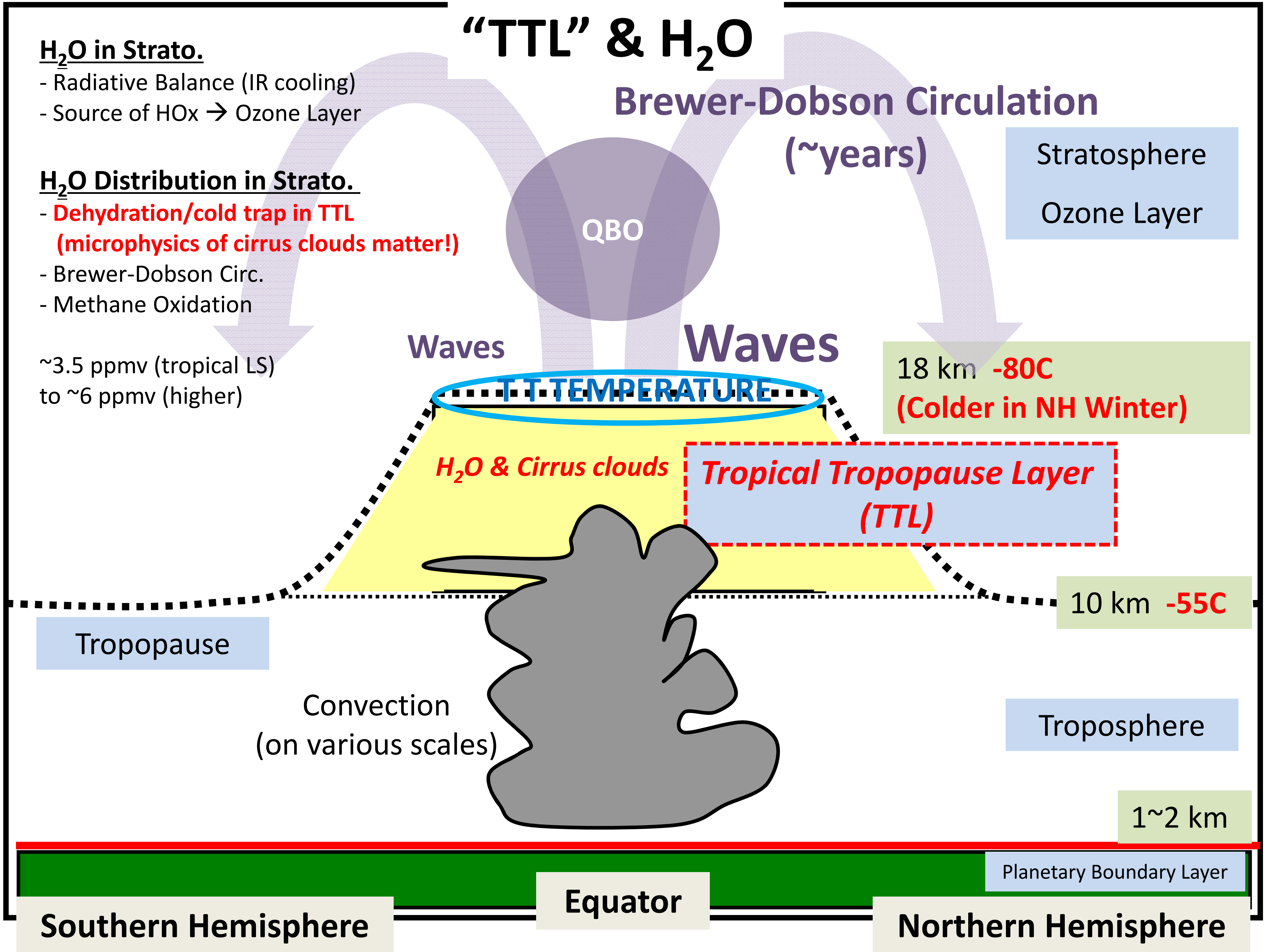


“TTL” & H_2O
H_2O in Strato.
- Radiative Balance (IR cooling)
- Source of HOx → Ozone Layer
H_2O Distribution in Strato.
- Dehydration/cold trap in TTL
(microphysics of cirrus clouds matter!)
- Brewer-Dobson Circ.
- Methane Oxidation
~3.5 ppmv (tropical LS)
to ~6 ppmv (higher)
Brewer-Dobson Circulation
(~years)
Stratosphere
Ozone Layer
QBO
Waves
Waves
T T TEMPERATURE
18 km -80C
(Colder in NH Winter)
H_2O & Cirrus clouds
Tropical Tropopause Layer
(TTL)
10 km -55C
Tropopause
Convection
(on various scales)
Troposphere
1~2 km
Planetary Boundary Layer
Equator
Southern Hemisphere
Northern Hemisphere

Tropical Tropopause Layer (TTL)
Upper Troposphere and Lower Stratospehre (UTLS)

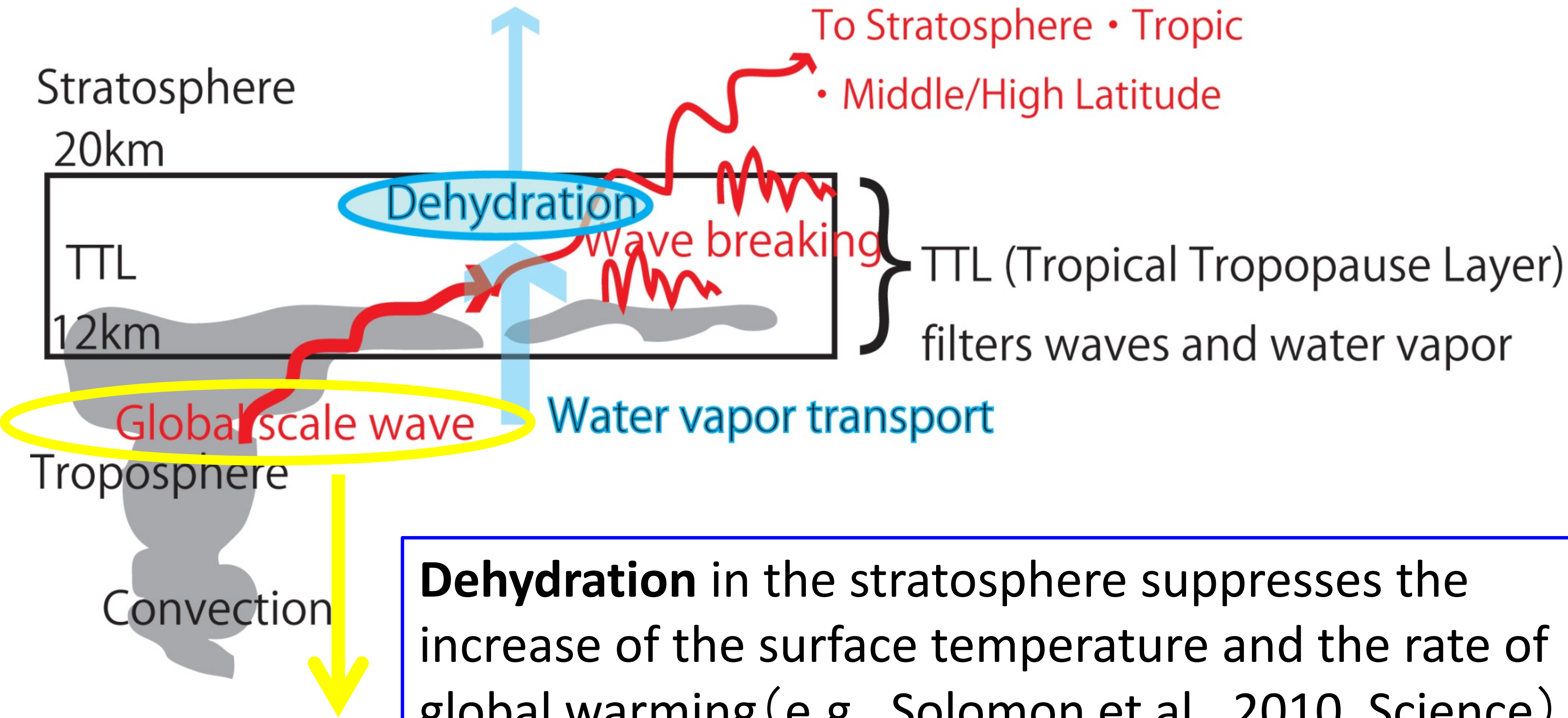
- Masatomo Fujiwara (Hokkaido U),

  Yoichi Inai, Takatoshi Sakazaki (Kyoto U),Suginori Iwasaki (NDA),

  Junko Suzuki, Shin-ya Ogino, Tomoe Nasuno (JAMSTEC), & the SOWER team

1. Roles of tropical organized convection and waves in the TTL
2. Investigation of dehydration processes in the TTL using the match technique
3. Roles of overshooting cumulonimbus clouds for hydration and dehydration of the tropical stratosphere
4. Diurnal variations in the TTL
5. Cross-tropopause transport by Asian monsoon circulation
6. TTL modeling using the Nonhydrostatic ICosahedral Atmospheric Model (NICAM)

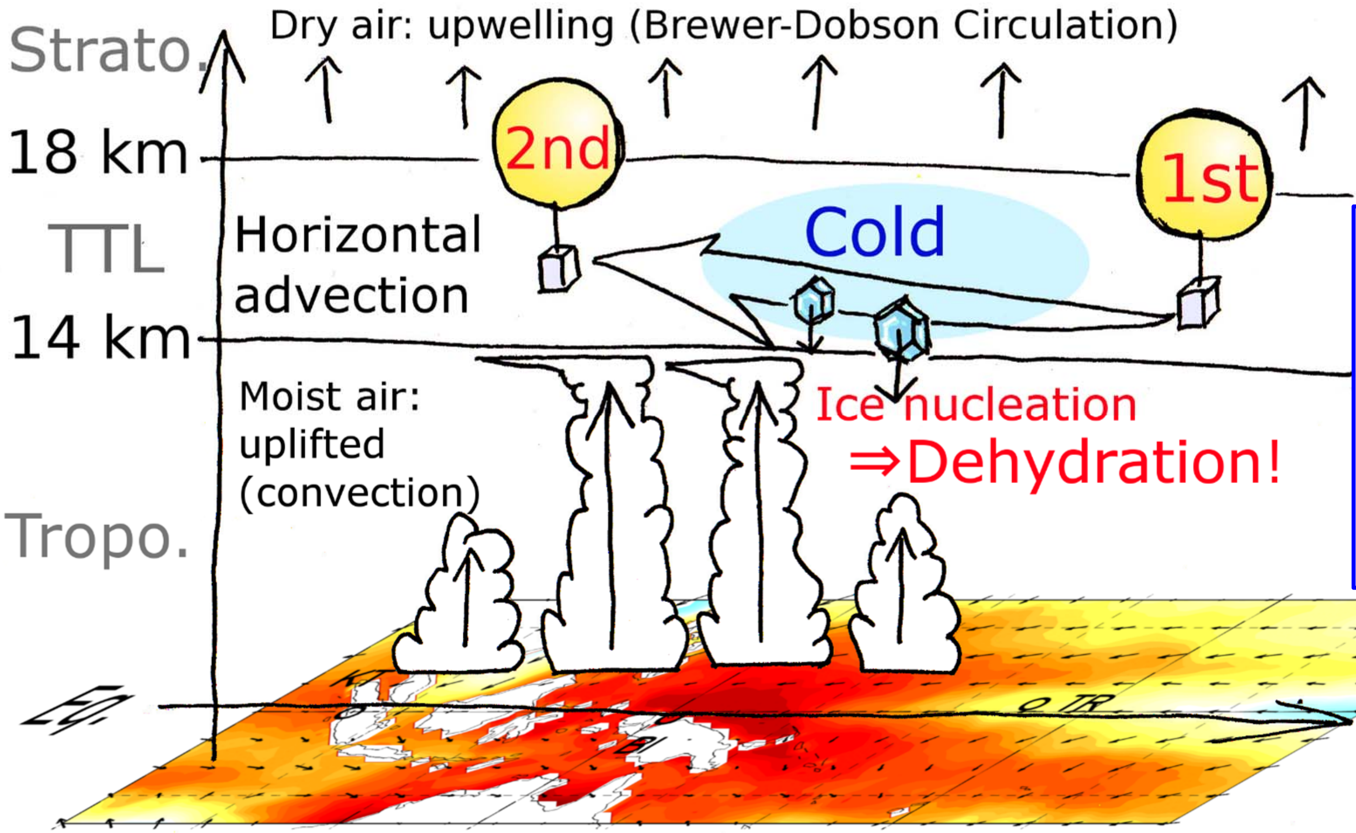
Roles of tropical organized convection and waves in the TTL



Dehydration in the stratosphere suppresses the increase of the surface temperature and the rate of global warming（e.g., Solomon et al., 2010, Science）

Approach: Observations using the Equatorial Atmosphere Radar (EAR), Ozonesondes, Water vapor sondes, cloud particle sensors, etc.

Investigation of dehydration processes in the TTL using the match technique



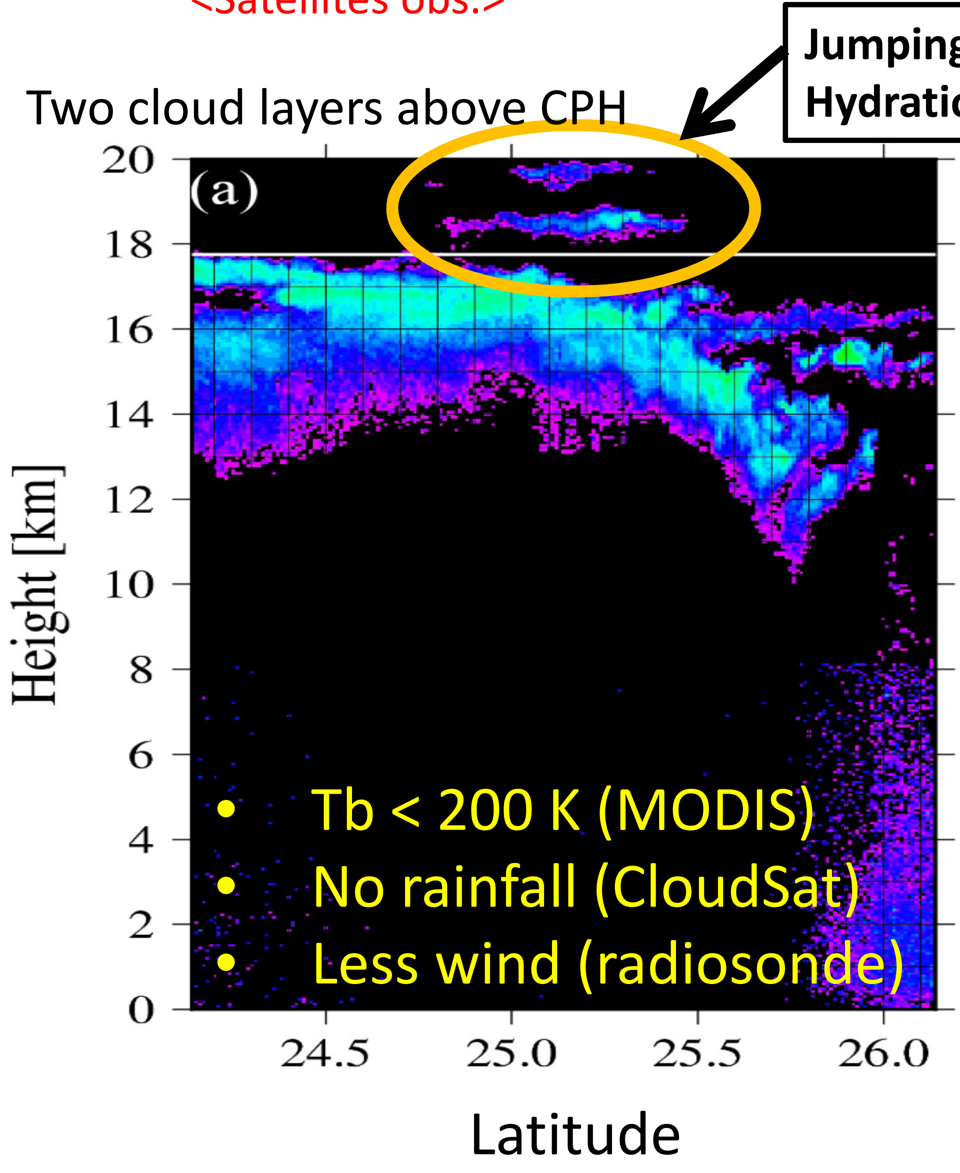
Match Technique …
Measuring water vapor amount before/after the dehydration in the TTL by multi-point balloon soundings

w.v. mixing ratio 2nd
−) w.v. mixing ratio 1st
————————————————
dehydration amount

quantify the dehydration in the lower TTL (Inai et al., ACP, 2013)

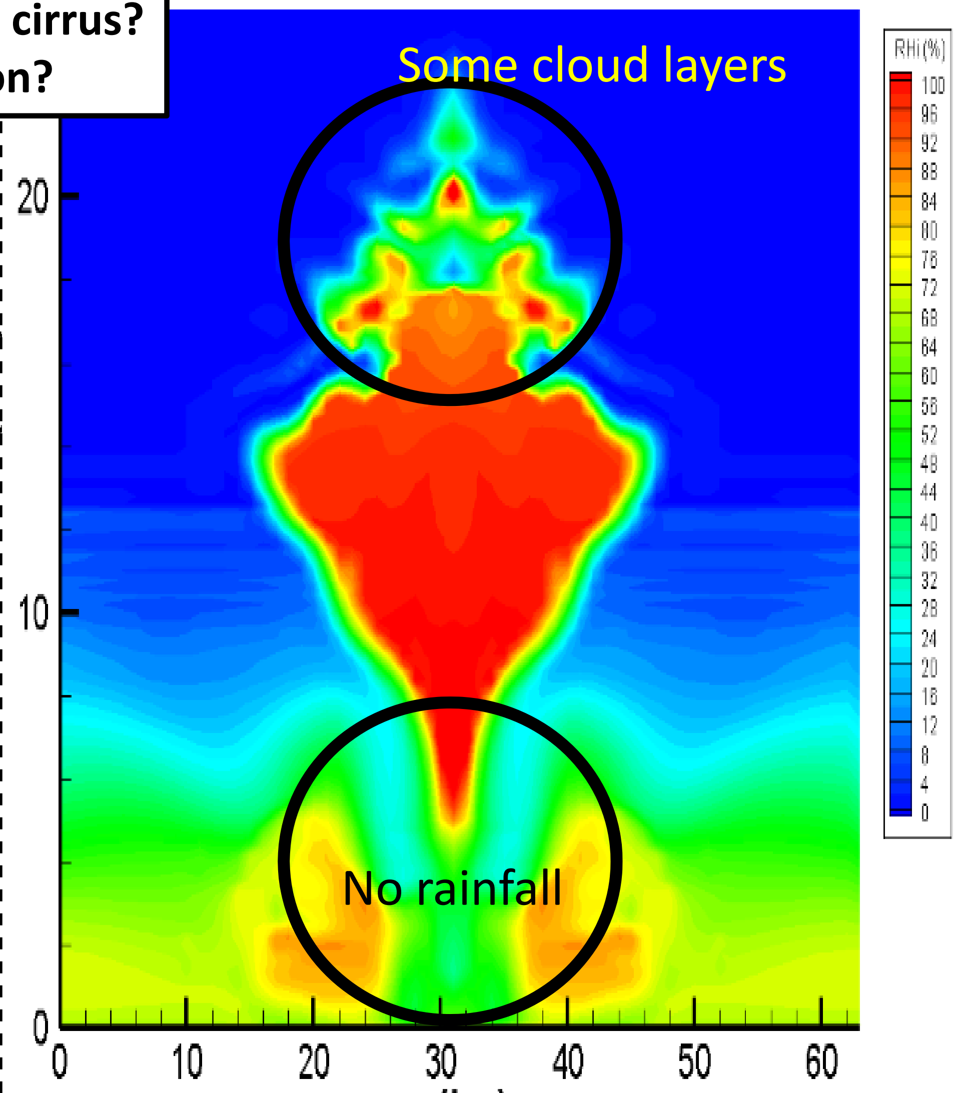
Roles of overshoot for hydration/dehydration of the tropical stratosphere

<Satellites obs.>



CALIOP signals

<Simulation>

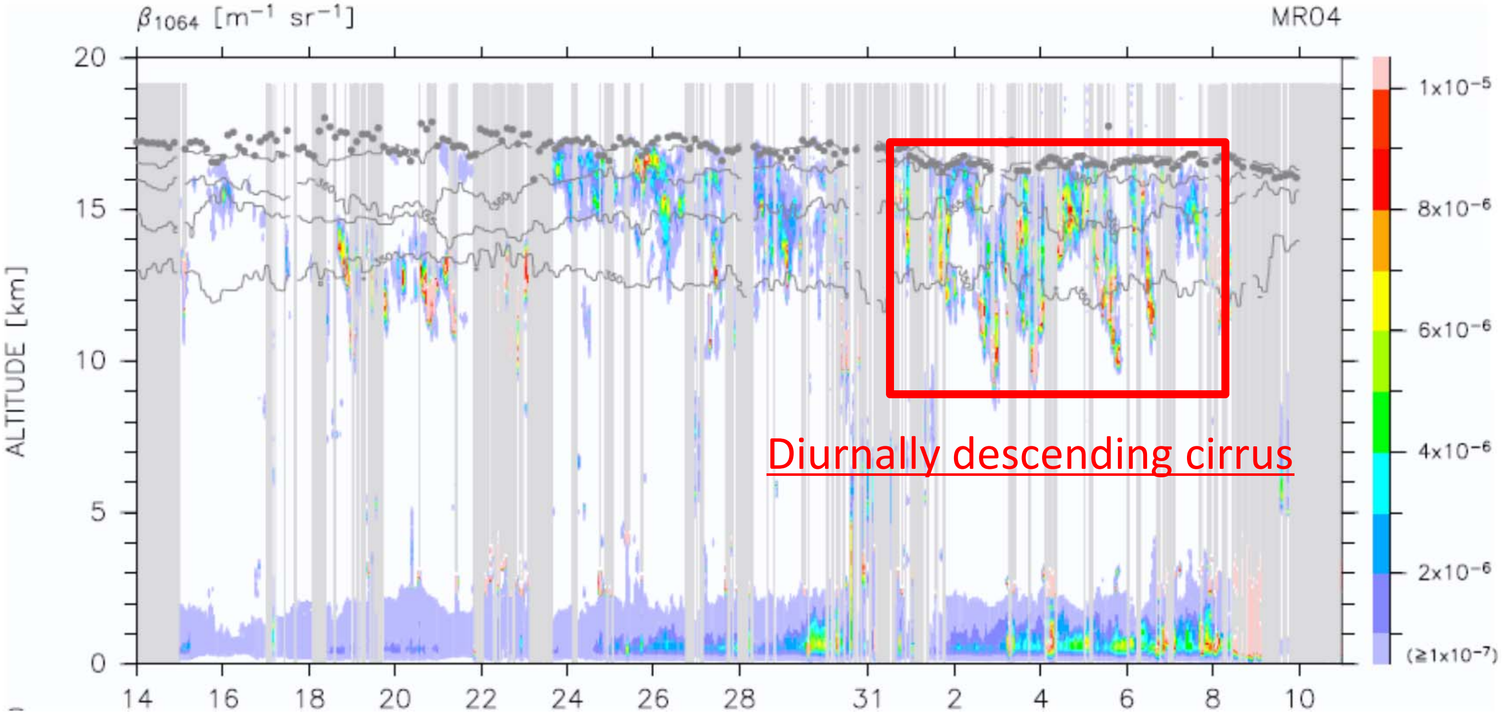


Numerical simulation of **overshoot** under **no wind** condition. Courtesy of Pao Wang.

Diurnal variations in the TTL

- Diurnal variations in cirrus clouds (Fujiwara et al., 2009)
  ← atmospheric tides? diurnal variations in convection?

Clouds (backscatter coefficient: β) measured by a lidar (7.5 ° N, 134.0 ° E)
[December 2004 to January 2005]



December 2004 January 2005 Fujiwara et al. (2009)

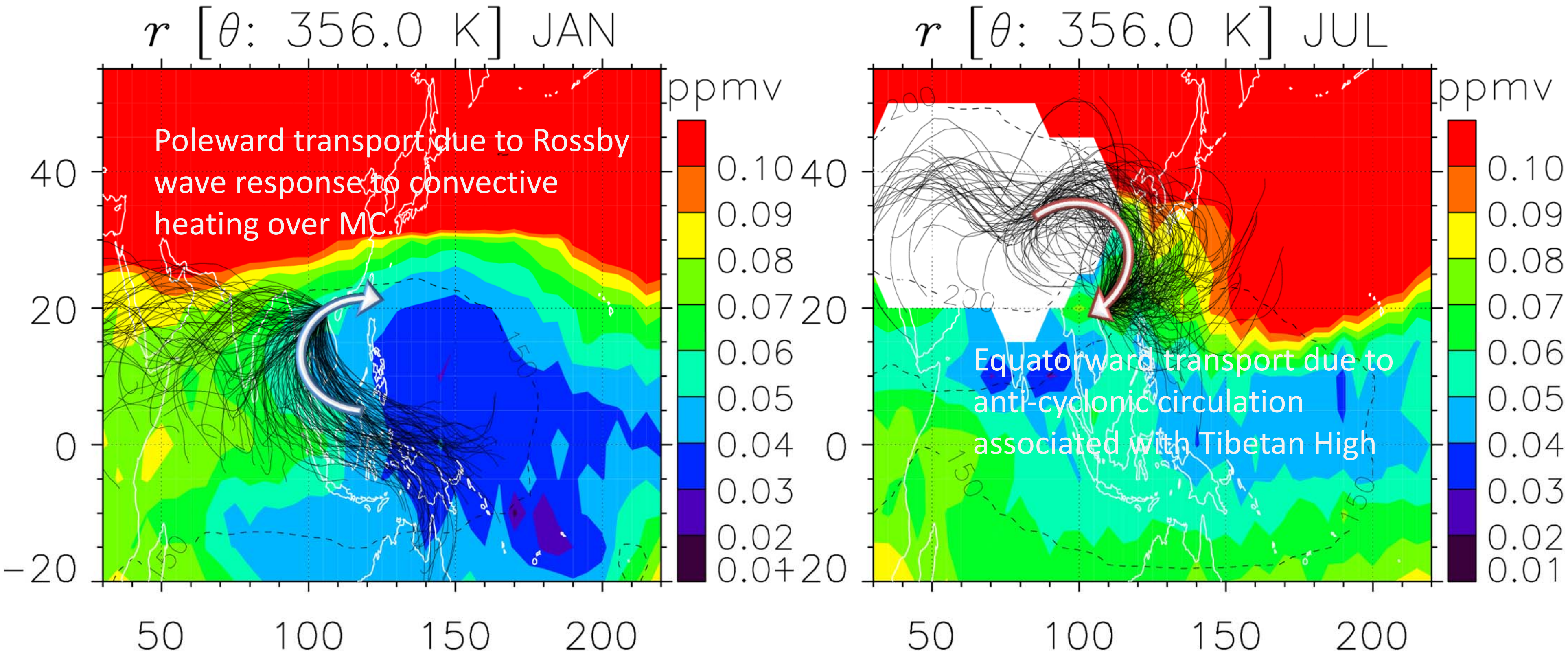
Diurnal variability (convections, tides) and its role in the transport and dehydration in the TTL.

Cross-tropopause transport by Asian monsoon circulation

Based on ozonesonde data taken at Hanoi, Vietnam, Ogino et al. (2013) showed that ozone transport over the subtropical region is strongly controlled by the monsoon circulation. We will investigate detailed processes of the ozone and water vapor transport by the Asian monsoon circulation in both winter and summer seasons to evaluate their budget in the TTL.

<Satellite ozone obs. & trajectories in UT>

Winter | Summer

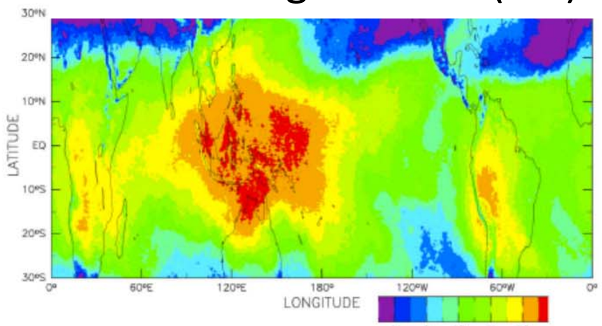


Ogino et al. (2013, JGR)

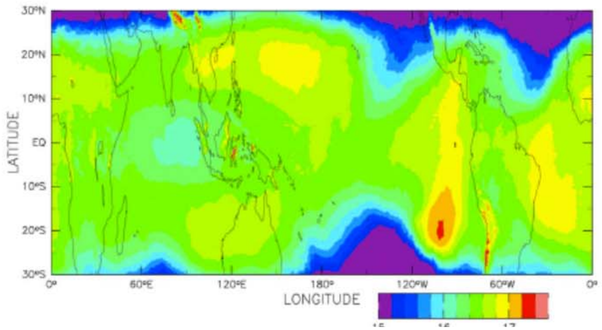
TTL in NICAM Simulation

Explicit representation of cloud processes in TTL → Dynamical Structure

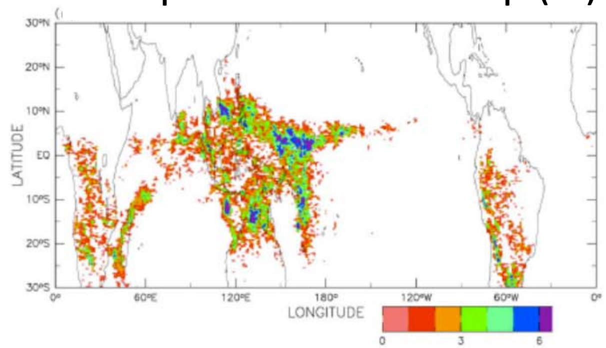
Bottom height of TTL (km)



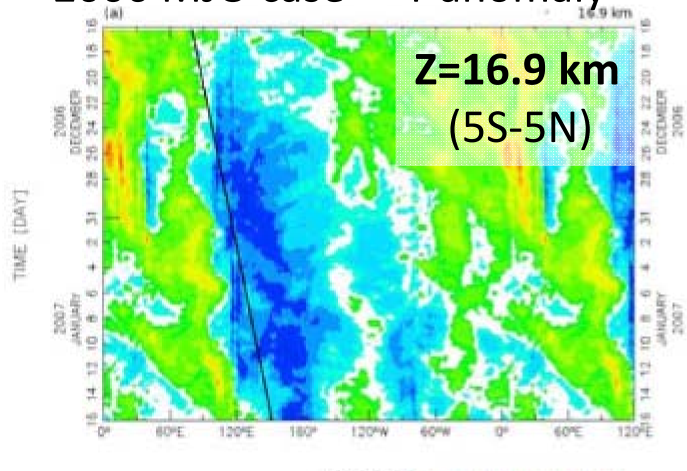
Tropopause height (km)



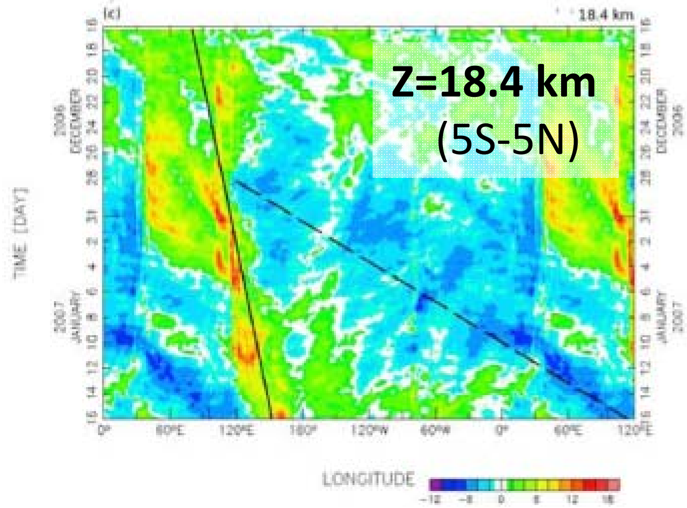
Deep Convection Freq. (%)



2006 MJO case - T anomaly

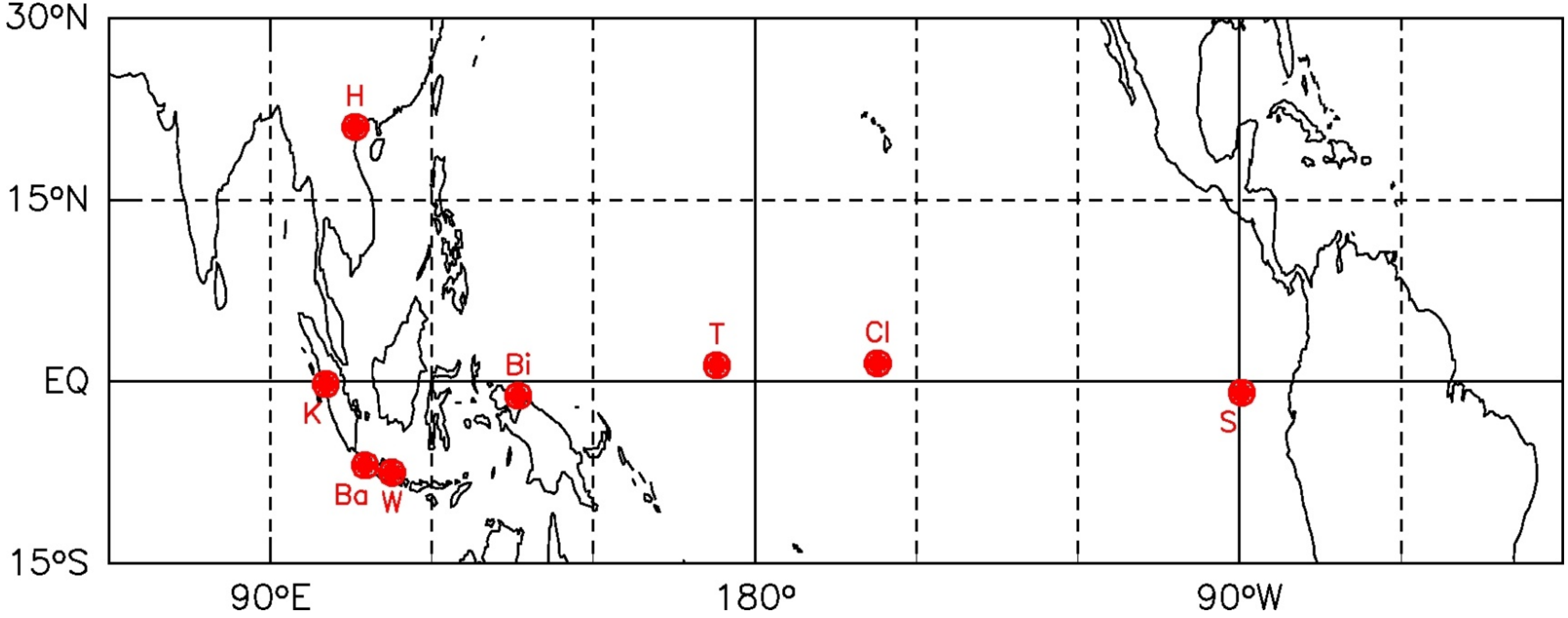


MJO and Kelvin wave signal in TTL



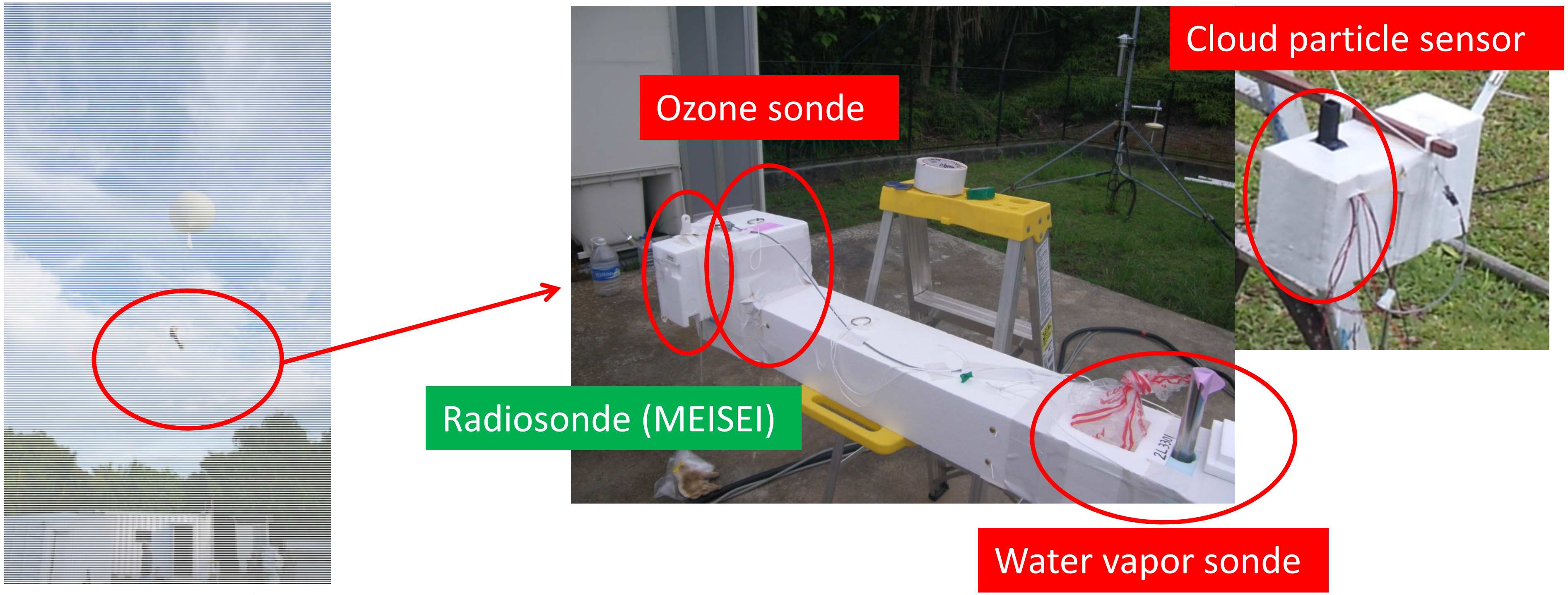
Kubokawa et al. (2012)

Potential Observation Sites



Indonesia: Kototabang, Bandung, Watukosek, Biak (LAPAN observatories)
Vietnam: Ha Noi
Kiribati: Tarawa, Christmas Island
Ecuador: San Cristobal Island (Galapagos Islands)

Observations by Various Sondes



2013 June at Palau

- Water vapor sonde: The RH with a high degree of accuracy
- Ozone sonde: The Ozone mixing ratio
- Cloud particle sensor: No. density, Particle size and shape