FASTER: a New DOE Effort to Bridge ESM and ASR Sciences

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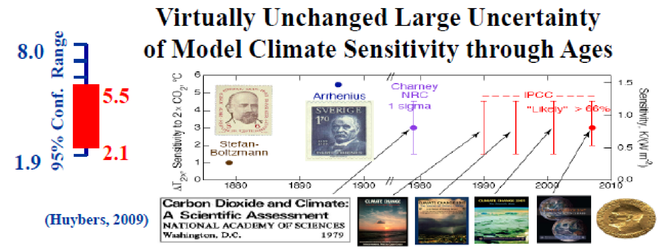
What is FASTER?

- FASTER = *FAst-physics System TEstbed and Research*
- Result from ESM proposal "*Continuous Evaluation of Fast Processes in Climate Models Using ARM Measurements*"
- 21+ investigators from 10 institutions (+ post docs and students)
- Co-managed by ASR (Atmospheric System Research) manager (Dr. Kiran Alapaty) and ESM (Earth System Modeling) program manager (TBD)

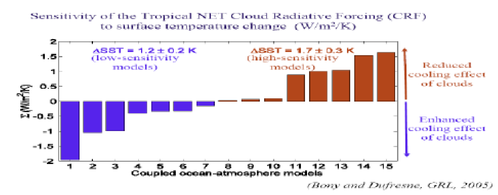
FASTER is a major ESM effort to bridge ESM and ASR Sciences by fully utilizing ARM measurements to evaluate GCM parameterizations of fast processes such as clouds.

Motivation One: Modeling Side



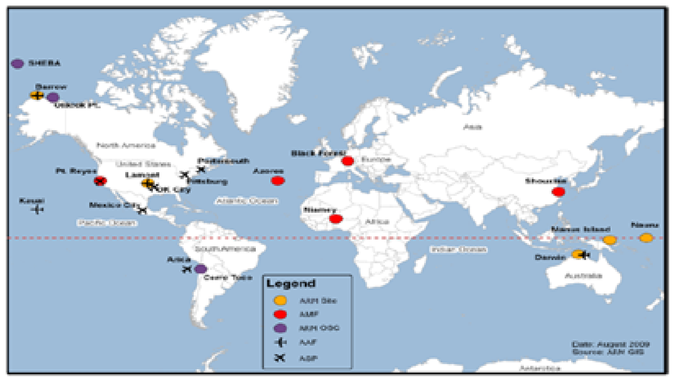
(Huybers, 2009)

Despite extensive research, climate sensitivity remains highly uncertain, and the source of uncertainty is likely with parameterizations of cloud-related fast processes in GCMs, e.g.:



(Adapted from Schwartz 2009 and Zhang 2010)

Motivation Two: Observation Side



Continuous, high-resolution, long-term surface-based/aircraft ARM observations at the various sites of different climate/weather regimes are complementary to global satellite observations in evaluating climate models and disentangling the physical processes whose representation in GCMs need to be improved, especially for issues related to clouds and radiation.

(Adapted from the 2010 ASR Science Plan)

Goal and Objectives

One Goal

Fully utilize continuous long-term ARM measurements to enhance/accelerate evaluation and improvement of parameterizations of cloud-related fast processes and narrow GCM uncertainties and biases.

Six Objectives

- Construction of a fast-physics testbed
- Execution of a suite of CRM/LES simulations
- Evaluation of model performance
- Examination and improvement of parameterizations
- Assessment and development of evaluation metrics
- Incorporation of acquired knowledge into the full GCMs

Eight Tasks and Major Fast Processes

Eight Tasks

- Fast-physics testbed (NWP-testbed & SCM-testbed)
- A suite of high-resolution model simulations
- Model evaluation against measurements
  - Model errors
  - Error sources
- Evaluation metrics
  - Statistical measures
  - Forecast skill
- Theory and parameterization
- Data assimilation
- Full GCM assessment
- Data integration

Evaluation approach →

Evaluation variables →

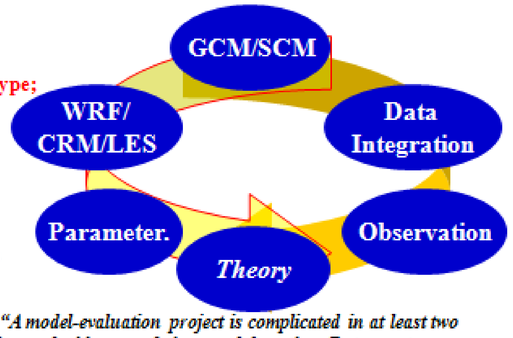
Major Fast Processes

- Microphysics
  - Warm clouds
  - Ice clouds
  - Mixed phase clouds
  - Mono vs. multi-moment schemes
- Aerosol-cloud interactions
- Radiation
- Shallow convection
- Deep convection
- Entrainment/Detrainment
- Boundary processes
- Subgrid turbulence
- Cloud fraction
- Land-surface-atmosphere interaction

The sheer complexity of the problem are certainly a reason for the slow progress.

Complexity:

- Scientific
  - 3M (multibody; multitype; multiscale interactions)
  - Conceptual
  - Numerical
  - Coupling
- Engineering
  - Inter-field interactions
  - Para. imple. in GCMs



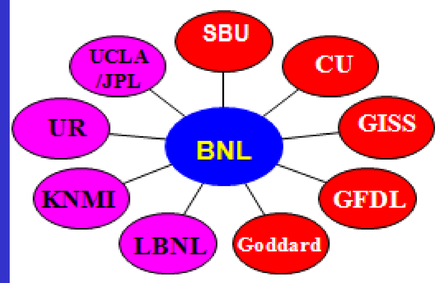
Randall et al. (BAMS, 2003): "A model-evaluation project is complicated in at least two distinctive ways. The technical complexities are obvious and daunting: Data must collected and analyzed, …. An additional and equally complex task is to foster communication and fruit interactions ….".

Some even considers the complexity as a *valley of death* for GCMs.

FASTER Team

BCC (10 institutions and 21 scientists)

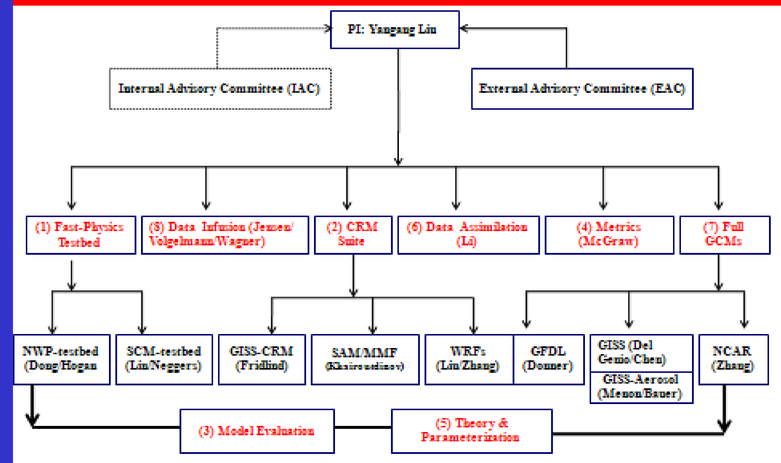
Hub · Core · Extended



Investigator	Institution
Yangang Liu	BNL
Stephen Schwartz	BNL
Warren Wiscombe	BNL/Goddard
Robert McGraw	BNL
Wuyin Lin	BNL
Andrew Vogelmann	BNL
Michael Jensen	BNL
Richard Wagener	BNL
Dong Huang	BNL
Wei Wu	BNL
Surabi Menon	LBNL
Susanna Bauer	CU
Minghua Zhang	SBU
Marat Khairoutdinov	SBU
Anthony Del Genio	GISS
Ann Fridlind	GISS
Yonghua Chen	CU
Leo Donner	GFDL
Zhijin Li	UCLA/JPL
Robin Hogan	UR
Roel Neggers	KNMI

Core institutions are adjacent to BNL and operate three major US GCMs; many team members participate in ASR or related research, and has strong theoretical background on top of other areas of expertise essential for success

Scientific Management



Note that the flow chart is for illustrative purpose; all scientists work closely together, with focused areas identified. All scientists participate in (3) and (5), focusing on different processes/aspects.

Project Gateway – Website

http://www.bnl.gov/esm/

- The site is still under development.
- See other FASTER posters for details of individual tasks.
- Welcome to the FASTER breakout for progress talks.

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