Satellites and Ocean Colour

Problem statement:

What is remote sensing?

Why do we use remote sensing?

Can you imagine how satellite images could be used?

What is Ocean Colour?

Method: Observation

Skills: Research skills

Target group: Junior UK school 7-11 yrs

Theoretical part:

In the world of science, remote sensing means observing the Earth with sensors from high above its surface. They are like cameras except that they use not only visible light but also other bands of the electromagnetic spectrum such as infrared, radar and ultraviolet. Because they are so high up, these sensors can make images of a very large area, sometimes a whole country. Today, remote sensing, also known as Earth Observation (EO), is often done from space using satellites. Many countries have them. Hundreds of images are sent every day from the satellites to receiving stations on Earth. The Earth's entire surface is imaged every week. Remote sensing of ocean colour is an important tool in Earth Observation. 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. The chlorophyll concentrations can be derived from satellite data by calculating the ratio blue / green of the ocean. When blue is more absorbed, green is more reflected which indicates a higher concentration of phytoplankton in the water and vice versa. Remote sensing can thus provide a wide visual picture and allows us to create more insight into the eutrophication processes.

Materials:

- Seawater sample
- Coffee filter
- Glass test tubes or glass jars
- Microscope
- Pipettes
- Green food colouring
- Brown food colouring or coffee
- Flour or very fine beach sand
- PC or laptop with internet connection (optional)
  Note: the food colouring and flour can be found in your local supermarket

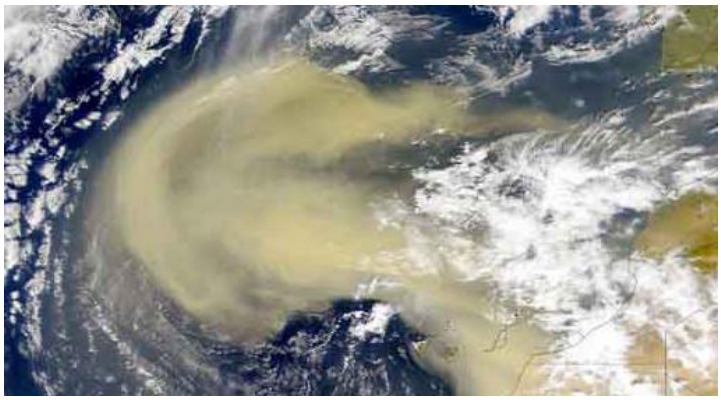
Practical part

Phytoplankton

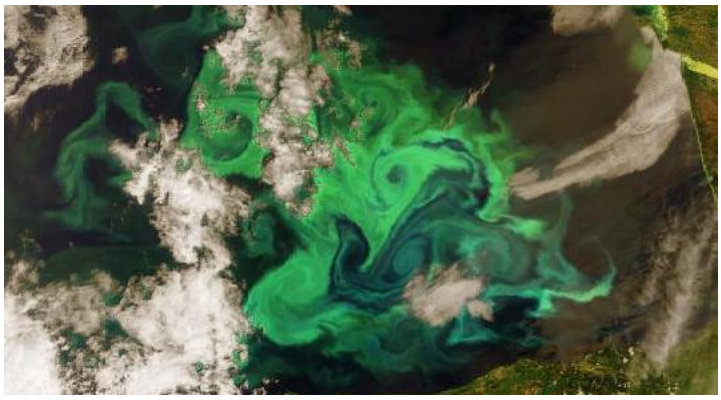
Analyze a seawater sample with the microscope to see if some species of phytoplankton are present.

Satellite images

Have a look at the satellite images below and try to match them to the pre-printed titles e.g. sand storm, phytoplankton bloom, hurricane, suspended sediments, etc…(You can easily expand this selection with satellite images of other phenomena!). Watch the video clip showing satellite images (ESA): http://spaceinvideos.esa.int/Videos/2011/09/ESA_-_Space_to_Relax_Our_Colourful_Planet.



Satellite image1 ©NASA



Satellite image2 ©ESA

Satellite image3 ©NASA

Ocean colour in a test tube

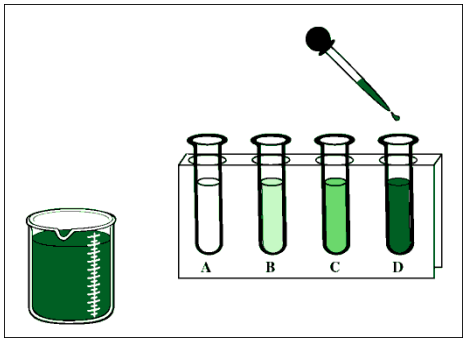
This is an experiment to demonstrate how changing concentrations of phytoplankton / dissolved organic matter (DOM) / suspended particles (SPM) can influence the colour of the ocean. Use filtered seawater to demonstrate that pure water is perfectly clear (take a sample of seawater and filter it using a simple coffee filter).

To mimic the effect of phytoplankton on ocean colour you can use a green food colouring. To mimic the effect of organic matter (DOM) on ocean colour you can use a brown food colouring. To mimic the effect of suspended particles (SPM) on ocean colour you can use flour. We will do the test three times (to explore the effect of phytoplankton, DOM or SPM on ocean colour).

Protocol

1. Fill each of the test tubes with the same amount of water using the measuring cup. Leave the first test tube (A) untouched as this will serve as your version of clear ocean water.
2. Fill the eye dropper with the green food coloring and carefully add **one drop** to the second test tube. Carefully shake the test tube so that the substance is evenly distributed throughout the water. The water should have turned a very pale green colour.
3. Now place **two drops** in the third test tube and repeat the procedure. You will notice that the colour is much darker than the second tube. That is because the concentration of the green food colouring (phytoplankton) in this test tube is twice as high as in the previous one.

4. In the last tube, add about **four drops** of the food colouring and see how much darker it is.
5. If we assume that there are about one thousand drops of water in each of the test tubes, then we can calculate the actual concentration of phytoplankton (or food colouring) in each of the test tubes and relate that concentration to the colour that we see. The higher the concentration of phytoplankton, the greener the water. Have someone take another test tube and secretly add some food colouring to it. See if you can estimate the number of drops added based on the colour that you see by holding the unknown sample next to the ones whose concentration you have measured.
6. Now create your own phytoplankton bloom by squirting a whole bunch of food colouring into the last tube and see what happens.
7. Clean the test tubes and repeat the protocol with the brown food colouring (the water should have turned a very pale brown colour) and the flour (the water should have turned a pale white colour).



Results and Comments:

Satellite images

Image 1: Hurricane / sand storm
Image 2: Phytoplankton bloom
Image 3: Suspended sediments (SPM)

Ocean colour in a test tube

The basic principle behind the remote sensing of ocean colour from space is: the more phytoplankton in the water, the greener it is and the less phytoplankton, the bluer or more transparent it is.

References and thanks to:

- http://oceancolor.gsfc.nasa.gov/SeaWiFS/TEACHERS/sanctuary_3.html
- http://www.iseca.eu/images/deliverables/A2.1%20What%20is%20ocean%20colour.pdf

Education links space agencies

- http://www.esa.int/esaKIDSen/
- http://www.nasa.gov/audience/forkids/kidsclub/flash/#.UpRuzeJV8yo

This educational tool has been developed for the ISECA project.

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