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Project Summary

Description of the Savannah River Laboratory Meteorological Data Base for 1975 to 1979

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A summary is presented of a meteorological data set collected during the period 1975 to 1979 by the Meteorology Group of the Savannah River Laboratory at the WJBF tower located 11 km southeast of Augusta, GA, and 23 km southwest of Aiken, SC. These data contain 15-min averages and standard deviations of temperature, horizontal wind speed and wind direction, and vertical wind direction. The data were collected at seven elevations above ground: 10, 35, 91, 137, 182, 243, and 304 m. The format of the data base is presented, and a summary is given of the analyses conducted in the course of processing these data. These analyses include checks for consistency and suspect values. Also, analyses were conducted to detect diurnal and seasonal trends in the time series of data. The goal of these analyses was to aid in the assessment of data integrity. Dimensional analyses employing scaling lengths and velocities were not performed, as these were beyond the scope of laying a basic foundation for future studies.

This Project Summary was developed by EPA's Atmospheric Sciences Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

There are few meteorological data sets having an extended period of record available from tall towers. This document summarizes one such meteorological data set collected during the period 1975 to 1979 by the Meteorology Group of the Savannah River Laboratory (SRL), Atomic Energy Division, E.I. du Pont de Nemours & Company. These data contain 15-min averages and standard deviations of temperature, horizontal wind speed and wind direction, and vertical wind direction. The data were collected on the WJBF tower at seven elevations above ground: 10, 36, 91, 137, 182, 243, and 304 m.

This document is structured to serve the needs of those aiming to employ these data in analyses of their own and of those reviewing the results gained already by this initial review of the data. A brief description is provided of the instrumentation and data handling employed to establish the original 15-min averages and standard deviations of the various meteorological elements. This discussion and the summary of the flagging procedures instituted during the review of the data provide the technical information for assessing the suitability of these data for a particular investigation. A summary is presented of the data processing accomplished by this study. Data descriptions and formats are provided for the various computer files established on the EPA Sperry UNIVAC 1110 computer. These tables will prove useful to those accessing these files in later studies. The data were analyzed for consistency and those values that appeared suspect were flagged. In most cases, the suspect values are attributable to values below instrument threshold or beyond instrument range. An inspection of the flagging procedures will

reveal that the intent was to identify the most extreme values. Procedures are outlined for estimating the surface fluxes and certain other parameters typically employed in meteorological analyses. A summary is presented of the trends and patterns seen in the course of the data processing. Plots were developed depicting the diurnal variation of the meteorological elements for each month. The goal of these analyses was to aid in the assessment of data integrity. Dimensional analyses employing terms such as mixing height, surface friction velocity, or Monin-Obukhov length were not performed,as they were beyond the scope of this study. The intent of this study was to lay the groundwork for the succeeding analyses.

The WJBF-SRL Meteorological Facility, is 11 km southeast of Augusta, GA, and 23 km southwest of Aiken, SC. The 365-m tower, the base of which stands 121 m above mean sea level, has been in use as a meteorological tower since October, 1965.

The WJBF tower is one of three TV-radio towers near the rural community of Beach Island, SC. There is no one dominant form of land use in its immediate vicinity. Along any given azimuth from the tower, the rolling terrain varies with pine tree forests (heights approximately 10 to 20 m), pastures and fields, and clearings of waist-high scrub and young saplings.

Two major topographical features are the Savannah River and an intermittent stream called Long Branch. The broad Savannah River flows within 5.6 km to the west and within 9.7 km to the south of the WJBF tower. Long Branch flows from northwest to southwest with its closest approach about 610 m southwest of the tower.

The terrain and ground cover in the vicinity of the tower is similar to much of the southeast piedmont region of the United States. Study of the climatology of these tower data should yield useful information on conditions experienced by sources of pollutants within this region. Those studies of dispersion conducted employing the tower data have not shown the meteorological conditions to be dominated by the rolling terrain and varied land use. To the contrary, it has been found that the similarity scaling relationships are still useful descriptions even though such relationships are applicable, strictly speaking, to flat homogeneous terrain.

Procedure

As the data came from several sources in different formats, the first step was to convert the data into convenient formats for the succeeding analyses. Those values within the SRL tower data deemed suspect were flagged in a manner that retained access to the original values. Suspect values within the National Weather Service data typically could be attributed to keypunch errors that were easily identified by a comparison with adjacent values in time or space. Those values identified as keypunch errors were replaced with corrected values.

Flagging Procedures for WJBF Meteorological Data

As often occurs in the review of data values from large sets, some values are deemed of questionable validity. In such cases, one has the choice of either eliminating those values from the data set or annotating them in some manner. The latter procedure is often referred to as "flagging." The reasons for flagging any single value are legion. We have chosen to flag questionable values by (1) adding 2000 to the original value and (2) assigning a specific code word to the value. This code word, when used with the appropriate key, provides the reason for the flagging. The user does not have to decode the code word unless he wants the reason for flagging. Since all the original data values contain, at most, three digits in front of the decimal, no significance was lost by the addition of the 2000. The code word was left blank for unflagged data values. If the user wishes, the flagging can be ignored altogether, and the original data set can be rebuilt by subtracting 2000 from all flagged values.

Results and Discussion

Surface Parameter Analyses

Atmospheric dispersion is controlled by turbulence in the air. Therefore, the parameters describing the scales of turbulence are of fundamental importance in a description of atmospheric dispersion. The meteorological instrumentation necessary to specify these scaling parameters directly is typically not available except during research field studes. In lieu of such measurements, the scaling parameters are specified through the use of semi-empirical relationships employing more easily obtainable meteorological data. It was not the purpose of this effort to analyze the SRL tower data in terms of these parameters. However, it was felt that it would be worthwhile to explore, on part of the data base, the specification of some of these scaling parameters. Such an analysis would provide insight into the difficulties to be encountered in specifying the scaling parameters with the available data.

The surface roughness length was estimated to be 0.30 m using the longitudinal turbulence intensity. This value is reasonable considering the surface ground cover and the site description. This value of roughness length was used to develop estimates of the surface fluxes. Comparison of the observed vertical and lateral turbulence intensities with theoretical estimates revealed no major inconsistencies. We did find a group of erroneous values for the standard deviation of the horizontal wind direction, having values below 2 degrees, that had gone undetected when the flagging procedures were developed. It was also found during these latter comparisons that the procedure employed for estimating the Monin-Obukhov length L has a bias against estimating L-values of about 15 m. This is considered of minor consequence. An anomalous behavior in the turbulence values for westerly wind directions was traced to the wind shadow cast by the cup anemometer on the bivane for wind directions between 269 and 285 degrees.

Diurnal Variations

In the course of assessing the tower data for continuity and veracity, we found it useful to develop analyses of the diurnal variation of the meteorological elements. The typical solution is to average all data by hour of day. The sharp changes in time and space are smeared by such a procedure. However, such averaged data are useful for a first assessment of the trends evident within a set of data.

For every other month starting with February, the 15-min data values were grouped into 2-h blocks, with 00-02 local standard time as the first block. About 240 cases were possible in each 2-h block at each height, a total of 8 (four 15 min periods per hour) times the number of days in the month. Missing and questionable data would reduce this number.

In general, the developed plots revealed the expected annual trends in the diurnal patterns. Too much emphasis should not be placed on the precise details in the patterns or in the precise magnitudes of the variables. These analyses are useful for developing a sense of the seasonal trends that occur in the structure and gradients in time and space. One can also develop some sense of the typical magnitudes to be expected.

Seasonal Variations

After inspecting a number of the diurnal

patterns for each month for each meteorological variable, characteristic (key) features of these patterns were chosen for analysis over the five-year period. As a working criterion in the selection of these features, those qualities were selected that, if properly approximated, would strongly promote an accurate description of the observed diurnal patterns for each month.

The key features selected for analysis for each of the meteorological variables follow:

Potential Temperature
- 10-m
  - average value
  - maximum value and hour of occurrence
  - minimum value and hour of occurrence
- Nocturnal structure
  - inversion strength when 10-m minimum temperature occurs

Wind Speed
- 10-m
  - average value
  - maximum value and hour of occurrence
  - minimum value and hour of occurrence
- Nocturnal structure
  - maximum value, height and time of occurrence
  - gradient in the vertical between maximum and 10-m value

Wind Direction Fluctuations
- 10-m
  - average value
  - maximum value and hour of occurrence
  - minimum value and hour of occurrence

Horizontal Wind Direction Shear
- maximum value, height and time of occurrence

An inspection of the time series of values determined for each of the key features suggested strong seasonal dependence for some of the key features. A procedure was established for determining a best fit sine wave to the key feature values as an aid in assessing the seasonal dependence. The period was assumed to be one year.

As an alternative to a seasonal dependence, one could hypothesize that no significant seasonal trends exist. An F-test can be used to test whether the variance is significantly reduced in choosing between a seasonal or a nonseasonal model.

The F-test results, comparing the above two models, suggest that seasonal variations can be detected and characterized. Those key features, shown to have a significant seasonal variation within the tower data, provide a standard for comparison in model evaluation studies. For instance, if boundary layer meteorology were simulated using routinely available NWS data, a comparison could be made to determine how well the simulated meteorology describe the determined seasonal variations. Objective statements could be made whether the simulated meteorology provided as precise a characterization of the variations as that determined with the available tower data.

Conclusions

A summary is presented of the data processing completed on the five-year data set of meteorological tower data collected by the Meteorology Group of the SRL. This data set provides a unique opportunity to study micrometeorological processes within the lower 300 m of the atmosphere. The purpose of this document is met if it provides potential users of these data the information needed to access the data files.

It is anticipated that users of these data have access to the EPA Sperry Univac computer. No plans have been made to provide copies of the data for use on other computer systems. Inquiries for gaining access to the data should be addressed to:

Chief, Environmental Operations
Branch (MD-80)
Meteorology Division
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D. Bruce Turner *is the EPA Project Officer (see below).*

The complete report, entitled "Description of the Savannah River Laboratory Meteorological Data Base for 1975 to 1979," (Order No. PB 86-166 287; Cost: $16.95, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

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