Aura Validation Experiment

Paul A. Newman
Randy Friedl

Outline

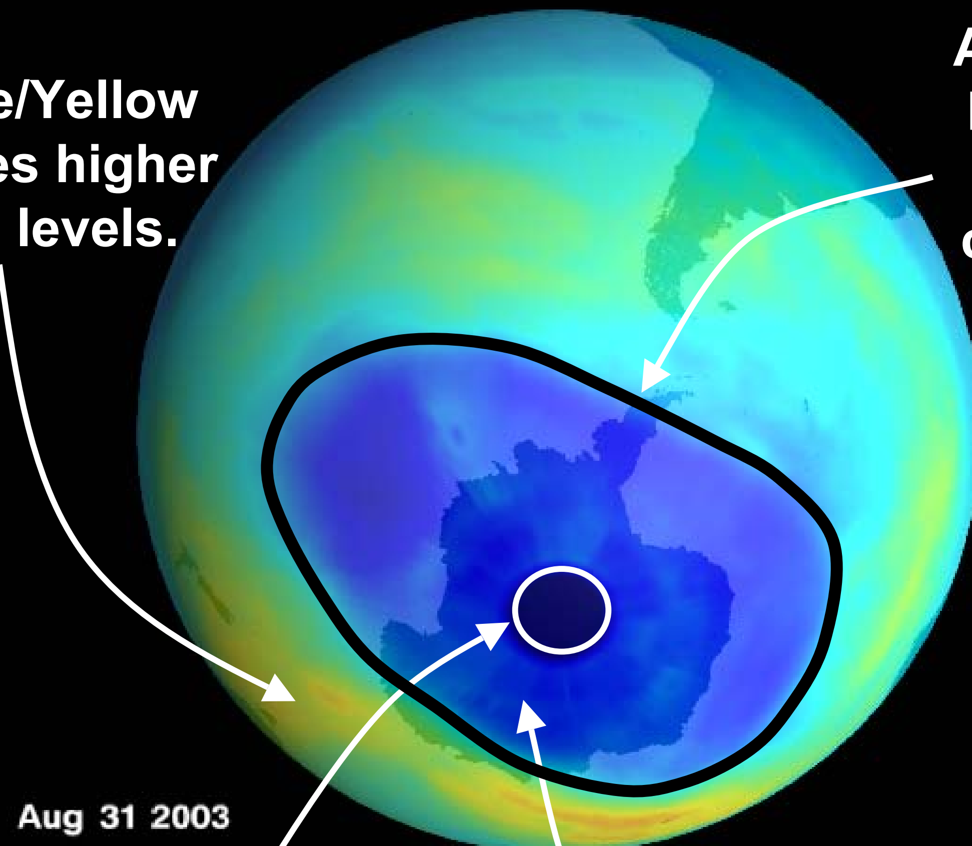
- Atmospheric science questions
- Satellite observations
- Pre-AVE
  - Schedule
  - Payload
  - Operations region
- Summary

Science

- Is the Earth's ozone layer recovering?
- Is air quality getting worse?
- How is Earth's climate changing?

Polar Ozone Loss and the Tropics

TOMS - August 31, 2003



Orange/Yellow indicates higher ozone levels.

Antarctic ozone hole is defined as the region covered by low ozone values

Dark color over pole shows the extent of polar night, no ozone observations

Blue colors indicate low ozone values

Chlorine Pathway

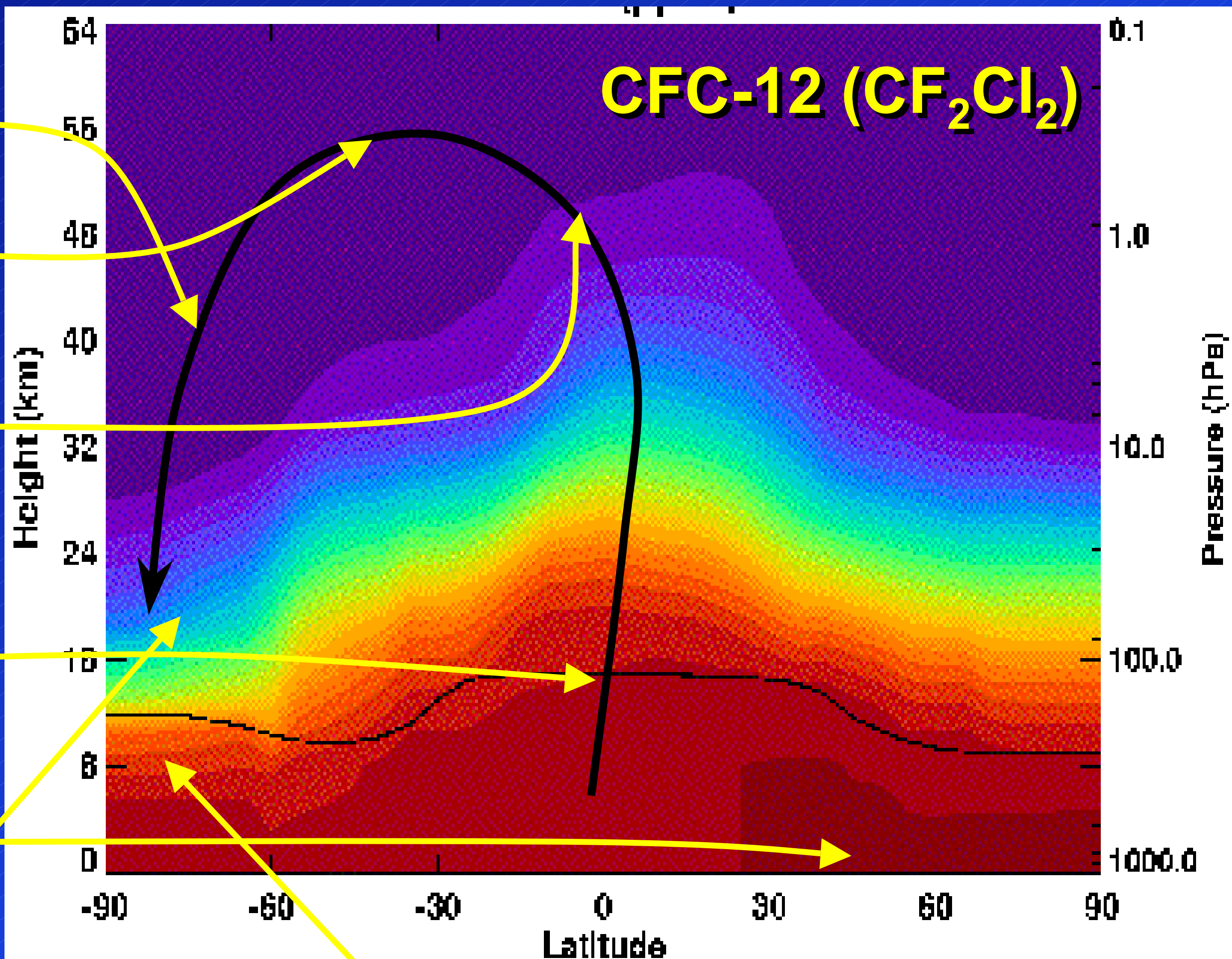
Cl reacts with CH_4 or NO_2 to form non-reactive HCl or $ClONO_2$

Cl catalytically destroys O_3

CFC-12 photolyzed in stratosphere by solar UV, releasing Cl

Carried into stratosphere in the tropics by slow rising circulation

CFC-12 released in troposphere



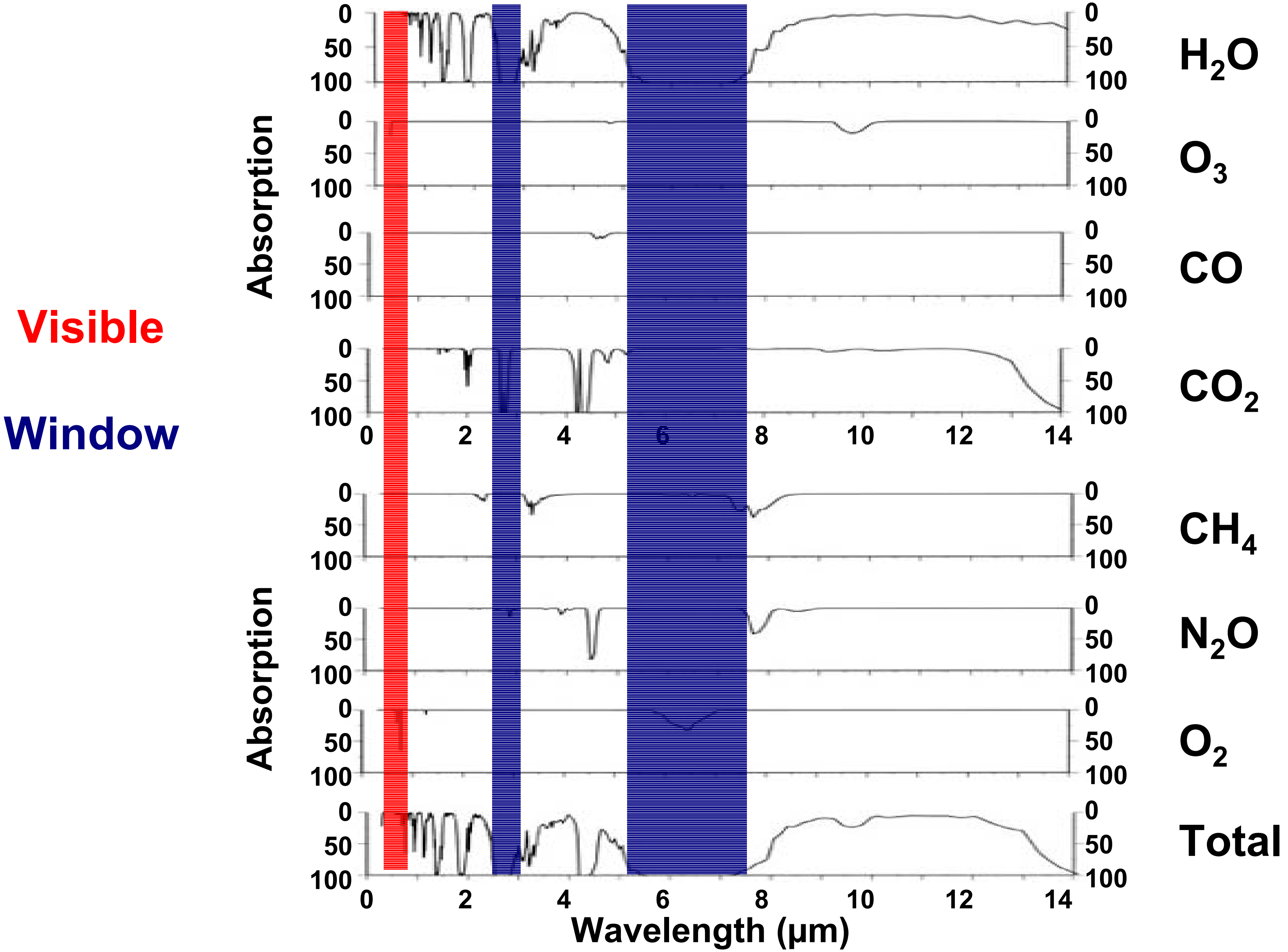
HCl reacts wtih $ClONO_2$ on the surfaces of PSCs, leading to massive ozone loss: Antarctic ozone hole

HCl and $ClONO_2$ carried out of stratosphere and rained out

Understanding tropical transport is critical to understanding the recovery of the ozone layer

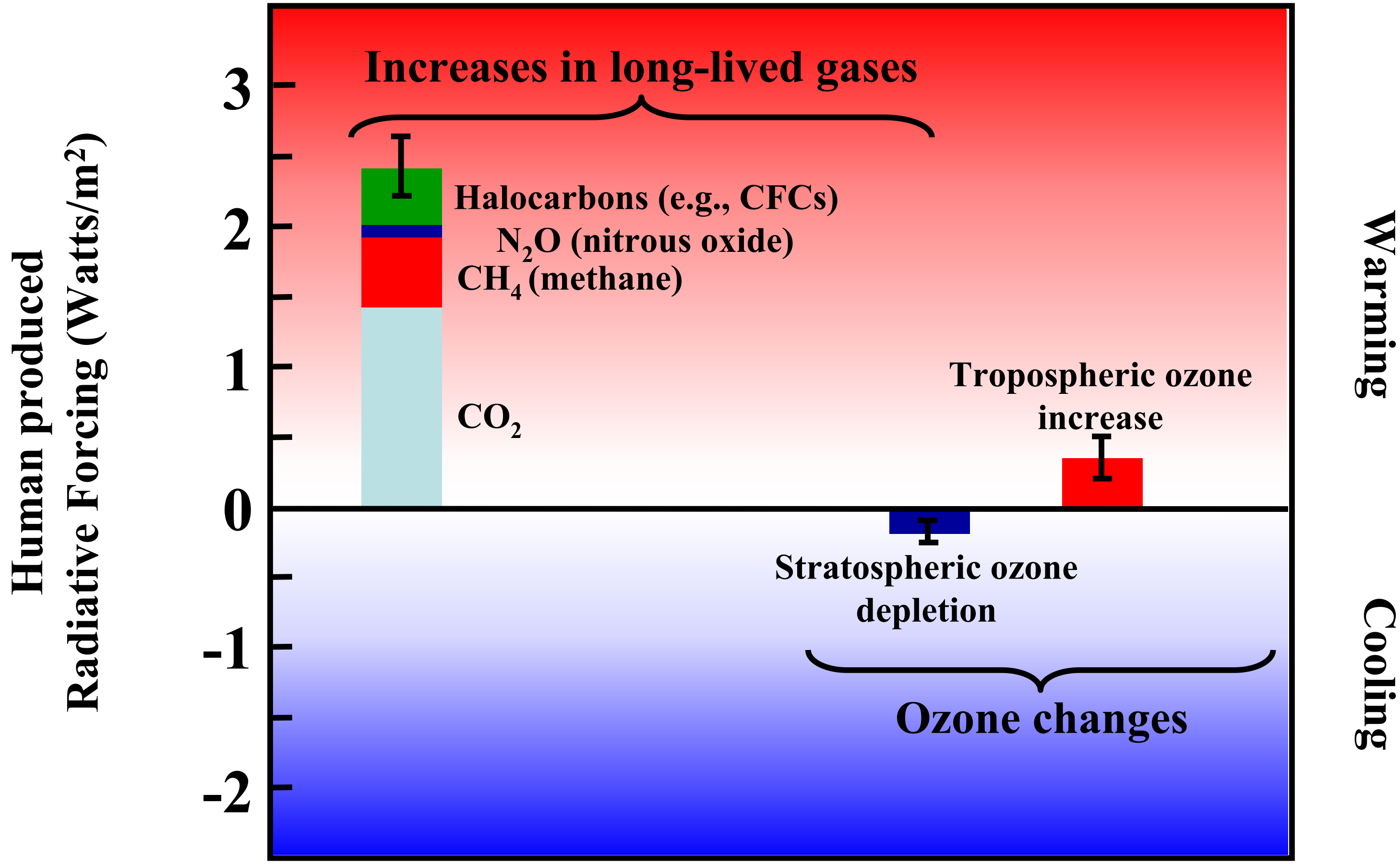
Climate Change and the Tropics

Some Absorbing Gases in the Earth's Atmosphere



H_2O is the dominant greenhouse gas in our atmosphere

Ozone and climate change



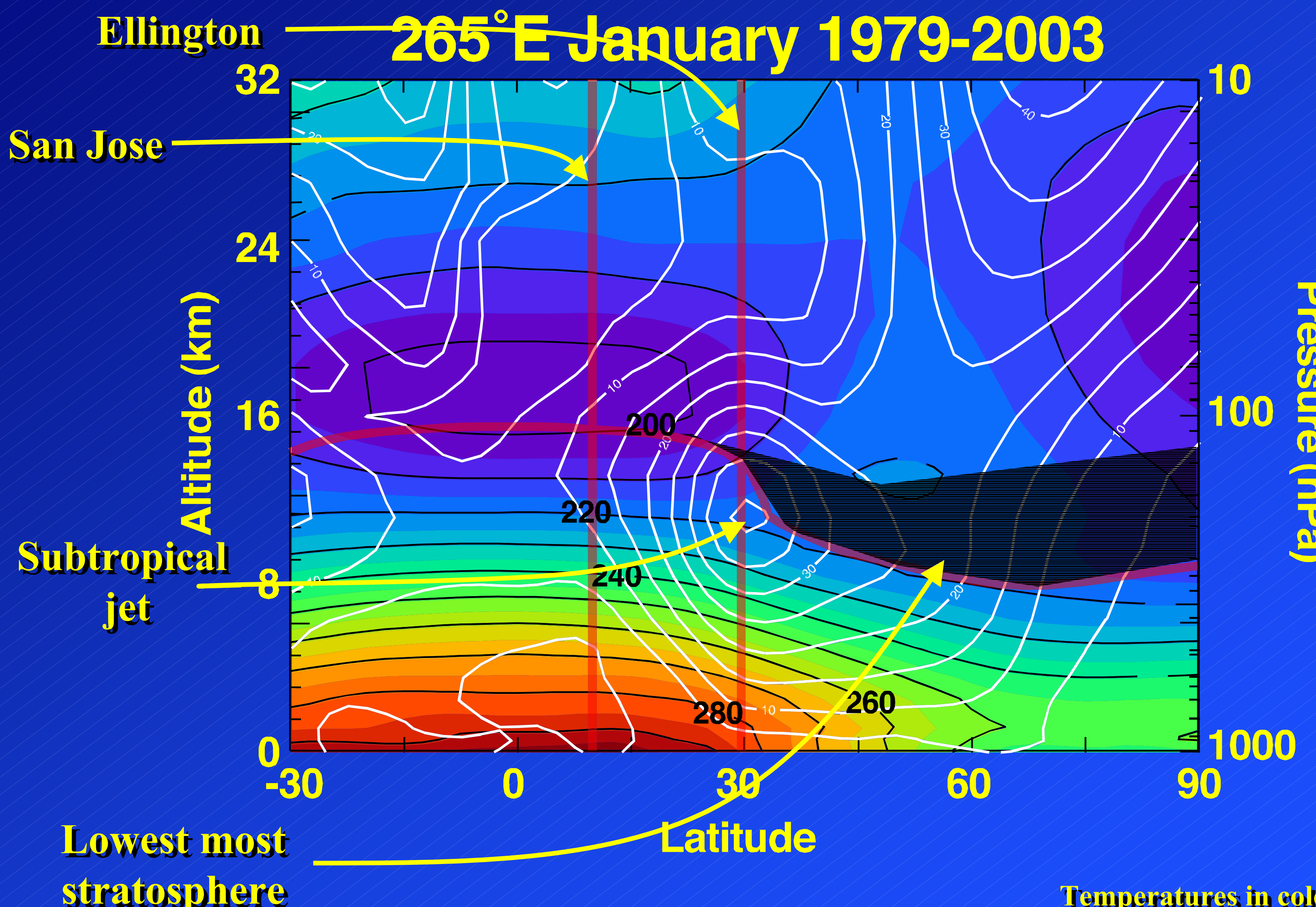
Ozone change is not a primary cause of climate change.

1) **Ozone depleting substances contribute to climate change.**
2) **Ozone changes causes a slight climate response.**
3) **Climate change may seriously impact ozone levels.**

See "Climate Change 2001: The Scientific Basis"

Ozone and water are critical gases for understanding climate change

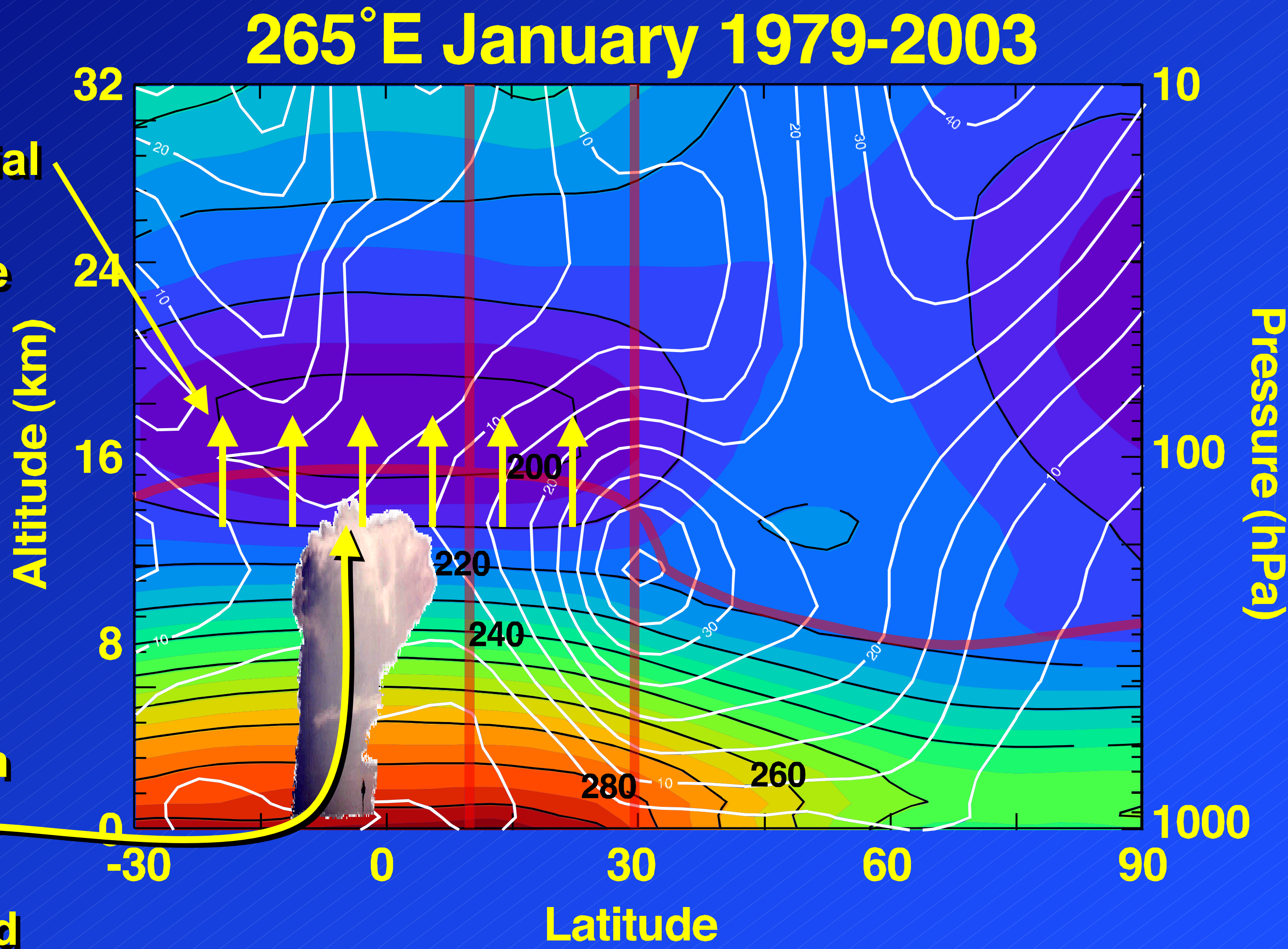
January Climatology



Temperatures in color
Wind speed contours in white
Isentropic as black dashed lines

January Climatology

Slow lifting circulation carries material into the stratosphere



Convection from surface deposits air in the upper troposphere (mainly around 14 km)

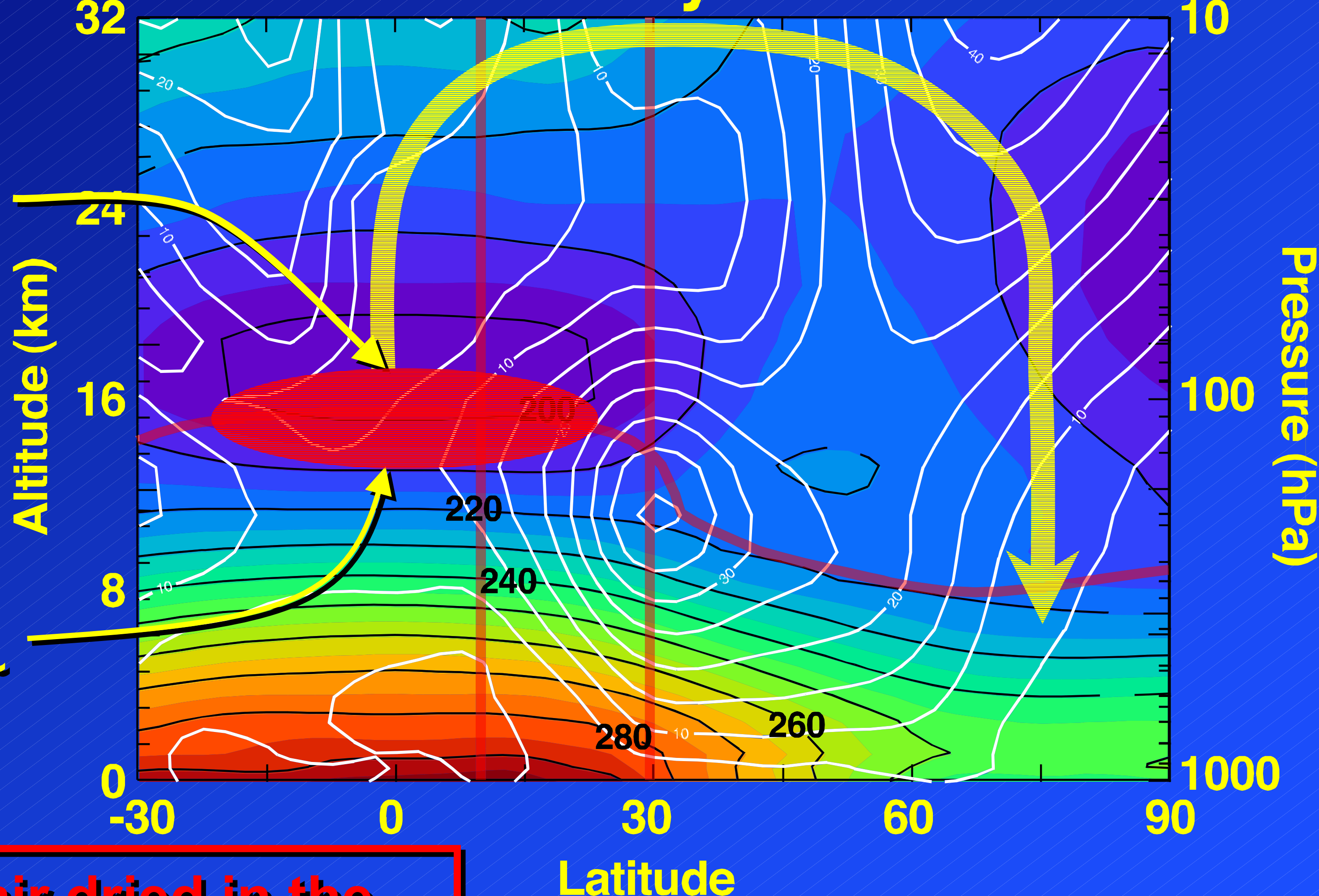
Temperatures in color
Wind speed contours in white
Isentropic as black dashed lines

Brewer, A.W., Evidence for a world circulation provided by the measurements of helium and water vapour distribution in the stratosphere, *Q. J. R. Meteorol. Soc.*, 1949.

265°E January 1979-2003

Water in the stratosphere ~ 3.85 ppmv

Water in the upper troposphere ~ 10-20 ppmv



How is air dried in the tropical tropopause layer?

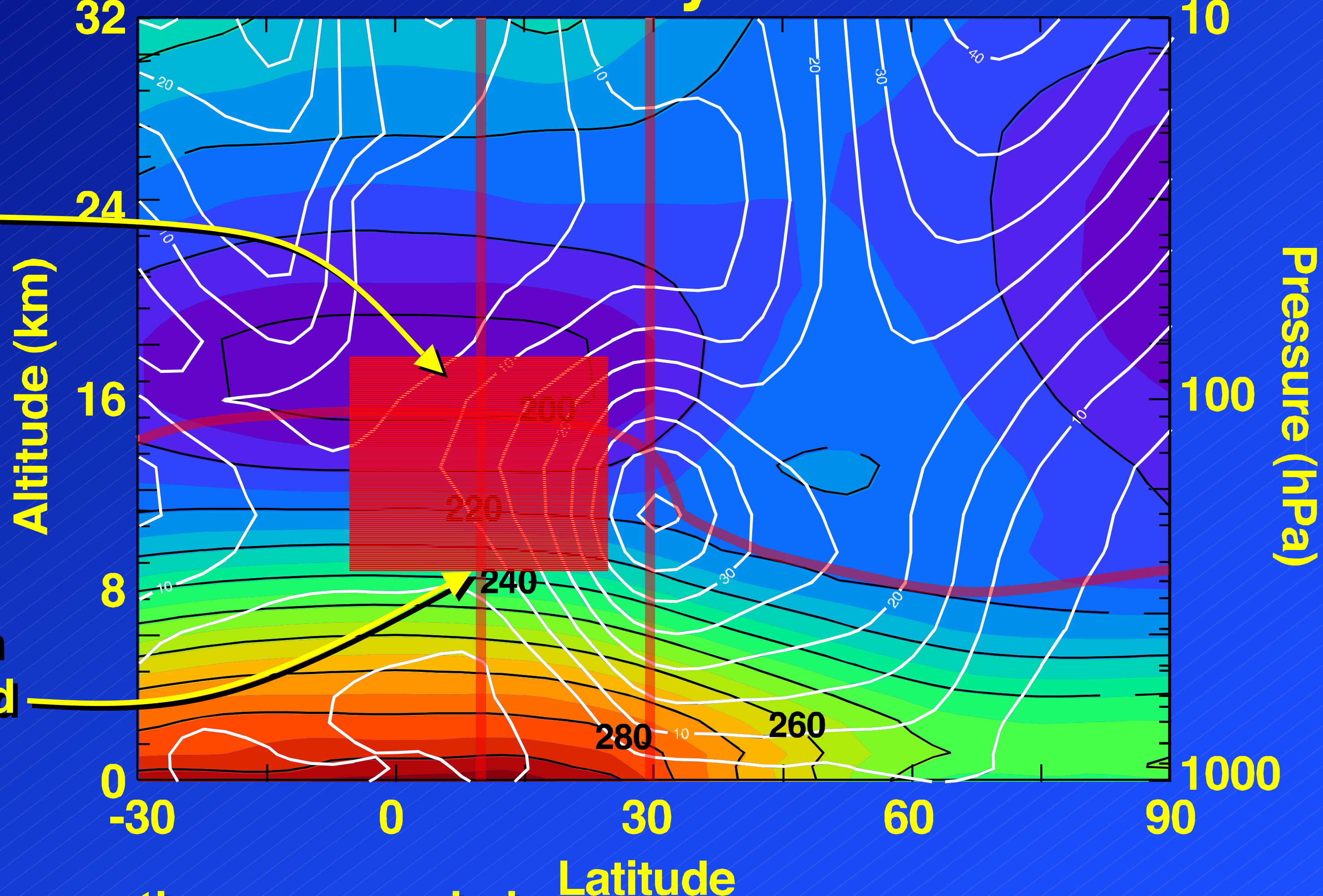
Temperatures in color
Wind speed contours in white
Isentropic as black dashed lines

If we don’t understand the physics of H_2O drying in the UT/LS, then we can’t predict how climate change impacts on H_2O

Observations in the tropics

265°E January 1979-2003

Few good H_2O observations in upper troposphere in the tropics

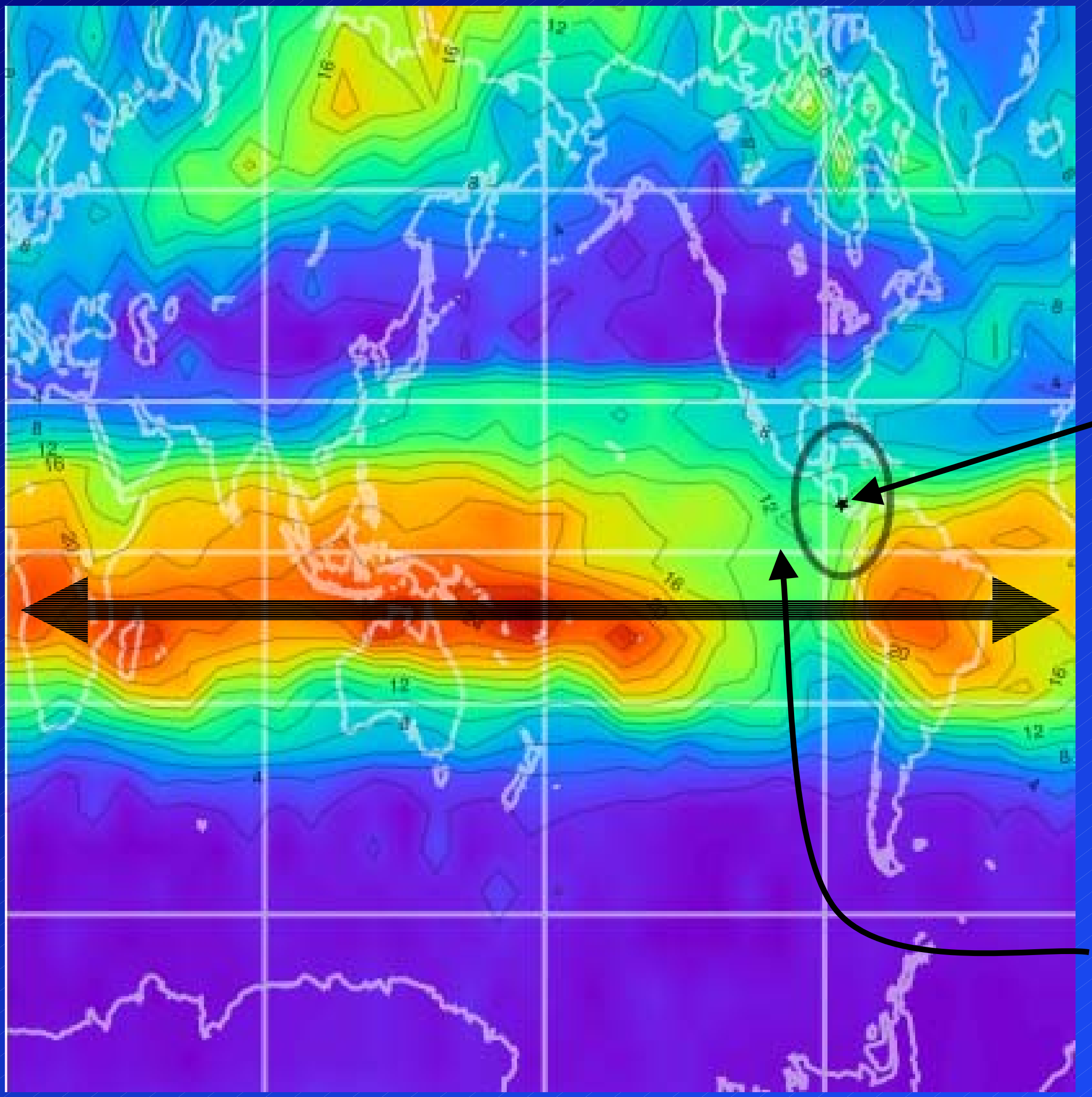


Humidity from sondes is good to 300 hPa

High quality observations are needed in the tropical upper troposphere

Temperatures in color
Wind speed contours in white
Isentropic as black dashed lines

January upper troposphere H_2O



Water at approximately 14 km (147 hPa)

Orange-Red: high water

Blue-Purple: low water

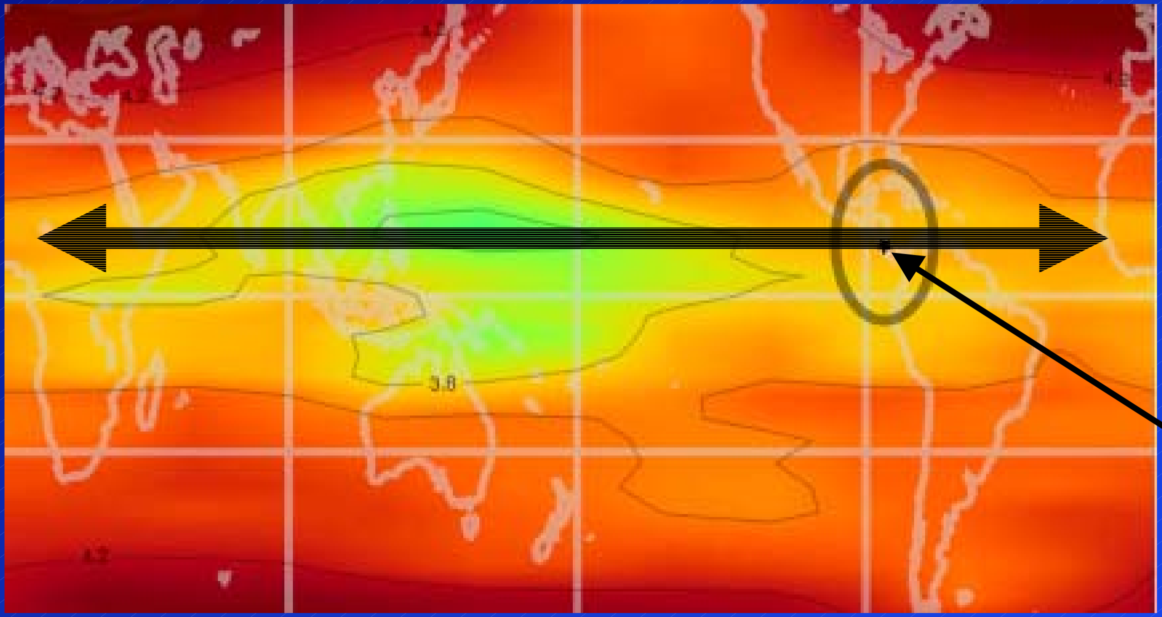
San Jose

High water concentrations found at ITCZ from convective detrainment

Lower water found in Eastern Pacific as a result of cross Pacific Walter circulation: few direct observations of upper tropospheric water

January lower stratosphere H_2O

Water at approximately 18 km (68 hPa)
Orange-Red: high water
Green: low water



Low water found north of equator possibly as a result of freeze drying of air during lofting from troposphere

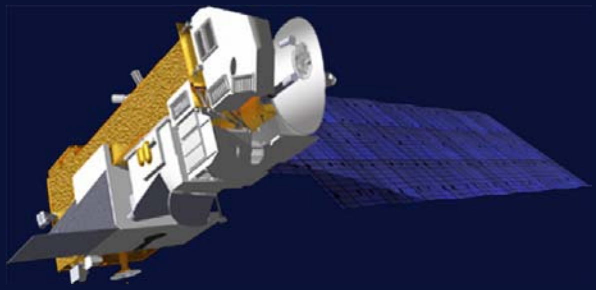
San Jose

What is the physics behind the freeze drying of air?
How will water change in the upper troposphere in a future climate world?

Observational Platforms
Aura satellite
WB-57F

Observations

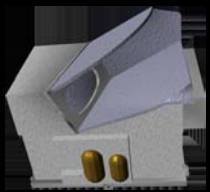
- Observations are key to understanding the science of ozone loss, air quality, and climate change
- NASA's observational strategy is built upon global satellite observations, aircraft measurements, and ground observations



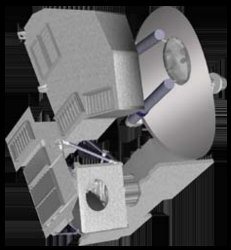
Aura

Atmospheric Chemistry and Climate

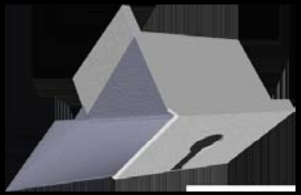
- **High Resolution Dynamics Limb Sounder (HIRDLS:USA/UK)**
  - Measures IR limb emission of stratospheric and upper tropospheric trace gases and aerosols



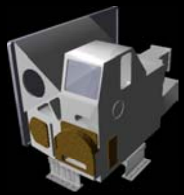
- **Microwave Limb Sounder (MLS:USA)**
  - Measures microwave limb emission of ozone destroying chemicals and upper tropospheric trace gases



- **Tropospheric Emission Spectrometer (TES: USA)**
  - Down looking and limb looking measurements of air pollution



- **Ozone Monitoring Instrument (OMI: Netherlands/Finland)**
  - Measures column ozone and aerosols - continues global ozone record of TOMS



AVE Platform

WB-57F

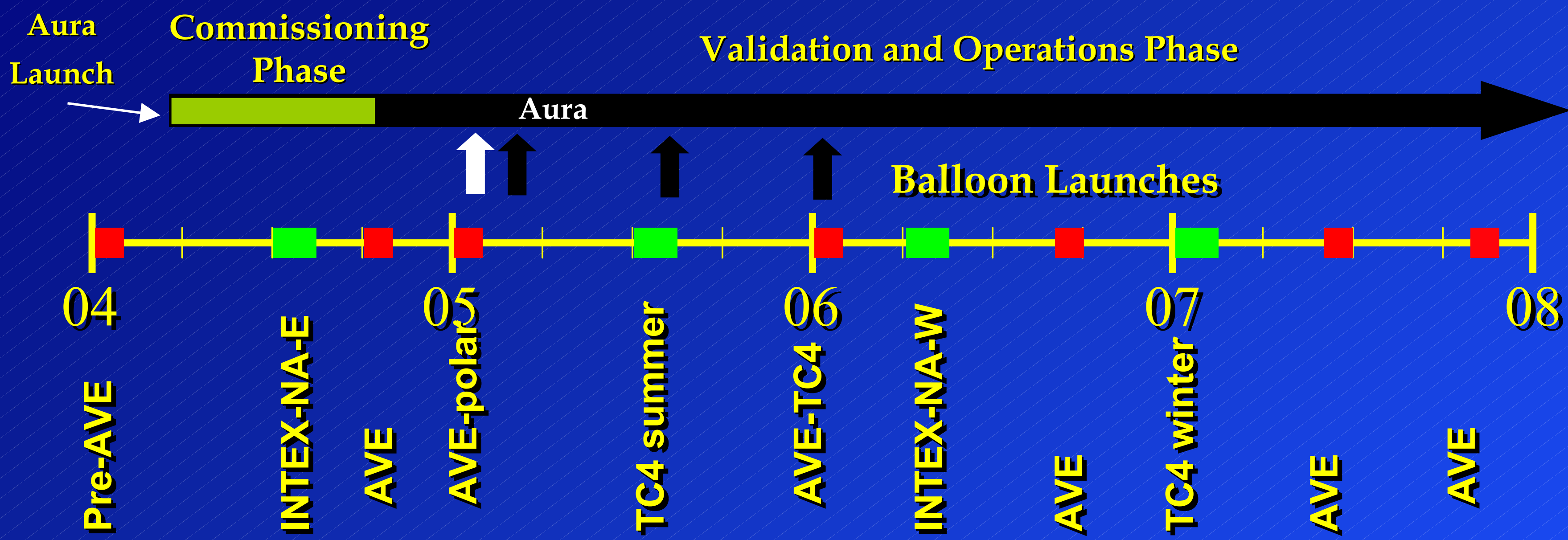
Payload:	6000 lbs. 4 pallets, 2 pods, wing hatches
Range:	2400 km
Ceiling:	19 km
Alt. range:	2-62 kft (~ 1-19 km)
Airspeed:	185 m/s (@19 km)
Endurance:	6.5 hours
Crew:	Pilot & payload operator

July 7, 2002

Developing Cb near Key West, Fla.
Photo taken from 60 kft

Shelley Baccus (WB-57F backseater)

Aura and Validation Campaign Timeline



Jan. 04	– pre-AVE (Costa Rica)
Jul. 04	– INTEX-NE-E, AVE (Ellington)
Oct. 04	– AVE (Ellington)
Jan. 05	– AVE - polar (Bangor)
Jul. 05	– TC4 summer (Costa Rica) + CAMEX5 + TEX/MEX (UAV?)
Jan. 06	– AVE/TC4 (Darwin) + DOE-IOP (UAV?)
Apr. 06	– INTEX-NA-W, AVE (Ellington) (UAV?)
Sep. 06	– AVE (Costa Rica) (UAV?)
Jan. 07	– TC4 winter (Guam) (UAV?)
Jun. 07	– AVE (TBD) (UAV?)
Nov. 07	– AVE (TBD) (UAV?)

Mini-missions

Joint campaigns

Heavy Lift Balloon

Medium Lift Balloon

Pre-Ave
January 2004

Objectives

- Tests concepts for using high quality in-situ and remote data sets for Aura validation
- Develop liason interactions with collaborating teams
- Make observations of the influx of material from the tropical troposphere into the stratosphere
- Characterize the Tropical Tropopause Layer (TTL) including relationships of water vapor, CO_2, ozone pre-cursors and ozone production
- Explore seasonal characteristics of strat-trop exchange.

Pre-AVE (January 2004)

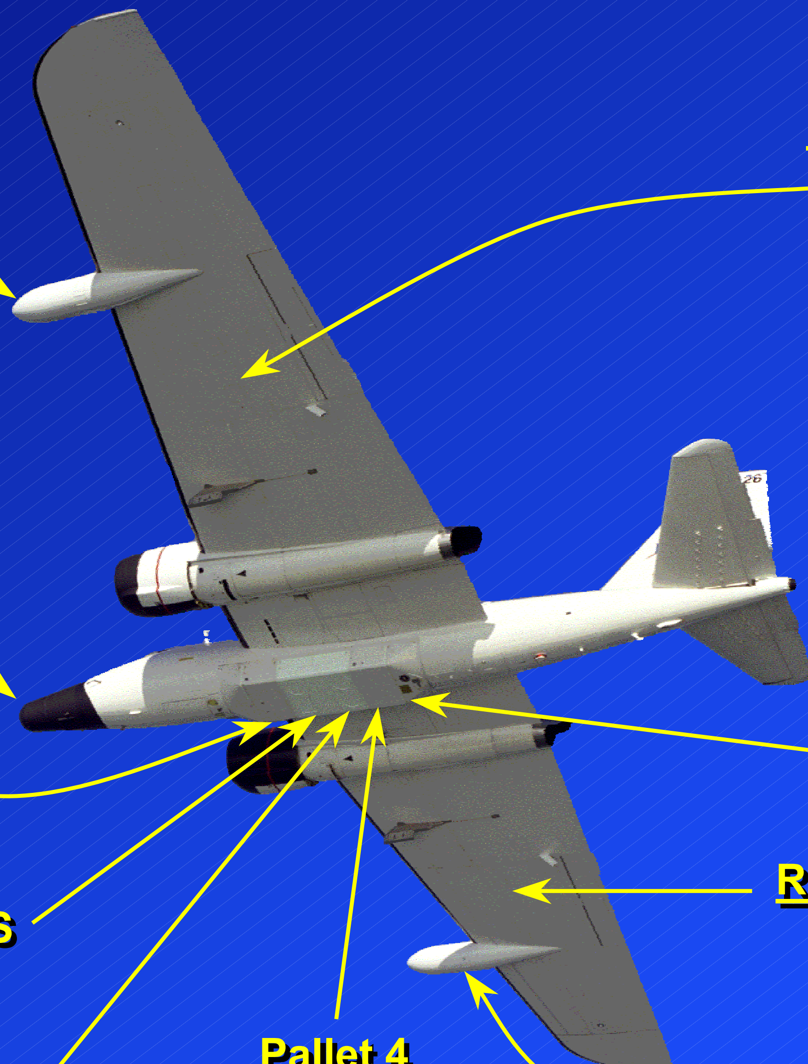
AVE-Jan 2004 Management

Don Anderson	Program Manager	NASA HQ
Mike Kurylo	Program Manager	NASA HQ
Phil DeCola	Program Manager	NASA HQ
Paul Newman	Co-Project Scientist	NASA GSFC
	Project Actor	
David Fahey	Co-Project Scientist	NOAA AL
Marty Ross	Payload Manager	Aerospace Corp
Mike Gaunce	Project Manager	NASA Ames
Michael Craig	Co-Project Manager	NASA Ames
Kathy Thompson	Project Coordinator	CSC

WB-57F Nose & Wing Pods

WB-57F Pallets

Pre-AVE January 2004 payload



Left Wing Pod
MTP, H_2O vapor, CAPS

Nose
PALMS, PT

Pallet 1
CO_2, total H_2O

Pallet 2
Argus, FCAS, MACS, NMASS

Pallet 3
CIMS (HCl, HNO_3), CH_4, O_3

Pallet 4
WAS

Left Wing Hatches
Frost point, VIPS

Upper Equip Bay

Aft Transition
PANTHER

Right Wing Hatches
JLH

Right Wing Pod
ALIAS

Operational Region

Schedule

Jan. 12 (Mo.) - 8AM - begin integration for wing pods and wing hatch instruments
Jan. 13 (Tu.) - 8AM - begin integration for fuselage
Jan. 16 (Fr.) - Test flight (5-6 hours)
Jan. 18 (Su.) - 1st science flight going north (5-6 hours)
Jan. 19 (Mo.)- Aura Liason visit to view operations
Jan. 20 (Tu.) - 2nd science flight going north (5-6 hours)
Jan. 24 (Sa.) - Flight to San Jose, CR (5-6 hours)
Jan. 27 (Tu.) - 1st Equator flight (5-6 hours)
Jan. 30 (Fr.) - 2nd Equator flight (5-6 hours)
Feb. 01 (Su.)- Return to Ellington (5-6 hours)

Total hours: 7 Flights, 35-42 hours, 21 day deployment.

Pre-AVE summary

- Platform: NASA WB-57F
- Pre-AVE flight series in Jan 2004
  - 3 mid-latitude flights
  - 2 transit flights
  - 2 tropical flights (Jan. 24-Feb. 1)
- Objectives:
  - Observed transport from tropical troposphere into the stratosphere
  - Characterize the Tropical Tropopause Layer (TTL)
  - Explore seasonal characteristics of strat-trop exchange.