WPL Application Note No. 5 **December 1990**

BASIC TESTS FOR CHECKING VALIDITY OF FIELD DATA

J.C. Kaimal

The following guidelines are suggested for verifying micrometeorological data gathered in field experiments. It is assumed, for simplicity, that the observations being tested are made over open, relatively flat and uniform terrain, with small roughness elements. It is also assumed that the sensors and the data acquisition and recording hardware are basically sound and that the purpose of the tests is to determine how good the measurements are. For this we divide the data into two categories: a) profile data from slow-response sensors like cup anemometers, glass-encapsulated platinum wire thermometers, and dew-point hygrometers, and b) turbulence data from sonic anemometers, sonic thermometers, infrared (or Lyman alpha) hygrometers. The former has response times of the order of seconds, or even minutes, while the latter typically has a usable frequency range extending to at least 5 Hz.

(a) *Profile data*

1) Make spot checks of collected time series by plotting concurrent 1-5 min segments from different heights. Look for spikes, signal dropouts, or any other unusual behavior.

2) Construct successive 15- (or 20-) minute averages of the time series for all heights over randomly selected periods and plot them as vertical profiles on the same graph**.** Look for consistent kinks in the profiles, indicative of faulty sensors or drifting calibration at one or more heights (see Figure 1).

3) Compute u_* from wind speed difference measured between winds at the lowest two heights (z_1 and z_2).

$$u_* \cong k\left[\frac{(u_2 - u_1)}{ln(z_2/z_1)}\right] \qquad \textbf{(1)}$$

Check for reasonableness of values obtained: $u_* \cong \sigma_w/1.3$ near the ground, or $u_* \lesssim 0.1\ \bar{u}_{1m}$

4) Plot mean wind profiles on log-linear paper and look for a straight fine fit for data points at the lowest levels (1-2 m). Extrapolate profile linearly to zero wind to estimate z_0 (the intercept when profile is passing through neutral stability). Z_0 should typically be a few centimeters high (or less) in open areas (see Figure 1).

5) Compute heat flux from the lowest (z < 2 m) $\bar{u}$ and $\overline{\theta}$ measurements

$$H\Big/\rho c_p = -\left[\frac{k}{ln(z_2/z_1)}\right]^2 \left(\overline{u_2} - \overline{u_1}\right)\left(\overline{\theta_2} - \overline{\theta_1}\right) \qquad \textbf{(2)}$$

With winds expressed in m s^{-1} and temperatures in °C, $H/\rho C_p$ $\left(= \overline{w\theta'}\right)$ on moderately unstable days should stay around 0.25 m °C s^{-1}.

6) Compute Richardson numbers from the vertical gradients of $\bar{u}$ and $\overline{\theta}$. On a moderately unstable day, one should find Ri ≈ -z/L, if turbulence data are available.

(b) *Turbulence data*

1) Make spot checks for spikes and signal dropouts by plotting the time series of the three wind components and temperature one below the other. Look for spikes (common in sonic anemometer channels) and for noise.

2) Construct statistical summaries: $\bar{u}, \bar{v}, \bar{w}, \sigma_u, \sigma_v, \sigma_w, \overline{u'w'}, \overline{w'\theta'}$ over 15- (or 20-) min periods. (Rotate coordinates for computing u and v). Check for the following:

(i) $\bar{u}$ reads close to the mean wind profile value at that height.

(ii) $\overline{w}$ reads close to zero.

(iii) $\sigma_w / u_* \cong 1.3$ near the ground; $\sigma_w / \left(\overline{u'w'}\right)^{1/2} \approx 1.3$ at any height.

(iv) Compute z/L. It should read close to 1 for moderate instability and very nearly equal to Ri.

(v) Test if $\left.\begin{matrix} r_{uw} \approx -0.3 \\ r_{w\theta} \approx +0.5 \end{matrix}\right\}$ for moderate instability.

3) Compute 1-h spectra of u, v, w, and θ and plot them on log-log paper (Figure 1).

(i) Check for -5/3 power law at frequency $f > 2\bar{u}/z$ (i.e., wavelength < z/2).

(ii) Check for 4/3 ratio between transverse and streamwise spectra in that region.

$$\frac{S_w(f)}{S_u(f)} = \frac{S_v(f)}{S_u(f)} = \frac{4}{3}$$

(iii) Compute dissipation rate ε where

$$\varepsilon \approx \left[4.6/\left(\bar{u}\right)^{2/3}\right] \quad \left[f S_w(f)\right]_{f=1Hz}$$

(iv) See if $k\,z\,\varepsilon/u_*^3 \approx 1$ in near-neutral air.

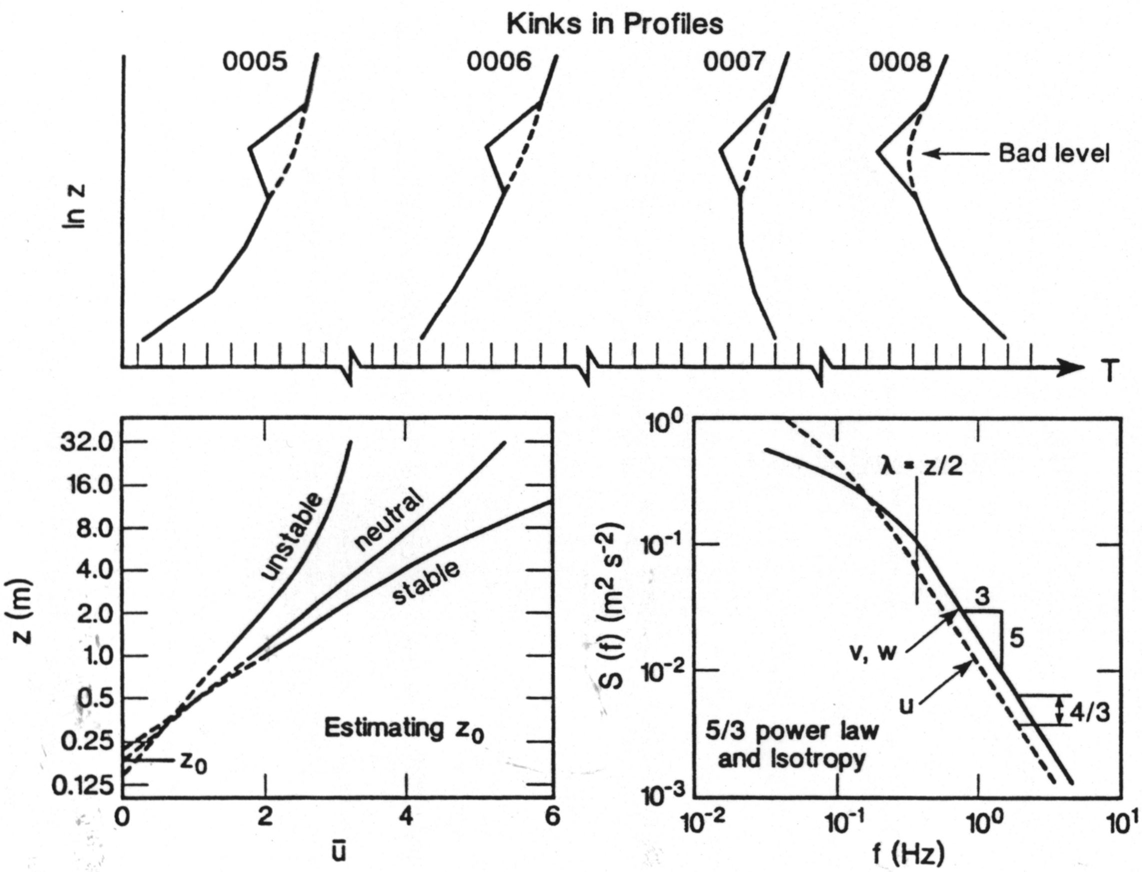

Figure 1. Illustrations of some basic checks for validation of field data.