INCOMING SOLAR RADIATION OVER EASTERN ADRIATIC SEA: A COMPARISON OF DIFFERENT PARAMETERIZATIONS

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Abstract
Two commonly used formulas that estimate solar radiation were analyzed with data collected in the period 2000 - 2003. It was found that Reed's formula gives a correct mean value but significant seasonal error connected with different air masses that occur over the Adriatic Sea during the year. Octa model was calibrated for the study area and was found that it shows significantly less seasonal error and is appropriate for investigation of smaller scale processes.
Keywords : Air-sea Interactions, Adriatic Sea.

Heat fluxes for the Adriatic Sea are basically controlled by solar radiation flux, cloudiness, and different atmospheric and marine properties at the air-sea boundary. Regional heat flux estimation is available from several authors with significant differences between them. Dispersion of the results is mostly caused by different selection of atmospheric and marine data sets and parameterizations used in the bulk formulas. Solar radiation is calculated using the formula proposed by Reed [1], and cloudiness obtained from reanalysis of different meteorological models and using stations monthly means [2, 3]. In order to minimize the error of one component of the total heat flux, the incoming solar radiation will be analyzed in detail in this paper. We will examine two formulas: the one proposed by Reed [1] and a second one called "octa" model proposed by Dobson and Smith [4].

The incoming solar radiation (SR) was measured in the period 2000 to 2003 with 10 minutes sampling using an Aanderaa sensor mounted on a meteo-ocean station located in front of the Institute of Oceanography and Fisheries (IZOR), Split, Croatia. The sensor was calibrated by the manufacturer. Quality control was regularly performed. Cloudiness was observed hourly by the Meteorological and Hydrological Service on the meteorological station Split - Marjan located 2 km northeast from the meteo-ocean station.

The original octa model was calibrated for the eastern Adriatic Sea using linear regressions on the observed transmission factors grouped by cloud categories form 0 to 8 octas. New coefficients and associated errors are listed in table 1. The error is rising form lower to higher cloud amount.

Tab. 1. New coefficients A_i and B_i of the octa model [4]: $Q_s^{Okta}=I_0\,(A_i+B_i \cos z)$ calibrated for eastern Adriatic Sea.

N	A_i	B_i	RMSE
0	0.4456	0.3939	0.0604
1	0.4365	0.4026	0.0634
2	0.4149	0.4265	0.0773
3	0.3918	0.4267	0.0936
4	0.3796	0.4055	0.1110
5	0.3527	0.4033	0.1349
6	0.3224	0.3217	0.1556
7	0.2126	0.2668	0.1510
8	0.1198	0.1047	0.1069

Table 2 shows monthly means of measured and calculated SR using calibrated and original octa model and Reed's formula. Usually Reed's formula slightly underestimates SR, opposite to the original octa model that significantly overestimates SR. As expected, the calibrated octa model does not show differences in annual mean, but all formulas show a significant seasonal error. A seasonal error also appears in estimated clear sky radiation. Following [5] we can conclude that seasonal error is caused by different air masses present over the Adriatic Sea. Also, overestimation of SR for higher cloudiness (C>4/8) in July and August can be connected to daily coastal circulation and cumulus cloud formation.

Tab. 2. Monthly and annual means of incoming solar radiation measured (first column) and calculated: using octa model with new and Dobson and Smith [4] coefficients, and Reed's formula.

Month	Mearsur.	Okta cal.	Okta	Reed
1	62.56	62.83	67.76	60.30
2	98.99	100.53	107.06	103.31
3	163.67	156.18	167.78	148.81
4	198.68	198.59	219.20	192.00
5	274.01	271.56	290.90	255.55
6	318.91	317.06	328.31	313.88
7	296.20	312.10	321.71	311.98
8	245.72	272.85	278.51	278.97
9	191.18	190.83	202.21	181.26
10	119.24	118.57	127.79	111.72
11	71.35	68.64	75.13	63.50
12	53.25	51.22	55.55	49.17
Year	176.31	176.75	186.83	172.54

Using Reed's formula with [5] correction is acceptable for annual means of SR. However, SR has a seasonal error as a consequence of the constant transmission factor used in the clear sky formula. Because the octa model is calibrated for the Adriatic Sea, it has significantly smaller seasonal error and is therefore suitable for smaller scale analysis.

References

1 - Reed R., 1977. On estimating insolation over the ocean. *J. Phys. Oceanogr.,* 7 (3): 482-485.
2 - Bone M. and Grbec B., 2001. A simple solar radiation model applicable in numerical hydrodynamical modeling on seasonalt ime-scale. *Acta Adriat.*, 41 (1): 15-22.
3 - Supić N. and Orlić M., 1999. Seasonal and interannual variability of the Norten Adriatic surface fluxes. *J. Marine Syst.,* 20: 205-229.
4 - Dobson F. and Smith S., 1988. Bulk models of solar radiation at sea. *Q. J. Roy. Meteor. Soc.,* 144: 165-182.
5 - Gilman C. and Garett C., 1994. Heat flux parameterizations for the Mediterranean Sea: The role of atmospheric aerosols and constraints from the water bugdet. *J. Geophys. Res.*, 99 (C3): 5119-5134.