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The seasonal energy budgets of the Mediterranean and Red Seas

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Determining the energy budgets of oceanic areas is very important in order to test our knowledge of ocean-atmosphere interactions and build reliable coupled ocean-atmosphere models. In this study, we calculate the monthly energy budget components for the Mediterranean and Red Seas, namely the net shortwave, net longwave, latent, sensible heat fluxes, and heat storage change. The period of interest is from 1984 to 2000. The radiative components of the budget are derived by a radiation transfer model, while in most other studies bulk formulae are used. A variety of data is required to run the model: 1. Cloud data from the International Satellite Cloud Climatology Project (ISCCP) D2 2. Aerosol data from the Global Aerosol Data Set (GADS) 3. Atmospheric temperature and humidity profiles from the National Center for Environmental Prediction / National Center for Atmospheric Research (NCEP/NCAR) and ECMWF Re-Analysis (ERA-40) 4. Oceanographical data from the Mediterranean Data Archaeology and Rescue (MEDAR) MEDATLAS 2000 database, as well as from the World Ocean Atlas 2001 compiled by the National Oceanic and Atmospheric Administration (NOAA).

The model agreement with radiation fluxes measured at surface stations is within 10 Wm^{-2}. The Mediterranean Sea longwave radiative cooling from our radiation transfer model is weaker compared with other studies based on parameterizations. The Red Sea net solar flux estimate is considerably lower and the longwave radiative cooling is stronger than parameterization studies.

The monthly heat contents of both Seas are estimated from water temperature and

salinity profiles. Although they have an annual value of zero, they dominate the seasonal energy exchange between the water and the atmosphere.

We compare three methods for the estimation of latent heat flux and evaporation: the bulk aerodynamic, the energy balance, and Penman's method. The bulk aerodynamic method is usually employed because it needs only a few standard meteorological quantities, however, the Penman method is recognized as the most accurate. The results show that there are significant differences between the energy balance and Penman's method on the one hand and the bulk aerodynamic method on the other.

Penman's method shows that using the aerodynamic bulk method we underestimate evaporation by 15–20% in the Mediterranean and by 11% in the Red Sea. The average annual evaporation rate for the Mediterranean and Red Seas is calculated as 1400 and 2100 mm yr^{-1}, respectively. The analysis of the heat content shows that the solar heat absorbed by the sea during summer is redistributed to winter evaporation, via sea heat storage. For both Seas, the peak evaporation occurs in winter and mainly comes from energy released from this heat storage. Its release rate during winter is 100–150 Wm^{-2} for the Mediterranean and around 100 Wm^{-2} for the Red Sea.