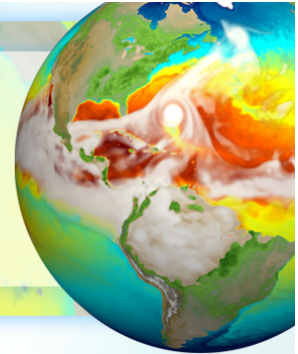# Energy Exascale Earth System Model Project

Dave Bader, E3SM Council Chair and Lead PI

DOE Internal Review of E3SM Phase II

November 9-10, 2020

E3SM Energy Exascale Earth System Model

Vision and Goal

- ***Vision** The Energy Exascale Earth System Model (E3SM) Project is an ongoing, state-of-the-science Earth system modeling, simulation, and prediction project that optimizes the use of DOE laboratory resources to meet the science needs of the nation and the mission needs of DOE.*

- **The E3SM Long-Term Goal** The E3SM project will assert and maintain an international scientific leadership position in the development of Earth system and climate models at the leading edge of scientific knowledge and computational capabilities. With its collaborators, it will demonstrate its leadership by using these models to achieve the goal of designing, executing, and analyzing climate and Earth system simulations that address the most critical scientific questions for the nation and DOE.

## "A DOE Model for the DOE Mission on DOE Computers"
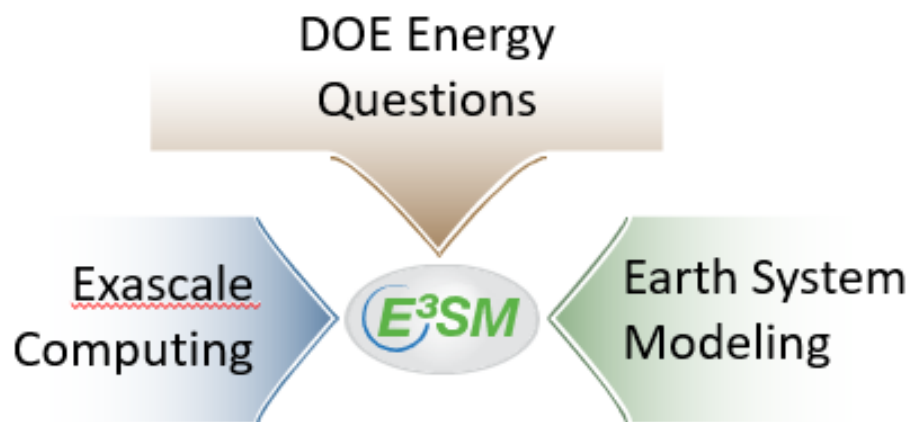

The E3SM Roadmap to 2027:

Four intersecting project elements:

- a series of **prediction and simulation experiments** addressing scientific questions and mission needs;
- a continuously advancing, evolving, and improving **system of model codes that comprise the E3SM Earth system model**;
- the ability to use effectively **leading (and "bleeding") edge computational facilities**; and
- **an infrastructure** to support code development, hypothesis testing, simulation execution, and analysis of results.

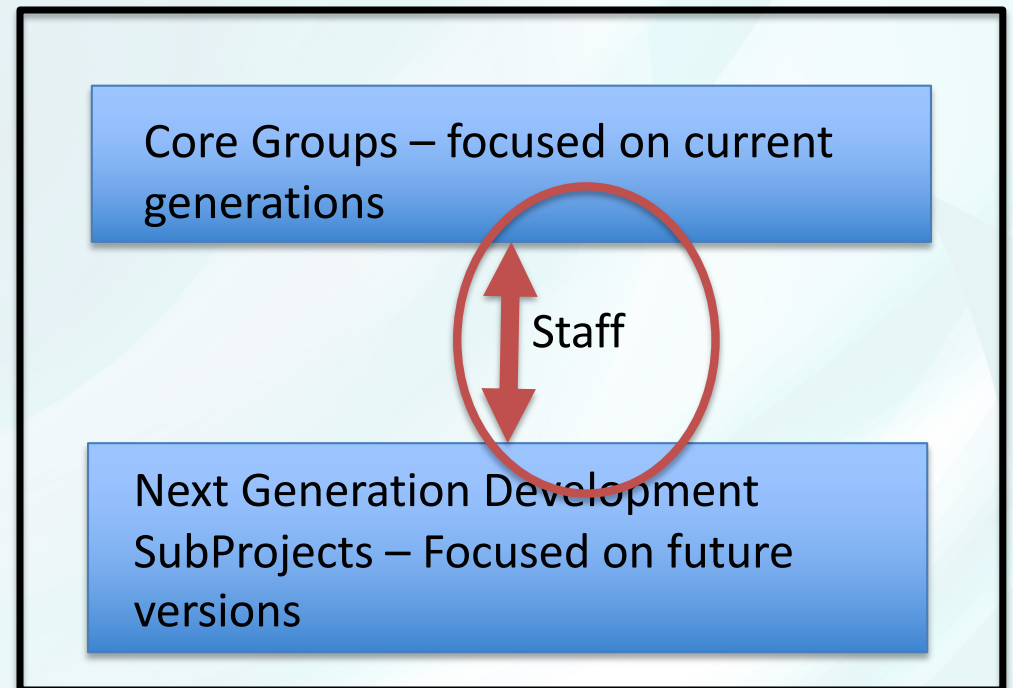# E3SM Roadmap - Overlapping Development Cycle Paradigm
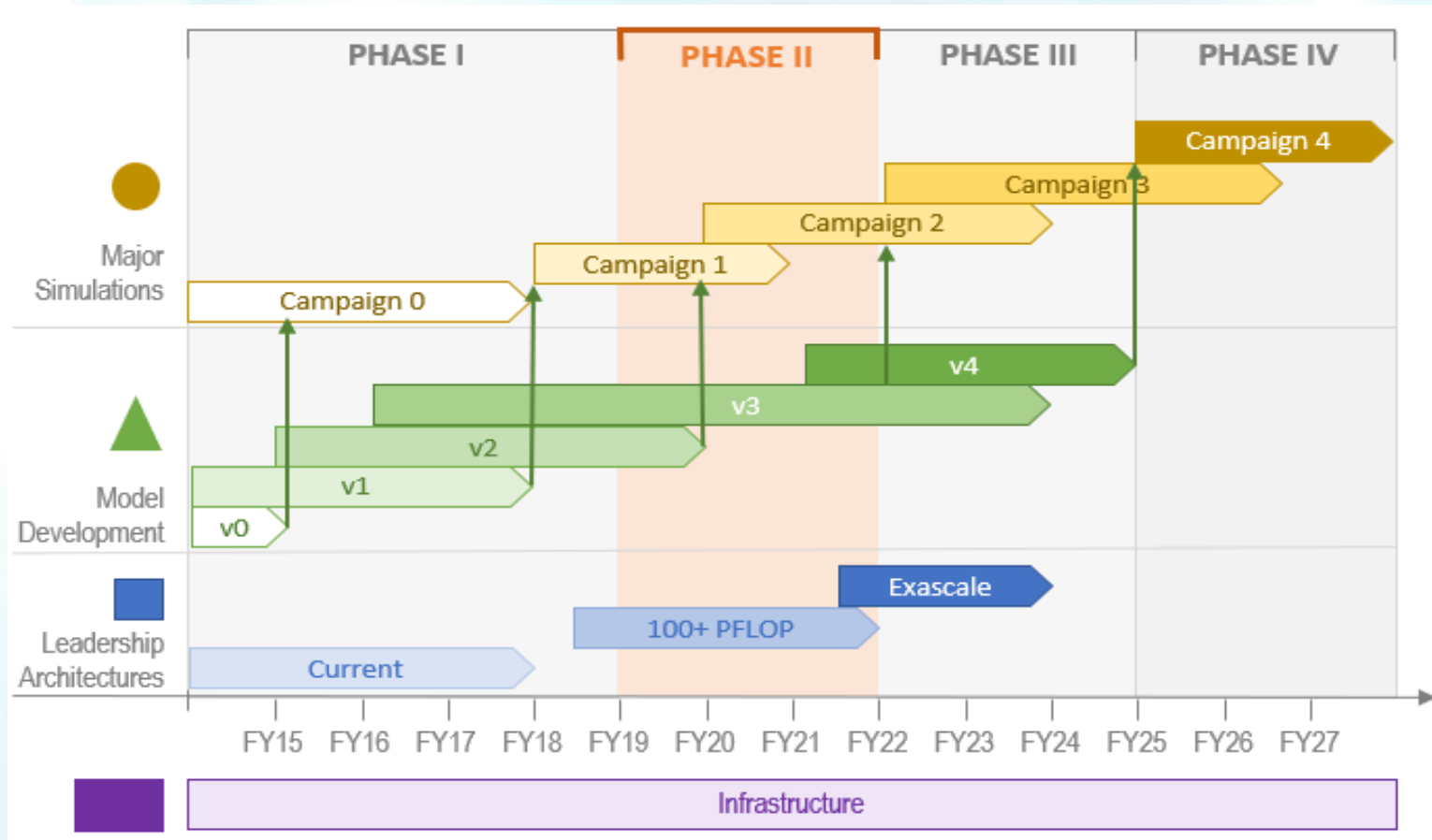
We are nearing the end of Phase II and preparing for Phase III
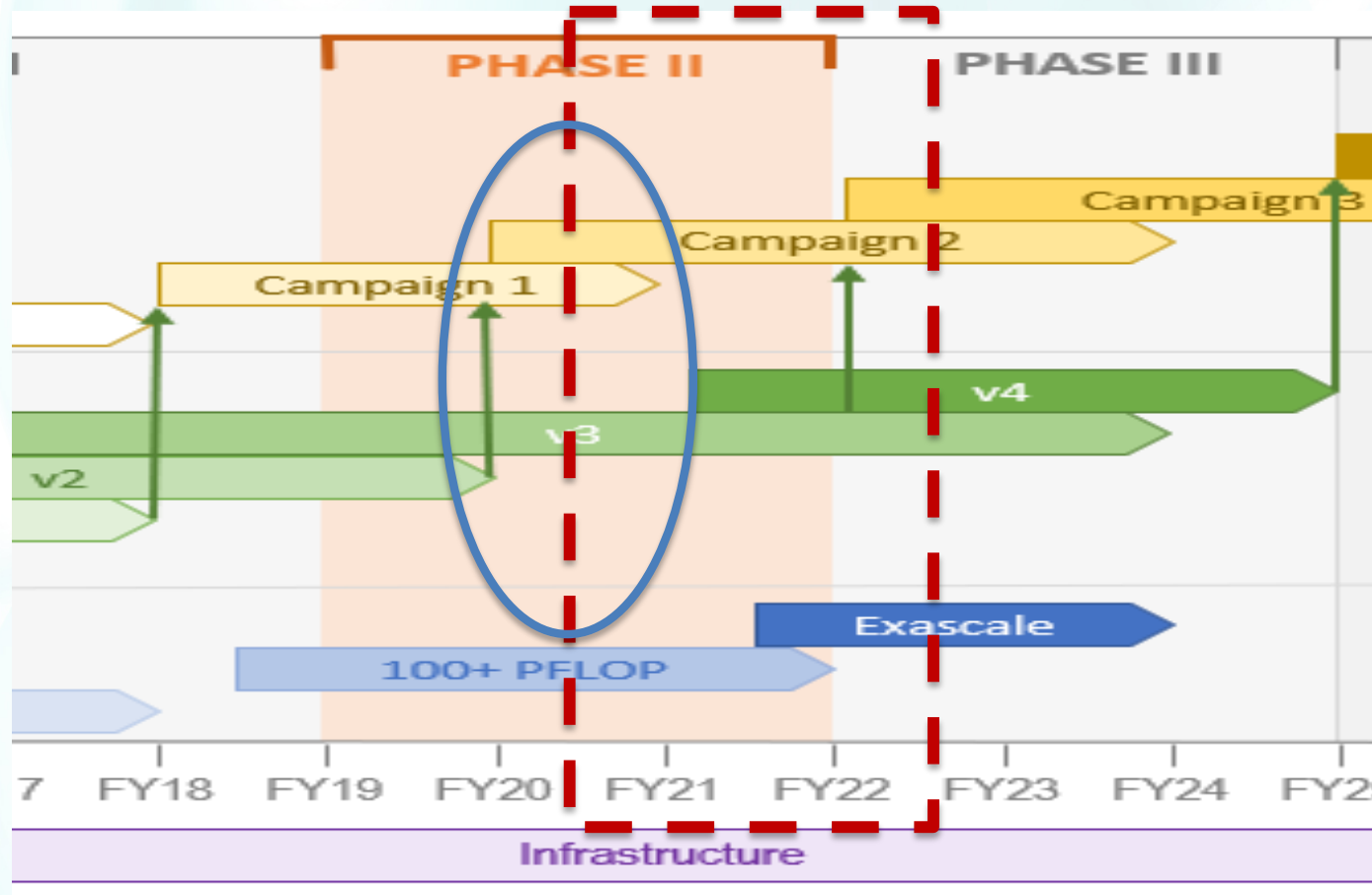
A DOE Model

- Eight Labs
- ~120 Lab staff
- Computer Scientists, Atmospheric Scientists Applied Mathematicians, Oceanographers, Software Engineers, Hydrologists, Ecologists, System Engineers, Statistician
- UC Irvine, UC Davis, Cornell, U of Houston, U of AZ, UMCP, UTK, Columbia, U Wisc-Milwaukee, UCLA

Core Groups – focused on current generations

Staff

Next Generation Development SubProjects – Focused on future versions

Released E3SM Model Versions

E3SMv1

Documented in AGU Special Collection

https://agupubs.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)2169-8996.ENERGY1

- **v1.0**   Golaz et al. 2019
- **v1.1**   Burrows, et al. 2020
- **V1.2**   Jeong, et al. 2020 (JClim https://doi.org/10.1175/JCLI-D-19-0683.1)
- *Code available on https://github.com/E3SM-Project/E3SM/*
- *Model output available on ESGF and NERSC HPSS*

E3SMv2

- Evolution from v1, but with many new features.
- Planning to freeze and start simulation campaign in **Fall 2020**.
- Compared to v1: "**faster and better**".

DOE Mission

- 3 science areas important to DOE
  - Water Cycle, esp over N. America
  - Biogeochemistry and Carbon Cycle
  - Cryosphere, esp Southern Ocean and Antarctic Ice Shelfs' potential impact on Seal-Level Rise
- Mission-focused simulations

On DOE computers

- OLCF Titan for v0
- HPC Project Clusters
    - Anvil
    - CompyMcNodeFace
    - Chrysalis
- Extensive performance improvements for Intel – Phi architectures for v1
    - ALCF Theta
    - NERSC Cori – Phase 2
- Summit – Current work on early v4 implementations on GPUs
- Future
    - ALCF Aurora
    - OLCF Frontier

Ouline of presentations to Come

- Ruby – Science Drivers and Motivation

- Mark – Computing Path and Computational readiness

- Core Group Leaders – Focus on v1 and v2 models and the computational and software infrastructure for them

- NGD Subproject Leaders – New computational and scientific developments for the v3 and v4 models

- Organization function and structure, communication and initial concept for Phase 3