Last millennia terrestrial ecosystem model intercomparison: challenges and goals

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Background

Ecosystem models are frequently used to forecast responses to climate over time scales exceeding that which the models were tested on. The lack of decadal to centennial scale model validation can be attributed to the limited availability of pre-industrial climate data. Past and pending projects (e.g., VEMAP, PMIP-1,2,3) have used common drivers and even historical reconstructions to compare ecosystem models [*e.g.*, 1], however extensive calibration and comparison over the last millennium and longer have not been conducted. The Paleo-Ecological Observatory Network (PalEON) is a new model intercomparison effort that includes working groups of modelers, statisticians, and paleo-data specialists collaborating to 1) generate consistent data products for validation and data assimilation, and 2) to compare the skill of ecosystem models (Table 1) at simulating processes within temperate North American forests using an ensemble of climate realizations covering the last 2 000 years.

Table 1. Model details.

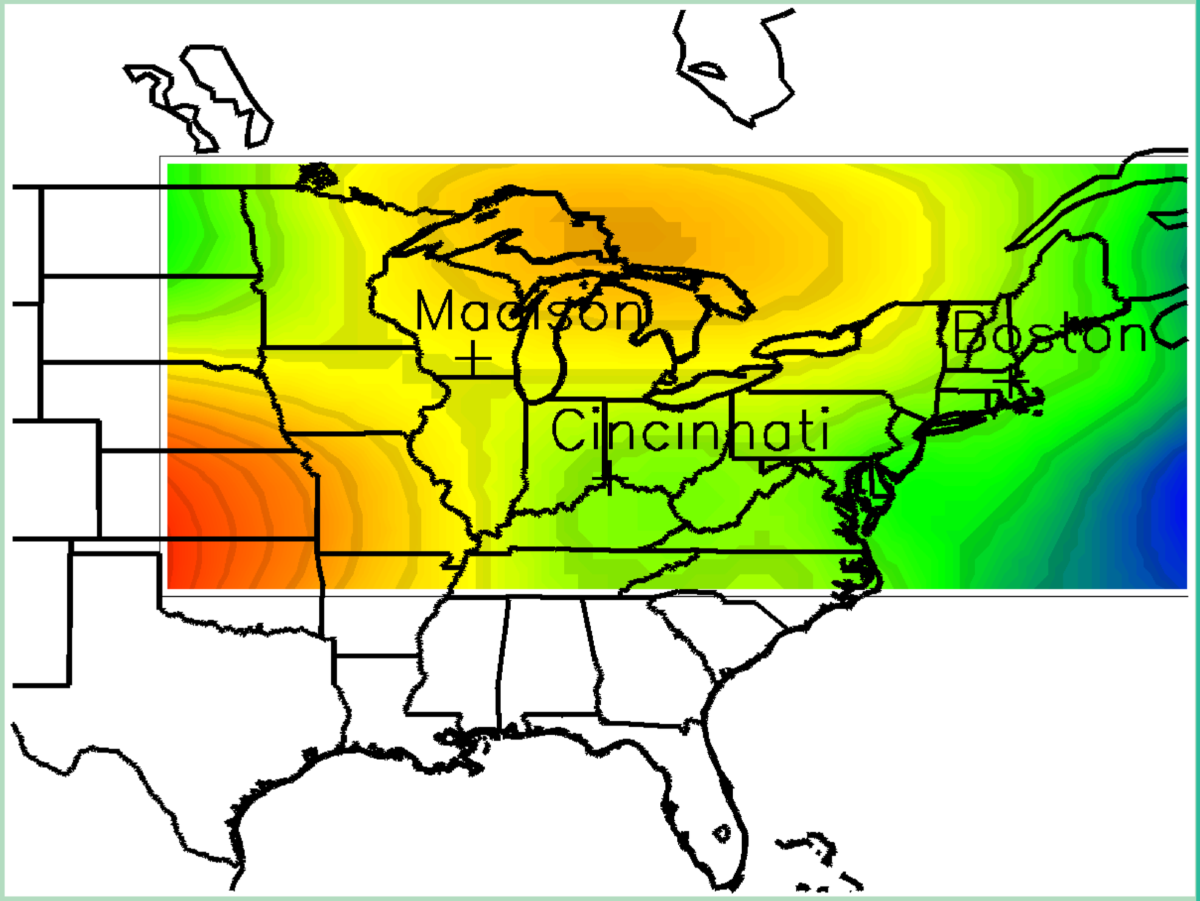
Model	Description
Biome4	pysiology-process ecosys.
CLM3	bigleaf ecosys. c-cycling
ED2	forest gap, ecosys. struct., c-cycling
LPJ-GUESS	dynamic vegetation c-cycling
LPJ	dynamic vegetation c-cycling
LoTEC	bigleaf ecosys. c-cycling
SiB-CASA	integrated canopy, c-cycling
SLIP	forest gap
SipNET	ecosys. c-cycling, e.c. data assim.
TECO	ecosys. c-cycling

Model initialization

North American temperate forests are an important carbon-sink. Carbon-cycle components such as soil carbon reflect a climate history of incremental change over hundreds of years. These slow changes are often initialized to be at or near equilibrium. PalEON will test these equilibrium assumptions by examining differences between carbon pools, and differences between model vegetation and potential vegetation.

PalEON domain

Fig. 1. The PalEON domain covering temperate North American forests from Great Lakes to New England (100–60 E,35–50 N) is highlighted using example temp. data from the MPI-ESM model.



Simulations

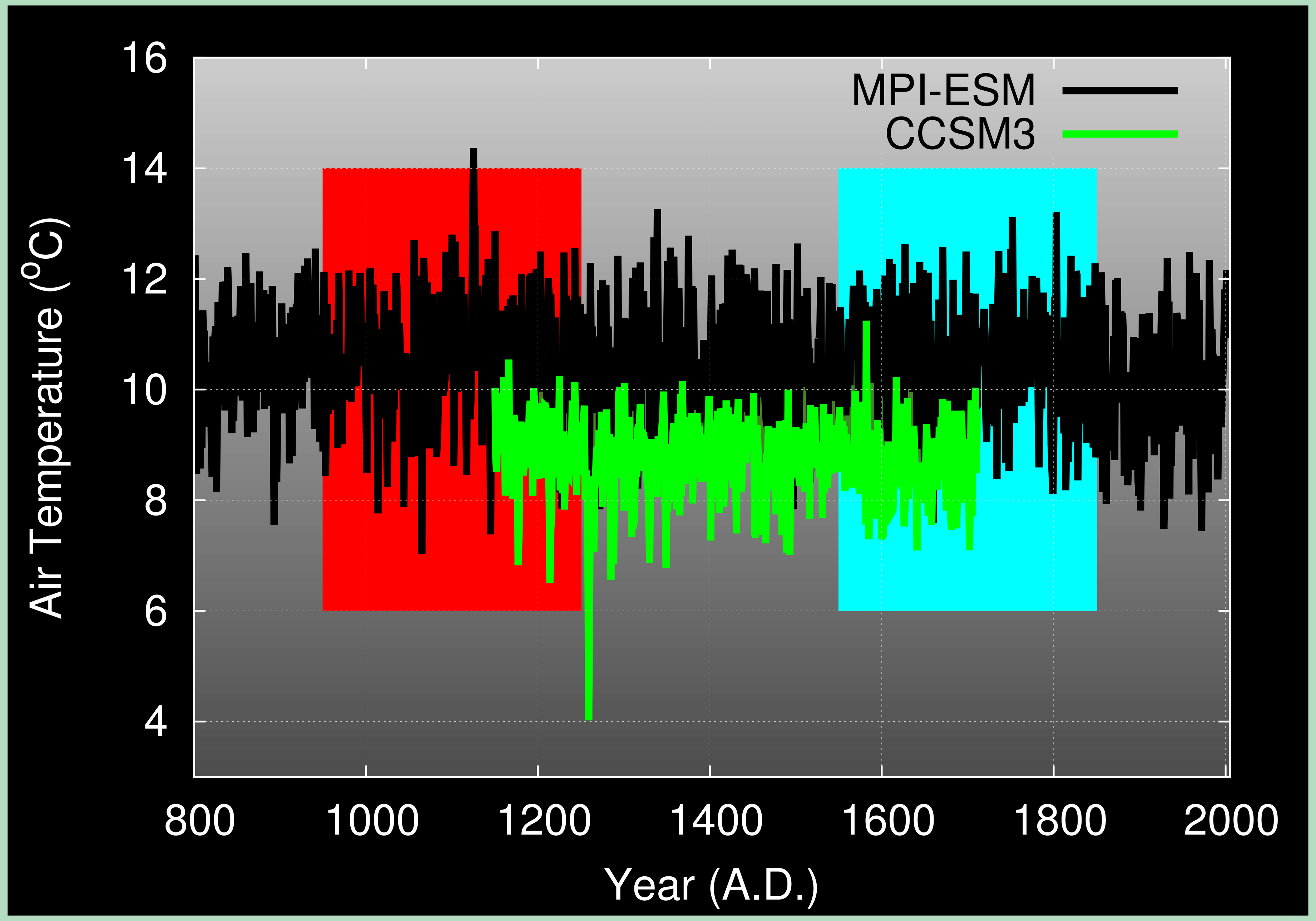
PalEON modeling group activities focus on conducting model simulations using different driver data. Differences in vegetation composition and carbon-pools will provide information on differences in model representations of past ecosystem dynamics and consistency between vegetation and climate. Table 2 outlines the ensemble runs that each model in Table 1 will conduct.

Table 2. Meteorological drivers and their environmental forcings are listed for each paleoclimate realization. GCM env. forcings include anthropogenic forcings (A), total solar irradiance (S), and volcanic aerosol (V).

Simulation	Paleoclimate Driver	Time Period	Forcing
PN1	steady-state		
PN2	MPI-ESM [2]	800-2005	A,S,V
PN3	CCSM-3 [3]	1150-1700	S,V
PN4	CCSM-4 [4]	850-2005	S,V
PN5	Paleo-proxy	0-2000	–

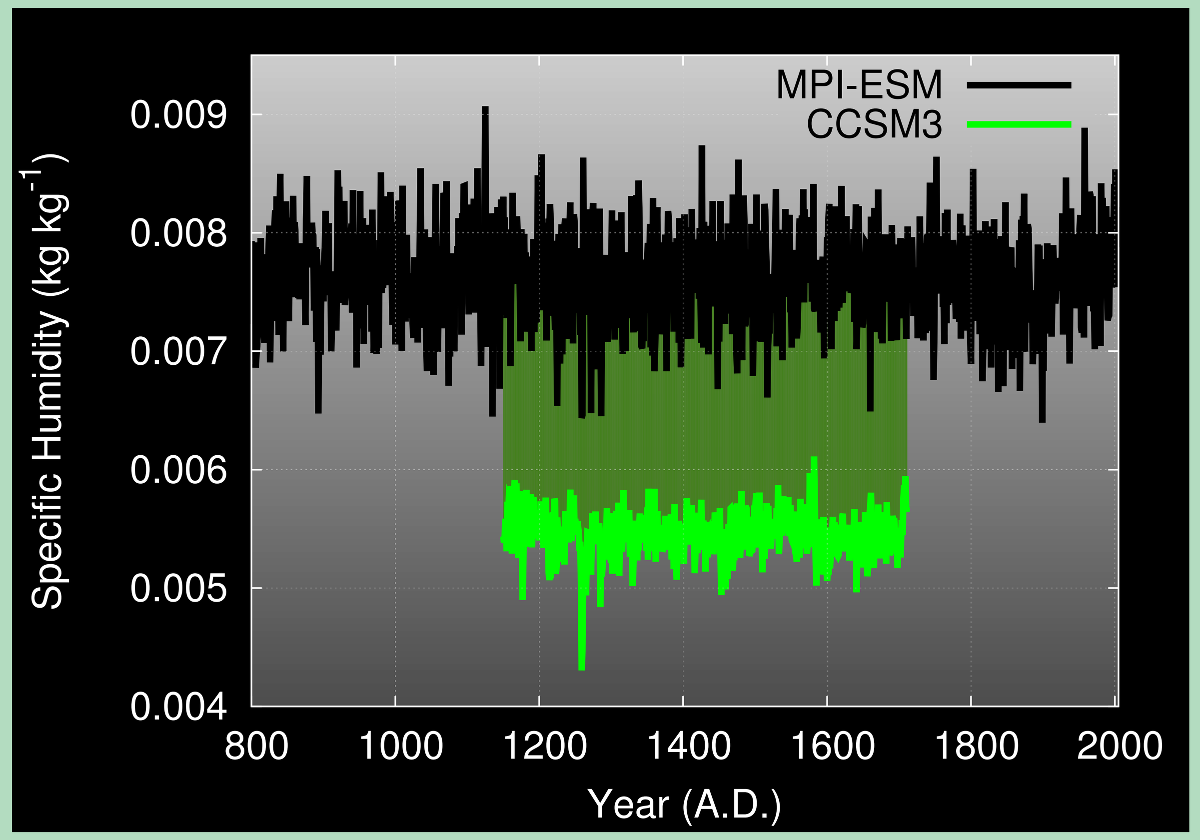
Prominent climate signals

Fig. 2. The PalEON ecosystem models from Table 1 will be forced using an ensemble of four last millennium datasets (PN2-PN5 in Table 2). Differences in magnitude and variability of temperature for 2 drivers are shown. The red shaded box locates the Medieval Warm Period, and blue is the Little Ice Age.



Different paleoclimate realizations

Fig. 3. Using different climate realizations forces the models to explore 'climate space' differently. Some model-sensitive-parameters like specific humidity shown here have a larger degree of discrepancy between driver datasets than others, which we expect to highlight differences between model types (*e.g.* forest gap and bigleaf).



Inferences from driver data

Standardized paleo-proxies, such as precipitation and temperature from pollen, are being developed by the paleo-data group for comparing the skill of models but also for data assimilation. These comparisons will help us to understand dynamic processes that are not observed in the paleo-proxies and how they interacted with climate.

Participating ecosystem models will run over protracted time periods to test whether their representations of biogeochemical and biogeophysical interactions hold true over centennial scales and whether these representations can still arrive at the observed ecosystem states.

Acknowledgments

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