

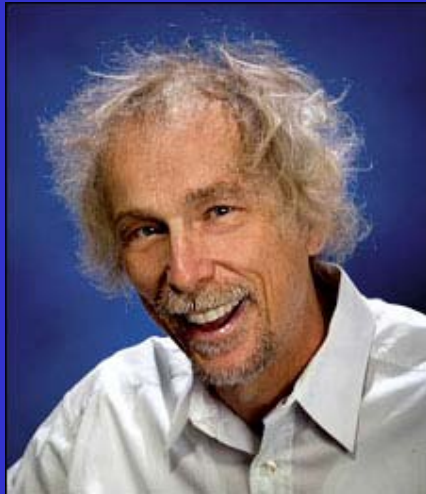


# Chief Scientist Report ARM Science Team Meeting 2008

Warren Wiscombe  
ARM Chief Scientist  
Brookhaven National Lab



# ARM Chief Scientist Team



Andy Vogelmann



Ric Cederwall



Yangang Liu



Sharon Zuhoski



Pavlos Kollias



## Submit your...

science highlights ([www.arm.gov](http://www.arm.gov))

poster PDFs (esp if you win CS Design Award)

feedback in text boxes on ARM web pages

Also...

vote for People's Choice Poster

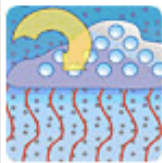

talk to our Thu morning speakers

## Research Highlights

Members of ARM's science team are major contributors to radiation and cloud research. ARM investigators publish about 150 refereed journal articles per year, and ARM data are used in many studies published by other scientific organizations. These documented research efforts represent tangible evidence of ARM's contribution to advances in almost all areas of atmospheric radiation and cloud research. Below is a selection of summaries highlighting recently-published ARM research. The entire collection of ARM Research Highlights can be accessed using the sorting buttons at right.

To send in a research highlight, please use the [submittal form](#).

### Recent Research Highlights

Principal Investigator	Affiliation	Research Area	Title	Thumbnail (if available)
Lubin, Dan	Scripps Institution of Oceanography	Radiation Measurements	<a href="#">Aerosols Help Clouds Warm Up Arctic</a>	
Cole, J.N.	Meteorological Service of Canada	General Circulation and Single Column Models/Parameterizations	<a href="#">Small Processes Make A Big Difference in Model Outcomes</a>	

### Sort Highlights

- [Principal Investigator](#)
- [Title](#)
- [Research Area](#)
- [Affiliation](#)
- [Publication Date](#)
- [Submission Date](#)

### DOE Research Progress Reports

- [Biological and Environmental Research Abstracts Database](#)



# Focus Groups

## Existing

- CLOWD (Clouds with Low Optical Depth)
- BBHRP (BroadBand Heating Rate Profile)
- Radar

## New

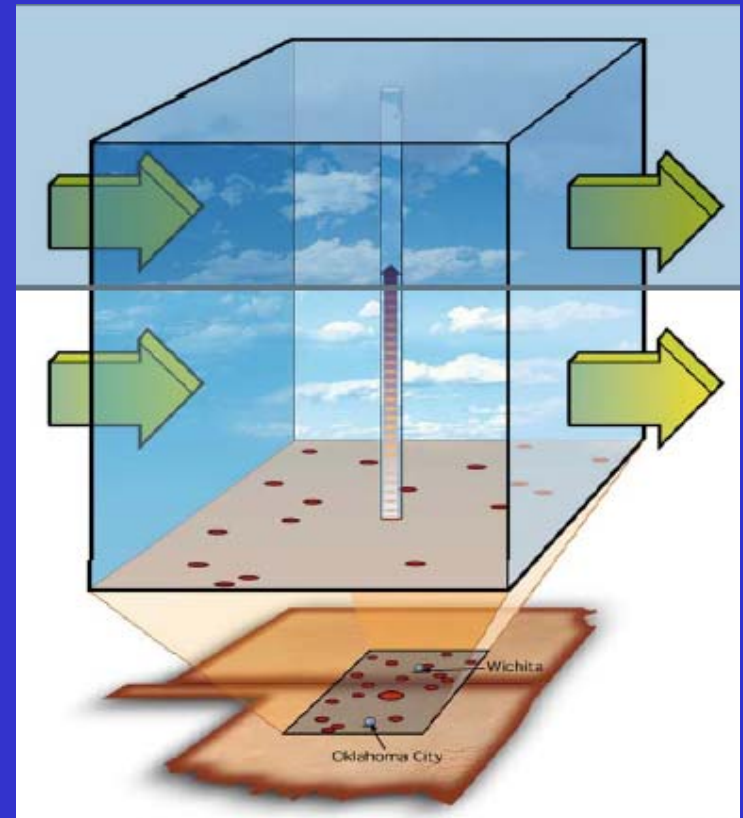
- Vertical Velocity for Climate Modelers
- Longwave/Microwave
- Surface Fluxes



# ARM's two fundamental science questions

If we can specify the properties of a cloud field, can we compute the radiative fluxes?

If we can specify the large-scale atmospheric fields, can we predict the cloud field properties?





# ARM SGP field campaigns, Dec 07

Aura satellite validation

Orbiting Carbon Observatory Validation **\*\*PLANNING\*\***

Characterization of Daytime Convective Boundary Layer

Hydro-Kansas Field Experiment

Magnetic Field Observations at Purcell

Precisions Gas Sampling Validation Field Experiment 2007

PURCELL RAIN MICROPHYSICS STUDY

RAMIX - Radon Measurements of Atmospheric Mixing

SINGLE FREQUENCY GPS WATER VAPOR NETWORK

WIND PROFILER PRECIPITATION STUDY



# Other ARM field campaigns, Dec 07

**NSA:** NSF UV Monitoring Support

Indirect and Semi-Direct Aerosol Campaign (ISDAC)

Pyranometer IR Loss Study

**TWP:** Orbiting Carbon Observatory Validation (combined with SGP)

**AMF** GERMANY **\*\*COMPLETED\*\***

CHINA **\*\*IMPLEMENTING \*\***

AZORES **\*\*IN PLANNING\*\***

CHILE **\*\*IN PLANNING\*\***



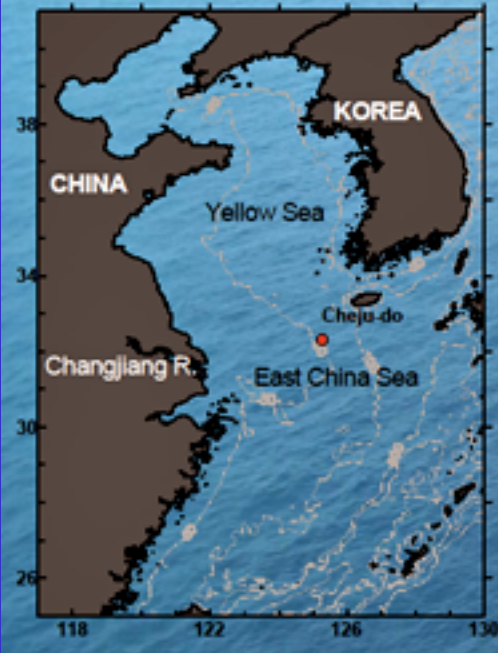


# We got \$2.5M to start building a 2nd Mobile Facility, for marine use



# 2nd Mobile Facility on a platform?

## KORDI: IEODO Ocean Research Station



California

Oil Platforms may turn into fish habitats



# ARM papers in BAMS, 2007

mm cloud radar (Kollias ...)

AMF in Niger (Miller...)

MPACE (Verlinde...)

CLOWD (Turner...)

Ice-nucleating aerosols (Prenni...)

COPS (Wulfmeyer ...)

Ice cloud retrievals (Comstock...)



# ARM highlights, 2007

## Mobile Facility deployments

- Germany (concluded)
- China (in customs)
- Azores (2009)

## CLASIC

Got AVP rolling, incl. routine flight part

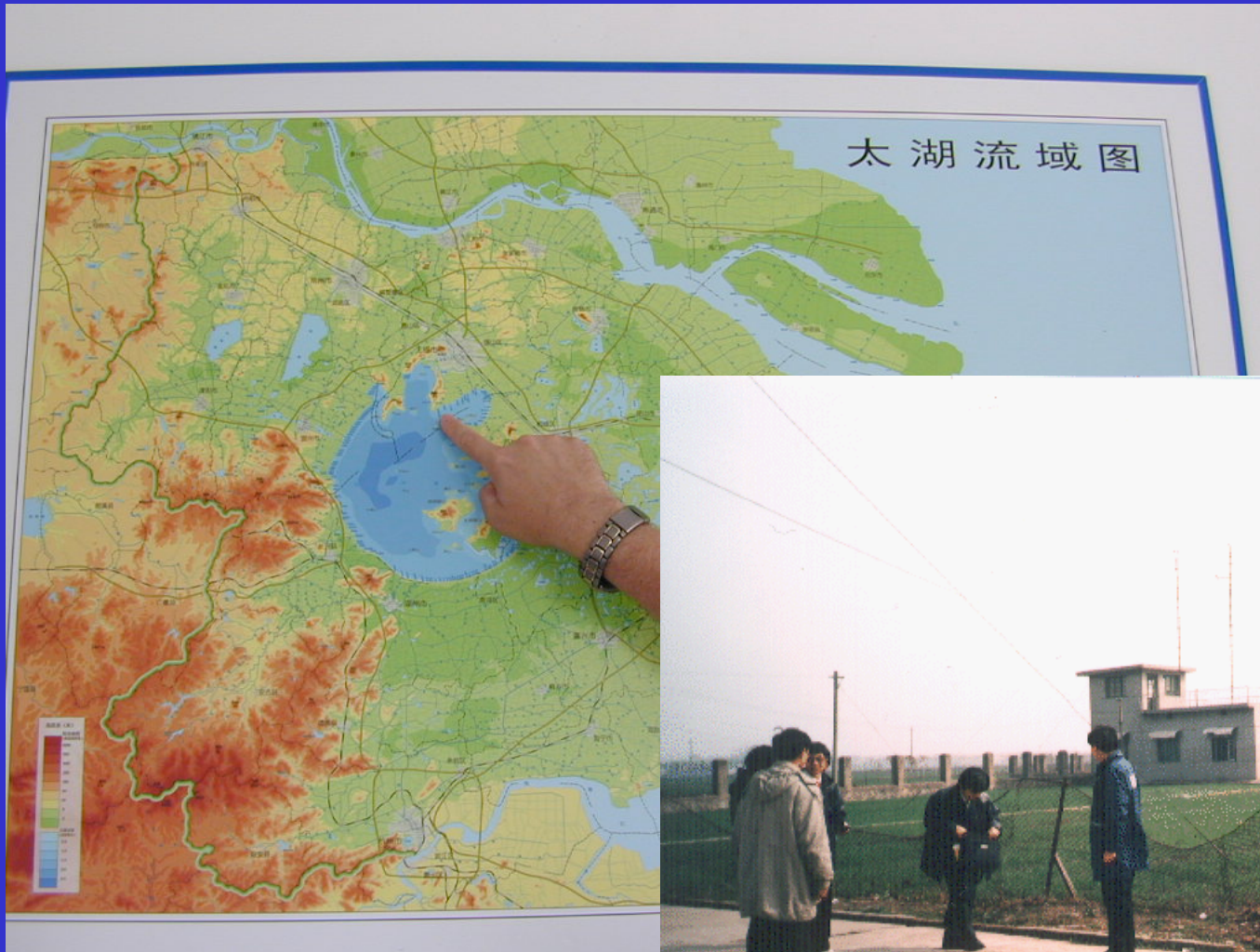
Concluded 7 yr of aerosol Cessna flights



# ARM Mobile Facility 2007 — Black Forest, Germany



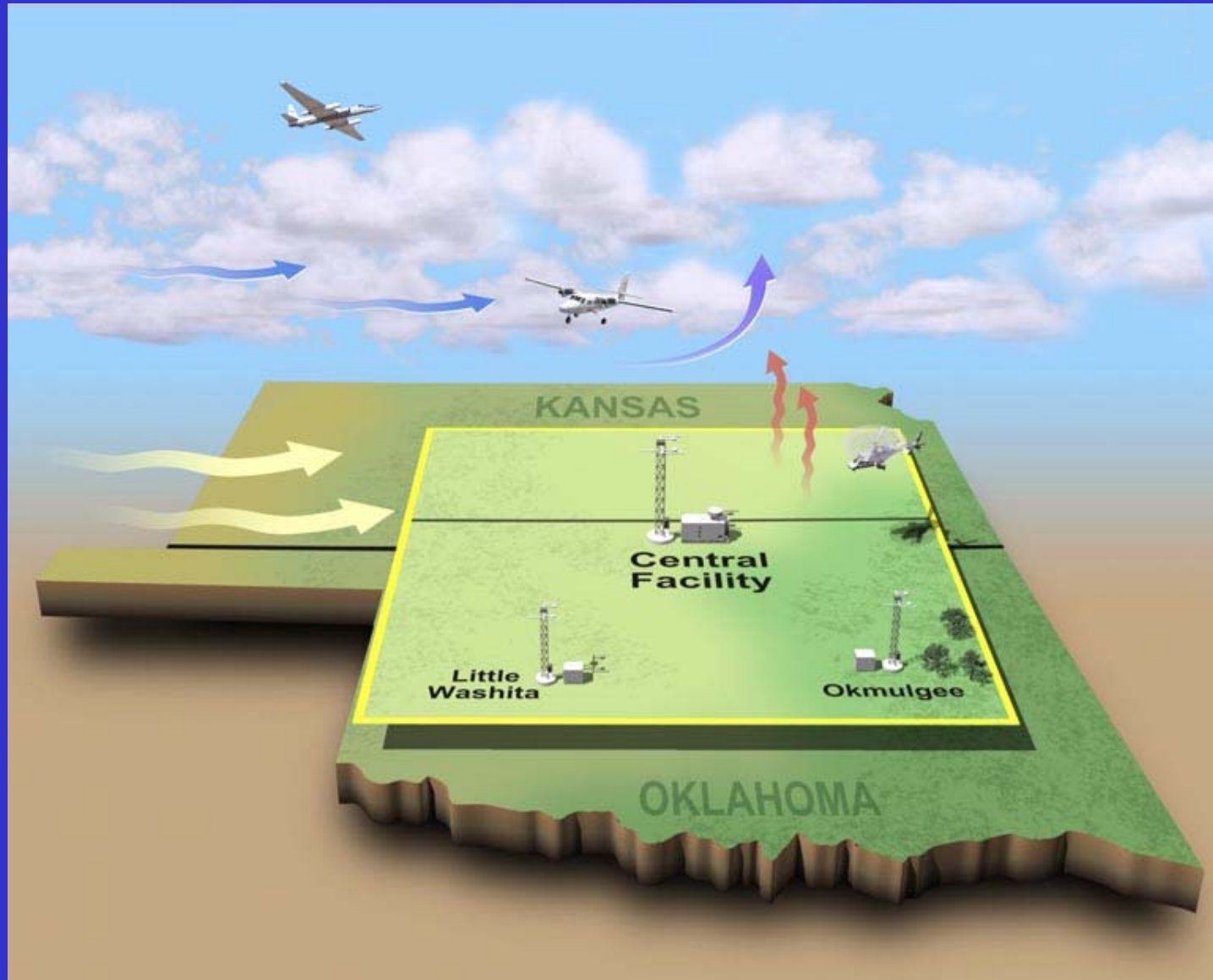
# Mobile Facility to China, 2008



# Mobile Facility to Azores, 2009



# CLASIC IOP, SGP, June 2007



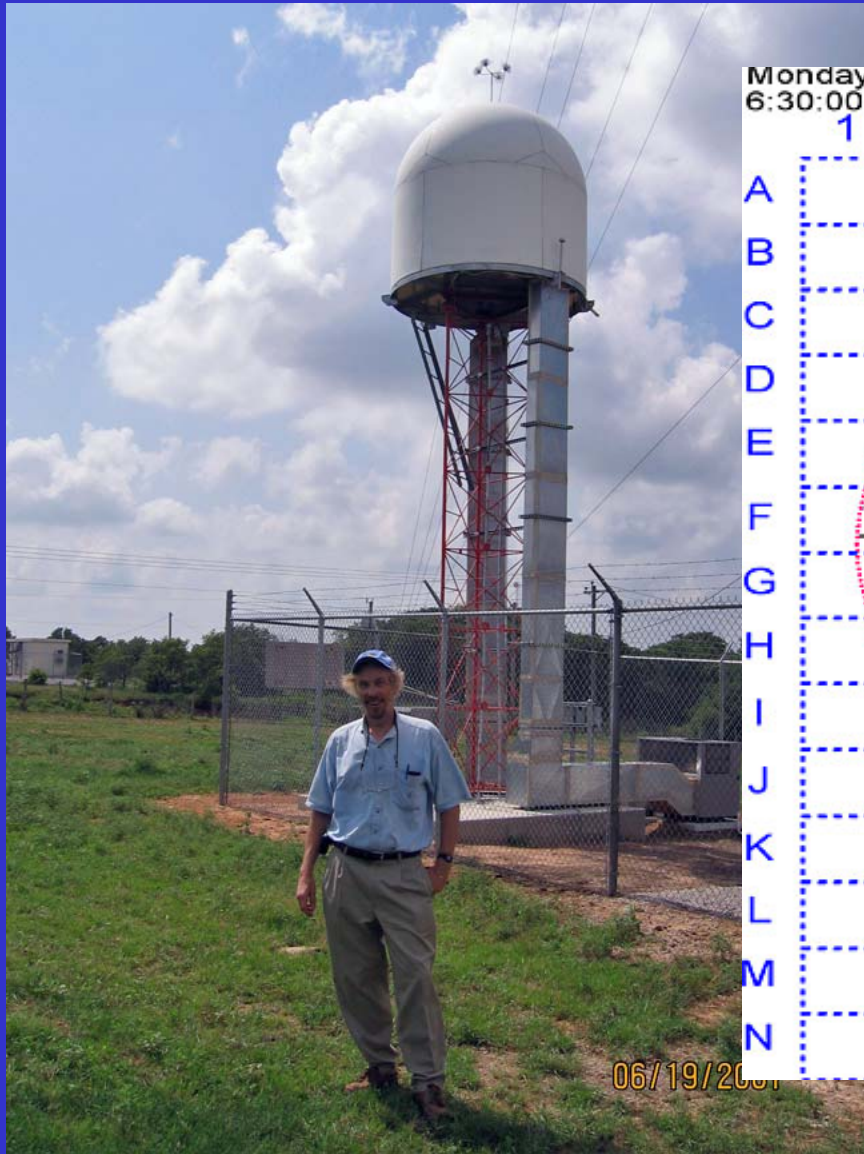




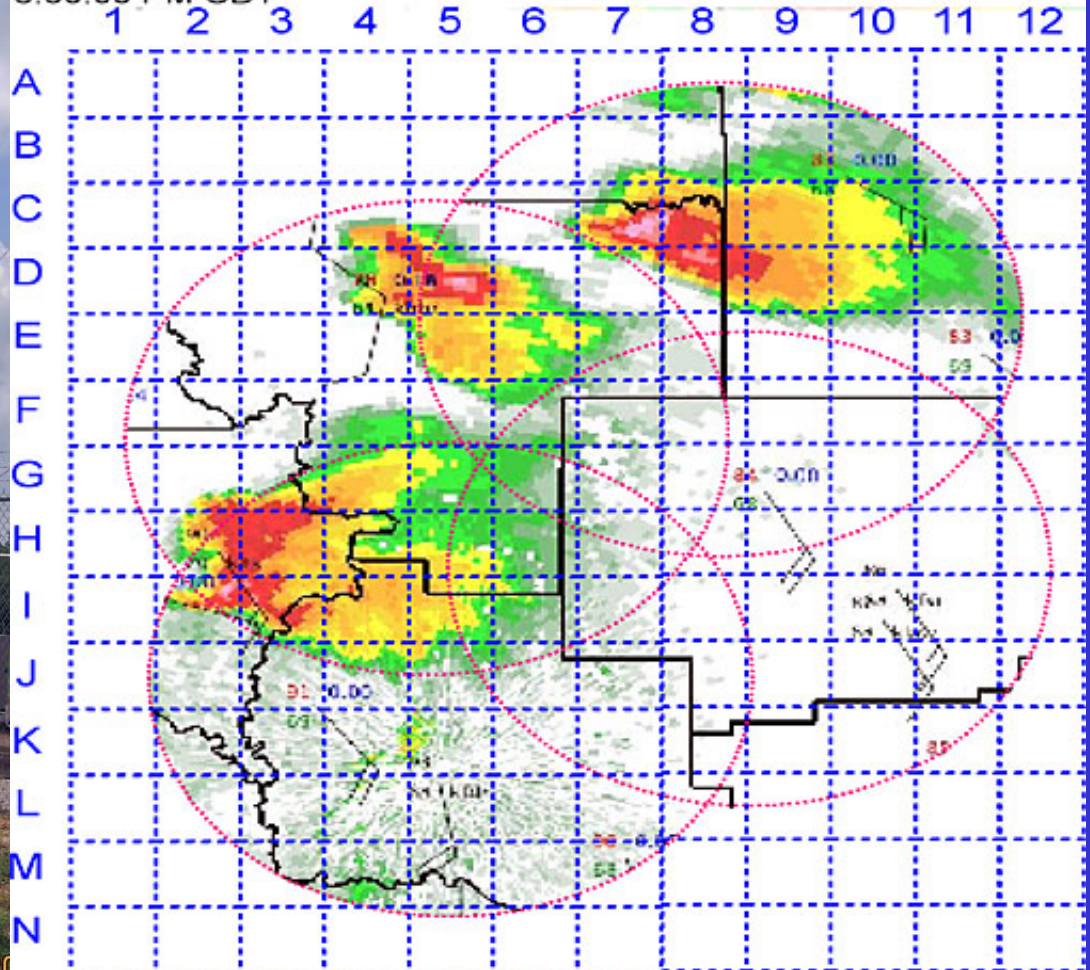
# CLASIC IOP, SGP, June 2007



# CLASIC IOP, SGP, June 2007



Monday, May 24th  
6:30:00 PM CDT



06/19/2007



## ARM highlights - 2

### Outreach to climate modeling groups

visits

simulators

statistical summaries

ARM Fellows (GFDL being selected now)

### ARM parameterizations moving into climate models

CCN

RRTM (radiation)

McICA (radiation)

convective triggering

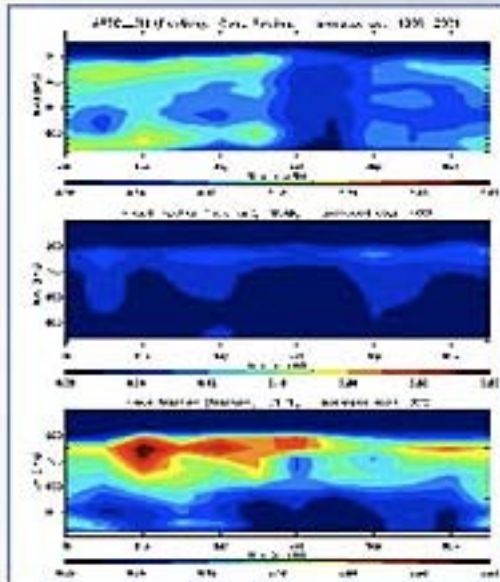


### Statistical Summaries of ARM data for Climate Modelers

The ARM program collects unique data related to radiation, clouds, water vapor, and aerosols of great value to climate modelers. This web page provides a few sample analyses of multi-year data from the Southern Great Plains site with comparisons to climate model simulations for the same location.

#### Seasonal Cycle at the Southern Great Plains

#### Cloud Fraction from the Cloud Radar



ARSCL, CAM and GFDL Cloud Fraction

[Explore the data yourself](#)

Would you like to explore the data yourselves?

[Browse the Dataset](#)

[Quick look plots](#)

[Seasonal and diurnal cycle](#)

The dataset extends the following years: 1999 - 2001.

There is more data available including data for the satellite observations, surface sensible and latent heat fluxes, and surface meteorology.

Would you like to download the data for your own exploration?

The data used in the statistical summaries is from a 3 year analysis (1999-2001) which is

# Statistical Summaries for climate modelers

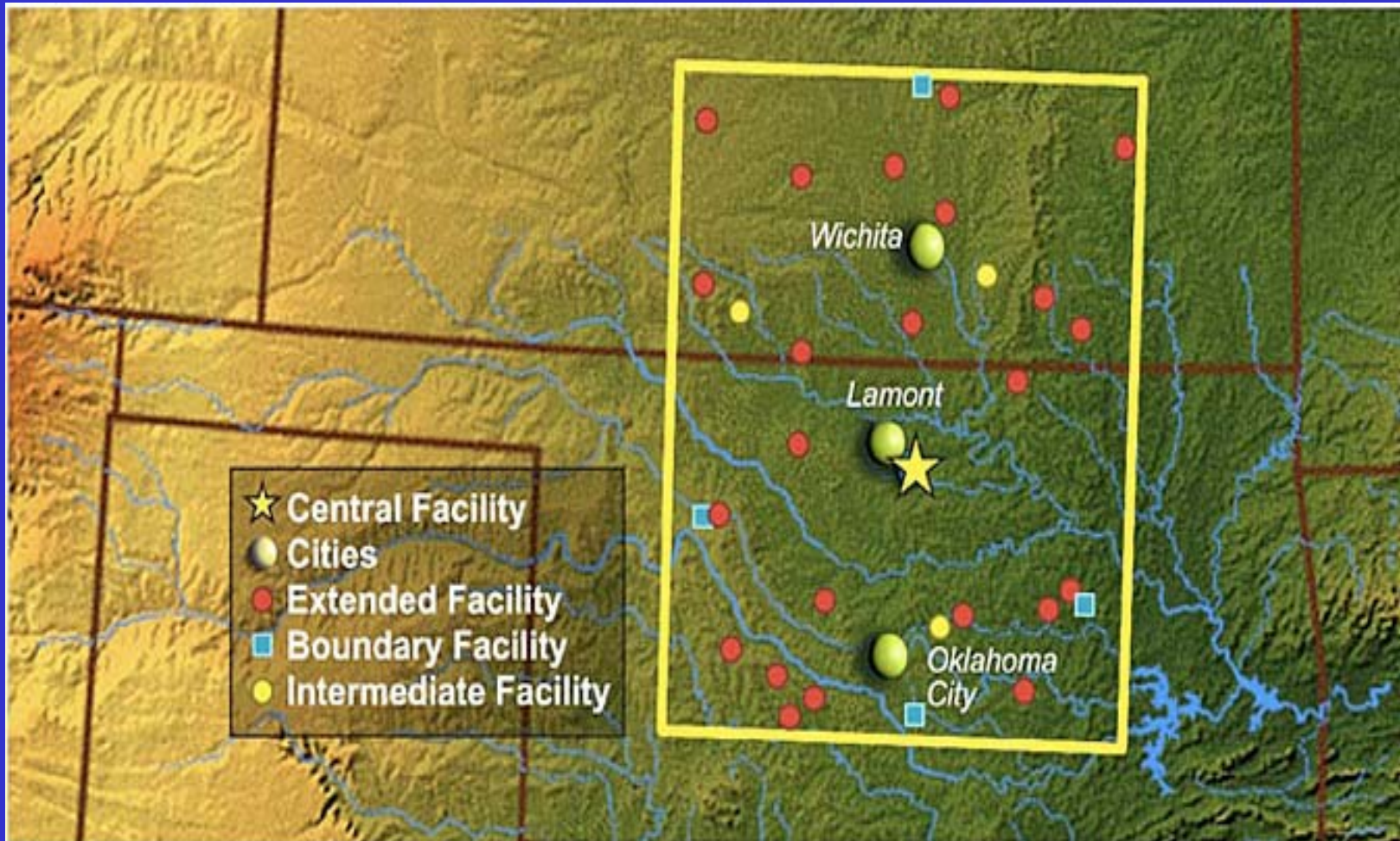


## ARM highlights - 3

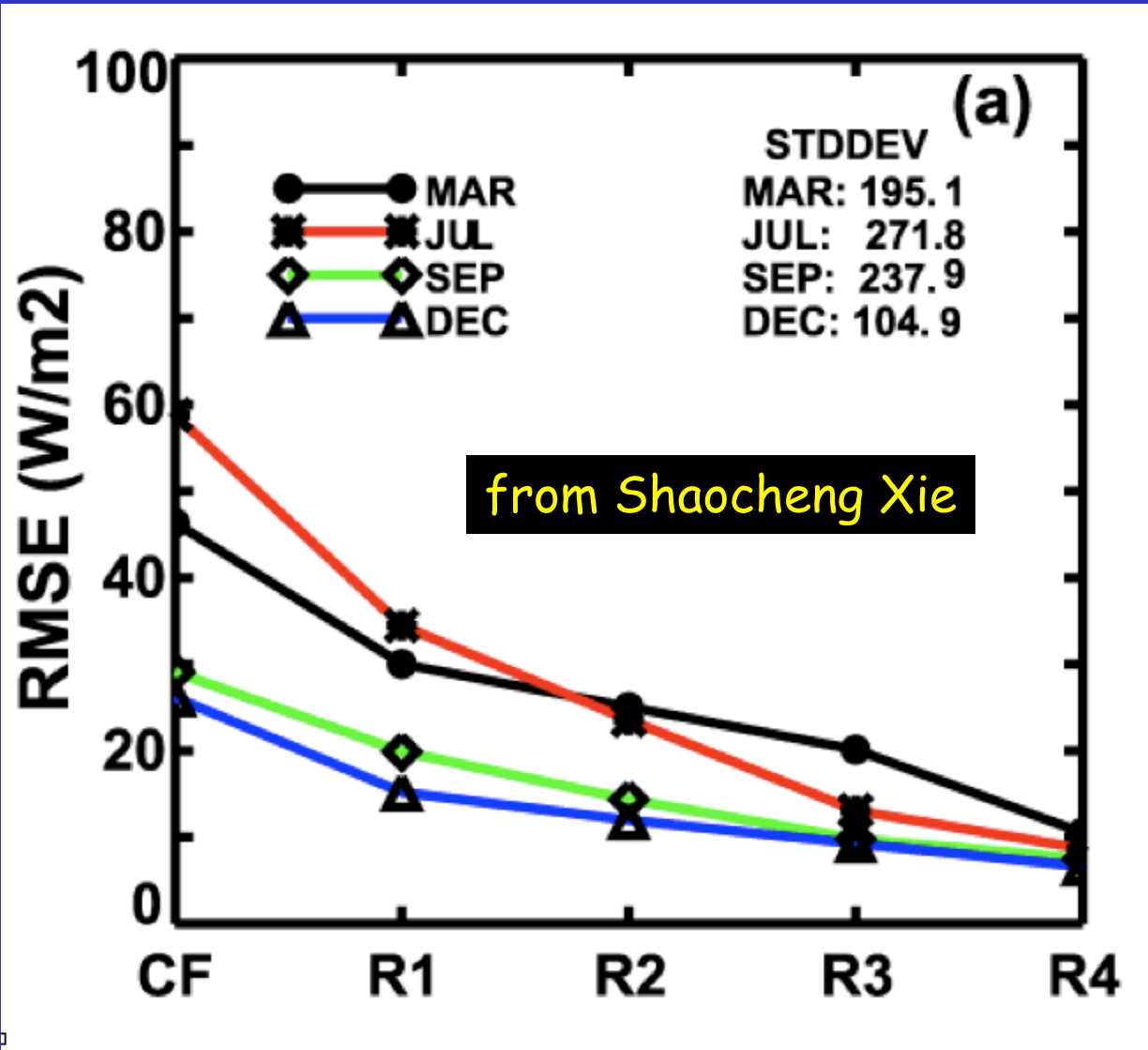
- Sunset Committee
  - Atqasuk
  - Wind profilers and RASS
  - Extended Facilities and surface energy budget
- RHUBC, Barrow (Feb 07)
- cloud tomography



# SGP (23 Extended, 4 Boundary, & 3 Intermediate Facilities)



# SunsetComm studies of Extended Facilities





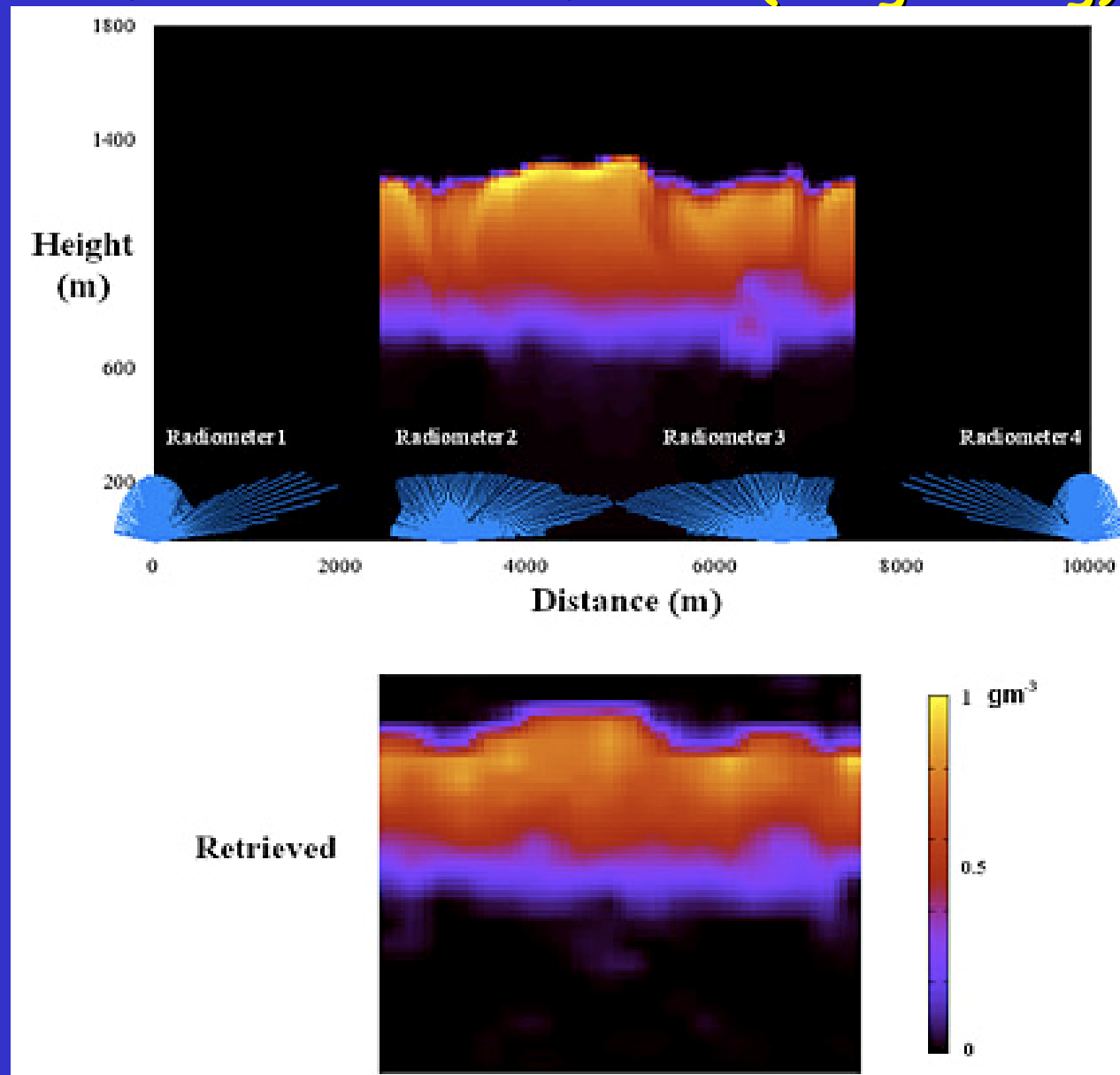
# RHUBC-II: Radiative Heating in Underexplored Bands campaign, Chile, 2009

A 5.5 km altitude site: Chajnantor, Chile





# Cloud liquid water tomography with 4 scanning microwave radiometers (Dong Huang)





# ARM highlights - new data

- Developed special data products for use in process studies and model development and evaluation.
  - ARSCL - Active Remotely-Sensed Cloud Locations
  - Broadband heating rate profiles
  - AERI Profiles of H<sub>2</sub>O and temperature
  - Best-Estimate Radiative Flux
  - MicroBase profiles
  - Continuous profiles (1-min)
  - and many others!



## ARM highlights - Radar

- ARM a strong presence at 1st Radar-Lidar Conference, AMS, 2008
- Radar Focus Group takes off
- Joined CASA
- Joint IOP in 2010 with GPM Ground Validation
- ... and maybe building a two-freq scanning radar through SBIR
- SGP 94-GHz radar being converted to scanning



# ARM highlights - Gordon Conference, 2007

highlighting many ARM scientific findings





# ARM Microwave Futures Meeting: Having 4 different microwave systems is not a good long-term solution



two 90/150 GHz systems



profiler

two profilers

(12 freqs in 22-30  
& 51-59 GHz)



GVR

two 183 GHz systems  
(GVR at Barrow)

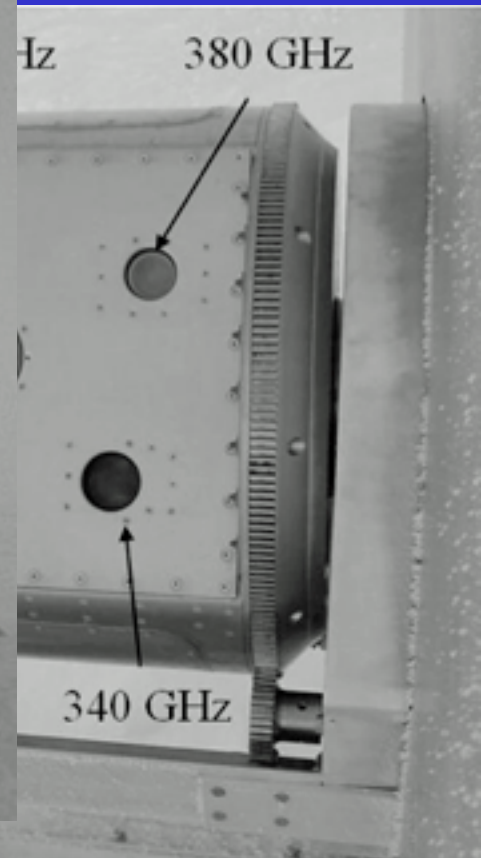


# Microwave Futures Meeting led to a specification which is almost out...

- addition of 90 GHz channel,
  - 183 GHz as a plug-in for NSA
- 2x better accuracy in  $T_b$  (0.1-0.2 K)
- 2x smaller FOV ( $3^\circ$  instead of  $6^\circ$ )
- 1-2 s sampling
- work while raining
- internal calibration
- play better with other ARM instruments
- be easier to repair, get back into service



# In the future, we need to measure more of the microwave spectrum





# ARM highlights - TC-RSR development



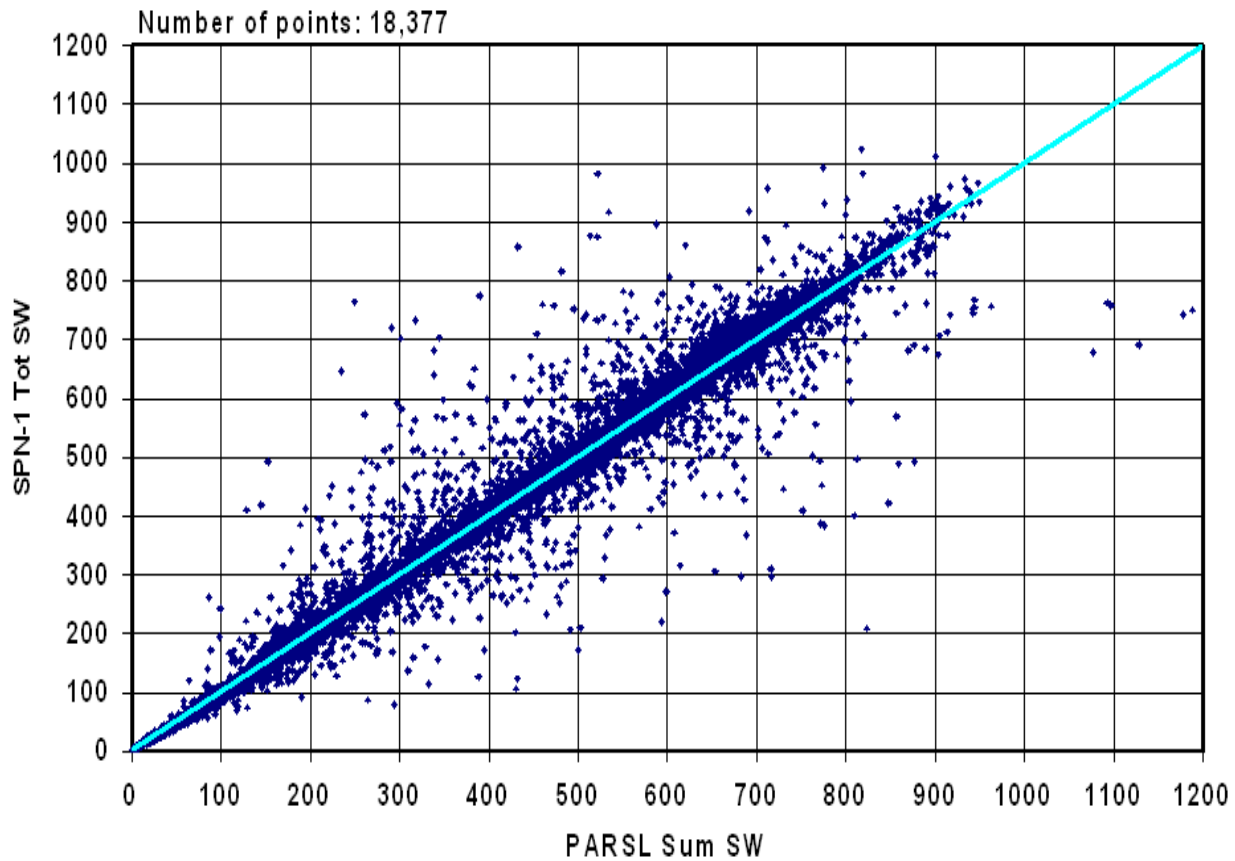




# ARM highlights - SPN1 testing

SPN-1 Test, Total SW, 1-min data

$R^2 = 0.9778$

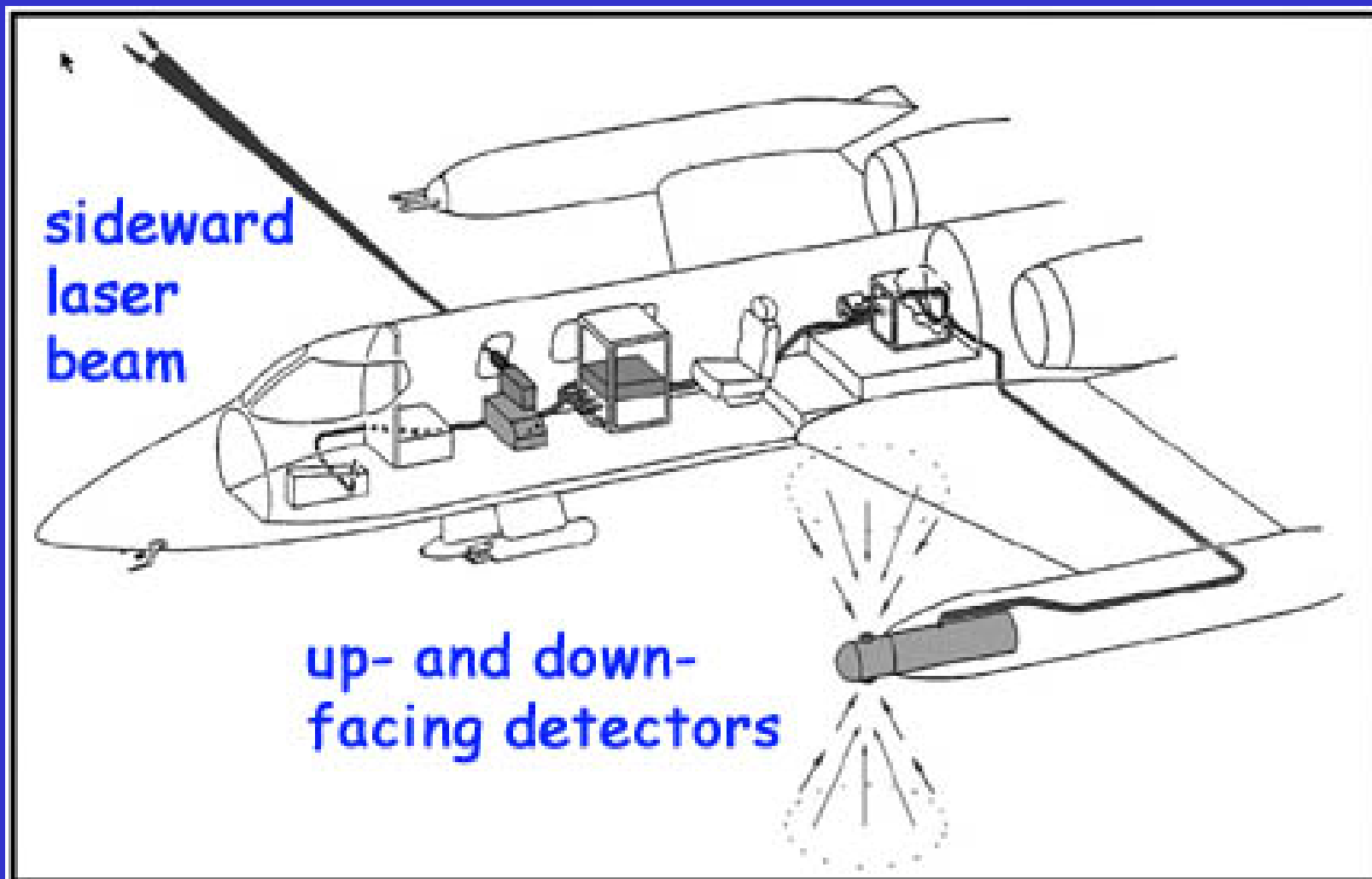




# ARM highlights - SWS producing data

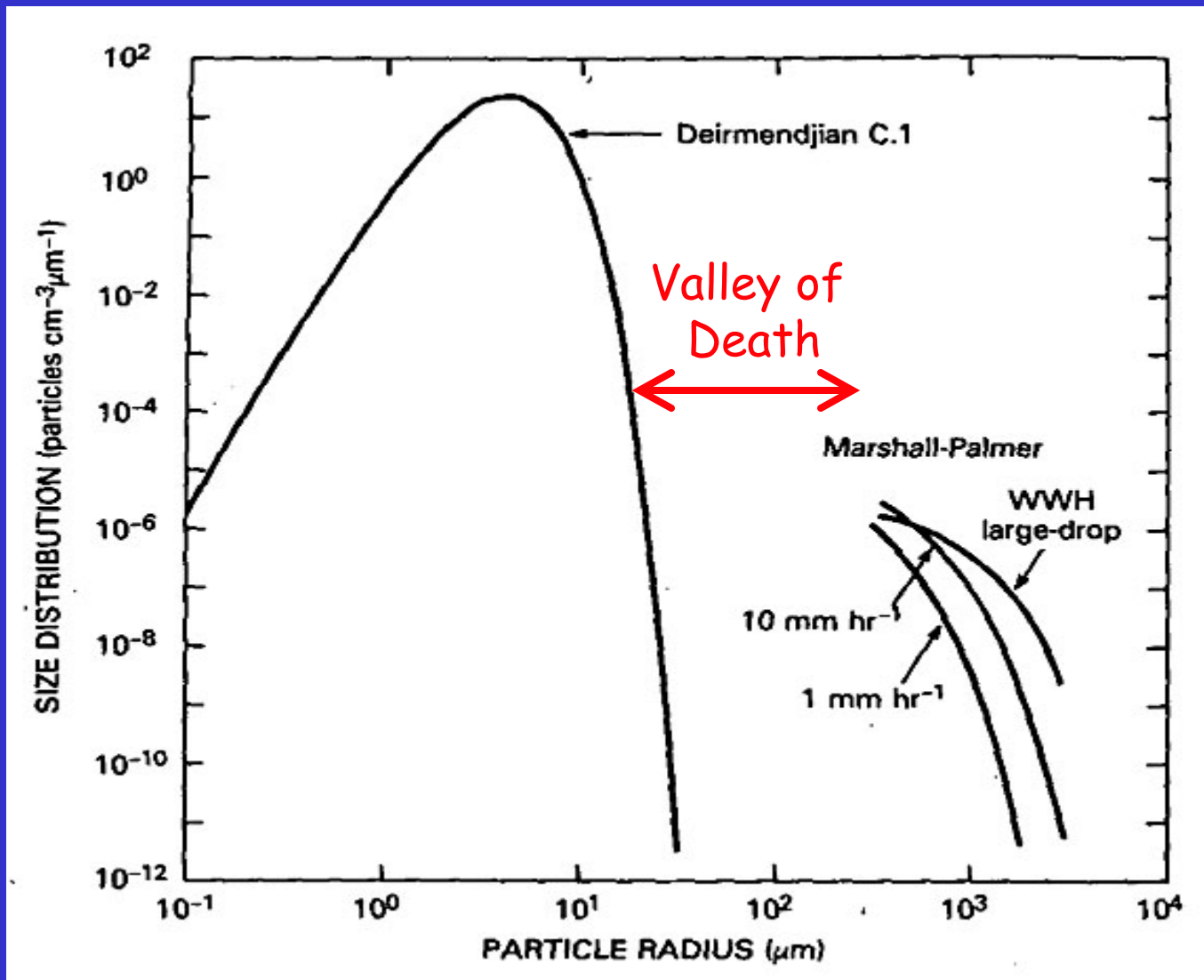


# We are using SBIR to develop multiple-scattering lidar





# Starting to measure ALL the drops up to precip sizes





# Not Yet Done: validating liquid water and cloud optical depth

- Variables central to ARM yet poorly validated
- CLOUD routine flights, 2008
- New instrument concepts:
  - Raman lidar liquid/ice channels
  - multiple scattering lidar (including in situ)
  - cloud tomography
- Stacked small UAVs to measure LWC and extinction profiles



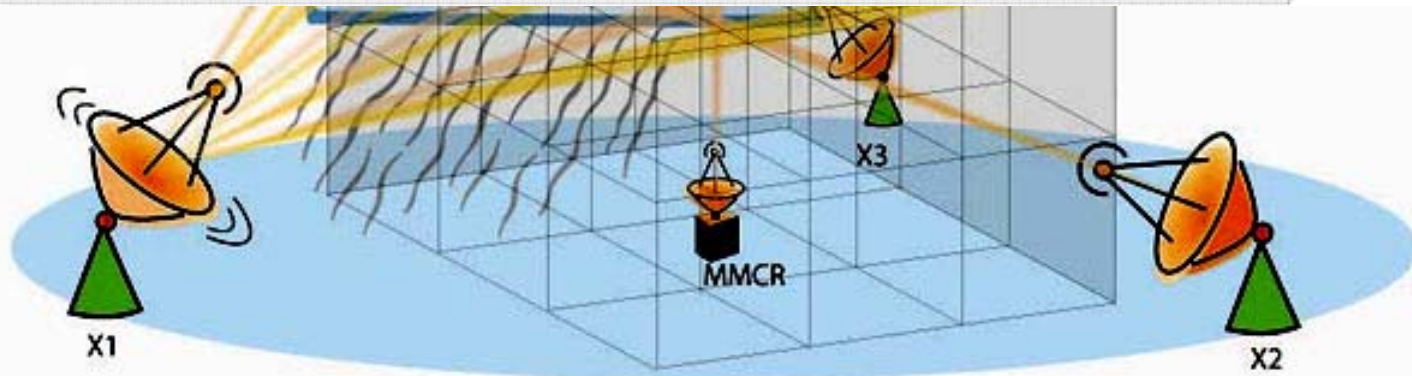
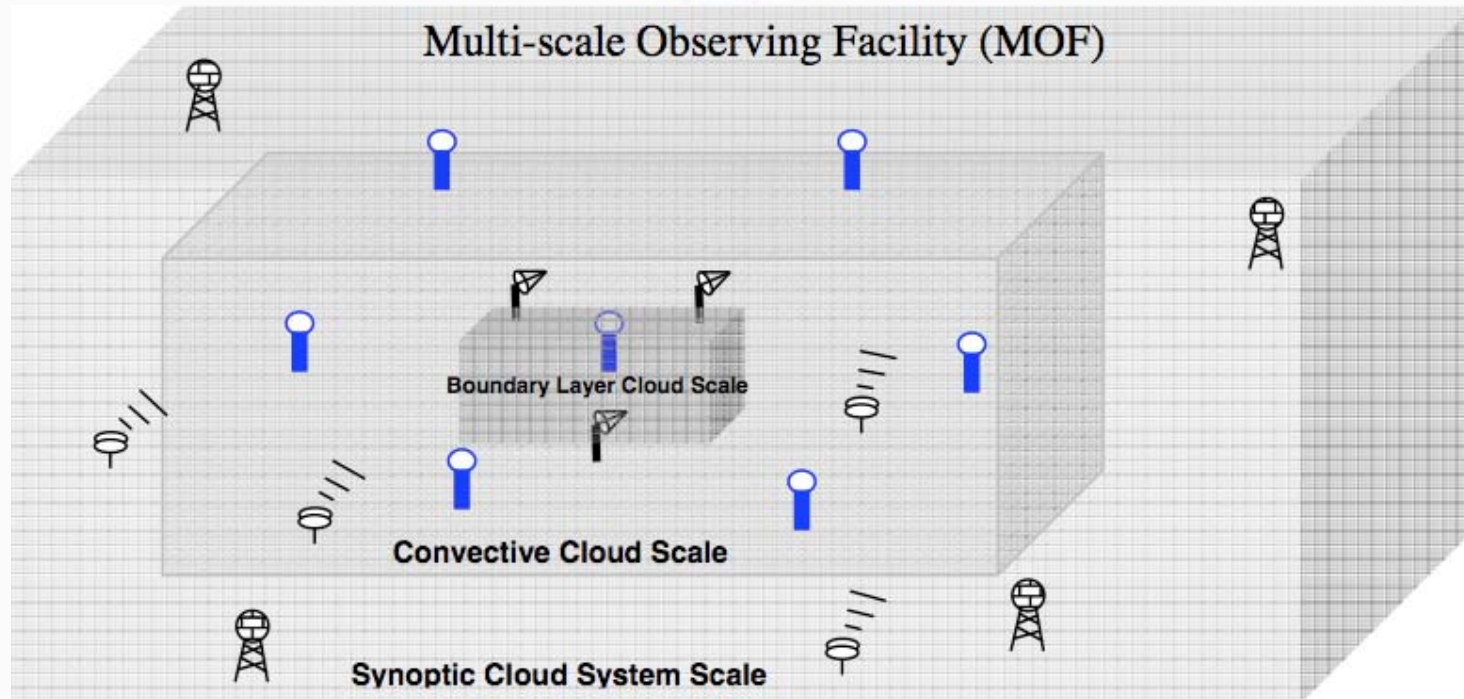
# Baby steps toward making ARM data less soda-straw and more 3D

Cloud models have moved to 3D while our meas'ts are stuck in 1D and 2D

Solutions:

- (1) Scanning
- (2) Multiple scattering lidars
- (3) Routine aircraft flights
  - (small UAV squadrons or conventional)
- (4) Cloud tomography

# We are moving slowly toward scanning radar





# We have permission to fly small UAVs at Oliktok Point







We should be doing this!

# Aerosonde™ UAS

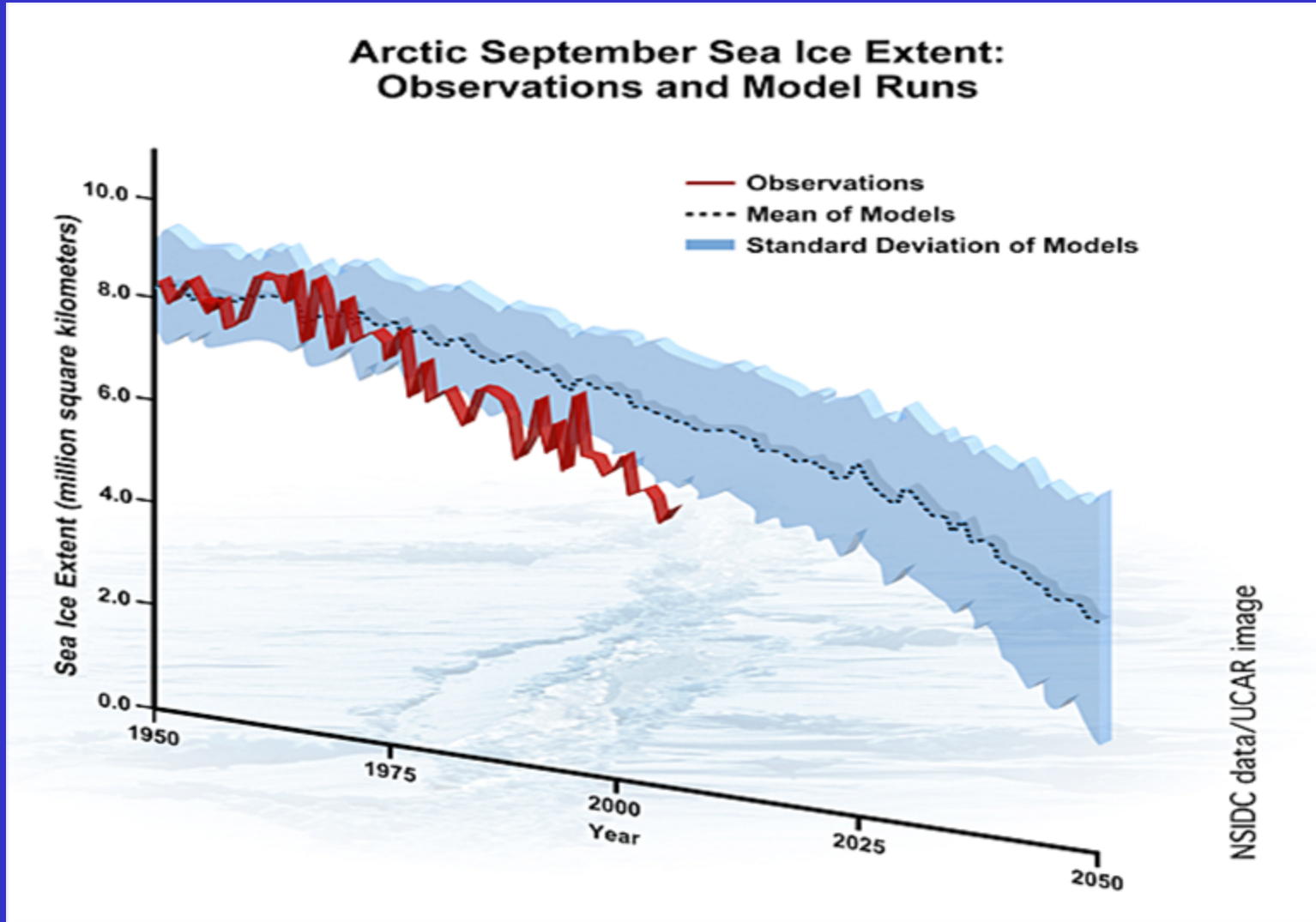




With small UAVs  
we can do things  
that are nearly  
impossible with  
crewed aircraft



# Arctic summer sea ice is collapsing, and ARM can't observe it without UAVs





# Parameterization is an intrinsically slow process

- Cloud Climate Process Team found that parameterizations cannot be rushed, or engineered
- Parameterizations need a relentless advocate to succeed; few are cut out for this task
- Generally takes years for parameterization to become part of IPCC runs:
  - observations --> box or column model --> off-line model
  - GCM
  - battle with other parameterizations (bake-off)

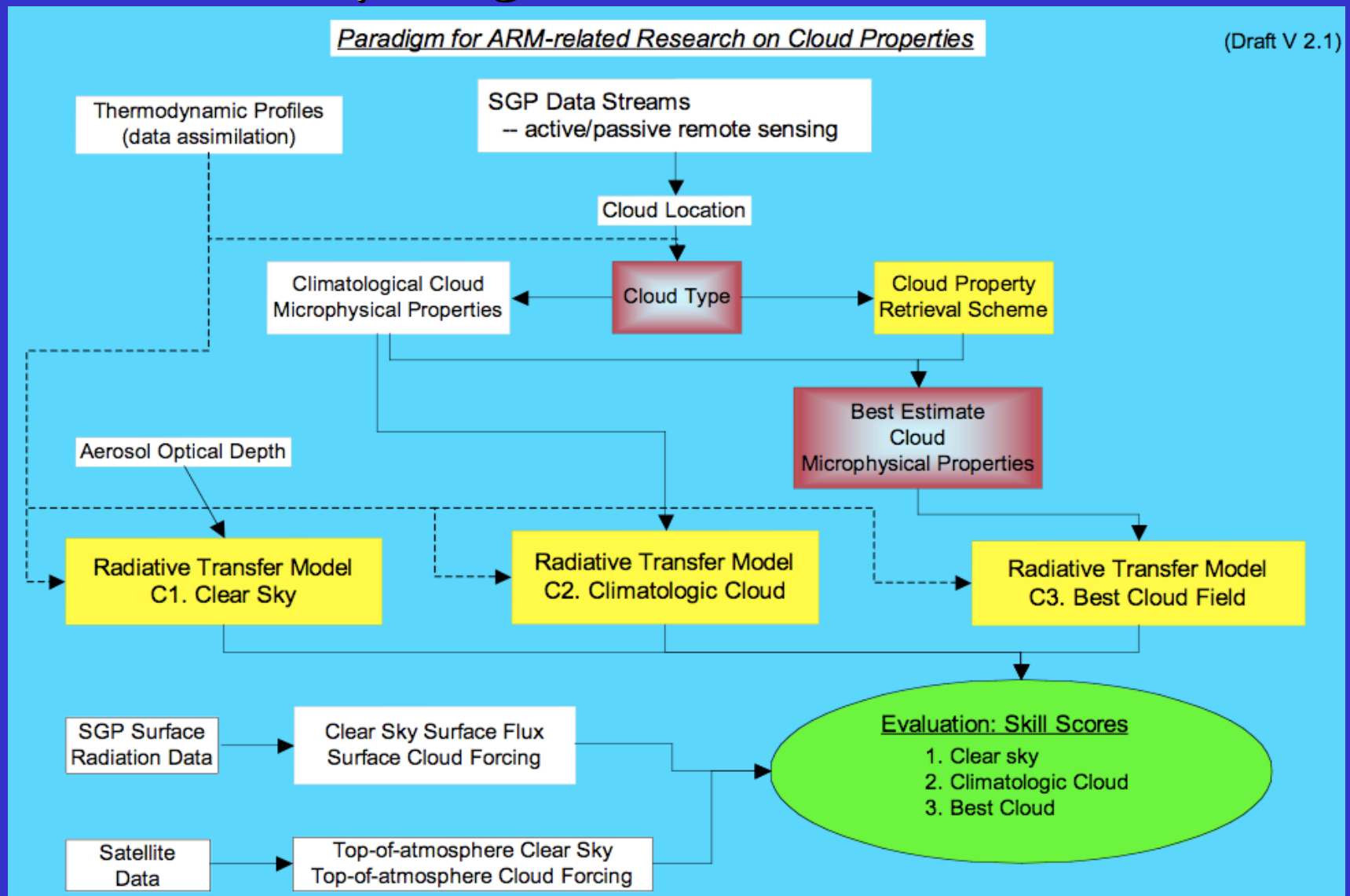


# My own view: we need a rapid turnaround capability for comparing models to ARM data

- CloudNet has led the way in this (cf Hogan talks), with weather models
- CAPT has shown how to do it with climate models
- ARM needs to blend these approaches and create an infrastructure activity for this purpose
- Our present rate of progress in cloud paramz'n capability is too slow (Nature will give the answer before we do) and will not meet DOE metrics

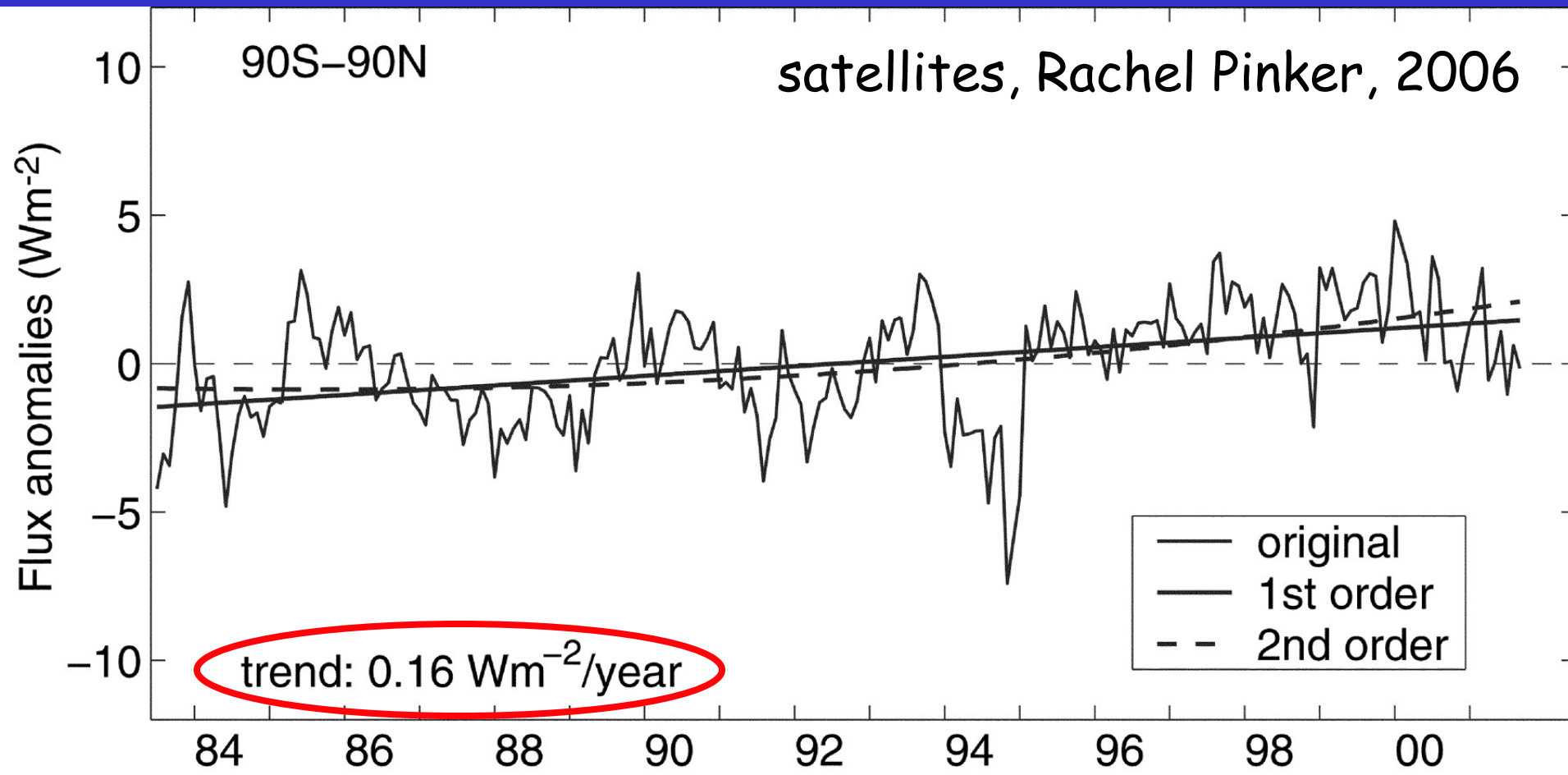


# We could automate this process (of comparing models to ARM data)





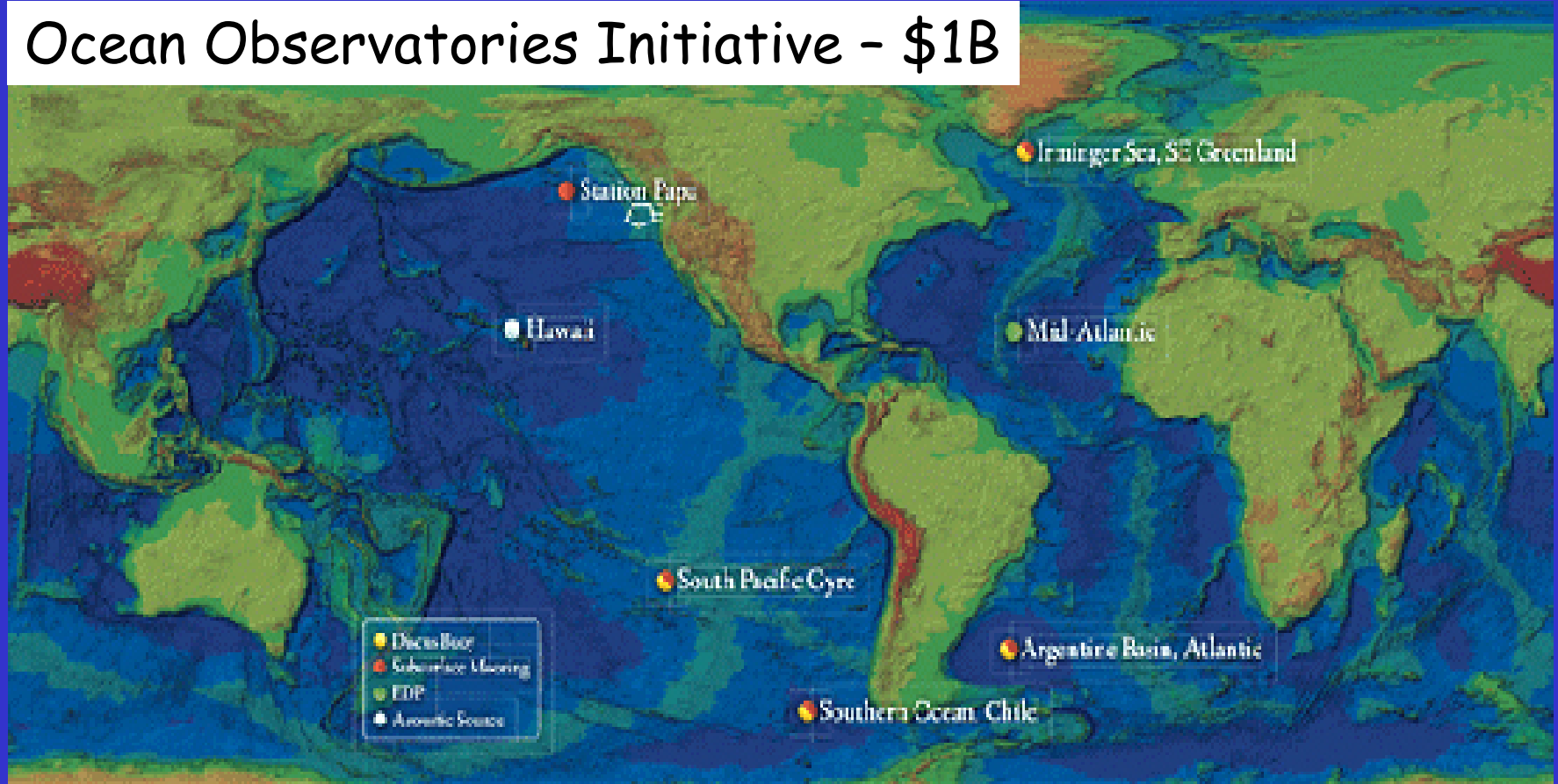
# Global Brightening, and its relation to global warming: a natural for ARM





# On the bright side, the ARM paradigm has been profoundly influential

## Ocean Observatories Initiative - \$1B







# Summary - 2008

- ARM is very active on many fronts: RACORO, ISDAC, RHUBC-II, China, Azores, 2nd AMF
- but...ARM is stretched to its outermost limits after a decade of flat funding & no relief for FY09
  - We work on a very thin margin which endangers our large IOPs and aircraft deployments
- We lag in moving beyond the soda straw
- ARM should be a leader in global dimming & brightening research
- We need faster turnaround on our primary goal of improving cloud and radiation parameterization
  - (CloudNet + CAPT) may be a model to follow



# In a year of not always good news, Chuck Long helped us keep our sense of humor

