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## *Overview*

This is a brief and preliminary report of work done on R/V Roger Revelle during DYNAMO Leg 2. Revelle left Phuket, Thailand 29 Sep 2011, and proceeded directly to 2N, 80.5E. An ADCP/XBT survey was conducted along 80.5 E from 2N to 2S to map out cross-equatorial current structure. Revelle returned to 0, 80.5E to conduct a 25-day times series that included measurements of surface fluxes, wind profiles, C-band radar, atmospheric soundings, aerosols, sonar-based ocean profiling and profiling of ocean structure including turbulence.

Seven individual group reports are followed by the ship's event log that intended as a reference to identify significant occurrences at sea. The seven groups are:

- Surface Fluxes
- Atmospheric Soundings
- Aerosols
- NOAA High-Resolution Doppler Lidar
- TOGA Radar
- Ocean Optics
- Ocean Mixing

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## *Surface Fluxes* (Simon de Szoeke, Dan Wolfe, June Marion)

ESRL/PSD and Oregon State University Flux Systems Status Report
Leg 2 DYNAMO 2011 September 30, 2011 to October 31, 2011
Simon de Szoeke, Dan Wolfe, and June Marion

In situ meteorology and high-rate flux sensors operated nearly continuously while in the sampling period for DYNAMO leg 2. PSD/OSU also operated a suite of remote sensing instruments for low clouds and light precipitation: the NOAA W-band cloud radar, a microwave radiometer, and a laser ceilometer. Leg 2 had relatively dry conditions upon first reaching station at the equator, 80°E. This period had strong daylight solar radiation, leading to a gradual increase of the sea surface temperature (SST). SST from the sea snake floating thermometer (0.05 m depth) could rise by as much as 3 °C during daylight (Figure 1) under strong solar radiation. This temperature perturbation was trapped near the surface, and mixed out at night, nevertheless the SST rose gradually until about year day 289 (Oct 16), after which it slowly declined. Wind speed decreased until Oct 14 (day 287), after which it remained low.

The entire time on station was punctuated by the passage of cold pools or "outflows," presumably from cool dense downdrafts. The cold pools are clearly visible as sharp decreases in the air temperature on the ship, followed by a slower recovery of the temperature. These cold pool flows temporarily increased the wind speed and usually changed the wind direction (see report from HRDL) as they passed. The cold outflows do result in up to a 10 W m$^{-2}$ (Figure 2) increase in sensible heat loss from the sea surface, yet because the prevailing wind was weak and the relative humidity was high (Figure 2) in the second half of the cruise, the stronger latent heat flux cooling term decreased from 150 to 80 W m$^{-2}$. The SST decreased because the average solar radiation during the cloudier more convective second half of the cruise was at least 100 W m$^{-2}$ less than the clear sunny first half of the cruise.

As is typical on the equator, the surface pressure was dominated by the semidiurnal atmospheric tide. When this semidiurnal tide was spectrally filtered out of the pressure measurements, the remaining pressure due to synoptic weather systems emerged (Figure 1). The clear dry period at the beginning of the time on station had high pressure, reaching 1012 hPa, which dropped quickly after year day 285 (Oct 12). The month-long trends of pressure and air temperature are correlated, with high pressure corresponding to fairer weather and higher air temperature, but day-to-day pressure and temperature are anticorrelated. This could have to do with the cold pools being relatively dense and driving positive hydrostatic pressure perturbations at the surface.

The relative humidity (Figure 2) and integrated water vapor in the atmosphere (Figure 3) increase after October 10 (year day 283). Integrated water vapor from microwave radiometer agrees well with the integrated vapor from radiosondes. The microwave radiometer has a few erratic values corresponding to automatic calibrations that are invalid under cloudy skies. This issue can be corrected in post calibration, and the integrated water vapor and liquid water path will be computed more accurately.

The OSU and PSD Flux group analyzed soundings released from the R/V *Revelle* for the vertical-temporal evolution of wind and thermodynamic variables. Figure 4 shows composite diurnal cycles of temperature and relative humidity anomalies in the lower 10 km of the atmosphere. Temperature has an abrupt and vertically uniform warming of about 1°C between its local minimum at dawn (0 UTC) and its maximum temperature at noon (6 UTC). The temporal structure is consistent with heating by solar warming, but why solar warming is vertically uniform in the atmosphere is not clear. The decrease of relative humidity is in phase with the dawn-noon increase in temperature, but the maximum relative humidity occurs at 18 UTC (sunset) during the slowly cooling period for temperature. Perhaps these cycles, particularly the rapid communication of diurnal anomalies in the vertical, are related to the diurnal cycles in convection over the Indian Ocean.

The following highlights some preliminary discoveries made by PSD/OSU personnel and their instrumentation on DYNAMO leg 2. The instrumentation under ESRL/PSD includes:

1. W-band cloud radar
2. Microwave radiometer
3. DYNAMO Air-Sea Flux Systems
   PSD Flux system (Chris Fairall chris.fairall@noaa.gov)
   Oregon State University Flux system (Simon de Szoeke sdeszoek@coas.oregonstate.edu)
   University of Connecticut Flux system (James Edson james.edson@uconn.edu)
4. Columbia University SST radiometer (Chris Zappa zappa@ldeo.columbia.edu)
5. Columbia University $pCO_2$ system (Wade R McGillis wrm2102@columbia.edu)

## 1. W-band cloud radar

The W-band radar operated continuously during leg 2 from Oct 1-31. It operated in the high mode Oct 1-4 (0-14 km range) and the low mode (0-7 km) from Oct 5-31. The W-band antenna is motion compensated on a stabilized platform that ran continuously with no problems.

The melting layer/bright band is very evident throughout much of leg 2 (e.g. Figure 5). Figure 5 shows an hour when stratiform rain was observed uniformly below the melting level at 4.6 km. Stratiform rain was usually too light to be observed by the rain gauges, yet it is clearly visible in the cloud radar. We presume stratiform particle fall velocities are so uniform that the vertical velocity of boundary layer eddies are visible in the lowest 1 km of the Doppler velocity retrieval. We are interested in analyzing the statistics and vertical structure of these vertical velocity signals.

Figure 6 is an approximately 30-minute time-height series featuring a shelf cloud observed to form atop a gravity current of cold air. Air temperature dropped by almost 3°C as this front passed the ship. Turbulent eddies appear to form on leading edge of the cloud. Subsequently the cloud bears rain with downward fall velocities, and reflectivities so great they attenuate the reflectivity of the cirrus cloud above 5 km. Shear is observed as high-reflectiivty rain shafts sloping upward with time within the lower 0.5 km of the atmosphere, with high-reflectivity rain shafts seen first at the surface, and only later at the 1 km near where they start to fall.

During three periods of heavy rain (e.g. Fig 7) the radar signal was attenuated severely. Even though these periods will not show the full extent of the clouds they show the intensity of the rain event as it passed overhead.

Figure 8 shows a summary overview of the reflectivity for the whole day of 2011 Oct 24, with cloud base from the ceilometer superimposed as stars. The period from 5 to 17 UTC exhibits widespread light stratiform rain, with reflectivity of about 0 dBZ. The daily summary and hourly images from the W-band radar are available for the whole cruise.

**2. Microwave radiometer and lidar ceilometer**

The 2-channel microwave radiometer operated continuously during leg 2. The two microwave channels (20 and 30 GHz) are sensitive to water vapor and liquid water resulting in total column precipitable water vapor and total column liquid measured directly above the sensor. During periods of rain the results are compromised. Data will be post calibrated using tip-calibrations from clear-sky conditions. Uncalibrated total column water vapor was compared well to the integrated water vapor observed by the radiosondes throughout leg 2 (Figure 3). Total column liquid water will be used with vertically-resolved data from the W-band radar and lidar ceilometer to constrain cloud properties.

The lidar ceilometer measured laser backscatter and detected the height of cloud bases continuously during leg 2. For such vertically oriented and horizontally variable clouds, estimation of a representative cloud base height is a challenge. Combination of calibrated liquid water path estimates from the microwave radiometer, cloud top from the W-band radar, and cloud base from the microwave ceilometer can be used to estimate the vertical profile of liquid water in the cloud.

**3. DYNAMO Flux Systems**

The ESRL/PSD flux system consists of a sonic anemometer, $CO_2$/water vapor gas analyzer, optical rain gauge, temperature/relative humidity, surface pressure, long and short-wave radiometers (motion stabilized), sea surface temperature, ceilometers, GPS, motion pack, and a laser wave meter. All instruments operated with over 95% efficiency. Examples of the data from Oct 26, 2011 are shown in Figures 9-16. Figure 9 shows the incoming short-wave solar radiation for a clear day (a, Oct 26, 2011) and a cloudy day (b, Oct 29, 2011) in comparison to ship's (SCS) solar radiometer (green) and a clear-sky model (red). Note the good agreement between the clear sky model and the measurements in (a). On the cloudy day when the clouds were almost opaque the incoming radiation. Figure 10 is the incoming short-wave radiaon for the clear day. Tropical variability of long-wave radiation is low. Since the tropical atmosphere is very humid and thus very emissive even in clear skies, cloud variations have little influence. Air temperatures (Figure 11) shows disagreement 2-14 UTC due to low winds and weak passive aspiration of the ship's sensor in strong sunlight.

A number of different sensors and retrieval methods are used to measure sea surface temperature (Figure 12). These include direct measurement using a floating PSD sea-snake thermistor (purple, 0.05 m depth) , the OSU SBE56 thermistor (brown) towed near the sea-snake. Blue and red lines are radiative skin temperatures from the Columbia and OSU infrared radiometers. Columbia University has deployed two IR temperature sensors used to measure the sea surface and sky temperatures. The blue line (skin) is corrected for the emissivity of the sea surface and the sky temperature. During periods of heavy rain the upward-looking (sky) sensor is compromised. The SBE56 is precise to 0.001 °C, and agrees within 0.1 of the sea snake temperature and Columbia skin temperature. It also agrees with the ship sea-chest thermosalinograph (TSG, 5.0 m, black) at night.

Surface pressure for Oct 26, 2011 in comparison to ship's barometer (SCS) is depictred in Figure 13. A calibration check and comparison to several other pressure sensors will be used to resolve the offset, which is inconsistent with the altitude difference between the two sensors. Small scale fearutres in the PSD sensor on top of the diurnal cycle are believed to be caused by ship heave, small-scale dynamical meteorology, and instrument noise; all of which are presumably averaged out of the ship barometer time series.

Figure 14 shows relative humidity from the PSD and the ship sensor. The PSD sensor is reading about 5% lower than the ship's sensor in the absence of solar radiation. The relative humidity is consistently above 70% with variability dominated by passage of covective systems over the ship or convective outflow.

Figures 15 and 16 are wind speed and direction for Oct 26, 2011 with comparisons to ship anemometer (SCS) and ship-relative direction. The flux systems mounted on the forward mast all rely on relative winds at most ±90 degrees of the bow, and ±45 degrees for best results. Figure 17 shows a time series of the relative wind speed and direction and Figure 18 shows a histogram of relative wind directions for leg 2 (Sept 30-Oct 30, 2011). The green line represents the ±45-degree window, the red line the ±60-degree window, and the magenta line the ±90-degree window.  Table 1 shows the percentages within the relative direction windows represented by Figure 18.

Table 1. Percentage of data within three wind direction windows and two wind speed ranges (see Figure 14)

| | All wind speeds | Speeds > 1 m/s | Speeds > 2 m/s |
|---|---|---|---|
| ±45 degree window | 60% | 58% | 55% |
| ±60 degree window | 69% | 68% | 64% |
| ±90 degree window | 77% | 75% | 70% |

Figure 20 shows the bulk fluxes calculated on October 26. Results are consistent for a clear day with strong incoming solar radiation. Positive latent heat flux indicates that the ocean is cooling, indicative of sea surface temperature being higher that the air temperature.

Oregon State University has deployed instruments to measure 3-D wind velocity, temperature and specific humidity fluctuations at 20 Hz. Air temperature, sea surface temperature, and solar and infrared downwelling radiation are measured approximately every 1 s. Data were recorded on an independent data acquisition system. During leg 2, programs were completed to download data from the acquisition system into Matlab analysis software. Figure 19 shows the 5-minute average ship-relative wind direction and its histogram from the OSU anemometer while the ship was on station (cf. Figs. 17 and 18).

The Univ. of Connecticut system consists of a sonic anemometer, accelerometer, CO2/water vapor gas analyzer, siphon rain gauge, temperature/relative humidity, GPS, and surface pressure. All instruments operated with over 95% efficiency. Data are logged to an independent data acquisition system. Programs compute turbulence and bulk fluxes.

Figure 21 shows the total daily rainfall from several sensors positioned around the ship, including standard manually-emptied rain gauges, siphoning gauges, acoustic rain gauges, and optical rain gauges.

## 5. Columbia Univ. p$CO_2$ system

The Columbia Univ. p$CO_2$ system is designed to measure sea and air $CO_2$. On Oct 12, 2011 it was discovered that the sea water intake to this system was downstream of the ship's de-bubbler compromising the results. Figure 22 is an example of the results for one day after re-plumbing. The PI of this particular measurement was not on board for leg 2 and has been asked to interpretation of these data to determine any further adjustments are necessary.

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## PSD/OSU Flux Figures

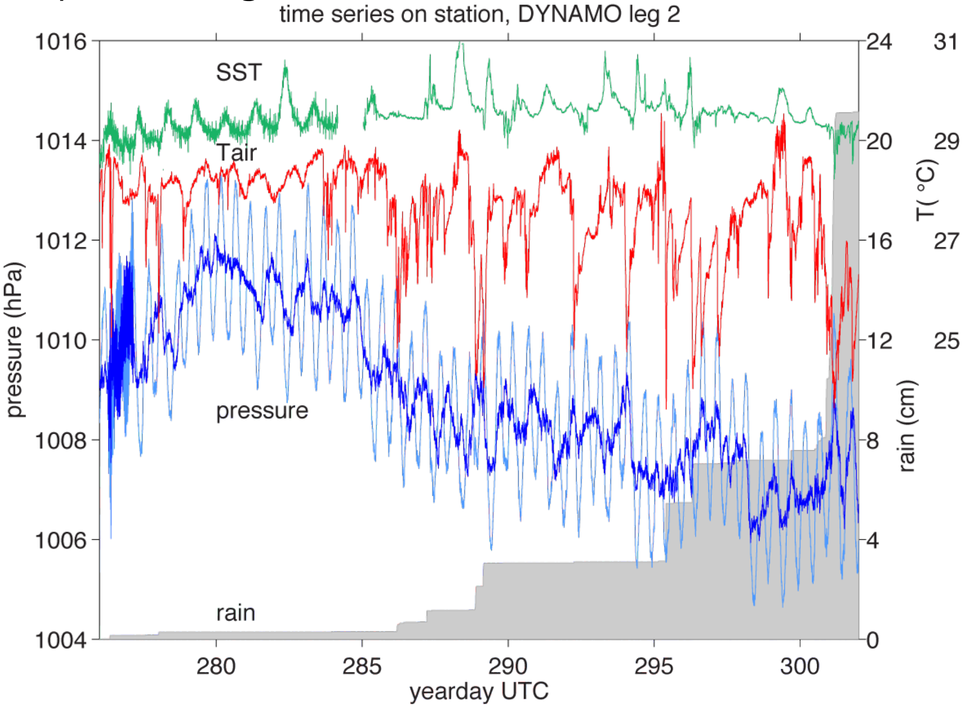


Figure 1. Time series of sea and air temperatures, pressure, and accumulated rain observed during the time on station at 80°E, 0°N for DYNAMO leg 2.

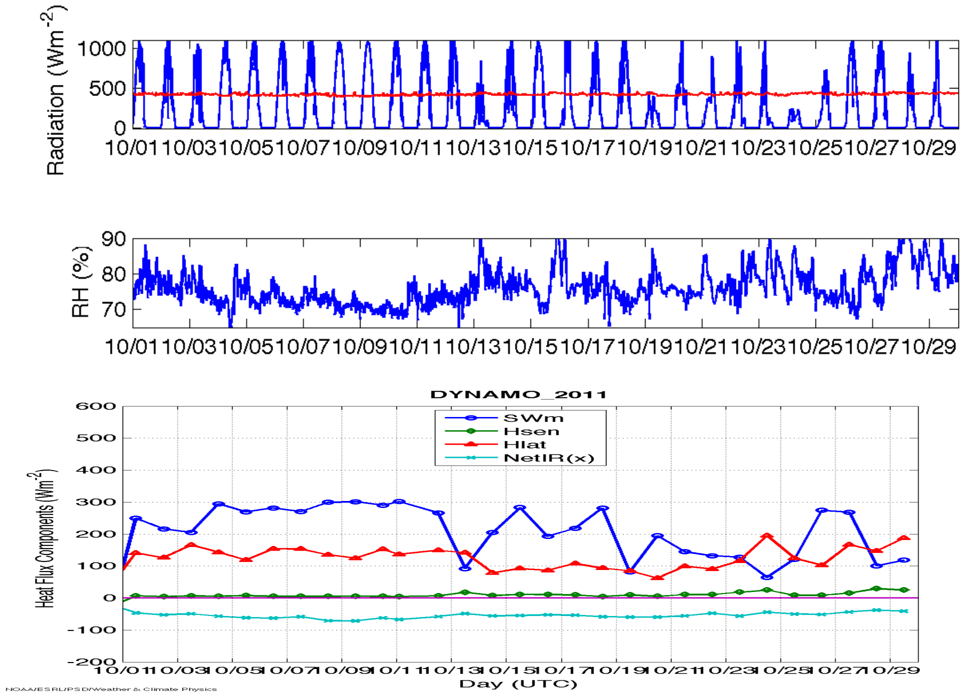


Figure 2. Top to bottom, time series of incoming solar (blue) and longwave (red) radiation, relative humidity, and heat surface heat flux terms for leg 2. Positive net solar flux is a warming, negtive infrared flux is a cooling, and positive sensible and latent heat fluxes are cooling the ocean surface.

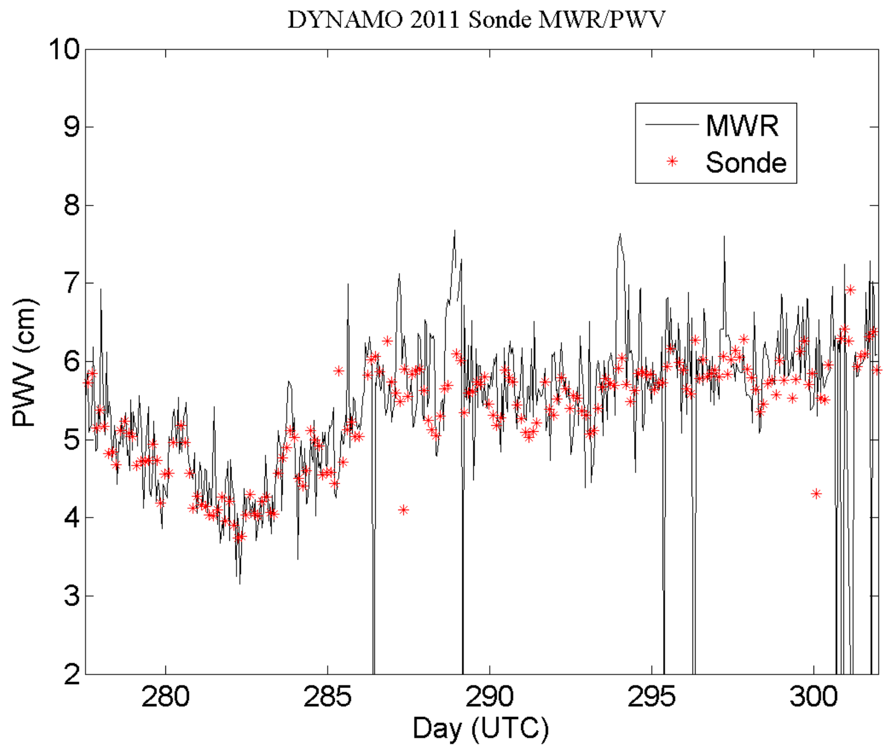


Figure 3. Total column precipitable water vapor compares well between the radiosondes and the microwave radiometer.

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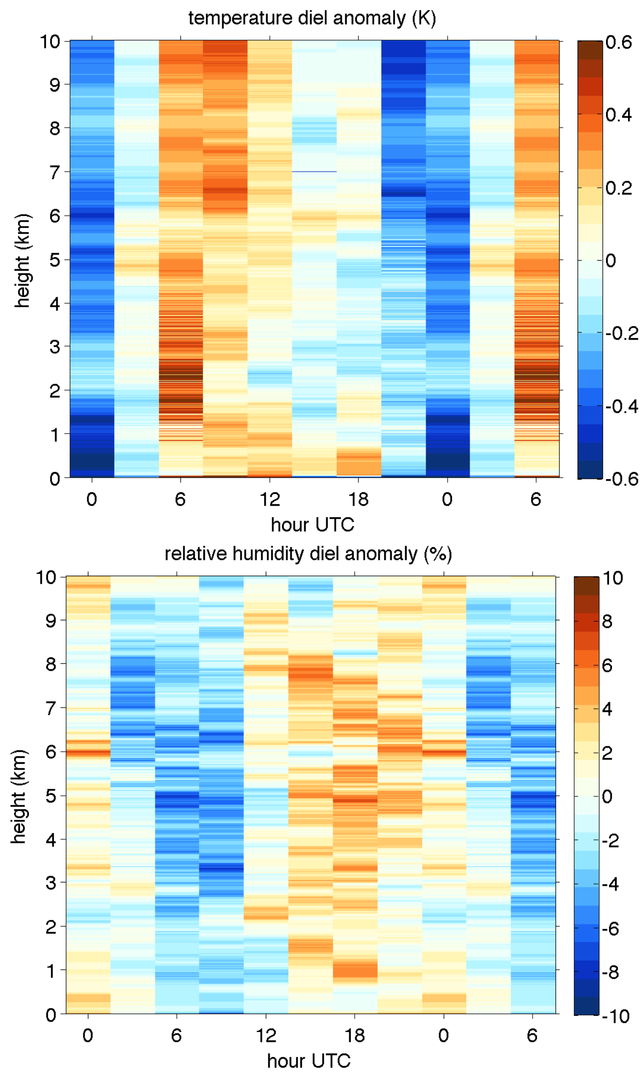


Figure 4. Diurnal anomalies of temperature (°C) and relative humidity (%) in the lower 10 km from radiosondes released at the *Revelle*.

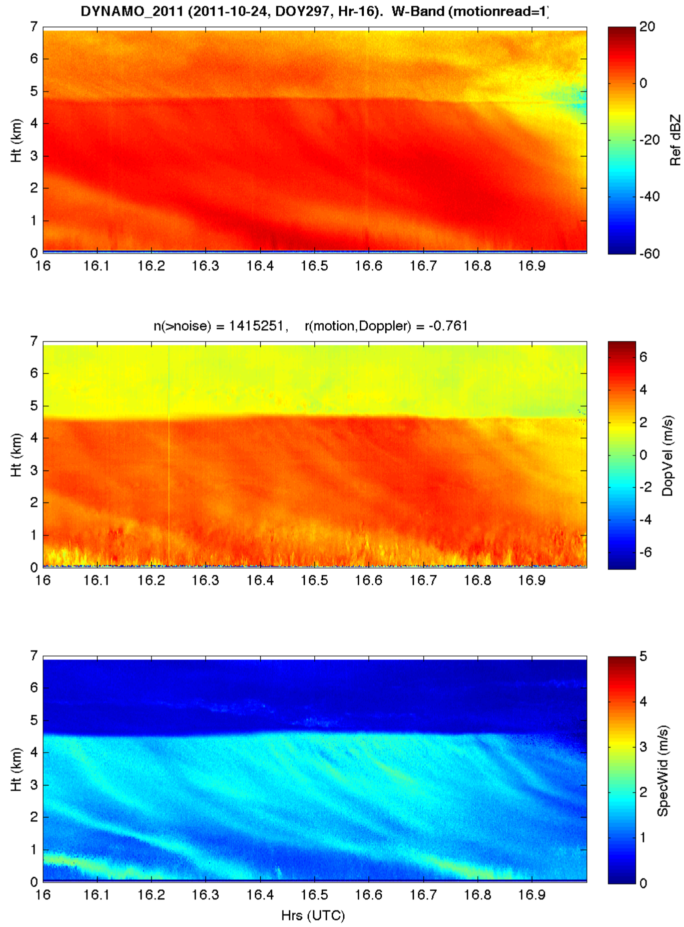


Figure 5. Typical light stratiform rain as seen by the W-band radar in DYNAMO leg 2. Top panel is radar reflectivity (dBZ), middle panel is Doppler velocity (m/s; red is downward towards the radar), and bottom panel is Doppler width., Turbulent vertical velocities of ±2 m $s^{-1}$ in the lowest 1 km perturb the fall velocities of the stratiform rain.

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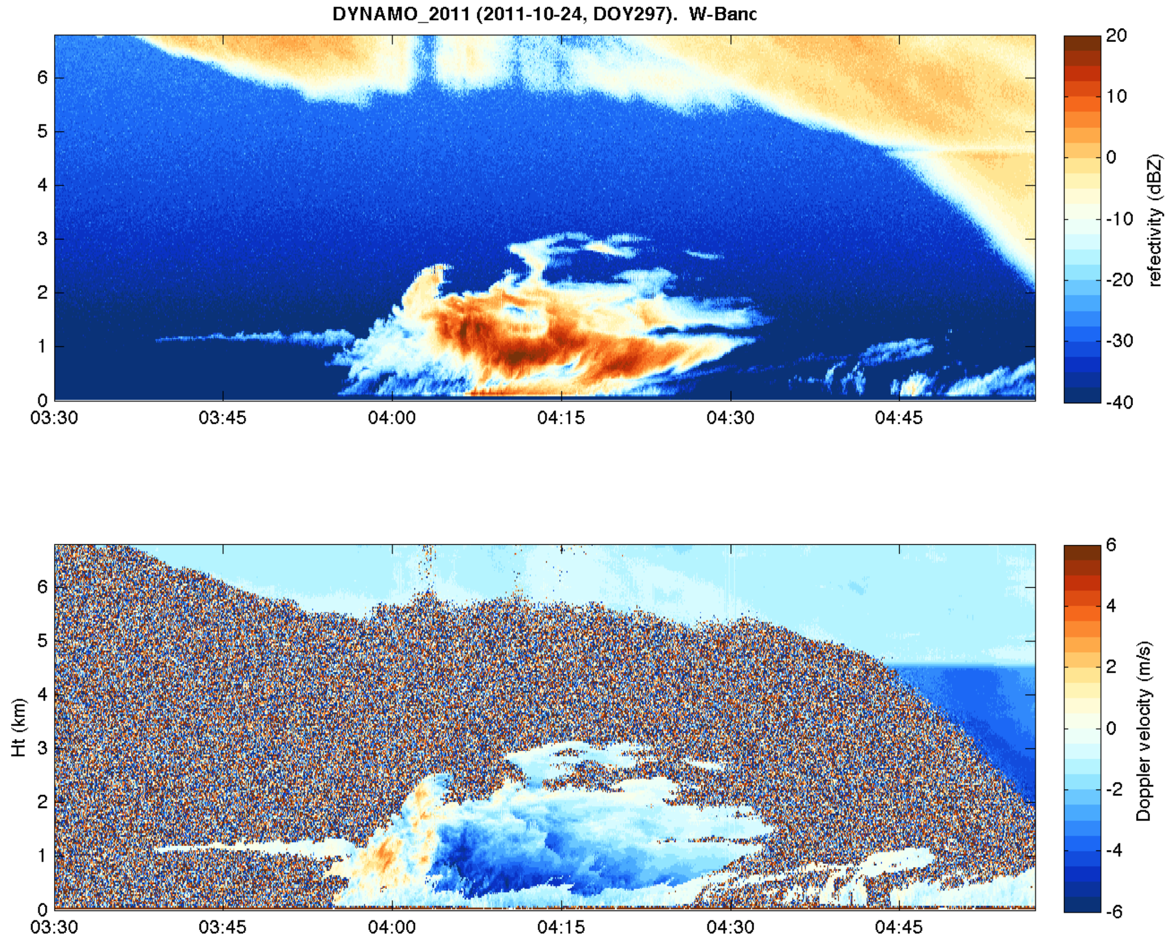



Figure 6. Time-height series of reflectivity and Doppler velocity of a shelf cloud (1-3 km) from a cold pool associated with a 2° C temperature drop and >5 m/s increase in the wind speed. The cold pool boundary flowed over the radar with time, so should be visualized as propagating from right to left. Red Doppler velocity is upward.

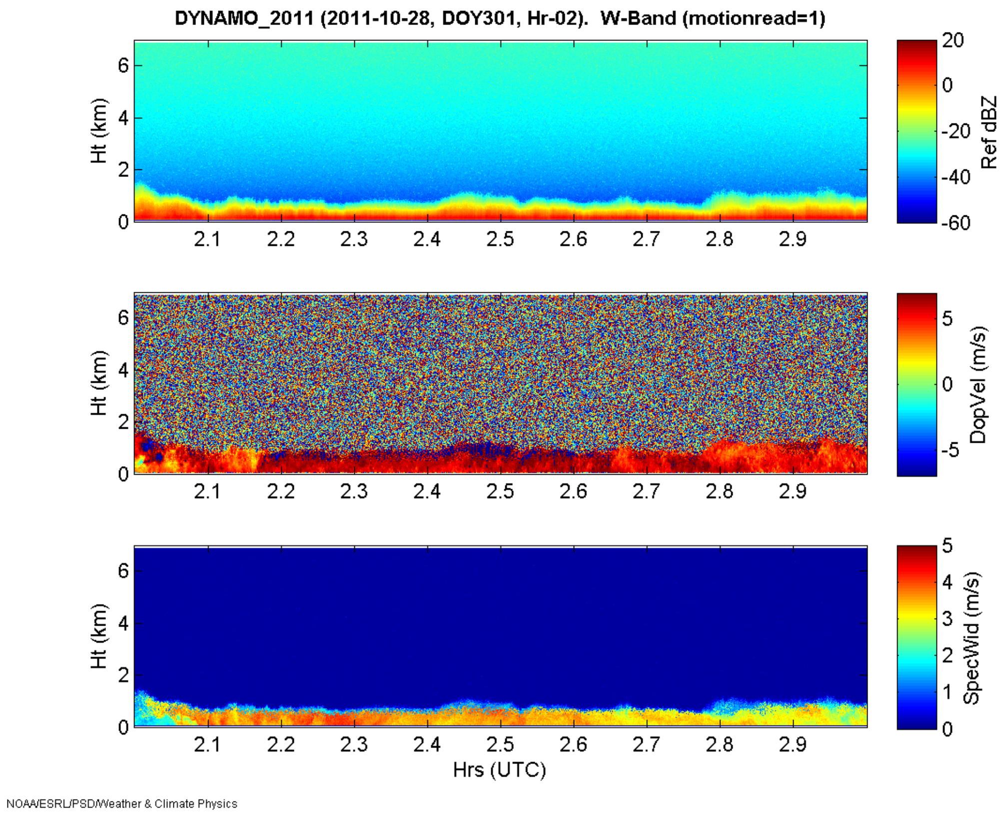



Figure 7. W-band time height profile for one hour on Oct 28, 2011 when the radar was attenuated below 1 km during heavy rains. Reflectivity (top), Doppler velocity (middle), and spectral width (bottom) are not valid estimates in attenuating conditions. Red is toward the radar. Here some fall velocities are greater than the Nyquist velocity, and fold into the negative part of the Doppler velocity.

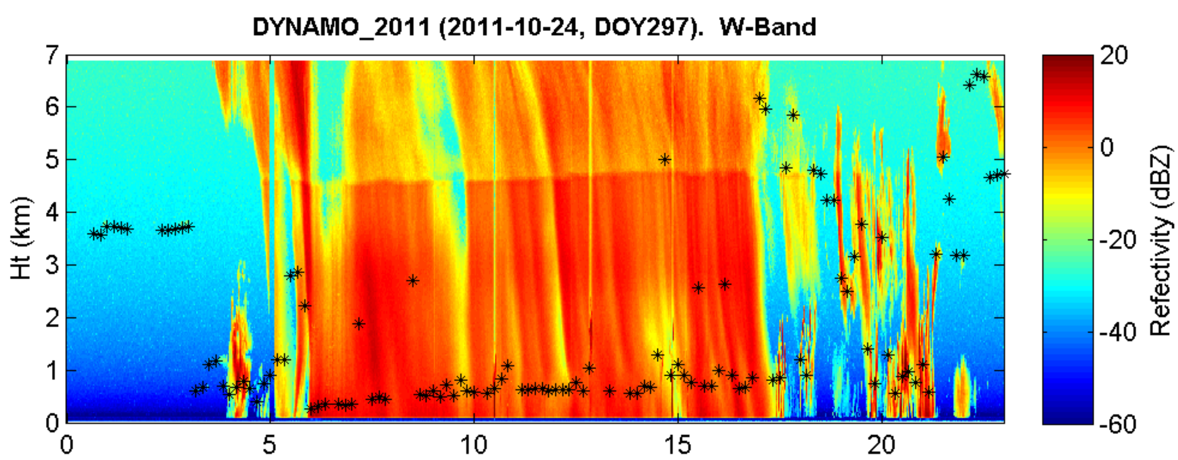
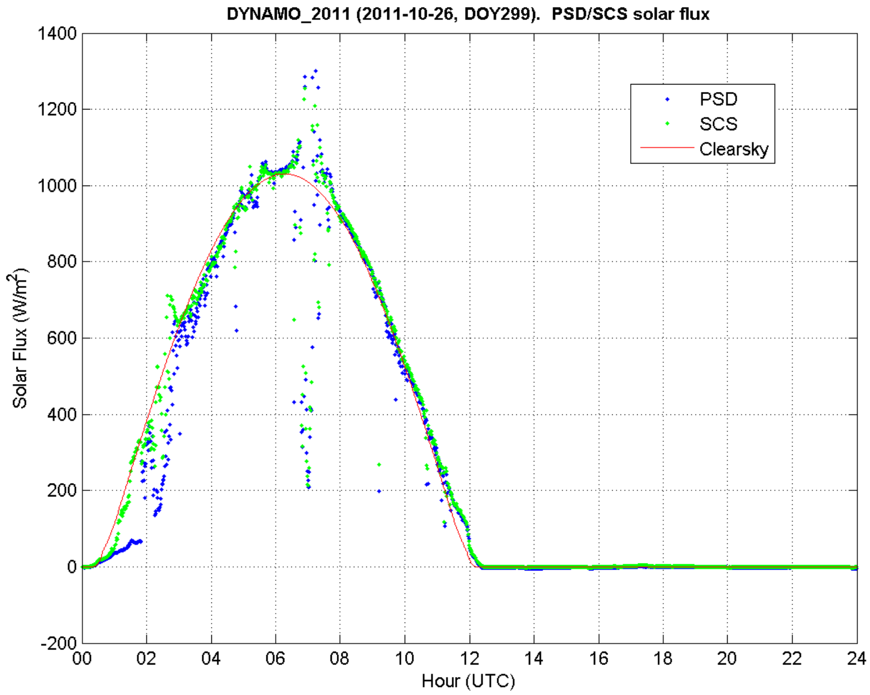
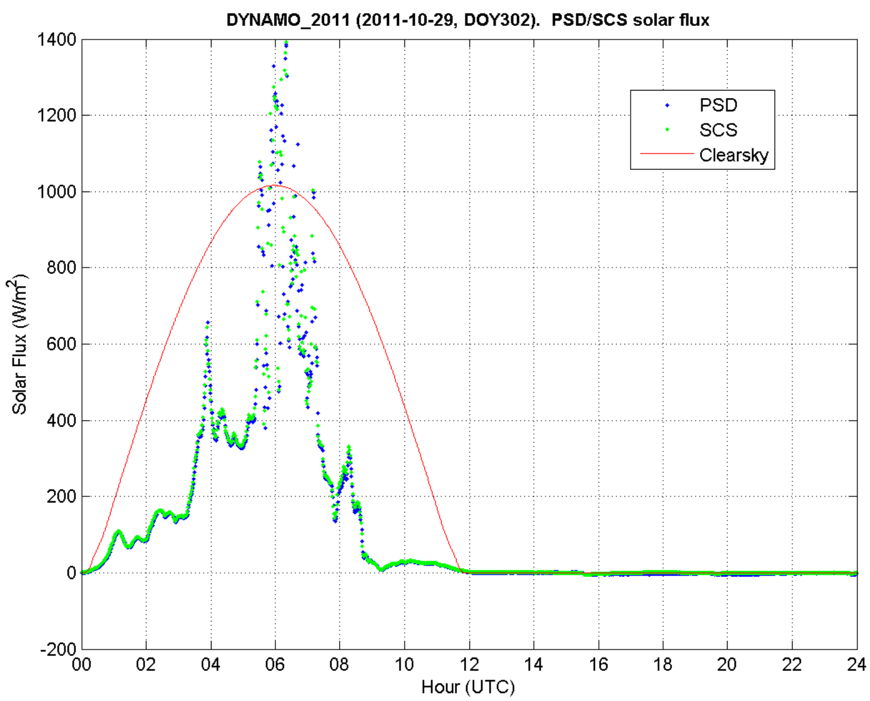



Figure 8. Daily summary of Wband reflectivity for Oct 24, 2011. Note bright-band near 5 km. Stars (*) are cloud base heights from the ceilometer.




(a) NOAA/ESRL/PSD/Weather & Climate Physics




(b) NOAA/ESRL/PSD/Weather & Climate Physics

Figure 9. Incoming short-wave solar radiation for a clear day (a, Oct 26, 2011) and a cloudy day (b, Oct 29, 2011). Comparison to ship's (SCS) sensor and clear-sky model.

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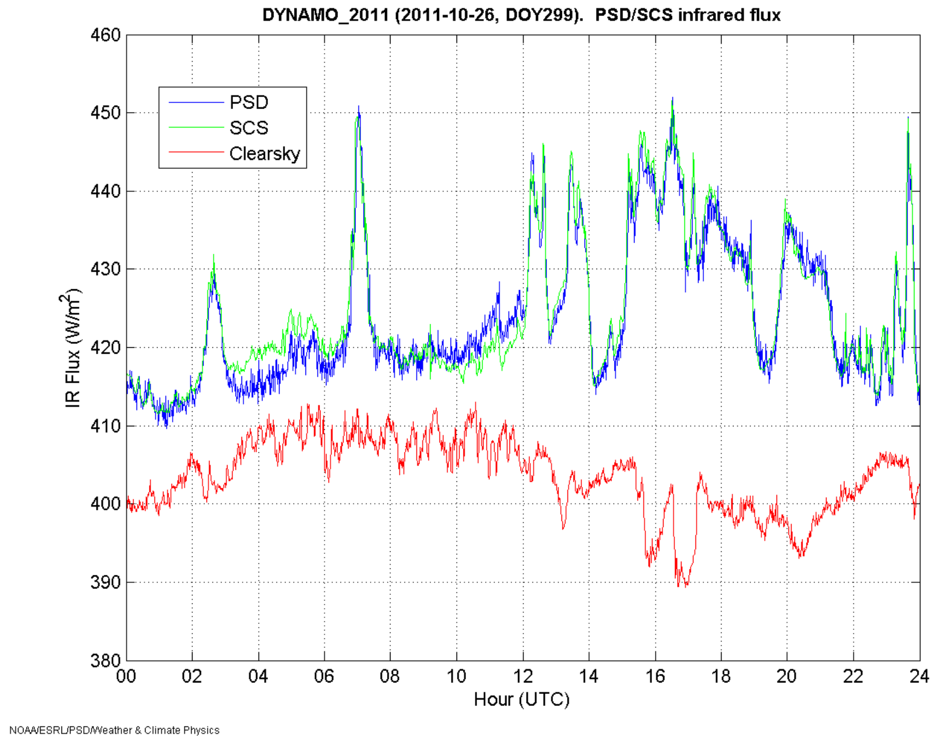


Figure 10. Incoming long-wave solar radiation for Oct 26, 2011. Comparison to ship's (SCS) sensor and clear-sky model.

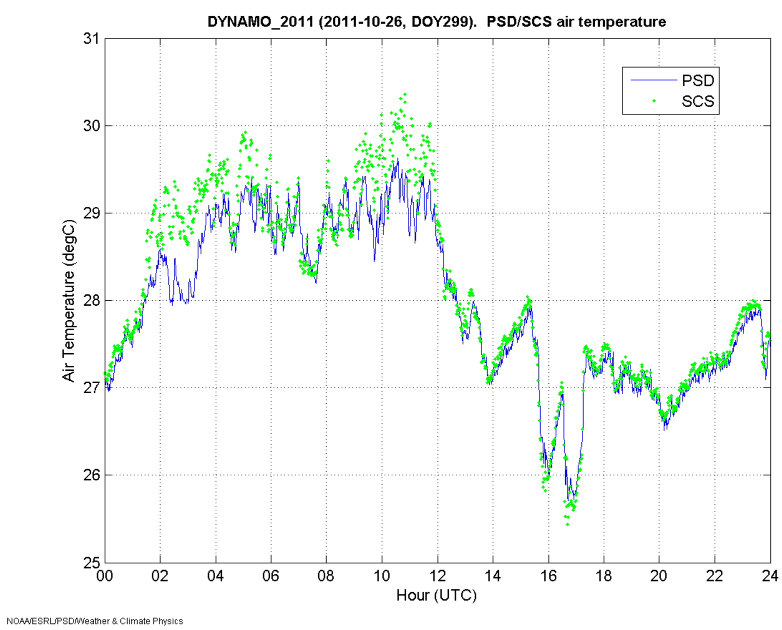


Figure 11. Air temperature for Oct 26, 2011. Comparison to ship's thermometer(SCS). Disagreement from 2-14 UTC is due to low winds and weak passive aspiration of the ship's sensor in strong sunlight.

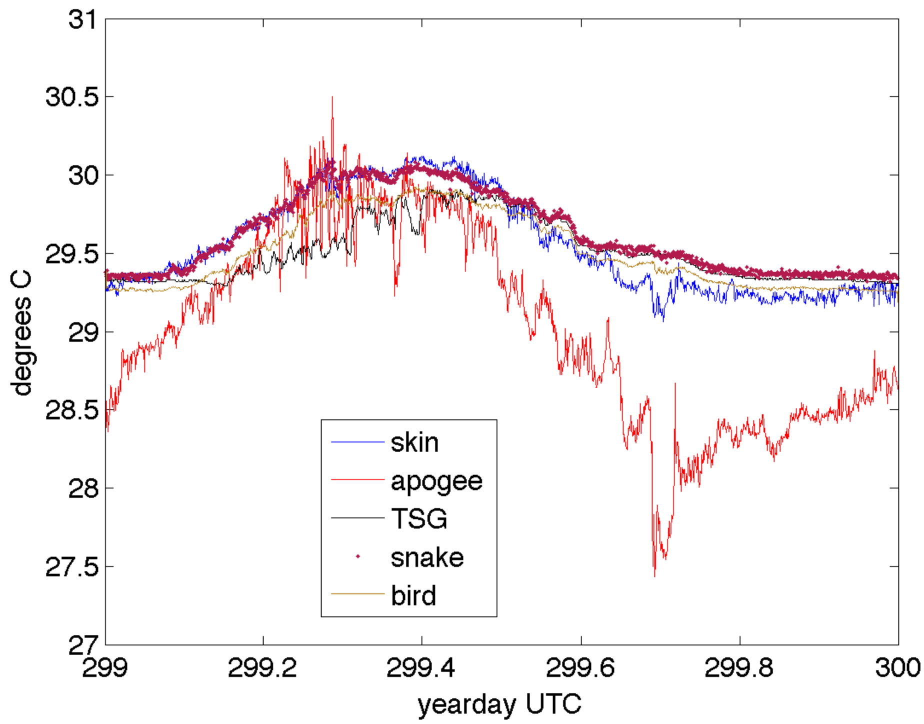


Figure 12. Sea surface temperature from the floating PSD sea-snake thermistor (purple, 0.05 m depth) and the ship sea-chest thermosalinograph (TSG, 5.0 m, black). Blue and red lines are radiative skin temperatures from the Columbia and OSU infrared radiometers. The blue line (skin) is corrected for the emissivity of the sea surface and the sky temperature. The OSU SBE56 thermistor (brown) is precise to 0.001 °C, and agrees within 0.1 of the Columbia University skin temperature and the sea snake temperature.

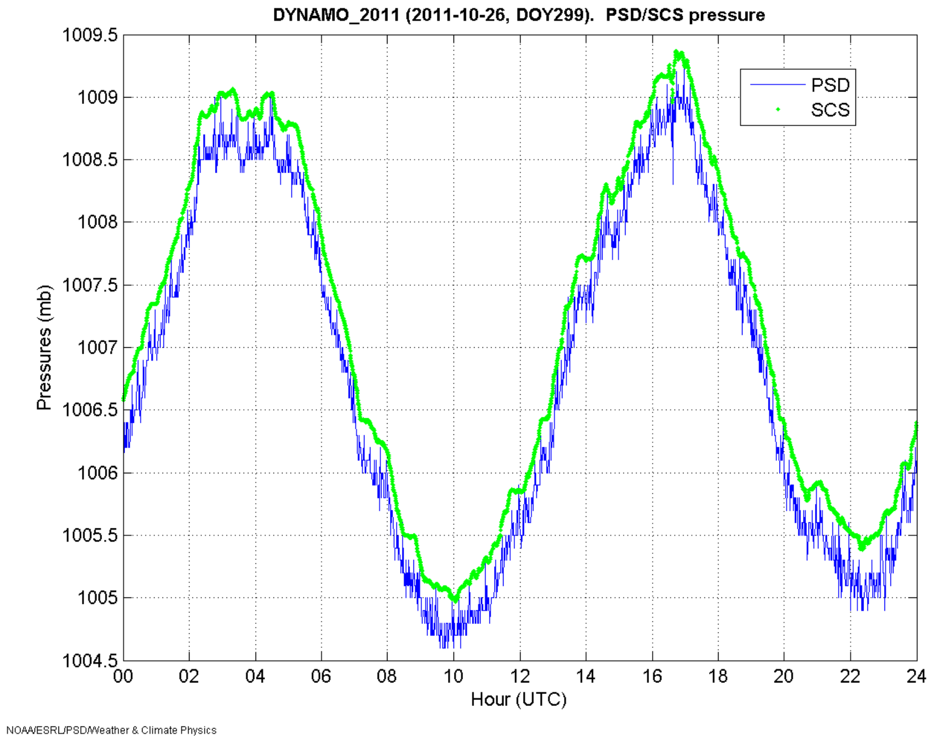


Figure 13. Surface pressure for Oct 26, 2011 in comparison to ship's barometer (SCS). The ship's barometer is approximately 5 m higher than the PSD barometer.

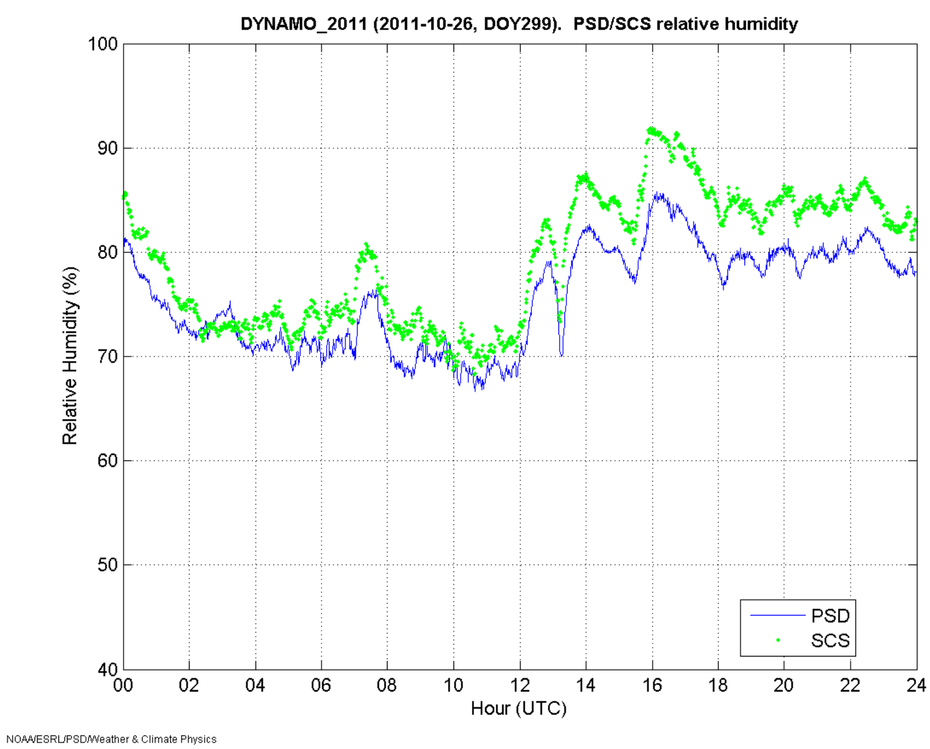


Figure 14. Relative humidity for Oct 26, 2011 in comparison to ship's relative humidity (SCS).

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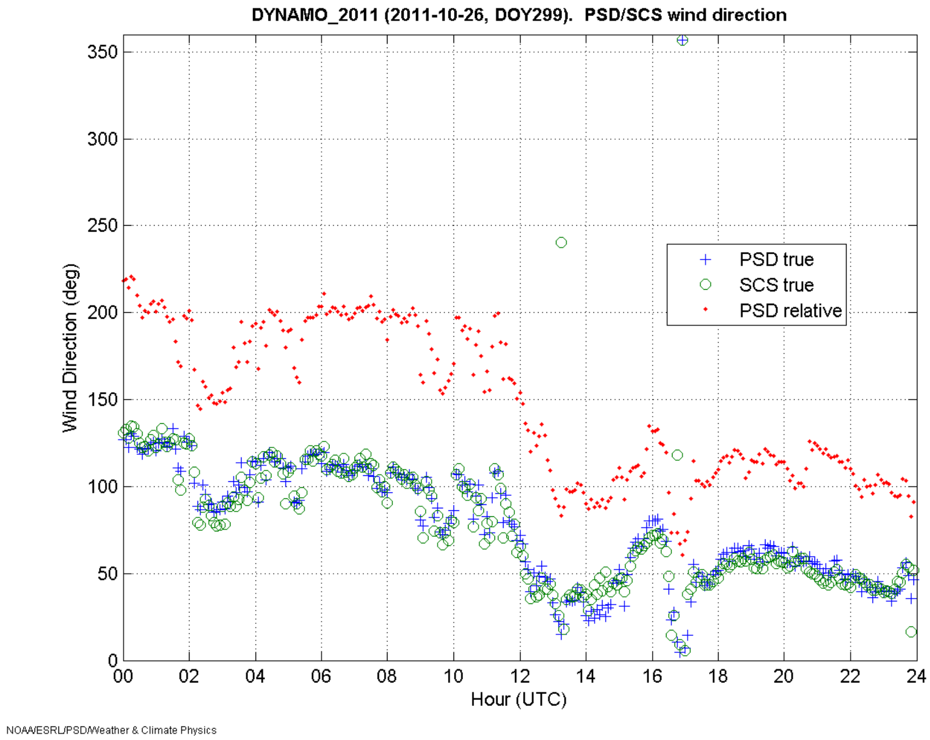



Figure 15. Wind speed for Oct 26, 2011. Comparison to ship's (SCS) and relative direction.

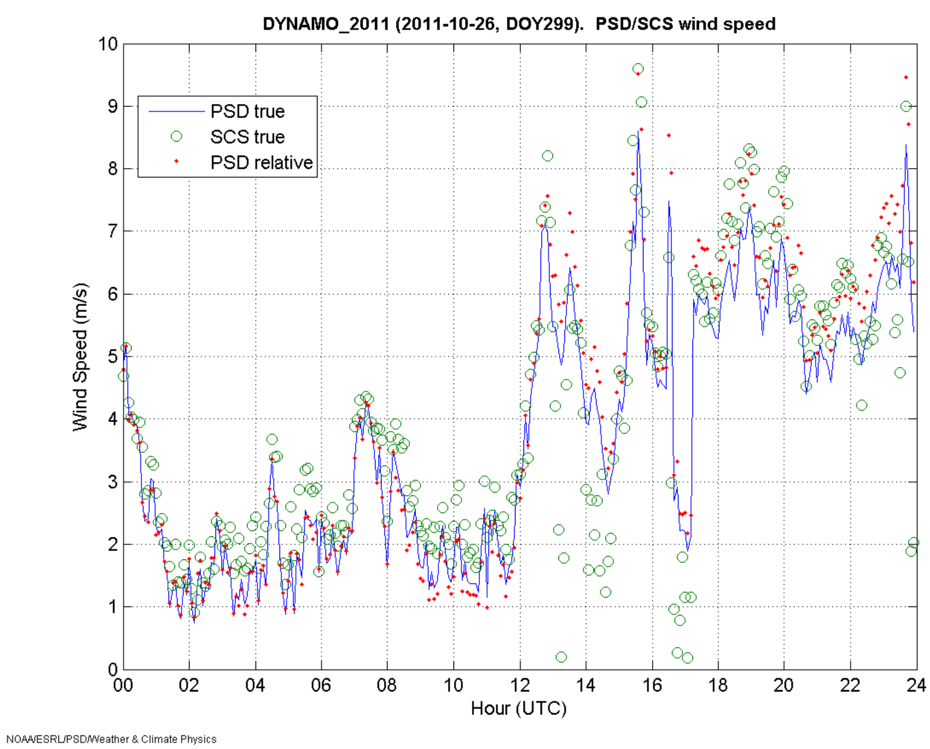



Figure 16. Wind speed for Oct 26, 2011. Comparison to ship's (SCS) and relative speed.

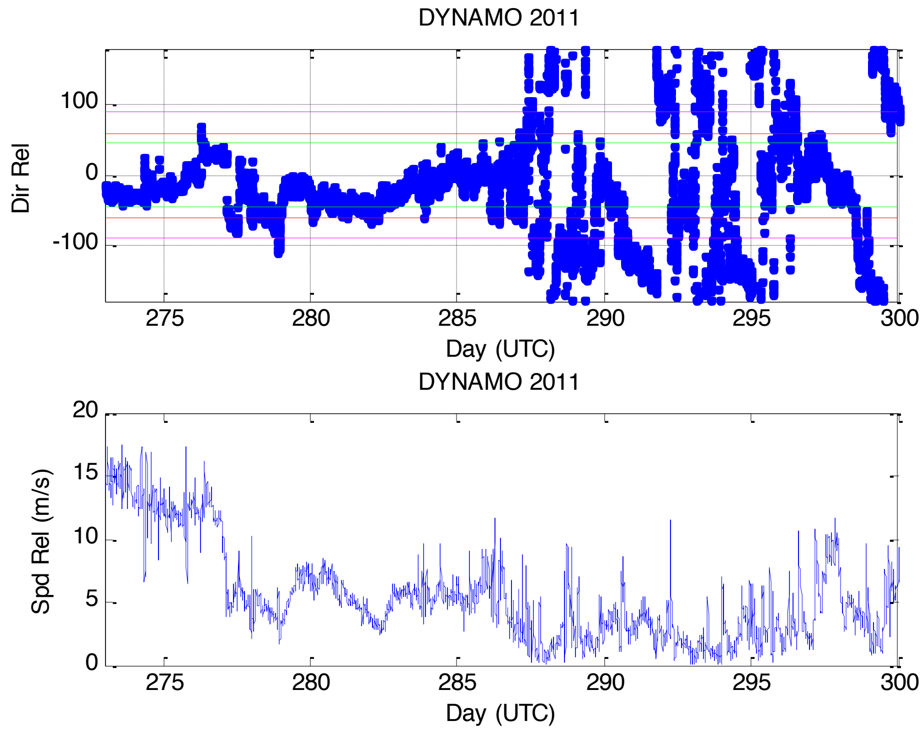



Figure 17. Time series of sonic relative wind speeds and directions

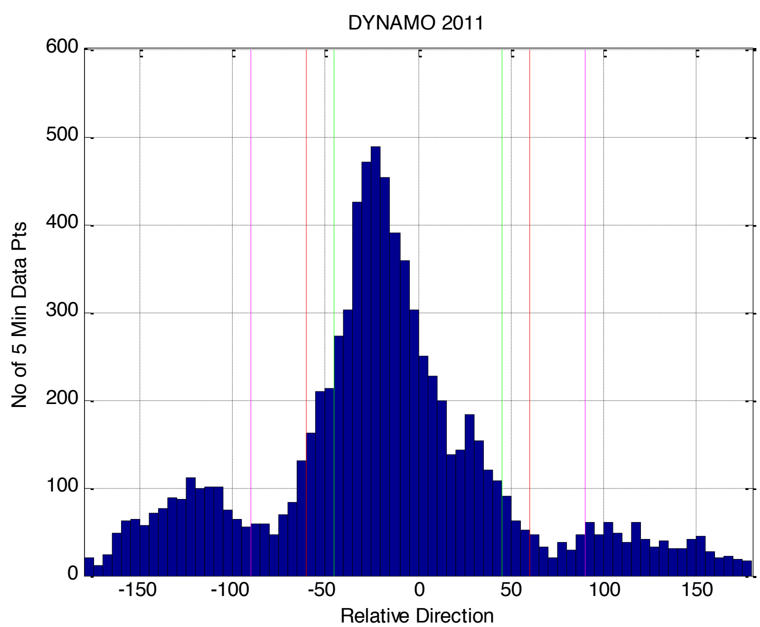
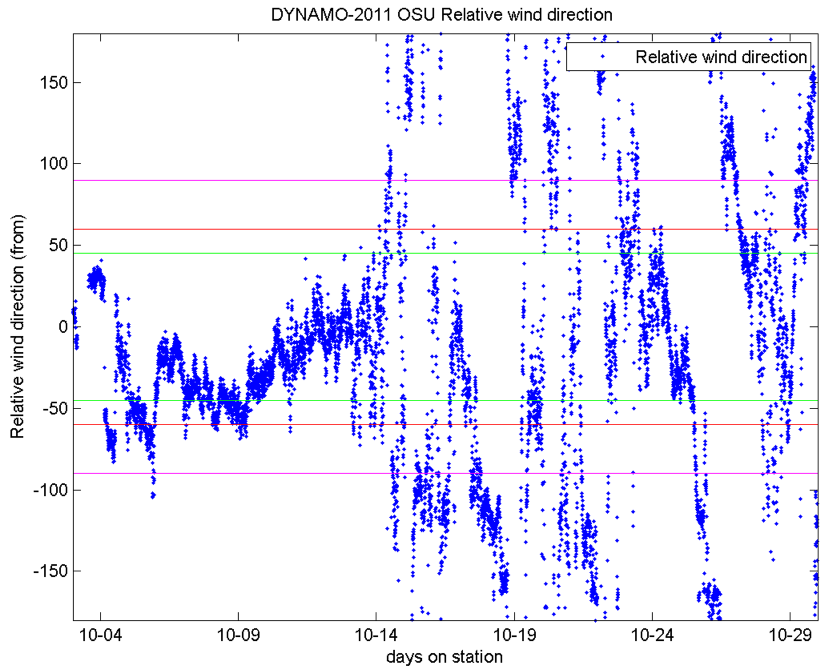



Figure 18. Histogram of PSD sonic relative wind directions for all wind speeds. Range bins are every 5 degrees.



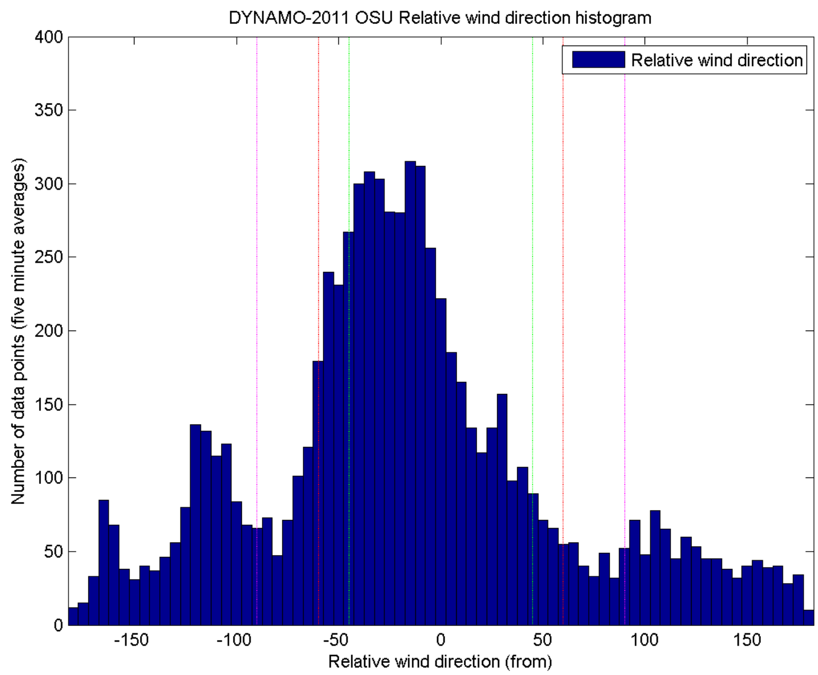




Figure 19. Five-minute average ship-relative wind direction time series (top) and histogram (bottom) from the OSU sonic anemometer during the time the ship was on station at the equator, 80° E.

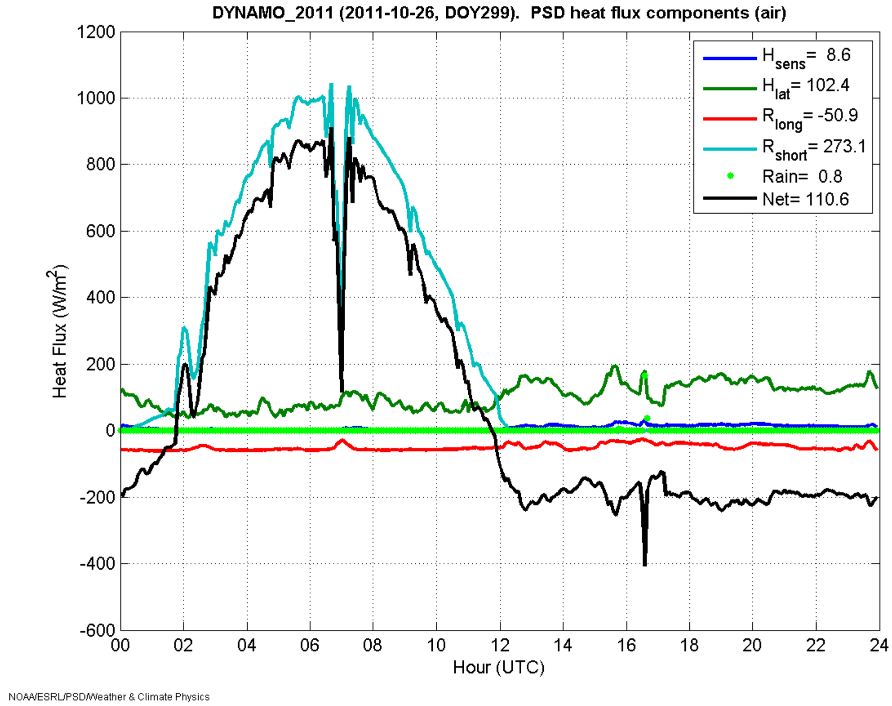



Figure 20. Bulk Heat Flux components calculated for Oct 26, 2011. Positive radiative terms warm the ocean, while positive turbulent fluxes are upward, so cool the ocean.

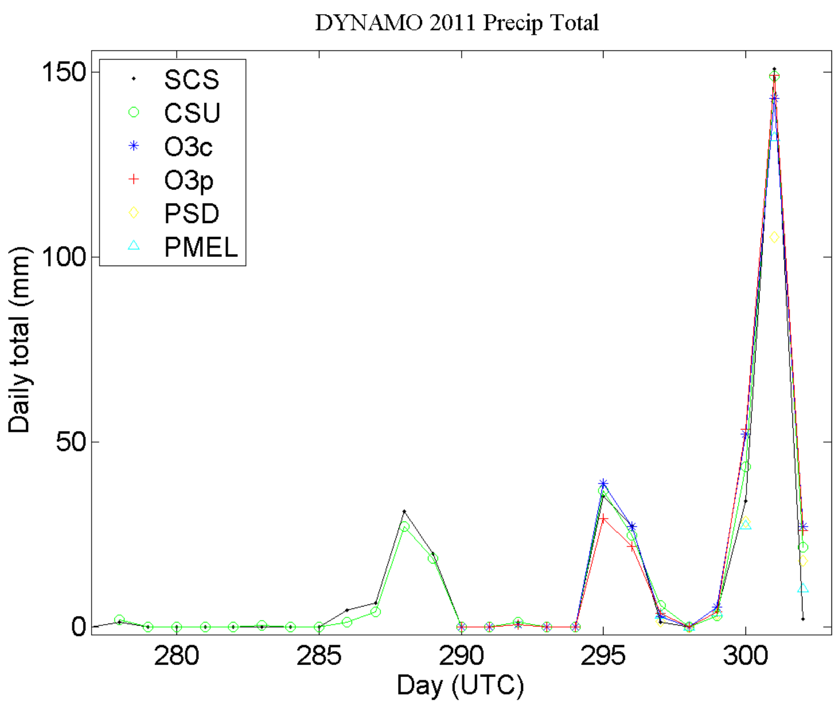



Figure 21. Daily rain totals from 7 of the 8 rain gauges on the ship. CSU, O3c and O3p are all standard 4" rain gauges.

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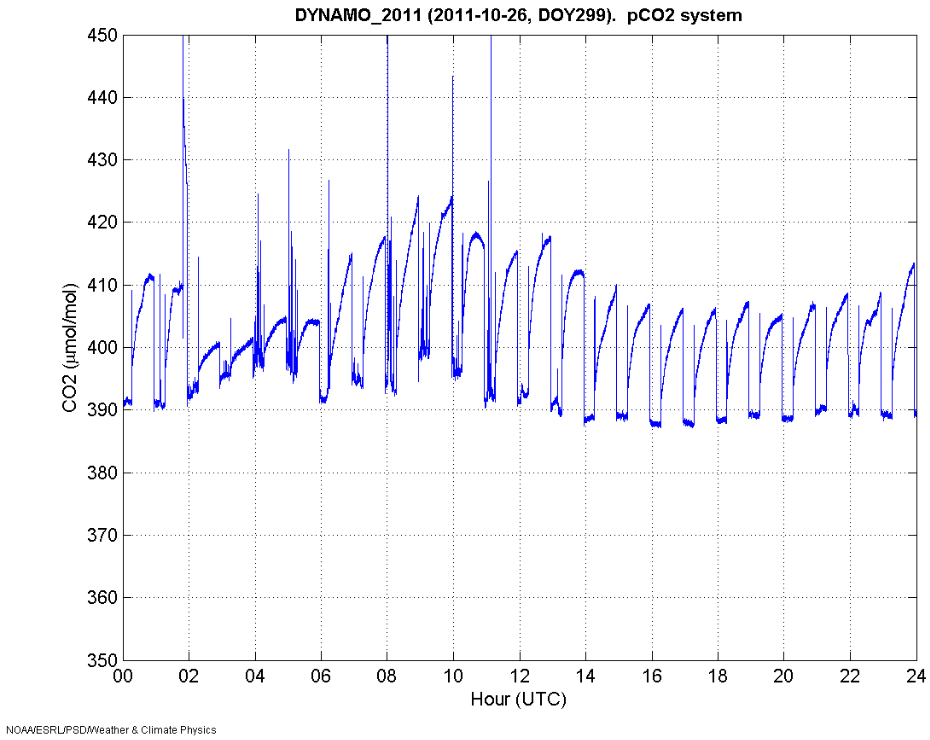



Figure 22. Air and sea $CO_2$ measuremensts for Oct 26, 2011. Air is sampled for 20 mins and sea for 40 mins.

## *Soundings* (Jennifer Standridge, Kurt Knudson, Matthew Paulus)

Date: 31 October 2011
Project: DYNAMO
Station: R/V Revelle
Cruise: Leg 2
Group: NCAR Integrated Sounding System (ISS)

| Total Radiosonde Launches | 242 |
|---|---|
| Lost Sondes | 8 |
| Successful Launches | 234 |
| Sondes with Some Missing Telemetry | 8 |
| Sondes with Some Missing PTH | 4 |
| Possible Icing/Signal Interference Issues | 3 |
| Helium Tanks Used | 57 |

| Remaining Inventory | |
|---|---|
| Balloons | 463 |
| Radiosondes | 410 |
| Helium Tanks | 80 |

Notes: Successful launches were considered to be all soundings that were not re-launched. Three sondes experienced issues with unusual upward and downward motion through parts of the sounding; which was attributed to possible icing, heavy precipitation drag, or signal interference and were not re-launched. We used 30 cu ft of helium under most conditions, and 35 – 40 cu ft in heavy rain.

## *Aerosols* (Derek Coffman, Kristen Schulz, Langley DeWitt)

During our time on station in DYNAMO Leg 2 we measured the chemical, physical, and optical properties of sub and supermicron aerosols in the local atmosphere. Our measurements included real-time and filter-based analysis of the aerosol chemical composition, size distributions from aitken mode to course mode aerosols, particle number concentrations, aerosol scattering and absorption, cloud condensation nuclei (CCN) measurements, and total mass of filter collected aerosol. We also collected meteorological data and $O_3$ and $SO_2$ gas phase measurements.

**Figure 1** shows a summary of the submicron chemistry and total size distribution of the aerosol particles observed. We show the time series of our data across the entire time we were on station. Plotted here from top to bottom are the vertical variance from the HRDL Lidar group--warm colors indicating downward transport in the atmosphere; rough wind directions from HRDL data; $O_3$ concentrations—a rise in $O_3$ also indicating a downwards transport of air mass; submicron aerosol chemistry from the Aerosol Mass Spectrometer showing concentrations of sulfate, ammonium, organics and nitrate over time; submicron MSA (a tracer for secondary marine aerosols) from filter sample analysis; precipitation; and aerosol volume, surface area, and number size distributions from 20 nm to 10 μm. Periods of zero air, test aerosol, and large ship contamination events have been removed.

We observed three distinct aerosol events (region 1, 2, and 3) during our time at station and a 4$^{th}$ event somewhat suppressed by precipitation events at the end of our time on station

*Period 1* contained mostly acidic sulfate mixed down from the free troposphere (both HRDL and $O_3$ data show downwards mixing events). The small amounts of organics and ammonium suggest a marine origin. MSA also grew during this time period.

*Period 2* contained mostly acidic sulfate again. Sulfate and MSA steadily grew during this time period, which was a period of high sun and little rain. $O_3$ and HRDL data do not show constant downwards mixing during this period, possibly indicating that we observed aerosol being processed in the atmosphere.

*Period 3* contained aerosol most likely continental in origin (indicated by the higher ammonium and organic concentration in the aerosol). $O_3$ rose steadily during this period. Winds shifted direction just before we observed this aerosol mass, from coming from the west to coming from the east.

**Figure 2** shows the optical parameters and particle concentrations for the same period as in Figure 1. Also included is the aerosol mass loading from the AMS. The optical parameters show sub- and supermicron scattering and submicron absorption. The supermicron scattering is dominated by the coarse mode aerosols while the submicron parameters track with mass loading from the AMS. Periods of zero air, test aerosol and instrument malfunction were removed but ship contamination was not. These periods of contamination can be clearly seen as spikes in the particle concentration and will be used to clean the data at a later date. There are also spikes in the supermicron scattering that can not be accounted for by contamination. We will explore these further to understand their sources and implications.

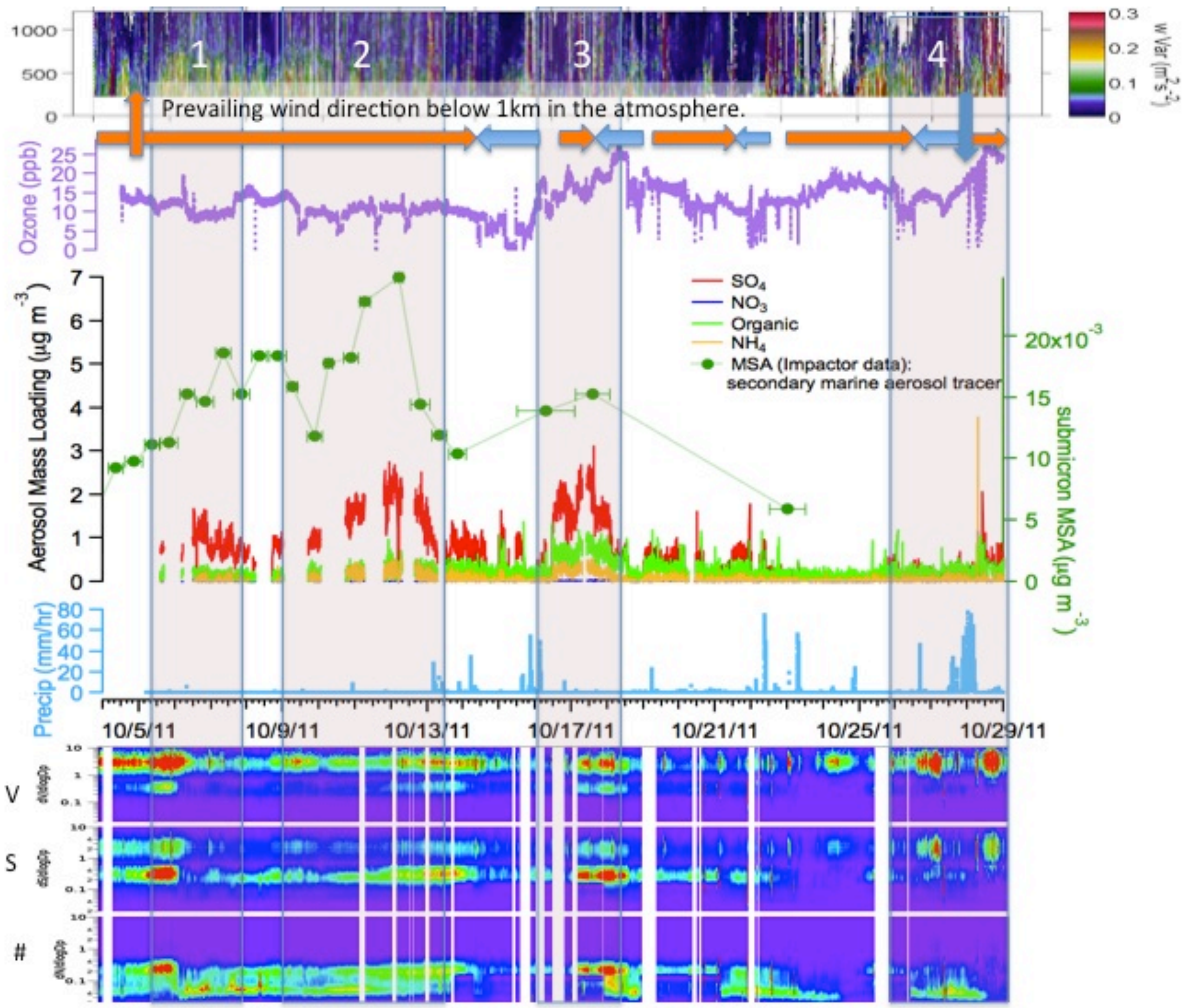

1000
500
0
1
2
3
4
0.3
0.2
0.1
0
w Var (m²s⁻²)
Prevailing wind direction below 1km in the atmosphere.
Ozone (ppb)
25
20
15
10
5
0
Aerosol Mass Loading (µg m⁻³)
7
6
5
4
3
2
1
0
SO4
NO3
Organic
NH4
MSA (Impactor data):
secondary marine aerosol tracer
20x10⁻³
15
10
5
0
submicron MSA (µg m⁻³)
Precip (mm/hr)
80
60
40
20
0
10/5/11
10/9/11
10/13/11
10/17/11
10/21/11
10/25/11
10/29/11
V
S
#

**Figure 1**

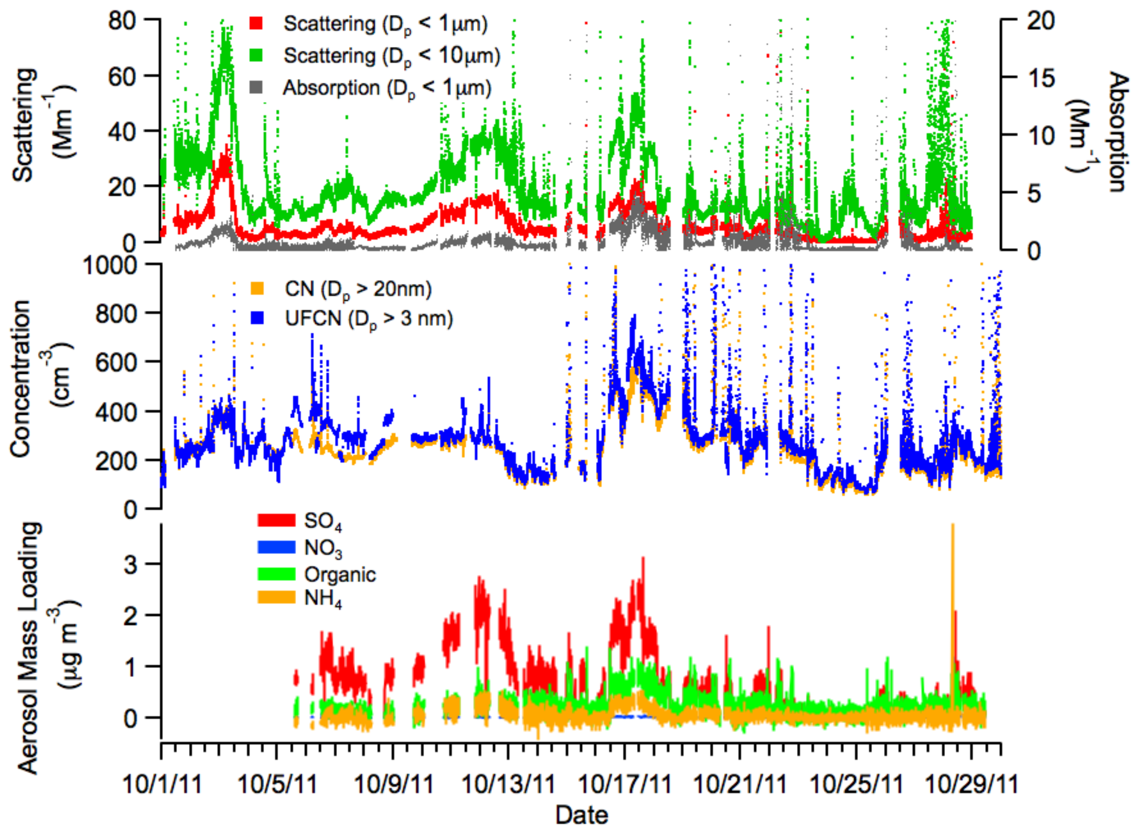

Scattering (Mm⁻¹)
Scattering (Dp < 1µm)
Scattering (Dp < 10µm)
Absorption (Dp < 1µm)
Absorption (Mm⁻¹)
80
60
40
20
0
20
15
10
5
0
Concentration (cm⁻³)
CN (Dp > 20nm)
UFCN (Dp > 3 nm)
1000
800
600
400
200
0
Aerosol Mass Loading (µg m⁻³)
SO4
NO3
Organic
NH4
3
2
1
0
10/1/11
10/5/11
10/9/11
10/13/11
10/17/11
10/21/11
10/25/11
10/29/11
Date

**Figure 2**

November 2, 2011

## NOAA High Res. Doppler Lidar (HRDL) (Alan Brewer, Raul Alvarez)

### Introduction

The goal of having HRDL on the RV Revelle during DYNAMO was to characterize and monitor the dynamics of the marine atmospheric boundary layer from the surface of the ocean up through cloud base or the top of the aerosol layer. This was accomplished by operating continuously during leg 2 and performing a repeating 20 minute sequence of scans. These scans, shown in Figure **Error! No text of specified style in document.**-1 were designed to measure vertical profiles of the horizontal wind speed and direction, moments of the vertical wind speed, and horizontal wind variance. In addition, the scanning data can be used to visualize spatial variations and their temporal evolution in the horizontal wind field out to a range of 6-8km and, in that mode, are useful in studying phenomena such as precipitation driven outflows. HRDL is a 2 micron, coherent-detection, Doppler lidar whose primary targets are atmospheric aerosol 1 micron and larger. The sensitivity of the instrument and hence its measurement range is heavily influenced by the distribution of aerosol. For typical conditions during Leg 2, HRDL could make measurements to a range of 6km horizontally and 2-3km vertically (typically limited by the top of the aerosol layer). Optically-thick clouds and heavy rain attenuate the signal and reduce the measurement range when present. HRDL operates with a pulse repetition frequency of 200 Hz and averages 100 pulses to form 2 Hz averaged beams of range-resolved, radial (line-of-site) wind speed and backscatter signal intensity. The along-beam resolution is matched to the length of the optical pulse which is 30m FWHM. The diameter of the beam is approximately 0.15m and is collimated at the output with a divergence angle of 20 $\mu$rad. The optical beam is invisible and eyesafe. HRDL is equipped with a motion compensated hemispheric scanner that is capable of maintaining pointing in the world frame with a precision of 0.5 degrees in moderate seas.

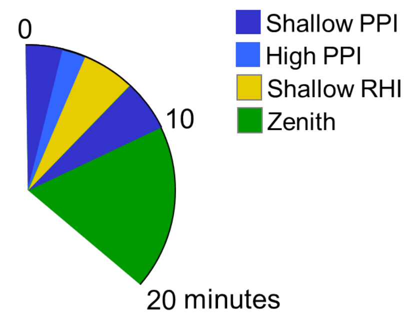



**Figure** Error! No text of specified style in document.**-1 Twenty minute scan sequence used during DYNAMO**

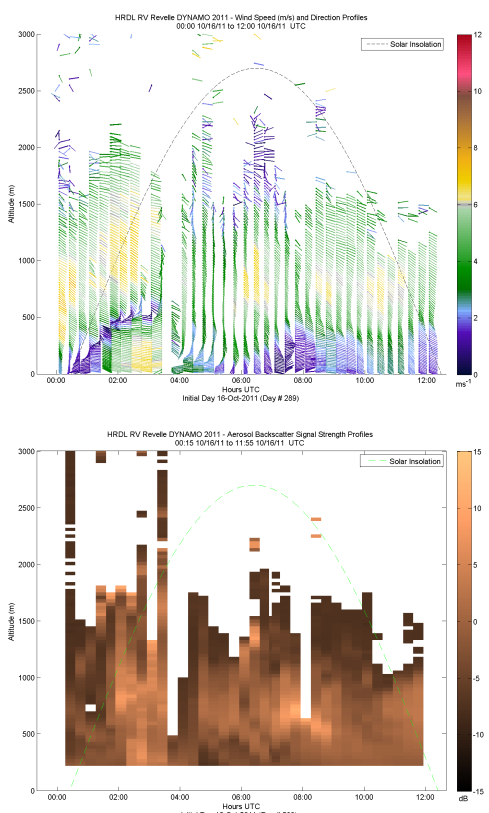
### The Scan Sequence

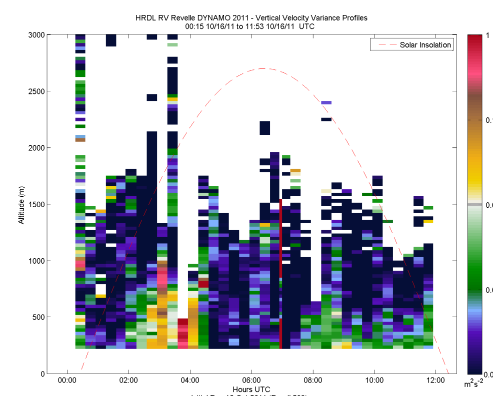
The scan sequence shown in Figure **Error! No text of specified style in document.**-1 has two low-elevation-angle (1 degree) azimuthal scanning (PPI) sweeps designated as Shallow PPI. These scans have 1 degree azimuth resolution for each beam and take approximately 2 minutes to perform. They are positioned in the sequence at the beginning and middle to provide as close to a regular spacing as possible. The parameters of the azimuthal scans designated as High PPI depended on conditions and the depth of the aerosol layer. Typically we operated with elevation angles of 8 and 45 degrees, but would often lower these elevation angles to fill in gaps in the vertical profiles as needed. The shallow RHI scans are elevations scans (0-30 degrees) performed at two fixed azimuth angles, typically separated by 90 degrees, one plane forward theopther off the starboard side. The two-sweep pattern would be repeated 3 times giving a total of 6 sweeps, 3 in each azimuth plane. The remainder of the time (approximately 10 minutes) was spent staring vertically. A summary of the scans and the data products derived from them are summarized in Table 1.

**Table 1 Scans and associated data products**

| Scan | Data Product |
|---|---|
| Shallow PPI | Horizontal wind profiles, Divergence profiles, Spatial feature tracking |
| High PPI | Horizontal Wind Profiles, Divergence profiles |
| Shallow RHI | Horizontal Wind Profiles, Horizontal wind variance, Spatial feature tracking |
| Zenith | Moments of the vertical velocity, Cloud statistics |

## Realtime data products



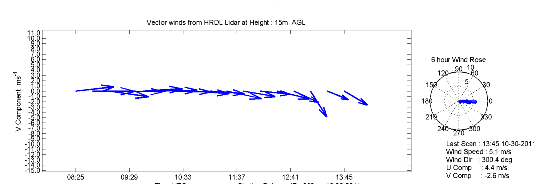




**Fig.** Error! No text of specified style in document.**-2 HRDL Lidar results posted to the web every twenty minutes during continuous operation: Vertical profiles of horizontal wind speed and direction, vertical velocity variance, aerosol backscatter signal strength for a 12 hour period and 6 hour**

vector surface winds.

At the end of every twenty minute scan sequence, basic data products (profiles of horizontal wind speed and direction, vertical velocity variance, aerosol backscatter signal intensity and surface wind vectors) were automatically generated and posted to a ship-based web page for on board usage. When the satellite internet connection was available, these products were also posted to a NOAA web page and were uploaded to the NCAR field catalog. When the connection was available, but limited, the results were uploaded every 4 hours. Fig. **Error! No text of specified style in document.**-2 shows typical images of these products for a 12-hourperiod: Horizontal wind speed and direction, vertical velocity variance, aerosol backscatter signal strength, and surface wind vectors (for a different 6 hour period). The address of the ship-based web page is: http://hrdlpp-pc/ and the NOAA web page can be found at: http://esrl.noaa.gov/csd/lidar/dynamo.

The ship-based web page also provides a variety of other real-time products that are updated every twenty minutes: An image of every scan within the sequence, web cam images from the bore-sighted scanner and allsky cameras, and diagnostic information including a raw, strip chart output of processed beams and a text file with current navigation and motion compensation information.

The ship-based web page also has a link to post processed results that include the most recent compilations of mean wind and boundary layer turbulence strength ( vertical and horizontal velocity variance) for the given phase of the experiment (for example, the on station results shown in the results section ).

**Compiled Running Statistics**

HRDL operated continuously during Leg 2 with no major outages - only going offline during periods of heavy rain twice.

Table 2 Running Statistics for Legs 1 and 2. and Figure 3 Scan chart for Leg 2 of DYNAMO. Colors represent the different scan types show the statistics and temporal coverage of the operational periods for HRDL during. The table indicates nearly 700 hours of operation during Leg 2. A total 328 hours, or nearly half the time, was spent starting vertically with 100 and 250 hours spend scanning in elevation and azimuth respectively. The number of files (and hence scans) are show in the second part of the table broken out for each type of scan with a total of over 10700 scans. Generating typically about 1.25 Gigabytes per hour in raw data, HRDL has stored nearly 900 Gigabytes of raw data during Leg2 operation.

**Table 2 Running Statistics for Legs 1 and 2.**

| | Number of hours | Number of scans | |
|---|---|---|---|

| Leg | Total | zenith | 30_60RHI | VAD | % uptime |
|---|---|---|---|---|---|
| 1 | 484.2 | 227.4 | 70.6 | 186.2 | 91.7% |
| 2 | 690.1 | 328.2 | 103.9 | 258.0 | 96.5% |

| zenith | 30_60RHI | 1ppi | VAD | Total |
|---|---|---|---|---|
| 1576 | 1560 | 3153 | 1560 | 7849 |
| 2162 | 2146 | 4320 | 2146 | 10774 |

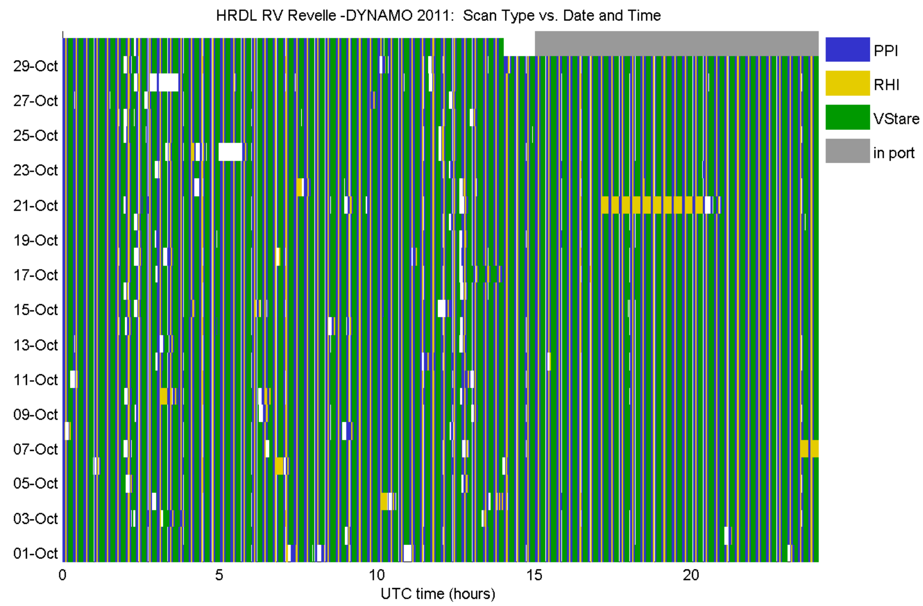



Figure 3 Scan chart for Leg 2 of DYNAMO. Colors represent the different scan types

The figure shows the temporal coverage of the scans completed during Leg2. As indicated by the legend, zenith scans are green, horizontal scans blue, and vertical scans yellow. The Y axis is date starting from the beginning of the leg at the bottom and progressing to the end of the leg at the top. The X axis is UTC time, 0-24 hours. Ideally, we strive for a complete, uniform pattern (to ensure even coverage and uniform sampling). The disruptions around 3 and 12 UTC are associated with routine maintenance performed twice a day. The two white patches in the early hours of 24 and 28 October are from heavy rain and the yellow patch in the overnight period of 21 Oct was from a parameter entered into the scan controller incorrectly and allowed to operate overnight. The system operated in a scanning mode that focused on vertical scans. The coverage in Leg 2 is 96.5% and represents a well operating system with no major downtime (most of the remaining 3.5% comprises the time between the files while the scanner moves into the next starting position).

**Preliminary Results**

With the enormous amount of data taken during Leg 2, every effort was made to analyze the data either in real time or within one day of operation, to ensure there were no subtle problems developing in the system, to monitor the conditions found on station, and to relate them to researchers on the ship and on shore. Figure **Error! No text of specified style in document.**-3 shows a compilation of HRDL data products taken while on station during Leg2. The top plot shows the insolation and rain rate during that time period. The 2nd and third plots show the mean horizontal wind taken along the U and V directions from the surface up through 1200 meters. These results show moderate wind speeds, with nearly uniform direction as a function of height that slowly changed their direction over days. The notable exception to this general pattern was the regular occurrence of what are believed to be precipitation driven outflows that would pass over the ship when convection was present. Figure **Error! No text of specified style in document.**-4 shows a two day detailed look at the horizontal wind speed to a height of 500m. The top second panel shows a 4-hour smoothed version of the wind speed and the third shows the highest temporal resolution version of the same data (20 minutes). The out flows are seen as events that occur within a single or double time periods. Stronger events cover the entire 500m depth while smaller events are limited in height. The time period shown begins on 12 October.

The top two panels in Figure **Error! No text of specified style in document.**-5 show the distribution of the horizontal wind speed and direction as a function of height for the period of time when the ship was on station for Leg 2. Generally, the winds were out of the West aloft, but there was a period of Southeasterly flow. Winds in the lower 500m of the atmosphere had a larger variability in direction. The wind speeds exhibit a bimodal distribution with peaks at 3 and 6 m/s. The lower panels in that figure show a composite of the variance in the vertical (left) and horizontal (right) velocity as a function of local solar time. These results show some evidence of a diurnal pattern that peaks in the early morning and late afternoon. The strongest variation in the horizontal variance is at the surface and the vertical velocity variance shows stronger values and variation in the lower portion of its measurement range.

**Conclusion**

The NOAA High Resolution Doppler Lidar operated continuously during Leg 2 of DYNAMO and had a 96% uptime. From the over 10,000 scans taken, profiles of horizontal wind speed, moments of the vertical velocity, and backscatter signal intensity were automatically generated every 20 minutes and were made available to the ship and the wider scientific community over the internet. Initial post processed results show interesting features in the horizontal wind field distribution and diurnal patterns in the vertical and horizontal variances. Precipitation driven outflows were encountered with great regularity and efforts are underway to use HRDL data together with other measurements made on the ship to characterize the outflows and determine what if any linkage exists with the ocean mixing.

November 2, 2011

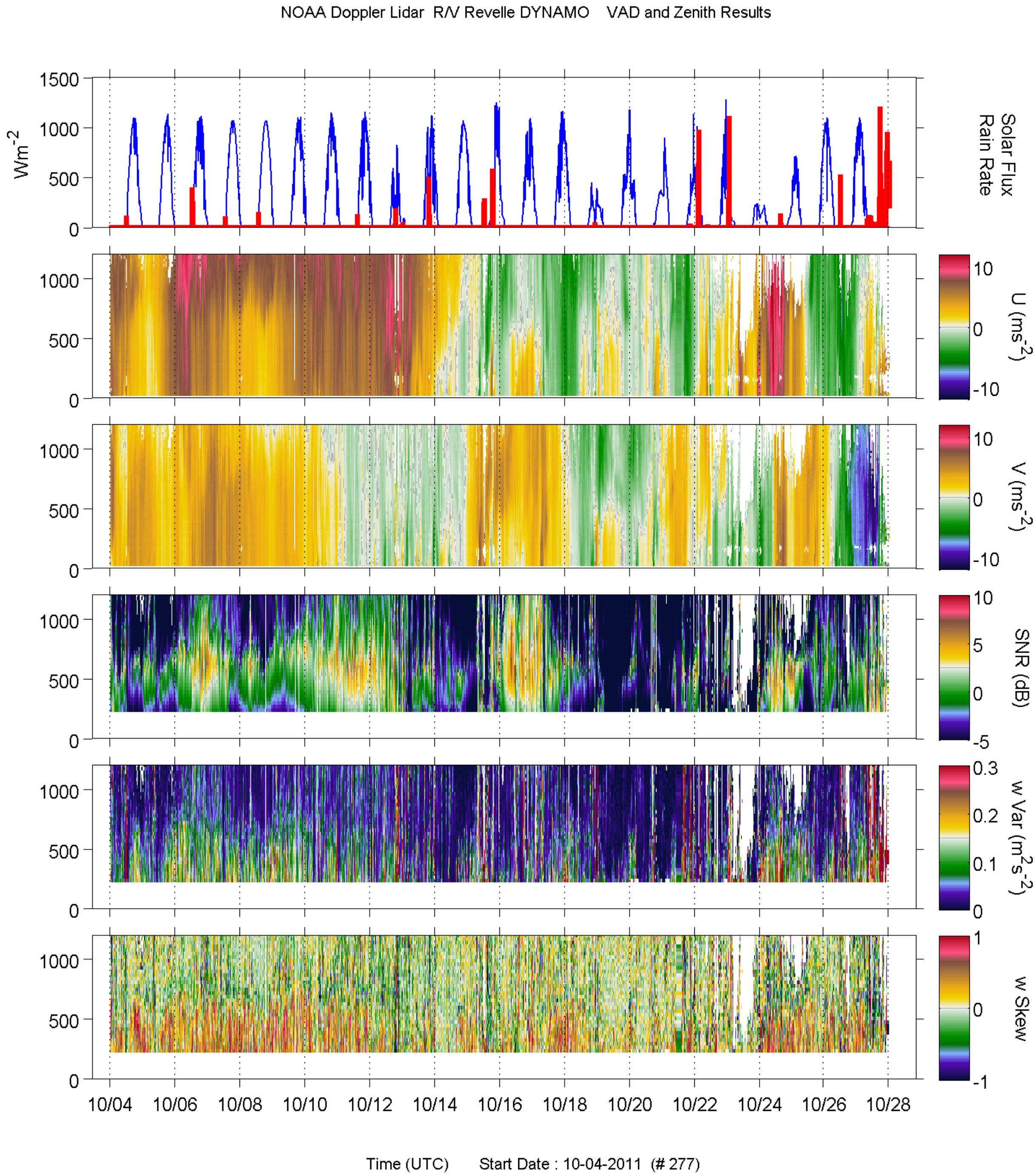



**Figure** Error! No text of specified style in document.**-3 Compilation of results from HRDL while on station during Leg2. The plots are of solar Insolation and rain rate, U an d V components of the mean wind, Backscatter intensity signal, and variance and skewness of the vertical velocity distribution for data**

November 2, 2011

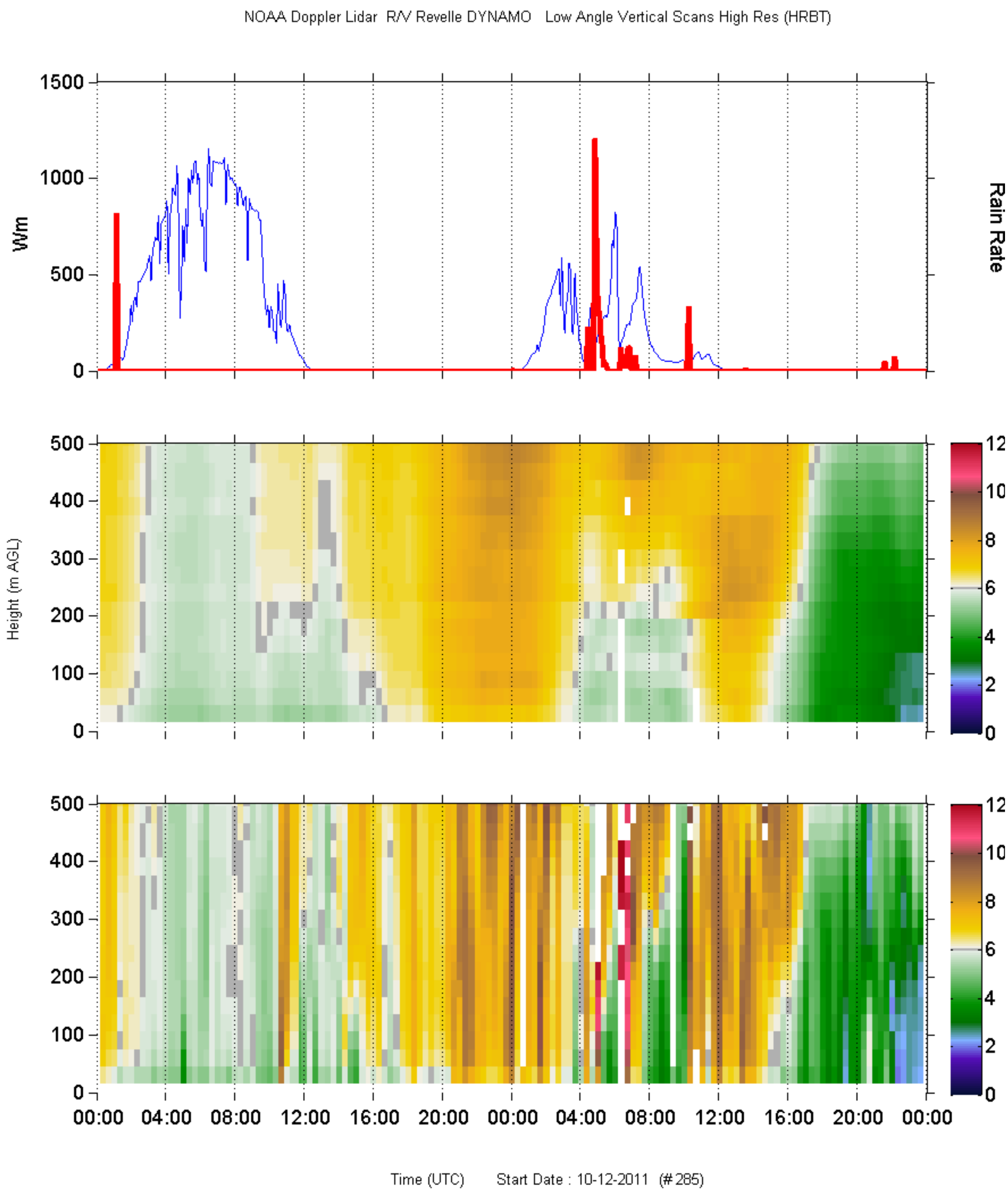



**Figure** Error! No text of specified style in document.**-4 Detailed look at two day period. Second and third plots are of 4 hour smoothed wind speed and 20 minute estimates of wind speed that show effects of outflows.**

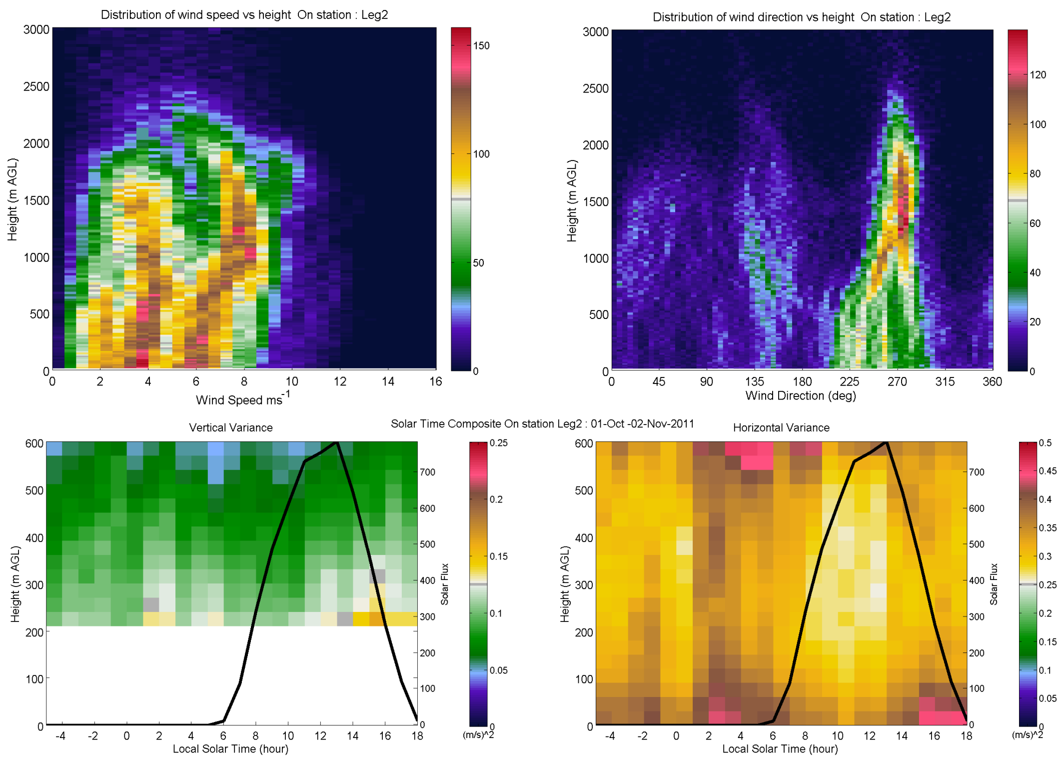



**Figure** Error! No text of specified style in document.**-5 Distributions of wind speed and direction vs height (top) and (bot) Vertical and Horizontal velocity variance copsited as a function of local solar time.**

## ***TOGA Radar*** (Angela Rowe, Nathan Gears, Tiffany Meyer)

The TOGA radar began collecting data at 0200 UTC on 1 October, running nearly continuously until the evening of 30 October. Full, 360-degree volume scans, to a maximum range of 150 km, were scheduled in 10-minute intervals, requiring almost 9 minutes to complete. This provided a minute of time for vertical cross-sections (RHIs) to be selected, usually consisting of 5 azimuthal angles with 1-degree spacing. At minutes :29 and :59, instead of RHIs, a single, low-level (0.8-degree elevation angle) scan was completed to a range of 300 km, and made available on CSU's DYNAMO website (http://radarmet.atmos.colostate.edu/dynamo) and the DYNAMO field catalog. Nearly 700 hours of data were collected from TOGA, resulting in approximately 3500 full volume scans and roughly 11,000 RHIs, providing an extensive dataset for computing echo statistics and for determining horizontal and vertical characteristics of precipitation in this region.

Several additional products were made available from TOGA during this cruise, including10-minute updates of echo-top height across the 150-km domain and 24-hour accumulated rainfall at each range bin. While these provided only rough estimates due to the extensive quality-control effort that will be required to eliminate non-meteorological echo, they proved to be useful tools for describing the overall relative day-to-day trends in precipitating features.

Throughout this month, a broad spectrum of convection was observed, ranging from shallow, short-lived, isolated cells to large mesoscale convective systems (MCSs) with embedded convection extending to 14-16 km in height, and, at times, even up to 18 km. During the first half of the month, mostly scattered convection dominated the radar domain, with echo top heights typically in the 6-8 km range. Cloud depth increased over the next couple of weeks as the number of MCSs also increased and overall convective percentage decreased. These large systems were characterized by widespread stratiform precipitation, covering half of the radar domain at times, displaying evidence of melting near the 0ºC level and consisting of deep embedded convection with maximum reflectivity around 45-50 dBZ. During those days consisting of widespread, organized systems, Revelle soundings showed strong vertical directional wind shear, typically with easterlies aloft and westerly or southwesterly flow at low levels. This led to an interesting observation, where overall storm motion, particularly associated with the stratiform region, was toward the W, consistent with the prevailing upper-level winds, while embedded convective elements, especially when oriented along lines perpendicular to the flow, moved in the opposite direction, with the low-level flow. In addition, outflow boundaries were found to play an important role in convective initiation, strengthening, and organization as they collided with each other and other ongoing precipitating systems.

## ***Optics*** (KG Fairbairn)

We did a total of 69 optics cast, 3 times per day for 23 days. Given the fact that the ship is unable to maneuver much due to the other operations, we were able to use the current, 1-2 knots running away from the stern, to send the micropro away from the ship's shadow. I am hoping this current persists during leg 3 therefore allowing 3 micropro casts per day. I collected water from 25 CTD casts deployed at 1300. Bottles were fired at the chlorophyll maximum, which was determined during the downcast from the CTD flourometer ranging from 60 meters to 87 meters, and at 2 meters. Water from 2 meters and chl-max was filtered and the filters frozen which will be analyzed in the lab using the HPLC (high performance liquid chromatography) method to quantify chlorophyll-a. Water was also frozen from 2 meters and chl-max for nutrient analysis. These samples will be shipped to UC Santa Barbara after leg 3.

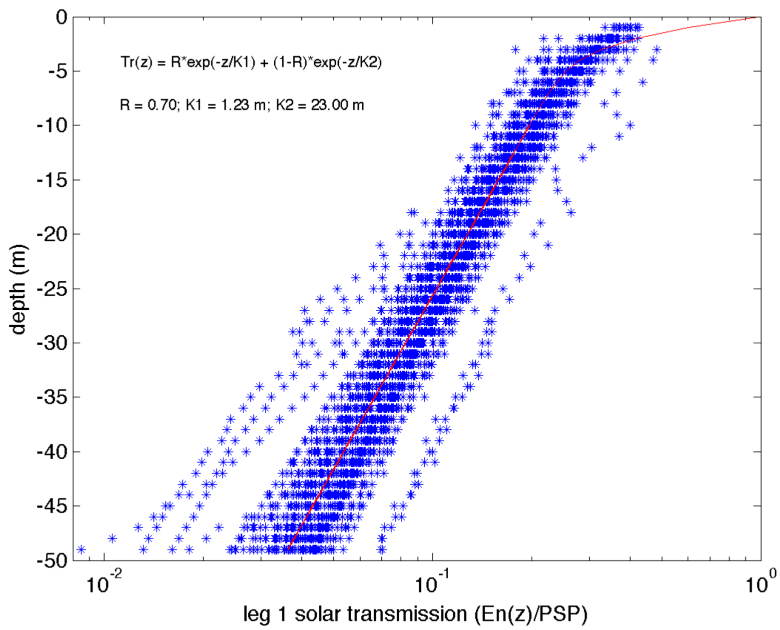



Figure 1 – Solar transmission parameters for a mean curve shape using least squares from all leg 2 profiles.

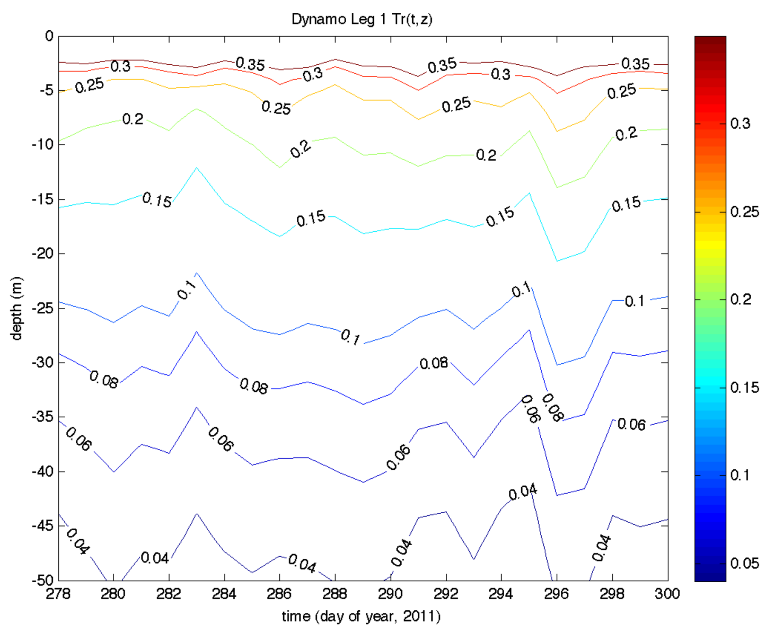



Figure 2 – Contours of Tr(z) over the time series. The increase in Tr(z) on days 296 and 297 seems real. Some other spikes (day 283 for example) are caused by significant changes in total solar energy at the sea surface during the cast.

## ***Ocean Mixing***

(Jim Moum, Bill Smyth, A. Perlin, M. Neeley-Bronwn, R. Kreth, L. Neeley-Brown, R. Brown, E. McHugh, A. Moulin)

The Ocean Mixing Group from Oregon State University was responsible for sonar measurements of ocean current profiles, high-frequency measurements of acoustic backscatter, turbulence/CTD profiling measurements and near-surface CTD measurements using bow chain-mounted sensors (7 Seabird microcats + 8 fast thermistors in the upper 10 m). A cross-equatorial transect from 2N – 2S along 80.5E was executed 03-04 October followed by a 25 day times series at 0 80.5E from 04-29 October.

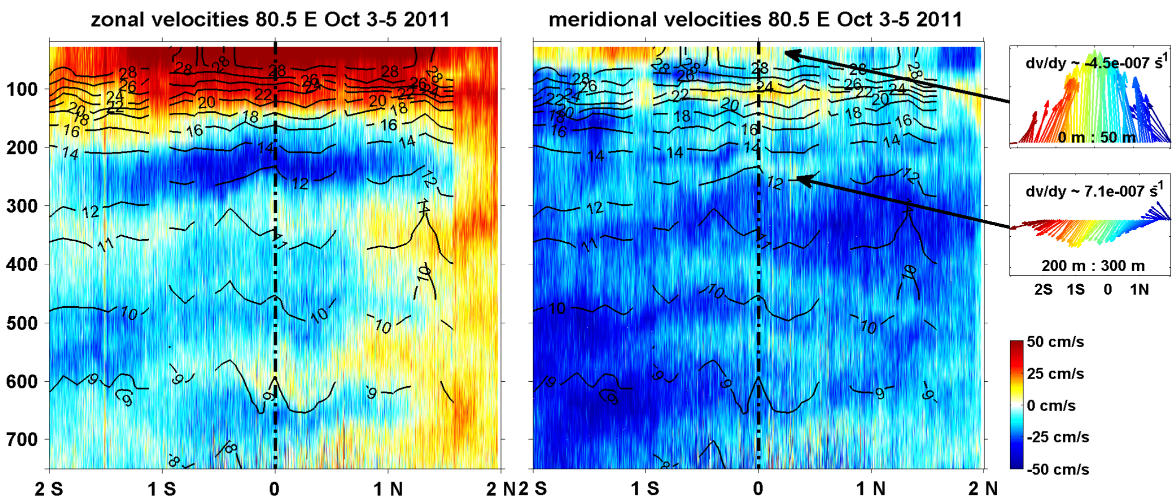



Figure O1 – Cross-equatorial structure of zonal / meridional velocity. Quivers show meridionally-convergent flow (dv/dy<0) in the eastward surface current and meridionally-divergent flow (dv/dy>0) in the westward undercurrent below.

Zonal currents were dominated by a persistent eastward (and meridionally-convergent) surface current, a Wyrtki Jet. Below was a westward undercurrent (Fig – O1, O2). The strongly-banded meridional current structure suggests vertical wave propagation.

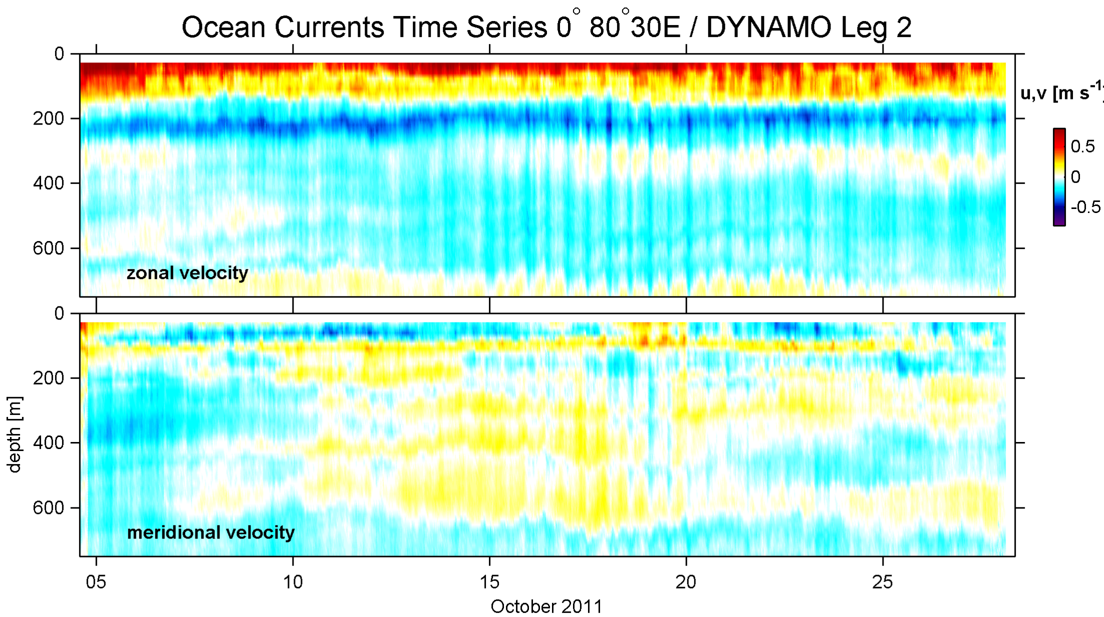



Figure O2 – Ocean currents during DYNAMO Leg 2 time series.

A total of 3776 Chameleon turbulence/CTD profiles to approximately 300 m depth were made while on station from 04 Oct – 29 Oct. A summary shows the variability due in part to changes in surface forcing (winds, precipitation) but also to instabilities associated with the shear in the persistent eastward Wyrtki Jet and westward undercurrent. As well, long term variations are likely due to large-scale ocean waves which will be an important aspect of our research. A summary that focuses on the upper ocean is shown in Fig. O3.

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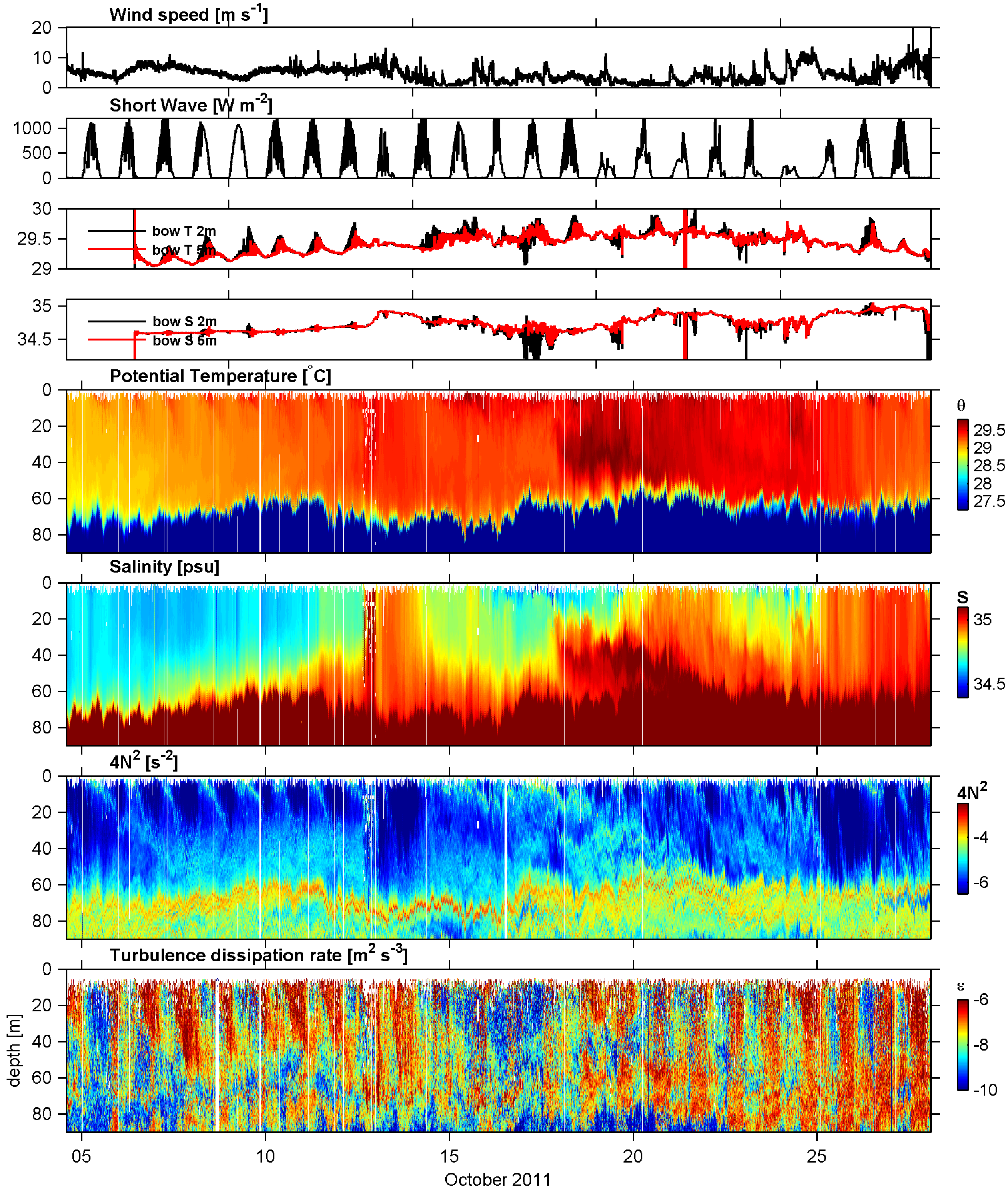


Figure O3 – Summary of 3766 upper ocean profiles / DYNAMO Leg 2.

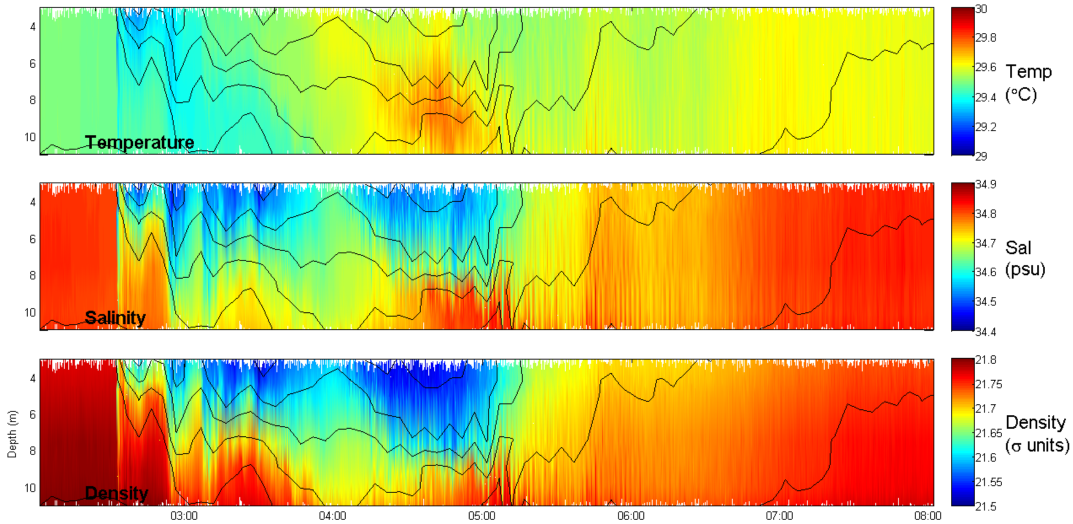


Figure O4 – Upper ocean structure of temperature, salinity and density as measured from 7 Seabird CTP sensors mounted on a bow chain an sensing fluid undisturbed by the presence of the ship.

Fresh water pools on the sea surface were measured using the bow-mounted chain of sensors. An example shows a pool that passed by the ship over a period of several hours (Fig. O4). If purely advected by the currents, it has a spatial extent of roughly 10 km. However, the sharp leading edge of the pool suggests that it propagates as a gravity current as well. How fresh water is distributed over the sea surface once deposited is an O(1) question for this experiment. In this case, no precipitation was measured on board the ship, so all of the fresh water was deposited upstream.

Because of the importance of this problem, we dedicated a day (28 Oct) to tracking fresh water pools in the hope of measuring the speed of gravity current fronts. We did observe and track a pool and will attempt another tracking experiment on Leg 3.

## *Revelle Event Log*

0019z 10/01/11 05 13.30N. 090 35.57E. Weather Balloon #1 TD
0809z 10/01/11 04 46.23N. 089 10.69E. Micro probe deployed JK
0817z 10/01/11 04 46.18N. 089 10.68E. Micro probe recovered JK
0857z 10/01/11 04 46.14N. 089 10.65E. Chameleon CTD deployed EW
0902z 10/01/11 04 46.04N. 089 10.59E. Chameleon CTD on deck EW
1118z 10/01/11 04 39.17N. 088 48.46E. Wx Balloon #2 Deployed EW
1415z 10/01/11 04 28.25N. 088 14.21E. Wx Balloon #3 Deployed GJ
1715z 10/01/11 04 17.04N. 087 39.11E. Wx Balloon #4 Deployed GJ
2020z 10/01/11 04 05.34N. 087 02.41E. Wx Balloon #5 Deployed JK
2313z 10/01/11 03 54.51N. 086 28.45E. WX Balloon #6 deployed TD
0215z 10/02/11 03 42.61N. 085 51.18E. Wx Balloon #7 Deployed GJ
0518z 10/02/11 03 31.10N. 085 15.13E. Wx Balloon #8 Deployed GJ
0816z 10/02/11 03 20.53N. 084 42.05E. Wx Balloon #9 Deployed JK
1114z 10/02/11 03 09.60N. 084 07.81E. Wx Balloon #10 Deployed JK
1415z 10/02/11 02 58.19N. 083 32.08E. Wx Balloon #11 Deployed GJ
1715z 10/02/11 02 46.97N. 082 56.95E. Wx Balloon #12 Deployed GJ
2015z 10/02/11 02 35.72N. 082 21.77E. Wx Balloon #13 Deployed JK
2312z 10/02/11 02 24.76N. 081 47.48E. WX Balloon #14 deployed TD
0215z 10/03/11 02 13.58N. 081 12.51E. Wx Balloon #15 Deployed GJ
0530z 10/03/11 02 02.21N. 080 36.90E. Wx Balloon #16 Deployed GJ
0611z 10/03/11 01 59.48N. 080 29.81E. Drifter #82318 Deployed JK
0818z 10/03/11 01 38.22N. 080 31.22E. Wx Balloon #17 Deployed JK
1115z 10/03/11 01 04.78N. 080 30.00E. WX Balloon #18 Deployed JK
1435z 10/03/11 00 26.78N. 080 29.99E. WX Balloon #19 Deployed GJ
1722z 10/03/11 00 04.87S. 080 30.00E. Wx Balloon #20 Deployed GJ
2012z 10/03/11 00 37.45S. 080 30.00E. Wx Balloon #21 Deployed JK
2155z 10/03/11 00 57.43S. 080 30.00E. XBT deployed TD
2315z 10/02/11 02 24.59N. 081 46.90E. XBT deployed TD
2317z 10/03/11 01 13.22S. 080 30.00E. WX Baloon #22 deployed TD
0006z 10/04/11 01 22.69S. 080 30.00E. XBT Deployed TD
0040z 10/04/11 01 29.36S. 080 30.16E. XBT Deployed TD
0123z 10/04/11 01 37.71S. 080 29.99E. XBT Deployed TD
0205z 10/04/11 01 46.14S. 080 30.00E. XBT Deployed GJ
0215z 10/04/11 01 48.13S. 080 29.99E. Wx Balloon #23 Deployed GJ
0243z 10/03/11 02 11.91N. 081 07.26E. XBT Deployed GJ
0320z 10/04/11 02 01.05S. 080 29.92E. XBT Deployed GJ
0515z 10/04/11 01 37.41S. 080 30.01E. WX Balloon #24 Deployed GJ
0540z 10/04/11 01 31.78S. 080 30.00E. Wx Balloon #25 Deployed JK
0825z 10/04/11 00 54.47S. 080 30.01E. Wx Balloon #26 Deployed JK
1115z 10/04/11 00 16.12S. 080 31.04E. Wx Balloon #27 Deployed GJ
1324z 10/04/11 00 04.43N. 080 32.58E. CTD Test cast deployed EW
0328z 10/04/11 02 01.28S. 080 29.94E. Drifter #82304 Deployed GJ
1357z 10/04/11 00 04.44N. 080 32.58E. CTD Test On Deck GJ
1400z 10/04/11 00 04.44N. 080 32.58E. Drifter # Deployed GJ
1414z 10/04/11 00 04.43N. 080 32.58E. Chameleon CTD Deployed GJ
1416z 10/04/11 00 04.43N. 080 32.58E. Wx Balloon #28 Deployed GJ
1717z 10/04/11 00 04.43N. 080 32.58E. Wx Balloon #29 Deployed GJ
2015z 10/04/11 00 04.44N. 080 32.58E. Wx Balloon #30 Deployed JK
2314z 10/04/11 00 04.43N. 080 32.58E. WX Balloon #31 deployed TD
0216z 10/05/11 00 04.43N. 080 32.58E. WX Balloon #32 Deployed GJ
0305z 10/05/11 00 04.43N. 080 32.58E. Chameleon CTD On Deck GJ
0307z 10/05/11 00 04.43N. 080 32.58E. Microprofiler #1 Deployed GJ
0312z 10/05/11 00 04.43N. 080 32.58E. Microprofiler #1 On Deck GJ
0326z 10/05/11 00 04.43N. 080 32.58E. Chameleon CTD Deployed GJ

0519z 10/05/11 00 04.43N. 080 32.58E. Wx Balloon #33 Deployed GJ
0602z 10/05/11 00 04.43N. 080 32.58E. Microprofiler #2 Deployed JK
0607z 10/05/11 00 04.43N. 080 32.58E. Microprofiler #2 Recovered JK
0703z 10/05/11 00 04.43N. 080 32.58E. CTD #1 Deployed JK
0713z 10/05/11 00 04.44N. 080 32.58E. CTD #1 @ 200m JK
0727z 10/05/11 00 04.43N. 080 32.58E. CTD #1 Recovered JK
0815z 10/05/11 00 04.43N. 080 32.58E. Wx Balloon #34 Deployed JK
0910z 10/05/11 00 04.43N. 080 32.58E. Microprofiler #3 Deployed JK
0918z 10/04/11 00 42.40S. 080 30.00E. Microprofiler #3 Recovered JK
1115z 10/05/11 00 04.43N. 080 32.58E. Wx Balloon #35 Deployed GJ
1417z 10/05/11 00 04.43N. 080 32.58E. Wx Balloon #36 Deployed GJ
1715z 10/05/11 00 04.44N. 080 32.58E. Wx Balloon # 37 Deployed GJ
2018z 10/04/11 00 04.43N. 080 32.58E. Wx Balloon #38 Deployed JK
2315z 10/05/11 00 04.43N. 080 32.58E. Wx Baloon #39 deployed TD
0222z 10/06/11 00 04.43N. 080 32.58E. Wx Balloon #40 Deployed GJ
0303z 10/06/11 00 04.43N. 080 32.58E. Microprolifer #4 Deployed GJ
0308z 10/06/11 00 04.43N. 080 32.58E. Microprofiler #4 Recovered GJ
0530z 10/06/11 00 04.43N. 080 32.58E. Wx Balloon #41 Deployed GJ
0604z 10/06/11 00 04.43N. 080 32.58E. Microprofiler #5 Deployed JK
0609z 10/06/11 00 04.43N. 080 32.58E. Microprofiler #5 Recovered JK
0716z 10/06/11 00 04.43N. 080 32.58E. CTD #2 Deployed JK
0723z 10/06/11 00 04.43N. 080 32.58E. CTD #2 @ 200m JK
0736z 10/05/11 00 04.43N. 080 32.58E. CTD #2 Recovered JK
0900z 10/06/11 00 04.43N. 080 32.58E. Microprofiler #6 Deployed JK
0906z 10/06/11 00 04.43N. 080 32.58E. Microprofiler #6 Recovered JK
1047z 10/06/11 00 04.43N. 080 32.58E. T Chain deployed on bow EW
1115z 10/06/11 00 04.43N. 080 32.58E. Wx Balloon #42 Deployed GJ
1416z 10/06/11 00 04.46N. 080 32.54E. WX Balloon #43 Deployed GJ
1715z 10/06/11 00 04.46N. 080 32.54E. Wx Balloon #44 Deployed GJ
2010z 10/06/11 00 04.46N. 080 32.54E. Wx Balloon #45 Deployed JK
2323z 10/06/11 00 04.46N. 080 32.54E. WX Balloon #46 deployed TD
0215z 10/07/11 00 04.46N. 080 32.54E. Wx Balloon #47 Deployed GJ
0301z 10/07/11 00 04.46N. 080 32.54E. Microprofiler #7 Deployed GJ
0306z 10/07/11 00 04.46N. 080 32.54E. Microprofiler #7 Recovered GJ
0517z 10/07/11 00 04.46N. 080 32.54E. WX Balloon #48 Deployed GJ
0603z 10/07/11 00 04.46N. 080 32.54E. Microprofiler #8 Deployed JK
0607z 10/07/11 00 04.46N. 080 32.54E. Microprofiler #8 Recovered JK
0658z 10/07/11 00 04.46N. 080 32.54E. CTD #3 Deployed JK
0709z 10/07/11 00 04.46N. 080 32.54E. CTD #3 @ 200m JK
0721z 10/07/11 00 04.46N. 080 32.54E. CTD #3 Recovered JK
0815z 10/07/11 00 04.46N. 080 32.54E. Wx Balloon #49 Deployed JK
0830z 10/07/11 00 04.46N. 080 32.54E. Drifter #82639 Deployed JK
0900z 10/07/11 00 04.46N. 080 32.54E. Microprofiler #9 Deployed JK
0907z 10/07/11 00 04.46N. 080 32.54E. Microprofiler #9 Recovered JK
1115z 10/07/11 00 04.47N. 080 32.54E. Wx Balloon #50 Deployed GJ
1415z 10/07/11 00 04.46N. 080 32.54E. Wx Balloon #51 Deployed GJ
1715z 10/07/11 00 04.47N. 080 32.54E. Wx Balloon #52 Deployed GJ
2017z 10/07/11 00 04.46N. 080 32.54E. Wx Balloon #53 Deployed JK
2319z 10/07/11 00 04.46N. 080 32.54E. WX Balloon #54 deployed TD
0217z 10/08/11 00 04.46N. 080 32.54E. Wx Balloon #55 Deployed GJ
0307z 10/08/11 00 04.46N. 080 32.54E. Microprofiler #10 Deployed GJ
0312z 10/08/11 00 04.46N. 080 32.54E. Microprofiler #10 Recovered GJ
0516z 10/08/11 00 04.47N. 080 32.54E. Wx Balloon #56 Deployed GJ
0602z 10/08/11 00 04.47N. 080 32.54E. Microprofiler #11 Deployed JK
0607z 10/08/11 00 04.46N. 080 32.54E. Microprofiler #11 Recovered JK
0701z 10/08/11 00 04.47N. 080 32.54E. CTD #4 Deployed JK

0713z 10/08/11 00 04.47N. 080 32.54E. CTD #4 @ 200m JK
0725z 10/08/11 00 04.47N. 080 32.54E. CTD #4 Recovered JK
0815z 10/08/11 00 04.47N. 080 32.54E. Wx Balloon #57 Deployed JK
0902z 10/08/11 00 04.47N. 080 32.54E. Microprofiler #12 Deployed JK
0905z 10/08/11 00 04.47N. 080 32.54E. Microprofiler #12 Recovered JK
1115z 10/08/11 00 04.47N. 080 32.54E. WX Balloon #58 Deployed GJ
1415z 10/08/11 00 04.47N. 080 32.54E. Wx Balloon #59 Deployed GJ
2156z 10/07/11 00 04.46N. 080 32.54E. Chameleon CTD Recovered GJ
2204z 10/07/11 00 04.46N. 080 32.54E. Chameleon CTD Deployed GJ
1718z 10/08/11 00 04.47N. 080 32.54E. Wx Balloon #60 Deployed GJ
2017z 10/08/11 00 04.47N. 080 32.54E. Wx Balloon #61 Deployed JK
2323z 10/08/11 00 04.47N. 080 32.54E. WX Baloon #62 deployed TD
0212z 10/09/11 00 04.47N. 080 32.54E. CTD #5 Deployed GJ
0215z 10/09/11 00 04.47N. 080 32.54E. Wx Balloon #63 Deployed GJ
0222z 10/09/11 00 04.47N. 080 32.54E. Chameleon CTD Recoverd GJ
0228z 10/09/11 00 04.47N. 080 32.54E. Chameleon CTD Deployed GJ
0231z 10/09/11 00 04.47N. 080 32.54E. CTD #5 Recovered GJ
0305z 10/09/11 00 04.47N. 080 32.54E. Microprofiler #13 Deployed GJ
0309z 10/09/11 00 04.47N. 080 32.54E. Microprofiler #13 Recovered GJ
0515z 10/09/11 00 04.47N. 080 32.54E. Wx Balloon #64 Deployed GJ
0607z 10/09/11 00 04.47N. 080 32.54E. Microprofiler #14 Deployed JK
0611z 10/09/11 00 04.46N. 080 32.54E. Microprofiler #14 Recovered JK
0658z 10/09/11 00 04.47N. 080 32.54E. CTD #6 Deployed JK
0709z 10/09/11 00 04.46N. 080 32.54E. CTD #6 @ 200m JK
0720z 10/09/11 00 04.47N. 080 32.54E. CTD #6 Recovered JK
0820z 10/09/11 00 04.47N. 080 32.54E. Wx Balloon #65 Deployed JK
0904z 10/09/11 00 04.47N. 080 32.54E. Microprofiler #15 Deployed JK
0910z 10/09/11 00 04.47N. 080 32.54E. Microprofiler #15 Recovered JK
1115z 10/08/11 00 04.47N. 080 32.54E. Wx Balloon #66 Deployed JK
1229z 10/08/11 00 04.47N. 080 32.54E. Chameleon CTD on deck EW
1239z 10/09/11 00 04.47N. 080 32.54E. Chameleon CTD deployed EW
1417z 10/09/11 00 04.47N. 080 32.54E. Wx Balloon #67 Deployed GJ
1715z 10/09/11 00 04.47N. 080 32.54E. Wx Balloon #68 Deployed GJ
2016z 10/09/11 00 04.47N. 080 32.54E. Wx Balloon #69 Deployed JK
2053z 10/09/11 00 04.47N. 080 32.54E. Chameleon CTD Recovered JK
2113z 10/09/11 00 04.47N. 080 32.54E. Chameleon CTD Deployed JK
2320z 10/08/11 00 04.47N. 080 32.54E. WX Balloon #70 deployed TD
0219z 10/10/11 00 04.47N. 080 32.54E. Wx Balloon #71 Deployed GJ
0308z 10/10/11 00 04.47N. 080 32.54E. Microprofiler #16 Deployed GJ
0314z 10/10/11 00 04.47N. 080 32.54E. Microprofiler #16 Recovered GJ
0516z 10/10/11 00 04.46N. 080 32.54E. Wx Balloon #72 Deployed GJ
0605z 10/10/11 00 04.46N. 080 32.54E. Microprofiler #17 Deployed JK
0611z 10/10/11 00 04.47N. 080 32.54E. Microprofiler #17 Recovered JK
0705z 10/10/11 00 04.47N. 080 32.54E. CTD #7 Deployed JK
0708z 10/09/11 00 04.46N. 080 32.54E. Chameleon CTD Recovered JK
0713z 10/10/11 00 04.47N. 080 32.54E. CTD #7 @ 200m JK
0717z 10/09/11 00 04.47N. 080 32.54E. Chameleon CTD Deployed JK
0726z 10/09/11 00 04.47N. 080 32.54E. CTD #7 Recovered JK
0820z 10/10/11 00 04.47N. 080 32.54E. Wx Balloon #73 Deployed JK
0838z 10/10/11 00 04.47N. 080 32.54E. Drifter #82641 Deployed JK
0905z 10/10/11 00 04.47N. 080 32.54E. Microprofiler #18 Deployed JK
0911z 10/09/11 00 04.47N. 080 32.54E. Microprofiler #18 Recovered JK
1115z 10/10/11 00 04.47N. 080 32.54E. Wx Balloon #74 Deployed JK
1415z 10/10/11 00 04.47N. 080 32.54E. Wx Balloon #75 Deployed GJ
1718z 10/10/11 00 04.46N. 080 32.54E. Wx Balloon #76 Deployed GJ
2015z 10/10/11 00 04.46N. 080 32.54E. Wx Balloon #77 Deployed JK

2318z 10/10/11 00 04.46N. 080 32.54E. WX Balloon #78 deployed TD
0215z 10/11/11 00 04.46N. 080 32.54E. Wx Balloon #79 Deployed GJ
0306z 10/11/11 00 04.46N. 080 32.54E. Microprofiler #19 Deployed GJ
0310z 10/11/11 00 04.46N. 080 32.54E. Microprofiler #19 Recovered GJ
0516z 10/11/11 00 04.46N. 080 32.54E. Wx Balloon #80 Deployed GJ
0604z 10/11/11 00 04.46N. 080 32.54E. Microprofiler #20 Deployed JK
0610z 10/11/11 00 04.46N. 080 32.54E. Microprofiler #20 Recovered JK
0702z 10/11/11 00 04.46N. 080 32.54E. CTD #8 Deployed JK
0704z 10/11/11 00 04.46N. 080 32.54E. Chameleon CTD Recovered JK
0709z 10/11/11 00 04.46N. 080 32.54E. CTD #8 @ 200m JK
0717z 10/11/11 00 04.46N. 080 32.54E. CTD #8 Recovered JK
0727z 10/11/11 00 04.46N. 080 32.54E. Chameleon CTD Deployed JK
0820z 10/11/11 00 04.46N. 080 32.54E. Wx Balloon #81 Deployed JK
0904z 10/11/11 00 04.46N. 080 32.54E. Chameleon CTD Recovered JK
0905z 10/11/11 00 04.46N. 080 32.54E. Microprofiler #21 Deployed JK
0911z 10/11/11 00 04.46N. 080 32.54E. Microprofiler #21 Recovered JK
0933z 10/10/11 00 04.47N. 080 32.54E. Chameleon CTD Deployed JK
1115z 10/11/11 00 04.46N. 080 32.54E. Wx Balloon #82 Deployed JK
1417z 10/11/11 00 04.46N. 080 32.54E. Wx Balloon #83 Deployed GJ
1716z 10/11/11 00 04.46N. 080 32.54E. Wx Balloon #84 Deployed GJ
0218z 10/11/11 00 04.46N. 080 32.54E. Wx Balloon #85 Deployed JK
2319z 10/11/11 00 04.46N. 080 32.54E. WX ballon deployed TD
0216z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #87 Deployed GJ
0300z 10/12/11 00 04.46N. 080 32.54E. Micrprofiler #22 Deployed GJ
0305z 10/12/11 00 04.46N. 080 32.54E. Microprofiler #22 Recovered GJ
0516z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #88 Deployed GJ
0603z 10/12/11 00 04.46N. 080 32.54E. Microprofiler #23 Deployed JK
0607z 10/12/11 00 04.46N. 080 32.54E. Microprofiler #23 Recovered JK
0701z 10/12/11 00 04.46N. 080 32.54E. CTD #9 Deployed JK
0707z 10/12/11 00 04.46N. 080 32.54E. CTD #9 @ 200m JK
0715z 10/12/11 00 04.46N. 080 32.54E. CTD #9 Recovered JK
0815z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #89 Deployed JK
0904z 10/12/11 00 04.46N. 080 32.54E. Microprofiler #24 Deployed JK
1510z 10/11/11 00 04.46N. 080 32.54E. Microprofiler #24 Recovered JK
1115z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #90 Deployed JK
1200z 10/12/11 00 04.46N. 080 32.54E. CTD #10 deployed EW
1205z 10/12/11 00 04.46N. 080 32.54E. Chameleon CTD on deck EW
1213z 10/12/11 00 04.46N. 080 32.54E. CTD #10 at 200m EW
1222z 10/12/11 00 04.46N. 080 32.54E. CTD #10 on deck EW
1218z 10/12/11 00 04.46N. 080 32.54E. Chameloen deployed EW
1236z 10/12/11 00 04.46N. 080 32.54E. Chameleon on deck EW
1246Z 10/12/11 00 04.46N. 080 32.54E. Chameleon deployed EW
1416z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #91 Deployed GJ
1717z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #92 Deployed GJ
2018z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #93 Deployed JK
2323z 10/12/11 00 04.46N. 080 32.54E. WX Balloon #94 deployed TD
0216z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #95 Deployed GJ
0304z 10/13/11 00 04.46N. 080 32.54E. Microprofiler #25 Deployed GJ
0308z 10/13/11 00 04.46N. 080 32.54E. Microprofiler #25 Recovered GJ
0519z 10/12/11 00 04.46N. 080 32.54E. Wx Balloon #96 Deployed GJ
0606z 10/13/11 00 04.46N. 080 32.54E. Microprofiler #26 Deployed JK
0611z 10/13/11 00 04.46N. 080 32.54E. Microprofiler #26 Recovered JK
0700z 10/12/11 00 04.46N. 080 32.54E. CTD #11 Deployed JK
0708z 10/13/11 00 04.46N. 080 32.54E. CTD #11 @ 200m JK
0719z 10/13/11 00 04.46N. 080 32.54E. CTD #11 Recovered JK
0820z 10/13/11 00 04.46N. 080 32.54E. Wx Balloon #97 Deployed JK

0831z 10/13/11 00 04.46N. 080 32.54E. Drifter #82303 Deployed JK
0905z 10/13/11 00 04.46N. 080 32.54E. Microprofiler #27 Deployed JK
0911z 10/13/11 00 04.46N. 080 32.54E. Microprofiler #27 Recovered JK
1115z 10/13/11 00 04.46N. 080 32.54E. WX Balloon #98 deployed EW
1418z 10/13/11 00 04.46N. 080 32.54E. Wx Balloon #99 Deployed GJ
1715z 10/13/11 00 04.46N. 080 32.54E. Wx Balloon #100 Deployed GJ
2015z 10/13/11 00 04.46N. 080 32.54E. Wx Balloon #101 Deployed JK
2315z 10/13/11 00 04.46N. 080 32.54E. WX Balloon #102 deployed TD
0216z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #103 Deployed GJ
0309z 10/14/11 00 04.46N. 080 32.54E. Microprofiler #28 Deployed GJ
0315z 10/14/11 00 04.46N. 080 32.54E. Microprofiler #28 Recovered GJ
0517z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #104 Deployed GJ
0604z 10/14/11 00 04.46N. 080 32.54E. Microprofiler #29 Deployed JK
0609z 10/14/11 00 04.46N. 080 32.54E. Microprofiler $29 Recovered JK
0701z 10/14/11 00 04.46N. 080 32.54E. CTD #12 Deployed JK
0710z 10/14/11 00 04.46N. 080 32.54E. CTD #12 @ 200m JK
0722z 10/14/11 00 04.46N. 080 32.54E. CTD #12 Recovered JK
0817z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #105 Deployed JK
0849z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #106 Deployed JK
0907z 10/14/11 00 04.46N. 080 32.54E. Microprofiler #30 Deployed JK
0913z 10/14/11 00 04.46N. 080 32.54E. Microprofiler #30 Recovered JK
1115z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #107 Deployed GJ
1415z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #108 Deployed GJ
1716z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #109 Deployed GJ
2015z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #110 Deployed JK
2317z 10/14/11 00 04.46N. 080 32.54E. WX Balloon #111 deployed TD
0215z 10/15/11 00 04.46N. 080 32.54E. Wx Balloon #112 Deployed GJ
0309z 10/15/11 00 04.46N. 080 32.54E. Microprofiler #31 Deployed GJ
0315z 10/15/11 00 04.46N. 080 32.54E. Microprofiler #31 Recovered GJ
0517z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #113 Deployed GJ
0608z 10/15/11 00 04.46N. 080 32.54E. Microprofiler #32 Deployed JK
0613z 10/15/11 00 04.46N. 080 32.54E. Microprofiler #32 Recovered JK
0706z 10/15/11 00 04.46N. 080 32.54E. CTD #13 Deployed JK
0710z 10/15/11 00 04.46N. 080 32.54E. CTD #13 @ 200m JK
1317z 10/14/11 00 04.46N. 080 32.54E. CTD #13 Recovered JK
0815z 10/15/11 00 04.46N. 080 32.54E. Wx Balloon #114 Deployed JK
0903z 10/15/11 00 04.46N. 080 32.54E. Microprofiler #33 Deployed JK
0908z 10/15/11 00 04.46N. 080 32.54E. Microprofiler #33 Recovered JK
1117z 10/14/11 00 04.46N. 080 32.54E. Wx Balloon #115 Deployed GJ
1417z 10/15/11 00 04.46N. 080 32.54E. Wx Balloon #116 deployed GJ
1715z 10/15/11 00 04.46N. 080 32.54E. Wx Balloon #117 Deployed GJ
1829z 10/15/11 00 04.47N. 080 32.54E. Chameleon CTD Recovered JK
1858z 10/15/11 00 04.47N. 080 32.54E. Chameleon CTD Deployed JK
2015z 10/15/11 00 04.47N. 080 32.54E. Wx Balloon #118 Deployed JK
2320z 10/15/11 00 04.47N. 080 32.54E. WX Balloon #119 Deployed TD
0217z 10/16/11 00 04.46N. 080 32.54E. Wx Balloon #120 Deployed GJ
0515z 10/16/11 00 04.46N. 080 32.54E. Wx Balloon #121 Deployed GJ
0606z 10/16/11 00 04.47N. 080 32.54E. Microprofiler #35 Deployed JK
0610z 10/16/11 00 04.47N. 080 32.54E. Microprofiler #35 Recovered JK
0701z 10/16/11 00 04.47N. 080 32.54E. Chameleon CTD Recovered JK
0703z 10/16/11 00 04.47N. 080 32.54E. CTD #14 Deployed JK
0711z 10/16/11 00 04.47N. 080 32.54E. CTD #14 @ 200m JK
0718z 10/16/11 00 04.47N. 080 32.54E. Chameleon CTD Deployed JK
0722z 10/16/11 00 04.47N. 080 32.54E. CTD #14 Recovered JK
0815z 10/16/11 00 04.47N. 080 32.54E. Wx Balloon #122 Deployed JK
0831z 10/16/11 00 04.47N. 080 32.54E. Drifter #82339 Deployed JK

0908z 10/16/11 00 04.47N. 080 32.54E. Microprofiler #36 Deployed JK
0913z 10/16/11 00 04.47N. 080 32.54E. Microprofiler #36 Recovered JK 1
115z 10/16/11 00 04.47N. 080 32.54E. Wx Balloon #123 Deployed GJ
1250z 10/16/11 00 04.47N. 080 32.54E. Chameleon on deck EW
1335z 10/16/11 00 04.47N. 080 32.54E. Chameleon deployed EW
1416z 10/16/11 00 04.47N. 080 32.54E. Wx Balloon #124 Deployed GJ
1717z 10/16/11 00 04.46N. 080 32.54E. Wx Balloon #125 Deployed GJ
2015z 10/16/11 00 04.46N. 080 32.54E. Wx Balloon #126 Deployed JK
2318z 10/16/11 00 04.46N. 080 32.54E. WX Balloon #127 Deployed TD
0218z 10/17/11 00 04.46N. 080 32.54E. Wx Balloon #128 Deployed GJ
0304z 10/17/11 00 04.46N. 080 32.54E. Microprofiler #37 Deployed GJ
0309z 10/17/11 00 04.46N. 080 32.54E. Microprofiler #37 Recovered GJ
0515z 10/17/11 00 04.46N. 080 32.54E. Wx Balloon #129 Deployed GJ
0600z 10/17/11 00 04.46N. 080 32.54E. Microprofiler #38 Deployed JK
0606z 10/17/11 00 04.47N. 080 32.54E. Microprofiler #38 Recovered JK
0700z 10/17/11 00 04.47N. 080 32.54E. CTD #15 Deployed JK
0709z 10/17/11 00 04.47N. 080 32.54E. CTD #15 @ 200m JK
0720z 10/16/11 00 04.47N. 080 32.54E. CTD #15 Recovered JK
0817z 10/17/11 00 04.47N. 080 32.54E. Wx Balloon #130 Deployed JK
0907z 10/17/11 00 04.47N. 080 32.54E. Microprofiler #39 Deployed JK
0912z 10/17/11 00 04.47N. 080 32.54E. Microprofiler #39 Recovered JK
1115z 10/17/11 00 04.47N. 080 32.54E. Wx Balloon #131 Deployed GJ
1418z 10/17/11 00 04.47N. 080 32.54E. Wx Balloon #132 Deployed GJ
1716z 10/16/11 00 04.47N. 080 32.54E. Wx Balloon #133 Deployed GJ
2018z 10/16/11 00 04.47N. 080 32.54E. Wx Balloon #134 Deployed JK
2316z 10/16/11 00 04.46N. 080 32.54E. WX Balloon #135 deployed TD
0217z 10/18/11 00 04.47N. 080 32.54E. Wx Balloon #136 Deployed GJ
0300z 10/18/11 00 04.47N. 080 32.54E. Microprofiler #40 Deployed GJ
0305z 10/18/11 00 04.47N. 080 32.54E. Microprofiler #40 Recovered GJ
0517z 10/18/11 00 04.47N. 080 32.54E. Wx Balloon #137 Deployed GJ
0600z 10/18/11 00 04.47N. 080 32.54E. Microprofiler #41 Deployed JK
0605z 10/18/11 00 04.47N. 080 32.54E. Microprofiler #41 Recovered JK
0701z 10/18/11 00 04.47N. 080 32.54E. CTD #16 Deployed JK
0710z 10/18/11 00 04.47N. 080 32.54E. CTD #16 @ 200m JK
0720z 10/18/11 00 04.47N. 080 32.54E. CTD #16 Recovered JK
0817z 10/18/11 00 04.47N. 080 32.54E. Wx Balloon #138 Deployed JK
0906z 10/18/11 00 04.47N. 080 32.53E. Microprofiler #42 Deployed JK
10/18/11 00 04.47N. 080 32.54E. Microprofiler #42 Recovered JK
1115z 10/18/11 00 04.47N. 080 32.54E. Wx Balloon #139 Deployed GJ
1416z 10/18/11 00 04.47N. 080 32.54E. Wx Balloon #140 Deployed GJ
1717z 10/18/11 00 04.47N. 080 32.54E. Wx Balloon #141 Deployed GJ
1918z 10/17/11 00 04.47N. 080 32.54E. Chameleon CTD Recovered JK
2004z 10/18/11 00 04.47N. 080 32.54E. Chameleon CTD Deployed JK
2018z 10/18/11 00 04.47N. 080 32.54E. Wx Balloon #142 Deployed JK
2024z 10/18/11 00 04.47N. 080 32.54E. Chameleon CTD Recovered JK
2041z 10/18/11 00 04.47N. 080 32.54E. Chameleon CTD Deployed JK
2320z 10/18/11 00 04.46N. 080 32.54E. WX Balloon #143 deployed TD
0215z 10/19/11 00 04.47N. 080 32.54E. Wx Balloon #144 Deployed GJ
0218z 10/19/11 00 04.47N. 080 32.54E. CTD #17 Deployed GJ
0226z 10/19/11 00 04.46N. 080 32.54E. CTD #17 @ 200m GJ
0234z 10/19/11 00 04.47N. 080 32.54E. CTD #17 Recovered GJ
0304z 10/19/11 00 04.47N. 080 32.54E. Microprofiler #43 Deployed GJ
0309z 10/19/11 00 04.47N. 080 32.54E. Microprofiler #43 Recovered GJ
0517z 10/19/11 00 04.47N. 080 32.54E. Wx Balloon #145 deployed GJ
0603z 10/19/11 00 04.47N. 080 32.53E. Microprofiler #44 Deployed JK
0608z 10/19/11 00 04.48N. 080 32.53E. Microprofiler #44 Recovered JK

0701z 10/19/11 00 04.48N. 080 32.53E. CTD #18 Deployed JK
0709z 10/19/11 00 04.48N. 080 32.53E. CTD #18 @ 200m JK
0719z 10/19/11 00 04.48N. 080 32.53E. CTD #18 Recovered JK
0817z 10/19/11 00 04.47N. 080 32.54E. Wx Balloon #146 Deployed JK
0841z 10/19/11 00 04.47N. 080 32.53E. Drifter #82322 Deployed JK
0907z 10/19/11 00 04.47N. 080 32.54E. Microprofiler #45 Deployed JK
0912z 10/19/11 00 04.47N. 080 32.53E. Microprofiler #45 Recovered JK
1416z 10/19/11 00 04.47N. 080 32.54E. Wx Balloon #148 Deployed GJ
1715z 10/19/11 00 04.47N. 080 32.54E. Wx Balloon #149 Deployed GJ
2018z 10/19/11 00 04.47N. 080 32.54E. Wx Balloon #150 Deployed JK
2317z 10/18/11 00 04.47N. 080 32.54E. WX Balloon #151 deployed TD
0216z 10/20/11 00 04.47N. 080 32.54E. Wx Ballon #152 Deployed GJ
0303z 10/20/11 00 04.47N. 080 32.53E. Microprofiler #46 Deployed GJ
0307z 10/20/11 00 04.47N. 080 32.54E. Microprofiler #46 Recovered GJ
0519z 10/20/11 00 04.47N. 080 32.53E. Wx Balloon #153 Deployed GJ
0603z 10/20/11 00 04.47N. 080 32.54E. Microprofiler #47 Deployed JK
0608z 10/20/11 00 04.47N. 080 32.54E. Microprofiler #47 Recovered JK 0
704z 10/19/11 00 04.48N. 080 32.53E. CTD #19 Deployed JK
0712z 10/19/11 00 04.48N. 080 32.53E. CTD #19 @ 200m JK
0723z 10/19/11 00 04.48N. 080 32.53E. CTD #19 Recovered JK
0817z 10/20/11 00 04.46N. 080 32.54E. Wx Balloon #154 Deployed JK
0903z 10/20/11 00 04.47N. 080 32.54E. Microprofiler #48 Deployed JK
0908z 10/20/11 00 04.47N. 080 32.54E. Microprofiler #48 Recovered JK
0955z 10/20/11 00 04.46N. 080 32.53E. Chameleoln on deck EW
1010z 10/20/11 00 04.47N. 080 32.54E. Chameleon deployed EW
1023z 10/20/11 00 04.46N. 080 32.54E. CTD # 20 deployed EW
1031z 10/20/11 00 04.46N. 080 32.54E. CTD # 20 at 200m EW
1041z 10/20/11 00 04.47N. 080 32.54E. CTD # 20 on deck EW
1117z 10/20/11 00 04.47N. 080 32.54E. Wx Balloon #155 Deployed JK
1423z 10/19/11 00 04.47N. 080 32.54E. Wx Balloon #156 Deployed GJ
1603z 10/20/11 00 04.47N. 080 32.54E. CTD #21 Deployed GJ
1614z 10/20/11 00 04.47N. 080 32.54E. CTD #21 @ 200m GJ
1623z 10/20/11 00 04.47N. 080 32.53E. CTD #21 Recovered GJ
1716z 10/20/11 00 04.47N. 080 32.54E. Wx Balloon #157 Deployed GJ
2018z 10/19/11 00 04.47N. 080 32.54E. Wx Balloon #158 Deployed JK
2318z 10/19/11 00 04.47N. 080 32.54E. WX Balloon #159 deployed TD
0218z 10/20/11 00 04.47N. 080 32.54E. Wx Balloon #160 Deployed GJ
0306z 10/21/11 00 04.46N. 080 32.53E. Microprofiler #49 Deployed GJ
0311z 10/21/11 00 04.46N. 080 32.53E. Microprofiler #49 Recovered GJ
0517z 10/21/11 00 04.47N. 080 32.54E. Wx Balloon #161 Deployed GJ
0601z 10/21/11 00 04.47N. 080 32.53E. Microprofiler #50 Deployed JK
0606z 10/21/11 00 04.47N. 080 32.54E. Microprofiler #50 Recovered JK
0702z 10/21/11 00 04.47N. 080 32.54E. CTD #22 Deployed JK
0710z 10/21/11 00 04.47N. 080 32.54E. CTD #22 @ 200m JK
0719z 10/21/11 00 04.47N. 080 32.54E. CTD #22 Recovered JK
0815z 10/21/11 00 04.46N. 080 32.53E. Wx Balloon #162 Deployed JK
0859z 10/21/11 00 04.46N. 080 32.53E. Microprofiler #51 Deployed JK
0904z 10/21/11 00 04.46N. 080 32.53E. Microprofiler #51 Recovered JK
0940z 10/21/11 00 04.46N. 080 32.53E. T-Chain Recovered JK
1049z 10/20/11 00 04.47N. 080 32.53E. T-Chain Deployed EW
1114z 10/21/11 00 04.46N. 080 32.53E. Wx Balloon #163 Deployed JK
1417z 10/21/11 00 04.46N. 080 32.54E. Wx Balloon #164 Deployed GJ
1603z 10/21/11 00 04.47N. 080 32.54E. CTD #23 Deployed GJ
1612z 10/21/11 00 04.47N. 080 32.53E. CTD #23 @ 200m GJ
1622z 10/21/11 00 04.47N. 080 32.54E. CTD #23 Recovered GJ
1718z 10/21/11 00 04.47N. 080 32.54E. Wx Balloon #165 Deployed GJ

2018z 10/21/11 00 04.46N. 080 32.53E. Wx Balloon #166 Deployed JK
2317z 10/20/11 00 04.47N. 080 32.54E. WX Balloon #167 deployed TD
0217z 10/22/11 00 04.46N. 080 32.53E. Wx Balloon #168 Deployed GJ
0305z 10/22/11 00 04.46N. 080 32.53E. Microprofiler #52 Deployed GJ
0310z 10/22/11 00 04.46N. 080 32.53E. Microprofiler #52 Recovered GJ
0518z 10/22/11 00 04.46N. 080 32.53E. Wx Balloon #169 Deployed GJ
0602z 10/22/11 00 04.46N. 080 32.53E. Microprofiler #53 Deployed JK
0608z 10/22/11 00 04.46N. 080 32.53E. Microprofiler #53 Recovered JK
0701z 10/22/11 00 04.46N. 080 32.53E. CTD #24 Deployed JK
0710z 10/21/11 00 04.47N. 080 32.54E. CTD #24 @ 200m JK
0719z 10/22/11 00 04.46N. 080 32.53E. CTD #24 Recovered JK
0817z 10/22/11 00 04.46N. 080 32.53E. Wx Balloon #170 Deployed JK
0838z 10/22/11 00 04.46N. 080 32.53E. Drifter #82643 Deployed JK
0903z 10/22/11 00 04.46N. 080 32.53E. Microprofiler #54 Deployed JK
0908z 10/22/11 00 04.46N. 080 32.53E. Microprofiler #54 Recovered JK
1117z 10/22/11 00 04.46N. 080 32.53E. Wx Balloon #171 Deployed JK
1415z 10/22/11 00 04.46N. 080 32.53E. Wx Balloon #172 Deployed GJ
1606z 10/22/11 00 04.46N. 080 32.53E. CTD #25 Deployed GJ
1616z 10/22/11 00 04.46N. 080 32.53E. CTD #25 @ 220m GJ
1632z 10/22/11 00 04.46N. 080 32.54E. CTD #25 Recovered GJ
1715z 10/22/11 00 04.46N. 080 32.54E. Wx Balloon #173 Deployed GJ
2015z 10/22/11 00 04.46N. 080 32.54E. Wx Balloon #174 Deployed JK
2316z 10/21/11 00 04.47N. 080 32.54E. WX Balloon #175 Deployed TD
0145z 10/23/11 00 04.46N. 080 32.53E. Chameleon CTD Recovered GJ
0223z 10/23/11 00 04.29N. 080 32.69E. Wx Balloon #176 Deployed GJ
0230z 10/23/11 00 04.29N. 080 32.69E. Chameleon CTD Deployed GJ
0302z 10/23/11 00 04.29N. 080 32.69E. Microprofiler #55 Deployed GJ
0303z 10/23/11 00 04.29N. 080 32.69E. Chameleon CTD Recovered GJ
0306z 10/23/11 00 04.29N. 080 32.69E. Microprofiler #55 Recovered GJ
0315z 10/23/11 00 04.29N. 080 32.69E. Chameleon CTD Deployed GJ
0515z 10/23/11 00 04.29N. 080 32.69E. Wx Balloon #177 Deployed GJ
0602z 10/23/11 00 04.29N. 080 32.69E. Microprofiler #56 Deployed JK
0607z 10/23/11 00 04.29N. 080 32.69E. Microprofiler #56 Recovered JK
0658z 10/22/11 00 04.46N. 080 32.54E. Chameleon CTD Recovered JK
0701z 10/23/11 00 04.29N. 080 32.69E. CTD #26 Deployed JK
0706z 10/23/11 00 04.29N. 080 32.69E. CTD #26 @ 220m JK
0707z 10/22/11 00 04.46N. 080 32.53E. Chameleon CTD Deployed JK
0713z 10/23/11 00 04.29N. 080 32.69E. CTD #26 Recovered JK
0815z 10/23/11 00 04.29N. 080 32.69E. Wx Balloon # 178 Deployed JK
0905z 10/23/11 00 04.29N. 080 32.69E. Microprofiler #57 Deployed JK
0909z 10/23/11 00 04.29N. 080 32.69E. Microprofiler #57 Recovered JK
1115z 10/23/11 00 04.29N. 080 32.69E. Wx Balloon #179 Deployed JK
1415z 10/23/11 00 04.29N. 080 32.69E. Wx Balloon #180 Deployed GJ
1603z 10/23/11 00 04.29N. 080 32.69E. CTD #27 Deployed GJ
1613z 10/23/11 00 04.29N. 080 32.69E. CTD #27 @ 220m GJ
1622z 10/23/11 00 04.29N. 080 32.69E. CTD #27 Recovered GJ
1715z 10/23/11 00 04.29N. 080 32.69E. Wx Balloon #181 Deployed GJ
2015z 10/23/11 00 04.29N. 080 32.69E. Wx Balloon #182 Deployed JK
2315z 10/22/11 00 04.47N. 080 32.54E. WX Balloon #183 Deployed TD
0215z 10/24/11 00 04.29N. 080 32.69E. Wx Balloon #184 Deployed GJ
0301z 10/24/11 00 04.29N. 080 32.69E. Microprofiler #58 Deployed GJ
0305z 10/24/11 00 04.29N. 080 32.69E. Microprofiler #58 Recovered GJ
0517z 10/24/11 00 04.29N. 080 32.69E. Wx Balloon #185 Deployed GJ
0604z 10/24/11 00 04.29N. 080 32.69E. Microprofiler #59 Deployed JK
0608z 10/24/11 00 04.29N. 080 32.69E. Microprofiler #59 Recovered JK
0705z 10/24/11 00 04.29N. 080 32.69E. CTD #28 Deployed JK

0714z 10/24/11 00 04.29N. 080 32.69E. CTD #28 @ 220m JK
0724z 10/24/11 00 04.29N. 080 32.69E. CTD #28 Recovered JK
0815z 10/23/11 00 04.29N. 080 32.69E. Wx Balloon #186 Deployed JK
0904z 10/24/11 00 04.29N. 080 32.69E. Microprofiler #60 Deployed JK
0909z 10/24/11 00 04.29N. 080 32.69E. Microprofiler #60 Recovered JK
1115z 10/24/11 00 04.29N. 080 32.69E. Wx Balloon #187 Deployed GJ
1416z 10/24/11 00 04.29N. 080 32.69E. Wx Balloon #188 Deployed GJ
1603z 10/24/11 00 04.29N. 080 32.69E. CTD #29 Deployed GJ
1609z 10/24/11 00 04.29N. 080 32.69E. CTD #29 @ 220m GJ
1619z 10/24/11 00 04.29N. 080 32.69E. CTD #29 Recovered GJ
1716z 10/24/11 00 04.29N. 080 32.69E. Wx Balloon #189 Deployed GJ
2315z 10/23/11 00 04.29N. 080 32.69E. WX Balloon #191 Deployed TD
0215z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #192 Deployed GJ
0307z 10/25/11 00 04.29N. 080 32.70E. Microprofiler #61 Deployed GJ
0311z 10/25/11 00 04.29N. 080 32.70E. Microprofiler #61 Recovered GJ
0515z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #193 Deployed GJ
0603z 10/25/11 00 04.29N. 080 32.70E. Microprofiler #62 Deployed JK
0608z 10/25/11 00 04.29N. 080 32.70E. Microprofiler #62 Recovered JK
0703z 10/25/11 00 04.29N. 080 32.70E. CTD #30 Deployed JK
0712z 10/24/11 00 04.29N. 080 32.69E. CTD #30 @ 220m JK
0722z 10/24/11 00 04.29N. 080 32.69E. CTD #30 Recovered JK
0816z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #194 Deployed JK
0834z 10/25/11 00 04.29N. 080 32.70E. Drifter #82587 Deployed JK
0906z 10/25/11 00 04.29N. 080 32.70E. Microprofiler #63 Deployed JK
0911z 10/25/11 00 04.29N. 080 32.70E. Microprofiler #63 Recovered JK
1115z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #195 Deployed GJ
1420z 10/24/11 00 04.29N. 080 32.69E. Wx Balloon #196 Deployed GJ
1602z 10/25/11 00 04.29N. 080 32.70E. CTD #31 Deployed GJ
1611z 10/25/11 00 04.29N. 080 32.70E. CTD #31 @ 220m GJ
1619z 10/25/11 00 04.29N. 080 32.70E. CTD #31 Recovered GJ
1715z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #197 Deployed GJ
2025z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #198 Deployed JK
2319z 10/25/11 00 04.29N. 080 32.70E. WX Balloon #199 deployed TD
2216z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #200 Deployed GJ
0300z 10/26/11 00 04.29N. 080 32.70E. Microprofiler #64 Deployed GJ
0904z 10/25/11 00 04.29N. 080 32.70E. Microprofiler #64 Recovered GJ
0515z 10/26/11 00 04.29N. 080 32.70E. Wx Balloon #201 Deployed GJ
0604z 10/26/11 00 04.29N. 080 32.70E. Microprofiler #65 Deployed JK
0609z 10/26/11 00 04.29N. 080 32.70E. Microprofiler #65 Recovered JK
0703z 10/26/11 00 04.29N. 080 32.70E. CTD #31 Deployed JK
0708z 10/26/11 00 04.29N. 080 32.70E. CTD #31 @ 220m JK
0714z 10/26/11 00 04.29N. 080 32.70E. CTD #31 Recovered JK
0816z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #202 Deployed JK
0859z 10/26/11 00 04.29N. 080 32.70E. Microprofiler #66 Deployed JK
0904z 10/26/11 00 04.29N. 080 32.70E. Microprofiler #66 Recovered JK
1115z 10/26/11 00 04.29N. 080 32.70E. Wx Balloon #203 Deployed GJ
1417z 10/26/11 00 04.26N. 080 32.69E. Wx Balloon #204 Deployed GJ
1603z 10/26/11 00 04.26N. 080 32.69E. CTD #33 Deployed GJ
1610z 10/26/11 00 04.26N. 080 32.69E. CTD #33 @ 220m GJ
1618z 10/26/11 00 04.26N. 080 32.69E. CTD #33 Recovered GJ
1715z 10/26/11 00 04.26N. 080 32.69E. Wx Balloon #205 Deployed GJ
2018z 10/25/11 00 04.29N. 080 32.70E. Wx Balloon #206 Deployed JK
2319z 10/25/11 00 04.29N. 080 32.70E. WX Balloon #207 deployed TD
0215z 10/27/11 00 04.27N. 080 32.69E. Wx Balloon #208 Deployed GJ
0304z 10/27/11 00 04.27N. 080 32.69E. Microprofiler #67 Deployed GJ
0309z 10/27/11 00 04.27N. 080 32.69E. Microprofiler #67 Recovered GJ

0515z 10/27/11 00 04.27N. 080 32.69E. Wx Balloon #209 Deployed GJ
0602z 10/27/11 00 04.27N. 080 32.69E. Microprofiler #68 Deployed JK
0608z 10/27/11 00 04.27N. 080 32.69E. Microprofiler #68 Recovered JK
0701z 10/27/11 00 04.27N. 080 32.69E. CTD #34 Deployed JK
0707z 10/27/11 00 04.27N. 080 32.69E. CTD #34 @ 220m JK
0713z 10/27/11 00 04.27N. 080 32.69E. CTD #34 Recovered JK
0816z 10/27/11 00 04.27N. 080 32.69E. Wx Balloon #210 Deployed JK
0905z 10/27/11 00 04.27N. 080 32.69E. Microprofiler #69 Deployed JK
0910z 10/27/11 00 04.27N. 080 32.69E. Microprofiler #69 Recovered JK
1115z 10/27/11 00 04.27N. 080 32.69E. Wx Balloon #211 Deployed GJ
1415z 10/27/11 00 04.26N. 080 32.69E. Wx Balloon #212 Deployed GJ
1602z 10/27/11 00 04.26N. 080 32.69E. CTD #35 Deployed GJ
1610z 10/27/11 00 04.26N. 080 32.69E. CTD #35 @ 220m GJ
1618z 10/27/11 00 04.26N. 080 32.69E. CTD #35 Recovered GJ
1718z 10/27/11 00 04.26N. 080 32.69E. Wx Balloon #213 Deployed GJ
2020z 10/27/11 00 04.26N. 080 32.69E. Wx Balloon #214 Deployed JK
2320z 10/27/11 00 04.27N. 080 32.69E. WX Balloon #215 deployed TD
0219z 10/28/11 00 04.26N. 080 32.70E. CTD #36 Deployed GJ
0225z 10/28/11 00 04.26N. 080 32.70E. Chameleon Recovered GJ
0243z 10/28/11 00 04.26N. 080 32.69E. Pipestring Recovered GJ
0244z 10/28/11 00 04.26N. 080 32.69E. CTD #36 @ 1000m GJ
0308z 10/28/11 00 04.26N. 080 32.69E. CTD #36 Recovered GJ
0314z 10/28/11 00 04.26N. 080 32.69E. Wx Balloon #217 Deployed GJ
0338z 10/28/11 00 04.26N. 080 32.70E. T-Chain Recovered GJ
0517z 10/28/11 00 10.49N. 080 38.68E. Wx Balloon #218 Deployed GJ
0802z 10/28/11 00 00.95N. 080 43.92E. Chameleon CTD Deployed JK
0817z 10/28/11 00 01.05N. 080 43.76E. Wx Balloon #219 Deployed JK
0851z 10/28/11 00 01.33N. 080 43.27E. Chameleon CTD Recovered JK
1255z 10/28/11 00 01.14N. 080 50.75E. Chameloen deployed EW
1500z 10/28/11 00 01.14N. 080 49.02E. Chameleon Recovered GJ
1115z 10/28/11 00 01.69N. 080 47.94E. Wx Balloon #220 Deployed GJ
1416z 10/28/11 00 01.15N. 080 50.09E. Wx Balloon #221 Deployed GJ
1503z 10/28/11 00 01.14N. 080 49.02E. CTD #37 Deployed GJ
1513z 10/28/11 00 01.14N. 080 49.02E. Drifter#82320 Deployed GJ
1518z 10/28/11 00 01.14N. 080 49.02E. CTD @ 300m GJ
1528z 10/28/11 00 01.14N. 080 49.02E. CTD #37 Recovered GJ
1716z 10/28/11 00 01.24N. 081 02.70E. Wx Balloon #222 Deployed GJ
2018z 10/28/11 00 17.03N. 081 40.48E. Wx Balloon #223 Deployed JK
2317z 10/27/11 00 04.27N. 080 32.69E. WX Balloon #224 deployed TD
0215z 10/29/11 00 52.62N. 083 02.64E. Wx Balloon #225 Deployed GJ
0348z 10/29/11 01 01.59N. 083 23.36E. XBT Deployed GJ
0517z 10/29/11 01 10.20N. 083 43.23E. Wx Balloon #226 Deployed GJ
0815z 10/29/11 01 27.41N. 084 22.87E. Wx Balloon #227 Deployed JK
1115z 10/29/11 01 48.95N. 084 59.22E. Wx Balloon #227 Deployed JK
1416z 10/29/11 02 06.66N. 085 37.93E. Wx Balloon #229 Deployed GJ
1717z 10/29/11 02 24.77N. 086 17.53E. Wx Balloon #230 Deployed GJ
2020z 10/29/11 02 42.92N. 086 57.23E. Wx Balloon #231 Deployed JK
2315z 10/29/11 03 00.64N. 087 35.97E. WX Balloon #232 deployed TD
0217z 10/30/11 03 19.03N. 088 16.21E. Wx Balloon #233 Deployed GJ
0515z 10/30/11 03 36.87N. 088 55.26E. Wx Balloon #234 Deployed GJ
1115z 10/30/11 04 13.19N. 090 14.80E. Wx Balloon #235 Deployed JK
1416z 10/30/11 04 31.12N. 090 54.10E. Wx Balloon #236 Deployed GJ