

**RHB RADAR SCIENCE LOG**  
**KWAJEX**  
**KWAJALEIN ATOLL**  
**Second Cruise**  
**24 August 1999 - 15 September 1999**

(DBW: David Wolff, ND: Neil Dunneman, CL Colleen Leary, DM, Dave Marsalek, GC Gordon Carrie, RG: Roberto Gasparini)

Local time = UTC + 12 hr

RPHASE = on

Fields collected, T, Z, VR, SW

Filters: T (log=0.8 dB), Z (log=0.8, CSR=18), VR(SQI=0.65, CSR=18), SW (SIG=5.0, SQI=0.65, CSR=18)

dbw

Current scans implemented:

Format: (RadarEchoht\_scan)

RHB6KM\_A (6 km echo top heights, hybrid scan A)

Elevation angles: 0.4, 1.3, 2.1, 3.0, 3.8, 4.7, 5.6, 6.6, 7.8, 9.3, 11.1, 13.3

RHB6KM\_B (6 km echo top heights, hybrid scan B)

Elevation angles: 0.4, 0.8, 1.7, 2.5, 3.4, 4.3, 5.2, 6.1, 7.2, 8.5, 10.2, 12.1

RHB8KM\_A (8 km echo top heights, hybrid scan A)

Elevation angles: 0.4, 1.6, 2.7, 3.9, 5.1, 6.2, 7.4, 8.8, 10.4, 12.4, 14.8, 17.8

RHB8KM\_B (8 km echo top heights, hybrid scan B)

Elevation angles: 0.4, 1.0, 2.1, 3.3, 4.5, 5.7, 6.8, 8.1, 9.6, 11.4, 13.6, 16.2

RHB10KM\_A (10 km echo top heights, hybrid scan A)

Elevation angles: 0.4, 1.8, 3.3, 4.7, 6.2, 7.6, 9.1, 10.8, 12.8, 15.3, 18.2, 21.9

RHB10KM\_B (10 km echo top heights, hybrid scan B)

Elevation angles: 0.4, 1.1, 2.6, 4.0, 5.4, 6.9, 8.3, 9.9, 11.7, 14.0, 16.7, 20.0

RHB13KM\_A (13 km echo top heights, hybrid scan A)

Elevation angles: 0.4, 2.3, 4.2, 6.1, 8.0, 9.9, 11.8, 14.0, 16.6, 19.6, 23.2, 27.6

RHB13KM\_B (13 km echo top heights, hybrid scan B)

Elevation angles: 0.4, 1.4, 3.3, 5.2, 7.1, 9.0, 10.9, 12.9, 15.2, 18.0, 21.3, 25.3

**Tuesday, August 24, 1999**

Left port on time at 0900 LST (990823/2100 UTC). Preparing for sphere calibration. Plan is to have rig located 2 nm south of Kwajalein radar, and 3 nm east of RHB. Some question as to how much line is available. Will launch balloon as high as possible, then bridge will report altitude which will then be used by Ops Center to determine the relative pointing angles. RHB is scheduled to be on station for Sphere Cal by 1030 LST (990823/2230 UTC). DBW

Neil D is performing Sun Track 0944 LST (990823/2144 UTC). Results show that pointing angle is fine. Will now perform a Zauto prior to SphereCal. DBW

Performed ZAUTO twice. Noise values were consistent. Will make three copies of all ZAUTO's, one for Neil, one for Wolff and one for Colleen. DBW

SphereCal was un-successful. Trade winds too strong and blew winds to sfc. Balloons finally broke free of line and now they are chasing the sphere. Will begin regular scanning as soon as rib is recovered and we get a bit away from the island. DBW

Need to work out tape procedure using Paul's notes. DBW

Rib was secure at 990823/2314 UTC. DBW

### **Wednesday, August 25, 1999**

Radar operating nominally. Sun track performed at 2111 UTC. **Radar down until 2119 UTC.** Will do ZAUTO at time of tape change. DBW

Radar Settings:

Mag current 16.5 mA  
HVPS 1.37 kV  
HVPS current 220 mA

E: 2358 UTC 24 AUG 99  
RB2\_99\_08\_24\_131 (313 files)

(DBW)

ZAUTO performed at: 990825/0039 UTC  
-105 dbz Resumed tape at this time. (ND)

990825/0137 UTC. Surveillance scan was modified to use RPHASE. This should eliminate the speckle. Note that SURVEILLANCE scan now uses RPHASE and set SURV2 to FFT. There was a lot of speckle in SURVEILLANCE Scan until this time. (DBW)

990825/0319UTC partly sunny with Cu and Cb on the horizon and blue sky overhead. Cb is to the north. The echoes are moving from east to west. I'm not sure of the north/south component. The echoes are scattered and isolated. We have had 2 drills in the last couple of hours, so not much time to observe the radar. The largest echo is at azimuth 240 degrees and range 50 km, and is about 30 km across. There is also a line of scattered echoes to the SE. The line extends from northwest to southeast, with the separation between echoes larger than the size of the echoes themselves. CL

990825/0637UTC partly sunny with some blue sky overhead. Ci, Cc, and Cs. The screen has scattered isolated echoes. The most intense are to the northeast and from southeast through southwest. The most intense at 0524 was 47 dBZ in a long narrow echo to the SSW oriented from NW to SE at a range of >100km. Of interest is an

intensifying cell to the northeast that is moving toward closer range. Pileus is visible at the top of two Tcu nearby. There are small white-caps on some of the waves. CL

990825/0701UTC Cu congestus seem to be building into Cb clouds very close to our southeast. They look to be approximately 7km or so away, and have decent updrafts within the clouds. A pileus cloud is still visible to our southwest. The cloud formation to our southeast is barely producing an echo at this time. Convection across the entire radar scan is spotty at best right now. DM

990825/0805UTC—maximum reflectivities of 47 dBZ in scattered convective echoes. Cu and Tcu are visible in the bright light of a full moon. Velocity and reflectivity field show sea clutter within about 25 km, with reflectivity of  $\leq 5$  dBZ. Velocities of 1-3 m/s from about 060 degrees are consistent with low-level winds. The lowest tilt angle shows receding winds at range  $>25$  km to the south at  $>13$  m/s. This is consistent with northeasterlies increasing with height as we have been seeing in the soundings. Echoes are moving from about 070 degrees at about 35 km/hr. CL

990825/0830UTC occasional lightning south east. Most of it is cloud-to-cloud. Light rain at ship 0830-0835. Rain ended before methyl blue measurement could be taken. GC

990825/0940UTC lightning southeast, approximately 90 seconds between flashes, some striking surface. Lightning is in same direction as 40-50 dbz echoes 70 km southeast, off Namu atoll. Halo around moon, possibly due to cirrus from anvil spreading from same system. Long narrow line of 40-50 dbz echoes with visible cumulonimbus approaching from 060. GC/MC

990825/1100UTC NE line has passed N of ship. Lightning continues from echoes to SE and S. Echo coverage has increased to S, but few new echoes N.

990825/1250UTC New batch of convection approaching from 080. Occasional lightning with this system, currently at 40-50km range with max 40-45dBZ. Numerous other echoes to SE. Old lightning system now widespread at 50-100km range from 150-240 azimuth.

990825/1445UTC Roughly 25% of 150km-range lowest-elevation scan filled with echo. Blobs ranging from a few km to over 50km across in all quadrants. Largest echoes remain to our southwest in 50-150km range. Intermittent lightning persists with these storms. Some nice Cbs visible in the moonlight to E. Still no rain on station.

/1505UTC  $>40$ dBZ echoes popping up within 40km in all directions now. Frequent lightning from storm to N.

990825/1500UTC Cell  $\sim 40$ km west of RHB also producing lightning...this morning has been the most active regarding lightning in the 10 days I've been here. Current CAPPI product in lab has some time inconsistency that concerns me slightly. Scan times for the last 4 scans are 1400 990825, 1412 990825, 1424 990825, then 0848 990826. Note jump in time AND day for the last scan. RG

990826/0157-0441 UTC

Only isolated scattered echoes on the screen, mainly in the northwest quadrant. Largest is 20 km in horizontal extent. They are moving from about 115 degrees at a speed of about 25 km/hr. The individual larger echoes are linear. There is no stratiform precipitation. A water vapor sample was taken at about 0330. One weak shower passed by the ship. Sky was overcast with cumulus clouds. Max reflectivities 35-40 dBZ, with a few pixels above 45 dBZ. At 0428 there were still few echoes, and all were small, weak, and hard to distinguish from noise. These echoes were monitored closely because there was an aircraft mission and a very good overpass of the TRMM satellite at 0452. CL

990826/0441-0621 UTC

A few small echoes, mainly in the northwest and northeast quadrants. They seemed to be moving at a direction of 110 degrees at a speed of about 50 km/hr. The largest echoes were linear in shape, but <20 km long. Again, if there were not a good overpass, this echo pattern would probably get little attention. At 0621 a shower was visible to the southeast at a range of about 15 km in a weak echo. The sky is about 7/8 cloud-covered. Upper level clouds are Ci, Cc, and Cs. Middle clouds As and Ac, particularly toward the setting sun. There are many Cu all quads, and the one Cb. CL

990826/1050 UTC New echoes 80km E of ship with max 40 dBZ. Line oriented WNW-ESE about 20km wide, 100km long.. Scattered Cu about the ship. Has been very quiet up to this point.

990826/1230 UTC N-S line of 45-50dBZ echoes passed over Kwajalein at 1200. OPS Center reports max 40dBZ. Line extends south of our location and is approaching at roughly 30kph. Expect precip on site within hour. OPS now confirms 48dBZ cell NE of Kwaj. This is apparently a new line, and not the 50dBZ cell we identified. At any rate, convection is now firing nicely, and a wide NW-SE line is approaching from SE.

990826/1515 UTC Caught the N edge of the line passing to S. Rained on ship 1322 – 1330. Took 2 meth blue samples (one during onset of pp; one a few minutes into event) Launched just after shower passed. Skies have cleared since. Now all quiet on eastern front.

990826/1745 UTC A plethora of tiny cells are visible on the surveillance scan as most of them fall near the edge or just outside of the 150km range ring. A few cells were larger approximately an hour before, but a strong speckle filter would probably erase what little is left out there near the RHB. There is one cell reaching 10km or so just north of the ship, but its horizontal extent is only 5-8 km. One cell is emerging from the east, and it appears to be our only hope for precipitation this morning. RG

990826/1858 UTC The echo emerging from the northeast is turning out to be an echo mass of dimension at least 50km across, moving towards the southwest. Showers are visible on the horizon to the northeast. Otherwise Cu all quads with a small Cb to the

southwest and a shower 90 degrees to the right of the rising sun. This shower is small but nearby. CL

990826/2035 UTC

**Radar taken down** for sun track. Weather is mostly sunny and we are getting good returns (first try got to 7.5 dB). Got a good 6.5 dB return on final suntrack.

ZAUTO: Right on the money. Radar back up at 21:12 UTC.

990826/2300 UTC left station at 2230 to meet the mail at the small boat pass near Kwaj. The time of meeting is 0100 UTC. We should also receive tie wraps for the sounding balloons. The sky is mostly clear, with Cu all quads on the horizon. There are small patches of Cc and Ac. There may be some Cs near the horizon.. CL

990827/0000 UTC

**Radar taken down** as we approach the atoll. Will change tapes and restart after getting the mail and getting back to port.

990827/0330 UTC

Only a few scattered echoes in the southeast quadrant. Cu all quads. Some blue sky. There is extensive high cloudiness, too. Ci, Cc, some Cs. Also, Ac, As. The variety and variability and variety of cloud forms in Kwajex is very impressive. CL

990827/0640 UTC

Echo activity increasing since the last log entry. Echoes mainly in the SE quadrant, But new activity is moving into range in the NE quadrant. Still on scan sequence for 13-km heights. Echo tops 6-7 km. A shower passed nearby but not at the ship at about 0530. Cells are moving from about 070 degrees. Strongest echoes 50-53 dBZ. Each individual echo of 10-20 km across shows multiple smaller cells within it. The new showers to the northeast are not yet visible on the bridge. There are numerous small cu all quads at 0649, but no showers are visible. Some Ci is visible at the horizon, but the horizon is mainly obscured by Cu.. Sunset will occur soon. CL

990827/1105 UTC

Brief shower soaked the deck around 0900. This was an isolated cell. Only a few scattered echoes on the radar now, with nothing more than 35dBZ. Cu appear to have more development than during the afternoon, but never really get going. Radar display in computer lab has stopped injecting, so we are unable to give more details on the current returns. MTC

990827/1505 UTC

Very quiet. Very quiet indeed. Analysis display in computer lab still down, but you'd hardly know. A couple 35dBZ echoes west of the profiler. Otherwise nothing. Swell has

increased significantly since yesterday, perhaps foreboding rougher weather tomorrow?  
Until then... MTC

990827/1748 UTC

Several lines of showers extend E to W about 50 km N of our position. Some have dBZ to 45. Some echo heights of about 10 km. It looks like there may be/ have been showers over the other profiler (the one on land). The line of showers is visible on the ship's horizon. Otherwise the sky shows a few isolated showers, and a horizon full of Cu. Overhead there are patches of Ci, Cc, and Cs. There are smaller patches of Ac and As.  
CL

990827/1907 UTC

Nice line of showers due north of the radar and directly over the atoll. Mostly restricted to the NW DD lobe. Line is oriented mostly E-W and reflectivities are in the 40-45 dBZ range. A very impressive anvil, showing is evident as is some fairly impressive shear.  
DBW

Saturday, 28 Aug 1999

0000UTC tapes changed—late start time due to proximity to Kwaj.

RB1990827 0121-2358UTC – 340files

RB2990827 0121-2358UTC – 198 files--iris restarted... files missing due to tape not being remounted. Times missing are 0813-1546UTC

RBHP1 tape drive cleaned

RBHP2 tape drive cleaned

DM

990828/0640 UTC

At 0141 there were only 2 very shallow, very weak echoes on the screen

At 0205 there were a few scattered echoes to the NE forming a weak line at about  $r=130$  km. These were the only signs of activity, but there is an overpass and an aircraft mission is planned.

At 0210 surveillance scan shows more small scattered echoes at  $r>150$  km to the NE.

At 0246 only 1 small echo to the NE at  $r<150$  km. There were a few more at  $r>150$  km.

At 0323 there were a few small scattered weak echoes to the NE and NW.

At 0404 there was no particular change.

At 0528 all echoes within 200 km were so weak that they were hard to tell from noise. The aircraft mission had little in the way of targets.

At 0630 a few small echoes between  $r=100$  and  $r=150$  to the SSE and SSW in the past 2 hours developed and are dissipating. CL

990828/0645 UTC

The sun is setting and I've come up to the bridge to look at the clouds. The sky is nearly overcast, even though the radar shows nothing much in the way of echoes. There are Cu all quads (some are Tcu), and a sky nearly full of Ac, the first time in Kwajex I've

seen so much Ac. Especially near the horizon there appears to be some Cs above the middle cloud layer. As always, a beautiful sunset.

990828/1100 UTC

Echoes up to 42 dBZ about 100 km SW and 100 km SE, moving westward. Small short-lived echoes forming and dissipating near ship. No significant weather or rain in visual range. Scattered Cu all quads. Thin Ci (moon is fuzzy).

990828/1147 UTC

Sky looks different tonight. Lots of Cirrocumulus and cumulus. Lights of Kwajalein visible on port bow (usually not visible).

990828/1530 UTC

It appears as if today will be a mirror image of yesterday, with tiny echoes dancing across the radar coverage area from the east. Whereas yesterday had a decent cell move through the upper of the two dual Doppler lobes, today has the best cell going through the lower of the two lobes from about 1415 UTC till approximately 1600 UTC. The next TRMM satellite overpass is at 1706 UTC, and it is classified as an above average type '3', but I am not holding my breath for anything exciting to pop up between now and then. RG

Sunday 29 Aug 1999

0002UTC --Tapes changed

RBHP2 is again not writing all the files to the tape. Missing files from 0745UTC-1530UTC for some reason.

RB1990828 – 0000UTC 28 Aug 99 – 2358UTC 28 Aug 99 --- 458 files

RB2990828 – 2201UTC 27 Aug 99 – 0000UTC 29 Aug 99 --- 297 files

Copies should be made from RBHP1 tape.

Otherwise, no problems

DM

0022UTC – The large stratiform event has moved off to the southwest of the ship. Small, newer echoes are moving in from the east and are a little less than 100km away right now. It's difficult to tell if they are going to strengthen or not. – DM

990829/0108 UTC On the 0036 scan, there appears to be an R-phase problem for a few azimuths between 180 and 190 degrees. Beams have data at inner ranges, then no data beyond that. R-Phase may be confused by data at close range, or it may be detecting 2<sup>nd</sup> trip echoes from echo in the large echo mass at ranges >150 km. CL

In the large echo mass to the southwest of our position, some tops go to 12-13 km at 0028. Peak reflectivities of 44-50 dBZ observed at 0048. In the echoes moving closer from the east, tops to 10 km at 0048 and peak reflectivities of 44-50 dBZ. CL

990829/0118 UTC To the east, Cb are visible in connection with the echo feature to the east. Sky is dark on the southwestern horizon, in connection with the large, largely

stratiform echo mass moving away. In other directions there are Cu. The sun is shining through upper clouds overhead—Ci, Cs, and Cc. There is also an extensive layer of As, so the sunshine has a watery appearance. At 0129, there appears to be virga from the As to the SW. The radar shows very weak echo there, close to the threshold. Not very bright for this time of day. This is all consistent with the aftermath of an MCS passage. CL

990829/0407 UTC At 0300 the radar screen had many echoes. Approaching was a line of showers about 50 km long that had rained on Kwajalein earlier this afternoon. The line passed the ship at about 0400 and gave us a small shower. At 0321 it was cloudy with a few patches of blue sky. The line of Cb extended N to S to the E of the ship. There was low cloud to the SE (Cu) behind stratiform precipitation. It looks like convergence into a wake low. There was also extensive middle cloud (Ac and As) that obscured the upper cloud that seemed to be present. At 0300 there were many individual cells with reflectivity 40 dBZ or higher. The main types of echo present were isolated cells and small lines about 50 km in length. There was one area of stratiform precipitation of size larger than 50 x 50 km. Highest tops at 0300 were 9-10 km with more typical tops of 6-7 km. The general appearance of the sky is the same now (0416) as at the beginning of this period. CL

990829/0636 UTC Over the last 2 hours or so, the convective activity has decreased greatly in intensity. There are 2 major echo areas, one to the northwest and the other to the southeast. To the southeast is stratiform precipitation from the dying system described above. The line to the northwest is more convective in appearance, and reflectivities get as high as 39 dBZ. Echo tops are 7-8 km in this line, with tops elsewhere in the 6-7 km range. This line to the northwest is dissipating too at 0606, although visually it appears to be still raining. Many of the areas occupied by echo have reflectivities in the very low range, down to 2-7 dBZ. Visually, at 0630 there are Cu in all quads as usual, and the Cb is visible to the NW. The sky is overcast. There are a few patches of blue sky, and in those Ci are visible. There is extensive Ac and As. The Ac near the Cb have a wavelike appearance. Does this mean there are gravity waves around? CL

990829/0900 UTC Over the last 2.5 hours, the intensity of convection has continued to decline. But at 0926 the XO on the bridge says that there is cloudiness ahead. There is a small cell to the east at <50 km range. It may pass overhead. Maybe the next shift will have a comment about it. CL

990829/1255 UTC Brief rain event 1050-1100. Northern fringe of 20km-long NW-SE oriented line moving from 85 degrees. This line was embedded in a larger-scale NW-SE oriented line which spanned the 150km display. Echo tops generally less than 8km, though one 12km top 50km SE of radar. Period of very light drizzle followed about an hour after rain event. 12Z balloon failed at 850mb. Relaunched after rain event. Optical rain gauges measured 20 mm/hr during event. Took meth blue sample at 1056, composed of mostly <1.6mm drops. -MC

990830/0230 UTC It has been raining for about 2 hours, usually lightly. A loosely organized linear collection of individual features extends from northeast to southwest over our position out to the 150 km boundary of echo coverage. It extends past the coverage of the surveillance scan as well. The most intense cells have reflectivity max of 39-44 dBZ. Other parts of the band are non-linear features of very weak reflectivity (2-28 dBZ). Right now one extends between here and the Kwaj radar. Within the last 90 minutes took 6 methyl blue samples. Total echo coverage of about 10%. The Convair is on a mission to the northeast of Kwaj. In the overall band. Rain here interfered with the balloon launch at about 0145. Tops of 13 km max at 0234 in convective cells to the northeast. At 0215 the sky shows Cu from SE to SW, Cb to SE, rain from SW to NE (clockwise), and still light rain at the ship. The cells are moving from about 65 degrees and the larger elements from about 85 degrees. CL

990830/0630 UTC The Convair earlier flew through the southeastern dual Doppler lobe while convective cells and stratiform rain flew through. Highest tops were 12-13 km, but most echo tops were more like 9-10 km. Peak pixel reflectivities were near 50 dBZ, but the more intense cells had areas of reflectivity in excess of 40 dBZ. By 0548, there were few cells and large areas of stratiform precipitation. Neil did some experimenting with the surveillance scan during this period, but the volume scans went on uninterrupted. I made some meth blue raindrop pictures. Light rain persisted at the ship for several hours. At 0627 not much cloud to report except for the extensive altostratus deck producing the rainfall. Some Cu are visible, and through breaks in the middle cloud some high cloud is visible. There are more whitecaps on the sea than I have seen so far on the cruise. CL

990830/0810 UTC The complex echo pattern is beginning to dissipate, but very slowly. There will probably be echo present for several hours. Looking at the surveillance scan shows that the generally east/west band of precipitation echo centered south of us about 50 km extends well beyond our 150-km range. In our vicinity, the pattern looks like 2 parallel, roughly east-west bands of mainly stratiform precipitation, moving slowly to the west, with an occasional convective cell with a northeast to southeast motion. The highest cell tops are 11-12 km, with the more typical echo tops of 9-10 km. At 0630 an extensive deck of altostratus cloud was visible, together with light rain at the ship. Some high cloud was visible through breaks in the middle cloud deck. There were also some Cu. CL

990830/1300 UTC Echoes are dissipating and moving out to the west. Sky bkn altocumulus. S-band profiler showed virga at around 1100 UTC from 2 to 8 km with freezing level at 5 km.GC

990830/1500 UTC Nothing spectacular in the way of precipitation. The best activity is between 50 and 100 km SW of the RHB, where a cell has mushroomed to about 45 dBZ. Elsewhere, minimal scattered stratiform precipitation exists, particularly in the SE quadrant of the scanning range. RG

Tuesday 31 August 99

0000UTC tapes changed

RB1990830 – 0000UTC-2358UTC 30 Aug 99 – 355 files – no problems

RB2990830 – 0000UTC – 2358 UTC 30 Aug 99 – 355 files – no problems

Both tapes had the exact same # of files for once!! ---- DM

990831/0300 UTC

For the past 3 hours we've had typical overpass weather, with few echoes, and those weak and dissipating. The echoes that have occurred have been mostly to the south and west at a range of about 150 km. Echo movement is from about 150 degrees. Typical tops of 2-3 km and highest tops of 3-4 km. At 0300 the sky is mostly cloud-covered, with a few patches of blue sky with Ci in them. Extensive Ac and As. Many Cu all quads, with some Tcu. The wind is light (3 kt) and the seas are less disturbed than the last 2 days. CL

990831/0825 UTC Late this afternoon and evening had two showers from small echoes that developed nearby and approached from the south. Echoes moved from about 160 degrees. The first shower was from about 0500 to about 0600. I took several methyl blue images of drop sizes ranging from very small at the end of the shower to fairly large when the shower was heaviest, to middle-sized at the beginning of the shower. Tops were 12-13 km in the deeper cells, and 7-8 km in the more typical cells. During this late afternoon period after the overpass, convective activity appeared to be on the increase. From about 0626 to 0704 there was a second shower at the ship, with about the same cycle in the appearance of the drops on the methyl blue samples. Precipitation came from short (about 20 km) linear convective features moving from the SSE. There were wind gusts in the showers but between showers the winds were quite weak. At 0800 the surveillance scan shows other such features between ranges 150 km and 300 km. Neil verified by printing out radar parameters and other info that no settings have been changed since 20 August. At 0800 most of the echoes are in the NW and SW quadrants. CL

990831/1305 UTC Negligible wind and echoes. Seas (and eyes) becoming glassy. Sky 2/8 altostratus. GC

990831/2050 UTC

**Radar taken down** to check the azimuth/elevation gears. Everything OK. Greased gears and left it at that. Very few echoes were present except some decaying showers. Also will do a ZAUTO and suntrack. DBW

990831/2200 UTC

The first attempt at a suntrack did not go very well, so a ZAUTO was done and the receiver checked out OK. The second suntrack worked out fine, and the radar was up and running again at 2200. Down time was only one hour, and there is hardly any precipitation out there at all, so little if anything was lost in the way of data. RG

Wednesday 01 September 99

0000UTC – tapes changed

RB1990831 – 0000-2358UTC 31 Aug 99 – 342 files

RB2990831 – 0000-2358UTC 31 Aug 99 – 342 files

No problems

DM

990901/0300 UTC

Small isolated showers have been present on the radar screen for several hours. The winds are light, the sea is nearly calm, and today looks like a good opportunity for a sphere calibration. We couldn't do it with the Kwajalein radar because the Aeromet chief tech is on Meck today working with the sounding equipment there. So the Brown is doing its own sphere calibration. The small boat is ready to be launched. We have FAA clearance for a balloon to go 600 ft until 16:30 local. Dave Marsalek and Gordon Carrie are going out with fishing line and the 6 inch sphere. Neil and Dave Wolff are setting up the scans as the RHIB (rigid hull inflatable boat) is launched at 0307. The RHIB is heading towards 090 degrees, and is headed for a distance 3 n. mi. from the ship. As of 0311 stopped taking data, but the radar is still radiating. Except for cirrus outflow from Cbs, there is no upper or middle cloud. The showers are visible as Cbs and there are also lots of Cu, with some Tcu. At 0328 the RHIB is in position at 3 n. mi. bearing 095 degrees (slight change in azimuth to keep away from a shower). At 600 ft, and 3 miles, my trig says an angle of 1.884 degrees. At 033128, radiating towards the balloon, which is being launched from the RHIB. At 0332 Neil and Dave are pleased to have found the sphere on the radar, at about 1.7 or 1.8 degrees. Data is being recorded as well. The signal is strong in the 15 to 27 dBZ range, in the lowest scan. The maximum strength is in the 25-30 dBZ range, although the digital data will have the precise value. At 0341 other echo is starting to appear in near the balloon. In the analysis, Dave will look particularly at azimuths 091-094 degrees and heights of 5-8 km. The last scan is being recorded at 0346, and the scan is stopped as of 034650. The RHIB is beginning to bring in the balloon and come back. From 0331 to 0344, eleven sector scans were recorded. The sphere calibration is complete as of 0348. This time we had specific FAA approval for a 600 ft balloon launch between 0300 and 0430. The radar was not scanning the TRMM scans from 0310 to 0348, when scanning in the TRMM mode was resumed. CL

990901/1300 UTC A 100km-long N-S oriented line with max tops >13km (190az/80km) passed S of ship and has since dissipated. Individual echoes within the line were moving from 030 at 25kts, about 20 degrees to the left of the overall line motion. Three brief showers on the ship at 0730;0800;0830. All were captured by the 03 optical rain gauge. Current scan is very quiet, with only a few isolated echoes to the west at >100km range. A few Cu of moderate vertical extent are in the area of the ship, but no sign of precip. Sky is otherwise crystal clear, with milky way, saturn, and jupiter clearly visible.

990901/2130

**Radar taken down** for ZAUTO and Sun Track. Notch Filter (5.587 GHz). Radar was back on line. SunTrack appears to be about 0.1 degree (low). Did manage to get 8.5 dB return via manual adjustment. ZAUTO went well, with noise of -109.56 dBm.

990902/0300 Typical overpass weather. A few scattered small echoes from small Cb, mainly to the S at >100 km range. Some cirrus, otherwise Cu all quads. Wind from the northeast. A very quiet day for the atmosphere. CL

990902/notes on 0300-0900 added from downstairs hand-written log on 09/03: For the overpass, the aircraft flew in isolated cells to the SE at range about 125 km. At 0330 hardly any change except that echoes were mainly in the southwest quadrant. At 0448, little change since 0330, and fewer echoes. At 0534, the surveillance scan showed many small weak echoes and 2 larger weak echoes to the SE at range >150 km. At 0903 there had been little change over the past several hours, except that echoes to the SE were closer in range, from 60 to 150 km. There were Cu visible all day. CL

990902/1309 100 km line of up to 40 dBZ echoes with tops up to 12-13 km oriented SW to NE passed ship going from SE to NW at 25km/h. Heavy rain 1245 to 1253. Cells passing over ship developed rapidly on SW end of pre-existing convection to NE

990902/1510

Several strong cells developed in the lee of the 1245 line. Three heavy showers (03 optical gauge maxed out at 160mm/hr in each of the events--see time series in log book) hit the ship: 1324-1336, 1339-1344, 1345-1357. Strong gusty winds accompanied the first and third showers, with max sustained 21kts and 24kts respectively. Radar indicated tops less than 8km on these cells. Launched just as third shower hit. Balloon terminated at 850mb. Skies cleared soon after third shower. Performed relaunch shortly before 1430. This event truly bears further study. Conditions appeared very stable, with only some high Cirrus prior to development of the line. Line spread quickly from NE quadrant across ship to beyond 100km range in SW quadrant. Took several meth blue samples, including one with two 4.2mm diameter drops – largest of the cruise. Line has moved well off to the west now. All in all a fun nite. –MTC

Friday 03 Sept 99

0000UTC

tapes changed

RB1990902 – 0000-2358UTC 02 Sept 99 – 360 files

RB2990902 – 0000-2358UTC 02 Sept 99 – 360 files

No problems

DM

0101UTC—good echo coverage for the past few hours. Excellent bright band showing up on the high elevation scans. Strongest echoes are 45-50 dBz to our northeast. Rain all around the RHB... could be a good day if it continues. DM

990903/0700 UTC And it did, all day, and now there is still another line of fairly strong echoes approaching from the southeast. The screen has showed large areas of stratiform precipitation since before 0000 UTC. Cells develop and propagate from the southeast,

and the areas of stratiform precipitation dissipate very slowly as they ooze westward. Rain at the ship is continuous, and methyl blue samples show few very small drops, even in the lightest rain. Echo tops were quite tall, 13 km and higher in the highest cells, with many areas of 8-10 km tops. This was probably the most disturbed day of the cruise. At 0600 Jeff Otten noted extremely low (for here) relative humidity, near 50%. This is consistent with the presence of a mesoscale unsaturated (even though it was raining slightly) downdraft penetrating the boundary layer. CL

990903/1130

Substantial clearing on radar. Stars now visible through very thin As. Stratiform echoes in NW quadrant have disappeared. However, convection along leading edge of outflow from convecting area along S perimeter of radar has intensified at 80-100deg az, 80-150km range. Outflow-boundary convection has motion from 170 at 40km/h with 10km tops, passing just W of Namu at 0922. New ensemble of 50+dBZ convection has entered radar range in SE quadrant. Occasional lightning observed by bridge watch in this direction. -MTC

990903/1305

Echoes to E developed motion from 110 at 35km/h. Tops grew to in excess of 13km at 1200, but have since decreased somewhat. System to SE of ship continues to approach slowly. Some >45dBZ echoes embedded in both systems.

990903/1515

Systems have clearly taken on a leading-line/trailing-stratiform appearance, with 10km tops and 40-45dBZ in the convective regions. Systems have motion from 130 at about 30km/h. System to SE at 40km may intersect ship.

990903/1625

Sharp jump in humidity and drop in temp with wind shift (ESE-ENE) at 1520Z. Appears to be outflow from NE quad system, which has 100x100km stratiform region now. Sky is darkening and lowering, with towering Cu visible. Almost entire E half of radar screen contains echo now—mostly stratiform. SE system is now <10km from ship, but has weakened, with tops under 9km and max dBZ <40. -MTC

990903/2105 UTC

**Taking the radar down** so that bridge can change light bulb and then will do a ZAUTO and SunTrack. Most of weather has exited the scene except for a few anvils left over from old stratiform. Looks like a quiet day for now.

Notch filter at 5.591 GHz.  
SIGGEN also at 5.59 GHz.

Noise -109.69 dB. Nice fit on ZAUTO curve.

Mag Current; 16.6 ma  
HVPS voltage: 1.33 kv

HVPS current: 404 ma

Saturday 04 September 99

0000UTC – tapes changed

RB1990903 – 0000-2358UTC 03 Sept 99 – 349 files

RB2990903 – 0000-2358UTC 03 Sept 99 – 349 files

No problems to note

DM

990904/0138

**Radar being taken down** for another sphere calibration. This time coordinated with Kwaj. We are looking into how to keep the radar recording while doing manual control of the antenna, but am not at all familiar with this methodology. We need to get some estimate of where the balloon will be.

990904/0245

The last volume scan before the sphere calibration was 013600. The balloon was released on time at 0200. Our radar was able to track the sphere, and using the slant range, azimuth, and elevation information provided by TRMM OPS relative to our position, Neil was able to update our scan to take into account the changing position of the balloon. Our radar painted the 12-inch seamless sphere to a range of more than 20 km. Our position was about 9 n. mi. S of KWA at 8 degrees 34.145 minutes N and 167 degrees 39.564 E. We recorded sphere calibration data from 0214 until 0240. At 0255 we are coming about and proceeding to return to station. It will take about 90 minutes. At 0255 Neil is bringing the radar back to volume scan mode.

990904/0303

Problem with DSP, had to qiris, then enter dspx, “power up reset”. Then do a “restore saved settings” and then restart irir. Now ok.

990904/1300

Large 100x50km stratiform region with embedded convection in SW quadrant slowly moving W. Max tops >13km in this system. A loosely organized N-S line of widely spaced single cells, also moving W at 25km/h, passed over ship from 1000 to 1100. A very brief sprinkle from one of these cells hit the ship, registering 0.1mm/hr for under a minute at 1045. Scattered Cu and a very thin, spotty Ac layer make for less-than-ideal star-gazing. E of ship there are almost no echoes, so expecting quiet remainder of shift. -MTC

990904/1510

Drizzle at ship 1425-1427 from puny cell. Otherwise totally clear/ great star gazing. New disorganized wave of popcorn convection coming in from E. Fairly extensive system at far S extent of radar with Srly component. Cell N of profiler surprisingly tall/strong for isolated (>13km tops, 50dBZ base reflect). -MTC

Sunday 05 September 99

0000UTC – tapes changed

RB1990904 0000UTC-2358UTC 05 Sept 99 – 337 files

RB2990904 0000UTC-2358UTC 05 Sept 99 – 337 files

No problems to note

DM

990905/0630

In the late morning there was extensive precipitation in the southeastern dual Doppler lobe. There was heavy rain at the ship from 2300 to 2330. There was a line of convective cells extending from northeast to southwest centered on the ship. There were other cells to the WSW and a large area of stratiform precipitation with a few embedded cells to the east. The stratiform area was dissipating as it approached. Made 2 meth blue samples just after noon.

The DC-8 flew this morning on a mission that included the cells and later stratiform precipitation that produced rainfall over the ship. Their flight path on this mission took them quite close to our position.

After noon, the stratiform area to the east was supplemented by fairly intense cells to the east at a range of 150 km. These dissipated, adding to the stratiform rain area. By the time this area of weak echo reached the ship it was an extensive deck of altostratus that produced only an occasional drop of rain (“spitting” as they say in Texas). Isolated cells continued to develop and dissipate in the NW and SW quadrants.

From 0200 to 0400, the stratiform echoes continued to weaken and move westward slowly. Tops were reduced from 11 to 12 km and greater this morning to highest heights this afternoon of 9-10 km.

.....From 0430 to 0600 the area of stratiform precipitation shrank further and the echo intensity decreased. By 0536 no cells or areas of even moderate reflectivity remained, even though echo coverage was still reasonably large, with echo features larger than 50 km in horizontal dimension.

At 0645 sunset is approaching. There are dark clouds to the west, and Cu all quads. The clouds to the west must be the thickest portion of the As deck. There are a few patches of blue sky overhead, to the southwest, and to the northwest, but Cu and As dominate the sky. It looks like the next several hours will be quiet ones in terms of radar echo activity, with continued dissipation of the echoes that remain. The next shift is more likely than this one to notice increases in convective activity. CL

990905/1300

Altostratus and Cirrus have moved out leaving only a few scattered Cu. Radar shows only a handful of weak cells. –MTC

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Monday (Labor Day) 06 September 1999

0000UTC--- tapes changed

RB1990905 0000-2358UTC 05 Sept 99 – 360 files

RB2990905 0000-2358UTC 05 Sept 99 – 360 files

No problems to note  
DM

990906/0310 UTC

At 0100 there were some small scattered cells typical of past overpasses. The DC-8 and Citation were flying for the overpass. The cells appeared to be moving from 090 degrees. The tallest echoes had tops of 10-11 km, with 6-9 km more typical.

At 0224 there was little change except that most echoes were in the SE and SW quadrants.

At 0252 there was a brief shower at the ship, and I collected 2 methyl blue samples. There were lots of drops on the 5 second samples, with none unusually large and few very small.

Visually at 0315 there are Cu and Tcu all quads with the shower that just passed still visible. There is extensive Ci, Cs, and some As. There are a few patches of blue sky, mostly containing Ci. CL

990906/0709 UTC

As the afternoon passed there was continued development of isolated cumulus showers. At 0500 the principal mode of organization was small lines (20-30 km long), one cell wide, and several cells long. These units were separated from one another by about 1 unit length. Tops reached 12-13 km. Typical tops were 8 km and higher. They were travelling from east to west.

By 0700 there was little change from 0500 except the echoes are in different places and the maximum and typical heights are 8-11 km. Showers are visible to the north and south, as well as Cu and Tcu all quads. There is still Ci and As, as the sky darkens for the night. CL

990906/1255 UTC

Isolated short lived showers moving east to west. No rain was observed at ship. Clear skies overhead most of the night. Started using 450 psi in sounding balloons in an attempt to get wind measurements more consistently, but 1200 sounding failed.

990906/2112

**Radar being taken down** for ZAUTO and Sun Track.

Sun track, and zauto completed. Radar up and scans started at 22:11(NSD)

Tuesday 07 September 1999

0000UTC -- tapes changed

RB1990906 – 0000-2358UTC 06 Sept 99 – 345 files

RB2990906 – 0000UTC-2358UTC 06 September 99 – 345 files

No problems to note

DM

990907/0630 UTC

This afternoon was not an active one for the project as a whole, at least we did not hear of any on the radio. There has been extensive echo activity, including in the dual-Doppler lobes.

At 0100 convection had been on the increase over the past 1.5 hours. At that time the OPS Center said there might be an aircraft missions. There were 3 larger echo features of 50 km or more in horizontal dimension.

At 0236 there was a heavy shower at the ship and I made the last (of about 90) methyl blue samples.

At 0300 there were tops of >13 km in one of the echo features, showing intensification since 0100. Two of the previously noted echo features showed areas of stratiform precipitation.

At 0412 the overall echo pattern showed a roughly linear feature extending E to W, centered between the ship and Kwaj. Extensive convection was organized in linear subfeatures. In the dual Doppler lobes there were a few pixels of 53-55 dBZ. New features continue to come into range from the east.

At 0530 the overall picture had changed little, just that the echoes had moved and gone through individual life cycles. If the echoes persist, the next overpass could be especially interesting.

At 0608 the pattern on the largest scale was still linear E-W. On the mesoscale each 50-100 km band is linear and oriented NW-SE. Within and between these smaller bands the pattern shows irregularities and regions of stratiform precipitation.

At 0628 it has been raining at the ship for about 15 minutes and heavier rain is approaching. The sky is overcast, with no patches of blue sky. There are Cu, Cb, and As. The sky is so dark (and the sun has not yet set) that I assume there are upper clouds present as well. It looks from the bridge as though a linear squall is about to pass the ship, approaching from the east. CL

990907/0900-1030

System passing S of ship spread N bringing good event 0855-0930. 03 optical gauge measured ~20mm/hr; 2C temp drop and wind shift from 100deg/10kts to 150/23 in 5 minute period. 45dBZ/11km tops in neighborhood of ship, but 55/13+ within 50km to S and W. Second event 0955-1015. Again ~20mm/hr. T,wind shift less pronounced with this cell. System motion during this period from 090, but individual cells moving both N and S within larger systems. SW quadrant now has leading-line/trailing strat appearance with an embedded SW-NE-oriented line moving N.

990907/1030-15000

System to S has become almost purely stratiform and is clearing out to south and west. A small line has developed at 45deg/50-100km az and is moving NW. Otherwise no echoes, clearing sky above.

990907/2129

Nice squall heading for ship. First drops at 2129. Max dBZ's about 45 dBZ. It is a small cell, and part of a line that is in the SE dd lobe, which is moving WNW. Quite a bit of convection in the SE dd lobe, although it is fairly unorganized, albeit intense. Sun starting

to break through the clouds at 2145 UTC, still light rain with small drops reducing visibility to  $\frac{1}{2}$  mile or so. Event over 2150 UTC.

Wednesday 08 September 1999

0000UTC – tapes changed

RB1990907 – 0000UTC-2358UTC 07 Sept 99 – 360 files

RB2990907 – 0000UTC-2358UTC 07 Sept 99 – 360 files

No problems to note

Tape drives cleaned!!

DM

990908/0623 UTC

This afternoon was a lot more active than it was forecast to be. At 0045 the tallest tops were 11-12 km at azimuths 270-330 degrees. Echoes were moving from the southeast. There was extensive stratiform precipitation to the west.

At 0136 the older systems were located to the west and a newer system to the ESE near 150 km range had attracted the attention of the aircraft, which had just taken off at 0143.

At 0201 attention focused on a line of cells to the SE that were just coming into radar range. The OPS Center asked us to make RHIs, and we complied, continuing these through the afternoon.

At 0412 the feature of interest to the aircraft had moved well into range, with extensive stratiform precipitation trailing an area of intense convective cells. Highest echo tops were 10-11 km, although most of the feature of interest was beyond the range of the TOPS product. The Citation had landed, but the DC-8 was still flying. A small line of showers centered about on the ship and extending from NE to SW was developing.

At 0606 convection continued to develop. New echoes were coming into range from the east, mainly fairly intense (dBZ>40) cells. The small line of cells that was over the ship at 0412 had moved northwestward and developed into an intense line about 100 km long, located NW of Kwajalein.

Visually at 0637 the sky is overcast with a couple of small clear patches through which high clouds can be seen. There are Cu all quads with showers visible. Mainly As overhead, with some mammatus, the first I've seen during Kwajex. There seems to be deep cloudiness, because it is fairly dark for the hour before sunset. Echo activity had been forecast to decrease on account of ridging, but so far there is no sign of it in the radar data. CL

990908/0800UTC

Occasional lightning to NE. Less than one stroke / 5 min. GC

990908/1251UTC

Ship rocking and rolling nicely ahead of strong NW-SE squall line approaching ship at 0900. Line contained 60dBZ echoes with tops >13km and a large stratiform region separated by about 50km to the NNE. Line had motion from 120 at 20km/h. Individual cells within line were moving from 150 at 40km/h. Line rapidly weakened as it

approached the ship and gave only a few drops of rain. Line and accompanying stratiform region have since dissipated, leaving little of note on the current scan.

990908/2223

**Radar taken down** to look at the antenna, do a ZAUTO and run a SunTrack.

Noticed that one strut from the feed horn to the dish has about a 4" crack!!! Will take a digital picture of it and report to whomever. Otherwise the gears look good. Captain would like to climb up after lunch to take a look at the equipment. DBW

990908/2303

DBW, RG and ND climb back up antenna. There is noticeable strain on all of the struts. Neil and I agree that **no more RHI's should be done, nor should the radar be operated in rough seas or while under way** until the strut(s) is (are) fixed. Several pictures of the antenna and struts may help to explain further, but it appears that the RHI's may have caused undue stress on the dish and joints. DBW

990908/2304

Performing ZAUTO. Will wait on Sun Track until tomorrow morning.

Notch filter: 5.591 GHz

SIGGEN: 5.58? GHz

BW: 1.614 (0.934 MHz)

Printed out bw.info

Noise right in line with other readings.

Thursday 09 September 1999

0000UTC – tapes changed

RB1990908 0000-2358UTC 08 Sept 99 – 354 files

RB2990908 0000-2358UTC 08 Sept 99 – 342 files

12 files did not get written to RB2

DM

990908/0028

Radar being taken down to take another look at the antenna with the Captain.

Scans Resumed at 00:51 (NSD)

99

0908/0240UTC

The radar has been down for about 10 minutes for another inspection. At 0140 there were only a few scattered isolated echoes to the southeast with tops below 6 km. The screen has not been so free of echoes in several days. The sky is also much clearer than over the last few days. At sunrise (about 6:45) there were still showers visible from the ship, and I saw a rainbow from the bridge just after sunrise. Now (0243) there is a lot of blue sky, but still a diversity of cloud forms. Overhead there are Ci and Cc. In all quads

there are Cu, mostly shallow. Near the horizon are Cs. A few TCu have virga. The absence of middle cloud is startling after several days with extensive areas of stratiform precipitation. CL

990908/025517 UTC

The radar is back up, and at 0257 started in the scan sequence again.

990909/1300

Rained at ship 1035-1100 from small isolated cell ~30mm/hr on 03 optical gauge. Widely scattered small cells moving from 070 at 45km/hr with max 45dBZ, 10km tops. No organized convection tonite. -MTC

990909/2045

Radar being taken down to take another look at antenna. Will also try to manually lower antenna past the soft limit to see if it shuts off. Also will check the IRIS/antenna control to see if there is software problem or if it is a physical problem.

At first guess, it appears that the limit switches are not working, as we were able to move the antenna to both -12 deg and + 90 deg w/o an RCP-02 error. Will now check the IRIS antenna setup.

The RCP02 limits were incorrect...

Max upper is now 75.0, was 85.0

Soft upper was 84.5, changed to 70.0

Hard upper was 85.0, changed to 75.0

Soft lower was -9.5, changed to -6.5

Hard lower was -10.0, changed to -7.0

Ran "antcheck -chat" to make the above changes and rebooted the RCPO2. Still fails to stop at lower limit, as we forced antenna to -9.5 degrees with no error; however, IRIS did seem to handle the upper soft limit as it did not allow the antenna beyond +70 degree.

Restarted IRIS, reset the RCP02, found our changes in there. Checked the relays and switches and they appear to be okay. Finally did get a EL-LO error, but no one was in aft bridge to note angle. Will climb radome again to check specifically what angle trips the relays.

Friday 10 September 1999

0000UTC - tapes changed

RB1990909 0000-2041UTC 09 Sept 99 - 295

RB2990909 0000-2041UTC 09 Sept 99 - 295

Radar down a few hours for maintenance... otherwise, no problems to note

DM

990910/0102UTC About 0100 the radar is back up and recording data. In the antenna check chat mode there of IRIS there is a site menu with a miscellaneous menu. In that menu there was a command to “enforce lower limit” that had been set to “no”. This overrode any other settings chosen for specific lower limits. Neil set the “enforce lower limit” to “yes”. Now the system is operating with the software switch operating properly and limiting the wear and tear on the hardware. CL

990910/0649UTC The sun is setting. Earlier this evening a waterspout was sighted nearby off the starboard bow. There are Cu and TCu all quads, with a few showers that show up as small isolated echoes on the radar. That has been the case all afternoon, which several of us have spent writing memos. Neil and Dave described the technical problems with the antenna elevation stops, and I wrote one justifying our shutdown schedule. Actually, I wrote 2, one from me to Sandra Yuter about the procedures for shutting down the radar, and one for Captain Parsons to use as a draft to justify the shutdown schedule for the soundings and ship data recording system. Even with this schedule in place, as unpopular as it is ashore, we will have to work hard to be packed and ready to leave the ship at 9:00 a.m. on Monday morning. CL

990910/1240 UTC

Patchy echoes up to 50 dBZ moving from NE at about 40 km/hr. Bridge reports lightning to south. Brief, light rain at ship 1100.

/1620 UTC

Good squall line hit ship, with lightning and 30 kts winds.

Saturday 11 September 1999

0000UTC – tapes changed

RB1990910 – 0038-2358UTC 10 Sept 99 – 350 files

RB2990910 – 0038-2358UTC 10 Sept 99 – 350 files

Some files absent at the start due to radar maintenance

Otherwise, no problems to note.

DM

Sunday, 12 September, 2035

**Radar taken down for SunTrack.** There is some convection in the NE dd lobe, so will hurry a sun track. Also need to climb pedestal to inspect antenna, but will wait for that until end of aircraft mission.

Injected signal= -49.6 dB at 7.0 dB in receiver

Performed ZAUTO.

FINAL ENTRY: Change tapes at 990912/0000

Will also be adding period 990912/0000-0600 UTC to dataset.