King Air N2UW flight report for January 16, 2005.

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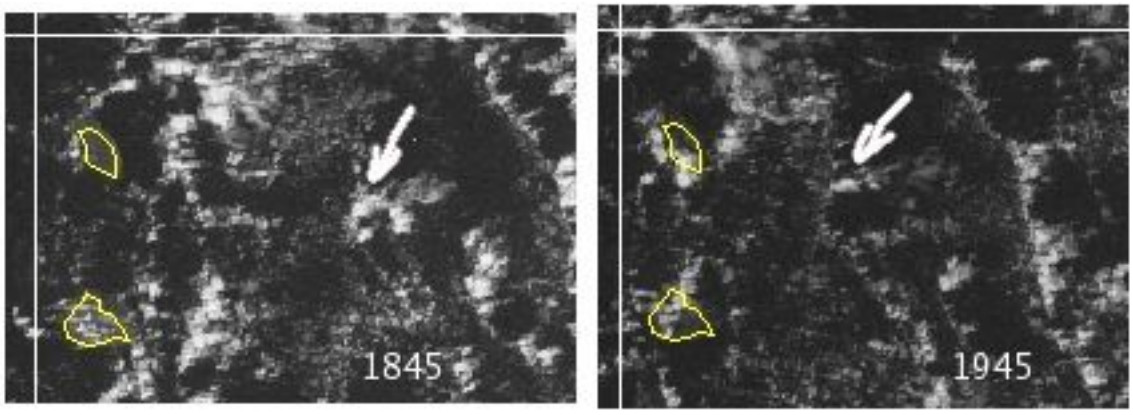
Summary:

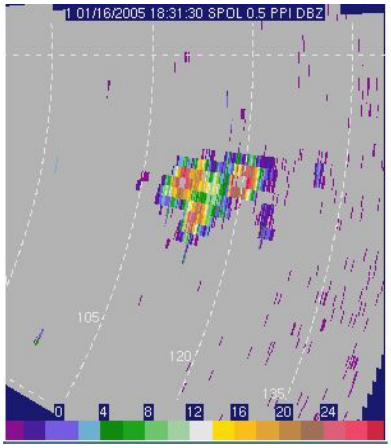
Flight had three major segments. First, extensive sampling in the vicinity of a point 110 km E and 20 S of SPol. This region was selected to avoid interference with C130 – they were attempting Jensen's line observations. Second, a brief period of sampling (20:18 – 20:40) ~40 km to NE of SPol. Third, sampling in the vicinity of Seward Johnson ~10 km west of SPol.

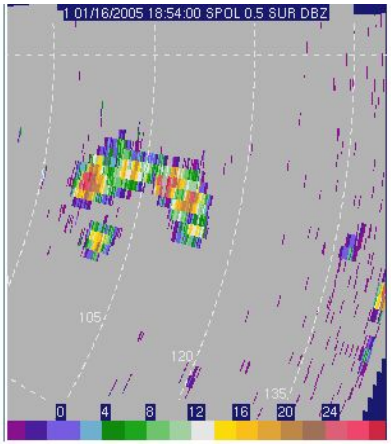
Narrative:

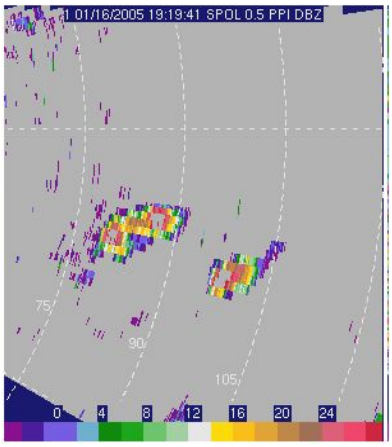
Flight segment A. This sequence examined a small cluster of active cells over the period 18:13 – 19:25. The cluster can be traced in the VIS images from about 16:15 to 20:45. From 18:45 on, the cluster appears to form the N segment of an open meso-cell which forms by the cluster splitting and opening. From then on, the open cell grows, but the two clusters into which the original one divided remain the most pronounced. In fact these are the only ones that produced SPol echoes.

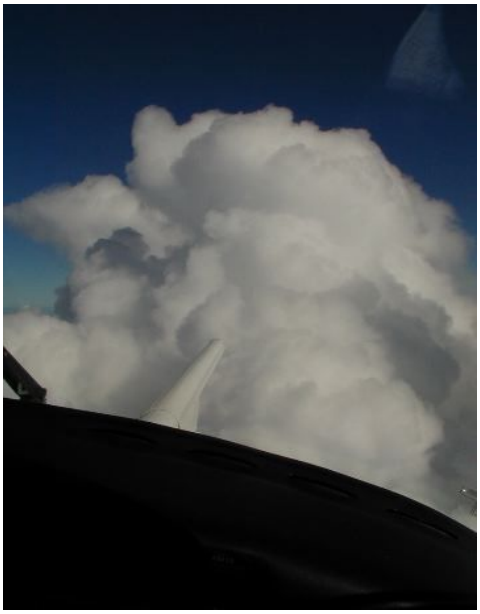


SPol echo at 18:30 for 0.5° elevation (about 1.5 km altitude at the range of the echo) was a nearly round patch of about 15 km across. By 18:54 it has several centers of reflectivity maxima, and by 19:19 it split into two separate echoes. This is sequence is shown on the next page. During the latter period, the echoes extend to 2.5° elevation (~4 km) , and maximum reflectivities reach 38 dBZ. The 4 km depth is confirmed by WCR echoes.







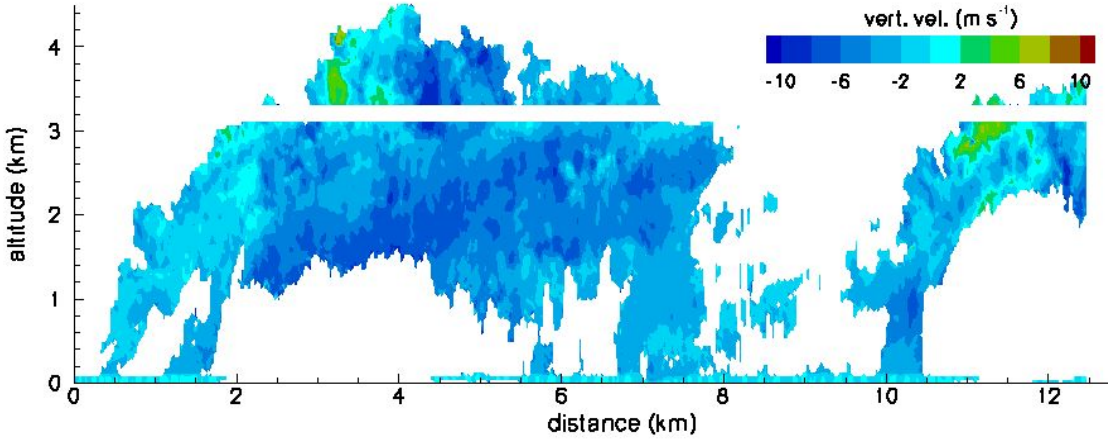


Looking E – 18:42, then looking back to W – 18:46

Rain from W at 19:16 and then from E at 19:20.

Two passes from the first portion of the flight are bracketed by the two pairs of photos on the previous page.

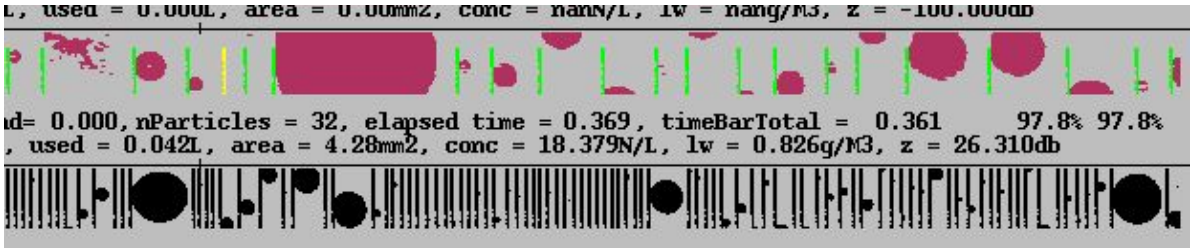
The first of these was at 3200 m (geometric) on a heading of 100°, i.e. against the easterly low level winds. At flight level, winds outside the clouds were from the south, but in clouds the easterly momentum was clearly present. Little above the flight level, beginning at the base of the inversion winds turned westerly; this is clearly visible in the inclination of the turrets in photographs and in the radar images. The velocity image from the WCR is shown below.



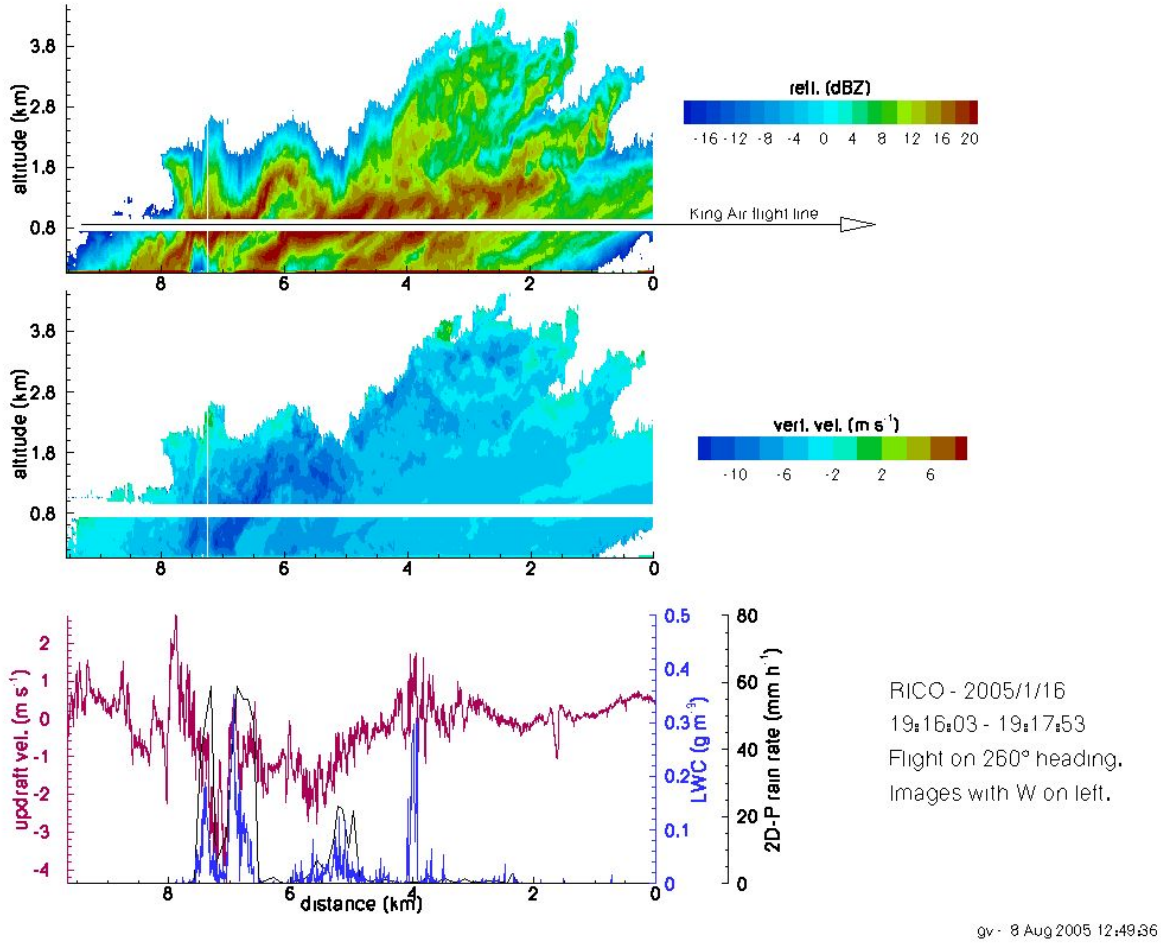
The arches in the lower portions of this image indicate that signals there fell below the noise level due to attenuation by high liquid water contents in the region at and just below flight level. Measured Doppler velocities are downward practically everywhere because the fall velocities of larger particles dominate the radar signal. Only at the very tops of turrets, on their W sides, are there positive velocities, as a result of strong updrafts and smaller fall velocities there. The dominance of fall velocities in the Doppler data is consistent with the fact that there were drizzle drops present even in strong updrafts. For example, near the 3 km mark in the image above (18:42:40), the King Air recorded updrafts of 6-8 m s^{-1} and there were drizzle drops of up to 500 μm in the updraft. The same holds for the updraft seen at 11 km (18:44:00); at that point the in situ measured updraft was up to 10 m s^{-1} and the LWC approached 2 g m^{-3}. The pronounced wind shear near cloud tops was a likely factor leading to injection of drizzle drops into updrafts.

The second sample of data is from a pass not far above cloud base, at 830 m altitude, approaching the cloud from the East. The image on the next page is reversed to show the same E->W orientation as the figure on this page from the earlier pass. As the photographs also show, a strong rainshaft was reaching the ocean surface. On the 2D probes, drops up to 5 mm were recorded and the calculated rain rate reached 50 mm h^{-1}. A sample of this record in also shown on the next page; 2D-C images (0.8 mm strip width) on top, and 2D-P (6.4

mm strip width) on the bottom.



The WCR reflectivity pattern shows a strong tilt of the echo streaks. In the deeper part of the cloud (right side), the velocity field is relatively uniform and neither does the in situ data show much updraft or downdraft activity. In contrast, the western part of the cloud, where echo tops are lower and show more pronounced turrets, there are significant in situ downdrafts (peaking at -4 m s^{-1}), and the velocity field has much more structure and larger negative values.



A rather interesting event is seen in the in situ data near 7.2 km: about 200 m of strong downdraft with no rain and much less LWC than nearby. Surprisingly, there is

nothing in either the reflectivity or the velocity fields to indicate what this might be, though the only plausible explanation is entrained air from cloud top descending to the observation level.

There were a few more passes beyond the last one shown here in the precipitation, below cloud base. The whole sequence of passes was roughly one hour in total. Then, for about half an hour sampled the other side of the open meso-cell (visible in the 19:45 satellite image on page 1).

Flight segment B: This was a relatively brief period from 20:19 to 20:40 in the vicinity of 20 km E, 20 km N of SPol.

Flight segment C: Between 20:45 and 21:15, several traverses were made of clouds near the Seward Johnson in the lee of Barbuda. The original plan of sampling a cloud as it was approaching the ship's location was difficult to follow due to the scattered cloud field. There may well be some useful data for compositing the ship and aircraft observations, but this will require more detailed work.

Flight notes:

1745 taxi; filed for 070/80 FL110

1752 T/O; CB ~ 2000' +20°C ; 70-120 cm^{-3}, 20-30 μm

1809 weak tower, will pass to see if echo is obtained or not; turning to 120 hdg toward a cluster

1812 As layer at 6700'

1818 cluster 090 hdg, 5000'

1821 out on E side, 90/270 and climb

1823 photo to E

1826 cell #1, updraft of 8 m s^{-1}; cell #2 coming

1827 out on W side, climb to 10000' with 90/270

three possible targets, one larger, two smaller; going for on on N

183114 photo

1834 out on E side; one radar channel stopped – starting new record brings it back

1834 lined up W; turbulence before entry

1840 exit, big bump!

1844 out on E side

1846 back toward W

1849 photo to left of new tower; 180° turn

1853 out on E side, descend to 8000', 90/270
1855 NRE (nose radar echo), 8000' W hdg
1857 out on W side, down to 6000'
[C130 has 010-060 40-80 segment, 5000' and below]
1905 W-bound; red NRE; 6200'
1909 red NRE; not sure if same echo as minutes before
1911 going back to pointer; E -> W heading
191254 photo; red NRE; 4500'
1923 passed precip at 1000'; photo of shadow/wave pattern on sfc (P1160882)
1924 270 turn to cross; photo of foam (P1160883)
1931 2 towers, small NRE in second one
1933 out on E side, will use 1 km offset pointer for first tower
1934 SD mode, 8000', 285 hdg
193610 nothing but whiff left; canceling offset
193945 lots of tiny NREs near the pointer;
got two passes on that one; going to the next
1945 7000' 5 m s-1, NRE patch, 2 nm along flight patch; 90/270
194526 at pointer
will join 130; up to 4000', 130 down to 3000'
2001 026/46 300' circle
2010 lining up on blow-off from Cu
2019 N-bound to small tower at 6500'
pointer set
2023 270 turn to pick up pointer on E hdg
2029 W-bound pass; continue to NRE
2031 through red NRE, 6000'
203500 at pointer
[now have clearance for 330-030, 35-50 nm, 4-10 kft]
203930 8000' at pointer
2048 E on new target; several NRE
SJ in sight on left wing, then arc {??}
2058 10 m s-1
2102 back to 2 nm dia red NRE; can't continue w/ current clearance on same

2108 photo to N of SJ
two passes over SJ
2115 photo of cell sampled earlier
2117 photo of cell looking back
2118 L/D