

Diurnal variation of certain meteorological and oceanographic factors off Visakhapatnam

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ABSTRACT. The diurnal variation of temperature of air, atmospheric pressure and evaporation over sea and of temperature and salinity of sea water about 55 miles off Visakhapatnam coast on 30 October 1952, is studied. Some of the main features are the cooling of air over the sea in the afternoon due to stronger surface wind, the smaller diurnal component of pressure over sea when compared to that of an inland station and the influence of tide besides evaporation on the diurnal variation of salinity.

1. During the Oceanographic Cruise 2, arranged by the Andhra University with the co-operation of the Defence Ministry, Government of India, hourly data of (a) temperature and salinity of sea water, (b) dry and wet bulb temperature of air, atmospheric pressure etc at about 10 ft a.s.l and (c) estimated surface wind on Beaufort Scale were collected on 30 October 1952 while the ship was drifting in the Bay of Bengal (between 17° 02' N, 83° 51' E and 16° 39' N, 83° 31' E) at a distance of about 55 miles from the Visakhapatnam coast. These data are discussed here.

2. *Temperature*—The diurnal variation of temperature of surface sea water was 2.0°F and of air over sea was 4.3°F. Both these values are quite small when compared with that over an inland station, *viz.*, Hyderabad (17° 22' N, 78° 27' E) where the diurnal variation of temperature was 28.5°F. A smooth curve (Fig. 1) drawn through the air temperature values over sea plotted against time shows two maxima and two minima during the 24-hour period unlike a single maximum and single minimum in the case of a land station. After 1100 IST the air temperature instead of rising fell to a minimum at 1400 IST. It rose to a maximum at 1700 IST and thereafter showed the normal falling tendency due to cooling. The fall in temperature after

1100 IST is attributed to cooling on account of stronger wind. The wind speed on Beaufort Scale was 2 during 1300 and 1500 IST and 1 during the rest of the period. The double diurnal oscillation in the air temperature over Indian waters was reported earlier by Dallas and Sewell (1938). The latter attributed this to the oscillation in the wind in certain months of the year and stated that increase in the wind speed is generally associated with a fall in the air temperature.

3. *Pressure*—The diurnal variation of pressure at sea and at Hyderabad (1787 ft a.s.l), the inland station referred to earlier can be expressed as follows—

Pressure sea

$$= 1009.83 + 0.23 \cos (0-90) + 1.51 \cos (20-283) + 0.16 \cos (30-35) + 0.11 \cos (40-280) + \dots$$

Pressure Hyderabad

$$= 950.44 + 0.67 \cos (0-92) + 1.54 \cos (20-288) + 0.13 \cos (30-30) + 0.08 \cos (40-175) + \dots$$

It will be seen that the chief components of the diurnal variation of pressure are the diurnal (24-hourly) and semi-diurnal (12-hourly) components. The magnitude of the diurnal component at the sea stations

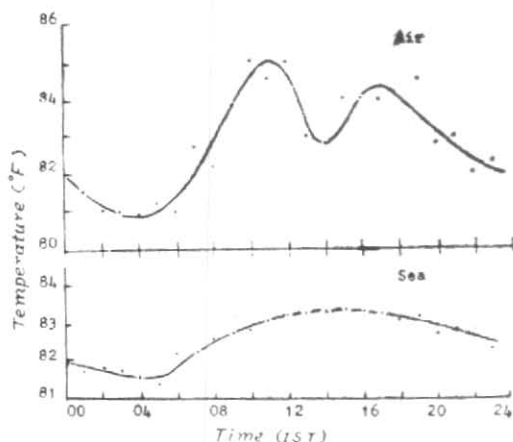


Fig. 1. Diurnal variation of air and sea temperatures

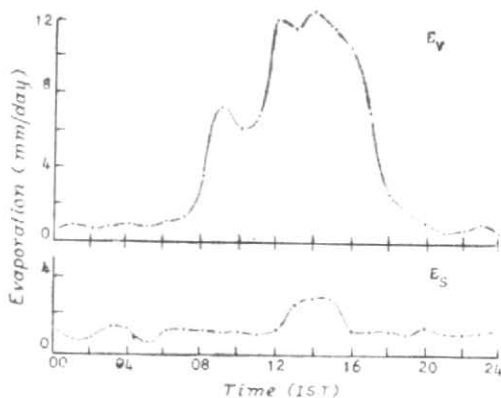


Fig. 2. Diurnal variation of evaporation at Visakhapatnam E_V and over Sea E_S

is smaller than that at the land station whereas the magnitude of the semi-diurnal component is nearly the same at both the stations. Thus the data bring out, as is well known, the dependence of the diurnal component on geographical factors and the independence of the semi-diurnal component on them.

4. *Evaporation*—For a comparative study of the diurnal variation of evaporation over the sea and from a water surface over land, hourly evaporation values expressed in mm/24 hr were calculated indirectly from meteorological factors using Sverdrup's formula (1951) for the sea station and Carl Rowher's formula (1931) for the land station, *viz.*, Visakhapatnam which is about 7 miles from the coast. The two formulae used are given below—

Sverdrup's formula—

$$E = K(e_s - e_a) W$$

where

- E = evaporation in mm/24 hr,
 W = wind velocity in m/sec at height Z ,
 e_s = vapour pressure at sea surface (mb),
 e_a = vapour pressure at height Z in mb,
 $K = 0.086$.

Carl Rowher's formula—

$$E = (1.465 - 0.0186B) \times (0.44 + 0.118W) \times (e_s - e_d)$$

where

- E = evaporation in inches,
 B = pressure in inches of mercury,
 W = velocity of ground wind in miles/hr,
 e_s = vapour pressure of saturated air at the temperature of water surface in inches of mercury, and
 e_d = vapour pressure of saturated air at the temperature of dew-point in inches of mercury.

In the Sverdrup's formula, e_s is taken as 0.98 times the vapour pressure at the temperature of the sea water and the available estimated wind data are used. In Carl Rowher's formula $[(100/h) - 1] e$ is substituted for $(e_s - e_d)$ where h is relative humidity (%) and e vapour pressure. The values in this expression are those at screen height and temperature of water surface at that level is taken to be equal to that of air.

The hourly evaporation data expressed in mm/24 hr are plotted in Fig. 2. The maximum, minimum and average values of evaporation during the 24-hour period were 3.0, 0.6 and 1.4 respectively over the sea and 12.5, 0.5 and 4.3 respectively over the land. Thus both the diurnal average and diurnal range of evaporation were small over the sea when compared to those over the land. The evaporation was small and nearly same (about 1 mm) throughout the day except during 1300 and 1500 IST over sea and generally during the night period (1900 to 0700 IST) over land. The maximum value occurred at about 1400 IST both over the sea and the land.

5. *Salinity*—The salinity variation during the 24-hour period (Fig. 3) can be expressed as follows—

$$S = 29.35 + 0.69 \cos (0 - 203) + 0.52 \cos (20 - 278) + 0.26 \cos (30 - 13) + 0.15 \cos (40 - 250) + \dots$$

where S is salinity in mille. It consists of three chief components, viz., diurnal, semi-diurnal and ter-diurnal components. The diurnal component is mainly due to evaporation with maximum and minimum values (at 1330 and 0130 IST) occurring at about the times of maximum and minimum evaporation (*vide* Fig. 2). The semi-diurnal component appears to be connected to the tide

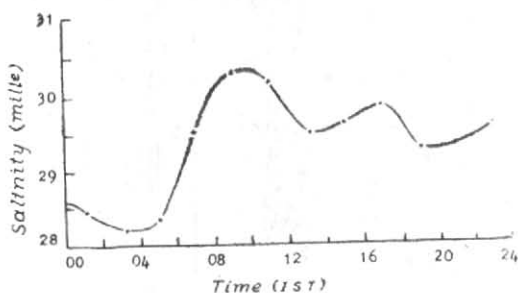


Fig. 3. Diurnal variation of salinity

with salinity high occurring about 3 hrs after the surface high water and salinity low about 3 hrs after the surface low water. It may be mentioned that at this time of the year (October) both horizontal and vertical gradients of salinity were large. On an average, in October, the surface salinity increased from 18‰ near Visakhapatnam coast to 29‰ at 50 miles off coast (Ganapati and Murthy 1954). In the vertical, the salinity increased by 3.6‰ from surface to 100 ft depth at Lat. 16°20' N, Long. 83°08' E on 19 November 1952. Similar data on 30 October 1952, however, are not available. The magnitude of ter-diurnal component is smaller than that of the diurnal and semi-diurnal components.

More data require examination to confirm the above conclusions.

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