Modulation of Tropical Tropopause Layer Characteristics by the Madden-Julian Oscillation during the DYNAMO/AMIE Field Campaigns

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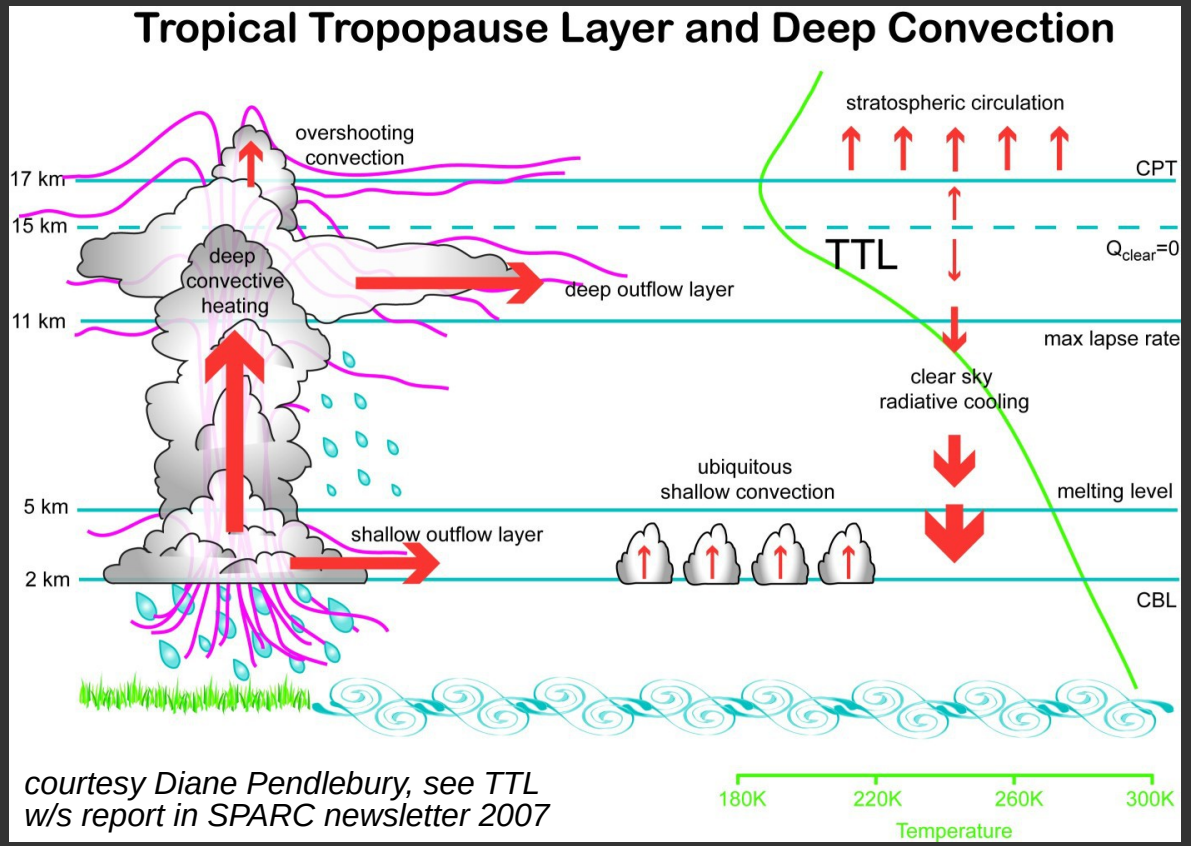
MJO and Convective Transitions Breakout

Tropical Upper Troposphere / Lower Stratosphere ~ Tropical Tropopause Layer (TTL)

- Sets boundary conditions for constituents entering the stratosphere, most importantly water vapor
- Stratospheric water vapor important for radiative budget (potential implications for surface climate)
- Temperature variability governed by unusually large number of processes (e.g. dynamics on a vast range of scales)

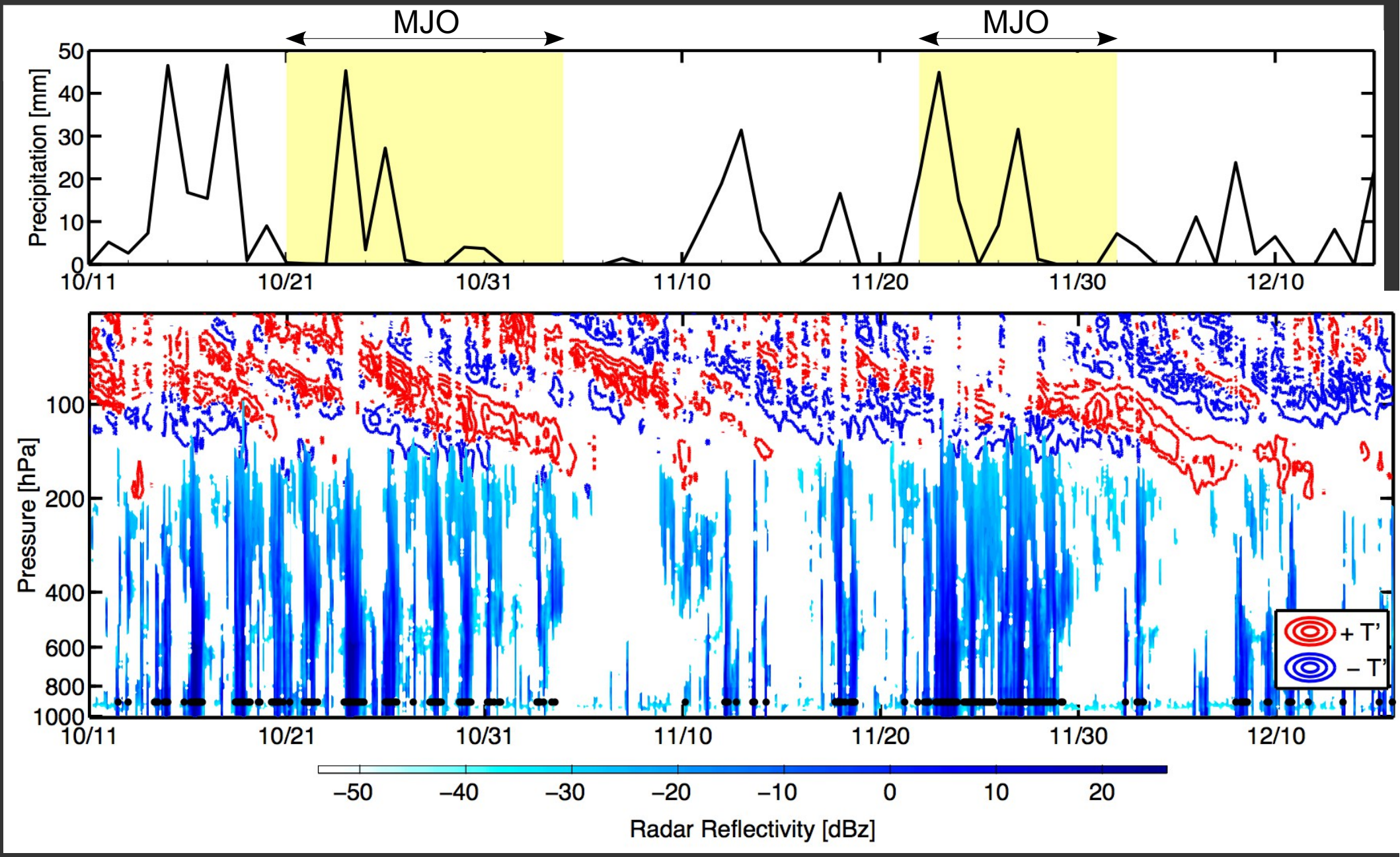


courtesy Diane Pendlebury, see TTL w/s report in SPARC newsletter 2007

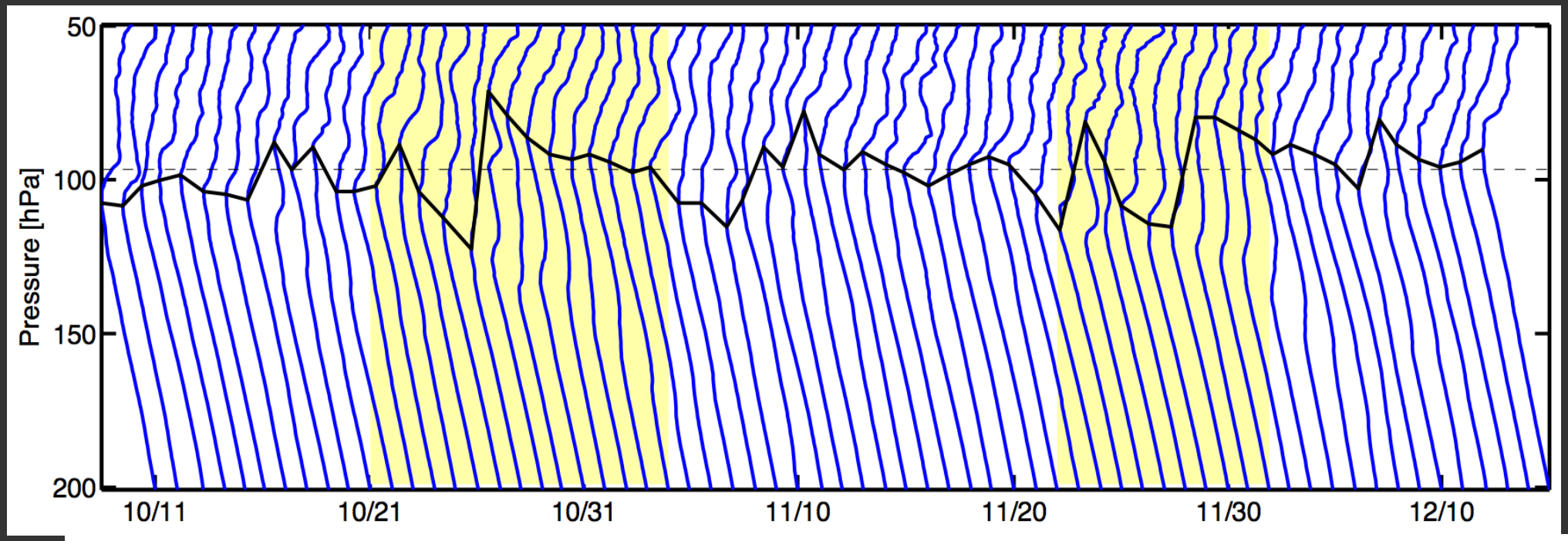
DATA

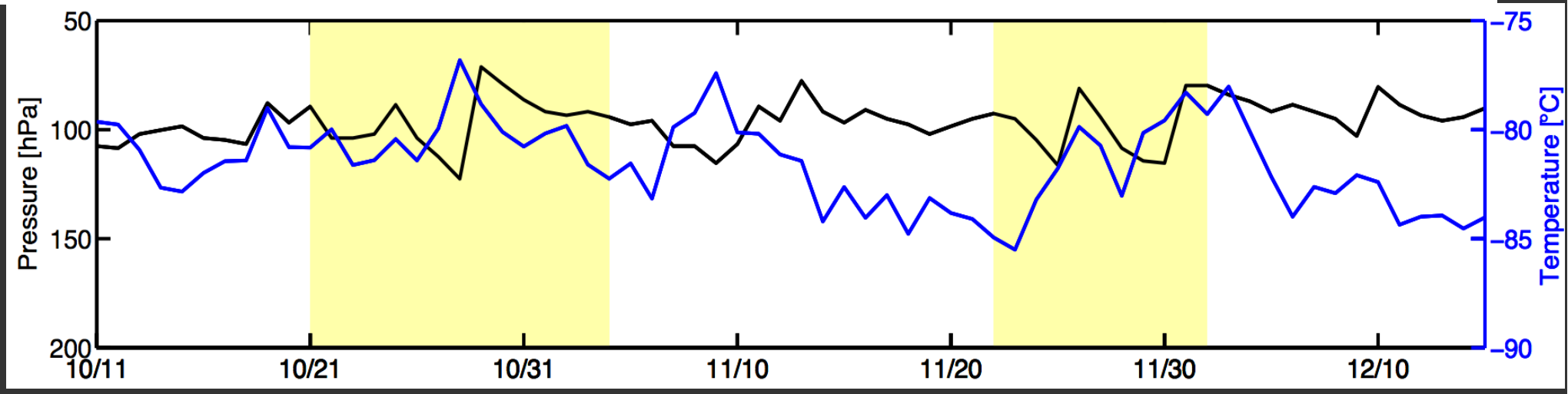
- Gan Island DYNAMO Soundings (50 m vertical resolution, every 3 hours, thanks to Paul Ciesielski)
- PNNL combined radar / lidar retrieval (thanks to Zhe Feng & PNNL group): clouds, precipitation, radiative heating rates, no tropopause-level cirrus clouds!
- CALIPSO data for cirrus

TTL Temperature Variability during DYNAMO/AMIE: Gan Island soundings



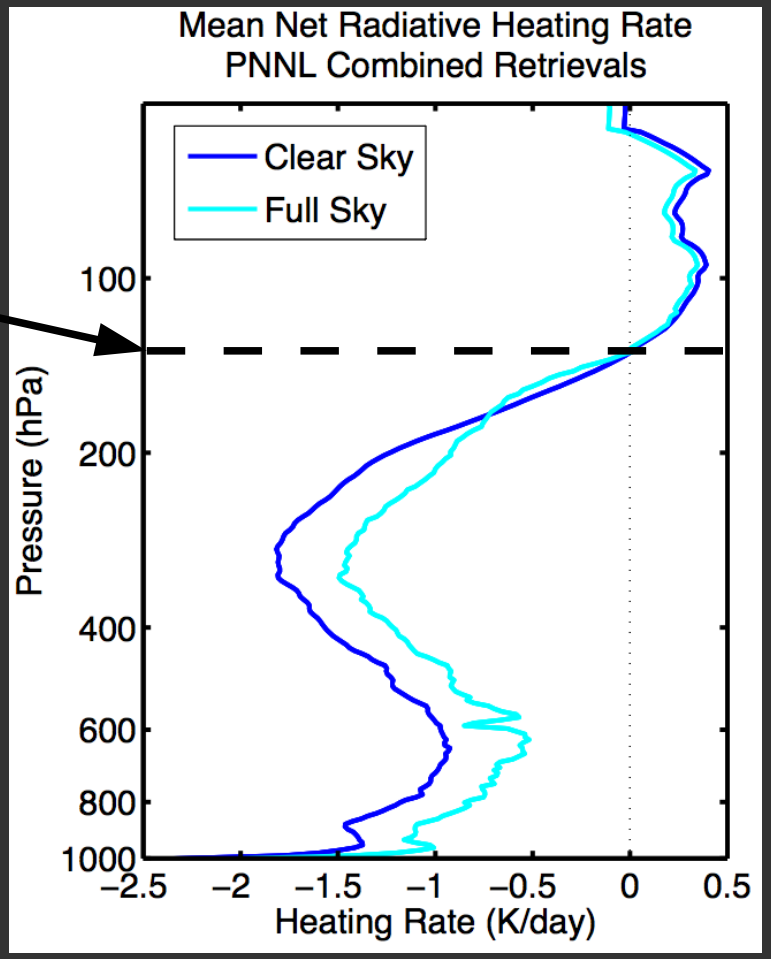
Cold Point Tropopause Variability, Gan Island

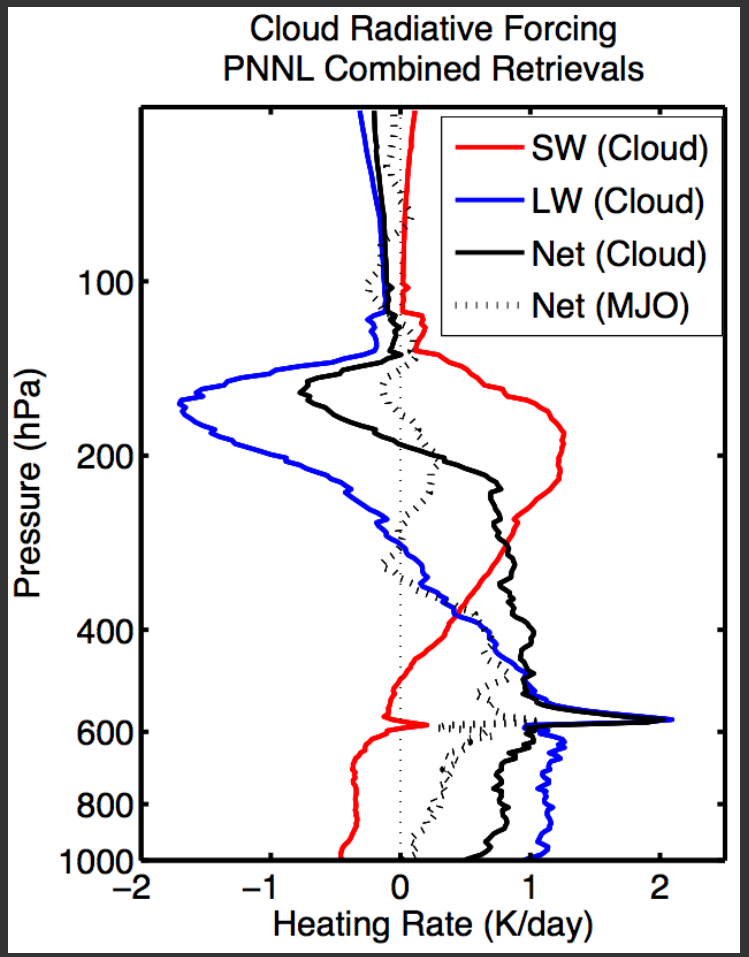




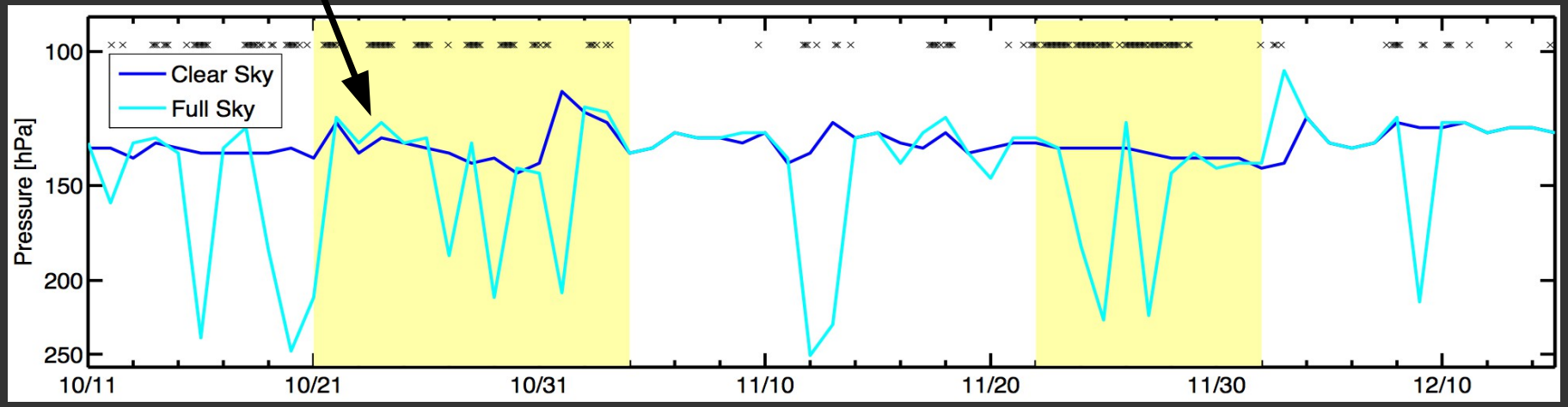
PNNL Radiative Heating Rates

Level of zero net radiative heating

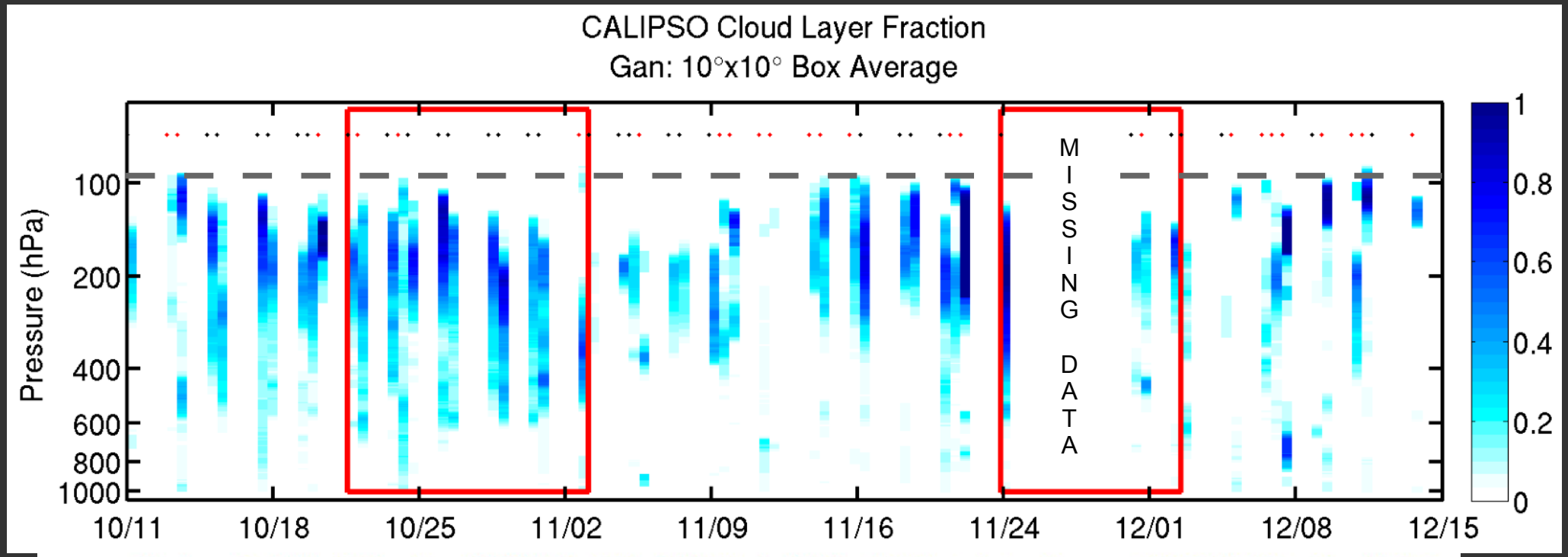


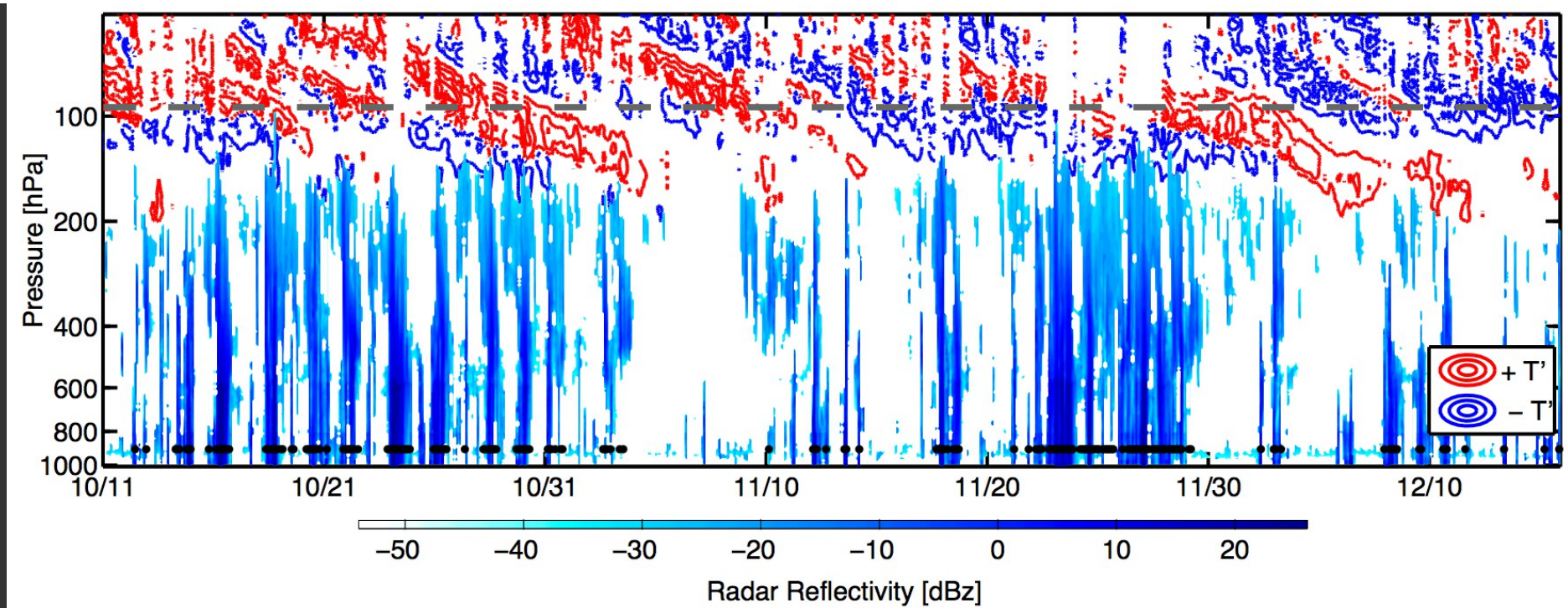


cf. Corti et al. (2005); Yang et al. (2010)



TTL Cirrus from CALIPSO





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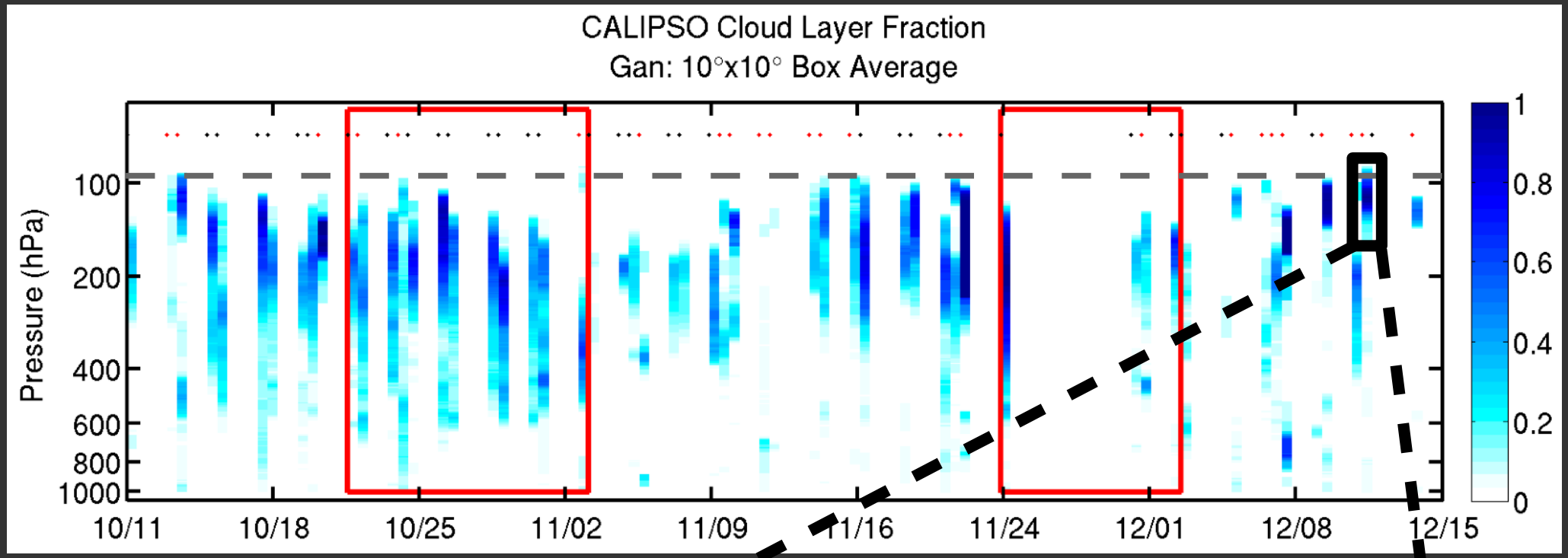
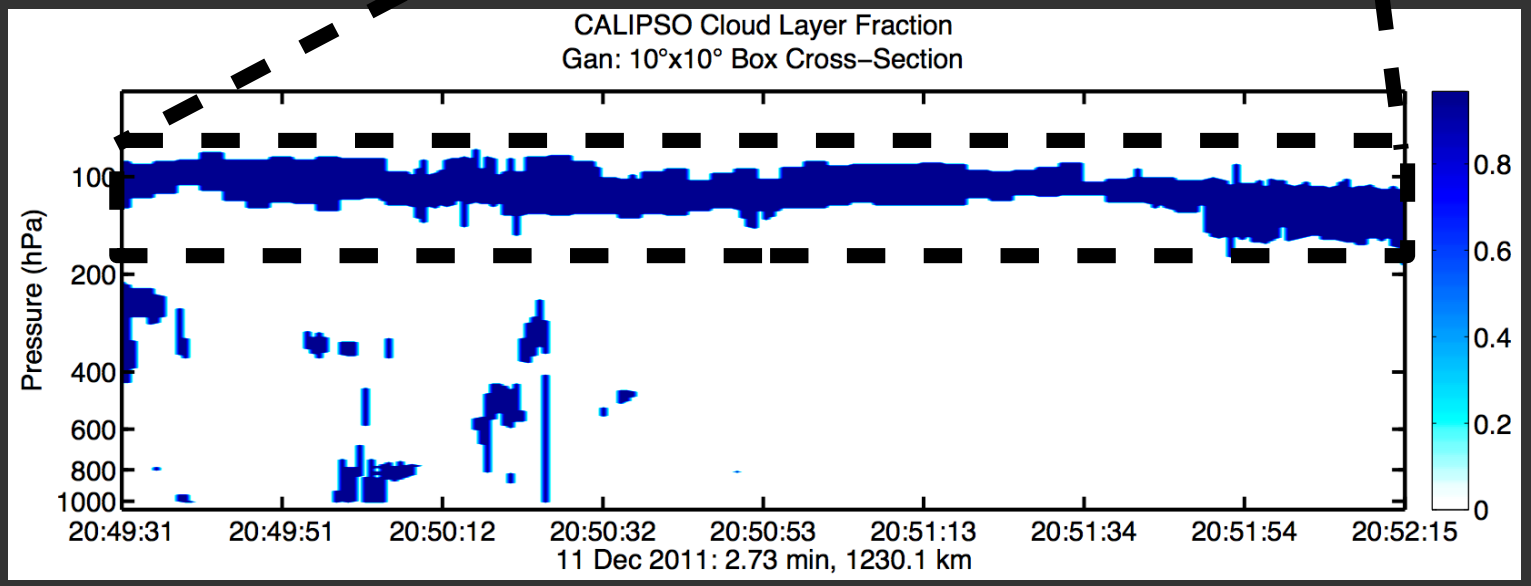
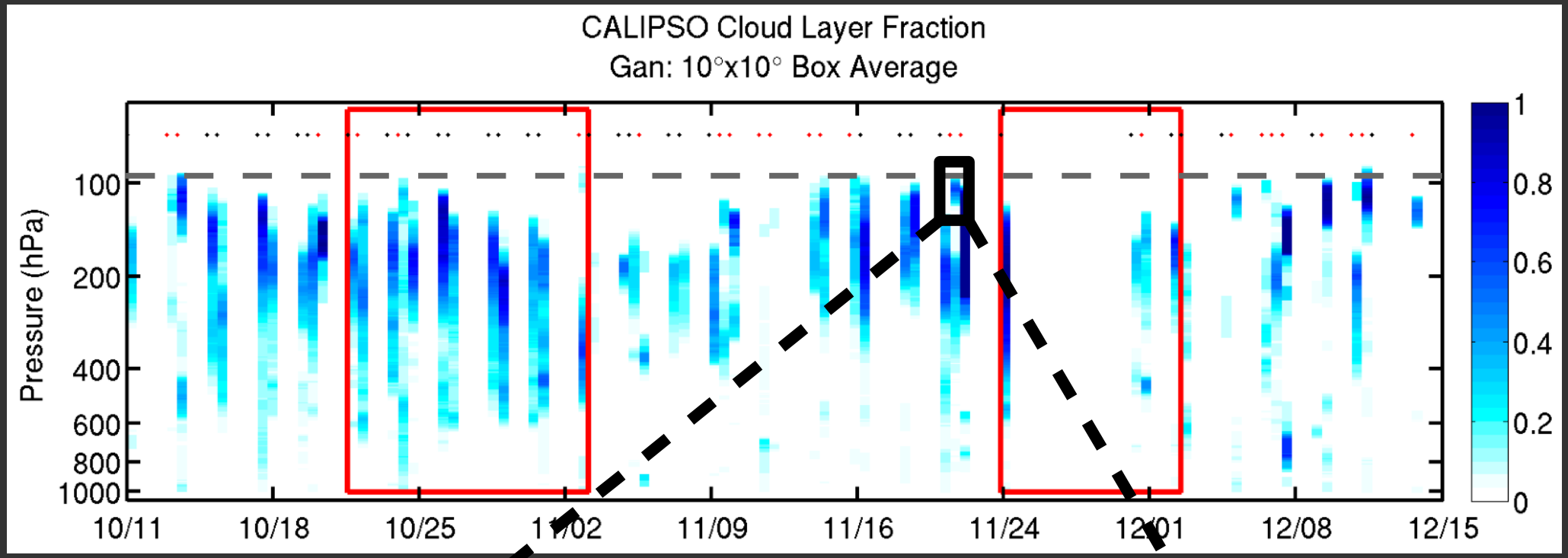
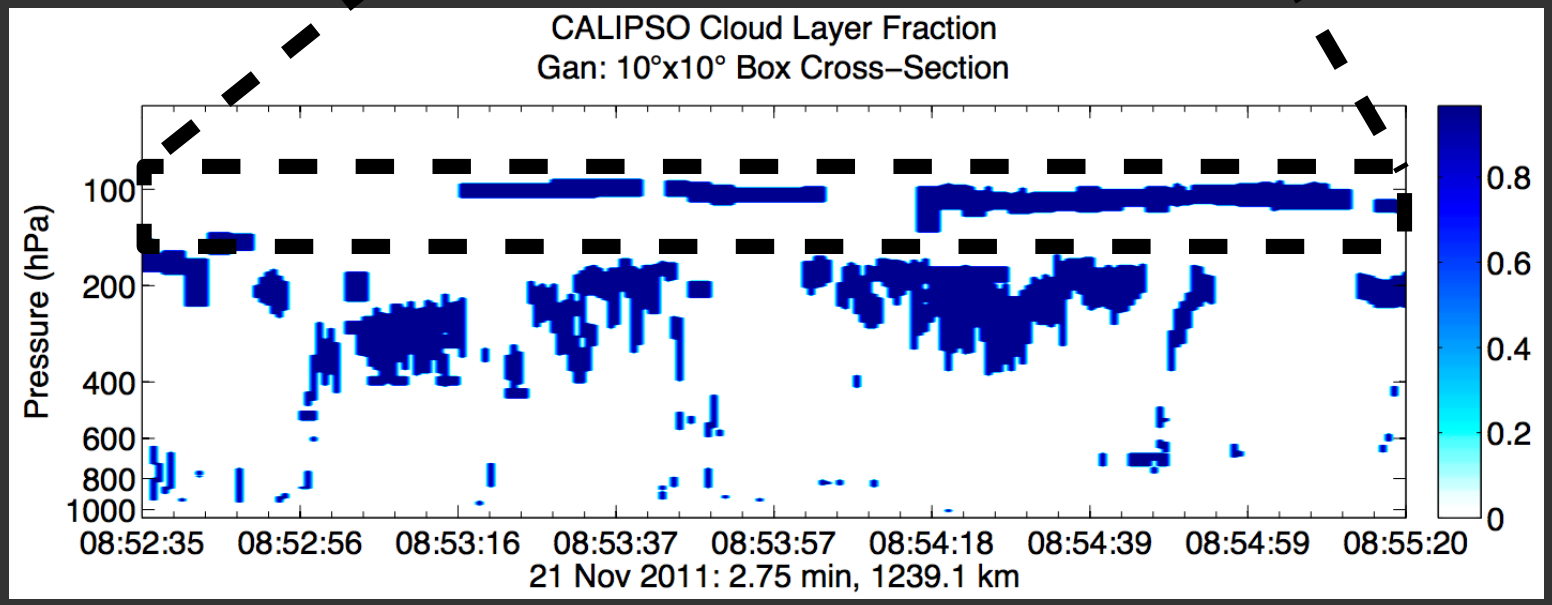




cf. Virts et al. (2010)

TTL Cirrus from CALIPSO





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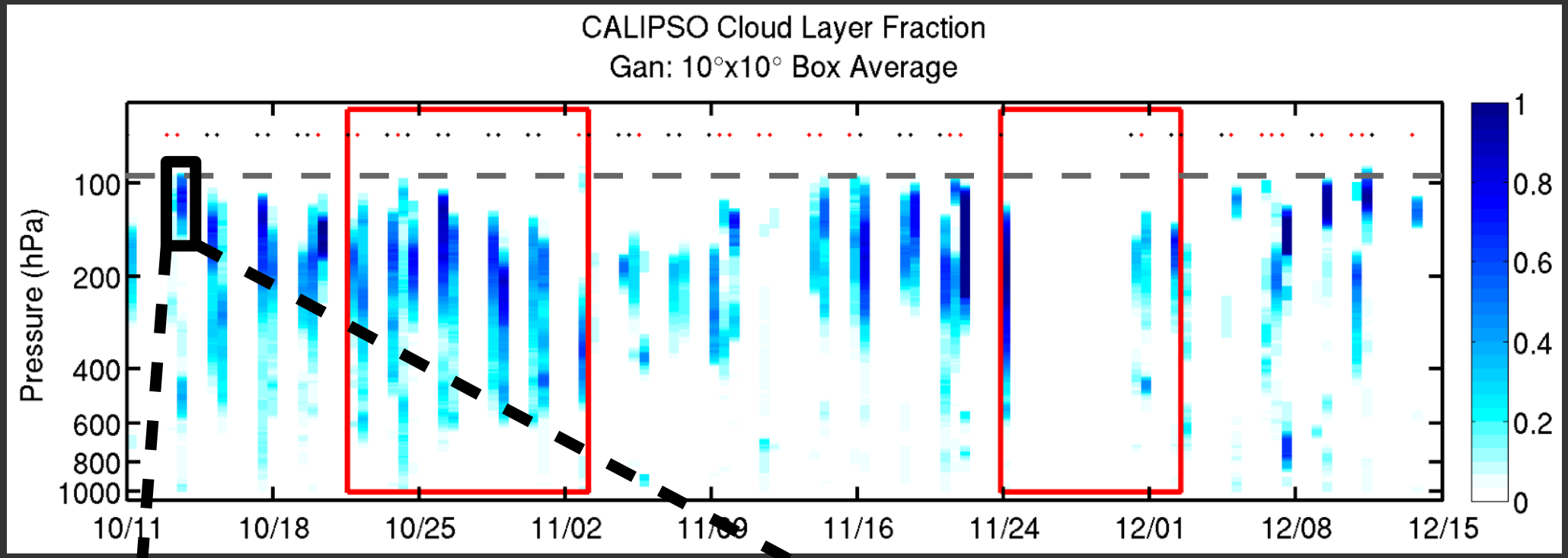
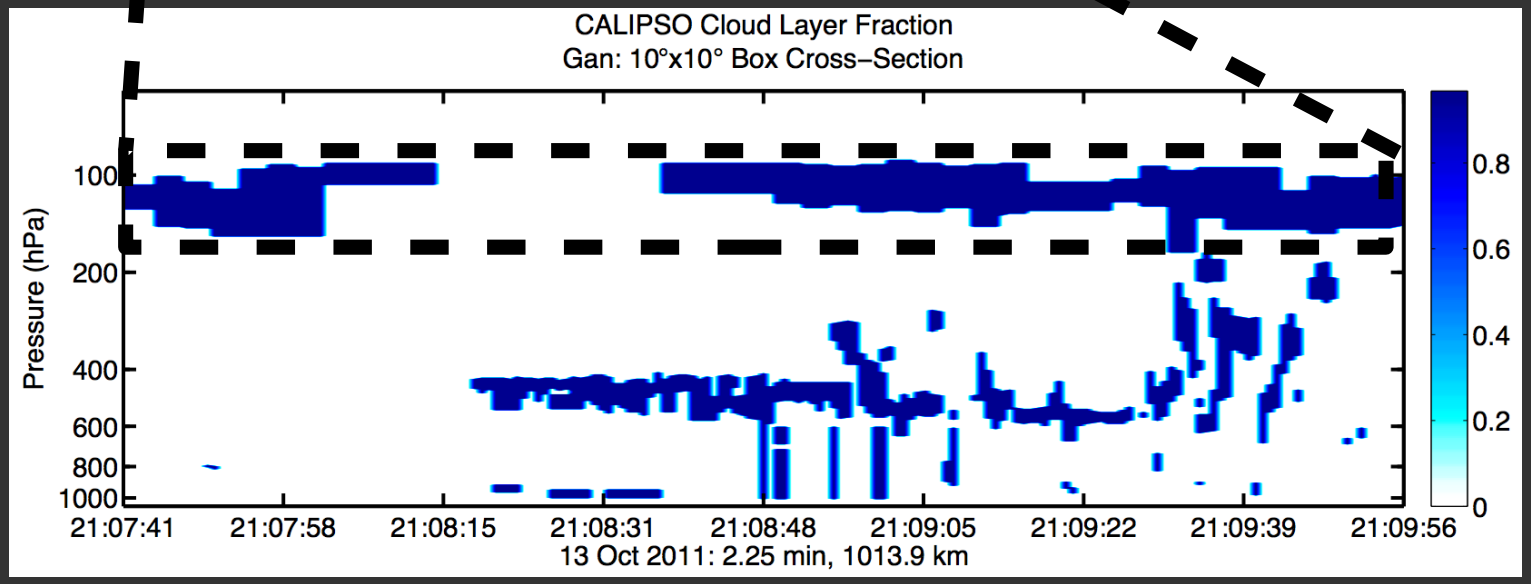
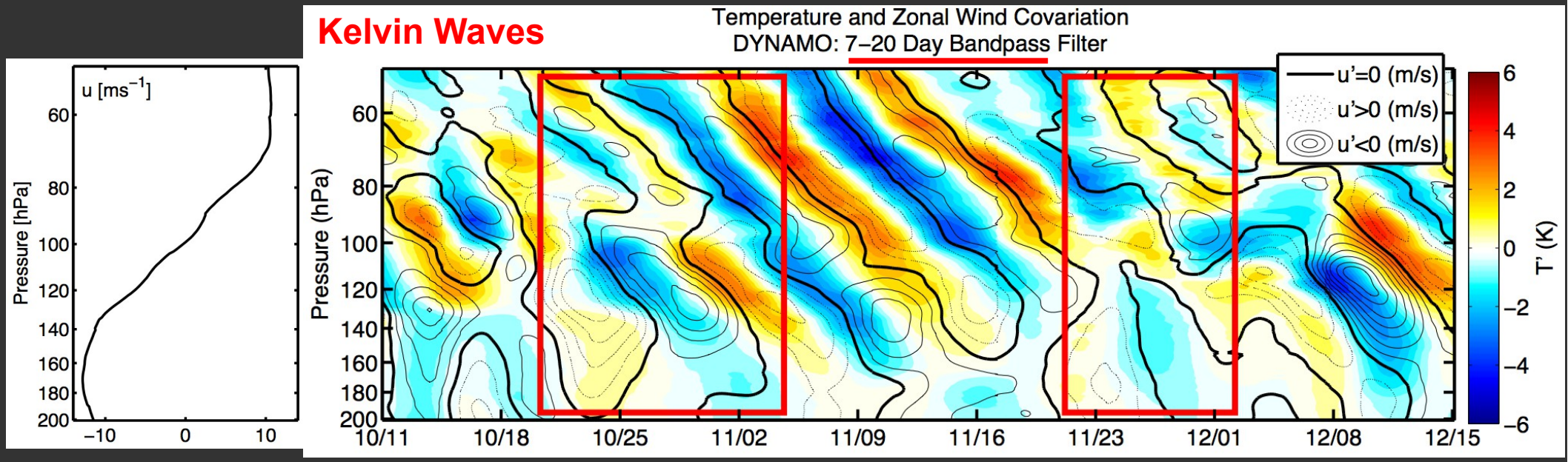
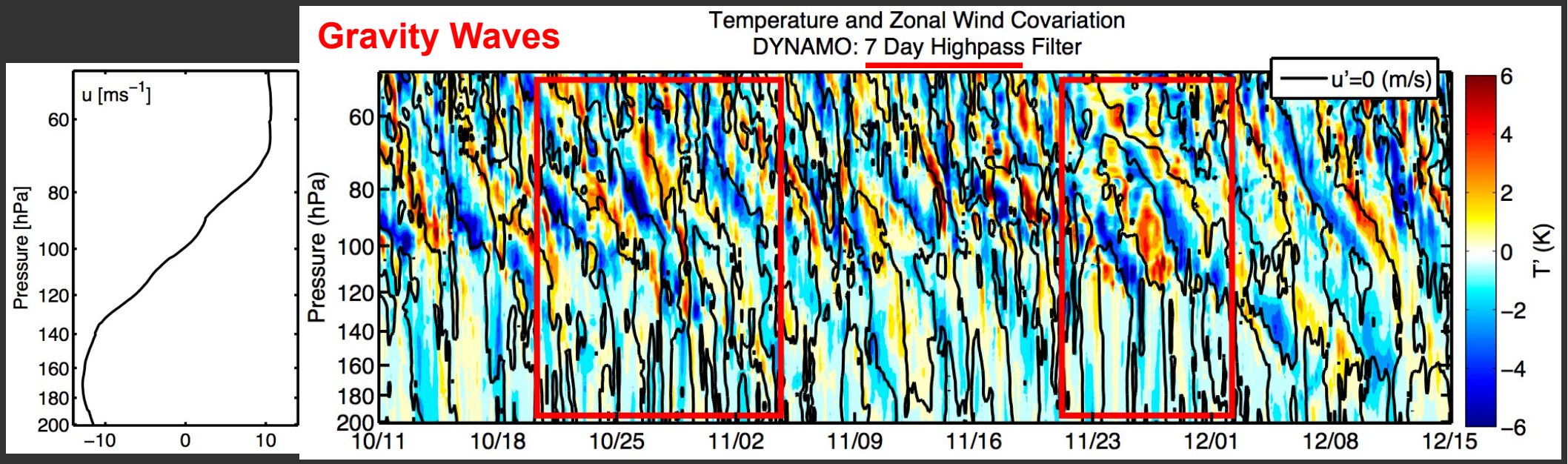


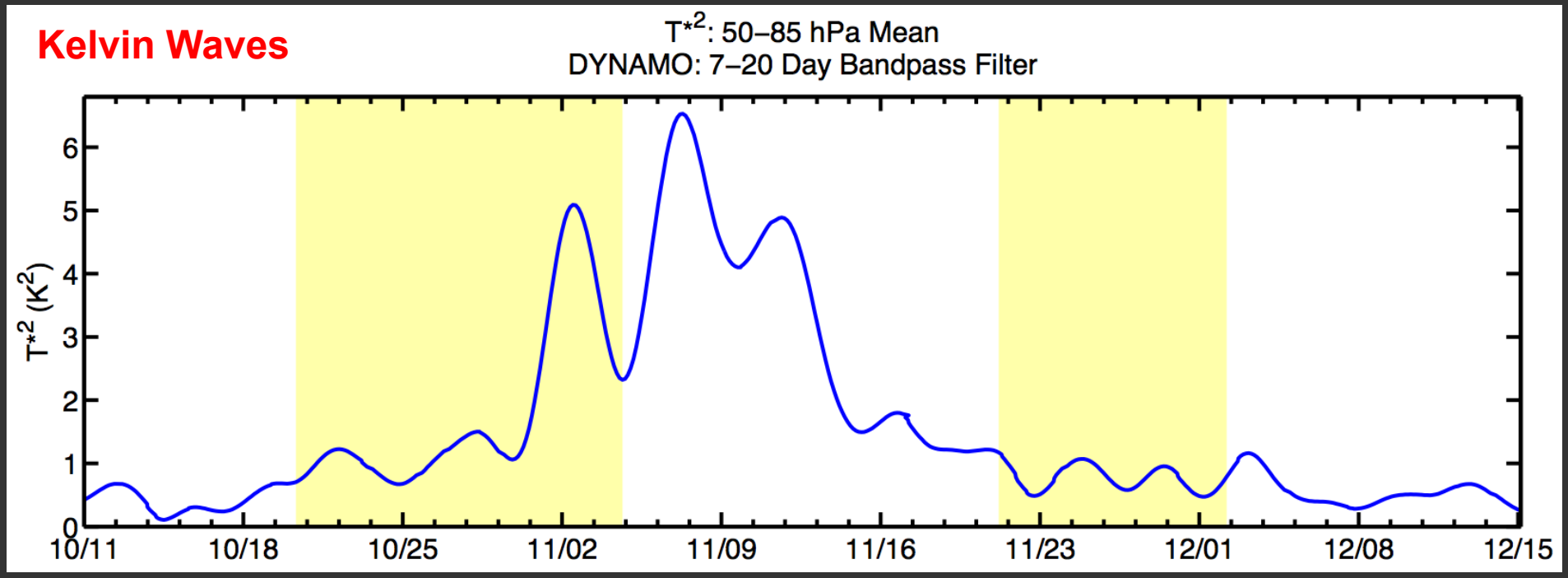


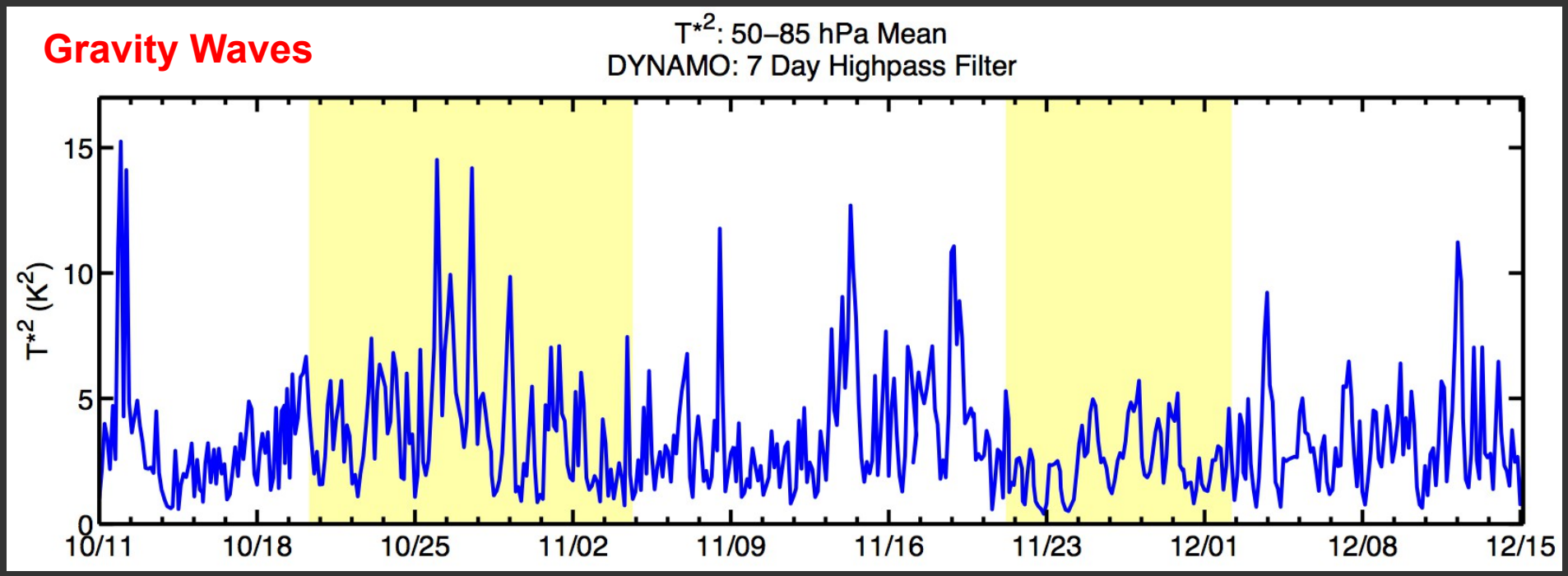
Tropopause & Lower Stratosphere Wave Activity





Lower Stratospheric Wave Energy

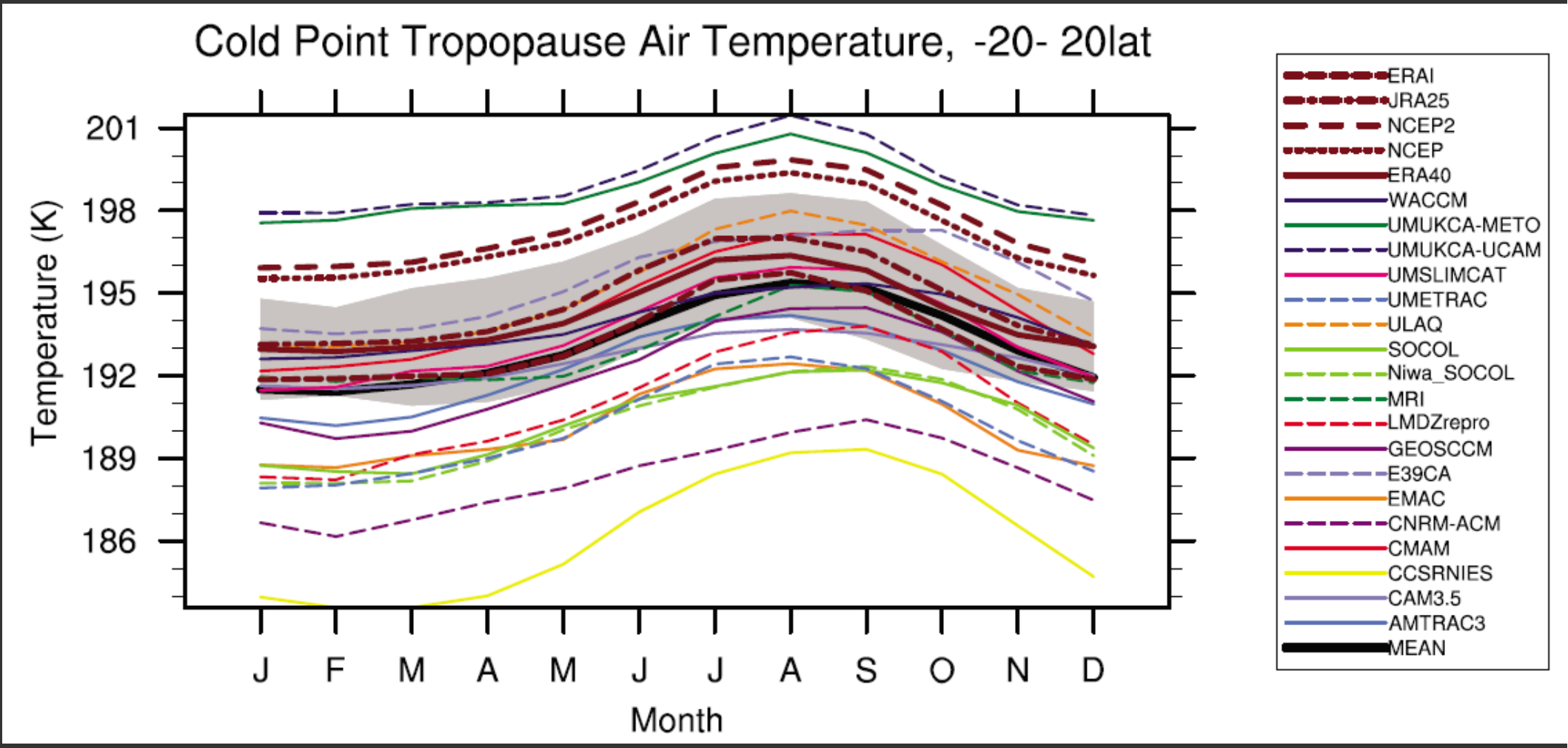




Conclusions

- High cloud tops, cold tropopause during MJO, but coldest tropopause outside of MJO periods
- Strong Kelvin wave activity, enhanced just following first (October) MJO
- Strong lower stratospheric gravity wave activity (presumably convectively generated), in particular during first MJO
- Level of zero radiative heating significantly lowered due to clouds
- CALIPSO shows tropopause-level cirrus, which were not incorporated into PNNL retrieval

Annual Cycle in Tropical Tropopause Temperature CCMVal2 Models



Gettelman et al., 2010