Benchmarking a New Version of the GFDL Radiation Code

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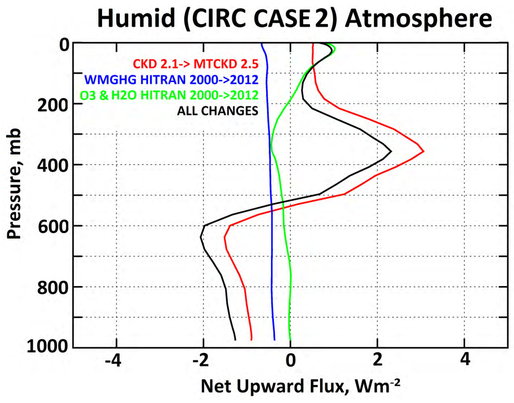
Motivation: To update the GFDL radiation code with the latest spectroscopic data and investigate the climate impacts

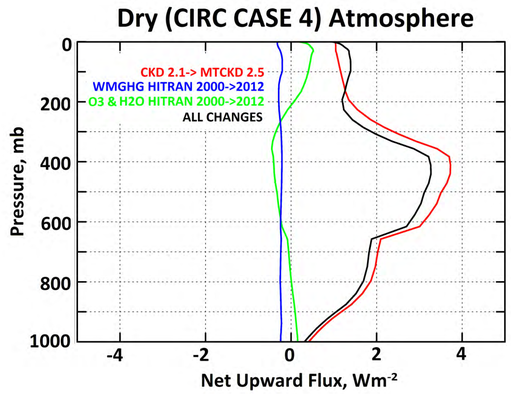
Part 1: Updates to the Longwave Radiation Code

- Updates have been made to both the spectral line and water vapor continuum parameters in the GFDL longwave SEA radiation code.
- We explore the changes in fluxes and heating rates due to these updates.

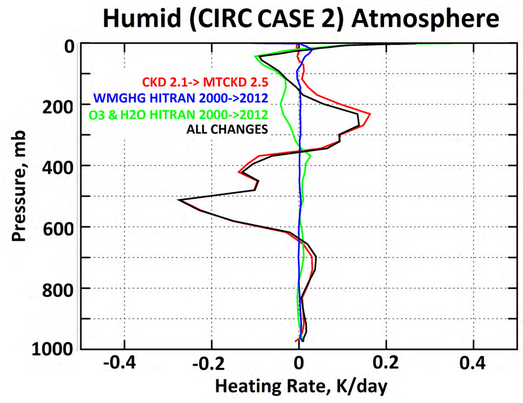
H2O and O3 lines: HITRAN 2000 → HITRAN 2012
CO2, CH4 and N2O (WMGHG) lines: HITRAN 2000 → HITRAN 2012
H2O Continuum: CKD 2.1 → MT_CKD 2.5

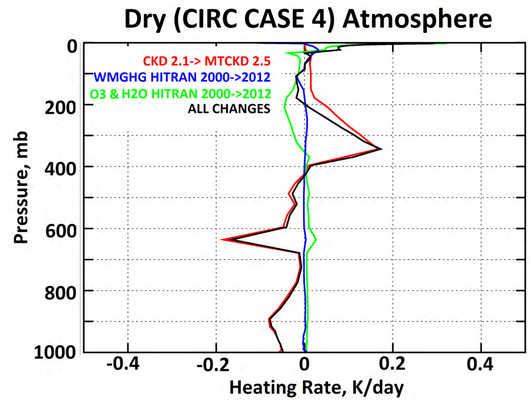
Changes in Flux





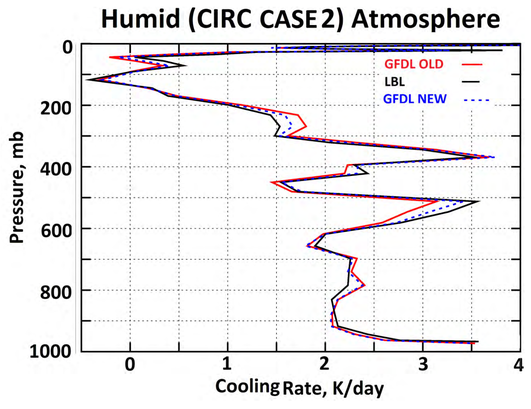
Changes in Heating Rates

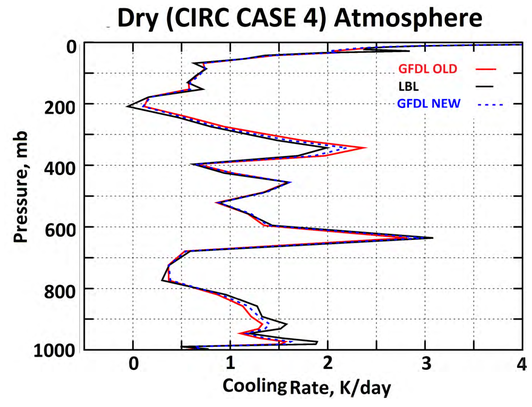


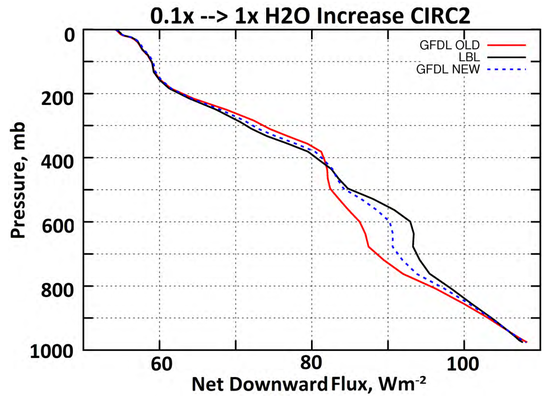


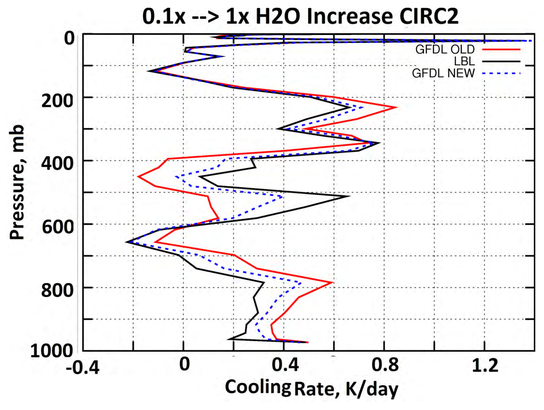
Part 2: Performance of GFDL Code In CIRC Cases

- The performance of the GFDL radiation code has been benchmarked using CIRC (Continual Intercomparison of Radiation Codes) atmospheres.
- We compare the performance of the GFDL radiation code in the warmest, most humid case (CIRC 2) and coldest, driest case (CIRC 4).
- In another experiment water vapor was increased from 10% of that prescribed for the CIRC2 atmosphere to 100%.
- The new version of the GFDL code performs much better in response to the perturbation.







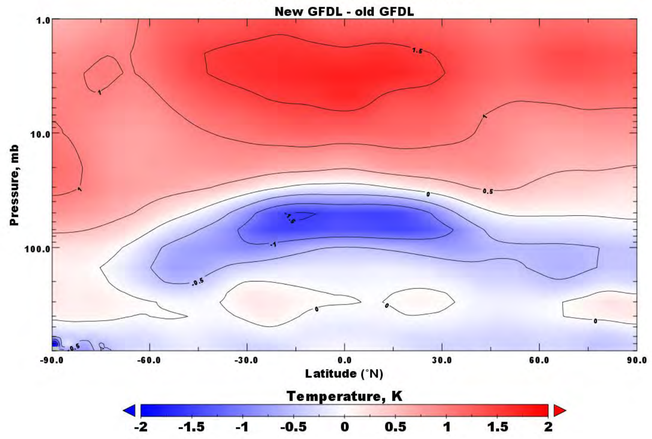


Part 3: Climate Response

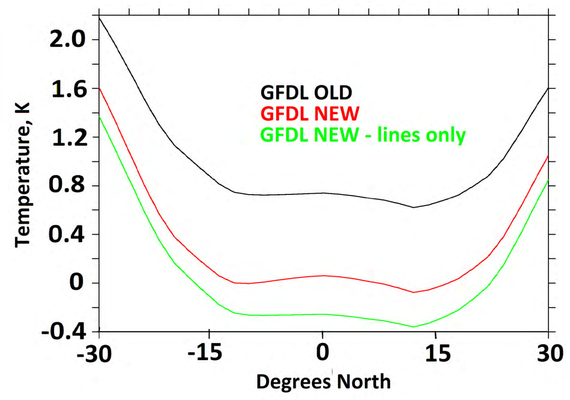
- 20 year 1980-2000 prescribed SST historical runs were performed with the original and updated versions of the radiation code and a version where only the spectral line parameters from HITRAN were updated.
- The updated radiation code produces an increase in atmospheric divergence and corresponding increase in precipitation, nearly all due to the continuum change.
- The model responds to the changes in the spectral lines through altering the stratospheric temperature. The stratospheric temperature is largely insensitive to the continuum change.
- The tropical lower stratospheric temperature (TLS) is nearer that predicted by MSU observations than the previous version of the code.

Changes in key atmospheric variables due to radiation code updates

	All Changes	HITRAN 2000 →2012 lines (all Gases)
OLR	0.9 Wm^{-2} lost to space	-0.2 Wm^{-2} lost to space
LWNET at surface	0.3 Wm^{-2} into surface	0.2 Wm^{-2} into the surface
ATM Divergence	1.4 Wm^{-2} lost by the atmosphere	0.1 Wm^{-2} lost by the atmosphere
Latent Heat	1.1 Wm^{-2}	0.1 Wm^{-2}
Precipitation	1.2% increase	0.1% increase



TLS: MSU - AM3



Part 4: Ongoing Work and Future Plans

- We are at present are performing several more updates to the GFDL radiation code:
  - -Improve our estimates of CO2 radiative forcing by including weaker bands.
  - -Update the shortwave radiation code to include HITRAN 2012 parameters.
- These updates, along with those detailed on this poster will be implemented into the new GFDL CM4 model.
- We are in the process of making a detailed comparison between the GFDL and RRTMG radiation codes for the CIRC Cases.
- The quality of the radiation codes response to perturbations to all greenhouse gases is being tested.
- We are also at the beginning stage of building and testing a longwave water vapor radiative transfer code that is based upon reference line by line calculations.