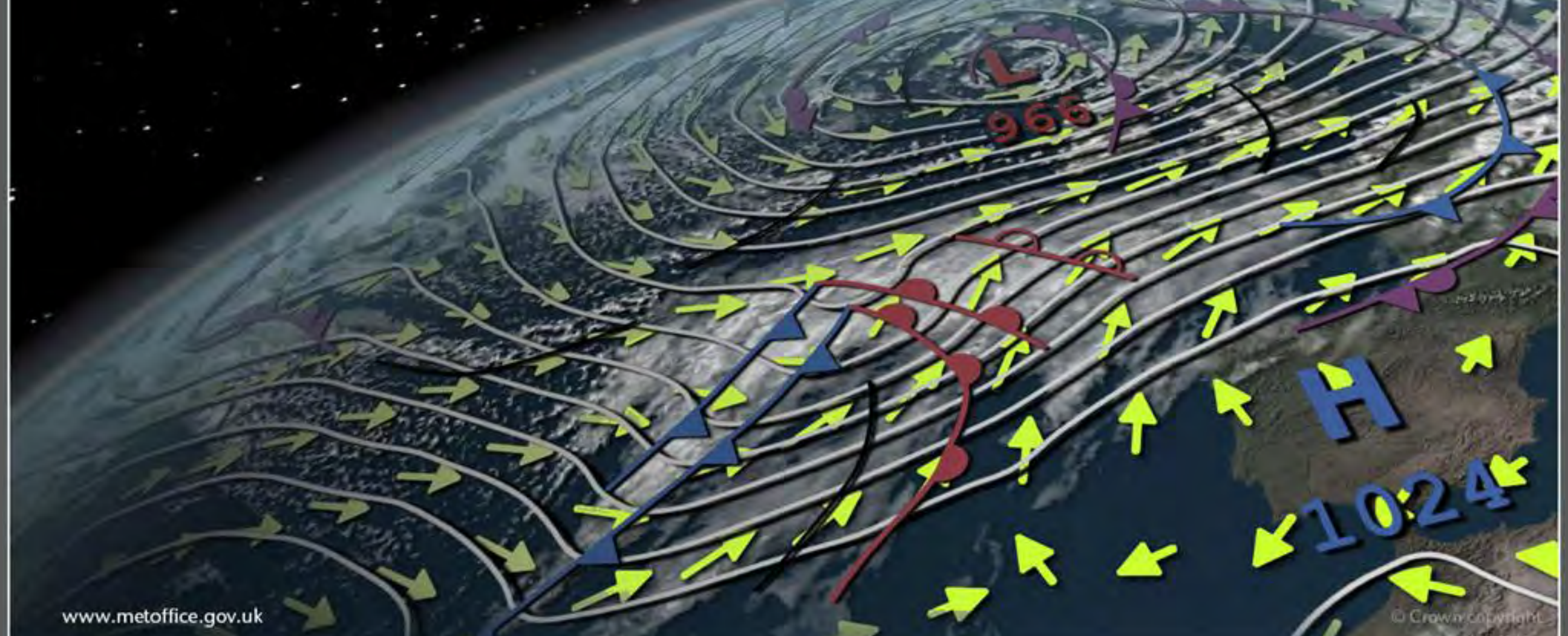
Update on Projects in GASS

GLASS Panel Meeting, May 2017

John M. Edwards



Projects within GASS

http://www.gewex.org/panels/global-atmospheric-system-studies-panel/gass-projects/

- GABLS(4) – Boundary layer over Antarctic Plateau
- CAUSES – Clouds and the warm bias over the American midwest
- Diabatic Processes and the MJO

Met Office

- Microphysics project
- Boundary Layer Cloud Projects
- CGILS – Boundary layer cloud feedbacks using idealized climate perturbations
- Polar Cloud Project – Mixed phase Arctic clouds
- Cirrus Model Intercomparison Project
- Grey Zone – Cold Air Outbreak

- Continuous Intercomparison of Radiation Codes

GABLS(4)

Eric Bazile, Fleur Couvreux, Patrick LeMoigne, Bert Holtslag

Met Office

- GABLS focuses the atmospheric boundary layer (especially the stable boundary layer)
  - Based on process studies
  - Strong involvement of LES
- Four cases so far:
  - GABLS1: Idealized weakly stable boundary layer over sea
  - GABLS2: Partly idealized diurnal cycle over land with prescribed surface temperature
    - Predecessor of DICE
  - GABLS3: Real diurnal cycle over land including land surface and radiation
  - GABLS4: Diurnal cycle over snow
- Progression to more stable BLs, closer alignment with real data and greater emphasis on coupling to the (land) surface

Met Office

GABLS4

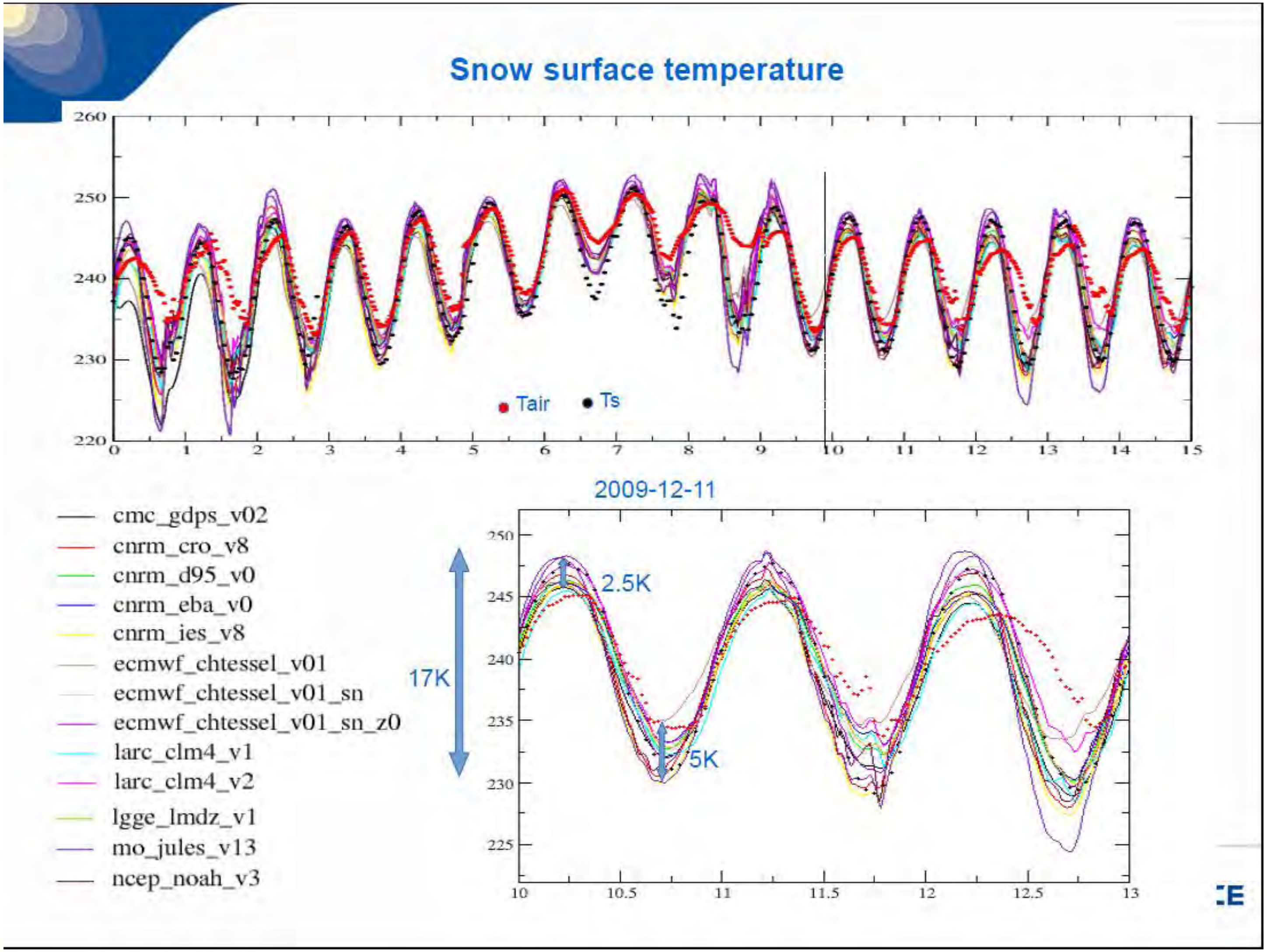
- Case released in 2014
- Based on observations from Dome C on the Antarctic Plateau in December 2009
    - Stage 0: Land surface (snow) model driven by near-surface observations for 15 days
        - 6 participants: Some modelling groups have only simple snow schemes
    - Stage 1: Coupled land and atmospheric models in SCM for 36 hours (no cloud)
        - 17 participants
    - Stages 2—4: Idealized simulations including LES, prescribed surface temperature
        - 10 participants

Current Status & Some Results

- Recent Meetings
  - Workshop in Toulouse, May 2015
    - Initial synthesis and definition of new reference cases
  - Side meeting at the BLT in Salt Lake City, June 2016
  - 1-day session at the SBL workshop in Delft, March 2017
    - Suggestions for new large-eddy runs
- Tighter specification of surface properties in new reference SCM runs helps to reduce spread in simulations
  - Significant impact of surface schemes
- LES of the very stable SBL is still a challenge
  - Try even finer resolution, 0.25 m?

P. Le Moigne, Météo France

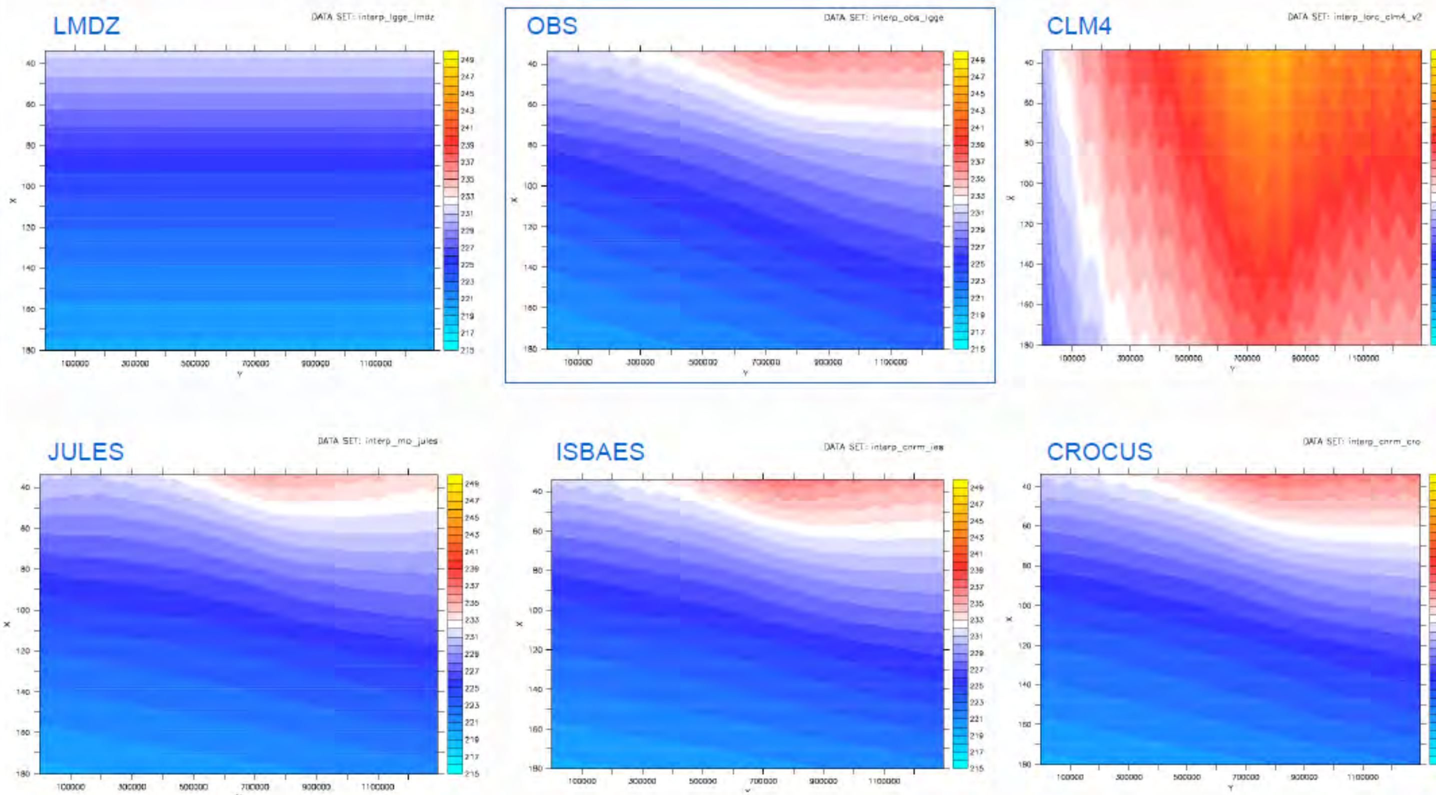
Stage 0



Met Office

Met Office

Snow temperature profiles



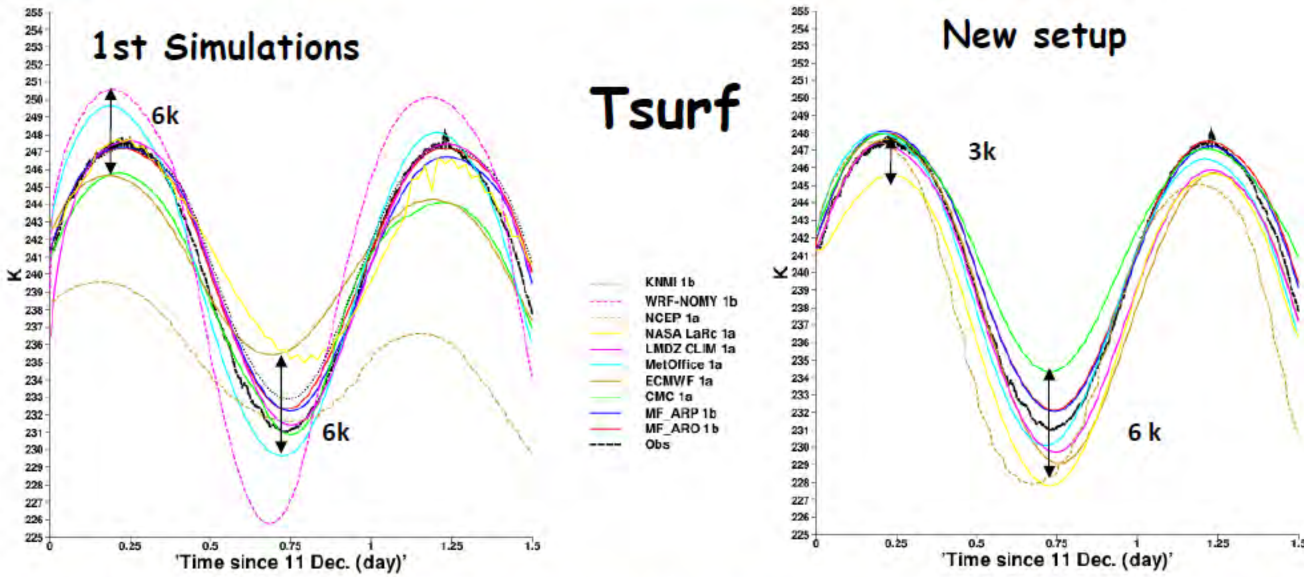
METEO FRANCE

www.metoffice.gov.uk

E. Bazile, Météo France

Stage 1

Impact of the new setup SCM stage1



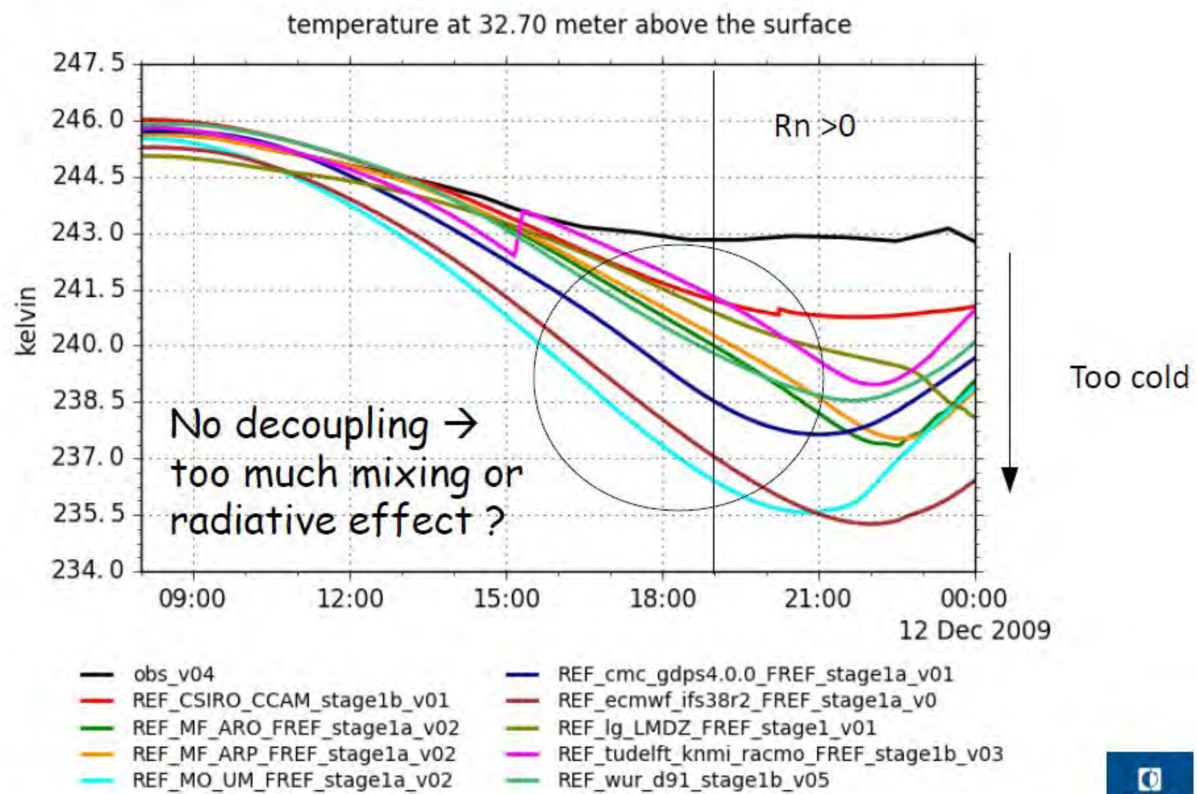
Less variability with the new simulations especially during day time (mainly due to the prescribed albedo). During night, for the Ts min, the variability is probably due to the turbulence scheme, radiation and surface layer

Turbulence in Stably Stratified PBL, 3rd Decennial Workshop
Delt 27-31 March 2017, Netherland

Met Office

www.metoffice.gov.uk

Phase C : warming (Rn>0) stage1



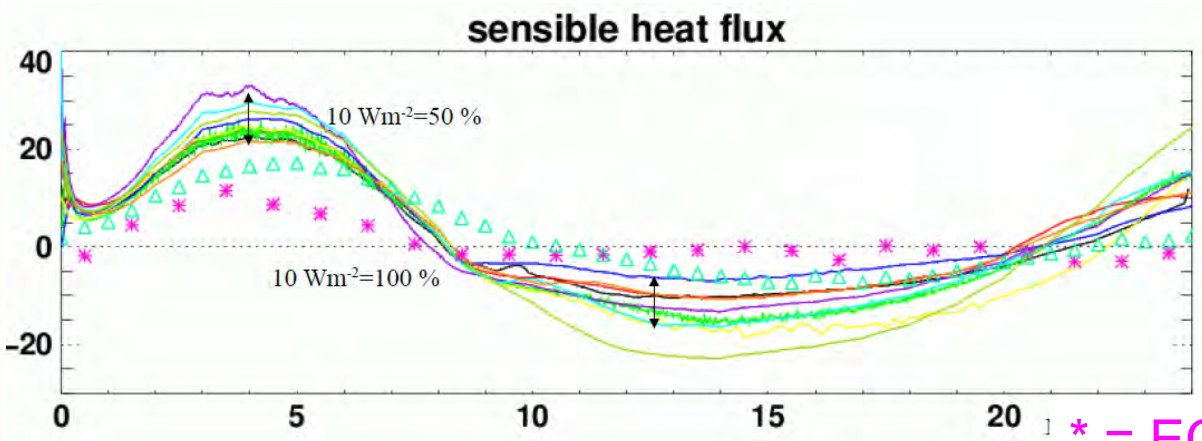
Met Office

Met Office

F. Couvreux, Météo France

Stage 3: LES Intercomparison

Prescribed surface temperature



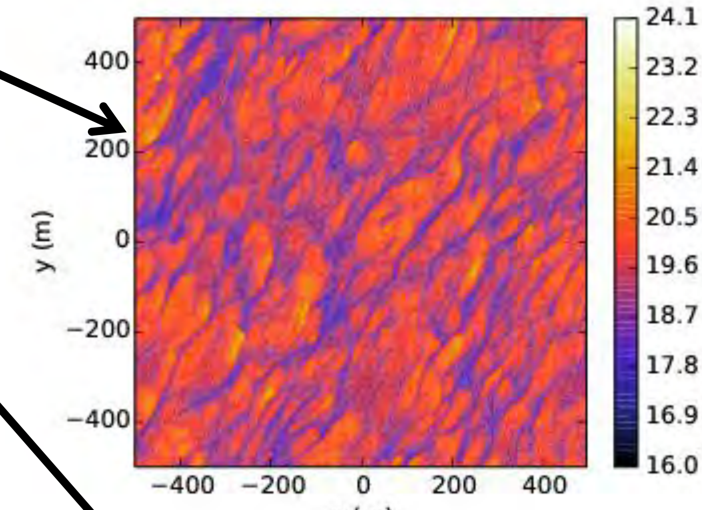
* = EC Flux

- Next Steps
  - Run the SBL with even higher resolution (0.25 m?)
  - Common formulation of surface similarity?
  - Simple treatment of radiative heating in the atmosphere?
  - Simple diffusive surface scheme?

Met Office

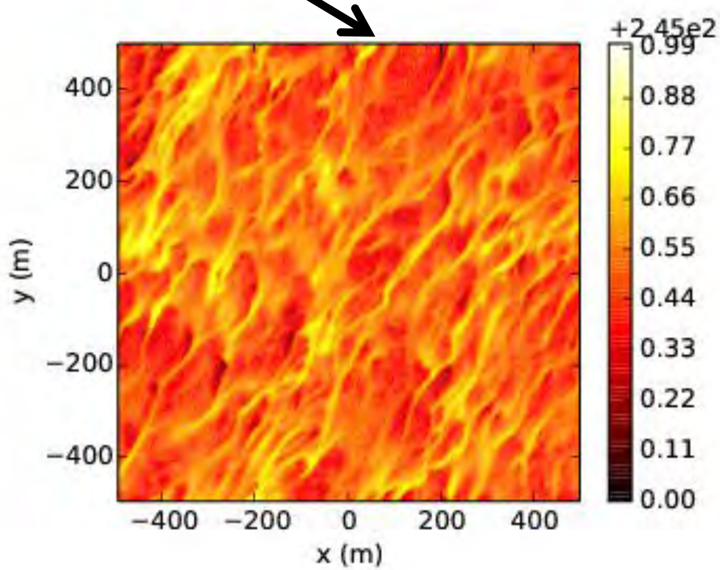
LES + JULES in Stage 3: Snapshots at 6 hours

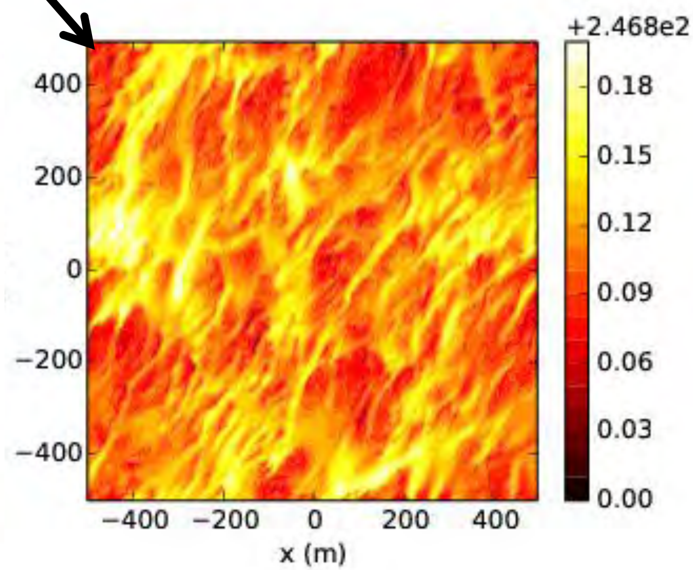
Sensible Heat Flux ($19.5 \pm 0.6\ Wm^{-2}$)



Snow temperature at 6mm (247 ± 0.07 K)

Air Temperature at 1m (245.5 ± 0.1 K)



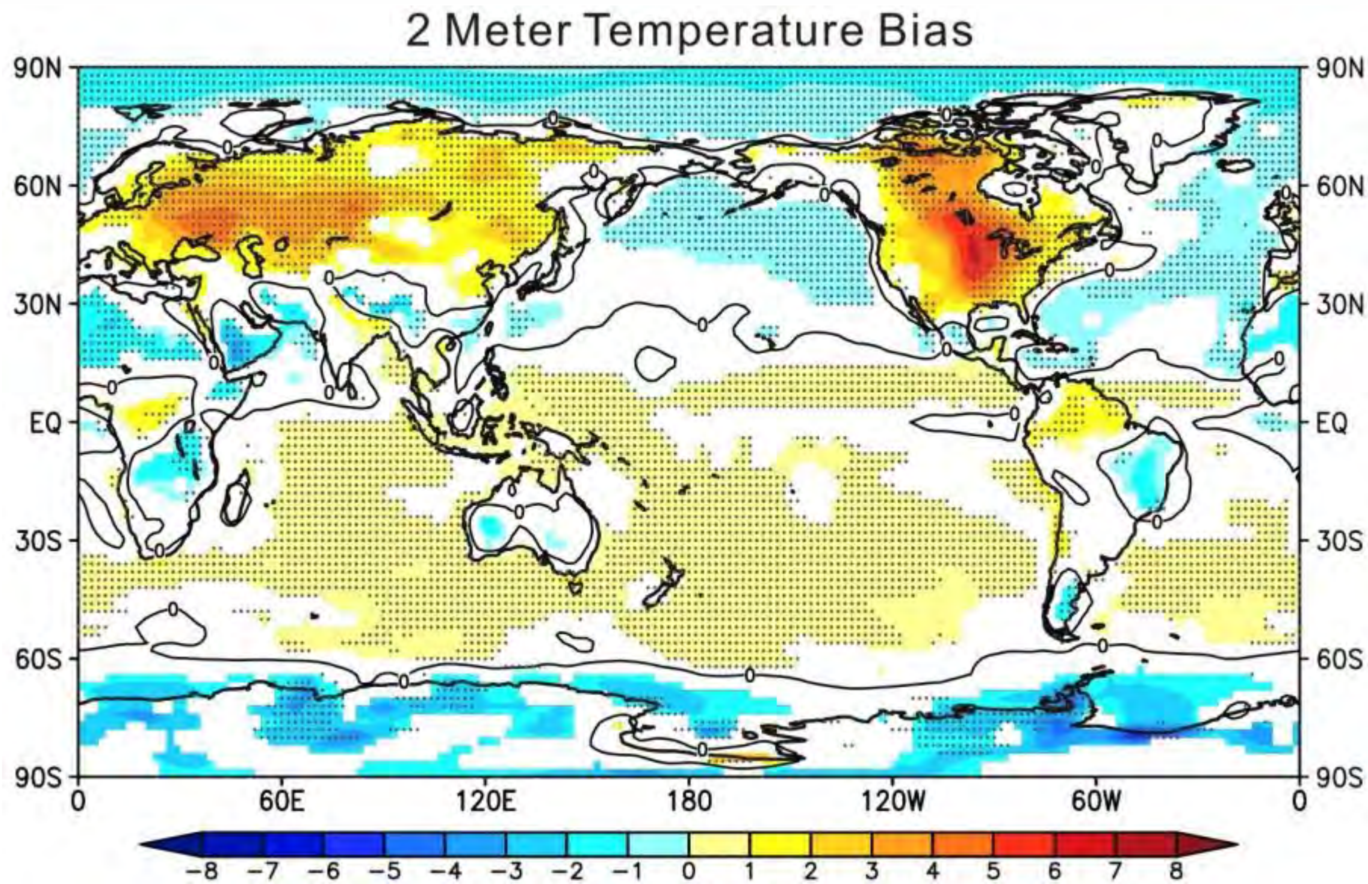


Met Office

CAUSES (ASR as well as GASS)

Cyril Morcrette et al.

Met Office



Shading: CMIP5 ensemble-mean screen-temperature bias.

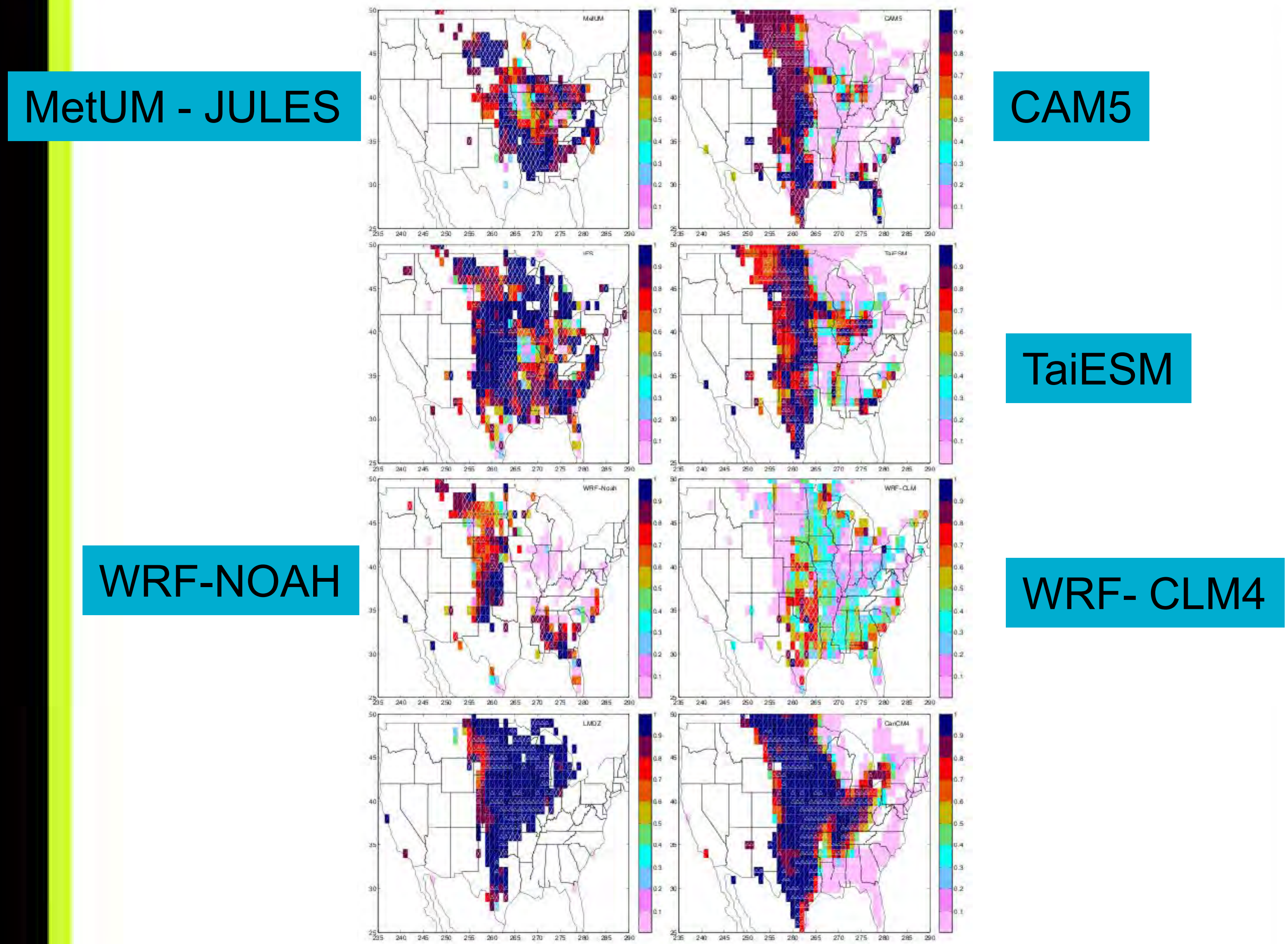
Stippling: where majority of same GCMs have a bias of the same sign, when running for 5-days from an analysis in NWP mode.

GASS GEWEX WCRP Global Atmospheric System Studies | ASR Atmospheric System Research | Met Office | PCMDI | RGCM

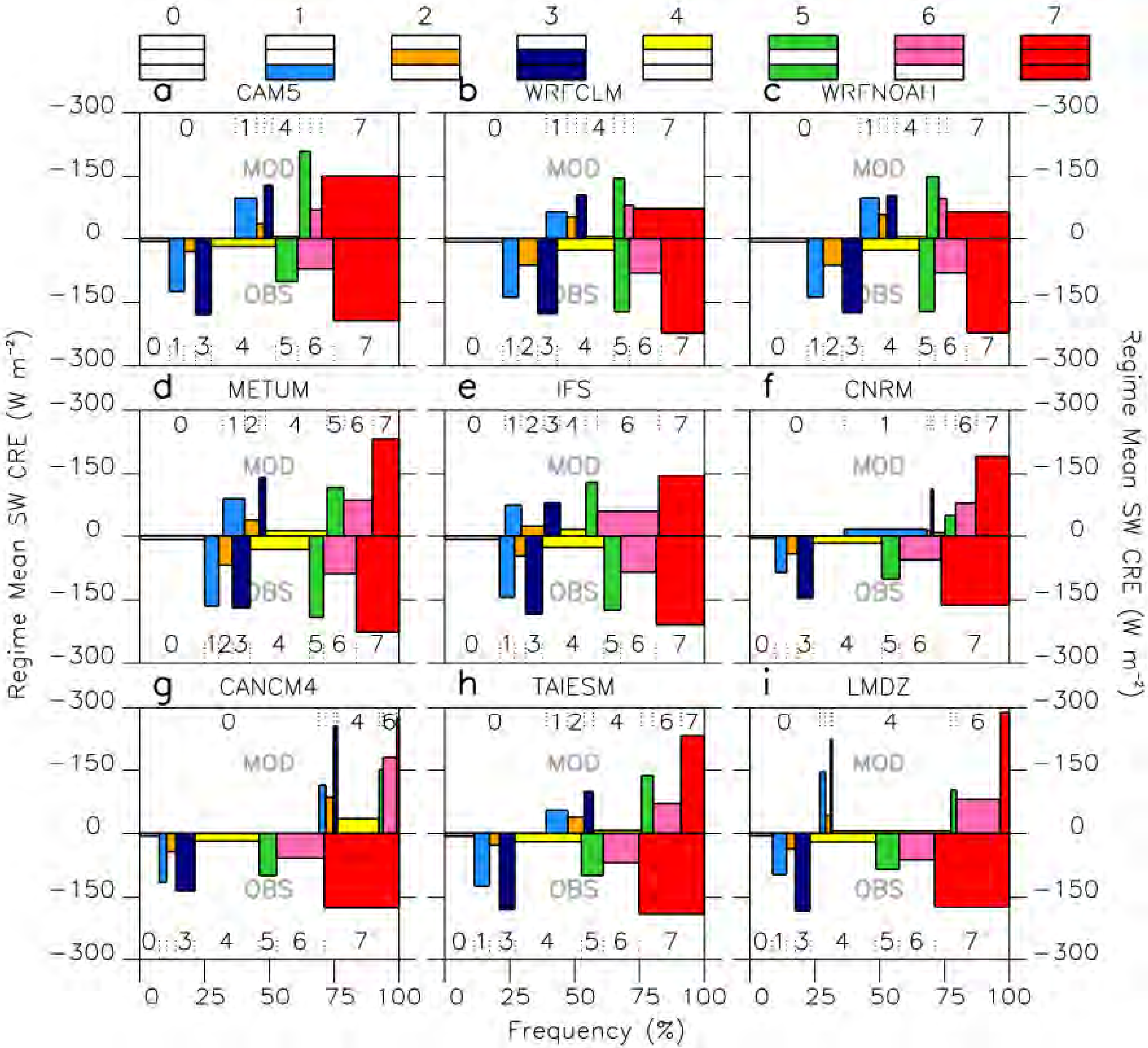
Please get in touch if you wish to participate

Met Office

- 3 experiments
  - 5-day hindcasts from ERA-I each day, April-Aug 2011
  - Multi-monthly atmosphere-only hindcasts
  - AMIP-like simulations
- Experiment 1 – in each model:
  - For each gridpoint calculate composite diurnal cycle of error in screen temperature (model – obs)
  - Correlate cycle for each point against cycle at SGP
  - Plot statistically significant correlations
    - Coherence over large areas – SGP should be representative


MetUM - JULES
CAM5
TaiESM
WRF-NOAH
WRF- CLM4

Met Office



www.metoffice.gov.uk

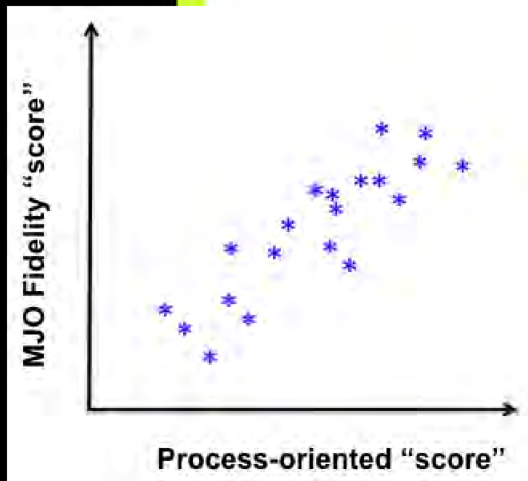
Diabatic Processes and the MJO

Prince Xavier

Met Office

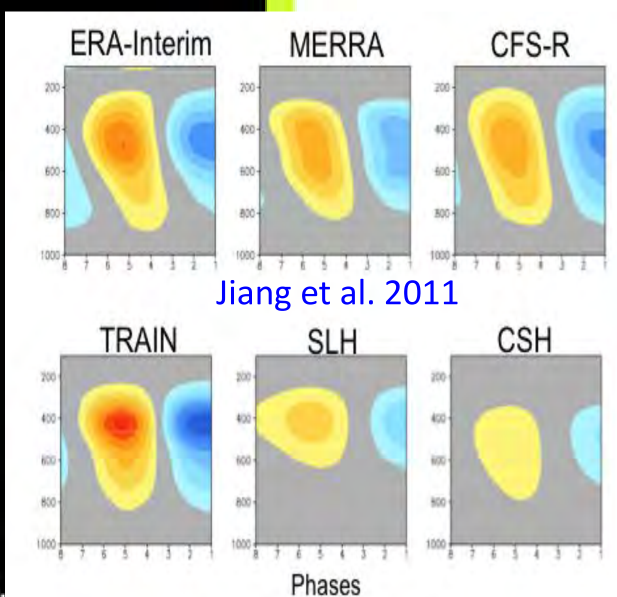
Exploring Key Physics in Modeling the MJO:

The YOTC/MJOTF-GEWEX GASS Multi-Model Experiment



MJO Physical Processes

- Performance metrics
- Process diagnostics
- Vertical structure
- Simulations + Forecasts (Short + Long Term Errors)



Jiang et al. 2011

- Petch et al., 2011, GEWEX News – Exp Overview
- Jiang et al. 2015, JGR – Climate simulations
- Xavier et al. 2015, JGR – 2-Day hindcasts
- Klingaman et al. 2015, JGR – 20-Day hindcasts
- Klingaman et al. 2015, JGR - Synthesis

Met Office

Experimental Design

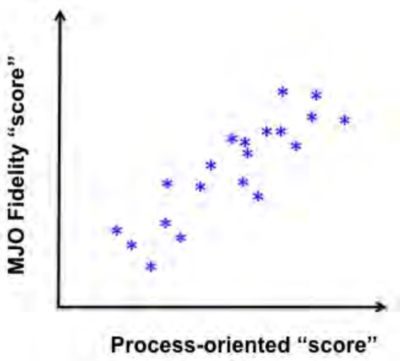
Model Experiment	Science	Exp.
I. **20 Yr Climatological Simulations** (1991-2010 if AGCM) 6-hr, Global Output Vertical Structure, Physical Tendencies	Model MJO Fidelity Vertical structure Multi-scale Interactions: (e.g., TCs, Monsoon, ENSO)	**UCLA/JPL** X. Jiang D. Waliser
II. **2-Day MJO Hindcasts** 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: About 30 Modeling Groups with AGCM and/or CGCM

https://www.earthsystemcog.org/projects/gass-yotc-mip/

Process-oriented metrics for the MJO



- Rainfall PDF
- Large-scale rainfall partition
- Mean zonal wind over Indo-Pacific warm pool
- Radiative vs convective heating ratio

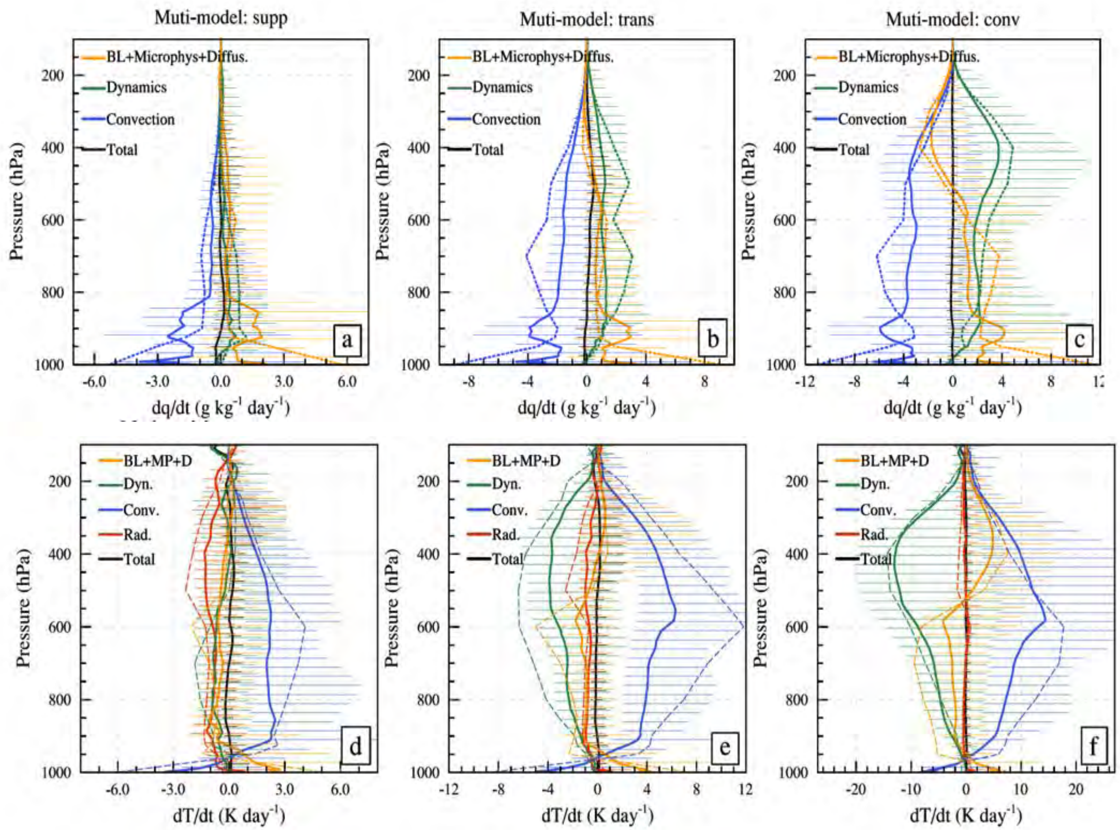
✓Vertical moisture profiles versus rainfall rate

✓Normalized gross moist stability (NGMS)

Jiang, et al (2015)

Diabatic processes & Vertical Structure: 2-Day Hindcasts

Suppressed | Transition | Active



Moistening

Heating

Convective moistening and radiative heating have large uncertainties at short-range (model shortcomings, possibly adjustment)

Xavier, et al (2015)

Met Office

www.metoffice.gov.uk

Cloud Projects

… one example

Met Office

A. Hill, Met Office

Microphysics Project

Aerosol-Cloud Interactions

- Aims:
  - Compare bulk and detailed microphysics
  - Understand if a benchmark can be established
  - Validate schemes against the benchmark
  - Develop and make available a framework for developing & testing schemes
- Current position (Lebo et al. 2017, BAMS, early release)
  - 'The large spread in current "detailed" schemes is problematic and presents a challenge for those hoping to constrain simple numerical approaches or define a benchmark.'

Pan-GASS Meeting

- 26th February 2018 in Melbourne

Met Office