

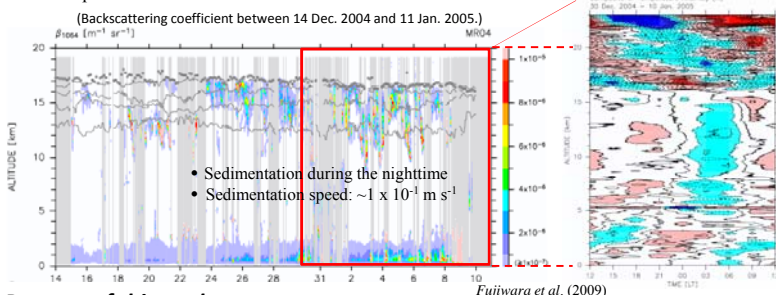
Atmospheric temperature tides in the tropical upper troposphere and lower stratosphere

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1. Introduction

- Recent studies reported **diurnal variations in cirrus cloud** in the TTL that may impact on the dehydration process (Fujiwara et al. 2009; Sassen et al., 2009). [“Nighttime > Daytime” (Sassen et al., 2009)]
- Diurnal temperature variations** may impact on the cirrus cloud formation and maintenance (Fujiwara et al., 2009).
- Although some in-situ observations were made in the tropics (e.g., Alexander and Tsuda, 2008), global structure of diurnal temperature variations are well not understood.



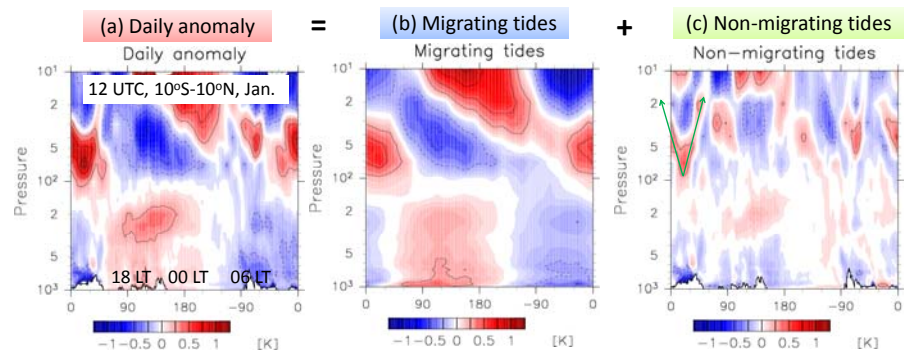
Fujiwara et al. (2009)

Purpose of this study

to reveal the global pattern of diurnal temperature variations and its seasonal dependence in the TTL.

4. Migrating tides & Non-migrating tides

- Daily anomaly** is decomposed into **migrating** and **non-migrating** component.



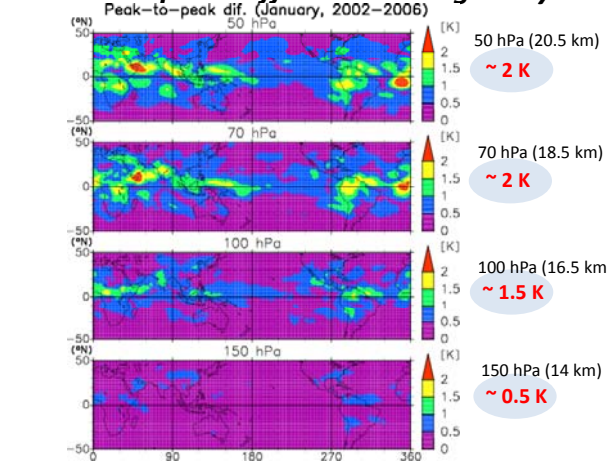
2. Data description

- MERRA**: Modern-era retrospective analysis for research and applications
 - Analysis period: 2002-2006
 - Horizontal resolutions: 1.25° x 1.25°
 - Vertical layers: 42 layers
 - Time resolution: 3-hourly

Validation of MERRA

- Temperature at 100 hPa (mean/equatorial waves): Fujiwara et al. (2012)
- The stratospheric temperature (mean/tides): Sakazaki et al. (2012a)

3. Peak-to-peak difference during a day

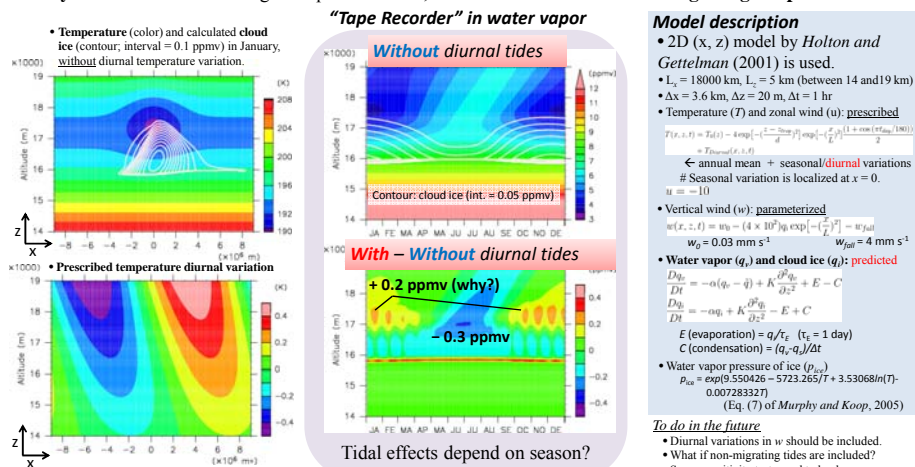


- Migrating tides**, particularly the **diurnal migrating tide**, is dominant (The peak-to-peak difference is **~1 K** in the TTL).
- Non-migrating tides** are excited over the continent by latent heat release, with the peak-to-peak difference of **~0.5 K** in the TTL.

5. Impact of temperature tide on the dehydration

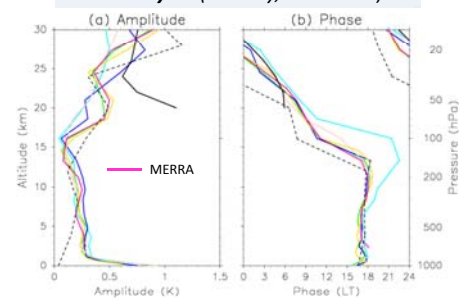
- Preliminary results with the model by Holton and Gettelman (2001) -

- Dehydration is assessed using a simple 2D model, **with** and **without** the diurnal migrating temperature tide.



6. Diurnal migrating tide (Sakazaki et al., 2012a, 2012b)

Reanalyses (January, 10°S-10°N)



Questions

What causes this vertical structure?

- amplitude maximum at ~20 km.
- constant phase within the troposphere.

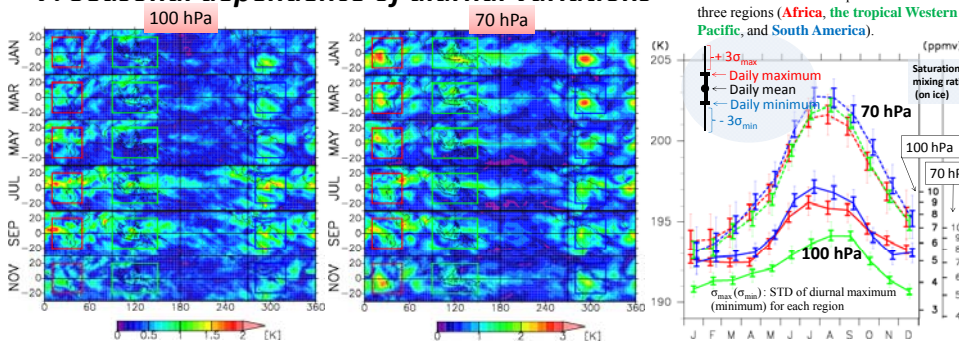
(1): The N^2 maxima at 20 km (e.g., Grise et al., 2010) amplify the **adiabatic process**.

(2): The **diabatic heating** has a constant phase (~50%), and the **adiabatic process** (~50%) also has a constant phase within the troposphere. The constant phase of diabatic process (i.e., w) is due to small N^2 value in the troposphere (vertical wavelength of the first propagating Hough mode is ~50 km in the troposphere).

$$\frac{\partial T_n}{\partial t} + \frac{HN^2}{R} w_n = \frac{Q_n}{c_p}$$

adiabatic process diabatic heating (maximizes at 1200 LT)

7. Seasonal dependence of diurnal variations



8. Conclusions

- The peak-to-peak difference within the TTL reaches 1-2 K, which might impact the dehydration by +/- 0.3 ppmv.
- The diurnal temperature variations are mainly caused by diurnal migrating tides, as well as non-migrating tides enhanced over the continent.
- Diurnal amplitude is large (small) in the Northern Hemisphere winter (summer) at 100 hPa (70 hPa).

References

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