551.553 : 551.584

STABILITY CLASSIFICATION IN MICRO-METEOROLOGY

Computation of concentrations by the Gaussian diffusion equation needs the knowledge of dispersion coefficients both in the horizontal and the vertical. The magnitude of these coefficients varies with the stability of the lower layers of the atmosphere. In micrometeorology, several indicators are used to identify the stability. Temperature lapse rate, if available, serves as the best indicator of stability. It is often difficult to have continuous record of temperatures over extended vertical extents; hence one has to resort to indirect methods of determining stability. Wind profile — the distribution of wind with height — depends upon turbulence, hence stability. But wind profile, similar to temperature profile, is also difficult to measure in practice. Presence of cloud cover in the sky causes less heating or cooling. Under these conditions stability tends to be neutral. Strong winds, leading to increased mixing also leads to neutral stability. Clear sky at night time with low winds leads to stability whereas similar condition in day time to instability. These features were utilised by Pasquill in classifying the stabilities which are widely used in the absence of any sophisticated observations. Much of the subjectivity in the above classification was removed by Turner (1961) by utilising solar altitude also alongwith wind and cloudiness. Further refinement to this classification was rendered by Holzworth (1974) by introducing net radiation index and an additional class of stability. Classification of stability utilizing Richardson's number (R_i) has sound physical basis but the parameters needed are neither conventionally measured nor is the accuracy needed usually achieved. However, where available, it should be used in preference to more empirical indicators. Instead of R_i an analogous parameter, called "Bulk Richardson number" (R_B), can also be used with equal accuracy. But this also needs temperatures at two levels and wind at one level at least.

Stability classification can also be based on the range of fluctuations of the horizontal wind direction trace as recorded by an aerovane at standard level (Cramer 1957, 1959). Islitzer (1965), Islitzer and Slade (1968) proposed correspondence between standard deviation of horizontal wind fluctuations (σ_θ) and Pasquill stability classification. In the present paper the magnitudes of standard deviation of wind direction fluctuations, Bulk Richardson numbers obtained from tower data at Mathura corresponding to Pasquill stability types are presented.

2. Wind speeds and temperatures continuously recorded at two levels (2½ & 20½ m) over a mast were used in these studies. Accuracies of wind speed, and temperature are 1 knot and 0.15°C respectively.

Bulk Richardson number (R_B) is calculated by

$$R_B = \frac{g}{T}\left(\frac{\triangle T}{\triangle Z} + \Gamma\right)\frac{Z^2}{u^2}$$

where, $\triangle T$ = Temperature difference between top and bottom of the layer of thickness $\triangle Z$

T = Mean absolute temperature of layer

Z = height of upper anemometer

u = mean wind speed at the upper level.

Standard deviation of wind direction fluctuations is determined utilising the continuous wind direction trace. The trace in any hour is subdivided conveniently into 15-minute or 10-minute periods depending upon the fluctuations. For example, if the trace is smooth and uniform longer averaging period would suffice. But, if the fluctuations are wild shorter averaging period (sometimes even less than 5 minutes) is to be chosen. The difference in the smoothed extreme values of wind direction fluctuations is taken as the range during that sampling periods. All such ranges during the one hour period are averaged and considered as the range of wind direction fluctuations for an hour. 1/6 of the above range is termed as σ_θ (Slade 1968).

Pasquill classification has been adopted with the cloud and wind data recorded at all synoptic hours. Slade (1968) has related these classes to standard deviations of horizontal wind direction fluctuations and corresponding lapse rates. Such relationships are useful when classifying meteorological data from continuous records of wind and temperature. It should be noted that the values given by Slade are not universal. In the present note therefore, the records of the windvane from the tower were analysed independently to obtain σ_θ values.

The site selected for the above study is southeast of Delhi about 150 km and is mainly flat country side.

3. Mean values of σ_θ both at lower (2½ m) and higher (20½ m) levels, corresponding to Pasquill categories are given in Table 1. For comparison, values of Slade (1968) and Shirvaikar (1965) are given. R_B values as obtained by the authors and that of R_i by Pasquill and Smith (1971) are also indicated.

Of all these methods, classification of stabilities by σ_θ is found to be easier and convenient hence in computations of concentrations this method may be used to determine the stability.

TABLE 1

Mean value of σ_θ at $2\frac{1}{2}$ m (P. & G.)	Pasquill stability category	Mean value of σ_θ given by			Mean value of	
		Slade	Shirvaikar	P. & G. (over the tower at $20\frac{1}{2}$ m)	R_B (P. & G.)	R_i (Pasquill & Smith 1971)
14.0	A	25.0	10.0	12.0	—0.146	—1.0 to —0.7
12.5	B	20.0	7.0	10.5	—0.014	—0.5 to —0.4
9.5	C	15.0	5.0	8.0	—0.08	—0.17 to —0.13
7.5	D	10.0	3.5	6.0	0.0	0
6.0	E	5.0	2.5	4.0	0.120	.03 to .05
4.0	F	2.5	1.5	2.0	0.398	.05 to .11

P. & G.=Padmanabhamurty & Gupta

4. For determining the stability at any particular locality in the begining it is suggested to determine the σ_θ values corresponding to the Pasquill stability classes which are generally available for synoptic hours. Subsequently classification by σ_θ method is recommended for the method is simple, objective and can be used continuously in comparison with other methods, particularly that of Pasquill.

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