ORNL progress in the IESM project

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Integrated Earth System Modelling (IESM)

- Improve knowledge of controls on future greenhouse gas concentrations and climate-biosphere feedbacks
- How sensitive are predicted land use change trajectories to inconsistencies in climate and BGC components of IAM & CESM?
- How sensitive are modeled climate-carbon cycle feedbacks to on-line vs. off-line representations of land use and land cover change?

Multi-lab collaboration

- PNNL-JGCRI: GCAM development and application, energy markets
- ORNL: CLM4/CESM simulations and loose coupling
- LBL: carbon pricing scenarios and coupler framework
- UMD: GLM
- PNNL: CLM4 hydrology modules

Experiment 0

The control for Experiment 1, allows policy exploration with the uncoupled model, and tests the coupling framework

- ✧Expt 0.1: GCAM Reference Case
- ✧Expt 0.2: RCP4.5 with Fossil Fuel and Industrial Emissions Carbon Tax (FFICT)
- ✧Expt 0.3: RCP4.5 with Universal Carbon Tax (UCT), i.e. CMIP5 RCP4.5

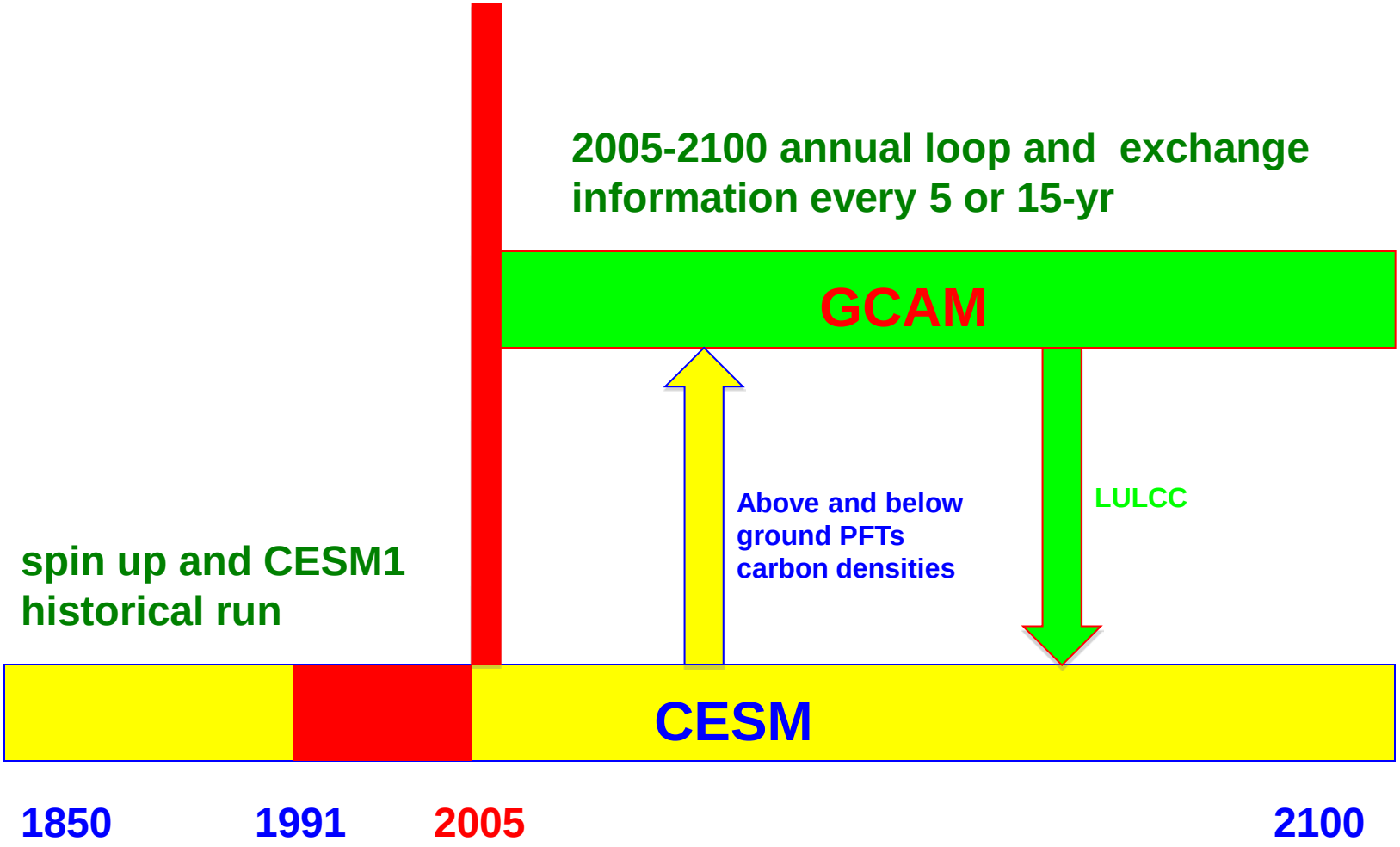
Experiment 1

- ✧Introducing coupling/feedback of carbon densities and LULCC between CLM/CESM and GCAM, and compares this with Experiment 0.3
- ✧Running on a 5 or 15-year time-step for GCAM – GLM – CCSM communication

Experiment 2

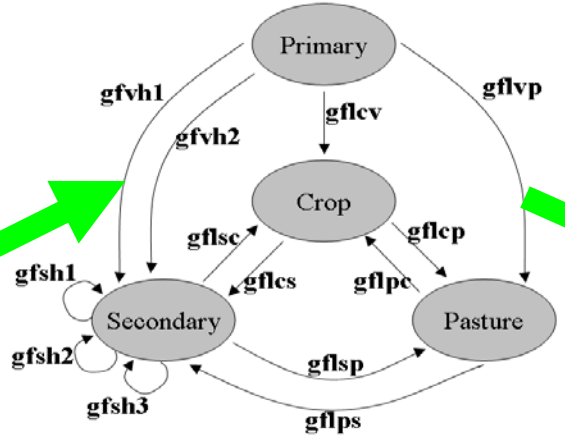
- ✧Feedbacks between CLM4 and GLM
- ✧More feedbacks between CESM1 and GCAM
- ✧…….

Loose coupling strategy

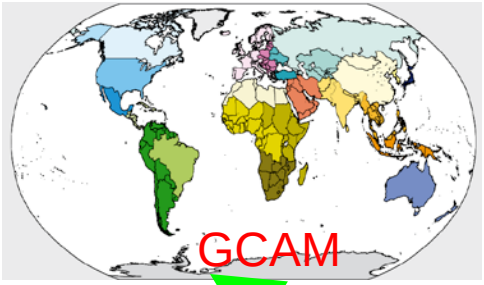


IESM coupling structure

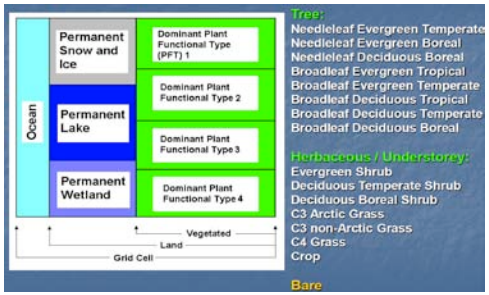
UMD GLM matrix



NCAR transition package



Every 5 or 15 years

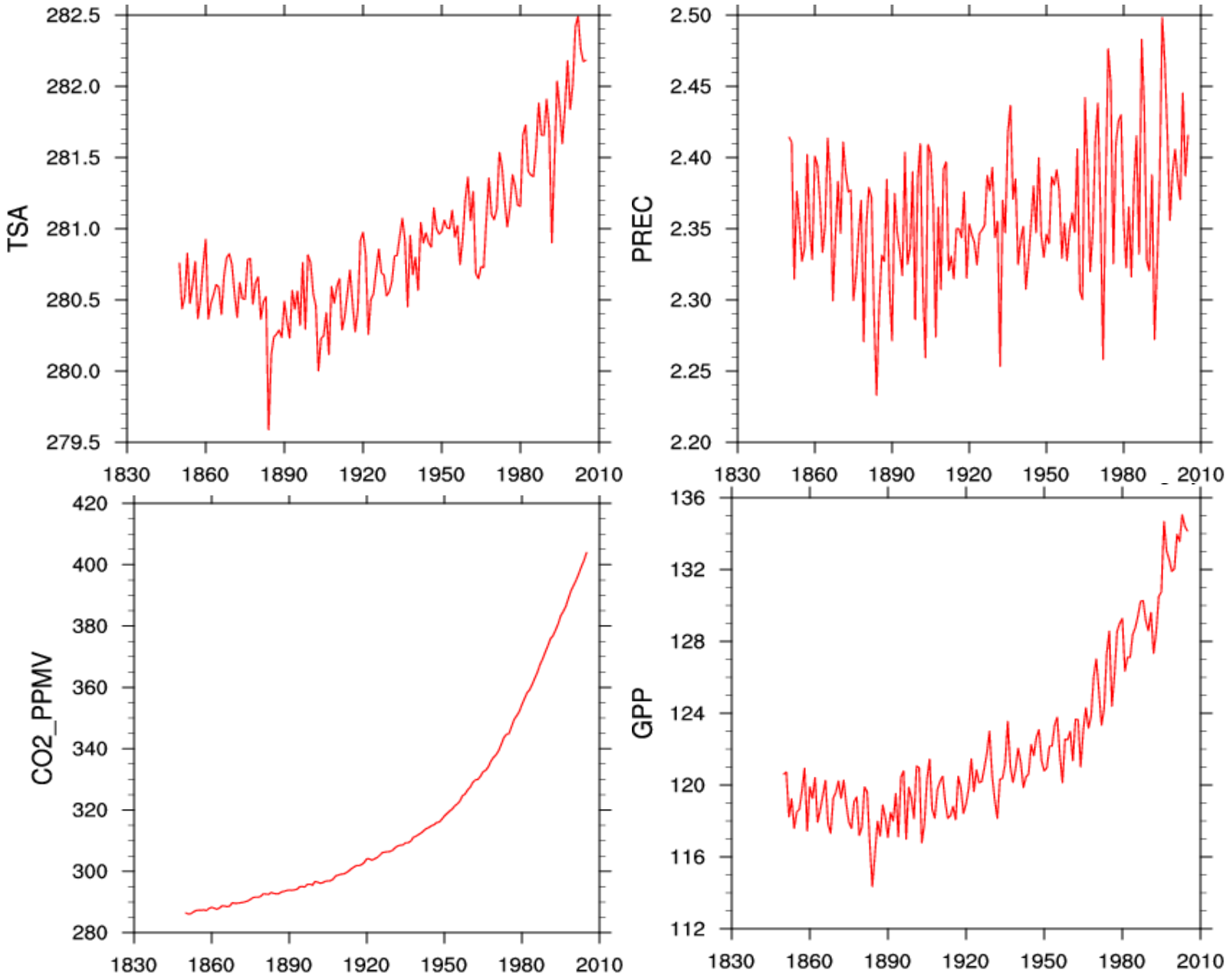


Downscaling Scripts, time and space

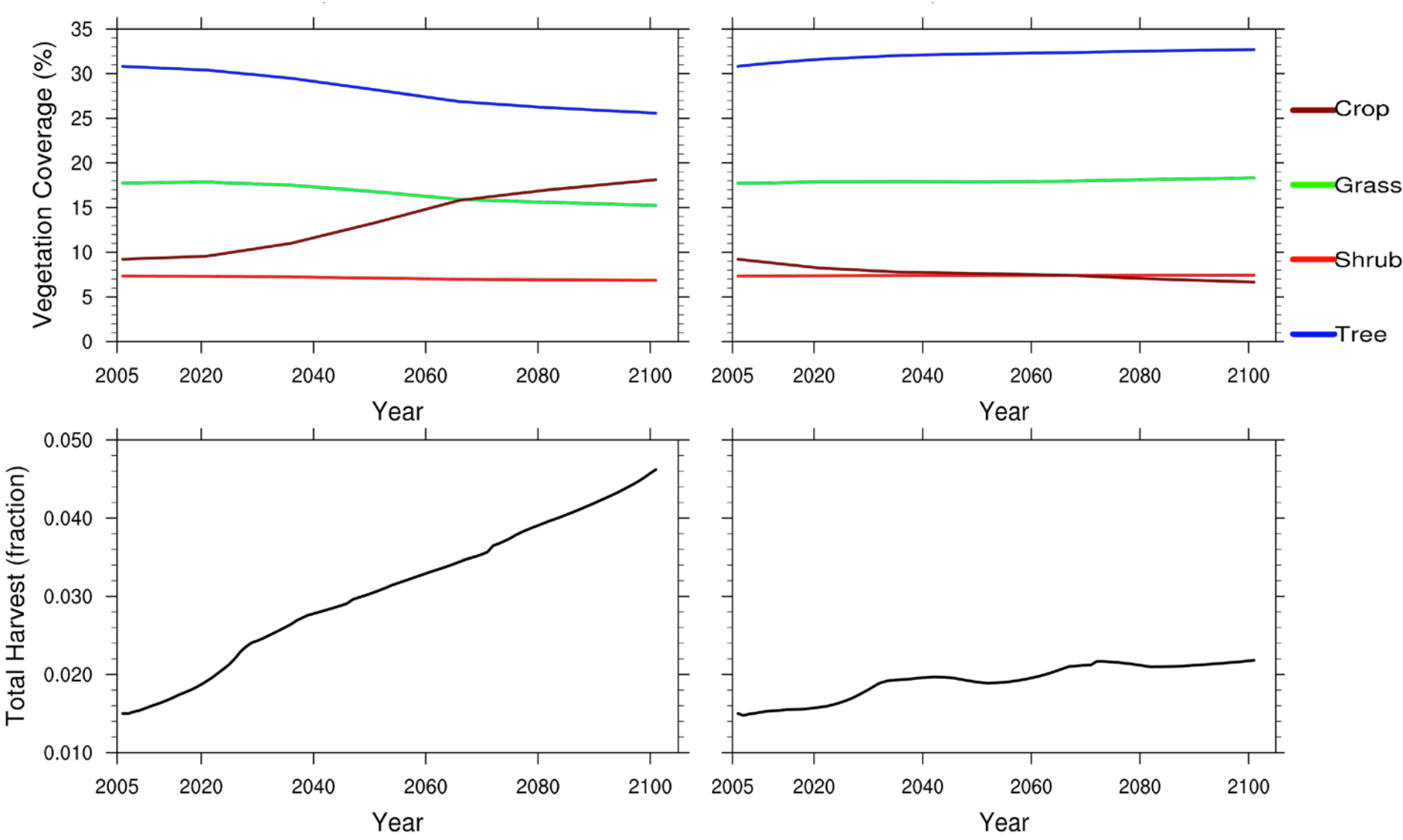
dynpft subroutines

Present coupling status

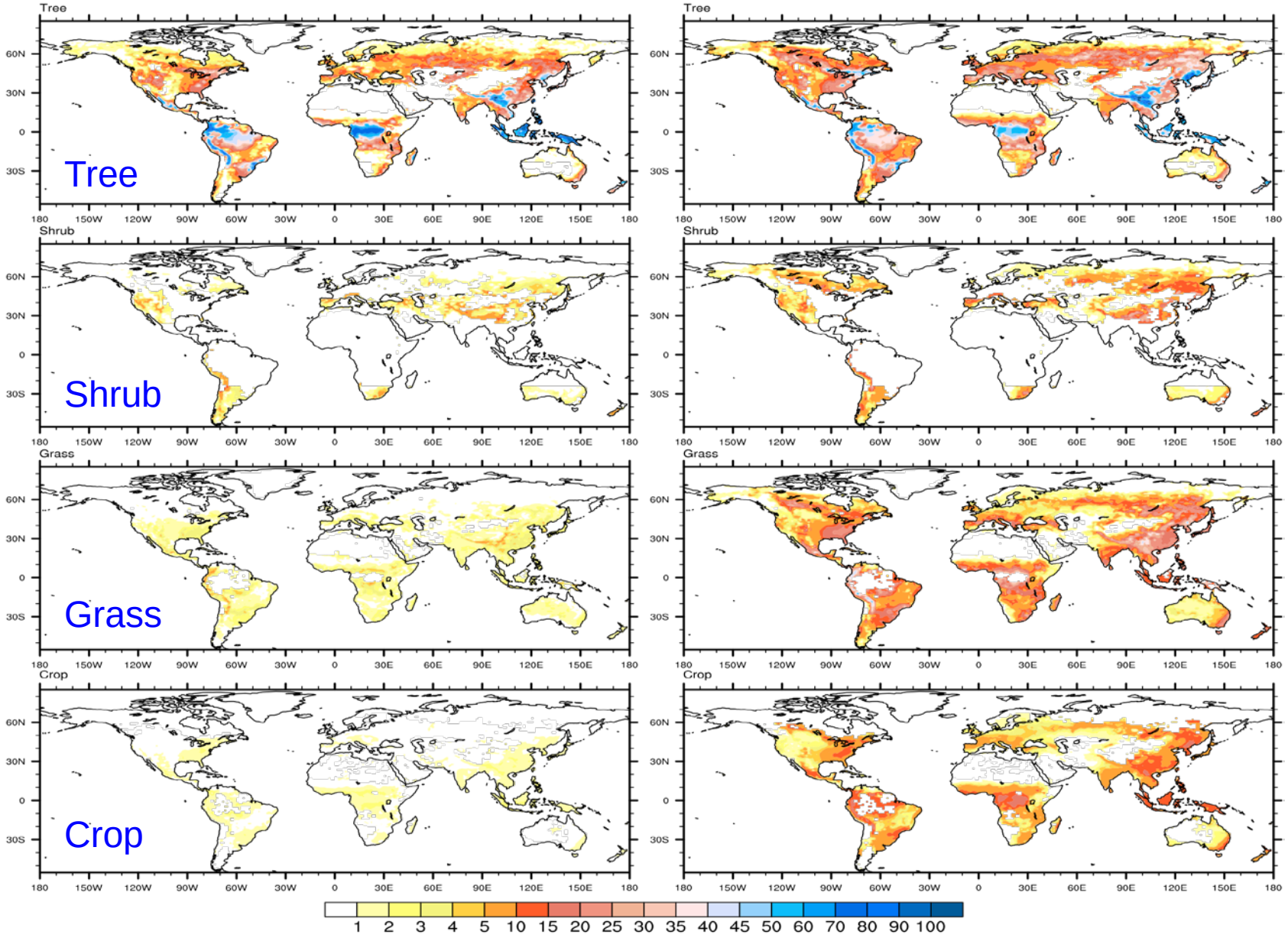
- ✓ 1850 CESM1 control (ccsm4_0_beta50, 301-800 (500 yrs))
- ✓ 1850–2005 historical transient CESM1 (ccsm4_0_beta55)
- ✓ 2005-2100 CESM1 RCP4.5 control simulation (exp0.3, cesm1_0_beta09, running….)
- ✓ Carbon densities between 1991-2005 for GCAM spin-up
- ✓ Dynamic land use inputs for concentration-driven CESM1
- ✓ Assisting LBL group on the coupling of PL code and mksurfdata
- ✓ …….



CESM1 b40.20th.1deg.coup.001_beta55_1850-2005



RCP ref (exp0.1, left) and 4.5 (exp0.3, right) PFTs dynamics during 2005-2100



Above (left) and below (right) ground mean carbon density (Kg C /m2) between 1991 and 2005

Next steps

- Keep the manual couplings
- Results analysis
- Work closely with other teams on the coupling by machine

Thanks