# CAM Development Process:
# The Software Engineering View
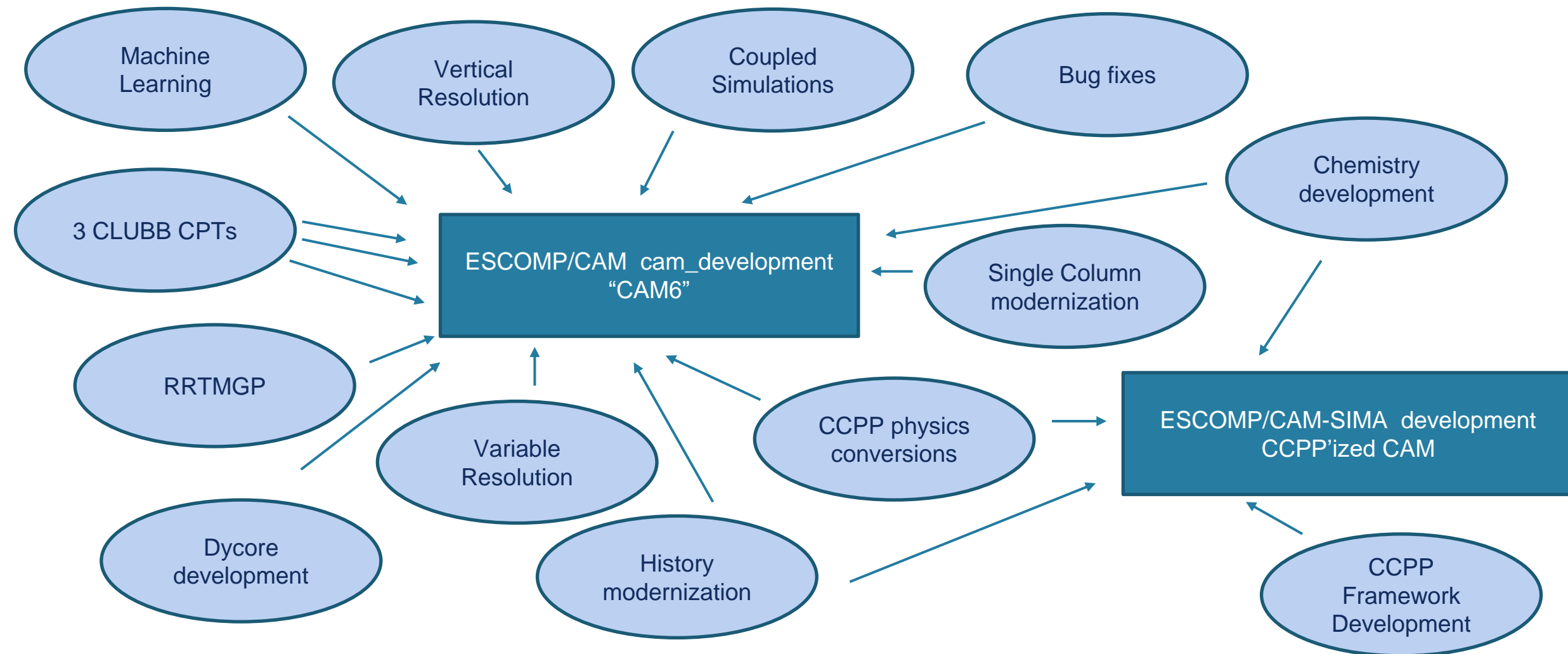
## "Creating order without stifling scientific progress"

*Cheryl Craig*
*NCAR, Software Engineer*

June 14, 2023

# CAM Simultaneous Development (non-exhaustive list)



Numerous development efforts occurring simultaneously into two code bases with some overlap – How do we maintain order?

# Two Way Communication between scientists and SEs is essential

To track progress both internally and externally, use a mixture of:

- fluid documentation

- verbal communication

- static documentation

# Fluid Documentation

# Github is key component for 2-way fluid communication

- Github features used include:
  - Issues
    - Way to communicate new features or bugs which need to be implemented

  - Pull Requests (PRs)
    - Way to communicate actual proposed code changes

  - Projects pages
    - Graphical display of issues and PRs

  **Key - no duplication of effort from SE side**

# CAM Development Progression - summary

**Developer's steps (scientists and SEs):**

- Open an issue
  - Discuss what they propose to do and initiate discussion if needed

- Open a Pull Request (PR)
  - Code modifications have been made and ready for review

**CAM Gatekeeper steps** (when ready for review):

- Directs timings of reviews

- Assigns CAM tag number

# Open an Issue

- Way to give everyone notification about a bug or future development
  - Use github templates to guide users to include pertinent information

- When select "New issue" get the following popup

**Example Template**

Fill-in fields differ by template, include:
* title

# Example Template

Fill-in fields differ by template, include:
    include:
      * title
      * description

## Issue: Bug Report

File a bug report - for CAM developers' use only (all other users should use the CESM forum) If this doesn't look right, choose a different type.

Put brief (<65 char) bug title here!

**What happened?** *
Also - what did you expect to happen?

Tell us what you see!

**What are the steps to reproduce the bug?** *
How can we see this issue?

ex. Sneeze twice and then do a 5-second jig

**What CAM tag were you using?** *
Type "git describe" to see the tag

ex. cam6_3_042

**What machine were you running CAM on?** *
Selections: ▾

**What compiler were you using?** *
Selections: ▾

**Path to a case directory, if applicable**
The full path to a case in which the error occurred

ex. /glade/scratch/3p0/where-could-he-be

**Will you be addressing this bug yourself?** *
If Yes, please also assign this issue to yourself (if possible)

Yes ▴▾

**Extra info**
Please provide any additional information here that you think might be relevant

ex. I am running CAM on izumi and I don't know what compiler I'm using.

**Assignees** ⚙
No one—assign yourself

**Labels** ⚙
bug

**Projects** ⚙
None yet

**Milestone** ⚙
No milestone

**Development**
Shows branches and pull requests linked to this issue.

**Helpful resources**
Code of conduct
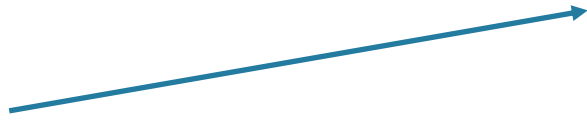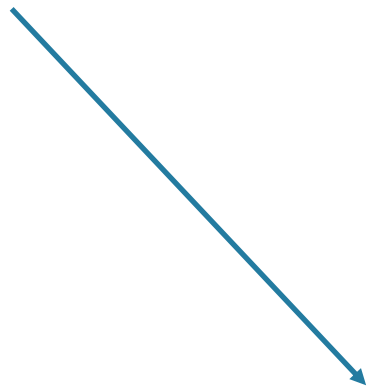GitHub Community Guidelines

Beta — You're using an issue form, a new type of issue template.

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NCAR UCAR | CAM Development Process

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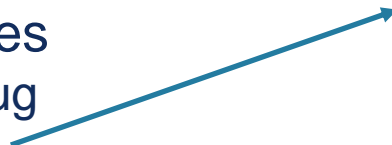
NCAR
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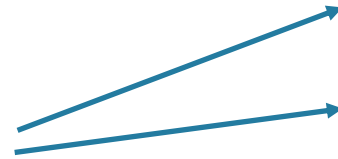# Example Template

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Bug template also includes
* Steps to reproduce bug
* CAM tag being used
* Machine and compiler
*Location of case directory, if applicable

# Once Code Development is Completed:
## Developer opens a Pull Request (PR)

- Two types of PRs to open

  - Draft PR
    - Draft designation indicates that development is still occurring.
    - Reviews are not started
    - Typically opened when two or more developers are working on a Pull Request

  - PR (without Draft designation)
    - Indicates that active code development is done
    - Indicates that the PR is ready to start the review process

  - PR contains a link to the original issue (where preliminary discussions may have occurred)

# After PR is opened "without draft" – CAM gatekeeper manages the timing of the next steps

- Once a PR is no longer draft, it will make its way through the following steps:

  - *PR- Review Not Started*
  - *PR – Initial Review*
  - *PR – Full Review*
  - *Next Tag*
  - *Tag*

- CAM Gatekeeper determines ordering of PRs based on several criteria

  - Urgency (based on specific request by developer)
  - Length of estimated time for review (minor PRs can slip in front of PRs which are intensive)
  - Discussions at weekly scientist/SE meeting
  - First-in, first-out

# Verbal Communication

# Weekly meeting with scientists and SEs

- Discuss SEs perspective on plans for the week and tweak as necessary based on feedback

- Meeting agenda is published a week before the meeting

  – Agenda is linked to the calendar invite (for viewing prior or after the meeting)

  – Agenda includes
    - Always reviewing the projects page (will show on next slides)
      – Projects page is key to communication between scientists and SEs
    - Additional items to report or which need discussion

  – Additional discussion items can be added by anyone prior to the meeting

  – Notes are taken during the meeting right into the agenda

# Communication on status of PRs done via github Projects page

**Projects page**

– is updated by hand weekly by CAM gatekeeper
  - Utilize github automation (to initially populate the projects pages)
  - Further automation is not implemented yet due to developer time constraints

– Plans for the upcoming week are described in detail

– Used in weekly meeting with Scientists/SEs to present plans and adjust as needed

# Github Projects page – Utilize 3 tabs in weekly meeting

https://github.com/orgs/ESCOMP/projects/7
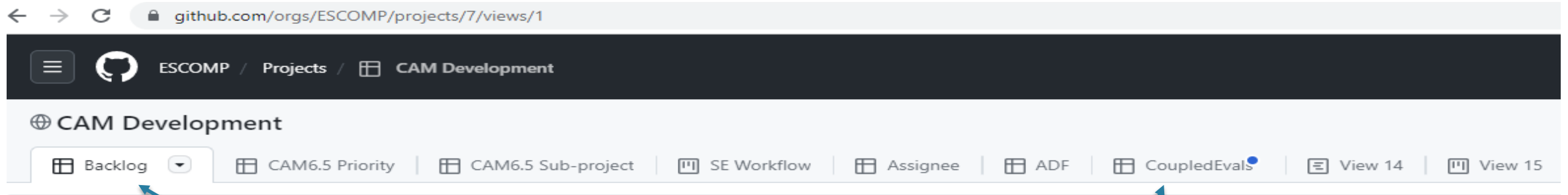


Backlog – List of all issues

SE Workflow – PRs Planning page

CoupledEvals

# Github Projects: Issue tracking (labeled Backlog)

## ⊕ CAM Development

| ⊞ Backlog ▾ | ⊞ CAM6.5 Priority | ⊞ CAM6.5 Sub-project | ▥ SE Workflow | ⊞ Assignee | ⊞ ADF | ⊞ CoupledEvals | ▤ View 14 | ▥ View 15 | ▥ View 16 | + New View |

is:issue -status:Done status:"To Do" -is:Draft repo:"ESCOMP/CAM","ESCOMP/PUMAS"

| Pri... ↑ ⋯ | Title | ⋯ | Assignees | ⋯ | Sub-project | ⋯ | Milestone | ⋯ | Notes | ⋯ | Status | ⋯ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 772 ▾ | ⊙ Issue with zonal means in regions of high terrain. #775 | | 🚌 fvitt ▾ | | ▾ | | CESM2.3 ▾ | | | | To Do ▾ | |
| 774 ▾ | ⊙ Expand dust_emis_fact namelist default values for different new dust_emis_method options #778 | | 🚌 fvitt ▾ | | ▾ | | CESM2.3 ▾ | | | | To Do ▾ | |
| 777 ▾ | ⊙ Initializing nag tests to NaN indicates there are issues which need to be addressed #786 | | ▾ | | ▾ | | CAM6.5 ▾ | | | | To Do ▾ | |
| 778 ▾ | ⊙ remove redundant mesh files in cam - point to mesh files in ccs_config #787 | | 👤 brian-eaton ▾ | | ▾ | | CESM3 ▾ | | | | To Do ▾ | |
| 781 ▾ | ⊙ MA chemistry scheme (waccm_ma_mam4) needs O3S #793 | | 🚌 fvitt ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 784 ▾ | ⊙ Energy Budget refactor (address deferred comments in PR #761) #796 | | 👾 jtruesdal ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 785 ▾ | ⊙ Bring in Machine Learning warm rain capability #801 | | 👥 cacraigucar ▾ | | ▾ | | CESM3 ▾ | | | | To Do ▾ | |
| 786 ▾ | ⊙ Kessler physics using inconsistent reference pressures #802 | | 🖼 nusbaume ▾ | | ▾ | | CAM6.5 ▾ | | | | To Do ▾ | |
| 789 ▾ | ⊙ cplsec.F90 needs to be in a module #805 | | ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 790 ▾ | ⊙ add UT and UQ to cam_diagnostics #807 | | ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 792 ▾ | ⊙ Increase PE layout for MT runs #812 | | ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 793 ▾ | ⊙ Add testing of zonal mean output to a cam_dev test. #811 | | ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 794 ▾ | ⊙ Remove check for zonal mean output with non-FV dycores. #809 | | ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 795 ▾ | ⊙ Add zonal mean output capability to simple models. #810 | | ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 796 ▾ | ⊙ Introduce "-phys cam7" and remove "-phys cam_dev" #813 | | ▾ | | ▾ | | ▾ | | | | To Do ▾ | |
| 797 ▾ | ⊙ Introduce QPC7 and possibly QPS7 aquaplanet compsets #814 | | ▾ | | ▾ | | ▾ | | | | To Do ▾ | |

# Github Projects: Tag planning (labeled SE workflow)

**CAM Tags**: Tags which are completed



PR - Full Review  7

Draft

🖊 This week's prioritized list for upcoming tags-------------
✨ ESCOMP/CAM #560 (HEMCO) - fvitt - One failing regression test - Louisa indicated that we should take the time to fix this -------------
✨ ESCOMP/CAM #820 Tuning "F" and increase PE layout for MT compsets -(Cheryl) - Cecile just added three more settings - moved to Draft until these and the comments are addressed and will then ask for rereview -------
✨ ESCOMP/CAM-SIMA #221 - Replace CAMDEN referneces with CAM-SIMA (Jesse) --
✨ ESCOMP/CAM-SIMA #220 - Update issue template to reference CAM-SIMA-------------
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✨ ESCOMP/CAM #688 (frontogenesis gw) - in queue for full review ---------------------

To Do

CAM #560

cam6_3_114: Integrating HEMCO emissions component in CESM

To Do    +3  6 reviewers

CAM-SIMA #221

Next Tag  0

CAM Tags  219

CAM #828

cam6_3_113: Update manage_externals

Tag    1 reviewer

CAM #822

cam_cesm2_1_rel_r58: Use case to support BSSP585smbb compset.

Tag    2 reviewers

Draft

👆 WORK SINCE LAST MEETING 👆

To Do

CAM #714

cam6_3_112: Refactor aerosol heterogeneou freezing process

Tag    answer changing    +3  6 reviewers

CAM6.5

CAM #806

cam6_3_111: create CAM LT and MT 1850 use_cases

Tag    CoupledEval2    2 reviewers

NCAR UCAR | CAM Development Process

# Github Projects: Tag planning (labeled SE workflow)

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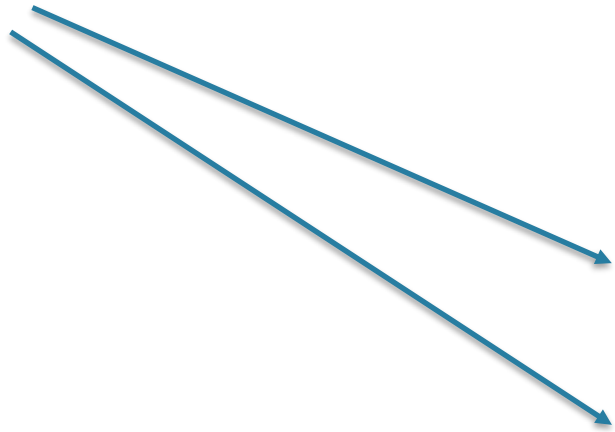
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*Both CAM and CAM-SIMA repositories are discussed*

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*Both CAM and CAM-SIMA repositories are discussed*

Description at top of each column is a "kludge"
- Needed comments for each column and this was the only way we figured out how to implement it
- Long comment
- Bullets are lined up by hand with dashes

## PR - Full Review  7

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| ⊞ Backlog | ⊞ CAM6.5 Priority | ⊞ CAM6.5 Sub-project | ▥ SE Workflow | ⊞ Assignee | ⊞ ADF | ⊞ CoupledEvals | ☰ View |

prstatus:"Upcoming PR","PR - Review Not Started","PR - Initial Review","PR - Full Review","Next Tag",Tag,"Closed (not tagged)","CAM-SIMA Tags","CAM Tags"

**Upcoming PR** 2          ⋯

◌ Draft ⋯
✦ ESCOMP/CAM #740 (update manage_externals)
To Do

⊙ CAM #740
Update manage_externals to latest version
To Do   enhancement

**PR - Review Not Started** 14          ⋯

⑂ CAM #815 ⋯
Add support for additional SE grids

⑂ CAM #824                                     🖶
Refactor aerosol optics for radiation transfer
answer changing    enhancement
👥 1 reviewer    ⊟ CESM2.3

◌ Draft
👆 New PRs Since Last Meeting 👆
To Do

◌ Draft
🖊 New PRs ----------------------------
🖊 Ready for initial review: ------------------
✦ ESCOMP/CAM #815 Coarse SE grid - ne3 - (John) - Will move out of draft soon and will be expedited to get coarse SE grids for testing
✦ ESCOMP/CAM #824 - Refactor aerosol optics for radiation transfer - (fvitt) - High priority PR to start the process ----------------
✦ ESCOMP/CAM #792 Fix PLB test - bring in with next externals update --------------------
✦ ESCOMP/CAM #650 CARMA unstructured grids-----------------------------------
✦ ESCOMP/CAM #702 (rainbows) - ready for initial review ------------------------------
To Do

+ Add item

**PR - Initial Review** 4          ⋯

◌ Draft
Progress:-----------------------------------
✦ ESCOMP/CAM #484 (GEOS-Chem) - fvitt - initial review ----------------------------------
🖊 PRs on HOLD ----------------------------
✦ ESCOMP/CAM #628 [replaces ESCOMP/CAM #595 (SCAM forcing)] - Julio suggested this go on hold until after CCPP? - need to concentrate on out-of-the-box setup ------------
To Do

⑂ CAM #484
GEOS-Chem chemistry and five new compsets that use it
To Do   🖶 1 reviewer    ⊟ CESM2.3

◌ Draft ⋯
👇 PRs on hold 👇
To Do

⑂ CAM #628                                     🖧
external gridded forcing capability for SCAM
Open PR - Initial Review    enhancement
👥 1 reviewer    ⊟ CESM2.3

+ Add item

**PR – Initial Review**: PRs where first reviewer has been assigned and is working on the preliminary review.  More efficient for the first reviewer to find the "obvious" changes

# Github Projects: Tag planning (labeled SE workflow)

## ⊕ CAM Development

| ▦ Backlog | ▦ CAM6.5 Priority | ▦ CAM6.5 Sub-project | ▥ SE Workflow ▾ | ▦ Assignee | ▦ ADF | ▦ CoupledEvals | ▤ View |
|---|---|---|---|---|---|---|---|

`prstatus:"Upcoming PR","PR - Review Not Started","PR - Initial Review","PR - Full Review","Next Tag",Tag,"Closed (not tagged)","CAM-SIMA Tags","CAM Tags"`

**Upcoming PR** 2   •••

◌ Draft •••
✷ ESCOMP/CAM #740 (update manage_externals)
To Do

⊙ CAM #740
Update manage_externals to latest version
To Do   enhancement

**PR - Review Not Started** 14   •••

⑂ CAM #815 •••
Add support for additional SE grids

⑂ CAM #824   🖶
Refactor aerosol optics for radiation transfer
answer changing   enhancement
👥 1 reviewer   ⊟ CESM2.3

◌ Draft
👆 New PRs Since Last Meeting 👆
To Do

◌ Draft
🖊 New PRs ------------------------------
🖊 Ready for initial review: -------------------
✷ ESCOMP/CAM #815 Coarse SE grid - ne3 - (John) - Will move out of draft soon and will be expedited to get coarse SE grids for testing
✷ ESCOMP/CAM #824 - Refactor aerosol optics for radiation transfer - (fvitt) - High priority PR to start the process ----------------
✷ ESCOMP/CAM #792 Fix PLB test - bring in with next externals update --------------------
✷ ESCOMP/CAM #650 CARMA unstructured grids------------------------------------
✷ ESCOMP/CAM #702 (rainbows) - ready for initial review -------------------------------
To Do

➕ Add item

**PR - Initial Review** 4   •••

◌ Draft
Progress: -------------------------------
✷ ESCOMP/CAM #484 (GEOS-Chem) - fvitt - initial review ------------------------------
🖊 PRs on HOLD -----------------------------
✷ ESCOMP/CAM #628 [replaces ESCOMP/CAM #595 (SCAM forcing)] - Julio suggested this go on hold until after CCPP? - need to concentrate on out-of-the-box setup ------------
To Do

⑂ CAM #484
GEOS-Chem chemistry and five new compsets that use it
To Do   🖶 1 reviewer   ⊟ CESM2.3

◌ Draft •••
👆 PRs on hold 👆
To Do

⑂ CAM #628   🔲
external gridded forcing capability for SCAM
Open PR - Initial Review   enhancement
👥 1 reviewer   ⊟ CESM2.3

➕ Add item

**PR – Initial Review**: PRs where first reviewer has been assigned and is working on the preliminary review.  More efficient for the first reviewer to find the "obvious" changes

**PR – Review Not Started**: PRs awaiting review.  Note the "New PRs Since Last Meeting"

# Github Projects: Tag planning (labeled SE workflow)



**PR – Initial Review**: PRs where first reviewer has been assigned and is working on the preliminary review. More efficient for the first reviewer to find the "obvious" changes

**PR – Review Not Started**: PRs awaiting review. Note the "New PRs Since Last Meeting"

**Upcoming PR**: Issues which are being actively worked and are very high priority (need tracking at this level), but PR is not yet created

# Github Projects: CoupledEval Tab

| 194 | ⊙ | add UT and UQ to cam_diagnostics  #807 | | | | CoupledEval3 |
| 195 | ⊙ | Introduce "-phys cam7" and remove "-phys cam_dev"  #813 | | | | CoupledEval3 |
| 196 | ⊙ | Introduce QPC7 and possibly QPS7 aquaplanet compsets  #814 | | | | CoupledEval3 |
| 197 | ⊙ | make HEMCO the default emissions module for all CAM configurations w/ emissions  #817 | | | | CoupledEval3 |
| 198 | ⊙ | dependance of some namelist default on the number of vertical levels (lev)?  #819 | | ⌄ | To Do ⌄ | CoupledEval3 |
| 199 | ⊙ | Provide RRTMGP as a radiation parameterization  #255 | brianpm an… ⌄ | | In Progress ⌄ | CoupledEval3 |
| 200 | ⊙ | Create testing compsets based on FLT,FMT,FW and FX  #765 | | ⌄ | To Do ⌄ | CoupledEval3 |
| 202 | ⊙ | Update tunings for LT and MT based on the "Tuning F"  #818 | cacraigucar | ⌄ | To Do ⌄ | CoupledEval2 |
| 204 | ⚏ | CAM tuning F and increase PE count for MT compsets  #820 | cacraigucar | ⚏ | | ⌄ | CoupledEval2 |
| 205 | ⊙ | Increase PE layout for MT runs  #812 | | ⌄ | To Do ⌄ | CoupledEval2 |
| 294 | ⊙ | bug in the lidar simulator (COSP1.4 and COSP2)  #262 | nusbaume | ⌄ | To Do ⌄ | bug  Coupled |
| 295 | ⊙ | Ensure CAM history files are closed when last frame is written  #290 | gold2718 | ⌄ | To Do ⌄ | bug  Coupled |
| 296 | ⊙ | failing history restart tests  #325 | | ⌄ | To Do ⌄ | bug  Coupled |

- CoupledEval2:  Current immediate need

- CoupledEval3:  Needed before next Coupled Evaluation or CESM release

- CoupledEval4-wish list: Wish list items for CESM release, but not crucial

# Static documentation

# Resources For CAM Developers

CAM wiki page: https://github.com/ESCOMP/CAM/wiki



Includes:
1. CAM documentation
2. How to submit changes to ESCOMP/CAM
3. CAM Coding Standards
4. CAM debugging techniques

# Specific CAM SE workflow

Have detailed "recipe" for CAM SEs to follow in making a tag
Includes:

- Opening a PR (if not already done)

- Addressing reviewer's comments

- Waiting for tag assignment to be made by CAM gatekeeper

- Merging to head of cam_development

- Running regression testing

- Committing changes (use github Merge button)

- Tagging the commit

- Archiving Baselines

- Adding CAM tag to CESM plans page

# Gatekeeper viewpoint of pros/cons

**Pros:**
- Able to use projects page to organize thoughts as I make plans for the week and users to dive down into issues/PRs for more details

- No duplication of effort – the tool I use to manage my gatekeeping tasks is the tool we use to communicate with the scientists

- Enables communication between scientists and SEs

**Cons:**
- Takes some manual effort to implement the process (but I use the process to organize my thoughts, so not a bad con)

- Competing priorities need verbal discussion to determine final order

- Sometimes plans change mid-week due to external factors – need to be flexible – I don't guarantee that the projects page is updated mid-week, but will communicate via email with people who are impacted

- Comment at top of each column is very much a hack and a pain to implement bullets (but necessary to add descriptions and keep everything in one place)

Thank you


Questions?