MIT LABORATORY FOR
AVIATION AND
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CESM-GC: GEOS-Chem in CESM

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Work planned as part of an MIT, Harvard, and NCAR ACOM collaboration

Motivation

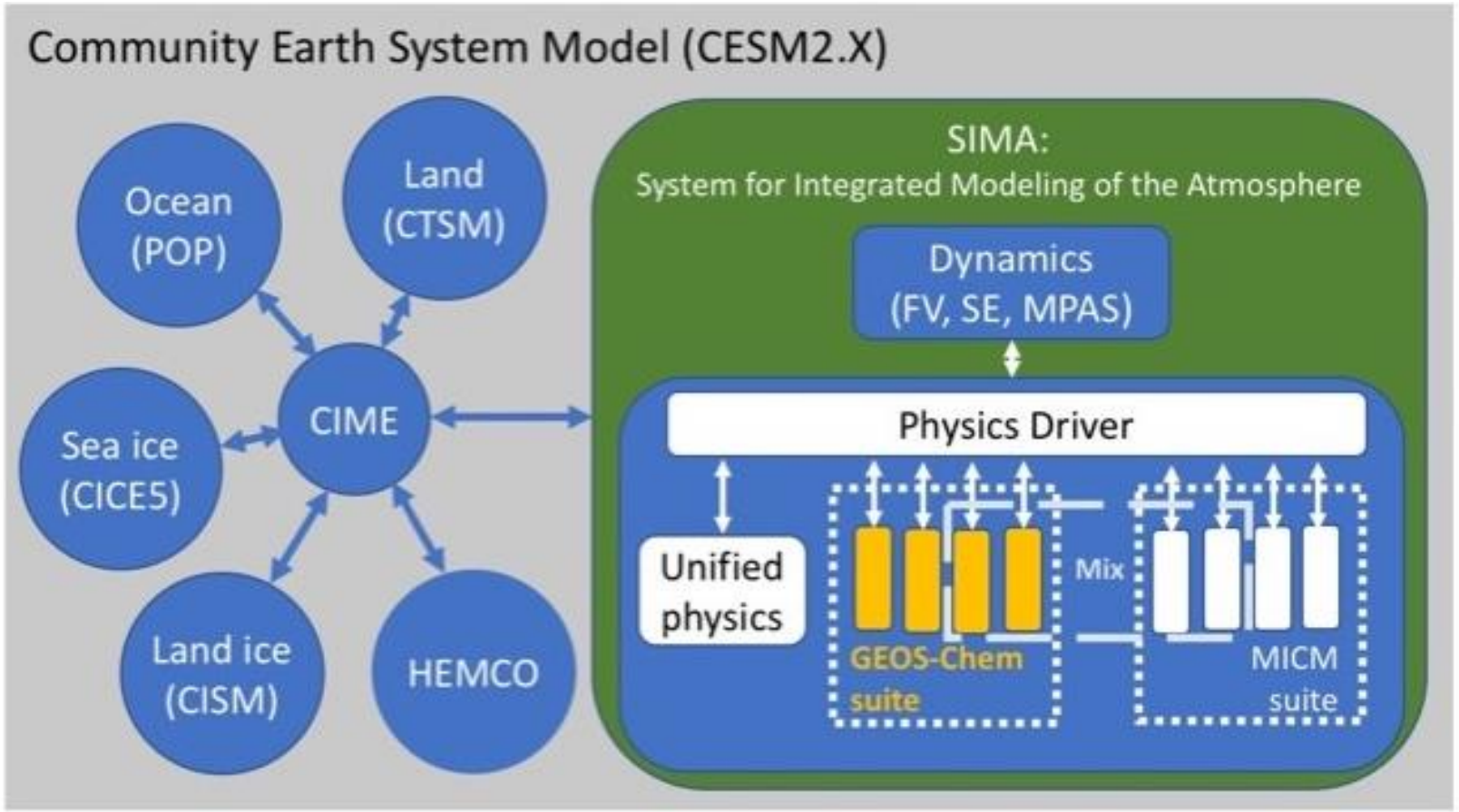
GEOS-Chem: State-of-the-art chemistry, *but..*

- Becoming I/O limited for high-resolution applications
- Want ability to include climate/surface feedbacks in chemistry studies
- Community not focused on (e.g.) dynamics

CESM: Industry standard for climate, *and..*

- GEOS-Chem could provide a new atmospheric chemistry option
- Specific components of GEOS-Chem (e.g. emissions) could be generically useful
- Pipeline for GC developments into CESM

Proposal


Community Earth System Model (CESM2.X)
Ocean (POP)
Land (CTSM)
Sea ice (CICE5)
CIME
Land ice (CISM)
HEMCO
SIMA:
System for Integrated Modeling of the Atmosphere
Dynamics (FV, SE, MPAS)
Physics Driver
Unified physics
GEOS-Chem suite
Mix
MICM suite

Agenda

Objectives of the proposed work

1. GEOS-Chem in CESM 2

2. Flexible emissions and gridded I/O with HEMCO

3. Ongoing integration

Conclusions

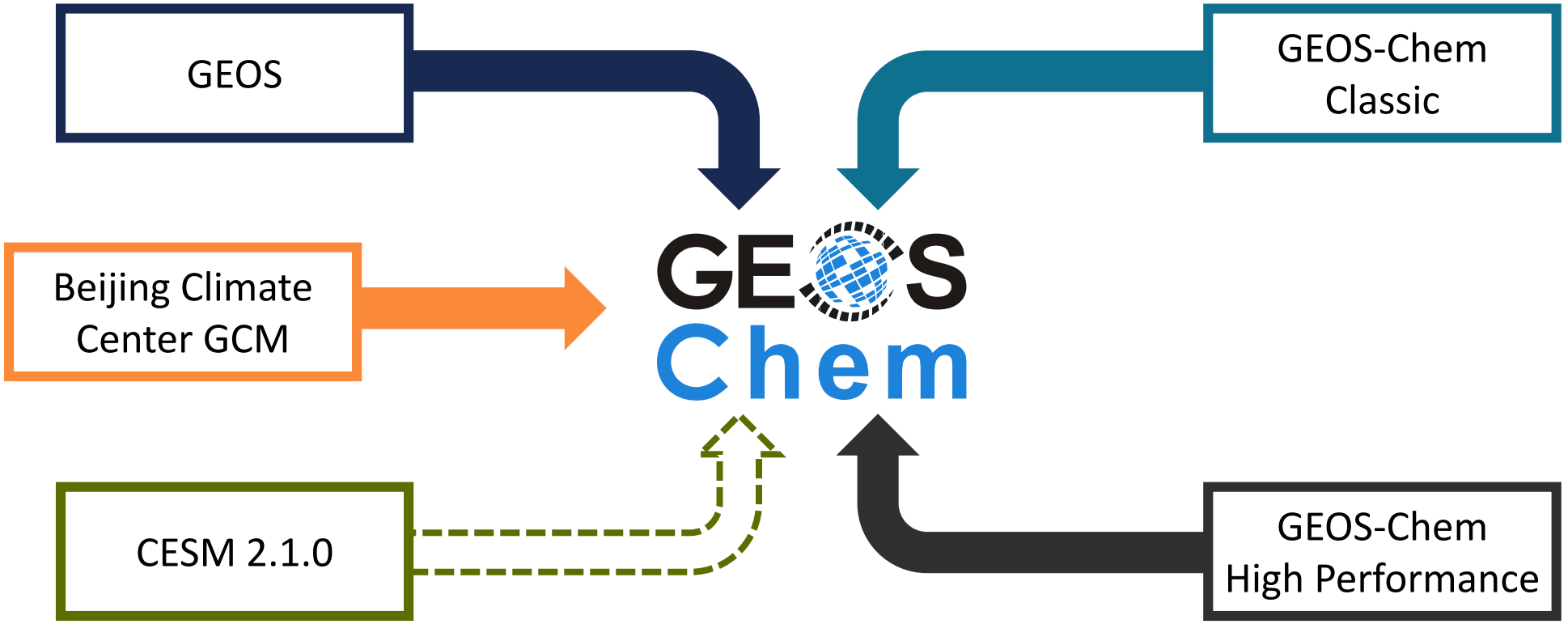
Objectives

1. **CESM-GC:** GEOS-Chem as a chemistry option in CESM 2

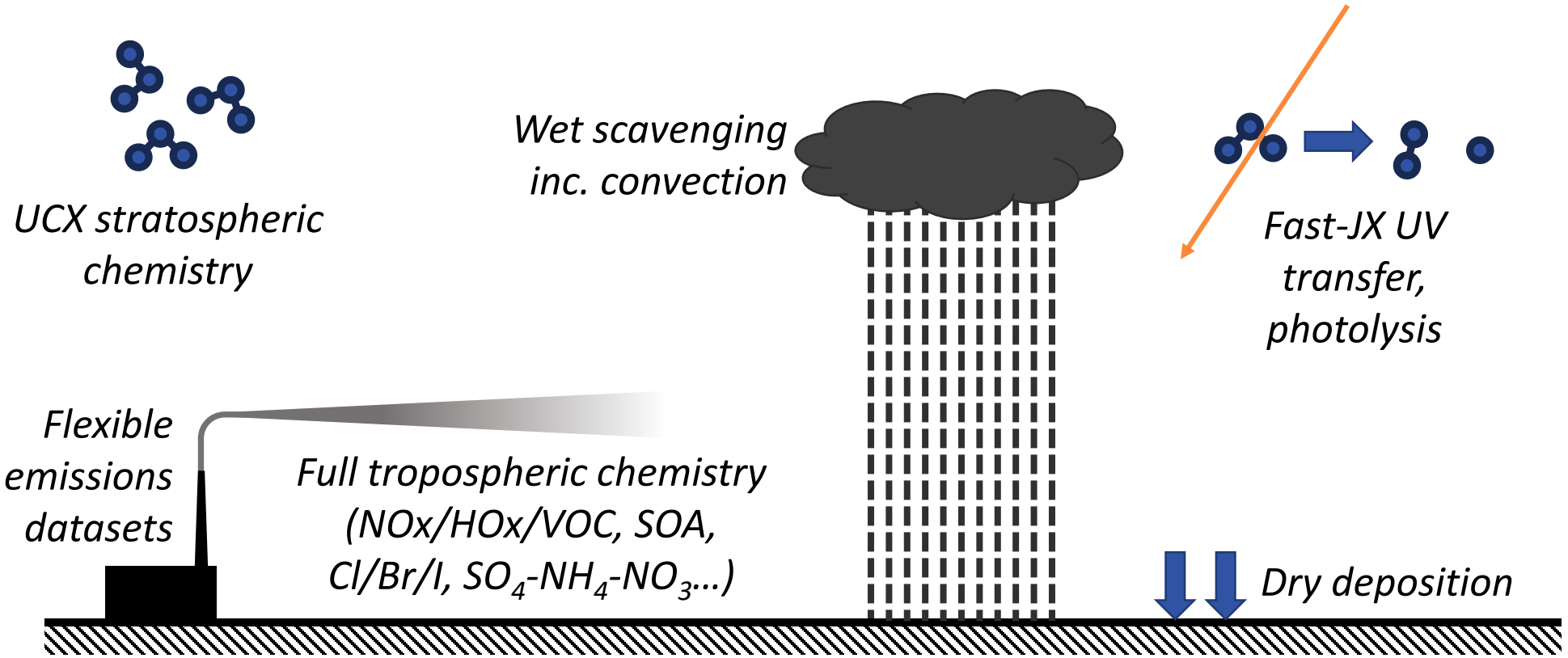
2. **HEMCO**: Grid-independent I/O in CESM 2

3. **Ongoing integration**: Future-proofing

Objective 1: GEOS-Chem in CESM 2

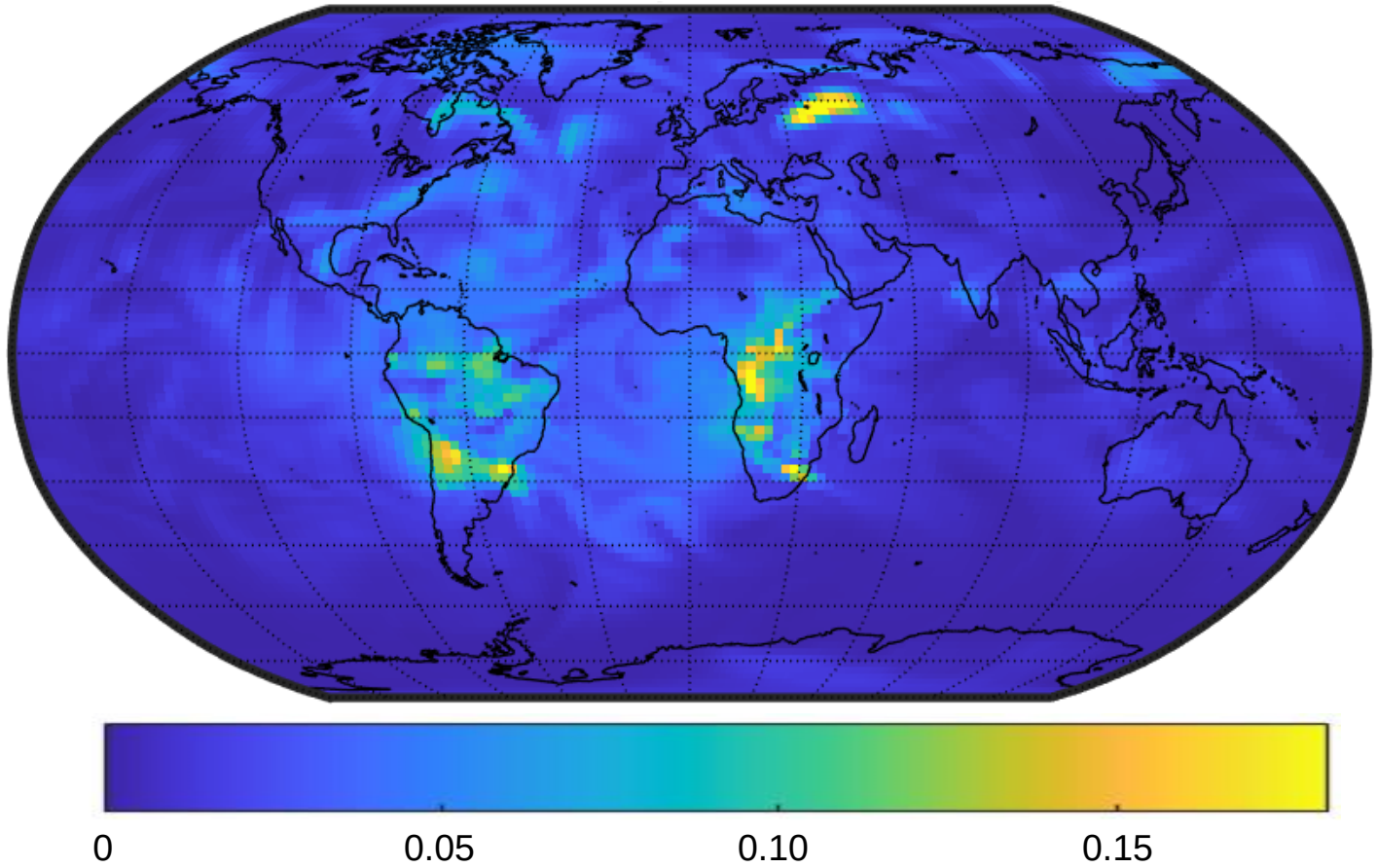


What we mean by “GEOS-Chem”



Status

- Demonstration implementation completed in late 2018
- Includes:
  - Gas-phase & het. chemistry
  - UV radiative transfer & photolysis (Fast-JX v7)
  - Aerosol thermodynamics (ISORROPIA II)
  - Wet (non-convective) and dry scavenging
- **Challenges** remain…



NO_2 at 7 km after 6 hours, ppbv

(Some of the) integration challenges

Aerosols

- GEOS-Chem tuned for bulk aerosol modeling
- CESM expects size-resolved aerosols
- Likely need to implement size-resolved aerosols into GEOS-Chem

Convection

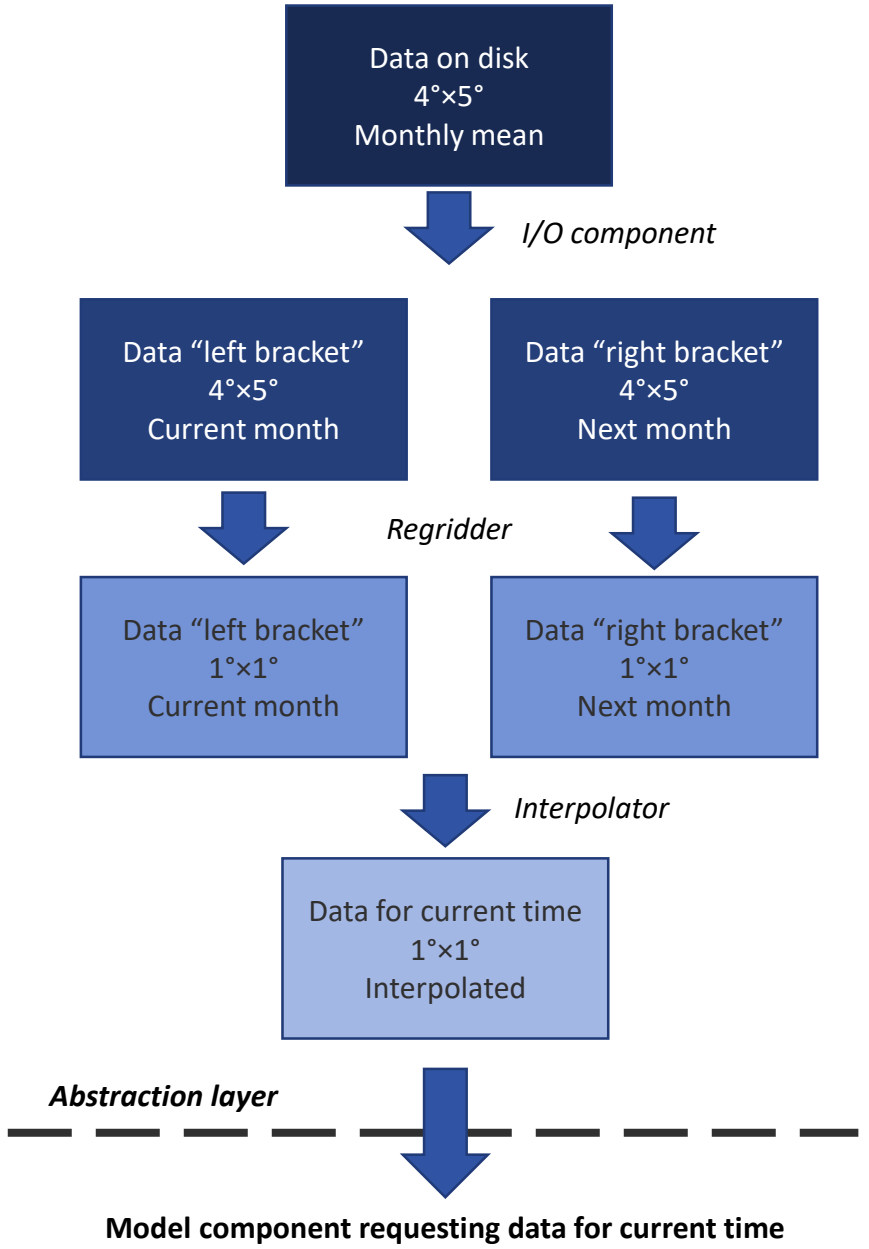
- Need **convective scavenging** and **convective transport** to be simultaneous
- CAM currently separates the operations – not clear how to resolve the issue without changing "**ownership**" of a process

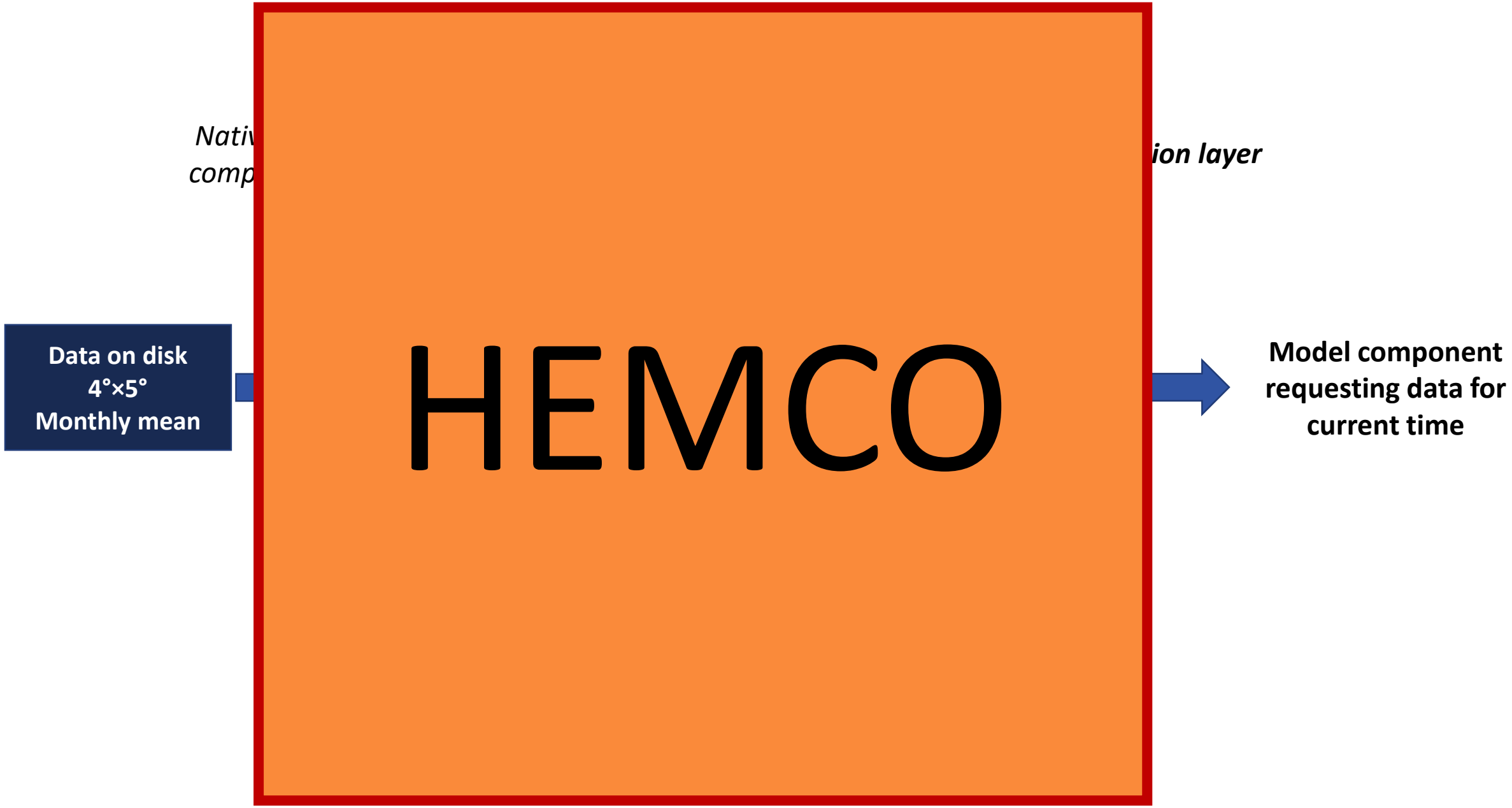
Emissions

- GEOS-Chem relies on a large emissions dataset library
- Data stored at many resolutions, with different spatial/temporal limits
- How can this be easily translated to CESM?

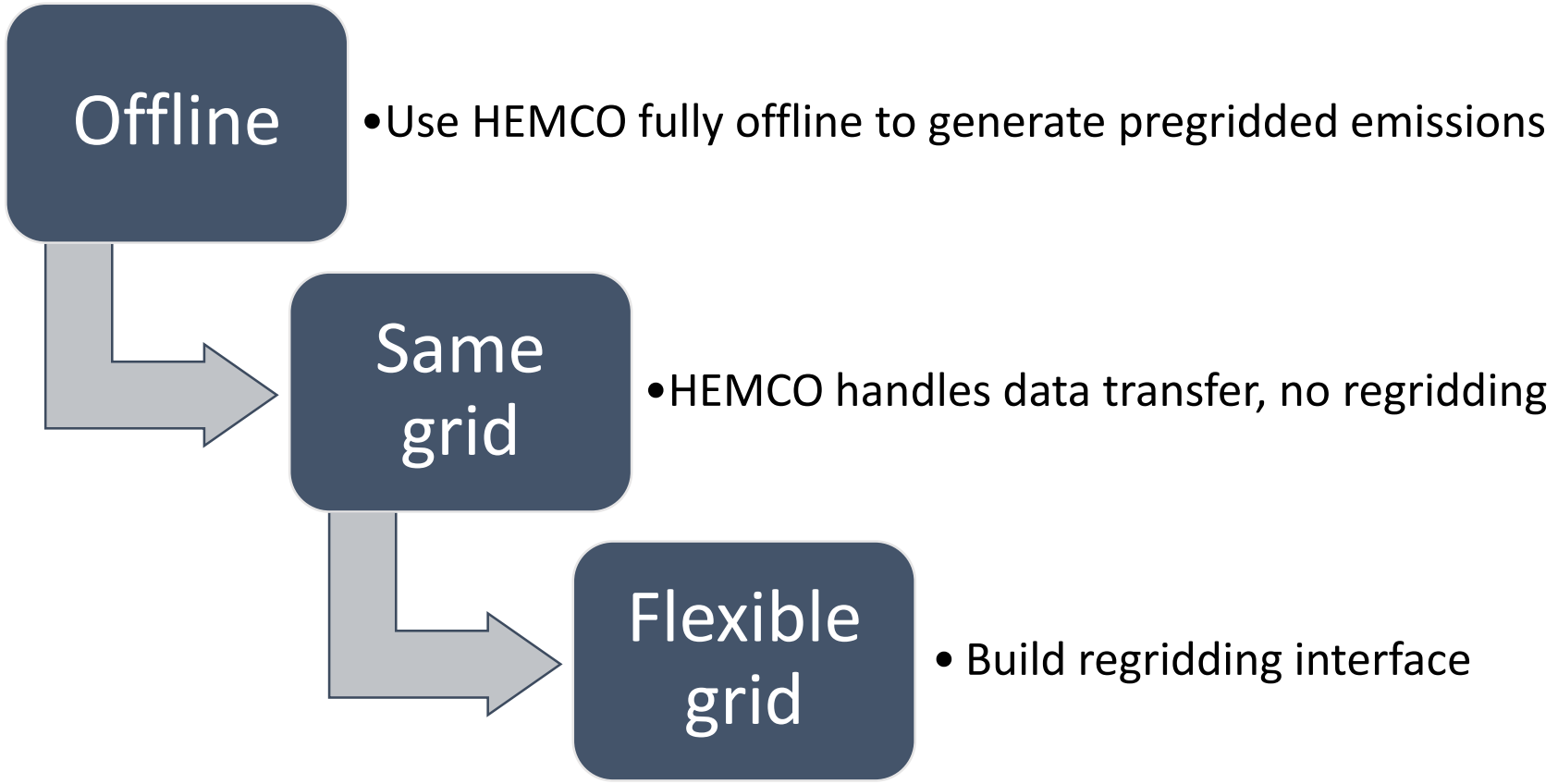
Objective 2: HEMCO in CESM 2

- GEOS-Chem uses the **Harmonized Emissions COmponent** (HEMCO) to read in all gridded input
- HEMCO can be **standalone** (GEOS-Chem Classic) or can expect **regridded fields** (GEOS, GCHP)
- Proposal: implement HEMCO as the **gridded data broker** for CESM

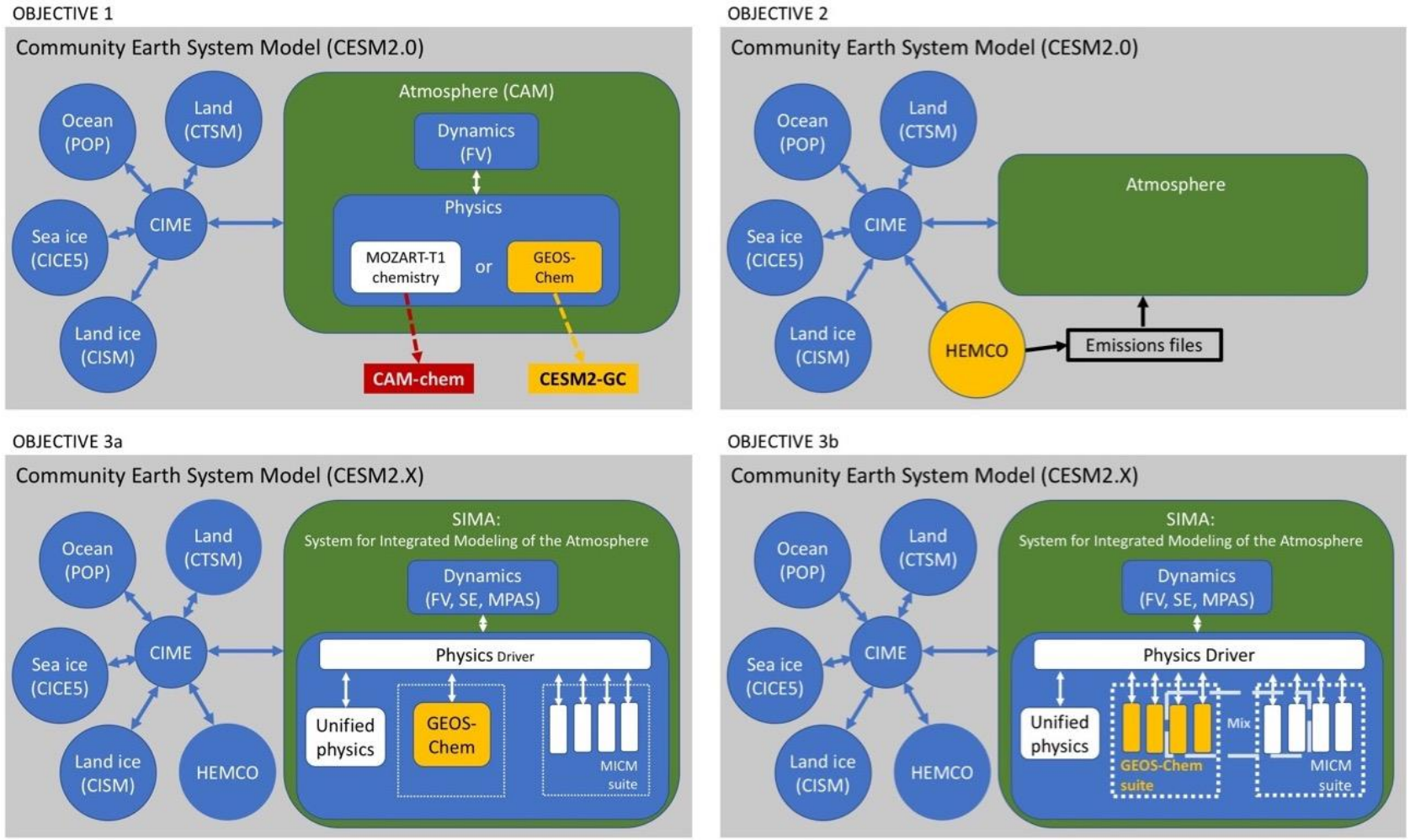



Nativ
comp
ion layer
Data on disk
4°×5°
Monthly mean
HEMCO
Model component
requesting data for
current time

HEMCO work plan



Objective 3: GEOS-Chem in SIMA



Conclusions

- GEOS-Chem is viable as a chemistry option in CESM 2

- Implementation will allow:

  - Seamless pipeline for improvements in GEOS-Chem to transfer to CESM
  - Opportunity for GEOS-Chem users to run online simulations
  - New chemistry option for CESM users

- Side-benefit will be **grid-independent emissions** and **data handling** in CESM

- Plan includes **future proofing** – will need **ongoing inter-community collaboration**

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Some basic elements to create slide structure (1/2)

Box heading goes here

- This element consists of 2 grouped elements.
- When scaling it, please scale the rectangle for the main text first, then adjust the heading box separately.
- Different colors from the pallet can used for this box.

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