



# **LASE measurements of water vapor, aerosol, and cloud distributions during GRIP**

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and the Science Team**

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**Acknowledge: Drs. Krishnamurti, McFarquhar, Halverson, Braun, Zipser  
Data from dropsondes, radiosondes, and MMS were used in the analysis.**

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# Outline

- Archival of LASE Data
- Advanced/Research Products
- Comparison with satellite retrievals
- Observations over Hurricane Earl
  - Development of the 'eye' on Aug. 30, 2010
  - Water vapor and temperature distributions within the eye and surrounding regions
- Additional analysis

# LASE System and Data Products

- **System Features:**

- DIAL system operating in the 817nm band of H<sub>2</sub>O
- Uses a Ti:sapphire laser (100 mJ at 5 Hz double pulsed)
- 3 line pairs are used to capture the full dynamic range of water vapor in the troposphere

- **Data Products (Archived) :**

- **Water vapor mixing ratio profiles**

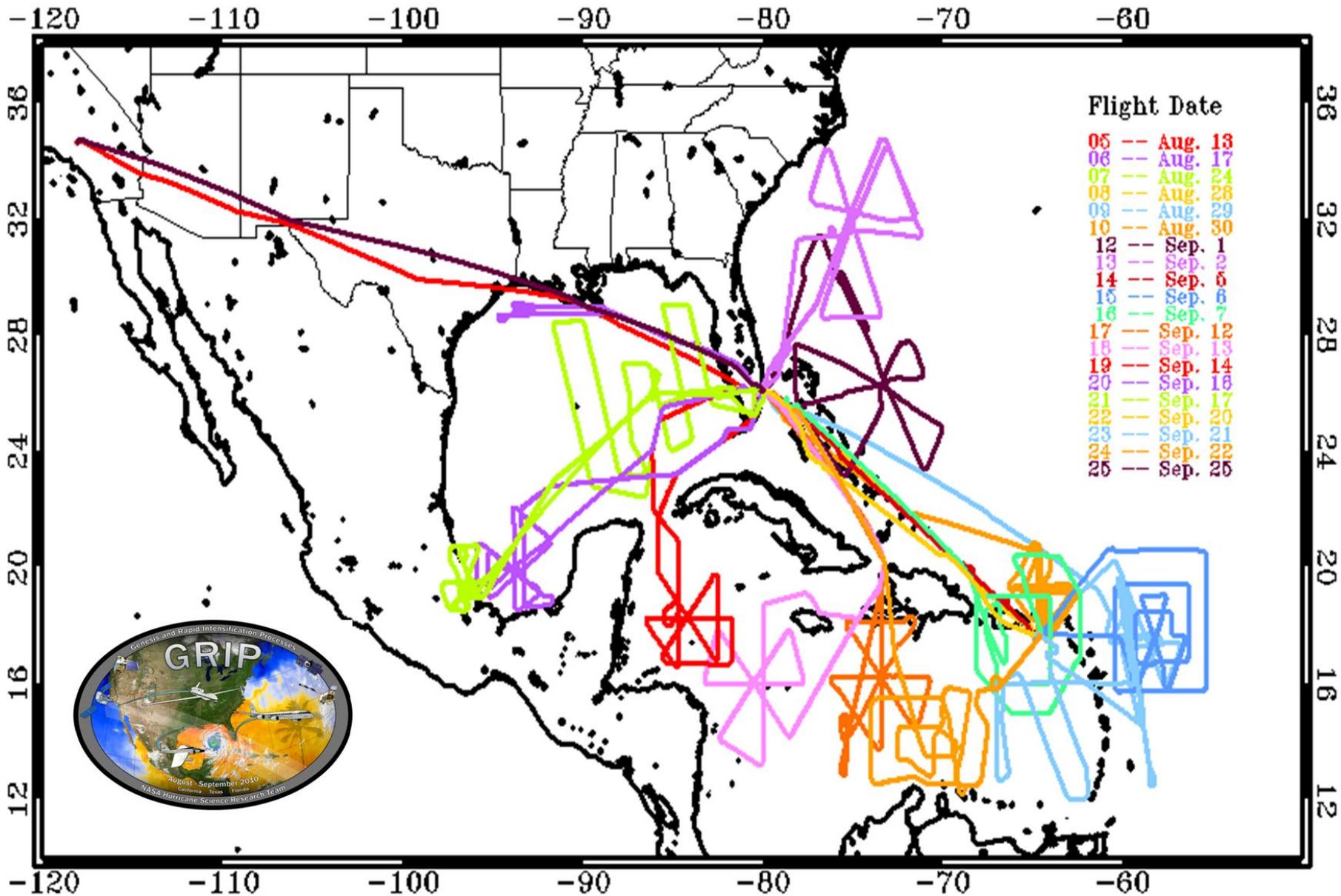
- surface to upper troposphere
- 0.01 to 25 g/kg
- accuracy: 6% or 0.01 g/kg
- resolution (variable)
  - vertical: 330 m nadir, 990 m zenith
  - horizontal: 42 to 70 km (3 - 5 min)

- **Aerosol/cloud profiles**

- daytime and nighttime
- 0.03 to 25 km
- resolution (nominal)
  - vertical: 30 m
  - horizontal: 2.1 km

# LASE DC-8 Composite Flight Tracks

## GRIP: August 13 - September 25



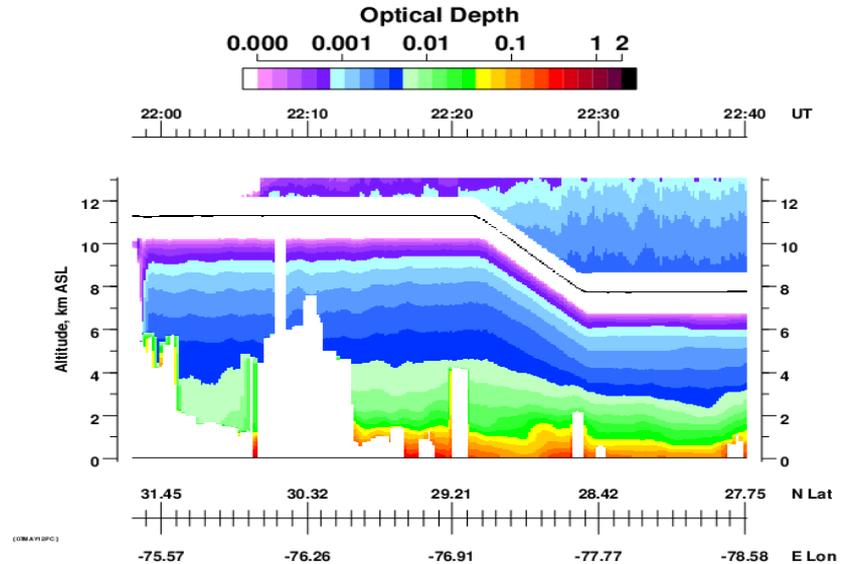
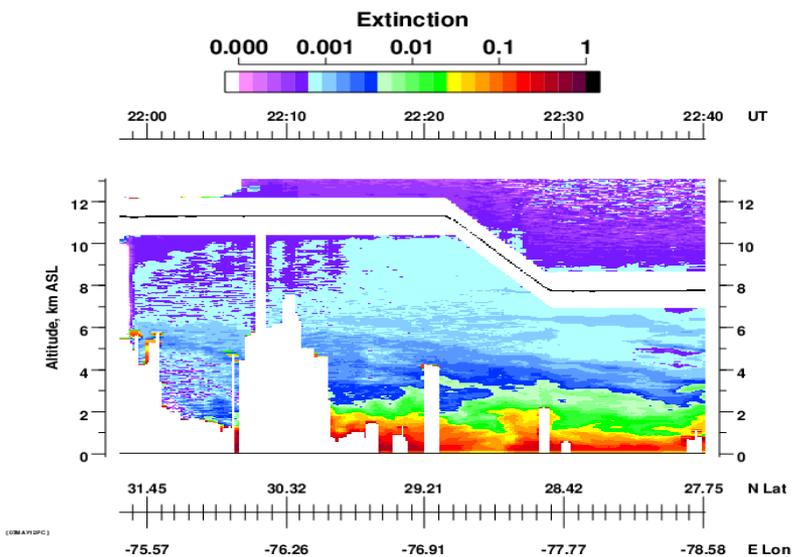
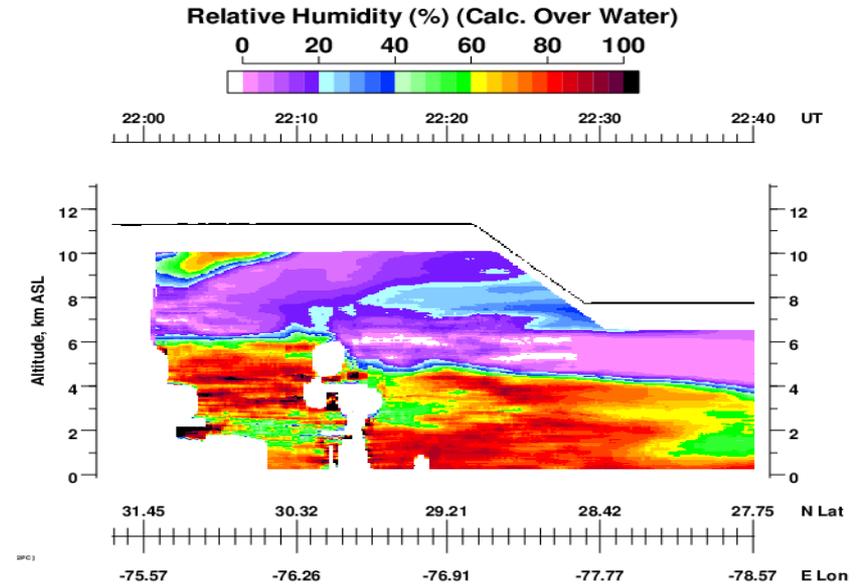
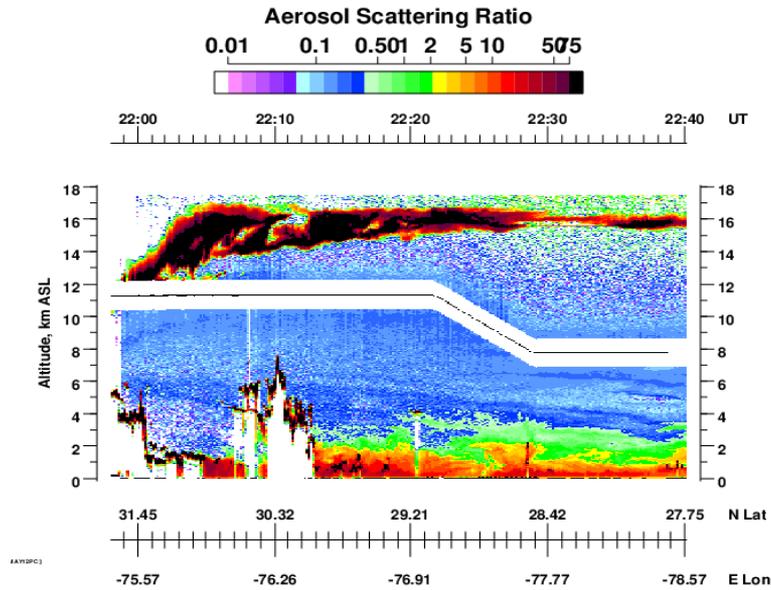
Flight # / Date		Objective	LASE Observations
5	8/13/10	Transit	TD-5 cirrus outflow; increased moisture and aerosols over the Gulf
6	8/17/10	System Tests	AQUA underpass 18:41 UT
7	8/24/10	Frontal Survey	AIRS underpass 19:00 UT; TRIMM overpass
8	8/28/10	Transit to STX	After 15:46 LASE has zenith only
9	8/29/10	Hurricane Earl	SAL below at 16:43; eye not well defined; 22:22 descent into SAL
10	8/30/10	Hurricane Earl	Evolution of eye during rapid intensification; 6 eye crossings; LASE measurements extend down close to surface in the eye
11	8/30/10	Transit to FLL	LASE did not operate
12	9/01/10	Hurricane Earl	Dry air to NW, W, and SW of storm; very moist in and near eye, and SE; Descent into SAL at end (~ 18:30)
13	9/02/10	Hurricane Earl	LASE measures water vapor and aerosols in the eye, water clouds in eye wall, cirrus outflow above the storm; global hawk above
14	9/05/10	Transit to STX	20:00 in situ sampling of SAL
15	9/06/10	Gaston	TS Remnants – intensification questionable
16	9/07/10	Gaston, to FLL	TS Remnants (LASE seeding problems)
17	9/12/10	PGI-44 (Karl)	Not a TD or TS in clouds
18	9/13/10	PGI-44 (Karl)	In clouds, Dry air mass observed near end of flight
19	9/14/10	PGI-44 (Karl)	In clouds
20	9/16/10	PGI-44 (Karl)	In clouds
21	9/17/10	PGI-44 (Karl)	Eye makes landfall over
22	9/20/10	Transit to STX	1 <sup>st</sup> hour is low leg for in situ aerosol
23	9/21/10	PGI-46/CALIPSO/CLOUDSAT	LARGE see Dust on runway before takeoff; Initial low leg for LARGE in Dust; LASE and CALIPSO qualitative agreement of aerosol features; Descent into SAL
24	9/22/10	PGI-46/CALIPSO/CLOUDSAT	Overpass at 18:14:20, 18:14:35 UT; 17:40:40 GV coincidence; dust and dry S of Haiti
25	9/25/10	Transit to Palmdale	A zenith test segment with all energy up

# Advanced\* data products

- RH derived from LASE mixing ratio and dropsonde/radiosondes
- Total Precipitable Water (TPW)
- Aerosol extinction and scattering coefficient profiles, and aerosol optical depth.

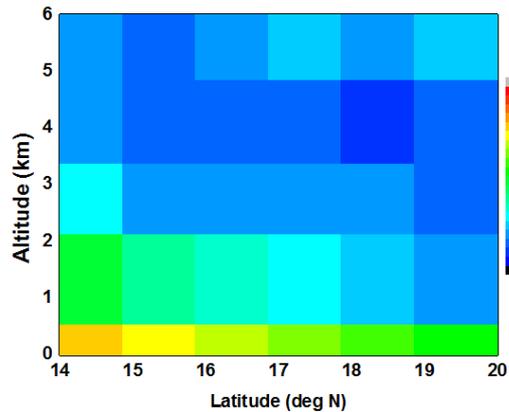
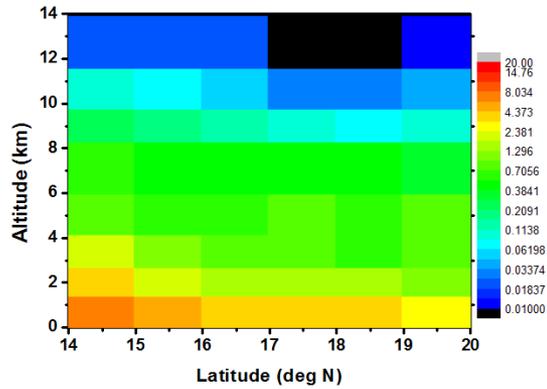
\*Retrieved on a case by case basis on request

# Retrievals of RH, Aerosol Extinction Profiles and Optical Depth Hurricane Earl Flt #4, Sept. 2, 2010

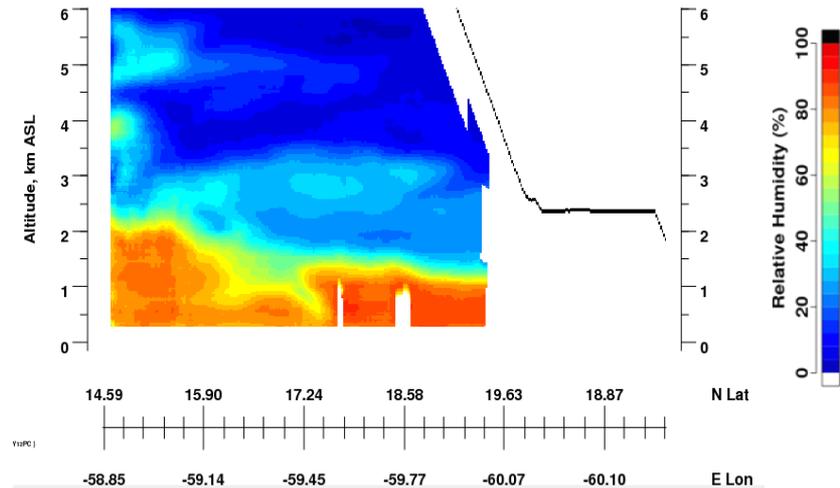
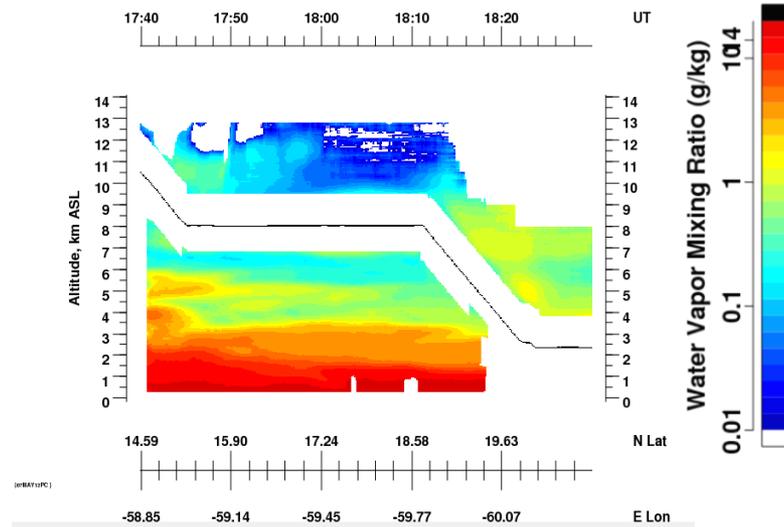


# Comparison of LASE and AIRS water vapor and RH retrievals September 21, 2010

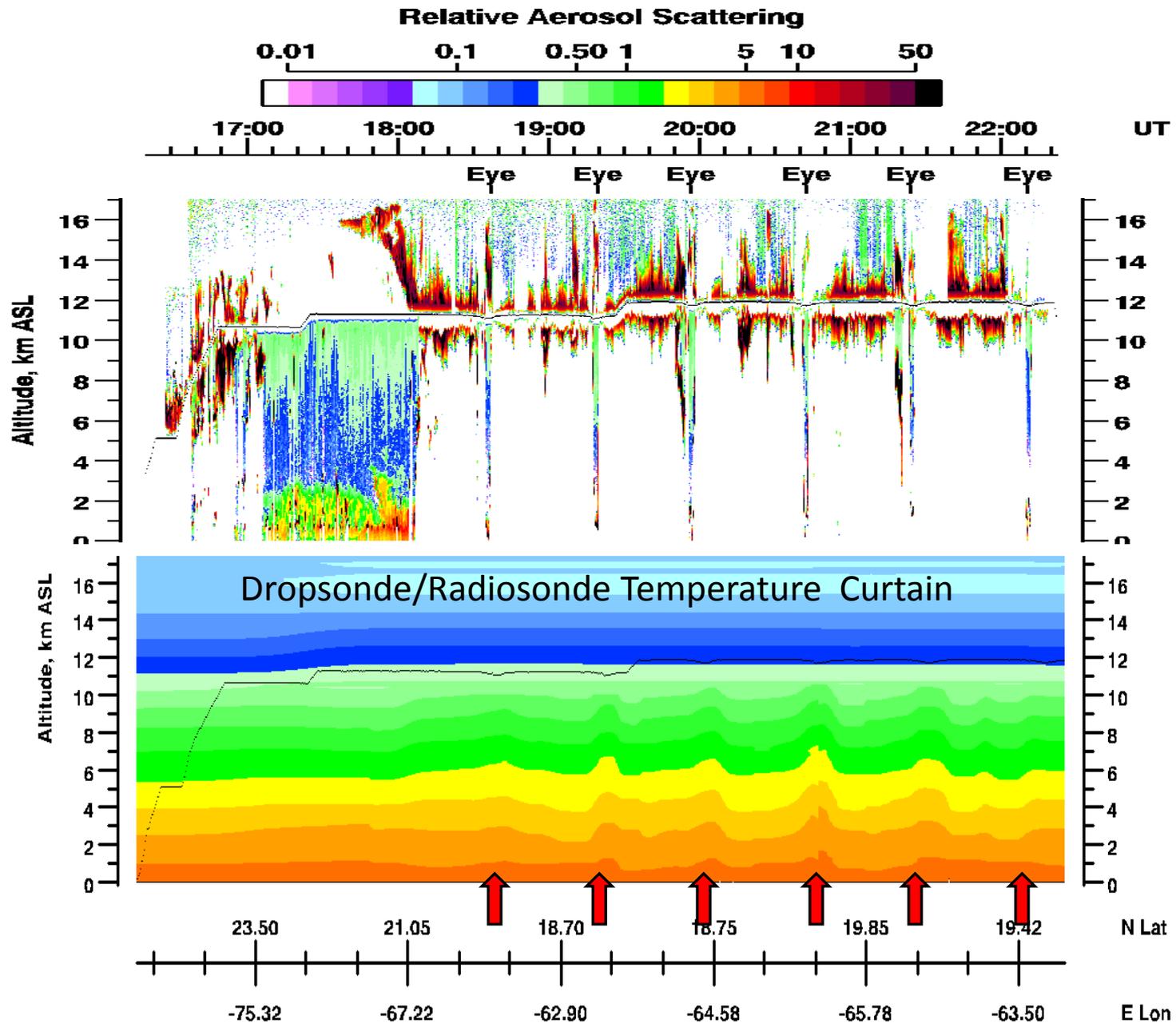
## AIRS



## LASE



# Evolution of the eye of Hurricane Earl on Aug 30, 2011

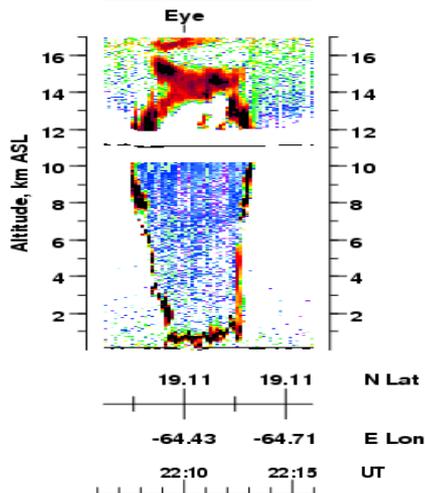


# Water vapor, aerosol, and cloud distributions in the 'eye'

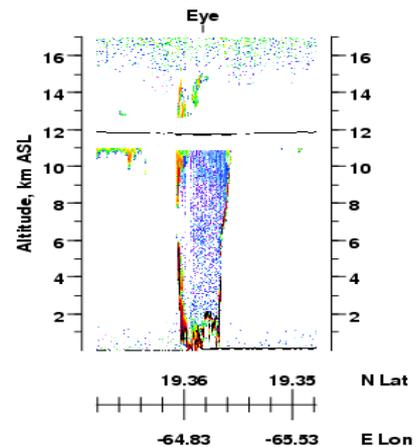
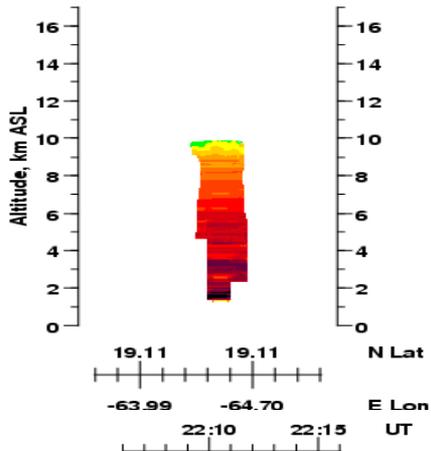
Aerosol Scattering Ratio  
0.01 0.1 1 5 10 50



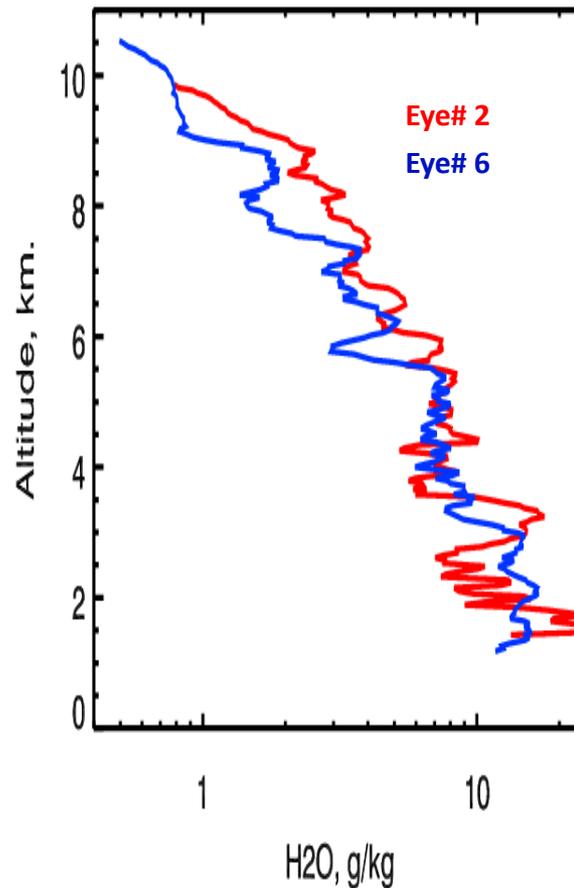
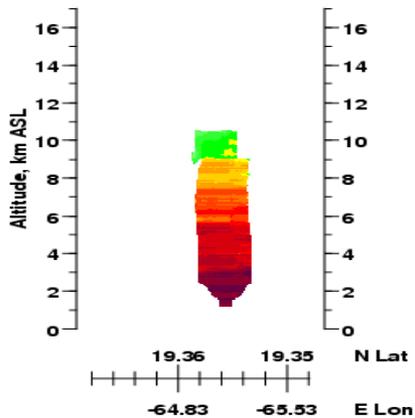
H<sub>2</sub>O (g/kg)  
0.01 0.1 1 5 10 20



Eye# 2

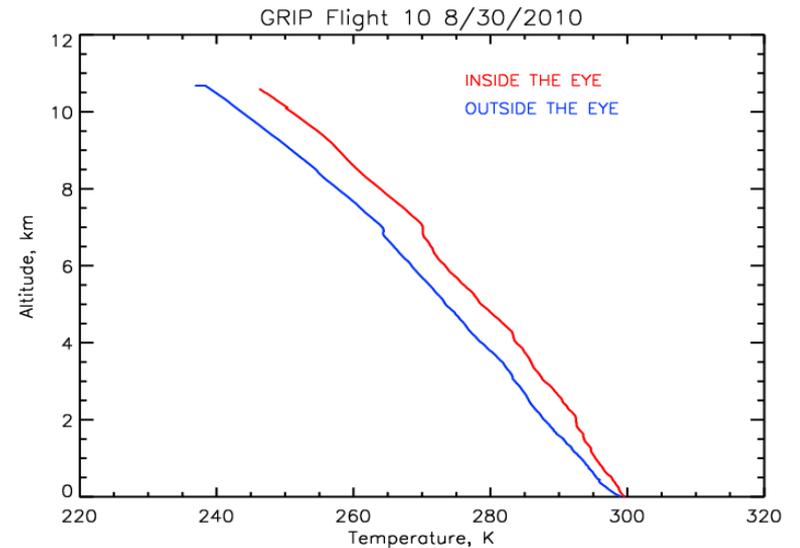
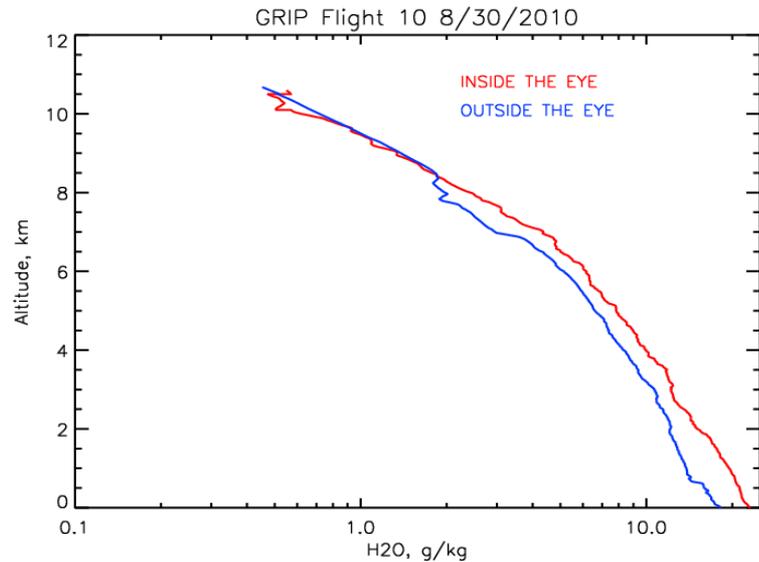
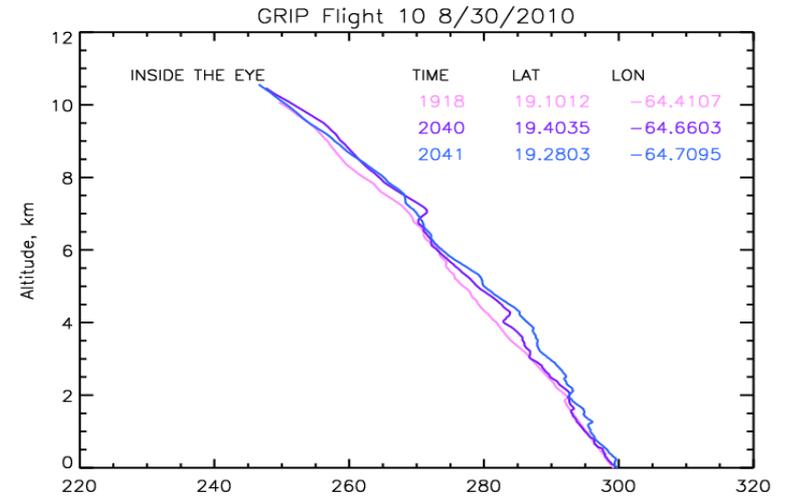
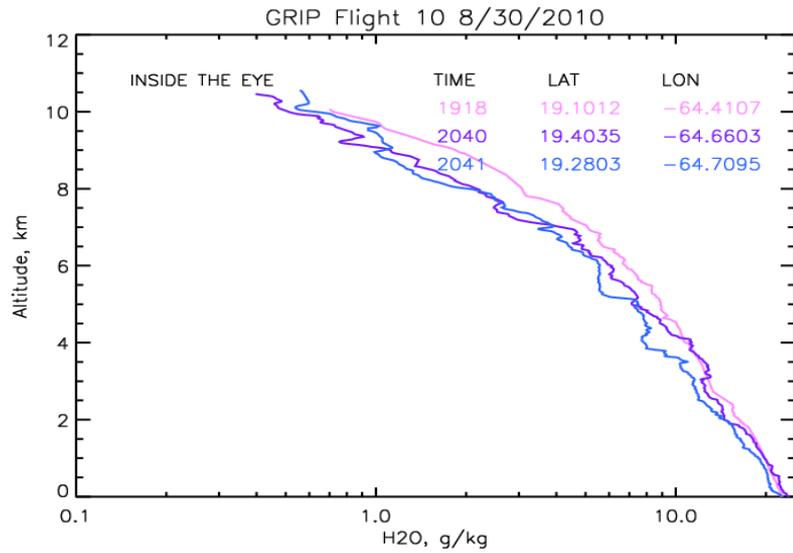


Eye# 6



# Dropsonde Temperature and water vapor Distributions Inside and Outside the 'Eye'

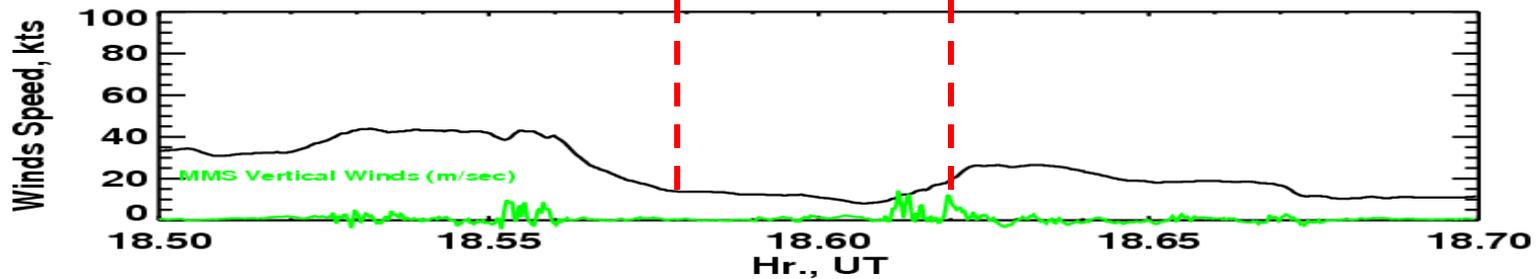
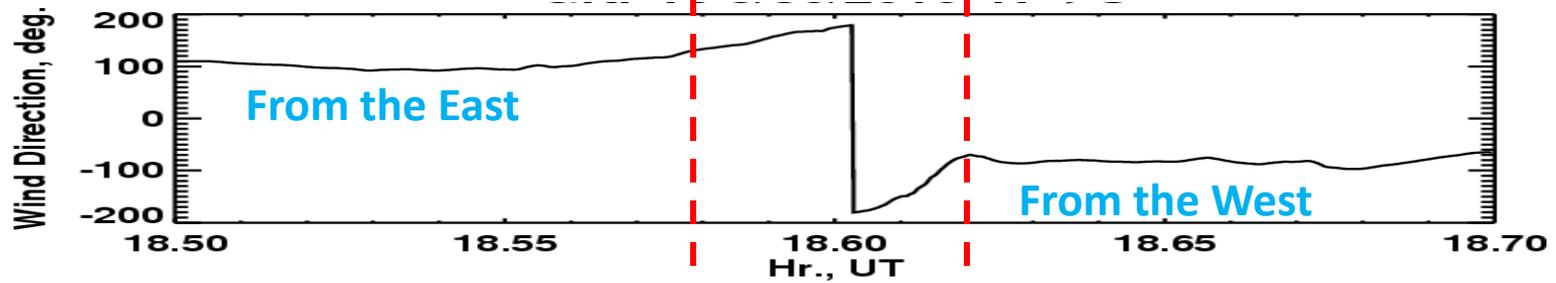
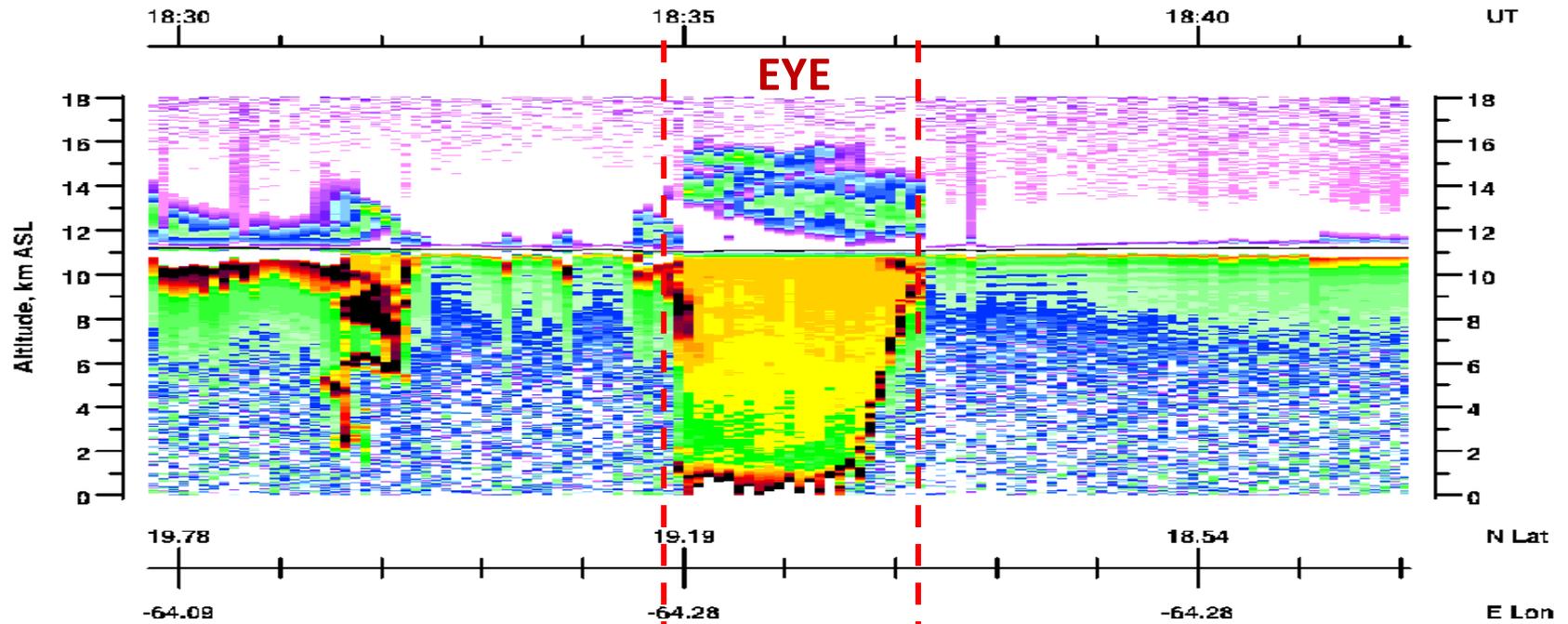
## September 30, 2010



# # 1 North → South

Relative Aerosol Scattering

0.01 0.1 0.50 1 2 5 10 5075





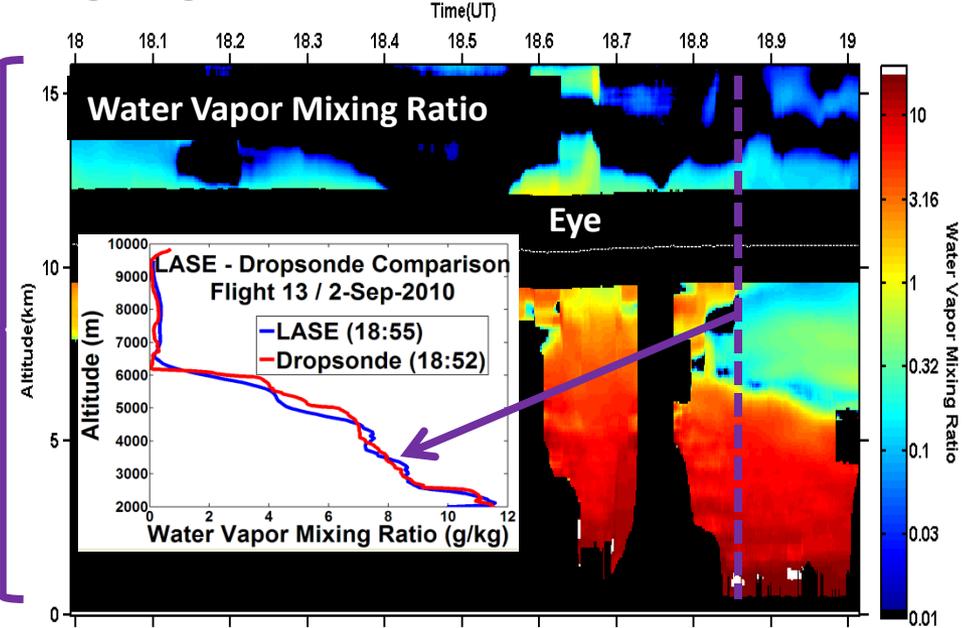
# NASA Langley LASE measurements over Hurricane Earl DC-8 GRIP Flight 13 - September 2, 2010



LASE measured water vapor, aerosol, and cloud distributions during flights over Hurricane Earl  
LASE and dropsonde measurements of water vapor just outside eyewall show good agreement



### Flight Segment across Earl between 18 – 19 UT



### Water Vapor Mixing Ratio

