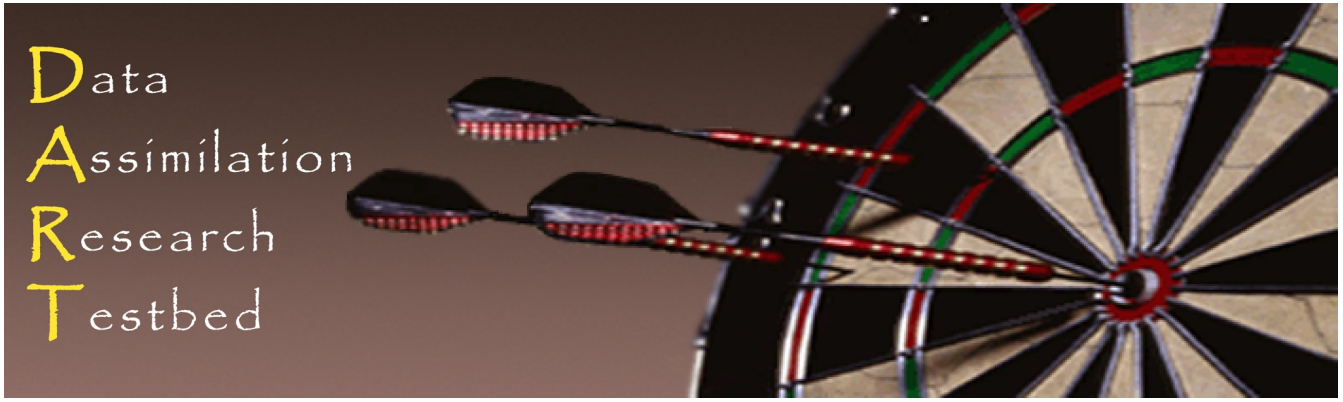
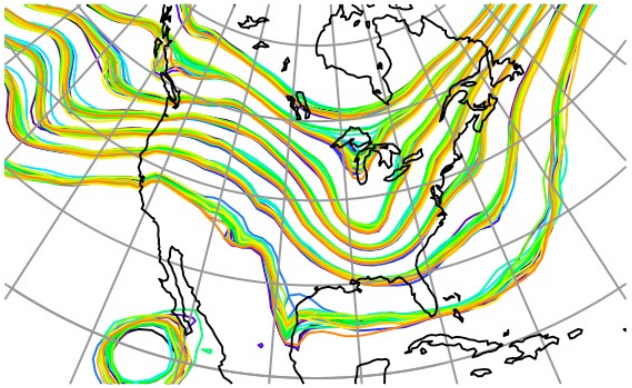


Opportunities for Data Assimilation in Land Surface Modeling

Brett Raczka, NCAR, Data Assimilation Research Section (DAReS)



The National Center for Atmospheric Research is sponsored by the National Science Foundation. Any opinions, findings and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

THE UNIVERSITY OF UTAH

NCAR | National Center for
UCAR | Atmospheric Research

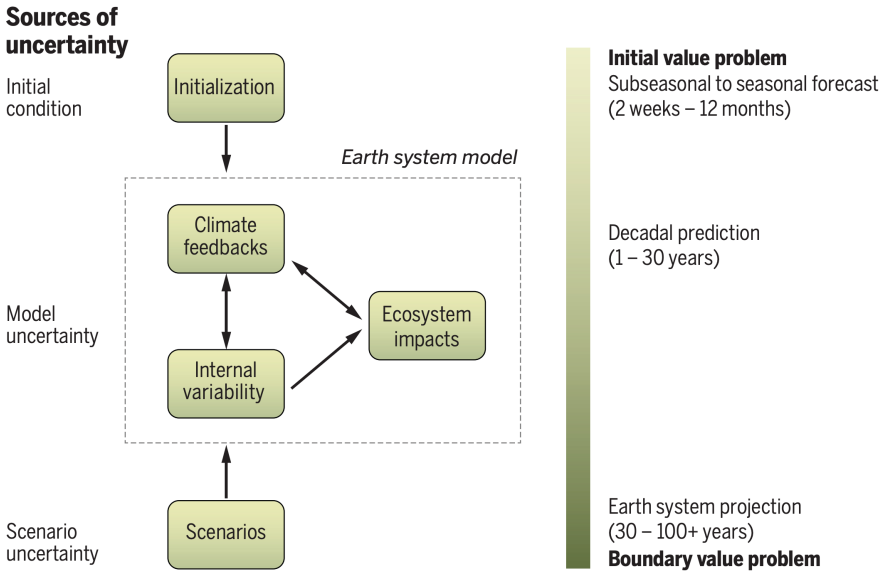
DA corrects errors in model state

Climate, ecosystems, and planetary futures: The challenge to predict life in Earth system models

Gordon B. Bonan[1]* and Scott C. Doney[2]*

REVIEW SUMMARY

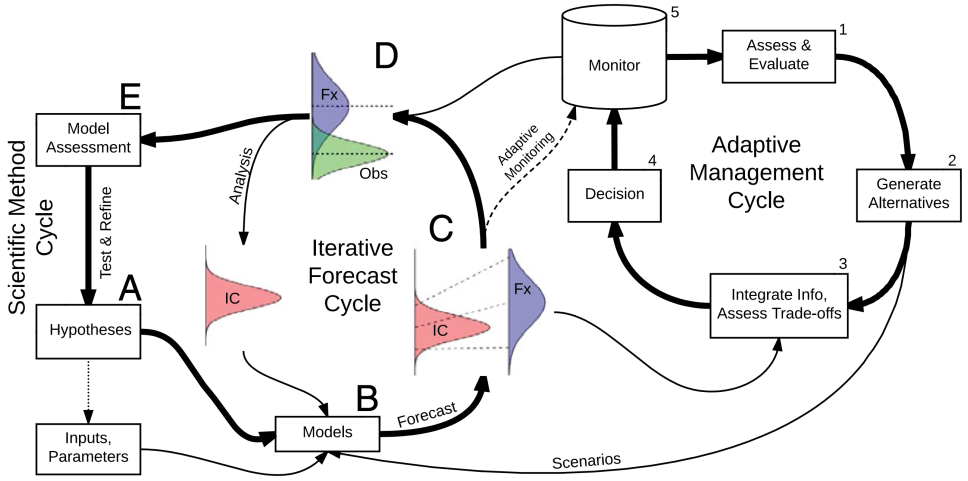
EARTH SYSTEMS



Iterative near-term ecological forecasting: Needs, opportunities, and challenges

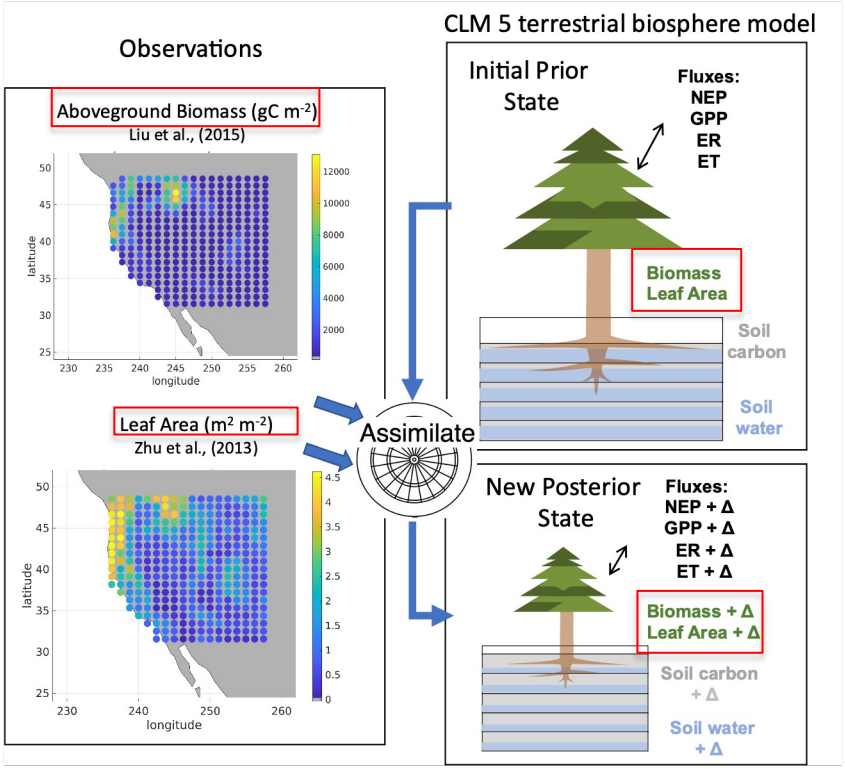
Michael C. Dietze[a,1], Andrew Fox[b], Lindsay M. Beck-Johnson[c], Julio L. Betancourt[d], Mevin B. Hooten[e,f,g], Catherine S. Jarnevich[h], Timothy H. Keitt[i], Melissa A. Kenney[j], Christine M. Laney[k], Laurel G. Larsen[l], Henry W. Loescher[k,m], Claire K. Lunch[k], Bryan C. Pijanowski[n], James T. Randerson[o], Emily K. Read[p], Andrew T. Tredennick[q,r], Rodrigo Vargas[s], Kathleen C. Weathers[t], and Ethan P. White[u,v,w]

PNAS



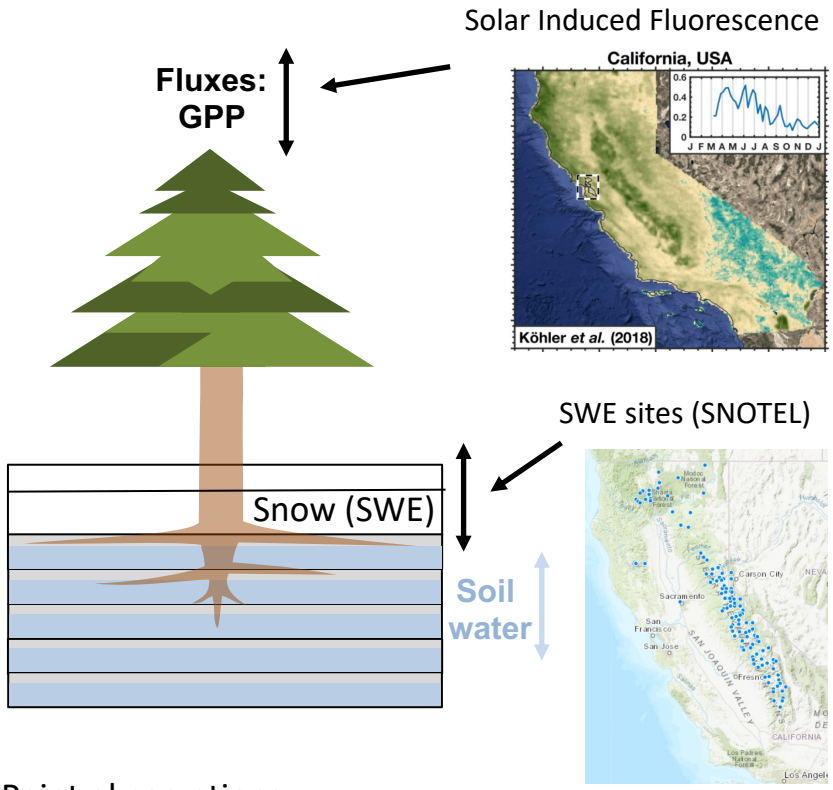
Carbon Cycling in Complex Terrain

Where we are:
(adjusting biomass states)



Raczka et al., (in revision); JAMES

Where we are going:
(adjusting water, SIF)



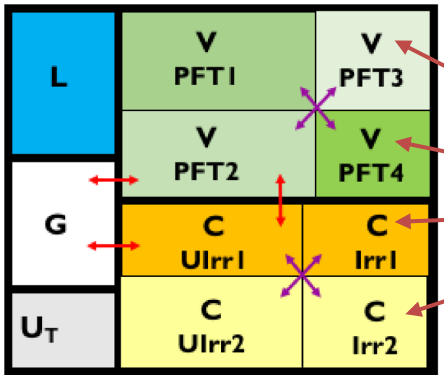
Point observations:
horizontal/vertical localization

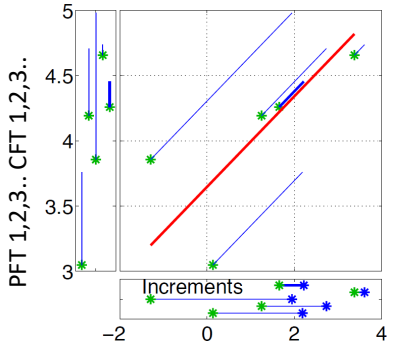
Regional data products:
(SMOS, SMAP, SNODAS) product uncertainty

Adjusting specific PFTs or columns

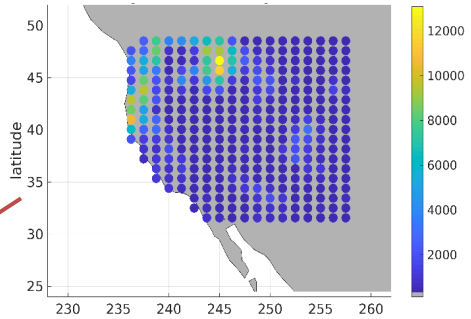
Present Approach:

'Updating PFTs based on CLM ensemble covariance'





Observed Biomass average

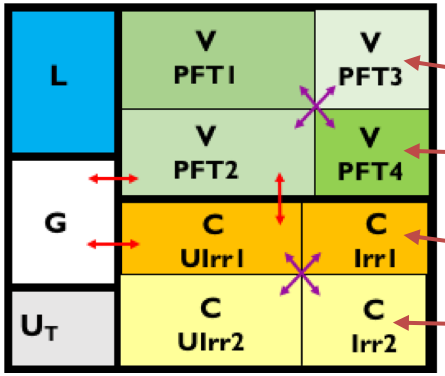


Ensemble estimated 'observation' (prior)

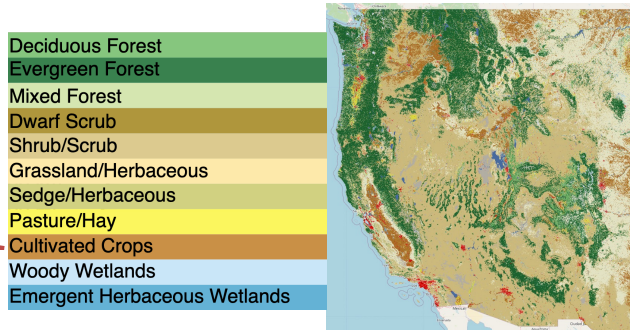
Ensemble Adjusted biomass (posterior)

Future Approach:

'Only updating PFTs known to be related to the observation'

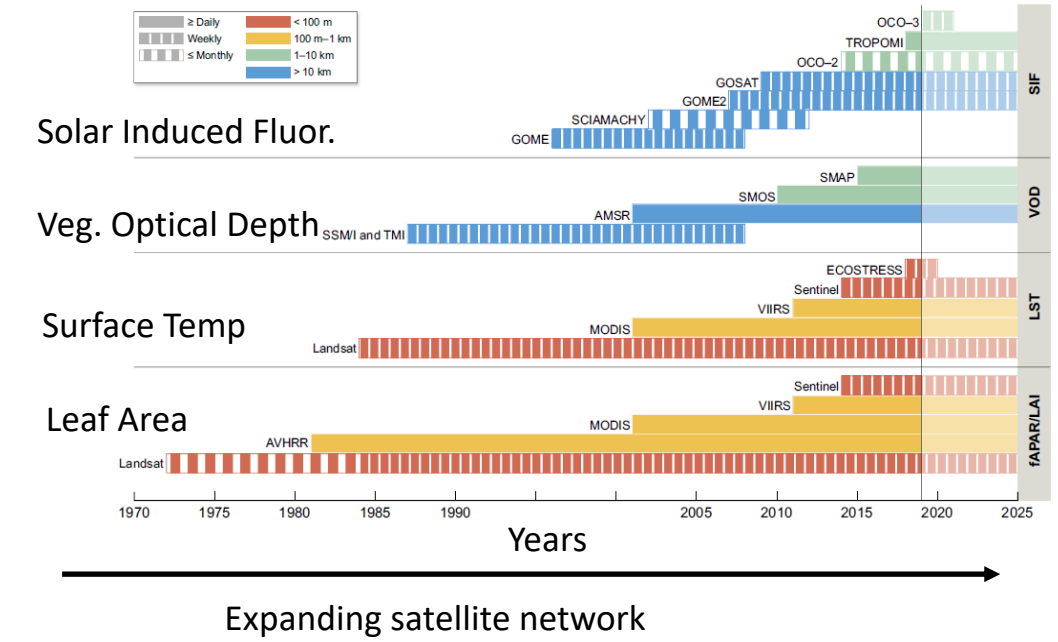


NASA-CMS LandCover Product



Advancing models & observations together

Expanding land surface properties



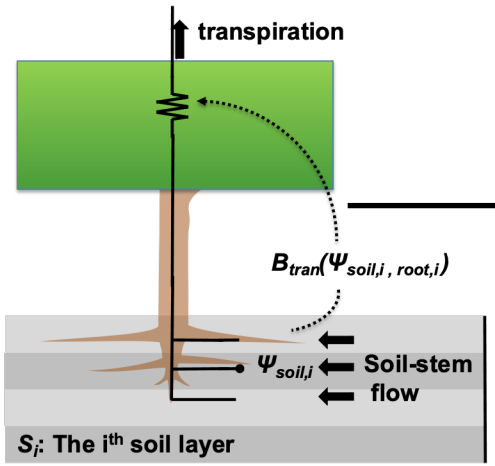
New Phytologist

Constraining estimates of terrestrial carbon uptake: new opportunities using long-term satellite observations and data assimilation

William K. Smith[1], Andrew M. Fox[1], Natasha MacBean[2], David J. P. Moore[1] and Nicholas C. Parazoo[3]

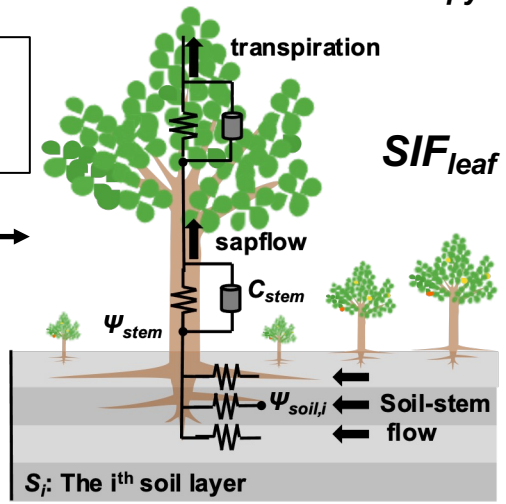
(Leaf water potential) Ψ_{leaf} SIF_{canopy}

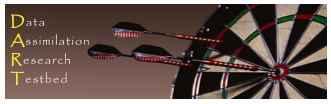
CLM 4.5
(Soil Moisture Stress Formulation)



Increasing model complexity

Current: CLM 5.0
Added Hydraulic Stress & SIF





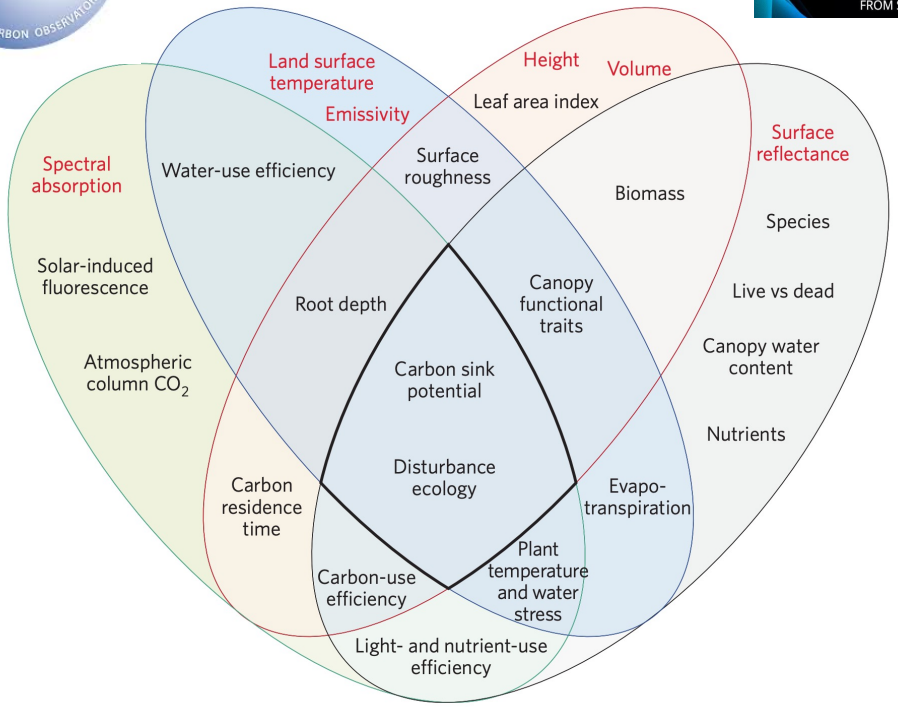
Emerging Satellite Data Products

2019

2018

2018

2020



ISS observations offer insights into plant function

nature ecology & evolution

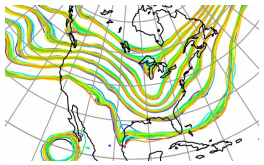
E. Natasha Stavros, David Schimel, Ryan Pavlick, Shawn Serbin, Abigail Swann, Laura Duncanson, Joshua B. Fisher, Fabian Fassnacht, Susan Ustin, Ralph Dubayah, Anna Schweiger and Paul Wennberg

DART is designed to add new data products:

- Observation Converters:
  80+ and growing
- Forward Operators:
  generates the expected observation from existing model states
- Adaptive Inflation:
  addresses systematic differences between data product and model simulation (Data product algorithm uncertainty, Model biases)

Parameter Estimation

Present: State estimation

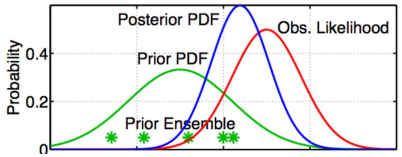


CAM6 DART Reanalysis

Research Data Archive
Computational & Information Systems Lab

Ds345.0 | DOI: 10.5065/JG1E-8525

+ CLM
+ data/obs



"The Community Land Model has many different parameters whose values cannot be measured directly in the field at the application scale of interest and instead have to be determined by calibration using observations of the system output."

Estimation of Community Land Model parameters for an improved assessment of net carbon fluxes at European sites

JGR Biogeosciences

Hanna Post, Jasper A. Vrugt, Andrew Fox, Harry Vereecken, Harrie-Jan Hendricks Franssen

A machine learning approach to emulation and biophysical parameter estimation with the Community Land Model, version 5

Advances in Statistical Climatology, Meteorology and Oceanography

Katherine Dagon[1], Benjamin M. Sanderson[1,2], Rosie A. Fisher[1,2], and David M. Lawrence[1]

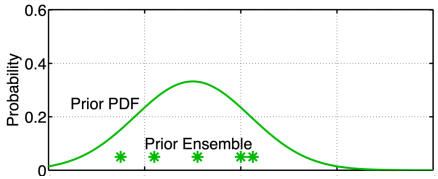
The Impact of Parametric Uncertainties on Biogeochemistry in the E3SM Land Model

JAMES | Journal of Advances in Modeling Earth Systems

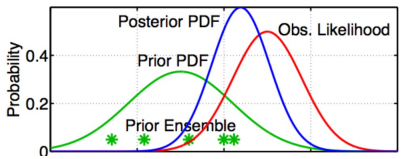
Daniel Ricciuto, Khachik Sargsyan, Peter Thornton

- Default CLM parameters are single value estimates (PDFs not provided)
- Parameter estimation studies are rare, computationally expensive (MCMC, surrogate approaches)
- EnKF treats 'parameters' similarly to 'state variables' at a relatively low computational cost
- DART is capable of providing improved parameter estimates, and associated model uncertainty

Future : Parameter estimation

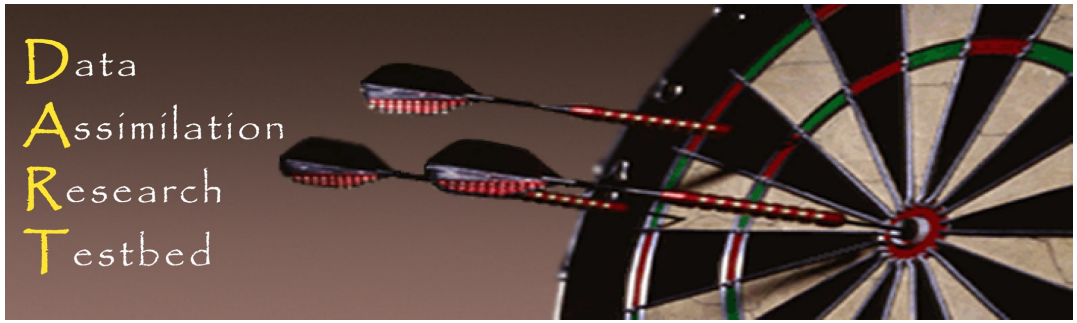


+ CLM
+ data/obs



For more information:

CAM GCOM CAM-Chem FESOM ROMS WRF
GITM CABLE WRF-Hydro WACCM
CLM
AM2
SQG
POP
BGRID



https://dart.ucar.edu

https://docs.dart.ucar.edu

dart@ucar.edu

COAMPS NOAH
NCOMMAS PE2LYR
MITgcm_ocean WRF-Chem COAMPS_nest
NAAPS TIEGCM MPAS_ATM
MPAS_OCN
WACCM-X PBL_1d NOAH-MP

CISL Computational & Information Systems Lab

We would like to acknowledge high-performance computing support from Cheyenne (doi:10.5065/D6RX99HX) provided by NCAR's Computational and Information Systems Laboratory, sponsored by the National Science Foundation.