# DOE Climate and Environmental Sciences Division

## (some topics relevant to this meeting)

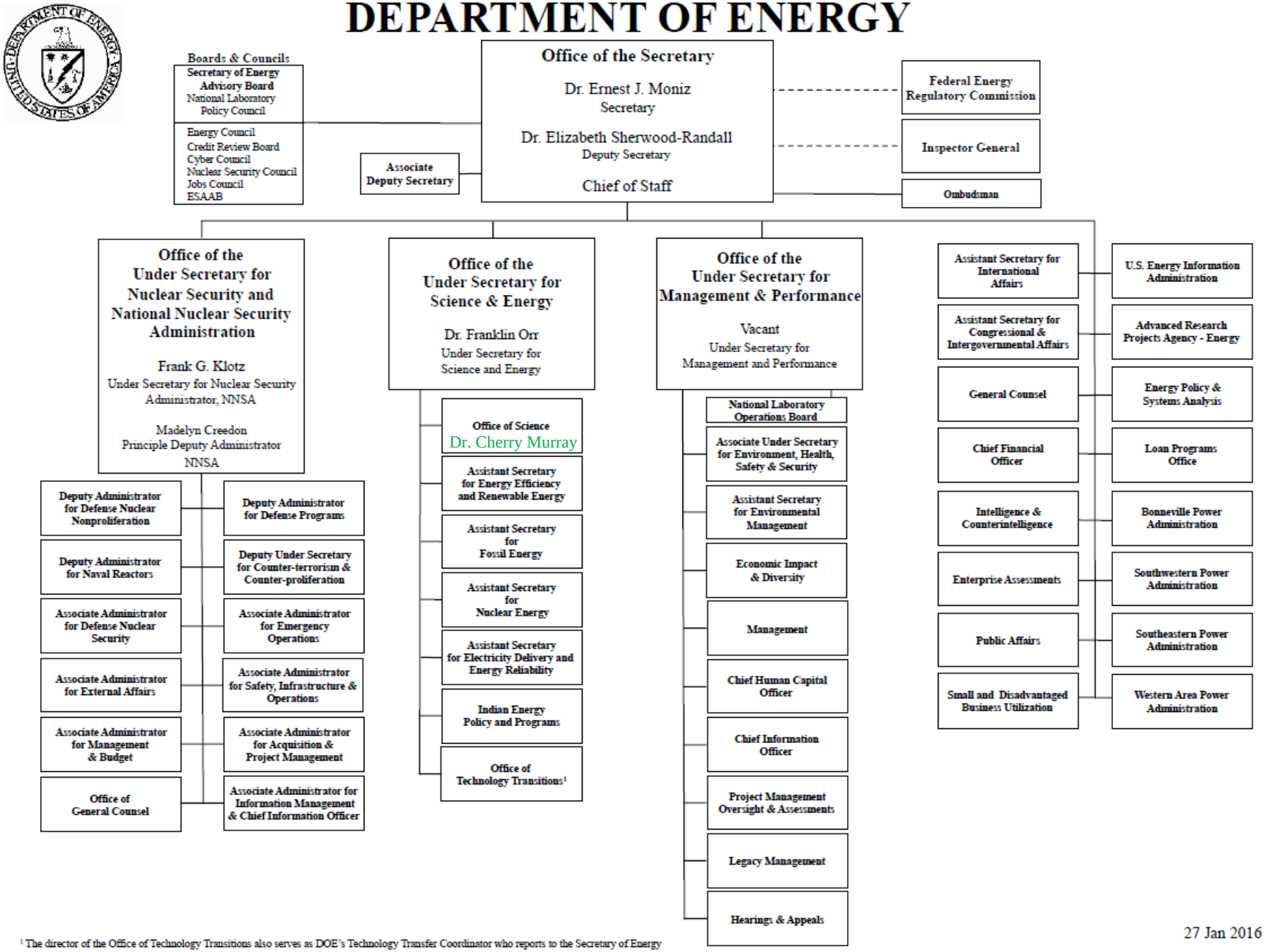
Gary Geernaert
Director, CESD

May 19, 2016

# Agenda

- **A little about DOE**
- **Our priorities**
- **Budget process**
- **The role that you all can play…**

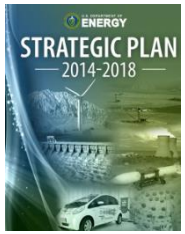
# DEPARTMENT OF ENERGY




[1] The director of the Office of Technology Transitions also serves as DOE's Technology Transfer Coordinator who reports to the Secretary of Energy

27 Jan 2016

# DOE Office of Science




"…Energy, Environmental and Nuclear Security…"
**"…Transformative Science…"**

**Cherry Murray**
Director

- Basic Energy Sciences
- **Biological and Environmental Research (BER)** — S. Weatherwax
  - **Climate and Environmental Sciences** — Gary Geernaert
  - **Biological System Sciences** — Todd Anderson
- High Energy Physics
- Nuclear Physics
- Fusion Energy Sciences
- Advanced Scientific Computing Research

BER Mission: To support fundamental research and scientific user facilities to achieve a predictive understanding of complex biological, climatic and environmental systems for a secure and sustainable energy future.

## Climate and Environmental Sciences Division

### Atmospheric Science

- Atmospheric System Research

### Climate and Earth System Modeling

- Earth System Modeling
- Regional & Global Climate Modeling
- Integrated Assessment

### Environmental System Science

- Terrestrial Ecosystem Sciences
- Subsurface Biogeochemical Research

Atmospheric Radiation Measurements Facility

**Environmental Molecular Sciences Laboratory**

CESD Mission: To advance a robust predictive understanding of Earth's climate and environmental systems and to inform the development of sustainable solutions to the Nation's energy and environmental challenges.

Budget: $310M, divided roughly equally among the three groups

# The Energy-Environment-Climate Nexus

Greenhouse gases are emitted during energy production…
and climate change will impact energy production

**Our CESD mission:**

**To advance a robust predictive understanding of Earth's climate and environmental systems and to inform the development of sustainable solution to the Nation's energy and environmental challenges.**

# Evolution of Earth System Modeling

| Atmosphere/ Land | Atmosphere/ Land | Atmosphere/ Land | Atmosphere/ Land | Atmosphere/ Land |
|---|---|---|---|---|
| Ocean | Ocean<br>Sea-ice | Ocean<br>Sea-ice | Ocean<br>Sea-ice | Ocean, Sea-ice |
| | | Sulfate aerosols | Sulfate, dust, sea-salt, carbon aerosols | Aerosol size, mixtures, cloud effects, chemistry |
| | | Carbon cycle | Carbon cycle<br>Interactive vegetation<br>Biogeochemical cycles | Dynamic vegetation<br>Biogeochemical cycles<br>Carbon-water coupling |
| | | | | Dynamic Ice sheet-ocean, SLR |
| | | | | Hybrid models of IA and IAV for water, energy, and climate |
| | | | | Variable mesh Atmosphere/ice-sheets/ocean |
| | | | | Computational upgrades for LCFs, coupled system performance |

Priorities today must demand DOE facilities, Legacy Class Computers, modeling, experiment, and agency partnerships

# Investments in academia and labs

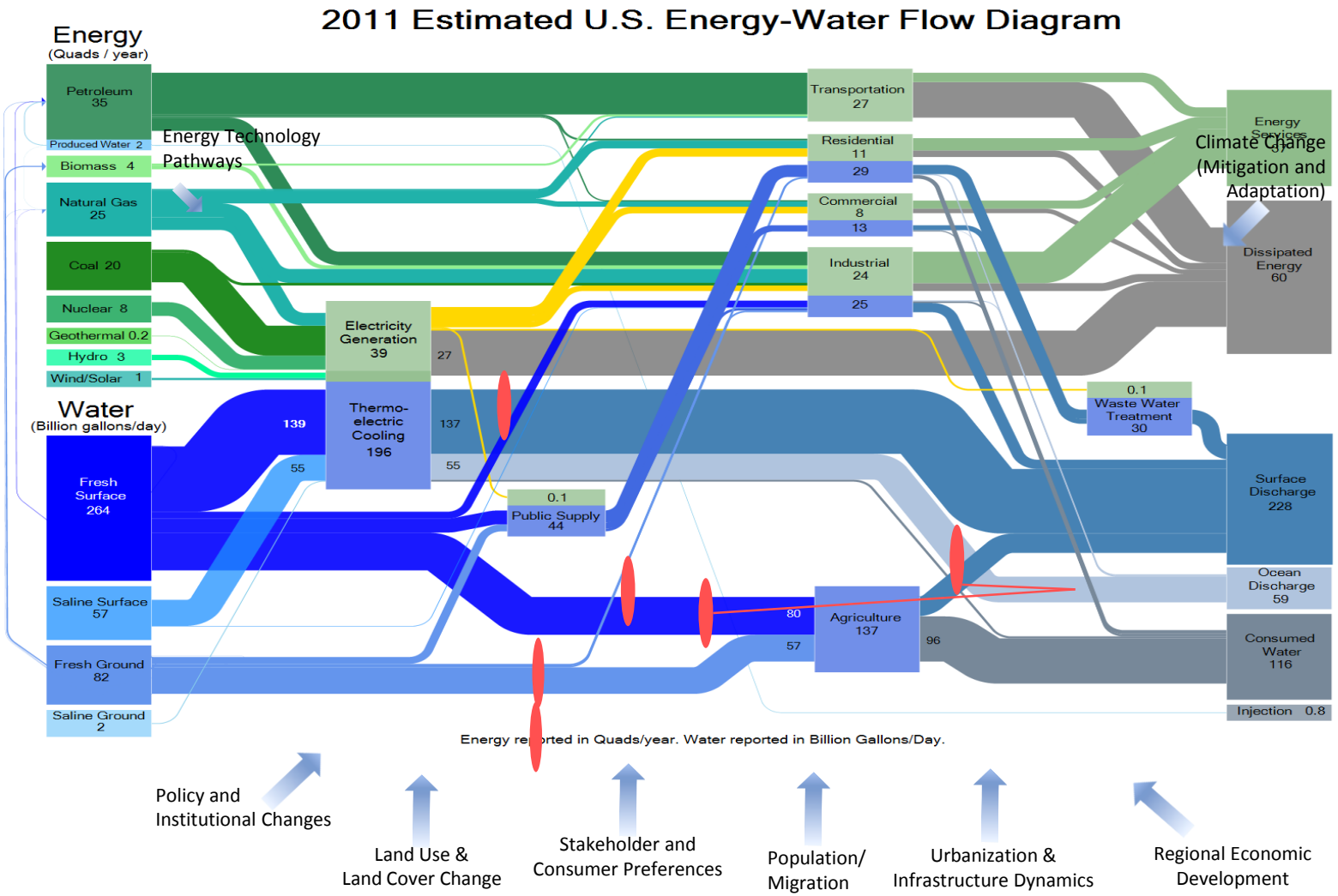
## The five goals and major bold developments in past 3 years

1. Predictive modeling (ACME, IDEAS, Diagnostic Modeling SFAs)
2. Field experiment coordinated with modeling agenda: MODEX
3. Biogeochemistry: incorporate into numerous SFAs and NGEEs
4. Exploiting user facilities: ARM; LCFs; EMSL; JGI; light sources
5. Capabilities serving DOE: IA; IAV; high resolution; UQ

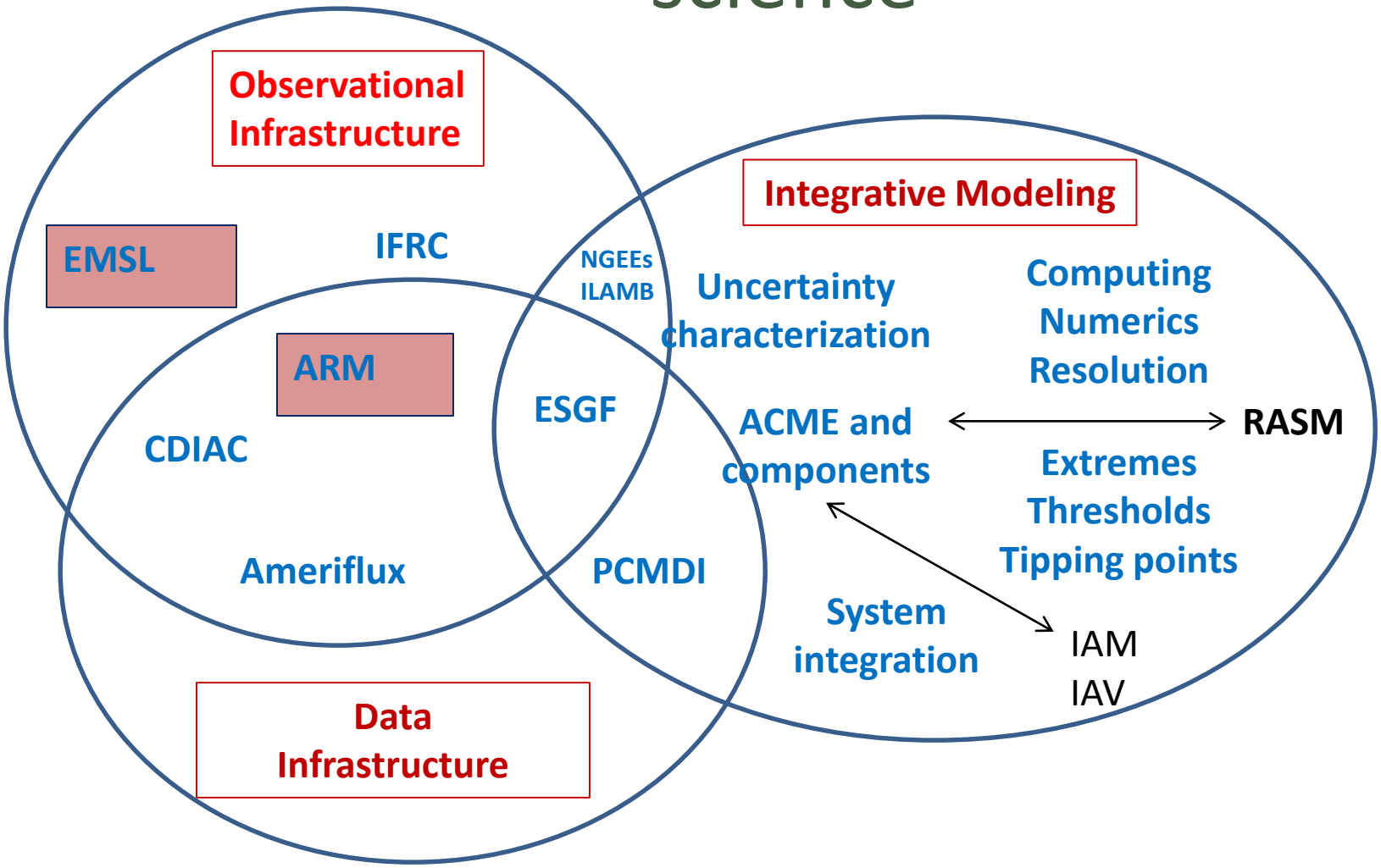
## Collaborate with other organizations, as appropriate

- NSF: educating workforce, basic science in GEO/SBE, NCAR
- NASA, NOAA: big data analytics (w/ESGF), Arctic ecology, data assimilation
- DARPA, IARPA: hybrid modeling and predictability concepts
- DOE applied, DHS and NOAA: demonstrated benefits in operationalized frame
- Use academies and societies (e.g., NAS, AGU, AMS, ESA) to advance agenda

# Responding to Challenges in the Energy-Water System



# Infrastructure to support CESD science



# So…what's governing CESD strategic priorities today

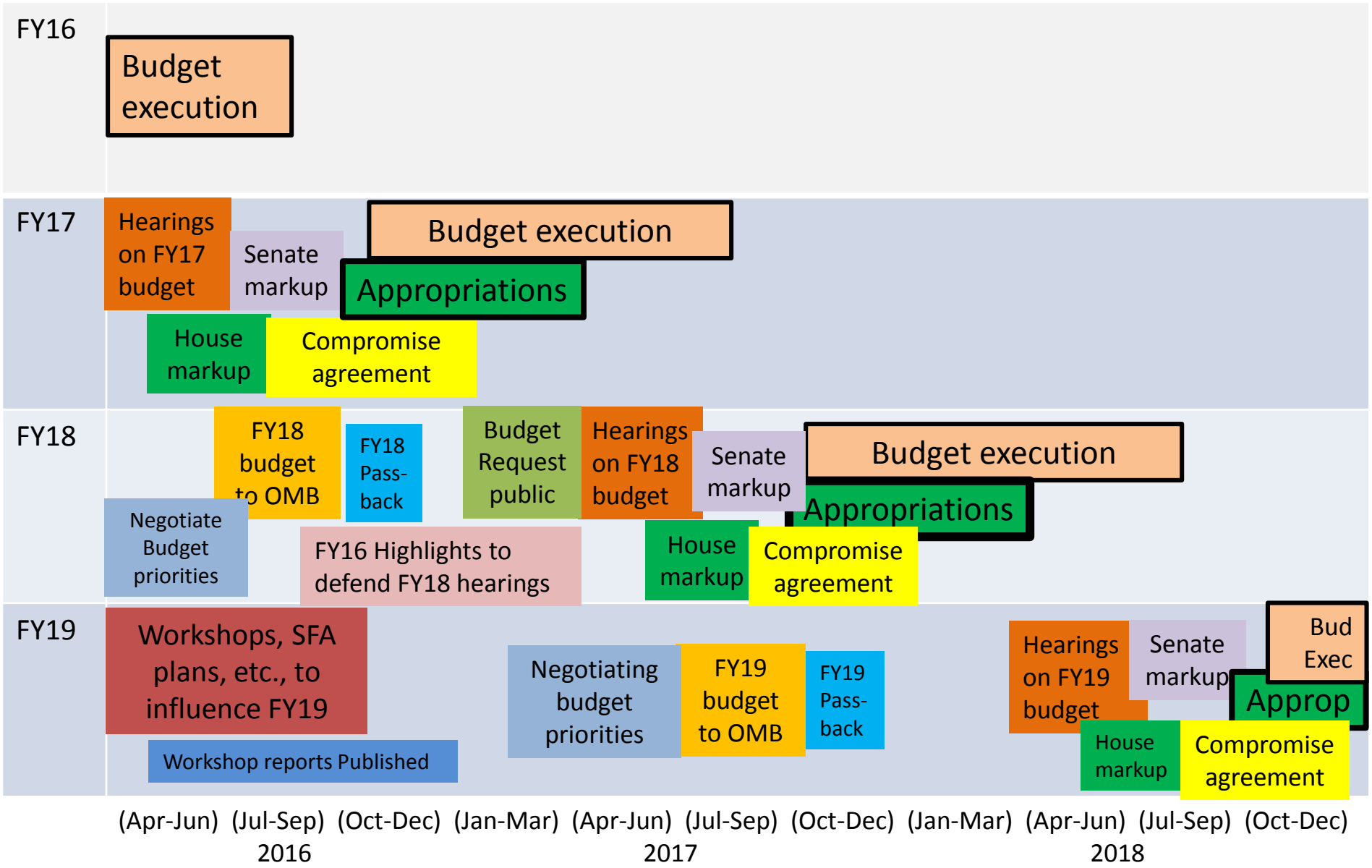
- **COMPUTING**: paradigm shift: earth system modeling as use case for successive generations of LCFs

- **SYSTEM DYNAMICS**: Earth system models must include Integrated Assessments and Impact, Adaptation, and Vulnerability (models). IA and IAV compatibility with Earth system modeling and prediction
  - emphasize cascading extremes that enhance feedbacks
  - Water-energy-land interdependencies. Advanced hydrological modeling, incl groundwater
  - Confidence, decisions, and risk analysis

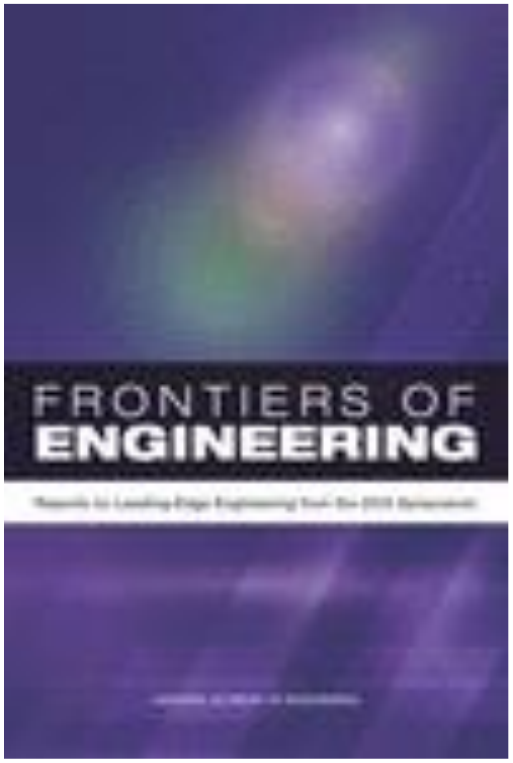
- **OBSERVATIONS, SENSOR NETWORKS, SERVER SIDE ANALYSIS**: Large scale observations map to model development and prediction strategies: NGEEs; Spruce; etc.

- **TOPICAL**: **engineering challenges**
  - Impacts of cascading extremes in chaotic systems
  - Uncertainty quantification in complex systems
  - Multiple interdependent cycles in the environment: water, carbon, nitrogen, etc.
  - Miniaturization of sensors, networks, server side analysis
  - Abrupt events that initiate large scale cascade: ice sheets; cascading simultaneous extremes
  - Continuum of weather to climate prediction: hybrid modeling…

# Concurrent federal budget processes



# National Academy Reports




Frontiers of Engineering (2015)

The past half century of engineering – and a look forward (2016)

Science and Technology Challenges for Environmental Engineering

2017

# How can we help each other?

- Science and engineering are co-dependent:  messaging is important
- Don’t ever be afraid to call a Program Manager or Division Director at an agency, but have an idea to share:
  - Science or engineering worthy of your home institution (university, national lab, industry)–
- Collaboration is a plus, especially with national labs

- We are starting the first phase of FY19 priority discussions
  - How can we assist you and your work?
  - Workshops and their reports matter
  - NAS acknowledgement and/or reports
  - Major findings published in journals
  - Briefings around DC