Scientific Opportunities and Practical Realities of the Meteorology near Costa Rico

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With great assistance of Lenny, Rennie, and anybody else from whom I could swipe something useful

Wed. April 25, 2007

Key Objective of this Meeting

1) To get all Flight Plan ideas on the table, i.e., what does each PI require for success

2) To develop integrated Flight Plans that best satisfy (1) and the overall TC4 Objectives

- Base Assumption: Maximize Coordination among the platforms => maximum science
  - All Platforms operate on same days
  - Platforms operate along same lines to extent possible.

Flight Planning Notions

- **Golden Rule :: Maximize Coordination among the platforms => maximum science**
  - **All Platforms operate on same days**
  - **Platforms operate along same lines to extent possible.**

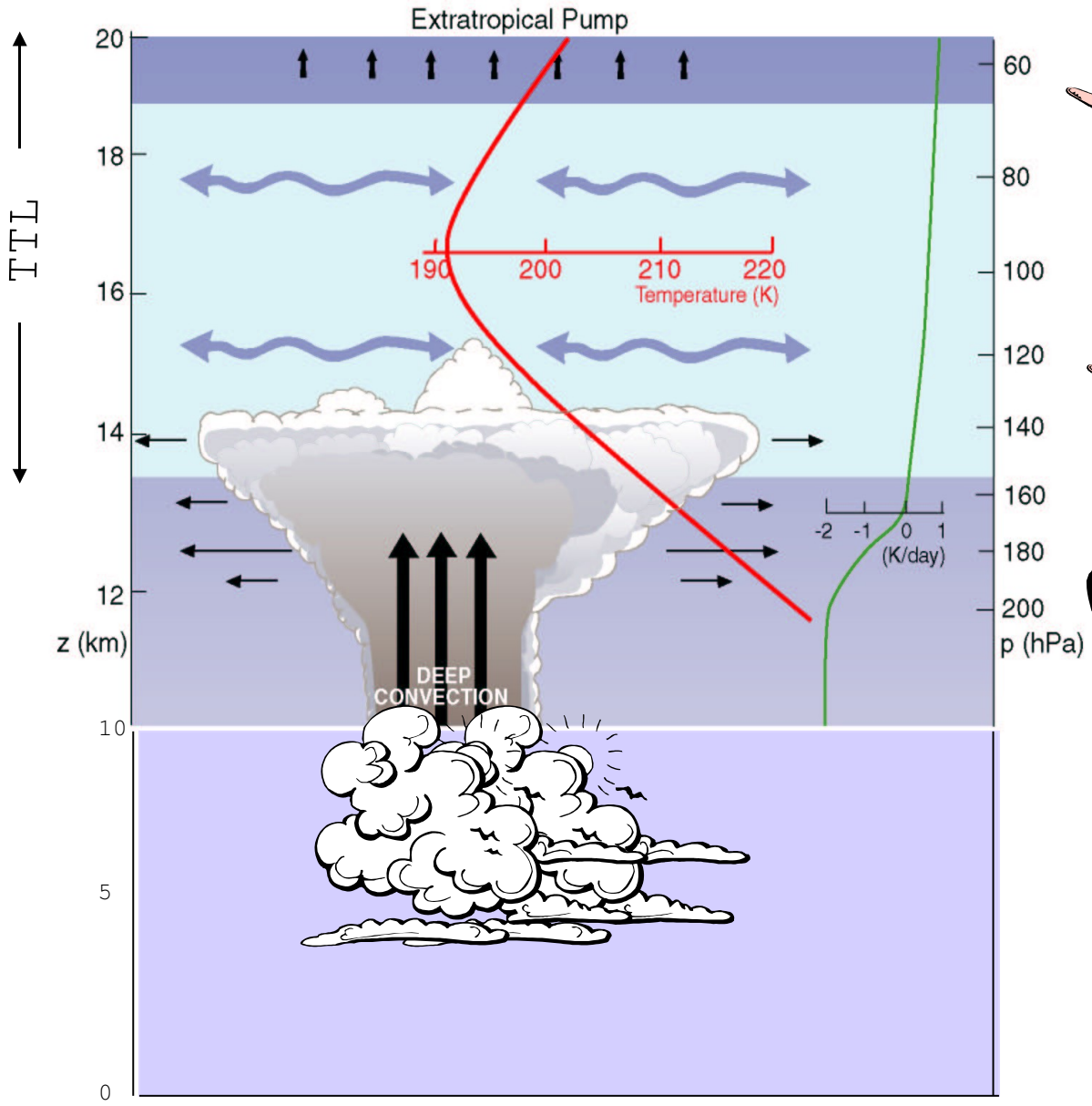
- **Schedule :: July 17 -> Aug 8 = 23 Flight days**

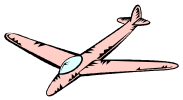
  No Back-to-back missions (ER-2 and WB-57)

  => 10 Flight Days at most

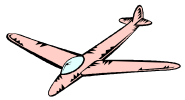
  => 9 Multi-aircraft Missions Likely

Sampling strategy–Costa Rica





Remote Sensing–ER–2



Cloud physics,
TTL chemistry
WB–57f

Cloud physics,
TTL chemistry,
Remote sensing
DC–8

Flight Plan Tactics

Questions:

- Night Flight ?
- DC-8 Penetration of "Benign" Convection ?
- DC-8 Profiling ? PBL sampling?
- WB-57 Porpoising versus Steps versus Spirals?
- DC-8 Line length?
- ER-2 Line Length?
- Orientation of Sample Lines
  - A-Train => along ground track or FOV track?…which?…when?
  - Science Goals = cross wind or along wind ? …….200 mb wind?
- Maritime Origin versus Land Origin
  - Where can we fly? …Central America?…South America?
  - Where are jetways in this region? i.e., impacts DC-8

Aerosol sources: Not fire season, Saharan dust unlikely

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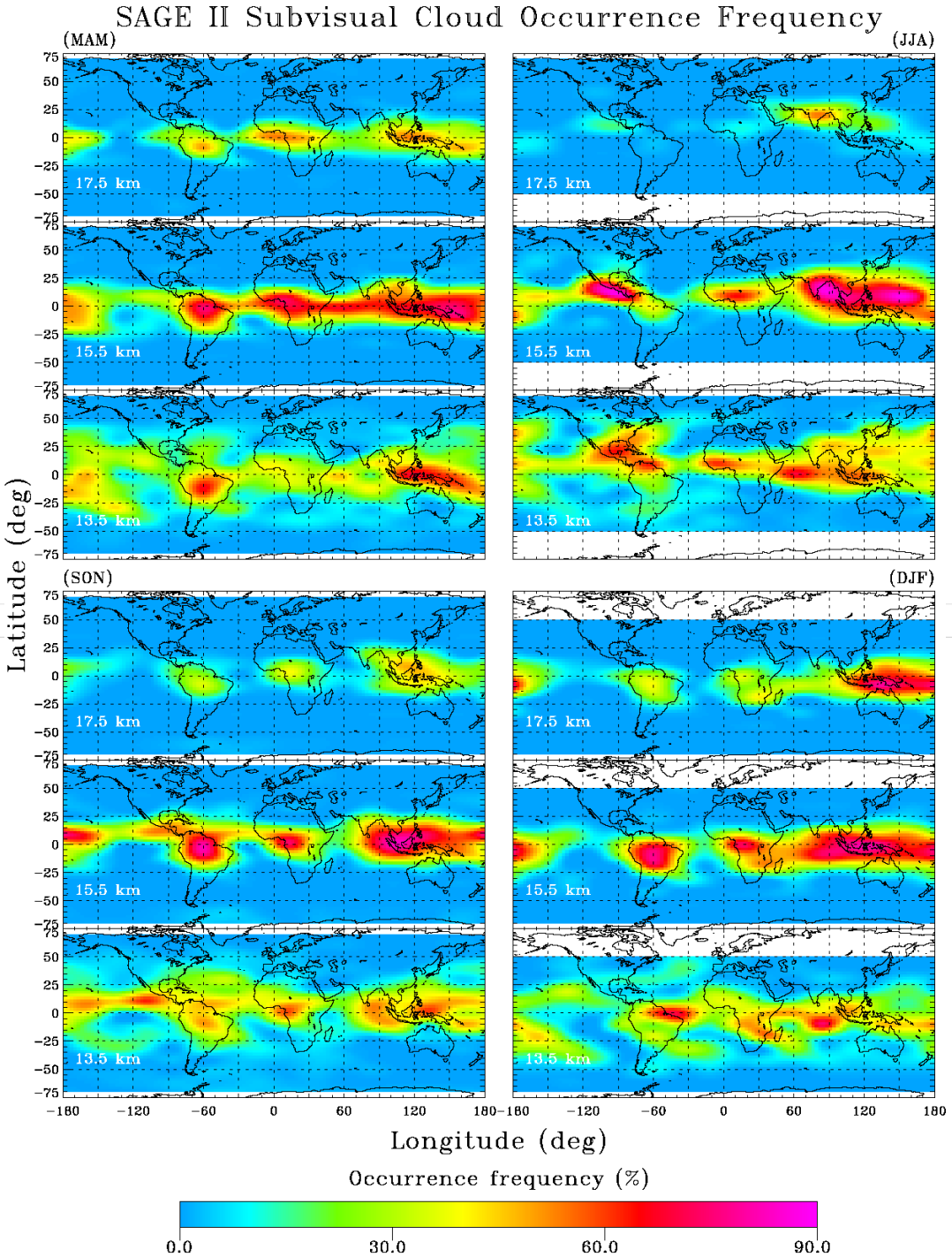
Science Questions => Focus on UT/TTL and connections to convective sources

Costa Rica summertime:

- TCSP experience => Cirrus nearly everyday

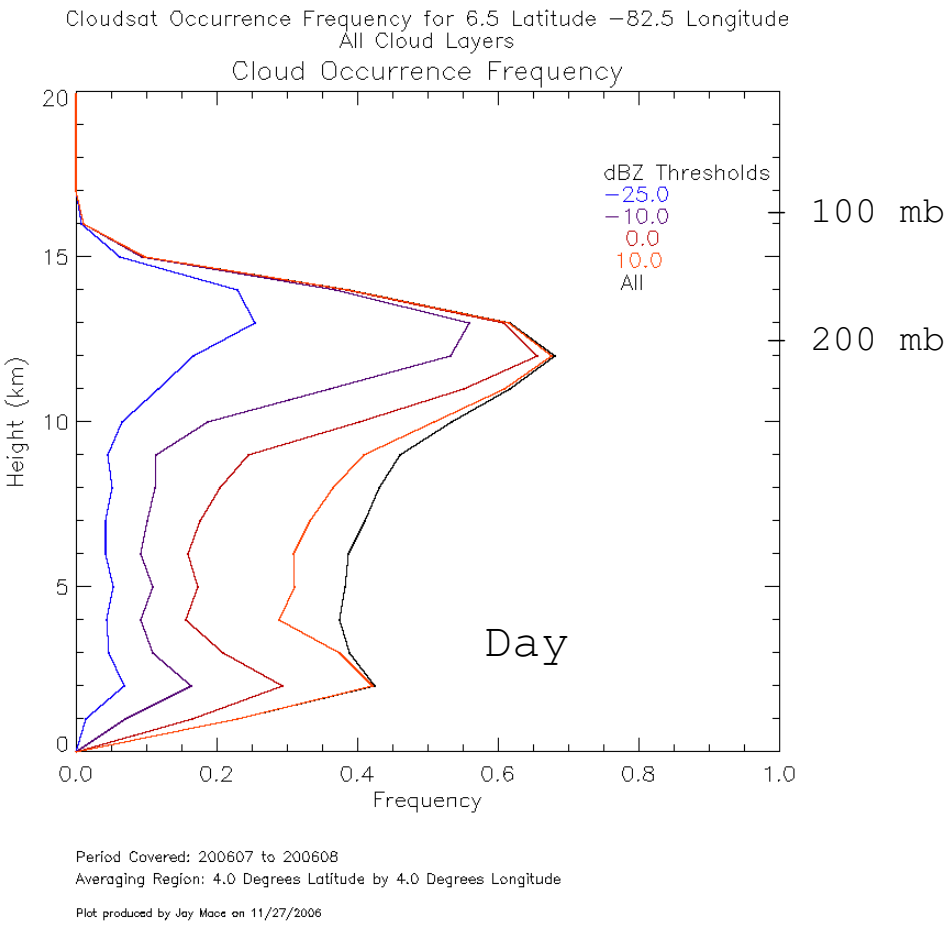


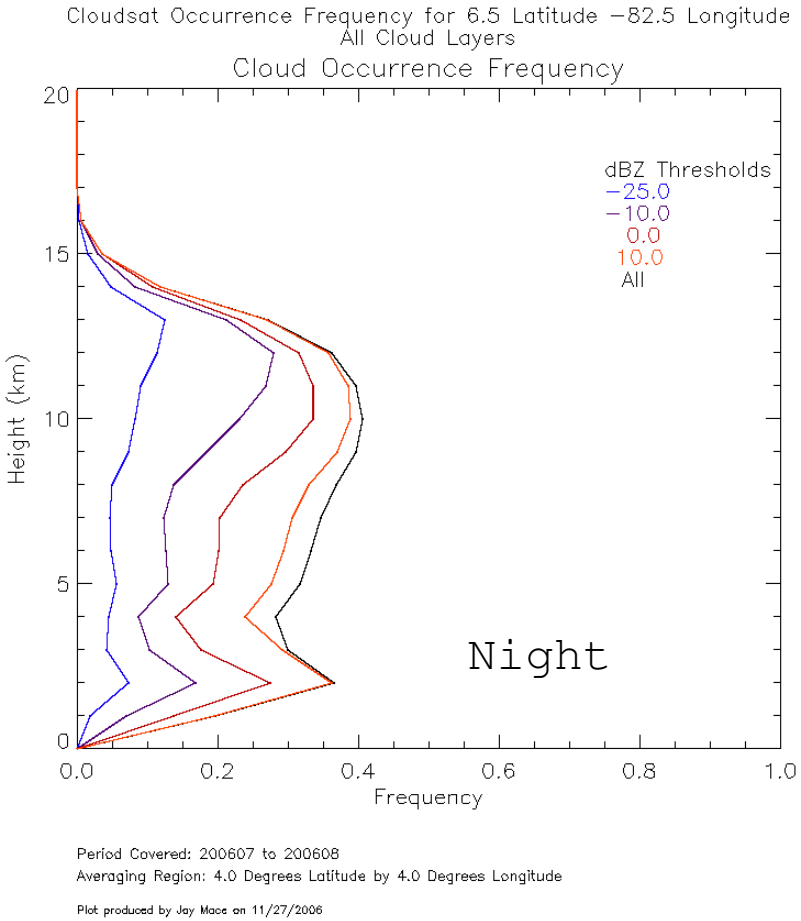
~86 mb

~122 mb

~168 mb

y-August 2006 CloudSat Reflectivity Vertical Distributions for TC4





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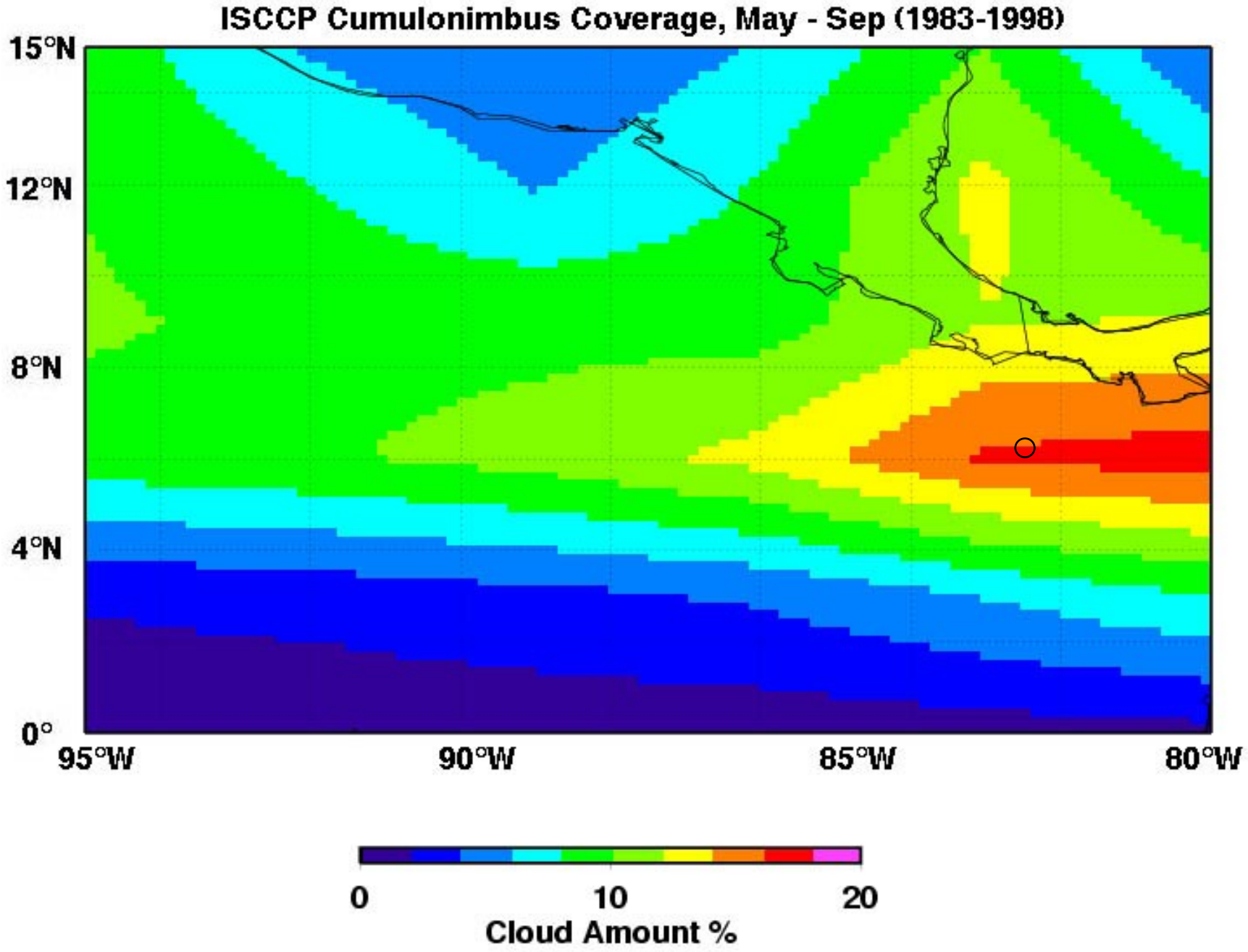
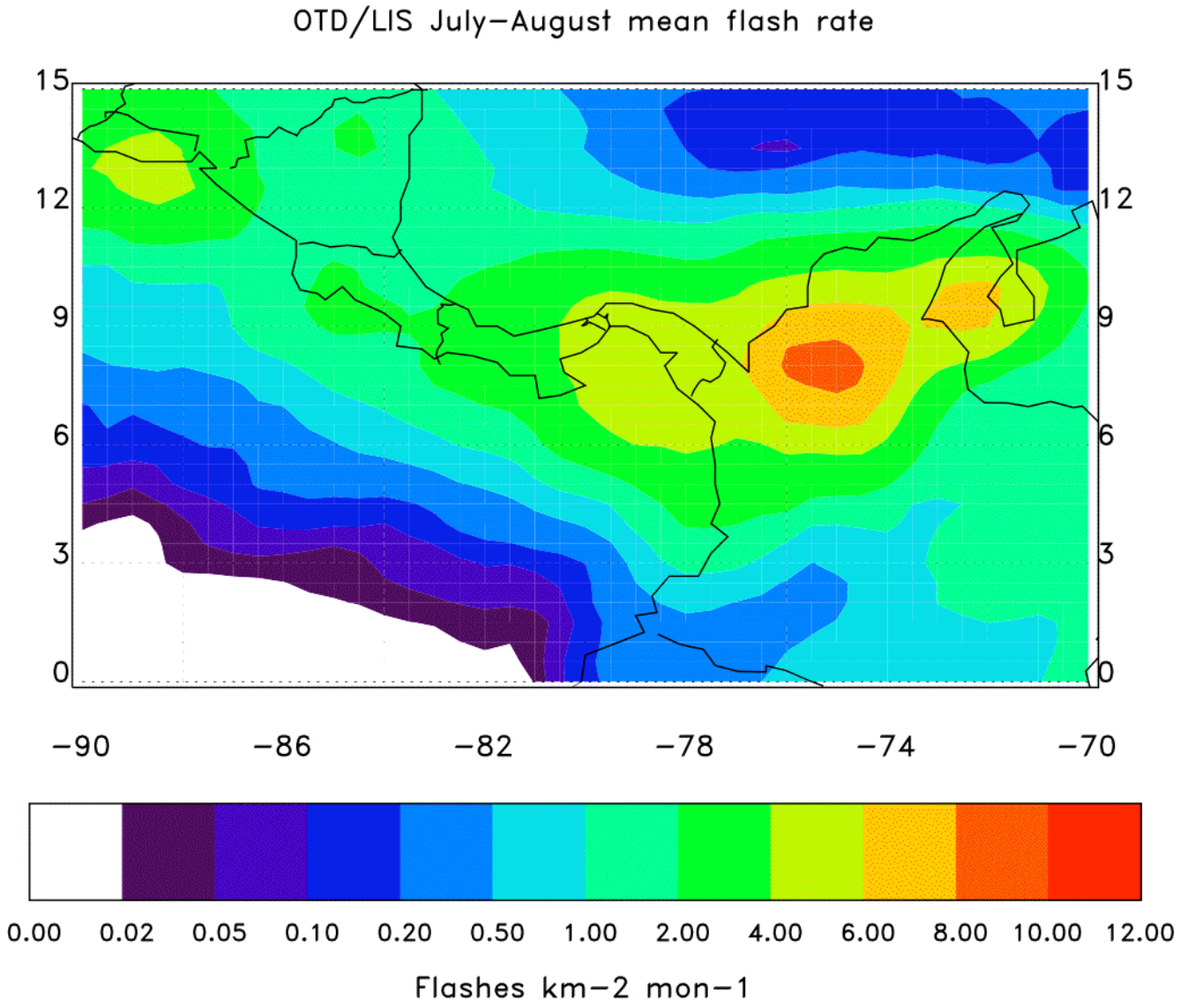
Science Questions => Focus on UT/TTL and connections to convective sources

Costa Rica summertime:

- TCSP experience => Cirrus nearly everyday
- Deep convection can occur anywhere, but strong focusing mechanisms (convergence zones) exist
  -


ISCCP Cumulonimbus Coverage, May - Sep (1983-1998)
15°N
12°N
8°N
4°N
0°
95°W
90°W
85°W
80°W
0
10
20
Cloud Amount %


OTD/LIS July–August mean flash rate
15
12
9
6
3
0
−90
−86
−82
−78
−74
−70
0.00
0.02
0.05
0.10
0.20
0.50
1.00
2.00
4.00
6.00
8.00
10.00
12.00
Flashes km−2 mon−1

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Science Questions => Focus on UT/TTL and connections to convective sources

Costa Rica summertime:

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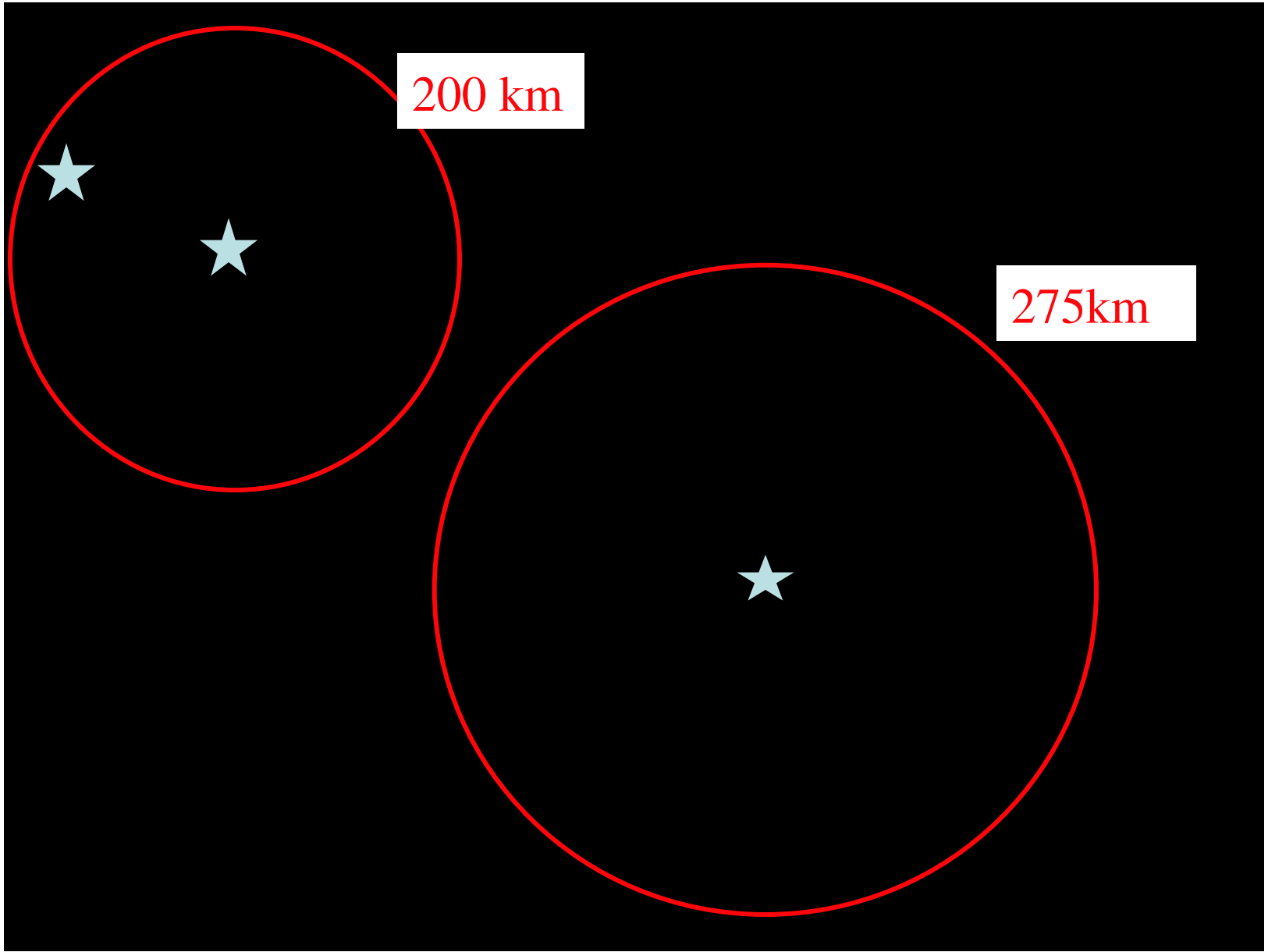
  - Panama Bight
  - Off-shore in Gulf (Land Breeze against Trades)


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

Locations of Ground Sites & Radar Coverage



Convection near Costa Rico

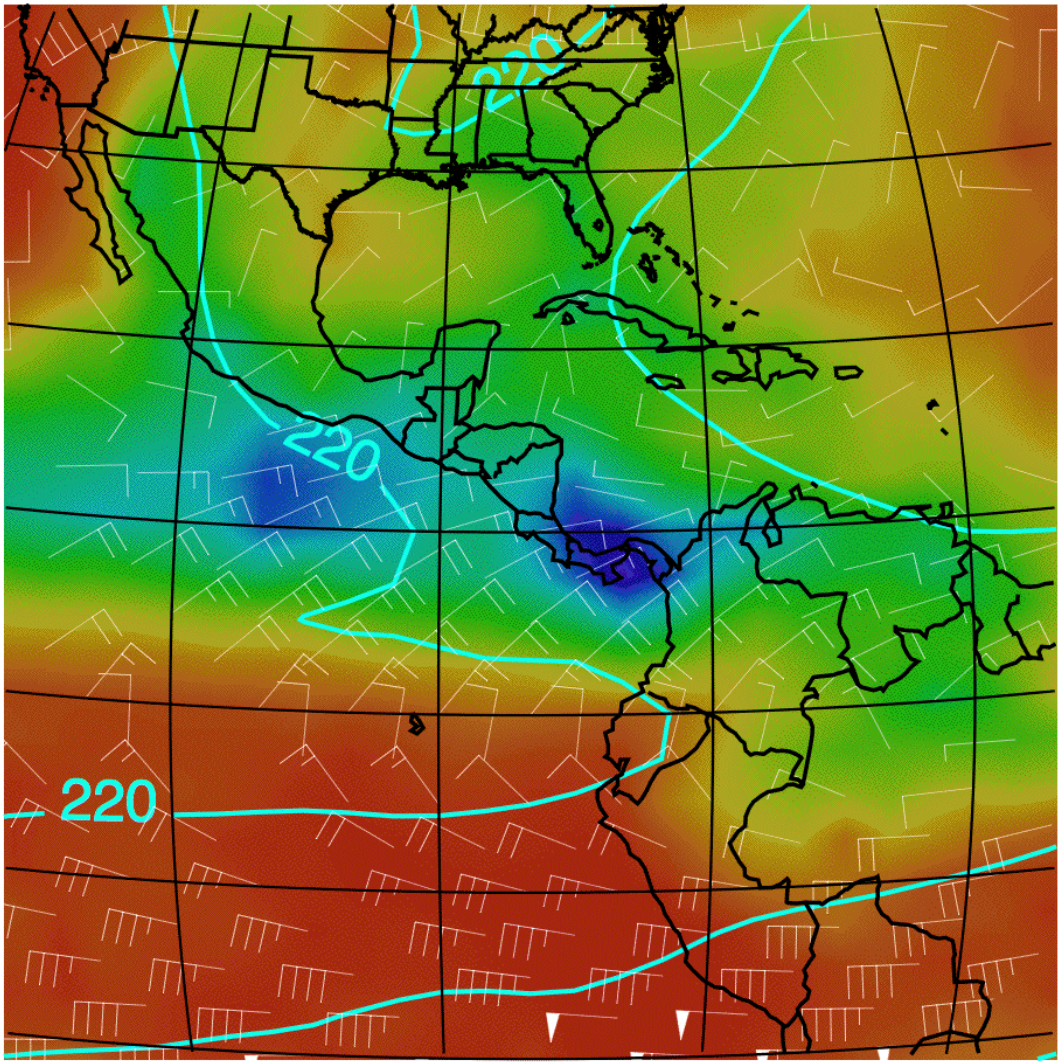
Panama Bight – Intense very deep convection, late night into early morning, reliable, very messy

Off-shore in Gulf (Land Breeze against Trades) – Weaker maritime convection, morning

Land Convection over CR and Nicaragua: Moderate? intensity, usually at SJ by 1-2 pm

Traveling Pacific Disturbances (post-Bight, Easterly Waves?) –
weak to moderate convection, maritime diurnal cycle

2000-2006 July 15 - August 15 Avg at 200.0 mb ~12.4 km



NMC, Grid: GG2%5X2%5

Seq: E01, Spec: SREAN2

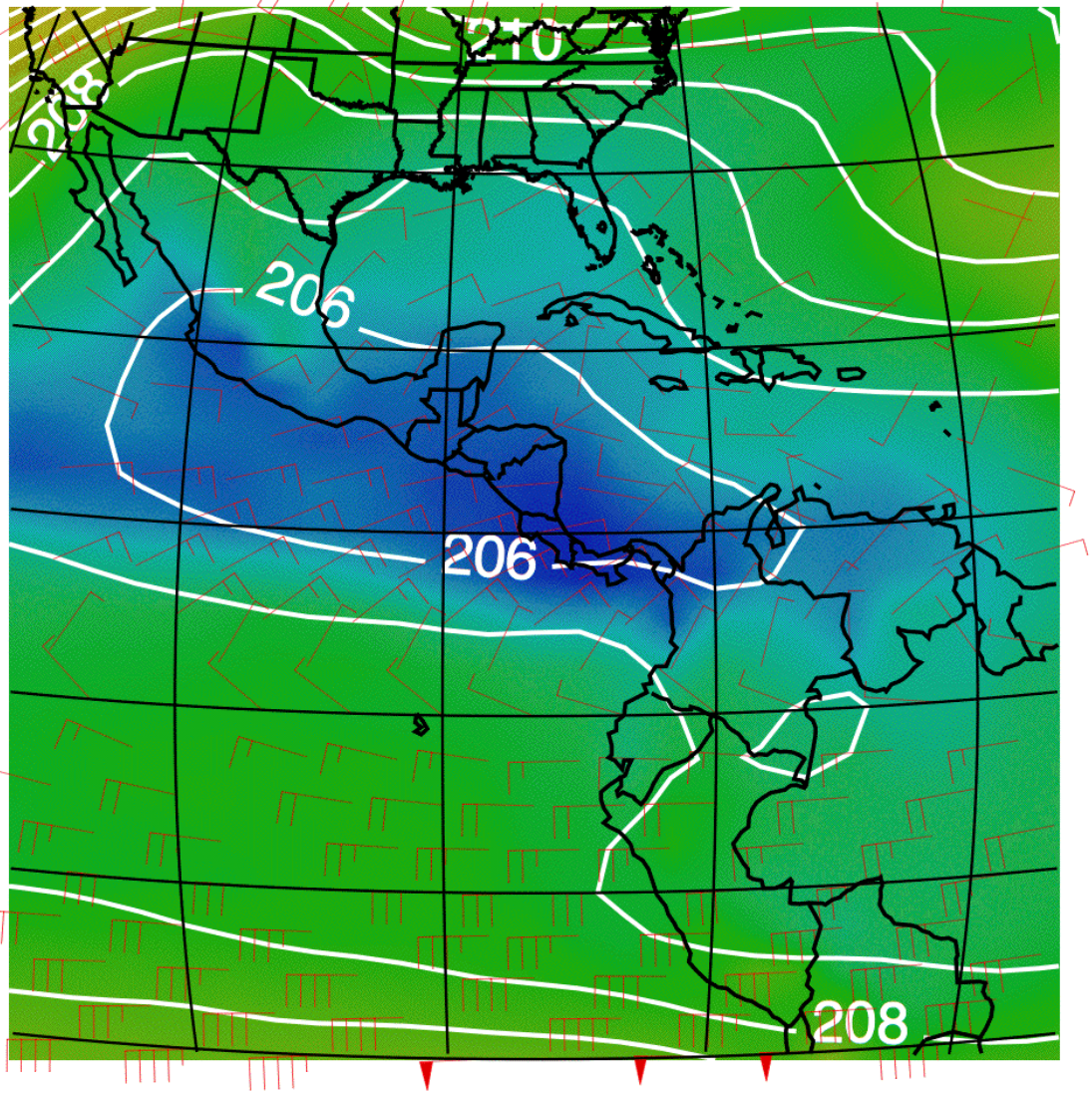
HIRS July Cld Freq Abv 12 km (%)

-8.0
0.5
9.0
17.5
26.0
34.5
43.0
51.5
60.0

Winds (knts)

T (K)

2000-2006 July 15 - August 15 Avg at 150.0 mb ~14.2 km



NMC, Grid: GG2%5X2%5

Seq: E01, Spec: SREAN2

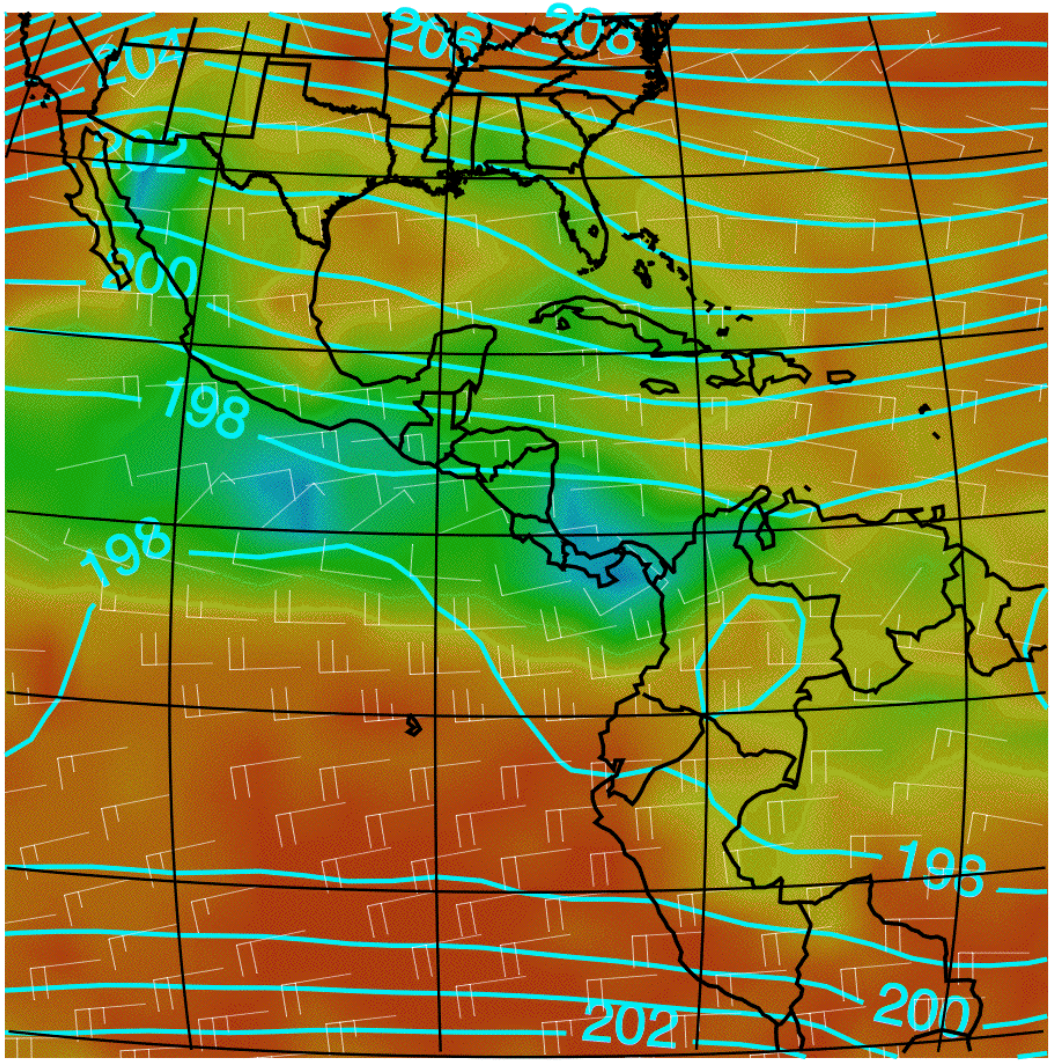
RH at 150 MB (%)

-12.0
2.0
16.0
30.0
44.0
58.0
72.0
86.0
100.0

Winds (knts)

T (K)

2000-2006 July 15 - August 15 Avg at 100.0 mb ~16.3 km



NMC, Grid: GG2%5X2%5

Seq: E01, Spec: SREAN2

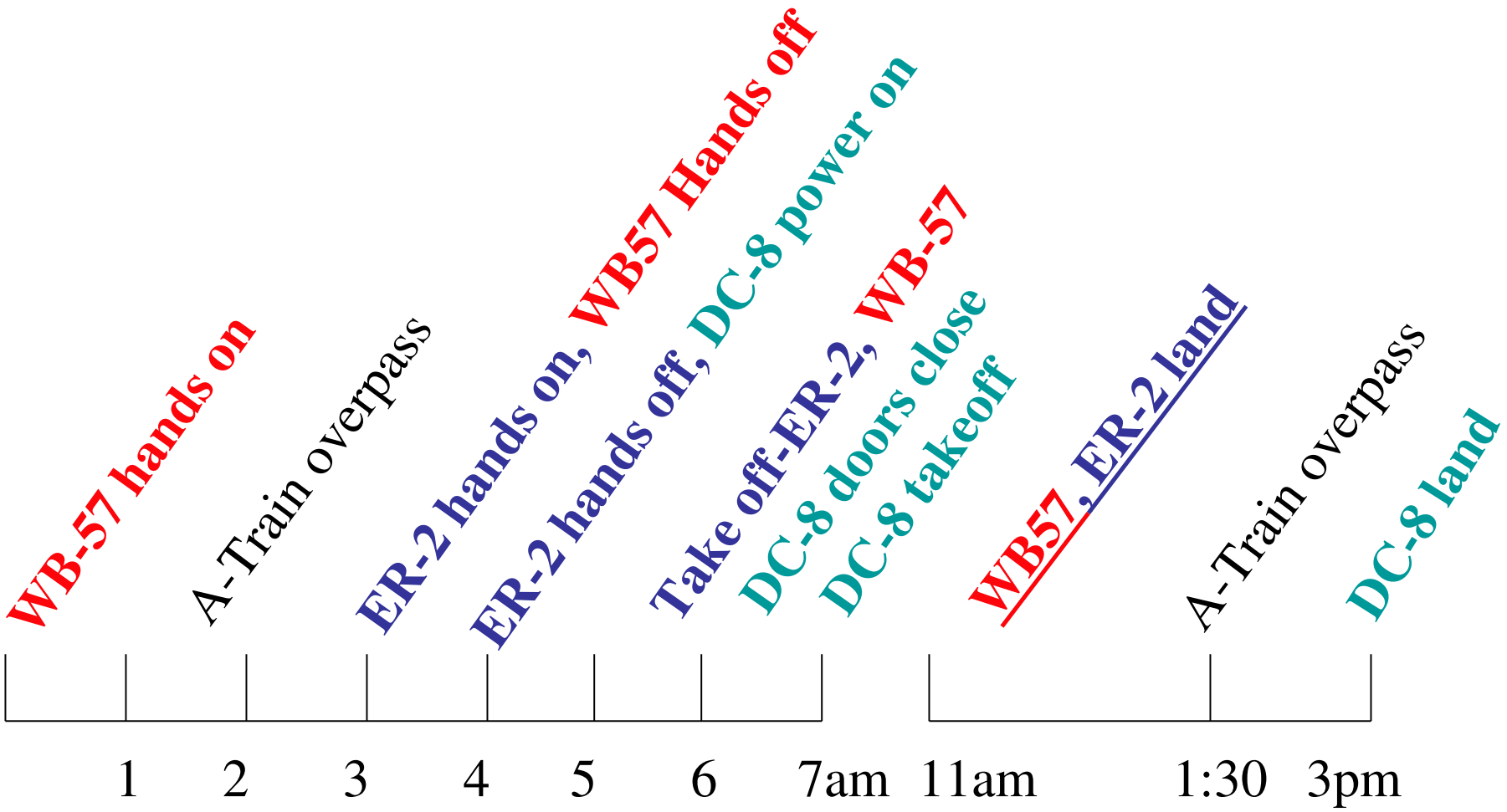
HIRS July Cld Freq Abv 16 km (%)

-3.0
-0.8
1.5
3.8
6.0
8.2
10.5
12.8
15.0

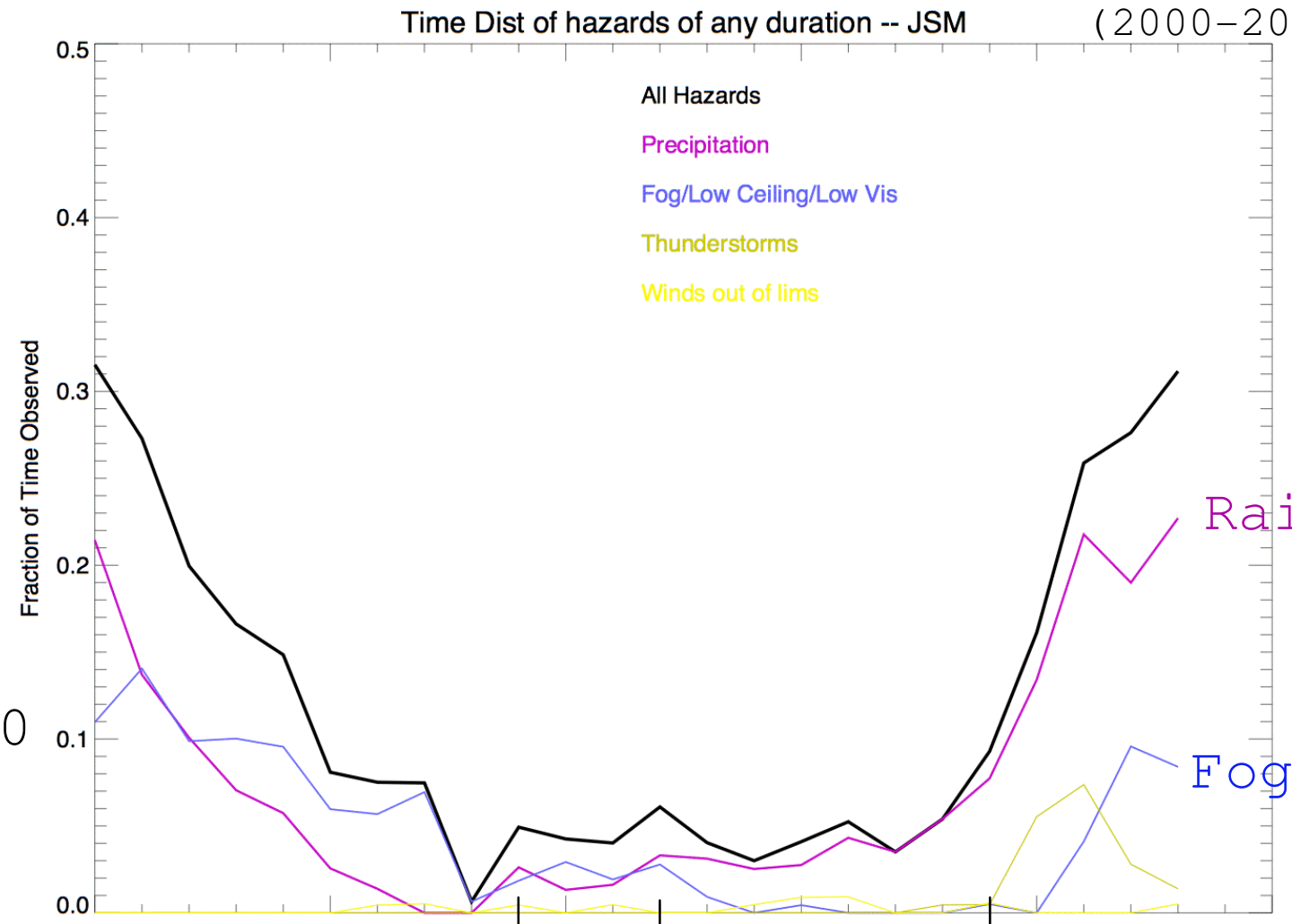
Winds (knts)

T (K)

Typical Flight Day Timeline



Daily Weather at San Jose



Rain

Fog/Vis

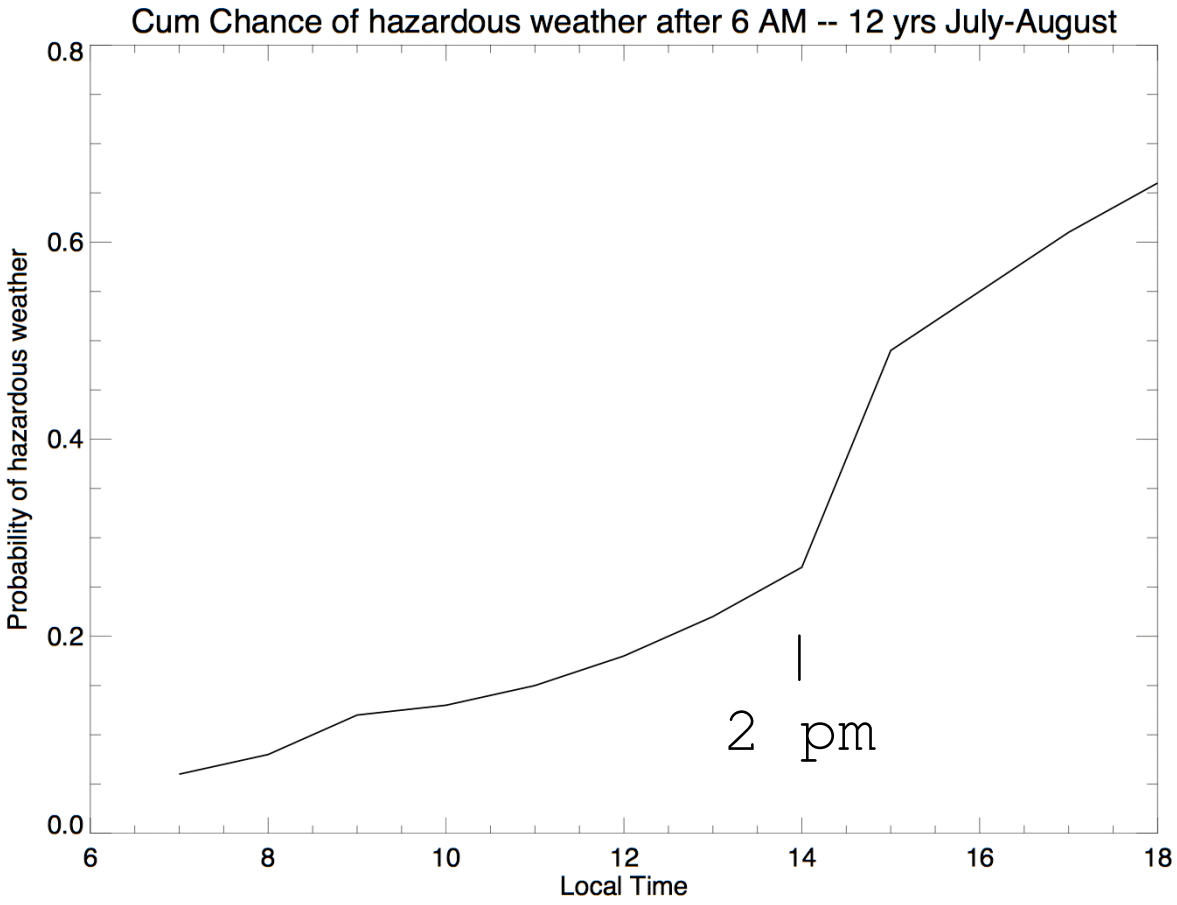
0.10

3 am

6 am

1 pm

Daily Weather at San Jose



0.40

0.20

20/23 days at 1030 for wx at 1200 LST (1800 UT)

10 of 20 = no haz wx (18-24 UT); 1 of 3 haz wx (18-24 UT)

ion: 3 hours is typical (rain followed by fog/low c

Major Issue: ER-2 and WB-57 will only rarely be available for A-Train underflights (pm)

- TAF statistics: only 2-3 opportunities to plan flotilla missions with A-Train pm overpass

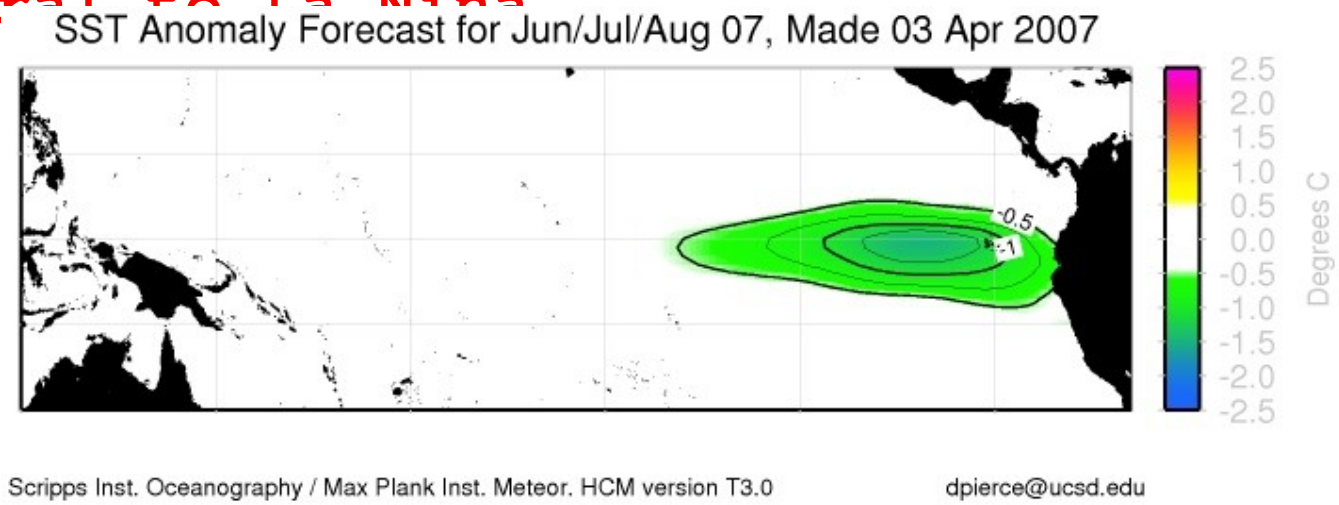
?? Mitigating Strategy for ER-2: On select occasions (forecast guidance), delay T/O slightly (7-8 am), plan for usual landing time, but delay landing based on real-time developments in San Jose area as observed by UO radar, land by 2-3 pm.

TCSP: Predominantly night flights (1 am T/O), Primary target was deep convective systems (Hurricanes)

Nighttime A-Train Overpass:

- MODIS, OMI use solar radiation
- Cirrus are notoriously indistinct, very challenging at night for in-situ measurements, even with full moon. Could use DC-8 lidar for guidance (we already plan this for daytime)
- ER-2 and especially WB-57 are heavily constrained in convective environment, much worse at night
- WB-57 night landings are possible, but not

El Niño Forecast: Transition from ENSO-neutral to La Niña



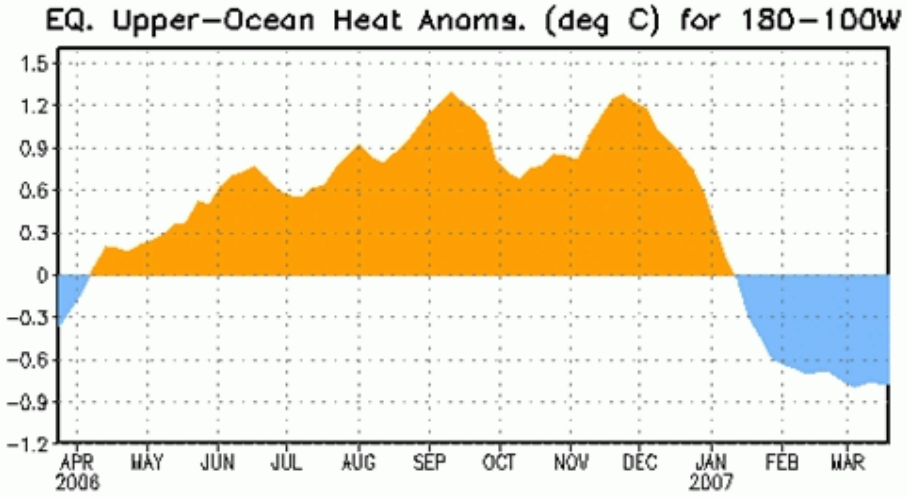
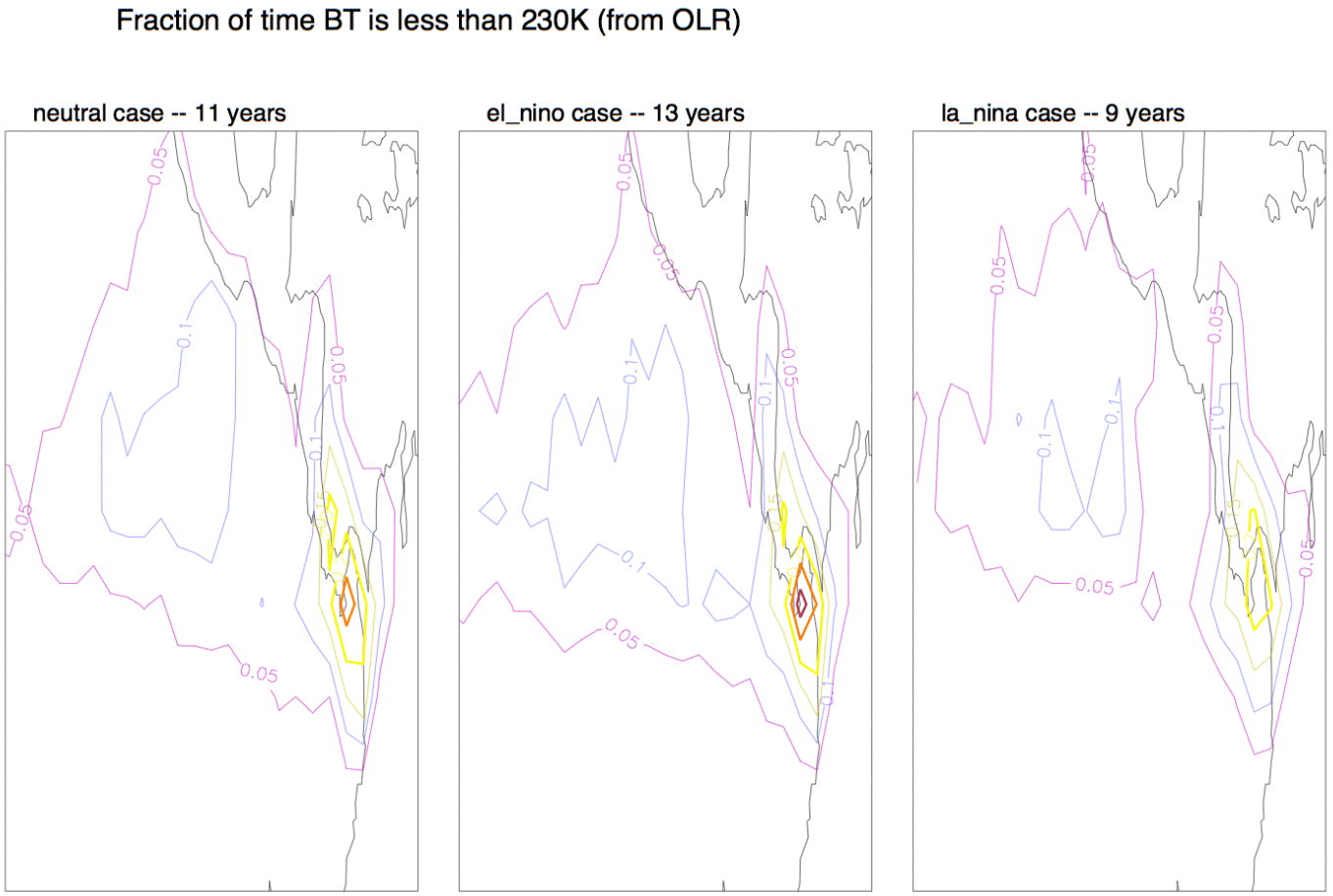


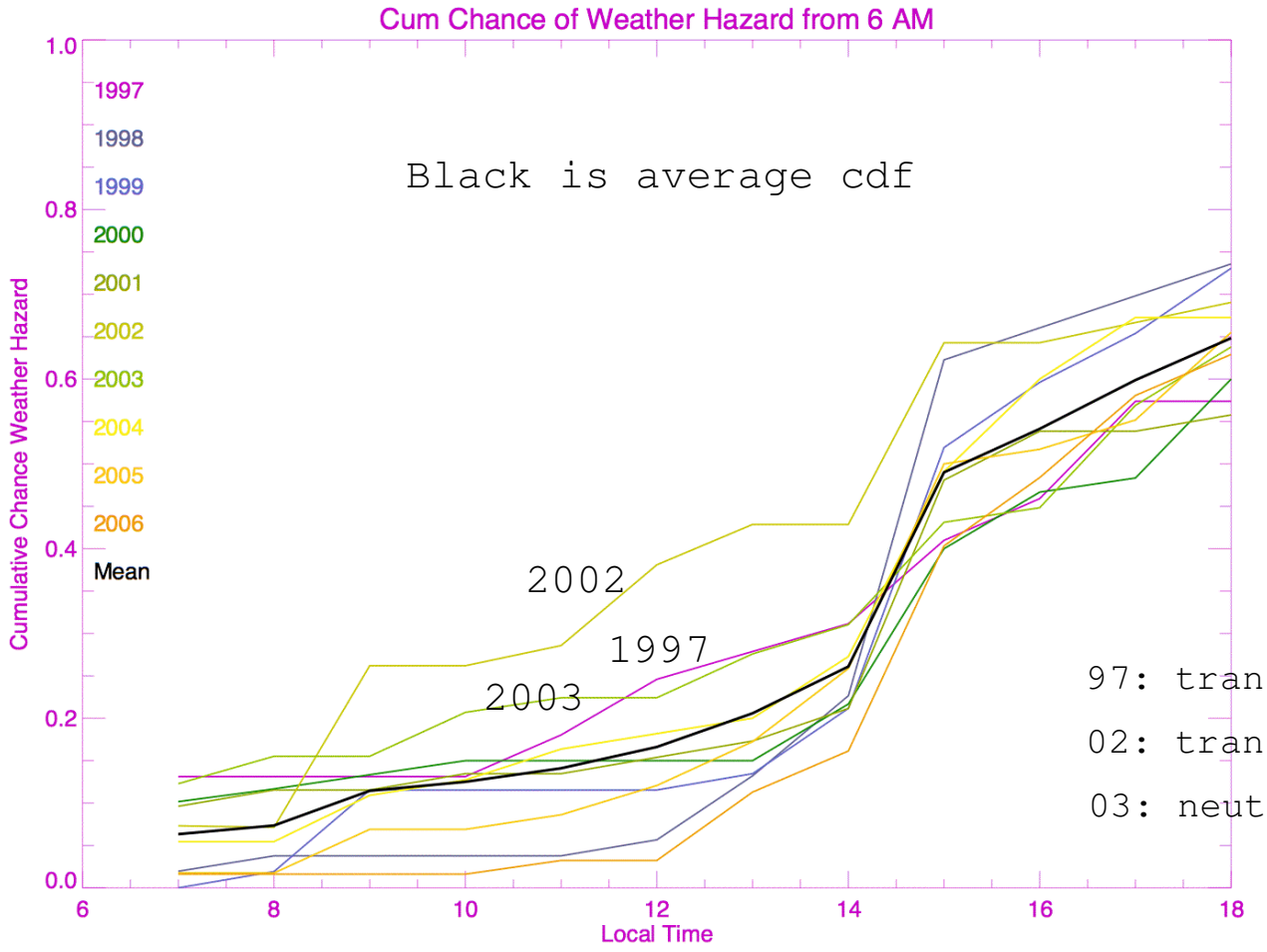
Figure 3. Anomalous equatorial upper-ocean heat content averaged over the longitude band 180°-100°W. Heat content anomalies are computed as departures from the 1982-2004 base period means.

El Nino: What it means for TC4?



Expect Panama Bight to be less active the usual

Daily Weather at San Jose



97: transition to El Nin

02: transition to El Nin

03: neutral within El Ni

Interannual Variability: No obvious ENSO signal

Summary

- Get ready for lots of cirrus !!!
  - "Clear" pixels will be issue for A-Train
- Have productive discussions of Flight Plan issues and develop some great plans
- Sleep management will be significant issue for all science and operational

Why

Major Questions
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?

Why (contd.)

Detailed Major Questions
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?

Example of flights in a summer mission-convection may be de-emphasized without radar

Number of multi-aircraft missions dedicated to goal	Goals (not prioritized) All flights include satellite validation
5	Deep maritime convection-anvils
2	Deep continental convection-anvils
5	Examine TTL properties (Clear sky)
3	Outflow sampling