Lidar Observation in the UTLS:
A global perspective

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Review of Lidar Capabilities for UTLS Observations

What species?

1- Ozone DIAL (stratosphere): 12-50 km
2- Ozone DIAL (troposphere): 0-20 km
3- Temperature Rayleigh: 20-90 km
4- Temperature vib.-Raman: 8-40 km
5- Temperature rot.-Raman: 0-30 km
6- Water vapor vib.-Raman: 0-20 km
7- Water Vapor DIAL: 0-12 km
8- Clouds and aerosols (tropo): 0-6 km
9- Clouds and aerosols (strato): 10-50 km

Accuracy and precision in the UTLS vary widely

1- Depends on target species
2- Depends on instrumentation
3- Depends on location
4- Depends on time of measurements
5- Depends on atmospheric conditions
6- Depends on measurement duration

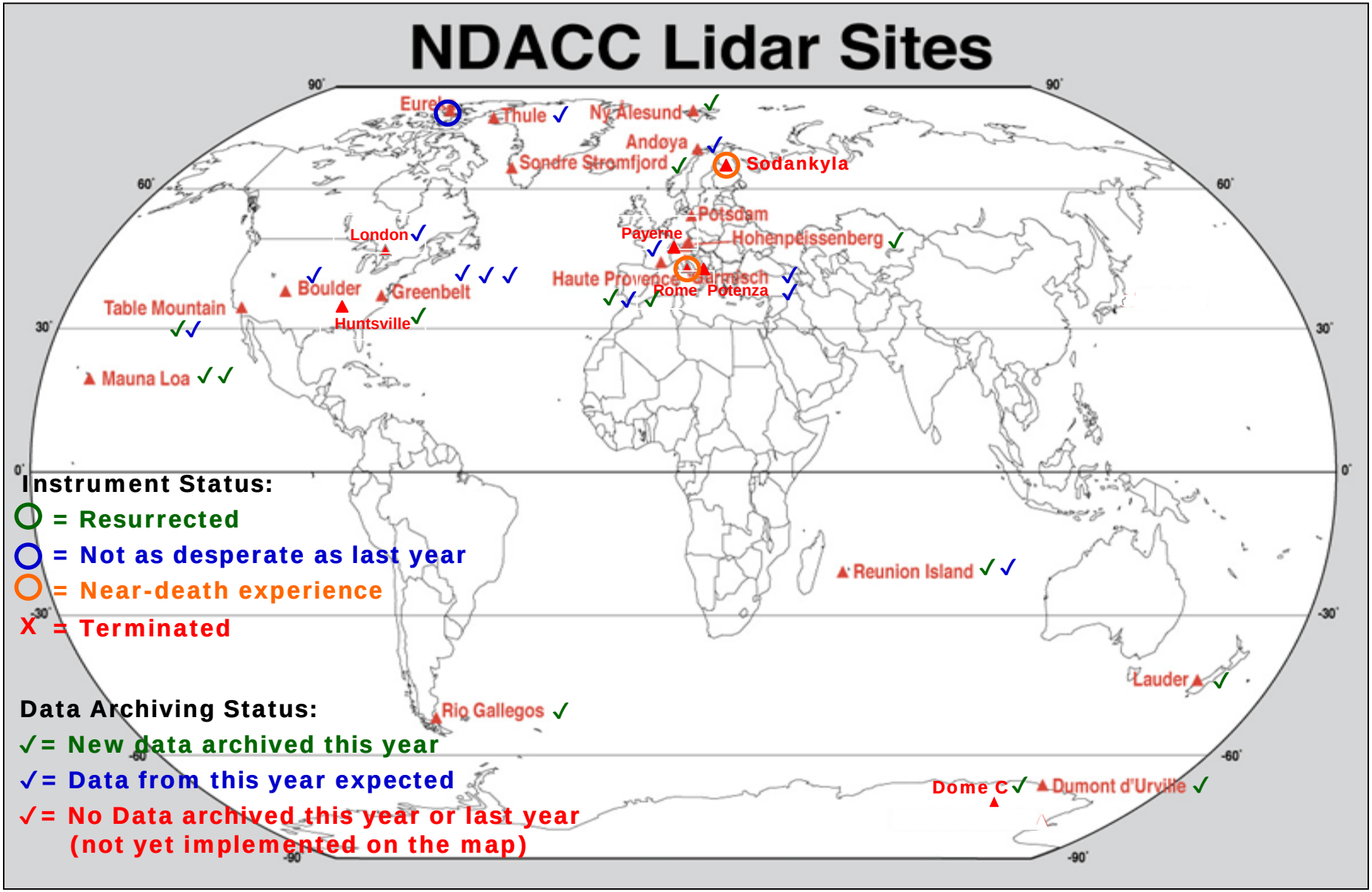
➔ Never assume performance beforehand!
➔ Always find out from expert in charge of specific dataset

Review of Lidar Capabilities for UTLS Observations

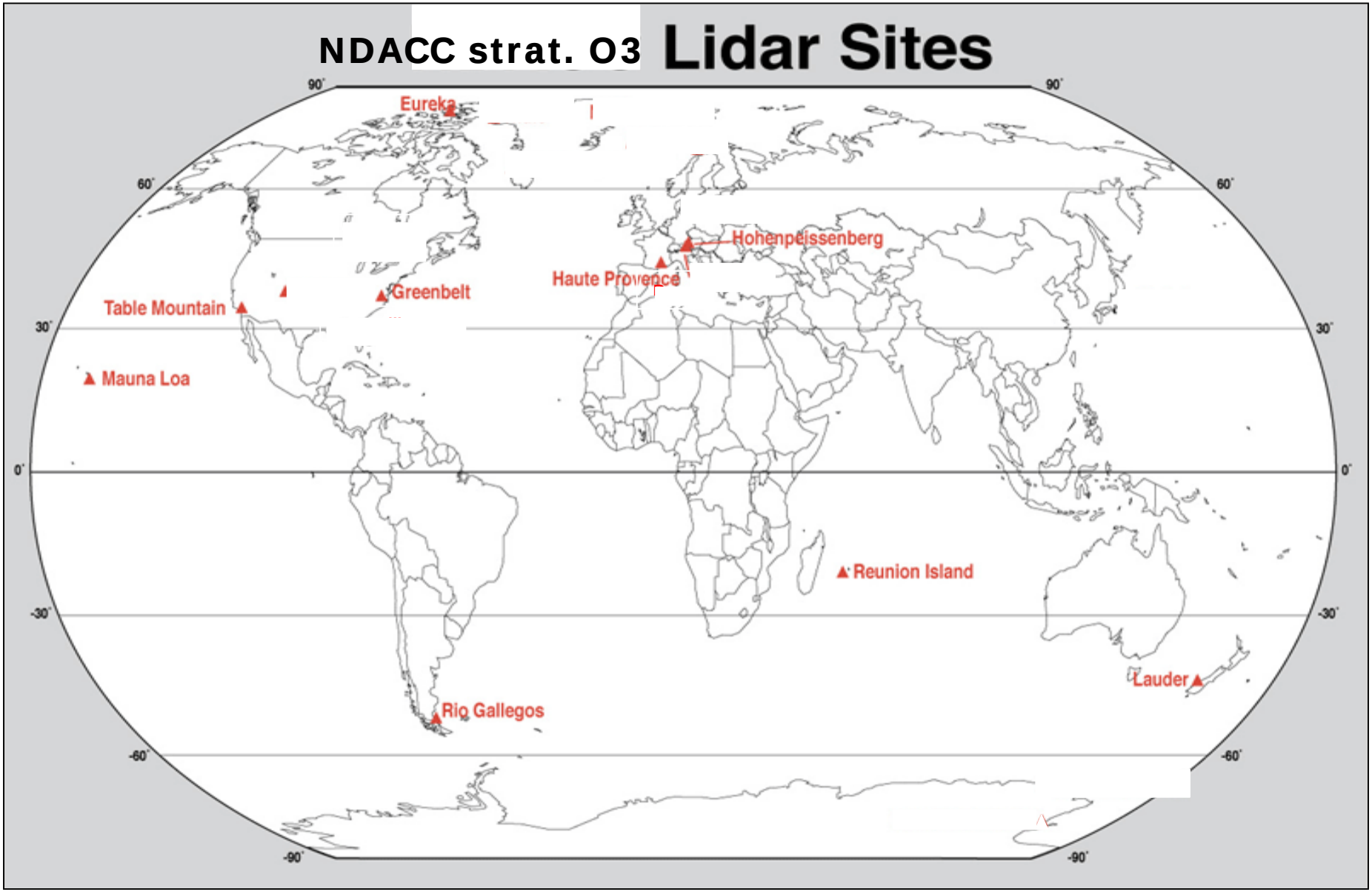
Where to find lidar data for the UTLS?

1- Ground-based, routine long-term: NDACC (O3, T, H2O, Aer)
2- Ground-based, mobile, campaign: NDACC (O3, T, H2O, Aer)
3- Ground-based, mostly campaign-basis: TOLNet (O3)
4- Sea-based (ship), fixed routes: Polarstern (H2O, Aer)
5- Aircraft, campaign basis: DLR (Aer, and more…)
6- Aircraft, campaign basis: NASA DC-8 (O3, H2O, Aer)
7- Aircraft, campaign basis: NASA ER-2 (O3)
8- Aircraft, campaign basis: NCAR G-5 (Aer)
9- Aircraft, campaign basis: NASA AJAX (O3)
10- Probably other aircrafts that I cannot remember…
11- Possibly other ships that I cannot remember…

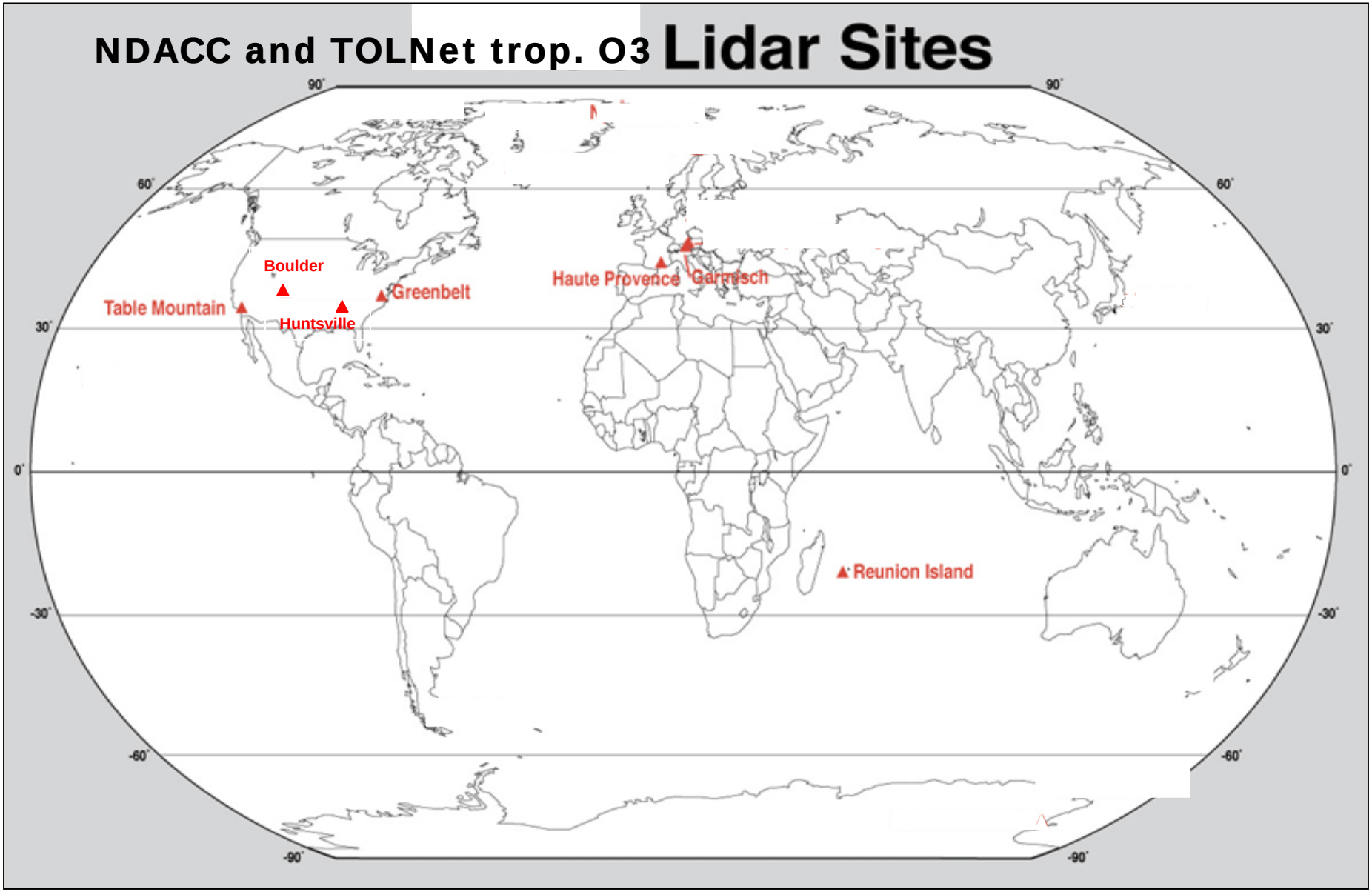
As of 2015…


NDACC Lidar Sites
Eureka
Thule
Ny Alesund
Andoya
Sondre Stromfjord
Sodankyla
Potsdam
London
Payerne
Hohenpeissenberg
Haute Provence
Garmisch
Rome
Potenza
Boulder
Greenbelt
Huntsville
Table Mountain
Mauna Loa
Reunion Island
Lauder
Rio Gallegos
Dome C
Dumont d'Urville
Instrument Status:
= Resurrected
= Not as desperate as last year
= Near-death experience
X = Terminated
Data Archiving Status:
✓= New data archived this year
✓= Data from this year expected
✓= No Data archived this year or last year
(not yet implemented on the map)

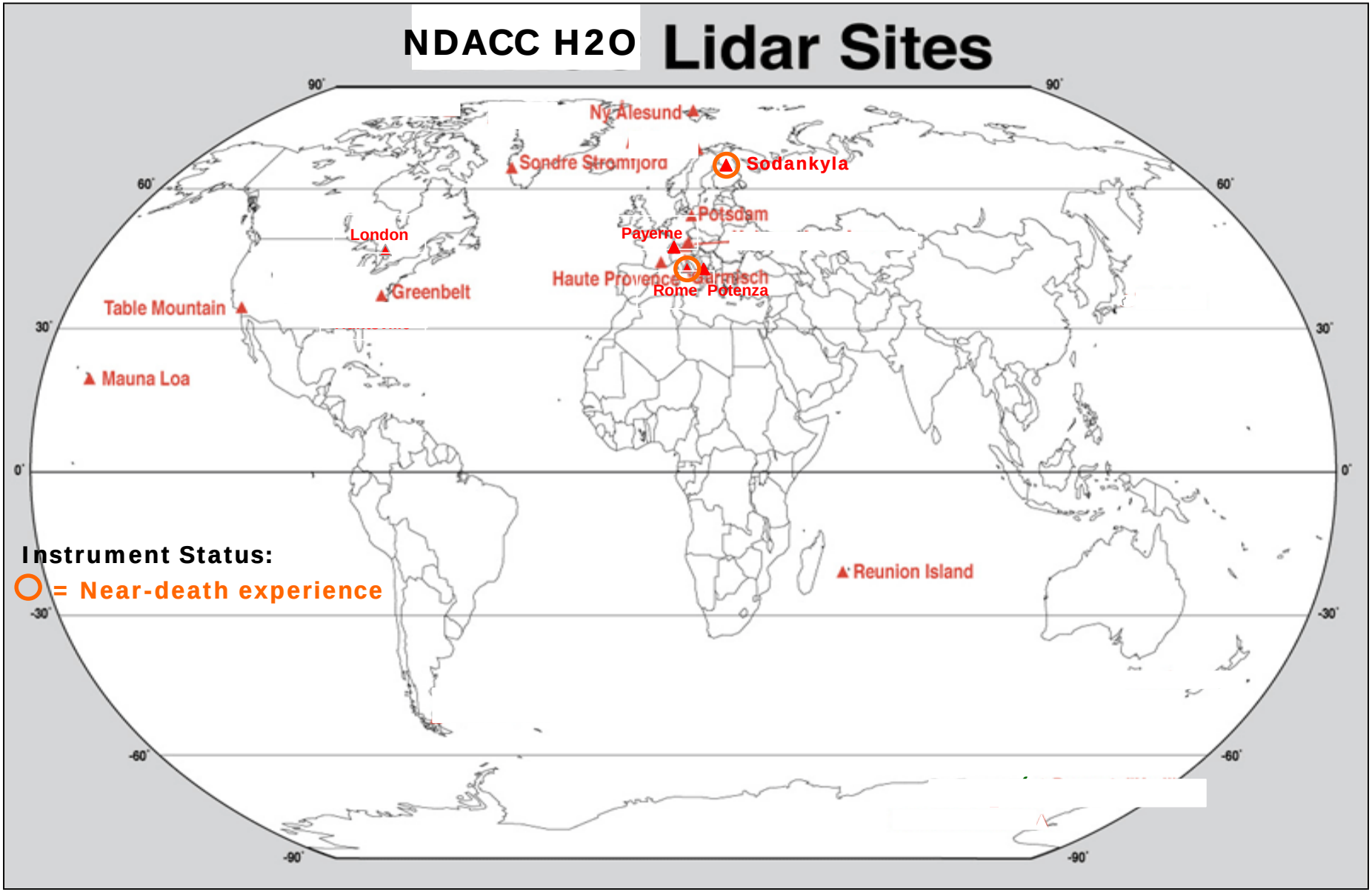
Where are the NDACC stratospheric O3 Lidars?



Where are the NDACC (and TOLNet) tropospheric O3 Lidars?

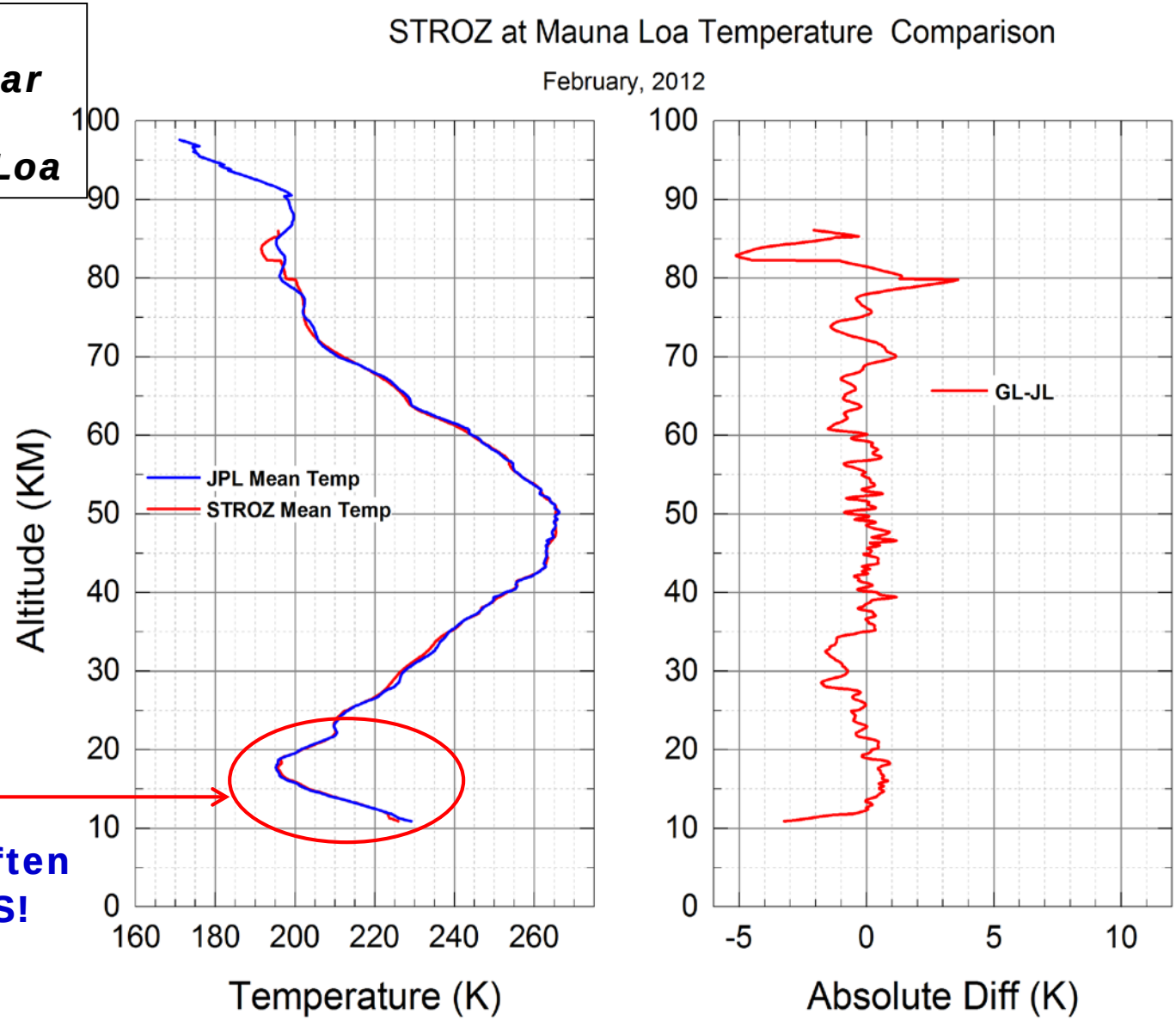


Where are the NDACC H2O Lidars?



Example: temperature

Comparison STROZ mobile lidar and JPL lidar@Mauna Loa

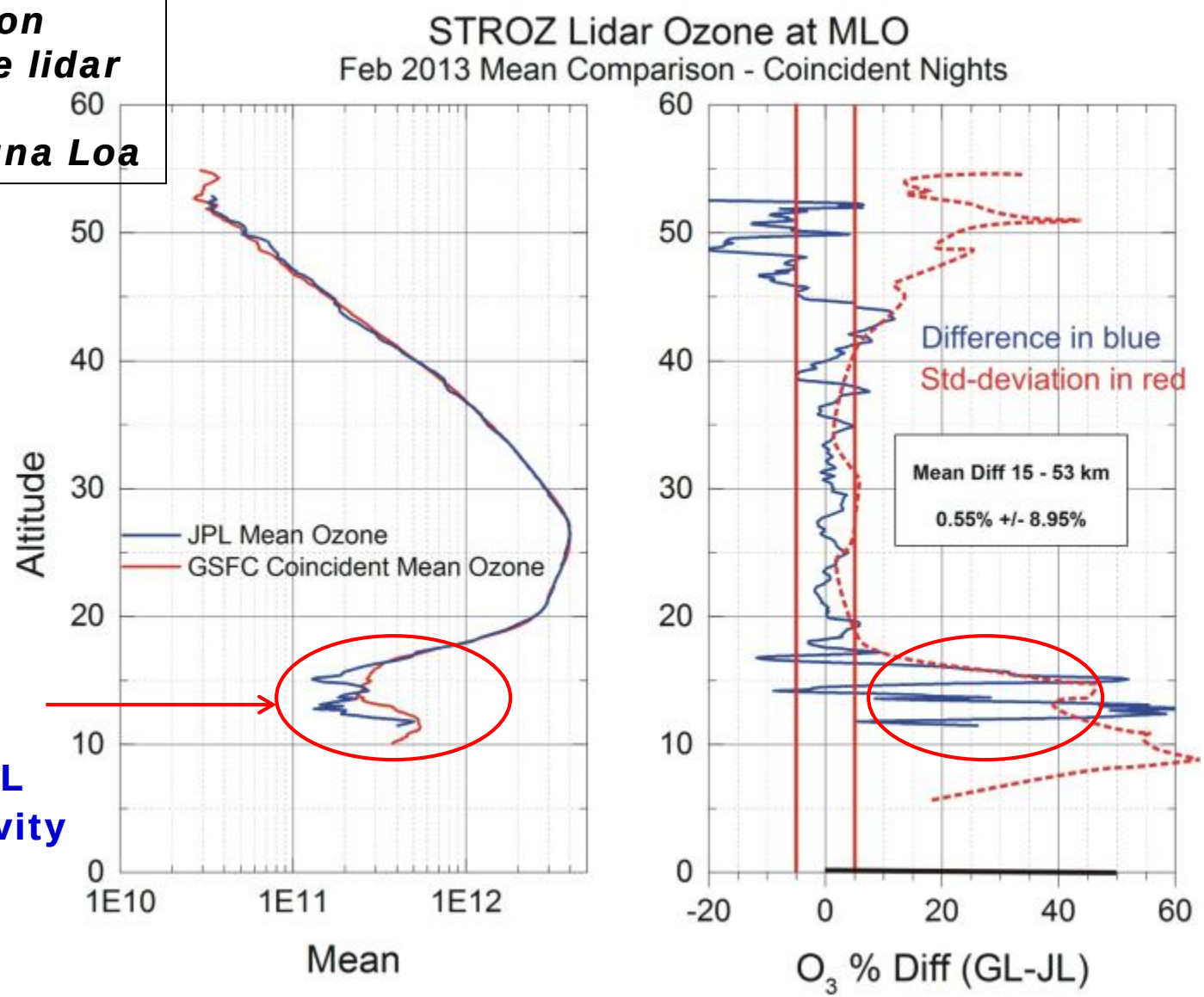


Excellent agreement

Yet, lidar obs. often ignored in the LS!

Example: Stratospheric O3 DIAL

Comparison
STROZ mobile lidar
and
JPL lidar@Mauna Loa



Ozone
Not so good

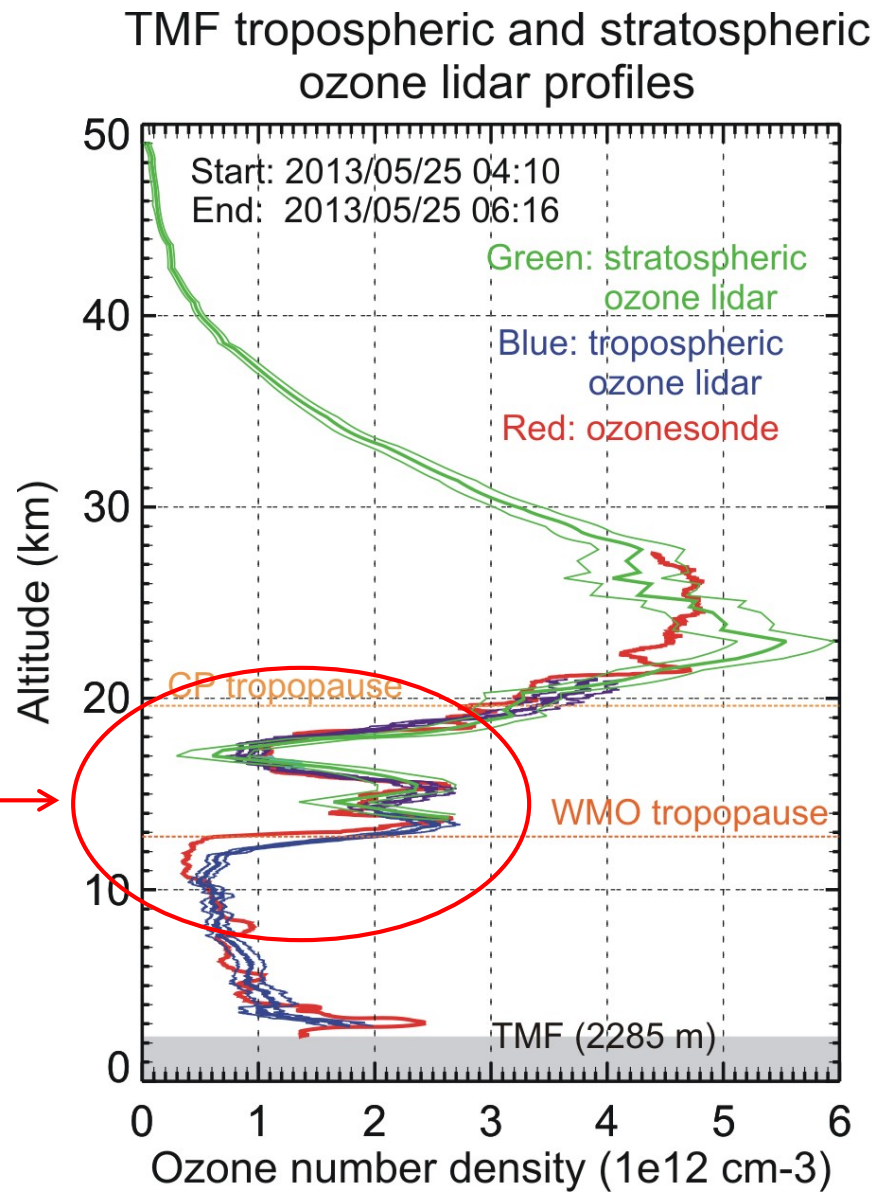
Strato O3 DIAL
looses sensitivity
in the UTLS

Example 3: Tropospheric O3 DIAL

JPL lidars@TMF

DIAL hybrid retrieval: uses 1 channel from tropo. O3 lidar and 1 channel from strato.. O3 lidar

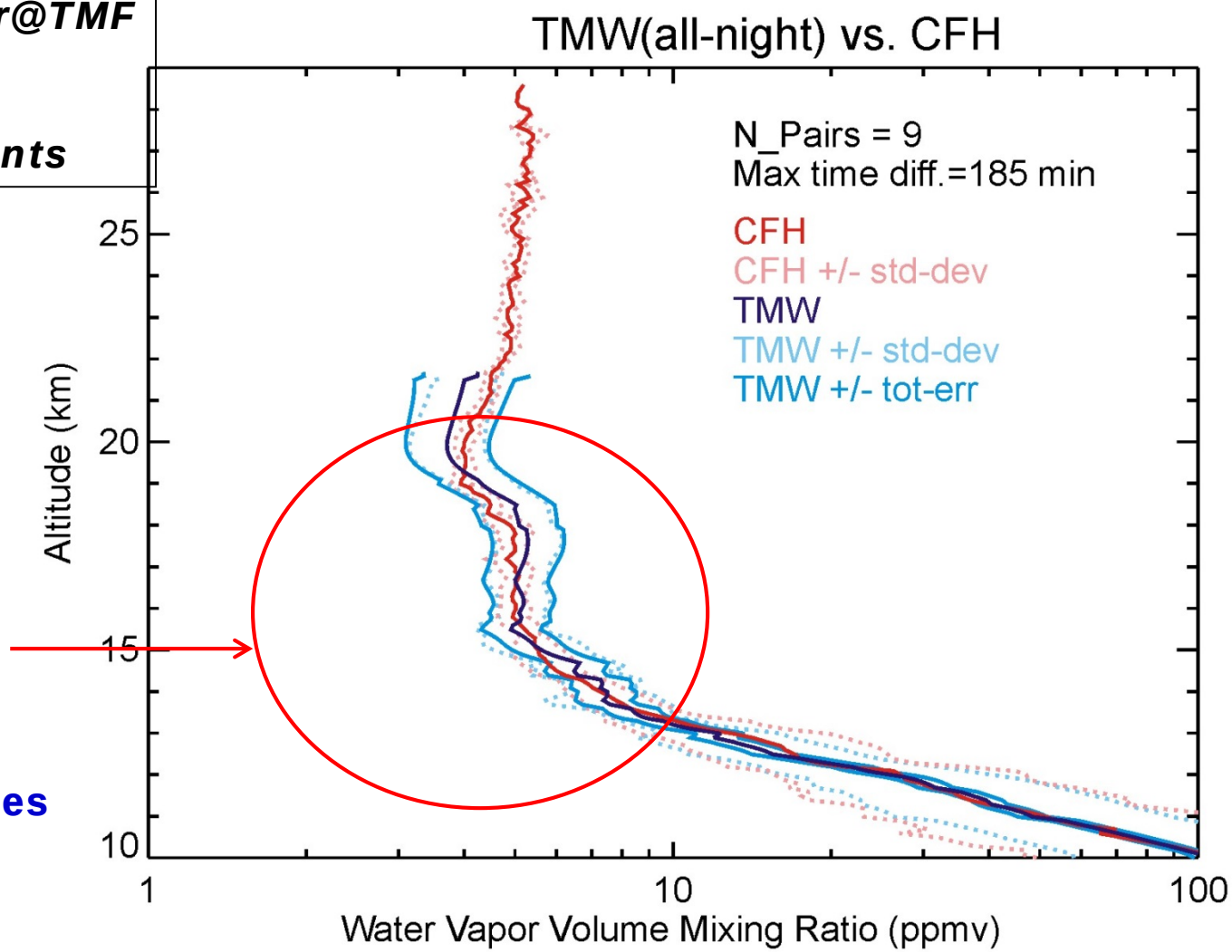
Great coverage of the UTLS!



Example 4: Water Vapor (Raman)

JPL Raman H2O lidar@TMF

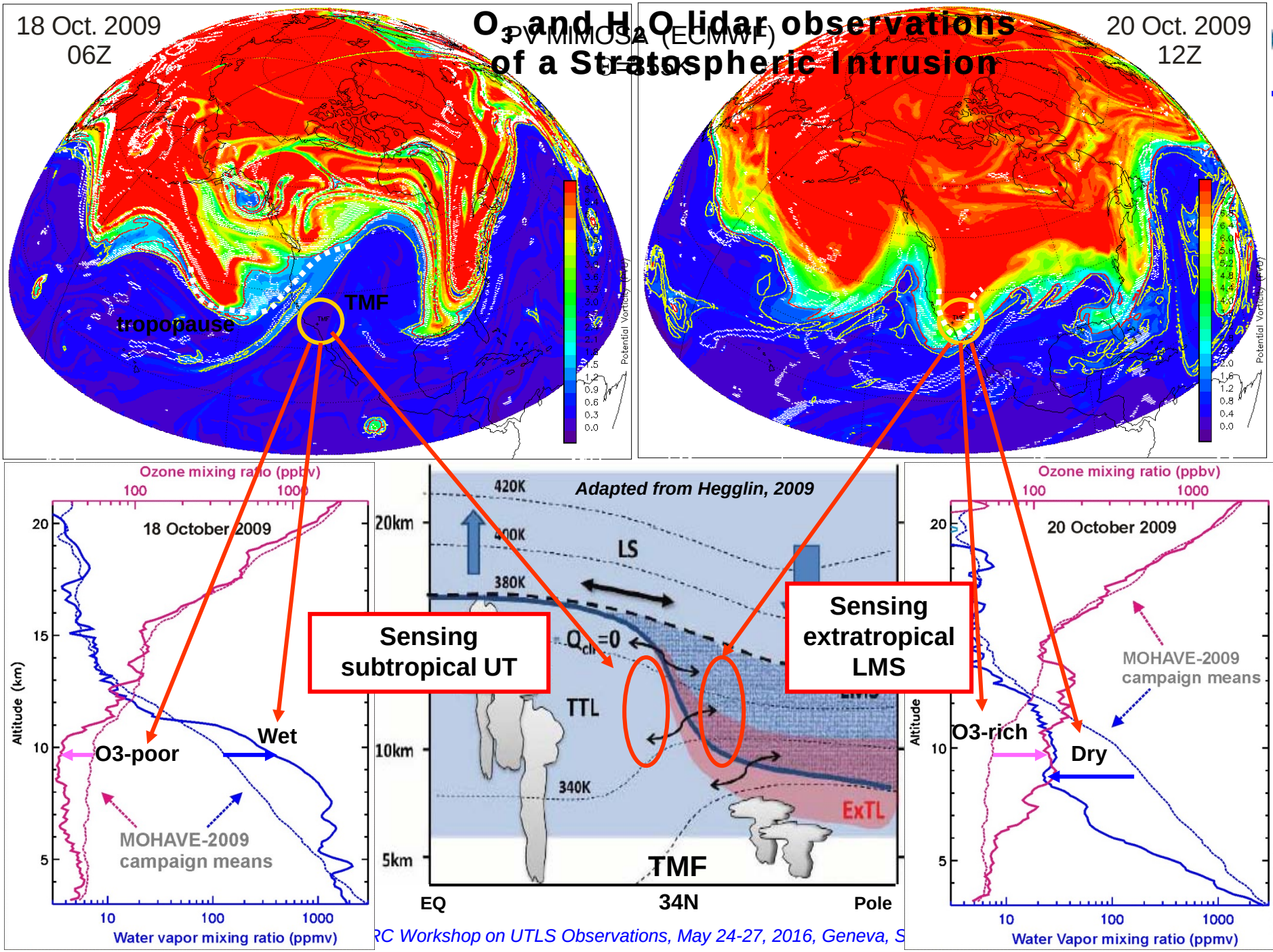
Optimized for UTLS measurements



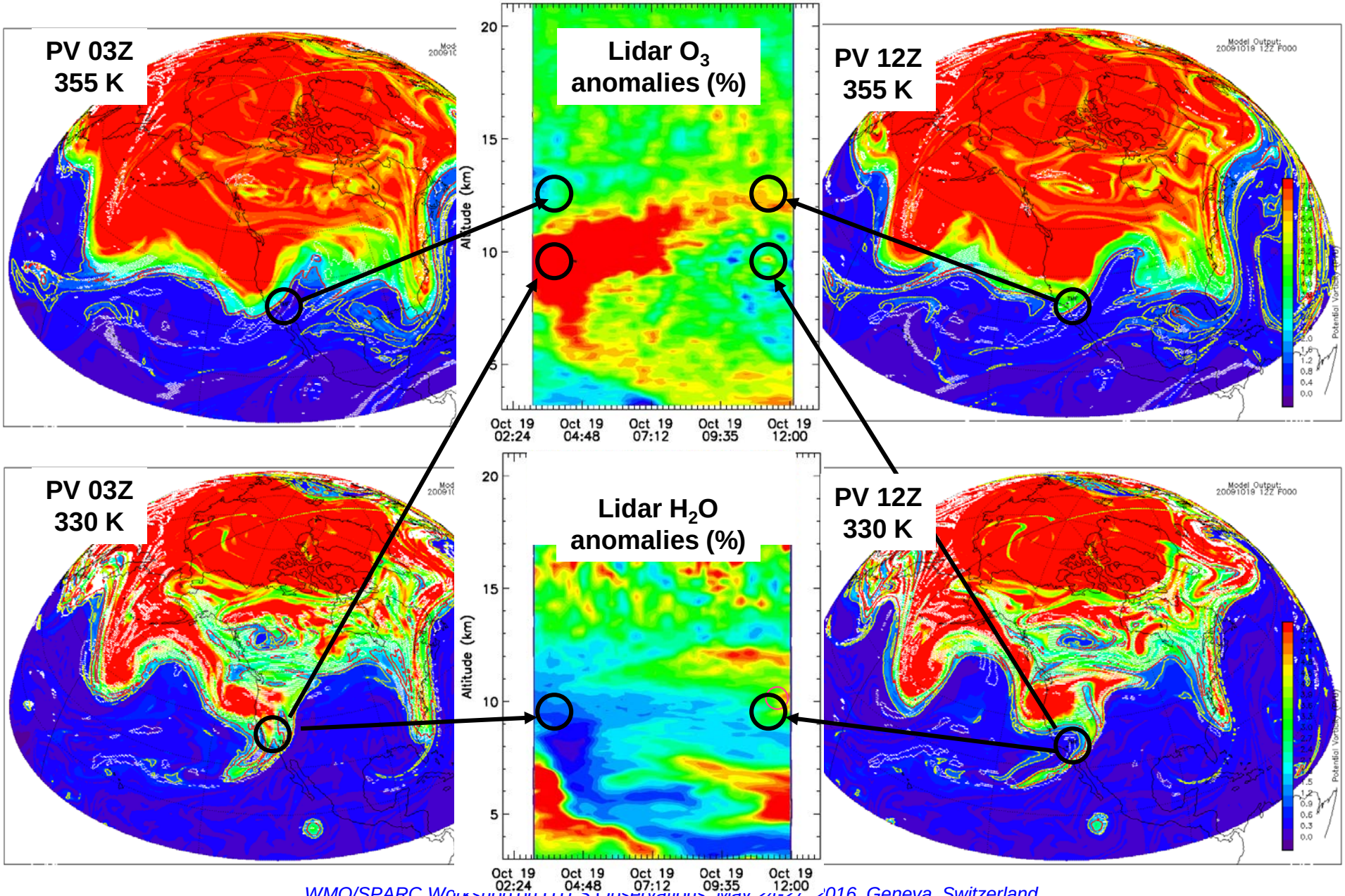
Very challenging for H2O lidars to reach the UTLS…

Long integration times required for LS but… Okay for UT!

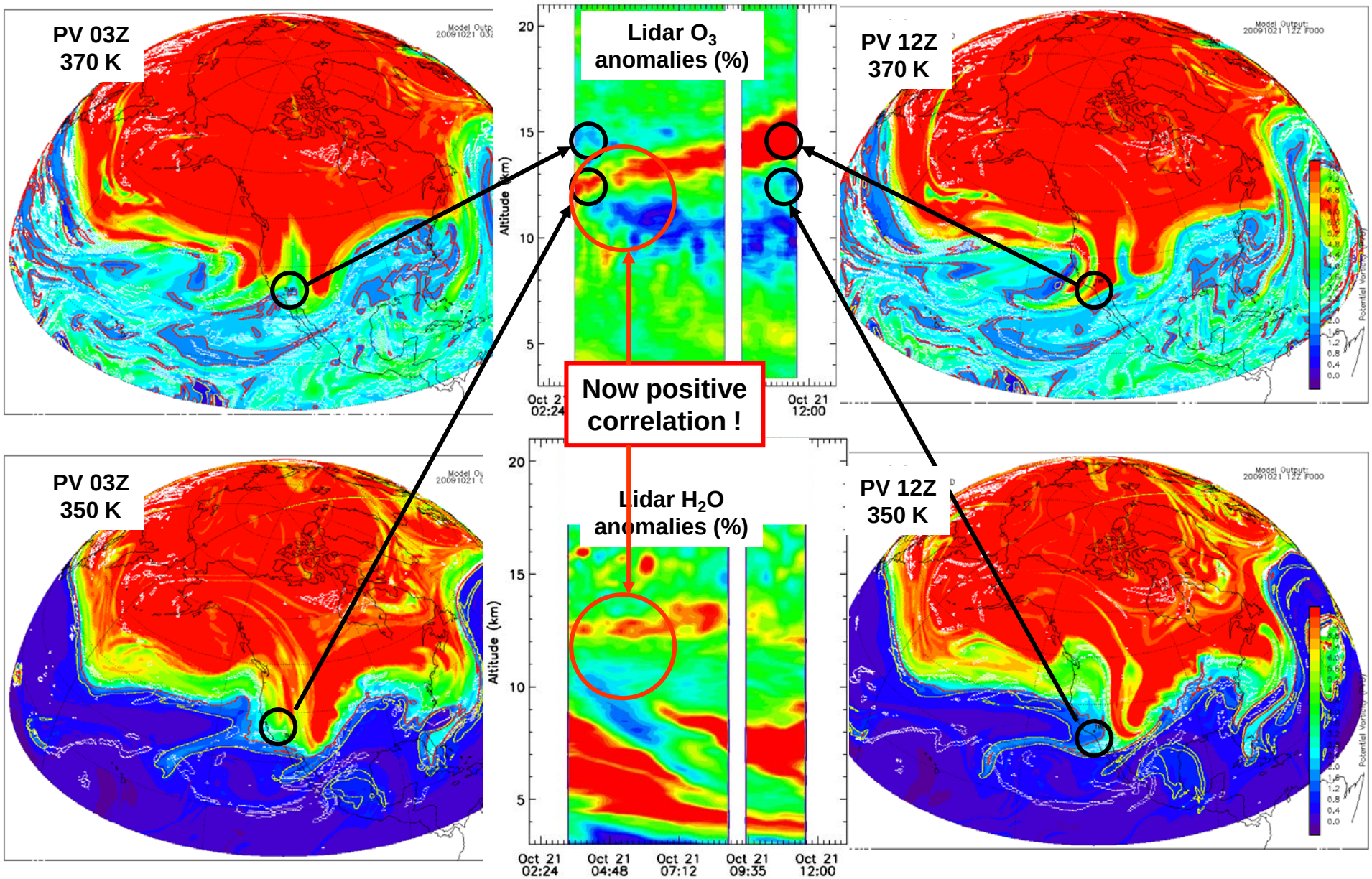
O_3 and H_2O lidar observations of a Stratospheric Intrusion



Oct. 19 O_3-H_2O anti-correlations, and PV maps

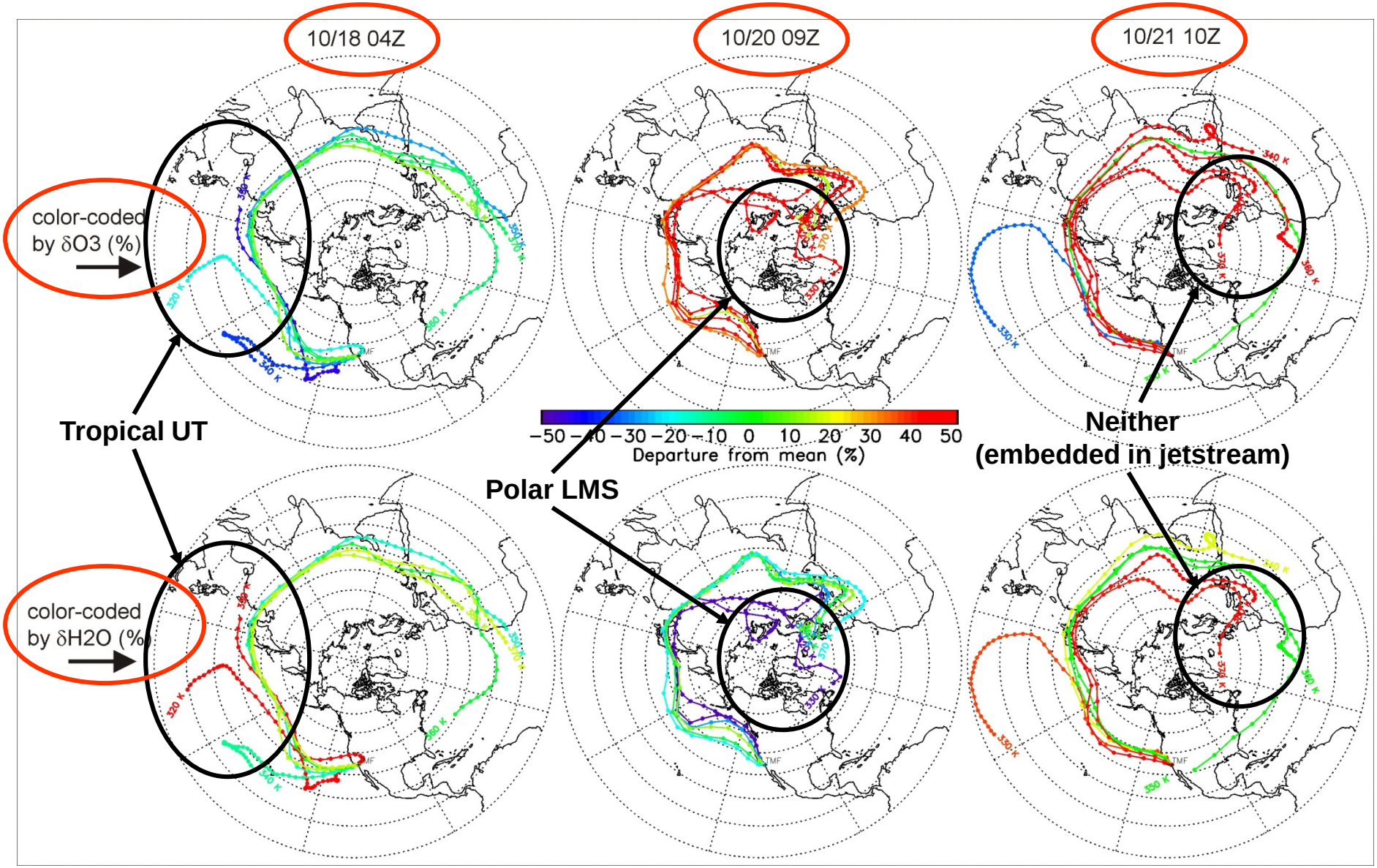


Oct. 21 (24 hours after the intrusion): Mixing?

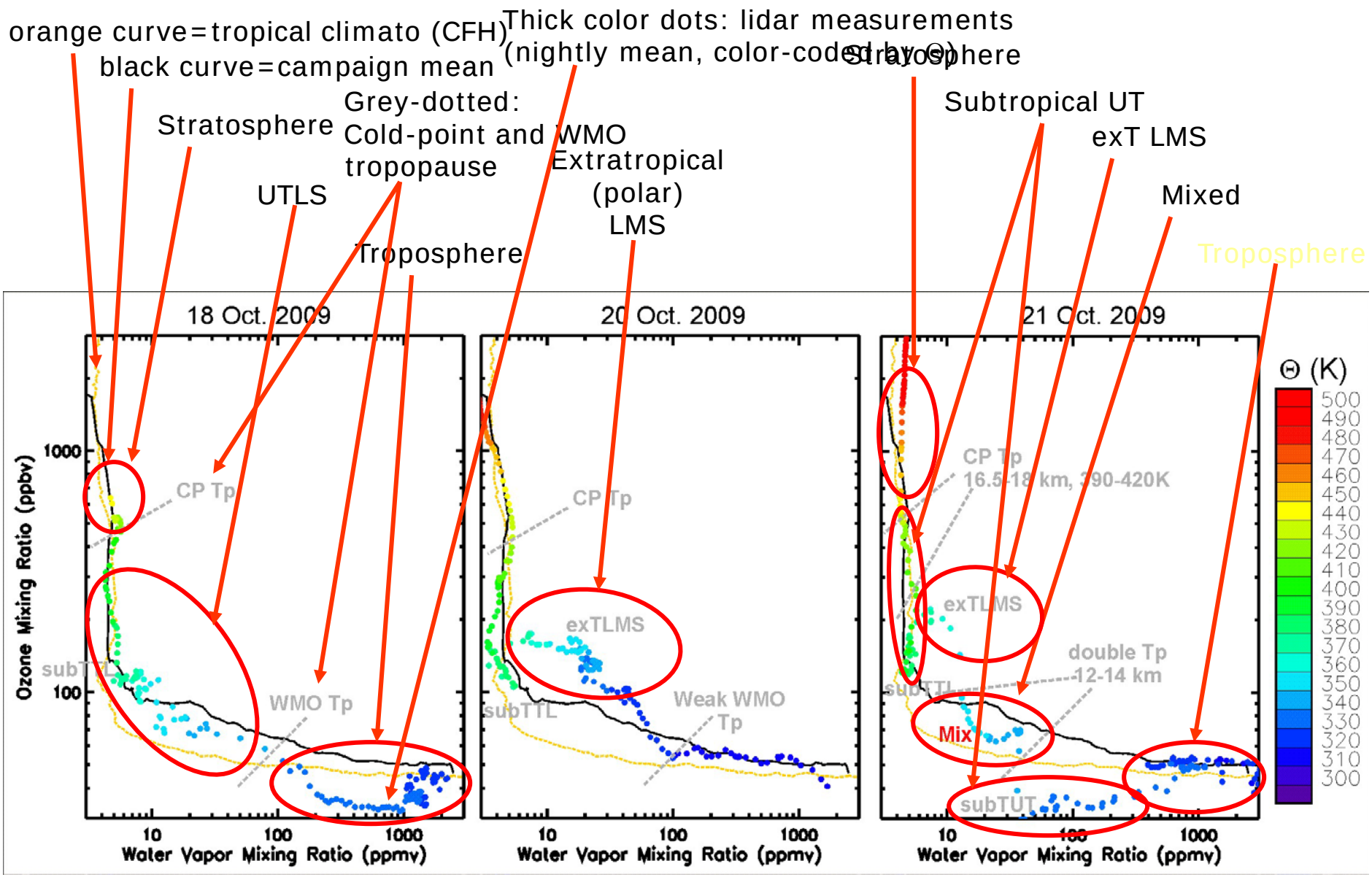


Origin of the airmasses: tropical UT, polar LMS, and mixed along the jetstream

10-day backward isentropic trajectories at levels between 320K and 370K



Finally: O_3-H_2O mixing lines as seen by the lidars



Last (but not least) word: Importance of separating air parcels vertically before classifying them

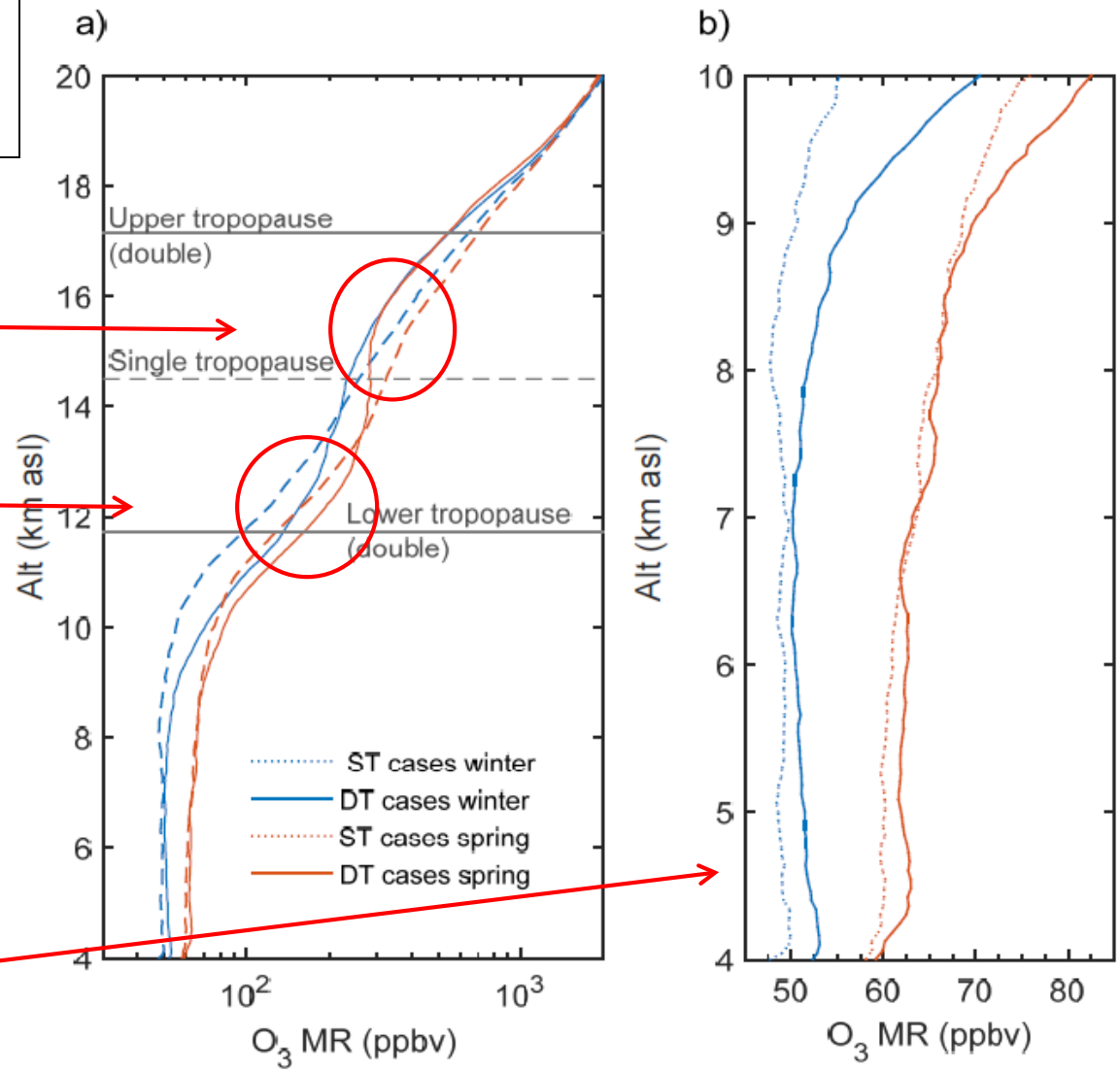
JPL lidar@TMF

Distinguishing air parcels within tropopause folds

Low ozone in upper half (upper tropical tropo.)

High ozone in lower half ("middleworld")

Ozone anomalies extend well below tropopause folds!



Thank you