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ETL 10 cruise PACS/EPIC dataset: Release #2.0

This is the second release of turbulent and bulk fluxes, background meteorology, ceilometer cloud statistics, and microwave radiometer cloud liquid water observations for 10 PSD cruises to 110 and 95 W longitude in the equatorial Pacific.  The are 3 spring cruises (S00,S01,S02) and 7 fall cruises (F99, F00, Epic01, F01, F02, F03, and F04).  Figure 1 shows the cruise tracks in the PACS region.  The data, documentation, powerpoints, and other background material are available at ftp://ftp.etl.noaa.gov/user/cfairall/EPIC/epicmonitor.  The flux, ceilometer and microwave data from each cruise have been appended into files combining all 10 cruises.  These three files are available at ftp://ftp.etl.noaa.gov/user/cfairall/EPIC/epicmonitor/combined_files . The most recent files carry the designator *filename*_10h.ext.  The 10 refers to the time resolution (10-minures) and the 'h' implies the file includes all 10 cruises.   A matlab script (*read_epicmonitor_10h.m*) is provided to read these files.

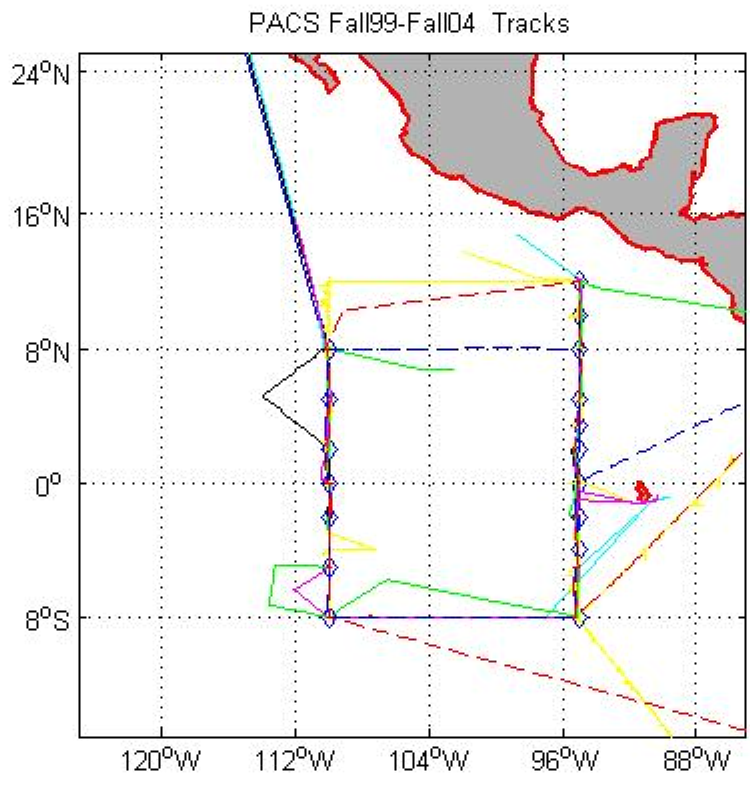


**Figure 1.**  Cruise tracks for 10 PSD projects from 1999 through 2004.  Lines are as follows:  F99 – solid blue; S00 – solid red; F00 – solid black; S01 – solid cyan; Epic01 & F01– solid yellow; S02 – solid magenta; F02 – solid green; F03 – dashed blue; F04 – dashed red.  The circles denote TAO buoys on the 95 W and 110 W lines.  The jogs off the buoy lines are usually to collect buoys that have broken loose or to visit the Galapagos Islands.

The data were obtained as part of the EPIC Monitoring program (Cronin et al. 2001), a joint PMEL and PSD effort to make climate quality oceanic and atmospheric observations in the Eastern Equatorial Pacific. The concept was to put the PSD ship-based flux/PBL observing system on the ship servicing the TAO buoys along 95 W and 110 W. M. Cronin of PMEL enhanced the regular TAO sensor set with Solar and IR flux radiometers and added buoys at 10 N and 12 N on 95 W. Details on the observations and some analysis are contained in a NOAA Tech Memo (Hare et al., 2006) and a publication (Fairall et al., 2008) which are available on the ftp site ftp://ftp.etl.noaa.gov/user/cfairall/EPIC/epicmonitor/pacs_pubs where there are also a few publications using these data. Additional observations (e.g., rawinsonde profiles, radar wind profiles, MMCR cloud properties) can be obtained for each cruise at ftp://ftp.etl.noaa.gov/et6/cruises .

ETL 10 cruise PACS/EPIC dataset Fluxes: Release #2.0

The flux data file *metz_epic_10h.txt* contains measurements of turbulent and radiative fluxes plus bulk meteorological variables from various PSD cruises. The files also contain bulk estimates of the turbulent fluxes computed using a recently updated version (3.0) of the COARE flux algorithm (see ftp://ftp.etl.noaa.gov/user/cfairall/bulkalg for documentation). Most quantities have been subjected to one round of intercomparison/calibration scrutiny; however, there may be future modifications based on accounting for other sources of data and revised calibrations. Both direct (covariance) and inertial-dissipation (ID) turbulent flux calculations are included in this present data. Covariances have not been computed for all cruises, so the turbulence columns are filled with *NaN*'s. .

The files are 48 columns; lengths depend on the length of the data sets. Following the decimal julian date, the next 10 columns are mean variables from the ETL system; the last 8 columns are similar data from the ships sensors. Columns 12-21 are turbulent fluxes (covariance, ID, and bulk); columns 22-23 the radiative fluxes and 24 the rain rate. Columns 25-28 are turbulence data quality indicators; 29-32 turbulent structure function parameters (indices of small-scale turbulence in the inertial subrange). Columns 33-34 are the minor (rain and Webb) heat flux components; 35-36 the latitude and longitude; 37-39 the heights of the ETL wind, temperature, and humidity mean sensors. The data columns are presently labeled and numbered at the top (first two rows). Delete the first two rows and restore as a .txt file so they can be directly acquired with a MATLAB 'load' statement.

```
x=load('your_local_directory\metz_epic_10h.txt');%read file with 10min-average data; set your local directory
```

The columns are as follows:

```
Year=x(:,1);%year of the field program
jdy=x(:,2);%julian day at beginning of time average
ushp=x(:,3);%doppler log, SCS (m/s)
U=x(:,4);%true wind,ETL sonic (m/s)
```

```
dir=x(:,5);%true wind direction, ETL sonic (deg)
urel=x(:,6);%relative wind speed, ETL (m/s)
reldir=x(:,7);%relative wind direction (from),clockwise rel ship's bow,  ETL sonic (deg)
head=x(:,8);%ship heading, deg clockwise rel north, SCS lasergyro (deg)
tsnk=x(:,9);%sea snake temperature, ETL, 0.05 m depth (C)
ta=x(:,10);%air temperature, ETL (C)
qse=x(:,11);%sea surface specific humidity, from snake (g/kg)
qa=x(:,12);%air specific humidity, ETL (g/kg)
hsc=x(:,13);%sensible heat flux, covariance, ETL sonic anemometer(W/m^2)
hsib=x(:,14);%sensible heat flux, ID, ETL sonic anemometer(W/m^2)
hsb=x(:,15);%bulk sensible heat flux, (W/m^2)
hlc=x(:,16);%latent heat flux, covariance, (W/m^2)
hlib=x(:,17);%latent heat flux, ID, (W/m^2)
hlb=x(:,18);%bulk latent heat flux, W/m^2 (includes Webb correction)
taucx=x(:,19);%covariance streamwise stress, ETL sonic anemometer (N/m^2)
taucy=x(:,20);%covariance cross-stream stress, ETL sonic anemometer (N/m^2)
tauib=x(:,21);%ID streamwise stress, ETL sonic anemometer (N/m^2)
taub=x(:,22);%bulk wind stress along mean wind, (N/m^2)
rs=x(:,23);%downward solar flux, ETL units (W/m^2)
rl=x(:,24);%downward IR flux,  ETL units (W/m^2)
org=x(:,25);%rainrate, ETL STI optical rain gauge, uncorrected (mm/hr)
J=x(:,26);%ship plume contamination index
sigoph=x(:,27);%standard deviation of ophir fast hygrometer clear channel
tiltx=x(:,28);%flow tilt at ETL sonic anemometer, earth frame
Jm=x(:,29);%ship maneuver index
ct=x(:,30);%ct^2 (K^2/m^.667)
cq=x(:,31);%cq^2 ((g/kg)^2/m^.667)
cu=x(:,32);%cu^2 ((m/s)^2/m^.667)
cw=x(:,33);%cw^2 ((m/s)^2/m^.667)
hrain=x(:,34);%rain heat flux,Gosnell et al 1995, JGR, 18437-18442, (W/m^2)
hlwebb=x(:,35);%correction to measured latent heat flux, Webb et al. 1980,QJRMS, 85-100
lat=x(:,36);%latitude, deg  (SCS pcode)
lon=x(:,37);%longitude, deg (SCS pcode)
    zu_etl=x(:,38);%height of mean wind sensor, 17.7 m
zt_etl=x(:,39);%height of mean air temperature sensor, 15.5 m
zq_etl=x(:,40);%height of mean air humidity sensor, 15.5 m
%*****   ships imet and scs data
sog=x(:,41);%speed over ground, SCS gps, (m/s)
U_scs=x(:,42); %true wind speed, imet propvane anemometer (m/s)
dir_scs=x(:,43);%true wind direction (from),clockwise rel north, imet,(deg)
cog=x(:,44);%%course over ground, SCS gps, (m/s)
tsg=x(:,45);%tsg water temperature, 5 m depth, (C)
ta_im=x(:,46);%imet air temperature (C)
qs_tsg=x(:,47);%imet bulk water specific humidity (g/kg)
qa_im=x(:,48);%imet air specific humidity, (g/kg)
```

The data in this file come from three sources: The ETL motion-correct flux package [sonic anemometer acquired at 20.83 Hz, fast hygrometer acquired at 20 Hz, and 6-component motion measurements acquired at 10 Hz), the ship’s system (acquired at 2 sec intervals), and the ETL mean measurement systems (sampled at 10 sec and averaged to 1 min).   A series of programs are run that read these data files, decode them, compute covariance, variances, spectra, etc. at 10-min time resolution.  A set of 10-min process files are written for each cruise.

Further experimental details are as follows:

True wind speed is computed from the sonic anemometer using the ship's Laser ring gyro and the odec doppler log; thus, it is interpreted as the speed relative to the water. Some modest eyeball flow distortion corrections to the relative wind components have been used in an attempt to reduce the transitions when stopping for stations.

Air temperature and humidity from the ETL (aspirated Vaisala HMP-235) were carefully compared with psychrometer values obtained during the experiment. The ETL humidities were increased about 3% based on these intercomparisons; the air temperatures were left unchanged. Final values are good to about 1% RH and 0.2 C.

At various times during some cruises the seasnake was removed from the water, in which case the ship's thermosalinograph, corrected for any warm layer effects, was substituted. Sea surface temperature measurements often showed contamination by the ship during stops and maneuvers at stations. The sensor was airborne a lot when the ship was underway in the stronger wind/rougher sea days and the accuracy under those conditions is uncertain.

Longwave flux was obtained from 2 Eppley PIR units, logged and computed as per Fairall et al. Jtech, 1998.

Shortwave flux was obtained from 2 Eppley PSP units.

The rainrate was obtained from the ETL STI optical raingauge. A model org-815 superseded the mini-org used on COARE. No correction for cosine response has been attempted.

Bulk estimates of air sea fluxes were computed using the COARE bulk algorithm version 2.5 or 2.6.

Turbulent fluxes were computed from motion-corrected time series of fast sensors. Covariance latent heat fluxes were obtained by cross-correlating the motion-corrected vertical velocity with fast humidity fluctuations from an OPHIR IR hygrometer. The turbulent fluctuations from the OPHIR were scaled by the mean ratio of the OPHIR humidity to the ETL Vaisala humidity. An additional scaling factor (4.5% increase) was used to account for the physical separation of the OPHIR and the sonic. Using a right-handed coordinate system with x boward, y to the port, and z up, the displacement vector from the OPHIR to the sonic is (1.0, 0.69, 1.57) m. We used Kristensen et al. (*J. Atmos. Oceanic Tech.*, **14**, 814-821, 1997) to estimate the correlation loss. On Jasmine and Nauru99 a closed-path Licor 6262 fast humidity/CO2 sensor was also used. The values from this unit were scaled to agree in <wq> with the corrected OPHIR values on a daily basis. This is necessary because some fraction (10-15%) of the correlation is lost in the Licor sampling tube. Because the IR hygrometers detect water vapor mass concentration (rho_v in kg/m^3), their water vapor - velocity correlations must be corrected as per Webb et al

Hlatent = Le <w' rho_v'> + hl_webb

The values given for covariance and ID latent heat fluxes in the file are Le<w' rho_v'>. Values for hl_webb are included in column 34. This should be applied to the covariance and ID values. It is already included in the bulk values given here.

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.

Simple data quality indicators have been use to edit the turbulence data. At each 10-min time step, values for ID turbulence variables were computed if the following criteria were met:

```
jj=find((reldir<90 | reldir>270) & sig_h<8 &sig_u<2 &sp2<2  & org<5 &
sqrt(ww)./ugw<.55+.002*U.^2 & sqrt(vv)./ugu<1.1);
```

*reldir* is the relative wind direction
*sig_h* the standard deviation of ship heading (deg)
*sig_u* the standard deviation of the ship speed
*sp2* the standard deviation of cross-ship motion corrections
*org* the rainrate
*ww* the vertical velocity variance
*vv* the cross stream velocity variance

Otherwise, the ID variables were set to NaN (not a number). In processing the 10-min data to one-hr averages, only the jj rows 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 criteria given above were subdivided to be approximately compatible with indices used in the past:

```
J=ones(length(jdy),1);
ii=find(sqrt(ww)./ugw<.55+.002*U.^2 & sqrt(vv)./ugu<1.1);
J(ii)=0;
jm=3*ones(length(jdy),1);
ij=find(sig_h<8 & sig_u<2 & sp2<2);
jm(ij)=sig_u(ij);
```

*A value of *J*=0 implies no ship contamination.
*A value of *jm*<3 implies no significant maneuver during the average.
**Sigoph* is an index of salt or rain contamination on the fast hygrometer (OPHIR) optics. Values for fluxes begin to be affected when *sigoph* exceeds 20 although a threshold of 50 gives acceptable data.
*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 shows that tilts greater than about 10 deg give questionable fluxes.

10-min PACS_Epic ceilometer statistics file
JLY 2008

The 15-s ceilometer data were used to generate hourly cloud base and cloud fraction statistics. The data are contained in files sMMDDYY.dat in the stat_data.zip archive. These daily files were read in and combined into a single ascii txt file (metz_epic_ceilo_10htxt) which contain 13 columns:

1 Year of the experiment
2 Julian day GMT (middle of hour)
3 # of "total" 15-s data points
4 # of "clear" data points
5 # of "single cloud base" data points
6 # of "multiple cloud base" data points
7 # of "totally obscured" data points
8 # of "partially obscured" data points
9 clear fraction
10 cloud fraction without including totally obscured points
11 cloud fraction including totally obscured points
12 15th percentile cloud base (m)
13 50th percentile (median) cloud base (m)
14 85th percentile cloud base (m)

PACS_Epic Monitoring cruises on R/V Ronald H. Brown and R/V Kai'imi Moana
C. Fairall 7/1/08
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The ETL radar group operated a microwave radiometer (MWR) manufactured by Radiometrics Inc. (Boulder) for this cruise. Contact Duane Hazen (ETL) for details on the instrument. Duane used sondes and tipcals to 'calibrate' the system and gave me hourly files. I wrote a matlab program that read his data, stripped out the stuff I wanted, and wrote new files with the raw 21-s time resolution (micro_s.txt) and 10-m time resolution (micro_10.txt). The data on the files is as follows:

metz_epic_micro_10h.txt
:,1 year
:,2 decimal julian date
:,3 IWC, integrated atmospheric water vapor (column precipitable water), cm
:,4 IWL, integrated cloud liquid content, cm
:,5 number of 21-s values in hourly median
:,6 standard deviation of IWV, cm
:,7 standard deviation of IWL, cm

Included on the ftp site are the original hourly files from Duane Hazen (YYMMDDHH.new), his descriptions (datainfo.txt, pacs.txt), and the matlab file I did the processing with (micro_red.txt).

1. The tends to be a time-varying bias in the IWL; it doesn't give zero when it is clear buy something like 0.003 cm (30 g/m^2). To use this data quantitatively, this bias must be computed and subtracted (I think).

2. In the deep convection regions there are a lot of bad values caused by rain water on the system.