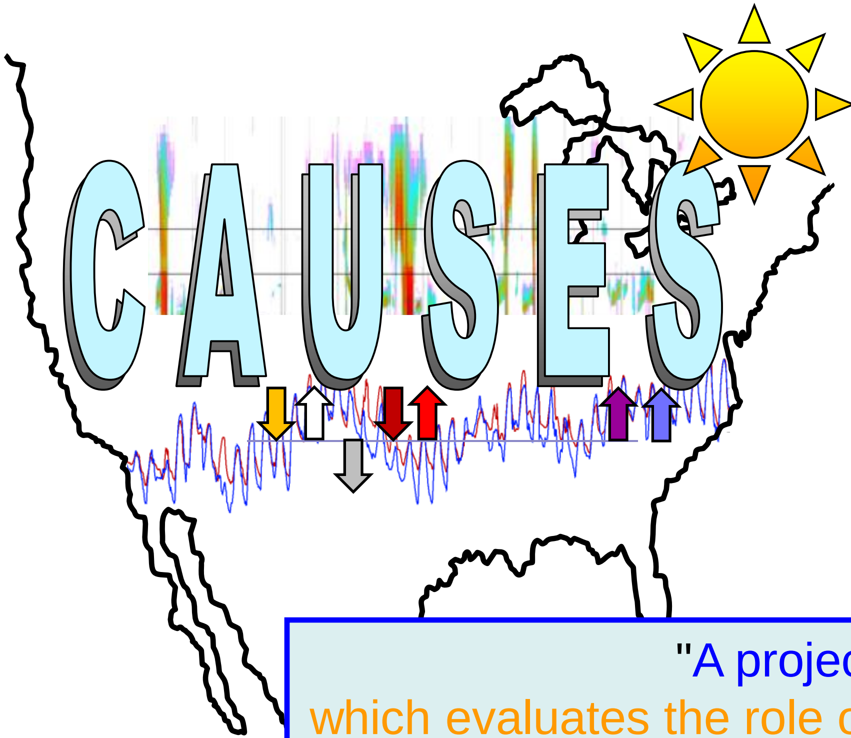


(Clouds Above the United States and Errors at the Surface)

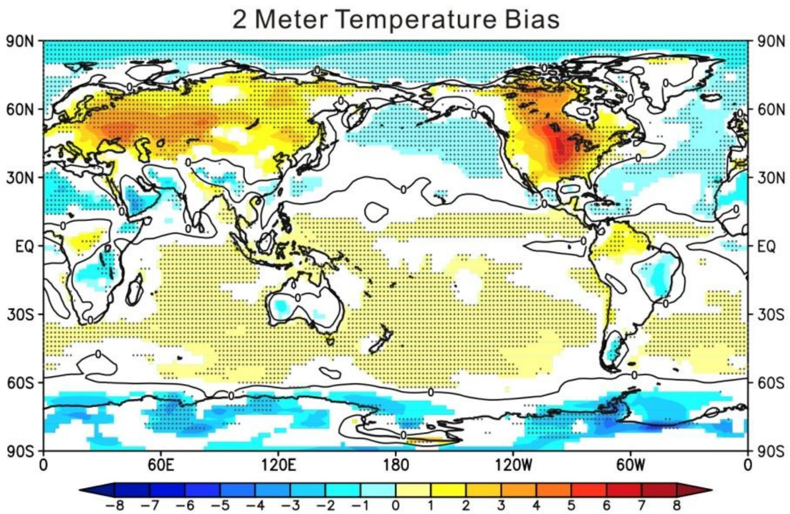
"A project with an observational focus,
which evaluates the role of clouds, radiation and precipitation processes
in contributing to the surface temperature biases in the region of the central United States and
which are seen in several weather and climate models."

Agenda: Tuesday 17 March
19:30 Introduction to CAUSES (Cyril Morcrette)
19:40 Cloud-regime analysis (Kwinten Van Weverberg)
20:00 Precipitation and surface energy budget (Hsi-Yen Ma)
20:20 Next steps for CAUSES
20:30 Open discussion
21:00 Close

RGCM

Please get in touch if you wish to participate

Introduction



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 <u>also</u> shows up as a bias within a *few days* when running climate models from analysis in NWP mode.

Aims:

A joint GASS/ASR comparison project aiming to evaluate clouds, radiation and precipitation in several weather and climate models using ground-based observations to better understand the reasons for the surface temperature error.

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Region and Period of Analysis

Use data from **Southern Great Plains** (SGP) site (located within region of warm bias).

Choose a period with the richest possible source of observations.
So can perform the most detailed analysis possible.

Initially focus on period of **MC3E** (Midlatitude Continental Convective Cloud Experiment, ARM campaign: 22 April to 6 June 2011).

Research Focus

Radiation errors - particularly due to clouds

Led by Met Office, UK: Cyril Morcrette, Kwinten Van Weverberg, and Jon Petch

Precipitation and surface energy budget errors

Led by U.S. Department of Energy, LLNL: Hsi-Yen Ma, Stephen Klein and Shaocheng Xie

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CAUSES consists of 3 experiments

Experiment 1

- 5-day hind-casts, starting at 00Z for each day of 6 week period.
- For column over SGP,
    - sub-hourly, profile of all thermodynamics, cloud cover, condensate.
- For 300 x 300 km region around SGP
    - Hourly 2d fields of surface fluxes, precip and TOA radiation

Experiment 2

- Multi-month atmosphere-only hind-casts. Start each on first day of month of JFMAMJJA (2011).
- CONUS domain, re-gridded onto 1 deg x 1 deg grid
    - 3-hourly 2d fields of surface fluxes, precip and TOA radiation

Experiment 3

- AMIP-style 10-year climate simulation (2000-2011)
- CONUS domain, re-gridded onto 1 deg x 1 deg grid
    - Monthly mean, 2d fields of surface fluxes, precip and TOA radiation
- SGP column, sub-hourly, profile of all thermodynamics, cloud cover, condensate.

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Please get in touch if you wish to participate

Instructions for taking part

Full details of the experimental set-up and the diagnostics required is available from CAUSES website:

http://portal.nersc.gov/project/capt/CAUSES/

Aim to get data contributions by May 2015

Participants who have said they would participate...

Most popular option: several | Close poll

9 participants	Expt 1a	Expt 1b	Expt 1c	Expt 1d	Expt 2a	Expt 2b	Expt 3a	Expt 3b	Expt 4a	Expt 4b
Cyril Morcrette/Had(	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Maike/Richard/ECMV	✓	✓	✓	✓	✓				?	?
Hsi-Yen Ma/CAM5	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Cole/Merryfield/Can(	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Roehrig/CNRM-CM	✓		✓	✓	✓	✓	✓	✓	?	?
Berg/Gustafson/WR	✓	✓	✓	✓					?	?
Bazile/Piriou/CNRM-	✓	✓	✓	✓					?	?
cheruy/hourdin/rio					✓	✓	✓	✓	✓	✓
Gabe Kooperman/M	✓	✓	✓	✓	✓	✓	✓	✓		
Your name	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	8	7	8	8	7	6	6	6	1	1

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First Paper: methodology / pilot study

Paper submitted to QJRMS, currently under review.

Most popular option: several | Close poll

9 participants	Expt 1a	Expt 1b	Expt 1c	Expt 1d	Expt 2a	Expt 2b	Expt 3a	Expt 3b	Expt 4a	Expt 4b
Cyril Morcrette/Had(	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Maike/Richard/ECMW	✓	✓	✓	✓	✓				?	?
Hsi-Yen Ma/CAM5	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Cole/Merryfield/Can(	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Roehrig/CNRM-CM	✓		✓	✓	✓	✓	✓	✓	?	?
Berg/Gustafson/WR	✓	✓	✓	✓					?	?
Bazile/Piriou/CNRM-	✓	✓	✓	✓					?	?
cheruy/hourdin/rio					✓	✓	✓	✓	✓	✓
Gabe Kooperman/M	✓	✓	✓	✓	✓	✓	✓	✓		
Your name	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	8	7	8	8	7	6	6	6	1	1

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Kwinten's talk

Expt 1: Looking at 5-day NWP-style runs

Contribution of clouds to surface-temperature errors.

- **MetUM (HadGEM3-GA6) and**
- **CAM5**

Hsi-Yen’s talk

Error contribution from precipitation and surface energy budget

Preliminary results

Expt 3: AMIP-style atmosphere-only climate runs.

- **MetUM (HadGEM3)**

Cloud regimes in atmosphere-only (AMIP) climate runs.

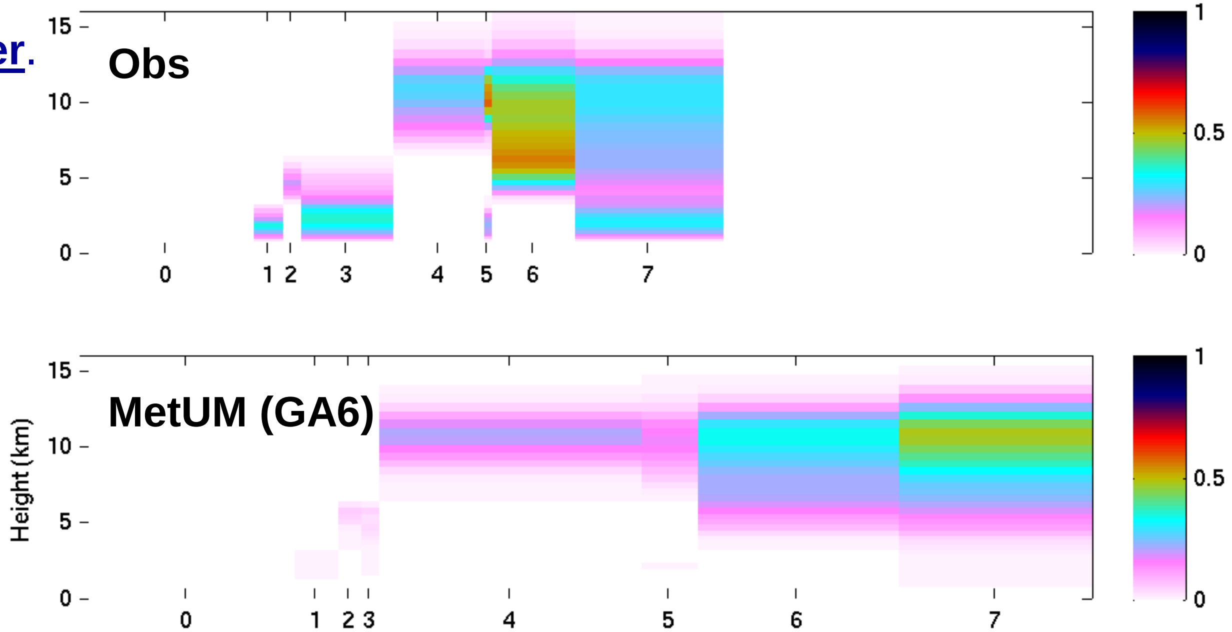
1-year climate run (Starting Sept 2006, look at April-August 2007, but will look at 2011 and year-to-year variability).

Output every (10-minute) time-step over SGP.

Use same 3 height layer to define 8 cloud regimes. Then produce mean profile for each regime.

Width of bar shows frequency of occurrence of regime.

Shading shows mean **cloud cover**.



High cloud only regime (4) is too frequent, but not enough cloud cover.

Compare with NWP where that regime was not frequent enough and too overcast.

Low and mid (3): not frequent enough.

Very low cloud cover in regime 1.

Cloud regimes in atmosphere-only (AMIP) climate runs.

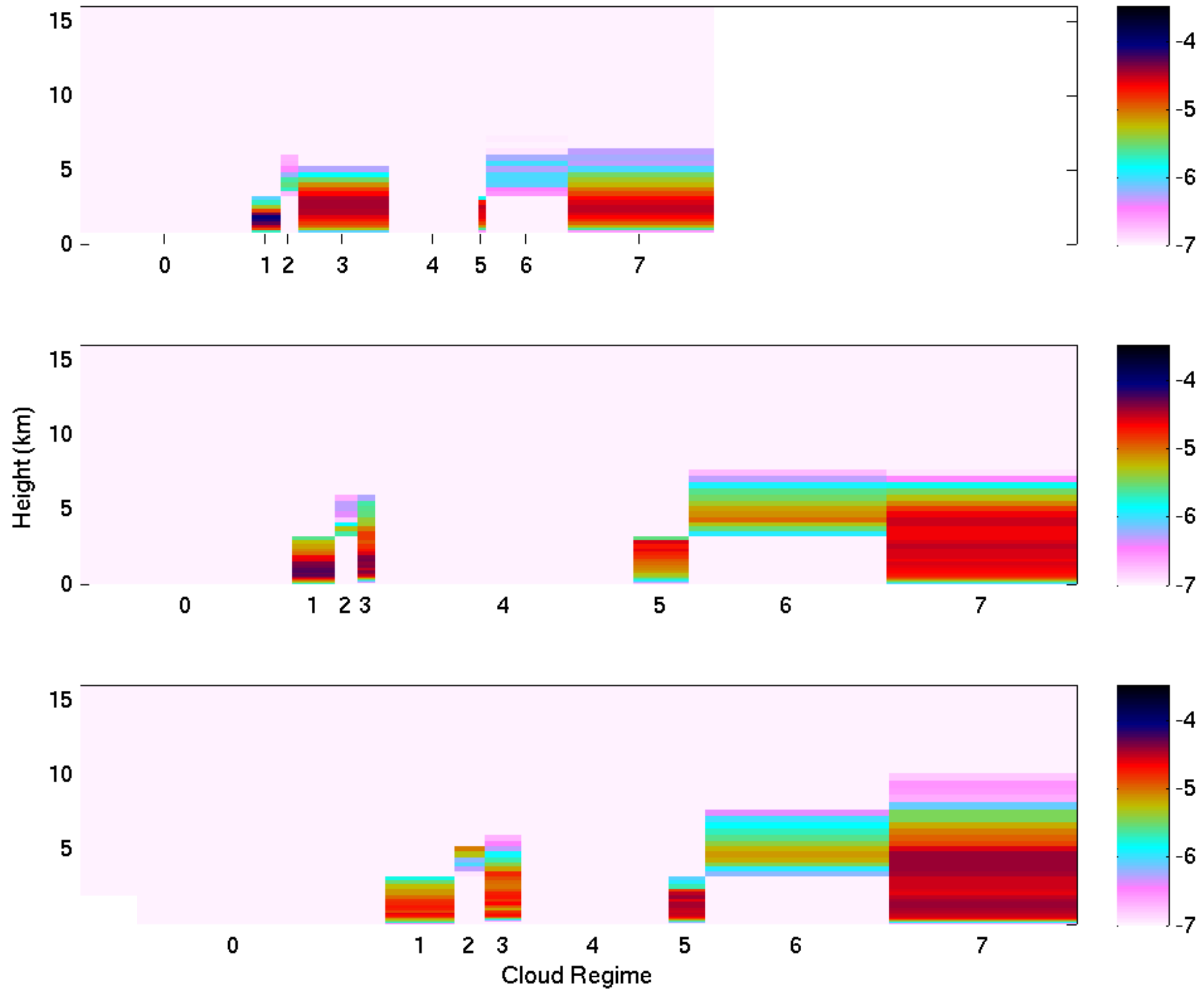
1-year climate run (Starting Sept 2006, look at April-May-June 2007, but will look at 2011 and year-to-year variability).

Output every (10-minute) time-step over SGP.

Use same 3 height layer to define 8 cloud regimes.

Width of bar shows frequency of occurrence of regime.

Shading shows mean **LWC**.



Cloud regimes in atmosphere-only (AMIP) climate runs.

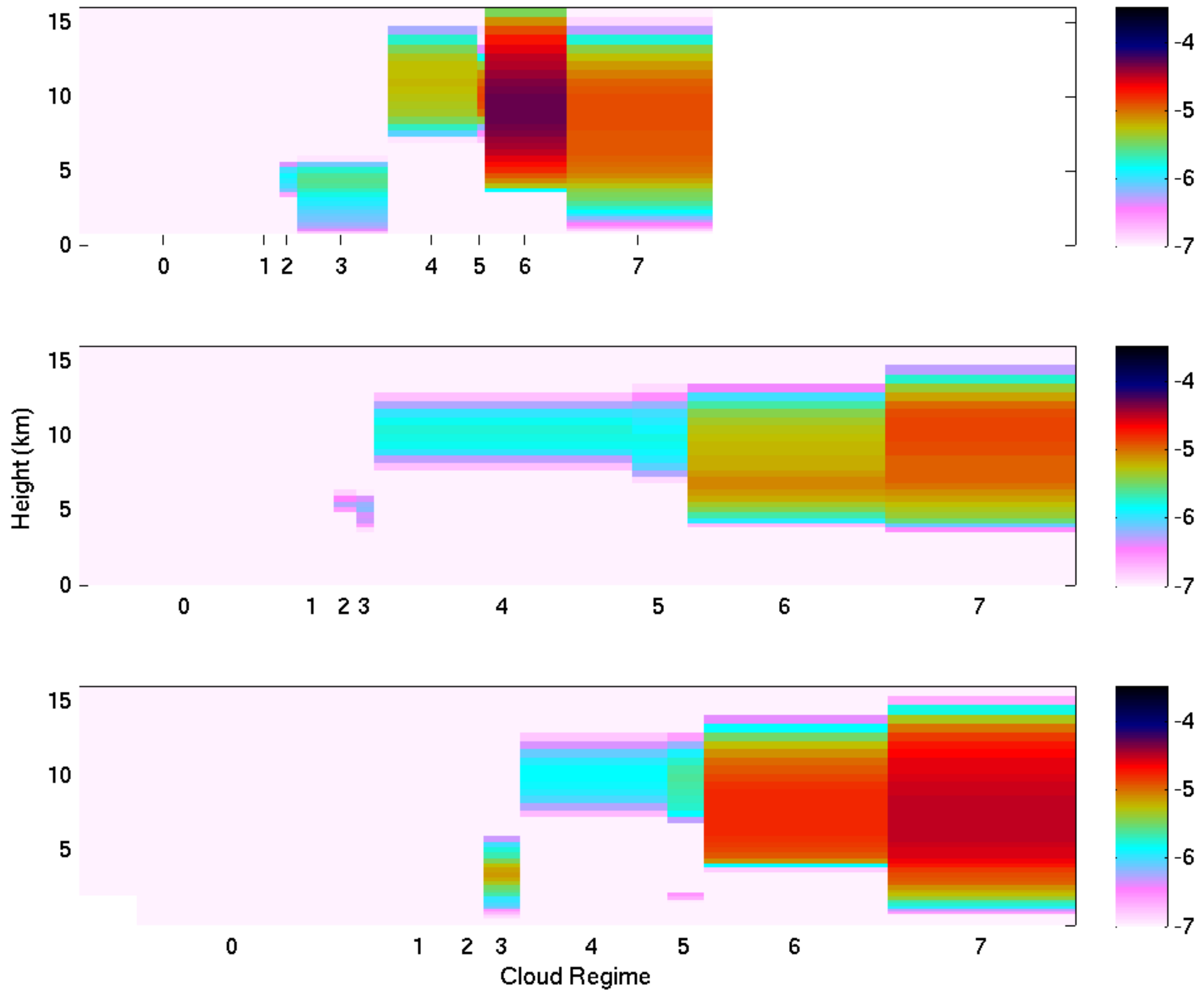
1-year climate run (Starting Sept 2006, look at April-May-June 2007, but will look at 2011 and year-to-year variability).

Output every (10-minute) time-step over SGP.

Use same 3 height layer to define 8 cloud regimes.

Width of bar shows frequency of occurrence of regime.

Shading shows mean **IWC**.



Project Gantt chart

Based on the assumption of a two-years project from April 2015 to March 2017.We have planned the distribution of results to occur shortly before ASR meetings so that they can be discussed at the meetings.

	2014			2015												2016		
Month	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Running simulation	UKMO and participants run their simulations																	
Data processing											Process expt 1 data				Process expt 2 data			
Scientific development							Develop method expt 2										Develop method expt 3	
Mass email													Results expt 1				Results expt 2	
Oral presentation														Discuss results				Discuss results
Written output: outline/plan																Outline of paper: expt 1		
Written output: draft document																		Paper expt 1
Written output: complete document																		
Final Report: highlighting outcomes																		
ASR/ARM meeting						■								■				■
Key Deliverable																*		

	2016									2017		
Month	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Running simulation	Rerun UKMO model (and some others) making parametrization changes based on results of expt 1 & 2											
Data processing		Process expt 3 data				Process any NEW model output from runs based on results of expt 1 & 2						
Scientific development				Develop method to bring expt 1, 2 and 3 together								
Mass email					Results expt 3							
Oral presentation								Discuss results				Discuss results
Written output: outline/plan						Outline of paper: expt 2 and 3						
Written output: draft document							Revisions		Expt 2&3		Collaborate model development paper with participants	
Written output: complete document			Submit paper expt 1							Submit paper expt 2 and 3		
Final Report: highlighting outcomes												Published as webpage e.g. on Met Office website
ASR/ARM meeting								■				■
Key Deliverable			*			*				*		*

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Please get in touch if you wish to participate

Planning ahead, other papers could be "columns" or "rows" or "everything"

9 participants	Expt 1a	Expt 1b	Expt 1c	Expt 1d	Expt 2a	Expt 2b	Expt 3a	Expt 3b	Expt 4a	Expt 4b
Cyril Morcrette/Had(	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Maike/Richard/ECMW	✓	✓	✓	✓	✓				?	?
Hsi-Yen Ma/CAM5	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Cole/Merryfield/Can(	✓	✓	✓	✓	✓	✓	✓	✓	?	?
Roehrig/CNRM-CM	✓		✓	✓	✓	✓	✓	✓	?	?
Berg/Gustafson/WR	✓	✓	✓	✓					?	?
Bazile/Piriou/CNRM-	✓	✓	✓	✓					?	?
cheruy/hourdin/rio					✓	✓	✓	✓	✓	✓
Gabe Kooperman/M	✓	✓	✓	✓	✓	✓	✓	✓		
Your name	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	8	7	8	8	7	6	6	6	1	1

Various Options (open to dicussion)

•Single row papers (e.g. compare version 1 and version 2 of same model) could be led by participants' (MetOffice/LLNL do evaluation of data), but with interpretation of results led by participants.

•Methodology paper focussing on joining expt 1,2 & 3 (timescale of responses).

•CAUSES project summary paper (probably last of all, highlighting results from other papers and bringing it all together,).

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Please get in touch if you wish to participate

What happens next?

The purpose of the CAUSES project is:

- to develop some useful model-evaluation tools
- to evaluate some models using common method and find where they could be improved
- to evaluate new model versions and see if they have improved.

We welcome discussion on how to further develop these evaluation tools.

We invite other modelling centres to submit model output for us to evaluate using the tools we have developed.

We invite participants to look at results from each of the participating models and discuss them.

Invite participation from instrument/retrieval specialists.

Organise CAUSES meeting at a subsequent conference.

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Please get in touch if you wish to participate

Timeline of the project

1: July 2014: Launch Project as GEWEX conference. ✓

2: Sep 1, 2014: Finalize experiment design (variable list, hindcast period) ✓

3: May 1, 2015: Submit model experiments

(review the deadline in the ASR spring meeting 2015)

4: Oct 1, 2015: Data processed and analyzed

5: Feb 1, 2016: Complete first draft of the inter-comparison papers led by Cyril and Hsi-Yen

6: May 1, 2016: Submit manuscripts

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Please get in touch if you wish to participate

Invitation to Participate

In order for model data to be evaluated using the CAUSES tools, please provide the following:

2D variables (for 300 km x 300 km region centred around the SGP central facility) every hour.

1. precipitation (mm/hr) hourly accumulated
2. convective precipitation (mm/hr) hourly accumulated
3. column water vapor (kg/m2)
4. downward shortwave at surface (W/m2)
5. upward shortwave at surface (W/m2)
6. downward longwave at surface (W/m2)
7. upward longwave at surface (W/m2)
8. downward shortwave at TOA (W/m2)
9. upward shortwave at TOA (W/m2)
10. upward longwave at TOA (W/m2)
11. surface sensible heat flux (W/m2)
12. surface latent heat flux (W/m2)
13. ground heat flux (W/m2)
14. 2 meter temperature (K)
15. total cloud fraction
16. surface wind u component (m/s)
17. surface wind v component (m/s)
18. surface pressure (Pa)
19. 10cm soil moisture (kg/m2)

RGCM

Please get in touch if you wish to participate

Invitation to Participate

In order for model data to be evaluated using the CAUSES tools, please provide the following:

3D variables (for 300 km x 300 km region centred around the SGP central facility) every hour.

20. u wind (m/s)
21. v wind (m/s)
22. omega (Pa/s)
23. geopotential height (m)
24. temperature (K)
25. specific humidity (kg/kg)
26. 3d cloud fraction
27. volumetric soil water (mm3/mm3)
28. soil liquid water (kg/m2)
29. soil ice (kg/m2)

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Please get in touch if you wish to participate

Invitation to Participate

In order for model data to be evaluated using the CAUSES tools, please provide the following:

2D Time-height date for column nearest SGP (every model level and every timestep - or every 10 minutes, which-ever is less frequent).

30. theta, Dry potential temperature (K)
31. qv, Specific humidity (kg/kg)
32. qcf, Grid-box-mean cloud ice water content (kg/kg)
33. qcl, Grid-box-mean cloud liquid water content (kg/kg)
34. rho, atmospheric density (kg/m3)
35. cfl, cloud fraction liquid (fraction of grid-box covered by liquid cloud) [dimensionless]
36. cff, cloud fraction frozen (fraction of grid-box covered by ice cloud) [dimensionless]
37. bcf, bulk cloud fraction (fraction of grid-box covered by either liquid or ice cloud, or both [bcf is not necessarily sum of cfl and cff due to mixed-phase regions]) [dimensionless]
38. p, pressure (Pa)

Note if your model does not have a separate liquid and ice cloud fraction, but rather a combined (or bulk) cloud fraction from which you then diagnose a liquid/ice split, it would be very helpful if you could populate the liquid and ice cloud fraction variables with whatever is consistent with your model.

Time-series of surface variables at SGP (every model level and every timestep - or every 10 minutes, which-ever is less frequent).

39. tsurf, Temperature at the surface (skin temperature) (K)
40. tscreen, temperature at screen level (1.5m or 2m) (K)
41. shf, surface sensible heat flux
42. lhf, surface latent heat fluxppn,
43. instantaneous surface precipitation rate (total, i.e. large-scale + convective), (mm/hr)

Radiative fluxes:

44. (net/up/down),(sfc/toa),(SW/LW)

Please get in touch if you wish to participate

Invitation to Participate

Please let us know about anything unusual about any of the data provided. e.g. if the data is not an instantaneous value valid at that time-step, but rather an accumulation up until that point, or if the value is a mean over the preceding hour, then please let us know.

We have been comparing our forecasts for different lead-times:

- day 1 (T+ 1 to T+24)
- day 2 (T+25 to T+48)
- day 3 (T+49 to T+72)
- day 4 (T+73 to T+96) (note there should be 24 hourly data points in each "day")

Ideally, it would be good to have the same from you, but if you can only provide day N we can work with that.

You will need to provide some additional information:

- Definition of the vertical level set used in you model (i.e. what is the height above ground level of each of the model levels you are providing data on).
- Size of gridbox at location of SGP.
- Height of model orography at location of SGP.

Format, netcdf would be nice. Using the names in columns given above (although this needs to be changed to standard names).

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Please get in touch if you wish to participate

Thing to try from land-surface/precipitation point –of-view.

1) Take away the ARM Continuous Forcing (which here we'll assume to be the "truth") from the two simulations and hence produce a T2m bias and net sfc rad bias. Plot these against each other as a scatter plot.
2) Plot a scatter plot of T2m bias against 10 cm soil moisture bias.
3) Calculate a PDF of "instantaneous" soil moisture bias, so just use the soil moisture at that point in time. Then split it into 3 terciles. Then calculate the mean T2m bias for each soil humidity tercile along with a standard deviation. Now check using a statistical significance test whether the T2m bias is statistically different between the dry conditions and the wet conditions. So is the bias bigger when it is wet or dry?
4) Since it may not be instantaneous soil moisture that matters, but perhaps soil moisture and its evolution over a few days, weeks or month, then the next thing to try would be to calculate the soil moisture bias over increasing long time window. So increase from instantaneous to daily, weekly, monthly and 3-month means.
Now produce scatter plot of the time-averaged soil moisture biases at each time window against the time-averaged T2m biases over the same window. Calculate lines of bet fit and correlation coefficients in each case.
5) Use the observed SW, LW, LHF, SHF etc to derive the ground heat flux (by enforcing closure of the surface energy balance). Now look at how the ground-heat flux, averaged over a day, week, month, season correlates with T2m.
6) Repeat with surface precipitation. Is there any correlation between the T2m bias and the surface precipitation (I guess probably not on an instantaneous basis, but what about when averaged over an hour, a week, a month etc.) (Or in the case of precip it could be a weekly, monthly accumulation)
7) *All* of the above could be repeated by not looking at the T2m bias, but at the T2m *growth*. And that growth could be calculated over a model time-step, or a day, week, month, season.
8) I would find it very interesting to know whether we can find any correlations between T2m bias and rainfall accumulation. Is the T2m larger or smaller for wet weeks and dry weeks and months. Again terciles could be useful. What is the T2m bias growth on average taking the sample for the period with the wettest tercile and driest tercile define using precipitation (rather than soil moisture as was done above).
9) Something else that may be interesting is the noisiness of precipitation and the possible response of the surface fluxes. I would find it interesting to know whether we can detect any difference. Using the ARM Continuous forcing or the ARM Best-Estimate, or the point observations at the Central Facility, I would be interested in knowing whether the PDF of rainrate has an impact on the surface fluxes. Consider 5 mm/hr averaged over the hour, that could be 5 mm /hr for 1 hour, or it could be 30 mm/hr for 10 minutes and then 50 minutes of no rain. Can we detect whether any of the surface energy balance components are any different. I realise that sampling may be an issue, but by putting precipitating hours into rainrate bins and then for each hourly rainrate bin, take the tercile of most short-lived but intense rain and compare it to the tercile of most long-lived but uniform rain and see whether each e.g. the LHF and SHF are statistically different for the same hourly rain but different intensities.
10) Composite diurnal cycles of the surface energy balance can be informative. Assuming we are using 3-hourly time-window (although it could be 1 hourly). Is there enough data to go through and produce a composite diurnal cycle separated out into the average diurnal cycle when there has been rain detected within the 3 hours and then the average diurnal cycle where there has been no rain in the 3 hours, but there was rain in the previous 3 hours, or previous day. And then average diurnal cycle when there has not been any rain for at least N days.

RGCM

Please get in touch if you wish to participate