SOSST contributions to clouds aerosols and radiation in the UTLS

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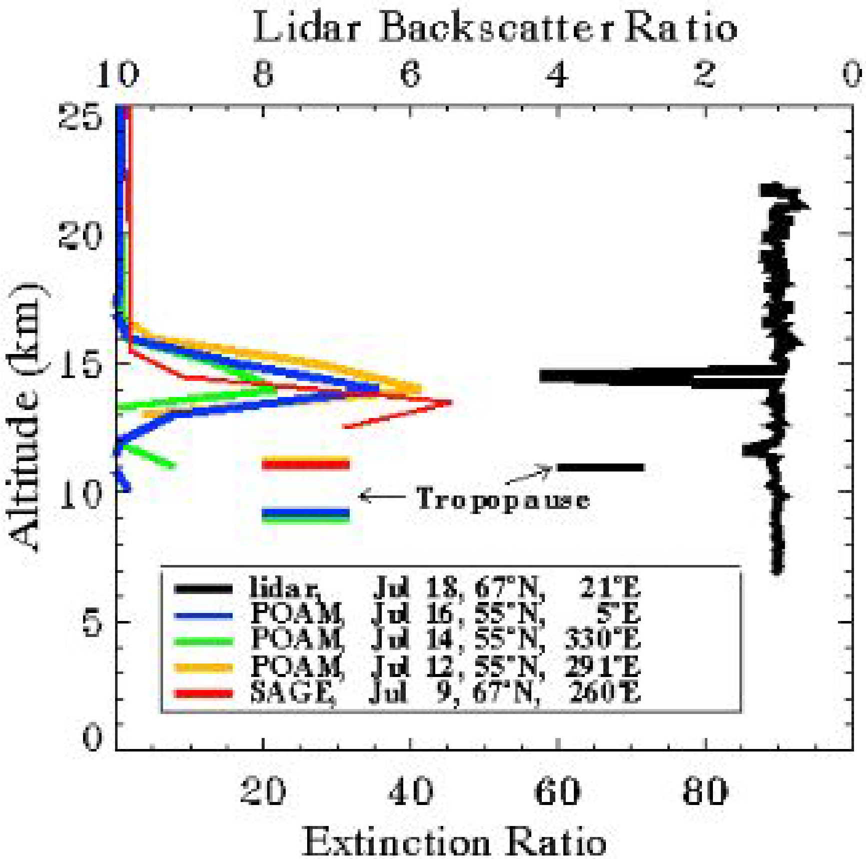
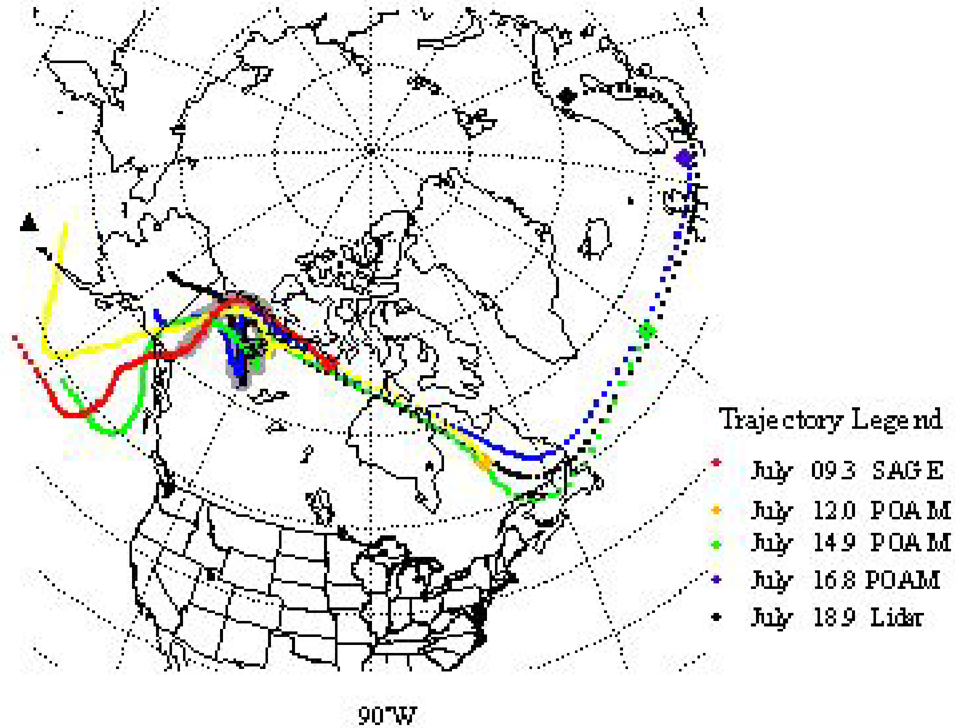
Important issues about aerosols
* indicates SOSST

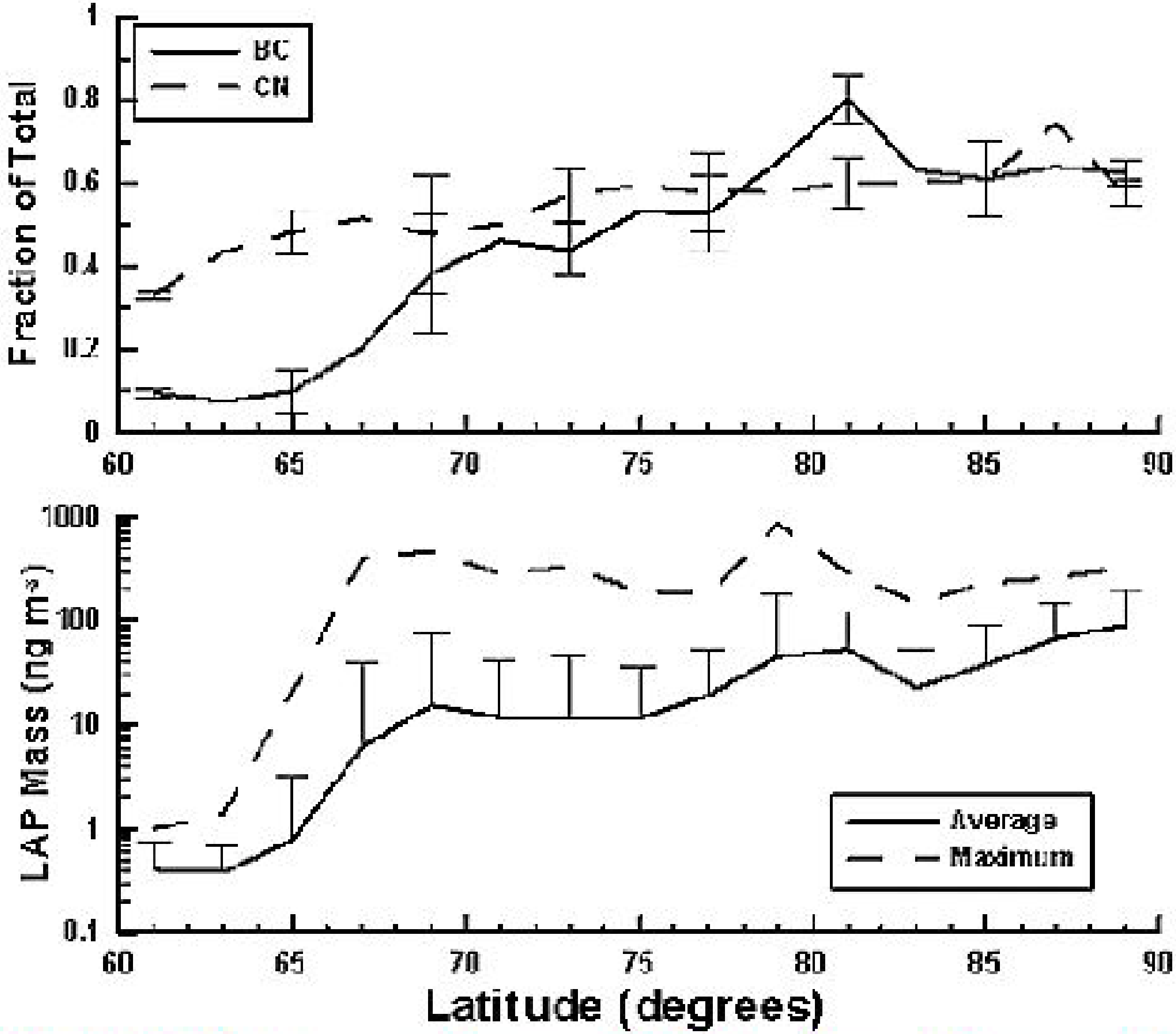
- How often do fires put soot into the stratosphere or upper troposphere? *
- Does the polar lower stratosphere really contain a lot of carbon?
- Why do mid-latitude fires inject material to high altitudes and not tropical ones, when we see the opposite behavior from volcanoes? *





Forest Fire smoke in the stratosphere

Fromm, M. D et al., *Geophys. Res. Lett.*, 27, 1407-1410, 2000.



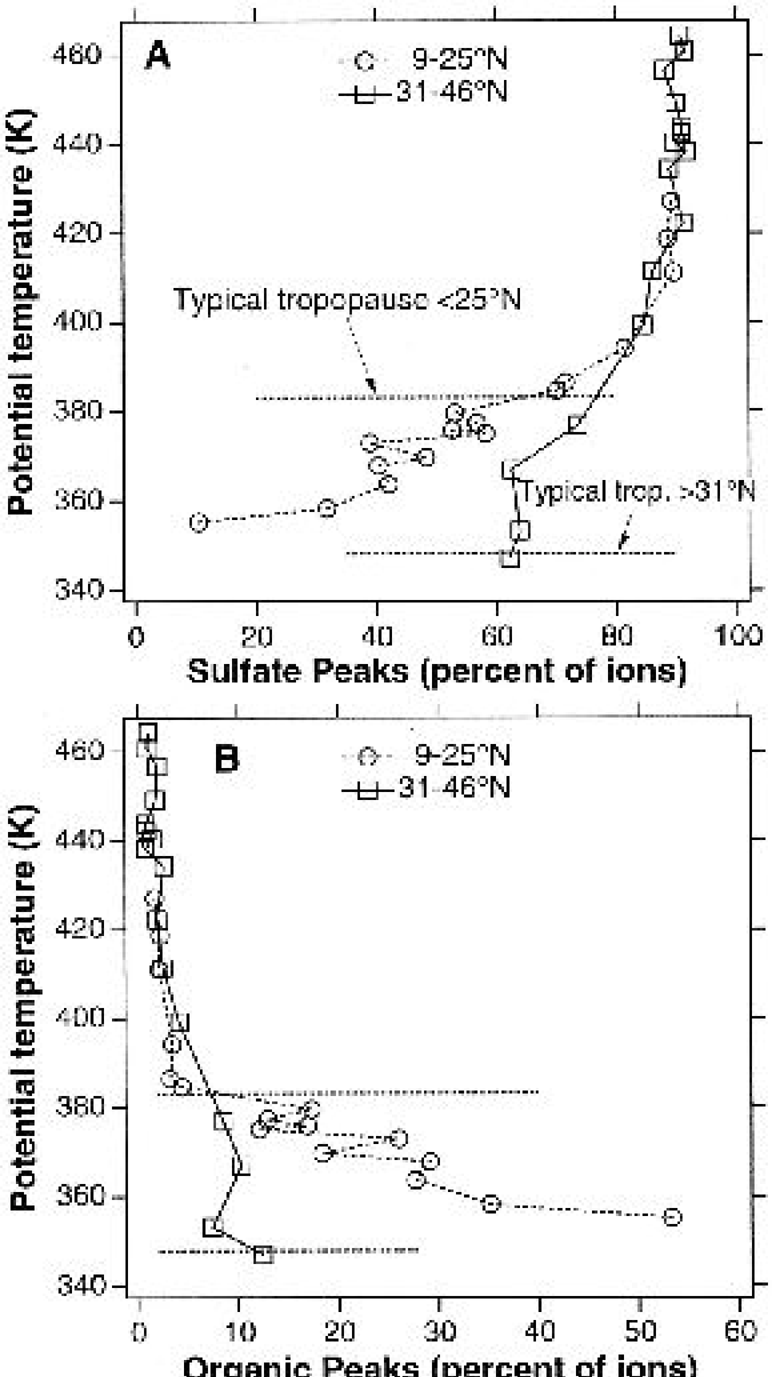
SOLVE II DC-8 observations of light absorbing particles in the lower stratosphere

Baumgardner D., G. Kok, G. Raga (2004)

Geophys. Res. Lett., 31, L06117, doi:10.1029/2003GL018883

Important issues about aerosols

- What composes the organic aerosols near the tropopause? Why don't they get into the stratosphere?-*
- What do micrometeorites do in the stratosphere?
- Are new particles formed by ion nucleation, does this matter?
- Are there nitric acid particles in the tropics?



Organic aerosols just below the Tropopause

D. M. Murphy, D. S. Thomson, M. J. Mahoney
Science, Vol 282, 1664-1669 , 27 November 1998

Important issues about sub visible cirrus

- Are these clouds removing water from the stratosphere, or preventing it from entering?- *
- What are the properties of subvisible cirrus?- *
- Do subvisible cirrus induce upward motion near the tropopause?
- How are subvisible cirrus formed?- *
- How do subvisible cirrus affect water and other materials transport into the stratosphere- *

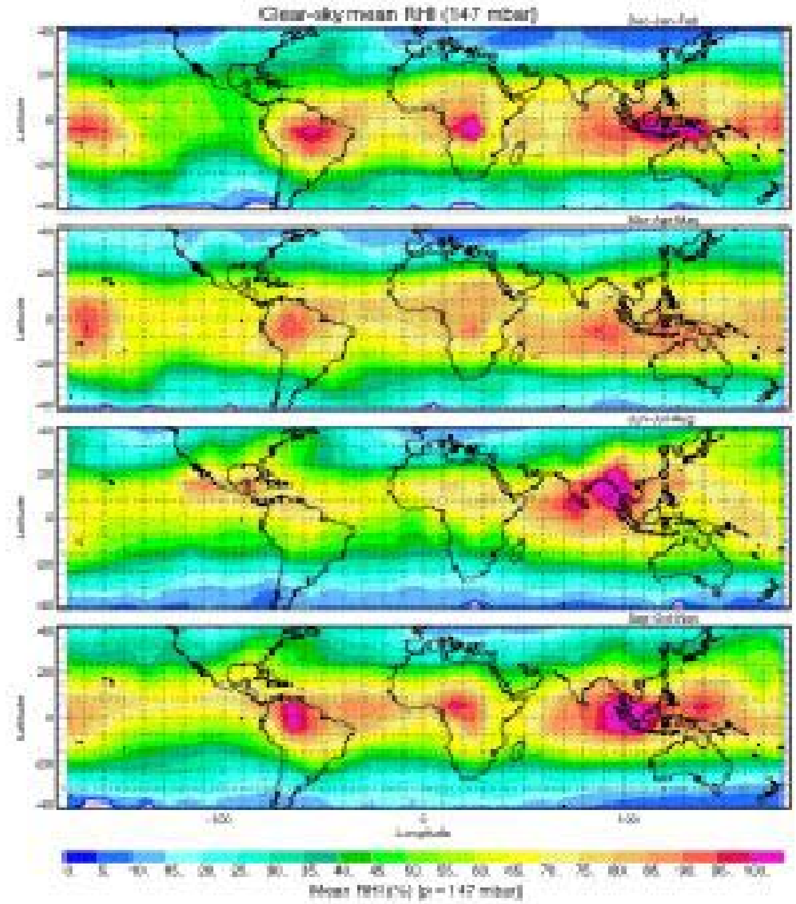
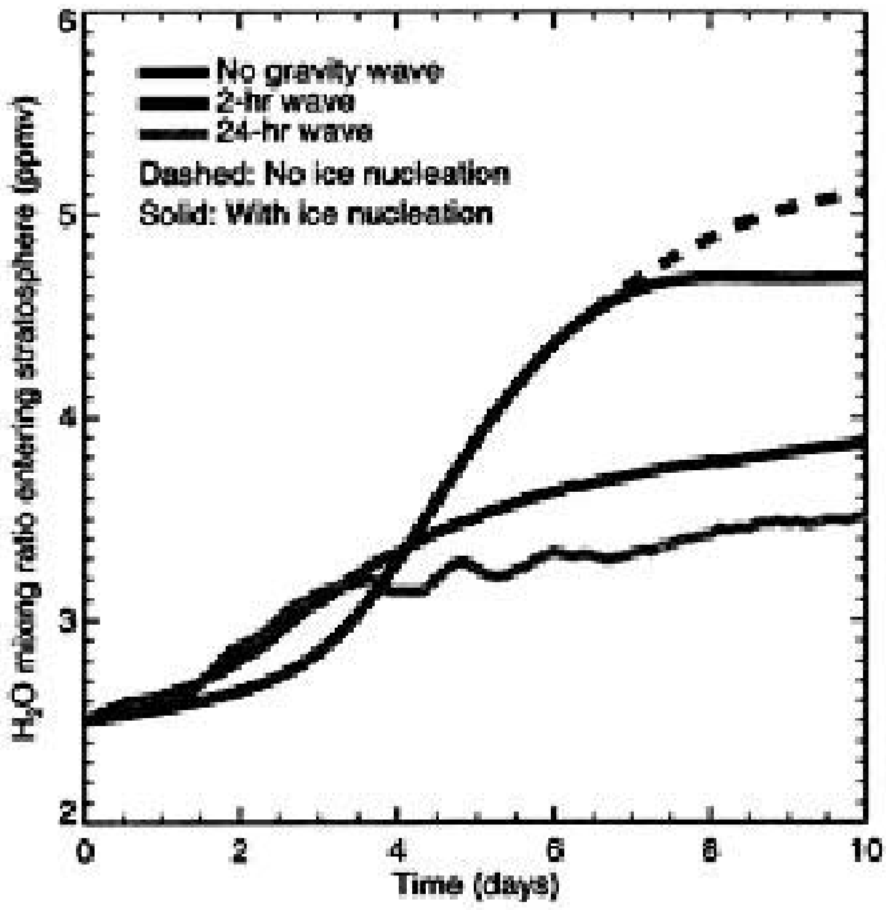


Figure 2. Seasonal maps of the mean RHI at 146 mbar calculated from the cloud-free 1992 MLS data. The mean humidities are relatively high throughout the tropics.

Tropopause relative humidity

E. Jensen et al.,GRL, 2347-2350, AUGUST 1, 1999



Dehydration of air entering the stratosphere

Jensen et al., JGR 106, 17,237, 2001

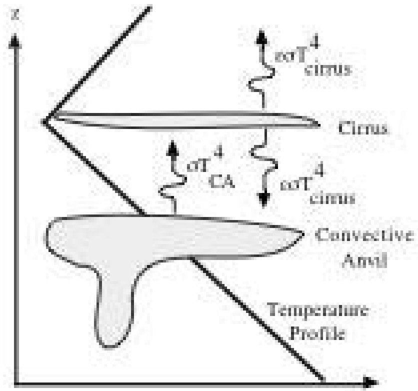


Figure 2. Schematic diagram of cirrus above convective anvil cloud including temperature profile.

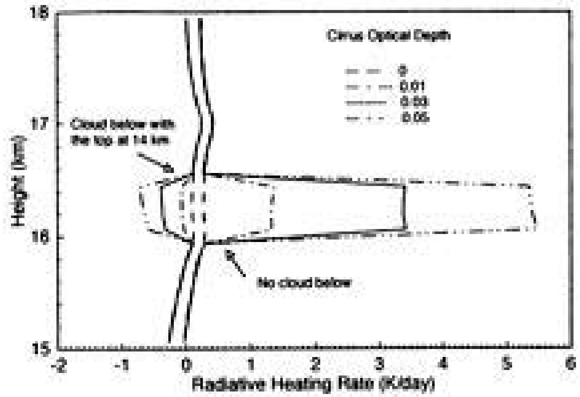
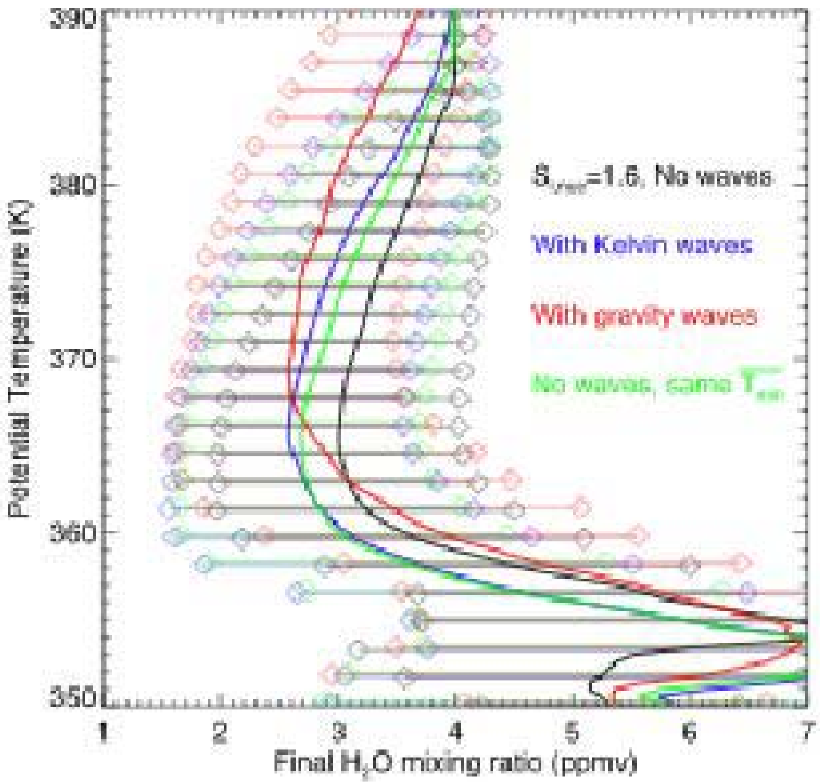


Figure 3. Radiative heating rates near the tropical tropopause with cirrus cloud present between 16 and 16.5 km with various optical depths for: no cloud below (rightmost 4 curves), and thick cloud below with cloud top at 14 km. See text for details.

Radiative heating by Sub-visible cirrus

D. Hartmann et al., GRL, 28, 1969-1972, 2001

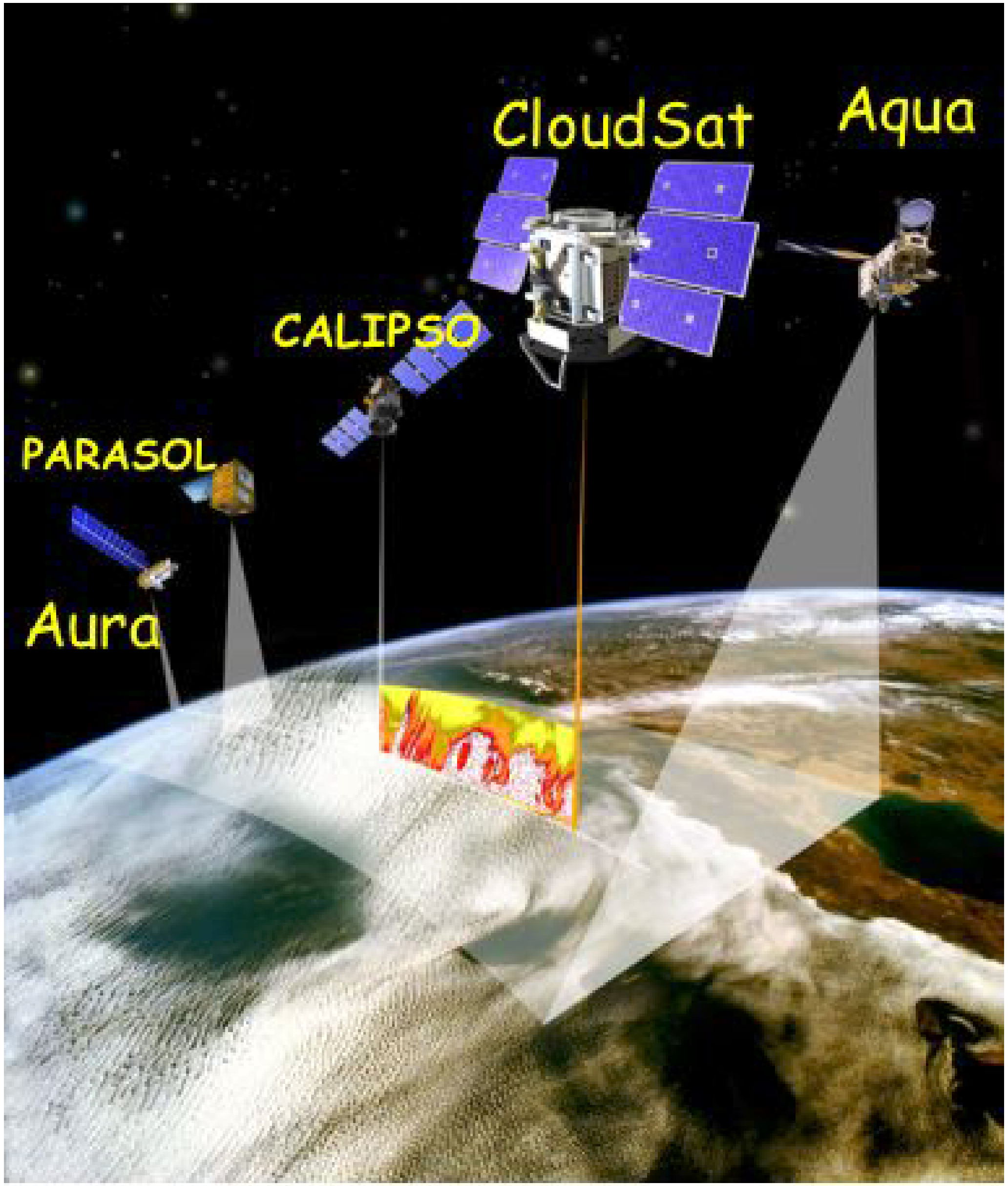


Tropical water profiles from air slowly entering the stratosphere and passing through sub-visible cirrus.

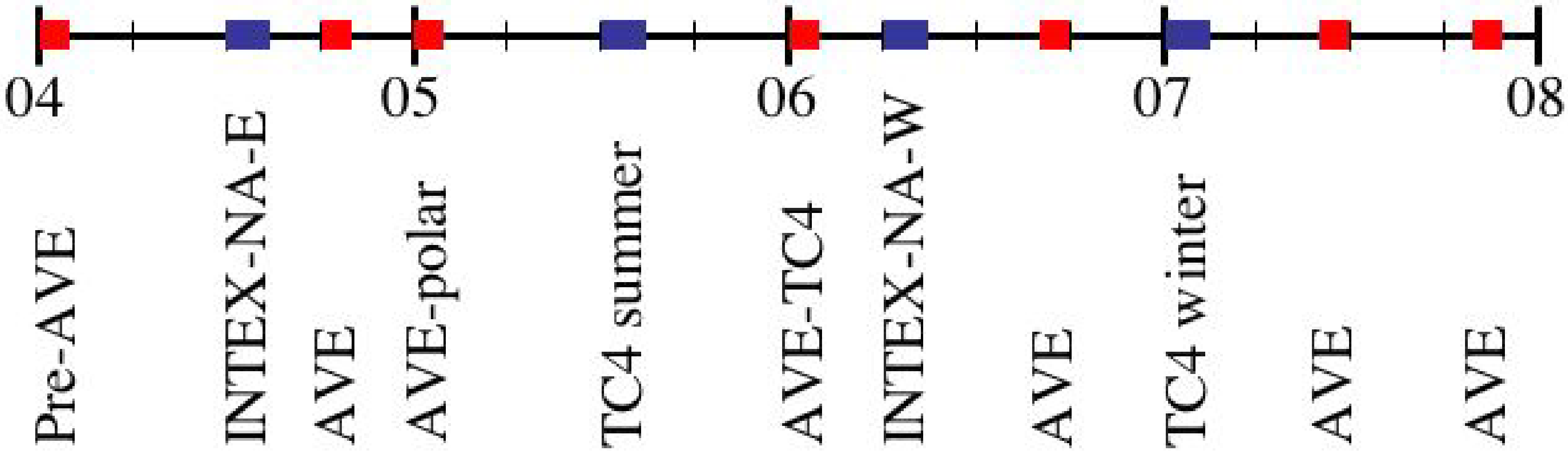
Jensen et al., JGR. 109 , 2004

Important issues about radiation

- Why do in situ and remote sensing disagree about the particle size in cirrus anvils?
- Does radiative cooling lead to subsidence over convection?- *
- Do subvisible cirrus radiatively induce upward motion near the tropopause?


CloudSat
Aqua
CALIPSO
PARASOL
Aura

Field 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

Jan. 06 – AVE/TC4 (Darwin) + DOE-IOP

Apr. 06 – INTEX-NA-W, AVE (Ellington)

Sep. 06 – AVE (Costa Rica)

Jan. 07 – TC4 winter (Guam)

Jun. 07- AVE (TBD)

Nov. 07- AVE (TBD)

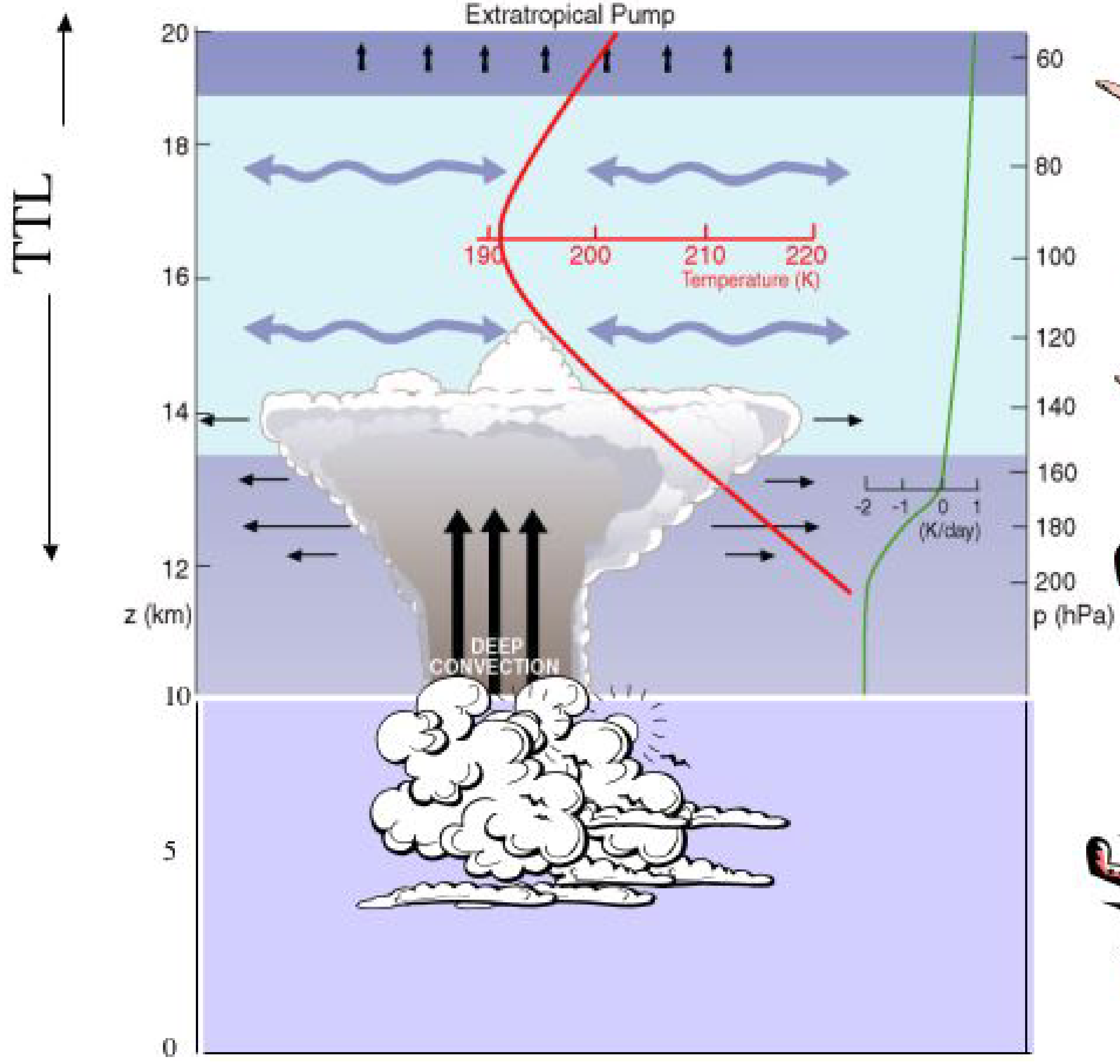
Major questions addressed by NASA in Costa Rica field program **Blue indicates relevance to SOSST**
1. How can space-based measurements of geophysical parameters, particularly those known to possess strong variations on small spatial scales (e.g., H_2O, cirrus), be validated in a meaningful fashion?
2. How do convective intensity and aerosol properties affect cirrus anvil properties?
3. How do cirrus anvils, and tropical cirrus in general, evolve over their life cycle? How do they impact the radiation budget and ultimately the circulation?
4. What controls the formation and distribution of thin cirrus in the Tropical Tropopause layer, and what is the influence of thin cirrus on radiative heating and cooling rates, and on vertical transport?

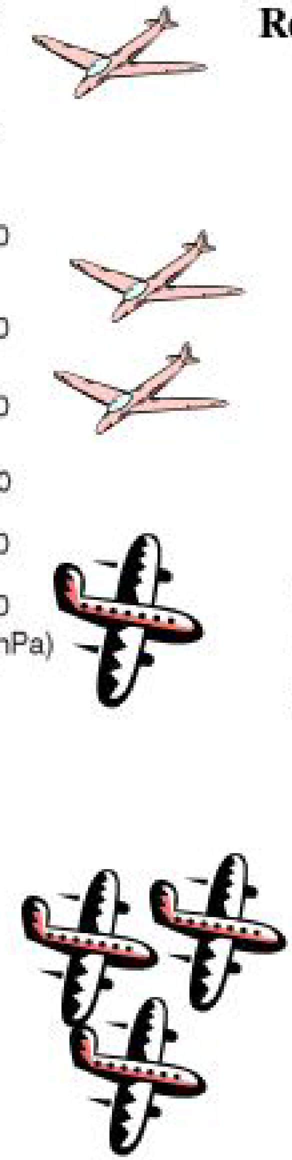
Major questions addressed by NASA in Costa Rica field program
5. What are the physical mechanisms that control (and cause) long-term changes in the humidity of the upper troposphere in the tropics and subtropics?
6. What are the chemical fates of short-lived compounds transported from the tropical boundary layer into the Tropical Tropopause layer. (i.e., what is the chemical boundary condition for the stratosphere?)
7. What are the mechanisms that control ozone within and below the Tropical Tropopause Transition layer?
8. What mechanisms maintain the humidity of the stratosphere? What are the relative roles of large-scale transport and convective transport and how are these processes coupled?

Major questions addressed by NASA in Costa Rica field program
9. What are the origins of incipient disturbances that have potential for genesis in the Eastern Pacific and what role does orography play?
10. How is convection organized in these incipient disturbances and what are the microphysical characteristics?
11. What is the role of convection in the organization, intensification, and eventual descent of the cyclonic circulation to the surface?
12. Do environmental stability and moisture play key roles in determining whether disturbances develop or fail to develop into tropical storms? Or is the key factor related to dynamic processes and interaction with environmental vertical wind shear?

Major questions addressed by NASA in Costa Rica field program
13. What factors affect predictability of cyclogenesis, or is it fundamentally unpredictable until a specific stage of development?
14. How do the organization of convection and the microphysical characteristics of mature hurricanes differ from those in the genesis stage?
15. How does environmental vertical wind shear alter storm development and how much shear is needed to either halt intensification or cause weakening of a hurricane?
16. How can unique NASA assets be used to improve prediction of storm track, intensity, and rainfall?

Sampling strategy-Costa Rica





Remote Sensing-ER-2

Remote Sensing-Proteus

Cloud physics, TTL chemistry WB57

Cloud physics, TTL chemistry DC-8

Bnd layer physics and chemistry, Radars-NOAA(2), NSF P-3

©GraphicMaps.com
Gulf of Mexico
Caribbean Sea
Mexico
Ambergris Cay
Jamaica
18° N
Belize
Turneffe Islands
Belmopan
Gulf of Honduras
Atlantic Ocean
Bahia Islands
Guatemala
Honduras
15° N
Guatemala
Tegucigalpa
San Salvador
Providencia Is. (Colombia)
Nicaragua
El Salvador
Gulf of Fonseca
Lake Managua
San Andres Is. (Colombia)
Managua
12° N
Maiz Islands (Nicaragua)
CENTRAL AMERICA
Lake Nicaragua
150 mi
150 km
Costa Rica
Bocas del Toro (Panama)
San Jose
Gulf of Nicaya
Mosquito Gulf
PANAMA CANAL
Panama City
9°N
Panama
Gulf of Panama
N
Pacific Ocean
Coiba Island
SOUTH AMERICA
Colombia
6°N
90° W
87° W
84° W
81° W
78° W

ER-2 payload proposed-Costa Rica

T, P,winds	MAS
Temperature profile	Sub-mm Radiometer (~600 GHz)
O_3	Microwave radiometer (~10-350GHz)
H_2O vapor	Solar spectral flux
Cloud/aerosol lidar	Broadband IR, Solar flux
94 GHz radar	DOAS (N_2O, BrO, HCHO)
Precip Doppler radar	
Dropsondes	
Lightning Inst. Package	

WB-57 payload proposed-Costa Rica

T, P,winds
Temperature profile
O_3
H_2O vapor (2)
CO, CH_4 and/or N2O
Aerosol size distribution
H_2O total (CVI+alternate)
Clouds particle size (1-1000μm)
Cloud Particle habit
Cloud extinction

NOx
HNO3
HO_x
HCl
H_2O isotopes
Whole air sampler (N_2O, CFCs, CH_4-CH_3Br-CH_3I-etc.)
BrO, ClO
GPS downlink

DC-8 payload proposed-Costa Rica

T, P, winds
Temperature profile
O_3
Ozone lidar nadir
Ozone lidar zenith
H2O lidar nadir
H2O lidar zenith
H_2O vapor
CO, CH_4 or N2O
H_2O total (CVI+alternate)
Aerosol size distribution

Ice Nuclei
Clouds particle size (1-1000μm)
Cloud Particle habit
Cloud extinction
Precipitation radar
Microwave radiometer
Lightning instr.
Dropsonde

NOx
HNO3
Acetone and PAN
HO_x
HCHO,HOOH ,CH_3OOH
Whole air sampler (N_2O, CFCs, CH_4-CH_3Br-CH_3I-etc.)
GPS downlink

UNIDENTIFIED LOW ALTITUDE AIRCRAFT CHEMISTRY PAYLOAD-Costa Rica

P.T, turbulence
O_3
H_2O vapor
CO
NO_x
Aerosol column opt. depth
Whole air sampler (N_2O, CFCs, CH_4-CH_3Br-CH_3I-
HCHO,HOOH, CH_3OOH
GPS downlink,

94 GHz radar
Aerosol size distribution
Aerosol composition
CCN
Solar spectral flux
Broad Band IR,solar flux