

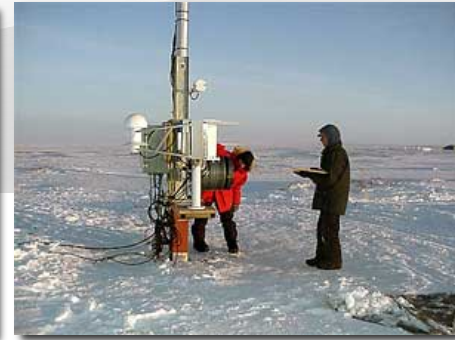
# Aerosol Lifecycle Working Group Efforts and the ARM Reorganization

Jerome Fast and Connor Flynn

## Outline:

- ▶ Review planned changes to ARM measurement strategy (additional details at other sessions, but will be open to all issues – not just the aerosol lifecycle)
- ▶ Upcoming DOE workshop
- ▶ Impact on ALWG research

# ARM Reorganization



## Quotes from the web site:

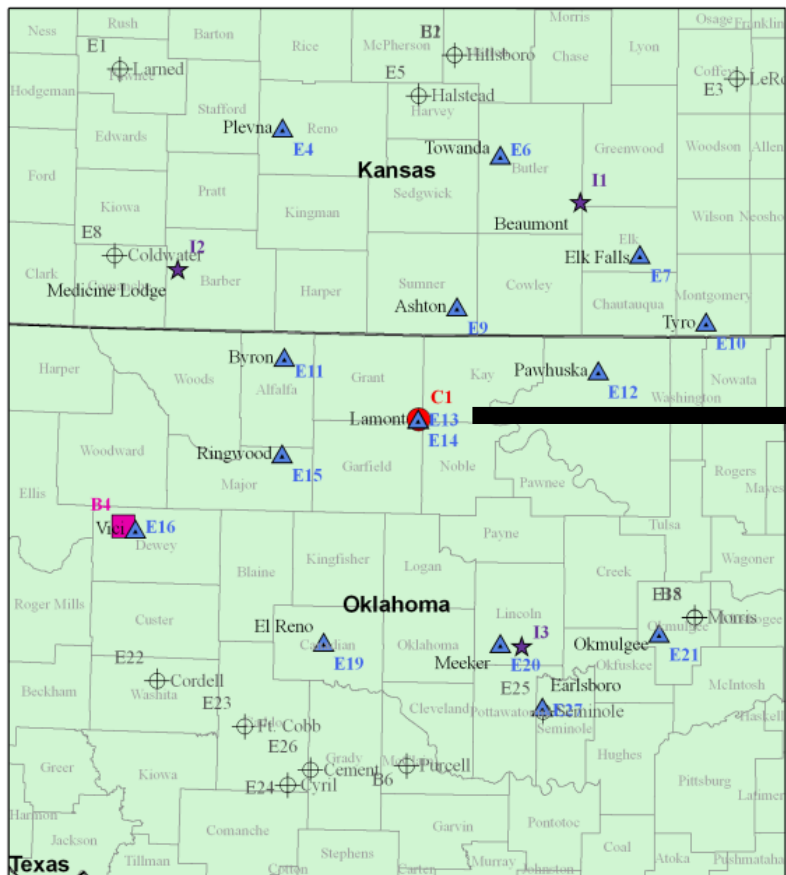
“... ARM Facility is now embarking on a **reconfiguration strategy** for even better observations of atmospheric processes to **constrain high-resolution process models**. Key elements of the new strategy include the creation of **two super sites** in the United States: SGP and NSA.”

“To support the expansion of the continental U.S. site in Oklahoma, **operations at ARM sites in the Tropical Western Pacific (TWP) will end in 2014**. Data obtained from these sites will remain available to the scientific community through the ARM Data Archive to support continuing research in tropical climate. Future observations in the tropics or other climate regimes will continue to be supported through deployments of the ARM Mobile Facilities via the selection of field campaigns proposed by the science community. This reconfiguration does not affect operations of the new ARM site in the Azores or the mobile facilities.”

“**ARM leadership will work with the science community in the coming year to optimize this new measurement strategy**, with the continued goal of improving the understanding of atmospheric processes and the representation of those processes in climate models.”

# Current SGP Instrumentation

alphabet soup of instruments



## Legend

- Boundary Facility
- Central Facility
- ▲ Extended Facility
- ★ Intermediate Facility
- ⊕ Retired

AERI, MWR,  
sonde, thwaps,  
VCEIL

EBBR, ECOR, IRT, MET, MFRS,  
MWR, SEBS, SIRS, SMOS,  
sonde, SWATS

## Aerosols & Gases:

- ▶ AOS
- ▶ Neph, PSAP in AOS
- ▶ PASS in AOS
- ▶ CLAP in AOS
- ▶ ACSM
- ▶ CCN
- ▶ CO
- ▶ CPC, TDMA
- ▶ Flask (isotopes)
- ▶ IAP (aerosol profiles, discontinues)
- ▶ PGS

## Meteorology & Profiles

- ▶ Distrometer, rain, VDIS, ORG
- ▶ Raman lidar
- ▶ Doppler lidar
- ▶ MPL
- ▶ RWP
- ▶ Sonde
- ▶ Surfthref
- ▶ thwaps
- ▶ TWR
- ▶ VCEIL

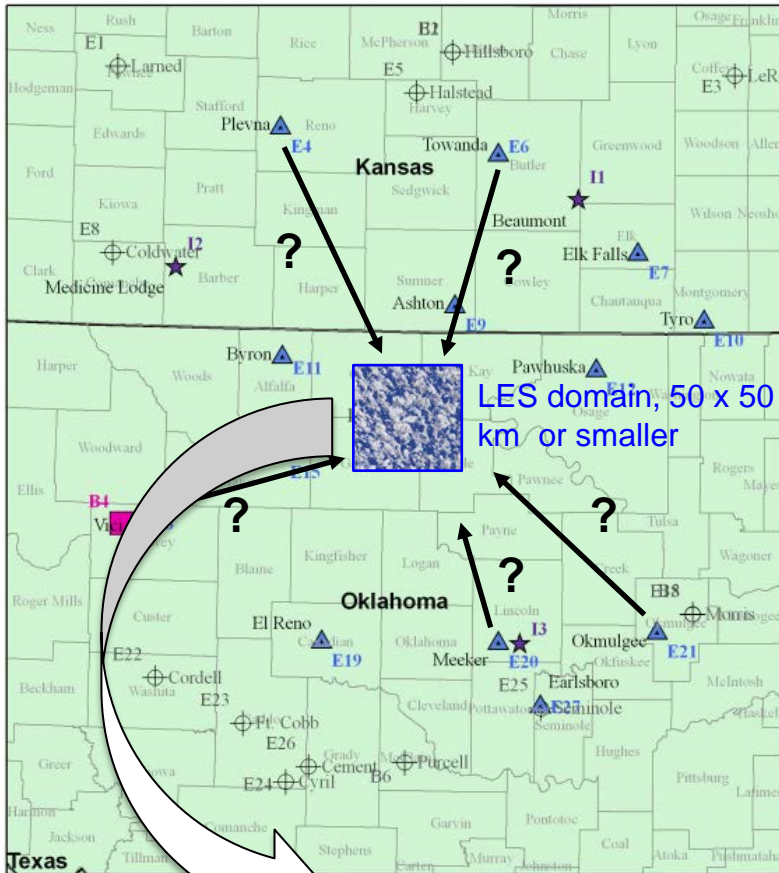
## Radiation:

- ▶ AERI
- ▶ BRS, BRSN
- ▶ CSPHOT
- ▶ IRT
- ▶ MFR, MFRSR, MFRIRT
- ▶ MWR3C, MWRHF
- ▶ NFOV, NIMFR
- ▶ RSS
- ▶ SASHE
- ▶ SASZe
- ▶ SIRS
- ▶ SRS
- ▶ SWS
- ▶ TSI

## Radar:

- ▶ KASACR
- ▶ KAZR
- ▶ MMCR
- ▶ SWACR
- ▶ WACR
- ▶ WSACR

# New Configuration – What We Know



## Measurements:

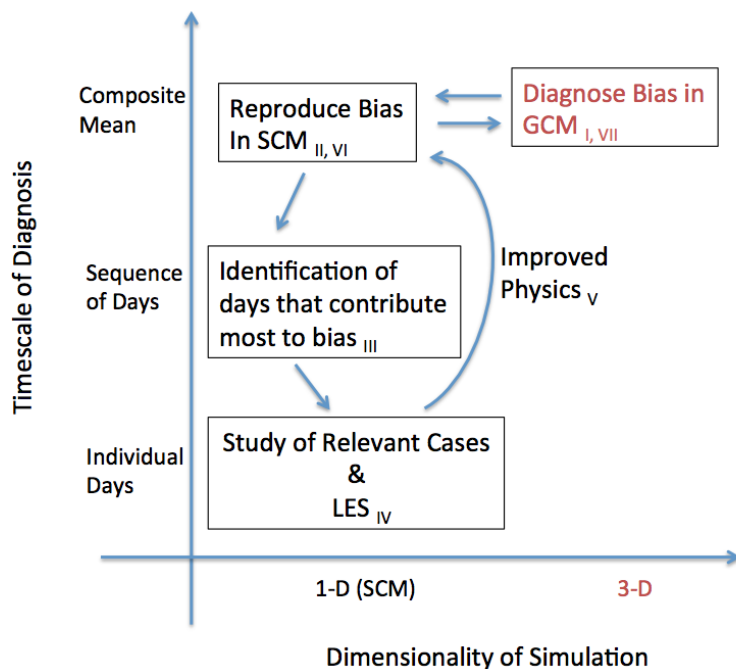
- ▶ Reorganize SGP (and NSA) to support high-resolution modeling
- ▶ Likely means moving some instrumentation closer to central facility, incorporating instrumentation from the TWP sites, and potentially adding other instruments
- ▶ Configuration and new instrument suite TBD

## Modeling:

- ▶ Inclusion of “operational” LES / CRM model (weeks or months, but not all the time)
- ▶ ARM responsible for modeling – a first
- ▶ Constrain model with observations (via data assimilation) to create a 3-D “best estimate” for other models, or ...
- ▶ Other purposes

- ▶ Much of the motivation for the reconfiguring is based on Graham Feingold's talk at the last ASR Fall Working group meeting, "Model Testbeds" evening breakout session
- ▶ Draws on a 2012 BAMS paper "Continuous single-column model evaluation at a permanent meteorological supersite" by Neggers et al.
- ▶ Talk had a focus on clouds and cloud-aerosol interactions

Adapted from Neggers et al., BAMS 2012



- I. Statistically identify a problem in a GCM or RCM (based on longterm GCM statistics)
- II. Assess if problem is reproduced by SCM; Does it match GCM stats (monthly/yearly means)?
- III. If so, identify days contributing most to error (Selected individual days are guaranteed to matter)
- IV. Study those days in great detail
- V. Identify/understand cause, and find solution
- VI. Re-simulate/evaluate modified SCM
- VII. Rerun GCM/RCM including improved physics

## Problems appropriate to address:

- ▶ Time and length scales of a phenomenon need to be much smaller than the circulation in which it is embedded
- ▶ Phenomenon is sufficiently locally forced that it can be studied in the absence of larger-scale forcing

also applies to many aerosol processes

# Upcoming DOE Workshop

Workshop to be held in May to discuss the **path forward** of the reorganization of ARM long-term measurements. Input from the scientific community is sought on:

- ▶ Identifying the **scientific problems** that would benefit from daily (or regular) Large Eddy Simulation (LES), single column modeling (SCM), and perhaps cloud resolving modeling (CRM)
- ▶ Exploring ways to **maximize the benefits of regular** LES / SCM / CRM, confronted with observations
- ▶ **Measurement and modeling strategies** and needs to advance specific science problems
- ▶ Developing a better understanding of the **computational challenges** and potential solutions to those challenges

Workshop is by Invitation only, so if you have ideas and/or concerns discuss them with those who will be attending the workshop



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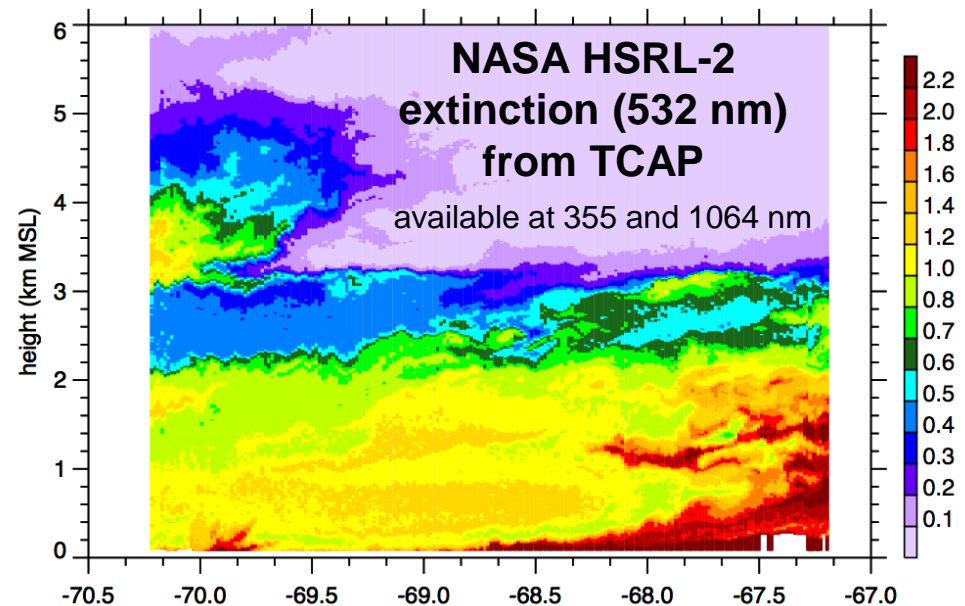
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# Impact on ALWG Research

# Long-Term Measurements (1)

- ▶ Since there is not much aerosol research conducted using TWP measurements, shut town of that site **will not have significant impact on ASR ALWG science**
- ▶ Some scientists have utilized long-term measurements from SGP and NSA sites, but **most research centered on ARM field campaigns**
- ▶ Would a SGP and NSA supersite create **new research possibilities**, or will the new measurements be more useful for clouds and cloud-aerosol interactions?
- ▶ What **new aerosol long-term measurements** does the ALWG want?
  - Plan path to obtaining  $3\beta-2\alpha$  lidar capability at both supersites for vertically resolved aerosol type, intensive aerosol properties, size distribution, SSA, etc. Moving Darwin Raman lidar to NSA will yield  $3\beta-2\alpha$  with HSRL. Still need long wavelength. How to approach at SGP?



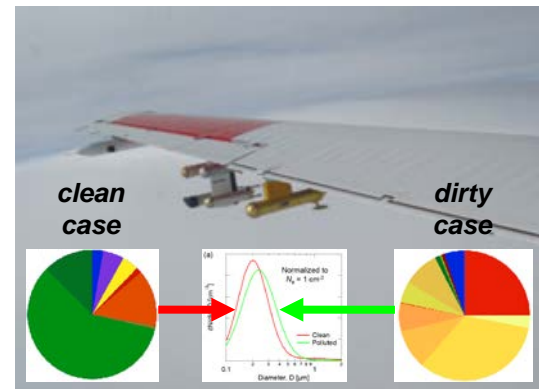
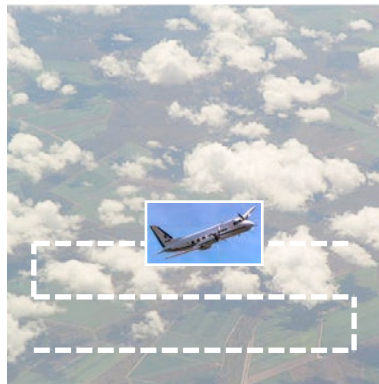
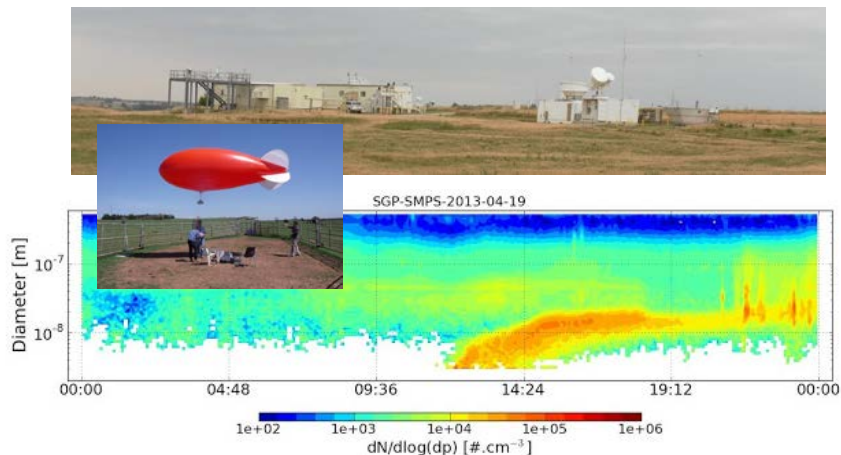


# Long-Term Measurements (2)

- ▶ Use SGP site to **inter-compare instruments** over the long-term (some activities already going on)
  - Demonstrate closure (with a small “c”) between surface aerosol optical properties with size distribution and size-resolved properties. Plan already exists but should reinforce need to routinely measure aerosol size distribution over entire ambient scale. 50-5000 nm critical for optical closure with in situ measurements.

# Field Campaign Measurements

- ▶ Some **aerosol campaigns conducted** in the vicinity of SGP and NSA sites: e.g. NPF study (ALWG), CHAPS (CAPI), ISDAC (CAPI)



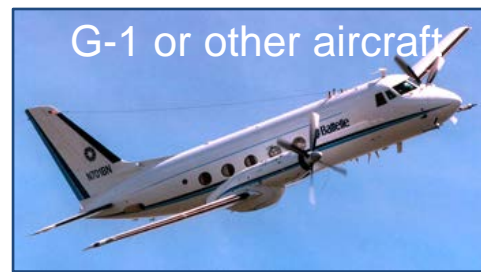
- ▶ Additional long-term measurements may **enhance future field campaigns**



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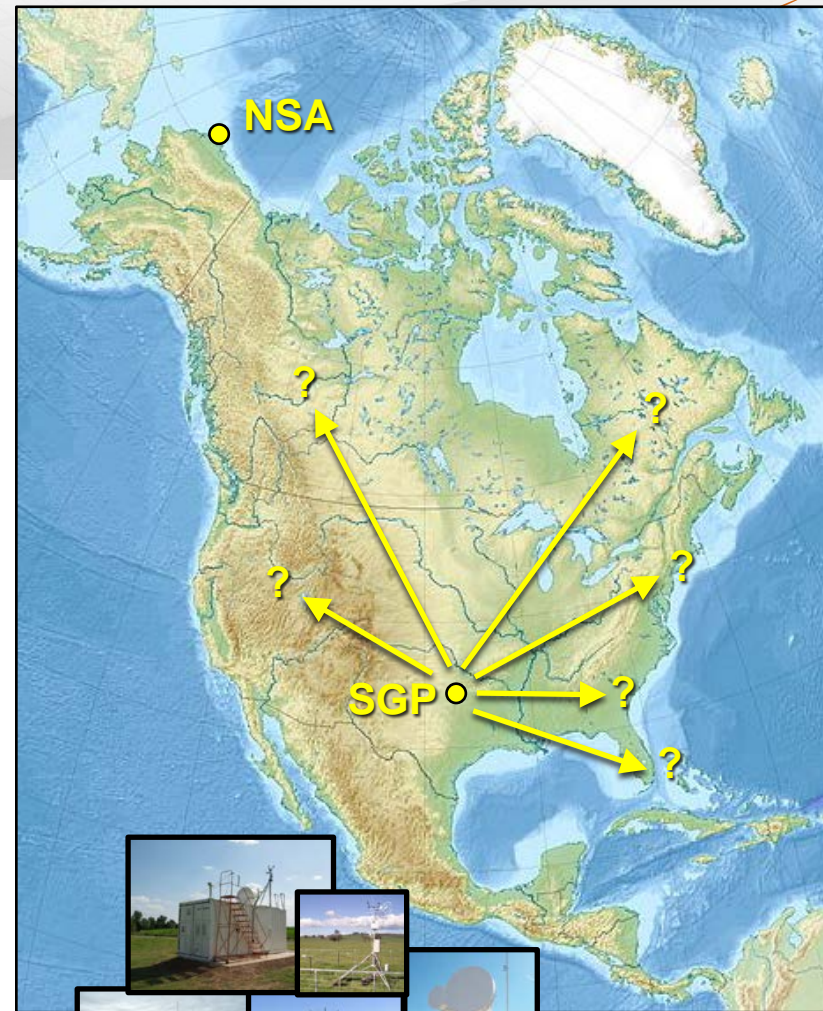


+ guest instruments and platforms

+ sound measurement strategy and post-campaign analysis and modeling strategy = AWESOME SCIENCE?

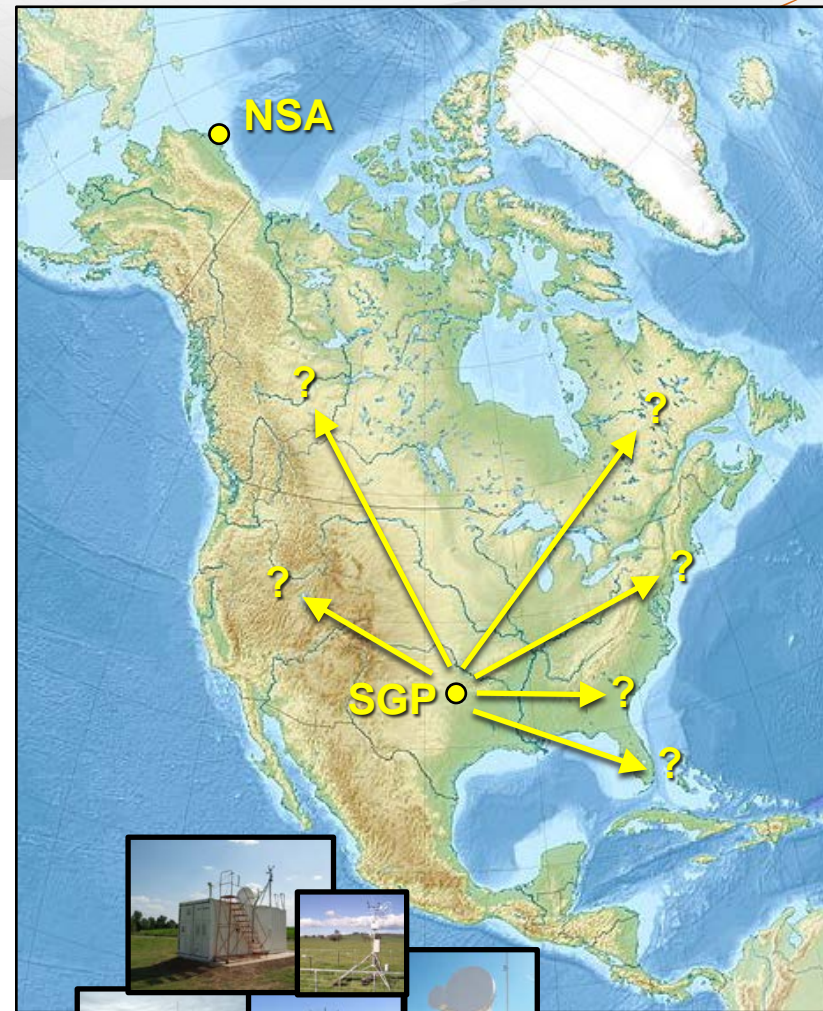
# “Mobile” Supersite Concept (1)

- ▶ ARM now assumes that science will be better served by having the permanent sites become more “AMF-like”
- ▶ Is mobility even desirable? **Continuity of the “very” long-term deployment will be lost.** Might be preferable – and more logistically feasible – to augment the AMF suites and deploy them in concert rather than move SGP super site
- ▶ If desirable, **where** would ALWG wish to have a supersite?
  - Is there sufficient funding for mobility?
  - Is moving the site more feasible in the U.S.?
- ▶ The SGP site may not be ideal for aerosol research, but if SGP becomes “mobile” the ALWG could take advantage of that instrumentation in **other locales**



## “Mobile” Supersite Concept (2)

- ▶ Such a deployment will be based on a **proposal-like process**, but probably at a much higher level, TBD
- ▶ This will mean ALWG needs to take a larger, more **collaborative role** with multi-institution buy-in and big science questions to justify expense
- ▶ Would be useful if science aligns with **clouds and cloud-aerosol interactions**
- ▶ Will CL and CAPI working groups consider ALWG (i.e. the “dirt people” needs)?
- ▶ What happens if some other group(s) not affiliated with ASR proposes to use supersite?

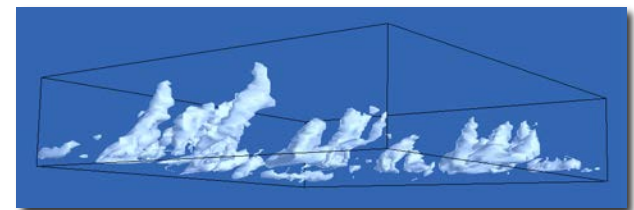
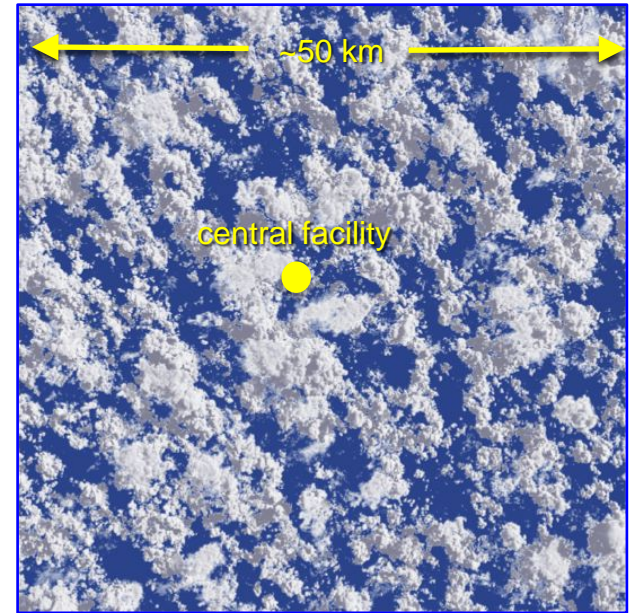


# Other Important Considerations

- ▶ Need to consider how ARM reconfiguration can address science questions for a range of ALWG Focus Groups at least **in the near-term** (< 3 years)
  - **New Particle Formation:** Already an IOP on NPF conducted at SGP
  - **Mixing State:** Will aerosols be too aged at SGP?
  - **SOA (proposed):** SOA from anthropogenic sources at SGP likely to be low?
  - **Absorption (proposed):** BC and other absorbing aerosols at SGP too low?
  - others
- ▶ What will the science questions be **3 – 5 years from now**? Need to look into the long-term, since that is the time frame the supersites may be available for other locales. Will ASR's mission be the same as it is now?
- ▶ What questions could a NSA supersite address for the ALWG?

# High-Resolution Modeling

- ▶ Should the proposed “operational” high-resolution model also include the aerosol lifecycle?
  - More tractable to reach “closure” comparing 3-D model predictions and measurements than IOPs with a range of source, complexities in meteorology, etc.
- ▶ If so, what level of detail?
  - Perhaps for shorter periods of time needed
- ▶ If ALWG does not want to get involved, the CAPI working group will likely propose some level of aerosol detail independent of ALWG findings and/or interests
  - Prescribed aerosol, or
  - Aerosol number and size from ARM measurements, but no chemistry
- ▶ Choice of model will matter
  - SAM is often used for cloud-resolving modeling, but does not have chemistry
  - WRF has chemistry, some feel there are issues of running model in LES mode



How variable are aerosols over this region?

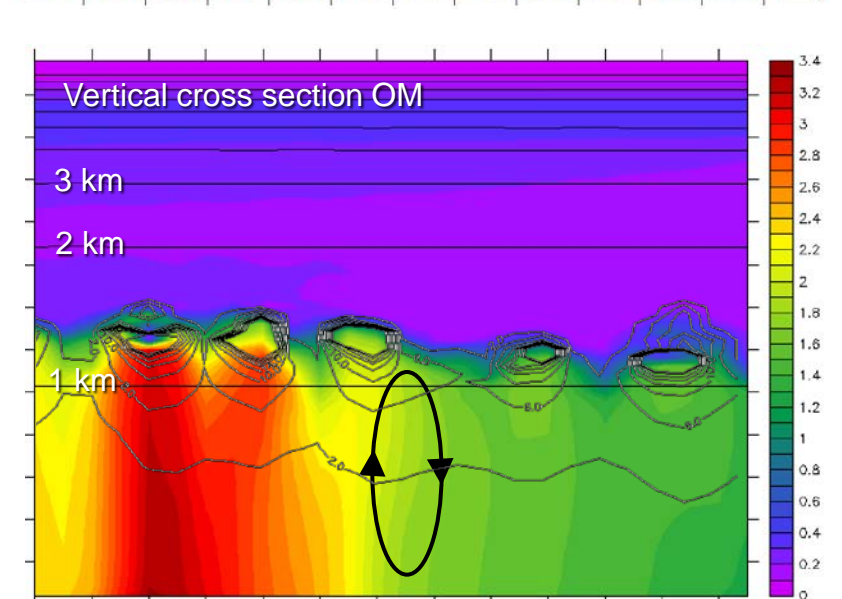
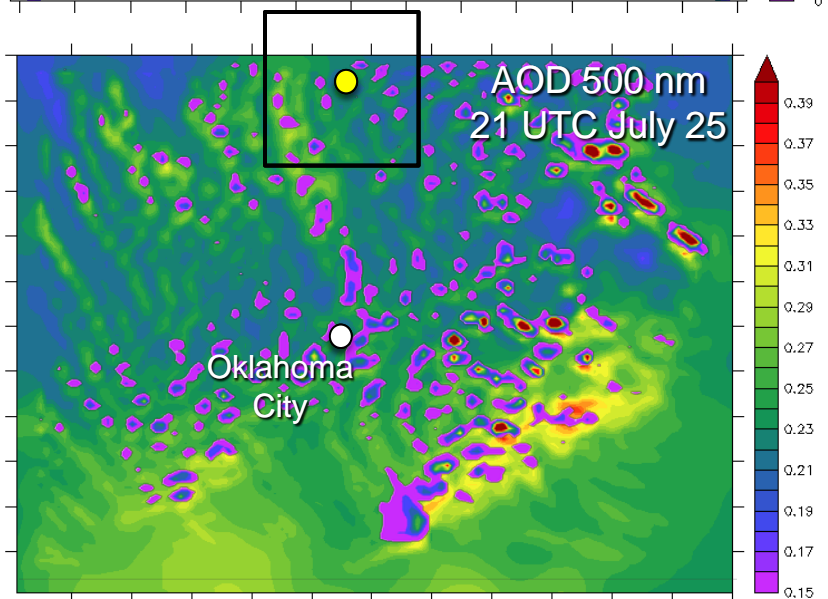
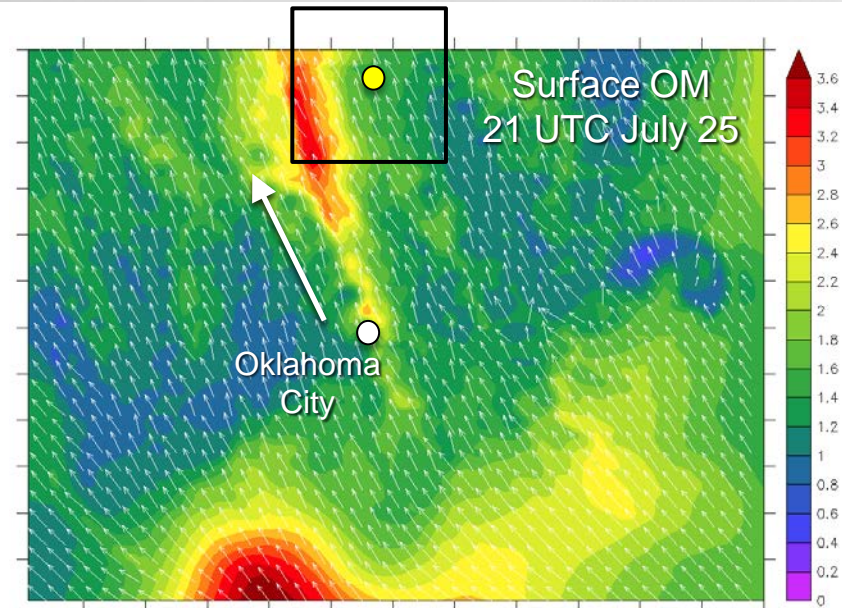
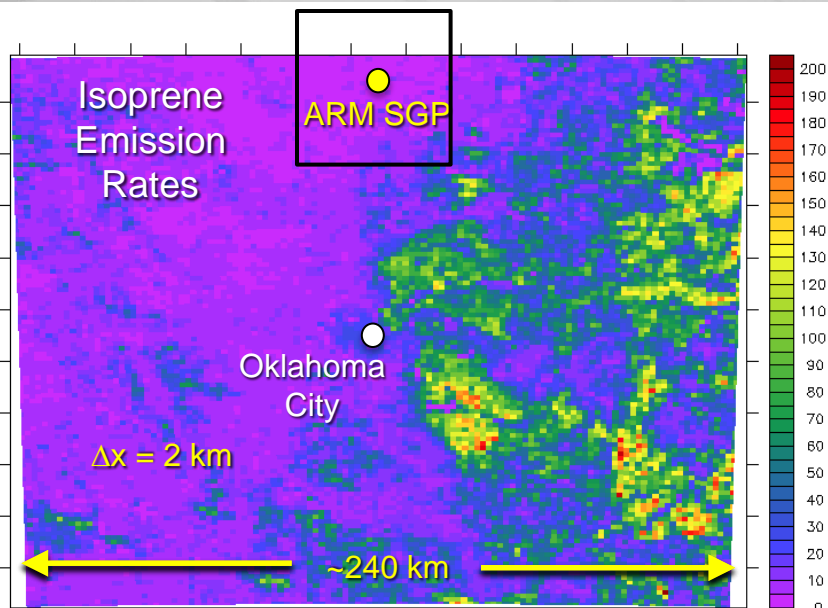
# Example of Aerosol Simulation over SGP

from Shrivastava et al., JGR, 2013



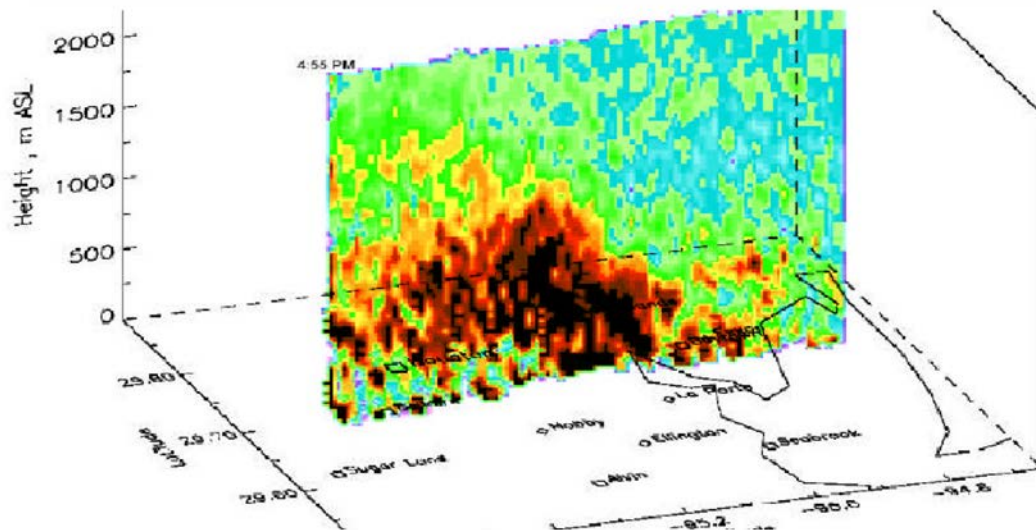
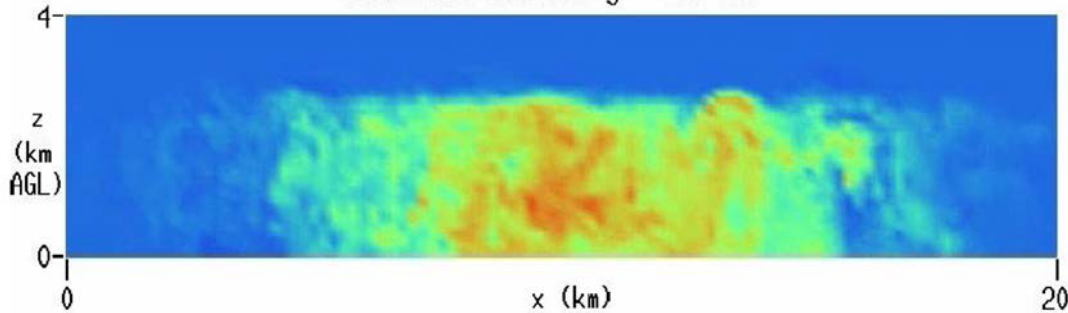
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## Ozone LES Simulation Compared to Lidar Measurements

(Vertical Slice at  $y = 4.8$  km)



From Jerald Herwehe

## LES $\alpha$ -pinene Simulation

