Air Origins and Convective Influence at 100mb

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A preliminary trajectory and convective influence analysis for the flights of 20111105 and 20111109

Major Points

- Sampled air in the tropics has a midlatitude origin, at least in the short term.
- Coldest point along short-term (2 week) trajectories is at or near the location of aircraft sampling.
- Recent convective influence is minimal
- Regions south of 10 degrees (which we did not sample at this level on these flights) had substantially more convective influence

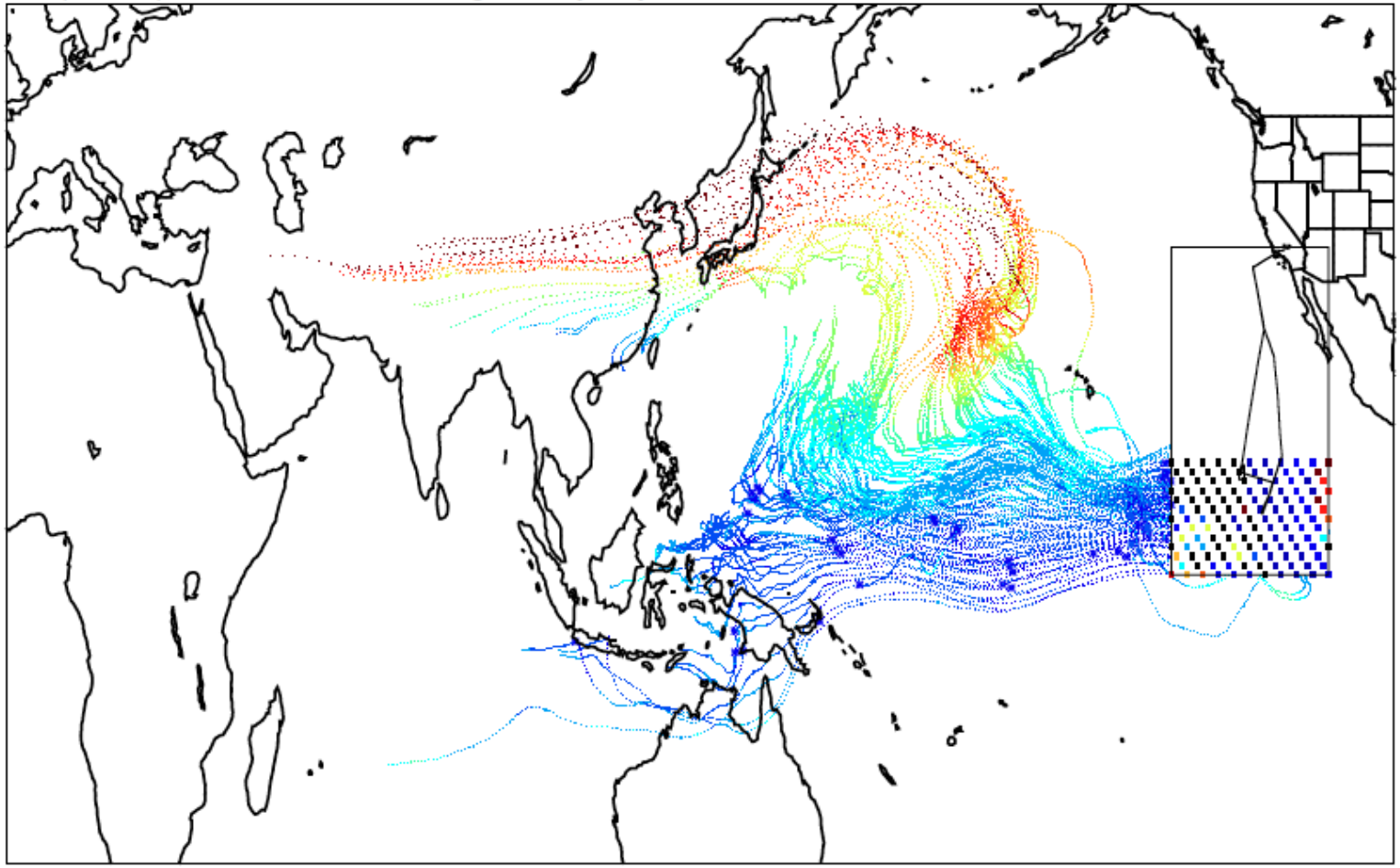
Approach

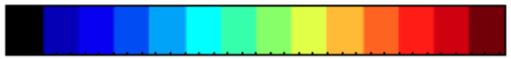
- Use diabatic trajectory model based on Mark Schoeberl's code.
- Diabatic heating rates from CLOUDSAT/CALISPO – Qiang and Fu
- Convective influence using 3-hourly global geostationary IR satellite imagery and 3-hourly merged rainfall imagery "calibrated" with CLOUDSAT and CALIPSO convective altitudes (Pfister et al, 2001, Bergman et al 2011).

Flight of 20111105

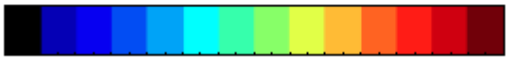
attre_11110600_NMC_SIAVN_42_48_54_60_66: 14 day back traj at altitude of 54kft from black rctngle

Colored squares represent time since min T along each trajectory at altitude of 54kft





Traj Temp, K (dots)

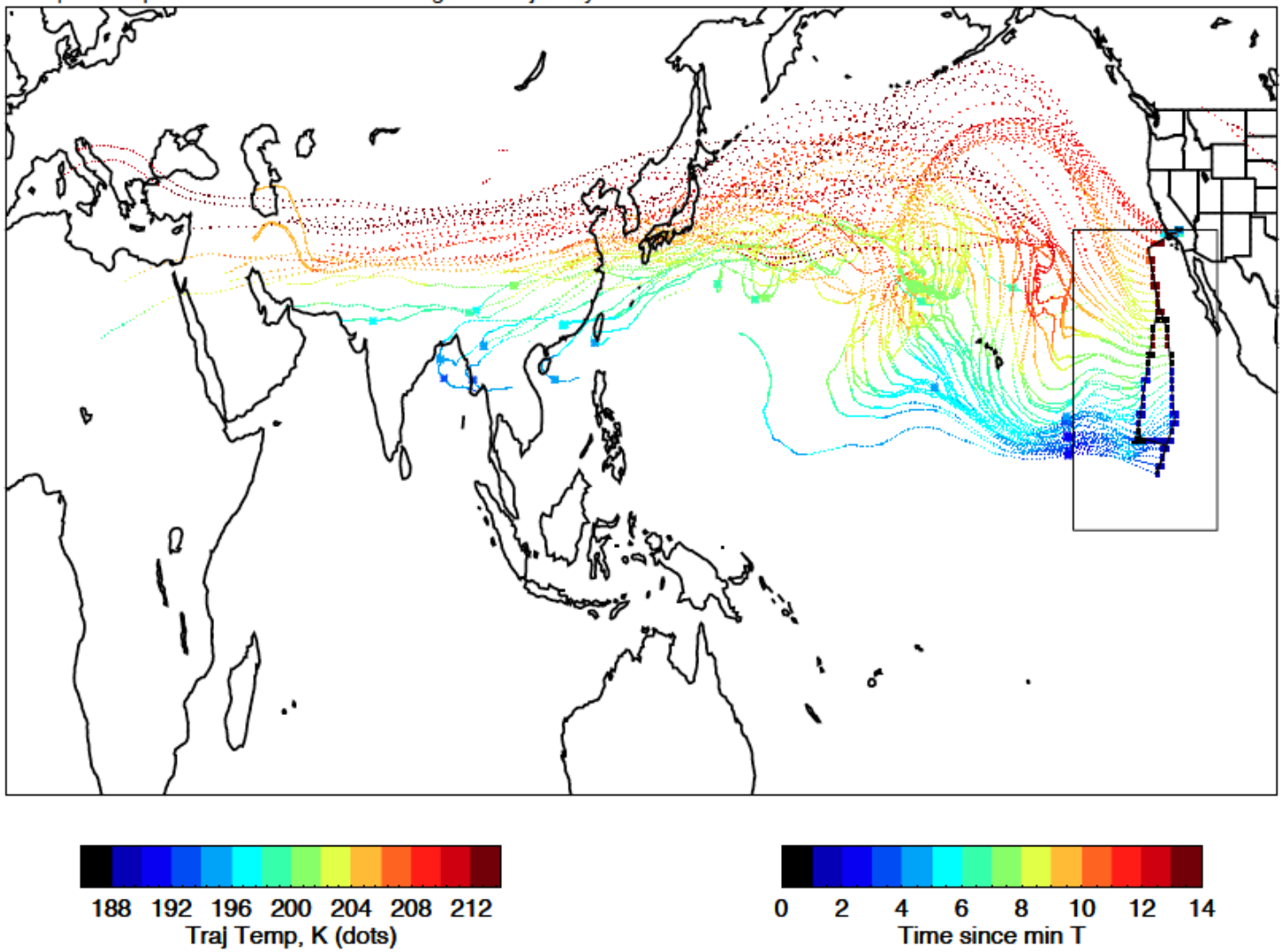


Time since min T

Back trajectories from a grid of points show branch from midlatitudes, branch from tropics. Black squares indicate that minimum long-trajectory temperature reached close to end (most recent time) of trajectory.

attre_11110600_NMC_SIAVN_42_48_54_60_66: 14 day back traj at altitude of 54kft from black rctngle

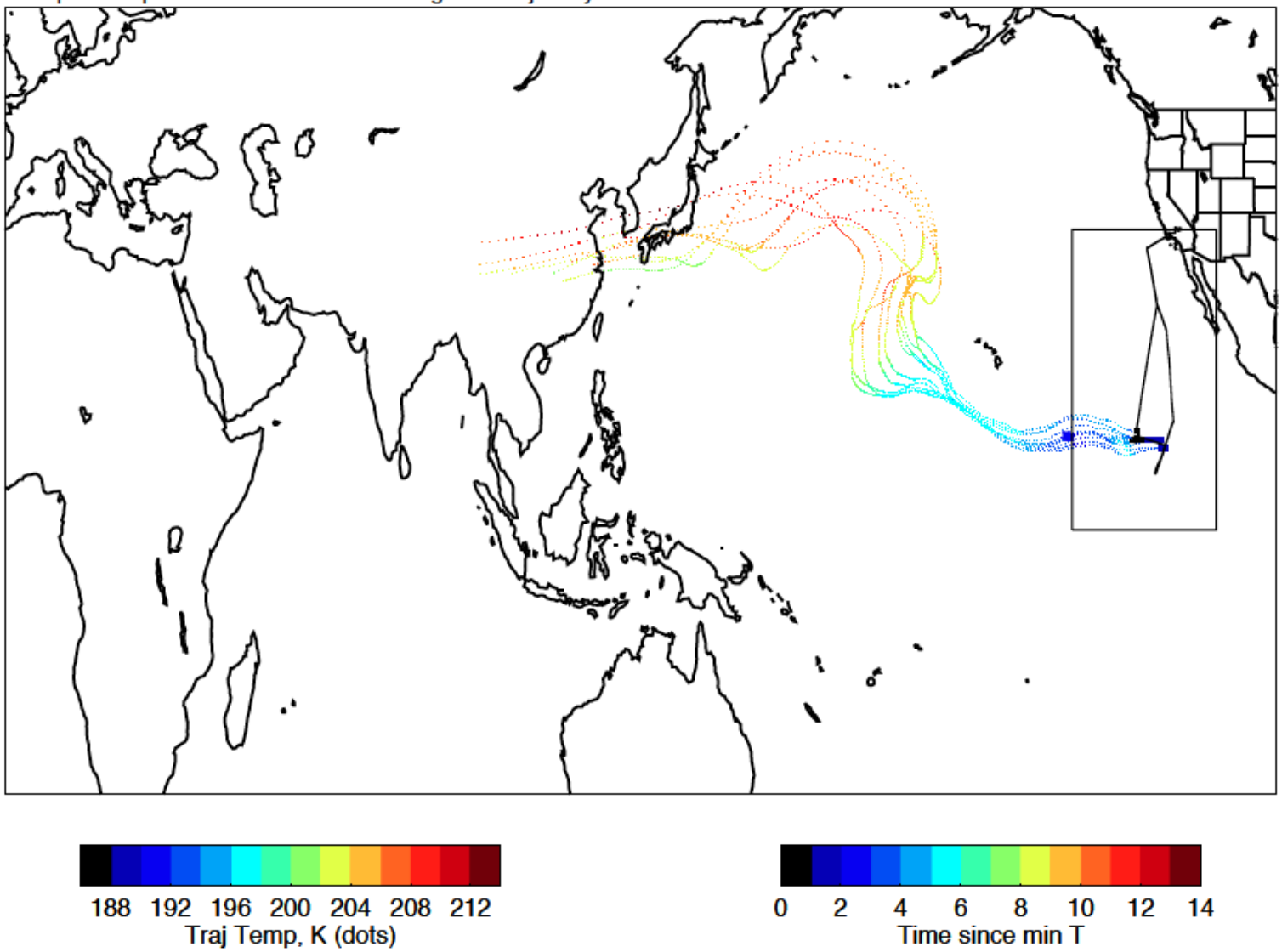
Colored squares represent time since min T along each trajectory at altitude of 54kft



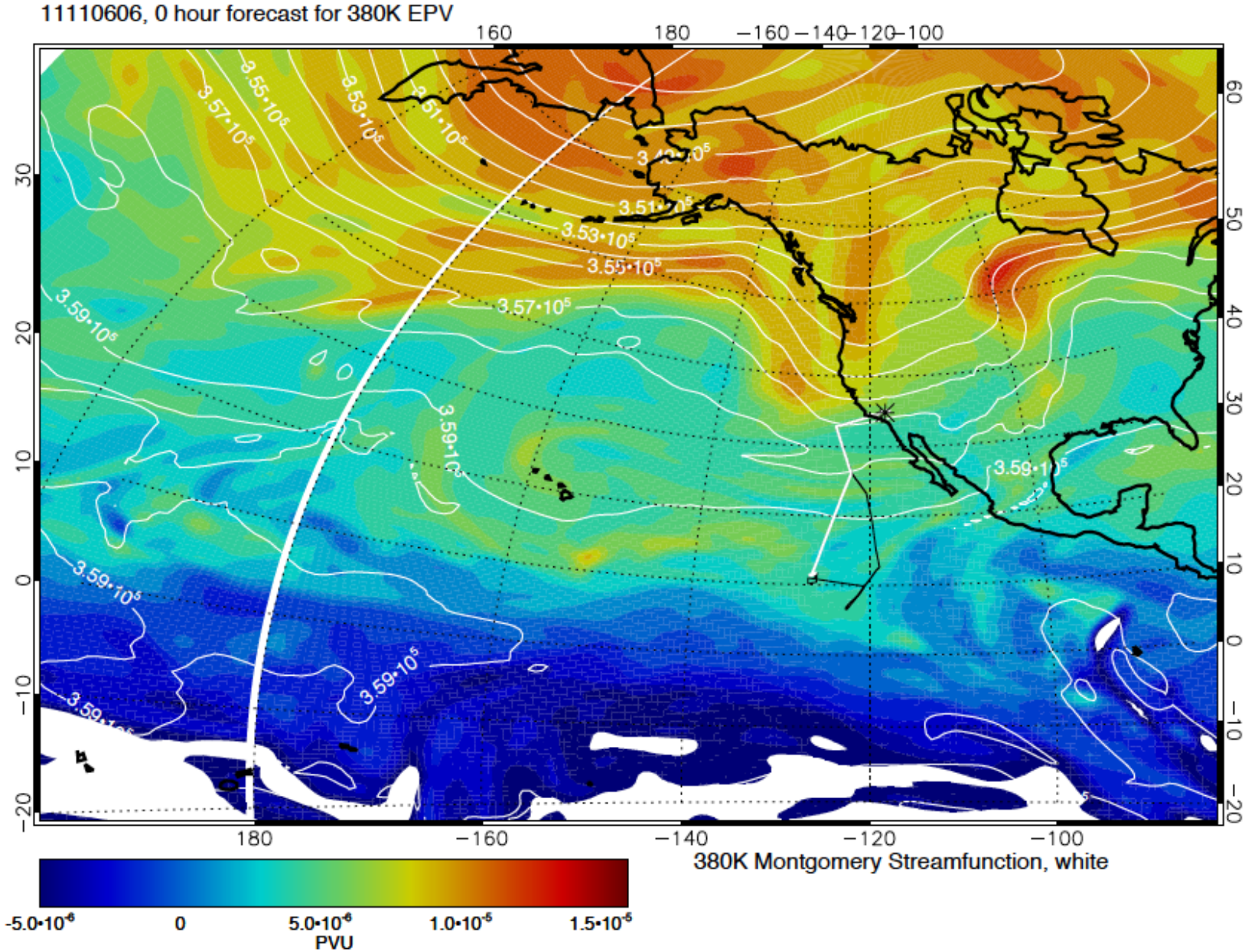
Points along flight track largely from midlatitudes. Note some parcels have tropical Origin, are shunted north to STJ, carried east, and brought to tropics again.

attre_11110600_NMC_SIAVN_42_48_54_60_66: 14 day back traj at altitude of 54kft from black rc

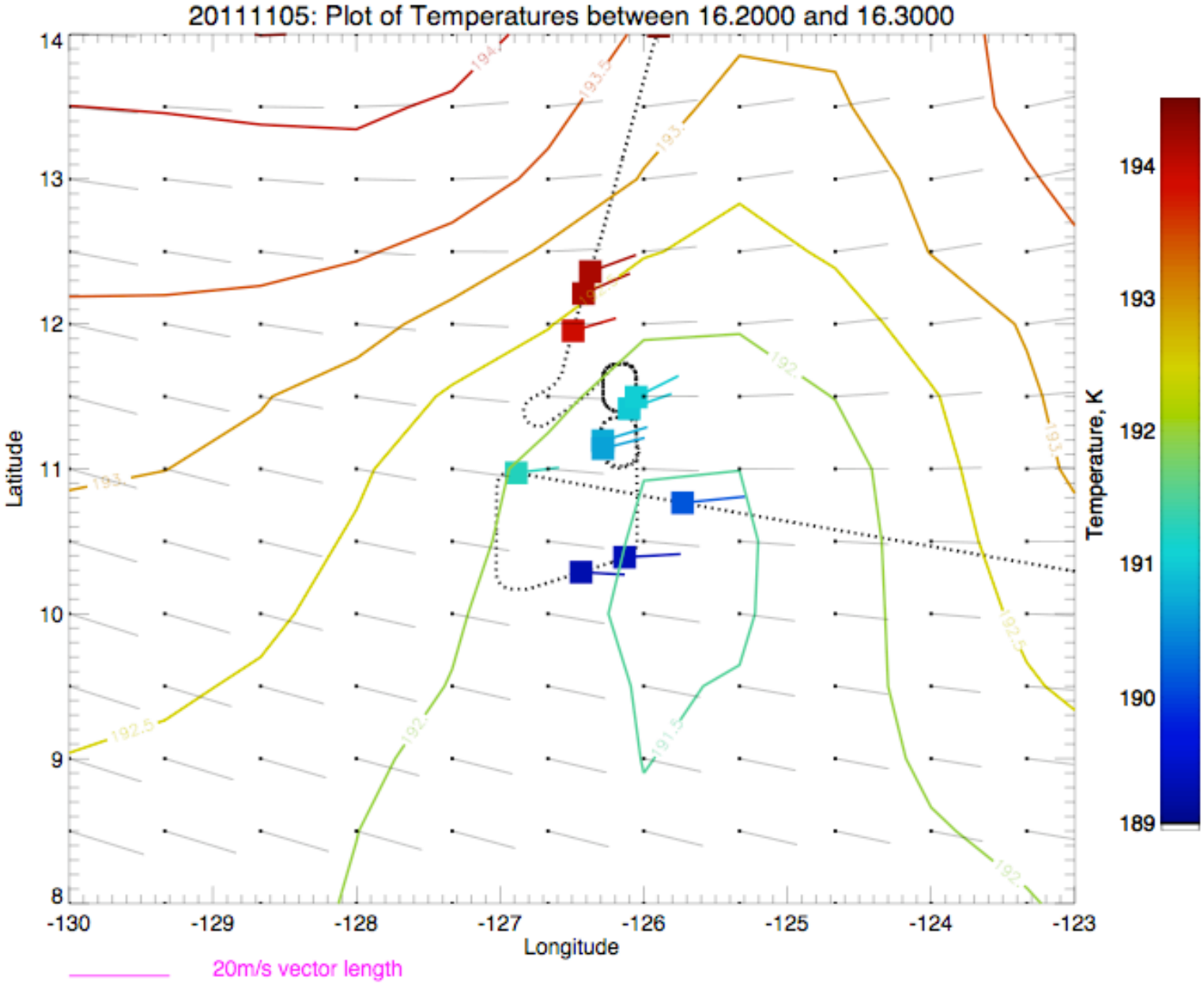
Colored squares represent time since min T along each trajectory at altitude of 54kft



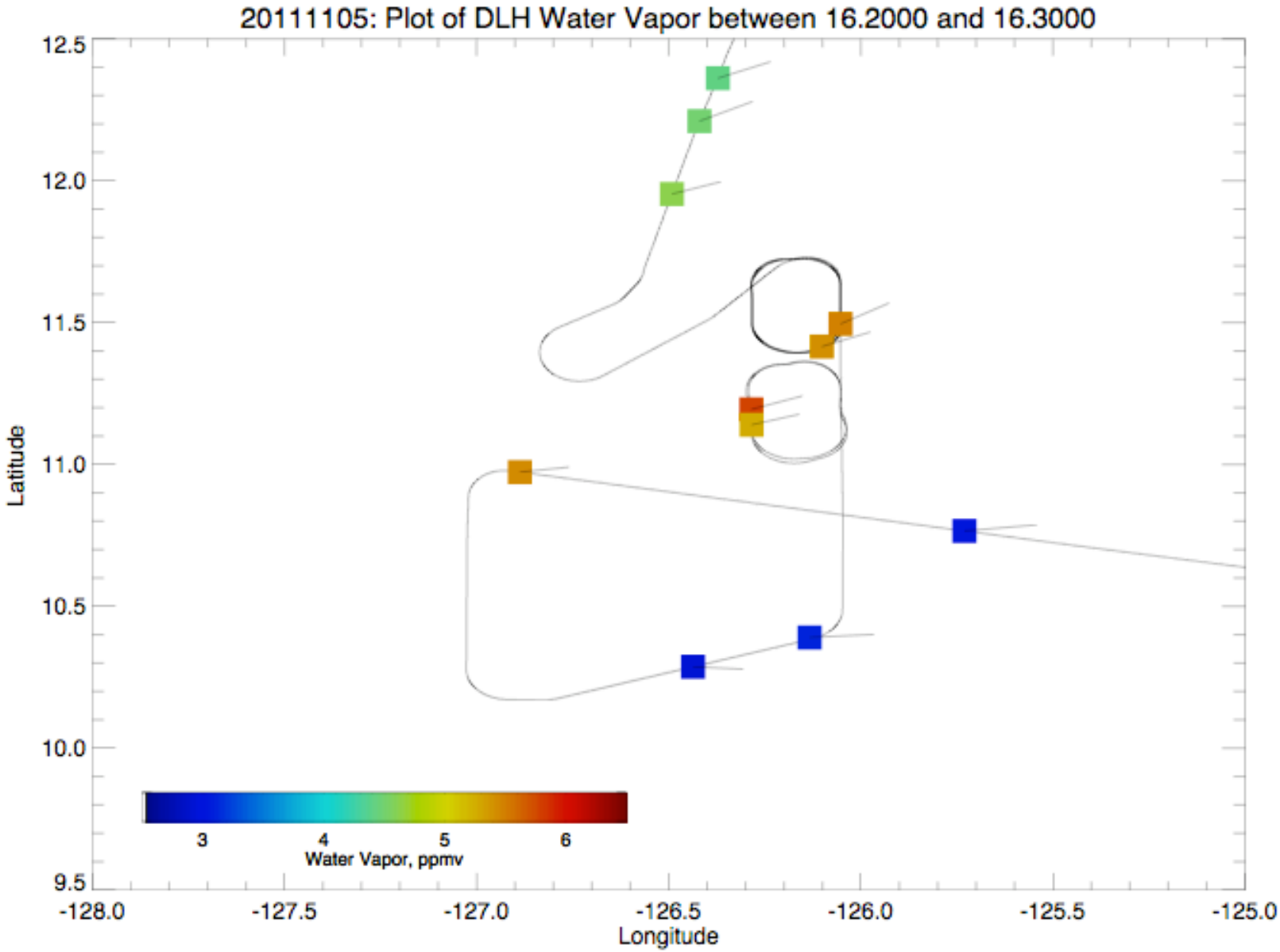
Picking points near flight track where we actually got to 100mb shows midlatitude origin. Except for a few, location of minimum long-trajectory temperature is at flight track.



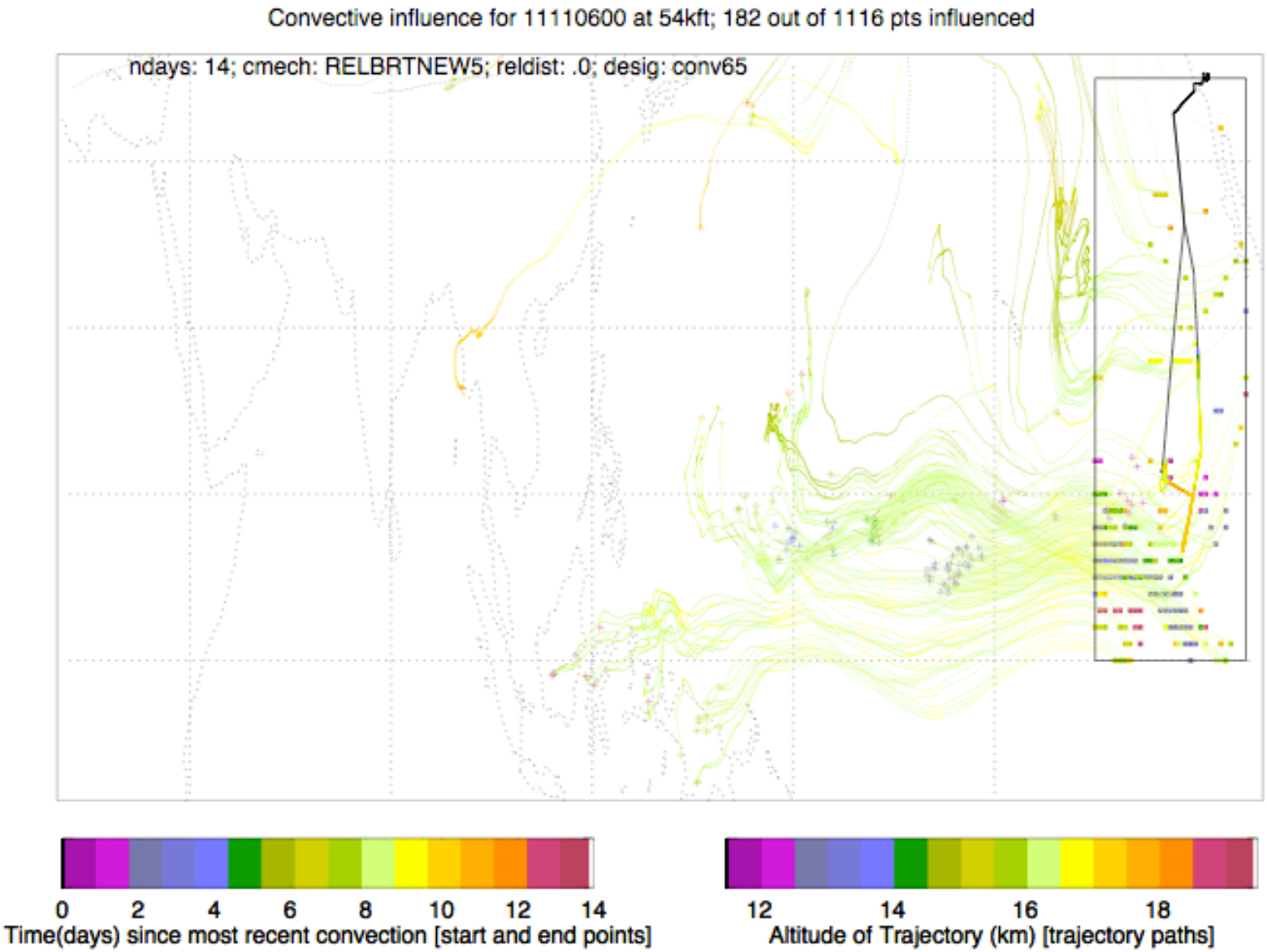
As noted yesterday, PV analysis suggests we are in a region of mixed midlatitude and tropical air.



Flight track, 16.2-16.3 kim temperatures (aircraft) and GEOS-5 analysis. Aircraft temps are 1-2 K colder than analysis. Shows air passing through a wave-induced cold spot. Aircraft temps are structurally consistent with the analysis



Lowest water vapor (dehydration) consistent with lowest aircraft and analysis temperatures

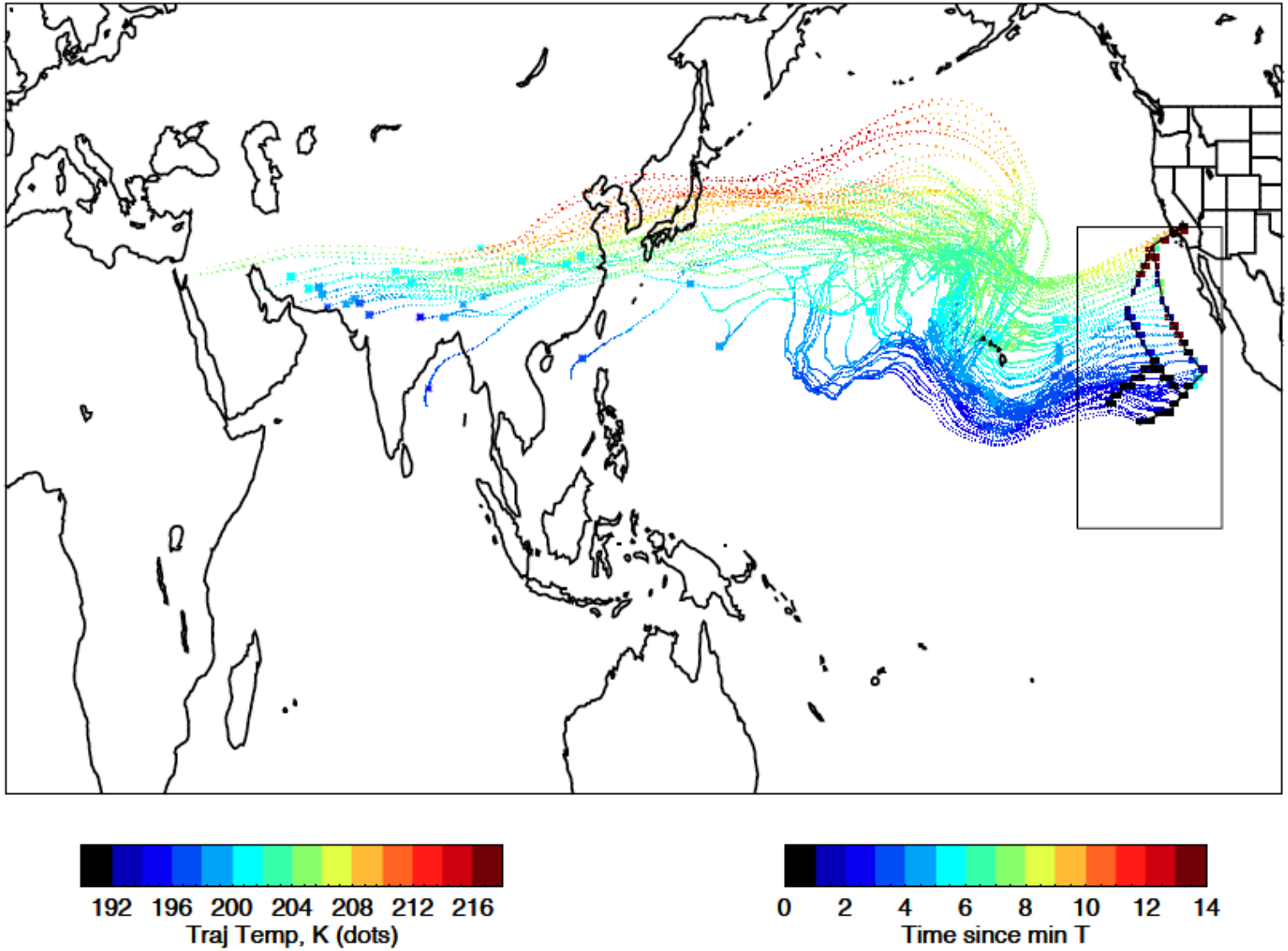


Convective influence at this altitude is minimal along the flight track. Air from the highest cloud tops flows south of flight track. Longer trajectories for parcels with tropical origin in Indian ocean may show some convective influence.

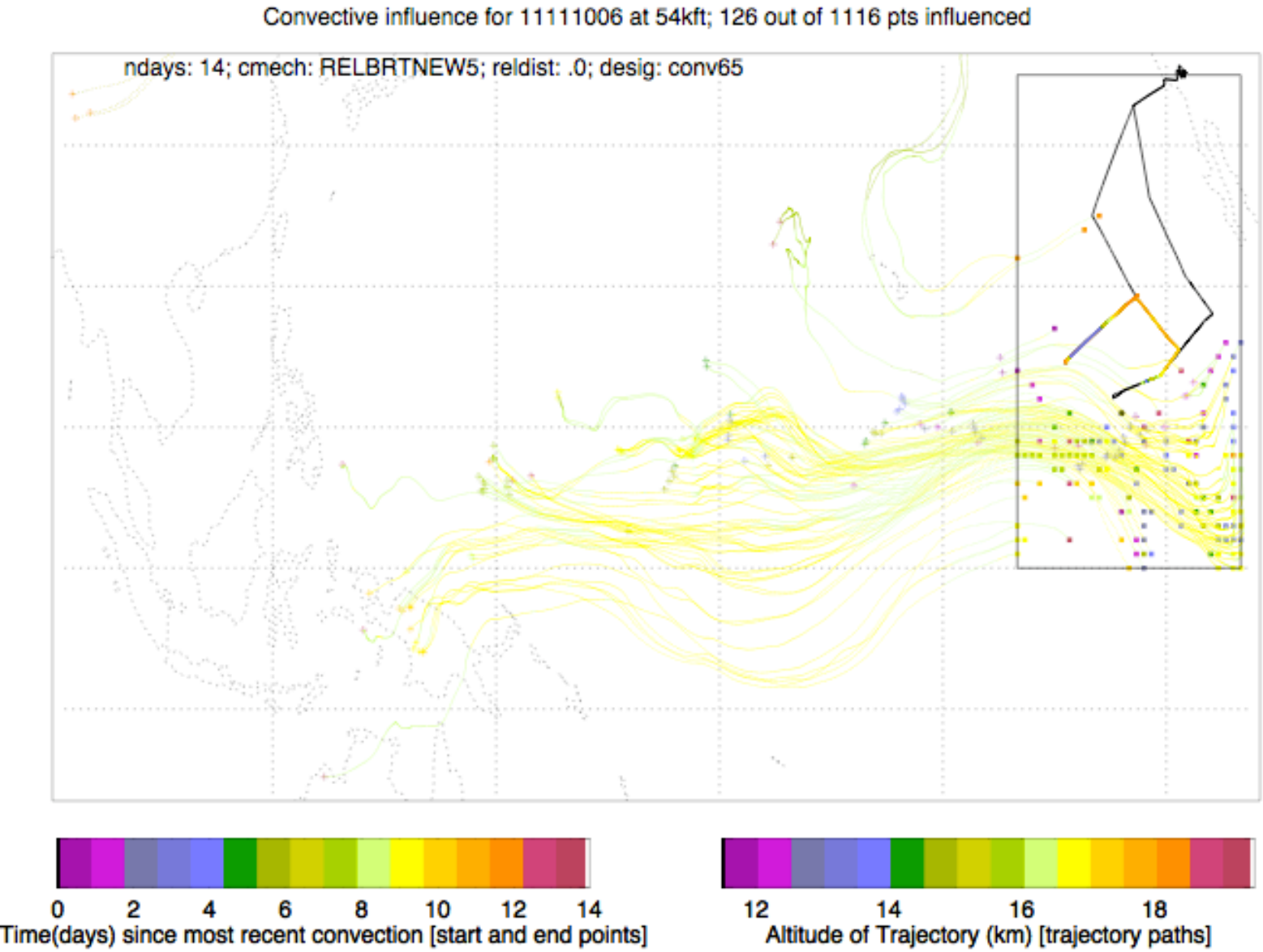
Flight of 20111109

attre_11111006_NMC_SIAVN_42_48_54_60_66: 14 day back traj at altitude of 54kft from black rctngle

Colored squares represent time since min T along each trajectory at altitude of 54kft



Similar picture to previous flight. Trajectories come from midlatitudes (though some clearly had a tropical origin, went north to STJ, and then came south again). In sections where we sampled at 100mb, minimum long-trajectory temperatures occur close to observation time.

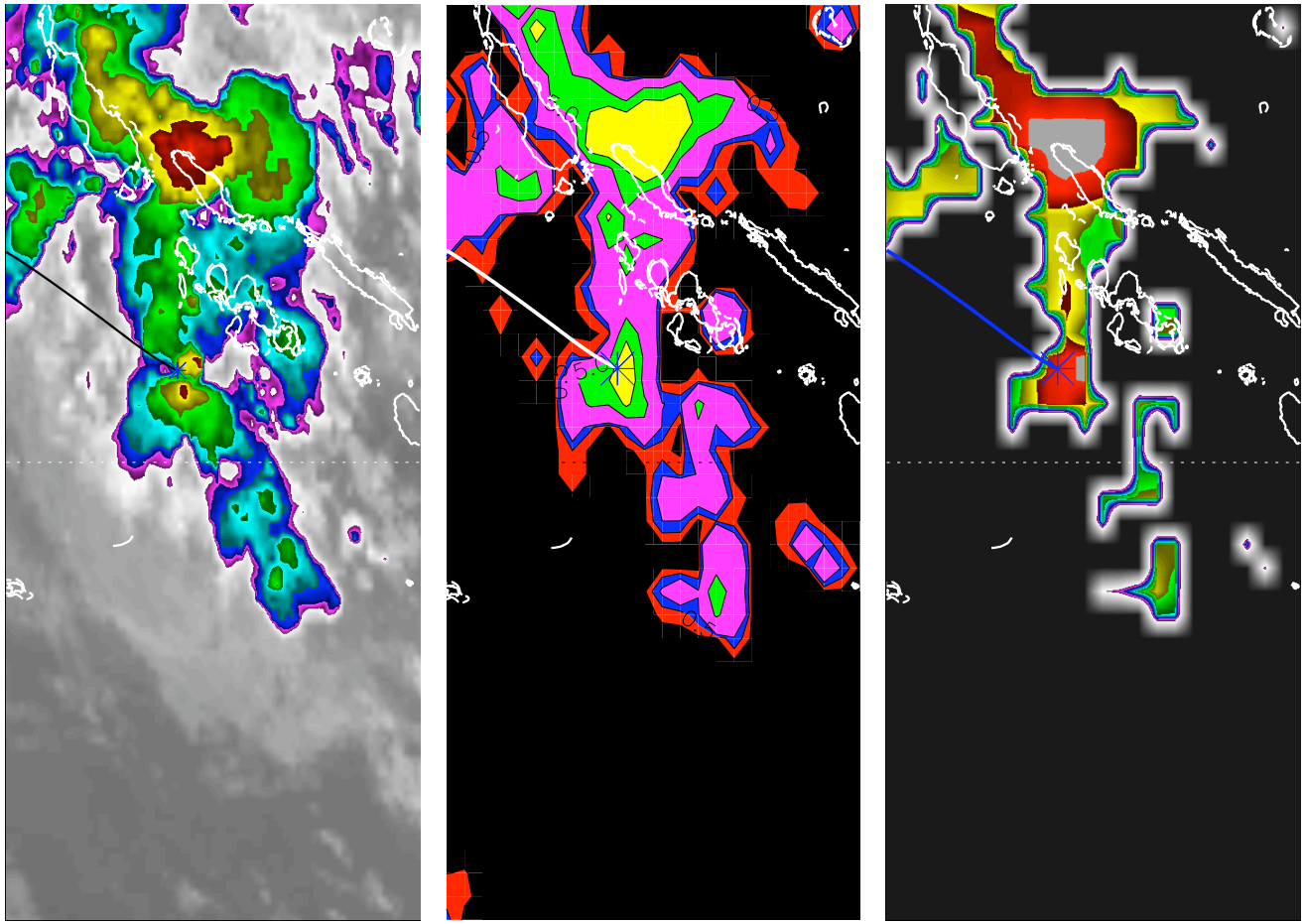


Again, at 100mb, most convective influence is south of our sampling latitudes.

Summary

- Sampled air at 100mb in the tropics has a midlatitude origin, at least in the short term.
- Coldest point along short-term (2 week) trajectories is at or near the location of aircraft sampling.
- For 20111105 flight, it appears that analyses do capture the basics of what is going on – a cold anomaly dehydrating air.
- Recent convective influence is minimal in sampling region at 100mb
- Regions south of 10 degrees at 100mb (which we did not sample at this level on these flights) had substantially more convective influence
- At next lowest altitude we looked at (48kft – 135mb), there was substantial recent convective influence

Convective Influence Description



Convection interacts with one of the trajectory curtains – standard satellite image (3-hourly)
TRMM dataset rain rates -- convection constrained to occur where rain rates greater than 1mm/hour
Effective brightness temperature of convective region, includes 6K adjustment (~1 km, Minniss et al)