

Summary of High Altitude Aircraft Data from NASA ER-2 Collected During CLASIC



**Greg M. McFarquhar and Brian F. Jewett
University of Illinois**

13 March 2008, CLASIC Breakout

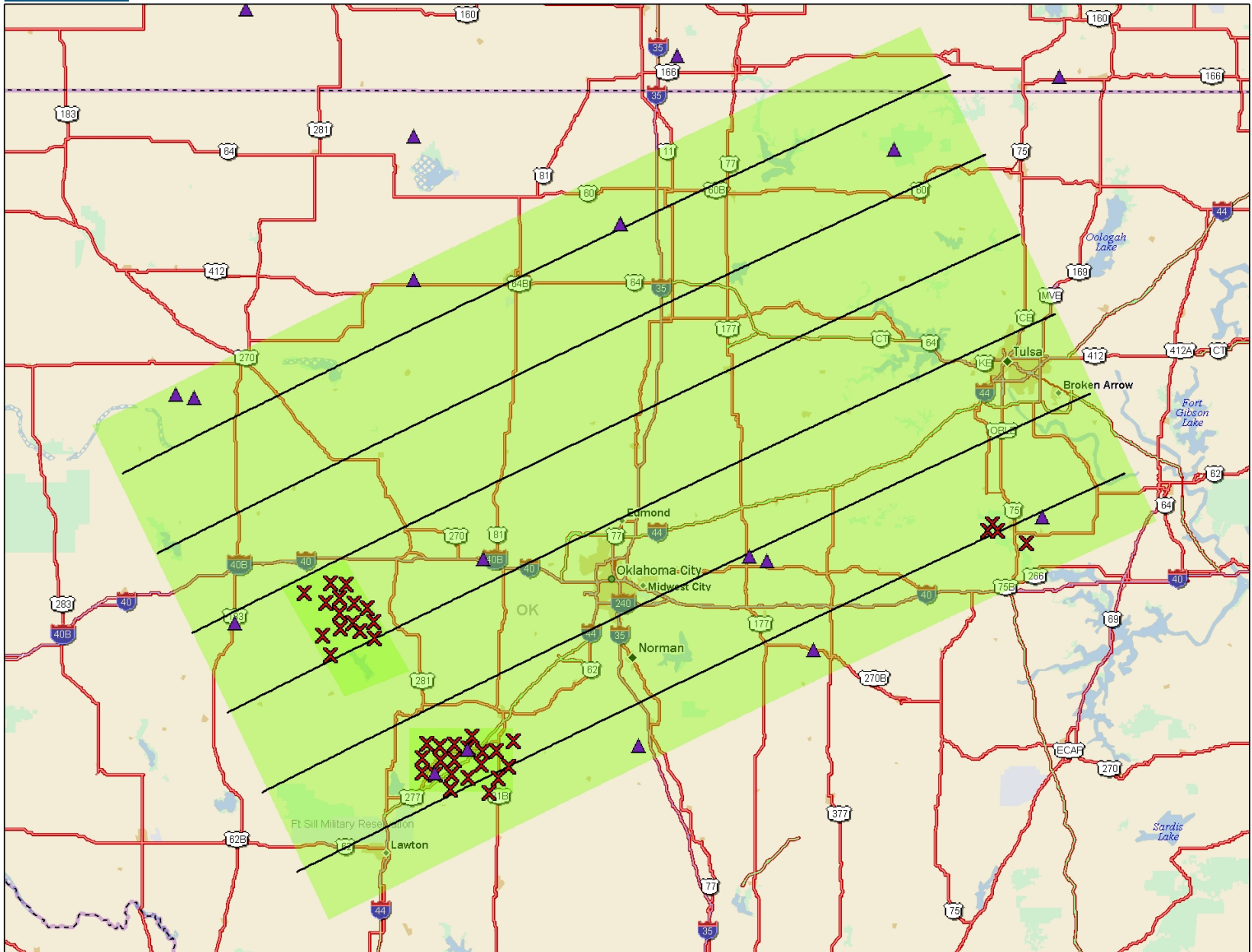
Goal of ER-2 flights

- Map out properties of cumuli fields in variety of soil moisture conditions, variety of surface and aerosol characteristics and variety of water vapor conditions
- Fly predetermined flight tracks for statistical analysis, including flights over all the surface sites
- Satellite evaluation
- Determine how cloud properties vary when following trajectories from Gulf of Mexico



4 Principal Flight Paths

1. Survey Pattern
2. Evolution Pattern
3. Gulf Trajectory Pattern
4. A-Train Validation Pattern



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Data Zoom 6-7

Nadir Temperature

07-628_Nadir Band 45

37.76°

Kelyîn

216,19

222,91

229,62

236,34

243,06

249,77

256,49

263,21

269,93

276,64

283,36

290,08

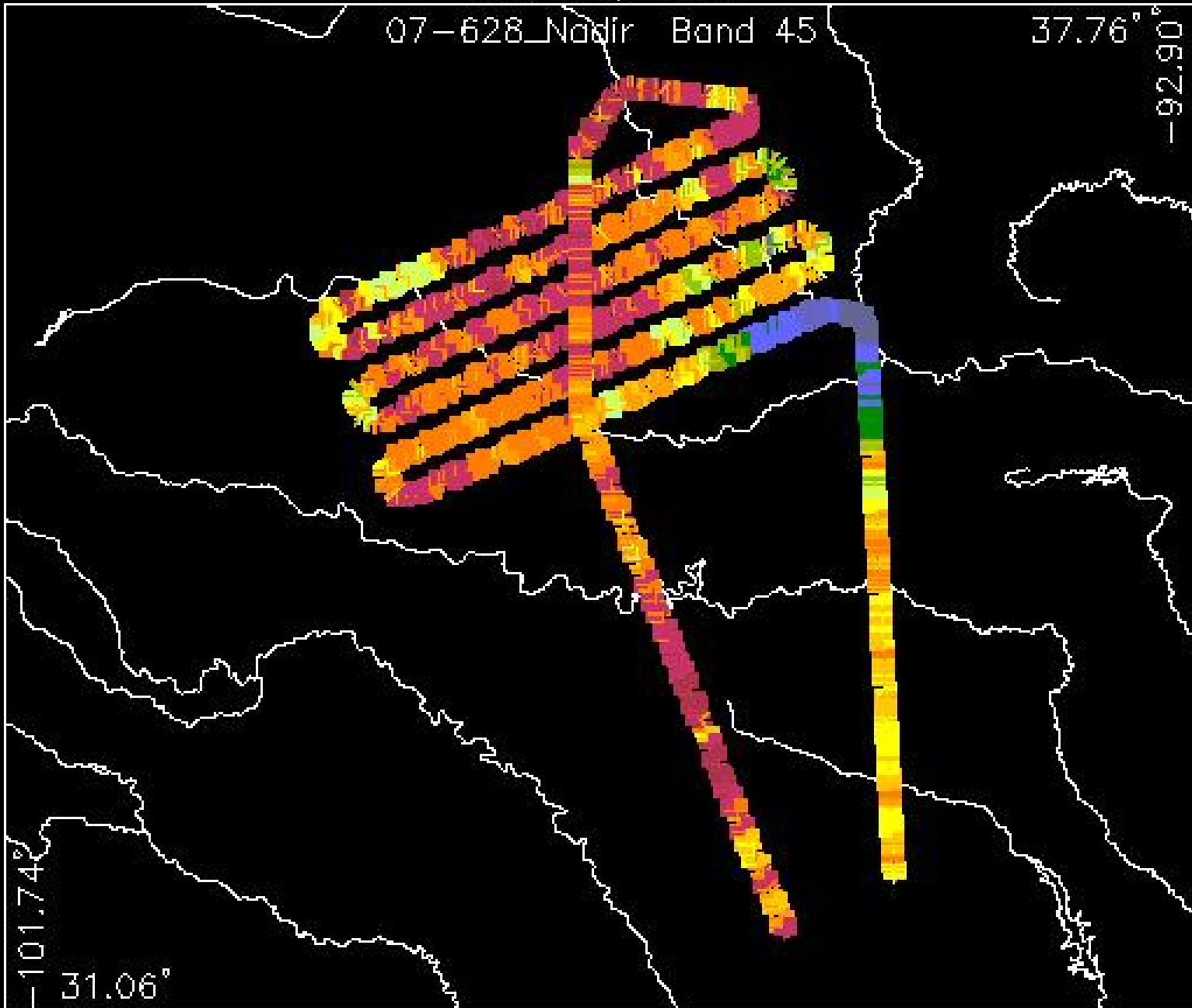
296,79

303,51

-101.74°

31.06°

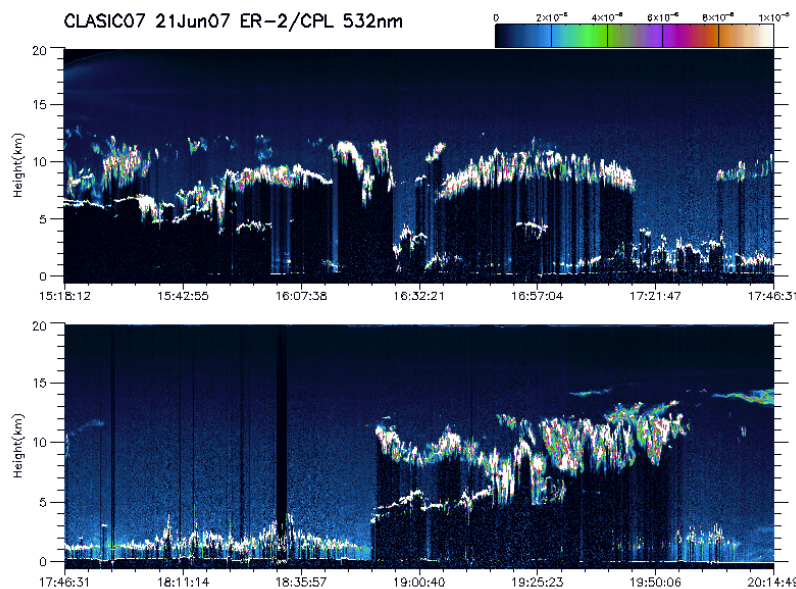
-92.90°



CPL (Cloud Physics LIDAR); Matt McGill



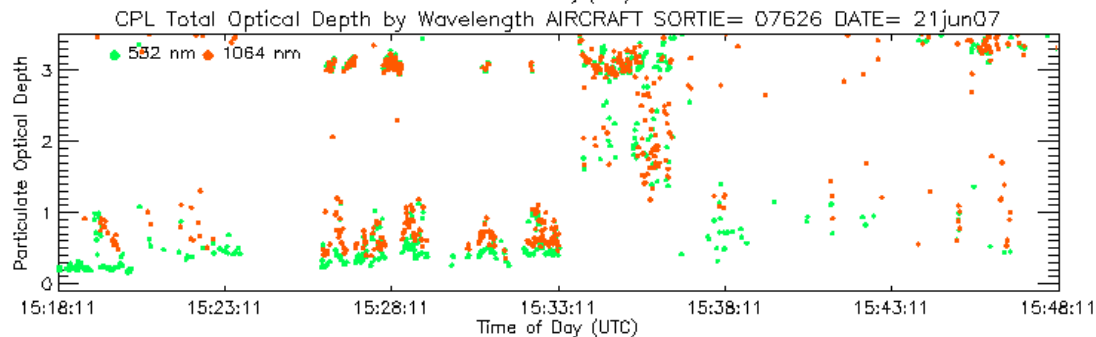
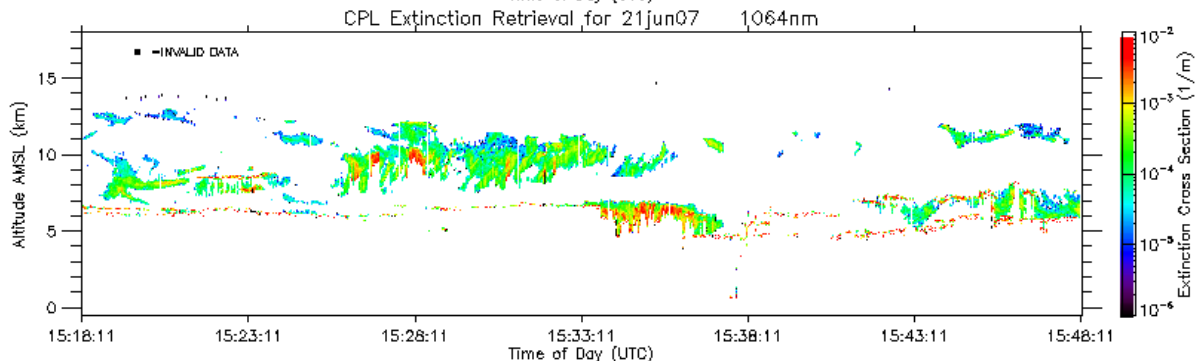
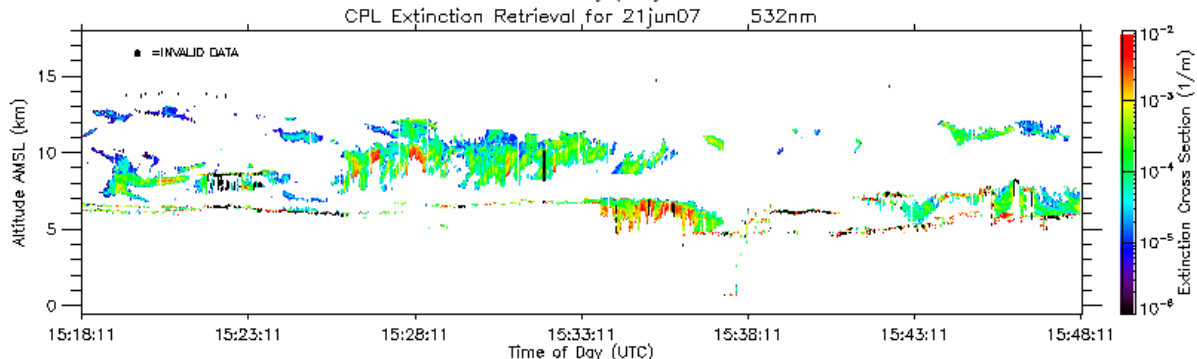
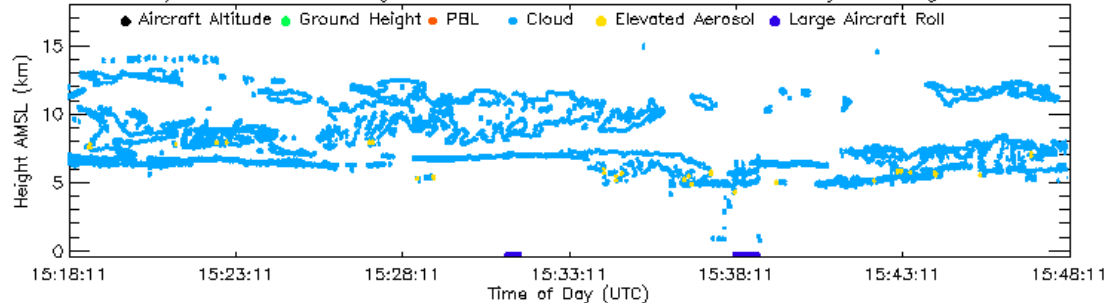
- Multi λ ; 1064, 532, and 355 nm
- Processed Data Resolution; 30 m vertical by 200 m horizontal
- Cloud Microphysics
- Aerosol backscatter coefficients
- Depolarization ratio for ice-water phase
- Cloud Particle Size
- Optical Depth (cloud and aerosol)
- Extinction to backscatter ratio
- Eye Safe
- Contact; Matt McGill)



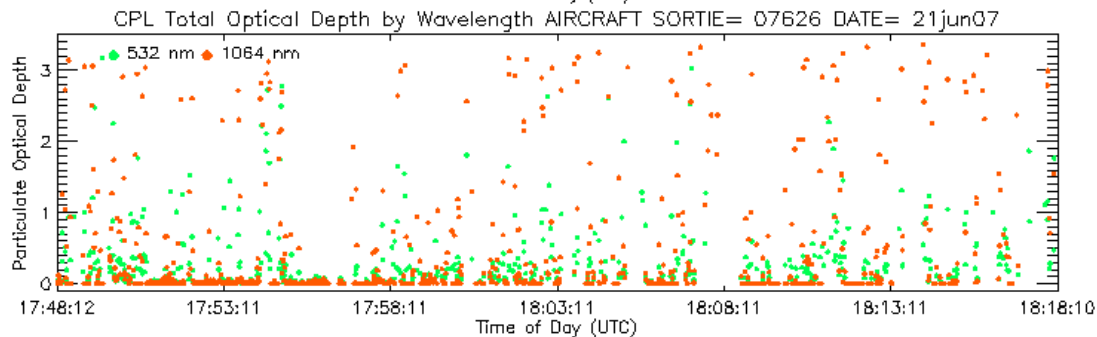
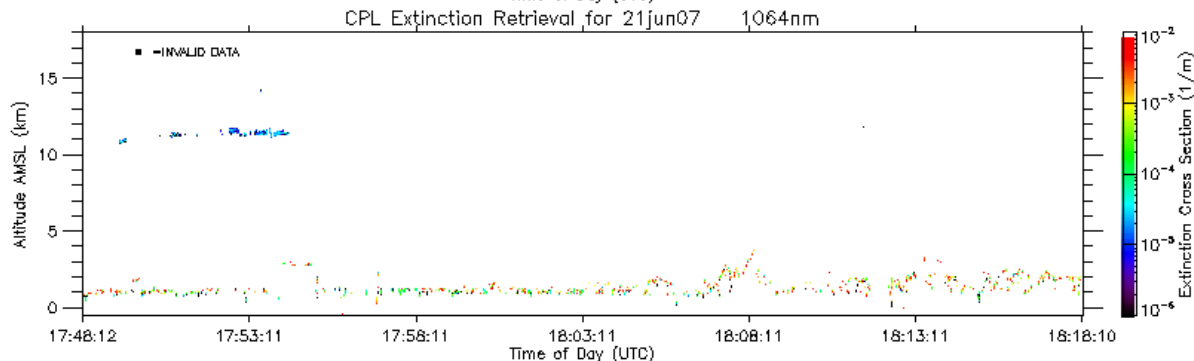
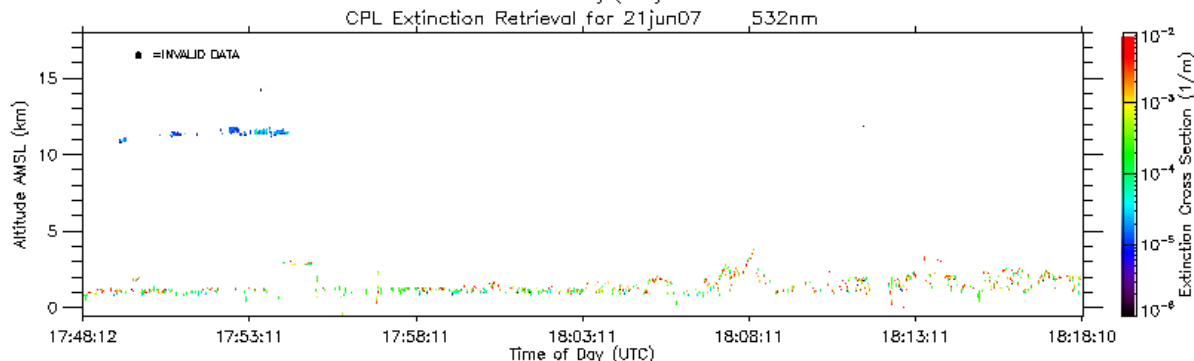
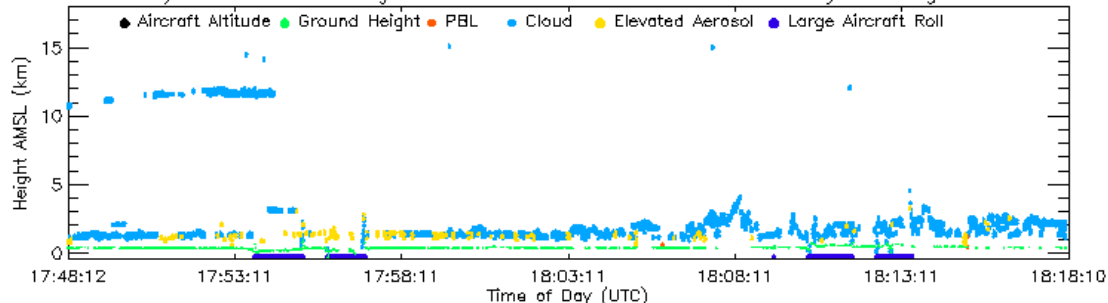
CPL Products

- http://cpl.gsfc.nasa.gov/clasic/clasic_enter.htm
- Backscatter signals for 355, 532 and 1064 nm and depolarization for 1064 nm
- Cloud, Aerosol & total optical depth by λ
- Extinction retrievals, etc.

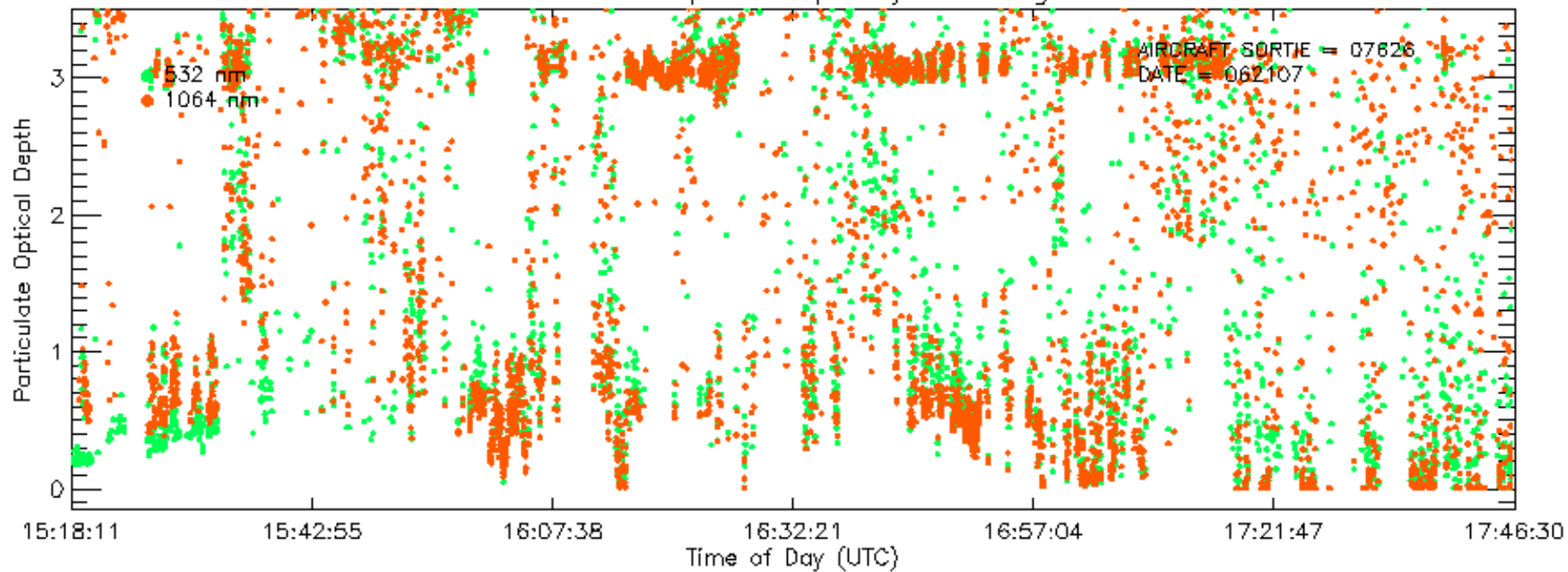
CPL Layer and Ground Heights AIRCRAFT SORTIE= 07626 DATE= 21jun07 Segment= 01



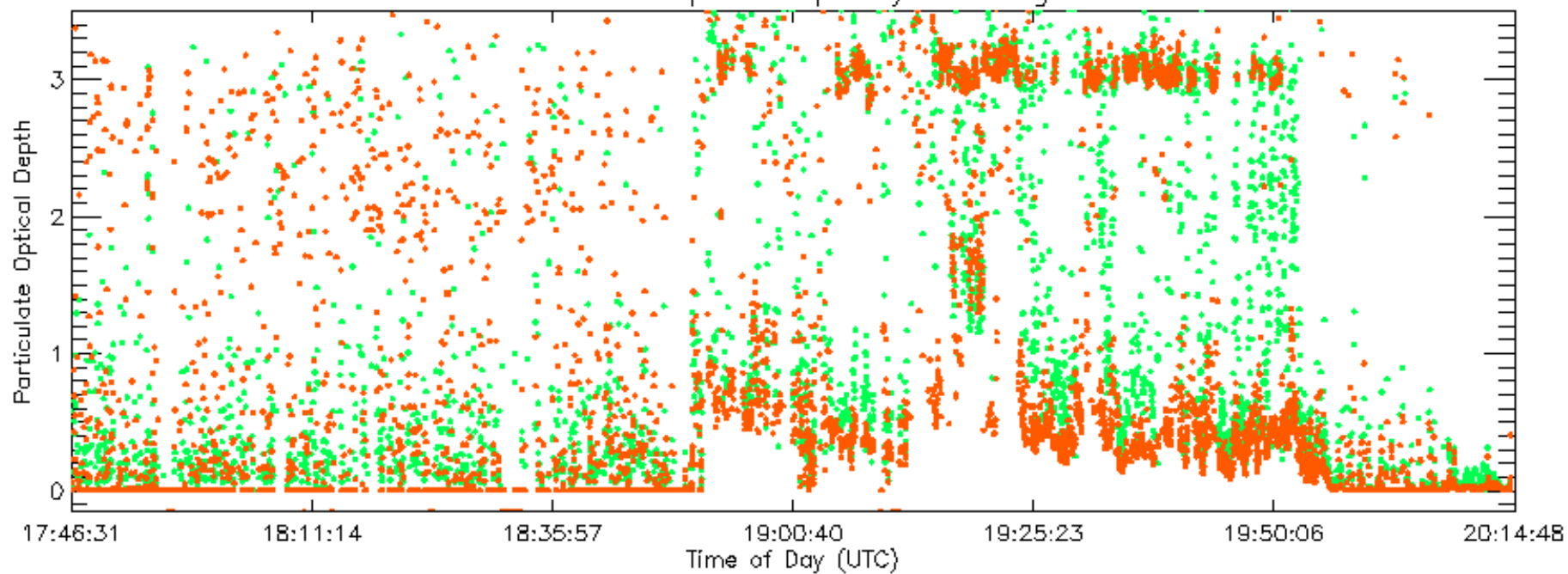
CPL Layer and Ground Heights AIRCRAFT SORTIE= 07626 DATE= 21jun07 Segment= 06



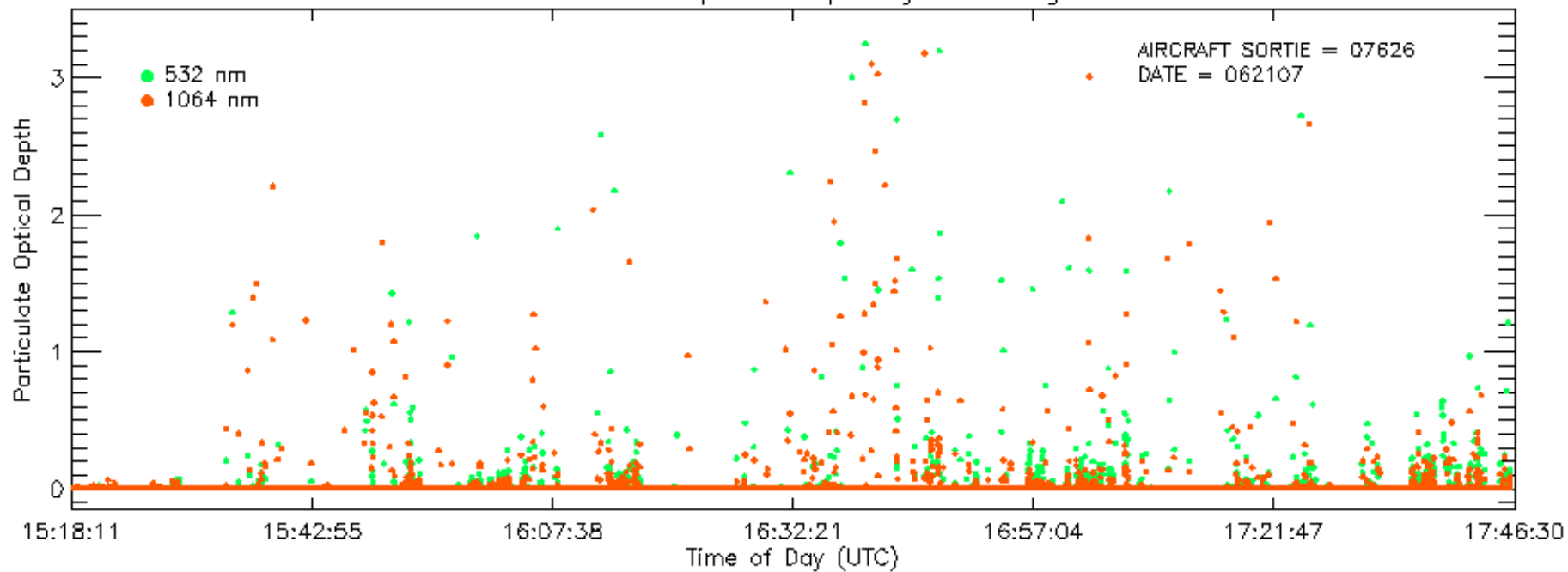
CPL Cloud Optical Depth by Wavelength



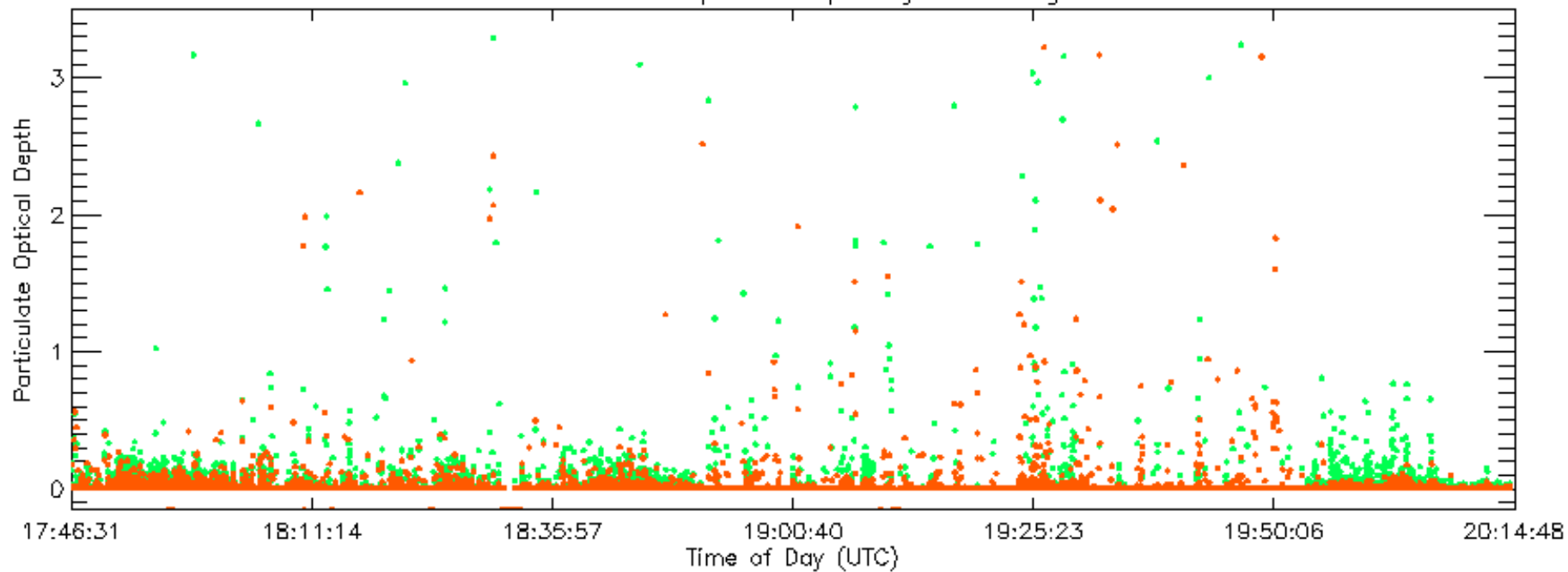
CPL Cloud Optical Depth by Wavelength



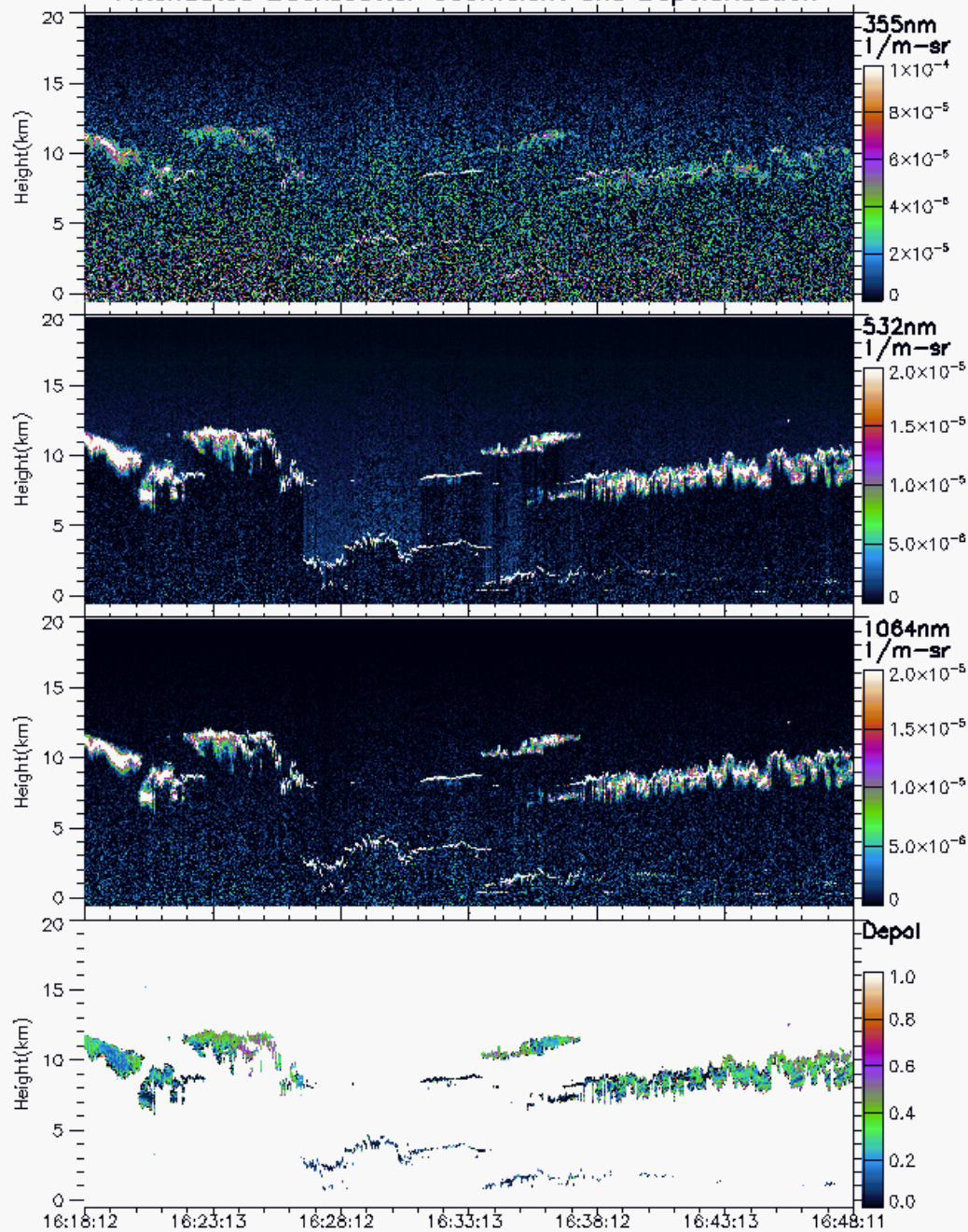
CPL Aerosol Optical Depth by Wavelength



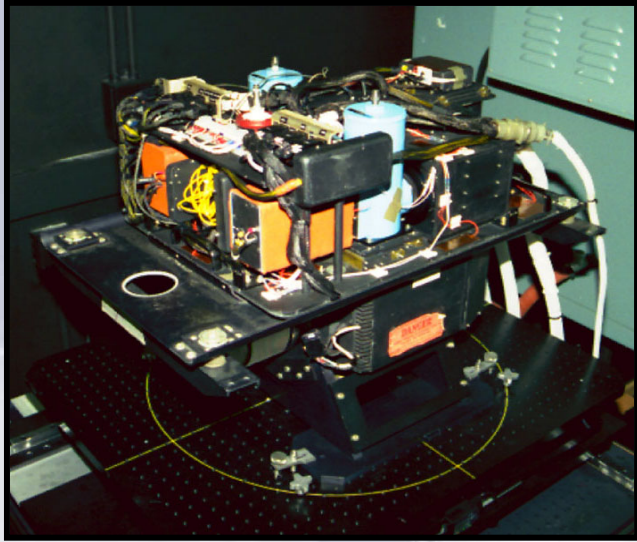
CPL Aerosol Optical Depth by Wavelength



Attenuated Backscatter Coefficient and Depolarization

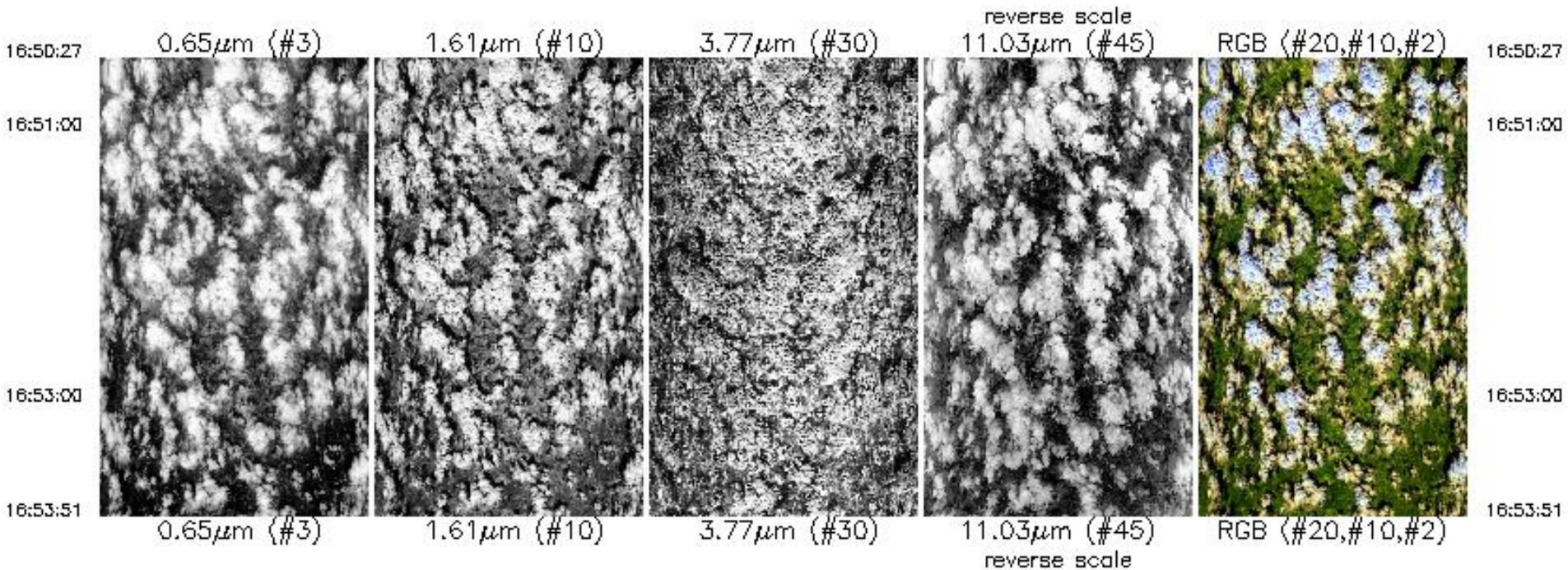


Instrument System and Measurement Specifications – MAS (MODIS Airborne Simulator)



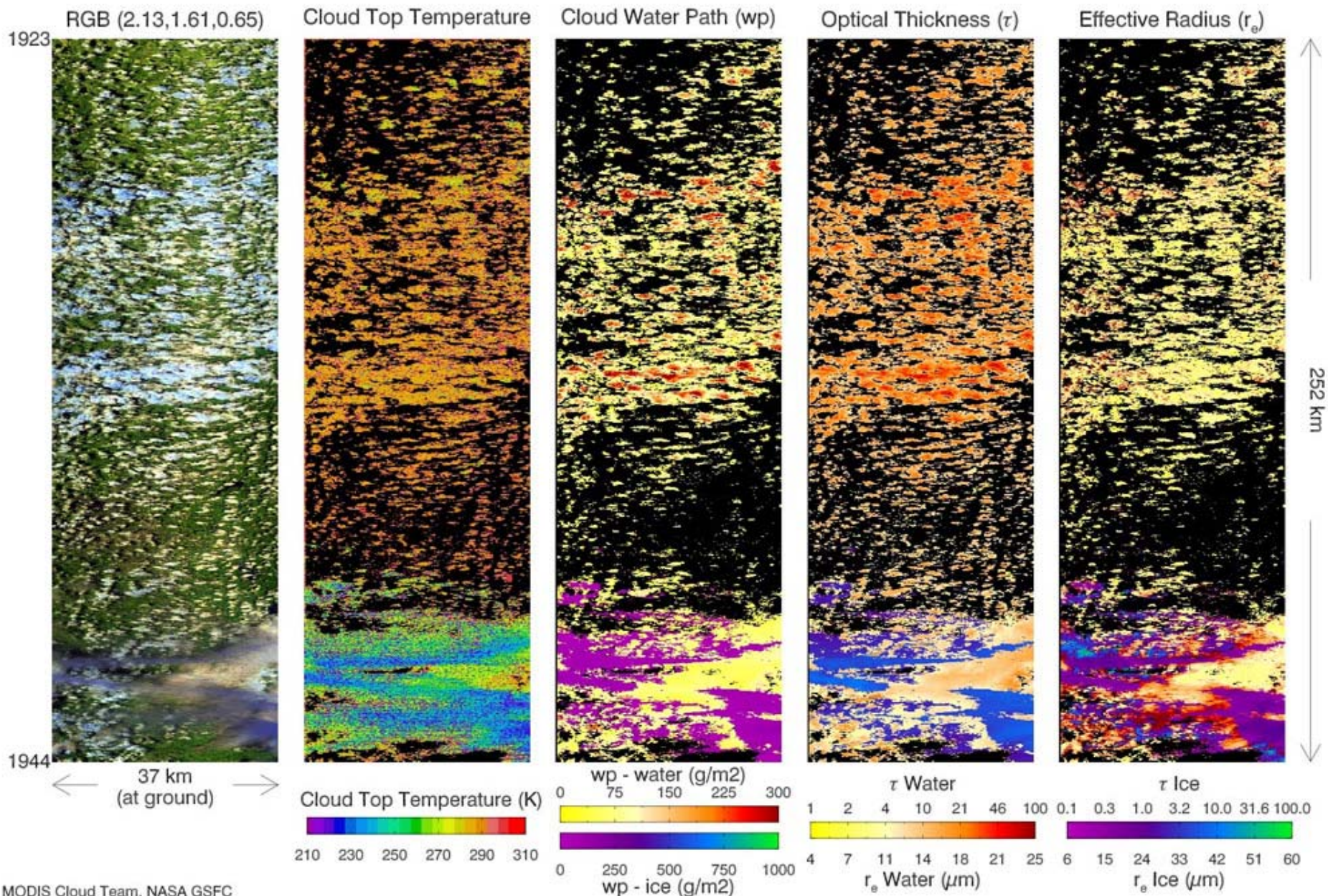
- http://mas.arc.nasa.gov/data/deploy_html/clasic_home.html
- Multi-Spectral IR Scanner
- MAS, MASTER and MAS hybrid used
- 50 Channels
- 0.46 to 14.2 μm
- IFOV 2.5 mrad (50 m @ 65K Ft.)
- Atmospheric Processes (Clouds, Water Vapor and Aerosols)
- Surface Properties
- Contact; Jeff Myers
(jmyers@arc.nasa.gov)

MODIS Airborne Simulator Browse Imagery
 CLASIC 2007 Campaign – 8 Jun 2007
 Central Texas
 Flight #07-622 Track #10

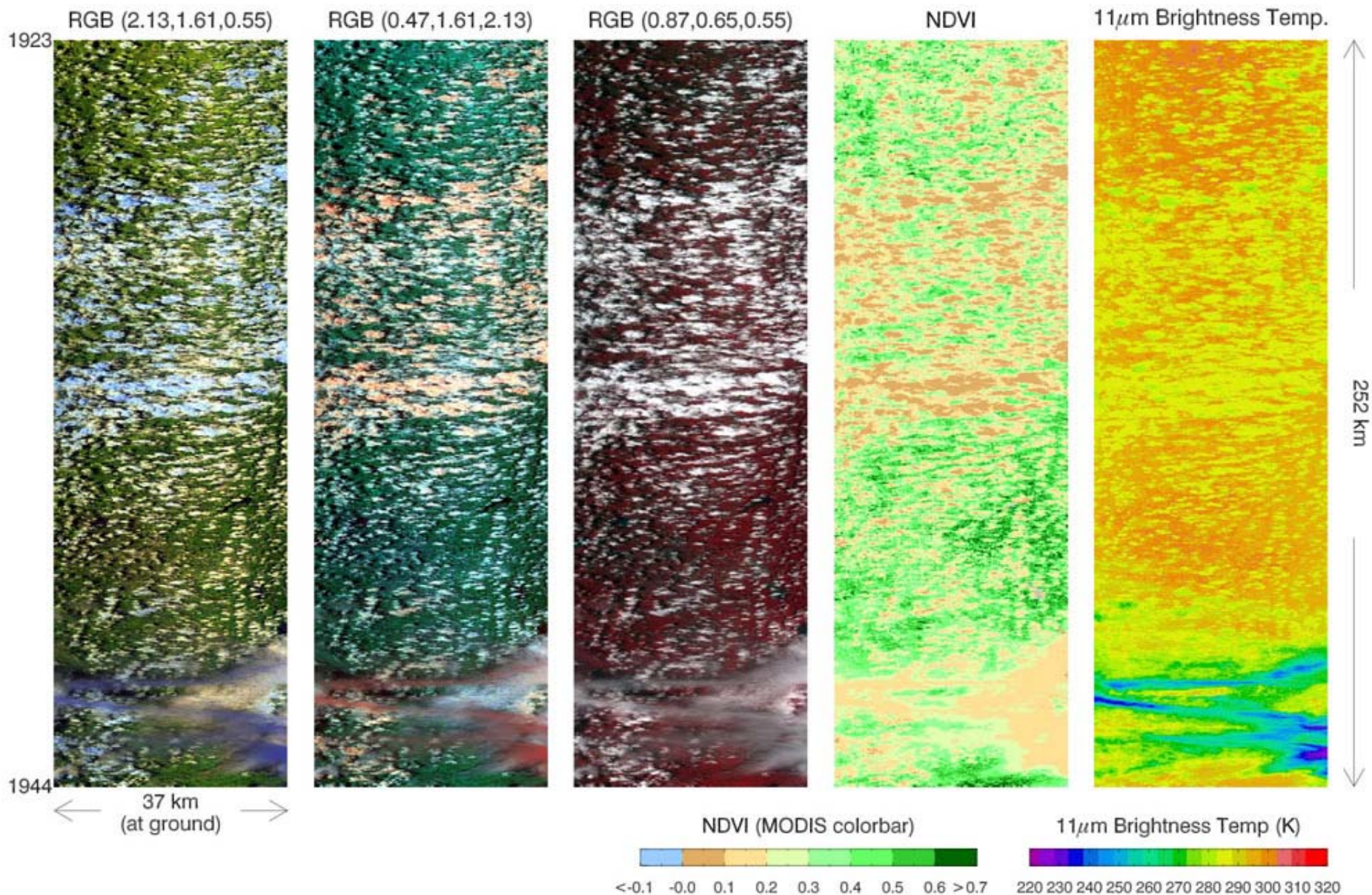


Upper Left Lat, Lon = 29.4°, -98.2°
 Lower Right Lat, Lon = 29.7°, -97.7°
 Aircraft Heading = 92.0°
 Solar Zenith = 23.5°
 GPS Altitude = 19684. m (MSL)

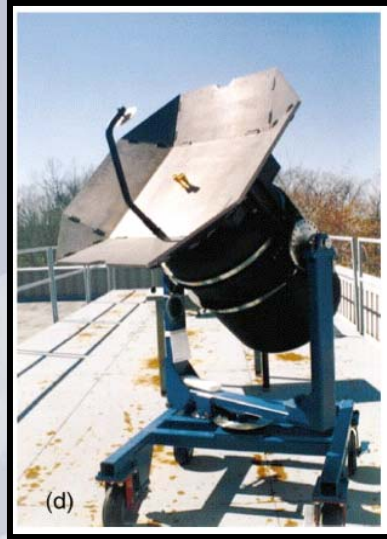
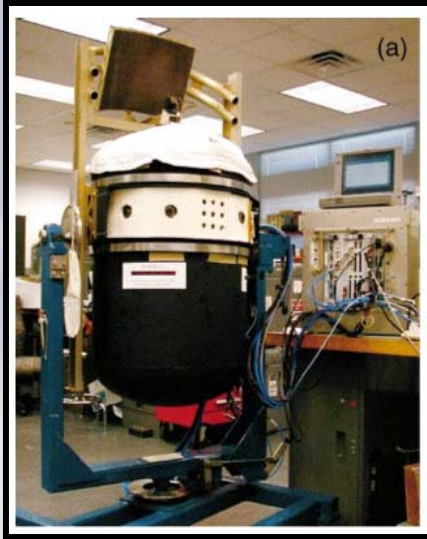
MODIS Airborne Simulator 22 June 2007 Flight # 07627 Track #11
 (CLASIC/CHAPS Preliminary Retrievals - Pre-deployment Calibration)



MODIS Airborne Simulator 22 June 2007 Flight # 07627 Track #11
 (CLASIC/CHAPS Preliminary data (no atm corr) - Pre-deployment Calibration)



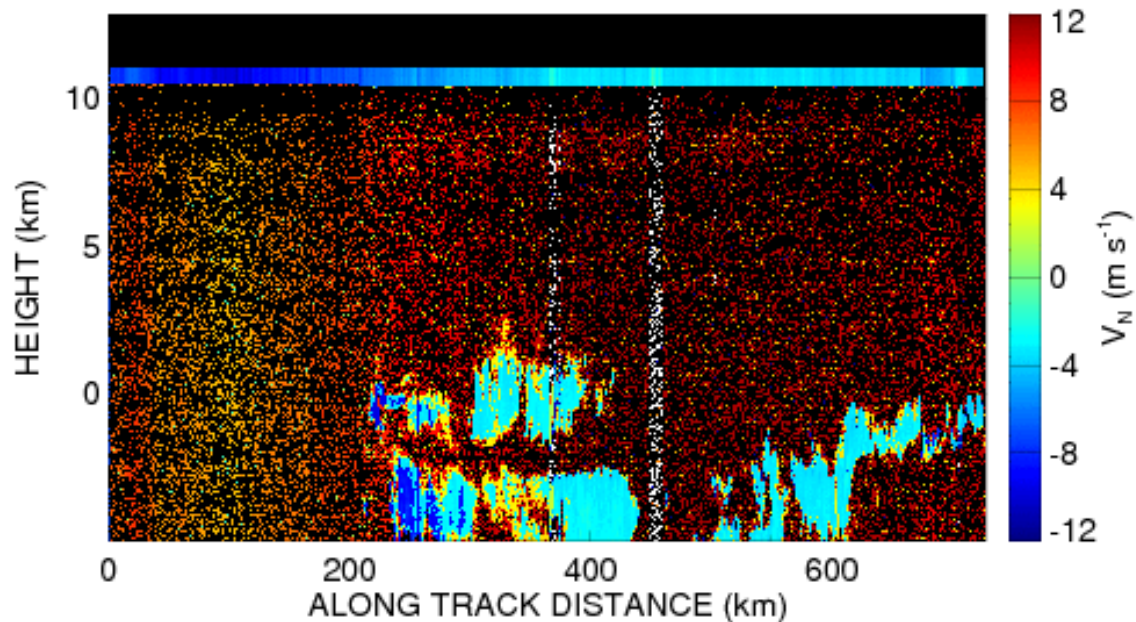
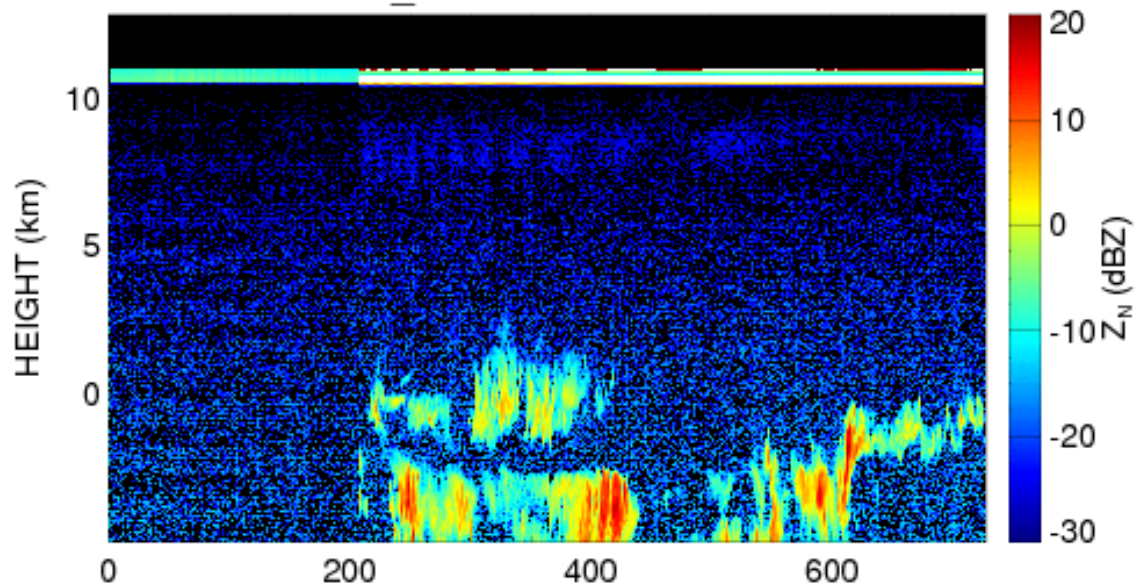
Instrument System and Measurement Specifications – CRS (94 GHz Cloud Radar System)



- http://rsd.gsfc.nasa.gov/912/edopp/crs_id_description.htm
- W-Band, polarimetric, Doppler radar
- Frequency; 94.155 GHz; Peak Power; 1.7 kW; PRF; 0.5-20 kHz
- Pulse Width; 0.25-2.0 microsec
- Beam Width / Gain; 0.6 by 0.8 / 46.4 Airborne
- Sensitivity; -29 dBZ
- Cloud properties
- Precipitation
- Contact; Gerry Heymsfield.

CRS Preliminary Data

070621_15:01:12-16:01:09 UTC



/Volumes/Internal/CLASIC/uf/crs_070621//CLOUD1182440920.ufs

CLASIC NASA ER-2

Missions

MAS: mission, status

	ER-2 Mission	Location	MAS: mission, status		Lidar	Radar	Underpass?	Notes
5/31	MAS test flight	offshore CA	MAS	Fine	n/a	n/a	-	
6/01	Test flight	Dryden	n/a		Fine	n/a	-	
6/07	Attempted ferry	CA - west TX	MAS	Fine	n/a	Fine	-	
6/08	Ferry to Houston	CA - TX	MAS	OK (But power cycled during flight)	Fine	Fine	-	
6/10	Test flight	Houston, Gulf	n/a		Fine	Fine	-	
6/11	Survey pattern	Oklahoma	Instrument down		Fine	Fine	-	MAS digitizer failed
6/12	A-Train Validation	OK, KS	MAS Hybrid	Near-IR channels noisy	Fine	Fine	19:47 36.7N 96.9W	CF: CRS test Gulf MAS pass
6/21	Survey + Satellite overpass	Oklahoma + overpass	MAS Hybrid	Dropped 100 scan lines (.1%)	Fine	Fine	19:40 32.8N, 94.2W	CF overpass N-S line: N. TX
6/22	Survey pattern	Oklahoma	MAS Hybrid	Fine	Fine	High noise	-	CF overpass
6/23	Survey pattern	Oklahoma	MAS Hybrid	Fine	Fine	Instrument down	-	CF overpass
6/28	OK box pattern + Satellite overpass	Oklahoma + overpass	MAS Hybrid	Fine	Fine	Fine	19:47 36.7N, 96.9W	CF overpass Gulf MAS pass
6/29	TX/OK survey	OK + west TX	MAS Hybrid	Dropped 166 scan lines (.2%)	Fine	High noise	-	4 longer, closer flight legs
6/30	Ferry to Dryden	TX - CA	MAS Hybrid	Fine	Fine	missing	-	
9/20	Test flight	CA/NV, Owens Valley CA	MASTER	Fine	n/a	n/a	-	
9/21	Survey over OK	OK - TX - CA	MASTER	Fine	n/a	n/a	-	

Results of Operational Near Real-Time Radiometric Soil Moisture Imaging during CLASIC 2007

Eric M. McIntyre
A.J. Gasiewski
Damian Manda



Instrumentation on NASA P-3B



PSR/CXI:

- C-band Radiometer

- **6.000 (200 MHz) v,h**
- **6.500 (200 MHz) v,h**
- **6.920 (200 MHz) v,h**
- 6.920 (200 MHz) U,V
- **7.325 (200 MHz) v,h**

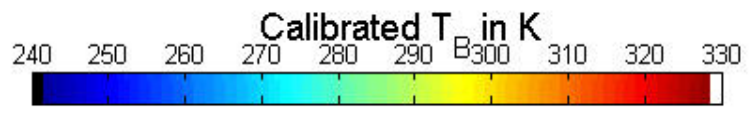
Channels used in soil moisture retrieval algorithm

- C-band Spectrometer

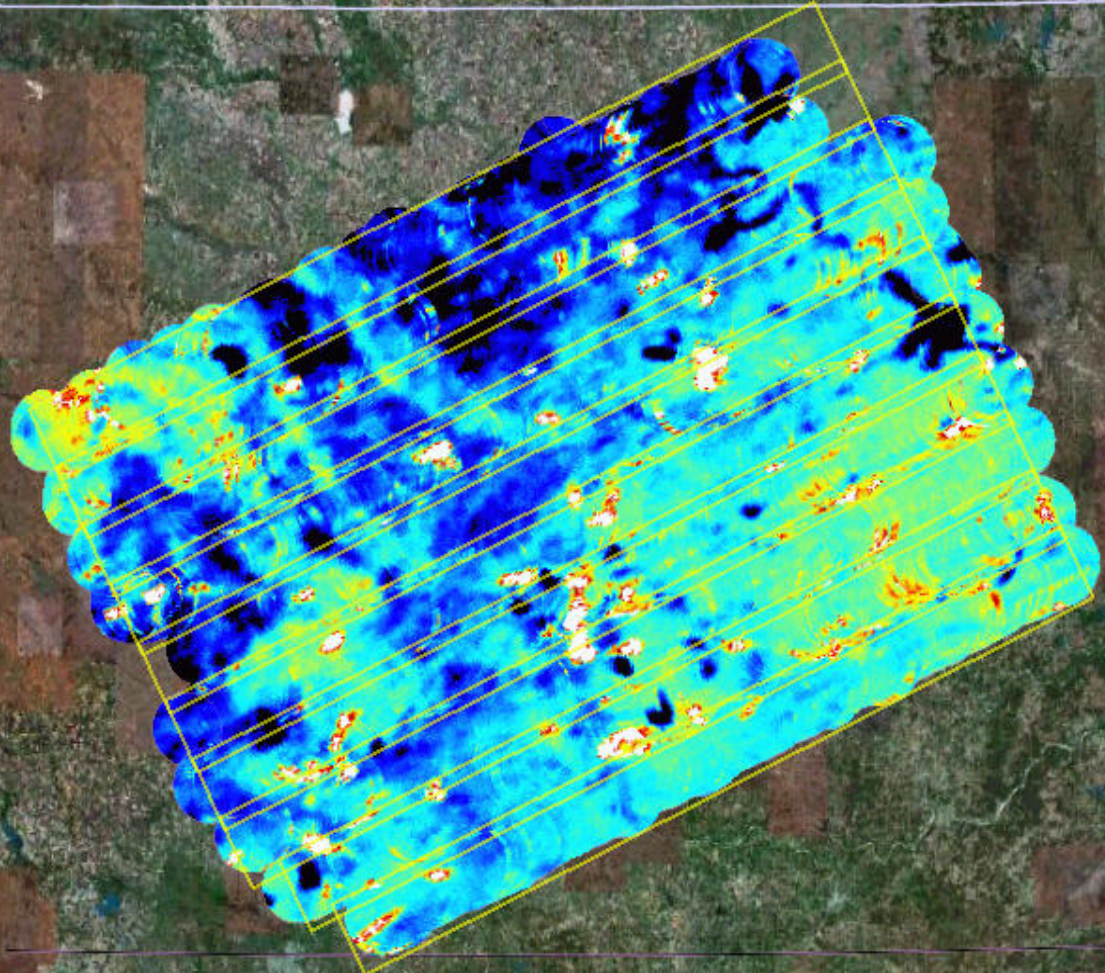
- Selectable CF Operational ~5.5 to ~7.6 GHz
- Two 100 MHz BW, Two 10 MHz BW Analog Linear
- Two 100 MHz BW Analog Logarithmic

- X-band Radiometer

- Four Fixed Analog Similar to C-band Radiometer
- ~10.6 to ~10.9 GHz



6.92 GHz H-pol

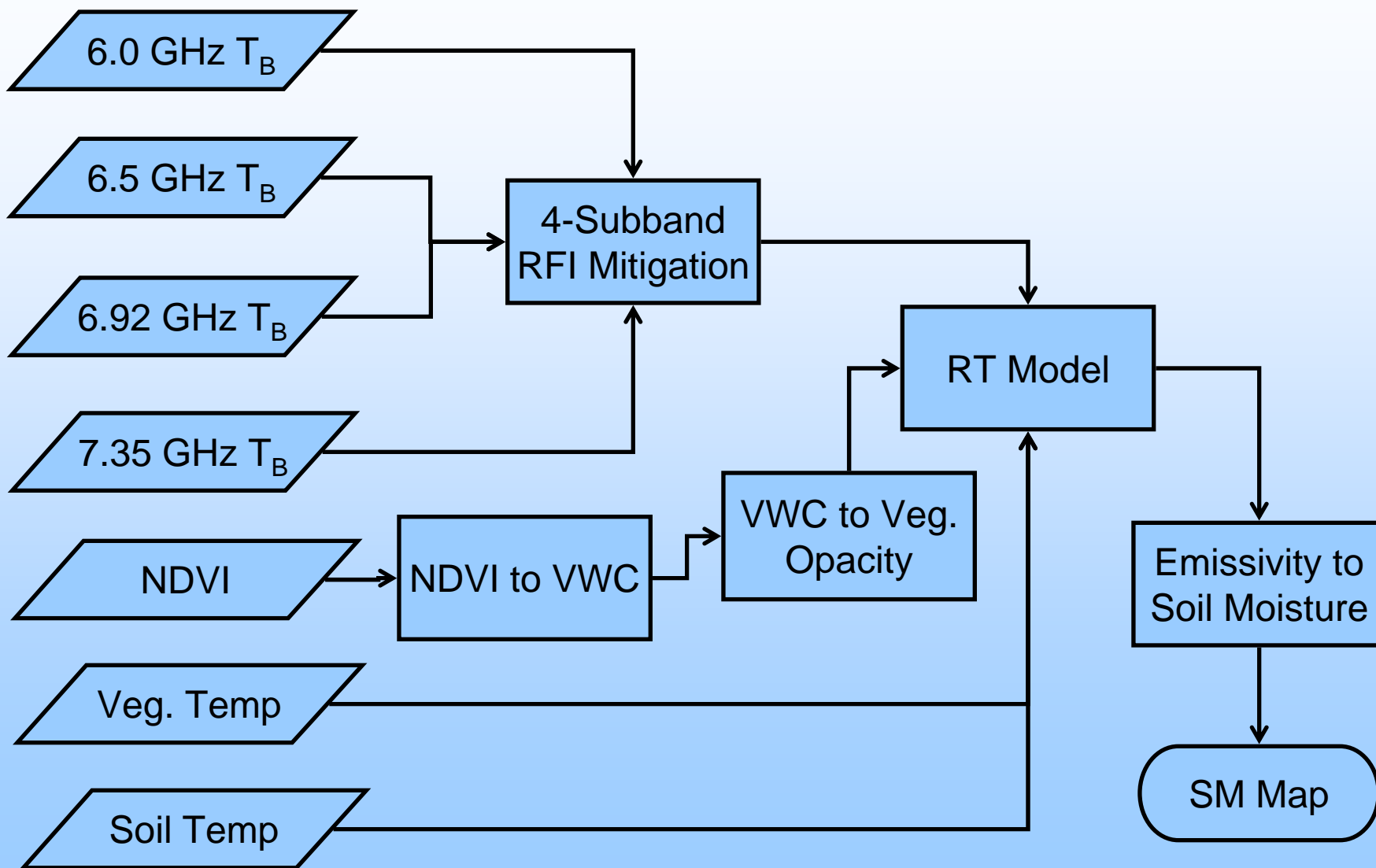


89 mi

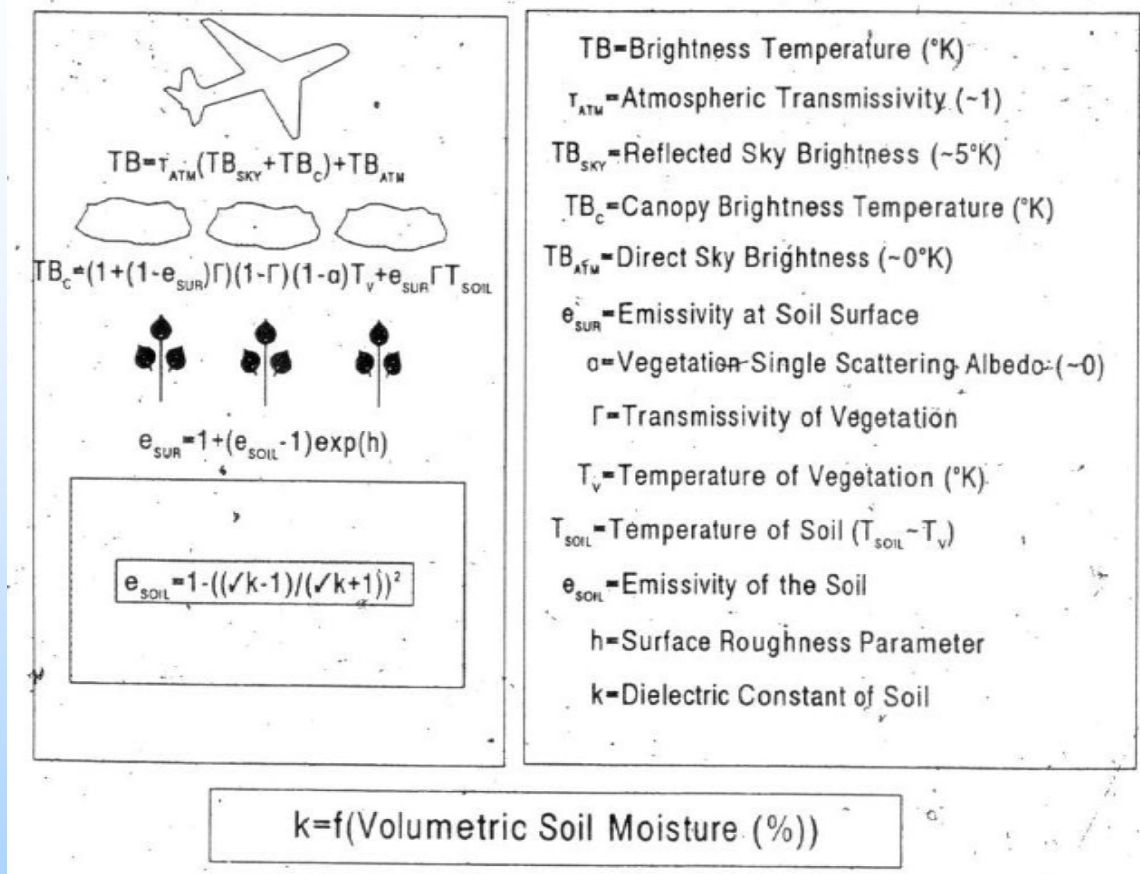
Image State of Arkansas
© 2007 Europa Technologies
Image © 2007 TerraMetrics

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SM Retrieval Algorithm



- RT model used considers effects of vegetation
- Vegetative opacity derived from NDVI (Jackson '99)



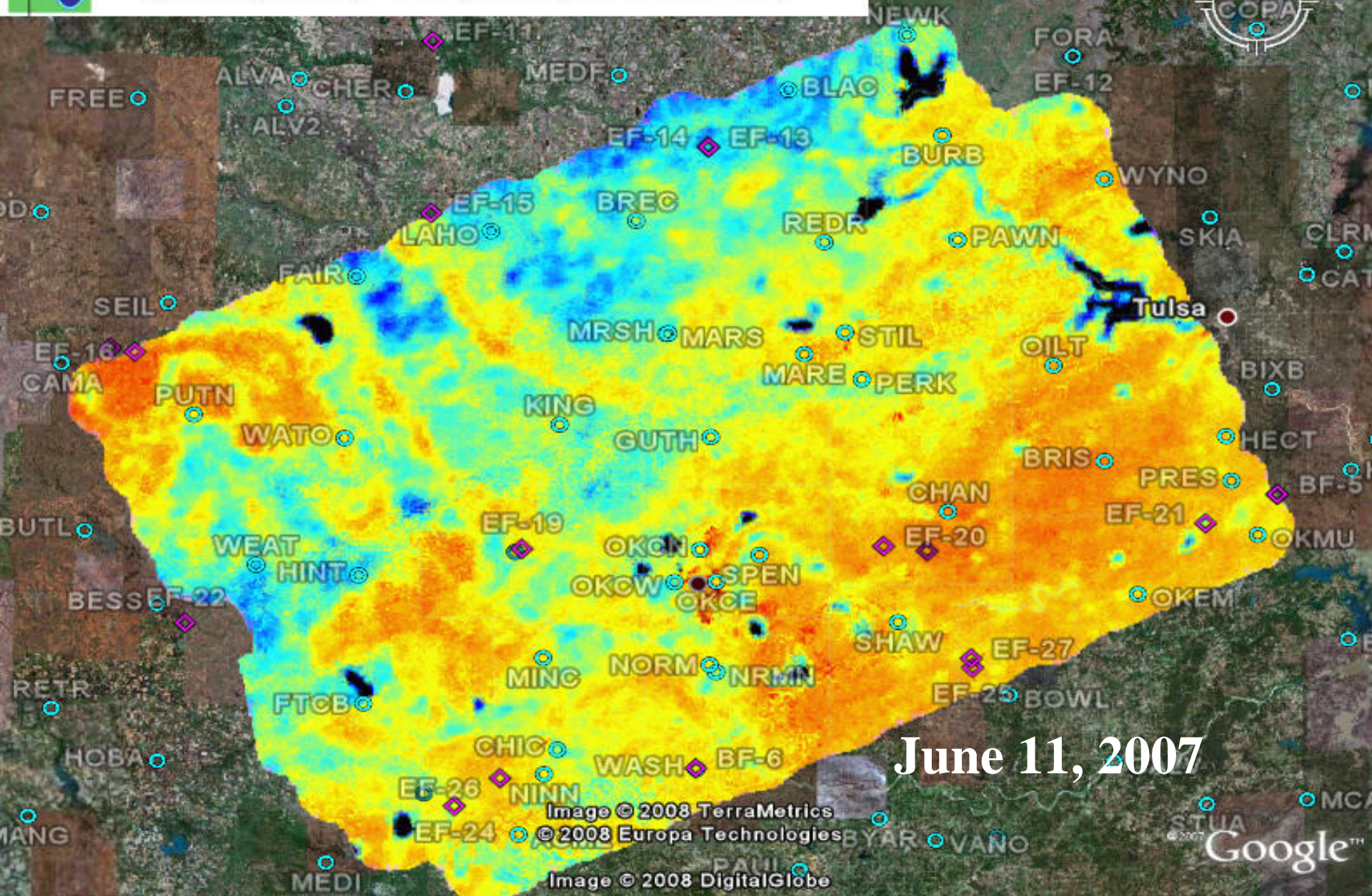
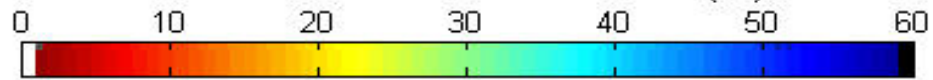
- Vegetation and soil temperatures estimated from OK Mesonet in-situ data

Jackson, '95

- Linearly approximates correlation between C-band emissivity and soil moisture.
- Neglects effects of vegetation canopy scattering at C-band
- Neglects effects of variations of soil type due to lack of data



Volumetric Soil Moisture (%)



June 11, 2007

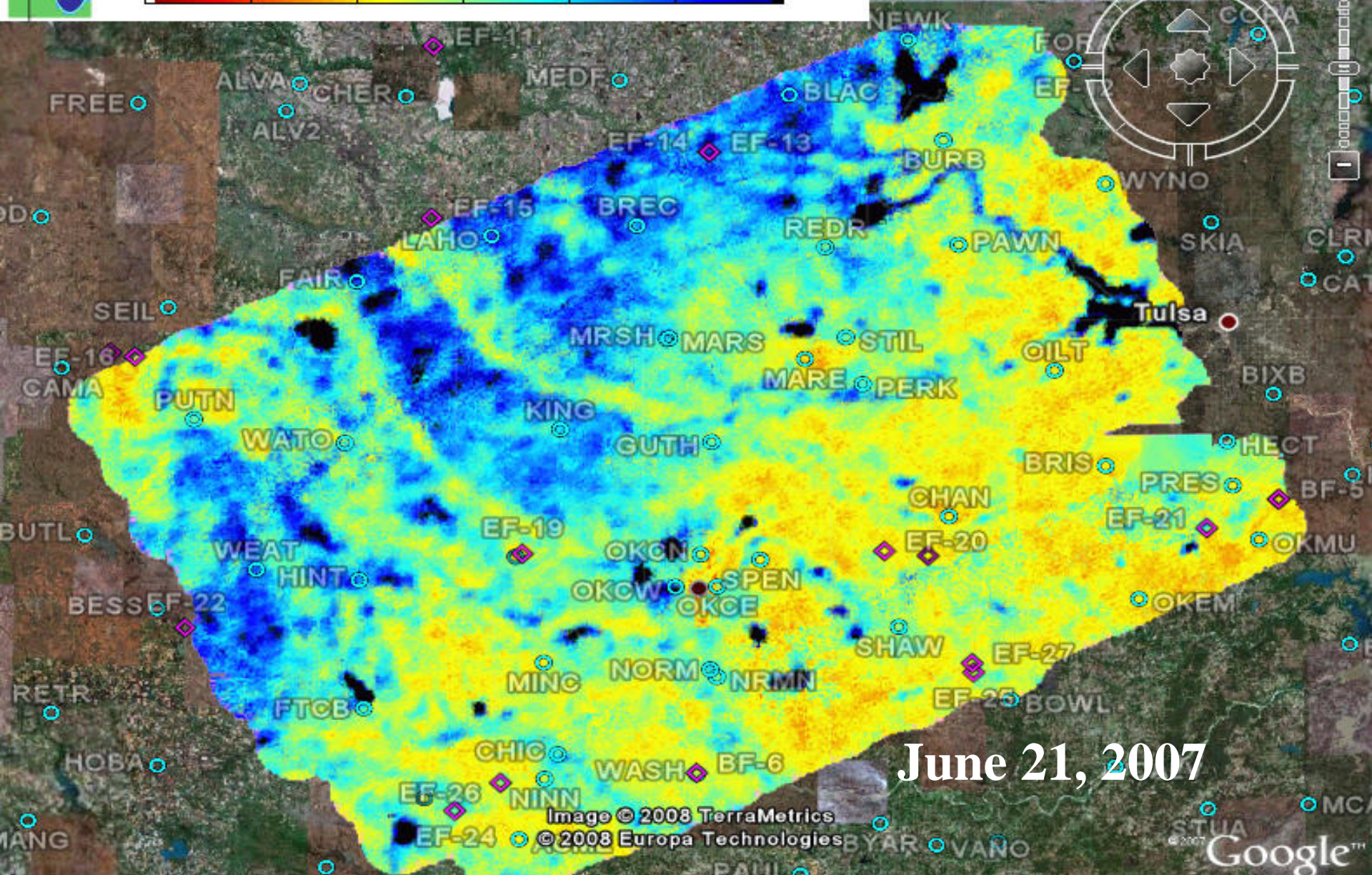
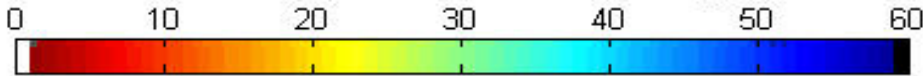
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Volumetric Soil Moisture (%)



June 21, 2007

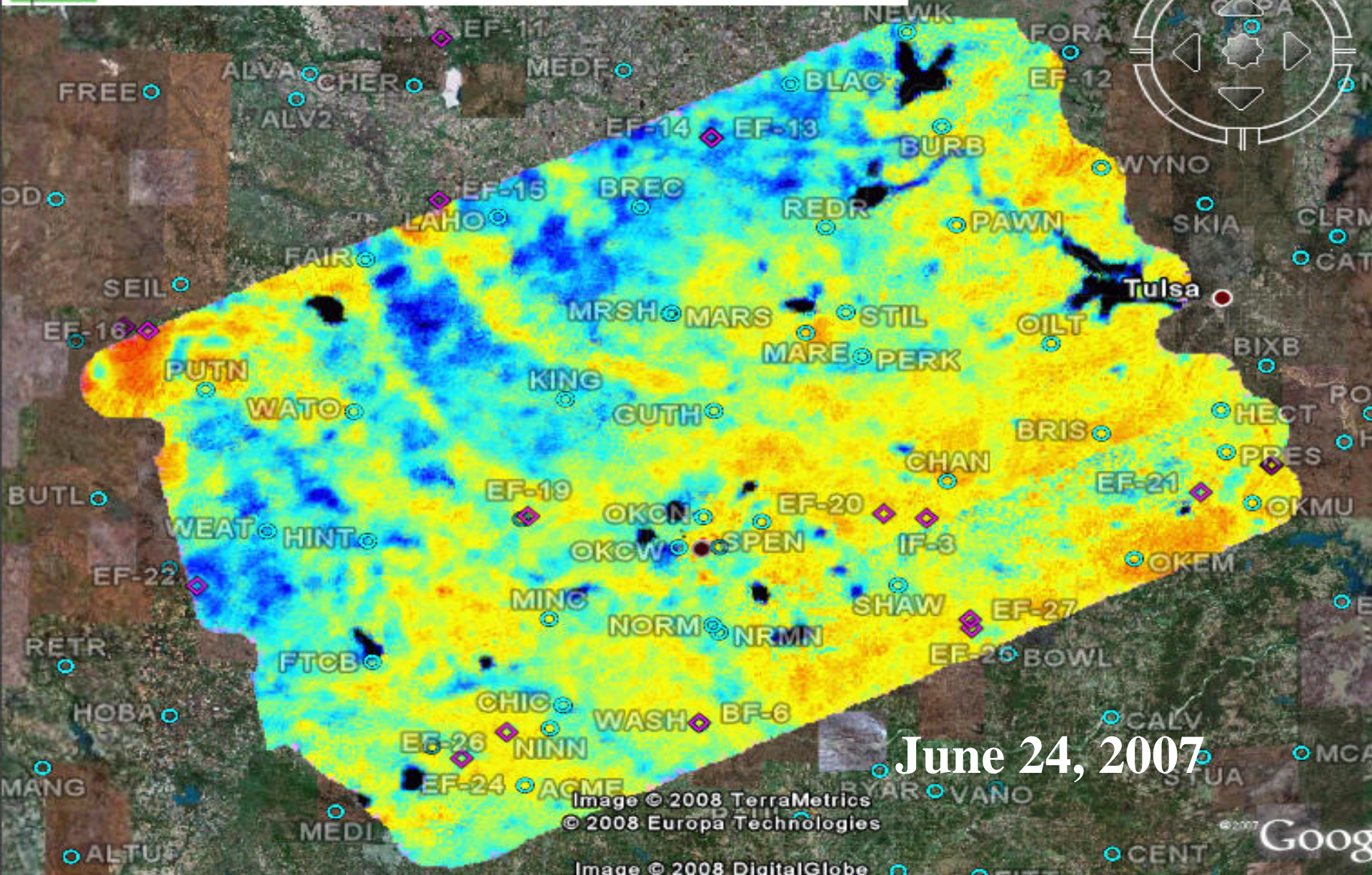
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Volumetric Soil Moisture (%)



June 24, 2007

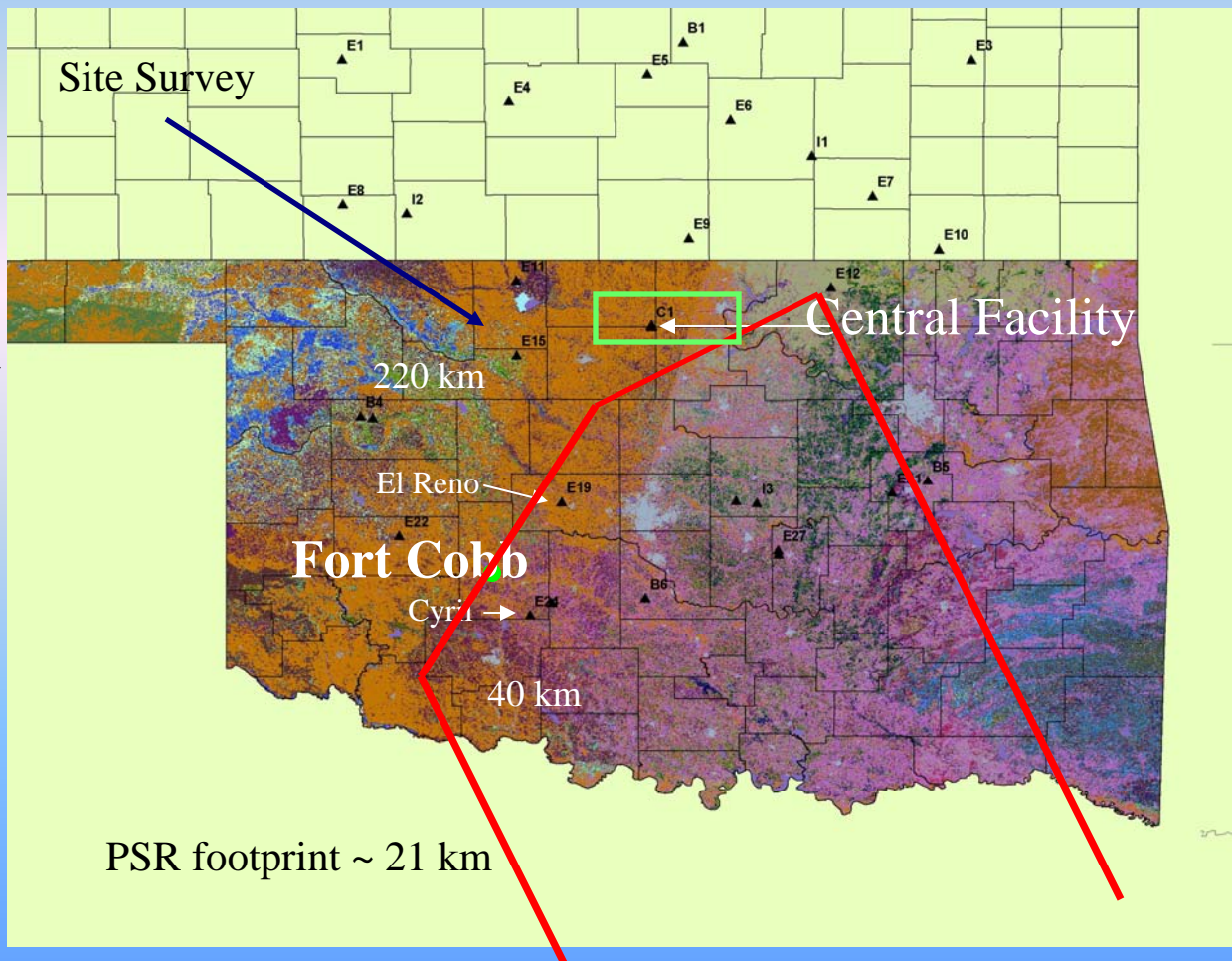
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Evolution/Gulf Trajectory

Gulf Trajectory

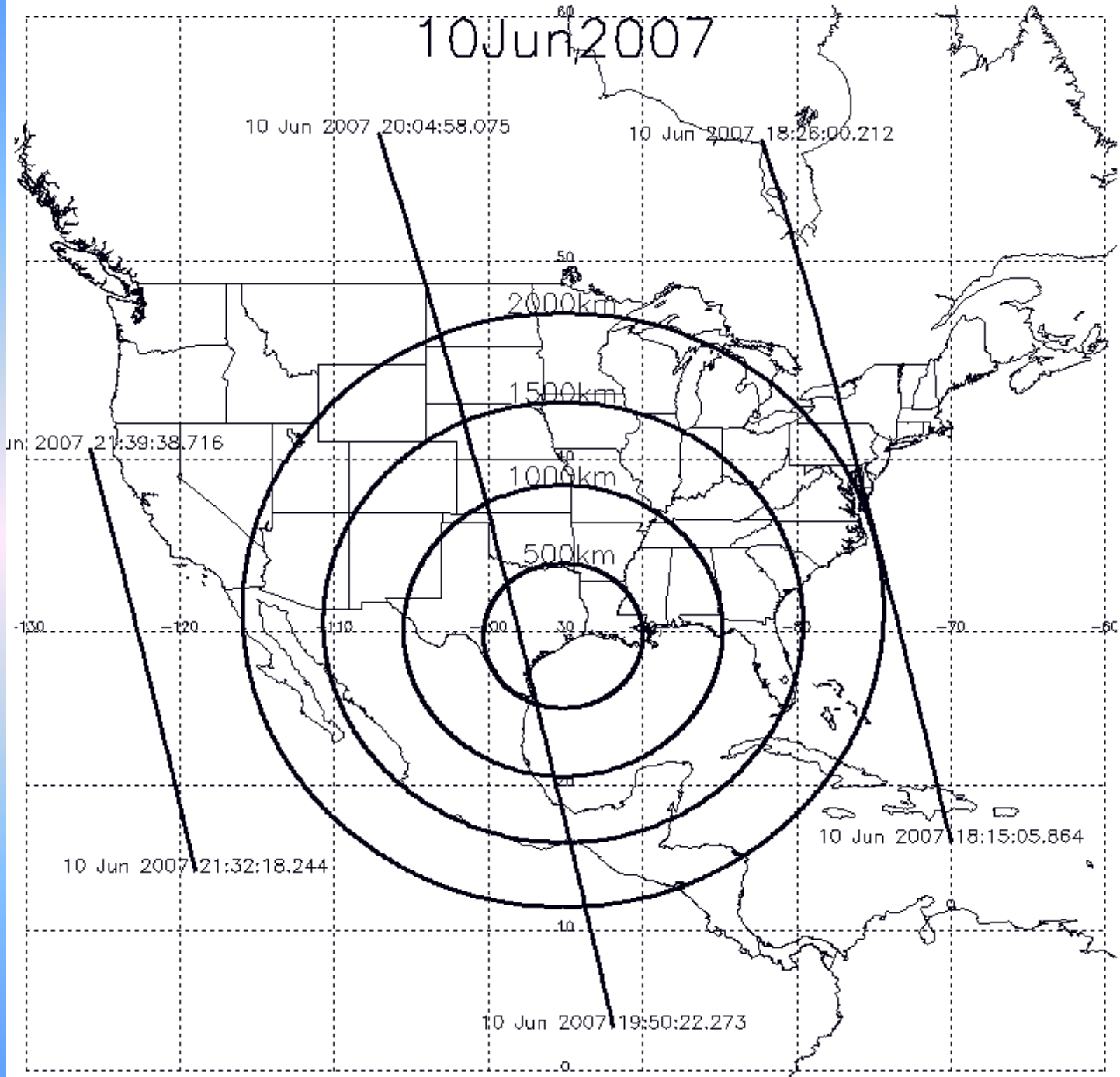
Cloud Development



Satellite Validation

- **Opportunities on**
 - **7 June (Dryden/Louisiana), 9 June (Gulf), 10, 12, 19, 21, 26 and 28 June (Houston/OK)**

10 Jun 2007



10 Jun 2007 20:04:58.075

10 Jun 2007 18:26:00.212

2000km

1500km

1000km

500km

10 Jun 2007 21:39:38.716

130

120

110

100

90

80

70

60

10 Jun 2007 21:32:18.244

10 Jun 2007 18:15:05.864

10 Jun 2007 19:50:22.273

0

Survey Pattern End Points

Line #	Start Latitude/Longitude	End Latitude/Longitude
1	(35.8, -95.535)	(34.55, -98.735)
2	(34.8, -98.87)	(36.05, -95.67)
3	(36.3, -95.805)	(35.05, -99.005)
4	(35.3, -99.14)	(36.55, -95.94)
5	(36.8, -96.075)	(35.55, -99.275)
6	(35.8, -99.41)	(37.05, -96.21)