Impact of RHUBC-I Water Vapor Continuum Absorption Updates on Climate Simulations with CESM

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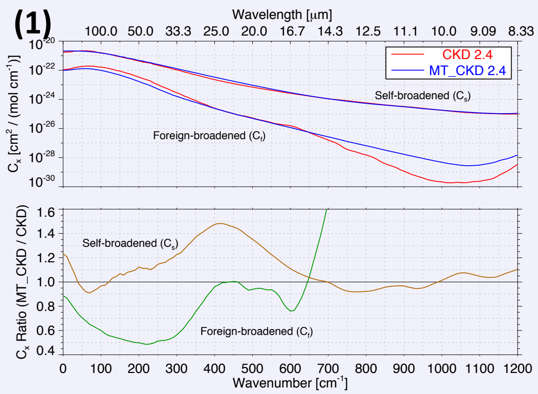
Results from RHUBC-I Analysis

Following RHUBC-I, the Water Vapor continuum coefficients were updated to obtain the MT_CKD 2.4 continuum model. [1]

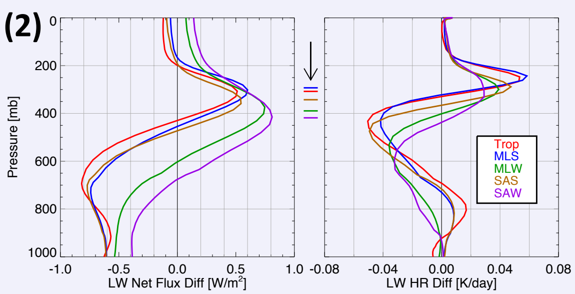
Compared to the previous model (CKD 2.4), the continuum coefficients change by up to a factor of 2 in the energetically important FIR (wavelength 25 – 100 μm) (Fig. 1)

(1)

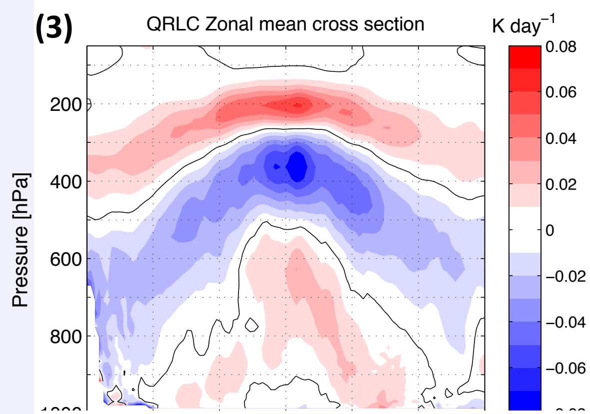


The change in vertical heating rate profile shows a consistent shape in different standard atmospheres, but the extrema occur progressively lower in the atmosphere as the water vapor amount drops. (Fig. 2)

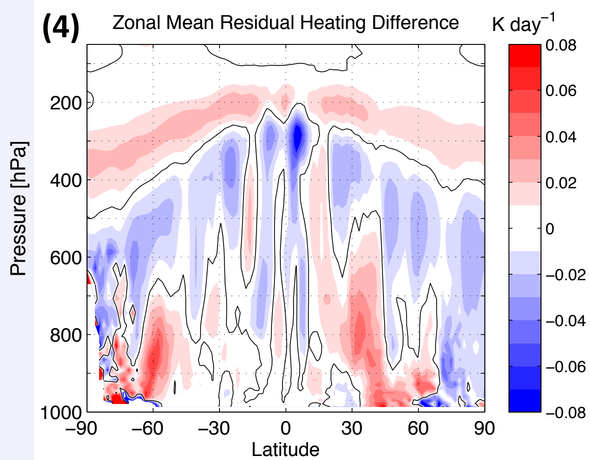
(2)



(3)



(4)



Average Zonal clear-sky longwave heating (Fig. 3) closely resembles offline RRTM calculations on standard atm. (Fig. 2)

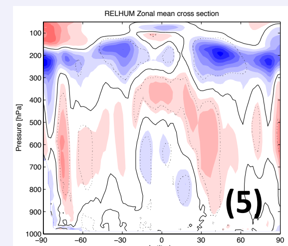
“Residual Heating” (Fig. 4) shows much of the imposed heating change from MT_CKD is compensated by other thermodynamic changes (Residual Heating = CAM variables QRL + QRS + DTCOND + DTV = Longwave + Shortwave + Moist Processes + Diffusion)

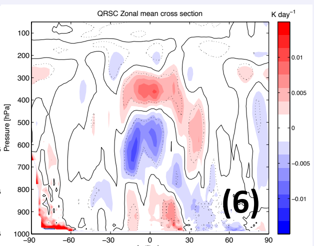
No robust changes in large-scale dynamical fields (U, V, Omega)

CESM Simulations

The **Control Run**:
CESM v1.0, with CAM 5.0 [2], using RRTMg with CKD 2.4 as the radiation parameterization (this is the CAM5 default)
The **Experimental Run**:
CAM 5.0 modified to use MT_CKD 2.4; otherwise identical to control

20 – year integrations, with 2 – year spin-up time, using a “data-ocean” model (e.g., prescribed climatological SST).
Zonal plots shown here are the difference in the mean values over entire 20 – year integrations (**Experiment – Control**)

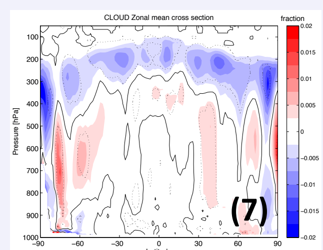


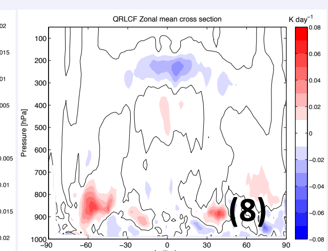


Opposing heating patterns are seen in SW and LW cloud forcing. These are related to RH and cloud changes. For example:

Fig. 5, 6 (above) show the Relative Humidity change, and corresponding SW heating change;
Fig. 7, 8 (below) show the cloud fraction change, and corresponding LW cloud forcing.

In both cases the heating rate tends to cancel the imposed LW heating change from MT_CKD (compare figures 6, 8 to figure 3)





References:
[1] Turner, D. D., E. J. Mlawer, 2010: The Radiative Heating in Underexplored Bands Campaigns. *Bull. Amer. Meteor. Soc.*, **91**, 911–923. doi:10.1175/2010BAMS2904.1
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