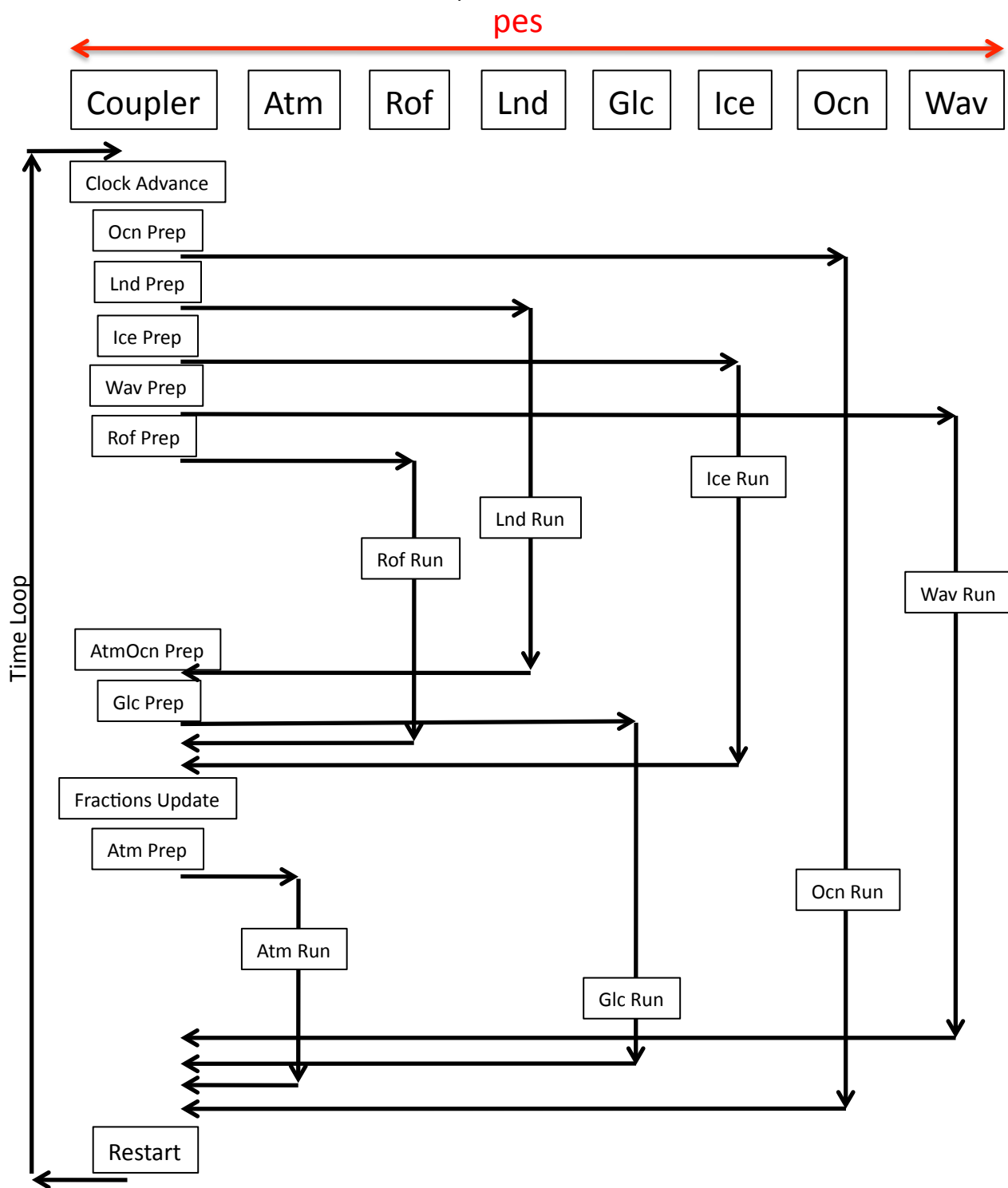


## CESM1.3 Coupler Sequencing

- In CESM1.3, a new option, `cpl_seq_option`, was added to the coupler to control the coupler sequencing. At the same time, the `ocean_tight_coupling` flag was removed and that feature was incorporated in the `cpl_seq_option`. There are currently six different settings for the `cpl_seq_option` flag
  - `CESM1_ORIG` – This was the default option prior to CESM1.2 and was defined many years ago to produce reasonable science and maximize model concurrency for efficiency.
  - `CESM1_ORIG_TIGHT` – This option matches the original CESM1.2 sequencing with the `TIGHT_COUPLING_OPTION` turned on. With the tight coupling option, the ocean fields are passed back to the coupler prior to the atm/ocean flux calculation reducing the lags between the ocean and atmosphere.
  - `CESM1_MOD` – This option introduces a small change in the sequencing to reduce the coupling lag. The order of the ocean accumulation and the atm/ocean flux calculation is reversed so the ocean forcing accumulates the latest atm/ocean flux instead of the one from the prior timestep. This reduces the lag between the atmosphere and ocean and has no impact on performance. It became the default in CESM1.3.
  - `CESM1_MOD_TIGHT` – This combines the `CESM1_MOD` setting with the tight ocean coupling.
  - `RASM_OPTION1` – This option shifts the atm/ocean flux calculation and ocean accumulation to the top of the run loop and eliminates concurrency of those calculations with the ocean model. But this significantly reduces many of the coupling lags including between the flux calculation, the ocean model, and the ice model.
  - `RASM_OPTION2` – This option builds on `RASM_OPTION1` but includes a further sequencing between the ice and ocean models. This option is only useful when the ocean model is running at the same coupling frequency as the ice model. In this case, the ocean model runs sequentially after the ice model and lags in coupling between the ocean and ice models are further reduced.
- In addition, another feature was added in CESM1.3 that allows the atm/ocean flux to be computed on the atm grid instead of the ocean grid. When that happens, the coupler operations are modified to support that feature. The namelist variable that controls the atm/ocn flux grid is called `aoflux_grid`. By default, that is set to “ocn” but the other option is for it to be set to “atm”.
- The following four schematics provide a high level summary of the sequencing and concurrency for the six coupler sequencing options above.
- That is followed by several detailed coupler flow diagrams for different coupler sequencing and atm/ocn flux grid settings. The `cpl_seq_option` and `aoflux_grid` option are noted in the upper right hand corner of these diagrams.

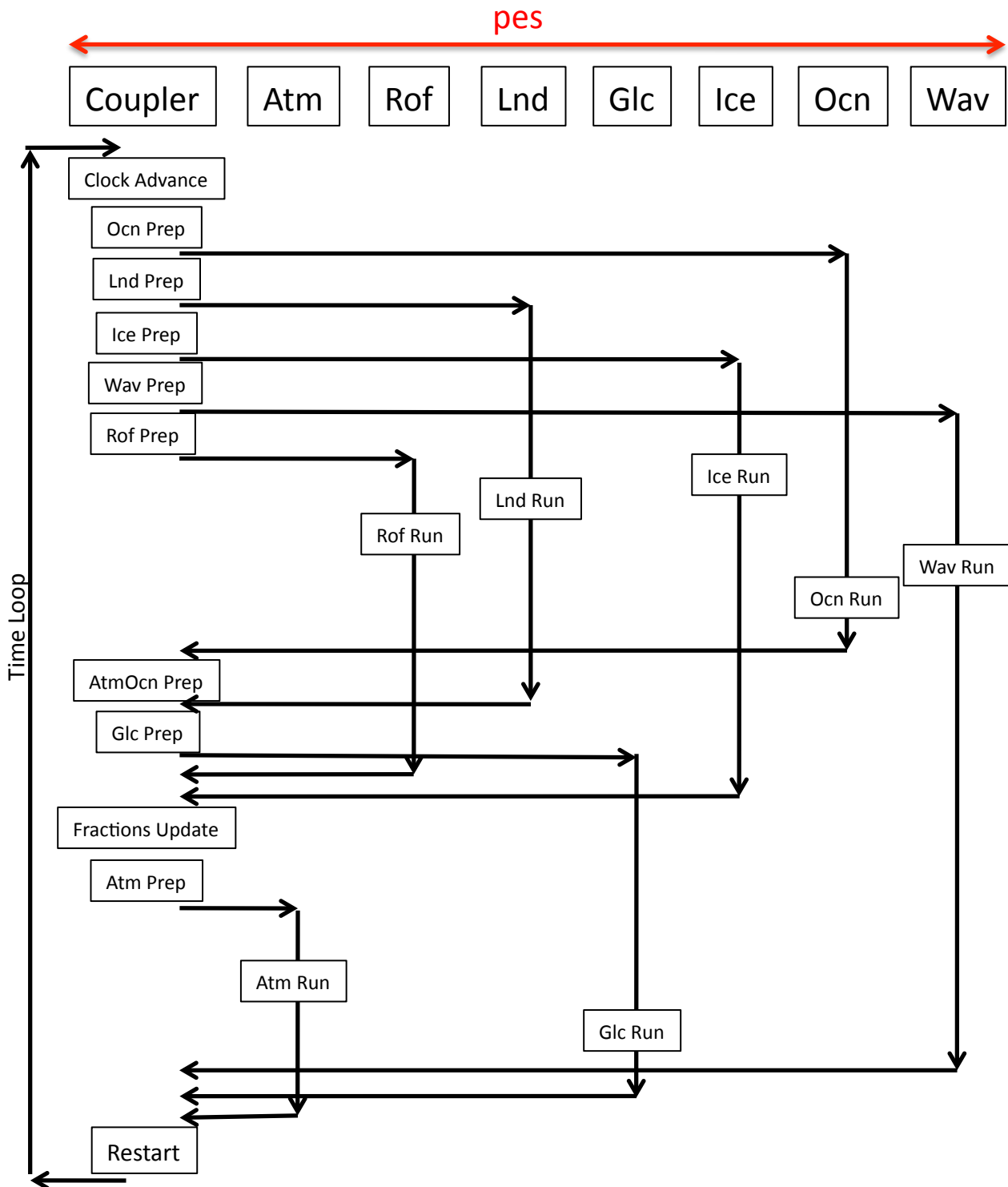
## CESM1.3 Concurrency Sequencing CESM1\_ORIG, CESM1\_MOD

- Plot of concurrency sequencing in CESM1.3 for standard default setup. Down is time, horizontal is processor layout.
- Horizontal Lines are Coupler-Component Communication.
- Vertical Lines Indicate when a component can run if concurrent.



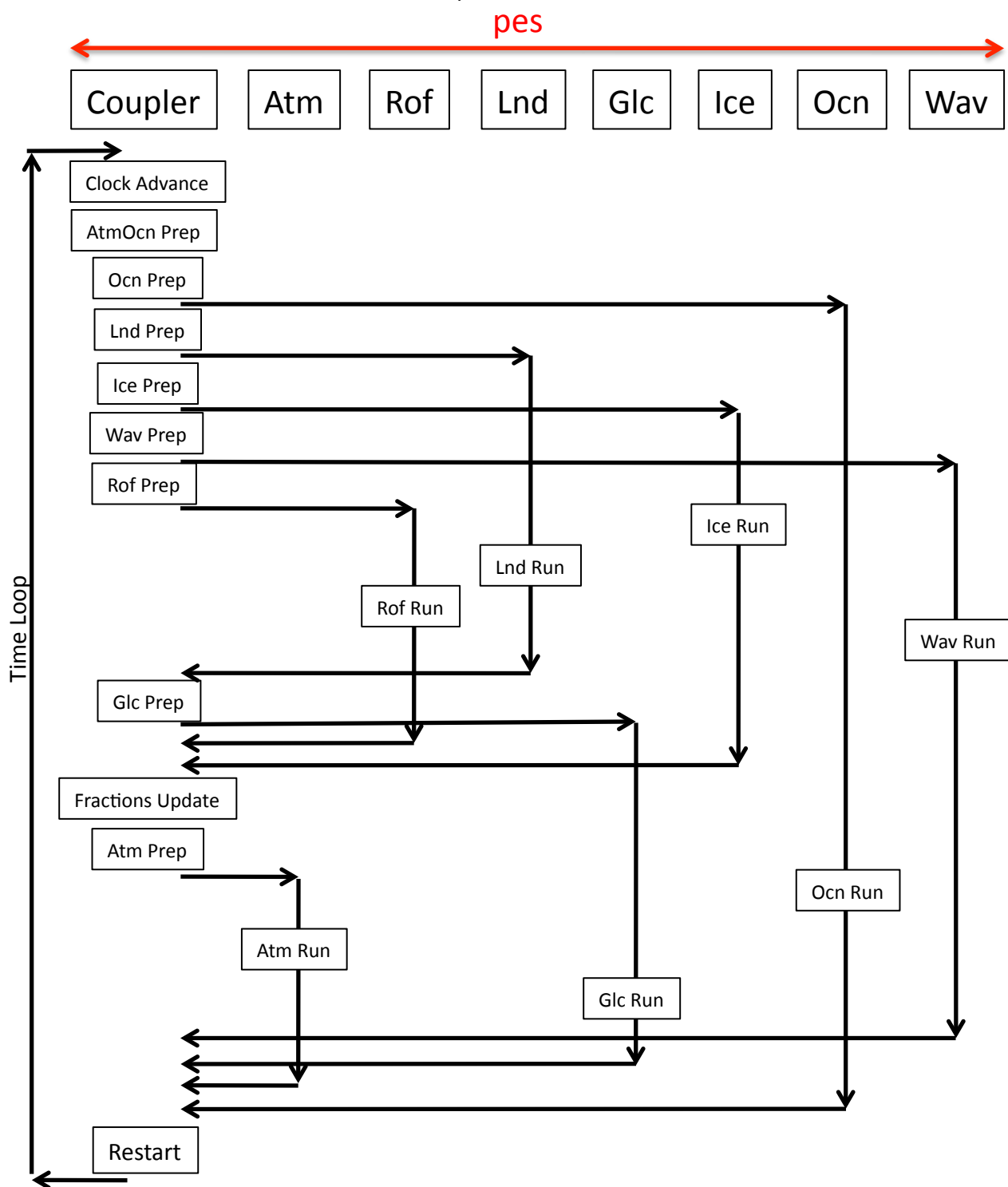
## CESM1.3 Concurrency Sequencing CESM1\_ORIG\_TIGHT, CESM1\_MOD\_TIGHT

- Plot of concurrency sequencing in CESM1.3 for standard default setup. Down is time, horizontal is processor layout.
- Horizontal Lines are Coupler-Component Communication.
- Vertical Lines Indicate when a component can run if concurrent.



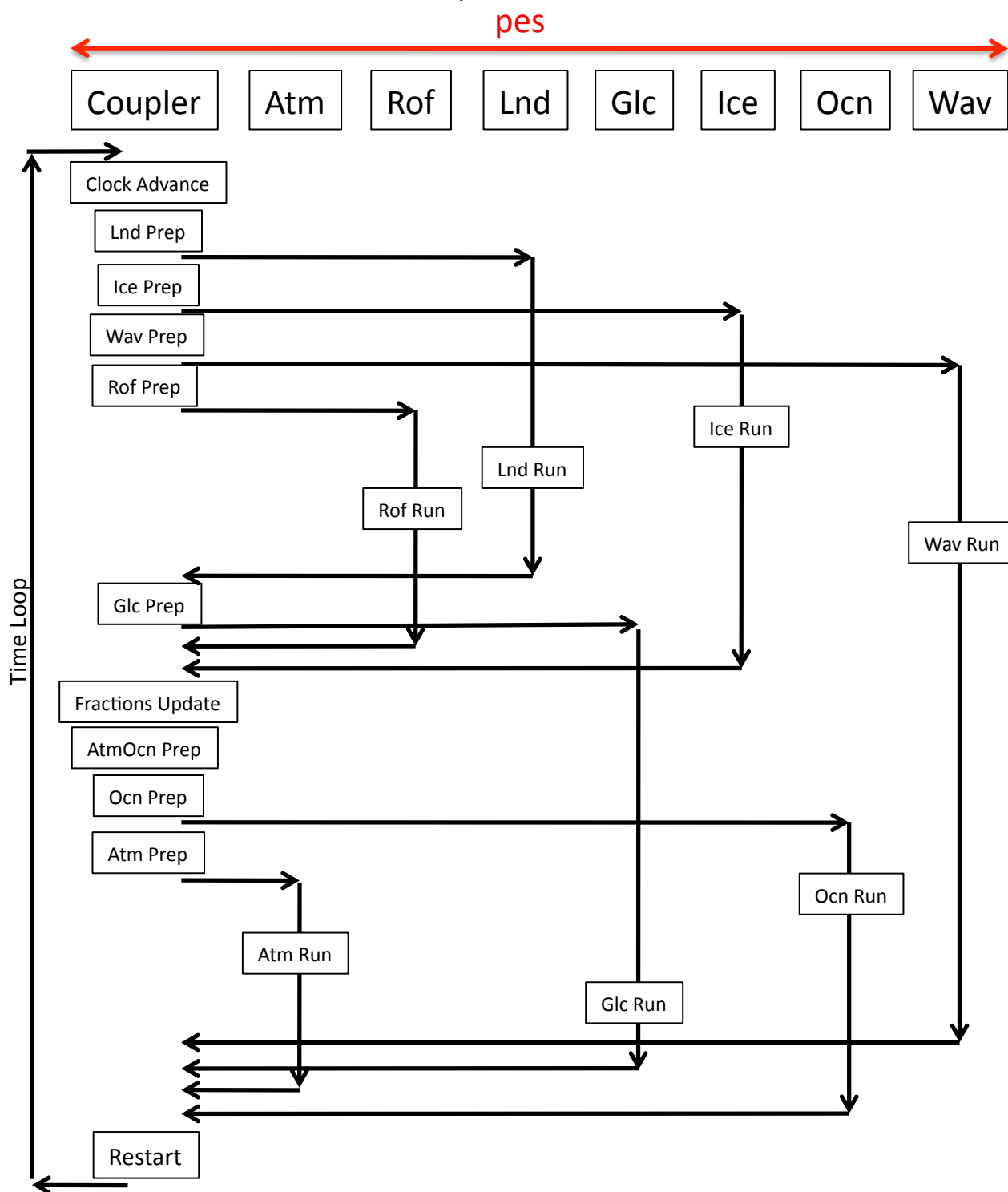
## CESM1.3 Concurrency Sequencing RASM\_OPTION1

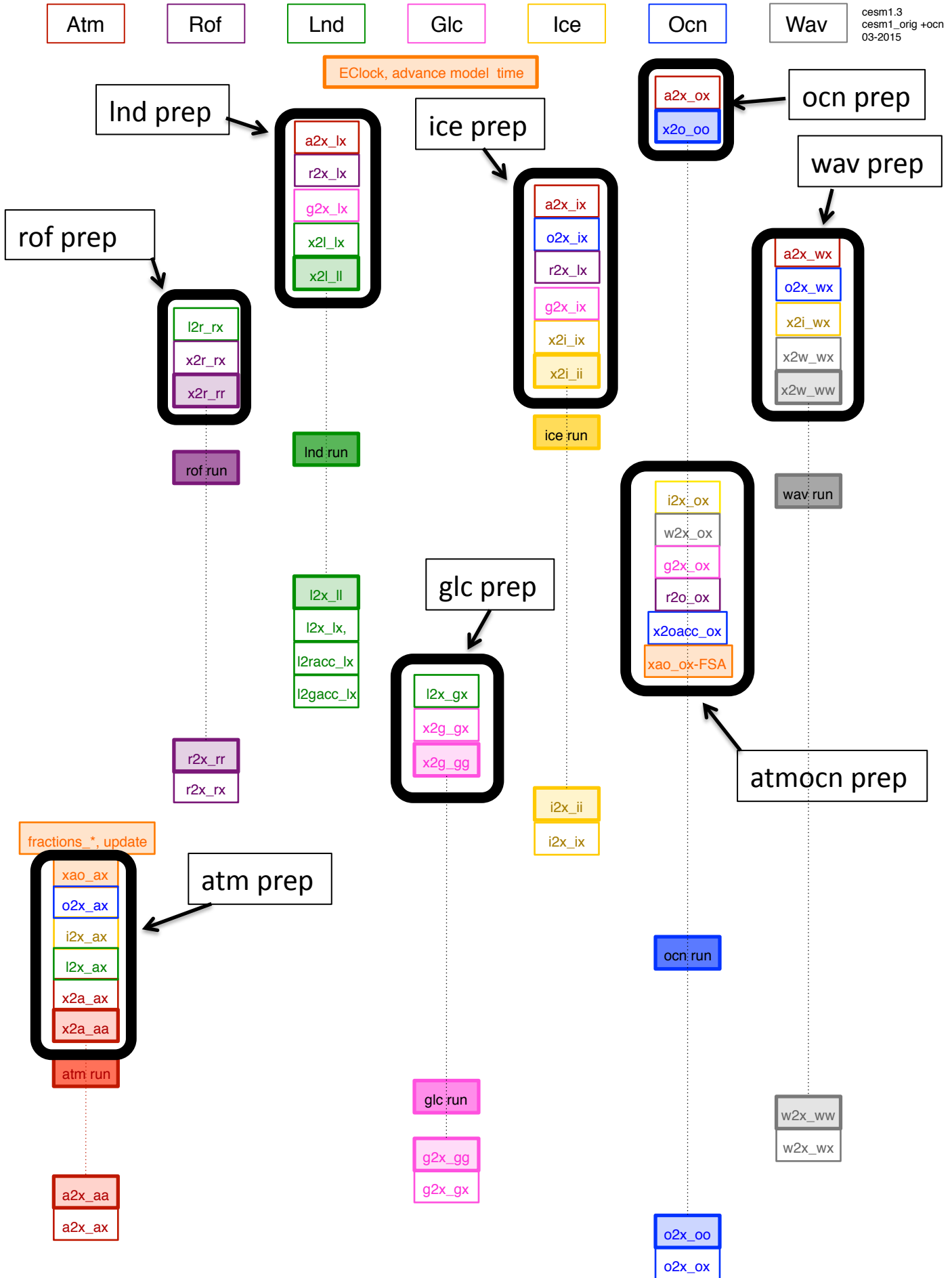
- Plot of concurrency sequencing in CESM1.3 for standard default setup. Down is time, horizontal is processor layout.
- Horizontal Lines are Coupler-Component Communication.
- Vertical Lines Indicate when a component can run if concurrent.



## CESM1.3 Concurrency Sequencing RASM\_OPTION2

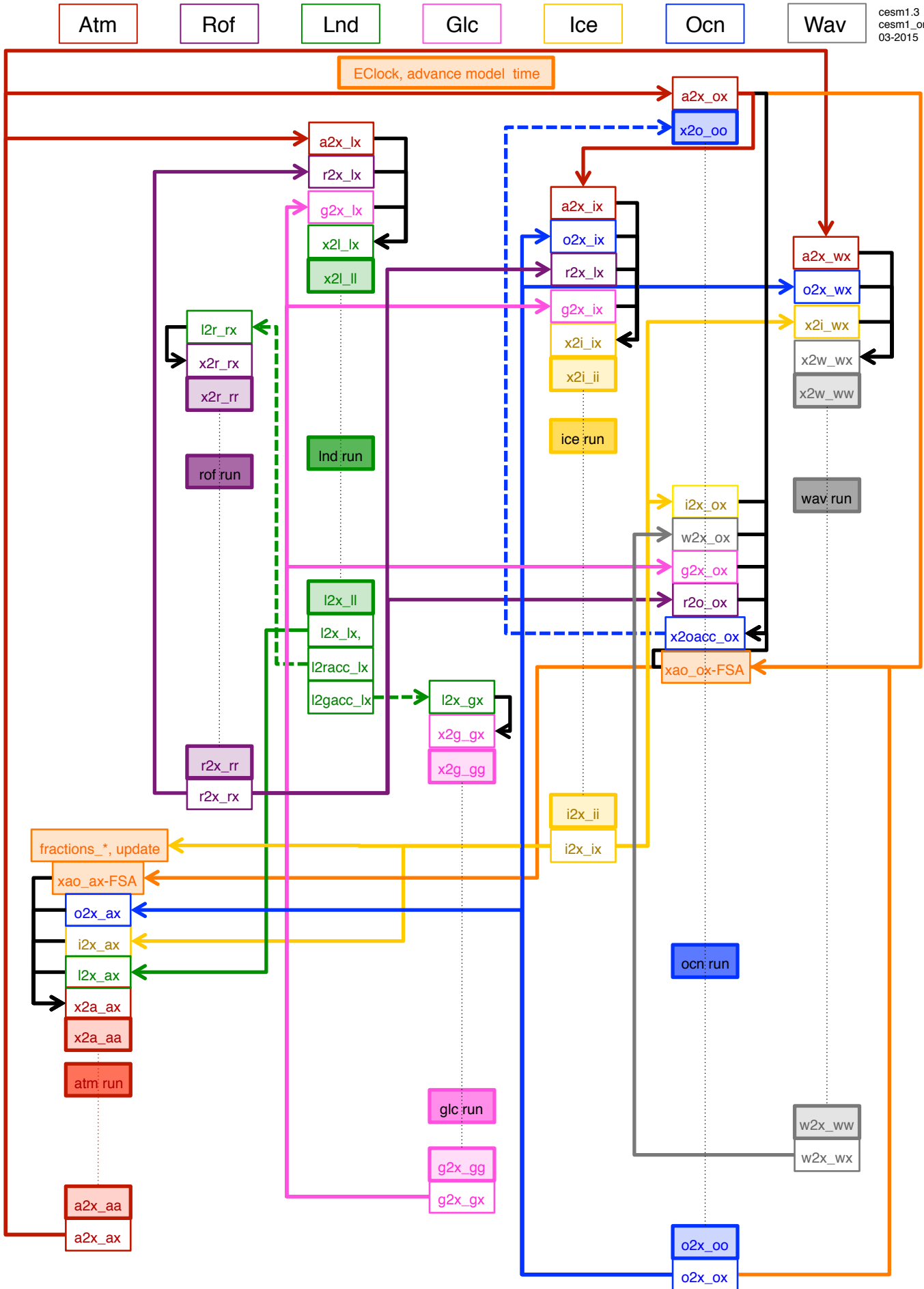
- Plot of concurrency sequencing in CESM1.3 for standard default setup. Down is time, horizontal is processor layout.
- Horizontal Lines are Coupler-Component Communication.
- Vertical Lines Indicate when a component can run if concurrent.





# CESM1.3 Coupler Flow Diagrams

- The diagram represents the flow of data in the driver/coupler in a coupler timestep from top to bottom. (Note that because of the ability to couple the runoff, glacier, wave and ocean models at lower frequencies, not every action is necessarily taken every coupler timestep)
- Boxes represent coupler data. Each colored box is associated with data from or for a particular component
  - atm = red
  - runoff = purple
  - land = green
  - glc (land ice) = pink
  - sea ice = yellow
  - ocean = blue
  - wav = grey
  - coupler = orange (coupler data is data that cannot be readily directly associated with just a single component model)
- Each column is associated with data on a component's grid. The time evolution of coupling data for a particular component can be traced by moving down a column. The columns do NOT represent work done on different processors.
- All operations are run on the coupler processors except
  - the darker shaded boxes are the component run methods and they run on the processors assigned to each component.
  - the lighter shaded boxes represent movement of coupling data from the coupler processors to the component processors (or vice versa). the light shaded boxes are the points where the coupler processors and component processors synchronize in time. At those points, the receiver is blocking and the sender is non-blocking.
- Arrows indicate coupler operations
  - Colored Solid arrows are associated with mapping data from one grid to another (colored arrows are always associated with that specific component's data)
  - Black Solid arrows are associated with merging data
  - Orange arrows are associated with coupler data
  - Dashed arrows are associated with coupler averaging
  - Arrows that are pointed up are indicative of data used from the previous timestep and will need to be saved to the coupler restart file.
- Data Naming convention follows CESM (ie. i2x\_ox)
  - x, a, l, r, g, o, i, and w mean coupler, atm, lnd, rof, glc, ocn, ice and wav respectively
  - the first part of the naming convention (ie. x2i) indicates the coupling data
    - x2\* is input data to component \*. (ie. x2a is coupler to atm data)
    - \*2x is output data from component \*. (ie. o2x is ocean to coupler data)
  - the second part of the naming convention (ie. \_lx) indicates the grid and processors associated with the data respectively. \_lx means data on the land grid on the coupler processors. \_ll means land data on the land processors. All unshaded boxes will have second character x because they are all on the coupler processors. Data passed between the coupler and component take the naming convention of the component model.
  - xao are the atmosphere/ocean fluxes and F, S, and A represent fluxes, states, and albedos respectively in that bundle. ocean albedos are always computed on the ocean grid.





Atm

Rof

Lnd

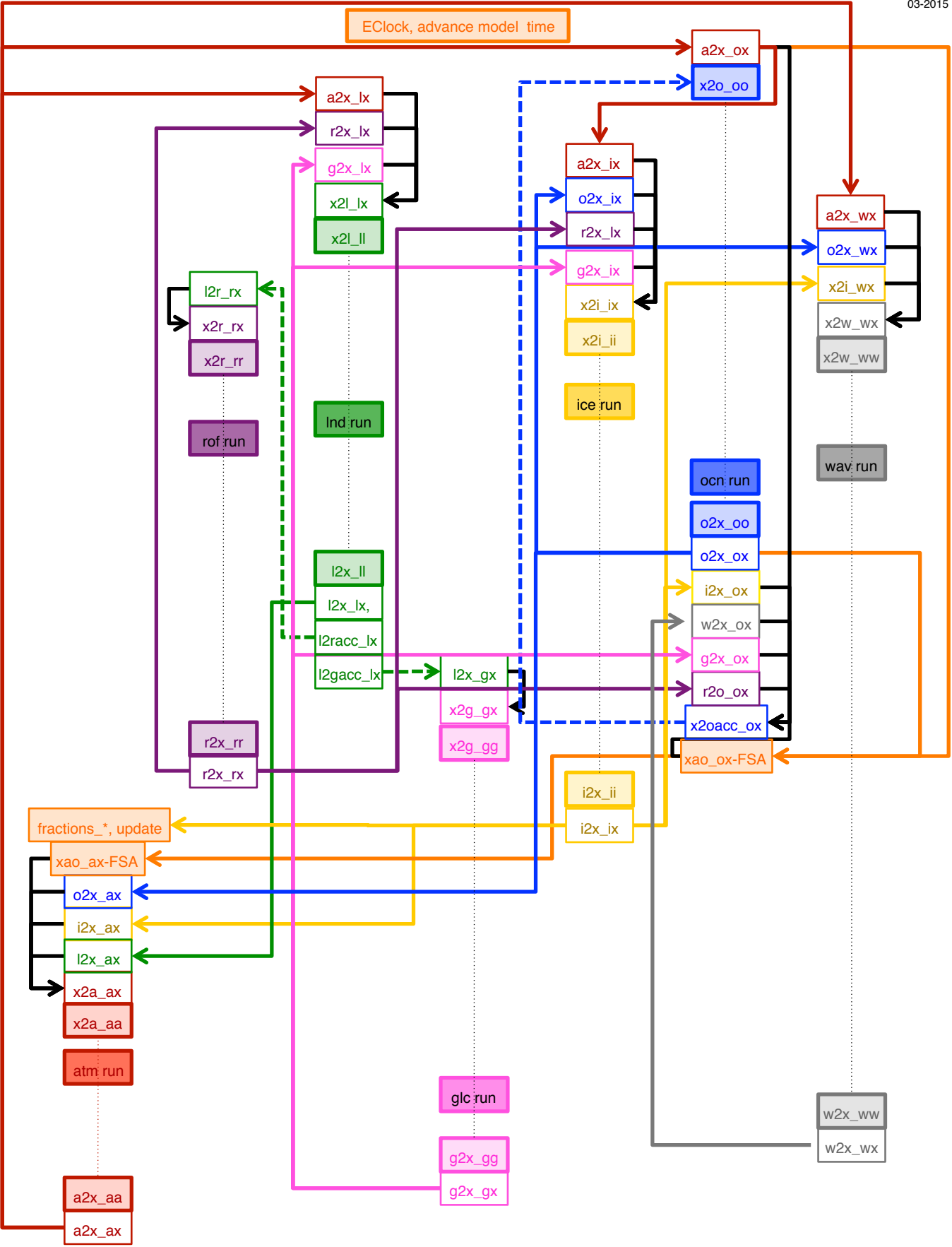
Glc

Ice

Ocn

Wav

cesm1.3  
cesm1\_orig\_tight  
+ ocn  
03-2015



Atm

Rof

Lnd

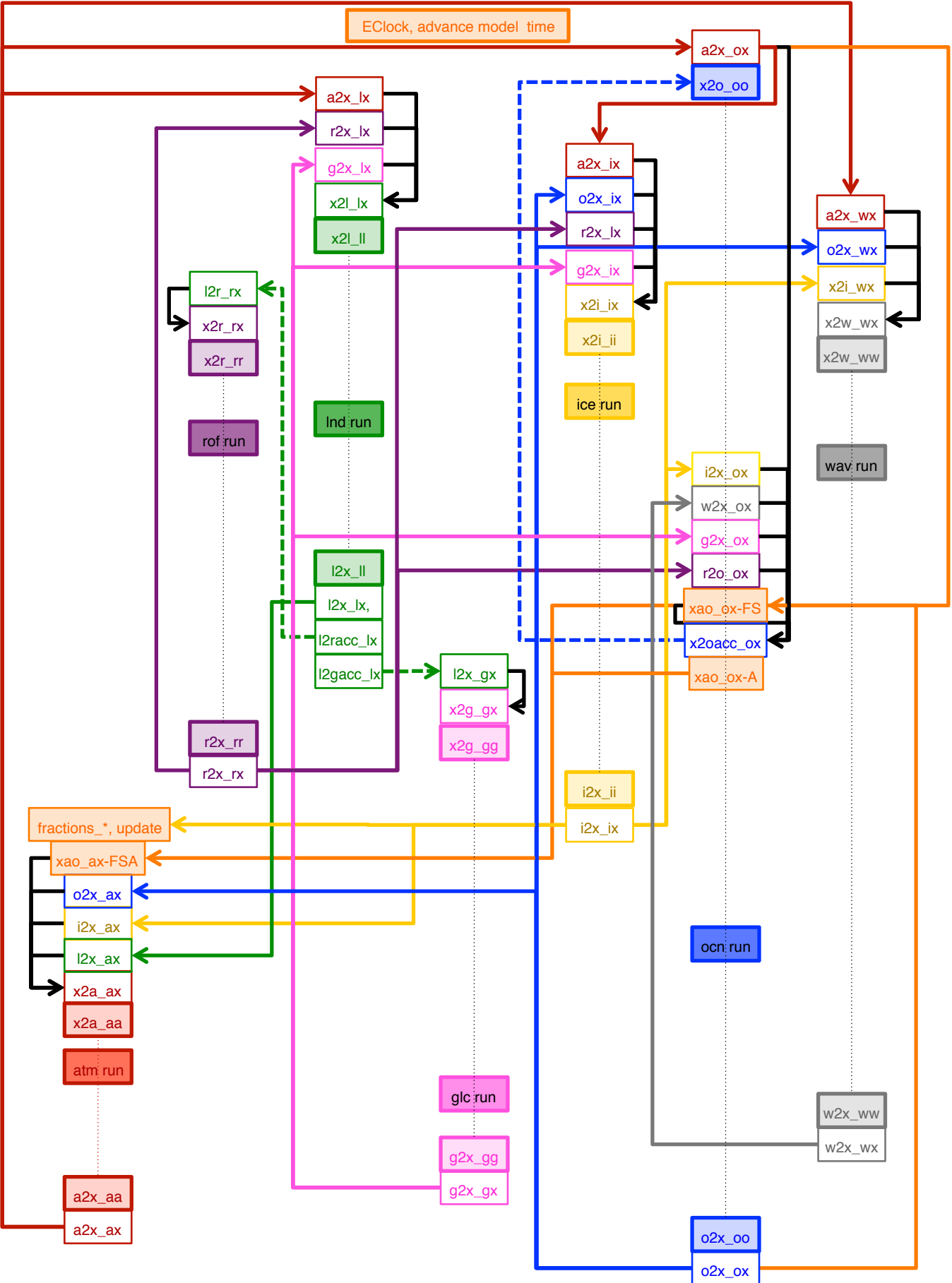
Glc

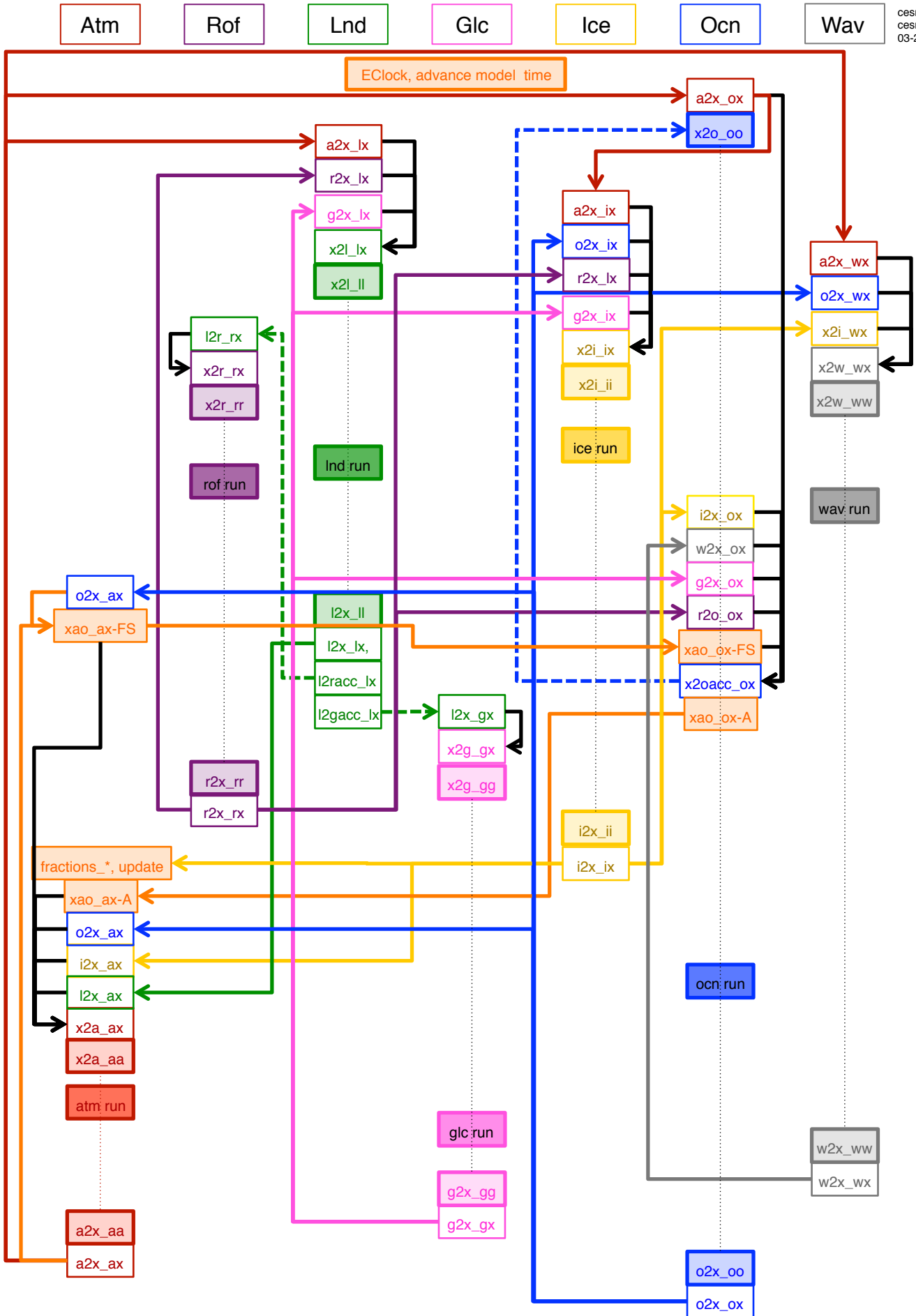
Ice

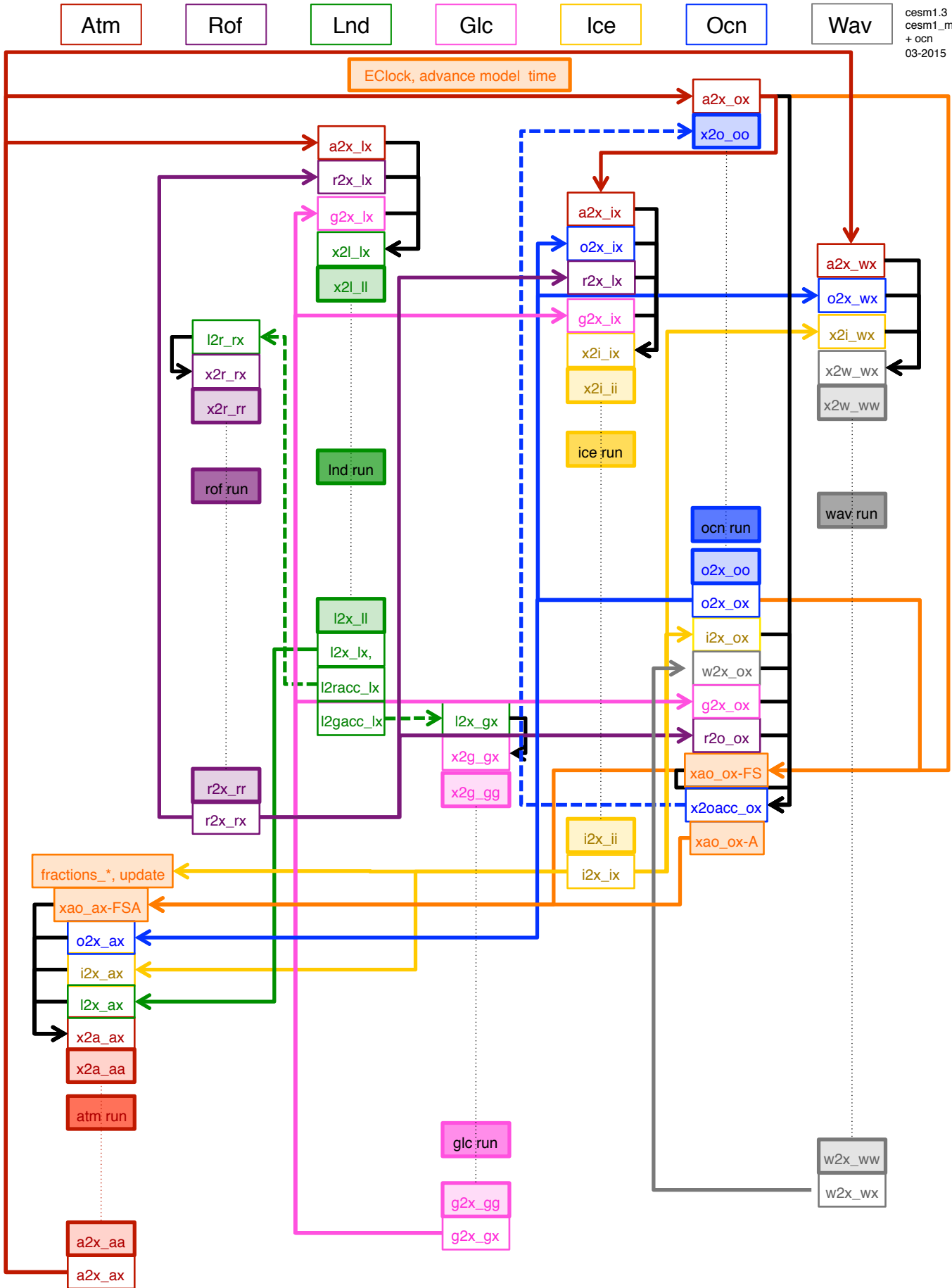
Ocn

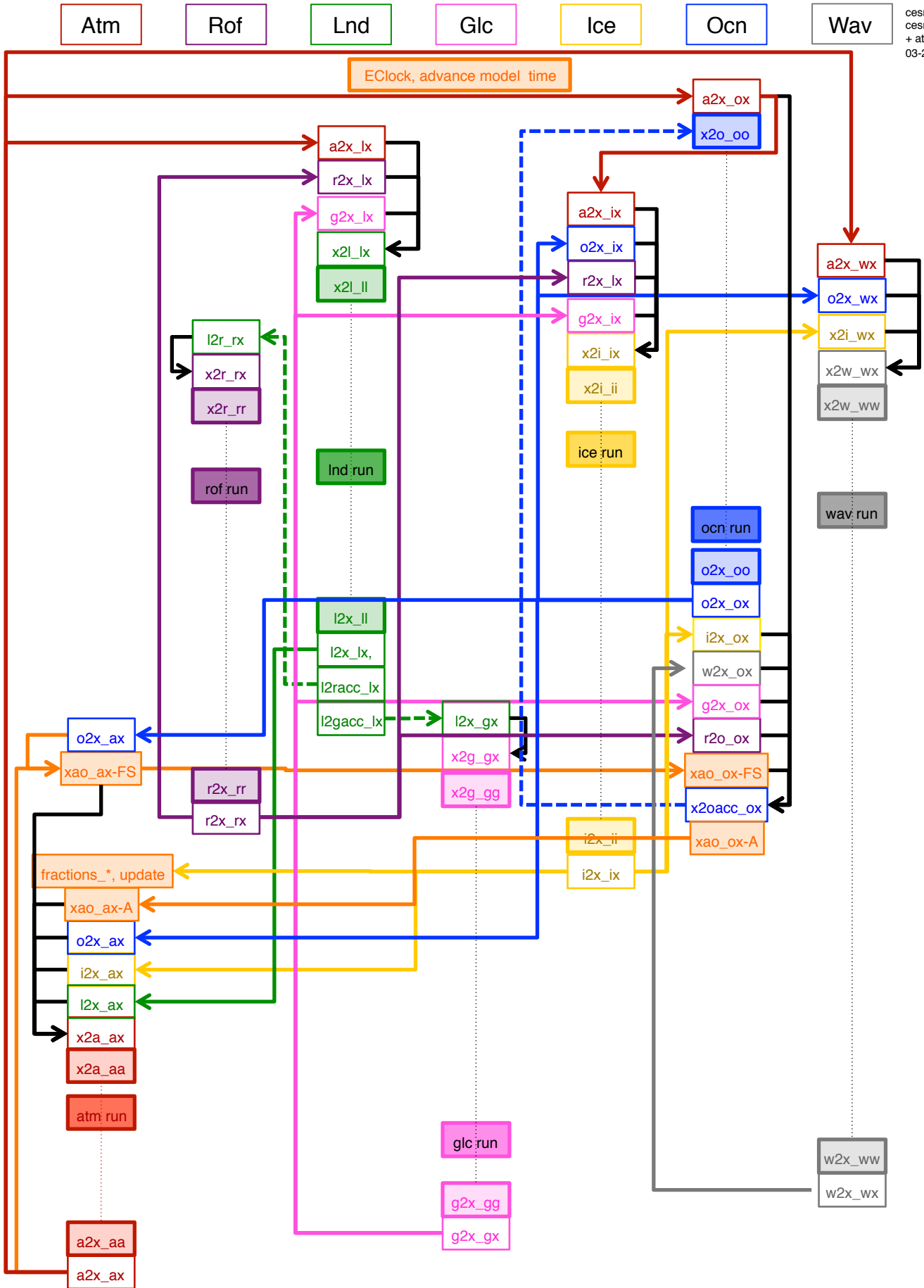
Wav

cesm1.3  
cesm1\_mod + ocn  
03-2015









Atm

Rof

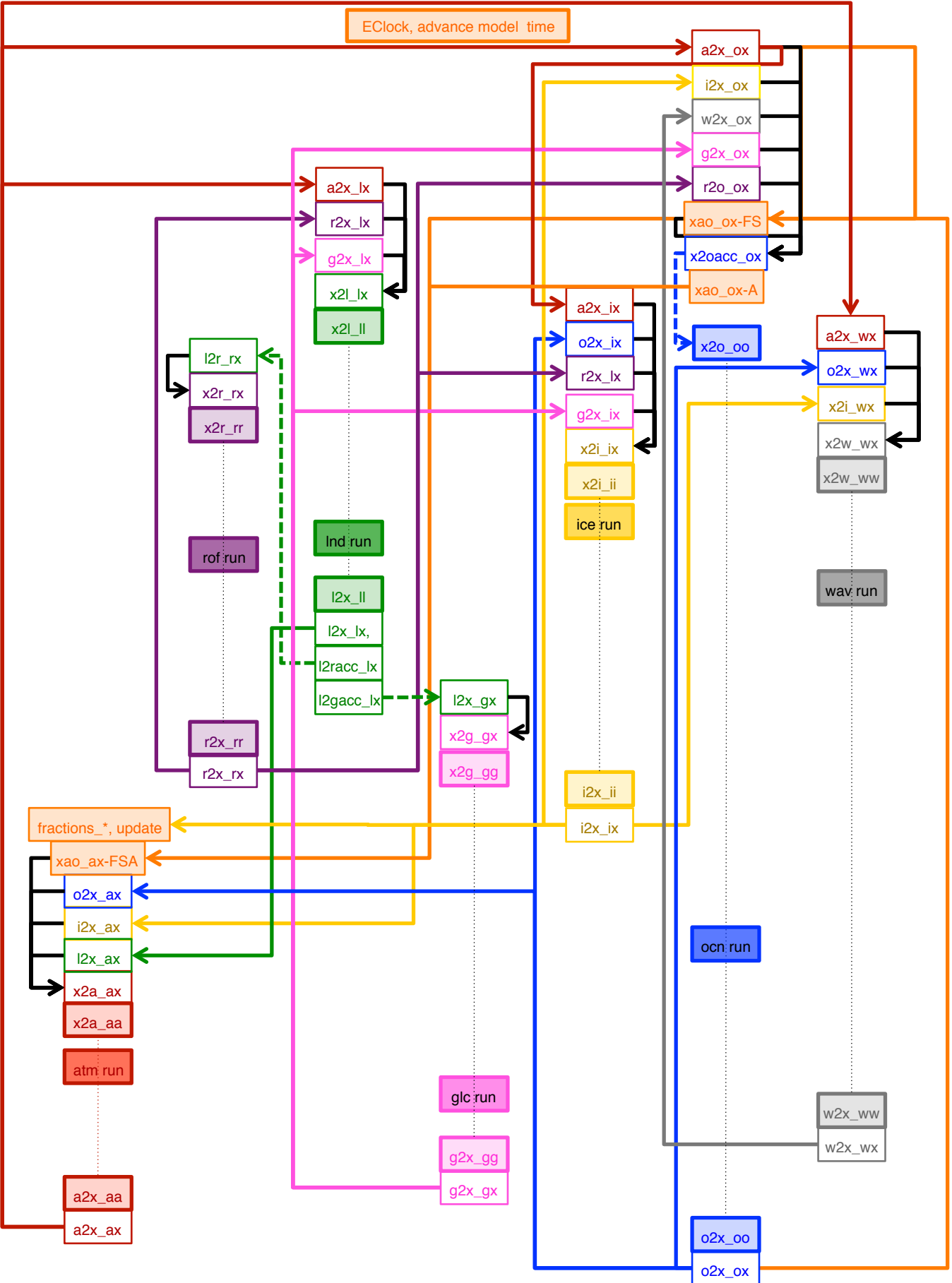
Lnd

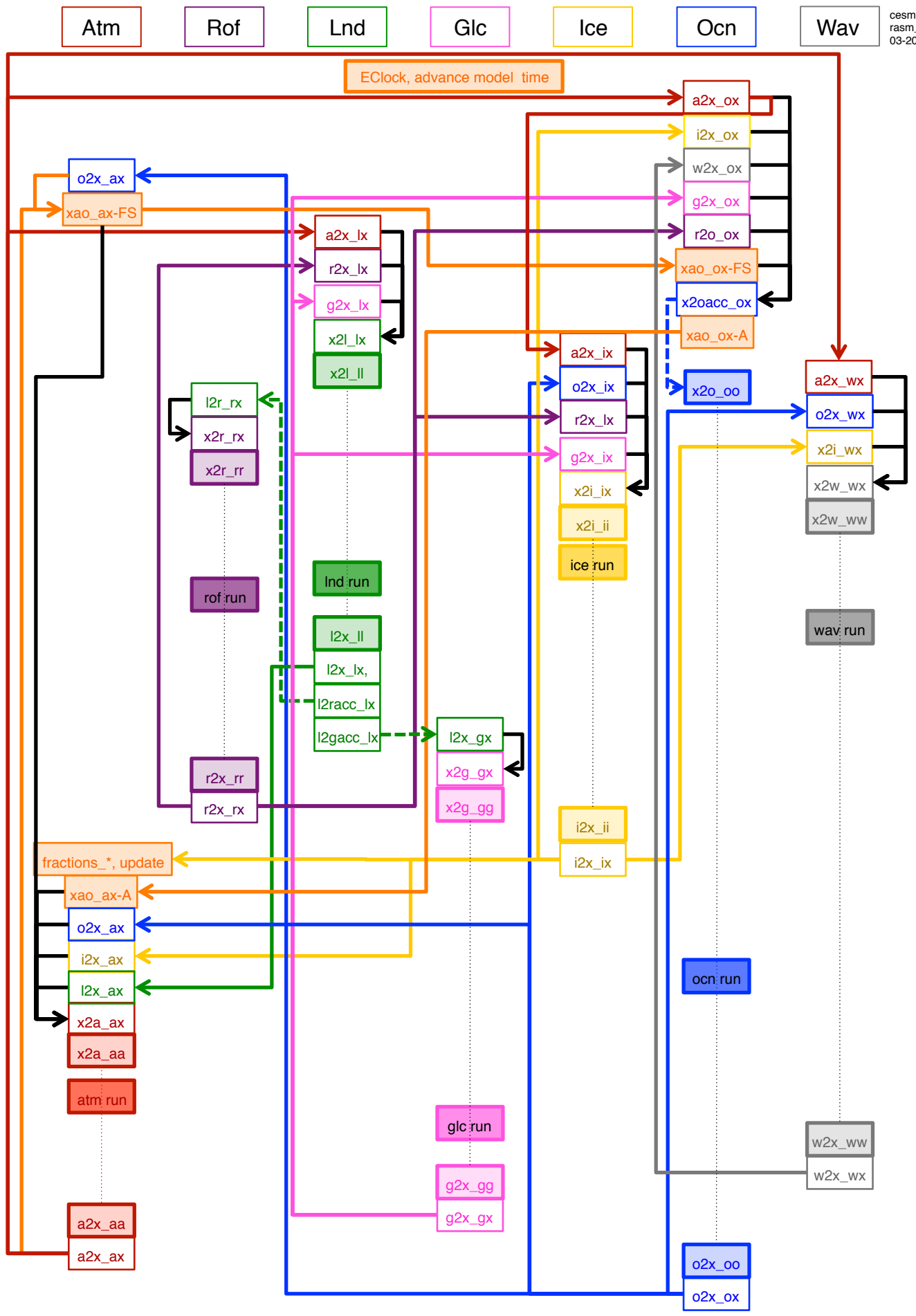
Glc

Ice

Ocn

Wav





Atm

Rof

Lnd

Glc

Ice

Ocn

Wav

EClck, advance model time

o2x\_ax

xao\_ax-FS

a2x\_lx

r2x\_lx

g2x\_lx

x2l\_lx

x2l\_ll

l2r\_rx

x2r\_rx

x2r\_rr

rof run

lnd run

l2x\_ll

l2x\_lx

l2racc\_lx

l2gacc\_lx

r2x\_rr

r2x\_rx

l2x\_gx

x2g\_gx

x2g\_gg

fractions\_\*, update

xao\_ax-A

o2x\_ax

i2x\_ax

l2x\_ax

x2a\_ax

x2a\_aa

atm run

a2x\_aa

a2x\_ax

glc run

g2x\_gg

g2x\_gx

i2x\_ii

i2x\_ix

ice run

ocn run

o2x\_oo

o2x\_ox

a2x\_wx

o2x\_wx

x2i\_wx

x2w\_wx

x2w\_ww

wav run

w2x\_ww

w2x\_wx

a2x\_ox

i2x\_ox

w2x\_ox

g2x\_ox

r2o\_ox

xao\_ox-FS

x2oacc\_ox

xao\_ox-A

x2o\_oo

a2x\_ix

o2x\_ix

r2x\_lx

g2x\_ix

x2i\_ix

x2i\_ii

ice run

