploitation projects are currently evaluating the potential of APEX for all kinds of remote sensing applications.

As far as water constituent retrieval is concerned, a joint Belgian-Swiss project is targeted at several aspects of imaging spectrometry of case II waters, such as the evaluation and intercomparison of reference measurement methods, a sensitivity study of aquatic and atmospheric model parameters, the limitations due to sensor noise and it's propagation to the final water constituent products or the evaluation of innovative retrieval algorithms.

Two dissimilar inland water bodies were chosen for the first APEX test flights: The highly turbid Scheldt estuary near Antwerp (Belgium) and oligotrophic Lake Constance on the border of Austria, Germany and Switzerland. Extensive reference measurements were carried out alongside, including spectroradiometric measurements by both submersible TriOS RAMSES instruments and an ASD operated above the water surface according to the SeaWiFS field protocol. Water constituent concentrations and SIOPs for several sites on both waters were measured in the laboratory [2].

The field data are compared to extensive automated Hydrolight/Modtran5 simulations. With the

SIOPs measured in the field, a database of typical water leaving reflectance spectra from Hydrolight and corresponding at-sensor radiances from Modtran5 is calculated for a wide range of bio-optical, geometrical and atmospheric parameter variations. All outputs are folded to the standard APEX binning pattern, and various types and levels of noise can be added to the simulated reflectances and radiances.

Two inversion algorithms are applied to retrieve water constituent concentrations from the simulated at sensor radiance spectra. The accordant module of EOMAP's Modular Inversion and Processing scheme is a multi-sensor processing tool for the coupled inversion of aquatic and atmospheric properties [3], and will also be used for the atmospheric correction over water in the planned German earth observation satellite mission ENMAP. The other algorithm is developed by VITO and based on a wavelet transform inversion that should be less sensitive to sensor noise.

The findings of these efforts will on one hand be used in the development of an APEX level 3 water constituent product and integrated in the PAF operated at VITO. On the other hand, the validation with convolved Hydrolight/Modtran simulations may be a first step towards the simulation of planned space borne sensors.

[1] K. I. Itten, F. Dell'Endice, A. Hueni, M. Kneubühler, D. Schläpfer, D. Odermatt, F. Seidel, S. Huber, J. Schopfer, T. Kellenberger, Y. Bühler, P. D'Odorico, J. Nieke, E. Alberti, K. Meuleman, "APEX - the Hyperspectral ESA Airborne Prism Experiment", *Sensors*, vol. 8, pp. 6235-6259, 2008.

[2] S. Tassan, G. M. Ferrari, "An Alternative Approach to Absorption Measurements of Aquatic Particles Retained on Filters", *Limnology and Oceanography*, vol. 40, nr. 8, pp. 1358-1368, 1995.

[3] D. Odermatt, T. Heege, J. Nieke, M. Kneubühler, K. I. Itten, "Water Quality Monitoring for Lake Constance with a Physically Based Algorithm for MERIS Data", *Sensors,* vol. 8, pp. 4582-4599, 2008.