Direct/bulk fluxes from the 2011 DYNAMO Cruise – Version 1

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This document is the Readme for *Dynamo2011_flux_10_alllegs_v1.txt* and *Dynamo2011_flux_hr_alllegs_v3.txt*. The *_hr* refers to hourly averages and the *_10* refers to the 10-minute averages. Both direct (covariance) and inertial-dissipation (ID) turbulent flux calculations are included in this present data. The period covered is DOY 246 (September 03, 2011) through DOY 365 (December 31, 2011). The graph below gives the ship tracks for the data period.

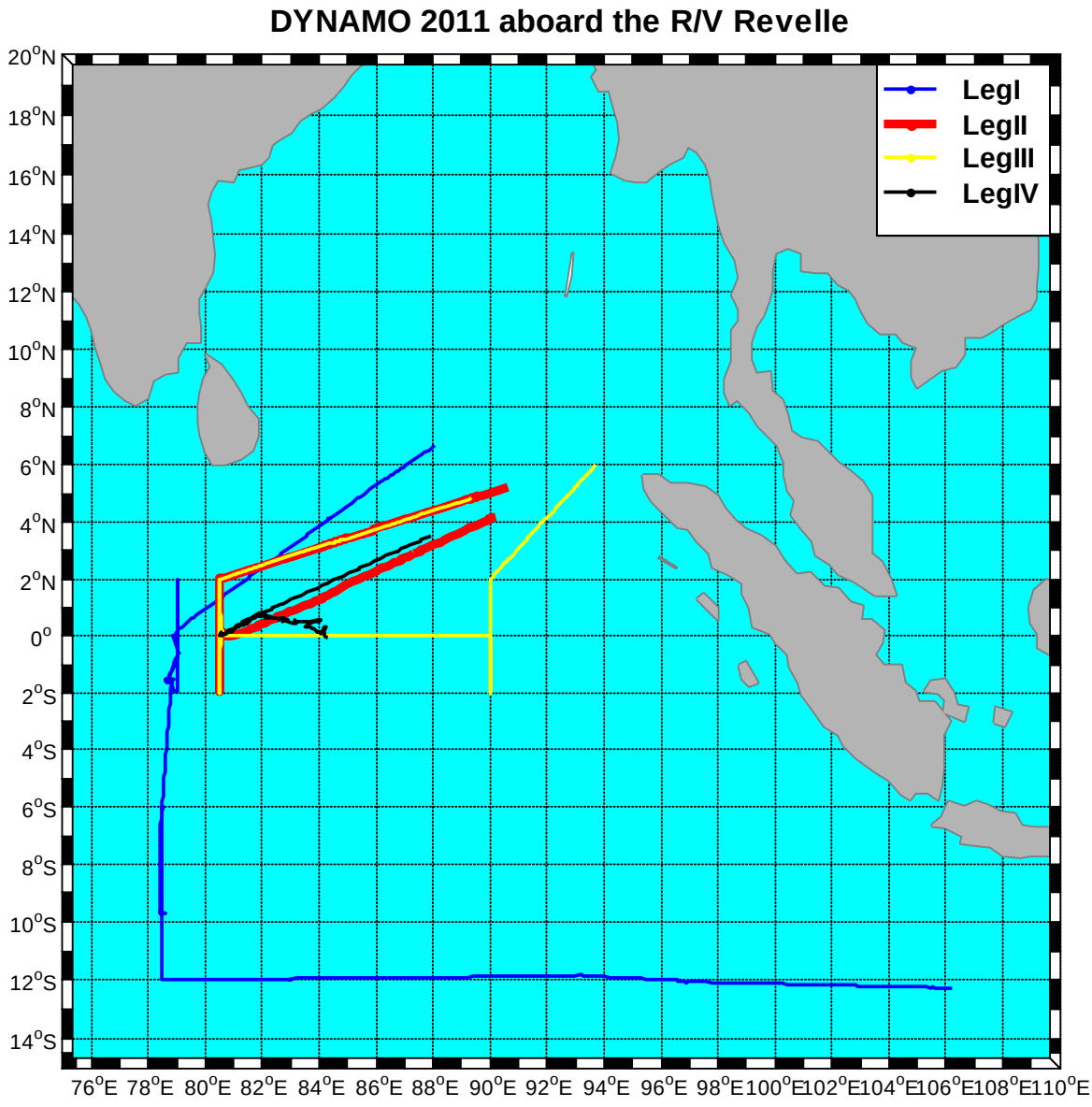

Figure 1. Tracks of R/V Revelle during DYNAMO 2011

The PSD turbulent flux system was mounted on the ship's foremast seen on Figure 2. Reference heights (with respect to water line) and sampling rates of the sensors used in the STRATUS2011 experiment can be found in table 1. More pictures of the instruments and setup can be found under ftp://ftp1.esrl.noaa.gov/psd3/cruises/DYNAMO_2011/Revelle/Pictures/

Figure 2. Views of the jackstaff and the PSD flux tower deployed on the R/V Moana Wave during STRATUS 2011.

Sensor	Sampling rate	Height (m)
Bow sonic	10 Hz	17.75
Motion Pack	10 Hz	16.95
ORG	0.1Hz, averaged to 1 sample/min	16.5
T/RH	0.1Hz, averaged to 1 sample/min	15.6
Licor7500 (CO2&H2O)	10 Hz	17.2
Radiometers (top PSD van)	0.1Hz, averaged to 1 sample/min	12.6
Barometer	0.1Hz, averaged to 1 sample/min	10.6
SST	0.1Hz, averaged to 1 sample/min	-0.05 to -0.10

Table 1. PSD sensor heights and sampling rates.

1) Column assignment for *Dynamo2011_flux_10.txt and Dynamo2011_flux_hr.txt* files

The files are 56 columns:
- First column is the decimal day-of-year date
- Columns 3 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. As no data from the ship were available, these variables were setup to Not-a-Number (NaN)
• Columns 49 to 53 are data computed from the LICOR-7500 open path IR sensor.
• Column 54 is the atmospheric pressure
• Columns 55 and 56 are the true wind speed and direction (from) relative to earth

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

```
x=load('your_local_directory\Dynamo2011_flux_10_alllegs_v1.txt');%read file with 10-min average data; set your local directory.
```

The columns assignment is as follows:

```
jdy=x(:,1);%day-of-year at beginning of time average
ushp=x(:,2)%doppler log, SCS (m/s) →not available, replaced by SOG
U=x(:,3);%true wind PSD sonic relative to water (m/s)
dir=x(:,4);%true wind direction from relative to water, PSD sonic (deg)
urel=x(:,5);%relative wind speed, PSD (m/s)
reldir=x(:,6);%relative wind dir (from),clockwise rel ship's bow, PSD sonic (deg)
head=x(:,7);%ship heading, deg clockwise rel north, PSD GPS
tsnk=x(:,8);%sea snake temperature, PSD (C)
ta=x(:,9);%air temperature, PSD (C)%
qse=x(:,10);%sea surface specific humidity from snake (g/kg)
qa=x(:,11);%air specific humidity, PSD (g/kg)
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)
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 (mm/hr)
J=x(:,25);%ship plume contamination index
tiltx=x(:,26);%flow tilt at PSD sonic anemometer
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.
lat=x(:,34);%latitude, deg (PSD pcode)
lon=x(:,35);%longitude, deg (PSD pcode)
zu_psd=x(:,36);%height of mean wind sensor, 17.75 m
zt_psd=x(:,37);%height of mean air temperature sensor, 15.6 m
zq_psd=x(:,38);%height of mean air humidity sensor, 15.6 m
%***** ships imet and scs data
```

```
sog=x(:,39);%speed over ground, SCS gps, (m/s)
U_scs=x(:,40); %true wind speed relative to earth  m/s) – 19.6m
dir_scs=x(:,41);%true wind direction from relative to earth, clockwise rel
north (deg)
cog=x(:,42);%%course over ground, SCS gps, (m/s)
tsg=x(:,43);%tsg water temperature (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 7500 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)
sgC_lic=x(:,53);%Standard deviation of CO2 concentration from LICOR
(microatm)
press=x(:,54); %Atmospheric pressure (mb)
Uearth=x(:,55);   %True wind speed (m/s) relative to earth
direarth=x(:,56); % True wind direction (deg) from relative to earth
```

Notes:

• True wind speed is computed from the sonic anemometer using PSD GPS system and the surface currents measured by the ship's ADCP; thus, *U* is interpreted as the speed relative to water. Some modest corrections have also been used to minimize flow distortion due to the ship's structure. The wind speed components relative to water have then been used to compute the fluxes.

• SST is from the PSD seasnake with some values provided by the IR radiometer deployed by LDEO when the sea snake misbehaved.

• Following post-calibration, the PSD air temperature was adjusted by +0.03C and a 0.95 factor was applied to the PSD relative humidity. Some erroneous values were replaced by the UConn sensor when the PSD aspirated system did not work properly.

• PSD shortwave flux was obtained from the 2 gyrostabilized Eppley PSP units.

• PSD longwave flux was obtained from 1 gyrostabilized Eppley PIR unit, logged and computed as per Fairall et al. Jtech, 1998.

• A correction factor of 1.43 was applied to the PSD optical raingauge estimates of rainfall rates. This factor was determined by careful comparison with the other gauges present on the ship.

• PSD atmospheric pressure was adjusted by -0.58mbar to match other pressure sensors present on the ship.

• Bulk estimates of air sea fluxes were computed using the COARE bulk algorithm version 3.0.

• 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.

• Because the IR hygrometer detects water vapor mass concentration (ρv in kg/m3), the water vapor -velocity correlation must be corrected as per Webb et al (Hlatent = Le <w' ρv'> + hl_webb). The values given for covariance and ID latent heat fluxes in the file are Le<w' ρv'>. 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 CO2 fluxes are computed from the LICOR-7500 open path IR sensor. The CO2 fluxes have been corrected for the humidity Webb effect but not for the temperature Webb effect. Comparison to CO2 flux measured during DYNAMO with a dried LICOR-7200 shows that the LICOR-7500 CO2 fluxes are not reliable.

• Sensible heat flux was computed from vertical velocity -sonic temperature covariance and Inertial-dissipation (ID) methods. The humidity contribution to sonic temperature was removed using the bulk latent heat flux.

• For reference, a QC mean meteorological data set has been assembled as a collaborative effort between NOAA/PSD/Earth Systems Research Laboratory, Oregon State University, and the University of Connecticut (ftp://ftp1.esrl.noaa.gov/psd3/cruises/DYNAMO_2011/Revelle/Scientific_analysis/PSD_UConn_OSU_MeanMetFiles/)

2) Time series

Figures 3, 4 and 5 show the time series for stress, sensible heat, and latent heat for that cruise.

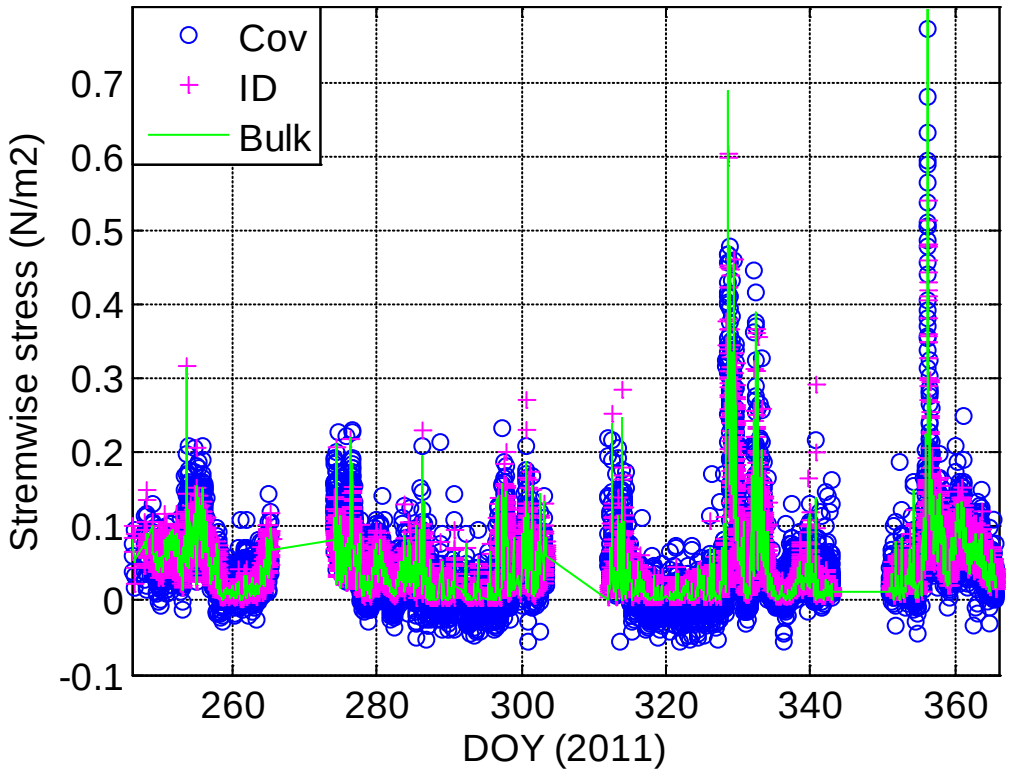

Figure 3. Time series of turbulent surface stress in DYNAMO2011: green line - bulk estimate; magenta '+' - ID; blue circles - covariance measurement.

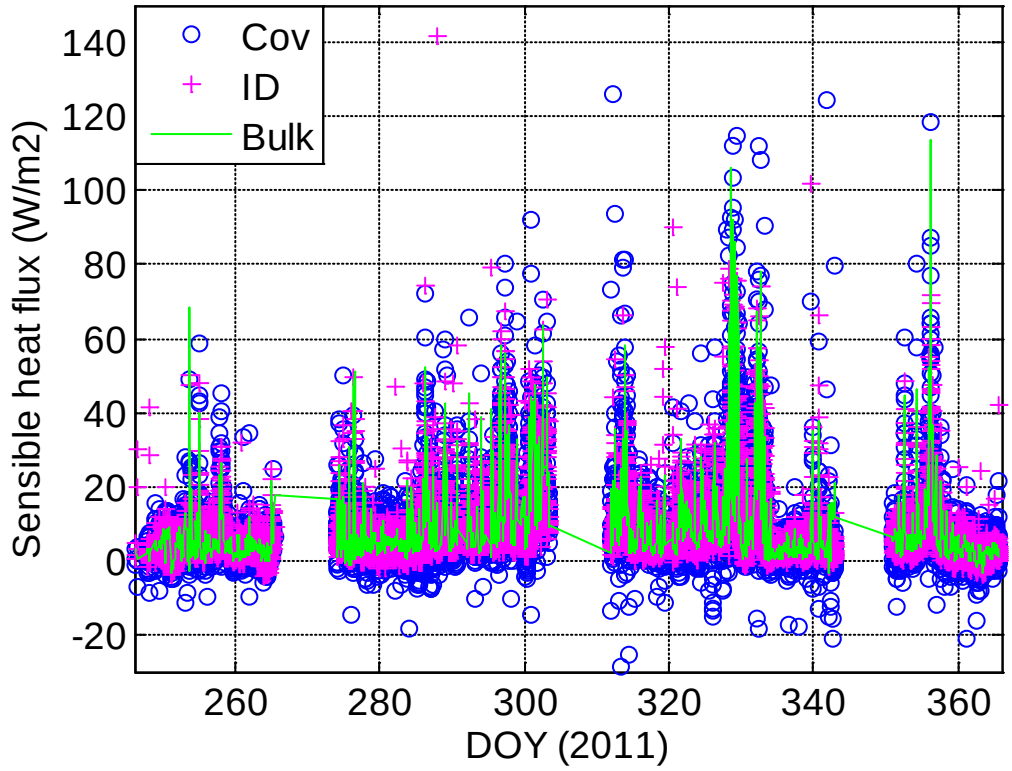

Figure 4. Time series of sensible heat flux in DYNAMO2011: green line - bulk estimate; magenta '+' - ID; blue circles - covariance measurement.

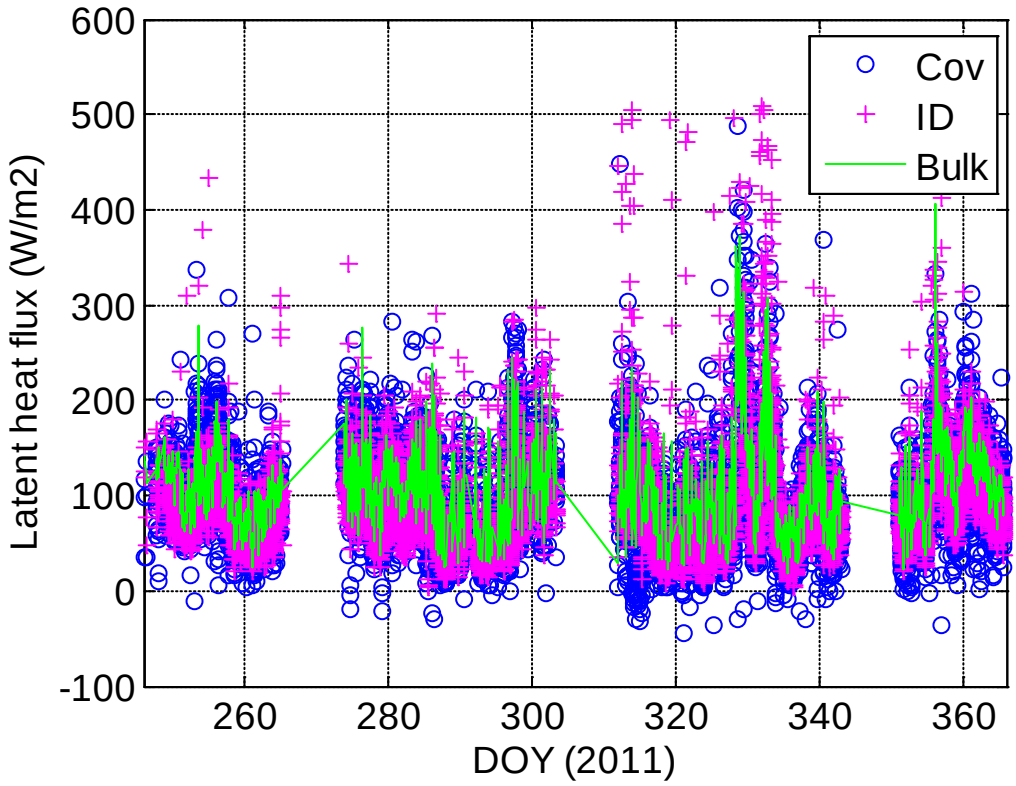

Figure 5. Time series of latent heat flux in DYNAMO2011: green line - bulk estimate; magenta '+' - ID; blue circles - covariance measurement.