The mean, trends and interannual variability in Mediterranean Air-Sea Interaction

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The semi-enclosed nature of the Mediterranean Sea makes it an excellent place to test data sets and formulae, for air-sea interaction, that may be applied globally. In particular, we have used COADS (the Comprehensive Ocean Atmosphere Data Set) for 1946 to 1988, together with standard heat flux formulae, to examine the heat budget of the Mediterranean.

The initial estimate of the long term mean heat input is 36 W/m^2 higher than is compatible with the exchange through the Strait of Gibraltar; it is important to establish which component of the heat flux is responsible for this imbalance. An adjustment of the latent heat loss to make up the difference seems implausible as this would require a doubling of the rainfall over the Mediterranean to be compatible with the freshwater budget of the Sea. The heat imbalance may be partly due to an underestimate of the longwave back radiation, but it seems unlikely that all of the discrepancy can be accounted for in this way. Thus, as the sensible heat flux term is small anyway, we are reduced to ascribing most of the imbalance to an overestimate of the insolation, possibly due to the influence of marine haze. Direct measurements of insolation at sea are thus required, as well as improvement of the other terms in the heat and freshwater budgets.

An apparent trend in the COADS wind speed appears to be due to a change in observing practice (from sea state observations to anemometer measurements) which is difficult to allow for precisely. Thus any real trend in the total heat flux is difficult to establish, though COADS does show a downward trend in the insolation of about 5 W/m^2 over 40 years due to an increase of about 10% in the cloudiness.

COADS implies an interannual variability in the annual average total heat flux with a range of about 30 W/m^2, implying changes in the total heat content of the Mediterranean that might be detectable with historical hydrographic data. If these are not found the global application of COADS and standard formulae in variability studies will be further weakened. Much of the heat flux variability comes from changes in the latent heat flux term, with contributions due to variations in the humidity of the air and the saturation humidity at the sea surface temperature.

We have also examined the net buoyancy flux from the sea, finding that contributions from run-off and precipitation are important for the long-term mean, but insignificant for seasonal and interannual variability. In some years the net buoyancy flux is "estuarine" rather than "lagoonal", but a reversal of the average circulation would require larger changes in the heat or water budgets than seems plausible without major climate change.

We have extended our analyses of COADS to consider such things as interannual variability and spatial patterns of the fluxes and welcome further suggestions. In turn, we can help plan the future measurements and modelling studies that will improve our understanding of this fascinating sea.