

Community Earth System Model (CESM) for CMIP6



U.S. DEPARTMENT OF
ENERGY
Office of Science

Target CESM2 and CMIP6 versions (2017-2018):

DECK and most MIP simulations:

1. AOGCM physical climate (atmos 1°, ocean 1°, low-top)
2. + biogeochemistry (atmos 1°, CO₂ emission and/or concentration driven, low-top)
3. + atmospheric chemistry + biogeochemistry (atmos 1°, ocean 1°, CO₂ emission driven, high-top; WACCM)

DECK + ScenarioMIP tier 1 simulations:

1. AOGCM physical climate (atmos 1/4°, ocean 1°, low-top)
(currently with CESM1 at this resolution: time slice, PI control 100 years, 20th century; planning on RCP8.5 and RCP2.6 in 2017)

Low-top: 32 levels up to 40 km

High-top: 70 levels up to 150 km

2018-2019: simulations with AOGCM atmos 1/4°, ocean 1/10° : 50 year PI control; 20C and RCP8.5

(currently with CESM1 at this resolution have 50 year perpetual 2000 and RCP8.5 to 2050)

CESM2 participation in CMIP6

| MIP acronym | MIP name | Interest (H-M-L) | Name of primary sponsor(s) |
|-----------------|---|------------------|---------------------------------------|
| AerChemMIP | Aerosols and Chemistry Model Intercomparison Project | H | Lamarque/Emmons |
| C4MIP | Coupled Climate Carbon Cycle Model Intercomparison Project | H | Lindsay |
| CFMIP | Cloud Feedback Model Intercomparison Project | H | Medeiros/Kay (CU)/Klein (LLNL) |
| DAMIP | Detection and Attribution Model Intercomparison Project | H | Tebaldi/Arblaster |
| DCPP | Decadal Climate Prediction Project | H | Danabasoglu/Meehl |
| GeoMIP | Geoengineering Model Intercomparison Project | H | Tilmes/Mills |
| GMMIP | Global Monsoons Model Intercomparison Project | M | Fasullo |
| ISMIP6 | Ice Sheet Model Intercomparison Project for CMIP6 | H | Lipscomb (LLNL)/Otto-Bliesner |
| LS3MIP | Land Surface, Snow and Soil Moisture | H | D. Lawrence |
| LUMIP | Land-Use Model Intercomparison Project | H | D. Lawrence/P. Lawrence |
| OMIP/OCMIP | Ocean Model Intercomparison Project | H | Danabasoglu |
| PMIP | Palaeoclimate Modelling Intercomparison Project | H | Otto-Bliesner |
| RFMIP | Radiative Forcing Model Intercomparison Project | H | Gettelman/Neale |
| ScenarioMIP | Scenario Model Intercomparison Project | H | Meehl/O'Neill/P. Lawrence |
| SolarMIP | Solar Model Intercomparison Project | H | Marsh |
| VolMIP | Volcanic Forcings Model Intercomparison Project | H | Mills/Otto-Bliesner |
| Diagnostic MIPs | | | |
| CORDEX* | Coordinated Regional Climate Downscaling Experiment | M | Mearns/Gutowski |
| DynVar | Dynamics and Variability of the Stratosphere-Troposphere System | H | Marsh |
| SIMIP | Sea-Ice Model Intercomparison Project | H | Bailey/Holland/Jahn (CU)/Hunke (LLNL) |
| VIAAB | VIA Advisory Board for CMIP6 | H | Mearns/O'Neill |
| | | | |
| FAFMIP | Flux-Anomaly-Forced Model Intercomparison Project | M | Aixue Hu |
| HighResMIP** | High Resolution Model Intercomparison Project AMIP runs | M | Neale/Bacmeister |

OMIP: ocean - sea-ice simulation at 1/10 degree resolution forced with the JRA-55 atmospheric data sets (in addition to 1 deg ocean)

CMIP6 DECK + Tier 1 Requirements

- CESM2 1° coupled versions
 - Standard CESM2: $\approx 12,800$ years
 - CESM2-BGC: $\approx 10,500$
 - CESM2 WACCM-BGC: $\approx 7,300$
 - Total cost: ≈ 150 M core-hours
- CESM2 1/4° coupled version
 - CESM2 1/4°: $\approx 2,200$ years
 - Total cost: ≈ 350 M core-hours

1) This is only for DECK+Tier 1 while a lot of interesting science resides in Tier 2/3 experiments

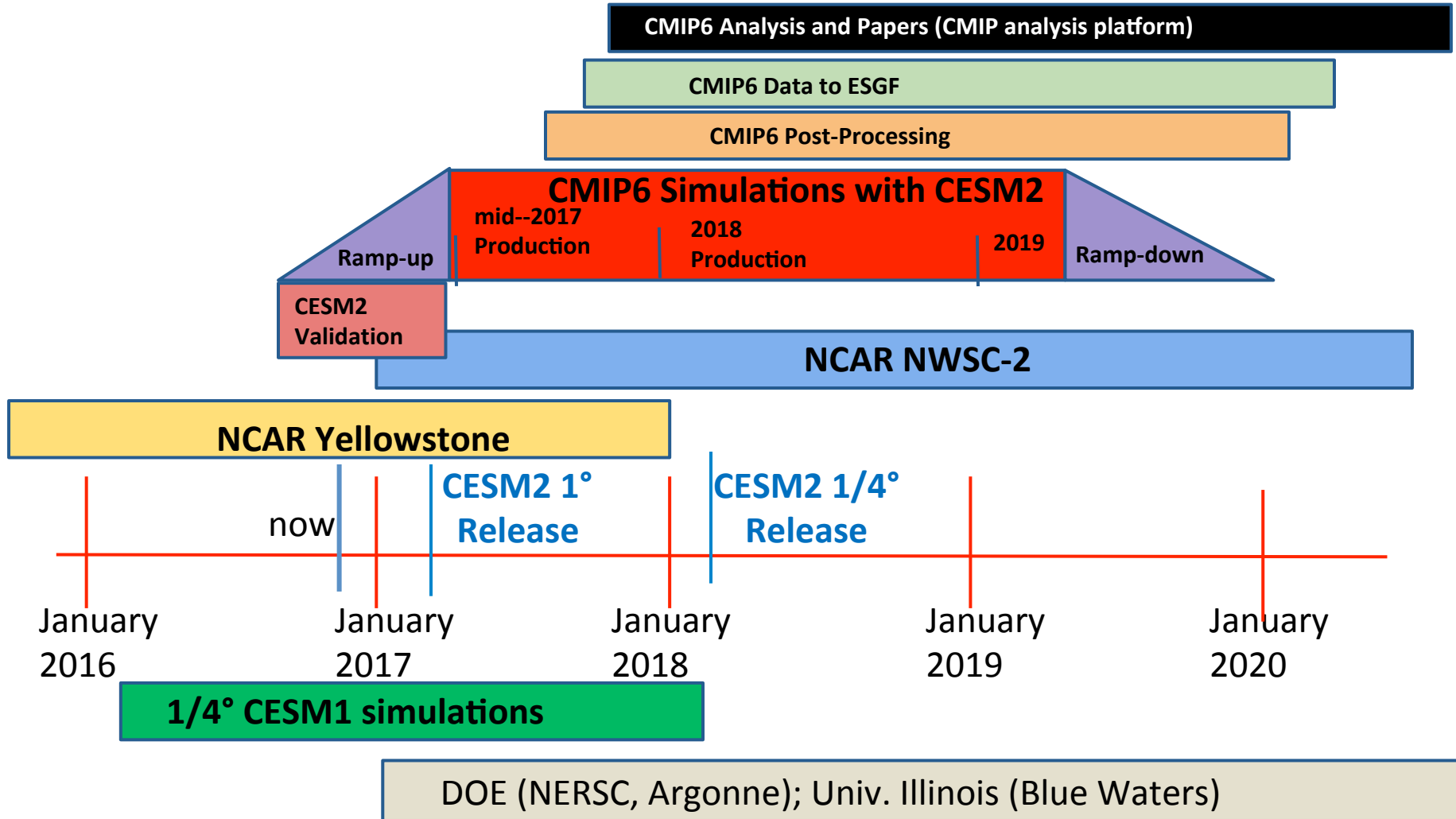
2) A large factor is #years performed at high-resolution.

Improved performance for CESM2 on current and upcoming supercomputers has been a focus over the last year

Throughput estimates for CESM2:

1. 1 deg atmos 1 deg ocean standard CESM2: ~18 model years per calendar day on NCAR Yellowstone
2. 1/4 deg atmos 1 deg ocean CESM2: ~2.4 model years per calendar day (on Blue Waters and Mira)
3. high top 1 deg WACCM, 72 layers ~2.25 model years per day on NCAR Yellowstone.
4. 1/4 deg atmos 1/10 deg ocean CESM2: ~1 model year per day (on Blue Waters)

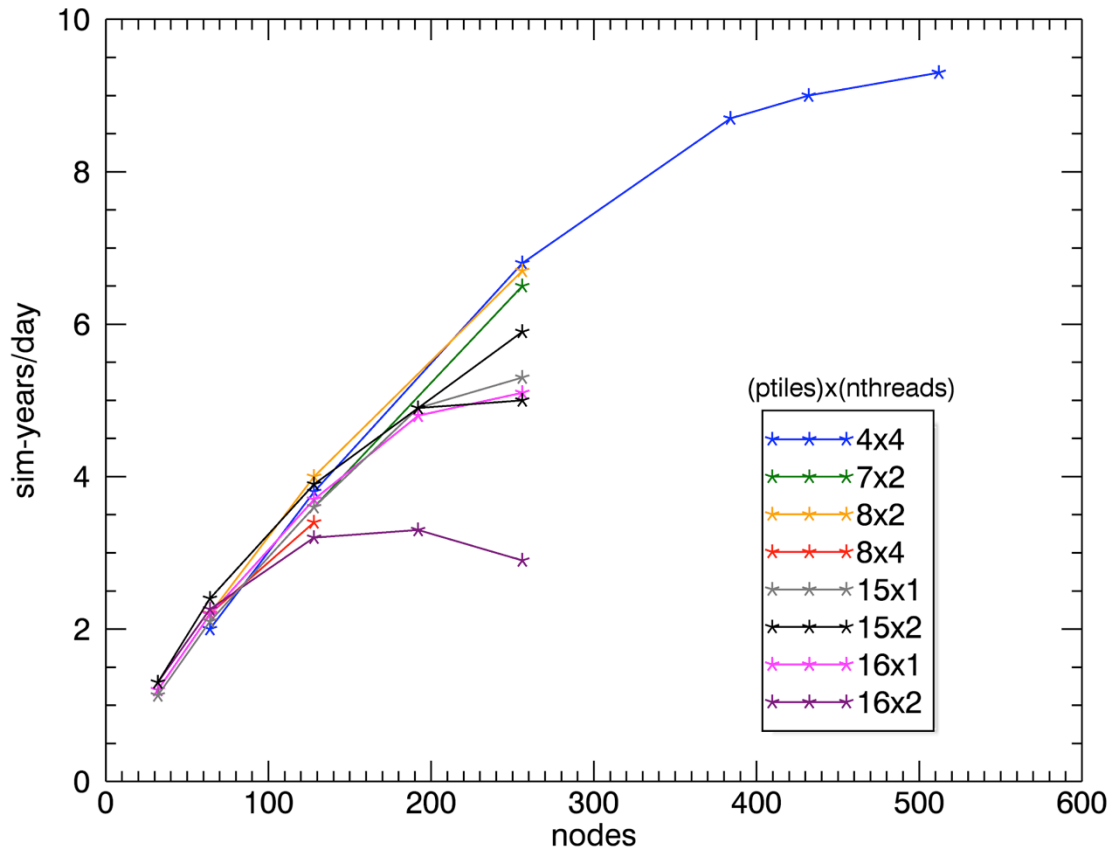
NCAR CMIP6 Planning



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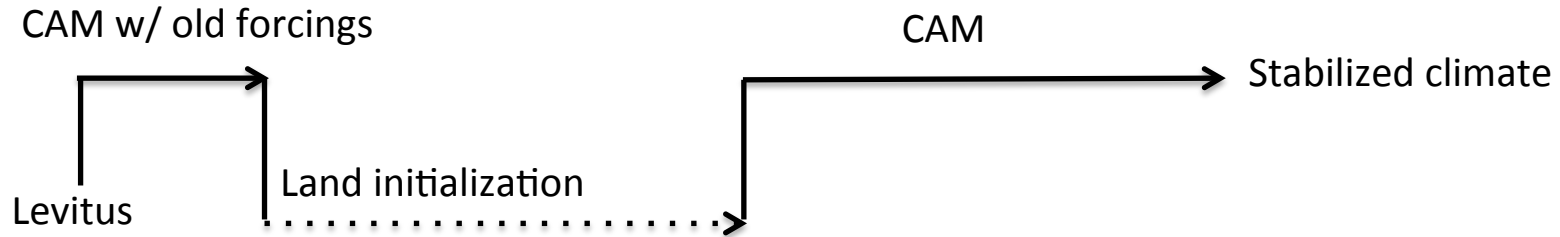
Improved throughput of WACCM on Yellowstone

FV 1-degree 135 advected tracers: Target 8-10 simulated years per day

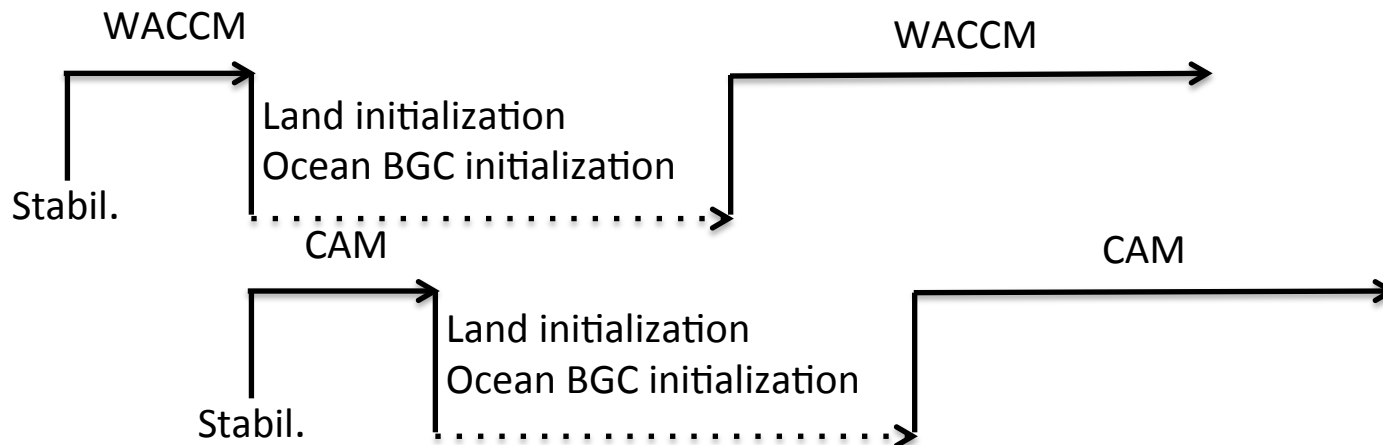


Staging simulations for PI control

1. Ocean spin-up from Levitus (will need a few iterations)



2. Atmospheric chemistry simulations (with WACCM) must be performed first to generate fields necessary for all other configurations



Exploring representing volcanic emission and evolution in CESM for CMIP

1992 1996 2000 2004 2008 2012

