The challenge of deploying biogeochemical ARGO floats at the Arctic ice-edge:

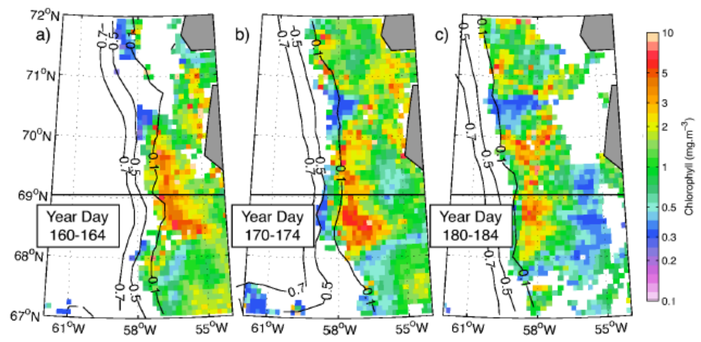
the need for an efficient sea-ice detection system

Claudie Marec[1], Marcel Babin[1], Edouard Leymarie[2], Christophe Penkerc'h[2], Guislain Bécu[1]
[1] **TAKUVIK** UMI 3376, Université Laval, Québec, Canada [2] **LOV** Laboratoire d'Oceanographie de Villefranche-sur-mer, France

Why? :

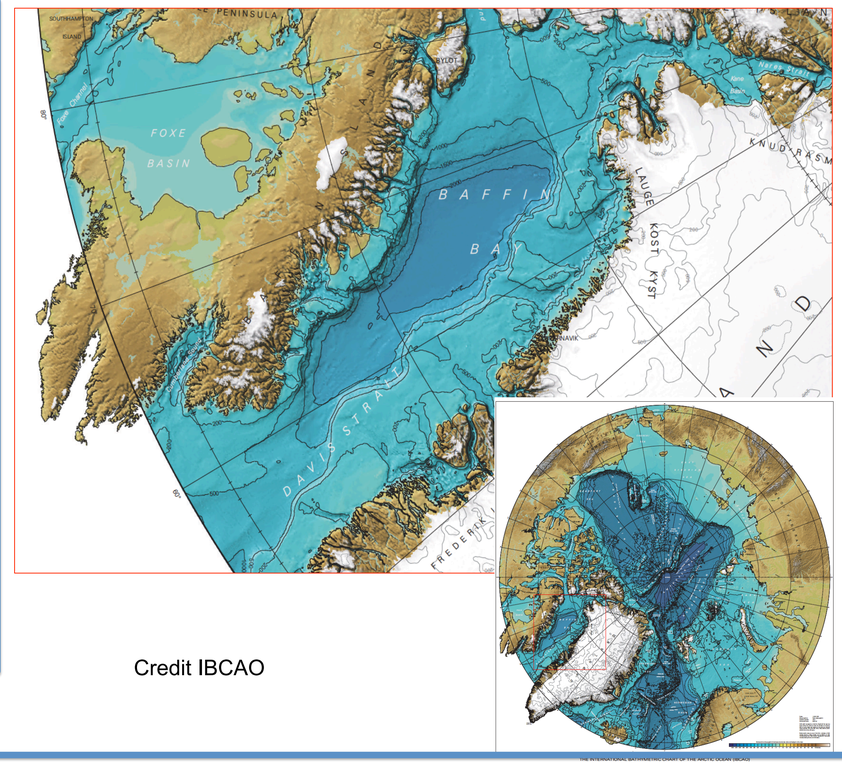
- To understand ice-edge blooms:
  - ✓ Physical mechanisms responsible for nutrient inputs
  - ✓ Propagation of sunlight (ice floe and water column)
  - ✓ Ice-edge bloom dynamics
  - ✓ Response of associated phytoplankton species

- Identify different nutrient sources



Example of the propagation of an Ice-edge phytoplankton bloom West of Greenland over a 25-day period (Images composites of chl*a* (Seawifs) overlaid with sea-ide contours (NSIDC). Perette et al.2011.

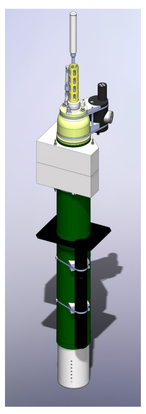
- Why Baffin Bay?: Ice edge blooms are systematically observed in the region. In addition, observations by remote sensing of ocean colour show that the spring blooms now occur 50 days earlier than in1997.



Credit IBCAO

How?

23* Argo NKE** floats equipped with additional bio-optical sensors:



- O_2 Aanderaa optode
- OCR-504 Ed 380/412nm, 490 and 555nm + PAR
- ECO FLBBCD: FL-chla, FL-CDOM , Bb
- C-Rover transmissiometer 650nm
- SUNA (nitrates)

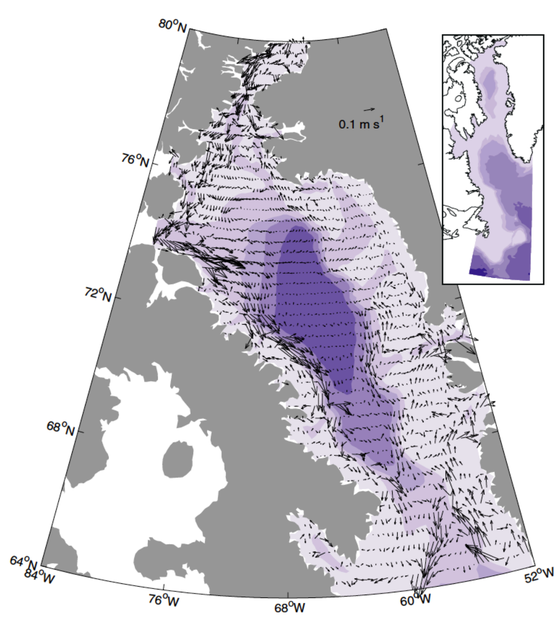
* 13 funded by Equipex NAOS,
10 funded by CFI (Canadian Foundation for Innovation)
**NKE Electronics, France

Credit LOV

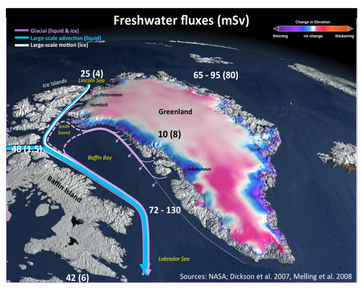
Where? Environmental conditions/tactical pattern for deployment

The strategy for float deployment in **Baffin Bay** will make provision for different environmental conditions (global circulation, climatology….)

Global circulation (mainly cyclonic): the choice of location for float launch and the tactical pattern for their deployment (parking depth and sequence of actions) will be optimised using high resolution hydrodynamic models and the Langrangian formulation (Collaboration with CONCEPTS : Canadian Operational Network of Coupled Environmental Prediction System / Fraser Davidson, DFO-St John's, NF).
Thanks to a bi-directional iridium communication, it is possible to modify and tactically adjust the pattern of the mission and transmit it to the float when it surfaces for data transmission.



Current simulation at 50m (Princeton Ocean Model) Tang et al. 2004



Sea-ice cover in Baffin Bay:
Taking into account typical sea-ice cover maps in Baffin Bay, floats will be programmed to park at a safe depth during the period of ice cover period and to start profiling again in spring.

Challenge : detecting and avoiding sea-ice

The main issue, when deploying floats in icy waters, is the capability to detect ice and, when it is present, to postpone surfacing of the floats. The floats need to surface to transmit data, geo-localize and, if required, receive instructions for a new mission.

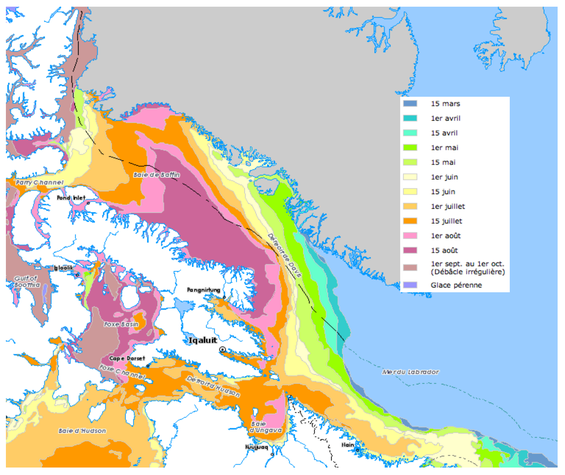
Sea-ice detection techniques (existing or under study, in the framework of NAOS WP2.6):

- ✓ **Mechanical technique:** pop-up technique where the float touches the ice-keel (Owens &Winsor); dismissed because of the fragile bio-optical payload.
- ✓ **Ice Sensing Algorithm** (ISA, Klatt et al, 2007) based on sea-water freezing temperature; reliable in Antarctica but needs to be adapted to Arctic Ocean conditions (several fresh water inputs).
- ✓ **Active acoustic technique:** sea-ice monitoring to detect or measure the sea-ice draft with an upward-looking altimeter.
- ✓ **Passive acoustic technique:** analysis of the recorded ambient environmental noise can be used to differentiate open water from icy water.
- ✓ **Optical technique:** a new system is under development by Takuvik and collaborators (DRDC and LRIO/Université Laval). Based on the depolarizing effect of sea-ice, this new system will estimate ice presence for a close range environmental characterization).

These techniques are complementary, and are suited to different situations and detection ranges.

Sea-ice detection will benefit from the enhanced features of the the new generation of floats designed under the NAOS project, particularly the feedback between the sensors and the vector.

Refer to the poster by E. LEYMARIE / LOV :
« New PROVOR float dedicated to challenging sensors and complex missions: opportunities for arctic deployments »



Typical receding of sea-ice cover from the end of winter to the end of summer (credit: Natural Resources Canada)