What is ocean colour ?

The "colour" of the ocean is determined by the impact of light with the water and any coloured particles or dissolved chemicals in the water. Colour is the light reflected by the water and the substances present in it. When light hits a water molecule or a coloured substance in it, the different colours (or wavelengths) can be absorbed or scattered in differing intensities. The colour we see results from the colours that are reflected.

The substances in seawater which most affect the water colour are: phytoplankton, inorganic particles (or sediments), dissolved organic chemicals, and the water molecules themselves. Phytoplankton contains chlorophyll (a coloured algal pigment), which absorbs red and blue light and reflects green light. Particles can reflect and absorb light, which increases turbidity of the water. Dissolved organic matter only absorbs, mainly blue light, and its presence can interfere with measurements of chlorophyll (Figure 1).

When we look at the sea from a beach or observe it from space, particularly in areas like the caribbean or eastern Mediterranean, we see that the colour is blue because water absorbs red and reflects blue light. However, in other areas the colour is often changed by the other constituents (phytoplankton, sediments and dissolved organic chemicals). Using highly accurate electronic instruments , we can measure a wide array of blue tones, which reveal the presence of varying amounts of these constituents.

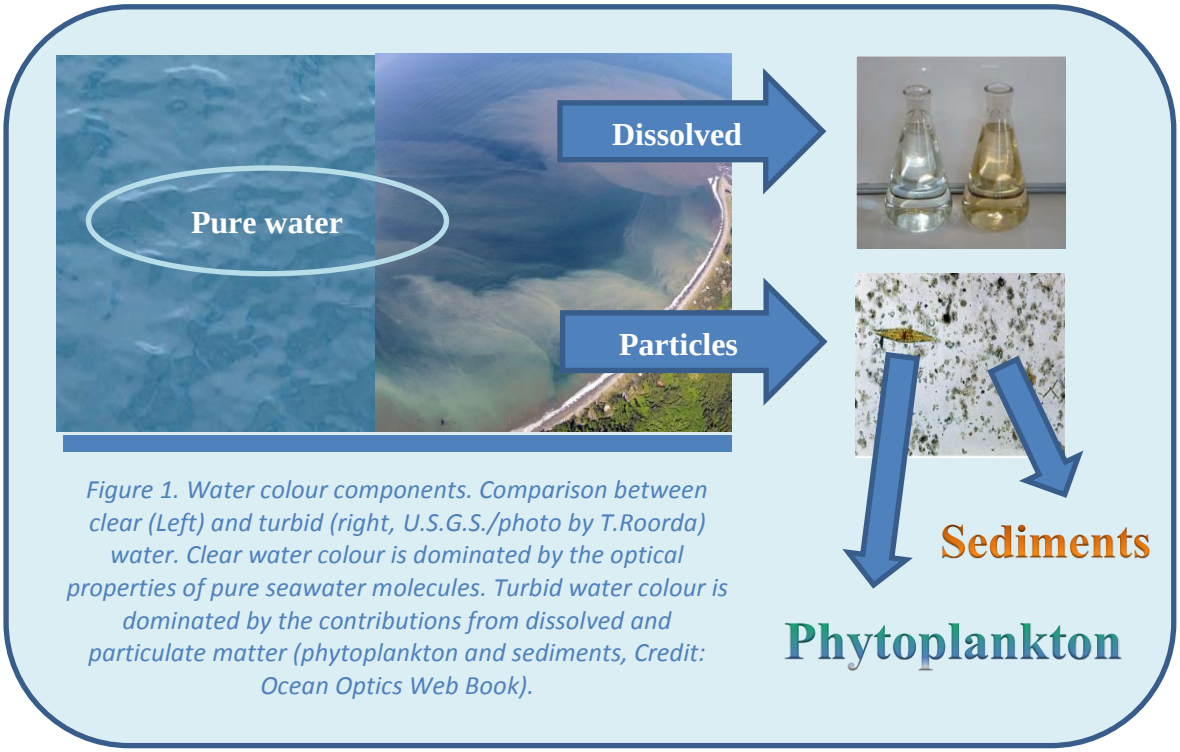


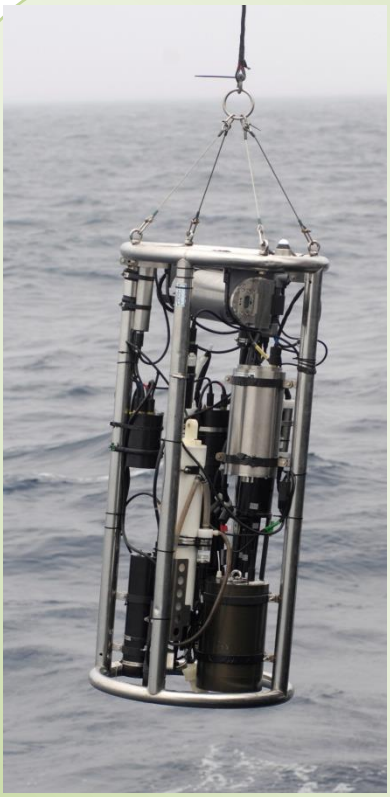
Figure 1. Water colour components. Comparison between clear (Left) and turbid (right, U.S.G.S./photo by T.Roorda) water. Clear water colour is dominated by the optical properties of pure seawater molecules. Turbid water colour is dominated by the contributions from dissolved and particulate matter (phytoplankton and sediments, Credit: Ocean Optics Web Book).

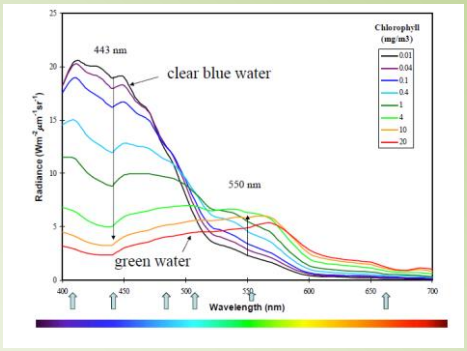
● Why is ocean colour important?

The main reason to measure ocean colour is to study phytoplankton, the microscopic ocean algae which are at the base of the oceanic food web. Phytoplankton produce organic carbon using light and carbon dioxide. This process is called photosynthesis. It is possible because plants contain chlorophyll, green-coloured compounds.

The ocean colour is also an indicator of the health of the ocean. In addition to light and carbon dioxide, phytoplankton also require nutrients such as nitrogen and phosphorus. When these nutrients are too high (either due to natural or man-made causes), phytoplankton can grow too much and when they decay consume the oxygen in the water, causing the death of many marine organisms. This phenomena is called **eutrophication** and the ISECA project is studying it through the satellites images.

However, in coastal waters, the optical properties from sediments and dissolved organic chemicals can mask the phytoplankton optical signal. To separate the different optical signatures, scientists need to sample coastal waters and relate each of the components concentrations to their optical properties (Figure 2). As these relationships become better understood, scientists can begin to decompose ocean colour from satellites into its components. This will lead to more accurate images of concentrations of components from earth observation.





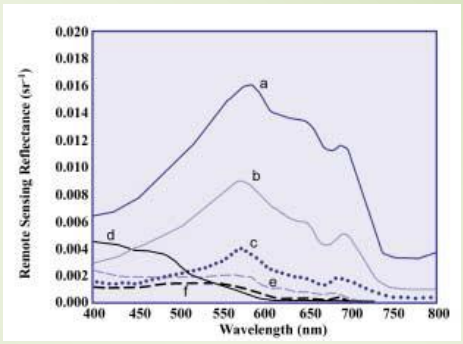


Figure 2. Oceanographic Optical Instrumentation deployment (Left) from an oceanographic vessel. Changes in colour related to phytoplankton chlorophyll concentration only (Up, T.Moore) and due to different mixes of chlorophyll, sediments and dissolved organic matter (Down, IOCCG report N3)

References

SeaWiFS project: The Wild Blue Wonder. NASA: http://kids.earth.nasa.gov/seawifs/

Ocean Optics Web Book: http://www.oceanopticsbook.info/

IOCCG Report 3 (2000): Remote Sensing of Ocean Colour in Coastal, and Other Optically-Complex, Waters. Edited by Shubha Sathyendranath, pp. 140.