INSTITUTE FOR MARINE & ANTARCTIC STUDIES
OCEANS & CRYOSPHERE RESEARCH CAPABILITY

The Oceans and Cryosphere Centre combines three main research capability areas.

They are Antarctic and Ocean policy and law, oceanography (physical, bio-geochemical and geophysics), and Antarctic science (sea-ice, ice shelf and ice sheet research). Many of the studies we undertake in science and policy have global scale and frequently contribute to the latest climate change assessments used in the reports of the Inter-governmental Panel for Climate Change and in the Antarctic Treaty Consultative Meetings. In oceanography, we focus on observational oceanography and ocean modelling. We lead Australian university research in blue-water oceanography and postgraduate research training. We work in the Antarctic, Southern and temperate oceans of the world. The cryosphere studies cover sea-ice biogeochemistry and sea ice-ocean interactions, ice shelf dynamics and ice shelf-ocean processes.

Antarctic and ocean policy and law
The IMAS Antarctic and ocean governance theme supports research in law, the social sciences and the humanities. This research explores the legal and governance challenges surrounding Antarctica and the Southern Ocean plus insights from the humanities on the history and culture of these areas. It involves national and international collaborations and crosses disciplines.

Policy assessments
We have the capability to integrate science, resource and environmental management and the broad social sciences with interests in Antarctica and Southern Ocean. The tools we use are symposia, scenario planning, and expertise in institutional analysis, and national and international legal frameworks (treaties and other legal instruments). These assessments often result in position statements and reports.

OCEANS & CRYOSPHERE
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Symposia
We organise and run symposia and "round table" discussions and meetings to related on current and emerging issues on ocean and Polar governance. These symposia range from "Chatham House" type forums to open international conferences. These approaches provide opportunities to advance discussion and policy relevant outcomes to a range of decision-making groups. This capability enhances informed decision-making and research outputs in Ocean and Polar governance, and frequently integrates research and decision-making.

Oceanography and geophysics
We have established programs that describe the large scale circulation of the Southern Ocean including the Antarctic Circumpolar Current and its changes. We have the capability to deploy instrumentation, moorings, autonomous floats, gliders and undertake ship-based measurements. We do this observational work with our collaborators. Ocean modelling is an essential part of understanding the observed changes and understanding the processes that control the large scale circulation and how the ocean would evolve. We want to know if the changing oceans and sea-ice are influenced by humans.

Ocean Voyages and Observational Oceanography
We measure the ocean circulation and its changing state. To measure ocean changes and circulation we deploy autonomous instruments (shown to the left), ocean gliders, and undertake measurements from ships. We also utilise data from instrumented elephant seals that fill many spatio-temporal gaps in our observational coverage around the Antarctic margin. We measure a wide range of physical and chemical properties, such as temperature, salinity, oxygen, nutrients and other biogeochemcial tracers through the water column. These measurements tell us about ocean currents, their past evolution, mixing processes and biological productivity in the ocean. We know the ocean state is changing and these measurements help us to understand how the oceans are changing and also to confirm theories about ocean circulation and the role played by ocean mixing.


Caroline McLaurin


Hugh Jones

Ocean Modelling

Numerical and analytical models are at the heart of ocean science. Models connect theory with observations for validation and for prediction. We use models of the oceans, atmosphere and earth system to understand ocean processes and the ocean's role in the earth system. Some of our models are run on high performance computers located in Hobart and Canberra. They often simulate small regions at fine spatial scale (1 km or less) through to global scales and use hundreds to thousands of processors. Some simulations take days to months to perform.

Biogeochemistry

Biogeochemistry in the oceans links the physical delivery of nutrients to the surface with biological productivity, air-sea gas exchange and sinking and decomposition of particulate material. IMAS has seagoing and shore-based laboratory capability to measure ocean photosynthesis, nutrients, trace metals, particle export and the historical record stored in ocean sediments. We use in situ measurements with in vitro experiments, satellite observations, long term global databases and computer simulations in studies. We train the next generation of ocean biogeochemists in an interdisciplinary and highly quantitative environment.

Ocean extremes and climate variability

Detecting and attributing human influence in the oceans: We use climate models to test whether rising greenhouse gases and aerosol pollution in the atmosphere are the cause of the changes in the oceans. Alternative causes of change like volcanic eruptions, solar variability or changing ozone concentrations or internal variability in the climate system are also detectable signals in the oceans and their contribution is also tested. This capability to attribute changes due to human activities in the ocean has been used in reports to the Inter-governmental Panel for Climate Change assessments of climate change.

Cryosphere science

Sea-ice biogeochemistry

We use a combination of field and laboratory-based facilities to evaluate the role of sea ice in exchanging nutrients and organic matter at the interfaces with the ocean and the atmosphere. Using non-contaminating equipment to sample snow, brine, sea ice and under-ice seawater, we are able to measure trace metals in the sea ice environment, and a suite of key physical (ice texture, in situ salinity and temperature), chemical and biological parameters. With sea ice field activities running on average once every four years, we have developed laboratory-based experimental capabilities, such as the cold-finger apparatus (to grow sea ice artificially) and open flow reactors (to study the solubility of particulate metals). These methods can be used in parallel with existing modelling capabilities to quantify biogeochemical processes.

Autonomous observation platforms

We are developing new systems for integrated observations of the sea ice environment, including its interfaces with the atmosphere and ocean, utilising new autonomous observation technologies. We have a growing capability in both multi-rotor and fixed-wing unmanned aerial systems (UAS). This aerial capability is linked to the TerraLuma UAV facility at UTAS, for deployments from Antarctic bases and icebreakers, in association with strong collaboration with UTAS's Australian Maritime College and international organisations that can provide autonomous underwater vehicle (AUVs) operations under sea ice.

Ice shelf- ocean studies

The largest uncertainty in estimates of future sea level change is the response of the Antarctic ice shelves to the warming of the surrounding oceans. Increased melt at the base of the fringing ice shelves results in more rapid mass loss from the Antarctic Ice Sheet and faster sea level rise. However, the processes regulating melting of ice shelves are poorly known and projections of future sea level rise are therefore uncertain. We study these processes using a combination of in-situ and remotely sensed observations, numerical ocean models and theoretical studies.

Facilities

A seaFAST system at IMAS in combination with the UTAS Central Science Laboratory's ICP-MS instrument allows the analysis of several key trace elements with an unprecedented throughput making high spatial and temporal resolution feasible.

The Tasmanian Partnership for Advanced Computing (TPAC) operates sophisticated e-Research capabilities on behalf of Australian and IMAS researchers. On our facilities we host research collections from research programs and research observing systems. Our flagship collections include the oceanographic data from the Integrated Marine Observing System facility, from IMAS simulations from Climate Futures for Tasmania and the Alps, and astronomy. We have more than 1 petabyte of collections being hosted and available to the research community representing research investments in excess of $250M. TPAC operates the Tasmanian node of the national cloud service and a high performance computing capability. This facility is an investment of over $5M in hardware by the National Collaboration Research Infrastructure Service (NCRIS).

Some of the e-Research services operated by TPAC are:

- Hosting research data collections (now >2 petabytes)
- Cloud Computing (as part of the NeCTAR national Federation >3000 cpu's)
- High Performance Computing (>1000 cpu's)
- High level services (The Marine Virtual Laboratory (MARVL), The Marine Virtual Laboratory Information System (MARVLIS), Coral Reef Scenario Evaluation Tool (CORSET), Polar Information Cloud)