National Center for Atmospheric Research

Integrated Surface Flux Facility (ISFF)

NEARLY FINAL.

Table of Contents

Introduction

This document is a standard product of NCAR/ATD/RTF which gives an overview of the measurements taken by ISFF and conditions during the OASIS98 field experiment. This document can be obtained either in hard copy from RTF or in electronic form from the NCAR/ATD WWW site.

Data Access

The NCAR data for OASIS are available in the following 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. These are available in NetCDF data files.

Also available is a computer-readable logbook of comments noted by RTF personnel.

A complete list of variables is available. This list shows the NetCDF variable name, dimensions, descriptive variable name, units, and additional comments, if available. Each file contains all the statistics for one day, beginning at 00:00:00 UTC. Most variables are dimensioned (time, station), where time is in 5 minute increments (288 per day), station is 1 or 2 for variables common to NCAR (station=1) and Oklahoma (station=2). Variables without a station dimension were measured by either NCAR or OK, but not both. See the Sensors description below for guidance as to where the variables were measured.

Most descriptive variable names hopefully are self-explanatory. Those beginning with Capital letters came from slow response sensors and those with lower cases letters from fast response sensors. Higher order statistics are indicated by products of variables. For example, w'tc' is the covariance between vertical velocity and sonic virtual temperature and h2o'h2o'h2o'h2o' is the fourth order moment of water vapor mixing density. For some variables, the sensor name is appended, e.g. "v.nuw1" is the lateral velocity component from the one of the new sonic anemometers we built with a University of Washington-style array, to distinguish it from "v" which is the same variable measured by other sonic anemometers.

Location

The NCAR sensors were deployed on the University of Oklahoma Mesonet site at Norman, OK. The towers were spaced about 7m apart along an east-west line beginning approximately 7m to the west of the prototype OASIS station near the center of the field at this site. From east to west, these towers were: hygrothermometer, prop, sonic, nuw sonic. The nuw sonic tower was only 5m high, all others were 11m. Our radiation stand was located approximately 15m north of the OASIS station.

A series of views forming a panorama from the 9m level of the sonic tower is available here:

1. North
2. Northeast
3. East
4. Southeast
5. South
6. Southwest
7. West
8. Northwest

Photographs

Sensors

Most of this section will be completed later.

The data files contain data from NCAR and the University of Oklahoma Mesonet. The NCAR sensors are mostly described in the ASTER Facility Description. A color-coded diagram of the variables from these sensors was created to help sort out the variables.

Table of Variables

The following variables were sampled during this project.

Most variables will have a "time" dimension, indicating they are time-series variables. Variables with a "station" dimension were sampled at more than one station or site.

Variables with a "sample" dimension are available at a resolution of 1/sample times the resolution of the dataset. For example, in a file of 5 minute statistics, a sample dimension of 5 indicates that the variable is available at 1 minute resolution.

For more information on variable names, see the ISFF Variable Name Convention .

Variables that were slowly sampled (usually once per second, or less) start with an upper case character (P, RH, T, etc). Lower case is used for more rapidly sampled variables, typically those used in eddy correlation, like u,v,w,tc,h2o, etc.

Higher moments are represented by products of variables, separated by single quotes. For example, u'v' is the covariance of u and v.

To save space, third and fourth moments of eddy correlation variables aren't listed in the table, but are available in the datasets.

Standard NetCDF variable names should only contain alphanumeric characters and underscores. Therefore, in Netcdf files the actual variable names will be the variable name shown here, with underscores substituted for periods and quotes. The variable name shown in this table will be saved as the "short_name" attribute of the Netcdf variable.

Variable Name	Description	Units	Dimension	Sensor	Notes
base_time	Seconds since 1970 Jan 1 00:00 GMT	seconds			
time	Seconds since base_time	seconds	time		
Gsoil.5cm.1	Soil Heat Flux	W/m^2	time x station		
Gsoil.5cm.2	Soil Heat Flux	W/m^2	time x station		
Gsoil.5cm.3	Soil Heat Flux	W/m^2	time		
Mp.5cm.1		msec	time		
Mp.5cm.2		msec	time		
Mp.5cm.3		msec	time		
Msoil.5cm.1	Soil Moisture	V frctn	time x station		
Msoil.5cm.2	Soil Moisture	V frctn	time		
Msoil.5cm.3	Soil Moisture	V frctn	time		
P	Barometric Pressure	mb	time x station		
RH.0.5m	Rel. Humidity	%	time		
RH.1.5m.2	Rel. Humidity	%	time		
RH.1.5m.3	Rel. Humidity	%	time		
RH.1.5m	Rel. Humidity	%	time x station		
RH.4.5m	Rel. Humidity	%	time		
RH.6.5m	Rel. Humidity	%	time		
RH.9m	Rel. Humidity	%	time x station		
Rlw.in.CNR1a	Incoming Longwave	W/m^2	time		
Rlw.out.CNR1a	Outgoing Longwave	W/m^2	time		
Rnet.CNR1a	Net Radiation	W/m^2	time		
Rnet.NRLite.3	Net Radiation	W/m^2	time		

Rnet	Net Radiation	W/m^2	time x station		
Rpile.in.CNR1a	Up-looking Thermopile	W/m^2	time		
Rpile.in	Up-looking Thermopile	W/m^2	time x station		
Rpile.out.CNR1a	Down-looking Thermopile	W/m^2	time		
Rpile.out	Down-looking Thermopile	W/m^2	time x station		
Rsw.in.CNR1a	Incoming Shortwave	W/m^2	time		
Rsw.in	Incoming Shortwave	W/m^2	time x station		
Rsw.out.CNR1a	Outgoing Shortwave	W/m^2	time		
Rsw.out	Outgoing Shortwave	W/m^2	time x station		
Spd.2m	Wind Speed	m/s	time x station		
Spd.9m	Wind Speed	m/s	time x station		
T.0.5m	Air Temp	degC	time		
T.1.5m.2	Air Temp	degC	time		
T.1.5m.3	Air Temp	degC	time		
T.1.5m	Air Temp	degC	time x station		
T.4.5m	Air Temp	degC	time		
T.6.5m	Air Temp	degC	time		
T.9m	Air Temp	degC	time x station		
Tadam.marigold	Electronics Temp	degC	time		
Tadam.ragwort	Electronics Temp	degC	time		
Tcase.CNR1a		W/m^2	time		
Tcase.in	Up-looking Case Temp	degC	time x station		
Tcase.out	Down-looking Case Temp	degC	time x station		
Tdome.in	Up-looking Dome Temp	degC	time x station		
Tdome.out	Down-looking Dome Temp	degC	time x station		
Tsfc	Surface Temp	C	time		
Tsoil.5cm.1	Soil Temperature	degC	time x station		
Tsoil.5cm.2	Soil Temperature	degC	time x station		
Tsoil.5cm.3	Soil Temperature	degC	time		
U.10m	Eastward Wind	m/s	time		
U.1m	Eastward Wind	m/s	time		
U.2m	Eastward Wind	m/s	time		
U.4.5m	Eastward Wind	m/s	time		
U.6.5m	Eastward Wind	m/s	time		

U.9m	Eastward Wind	m/s	time		
V.10m	Northward Wind	m/s	time		
V.1m	Northward Wind	m/s	time		
V.2m	Northward Wind	m/s	time		
V.4.5m	Northward Wind	m/s	time		
V.6.5m	Northward Wind	m/s	time		
V.9m	Northward Wind	m/s	time		
cflag.nuw1			time		
cflag.nuw2			time		
diag.csat			time		
h2o'h2o'.4.5m	h2o variance	(g/m^3)^2	time x station		
h2o'h2o'.9m	h2o variance	(g/m^3)^2	time		
h2o.4.5m	Water Vapor Density	g/m^3	time x station		
h2o.9m	Water Vapor Density	g/m^3	time		
lev.rad.x		deg	time		
lev.rad.y		deg	time		
lev.u.4.5m		deg	time		
lev.u.9m		deg	time		
lev.v.4.5m		deg	time		
lev.v.9m		deg	time		
mr'mr'.bph.4.5m		(gm/kg)^2	time		
mr.bph.4.5m		gm/kg	time		
raina	Rain Accumulation	mm	time x station		
rainr	Rain Rate	mm/hr	time x station		
rh.bph.4.5m		%	time		
t't'.4.5m	t variance	(degC)^2	time x station		
t't'.bph.4.5m	t variance	(degC)^2	time		
t.4.5m	Air Temperature	degC	time x station		
t.bph.4.5m	Air Temperature	degC	time		
tc'tc'.4.5m	tc variance	(degC)^2	time x station		
tc'tc'.9m	tc variance	(degC)^2	time		
tc'tc'.csat	tc variance	(degC)^2	time		
tc'tc'.nuw1	tc variance	(degC)^2	time		

tc'tc'.nuw2	tc variance	(degC)^2	time		
tc.4.5m	Virtual Temperature	degC	time x station		
tc.9m	Virtual Temperature	degC	time		
tc.csat	Virtual Temperature	degC	time		
tc.nuw1	Virtual Temperature	degC	time		
tc.nuw2	Virtual Temperature	degC	time		
tcflag.4.5m	Spike fract for tc		time		
tcflag.9m	Spike fract for tc		time		
tcflag.csat	Spike fract for tc		time		
u'h2o'.4.5m	u h2o covariance	m/s g/m^3	time x station		
u'h2o'.9m	u h2o covariance	m/s g/m^3	time		
u'mr'.(,bph).4.5m		m/s gm/kg	time		
u't'.(,bph).4.5m	u t covariance	m/s degC	time		
u't'.4.5m	u t covariance	m/s degC	time x station		
u'tc'.4.5m	u tc covariance	m/s degC	time x station		
u'tc'.9m	u tc covariance	m/s degC	time		
u'tc'.csat	u tc covariance	m/s degC	time		
u'tc'.nuw1	u tc covariance	m/s degC	time		
u'tc'.nuw2	u tc covariance	m/s degC	time		
u'u'.4.5m	u variance	(m/s)^2	time x station		
u'u'.9m	u variance	(m/s)^2	time		
u'u'.csat	u variance	(m/s)^2	time		
u'u'.nuw1	u variance	(m/s)^2	time		
u'u'.nuw2	u variance	(m/s)^2	time		
u'v'.4.5m	u v covariance	(m/s)^2	time x station		
u'v'.9m	u v covariance	(m/s)^2	time		
u'v'.csat	u v covariance	(m/s)^2	time		
u'v'.nuw1	u v covariance	(m/s)^2	time		
u'v'.nuw2	u v covariance	(m/s)^2	time		
u'w'.4.5m	u w covariance	(m/s)^2	time x station		
u'w'.9m	u w covariance	(m/s)^2	time		
u'w'.csat	u w covariance	(m/s)^2	time		
u'w'.nuw1	u w covariance	(m/s)^2	time		
u'w'.nuw2	u w covariance	(m/s)^2	time		

u.4.5m	Sonic U Wind Comp	m/s	time x station		
u.9m	Sonic U Wind Comp	m/s	time		
u.csat	Sonic U Wind Comp	m/s	time		
u.nuw1	Sonic U Wind Comp	m/s	time		
u.nuw2	Sonic U Wind Comp	m/s	time		
uaflag.nuw1		G	time		
uaflag.nuw2		G	time		
uasamples.nuw1			time		
uasamples.nuw2			time		
ubflag.nuw1			time		
ubflag.nuw2			time		
ubsamples.nuw1		G	time		
ubsamples.nuw2		G	time		
ucflag.nuw1			time		
ucflag.nuw2			time		
ucsamples.nuw1		G	time		
ucsamples.nuw2		G	time		
uflag.4.5m	Spike fract for u	G	time		
uflag.9m	Spike fract for u	G	time		
uflag.csat	Spike fract for u		time		
usamples.4.5m	# of samples averaged	G	time		
usamples.9m	# of samples averaged	G	time		
v'h2o'.4.5m	v h2o covariance	m/s g/m^3	time x station		
v'h2o'.9m	v h2o covariance	m/s g/m^3	time		
v'mr'.(,bph).4.5m		m/s gm/kg	time		
v't'.(,bph).4.5m	v t covariance	m/s degC	time		
v't'.4.5m	v t covariance	m/s degC	time x station		
v'tc'.4.5m	v tc covariance	m/s degC	time x station		
v'tc'.9m	v tc covariance	m/s degC	time		
v'tc'.csat	v tc covariance	m/s degC	time		
v'tc'.nuw1	v tc covariance	m/s degC	time		
v'tc'.nuw2	v tc covariance	m/s degC	time		
v'v'.4.5m	v variance	(m/s)^2	time x station		
v'v'.9m	v variance	(m/s)^2	time		

v'v'.csat	v variance	(m/s)^2	time		
v'v'.nuw1	v variance	(m/s)^2	time		
v'v'.nuw2	v variance	(m/s)^2	time		
v'w'.4.5m	v w covariance	(m/s)^2	time x station		
v'w'.9m	v w covariance	(m/s)^2	time		
v'w'.csat	v w covariance	(m/s)^2	time		
v'w'.nuw1	v w covariance	(m/s)^2	time		
v'w'.nuw2	v w covariance	(m/s)^2	time		
v.4.5m	Sonic V Wind Comp	m/s	time x station		
v.9m	Sonic V Wind Comp	m/s	time		
v.csat	Sonic V Wind Comp	m/s	time		
v.nuw1	Sonic V Wind Comp	m/s	time		
v.nuw2	Sonic V Wind Comp	m/s	time		
vflag.4.5m	Spike fract for v		time		
vflag.9m	Spike fract for v		time		
vflag.csat	Spike fract for v		time		
vsamples.4.5m	# of samples averaged	G	time		
vsamples.9m	# of samples averaged	G	time		
w'h2o'.4.5m	w h2o covariance	m/s g/m^3	time x station		
w'h2o'.9m	w h2o covariance	m/s g/m^3	time		
w'mr'.(,bph).4.5m		m/s gm/kg	time		
w't'.(,bph).4.5m	w t covariance	m/s degC	time		
w't'.4.5m	w t covariance	m/s degC	time x station		
w'tc'.4.5m	w tc covariance	m/s degC	time x station		
w'tc'.9m	w tc covariance	m/s degC	time		
w'tc'.csat	w tc covariance	m/s degC	time		
w'tc'.nuw1	w tc covariance	m/s degC	time		
w'tc'.nuw2	w tc covariance	m/s degC	time		
w'w'.4.5m	w variance	(m/s)^2	time x station		
w'w'.9m	w variance	(m/s)^2	time		
w'w'.csat	w variance	(m/s)^2	time		
w'w'.nuw1	w variance	(m/s)^2	time		
w'w'.nuw2	w variance	(m/s)^2	time		

w.4.5m	Sonic W Wind Comp	m/s	time x station		
w.9m	Sonic W Wind Comp	m/s	time		
w.csat	Sonic W Wind Comp	m/s	time		
w.nuw1	Sonic W Wind Comp	m/s	time		
w.nuw2	Sonic W Wind Comp	m/s	time		
wflag.4.5m	Spike fract for w		time		
wflag.9m	Spike fract for w		time		
wflag.csat	Spike fract for w		time		
wsamples.4.5m	# of samples averaged	G	time		
wsamples.9m	# of samples averaged	G	time		

General

Most sensors performed as expected, so only a few changes were made to the data from the in-field configuration. The primary reason to reprocess the data were to ensure that the format was consistent throughout the project. (As usual, some changes were made during the program.)

Temperature-Humidity Sensors

Considerable effort was expended during OASIS98 to reduce radiation errors in the NCAR temperature measurements. No attempt to correct the data was made (since it would be very difficult to model this effect), so the NetCDF data are unchanged from the in-field results. See the logbook for details of how the configuration of the sensors changed. The final configuration, with a pump connected through a manifold, appeared to be the most effective. The sensors at 1.5 and 9m were operated in this mode beginning 23 July and the sensors at 0.5 and 4.5m were added on 29 July (when a bigger pump was delivered).

Propeller-vane Anemometers

The azimuth angles of the boom were entered into the props on June 21, so the wind directions for earlier data were not defined. Thus, the U and V components in the NetCDF files have been set to NA. Data from the sonic anemometers at 4.5 and 9m can be used to provide wind information before this date.

Note that small wind direction differences were observed during the field program which were tracked down to the vanes being slightly bent. Once this problem was identified, some of the vanes were flipped (upside-down) to make the directions more consistent. Again, no attempt to correct the data was made (since it would be very difficult to model this effect and the error is smaller than the accuracy needed for wind directions for this program). See the logbook for details of this problem.

Sonic Anemometers

The sonic anemometers performed reasonably well during OASIS. The ATIs had some spikes related to high temperatures, but these generally were under 1% of the time and should not affect the statistics. The major exception was that U2 on the 9m ATI developed an increased sensitivity to temperature and was replaced on 14 July.

The new UW sonic anemometers spiked much worse (5-10%; probably due to the longer pathlength). Furthermore, nuw1 developed a transducer problem on 7/26, and nuw2 stopped reporting data on 8/5. These problems are being investigated. The geometry for both arrays was measured on 10/6/98 and found to be within 1 degree of specifications. The new angles have been used in post-processing of the data.

Tilt corrections have been calculated for all of the sonic anemometers using our standard algorithm. These corrections have been applied to all of the statistics in the data files (including those from the Oklahoma Mesonet CSAT sonic anemometer). The maximum "lean" angle found was 1.9 degrees, and most were less than 1 degree, which is typical for a nearly flat site. The values used are:

```
# yr mon day hh:mm(GMT) lean    leanaz  woffset

4.5m.OKMN:
98 6 23 00:00   0.642   176.3   0.018

4.5m.NCAR:
98 6 17 00:00   1.239   25.3    0.006
# Releveled using bubble level
98 6 29 14:30   0.316   -146.9  -0.022

9m.NCAR:
98 6 17 00:00   0.693   27.4    -0.017
# After v transducer replacement
98 7 10 00:00   1.908   20.5    -0.023

nuw1:
98 7 15 00:00   0.771   -26.6
# After rotating
98 7 24 15:00   0.882   -74.0
# Sensor goes bad (path a transducer?)
98 7 26 12:00   0       0       0

nuw2:
98 7  1 00:00   0.300   27.6
# after flipping and rotating
# (179.3 = 180.0-0.6 and -177 = 2.7 - 180, to compensate for flip)
98 7 24 15:00   179.341 -177.3
```

The corresponding plots are:
4.5m.OKMN
4.5m.NCAR; first part
4.5m.NCAR; second part
9m.NCAR; first part
9m.NCAR; second part
nuw1; before flip & rotate
nuw1; after flip & rotate
nuw2; before flip & rotate
nuw2; after flip & rotate

Radiometers

Tony Delany has written a report on OASIS98 Radiometer Response. Several potential problems with some of the sensors have been identified, however the only correction which was applied to the data in post-processing was correction of the case temperature calibration from the Okalahoma CNR1 (and recalculation of its long-wave radiation). As noted in the last section of Tony's report,h this accounted for about half of the difference between the long-wave radiation from the Epplys and CNR1 observed in the field.

Soil Properties

Tony Delany has written a summary of Soil Measurements for OASIS98, including the gravimetric soil moisture samples, the manual bulk density determinations, and the resulting calibrations for the CSI soil moisture probes. The new second-order calibrations to the CSI probes have been applied to the data in the NetCDF files.

Daily Weather Plots

The following plots summarize conditions measured by the NCAR sensors for each day of the project. Each plot covers one days (00-23 CDT) and is labeled with time in GMT at the bottom and local time (CDT) at the top. The top panel displays temperature and specific humidity measured at both 1.5 and 9m, pressure, and precipitation rates (if present). Below that is a plot of wind speed and direction measured at 9m, with a dotted line showing the direction of the best fetch (South). The next panel shows net radiation, sensible and latent heat flux, and the heat into the surface (derived from the soil heat flux, temperature, and moisture sensors). The bottom panel shows the Monin-Obukhov stability parameter, z/L, the friction velocity, u*, and the Bowen ratio calculated from the flux 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.

June

				18	19	20
21	22	23	24	25	26	27
28	29	30	.	.	.	.

July

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	.

August

						1
2	3	4	5	6	7	8

Other plots

ATI/CSAT Comparison

We observed differences in the statistics between the CSAT3 and ATI sonic anemometers which we were unable to explain due to spatial averaging, tilts, aliasing, or data sampling effects. (See logbook entries 44, 50, 89, and 105.) A plot of spectra for one case is given here in GIF (large) and PostScript (small) formats.

NUW Comparison

The first attempt at plotting the comparison of the new UW sonic anemometers is shown here. The left panels show the speed from each of the two sonics differenced from the prop (at 4.5m) and the right panels show the wind speed ratio from the two sonics. These data are 10-minute averages of the data which have been tilted and rotated into geographic coordinates. Only data with wind directions within 80 degrees of South are shown, since the wake from either the tower, boom, or other sonic would be present for other directions. Also, data with speeds less than 2 m/s have not been plotted.

If anything, the flipped and rotated comparision looks better than for the parallel configuration. This may be due to the arrangement of the supporting booms. The sonic arrays were closer together (and thus would have affected each other over a wider range of wind directions) for the parallel configuration than for flipped and rotated. However, in both cases directions from about 110 to 250 through 180 should have been okay. This still doesn't explain the apparent variation of the parallel data - perhaps the tilt correction was confused by the distortion from the sides and should be recomputed.

Also, the flipped and rotated data show a consistent speed difference (nuw2 higher by 2%). During this period, the Tc values also are higher from nuw2 by 4C (1.3%). Since u~Tc(t1-t2)/2d, about half of the error is explained by how the sensors were zeroed. I'm not sure why this 4C error occurred.

In any case, I would conclude that these arrays do not appear to have flow distortion (no flow distortion correction has been applied to these data) which is evident from this test.

Last modified:

This page was prepared by Steven Oncley, NCAR Research Technology Facility