

# ARM 2003

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**WARNING!**

**Today is April 1**

**But that has NO bearing on this message**

# Two Topics

- **Status of ARM (quick overview)**
- **Science plan – ARM in the next 5 years**

# ARM Status – Science

- **Steadily increasing productivity**
  - Poster session – over 220 posters (may need to do something about submissions next year)
  - Peer-reviewed articles: 2.5 to 3 per year per funded grant
  - Increasing presence at radiation and cloud meetings
- **Quality**
  - How to measure?
  - Gradual shift from technique development to applications in physics and modeling

# Remember: *Please send*

- Illustrative slides
  - Simple
  - Effective
  - Digital (color)
- Journal articles when submitted
- Journal reprints when published
- Annual reports
- ARM Extended Abstracts: **HARD DEADLINE**  
**of June 30!**

# ARM Status – Science Team Structure

- **Working Groups**
  - **Functioning well (from my perspective)**
  - **Discontinued separate group on data integration (subsumed back into CPM)**
  - **Cross-working group issues becoming more important; how does that affect our current structure?**

# ARM Status – STEC

- Bob Ellingson (Chair, IRF)
- Tony Delgenio (CPM)
- Steve Klein (CPM)
- Rich Ferrare (Aerosol)
- Greg McFarquhar (CP)
- Pete Lamb (SGP)
- Chuck Long (TWP)
- Hans Verlinde (NSA)
- Tom Ackerman
- Wanda Ferrell
- Ted Cress
- Raymond McCord
- Doug Sisterson
- Jimmy Voyles

Special mention: Jay Mace, Minghua Zhang

# **ARM Status – Value Added Products (VAP)**

- **Increasing importance to program – legacy data set**
- **Increasing level of effort – limited by available funds**
- **Key scientists: Ric Cederwall, Connor Flynn, Chuck Long, Mark Miller**
- **Further discussion in later talks this AM**



# ARM Status – Data

- Archive statistics courtesy of Raymond McCord




# **ARM Status – Sites**

- **Fixed instrument complement and operations budget**
- **Signs of instrument fatigue in radars and lidars => too much down time**
- **No funds available for new instrument development and/or purchase**
- **Darwin site officially dedicated in 2002**

# **ARM Status – IOP activity**

- **Last large IOP: 2000 Cloud IOP and ARESE II**
- **FY03 – Aerosol experiment**
- **FY04 – Proposed NSA experiment on mixed phase clouds**
- **FY05 – Proposed TWP Darwin experiment on monsoon clouds**
- **UAV – participation in NSA and TWP experiments planned**

# ARM Status – Collaborations

- GCSS working group involvement\*
- Two ARM post-doc positions being advertised at NCEP and ECMWF
- GEWEX Working Group on Atmospheric Profiling – ground-based sites in France, the Netherlands, Britain, Germany
- CRYSTAL-FACE – participation in NASA campaign
- NASA Global Precipitation Mission – working on agreement to put precip instruments at SGP
- Water cycle initiative – hydrologic community
- CAPT 

*\*Credit to Dave Randall, Steve Krueger*

# ARM – Overall Status

- **Mature program**
  - **Scientifically productive and respected**
  - **Well functioning infrastructure**
  - **Fixed budget in dollar amount (eroding via inflation) but expect a \$4M/year user facility increment**
  - **Key component of the US climate research program**
  
- **Where do we go from here?**

# **A New ARM Science Plan**

- **Completed prior to next Science Team Meeting**
- **Authors**
  - **Coordinating author: Chief Scientist**
  - **Contributing authors: STEC members**
- **ARM science team contributions**
  - **Input to STEC members during next 1-2 months**
  - **Input to Chief Scientist at any time**
  - **Opportunity to review draft plan near end of this calendar year**

# Science Plan Outline

- **Accomplishments**
  - What problems have we solved?
- **The Future of ARM – Three Foci**
  - Cloud and radiation physics – building on our past successes
  - The ARM Mobile Facility
  - **Climate Physics Simulation Project**

Requires new money!



# Existing Sites

- **Site Vision for each existing locale**
  - What are the science questions that will drive site operations?
  - What are the implications for operations: maintain, increase or decrease operations?
  - More on this tomorrow morning
- **Improve reliability of MMCR and MPL at all sites**
- **Restore instrument development program**



# Radiative Transfer and Aerosols

- **3D radiative transfer**
  - Can we measure 3D cloud geometry and radiative transfer simultaneously?
  - How important are 3D cloud effects in large scale models?
- **Aerosol effects**
  - Can we measure and model the indirect aerosol effect? How important is the effect?
  - How important is black carbon in clouds?

# Clouds

- **Improved retrievals**
  - Can we create a set of algorithms that provide bulk microphysical information for all cloud types?
  - How do we do retrievals in mixed phase clouds?
- **Carry out IOP's targeted at validating new retrieval schemes**
- **Create new data streams for microphysics in the archive**

# Cloud Modeling

- **Forcing fields for SCM and CRM studies**
  - Can we create continuous forcing fields at the SGP?
  - Are NWP fields adequate at the remote sites? If not, what alternatives do we have?
- **Cloud resolving models – develop an operational CRM at the SGP to study cloud life cycle and produce statistics for parameterization development**
- **Build on CAPT project (initial condition CAM) to evaluate and improve cloud and radiation processes**

# Parameterization

- **Support parameterization development and implementation**
  - **GFDL, Canadian climate model, ECMWF, NCEP, GISS, NCAR**
- **Create a software library of standard routines and models that can be used by the science community**

## **Focus 2. ARM Mobile Facility**

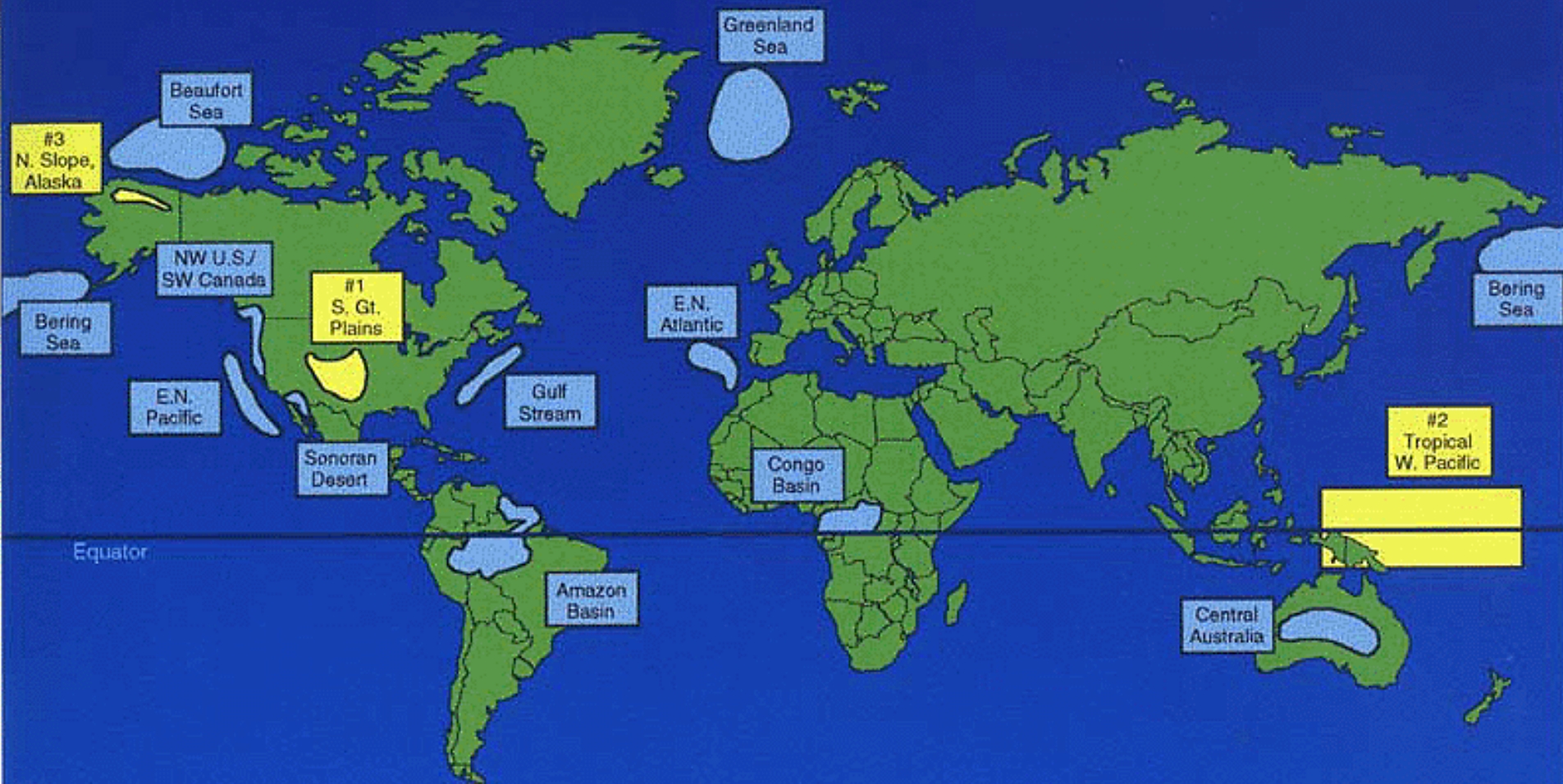
- **Needed to address science questions beyond those addressed by current fixed sites**
- **Instrumentation similar to ARM remote sites in NSA and TWP**
- **Mobile – envision deployments on the timescale of 6 to 18 months**
- **Synergistic operations with other programs (national and international) likely**

# Some suggested science targets

- **Marine stratus and stratocumulus**
- **North Atlantic and southern ocean storm tracks**
- **Aerosol properties (multiple locations)**
- **Representative nature of current sites**
- **Validation of satellite cloud products**
- **Tropical forests**
- **Antarctic – South pole**
- **Monsoon climate**
- **Anthropogenically polluted**



1993 ARM siting strategy. Fixed sites are in Yellow; temporary deployment sites in Blue



# What will we measure?

- **Surface radiation fluxes (broad band and narrow band)**
- **Cloud properties (occurrence, height, microphysics)**
- **Aerosol optical depth (composition?)**
- **Standard meteorology (surface and profiles)**
- **Surface latent and sensible heat**
- **Additions?**



# Timeline

- Revised due to FY03 budget follies
- Have 1<sup>st</sup> phase of AMF completed in FY04
- Deploy in USA with “rented” radar in FY05
- Complete Basic configuration in FY05 (add radar and AERI)
- Deploy full system in FY06 in location to be determined

# **Expected benefits**

- **New datasets from other climatic regimes**
- **Improved understanding of cloud physics and radiation interactions through testing and comparison in other regimes**
- **New science questions and drivers**
- **Expanded interaction with other programs, both national and international**

# **AMF Breakout Discussion\***

- **Climatic regimes of interest**
- **Priorities**
- **Possible interactions with other programs**
- **Science management**

*\*Tomorrow afternoon*

## **Focus 3: Climate Physics Simulation Project**

**Despite the ARM successes in understanding physics and developing new parameterizations,**

***The ARM Program has not had the breakthrough success in climate model improvement that we had hoped for!***

# **Why not?** *(Straight-forward answer)*

- **Mismatch between ARM data and GCM needs**
  - **ARM not producing all the required quantities routinely (e. g., IWC, microphysical retrievals)**
  - **Climate modelers don't know how to use single-point, time series data**
    - **Research on aggregation of ARM data to GCM scale**
    - **ISCCP simulator may provide a key to improvement**
  - **Cloud information not linked to dynamics**
    - **Improving at SGP (continuous forcing fields)**
    - **Need to solve this problem for the remote sites**

# Why not?

*(More complex answer)*

- **No “unified theory” of cloud parameterization**
  - **Inputs and outputs vary substantially from one mode to the next**
  - **Models often contain multiple parameterizations connected by assumptions**
- **Parameterization components are often not directly relatable to observables**
- **No easy way to include incremental improvements in knowledge of physics**



# **Proposed extension to ARM:**

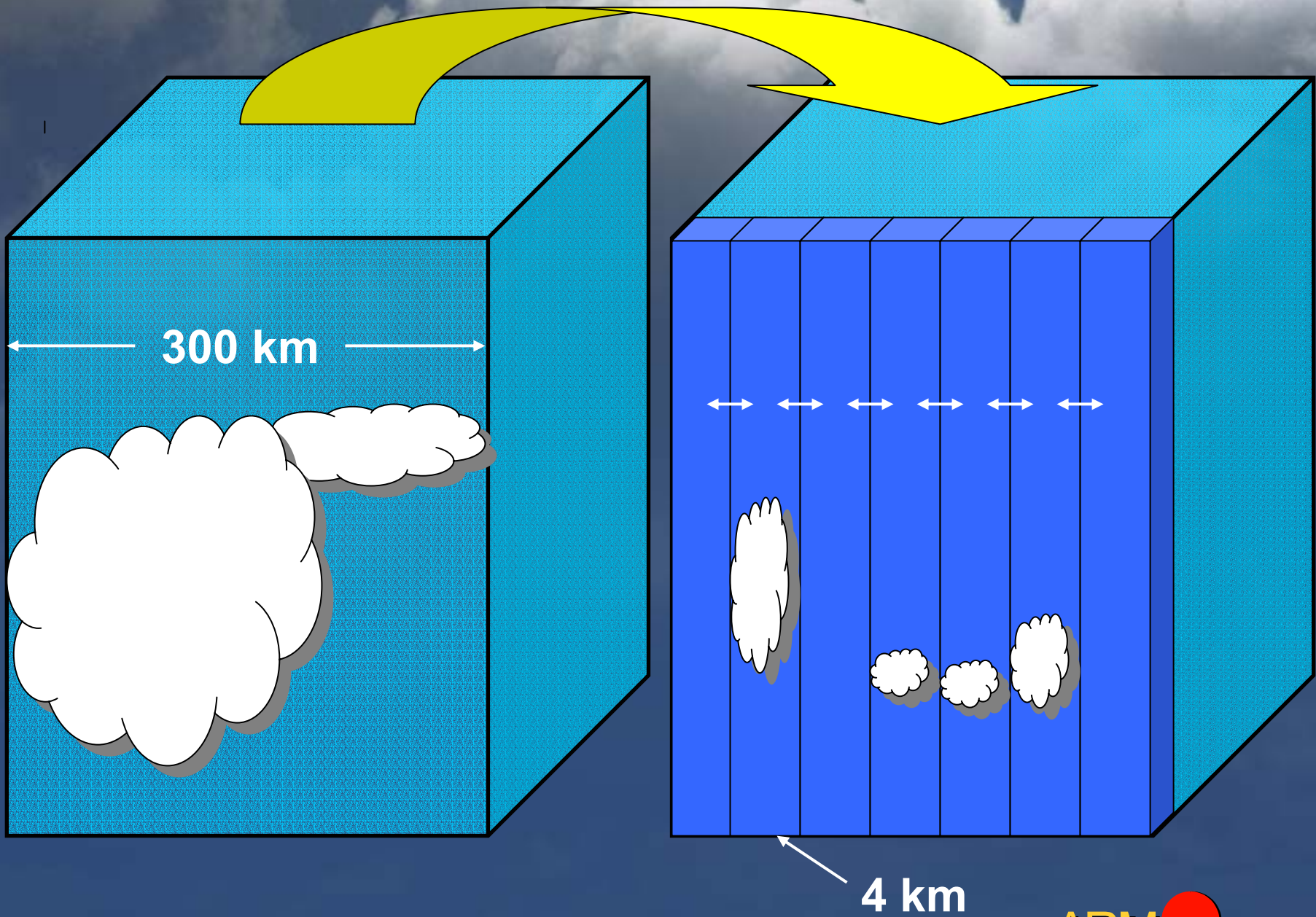
## ***Climate Physics Simulation Project***

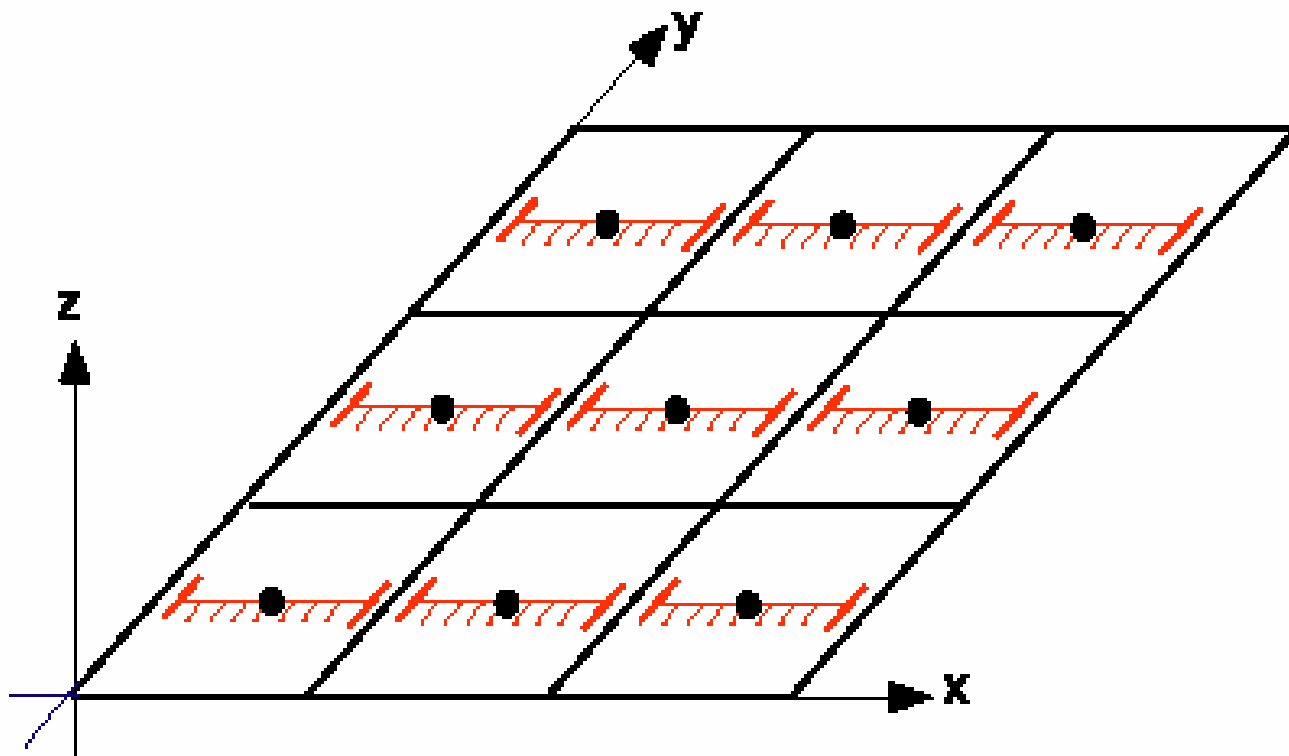
- 1. Enhanced focus on matching data to GCMs**
  - **Developing an ARM Simulator (will require cooperation with GCM'ers – different model output strategy)**
  - **Merging satellite and ground-based data for limited areas**
- 2. Increase use of new modeling tools**
  - **Initial condition framework (CAPT) to test parameterizations**
  - **Use cloud resolving models to bridge scale between observations and GCM (operational CSRM?)**
- 3. New project on Super-parameterization**

# What is Superparameterization?

- Based on pioneering work by W. Grabowski (NCAR) and D. Randall (CSU)
- Replace cloud parameterization scheme in a GCM with a 2-D cloud-resolving model.
- Result
  - Computation of cloud properties on the cloud scale (4 km horizontal scale)
  - Computer intensive model

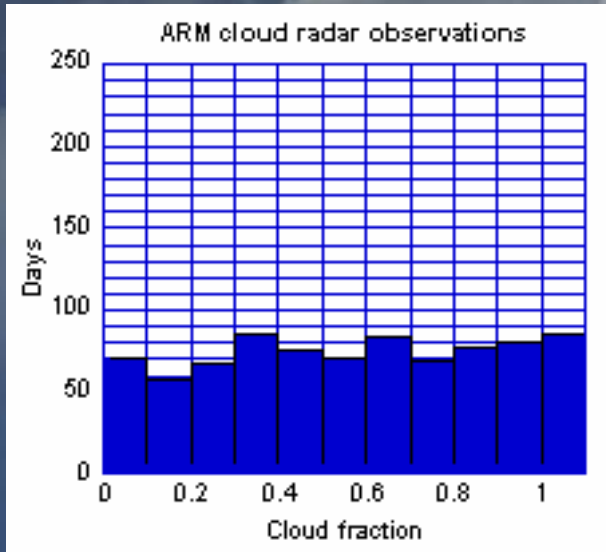






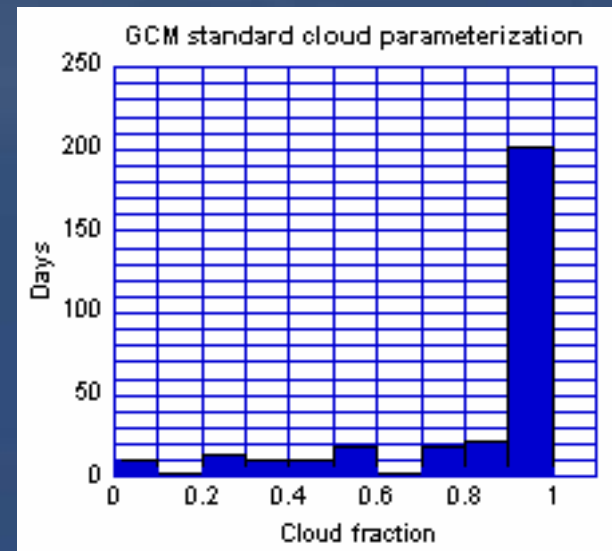
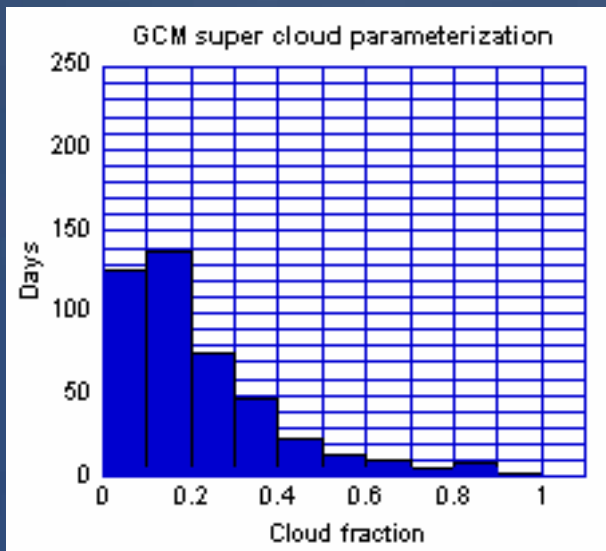
# Why Focus on Super-parameterization?

- **Calculation of cloud properties on cloud scale**
- **Much easier to relate components to observables**
- **Can test incremental improvements in knowledge of physics**
- **Scale of model matches scale of observables**



## Histograms of cloud fraction

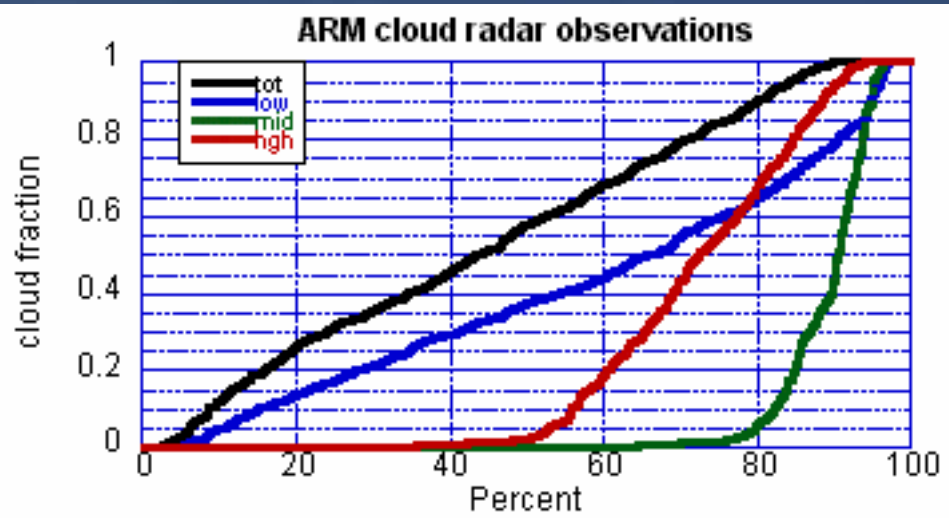
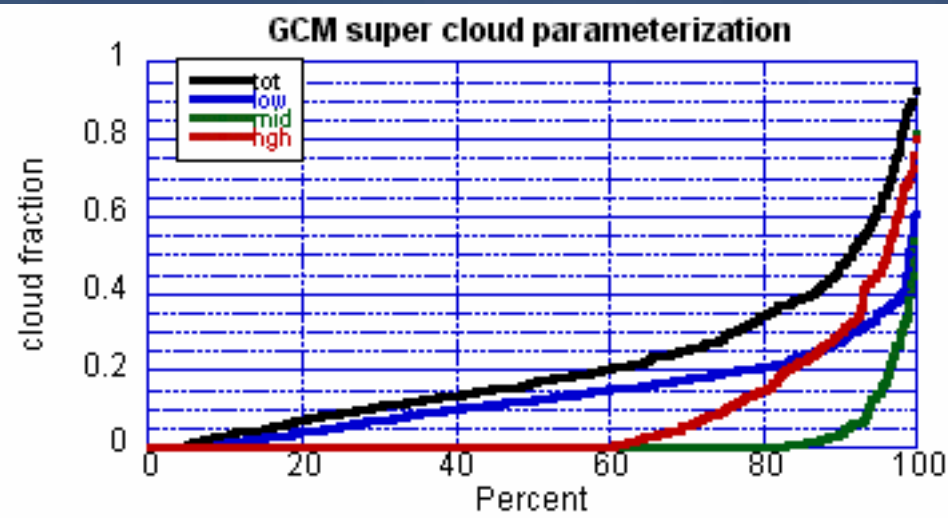
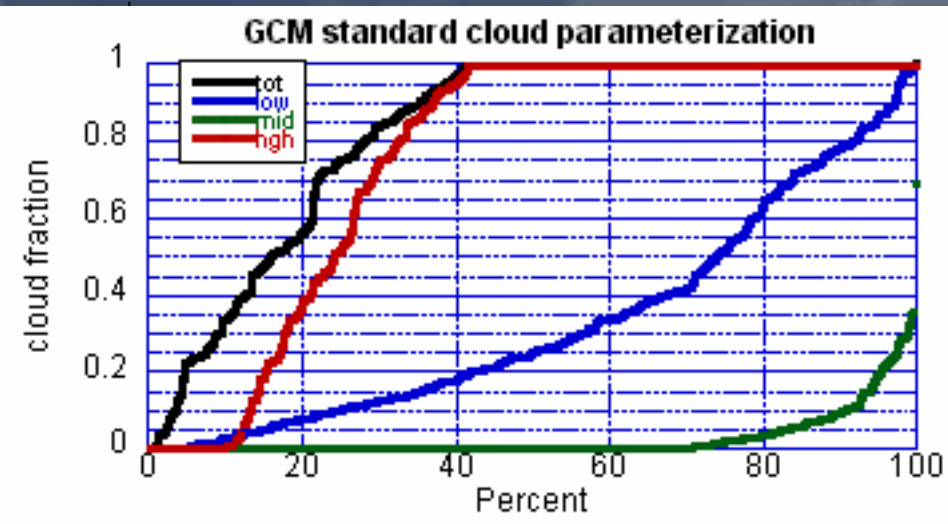
- ARM Nauru observations
- GCM Superparameterization
- Standard GCM

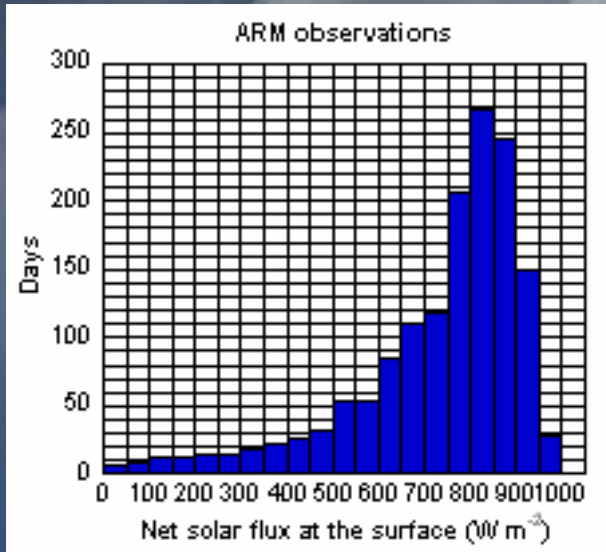




## Cumulative frequency of cloud fraction

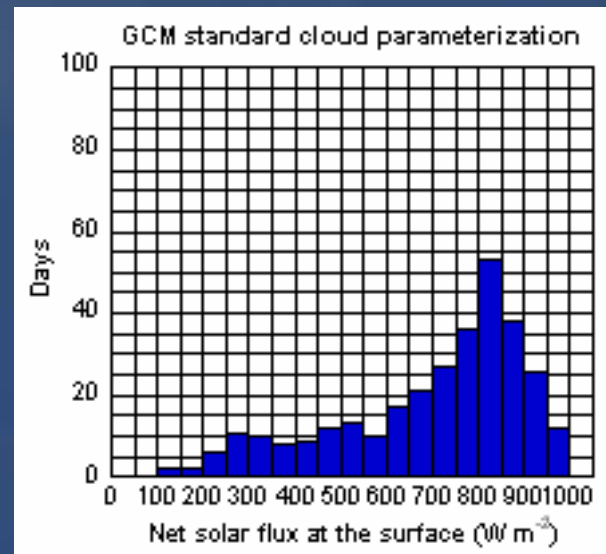
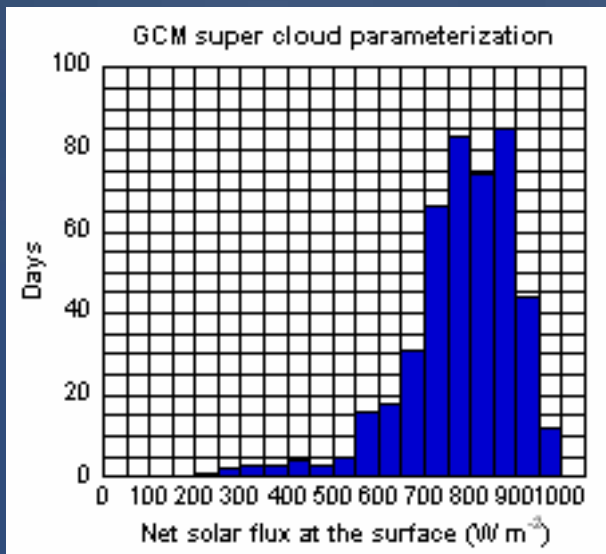
- Standard GCM
- GCM Superparameterization
- ARM Nauru observations



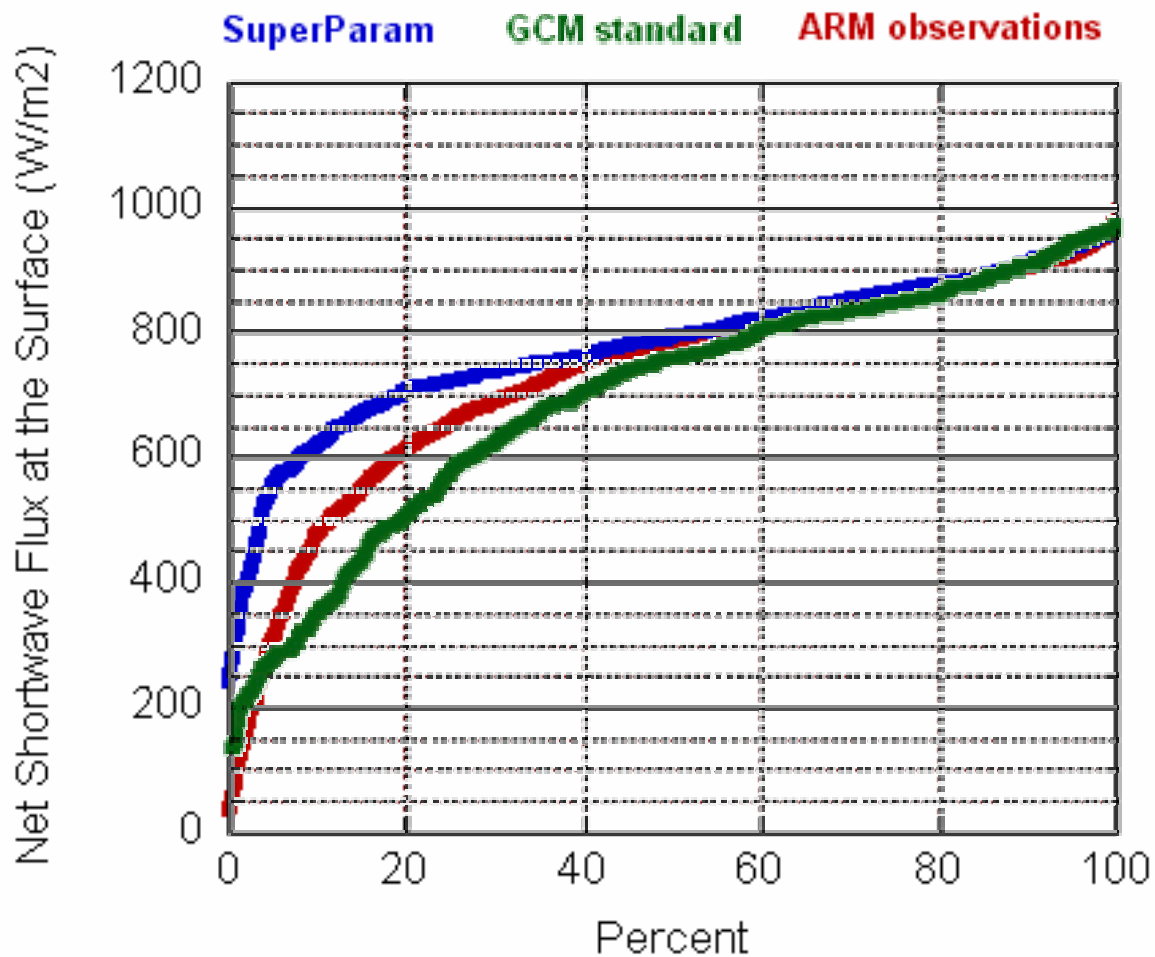


## Histograms of solar flux transmitted to the surface

- ARM Nauru observations
- GCM Superparameterization
- Standard GCM







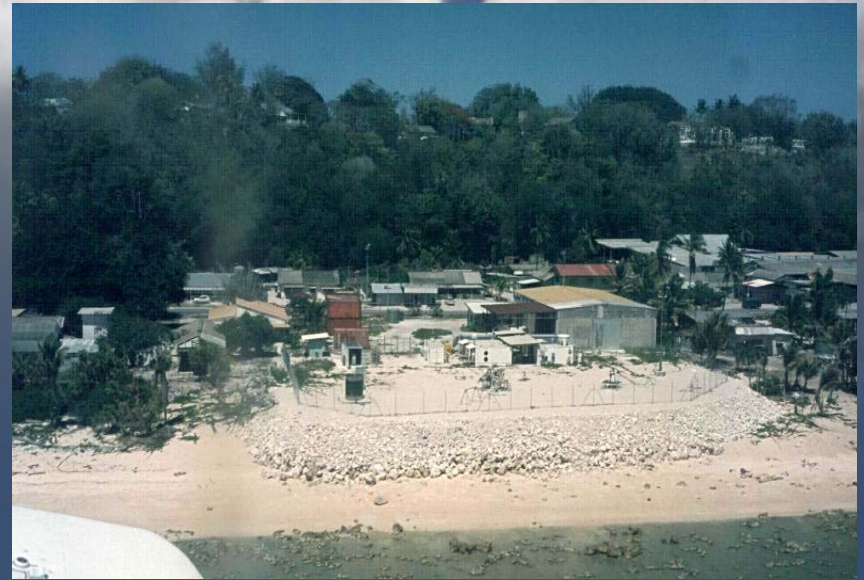
# **Expected Benefits of**

## ***Climate Physics Simulation Project***

- **Significant improvement in the match between data and GCM output (working on both traditional GCM scale and SP)**
- **Focus on the physical processes important to parameterizations through use of initial condition model, CSRM, and SP**
- **Use SP and coincident data to test the processes most relevant to cloud feedback and climate sensitivity**



***Thanks for your  
attention!***



**Tropical Western Pacific**

**Southern Great Plains**



**North Slope of Alaska**

