

A modular, open-source model for scientific and policy analyses of the global carbon cycle: Hector

Corinne A. Hartin

Ben Bond-Lamberty

Joint Global Change Research Institute

May 12, 2014

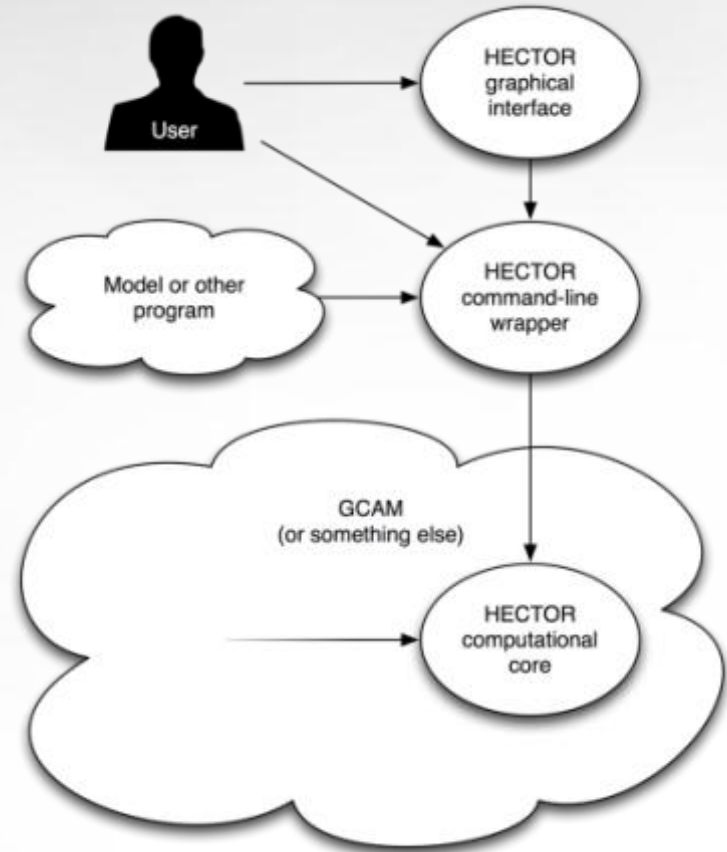
Integrated Climate Modeling Principal Investigator Meeting

Motivation for Hector

- ▶ GCMs are detailed and powerful, but complex and slow
- ▶ Fast executing simple global climate models
 - Quick ‘what-if’ (e.g. policy) analyses
 - Model analyses requiring *many* runs (e.g. MCMC)
 - Coupling to other (e.g. IA) models
- ▶ E.g. MAGICC
 - Used across many scientific and policy communities
 - “Tried and true workhorse” (John Weyant this morning)
 - Many strengths
 - Old code to work with
 - Not open source, legal encumbrances unclear

Goals for Hector

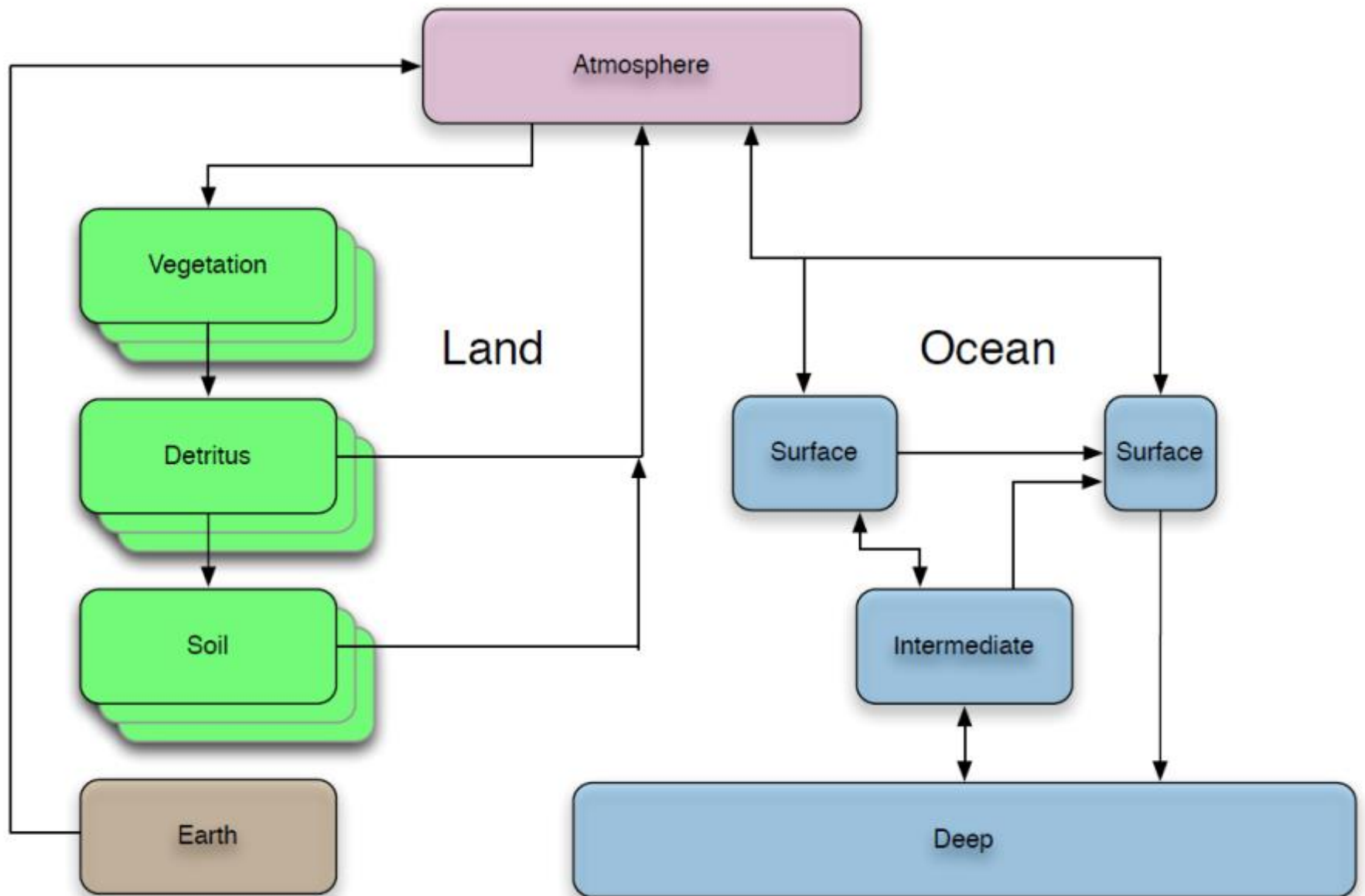
- ▶ Reproduce first-order GCM responses
- ▶ Very fast executing
 - Adaptive-timestep solver
- ▶ Free and open source
 - Community model available to all
- ▶ Fairly easy to use
- ▶ Modular
 - Easy coupling to other models



Hector philosophy and structure

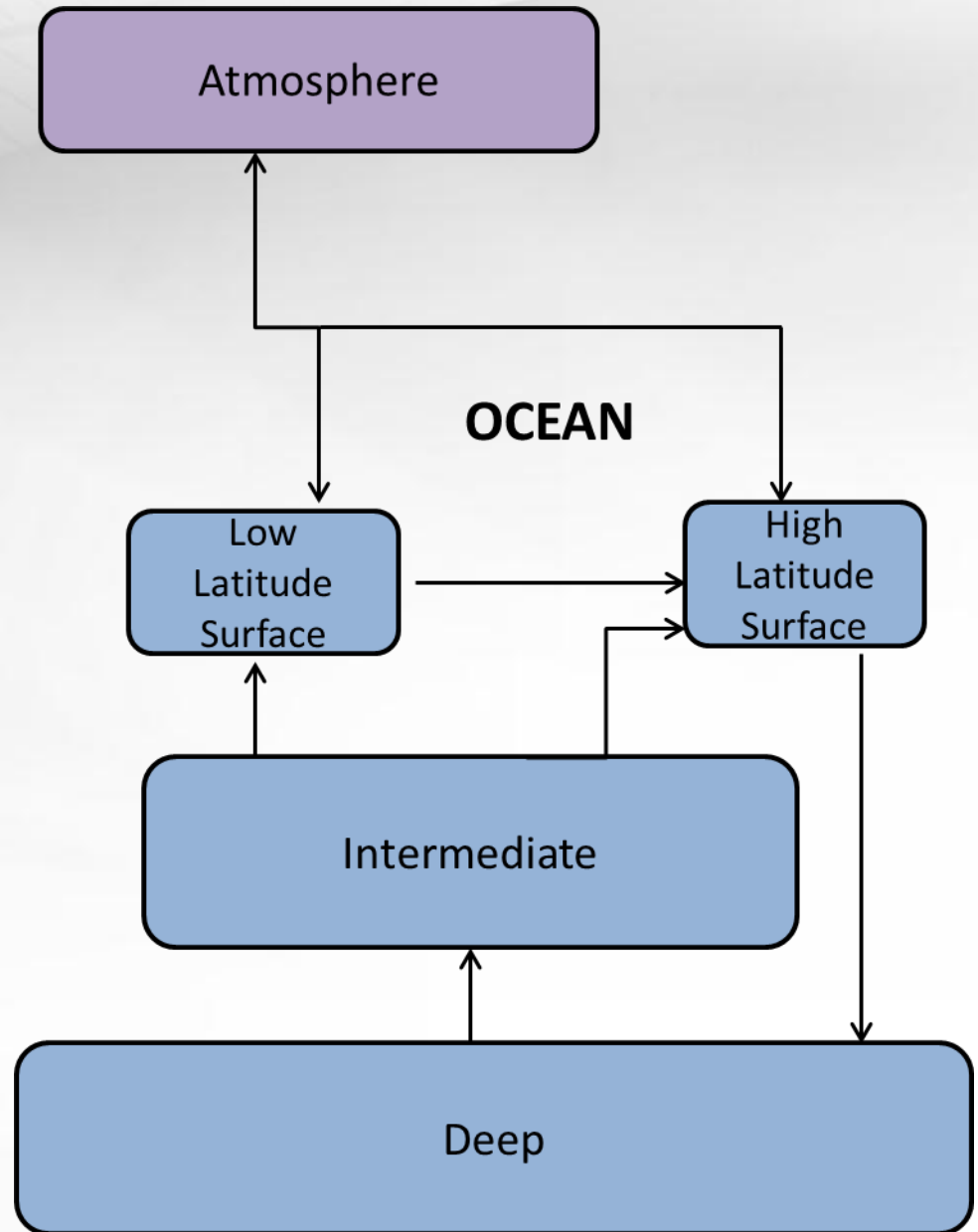
- ▶ Complexity only where warranted
- ▶ Components can be enabled/disabled via inputs
 - E.g. you can test two different ocean submodels against each other
- ▶ Modern, clean code software structure
 - E.g. coupler enforces unit checking between submodels
- ▶ R backend for summarizing and analyzing results
 - Ships with MAGICC, CMIP5, and observational data for comparison

Science: overview

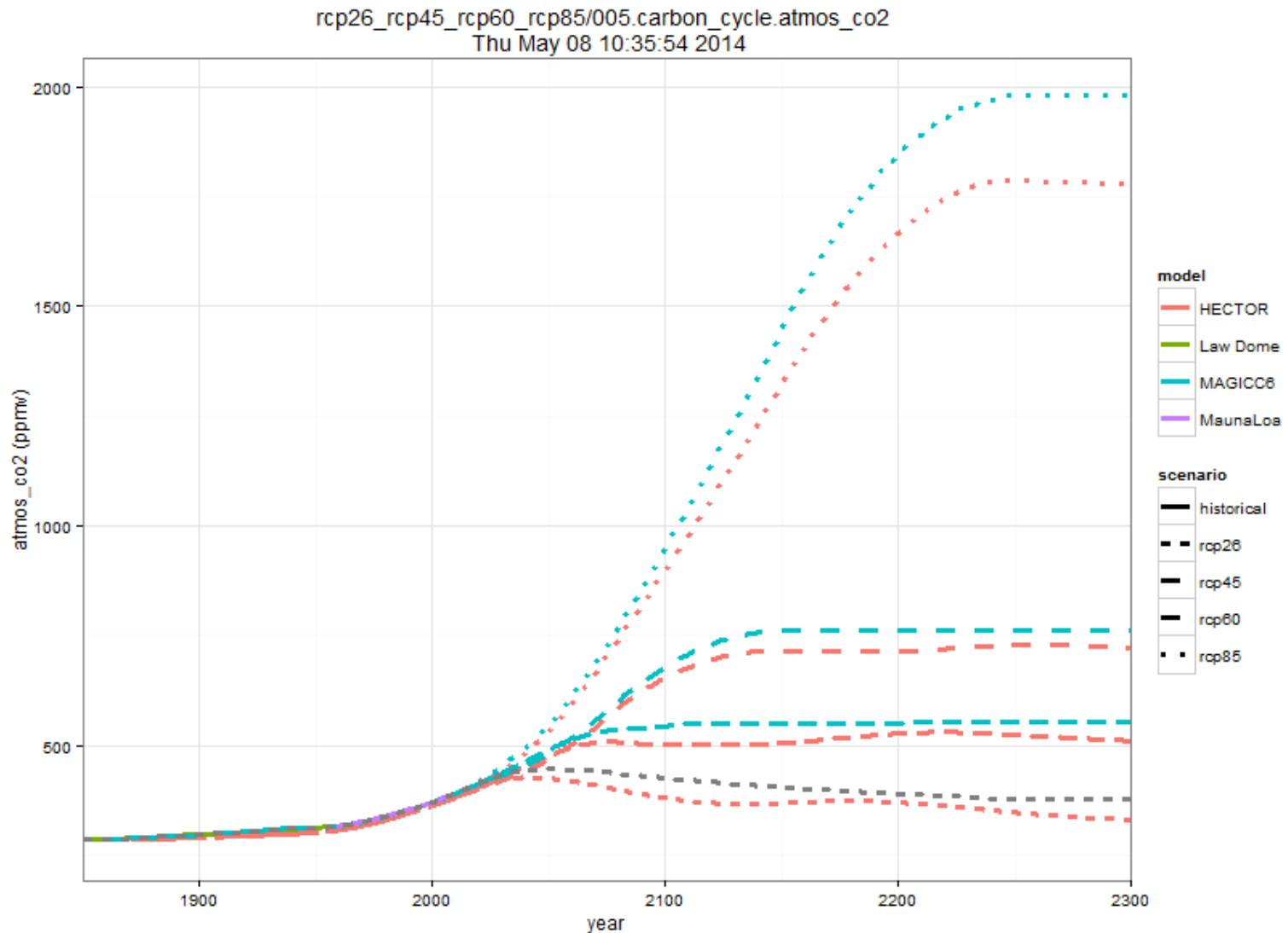


Science: ocean

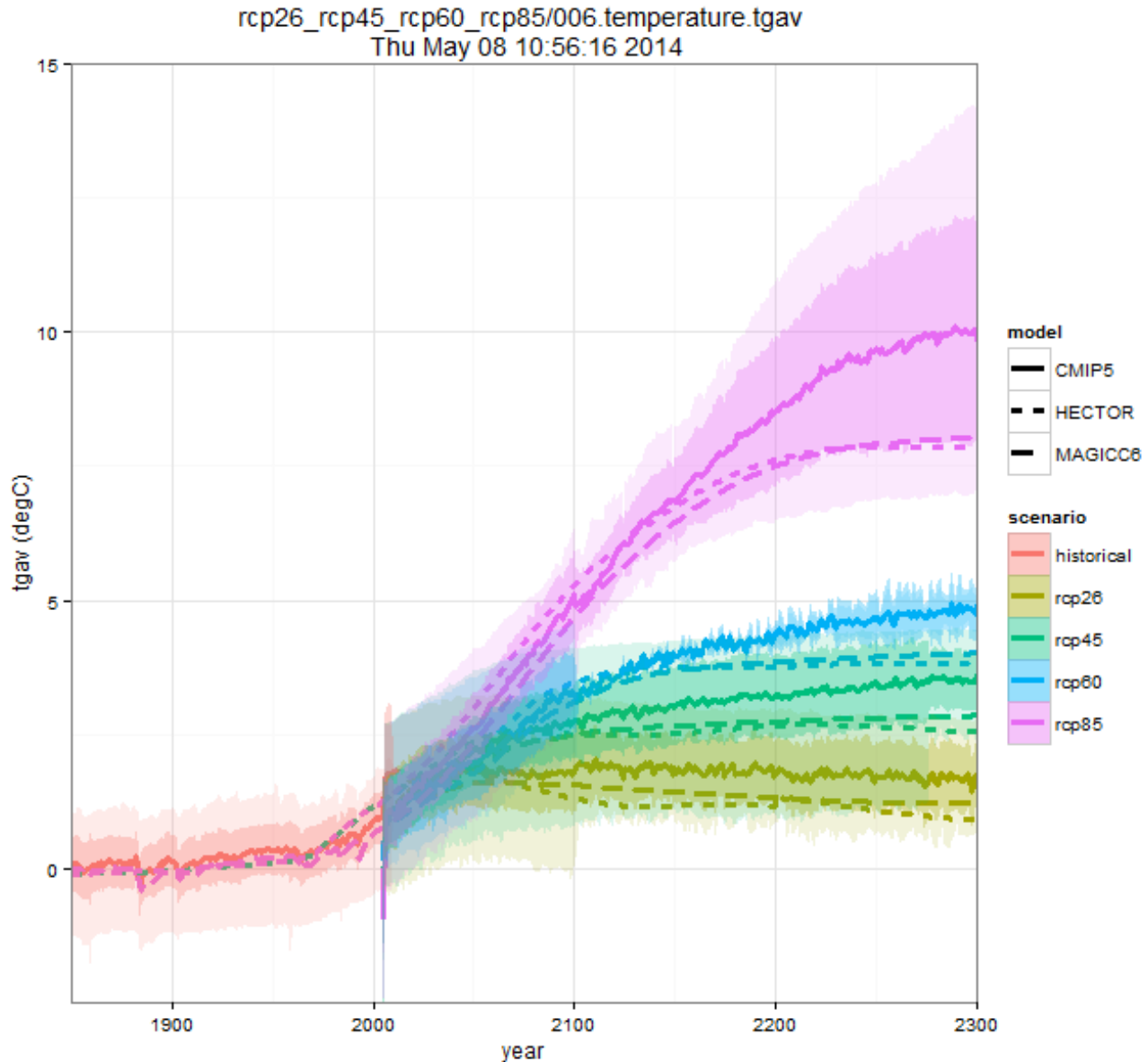
- ▶ 4 boxes
 - 2 surface boxes (100m)
 - Intermediate box
 - Deep box (~3777m)
- ▶ Advection and water mass exchange
- ▶ Heat uptake in surface boxes
- ▶ Carbon chemistry in surface boxes (e.g., atmosphere-ocean flux, pH, CaCO_3 saturations)



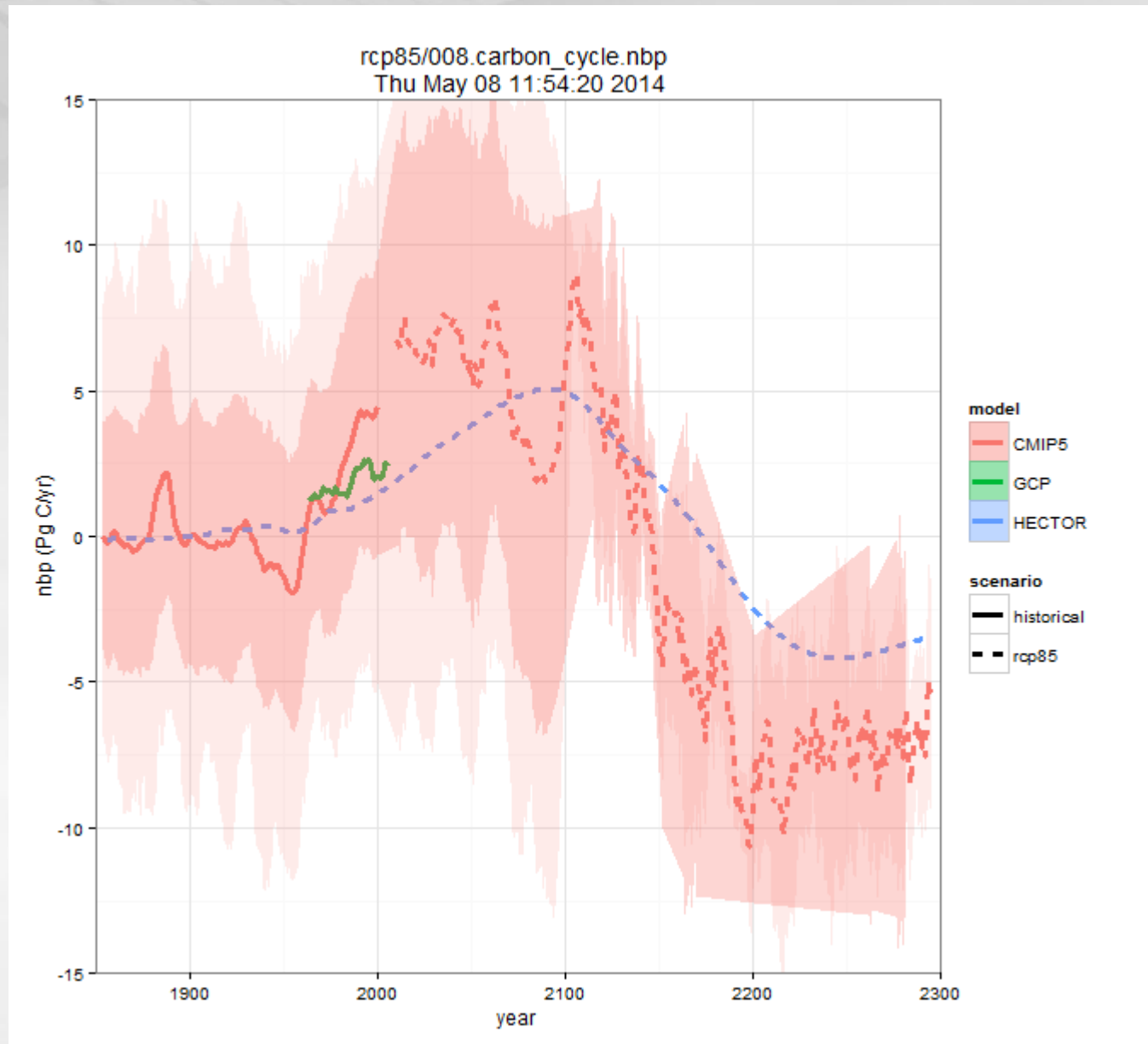
Results: atmospheric pCO₂



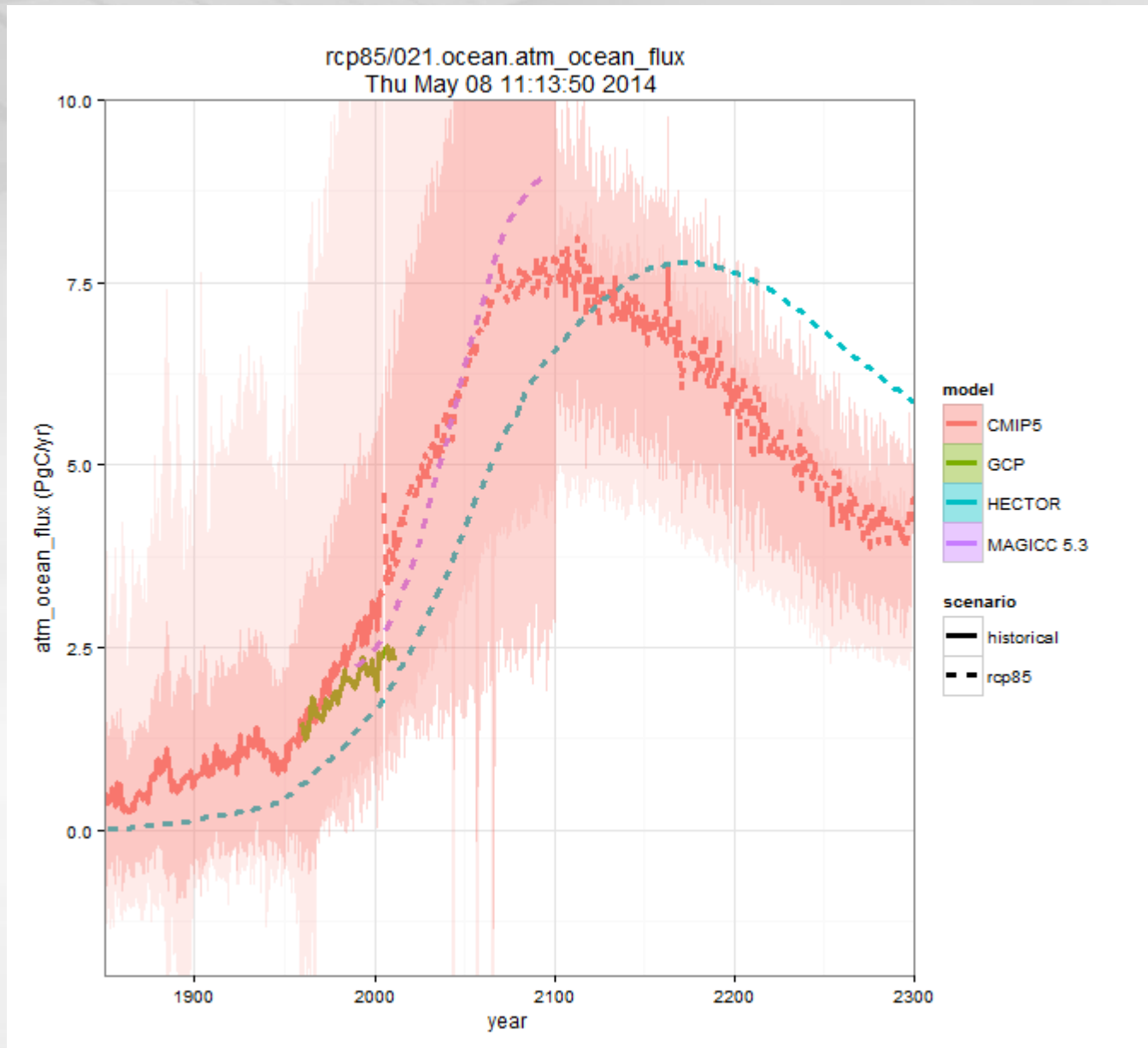
Results: global temperature change



Results: land carbon exchange - RCP 8.5

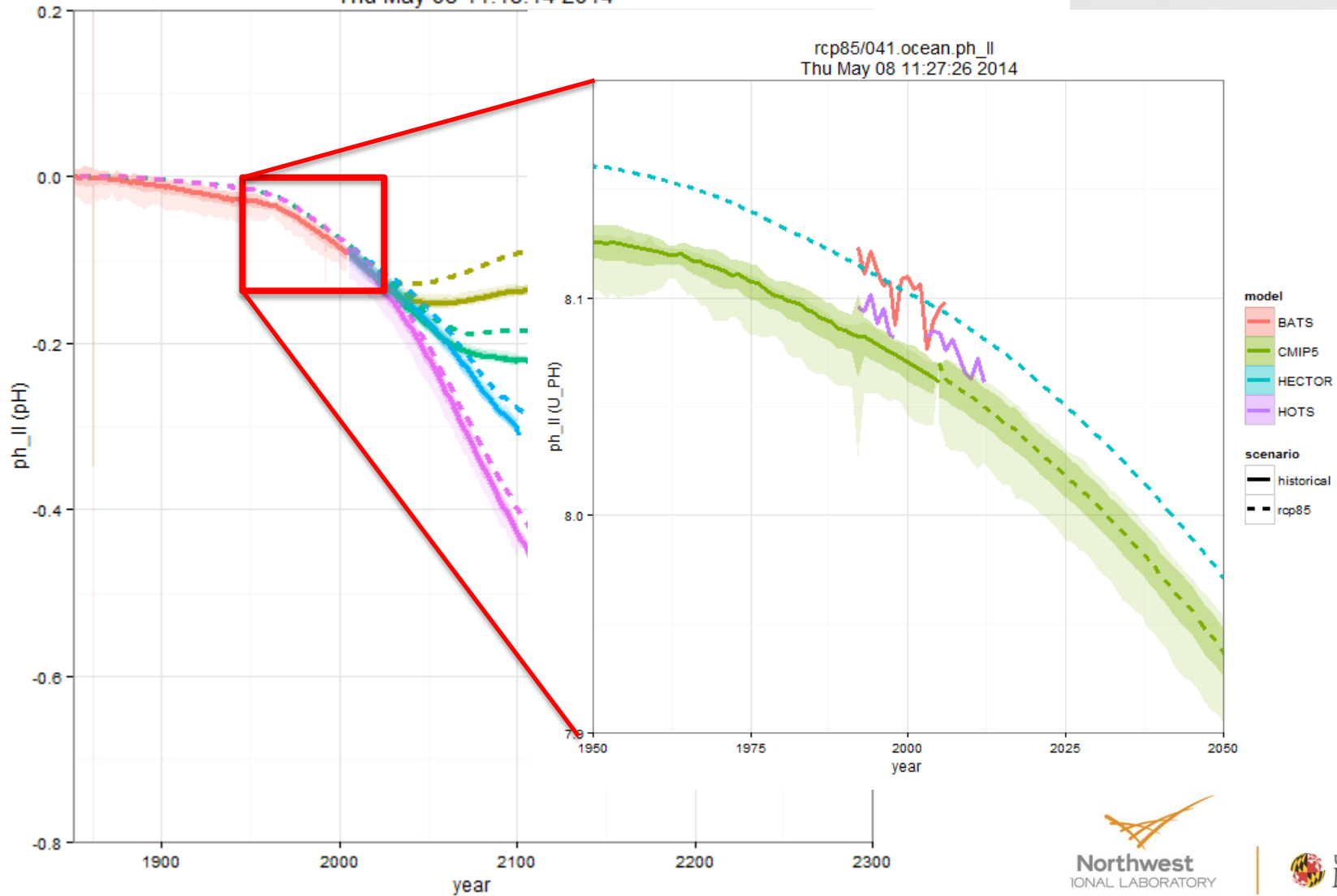


Results: ocean carbon exchange - RCP 8.5



Results: Low Latitude pH

rcp26_rcp45_rcp60_rcp85/028.ocean.ph_II
Thu May 08 11:18:14 2014



Future directions

- ▶ Finalizing initial “0.1” release
 - Public Github repository coming soon
 - Several manuscripts to be submitted
- ▶ Link to GCAM
- ▶ Collaboration with PSU
 - Test alternative ocean
 - Better sea level rise
- ▶ Hopefully useful for certain classes of problems
 - Fast-executing emulation and policy/model exploration
- ▶ We welcome feedback and future use!

