8/23/01
Trip Report
RHBrown Calibration and Alignment

8/23/01

Bob Bowie (CSU) and I met at Pacific Marine Center (PMC) in the late afternoon of 8/23/01. We briefly discussed the known status of the radar, including the antenna, and made a tentative plan for activities the following day. I boarded the ship and met with Sandra Yuter regarding her plans for EPIC 2.

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Yuter had expressed some concern that the pulse lengths from the radar were not the proper length. This concern was based on pulse shape displays generated by the Sigmet RVP-7 software. Bowie and I examined the pulse output using a Tektronix 492 Spectrum Analyzer and verified that, within the limits of measurement of the 492: a) the pulse lengths were correct, b) the magnetron spectrum was quite symmetric, and c) the first lobes of the spectrum were close to 11.5 dB down from the main lobe. This is excellent performance for a magnetron transmitter. We also performed three solar alignment checks through the day. Elevation was consistently off by 0.6 degrees and azimuth by as much as 1.2 degrees. We borrowed a Tektronix 465 oscilloscope from the ships electronics shop and observed the detected RF output from a diode detector connected via a splitter to the directional coupler. We verified that the pulse lengths were 0.5, 0.8, 1.2, and 2.0 microseconds.

Bowie had brought with him two high-quality digital levels. We went through the calibration procedure for these and verified that they agreed to better than their readout accuracy (0.1 degree) at various random orientations. As there was very little activity on the ship (due to imminent sailing) we took the opportunity to measure the deviation of the pedestal and the INU axes from true (gravity) vertical. The pedestal indicated a 1.7 degree tilt toward the bow and .5 degree tilt toward the port. The INU also indicated a 1.7 degree tilt toward the bow, but 0 degrees tilt athwartship. Sigmet had stressed that the INU and pedestal axes *must* be parallel. We examined the pedestal mounting and determined that it would probably be possible (with a bit of effort) to straighten the pedestal. However, with few tools available and with much of the ship's crew on leave prior to sailing, we decided that such a major undertaking would have to wait until the next in-port in Charleston. With little time left in the day, we decided to perform a stabilization test and perform any corrections to the INU alignment on the 25th.

During the day we set the radar host computer clock to WWV and performed two solar alignment checks at 1645Z and 1915 Z. The 1645Z offsets were: El +0.3 deg, Az +0.45 deg. AT 1915 Z the offsets were: EL 0.0 deg, Az 1.5 deg.

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A solar alignment check at 1535Z gave: El +.6 deg, Az +.5 deg. Az was in good agreement with the same time period on the 24th, but elevation was 0.3 degrees farther off.

We re-verified agreement of the digital levels. We stationed one person in the radome with one of the levels, and the other on the bridge at the INU position with the other level, while we coordinated activities via radio. Using two levels ensured that any ship motion would not be a factor. The person in the dome measured the forward and athwartship tilt of the antenna pedestal and the person at the INU shifted the nuts on the two port INU baseplate studs until the two INU tilt measurements matched those of the pedestal. INU measurements were made directly on the body of the INU. Pedestal measurements were made directly on the pedestal.

A digital level was attached to a counterweight arm and the elevation was set to about 30 degrees. We took measurements with the level at 60 degree increments around the circle with stablilization turned on and observed a swing of +/- 1.7 degrees in elevation. As a peripheral note: while measuring the elevation angles, in order to see the reading on the level we had to frequently climb up on the lip where the dome bolted to the riser. In doing so we would sometimes see elevation changes of up to 0.2 degrees, presumably due to flexing of the mounting plate. We were running out of daylight by this time and shut down operations for the day.

8/26/01

We set the antenna pointing directly toward the bow at 0 elevation as indicated by the Sigmet ‘antenna’ utility. We attached a digital level to one of the elevation counterweight supports (which are supposed to be in alignment with the feed) and moved the antenna to indicate a true angle orthogonal to the azimuth axis, i.e. 1.7 degrees down. The Seapath roll and pitch offsets in software were adjusted to reflect the roll and pitch offsets of the pedestal The 0.4 degree elevation offset in the Sigmet RCP02 Antenna Controller was set to 0. (We don’t know where the 0.4 number came from) The roll and pitch offset in the RCP02 were set to –0.5 and –1.7 degrees, respectively, using the 'antcheck –chat' utility. The stable platform elevation then read –1.7 degrees, or 1.7 degrees down to the bow, as one would expect. We set the elevation at about 30 degrees up, and made measurements using the digital level on the counterweight arm every 60 degrees, as was done before. This time the maximum deviation from the initial angle was +/- 0.2 degrees.

As a second check we took out the corrections in the RCP02 and repeated the above measurement. We obtained a deviation in level measurements of +/- 1.6 degrees. The replaced the corrections in the RCP02.

8/27/01
A solar alignment check was performed at 0730 local. Elevation offset was 0.0 degrees, but azimuth needed a correction of 0.8 degrees. This was verified at 0830 and 0.8 degrees was put into the RCP02 as yaw correction in antcheck –chat/INU. Azimuth seems perfect, but will be subject to a recheck at noon and late in the day. A surveillance scan was set up with two levels, 0.5 and 0.8 per Sandra's request. This will be run alternately with a volume scan to document the trip except during calibration activities.

We left port at about 10:20 PDT. At about this time the wind picked up, the temperature dropped, and cirrus began moving in. We passed through the Ballard locks about noon and headed up Puget Sound toward the San Juan Islands and the Straits of Juan de Fuca. I started radiating when we were out in the middle of the Sound. The seas were not yet picking up from the wind, so I was able to take a look at the sea clutter pattern. Under these conditions the pattern looked quite symmetrical at low angles (.5 and .8). We were in the Straits until very late, so no sphere calibration was attempted. I spent most of the day re-familiarizing myself with the operational side of the Sigmet software. Michelle Ryan directed me to a book of documentation she had found in various places around the ship, and I was very happy to see that writeups on the sphere calibrations done during JASMINE and the solar calibration we did in Darwin, Australia had survived.

8/28/01

Due to requirements handed down by Chris Fox (the PI for this leg) we were not going to have an opportunity to have the ship pointed directly into the wind for 30 to 60 minutes for a calibration flight. We were headed toward a buoy some 300 km off the coast at a heading of about 235 degrees with the wind off the port bow. The relative wind was fairly steady at about 22 knots (11 m/s) and angled about 10 degrees off the bow. There was light cloud cover, which was not ideal, but we decided to launch a sphere in the spirit of practice and technique development. Michelle attached the sphere to a 200 gram balloon using 2.5 meters of monofilament fishing line (monofilament line does not absorb water). The balloon was inflated somewhat less than one would inflate it for a GPS sonde flight, and was launched off the fantail at around 1720Z. We acquired the sphere about 8 km out and followed it easily on the Sigmet realtime display for over 20 km. The elevation angle held fairly constant throughout the flight, while the azimuth angle veered slightly clockwise. Flight data in the form of Sigmet RAW data files were transferred to my laptop computer for analysis later.

Another opportunity for a launch occurred later in the day, but the relative wind was somewhat lower (about 6 - 7 m/s). The ship was to be on-station for at least 2 hours, so we adjusted the radar scan window and launched. The balloon never showed up on the real-time display or in the data. It either ascended faster than expected, or encountered a wind shear which took it out of the scan volume.

During the evening I reduced the early flight data and found that it varied less than 0.5 dB from the calibration data obtained in JASMINE in 1999. This sounded too good to be true, given that we did not have ideal conditions. Our original intent was to perform calibration flights in clear conditions, but the weather and ship's schedule did not cooperate with this goal.

Solar alignment checks today required 0.3 degrees azimuth offset and –0.3 degrees elevation offset at noon.

8/29/01

We had another launch opportunity with about 20 kt relative winds close to the bow at 2345Z. We followed the sphere for 40 km to an altitude of nearly 17 km (56000 ft). There was considerably more weather activity this day with a thicker cloud layer and some rain. Although the tendency of the data looked consistent with the JASMINE calibration flights and the flight lf 8/28/01, the data were too scattered to trust the data. This flight was relegated to the 'practice and technique development' category. The heavier meteorological activity may well have biased many of the target measurements. I strongly recommend only accepting sphere calibration data obtained during clear conditions.

As a note: it took nearly 9 hours to reduce the 1 hour calibration flight. The more recent software has reduced that to less than three hours.

Solar alignment checks today required 0.3 degrees azimuth offset and –0.3 degrees elevation offset at noon. These numbers seemed to be consistent with other days' readings.

8/30/01

Most of the day was spent transferring data to my laptop from the radar host computer and cleaning up documentation, as well as moving out of and cleaning our cabins, etc. I looked into a problem that Cifelli had asked about, namely the fact that the radar host would not recognize two SCSI DLT tape drives they had connected to the host. On examining the drives, I found that one had been given SCSI ID 6, a slot occupied by one of the system disks (the CDROM drive), and the other may have been interfering with another device in SCSI ID slot 4 (the Sigmet RVP7 Digital IF). I moved the drives to SCSI ID's 3 and 5, which would not interfere with either SCSI controller (there are two in the host). However, the host still would not recognize the drives by the time I had to get ready to disembark. Since no one was to be on board to run the radar for the San Francisco to San Diego leg, I stowed the antenna looking 45 degrees up and straight over the bow. The circuit breakers for the servos and the brakes were pulled to lock the antenna in that position. (Brakes are ON when unpowered). The ship docked in San Francisco at about 18:00 PDT. We had to disembark as quickly as possible as the time in port was very short.

Summary, conclusions, and comments.

The ship pedestal and INU axes were aligned using digital levels to within 0.1 degrees. Tests indicated that the elevation excursions from a commanded conical scan dropped from +/- 1.7 degrees to +/- 0.2 degrees, or less. The +/- 0.2 could probably be eliminated if more time were available to work on the problem. The sea clutter pattern appeared much more symmetric after the alignment effort.

We examined the pedestal mounting and determined that the pedestal tilt could probably be removed. The galled stainless bolts are in the outer mounting bolts and not in the inner (adjustable) ring. This could be done at the next in-port in Charleston. We had neither the time, the tools, nor the personnel to perform the realignment in Seattle.

Two successful sphere calibration flights were made under less than perfect weather conditions. Apparent sphere reflectivity values for the first flight on 8/28/01, in very light cloud conditions, were consistent with values obtained during JASMINE in 1999, but measurements made during the 8/29/01 flight were scattered and may have been biased by clouds and precipitation. More flights in clear conditions need to be made, and should be a routine task during any experiment using the radar. The JASMINE calibration and the the 8/28/01 flight agree that Sigmet overestimates the sphere effective reflectivity by 35.27 (Sigmet, corrected for point target) – 27.36 (calculated sphere) = 7.91 dB. This seems to be a rather large difference. The Sigmet setup parameters affecting reflectivity measurements were not changed during this effort, but they should be checked and changed as necessary and appropriate. Careful measurements of waveguide loss, antenna gain, and antenna efficiency were made in the course of performing a solar reflectivity calibration in Darwin. These data are available in the radar documentation binder Michelle started. Again, more sphere flights in clear conditions are necessary to demonstrate that these numbers are indeed valid.

The solar alignment checks are more consistent since the INU/pedestal alignment efforts, but need a few more samples at low and high sun angles to arrive at a final correction. As of the time I left the ship, it appeared that we need to subtract 0.3 degrees from azimuth (yaw correction) and add 0.3 degrees to elevation. (The original 0.4 degrees correction we found in the antcheck –chat setup may have been correct).

I noted during the last calibration flight that occasionally the azimuth would swing far outside the sector through which it was scanning. This could be an indication that the coupling between the azimuth motor and the azimuth gearbox is loosening again. This coupling should be checked for tightness as soon as it is practical to do so.

The safety switch on the hatch leading into the dome has been destroyed by salt and is currently bypassed. I would suggest mounting a sealed, manually operated switch either outside the dome, or just inside the dome, so that the transmitter can be disabled by anyone entering the dome.