



ASTER facility Info

Files & Brochures

This program was designed to provide data for the development of a new computer model to represent the plume rise and building-induced downwash from power plants.

INTRODUCTION

This document is a standard product of the NCAR/ATD/SSSF [ASTER](#) facility, which gives an overview of the measurements taken and conditions during the DOWNWASH94 field experiment.

ASTER data are stored in two forms:

- 5-minute averages of first and second-order moments of calibrated data. We recommend combining these to obtain more statistically-significant averages over longer time periods.
- 1, 10, or 20 sample/second uncalibrated values. Software is maintained at SSSF to generate calibrated time series on demand using the most current calibration routines.

Also available is a computer-readable log of comments noted by ASTER personnel. The [logbook](#) can be read here (sorry, some comments are garbled and this version cannot be searched). For access to the ASTER data, please contact SSSF. For access to other data from the DOWNWASH program, please contact Dave Strimaitis at Sigma Research Corporation.

Several [photographs](#) are available in compressed TIFF format.

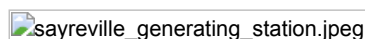
EXPERIMENT DESCRIPTION

DOWNWASH94 (Full name: Combustion Turbine Plume Rise and Building Downwash Model Development) was an EPRI-funded program with principal investigator Lloyd Schulman (Sigma Research Corporation). This program was designed to provide data for the development of a new computer model to represent the plume rise and building-induced downwash from power plants, especially those with "less than Good Engineering Practice" stack heights. In particular, the research goal was to define conditions under which the exhaust plume from a combustion turbine would be drawn downward due to the turbulence induced by the structure housing the turbine.

Norman Bowne (ENSR Consulting and Engineering) was the manager for the field phase of this program which, in addition to ASTER, included an auxiliary weather station and tethersonde operated by ENSR and a scanning aerosol LIDAR operated by Norm Nielsen (SRI International). New Jersey Power and Light also operated a Doppler SODAR at a nearby plant. The entire EPRI program also included wind-tunnel and numerical modeling studies of plume rise and downwash.

LOCATION

This experiment was located in [Sayreville](#), New Jersey (about 20 miles south of Newark) at the [Sayreville Generating Station](#). This site was quite complex, with the CT stacks about 12m high, the three oil storage tanks to the west about 18m high, and the main power plant to the northwest about 45m high, with stacks going up to 67m. Bordering the plant were marsh lands and the Raritan River.



SENSORS

The [DOWNWASH Tower Layout](#) shows the location of the ASTER towers ("cav1", "cav2", and "far") used for this program relative to structures in the power plant. Most of the towers were located near the southern-most combustion turbine (CT4) to obtain mean and turbulent flow statistics in a two-dimensional cross section aligned with the expected mean flow direction. (The [DOWNWASH Tower Survey](#), shows detailed locations of these towers.) The third tower ("upwind") was located in an unused parking lot near the plant entrance to provide reference flow measurements. The [DOWNWASH Configuration](#) documents which sensors were deployed on each of the towers. Each sensor is labeled by the quantities it measures, its name, its height on the tower, and the tower name. [DOWNWASH Sensor Table](#) lists the type, manufacturer, and other specifications of the sensors used for this project. "Cav1" had three levels of mean temperature and humidity sensors and two levels of turbulence sensors (three-dimensional sonic anemometer and temperature sensor). "Cav2" had three levels of mean wind speed and direction sensors (propeller-vanes). "Far" had one level with a mean wind sensor and another level with turbulence sensors, which can be combined to give a two-level wind profile. The reference "upwind" tower also had

three levels, each with wind, temperature, and humidity sensors and one with turbulence sensors (including a fast-response hygrometer). Also included at the "far" tower were measurements of net, upward and downward visible and infrared radiation, radiometric surface temperature, and precipitation.

The non-standard (not included with ASTER) sensors used for this program were:

- A temperature and humidity data logger on the roof of the main plant deployed by NCAR to give a crude measure of the atmospheric stability at the height of the plume. (Data were not archived by ASTER, but are available as an ASCII file of 1-minute values from SSSF.)
- Two NO_x analyzers deployed by ENSR, each with three multiplexed inlets, which sampled the NO_x concentration from tubes placed at two levels on each of the cav1, cav2, and far towers.
- A weather station deployed by ENSR which reported temperature, wind speed, direction, and variation of wind direction every 5 minutes. This station was located off of the axis of the cav1, cav2, and far towers to provide some information about the lateral extent of the building wake.

OPERATION

This program occurred during one of the worst winters on record for the northeastern U.S., characterized by freezing rain, cold temperatures which caused "brown-out" electrical power conditions, and flooding due to ice-jammed rivers. Flooding extended to the "upwind" and "far" towers in conjunction with a tidal surge on day 63, which damaged the data acquisition system for the "far" tower.

Albedo from the radiometers should give a good indication of when snow was on the ground (most of the time). Surface conditions (including snow depth) often were noted in the system logbook.

Setup of cav1 and cav2 was delayed until day 41 while CT4 was being repaired. During this time, data were being collected from these towers while they were laying close to the ground.

Known instrument problems:

- All psychrometer temperature measurements are high by about 0.9 C, due to a laboratory calibration error. These measurements should be corrected (and this comment deleted) by Spring 1995. No other temperature measurements were affected by this problem.
- Soil measurements, usually included with ASTER to measure the total energy balance, were not made since the surface was a gravel parking lot.
- The Krypton hygrometer had a very low signal level, and might not have recoverable data. Our only spare also was not working correctly and was not fixed until too late in the program. It should be possible to make a crude estimate of the latent heat flux using a Bowen ratio from the upwind tower sensors.
- Fast temperature sensors (fine-wire Platinum resistance thermometers) usually broke during precipitation. This common problem was worse than usual since the precipitation often was freezing rain. Heat fluxes also can be obtained from the sonic anemometer virtual temperature measurements.
- Tilt corrections were not applied to the sonic anemometer data due to the irregular flow conditions at this site. All towers were leveled using the theodolite, so the data should be close to a gravitational coordinate system. Also, data from two-axis electrolytic levels on the sonic anemometers used on the cav1 tower are available as a check of the instrument orientation.
- The cav1 sonic anemometers were observed to "sway" (yaw) in high winds, probably due to the wind loading from the psychrometers on the same tower. We have been unable to detect this motion in the sonic anemometer velocity data.
- The atik.4m.cav1 sonic anemometer failed a few days before the first CT run on day 45 due to a faulty CPU board. A replacement arrived 30 minutes into this run and was installed.
- The UW sonic anemometer processing used the wrong calibrations prior to day 38. Since this was before operations, these data have not been reprocessed.
- The UW sonic anemometers typically had 2 spikes per hour, which was considered acceptable. All sonic anemometers had spiking problems and eventually failed with heavy precipitation. Light spiking can be removed using standard ASTER despiking software.
- The upward-looking Epply pyrgeometer batteries had to be replaced early in the experiment. Data was bad before Day 039, 14:50 until this was corrected. Also note that the radiometer was cooling from the trailer to the outside temperature just after replacement, so it might not be accurate for the first 1/2 hour.
- The Epply pyrgeometer, and possibly the other upward-looking (and net) radiometers often had snow/ice accumulated on the domes during and after precipitation.
- All radiometers were shadowed (when there was sun) frequently during the day from nearby power line towers.
- Prop wind directions on upwind tower are off by about 0.5 degree prior to day 37. Since operations had not started then, this small error has not been corrected.
- The prop.10m.far, and sometimes prop.6m.upwind, had periods with lost or reduced wind speeds. We have identified these units for repair.
- We replaced psychrometers on the upwind tower to reduce apparent biases early in the experiment. Between day 39 and 40 the "6m" unit was at 0.5m for testing. Biases noted on day 43 were +0.1 C and +1% RH for the psyc.6m.upwind.
- psyc.2m.cav1 was at 1.8m between erection of cav1 on day 41 and day 44 at 2100Z, since we couldn't climb the tower due to ice.
- The ENSR met tower blew down at 1800 on day 54, but was reinstalled a short time later. The wind vane was damaged by this.
- Note that all azimuth angles were shot using the theodolite with the sun as a reference (which is normal ASTER operations) since compass readings could not be trusted at this site. There were enough sunny periods to accomplish this task.
- Vehicles often were parked just to the west of CT 3 and 4, which might affect the flow. Vehicles also accessed the garage between cav2 and far occasionally throughout the experiment.

Refer to the logbook for more details on sensor operation.

CHRONOLOGY

Julian Day: Action

- 035: Archiving Started; Far tower up
- 036: Upwind tower erected
- 041: CT4 fixed; cav1 and cav2 towers erected
- 044: cav1 and cav2 towers leveled.
- 045: CT started 1630, low-load (4 MW) run from 1700-2000, base load (62 MW) from 2000-2115.
- 047: CT @4 MW from 1630-1830, 30 MW from 1830-1930, 62 MW from 1930-2130, shutdown 2150.
- 048: CT ran from 1500-1900 for a plume rise experiment.
- 049: CT ran from 2100-0117 for plume rise
- 050: CT started at 1420 for plume rise
- 053: CT ran from 1345-1545 on gas for downwash experiment
- 057: CT started 1300 for downwash
- 058: CT ran from 1400-2100
- 059: CT ran from 1100-1415 for plume rise; CT 1 and CT 3 also ran during this period
- 062: far and upwind towers flooded overnight; prop.10m.far destroyed; prop.6m.cav2 missing blades; uw.4m.far destroyed; other sonics iced up
- 063: CT operating for power; recoverable sensors fixed
- 065: ASTER operations ended

DAILY PLOTS

The following plots summarize conditions during each day of the project. Each plot covers one Julian day (0000-2359 GMT) and is labeled with time in GMT at the bottom and local time (EST) at the top. The top panel displays temperature and specific humidity from the 2m upwind tower, pressure, and precipitation rates (if present). Below that is a plot of wind speed and direction from the 6m upwind tower, with dotted lines showing the best directions for downwash to occur. The next panel shows net radiation measured near the far tower, and sensible heat flux from 10m on the upwind tower. The bottom panel shows the Monin-Obukhov stability parameter, z/L , and the friction velocity, u^* , calculated from the 10m upwind data. Since these fluxes and derived parameters are based on smoothed, 5-minute average statistics, they should not be used quantitatively and are only shown for guidance in selecting periods to analyze further. The latent heat flux and Bowen ratio, which normally are shown on this series of plots from ASTER, are not present due to the above-mentioned poor performance of the Krypton hygrometer.

<ul style="list-style-type: none">• Julian Day 35• Julian Day 36• Julian Day 37• Julian Day 38• Julian Day 39• Julian Day 40• Julian Day 41• Julian Day 42• Julian Day 43• Julian Day 44• Julian Day 45• Julian Day 46• Julian Day 47	<ul style="list-style-type: none">• Julian Day 48• Julian Day 49• Julian Day 50• Julian Day 51• Julian Day 52• Julian Day 53• Julian Day 54• Julian Day 55• Julian Day 56• Julian Day 57• Julian Day 58• Julian Day 59• Julian Day 60	<ul style="list-style-type: none">• Julian Day 61• Julian Day 62• Julian Day 63• Julian Day 64• Julian Day 65
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OTHER PLOTS

- Data from the entire experiment from the [roof-top sensors](#) along with measurements from the 10m level of the upwind tower

FIELD LOGBOOK

A computer-readable [field logbook](#) of comments by NCAR and other personnel is available in read-only html form.

[More information about this event...](#)

PROJECT WEBSITES

[Former Project Page](#)

CONTACT INFORMATION

Principal Investigators:

Project Manager:

[Steve Oncley](#) NCAR/EOL

Data Manager:

[EOL Archive](#) NCAR/EOL



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