National Aeronautics and Space Administration

CloudSat and Aura MLS Constraints on Ice Cloud Particle Size Distribution

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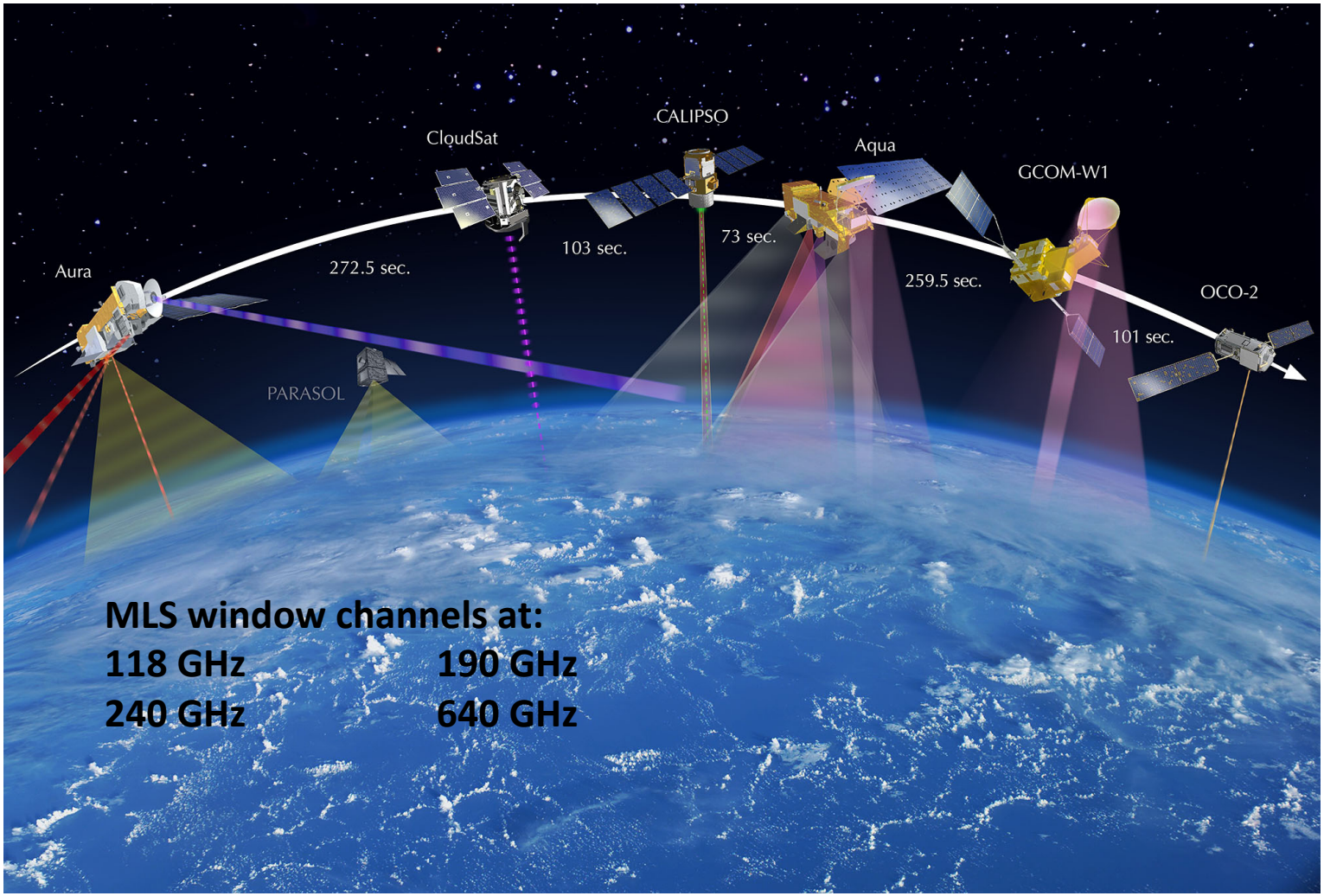
Despite terabytes of data, ice clouds remain one of the main error sources in climate models.

Outline

Measurements



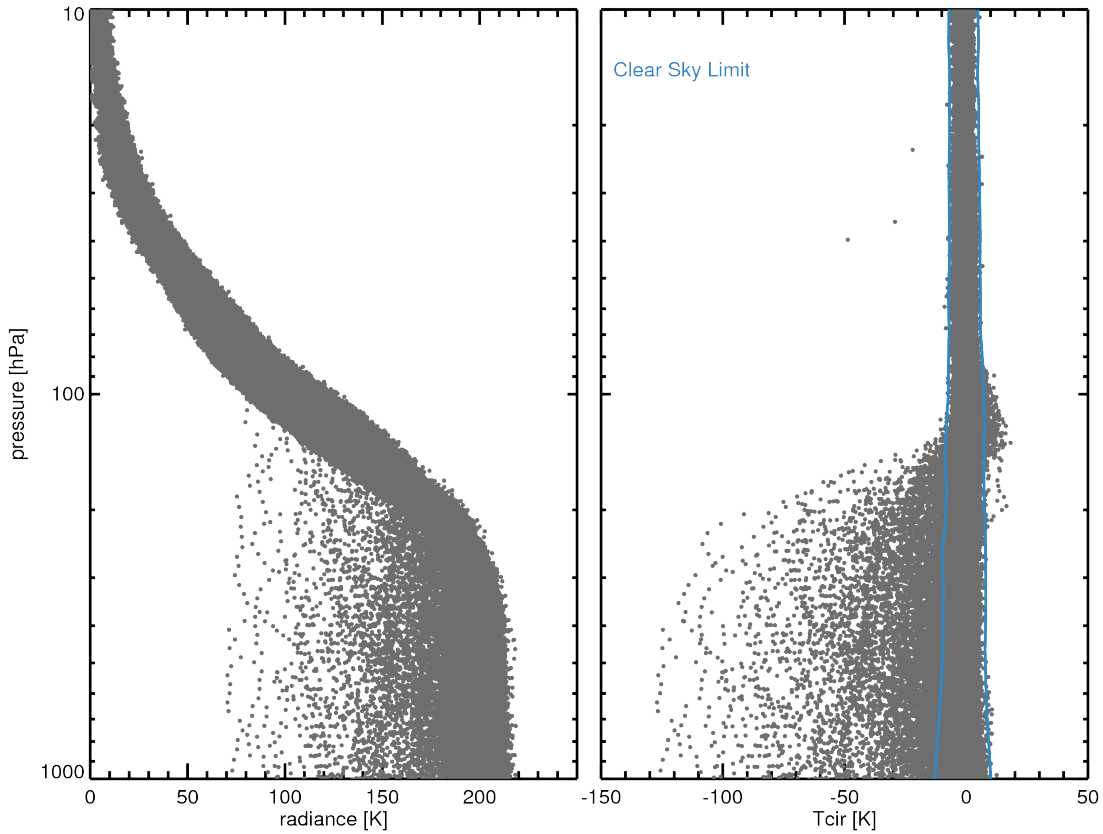
Measurements

MLS Cloud Induce Radiances

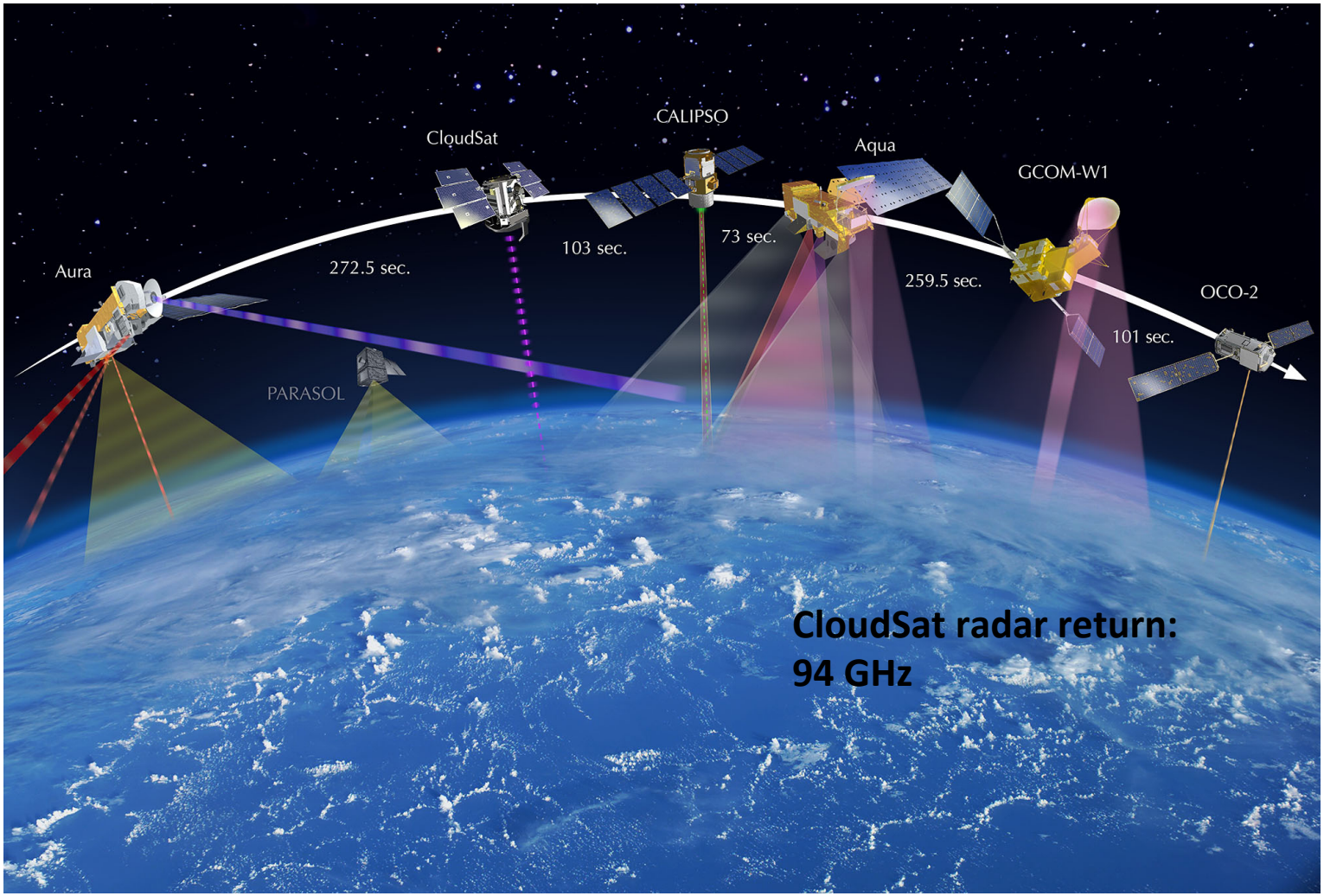
Clear Sky Radiances
Previously retrieved:
Temperature
Pressure
Gases
Relative humidity < 110%

Clear Sky Radiative
Transfer model (Tclear)

Tcir = Tmeas - Tclear

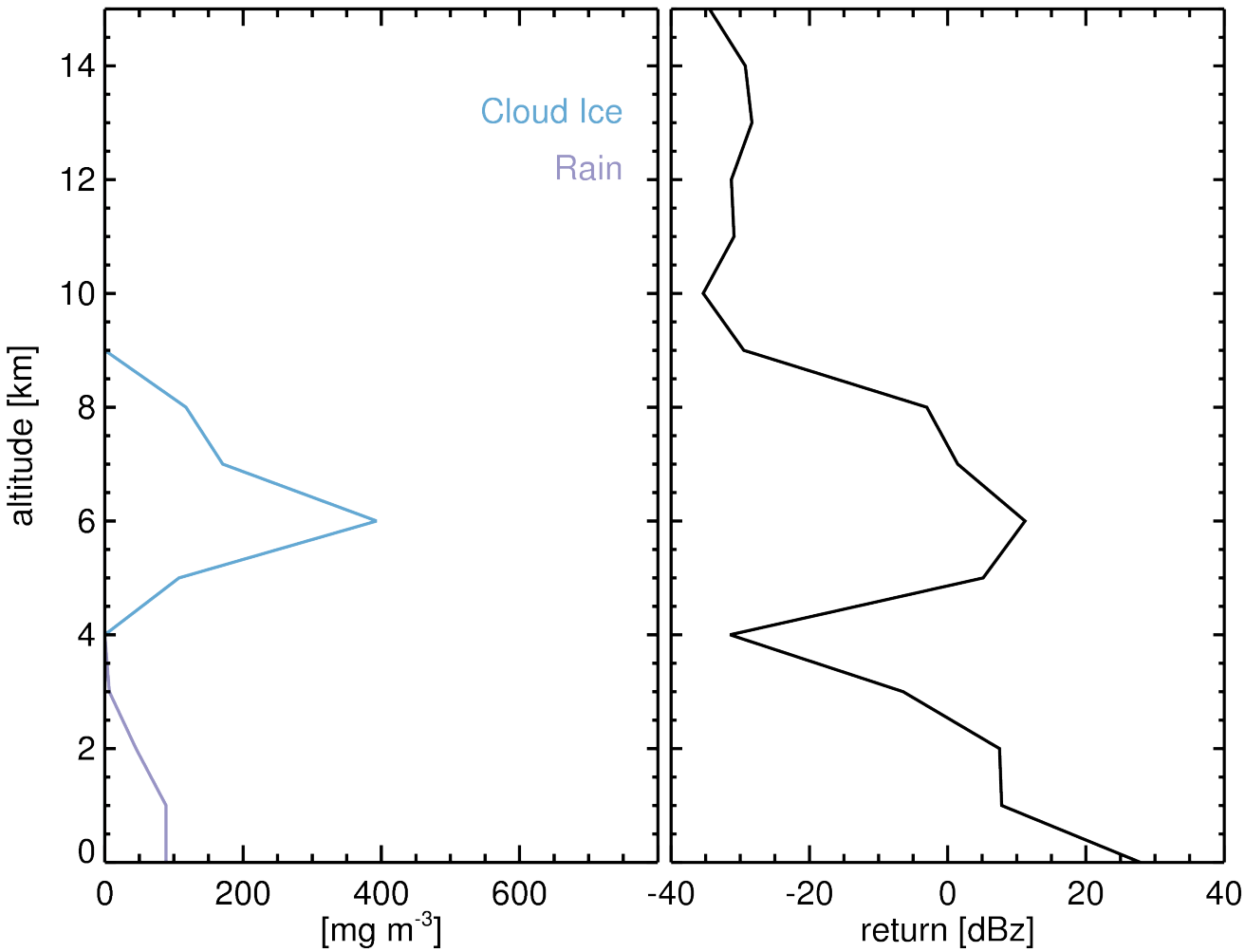


Measurements



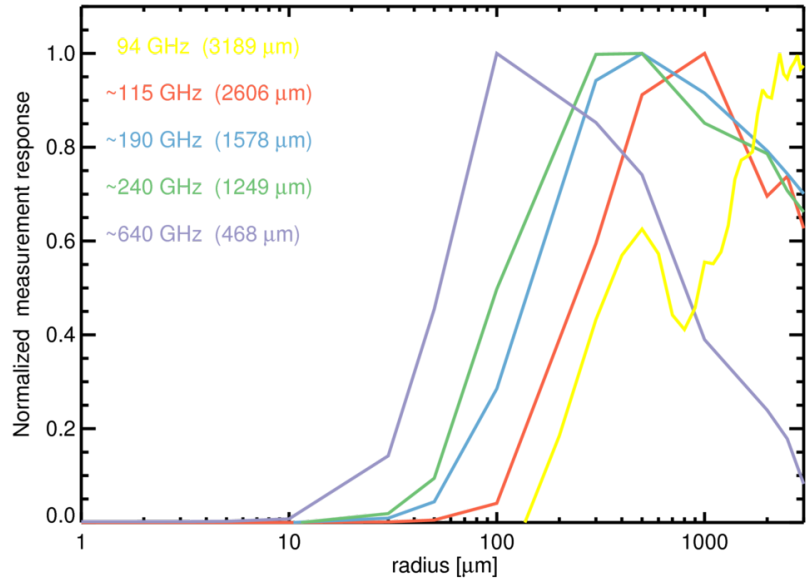
Measurements

CloudSat return example

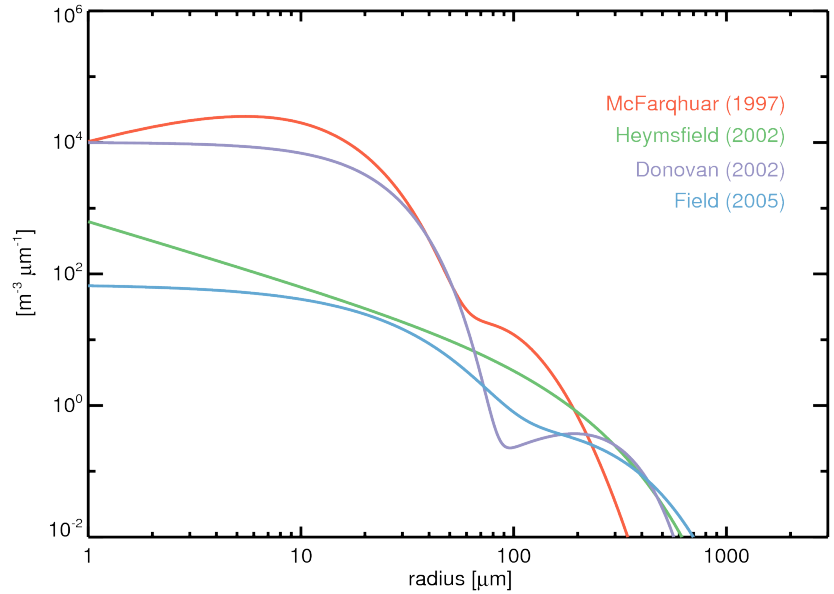


Measurements

High frequencies interact more strongly with small particles, whereas low frequencies interact more strongly with larger particles

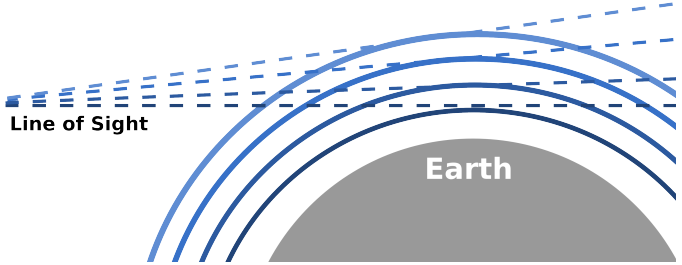


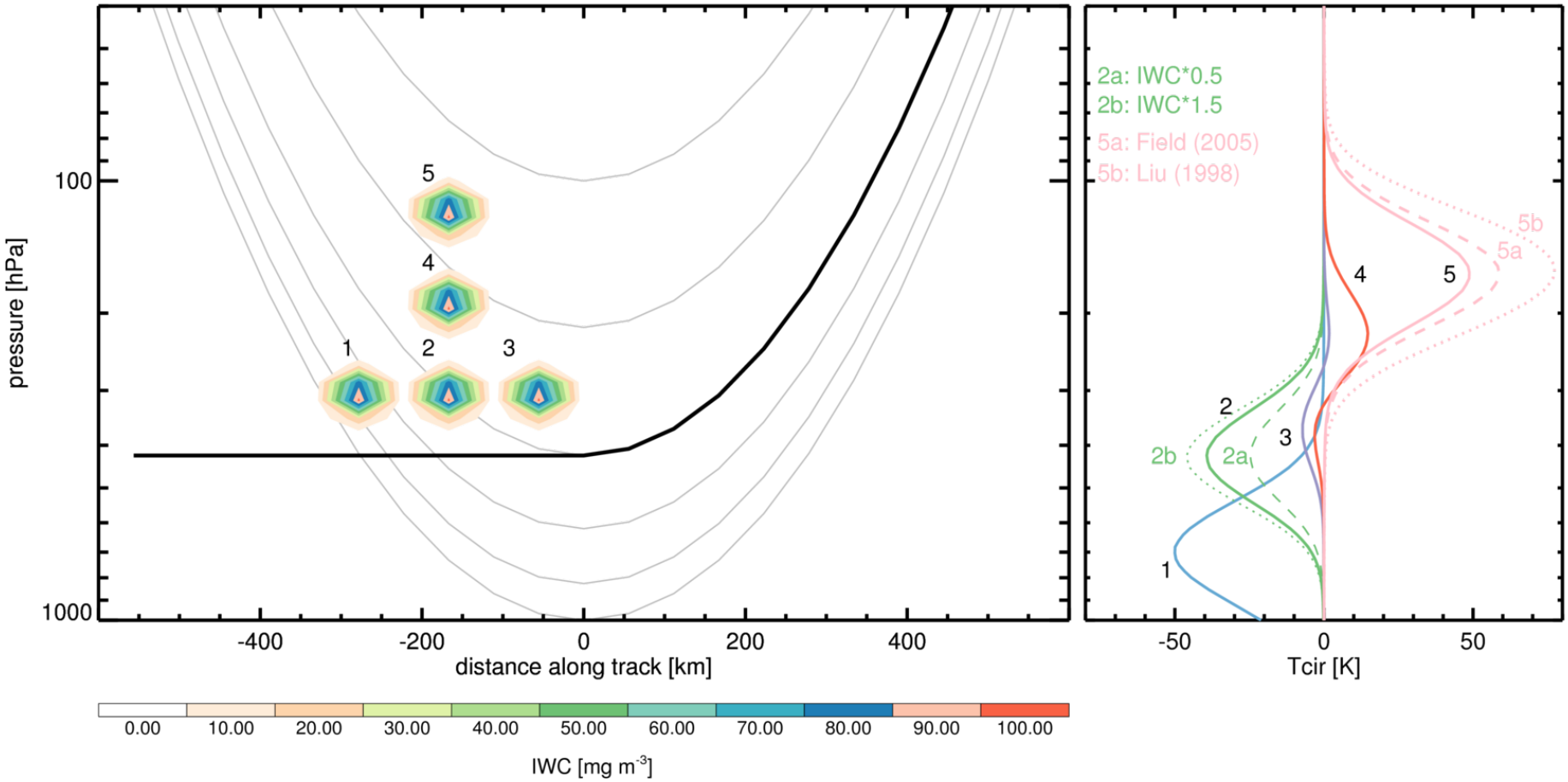
Typical ice particle size distributions (0.024 g m^{-3} @ -10°C)



Measurements

MLS 240GHz



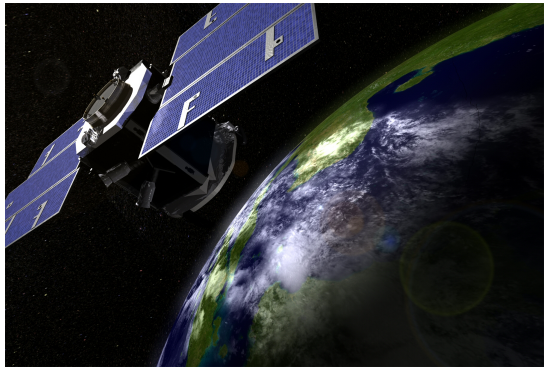


To simulate cloud ice MLS measurements we need to know:

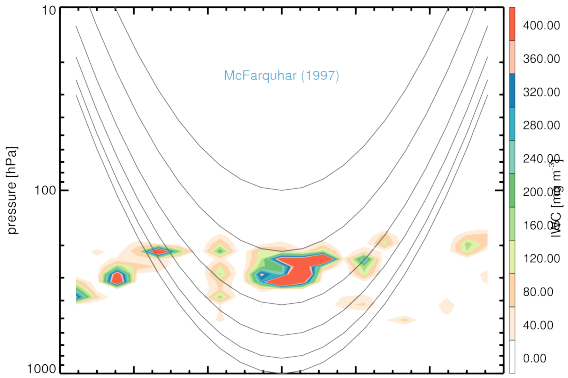
Cloud Ice, Cloud Location, and PSD

Methodology

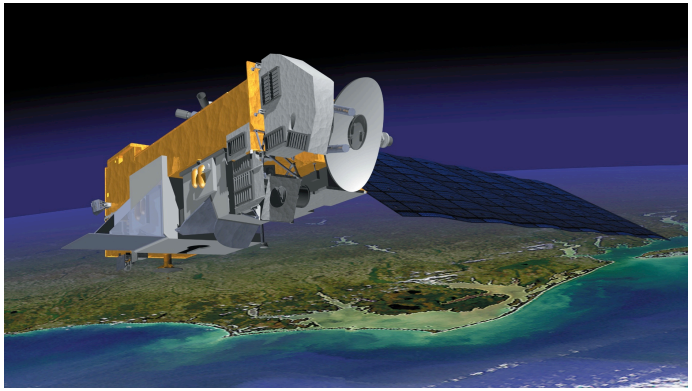
CloudSat: Cloud Ice & Cloud location



CloudSat MLS colocation



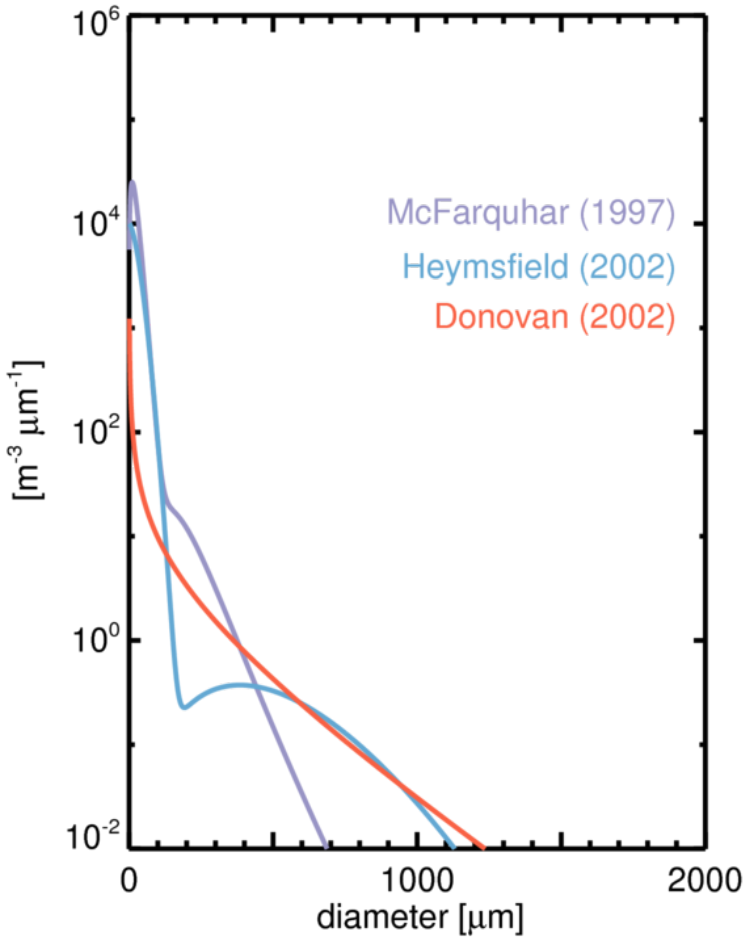
Construction of the MLS scene

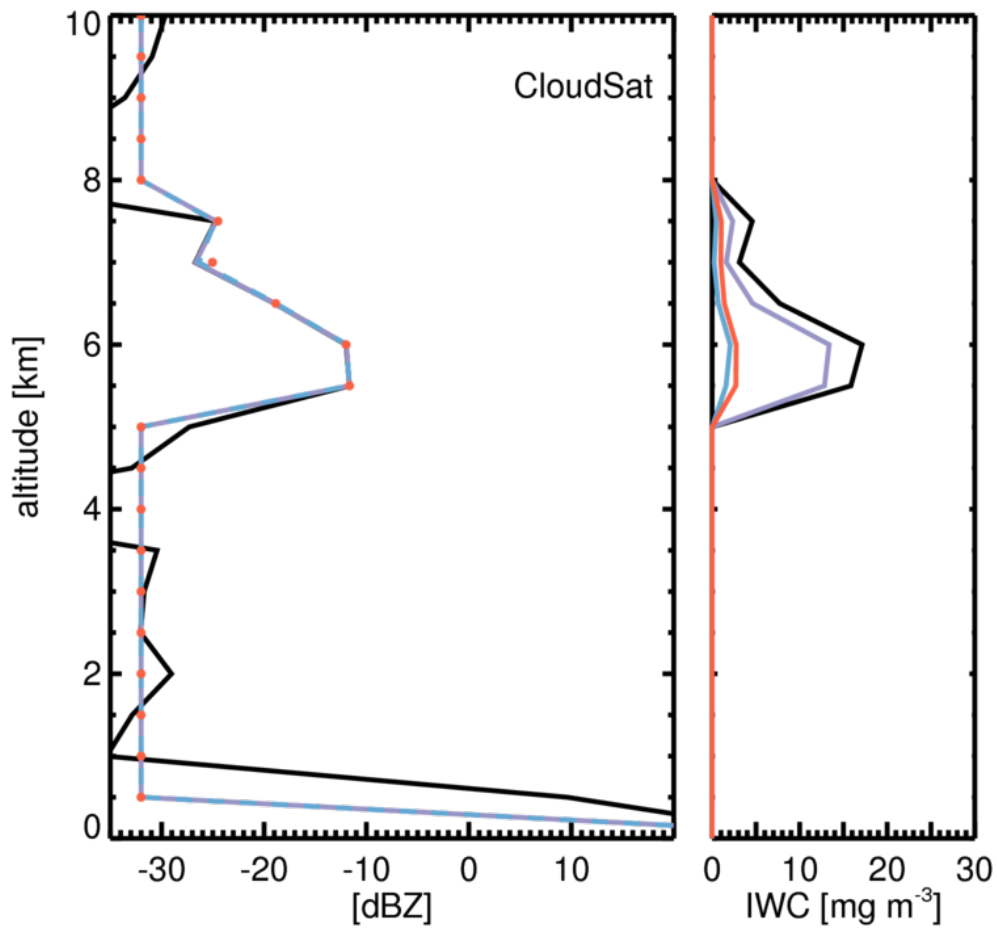


Comparison with MLS measurements

Methodology

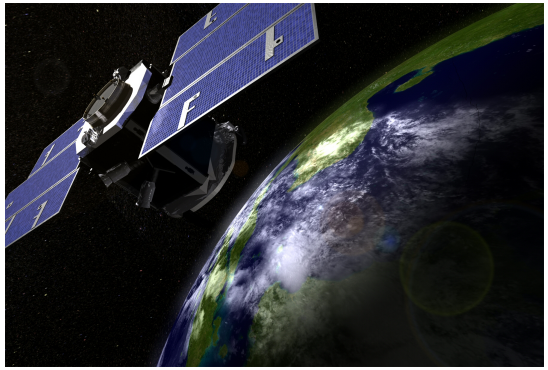
CloudSat Cloud Ice Retrieval



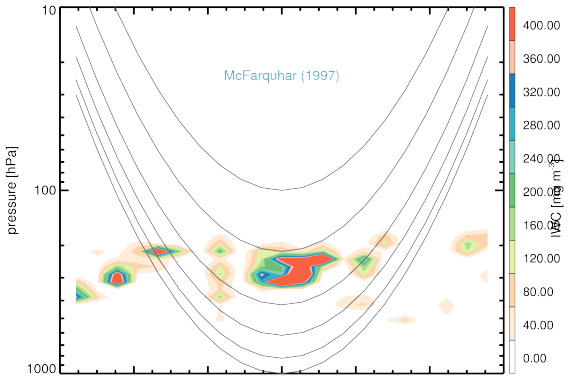


Methodology

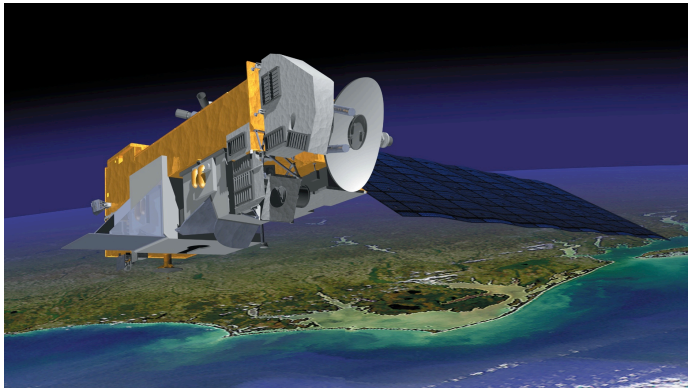
CloudSat: Cloud Ice & Cloud location



CloudSat MLS colocation

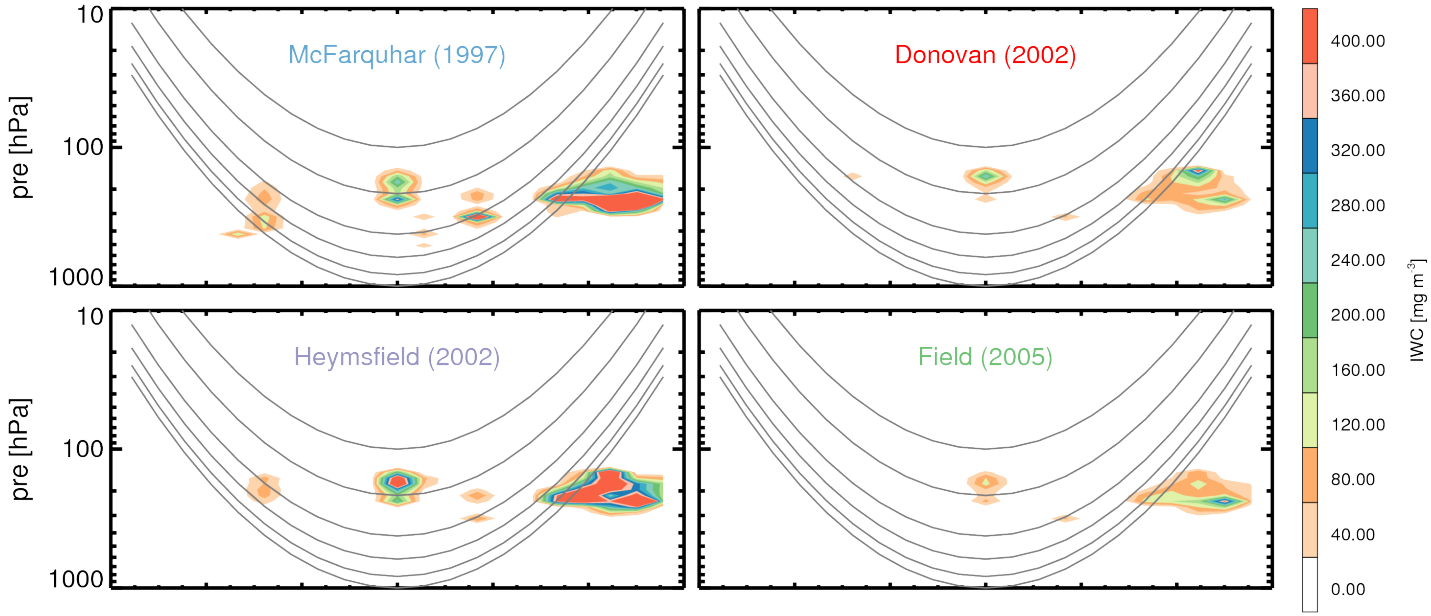


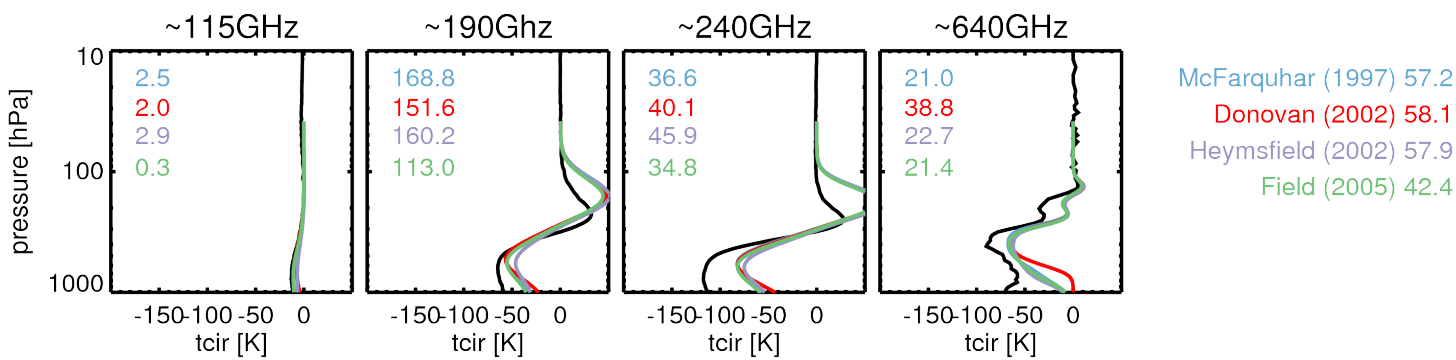
Construction of the MLS scene



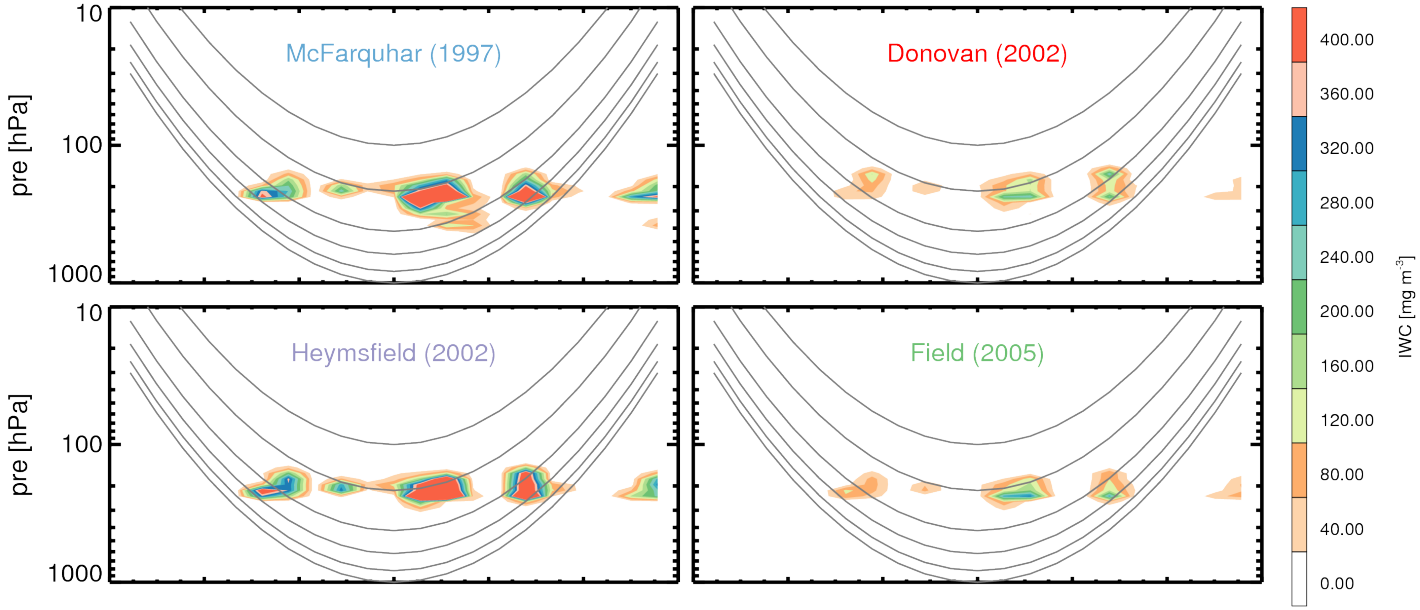
Comparison with MLS measurements

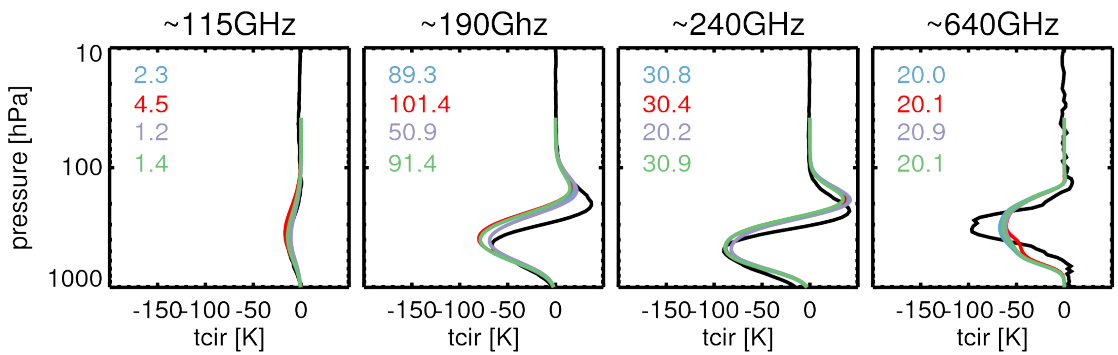
Results


McFarquhar (1997)
Donovan (2002)
Heymsfield (2002)
Field (2005)
pre [hPa]
10
100
1000
IWC [mg m^{-3}]
400.00
360.00
320.00
280.00
240.00
200.00
160.00
120.00
80.00
40.00
0.00


~115GHz
~190Ghz
~240GHz
~640GHz
pressure [hPa]
10
100
1000
2.5
2.0
2.9
0.3
168.8
151.6
160.2
113.0
36.6
40.1
45.9
34.8
21.0
38.8
22.7
21.4
-150 -100 -50 0
tcir [K]
McFarquhar (1997) 57.2
Donovan (2002) 58.1
Heymsfield (2002) 57.9
Field (2005) 42.4

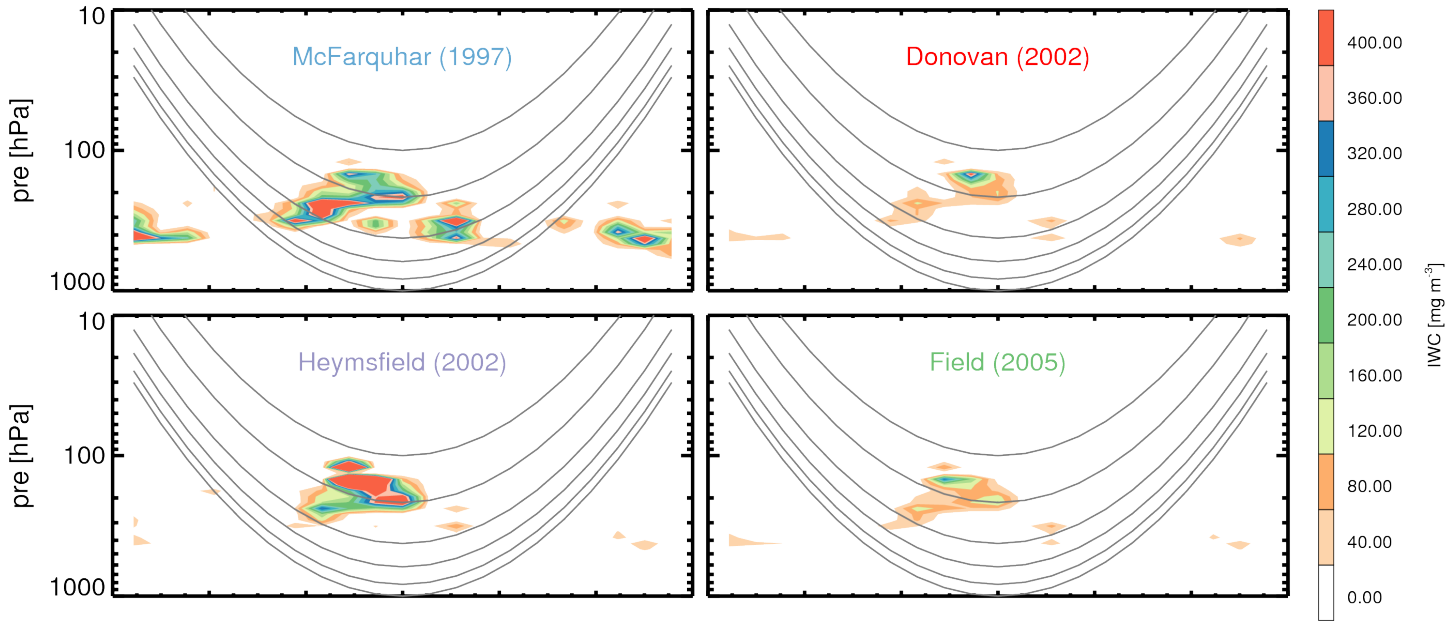
Results

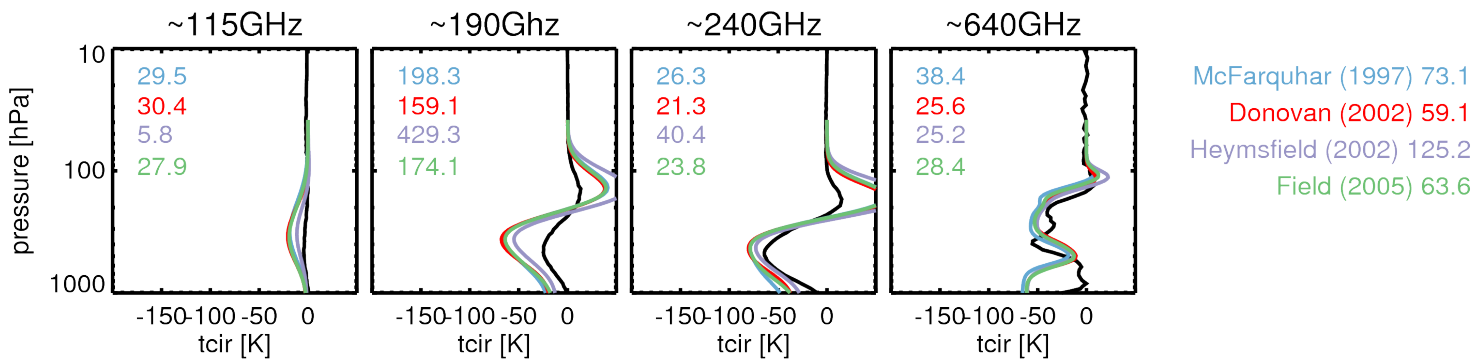




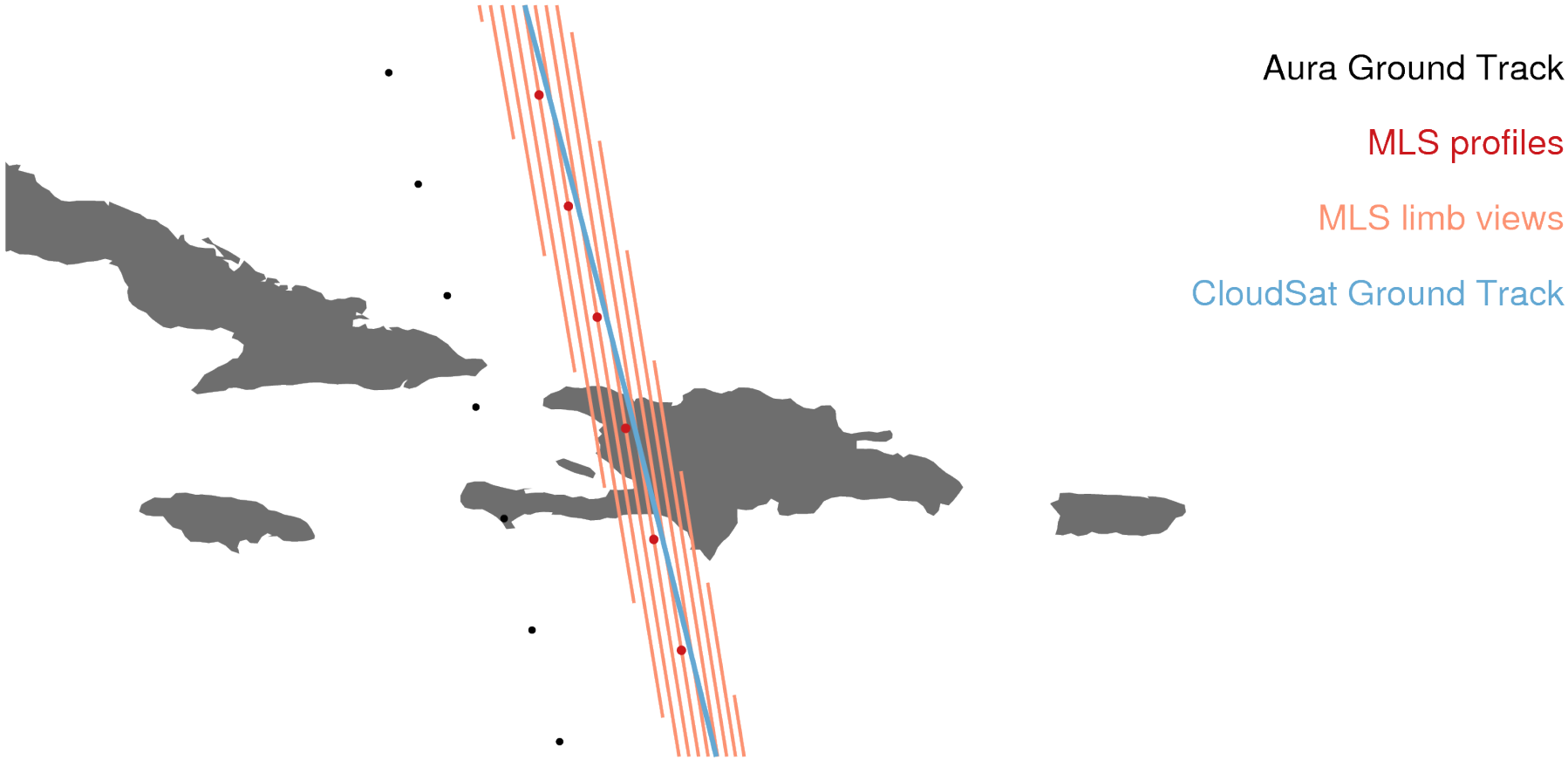
McFarquhar (1997) 35.6
Donovan (2002) 39.1
Heymsfield (2002) 23.3
Field (2005) 36.0

Results


McFarquhar (1997)
Donovan (2002)
Heymsfield (2002)
Field (2005)
pre [hPa]
10
100
1000
IWC [mg m-3]
400.00
360.00
320.00
280.00
240.00
200.00
160.00
120.00
80.00
40.00
0.00

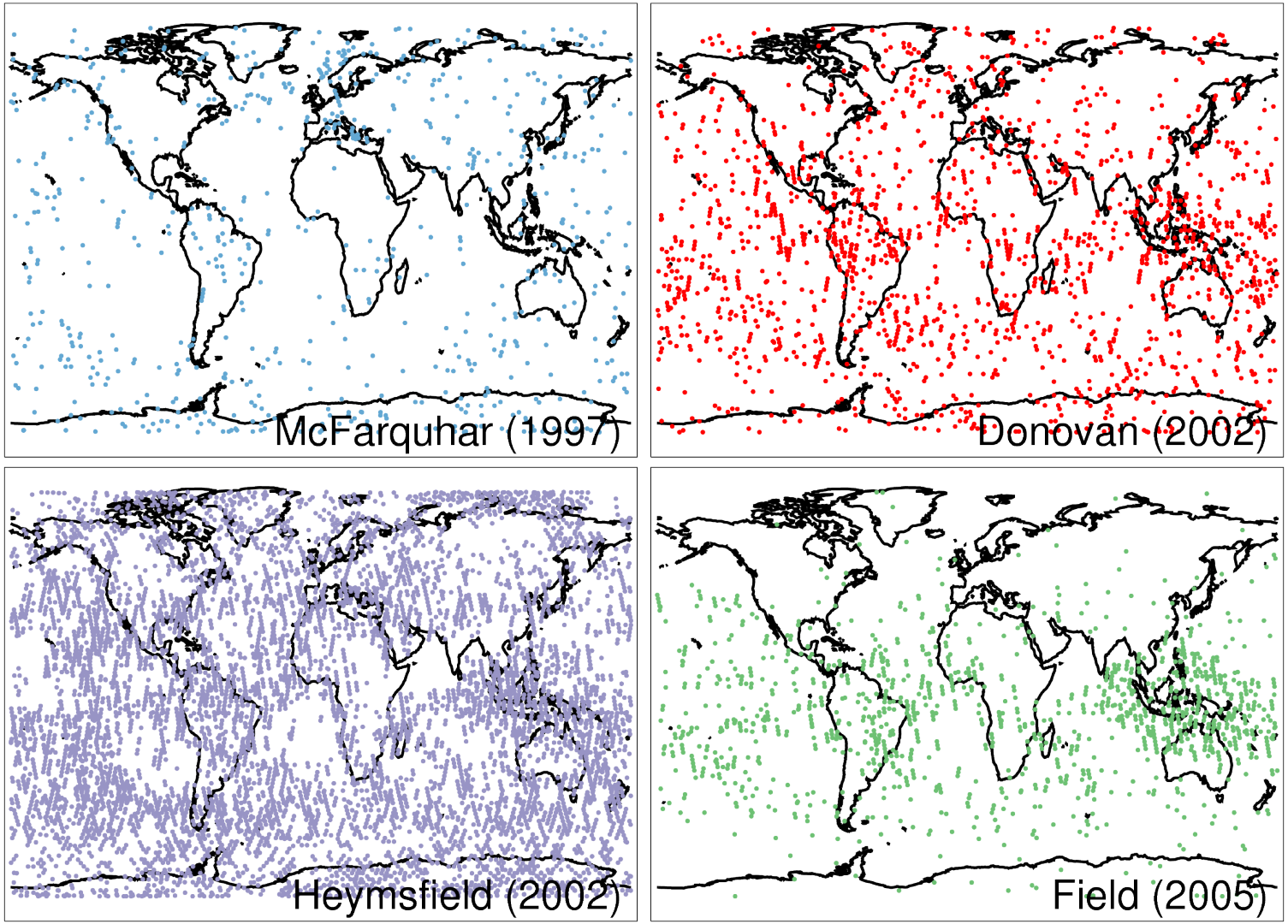

~115GHz
~190Ghz
~240GHz
~640GHz
pressure [hPa]
10
100
1000
29.5
30.4
5.8
27.9
198.3
159.1
429.3
174.1
26.3
21.3
40.4
23.8
38.4
25.6
25.2
28.4
-150 -100 -50 0
tcir [K]
McFarquhar (1997) 73.1
Donovan (2002) 59.1
Heymsfield (2002) 125.2
Field (2005) 63.6

Results



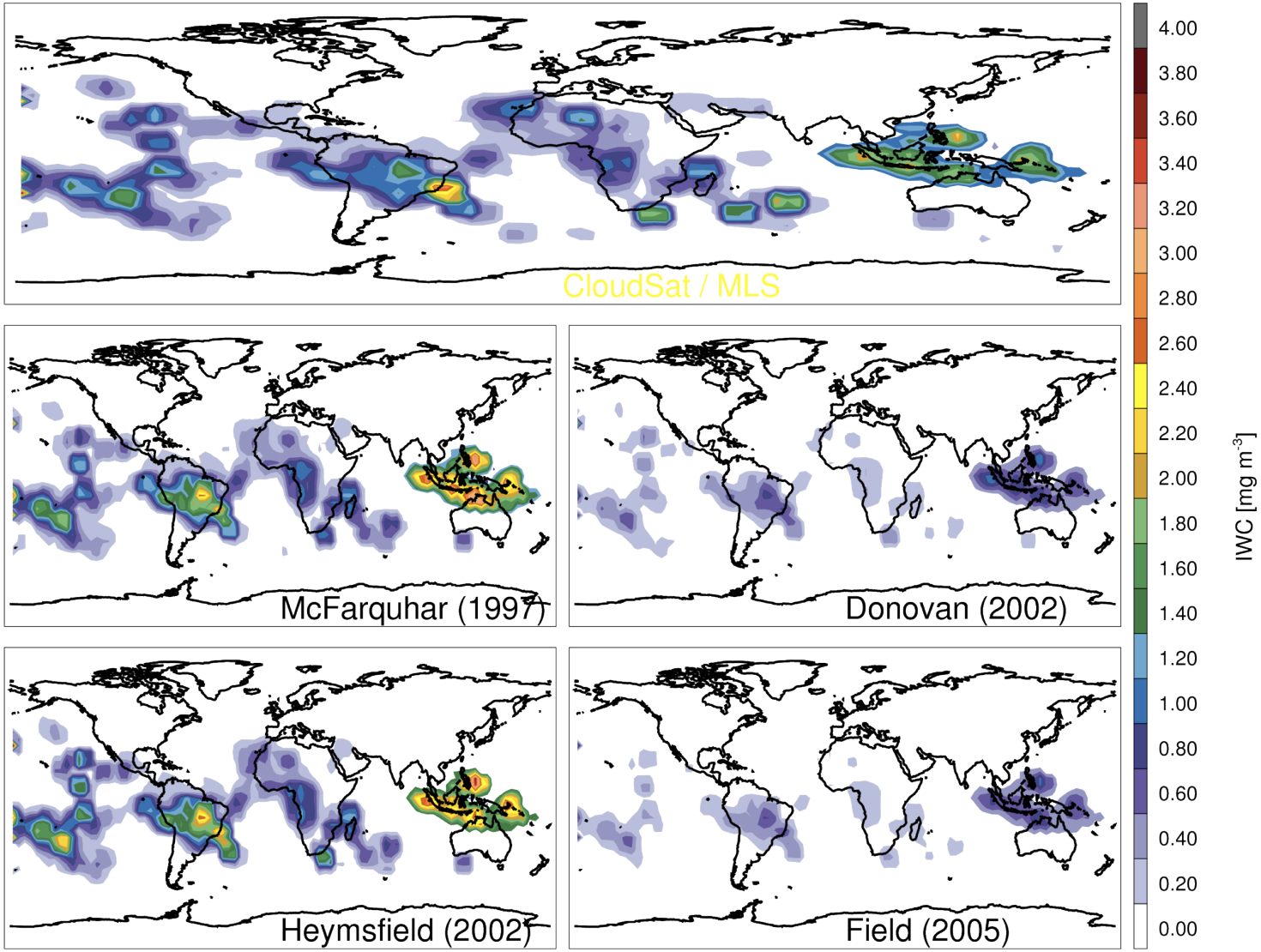
Schematic showing the “skewed” view (due to the Earth’s rotation) between the CloudSat ground track and the MLS limb views.

Results



X^2 maps (8 Feb 2009 – 14 Feb 2009)

Results



IWC maps at 215hPa (8 Feb 2009 – 14 Feb 2009)

Future Work

Test more particle size distributions

Error analysis

Run many more days

Try to do a cloud ice – particle size distribution retrieval.