Using the CAM5 physics in WRF to better understand physics behavior across scales

William I. Gustafson Jr.[1], Po-Lun Ma[1], Philip J. Rasch[1], Jerome D. Fast[1], Richard C. Easter[1], Xiaohong Liu[2], Balwinder Singh[1], Heng Xiao[1], and Steven J. Ghan[1]

[1]Atmospheric Sciences and Global Change Division, PNNL; [2]Department of Atmospheric Sciences, University of Wyoming

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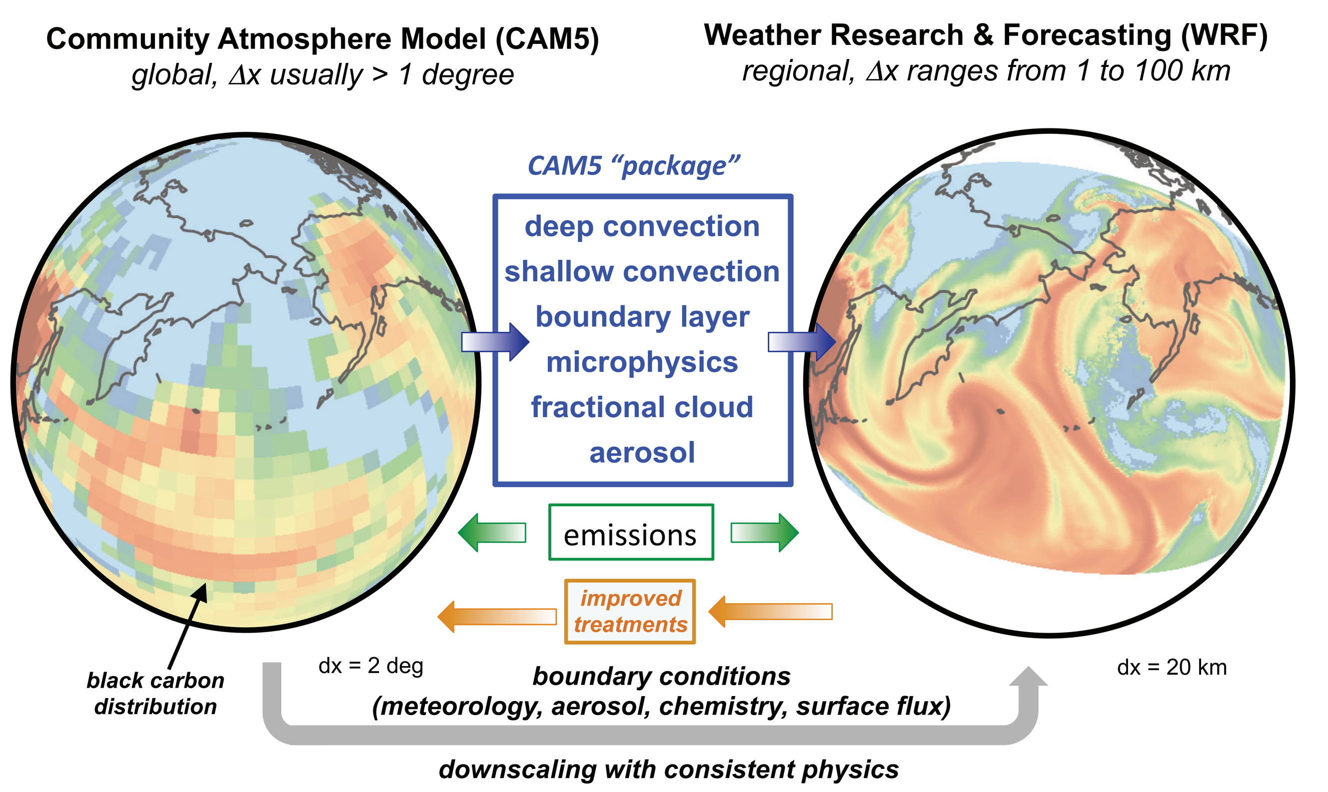
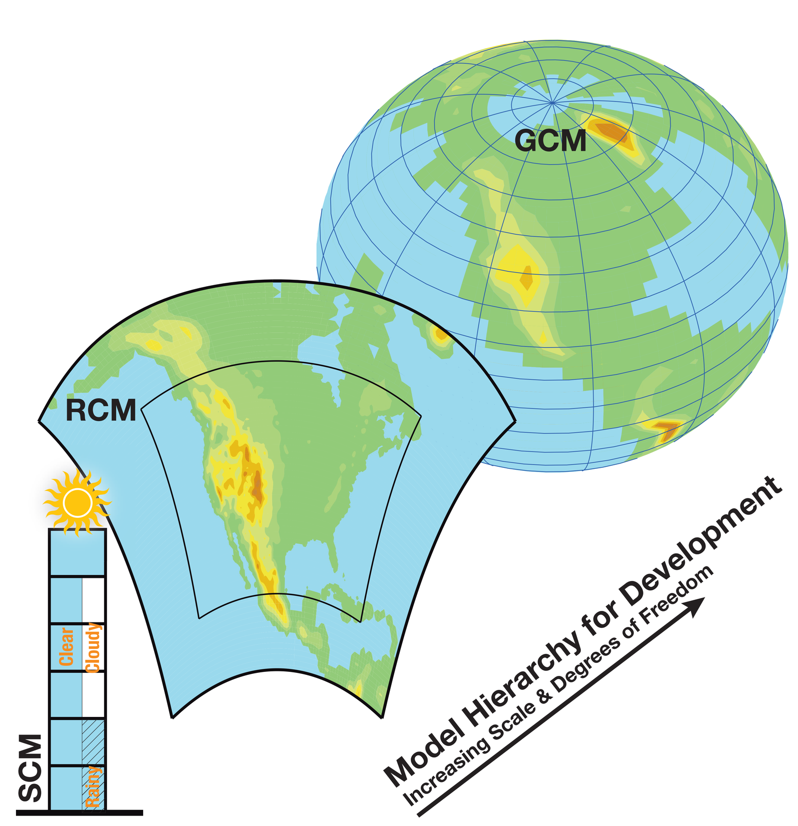
CAM5 physics in WRF offers many advantages for model development



In the past year the porting of the full atmopheric physics suite from CAM5 into WRF has been completed and is now being used for various purposes. Having the global model physics available in a regional model opens many options to quicken global model develoment.

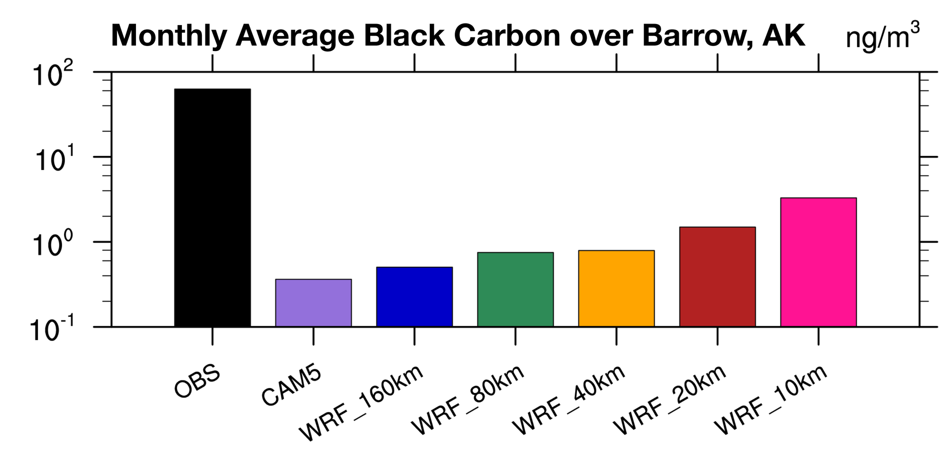
- Constrained boundaries to control large-scale meteorology simplifies direct comparison with observations
- Efficient resolution dependence testing
- Easy testing of interactions between different physics components and between different formulations of the same component

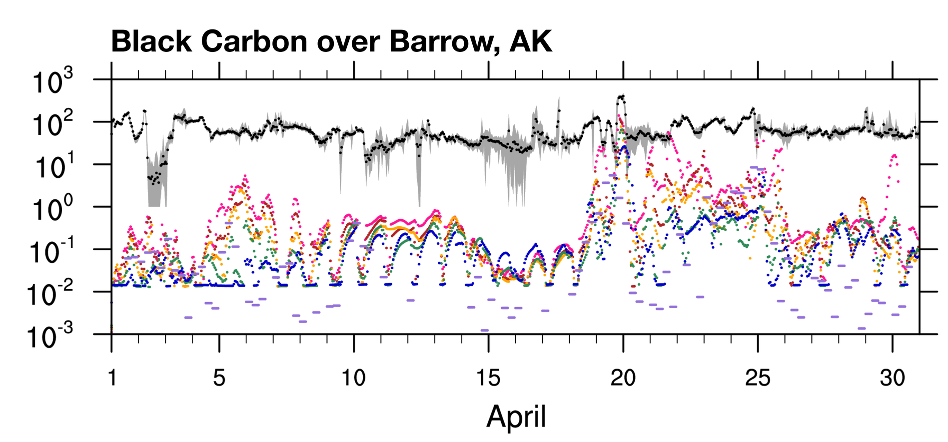
The regional model fills a gap in the current CAM5 development portfolio



Previously, one could only use CAM5 physics in single column or full global configurations. Now, a regional configuration is available via WRF to better understand physics behavior and quicken the development process.

Added resolution improves black carbon transport



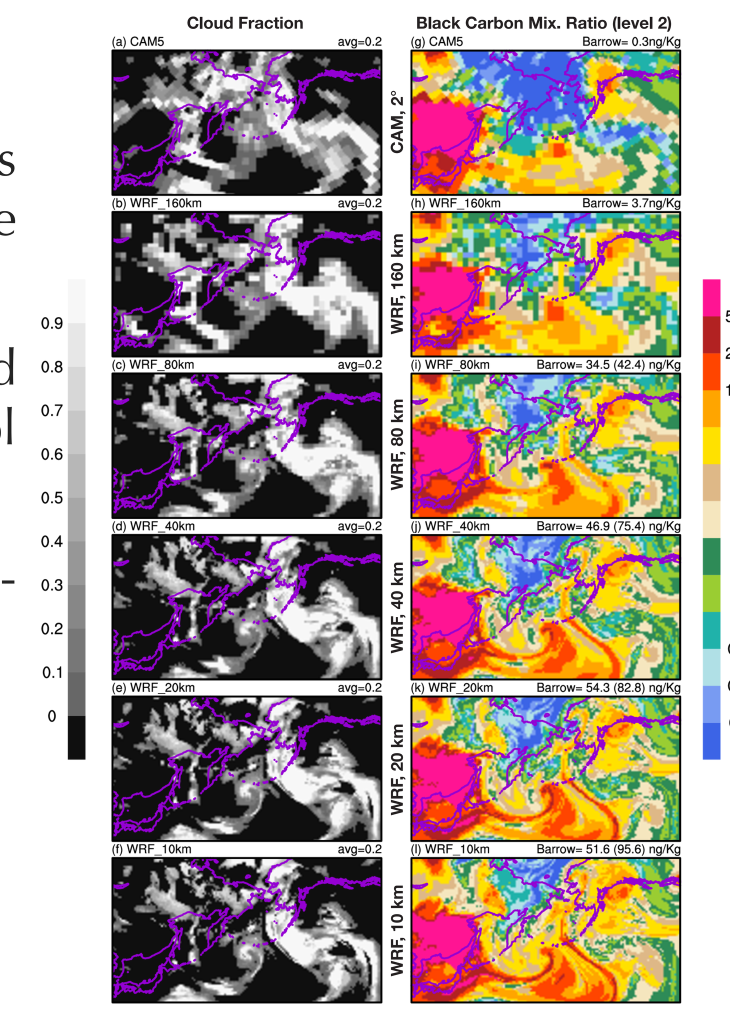


WRF's capability to easily configure for various resolutions is used to test grid spacings from "GCM like" down to the cloud gray-scale.

Simulations of the northern and central Pacific show increased resolution helps alleviate negative biases in poleward aerosol transport.

High resolution allows more cloud-free gaps, providing pathways with no wet scavenging.

Ma, P.-L., P. J. Rasch, J. D. Fast, R. C. Easter, W. I. Gustafson, X. Liu, S. J. Ghan, and B. Singh, 2014: Assessing the CAM5 physics suite in the WRF-Chem model: implementation, resolution sensitivity, and a first evaluation for a regional case study, *Geosci. Model. Devel.*, **7**, 755–778, doi:10.5194/gmd-7-755-2014.

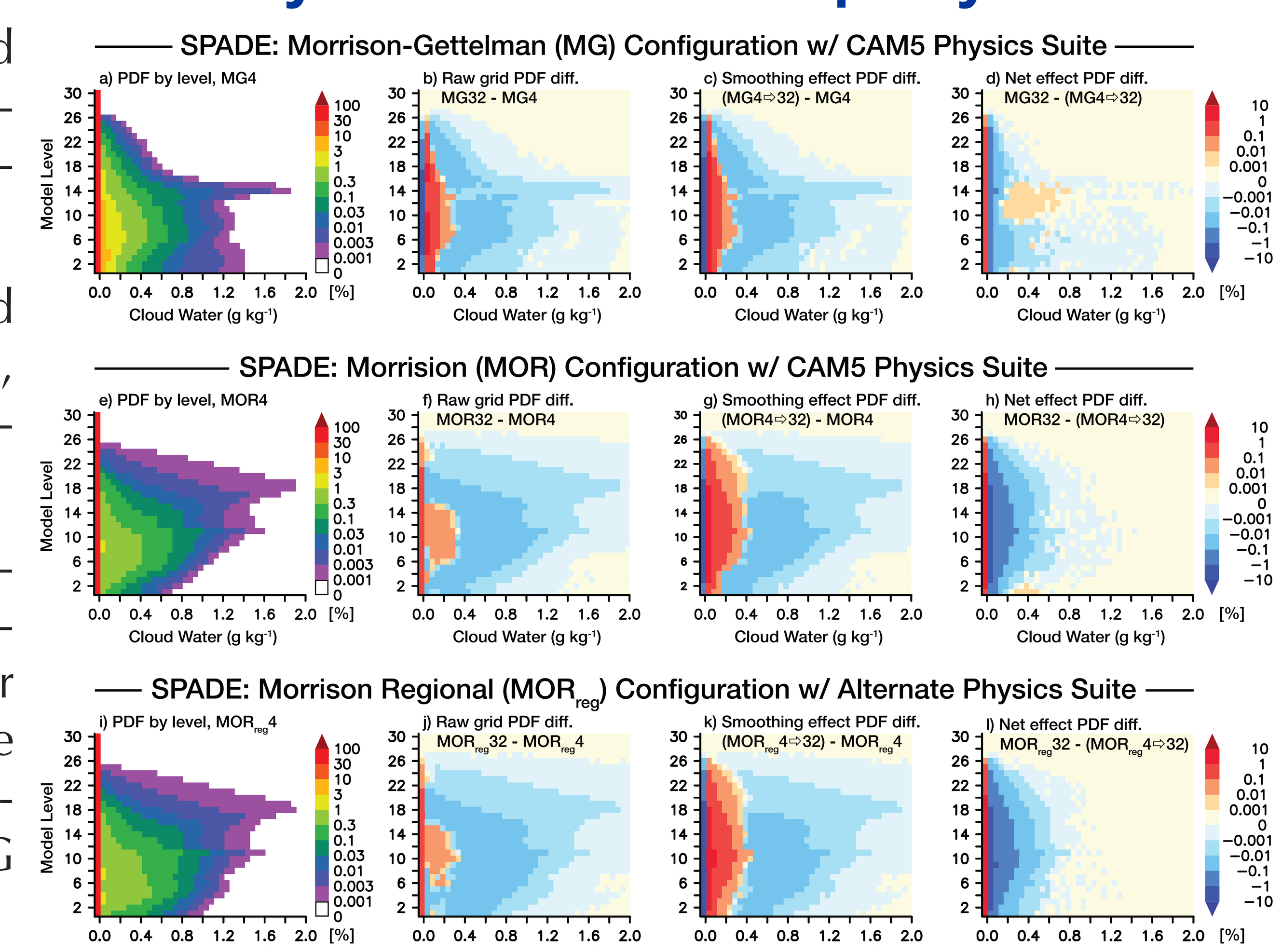


Comparison of resolution sensitivity between microphysics

WRF's interchangeable physics options and easy scheme implementation allows efficient comparison between alternate parameterization schemes.

WRF tools, such as the Separate Physics and Dynamics Experiment (SPADE) framework, allow more specific testing of certain behaviors.

Find that Morrison-Gettelman (MG) microphysics, with diagnostic rain and continuous cloud fraction, generates cloud water concentrations at lower elevations than the Morrison (Mor) microphysics that uses prognostic rain and a binary cloud fraction. MG also has less net resolution sensitivity.

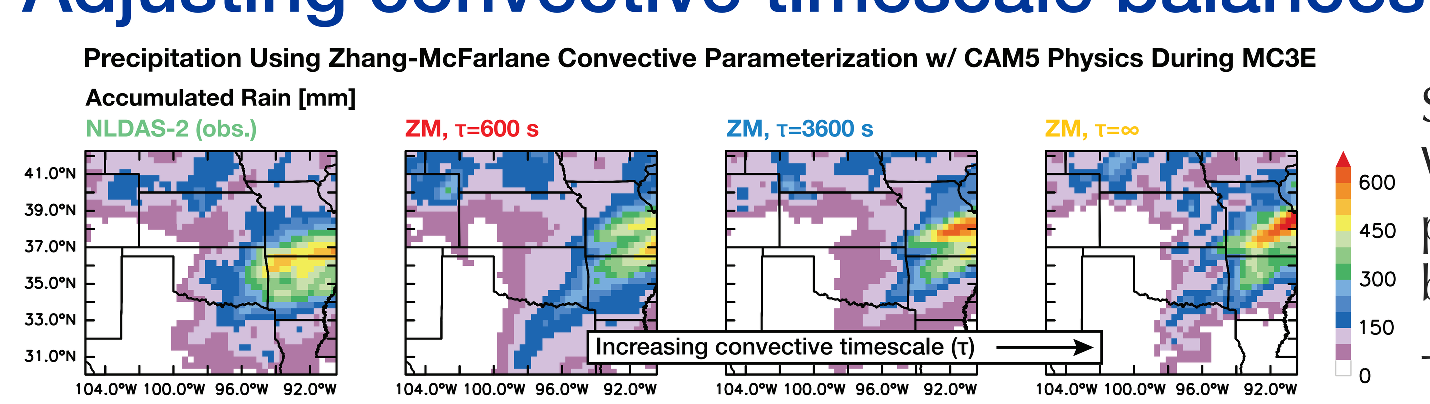


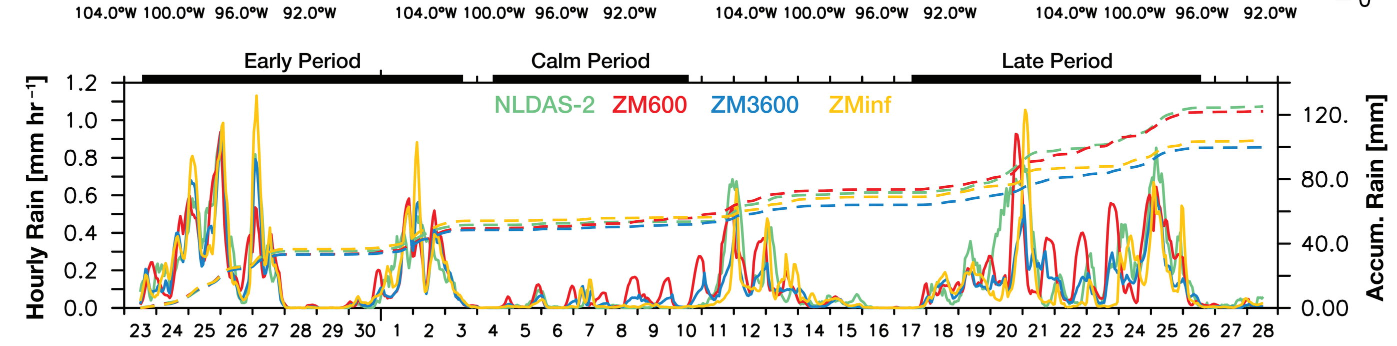
SPADE allows comparison of specific physics component behavior on an alternate grid from the rest of the model.

The comparison shown is for a 4-km grid spacing with microphysics alternatively run on a 4- or 32-km grid.

Gustafson, W. I., P.-L. Ma, H. Xiao, B. Singh, P. J. Rasch, and J. D. Fast, 2013: The Separate Physics and Dynamics Experiment (SPADE) framework for determining resolution awareness: A case study of microphysics. *J. Geophys. Res.*, **118**, 9258–9276, doi:10.1002/jgrd.50711.

Adjusting convective timescale balances overall bias with diurnal cycle over US



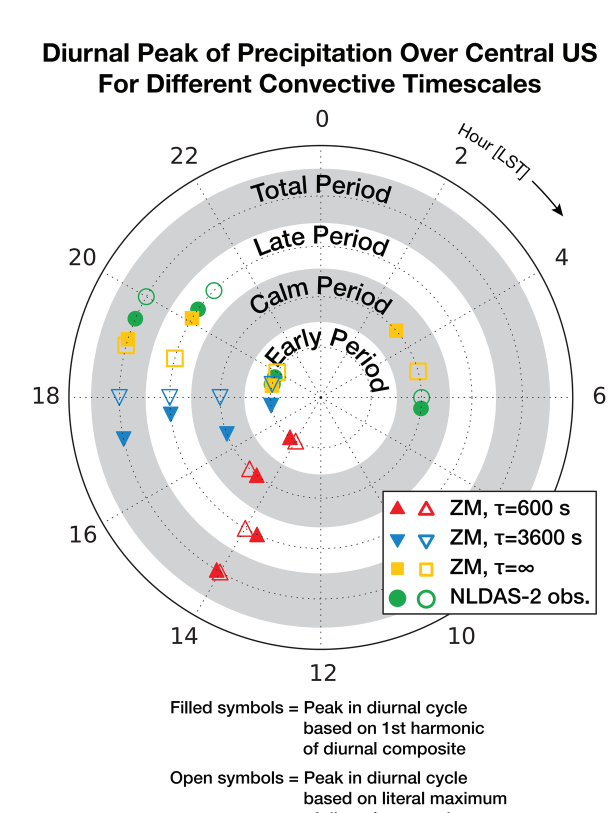


Gustafson, W. I., P.-L. Ma, and B. Singh, 2014: Precipitation characteristics of CAM5 physics at mesoscale resolution during MC3E and the impact of convective timescale choice. *J. Adv. Model. Earth Sys.*, in review.

Specified lateral boundary conditions with WRF's regional domains allow for direct comparison to observations for case studies to better understand specific model behaviors.

The MC3E field campaign has been used to understand the choice of convective timescale at mesoscale resolution, Δx=32 km.

A short convective timescale (600 s) provides most accurate regional-average rain amount but has worst diurnal cycle. A longer convective timescale (3600 s or ∞) improves the diurnal cycle but adds a negative bias.



For more information contact William.Gustafson@pnnl.gov.
http://www.pnnl.gov/atmospheric/staff/staff_info.asp?staff_num=5716; http://www.researcherid.com/rid/A-7732-2008

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