2nd GreenEdge Science meeting
Hotel Saint Paul, Nice France
13-15 Decembre 2016

63 participants – December 13,14
51 participants – December 15

Introduction- Marcel Babin
Marcel welcomed the participants to Nice and gave a short summary of the 7 workpackages, their objectives. Two approaches were used to monitor the Phytoplankton Spring Bloom (PSB), from transects aboard the Amundsen (2016) and from the ice camp time series (2015-2016). Lab experiments and remote sensing were also used to have the growth parameters of phytoplankton and other organisms and their spatial distribution. These data will then be included in models. Inuit knowledge was gathered through a series of interviews in the community of Qikiqtarjuaq and at a 2-day hunting camp. The 7 workpackages and the study sites were presented. The GE consortium include laboratories in France, Canada, USA and Denmark. The goals of the meeting were defined: 1. Share information about ongoing activities, 2. Identify gaps and priorities, 3. Coordinate modeling and other activities, 4. Develop a draft plan for publication, and 5. Set timelime. Participants were asked to mark their calendars for a possible follow up meeting in May/June 2017 in Québec City.

Database – Flavienne Bruyant, Joannie Ferland and Catherine Schmechtig
http://www.obs-vlfr.fr/proof/php/GREENEDGE/greenedge.php
Login: greenedge, Password: GE2015-16

Accessing some data may require an additional password. In this case, users must contact the data owner. It is important to maintain the most recent version of your data on the website and to inform Catherine, Flavienne or Joannie if you encounter any problems with the site.

The database on the CYBER website was presented. Metadata information are linked to each set of data. A colour code indicates the status of the data. The data must be taken from the database, and not shared between laboratories to avoid using database that are not validated or 'final'. The log and basic files were presented. The official coordinates for a station are the coordinates from the first CTD cast. If possible, data should be in ODV or .csv format. Glider data will be posted on the CYBER website, the Bio-argo floats will be linked from the CYBER website to CORIOLIS, where the data is being stored

Joannie will take care of the ice camp data and Flavienne will be responsible for the Amundsen cruise data.

GreenEdge Amundsen campaign – Flavienne Bruyant
Statistics of the Amundsen campaign were provided. During the 41 day cruise, there were 36 days of operations, of which 33 were sampling days. Seven transects, 0.5° of latitude apart, were made in central Baffin Bay. A total of 135 stations were sampled including Full (28), Basic (19, AOP and core sampling), Nut (44, nutrient & DIC) and CTD only (42). The operations executed and the equipment deployed at each type of station were described. Usually, there were about 6 nautical miles between stations. Continuous measurement included met tower and irradiance,

360 degrees time laps, bottom mapping, s-ADCP and MVP (in open waters). The following autonomous platforms were deployed: Bio-Argo floats, slocum gliders, iSVP buoys, and 2 sediment traps (although only one was recovered. Sampling stats included 203 CTD casts (twice as many as a regular leg), 34 box cores and 42K litres of filtered see water.

GreenEdge ice camp operations – Joannie Ferland
Operations were conducted in 2015 (124 days, 47 participants) and 2016 (109 days, 52 participants) at the same location, aprroximately 30 km from the municipality of Qikiqtarjuaq, Nunavut. A total of 47 and 37 stations were sampled in 2015 and 2016, respectively. Transportation to and from the camp was conducted using 4 skidoos equipped with qamutiks. In 2016, the last five stations were conducted from an airboat. The installation on the ice included a Polar Haven tent and a wooden cabin mounted on a sled. Operations in the tent and cabin included deployment of instruments (CTD, UVP), water sampling and a 13h tidal series (in 2015 and 2016, scamp and optical measurements), as well as productivity experiments. Ice operations included the deployment of the C-OPS, ROV, and sediment traps, snow optics, incubations, nutrient bioassays and an extensive ice coring. Continuous meteorlogical measurements were captured weather station instruments and a temporal series of images of the ice camp were taken in 2014, 2015 and 2016 by a drone. After 9-10 hours on the ice each day, researchers worked in the laboratory at Inuksuit School, filtering the water samples brought back from the ice camp and conducting particulate aborption, taxonomy, microscopy, incubation CDOM and salinity analyses. The chlorophyll profile time series for 2015 and 2016 show that the bloom was captured in both years. Chlorophyll concentrations reached 9.8 mg/l in 2015 and 10.8 mg/l in 2016.

Upper ocean physics of of Baffin Bay marginal ice zone – Marie-Noelle Houssais, Dany Dumont, Marcel Babin

- *The presentation was based on a first paper that is in preparation by Dumont et al*.

A summary of the physical observation was presented, including CTD, SCAMP, MVP, ADCP and much more. Three transects were presented using the CTD data, showing the features of cold and under ice waters on the left side of the plot and warmer and open waters on the right side of the plots. The fluorescence data show the under ice bloom that develop at the surface with a deepening of the bloom as we move further away from the ice edge. Float and glider data were quickly presented. Fine scale features were featured in the glider data whereas float data showed a long time series including the feature of the water column in the fall. A physical paper on upper ocean physics will try to describe and document the physical context in which the phytoplankton bloom was observed during the GreenEdge project. Upwelling features at the ice edge drive the upward velocity of tracers, including nutrients and phytoplankton and the sinking of surface waters. Primary production is large in the coastal ocean near topographical features and the ice edge. Fine scale signature of the watercolum physical properties were shown through MVP data. The presence of fronts is indicative of a strong baroclinic activities in the upper ocean layer. An overview of the physical paper was presented for the Amundsen data, which will mostly be a descriptive paper. Another paper is also currently being prepared for the physics properties at the ice camp, including tidal currents as well as some of the properties studied on the Amundsen cruise.

Ice and wind pattern - Philippe Massicotte

Contributions to the physical project, including atmosphere and ice satellite data. The ice pattern and the wind patterns were presented. Data exploitation was facilitated by processing the data in a common format. 360 degrees ice-cam data were processed from 3 camera to provide a panorama of ice content around the Amundsen. Through trigonometric processing, a georeference image is produced and ice detection was processed to the image. A % ice concentration will be provided for each image. However, data were missing during the GreenEdge campaign due to a malfunctioning of the system. JET requests a history of ice concentration for each FULL day using remote sensing. Could melt ponds be identified from the 360degree images.

Turbulence and microstructur and SCAMP data –Anda Vladou

The SCAMP was deployed at almost every FULL station, providing fine scale vertical data to a depth of 100m. From the CTD data, features of instability in the water column were identified. Ice concentration had an impact on the amount of turbulence. The main variable measured is the SCAMP is the turbulent kinetic energy dissipation rate (ε), which showed variability at fine spatial and temporal scales. A high dissipation was associated with convective instabilities in the top 30m. Calculations of the turbulent diffusion coefficient and strong upward diffusive nitrate fluxes showed a sharp nitracline at many stations. The carbon fluxes can be compared with incubation data and there is some application for heat and buoyancy fluxes.

Plankton dynamics in sea ice environments - Martin Vancoppenolle

Martin provided an overview of Marion Lebrun's thesis, which will be linked to this project, including topcis on the sea ice environment, light limitation (radiative transfer and plankton response), stratification. A schematic representation showed expected future features in seasonal and perennial ice cover.

Sub group discussion, instruction
WP2 1 biodiveristy (Vaulot), 2 biogeochemistry (Tremblay)
WP3 Vertical fluxes and zoo, fish, bird div (Lalande)
WP4 Optics and remote sensing
WP5 Paleo Massé and Giraudeau
WP6 modeling (Memery)
WP7 human (Sansoulet/Therrien)

Objectives of the first sub-group discussion

1. update each other about progress, people involved
2. Refine the overview presentation for your block
3. Start identifying gaps, priorities,…

Overview of WP6 - Laurent Memery

The 1D model coupling with PISCES started running in January and should be completed by early 2018. The 3D physics modeling (1/4° NEMO/LIMZ), should be completed end of 2017 and the 3D Pan Arctic IPCC run (NEMO/PISCES) by the end of 2018. The issue with the last approach, is the forcings are not easy at the boundaries, so it may be easier to use a global model and then focus on the Arctic, which raises questions as to how to account for ice and the intricacies of the physics and biology of Arctic marine ecosystems.

A question that needs to be discussed is how to treat the ice, its physics and biology. A comparison between the outputs of the model will provide interesting information regarding the models and the environment. Different approaches of parameterisation of the verticality in PISCES should be explored. The timing of the bloom is excessively important to identify, and the variability at various latitudes in the future. Any change in the timing of the bloom may have direct impact on the rest of the ecosystem, by match/mismatch mechanism on grazing, for example. If it was possible, it would interesting to have the resolution to assess physics at the ice edge to evaluate potential upwellings. It would be interesting to have a better understanding of winter biology, to apply in the model. Vaulot mentioned that from ice camp operation, the first stations were in 'winter' type environment (lots of dinoflagellates, no diatoms)and the water was nearly clear.. The model could be adjusted for nanophytoplankton and microzooplankton if enough information available. Modellers will need information from biologists about the physiology of the ecosystem, a list of parameters will be provided later. Levasseur was wondering if there should be another box for pheocystis bloom, and Memery thought it was an interesting idea for Arctic environments.
Sensitivity studies:Vaulot was wondering if the mortality should account of viruses. What are the consequences of increasing mortality due to virus raltive to grazing and check result.
The model will be adjusted post GE to account for autotrophic/heterotrophic balance and light conditions (i.e. the lag time before bloom)

Darwin and trophic network- NeoLab - Frederic Maps
The models being used by the NEOlab in the context of GreenEdge were explained:
The Darwin model is being used to provide distribution and abundance of phytoplankton functional groups, with results validated from moorings and later applied to Baffin Bay. Preliminary results show a variability in the phytoplankton functional groups and will be compared to groups identified through HPLC or taxonomic counts. Linear Inverse Modeling (LIM) is being employed to reconstruct food webs. Through the ecological network analysis (ENA), carbon flows through the food web can be ascertained, providing information on how feeding interactions are distributed between trophic levels.

Optics and remote sensing overview – Marcel Babin
A list of objectives and activities of this group include:
1. Improve the ocean colour remote sensing algorithms in bloom conditions,
    Assess the SCM problem during blooms (Simon Lambert-Girard)
    Tune OC algorithm for bloom conditions
2. Correct for sea-ice related signal contamination, (Clemence Goyens)
    Simulate reflectance at the ice-edge
    Test existing AC algorithm
3. Develop a multi-technique approach to deal with under-ice blooms,
    Snow and ice optics (Gauthier Verin, Simon Lambert Girard)
    Use a various remote sensing data to constrain light available for phyto in seawater (Julien Laliberté)
    Respective roles of cloud, snow, and sea-ice in light attenuation (Julien Laliberté)
4. Look at time-series in the phytoplankton spring bloom,
    Include CZCS data (1978-1986) (Laurent Oziel)
    Use all improvements from above activities

5. Provide the appropriate light data for the interpretation of biogeochemical processes.
Account for light history (under clouds and sea ice)

Optics in snow – Gauthier Verin
Main objective is to study the evolution of physical and optical properties. During an experiment on spatial variability, snow and ice thickness proved to be well correlated. Grain size and shape are two properties that are important to be measured or estimated to estimate the absorption and scattering properties. Snow specific area (SSA) /is a function of both parameters. The time evolution of the SSA was presented, where 3 phases could be identified, first one is cold and dry snow (winter conditions) and the SSA of the cover is decreasing due to metamorphism, the second phase is the surface melting, with a wet layer at the surface, and the third phase is spatial variability where the snow is almost completely melted. The albedo shows different signature for each phase. Spatial variability has not been studied at large spatial scale. The use of a drone could provide albedo at much larger scale. Because of sample period difference, the SSA from 2016 only presented properties corresponding to the end of the second phase and the last phase.

Optics in ice – Simon Lambert Girard, Lisa Matthes, CJ Mundy and Jens Ehn
The use of a Remotely Operated Vehicle (ROV), a drone and a cosine camera enabled us to conduct light measurements below the ice at the ice camp. Ice thickness did not vary spatially over the study area. Vertical profiles of light were directly affected by distribution of melt ponds, cracks and ridges. Patterns of ice algae growth were related to the presence of brine channels. A cosine collector was also deployed from an arm under the ice, data will be analysed soon. Finally a camlum was deployed to look at the angular distribution of irradiance.

IOP and AOP in the watercolumn – Laurent Oziel, Julien Laliberté, Guislain Bécu, Bélanger Babin
In 2016, inherent (IOP) and apparent optical properties (AOP) were measured *in situ* both at the ice camp (84 good profiles, 29 different days, May 4- July 18) and during the Amundsen cruise (34 profiles, 11 stations, June 12- July 3) using a C-OPS and Ice-Pro instruments, providing a profile of downward and upward marine irradiance. A bump was seen in the red part of the spectrum at depth when phytoplankton bloomed at depth. The blue and green irradiance showed similar patterns. The vertical diffuse attenuation coefficient (Kd) for blue and green parts of the spectrum increased to depth with time whereas the red Kd was very noisy. Ice camp measurements of Kd show a nice time series for the different wavebands, with a significant increase in Kd in July, indicating the onset of the PSB. The signal to noise ratio (SNR) showed also increased with depth. In 2015, there was a 'low snow' and a 'high snow' site for C-OPS measurements, which presented different watercolumn irradiance features.

Gliders – Eric Rehm
Two gliders were deployed from the Amundsen in 2016. Chlorophyll-a fluorescence showed mostly sub-surface phytoplankton bloom in open ocean whereas the bloom was much closer to the surface when under the ice. Only a few excurions were made under the ice. The ice edge moved significantly during their deployments. The 2 gliders were deployed on parallel transects about 20km apart and showed similar patterns, although fine scales showed more variability for most variables. A float-glider inter-calibration showed very similar features for most variables. A distinct mass of cooler, fresher water was observed at depth in water near the east coast of the Baffin Bay, which is an unidentified water mass from an undetermined source. When compared

to World Ocean Atlas climatology, large variation was found, prove the needs to verify these measurements. A T-S diagram shows different water masses sampled with these platforms.

Bio-Argo floats – Claudie Marec, Xiaogang Xing, Marcel Babin

Five Pro-ice platforms were deployed in Baffin Bay in 2016. This is in addition to the floats deployed in 2015 (2) and those planned for the future (2017 (7); 2018 (6), for a total of 20 floats). These BioArgo floats are equipped with ice detectors, which prevent them from surfacing under ice cover and damaging their payload. However, the sensors also prevent transmission of data by iridium satellite communication. The float deployment sites were identified through modeling exercise of the circulation pattern in Baffin Bay, Observations from the different sensors show seasonal variation of the different variables. A deepening of the DCM during spring and summer, with a shallowing and decreasing of the DCM in the fall. Although the floats show time-series, they are also affected by 3d features. The depth of the deep chlorophyll maximum (DCM) does not seem to be related to nutricline but rather to the depth of the available incident irradiance. Averaged [O_2] in the mixed layer began to increase in September after a marked decrease in July and August. [NO_3] concentration also showed an increase in the fall as the mixed layer deepened.

Light absorption properties of particles and CDOM – Annick Bricaud and Atsushi Matsuoka

The goal of these measurements is to develop regional bio-optical models for the Arctic and analyse possible bio-optical anomalies. The particulate measurement is also required for PI parameters. Measurements were conducted in 2015 and 2016 on the Amundsen and at the ice camp. Preliminary results show a large variability in 2015 whereas it's much smaller in 2016 for ice cores. In 2016, the variability was much larger for the watercolumn due to PSB conditions in July. A relationship between chla (fluorescence) and a_p show consistent features with Bricaud et al 1998. For ice cores, values are usually above the general relationship, which means less packaging effect than anticipated. The relationship for Amundsen measurements is much tighter than ice camp data and not significantly different from Matsuoka 2014. The non-algal absorption decreases with and increase chla. Phytoplankton absorption when related to chla is significantly different from tropical waters.

CZCS – Laurent Oziel, Emmanuel Devred

The CZCS satellite provides an opportunity to look at the chla pattern in the 1978-1984 period, when Arctic waters had a larger ice cover. A climatology shows limited data available from CZCS. The atmospheric correction from MODIS needs to be applied to CZCS data to compare similar results. Results will be used to compute PP from the Takuvik and the BIO PP models.

Communications – Julie Sansoulet

The communication consortium includes Parafilms, KNGFU, Takuvik, Criterium, Eclat de Lumière. The communication strategy includes a website, blogs in both 2015 and 2016, a 52min documentary (the teaser was presented), an educative website including 12 modules and web-documentaries, interactive multimedia, school activities, public events, social media. The budget includes numerous sources of funding.

Diversity of Microbes, overview – Daniel Vaulot

The diversity group focused on bacteria, autotrophic eukaryotes and heterotrophic eukaryotes, viruses were not studied. Different methods were used to assess microbial diversity such as cultures, flow cytometry, microscopy, pigments and molecular biology. Flow cytometry only allows the differentiation between a few populations. HPLC pigments permits more phytoplankton groups to be distinguished. The flow cytobot produces a very large number of images and provides more information than flow cytometry. Scanning electron microscopy provide more details but can only be applied to limited samples. The molecular technology can be applied through metagenomics which is limited in number of samples. Metabarcoding can provide information on 1 gene, but for a very large number of organisms. QPCR can provide quantitative information on 1 gene for 1 organism. Finally the cultures require a large effort to get information on single organisms, which are then referenced for molecular analyses.

Cultures from the Edge: A glimpse into the diversity of Arctic phytoplankton - Catherine Ribeiro et al.

Cultures were obtained both from the Amundsen (water column) and ice camp (water column, melt ponds and ice cores). A total of more than 1,000 cultures were obtained, they have been identified and molecular (18s) approaches were applied. The identified cultures included groups of Micromonas, Diatoms, Prasinophyceae and Fragilariaceae. Other markers are planned to be applied on the cultures such as 28s and ISSR. Scanning electron microscope imagery will be applied to the cultures to investigate the diversity**.**

Exploring diversity at the ice edge using flow cytometry – Margot Tragin

Flow cytometry is used to enumerate specific population, which can be done on natural samples or on SYBR green marked samples. A temporal series of pico and nano phytoplankton at the ice camp show blooms both appearing in July, although it seems that picophytoplanton occurred prior to the nanophytoplankton bloom. Two bacterial populations were identified (high and low DNA populations). Maps of the abundance of nano, pico and bacteria show the distribution in the Baffin Bay from the Amundsen samples. Detailed information was shown for Transect 2. Pre-bloom conditions show high density of nanophytoplankton. Bloom and post-bloom conditions were also presented, with high density of all 3 groups in bloom conditions, at the surface under the ice, and post-bloom conditions with a deep chla maximum composed mainly of nanophytoplankton and bacteria. A conversion factor can be applied to pico and nanophytoplankton to get the carbon concentration. However, Queguiner made the point that we need to identify the accurate biovolume to get the carbon content, which is not a trivial operation. To assess the ice biology, we need to focus on ice camp samples. A discussion should take place within the diversity group on a common approach/unit to represent the diversity in ice, taking into account for the dilution. Joannie will oversee this activity.

Phytoplankton diversity with the Imaging flow cytometer – Pierre-Luc Grondin

Samples were acquired both on the Amundsen (leg 1b) and at the ice camp on discrete water samples from the water column, ice cores, sediment traps, experiment and melt ponds. Images are identified automatically through and algorithm in ecotaxa, and then manually validated. Preliminary results from the ice camp 2015 show an ice algae bloom that is then found in the water column. A second event in the water column showed a very different population of diatoms. In ice core samples, the phytoplankton community is dominated in pennate diatoms, whereas in the watercolumn, pennate diatoms are dominant early in the season, which

transitioned to centric diatoms in en of June. Preliminary results from the Transect 6 of the Amundsen show an increase in pheocystis related in with an increase in DMS concentration. Biovolume can be computed with this technology.
An overview of the size spectra of the samples of all organisms sampled was presented (phyto and zooplankton).

HPLC pigments – Joséphine Ras, Celine Dimier and Hervé Claustre
Preliminary results for HPLC analyses from the 2016 ice camp show an increase in chl *a* in the water in early June (Figure 14). Results from the ice cores showed an increase in concentration at end of May on the 0-3cm layer. The photoprotection index in the ice core show an increase starting in early May. A predominance of microphytoplankton was found in both ice and seawater at the ice camp and in Amundsen samples. Results from the Amundsen show high concentration of Tchl *a* near the ice edge. There was a significant spatial heterogeneity in the distribution of phytoplankton populations. The phytoplankton maximum was at the surface under the ice, progressively deepening eastwards in ice free waters, with an increase in the contribution of microphytoplankton. Ice covered waters were dominated by picoplankton and crytophytes. A comparison between HPLC pigment and fluorescence profiles from the floats showed a discrepancy at very high concentrations of chl *a*. Amundsen and ice camp data should be fully validated by January and March 2017, respectively. An effort should be put towards the reconciliation of the different techniques to have the big picture.

Zooplankton biodiversity – Philippe Archambault and Catherine Lalande
Despite the high diversity of Arctic waters relative to the Atlantic and Pacific regions of Canada, only a few key species of fish and zooplankton are important for carbon transfer purposes. Arctic Cod is the main species of interest in Baffin Bay. It is estimated that a total of 4,600 benthic species are present in Arctic waters. Trawl data from the GreenEdge cruise will be used to monitor the estimated 4,600 benthic species present in Baffin Bay diversity. A macrobenthos catalogue is currently being developed for West Greenland waters.

UVP – Marc Picheral
An Underwater Vision Profiler (UVP) is used to count particles > 100 µm and take images of aggregates and plankton >700 µm. Of the 187,000 images taken during the 197 casts during the GreenEdge oceanographic cruise in 2016, 87% have been analysed by ecotaxa@obs-vlfr.fr. About 20 groups of plankton can be identified from this system. Data are available through greenedge@free.fr . Aggregates represent 80-90% of the images, diatom chains about 7%, copepod about 2-3%. Results show higher values of aggregates and diatom chains near the Greenland side of the transects. Copepods represent about 80% of the zooplankton present. Other zooplankton included Acantharea, Limacinidae and Appendicularians. A preliminary analysis show an shallowing of the depth of the copepods in the ice camp 2015 data.

Zooplankton and fish (Loki and net) – Catherine Lalande
The ring net was deployed at the ice camp and various nets were deployed on the Amundsen: Tucker net, Monster, LOKI, and HydroBios (vertical distribution of zooplankton). The IKMT is used when an ecosounder showa high density of fish and the the Beam trawl for adult cod on the sea floor.
Contents of the zooplankton nets deployed from the CCGS Amundsen (primarily Monster + LOKI) revealed that 95% of the fish were juvenile Arctic cod. Of the adult population,

approximately 75% were Arctic cod. A relationship was found between the presence of fish (determined by acoustics) and the bird populations (Thick billed murre, Northern fulmar, Black-legged killiwake) in parts of Baffin Bay.

Benthic diversity – Philippe Archambault
How does the benthic community respond to different ice and PP conditions, and can key species be used as bio-markers? Unfortunatelly, the Lander that was deployed near the ice camp did not function. Stable isotope delta15N and delta13C will be analysed. An experiment from 2014 in 2 polynias with 13C-15N with 2 different type of algae (phytoplankton vs ice algae). Results show opposite responses in the 2 polynyas. Using the bivalve Mya truncata as a model species. Two approaches are the trophic multi-marker, which will identify the food source (diatom dominated diet or low diatom diet), and shell composition. The data came from a site near Qikiqtarjuaq and a site on the eastern coast of Greenland. A contrast in the population from these two sites in term of diatom diet was presented. Sclerogeochemistry results show a peak in composition every year showing the high growth related to the bloom on the site from Greenland, whereas the samples coming from the Qikiqtarjuaq site show a high inter-anually variability. Could it be related to low-ice years? Maybe we should check the date of the ice break up. Could pH affect shell growth, now or in the future. The Mya truncate species has a pan-Arctic distribution and is also found at lower latitudes. The use of sclerochronology provides a longer time series in terms of carbon transfer over for example the last 10-15 years.

Biogeochemistry, overview – Jean-Éric Tremblay
An overview of the different biogeochemistry processes was presented through a diagram. A map of the different water masses presented a large contribution of Pacific water on the Western side of the Baffin Bay. Silicate and nitrate ratio was presented, showing a deficit of silicate on the eastern side of the Baffin Bay. Different processes studied in GreenEdge are growth parameters of microalgae, grazing by zooplankton, production of DOM by phyto and zooplankton, bacteria production and respiration, DMS production from phytoplankton, N reminirelization, silicate dissolution, C respiration.

Implication of the organic geochemistry to the biogeochemistry in GreenEdge - Jean-François Rontani
Sampling occurred in atmospheric, watercolumn and ice core. The sub-group from Sempere was interested in DOC, TOC, moleculars compounds of POC and DOC to assess liability, and analyses of specific contaminants in atmospheric compounds . The Rontani group will use the lipid degradation products to monitor the degradation of algal material in the Arctic through biotic and abiotic processes, to answer questions such as: What is the efficiency of photo-oxydation on diatoms and bacteria in sea ice and under the ice? Are bacteria and algae stressed in sea ice (good or bad health states).

Nutrients, nitrogen cycling and Primary production – Jean-Eric Tremblay
Samples were obtained both from the ice camp and Amundsen campaign in 2016. Preliminary results from the 2015 ice camp 2015 showed reduction of nutrients in the water column (nitrate complete depletion), in early July. The nutrients from the ice cores showed a low nutrient concentration at the beginning and end of the ice sampling season whereas in high concentrations were found in May. DOC and DON concentrations in the water column were increased over the sampling season. In 2016, both the ice algae and phytoplankton bloom were captured. The

Amundsen study looked at the distribution of nutrients and differentiated between new and regenerated production and looked at the impact of light on nitrogen uptake. A depletion of nitrate was found on the eastern side of Baffin Bay. Primary production profile showed variability, the pattern of which appears to be related to the proximity to the ice edge.

Silicate and diatoms – Aude Leynaert, Karine Leblanc, Bernard Queguiner, Brivaela Morisseau.
Operations including, in situ incubation with label ^{31}Si and PDMPO staining were used to quantify silicate stocks and fluxes in samples from Arctic waters, ice and sediment traps. Ice core sampling in 2016 was performed under a tent the dark. At the ice camp, the temporal series in biogenic silicate stocks agreed with chl *a* patterns in the ice and water column. Production rates showed a very large peak in the water column on May 8 followed with another peak with the bloom, showing values in the range of Antarctica values or Bay of Brest under diatom bloom. An experiment of nutrient limitation (silicate) showed variability in the water column whereas in the ice there was only one peak around May 21. On the Amundsen, the integrated biogenic silicate showed high concentrations when integrated down to 200m on the Eastern side of the Baffin Bay. PDMPO labelling permits newly produced silicate to be visualized (fluorescence), which can then be analysed by microscopy

Exacerbation of stress in ice algea and phytoplankton – Rémi Amiraux and Jean-François Rontani
There is a net increase in photodegration with latitude. Lab experiments on chaetoceros cultures showed that at low temperature and low irradiance there is strong photodegradation. The sensitizer is preserved and there is less diffusion of $^1O_2$ at low temp and low irradiance. Whereas, at high temperature and high irradiance there is a loss of sensitizer and $^1O_2$. Bacteria could undergo oxidative stress induced by phytoplankton. Using measurements from Malina, ArcticNet 2012 and GreenEdge 2015, the stress on algae and bacteria was studied during summer and ice melt. In spring 2015, no photochemical stress was found, most likely due to the high snow cover, in spring 2012, phytoplankton experienced high photochemical stress, and in 2009, high photochemical stress was seen in both phytoplankton and bacteria. Hi Bacterial salinity stress was observed in the spring of 2015. In 2012, the brine channels had discharged before sampling, so no stress was seen. Equally, no stress was found under open water conditions in 2009 (Malina). Salinity stress leads to high sinking rates. This lead to a high contribution to sediment in 2015, but low contributions in 2012 and 2009. It would be important to know which bacteria are involved in this process.

Bacterial community – Laticia Dadaglio, Fabien Joux
Preliminary results from ice camp 2016 and the Amundsen campaign show a delay compared the chl *a* concentration time series. The integrated values of bacterial abundance and production show high spatial variability from the Amundsen dataset. Bacterial respiration was studied after 5-day incubations at 1°C. Respiration was measured on samples filtered at 1um, which results in a loss of respiration from large cells, resulting in BR=1-19.5 $\mu gC^{-1}d^{-1}$ (mean BA=32%, mean BP=19%).
An experiment was conducted on different treatments (filtered sea water, nutrient and DOM addition), on samples from open water and ice station, which showed different response over time.

PAM fluorescence – Johann Lavaud

PAM Fluorescence, measured both at the ice camp and on the Amundsen, provided information about photo protection and the photochemical efficiency (Fv/Fm). High Fv/Fm values were observed from early May to early June. The value collapsed in mid-June, probably due to photoinhibition or nutrient limitation. This decrease preceded the collapse chl *a* biomass by 2 days. The quantum yield of photochemistry is computed from rETR curve related to irradiance. Under prebloom and bloom conditions, the alpha was high, proving the light limiting status of the cells. The rETRm fluctuated with a shift compared to the chla when looking at the time series. NPQ curves related to irradiance, which is an indication of photochemistry, showed low values under bloom and pre-bloom conditions, and brutally increased with the decrease of chla. A comparison of ENPQ50 with Ek and Eopt show that ENPQ50 is about half-way between the other two parameters. A second experiment shows a full recovery of the photosynthetic capacity after light stress

Overview of 2015 and 2016 experiments – Virginie Galindo

The objective of the 2015 experiment was to assess the pigment changes of ice algae. The difference of photo-protection between ice algae and phytoplankton (2015 and 2016 ice camp). In 2015, the chla concentration peaked around mid-May, and snowfalls during that period may have increased the duration of the ice-algae. Two sites were sampled (low and high snow), showing different chla concentrations under pre-bloom conditions. Photo-protective pigments were produced and the xanthophyll cycle was activated prior to the thining of the snow cover. An experiment was conducted to expose ice algae from low and high snow sites to different light level treatments. The ice-algae showed a very high level of resilience after light stress. A time series of photosynthetic parameters from water and ice samples showed that water column samples show an adaptation to higher light level than the ice samples, which is counter intuitive. Finally, an experiment was conducted in 2016 to compare the response of ice algae and phytoplankton to different nutrients treatments. Preliminary results show unexpected results for addition of all nutrients, but generally an increase in the PP of phytoplankton, whereas the ice algae PP peaked and then decreased after a 10 days. The bacterial production showed opposite trends. Finally, an experiment was conducted by Aurelie under different conditions (LL, HL, nutrient, UV) with phytoplankton a depth of 5m. The highest response was obtained with cultures exposed to low light and nutrient addition.

How do phytoplankton respond to high light? - Hannah Warren Joy

The objective is to quantify the effects of high light on phytoplankton. A light shock was applied on the samples and then measured PAM, as well as other variables such as PI curves, absorption and HPLC. From this experiment, in theory, under light shock, the fluorescence decreased brutally, then the recovery was full under the no repair inhibitor condition and the recovery was partial under repair inhibitor addition. In fact, when looking at the results, no trends were observed. The containers used for the incubations have an impact on the UV irradiance field and may explain the difference.

P vs E curves – Flavienne Bruyant, Joannie Ferlant, Kate Mary Lewis, Marie-Hélène Forget

Production vs irradiance curves were performed both on the Amundsen and at the ice camp, in the water and from ice samples (0-1 cm at ice camp, and 0-3cm on Amundsen). The photosynthetic parameters are alpha (light limited), PBmax (max production), Ek (irradiance where production start to saturate), and Beta (photoinhibition). Preliminary results from 2015 show Ek values for the ice algae under low snow that are higher than under low snow cover. A significant increase is noted after day 160, which matches the decrease of the fluorescence rates. The shape of the curves varied significantly between surface to 40m samples. Average Ek values for ice algae is around 40uE.

Sea ice related sources of DMS – Maurice Levasseur
DMS has a climate role as well as physiological functions. Netcare is currently evaluating the nucleation events associated with high DMS emission from Lancaster Sound and Baffin Bay. The DMS cycle is complicated, and therefore requires information from many different groups. Two historical datasets from higher latitude on marginal ice zones show a good relationship under pre-bloom conditions, but is very messy under post-bloom conditions. These results that can be explained by various factors. DMS was measured at the ice camp under different conditions. From ice cores, profiles of DMS generally show an increase at the bottom of the ice core, but under bare ice conditions, a large concentration of DMS was also found near the surface, indicating of fluxes. Samples from under ice water and in melt ponds domes show high values of DMS concentration. Similarly, DMS in melt ponds is high, which seems to be a 'new' source of DMS for the atmosphere. From the Netcare experiments, a relationship was found between DMS and salinity, which means that the meltponds need to be 'fed' by sea water. The 'slush snow' seems to be a good source of salinity and DMS. From the Amundsen results, very high concentration of DMS is found in hot spots. Transect 5 and 6 show profile of DMS with a sub-surface peak. Finally, a MIMS was deployed on leg 2 of the Amundsen, which showed a large increase in DMS concentration when crossing a large piece of ice.

WP3, Carbon fluxes, an overview and results from the sediment traps – Catherine Lalande
Sinking of particles is important for the benthic community. What is important for carbon fluxes towards the bottom is the match/mismatch between phytoplankton and zooplankton. At the ice camp, 2 short term sediment traps were deployed, and no poison was added to the samples. Long term sediment traps were deployed from 15 May to 19 July, with rotation of the carrousel every 2-3 days, and poison was added for storage. The phytoplankton export data showed very low exports until mid-June followed by a large increase in export until end of July. The drifting sediment trap was deployed in Baffin Bay from 15 June to 9 July. Number of cells that are indicative of ice condition peaked and then decreased by July. Other phytoplankton cells showed a large export in early July. This has be be investigated.

Pelago-benthic coupling – Nathalie Morata
What is the response of the benthos to organic matter pulses from spring bloom? Sampling was carried out at 12 sites using box corer, then cores were incubated. Variables analysed include nutrients, respiration. A map of benthic carbon demand showed higher demand on the shelf in post-bloom conditions. Aspects that may affect the coupling between the pelagic and the benthic ecosystems, timing, species, duration of the production, depth of the sea floor are important variables to take into consideration.

WP5, an overview – Jacques Giraudeau
The paleoceanography workpackage is looking at a different temporal and spatial scales. A wide consortium has been put together to process a large series of variables. The work is achieved using sedimentary archives, from box cores and gravity corer (Casq). Samples were collected at

various sites along the Greenland coast. The chronology has to be established for cores, using 210Pb and 137Cs. Sedimentation rates are overall very low in Baffin Bay, providing a resolution of 6-24 yr/cm. Paleomagnetism is another alternative to complete chronology. The mineralogical signature of the different cores varies, especially for the Kane core. From the core near the NOW polynia, we see a cooling of the water over the last 5,000years. The establishment of the polynia occurred near the last 1000-2000 years.

Eleanor Georgiadis
The two cores used covered the last 10,000 years, one is coming from the western coast of Greenland and the Kane core. About 10,000 years ago, the ice that limited the entry of Arctic and Pacific water in the Baffin Bay melted and changed the water masses distribution in Baffin Bay. From the core near the Greenland west coast showed 2 distinct periods, with an older period dominated with terrigenous input, whereas after 7900 years, there's a significant increase in organic fraction and nutrient consumption. The Kane2b site is important because of the occurrence of ice ridge in that area promote the creation of the NOW polynia. IP25 index show seasonal sea ice, which enabled the identification of different periods.

Response of benthic forminifera in different arctic environment – Calypso Racine
The cores come from different sites at the pan-arctic level, and provide information at the . Foraminifera will be evaluated as their ecology may be a potential bio-indicator. Preliminary results show the distribution of calcareous and agglutinated Foraminifera species, with predominance of agglutinated species in most region except for the Kane 2b core, which may be an indicator of corrosive waters.

Food security and climate change Julie Sansoulet
The model of food security is based on 4 pillars: i) quality, ii) quantity and availability, iii) access of food, and iv) preference. Different projects will address food security. Preliminary results from this latest study points towards a melting of the ice in the recent years, and more ice seem to be drifting from the North. There is also a noted decrease of snow cover. A large database of marine resources consumed by the Inuit has been put together. It is important to avoid generalisation, as knowledge will differ according to age groups, location etc. Silence and observation is a key component in the Inuit culture. To develop the food security model, a post-doc will integrate the four pillars and the information from GreenEdge and IPY to develop indicators for food security using a Linear Inverse Model (LIM).

Group discussion:
Proposed goals

1. Fill in the list of variables
2. List foreseen contributions (titles, authors, timeline)
3. Identify gaps in contributions
4. Organise/prioritise efforts for next months (milestones, critical steps, …)

General Discussion:
Next science meeting suggested for Quebec City at the end of May 2017, with a special session at the Arctic Change meeting in December 2017 in Quebec City

Special issue, suggestions:

- *Biogeosciences
- *Frontiers in Marine Science
- Deep-sea
- Progress in Oceanography
- Peer G
- *Elementa (impact factor to be available next year)
- Polar Biology

Priority for the biodiversity groups:
Which sample to complete the molecular analysis, will probably focus on Amundsen samples first

Modellers:
Should a study focus on LIM modeling?

Food security:
Next step is to complete the table and validate with local collaborators

Presentation of the research station in Qikiqtarjuaq- Debbie Christiansen Stowe
An overview was presented of the recently submitted CFI proposal for the establishment of a permanent research station in Qikitarjuaq. Consultations with the community and regional officials began in February 2015. A presentation was made to the local population in May 2016 and a letter of agreement was signed by the Hamlet council in August 2016. A $13M funding proposal for the construction of the station was submitted to the Canadian Foundation for Innovation in October 2016. Several possible locations have been proposed, including the site of the old AHamlet building, near the proposed port facility and near the HTO office. The proposed station will have a wet and a dry laboratory, as well as living facilities for 18 people. It will be integrated into the CEN netowork of research stations and be governed under the aupices of INQ. The governing board will include academic and government partners as well as representatives of the HTO, NRI, and other community and regional bodies.

A decision on the funding proposal will be announced in June 2017.

Submitted by
Marie Hélène Forget
Debbie Christiansen Stowe