Method and Toolkit for Two-way Ice Sheet - GCM Coupling

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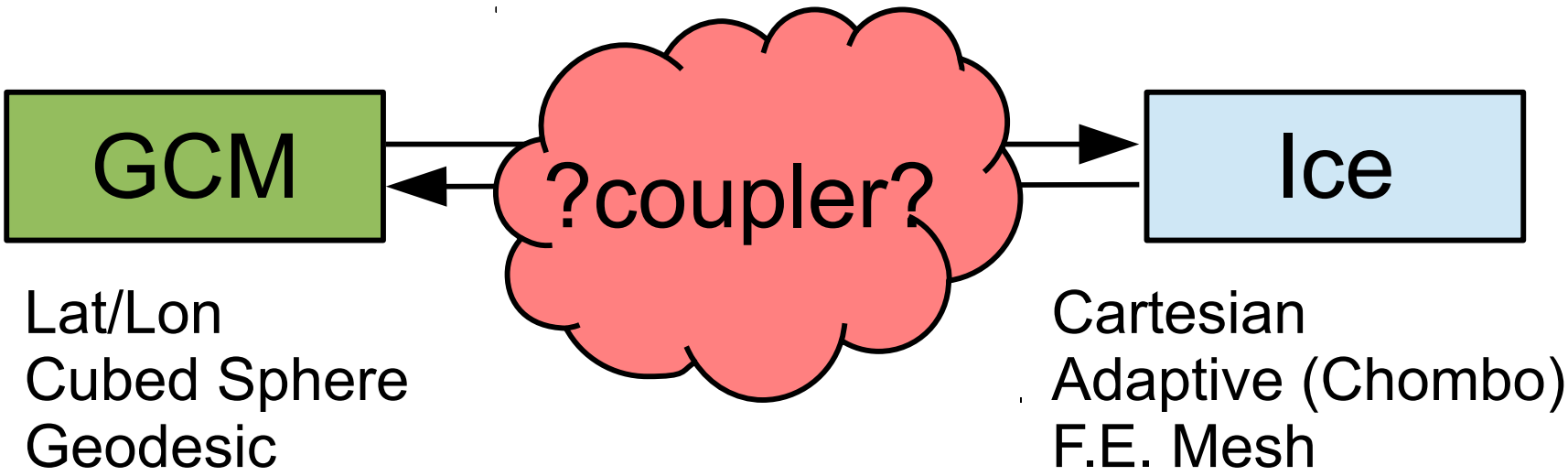
Problem Overview

Goal: Two-way coupling of GCM and ice model



Problems:

- Many GCMs, many Ice Models.
- No "standardized" transfer grid.
- Conservation: Mass & Energy

GLINT2

Library for coupling GCMs and Ice Models

Features:

- Direct transfer from GCM to Ice Grid.
- Works for all grids.
- Conserves mass and energy.
- De-couples programming of GCM and ice model.
- Some prerequisites required of GCM
- GLINT2 exists NOW!

Talk Outline

1. Review GCM Prerequisites
2. Explain GLINT2
3. Propose full GCM/Ice Model API

NOTES:

- GLINT2 makes matrices, it is not an API.
- API needed for complete solution.
- Community agreement needed for API.

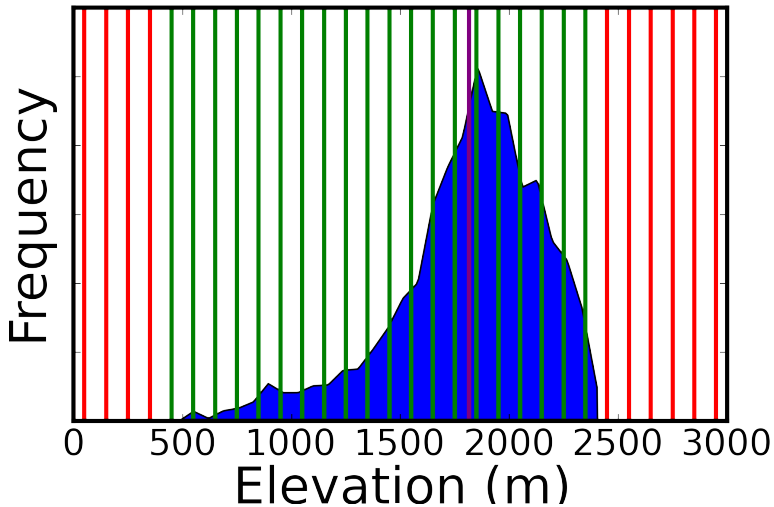
Community Invitation: Let's make an API!!

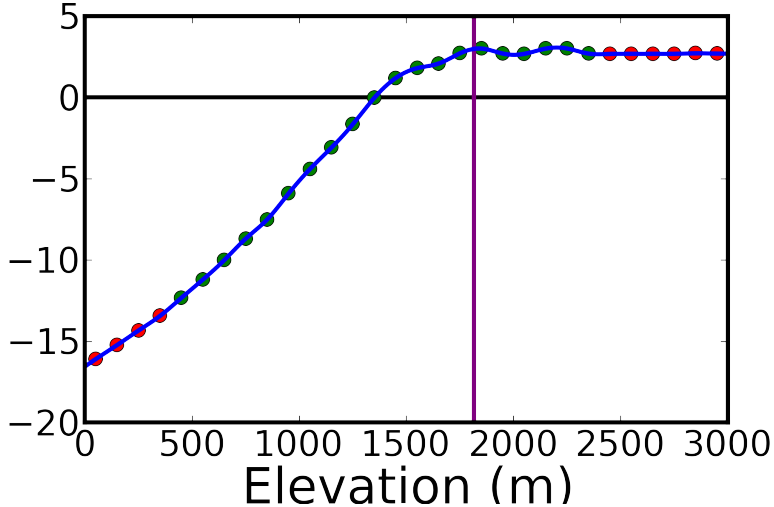
GCM Prerequisite: Elevation Points

Purpose: Produce high-res SMB from low-res GCM.

Idea:

1. GCM Cell covers range of elevations.
2. Compute SMB at variety of elevations within each GCM cell.
3. Interpolate function of elevation vs. SMB within each GCM cell.

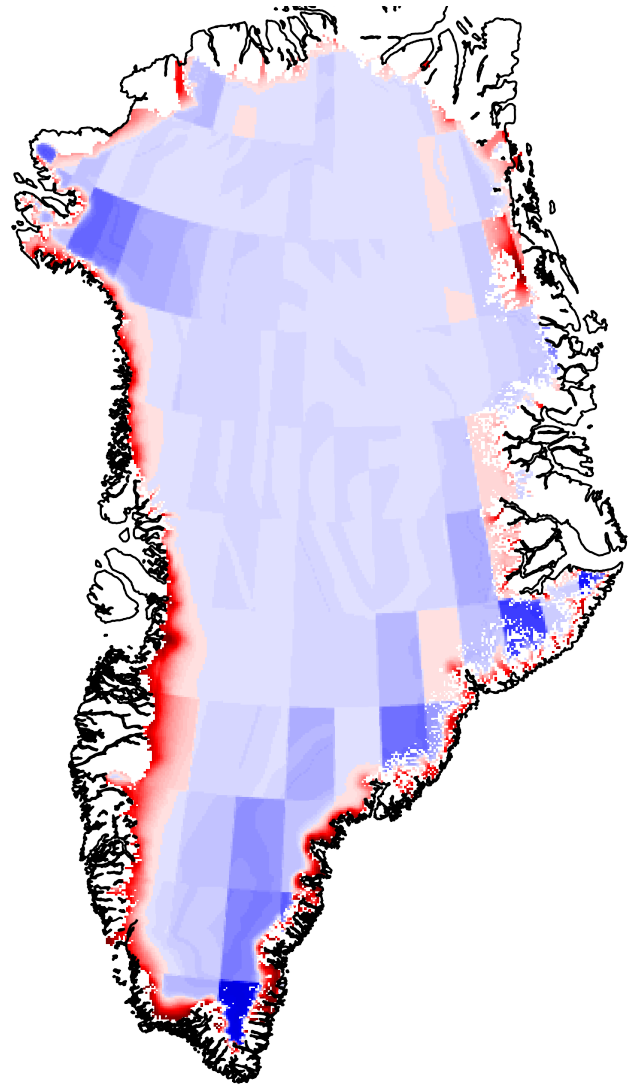




GCM Prerequisite: Elevation Points (cont)

Idea (cont):

4. Evaluate interpolated functions on ice grid.
5. Smooth, if desired (eg, bilinear interpolation).



References

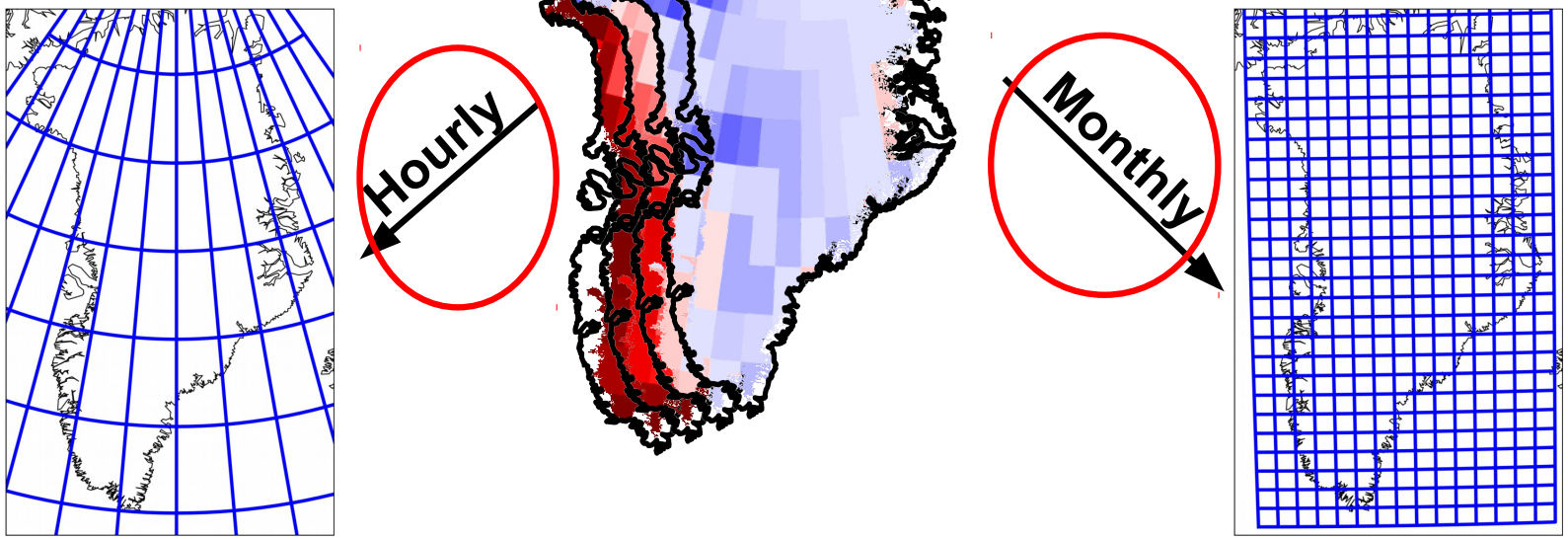
- W Lipscomb et al (2012), *Implementation and initial evaluation of the Glimmer Community Ice Sheet Model in the Community Earth System Model*, submitted to *J. Climate*.
- R Fischer et all, *Downscaled and Smoothed Surface Fluxes for GCM / Ice Model Coupling*, AGU Fall Meeting 2012.

Two-Way Coupling: Conservation Requirement

GCM Internal SMB
(Elevation Classified)

To Atmosphere
(2x/hour)

To Ice Sheet
(1x/month)

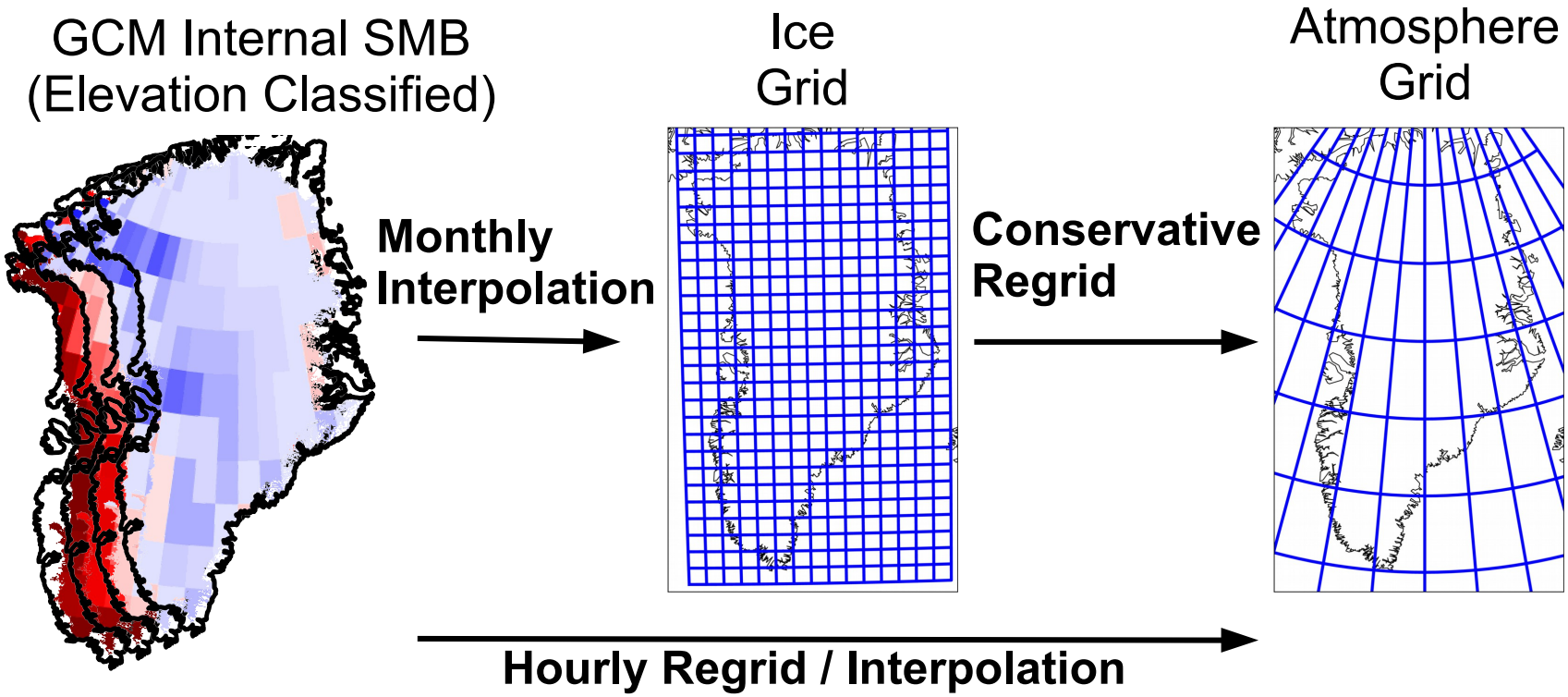


Are they consistent?

Atmosphere Grid ← – – – – – – – – – – – – → **Ice Grid**

NOTE: Grids not to scale.

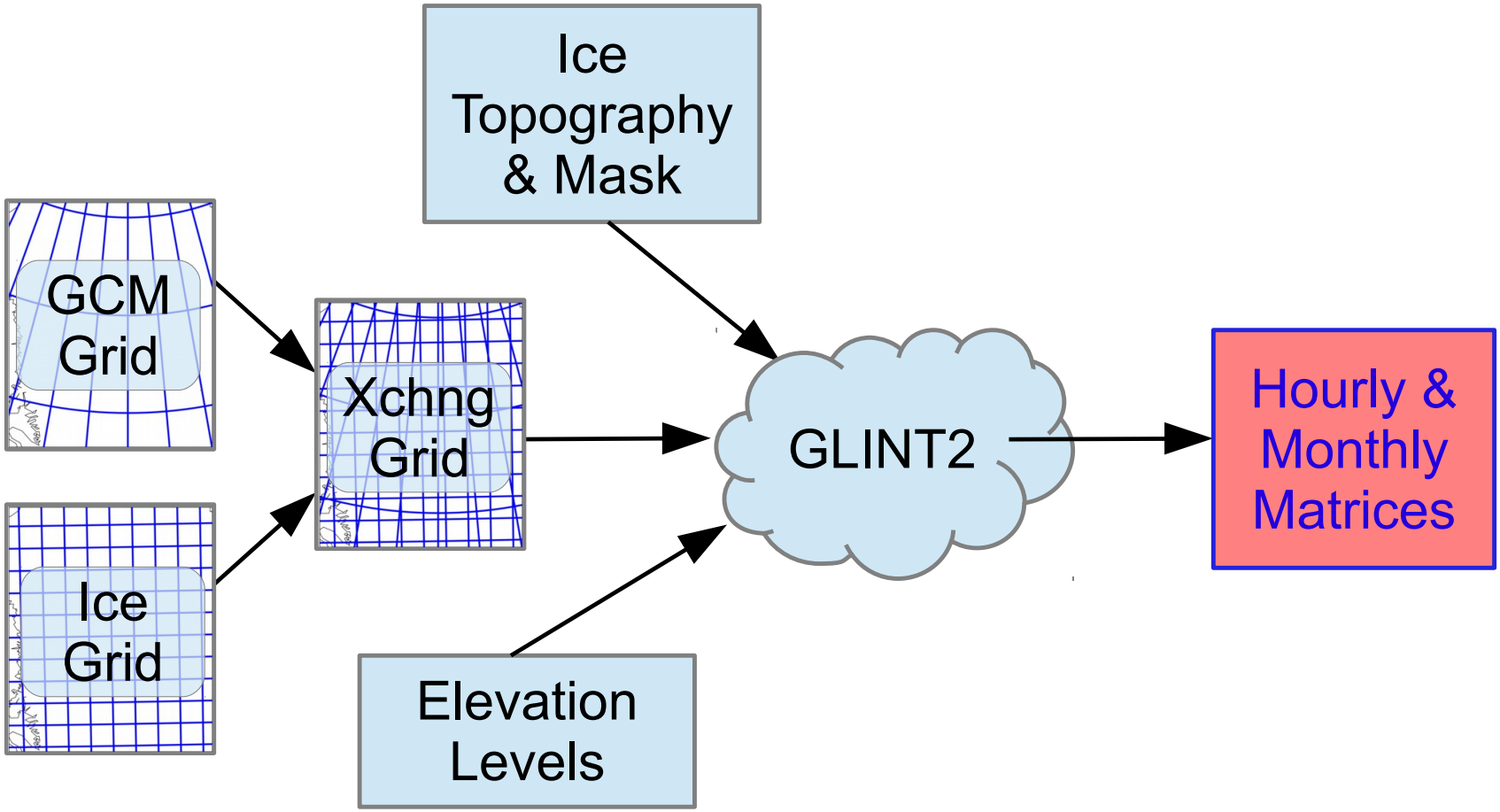
Derivation: Hourly Regrid / Interpolation



NOTES:

- All transformations are linear.
- GLINT2 computes sparse matrices for Hourly and Monthly regrid/interpolation steps.

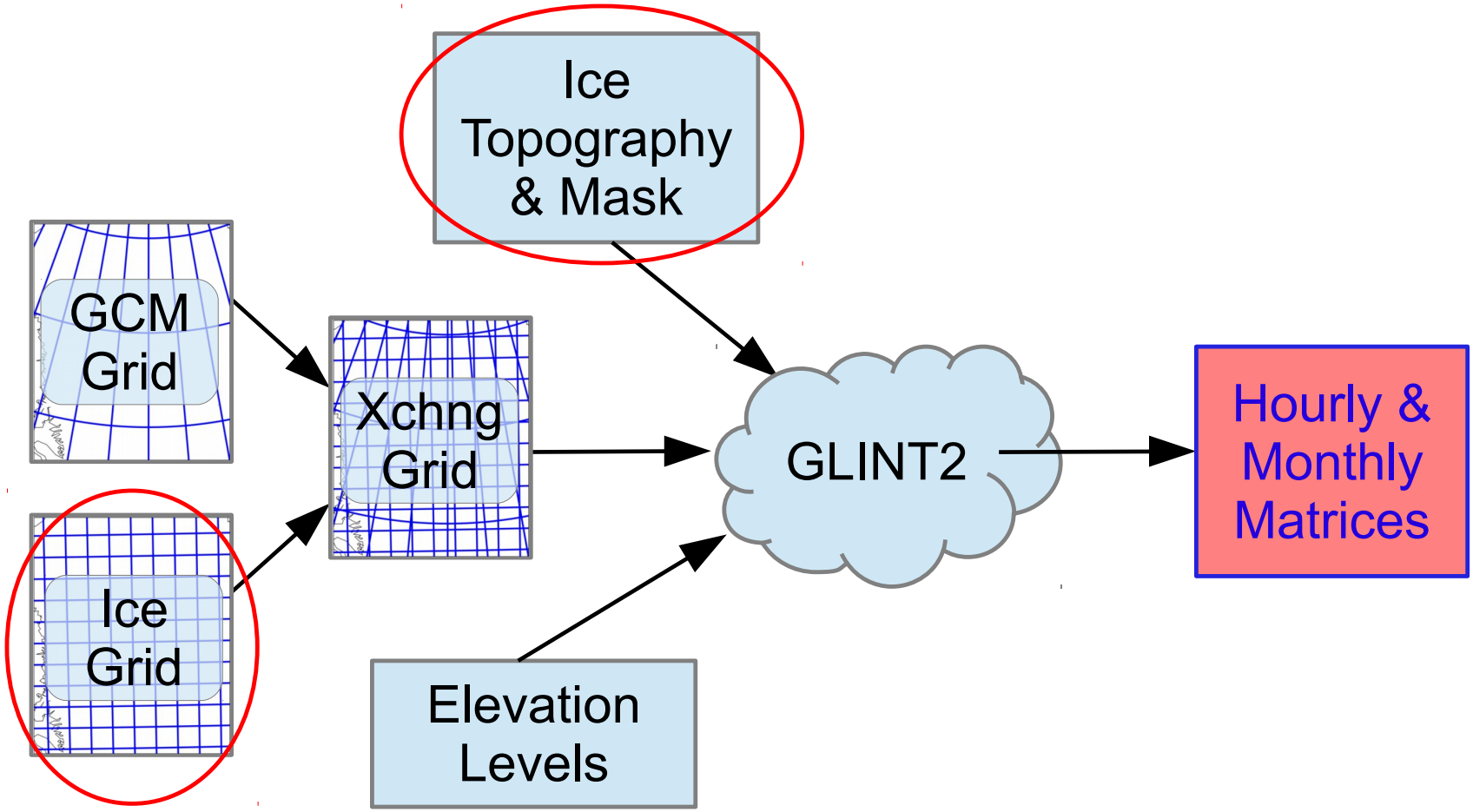
GLINT2: Summary



B Balaji et al, "The Exchange Grid: a mechanism for data exchange between Earth System components on independent grids," *Parallel Computational Fluid Dynamics: Theory and Applications, Proceedings of the 2005 International Conference on Parallel Computational Fluid Dynamics*, Elsevier (2006).

Dynamic Grids

What can Change?



The GCM: Using GLINT2

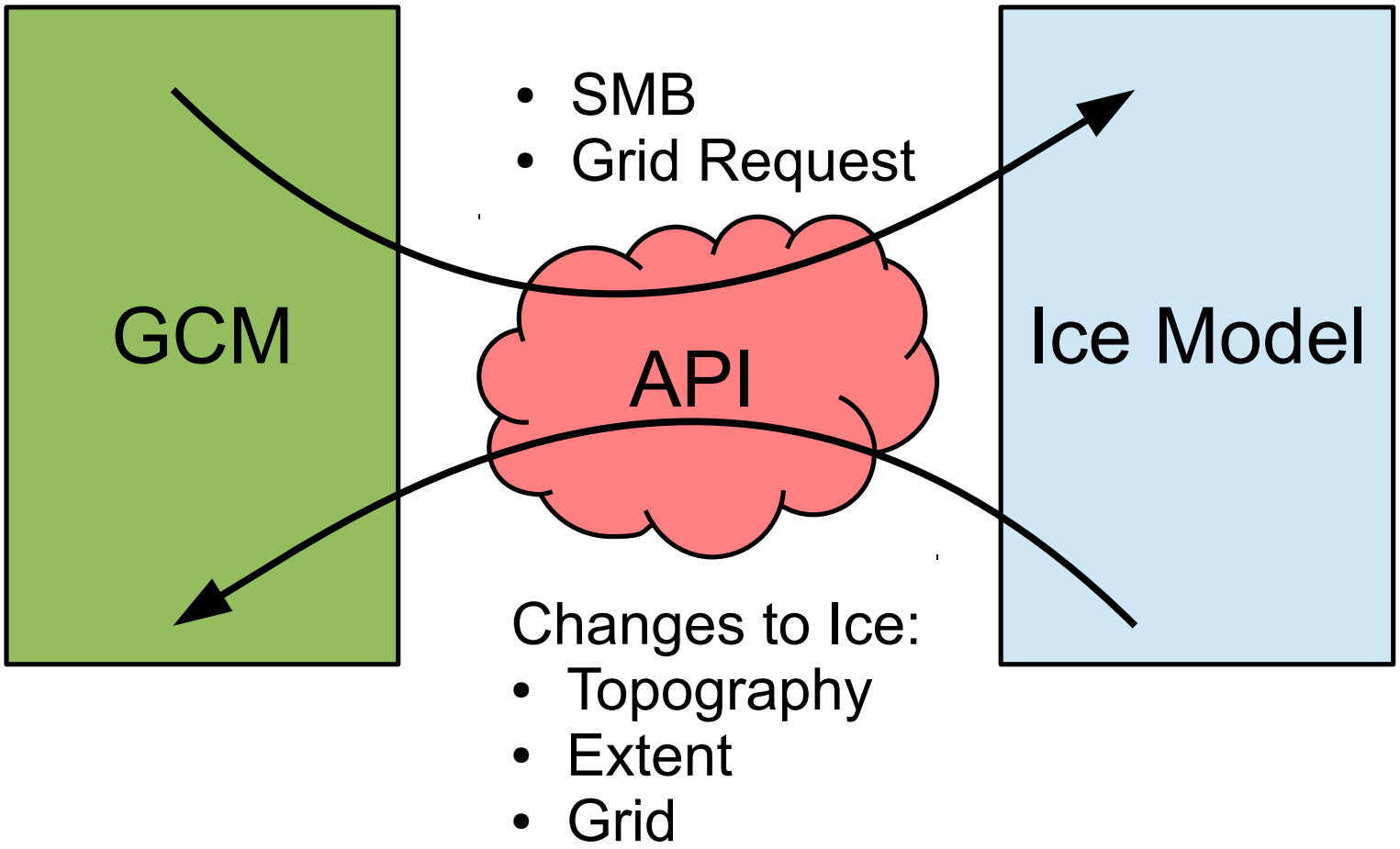
GLINT2 computes matrices. How can GCM use them?

- GLINT2 library links with GCM runtime.
- GCM calls GLINT2 to compute or update hourly & monthly matrices.
- GCM responsible for domain decomposition of GLINT2 matrices.

Community API

GLINT2 lets GCM speak on Ice grid...

But API required to say it!



Community Invitation: Let's make an API!!