On the determination of weighted mean temperature in Indonesia

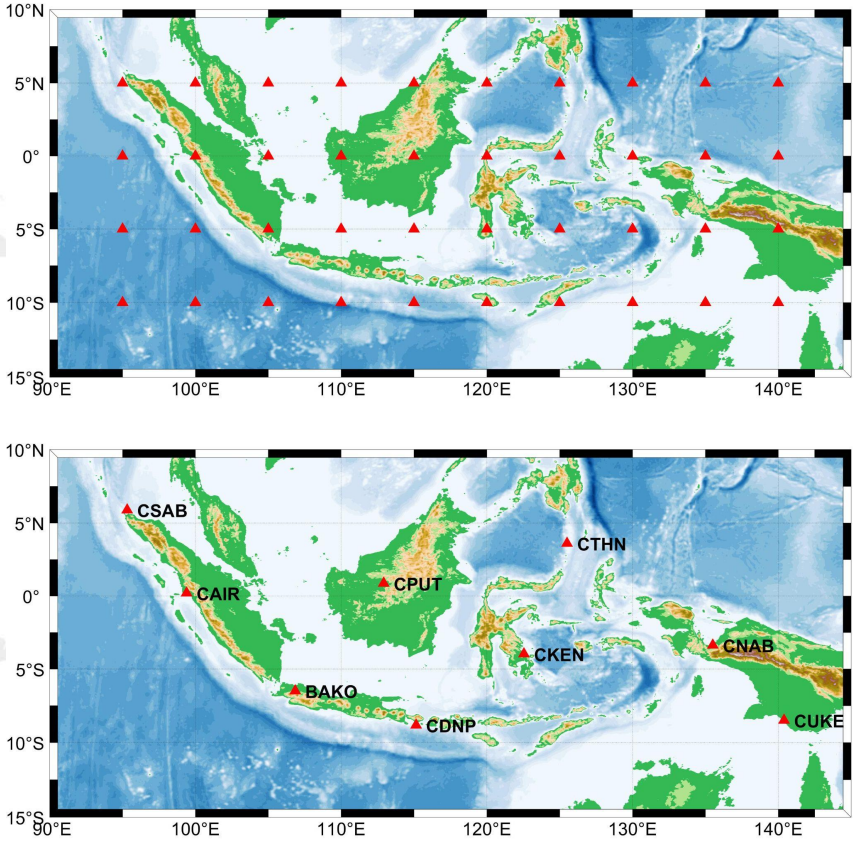
Nabila Putri[1,2], Johannes Böhm[2], Dudy D. Wijaya[1], Wedyanto Kuntjoro[1], Zamzam Tanuwijaya[1], Dhota Pradipta[1]

[1] Institut Teknologi Bandung, Bandung, Indonesia, [2] Technische Universität Wien, Vienna, Austria

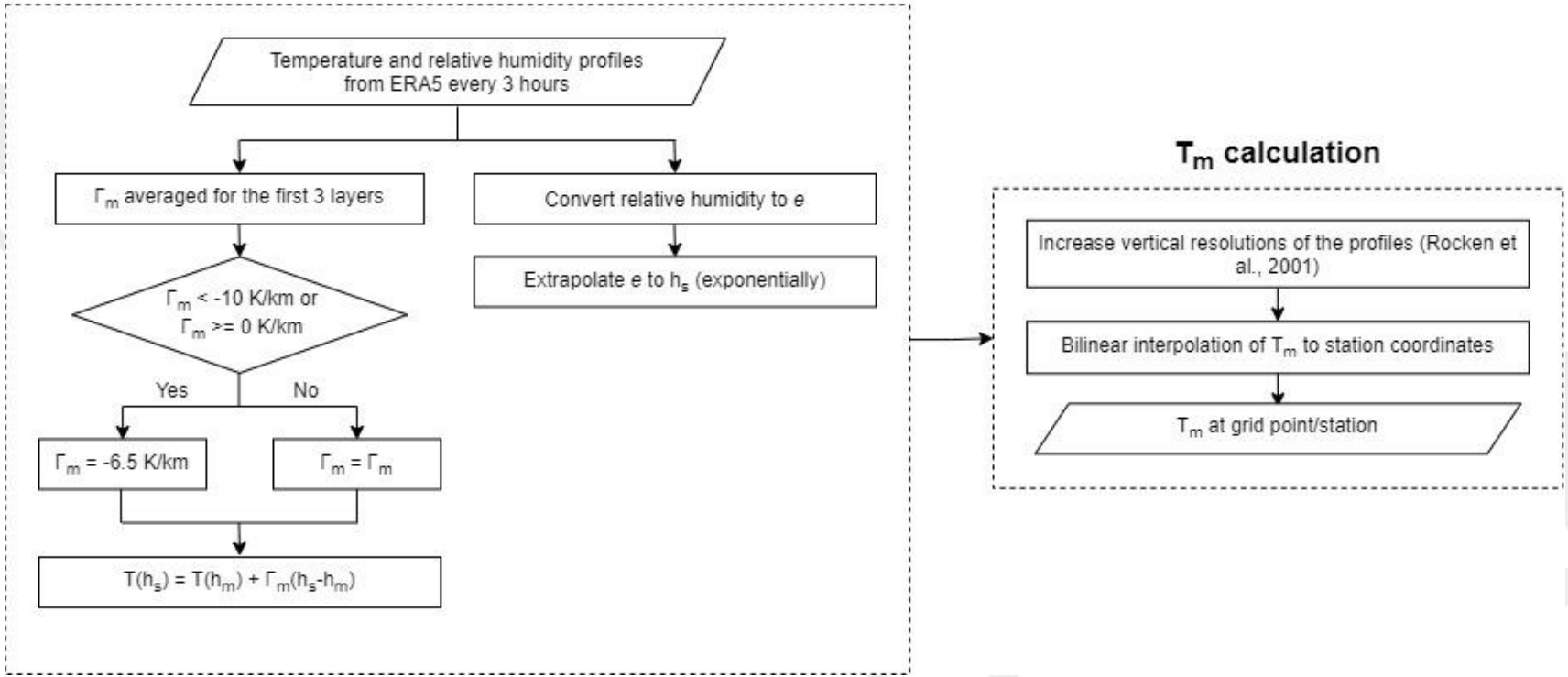
Data and methods

- ERA5 data
  - Profiles of temperature and humidity
  - 3-hourly (00:21), for the year 2019
  - 40 grid points + 9 CORS stations
- Procedure to calculate Tm is similar to that outlined by Wang et al. (2005).
- Tm is calculated by (Davis et al. 1985):

$$T_m = \frac{\int \left(\frac{e}{T}\right) dz}{\int \left(\frac{e}{T^2}\right) dz}$$

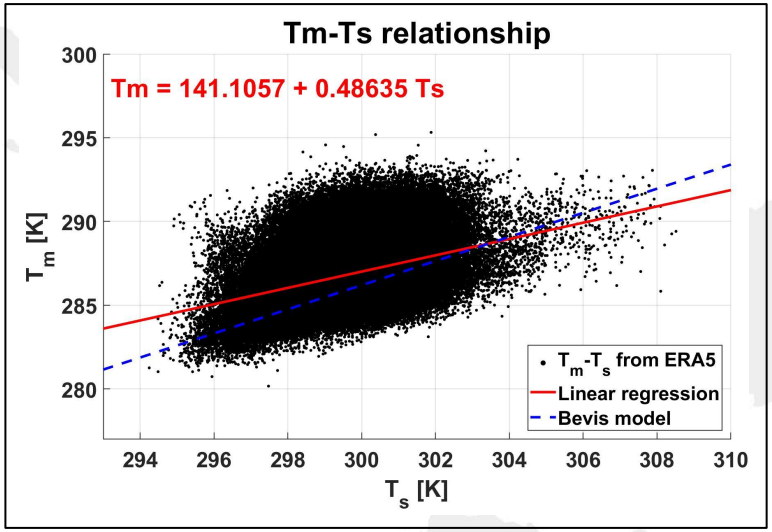


Data and methods

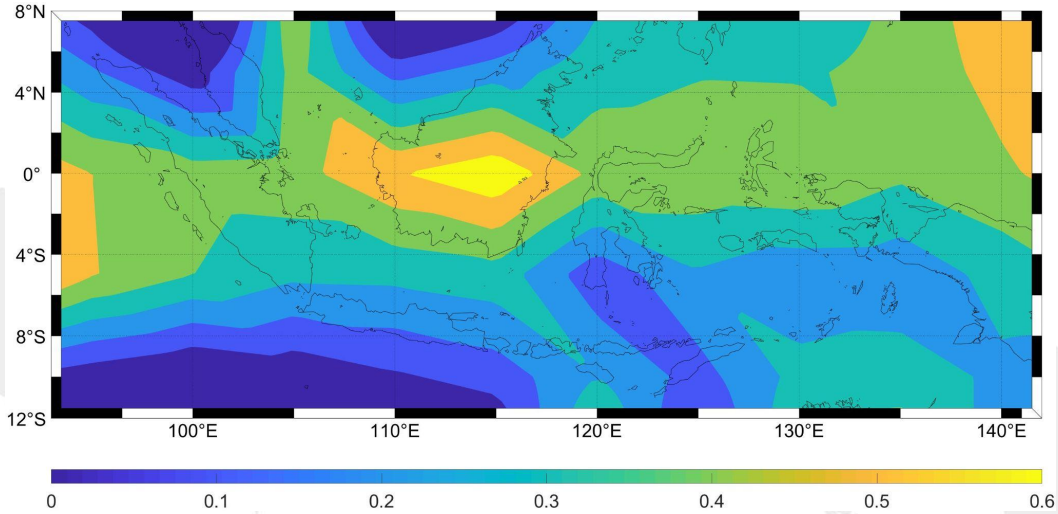


Adapted from Wang et al. (2005). The height h_s refers to ETOPO1 surface (grid-wise) or station height (site-wise), and h_m refers to the height of 1000 hPa.

Tm-Ts relationship in Indonesia

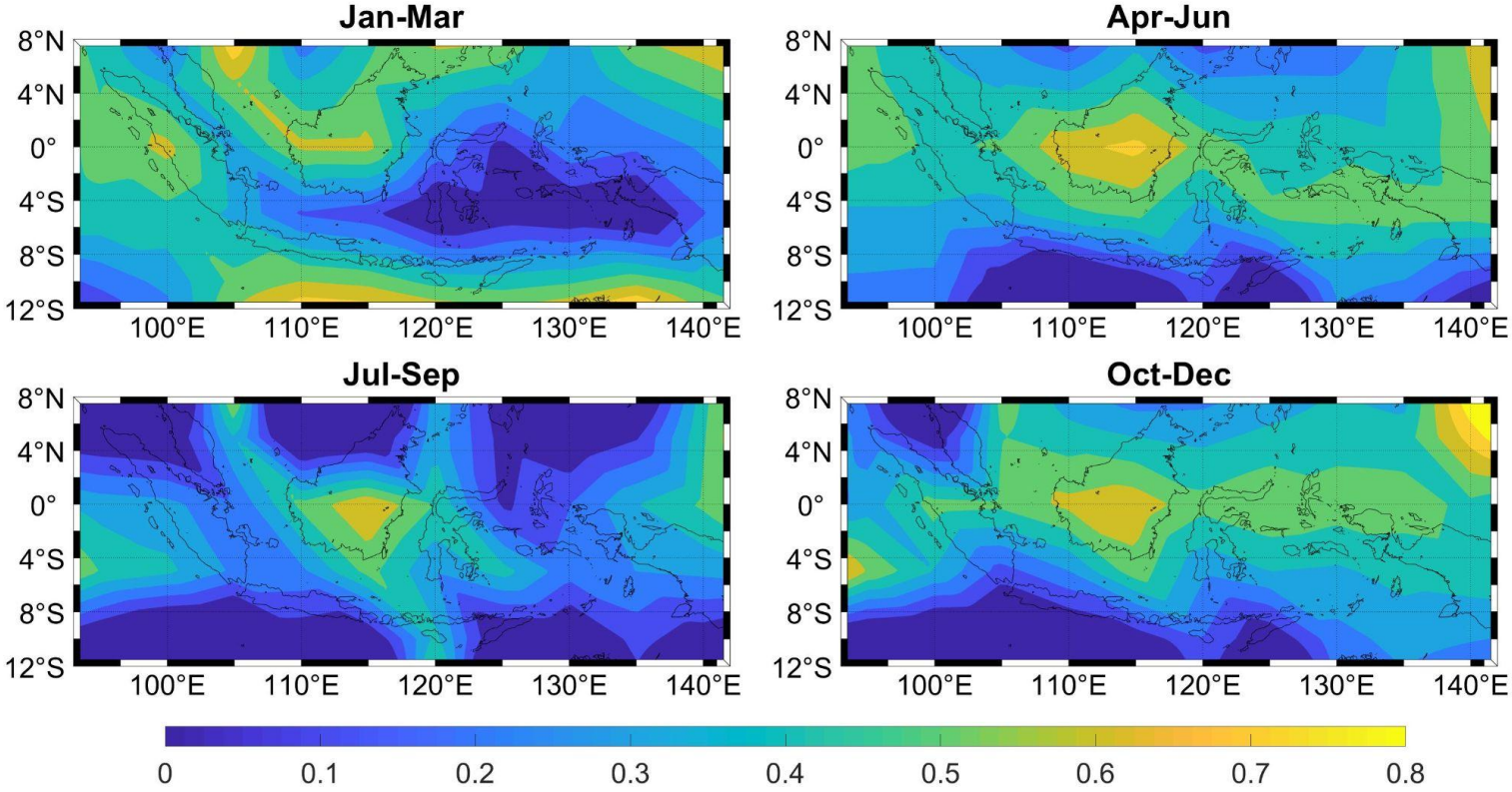


Overall correlation coefficient
r = 0.36 (from 40 grid points).



Spatial variation of correlation coefficients based on 40 grid points.

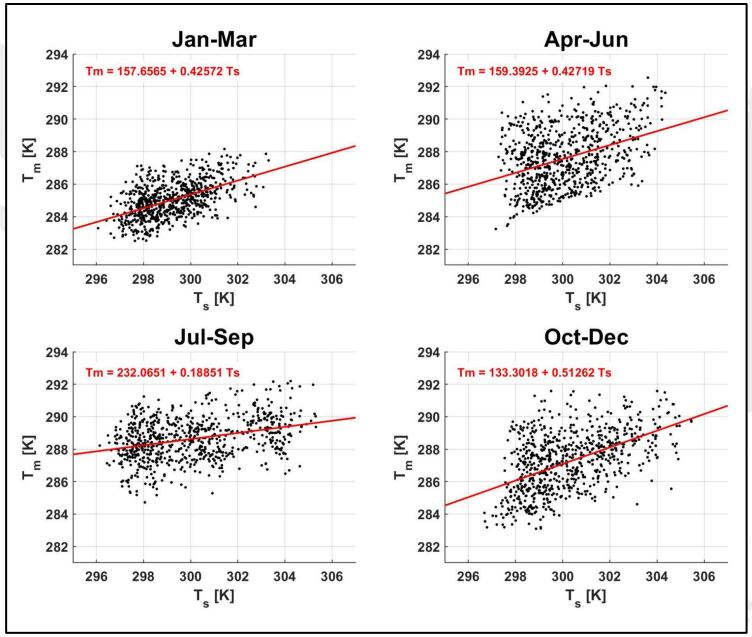
Seasonal Tm-Ts relationship in Indonesia



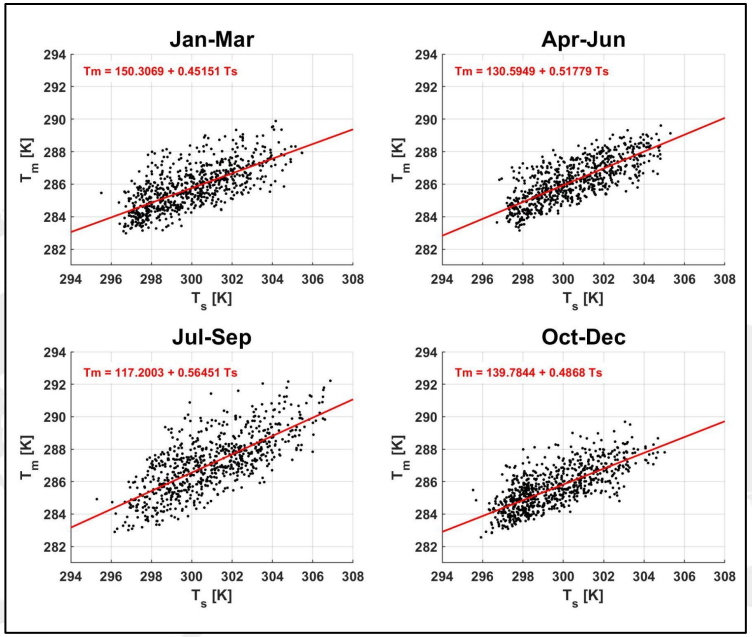
Spatial variation of seasonal correlation coefficients based on 40 grid points.

Site-specific, seasonal Tm-Ts relationship

BAKO



CPUT

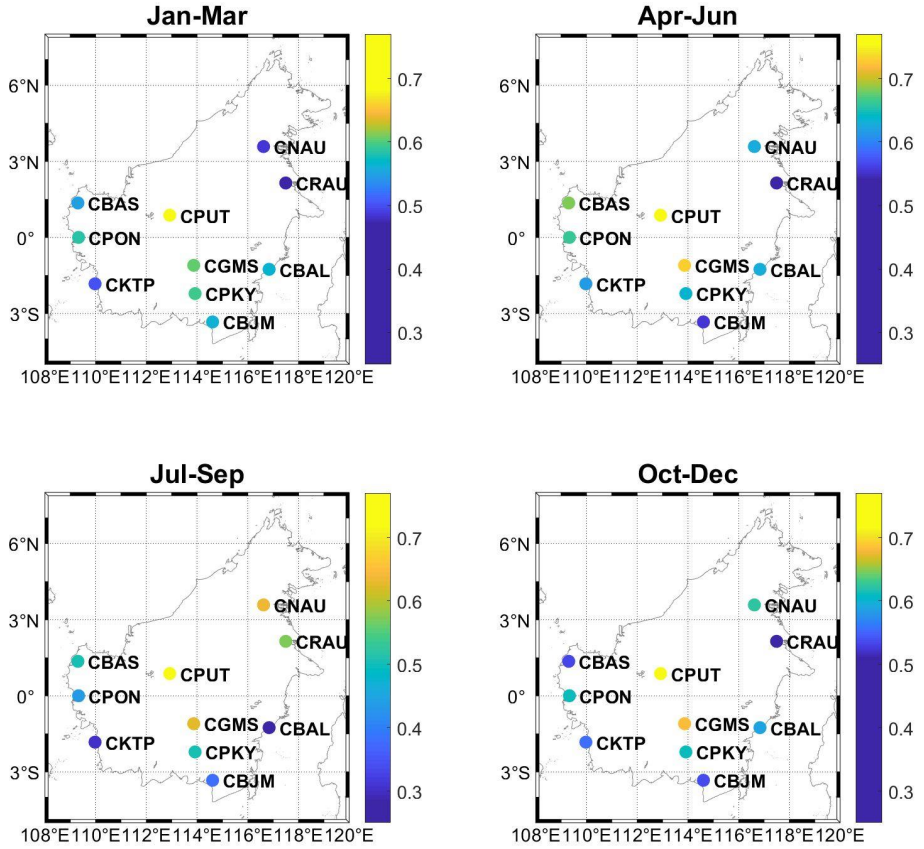


Station	r Jan-Mar	r Apr-Jun	r Jul-Sep	r Oct-Dec
BAKO	0.52	0.37	0.34	0.49
CPUT	0.68	0.75	0.72	0.73

Tm-Ts relationship in Kalimantan

Strong correlation in Kalimantan →
Tm was calculated at additional 9 CORS stations

Station	r Jan-Mar	r Apr-Jun	r Jul-Sep	r Oct-Dec
CBAL	0.56	0.63	0.28	0.59
CBAS	0.55	0.68	0.50	0.53
CBJM	0.56	0.55	0.38	0.54
CGMS	0.60	0.73	0.63	0.68
CKTP	0.50	0.61	0.30	0.55
CNAU	0.48	0.63	0.63	0.62
CPKY	0.59	0.64	0.50	0.61
CPON	0.58	0.66	0.44	0.61
CPUT	0.68	0.75	0.72	0.73
CRAU	0.47	0.54	0.57	0.51



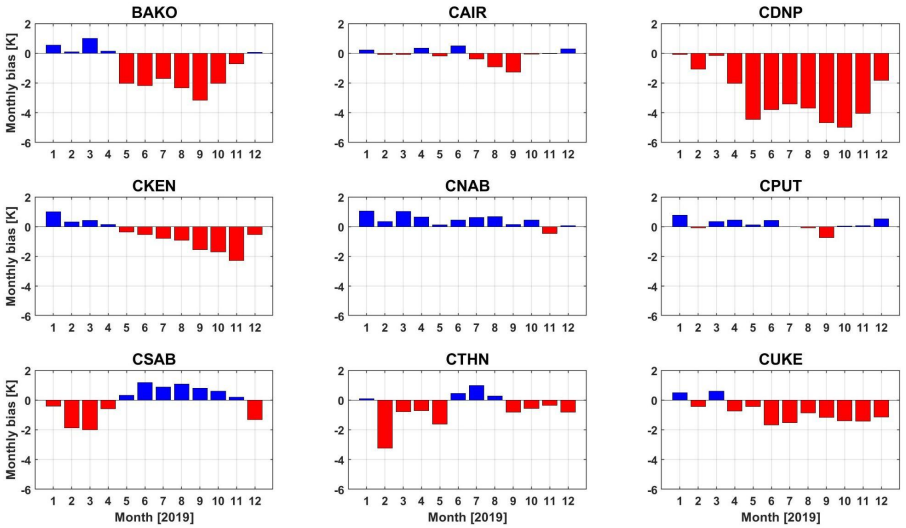
Effects of Tm error in PWV

Errors in PWV due to errors in Tm can be calculated as follows (Wang et al., 2005):

$$\frac{\Delta PWV}{PWV} = \frac{\Delta \Pi}{\Pi} = \frac{1}{1 + \frac{k_2'}{k_3} T_m} \cdot \frac{\Delta T_m}{T_m}$$

Maximum absolute biases of Tm range between **4.2-8.5 K**, with Tm range between **289-293 K**. Hence the maximum relative error of PWV is **1.4-2.8%**.

Assuming PWV in Indonesia is ranging between **20-80 mm**, the uncertainty in PWV caused by Tm is between less than 1 mm to **more than 2 mm**.



ΔTm = Tm Bevis - Tm ERA5

Conclusions

- Tm in Indonesia is weakly correlated to Ts (overall r = 0.36), suggesting that using a general Tm-Ts relationship to determine Tm may not be appropriate.

- Seasonal site-specific Tm-Ts correlation is slightly stronger, albeit with r value still mostly less than 0.5.

- Tm-Ts in Kalimantan has higher r values compared to other regions, independent of the seasons. Inland stations has higher r values than coastal stations, suggesting that Tm-Ts relationship in Indonesia might be influenced by station's vicinity to the coast.

- Errors in PWV due to errors in Tm in Indonesia range from < 1 mm to > 2 mm.

References

M. Bevis, S. Businger, T. Herring, C. Rocken, R. Anthes, and R. Ware. GPS meteorology: Remote sensing of atmospheric water vapor using the Global Positioning System. Journal of Geophysical Research: Atmospheres, 97(D14):15787–15801, 1992.

M. Bevis, S. Businger, S. Chiswell, T. Herring, R. Anthes, C. Rocken, and R. Ware. GPS meteorology: Mapping zenith wet delays onto precipitable water. Journal of Applied Meteorology , 33(3):379–386, 1994.

J. Davis, T. Herring, I. Shapiro, A. Rogers, and G. Elgered. Geodesy by radio interferometry: Effects of atmospheric modeling errors on estimates of baseline length. Radio Science, 20(6):1593–1607, 1985.

J. Wang, L. Zhang, and A. Dai. Global estimates of water-vapor-weighted mean temperature of the atmosphere for gps applications.Journal of Geophysical Research: Atmospheres, 110(D21), 2005.