Chlorophyll Structure in the Ocean

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Before we started our program we simulated an experiment with the spectral response of the 0.5 to 0.6 µm region of the MSS over oceanic regions with different chlorophyll concentrations. It showed a significant relationship between the obtained signal and the chlorophyll concentration in water. Our studies in upwelling areas with ERTS-1 make it necessary to estimate the chlorophyll concentration. Since sediments in near coastal areas respond in a similar way as chlorophyll within the spectral response of the MSS, it was intended to differentiate in a qualitative study between the effect of sediments suspended in water and chlorophyll on the different channels.

Figure 1. The target for a representative estuary with sediment discharge was the St. John's River in the south of the United States as shown in the color composit from channels 4, 5 and 7. Over cloud-free areas the river discharge is indicated by a higher reflected energy in the visible compared to the open ocean. Clouds are very easy to distinguish from sediment loaded water masses.

Figure 2. The black and white imagery of the channels 0.5-0.6 µm, 0.6-0.7 µm, 0.7-0.8 µm and 0.8-1.1 µm was color enhanced to display the reflective properties of seston and chlorophyll concentration. Channel 4 (0.5-0.6 µm) monitored the effect of chlorophyll as well as sediments and exhibits a diffuse structure in the response of the MSS. The next channel, located at 0.6-0.7 µm indicates a very pronounced gradient within the sediment plume.

This is caused by the position of the second absorption band of chlorophyll at 0.66 μm and the increased absorption of water which limit the photon penetration depth. The recordings in the near infrared (0.8-1.1 μm) gave a response only in the near coastal areas, thus indicating near surface parameters. The transport of sediments is limited to the coast and in agreement with the direction of near coastal currents and the Coriolis effect, is forced toward the south. As a consequence, we may state that very high concentration of sediments and/or inorganic particulate matter are visible in all four bands of the MSS.

Pure phytoplankton populations should cause a response principally in channel 4. This response is the result of increased reflectivity at short wavelengths and the compensation of reflection by absorbtion in channel 5.

Figure 3. A second test site along the Northwest Coast of Africa was analyzed. Figure 3 shows the color enhanced imagery obtained from channel 4 (0.5-0.6 μm), where the white area represents the Coast near Cape Blanc.

Our ground truth measurements indicated chlorophyll concentration up to 20 $\mu g \cdot \ell^{-1}$. The visibility measured with the secchi disc is only several meters, which shows that the topography does not affect the signal obtained with ERTS-1. Since channel five showed no visible structure, and also sediment transport by river discharge is absent we can conclude that the structure visible in channel 4 is due to the distribution of chlorophyll.

The oscillation of chlorophyll boundaries as seen with ERTS-1 was also recognized by continuous chlorophyll measurements carried out with a fluorescence technique aboard a research vessel in the same area. as well as the separated zones with high chlorophyll concentration