University of Wyoming **King Air and Cloud Radar.**
Airborne millimeter radar research since 1992.


Marine Sc, E. Pacific (DYCOMS, 2001) ---- coming in July 2001

URL : [//www-das.uwyo.edu/wcr](http://www-das.uwyo.edu/wcr)

**Pending proposal:** *Improvements to spaceborne cloud profiling, based on aircraft and radar observations of cloud structure.*

- insights into cloud processes of relevance to CloudSat
- improvements to algorithms for cloud profiling

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**Pixel size:**
- WCR: $10^2 \times \pi \times 30 \approx 10^4 \text{ m}^3$
- CloudSat: $3 \times 10^9 \text{ m}^3$

**Time to cover 50 km:**
- WCR: **10 minutes**
- CloudSat: **7.5 seconds**
The cloud located at 1 km has reached the dissipation stage, with all of the cloud volume moving downward. At the flight level, the temperature was 18.5°C, the liquid water content 0.7 g m⁻³ and very light drizzle with drops 200 μm diameter was recorded. The total cloud droplet concentration was about 150 cm⁻³. The reflectivity field indicates the presence of 3 precipitation shafts above 1.8 km altitude. These merge into one main core of precipitation. Smaller clouds at 2 and 2.9 km have some weak updraft regions.
Vertical sections of reflectivity and of vertical velocity. The horizontal and vertical scales of the images are 1:1.
Horizontal sections of various coastal stratus cases. Attenuation correction has been applied, but signal to noise ratio limits the range of detection. These images demonstrate large variety in the scales and textures of reflectivity fields.
The correlation between $Z_{\text{calc}}$ (derived from in situ data along the flight path) and $Z_{\text{obs}}$ (radar measurement 90 m to the side of the aircraft), is very similar to that between radar ranges separated by a similar distance.

Interpretation of reflectivity patterns in terms of spectral characteristics is possible.
Conclusion from observations of Oregon coastal stratus:

Reflectivity is dominated by drizzle through the major part of the cloud depth.
Mass and reflectivity are correlated, but range of Z for given M is large. Over 80% of total mass is in cloud droplet sizes (< 50 µm), whereas these droplet contribute small fractions of the reflectivity.

780 m altitude; $\phi = 0.6$

Mass and reflectivity are better correlated, but range of Z for given M is still large. Over 90% of total mass is in cloud droplet sizes (< 50 µm), and these droplet now contribute varying fractions of the reflectivity.

Mass - reflectivity (Z - M) relationship is complex. Simple rule would be unreliable.
The use of M - Z relationships based on cloud droplet spectra, without the inclusion of drizzle, will seriously overestimate LWC from radar data.

990817 flight

Attenuation correction is quite straightforward when mass and reflectivity are decoupled.
on the other hand ...

reflectivity and precipitation rate show strong correlations, justifying the use of power-law equations, like

\[ Z = 4.8 R^{0.97} \]

but slope parameter is altitude dependent.

950916: 630 and 780 m alt.
October 31, 1992  
Ns, Wyoming-Nebraska border
The relationship between $Z$ and $\lambda$ is reversed through the cloud region above the melting layer. The $Ze$ vs. $D_{\text{max}}$ relationship appears to be more robust.
September 6, 1995 - Ns, Oregon coast

NOAA - Ka vert. point and RHI

WCR spiral

(dBZ)

0 3 6 9 km East

160350-160439
September 6, 1995 - Ns, Oregon coast
\[ N = N_0 e^{-\lambda D} \]

\[ N_0 = a \left( \frac{\lambda}{1000} \right)^b \]

<table>
<thead>
<tr>
<th>Case/author</th>
<th>( D_{\text{min}} ) (: m)</th>
<th>a</th>
<th>b</th>
<th>r</th>
<th>( \lambda ) (( H10^3 )) m(^{-1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 06, 1995 (Ns over Oregon)</td>
<td>100</td>
<td>3.3</td>
<td>2.74</td>
<td>0.93</td>
<td>3.7 - 30</td>
</tr>
<tr>
<td>October 31, 1992 (Ns over Wyoming)</td>
<td>100</td>
<td>1.88</td>
<td>2.32</td>
<td>0.91</td>
<td>1.5 - 9.3</td>
</tr>
<tr>
<td>October 31, 1992 (Ns over Wyoming)</td>
<td>900</td>
<td>0.68</td>
<td>2.41</td>
<td>0.91</td>
<td>1.2 - 3.7</td>
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<tr>
<td>Altostratus cloud (Field 1999)</td>
<td>800</td>
<td>1.54</td>
<td>2.89</td>
<td>0.7</td>
<td>1.9 - 5.8</td>
</tr>
<tr>
<td>Winter cyclonic storm (Lo and Passarelli 1982)</td>
<td>300</td>
<td>1.07</td>
<td>1.85</td>
<td></td>
<td>1.0 - 8.0</td>
</tr>
<tr>
<td>Rainband (Gordon and Marwit 1986)</td>
<td>500</td>
<td>0.13</td>
<td>2.26</td>
<td>0.9</td>
<td>1.1 - 10.7</td>
</tr>
</tbody>
</table>
vertical plane dual_Doppler
vertical plane dual-Doppler analysis