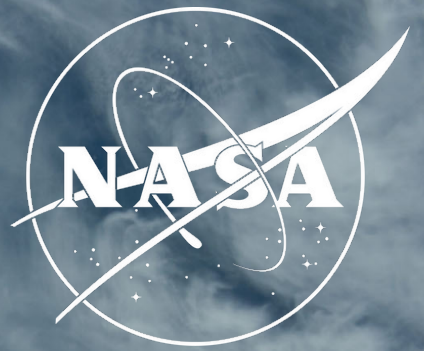




Ice Cloud Observations and Science using Submillimeter-Wave Radiometry

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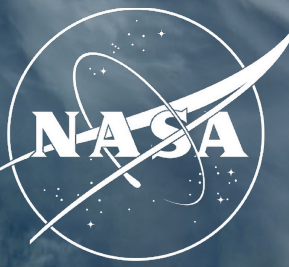
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²University of Maryland Baltimore County

³Morgan State University

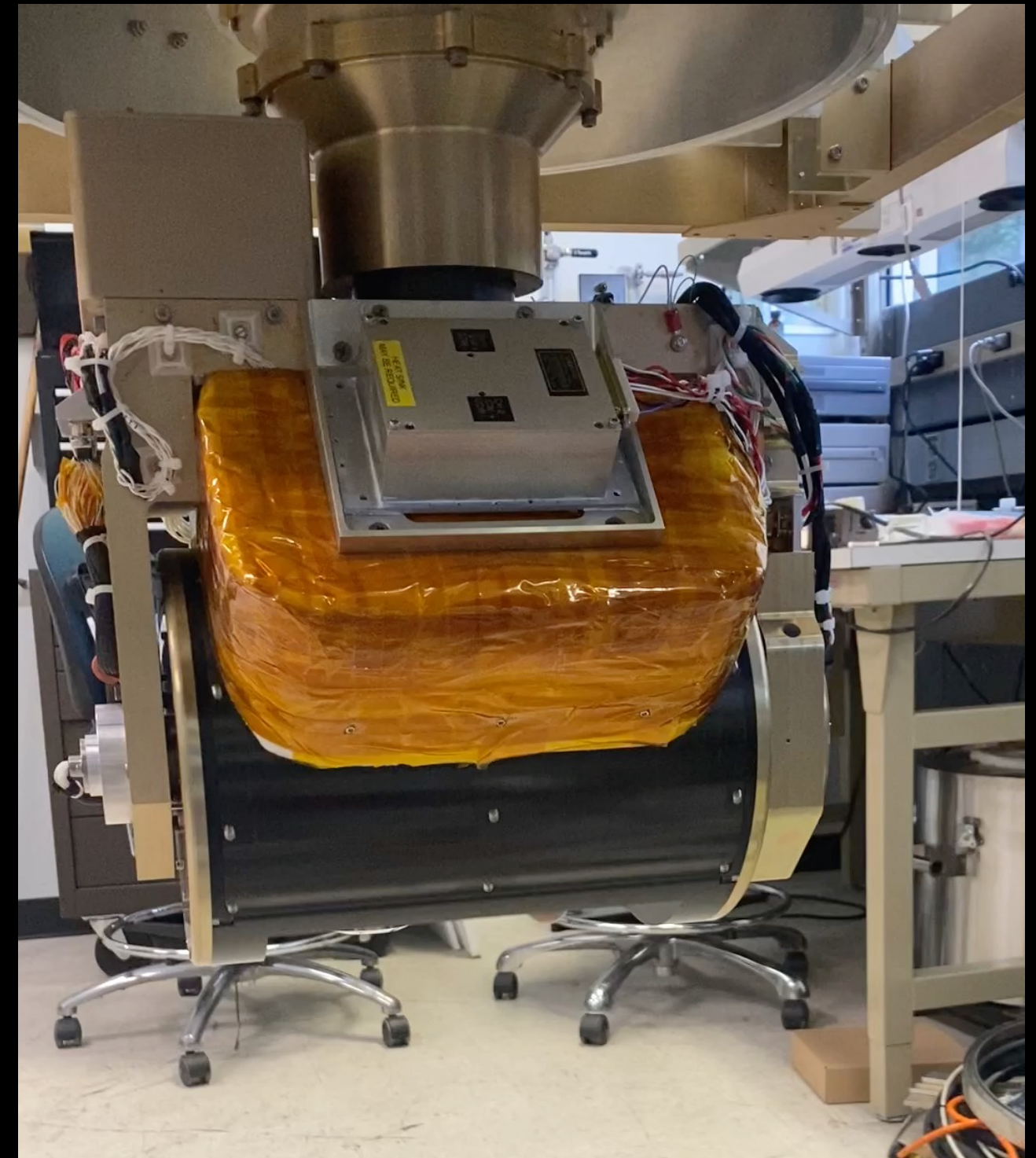
⁴University of Maryland College Park

A Brief History of CoSSIR

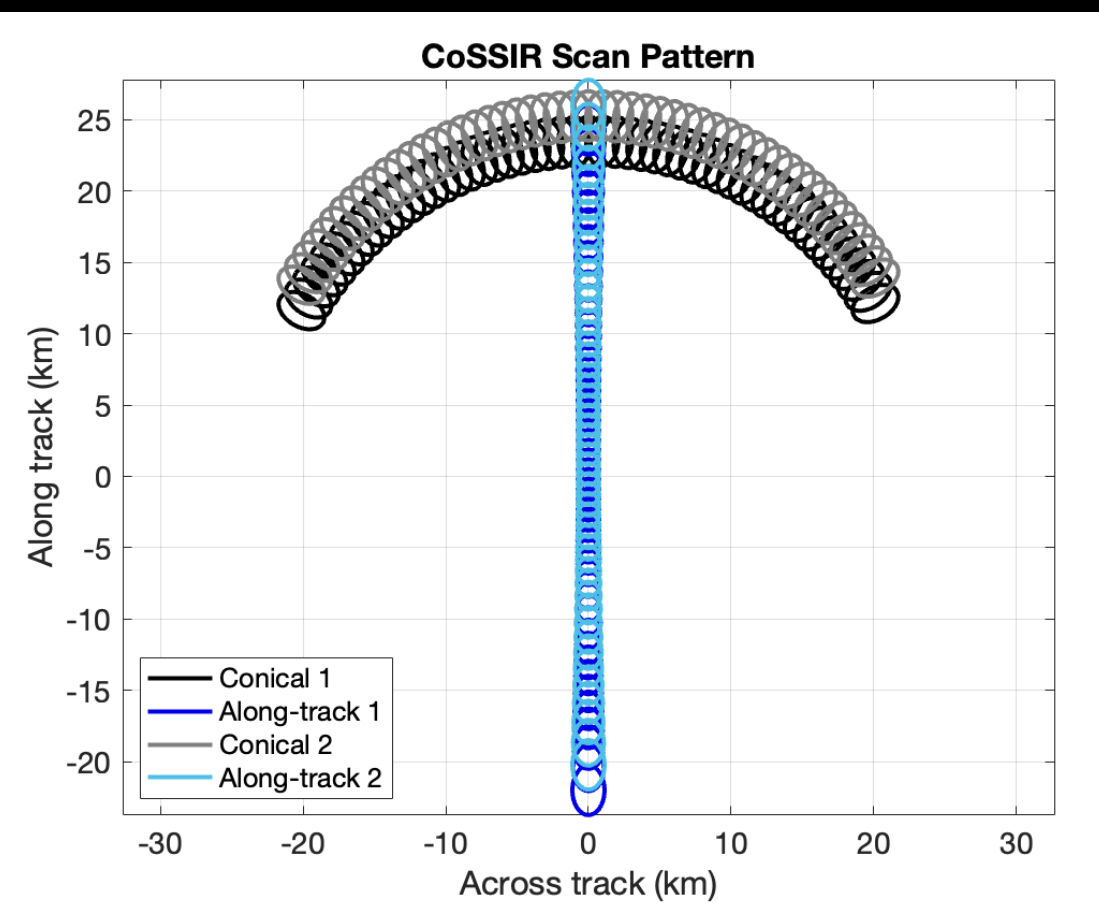
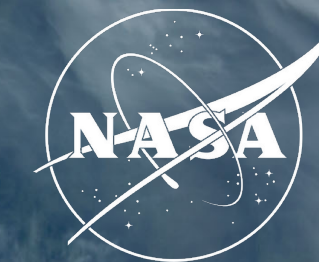


(The Instrument Formerly Known as the Compact Scanning Submillimeter-wave Imaging Radiometer)

- Originally built in the early 2000s with 15 channels spanning 183-874 GHz
- Provided first images of clouds at frequencies above 340 GHz including polarized sub-mm measurements at 640 GHz
- Shared pedestal with CoSMIR, providing cross-track and conical scan capability
- Flown in CRYSTAL-FACE (2002), CR-AVE (2006) and TC4 (2007) field campaigns
- One of two airborne submillimeter-wave radiometers (along with ISMAR)



Sensor Overview



Channel	Center Frequency (GHz)	Bandwidth (GHz)	Spectral Band (GHz)	NEDT* (K)
170v/h	170.5	1.0	170.0-171.0	0.2/0.3
177v/h	177.3	1.0	176.8-177.8	0.4/0.5
180v/h	180.3	1.0	179.8-180.8	0.4/0.4
182v/h	182.3	1.0	181.8-182.8	0.4/0.5
325±11v/h	325.0±11.3	3.6 (x2)	311.9-315.5 and 334.5-338.1	0.5/0.7
325±3v/h	325.0±3.55	2.85 (x2)	320.0-322.85 and 327.15-330	0.5/0.5
325±1v/h	325.0±0.9	0.9 (x2)	323.6-324.5 and 325.9-326.4	1.5/1.5
684v/h	684±4.0	6.0 (x2)	677.0-683.0 and 685.0-691.0	0.9/0.6

Parameters for IMPACTS 2023 deployment

*No antenna pattern correction

Conical scan: Forward conical scanning left to right, 120° swath (-60° to 60°), 49.2° off-nadir angle

Along-track scan: Scanning fore to aft, -49.2° to 49.2° elevation angle (NOT mixed polarization)

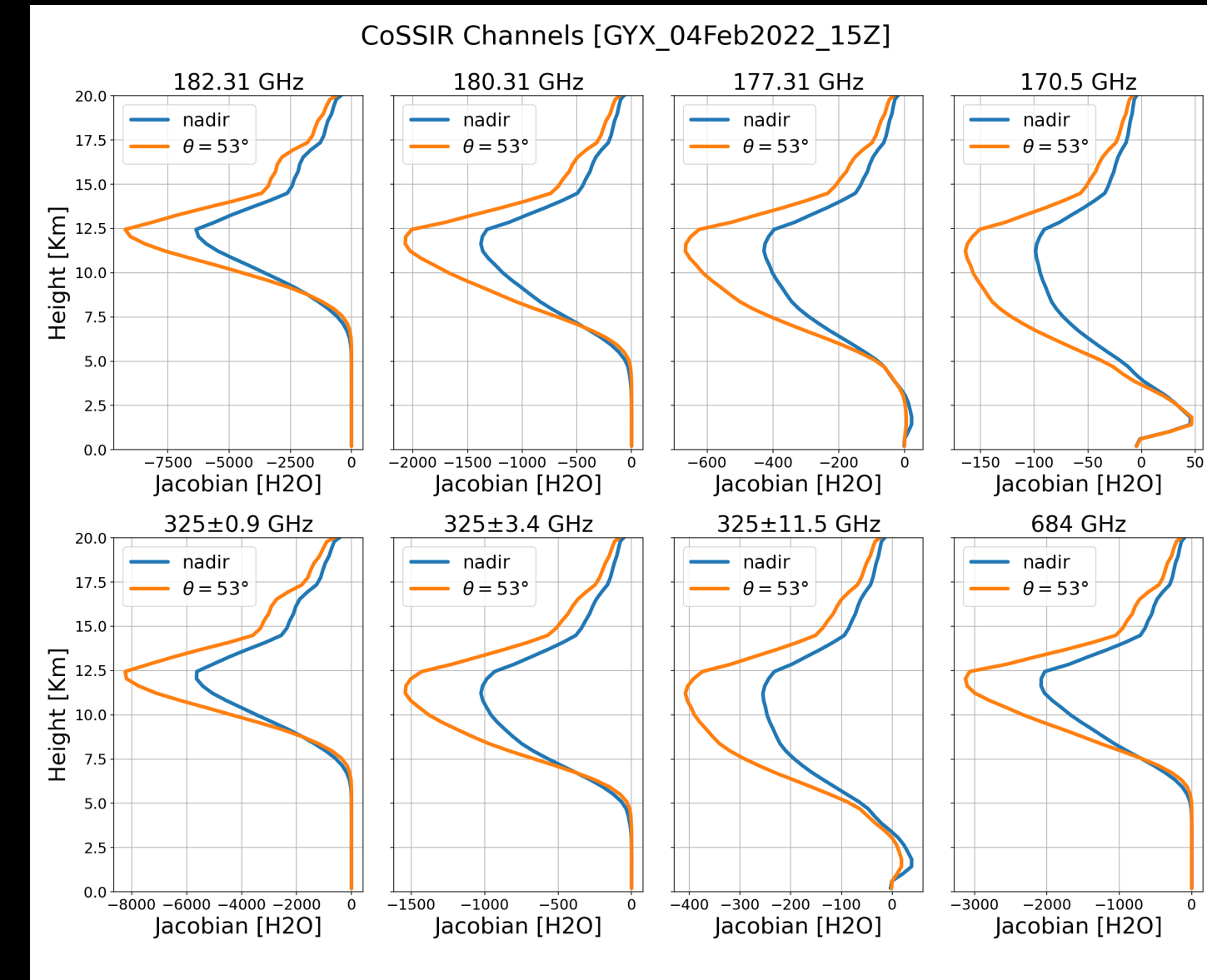
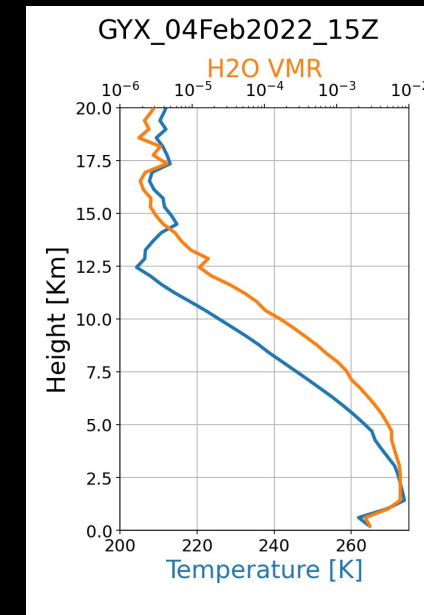
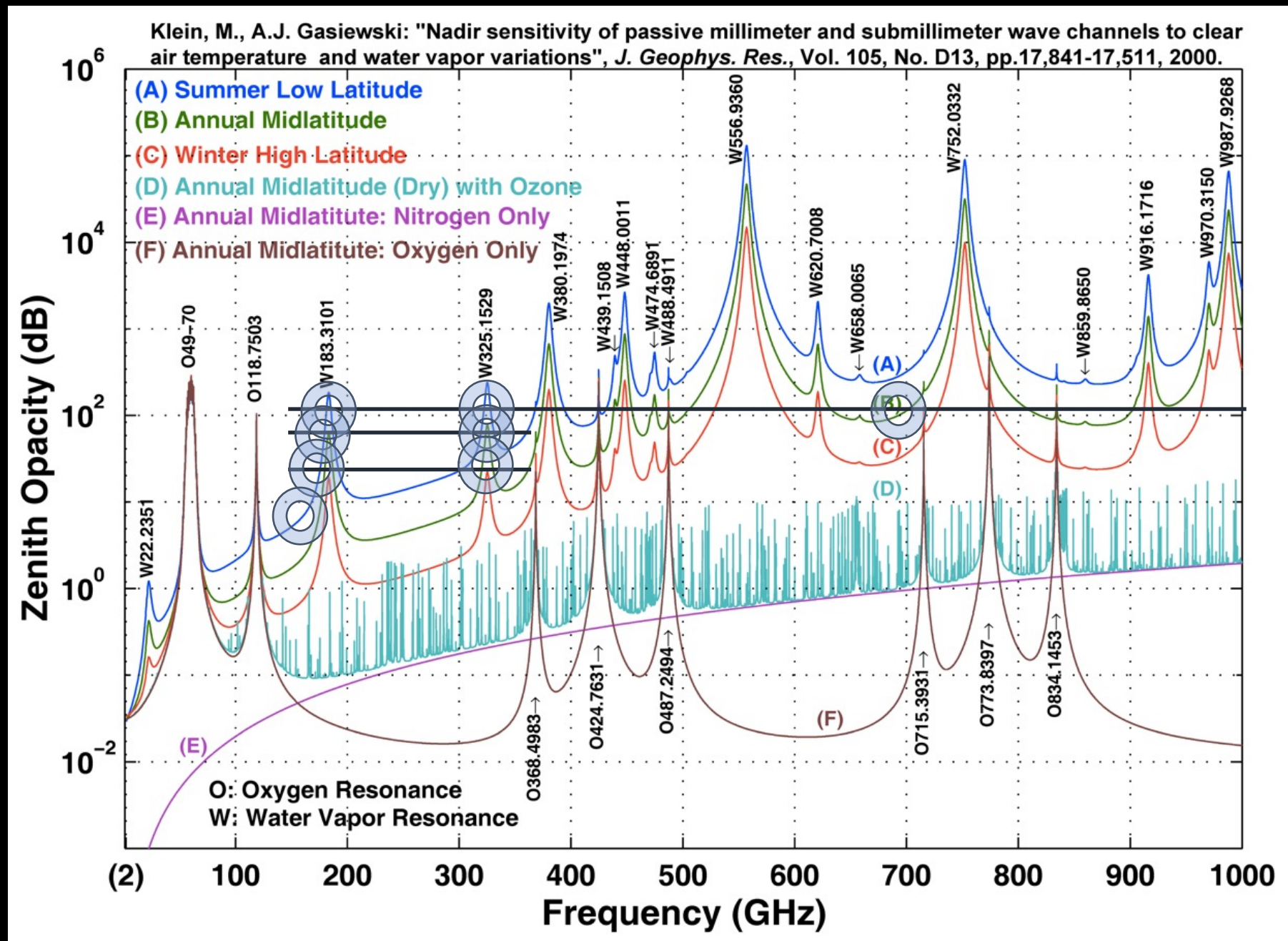
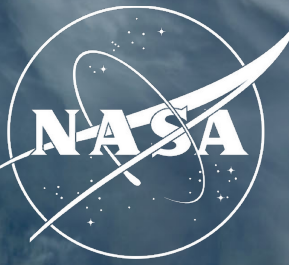
Aircraft altitude: ~20 km for ER-2

CoSSIR half-power beamwidth: 4.4° for 183 GHz channels, 4.0° for 325, 4.25° for 684

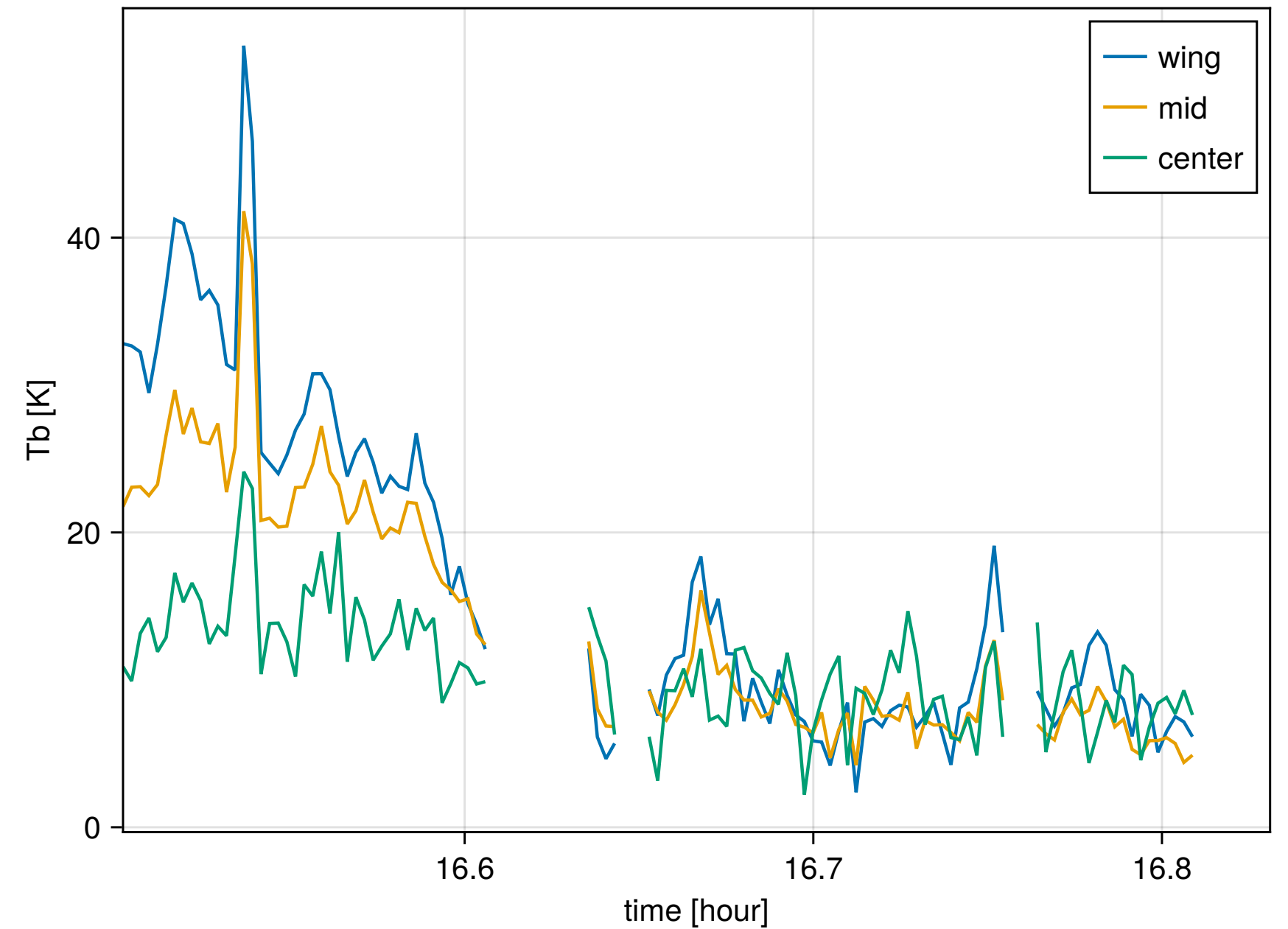
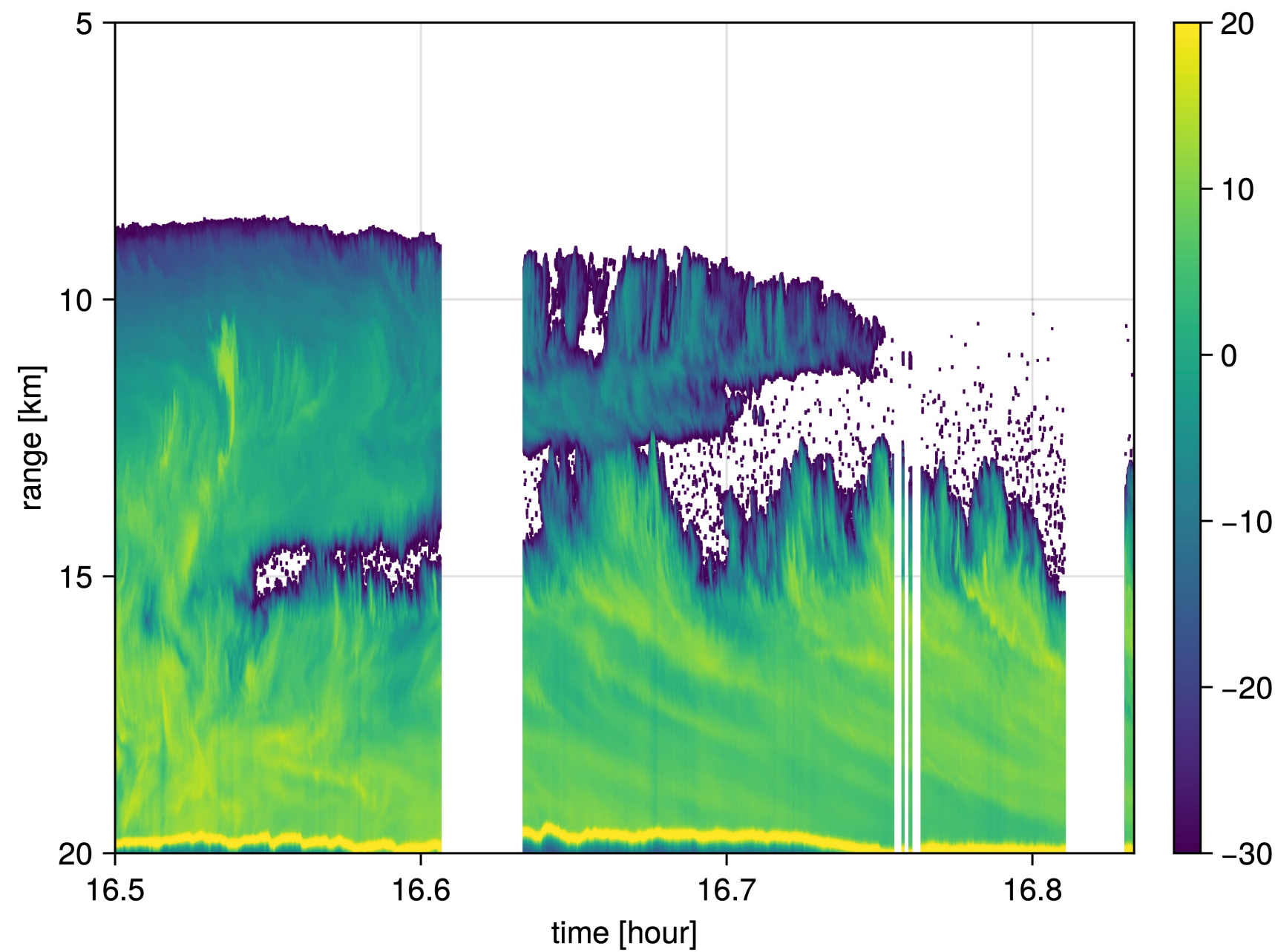
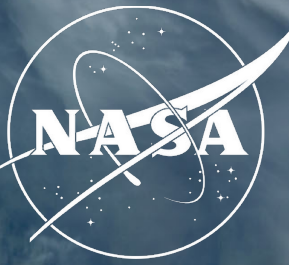
Nadir footprint: ~1.5x1.5 km

Off-nadir footprint at 49.2°: ~2.3x3.5

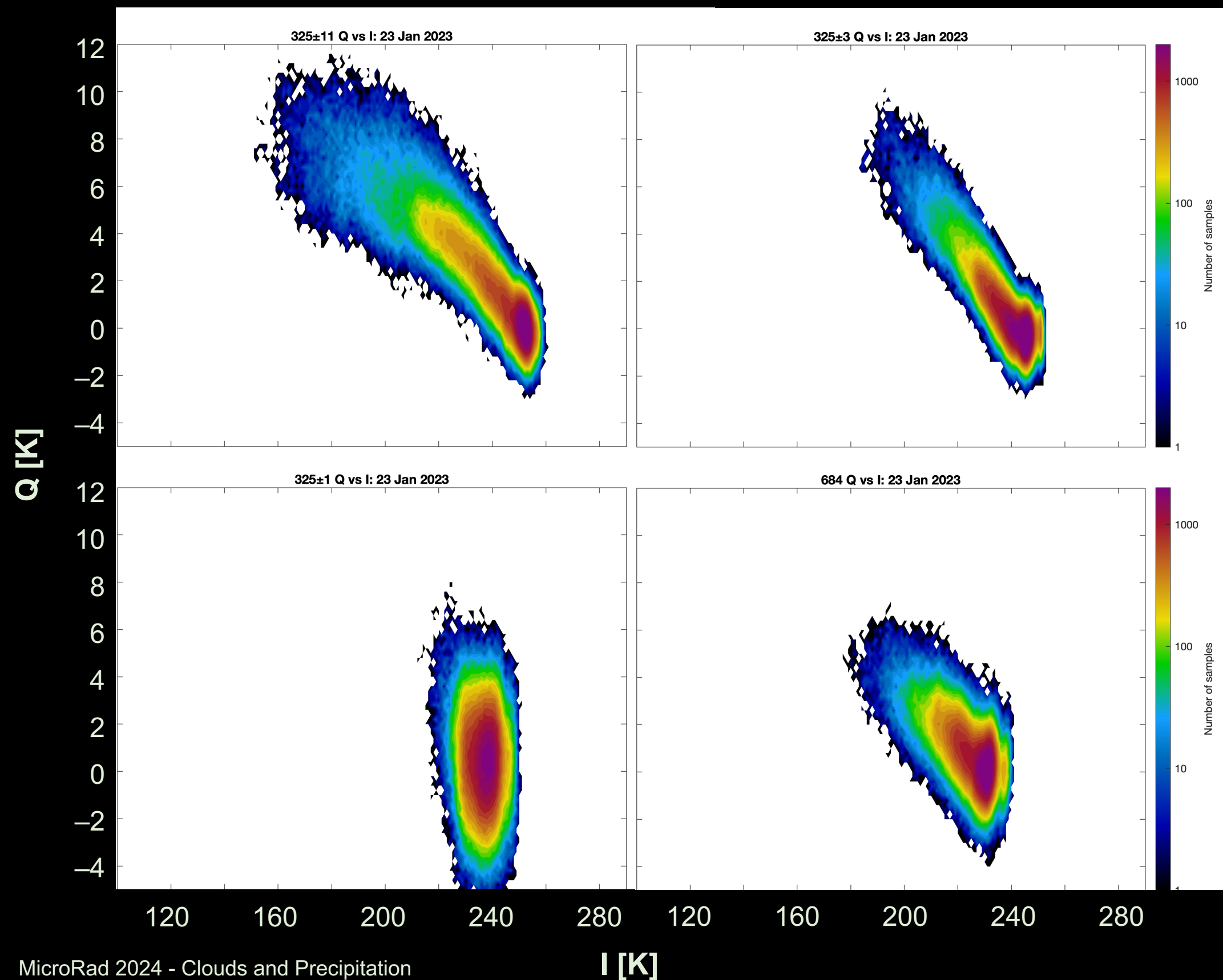
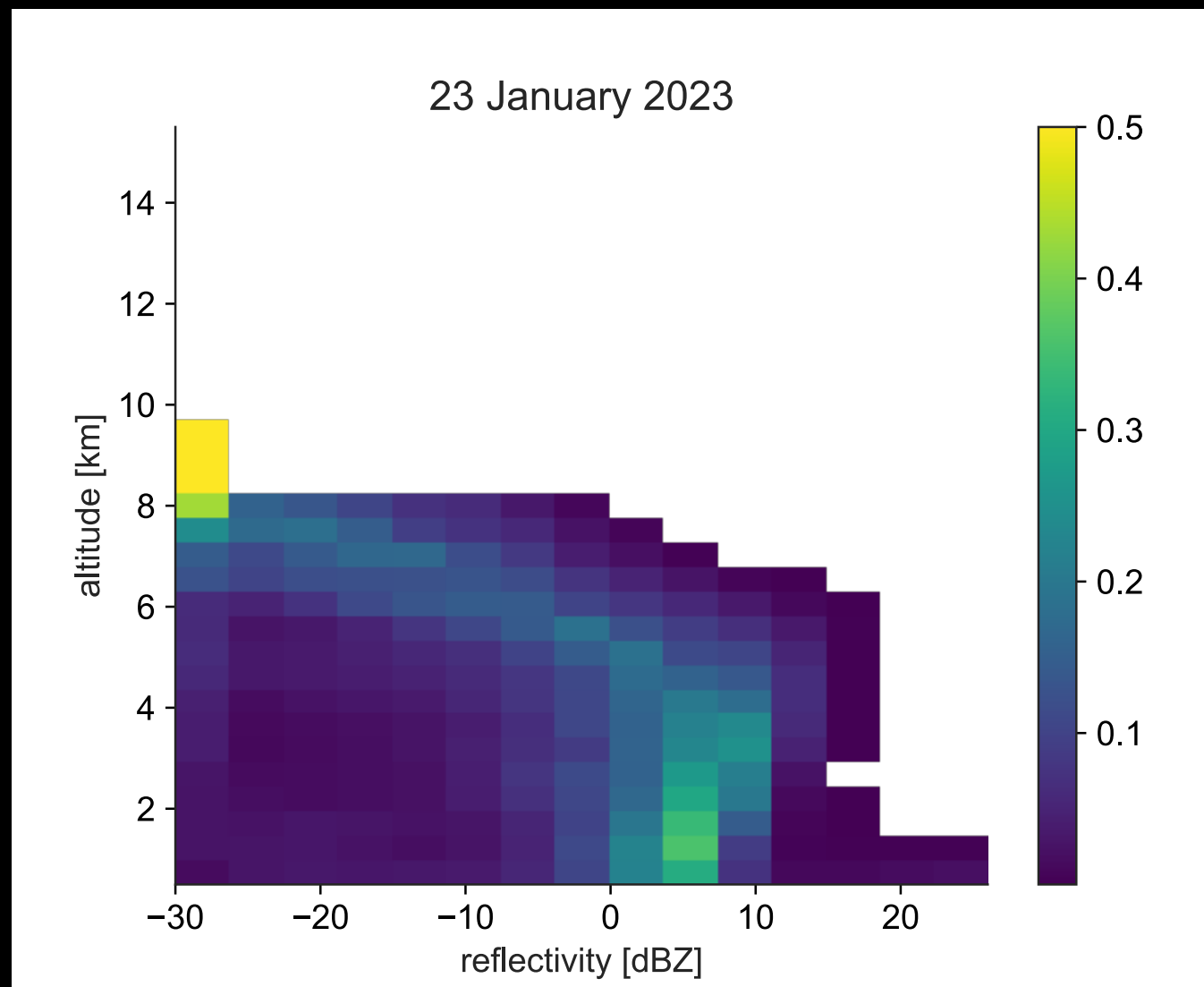
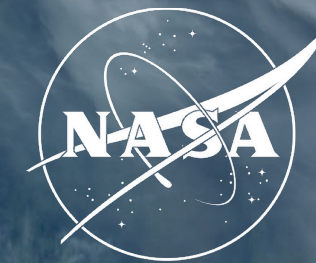
What and Where Are We Observing?



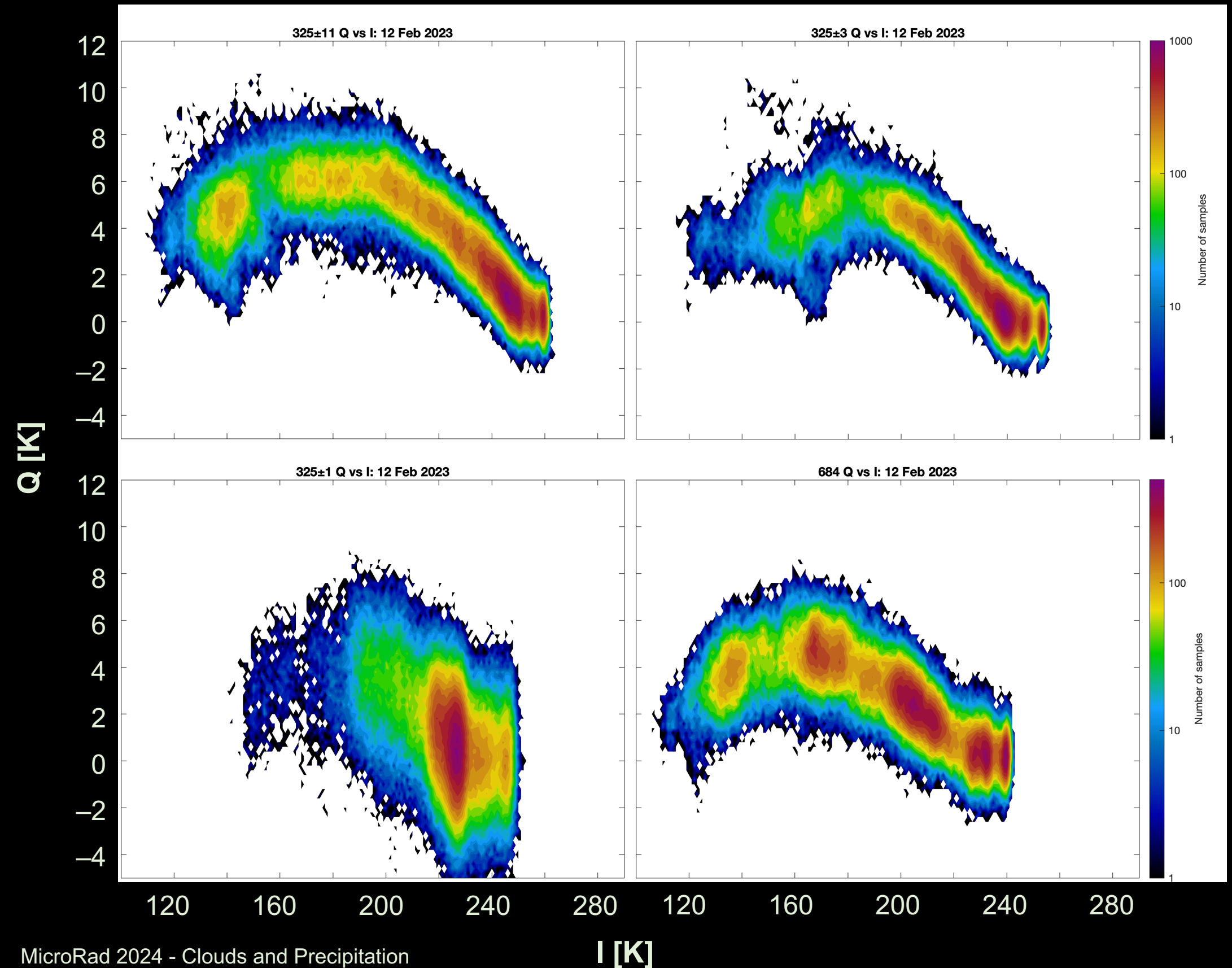
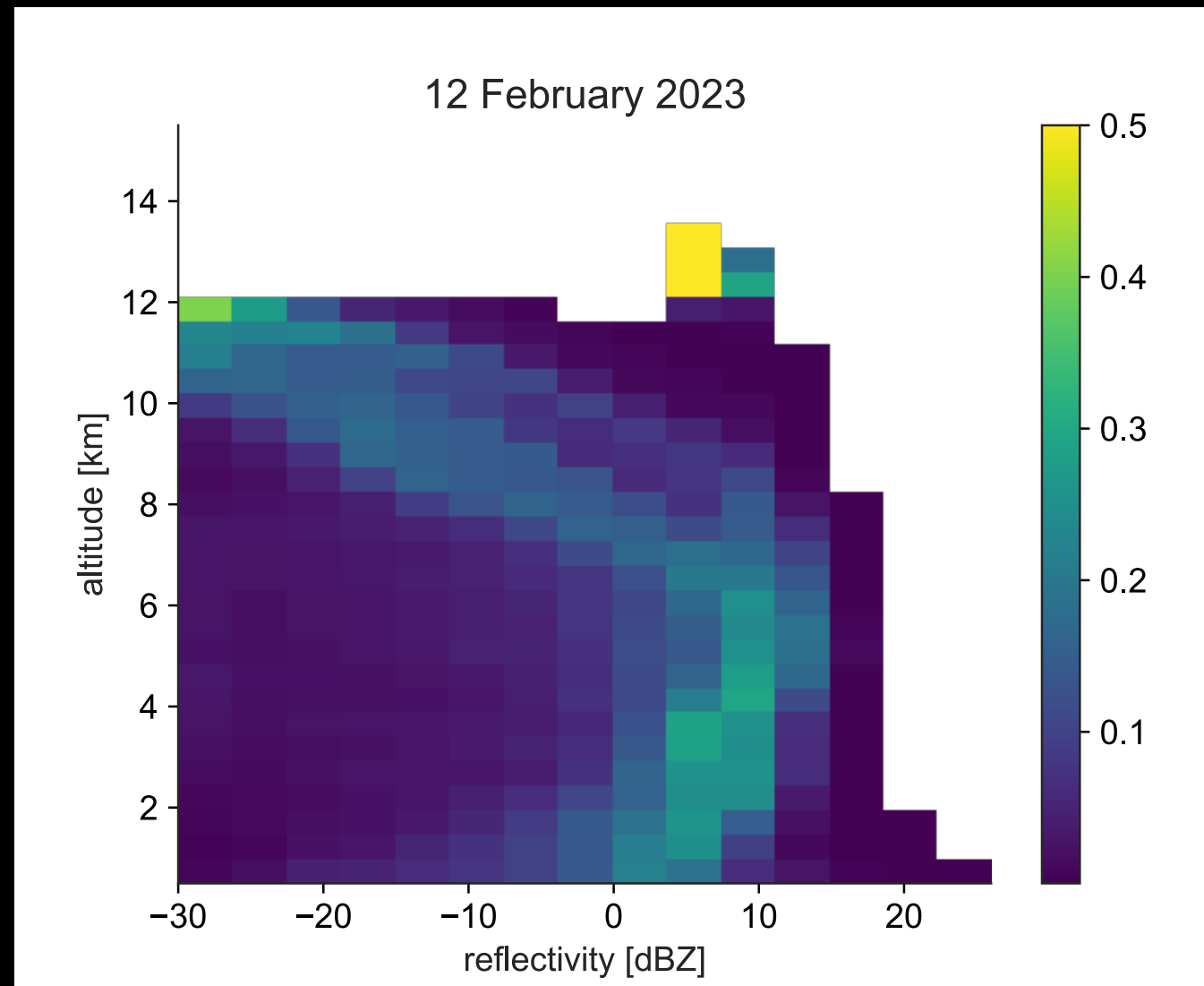
Example: 2023 February 17



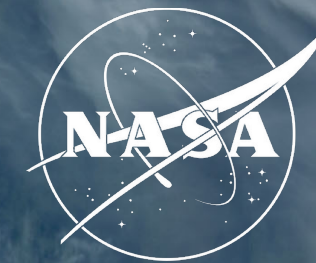
Q vs I for “Typical” Snowstorm



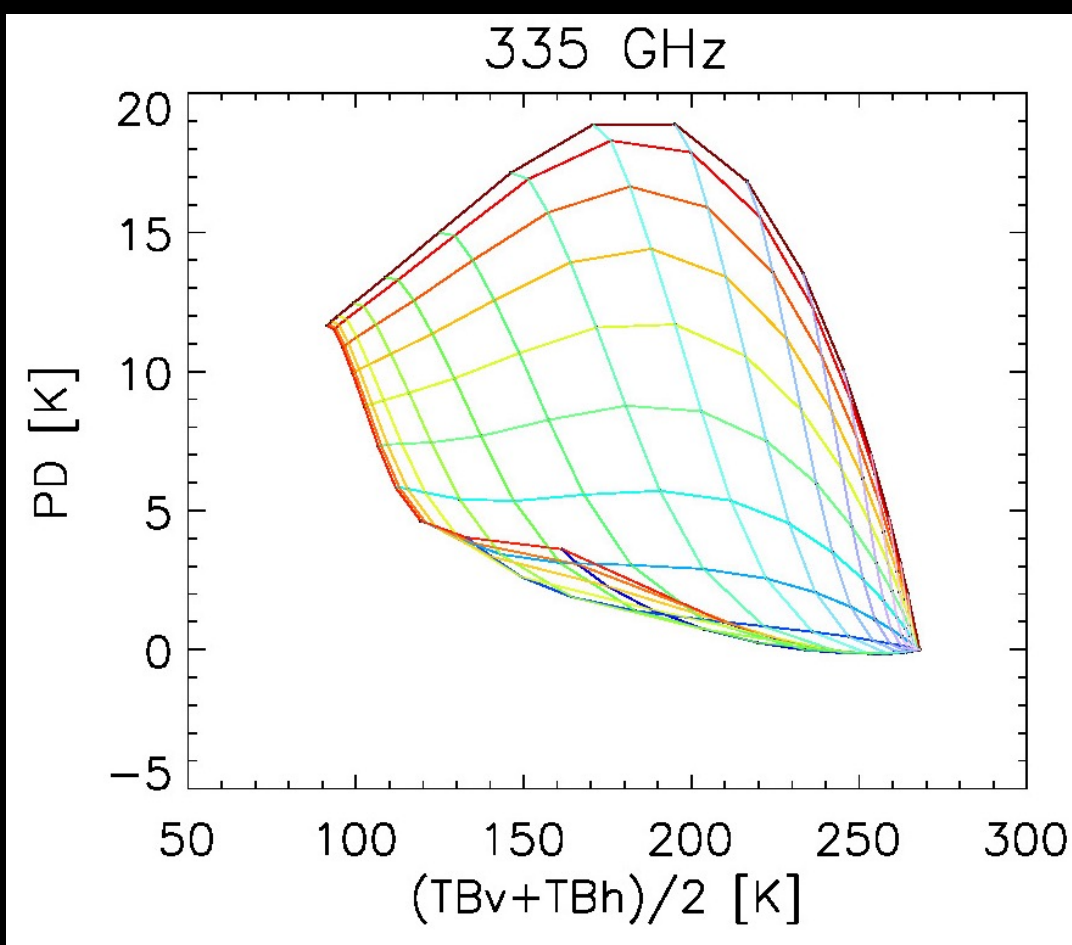
Response for Deeper System



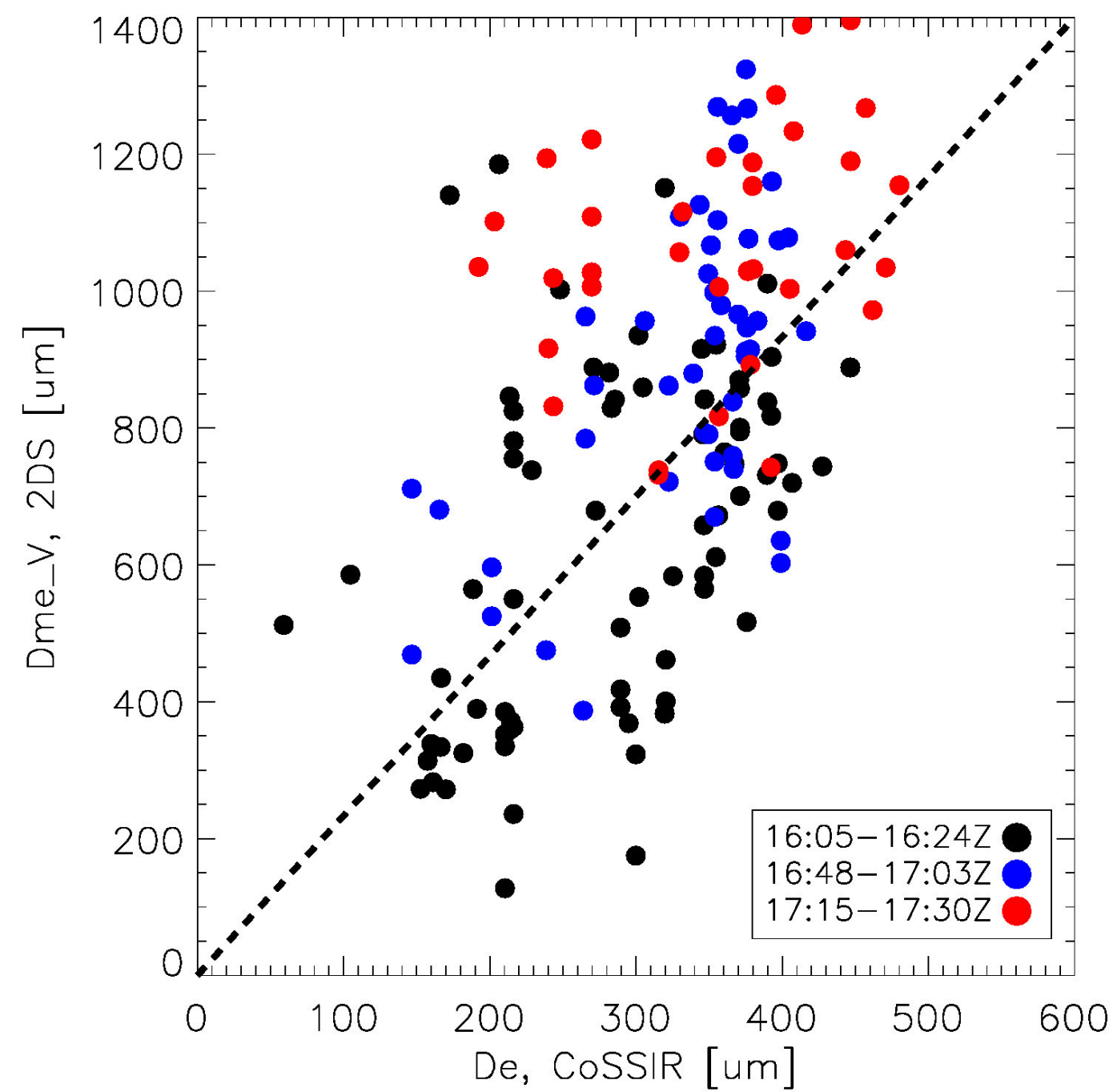
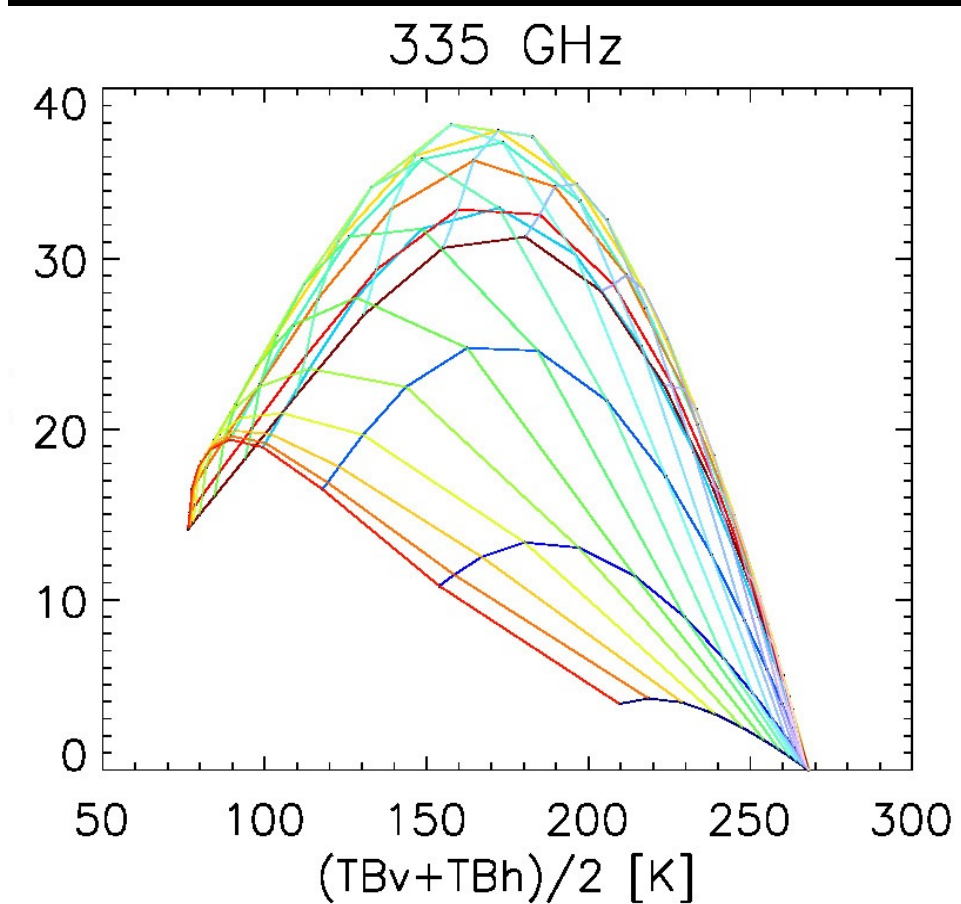
Quantitative Use of Polarization



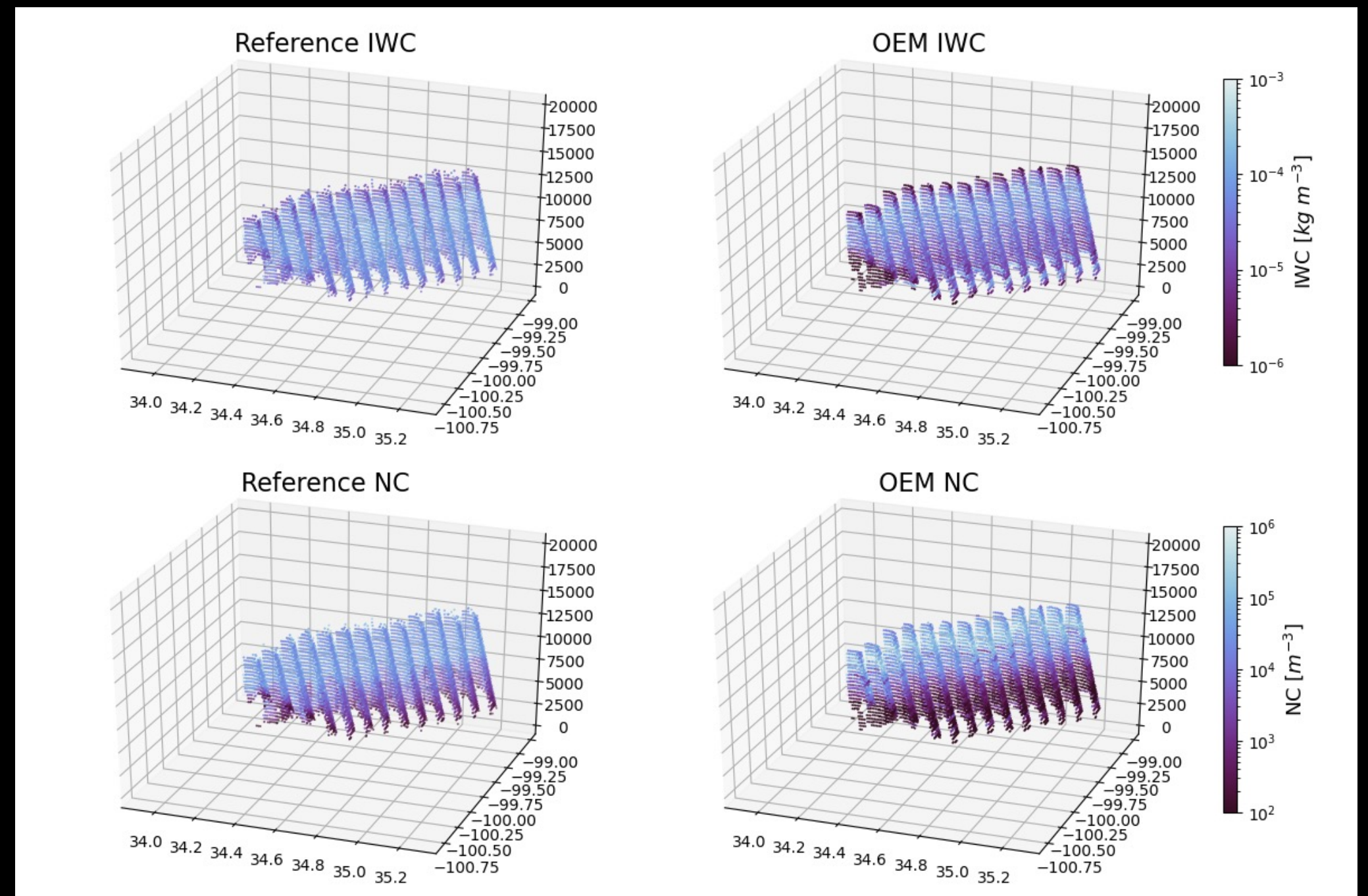
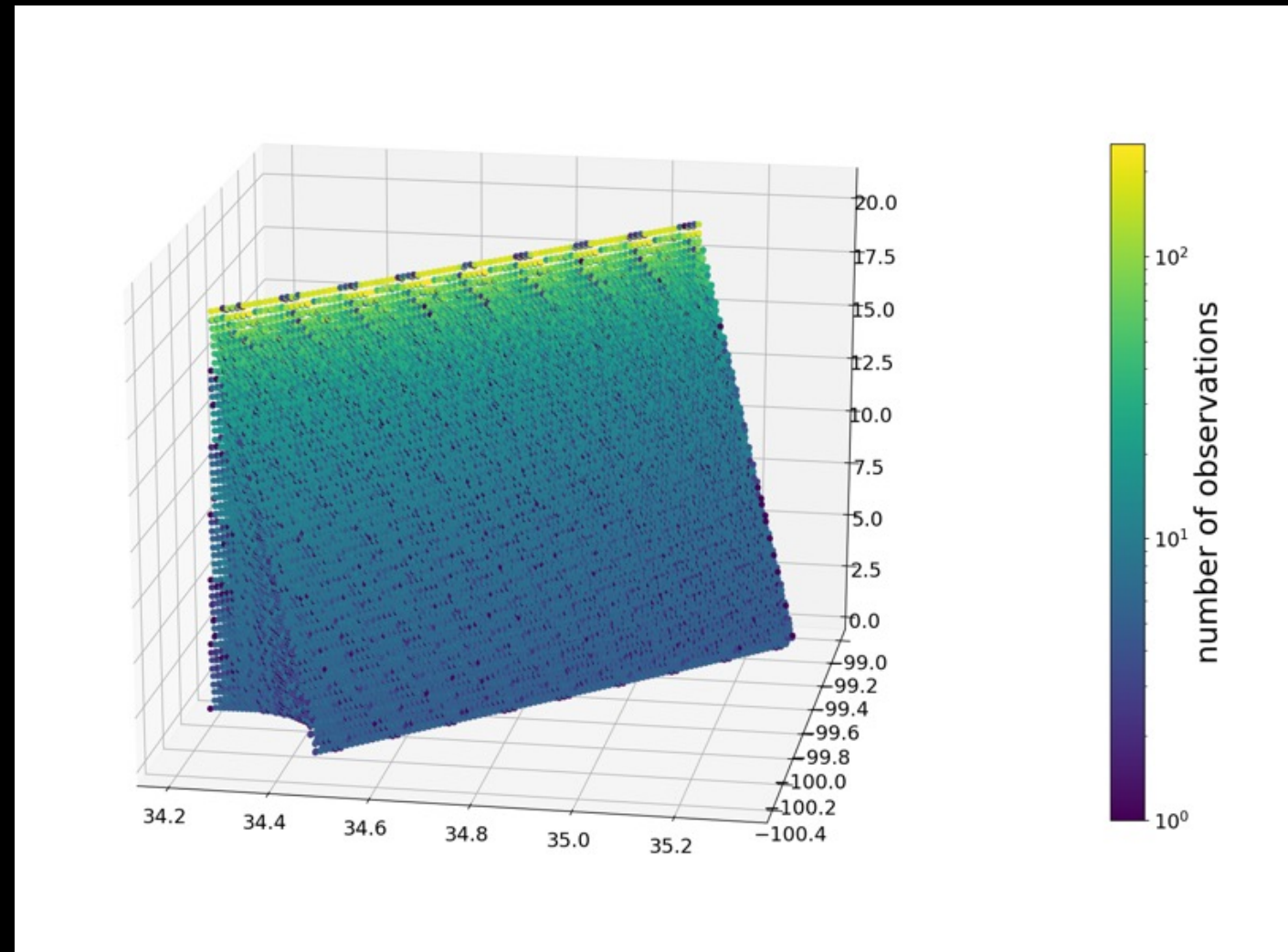
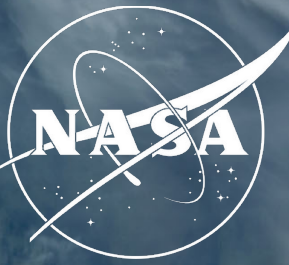
Rosette



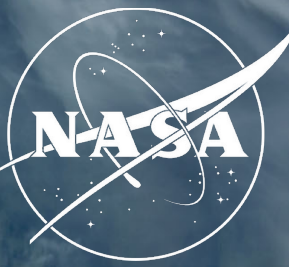
Column Ice



3D Cloud Reconstruction



Summary



Submillimeter-wave radiometers are powerful tools for probing ice-phase clouds and precipitation.

- Historical observations from CoSSIR provided the basis for submillimeter sensing of clouds using spectral information to estimate ice water path
- Recent observations from the IMPACTS field campaign demonstrate sin
- Polarization due to oriented hydrometeors constrains particle size
- Advanced retrieval methods can improve the vertical resolution when reconstructing cloud profiles

