The Bowen ratio is an important parameter in the study of air–sea interaction, particularly in the study of moisture convergence. It is the ratio of sensible to latent heat exchange. Recently, Hsu (1998) reported an interesting relationship between the sea–air temperature difference \((T_s - T_a)\) and the overwater Bowen ratio \((B)\), based on thermodynamic considerations. He used the data collected at four stations in the Gulf of Mexico during the period 1993–97 and proposed a generic relationship of the form

\[ B = a(T_s - T_a)^b \]  

(1)

where the values of \(a\) and \(b\) are estimated from the field experiments. For open sea conditions, the value of \(a\) varied from 0.077 to 0.078, \(b\) from 0.67 to 0.71, and the correlation coefficient \((r)\) from 0.85 to 0.89. Very similar results were found in a nearshore region (for Grand Isle, Louisiana). The equation with the highest correlation coefficient \((r = 0.85)\) is given by Hsu (1998) as

\[ B = 0.077(T_s - T_a)^{0.69}. \]  

(2)

Normally, values of \(B\) are large for cold air outbreak conditions. Chou and Yeh (1986) observed \(B\) to vary between 0.61 and 0.78 over midlatitude coastal water during cold air outbreak events. During Air-Mass Transportation Experiment (14–28 February 1974), the value of \(B\) was about 0.8 over the Yellow Sea. Hsu also reported Bowen ratios that were substantially higher during a cold-air outbreak that resulted in enhanced sensible heat flux over latent heat flux under these conditions. The linear regression given by Hsu (1998) is

\[ B = 0.097(T_s - T_a)^{0.81}. \]  

(3)

Hsu (1999) further studied the relationship using the measurements made in the East China Sea, off San Diego, and in the equatorial Atlantic Ocean and proposed the following equation,

\[ B = 0.146(T_s - T_a)^{0.49}, \]  

(4)

which, in his opinion, is useful for tropical ocean and cold air outbreak conditions as well. However, Eq. (4) yielded higher rms (±0.049) with our data (Table 1). He suggested that more data is needed to verify Eq. (1) for open sea conditions. He also expressed the need for the measurements over other oceanic areas to substantiate his results.

The main purpose of this study is to test the generic relationship proposed by Hsu (1998, 1999) over the northern Bay of Bengal (Indian Ocean), where the values of \((T_s - T_a)\) do not normally exceed 2°C, and the Bowen ratio varies in the range from 0.02 to 0.2 (Sarma and Rao 1992; Sarma et al. 1997).

The long-term time series measurements on the surface meteorological parameters, collected on board ORV Sagar Kanya during the Monsoon Trough Boundary Layer Experiment during the summer monsoon period of 1990 were used to examine the relationships between \((T_s - T_a)\) and \(B\) over the northern Bay of Bengal. The data were obtained at 20°N, 89°E from 18 August–1 September (Phase I) and from 8–19 September (Phase II), in the monsoon trough region. Air–sea heat fluxes and the overwater Bowen ratio were computed and reported earlier (Sarma et al. 1997).

Table 1 shows the daily mean values of latent \((Q_e)\) and sensible \((Q_s)\) heat fluxes, sea–air temperature difference \((T_s - T_a)\), and overwater Bowen ratio \((B)\) during 18 August–19 September 1990 with a data gap from 2 to 7 September. Figure 1 shows the scatter diagram plotted for the parameters \((T_s - T_a)\) and \(B\). We have noticed a very high correlation of 0.93 between \((T_s - T_a)\) and \(B\) with 27 values. The power law curve fitting yielded values of \(a\) and \(b\) as 0.094 and 0.80 respectively. Thus the relationship between \((T_s - T_a)\) and \(B\) emerges as

\[ B = 0.094(T_s - T_a)^{0.80}. \]  

(5)
It is interesting to see that Eq. (5), with its coefficients $a$ and $b$ is nearly the same as Eq. (3) proposed by Hsu (1998) for cold air outbreak conditions. It may be noted that our values of $C_e$ and $C_h$ (bulk transfer coefficients for latent and sensible heat fluxes, also known as Dalton and Stanton numbers respectively) are different from those of Hsu.

We have estimated rms errors from Eqs. (2), (3), (4), and (5) using the dataset given in Table 1 and presented in Table 2. Equation (4), proposed by Hsu (1999) which represents cold air outbreak conditions, gives a higher rms error than Eq. (5) for operational use in the northern Indian Ocean generally remains small (Sarma and Rao 1992; Sarma et al. 1997). Hence, we recommend our Eq. (5) for operational use in the northern Indian Ocean in general and the Bay of Bengal in particular. However, this relationship (Eq. 5) needs to be tested for different conditions, with long-term time series data.

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