LASE Measurements of Water Vapor, Aerosols, and Clouds During IHOP

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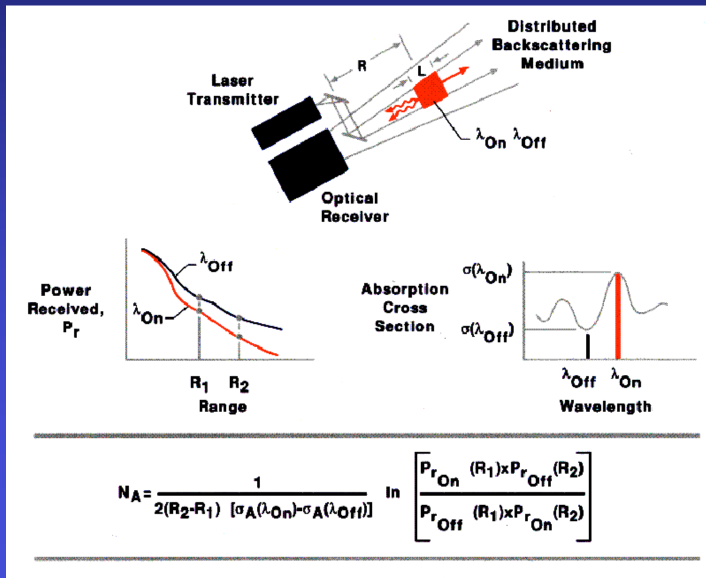
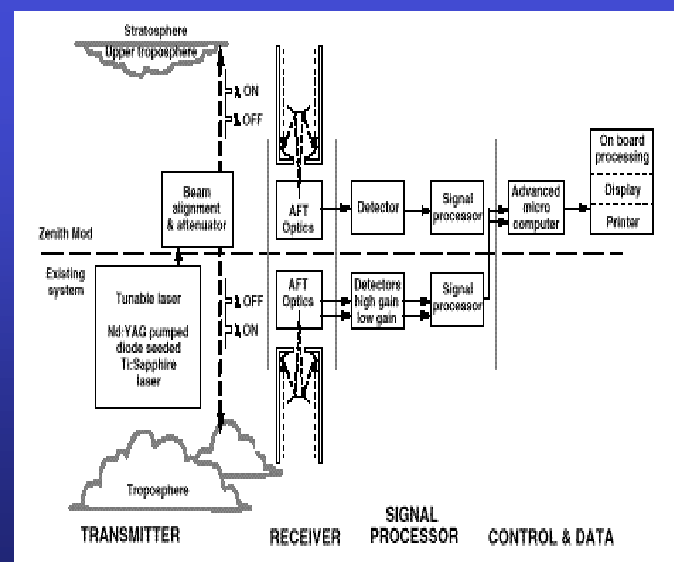
Outline

- LASE system and measurements
- IHOP Objectives
- Data Summary
- Water Vapor Comparisons
- Examples from CI Flights
- Status and Future Activities

Lidar Atmospheric Sensing Experiment (LASE)



- Airborne Water Vapor DIAL
- Laser
  - 5 Hz doubled-pulsed Ti:sapphire
  - 100 mj (on and off lines)
- Wavelengths
  - 815 nm (on-off □= □□= 40-70 pm)
  - Two separate line pairs
- NASA ER-2, P-3, DC-8 aircraft
- Simultaneous nadir, zenith operations
- Real-time data analysis and display

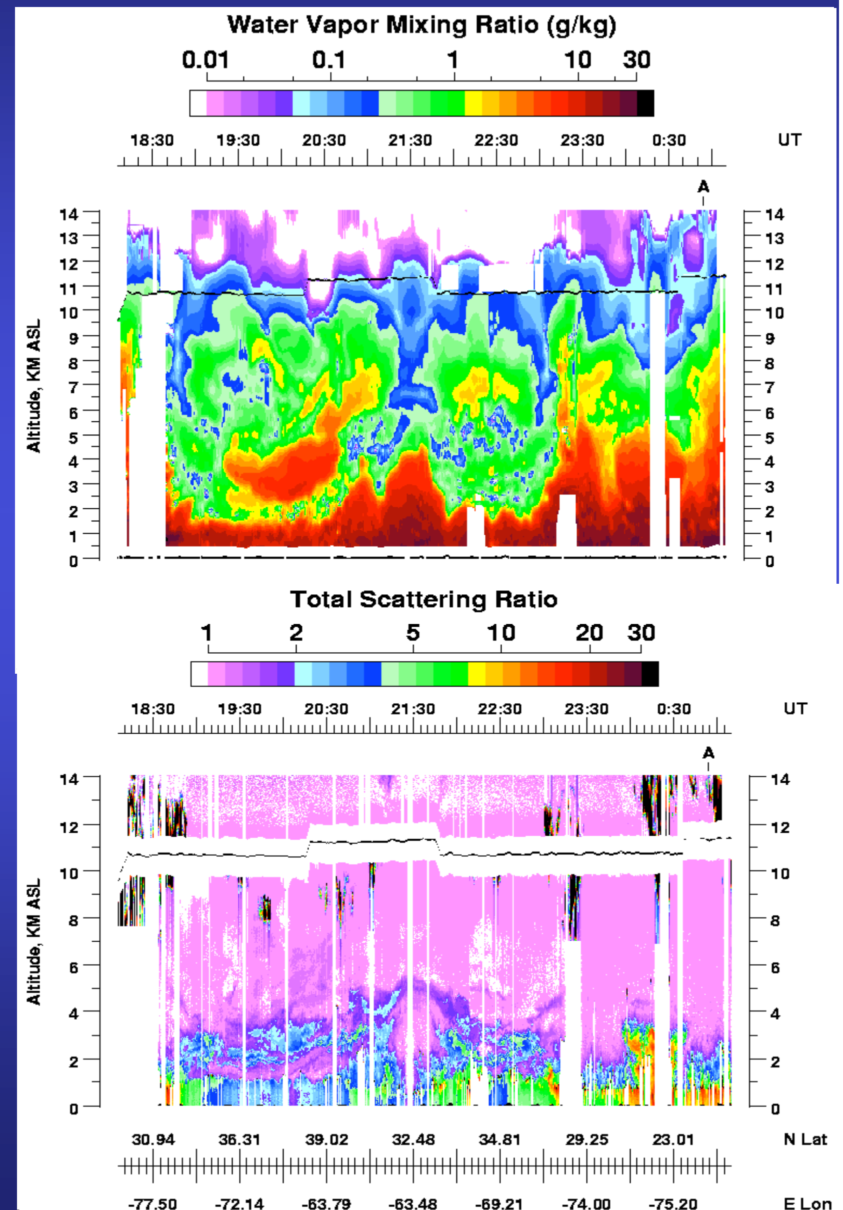


LASE Water Vapor and Aerosol/Cloud Profiling on NASA DC-8

- Water vapor profiles
  - daytime and nighttime
  - 0.2 km to tropopause (12-14 km)
  - 0.01 to 25 g/kg
  - accuracy (6% or 0.01 g/kg)
  - resolution (variable)
    _ 330 m (vertical)
    _ 14 km (1 min) (horizontal)
  - DC-8 in situ used within
    +/- 1 km of plane

- Aerosol/cloud profiles
  - daytime and nighttime
  - 0.03 to 25 km
  - resolution (variable)
    _ 30 m (vertical)
    _ 200 m (horizontal)

CAMEX3 DC-8 Flight 7 T.S. Bonnie Synoptic Flow Aug. 21-22, 1998



LASE IHOP Objectives

- Provide real-time water vapor, aerosol, cloud profiles
  - Assist in flight planning and execution
- Help assess utility of high resolution water vapor profiles for investigating/evaluating
  - Development of the convective boundary layer
  - Impact on forecasts of convective initiation
  - Relationship between moisture gradients and low level jet development
  - Relationships between atmospheric water vapor and surface and boundary layer processes
  - Impact on quantitative prediction forecasts
  - Capabilities of future active and passive remote sensing to measure water vapor, temperature, and RH fields
- Conduct additional research activities, e.g., relative humidity fields, precipitable water vapor, cirrus cloud properties, aerosol extinction and optical depths

LASE Measurements during IHOP

- Acquired data on 8 science flights (4 CI flights)

Date	DC-8 Flight Number	Start Time (UT)	Stop Time (UT)	Duration (hours)	Objective(s)	LASE Measurements
May 23	4	17:13	19:40	2:27	Transit	- Possible region of stratosphere-troposphere exchange near 36.5 N, 104 W at 18:45 UT
May 24	5	17:17	22:44	5:27	Convective Initiation #1	- Strong gradients of water vapor across the front with dry conditions on the west side of the dry line and very moist conditions on the east side
May 30	6	17:22	22:35	5:13	PBL Water Vapor Heterogeneity	-Substantial gradients in the low level water vapor field. -Dry region over the western part of the flight tracks moved slightly east during this period
June 2	7	02:24	06:56	4:32	Nocturnal Low Level Jet	- 2-km-deep layer of enhanced moisture with very shallow boundary layer associated with LLJ - On the east a moist boundary layer capped by a relatively thin dry layer with a broad moist layer aloft (3-7 km), which was probably due to advection of upstream outflow regions
June 3	8	17:40	22:44	5:04	Convective Initiation #2	- Great sequence of three passes which will aid in the interpretation of the evolution of convection over the dry line - Many fires and smoke plumes, which are probably responsible for the enhance aerosol scattering in the lower troposphere
June 9	9	13:29	21:15	7:46	Morning Low Level Jet and Convective Initiation #3	- Aerosol layer from 3-7 km, which had slightly enhanced moisture, and was probably associated with a smoke plume - Some indication of downward mixing of dry air into the moist boundary layer as the PBL depth increased during the morning - "Null case"
June 11	10	16:40	21:57	5:17	Convective Initiation #4	- Even better null case
June 14	11	13:27	21:26	7:59	Boundary Layer Evolution and Transit	- Water vapor associated with growth of the boundary layer - Elevated moisture layer gradually merged into the growing boundary layer

DC-8 Overpasses of Homestead and ARM SGP Sites

Homestead
(36.558 N, 100.606 W)

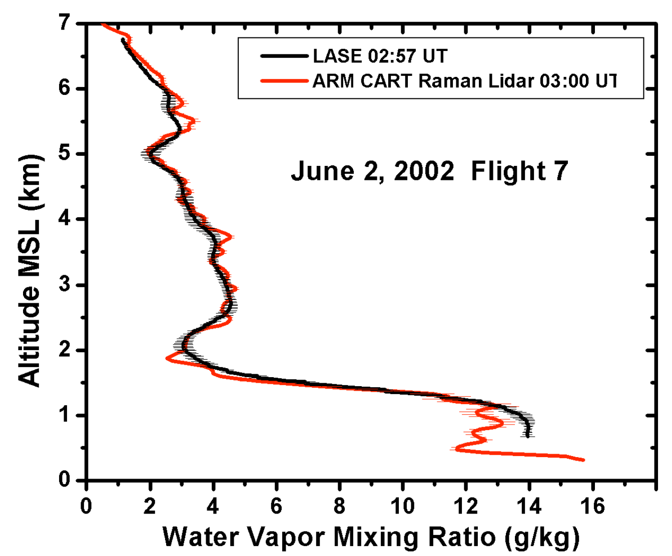
Date	DC-8 Flight #	Mission	Overpass Times (UT)	Comment
May 23	4	Transit	19:05	
May 24	5	CI #1	None	
May 30	6	BL Mapping	19:44, 20:35, 21:49	
June 2	7	Nocturnal LLJ	06:00	
June 3	8	CI #2	19:30, 20:30, 21:32	
June 9	9	LLJ & CI#3	18:07, 19:17, 20:31	
June 11	10	CI#4	17:09, 18:13, 19:13, 20:08	17:05 was cloudy
June 14	11	BL Evolution	14:03, 14:40, 15:14, 15:57, 16:28, 17:08, 17:39, 18:20, 18:49	14:03 was cloudy

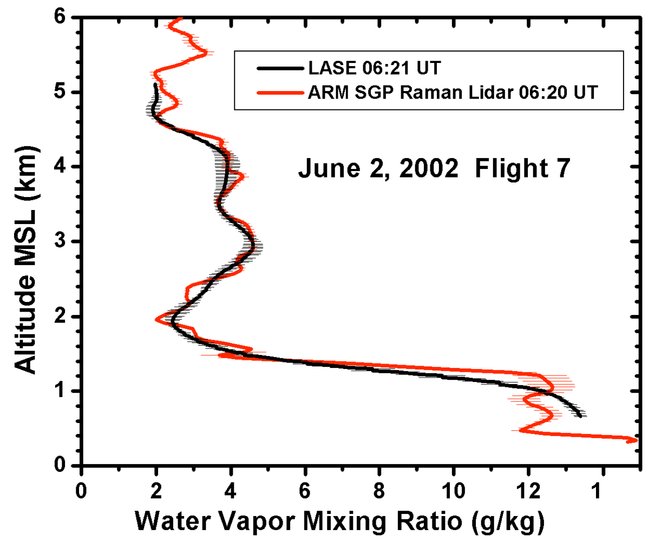
ARM SGP
(36.605 N, 97.489 W)

Date	DC-8 Flight #	Mission	Overpass Times (UT)	Comment
May 23	4	Transit	None	
May 24	5	CI #1	None	
May 30	6	BL Mapping	19:42, 20:48	LASE nadir blocked due to Vance MOA
June 2	7	Nocturnal LLJ	02:58, 06:21	
June 3	8	CI #2	None	
June 9	9	LLJ & CI#3	13:54, 20:52	Cloudy directly over site, but clear just north
June 11	10	CI#4	None	
June 14	11	BL Evolution	None	

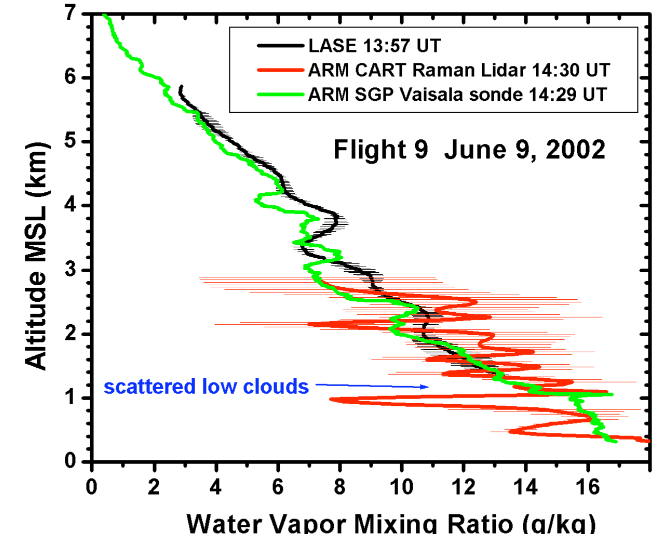
LASE Water Vapor Comparisons

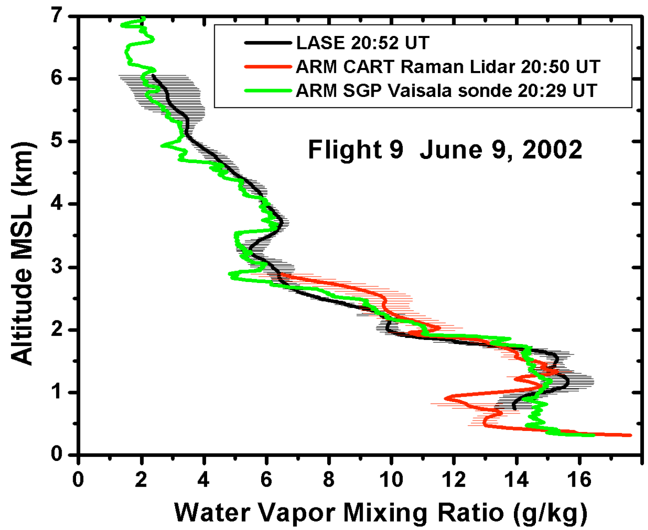
Nighttime



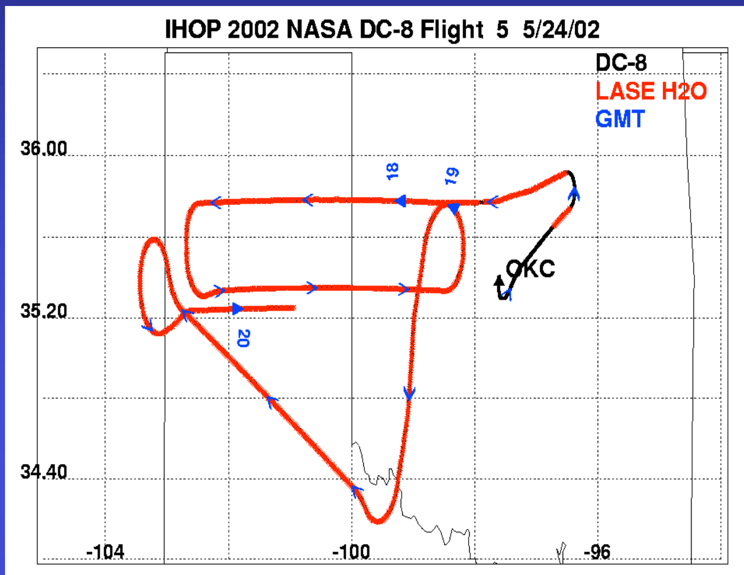


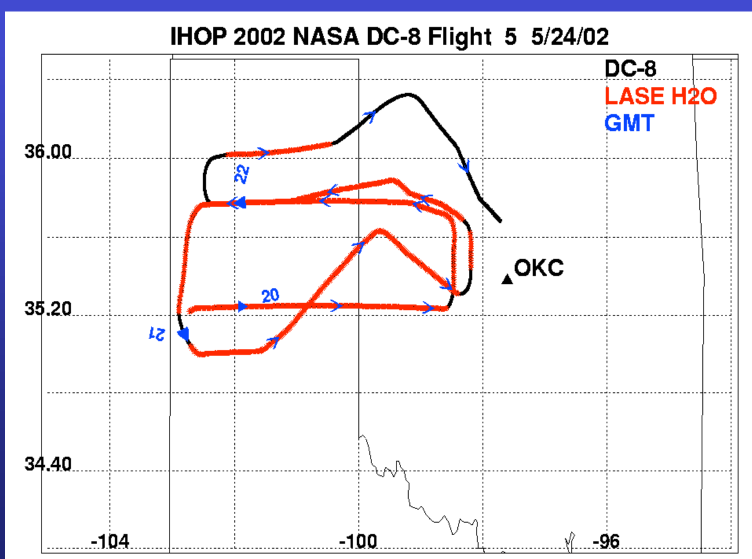
Daytime

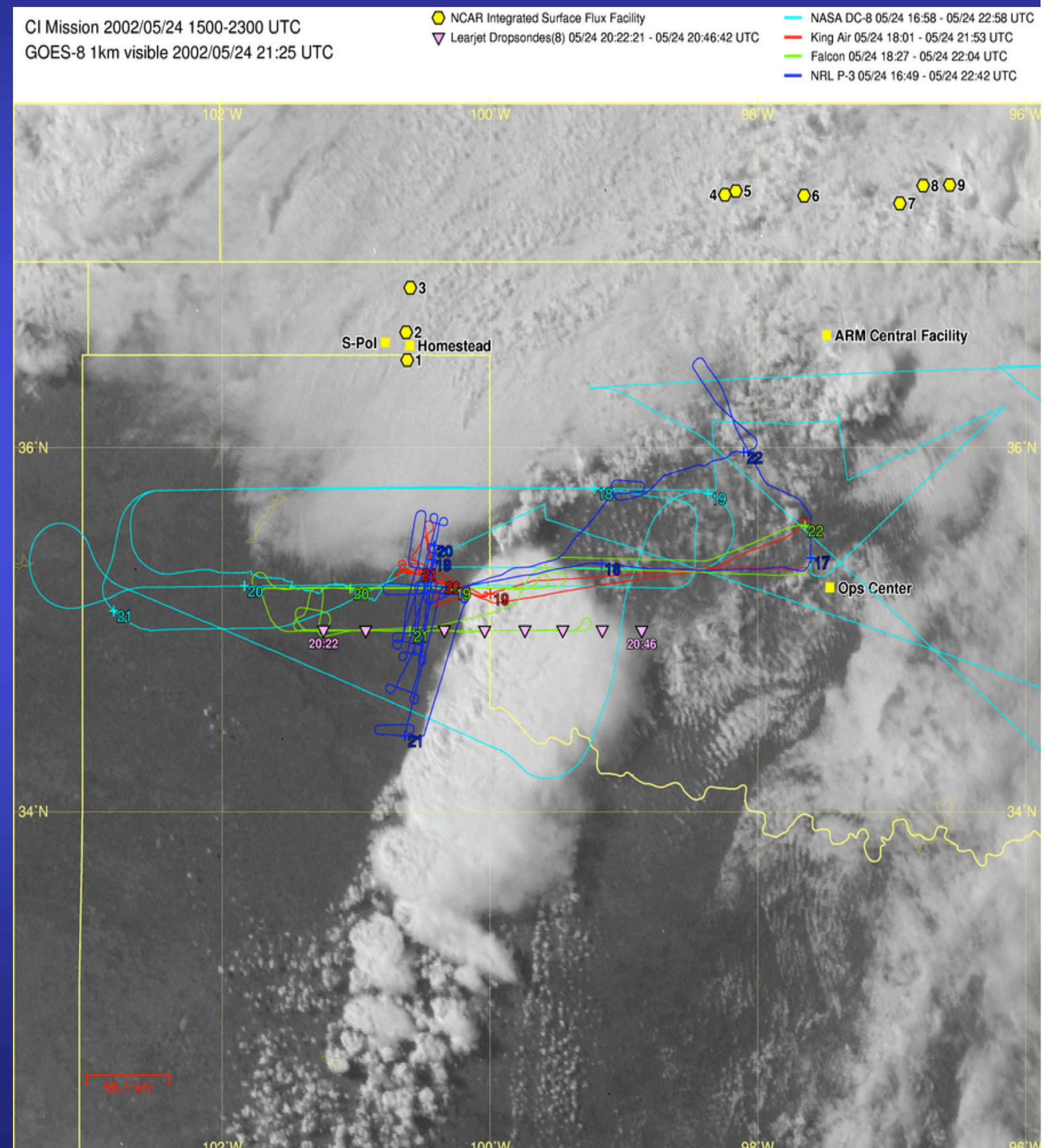




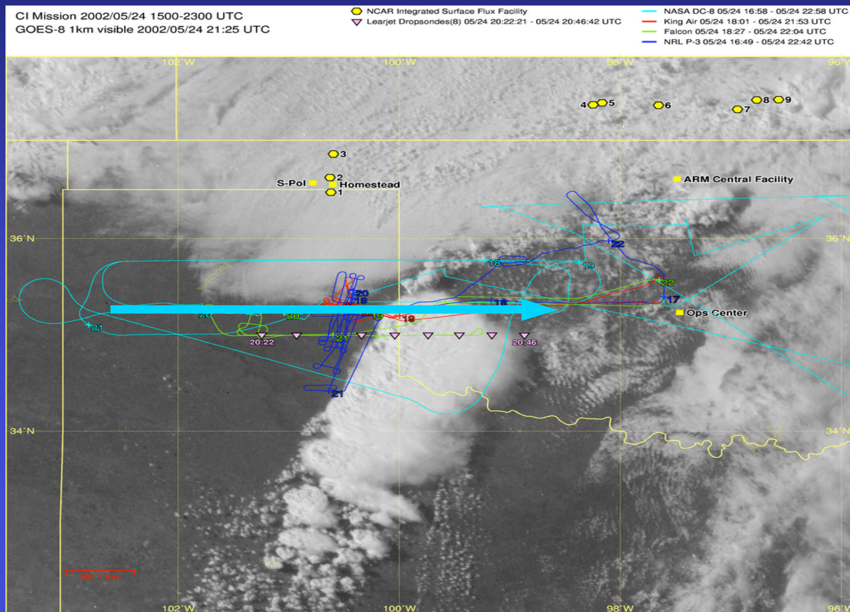
May 24, 2002 DC-8 Flight 5 CI #1 Flight Tracks

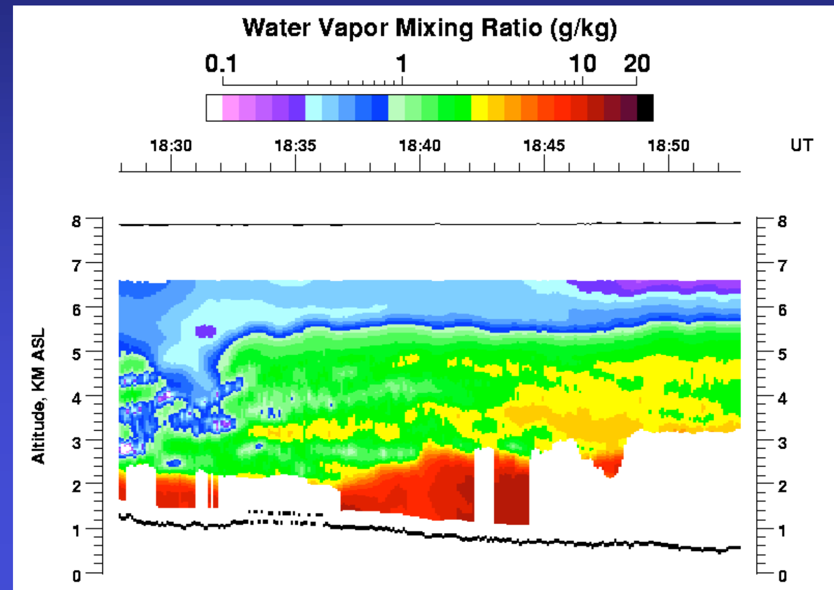


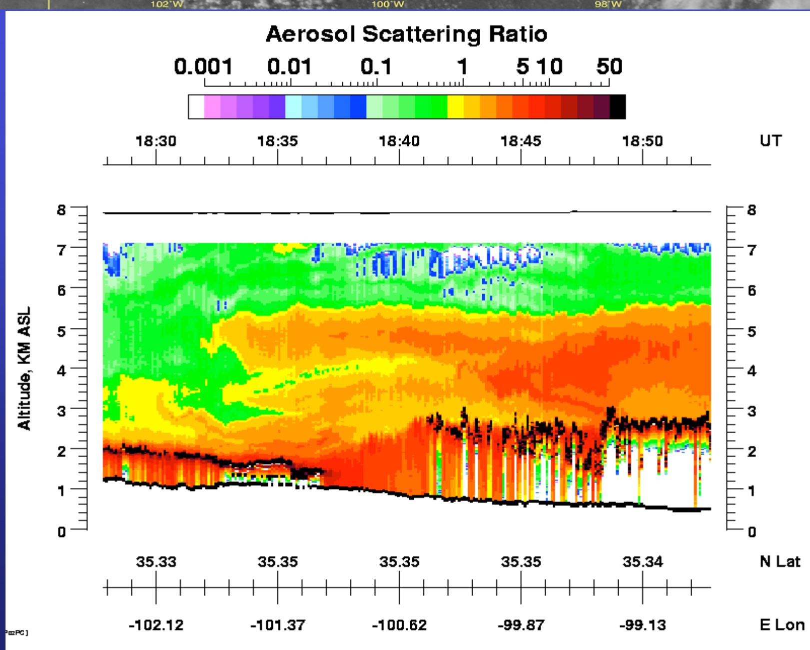


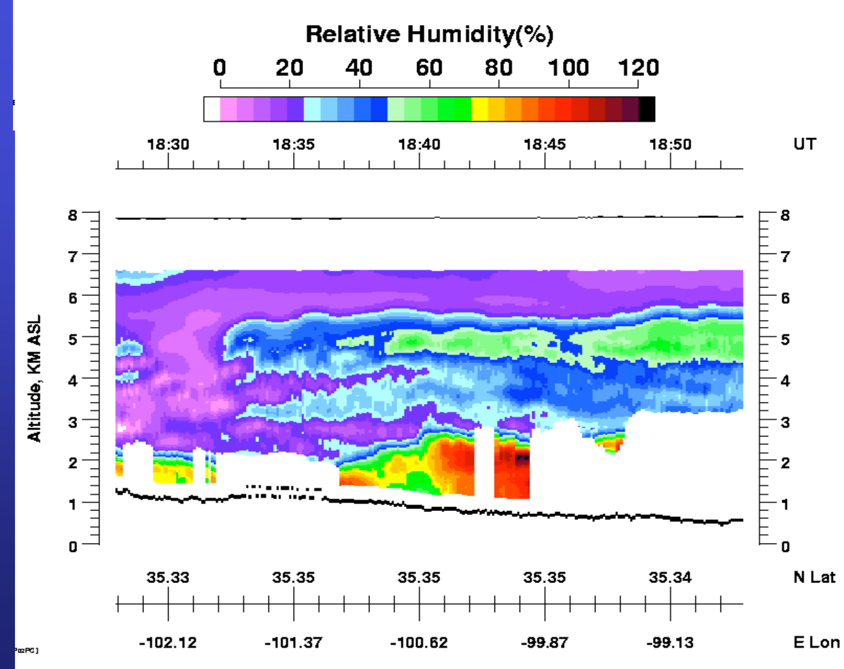


May 24, 2002 CI #1 DC-8 Flight 5 18:28-18:53 UT

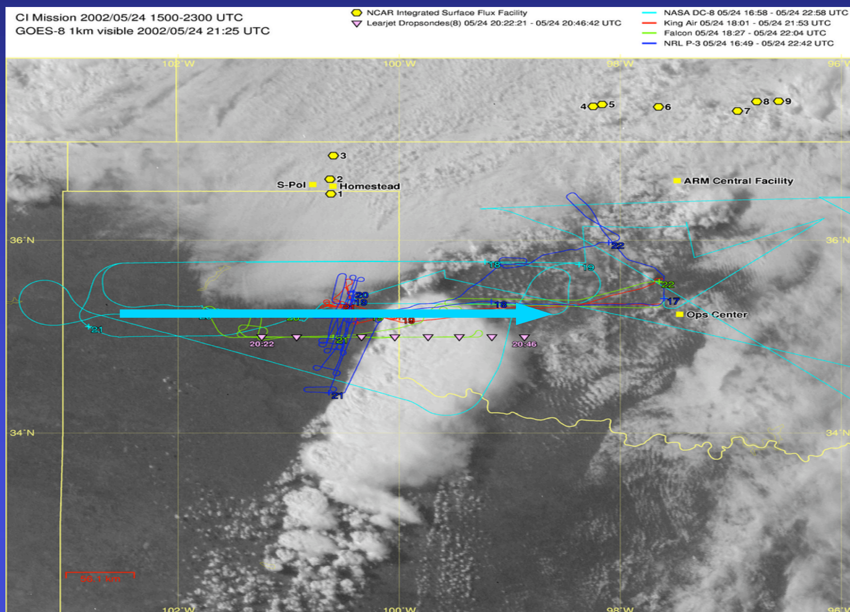


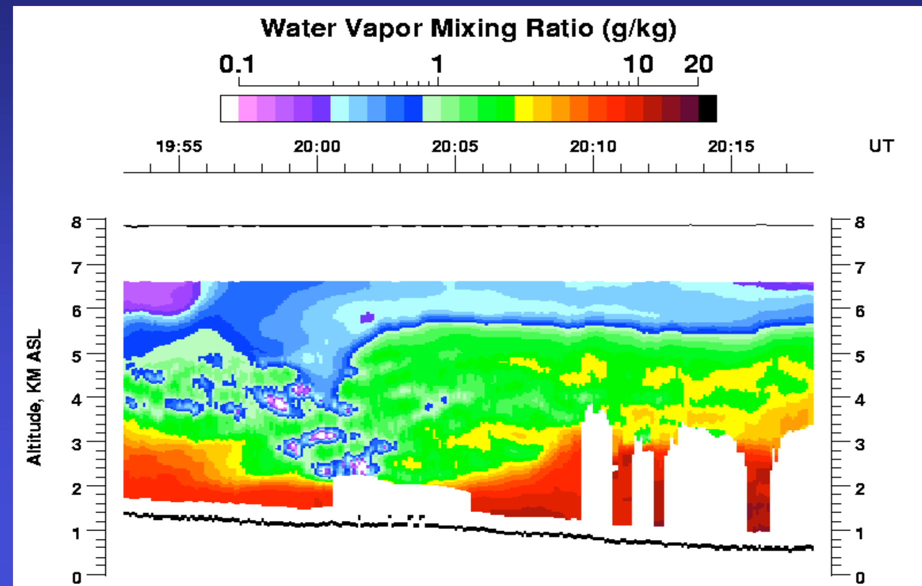


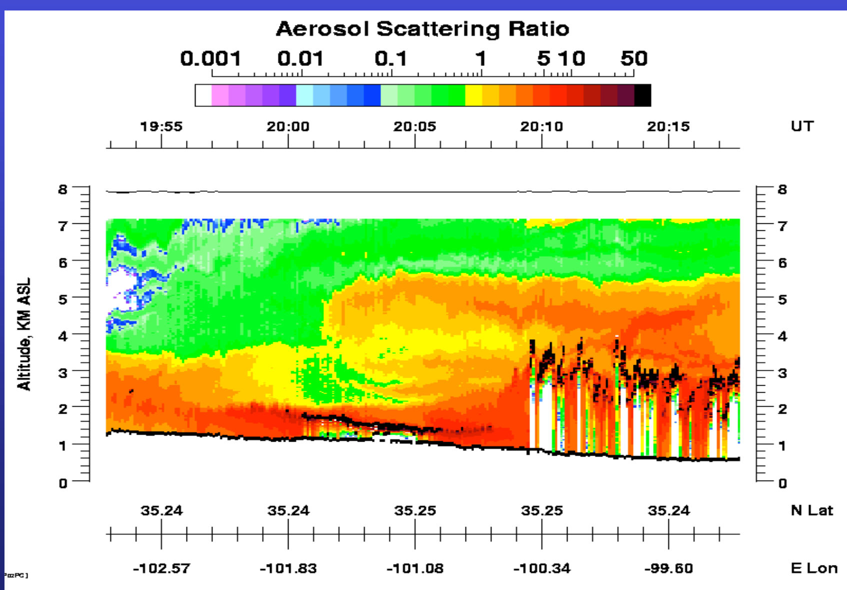


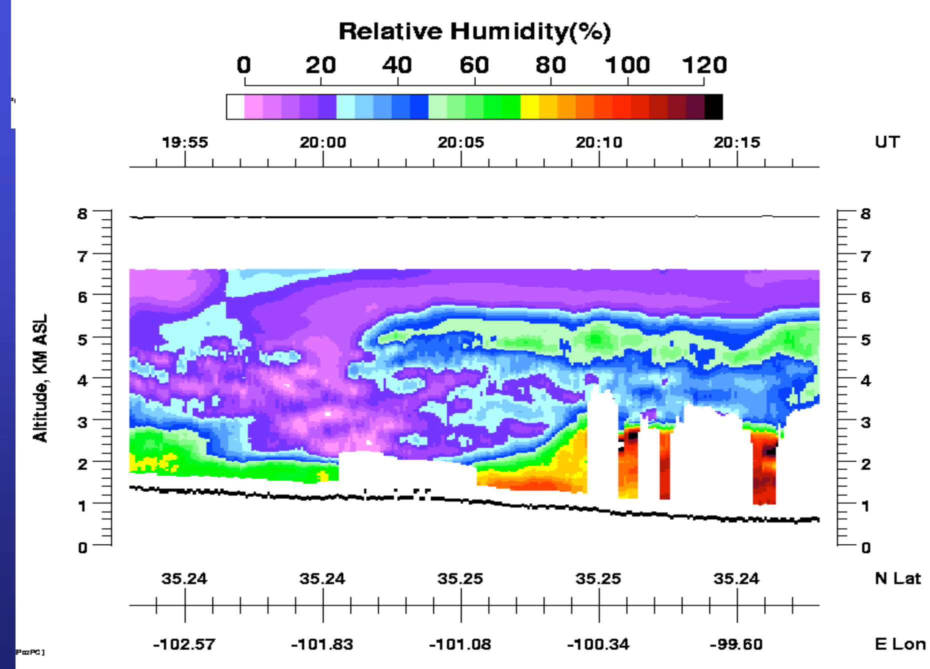


May 24, 2002 CI #1 DC-8 Flight 5   19:53-20:18 UT

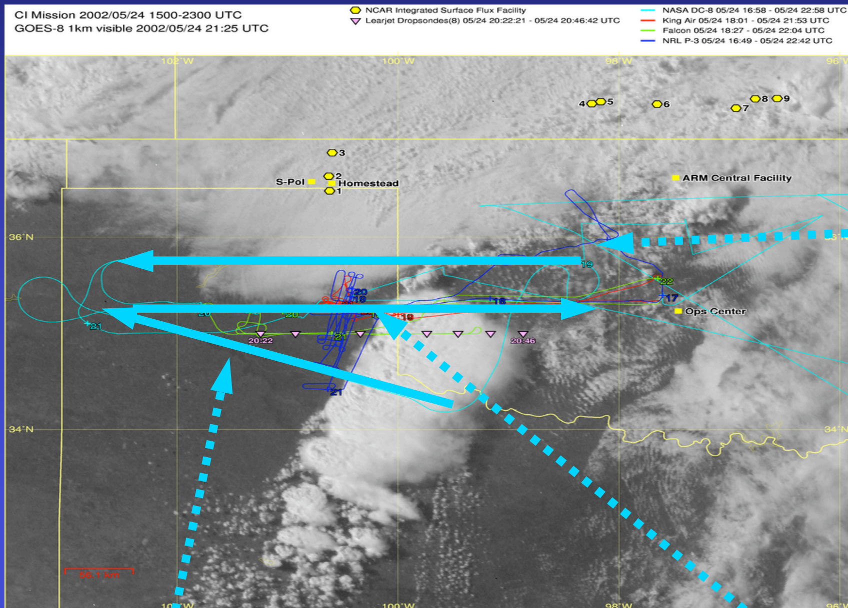


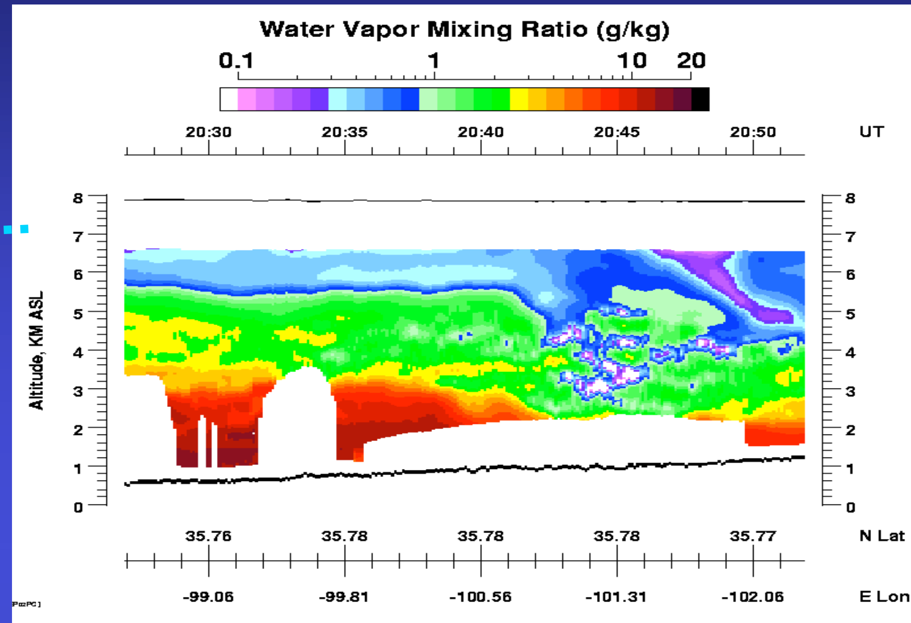


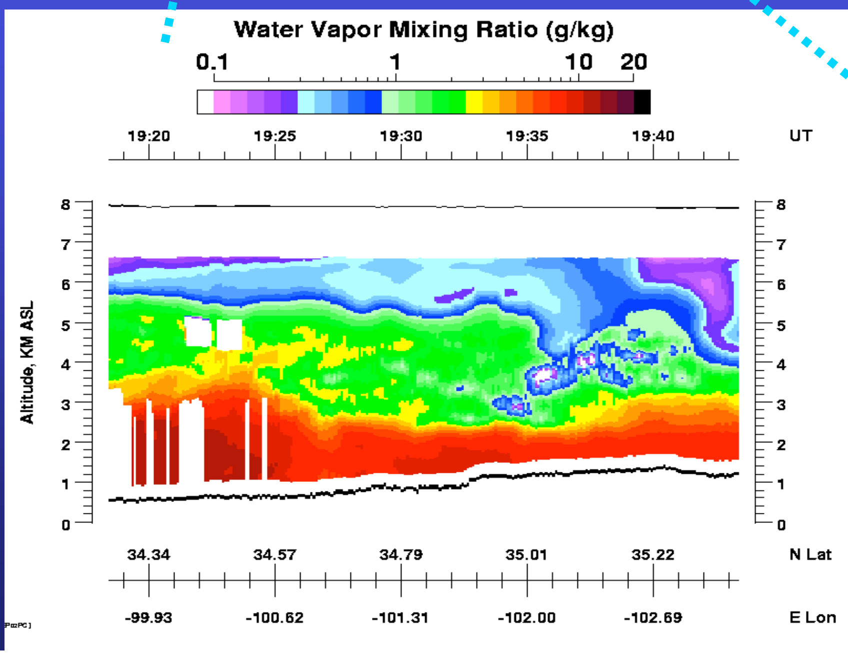


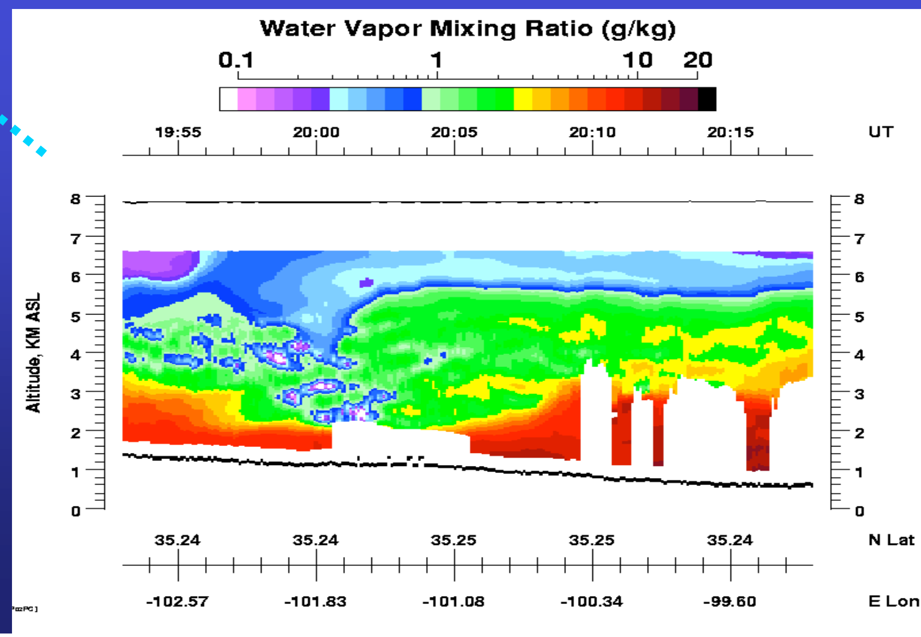


May 24, 2002 CI #1 DC-8 Flight 5



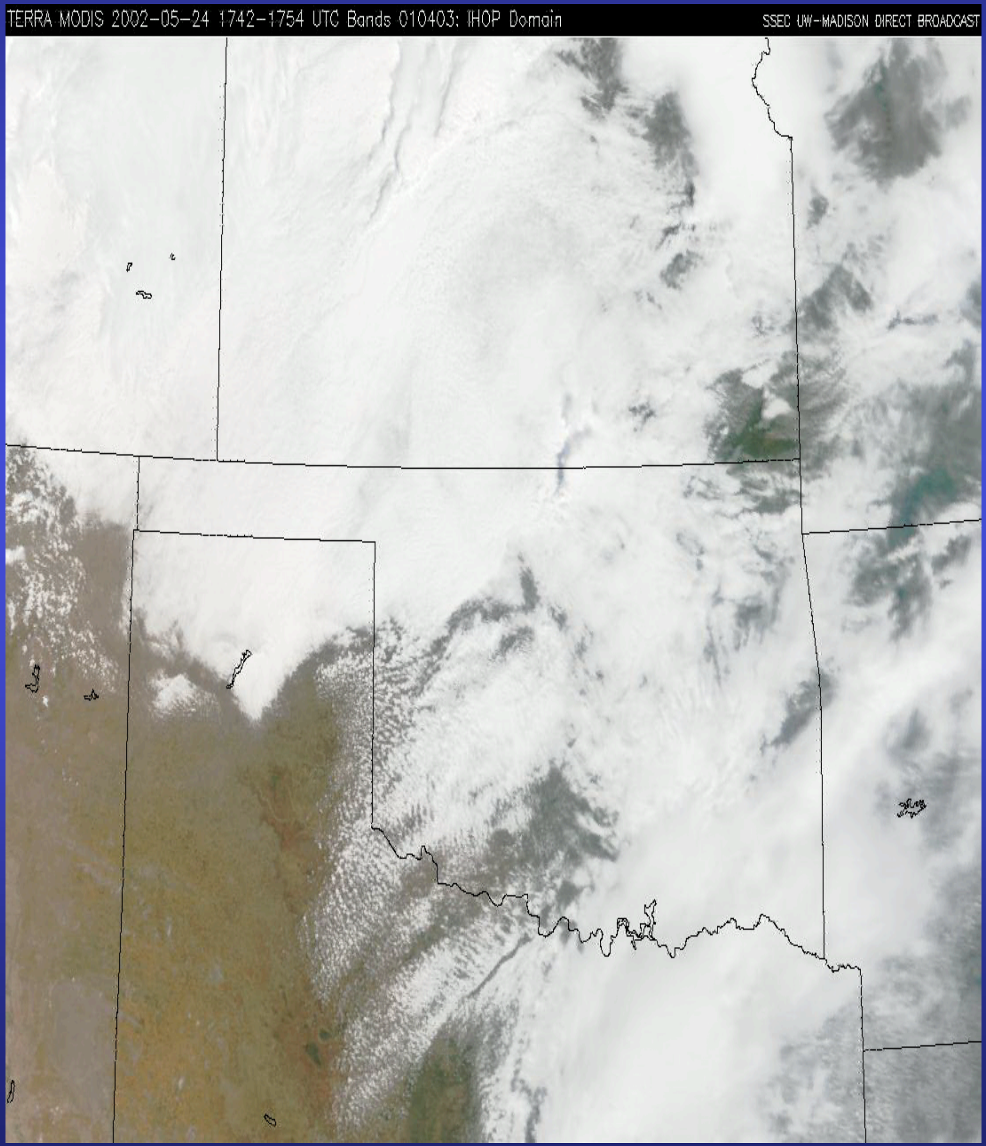




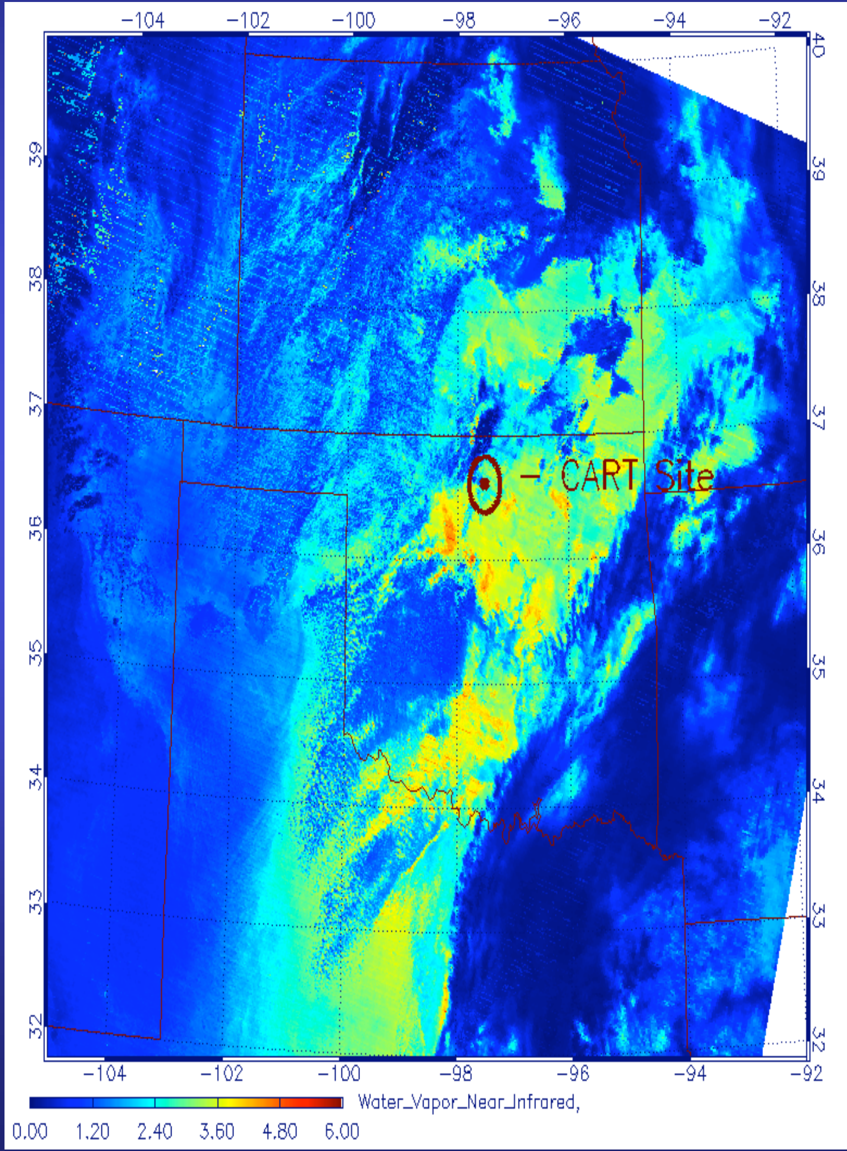


May 24, 2002 Terra MODIS Precipitable Water Vapor

MODIS 17:50 UT

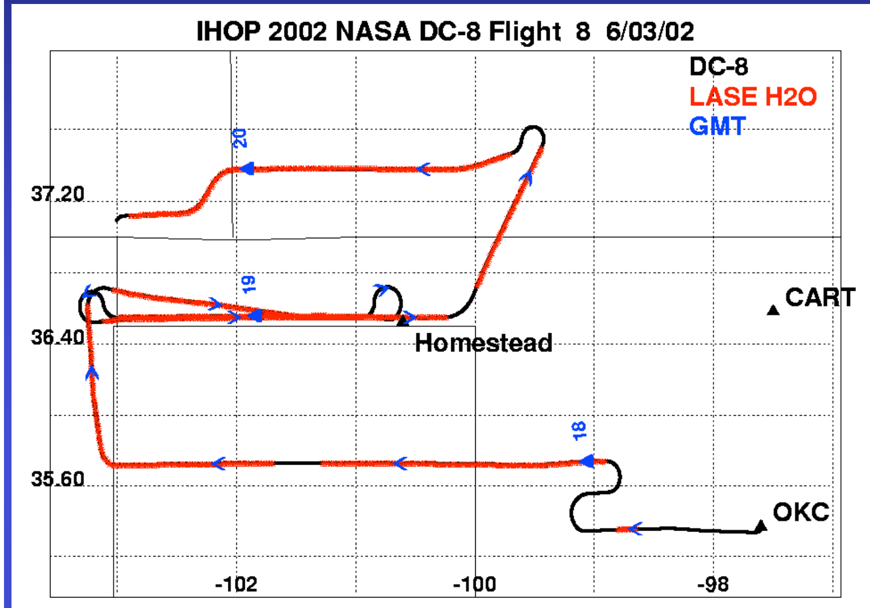


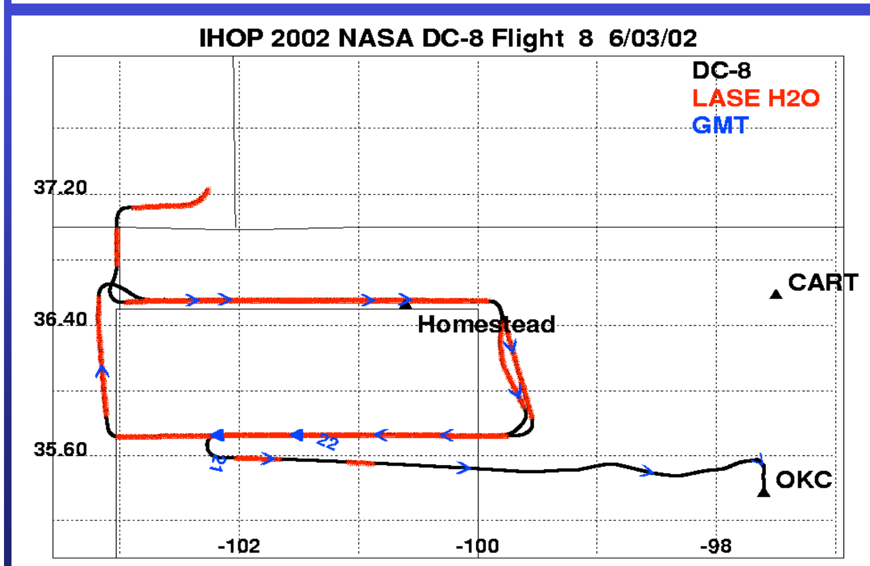
MODIS near-IR PWV 17:50 UT

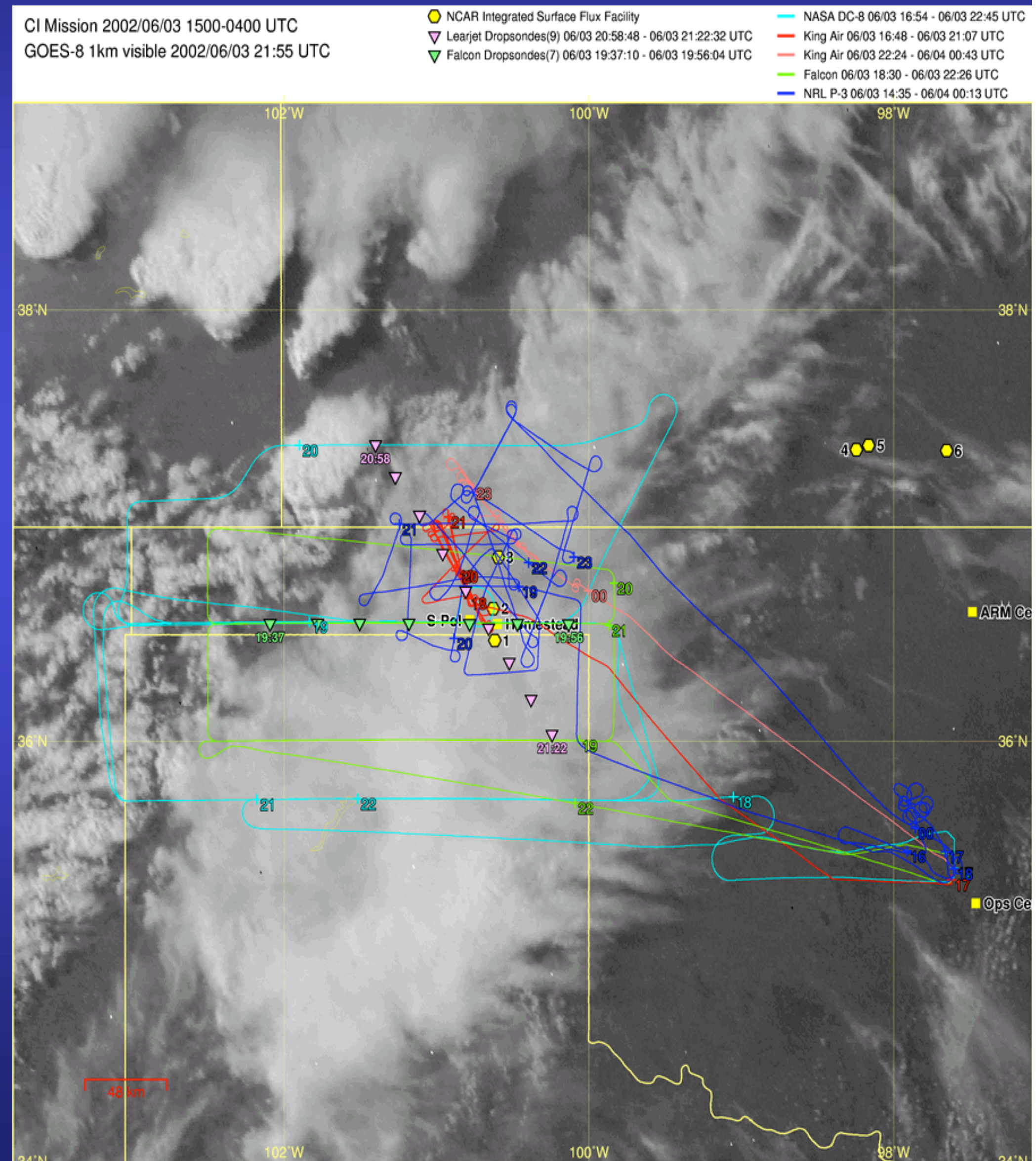


June 3, 2002 DC-8 Flight 8 CI #2

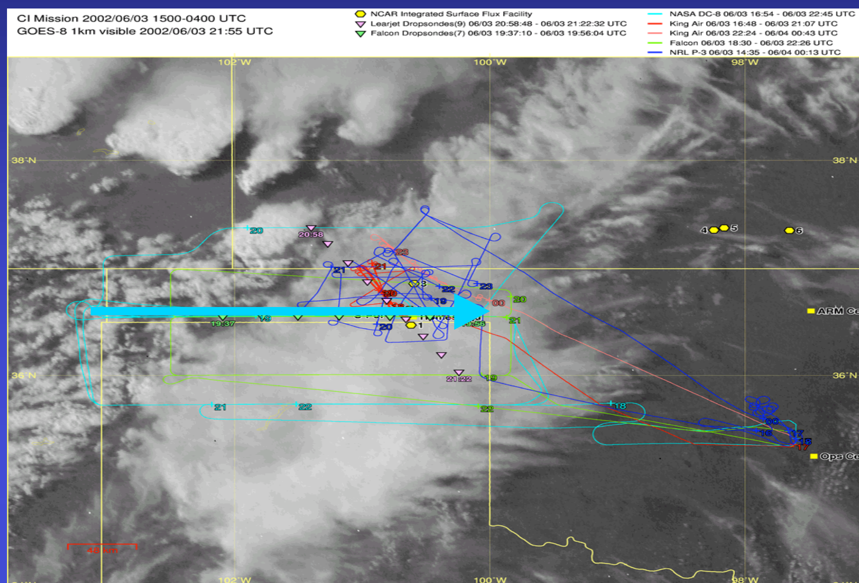
Flight Track

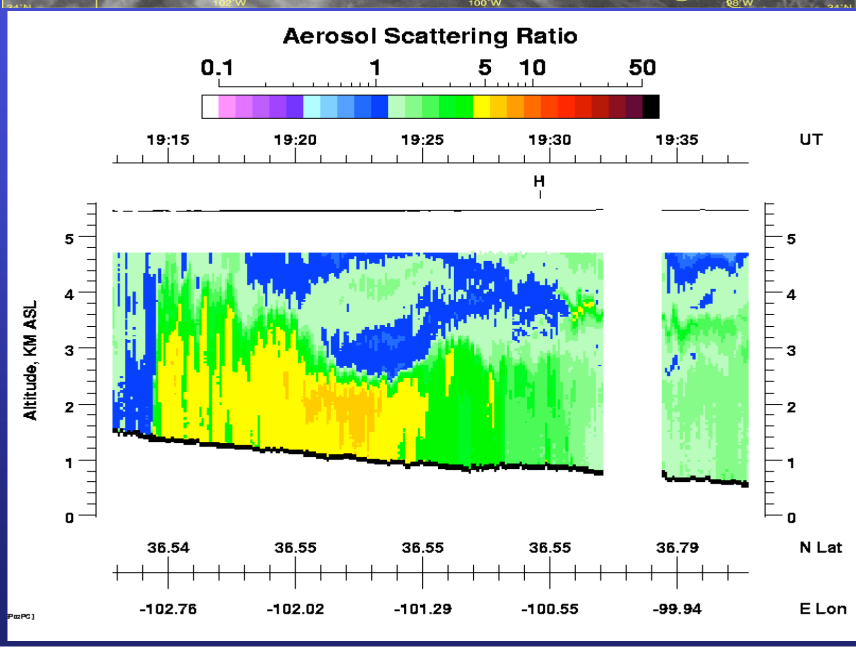


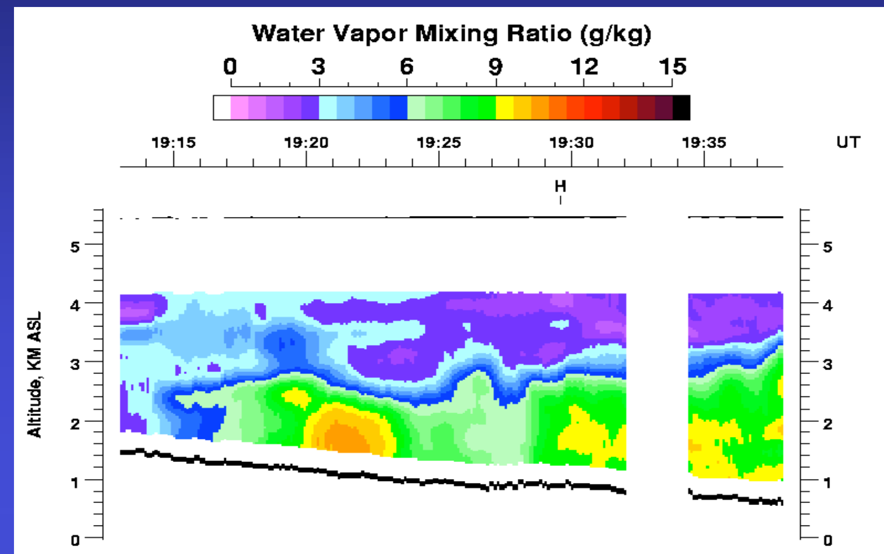


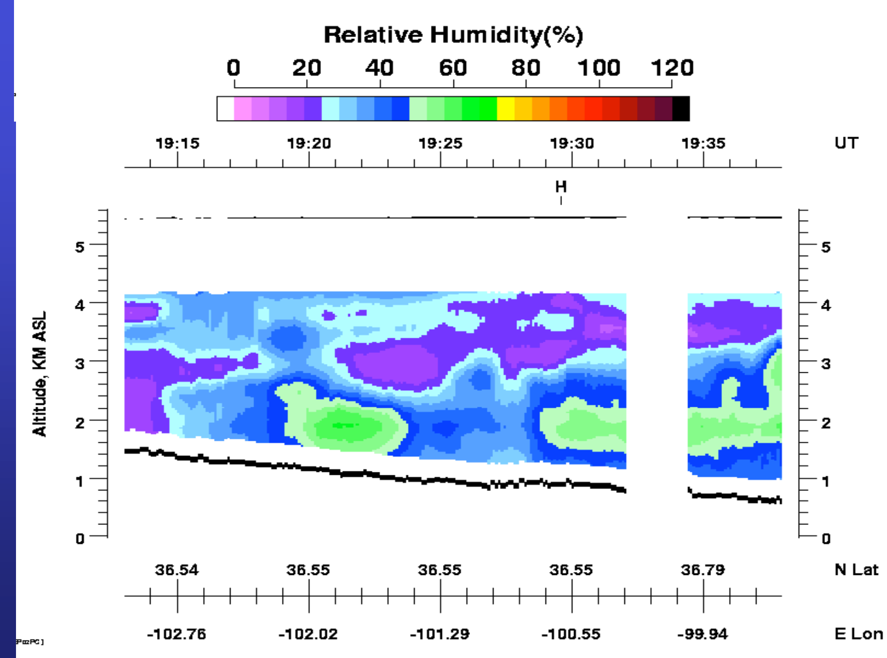


June 3, 2002 DC-8 Flight 8 CI #2

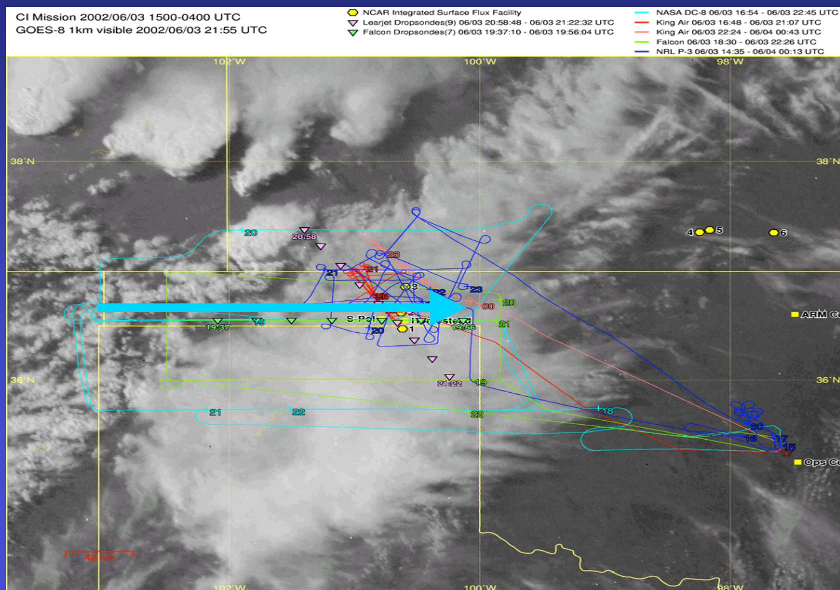


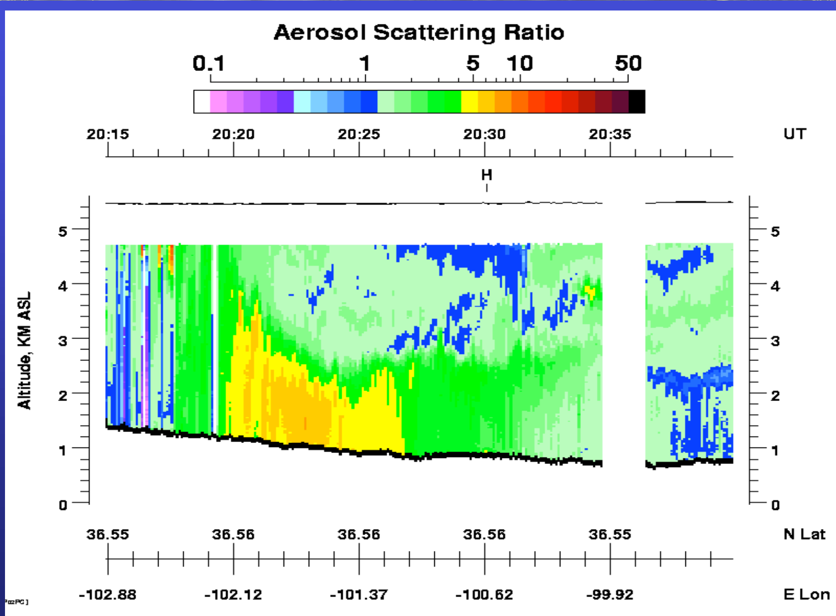


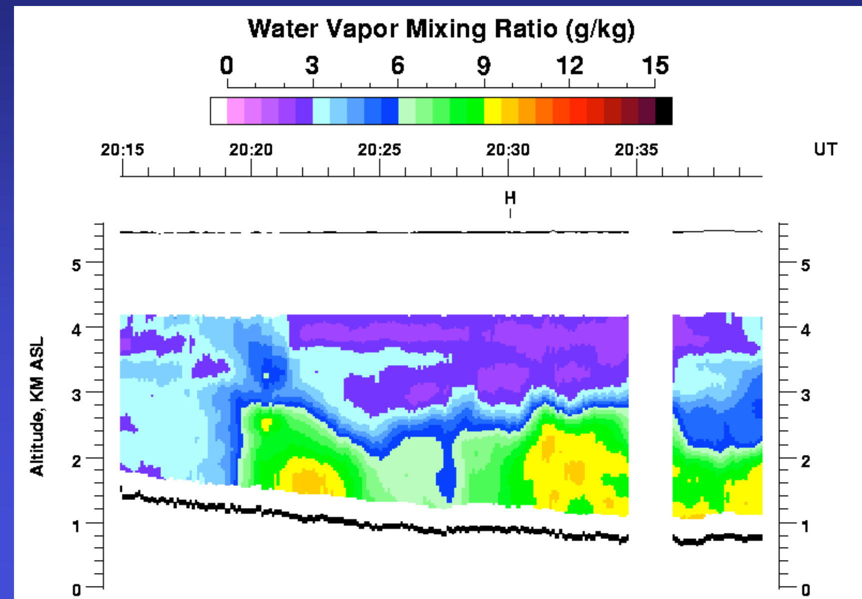


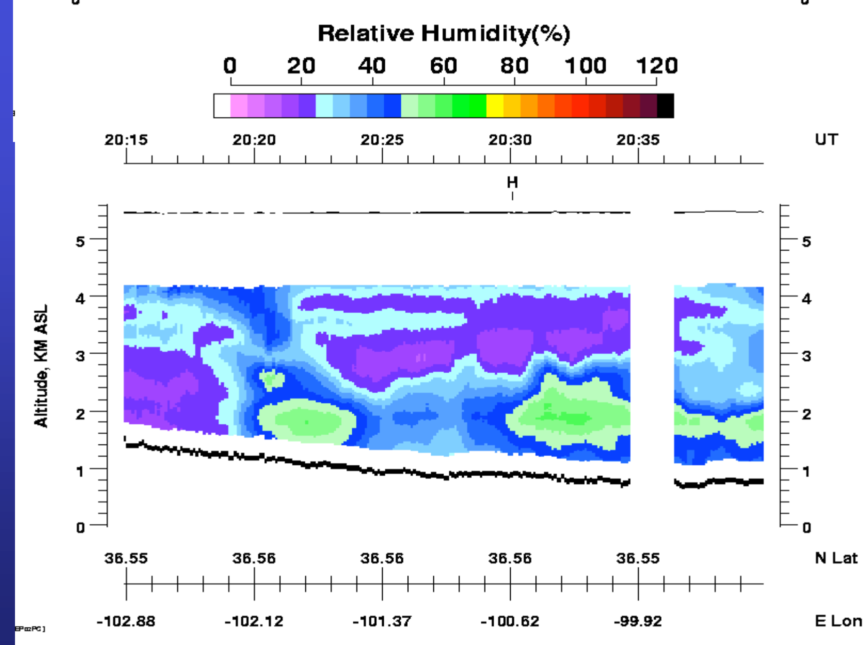


June 3, 2002 DC-8 Flight 8 CI #2

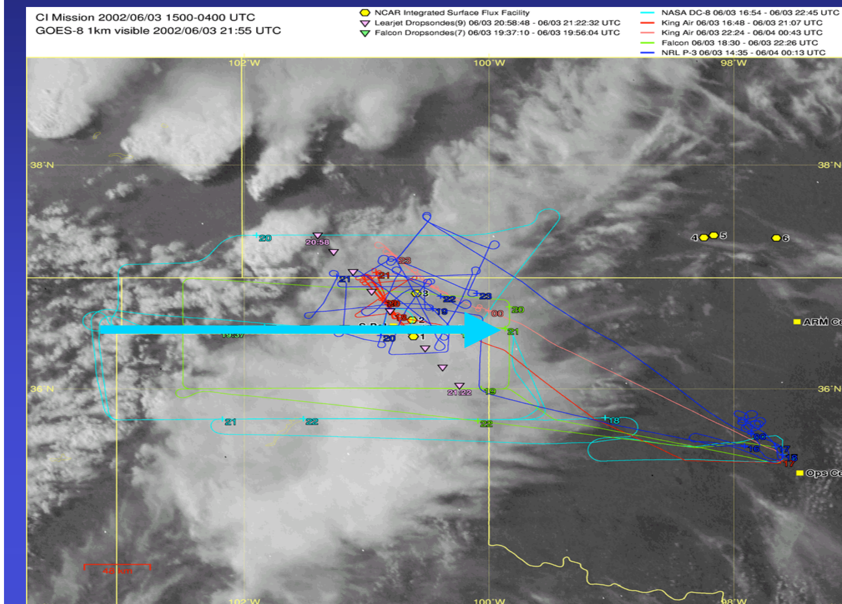


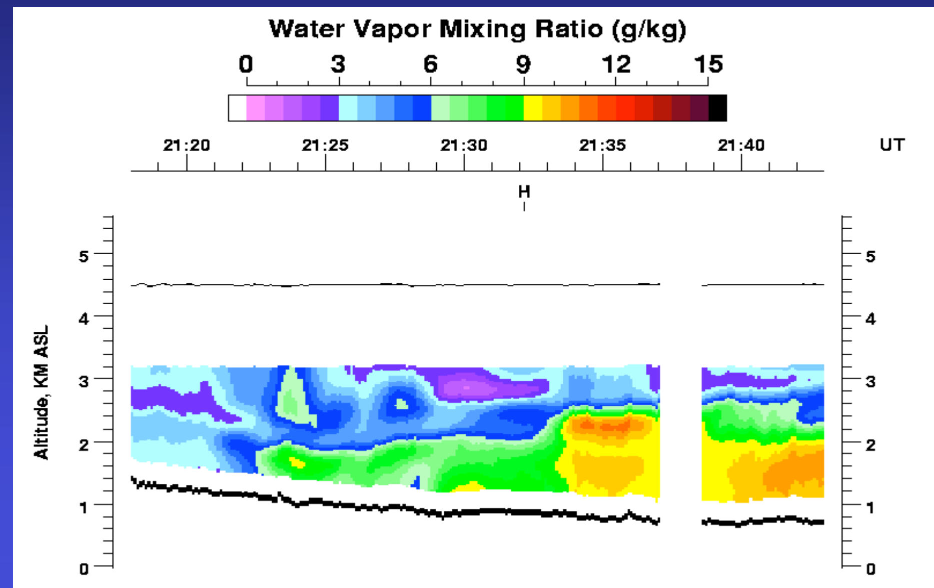


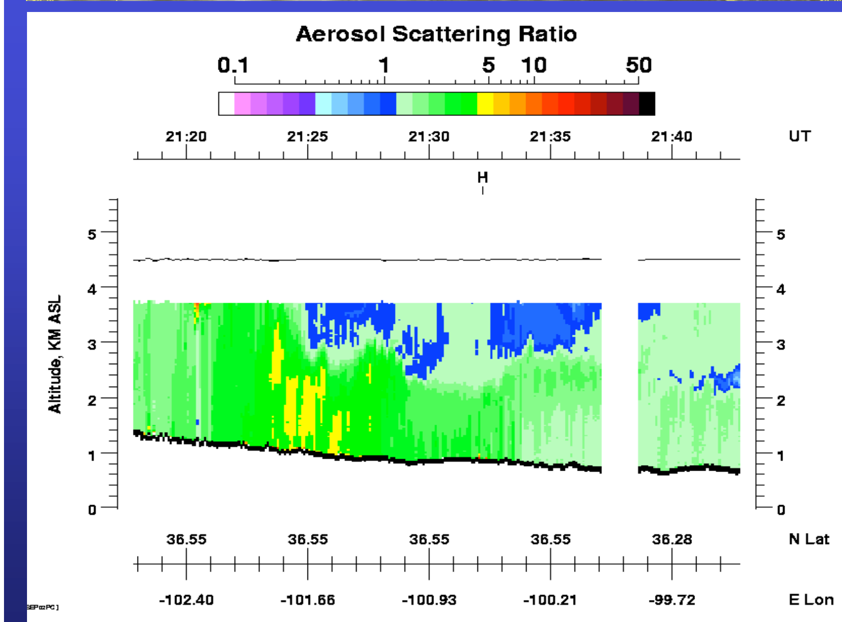


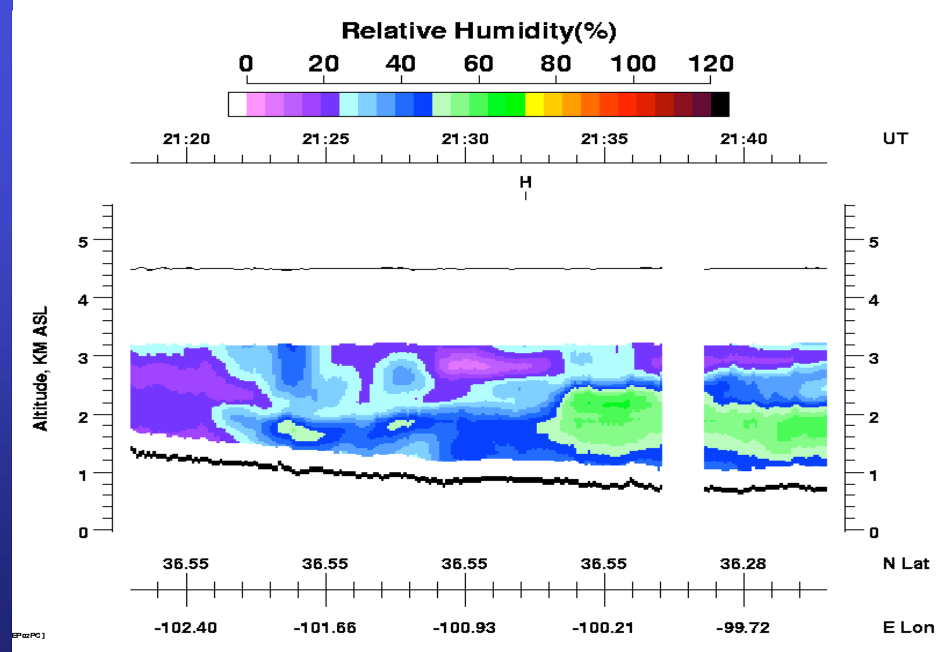


June 3, 2002 DC-8 Flight 8 CI #2

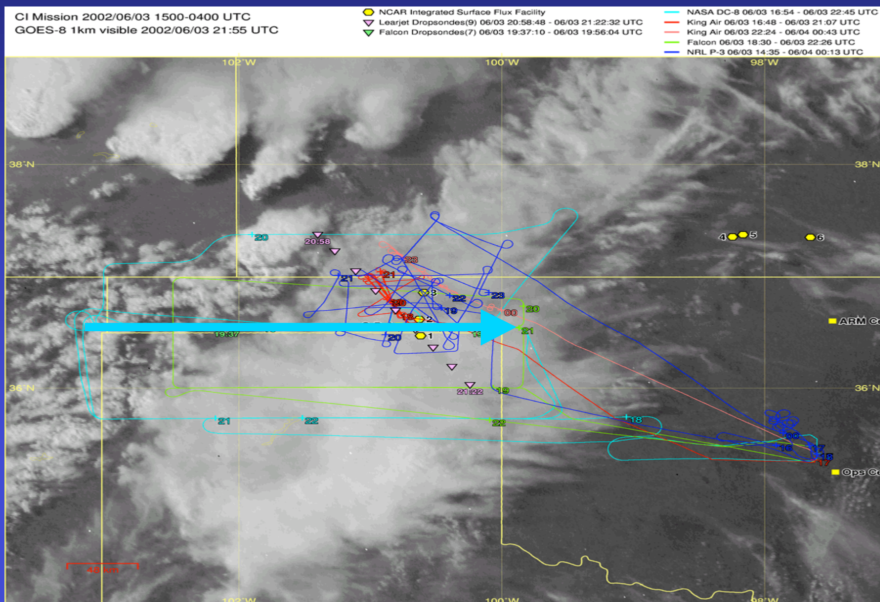


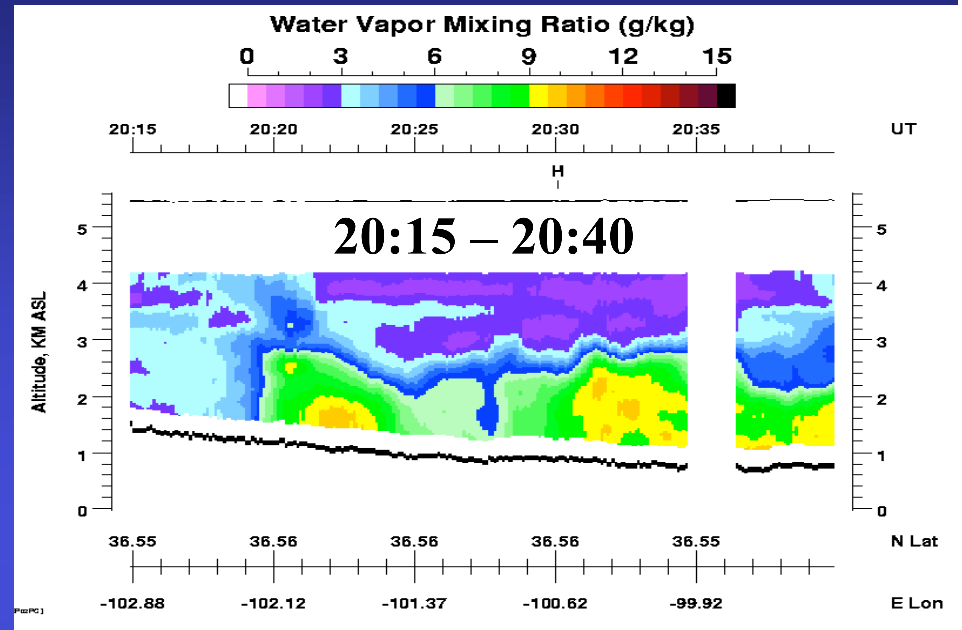


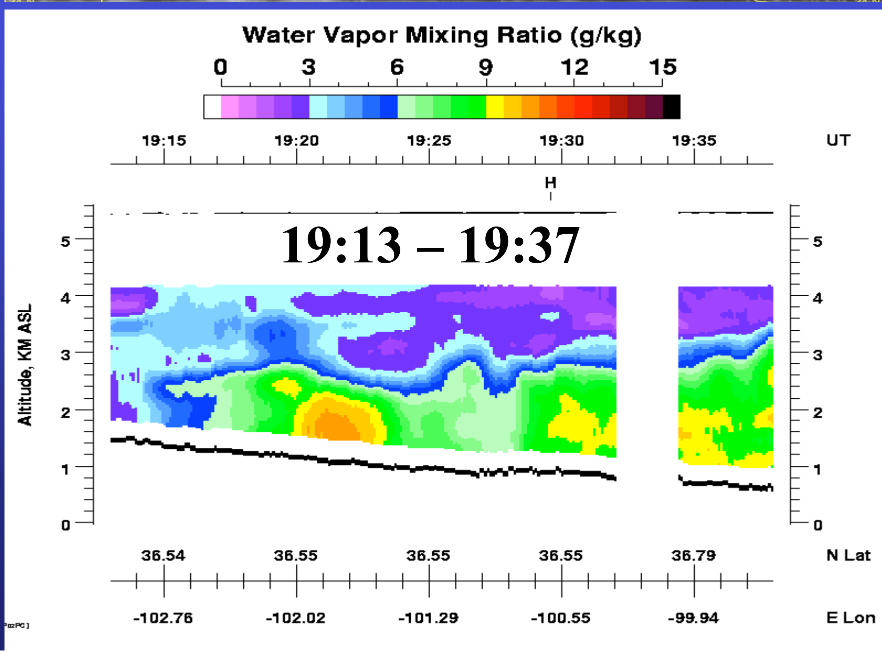


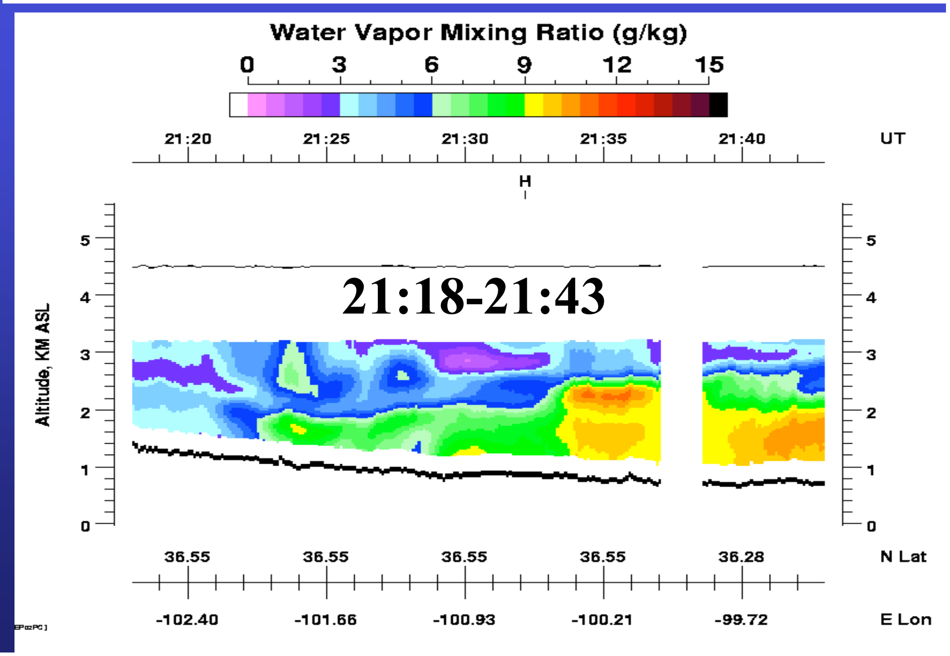


June 3, 2002 DC-8 Flight 8 CI #2



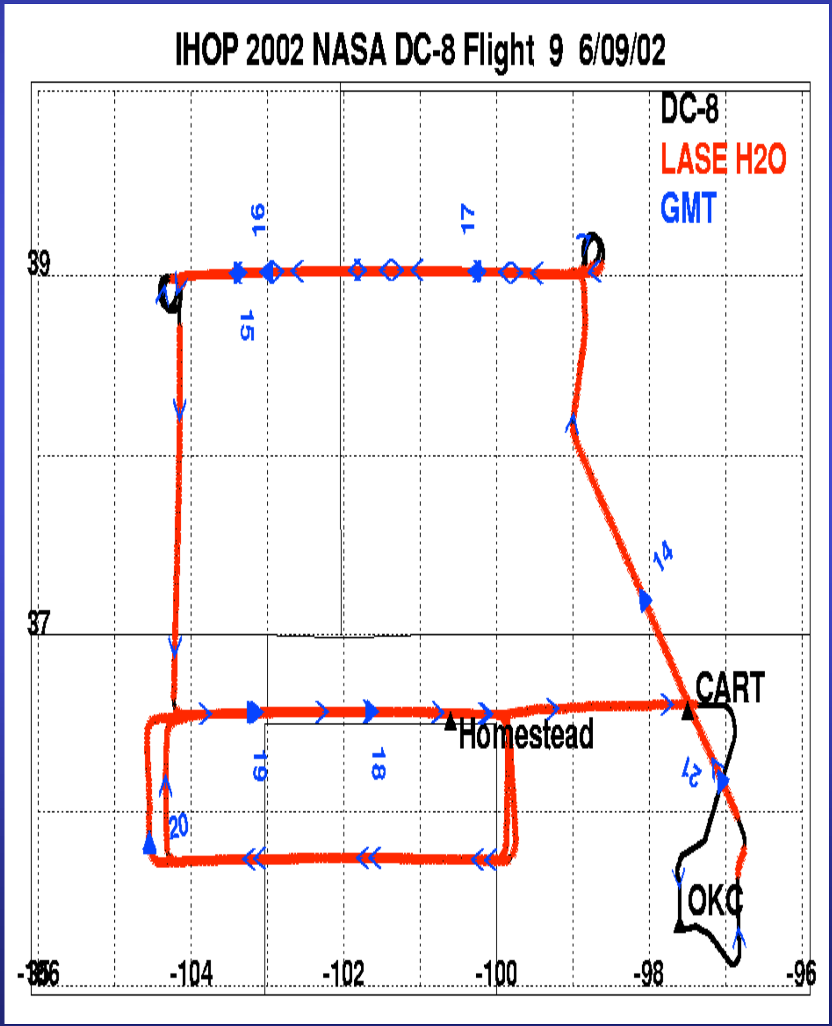


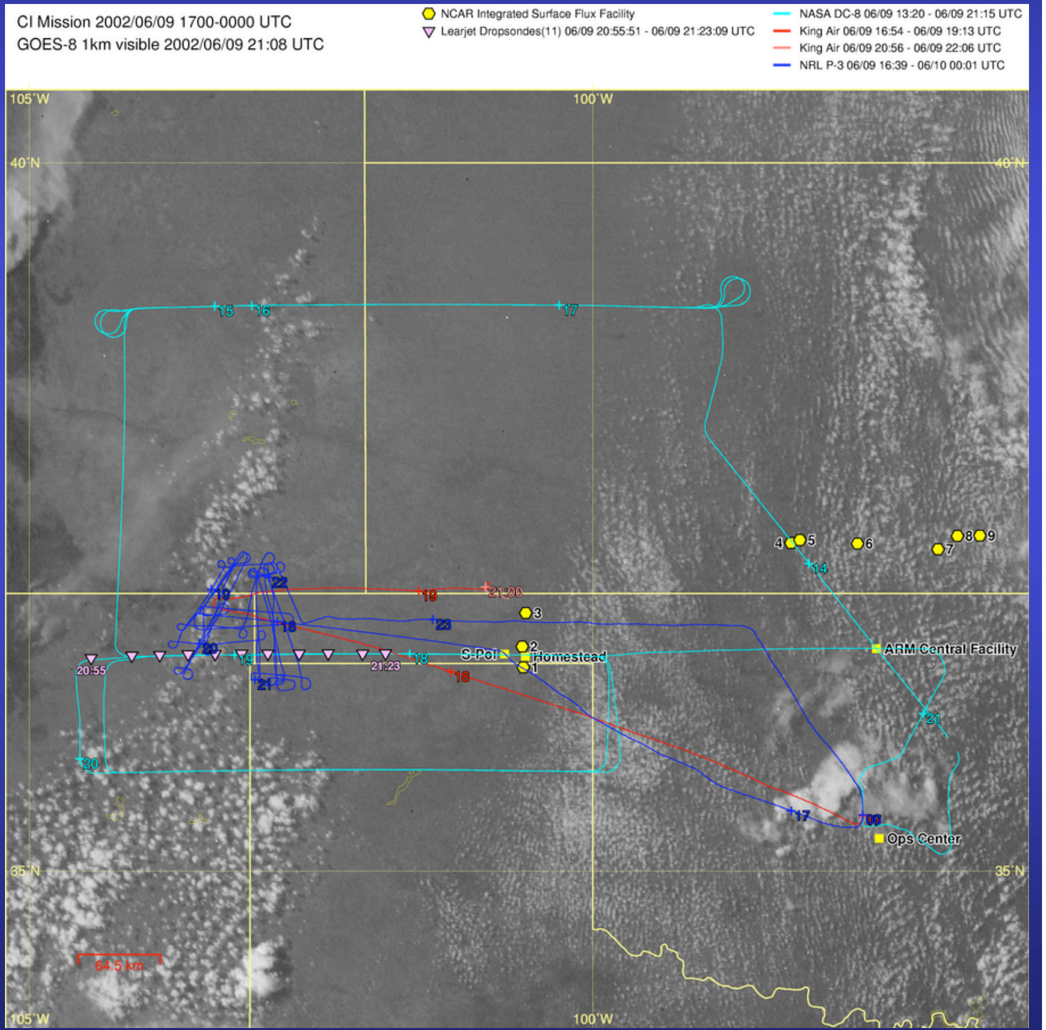




June 9, 2002 DC-8 Flight 9 Morning LLJ and CI #3

Flight Track

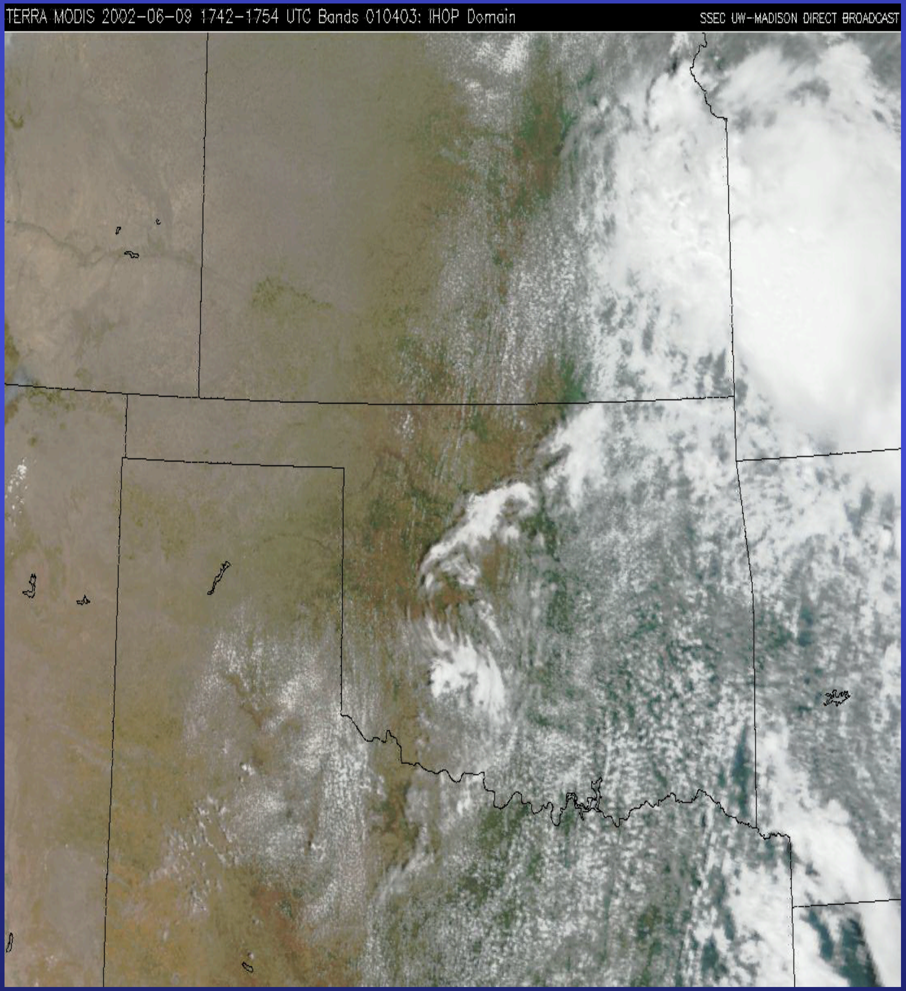




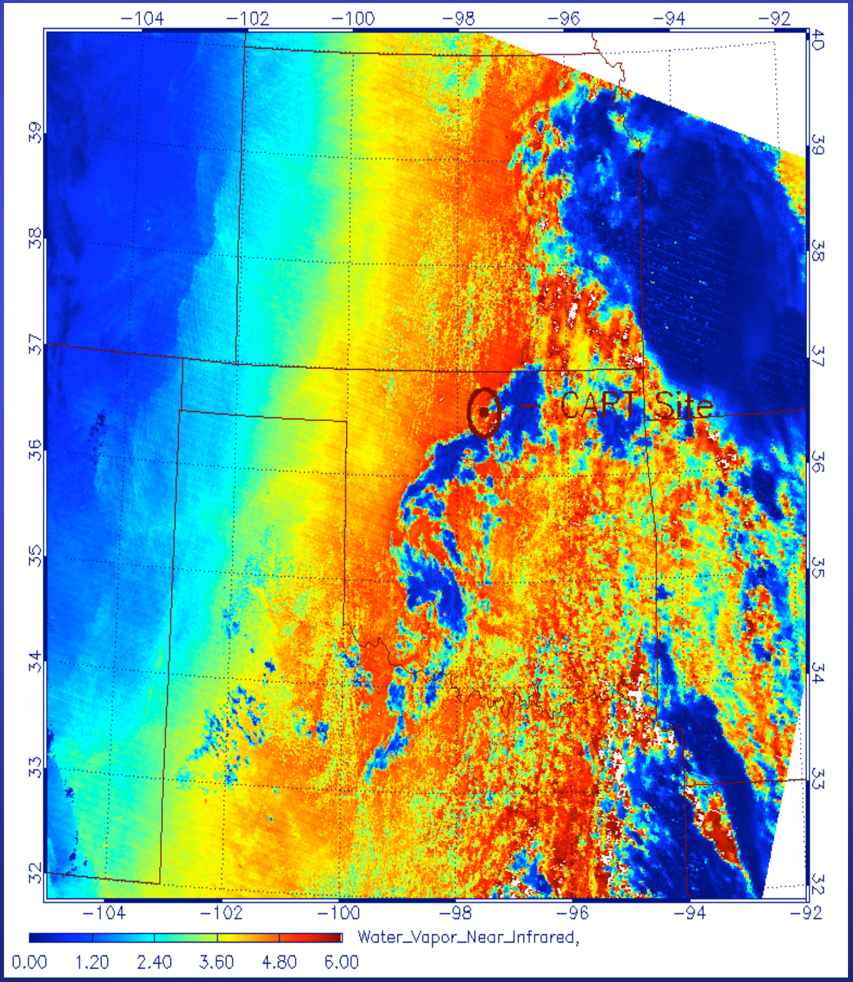
June 9, 2002 DC-8 Flight 9 Morning LLJ and CI #3

Terra MODIS 17:45 UT

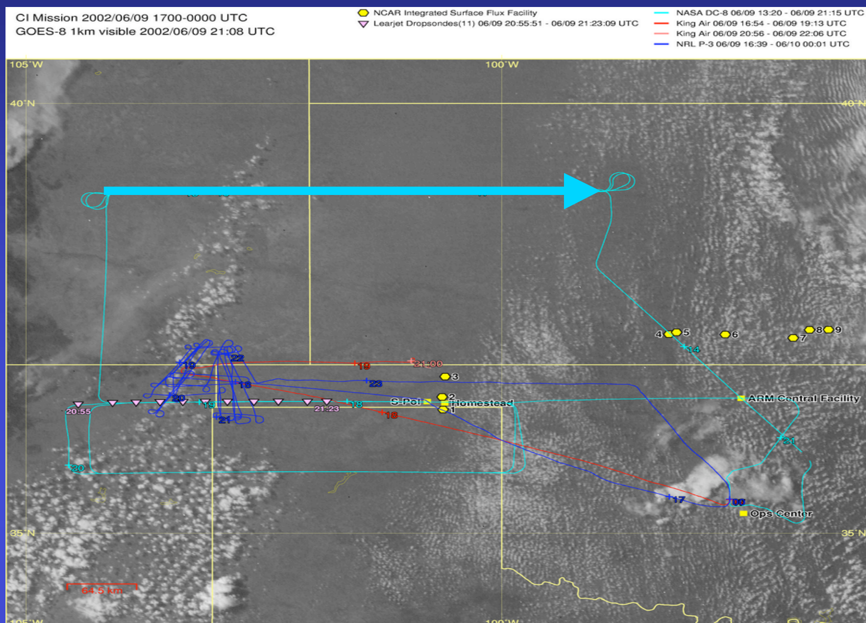
Visible

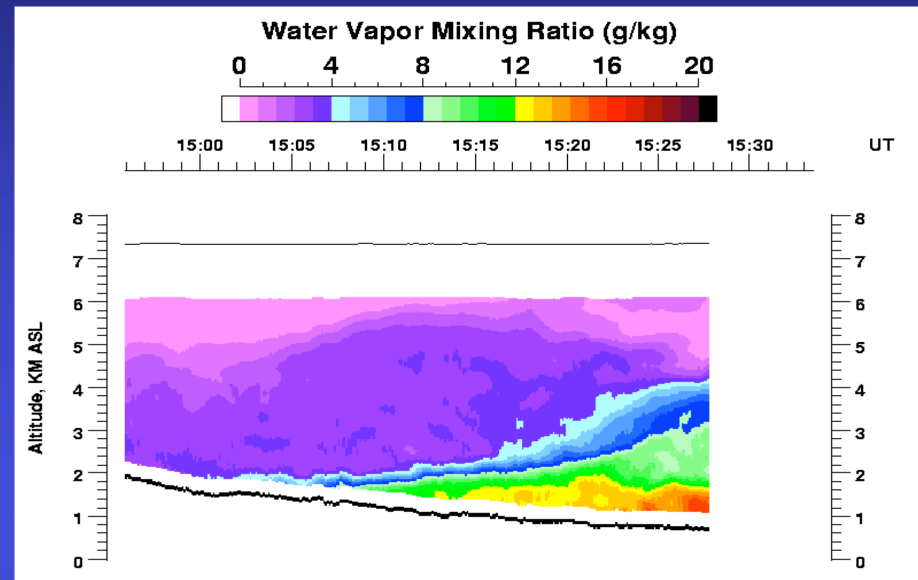


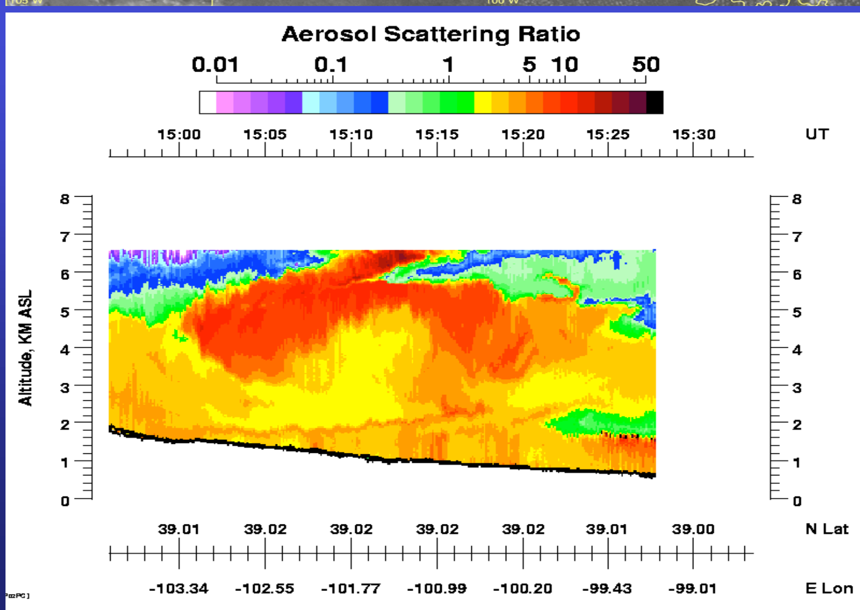
PWV

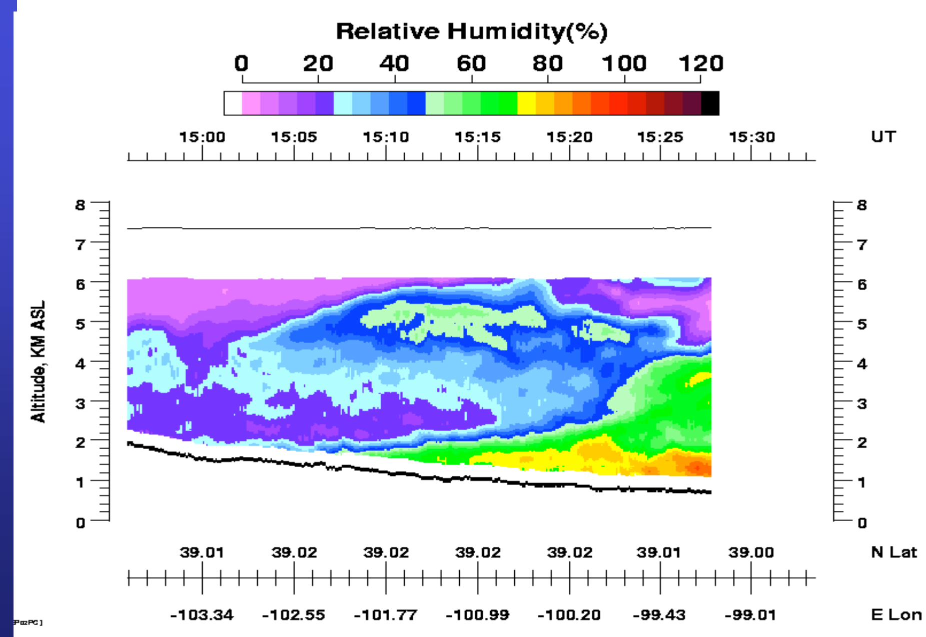


June 9, 2002 DC-8 Flight 9 Morning LLJ and CI #3

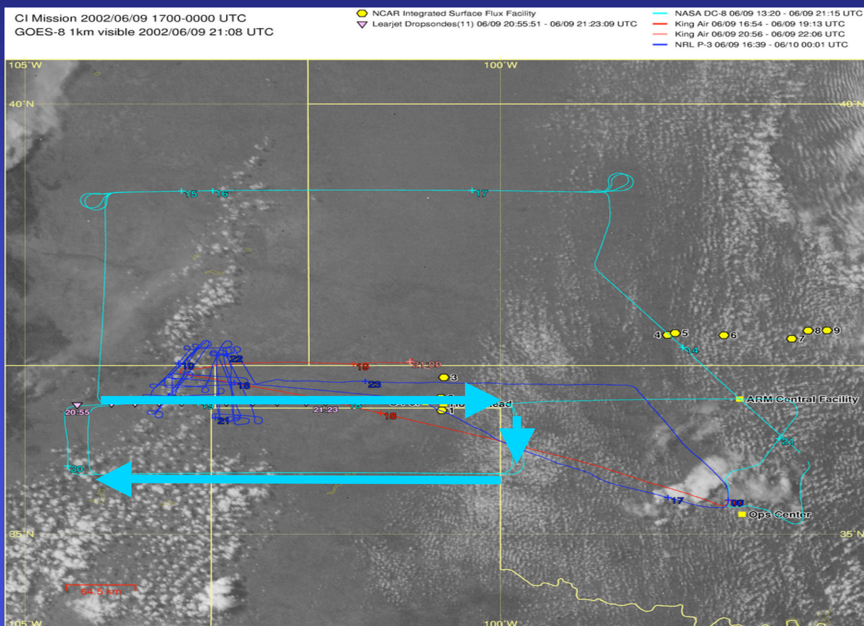


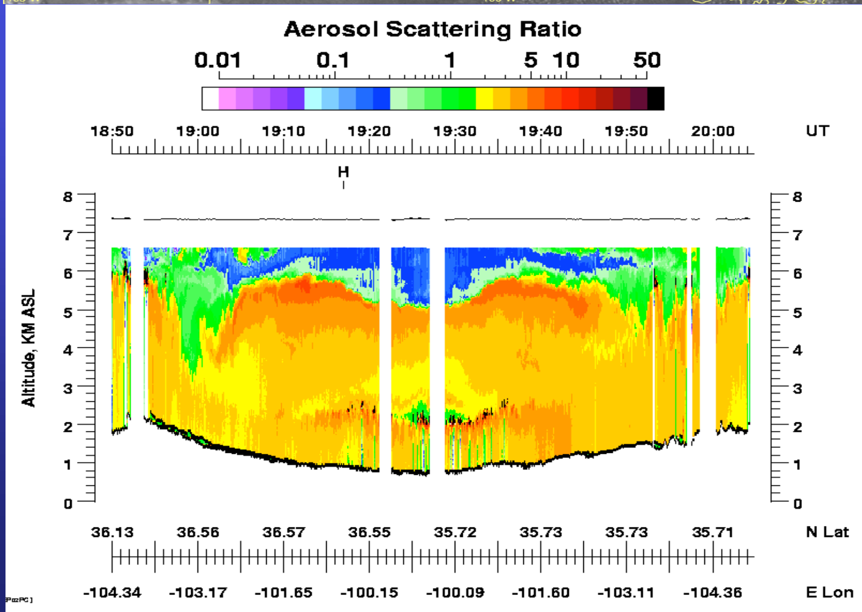


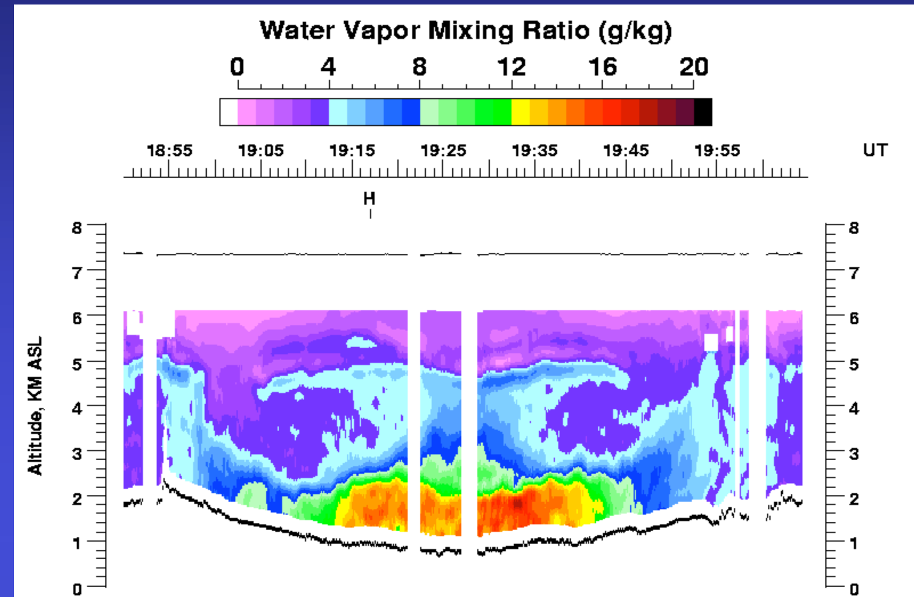


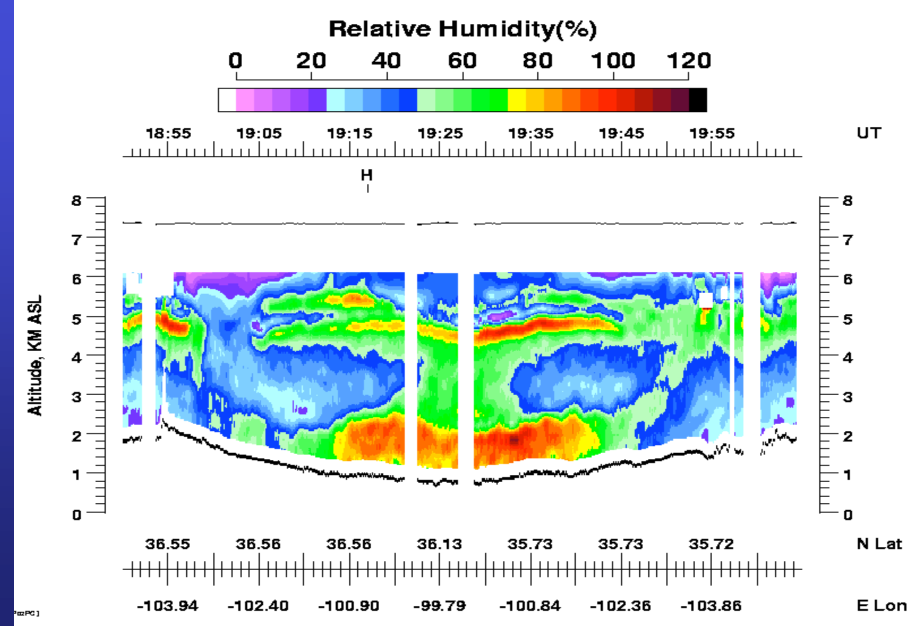


June 9, 2002 DC-8 Flight 9 Morning LLJ and CI #3









LASE Investigations during IHOP: Status and Future Activities

- Produced preliminary "real-time" images of water vapor and relative backscatter
  - available via IHOP or LaRC web pages (http://asd-www.larc.nasa.gov/lidar/ihop/ihop.html) (call for password)
  - digital version of "real-time" data also available
- Currently reprocessing all data
  - nadir water vapor and aerosol scattering ratio data currently underway
  - producing preliminary, crude RH using radiosonde temperature profiles
  - zenith water vapor and aerosol scattering ratio data to follow
  - initial images and digital data available on request prior to archival
- Archival of nadir water vapor & aerosol scattering ratio data by January 1, 2003
- Potential "research type" products and activities
  - Relative Humidity (RH) using LASE water vapor and temperature from Scanning HIS, NAST-I, AERI, and/or high resolution model
  - Precipitable Water Vapor (PWV)
  - Cirrus cloud optical and geometrical thickness
  - Aerosol extinction, Aerosol Optical Thickness (AOT)
  - Others identified at this meeting??