Environmental Research Laboratories

**Air Resources
Atmospheric Turbulence and Diffusion Laboratory**

Oak Ridge, Tennessee

March 1981

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for
1979 and 1980

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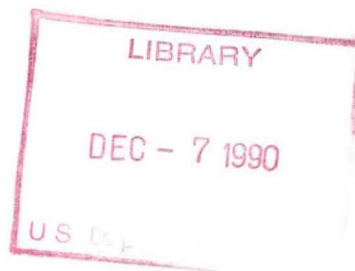Price: Printed Copy A04
Microfiche A01

Foreword

The following is a compilation of abstracts of research
contributions from the National Oceanic and Atmospheric
Administration Air Resources Atmospheric Turbulence and
Diffusion Laboratory for the calendar years 1979 and 1980.
It was prepared by the Technical Information Center, U. S.
Department of Energy, Oak Ridge, Tennessee. Copies of
individual papers are generally available from the author.
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the National Oceanic and Atmospheric Administration.

Steven R. Hanna
Acting Director
Atmospheric Turbulence and
Diffusion Laboratory

CONTENTS

FY 1980

Atmospheric Turbulence
and Diffusion Laboratory

Summary of Activities
and Plans - FY 1980 - 1981

The Atmospheric Turbulence and Diffusion Laboratory (ATDL) in
Oak Ridge, Tennessee, is operated for the Department of Energy by the
National Oceanic and Atmospheric Administration's (NOAA) Air Resources
Laboratories. The ATDL is generally concerned with research on the
atmospheric consequences of energy production, and the prediction and
control of environmental air pollution. Major funding is from DOE's
Office of Health and Environmental Research, Pollutant Characterization
and Safety Research Division. The ATDL works closely with various
divisions of Oak Ridge National Laboratory (ORNL) and with atmospheric
sciences units at other national laboratories on environmental projects
of mutual concern.

The ATDL research program is organized around the following subject
areas: transport and diffusion over complex terrain, atmospheric turbulence
and plume diffusion, and forest meteorology and climatological studies.
Current research efforts involve experimental and numerical modeling studies
of flow over rugged terrain, studies of transport of airborne material in
and above a forest canopy, basic studies of atmopsheric diffusion parameters
for applications to environmental impact evaluation, plume rise studies, and
scientific collaboration with personnel in DOE-funded installations, univer-
sities, and government agencies on meteorological studies in our area of
expertise.

Transport and Diffusion over Complex Terrain

This research on transport and diffusion over complex terrain represents
the ATDL's contribution to the Department of Energy's Atmospheric Studies
in Complex Terrain (ASCOT) program. Elements of this contribution include
program planning, experimental design, analytical and numerical modeling,
data analysis and field studies of the nighttime atmospheric flow in
valley environments.

A. Analytical and Numerical Modeling of Drainage Flows.

The driving force for nighttime flows in valley environments
is the drainage wind along the valley side-walls. Because of its
fundamental role in nighttime flows, the drainage wind was selected
for intensive investigation using numerical and analytical modeling
techniques. Analytical modeling makes use of basic principals,
i.e., fundamental physics, to relate drainage flow windspeed,
temperature and thickness to slope angle, cooling at the ground
surface and atmospheric stability. Numerical modeling of drainage
flows attempts to simulate the detailed temporal and spatial struc-
ture of the flow using time-dependent one- and two-dimensional
models. These models make use of a physically realistic turbu-
lence parameterization based on the turbulence kinetic energy

equation. Very realistic simulations have been performed; however, because these models require a fine computational grid with small time-steps, a long computer running time is required. Efforts are under way to optimize the computer code to achieve faster running times.

B. Field Experiments.

Data collected during the October 1979 drainage flow experiment conducted on a steep ski slope near Los Alamos, New Mexico are being analyzed to determine a threshold bulk Richardson's number below which drainage flows fail to develop. Initial results show that the thickness of the drainage layer verified the predictions of the analytical model.

During the September 1980 Anderson Creek Valley field experiment, ATDL personnel took observations of the nighttime vertical structure of the drainage wind above Putah Creek. Observations were made using pilot balloons, tethersonde, laser anemometer, acoustic sounder and net radiometer. These data are now being reduced.

Observations of nighttime flow continue on a nearly two-dimensional ridge located about 10 mi. from Oak Ridge. Wind observations made at 2 m height above the ground surface at mid-slope and near slope bottom, do not show a drainage wind. Instrumentation has recently been added to gather wind data at these two sites at the 0.5 meter height.

Plans are under way for ATDL's participation in the ASCOT August 1981 field study in the Geysers region of California. ATDL will provide tethersonde observations in support of cooling tower plume rise and diffusion studies.

Atmospheric Turbulence and Plume Diffusion.

Presently practical techniques for atmospheric dispersion estimates (for instance, those recommended by the NRC Safety Guides and the EPA regulations) depend largely on the numerous diffusion experiments conducted during the 1950's and early 1960's. However, current theories and turbulence experiments are forcing a reconsideration of these results for certain cases, especially for strongly convective daytime conditions, and for stable nocturnal conditions.

As a background for diffusion calculations, it is necessary to know the structure of the planetary boundary layer. The latest techniques (second order closure) and physical formulations are being used to calculate the vertical variations of winds, turbulent fluxes, temperature, and cloud physics parameters in the PBL. This model has been used to estimate the diffusion of waste heat from a cooling pond and to estimate

flow in the nocturnal boundary layer, for which a new turbulent kinetic energy closure method was developed. Future plans for this model include application to slope flows and to turbulence structure within and above a forest canopy.

A Lagrangian statistical diffusion model permits calculation of diffusion in areas where there are mesoscale variations in mean wind speed and turbulence quantities. In this model the trajectory of each particle adjusts itself to the local mean and turbulent wind field in which it is immersed. Thus it can be applied to diffusion over complex terrain or seashores. An experiment in Boulder, Colorado, was used to provide information on the link between Lagrangian and Eulerian turbulence, so that the model could be operated using Eulerian tower data. The model is used to determine the effects of release height on σ_y and σ_z, the influence of wind shears on diffusion, and to calculate diffusion in complex terrain experiments such as the DOE Geysers experiment.

The St. Louis RAMS data are the best urban meteorological and air pollution data ever collected. Unfortunately very little analysis of these data has been done. ATDL has acquired the hourly data from 1976 and is determining the correlations between meteorological parameters and pollutant concentrations. Statistical relationships for the air pollution data are being studied. Once this analysis is complete, we plan to test the ATDL simple model and a mesoscale puff model with the data. Previous studies with EPA models indicate agreement between predicted and observed concentrations for one-hour averages. Performance standards and methods of evaluating models will be developed.

Forest meteorology and Climatological Studies.

The ATDL deciduous forest meteorology research facility adjacent to ORNL's Walker Branch Watershed has been essentially completed. This facility allows measurements of space and time distribution of a variety of micrometeorological variables within and above the deciduous forest and represents a unique and invaluable national scientific resource.

Instrumentation suitable for measurement of vector wind velocities and turbulence characteristics above the forest were acquired, their calibrators checked in the ATDL wind tunnel, and the sensors installed above the forest at the Walker Branch site.

Preliminary data on component wind velocities and their turbulent fluctuations were collected above the fully-leafed forest. Vertical distributions of woody biomass were observed and this survey was two-thirds completed during FY 1980.

Periodic observations of space and time distributions of wind speeds within the forest were initiated under a variety of synoptic conditions in the various seasons and phenological phases of the deciduous forest. These observations were augmented with a limited study of the spatial and temporal variations in vector wind velocities and in turbulence characteristics within the forest. Comparisons of wind speed and velocity distributions will yield important information about the reality of the universally observed subcanopy wind speed maximum and consequently, about the nature of dispersion processes occurring within deciduous forests.

Collection, as needed, and analysis of forest radiation distribution data continued. Significant models of radiation in vegetation were computer coded and model predictions compared against observed data in preliminary tests of these models.

Title   :   Lagrangian and Eulerian Time Scale Relations in the Daytime
              Boundary Layer

Author(s):   Steven R. Hanna

Date   :   January 1980

Abstract

Lagrangian (neutral balloon) and Eulerian (tower and aircraft) turbulence observations were made in the daytime mixed layer near Boulder, Colorado. Average sampling time was about 25 minutes. Average Lagrangian time scale is about 70 seconds and average ratio of Lagrangian to Eulerian time scales ($\beta = T_L/T_E$) is about 1.7. The ratio β is inversely proportional to turbulence intensity, i. These data support the formula $\beta = .7/i$. Lagrangian time scale for the vertical component of turbulence at heights above about 100 m is given by the formula $T_L = .17 z_i/\sigma_w$, where z_i is mixing depth. This formula is valid for the horizontal components of turbulence at all heights in the mixed layer. Lagrangian spectra in the inertial subrange are best represented by the formula $F_v(n) = 0.2 \, \epsilon n^{-2}$.

Title   :   Atmospheric Turbulence and Diffusion Estimates Derived
               From Observations of a Smoke Plume

Author(s):   Carmen J. Nappo

Date   :   January 1980

Abstract

Plan view and elevation photographs of a smoke plume are used to
estimate horizontal and vertical dispersion rates. Dispersion rates measured
from individual photographs agree with Batchelor's theoretical analysis of
relative diffusion. Dispersion rates measured from a composite of plume
photographs agree with Taylor's theoretical analysis of single-particle
diffusion. These dispersion rates are then used to calculate Eulerian
turbulence parameters which are compared with observations made on a 60 m
tower near the smoke-plume source. In addition, the Lagrangian turbulence
time scale, and the horizontal eddy diffusivity are estimated. The comparisons
of estimated with observed parameters are good, suggesting that the smoke-
plume technique for estimating atmospheric dispersion is realistic.

ATDL Contribution File No. 80/2

Title : A Nonstationary Nocturnal Drainage Flow Model

Author(s): K. S. Rao and H. F. Snodgrass

Date : March 1980

Published: Proceedings of 2nd Joint Conference on Applications of
Air Pollution Meteorology and 2nd Conference on Industrial
Meteorology, March 24-28, 1980, New Orleans, LA., pp. 499-504.

Abstract

The evolution of an idealized nocturnal drainage flow over a large
homogeneous uniformly-sloping surface is investigated by a nonstationary
model using a variable eddy diffusivity profile determined from considera-
tions of the surface energy budget, ambient atmospheric conditions, surface
characteristics and the flow structure. The model formulations and numeri-
cal simulations of the evolution of mean wind and temperature profiles in
the drainage layer are presented. The effects of important physical pa-
rameters, such as the slope, ambient atmospheric stability, surface heat
flux (or cooling rate) and aerodynamic roughness, on the drainage flow
development are investigated. The assumptions, limitations, and appli-
cations of the model are discussed.

Title   : Drainage Wind Observations Using Neutral-Lift Balloons

Author(s): C. J. Nappo, S. R. Hanna, and H. F. Snodgrass

Date   : March 1980

Published: Proceedings of 2nd Joint Conference on Applications of
Air Pollution Meteorology and 2nd Conference on Industrial
Meteorology, March 24-28, 1980, New Orleans, LA., pp. 495-498

Abstract

Neutral-lift pilot balloons, released at a rate of about two per
hour between 6:00 p.m. and 6:00 a.m. and tracked with double theodolite
technique, were used to observe the structure of nocturnal drainage
winds in the Anderson Creek Valley near the Geysers geothermal region.
Observations made during five nights show a persistent drainage flow
~80 m thick lying above the creek. Wind speeds in the drainage flow
ranged from 1 m/s to 5 m/s with a mean speed of ~3 m/s. A second
drainage flow was observed above the creek drainage flow. Complex
valley circulations such as rotors, return flows, and helical flows
were also observed.

Title   :   Complex Terrain Influence on σ_θ and σ_y at TVA's Widows
               Creek Steam Plant

Author(s):   Steven R. Hanna

Date   :   March 1980

Published: <u>Proceedings of the 2nd Joint Conference on Applications of
             Air Pollution Meteorology and 2nd Conference on Industrial
             Meteorology</u>, March 24-28, 1980, New Orleans, La., pp. 567-570.

Abstract

    The Widows Creek Steam Plant of the Tennessee Valley Authority (TVA)
is located along the Tennessee River in northern Alabama in the Appalachian
Mountains. High quality meteorological observations are routinely made from
two towers and SO_2 concentrations are measured at about 20 stations. Using
these data, the relationships between σ_θ and σ_y in complex terrain were
investigated. It was found that observed σ_θ at the valley tower is 60%
enhanced for cross valley wind directions. This increase is caused by
mesoscale eddies shed by the complex terrain. Pasquill's formula, $\sigma_y =
\sigma_\theta \times f(x)$, yields fair agreement with observed σ_y on a monitoring arc
3.5 km from the steam plant. It is necessary to account for initial plume
size, σ_{yo}, in making the estimate of σ_y.

ATDL Contribution File No. <u>80/5</u>

Title   : Dispersion in the Vicinity of Buildings

Author(s): R. P. Hosker, Jr.

Date   : March 1980

Published: <u>Proceedings of 2nd Joint Conference on Applications of Air
            Pollution Meteorology and 2nd Conference on Industrial
            Meteorology</u>, March 24-28, 1980, New Orleans, La., pp. 92-107.

Abstract

     This paper very briefly reviews current understanding of flow patterns
near simple block-like buildings. Procedures for stack height selection
and for estimating effluent dispersion near and downwind of such simple
structures are summarized. The discussion emphasizes the case of a source
on or close to a building, although upwind and downwind source locations
are briefly considered.

Title   :   Experimental Methods and Preliminary Analyses of Drainage
Flow Observations During the First ASCOT Field Study.

Author(s):   R. P. Hosker, K. S. Rao, and G. A. Briggs

Date   :   March 1980

Abstract

Wind and temperature data obtained with two instrumented masts and
two wiresondes during the first ASCOT field study, July, 1979 are described
and analyzed. Instrument characteristics are given. Features of the
nocturnal cold air drainage along Anderson Creek are presented in some
detail. Interpretations of the results are given in terms of the local
topography and the possible development of a cold air "pool" at the
confluence of several surrounding drainage areas.

Title   :   Practical Application of Air Pollutant Deposition Models --
                Current Status, Data Requirements, and Research Needs

Author(s):   R. P. Hosker, Jr.

Date   :   April 1980

Published: To appear in: Proc. of Internat. Conf. on Air Pollutants and
                Their Effects on the Terrestrial Ecosystem, Banff, Alberta,
                Canada, May 10-17, 1980. (S. V. Krupa & A. H. Legge, editors,
                John Wiley & Sons, New York).

ABSTRACT

    Methods presently available for simulating transport, diffusion,
and wet and dry removal of atmospheric pollutants are surveyed.
Current transport and dispersion models are briefly described. Techniques
for estimating wet and dry delivery of effluent to the landscape are
summarized. Methods for calculating the required removal parameters
are given, along with references to available experimental data. Particular
transport models and removal schemes are recommended according to the
size of the region under study. Data requirements and model weaknesses
are described, and topics for additional research are suggested.

Title   :   Sub-Grid Scale Plume Dispersion in Coarse
                Resolution Mesoscale Models

Author(s):   Richard T. McNider, Steven R. Hanna, and Roger A. Pielke

Date   :   April 1980

Abstract

A Lagrangian conditioned particle scheme
which is easy to apply in non-uniform mesoscale
flow fields was combined with a coarse grid
mesoscale model boundary layer to make simple
dispersion calculations. Turbulent statistics
needed to utilize the conditioned particle
scheme were extracted from the simplified
exchange coefficient boundary layer and agreed
reasonably well with observations. Dispersion
statistics from particles released within the
model boundary layer also agreed very well with
the experiments of Lamb (1978) and Willis and
Deardorff (1978).

ATDL Contribution File No. 80/9

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Title   :   Observations of Nighttime Winds Using Pilot Balloons in
                Anderson Creek Valley, Geysers, California

Author(s):   Carmen J. Nappo and Howell F. Snodgrass

Date   :   June 1980

Published: Submitted to Journal of Applied Meteorology

Abstract

    Nightime winds in Anderson Creek Valley located in the Geysers area
of northern California are examined using pilot balloons as air parcel
tracers. Observations show a persistent night-to-night pattern of winds
above Anderson Creek Canyon and in the valley basin. Before sunset,
strong down-slope winds exist; these are believed due to terrain inter-
actions with the late afternoon sea-breeze. The drainage wind within the
creek canyon has an average speed of about 3 m/s, grows in thickness at
a rate of about 80 m per kilometer of downwind distance and is insensitive
to above-valley wind speeds. Balloons in the drainage wind quickly spread
throughout the creek canyon. The transition from valley winds to the free,
above-valley winds occurs at about 500 m above the valley floor for weak
above-valley winds, and about 300 m for strong above-valley winds.

Title   :   Thermal Vegetation Canopy Model Studies

Author(s):   J. A. Smith, K. J. Ranson, D. Nguyen, L. Balick, L. E. Link,
L. Fritschen, and B. Hutchison

Date   :   May 1980

Abstract

An iterative type thermal model applicable to forest canopies was tested with data from two diverse forest types. The model framework consists of a system of energy budget equations describing the inter-actions of short and long-wave radiation within three horizontally infinite canopy layers. A formulation of the energy dynamics within the canopy is used which permits a factorization of canopy geometrical parameters from canopy optical and thermal coefficients as well as environmental driving variables.

Two sets of data characterizing a coniferous (Douglas-fir) and deciduous (oak-hickory) canopy were collected to validate the thermal model. The results show that the model approximates measured mean canopy temperatures to within 2°C for relatively clear weather con-ditions and deviates by a maximum of 3°C for very hazy or foggy conditions.

Title : Diurnal Variation of Horizontal Wind Direction Fluctuations
σ_θ in Complex Terrain at Geysers, Cal.

Author(s): Steven R. Hanna

Date : May 1980

Abstract

Horizontal diffusion in the surface layer is dependent on the standard deviation of wind direction fluctuations σ_θ. Diurnal variation of this parameter in complex terrain was studied for the July 1979 Geysers, Cal., experiment using data from a network of 11 short meteorological towers in the 25 km^2 Anderson Creek watershed. Valley side slopes are roughly 20° and maximum terrain difference is about 1 km.

Values of σ_θ for wind directions sampled for one hour at a height of 10 m are about 35° during the daytime. They slowly decrease to about 20° by 8 to 10 p.m. as stability increases but wind speeds are still relatively high. After 10 p.m. the drainage flow sets in at most stations, with speeds of 1 to 2 m/s, and average σ_θ increases to about 30° during the period 11 p.m. to 6 a.m. In general, highest values of σ_θ at night are associated with lowest values of wind speed and greatest static stability. This enhancement of σ_θ by the terrain suggests that horizontal diffusion at night always conforms to that expected during nearly neutral stabilities. That is, Pasquill class D diffusion applies to the horizontal component all night in complex terrain.

Title   : What Convective Scaling Does for Diffusion Data

Author(s): Gary A. Briggs

Date   : February 1980

Abstract

The purpose of this paper is to illustrate the effectiveness of convective scaling when applied to convective boundary layer turbulence, and to demonstrate its potential for ordering diffusion data. The historical development of convective scaling ideas is reviewed, contrasting the success of the analyses of the Kansas and the Minnesota boundary layer experiments of 1968 and 1973 (convective scaling was applied to the analysis of the latter experiment, but not to the former). Both early and very recent analyses of the famous Prairie Grass diffusion experiment are reviewed, showing how convective scaling resolves questions that were raised in earlier work. Finally, further analyses are carried out on both the Prairie Grass and the Morgantown power plant data sets to compare the effectiveness of several genre of ordering schemes.

Title   : User's Guide for ATCOOL Cooling Tower Plume Model

Author(s): Steven R. Hanna

Date   : June 1980

Published: NOAA Technical Memorandum ERL ARL-85

Abstract

ATCOOL is a computer program for calculating the variation
of cooling tower plume parameters with height and distance down-
wind. It combines Briggs' plume rise model with Weinstein's cloud
physics model. Plume rise, visible plume length, and cloud forma-
tion can be calculated. The program listing and a worked example
are given.

Title   :   Handbook on Atmospheric Diffusion

Author(s):   Steven R. Hanna, Gary A. Briggs, and Rayford P. Hosker, Jr.

Date   :   July 1980

Published: To be published as a handbook by the Technical Information
             Center, DOE, Oak Ridge, Tennessee

Abstract

See attached Table of Contents in lieu of abstract.

Table of Contents

Preface

Title   : Canopy Effects on Predicted Drainage Flow Characteristics
              and Comparisons with Observations

Author(s): Gary A. Briggs

Date   : June 1980

Published: Extended Abstract - Proceedings of Fifth Symposium on
            Turbulence, Diffusion, and Air Pollution, March 9-13, 1981,
            Atlanta, Ga., pp. 113-115.

Abstract

A simple model for drainage flow confined by canopy to a height h above a slope of angle β is developed, using a canopy drag characteristics area per unit volume A; A^{-1} can be interpreted as a "line of sight" distance, and Ah as a "canopy density factor." The predictions of this model are compared to those of a previously-developed "open slope" model, in which the flow thickness grows linearly with distance down the slope; the main differences between the models are that the flow speed is more restricted, the flow volume grows much more slowly, and the degree of cooling increases instead of decreases with distance down the slope in the canopy-confined model. In addition, a very simple model that neglects friction and entrainment is suggested for flow traveling down stream beds, converging from the slopes on either side. Some measurements and estimates from measurements of temperature differences, flow speeds, and flow volumes in drainage flows near Anderson Springs, CA are described and compared to the model predictions. The best comparisons are with the canopy-confined model with h = 20m and A^{-1} = 40m, which befits a somewhat sparse canopy, such as occurs in most of the experimental area. The creek bed flow model is partially successful at predicting flow speeds near the creek beds, but appears to need refinement, such as the inclusion of canopy-induced friction.

ATDL Contribution File No. 80/16

Title   : Turbulent Energy and Lagrangian Time Scales in the Planetary
            Boundary Layer

Author(s): Steven R. Hanna

Date   : October 1980

Published: Proceedings of Fifth Symposium on Turbulence, Diffusion and
           Air Pollution, March 9-13, 1981, Atlanta, Ga., pp. 61-62.

Abstract

In order to apply Taylor's statistical diffusion theory or computerized
Monte Carlo models to estimate diffusion in the planetary boundary layer (PBL),
it is necessary to know the variation with height of the turbulent energy
components σ_u^2, σ_v^2, and σ_w^2, and the Lagrangian time scales T_{Lu}, T_{Lv}, and
T_{Lw}. In this short note, formulas are recommended for the variation of the
turbulent energies and Lagrangian time scales with height for all stability
conditions.

Title   : Cooling Tower Drift Studies at the Paducah, Kentucky
             Gaseous Diffusion Plant

Author(s): Fred G. Taylor, Steven R. Hanna, and Patricia D. Parr

Date   : December 1978

Published: By ORNL as ORNL/TM-6131, Environmental Sciences Division
            Publication No. 1275

Abstract

The transfer and fate of chromium from cooling tower drift to terrestrial
ecosystems were quantified at the Department of Energy's uranium enrichment
facility at Paducah, Kentucky. Chromium concentrations in plant materials
(fescue grass) decreased with increasing distance from the cooling tower,
ranging from 251 $\pm$ 19 ppm at 15 meters to 0.52 $\pm$ 0.07 ppm at 1500 meters.
The site of drift contamination, size characteristics and elemental content
of drift particles were determined using a scanning electron microscope
with energy dispersive x-ray analysis capabilities. Results indicate that
elemental content in drift water (mineral residue) may not be equivalent to
the content in the recirculating cooling water of the tower. This hypothesis
is contrary to basic assumptions in calculating drift emissions. A laboratory
study simulating throughfall from 1 to 6 inches of rain suggested that there
are more exchange sites associated with litter than live foliage. Leachate
from each one inch throughfall simulant removed 3% of the drift mass from
litter compared to 7 to 9% from live foliage. Results suggest that differences
in retention are related to chemical properties of the drift rather than
physical lodging of the particle residue. To determine the potential for
movement of drift-derived chromium to surface streams, soil-water samplers
(wells) were placed along a distance gradient to Little Bayou Creek. Samples
from two depths following rainstorms revealed the absence of vertical or hori-
zontal movement with maximum concentrations of 0.13 ppb at 50 meters from the
tower. Preliminary model estimates of drift deposition are compared to dep-
osition measurements. Isopleths of the predicted deposition are useful to
identify areas of maximum drift transport in the environs of the gaseous
diffusion plant.

ATDL Contribution File No. 80/18

Title   :   A Study of the Sensitivity of Intermediate Scale Transport
              Models to Various Wind Direction Intervals

Author(s):   Walter M. Culkowski

Date   :   September 1980

Published: Pending publication in the Proceedings of the Symposium on
              Intermediate Range Atmospheric Transport Processes and
              Technology Assessment, Gatlinburg, Tennessee, October 1-3, 1980.

Abstract

        Extensive data has been made available for the
meteorology and releases of Krypton-85 in the area of the
Savannah River Laboratory. The following study was
performed principally to determine the efficacy of
"straight-line" models to the estimation of diffusion
parameters at distances of the order of 100 kilometers.
Material transported over such intermediate distance
scales may be expected to be influenced by numerous wind
vectors, sometimes diametrically opposed to one another.
This paper concerns itself primarily with the calculation
of optimum wind direction intervals for the particular
data set. The results are improved considerably if a
"power law" with distance is substituted for the mixing
depth and arc length.

Title   :   A Review of Physical Assumptions in Intermediate Range
              Transport and Diffusion Models

Author(s):   Steven R. Hanna

Date   :   September 1980

Published: Pending publication in <u>Proceedings of Symposium on Intermediate
              Range Atmospheric Transport Processes and Technology Assessment,</u>
              Gatlinburg, Tennessee, October 1-3, 1980.

Abstract

Several intermediate range transport and diffusion models are briefly reviewed. The basic physical assumptions in each are summarized and compared, including horizontal and vertical diffusion, specification of wind field interpolation from the wind field to a point, dry and wet deposition, and chemical transformations. Results of model comparisons for inert tracers are presented showing that a good knowledge of the wind field (speed and direction at plume height) is essential for making accurate calculations for both short term episodes and long term averages.

ATDL Contribution File No. <u>80/20</u>

Title   :   A Note of the Fundamental Accuracy of Air Pollution Models

Author(s):   Carmen J. Nappo

Date   :   September 1980

Published: Pending publication in Proceedings of Symposium on Intermediate
              Range Atmospheric Transport Processes and Technology Assessment,
              Gatlinburg, Tennessee, October 1-3, 1980.

Abstract

     The measure of accuracy of air pollution models is be-
coming a subject of increasing concern. These measures are
almost always based on a comparison of model predictions
with observations; however, because models must necessarily
parameterize some physical processes (e.g. turbulence, dep-
osition, or diffusion) and make some limiting assumptions,
(e.g. steady-state, isotropic, or homogeneous meteorological
conditions), model predictions, in fact, represent averages
of ensembles of observations made over those atmospheric
conditions which have been assumed and parameterized. The
variance of these ensemble averages will increase with the
extent of model parameterizations so that the difference
between a single element of an ensemble, i.e. an observa-
tion, and the ensemble average, i.e. a model prediction,
can be quite large. The variances of these ensemble aver-
ages of observations define the fundamental accuracy of an
air pollution model, i.e. the error bars on the model pre-
dictions.

     This paper examines the fundamental accuracy of air
pollution models by forming ensemble averages of air pol-
lution observations for meteorological conditions assumed
and physical parameterizations made by these models. These
calculations are made on the urban scale (~25 km) using the
St. Louis Regional Air Pollution Study data, and on the
regional scale (~100 km) using krypton-85 surface concen-
trations observations made around the Savannah River Plant.
A result of this study is the range of accuracy of various
air pollution models for differing meteorological conditions.

Title   :   The Nocturnal Boundary Layer Over a Sloping Surface

Author(s):   K. S. Rao and H. F. Snodgrass

Date   :   October 1980

Published: <u>Proceedings of Fifth Symposium on Turbulence, Diffusion, and
             Air Pollution</u>, March 9-13, 1981, Atlanta, Ga., pp. 106-108

Abstract

The nocturnal boundary layer over a large homogeneous sloping
surface is investigated by a numerical model using a variable eddy
diffusivity profile determined from considerations of the turbulent
kinetic energy (TKE) equations, surface characteristics, and ambient
atmospheric conditions. The model formulations are presented and
conditions for the existence of a stationary solution are discussed.
For small slope angles ($\beta \sim 0.01$ radians), the Coriolis force is
typically of the same order of magnitude as the drainage force. For
large slope angles, the Coriolis force is negligible compared to the
drainage force. For these two cases, the steady state mean wind and
temperature profiles calculated from the model are compared with the
stationary analytical solutions based on a constant eddy diffusivity.

Title   :   Effects of Release Height on σ_y and σ_z in Daytime Conditions

Author(s):   Steven R. Hanna

Date   :   October 1980

Published: Pending publication in <u>Proceedings of NATO-CCMS Conference</u>,
             November 25-28, 1980, Amsterdam, The Netherlands.

Abstract

A statistical diffusion model is used to estimate the variation
of σ_y and σ_z with height in daytime conditions. The existing liter-
ature is reviewed, showing inconsistencies among the few field data.
The statistical Monte Carlo-type model is described in detail and
some asymptotic predictions of the theory are outlined. For example,
the usefulness of the formulas $\sigma_y = \sigma_\theta \, x$ and $\sigma_z = \sigma_e x$ are shown,
where σ_θ and σ_e are the standard deviations of the horizontal and
vertical wind directions.

Results of the model show that σ_y varies little with release
height in daytime conditions, but that it can depart significantly
from the standard Pasquill-Gifford-Turner (PGT) curves for rough-
nesses outside their range of derivation. The vertical component
σ_z typically increases by a factor of two as heights increase from
the surface layer to mid-planetary boundary layer height.

ATDL Contribution File No.   <u>80/23</u>

Title   : Plume Diffusion Modeling - An Annual Report to the
              Nuclear Regulatory Commission

Author(s): S. R. Hanna, G. A. Briggs, F. A. Gifford, and C. J. Nappo

Date   : September 30, 1980

Published: In-house publication

Abstract

1. Effects of Release Height on σ_y and σ_z. (S. R. Hanna)

A Monte Carlo diffusion model was developed for use in estimating
$\sigma_y(x)$ and $\sigma_z(x)$ as a function of release height, stability, and roughness.
First calculations assumed daytime conditions, zero horizontal wind shear,
and concentrated on plume travel distances less than 1 km. Forty eight
combinations of roughness, stability, and wind speed were used in the model,
giving the result that σ_y is only a weak function of release height, but that
σ_z increases by a factor of two from the bottom to the middle of the planetary
boundary layer (PBL). In future work, neutral and stable conditions, non-zero
horizontal wind shears and larger travel distances will be emphasized.

2. What Convective Scaling does for Diffusion Data. (G. A. Briggs)

The concept of convective scaling has come up in the time since
several well-known comprehensive diffusion experiments took place (e.g.
Prairie Grass, Green Glow, Porton). In convective scaling, the mixing
depth, z_i, and the convective velocity, w_*, are important scaling para-
meters. The Prairie Grass diffusion observations are examined to see
whether convective scaling can be used to compare different experiments.
For example σ_z/z_i is plotted as a function of $(x/z_i)(w_*/u)$. The para-
meters z_i and w_* were estimated for all runs. It is found that this
approach is very useful in daytime conditions and should be in all
future data analyses. This work is essentially complete at this time.

3. Study of the Horizontal Diffusion Length, σ_y. (F. A. Gifford)

The Langevin diffusion equation was applied to estimate σ_y. It is
found that use of a Lagrangian time scale of 10^4 seconds yields a theoretical
$\sigma_y(t)$ curve that agrees with tropospheric observations of σ_y over several
orders of magnitude of σ_y and time. This work is complete with this report.

ATDL Contribution File No. 80/24

4. Representativeness of Meteorological Observations (C. J. Nappo)

In setting up a network of meteorological observation stations, one
must always consider the question of number and spacing of the stations,
This question relates to the representativeness of observations; i.e.,
in an urban area is one station sufficient, or is ten a better number?
To help answer this question, we are studying the variability of wind
speed and direction using data from networks in St. Louis, Savannah
River Laboratory, and Idaho Falls. Statistical techniques have been
devised and preliminary calculations performed with the St. Louis RAPS
data. During the next year, analysis of the remaining data sets will
take place.

Title   :   Atmospheric Removal Processes for Toxic Chemicals

Author(s):   Steven R. Hanna

Date   :   September 1980

Published: In-house publication

Abstract

The literature on atmospheric removal processes for toxic chemicals
was reviewed, covering dry and wet deposition and chemical transformation.
Not much is known about specific toxic chemicals, but estimates of removal
can be made by assuming that measurements of removal rates for other
chemicals are roughly valid for toxic chemicals.

ATDL Contribution File No. 80/25

Title   : A Study of the Probable Environmental Impact of the Fugitive
             Coal Dust Emissions at the Ravenswood Power Plant, New York

Author(s): K. S. Rao and L. Satterfield

Date   : August 1980

Published: ORNL-EPA Fuel Use Active Program: EIS on Fugitive Emissions,
           86 pp.

Abstract

The Ravenswood Power Plant of the Consolidated Edison Company of
New York is being converted to use coal as the primary fuel. This
report addresses the probable short and long-term air pollution impacts
of the fugitive coal dust emissions that are likely to occur during the
coal unloading at the facility.

The coal drift consists of particles ranging in size from 0.1 to
200 μm. Assuming a lognormal probability of the particle size distribution,
a drift mass spectrum was developed for six particle size ranges considered
in the study. A steady state atmospheric advection-diffusion model that
accounts for the gravitational settling and dry deposition of the particles
was formulated, and an exact analytical solution, consistent with the basic
assumptions of the Gaussian plume model, was derived and applied to the
present study. The meteorological data used consist of a five year record
of hourly surface wind observations. Six wind speed classes and sixteen
wind direction classes were considered in the analyses.

This study considers two different coal unloading schedules: coal
is unloaded only during daytime (0700-1900 hrs.) in Case I, and around
the clock (both day and night) in Case II. The calculated results of
ground-level concentrations, atmospheric concentrations and visibilites,
hourly surface deposition fluxes, and deposition flux and net deposition
rates on monthly and yearly basis were presented for Cases I and II
separately.

ATDL Contribution File No. 80/26

Title : Numerical Simulation of the Transport and Dispersion of
Pollutants in Slope and Mountain-Valley Flows

Author(s): Steven R. Hanna, Richard T. McNider, & Roger A. Pielke

Date : October 1980

Published: Proceedings of Fifth Symposium on Turbulence, Diffusion,
and Air Pollution, March 9-13, 1981, Atlanta, Ga., pp. 220-221.

Abstract

In the present investigation a numerical mesoscale model (the
University of Virginia Mesoscale Model, Pielke (1974)) is used to exam-
ine the development of slope and mountain flows in two and three-
dimensional idealized valleys. Also pollutant dispersion and transport
is examined using a Lagrangian conditioned particle model (McNider
et al. (1980)).

Title   : A Nonstationary Nocturnal Drainage Flow Model

Author(s): K. S. Rao and H. F. Snodgrass

Date   : July 1980

Published: Pending publication in <u>Boundary-Layer Meteorology</u>

Abstract

The evolution and structure of the steady state of an idealized
nocturnal drainage flow over a large uniformly-sloping surface are
studied using a nonstationary model with a height-dependent eddy dif-
fusivity profile and a specified surface cooling rate. The predicted
mean velocity and temperature profiles are compared with Prandtl's
stationary analytical solutions based on the assumption of a constant
eddy diffusivity in the drainage layer. The effects of important phy-
sical parameters, such as the slope angle, surface cooling, atmospheric
stability, and surface roughness, on the steady drainage flow are inves-
tigated.

ATDL Contribution File No. 80/28

Title   : Atmospheric Studies in Complex Terrain (ASCOT) Information
            Survey

Author(s): M. H. Dickerson, Editor

Data   : May 1980

Published: UCID-18572, ASCOT 80-3 by Lawrence Livermore National Laboratory,
            University of California   94550

Abstract

In 1978, under sponsorship of the U. S. Department of Energy (DOE),
several laboratories and organizations involved in meteorology research
launched the Atmospheric Studies in Complex Terrain (ASCOT) program to
investigate atmospheric flow, air concentrations, and dispersion over hilly
and mountainous terrain. Participating agencies were Argonne National
Laboratory (ANL), Brookhaven National Laboratory (BNL), Los Alamos Scientific
Laboratory (LASL), Lawrence Livermore National Laboratory (LLNL), Pacific
Northwest Laboratory (PNL), Savannah River Laboratory (SRL), the University
of Utah's Department of Meteorology and two facilities of the National
Oceanic and Atmospheric Administration: the Air Resources Laboratory (NOAA-
ARL) and the Atmospheric Turbulence and Diffusion Laboratory (NOAA-ATDL).

The first task undertaken by participants was to review previous studies
on the interaction of the atmospheric boundary layer with underlying terrain.
The original intent of this review was to develop a reference document for the
ASCOT researchers. Most of the work was completed in about six months and,
although the review is not all-inclusive, it has proved to be of great help.

This document is a comprehensive, though not all-inclusive, survey of
atmospheric studies in complex terrain. The work is divided into three major
sections: (1) physical concepts, (2) modeling, and (3) measurements. Each
section contains a brief review and discussion of subtopics accompanied by
a liberal number of references. We did not attempt to draw many specific
conclusions but, in some cases, noted research areas where further work is
indicated. Although the ASCOT program has concentrated on noctural drainage
wind studies during the past two years, the reader will find material that
spans a broader aspect of atmospheric flow in complex terrain. The ATDL staff
worked on the following sections:

1.1 Transport and Diffusion Physics in Valley Environments, pp. 1-2 - 1-67,
     C. J. Nappo, et al. ATDL Contribution File No. 80/29.

1.2 Plume Rise in a Drainage Flow, pp.1-69 - 1-75, G. Briggs. ATDL
     Contribution File No. 80/30.

2.1 Using Laboratory Flow Models to Simulate Terrain-Influenced Meteorology, pp 2-1 - 2-35, R. P. Hosker and S. Barr, ATDL Contribution File No. 80/31.

2.2 Numerical Modeling, pp. 2-36 - 2-76, S. Rao, et al. ATDL Contribution File No. 80/32.

2.3 Statistical Modeling, pp. 2-77 - 2-81, S. R. Hanna. ATDL Contribution File No. 80/33.

3.1 Meteorological Measurements Applied to Transport in Complex Terrain, pp 3-1 - 3-28, C. Nappo, R. Hosker, et al. ATDL Contribution File No. 80/34.

3.3 Tracer and Diffusion Experiments, pp. 3-40 - 3-57, C. Nappo. ATDL Contribution File No. 80/35.

Title : Spectral Radiation Balances Above an Oak-Hickory Stand
During the Spring Leafing Season

Author(s): D. R. Matt, R. T. McMillen, and B. A. Hutchison

Date : January 1979

Abstract

This paper presents preliminary data on radiation fluxes in three wavebands above a deciduous forest. Data presented were for three days only. The intent of this paper is to acquaint researchers in forest meteorology with our newly completed research site at Walker Branch Watershed.

ATDL Contribution File No. 79/1

Title : Diffuse Radiation in a Deciduous Forest Varies with Sky
Brightness Distributions

Author(s): B. A. Hutchison, D. R. Matt, and R. T. McMillen

Date : January 1979

Published: Proceedings of the Symposium on Forest Meteorology,
August 21-24, 1978, Ottawa, Ontario, Canada, pp 213-216.

Abstract

The penetration of diffuse sky radiation via canopy opening into a fully-leafed tulip
poplar forest was estimated from canopy structure data obtained from canopy photo-
graphs and from sky brightness distribution approximations, using techniques originally
developed by Anderson (1964). Small differences were found among mean daily pene-
tration fractions predicted assuming an isotropic sky (UOC), a standard overcast sky
(SOC), or an approximation of the weighted daily average predicted using a clear sky
brightness distribution. For shorter time periods, penetration of diffuse radiation esti-
mated using the UOC and SOC approximations differed substantially from estimates
made using the clear-sky brightness distribution. Most diffuse radiation passes through
openings that are within 10 degrees of the solar disk. Hence the directional distribution
of diffuse radiation in the forest is strongly controlled by solar position on clear to partly
cloudy days. Amounts of diffuse radiation observed in the forest under clear skies agree
fairly well with those predicted by the model developed by Reifsnyder et al. (1971).
In both cases, penetration increases with increasing solar elevation on clear days. We con-
clude that the SOC assumption produces acceptable results for time periods of a day or
longer, but for shorter times with clear skies the use of the clear sky brightness distri-
bution is necessary for most simulation or prediction modeling.

Title   : Estimating Ground-Level Concentration Patterns from Isolated
             Air-Pollution Sources: A Brief Summary

Author(s): Frank A. Gifford

Date   : January 1979

Published: Accepted for publication in <u>Environmental Research</u>

Abstract

The current state of the art of modeling the dispersion of air pollutants
emitted from isolated sources into the lower atmosphere is briefly described.
Thermal and mechanical turbulence in the atmospheric boundary layer are strongly
related to solar heating and nocturnal cooling of the ground surface. This
results in a marked diurnal variation in the rate of low level pollutants
dispersion. The standard mathematical model to describe this phenomenon,
the Gaussian plume model, is reviewed and various special problems that arise
in applications are discussed, including diffusion parameters, the effect of
the averaging period, computational aids to air pollution estimation, removal
processes, plume rise, terrain effects, and the attainable accuracy of air
quality models.

Title : Horizontal Variability of Seasonal Precipitation over the
Eastern Tennessee River Valley

Author(s): Carmen J. Nappo and Linda J. Gabbard

Date : February 1979

Abstract

Rainfall data from 38 stations over a 32-year period are used to study the horizontal variability of seasonal precipitation over the complex terrain of the eastern Tennessee River Valley region. Subjective analysis of precipitation patterns suggests that horizontal variability is large during summer and small during winter. Objective measures of horizontal variability show that summertime variability is about twice as great as winter and annual variability and that variability is about four times greater across the valley than along the valley during winter and about two times greater during summer. A comparison of seasonal precipitation variability over uniform and complex terrain is made. Horizontal variability is always greater over the eastern Tennessee River Valley region with the greatest difference in summer and the least in winter; also, spatial correlations are always greater over uniform terrain.

Title   :   Modeling the Nocturnal Drainage Flows, Part I

Author(s):   K. S. Rao and H. F. Snodgrass

Date   :   December 1979

Published: In-house publication

Abstract

The evolution and structure of the steady state of an idealized
nocturnal drainage flow over a large uniformly-sloping surface are studied
using a nonstationary model with height-dependent eddy diffusivity
profile and a specified cooling rate. The predicted mean velocity and
temperature profiles are compared with Prandtl's stationary analytical
solutions based on the assumption of a constant eddy diffusivity in the
drainage layer. The effects of important physical parameters, such as
the slope angle, surface cooling, atmospheric stability, and surface
roughness, on the steady drainage flow are investigated. The extension
of the model to account for the ambient winds and Coriolis effects is
outlined, and its stationary analytical solutions are discussed.

ATDL Contribution File No. 79/5

Title   : Plume Rise and Buoyancy Effects

Author(s): Gary A. Briggs

Date   : March 1979

Published: Chapter 8 in Atmospheric Science and Power Production,
            D. Randerson (ed.), U. S. Dept. of Energy Tech. Info.
            Center, Oak Ridge, TN (in press).

Abstract

Basic conservation relationships and closure assumptions used in
plume rise modeling are reviewed. The existence of a drag force term
is questioned, and implications of various closure assumptions are
reviewed. A relatively simple model is chosen as a basis for comparing
predictions with observations. Comparisons are made for the trajectories
of both buoyant plumes and jets, and simple prediction formulas are recom-
mended. For rise limited by stable stratification, prediction techniques
are developed for linear stratification, sharp inversions, neutral air
overlayed by stable air, and for arbitrary temperature profiles. For
rise limited by ambient turbulence, the effects of both large and small
eddies and both mechanical and convective turbulence are considered.
The prediction for rise in mechanical turbulence is supported both di-
rectly and indirectly, but the recommended formula for rise in convective
turbulence must be considered tentative until adequate data are available.
Finally, plume rise from multiple sources, gas turbines, and moist plumes
are considered, as well as stack downwash effects.

ATDL Contribution File No. 79/6

Title : Forest Meteorology - - Research Needs for an Energy and
Resource Limited Future

Editor : Boyd A. Hutchison

Date : February 1979

Published: U.S.DOE Conference Summary [CONF-7808100 (SUMM)]

Abstract

A workshop entitled *Forest Meteorology, Research Needs for an Energy and Resource Limited Future,* was convened 28–30 August 1978 at the University of Ottawa in Ottawa, Ontario. This workshop was held in conjunction with the World Meteorological Organization's International Symposium on Forest Meteorology and was sponsored by the Division of Biomedical and Environmental Research, U.S. Department of Energy.

Forty-two scientists representing Canada and the United States as well as Spain, Sweden, and the United Kingdom participated in the workshop. Current research efforts were discussed and research needs critical to the development of unifying theories in forest meteorology were identified.

The lack of knowledge most seriously limiting the development of unifying theories at this time involves the mechanics of turbulent exchanges. Studies are needed of the mechanisms by which turbulence is created, transported, and destroyed in forest canopies, of the structural characteristics and aeroelastic properties of forests which control the generation and dissipation of turbulence, and of the turbulence structure of the boundary layer above forests.

Less critical but of considerable importance in view of societal problems of energy and resource limitations is the problem of radiation exchanges in and above forests and of how they relate to forest productivity. Simple techniques must be developed for the determination of the structural features of forests that control radiation exchanges and these structural data must then be used to validate existing radiation exchange models which have largely been developed and tested in agricultural crop canopies. With a better understanding of how forest structure controls radiation penetration and consequently, photosynthetic production, possibilities for genetically engineering highly productive forests for energy, fiber, or saw logs could be better assessed.

It was further noted that the historical absence of responsibility for forest meteorology in either the forestry or weather service bureaucracies of Canada and the U.S. has seriously hampered advancement of scientific knowledge in this field. Most forest meteorology research conducted in the past was made in support of other research efforts; as a result, there has been little continuity in our research efforts. The workshop recommended that serious consideration be given to the establishment of federal agency responsibility for forest meteorology and suggested that an organization along the lines of the Pinchot Institute or the Eisenhower Consortium of the U.S. Forest Service may serve to administer such responsibility.

Finally, the workshop created a task force on forest meteorology that was charged to continue efforts on behalf of this field of science in terms of specific workshop recommendations. Task force members include Lloyd W. Gay, University of Arizona, Tucson; James Harrington, Forest Fire Research Institute, Ottawa, Ontario; Willy Z. Sadeh, Colorado State University, Fort Collins; Roger H. Shaw, Purdue University, West Lafayette, Indiana; Stan Tajchman, West Virginia University, Morgantown; and chairman, Boyd A. Hutchison, Atmospheric Turbulence and Diffusion Laboratory, National Oceanic and Atmospheric Administration, Oak Ridge, Tenn.

ATDL Contribution File No. 79/7

Title   : Power Law Variations of Wind Speed Profiles at Three Sites
             in the Oak Ridge Area

Author(s): Walter M. Culkowski

Date   : June 1979

Published: Preprints of 72nd APCA Annual Meeting held in Cincinnati,
            Ohio, June 24-28, 1979. Preprint number 79-22.5.

Abstract

Three towers near the Tennessee Valley Authority's Kingston,
Tennessee steam plant are in locations having distinct terrain
features. The first, the subject of a report at the previous
APCA meeting (1), is a 110-meter tower located on the side of a
hill overlooking a moderately sized lake; the second, a 45-meter
tower, is located on an extensive ridge; the third, a 61-meter
temporary tower built to supply site survey data for the Clinch
River Breeder Reactor (CRBR) project, was located in a heavily
wooded river valley. The comparison of wind speed and diffusion
data at these three locations is the subject of this report. The
data for the Kingston stations are presented on an annual basis
from data gathered from October 1975 through December 1977. The
CRBR data is based on data taken from April through December 1976.

Title   :   Smoke as a Quantitative Atmospheric Diffusion Tracer

Author(s):   F. A. Gifford

Date   :   September 1979

Abstract

Abstract – Generalizations of the "opacity method" of analyzing visible smoke-plume diffusion are presented. The horizontal dispersion length, σ_y, is derived from the outline of a plume having an arbitrary vertical concentration distribution. The vertical dispersion length, σ_z, is derived for a plume with concentration varying as arbitrary powers of y and z in the exponential terms. Examples of observations of σ_y and σ_z based on Skylab-4, U-2, and ordinary land-based photographs are presented.

Title   :   Flow and Diffusion Near Obstacles

Author(s):   R. P. Hosker, Jr.

Date   :   March 1979

Published: Chapter 7 in Atmospheric Science & Power Production,
             D. Randerson (ed.), U. S. Dept. of Energy Tech. Inf.
             Center, Oak Ridge, TN (in press).

Abstract

    This chapter consolidates presently available information on
flow and effluent diffusion near obstacles. The flow patterns found
near bluff bodies in general, and buildings in particular, are dis-
cussed in detail. The responses of near-body flows to velocity
gradients, to the presence of a ground plane, to wind incidence
angle, to clustering effects, to ambient turbulence level, and to
atmospheric stability are examined. Estimation procedures for roof
and wake cavity size and the downwind behavior of the turbulent wake
are given. Methods for estimating stack heights, downwash, and con-
centrations near and downwind of buildings are summarized. Cases
where the source is upwind, on or close to a structure, or downwind
are considered.

Title   :   Recent Studies of Diffusion Parameters for Air
                Pollution Applications

Author(s): F. A. Gifford

Date   :   July 1979

Published: In-house publication

Abstract

The turbulence structure of the planetary boundary, or mixed layer, is now well know as a result of the Kansas and Minnesota experiments. This paper summarizes recent studies in which diffusion data are examined from the vantage point of current boundary layer structure information, to improve and extend specification of the crosswind and vertical diffusion lengths, σ_y and σ_z. The vertical diffusion length, σ_z, is found generally to agree well with the early (P-G) σ_z-curves, now in widespread use. An improved parameterization of σ_z in daytime convective conditions is obtained by use of the Deardorff-Willis free-convection similarity scaling. The horizontal diffusion length is best expressed as $\sigma_y = \sigma_\theta \times f(x)$ where σ_θ is the standard deviation of the wind direction, and the universal function f is defined by several studies. Recent detailed guidelines on many particular diffusion parameterization problems, including sampling duration, surface roughness, wind turning, mixing depth, plume buoyancy, and stability categorization are summarized.

Title   :   Phoenix Lagrangian Turbulence Observations Using Pibals
              and Tetroons

Author(s):   Steven R. Hanna

Date   :   June 1979

Published: Project Phoenix - The September 1978 Field Operation NOAA/ERL
              Propagation Lab. & NCAR, Dec. 1979, Boulder, CO, Chapt.12, pp 138-149.

Abstract

To complement Eulerian turbulence observations made during Project
PHOENIX by WPL remote sensors, instruments on the WPL 300-m tower, and
the NCAR aircraft, we have developed a method of tracking balloons by
radar that permits Lagrangian turbulence observations. The resulting
measurements enable us to compare Lagrangian and Eulerian time scales
and determine the shape of the Lagrangian energy spectrum. The ratio of
Lagrangian to Eulerian time scales in daytime conditions was measured to
be about two. Typical Lagrangian time scales were about 100 seconds for
20 minute sampling times.

ATDL Contribution File No. 79/12

Title   :   SPIF: A Preprocessor for Structured Programming In
               FORTRAN

Author(s):   David B. Elliott and Lee E. Nipper

Date   :   August 1979

Published: In-house publication

Abstract

FORTRAN, a 22-year old programming language, has some major weak-
nesses as a higher-level computer language. In this paper some extra
control statements are presented which remove a few of FORTRAN's weak-
nesses. These control statements are similar to those found in other
preprocessor. One such preprocessor, SPIF (Structured Programming In
FORTRAN), is described in this paper.

Using a preprocessor such as SPIF can yield many benefits. Among
these are (1) easier coding, (2) more readable computer code, and (3)
enhanced skill in using structured coding techniques.

The SPIF proprocessor has been implemented at the Atmospheric
Turbulence and Diffusion Laboratory (ATDL) in Oak Ridge, Tennessee. The
portability of this preprocessor and the computer time required in its
use are discussed. An example application of SPIF is in the appendix.

ATDL Contribution File No. 79/13

Title   : A Comparison of Temperature and Wind Speed Functions in the
Lowest Thirty-Two Meters During Unstable Conditions

Author(s): Walter M. Culkowski

Date   : July 1979

Published: In-house publication

Abstract

The results of fitting wind speed and temperature functions suggested
by Benoit (1977) to the Minnesota 1973 data are compared to the functions
of the primitive logarithmic and to the logarithmic plus simpler logarithmic
and logarithmic plus linear profiles appear sufficiently accurate for many
practical purposes, fitting the experimental curves to within a few hundreths
of a degree for temperatures and a few centimeters per second for wind speeds.

Title   :   Instrument Guidelines for Measurement of Meteorological
                Characteristics of Long-Term Ecological Research Sites

Author(s):   Boyd A. Hutchison

Date   :   September 1979

Published: Final Report to the National Science Foundation by the
             Institute of Ecology (Grant DEB 7920243) entitled:
             Guidance Documents for Long-Term Ecological Research

Abstract

Guidelines for meteorological instrumentation for measurement and characterization of meteorological processes of ecological and biological importance at long-term ecological research sites are developed. The following instrument options are recommended:

1. Shortwave Radiation:
    Eppley Precision Spectral Pyranometer equipped with dual, precision ground and polished Schott WG 7 optical glass domes.

    Eppley Black and White Pyranometer.

2. Air Temperature:
    Analog Devices Two-Terminal IC (integrated circuit) Temperature Transducer Model AD590L.

    Platinum resistance thermometer.

3. Dewpoint:
    Thermoelectric Dew Point Hygrometer (General Eastern Instruments Corporation System No. 1100 MPS or EG&G Cambridge Systems Model 220)

    Thermoelectric Dew Point Hygrometer (General Eastern Instruments Corporation System No. 1100 AP or EG&G Cambridge Systems Model 880A).

    Hair hygrometer.

4. Wind Speed:
    Kurz Instruments Incorporated Model 475 Meteorological Wind Speed Sensor.

    Sensitive cup anemometer (Gill Generator anemometer, R. M. Young Model 12102 or equivalent).

5. Wind Direction:
    Potentiometric sensitive direction vane (Gill microvane, R. M. Young Model 12302 or equivalent).

ATDL Contribution File No. 79/15

6. Precipitation:
   Weighing bucket recording rain gauge (Belfort Instrument Company Model No. 5-780 or equivalent).

   Remote recording weighing bucket rain gauge (Belfort Instrument Company Model No. 5915 or equivalent).

7. Net Allwave Radiation*:
   Funk type net pyrradiometer (Swissteco Type S-1 or equivalent)

   Fritschen net pyrradiometer with heavy-duty domes.

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*Optional as determined by site considerations.

Publication of the Air Resources
Atmospheric Turbulence and Diffusion Laboratory
National Oceanic and Atmospheric Administration
1979

Title   :   1978 Annual Report

Author(s):   Atmospheric Turbulence and Diffusion Laboratory, NOAA

Date   :   December 1979

Published: National Technical Information Service, U. S. Department of
             Commerce, Springfield, Virginia 22161, 347 pages, $19.00

Abstract

    Bound volume containing all ATDL papers, reports, etc., published
during 1978.

Title   :   Comments on "Similarity Model for Maximum Ground-Level
                Concentration in a Freely Convective Atmospheric Boundary
                Layer"

Author(s): Gary A. Briggs

Date   :   October 1979

Published: Submitted to Boundary Layer Meteorology

Abstract

Comments on a paper by Bryan R. Kerman published in Boundary Layer
Meteorology, vol. 16, pp. 345-408. Mainly critizes paper for inconsistencies
in modeling approach and in analysis of data. Submitted to BLM, reply from
author forwarded by editor, resubmission delayed pending diplomatic negotations
with the author.

Title : Studies of Wind & Turbulence Above a Deciduous Forest in
Complex Terrain

Author(s): Detlef R. Matt

Date : September 1979

Published: (Withdrawn)

Abstract

Title : Hourly-Averaged Mast Data, Tethered Balloon Temperature
Soundings, and Neutral-Density Balloon Trajectories
Observed in Nocturnal Drainage Flows During the First
ASCOT Field Study on Anderson Creek, CA

Author(s): C. J. Nappo, R. P. Hosker, S. R. Hanna, G. A. Briggs,
R. T. McMillen, K. S. Rao, and H. F. Snodgrass

Date : December 1979

Published: In-house publication

Abstract

The data as well as a description of the measurement equipment
used during the first ASCOT field study of 15-27 July, 1979 near
Anderson Springs, California are presented. The data taken during
nighttime drainage wind conditions include hourly-averaged wind speed,
direction, and temperature measured on instrumented 10 m masts, tem-
perature soundings obtained with tethered balloons, and double-
theodolite trajectory observations of neutrally buoyant pilot balloons.

Title   :   Entrainment Coefficient Versus Ri for Drainage Flows and
               Compatibility with Turbulence Scaling Assumptions

Author(s): Gary A. Briggs

Date   :   December 1979

Published: In-house publication

Abstract

This report summarizes an analysis of the slope flow laboratory
experiment of Ellison and Turner (J. Fluid Mech., 1959) to determine
flow Richardson number, Ri, and flow entrainment coefficient, E, as a
function of the slope angle above horizontal, β. Various assumptions
for turbulent velocities and length scales are examined theoretically
for compatibility with the experimental results, making use of buoyancy,
momentum, and energy conservation relationships. It is concluded that
the turbulent length scale may be of the order of the flow depth for
large β, but must be limited by the turbulent velocity variance and the
local stratification for the small β case. This result is consistent
with the assumption that the local turbulent length scale is proportional
to z/(constant + z/L), where z is height above the surface and L is the
Monin-Obukhov length.

Title   :   The Logarithmic Integral as a Functional for Estimating Wind
              and Temperature Profiles in Unstable Cases

Author(s):   Walter M. Culkowski

Date   :   December 1979

Published: In-house publication

Abstract

Temperature and wind profiles from the Prairie Grass and Minnesota
experiments were examined for those cases where solar radiation exceeded
0.020 cal/cm^2 sec (Prairie Grass) or the reported Monin-Obulkhov length
indicated unstable conditions (Minnesota). The logarithmic integral
provided an excellent fit to the data sets yielding an average error of
0.09°C for temperature profiles and 6 cm/sec for wind speed data.

Title   :   Analytic Modeling of Drainage Flows

Author(s):   Gary A. Briggs

Date   :   July 1979

Published: In-house publication

Abstract

A simple analytic model is developed for drainage flow down a constant slope with a well-defined crest. From buoyancy and momentum conservation, it is shown that on a constant slope, the flow Richardson number, Ri, tends toward a constant value. Experience with plumes suggests that the entrainment constant, E, also approaches a constant. Together, Ri and E being constant implies linear growth of the drainage depth, dh/dx = constant. All of these predictions are confirmed by the results of Ellison and Turner's laboratory experiments (J. Fluid Mech., 1959). Their experimental results for E and Ri as a function of slope angle are used in this model (which is a simplified form of Ellison and Turner's model) to make specific predictions for flow velocity, U, flow depth, h, and flow cooling compared to the ambient temperature, ΔT. For the case with constant heat flux removed from the drainage layer it is predicted that $U \propto x^{1/3}$ and that $\Delta T \propto x^{-1/3}$. For the case with constant cooling of the layer (ΔT = constant and heat flux limited by ground cooling), we find $U \propto x^{1/2}$ and heat flux $\propto x^{3/2}$; this regime could only hold until the heat flux approaches the net outgoing radiation. An analysis of the surface drag term is made, demonstrating that it is negligible on slopes larger than a few degrees.