ITP33 Overview

Deployment Location: 10/7/2009, 00:00 UTC at 77° 59.7'N, 149° 14.5'W

Recovered Location: 8/2/2011, 19:07 UTC at 78° 50.4' N, 150° 20.5' W

Duration: 665 days

Distance Traveled: 6359 km

Number of profiles: 952 in 475 days

Other instruments: none

ITP 33 was deployed on a 4.2 m thick ice floe in the Beaufort Sea as part of the Beaufort Gyre Observing System (BGOS) during the JOIS 2009 cruise on the *CCGS Louis S. St. Laurent*. The ITP operated on a standard sampling schedule of 2 one-way profiles between 7 and 760 m depth each day. Twenty-two months after deployment, the surface package and part of the tether were recovered without the profiler during the JOIS 2011 cruise also on the *CCGS Louis S. St. Laurent*.

ITP33 Deployment Operations

The second ice station to be occupied during the JOIS 2009 cruise was intended to be a platform for a Ice-Based Observatory deployment consisting of 3 buoys, but limited visibility due to fog prevented an extended helicopter reconnaissance, and the ice conditions in the area were rather thin and broken. However, in the afternoon, a small but thick floe was spotted than stood out compared to the surroundings, due to its higher freeboard above the waterline. The floe was found to be over 4 m thick, but only several tens of meters in diameter so consequently it was decided that only a single ITP would be deployed at this site. A standard 3-hour deployment operation of ITP 33 ensued while the fog gradually lifted, and the floe was concurrently sampled by several ice researchers.

ITP 33 Recovery Operations

During the JOIS 2011 expedition, the cruise would pass near the location of ITP 33 which had stopped receiving profile data from the underwater unit 7 months earlier. As the possibility existed that the profiler could still be acquiring profiles and storing this data internally, it was desirable to retrieve the system to perhaps rescue these data. A tracking command had been sent to the buoy via its Iridium connection, so that the unit would call in GPS locations hourly, which were then relayed to the ship. On the morning of August 2, 2011, the Louis was within 30 miles of the most recent location of the buoy, so the rescue operation was initiated.

The morning was clear, and the ship's helicopter set off north to the last location, arrived at the site within 30 minutes, and immediately the surface package was spotted in a melt pond. Upon

landing on the ponded floe, it was determined that the ice floe thickness was still 2.2 m thick. As the surface package was in a pond, we knew from previous experience that it would take a considerable amount of time to melt around the buoy to release it from the ice and be a very difficult operation. Consequently, it was decided to break the buoy out of the ice by running it over with the icebreaker as had been done with ITP 21. A sling was attached to the surface package to provide a grab point, the buoy uprighted on plywood, and the helicopter and passengers returned to the ship.

A couple of hours later, the ship arrived at the site of ITP 33, released it from the ice, and the surface package was tagged and hauled onboard. Over the next half hour, approximately 300 m of tether were hauled onboard before the bitter end of the wire rope was reached. The mooring tether had apparently dragged over shallow bathymetry back during winter (as rust on the end of the wire indicated it had been some significant time since it had parted), and the profiler had likely profiled or dragged off the open end.

ITP 33 Data Processing

ITP33 transmitted 953 profiles from the time that it was deployed until January 25, 2011. These were processed according to the procedures described in the ITP Updated Data Processing Procedures. The processing parameters for this ITP are shown in the figures to the right. Buoy drift speeds stayed mostly between 10 and 20 cm/s, with a few spikes exceeding 40 cm/s.

As usual, some conductivity (salinity) data were affected by biofouling or similar glitches. However, they were relatively few here, most were short or even single bins, and none lasting over several profiles.

Thermohaline staircases were present for a large portion of the time series, enabling CTD lag corrections. The lags were in the typical range found for previous systems. During manual editing, thermal lag corrections were dialed back somewhat to remove overcompensation. The combination of Alpha = 0.11 and Tao = 4.5 worked well in most cases. There were few stair cases during the last 1/4 of the record. Previous settings were maintained here, though these profiles displayed less change when modifying alpha and tao. A few instances of the thermistor lag corrections ("tlag" in the code) were modified to better adjust sharp spikes at the top/bottom of staircases. The conductivity - temperature time offsets ("cshift") were not modified from those calculated by the processing code.

The conductivity adjustment ("rat") remains fairly flat and close to unity for nearly the whole deployment, interrupted only for five to six short periods of larger adjustments for a small set of profiles ("rat spikes"). Presumably these adjustments were triggered by conductivity cell contaminations. The two highest ones (around profiles 150 and 805, respectively) also triggered editing of whole or portions of profiles. For example, following a subtle but clearly unusual change in TS around 585 dbar, most of profile 805 as well as profile 806 were edited out. The next several profiles received a (relatively) large calibration adjustment. At least one of them also showed a somewhat "different" TS signature at depth. While these profiles are most likely fine, I changed their quality flag from 3 to 1 ("good" to "questionable"). The lower amplitude rat spikes (e.g., around profile 175 and 520) modified the affected profiles such that they fit in well

with their surroundings, and little or no further editing was required. A number of the smaller deviations in the calibration time series were smoothed out when values closer to a running mean brought the profiles better in line with the deep TS pattern.

ITP 33 Data Description

The ITP profiler was configured to operate with a standard sampling schedule of 2 one-way profiles between 7 and 750 m depth each day. In the surface package, the GPS receiver was powered hourly to obtain locations, and buoy temperature and battery voltage status were recorded.

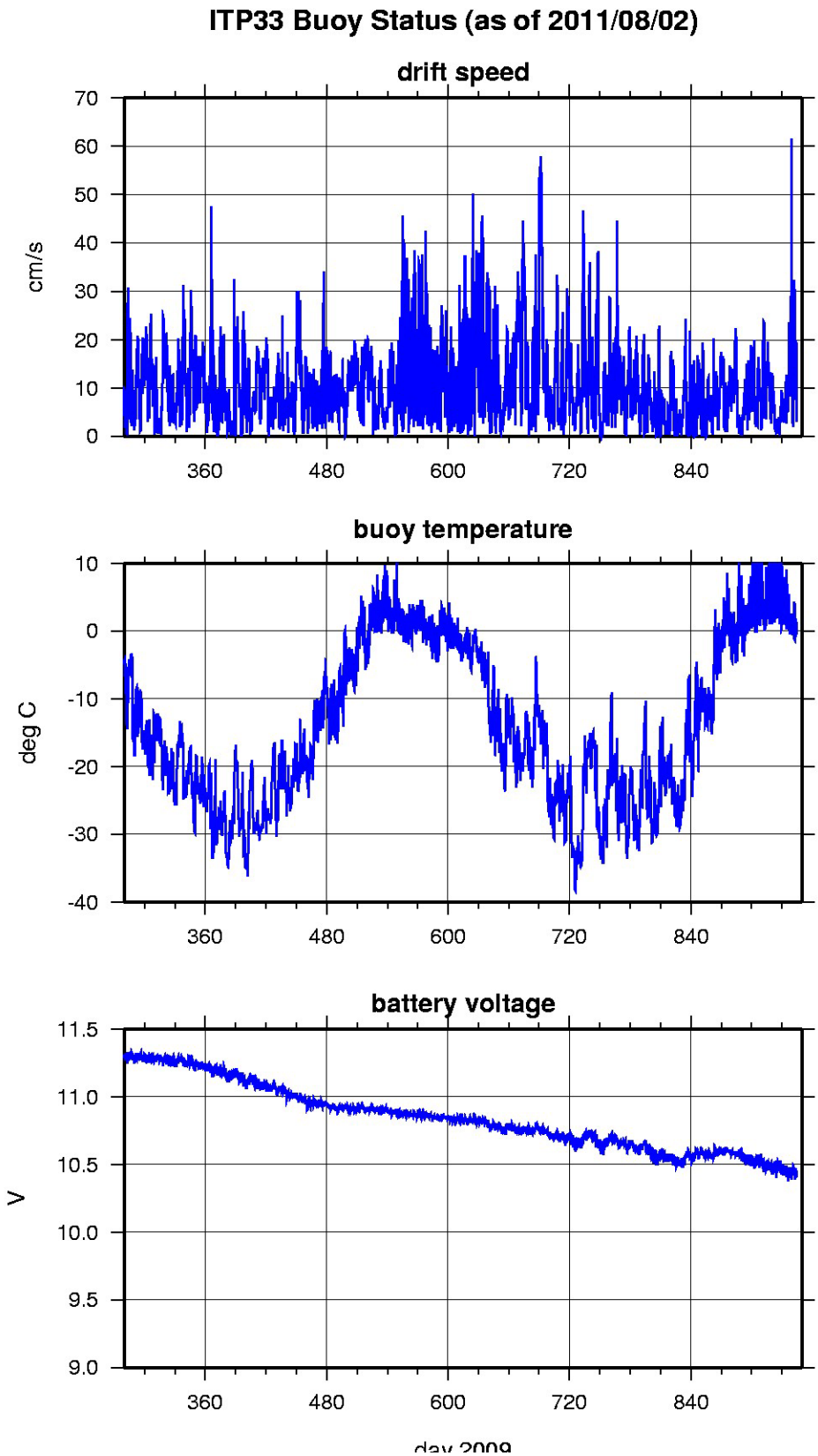
After deployment, the buoy drifted generally south, then west heading out of the Canada Plain (and thermohaline staircase region) during the first six winter months and over the Northwind Ridge for the next three months in spring 2010. Over the next five months in summer and autumn, the system sped up and largely backtracked over its previous drift track back into the basin. During the subsequent early winter months, it then completed a cyclonic loop, and returned to nearly the same westernmost location over the Northwind Ridge that it had visited over 6 months earlier. It is notable that the summer Pacific Water layer temperature maximum detected at this spot was generally below 0 °C in 2010, but several degrees above zero in 2011. Soon afterwards, the system began drifting northeast and communications with the profiler ceased on January 25, 2011. We now know after recovery of the surface package and damaged tether that the mooring likely dragged, and the profiler was probably lost around the same time. The surface unit continued broadcasting locations as it meandered northeastward back into the Canada basin until it was recovered in August 2011.

The plots below are of the final, calibrated, edited data (as opposed to the raw data presented on the active instrument pages).

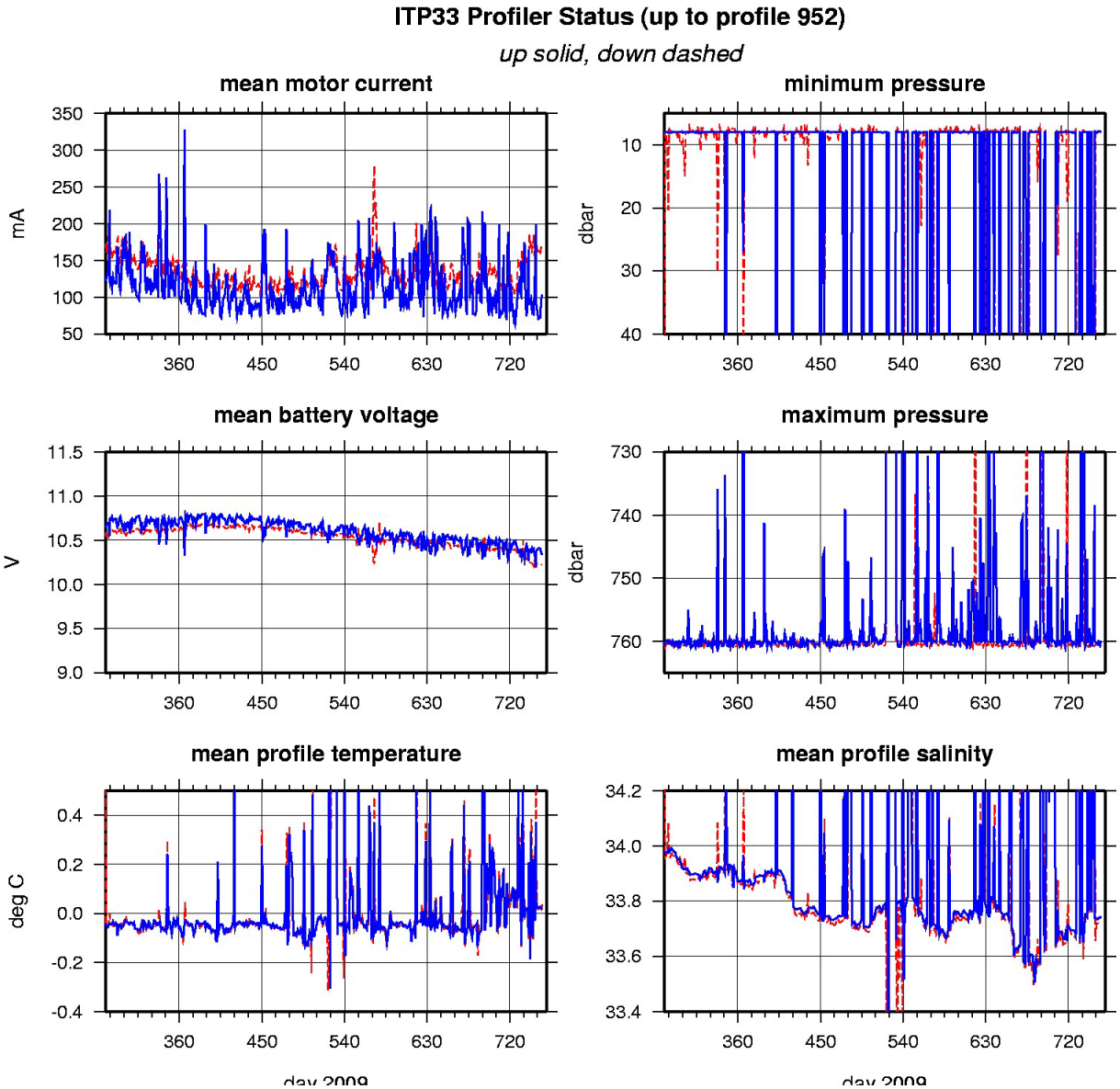
Level II hourly buoy location data in ASCII format: itp33rawlocs.dat

Level III 1-Hz processed profile data in MATLAB format: itp33cormat.tar.Z and itp33cormat.zip

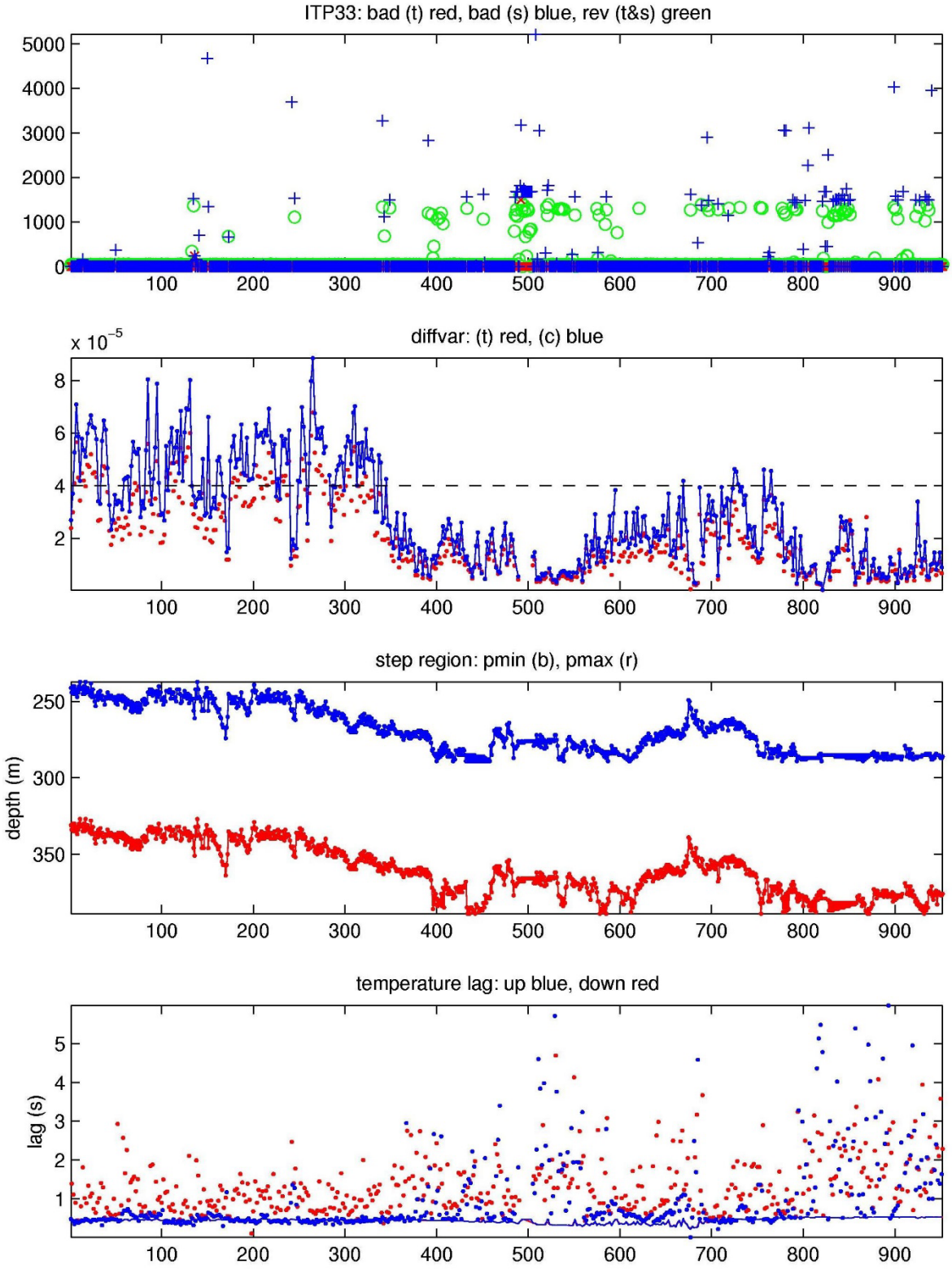
Level III 1-db bin-averaged processed profile data in MATLAB format: itp33final.mat
Level III 1-db bin-averaged processed profile data in ASCII
format: itp33final.tar.Z and itp33final.zip



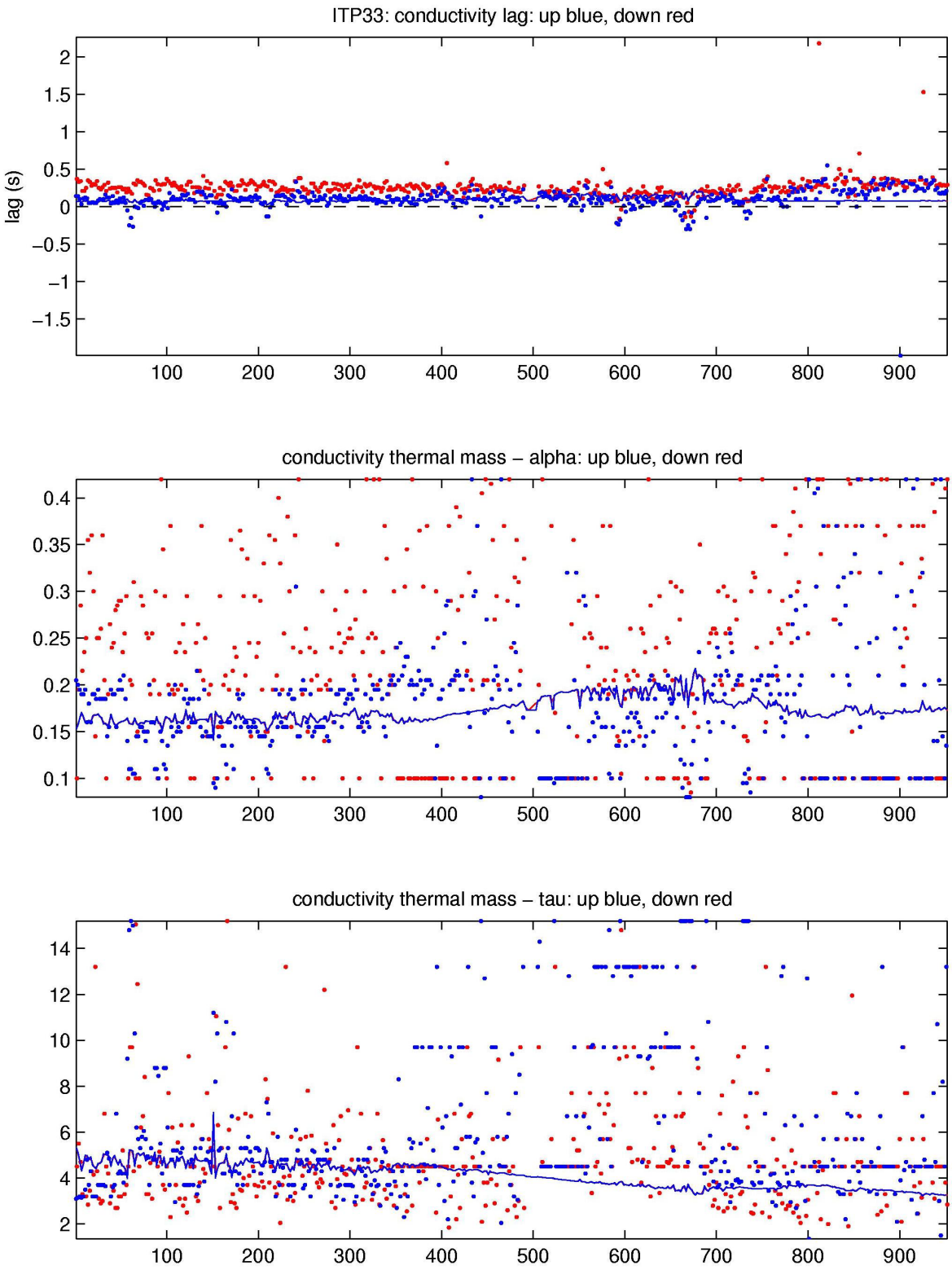
ITP Surface Buoy Status.



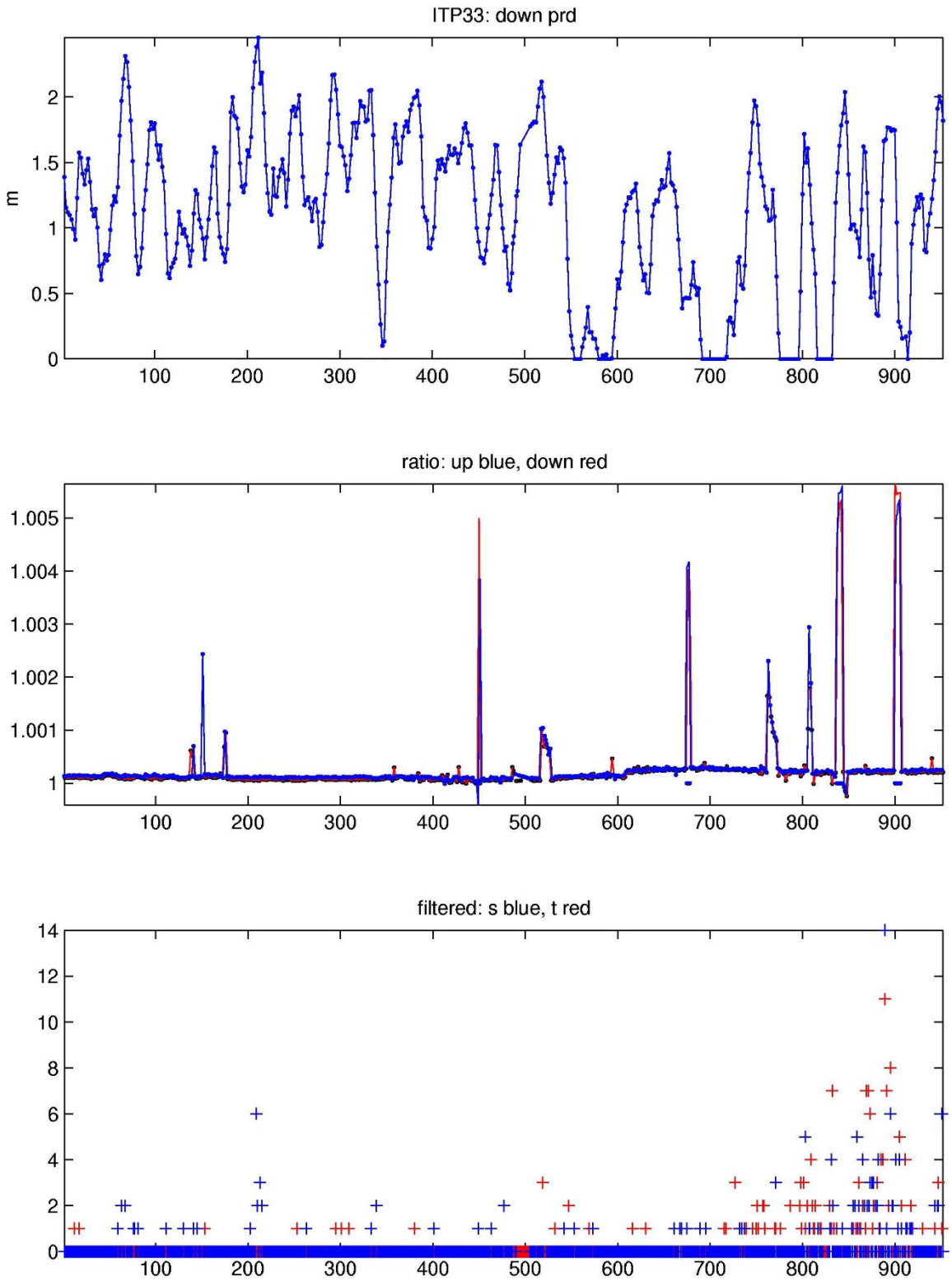
ITP profiler engineering data.



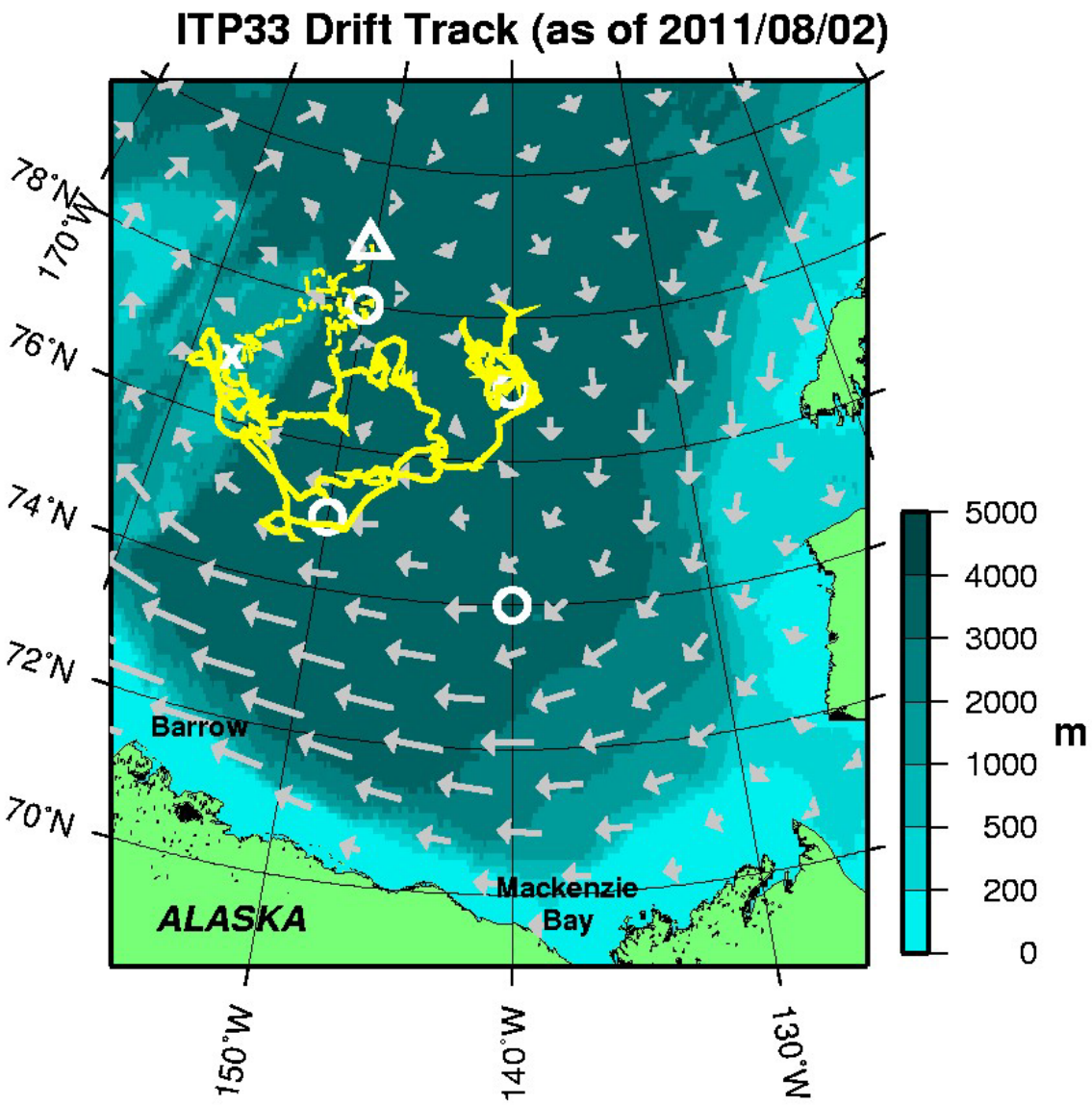
Top: number of bad points removed, Middle: variance of verticle difference of temperature and salinity in step region for up-going profiles, Bottom: temperature lag



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

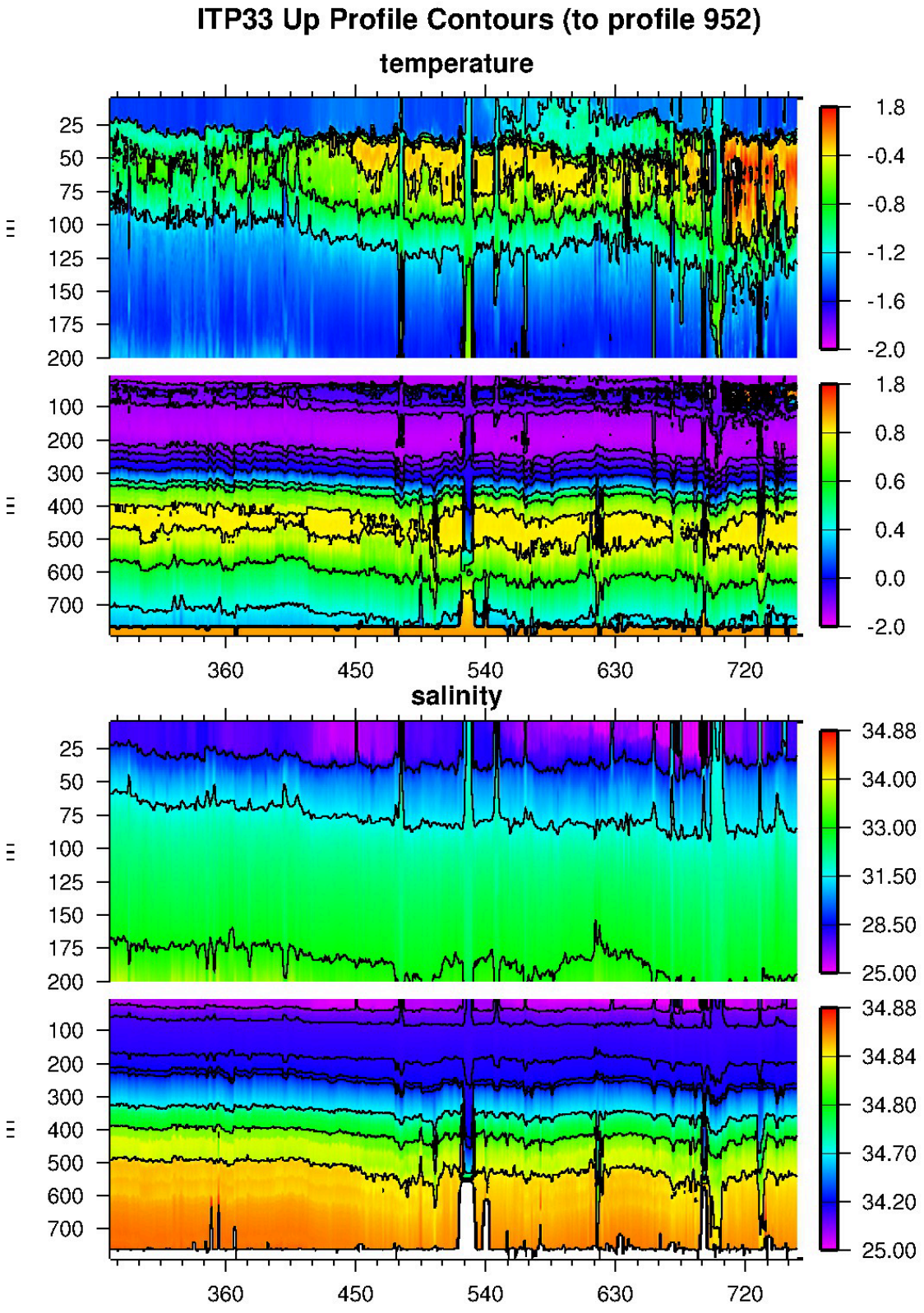


Top: down pressure deviation correction, Middle: salinity ratio adjustment, Bottom: Number of filtered spikes.

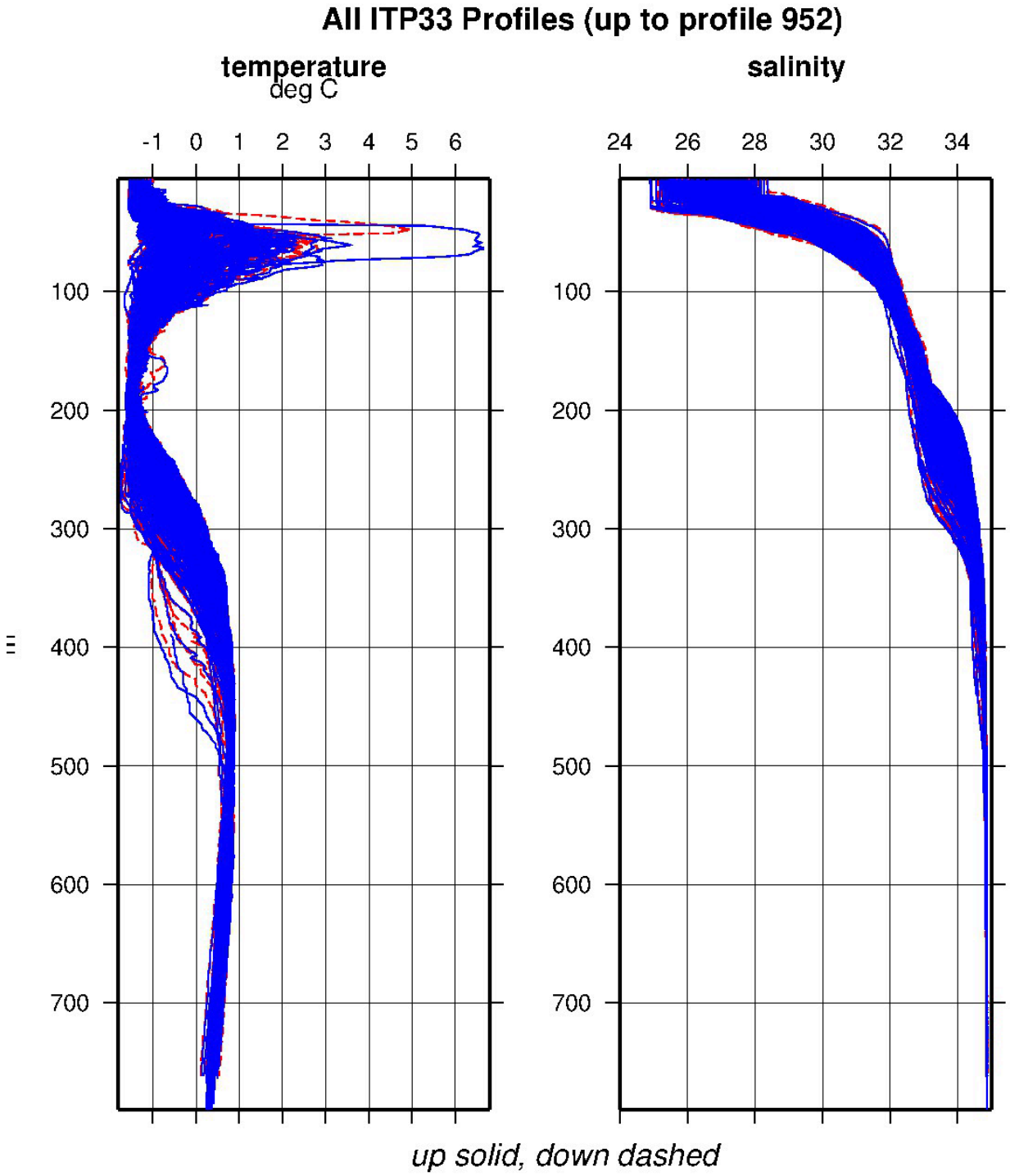


ITP drift (yellow line), last profile (cross), and last location (triangle), BGOS moorings (circles) and annual ice drift from IABP (grey vectors) on IBCAO bathymetry (shading).

Plot of buoy locations.

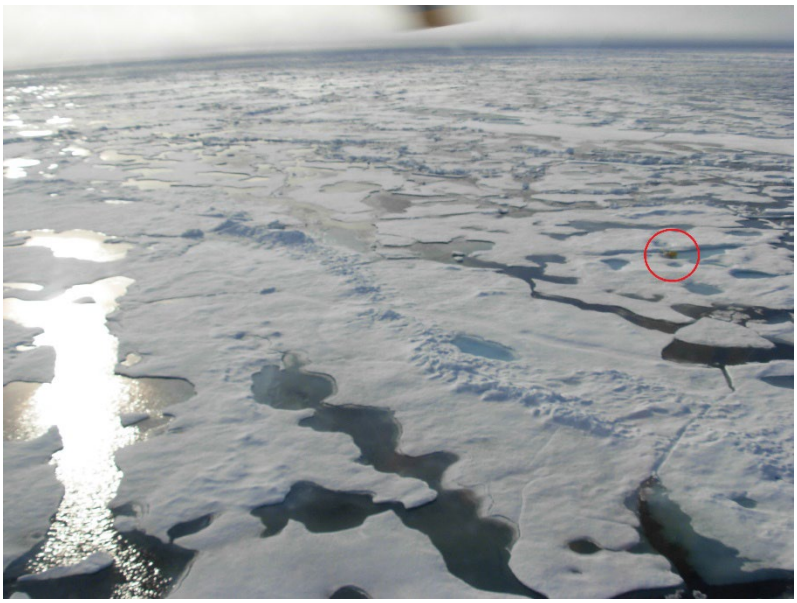


ITP33 temperature and salinity contours.



Composite plot of ITP temperature and salinity contours.

The surface package of ITP 33 deployed on a rather small, but thick ice floe with 25 cm of snow on the surface and surrounded by thinner floes consisting mostly of rubble. (Rick Krishfield)



Even with recent position fixes, it can be very difficult relocating an ITP from the air, especially if it is half submersed in a melt pond, like ITP 33 was on this morning (circled in red). The yellow color of surface package was selected so that it would stand out in either ice or ocean. (Rick Krishfield)

The Louis bears down on the re-righted ITP 33 in order to break up the icefloe containing the system. (Rick Krishfield)