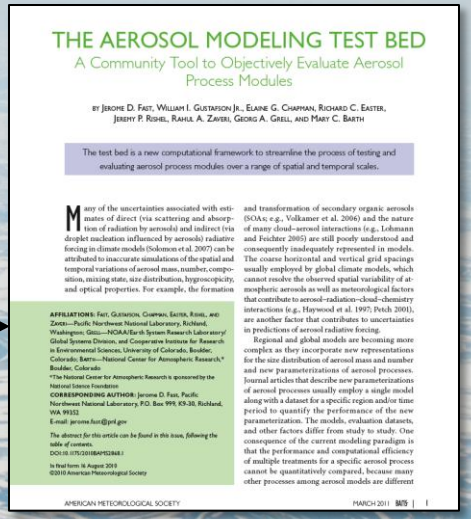
Using ISDAC Data as a Testbed for Evaluating the Performance of CAM5 Physics Treatments in the Arctic

Jerome Fast and Phil Rasch

- Evaluate CAM5 physics suite within WRF at higher spatial resolution more compatible with data
- Compare CAM5 physics modules against more complex and expensive representations using systematic and consistent methodology of the Aerosol Modeling Testbed
- Use performance metrics to identify more desirable parameterization choices for both models



THE AEROSOL MODELING TEST BED

A Community Tool to Objectively Evaluate Aerosol Process Modules

BY JEROME D. FAST, WILLIAM I. GUSTAFSON JR., ELAINE G. CHAPMAN, RICHARD C. EASTER, JEREMY P. RISHEL, RAHUL A. ZAVERI, GEORG A. GRELL, AND MARY C. BARTH

The test bed is a new computational framework to streamline the process of testing and evaluating aerosol process modules over a range of spatial and temporal scales.

Many of the uncertainties associated with estimates of direct (via scattering and absorption of radiation by aerosols) and indirect (via droplet nucleation influenced by aerosols) radiative forcing in climate models (Solomon et al. 2007) can be attributed to inaccurate simulations of the spatial and temporal variations of aerosol mass, number, composition, mixing state, size distribution, hygroscopicity, and optical properties. For example, the formation and transformation of secondary organic aerosols (SOAs; e.g., Volkamer et al. 2006) and the nature of many cloud–aerosol interactions (e.g., Lohmann and Feichter 2005) are still poorly understood and consequently inadequately represented in models. The coarse horizontal and vertical grid spacings usually employed by global climate models, which cannot resolve the observed spatial variability of atmospheric aerosols as well as meteorological factors that contribute to aerosol–radiation–cloud–chemistry interactions (e.g., Haywood et al. 1997; Petch 2001), are another factor that contributes to uncertainties in predictions of aerosol radiative forcing.

Regional and global models are becoming more complex as they incorporate new representations for the size distribution of aerosol mass and number and new parameterizations of aerosol processes. Journal articles that describe new parameterizations of aerosol processes usually employ a single model along with a dataset for a specific region and/or time period to quantify the performance of the new parameterization. The models, evaluation datasets, and other factors differ from study to study. One consequence of the current modeling paradigm is that the performance and computational efficiency of multiple treatments for a specific aerosol process cannot be quantitatively compared, because many other processes among aerosol models are different

AFFILIATIONS: FAST, GUSTAFSON, CHAPMAN, EASTER, RISHEL, AND ZAVERI—Pacific Northwest National Laboratory, Richland, Washington; GRELL—NOAA/Earth System Research Laboratory/Global Systems Division, and Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado; BARTH—National Center for Atmospheric Research,* Boulder, Colorado

*The National Center for Atmospheric Research is sponsored by the National Science Foundation

CORRESPONDING AUTHOR: Jerome D. Fast, Pacific Northwest National Laboratory, P.O. Box 999, K9-30, Richland, WA 99352

E-mail: jerome.fast@pnl.gov

The abstract for this article can be found in this issue, following the table of contents.

DOI:10.1175/2010BAMS2890.1

In final form 16 August 2010

©2010 American Meteorological Society

AMERICAN METEOROLOGICAL SOCIETY MARCH 2011 | 1

BAMS March Issue

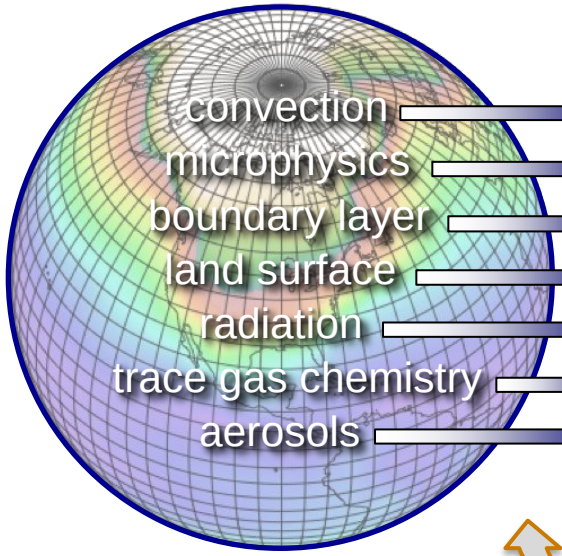
Photo: NASA P3-B

Pacific Northwest NATIONAL LABORATORY

Concept

Using The AMT for Earth System Modeling Project on Arctic Processes

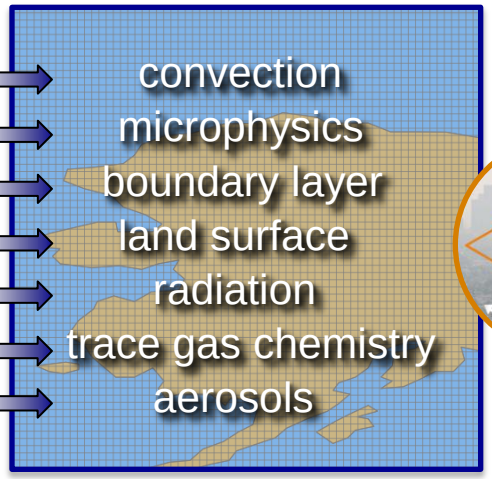
Community Atmosphere Model (CAM5)



ZM deep & UW shallow
Morrison & Gettleman
Park & Bretherton
CLM
RRTMG
MOZART
MAM

Weather Research & Forecasting (WRF)

ISDAC / ARCTAS Testbed Case



module

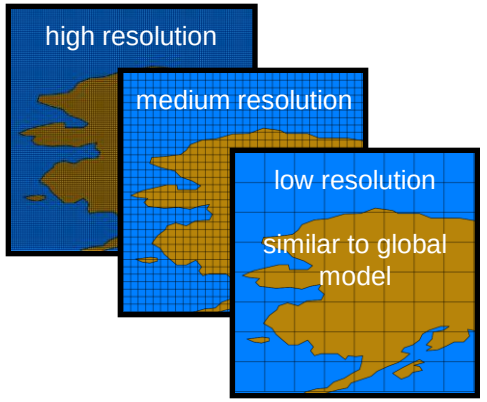
Philosophy: Single parameterization for each atmospheric process for long-term climate simulations using a coarse grid

Philosophy: Several parameterizations for each atmospheric process for short-term simulations using range of grid spacings

POLARCAT Data
(LATMOS collaboration)

Testbed Case Data

Aerosol Modeling Testbed



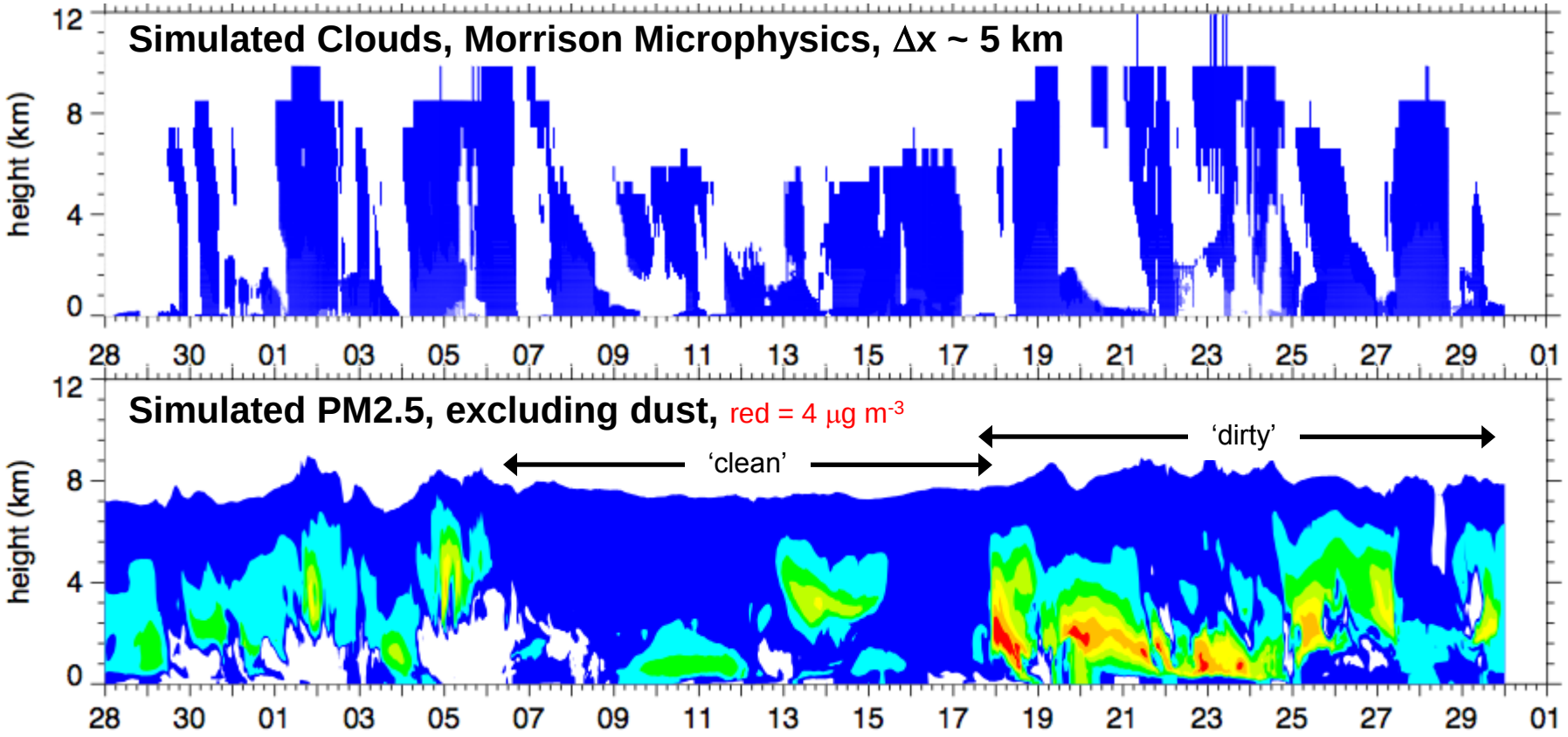
boundary conditions

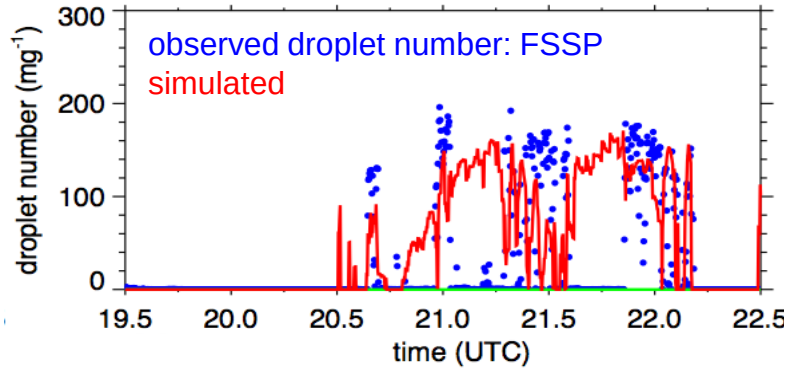
downscaling with consistent physics

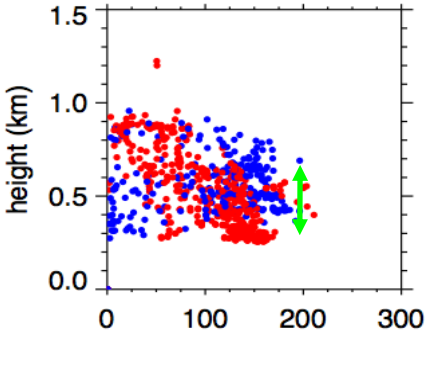
POLar Model Intercomparison Program (POLMIP)

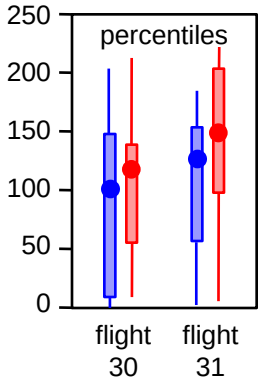
Pacific Northwest NATIONAL LABORATORY

Preliminary Results







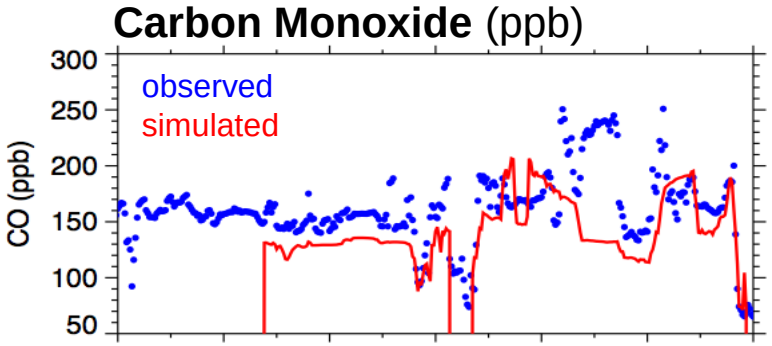


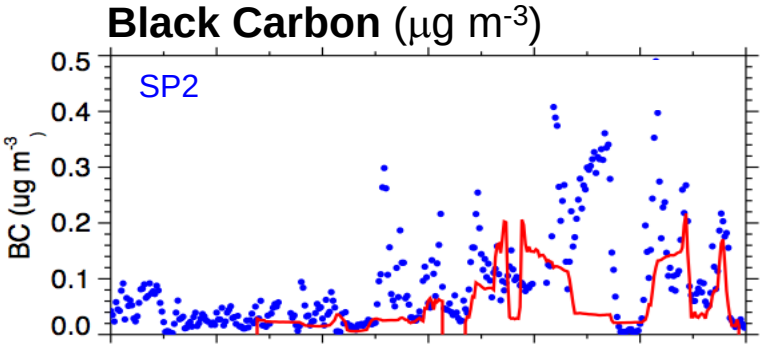
Convair flight #30 as an example

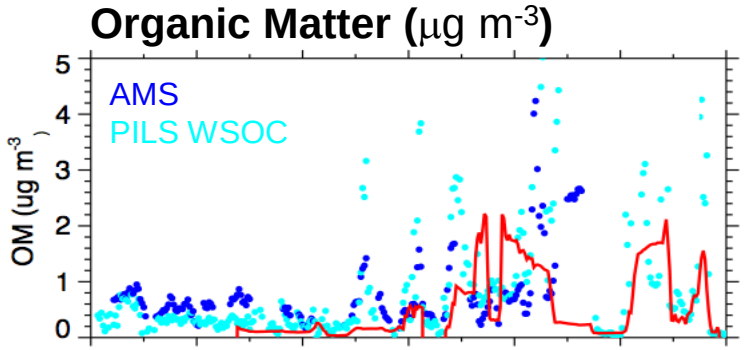
Pacific Northwest NATIONAL LABORATORY

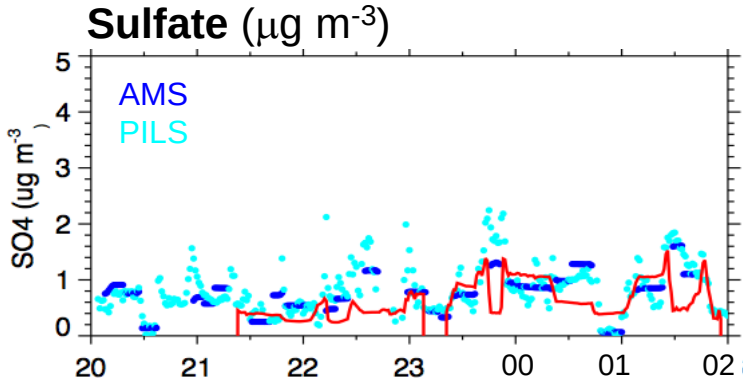
DC-8 Flight: April 16, 2008

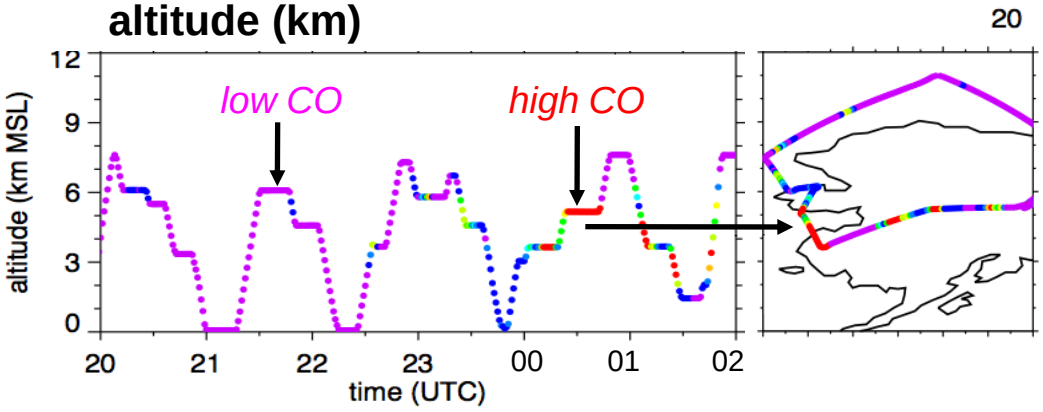
Simulated CO and Aerosols Usually Too Low and Poorly Correlated with Data











Statistics for All Flights

	WRF	Obs	Correlation
CO	121	157	0.69
BC	0.04	0.08	0.38
OM	0.17	0.48	0.08
Other	0.56	0.98	-0.04