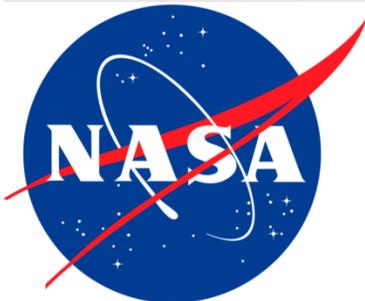


The value of GRACE TWS data in estimating snow mass

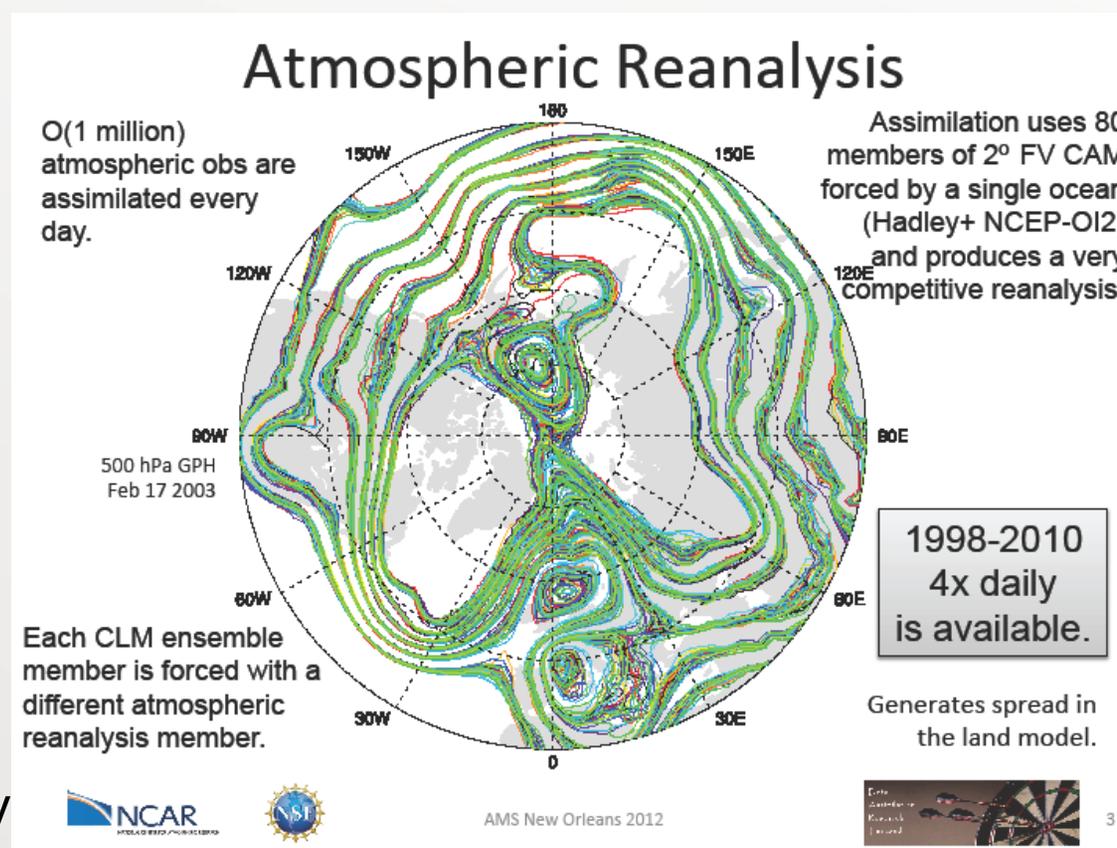
Yongfei Zhang¹, Hua Su¹, Zong-Liang Yang¹, Tim
Hoar², Jeffrey Anderson²

¹The University of Texas at Austin, Jackson School of
Geosciences, Austin, Texas

²The National Center for Atmospheric Research,
Boulder, Colorado



CLM4/DART: data assimilation system



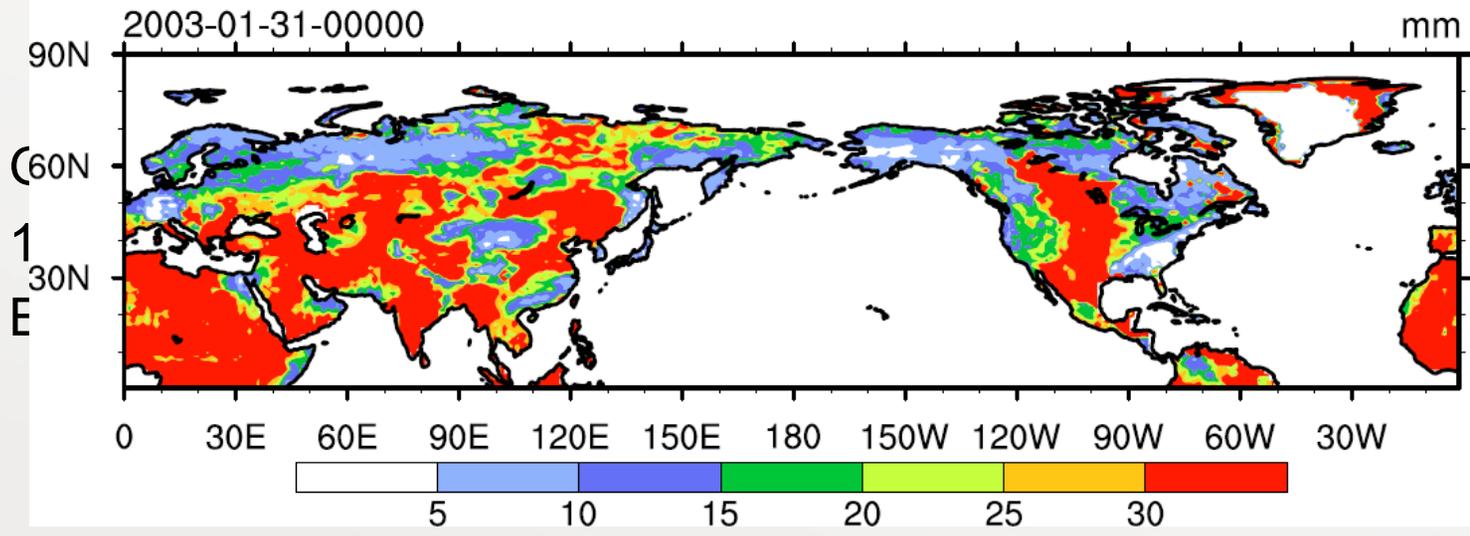
Satellite observ
data.

CLM4: The Community Land Model version 4
DART: The Data Assimilation Research Testbed
MODIS: The Moderate Resolution Imaging Spectroradiometer

FACE TWS

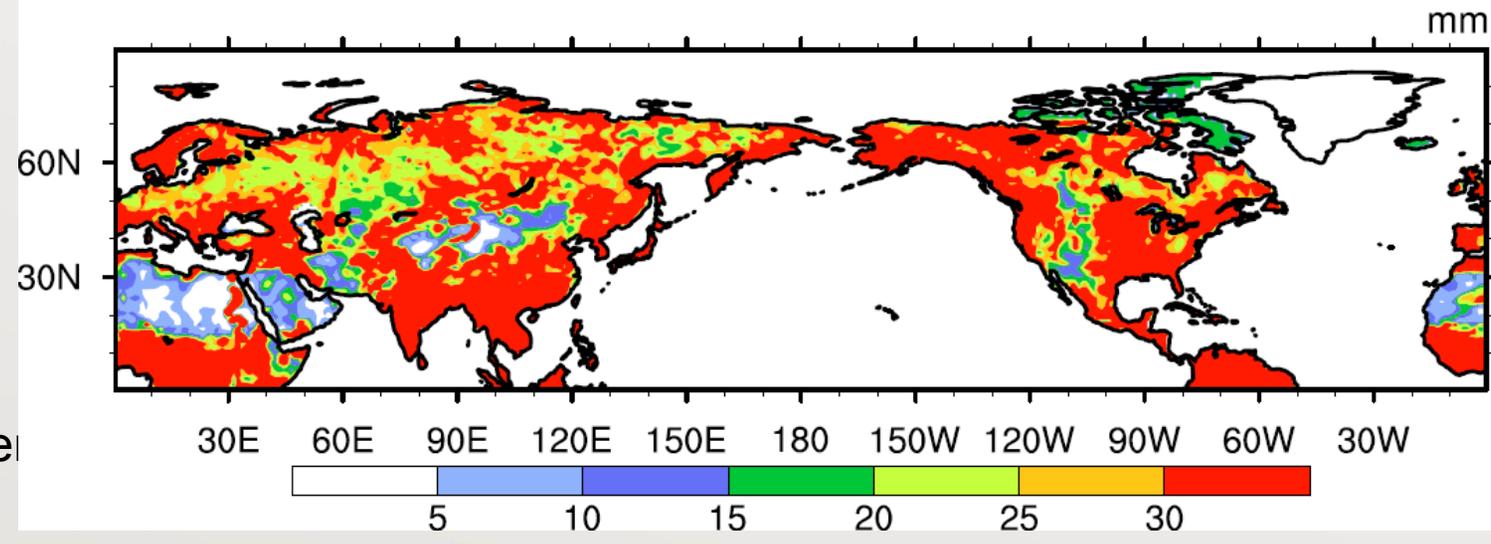
*Hoar et al.,
2012 AMS*

Ensemble Spread of TWS



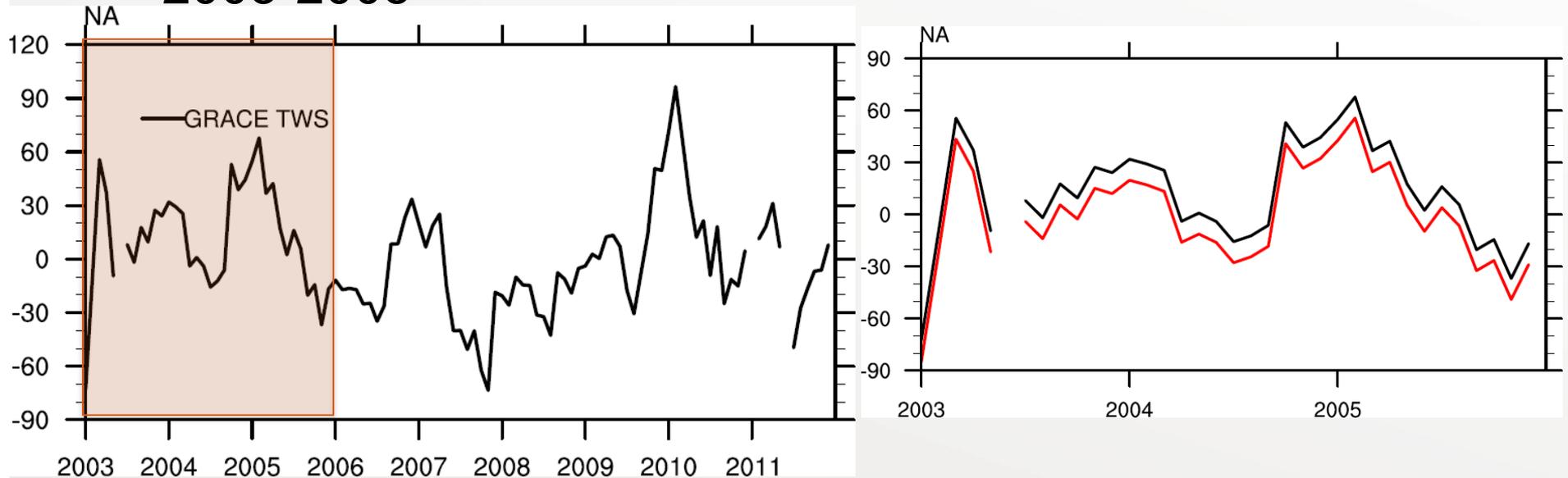
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-
-

Total Error of GRACE TWS Variations



TWS: Terrestrial Water Storage

- Remove the mean over the model simulation period:
 2003-2005



- GRACE provides monthly variations, not the absolute value
- Add a mean to the GRACE variations
 - An open loop CLM4 ran for 3 years from 2003 and produced the mean

MODIS snow cover observations

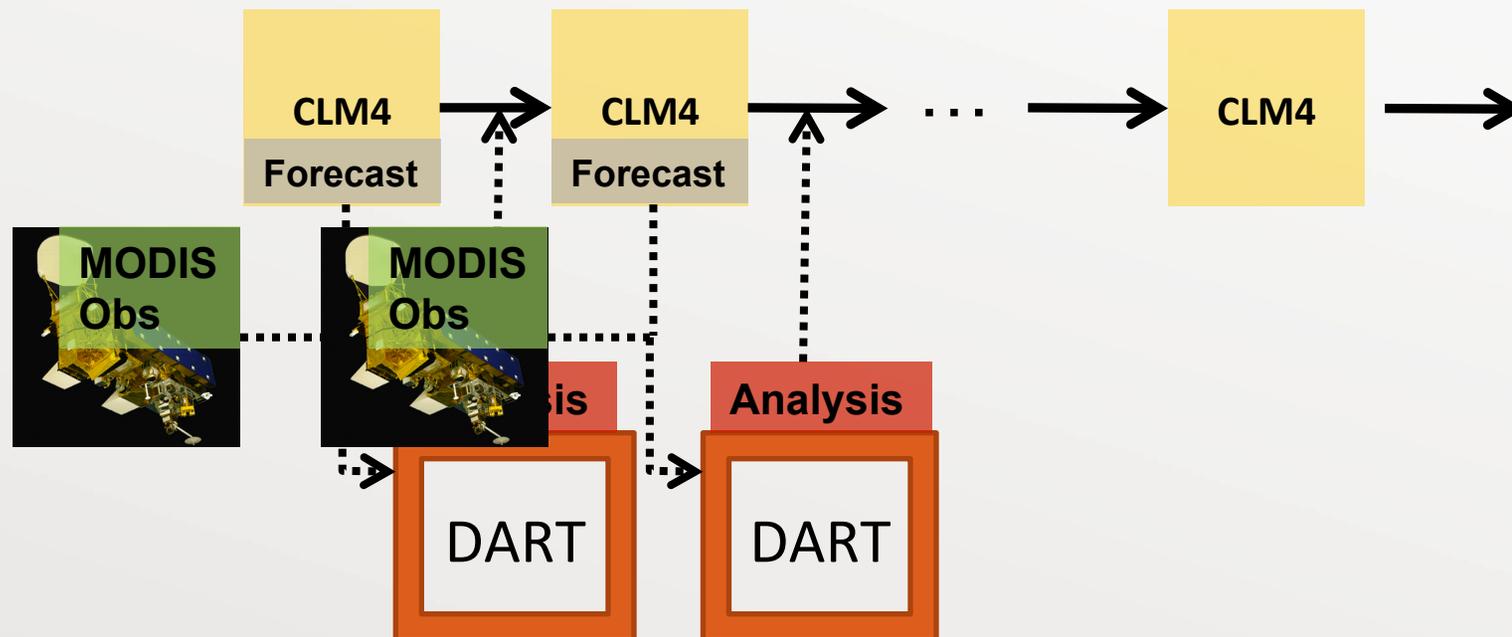
- MODIS/Terra daily snow cover (MOD10C2; 0.05° resolution; northern hemisphere)
 - Retrieved using the Normalized Difference Snow Index (NDSI)

$$\text{NDSI} = \frac{\text{band 4} - \text{band 6}}{\text{band 4} + \text{band 6}}$$

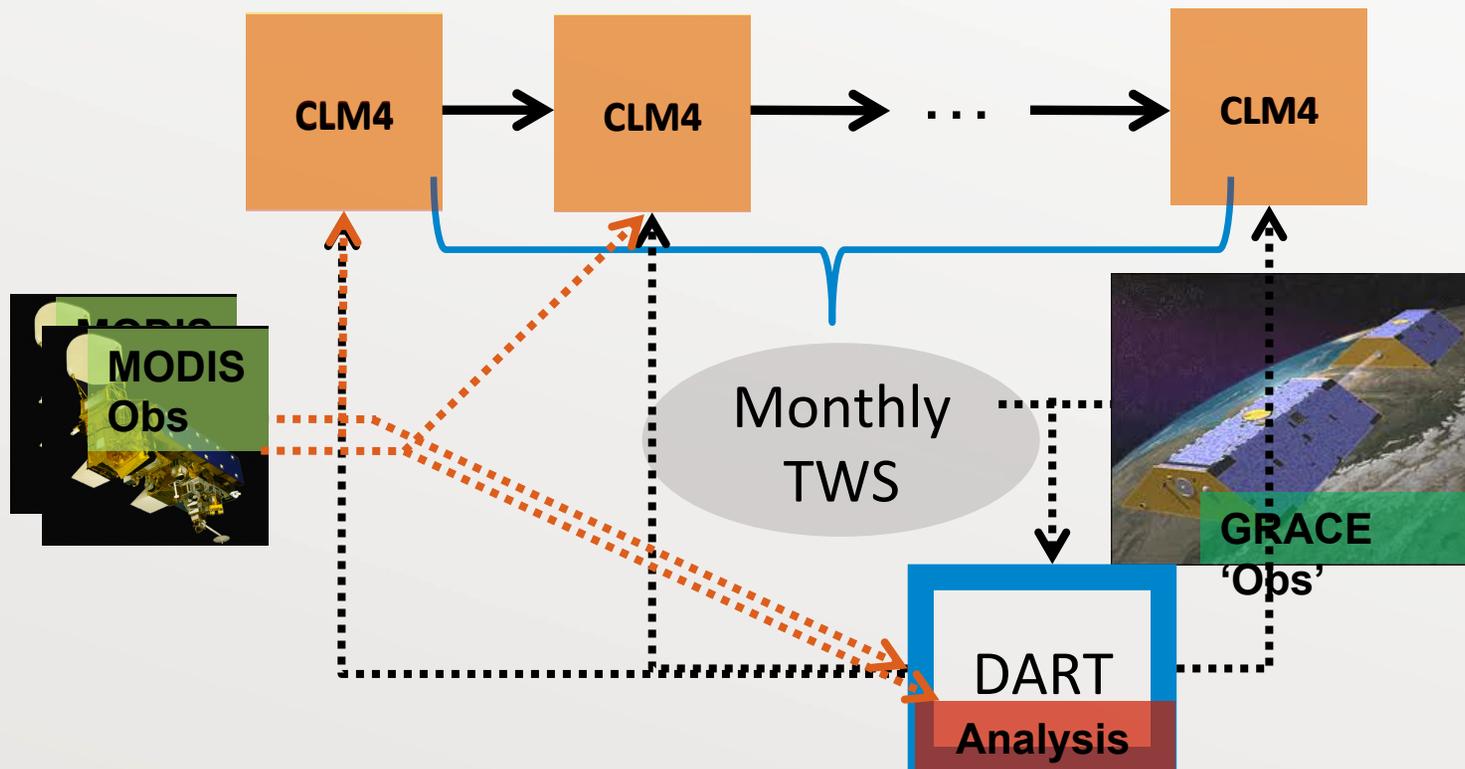
- Preprocessed to 0.9 ° x 1.25 ° “Level 4” data
 - Pixels with lower than 20% confidence index (percentage of clear sky over certain grid) will be discarded.

Collaboration with Ally Toure and Matt Rodell at NASA

Flowchart of MODIS data assimilation

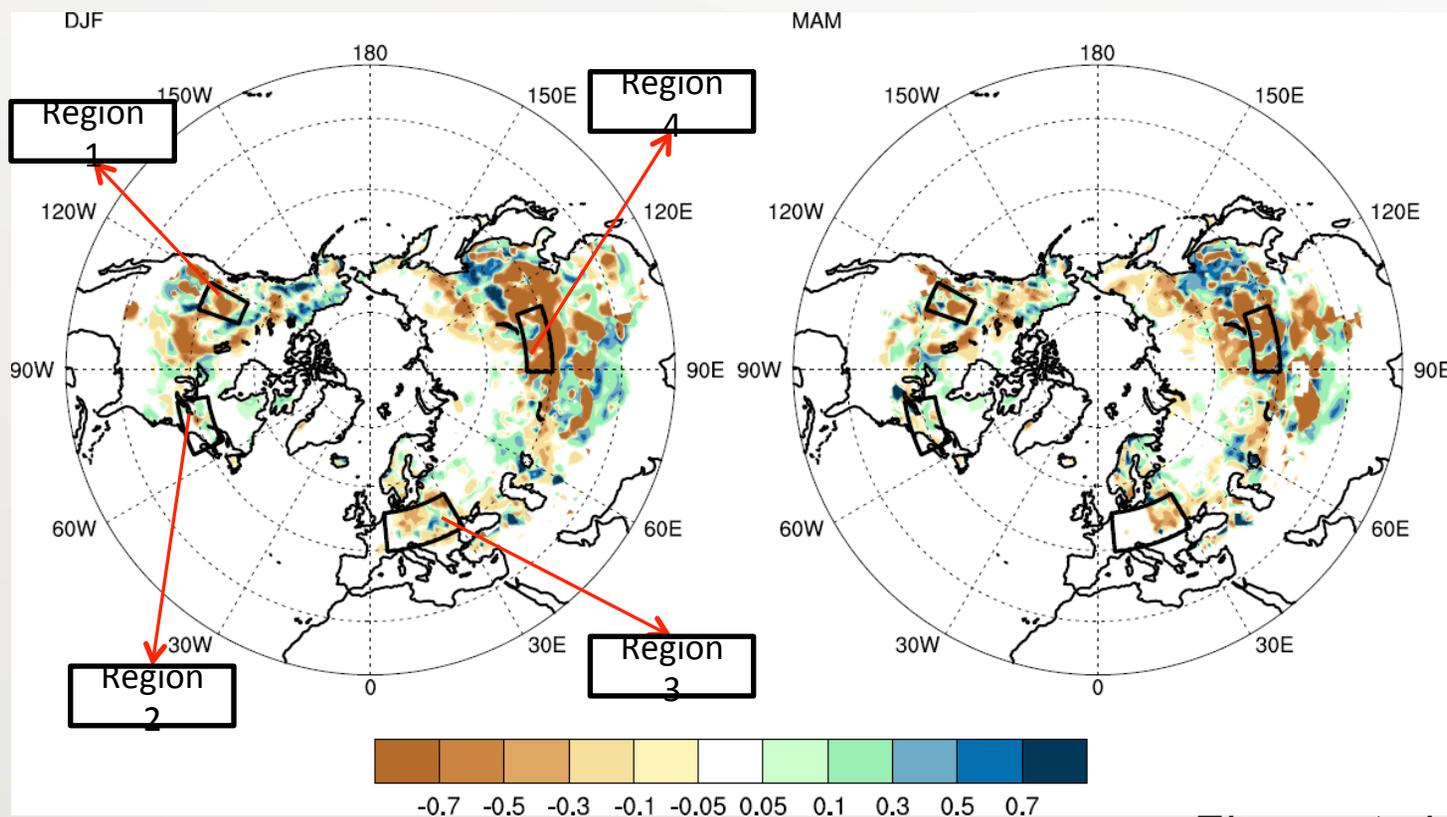


Assimilation of MODIS + GRACE



Assimilation of MODIS data

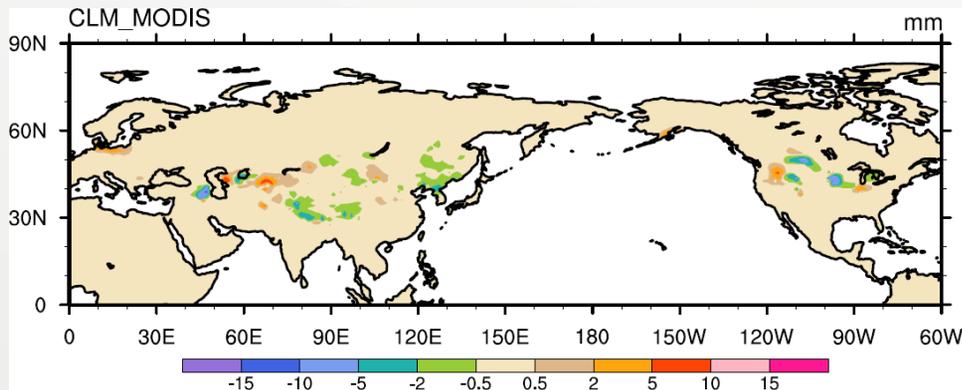
Relative difference between Model SWE and CMC SWE:
Data assimilation minus Control



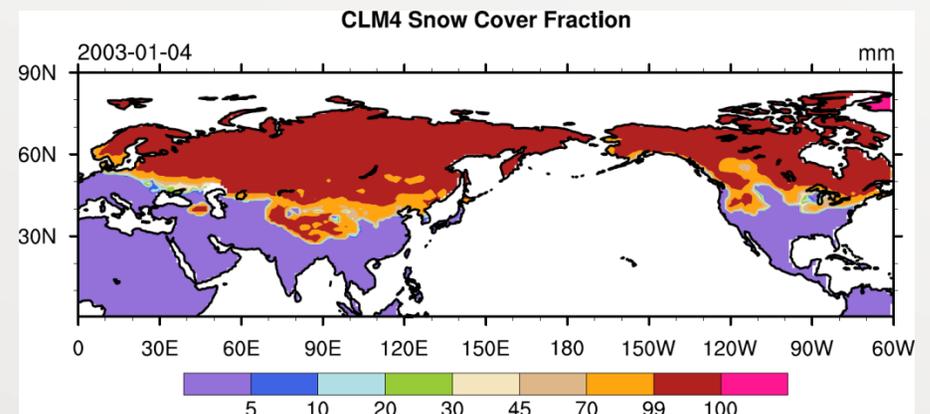
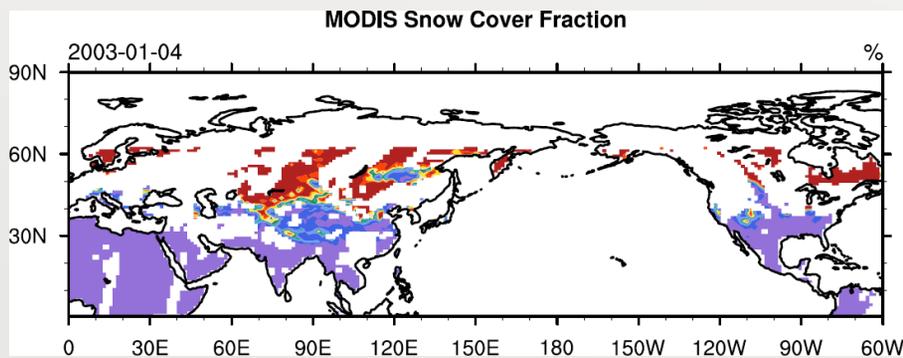
*Zhang et al, In
Prep.*

CMC: Canadian Meteorological Center
SWE: Snow Water Equivalent

Innovation: Analysis minus Forecast for SWE on 2003-01-04



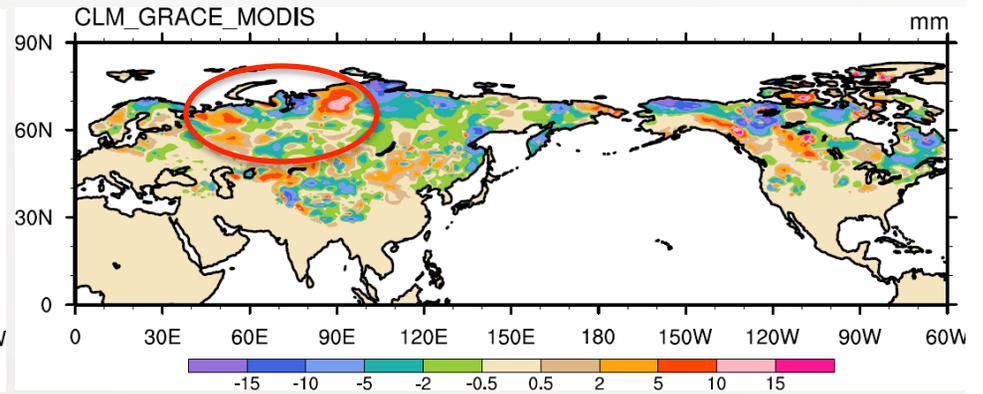
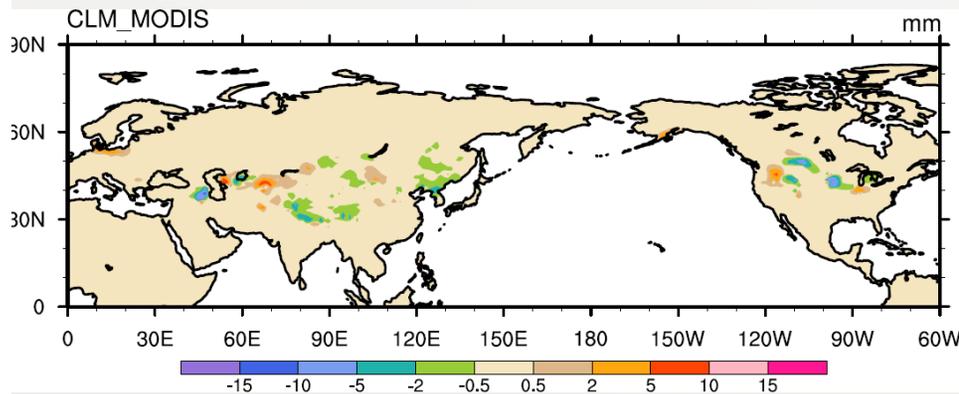
CLM_MODIS: CLM4 assimilates MODIS data



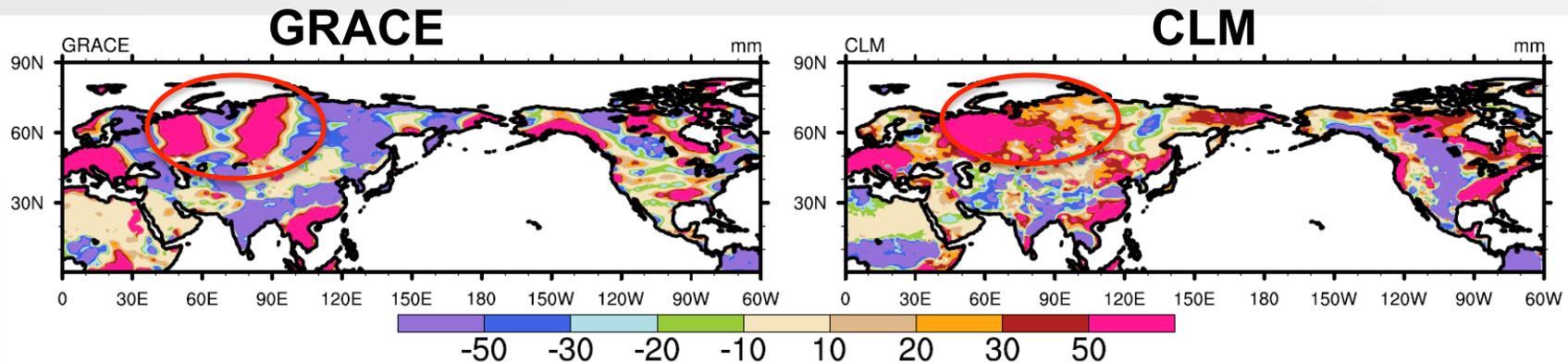
Innovation: Analysis minus Forecast for SWE on 2003-01-04

CLM_MODIS: CLM4 assimilates MODIS data

CLM_MODIS_GRACE: CLM4 assimilates both MODIS and GRACE data.

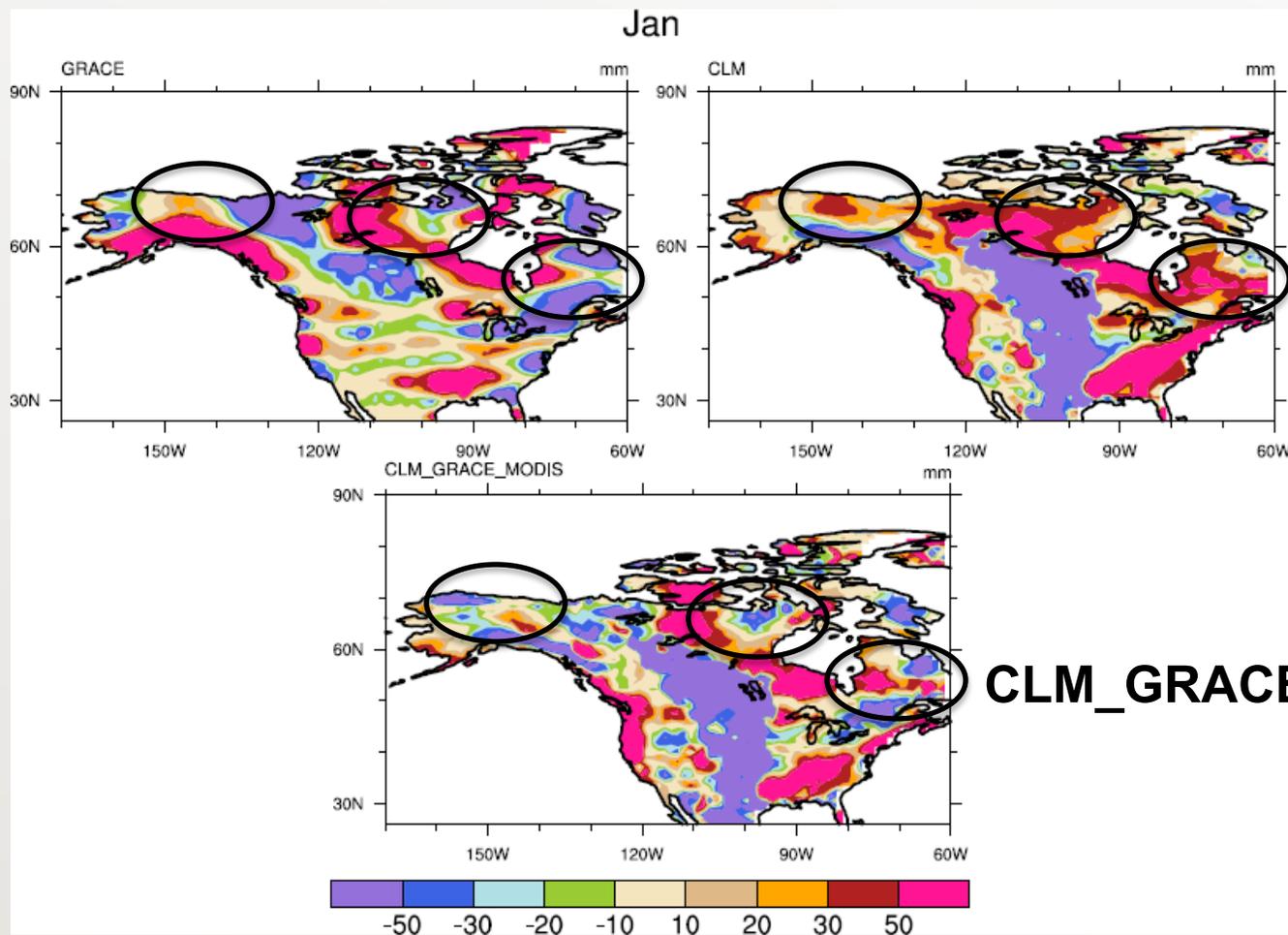


TWS variations for Jan 2003



TWS variations for Jan 2003 over NA

GRACE



CLM

CLM_GRACE_MODIS

Summary

- The study assimilates GRACE and MODIS data jointly into CLM4, one step towards our 'multi-sensor' data assimilation goal.
- While MODIS data assimilation are mainly effective along snowline, GRACE provides valuable information on higher latitudes.
- More comprehensive evaluation of model results will be conducted and presented at the upcoming AGU.