

Calibrating Hector, a simple climate model

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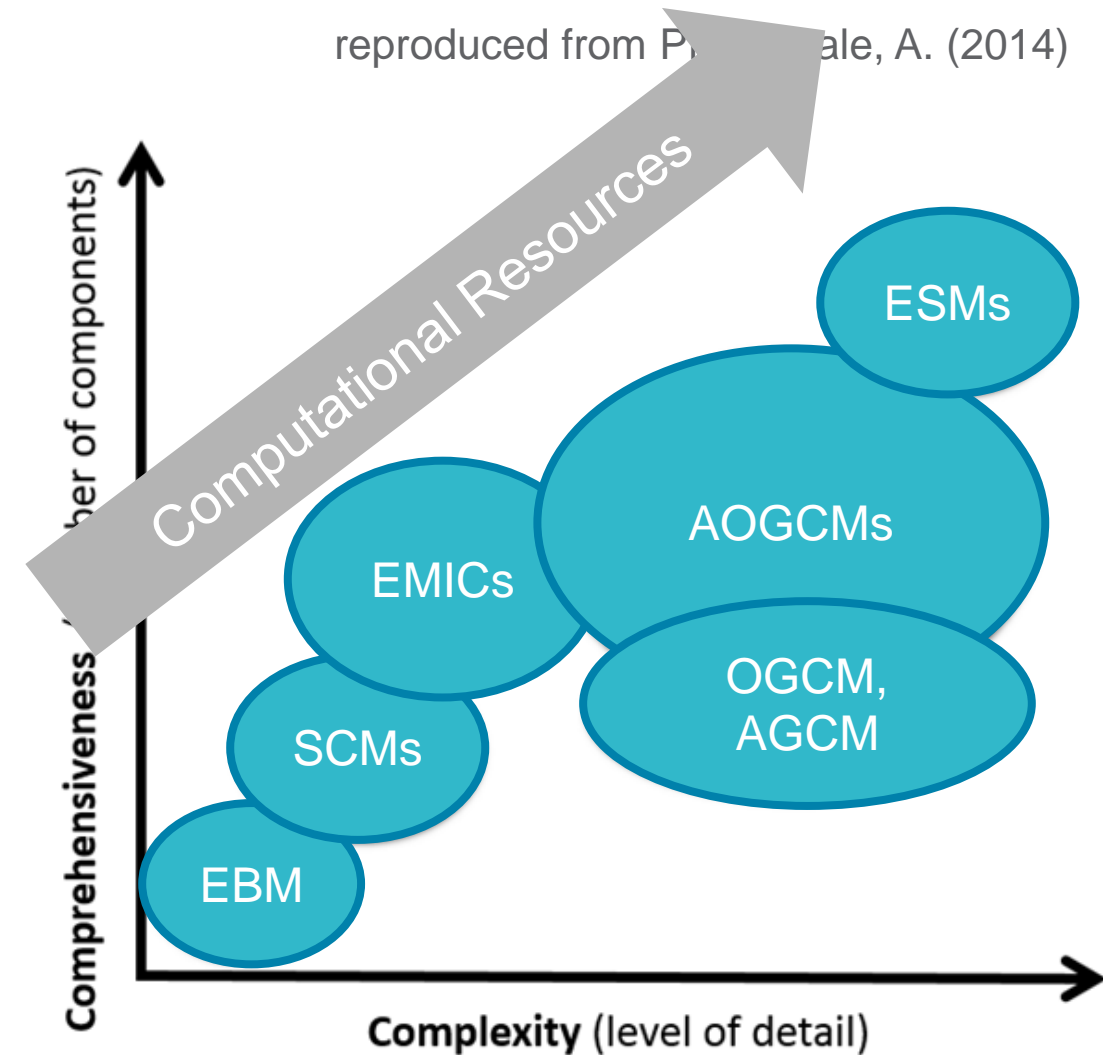
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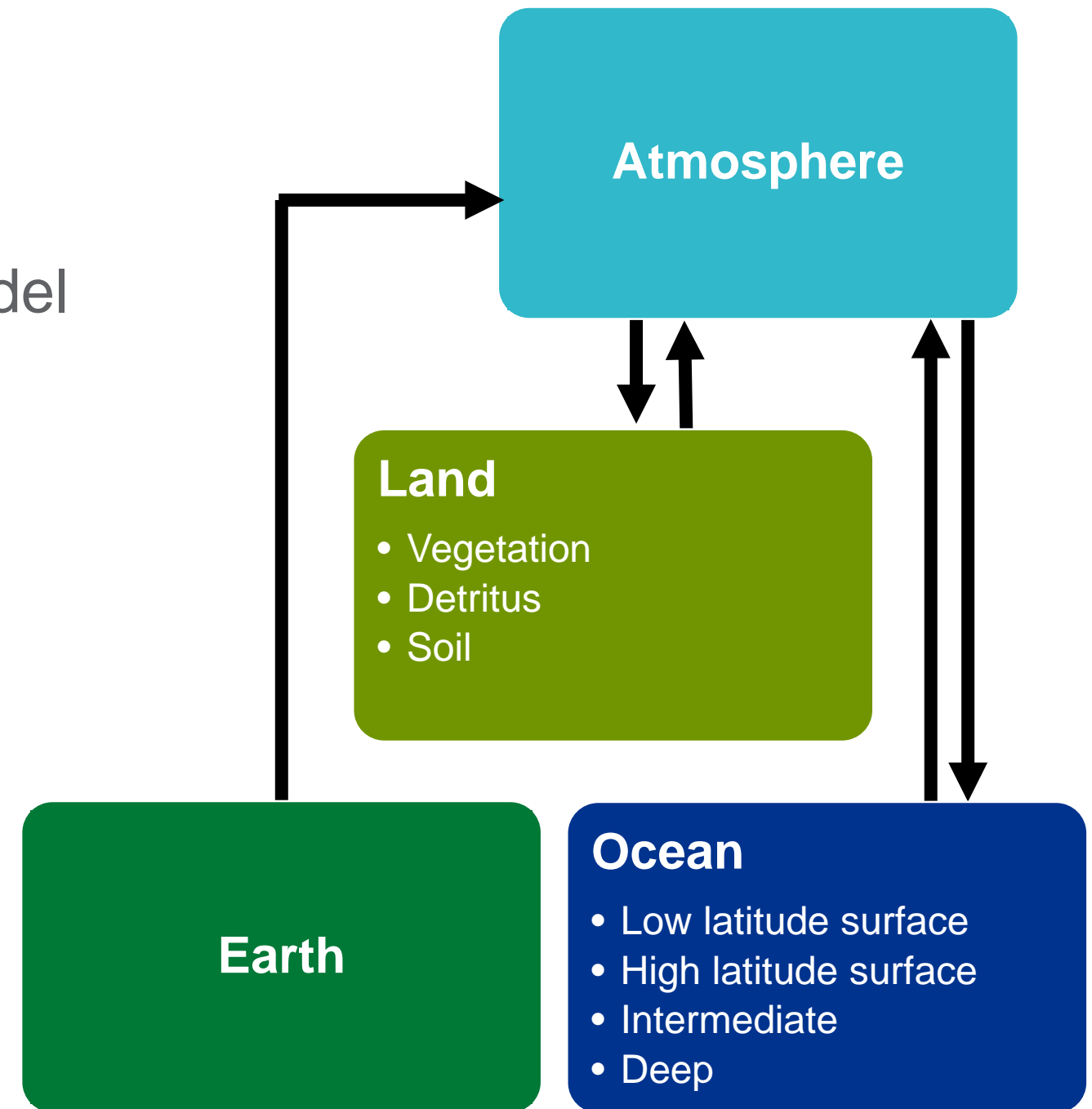
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Overview of Climate Models

- Earth/climate models are diverse in complexity
- Simplified Climate Models (SCMs) are computationally inexpensive but less detailed
- SCMs can be used
 - As stand alone climate models
 - Model coupling exercises
 - As an emulator
 - Uncertainty studies



- Globally resolved energy balance model with a diffusive ocean and a carbon cycle component
- Hector can be used to emulate aggregate ESM behavior
- Two calibration studies to calibrate
- Calibrated Hector parameters
 - S – equilibrium climate sensitivity
 - α_a – aerosol scaling factor
 - α_v – volcanic scaling factor
 - κ – ocean heat diffusivity

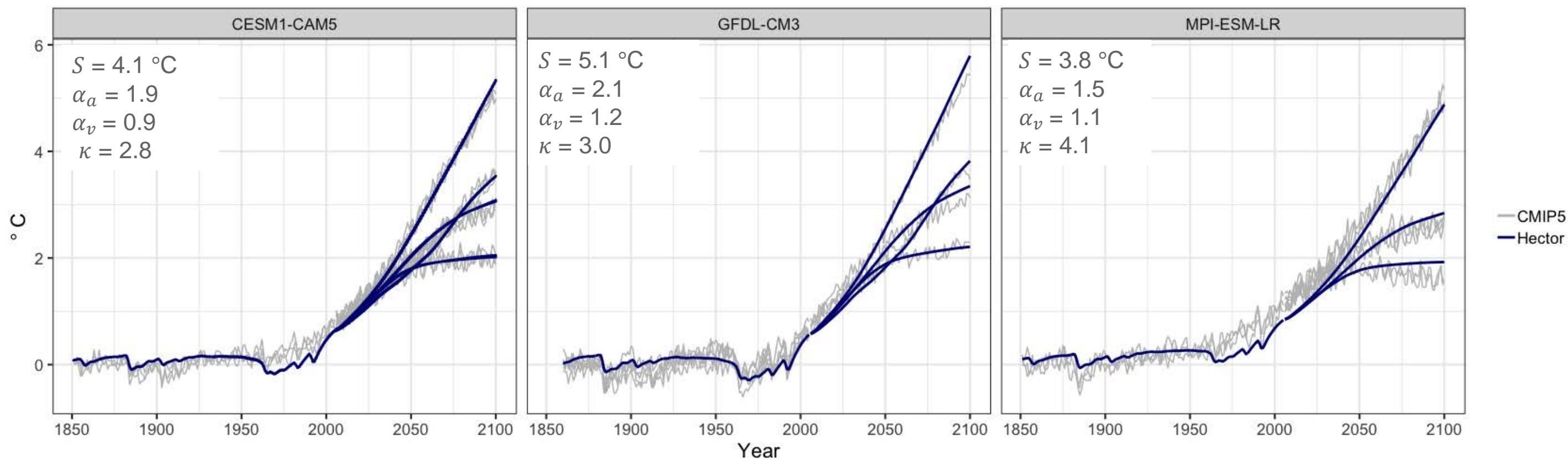


Modified from Hartin et al., 2015, 2016

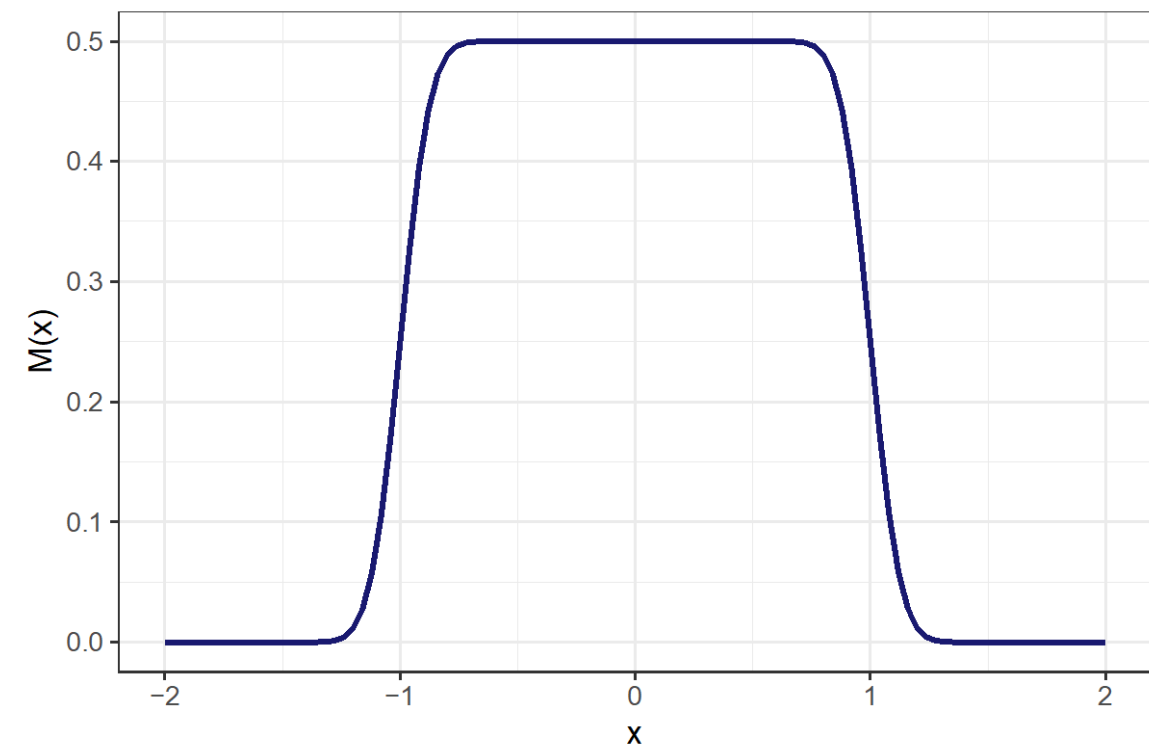
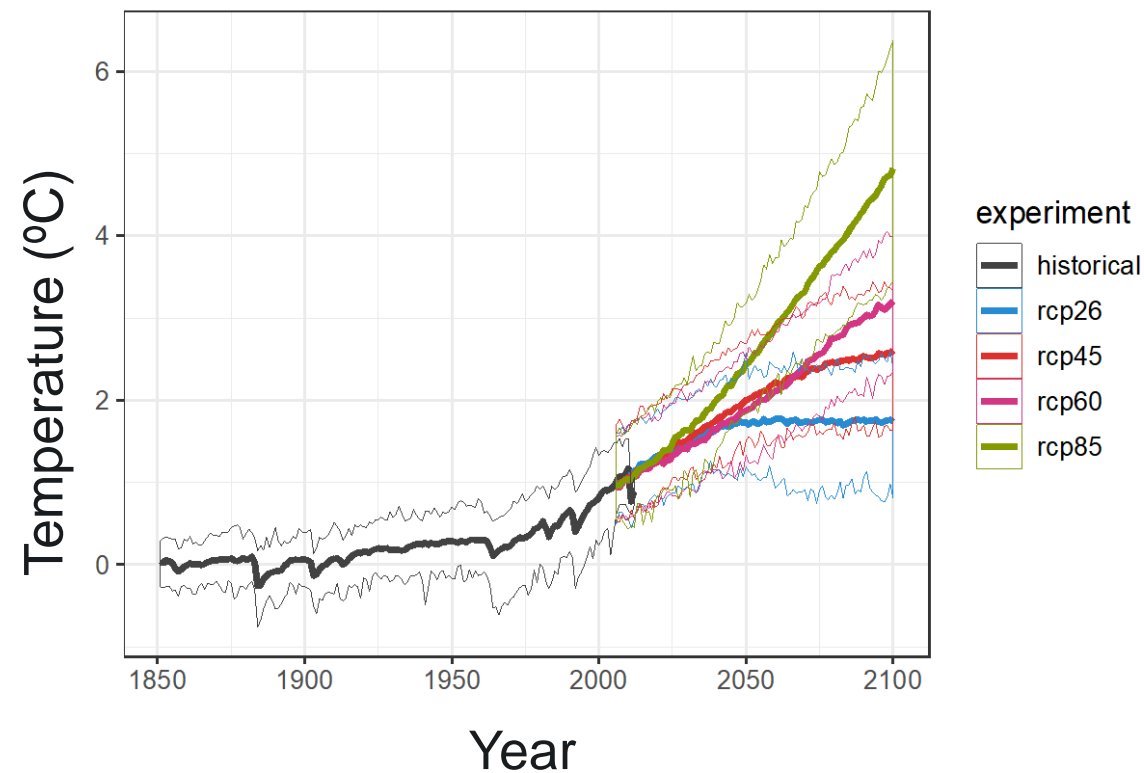
Calibrating to individual ESMs

- Tune Hector climate parameters to successfully emulate individual ESMs
- Our definition of success
 - Hector is able to reproduce major behavior of ESMs
 - Calibration protocol is able to identify a unique solution
 - Calibration results use realistic parameter values
- Developed a protocol to calibrate to CMIP5 ESM
 - Calibrated Hector to emulate 31 different ESM

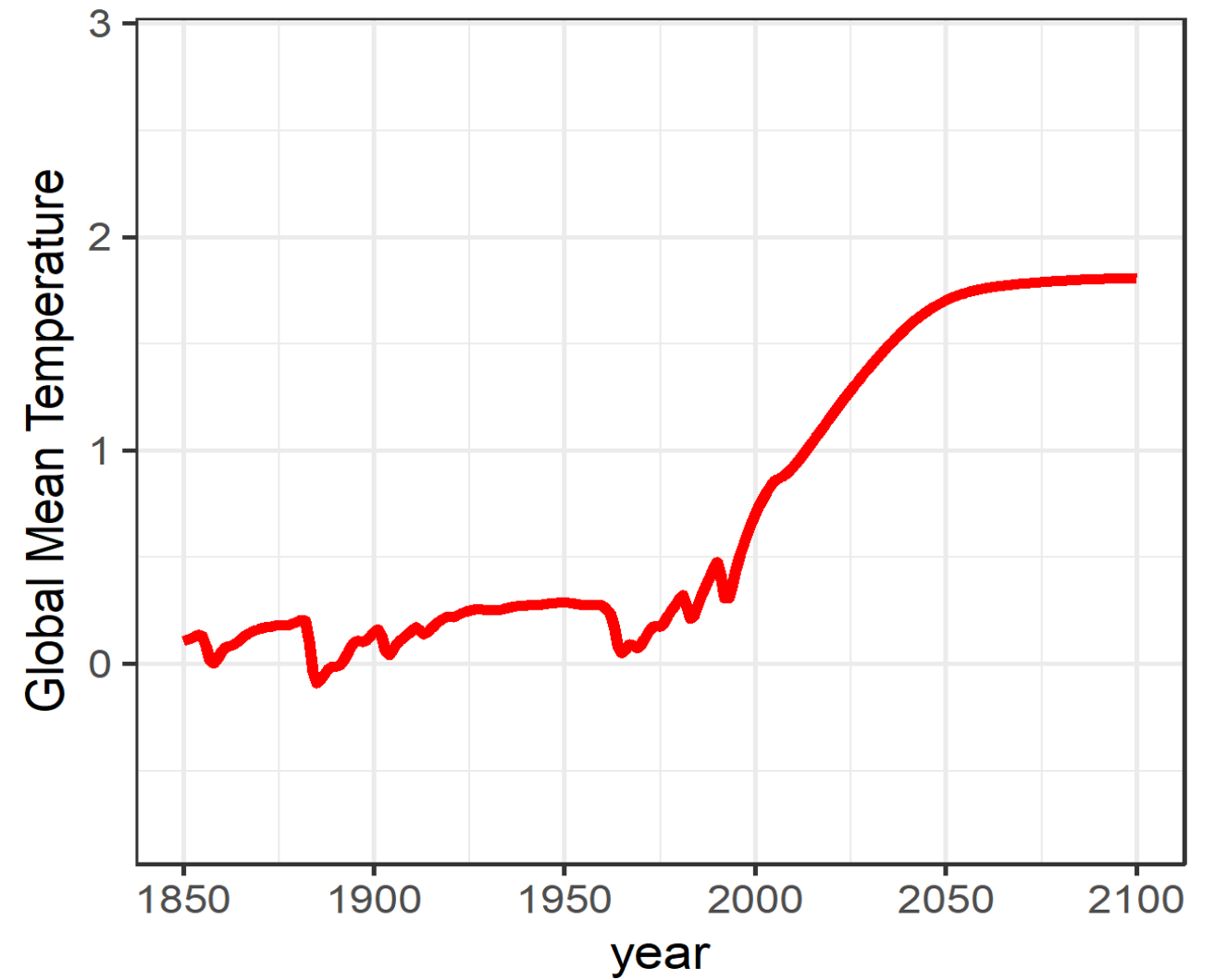
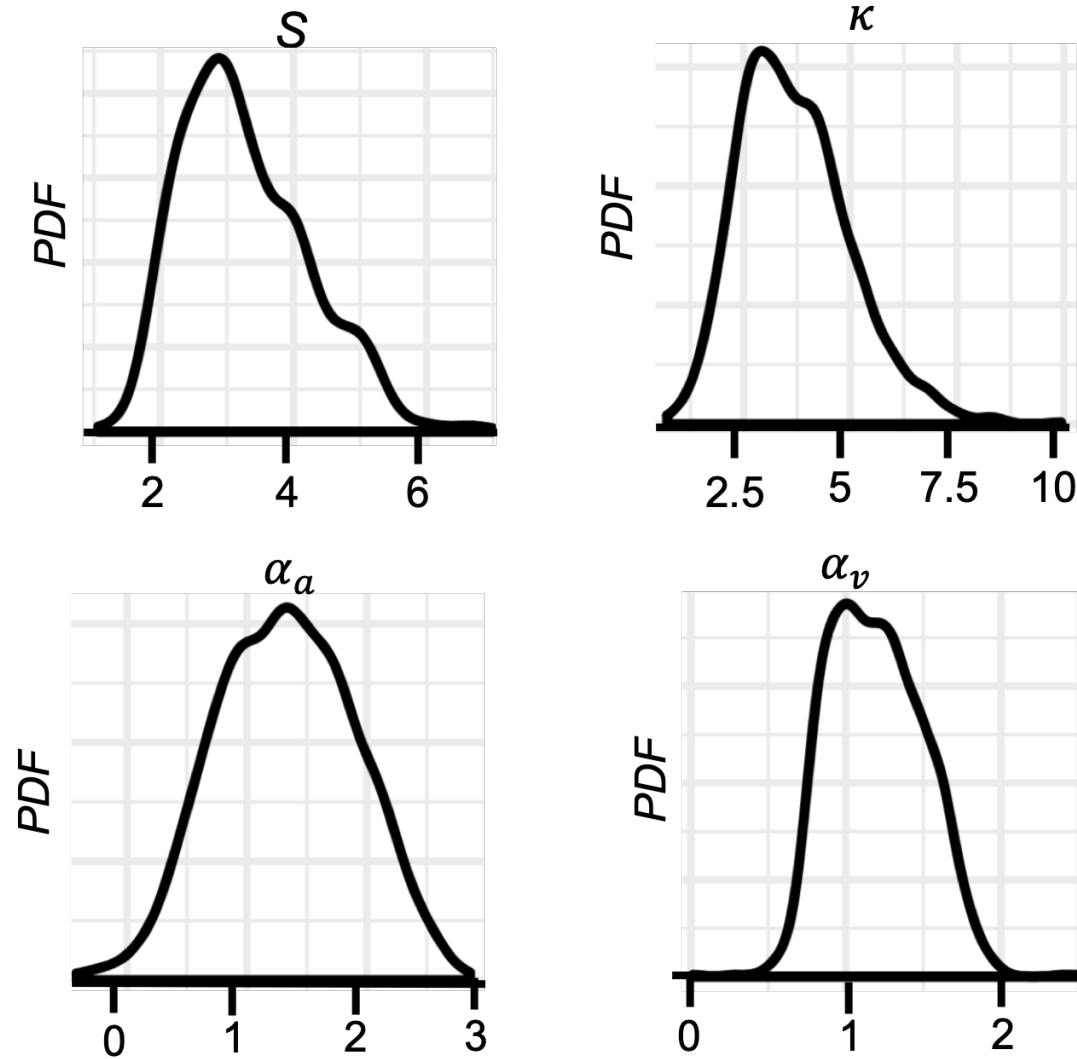
Calibration to individual ESMs Results



- Perform a Bayesian calibration climate parameters
- Generate probabilistic output of Hector
- We calibrated to the CMIP5 range for temperature and ocean heat flux as well as to the multi model mean



Bayesian calibration Results



- Calibrated Hector to emulate individual ESMs
 - Parameterize Hector
 - Investigate differences between ESMs
- Bayesian calibration
 - Use joint probability distributions in sensitivity analyses
 - Use probabilistic output
- Results are available at <https://zenodo.org/record/3515153#.XcClvkVKiUk>