AIR-SEA HEAT FLUXES ESTIMATION IN THE AEGEAN SEA (EASTERN MEDITERRANEAN SEA)

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Abstract

We present a merged technique for producing monthly mean air-sea heat fluxes values in the Aegean Sea from bulk formulae. The input variables are mainly drawn from the POSEIDON buoy network of the Hellenic Centre for Marine Research (HCMR). Time series derived from five buoys encompassing a period from January 2000 to December 2008 are used together with satellite data and coastal meteorological observations to estimate heat fluxes over the marine boundary layer. The estimated monthly mean values are further compared with widely used global gridded datasets.

Keywords: Air-Sea Interactions, Heat Budget, Aegean Sea

Air-sea heat fluxes are crucial for understanding the role of the oceanic environment in the climatic processes as a main driver of the global atmospheric and oceanic circulations. But they are not readily quantified and their basic input variables mostly come from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS, Voluntary Observing Ship program) since the buoy measurements are scarce and the satellites are still unable to provide accurately all the necessary variables [1, 2]. HCMR's Poseidon network consists of oceanographic buoys that monitor meteorological, sea state, upper ocean physical and biochemical data in a 3-hour time intervals [3]. The network is operational since late 1999 and provides four key variables needed for estimating the aforementioned heat fluxes. These are atmospheric pressure, air temperature, sea surface temperature and wind speed. Seasonal maintenance and sensors calibration ensures the network reliability. Cloud fraction is estimated based on 3-h observations provided by a number of coastal stations of Hellenic National Meteorological Service (Fig.1). Simultaneous cloudiness observations from 2-3 nearby stations are spatially interpolated to produce a composite cloud fraction at each buoy location.

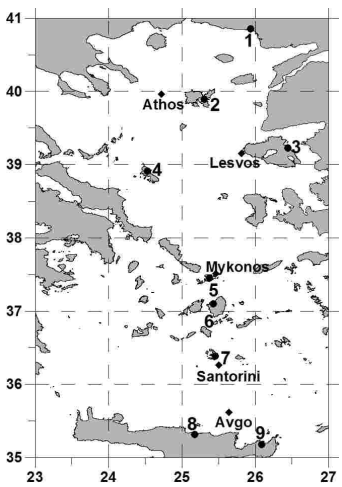

Fig. 1. Buoy sites and the 9 meteo stations over the Aegean Sea.

Additionally, the specific humidity is estimated from the SSM/I brightness temperatures (F13, F14 and F15 platforms; [4]). Over the study area an average of 5-6 overpasses were available on a daily basis (while F14 was operational). In order to achieve more representative values, the satellite brightness temperatures from all the daily swaths are selected within a radius of 0.5^{o} from the buoy site and are interpolated in time to be fitted in the 3-h interval dataset. The incoming solar shortwave radiation Q_s is calculated from the Reed bulk formula using the List formula for clear sky irradiance as more appropriate for the Mediterranean Sea conditions. A correction to the clear sky insolation due to the aerosol attenuation is applied according to Tragou and Lascaratos [5]. The net longwave radiation Q_b is computed using the most suitable for the Mediterranean, Bignami formula. For the turbulent components, latent heat Q_e and sensible heat Q_h, the state-of-the-art COARE v3.0 algorithm is used [8]. As a general rule, monthly mean values are estimated when less than 10% data are missing. The final products are further statistically compared against the following heat flux datasets: a) the National Oceanography Centre of Southampton air-sea interaction gridded dataset [1]; b) the OAFlux project dataset of WHOI [6]; and c) the HIPOCAS Mediterranean Sea high-resolution atmospheric dataset [7]. Due to large gaps in our dataset a statistical comparison over a whole year is not possible, therefore only concurrent measurements are involved. Table 1 illustrates results from the preceded statistical comparisons. The period of comparison is referred to 2000-2006 for NOC dataset, 2000-2007 for OAFlux and 2000-2001 for HIPOCAS. According to the main statistical features the most suitable gridded product is appeared to be the OAFlux dataset for all the components except the net longwave radiation for which the HIPOCAS dataset seems to fit better. The relatively large biases of NOC dataset are apparently attributed to the different bulk formulae for the clear sky insolation and for the net longwave radiation. Q_b from OAFlux dataset exhibits no correlation not only with the in situ data but also compared against the other two gridded products.

Tab. 1. Main statistics of the comparisons with the gridded datasets. N is the number of compared values.

Heat Fluxes Comp.	NOC				OAFLUX				HIPOCAS			
	N	bias	rmse	cc	N	bias	rmse	cc	N	bias	rmse	cc
Q_{net}	131	-66.5	91.0	0.93	131	-10.5	35.0	0.96	63	-19.3	40.6	0.95
Q_s	399	-25.0	35.9	0.97	459	-2.3	13.6	0.99	120	9.0	15.8	0.98
Q_b	131	-28.2	30.7	0.60	142	-12.2	19.5	0.08	63	-15.2	16.7	0.62
Q_e	131	-0.2	42.6	0.64	131	5.4	25.8	0.82	63	-8.3	32.2	0.76
Q_h	131	-9.5	17.4	0.85	131	-0.4	7.3	0.97	63	-8.0	13.6	0.93

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