

King Air N2UW flight report for January 11, 2005.

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General: Scattered echoes early morning decreasing with time. C130 takeoff at 10, KA at 1230. Plan on file, with 50 nm DME as separation.

Extensive fields of smaller Cu developed. Deeper clouds were sparse, though some clouds to the north of the study area shot up to probably near 6 km. Patches of As also formed mixed with the areas of convection. Satellite images reveal clear effects of mesoscale organization, as large areas mostly clear of clouds and with deepest clouds at the boundaries.

Narrative: The King Air flight started hesitatingly, not zeroing in a good targets for some time. Between 16:40 and 17:10, a few passes were made at 2500, 2000 and 1600 m altitude. Then, in the period roughly from 17:10 to 18:10 sampling was just above and below cloud base to document variations in cloud base height and associated changes, with some time included for sampling precipitation below cloud base. Then from 18:10 to 19:00 two sets of repeat passes were made; one is a small cloud, the second in a deeper, more vigorous one. The last set, with 13 passes ranging from cloud top to near the surface, is very promising.

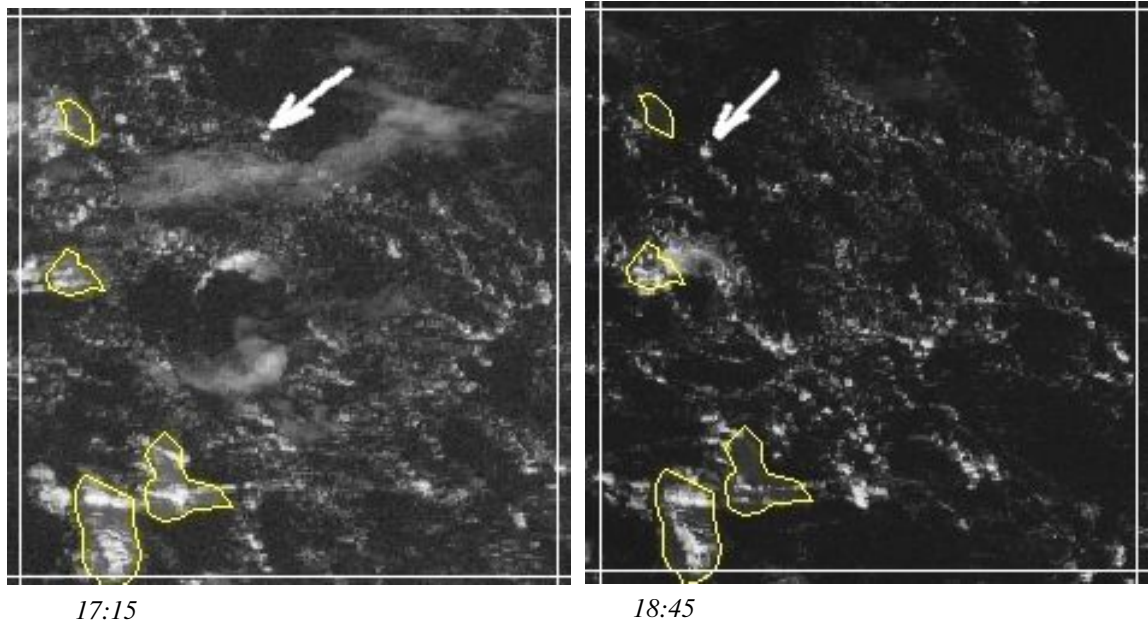
A. 16:45 – 17:07 three passes at various altitudes in cloud cluster reaching to about 2500 m altitude and producing rain to the surface. 17:10 – 17:17 a pair of passes, one with side-looking beam; fine structure is striking! After a gap in time, the cloud group was sampled again at about 17:30.

B. Cloud base samples in small Cu (17:45 – 17:53) followed by precipitation samples below cloud base from large and deep cloud group well to the SE of Barbuda (no SPol coverage) (17:55 – 18:12).

C. Still to the SE of Barbuda, a small cloud, only about a kilometer in diameter, was sampled with repeated penetrations. The passes started early in the development of the cloud, when its top was at about 1400 m. By the end of the sequence the cloud grew by an additional 3-400 m. There was a detectable WCR echo from the beginning, but no rain to the surface.

D. A small, tight and isolated cluster was sampled between 18:29 and 18:58. This cluster could be tracked on SPol from at least an hour prior to this period. It moved from a position about 73 km E / 5 km S of SPol at 17:29, until it moved out of radar coverage at about

18:52, the last position being 23 km E / 13 km S. The origin of the cluster appeared to be a cusp in the relatively clear area to the E of a long multiply-curved line marking generally deeper clouds to the W of the line. The two images below show this.

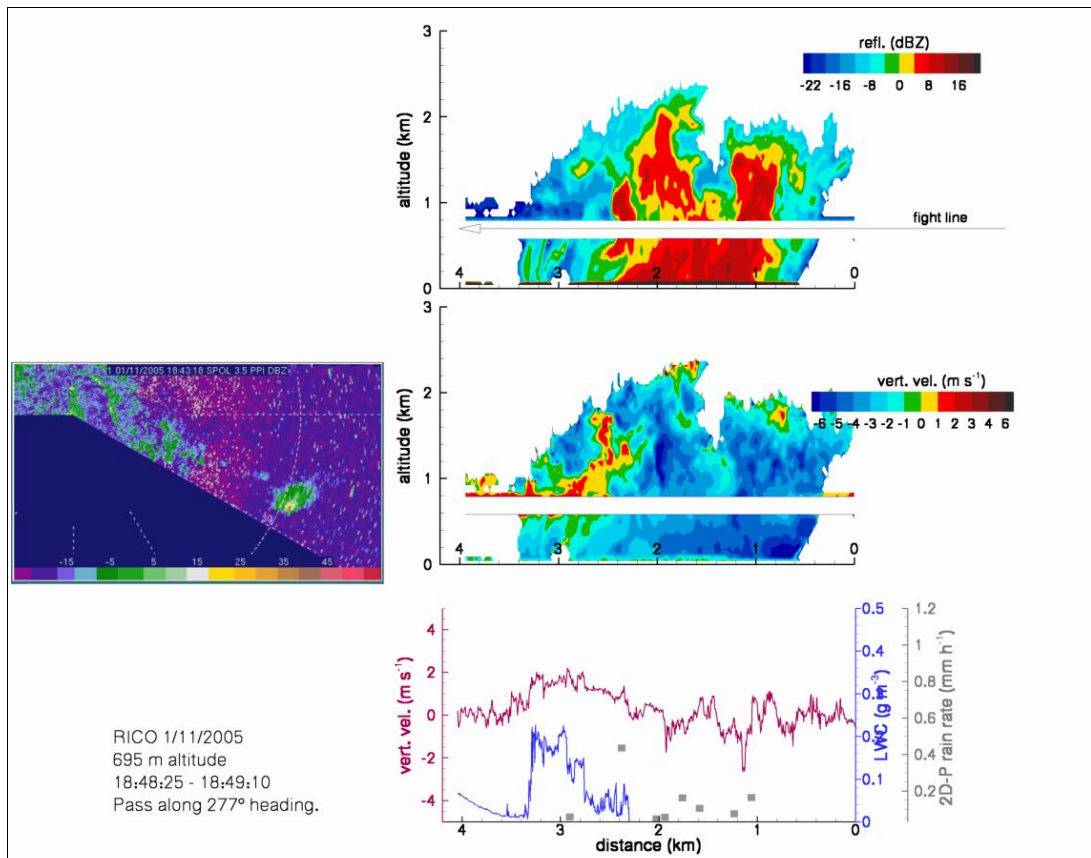
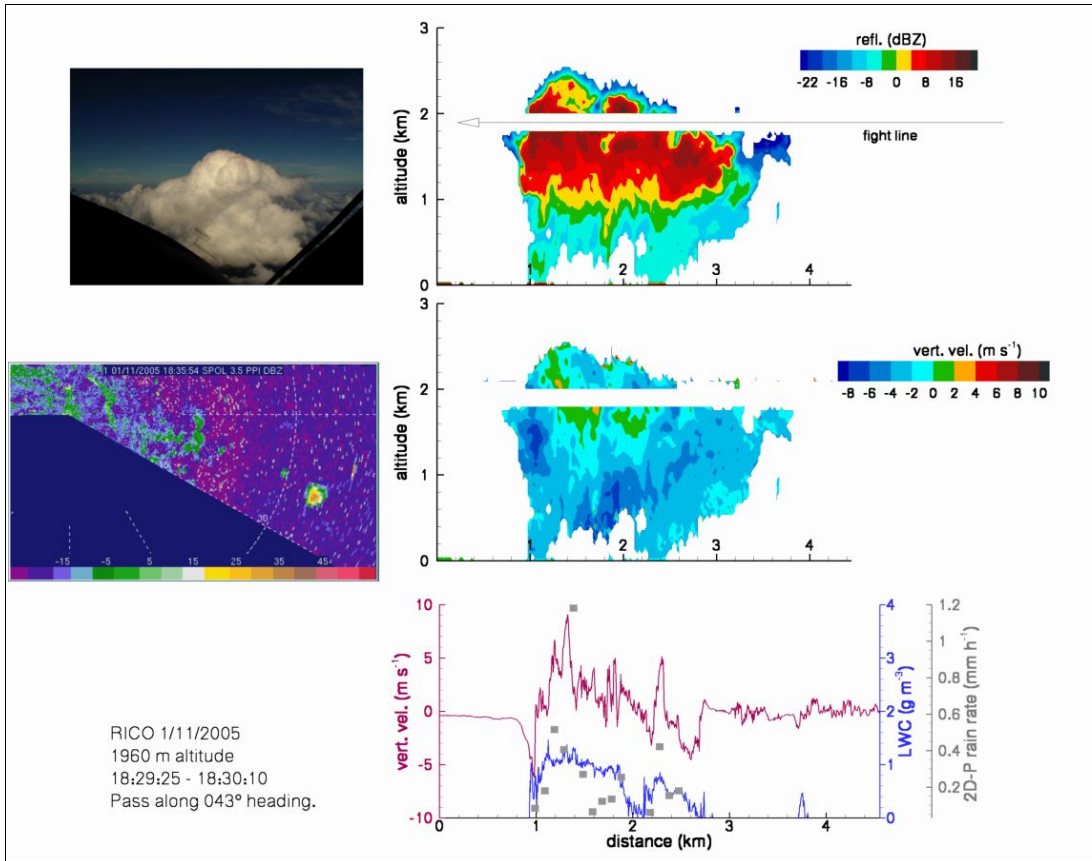


While the overall size and height of the cluster remained roughly the same during the period it was tracked, there was a period of lower SPol reflectivity at about 17:44, and an increase in maximum reflectivity between 18:00 and 18:30 from about 0 dBZ to 35 dBZ. This may have been in part because of beam spreading and changes in the beam height.

The King Air made 13 penetrations in all, starting at 1960 m, then at 2620 m and back down to 1330 and 700 m altitudes. Data from two of these penetrations is given on the next page. The first one at 1960 m shows updrafts through most of the intersected path, with sharp downdrafts at the edges. Nonetheless, there was drizzle/rain at all points along the path, with the maximum in rainrate practically coincident with the maximum in updraft. The LWC was, of course, only about 35 % of the adiabatic value in spite of updraft maxima approaching 10 m s^{-1} . Maximum drop sizes seen on the PMS-2D probes were close to 1 mm in diameter, but only about $300 \mu\text{m}$ in the strongest updrafts.

The WCR reflectivity data shows precipitation just reaching the surface, though some of the signal is attenuated in the middle of the cloud. The Doppler velocity image shows an updraft region extending to echo top; assuming a $1\text{-}2 \text{ m s}^{-1}$ offset in these values due to drop fall velocities, the updraft region is depicted to be quite large and overlapping with high reflectivities. Clearly, the updraft carried considerable drizzle/rain flux upwards.

The second pass shown is from an altitude close to cloud base. There was measurable



LWC only in the updraft zone on the west side of the cloud. In this case, the updraft region is of relatively low reflectivity to the side of the stronger echoes. Rainrates derived from the PMS-2DC probe are $< 0.5 \text{ mm h}^{-1}$, and maximum drop sizes were $< 1\text{mm}$ on this pass. That is smaller, but not by much of the maximum sizes detected on any pass. The largest drop in the whole sequence was 4 mm in diameter; it was detected at the highest flight level of 2620 m at 18:33:56.

Summary:

All told, each of the four parts of the flight were quite different and each has something to offer for further analysis.

Flight notes:

1617 engines started; no chat available
 1627 T/O; max cloud top 5500'
 1640 11,000'; going to 090 / 30-60.
 ~1647 cloud pass at 8000', UD mode
 1652 6000' pass, 90/270 afterwards
 1654 radar now on; was not radiating up to this point
 1658 DD on cloud to the W of earlier one; on to strong NRE; turn before last part; pointer set in updraft
 1704 at pointer; UD mode
 1710 1-km offset pointer; didn't seem right – made visual pass pass SD mode
 1729 after period of 'cloud hunt', tall narrow turret on 160 hdg.
 1733 across clear patch w/ As above

start near-cloud base passes: 1900' base with some a little higher;

174526 above base at ~980 m
 174619 in cloud at ~980 m; many similar ones to follow
 174702 right at base; ~630 m
 174740 v. thin cloud; can see the ocean.
 174930 seem to be below base
 175312 above base visually

end of cloud base runs

1755 precip. at 1500' from cloud ~2.5 km deep; large echo

1800 precip. at 500'; will extend beyond into clear
1804 precip. on reverse heading; then turn and climb
1810 4000' through same echo; getting too close to ANU for 20-60 nm clearance
1812 Cu+ penetration near top; 4000'; pointer set
1814 pass 2 with butterfly pattern, 6 m s^{-1} up
1820 pass 4 on E hdg; UD mode
1823 90 / 270 turn DD next pass
1824 going to new target at 6000'
1832 after 90 / 270 for pass 3; first pass was UD on 055 hdg. then did right turn for pass 2; first two passes UD, 9 m s^{-1}
1834 pass 4 with DD
1835 climb to 8000'; no rain seen below cloud; tiny NRE; DD on westerly hdg.
1838 UD; soft top visually, harder tops rising to left of track
1842 6000', new part of cloud, 7 m s^{-1}
1848 90 / 270 and descend to 2000' west hdg, then same for east hdg.
1851 2000' on 130 hdg. aiming at NRE
1852 descend to 500'; few drops on this pass
1902 sounding, E-bound, to 15,000'; CN count up
1910 head to ANU
1933 L/D