Hydrometeor/air velocity discrimination

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Background

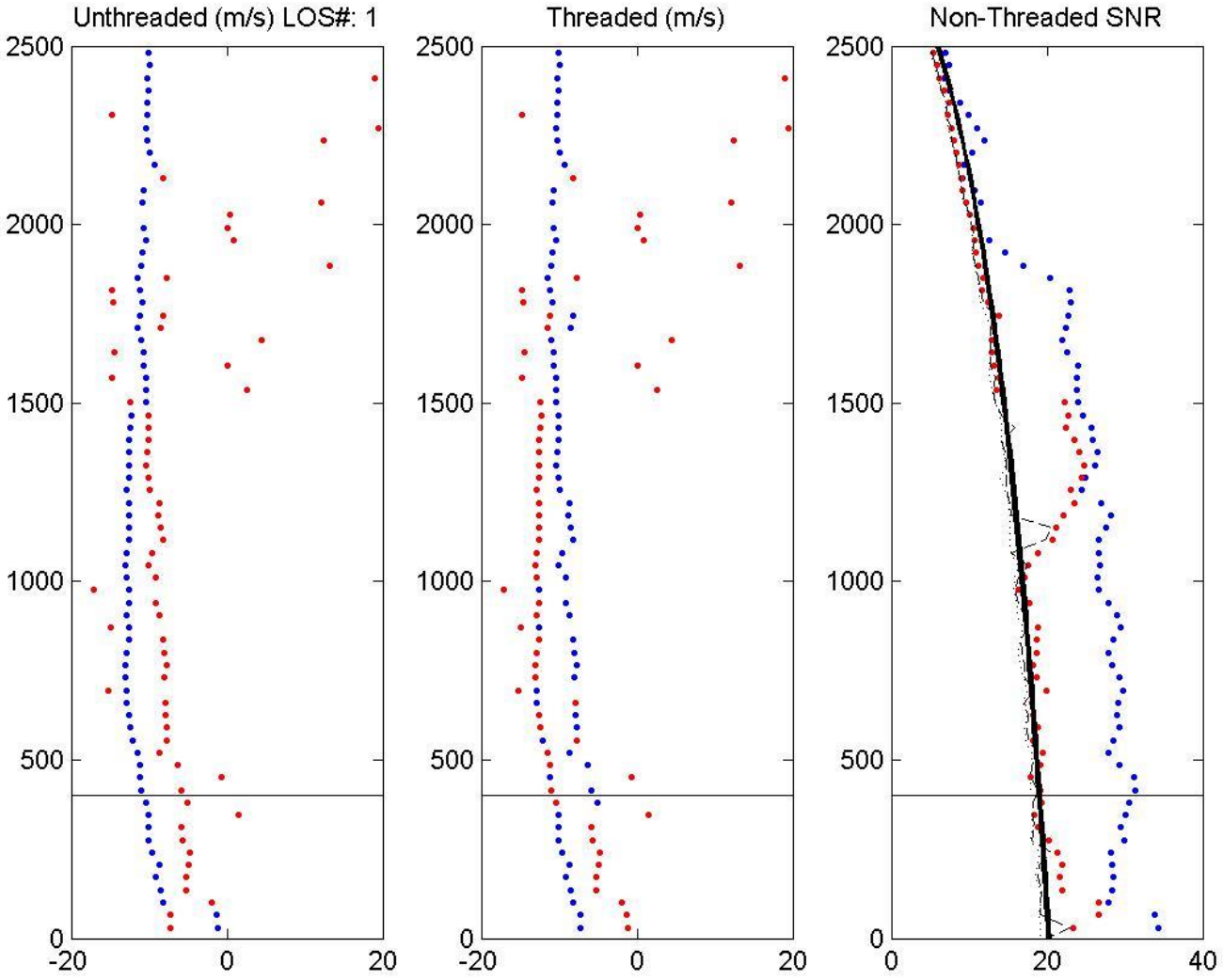
- Most of the TODWL research has been conducted during precipitation free situations
- Most of the P3DWL flights were targeting severe tropical convective systems
- During processing of the P3DWL wind profiles, the issue of hydrometeors became obvious.
- Developed algorithm for dealing with hydrometeors
- Now working with DAWN (GRIP) and NOAA HRDL (DYNAMO) data associated with clouds, both convective and cirrus.

Hydrometeor effects at 30 degree nadir

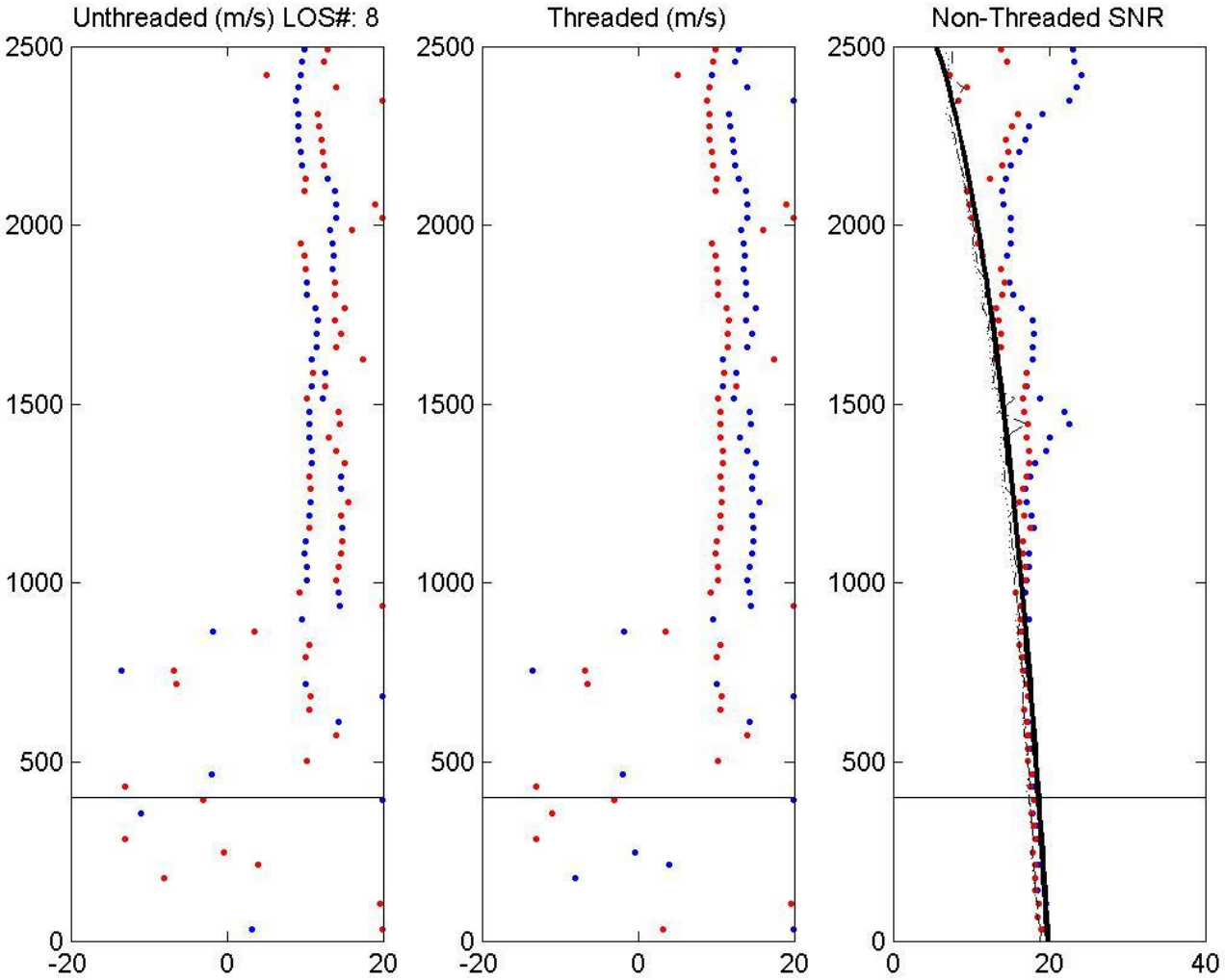
Hydrometeor	Fall Velocity	LOS contribution	Inferred horizontal wind
Ice crystal	.5 -1.0	.65	1.30
Grauple	1 -5	2.61	5.19
Hail	5 -50	21.75	43.25
Drizzle	1 -4	2.17	4.33
Rain	4 -10	6.09	12.11

Nadir angle	Horizontal “error”
20	2.74
30	1.73
45	1.0

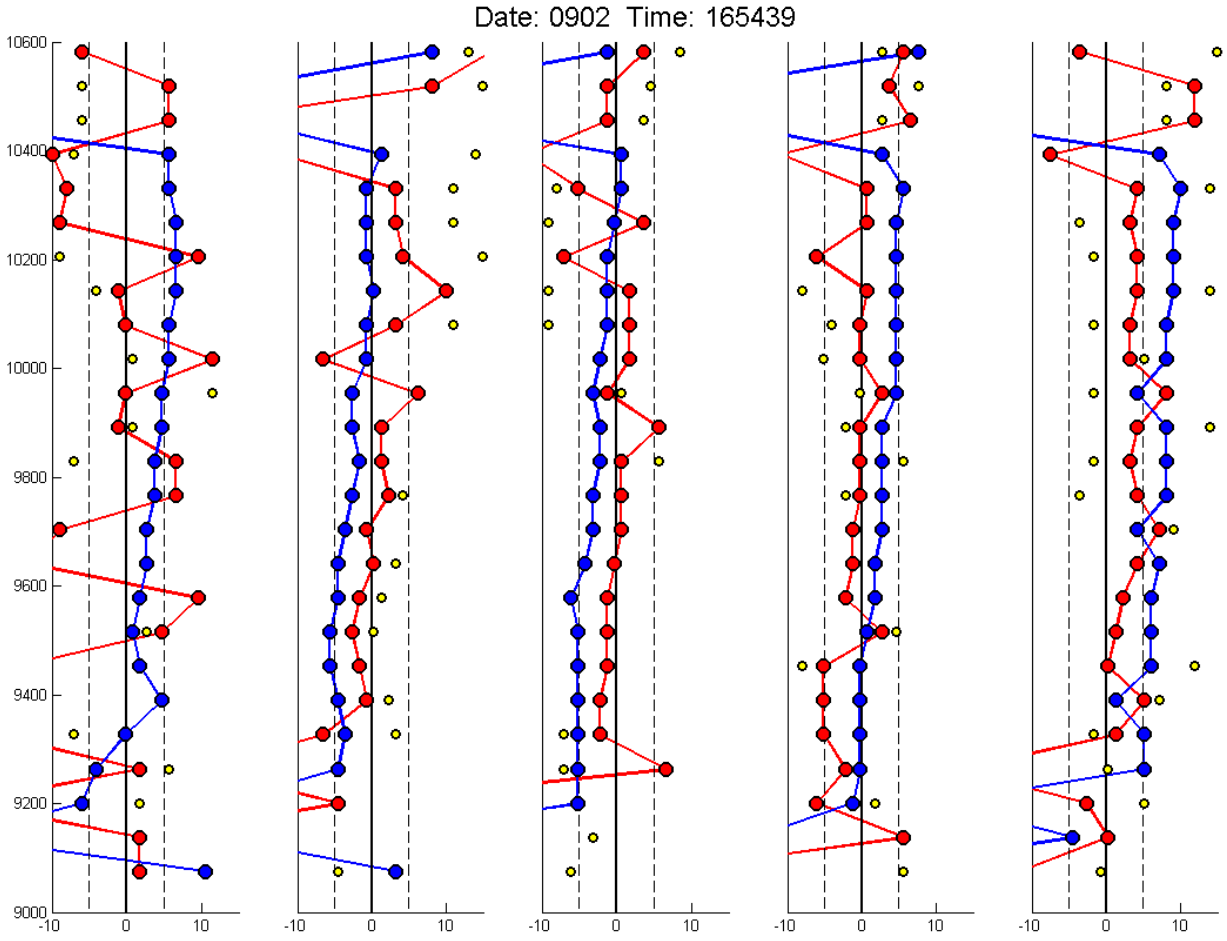
P3DWL TPARC -08



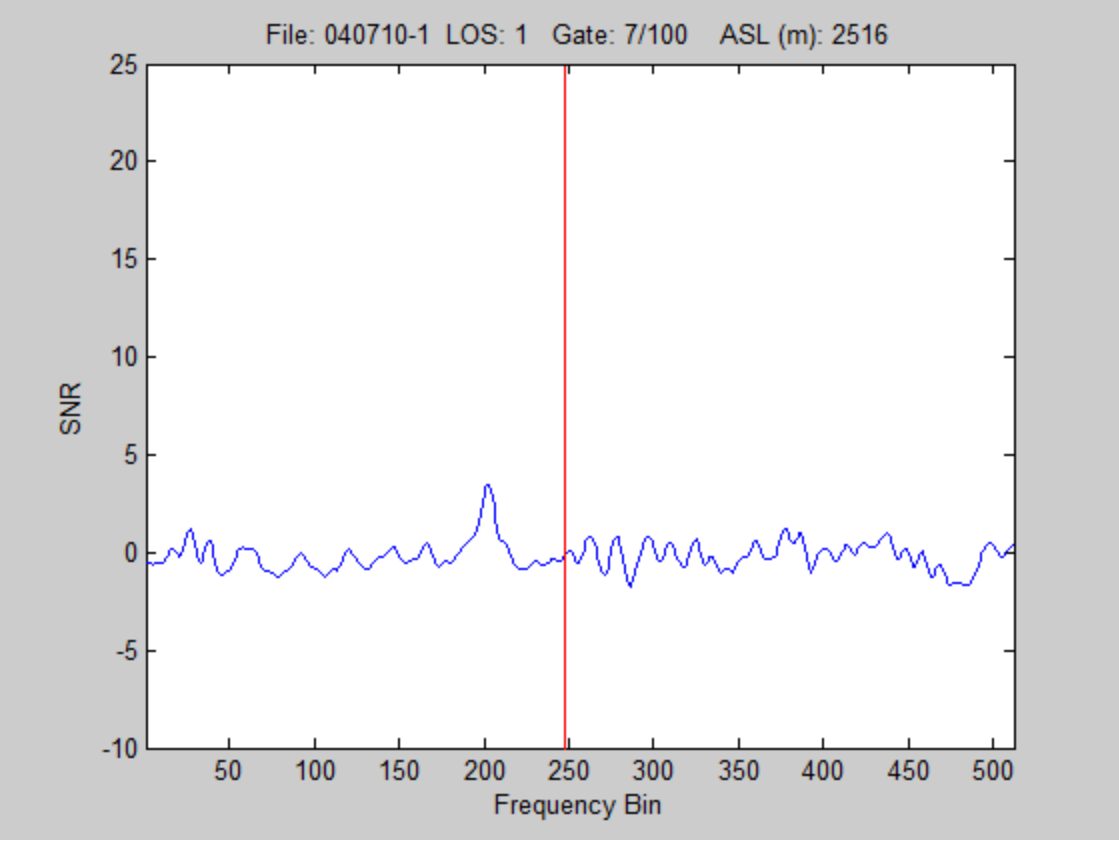
Rain/air mix


Unthreaded (m/s) LOS#: 8
Threaded (m/s)
Non-Threaded SNR
2500
2000
1500
1000
500
0
-20
0
20
40

DAWN in GRIP


Date: 0902 Time: 165439
10600
10400
10200
10000
9800
9600
9400
9200
9000
-10
0
10

Rain/air mix by range gate



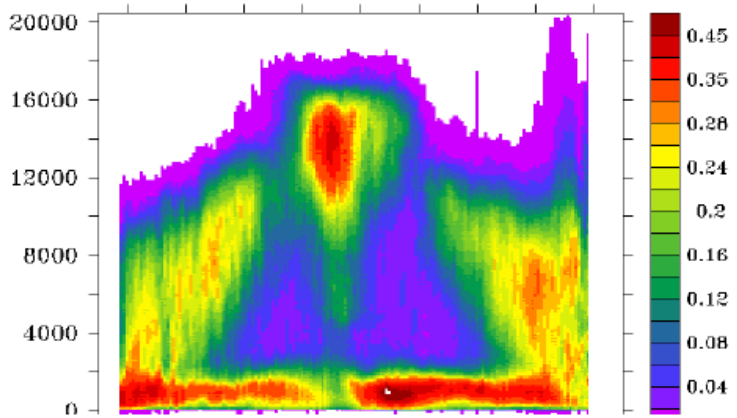
Example of situation where precipitating clouds may significantly confound obtaining useful wind profiles

Overview

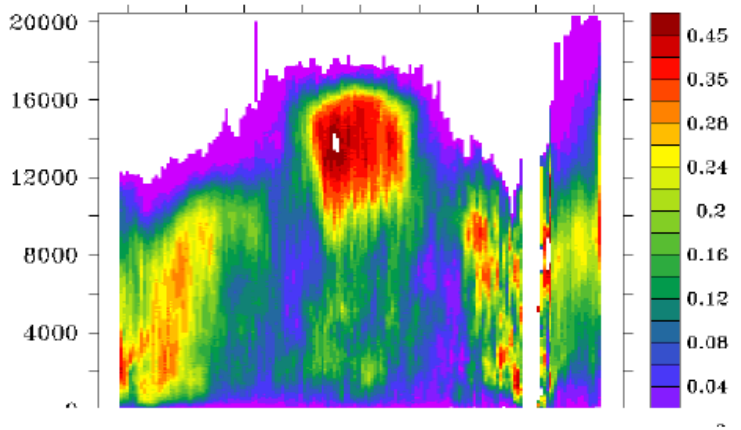
- Sub visual cirrus has been understated in DLSM simulations prior to this year; now included in 3 months of T511 simulations for OSSEs.
- CALIPSO and other satellite data regarding sub-visual cirrus
  - Global distribution
- WISCCR/GWOS simulations with and without sub-visual cirrus
  - Focus on equatorial band and the Somalia Current

WHAT IS OBTAINED From CALIOP/CALIPSO
October 2006

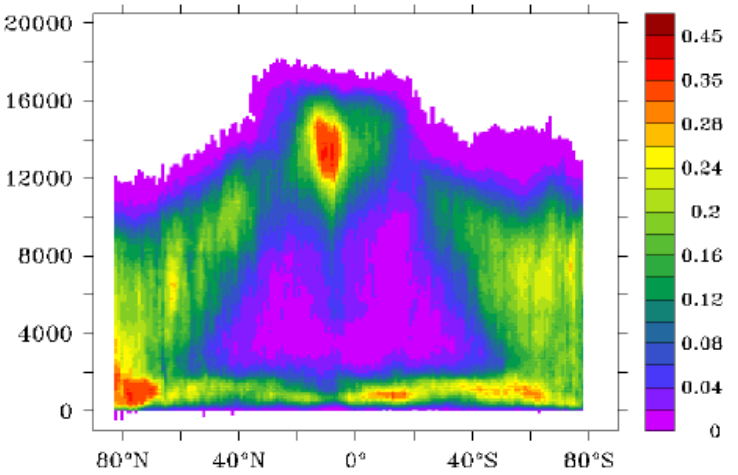
Night Ocean



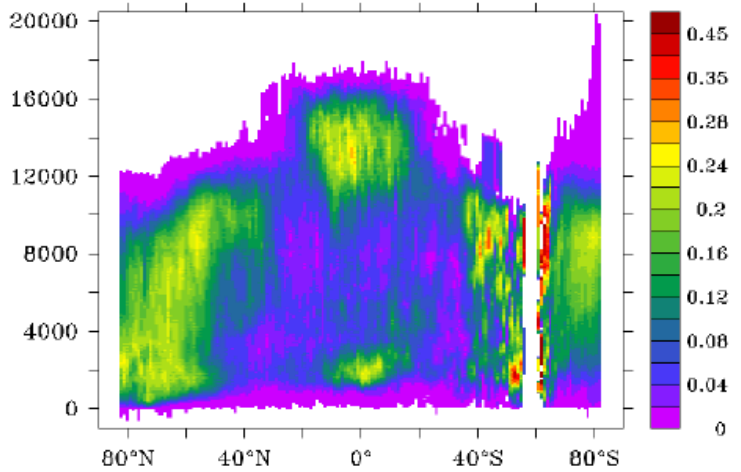
Land



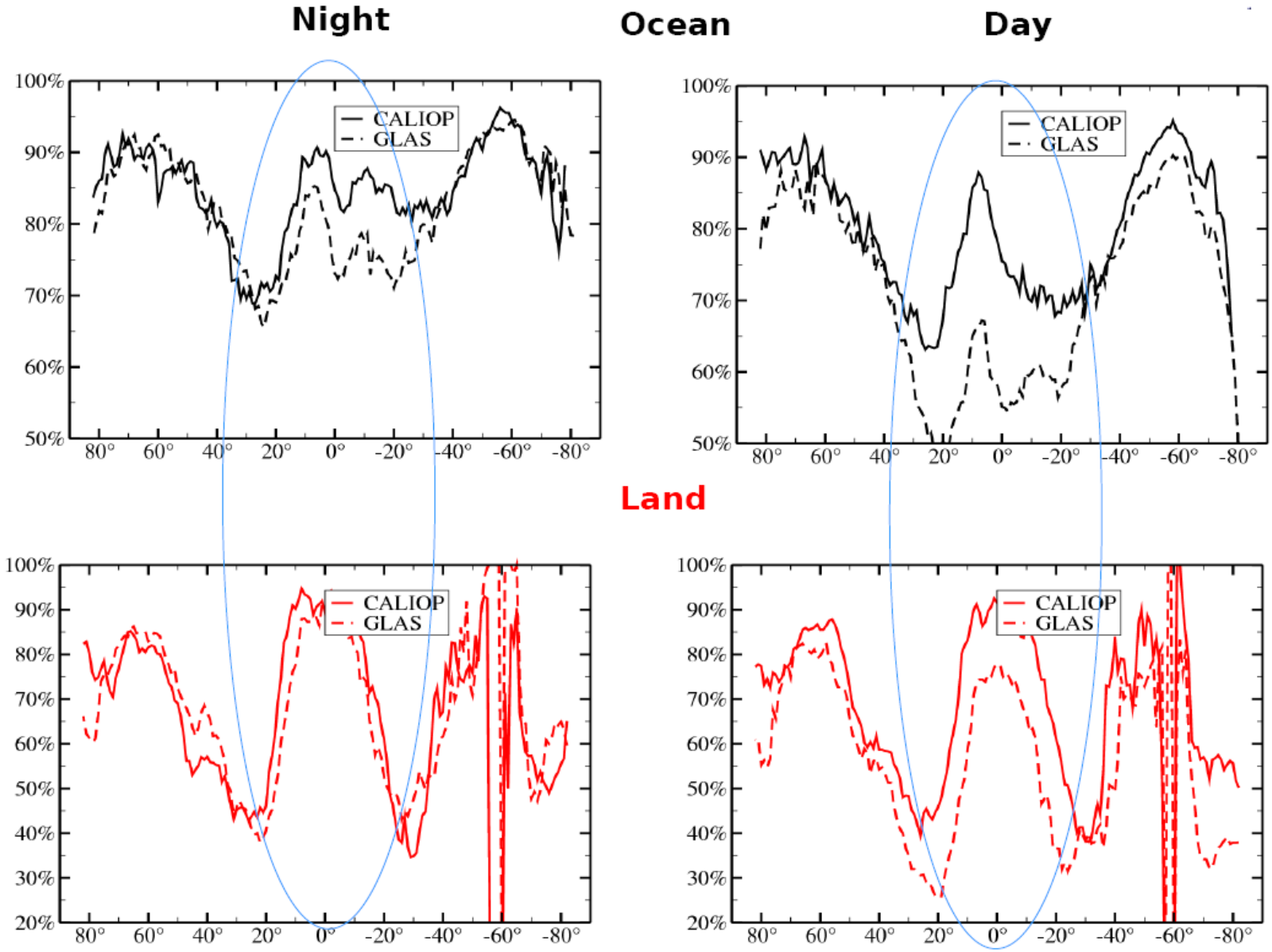
Day



Calipso data v1.10

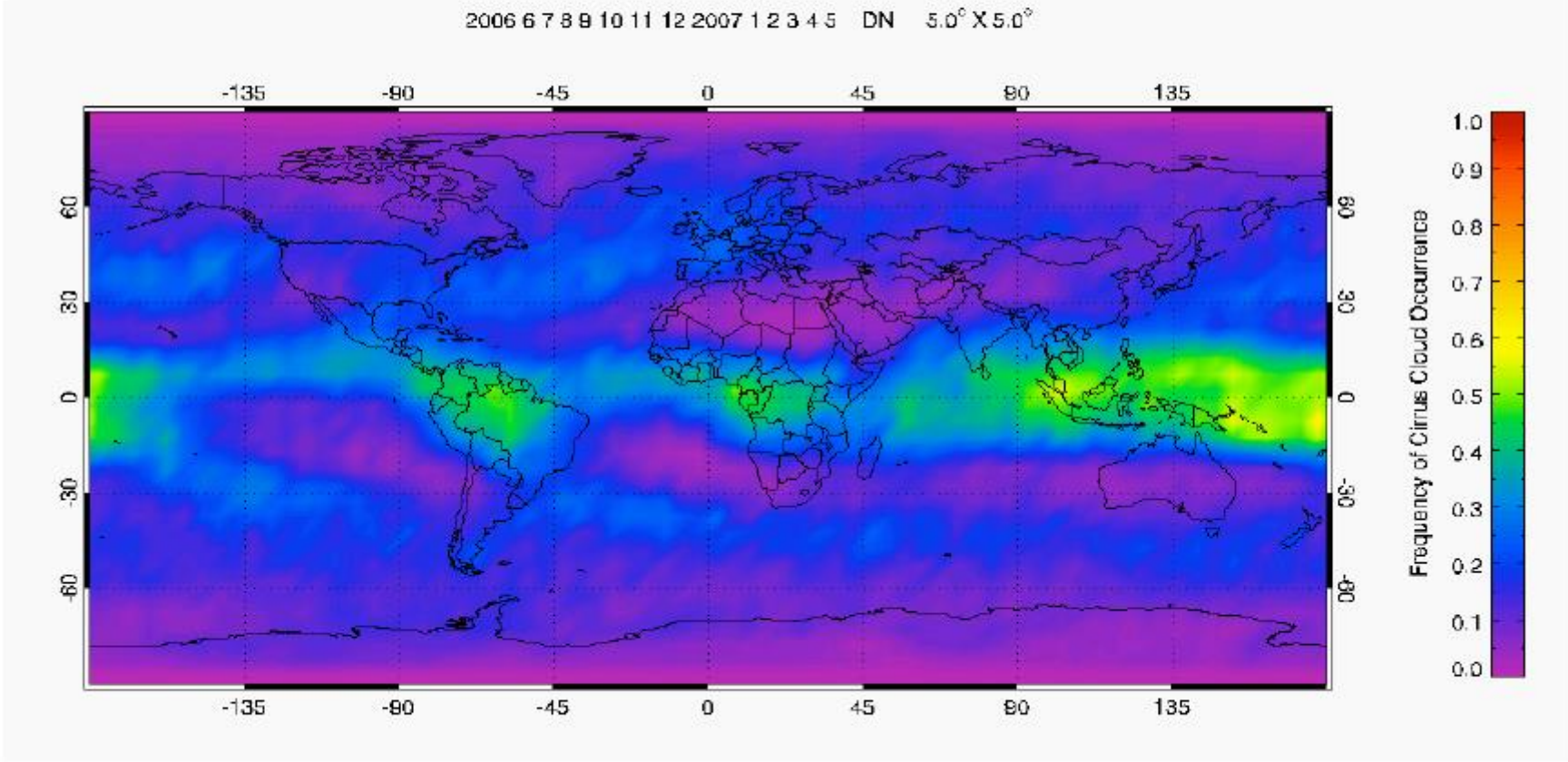


Seze, Pelon, Flamant, Vaughn, Trepte and Winker



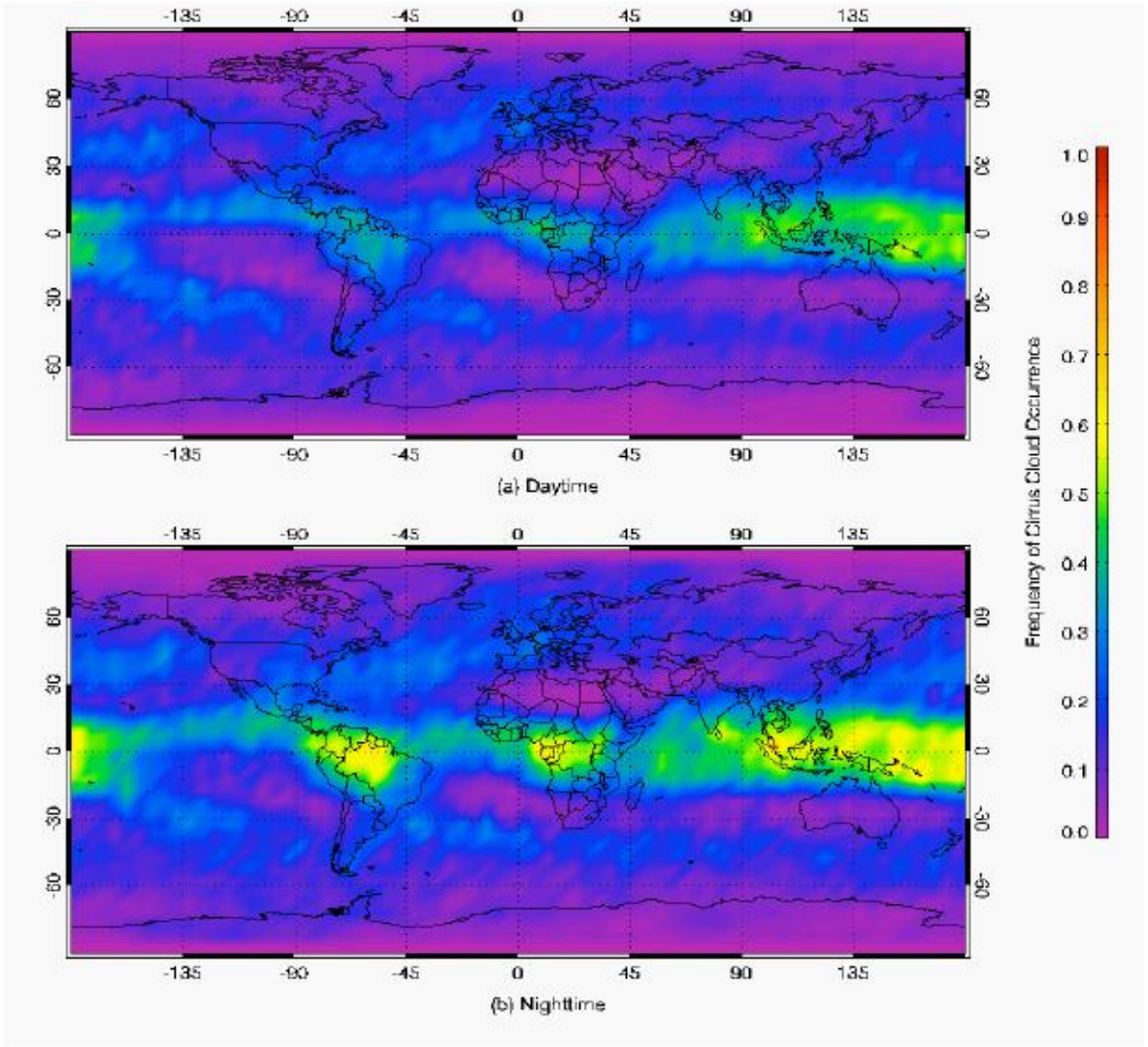
GLAS october 2003 – CALIOP october 2006

Average 1-Y Global Cirrus Frequency

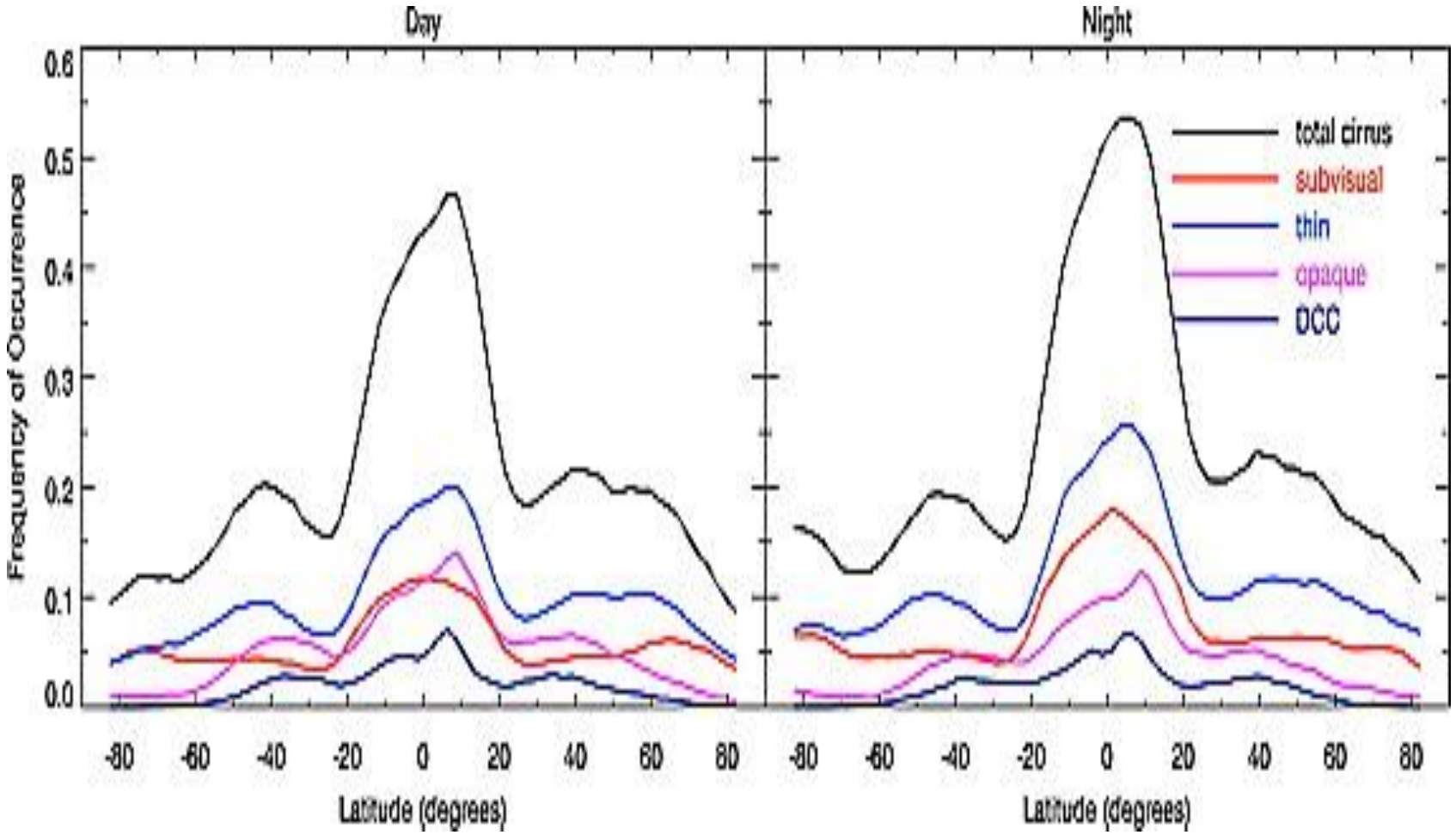


Sassen et al., (2008)

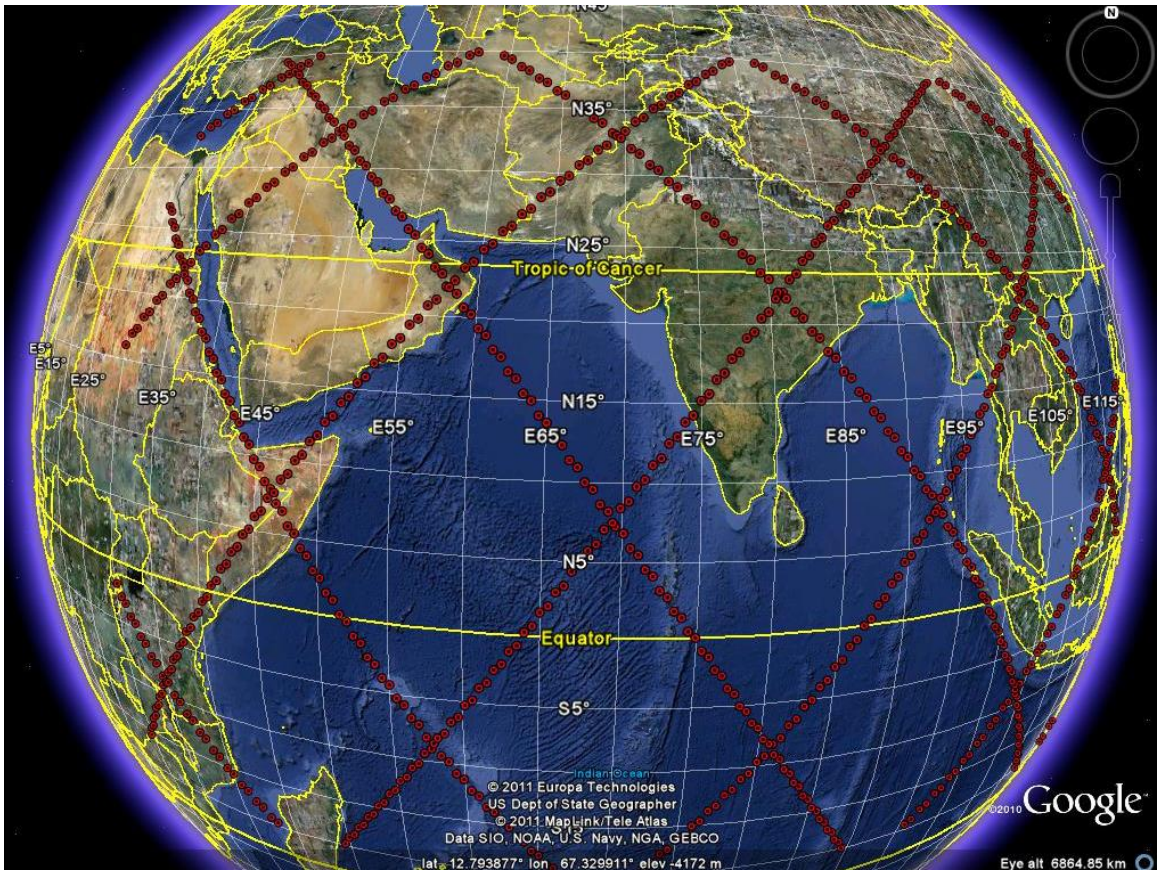
Global Cirrus Day Vs. Night



Sassen et al., (2008)



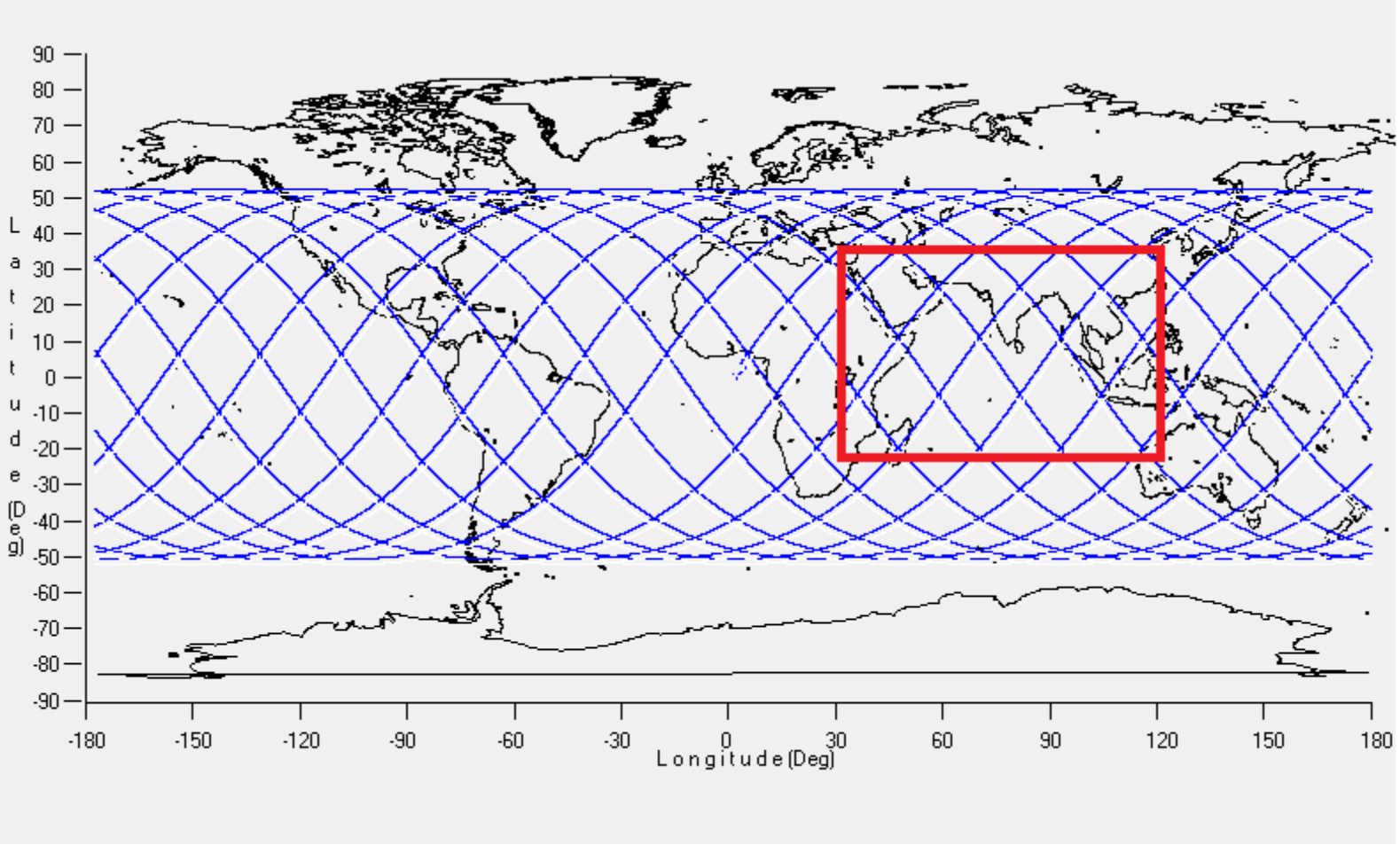
Sassen et al., (2009): Total, SUBVISUAL Cirrus, Thin Cirrus, Opaque Cirrus



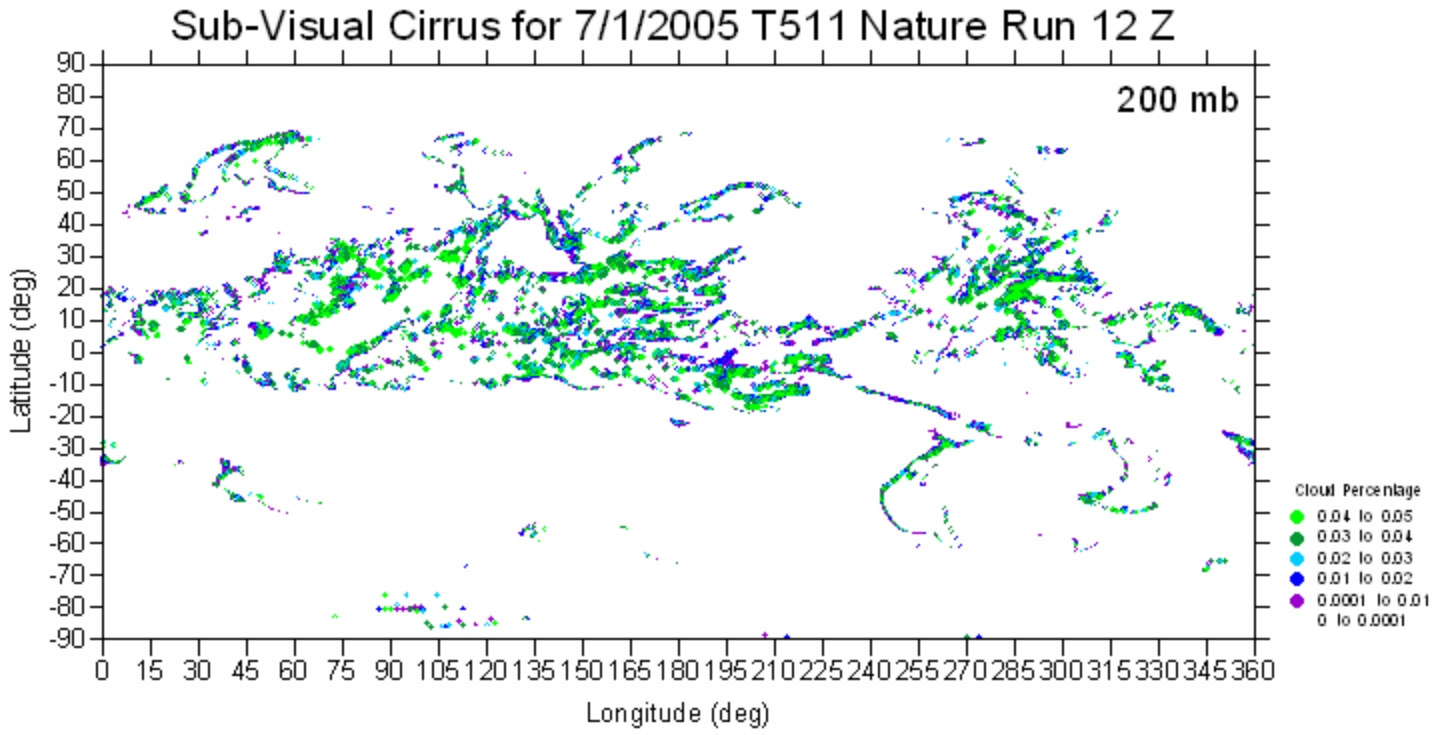
WISSCR Sampling Coverage

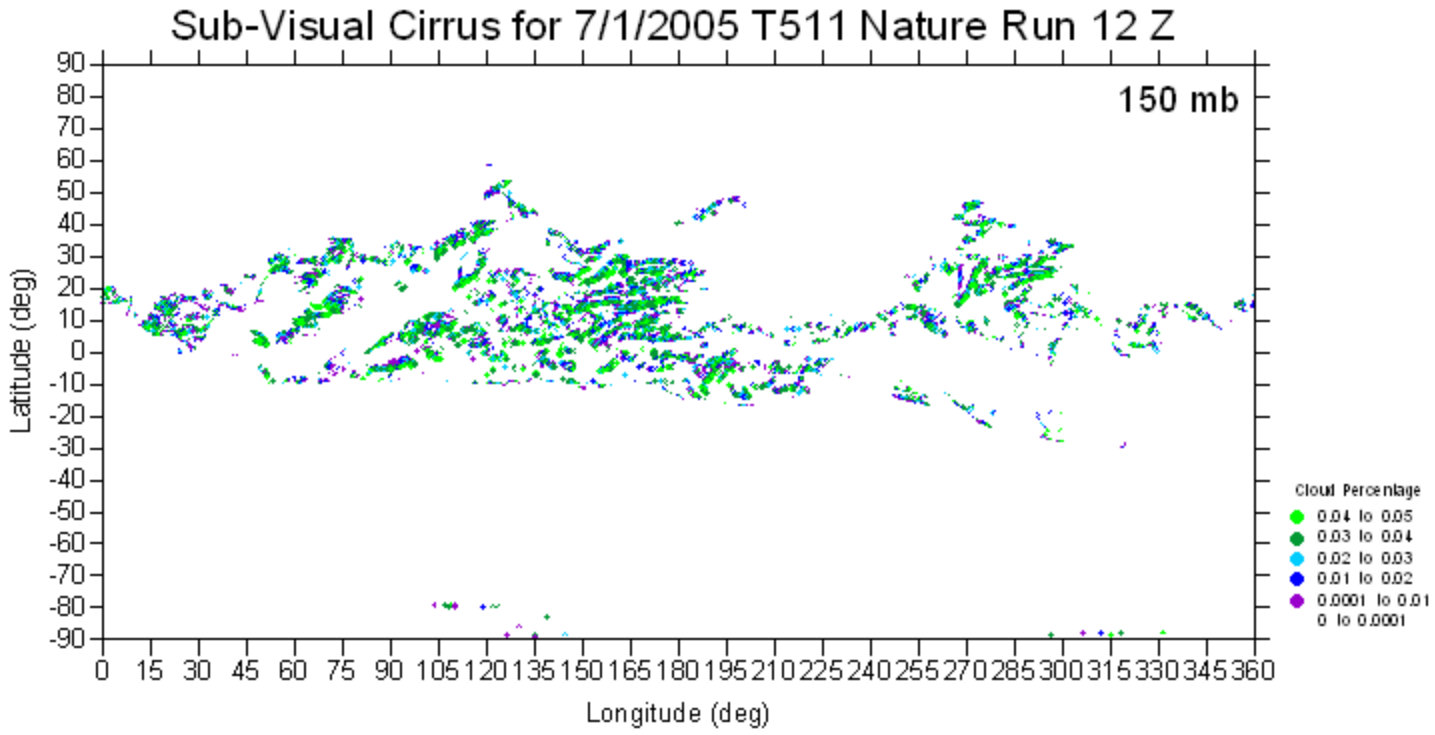
WISSCR sounding locations over 24 hours within the Monsoon Region. There are 720 LOS products, each the result of averaging 120 individual laser pulses with 1 km vertical resolution above 2km and 250m resolution within the lowest 2km.

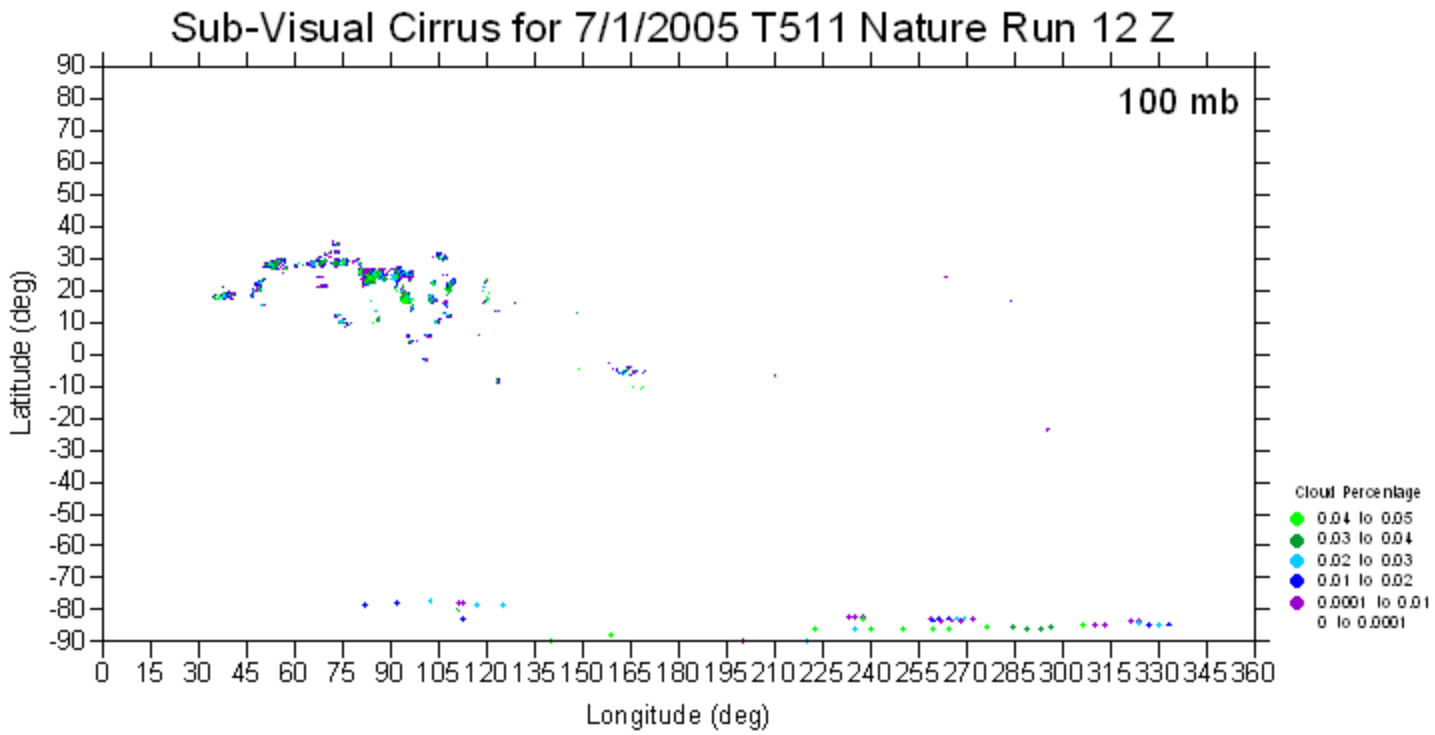
Global coverage of WISSCR for 24 hours

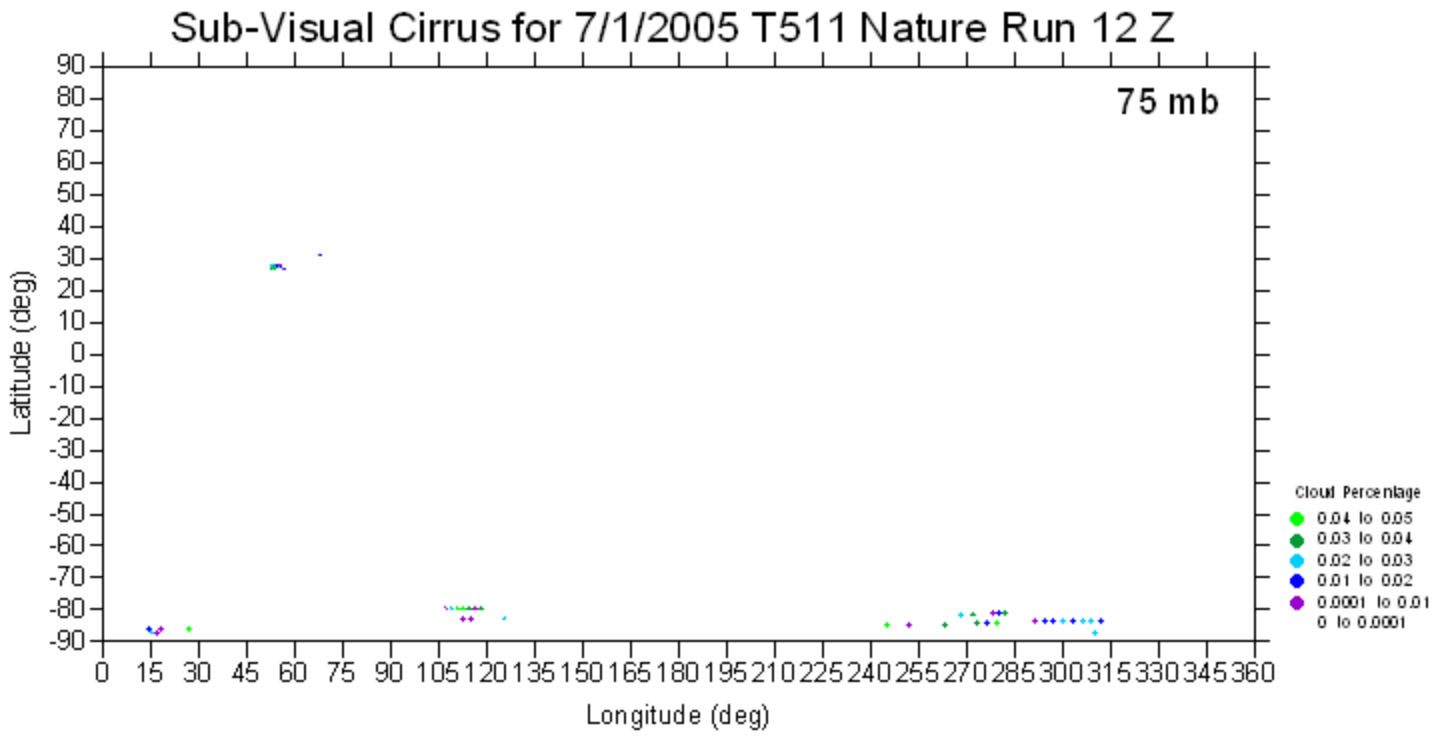


Simulated thin and sub-visual cirrus


Sub-Visual Cirrus for 7/1/2005 T511 Nature Run 12 Z
200 mb
Latitude (deg)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360
Longitude (deg)
Cloud Percentage
0.04 to 0.05
0.03 to 0.04
0.02 to 0.03
0.01 to 0.02
0.0001 to 0.01
0 to 0.0001

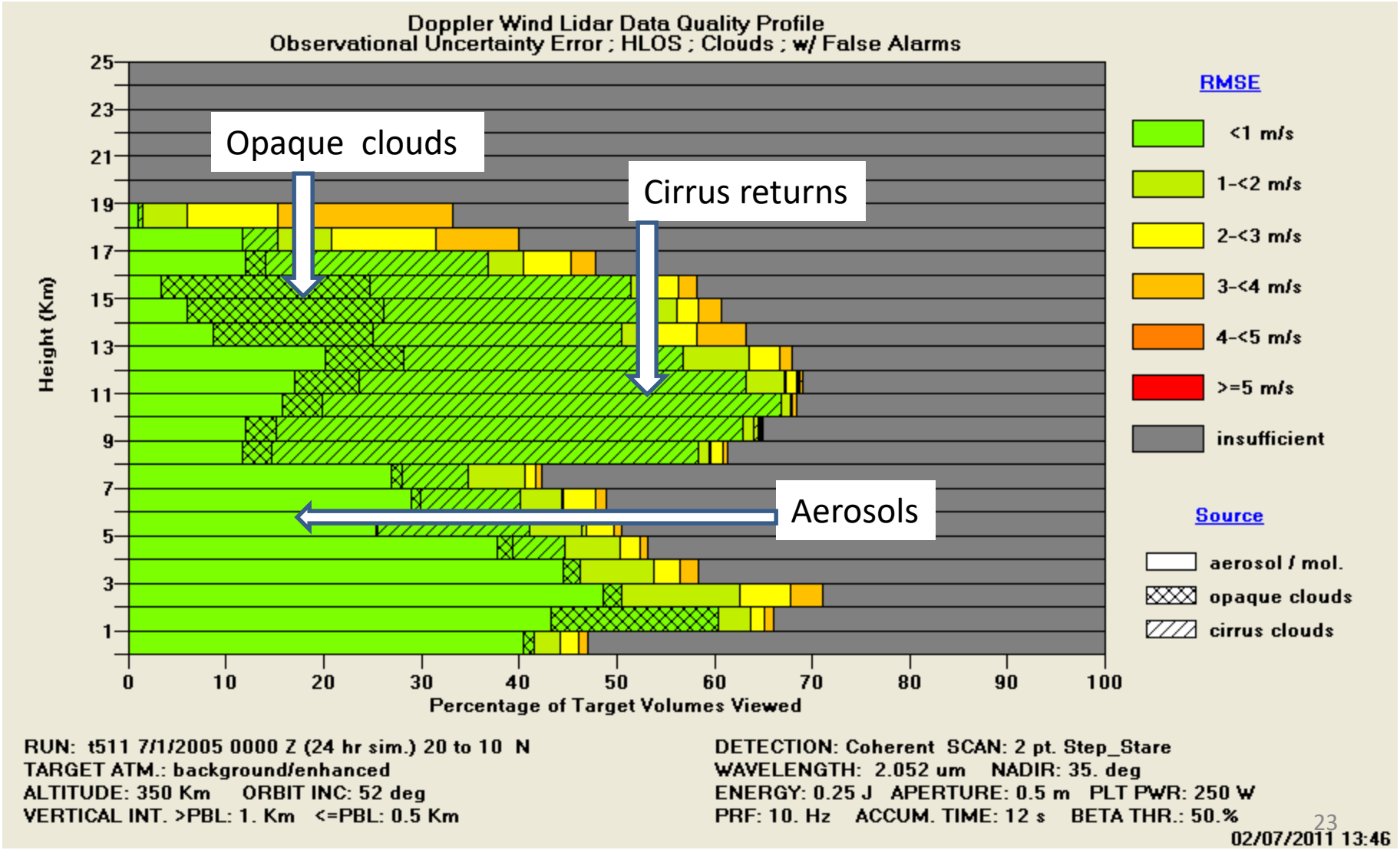

Sub-Visual Cirrus for 7/1/2005 T511 Nature Run 12 Z
150 mb
Latitude (deg)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360
Longitude (deg)
Cloud Percentage
0.04 to 0.05
0.03 to 0.04
0.02 to 0.03
0.01 to 0.02
0.0001 to 0.01
0 to 0.0001


Sub-Visual Cirrus for 7/1/2005 T511 Nature Run 12 Z
100 mb
Latitude (deg)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360
Longitude (deg)
Cloud Percentage
0.04 to 0.05
0.03 to 0.04
0.02 to 0.03
0.01 to 0.02
0.0001 to 0.01
0 to 0.0001

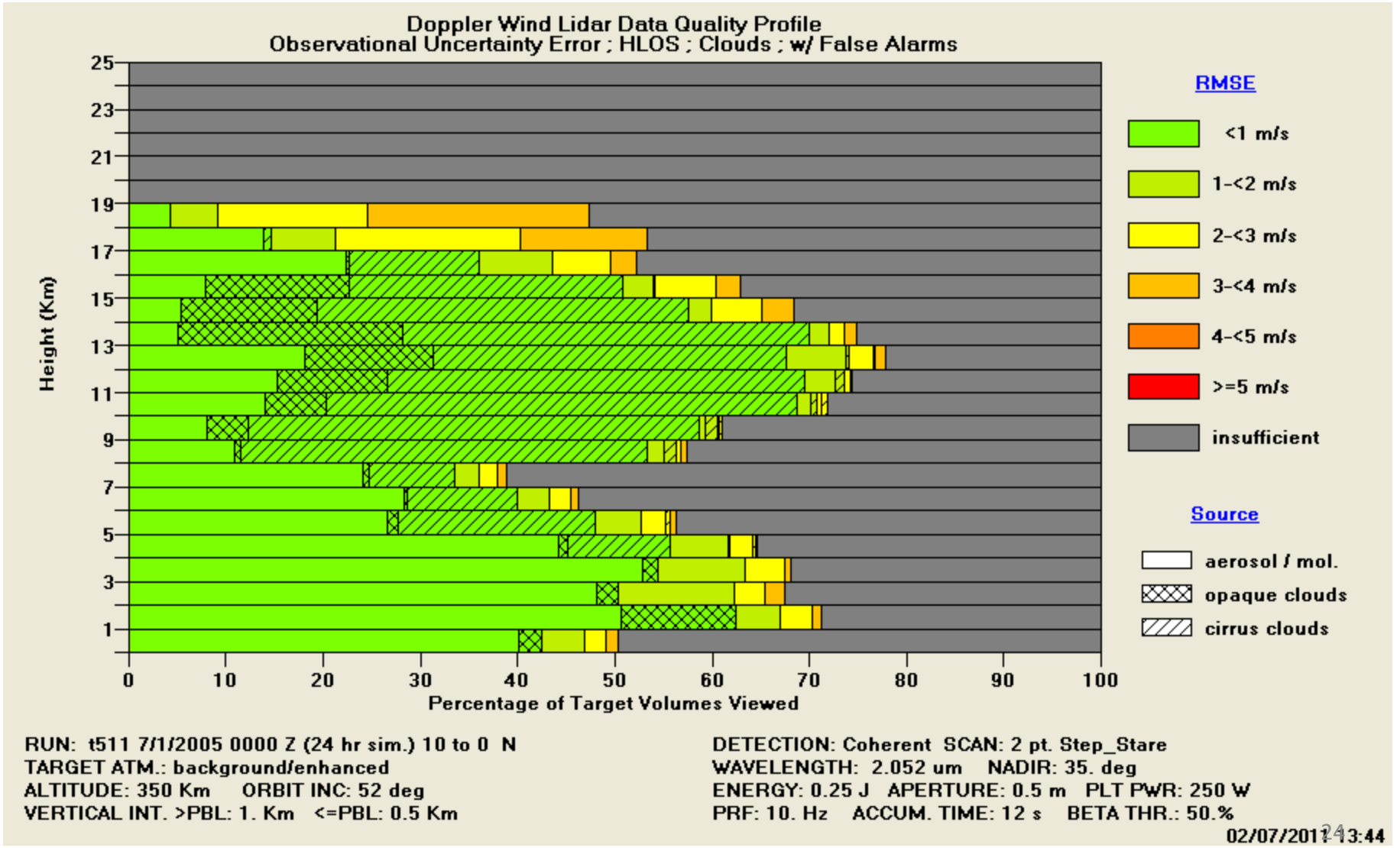

Sub-Visual Cirrus for 7/1/2005 T511 Nature Run 12 Z
75 mb
Latitude (deg)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315 330 345 360
Longitude (deg)
Cloud Percentage
0.04 to 0.05
0.03 to 0.04
0.02 to 0.03
0.01 to 0.02
0.0001 to 0.01
0 to 0.0001

Simulated WISSCR's performance using the DLSM with the T511 ECMWF Nature Run

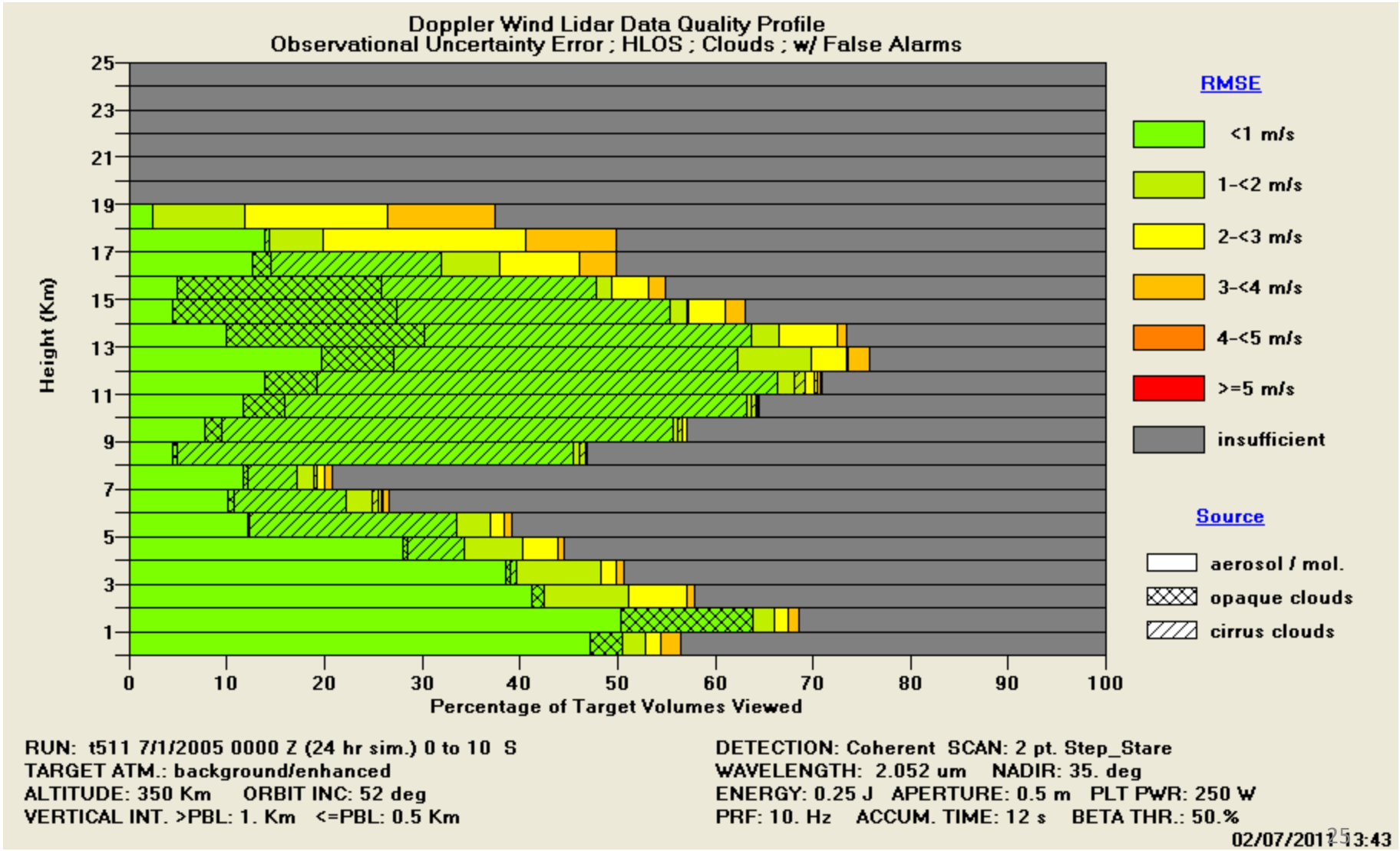
Aerosol/cloud subsystem of the Wind Lidar on ISS 20 – 10 N



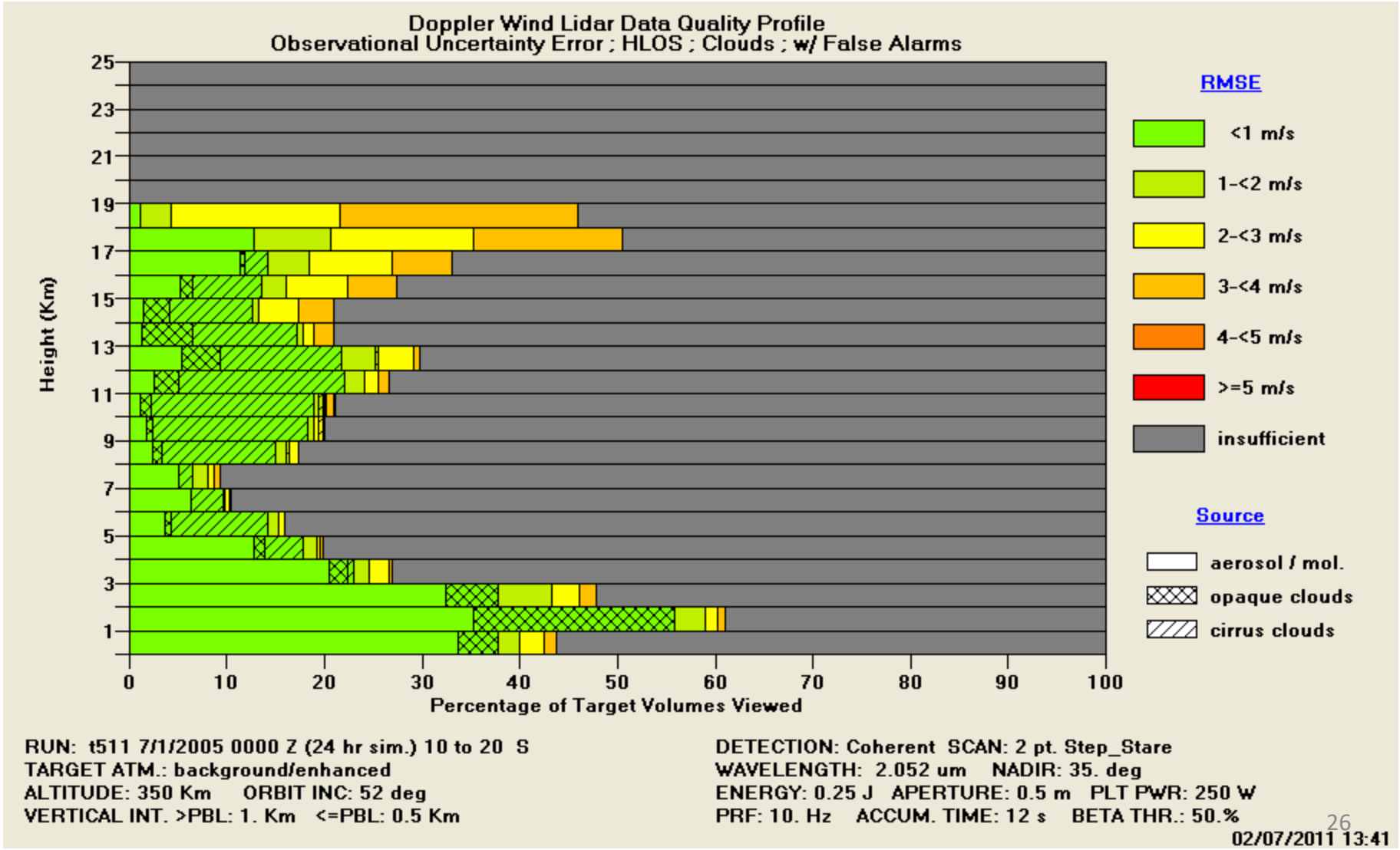
Aerosol/cloud subsystem of the Wind Lidar on ISS 10 -0 N



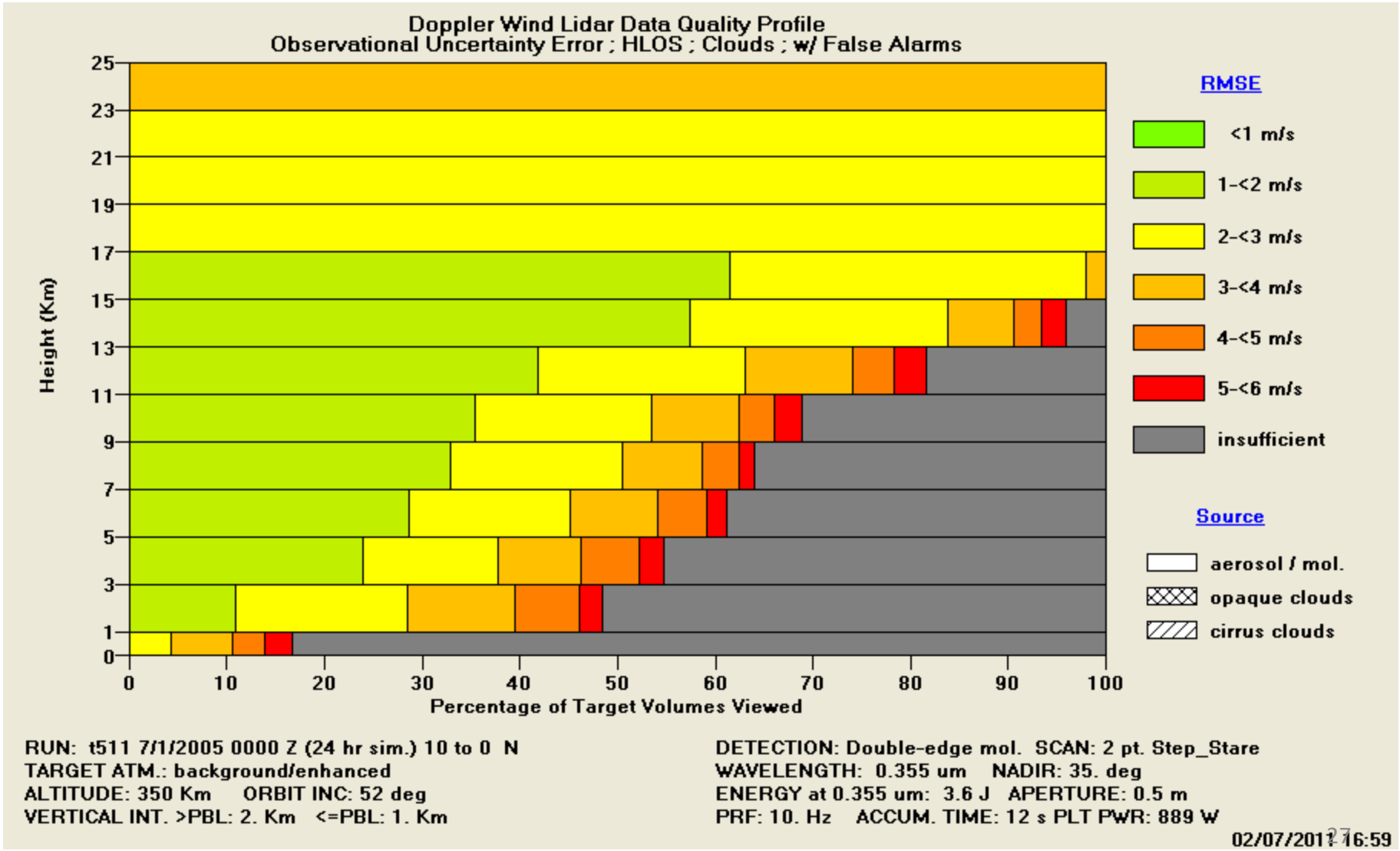
Aerosol/cloud subsystem of the Wind Lidar on ISS
0 – 10 S



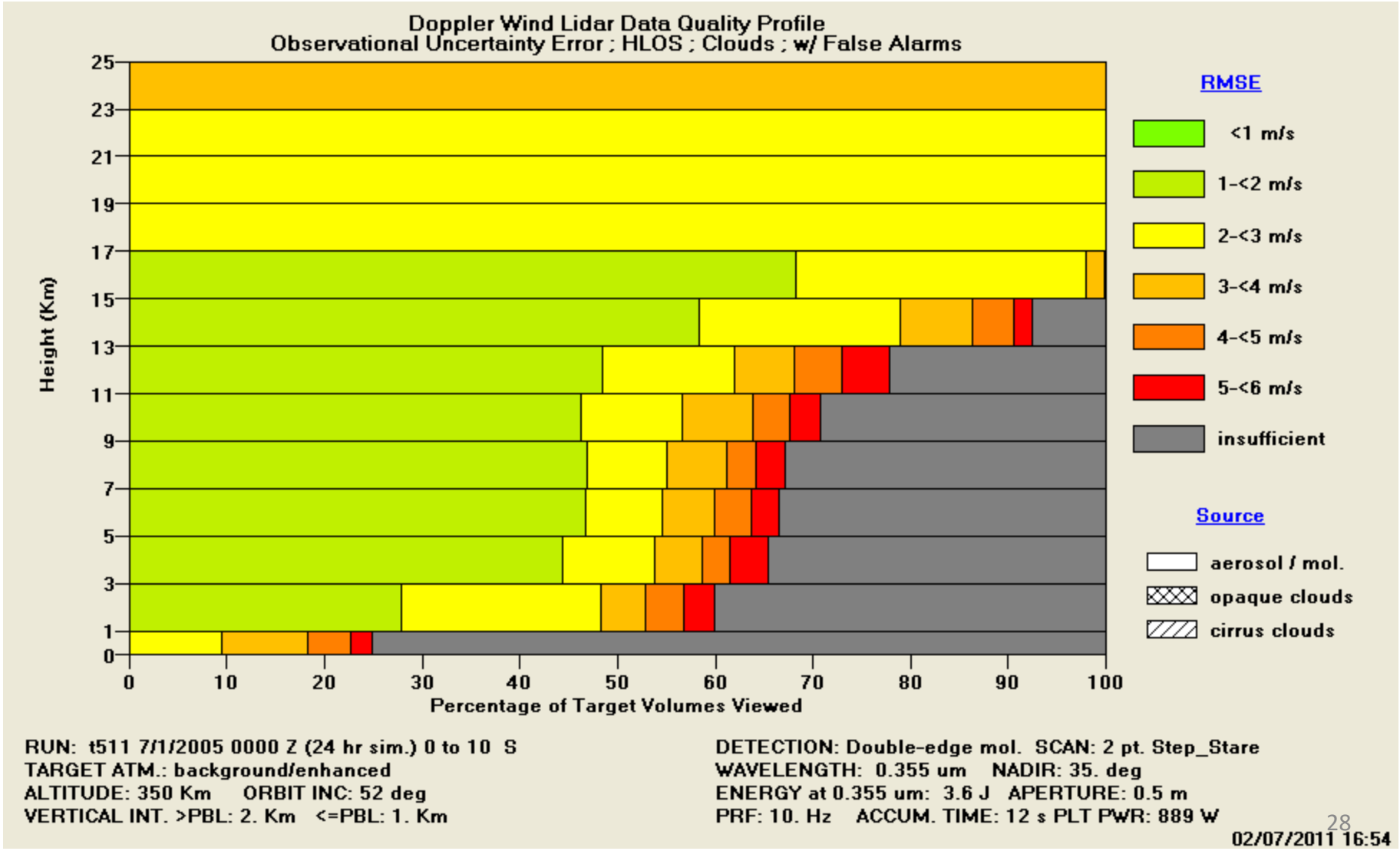
Aerosol/cloud subsystem of the Wind Lidar on ISS 10 -20 S



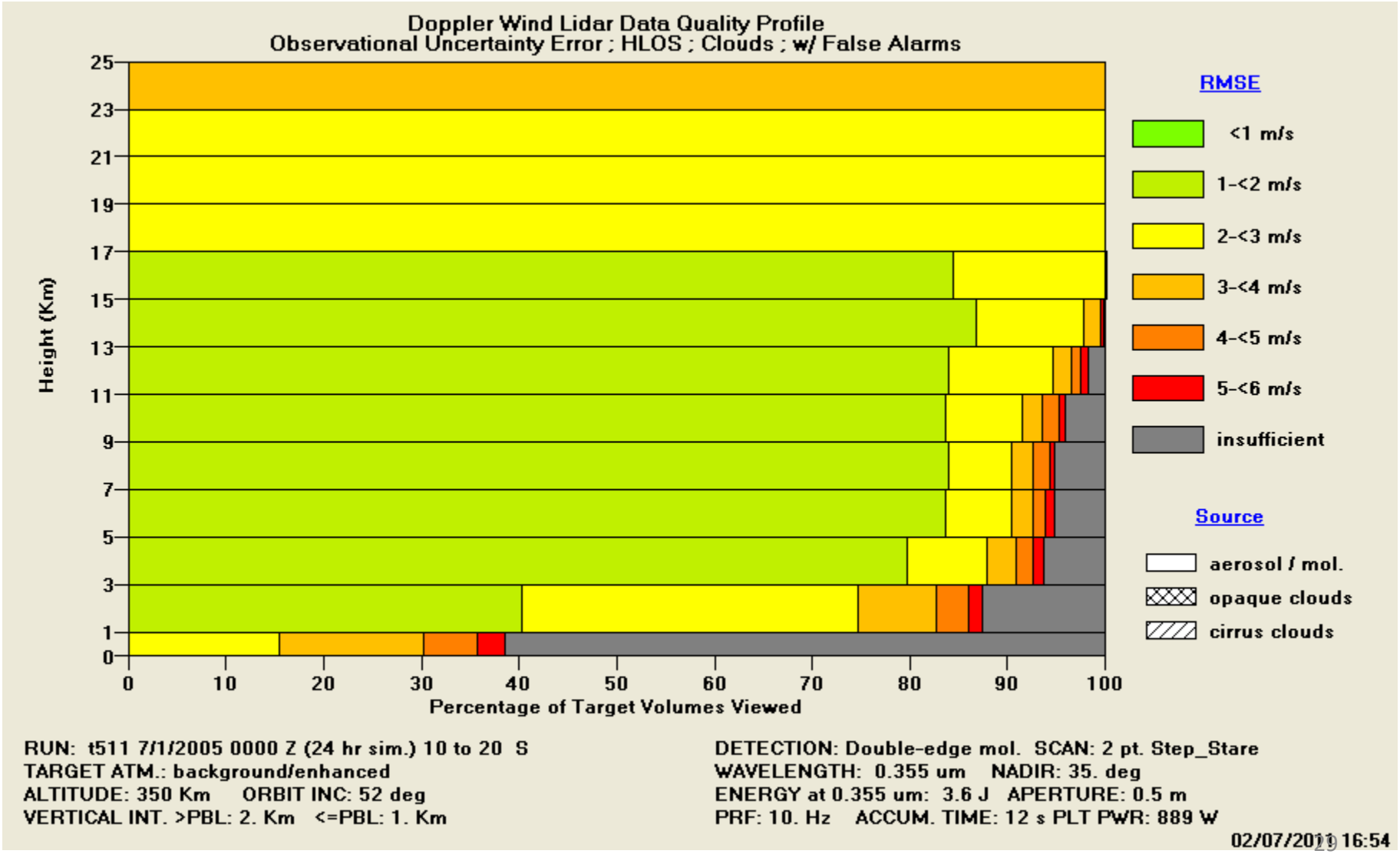
Molecular subsystem of the Wind Lidar on ISS
10 – 0 N



Molecular subsystem of the Wind Lidar on ISS
0 - 10 S



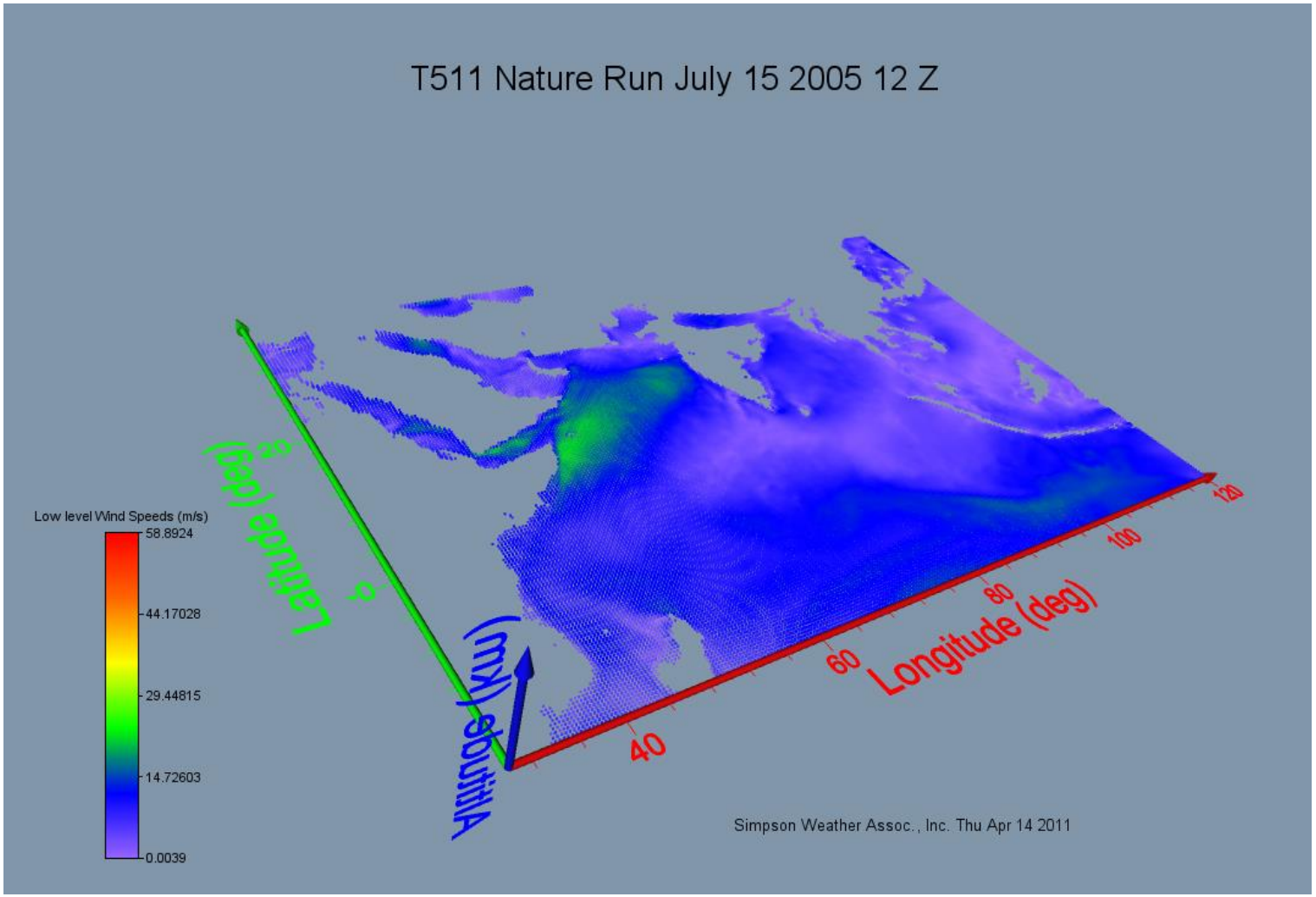
Molecular subsystem of the Wind Lidar on ISS
10 -20 S



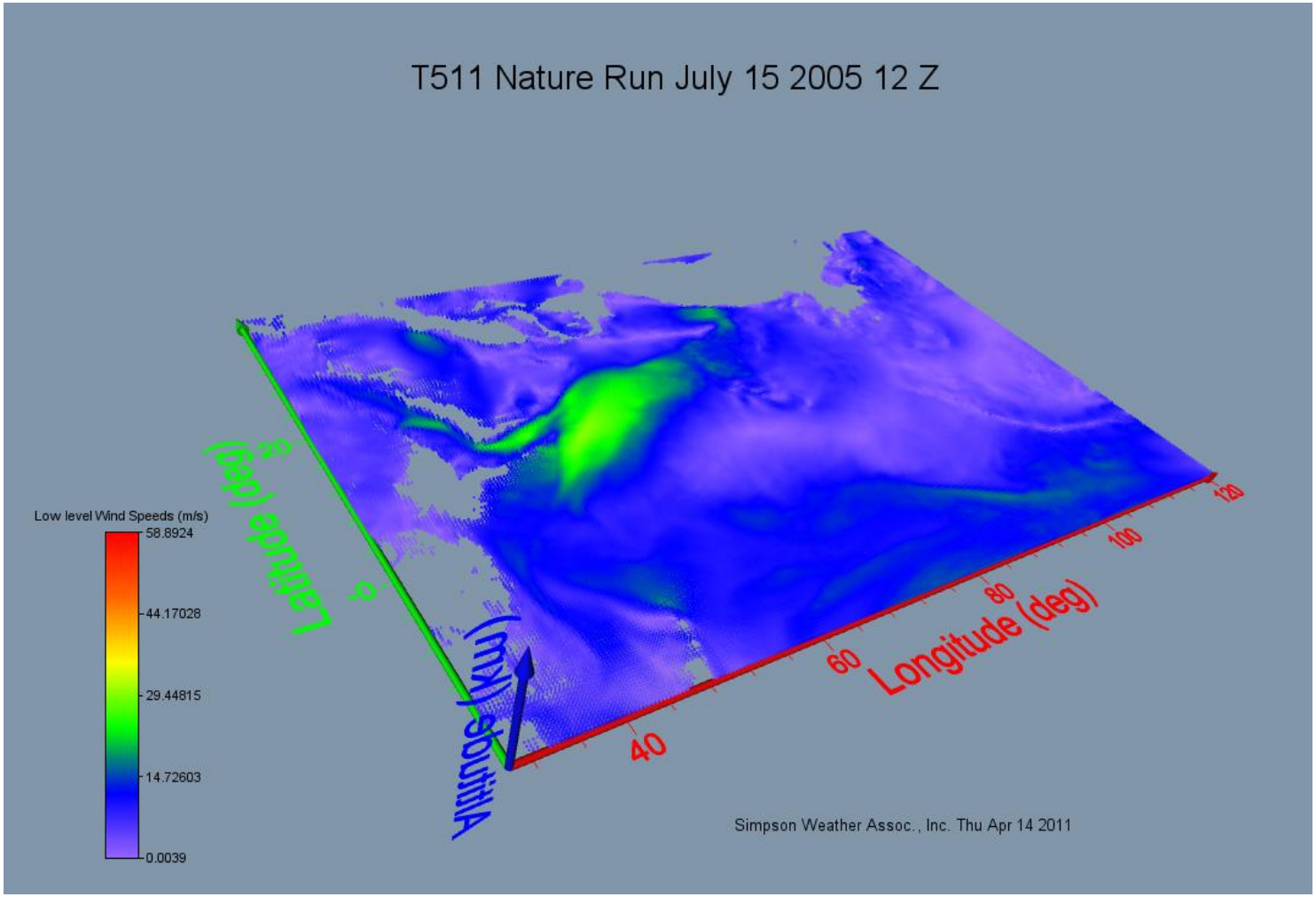
Simulation of WISSCR over Monsoon Region

- Use the Doppler Lidar Simulation Model (DLSM) developed for instrument concept evaluations and potential Numerical Weather Prediction model impact studies.
- Simulate WISSCR observations using ECMWF Nature Run (T511).
- Select days in July and August with Somalia Low Level Jets with varying intensities and locations.

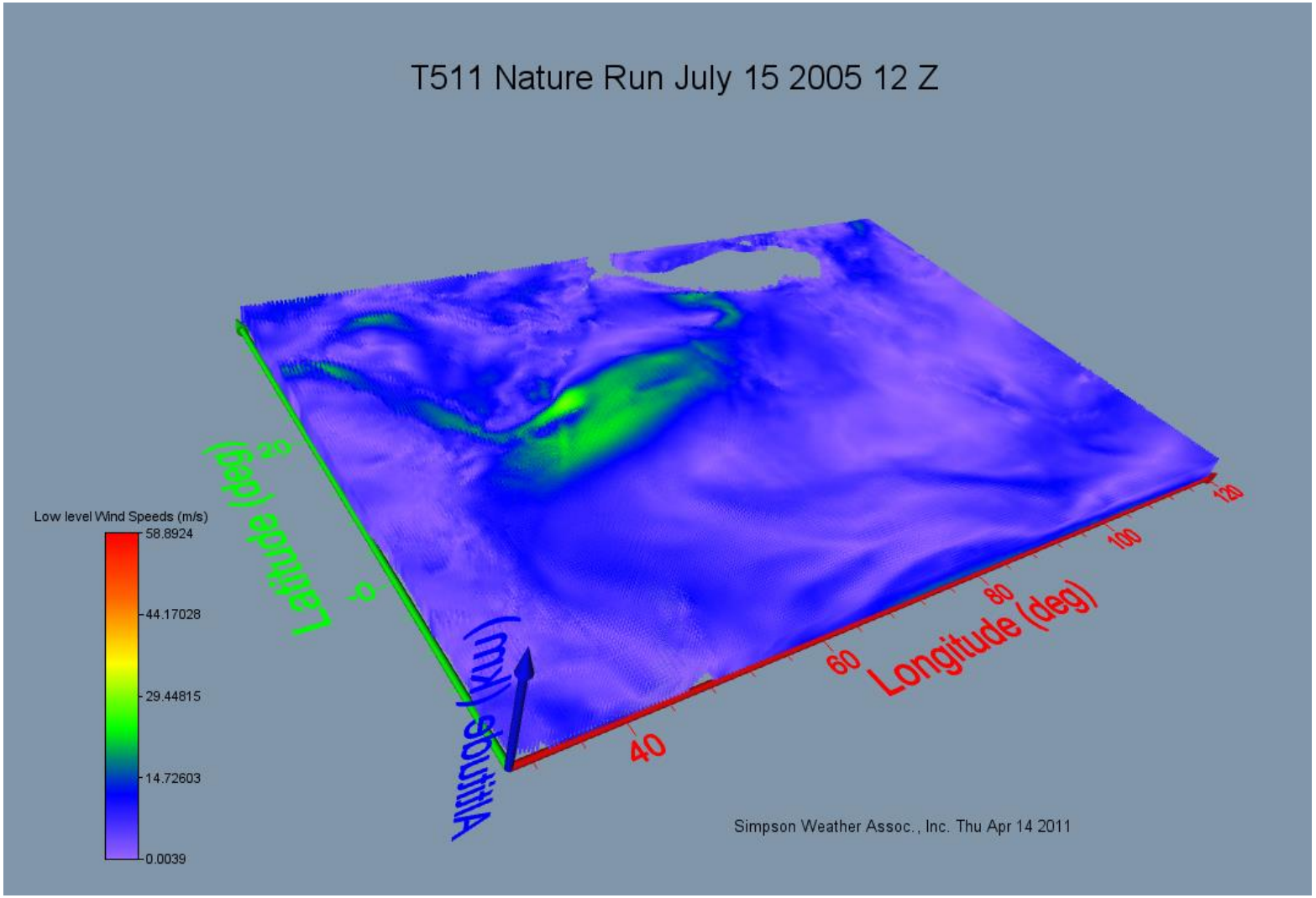
Somalia LLJ within 250 meters MSL



Somalia LLJ at 1000 meters MSL

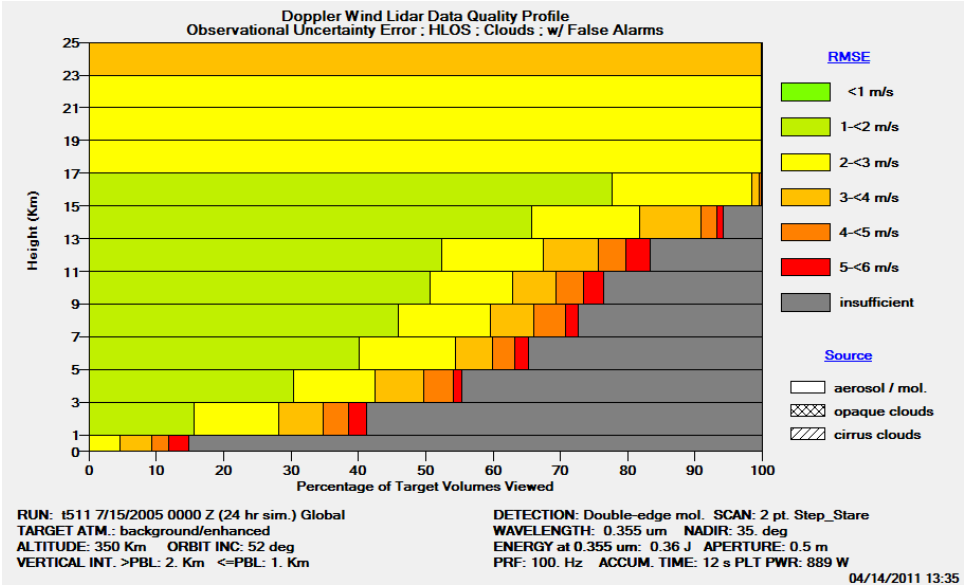


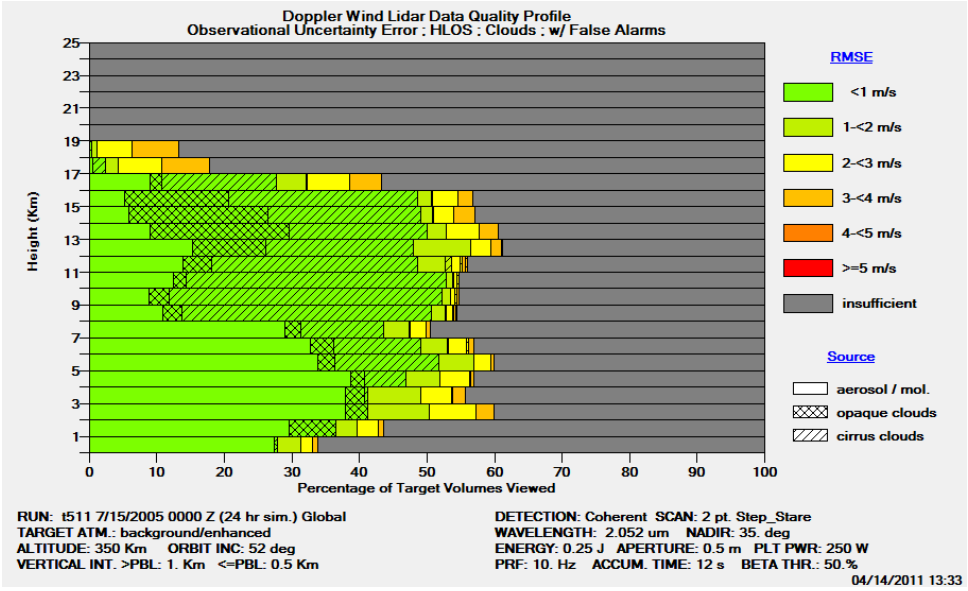
Somalia LLJ at 1500 meters MSL



Summary of WISSCR data products for 24 hours over Monsoon Region

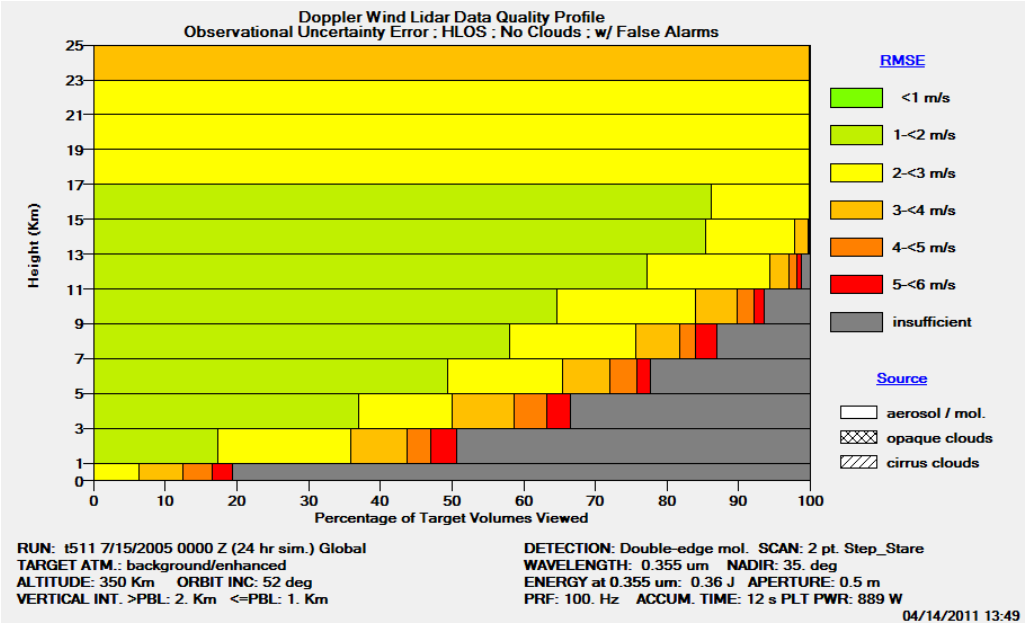
The charts show the percentage of the attempts to make a wind observation at each level below 25km during a 24 hour period over the Monsoon Region. The colors denote accuracy (m/s) and the hatching in the lower figure denote returns from clouds, including those that are penetrated by the laser beam. The top figure represent the performance of the direct detection subsystem of the hybrid technology WISSCR. Note the 2 km vertical resolution and the best accuracy of 1-2 m/s RMSE. The lower figure represents the performance of the coherent subsystem. Note the vertical resolution of 1 km and the returns from clouds (cirrus, subvisual cirrus and opaque. The accuracies are mostly in the < 1 m/s level.

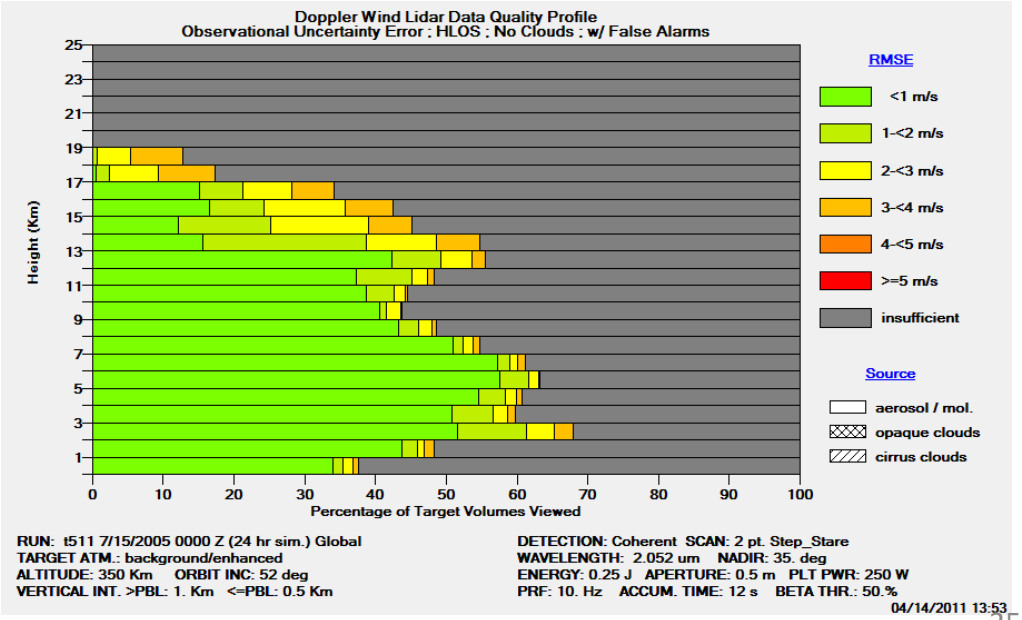




Summary of WISSCR data products for 24 hours over Monsoon Region

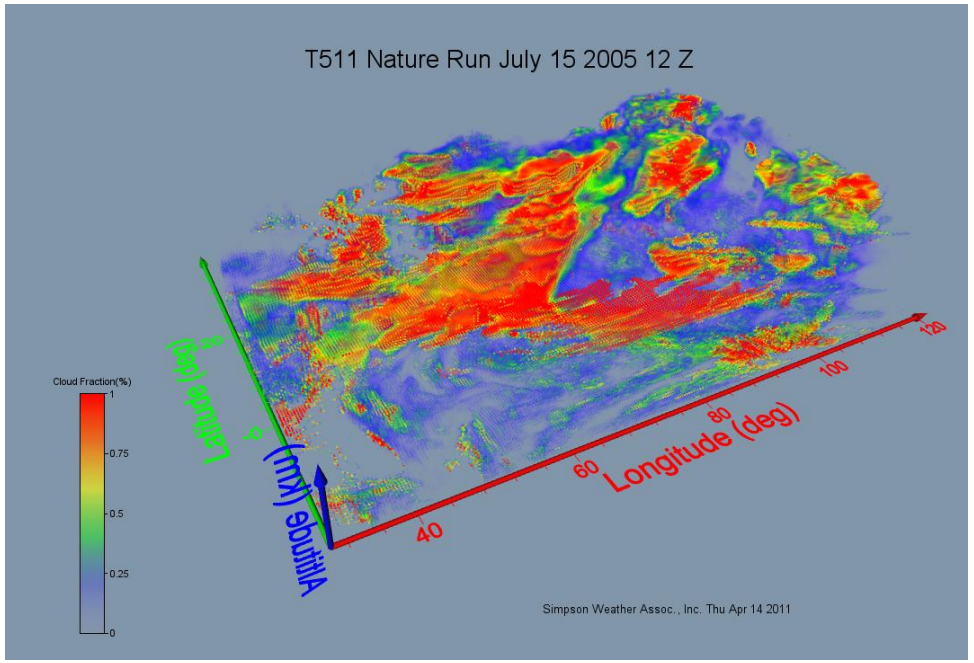
This is a similar presentation as that in the previous slide except that the simulation was done with no clouds were used from the T511 Nature Run. Note that there is actually more useful wind measurements available from the coherent system when clouds are present.

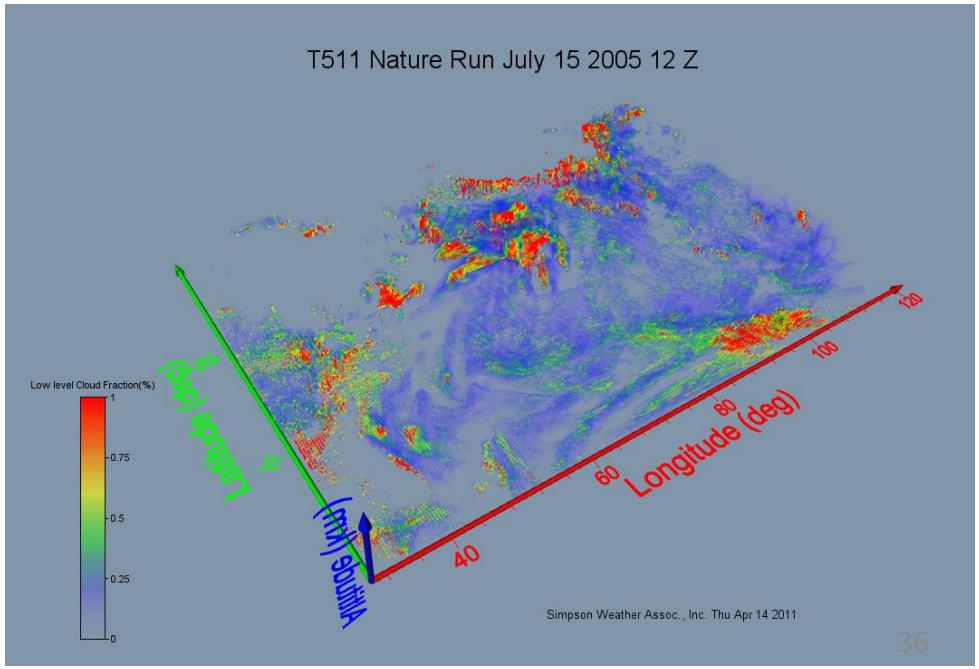




Cloud Coverage as represented in T511 Nature Run

The top figure illustrates the cloud coverage provided by the T511 Nature Run for all levels within the troposphere. The lower figure represents only those clouds below 5000 meters. Note that much of the upper level cloud is of sufficiently low optical depth that the coherent subsystem can obtain a good wind measurement within the cloud layer and also penetrate to aerosol and cloud layers below.





Summary

- Clouds will be a major factor in DWL coverage of significant weather features
  - A molecular system will be negatively effected by the high clouds in the tropics.
  - An aerosol system will provide winds within most of the high level clouds and within the lower troposphere below.
- The hybrid technology approach provides the best vertical coverage for science investigations in the tropics
  - A molecular subsystem is critical to tropospheric/stratospheric exchange investigations
  - The aerosol subsystem is critical for accurate, high spatial resolution measurements in cloudy scenes and in the lower troposphere.
  - Spectral discrimination of hydrometeors/air is highly desirable