

Status of NCAR's Data Assimilation Initiative (DAI)

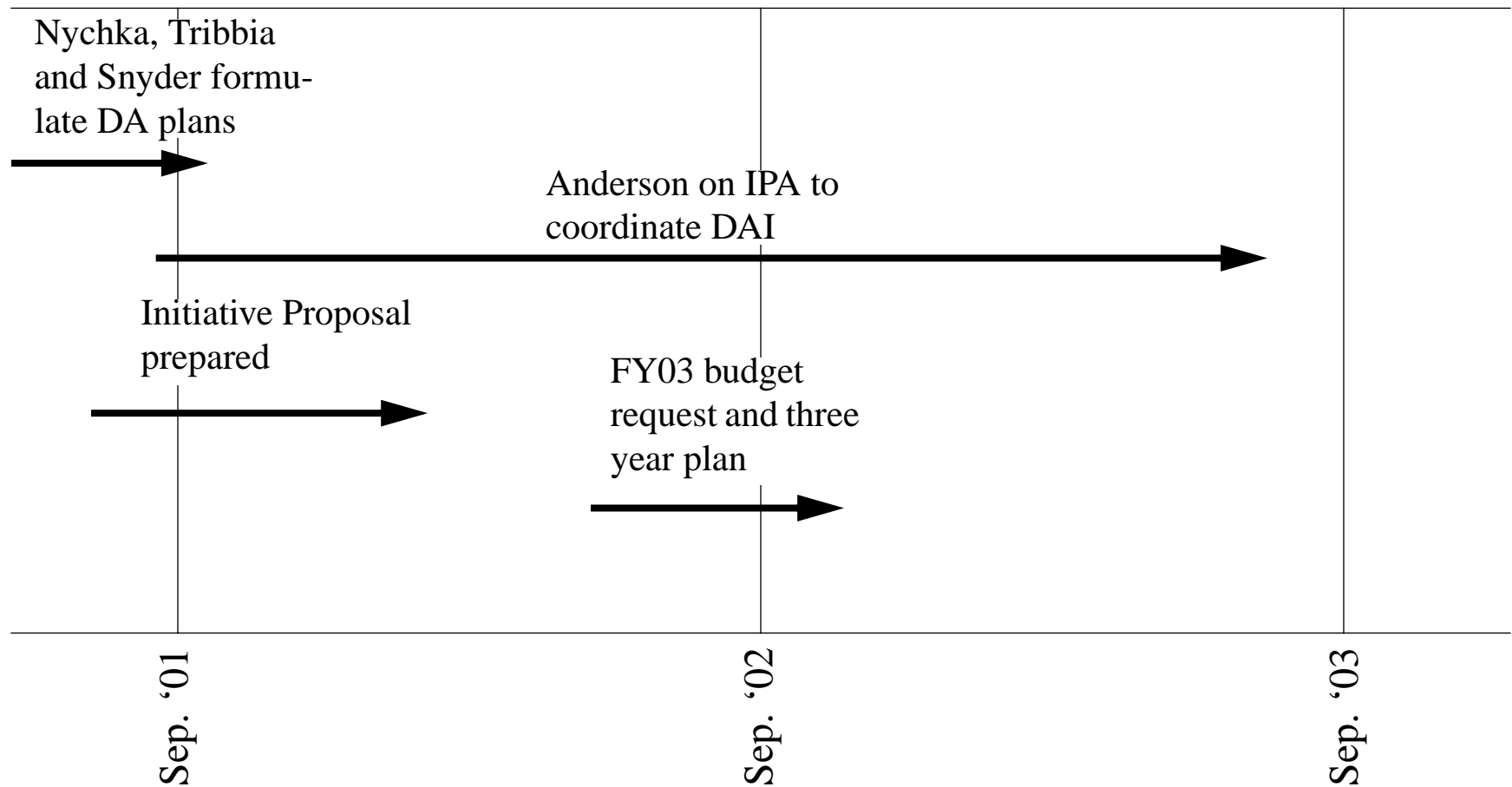
Report to NCAR Directors Committee
17 April, 2003

“DAI aims to create and lead a research community for data assimilation where individuals benefit from sharing ideas, methodologies, and software tools as well as access to a data assimilation testbed.”

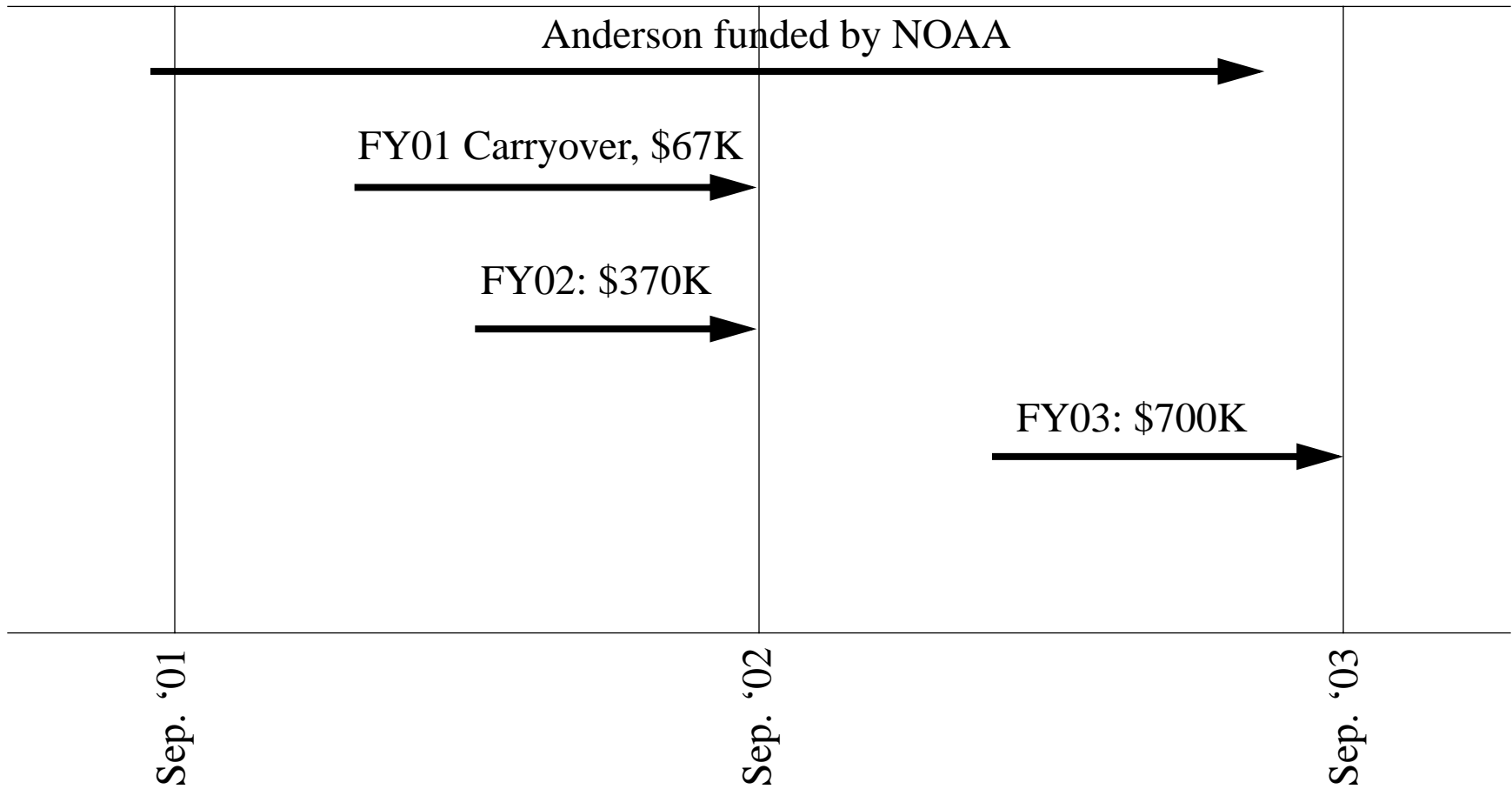
“With a carefully controlled but rapid expansion of DAI, it should be possible for NCAR to be recognized as a leader in research data assimilation within 4 years (FY07).”

Summary: On track, so far...

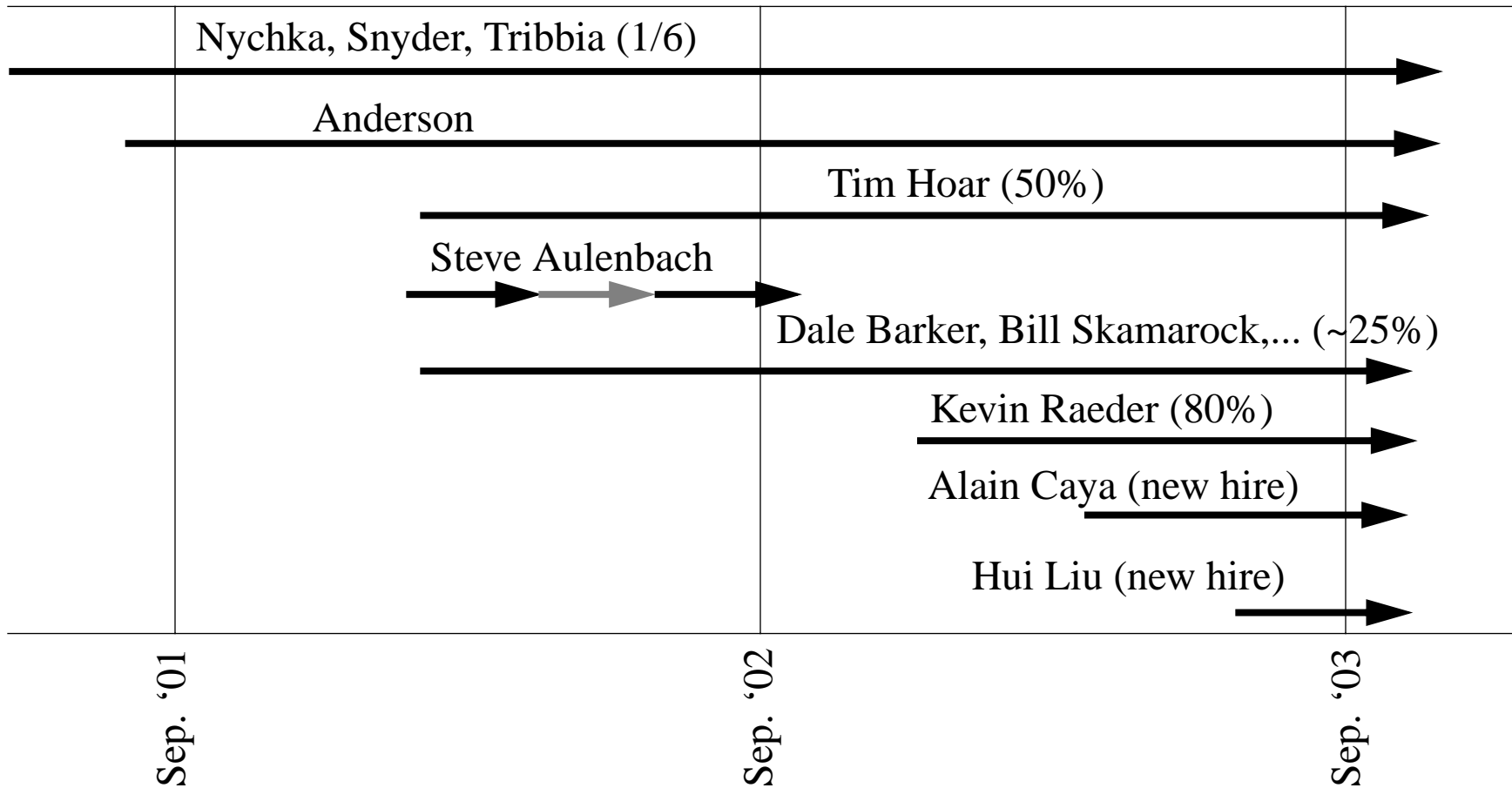
History of DAI: Organization



History of DAI: Funding



History of DAI: Personnel



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4. Software tools for use in undergraduate and graduate education;
5. Basic research and implementation support for 'operational' partners, both within NCAR and outside.

Strategic Approach: Use DART (software infrastructure) to Focus Efforts

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What is DART?

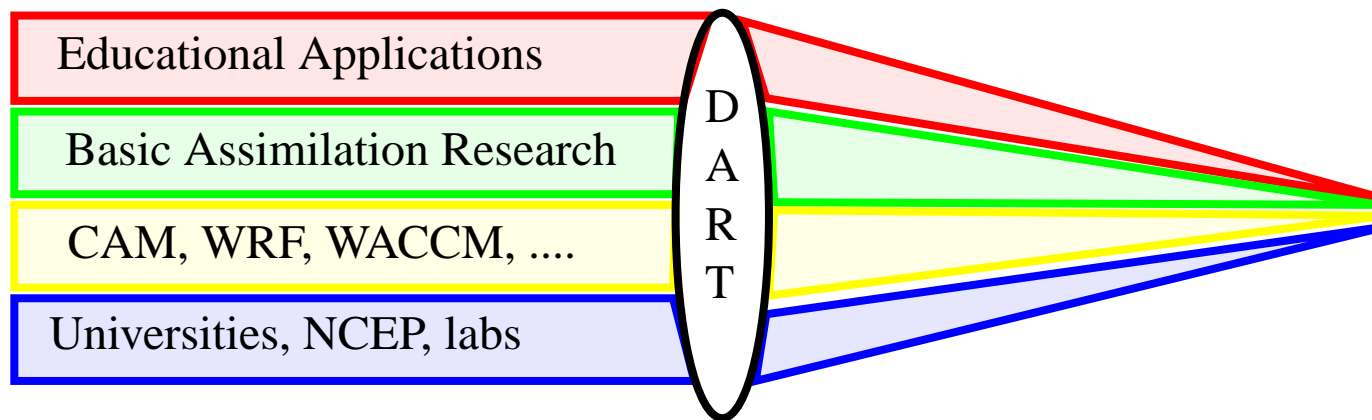
- A. Allows combinations of assimilation algorithms, models, and observation sets
- B. Diagnostic tools for assimilation experimentation
- C. Set of compliant models, observational system designs, and observation sets

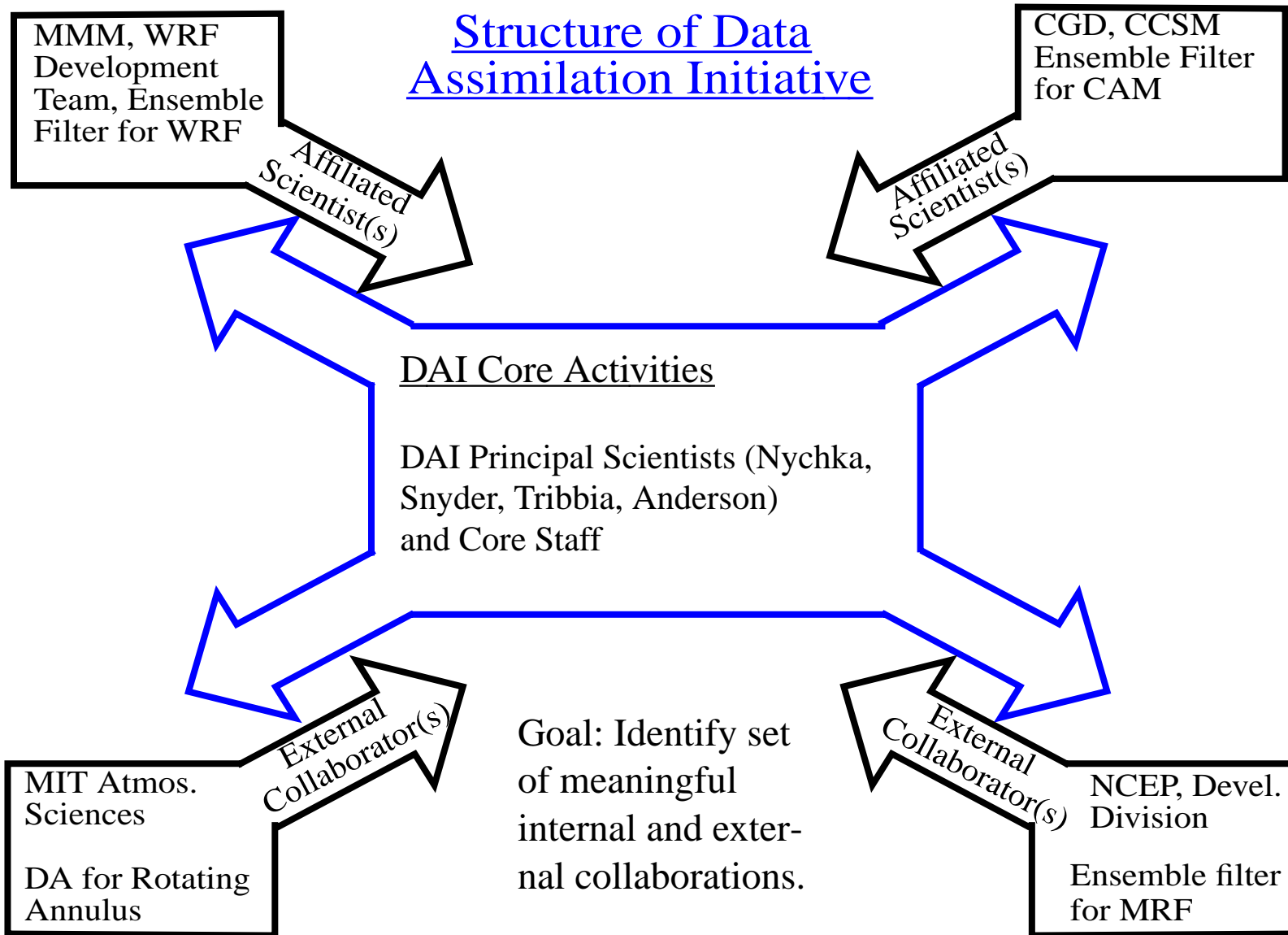
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DAI Provides:

Expertise on Assim. Methodologies and Applications

Software Infrastructure (DART)

Basic Research Support

Support for Core Scientists and Staff

Collaborator Provides:

Expertise on particular application

Model or observational data sets

Affiliated scientists with expertise on application

DAI: Accomplishments and Plans

1. Data Assimilation Research Testbed (DART)

Basic framework implemented

Currently using GFDL FMS infrastructure

Switch to ESMF infrastructure when available

Primarily implementing ensemble (Kalman) filters

Variational for low-order models only

Plans MAY include a variational (4D-Var) capability

DART compliant models (largest collection ever available with assim system)

CGD's CAM 2.0

GFDL FMS B-grid GCM incorporated and in use

Many low-order models available

MMM's WRF model in process of being incorporated

NCEP MRF being tested quasi-operationally in partial implementation

GFDL MOM ocean model partially incorporated in earlier version

DAI: Accomplishments and Plans

2. Supporting ASP Summer Colloquium on data assimilation

DART will be used for student exercises

3. Hosting numerous data assimilation visitors

Luc Fillion, Canadian Meteorological Center

Jim Hansen, MIT

Xiaolei Zou, FSU

Ron Errico, NASA/DAO

Shree Khare, Princeton

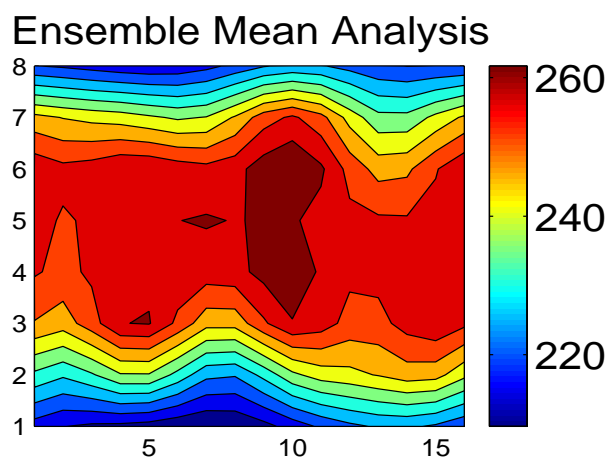
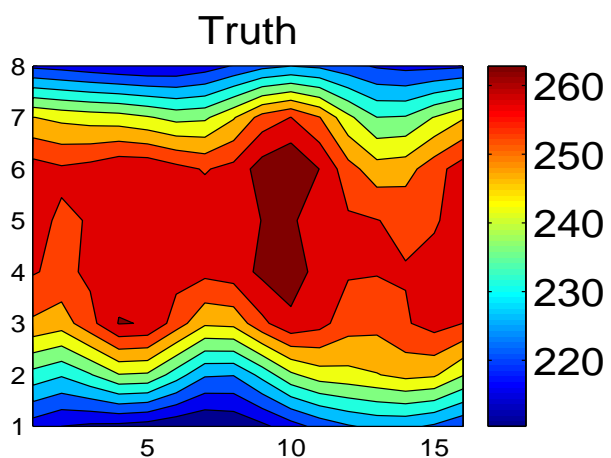
Ryan Torn, U. Washington

DAI: Accomplishments and Plans

4. An Ensemble Filter DA system for CGD's CAM

Testing underway at low resolution

Standard T42 configuration also working

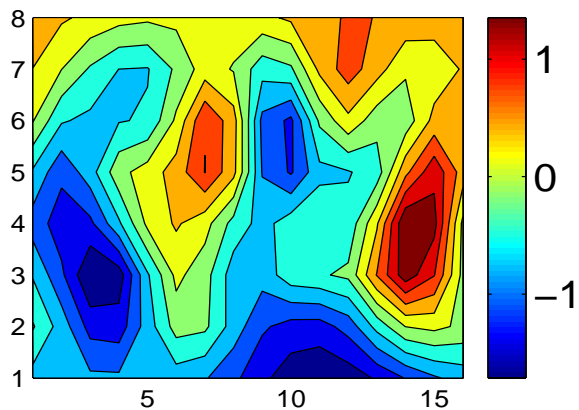


Results from assimilating only 1800 surface pressure observations every 12 hours

Temperature at 700mb shown

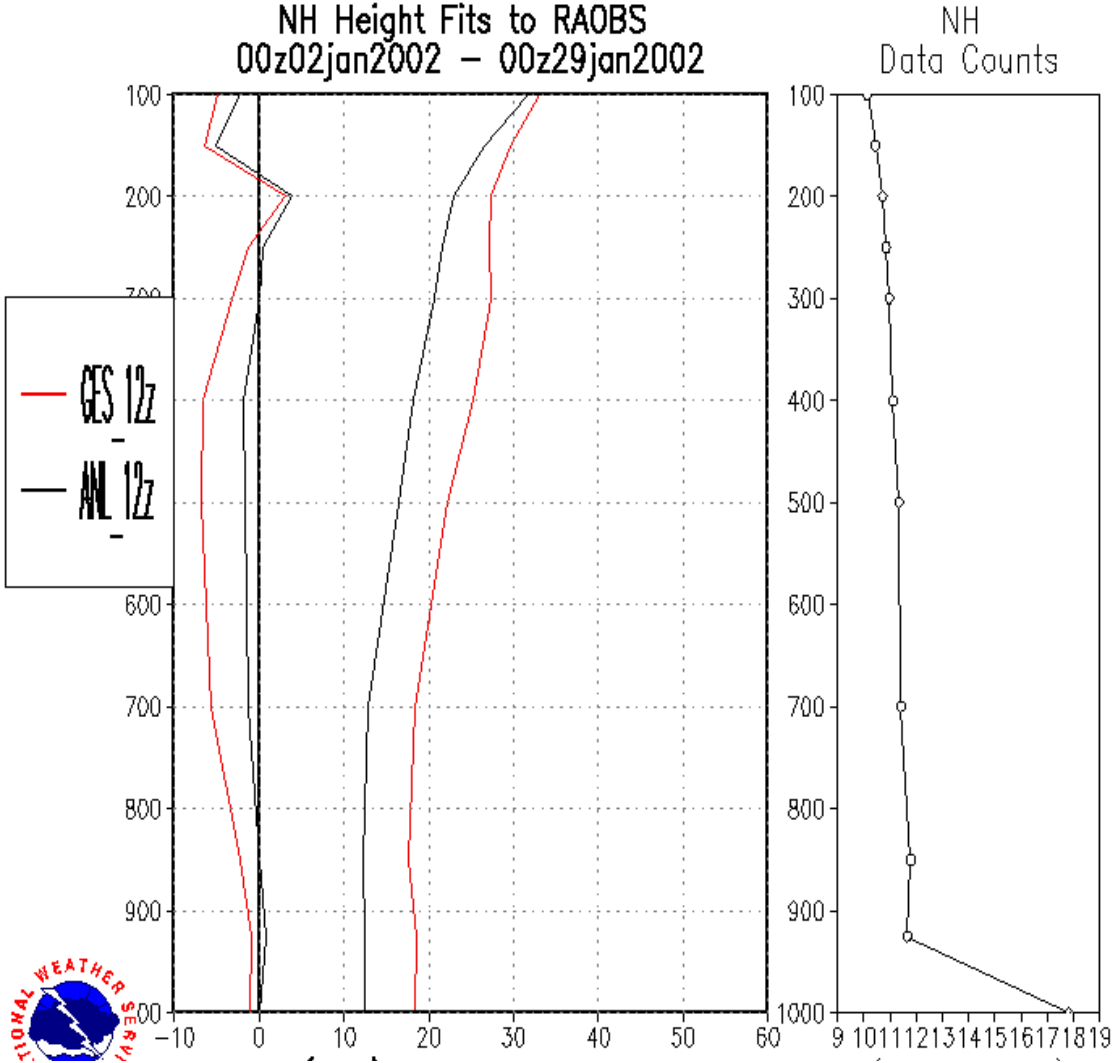
Mean error reduced to about 0.6 C

RMS ERROR = 0.61412



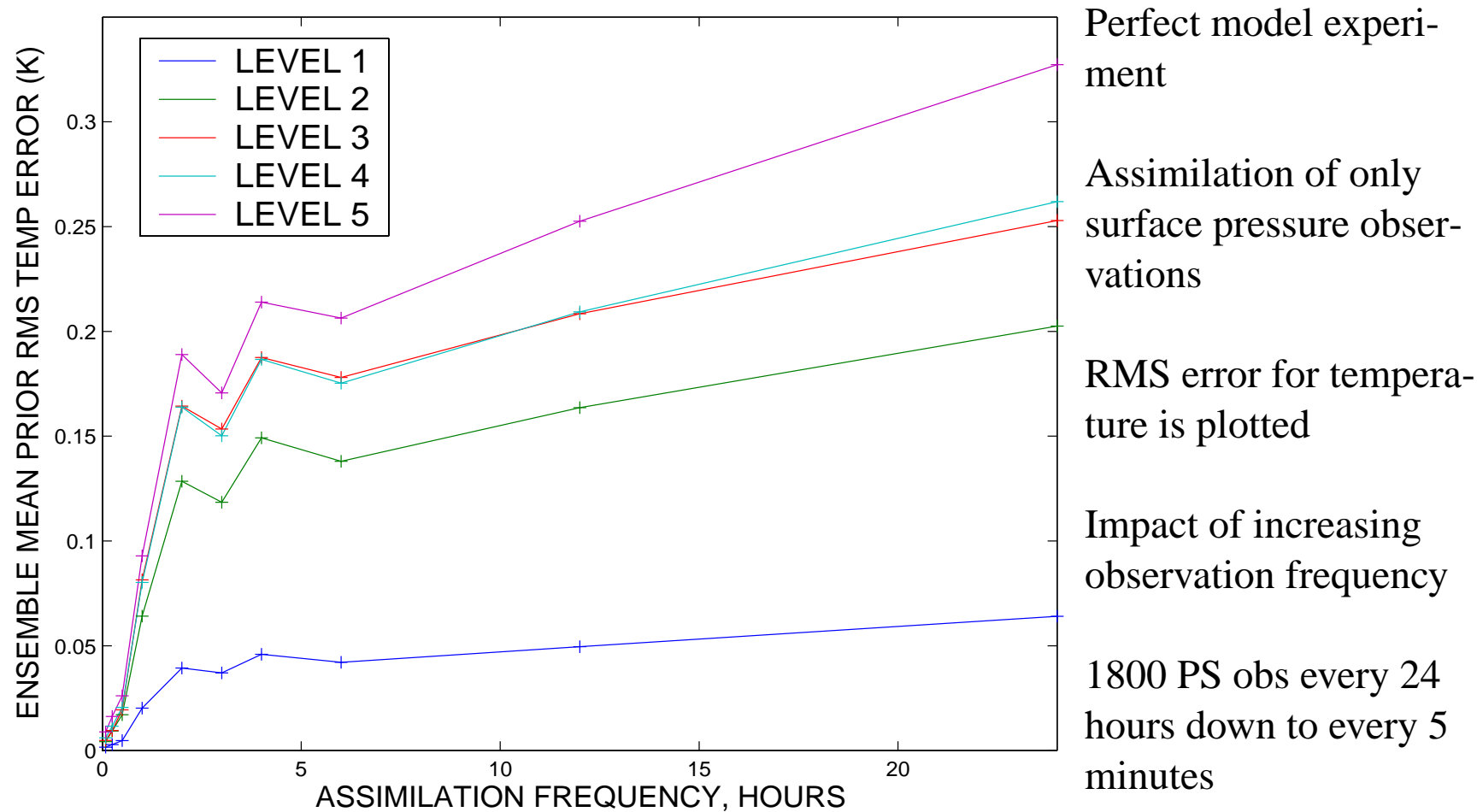
DAI: Accomplishments and Plans

5. DART filter being used for parallel tests in NCEP operational global model



DAI: Accomplishments and Plans

6. Filter implemented for GFDL B-grid GCM



DAI: Accomplishments and Plans

7. Fundamental research on filtering data assimilation

Ability to use limited observations

Observation system simulations

Localizing impact of observations (GSP Postdocs helping out here)

8. Incorporation of WRF into DART

Compiling but untested

Initial version available by summer

9. WRF / CAM integrated filter assimilation system

Fundamental problem for regional models is boundary

Use CAM assimilations for WRF boundaries

Prototype for embedded regional models?

Encourage CGD/MMM assimilation collaboration

DAI: Accomplishments and Plans

10. Ability to assimilate real data (operational streams plus GPS, etc.)

Will allow DART models to be used as 'operational' prediction models

Allows evaluation of data value

New hire, Hui Liu, will do this as first task (initial version Sep. '03)

11. Variational assimilation methods

Luc Fillion has spent 2 months on adjoint for Errico regional model (MAMS)

Adjoint nearing completion

Variational assimilation capability to follow

Planned as first large model with variational assimilation capability in DART

Some Additional Long-term Science Goals

I. Ensemble filtering

Performance vs. ensemble size

Theory for tuning parameters

Use of difficult non-linear observations (radar, satellite radiances...)

Assimilating 'discrete' structures (thunderstorms, ocean eddies...)

II. Using assimilation to address model deficiencies

Assimilating model parameters

Evaluating relative error characteristics of different parameterizations

III. Design and evaluation of observing systems

Measuring information content of an observation

Cost function constrained observation system design

IV. Variational data assimilation (requires enhanced funding)

Theory

Synergy with ensemble methods;

Reaching out to Other NCAR Divisions

1. HAO:

Co-sponsoring GSP Postdoc to look at ionospheric assimilation

2. ACD:

Plans to incorporate WACCM and chemical observations into DART

3. SCD:

Coordinating with NASA ESMF project

Interest in other computational issues and new models

4. ATD:

Observing system simulation experiments to estimate value of instruments???

Summary

Initial progress has been very good, mostly due to building an excellent core staff

Strategy for focusing the effort has been key to progress

Initial growing pains (budget, hiring, identifying key collaborators) going away

Several high impact assimilation applications are being developed by DAI

Continued progress with NCEP assimilation should increase our credibility

Primary fear: initial successes will lead to expanding too rapidly;

Must avoid letting our success kill us.

What's worked well:

Interactions with MMM on WRF, convective scale

Interactions with CGD on statistics, theoretical DA

Interactions with selected university researchers through visits (Jim Hansen, MIT)

What's been difficult:

Understanding process (not a surprise for a developing program)

Budget time lag

Acquiring dedicated staff (we've been lucky to date)

Key points (personal opinion):

1. Obvious existing gap at NCAR; limited existing activity (in core, not applications)
2. Congenial relations between principals in several divisions
3. Mixture of basic science, applied science, and collaborative deliverables; some are very high visibility
4. Aggressive (but realistic?) proposal
5. High visibility area due to advances in observing systems, software engineering, and assimilation methodology