Direct/bulk fluxes from the 2006 STRATUS Cruise

This document is the Readme for *stratus06flux_hr.txt* and *stratus06flux_10.txt* files. The *_hr* refers to hourly averages and the *_10* to 10-minute averages.
Both direct (covariance) and inertial-dissipation (ID) turbulent flux calculations are included in this present data. The files are 53 columns:

- First column is the decimal Julian date
- Columns 2 to 11 are mean variables from the PSD system
- Columns 12 to 21 are turbulent fluxes (covariance, ID, and bulk)
- Columns 22 to 23 are the radiative fluxes
- Columns 24 is the rain rate
- Columns 25 to 27 are turbulence data quality indicators
- Columns 28 to 31 are the turbulent structure function parameters (indices of small-scale turbulence in the inertial subrange).
- Columns 32 to 33 are the minor (rain and Webb) heat flux components;
- Columns 34 to 35 are latitude and longitude;
- Columns 36 to 38 are the heights of the PSD wind, temperature, and humidity mean sensors.
- Columns 39 to 48 are mean variables from the ships sensors.
- Columns 49 to 53 are data computed from the LICOR-7500 open path IR sensor.

The files can be directly acquired with a MATLAB 'load' statement. For instance:

```
x=load('your_local_directory\stratus06flux_hr.txt');%read file with hr-average data; set your local directory
```

The columns assignment is as follows:

```
jdy=x(:,1);%julian day at beginning of time average
ushp=x(:,2);%doppler log, SCS (m/s)
U=x(:,3);%true wind,PSD sonic (m/s) 17.7 m
dir=x(:,4);%true wind direction, PSD sonic (deg) 17.7 m
urel=x(:,5);%relative wind speed, PSD (m/s) 17.7 m
reldir=x(:,6);%relative wind direction (from),clockwise rel ship's bow, PSD sonic (deg)
head=x(:,7);%ship heading, deg clockwise rel north, SCS laser ring gyro (deg)
tsnk=x(:,8);%sea snake temperature, PSD, 0.05 m depth (C)
ta=x(:,9);%air temperature, PSD (C) 15.5 m
qse=x(:,10);%sea surface specific humidity, from snake (g/kg)
qa=x(:,11);%air specific humidity, PSD (g/kg) 15.5 m
hsc=x(:,12);%sensible heat flux, covariance, PSD sonic anemometer(W/m^2)
hsib=x(:,13);%sensible heat flux, ID, PSD sonic anemometer(W/m^2)
hsb=x(:,14);%bulk sensible heat flux, (W/m^2)
hlc=x(:,15);%latent heat flux, covariance, (W/m^2)
hlib=x(:,16);%latent heat flux, ID, (W/m^2)
hlb=x(:,17);%bulk latent heat flux, W/m^2 (includes Webb et al. correction)
taucx=x(:,18);%covariance streamwise stress, PSD sonic anemometer (N/m^2)
```

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taucy=x(:,19);%covariance cross-stream stress, PSD sonic anemometer (N/m^2)
tauib=x(:,20);%ID streamwise stress, PSD sonic anemometer (N/m^2)
taub=x(:,21);%bulk wind stress along mean wind, (N/m^2)
rs=x(:,22);%downward solar flux, PSD units (W/m^2)
rl=x(:,23);%downward IR flux, PSD units (W/m^2)
org=x(:,24);%rainrate, PSD STI optical rain gauge, uncorrected (mm/hr)
J=x(:,25);%ship plume contamination index
tiltx=x(:,26);%flow tilt at PSD sonic anemometer, earth frame
Jm=x(:,27);%ship maneuver index
ct=x(:,28);%ct^2 (K^2/m^.667)
cq=x(:,29);%cq^2 ((g/kg)^2/m^.667)
cu=x(:,30);%cu^2 ((m/s)^2/m^.667)
cw=x(:,31);%cw^2 ((m/s)^2/m^.667)
hrain=x(:,32);%rain heat flux,Gosnell et al 1995, JGR, 18437-18442, (W/m^2)
hlwebb=x(:,33);%correction to measured latent heat flux, Webb et al. 1980,QJRMS, 85-100
lat=x(:,34);%latitude, deg (SCS pcode)
lon=x(:,35);%longitude, deg (SCS pcode)
zu_PSD=x(:,36);%height of mean wind sensor, 17.7 m
zt_PSD=x(:,37);%height of mean air temperature sensor, 15.5 m
zq_PSD=x(:,38);%height of mean air humidity sensor, 15.5 m
%***** ships imet and scs data
sog=x(:,39);%speed over ground, SCS gps, (m/s)
U_scs=x(:,40); %true wind speed, imet propvane anemometer (m/s)
dir_scs=x(:,41);%true wind direction (from),clockwise rel north, imet,(deg)
cog=x(:,42);%%course over ground, SCS gps, (m/s)
tsg=x(:,43);%tsg water temperature, 5 m depth, (C)
ta_im=x(:,44);%imet air temperature (C)
qs_tsg=x(:,45);%imet bulk water specific humidity (g/kg)
qa_im=x(:,46);%imet air specific humidity, (g/kg)
rs_im=x(:,47);%imet solar flux, (W/m^2)
rl_im=x(:,48);%imet IR flux (W/m^2)
wco2_lic=x(:,49);%LICOR CO2 flux, (micatm m/s)
q_lic=x(:,50);%Specific humidity from LICOR (g/kg)
sgq_lic=x(:,51);%Standard deviation of specific humidity from LICOR (g/kg)
co2_lic=x(:,52); %CO2 concentration from Licor (umol/mol)
sgq_lic=x(:,53);%Standard deviation of CO2 concentration from Licor (umol/mol)
```

Notes:

- The flow distortion corrections to the relative wind components have been used in an attempt to reduce the transitions when stopping for stations.
- In processing the 10-min data to one-hr averages, only the filtered data were used in averaging the turbulence variables. If there were no valid values in the 1-hr interval, the turbulence variables were set to NaN.

The quality criteria were subdivided in two parts:

* A value of J=0 implies no ship contamination.

* A value of Jm<3 implies no significant maneuver during the average.

- Bulk estimates of air sea fluxes were computed using the COARE bulk algorithm version 3.0.
- Because the IR hygrometer detects water vapor mass concentration (ρ_v in kg/m^3), the water vapor - velocity correlation must be corrected as per Webb et al ($H_{latent} = L_e \langle w' \rho_v' \rangle$ + hl_webb).

  The values given for covariance and ID latent heat fluxes in the file are $L_e \langle w' \rho_v' \rangle$. Values for hl_webb are included in column 33. This should be applied to the covariance and ID values. It is already included in the bulk values given here.
- Both latent and CO_2 fluxes are computed from the LICOR-7500 open path IR sensor. The CO_2 fluxes have been corrected for the humidity Webb effect but not for the temperature Webb effect.
- Sensible heat flux was computed from vertical velocity - sonic temperature covariance. The humidity contribution to sonic temperature was removed using the bulk latent heat flux.
- Turbulent fluxes are computed by converting the anemometer 3-component velocities to fixed earth coordinates, correcting the fast time series for ship motion, and re-setting the coordinate system normal to the 10-min mean flow through one rotation about the original vertical and one tilt. The variable *tiltx* gives the tilt used for the computation. Experience show that tilts greater than about 10 deg give questionable fluxes.