Geophysical Research Abstracts,
Vol. 11, EGU2009-6261, 2009
EGU General Assembly 2009

Sediment characterization in intertidal zone of the Bourgneuf bay using the Automatic Modified Gaussian Model (AMGM)

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Understanding of the uppermost layer of cohesive sediment beds provides important clues for predicting future sediment behaviours. Sediment consolidation, grain size, water content and biological slimes (EPS: extracellular polymeric substances) were found to be significant factors influencing erosion resistance. The surface spectral signatures of mudflat sediments reflect such bio-geophysical parameters. The overall shape of the spectrum, also called a continuum, is a function of grain size and moisture content. Composition translates into specific absorption features. Finally, the chlorophyll-a concentration derived from the strength of the absorption at 675 nm, is a good proxy for biofilm biomass. Bourgneuf Bay site, south of the Loire river estuary, France, was chosen to represent a range of physical and biological influences on sediment erodability. Field spectral measurements and samples of sediments were collected during various field campaigns. An ASD Fieldspec 3 spectroradiometer was used to produce sediment reflectance hyperspectra in the wavelength range 350-2500 nm. We have developed an automatic procedure based on the Modified Gaussian Model that uses, as the first step, the Spectroscopic Derivative Analysis (SDA) to extract from spectra the bio-geophysical properties on mudflat sediments (Verpoorter et al., 2007). This AMGM algorithm is a powerfull tool to deconvolve spectra into two components, first gaussian curves for the absorptions bands, and second a straight line in the wavenumber range for the continuum. We are investigating the possibility of including other approaches, as the inverse gaussian band centred on 2800 nm initially developed by Whiting et al., (2006) to estimate water content.
Additionally, soils samples were analysed to determine moisture content, grain size (laser grain size analyses), organic matter content, carbonate content (calcimetry) and clay content. X-ray diffraction analysis was performed on selected non-consolidated samples to confirm field observations regarding mineralogical content. We focus our analysis on moisture content and grain size. Results show a quantitative relationship between moisture content and the way in which the shape (area, asymmetry, FWHM) of the molecular water band depth changes. With futher analysis, we obtained an acceptable correlation between the moisture content, grain size and the AMGM continuum parameters. Continuum results have the main advantage of being less dependent on the atmospheric conditions, contrary to the water absorptions bands. The relationship between grain size, moisture content and the gaussian parameters or AMGM continuum parameters allows one to identify and separate the various types of water present in sediment (saturated water, free water, adsorption water and hygroscopic water).
This study deals with the evaluation of a methodological approach to extract the main useful information from hyperspectral data from a mudflat coastal environment. These results demonstrate the ability of AMGM to retrieve qualitative and quantitative information on sediment properties. Such data have implications on a large variety of coastal research. The process of sediment transport and deposition is strongly dependant on the bio-geophysical properties. The spatial distribution of sediment properties in the intertidal zone are affected by both natural factors and disturbances arising from human influences. Finding this relationship, requires spatial information on sediment parameters. To test the validity of our technique, the same approach was applied successfully on hyperspectral images collected over Bourgneuf Bay.