WACCM Extension to the Thermosphere/Ionosphere and plans for the Magnetosphere

Hanli Liu

Stan Solomon

Mike Wiltberger

High Altitude Observatory
National Center for Atmospheric Research

NCAR

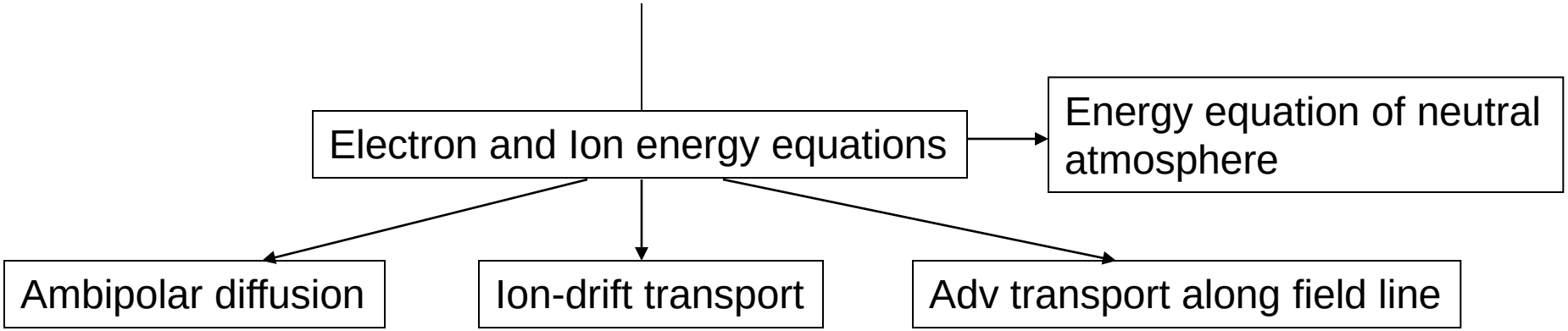
WACCM-X Development Status

- Thermospheric extension and preliminary validation are done (reported in last WG meeting and draft manuscript to be submitted soon).
- Electron/ion energy equations for WACCM-X are being developed.
- Electron/ion transport (ambipolar diffusion, field aligned transport) development will follow once the energy equations are done.
- Parameterized IGW and generation of QBO being tested on WACCM. Will implement in WACCM-X and study impact on thermosphere variability.
- Inter-model comparison between WACCM-X and NOAA WAM.

Electron / Ion Energy Equations

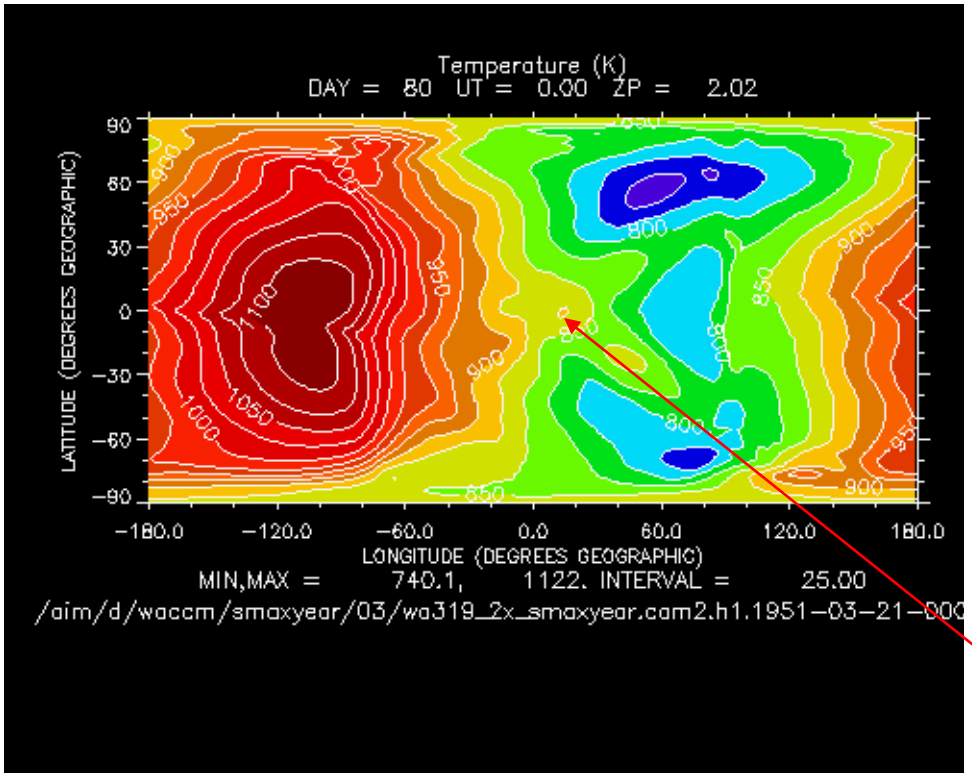
- Important for ionosphere/thermosphere energetics, and for ambipolar diffusion and other ion transport calculations.

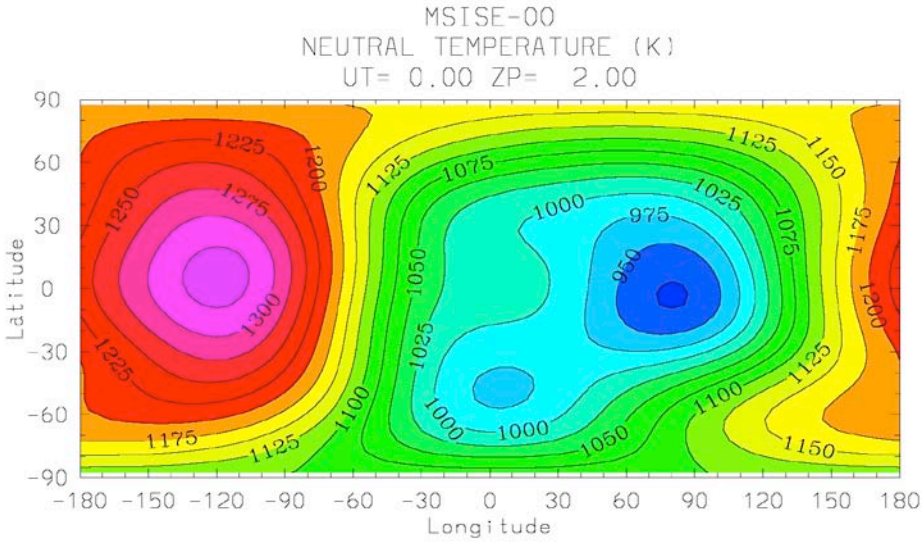
- The module currently under development is time-dependent iterative solver, which is an improvement over TIME-GCM.



Electron / Ion Energy Equations

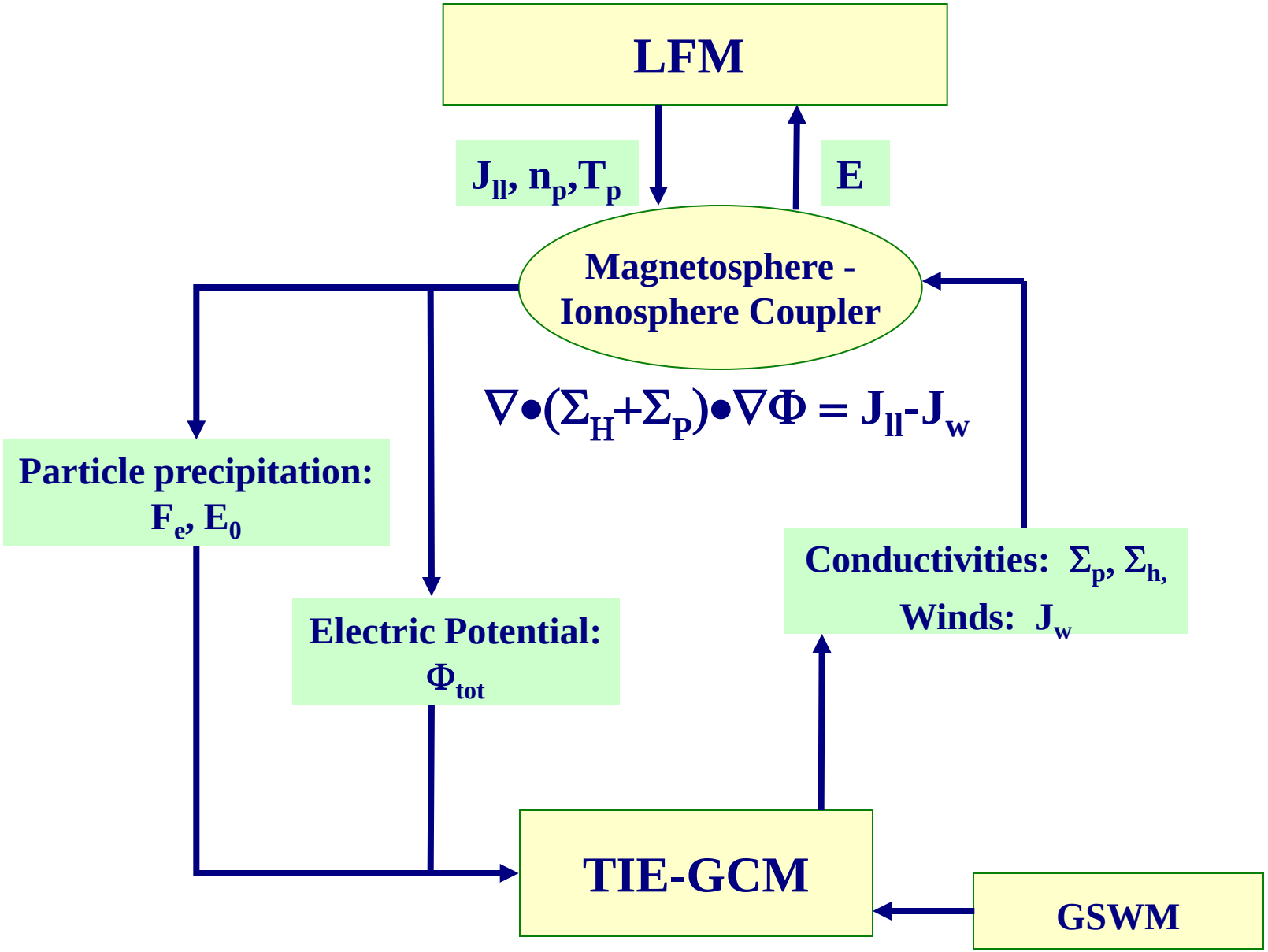
- Lack of electron and ion heating may account for the cooler thermosphere in the current WACCM-X.





Midnight temperature maximum

Coupled Magnetosphere-Ionosphere-Thermosphere Model



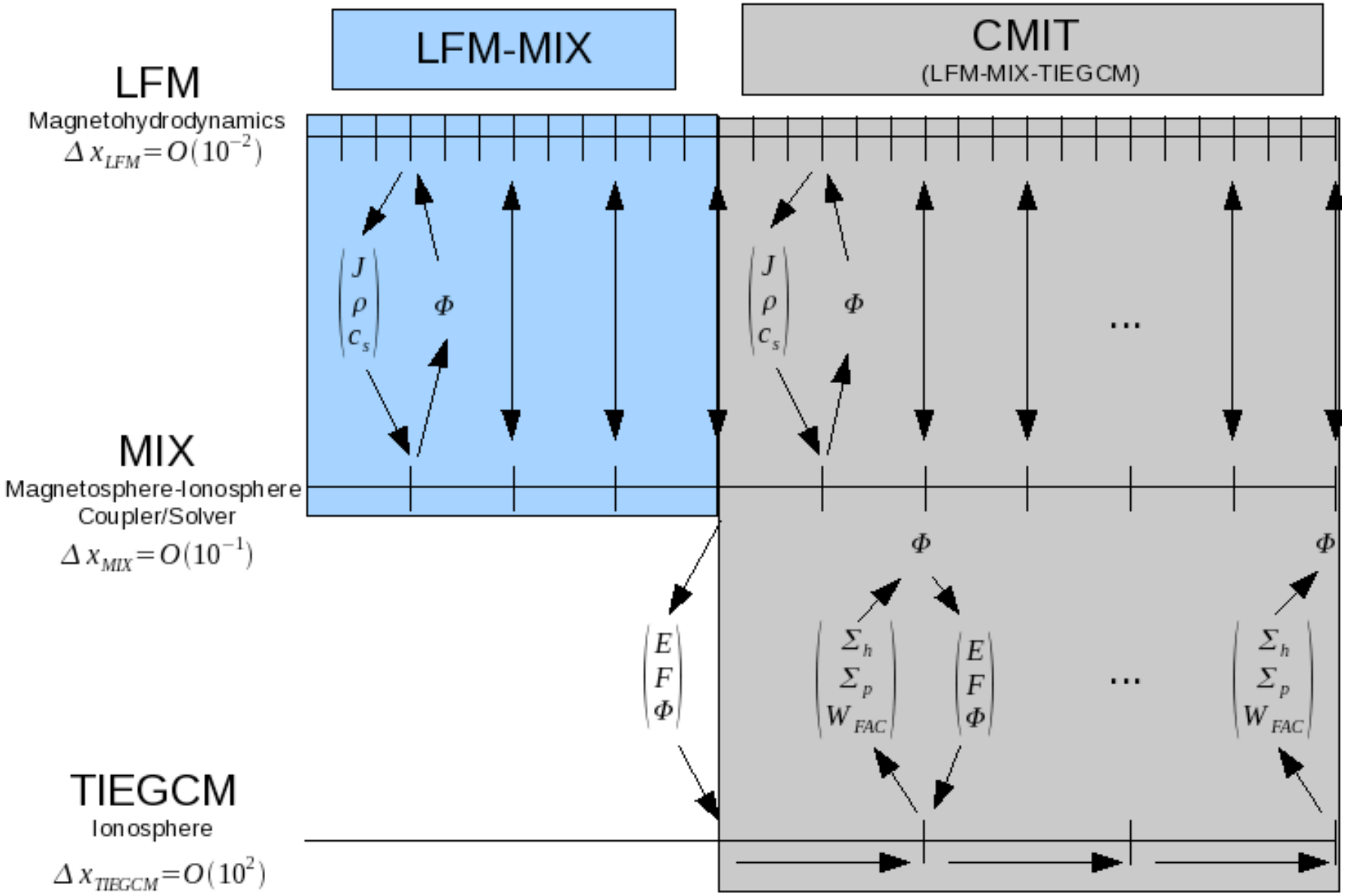
Code Coupling Technology

- Complex codes with very different spatial and temporal domains, such as WACCM and LFM, are difficult to integrate into a single executable.

- Require efficient, flexible, model coupling in a parallel environment
  - Efficient transmission of information among codes
  - Interpolation of data between grids
  - Translation of physical variables between codes
  - Control mechanisms to synchronize execution and interaction
  - Minimal modifications to existing code base

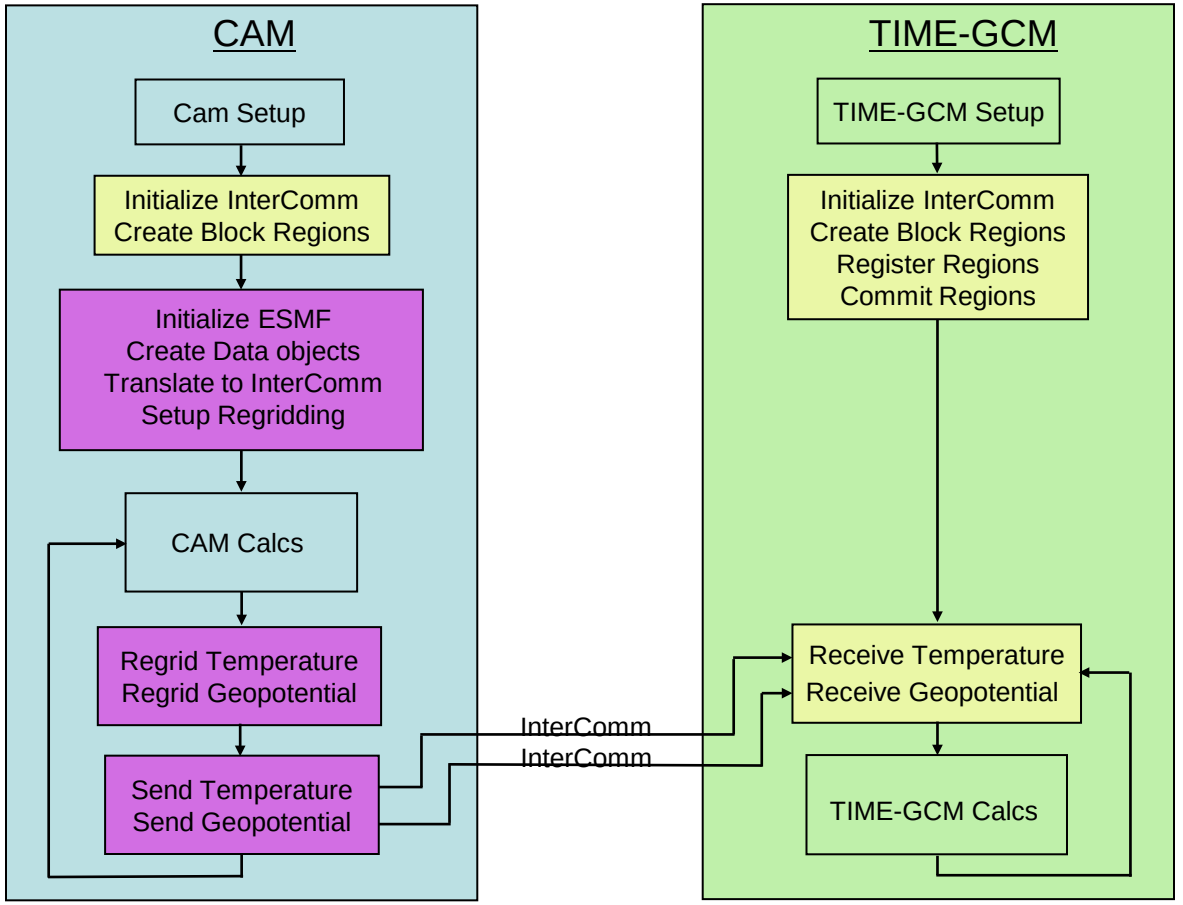
- *Intercomm*
  - Developed by Alan Sussman et al. at the University of Maryland
  - Enables separate executables on different processors to exchange data
  - Solution to the MxN problem in coupling parallel codes
  - Addresses control and timing issues

CMIT Implementation in Intercomm



Intercomm Interface with ESMF

- The Earth System Modeling Framework (ESMF) now includes an interface module enabling to exchange data with Intercomm.
- Bob Oemke of the ESMF development group conducted a demonstration project to show how this works, using CAM and TIME-GCM.



Plan for Magnetosphere-Ionosphere-Atmosphere Coupling

- Continue to maintain and develop LFM-MIX as a stand-alone model
- Use Intercomm to couple to TIE-GCM, WACCM, CCSM, ESM, etc.
- Extend grid interpolations, solvers, etc., as necessary in the MIX module
- Maintain ESMF compatibility