GASS GEWEX WCRP Global Atmospheric System Studies

GASS: report to WGNE

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

November 2012

The 1st Pan-GASS meeting:

Observing, modelling and representing atmospheric processes in weather and climate models

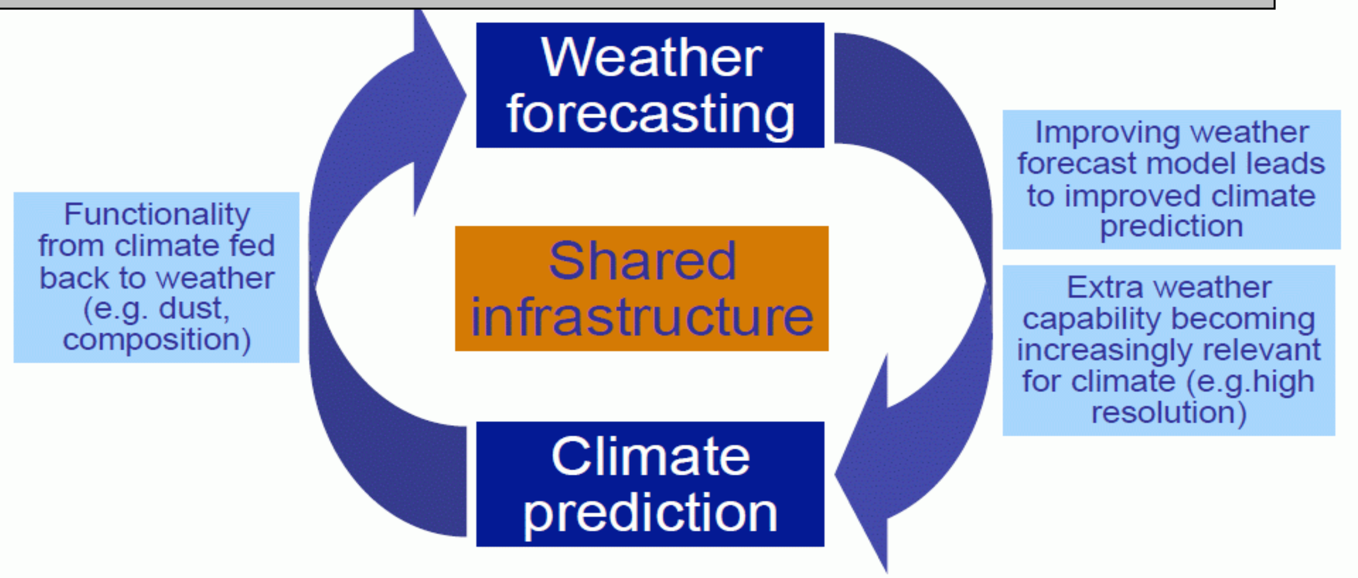
•60K of support in total from: WCRP; NASA; NOAA
•GEWEX IPO hosted a web site and the talks
•Most critical support was from NCAR for the Centre Green facilities and organisational support

220 participants with a focus on:

- •Land-atmosphere interactions (with GLASS)
- •Tropical processes and dynamics (with MJO task force)
- •Radiation processes included for first time (CIRC presentation; Bill Collins on radiation in climate models; discussions of radiation projects)
- •Panel discussion on observations to support model development
- •Seamless prediction – weather and climate

Past (pan-GCSS meetings)

Year	Location
1998	Reading
2002	Kananaskis
2005	Athens
2008	Toulouse



Accomplishments

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

Resourcing the archiving of past projects

- Past cases were archived on an ad-hoc basis by working group leads but 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 be quite a bit of work to organise this
  - Contact past project leads
  - Gather data/papers/instructions
  - Make a common format where possible

How do we resource such an activity – GEWEX SSG suggested we needed a grant proposal for this? Any wise words from WGNE?

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Current activities

Proposed and active projects
Stable boundary layers: Antarctic case
The diagnosis of cloud and radiation processes in models
Weak temperature gradient
Grey-zone project [separate talk]
Microphysics modelling (KiD)
LoCo/SGP Testbed (GLASS project)
Marine Boundary Layer Cloud Feedbacks (CGILS)
Land-Atmosphere Interactions (GLASS/GABLS joint project) [MB]
Radiative Processes in Observations and Models
Cirrus
Tropical Convection observed during CINDY/DYNAMO
Polar Clouds (ISDAC)
Stratocumulus-to-trade cumulus transition
Vertical structure and diabatic heating of the MJO

Mature/completing projects	
GABLS3	Boundary layer processes
ISDAC	Polar clouds
SHEBA	Polar clouds
TWP-ICE	Deep convection

Radiation in GASS

- First steps with Lazaros Oreopoulos and Robert Pincus on the SSC
- Bill Collins invited talk and CIRC talk at pan-GASS
- Dialog between several Project leads and Lazaros/Robert about radiation evaluation within their projects
  - CIRC cases related to ongoing GASS projects (GABLS)
- Potential cloud and radiation project perhaps focused around the summer warm bias over US
- Ideas about a Cirrus radiation component
- Radiative impacts of precipitating particles in GCMs

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Global Atmospheric System Studies

GLASS/GASS joint project on atmosphere-land interaction

Land-atmosphere Interactions project

Joint GASS-GLASS activity

- New project initiated at pan-GASS 2012
- Will be led by Adrian Lock and Martin Best at the Met Office, UK
- Joint activity between GASS (atmospheric boundary layer modellers) and GLASS (land surface modellers)
- Aim to release the case by end of 2012 with workshop in 2013 to be arranged

Covered by Martin

Project science

Covered by Martin...

- Use CASES-99 observations from SGP site (very similar conditions to previous PBL intercomparison, “GABLS 2”)
  - for 3 complete days with varying nocturnal stability, but all clear sky
- Basic idea
  1. Run stand-alone land surface forced by observed near-surface parameters
     - Including a ~2 year spin-up period to generate initial soil profiles
  2. Run stand-alone atmospheric SCM forced by observed surface fluxes and stresses and large-scale forcing, from an initial observed profile
  3. Run coupled atmospheric SCM and land surface
- Questions:
  - What are the systematic biases in the land and atmosphere models when forced by the surface observations?
  - What is the impact of coupling the two models together?
- Additionally this activity will bring land and boundary layer modelling communities together
- Future extensions can include daytime formation of shallow cumulus

GASS GEWEX WCRP Global Atmospheric System Studies

Vertical Structure and Diabatic Processes of the MJO: Global Model Evaluation Project

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).

Covered by Duane

	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

- Model data submitted during 2012, Preliminary analysis of MJO representation presented at Pan-GASS meeting, September 2012
  - Range of behaviours across models in all components
  - Good hindcasts does not imply good climate MJO
  - No clear relationships between MJO skill and initial diagnostics based on mean state or precipitation characteristics at this stage
  - Next step of analysis will focus on the diabatic processes

Covered by Duane

- Timeline going forward
  - Dec 2012 : Deadline for submission of data for inclusion in papers
  - Apr 2013 : Workshop (possibly attached to WGNE systematic errors meeting)
  - Jun 2013 : Draft of papers on each component & release of data
  - Sep 2013 : Submission of papers on each component
  - Fall 2013 : Summary paper and recommendation for high priority process studies

Climate simulations (1)

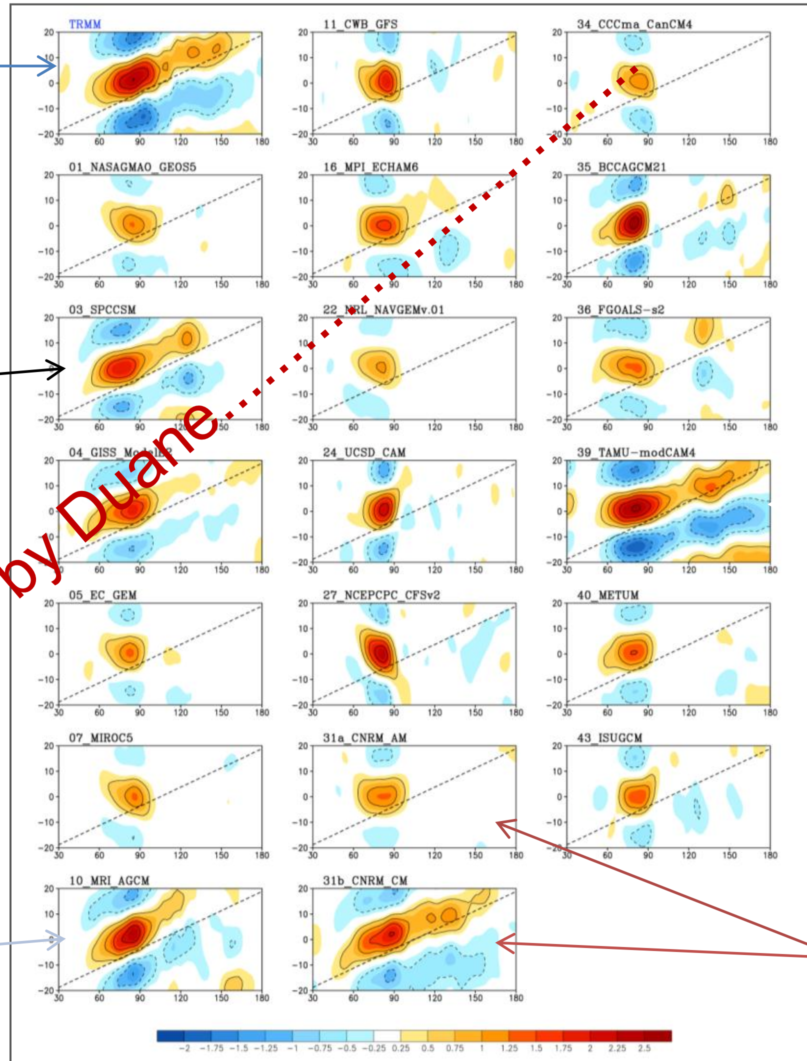
Xianan Jiang

Lag-regression of rainfall (20-90day filtered) with Indian Ocean (70-90E; 5S-5N) base point

Observations

Super-parametrization

MRI-AGCM



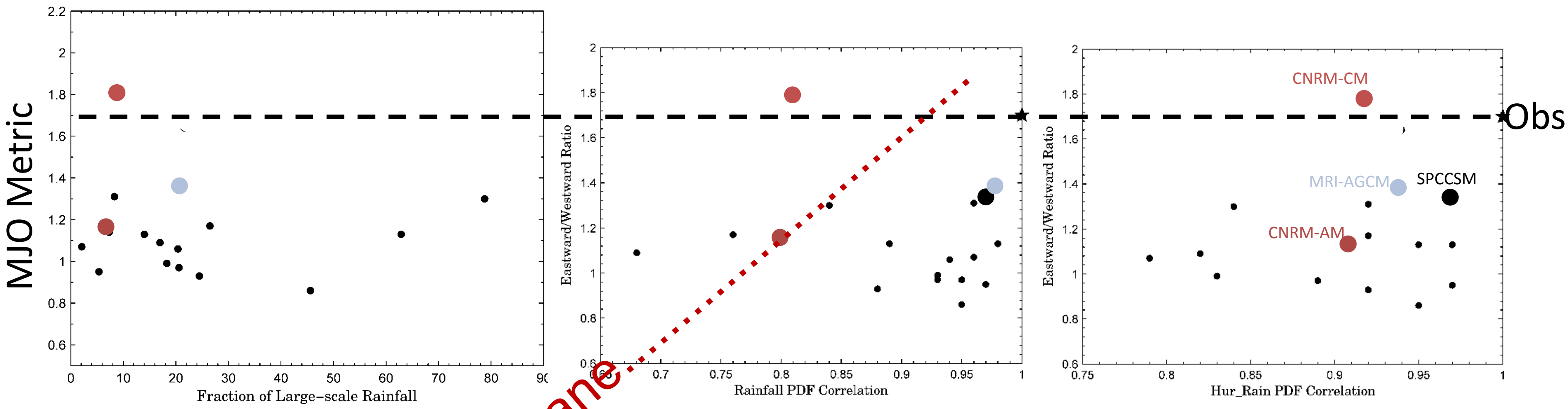
Covered by Duane…

Uncoupled and coupled version of same model

dash line – 5 m/s

Climate Simulations (2)

Xianan Jiang



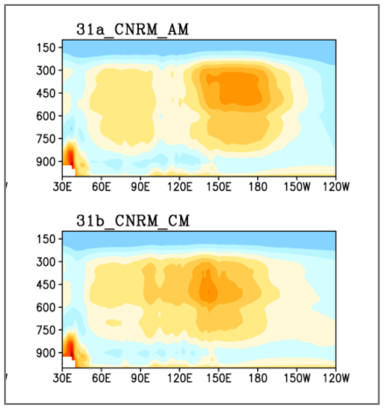
Metrics related to rainfall characteristics

- Large-scale rain fraction
- Rainfall Intensity PDF
- Rainfall-Humidity Relationship

are unable to discriminate between good and bad MJOs, in particular coupled and uncoupled CNRM cannot be separated

NB: Mean LH profiles (right) do show different longitudinal differences for coupled and uncoupled CNRM, is it coupling or basic state

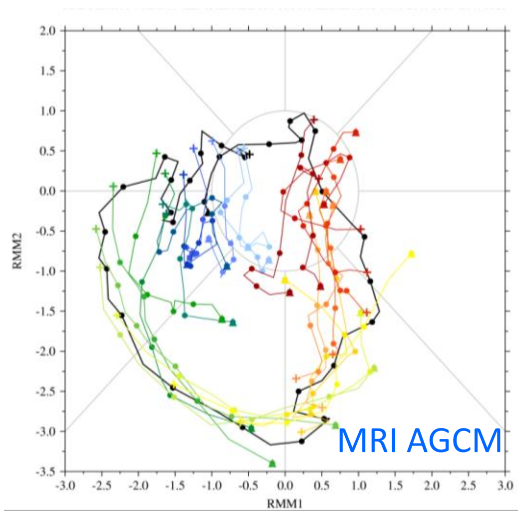
Uncoupled

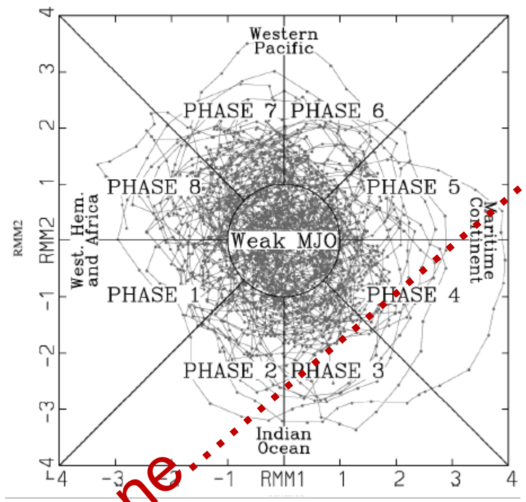


Coupled

20-day hindcasts (1)

Nick Klingaman

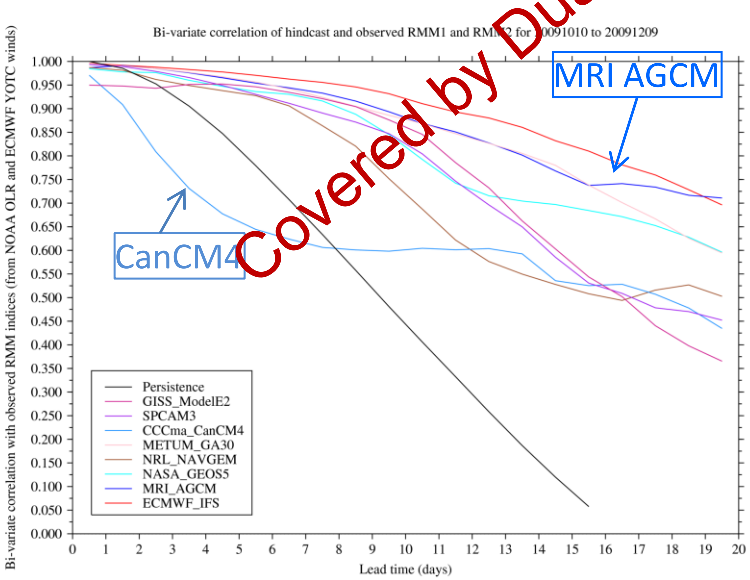


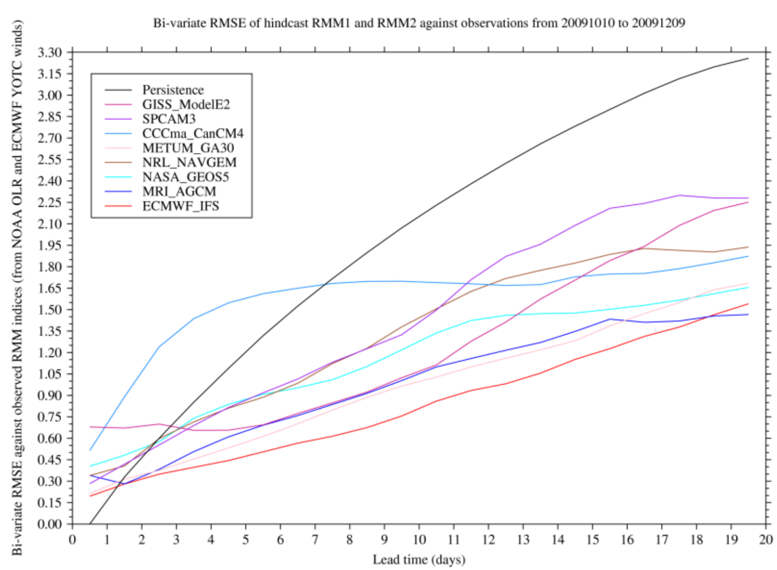


(left) Evolution of forecasts for two models in Wheeler-Hendon Phase Space each coloured line shows a forecast from a different start date

The forecast skill can be quantified in terms of bi-variate correlations (bottom left) or RMSE (bottom right)

Covered by Duane





20-day hindcasts (2)

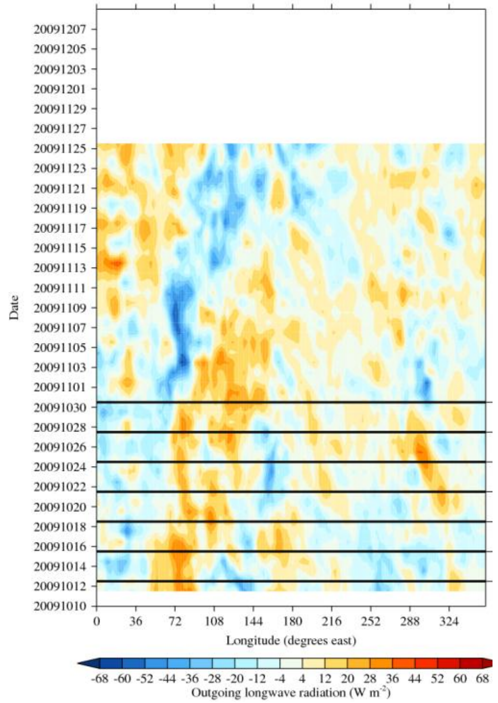
Nick Klingaman

Lead time animations of

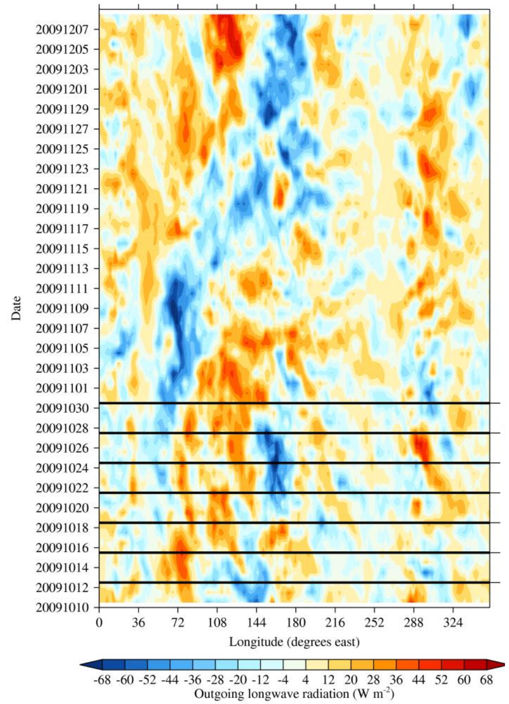
Daily-mean anomalies of OLR (10° S-10° N mean) from the daily climatology of the 20-year integrations

Loss of large-scale organization indicates drift to model climate

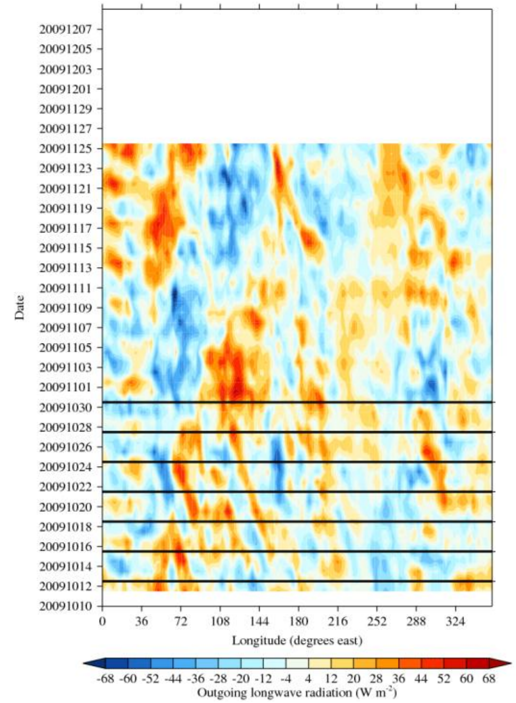
MRI AGCM



NOAA CIRES Obs

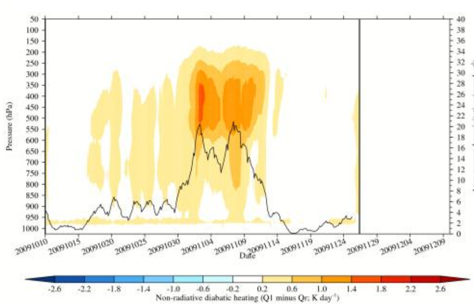


CCCma CANCM4

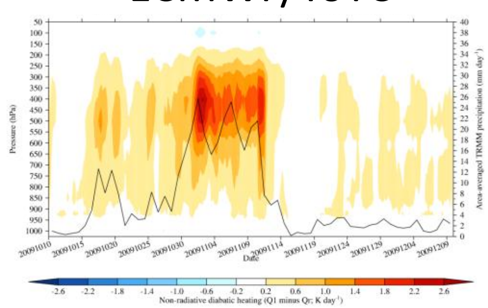


Non-radiative diabatic heating (5° S-5° N , 70° -80° E)

MRI AGCM



ECMWF/YoTC



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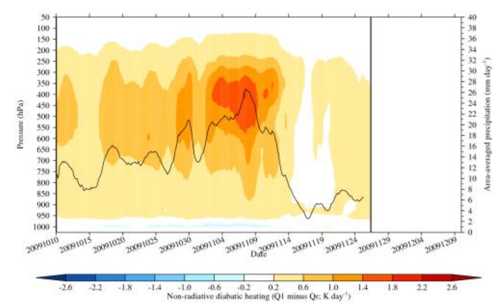
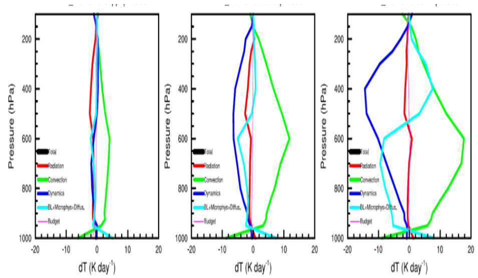
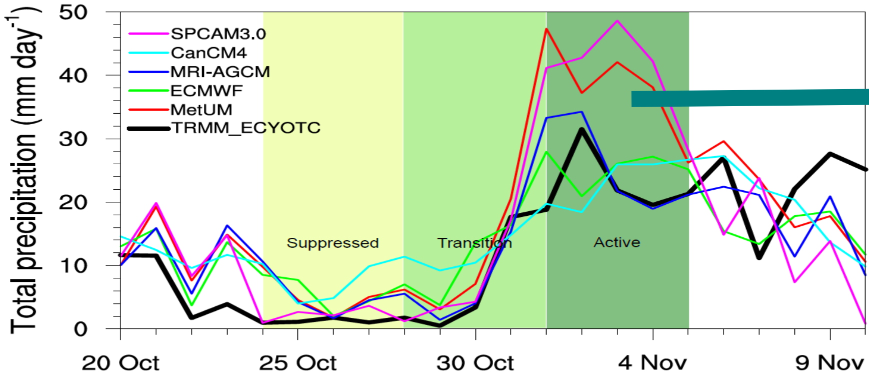


2-day hindcasts(1)

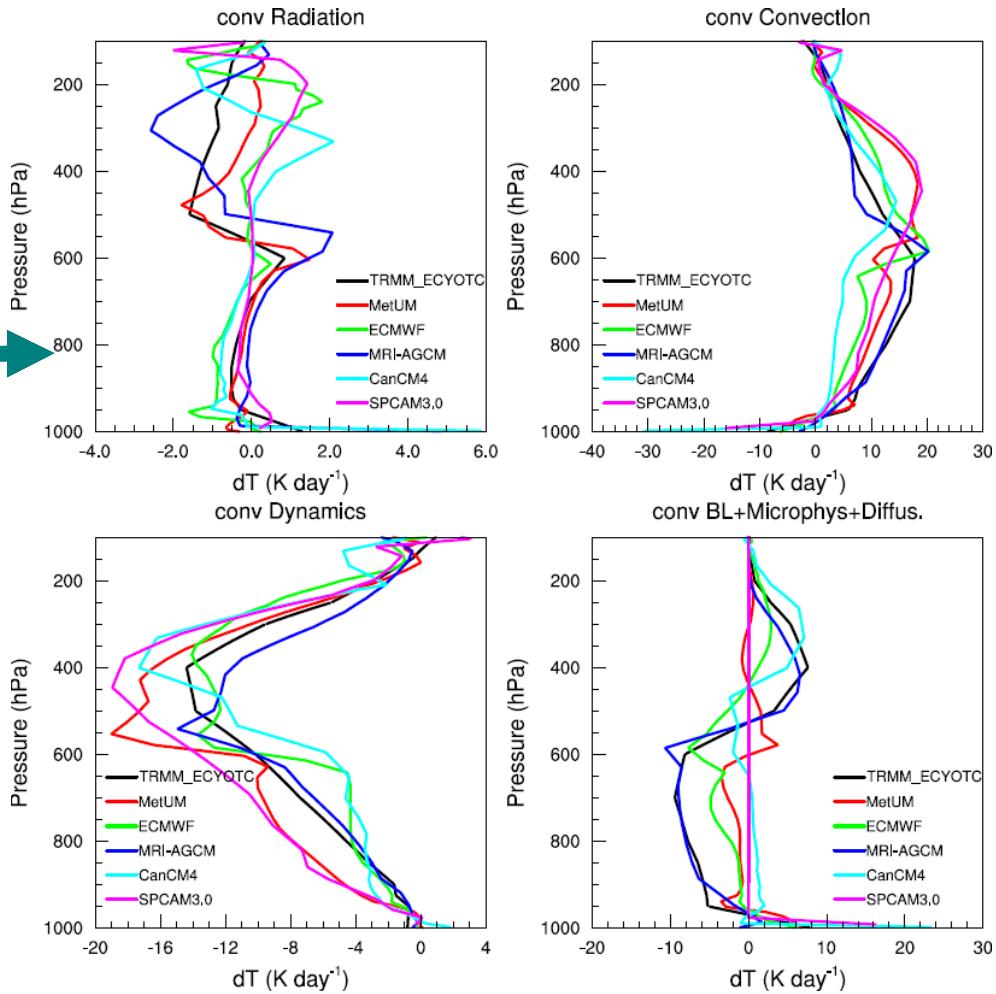
Prince Xavier





Total 12-36hour precipitation averaged over (75-80E,0-5N)

- All models show some kind of transition from suppressed to active convection
- CanCM4 has overactive suppressed phase
- SPCAM and Met UM have overactive active phase
- SPCAM is most strongly suppressed

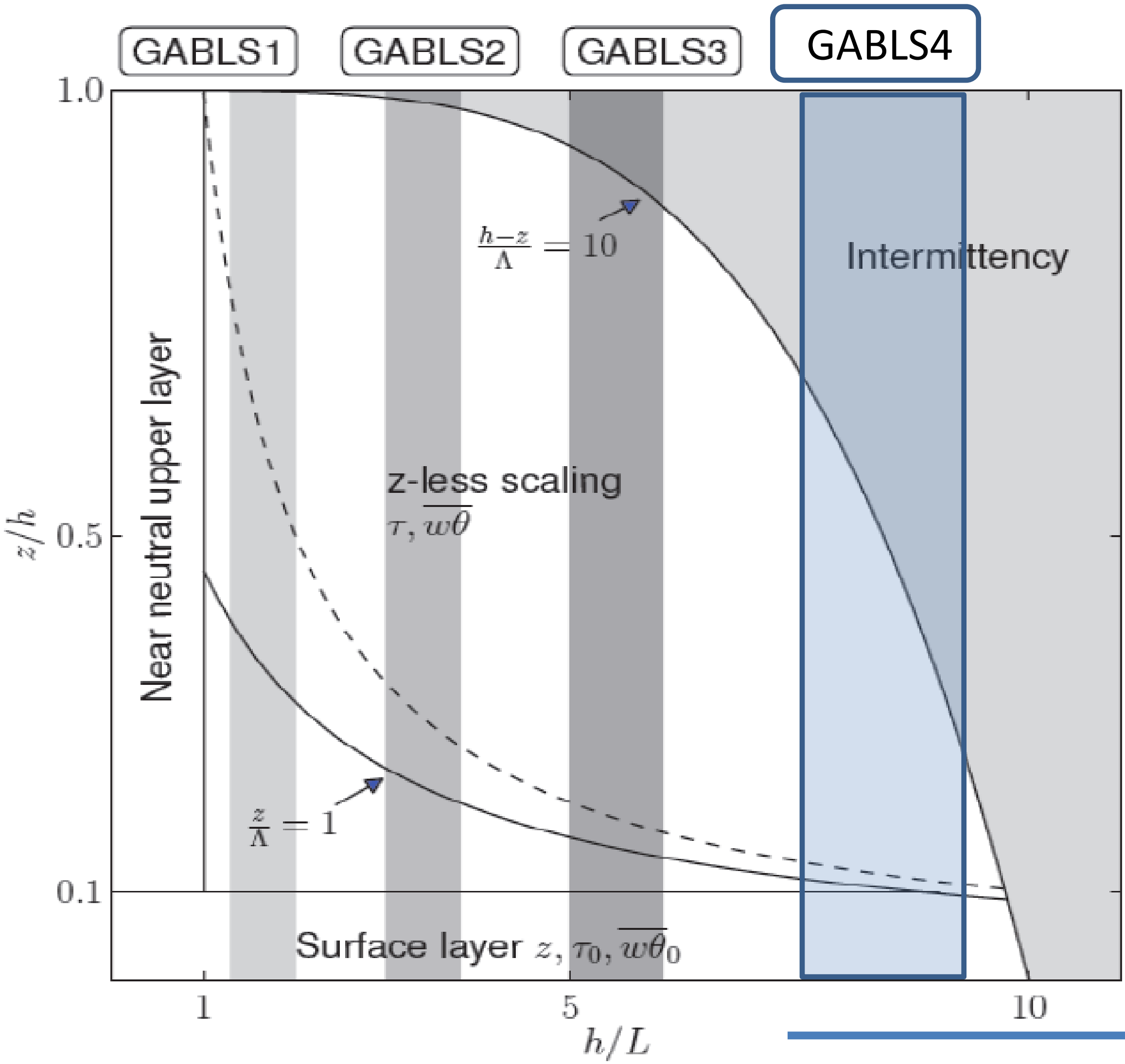


GASS Atmospheric Boundary Layer Study

GABLS Antarctic case

Timo Vihma, Bert Holtslag and Gunilla Svensson

GABLS4 – Antarctic case



Based on recommendations from the ECMWF/GABLS workshop in Nov 2011, a case based on Antarctic data is being prepared

Increasing stability

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

GABLS4

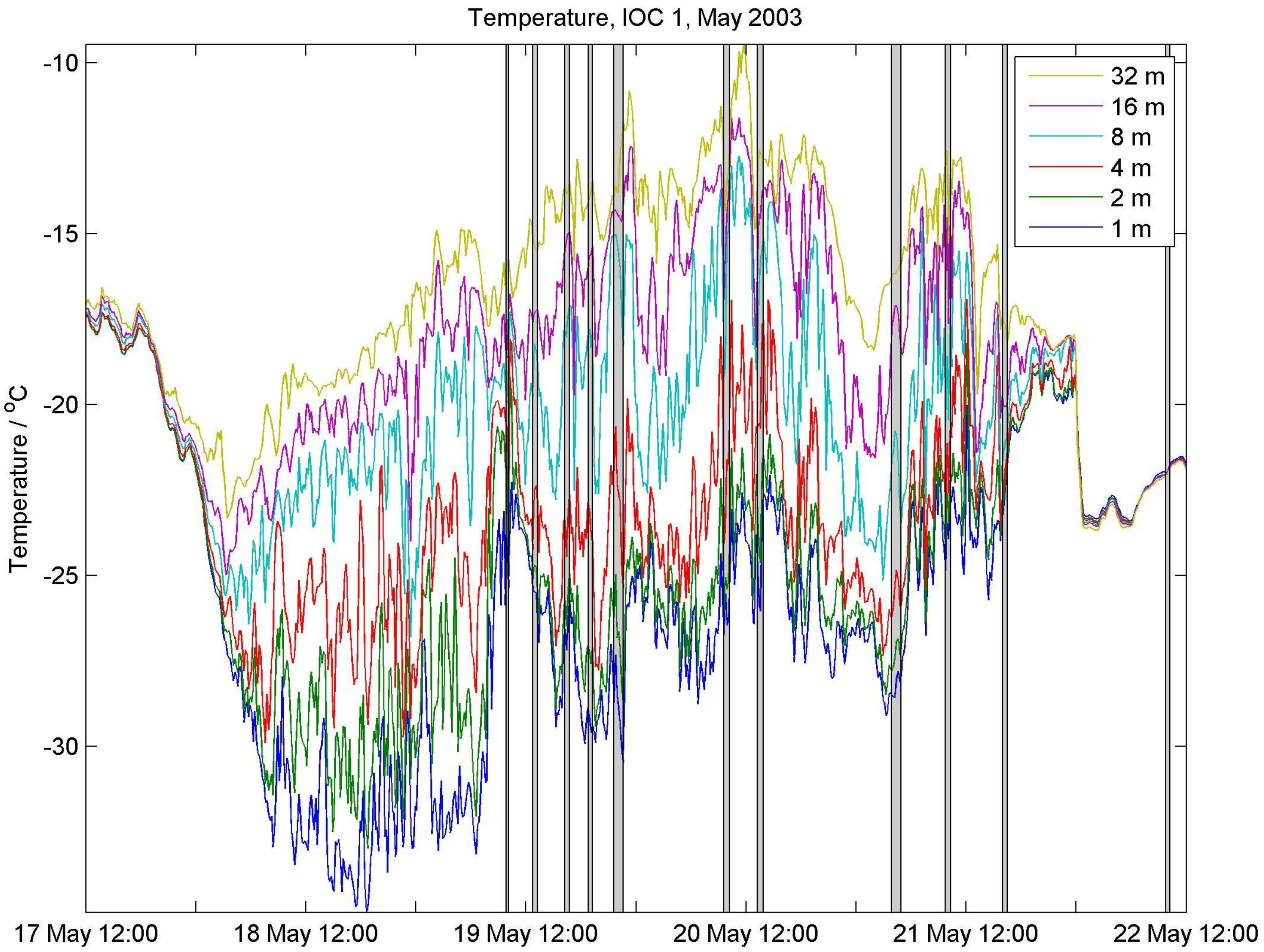
“to increase the further understanding, evaluate the performance of numerical models in very stable conditions and contribute to the development of parameterization schemes”

In this study we explore the set-up of a case over the Brunt Ice Shelf, Antarctica, where the British Antarctic Survey carries out measurements at the Halley station

Halley station

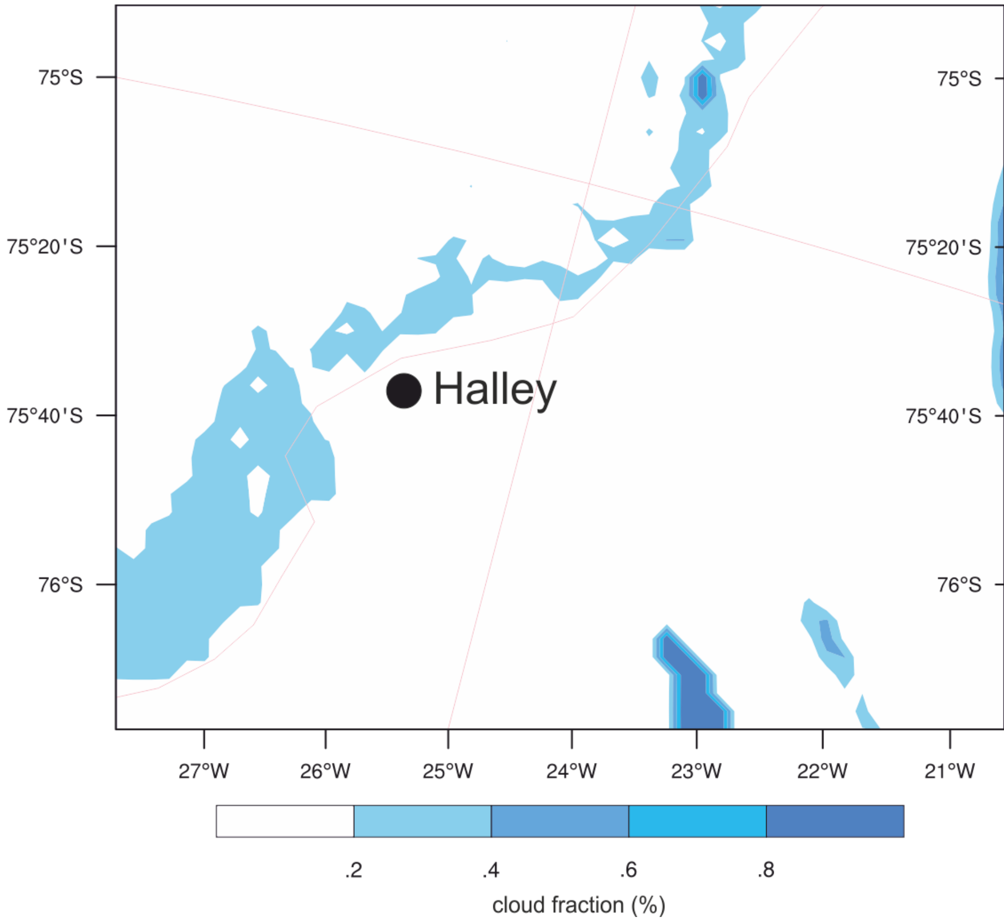
75° 35'S, 26° 34'W, since 1956

Observed temperatures in the tower during early winter

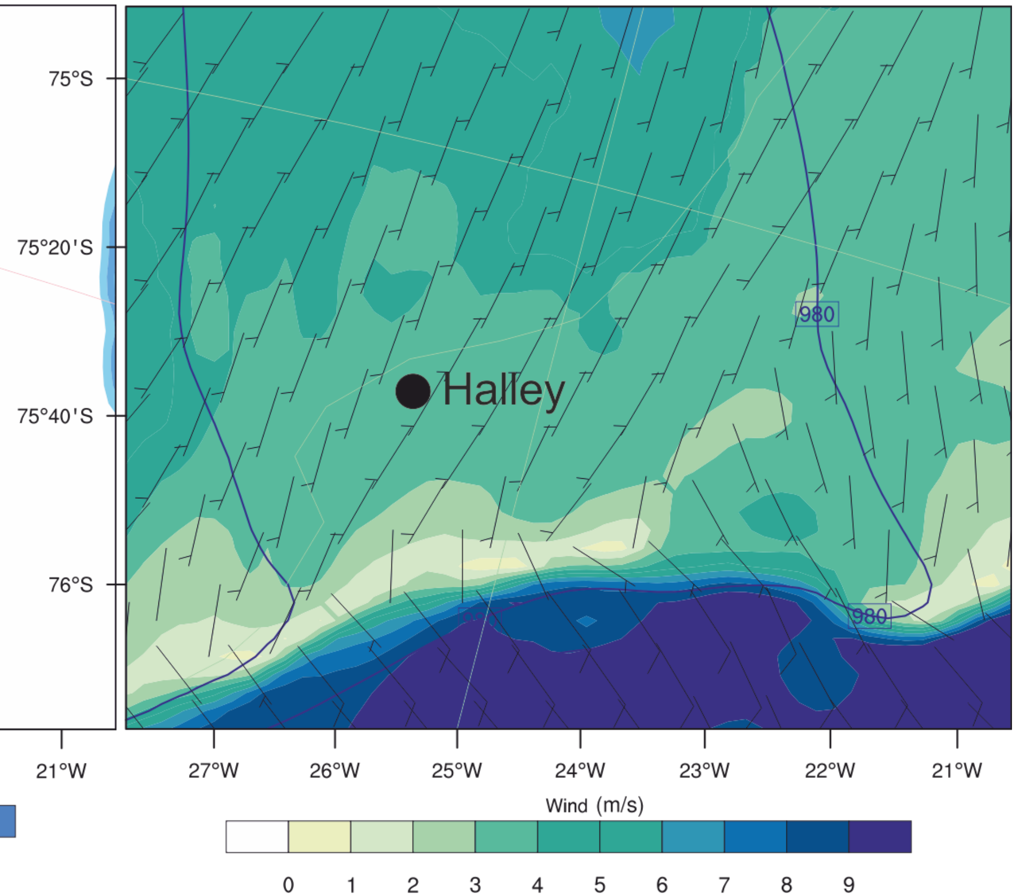


Preliminary Polar WRF results

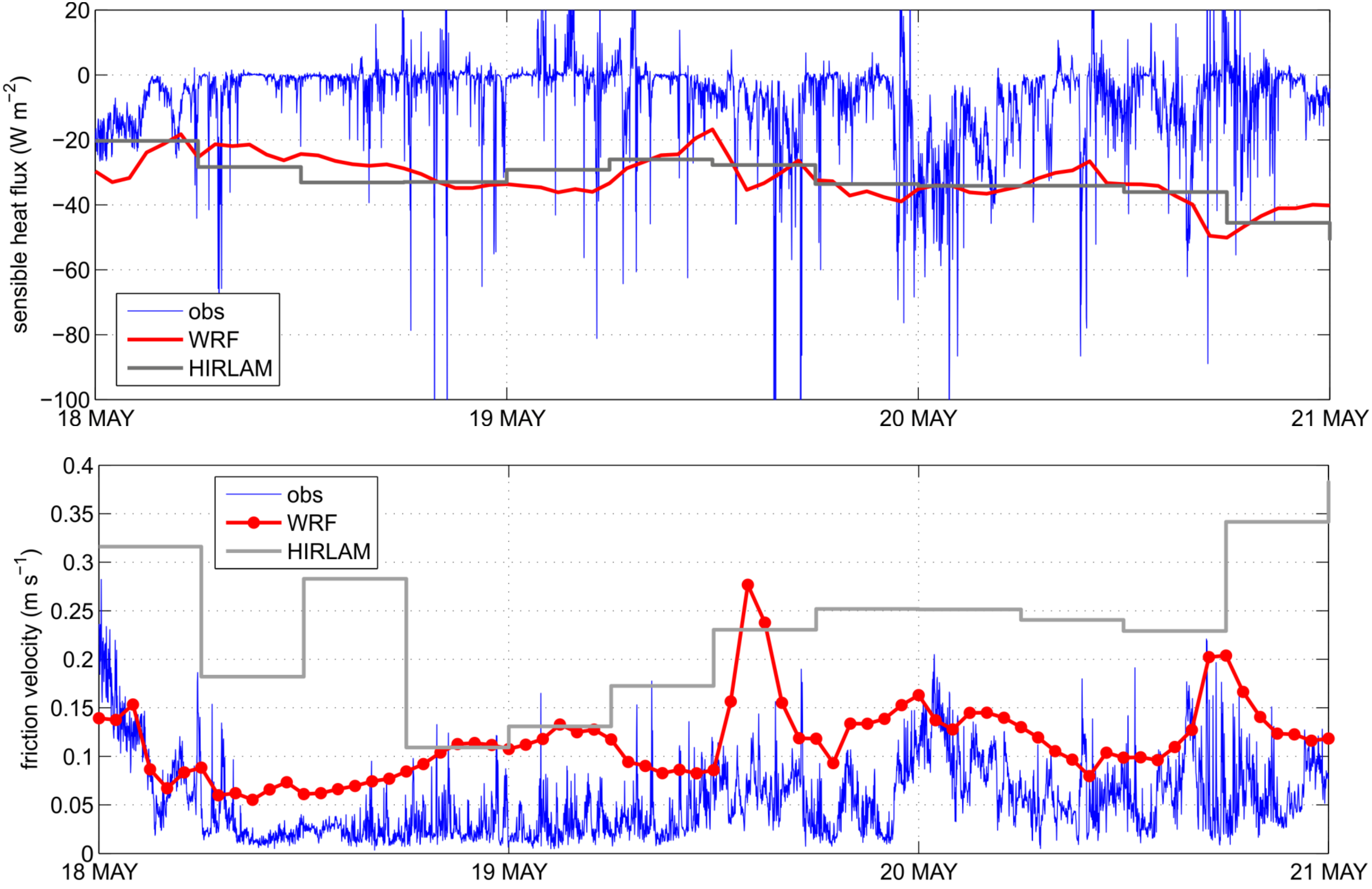
Cloud fraction



Wind and sea level pressure



Preliminary results: Observations and regional models (WRF HIRLAM)



Preliminary plan

Continue 3D model experiments for the Halley 2003 case:

- detailed analyses on the vertical profiles of heat and momentum advection

- the study period should start already on 17 May 12 UTC to also include hours with larger fluxes, which allow to study the evolution towards very stable stratification

Possibly include in GABLS4 both the Halley 2003 case and a summer case from Dome C, where the environment is homogeneous over larger spatial scales

Suggested additional intercomparison of single column models:

- coupled atmosphere – snow experiments
- atmosphere only, with (a) prescribed Ts or (b) prescribed conductive heat flux from snow
- possibly: snow only, with (a) prescribed Ts or (b) prescribed longwave radiaton, Ta, RH, and U

Summary

- GASS remains a very active group with 220 attending Pan-GASS
- More than 10 active projects
  - Tackling all timescales – weather through to climate
  - Isolating processes in great detail
  - Working with observations
  - **Truly supporting model development – not just evaluation**
- Radiation activities are growing through new links with the CIRC community
- Continued relationship with WGCM though cloud-feedback project and the new WTG project.
- Actively working on a WCRP GC with WGCM...

The end

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.

WGNE

Working Group for Numerical Experimentation

GEWEX

Global and regional Energy and Water Exchange

GASS

Co-chairs: Jon Petch & Steve Klein

Science Steering Committee: Chris Bretherton, Ann Fridlind, Christian Jakob, Adrian Lock, Hugh Morrison, Robert Pincus, Lazaros Oreopoulos; Pier Siebesma, Gunilla Svensson, Steve Woolnough

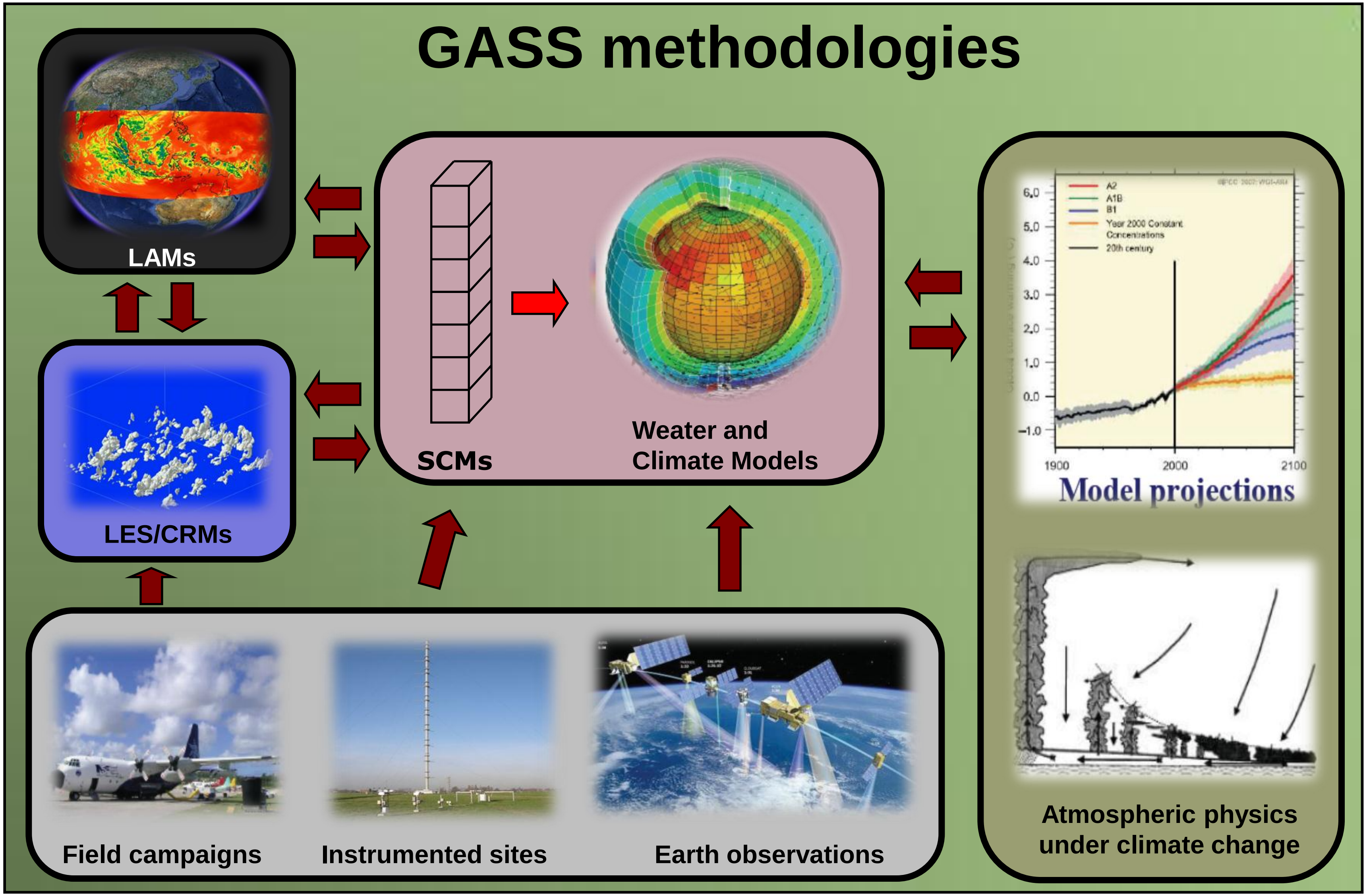
Cross Cutting Projects

e.g. MJO-TF/YOTC, EUCLIPSE, SPARC, WMO cloud modelling...

GASS Projects

Working with many model types

bringing together observations, modelling and understanding in intercomparison projects



GASS GEWEX WCRP Global Atmospheric System Studies

Looking forward

- Pushing the boundaries of numerical studies to tackle scale interactions (large domains, high resolutions, key physics & aerosols)
- Utilizing and helping focus global and regional observations to support model development
- Promoting and supporting those with careers in developing weather and climate models

WTG

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 difference 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 simulations of convection with a 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
  - Parametrization parameters (i.e. strength of circulation coupling to convection)
  - Treatment of moisture advection

Timeline

Sep 12: Initial discussion at Pan-GASS meeting

Dec 12: Draft project specification

Jan-Mar 13: Test run of project, invite participants

Mar 13: Finalize project specification

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

Further details (1)

Parametrization Approaches

- Weak Temperature Gradient
  - as in Sobel and Bretherton (2000), PBL treated separately with fixed PBL top
  - as in Raymond and Zeng (2006), PBL not treated separately WTG tendencies modulated by vertical profile of timescale
- Weak Pressure Gradient/ Wave methods (note that although formulation different may not be materially different)
  - as in Kuang (2011)
  - as in Romps (2012)

Sensitivity Experiments

- Moisture advection
  - none, relaxation using WTG divergent velocity, relaxation with fixed time scale. Reference profile from RCE?
- Parameters
  - WTG relaxation time (zero for SCMs as one case?), wave number & momentum dissipation in wave method, PBL top/vertical profile in WTG

Further details (2)

Convection Experiments (CRMs and SCMs)

- RCE
  - Specify SST, surface wind speed, radiative cooling profile or necessary radiative parameters (insolation, CO2, ozone etc.)
  - Possible extension to a set of different RCE states
- Sensitivity to SST under coupling to large-scale circulation
  - Holding reference profiles fixed change SST/surface wind
  - Examine sensitivity to parameter choices in large-scale circulation
- Sensitivity to initial conditions under coupling to large-scale circulation
  - Use "dry" and "wet" initial conditions for a range of SSTs to look for multiple equilibria

Analysis

- Compare behaviour across models
  - Are the results sensitive to choice of parametrization approach within a given SCM/CRM?
  - Are the results sensitive to the choice of CRM/SCM within a given parametrization approach?
  - Is there a systematic difference between the behaviour of CRMs/SCMs within this framework or is the range of behaviour across SCMs different to that in CRMs?

GASS GEWEX WCRP

Global Atmospheric System Studies

MJO briefer – set 2…

Vertical Structure and Diabatic Processes of the MJO: *Global Model Evaluation Project*

MJO Task Force and GEWEX GASS

Organizers
Jon Petch & Prince Xavier --- Met Office*
Duane Waliser & Xianan Jiang --- JPL/UCLA*
Steve Woolnough & Nick Klingaman --- U. Reading*

** Leading Analyses*

WCRP World Climate Research Programme | MJO TF | THORPEX A World Weather Research Programme
WWRP | GASS | GEWEX Atmospheric System Studies | YOTC

October 2012

Vertical Structure and Diabatic Processes of the MJO: *Global Model Evaluation Project*

MJO Task Force/YOTC and GASS

WCRP World Climate Research Programme · MJO TF · THORPEX A World Weather Research Programme · WWRP · GASS · GEWEX Global Atmospheric System Studies · YOTC

www.ucar.edu/yotc/mjodiab.html

Model Experiment	Science Focus	Exp. POC
I. **20 Yr Climatological Simulations** (1991-2010 if AGCM) 6-hr, Global Output Vertical Structure, Physical Tendencies	Model MJO Fidelity Vertical structure Multi-scale Interactions: (e.g., TCs, Monsoon, ENSO)	**UCLA/JPL** X. Jiang D. Waliser
II. **2-Day MJO Hindcasts** YOTC MJO Cases E & F (winter 2009)* Time Step, Indo-Pacific Domain Output Very Detailed Physical/Model Processes	Heat and moisture budgets Model Physics Evaluation (e.g. Convection/Cloud/BL) *Short range Degradation*	**Met Office** P. Xavier J. Petch
III. **20-Day MJO Hindcasts** YOTC MJO Cases E & F (winter 2009)* 3-hr, Global Output Elements of I & II	MJO Forecast Skill State Evolution/Degradation Elements of I & II	**NCAS/Walker in.** N. Klingaman S. Woolnough

*DYNAMO Case TBD

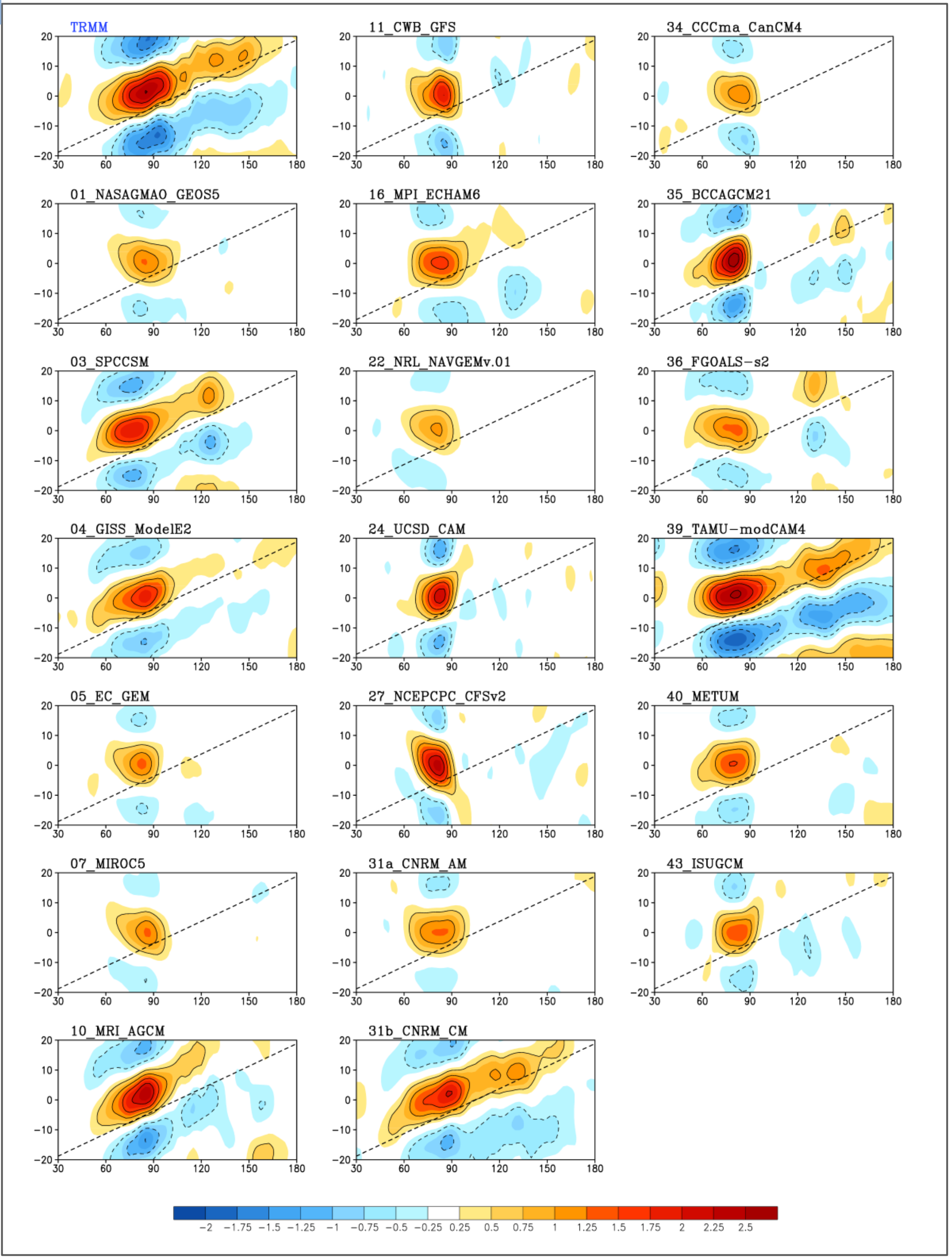
Commitments: Over 40 Modeling Groups with AGCM and/or CGCM

Met Office · JPL · UCLA · National Centre for Atmospheric Science NATURAL ENVIRONMENT RESEARCH COUNCIL

Lag-regression of rainfall with Indian Ocean (70-90E; 5S-5N) base point

20-90day filtered

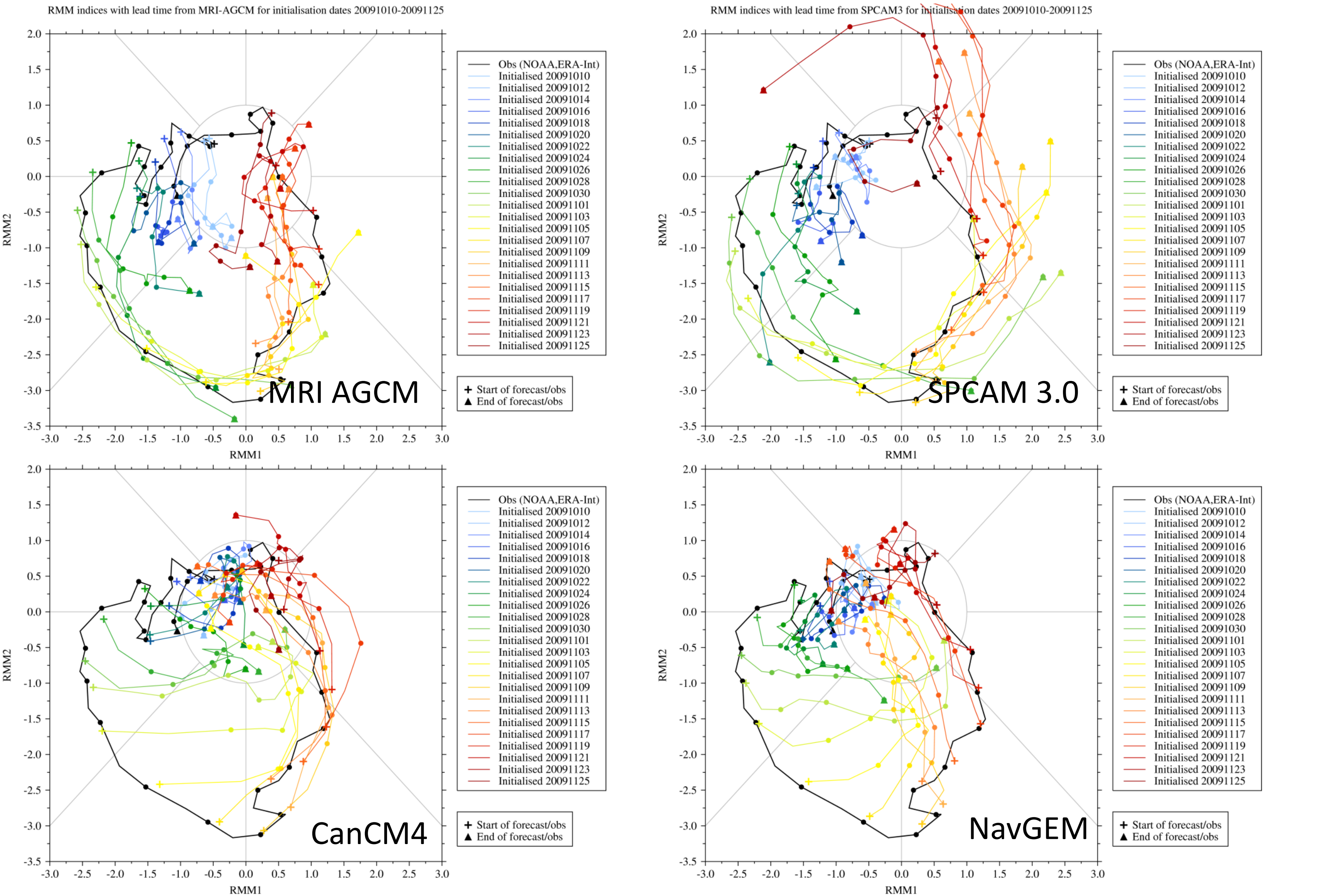
dash line – 5 m/s



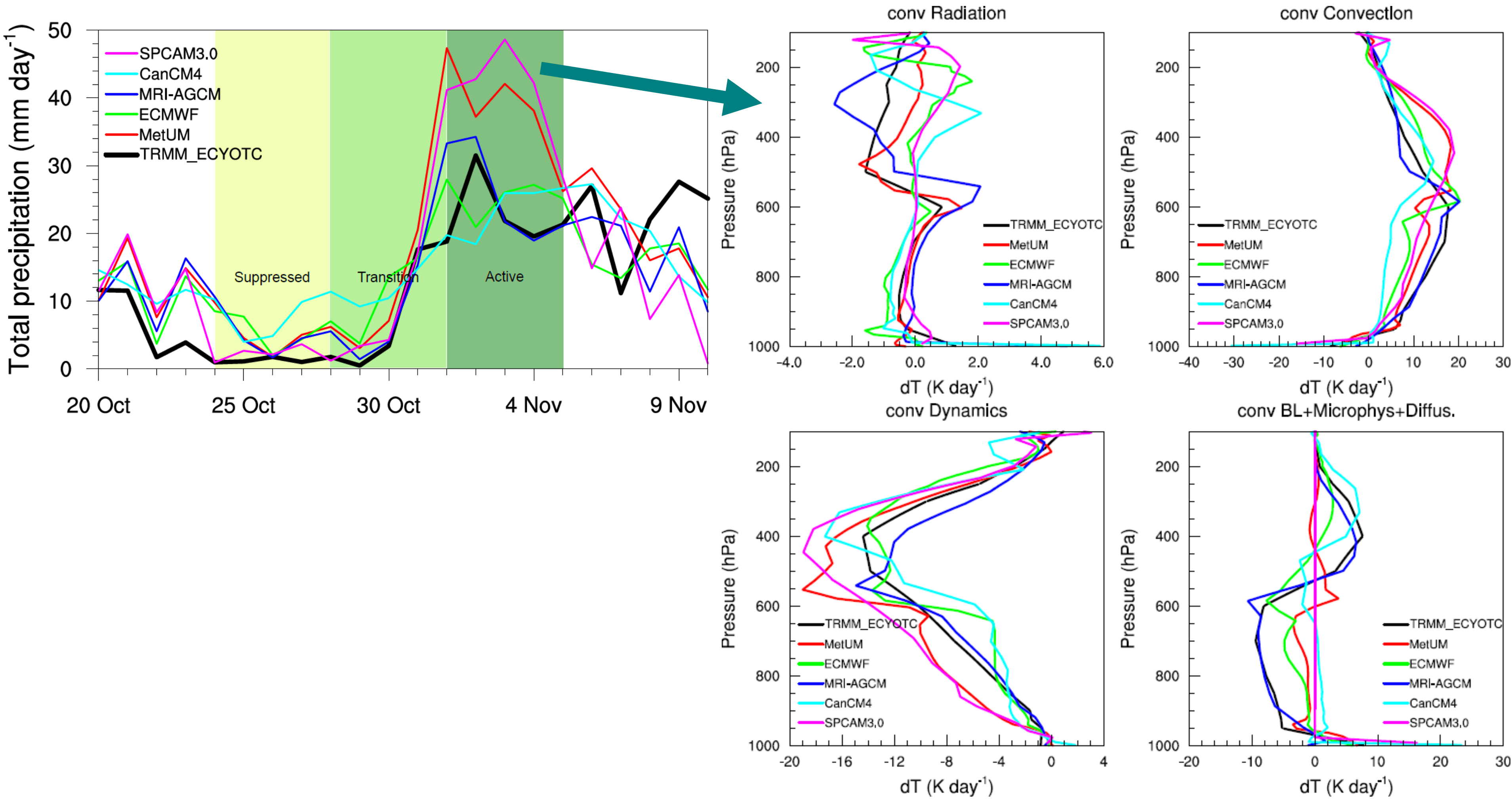
JPL UCLA

RMM indices at constant start date

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL



Precip. and dT during convective phase [75-80E, 0-5N]



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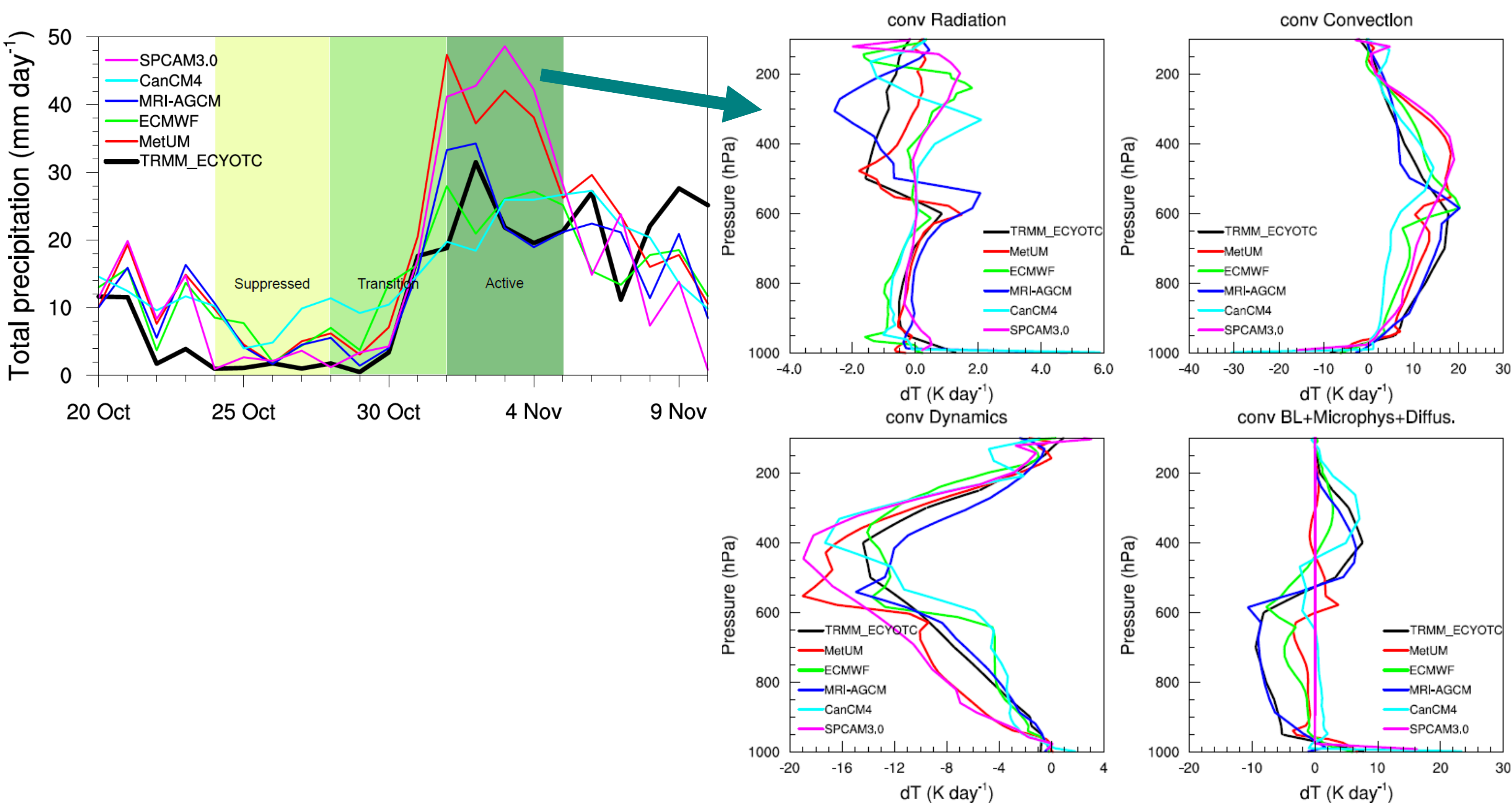
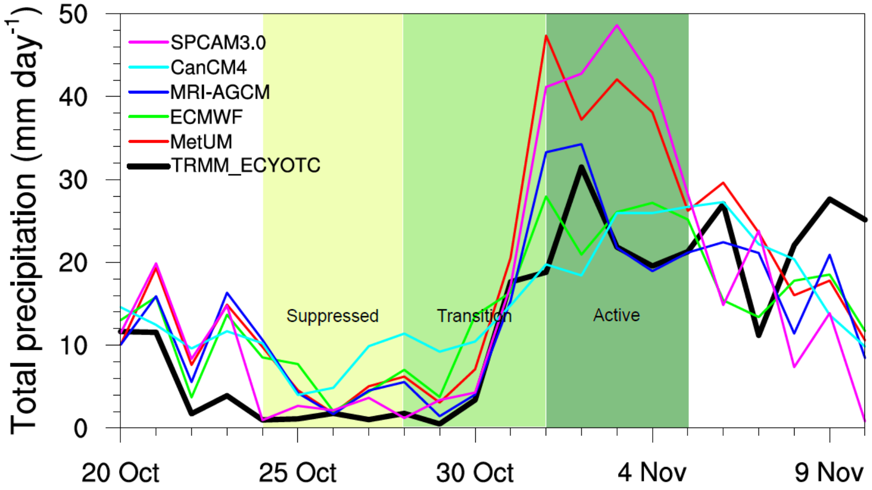


2-day hindcasts

Prince Xavier



Total 12-36hour precipitation averaged over (75-80E,0-5N)

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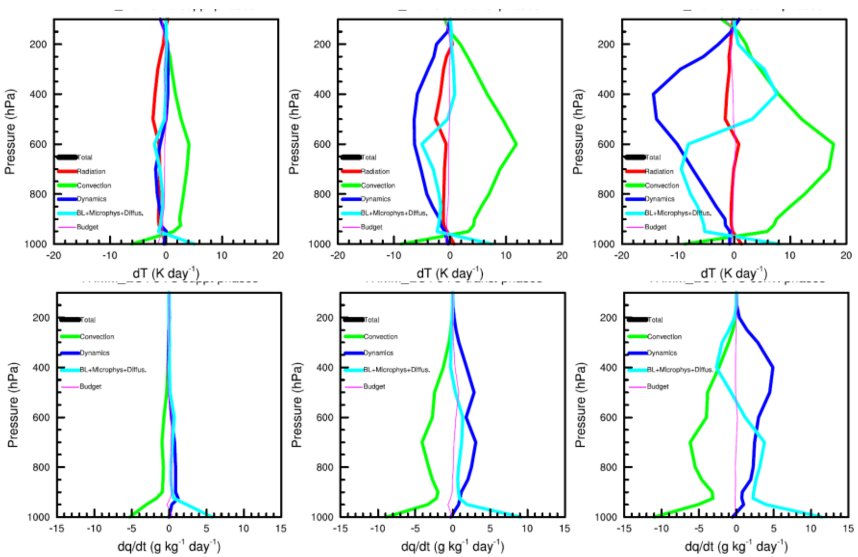
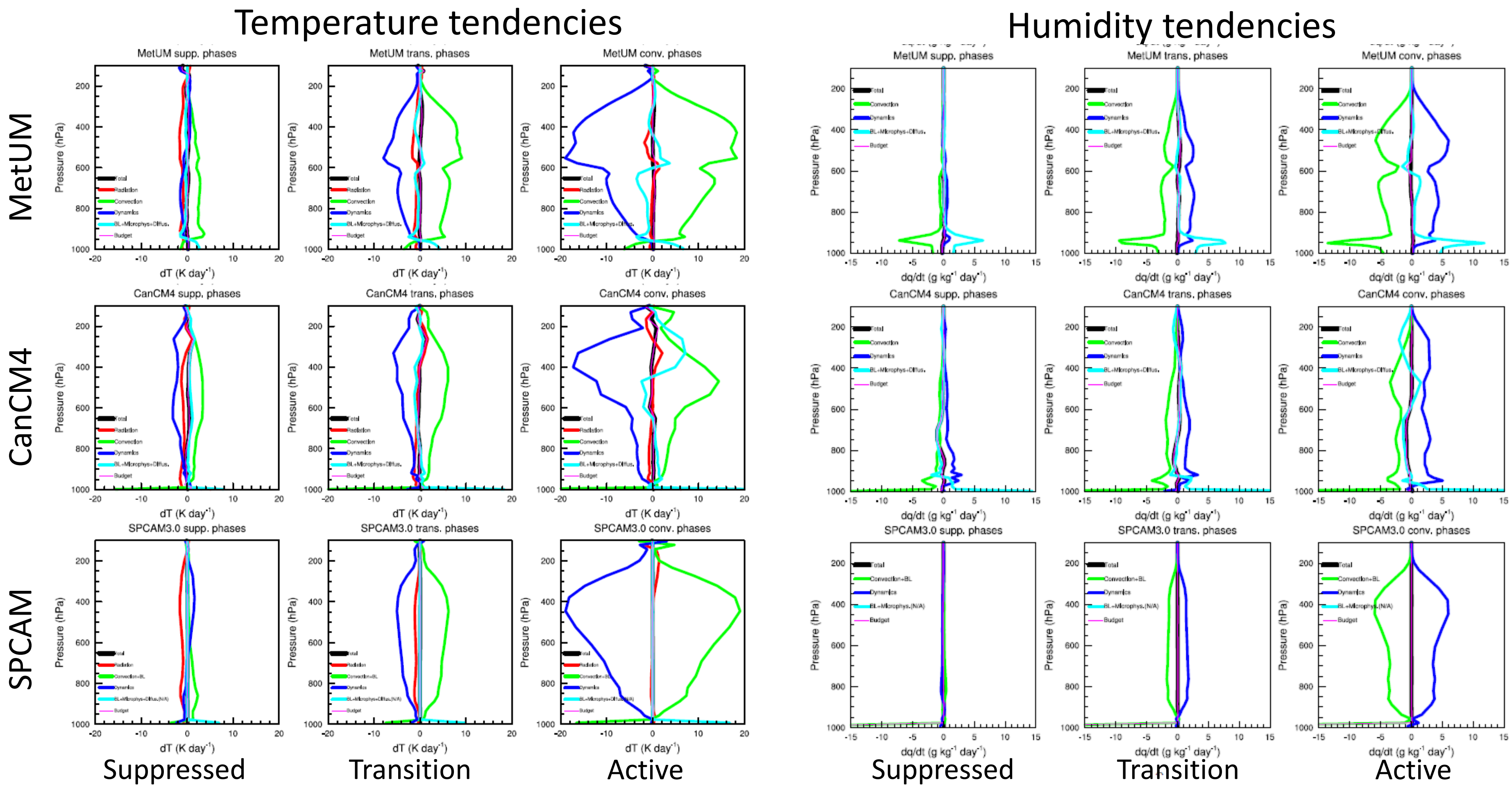


Suppressed Transition Active

Temperature (top) and **specific humidity variations during the three phases in ECMWF/YoTC analysis**

2-day hindcasts(2)

Prince Xavier



Variations between model behaviours including: partitioning between parameterised vs large scale contribution to diabatic heating; behaviour around freezing level; radiative contributions. Future analysis will consider total Q1,Q2 as well as individual models partitioning

ISDAC LES Intercomparison: Overview and preliminary results

Mikhail Ovchinnikov (PNNL)

GASS

Atmospheric System Research (ASR)

8th International Cloud Modeling Workshop 2012

Goal: To quantify the role of **dynamics** (turbulence) and **microphysics** in simulations of a lifecycle of a mixed-phase cloud

A follow-up to the M-PACE and SHEBA intercomparisons:

- Dynamics: Additional diagnostics for vertical velocity, TKE budget terms, buoyancy flux, etc.
- Microphysics: Constrain parameters and rates for ice processes (e.g., size-mass ratio, deposition growth rate, sedimentation, etc.)
- Radiation: Unified parameterized radiation/heating rates calculations

Coordinated activities

Case description released in December 2011
https://engineering.arm.gov/~mikhail/ISDAC_F31.html

Two ASR breakout sessions held in 2011 and 2012

Preliminary results submitted in June 2012 and discussed at the international Cloud Modeling Workshop in Warsaw, Poland in July 2012.

Participation: 8 submissions*

- DHARMA-2M
- WRF-LES
- UCLA-LES
- COSMO
- MetOffice
- RAMS
- SAM-SBM
- DHARMA-bin

DHARMA-2M, WRF-LES, UCLA-LES: Nearly identical microphysics

UCLA-LES, COSMO: First time runs for LES with ice

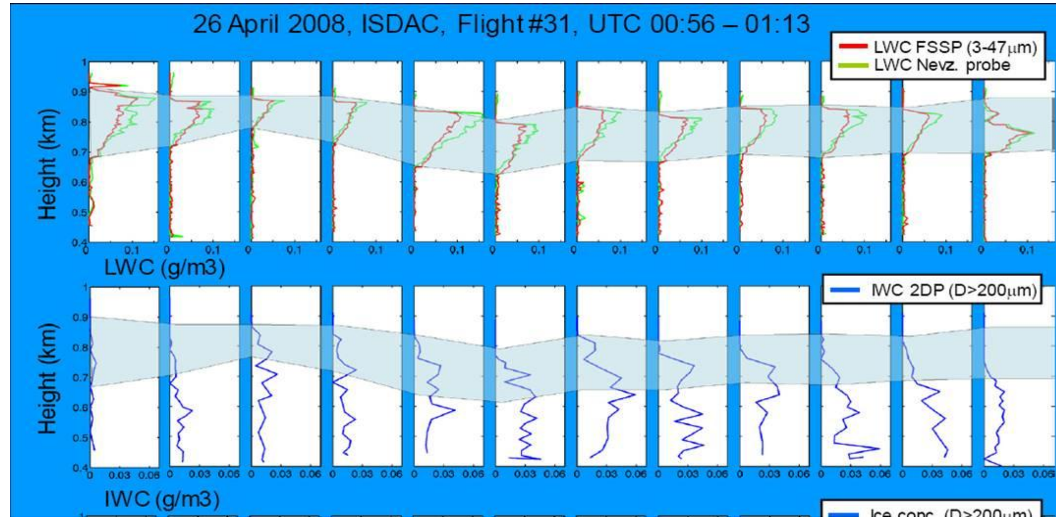
DHARMA-2M, WRF-LES, UCLA-LES, COSMO, MetOffice, RAMS: Bulk 2 moment microphysics

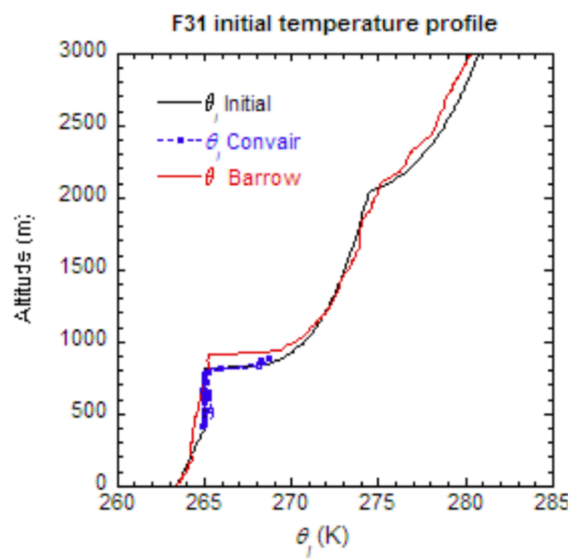
SAM-SBM, DHARMA-bin: Bin (size-resolved) microphysics

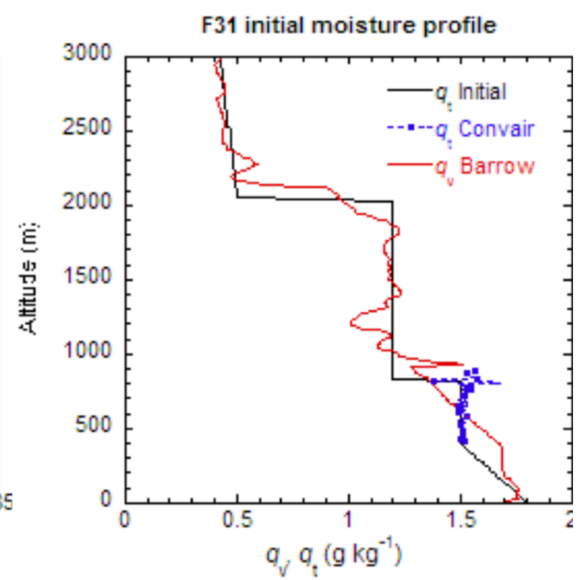
* as of 6 Sept 2012 with two more in progress

ISDAC flight 31 case

- Semi-idealized case based on ISDAC Flight 31.
- Elevated mixed-layer, temperature inversion above and slightly stable & moist layer below.
- Zero surface sensible and latent heat fluxes







Model setup

Large-eddy simulations (LES): 64x64x120+ domain; 50x50x10 m^3 grid size; 8-hr simulations; liquid-only spin-up for dynamics in the first 2 hrs

Constrained ice number concentration*, N_i

3 runs: **ICE0:** N_{i0}= 0 L^{-1}

ICE1: N_{i0}= 1 L^{-1}

ICE4: N_{i0}= 4 L^{-1}

Prescribed/parameterized ice properties for

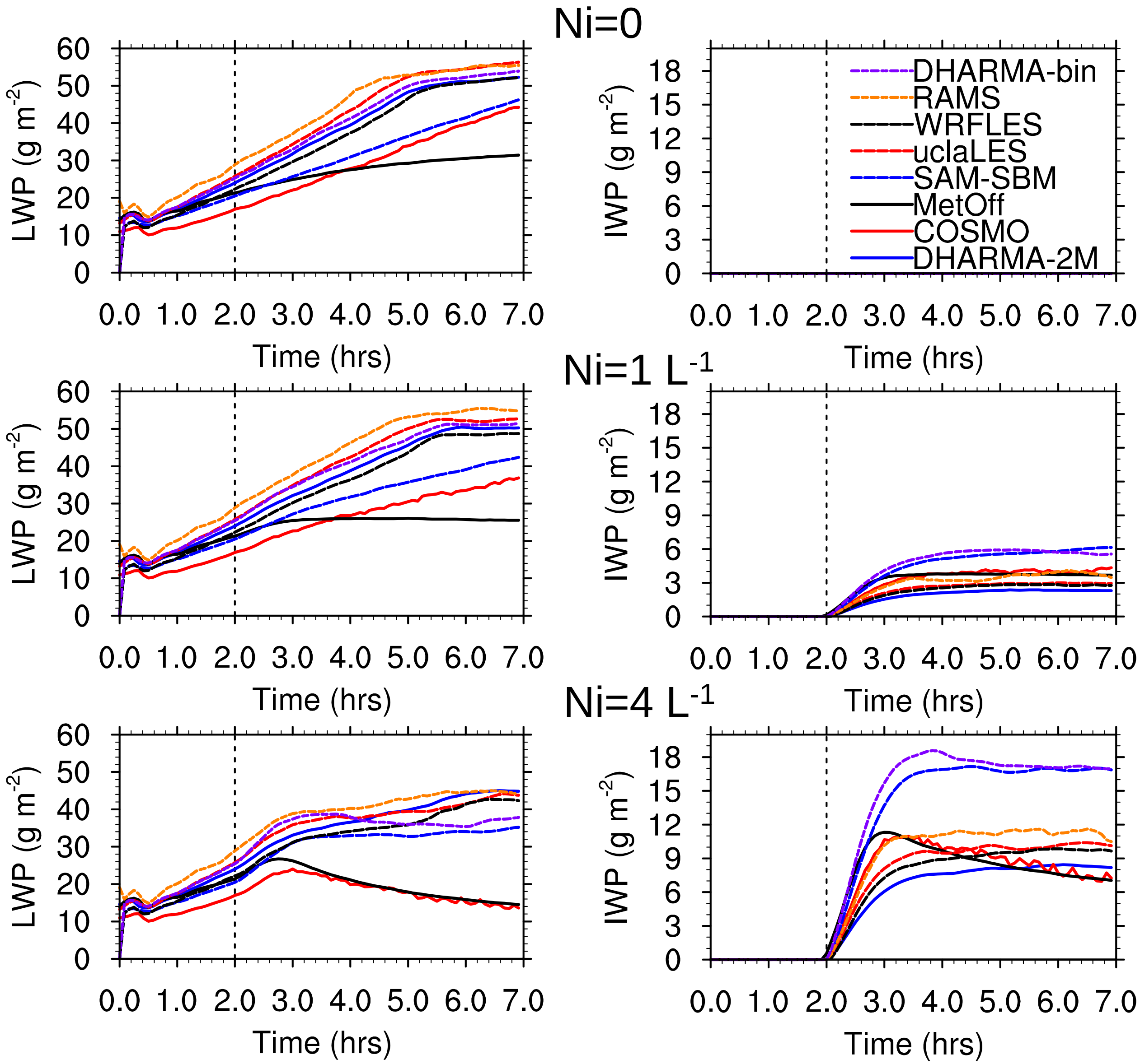
- depositional growth (a size [capacitance] – mass relation)
- sedimentation (a fall speed – mass relation)
- no collisions among ice or liquid particles

Set net longwave flux as a function of liquid water profile

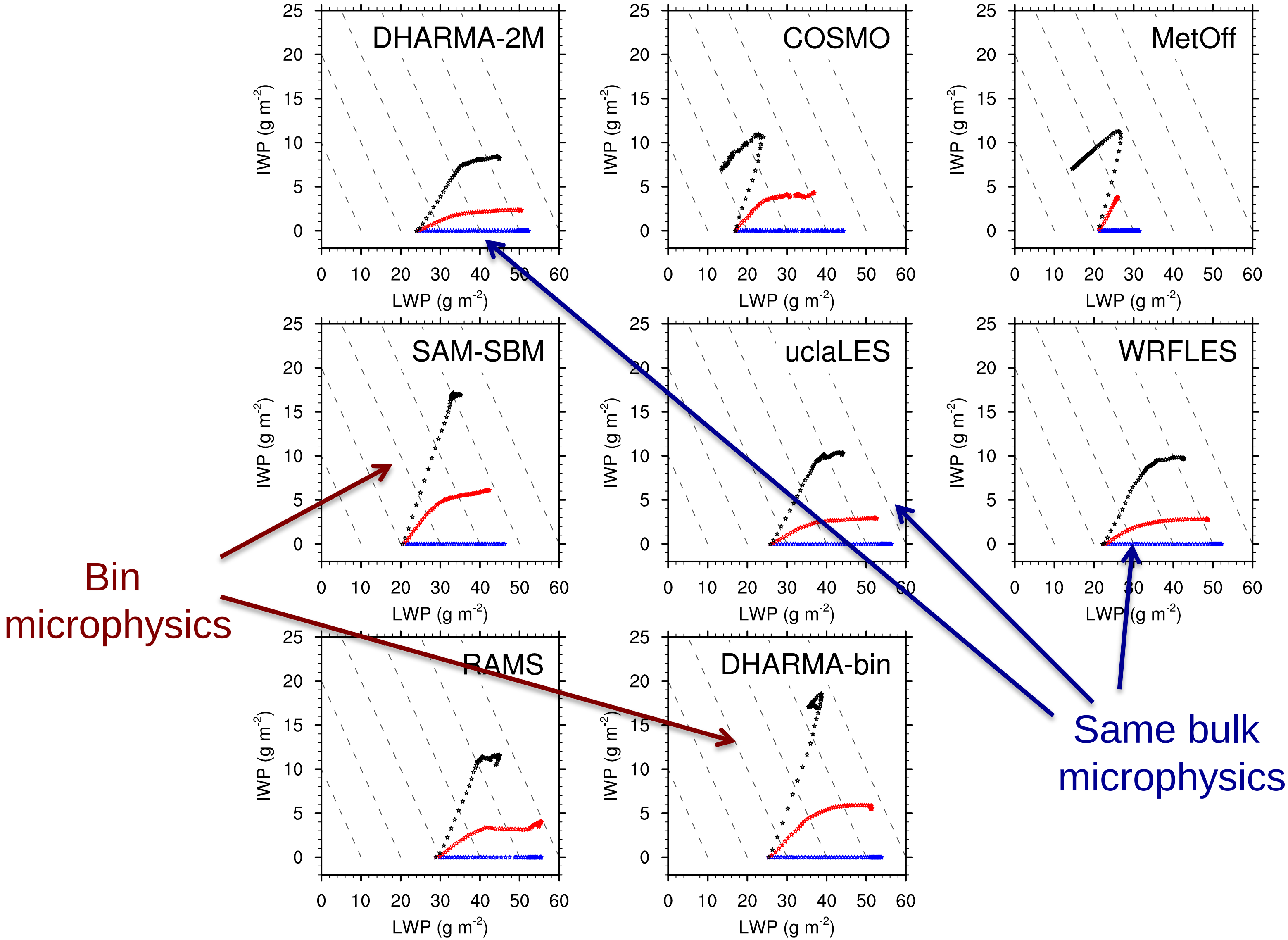
**Implies unlimited source of IN*

Liquid & ice water paths evolution

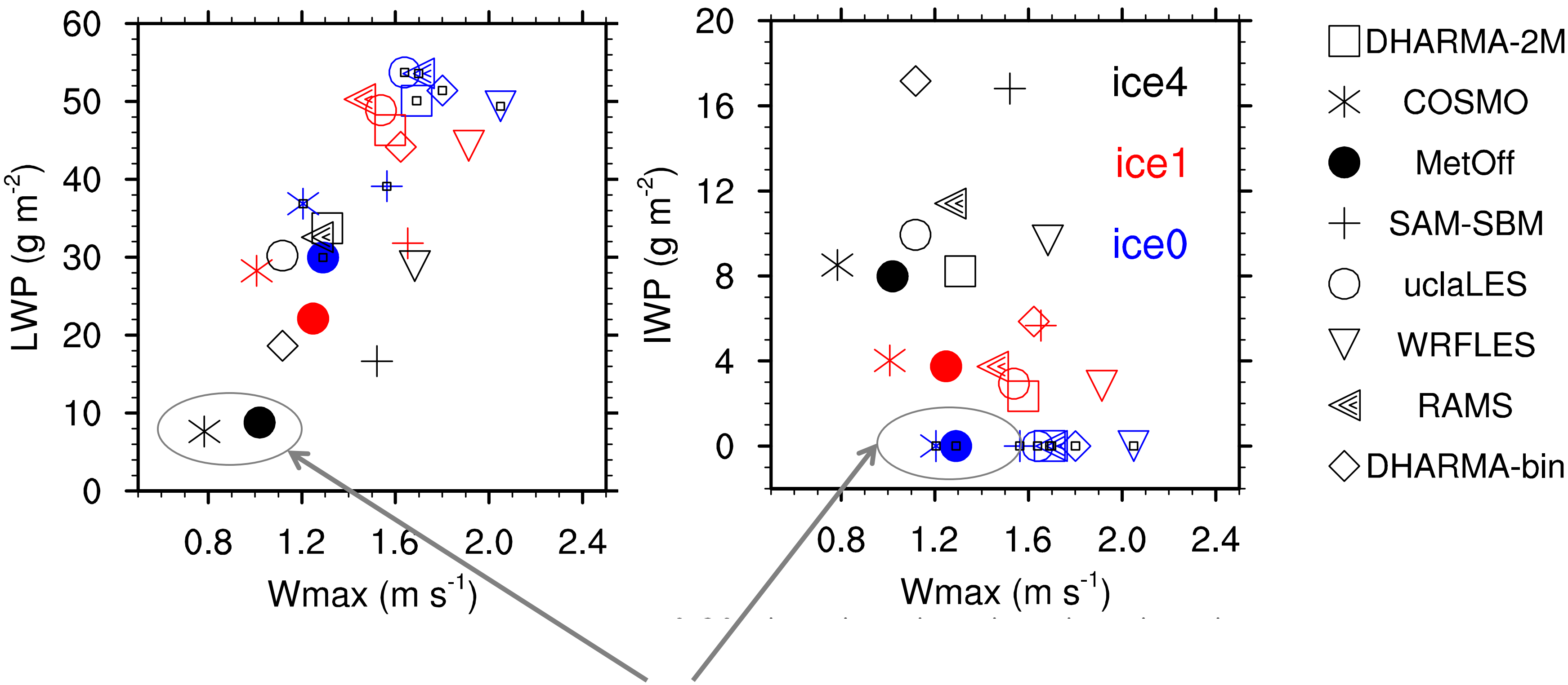
- Cloud top is relatively stable
- Mixed layer is deepening downward
- Quasi-steady state LWP, IWP and precipitation after the layer is mixed to the ground
- Differences in ICE0 runs after the spinup (initialization, dynamics, entrainment, turbulence, etc.)
- Sensitivities to Ni are similar.



Microphysics largely determines liquid & ice water paths sensitivity to N_i



Strength of vertical circulation is important for maintaining liquid phase



Models with slowest circulations have the lowest LWP

Mid-term report

Over the past 9-month the intercomparison has progressed from case specification toward **analysis stage**

- Setup is practical
- A representative ensemble of models

Focus on **sensitivity** of simulations to **ice number** concentration

Two important sources for inter-model differences:

- simulations without ice are different due to **variations in dynamics** (entrainment, advection, SGS turbulence)
- ice simulations are affected by **microphysics treatment**:
  - Comparable results from different models using the same microphysics
  - Agreement between bin schemes

… but **dynamics and microphysics do interact**:

- Models with weaker circulations loose liquid water more rapidly

Next steps:

- Analysis of updraft-downdraft differences for ice particle properties, e.g., moments, spectral shape (3D results?);
- Paper draft (?)

Polar clouds – ISDAC/Microphysics KiD
(Indirect and Semi-Direct Aerosol Campaign)

Mikhail Ovchinnikov (PNNL, mikhail@pnnl.gov)
Andrew Ackerman, Alex Avramov, Gijs de Boer, Ann Fridlind, Alexei Korolev, Hugh Morrison, Ben Shipway, and others)

ISDAC – based model intercomparison

Mikhail Ovchinnikov (PNNL, mikhail@pnnl.gov)

GASS GEWEX WCRP Global Atmospheric System Studies

ASR Atmospheric System Research

Joint activity:

- DOE Atmospheric System Research (ASR) Program – Cloud-Aerosol-Precipitation Interactions (CAPI) Working Group;
- Global Atmospheric System Studies (GASS);
- WMO Cloud Modeling Workshop (CMW) (July 2012)

Goals:

Dynamics-microphysics-radiation interactions are important and need to be understood and modeled better

- Dynamics: Additional diagnostics for vertical velocity, TKE, buoyancy flux, etc.
- Microphysics: Constrain other parameters or process rates for ice (e.g., size-mass ratio, deposition growth rate, sedimentation, etc.)
- Radiation: Unified parameterized radiation/heating rates calculations

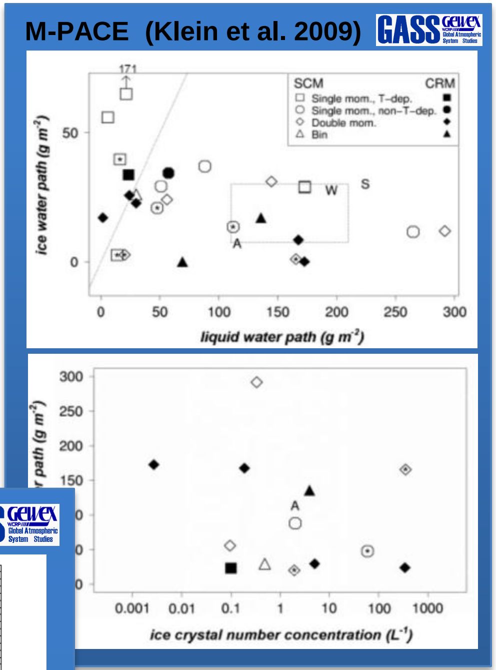
Target models: LES/CRM (SCM is being discussed)

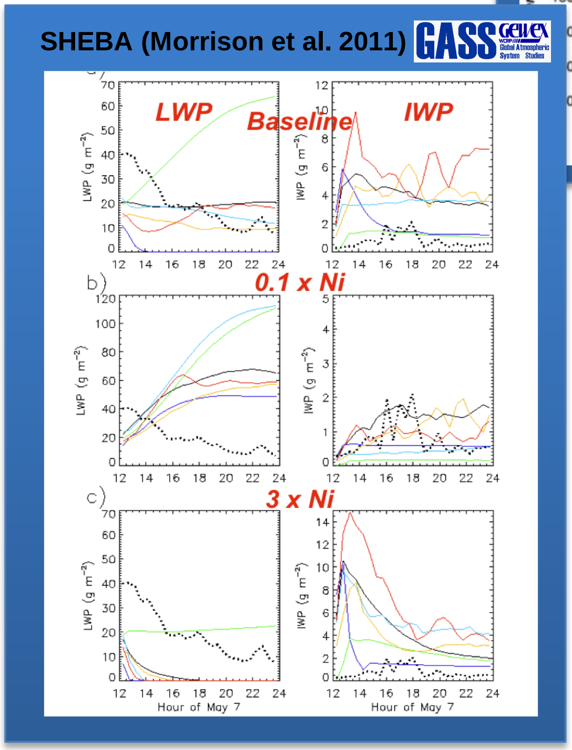
ISDAC – based model intercomparison

Background:

Build on previous intercomparisons (M-PACE, SHEBA, etc)

- Large spread of LWP and IWP among models (CRM and SCM)
    - Uncertainty in ice nucleation mechanisms plays a big role
    - … but constraining ice number does not eliminate LWP spread (SHEBA)
- For many models there is a sharp transition from mixed-phased to ice-only clouds when N_i is increased (SHEBA)





GASS GEWEX WCRP Global Atmospheric System Studies

GABLS

GASS Atmospheric Boundary Layer Study

GABLS third experiment

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

GASS Atmospheric Boundary Layer Study
GABLS third experiment

SCM

12 Z
01 Jul

12 Z
02 Jul

~20 SCM

LES (6.5 m 0.8km)

00 Z
02 Jul

09 Z
02 Jul

~10 LES

Cabauw tower
(KNMI, NL)

Observational based:

- Initial Profiles
- Geostrophic Wind (time-height dependent)
- Large-scale Advection (time-height dependent)
- Surface Boundary Conditions (SCM solves surface energy balance, LES prescribed temperature at first model level)

Results are documented in papers

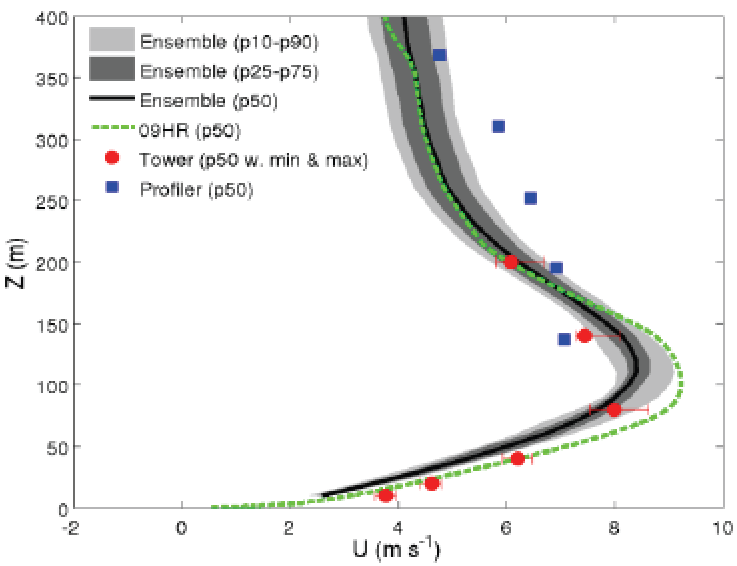
Coordinators: Fred Bosveld (SCM), Sukanta Basu (LES), Bert Holtslag and Gunilla Svensson

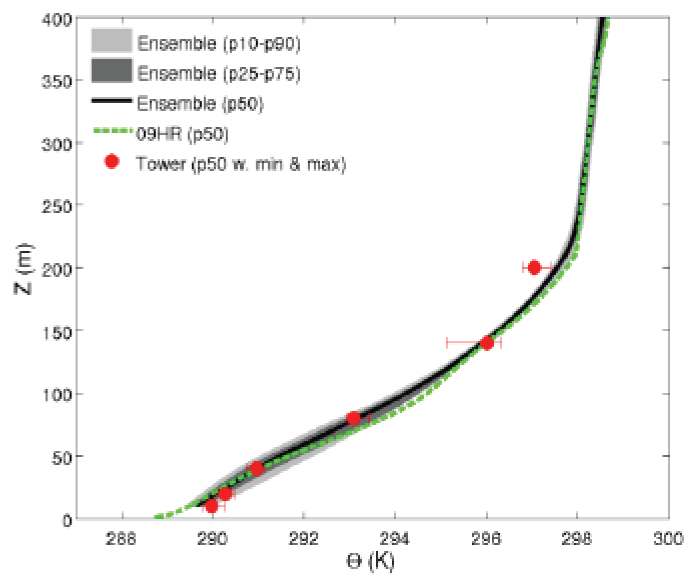
GABLS3 Large Eddy Simulation intercomparison
(coordinated by Sukanta Basu, NC State Univ)

Initialized at midnight (02-jul-2006 00:00 UTC) and run for 9 hours (11 LES models)
Prescribed temperature at lowest model level from observations!

Wind speed magnitude

Potential Temperature





Mean profiles 03-04 UTC
(Red dots: Tower; Blue squares: Wind Profiler)
Green dashed line: 1m LES run (Courtesy Siegfried Raasch)

GABLS GEWEX Atmospheric Boundary Layer Study

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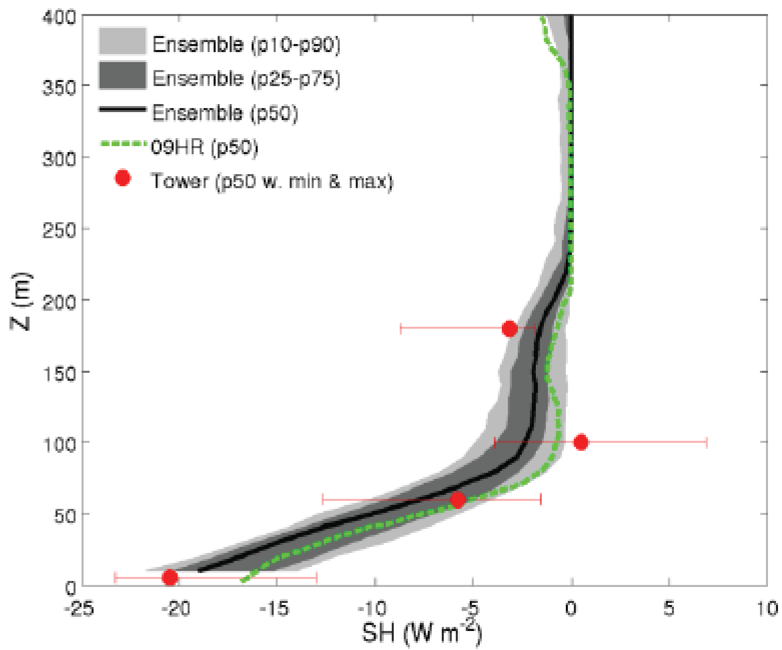
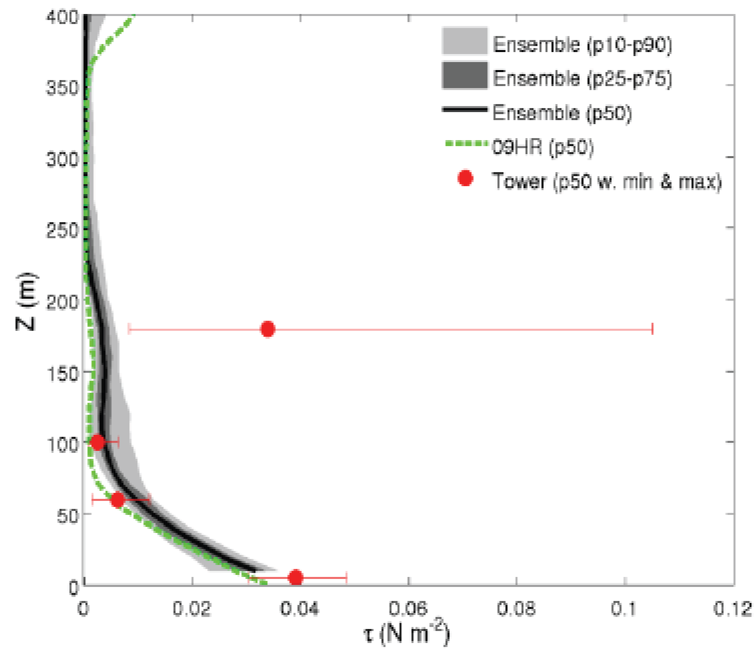
GABLS3 Large Eddy Simulation intercomparison (coordinated by Sukanta Basu, NC State Univ)

Sensible Heat flux (W/m2)



Momentum flux (N/m2)



Flux profiles 03-04 UTC

(Red dots: Cabauw Tower observations)

Green dashed line: 1m LES run (Courtesy Siegfried Raasch)

GABLS GEWEX Atmospheric Boundary Layer Study

GASS GEWEX WCRP Global Atmospheric System Studies

ECMWF/GABLS workshop

"Diurnal cycles and the stable atmospheric boundary layer",

ECMWF, 5-8 November 2011

GABLS GEWEX Atmospheric Boundary Layer Study

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Cirrus - SPartICus

SPartICus RF 45: An observationally-based mid-latitude cirrus case over the ARM SGP site

Case leaders: Andreas Muhlbauer and Thomas Ackerman

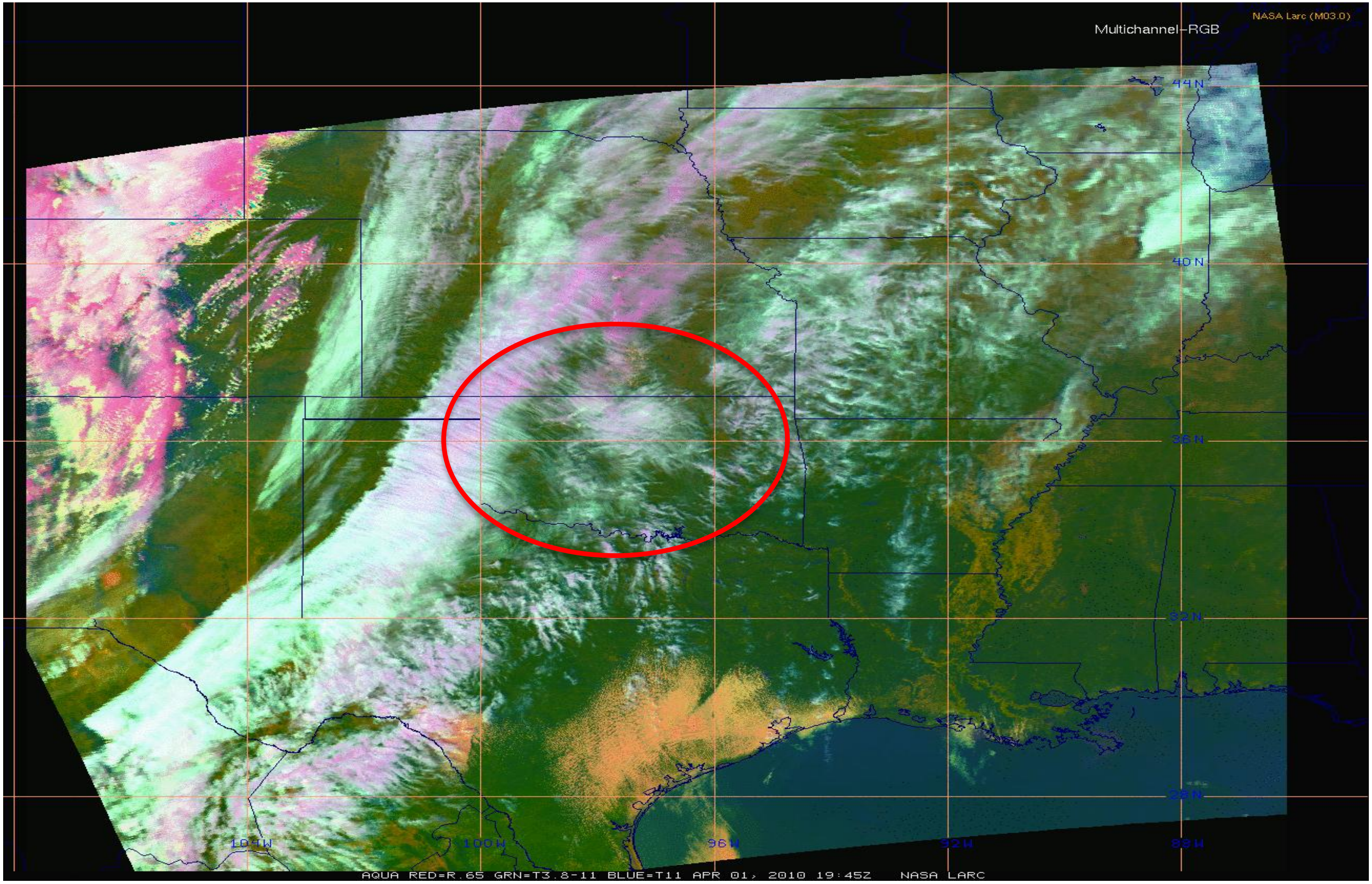
Objectives:

- Observationally-based reference case for cirrus simulations
- Observations from multiple platforms (in situ aircraft data, ground-based and spaceborne remote sensors) collected during the DOE Small Particles in Cirrus (SPartICus) campaign
- Provide simplified 2D setup (multi-moment bulk and bin schemes, high resolution LES, CRM, SCM) and "real" 3D setup (CSRM)

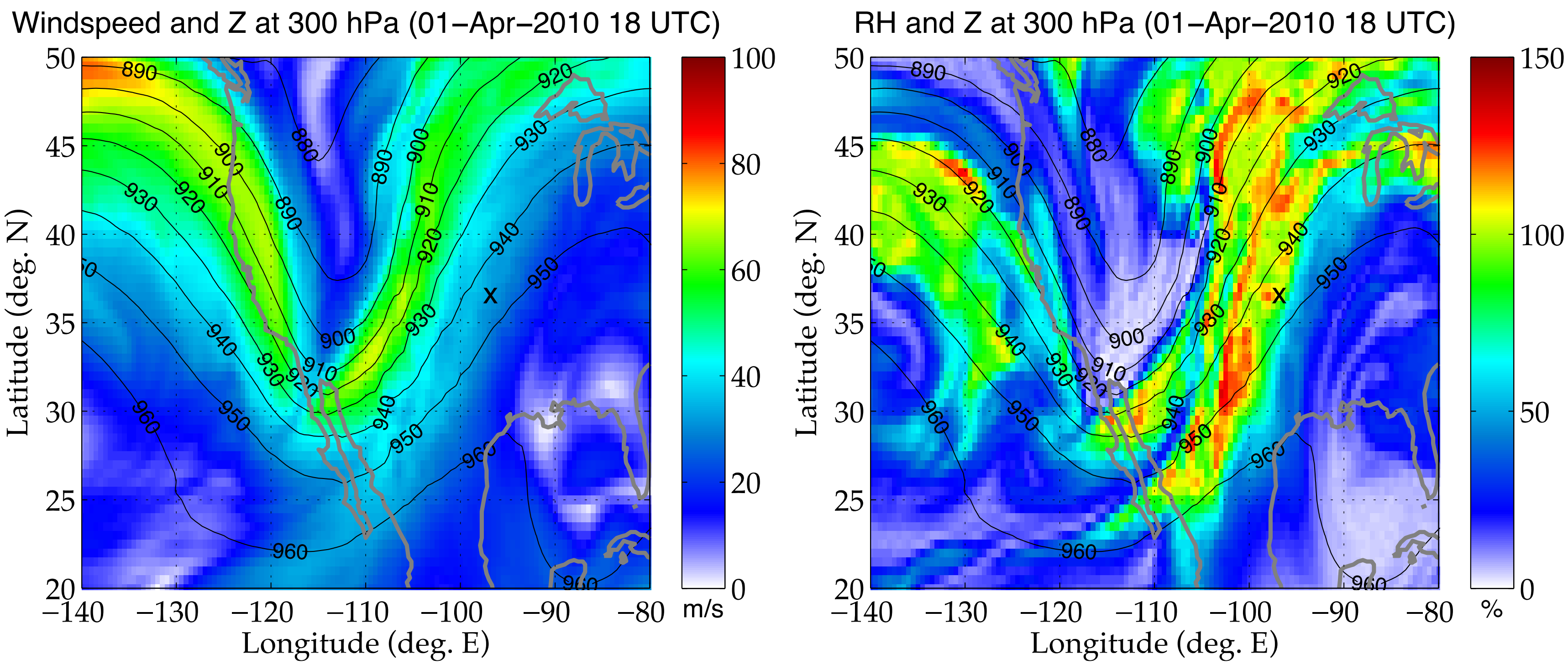
Broader goals:

- Identify key deficiencies in ice microphysics parameterizations (e. g., ice nucleation, diffusional growth, ice fall speeds)
- Document success or failure (model intercomparison paper)
- Spur improvements in cloud parameterizations

SPartICus 1 April 2010 case

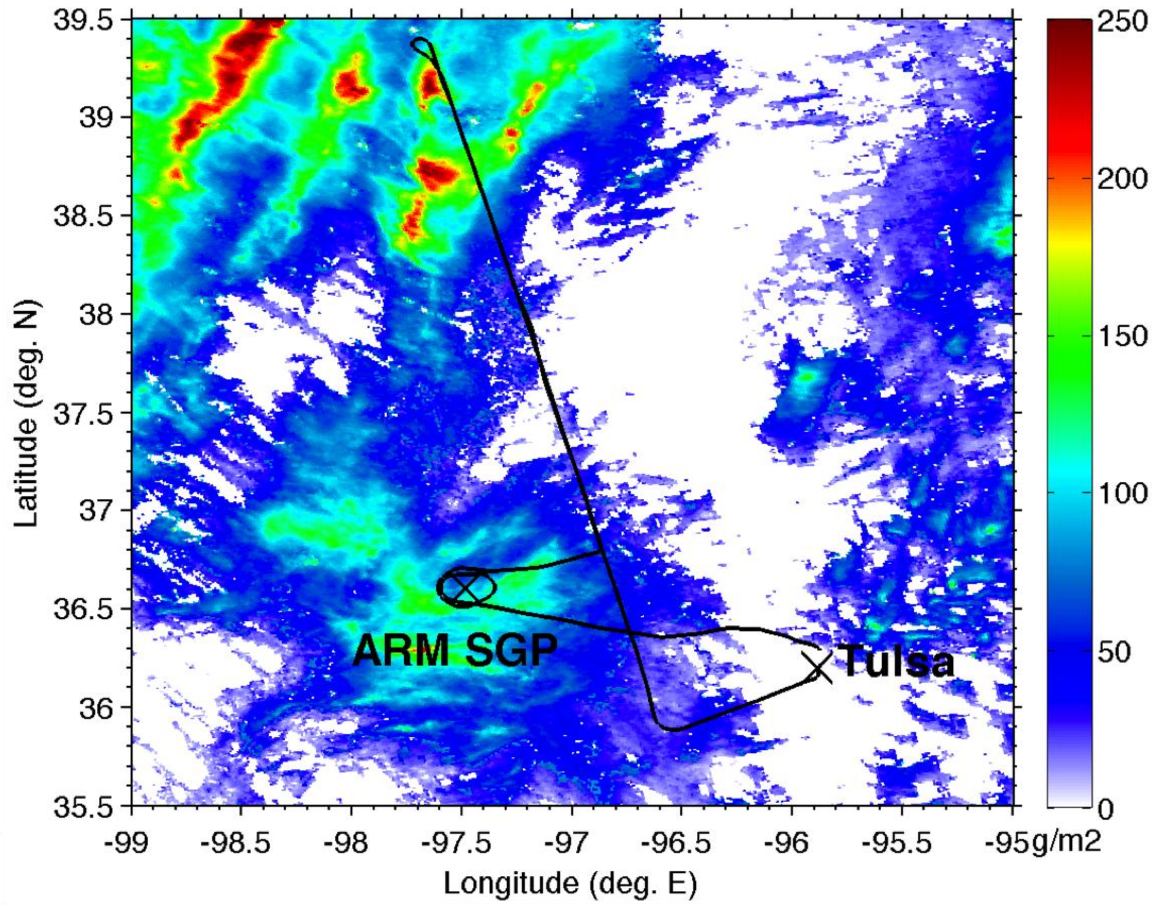


Meteorology

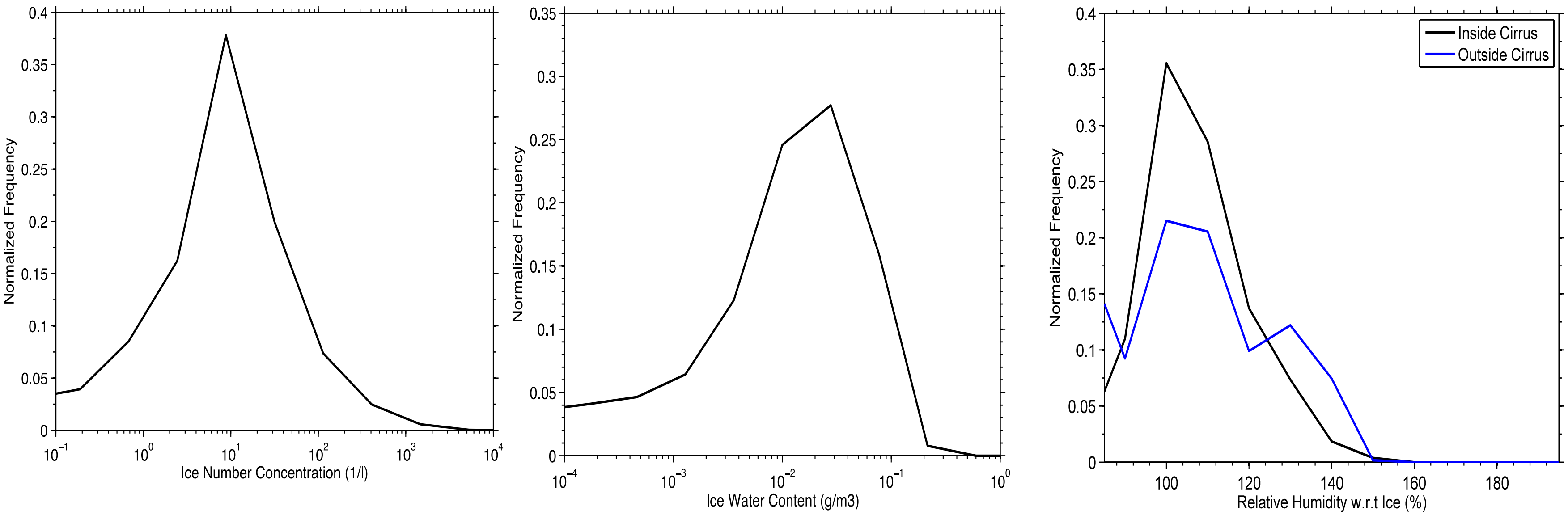


- Deep Rossby wave with embedded jetstream
- Southwesterly flow advects subtropical airmass to the ARM SGP site

RF 45: Aircraft flight track

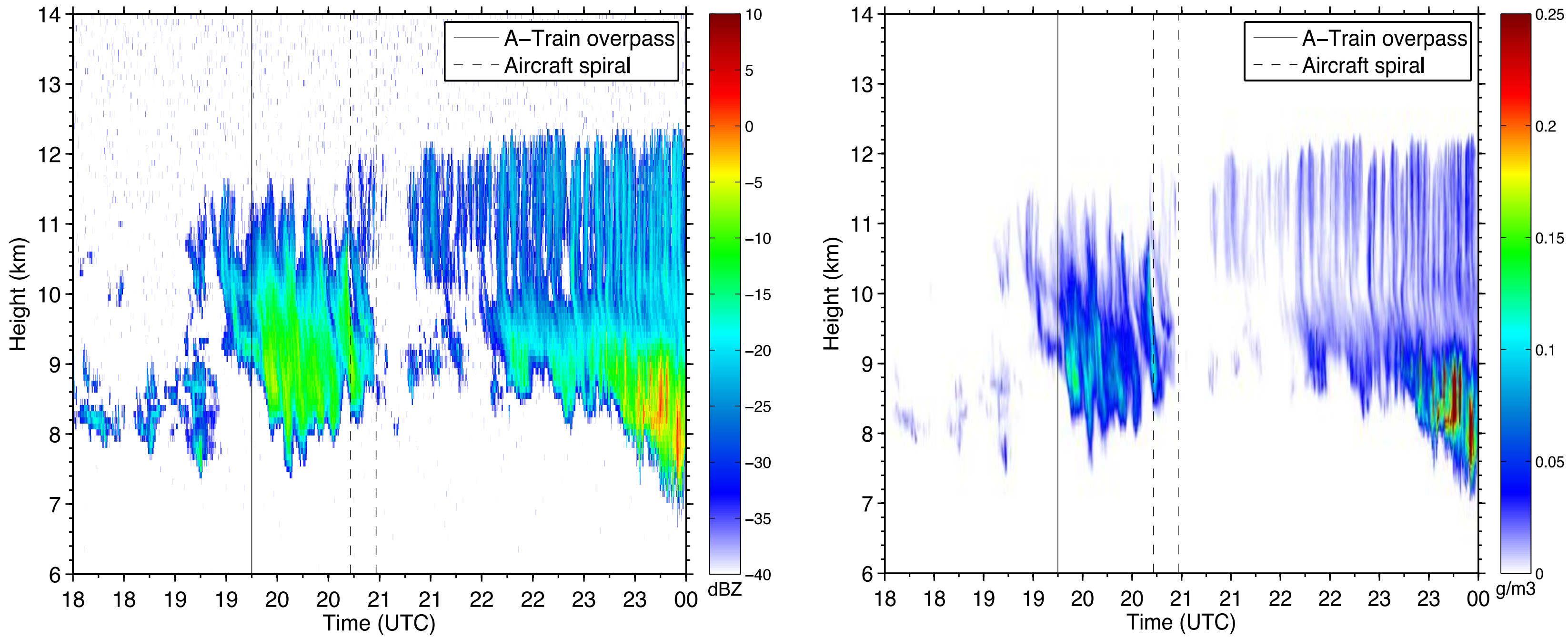


In situ aircraft measurements



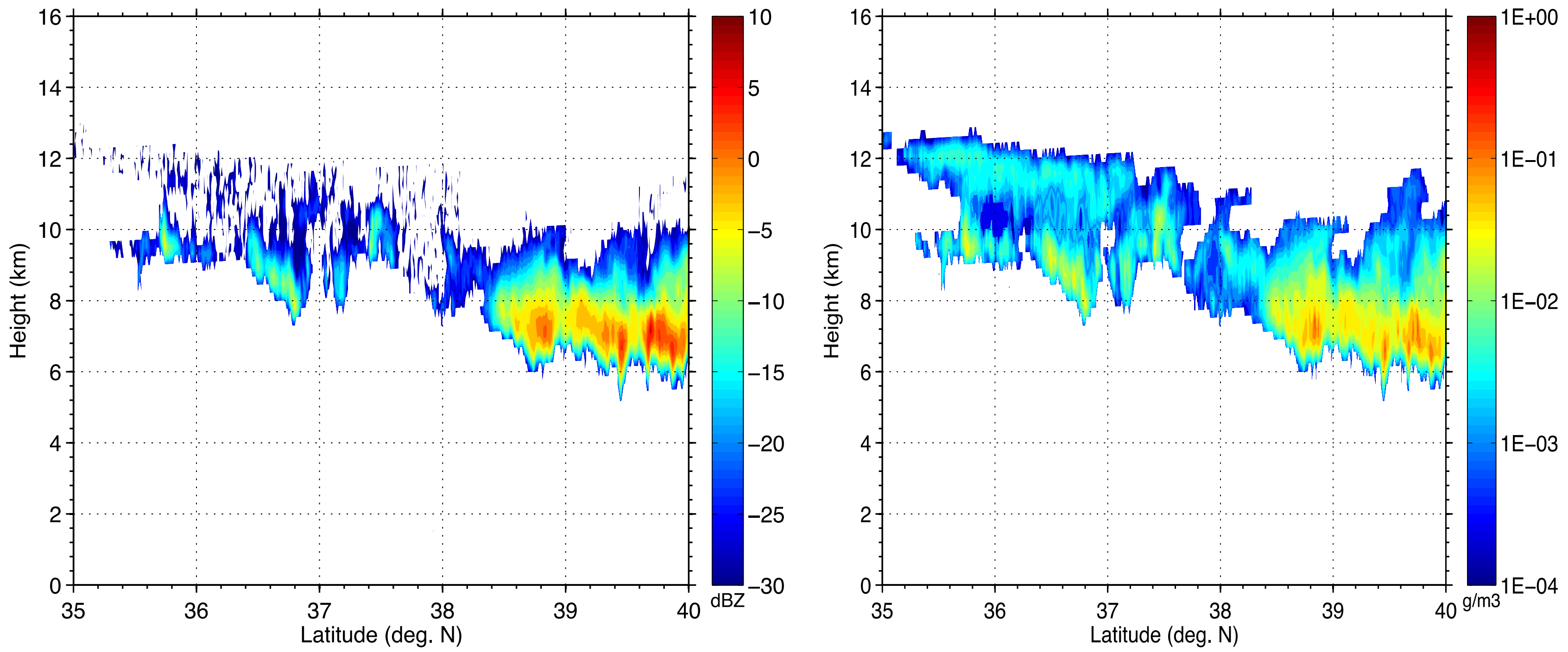
Ice concentrations (2-DS), ice water content (2-DS, Nevzorov), relative humidity (NASA DLH), vertical velocity (turbulence probe)

MMCR radar reflectivity and IWC



2C-ICE IWC retrieval courtesy of Min Deng

CloudSat 94 GHz backscatter and IWC



CloudSat radar reflectivity for combined radar/lidar cloud mask (2B-GEOPROF-LIDAR), IWC from 2C-ICE product (courtesy Min Deng, U. Wyoming)

Model setup

- 2D: ARM forcing data provided by Shaocheng Xie and Yunyan Zhang. Prescribed T, Q tendencies, SH + LH surface fluxes, nudged wind fields.
- 3D: ECMWF boundary conditions/boundary conditions from regional model (e. g., COSMO-UW)
- Use CFMIP Observations Simulator Package (COSP) to “simulate” MMCR/CloudSat radar reflectivities and MODIS fields directly from model output

Tentative timeline

- Q3 2012: Resolve remaining issues (observational data, ARM forcing for 2D setup)
- December 2012: Tentative deadline for submission of contributions
- Q1 2013: Analysis of model results
- Q2 2013: Submission of model inter-comparison paper

GASS GEWEX WCRP Global Atmospheric System Studies

Sc to Cu transition

Stratocumulus to cumulus transitions model intercomparison

Joint GASS-EUCLIPSE activity

Why?

- Huge impact on radiative fluxes hence climatologically important
- Found to be a sensitive region in studies of cloud feedbacks to climate change
- Potentially hard for parametrizations to make the transition (eg PBL to massflux)

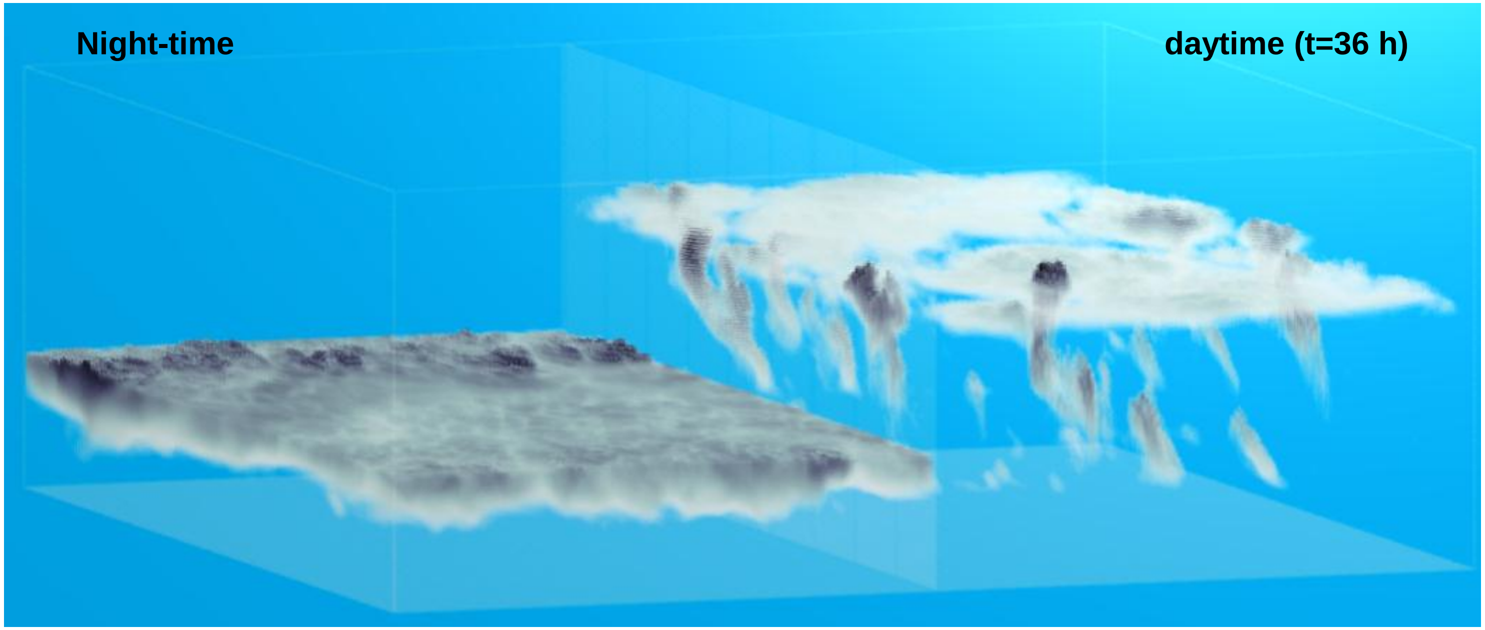
How?

- Composite cases: an ensemble of cases, derived from the Lagrangian analysis of O(1000) trajectories based on satellite and reanalysis data
- ASTEX: revisiting the ASTEX field campaign (1992)
- Project leads: Irina Sandu, Stephan de Roode, Roel Neggers

Questions?

- Are the LES/SCM able to reproduce:
  - the observed rate of change in cloudiness induced by increasing SST?
  - the differences in the transition time scale driven by variations in the initial conditions/forcing?
  - the observed changes in the boundary layer structure and cloud microphysics?

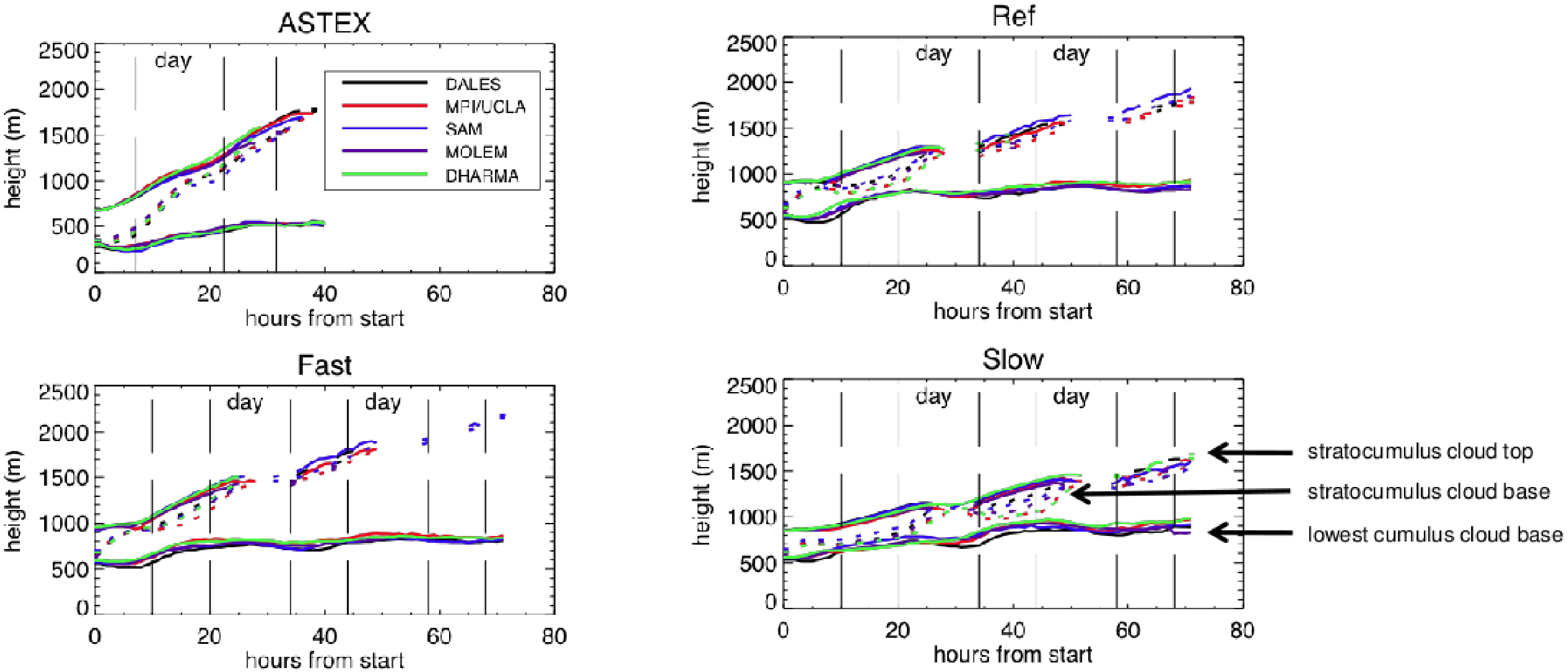
Snapshots of LES cloud near the start and end of the ASTEX simulation



Solid stratocumulus

Thin and broken stratocumulus penetrated by shallow cumulus

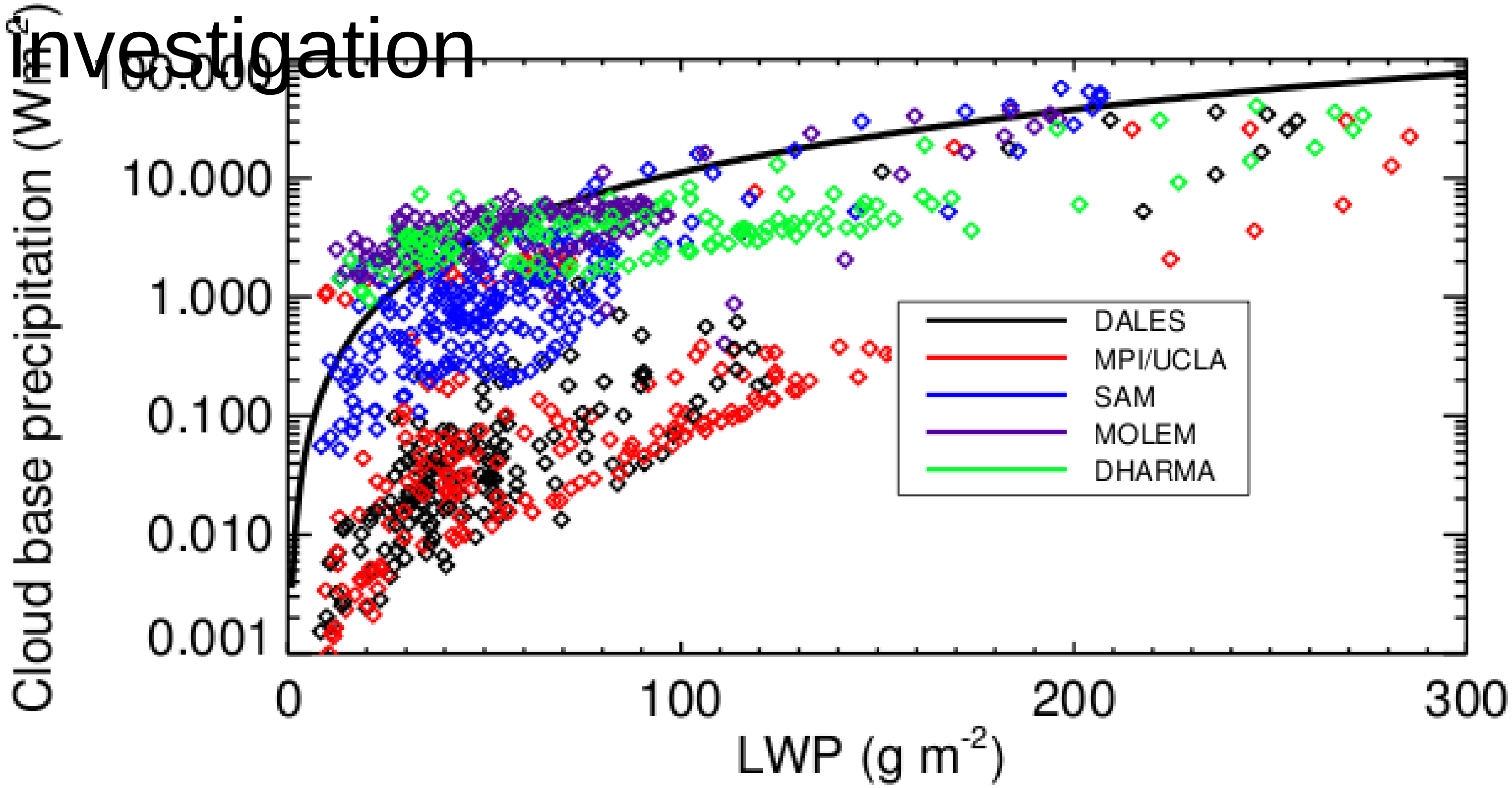
LES cloud evolution



- cumulus cloud base tends to go towards a constant height
- stratocumulus (cloud fraction > 0.9) cloud base rises rapidly
  → two layer cloud structure
- LES reproduce all the transitions consistently and realistically

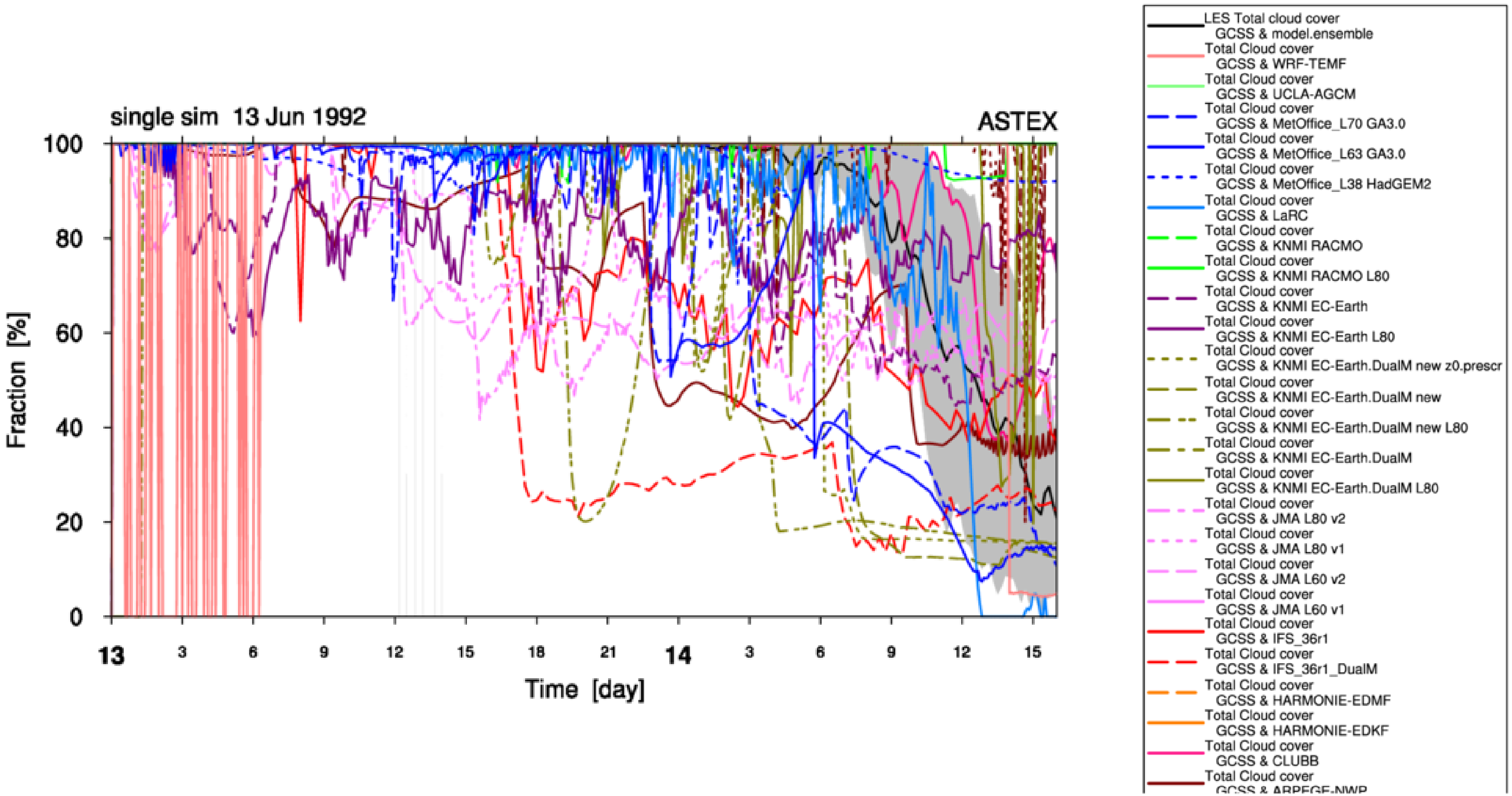
LES drizzle sensitivity

- Large variation in precipitation efficiency between different LES, needs further investigation



SCM intercomparison

General model performance: cloud cover = spaghetti?



SCM intercomparison

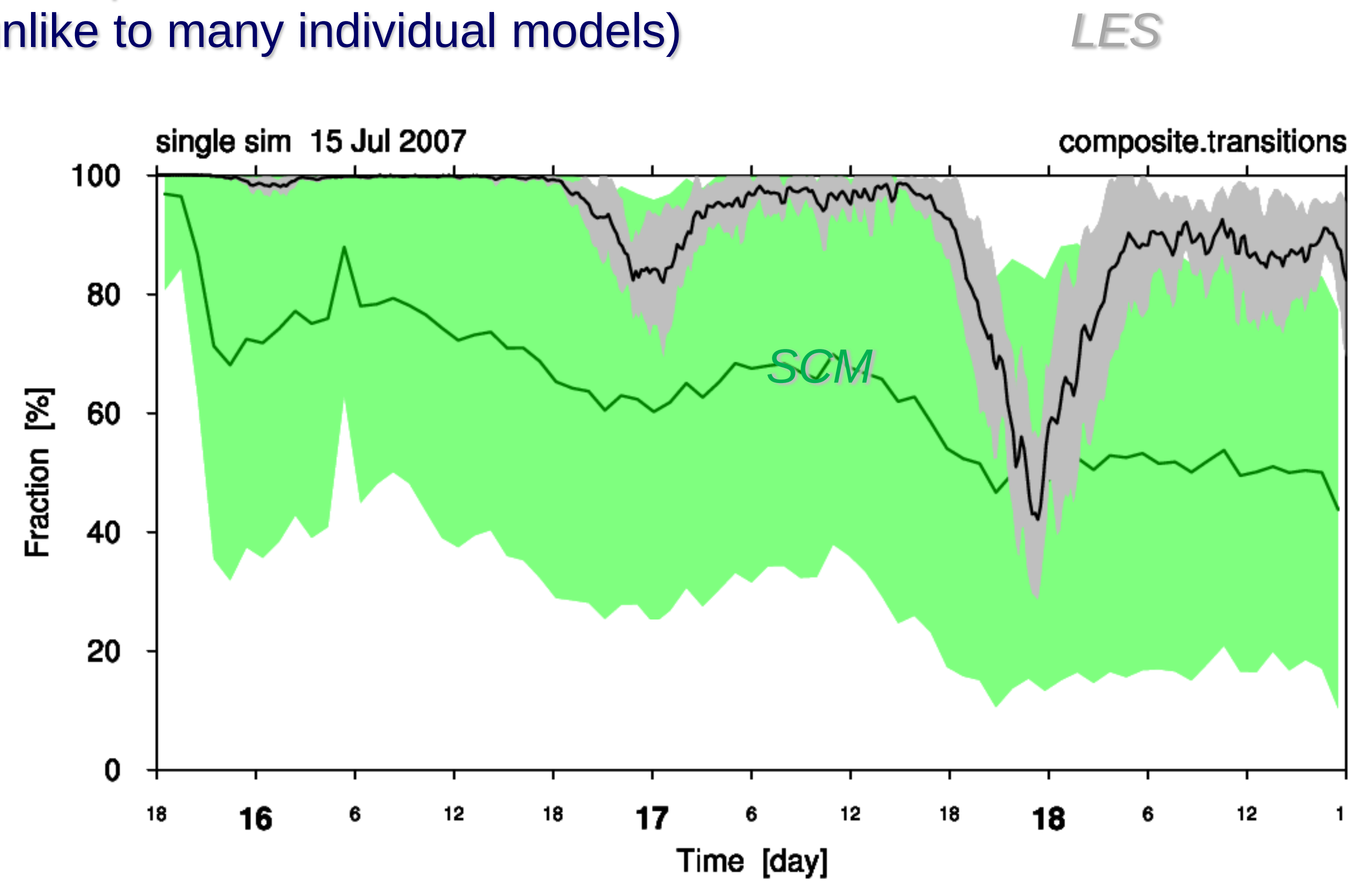
SCM ensemble plots show:

i) performance of model ensemble as a whole

ii) spread among ensemble (2 σ)

For example, ensemble-mean shows a clear diurnal (unlike to many individual models)

TCC
fast composite case



Status and future work

- LES are generally successful at reproducing both the ASTEX aircraft observations and the satellite-observed sensitivity in speed of transition
  - Still some work required to understand microphysical sensitivity, e.g., via KiD framework
  - Paper in preparation

- Many SCM struggle to produce realistic transitions (or any transition at all)
  - But ensemble mean performs much better
  - Initial tests of running one SCM with the full ~500 ensemble of transition forcings shows better mean performance than running with the ensemble mean forcing
  - Plan is to supply the full ensemble of forcing to the rest of the SCM participants

Additional slides

Transitions intercomparison participants Large-Eddy Simulations

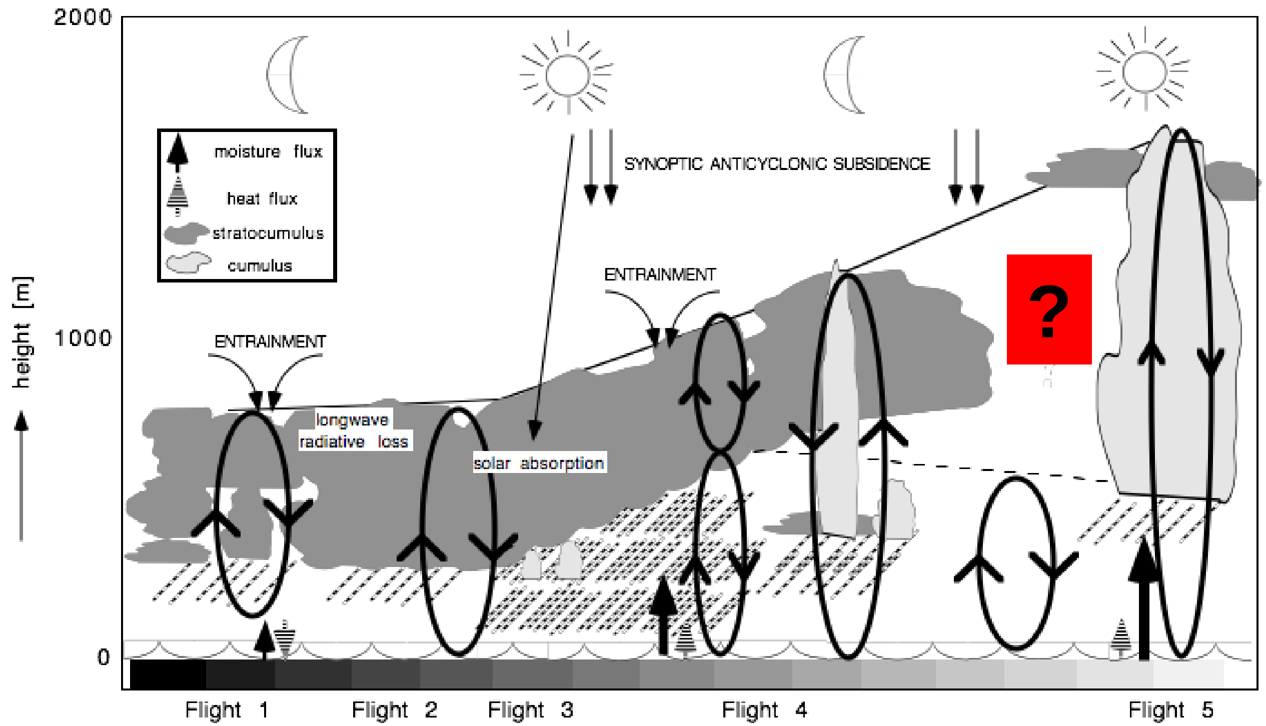
Name	Affiliation	LES Model
Johan van der Dussen	TU Delft	DALES
Andy Ackerman	NASA	DHARMA
Irina Sandu	MPI	UCLA-LES
Peter Blossey	Univ. of Washington	SAM
Adrian Lock	UK Met Office	MOLEM

Transitions intercomparison participants

List of SCM participants – 13 October 2011

Name	Affiliation	Model	ASTEX	Composite cases
Eric Basile	Météo France	AROME	✓	✓
		ARPEGE-NWP	✓	✓
Isabelle Beau	Météo France	ARPEGE-CLIMAT	✓	✓
Vincent Larson	UWM	CLUBB	✓	✗
Sara dal Gesso Roel Neggers	KNMI	EC-Earth	✓	✓
		RACMO	✓	✓
Suvarchal Kumar	MPI-M Hamburg	ECHAM6	*Expected soon*	✓
Irina Sandu Martin Köhler	ECMWF DWD	IFS cy36r1	✓	✓
Hideaki Kawai	JMA	JMA	✓	✓
Anning Cheng	NASA LaRC	LaRC	✓	✓
Heng Xiao	UCLA	UCLA-AGCM	✓	✓
Marie-Pierre Lefebvre	Météo France	LMDZ	✗	✓
Wayne Angevine	NOAA	WRF TEMF	✓	✗
Cisco de Bruijn Wim de Rooij	KNMI	HARMONIE EDKF	✓	*Expected soon*
		HARMONIE EDMF	✓	*Expected soon*
Jennifer Fletcher	University of Washington	NCEP GFS	✗	✓
Sungsu Park	University of Washington	NCAR CAM5	✗	✗
Ian Boutle	UK Met Office	UKMO	✓	✓

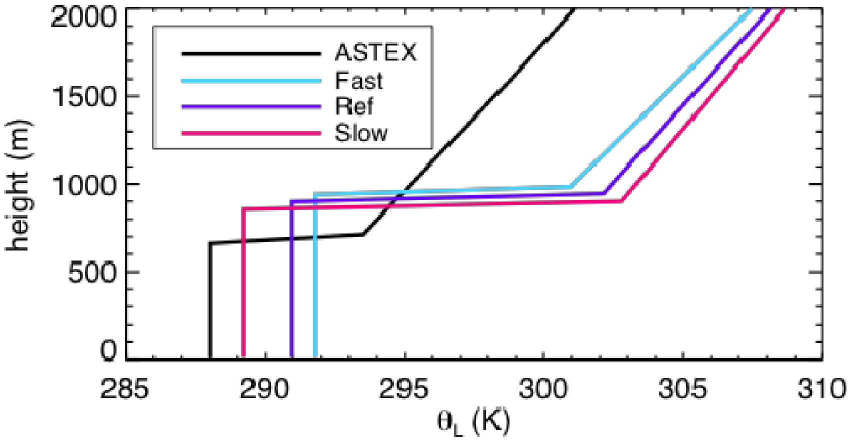
ASTEX stratocumulus to cumulus transition



Johan van der Dussen, Roel Neggers (KNMI), Stephan de Roode

LES & SCM participants

Initial profiles

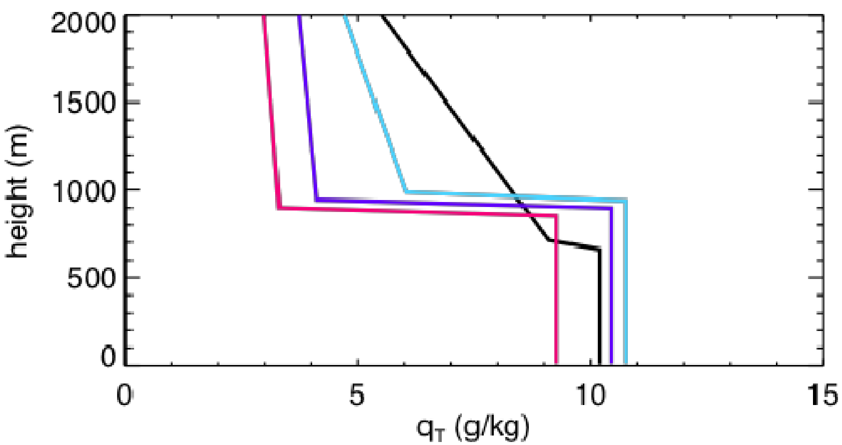


Composite cases

- speed of transition correlates with initial strength of inversion

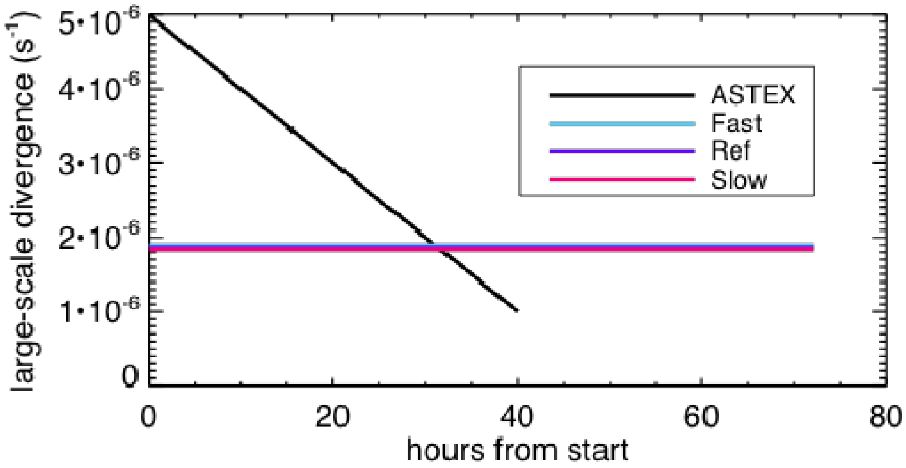
ASTEX case

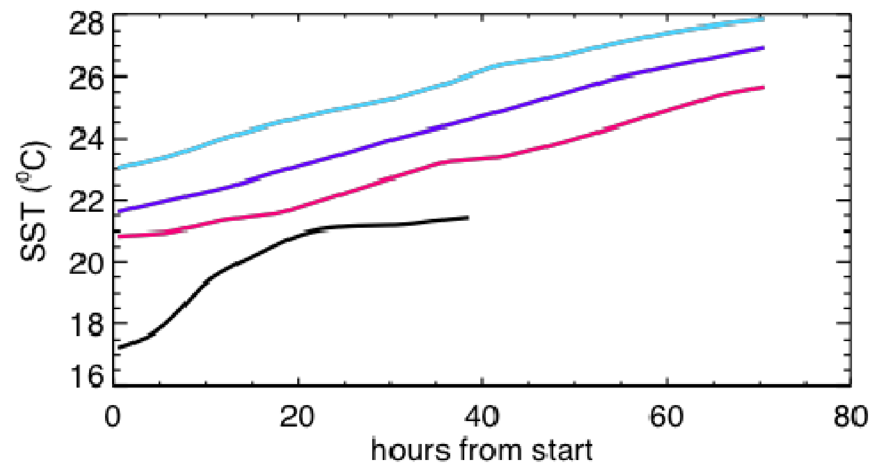
- weakest inversion strength
- moistest free troposphere



Astex : van der Dussen et al., in preparation
Composite cases:
Sandu, Stevens and Pincus, ACP, 2010
Sandu and Stevens, JAS, 2011

Forcing





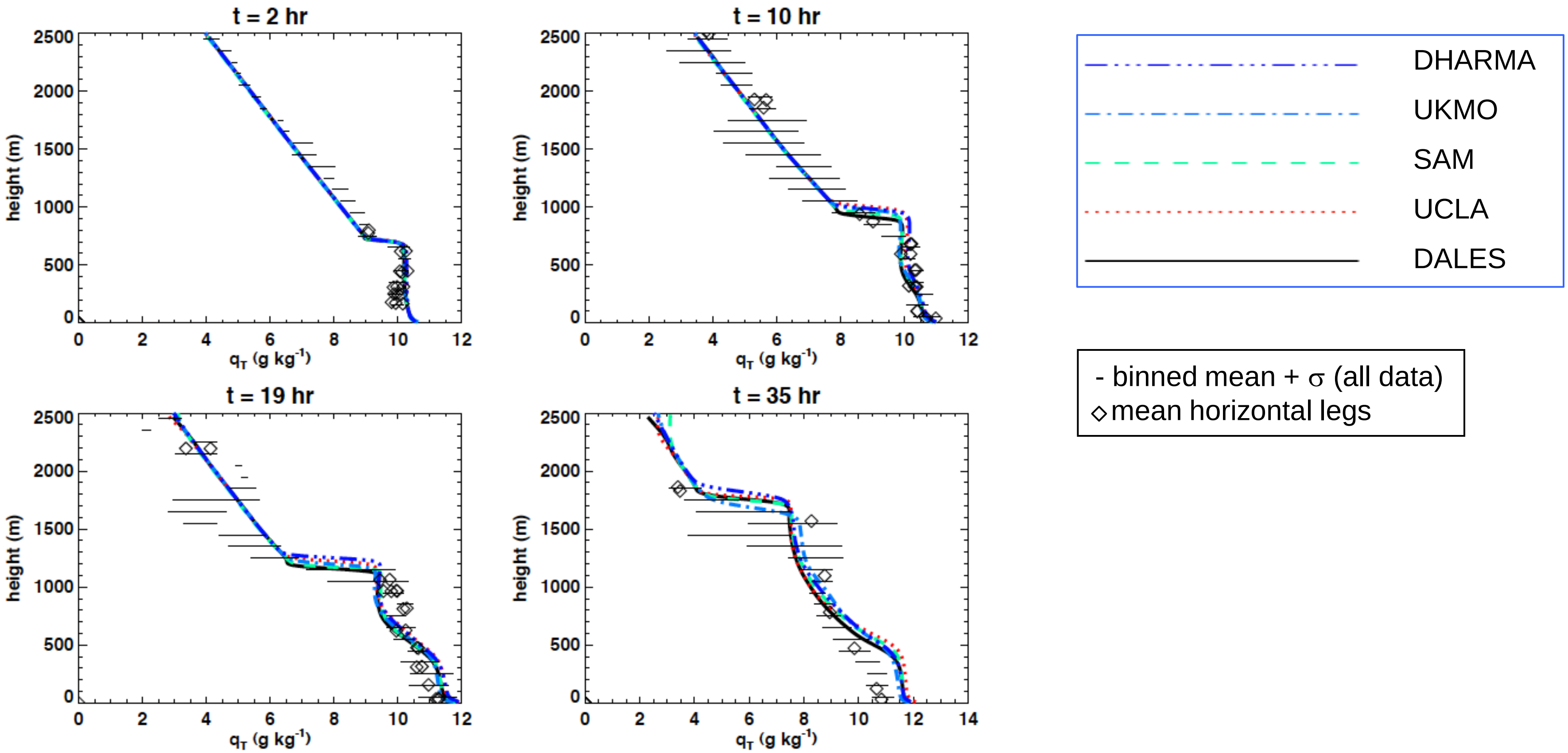
Composite cases

• constant subsidence (the same in all three)
• no advective tendency (lagrangian)

ASTEX case

• decreases but remains positive (following Sigg and Svensson, 2004)
• slightly larger than in the intercomparison study by Bretherton et al. (1999), which became slightly negative at the end

ASTEX LES comparison with in situ observations: Total water content



• **Good agreement during the first part of the Lagrangian**

• **Subcloud layer too moist at the end of the transition**

Observations collected during the last flight exhibit considerable mesoscale fluctuations

• **Additional runs are made using a large horizontal domain to allow for mesoscale fluctuations**

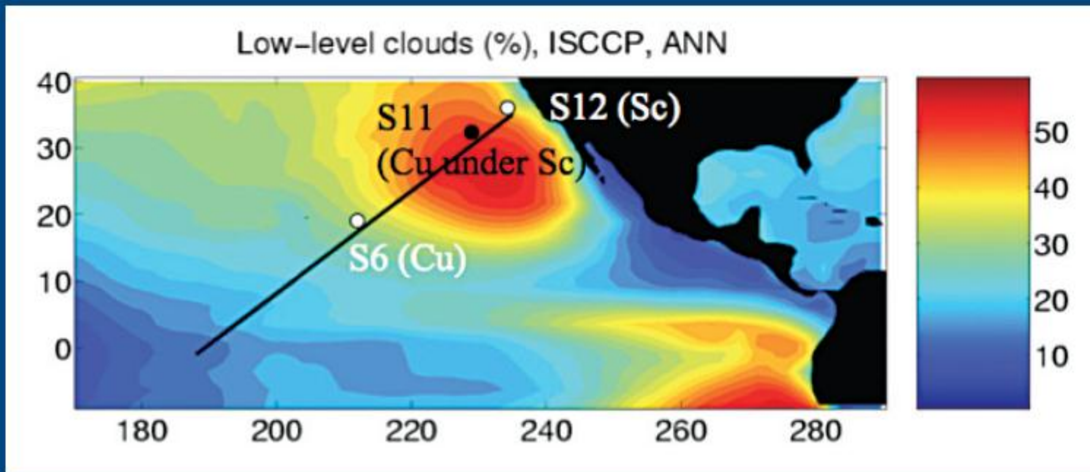
GASS GEWEX WCRP
Global Atmospheric System Studies

CGILS

The CGILS column cloud feedback intercomparison study

Project leaders: M. Zhang, P. Blossey, C. Bretherton

Zhang et al (2010)



The CGILS intercomparison transect overlaid on the Northeast Pacific annual-mean low cloud amount. Initially, CGILS focused on location S11 (32°N, 129°W) near the northern end of the GCSS Pacific Cross-Section Intercomparison study region. The other two locations are S6 and S12. S11 is near the climatological summertime maximum of low-level cloud cover. S6 is characterized by shallow cumuli, and S12 by shallow coastal stratocumulus.

CGILS: The **C**FMIP–**G**ASS **I**ntercomparison of **L**arge-Eddy Simulation and **S**ingle-Column Models

Motivation: Boundary-layer cloud feedbacks are a primary driver of the substantial range between climate sensitivities predicted by leading climate models. Our physical and observational understanding of these feedbacks is inadequate.

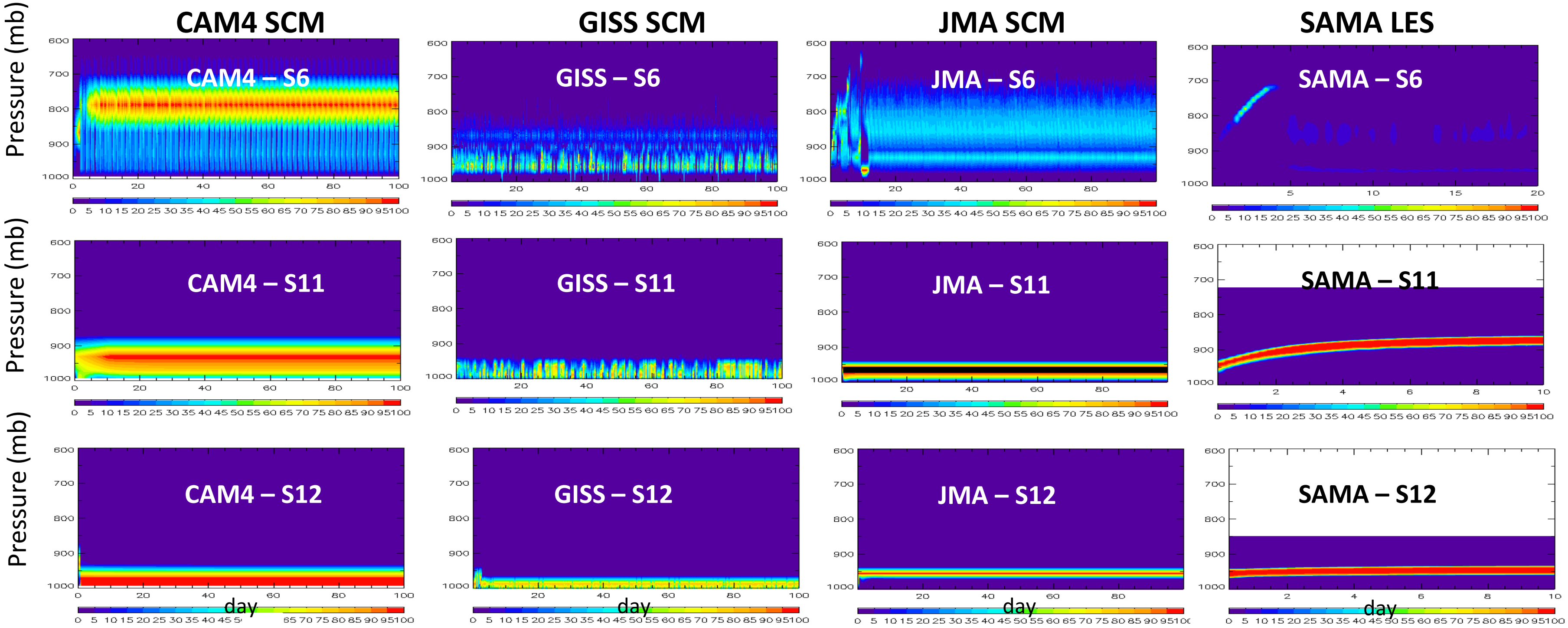
Goal: Compare LES and SCM simulations of representative subtropical boundary cloud regimes with large-scale forcings representative of present and perturbed climates

Approach: Use observed JJA-mean forcings: S12 (well-mixed Sc), S11 (Cu under Sc) and S6 (Cu).

(1) Compare column simulations with current climatology.

(2) Compare their response to ‘Cess’ climate perturbation: +2 K SST with moist-adiabatically warmed free troposphere, constant free-trop RH, reduced subsidence.

Results: Control climate cloud-fraction vs. p and time – LESs agree but SCMs scatter

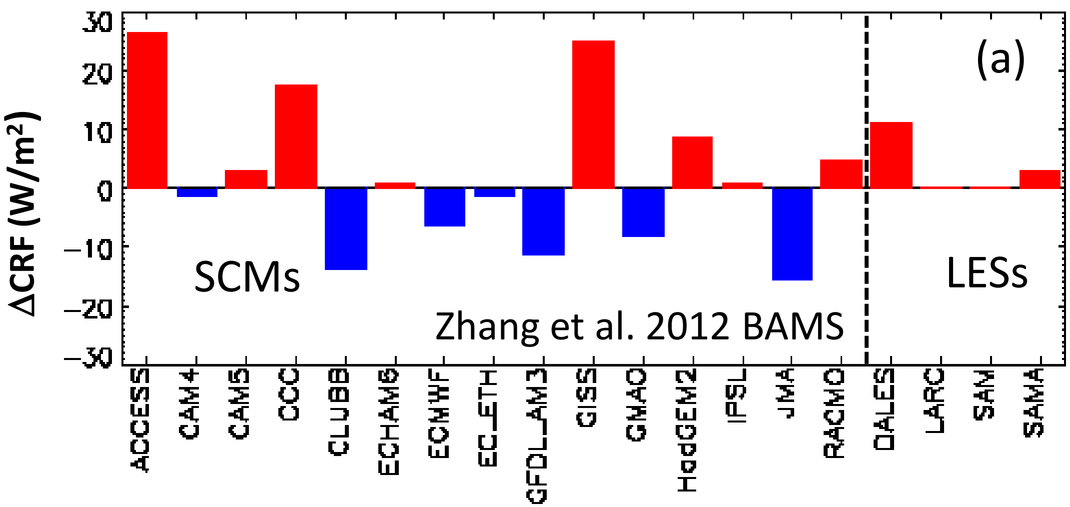


Results: +2K cloud response at S11

- LES show zero to positive cloud feedback
- SCMs scatter much more

Issues:

- Vertical 'grid locking' can distort SCM responses.
- Need to add transient forcing variability to get realistic cloud climatology.



LES show compensating thermodynamic, dynamic cloud responses

S12 case

'Thermodynamic' response to +2K change with no subsidence decrease:

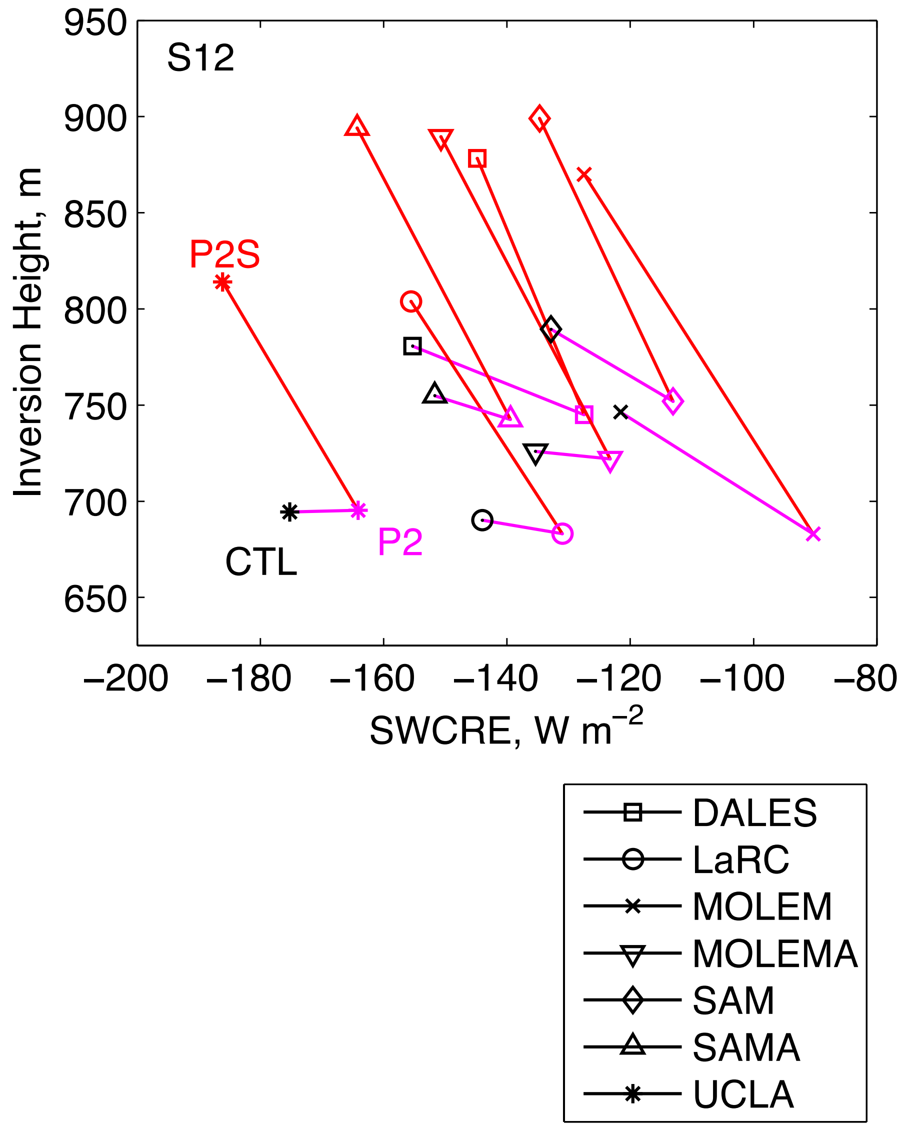
- Thinner cloud = weaker SWCRE
- Little change in PBL depth

'Dynamic' response of reducing subsidence:

- Deeper PBL
- Cloud thickening

Net result (P2S):

- Cloud thickening in most LESs but thinning in a few.

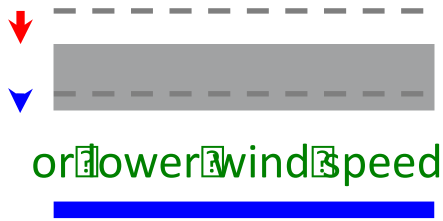


Blossey et al. 2012 JAMES

CGILS LES cloud feedback mechanisms

Turbulence driving

More emissive FT
(more CO_2 or H_20)

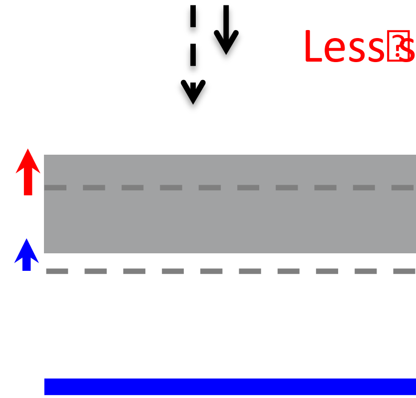


or lower wind speed

Less turbulence production by top cooling or sfc flu.
Less entrainment.
Sc lowers, thins.

Dynamic

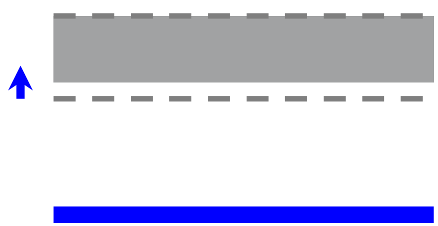
Less subsidence



Sc top rises. More entrainment lifts cloud base.
Sc may thicken (S12).

Moisture gradient

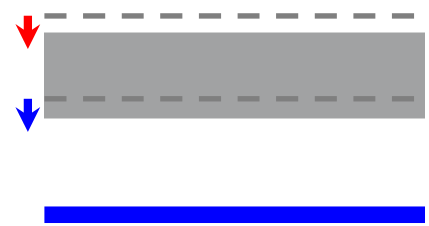
Drier RH or
warmer SST



Larger surface – FT moisture difference allows thinner cloud to sustain same entrainment.
Sc thins.

Inversion strength

FT warms more than SST



Stronger inversion reduces entrainment.
Sc top and base lower.
Sc may thicken (S11).

Based on single-LES sensitivity studies of CGILS S12 and S11 cases
Bretherton et al. 2012 JAMES

GASS GEWEX WCRP Global Atmospheric System Studies

WGNE

The Gray-Zone

A WGNE-GASS project – Pier Siebesma, Paul Field

WGNE

Motivation

- Increased use of (operational) models in the “gray zone” (Dx = 1 ~10km)

•Models operating in this resolution range resolve some of the “aggregation of convective cells” but certainly no individual convective cells.

•This leads to the “wrong” perception that these “gray-zone” models can realistically represent turbulent fluxes of heat, moisture and momentum.

•There is an urgent need of a systematic analysis of the behavior of models operating in the “gray-zone”:

“The Gray Zone Project”

WGNE

The plan

- Project driven by a few expensive experiments **(controls)** on a large domain at a ultra-high resolution (Dx=100~500m) (~2000x2000x100 grid points).

- Coarse grain the output and diagnostics (fluxes etc) at resolutions of 1, 2, 4, 8, 16, 32 km. (pseudo experiments: coarse)

- Repeat CONTROLS with 1km, 2km, 4km, 8km, etc without convective parametrizations etc (NOPARAMS)

- Run (coarse-grain) resolutions say 4km, 8km, 16km and 32km with (deep) convection parametrizations (PARAMS)

Interest on participation on the Gray Zone Project

	global	Meso Operational	Meso idealised	LES	contacts
MetO	MetO globa Model	MetO meso model	MetO meso model	MOLEM	Paul Field Adrian Lock Andy Brown
Meteo France	Arpege	AROME MesoNH	AROME MesoNH (p)	MesoNH	Bouysel Eric Bazile Fleur Couvreux
DWD (MPI-H)	ICON	COSMO-EU COSMO-DE	COSMO-EU COSMO-DE	UCLA-LES	Martin Kohler Axel Seifert Verena Grutzun
Met Service Canada		Canadian LAM		Canadian LES	Vaillancourt Jason Milbrandt Aytron Zadra Stephan Belair
NCAR		WRF	WRF (p)	WRF(p)	Jim Dudhia
ECMWF	IFS (p)				Anton Beljaars
KNMI		HARMONIE	HARMONIE (p)		Wim de Rooy
TU Delft		Harmonie		DALES	Stephan de Roode Ramon Mendez
		Alaro	Alaro		J-F Geleyn
JMA Univ. of Tokyo	NICAM	JMA model	JMA model	LES	Kazuo Saito Niino Kimoto

WGNE

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CONSTRAIN

Proposal: "Constrain" cold-air outbreak experiment 31 January 2010

4 Different flavours

1. Global Simulations (at the highest possible resolution up to 5 km)

2. Mesoscale Models (Eulerian)

   At various resolutions (up to ?)

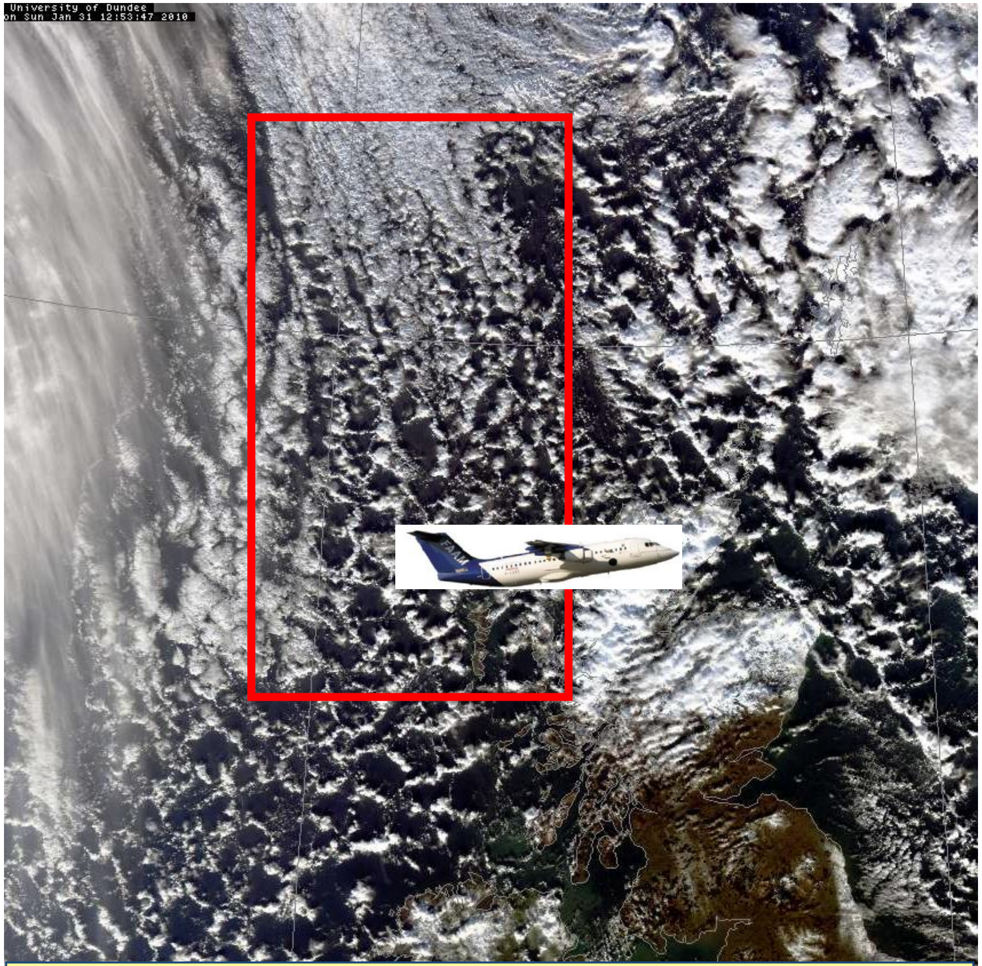
3. Mesoscale Models (Lagrangian)

   Idealized with periodic BC

4. LES models (Lagrangian)

   (in the same set up as 3)

4 case leaders?



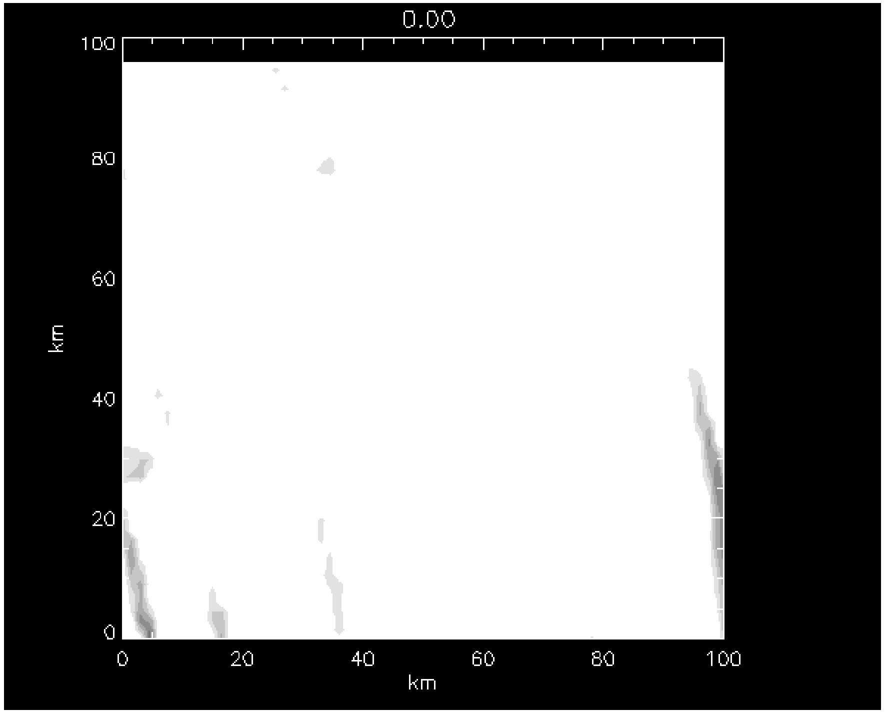
Domain of interest: 1500X1000 km
Quick Transition : ~ 12 hours

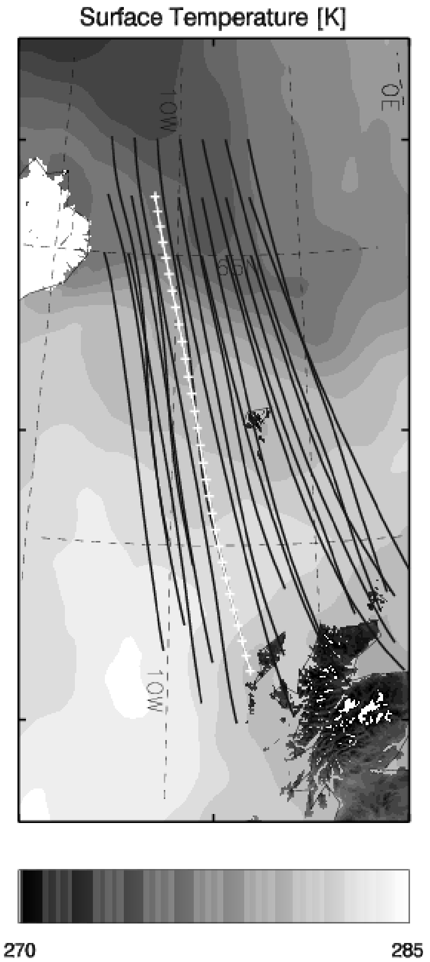
WGNE

LAM simulation

Quasi-lagrangian trajectory

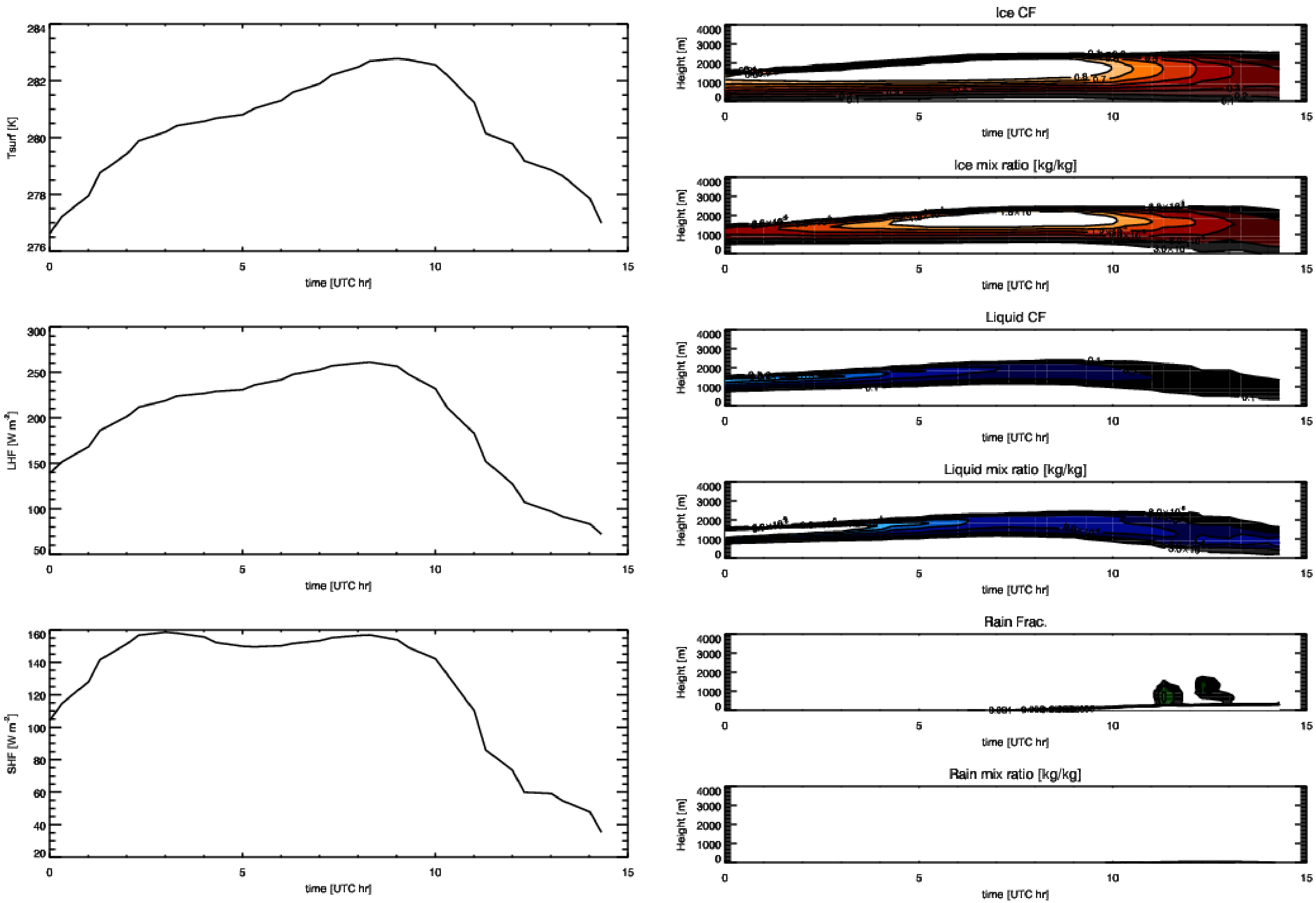
Low cloud fraction





Quasi-lagrangian timeseries

start point 65 N -10 W, 0 UTC



Initial Proposal for LES/Mesoscale Langrangian set-up

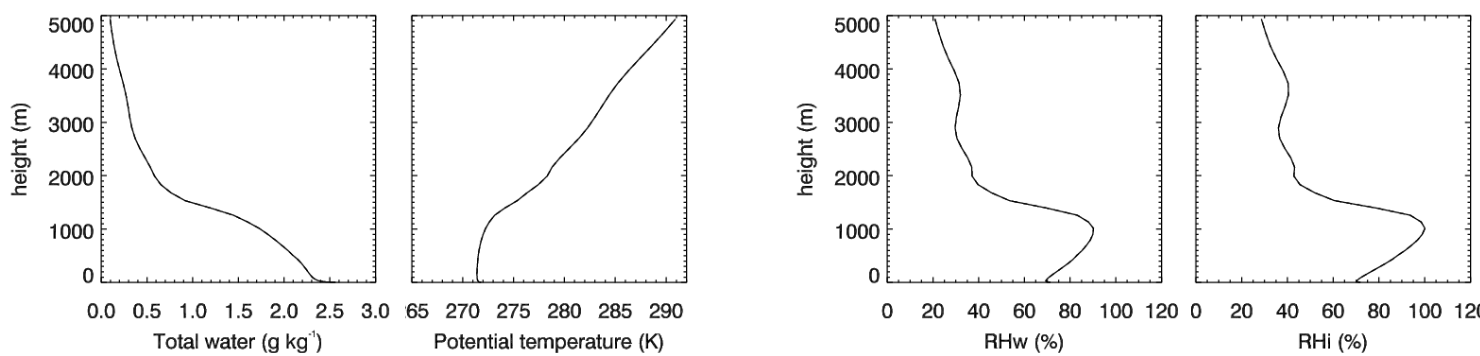
x,y domain = 250 X 250 km (how large is large enough?)

dx, dy ~ 250 m

z domain = 5 km

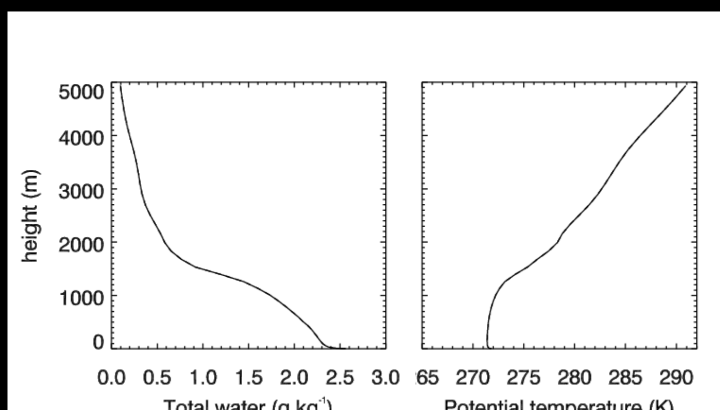
dz = 20 m between surface up to 100m at 5000m

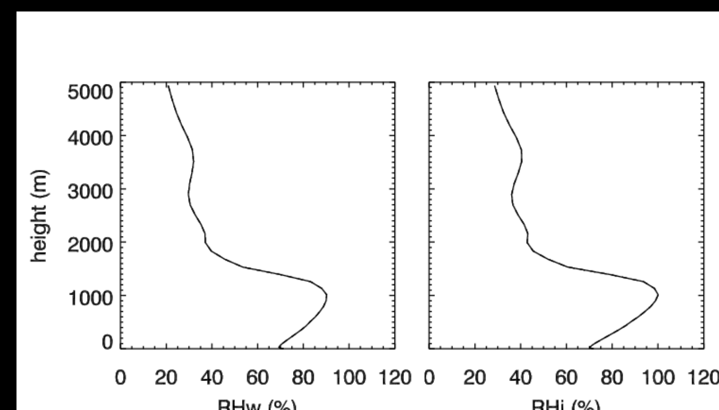
The case is initialised with total water and liquid/ice water potential temperature based on output from the NWP simulation



Initial Proposal for CRM case set-up

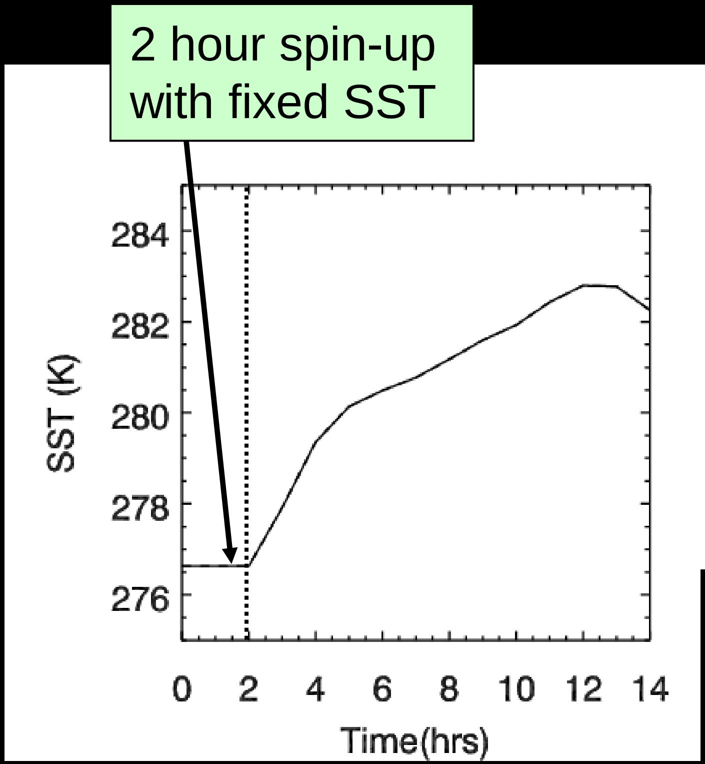
- x,y domain = 12.8 x 12.8 km
  - dx, dy = 100 m
- z domain = 5 km
  - dz = 20 m between surface and 1500 m
  - dz = 40 m between 1500 m and 3500 m
  - dz = 100 m between 3500 m and 5000 m
- (Note: vertical resolution is coarse it is planned that dx and dz will be decreased for the intercomparison simulation)
- The case is initialised with total water and liquid/ice water potential temperature based on output from the NWP simulation



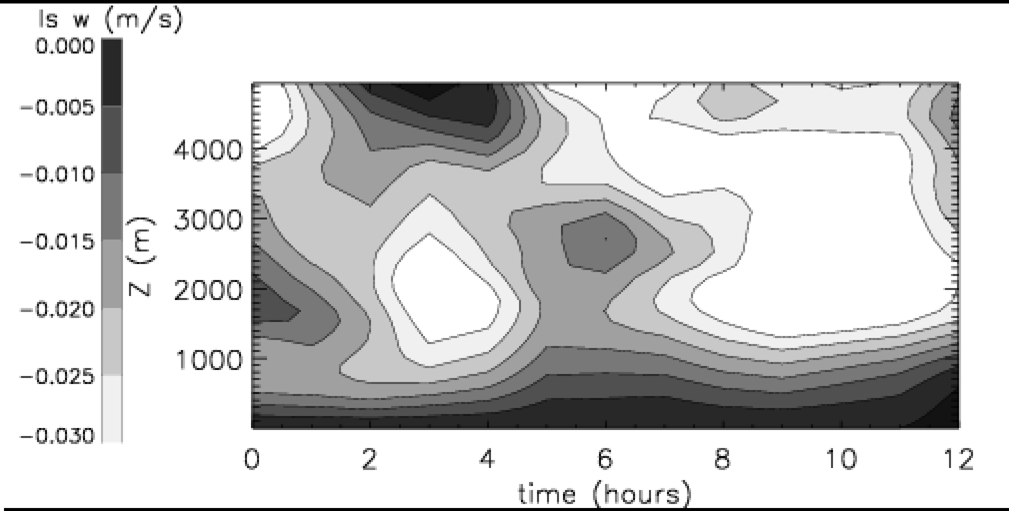


Forcing

Surface forcing



Subsidence



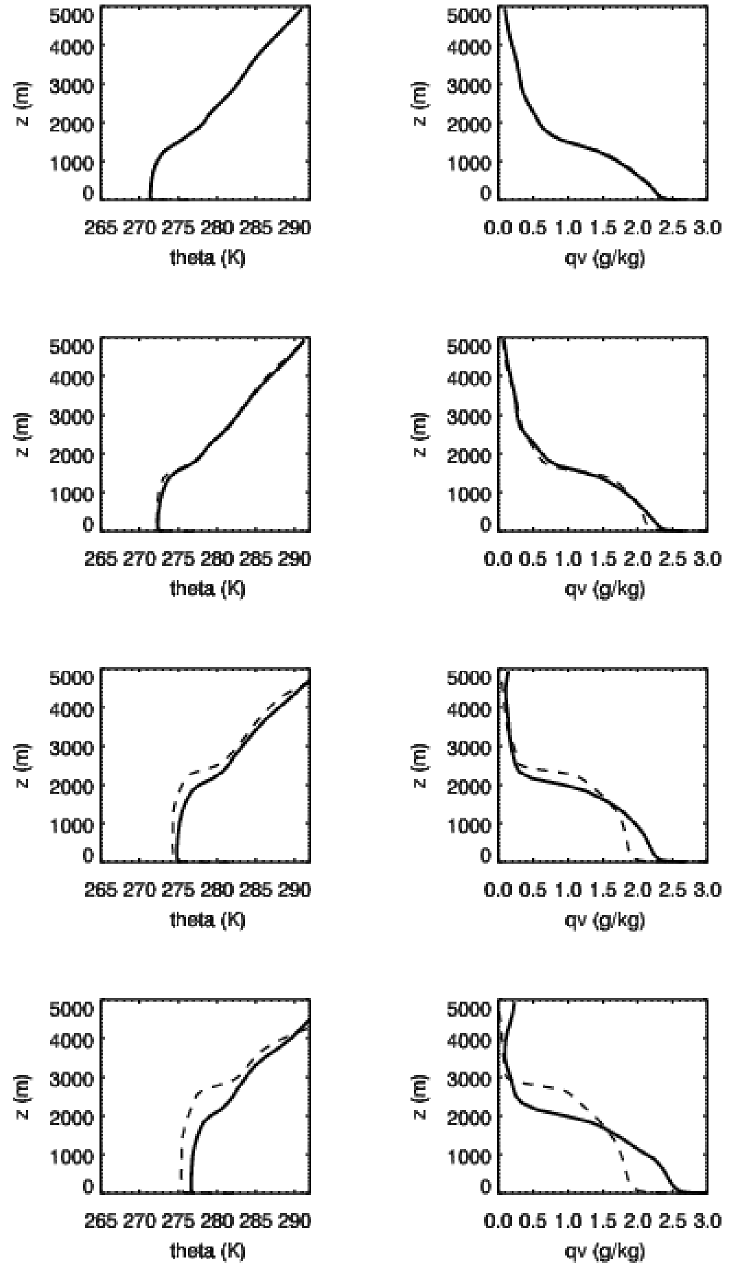
Comparison of thermodynamic profiles from the UM (solid line) and CRM (dashed line)

Initial profile

3hrs – “Spun up”

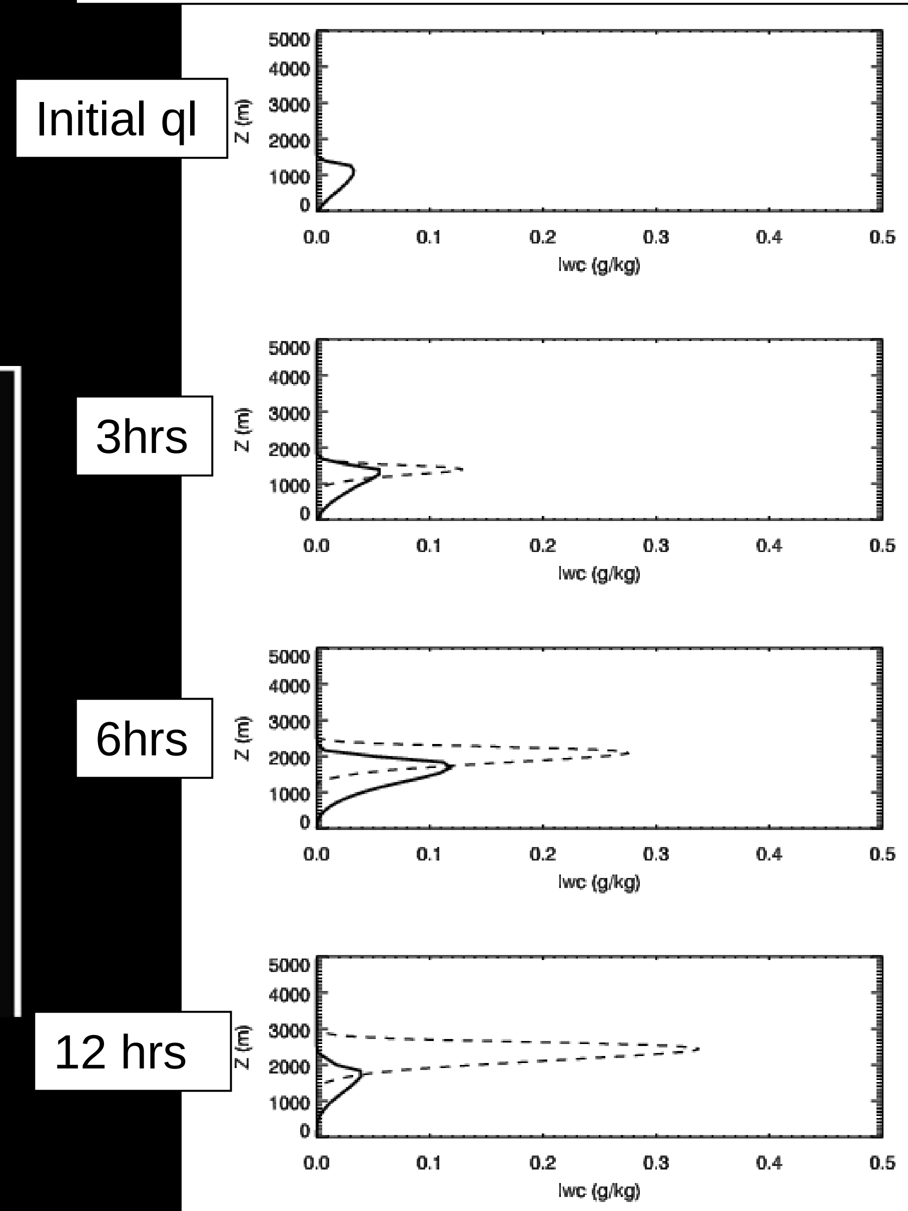
After 6 hours

After 12 hours



LWP Movie from CRM sim (no ice)

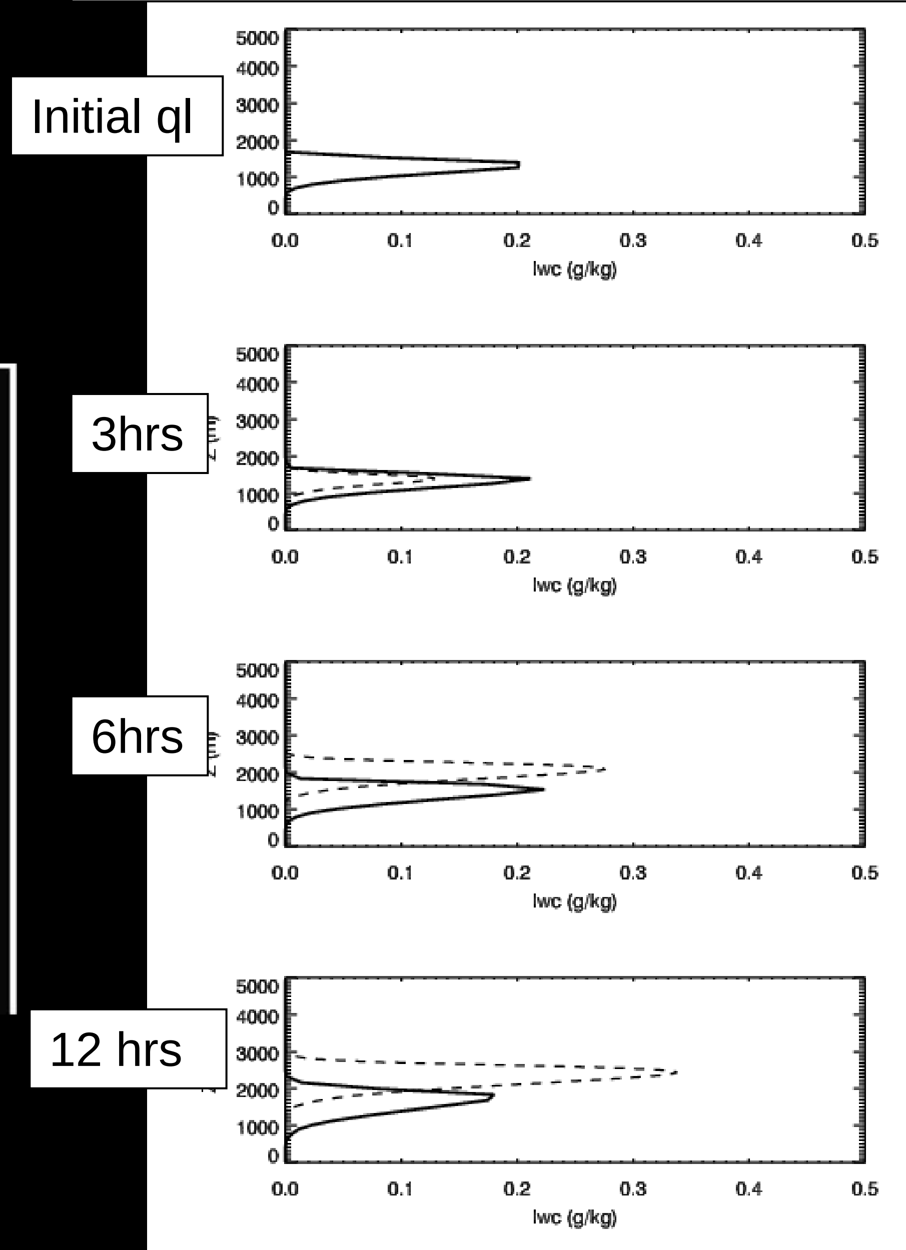
Comparison of LWC from UM with ice (solid line) and CRM (dashed line)



Met Office

LWP Movie from CRM sim (no ice)

Comparison of LWC from UM with no ice (solid line) and CRM (dashed line)



Discussion Points

- Target cloud types perhaps a bit too small for Grey Zone issues (i.e. is it more a classic parametrization issue)
- Are the mesoscale models requested to be constrained lateral to the same global model or not?
- Can we reach a fully resolved mode in the Eulerian mesoscale case?
- How large is large enough in the langrangian mode
- How much do we constrain/simplify the case in the Lagrangian mode:
  - **simplify subsidence fields?**
  - **Prescribe drag coefficients for the surface fluxes?**
  - **Nudge winds?**

Timeline: october/november : testruns with at least 2 LES

Release December 2011

Organisation: different case leaders for the 4 flavours (a la TWP-ICE)?

Met Office

GFDL

National Aeronautics and Space Administration
Goddard Institute for Space Studies

FLORIDA INTERNATIONAL UNIVERSITY

MONASH University

Convective and cloud processes during TWP-ICE: A Multi-Model Evaluation Project

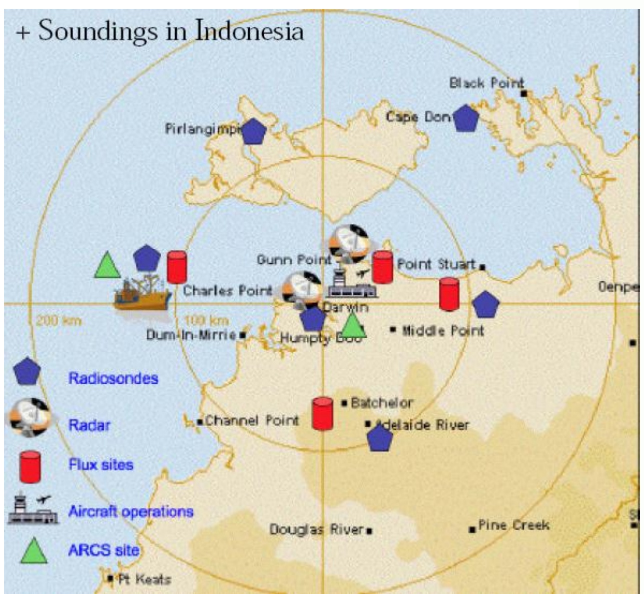
Jon Petch (Met Office), Ann Fridlind (GISS)
Ping Zhu (FIU), Yanluan Lin (GFDL), Laura Davis (Monash University)

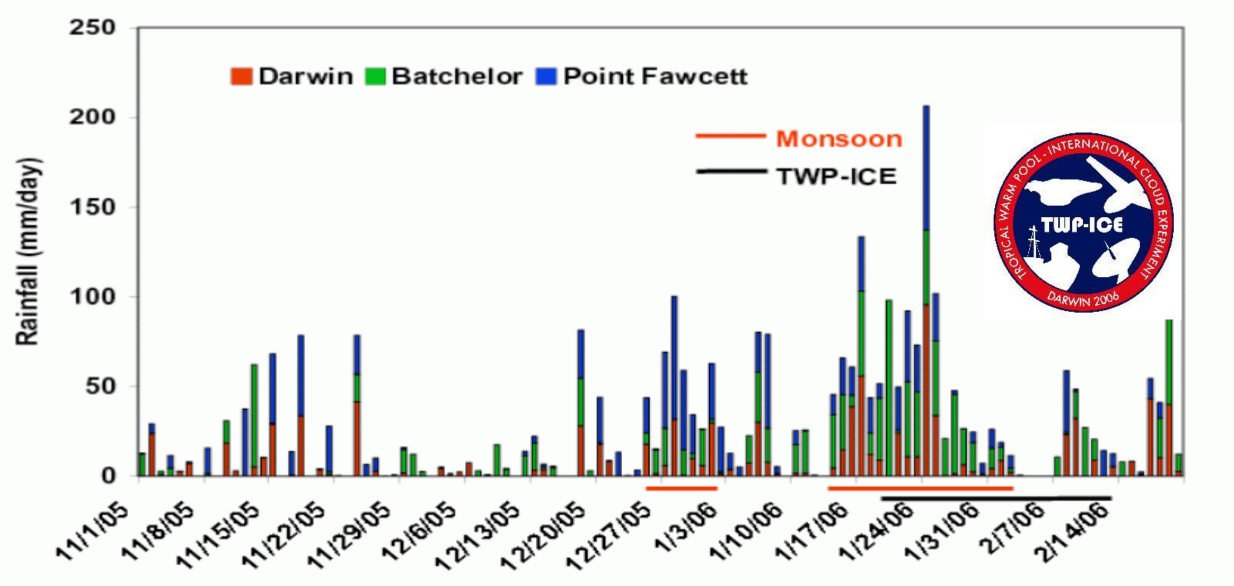
TWP-ICE **Tropical Warm Pool–International Cloud Experiment**

Darwin, Australia – 20 Jan to 13 Feb 2006

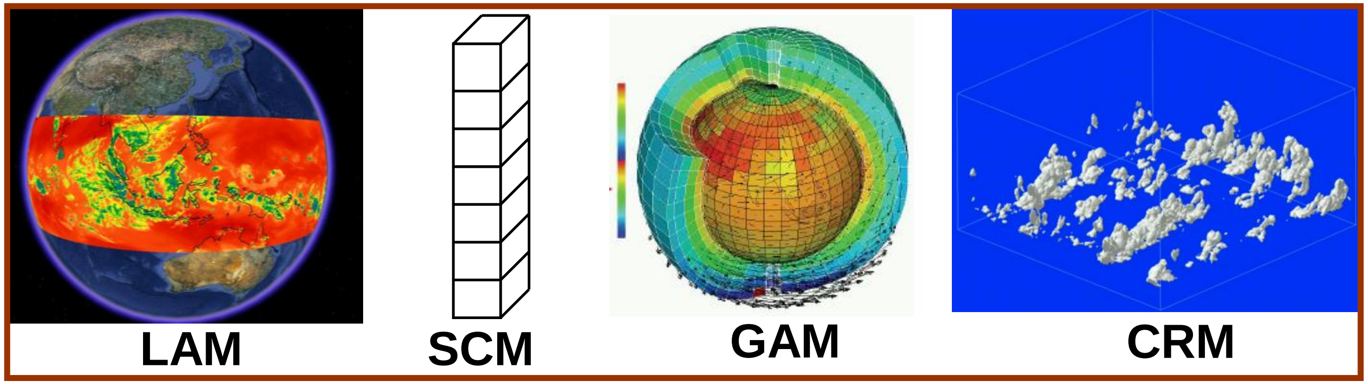
Goals:

- describe the evolution of tropical convection, including the large-scale heat, moisture, and momentum budgets at 3-hourly time resolution
- detailed observations of cloud properties and the impact of the clouds on their environment
- an ideal test bed for driving and evaluating a range of atmospheric models used in weather and climate





TWP-ICE multi model comparison



From a GASS perspective, this is our first case:

- with ensemble forcing (SCM; CRMs 2D)
- with a comparison of LAMs
- With a land-ocean mix in the domain (represented in the LAMs and NWP models)

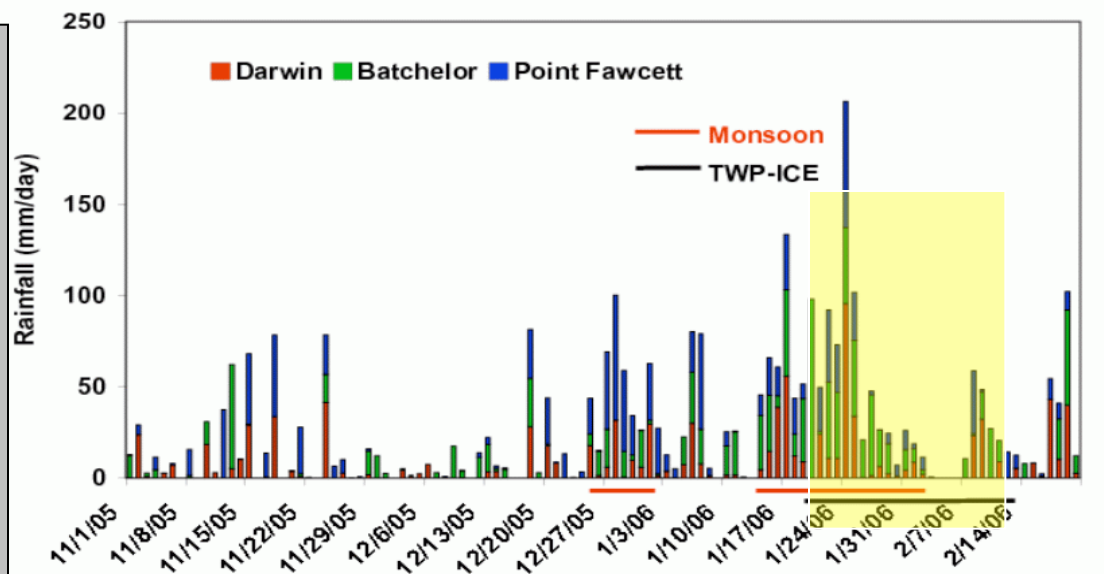


Figure 3. Cumulative rainfall at three locations in the Northern Territory during the 2005-2006 monsoon season. Figure courtesy of Lori Chappel, Australian BOM.

So far (as of Oct 2012):

4 papers – one on each model type 3 published (SCM paper soon)

- **A Comparison of TWP-ICE Observational Data with Cloud-Resolving Model Results**

  Ann Fridlind, A. Ackerman , J-P. Chaboureau , J. Fan , W. Grabowski , A. Hill , T. Jones , M. Khaiyer , G. Liu , P. Minnis , H. Morrison , L. Nguyen , S. Park , J. Petch , J-P. Pinty , C. Schumacher , B. Shipway , A. Varble , X. Wu , S. Xie , M. Zhang

- **TWP-ICE global atmospheric model intercomparison: convection responsiveness and resolution impact**

  Yanluan Lin*, L. J. Donner[1], J. Petch[3], P. Bechtold[4], J. Boyle[2], S.A. Klein[2], T. Komori[5], K. Wapler[6], M. Willett[3], X. Xie[7], M. Zhao*, S.Xie[2], S. A. McFarlane[8], C. Schumacher[9]

- **A Limited Area Model (LAM) Intercomparison Study of a TWP-ICE Active Monsoon Mesoscale Convective Event**

  Ping Zhu, J. Dudhia , P. Field , K. Wapler , A. Fridlind , A. Varble , E. Zipser , J. Petch , M. Chen , Z. Zhu

- **Single column model intercomparison for TWP-ICE**

  Laura Davies et al

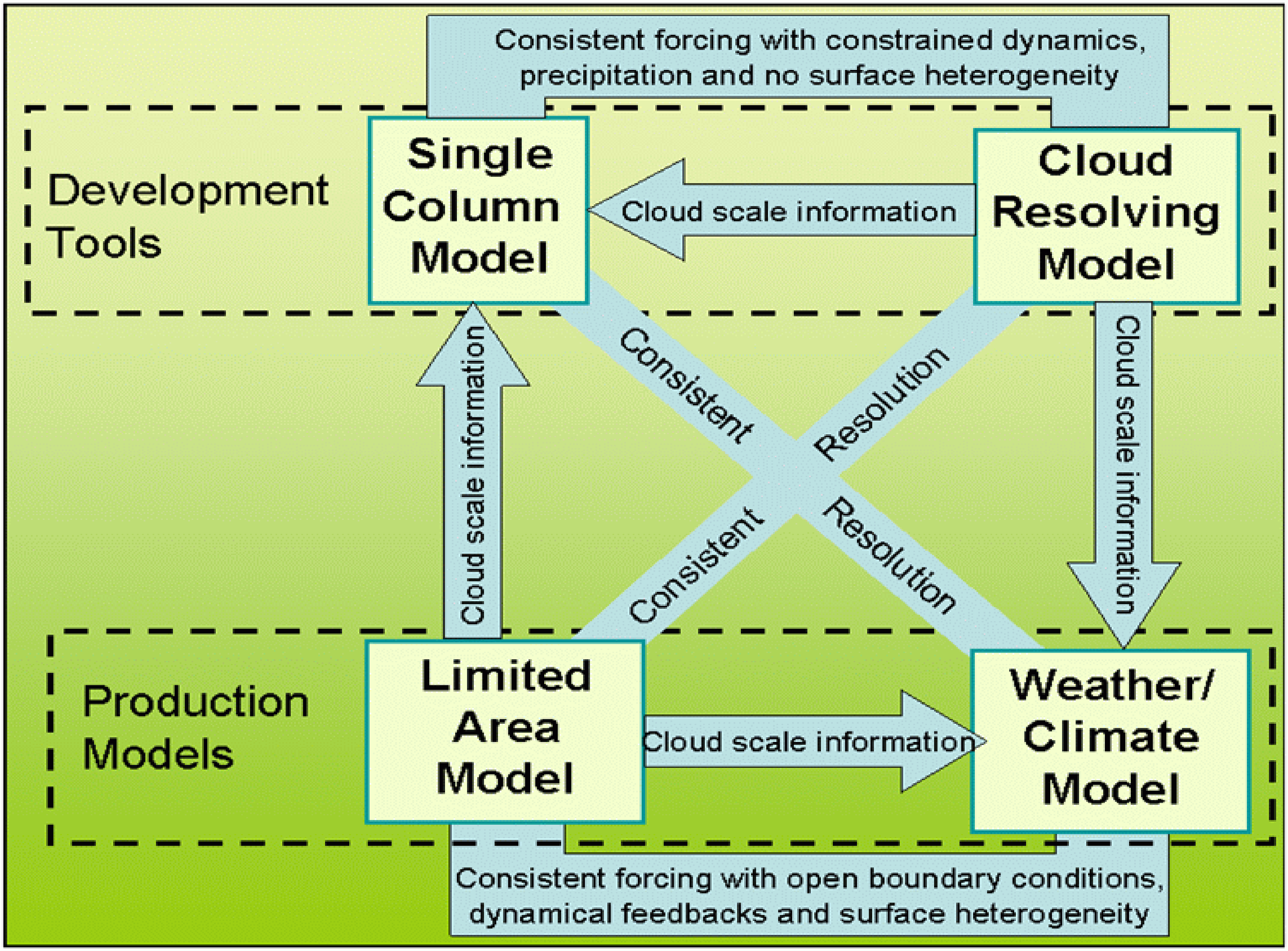
Overview paper about to be submitted

- **Simulation of tropical convection during TWP-ICE with a multi-modelling framework.**

  Jon Petch, A. Fridlind, P. Zhu, Y. Lin, L. Davies, S. Xie & A. Hill

Model Type Reference	LEM/CRM Fridlind et al 2012	LAM Zhu et al 2012	Global Lin et al 2012	SCM Davies et al 2012
Number of models	**10**	**6**	**9**	**10**
Domain width	~250 km	~450 km	Global	NA
Horizontal grid length	0.9 to 3 km	1 to 3 km	20-250 km	25 – 200 km
Vertical grid length (around 500 mb)	200 to 600 m	300 to 500 m	400 m - 1.2 km	500 m to 1km
Forecast lead time analysed	Free running	12 to 36 hours	24 to 48 hours	Free running
Forcing	Variational analysis	Nested in global models/ driven by EC analysis	Driven by EC analysis	Ensemble Variational analysis
Deep Convection	Explicit	Explicit	Parametrized	Parametrized
Shallow convection	Explicit	Mix of BL, Shallow schemes, numerical/explicit	Parametrized	Parametrized
Cloud scheme	All or nothing	Some all or nothing, some parametrized	Parametrized	Parametrized

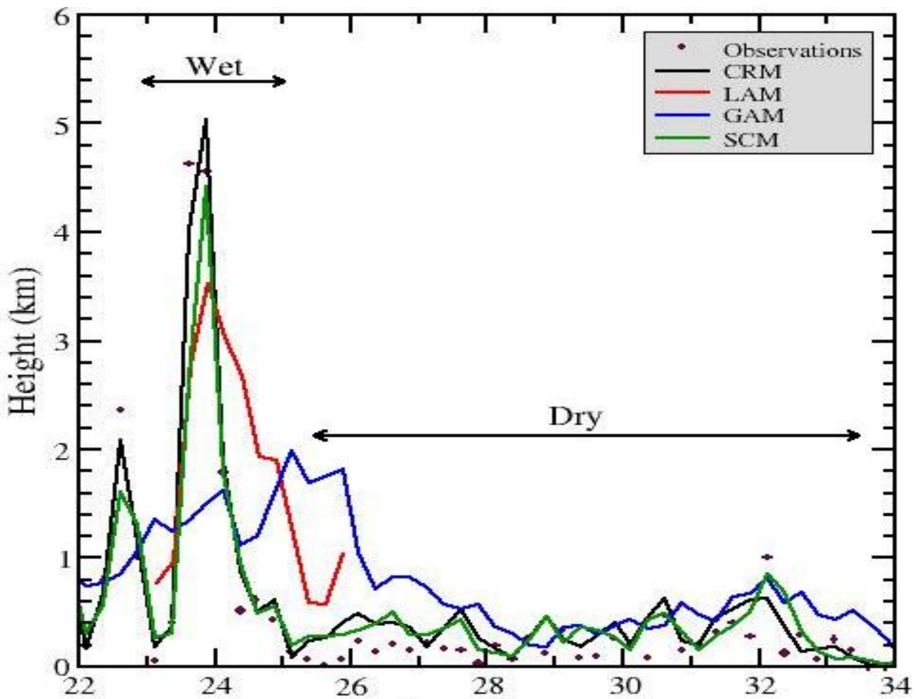
Bringing the results together



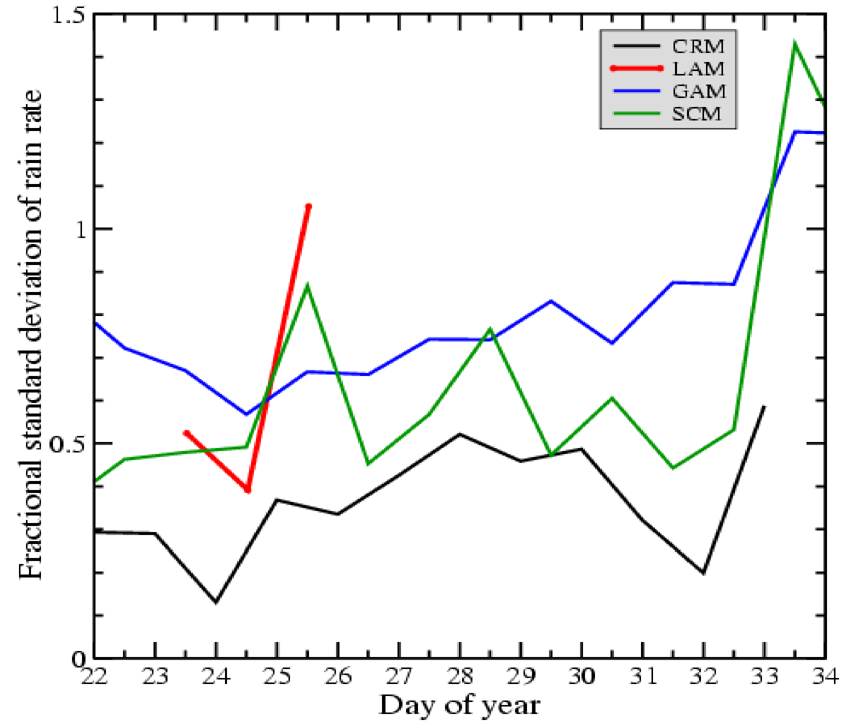
Bringing the results together

- While they do all do better at precip than other diagnostics, there are clearly differences across model type
  - CRMs and SCM constrained but note CRMs have higher peaks (3 hour averages)
  - More spread in SCMs than CRMs
  - LAMs delayed and less sharp peak
  - GAMs are more delayed than LAMs and seem to smooth out the sharper events

Mean



Spread

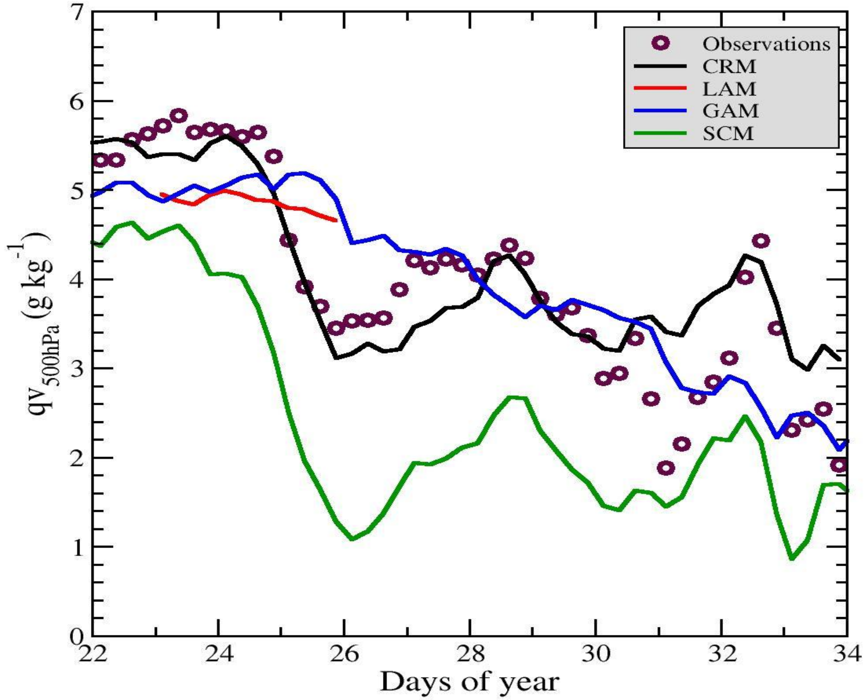


Met Office · NASA · GFDL · MONASH University · FIU · TWP-ICE · WCRP World Climate Research Programme · GASS · GEWEX WCRP Global Atmospheric System Studies

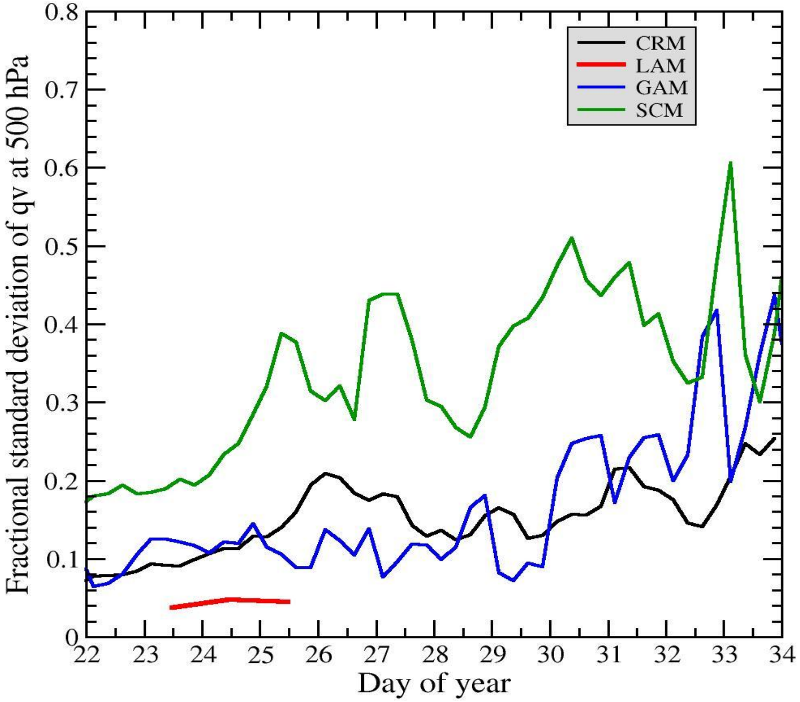
Bringing the results together

- Need to consider forcing carefully when looking at the mid-tropospheric moisture
    - CRMs follow observations very well (surprisingly so?)
    - GAMs and LAMs closer to obs but missing sharp changes. Will be closer as only short forecasts
    - SCMs much drier than other models throughout. Also have largest spread. In theory should have same forcing as CRMs although some differences which may be important.

Mean

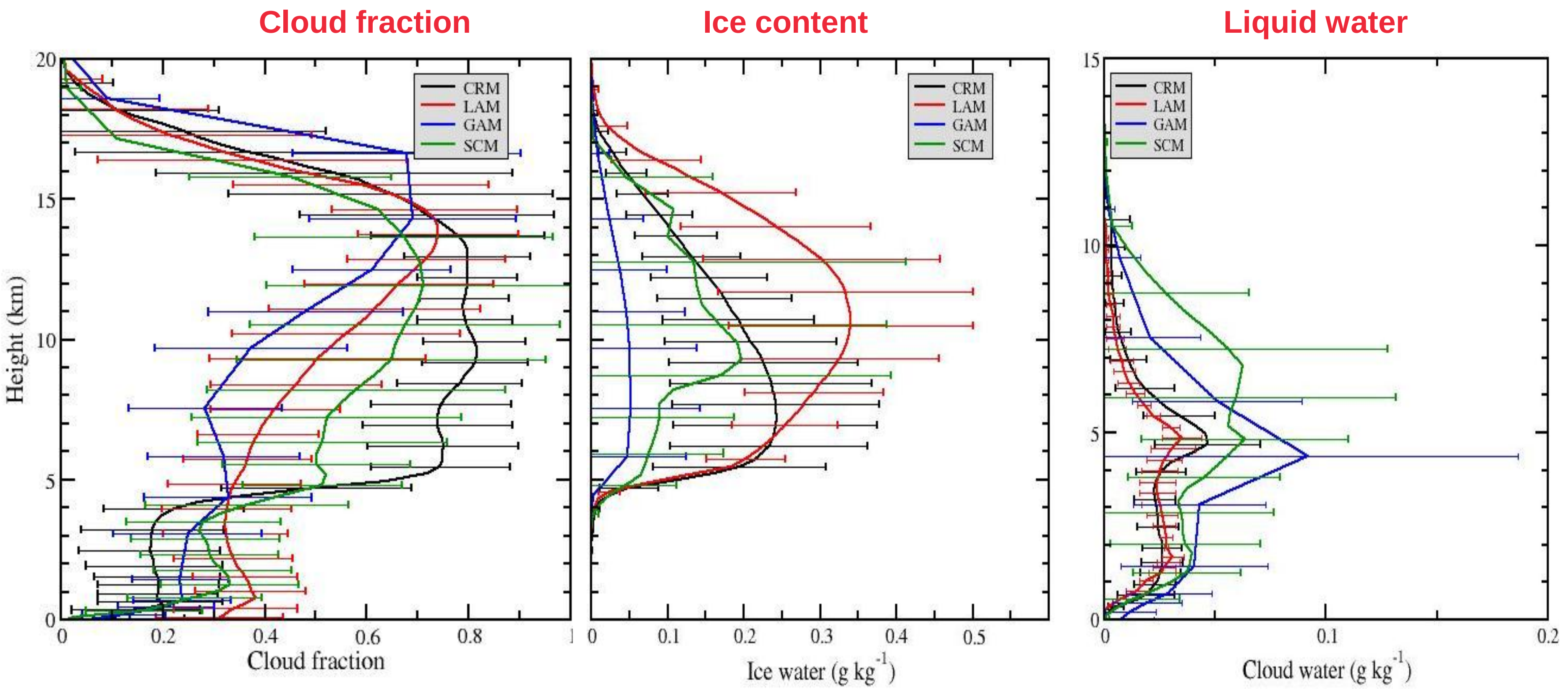


Spread



Bringing the results together

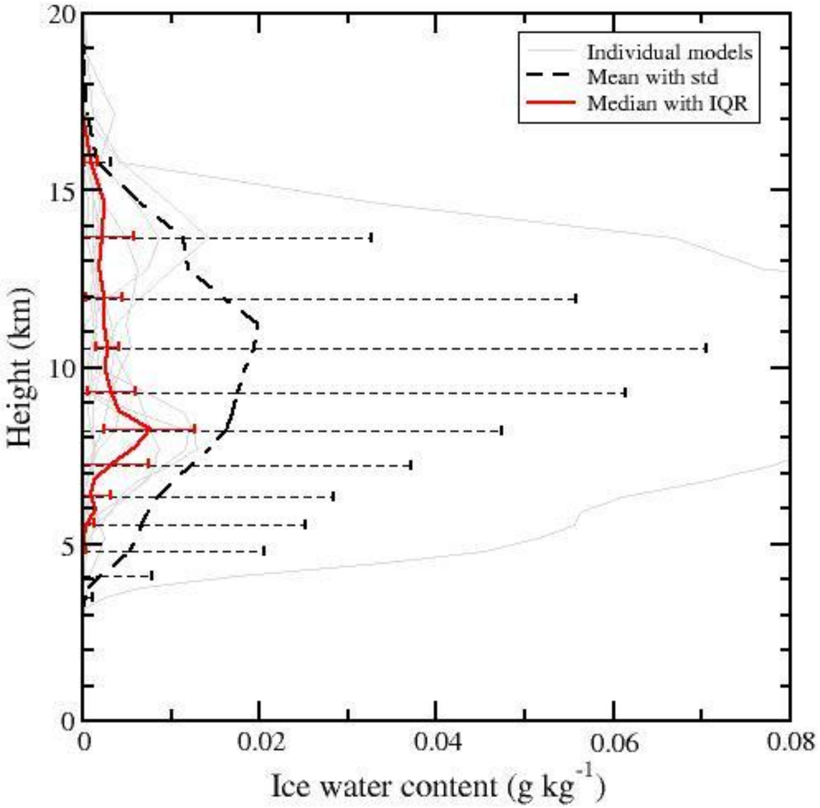
- Clouds
  - The large spread in ice is across all models (microphysical?)
  - The spread in liquid water is in the GAMs and SCMs (parametrized convection/clouds?)



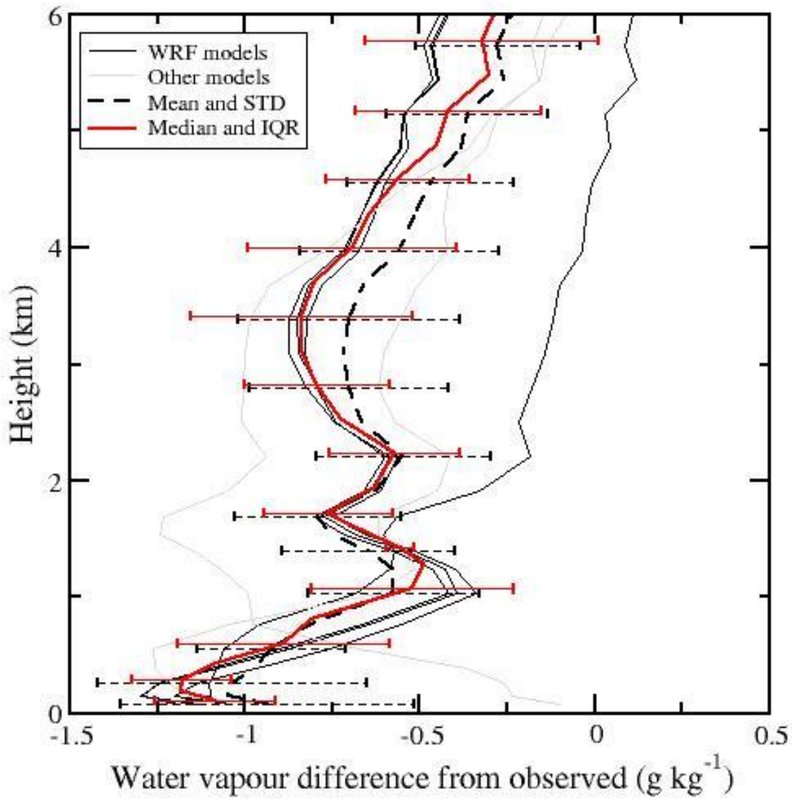
Bringing the results together

- Outliers and similar models
  - One SCM has far more ice – is it wrong?
  - How do you account for “similar models”?

SCMs



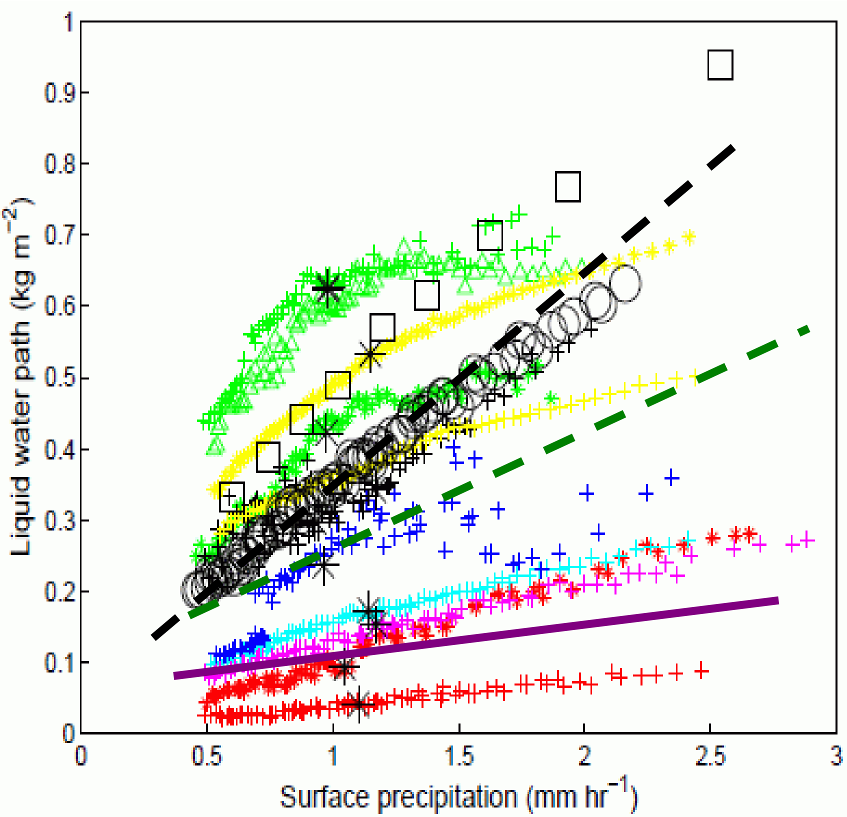
LAMs



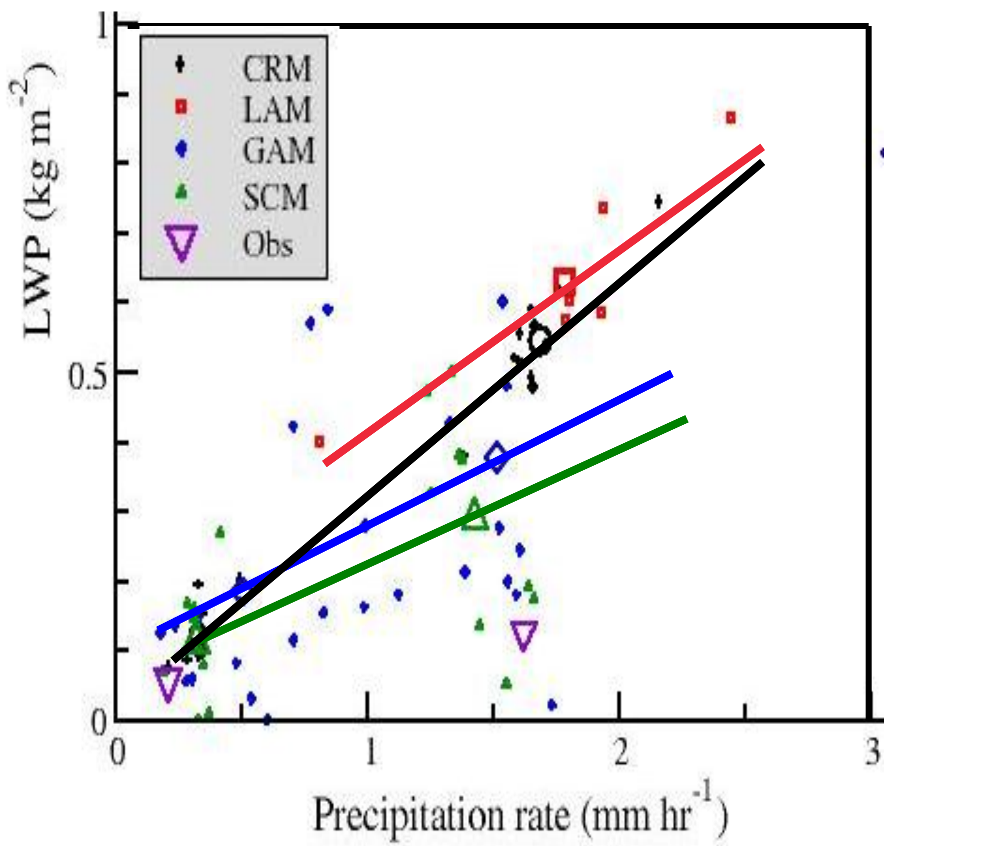
Bringing the results together

- Relationships
  - Ensemble SCM runs good for this but:
  - Multi models seem to have similar relationship for SCM/CRM

CRM/SCM ensembles



All models



Key conclusions

- Large spread in ice in all models – bulk microphysics still needs refining?
- Large spread in liquid water in SCM/GAMs – more related to parametrizations of cloud and convection?
- The “dry” or “suppressed” period appears to be a good test bed for the response of convection schemes to free troposphere
- Drift of SCMs (and CRMs?) Why not run 48 hour forecasts for SCMs like GAMs.
  - Ensemble impacts on this?

Some thoughts/lessons learnt for similar comparisons

- More coordination across cases is needed
  - Forcing methods for SCMs/CRMs (perhaps small sub sampled ensembles for CRMs)
  - Diagnostics and focus of the study – CRMs this time had a microphysics focus and did not have the diagnostics to ask questions about Mass Flux and bulk cloud properties
  - Cross model type but single model of each may be better start to design case
- Relationships between Analysis and variational Analysis driving the models
  - Add some runs of SCMs with Analysis driven forcing
- Need plans on dealing with “similar models” in presenting a combined view
  - Is it a different model or a sensitivity study
- Plans on dealing with outliers in presenting overview (use of median etc…?)
- Still need to entrain more LAM participants
  - Perhaps LAMs at lower resolution 4-12km

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Polar clouds – ISDAC/Microphysics KiD (Indirect and Semi-Direct Aerosol Campaign)

Mikhail Ovchinnikov (PNNL, mikhail@pnnl.gov)
Andrew Ackerman, Alex Avramov, Gijs de Boer, Ann Fridlind, Alexei Korolev,
Hugh Morrison, Ben Shipway, and others)

ISDAC – based model intercomparison

Mikhail Ovchinnikov (PNNL, mikhail@pnnl.gov)

Joint activity:

- DOE Atmospheric System Research (ASR) Program – Cloud-Aerosol-Precipitation Interactions (CAPI) Working Group;
- Global Atmospheric System Studies (GASS);
- WMO Cloud Modeling Workshop (CMW) (July 2012)

Goals:

Dynamics-microphysics-radiation interactions are important and need to be understood and modeled better

- Dynamics: Additional diagnostics for vertical velocity, TKE, buoyancy flux, etc.
- Microphysics: Constrain other parameters or process rates for ice (e.g., size-mass ratio, deposition growth rate, sedimentation, etc.)
- Radiation: Unified parameterized radiation/heating rates calculations

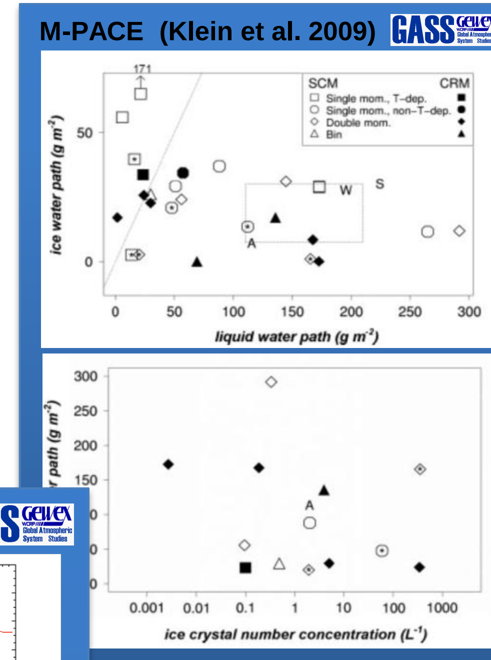
Target models: LES/CRM (SCM is being discussed)

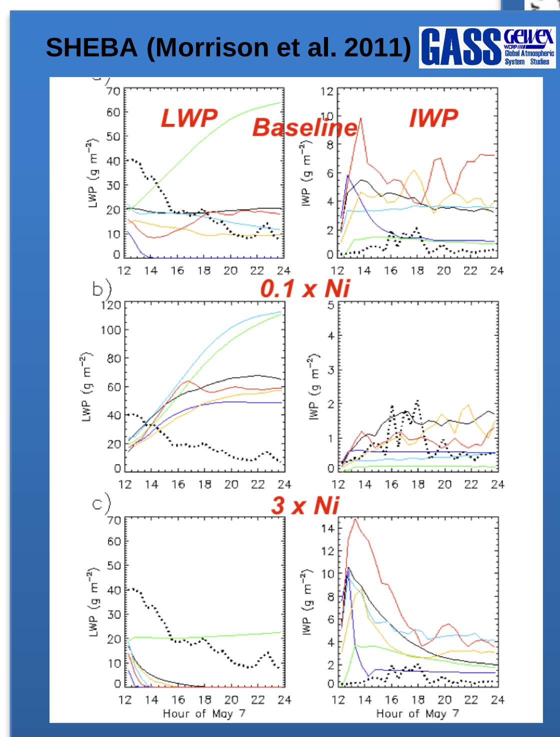
ISDAC – based model intercomparison

Background:

Build on previous intercomparisons (M-PACE, SHEBA, etc)

- Large spread of LWP and IWP among models (CRM and SCM)
    - Uncertainty in ice nucleation mechanisms plays a big role
    - … but constraining ice number does not eliminate LWP spread (SHEBA)
- For many models there is a sharp transition from mixed-phased to ice-only clouds when N_i is increased (SHEBA)

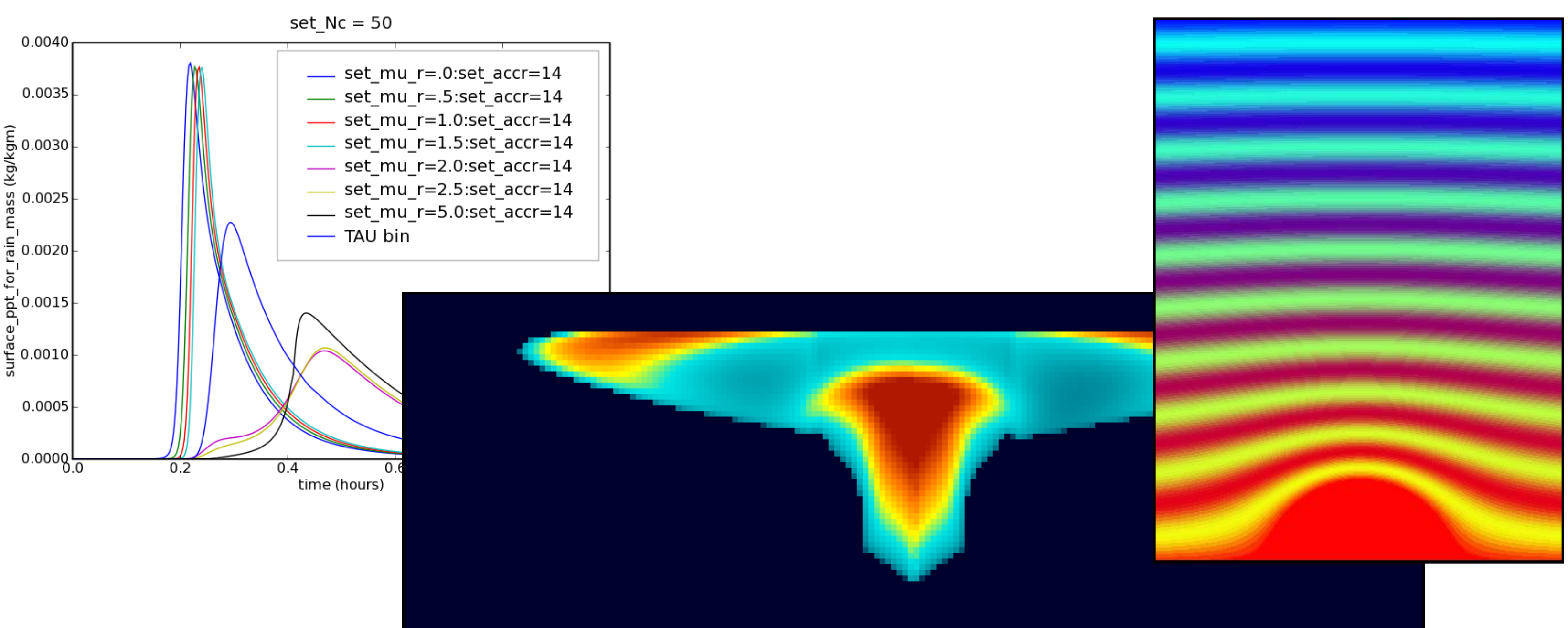




Microphysics

- The KiD model has been upgraded to provide 2-D forcings as well as 1-D
- 2-D intercomparison of warm rain processes
- Links with GASS/WMO ISDAC intercomparison case

•Potential links with other WMO cloud modelling group cases (e.g. squall line case)



KiD 2-D intercomparison

Primary focus:

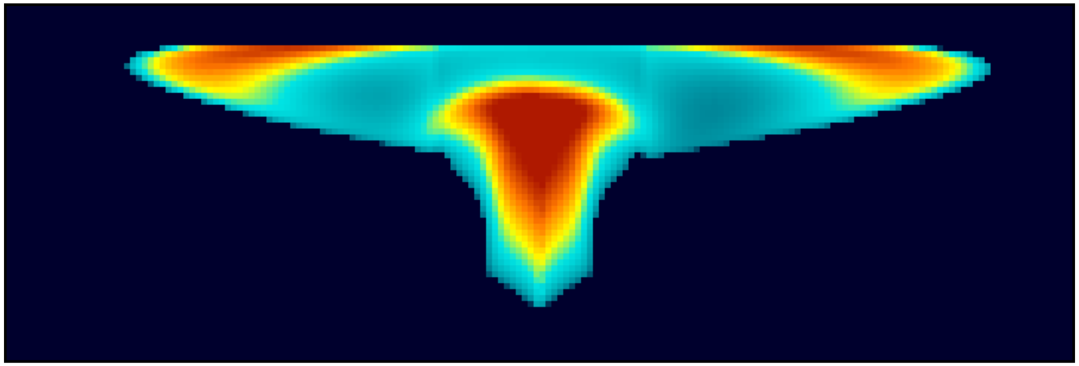
Understanding differences in onset and evolution of precipitation in warm rain scheme of differing complexity (1-M/2-M/1-Mbin/2-Mbin..)

Outcomes:

- Determine if bin schemes provide a reliable benchmark for developing bulk parametrizations
- Determine limitations of simpler (cheaper) microphysics schemes.

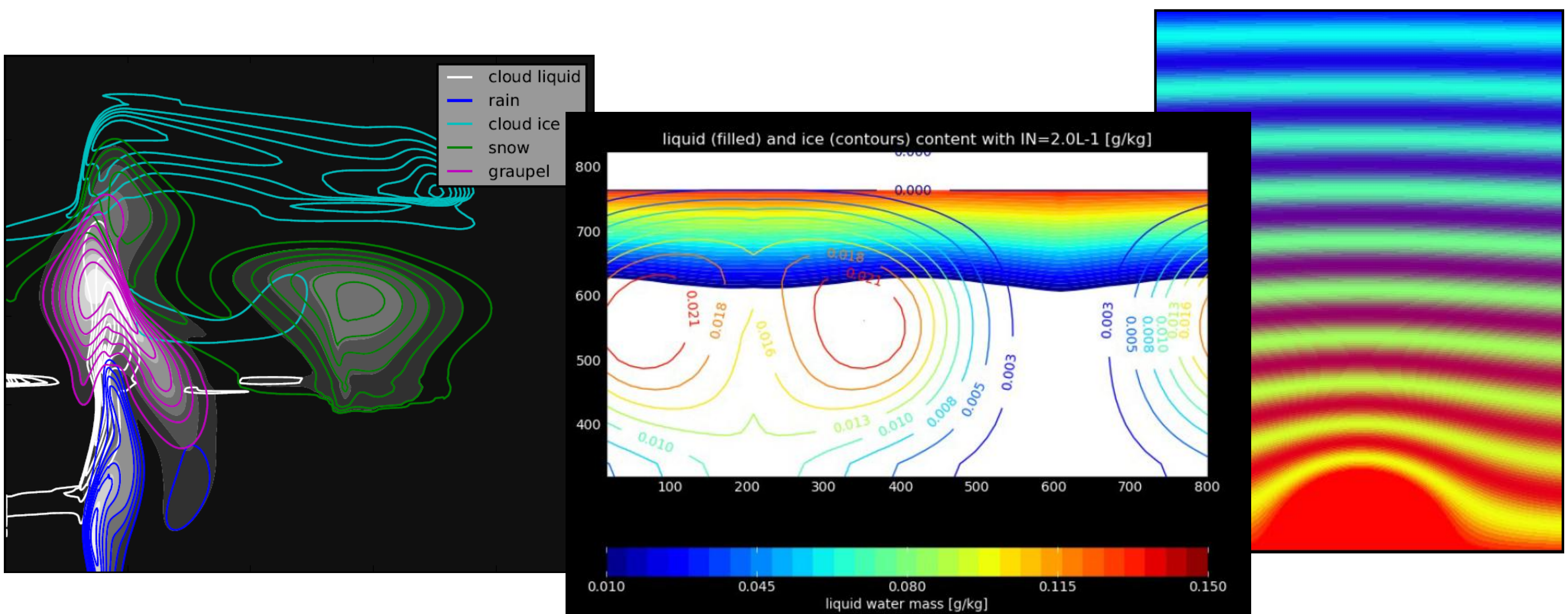
Details:

- Based on 2-D kinematic cumulus case (Szumowski et al. 1998)
- Further details to be posted on http://appconv.metoffice.gov.uk/microphysics



Links to WMO cloud modelling group

- The WMO cloud modelling group meets every 4 years and already has links with GASS through the polar cloud projects
- There exists potential overlap in the use of the KiD model. Specifically the 2-D KiD has:
  - a warm stratocumulus case, which can be used for studying CCN processing
  - a squall-line case
  - a cold stratocumulus case (ISDAC)
  - a flow over orography case



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Enjoy…