A Meteorological Overview of the TC4 Mission

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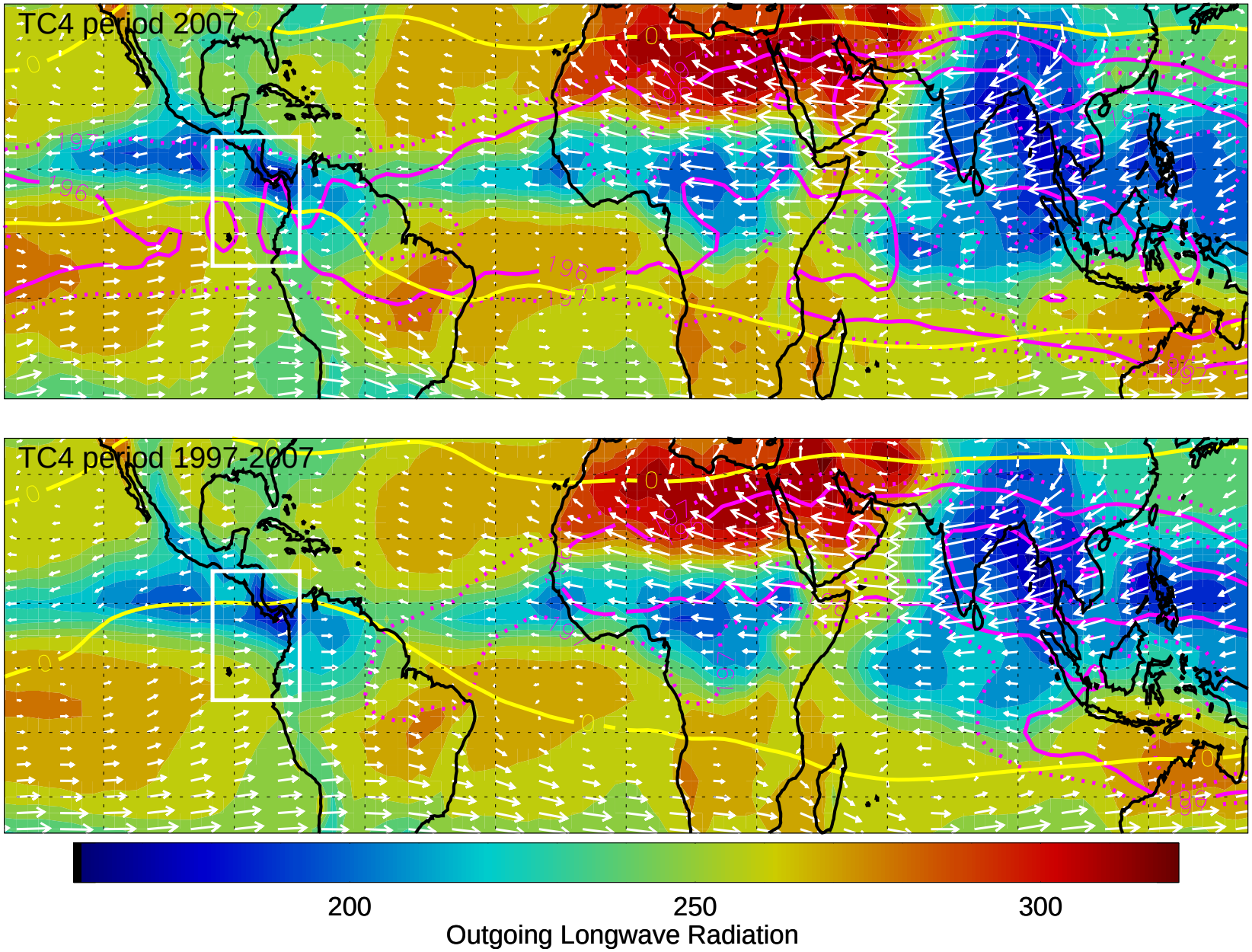
- Basic Flow Patterns for TC4 and comparison with previous years
- Air Mass origins through the depth of the atmosphere during TC4
- Temporal Variations during TC4
- Mesoscale Motions near the Tropopause

The TC4 met effort would not have been possible without:

- The forecasters (IMN)
  - Evelyn Quiros
  - Berny Fallas
  - Eladio Solano Leon
  - Gustavo Murillo
- The modelers (UCR CIGEFI):
  - Jorge Amador
  - Erick Rivera
  - Marcela Ulate
  - Ana Maria Duran

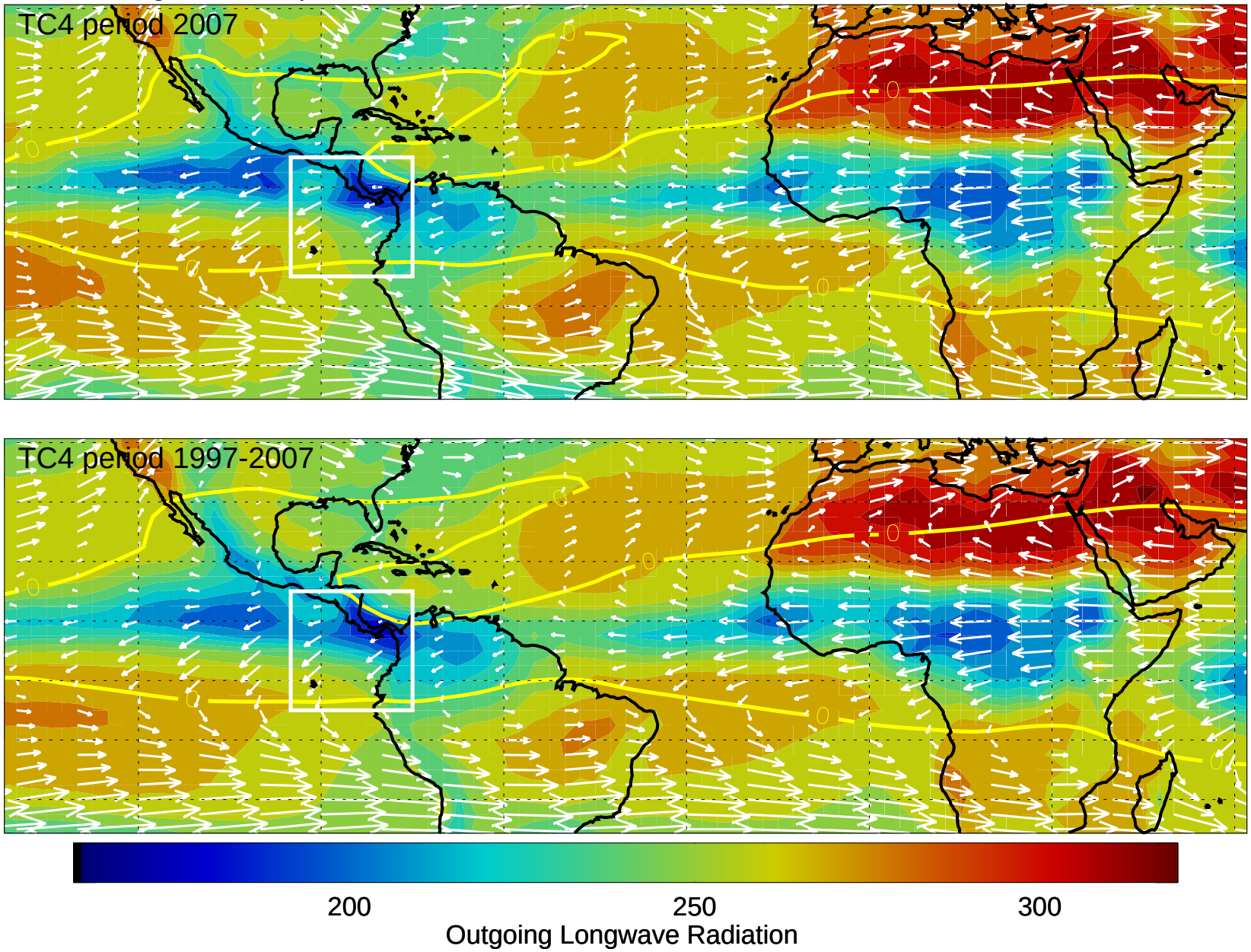
OLR, Winds and Temperature at 100mb (TTL) during TC4 period

Average for TC4 period at 100 mb



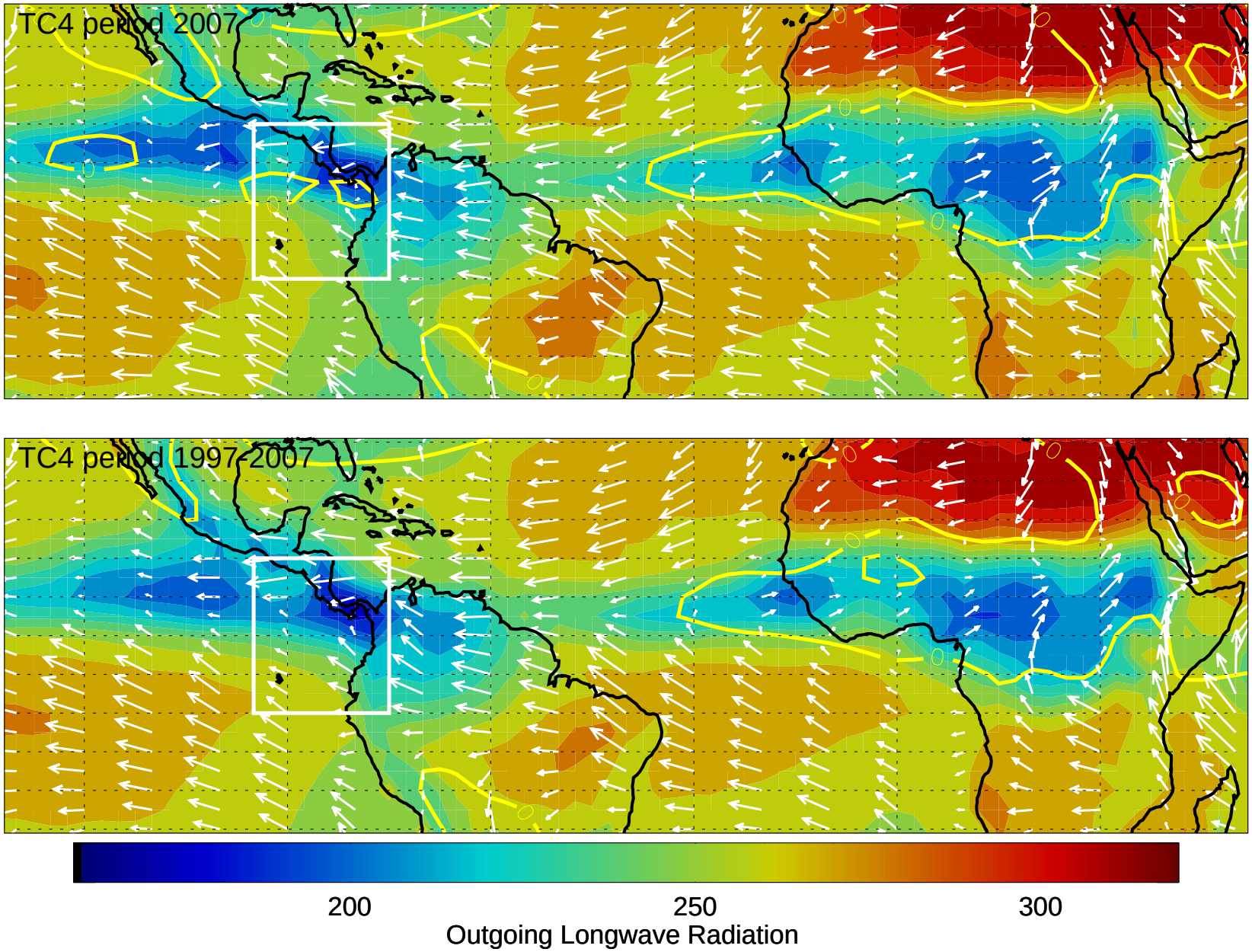
OLR and Winds at 200mb (DC-8 altitude) during TC4 period

Average for TC4 period at 200 mb



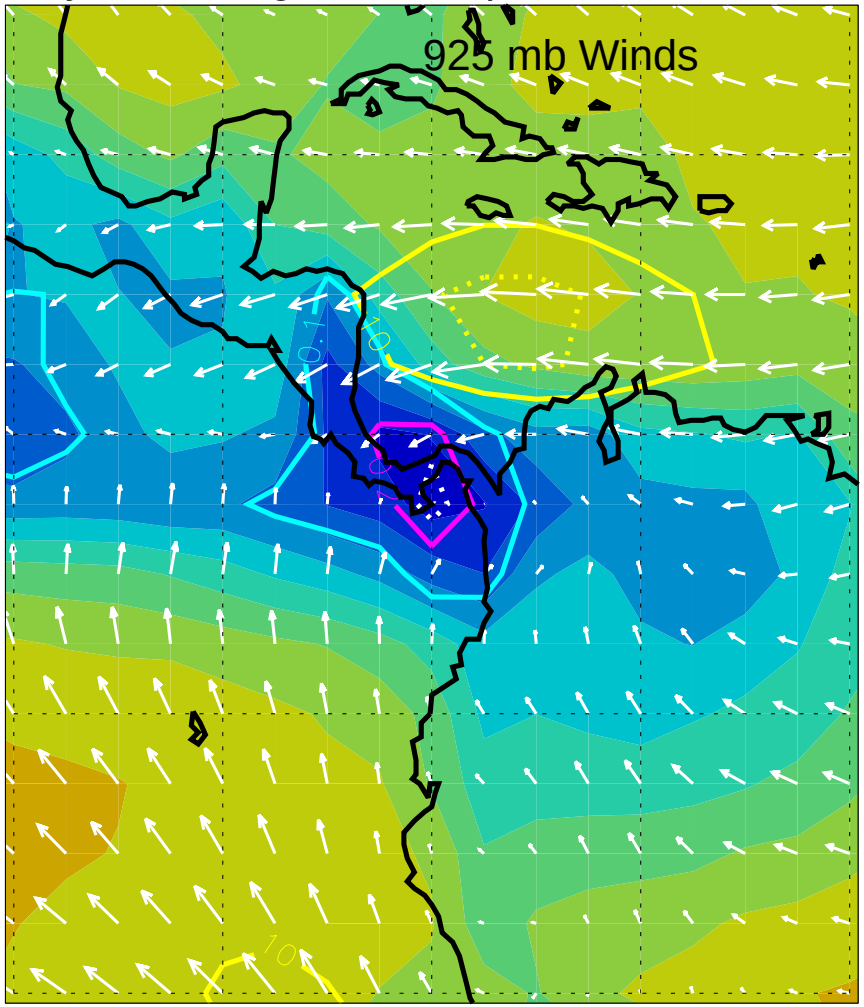
OLR and Winds at 850mb (1.6 km) during TC4 period

Average for TC4 period at 850 mb

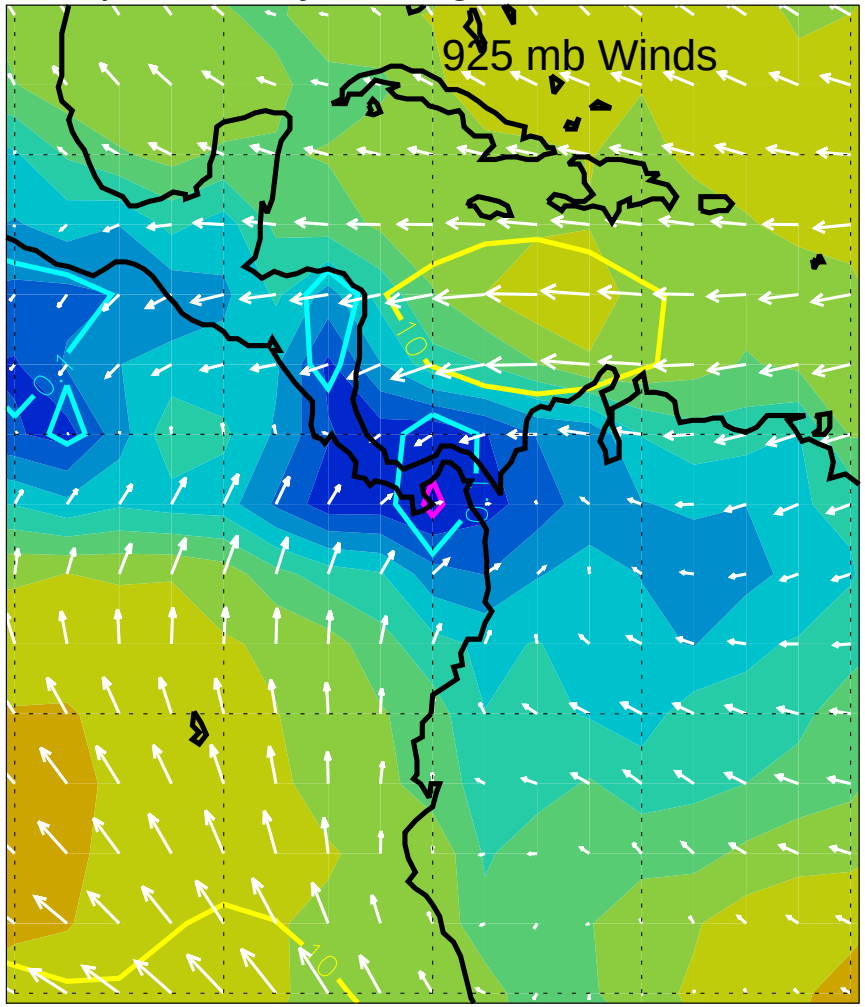


OLR and Winds at 925mb (Boundary Layer) during TC4 period

10 year average for TC4 period



TC4 period, July 5 - August 15, 2007



200 250 300

NOAA Outgoing Longwave Radiation

Yellow -- 10 and 12.5 ms-1 isotachs

Cyan -- 10% Frequency BT < 230K

Magenta -- 20% Frequency BT < 230K

Dotted White -- .25% Frequency BT < 230K

Major points, basic flow patterns

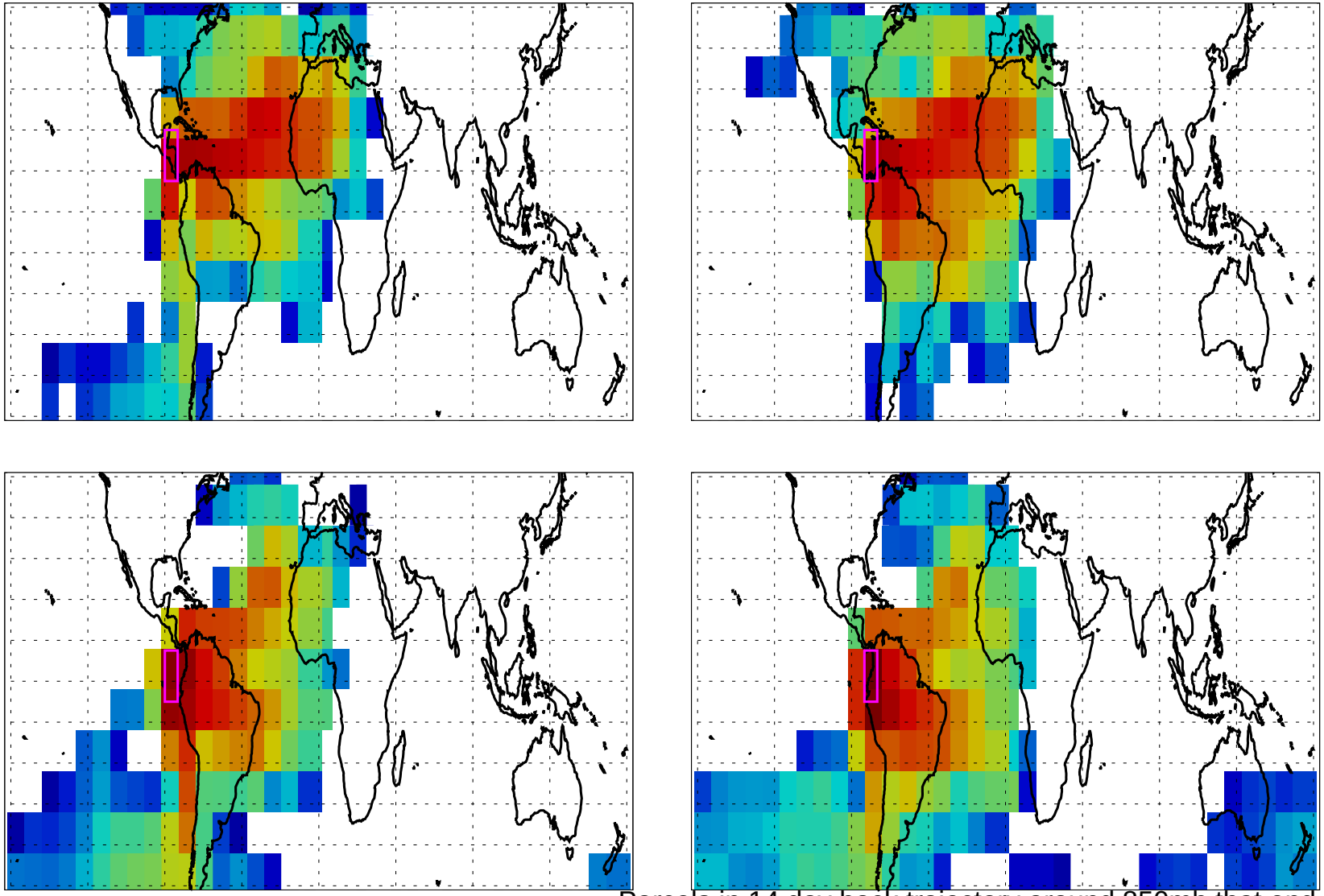
- TTL region – most of the air comes from the east from colder regions
- TTL region – easterly flow more persistent than in a typical year
- DC-8 levels – significant flow around NA anticyclone into TC4 region
- low levels – Easterly flow – from the Sahara
- low levels – northerly flow from African BB regions into African convective zones (which might feed into the TC4 TTL region)
- Boundary Layer and local convection – weaker than normal easterly flow, and weaker than normal convection

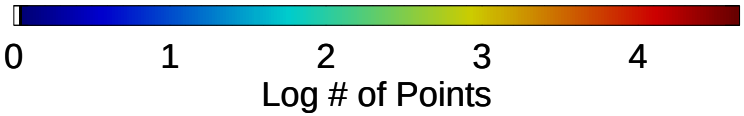
Origin of Air in TC4 region – two approaches

- Kinematic Back trajectory analyses (for altitudes up to 200mb)
  - 14 day back trajectories from 1 by 1 degree grid of points in 4 quadrants
  - Examine distribution of where parcels have been in previous 14 days
- Convective Influence Calculations (for TTL region)
  - 20 day (diabatic, clear sky) back trajectories from same grid of points
  - Run trajectories through satellite imagery and establish location and time of convective influence
  - Examine distributions of convective influence
  - Compare with distributions during CRAVE (time permitting)

Distribution of points of 14 day back trajectories from 850mb

TC4 850mb Trajectory Climo

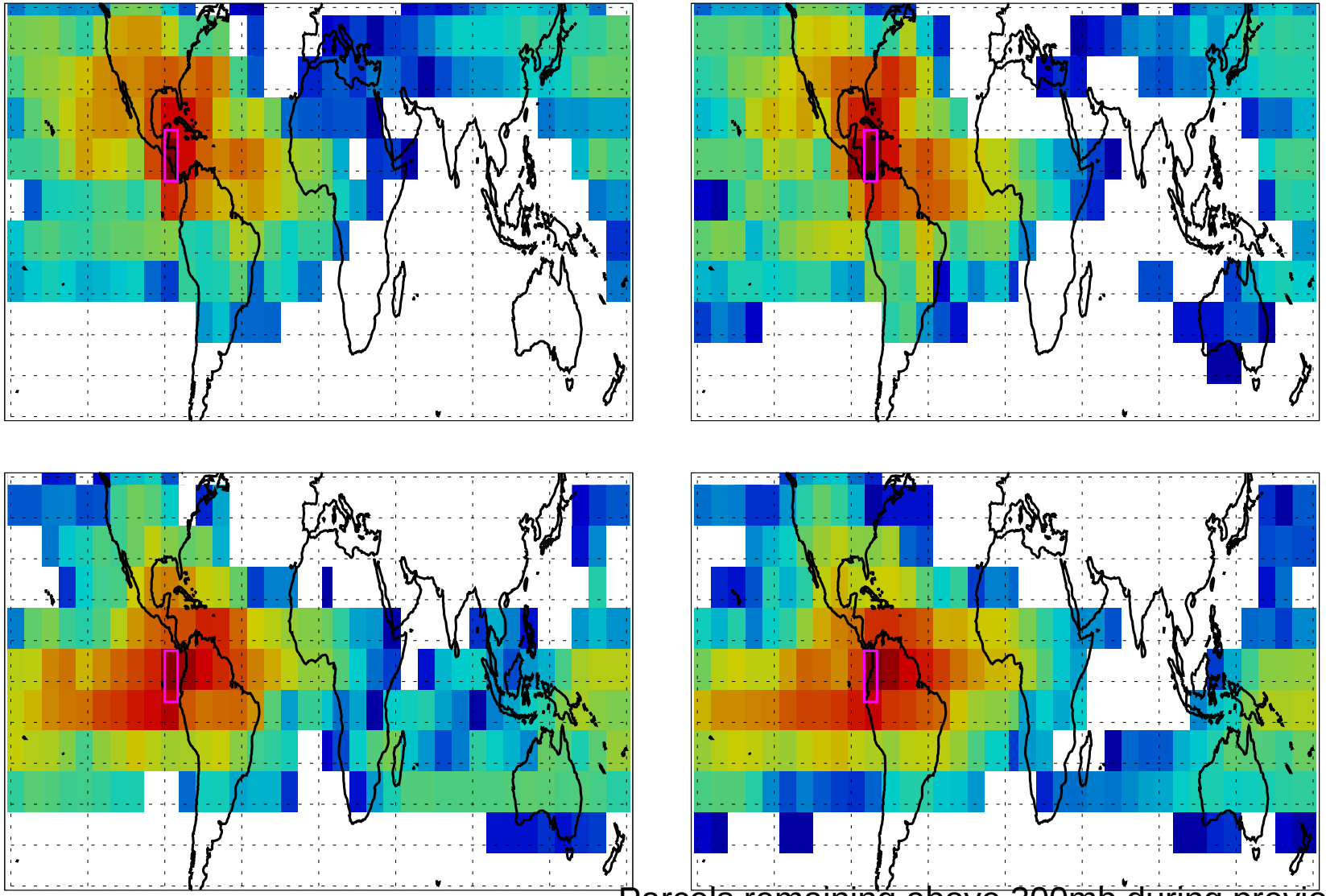




Parcels in 14 day back trajectory around 850mb that end up inside magenta box originate in locations proportional to # of pts

Distribution of points of 14 day back trajectories from 200mb – high altitude

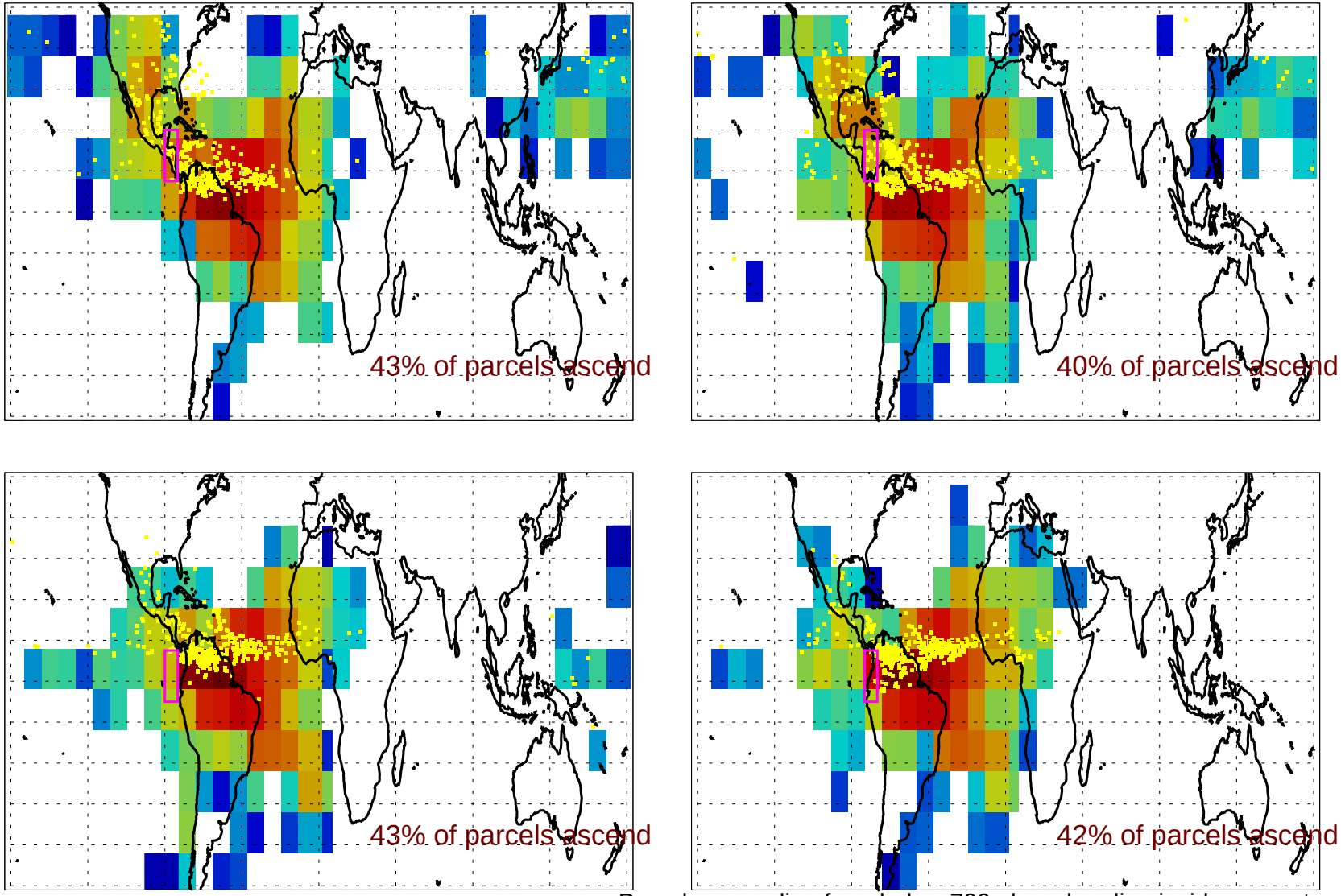
TC4 200mb Trajectory Climo -- High Altitude Parcels

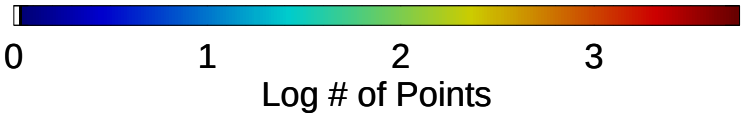


Parcels remaining above 300mb during previous 14 days ar
inside magenta box originate in locations proportional to # o

Distribution of points of 14 day back trajectories from 200mb – low altitude

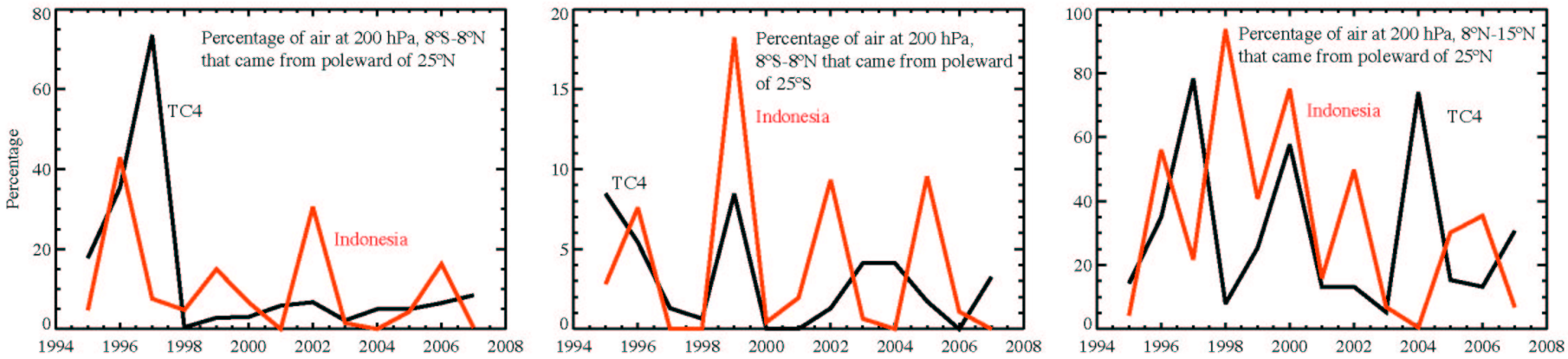
TC4 200mb Trajectory Climo -- Ascending Parcels





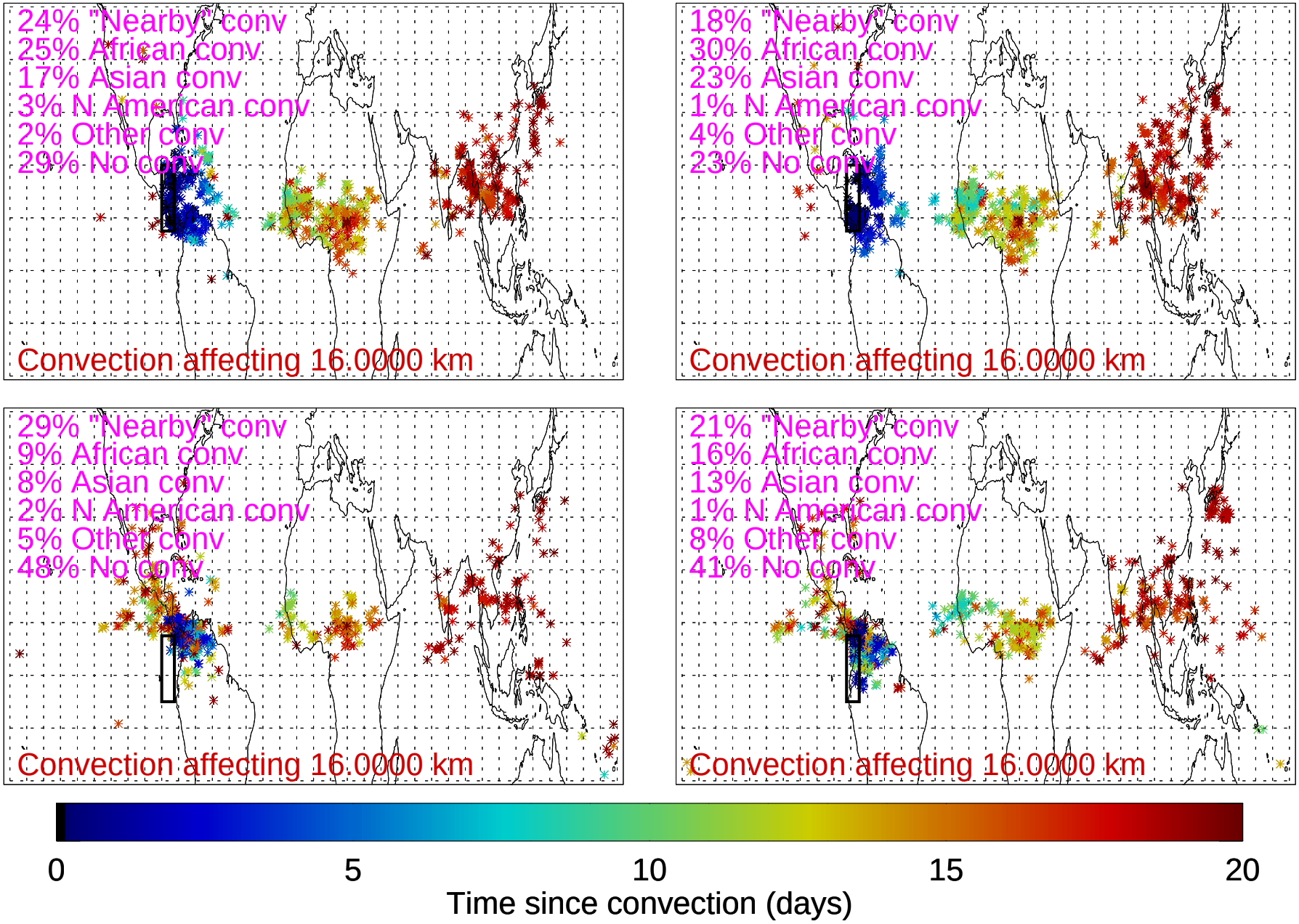
Parcels ascending from below 700mb and ending inside magenta box at 200mb originate in locations proportional to # of pts

Interannual Variability in trajectory endpoints reaching high latitudes



Courtesy Karen Rosenlof

Locations and times of convection influencing grid of points in TC4 region at 16.0 km



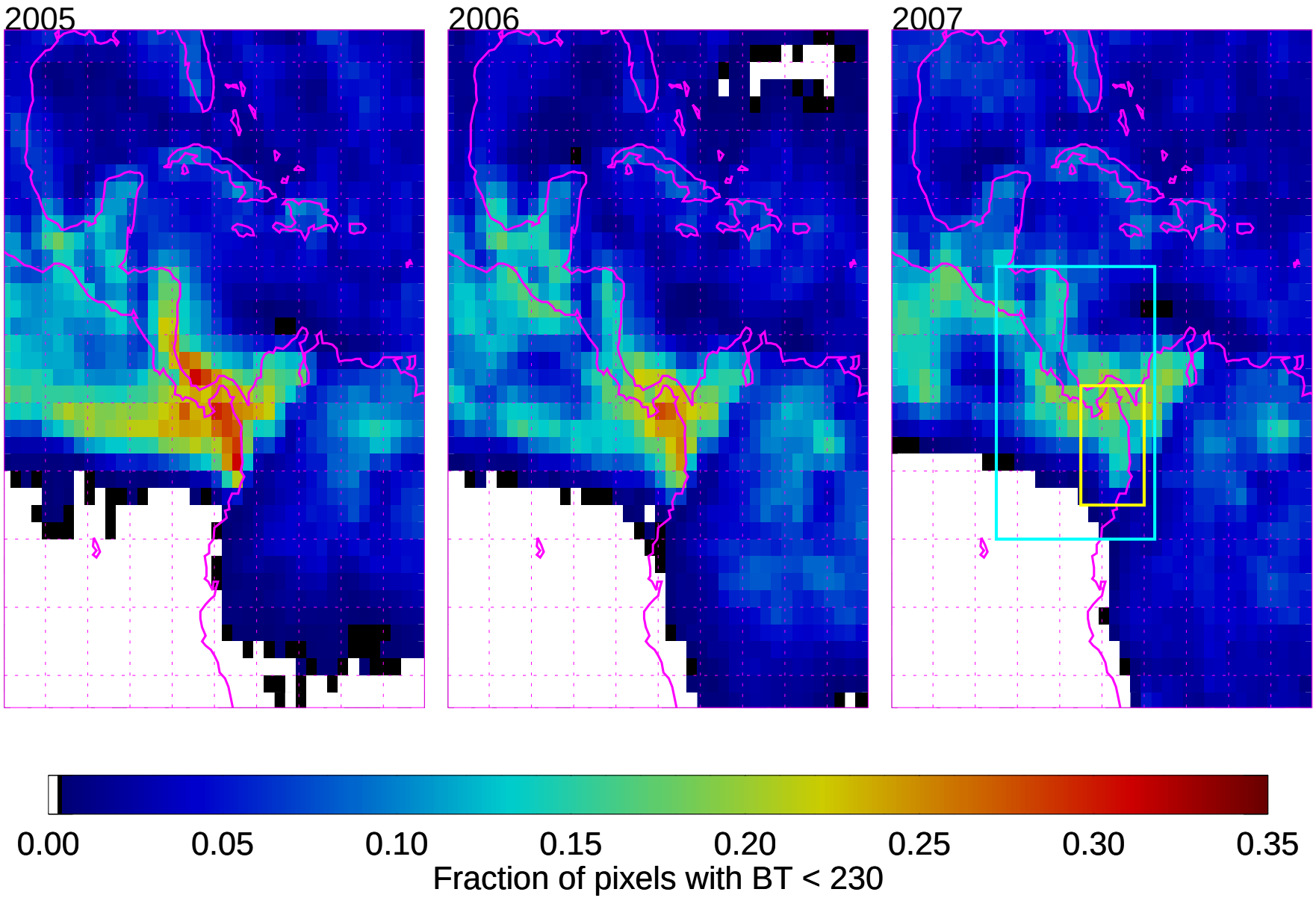
Major points, Origin of air

- Low altitude – most air comes from the east and slightly north – Sahara, SAmerica, not much from Africa
- DC-8 altitude – Convected air comes from SA, Sahara, and North America
- DC-8 altitude – 2007 is a fairly typical year in terms of transport from northern latitudes
- DC-8 altitude – Significant difference between north and south TC4 region
- TTL region – Less influence from North America, and more from Asia and Africa than at lower levels
- TTL region – More convective influence in north than south TC4 region

Meteorological Evolution during the TC4 mission

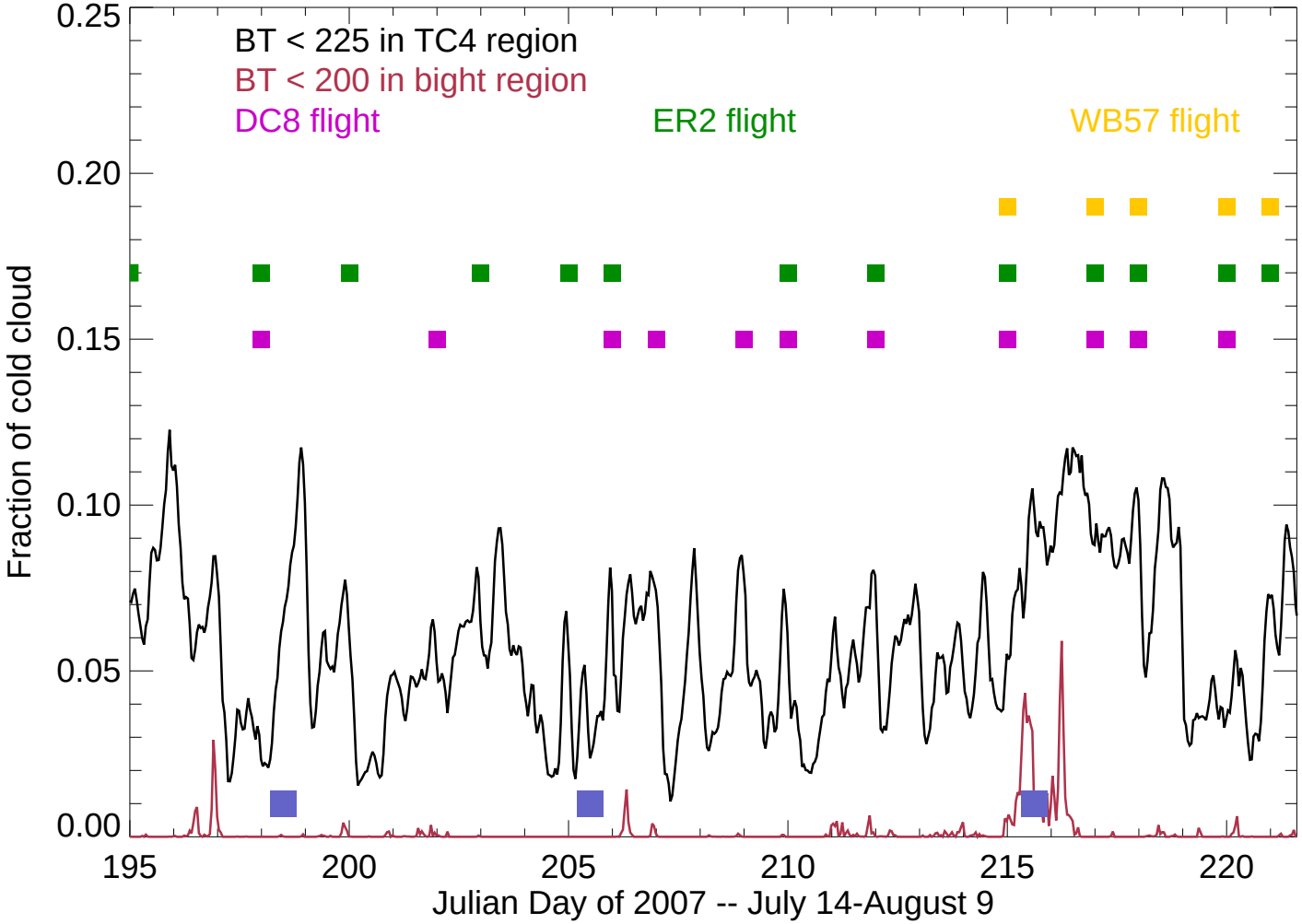
Distribution of Cold Brightness Temperatures

Cold Clouds 7/13-8/13

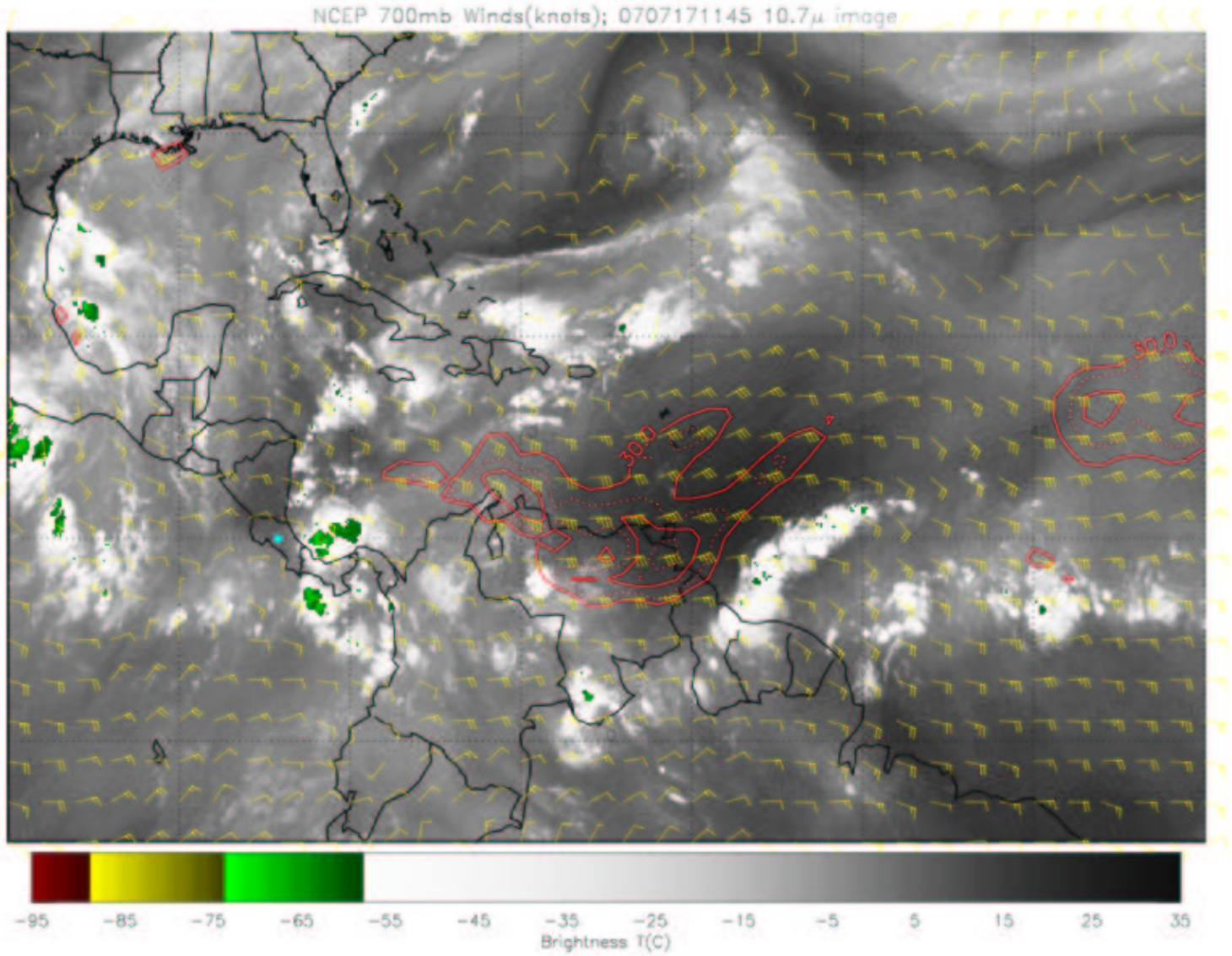


Fraction of pixels in 1 by 1 degree squares with Brightness Temperatures ¡ 230K

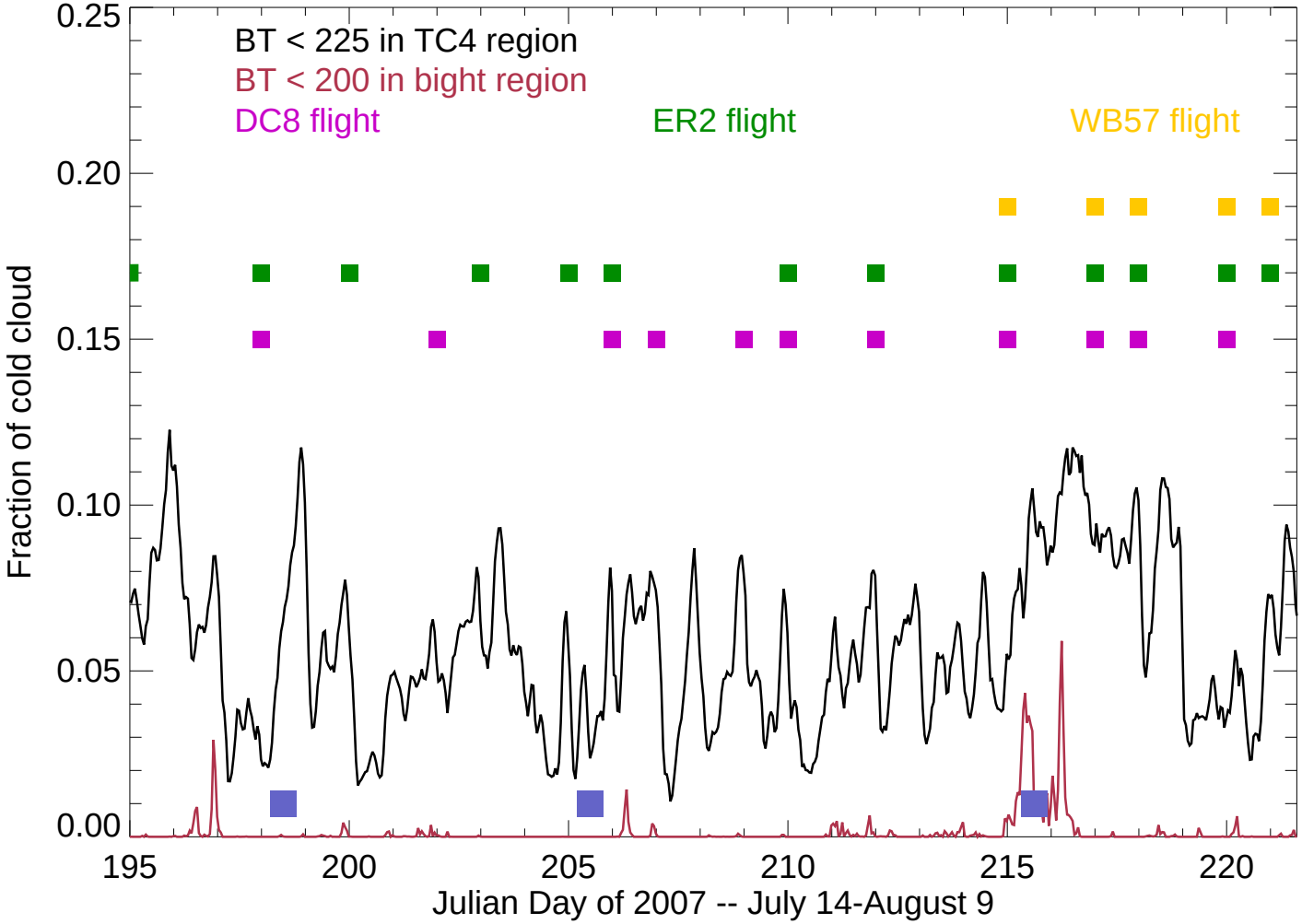
Evolution of convective intensity during the mission



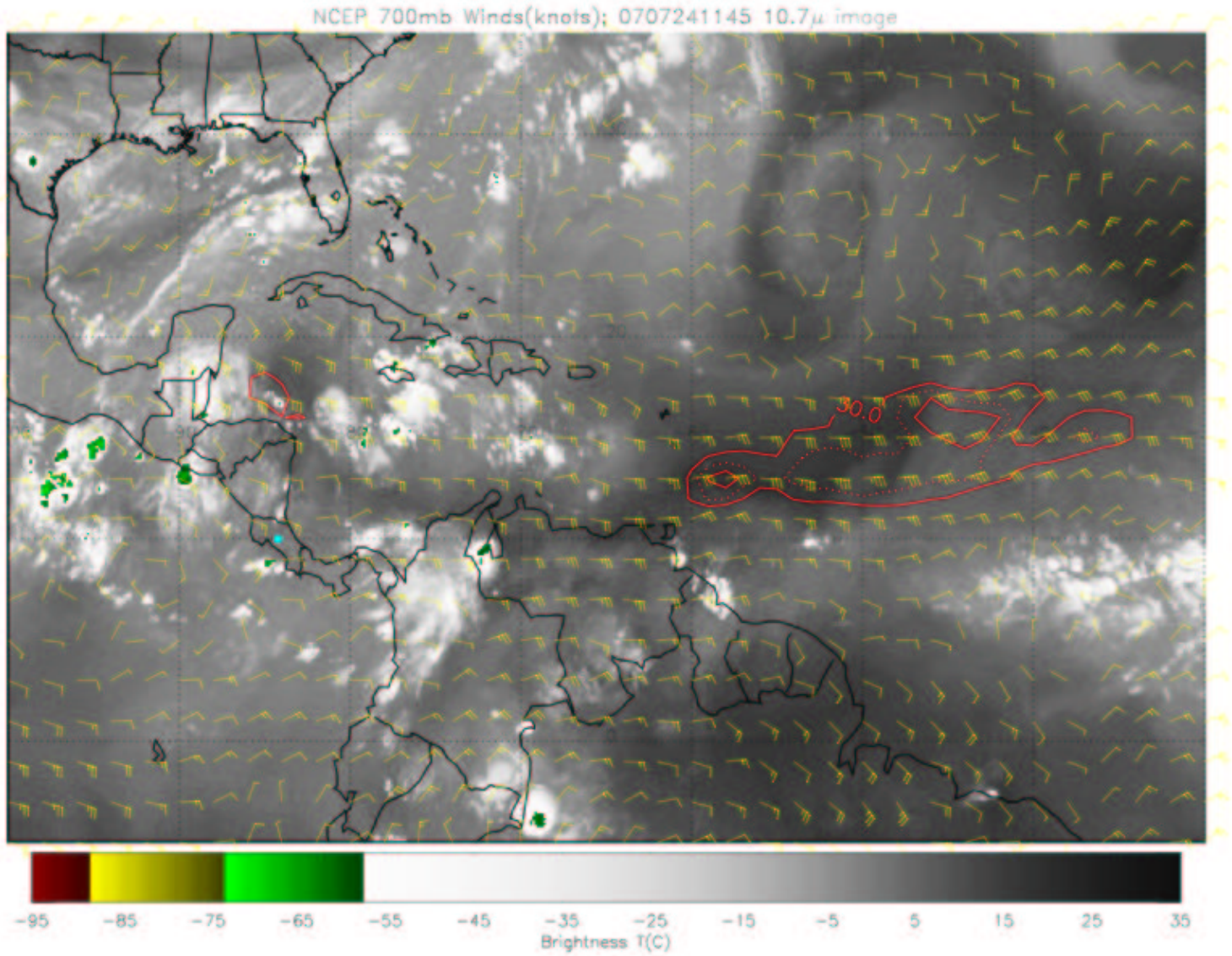
Easterly Wave Early in the Mission – Active Period



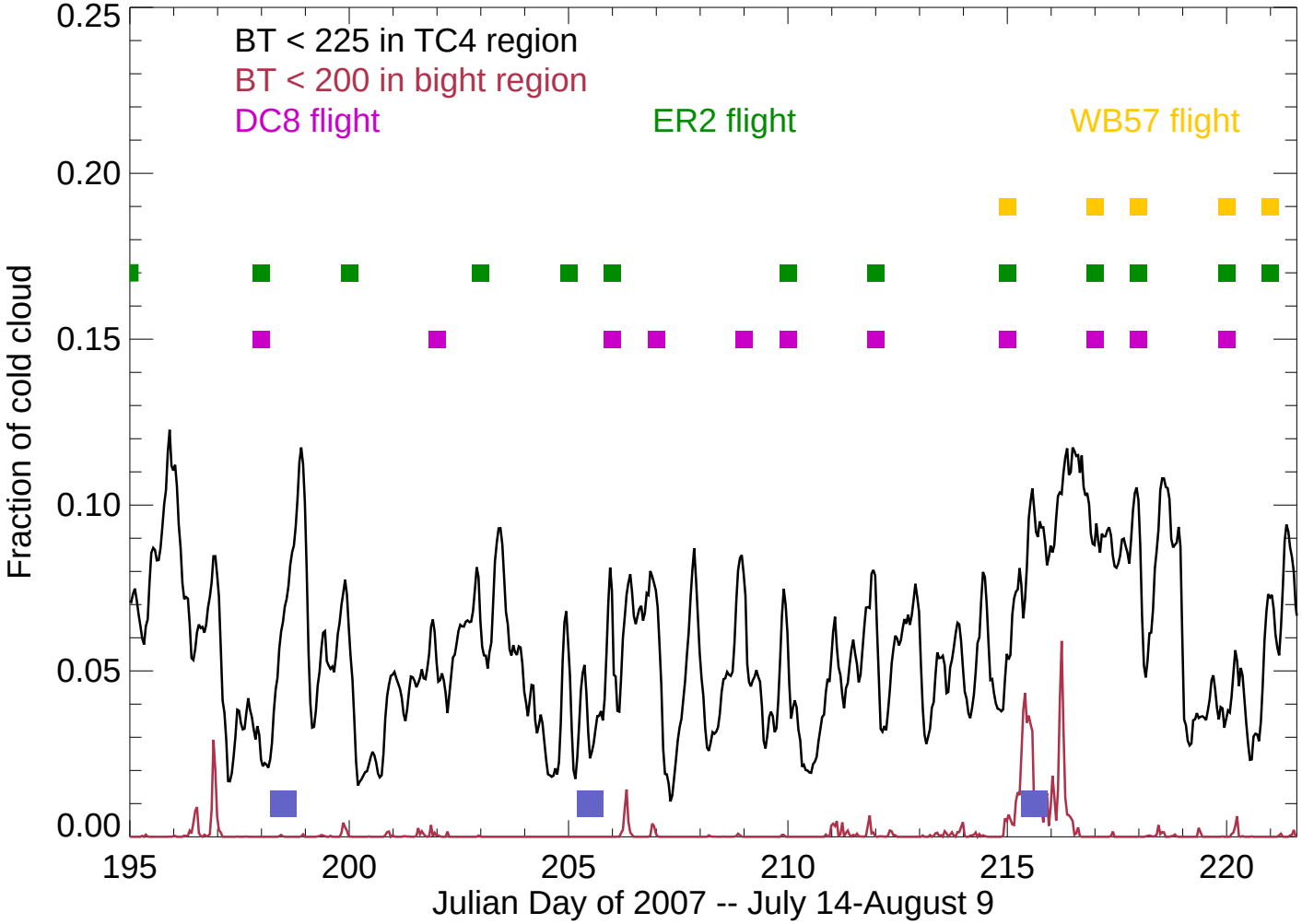
Evolution of convective intensity during the mission



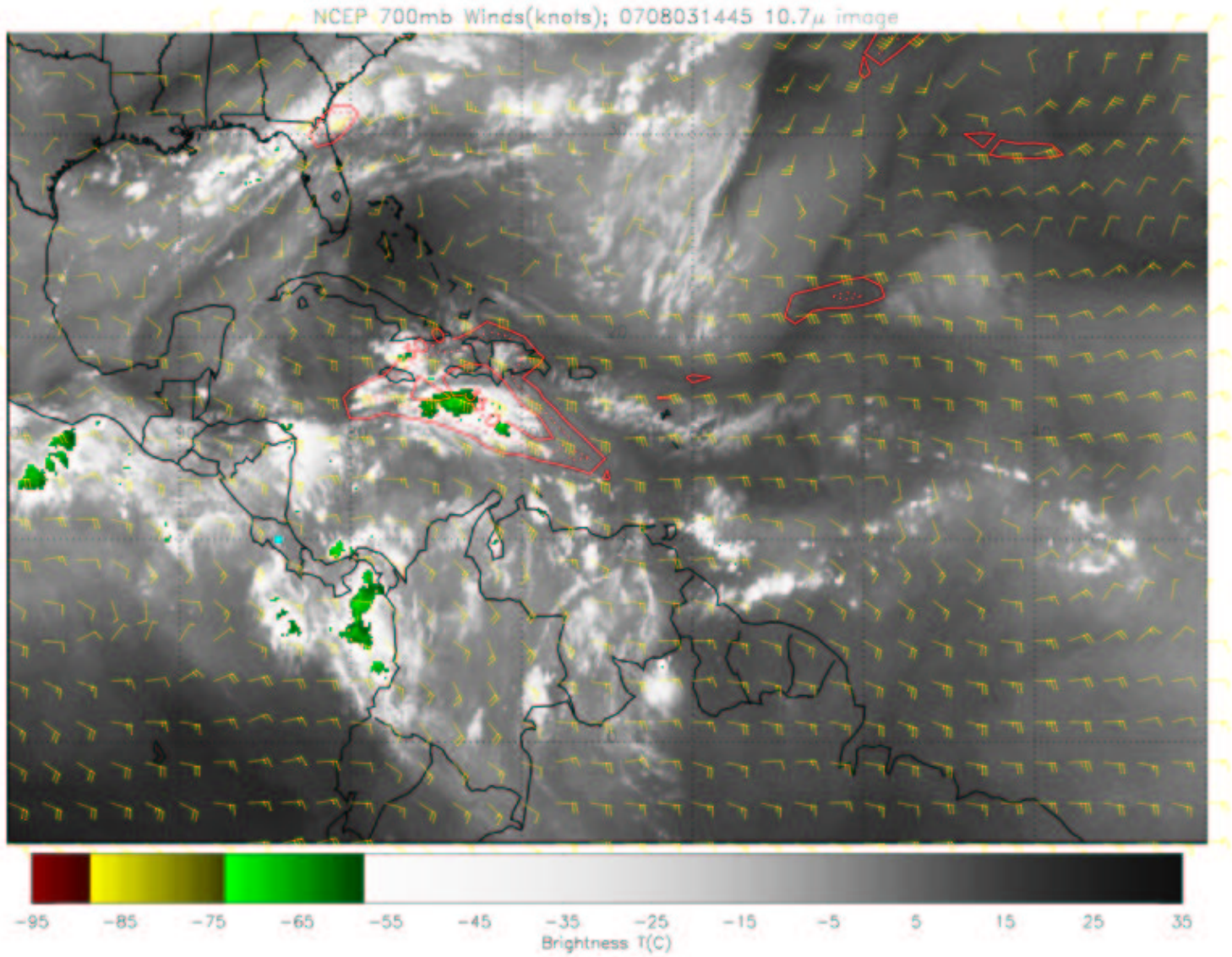
Weak disturbances through the middle of the mission – less active



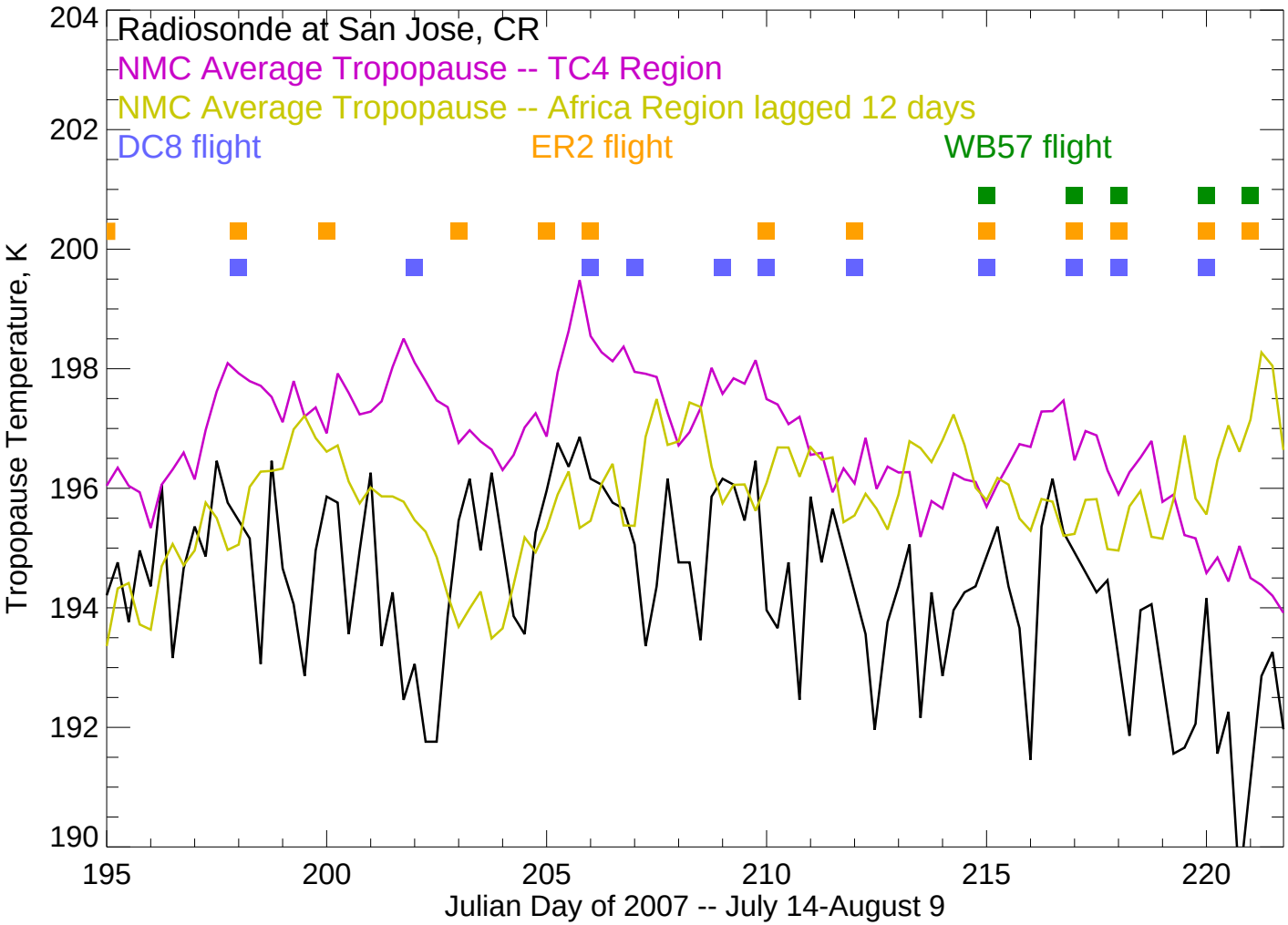
Evolution of convective intensity during the mission



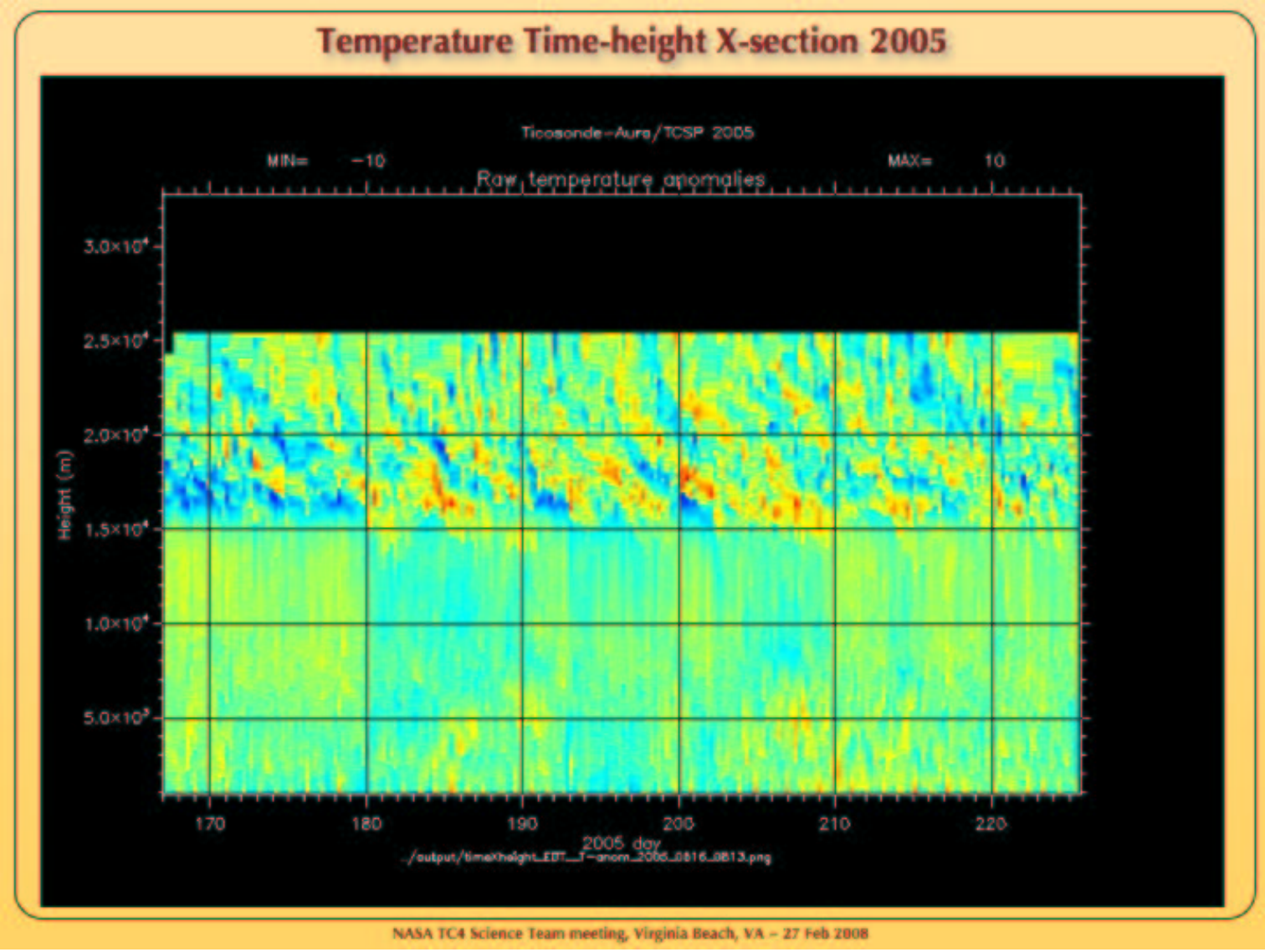
Strong easterly wave near end of the mission – more active



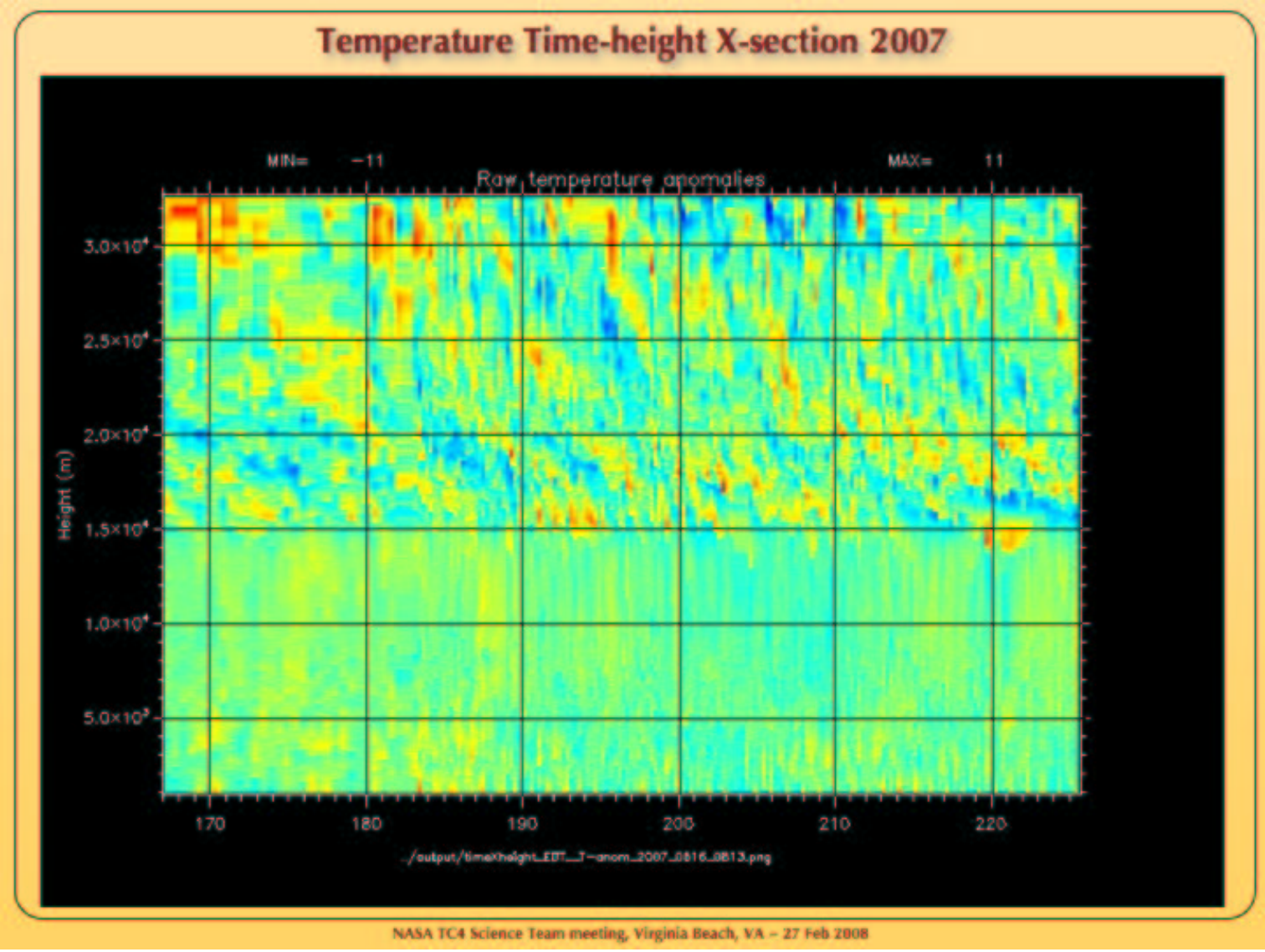
Evolution of tropopause conditions during the mission



Inertio-Gravity Waves during TC4 above the tropopause – 2005



Inertio-Gravity Waves during TC4 above the tropopause – 2007



Summary(1)

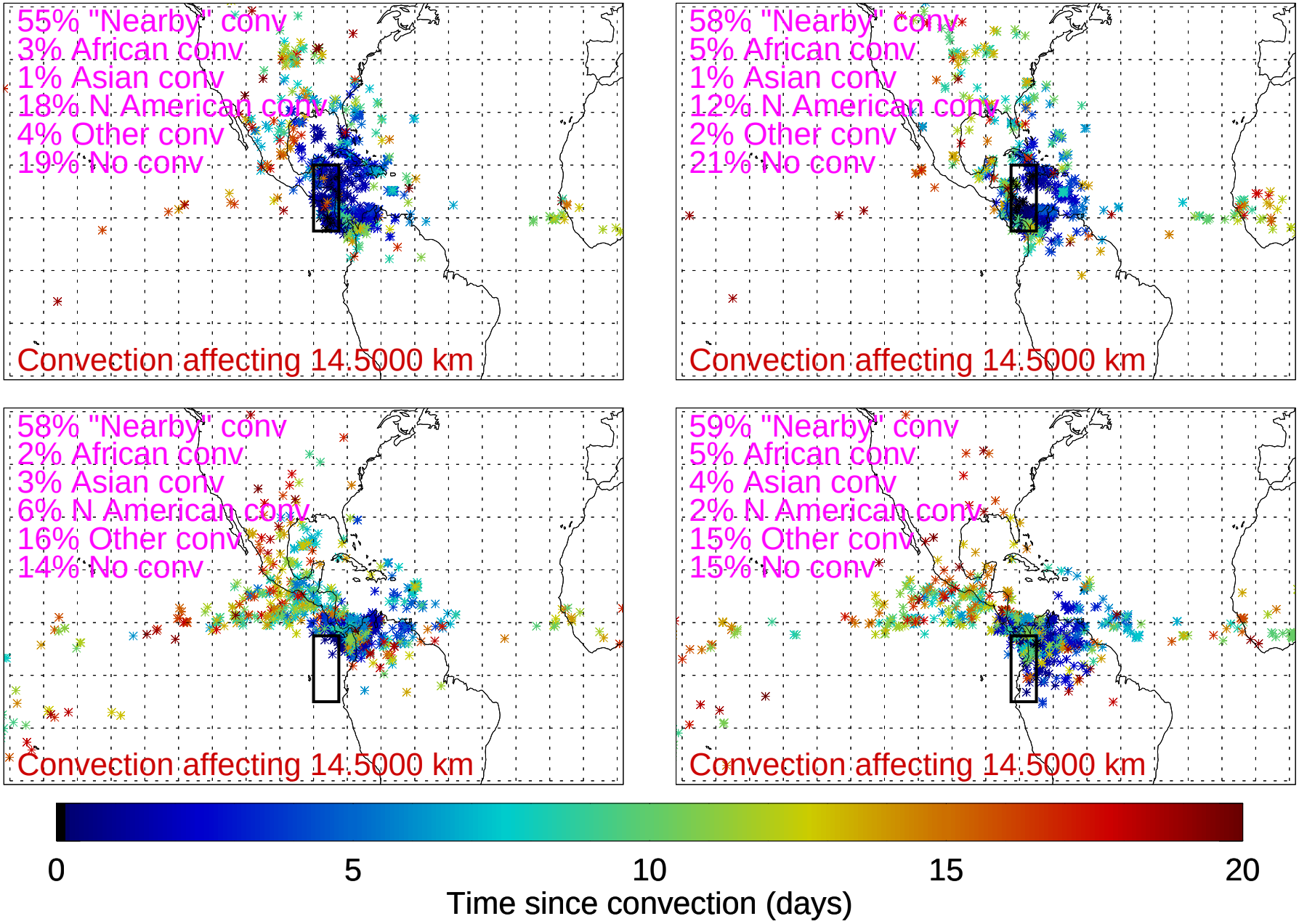
- In TTL, most of the air comes from the east, from colder regions with significant convection nearby and far upstream.
- In TTL, easterly flow is more persistent than in a typical year
- In TTL, there is possibility of influence from African BB regions and Asia, not much from North America
- At DC-8 levels there is significant flow around NA anticyclone into TC4 region
- At DC-8 levels, convected low level air comes from SA, Sahara, and North America, but not much from Africa (have not looked at convected air from midlevels)
- At DC-8 levels incidence of flow from high latitudes varies year-to-year. TC4 was fairly typical in this respect.
- At low levels we have significant flow from Sahara desert region and S America
- At low levels, flow from African BB regions goes into African convection, which feeds into TTL
- In the Boundary Layer, we have a weaker than normal low level jet, related to weaker than normal convection in the TC4 region

Summary(2)

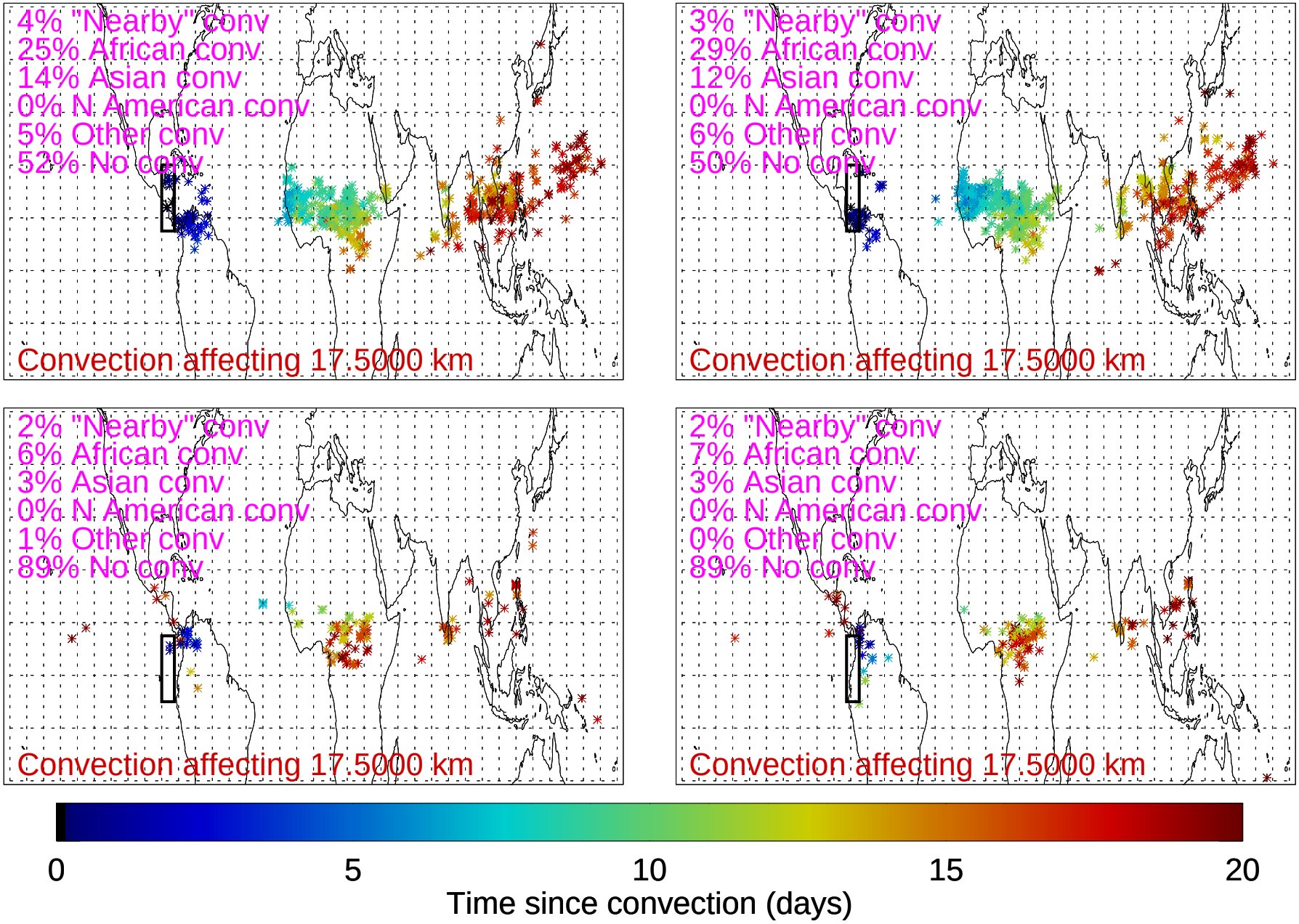
- During TC4 period convection was significantly less intense (incidence of cold brightness temperatures) than in a typical year.
- It was not a good period for big-time Panama bight convection
- Strong easterly waves at beginning and end of experiment led to periods of very active convection throughout the region
- These disturbances in mid-experiment were generally weak, leading to less active convection, especially in the bight
- Tropopause temperatures exhibited a cooling trend during the experiment, with significant variability.
- Relationship of local to upstream TTL temperatures suggests higher incidence of SVC late in the experiment.
- Near-tropopause region exhibits substantial inertia-gravity wave activity, related primarily to stratospheric easterly flow. Slightly weaker activity in 2007 than in 2005.

BACKUP SLIDES

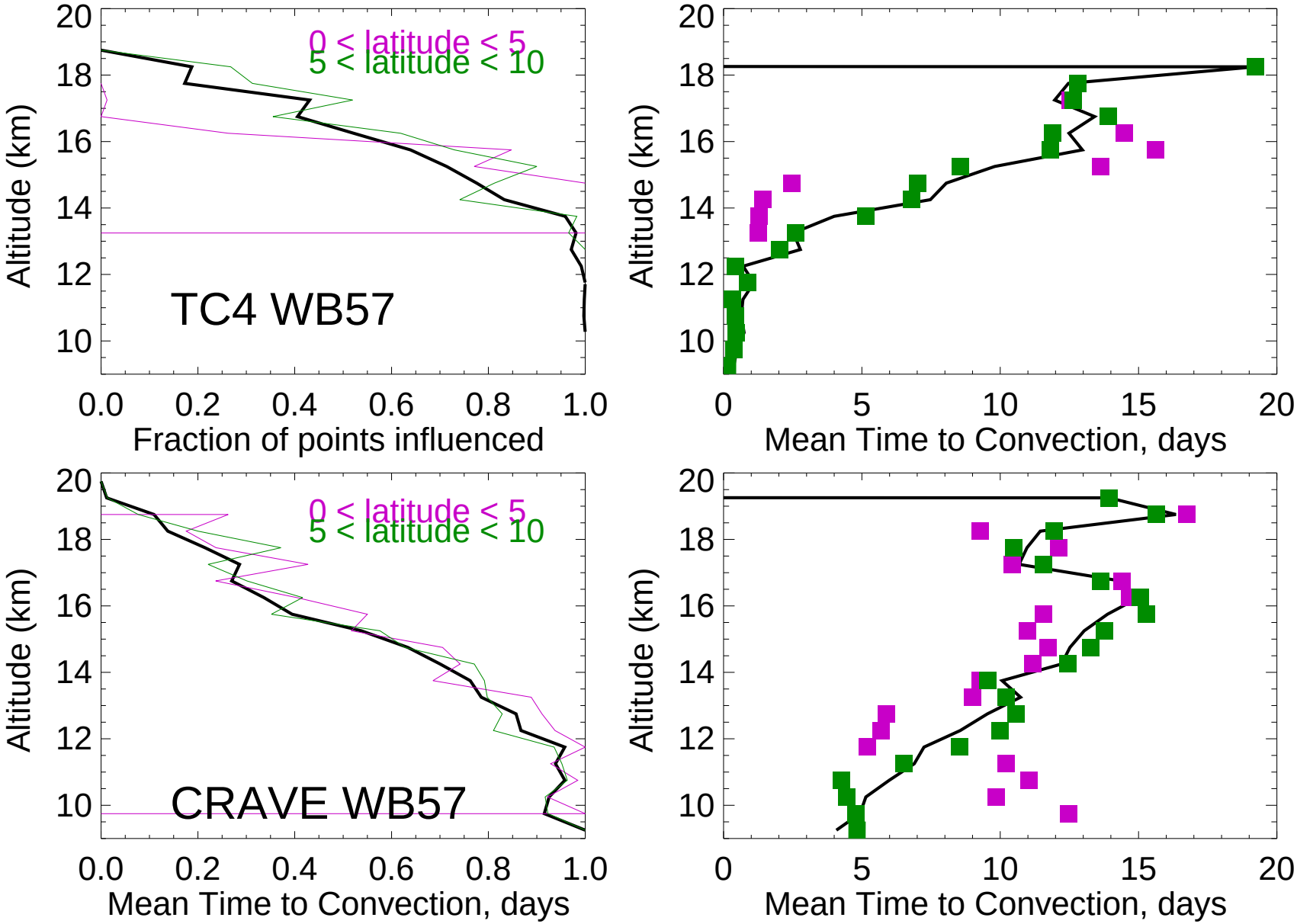
Locations and times of convection influencing grid of points in TC4 region at 14.5 km



Locations and times of convection influencing grid of points in TC4 region at 17.5 km

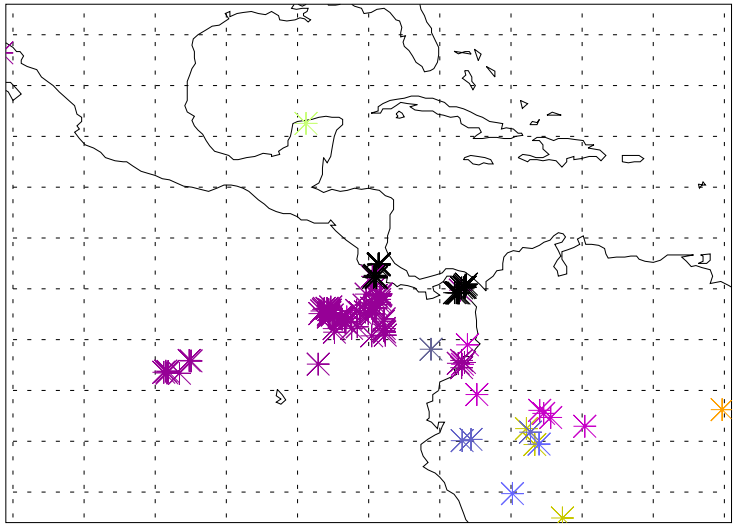


Comparison of CRAVE and TC4 (for B-57 flight points only)

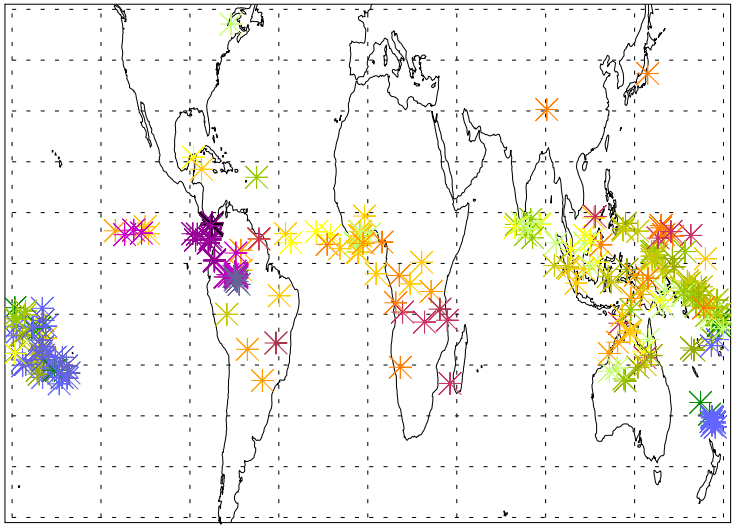


Distribution of convection influencing different altitudes – CRAVE WB57

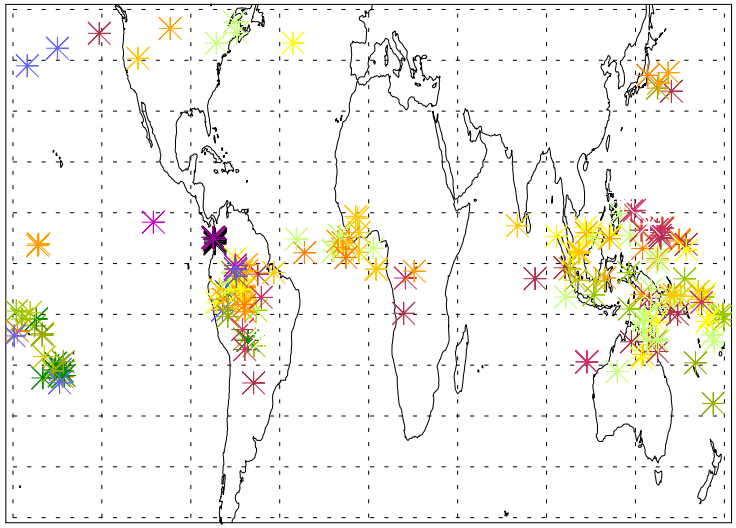
10 to 12 km



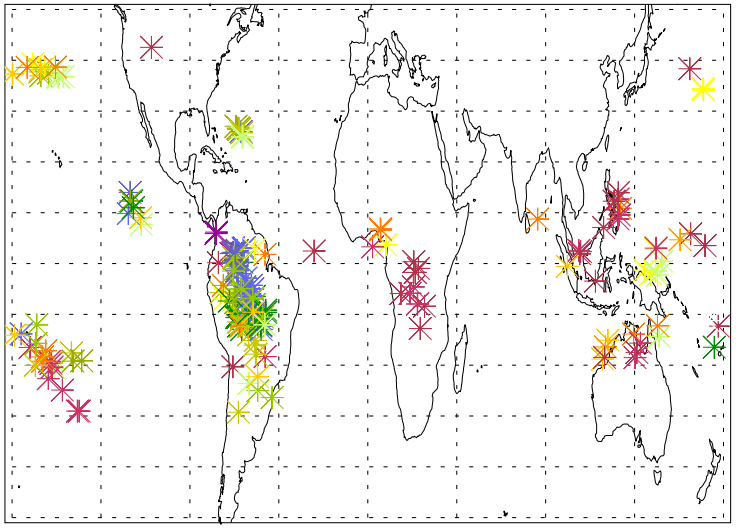
12 to 14 km



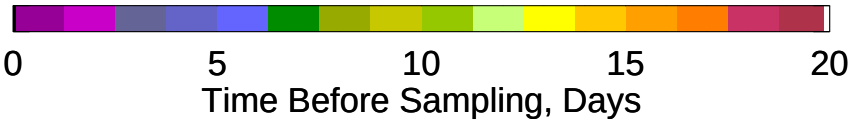
14 to 16 km



16 to 18 km

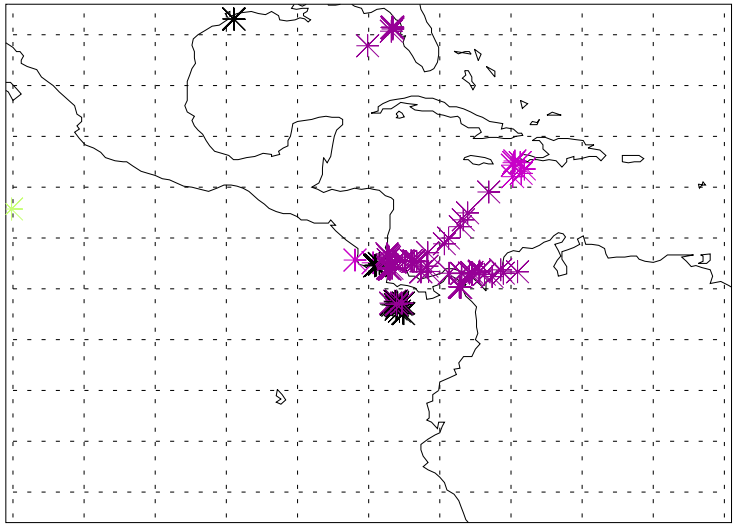


Locs of most recent conv (20 day BT) for:
All_CRAVE_Flights

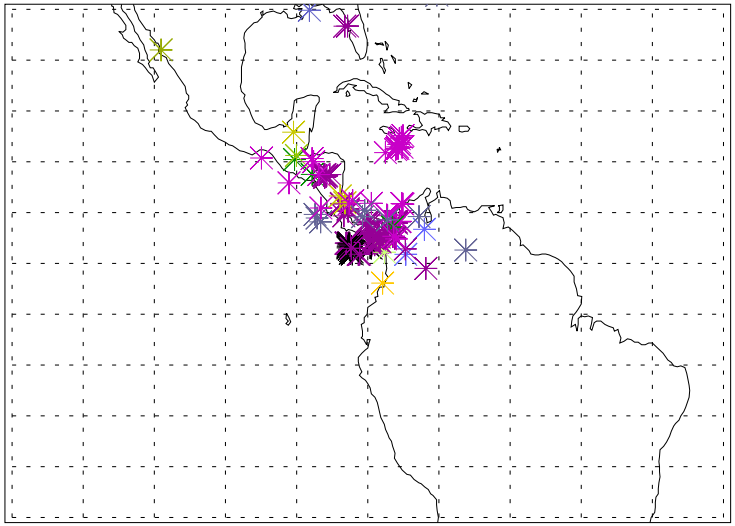


Distribution of convection influencing different altitudes – TC4 WB57

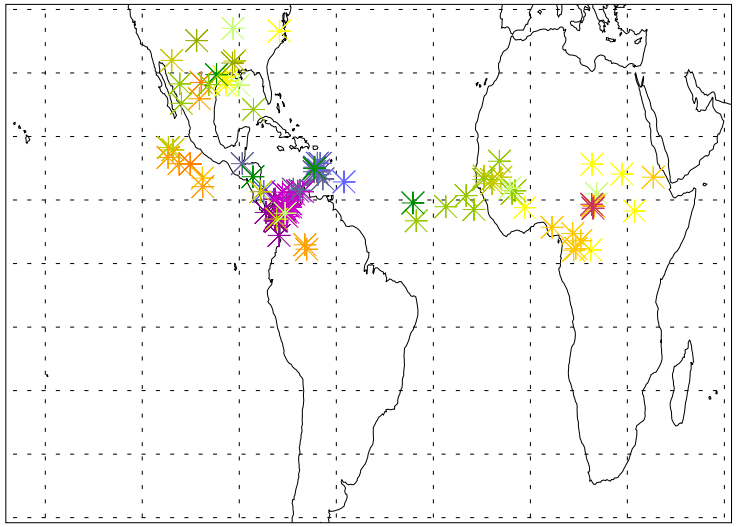
10 to 12 km



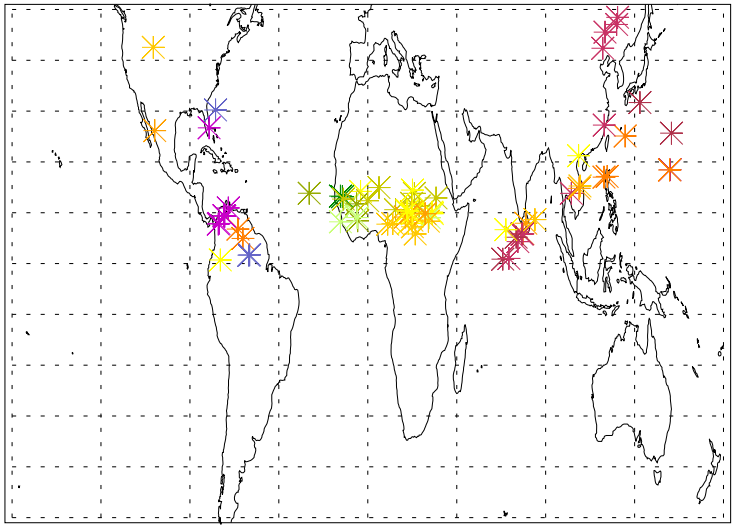
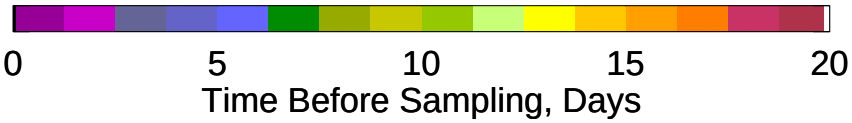
12 to 14 km



14 to 16 km



16 to 18 km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