CAUSES breakout session

Wednesday, March 21, 2018

1030: Introduction to CAUSES project (Cyril Morcrette)
1045: Diagnosis of the Summertime Warm Bias in CMIP5 (Shaocheng Xie)
1100: On the role of surface energy budget errors (Hsi-Yen Ma)
1115: Theoretical interpretation of surface temperature bias (Steve Klein)
1130: Attribution of surface radiation biases (Kwinten Van Weverberg)
1145: The connection between MCSs and SGP warm biases (Minghua Zhang)

1200: Discussion on further analysis with current model data (All)
1215: Discussion on evaluating new model configurations (All)

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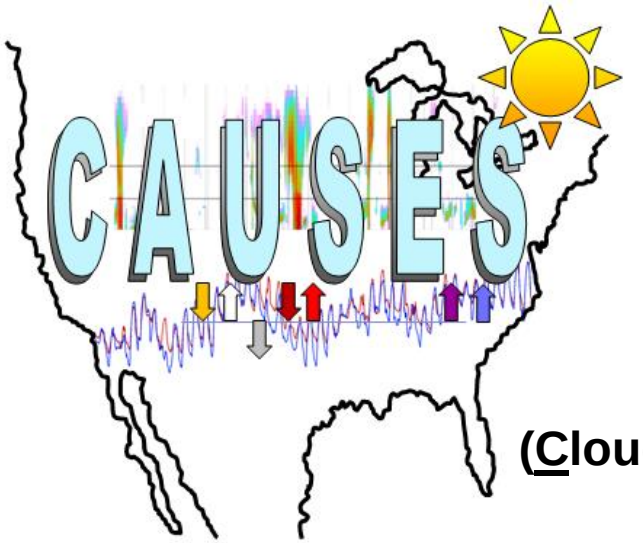
Introduction to CAUSES:

Description of model near-surface temperature errors in 5-day hind-casts near the Southern Great Plains

The CAUSES project team:

Cyril Morcrette, Kwinten Van Weverberg, Jon Petch:	Met Office, UK	MetUM-HadGEM3-GA6
Hsi-Yen Ma, Steve Klein, Jill Zhang, Shaocheng Xie:	Lawrence Livermore National Laboratory	CAM5
Maike Ahlgrimm, Richard Forbes:	ECMWF	IFS
Larry Berg, Bill Gustafson Jr., Maoyi Huang, Ying Liu, Yun Qian:	Pacific Northwest National Laboratory	WRF-CAM5-CLM/Noah
Romain Roehrig, Eric Bazile:	CNRM, Meteo-France/CNRS	CNRM (NWP & climate)
Anning Cheng, Kuan-Man Xu:	NASA Langley	CAM5-IPHOC
Frederique Cheruy, Lidia Mellul:	LMD	LMDZOR
Jason Cole, Bill Merryfield, Woo-Sung Lee:	Environment and Climate Change Canada	CanCM4
Yi-Chi Wang:	Academia Sinica, Taiwan	TaiESM



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

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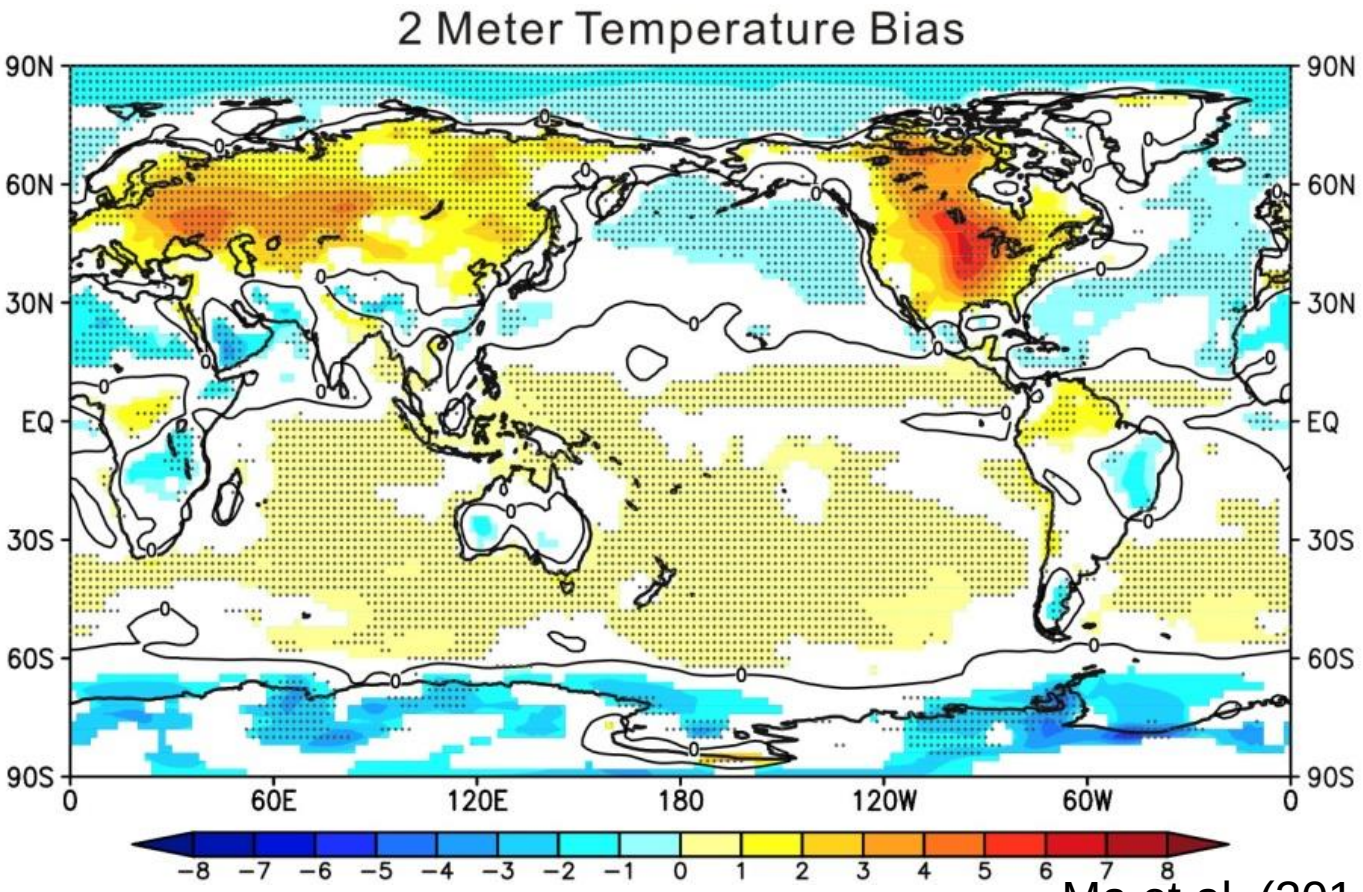
Introduction



Ma et al. (2014)

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.

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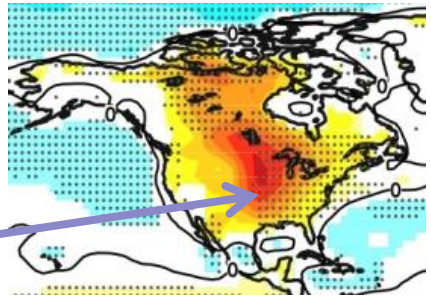
Introduction



There is a large bias in the Midwest.

Use data from **Southern Great Plains** (SGP) site (located within region of warm bias).
Site is operated by the US Department of Energy's (DoE) Atmospheric Radiation Measurement (**ARM**) programme.

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

Focus on April-August 2011, which includes **MC3E** (Midlatitude Continental Convective Cloud Experiment: 22 April to 6 June 2011).

So, within **GASS** (GEWEX-Global Atmospheric System Studies) and **ASR** (DoE's Atmospheric System Research programme), have set-up:

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

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CAUSES Overview

As of February 2018: 4 new CAUSES papers accepted.

- Morcrette et al (2018) Introduction to CAUSES
- Ma et al (2018) On the role of surface energy budget errors
- Van Weverberg et al (2015) Attribution of surface radiation biases
- Zhang et al (2018) Diagnosis of the Summertime Warm Bias in CMIP5 at SGP

Experiment 1

- 5-day hind-casts, starting from ERA-Interim analyses at 00Z for each day of April to August 2011.
- For column over SGP,
  - sub-hourly, profile of all thermodynamics, cloud cover, condensate & surface and TOA fields.
- For CONUS region, re-gridded onto 1 deg x 1 deg grid.
  - Hourly fields 2d fields of surface fluxes, precip and TOA radiation

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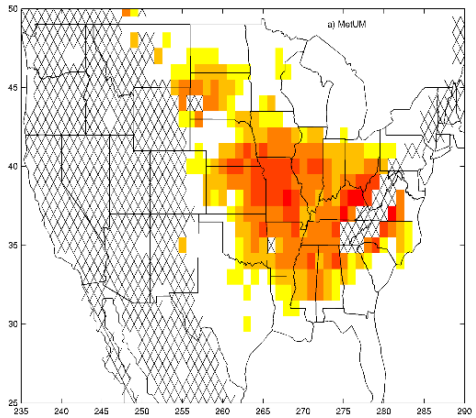
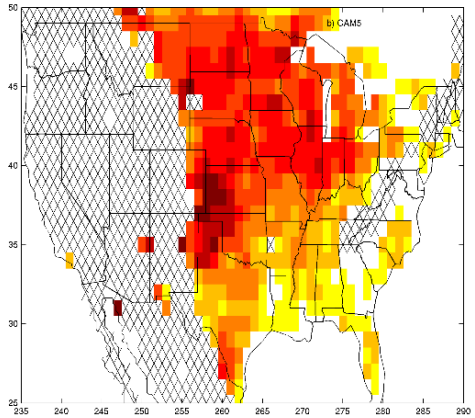
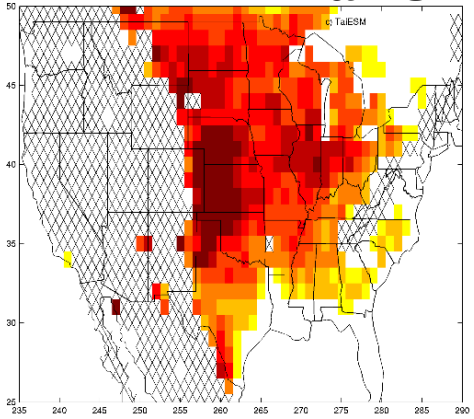
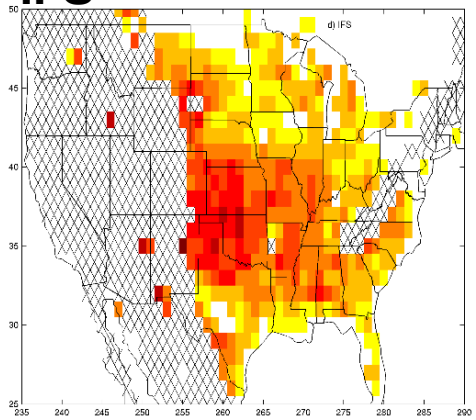
Mean T2M error

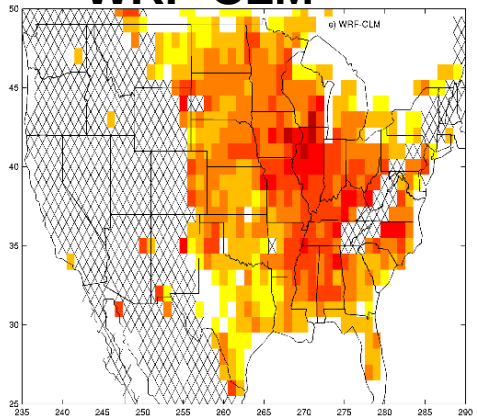
(Day 2-to-5 mean; April-Aug mean)

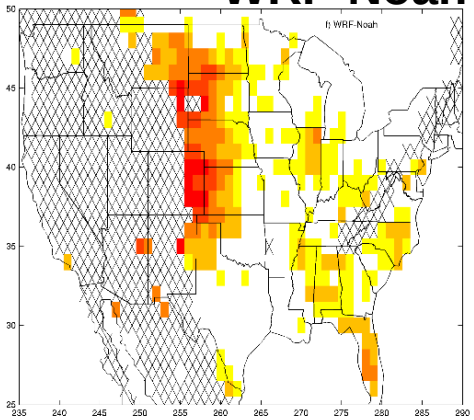


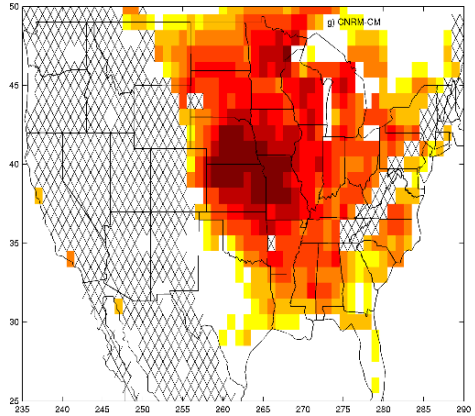


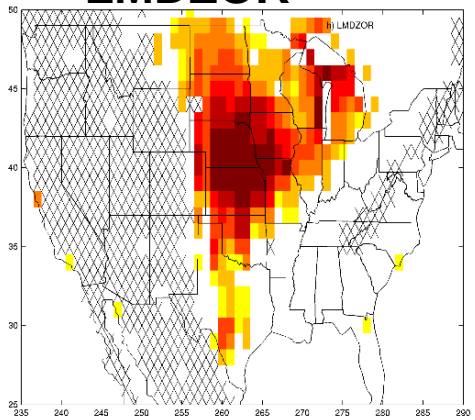


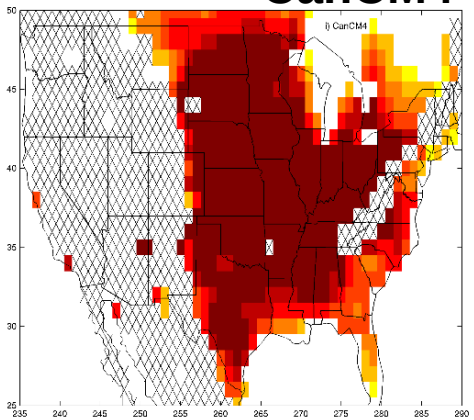








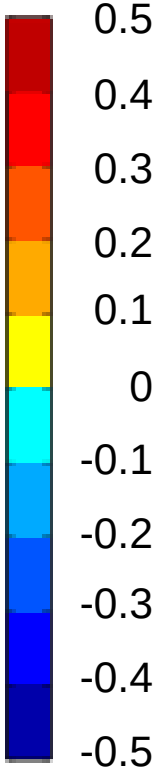


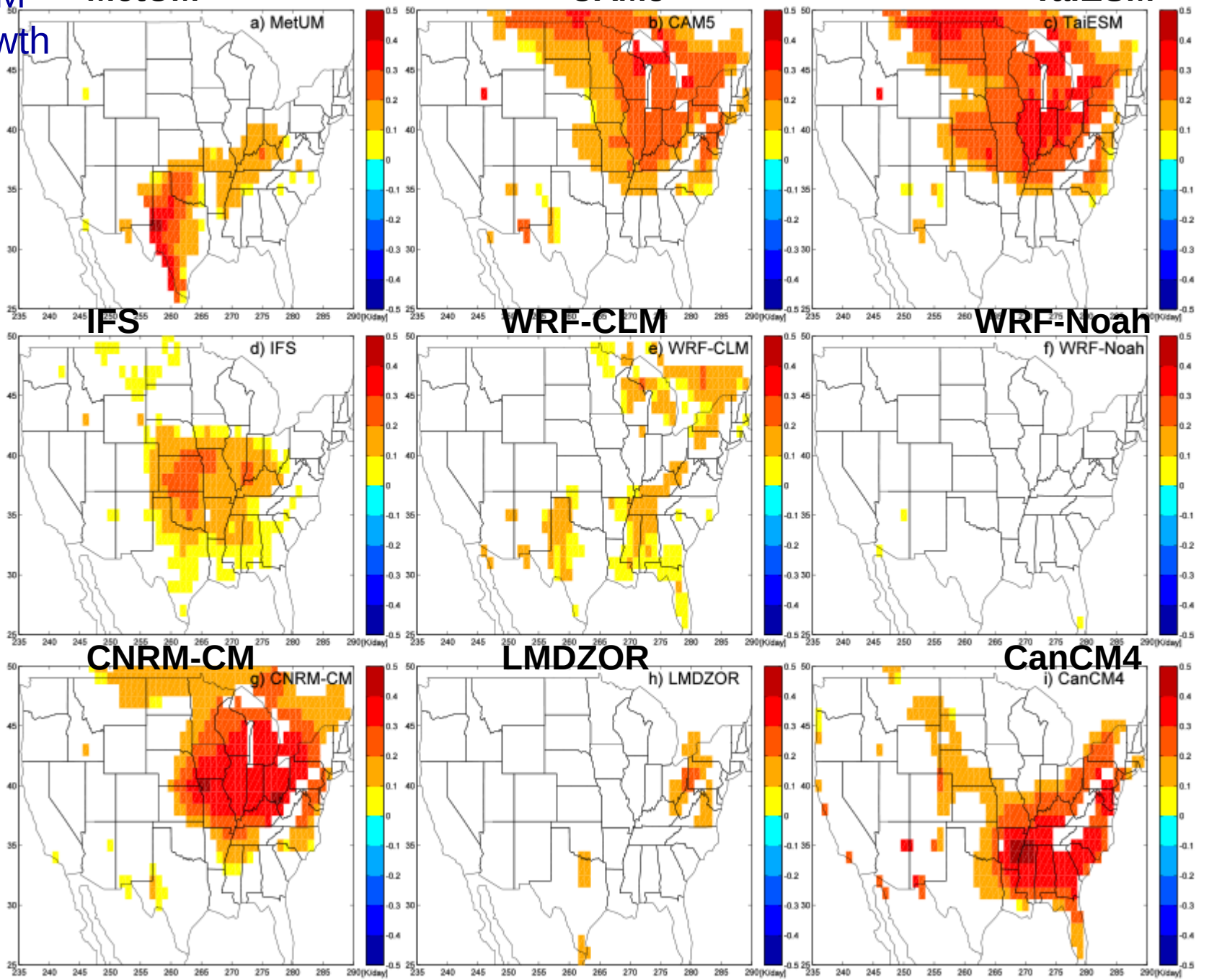


Morcrette *et al.* (2018)

Mean T2M error growth

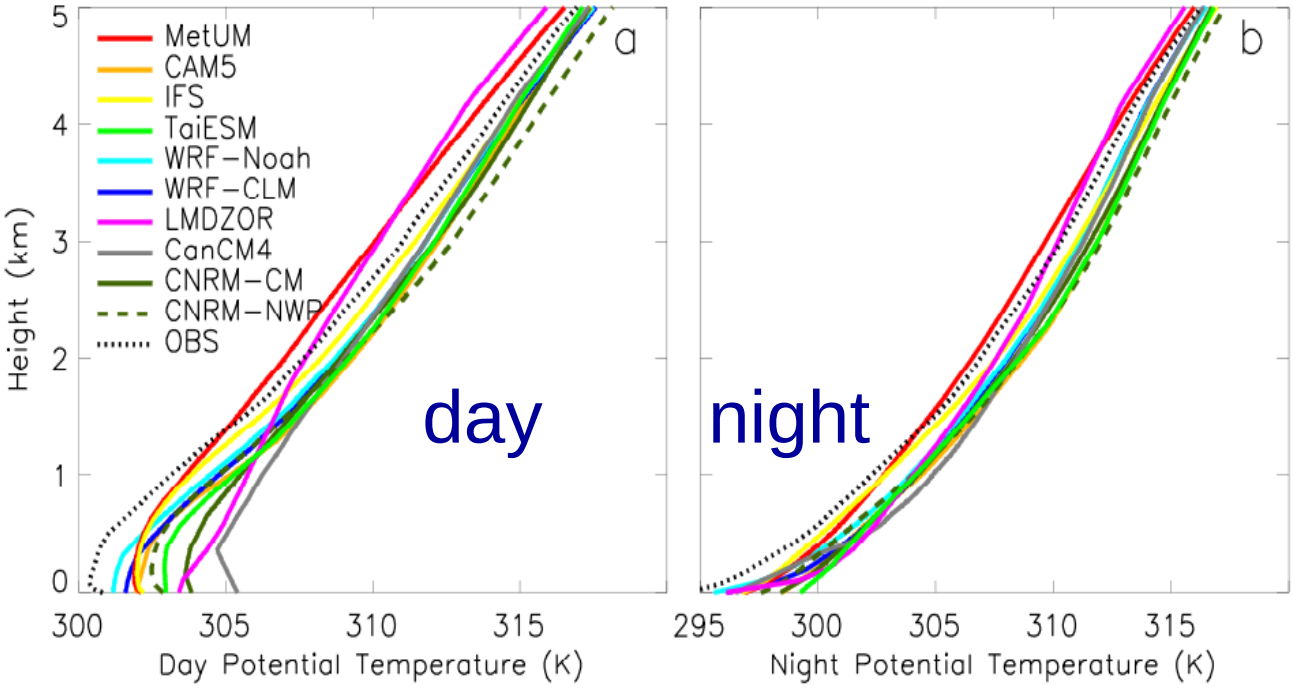
(Mean
Day 2 to Day 5;
April-Aug mean)

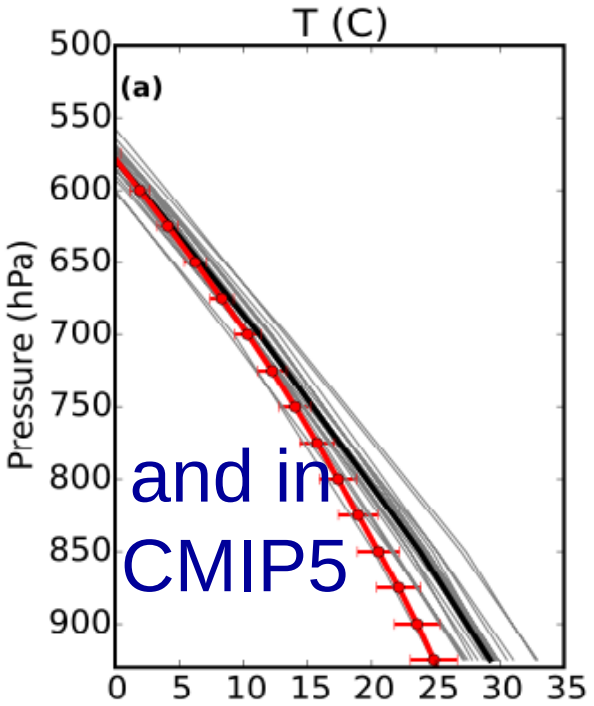




Warm bias is not just at surface.

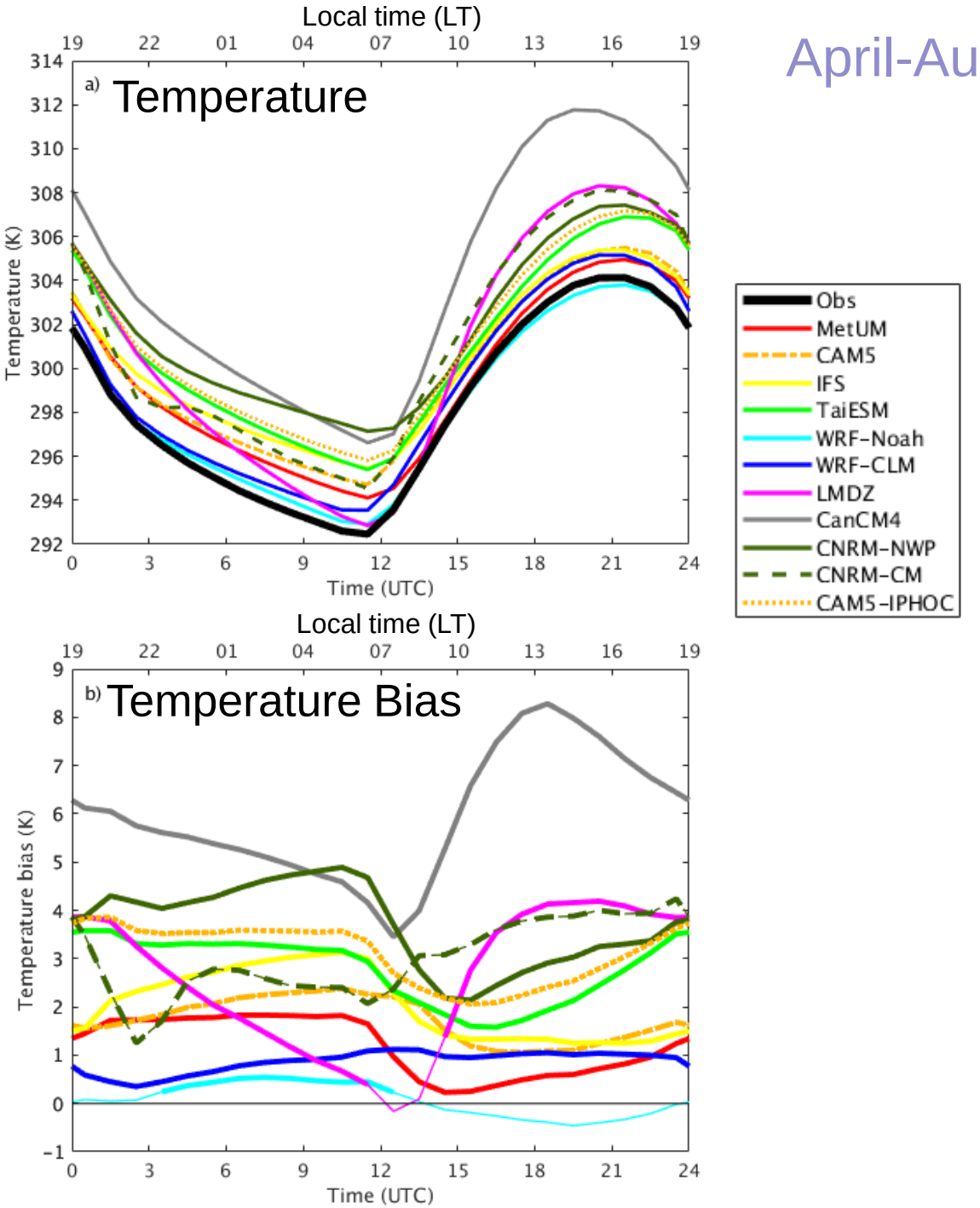
It extends several km into atmosphere





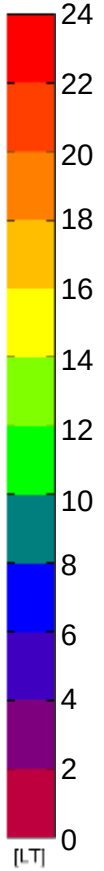
Morcrette *et al.* (2018) and Zhang *et al.* (2018)

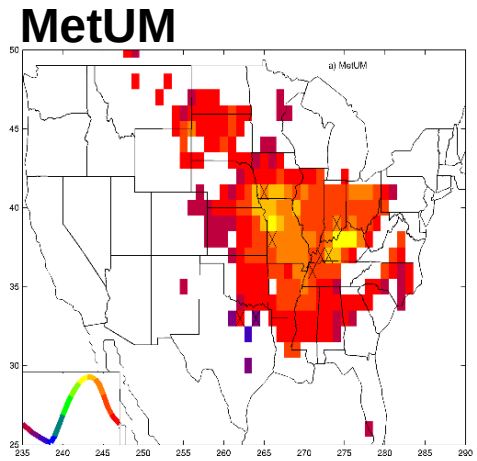
April-Aug mean diurnal cycles at SGP

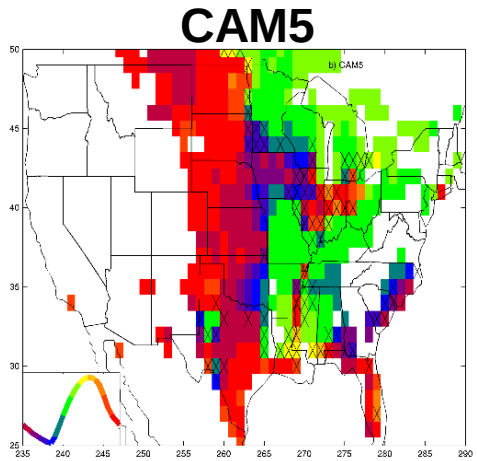


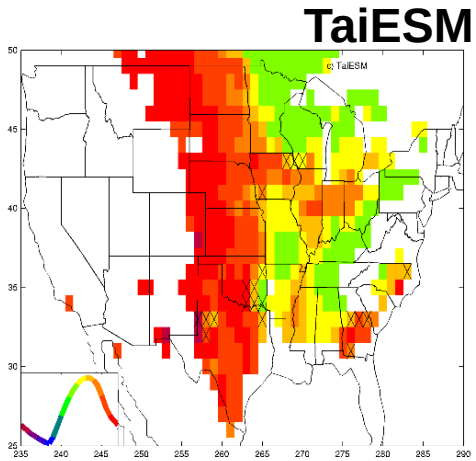
Local time of max error

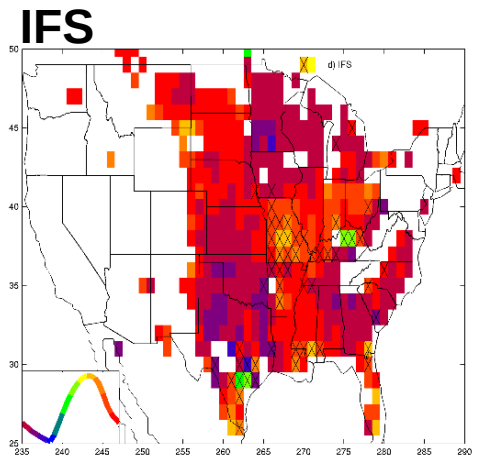
(Phase of diurnal cycle of T2M error from FFTs)

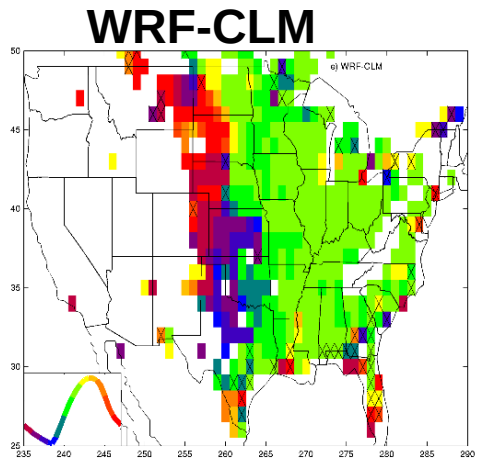


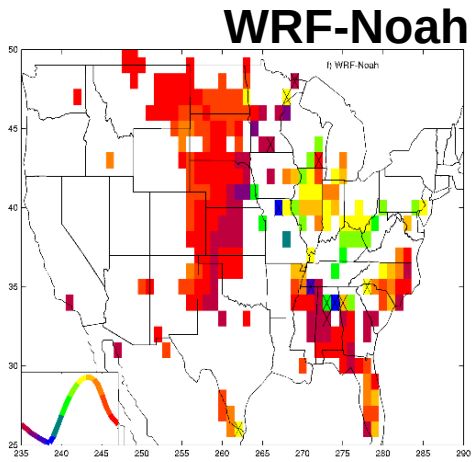


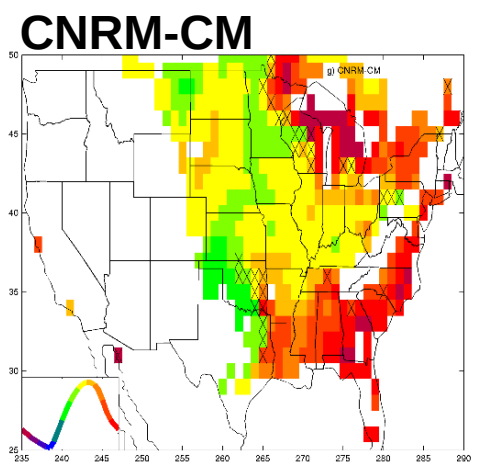


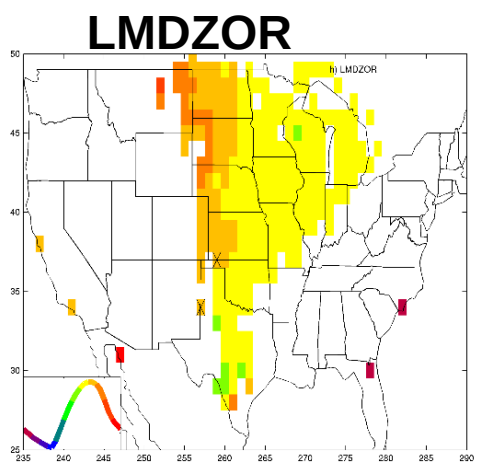


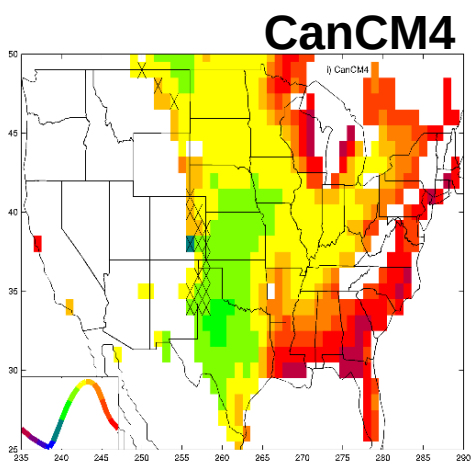








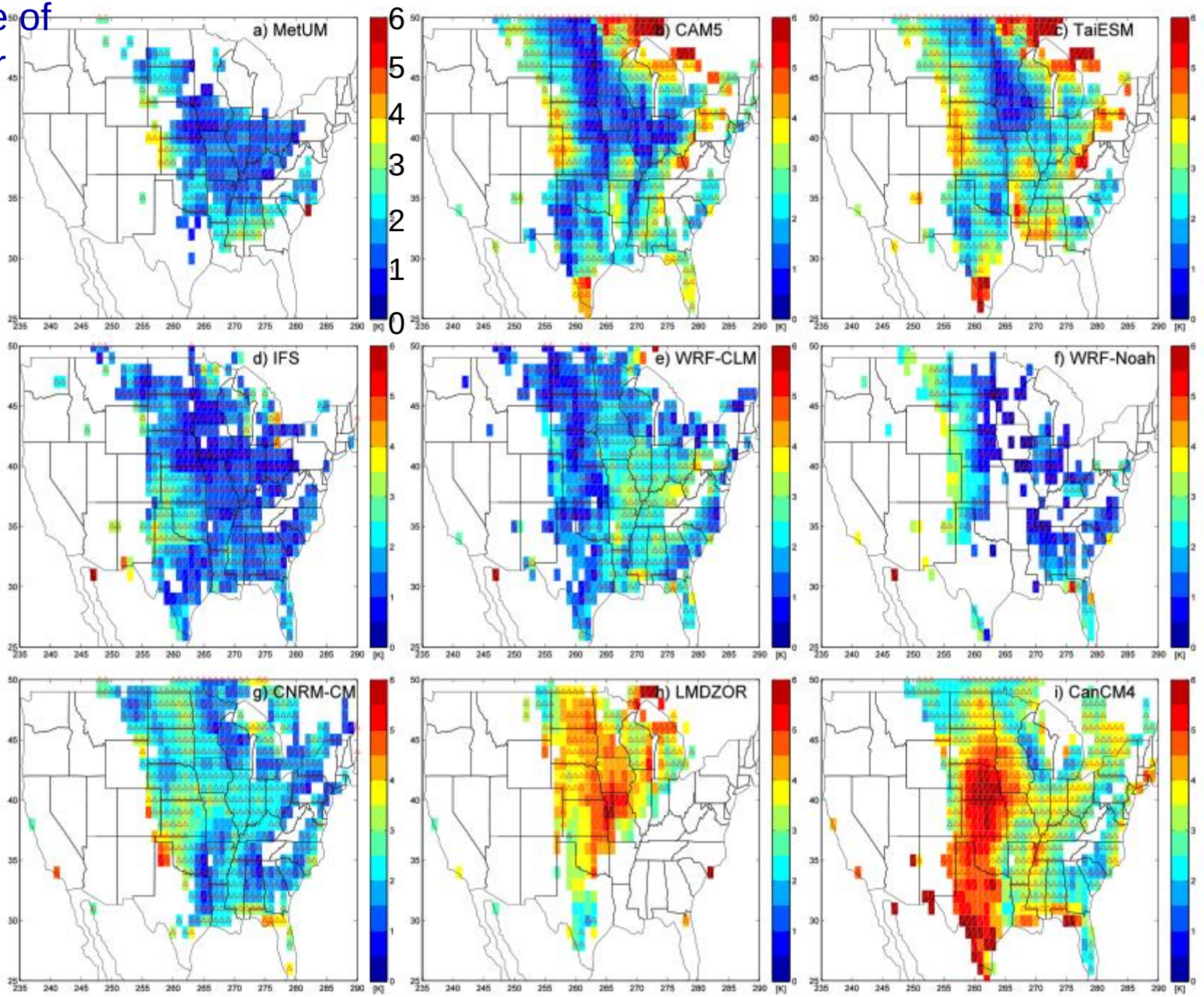




Morcrette *et al.* (2018)

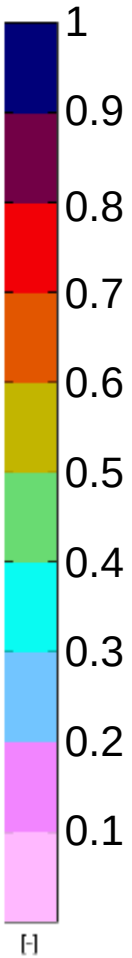
Amplitude of T2M error diurnal cycle

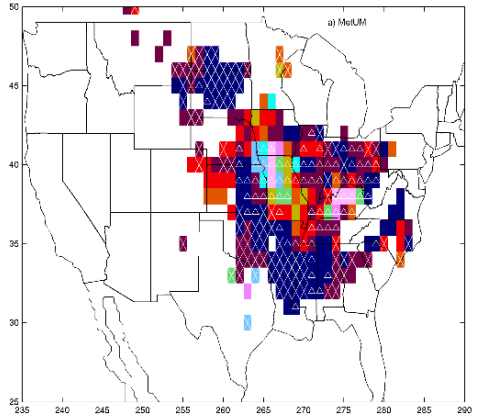
(Day 2-to-5 mean; April-Aug mean)

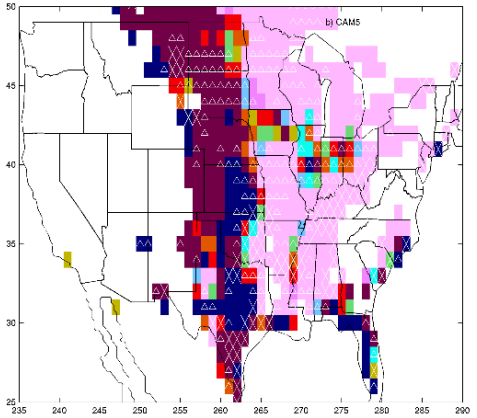


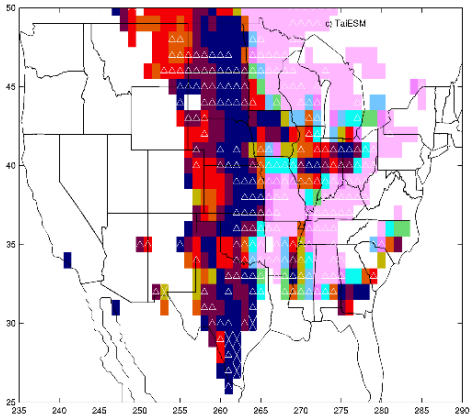
Correlation of T2M error at any point with T2M error at SGP.

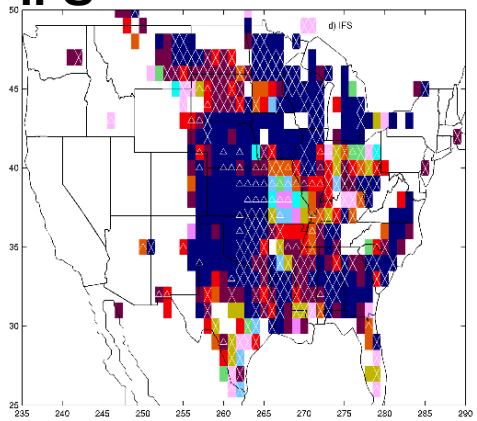
(Use April-Aug mean diurnal cycle)

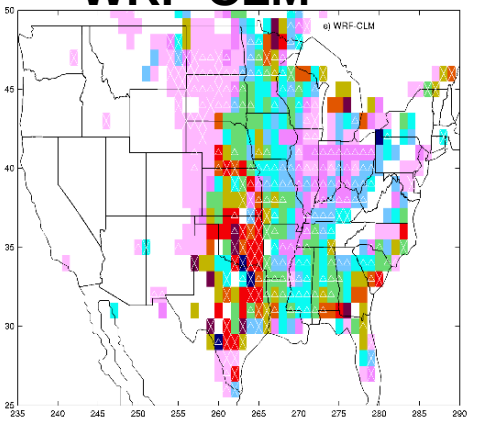


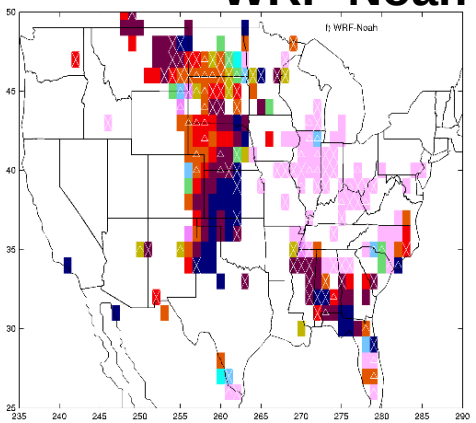


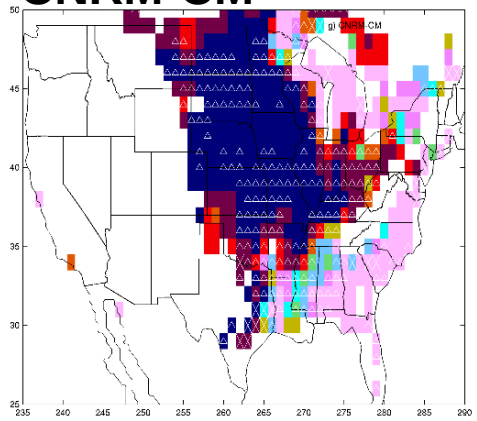


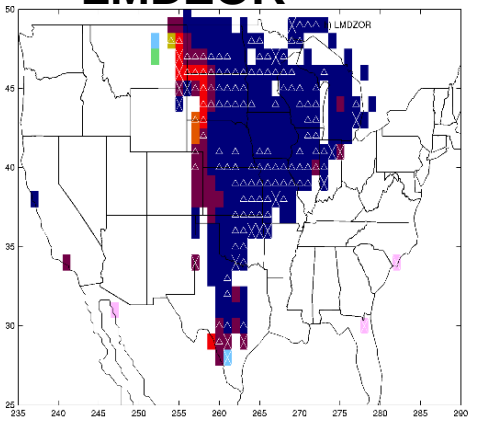


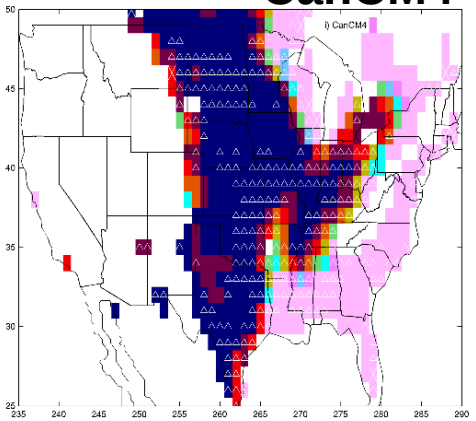












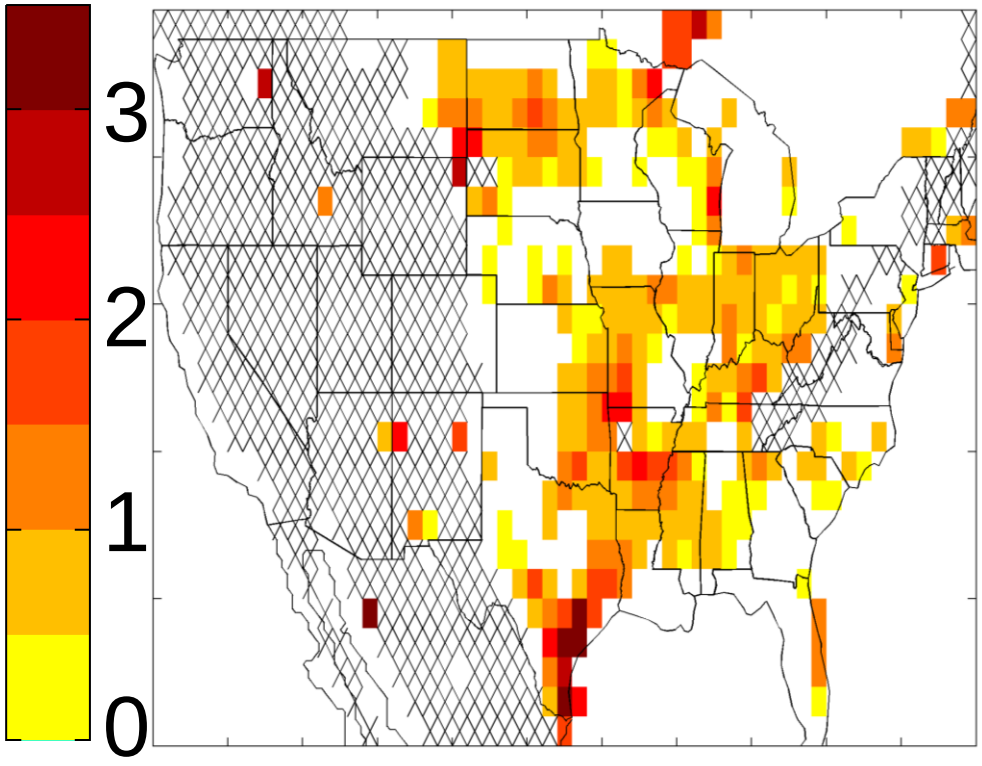
Morcrette *et al.* (2018)

Summary:

- 11 models (9 institutes) ran 5-day hind-casts over USA.
- Most models have a warm screen-level temperature bias over parts of American Midwest.
- Biases are not confined to the surface.
- Biases are not even across the day.
- Some models have largest error during day and others at night.
- Mean biases increase with lead-time.
- Diurnal range of bias increases with lead-time.
- Diurnal phase of bias coherent over large regions.
- Diurnal cycle of biases over wide region are highly correlated with biases at SGP site.
- What we learn at SGP is likely to reflect what is happening elsewhere.

Extra slides

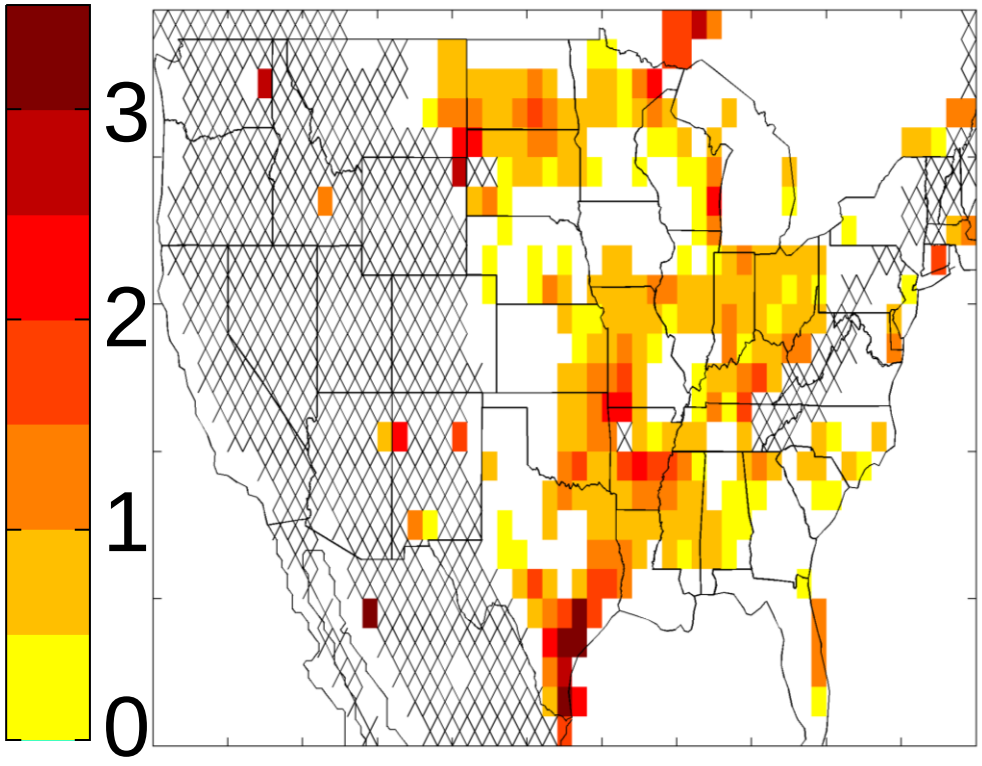
How extensive is ERA-Interim bias seen at SGP?

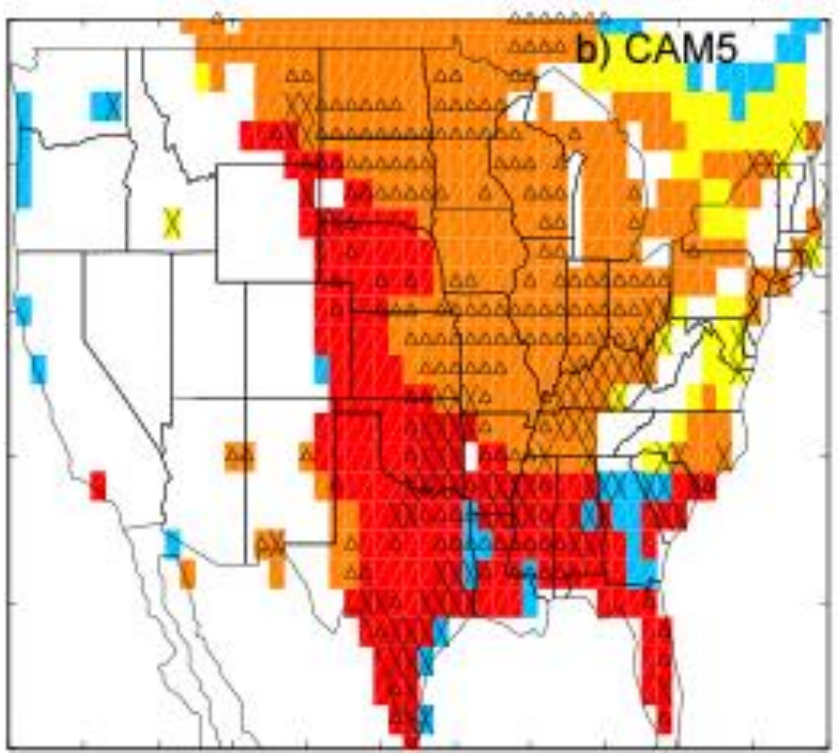


Is that going to corrupt simulations initialised from ERA-Interim?

Morcrette *et al.* (2018)

How extensive is ERA-Interim bias seen at SGP?





X = ERA-I is biased

Δ = ERA-I is biased but model is significantly warmer.

There is a warming **and** a warm bias

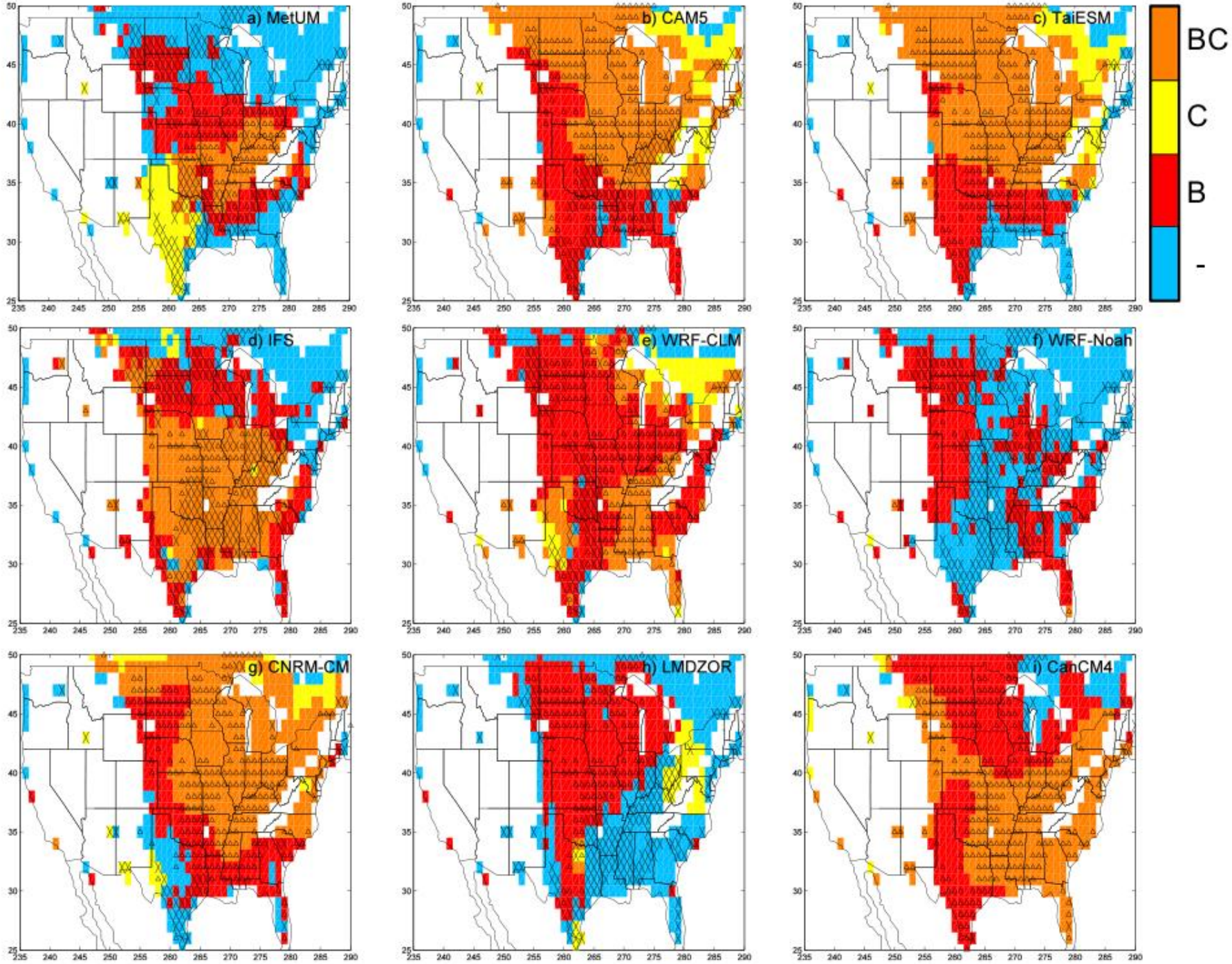
There is a warming

There is a warm bias

Nothing

Is that going to corrupt simulations initialised from ERA-Interim?

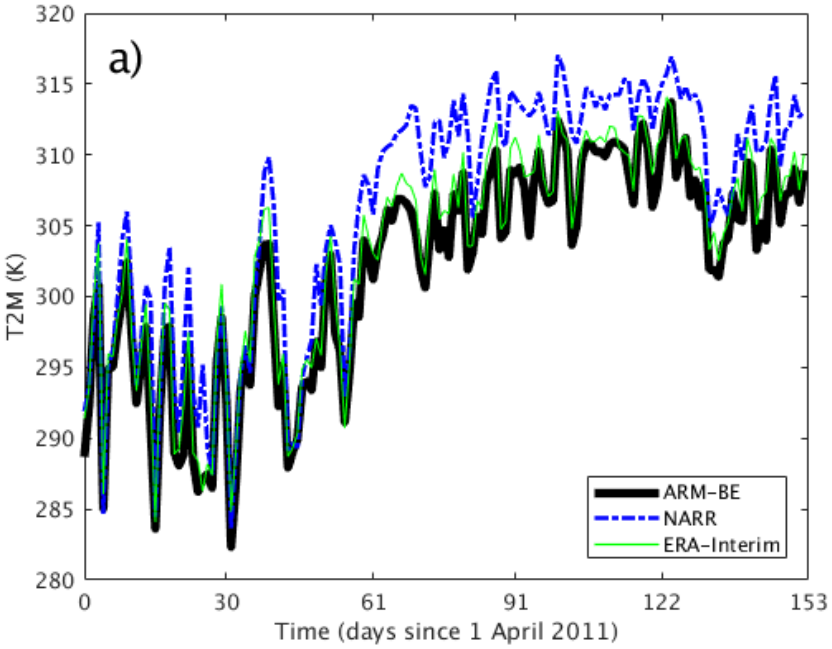
Morcrette *et al.* (2018)

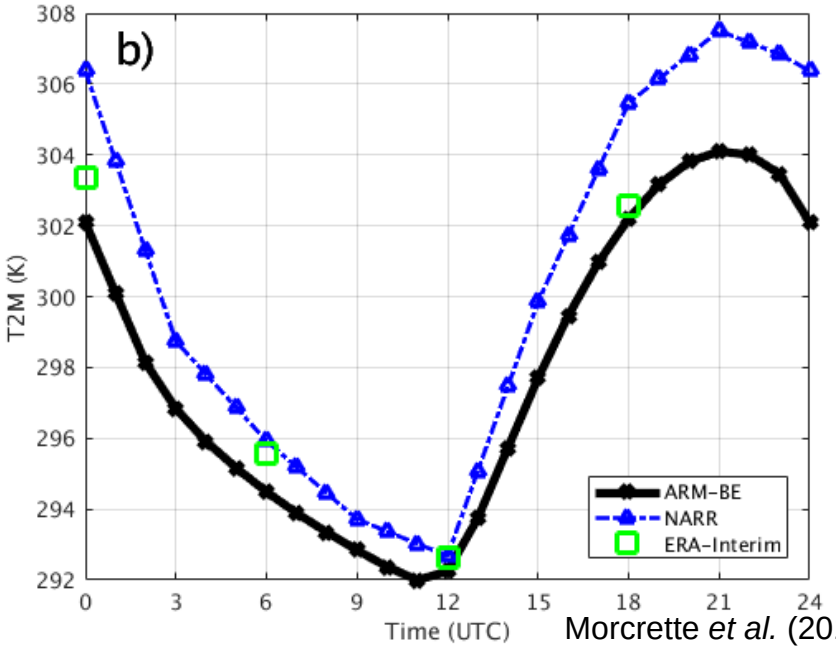

a) MetUM
b) CAM5
c) TaiESM
d) IFS
e) WRF-CLM
f) WRF-Noah
g) CNRM-CM
h) LMDZOR
i) CanCM4
BC
C
B
-

What shall we use for validating T2M?

ARM-Best-Estimate (good for SGP and 3deg x 3deg surroundings)
But need something for rest of CONUS.
Try:

- ERA-Interim
- North-American Regional Analysis (NARR)





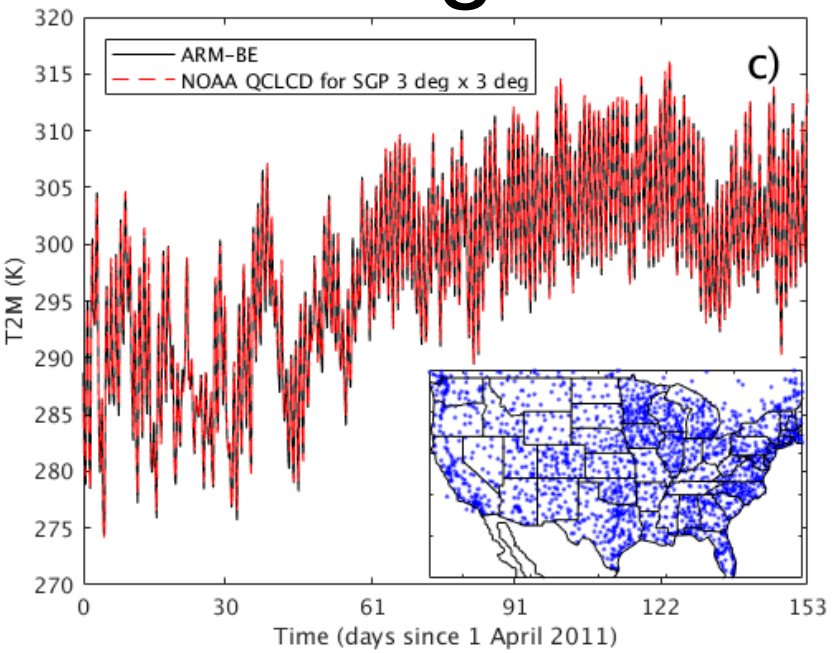
Morcrette *et al.* (2018)

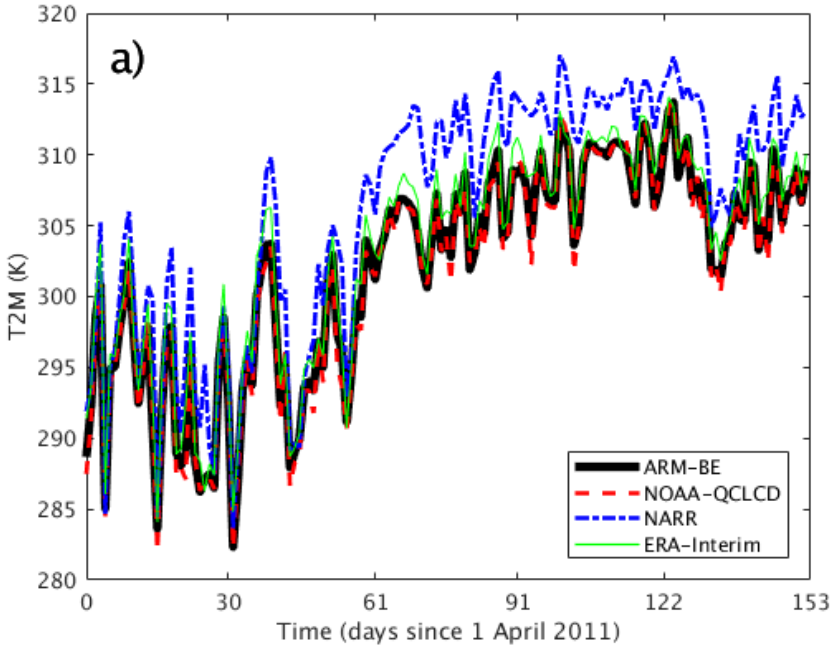
What shall we use for validating T2M?

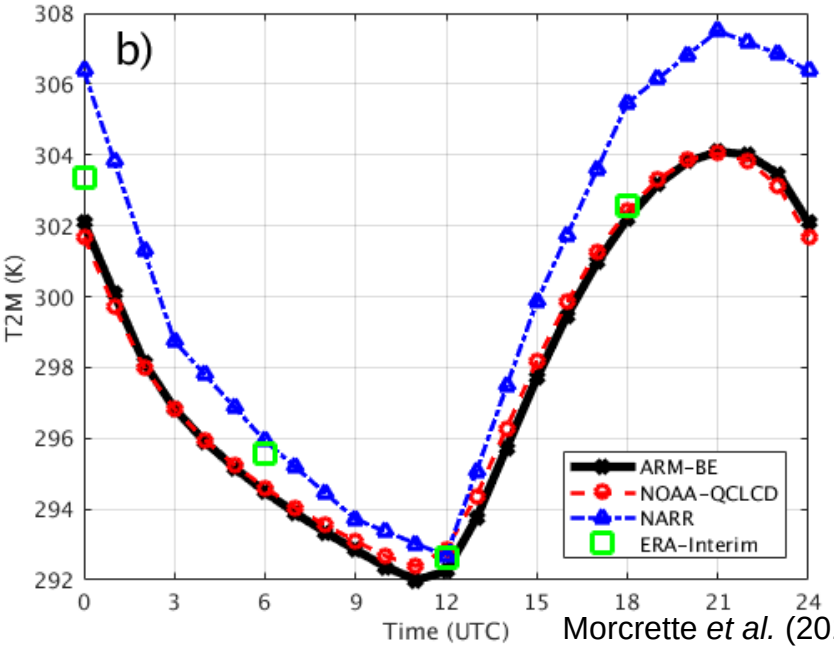
Hourly from April-Aug 2011.

Take obs from ~2000 NOAA "Quality controlled local climate data" (QCLCD) sites.

Produce gridded data set.







Morcrette *et al.* (2018)