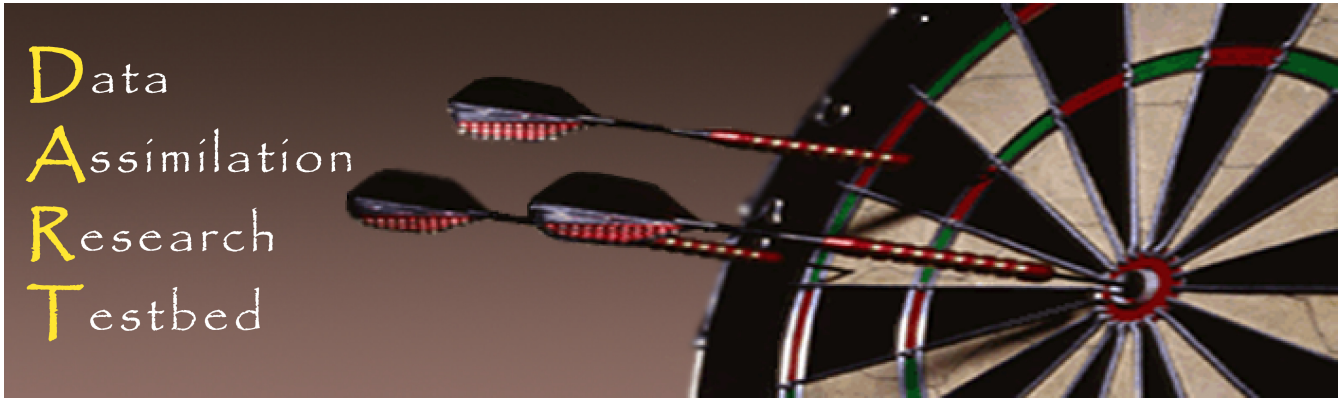
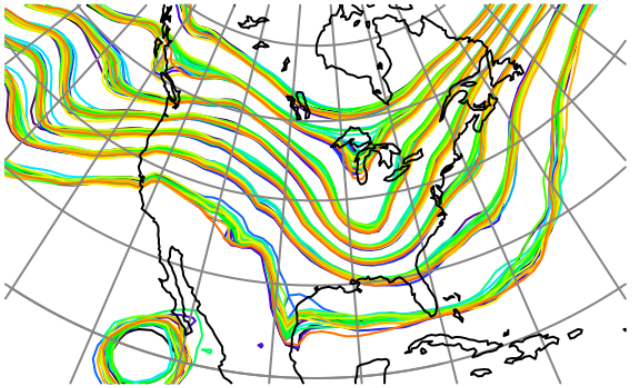


CAHMDA/DAFOH
Ensemble Data Assimilation Tutorial



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NCAR | National Center for
UCAR | Atmospheric Research

Who is the instructor?

Tim Hoar thoar@ucar.edu www.image.ucar.edu/~thoar

- I got my Bachelors degree from a school in New York in 1983.
- Several jobs and 10 years later, I graduated from University of Texas in Austin.
- I worked in the Geophysical Statistics Project at the U.S. National Center for Atmospheric Research (NCAR) for about 10 years.
- I've been working with Jeff Anderson and the rest of the Data Assimilation Research Section at NCAR for about 10 years.

But Really … I just love to fish!

Who is the instructor?

Something to think about all day …

One statement is a lie.

- I have been to all 7 continents.
- I was the president of the UT Austin dart league. (as in the pub game, not the software)
- I can lift a canoe over my head with one hand.

Here is a hint:

It's actually a very light canoe! (10kg)

What to expect for today:

1. I want this to be a fun, engaging, informative, interactive day!

2. I expect you to ASK QUESTIONS! ***Please!*** I've heard everything I'm going to say!

3. I ***need you*** to help guide the tutorial. This is an audience participation day. I am **not** going to be a talking head for 8 hours. That is most definitely *NOT ME*!

Introductions:

Yes, we are going to go around the room and introduce ourselves. As you introduce yourself, please:

1. Tell us your name and where you're from.

2. What, if any, (land or hydrological) model you are most familiar with.

3. What you hope to get out of this tutorial.

DART "home page":

http://www.image.ucar.edu/DAReS/DART

The most useful (to me) pull-down menus:

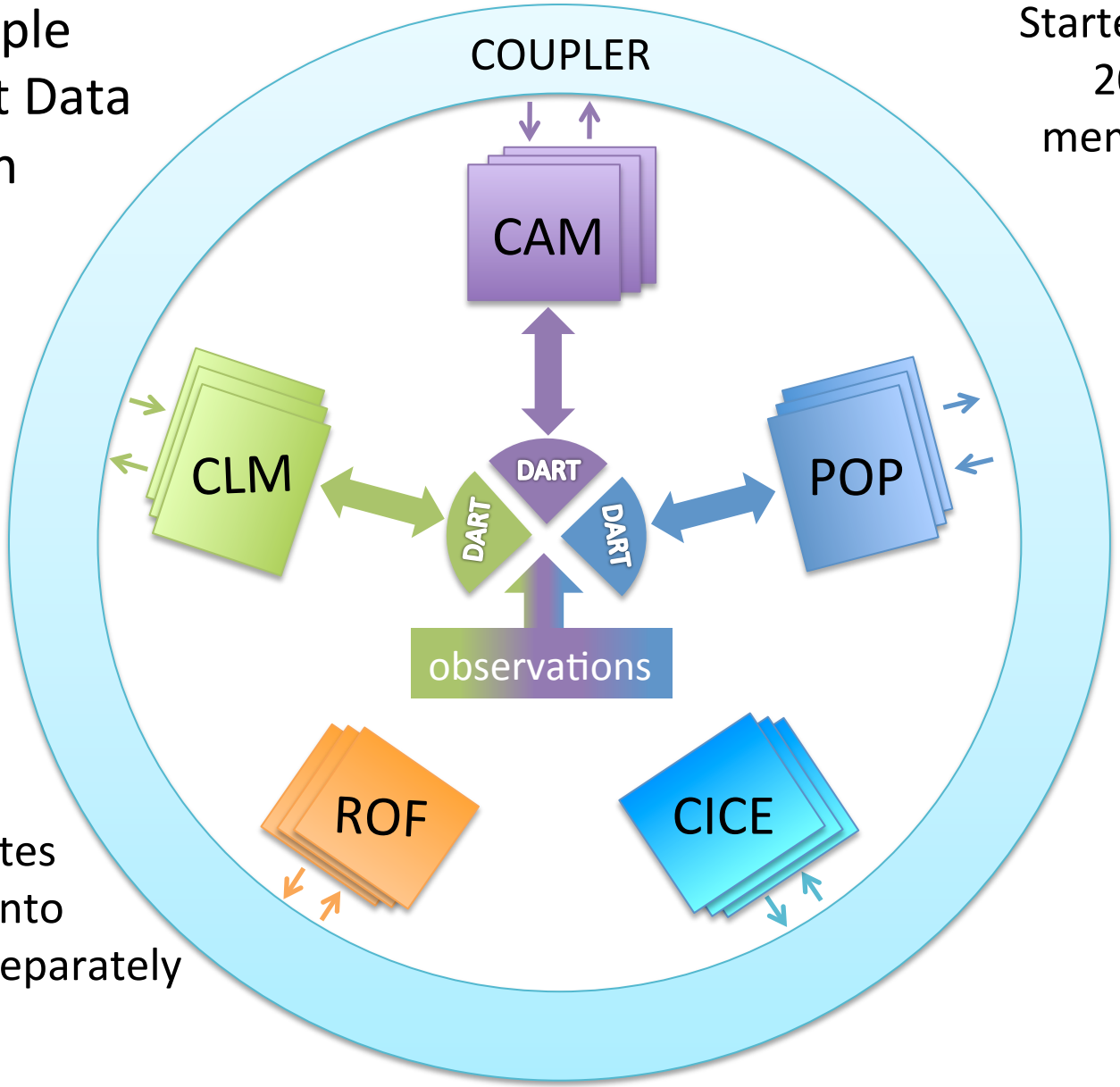
- Getting Started
- Documentation
- Diagnostics
- Miscellany: Platform-specific Notes

Overview article of DART:

Anderson, Jeffrey, T. Hoar, K. Raeder, H. Liu, N. Collins, R. Torn, A. Arellano, 2009: The Data Assimilation Research Testbed: A Community Facility. *Bull. Amer. Meteor. Soc.*, **90**, 1283–1296. doi:10.1175/2009BAMS2618.1

Some Research using DART & land models

DART Multiple Component Data Assimilation



Started with CCSM4 20th Century 30-member ensemble for all model components

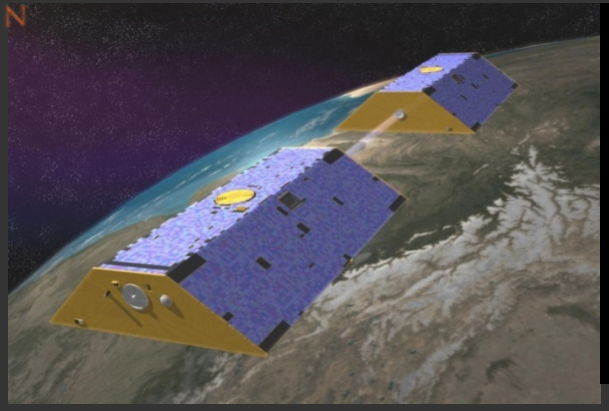
Important! There are *multiple* instances of each model component.

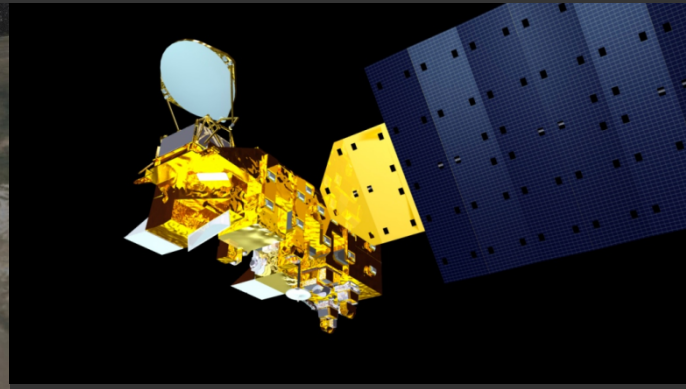
Abhishek Chatterjee is doing this now!

DART assimilates observations into components separately

Some of the researchers using CLM/DART

- **Yong-Fei Zhang** (UT Austin)
  - multisensor snow data assimilation
- **Andy Fox** (NEON)
  - flux observations/state estimation
- **Hanna Post** (Jülich)
  - assimilation & parameter estimation
- **Raj Shekhar Singh** (UC Berkeley)
  - groundwater
- **Long Zhao** (UT Austin)
  - AMSR-E radiances, empirical vegetated surface RTM, soil moisture (SMAP)
- **Ally Toure** (NASA-Goddard USRA)
  - brightness temperatures
- **Yonghwan Kwon** (UT Austin)
  - sensitivity of assimilation of brightness temperatures from multiple radiative transfer models on estimates of snow water equivalent.





Improving Estimates of Snowpack Water Storage in the Northern Hemisphere Through a Newly Developed Land Data Assimilation System

Yong-Fei Zhang[1], Zong-Liang Yang[1,2], Yonghwan Kwon[1], Tim J. Hoar[3], Hua Su[1], Jeffrey L. Anderson [3], Ally M. Toure [4,5], and Matthew Rodell [5]

[1]Jackson School of Geosciences, University of Texas at Austin, Austin, TX, United States.

[2]Key Lab of Regional Climate-Environment for Temperate East Asia (RCE-TEA), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China.

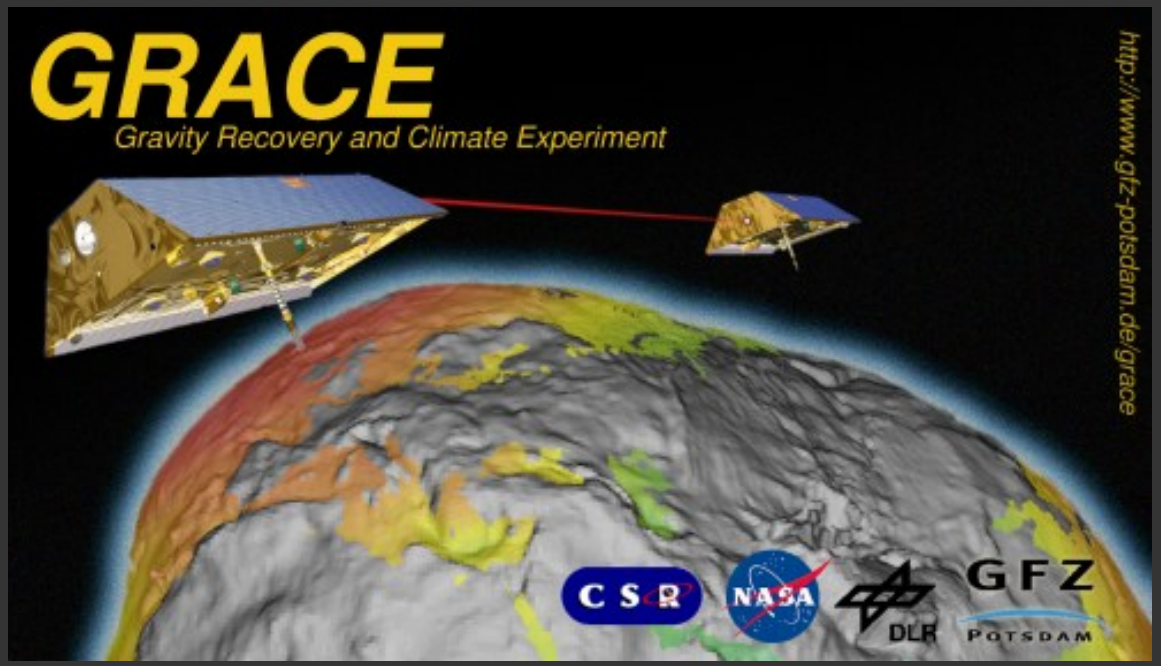
[3]The National Center for Atmospheric Research, Boulder, CO, United States.

[4]Universities Space Research Association (USRA), Columbia, MD, United States.

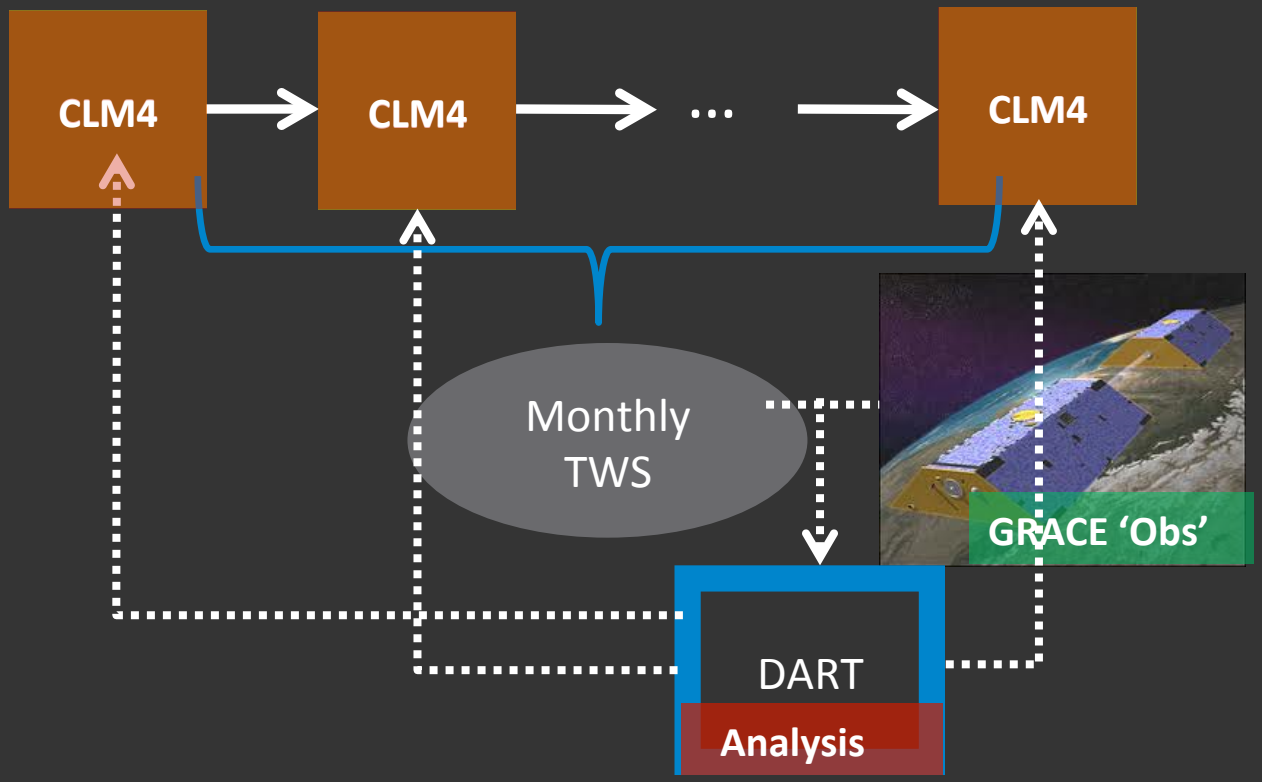
[5]NASA Goddard Space Flight Center, Greenbelt, MD, United States.

GRACE satellite data

- Different from MODIS that measures radiances, GRACE measures the distance between two satellites and retrieves gravitational anomalies. One of the products is a change in monthly total water storage (TWS).



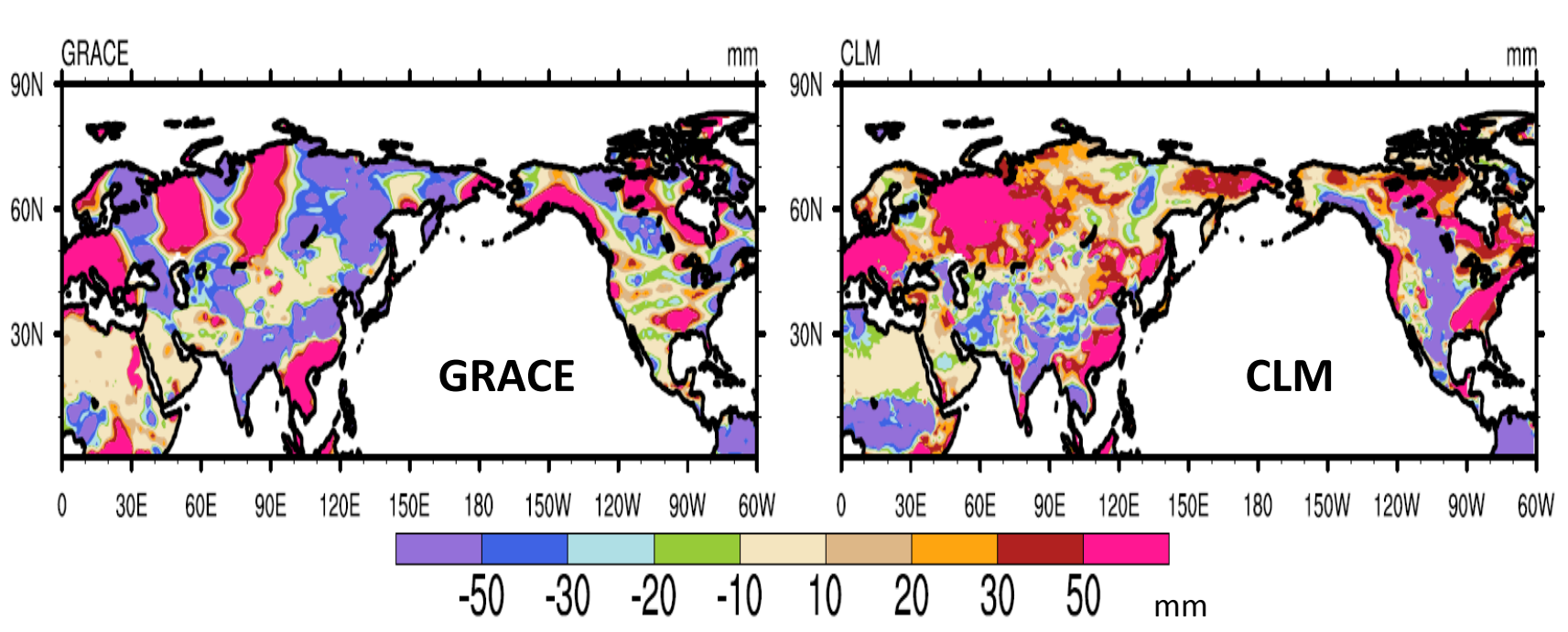
Two passes in GRACE data assimilation



1 Run CLM for one month to be able to calculate change in monthly total water storage.
2 Re-run CLM with data assimilation.

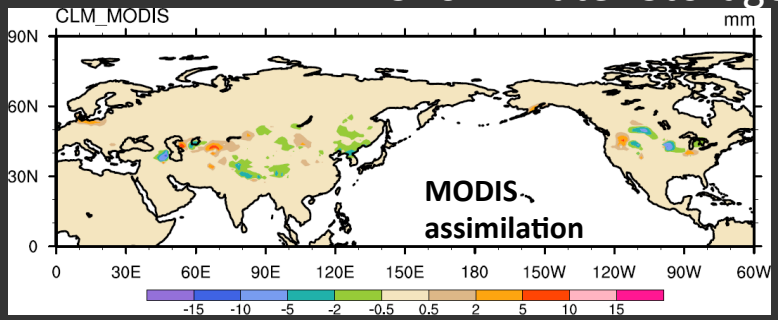
Total Water Storage change Jan 2003

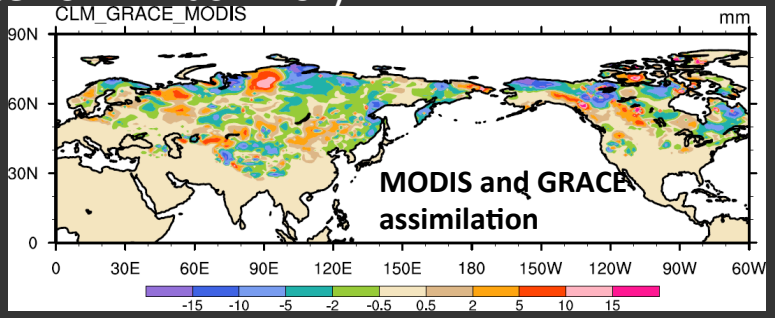
No assimilation.

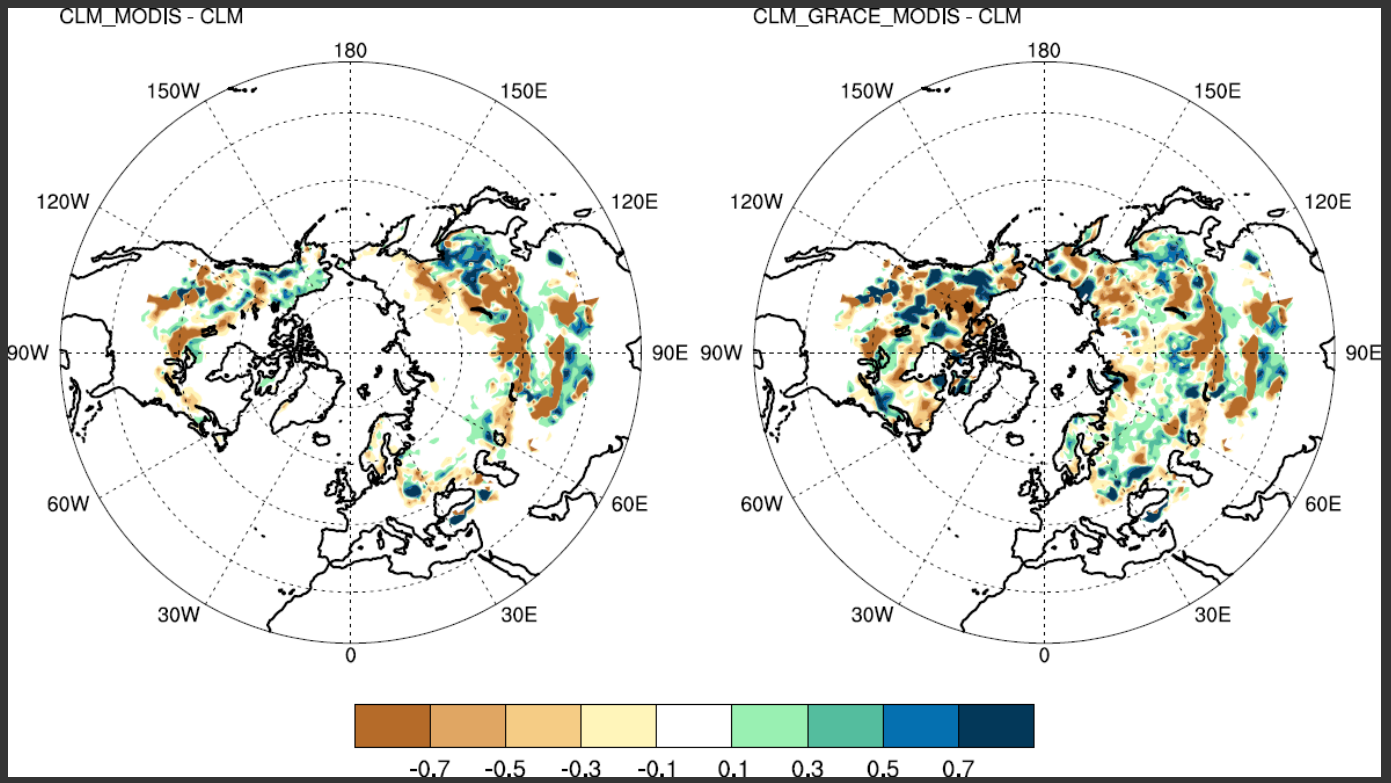


Assimilation Results

Snow Water Storage (Posterior minus Prior)



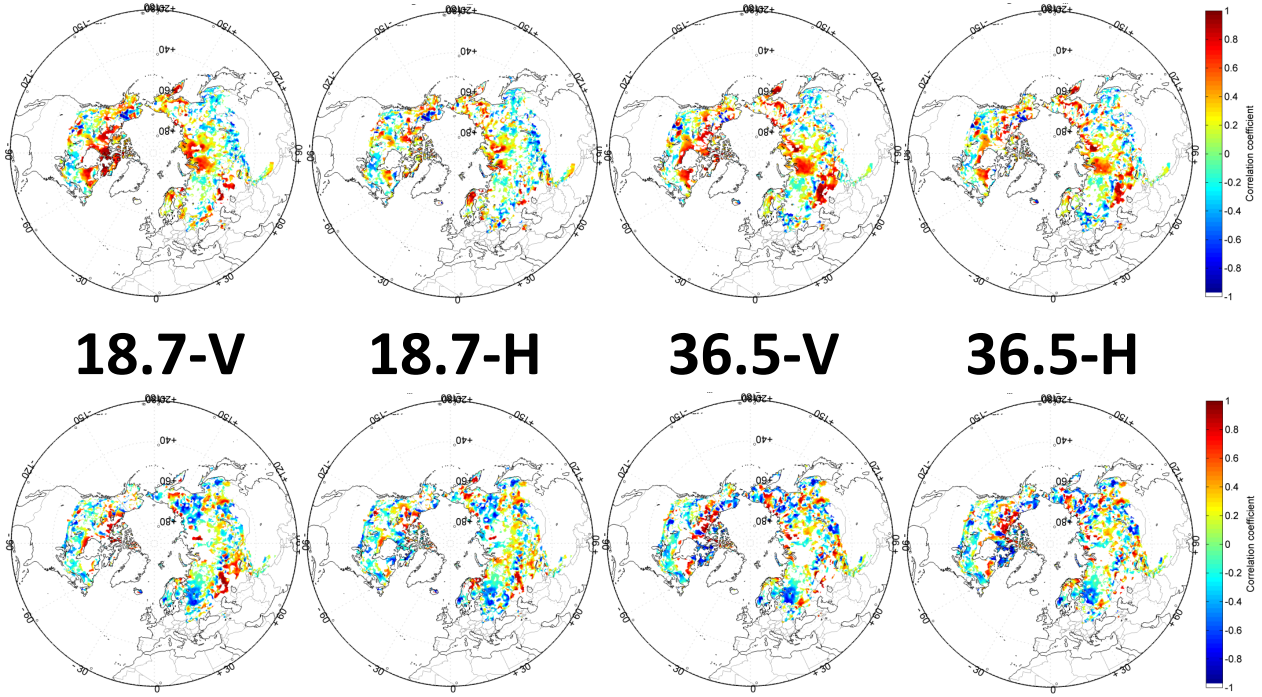




Multi-RTM ensemble approaches in SWE assimilation.

Yonghwan Kwon, UT Austin

Develop an advanced radiance assimilation scheme to estimate SWE at continental scale by using multiple snowpack RTMs: Microwave Emission Model for Layered Snowpacks (**MEMLS**) and Dense Media Radiative Transfer – Multi Layers model (**DMRT-ML**).



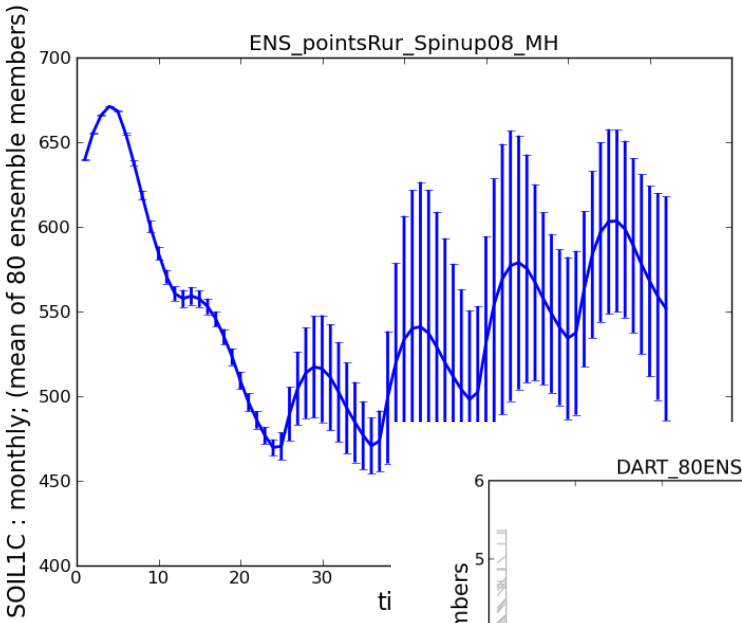
CLM4 & MEMLS

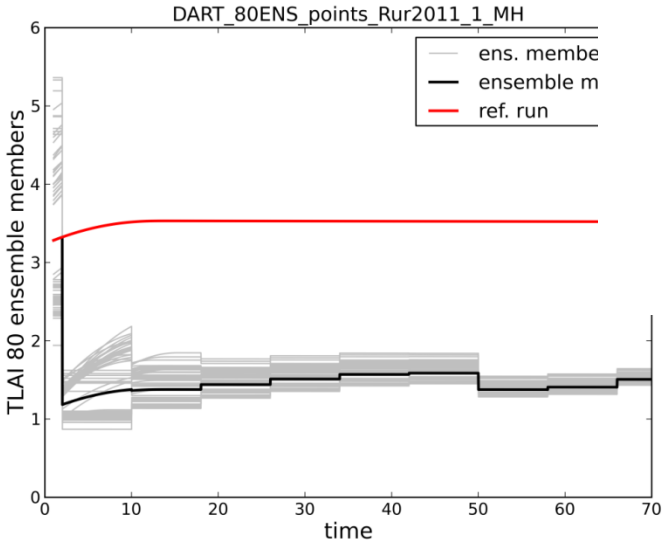
Correlations between:

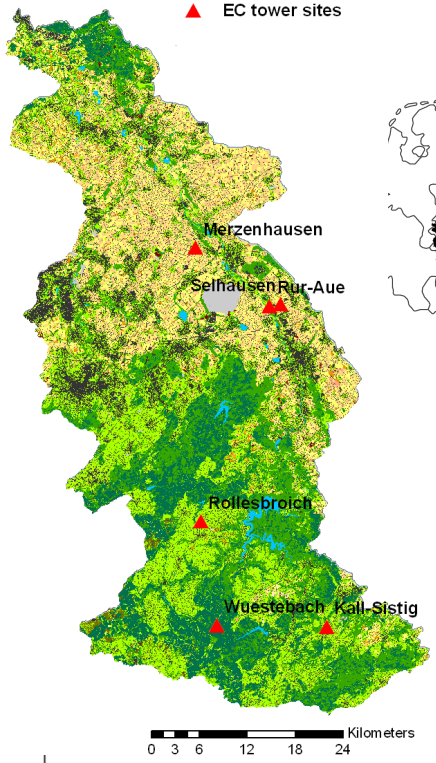
CLM4 & DMRT-ML

MEMLS; Wiesmann and Mätzler, 1999
DMRT-ML; Picard et al., 2013

Assimilation of eddy covariance fluxes & MODIS LAI data and CLM upscale NEE from plot to catchment scale



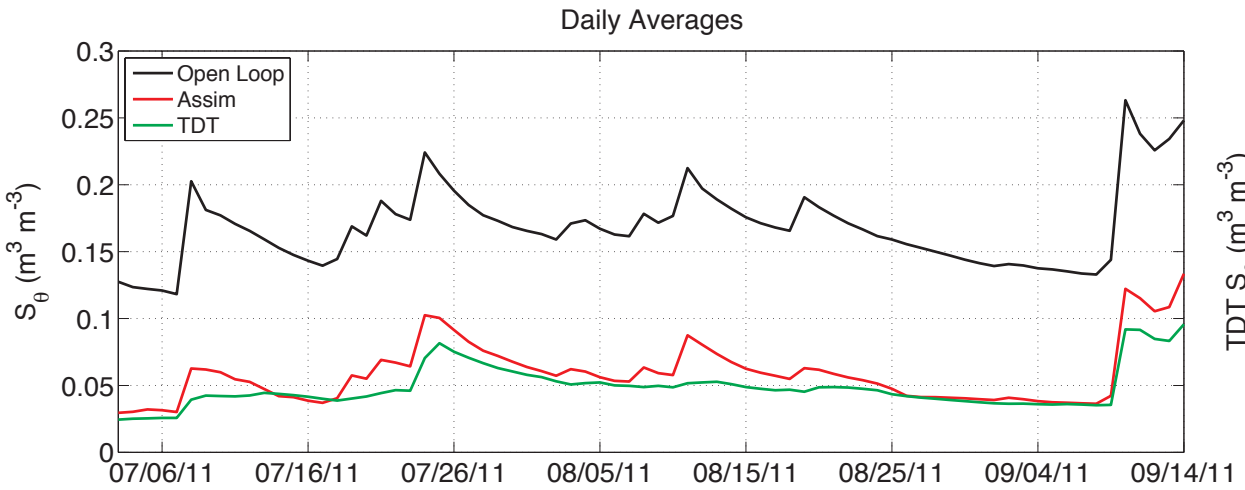


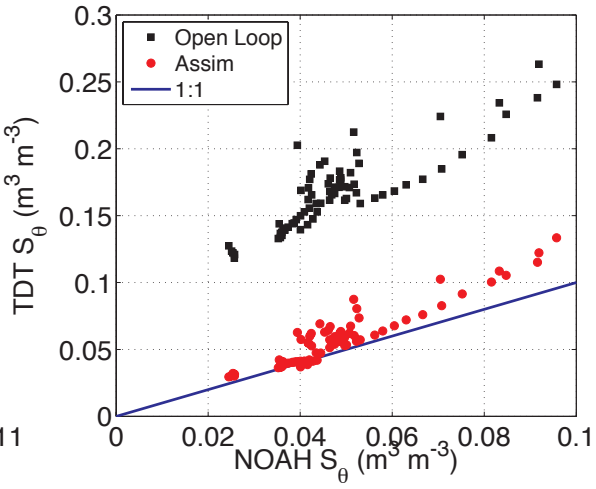


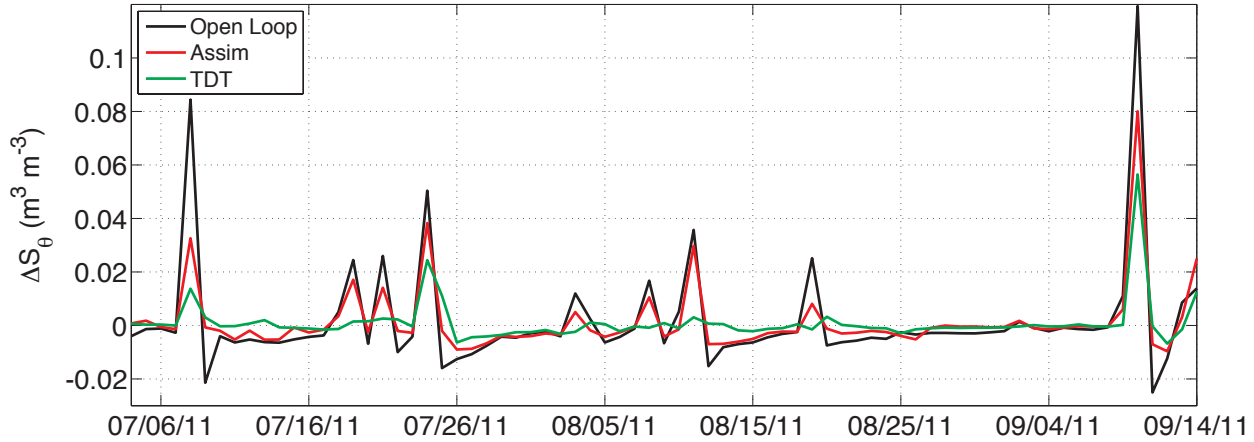
Hanna Post visited Gordon Bonan, Andy Fox and me for 3 months earlier this year.

Hanna Post, IBG-3: Agrosphere

NOAH-DART: Integrated Soil Moisture



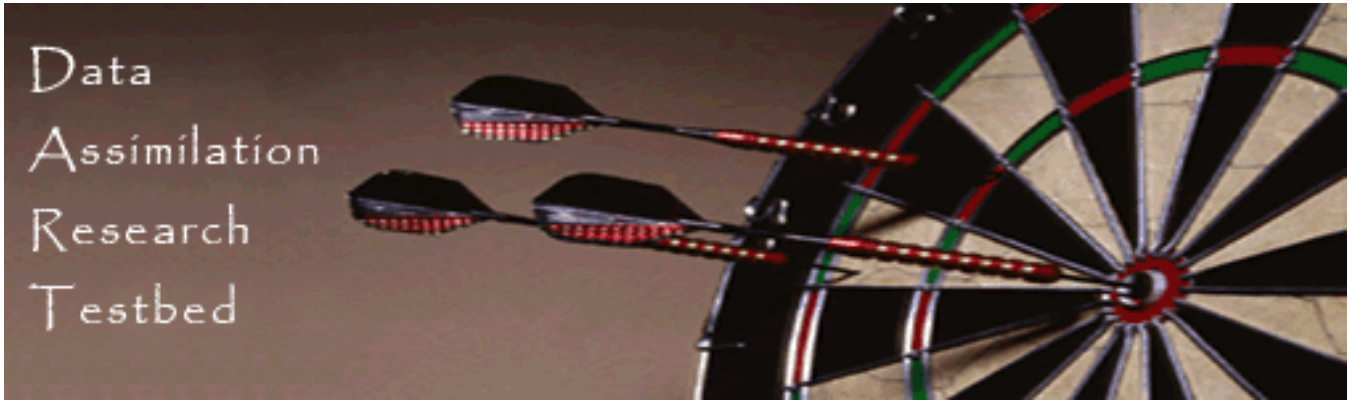




For more information:

CAM GITM ROMS wrfHydro WACCM WRF

CLM AM2 POP BGRID



COAMPS NOAH

www.image.ucar.edu/DAReS/DART

dart@ucar.edu

MITgcm_ocean MPAS_ATM COAMPS_nest

SQG NAAPS MPAS_OCN TIEGCM PBL_1d

CABLE NCOMMAS PE2LYR