UNDERSAMPLING PROBLEM FOR HEAT FLUX CALCULATION

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Abstract

The results of the data analyses presented in this work consisted of the long-wave radiation, sensible and latent heat, calculated using the bulk method. Errors due to undersampling of the calculated parameters were determined for different sampling intervals.

Kex words: Automatic Metocean Station Split, Adriatic Sea, undersampling error

Introduction

The two radiation parameters: global (incoming solar and sky radiation within 0.3-2.5 μm) and net radiation (the difference between incoming and outgoing radiation within 0.3-60.0 μm) measured from the AMOS (Automatic Metocean Station) station at Split Marjan-Cape were analyzed in this work. The scope of this paper is to show differences in calculated values when the data from different sampling intervals were used. The methods for the heat flux calculations utilized here are presented in details in Grbec *et al.* (1).

Results and discussion

For determination of individual components of thermal equilibrium, the selection of formulae is very important. Heat fluxes for the Mediterranean (2) showed different results from those in this work. The discrepancies depended upon the selection of formulae used for calculation. Different results obtained using different input values can be also the reason for discrepancies, as a result of undersampling. In order to demonstrate how large can be these differences on the seasonal scale, different input values were used and the heat fluxes were calculated in the three ways: $(Q_{NET})^{10}$ - based on the row data (from 10 min intervals); $(Q_{NET})^{d}$ - based on the daily means; $(Q_{NET})^{m}$ - based on the monthly means. These are listed in the table 1, together with the amount of error, calculated using the following formula:

$$error^{j} = \frac{\left|(Q_{NET})^{i} - (Q_{NET})^{j}\right|}{(Q_{NET})^{i}}\cdot 100; \quad \left\{ \begin{array}{l} i = 10, d \\ j = d, m \end{array} \right., \quad i \neq j \qquad (1)$$

The fluxes calculated from 10-min intervals, daily means and monthly means are presented in the Fig. 1. Heat loss due to evaporation was higher from March to September, and in January, than the others, calculated from daily means or 10min intervals. However, the values were negative, reflecting that the heat loss due to evaporation was present all the seasons. This shows that, calculating with monthly means, we may overestimate the heat loss due to evaporation, up to 10% in June, or less in other months.

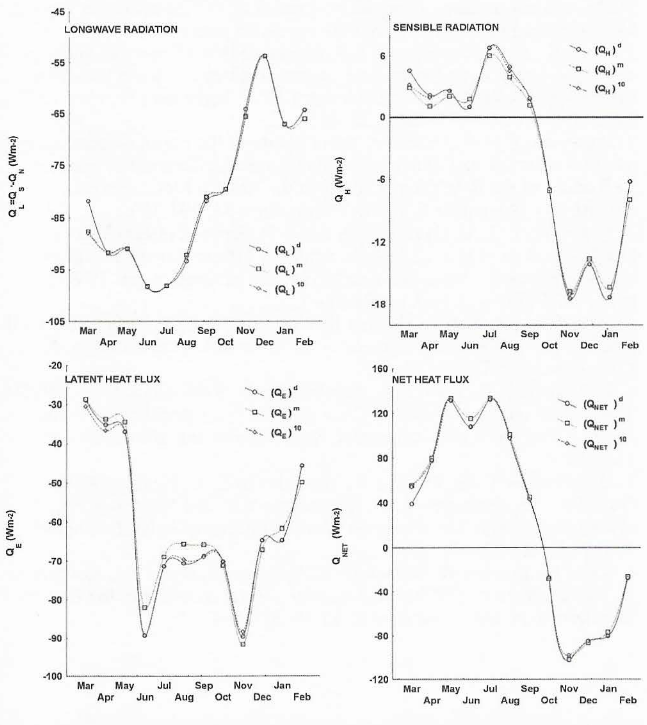

Figure 1. Monthly mean a) global radiation, net radiation and longwave radiation fluxes, calculated from hourly means; b) monthly mean flux lost/gained by evaporation and conduction calculated from hourly means at the metocean station AMOS for the period March, 1999 - February, 2000.

From March to September, sensible heat flux is positive, and the rest of the year negative. Maximum values are reached in July and minimum in November and January. In March, the heat gain due to conduction, calculated from daily means, showed highest departure from the conduction calculated from monthly means or 10min intervals. Heat loss due to long-wave radiation was highest in June, and lowest in December. Only in March, the departure between the values calculated from daily means and others was considerable, and showed about 10% difference.

Resulting heat budget (Fig. 2) shows that the sea looses heat from October to February and gains heat from March to September. The only considerable departure between the results if different averaging is considered was in March, when daily mean values resulted in lower heat gain. From the climatological point of view, it seems that daily values are good enough for heat flux calculation.

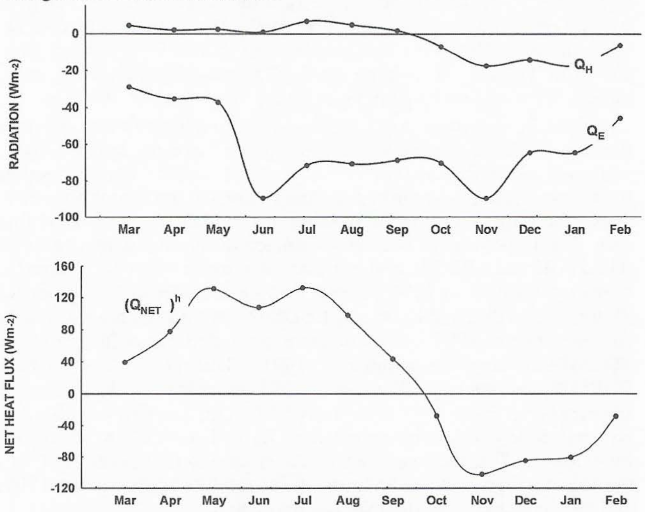

Figure 2. Monthly mean net heat fluxes (QNET), calculated from hourly means, at the metocean station AMOS for the period March, 1999 - February, 2000

Global and net radiation were measured with the error 20Wm^{-2}, while all other parameters were measured with the error neglectable in relation to those originated form the mentioned equations. Since continuous measurements of relevant parameters minimise the undersampling error, which is important for better understanding of heat exchange.

	$(Q_{NET})^d$	$Q_{NET})^m$	$Q_{NET})^{10}$	$(error)^d$	$error)^m$
March	39.14	55.56	54.61	28.33	1.74
April	77.86	80.37	78.12	0.33	2.89
May	131.42	133.13	131.39	0.02	1.33
June	108.03	115.31	108.08	0.05	6.69
July	132.35	133.46	132.37	0.01	0.82
August	98.17	101.18	97.59	0.59	3.68
September	43.83	45.48	43.01	1.89	5.72
October	-27.36	-28.58	-27.36	0.00	4.45
November	-102.37	-101.89	-98.93	3.47	2.98
December	-84.86	-86.84	-84.86	0.00	2.34
January	-80.44	-76.84	-80.44	0.00	4.47
February	-27.72	-26.58	-27.72	0.00	4.12

Table 1. Errors according to equation 1 for heat fluxes calculated from 10 minutes intervals relative to the monthly means and, from daily means relative to the monthly means (%), and heat flux (Wm-2) calculated using different measurement intervals.

References

(1) Grbec B., Dadic V., Ivankovic D., Morovic M. and Matic F., 2001. The First Year of the Automatic Metocean Station Split Marjan-Cape-Preliminary Results. *Acta Adriat.* 42 (1) July 2001 (in press).
(2) Garret C., Outerbridge R. and Thompson K., 1993. Interannual variability in the Mediterranean heat and buoyancy fluxes. *J. Climate*, 6: 900-910.