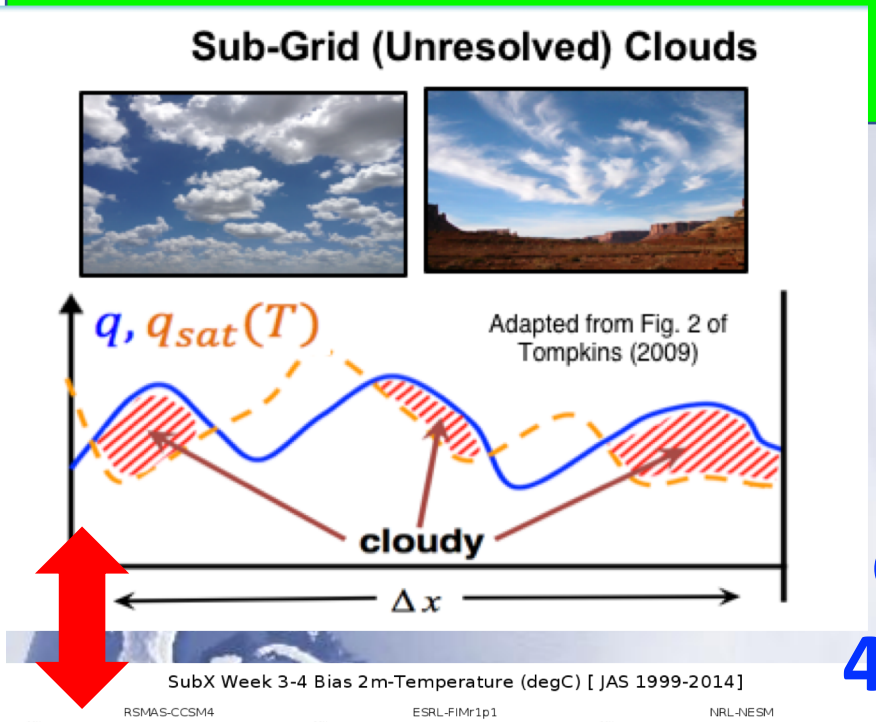
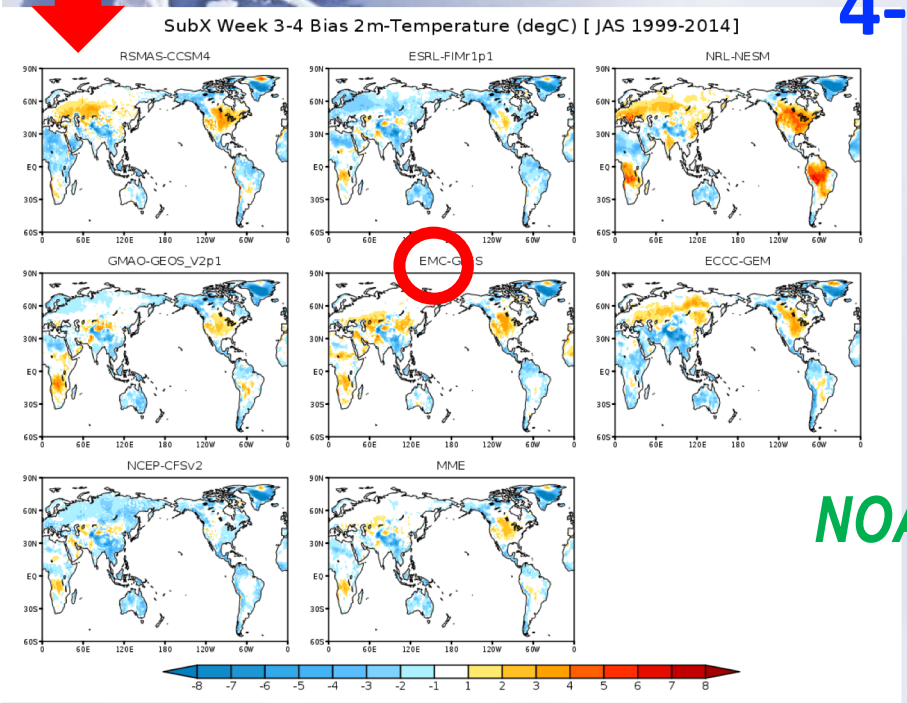




Toward reducing cloud-radiation errors from 4-hour to 4-week prediction

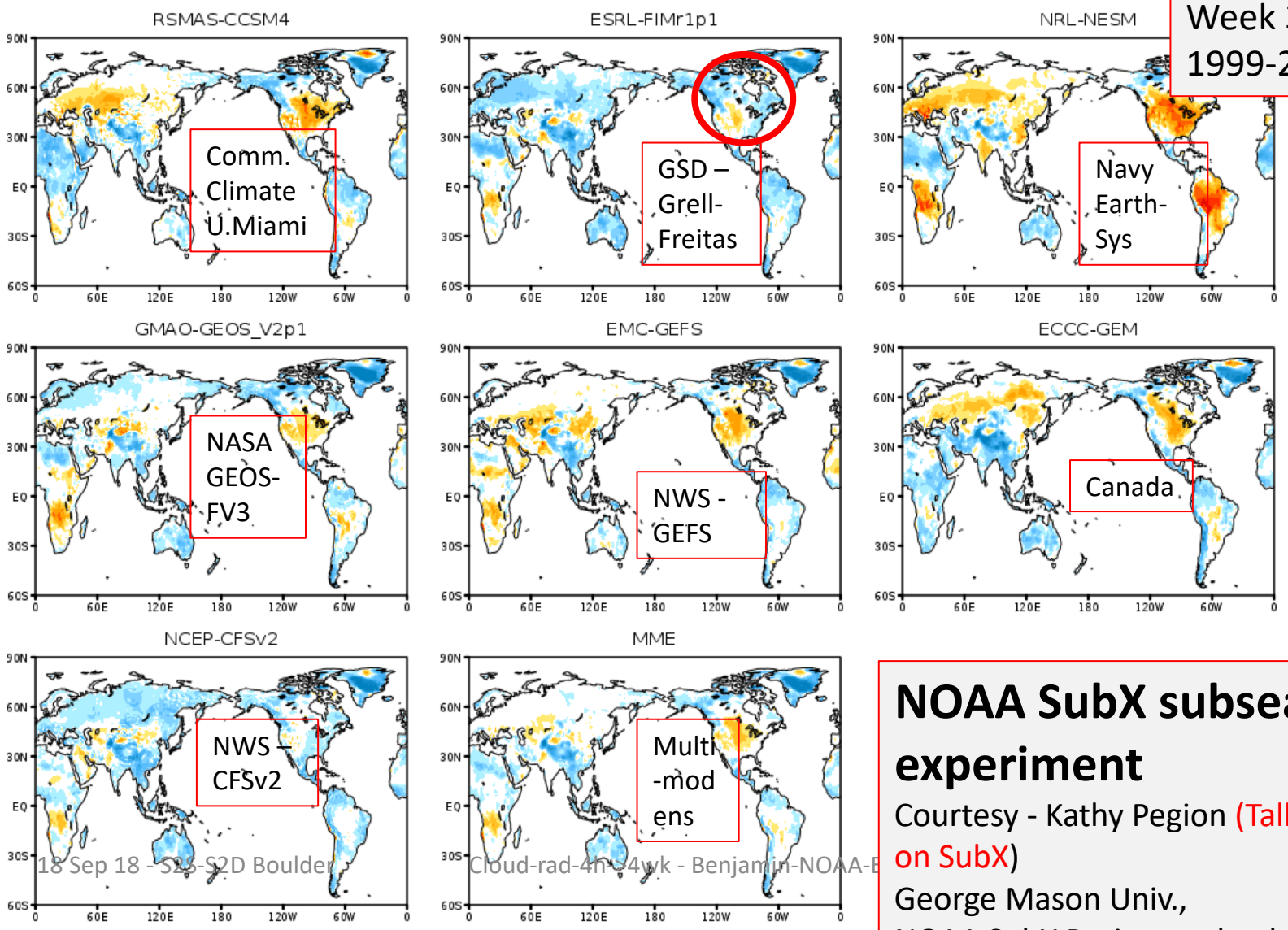
Stan Benjamin

Shan Sun, Georg Grell, Joseph Olson, Ben Green

NOAA Earth System Research Laboratory, Boulder, CO USA

Intl. Confs. on S2S and S2D Prediction
Boulder, CO USA, 18 Sept 2018

JAS –NH summer
2m temp bias
Week 3-4
1999-2014 - SubX



Warm 2m bias over central North America in summer

NOAA SubX subseasonal experiment

Courtesy - Kathy Pegion (Talk 1430 today on SubX)

George Mason Univ.,
NOAA SubX Project co-lead

CAUSES - Clouds Above the United States and Errors at the Surface

About
Experiment
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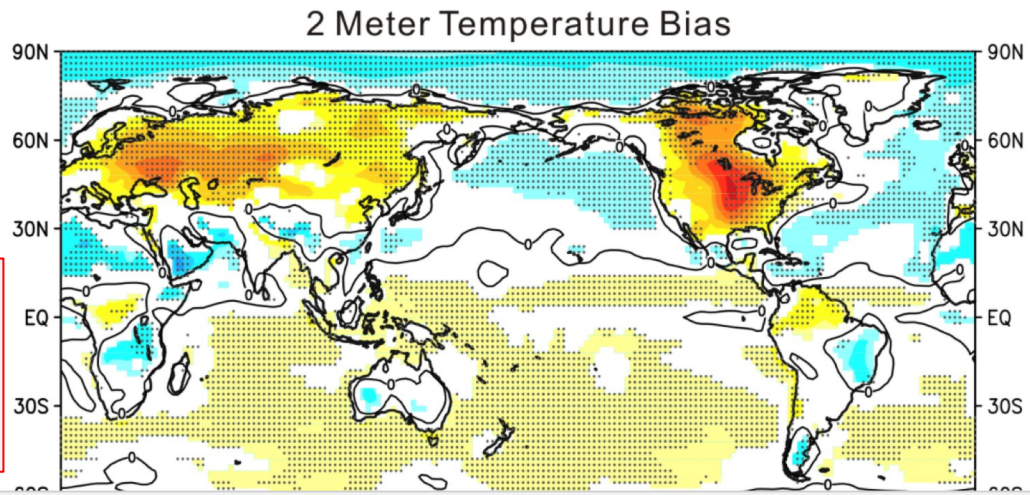
What is CAUSES?

Purpose

The Clouds Above the United States and Errors at the Surface (CAUSES) is a joint GASS-RGCM-ASR model intercomparison project with an observationally-based focus, which evaluates the role of clouds, radiation and precipitation processes in contributin to the surface temperature biases in the region of the central United States. These biases are seen in several weather and climate models.

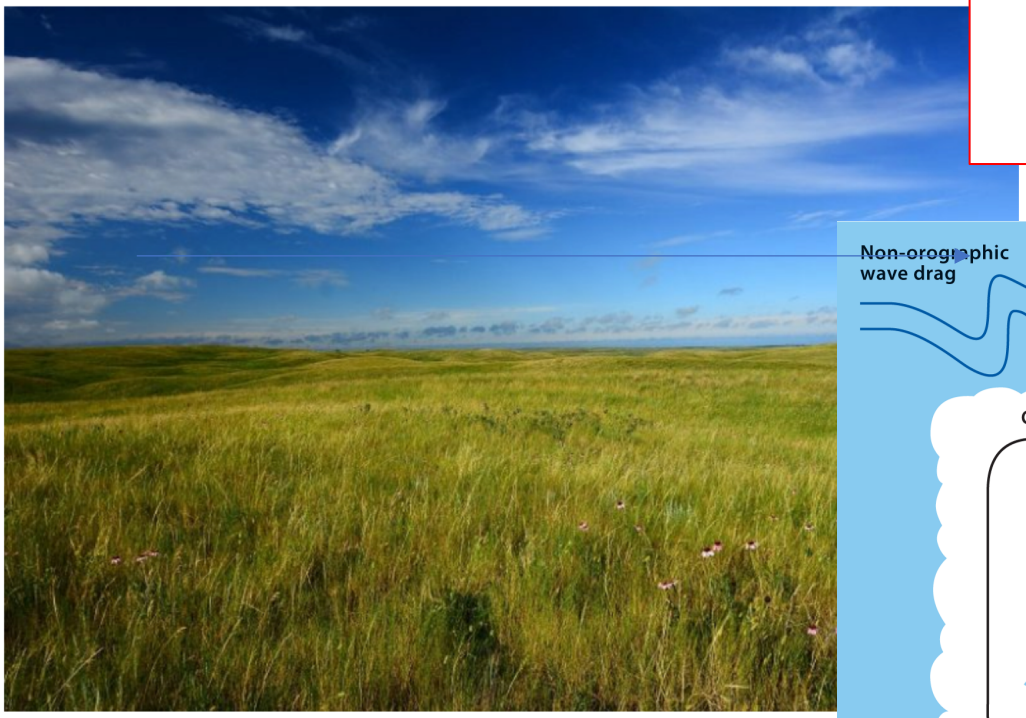
GASS GEWEX
RGCM
ASR Atmospheric System Research

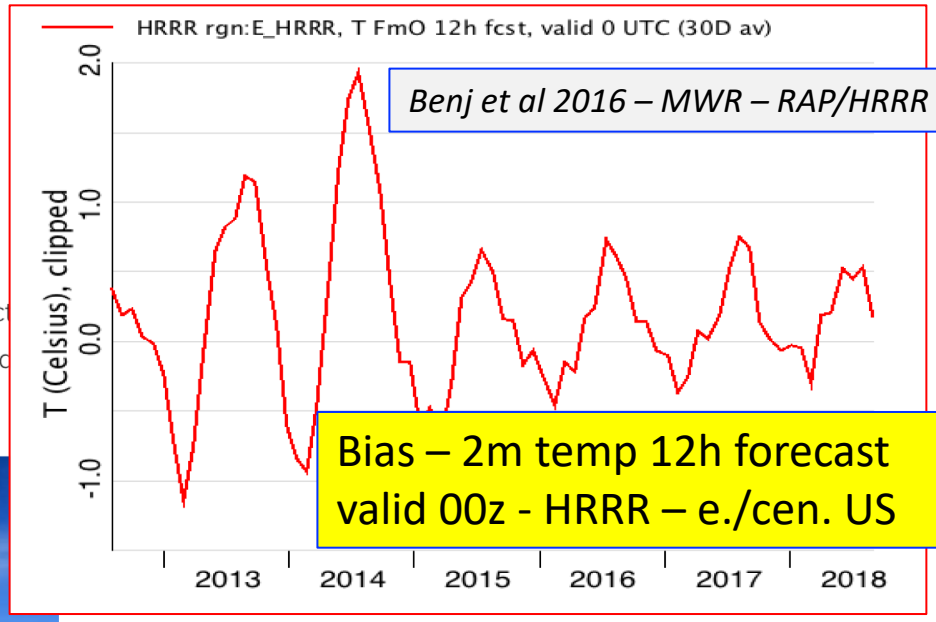
Led by:
UKMO – Cyril Morcrette
DOE – US – Steve Klein

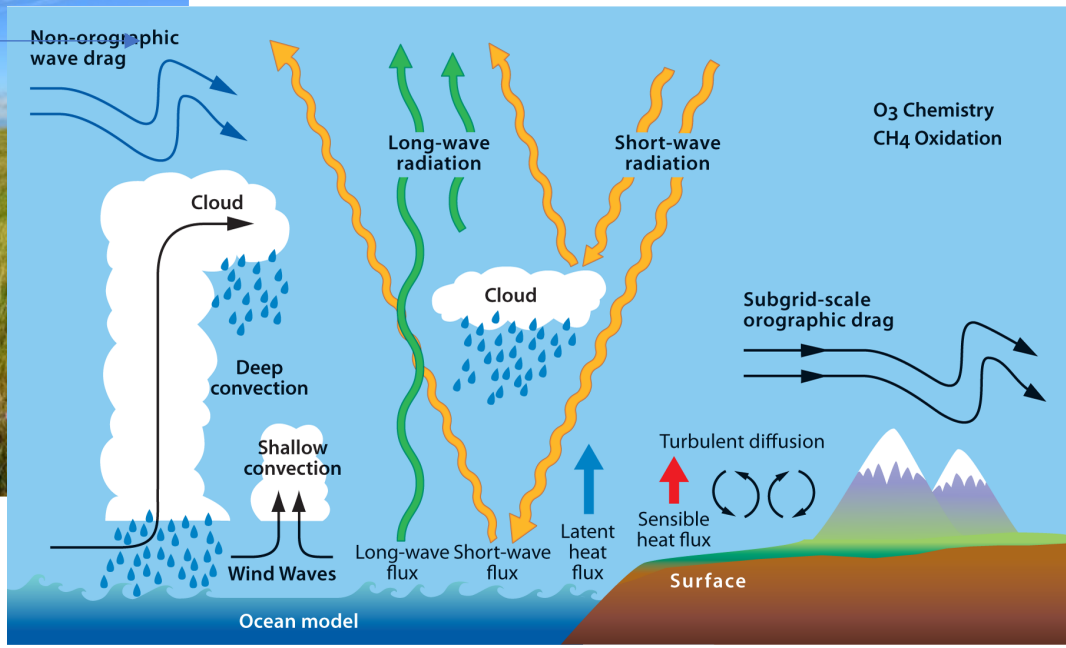


Diagnosing the Warm Bias in the Central United States

A set of four papers published in *JGR: Atmospheres* present results from a project investigating why models predict warmer surface temperatures than are observed the central United States.







Unified model development in NOAA/ESRL

(ESRL divisions: GSD with PSD/GMD/CSD), NCEP, NCAR, etc.)

Spatial resolution **Forecast range** **Domain**	**3km** **1-36h** **Regional**	**13km** **1-39h** **Regional**	**10-15km** **1-10 day** **Global**	**15-60km** **Week 2 – 9 month** **Global**
Model development area	**HRRR (High-Resolution Rapid Refresh model) –**	**RAP (Rapid Refresh)**	**NGGPS – FV3 (current physics testing with FIM and FV3)**	**SubX – current FIM-HYCOM coupled seasonal (for SubX exper, 2019 switch to FV3)**
Data assimilation	Radar/cloud/surface/land, 3km ensemble DA		4D Ensemble DA (Whitaker-PSD, EMC)	
Dynamic core numerics	Use/refinement of WRF-ARW, hybrid vert coordinate		FV3 – cubed sphere, FIM - icosahedral	
Physical parameterization	PBL/MYNN, cloud microphysics (Thompson), RUC land-surface,	Same as HRRR but with Grell-Freitas scale-aware cumulus	GFS physics + Grell-Freitas cu. Testing full HRRR/RAP suite	1) GFS physics + Grell-Freitas cumulus. 2) Full HRRR suite including Grell-Freitas
Application of inline chemistry	2-aerosol – NCEP, testing of 18-aerosol	" + gas-phase chemistry	18-aerosol and gas-phase chem	18-aerosol only so far
Systematic error investigations	Clouds, precipitation	Clouds	**Clouds, blocking, precipitation**	**Clouds, blocking, precipitation**

RAP/HRRR: NOAA Hourly-Updating Weather Forecast Suite

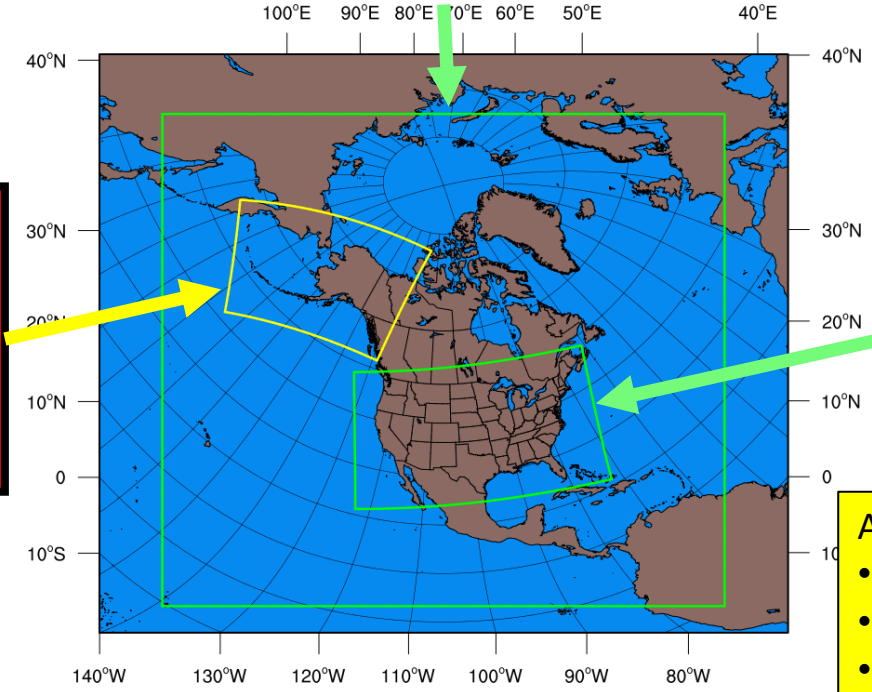
- July 2018 NOAA/NCEP upgrade

13-km Rapid Refresh (RAPv4) – to 39h (July 2018)

Initial & Lateral Boundary Conditions

Initial & Lateral Boundary Conditions

3-km High-Resolution Rapid Refresh Alaska (HRRR-AK) 36 hr (Jul 2018)



3-km High-Resolution Rapid Refresh (HRRRv3) – to 36h (Jul 2018)

Applications
- Severe weather
- Aviation/transportation
- Energy
- Hydrology/ Nat. Water Model

All critically dependent on clouds