Workflow in CESM2

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Building reproducible workflows for earth sciences

ECMWF Oct 14-16, 2019

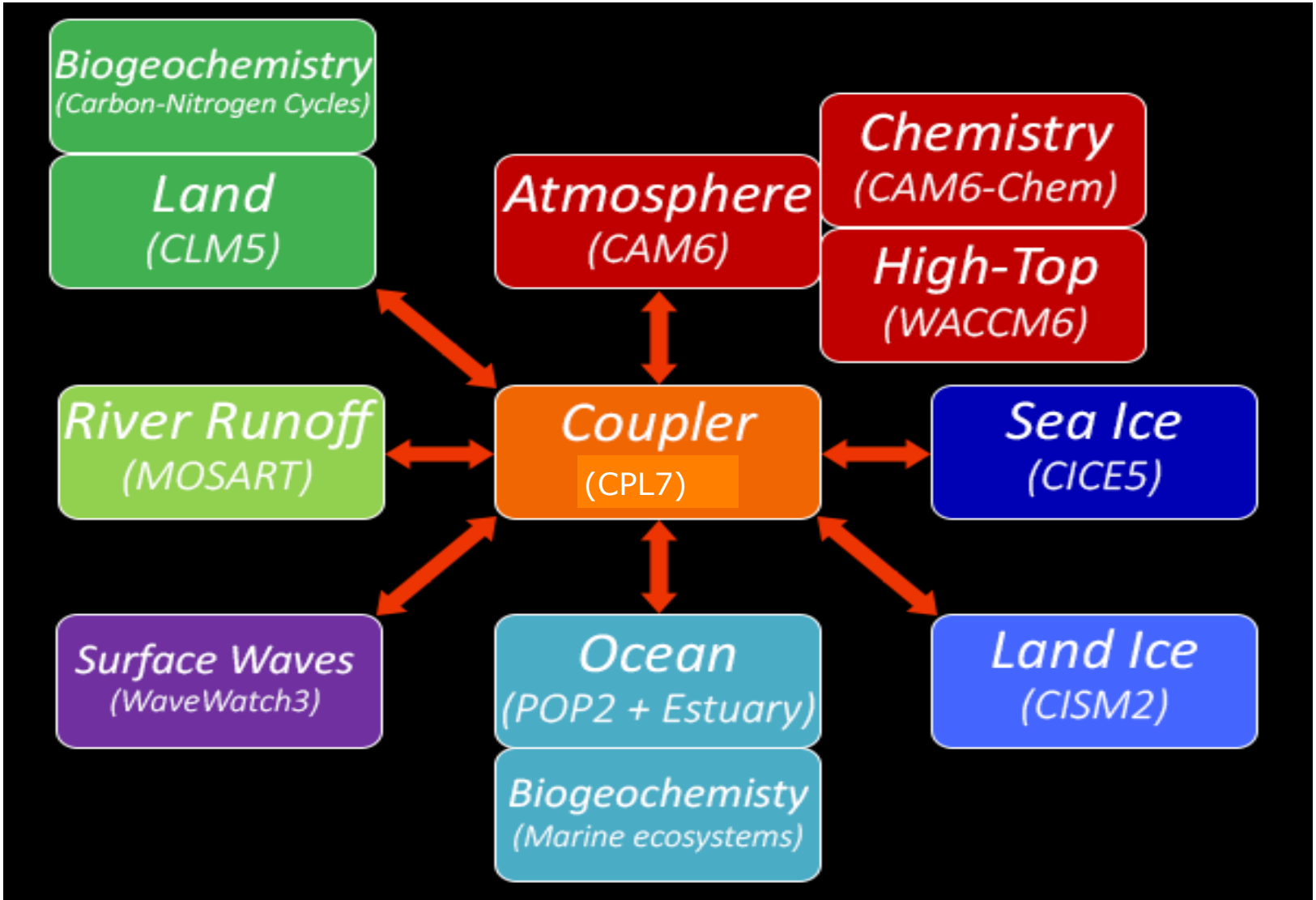
NCAR

NSF

Overview

1. CESM2, CIME and the Case Control System.
2. Expanding CIME workflow capability
3. Projects using CIME workflow:
   a. Basic experiment workflow
   b. Ensemble workflow using CYLC
   c. NCAR/ICCC CMIP6 Large Ensemble
   d. Seasonal Forecast Experiment

CESM2 Components



CESM2

- Version Control
  - Each component has its own version control and governance
  - Top level repo is a collection of hashes referring to component repositories
  - Component repos may use git or svn
  - Managed via an NCAR developed tool manage_externals
- Supports a diverse user community and range of hardware

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air • planet • people

CESM Development Management database

Tag lists | Version: CESM2_1_z

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CESM2_1_z Testing and Porting Database

Planned Tags | Alpha Tags | Beta Tags | Release Tags | Test Reports

Show 10 entries Search:

Tag Name	Status		Problems Identified After Tag Creation		Answer Changes and Notes
cesm2_1_beta01 (white board)					
cesm2_1_alpha01f	Done 2018-12-11	*Chris Fischer 2018-12-03*	- There are known issue with the pgi and cray compilers. - Intel 18 issues on hobart with larger tests. - PGI on hobart failes to run across multiple processors.	*Erik Kluzek 2018-10-26*	No
cesm2_1_alpha01e	Done 2018-11-15	*Chris Fischer 2018-11-16*	- There are known issue with the pgi and cray compilers. - Intel 18 issues on hobart with larger tests. - PGI on hobart failes to run across multiple processors.		Double-click to edit
cesm2_1_alpha01d	Done 2018-10-16	*Chris Fischer 2018-10-16*	- SMS_D_Ld1.f09_g17.B1850.cheyenne_intel.allactive-cmip6 is expected to fail. - IRT_N3_PM3_Ld7.f19_g17.BHISTWs.cheyenne_intel.allactive-defaultio still failing. - There are known issue with the pgi and cray compilers.		
cesm2_1_alpha01c	Done 2018-10-04	*Chris Fischer 2018-10-04*	- IRT_N3_PM3_Ld7.f19_g17.BHISTWs.cheyenne_intel.allactive-defaultio still failing. - There are known issue with the pgi and cray compilers.		
cesm2_1_alpha01b	Done 2018-09-18	*Chris Fischer 2018-08-30*	- f19_g17.BHIST missing 2 degree co2flux_fuel_file. - f09_g17.BHIST Diagnostic CO2 answer changes. - There are known issues for the pgi and cray compilers.		
cesm2_1_alpha01a	Done 2018-08-10		Double-click to edit		

Showing 1 to 6 of 6 entries

(* indicates current revision used in externals tagging)

cesm (1 entries)

Who / When	Revision	Path	Clickable URL	bfb?	Exists?
Chris Fischer (2018-11-15)	cesm2_1_alpha01f		https://github.com/ESCOMP/cesm/tree/cesm2_1_alpha01f	some	NA *
Note	Use cmip6 refcases for standard B1850 and BHIST compsets - changes answers for B1850, BHIST, BW1850, BWHIST and BWma1850 at f09_g17 - Add tests for BWHISTcmip6 and BWCO2x4cmips Fix use_init_interp with B1850 ERI test.				

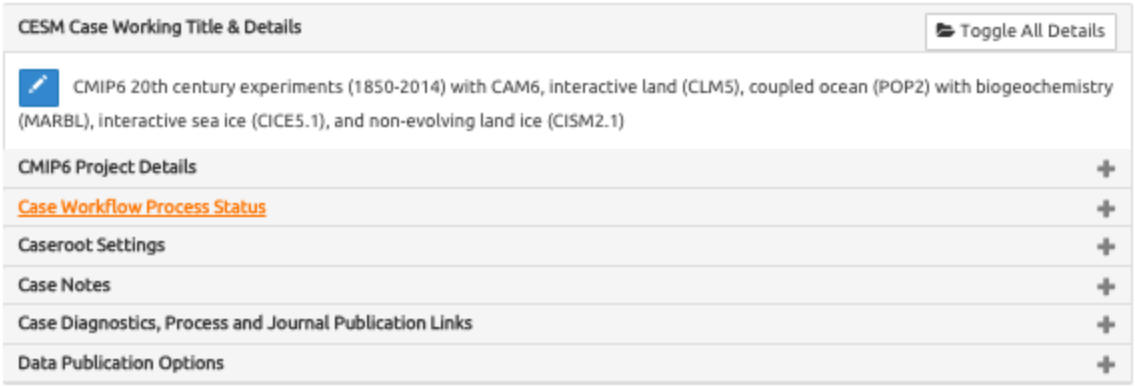
cime (3 entries)

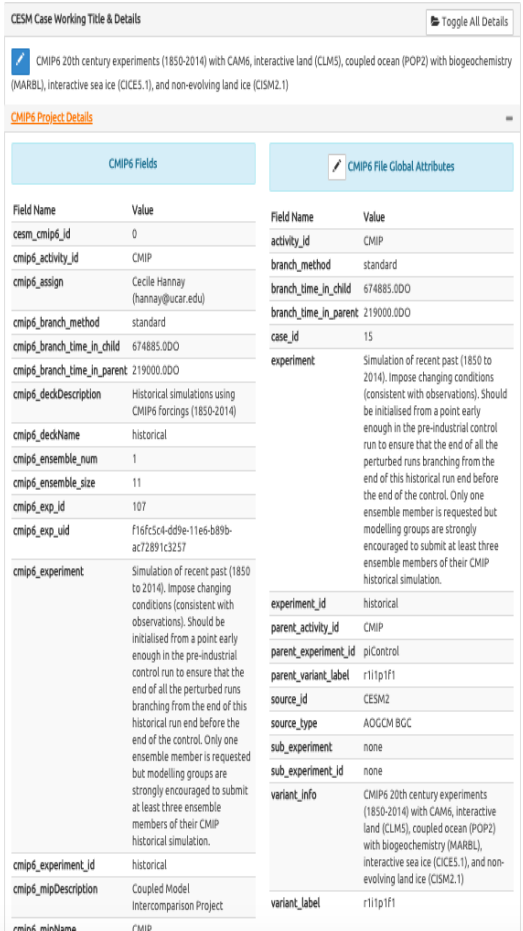
Who / When	Revision	Path	Clickable URL	bfb?	Exists?
Chris Fischer (2018-11-27)	cime_cesm2_1_rel_06	cime	https://github.com/ESMCI/cime/tree/cime_cesm2_1_rel_06	all	Yes *
Note	Update addmetadata for POP-ECT. Fix new pylint errors				
Chris Fischer (2018-11-16)	cime_cesm2_1_rel_05	cime	https://github.com/ESMCI/cime/tree/cime_cesm2_1_rel_05	all	Yes
Note	Do not include time of day in cpl auxiliary hist file names				
Chris Fischer (2018-11-13)	cime_cesm2_1_rel_04	cime	https://github.com/ESMCI/cime/tree/cime_cesm2_1_rel_04	all	Yes
Note	- Fix 2010 period for datm GSWP3v1. - Update pyCECT to v3.0.8				

cam (5 entries)

Who / When	Revision	Path	Clickable URL	bfb?	Exists?
Cheryl Craig (2018-11-26)	release_tags/cam_cesm2_1_rel_05	components/cam	https://svn-ccsm-models.cgd.ucar.edu/cam1/release_tags/cam_cesm2_1_rel_05	some	Yes *
Note	Change how SDYN is selected in CAM from a time component to a CAM qualifier SD compsets change answers				
Brian Eaton (2018-11-26)	release_tags/cam_cesm2_1_rel_04	components/cam	https://svn-ccsm-models.cgd.ucar.edu/cam1/release_tags/cam_cesm2_1_rel_04	some	Yes
Note	Fixes for simple models w/ EUL dycore. BFB except: 1) Eulerian dycore with analytic baroclinic wave ICs and terminator chemistry. 2) Eulerian dycore with moist simple physics (kessler or tj2016).				
Brian Eaton (2018-11-21)	release_tags/cam_cesm2_1_rel_03	components/cam	https://svn-ccsm-models.cgd.ucar.edu/cam1/release_tags/cam_cesm2_1_rel_03	all	Yes
Note	Workaround to add aircraft CO2 emissions file used by BGC to cam.input_data_list				
Cheryl Craig (2018-11-15)	release_tags/cam_cesm2_1_rel_02	components/cam	https://svn-ccsm-models.cgd.ucar.edu/cam1/release_tags/cam_cesm2_1_rel_02	all	Yes
Note	Cleanup science support flags and remove failing SE test				
Brian Eaton (2018-11-06)	release_tags/cam_cesm2_1_rel_01	components/cam	https://svn-ccsm-models.cgd.ucar.edu/cam1/release_tags/cam_cesm2_1_rel_01	all	Yes
Note	. Change CAM externals to use release_tag versions. . Disable ability of SE dycore to run with topography or with the new CSLAM advection and physics grid. The dycore may still be run for simple models and aquaplanet mode using the GLL advection.				

CESM2 Experiment Database





CIME:

Common Infrastructure for Modeling the Earth

A collection of earth system model infrastructure tools

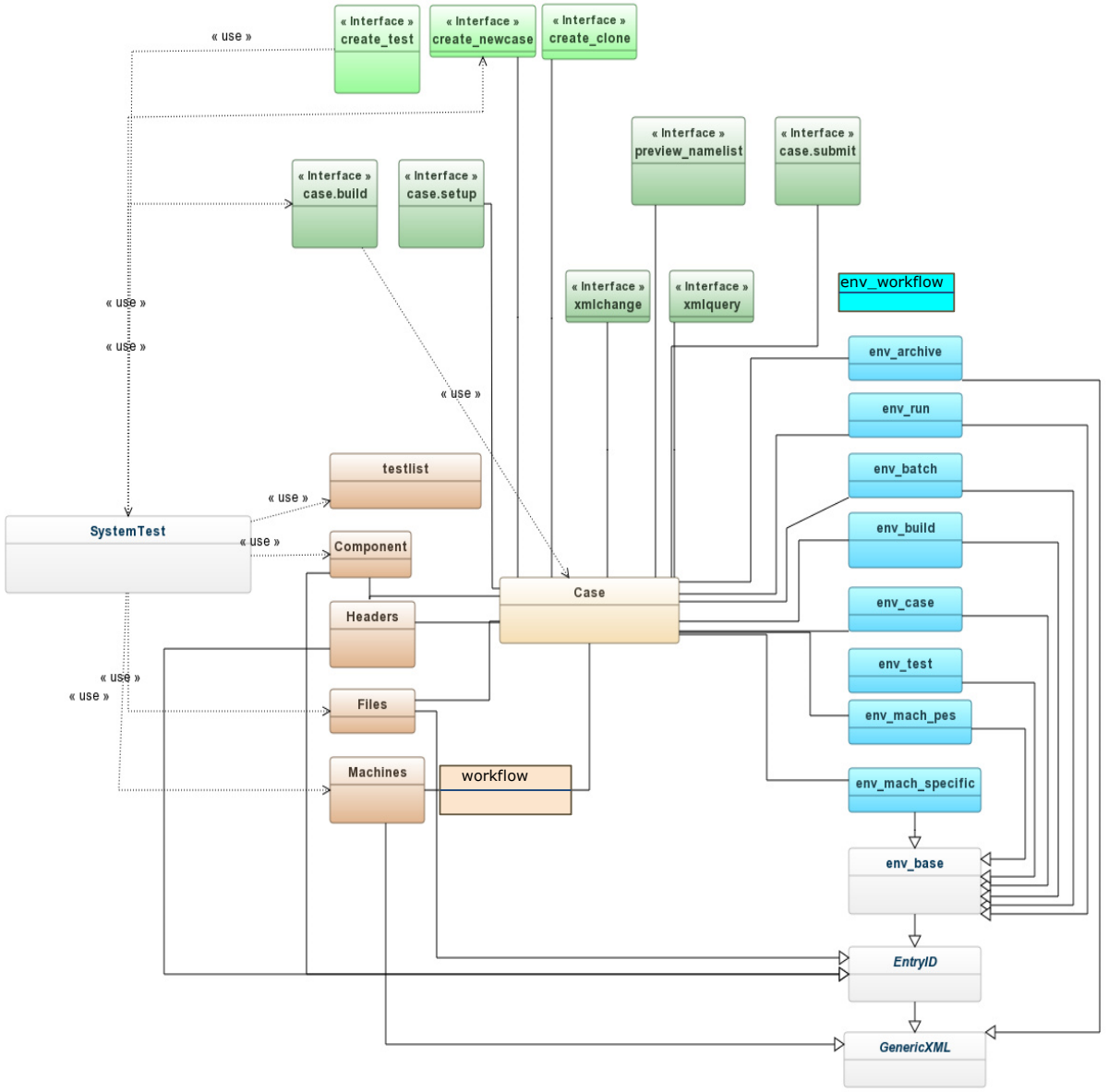
- Case Control System
  - Create, build and run an experiment
  - Unit testing
  - System testing
  - Record experiment provenance
- Inter-component Coupling Infrastructure
- Data Models (permits control of feedbacks)

CIME is used by CESM, E3SM, NORESM and is being considered for use in UFS

The CIME Case Control System (CCS)

The CCS is an extensible, coherent and coordinated set of object-oriented python scripts which uses a library of python objects along with data in xml to design, build and control the run of an earth system model.

The CCS has been designed to facilitate and encourage community collaboration!


« Interface »
create_test
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create_newcase
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preview_namelist
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case.submit
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case.build
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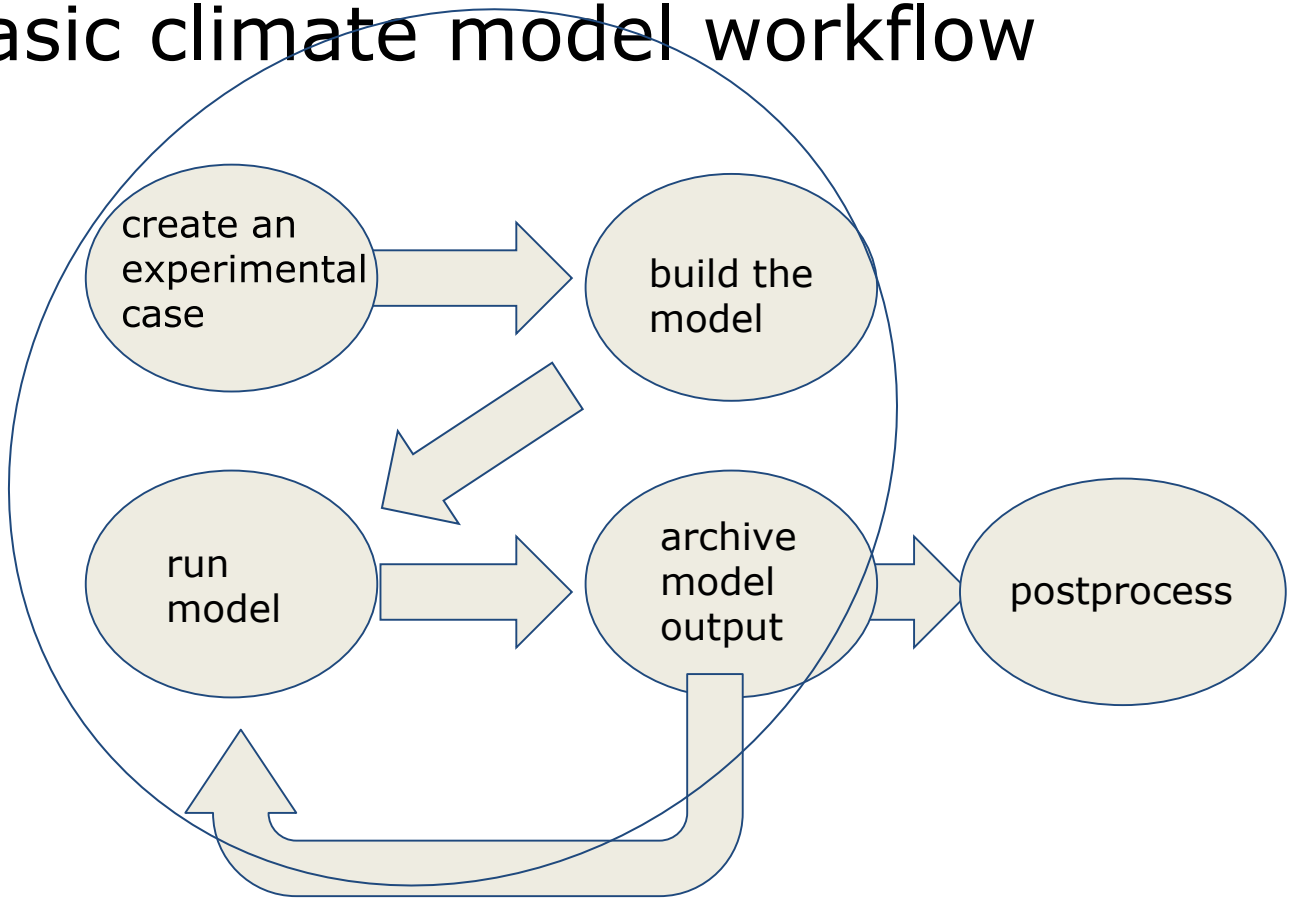
case.setup
« Interface »
xmlchange
« Interface »
xmlquery
env_workflow
env_archive
env_run
env_batch
env_build
env_case
env_test
env_mach_pes
env_mach_specific
env_base
EntryID
GenericXML
testlist
SystemTest
Component
Case
Headers
Files
Machines
workflow

Basic climate model workflow



CCS workflow generator

The CCS provides a basic workflow generator which uses queueing system native dependency tools to schedule jobs in a workflow.

Limitations:

- all jobs are submitted to queues
- no submission clock or calendar support
- limited to a single case

Use preview_run to view the current workflow.

XML Elements of a workflow definition.

- workflow_jobs {case, [prepend], [append]}
  - job {name}
    - template (script template to submit)
    - dependency (other job that must complete first)
    - prereq (logical to include in workflow)
    - runtime_parameters
      - task_count
      - tasks_per_node
      - walltime

Adding CYLC

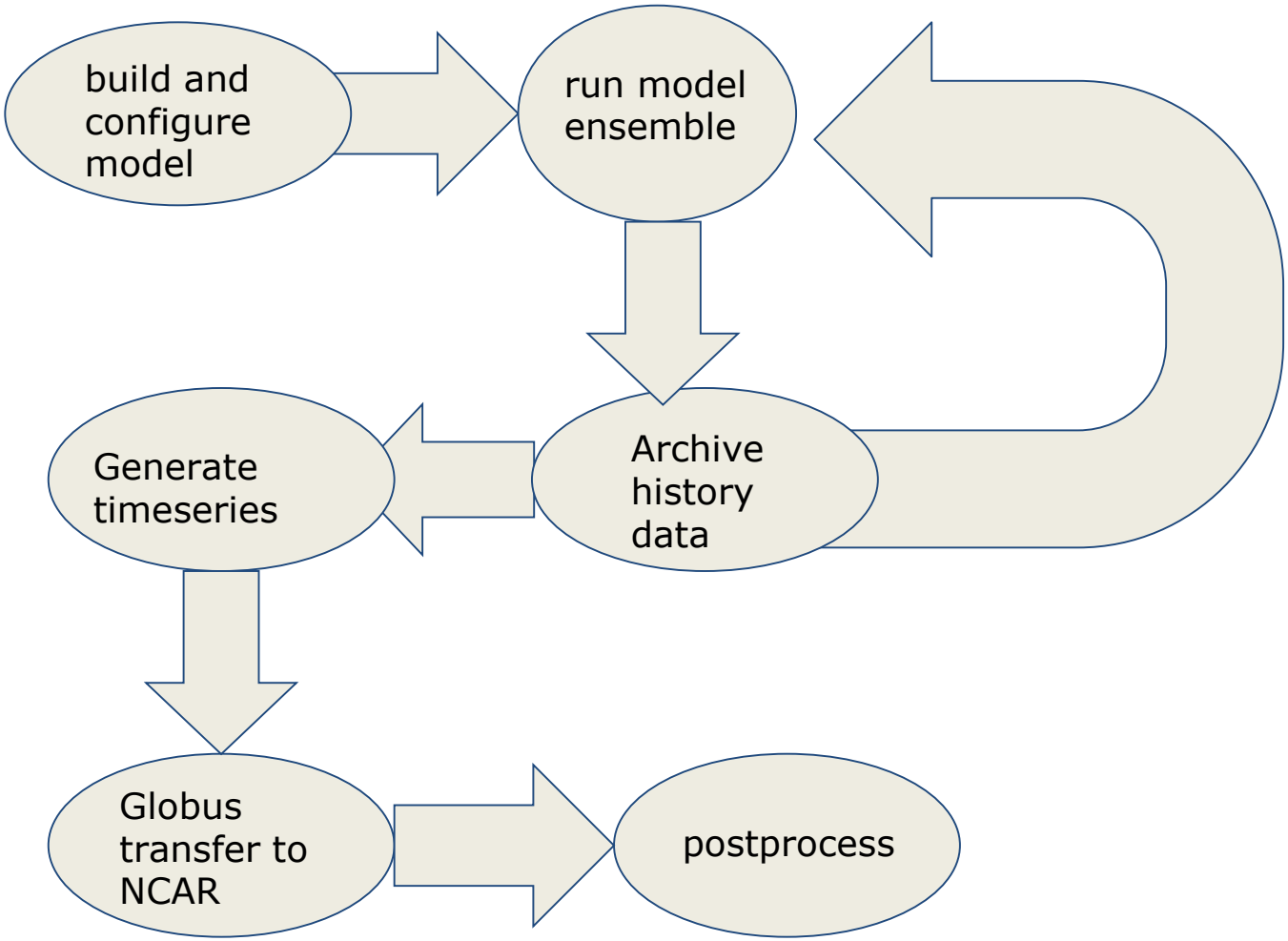
CCS provides a script **generate_cylc_workflow.py** to translate a CCS workflow to a CYLC suite.rc

- Provides support for ensembles
- Allows the user to customize workflows with all of the extensive feature set of CYLC

https://cylc.github.io/

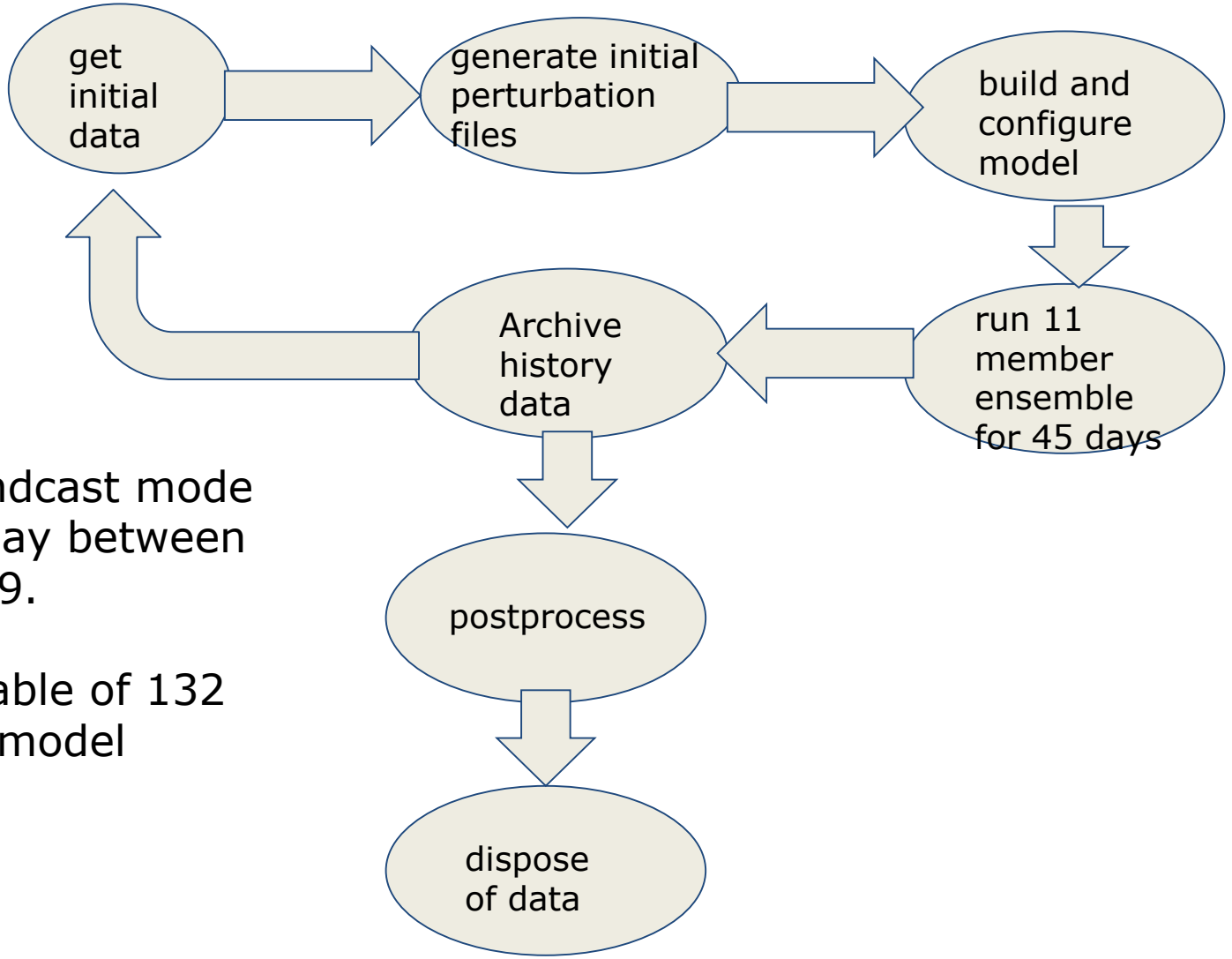
CESM2 Large Ensemble Experiment

- Cooperative project with ICCP South Korea
- 100 member ensemble climate study running from 1850-2100
- Will be run on the ICCP system Aleph with postprocessing and data storage at NCAR



NCAR/ICCP CESM2 CMIP6 Large Ensemble Experiment Workflow

Subseasonal to Seasonal prediction using CESM and CYLC



Running in hindcast mode for each Monday between 1999 and 2019.

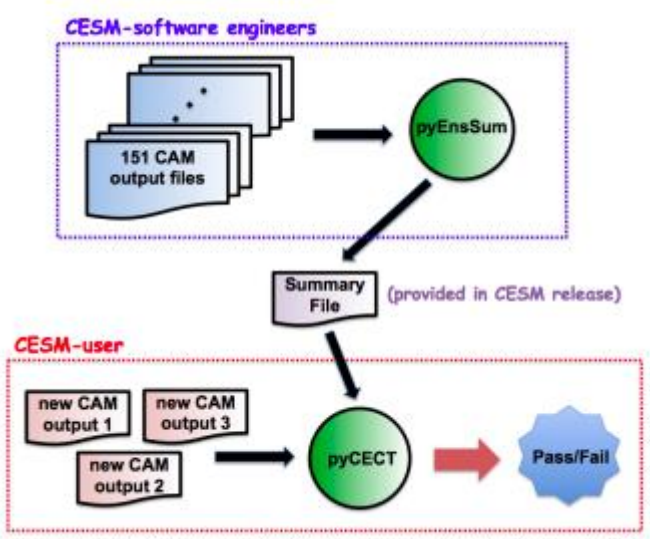
Currently capable of 132 simultaneous model simulations.

Foundational CESM2 workflow experience:

We would like to acknowledge and credit the work done by NCAR's ASAP group, especially Sheri Mickelson, in instrumenting CESM2 with CYLC for the CMIP6 experiments.

- CMIP6 Experimental Status (since August 2018)
  - Have run 979 different CESM cases.
  - Published 690 cases.
  - Generated ~1.3 PB of compressed (lossless) time series files.
  - Published ~310 TB of compressed CMIP6 files to ESGF.

CESM Ensemble verification test



CESM2 Ensemble Verification

Please see CESM2 Python Tools for details or for help with this form see DiscussCESM

ECT & UF-ECT *ONLY .NC FILES

Switch to POP-ECT

Run 1

Choose File No file chosen

Run 2

Choose File No file chosen

Run 3

Choose File No file chosen

Important

The process will take 6-10 minutes or more to complete

CIME

github repository:
https://github.com/ESMCI/cime

documentation:
esmci.github.io/cime

developers guide:
https://github.com/ESMCI/cime/wiki/CIME-Developers-Guide

Questions?

Thank You