Structure and Seasonal Variation of Migrating Tides in the Whole Atmosphere Community Climate Model with Thermosphere and Ionosphere Extension (WACCM-X)

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Abstract

The Whole Atmosphere Community Climate model – eXteended (WACCM-X) is a comprehensive numerical model with a range from the Earth's surface to the upper thermosphere (~ 500 km) and also includes the ionosphere. In this study, we used the least squares method to extract diurnal and semidiurnal migrating tides from free running WACCM-X temperatures in the mesosphere and lower thermosphere region (MLT). The results are compared to tides in Specified Dynamics WACCM (SD-WACCM) and observations from TIMED/SABER. Differences in tidal structure and variation during solar maximum and minimum in March and June are examined, to better understand the fidelity of migrating tides resolved in free running WACCM-X, and its implications for future studies utilizing this model.

Dataset

WACCM-X

Whole Atmosphere Community Climate Model with thermosphere and ionosphere extension.

WACCM-X is a comprehensive numerical model, spanning the range of altitudes from the Earth's surface to the upper thermosphere (~500 km) and includes the ionosphere. The model resolution is 1.9° in latitude and 2.5° in longitude. The vertical resolution is 125 levels and the same as WACCM with 2 points per scale height and below 50 km and 4 points per scale height above 50 km.

The model output was an hourly results and was ran for March 20th and June 20th for solar maximum and solar minimum condition. We used one day of the results in the least-squares fit.

SD-WACCM

Specified Dynamics Whole Atmosphere Community Climate The vertical coverage is from surface to ~145km, with a resolution of 0.95° in latitude and 1.25° in longitude. The vertical resolution is 88 levels. The results are nudged by the Modern-Era Retrospective analysis for Research and Applications (MERRA) dataset from 0 – 50km.

The results we used are "h0", which are the monthly average files.

SABER

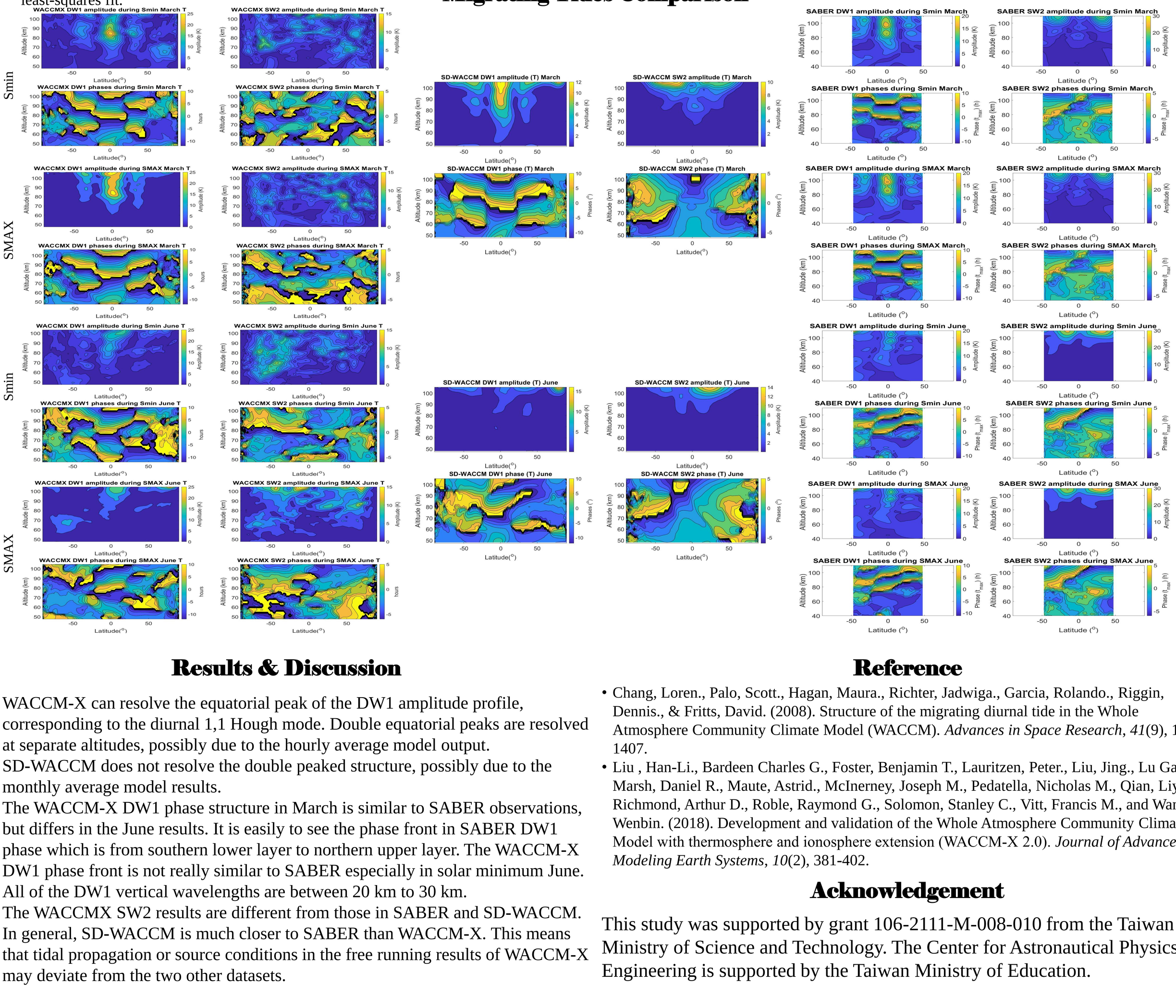
Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) is one of the instruments on NASA's TIMED (Thermosphere Ionosphaere Mesosphere Energetic Dynamics) satellite.

It can provide global and vertical profile of atmosphere parameters. (temperature, pressure … etc.)

Continuous coverage is constrained between 50° latitude.

The tides are fitted using a 60 days integration window.

Migrating Tides Comparison



Results & Discussion

- WACCM-X can resolve the equatorial peak of the DW1 amplitude profile, corresponding to the diurnal 1,1 Hough mode. Double equatorial peaks are resolved at separate altitudes, possibly due to the hourly average model output.
- SD-WACCM does not resolve the double peaked structure, possibly due to the monthly average model results.
- The WACCM-X DW1 phase structure in March is similar to SABER observations, but differs in the June results. It is easily to see the phase front in SABER DW1 phase which is from southern lower layer to northern upper layer. The WACCM-X DW1 phase front is not really similar to SABER especially in solar minimum June.
- All of the DW1 vertical wavelengths are between 20 km to 30 km.
- The WACCMX SW2 results are different from those in SABER and SD-WACCM.
- In general, SD-WACCM is much closer to SABER than WACCM-X. This means that tidal propagation or source conditions in the free running results of WACCM-X may deviate from the two other datasets.

Reference

- Chang, Loren., Palo, Scott., Hagan, Maura., Richter, Jadwiga., Garcia, Rolando., Riggin, Dennis., & Fritts, David. (2008). Structure of the migrating diurnal tide in the Whole Atmosphere Community Climate Model (WACCM). *Advances in Space Research*, *41*(9), 1398-1407.
- Liu , Han-Li., Bardeen Charles G., Foster, Benjamin T., Lauritzen, Peter., Liu, Jing., Lu Gang., Marsh, Daniel R., Maute, Astrid., McInerney, Joseph M., Pedatella, Nicholas M., Qian, Liying., Richmond, Arthur D., Roble, Raymond G., Solomon, Stanley C., Vitt, Francis M., and Wang, Wenbin. (2018). Development and validation of the Whole Atmosphere Community Climate Model with thermosphere and ionosphere extension (WACCM-X 2.0). *Journal of Advances in Modeling Earth Systems*, *10*(2), 381-402.

Acknowledgement

This study was supported by grant 106-2111-M-008-010 from the Taiwan Ministry of Science and Technology. The Center for Astronautical Physics and Engineering is supported by the Taiwan Ministry of Education.