



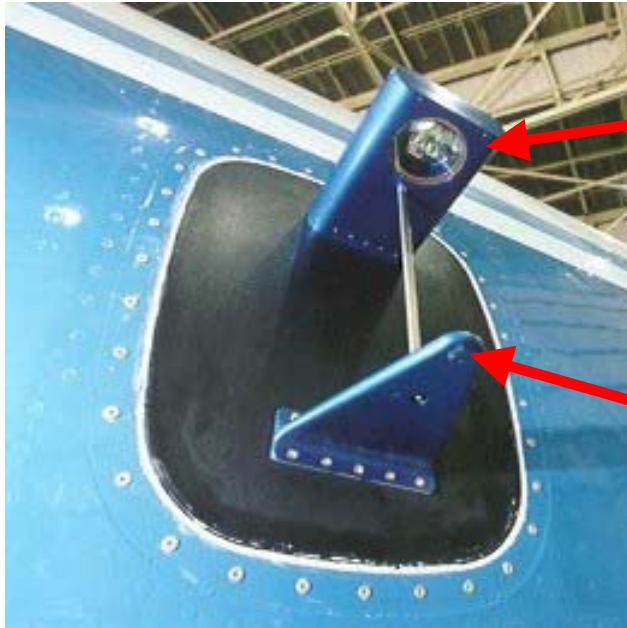
In Situ water vapor measurements from the NASA DC-8 aircraft for studies of convection

P.I. Robert L. Herman (Jet Propulsion Laboratory)
Co-I. Leonhard Pfister (NASA Ames Research Center)

CAMEX-4 Workshop
March 13, 2002



JPL Laser Hygrometer on the DC-8



Laser and detector

(50-cm total optical path
15.24 cm from the fuselage)

Mirror

Measurement: *in situ* water vapor (mixing ratio, dewpoint or frostpoint, etc.) measured from the NASA DC-8 aircraft, right fuselage station 490.

Technique: near-infrared (1.370 μm), tunable diode laser, wavelength-modulation absorption spectroscopy. Rapid measurements allow 0.8-Hz time resolution.

Configuration: to ensure measurements in “clean” air and avoid particle sampling issues, the optical cell is mounted outside the aircraft.



JPL Laser Hygrometer on the DC-8



Specifications:

- Detection range for water vapor:
24,000 to 10 ppmv (corresponds to a range of 20°C dewpoint on the ground to -75°C frostpoint at cruise altitude).
- Precision: 3% (1σ)
- Time-resolution: 1.3 sec (0.8 Hz)
- Mass: 9 lbs (not including window port)
- Power: 100 W (maximum)
- Voltage: 28 V DC

JLH Missions on the DC-8:

- CAMEX-3 (1998)
- SOLVE (1999-2000)
- CAMEX-4 (2001)





Overall research objectives



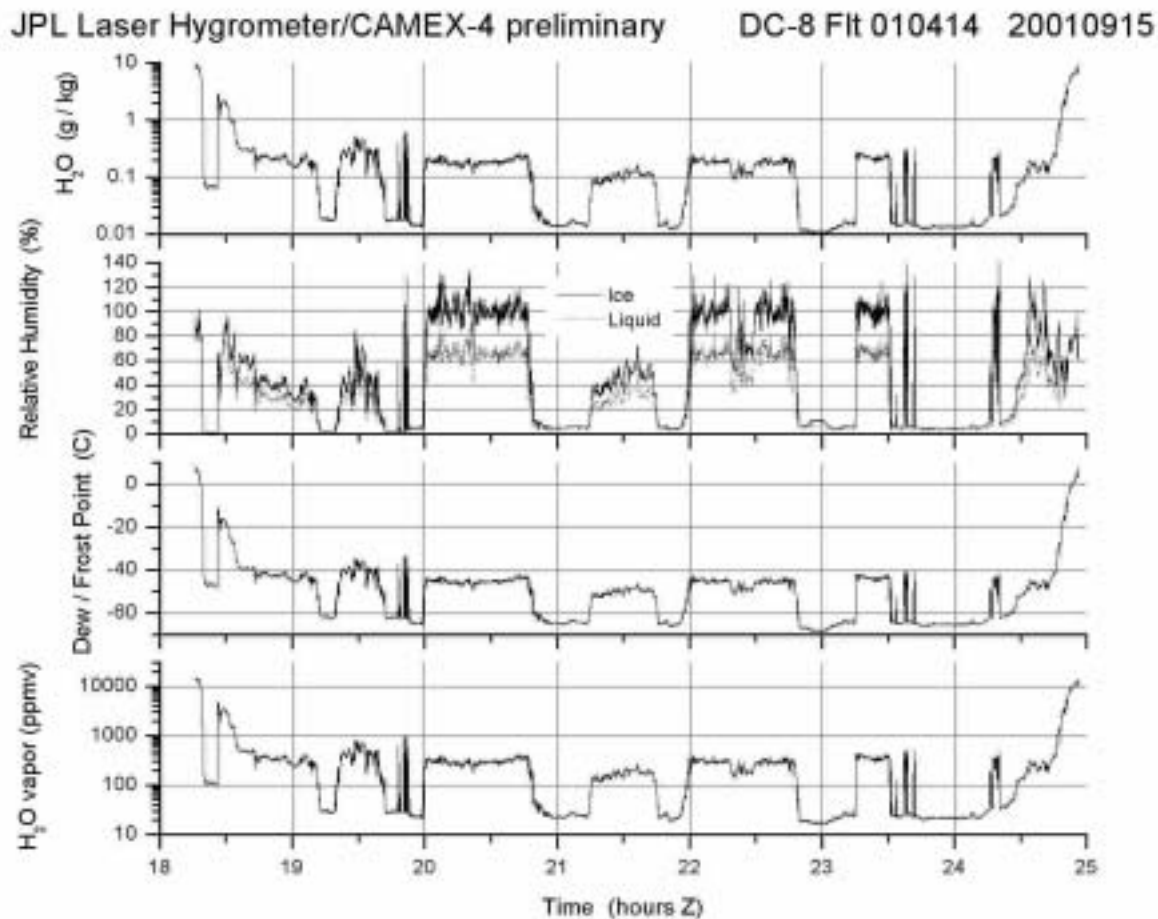
- Measure water vapor *in situ* at high spatial resolution
- Compare with other DC-8 instruments (LASE, Dropsondes)
- Compare with remote sensing instruments (GPS occultation)
- Analyze supersaturation in tropical storms



Past Year accomplishments



- Participation in CAMEX-4 mission
- Preparation of preliminary ascii data files and “quick-look” plots:

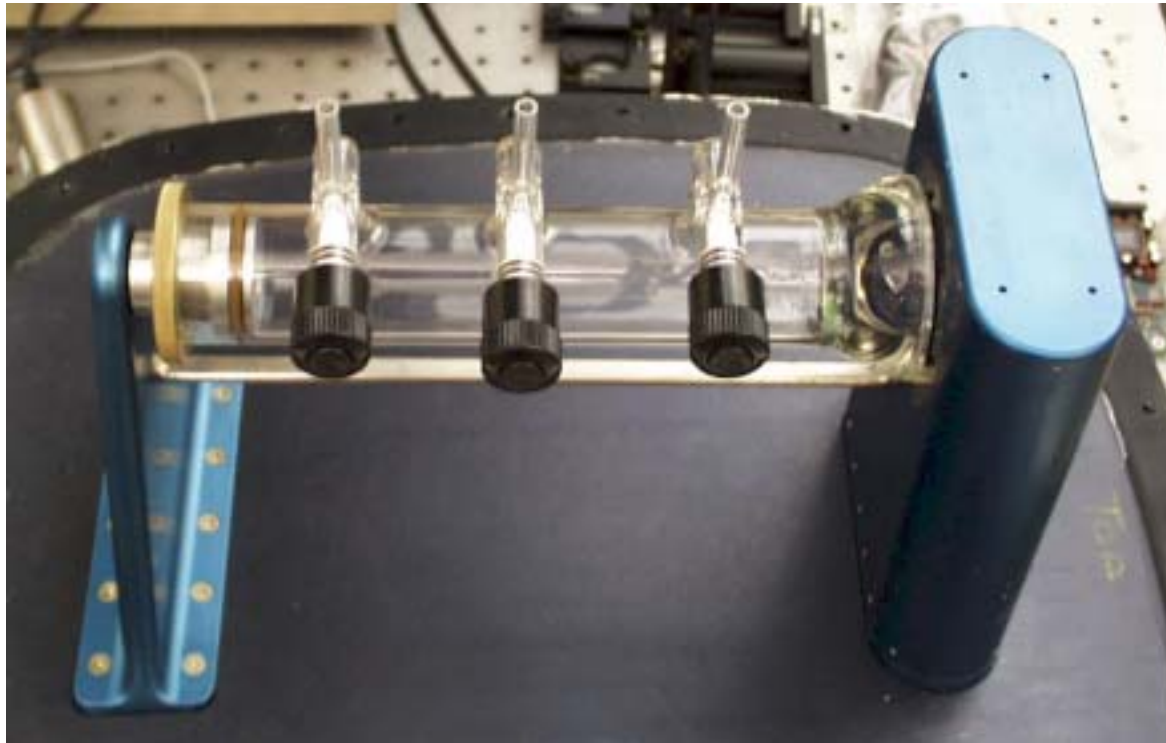




Past Year accomplishments



- **Laboratory calibration at JPL:** flow system set up to measure a range of water vapor concentrations and pressures (compared with General Eastern chilled-mirror hygrometer).





Past Year accomplishments



- **Cloud Chamber tests:** Operation of JLH inside the UCLA cloud chamber to assess the impact of ice particles on our water measurements.
- **Collaborator:** Prof. K. N. Liou (UCLA)





Supersaturation in tropical convection

Case Studies:

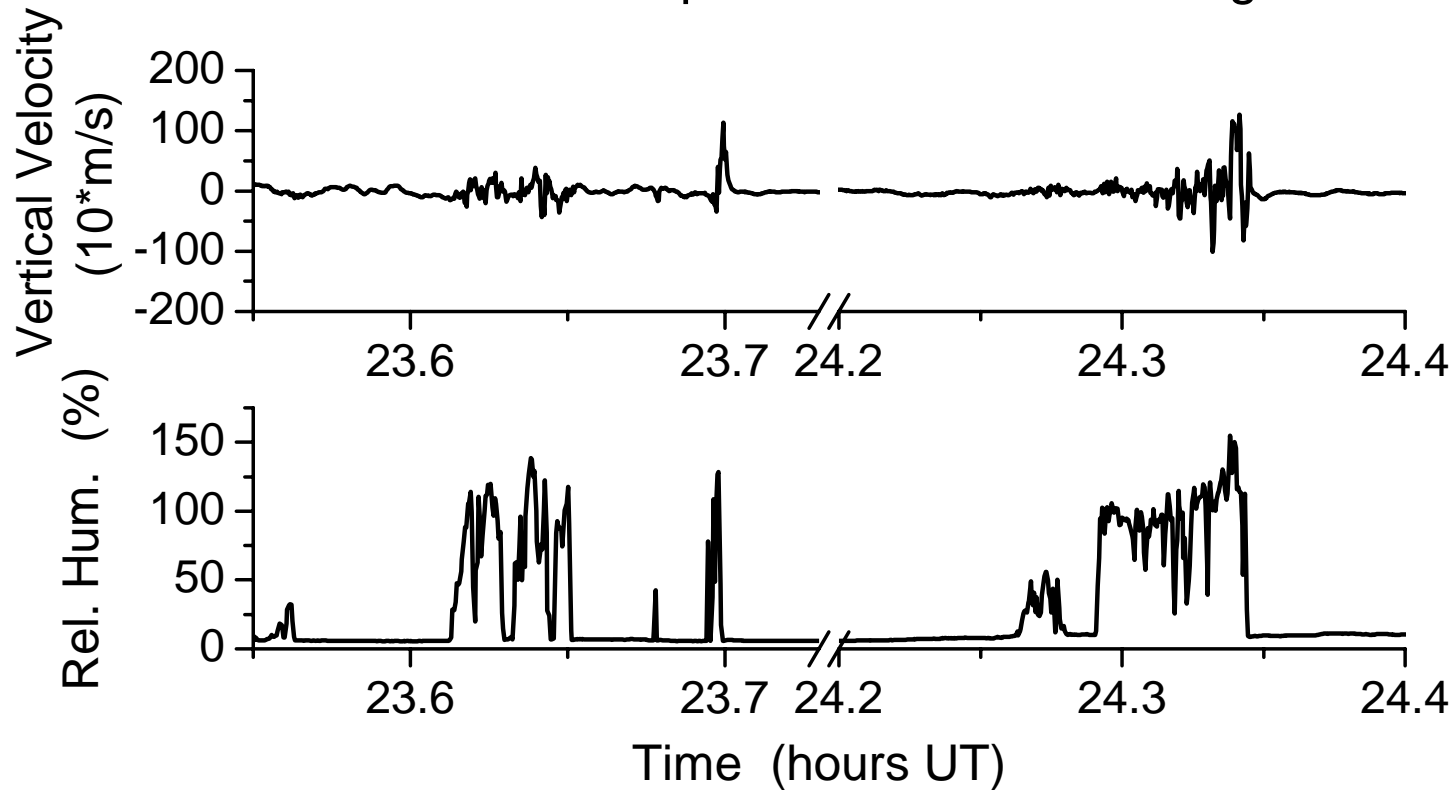
- 19980823, Hurricane Bonnie (CAMEX-3)
- 20010820, Tropical Storm Chantal (CAMEX-4)
- 20010915, Tropical Storm Gabrielle (CAMEX-4)
- Also Hurricane Humberto (CAMEX-4)

- **Observation:** Supersaturation in strong updrafts
- **Scientific goal:** improve understanding of cloud microphysics in convection
- **Collaborators:** Andrew Heymsfield (NCAR), Leonhard Pfister (NASA ARC)



Supersaturation in tropical convection

20010915 Tropical Storm Gabrielle flight





Future plans:



- **Poster:** American Meteorological Society 25th Conference on Hurricanes and Tropical Meteorology (29 April – 3 May, 2002, San Diego).
- **Publication:** supersaturation analysis.
- **Spectroscopy:** improve near-infrared spectral parameters and our data processing technique.
- **Computational Fluid Dynamics (CFD):** analyze the DC-8 fuselage to better understand the flow of air and particles to JLH.
- **Improve instrument:** mount farther away from aircraft, remove black coating of window port and replace with clear chem-film.



Archive data: status



- **Deliverables:** water vapor mixing ratio, frostpoint, relative humidity, specific humidity.
- **Spectroscopy:** new spectral parameters need to be implemented
- **Required inputs:** final temperature and pressure data.
- **Delivery date:** April 1, 2002.



Outreach Activities



- Tour and interview given to two 6th grade honors students.
- They subsequently created a science fair project on hurricanes.





Acknowledgments



Technical Support

K. Modarress

D. C. Scott

M. J. Mahoney

L. Pfister

R. D. May (CAMEX-3)

Financial Support

Dr. Ramesh Kakar, NASA Atmospheric
Dynamics and Remote Sensing Program