

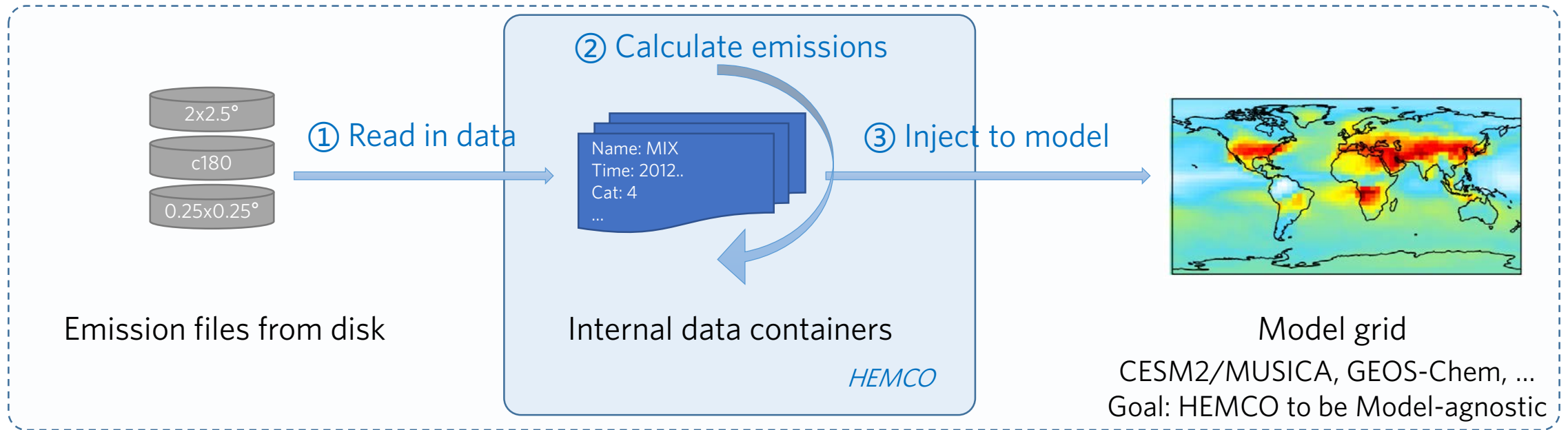
Harmonized Emissions Component (HEMCO)

# Developments at Harvard and collaboration with NCAR

Haipeng Lin, March 4, 2020

# Task separation

*"Emissions Tool" = HEMCO + Interfaces*



Goals:

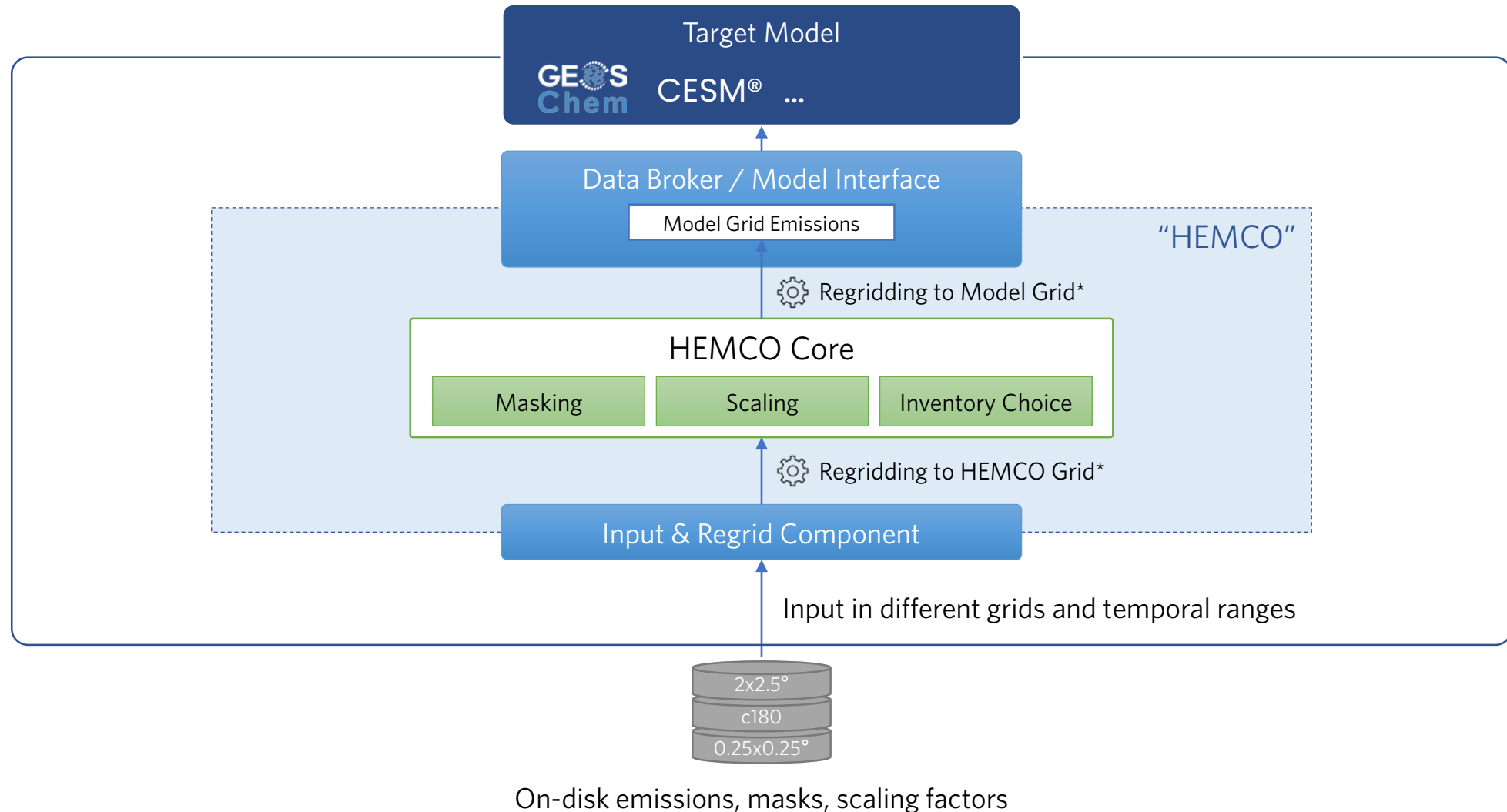
- (1) Separating "hard-coded" GEOS-Chem or MAPL ExtData input layers
- (2) Isolate the "HEMCO Core"
- (3) Creating a more flexible "model speciation" interface

# Challenges and requirements

- Key goal: **on-line emissions tool** with support for many formats
  - Input: gridded, point, airplane, 2D, 3D, ... (*\* only gridded for now, see discussion for others*)
  - Output: (**maybe adaptive**) model grid.
- **Isolate** code that is specific to how HEMCO **interfaces** with the model
  - i.e. I/O, regrid (either as part of input which is in different grids & injection to model grid)
  - & data “injection” phase (interface with the atmospheric model)
  - Includes isolating frameworks (ESMF, MAPL...) to reduce external dependencies
- Foster collaboration through **unified HEMCO code-base** for all models
  - Two-stage restructuring:
    - Clean structure within GEOS-Chem “Classic” to avoid code divergence;
    - HEMCO\_CESM will build upon the restructured HEMCO asap.

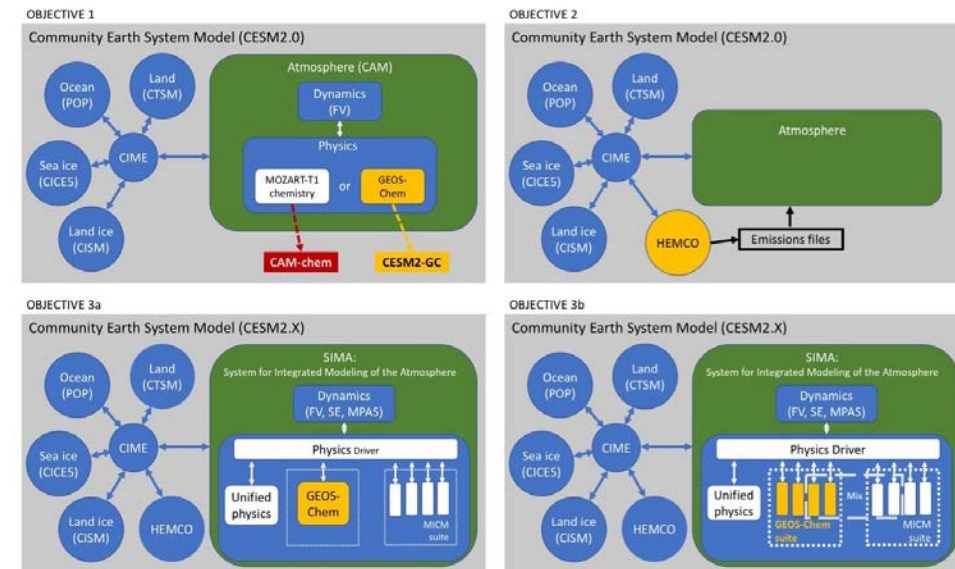
\* HEMCO Grid is *optionally* different from the model grid.

# HEMCO 3.0 Overview



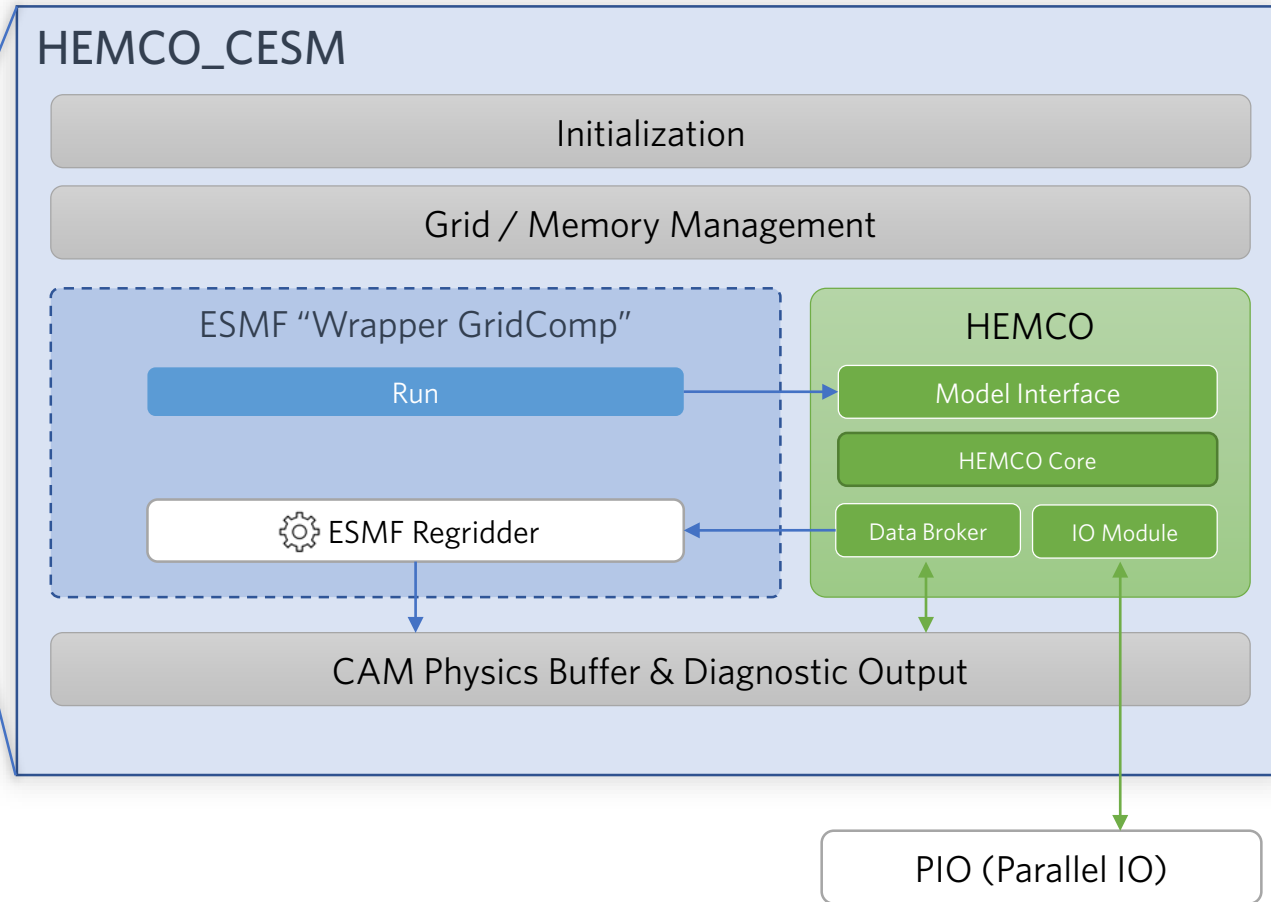
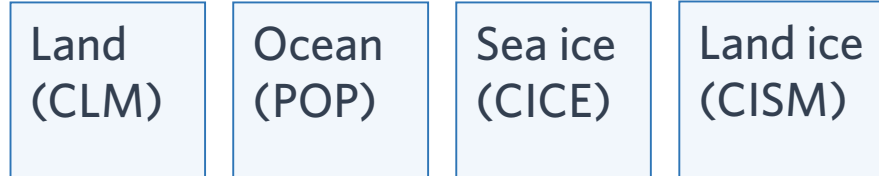
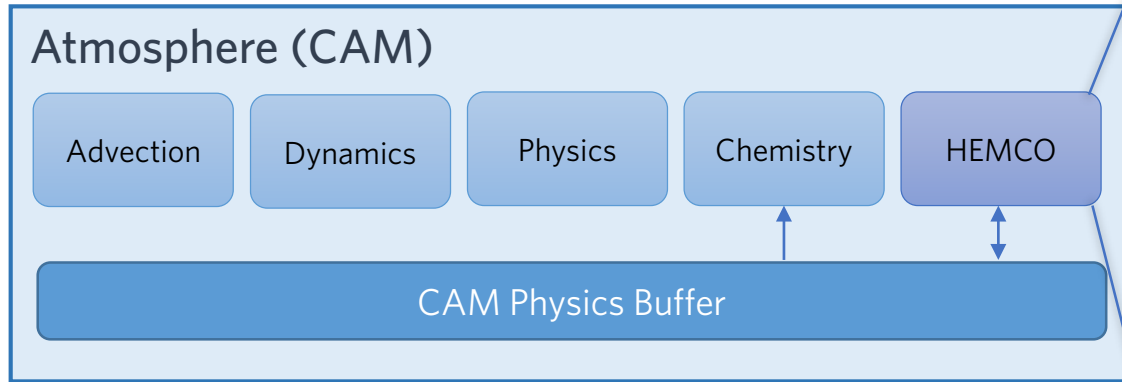
# HEMCO-CESM Project

- Online emissions for *chemistry* in CESM
- Independent of chemistry scheme (CAM-Chem, CESM-GC)
  - Serve emission fluxes given arbitrary configuration
- Independent module within the atmosphere (CAM)
  - Runs on its own grid
  - Own memory and process space
  - Independently updated as an external in CAM
  - CESM3 ready



# HEMCO-CESM Architecture

CESM2



# Working timeline

## Dec '19 – Mar '20

- Meet with NCAR, designing HEMCO-CESM interface
- Prototyping of HEMCO-CESM ESMF interface with “intermediate grid” capability
- Restructuring of HEMCO I/O, Regrid

Follow developments at:  [jimmielin/HEMCO\\_CESM](https://github.com/jimmielin/HEMCO_CESM) (nightly), [geoschem/HEMCO](https://github.com/geoschem/HEMCO) (dev/3.0.0)

## March – June '20

- Restructuring of HEMCO Model interface, configuration file split
  - “Git submodule” in GEOS-Chem Classic
- Continue work on HEMCO-CESM, “Alpha” version by summer
  - Testing with CAM-Chem and/or CESM2-GC (depending on version compatibility)

## Throughout summer/fall 2020

- Merge HEMCO-CESM into CESM2 “trunk”
- Merge restructured HEMCO “3.0” into GEOS-Chem/GCHP, GEOS-5, CESM2/3, ...
- ...

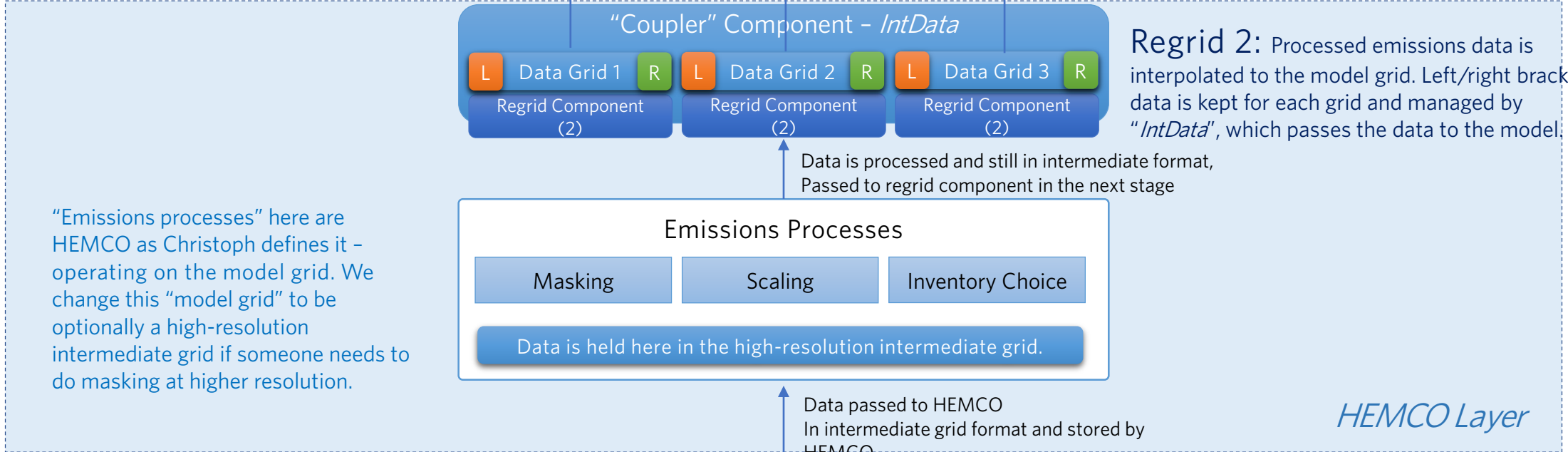




*High-level overview*

*Data flow: Bottom to top*

Data leaves "HEMCO" in the grid that the model operates on, which may be multiple grids. If not just ignore the below three horizontal boxes and consider them as one.



"Emissions processes" here are HEMCO as Christoph defines it - operating on the model grid. We change this "model grid" to be optionally a high-resolution intermediate grid if someone needs to do masking at higher resolution.

**Regrid 2:** Processed emissions data is interpolated to the model grid. Left/right bracket data is kept for each grid and managed by "IntData", which passes the data to the model.

Data is processed and still in intermediate format, Passed to regrid component in the next stage

Emissions Processes

Masking

Scaling

Inventory Choice

Data is held here in the high-resolution intermediate grid.

Data passed to HEMCO  
In intermediate grid format and stored by HEMCO

*HEMCO Layer*

Regrid Component (1)

**Regrid 1:** Regrid from input to unified grid, at user-defined "intermediate resolution". Can be model resolution if user has no special needs.

Input Component

Analogous to ExtData in ESMF/MAPL, or NcdfUtil in GCC. Role: Read data from disk using whatever method that is suited to the model (serial, parallel...)

Input in different grids and temporal ranges

Emissions, masks, scales data on disk (any resolution, netCDF)