

# B.1 Satellite CPR simulation using airborne cloud radar

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Abstract: The satellite-borne cloud profiling radar (CPR) has wider beam footprint compared by ground based CPR. Non-uniformity of clouds within beam footprint may be concerned, then the dataset of airborne experiment can be used for this study. The simulated data for EarthCARE/CPR are produced from NICT's airborne cloud radar (SPIDER). Especially, EarthCARE/CPR has Doppler velocity measuring function, so these effects are investigated. While the Doppler velocity of surface return is considered to use Doppler velocity calibration, which consists of to estimate offset angle of antenna boresite and to estimate offset angle of satellite attitude, effect of Doppler velocity from surface is also investigated.

Objective of simulation: create and discussion

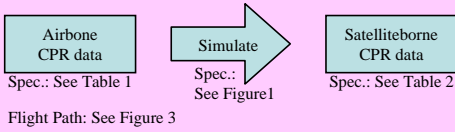


Figure 2 Schematic of presentation

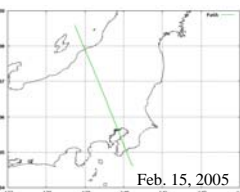


Figure 3 Flight path (simulated cloudsat track)

Experiment was originally planned with cloudsat synchronous observation, but launch was delayed. So objective was changed to obtain simulation data for satelliteborne CPR development.

Figure 4 and 5 show original data and simulated data with various integration. These data is not used moving average. The 10km grid data is not suitable for cloud process studies.

Figure 5 is used simple average to calculate simulation data. Actual Doppler velocities are obtained by weighted of Z factor (indicated "use velocity"), and folding velocity is needed to take into account (indicated "use vector"). Figure 6 shows these effect and Figure 7 shows expanded image.

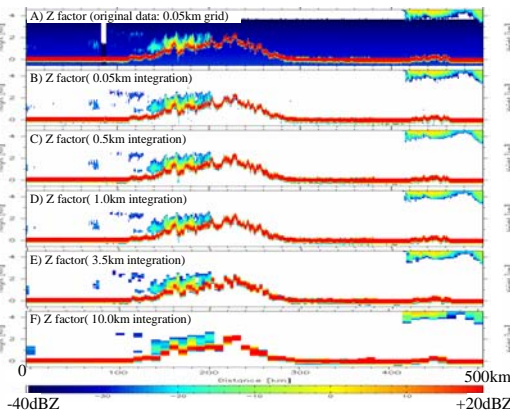


Figure 4 Simulated Data (Z)

**Table 1 Spec. of SPIDER**

Frequency	95.040 GHz
Beam width	0.6 deg.
Antenna Gain	49.4 dBi
Tx Power	1600 W
Pulse width	0.25-2.0 μ sec
Tx/Rx Pol.	Linear (H,V)
Doppler Mes.	Pulse Pair
Nominal Parameter	
Pulse width	0.1 μ sec
Pulse length	165m
Sampling	82.5m
Integration Number	32
Integration Time	50msec
Flight Altitude	5000m
Airplane Speed	180m/sec

**Table 2 Spec. of EarthCARE/CPR**

Frequency:	94.050GHz
Antenna Diameter:	2.5m
Antenna Gain:	66.2dBi
Beam Width:	0.095deg.
Beam Footprint:	<800m
Tx Power:	1500W (EOL)
Pulse width:	3.33 μ sec
Sampling:	100m
Satellite Altitude:	458km <sub>(max)</sub>
PRF:	6100-7500Hz
Minimum Z:	-35dBZ
(Integration: 10km)	
Doppler Vel.:	1.0m/s
(Integration: 10km, -19dBZ)	

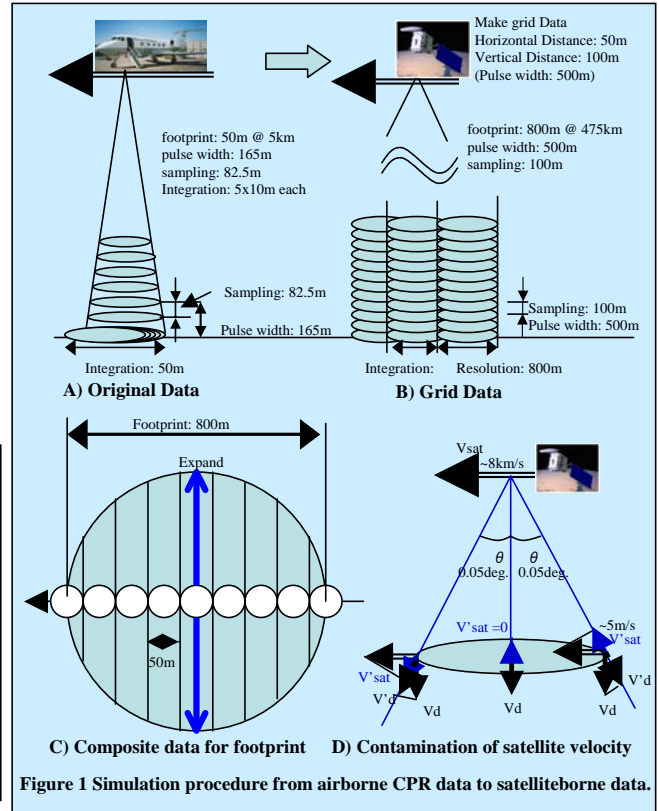


Figure 1 Simulation procedure from airborne CPR data to satelliteborne data.

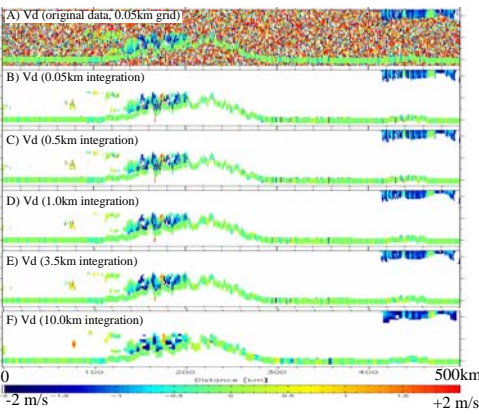


Figure 5 Simulated Data (Vd)

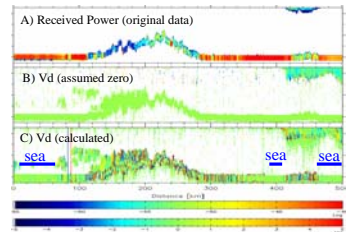


Figure 8 Doppler Velocity from Surface

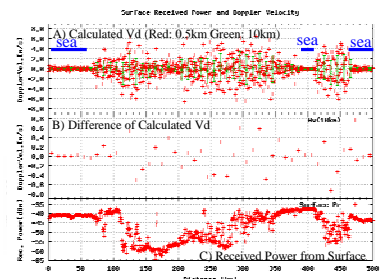


Figure 9 Difference between estimated value and measured value

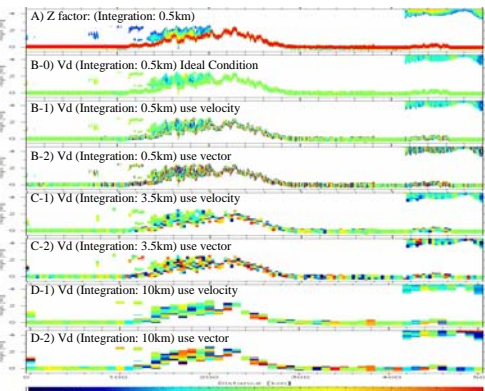


Figure 6 Doppler Velocity Calculation

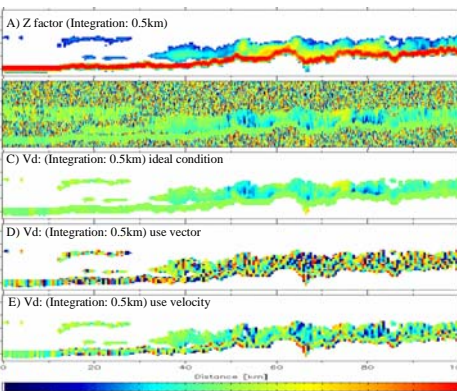


Figure 7 Expanded image of Figure 6

Summary: Satellite CPR simulation data is calculated from airborne experiment. Unfortunately, satellite CPR data can not be available at this time, then comparison can not be done. We have another experiment in order to compare the result to satellite CPR data. (Experiment was successfully done in weeks ago.) Simulated Z factor is considered to reasonable result corresponding to integration length, but simulated Doppler velocity is degraded due to difference in Z factor. The homogeneity is issue for Doppler velocity measurement. In other hand, sea surface is considered to more homogeneously than ground, then sea surface return is suitable for Doppler velocity calibration.