ISARD-2025-aeosol013

Analysis of Radiation Forcing in the Atlantic Ocean: The Role of Cloudiness

Alexey Sinitsyn[1] , Sergey Gulev[1]

[1] P.P. Shirshov Institute of Oceanology of the Russian Academy of Sciences

sinitsyn@sail.msk.ru

The study of Earth's radiation budget is based on three key radiation fluxes at the top of the atmosphere: incoming solar radiation, reflected solar radiation, and outgoing longwave radiation. These components drive the planet's climate system. Satellite observations, particularly the CERES system, are used for their monitoring and are recognized as the gold standard for radiation flux data, although it has limitations in terms of time (data since 2000) and spatial resolution (1°x1°).

The new CLARA-A3 products developed by CM SAF overcome these limitations by providing a longer time series from the late 1970s and improved spatial resolution up to 0.25°x0.25°. The data are presented as percentages of total cloud cover (0-100%) and in W/m² for radiation parameters.

Analysis of radiation forcing in the Atlantic Ocean revealed significant changes in cloudiness and radiation fluxes. In the tropical part of the ocean, there is a decrease in total cloud cover by 16% during the winter period, while in the temperate latitudes, an increase of up to +10% is observed for all seasons. These changes affect the incoming shortwave flux: a decrease in cloud cover leads to an increase in the flux by 20 W/m² in the tropical zone and temperate latitudes.

Cloud changes also affect longwave radiation. When cloud cover decreases, outgoing longwave radiation increases by 8 W/m² due to the opening of the atmospheric "transparency window". At the top of the atmosphere, an increase in longwave flux up to 12 W/m² is observed in the tropical zone during winter. In areas with increased cloud cover, the flux decreases by 8 W/m².

The radiation balance is formed by the interaction of shortwave and longwave fluxes. In the southern part of the Atlantic Ocean, balance changes are less than 10 W/m² and always have a negative value. However, during the summer period in temperate latitudes, a positive balance is observed due to a significant increase in incoming shortwave flux (about 20 W/m²), which exceeds changes in longwave radiation (up to 8 W/m²).

Changes in the regime of total cloud cover and its components significantly affect radiation processes in the Atlantic Ocean. An increase in incoming shortwave radiation, combined with a decrease in cloud cover, leads to an increase in outgoing longwave radiation from both the ocean surface and the top of the atmosphere. At the same time, the radiation balance of the ocean surface remains close to zero, and its variability over time remains insignificant.

This research has been supported by:

1. "State Assignment within Research and Development Activities", grant FMWE-2024-0017