IGP

The Iceland - Greenland Seas Project

Principal investigator

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Areas of contribution

Polar atmospheric processes

Oceanic processes

Modelling and forecasting

Polar-lower latitude linkages

Observations

Data assimilation

Data archiving

Outreach

Summary

We will examine wintertime atmosphere-ocean processes in the Iceland and Greenland Seas by characterising its atmospheric forcing and the ocean response by observing the spatial structure and variability of surface flux fields in the region and the weather systems that dictate these fluxes, through the first meteorological field campaign in the Iceland Sea. This will be done as part of a coupled atmosphere-ocean field campaign in winter 2018 – the first such campaign in the subpolar seas – involving a rare wintertime research cruise and a host of ocean observing systems. We will make in situ observations of air-sea interaction processes from several

platforms and use these to evaluate meteorological analyses, reanalyses and climate models. We will carry out numerical modelling experiments to investigate the dynamics of selected weather systems which strongly influence the region, but appear not to be well represented in many models; for example, the cold-air outbreaks that stream south over the marginal-ice-zone and densify the surface water resulting in convection; and the orographic jets and wakes that occur downstream of Iceland. We will determine what is required for atmospheric models to produce accurate surface flux fields. We will assess how the Iceland and Greenland Seas are represented in current global and regional climate models and investigate likely changes in the atmospheric circulation and surface fluxes due to climate change. We will use a range of ocean and atmospheric models to establish how current and future ocean circulation pathways function. In short, we will determine the role that atmosphere-ocean processes in the Iceland and Greenland Seas play in creating the dense waters that flow through Denmark Strait and feed the lower limb of the AMOC.

Description

The IGP will encompass a novel programme of research examining both the ocean and the atmospheric weather systems that are forcing the ocean. Our approach is a collaboration between UK, US, Canadian, Icelandic and Norwegian researchers to tackle this problem, through a comprehensive observational and numerical modelling programme.

The overall programme hypothesis is that:
Wintertime convection in the northwest Iceland Sea and southeast Greenland Sea, forced by intermittent cold-air outbreaks, forms the densest component of the AMOC.

Objectives of the atmospheric component are to:
(i) Obtain in situ observations of cold-air outbreaks, orographic flows and their associated air-sea fluxes over the Iceland Sea and the marginal-ice-zone.
(ii) Determine the role these weather systems play in the atmospheric forcing of ocean convection in the Iceland Sea.
(iii) Use these observations to evaluate meteorological analyses, reanalyses and climate models: testing model sensitivities to surface-exchange parameterization, boundary-layer transitions and model resolution.
(iv) Evaluate atmosphere-ocean coupling in the subpolar North Atlantic in climate models: determine how it will change in the future and how this will affect the ocean circulation.

Objectives of the oceanic component are to:
1) Document the broad-scale ventilation of dense water in the northwest Iceland Sea and southeast Greenland Sea.
2) Characterize the ocean’s response to cold-air outbreaks downwind of the ice edge.
3) Determine the exchange of newly ventilated dense water between the Greenland and Iceland Seas.
4) Elucidate the dynamics and timescales that link the ventilation process, the circulation and mixing of the newly-formed water, and the manner in which the dense water feeds the North Icelandic Jet.

A close coupling between the atmospheric and ocean components will be essential. It is being enabled by a coupled atmosphere-ocean field campaign and a wealth of numerical modelling.

Atmospheric fieldwork
The atmospheric observational component will centre on an aircraft-based field campaign, which will generate a unique data set of surface, boundary-layer and weather-system observations that are collocated with ocean

observations. The aircraft will undertake a flying programme focused on surface-exchange and ABL processes while mapping out the structure of the associated mesoscale weather systems: namely cold-air outbreaks, orographic jets, wakes and foehn flows around Iceland. Re-fuelling in Greenland will allow a focus on stable to unstable ABL transitions over the marginal-ice-zone. We will closely coordinate our atmospheric sampling with the shipboard measurements during cold-air outbreaks, and focus on the NW Iceland Sea where the deepest and densest mixed layers appear to be.
In addition to the aircraft campaign, an atmospheric observation programme from the wintertime research cruise will include radiosondes, an ABL radiometer, Unmanned Airborne Vehicles, standard meteorology and possibly turbulent fluxes. There should be a meteorological buoy deployed for winter 2017/18.

The radiosondes will be sent to the GTS, as will the buoy observations. All other observations will require processing and so be available in national data centres shortly after the field work.

Atmospheric research
The observations will be analysed in conjunction with operational meteorological analyses, reanalyses and new NWP experiments. Aims include parameterization development, in particular for surface exchange and the ABL. There will be a focus on atmosphere-ocean coupling adjacent and hopefully within the marginal-ice-zone. These aims contribute to the aims of YOPP.

Forecasting
Bespoke forecasts for the Iceland – Greenland Seas area are planned by project partners the UK Met Office. These will use a limited area version of the Unified Model (metUM) at convection-permitting resolution. These products will be evaluated with the observational data. It is hoped that some data denial experiments will be undertaken for this period in time, led by new project partners Inoue (Japan).

Ocean observations
The ocean observations include a wintertime cruise on a research vessel during late February and March 2018, led by Bob Pickart (WHOI). This cruise will be used as a platform for a wealth of ocean observing systems, e.g. CTD, ADCP, XCTDs, microstructure glider(s), ocean chemistry, Argo floats, etc. In addition there are moorings deployed (2016-2018), surveying gliders and RAFOS floats already surveying or planned.

Modelling
A range of modelling activities will be used to try to understand atmosphere-ocean processes, weather systems and the climate system in this area. This will include NWP case studies with the MetUM, regional climate simulations with the MetUM, CMIP5 model analysis and eddy-resolving ocean modelling experiments.

Timeline

2016-10-01 - 2020-10-25

Regional emphasis

Northern hemisphere: Yes

Southern hemisphere: No

Key project deliverables

Observational data sets for both the atmosphere and ocean (for details see above),
Short-term weather forecasts,
Regional climate simulations.

Data management

Atmospheric data will be at the British Atmospheric Data Centre (BADC), http://badc.nerc.ac.uk/

Is data provided to WMO Global Telecommunication System

Yes

Real-time provision

Radiosondes
Meteorological buoy
Argo floats

Other information

Project leaders: Ian Renfrew (UK), Bob Pickart (US), Kjetil Vage (Norway), Kent Moore (Canada)

Timelines

Location	Latitude	Longitude	Start date	End date	Activity
Iceland and Greenland Seas	69N	15W	2018-02-01	2018-03-25	Aircraft campaign and wintertime cruise