Links with GASS

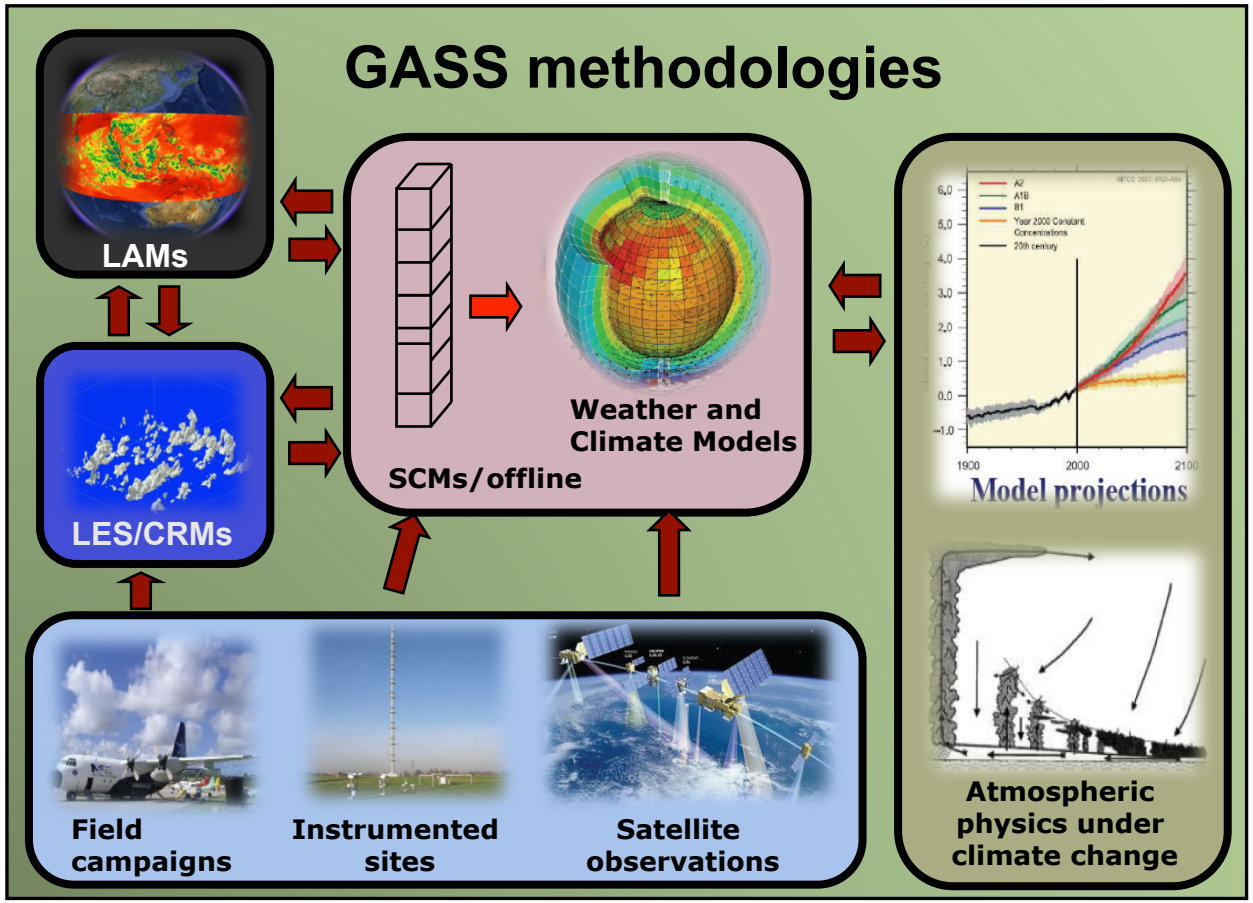
GASS Co-Chairs:
Jon Petch and Stephen Klein

GASS GEWEX WCRP Global Atmospheric System Studies

Co-Chairs: Jon Petch (UKMO) and Stephen Klein (LLNL)

A community who carry out and use observations, process studies and model experiments with a focused goal of **improving the representation of the atmosphere** in weather and climate models.

Working with many model types bringing together observations, modelling and understanding in intercomparison projects



Topics of Current Projects (partial list)

- Tropical convection (MJO)
- Convection in the grey-zone (1-5 km)
- Land-Atmosphere Interactions (DICE)
- Stable boundary layers (GABLS)
- Cloud microphysics and aerosol interactions
- Boundary layer cloud feedbacks (CGILS)
- Polar clouds (ISDAC)
- CAUSES for US warm bias
- Weak-Temperature Gradient modeling of tropical convection

GASS Projects: Topical Areas

1. Tropical Convection
2. The Grey-Zone Project
3. Land-Atmosphere Interactions
4. Ice & Mixed-Phase Cloud Microphysics

5. Ideas for projects that could link with CFMIP

Tropical Convection

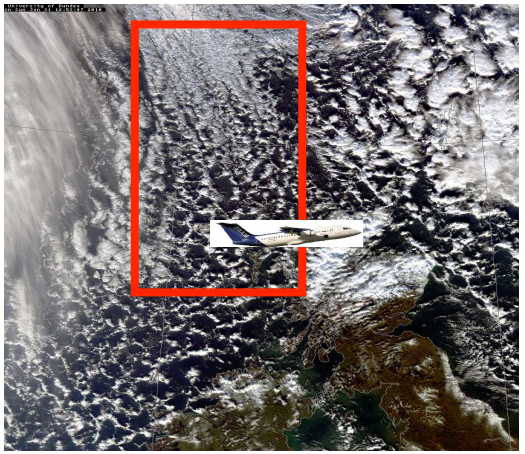
- MJO Model Evaluation Project *(finishing)*
  - Leads: Jon Petch, Duane Waliser, Prince Xavier, Nick Klingaman, Xianan Jiang & Steve Woolnough
  - Joint with CLIVAR
  - Global model evaluation of MJOs in both free-running and initialized simulations, also some CRM runs
- CINDY/DYNAMO *(discussion phase)*
  - To utilize Indian Ocean field campaign observations (fall 2011)
- Weak-Temperature Gradient Modeling *(starting)*
  - Leads: Steve Woolnough, Chimene Daleu, Adam Sobel, Sharon Sessions, Gilles Bellon, Shugang Wang
  - Joint with WGCM/Euclipse
  - What are the strengths and weaknesses of the various ways (WTG, Damped Gravity Waves) that large-scale dynamics can be represented?

Grey-Zone Project *(early)*

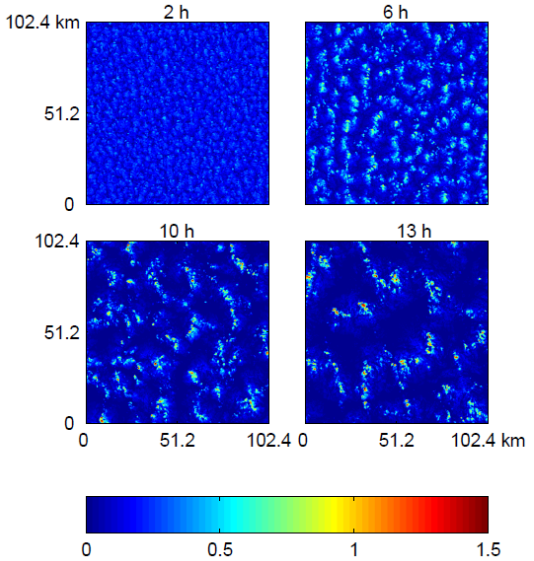
Pier Siebesma (KNMI) et al.

Motivation

- Increased use of atmospheric models (e.g. NWP or mesoscale) with horizontal resolution in the grey-zone (1 – 10 km)
- Because these models cannot resolve all individual convective elements, there is a need to systematically evaluate their behaviors by comparison to benchmark large-domain Large-Eddy Simulations
- The project aims to guide the development of scale-aware and stochastic parameterizations to treat the mixing that needs to be parameterized



Liquid Water Path from LES
(at 4 times showing the transition in scale)



Case Setup and Participation

- Cold-air outbreak case from the North Atlantic (CONSTRAIN) with quick transition from small closed cells to open cells
- Mix of models: LES, mesoscale, and global models
- Benchmark LES simulation: 100 km domain at 100 m resolution

Land – Atmosphere Interactions

- DIurnal Land-atmosphere Coupling Experiment (DICE) *(ongoing)*
  - Leads: Adrian Lock and Martin Best (Joint with GLASS)
  - Run Single-Column Models of atmosphere and land separately with observations, then with the forcings of the other component model (e.g. atmopshere with land, land with atmosphere)
  - Evaluate land and atmosphere model performance with observations
  - What is the impact of coupling?
- Clouds Above the United States and Errors at the Surface (CAUSES) *(formation)*
  - Leads: Cyril Morcrette, Hsi-Yen Ma, Jon Petch, Shaocheng Xie
  - What is the role of errors in radiation and precipitation on the development of 2 meter temperature warm biases over summertime middle-latitude continents?
  - Hindcast evaluation of global and regional models with observations

Ice & Mixed-Phase Cloud Microphysics

- Indirect and Semi-Direct Aerosol Campaign *(finished)*
  - Lead: Mikhail Ovtchinnikov
  - LES of an Arctic mixed-phase cloud observed by ARM
  - Using bin microphysics to critique the effects of assumed ice size distribution in bulk schemes on deposition and sedimentation
- Mid-Latitude Cirrus *(early)*
  - Leads: Andreas Muhlbauer, Tom Ackerman
  - Evaluation with ARM aircraft observations of Oklahoma cirrus
  - What is contribution of small ice crystals in cirrus and the role of homogeneous and heterogeneous ice nucleation?
- Arctic Idealized Mixed-Phase Cloud Formation *(formation)*
  - Leads: Felix Pithan, Gunilla Svensson
  - SCM study under Idealized radiative cooling of a boundary layer air

Ideas for GASS links with CFMIP

- CGILS Phase 3?
- Radiative Forcing Model Intercomparison Project (RFMIP) (Robert Pincus)
  - Lead: Robert Pincus
  - Assessment at global scales of radiation parameterizations of various forcing agents (e.g. $4XCO_2$)
- Radiative convective equilibrium ???
- Assessment of Water Cycle in 10 km global models (Graeme Stephens) ???
- Isotopes in Deep Convection ???
- Your ideas …

Vertical Structure and Diabatic Processes of the Madden-Julian Oscillation: *A Global Model Evaluation Project*

Objectives

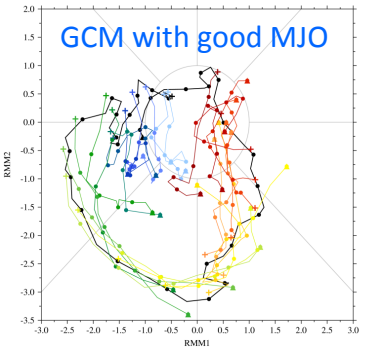
- Characterize observed and modelled temperature, moisture, and cloud structures during the MJO life cycle and determine the roles of various heating, moistening and momentum mixing processes.
- Evaluate the ability of current models to hindcast MJO events, and characterize the evolution of the "error" growth in the profiles of moistening, diabatic heating, etc.
- Elucidate key model deficiencies in depicting the MJO physical process evolution, and provide guidance to model development/improvement efforts.

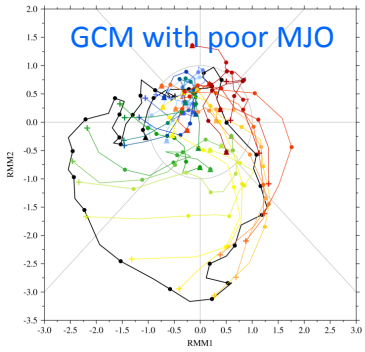
Experiment Types	No. Models
20 year climate simulation (1991-2010)	20
2 day hindcasts YoTC MJO cases E&F	7
20 day hindcasts YoYC MJO cases E&F	11

Results

- A wide range of behaviours (some good/some bad) across models in all components
- Good hindcast of MJO does not imply a good climate MJO and vice-versa
- No clear relationships between MJO skill and representation of diabatic processes however all 3 components appear to show that moistening at low and mid-levels due to the transition phase seems to be a necessary but not sufficient condition for good MJO simulation

MJO Phase Diagrams for Hindcasts





Future Work

- Examination of CINDY/DYNAMO 2011 field campaign

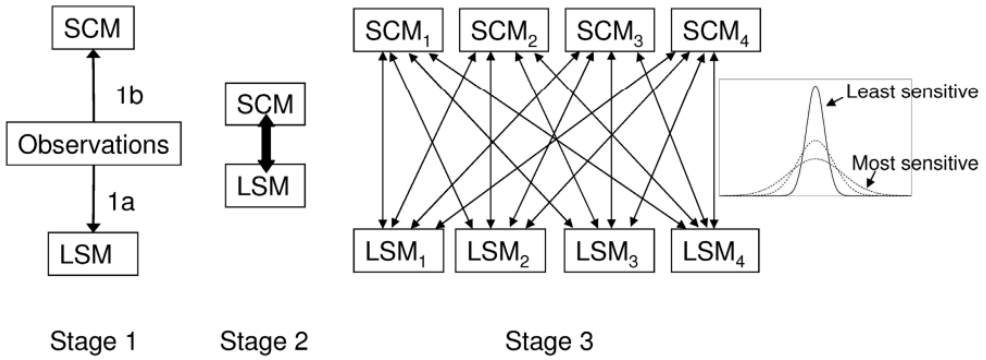
Jon Petch, Duane Waliser, Prince Xavier, Nick Klingaman, Xianan Jiang & Steve Woolnough

DIurnal Land-Atmosphere Coupling Experiment (DICE)

M. J. Best (UKMO) and A. P. Lock (UKMO)

Overview

- Joint GLASSS/GASS activity bringing together land and boundary layer modeling communities together
- Case study focused on of 3 consecutive diurnal cycles with no clouds from CASES 99 (Kansas) (prior GABLS case)



Motivation and Questions

- Intercomparison study involving single columns models (SCM) of the atmosphere and land-surface model (LSM)
- **Stage 1**: Evaluate LSM and SCM stand-alone performance against observations
- **Stage 2:** What is the impact of coupling?
- **Stage 3:** How sensitive are different LSM and SCM to variations in forcing and why are some models more sensitive than others?

Preliminary Results

- Climatological vegetation leads to large errors in simulated evaporation overwhelming any signal resulting from coupling
- Case being modified to control for this factor
- Still there are some interesting differences in models' sensitivity to changes in forcing that are likely to be important in GCMs and need to be understood

Microphysics of Arctic Mixed-Phase Clouds: ISDAC LES Intercomparison

Mikhail Ovchinnikov (PNNL)

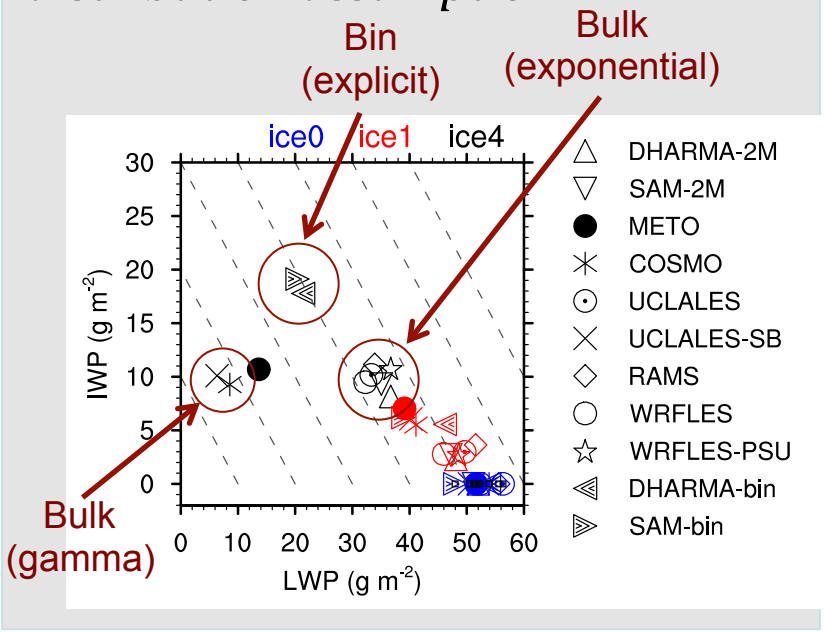
Case setup

- Based on observations from ARM observations for the Indirect and Semi-Direct Aerosol Campaign (ISDAC) at Barrow, Alaska
- The sensitivity to ice particle properties is examined in 11 models all with the same radiation scheme, and domain size

Key findings

- Confirmed ***first order importance*** of predicting correct ***liquid phase cloud*** (challenging for GCMs in the Arctic) and ***ice number concentration*** (always challenging) .
- ***Constrained setup*** revealed the ***importance of ice size distribution***
- ***Exponential ice size spectrum*** (a common default assumption in bulk Schemes) ***is too broad*** and can underestimate ice water path by a factor of 2.
- Size distribution effects on both **deposition growth** and **sedimentation** are important

Liquid-to-ice partitioning is a strong function of ice size distribution assumption



GASS Participation in WCRP Grand Challenges

Clouds, Circulation, and Climate Sensitivity Grand Challenge

- Radiative-convective equilibrium project to study convective aggregation
- Diagnostic study of radiative forcing in CMIP-class ("climate change") models
- Weak-temperature gradient project to study the interactions of tropical convection with the large-scale circulation (with applications to regional climate change in tropical precipitation)
- Grey-Zone study for the representation of convection

Water Availability Grand Challenge *(more provisional)*

- CAUSES: Evaluation of the contribution atmospheric errors in precipitation and radiation processes to errors in simulated summertime climate
- Evaluation of water cycle processes in high-resolution model (prospective HiRes project)