



## Climate and Environmental Sciences Division

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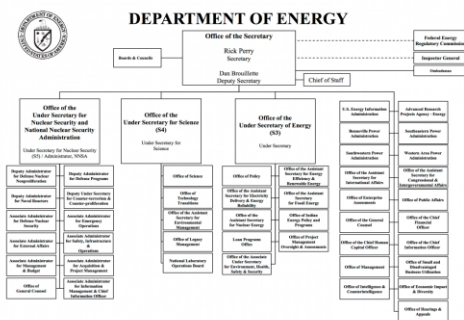
April 26, 2018



## Outline of presentation

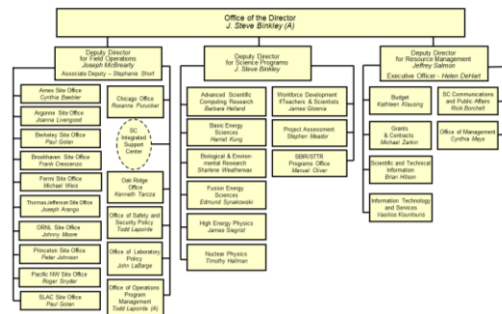
- Organization
- Strategic planning
- Priorities framing future investments
- Some challenges for the community

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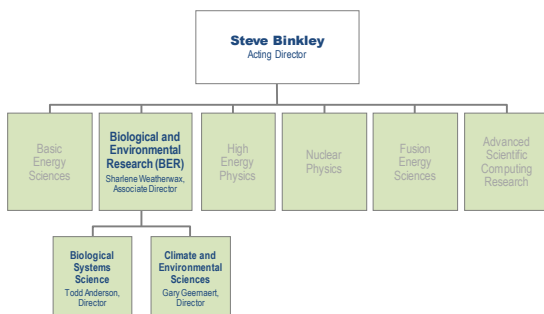
December 2017

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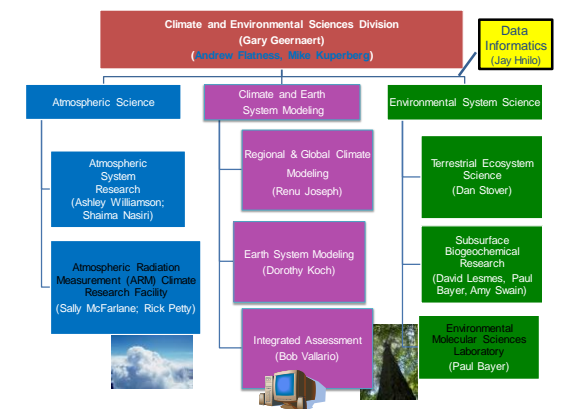


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## Office of Science



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## Key words describing DOE's unique niche

### Decadal scale science

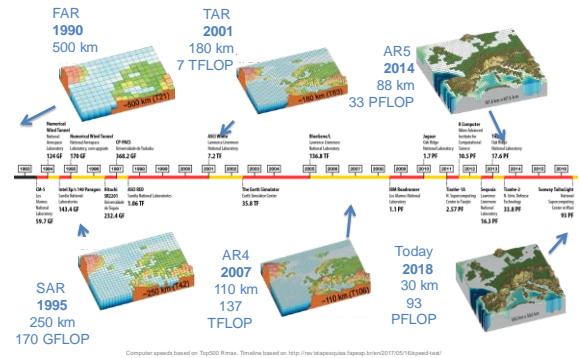
- National Lab projects of order 10 years
- University grants, coordinated or collaborating

### User Facilities for Experimental Research

- Atmospheric Radiation Measurements (ARM)
- Environmental Molecular Science Lab
- SPRUCE, NGEE Arctic, etc.

### Computing

- Exascale use cases
- Advanced software



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## CESD strategic plan frames priorities in programs and facilities

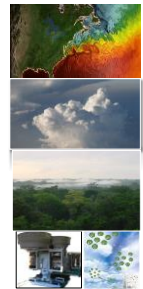
## Execution of strategic plan during FY18-23

## CESD – Strategic plan is forward looking and packaged

Mission: To provide the fundamental science needed to inform the development and deployment of advanced solutions to the Nation's energy challenges.

### Scientific Grand Challenges

- Integrated Water Cycle – interdependencies, feedbacks, and perturbations
- Biogeochemistry – natural and anthropogenic interactions and feedbacks, extending from bedrock to the top of the vegetative canopy
- High Latitude – drivers, interactions, and feedbacks involving high latitudes and interactions with midlatitudes
- Drivers and Responses – involving the integrated Earth-energy-human system
- Data-Model Integration – interconnected infrastructure and tools



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## Priorities during the next few years

- Atmospheric sciences
- LES development for SGP, preparation for Arctic
  - During FY20-21, four of ARM's six observatories in the Arctic

- Environmental sciences
- Permafrost ecology, Arctic, and SPRUCE projects continue
  - New thrust on coastal TAI, as decadal scale investment

- Modeling
- 'Energy Exascale Earth System Model' development for v2
  - Software development for ESMs compatible with exascale
  - Modes of variability, metrics, diagnostics
  - Hydrological modeling – nested, mapped to exascale

- Cross-cutting
- Development of microbial dynamics and groundwater for ESMs
  - Coastal issues and watersheds
  - Incorporation of multi-sector models into E3SM (grid, water, socio-economics, ...)
  - Extremes/perturbations (triggers, recovery time scales, feedbacks)
  - Machine learning
  - Time horizons shortening to subseasonal to multi-decadal

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Some converging community challenges are going to change how science is done, within 4-8 years

- Revolutions in computing within 3-10 years
  - Exascale machine by 2021
  - Neuromorphic within a decade
  - Quantum also on horizon but not suited for ESMs
- Training students to work on next generation machines
  - Happening in other countries but not so much here
- Sensor networks and AI
  - Incredible opportunities for atmospheric sensing
- Modeling and Data Assimilation
  - Dynamic assimilation of crowd-sourced info
  - Predictability - Hybridized with machine learning
  - Earth system prediction – S2D

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