Cloud Modeling Working Group Break-Out

- Announcements
- Stimulus funds
- Science plan
- Data needs

Ann Fridlind, Larry Berg, Tony Del Genio, Christian Jakob,
Steve Klein, Steve Krueger, Shaocheng Xie, Minghua Zhang

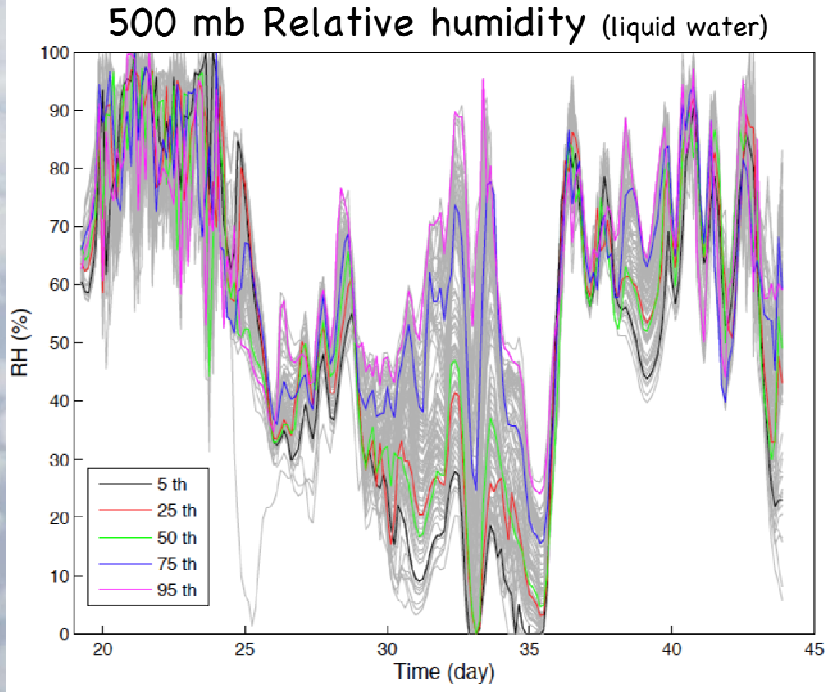
19th Annual ARM Science Team Meeting • Louisville, Kentucky • 30 March 2009

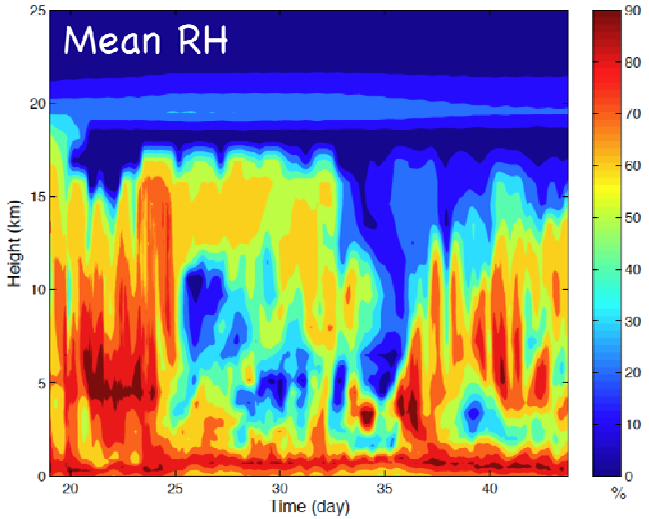
Welcome New PIs

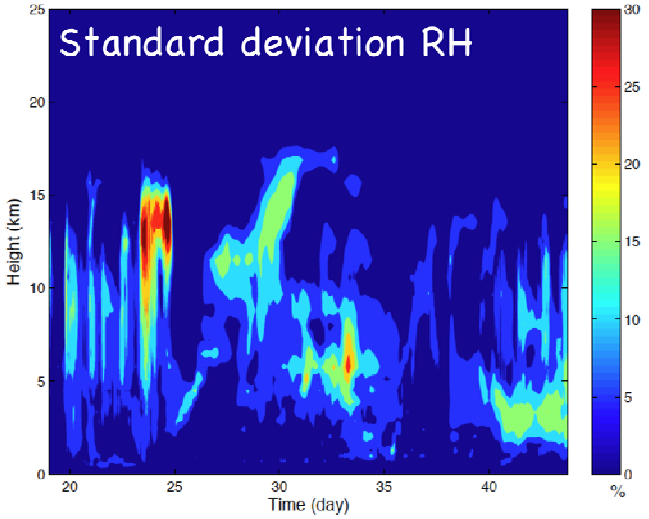
- Liu Peter, Environment Canada
- Ping Zhu, Florida International University
- Richard Sommerville & Sam Shen, UC San Diego
- Qiang Fu, University of Washington
- Zafer Boybeyi, George Mason University
- Michael Reeder, Monash University, Australia
- Brian Mapes, University of Miami
- Vaughan Phillips, University of Hawaii

C. Jakob ~4:30 pm Tuesday @ TWP-ICE Break-out

TWP-ICE SCM intercomparison







http://users.monash.edu.au/~ladavies/gcss.html

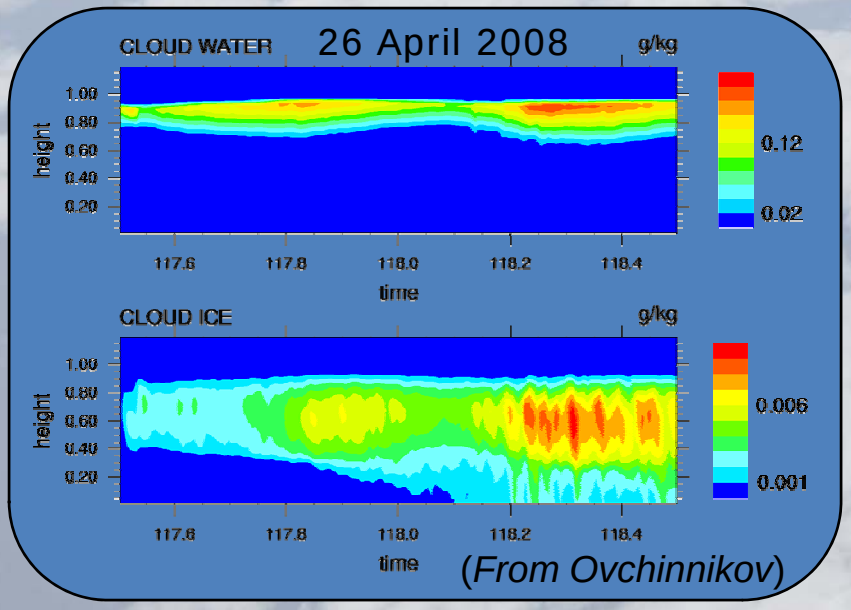
laura.davies@sci.monash.edu.au

ISDAC Breakout ~2:40 pm Tuesday

*(**I**ndirect **S**emi-**D**irect **A**erosol **C**ampaign, McFarquhar & Ghan* PI*'s)*

- Two "golden" days, 8 & 26 April 2008:
  - Single-layer mixed-phase clouds;
  - Multiple flights + ground observations;
  - Exceptional aerosol measurements (size, composition, hygroscopicity, CCN, IN, etc)
- Opportunities for closure studies, process and regional modeling

(*From Korolev*)



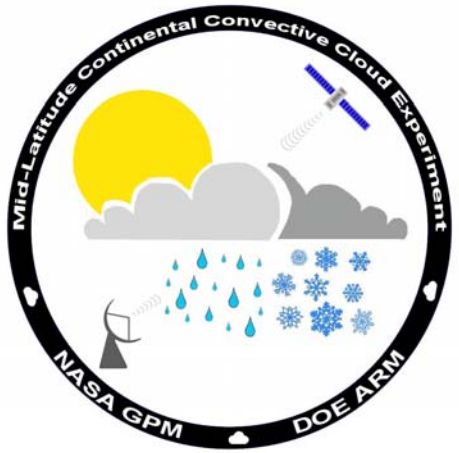
(*From Ovchinnikov*)

- Large-scale forcing available
- Contrast with M-PACE:
  - polluted vs. "clean" environment;
  - radiatively vs. surface-flux driven clouds.

Midlatitude Continental Convective Cloud Experiment (MC^3E)

A joint NASA/GPM DOE/ARM field campaign in Oklahoma

May-June 2011



Precipitation Intensive Operational Period (IOP)/Modeling

Break out Session

Tuesday, March 31 1-3 pm

Chairs: P. Kollias and A. Fridlind

Meeting Objectives

Engage early in the planning state of the IOP the ARM modeling group and seek their active involvement and guidance in the planning, preparation and execution of the field campaign.

Discuss scientific objectives, define critical measurements and requirements and outline data products suitable for model evaluation and improvement.

Cooperative Indian Ocean Experiment on Intraseasonal Variability in Year 2011 (CINDY2011) and its US participation - Dynamics of the MJO (DYNAMO) – MJO Break-out @ ~1:10 pm Tuesday

Other participating countries: Australia, India, China, French
Other US components: DOE AMIE, ONR air-sea interaction experiment
Time window: November 2011 – February 2012

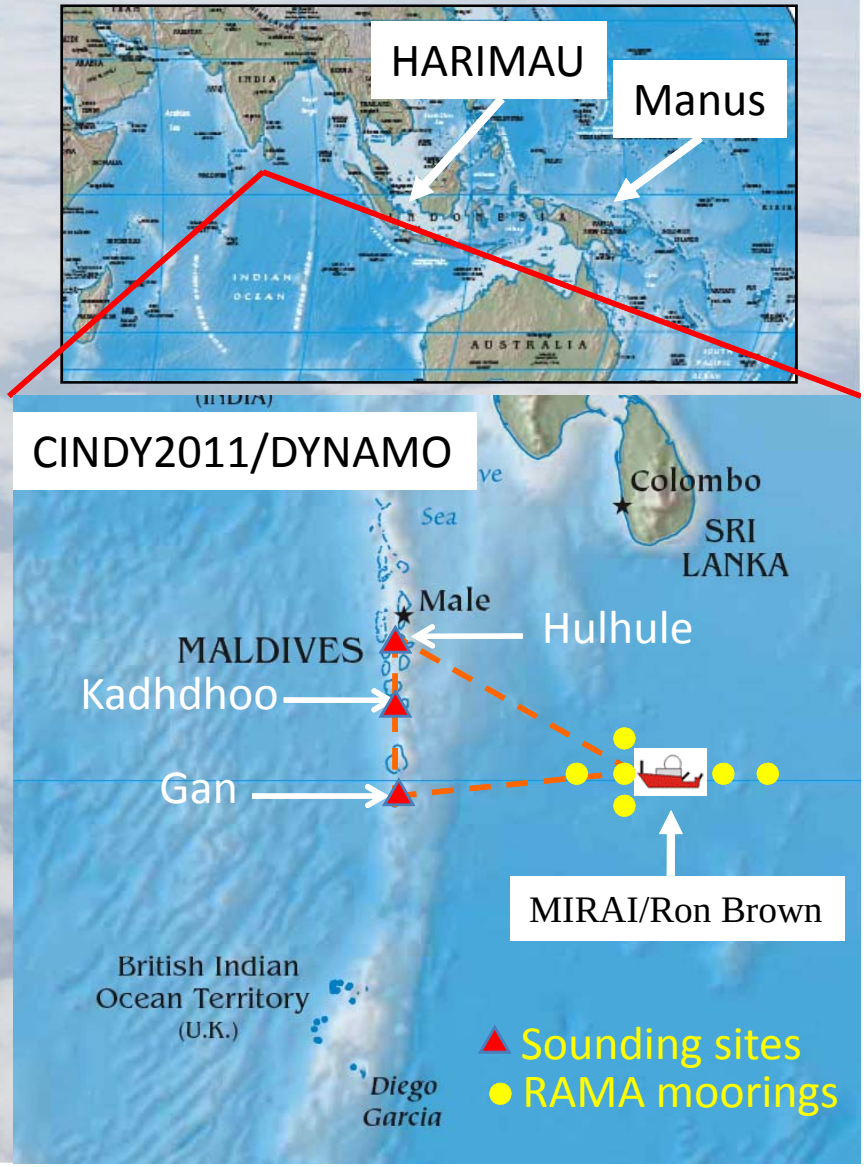
Objective: Collect in situ observations needed to advance our understanding of MJO initiation mechanisms and to improve our simulations and prediction of MJO initiation

Scientific Hypothesis: Moistening and diabatic heating in the lower troposphere by shallow convection play key roles in MJO initiation and maintenance.

Planned major observational instruments: ship-borne (MIRAI, Ron Brown) Doppler radars and radiation/surface flux package (AMF2), sounding array, surface and subsurface mooring array (RAMA), wind profiler array (HARIMAU), cloud radar and ARM Manus site (AMIE)

Modeling component: regional and global cloud-resolving and meso-scale models, global climate models

ARM contributions: Combine DYNAMO-ARM observing, data analysis, and modeling efforts to cover the entire MJO life cycle from its initiation in the Indian Ocean to eastward propagation into the western Pacific



New Observational Capabilities for the ARM Program

Discussion by WG Chairs

WG Breakout Sessions

2009 ARM Science Team Meeting

Louisville, Kentucky

The Opportunity

- ACRF has received $60M in one-time stimulus funds as part of the "American Recovery and Reinvestment Act of 2009"
- The stimulus funds need to be spent on capital, with the equipment received by Sep 2010
- Foresight by the ACRF program manager months before this Act was passed resulted in documentation that outlined significant capital expenses that would greatly enhance the ACRFs
  - These documents also outlined the scientific benefit and hence the justification

Seizing the Opportunity (1)

- These documents are:
  - ARM working group reports
  - ACRF fall workshop report (Nov 2008)

    http://www.arm.gov/publications/programdocs/doe-sc-arm-0804.pdf

- ARM Technical Director and ACRF Program Manager evaluated all recommendations within these documents; items that could be received by Sep 2010 were put on "The List"

Seizing the Opportunity (2)

- "The List" largely defines what ACRF will acquire in the next 18 months
  - It was drawn from WG reports & wish-lists and from the Fall '08 ARM Futures Workshop
  - No time for debate on the items or on the general breakdown of fund allocation
- Request for bids / contracts being put out now
  - Many of these items require significant lead time
  - Sep 2010 deadline looms
- Want to provide input?
  - Instrument focus groups are best avenue
  - ACRF Program Manager and Program Director are leaning on these focus groups for guidance, specs, etc

Instrument Focus Groups

- Focus groups have both science and infrastructure members
  - General source of expertise for each “observation” class
  - Meant to be a source of expertise for the program managers and a way to provide continuity
- Current focus groups:
  - Radar (Kevin Widener, *Thu 1:00 pm*)
  - Lidar (Jennifer Comstock, *Wed noon*)
  - Vertical velocity (Pavlos Kollias, *Mon 7:00pm*)
  - Surface heat flux (Ric Cederwall, *Mon 7:30pm*)
  - Microwave radiometers (Maria Cadeddu)
  - Spectral radiance / flux (Dave Turner)
  - Other? See instrument mentors

“The List” in Broad Strokes (1)

- Infrastructure upgrades
  - Instrument refurbishment (e.g., MMCR antennas, radiometer calibration facility)
  - Modifications to accept new instruments
  - Automatic sonde launcher for NSA
  - Expanded computing capability at DMF and Archive
- Radars
  - Scanning dual-frequency cloud radars
  - Scanning precipitation radars
  - Wind profiler (AMF-2)

“The List” in Broad Strokes (2)

- Lidars
  - Replace all ceilometers
  - HSRL for AMF and Barrow
  - Raman lidar for Darwin
- Instruments for the ARM Aerial Facility (AAF)
  - Cloud probes (e.g., total water, liquid water)
  - Aerosol instruments (e.g., TMDA, mass spec)
  - Cloud radar

“The List” in Broad Strokes (3)

- Ground-based aerosol instruments
  - Darwin, AMF-2
  - Advanced aerosol & chemistry instruments
- Other ground-based instruments
  - New 3-channel microwave radiometers
  - New AERIs
  - Shortwave spectrometer
  - Surface flux measurement upgrade at SGP, NSA

What We (the WGs) Need to Do

- This new observational capability will greatly enhance the science that can be done at the ACRF sites
  - Update the new ARM science plan accordingly
  - Need your input!
- New observations will yield new data streams, but processing will be needed
  - What are the right products?
  - What accuracy is needed?
  - What is the priority of these products?
  - When do we need them?
- Will certainly require more financial support
  - Infrastructure (ingests, VAPs, etc)
  - Science (basic research on using these new data, especially in combination with other data sets)

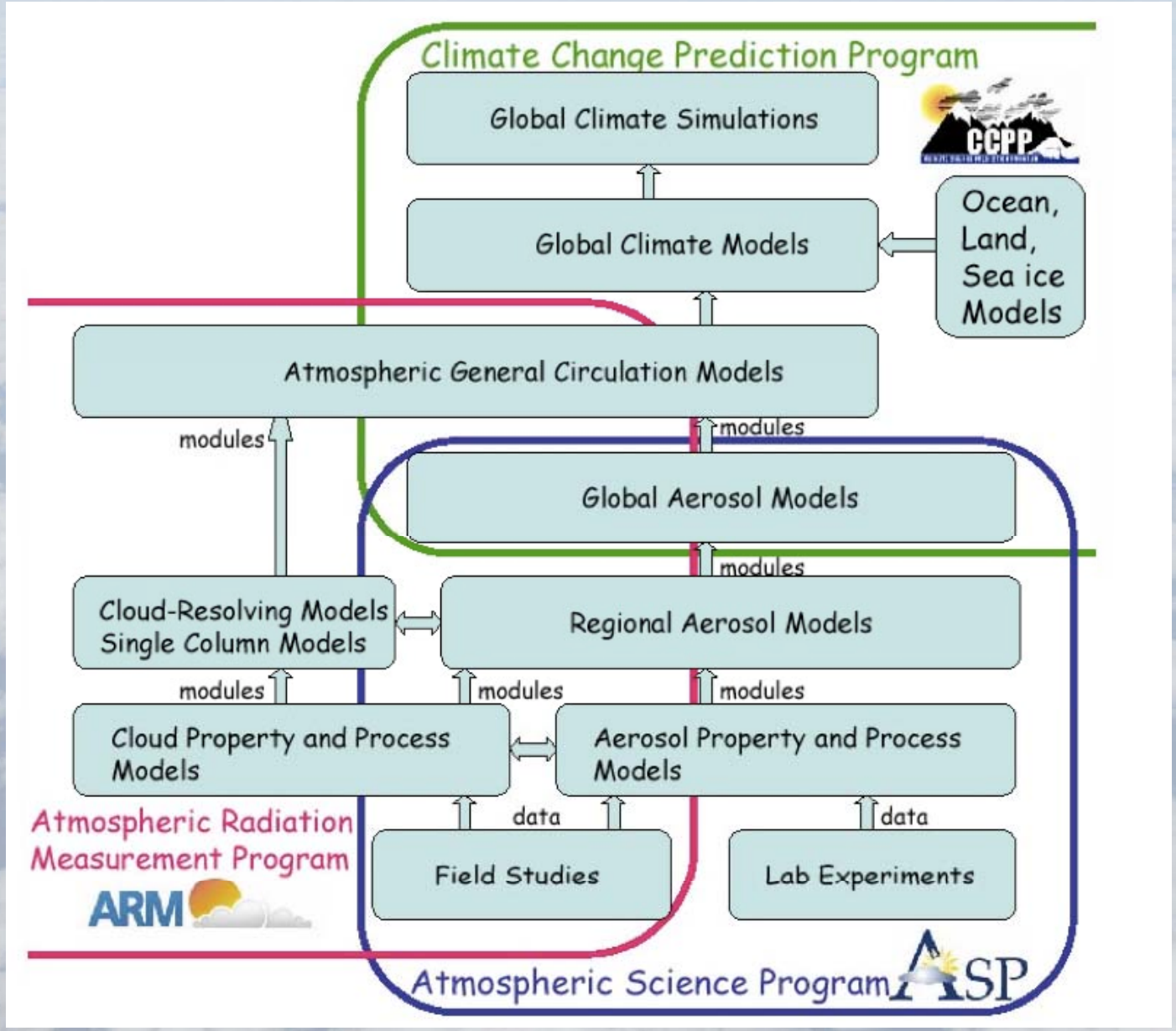
CMWG Steering Committee Feedback

- Response to “The List” provided on 2/27 (3/4)
  - the plan is a good one
  - biggest concern is whether or not the resources will be available to produce data products useful for modelers
  - science funding needs to increase
- What are priority data sets for modelers? (3/18)
  - 4-D (x,y,z,t) fields of hydrometeor occurrence, liquid and ice mass mixing ratio, precipitation rate, vector winds, temperature, and water vapor
  - 2-D (z,t) fields of double-moment microphysics parameters for liquid and ice in cloud and precipitation size ranges
  - crucial that the data sets also contain sound guidance on data quality in terms of both the quantitative uncertainty and the qualitative conditions under which the data are more or less trustworthy
- On precipitation radar specifications left open (3/19)
  - most crucial design element for derivation of large-scale forcing is the range of retrieval under the most strongly precipitating conditions: at least 100 km
  - urge that a mobile system be purchased that will be capable of deriving large-scale forcings for an AMF deployment (more important than another such radar for SGP)

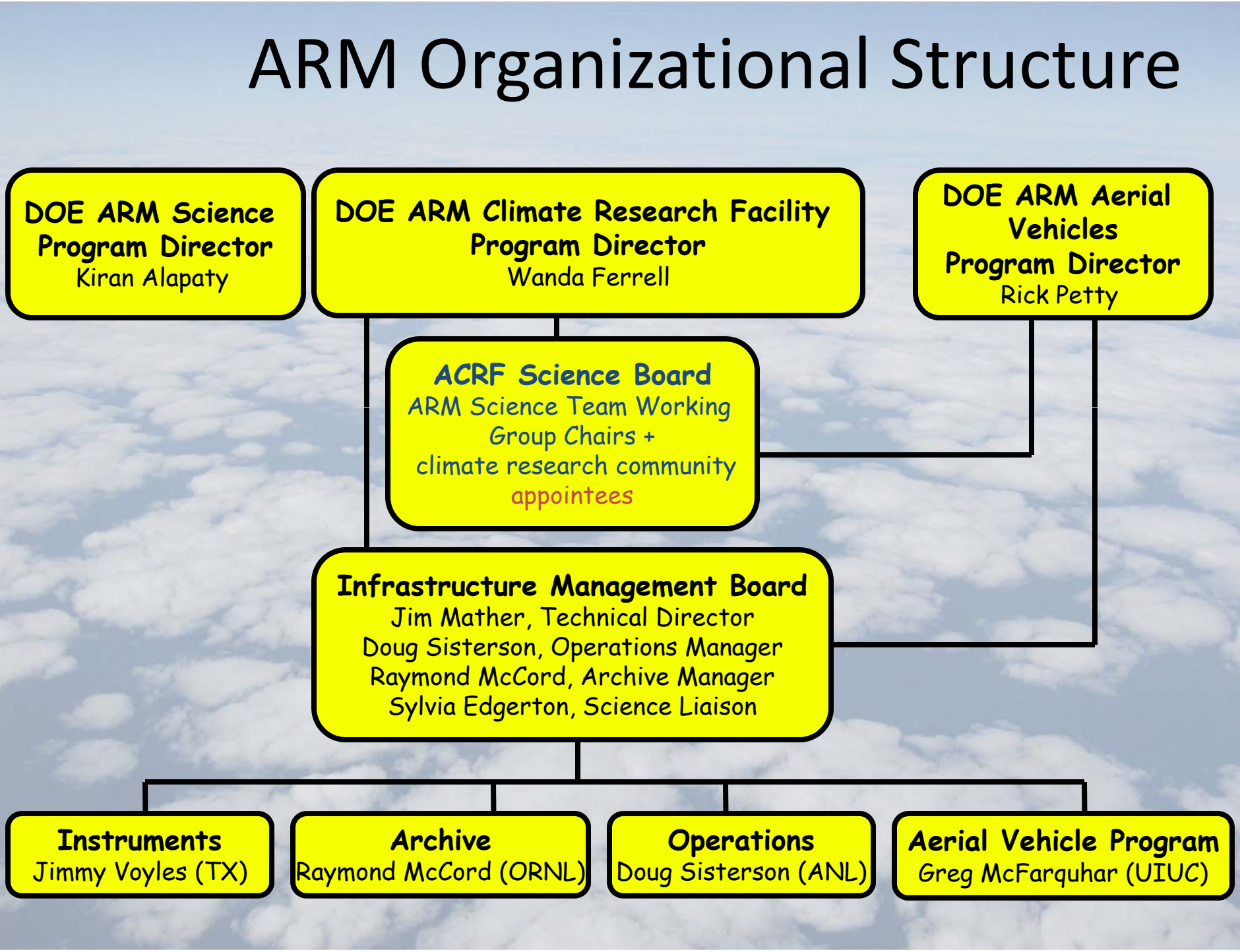
ARM in a nutshell

- Largest global change research program funded by the U.S. Department of Energy
  - $50M/yr
  - ~$14M/yr for Science Team

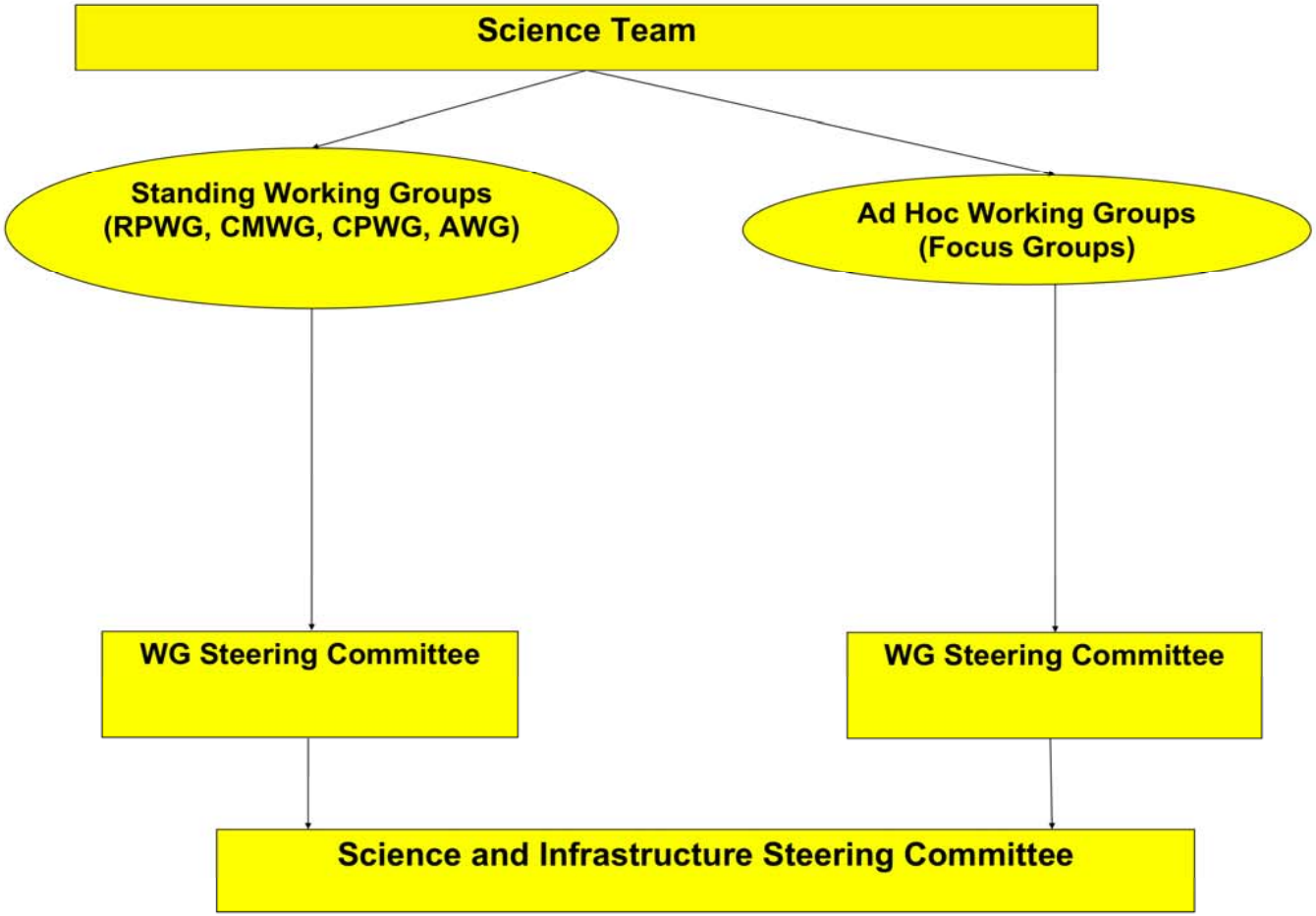
ARM's place in DOE climate program



ARM Organizational Structure



ARM Science Team Structure



Evolutions rather than revolutions

- A big change occurred in 1999 when Wanda formed the ARM Infrastructure Review (AIR) panel
- That was where we decided to empower the WGs, in particular in the instrument purchase area

Today's Break-Out

- Original focus
  - Science plan
  - Instrument plan
    - develop momentum for things on the spreadsheet
    - fill the hopper (add new things?)
- Revised focus
  - Science plan
  - Data plan
    - we are better suited for this, but demand is stronger
    - still need to understand what instruments can do (dialog)

A CMWG-Specific Mission ...

- Engage more closely (as a group) with data product development
  - Better understand our own (and outside) data usage and unmet needs
    - e.g., what is the ARM data stream most used? (e.g., Shaocheng's recent survey of VAPs)
    - what do we most want that we don't have now?
  - Target and prioritize new VAPs, retrievals, re-processing, adjustments, ...
    - e.g., CMBE for CRMs?, ARMNet?, vertical wind speeds
  - Communicate this!
    - efficient, ongoing/rolling, annual survey?, goal-setting/problem-finding and follow-up
- Central principle
  - Data development process should flow from priority science questions
- Challenges
  - Another volunteer activity of a large group
  - Efficient, comfortable framework is not in place (should we pursue one?)
- Opportunities
  - ARM funds attendance at two meetings per year
  - Our guidance is already being sought by ARM leads, CPWG
  - WG feedback is part of the ARM plan (no need to ask permission)

Science Plan Input

- How can ARM science be more effective in addressing the outstanding science questions identified by organizations such as the Intergovernmental Panel on Climate Change and the National Academy of Sciences?
  - Reduce uncertainties associated with (understand) cloud-climate feedbacks
  - Understand aerosol indirect effects in climate models
  - To address IPCC concerns about low-level clouds, deploy in trade Cu
  - Encourage ARM scientists to participate in the national and international assessment processes (built-in mechanism needed?)

Science Plan Input

- How can ARM be more effective in improving aerosol, cloud, radiation and precipitation parameterizations in global climate models?
  - Provide first order variables for convenient use by the modeling community, such as cloudiness and aerosol optical depth
  - Support and expand VAPs (in particular the CMBE) because the data base is still hard for modelers to use
  - Organize campaigns in which people with interests in observations, process understanding, and modeling truly work together
  - Work and leverage with other programs such as DOE ASP, NASA to obtain coordinated measurements
  - Support further evaluation of LES and CRM models
  - Support further development of methodologies that evaluate simulated precipitation (such as the CAPT framework)

Science Plan Input

- What are the outstanding aerosol, cloud, radiation and precipitation questions for ARM science in the next five years?
  - Better understanding of the entrainment at the PBL top for shallow cumulus clouds
  - Better understanding of the interactions among cirrus, stratiform anvils, convective updrafts and downdrafts, entrainment, and PBL inhomogeneities that trigger convection
  - Almost every aspect of convection (closure, trigger, entrainment effects), ice nucleation, ice microphysics, and ice fall speeds, and precipitation overlap, as well as cloud fraction and PDF condensate overlap
  - Better understanding of the behavior of oceanic versus land convection
  - Better understanding of the interactions and feedbacks between cloud dynamics and cloud microphysics, including but not limited to the role of aerosols
  - Better understanding of the role of ice nuclei in the climate system
  - Some continued focus on the radiative impact of various cloud types (may be wise to use findings from cloud-climate feedback studies to provide this focus)
  - Better understanding of global dimming and brightening phenomena
  - Evaluations of the above processes in CRM/LES and parameterization in GCMs

Science Plan Input

- What ARM observations and data products are needed to address these questions? Are current ARM locations sufficient?
  - Properties of precipitating clouds
  - Vertical velocities in both non-precipitating and precipitating clouds and also in clear air (perhaps from doppler lidar just beneath cloud base)
  - Collocated measurements of cloud properties, aerosols and cloud-scale vertical velocity, as well as the large-scale conditions in which the cloud fields are embedded
  - Cloud particle size, number concentration, size distribution parameters
  - Better mixed phase detection
  - Ice nucleus measurements
  - Integrated retrievals that are time continuous and have adaptive error bars
  - Ensemble forcing data sets
  - Of course the current locations are not sufficient
  - A TWP site with a weather radar would be good (e.g., Kwajalein)

~~Instrument~~ Data Plan Input

- What ARM observations and data products are needed to address the priority science questions?
  - what is the full list of final data products that could be available?
  - what would be the likely achievable time and space resolution of each?
  - what would be the likely measurement domain extent?
  - what is the range of conditions under which the measurement/retrieval could be reliable?
  - what is the likely ballpark uncertainties and minimum and maximum detection limits?
  - can we place this into the context of what the DOE ARM program currently delivers in terms of data products and/or what is delivered by other programs?

- An initial survey/question-and-answer about what some (slated) new instruments can do

Thank you for your participation

- **3:20 - 3:40** **Shaocheng Xie**—How do variational analysis and SCMs/CRMs respond to a reduced ARM SGP network?
- **3:40 - 3:55** **Dave Turner**—Advanced lidars for ARM: what would we get?
- **3:55 - 4:10** **Pavlos Kollias**—ARM's efforts to address the need for 3D cloud and precipitation measurements
- **4:10 - 4:25** **Jay Mace**—Bimodality in cirrus: Evidence from ARM measurements and implications for new retrieval algorithms
- **4:25 - 4:40** **Ed Eloranta**—Snowfall precipitation rate measurements using combined HSRL and MMCR observations
- **4:40 - 4:55** **Sergey Matrosov**—Simultaneous retrievals of cloud and rainfall parameters in the atmospheric vertical column above ARM sites
- **4:55 - 5:10** **Zhien Wang**—Retrieving precipitating mixed-phase cloud properties and a suggestion for a new focus on cloud microphysical process study in the ARM Program
- **5:10 - 5:30** **Discussion** of priority data products
- **5:30 - 6:00** **Kiran Alapaty**—CAM4-SCM + ARM site data