Antarctic Sea ice – An online resource
Peter Wilson – PCAS 2011/2012 Supervised Project
http://www.thinkingminds.co.nz/seaice.php

Abstract:

The objective of the project was to produce an educational resource that would be used by students at New Zealand Secondary schools. There are multiple aims for this educational resource that blend together.

- To provide a context for teaching a section of the Secondary school Physics curriculum.
- To promote an understanding of Antarctica and the Southern oceans.
    - To explore the ongoing work related to sea ice thickness measurements.
    - To explore the role of sea ice in the global climate system.
- To explore the use of an online learning tool.

An online resource was produced that works. There is scope for further improvements.

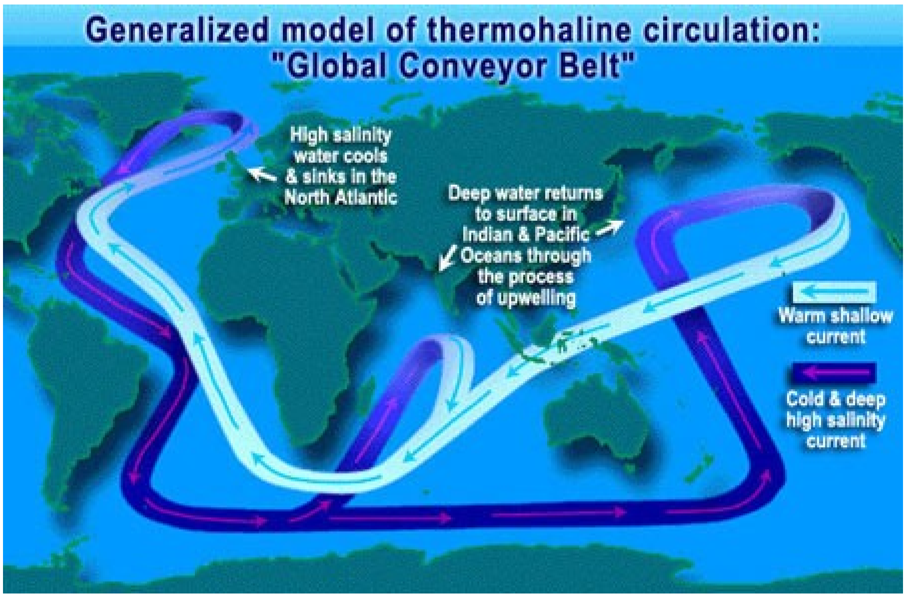
Introduction:

The New Zealand Curriculum is a document created by the Ministry of Education to guide the teaching and learning that happens in New Zealand schools. The Curriculum is a blend of visions, key competencies, values, principles, learning areas and achievement objectives. It would be fair to say that the document does not focus on the specific content that is to be taught, but tends to shift the focus onto creating life long learners who are active and positive members of New Zealand and global society. http://nzcurriculum.tki.org.nz/. In order to create these life long learners, students are encouraged to be aware of their own learning and to develop a range of strengths that enable them to function effectively in a modern world. That is, there is a significant focus on the act of learning as well as the content of what is being learned.

It was with this document in mind that the context of sea ice was chosen. This context has the potential to fulfill a variety of functions:

- It fits into the idea of what it means to be a global citizen and the connections between how people function locally and the consequential effects globally.
- There is specific content that relates to the Physics strand relating to the scientific models of electromagnetic induction.
- Problem solving opportunities exist.
- The Nature of science is explored with an active area of research.

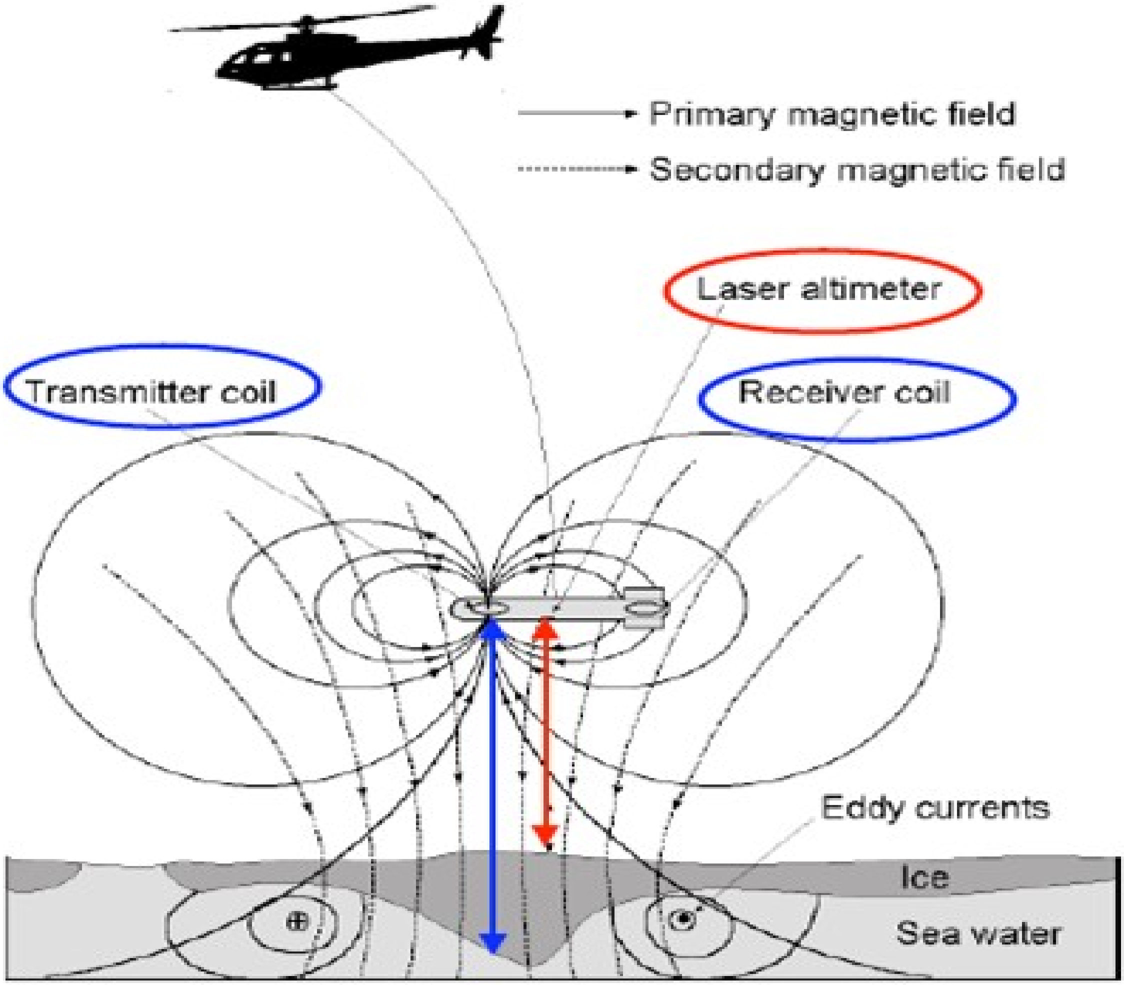
Sea ice background:
Sea ice is important in a global sense for it's influence over the climate and it's impacts on the ecosystem. http://nsidc.org/cryosphere/seaice/



The formation of sea ice concentrates salts in the remaining water making it dense and causing it to sink. Sea ice also insulates the ocean – atmosphere interface moderating the rate of heat transfer. The reflective nature of sea ice also has an impact on the radiation heat balance. The presence of sea ice impacts on the local ocean habitat by altering the amount of light entering the water column whilst providing a habitat in itself. These facts give importance to an understanding of the sea ice and also provide additional contexts for students to engage with.

Measuring the sea ice is a difficult task for a number of reasons including the vast and remote areas involved and the difficulties in measuring the thickness directly. Satellite measurements of altitude are one technique used, which combined with an expected sea level give rise to an estimate of the ice free-board and hence thickness. These measurements need to be verified by ground measurements. This can be done on a small scale by drilling holes into the ice and measuring the thickness directly. Additionally techniques such as Helicopter Electromagnetics (HEM) can be used to cover larger areas. (This technique must first be validated by comparison to the ice holes.) [Pfaffling 2007]

Helicopter Electromagnetics involves carrying an instrument below the helicopter that measures the response to electromagnetic emissions whilst measuring the altitude above the snow / ice surface with a laser altimeter. The magnitude and phase of the response is indicative of the distance from the instrument to the sea water surface below the ice. There is a body of theory that predicts the response for different altitudes, but it seems that in practice some form of empirical calibration is required.


Primary magnetic field
Secondary magnetic field
Laser altimeter
Transmitter coil
Receiver coil
Eddy currents
Ice
Sea water

The HEM 31 ready to be used below a helicopter.

E-Learning:

The use of ICT (information communication technology) in schools is increasing. There is significant investment being undertaken in the hardware and networking infrastructure from both central government and through individual school budgets and the students (parents) themselves. http://www.educationcounts.govt.nz/publications/ict/6518

One of the difficulties with providing educational resourcing is creating a match between the resource and the needs of the individual students. On the one hand there are the benefits of mass production of resources and on the other is the requirement to meet the individual needs of the students. Often this matching of resources to student needs is done manually by a teacher. This can create a significant work load and may not be the best use of resource.

Another approach is to develop technology that adapts the students experience to their learning needs. Here the investment is in producing a dynamic and responsive resource. This can be time consuming and expensive, but may enable the one resource to be used by many students, with an overall gain in efficiency and effectiveness.

The use of computer technology to produce dynamic resourcing opens up the question of the most appropriate format. Applications could be installed on individual computers, or a centralised server based system could be used. A decision was made to used a web based system as it was considered more straight forward than developing applications for the wide variety of devices now in use. Web pages with Javascript and HTML 5 Canvas objects were chosen to be both generic and likely to be able to be used across a wide range of platforms into the future. There are some problems with older browsers using the HTML 5 canvas objects, but Mozilla Firefox can be installed on most devices and is compatible with canvas objects. Significantly most portable devices can view these pages.

The website:

A variety of possible student activities are provided for within the website resource. The original intention was that students would attempt the sea-ice-travel activity and develop some motivation to understand the readings from the instrument. In this activity students are required to guide a dozer across the ice to arrive at Scott base without crossing thin ice and falling into the water. The dozer is controlled by setting a direction and adjusting the speed. A timer is included as some form of performance measure. A probe can be controlled to measure the electromagnetic responses at different parts of the journey. In order to use these responses students will need to either use a trial and error approach or they may find the web page on instrument calibration is useful.

The instrument calibration page allows students to record the instrument response for various heights above the sea water. Combined with the fact that they are told the probe stays 10m above the ice (when flown from a helicopter) they should be able to determine the ice thickness at each point. A reference to safe ice thickness is included to allow students to judge what might be a safe path.

The use of the calibration model should allow the students to use the data from the probe to safely guide the dozer. This might lead them to explore the Physics behind the instrument or a teacher might direct them to this page. The Physics page involves students reading some information, observing some animations and answering some basic questions to give a record of learning. This section is that most related to the Level 3 Physics examination content. The motivation for including Physics from the Level three curriculum is that electromagnetic induction is considered by some to be one of the more difficult topics in the Physics strand. The provision of a resource to assist students learn the concepts of this topic and prepare them for exam questions may increase it's appeal to both students and teachers of the Level 3 course.

There is also the possibility of using the site as a starting point for more open questions such as "How does sea ice interact with the rest of the worlds climate?" Links to the National Sea Ice Data Center are included for this purpose.

A range of practical activities are also possible connected to this topic, such as growing sea ice in a refrigerator and examining it's structure under magnification. The connections between the sea ice and the marine ecosystem could also be explored. There are also links to human exploration of polar regions and also human exploitation of these areas.

Development:
As with most software projects, a significant amount of effort is spent getting the background functionality working before tangible results are produced. This has been the case in this exercise. It can be difficult to see the effort that has gone into producing the behind the scenes functionality and developing ideas to a workable stage. This website represents a significant amount of effort by the Author in turning conceptual ideas into reality.

There is significant scope to improve the resource over time, which is the intention of the author. Features such as logging of student performance into a database have been started but not developed. This could be connected to improved feedback to the students and customisation of the resource to the individual student.

Another feature of software projects is the difficulties involved in making the product highly polished. There is significant effort required to iron out all the bugs and to get the product to work well across a large number of platforms under varying conditions. It is anticipated that this will be the case here, with a number of issues coming to light as the resource is used, requiring some ongoing maintenance.

Once the product is working reasonably well the next step is to facilitate deployment and uptake by a large number of teachers and students. One strategy proposed is connect to the resource through existing websites such as the Greater Christchurch Schools Network website, the Canterbury Science Teachers Association website and the New Zealand Institute of Physics eduction section site.

References:

Pfaffling A., Haas C., and Reid J.E., 2007. Direct helicopter EM — Sea-ice thickness inversion assessed with synthetic and field data. Geophysics, VOL. 72, No. 4 July-August 2007; P. F127–F137, 10.1190/1.2732551.

Creating digital age learners through school ICT projects: What can the Tech Angels project teach us? http://www.educationcounts.govt.nz/publications/ict/6518

All about sea ice. National Snow and Ice Data Center http://nsidc.org/cryosphere/seaice/

The New Zealand Curriculum http://nzcurriculum.tki.org.nz/

How to know when ice is safe http://www.wikihow.com/Know-When-Ice-is-Safe