Radiation Measurements in the Tyrrhenian Sea during TEMPO

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Measurements of the various components of the radiation budget were made from the R/V Minerva of the Italian National Research Council (CNR) in the North Tyrrhenian Sea , during the 1989 Tyrrhenian Eddy Multi-Platform Observations (TEMPO) experiment (September 26 - October 9, 1989).

The two main objectives of TEMPO were the investigation of the structure of the North Tyrrhenian Sea and intercalibration and validation of measurements from different sources (satellite, aircraft and ship) in order to study the upper ocean response to the atmospheric forcing in the vicinity of eddies and fronts.

Budget measurements were aimed at quantifying both air-sea radiative exchanges, as one of the possible forcing of dynamic of the basin, and to study the effect of a sea surface temperature (SST) front on the terms of radiative budget.

The short- and long-wave irradiances were directly measured by two piranometers and two pyrgeometers, respectively. The instruments were gimbal mounted on the upper bridge of the ship. Two instruments were used for each measured component, in order to avoid the shadows of ship superstructure and provide redundant information for quality control purposes. The long-wave exitance was calculated from sea surface temperature measured by radiometer, mounted on a boom over the bow of N/O Minerva. All the data were sampled at 1 Hz quality controlled and averaged over 1 minute time intervals.

The short-wave upwelling radiance and albedo were calculated from smoothed observations of Payne (1972) relating albedo to solar zenith angle and short-wave trasmittance.

Each component of the balance was analyzed to examine its behavior across the SST front associated with the Tyrrhenian Eddy. The presence of the eddy has been evidenced by means of the SST radiometer measurements and confirmed either by the satellite images or by the hydrographic data obtained during the cruise. The difference of temperature between the eddy and the surrounding waters results approximately 2.5°C. A strong correlation between the upwelling and downwelling long-wave radiation was observed in the vicinity of the front revealing a correspondence between atmospheric and marine structure across the Tyrrhenian front.

The daily mean short-wave irradiance ranges from 150 to 220 Wm^{-2} while the daily long-wave irradiance ranges from 420 to 470 Wm^{-2} and therefore its contribution to the net budget is more relevant. The daily value of the upwelling infrared radiance is rather constant over the entire period (420 Wm^{-2}).

The net radiation budget was computed from our data. The daily mean value ranges from to 180 to 300 Wm^{-2} and is modulated by the behaviour of the visible downwelling radiation. The nocturnal budget shows a negative trend from 50 to approximately 0 Wm^{-2} in agreement with the transition to colder weather conditions typical of this period of the year.

Several empirical models exist in literature to evaluate the short and long wave irradiance from weather measurements, these models are tested only for open ocean, while their possible use for a close basin, like the Mediterranean Sea, is to be verified. Therefore, empirical formulae for calculating short-wave radiative flux were compared with measurements. A formula by Lamb (1964) for determining the incident solar flux given solar altitude, cloud amount and cloud type, agrees with our measurements within 10%. Similar results were obtained comparing our data with the empirical formulae of Reed (1977).

Comparison between long wave irradiance and empirical formulae is planned in order to test the different models for the Mediterranean Sea case.

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