ITP 6 Overview

Deployment Location: 9/4/2006, 10:00 UTC at 77° 53.6' N, 140° 25.2' W

Last Location: 10/11/2009, 23:13 UTC at 84° 2.7' N, 58° 55.3' W

Duration: 1133 days

Distance Travelled: 7202 km

Number of profiles: 1335 in 844 days

Other instruments: IMB 2006-C, AOFB 10

ITP 6 was deployed on a 3.1 m thick ice floe in the Beaufort Sea as part of the Beaufort Gyre Observing System (BGOS) during the JWACS 2006 cruise on the CCGS Louis S. St. Laurent. On the same ice floe, a US Army Cold Regions Research and Engineering Laboratory (CRREL) Ice Mass Balance Buoy (IMB 2006-C) and a Naval Postgraduate School Arctic Ocean Flux Buoy (AOFB 10) were also installed. The ITP was additionally equipped with a dissolved oxygen sensor (SBE 43-F) and operated on a standard sampling schedule of 2 one-way profiles between 9 and 760 m depth each day. No GPS locations (or satellite data transmissions) were obtained by the ITP from September 13 to November 10, 2007, and from January 22 to September 15, 2008, so hourly averaged Argos locations from the nearby IMB are used for those periods. Also, no GPS locations (or satellite transmissions) were obtained from May 23, 2009, to September 23, 2009 (after the profiler ceased operating). Presumably the ITP surface package was buried under sea ice during these periods.

ITP 6 Deployment Operations

The Arctic scientific community has coined the acronym Ice-Based Observatory (or IBO) to signify a cluster of ice-tethered measuring devices deployed and drifting with sea ice to monitor numerous environmental properties in the air, ice, and ocean (see IBO workshop report). IBOs are just one of the technologies that are contributing to the Arctic Observing Network to provide environmental data from this remote region for scientific and operational purposes. An array of IBOs would observe the weather of the ocean for operational purposes and provide unique valuable climate data.

On this Labor Day holiday in Canada and the US, an IBO consisting of an ITP, an Ice Mass Balance buoy (IMB), and an Arctic Ocean Flux Buoy (AOFB) was deployed in the traditional center of the Beaufort Gyre with a ring of six GPS (Global Positioning System) drifters in a 10 mile radius around the site to study ice deformation. The IMB measures the temperature profile through the ice, ice thickness, snow depth, air temperature and barometric pressure. Generally speaking, the data determines "mass balance" from the difference in the growth and ablation (melt) rates at the top and bottom of the ice floe. The AOFB measures the flux of the heat to the bottom of the ice floe from the perspective of the upper ocean immediately below the ice floe.

The ITP measures the seawater properties to a depth of 750 m. All of these systems are designed to last for several years (or as long as the ice allows). Combined, this IBO provides time series of profiles of the near surface atmosphere, ice, and seawater in all seasons while drifting with the sea ice. These data are transmitted via satellites in near real time to our laboratories and are being shared amongst the scientific community to better understand the mechanisms regulating the Arctic climate.

Helicopter operations began after breakfast with a helicopter reconnaissance for an appropriate ice floe to accommodate the needs of all three buoys. A 3 m thick (10 ft) relatively flat ice floe with old ridges around the edges was selected. In addition to the WHOI mooring team, Mike Dempsey (Oceanetic Measurement), Gary Morgan, Bill May, and Joe Illasiak participated on the deployments. Numerous 10", 4" and 2" diameter holes were bored through the ice to deploy the buoys. A tripod was set up to provide the mechanical advantage needed to manipulate the ITP and AOFB buoys, while the IMB could be installed by hand. The AOFB was operational first, then there was a short break for box lunches provided by the galley, then the IMB was completed, and finally the ITP was in place. While the work site was tidied and the ice party transported back to the ship, Jennifer Hutchings and Pat McKeown arrived to install a radar reflector near the buoy array.

ITP 6 Data Processing

The 1335 profiles that were transmitted from the ITP were processed according to the procedures described in the ITP Updated Data Processing Procedures. Beginning with ITP 6 several new processing procedures were implemented to refine the output product and to handle the added information provided by the dissolved oxygen sensor (when incorporated on CTD sensor package). The processing scheme for the oxygen parallels the processing of the salinity data, including a calibration procedure to tie deep oxygen values to climatological values to remove profile-to-profile variations.

During the first year, the ITP returned predominantly uncontaminated full profiles of temperature, conductivity and oxygen (although the oxygen data contained numerous spikes throughout). During the second year, instances when the profiler could not climb, or reversed and retried were common. Over 98% of the profiles ranged greater than 500 m vertically, but 5% less were able to profile more than 700 m. Most stoppages occurred near the top of up profiles between 600 and 1000 (while the surface buoy was pushed under the ice) and at the end of the record after 1200 until the battery expired on profile 1335. Profiles 528 and 1059 did not arrive with profiler engineering data (no timecode). A comparable number of bad points due to suspected biofouling or sensor icing are removed as in previous ITPs, however slightly more (over 1%) were completely corrupted (profiles 927 through 940) so were eliminated from the final data. An extensive amount of effort was applied to manually remove bad data in the dissolved oxygen measurements, which included a substantial number of spikes, perhaps due to a greater sensitivity to fouling. The final product still includes some sensor noise, and there is no useful dissolved oxygen data after profile 969.

ITP 6 Data Description

The ITP profiler was configured to operate on a standard burst sampling schedule of 2 one-way profiles between 9 and 760 m depth each day at 0000 and 0600 UTC. The times were chosen so as to avoid aliasing any tidal signals. GPS locations and buoy temperature and battery voltage status were recorded every hour in the surface package.

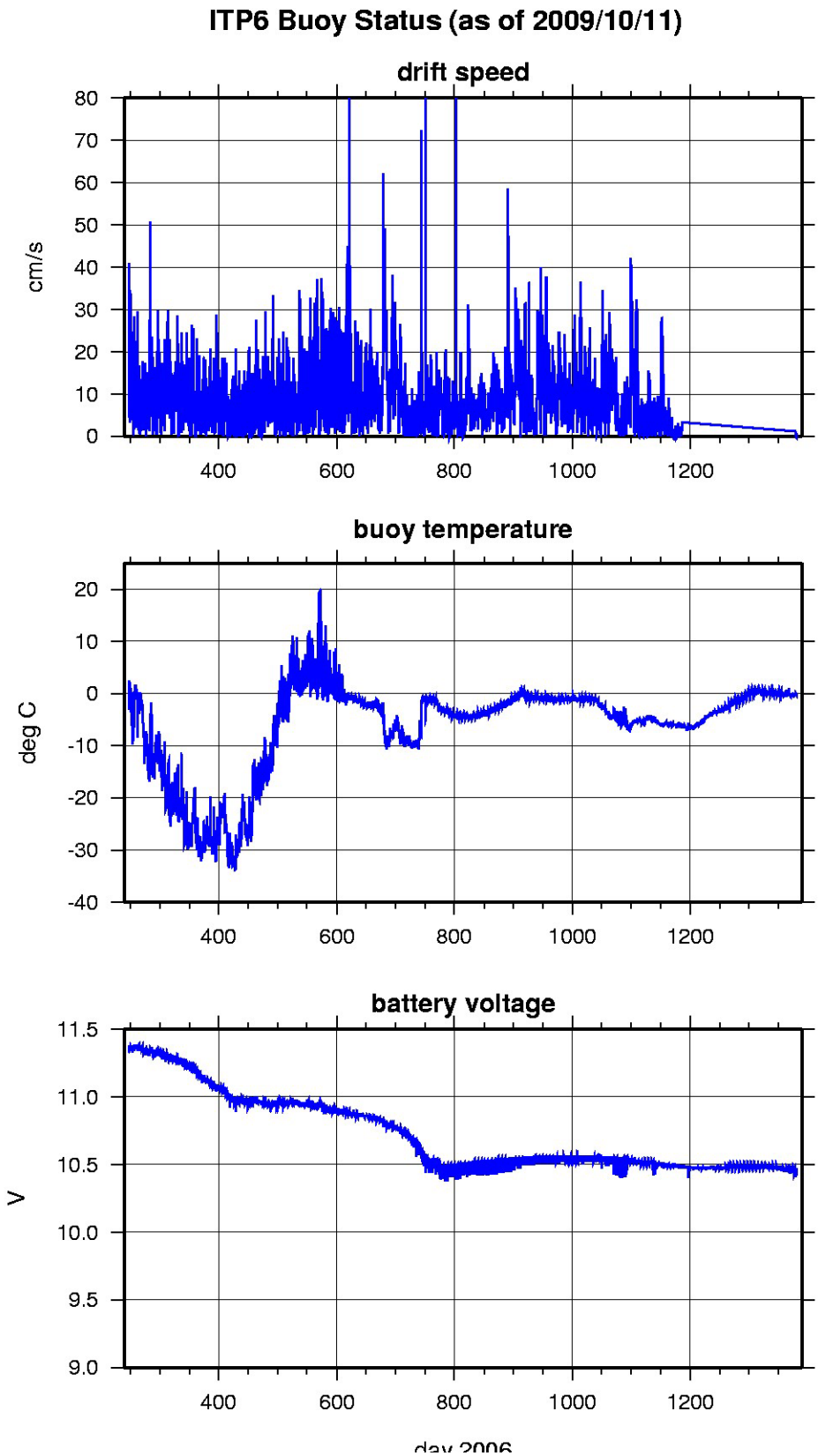
During the first year, the ITP generally drifted southward in the center of the anticyclonic circulation center of the Beaufort Gyre, then ceased communications (presumably ridged under the icefloe) for 2 months in 2007 and 8 months in 2008 (where cotemporaneous IMB locations are used for the ITP). Stored data for profiles acquired during these periods were recovered when the surface buoy resurfaced, after drifting north and eventually west toward the Canadian Archipelago. The profiler ceased operating in July 2008 and communications with the surface package ceased for good in October 2009 about 100 m north of Ellsmere Island over the continental slope.

The temperature and salinity data acquired by the system are obtained entirely within the thermohaline staircase region. They highlight the evolution of the near-surface temperature maximum layer and are largely absent of eddies. The dissolved oxygen dataset is the first of its kind, covering over an entire annual cycle unattended beneath the Arctic ice pack with high vertical resolution.

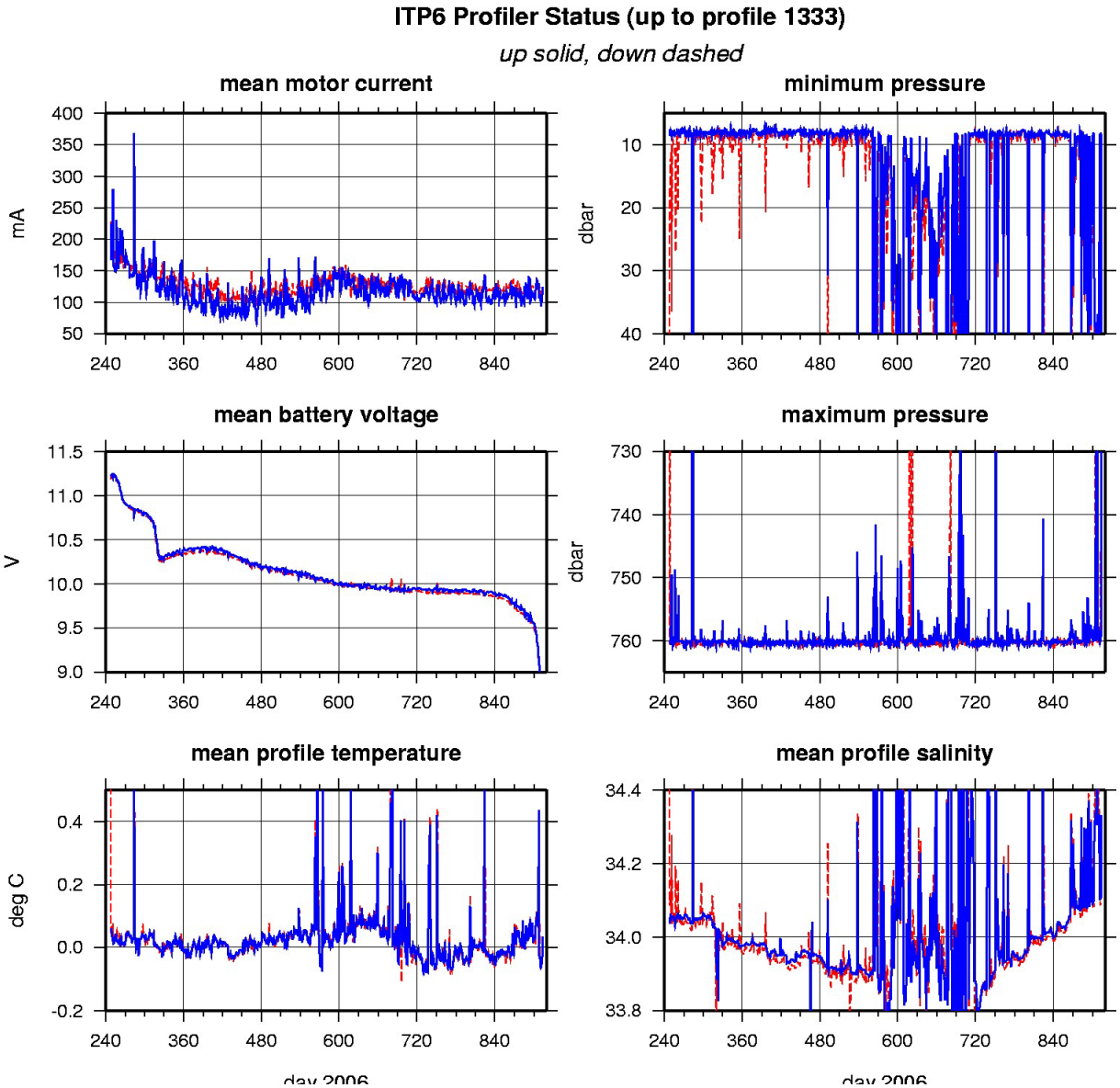
Level II hourly buoy location data in ASCII format: itp6rawlocs.dat

Level III 1-Hz processed profile data in MATLAB format: itp6cormat.tar.Z or itp6cormat.zip

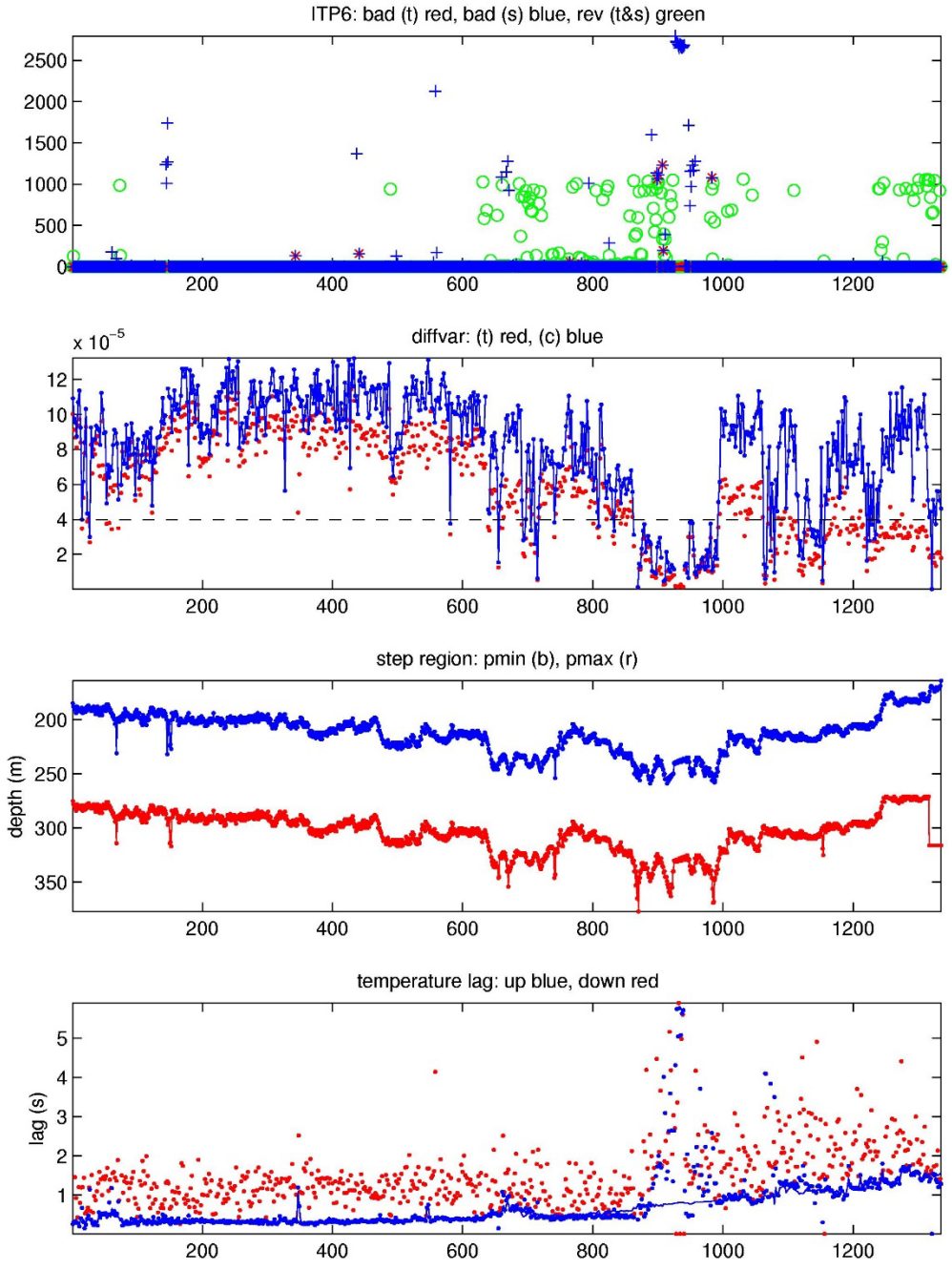
Level III 1-db bin-averaged processed profile data in MATLAB format: itp6final.mat
Level III 1-db bin-averaged processed profile data in ASCII
format: itp6final.tar.Z or itp6final.zip



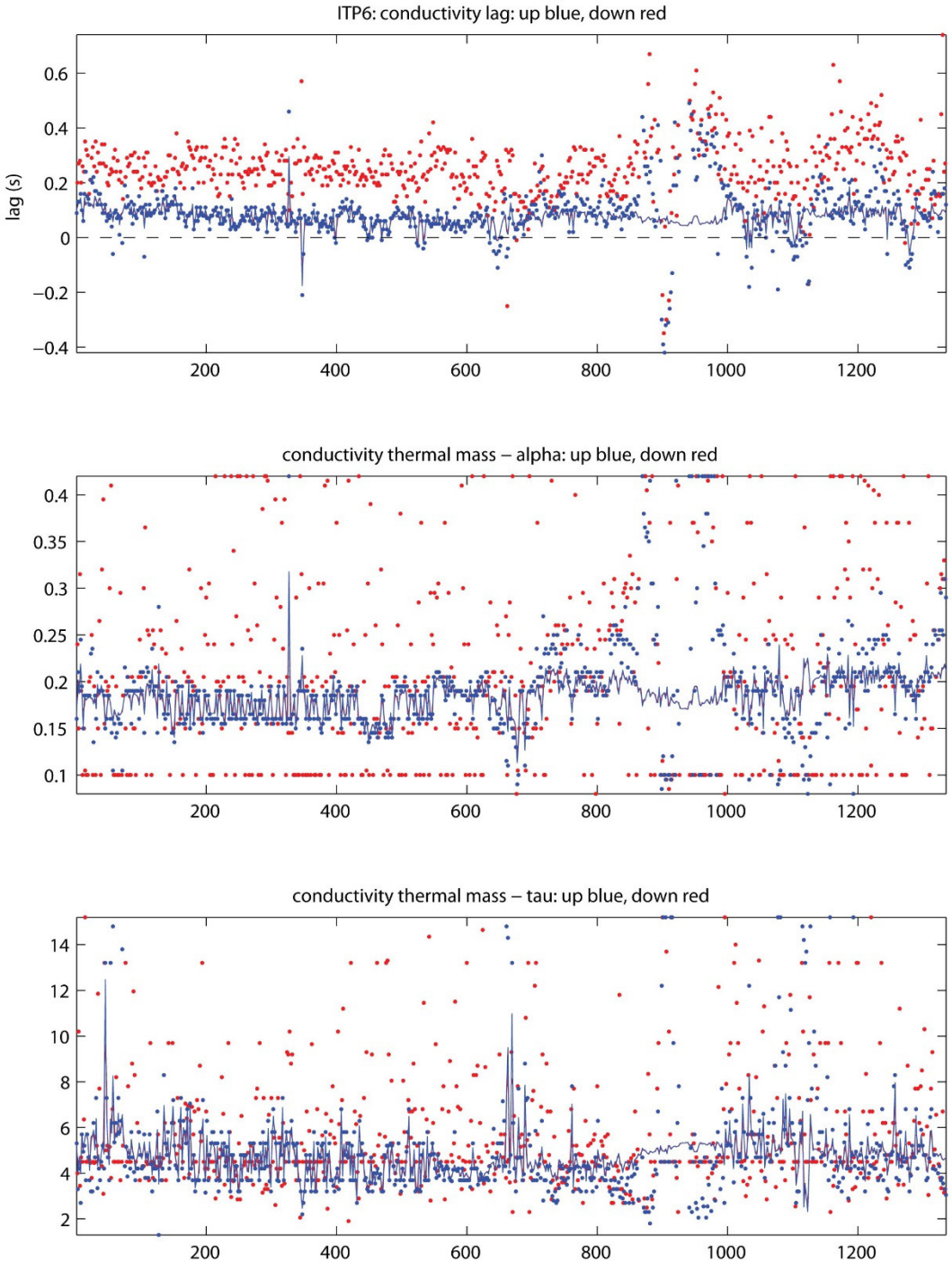
ITP surface buoy status



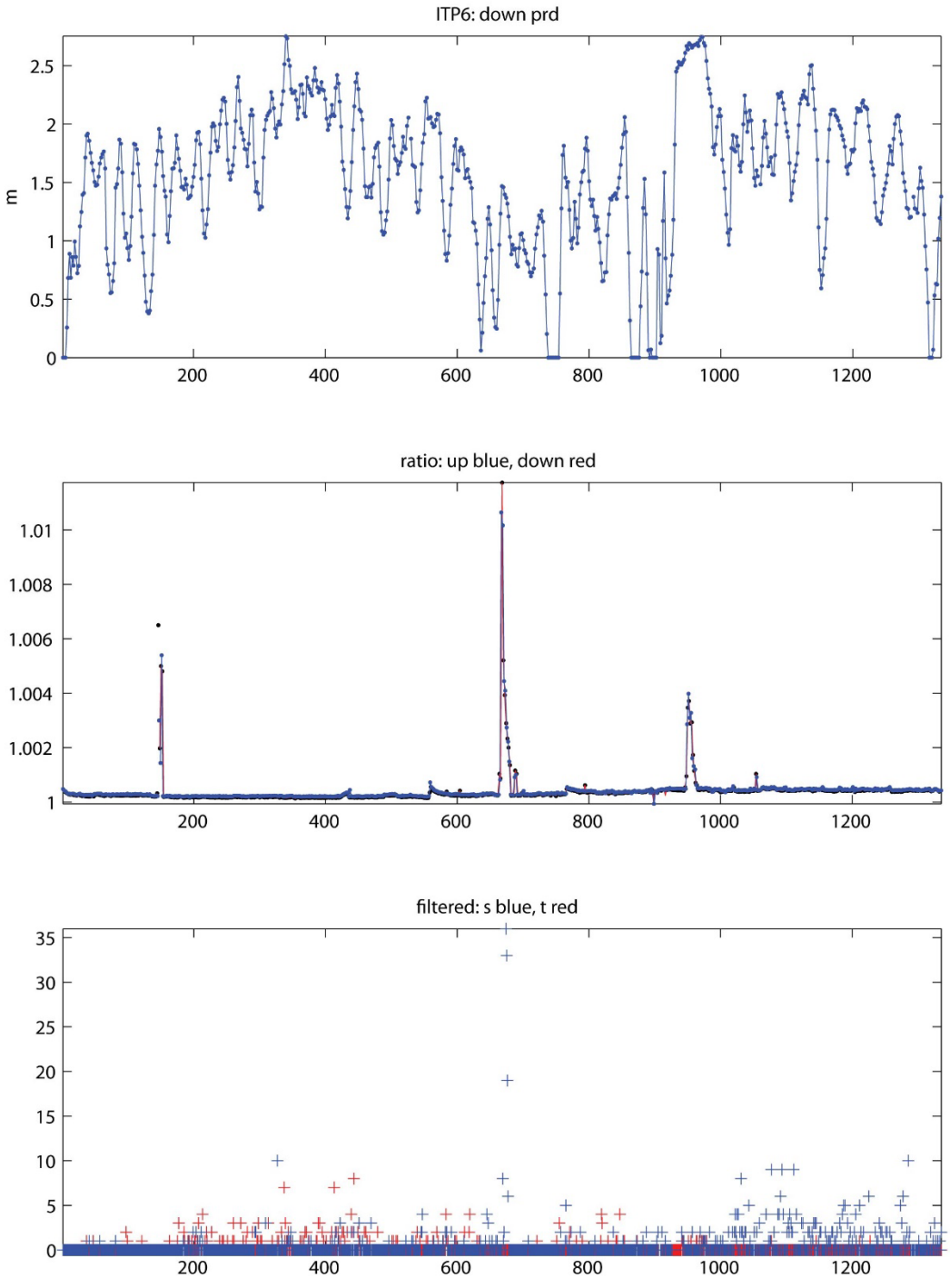
ITP profiler engineering data



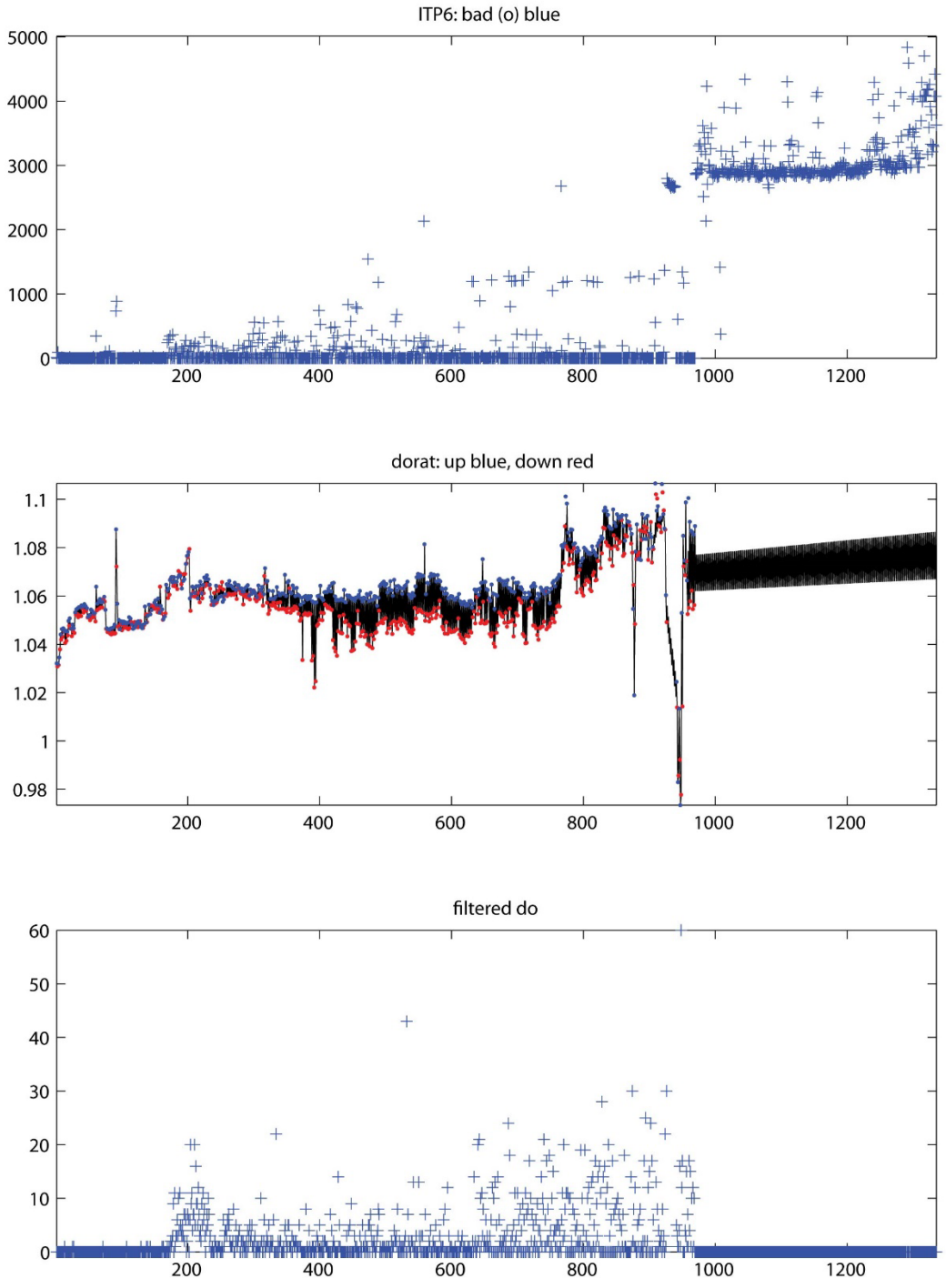
Number of bad points removed (top); variance of vertical difference of temperature and salinity in step region for up-going profiles; depth of staircase layer; temperature lag (bottom).



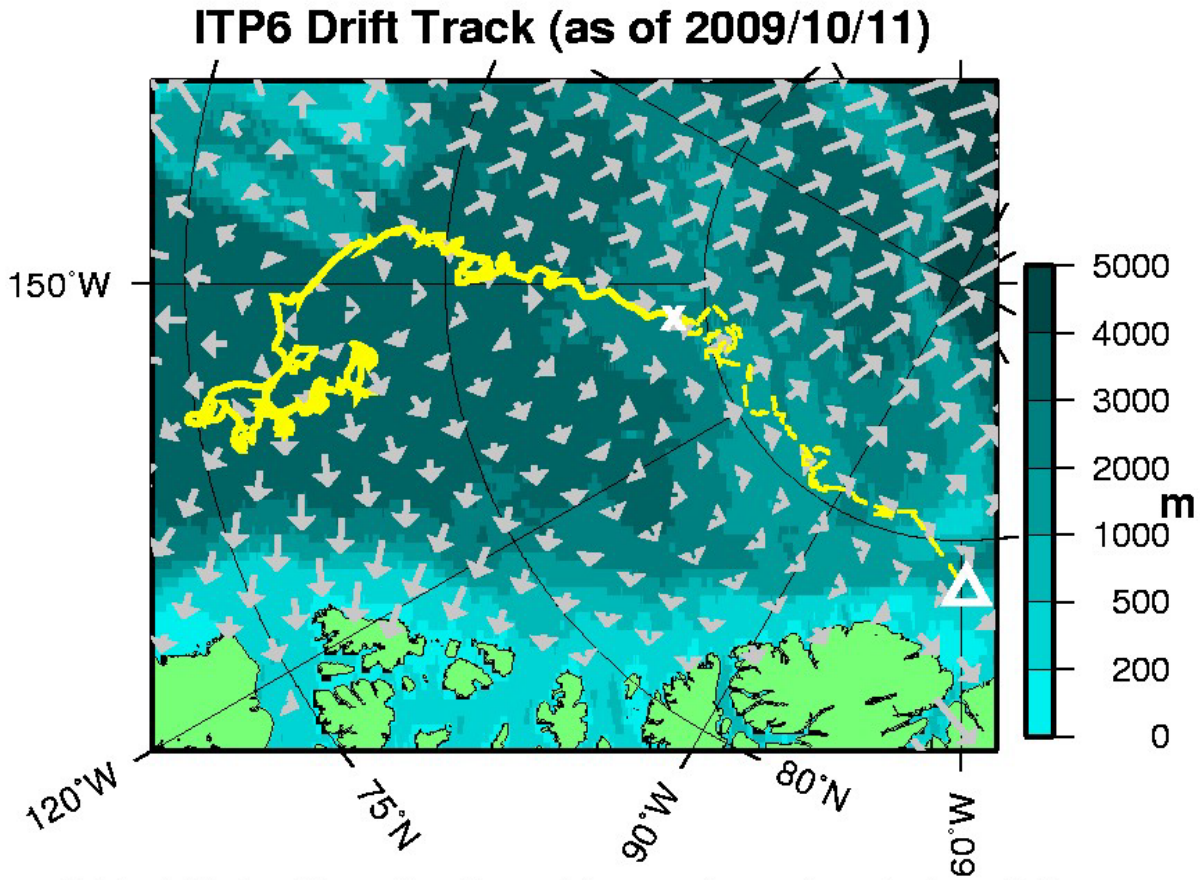
Top: conductivity lag, Middle: conductivity thermal mass amplitude correction, Bottom: conductivity thermal mass lag correction.



Top: down pressure deviation correction, Middle: salinity ratio adjustment, Bottom: Number of filtered spikes.

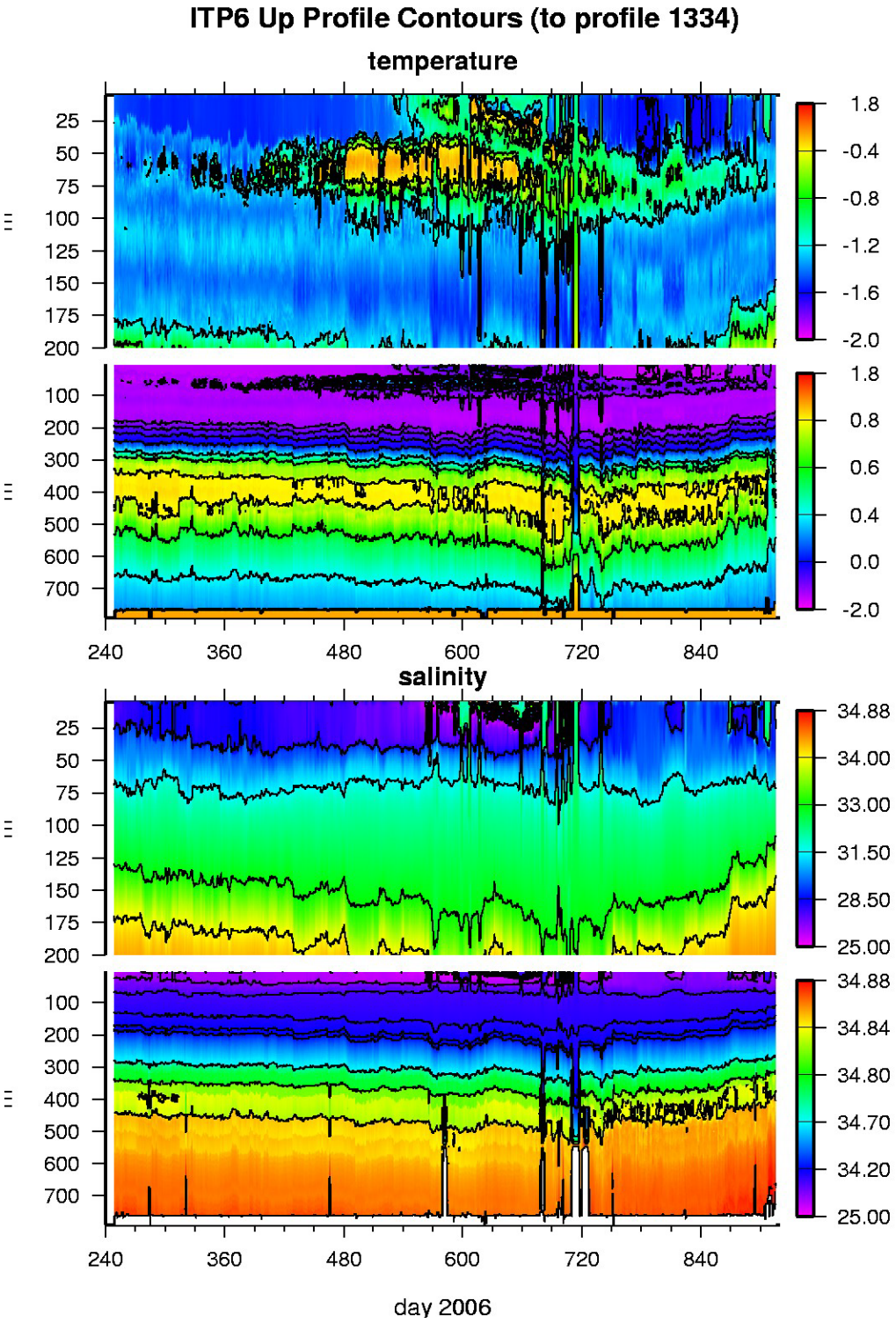


Top: number of bad dissolved oxygen points removed, Middle: dissolved oxygen ratio adjustment, Bottom: Number of filtered spikes.

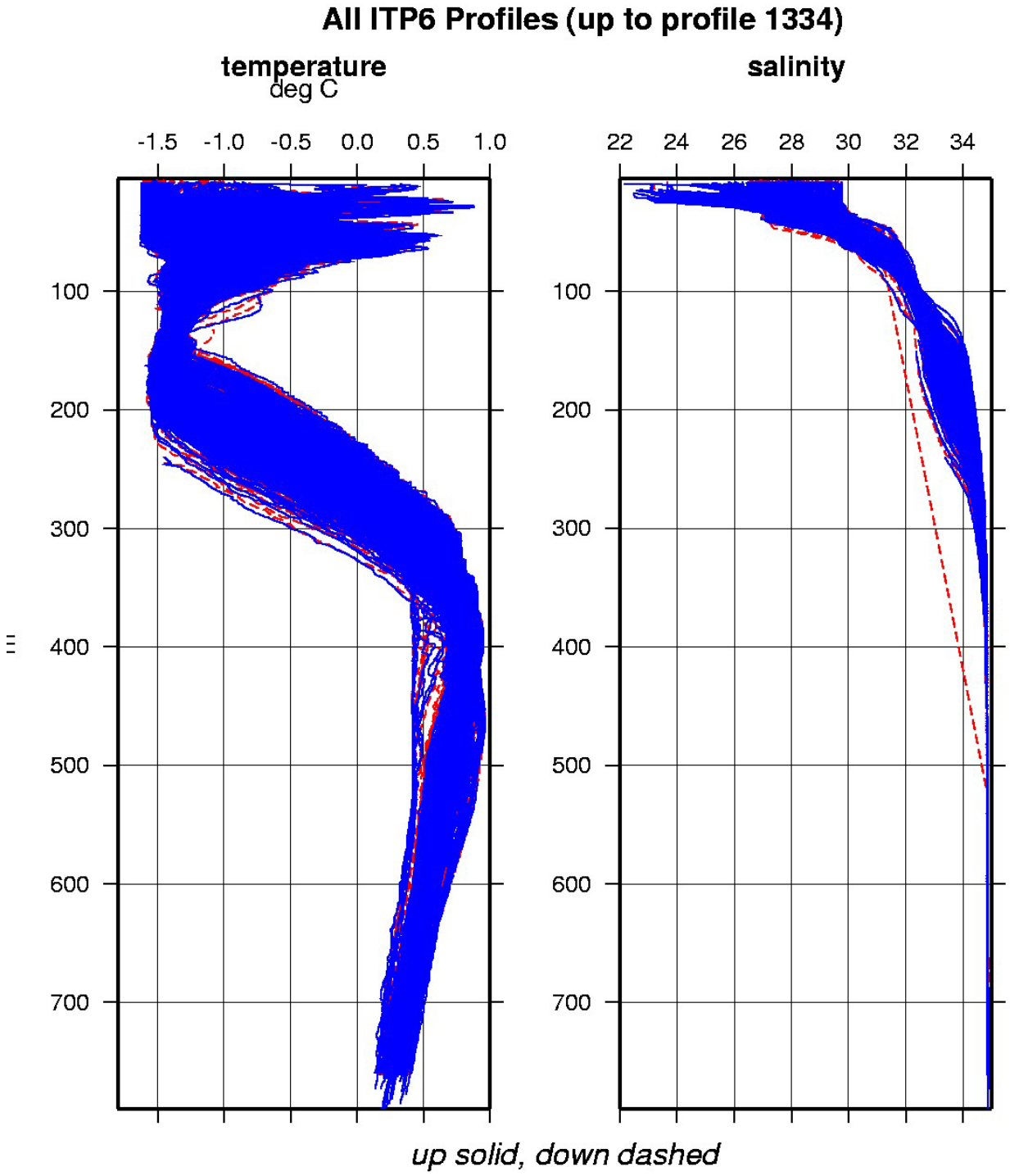


ITP drift (yellow line) and latest location (triangle), and annual ice drift from IABP (grey vectors) on IBCAO bathymetry (shading).

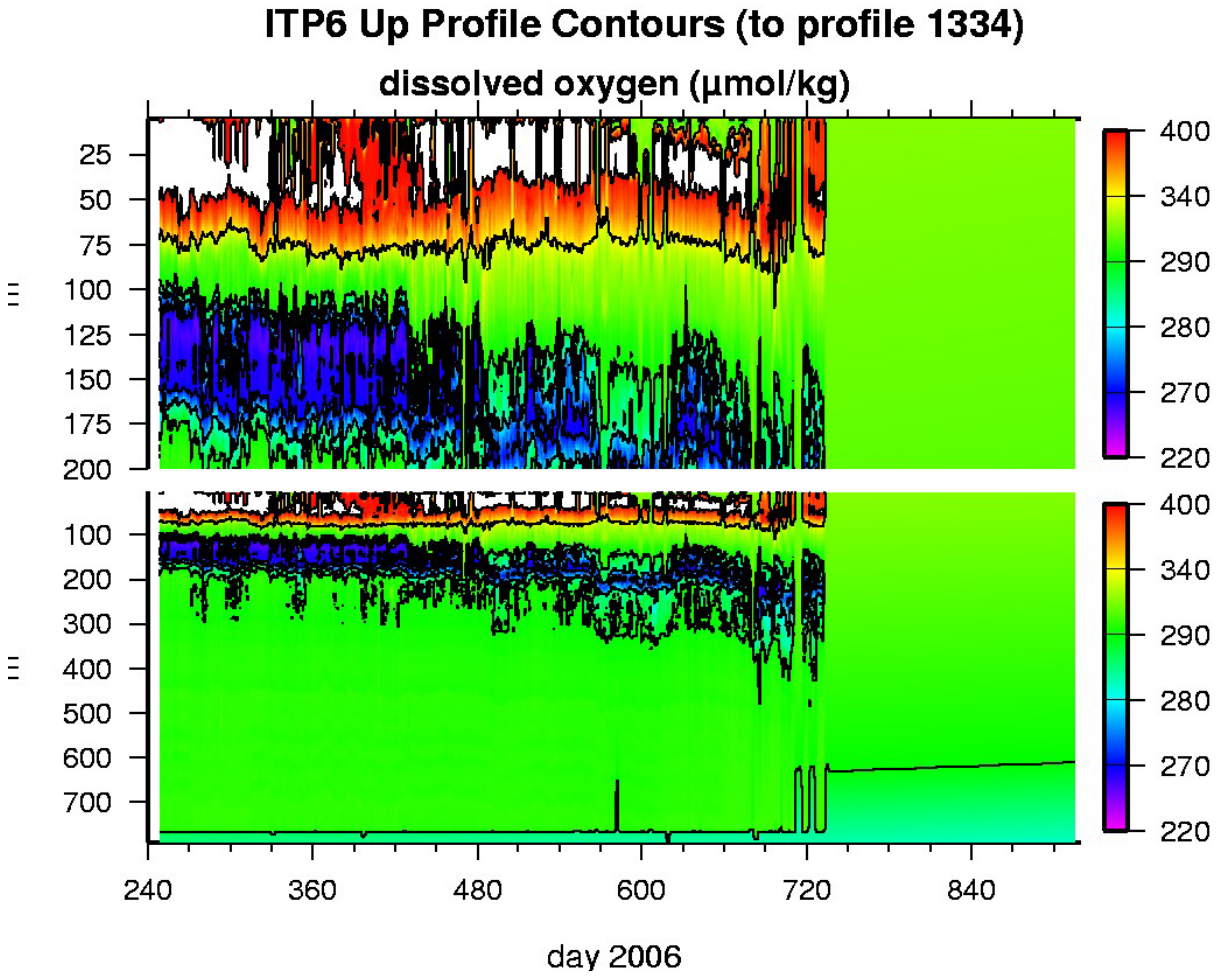
Plot of buoy locations.



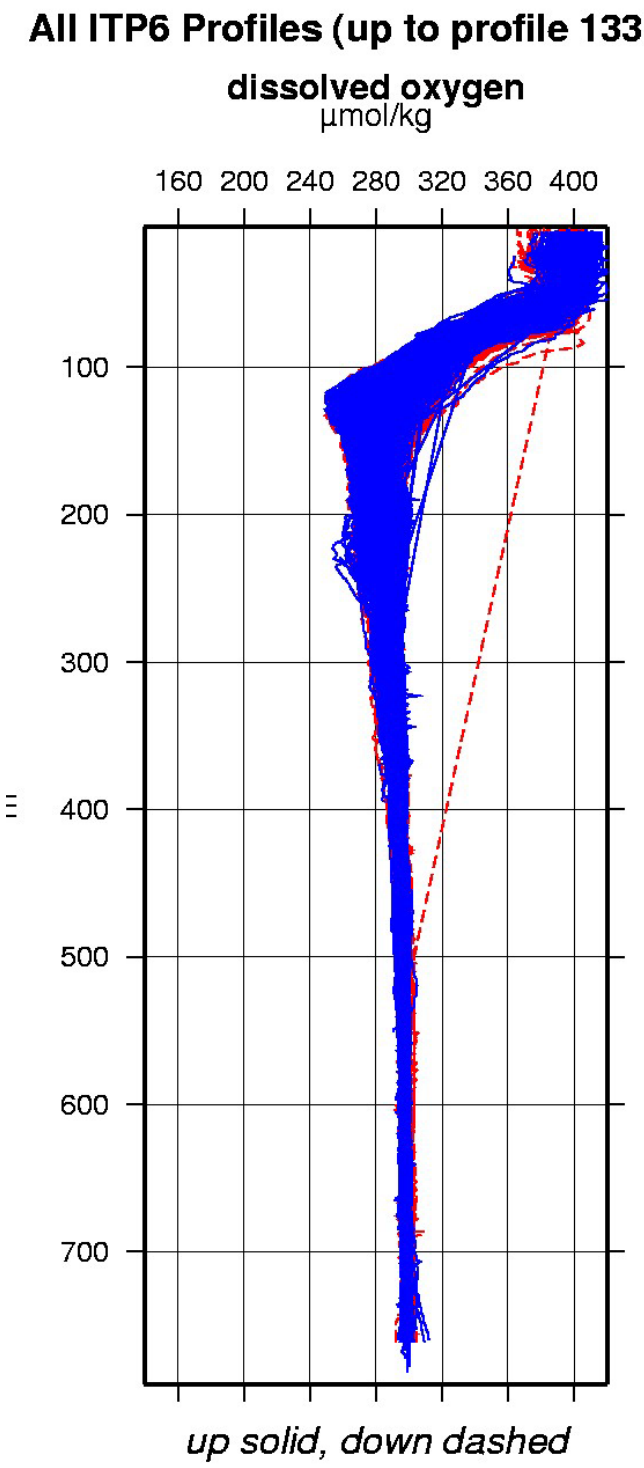
ITP 6 Temperature and Salinity contours.



Composite plot of ITP temperature and salinity profiles.



ITP6 dissolved oxygen contours.



Composite plot of dissolved oxygen profiles.

After deployment in the Beaufort Gyre: the IBO consisting of ITP 6, an AOFB, and IMB. Photo by Rick Krishfield.