The aim of this research is to automatically detect and visualise dynamic ocean colour phenomena such as phytoplankton or algae blooms, fronts and eddies from a sequence of cloudy satellite images.

**How does it work?**

**Conventional composites**

The conventional method for obtaining a synoptic view of a cloudy region is to calculate the average value (e.g. chlorophyll) for each location during a certain time period. This is not ideal for studying dynamic processes which will be blurred or disappear. This example is a 5-day composite of the sequence of SeaWiFS chlorophyll images from 18-22 Jul. 2000 shown on the left.

**Front detection**

First we detect all chlorophyll fronts on each individual image, using an edge detection method designed for thermal oceanic fronts (Cayula and Cornillon, 1992). This is the first time such techniques have been applied to ocean colour data. The automatically detected fronts are shown as black lines overlaying the chlorophyll images. The phytoplankton blooms and other structures are well described by the front contours. Note that different features are detected in each image depending on the varying cloud cover.

**Composite front map**

The composite front map approach is to combine the locations of all fronts observed over those 5 days into a single map. Information on both the temporal persistence and gradient strength of those fronts is integrated in this unique visualisation that allows intuitive interpretation of the important oceanic processes (Miller, in prep.). Darker lines indicate more significant fronts. The dynamic features are not blurred, but form a time-lapse picture showing a series of locations for the same structure.

The chlorophyll front map is on the left; the middle image was created in the same way but using the SeaWiFS near-water leaving radiance at 670 nm, to attempt to detect sediment fronts. The right image shows the thermal fronts detected using AVHRR.

**Multispectral front map**

In order to better understand the relationships between the physical and biological properties of the ocean, the chlorophyll, sediment, and thermal fronts have been combined into a single multispectral front map. Although this results in many lines on the final image, it is possible to extract useful information on the relationships between these three properties that would be very difficult to achieve in any other way.

Certain interesting features are labelled, such as the joint SST/chlor. signal of the Irish Sea front illustrating the enhanced plankton production along fronts. High suspended sediment in the Bristol Channel results in strong sediment fronts. The phytoplankton off Plymouth was unusual in its extremely high concentration of chlorophyll, and also that it contained a type of plankton called Gyrodinium which turned the water reddish-brown - the high particulate matter has been picked up well in the near-water leaving radiance (nLw 670), with stronger chlorophyll fronts in certain areas.

**Animations**

The most helpful way to understand such dynamic structures is by animating sequences of front maps like these. Ask Peter to show you these sequences on his laptop PC.

**Results**

**Conclusions**

A novel set of techniques have been developed for increasing the value of cloudy sequences of SeaWiFS ocean colour imagery for visualising dynamic physical and biological oceanic processes, such as fronts, blooms and eddies. Animations reveal new insights into the dynamic nature of these phenomena. These techniques are even more appropriate for NASA’s new Moderate Resolution Imaging Spectroradiometer (MODIS) in order to summarise in a single image the increased multispectral information available from its 10 ocean colour channels.

This poster received a commendation at Oceans from Space, Venice, October 2000.

**References**


Miller, P.I., Composite front maps for improved visibility of sea-surface features on cloudy SeaWiFS and AVHRR imagery. Imaging for Oceanic and Geophysical Research.

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