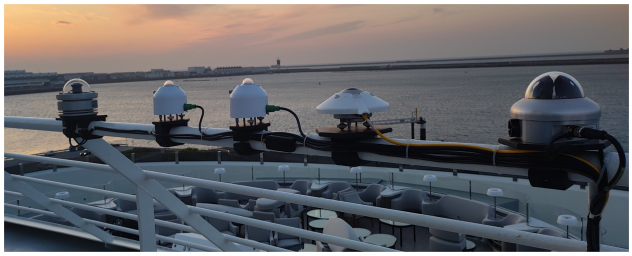
WHAT ARE WE MEASURING AND HOW

Ideally, a radiation measurement should be able to rely on a stable horizon completely free of obstructions to be able to capture the signal of the entire half-space. Compared to these ideal conditions, a ship (even a research ship) presents significant challenges. If the importance of the result justifies the deviation from ideal situations, this does not mean that we should not do everything to reduce errors, both through a judicious installation and then the development of ad hoc data analysis procedures. Until a few years ago on a ship it was possible to measure only the sum of direct and diffuse radiation (global radiation). But the developments of the instrumentation now allow the overcoming of this limit, allowing to collect information capable of enriching the subsequent analysis and the results (see next section).



The choice of sensors and parameters to be measured was made considering the following objectives: 1) to be able to monitor the radiation balance at the surface and its components; 2) use measurements to obtain information on clouds; 3) obtain information on components of radiation such as UV and photosynthetic radiation (PAR) important for ecosystems. In relation to objective 2, the addition of an all-sky camera also offers us the possibility of continuing the development of analysis techniques which are for measurements of this type at a preliminary stage.

MEASURE INCOMING SOLAR RADIATION

Drived by needs of renewable solar energy, around the end of 90s a new concept was developed with the aim to be able to measure all components with only one sensor and no moving parts. **The Delta-T sunshine pyranometer SPN1** provides outputs for global and diffuse radiation. This is possible thanks to a design where shading pattern and 7 thermopiles are arranged so that at least one thermopile is always fully exposed to the solar beam, and at least one is fully shaded from it, regardless of the position of the sun in the sky. All seven thermopiles receive an equal amount of diffuse light. SPN1 computes direct radiation by subtracting the diffuse from the global (total) radiation. SPN1 needs no routine adjustment or polar alignment and works at any latitude.

MEASURE INCOMING THERMAL RADIATION

The Infrared thermal radiation (IR) emitted by the atmosphere can be measured with a **pyrgeometer**. It provides a voltage that is proportional to the radiation exchange between the instrument and the sky (or ground) in its field of view. The detector signal output can be positive or negative. For example, if the sky is colder than the pyrgeometer, the instrument radiates energy to the sky and the output is negative.

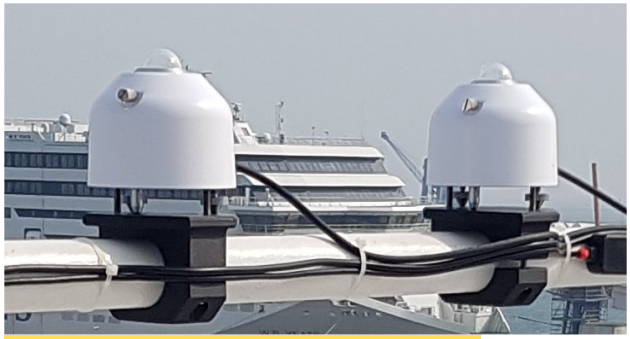
So, in order to calculate the incoming IR it is necessary to know the temperature of the instrument housing close to the detector and the data must be recorded simultaneously with the detector signal.

The typical wavelenght range cover the relevant part of radiation emitted by Earth atmosphere: 4.0 µm till about 50 µm. The dome is made in silicon to cover this spectral range, and its shape is usually realized in such a way to reduce solar

influence if the instrument dome is not shaded. We use a SGR4 Kipp&Zonen pyrgeometer one of the best performing tools on the market.

MEASURE UV-A AND UV-B RADIATION

Interest in the effects of ultraviolet (UV) radiation on the marine environment surged after the Antarctic ozone hole was discovered in the mid 1980s. Much of the ensuing research has focused on quantifying the potential influence of stratospheric ozone depletion on primary productivity, the survival of marine organisms, food web processes and biogeochemical cycling. Ultraviolet radiation is now recognized as a potent environmental factor that significantly influences marine chemistry, water clarity, primary productivity, and probably pelagic food web structure. Exposures of aquatic organisms to UV are a function of location and time, modulated by clouds, vertical mixing of plankton and depth of benthic organisms and other factors. Owing to the complexity of the interactions and their demonstrated importance, the effects of UV must be understood to describe the workings of the ocean. Measure the fluxes of UV spectral components is for sure the first fundamental step for that, and our measurements can support research of marine scientists on this topic. An UV radiometer in short is basically a pyranometer (instrument used to measure global solar radiation) to which is added an element limiting the measured spectral region (band pass filter). For our measurements we have selected two radiometers produced by the company EKO always on the basis of their high performance.



OBSERVE CLOUDINESS CONDITIONS

All sky camera can carry out Full Sky (180°) images of the night or day sky, and in a continuous fashion. High sensitivity systems can record a very good image quality of the night sky. Atmospheric studies are one of the many application fields of these equipments. The most popular being astronomical observations.
For our scopes, the ALCOR camera (ALPHEA model) will collect any 15 minutes ands image of the sky, giving us the possibility to derive quantitative (cloud coverage) and qualitative (clouds type) information thanks post-processing analysis of the images. The camera has been optimized for diurnal observations.

WHERE ARE STORED AND HOW ARE USED DATA

Data are acquired locally on the ship data sharing system and at the end of the day also transferred to Italy. Our plan is to develop analysis procedures that are as automatic as possible, the only way to be able to sustain the rhythm of a daily data flow. The procedures will also include data quality controls, defined thanks to our experience in the international Baseline Surface Radiation Network (BSRN). The objective is to obtain, on a 15-minute basis, values of the incoming components of the radiation balance at the surface (global SHORTWAVE, direct, diffuse, LONGWAVE, UVA and UVB) and for cloud cover the percentage of sky covered by clouds (cloud coverage), and developing new procedures, information on the type of clouds. Once consolidated, these results will be included in the Italian databases for Antarctica (NADC) and Arctic (IADC)) and through them shared with the international community according to the principles and good practices about access to data (FAIR principles https://ogsl.ca/en/fair-principles/)