ARCTIC 2022 – IMPLEMENTED PROJECTS

Monitor Radiation and Clouds Characteristics over Arctic ocean (MoRaCCA)

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ABSTRACT

Context/Motivation

Given the initial forcing due to the increase in greenhouse gases, through internal feedbacks the climate system adjusts itself to a new equilibrium state. Te basic adjustment is higher Surface Air Temperature (SAT). Due to several feedback mechanisms, the SAT increase in the Arctic is 2–4 times larger than the global mean. This phenomenon, called the Arctic Amplifcation, has been confrmed by observations as well as model simulations. Te mechanisms responsible for the Arctic Amplifcation include: Albedo feedback due to changes in sea ice extent, atmospheric and oceanic heat transports: transport of heat fux that warms the polar area, cloud cover and water vapor that alter the longwave irradiance to the surface, soot on snow, increased black carbon aerosol concentrations. Reduction in sea ice extent and thickness largely impact surface energy exchange processes. Open ocean liberated from ice in summer can absorb and store significant amounts of heat into the following season. Processes specific of high-latitude regimes can strongly modulate fluxes of radiation, momentum heat and mass. . Cloud coverage over the changing surface and the response of the clouds to the changing surface conditions will modify the change in planetary albedo when sea ice melts. We have a very poor knowledge of all process and interactions, being systematic measurements only made from space meanwhile ground-based observations are very low and sporadic. This limitation having an impact also on satellite measurements as a consequence of a lack of data for validation activities using observation over sea and at high-latitude.

Objectives

In this context, the proposed activity aims to take the opportunity offered by PONANT cruises to implement a very cost-effective monitor programme for surface radiation fluxes and cloud measurements over the Arctic Ocean.

Specific objectives will be both scientific and technical.

With respect to science, continuous observation with allow characterization of downwelling radiation at the surface, its Shortwave (SW) and Longwave (LW) components, cloud coverage and radiative impact over a very wide range of latitudes along the whole summer season. Together to provide relevant information to investigate

processes indicated above, collected data will provide useful ancillary information to researcher interested to investigate marine ecosystems. To this scope we also add to the instrumental suite, UV-A and UV-B surface flux measurements.

From a technological point of view, along the five years proposed activity, new technical solutions to improve atmospheric measurements over a ship will be implemented: inertial platform to collect SW and LW radiation components as well as cloud's characteristics; automatic sun-spectrometer for columnar aerosol characterization. Experience acquired on previous cruices (e.g. High-North 17) and ognoing project in the frame of Italian Antarctic Programme (PNRA) will help to develop and test these solutions.

Specific outputs (deliverables) of the project together with datasets will be

(i) Characterization of the radiative flux balance in the Arctic Ocean;

(ii) summer cloudiness index and cloud cover estimates;

(iii) estimate of cloud radiative forcing (CRF);

Methodology/Activity planned

Downwelling radiation components will be measured by a delta-T SPN-1 radiometer (SW) and a pyrgeometer (LW)instruments together with UV-A and UV-B fluxes. An all-sky camera will collect 180° sky images every 10-15 minutes. A custom radiation Unit (RU) based on a custom conversion board and a mini PC Raspberry will assure data acquisition, pre-elaboration and transfer to the PC dedicated to all data collected by the ship. We will start from the Laura Bassi implementation, adapting HW and SW solutions to the specific conditions. A preliminary survey on the ship will able to (i) identify the best location for instruments, (ii) collect information on the IT integration system for all scientific ship observations, and discuss with PONANT details to connect to it our RU, (iv) define strategy for NRT transfer to Italy of data and images as well as dissemination on-board for outreach activities. New technologies, in particular the inertial platform, will be implemented during the second or third year, to give time to acquire any information necessary to achieve the best results.

Integration of radiation measurements and all-sky camera observations, and use of algorithms adapted to ship conditions, will allow us to evaluate cloud coverage and evaluate the Cloud Radiative Forcing (CRF). We will look to the possibility to have at disposal data of water skin temperature and fractional coverage of open water, sea ice and melt ponds, from which to estimate through parameterization upwelling fluxes. In this way we will have the possibility to determine the radiation budget.

Outreach activity

About outreach, we can propose a strategy base on three elements:

A - information material on relevance of our measurements, role of radiation and clouds in the climate system, they importance as indicators of climate change will be developed/provided.

B - NRT pre-analysed data in graphical format will be put at disposal to be diplayed on dedicated monitors.

C - seminars/lectures will be scheduled and held by researcher of the group proposing this activity. We are at disposal to discuss topics and programme without real limitation (apart that arising from our competencies).