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Remote Sensing in the DOE Atmospheric Radiation Measurement (ARM) Program

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Remote Sensing in the DOE Atmospheric Radiation Measurement (ARM) Program

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PNNL is operated by Battelle for the U.S. Department of Energy



DOE Atmospheric Radiation Measurement (ARM) Program

ARM is a multi-lab user facility providing instrumentation and field-campaign data for weather and climate research across the globe.

- 3 permanent and 3 requestable mobile sites with campaigns spanning the globe
- Campaigns span topics from tropical to arctic, severe weather to clear air
- User facility means shared resource for the science community
- One of the largest sources of atmospheric remote sensing data

Remote Sensing Data Observations of the Atmosphere

- The ARM program deploys multiple types of remote sensing instrumentation including:

Radars

Lidars

Radiometers

Optical

- These instruments, along with in-situ instruments, characterize the atmospheric state
- Includes distributions of clouds, temperature, moisture, and atmospheric aerosols, and winds
- Multiple methodologies including scanning, vertical profiling, and video observations
- Aerial observing facility and unmanned aerial systems capabilities



The DOE ARM Radar Program

- Radars form the backbone of precipitation and cloud remote sensing
- Large range with the ability to see through even the most intense of clouds
- Currently 27 radars, with frequencies ranging from 5 to 95 GHz
- Vertically pointing and scanning gives high spatial and temporal evolution of cloud systems ranging from shallow cumulus to intense thunderstorms.
- Able to distinguish numbers, shapes, and types of particles in the atmosphere as well as cloud evolution
- Interested in new processing techniques and technologies

Atmospheric State from ARM Lidars

- ARM operates a wide variety of lidars for clouds to characterize aerosols, thermodynamics, and winds.
- Multiple Types: Doppler, Raman, MPL, HSRL
- Retrievals of atmospheric state including
 - Cloud base height, extinction coefficients, thermodynamics and humidity
- Cloud phase from depolarization ratios
- Aerosol and thin cloud optical depth
- Interest in multi-wavelength retrievals

Characterizing the Energy Budget with Radiometers

- ARM has a fleet of radiometers to characterize the surface energy budget providing input and evaluation for cloud and climate models
 - i.e. how does aerosol composition affect energy budget?
- These radiometers operate at multiple frequencies using a wide variety of methodologies
- The combination of radiometers allows us to characterize
 - Cloud and aerosol radiative effects
 - Broadband visible and infrared radiation
 - Upwell and downwelling radiation as well as surface albedo
- Spectral radiometers – multiple discrete wavelengths
 - Cloud and aerosol bulk properties, optical depth, and effective radius.

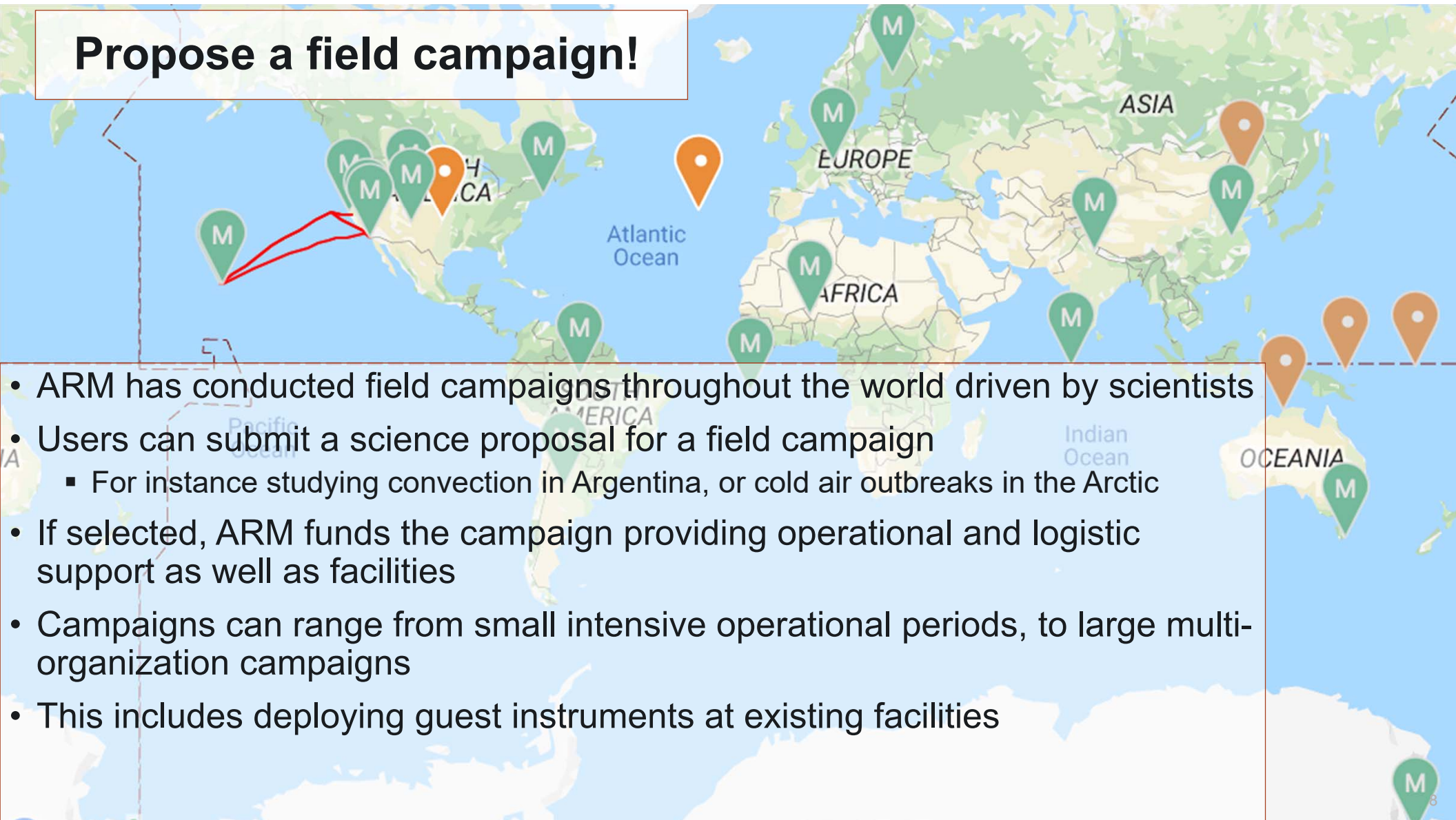
One of the Largest Atmospheric Data Repositories

- > 2PB of data from all around the globe
- Data is immediately and freely accessible through an interactive archive
 - <https://www.arm.gov/data>
- Also includes science products from community researchers
- ARM has personnel to help with the use of ARM data
- ARM also operates 2 HPC clusters to support research in modeling and observations using ARM data
 - (<https://www.arm.gov/capabilities/computing-resources>)



Propose a field campaign!

- ARM has conducted field campaigns throughout the world driven by scientists
- Users can submit a science proposal for a field campaign
 - For instance studying convection in Argentina, or cold air outbreaks in the Arctic
- If selected, ARM funds the campaign providing operational and logistic support as well as facilities
- Campaigns can range from small intensive operational periods, to large multi-organization campaigns
- This includes deploying guest instruments at existing facilities



Collaborations and Opportunities

- ARM is always actively looking for collaborations on instrumentation, science, and new technologies
- Propose a field campaign
- Topical summer schools for aerosols and remote sensing for early career researchers and students
- Mentors for student interns/senior projects/grad projects
- Host guest instrumentation at facilities
- Small Campaigns (IOPS)
- New data processing techniques/ algorithms and science products
 - Most science products originate from outside sources
- We have many operational, technological, and science challenges we would love to collaborate on

Questions and more information?

- Contact: joseph.hardin@pnnl.gov
- Website: <https://www.arm.gov>
- Data: <https://www.arm.gov/data>

ARM

