GASS

GEWEX WCRP

Global Atmospheric System Studies

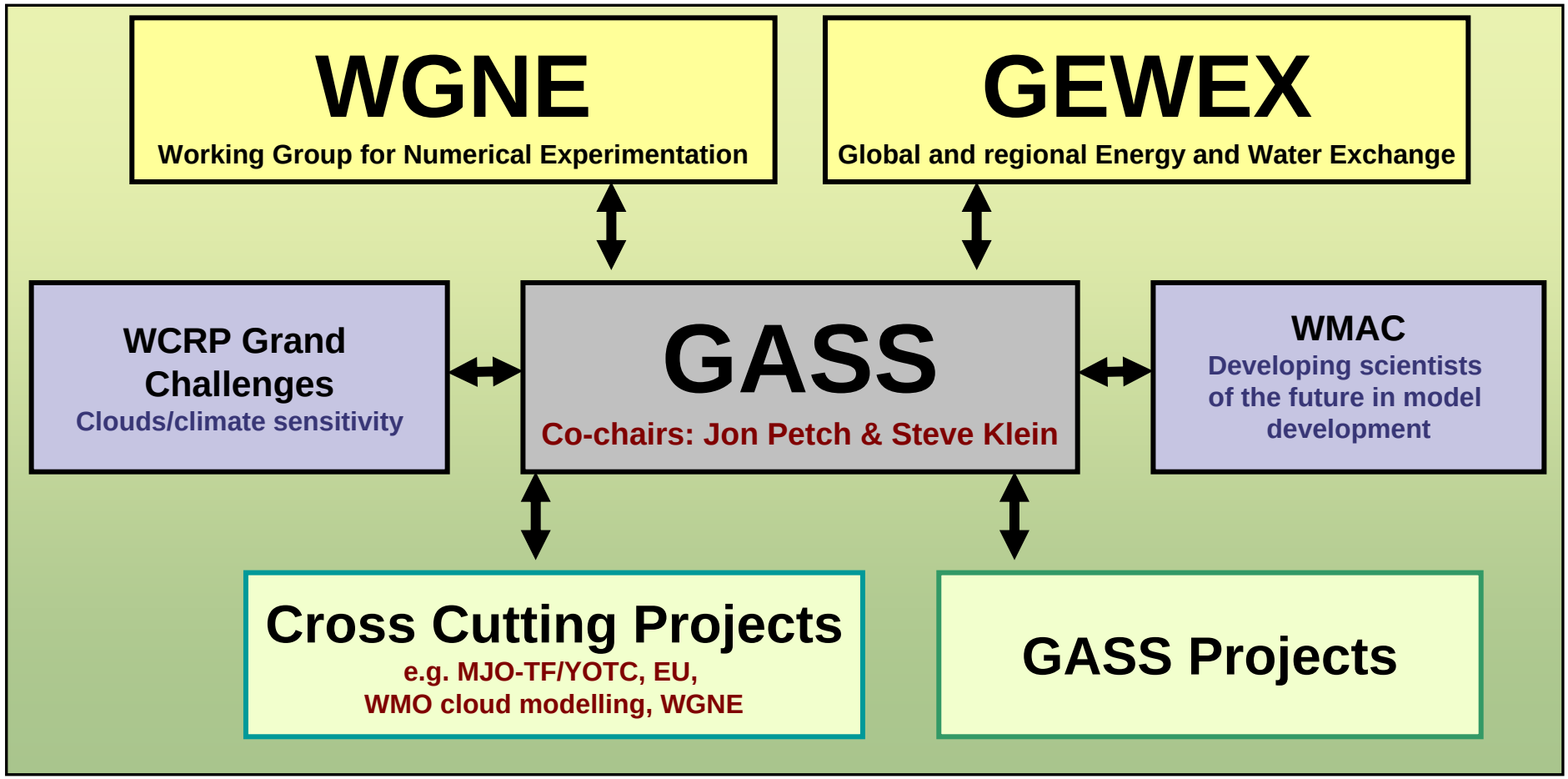
(GASS: report to GEWEX SSG)

Steve Klein, Jon Petch the GASS SSC and all the GASS community

October 2013

GASS GEWEX WCRP Global Atmospheric System Studies

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.



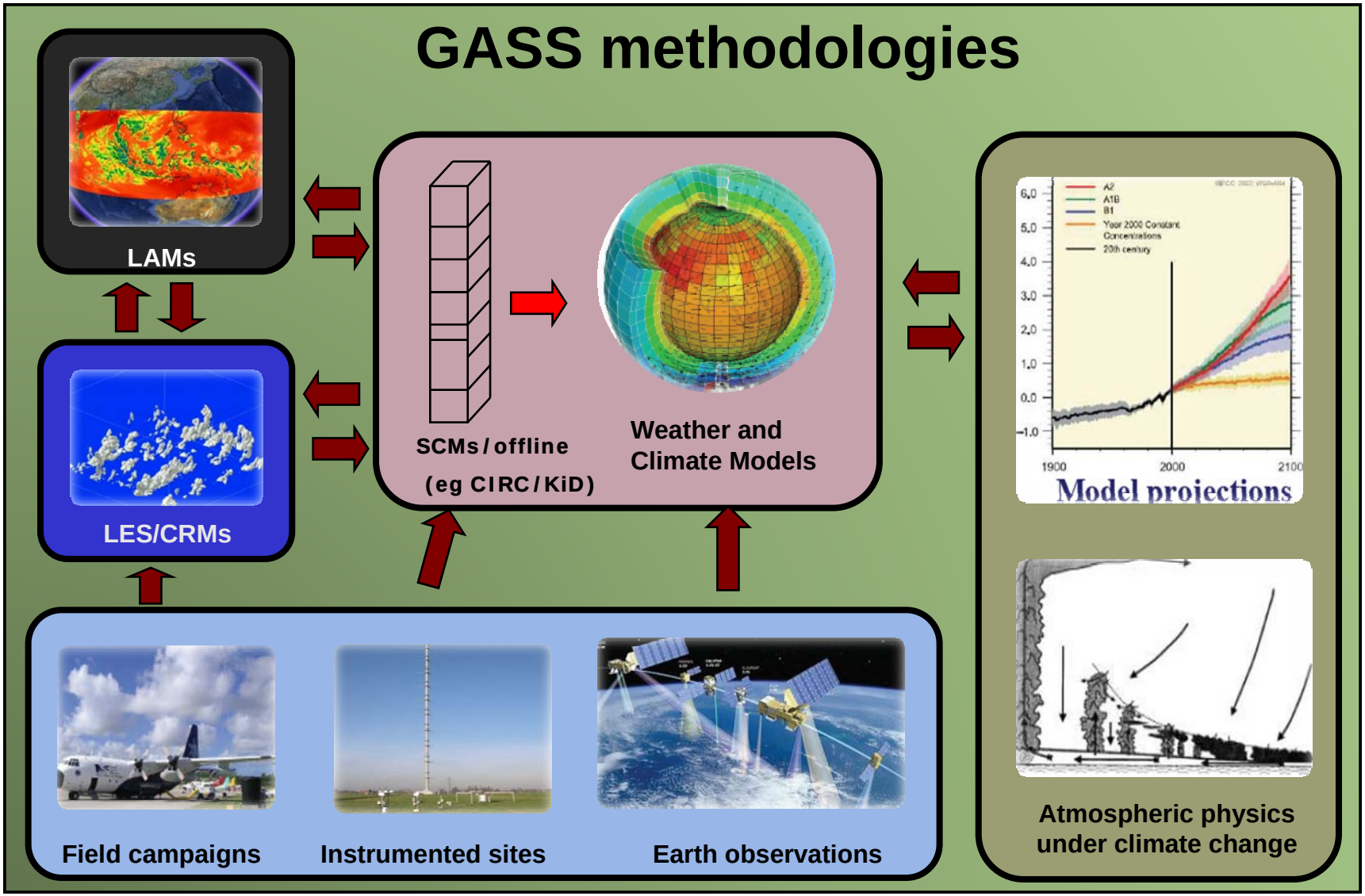
Some highlights of GASS 2012/2013

GASS has 13 current and planned projects; one project was completed in the past year. Newer projects of note include:

- **a collaboration with GLASS on land-atmosphere interactions (DICE project)**
- **moist processes parameterizations interactions with the large-scale circulation – the Weak-Temperature Gradient approximation. (joint with WGCM/EUCLIPSE)**
- **the cold air outbreak project looking at convection in the so called "Grey-Zone"**
- **GABLS project to study the ability of models to simulate the very stable boundary layers seen over Antarctica**
- **The examination of cloud radiation errors and associated surface temperature biases occurring in model over the central United States in summertime (CAUSES)**

Working with many model types

bringing together observations, modelling and understanding in intercomparison projects



Accomplishments in last 20 years

Often in collaboration with other groups, there have been over 40 projects in the last 20 years.

Area	no.	Project
Boundary layer clouds	13	Fire stratocumulus, smoke cloud case, Astex Lagrangians (2), Astex stratocumulus, Bomex, ATEX, ARM Shallow Cu, Eurocs FIRE diurnal cycle, DYCOMS (2), RICO stratocu->trade cu transition, climate change (CGILS)
Deep convection	9	ARM summer 1997, ARM summer 1999, TOGA-COARE (3), TWP-ICE; EUROCS
Polar clouds	4	MPACE (2), Sheba May 8 , ISDAC
Cirrus	4	ICMCP, Parcel Model, 9 March 2000 ARM, sparticus
Frontal clouds	4	Australian cold front, FASTEX, ARM March 2000 IOP (2)
Global clouds	2	GPCI, MJO Diabatic heating
Stable boundary layer	3	GABLS cases
Radiation	1	CIRC – now GASS/GDAP joint
Microphyics	1	KiD

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Current and future projects
Stable boundary layers: Antarctic case
The role of cloud and radiation processes in models US warm bias (CAUSES)
Weak temperature gradient
Grey-zone project
Microphysics modelling (KiD)
DICE: LoCo/SGP Testbed (GLASS project)
Marine Boundary Layer Cloud Feedbacks (CGILS)
Land-Atmosphere Interactions (GLASS/GABLS joint project)
CIRC – the continuous intercomparison of radiation codes
Cirrus
Tropical Convection observed during CINDY/DYNAMO
Polar Clouds (ISDAC)
Stratocumulus-to-trade cumulus transition
Vertical structure and diabatic heating of the MJO

CAUSES

(Clouds Above the United States and Errors at the Surface)

"A new project with an observationally-based focus,
which evaluates the role of clouds, radiation and precipitation processes
in contributing to the surface temperature biases in the region of the central United States and
which are seen in several weather and climate models."

Cyril Morcrette, Jon Petch, **Met Office, Exeter, United Kingdom.**

Hsi-Yen Ma, Stephen Klein, Shaocheng Xie, **Program for Climate Model Diagnosis and Intercomparison, Livermore, California, United States.**

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ASR Atmospheric System Research

Met Office

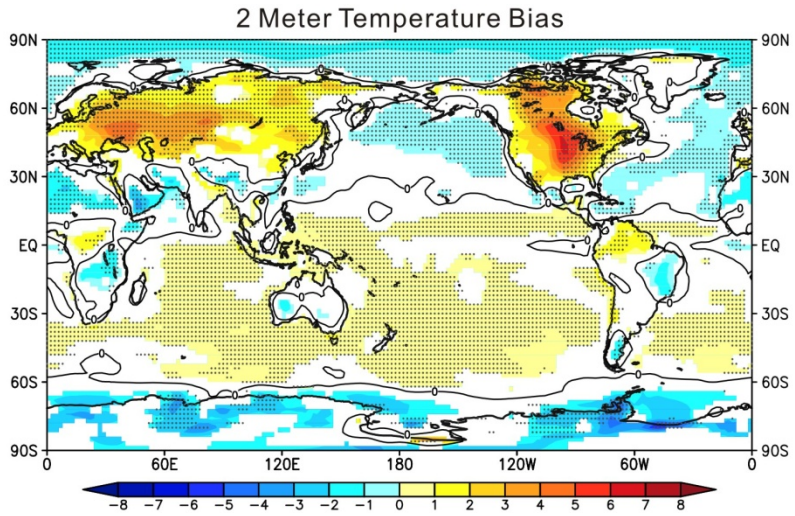
PCMDI Program for Climate Model Diagnosis and Intercomparison

Please get in touch if you wish to participate

Introduction (1)

Aims:

A joint GASS/ASR comparison project aiming to evaluate clouds and radiation in several weather and climate models using ground-based observations.



The warm bias over the US in summer is common to many GCMs.

It is seen in several climate models' long-term climate mean and it shows up as a bias within a few days when running climate models from analysis in NWP mode.

Please get in touch if you wish to participate

Model Simulations

All models to be run in weather forecasting (NWP) mode.(Transpose-AMIP)

We aim to look at the growth of the errors as a function of lead time.

Initially we will focus on the period T+00 to T+72, with daily re-initialization from analyses (i.e. ECMWF, 00Z analyses)

We may also look at some longer range hindcasts such as 30-day simulations started on the first of the month, to study how the model drift from its day-3 bias to its climate-mean bias.

Please get in touch if you wish to participate

Weak Temperature Gradient Project

Basic Proposal (initial discussion led by Steve Woolnough, Adam Sobel and Sharon Sessions)

- Weak Temperature Gradient (WTG) and similar approximations are becoming widely used to study tropical convection
  - A range of different approaches have been used with vary degrees of difference
  - A range of different CRMs and SCMs used
  - A range of different problems addressed
- The combination of the above makes it difficult to assess the robustness of the results
- GASS is starting a new intercomparison project to look at simulations of convection with parametrizations of the large-scale dynamics to
  1) Compare some different parametrization approaches (*to assess their usefulness in a process modelling studies*)
  2) Compare the behaviour of a range different CRMs and SCMs under a consistent parametrization framework (*to extend the range of situations in which our parmetrization schemes are compared to process models*)

Project Outline

Strawman Project Outline

A number of models (CRMs & SCMs) to perform a set of common simulations

- Comparing 2 parametrization approaches
  - Weak Temperature Gradient (2 separate "flavours")
  - Weak pressure gradient / damped linear wave (possibly 2 separate "flavours")
- A set of common convection experiments
  - Sensitivity to SST/surface fluxes
  - Sensitivity to initial conditions (multiple equilibria)
- Sensitivity studies (as a potential follow up)
  - Parametrization parameters (i.e. strength of circulation coupling to convection)
  - Treatment of moisture advection

Timeline

Sep 12: Initial discussion at Pan-GASS meeting

Spring 13: Draft project specification

Oct 13: Invitiation to participate

Spring 14: Initial Data Analysis

Note this project will interact strongly with a WTG-CRM/SCMs comparison led by Gilles Bellon under an EU project EMBRACE

Diurnal land-atmosphere Coupling Experiment: DICE

Joint GASS-GLASS activity

- New project released April 2013
  - Led by Adrian Lock and Martin Best at UK Met Office
  - To date 12 models are participating
- Joint activity between GASS (atmospheric boundary layer modellers) and GLASS (land surface modellers)
  - to study the interactions between the atmosphere and land surface
- Workshop 14-16th Oct at UK Met Office, Exeter

- Website: http://appconv.metoffice.com/dice/dice.html

Vertical Structure and Diabatic Processes of the MJO: *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.
- Based on above analyses, develop more targeted physics/detailed process model studies as well as formulate plans for needed observations (in-situ, airborne, satellite).

	Experiment	Output Data	Science Focus	Leads	No. Models to date
I.	20 year climate simulation (1991-2010)	Global 6 hourly Including vertical profiles of tendencies	MJO fidelity Vertical Structure	UCLA/JPL Xianan Jiang Duane Waliser	20
II.	2 day hindcasts YoTC MJO cases E&F * (Winter 2009)	Detailed time step data on model grid over Indo-Pacfic domain	Evaluation of model physics during different MJO phases	Met Office Prince Xavier Jon Petch	7
III.	20 day hindcasts YoYC MJO cases E&F * (Winter 2009)	Global 3 hourly Including vertical profiles of tendencies	MJO hindcast skill Lead time dependent evolution of diabatic processes	NCAS Nick Klingaman Steve Woolnough	11

* CINDY/DYNAMO Case from Nov 2011 to be performed after preliminary analysis

Progress to date

- Main analysis of each component complete and 3 papers in preparation for submission this autumn. Analysis presented at project meeting in Singapore in Jun 2013
  - Range of behaviour across models in all components
  - Good hindcasts do not necessarily imply 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

- Timeline going forward
  - Autumn 2013 : Submission of papers on each component
  - Spring 2014 : Summary paper and recommendation for high priority process studies

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GABLS 3

GASS Atmospheric Boundary Layer Study
GABLS third experiment

Coordinators: Fred Bosveld (SCM), Sukanta Basu (LES), Bert Holtslag and Gunilla Svensson

Cabauw tower (KNMI, NL)

- Focus on the representation of nighttime conditions and morning transition.
- Based on observations from Cabauw, the Netherlands
- Similar, but not identical, case setup for SCM and LES.
- SCM study involve turbulence, radiation and interaction with the land surface

Almost finished, results discussed in three papers that are in the final stage of publication

A position paper of the first three GABLS cases is available:

Holtslag, A.A.M., G. Svensson, P. Baas, S. Basu, B. Beare, A.C.M. Beljaars, F.C. Bosveld, J. Cuxart, J. Lindvall, G.J. Steeneveld, M. Tjernström, and B.J.H. Van De Wiel , 2013: Diurnal cycles of temperature and wind – A challenge for weather and climate models. Bulletin of the American Meteorological Society.
doi: 10.1175/BAMS-D-11-00187.1

GASS Atmospheric Boundary Layer Study
GABLS fourth experiment

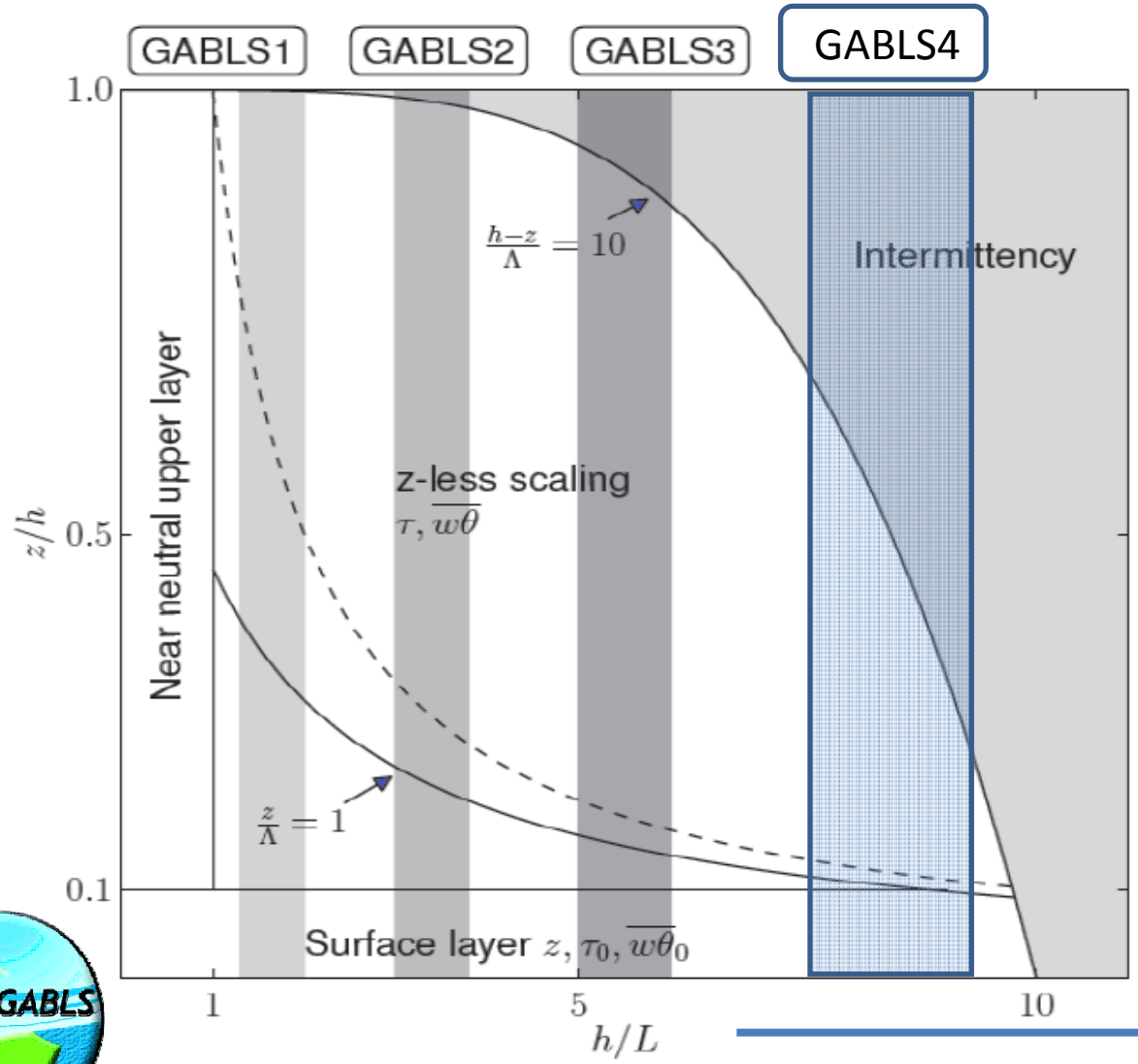

Figure by Holtslag and Nieuwstadt (1986), modified for GABLS by Arnold Moene

Coordinators: Eric Bazile, Timo Vihma, Bert Holtslag and Gunilla Svensson

Based on recommendations from the ECMWF/GABLS workshop in Nov 2011, a case based on Antarctic will be released late 2013

GASS links

Active participant in the WCRP Clouds, Circulation and Climate Sensitivity Grand Challenge project

- GASS co-chairs have helped to write the white paper for the project
- GASS SSC members Robert Pincus and Pier Siebesma are co-leaders of initiatives
- Many GASS members will attend GC Planning Workshop in Ringberg in March 2014
- GASS projects will be an active part of this Grand Challenge including an anticipated project to study the accuracy of the radiative forcings simulated by climate models.
- Other projects that will contribute to this Grand Challenge include the current project on Low-Cloud Feedbacks and the new project on the Weak Temperature Gradient. The Grey Zone and Microphysics projects are also expected to play a role in this Grand Challenge.

GASS links

Links to other WCRP projects and groups

- The vertical structure and diabatic heating of the MJO project is conducted jointly between GASS and the WCRP-WWRP-WGNE MJO task force
- GASS presents reports to the annual WGNE meetings
- The Low-Cloud Feedbacks project (CGILS) has been conducted jointly with the CFMIP project of WGCM
- Gunilla Svensson (SSC member) represents GASS on the Polar project initiatives of WWRP and WCRP.
- Steve Woolnough (SSC member) represents GASS on the joint WWRP/WCRP seasonal prediction project.

Resourcing the archiving of past projects

- Past cases were archived on an ad-hoc basis by working group leads.
- There are no longer any working groups and the WG web pages are removed/redundant.
- There would be a benefit to the community if they had case forcing data, descriptions and papers easily accessible.
  - There would also be a benefit to having the results there too in some cases although there are storage size implications to this
- There would be quite a bit of work or organise this
  - Contact past project leads
  - Gather data/papers/instructions
  - Make a common format where possible
- I note that DIME had something like this (and more) in mind but never produced this.
  - problem was the (link to/engagement of) the project leads I think

No progress since last year – what are the next steps here?

Summary

- GASS still remains a very active group with 13 active projects
  - Tackling all timescales – weather through to climate
  - Isolating processes in great detail
  - Working with observations
  - **Truly supporting model development – not just evaluation**
- 4 papers from TWP-ICE comparison were an ASR featured research article
- Links to GLASS with the new DICE project
- Links to WCRP Grand challenge on Clouds/climate sensitivity
- Links with WMAC and work on a physics summer school
- Continued relationship with WGCM though cloud-feedback project and the new WTG project and WCRP G.C.

Additional slides for information

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CAUSES

Introduction (2)

We hypothesize that the US warm bias is due to a combination of errors involving the land and atmosphere.

Potential issues include:

- the diurnal cycle of convection,
- timing of precipitation and how much evaporates,
- soil moisture,
- surface fluxes,
- organization and propagation of convection,
- shallow convection,
- radiative impact of convective cores, detrained cloud and anvils.

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Introduction (3)

In this project, we aim to understand the role of errors in the atmosphere model in contributing to the warm bias seen in climate models.

Specifically, we are proposing study of two areas of investigation:

Part I) Focus on the errors in clouds and radiation

•What is the contribution of radiation errors to the temperature errors?
•How much of the errors in radiation result from errors in clouds and their properties?
•Which cloud regimes contribute most to the radiation errors?
•Based on method in Morcrette *et al.* (2012).
•This effort will be led Cyril Morcrette.

Part II) Focus on the simulated precipitation and surface energy balance

•What is the relative contribution of precipitation errors to the temperature errors?
•Does the atmosphere provide the correct amount of precipitation for the soil?
•Which type of precipitating convection systems dominate the errors in the surface precipitation?
•Does the surface energy balance reveal signs that evaporation is underestimated due to the lack of soil moisture?
•Based largely upon Klein *et al.* (2006).
•This effort will be led by Hsi-Yen Ma.

Please get in touch if you wish to participate

Region and Period of Analysis

The **investigation will be focussed on the American mid-west and use observations obtained from the SGP site (36.61 N, 97.49 W).**

The period we have chosen is the warm season of 2011, which at its start featured a major ARM field campaign: the Midlatitude Continental Convective Cloud Exeperiment (**MC3E, 22 April to 6 June 2011**).

Please get in touch if you wish to participate

Model Output Requested (this is open to discussion)

Hourly, 2d fields for the region of the MC3E experiment (roughly 400 km x 400 km, centred on SGP site).

- Surface SW (diffuse & direct)
- Surface LW
- TOA (SW, LW)
- WVP, LWP, IWP
- Sfc sensible heat flx, sfc latent heat flx, soil moisture

Hourly, 2d fields for continental US (to put ARM-SGP site into context).

- MSLP (hPa)
- sfc precip (mm/hr)
- 2m temperature

15-minute (or every timestep, if timestep>15 mins) frequency single-column output for the SGP site of:

- Temperature, specific humidity, pressure
- LWC, IWC, cloud fraction (separate liq & ice if appropriate)

Anything else?

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Model Participation

So far we have heard expressions of interest from groups running:

- Unified Model/HadGEM
- CAM
- NASA-GISS
- ECMWF? ECHAM?

Model/Gridlength	250-200km	200-75km	75-25km	25-10km	< 10 km
NASA-GISS	2.5 deg	1 deg (maybe)			
CAM		1 deg		12 km	
MetOffice		N96(140km)	N216(60km)	12 km	4 & 1 km

We are keen for this project to be an opportunity to bring model people and observations people together.

Anyone else?

Please get in touch if you wish to participate