

On the applications of CLM/CLMVIC at multiple scales

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Motivation

- ▶ To improve the capability of CLM for hydrologic simulations at various scales, so that CLM could be used to represent hydrology, soil, managed and unmanaged ecosystems, and biogeochemical processes across scales, and provide hydrologic information being passed through all the components in a single modeling framework in integrated earth system models.
- ▶ To quantify uncertainties in simulated water and energy fluxes from CLM for better understanding of feedbacks between terrestrial hydrologic cycle and other components in the earth system.



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CLM development and evaluation tasks

► Development tasks

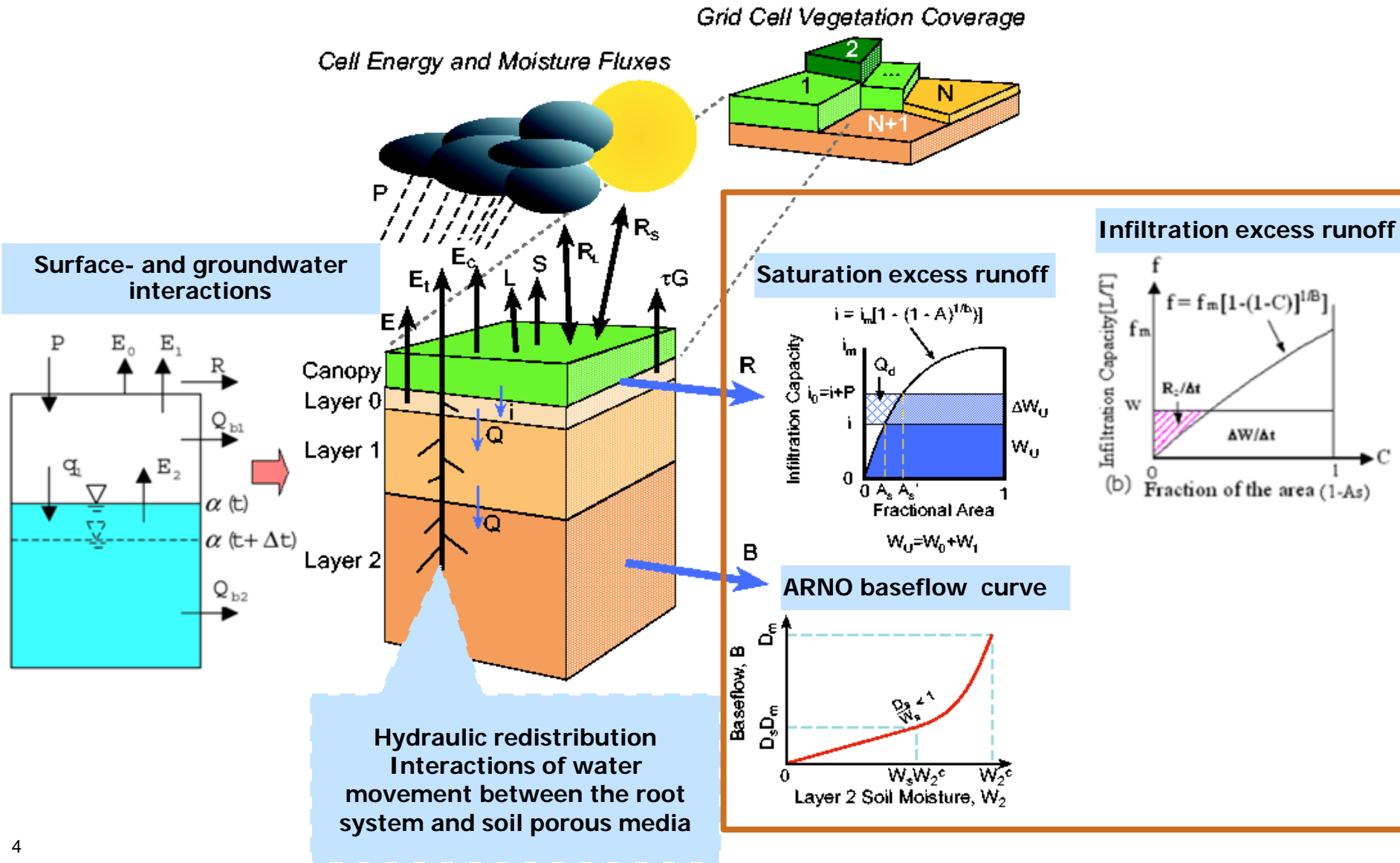
- Incorporating parameterizations from the Variable Infiltration Capacity (VIC) land surface model into CLM;
- Developing a high resolution input dataset for CLM
- Developing a semi-distributed extension of CLM (DCLM) using watersheds as units;
- Adding elevation bands into CLM

► Evaluation tasks: applying the model at multiple resolutions

- Global testing of CLMVIC global testing at 1-deg
- Global testing of new PFT/SP dataset for CLM
- CLM/CLMVIC applications at 1/8 deg (NA, NLDAS-2)
- CLMVICCN testing at 0.5-deg (global) and 0.25-deg (NA)
- DCLM applications over the Columbia River Basin and the Midwest.

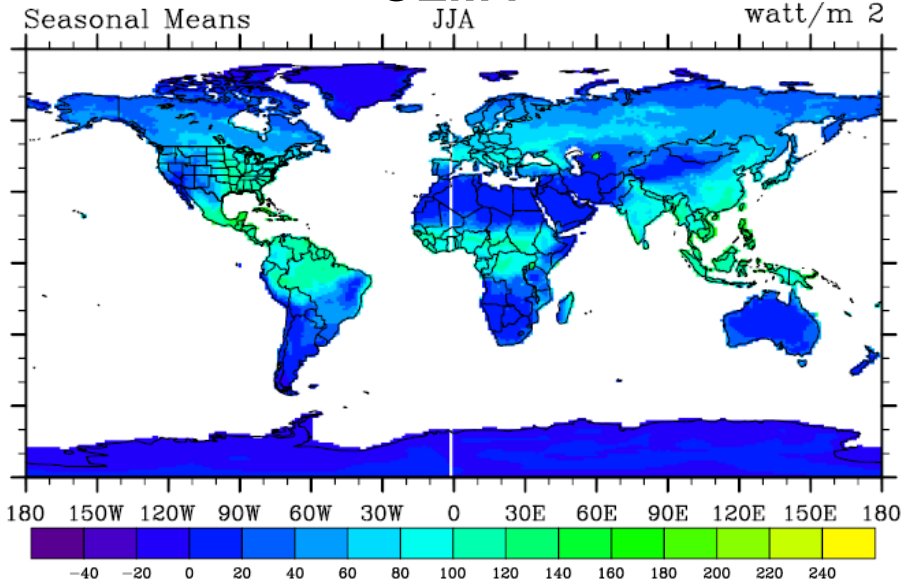


Merging of CLM4 and VIC

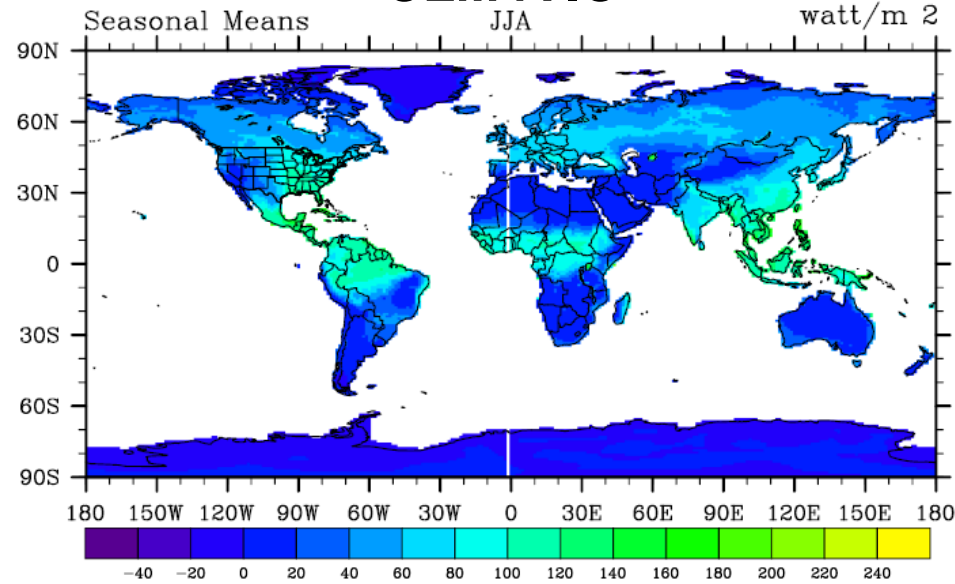


Summer LH, 1-day, 1-degree, 1995-2004

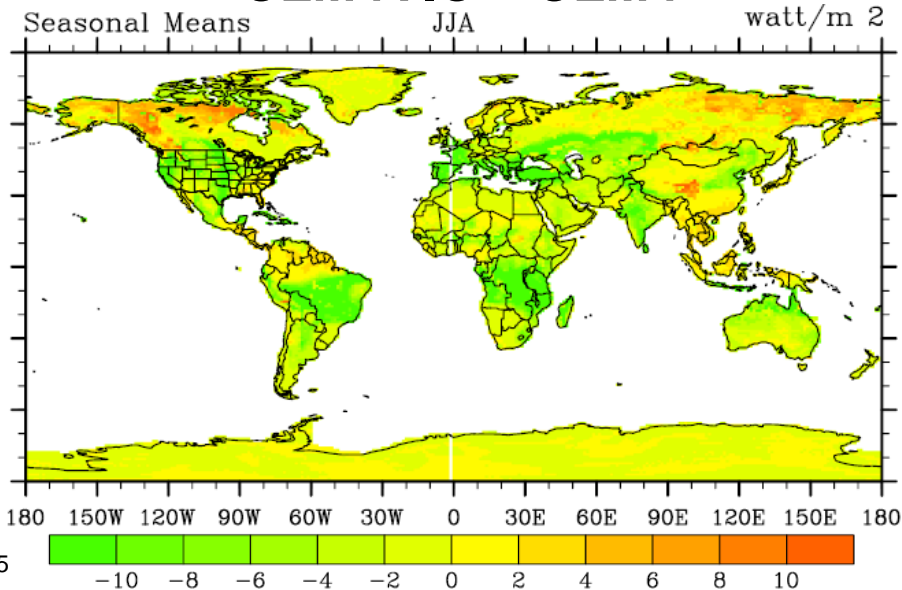
CLM4



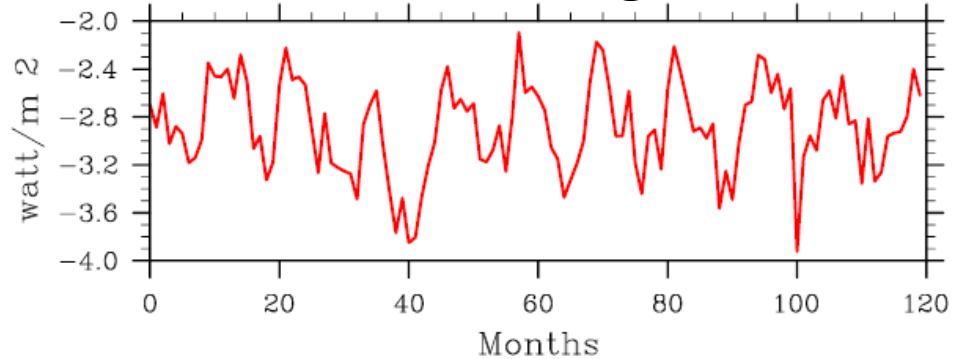
CLM4VIC



CLM4VIC - CLM4



CLM4VIC - CLM4, global mean

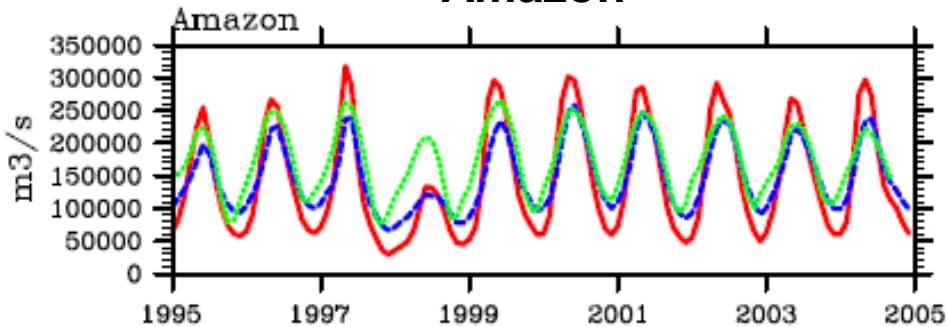


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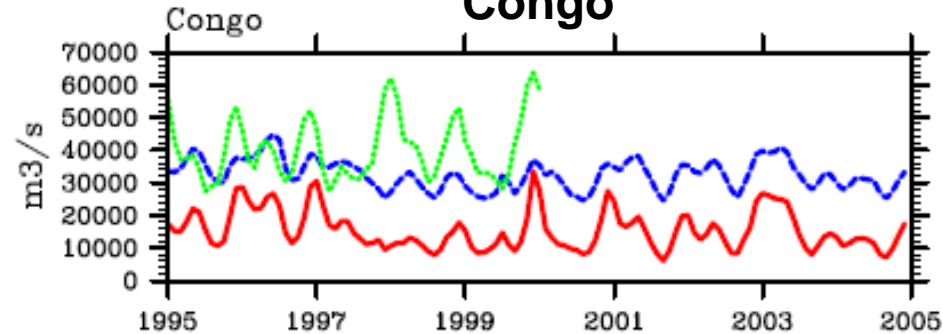
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River discharge from large river basins

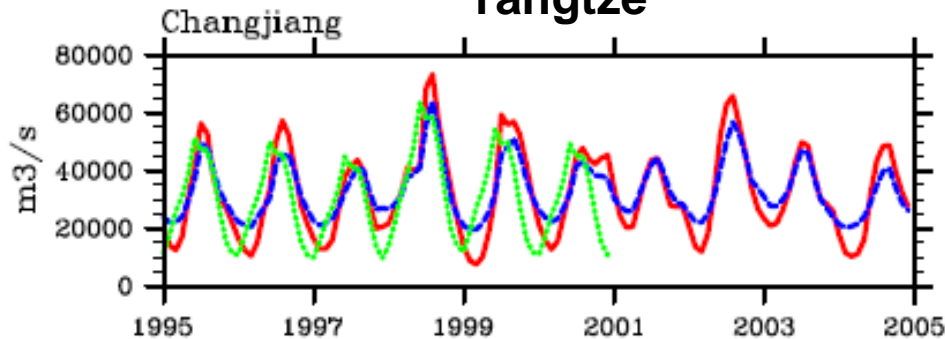
Amazon



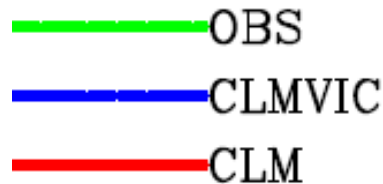
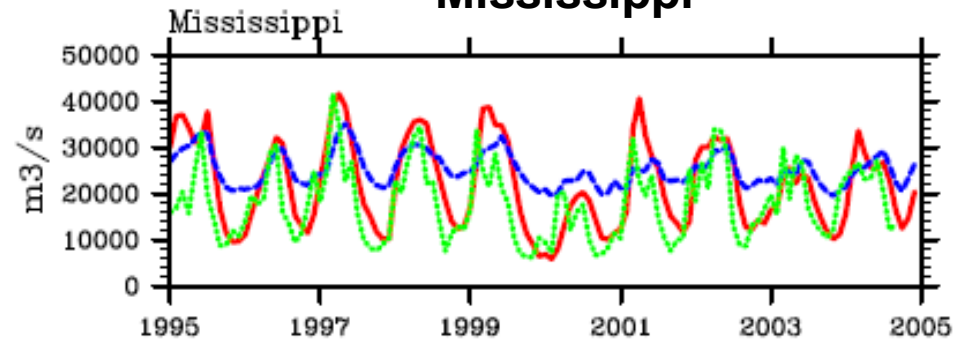
Congo



Yangtze



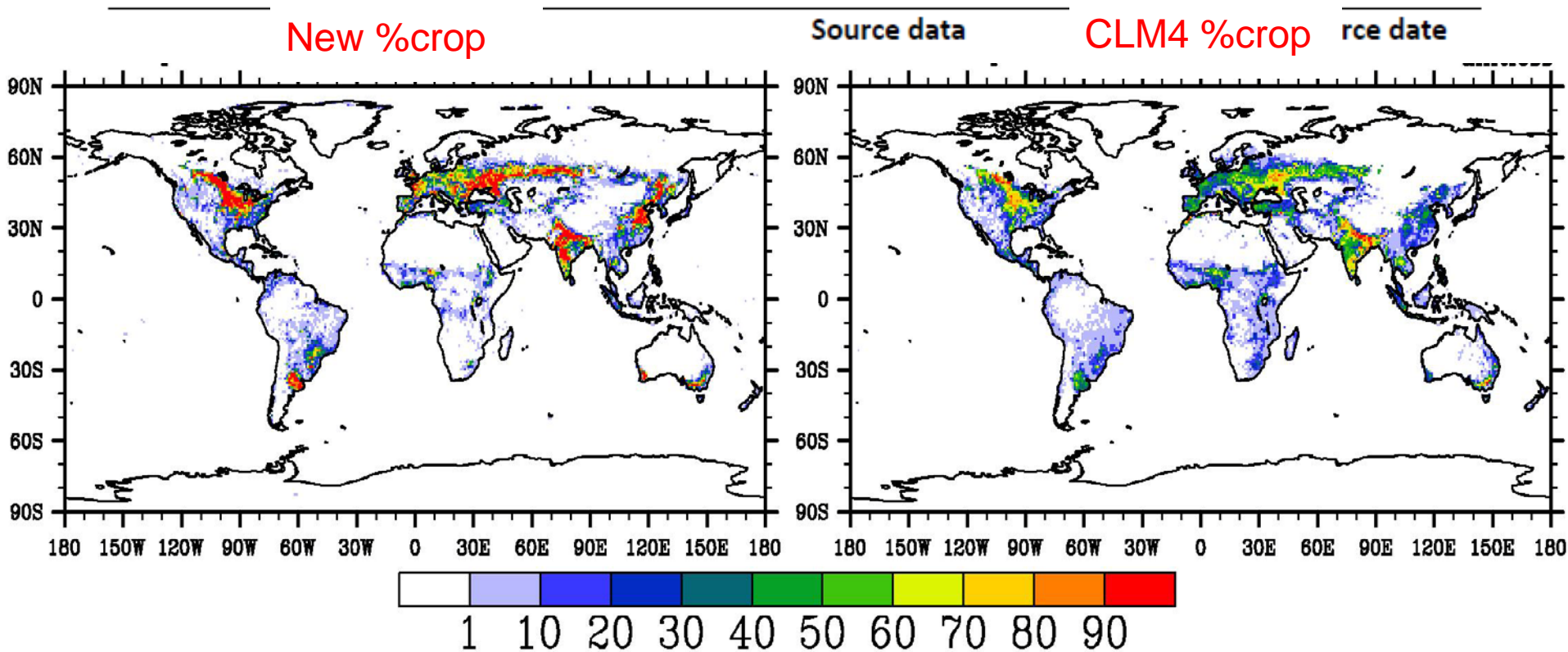
Mississippi



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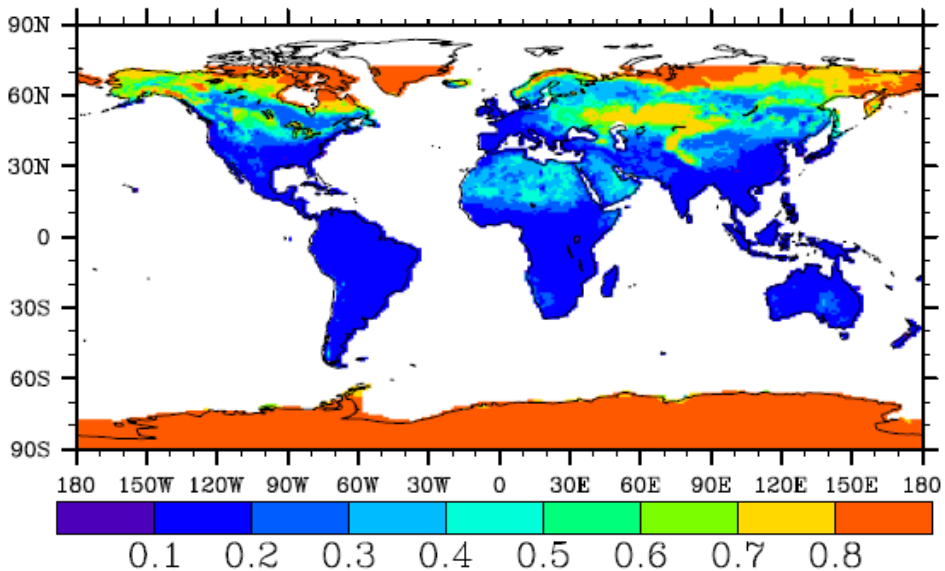
A 0.05-degree input dataset for CLM



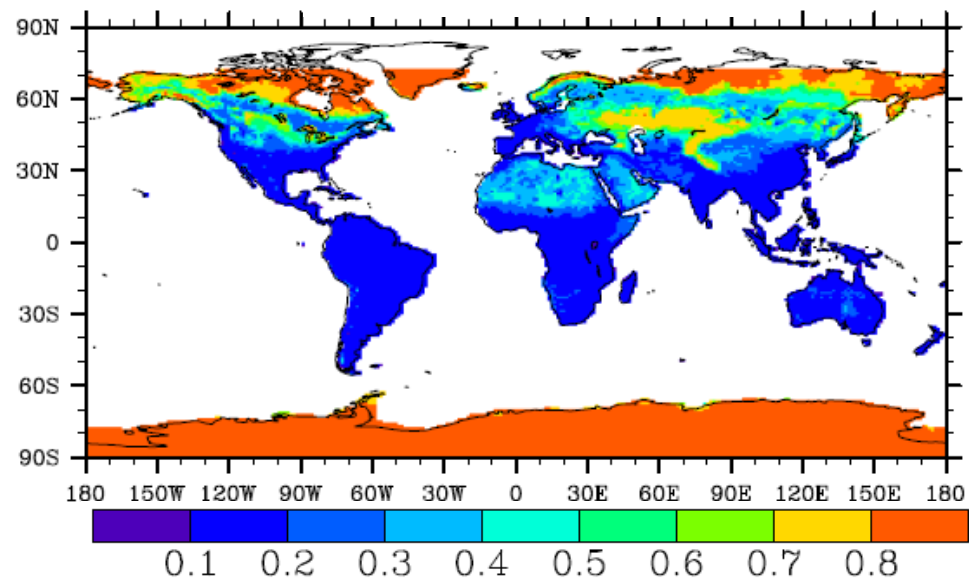
PFTs	0.05°	0.05°	MCD12Q1 PFT classification, WorldClim climate	AVHRR continuous fields +MODIS vegetation continuous fields, Willmott and Matsuura Climate, global agriculture land (2008)	2005	1993-2008
LAI and SAI	0.05°	0.5°	Continuous LAI improved from MOD15A1	MCD15A2	2005	2001-2003

Winter-time albedo, 1-degree, 1995-2004

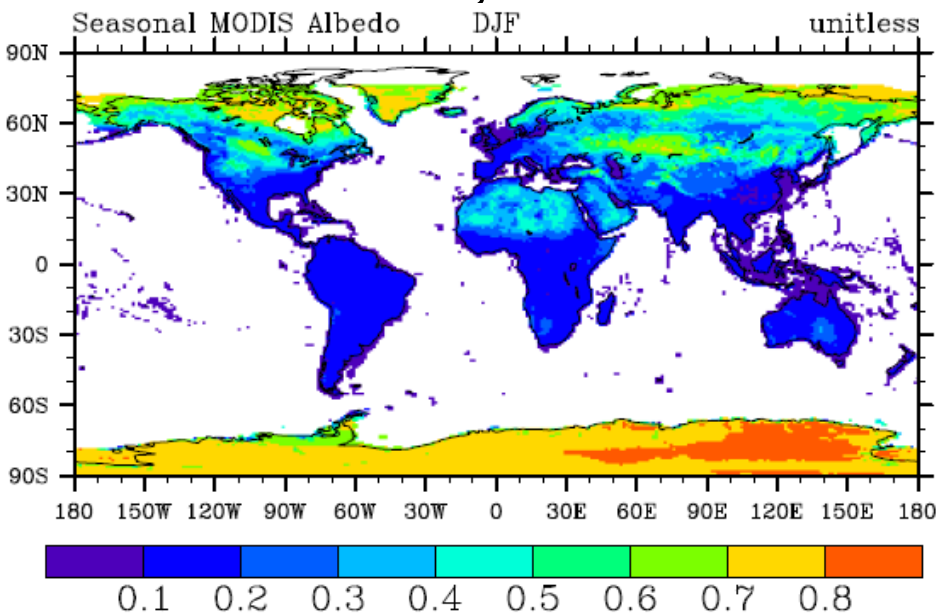
CLM4



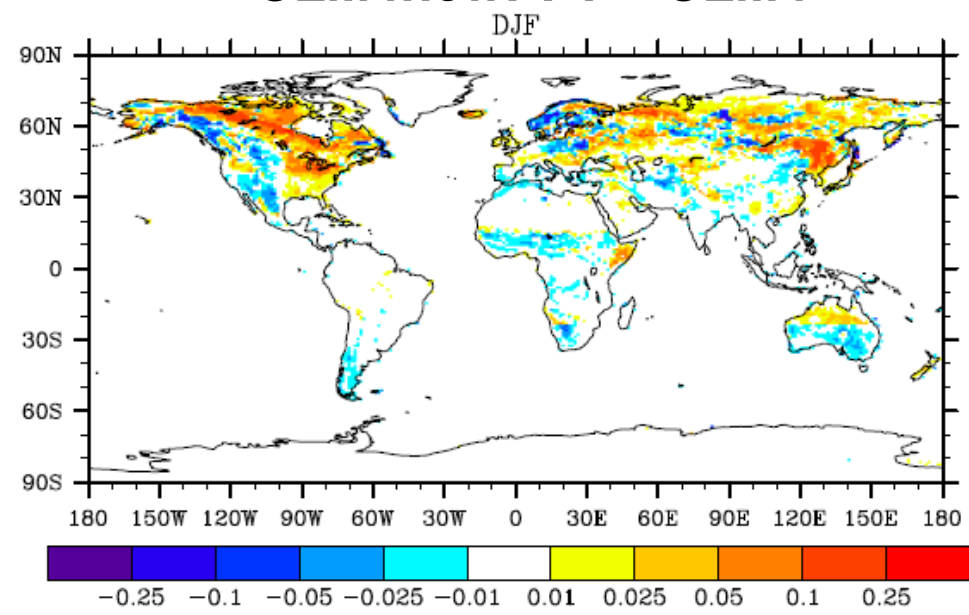
CLM4newPFT



MODIS, 2001-2011

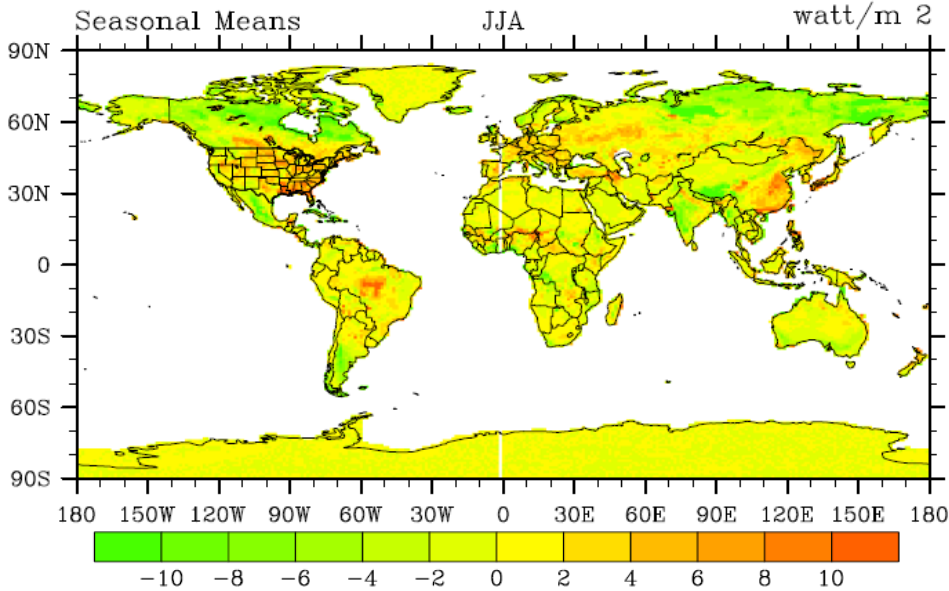


CLM4newPFT - CLM4

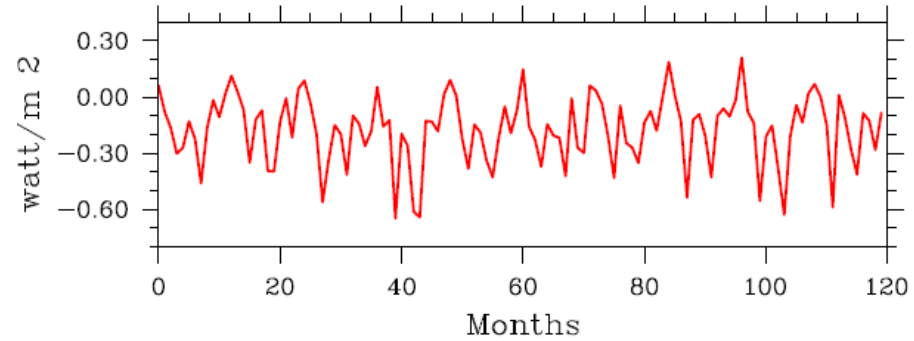


Summer LH, 1-degree, 1995-2004

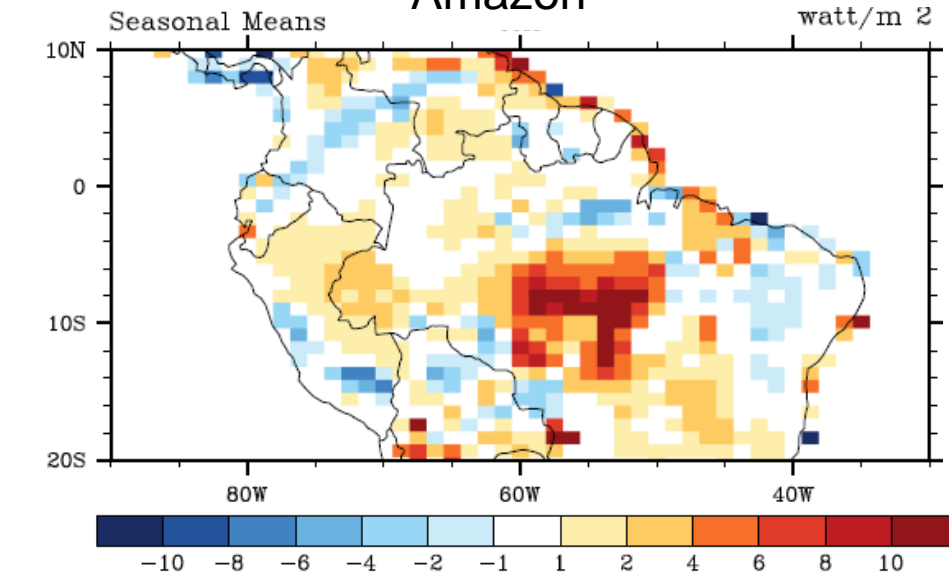
CLM4newPFT – CLM4



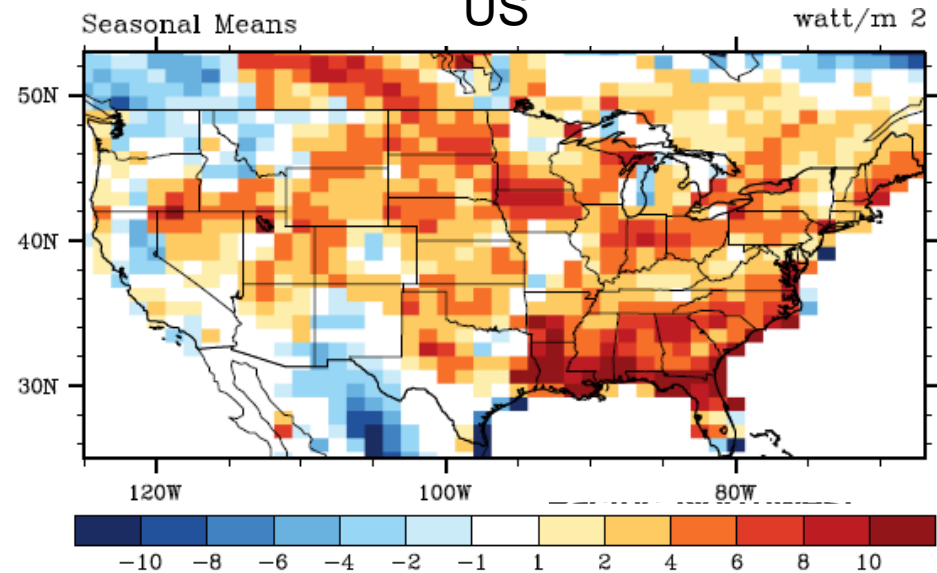
CLM4newPFT – CLM4 global mean



Amazon



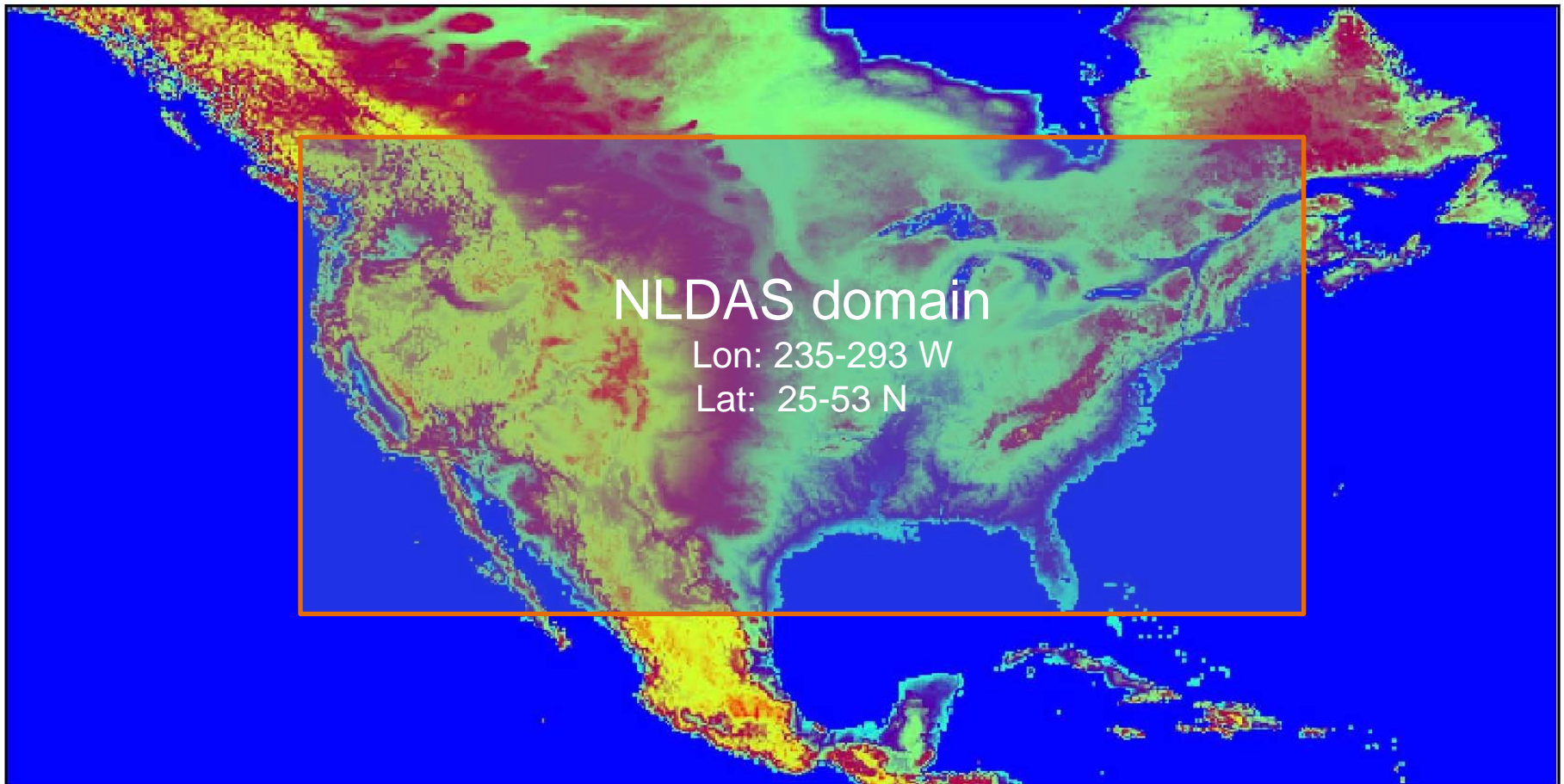
US



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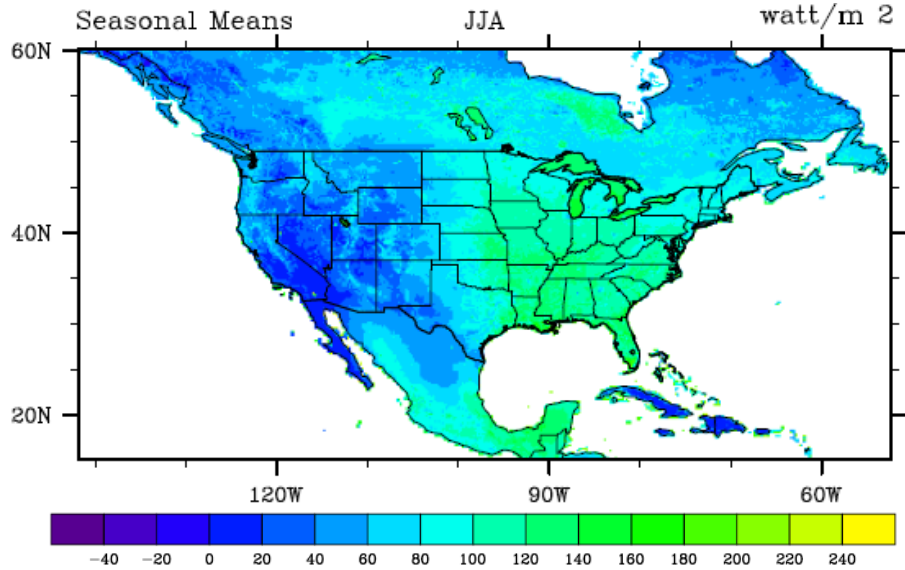
The extended US domain (US0.125)

- ▶ Lon: 218-307.75, Lat: 15-60.25
- ▶ Dimensions: 718 x 362
- ▶ Resolution: 1/8th degree; Range of elevation: 0 - 3766 m
- ▶ Meteo. forcing: NLDAS2+NARR

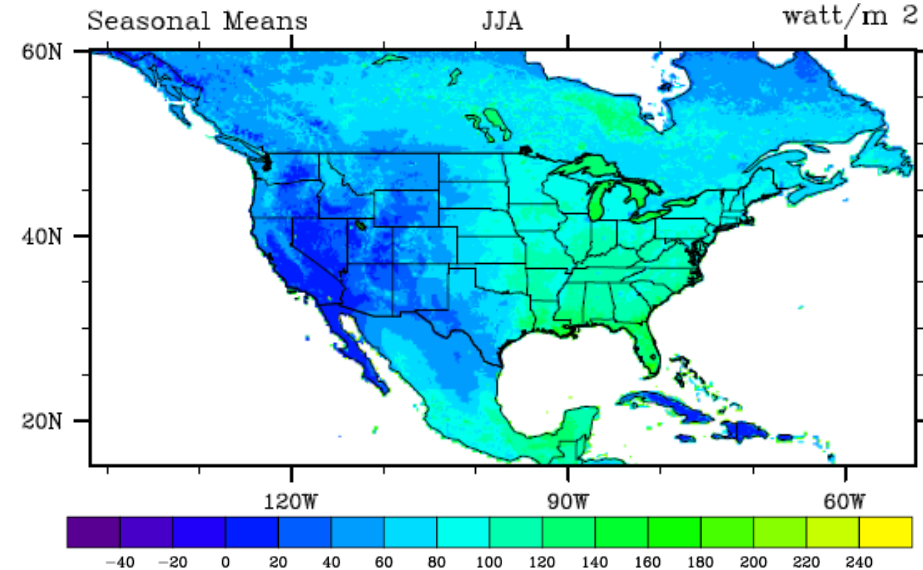


Summer LH, US0.125, 1979-2007

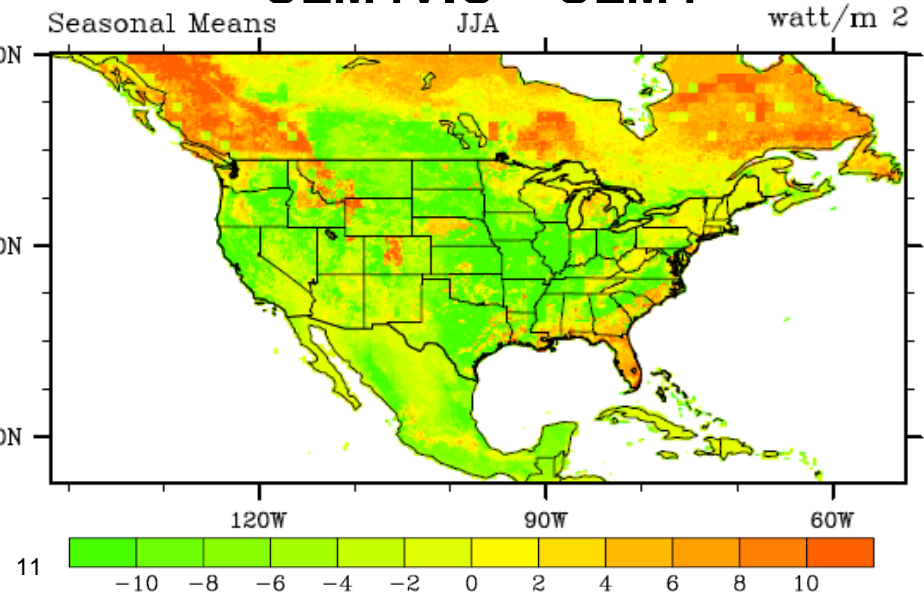
CLM4



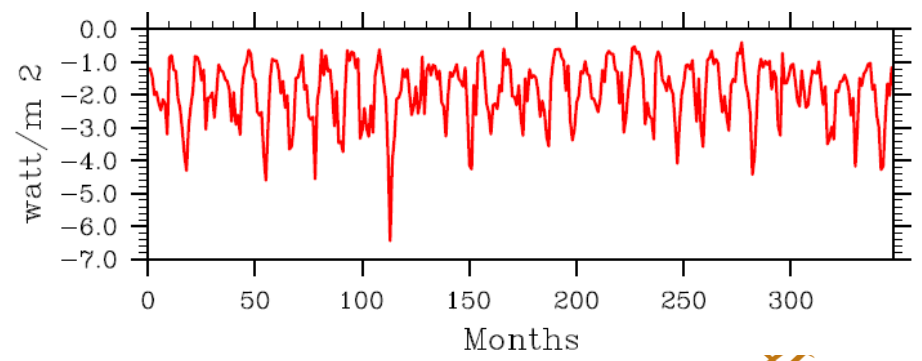
CLM4VIC



CLM4VIC – CLM4



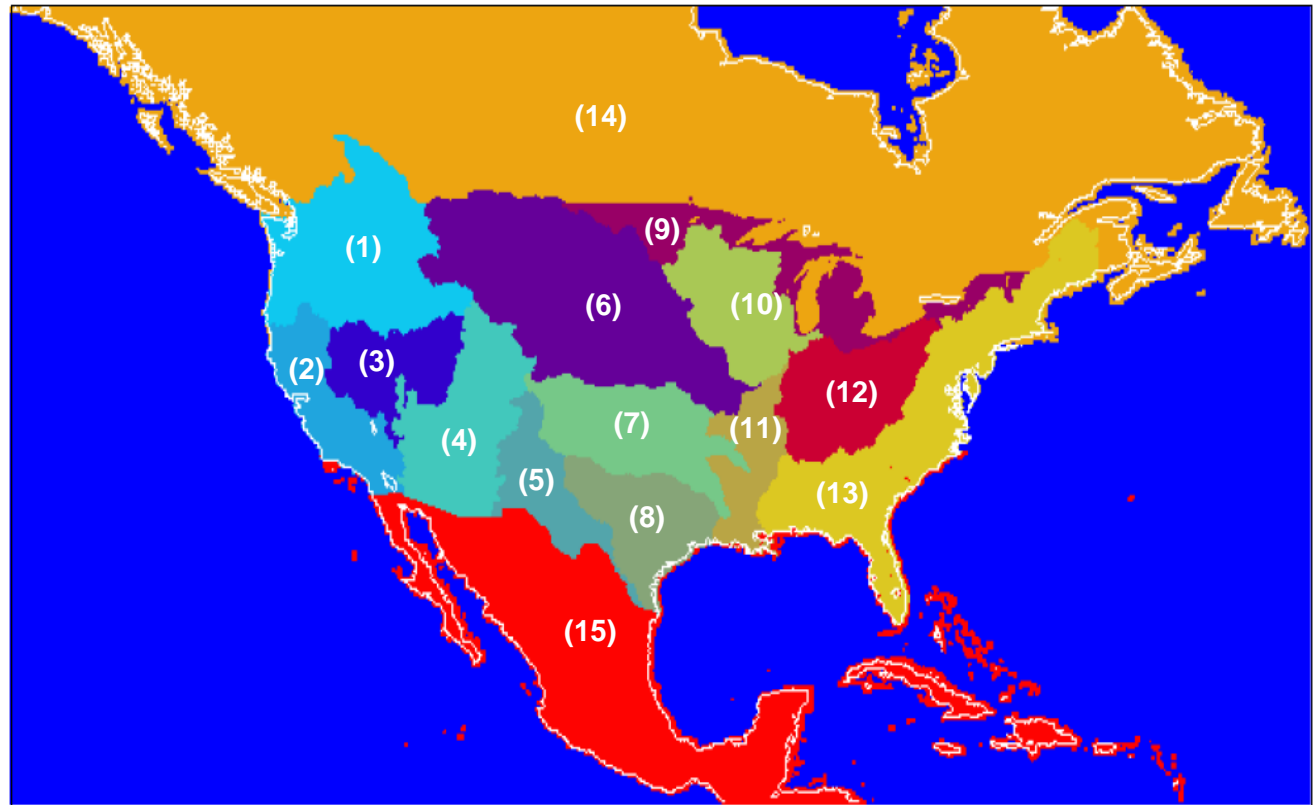
CLM4VIC – CLM4, domain mean



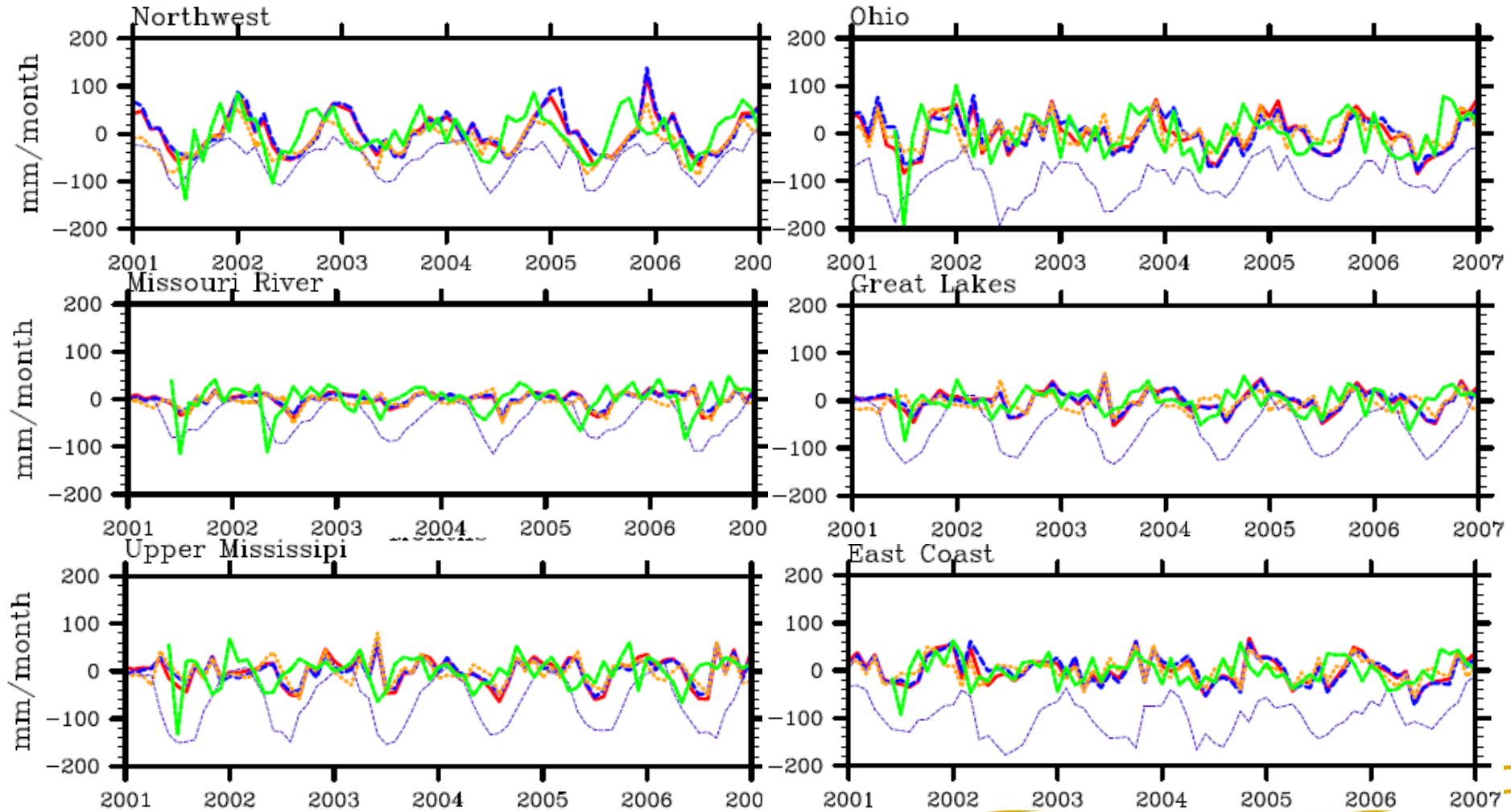
15 hydrologic regions in the US0.125 domain

Basin/Region

- 1 Northwest and Columbia
- 2 California
- 3 Great Basin
- 4 Colorado River
- 5 Rio Grande
- 6 Missouri River
- 7 Arkansas-Red
- 8 South Central (Gulf)
- 9 Great Lakes Drainage
- 10 Upper Mississippi
- 11 Lower Mississippi
- 12 Ohio
- 13 East Coast
- 14 Canada (excl. Columbia)
- 15 Mexico



Change in total water storage



- GRACE
- SAC
- - MOSAIC
- - VIC
- · - Noah
- · - CLMVIC
- CLM

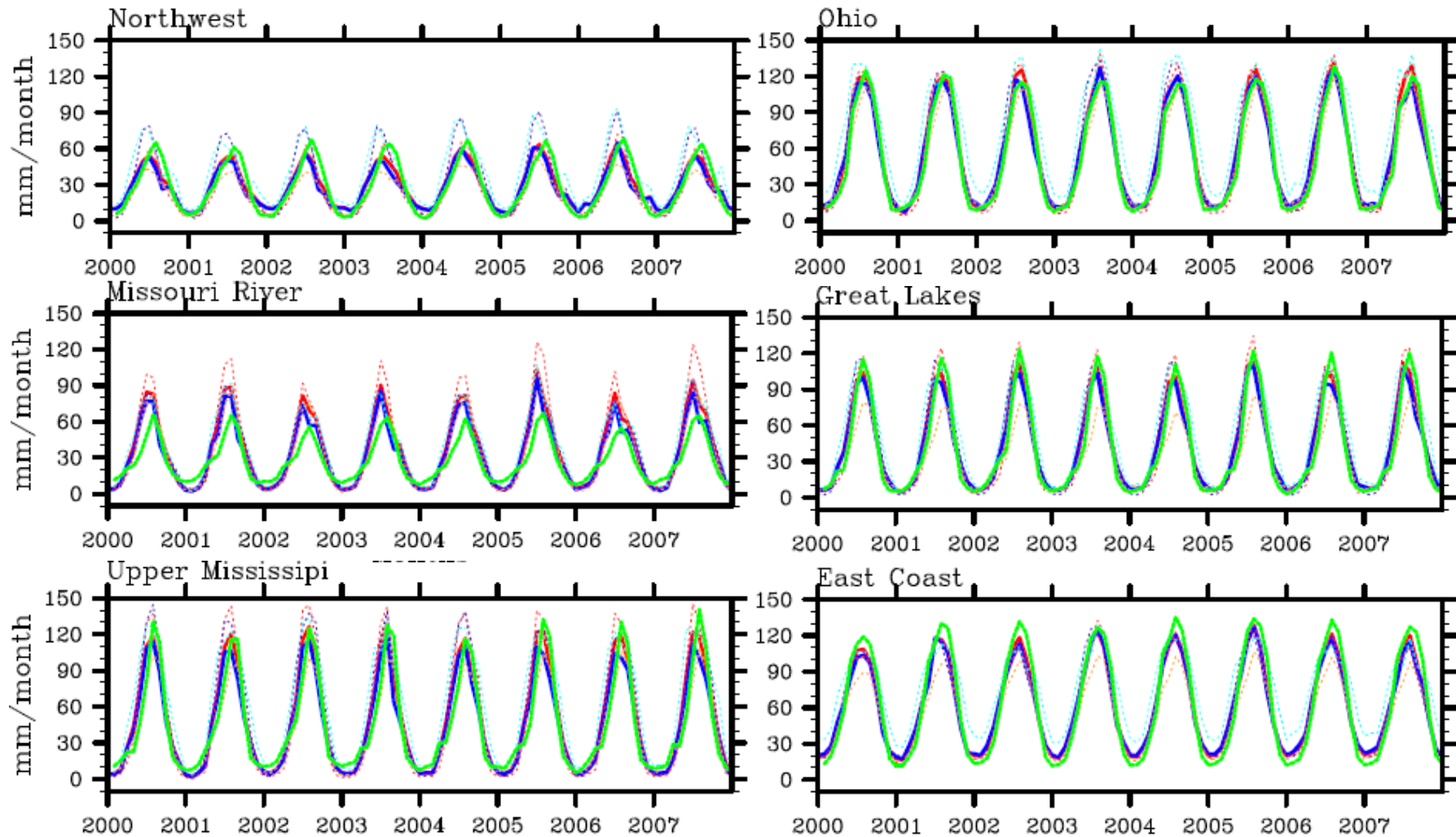
Courtesy of Dr. H. Gao

NLDAS2



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Evapotranspiration



- MODIS
- SAC
- MOSAIC
- VIC
- NOAH
- CLMVIC
- CLM

NLDAS2

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Summary and future work

- ▶ The VIC runoff parameterizations have been implemented into CLM4. Numerical experiments show that CLM4VIC could capture the water and energy budgets reasonably well;
- ▶ A new MODIS–based input dataset at 0.05 degree resolution has been developed and its impacts on model simulations are being evaluated;
- ▶ More numerical experiments will be conducted to evaluate how hydrologic parameterizations/parameter values could affect C cycle simulations, as well as atmospheric processes through coupling with WRF and CAM;
- ▶ Global testing of CLMVICGROUND.



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Acknowledgement

- ▶ **DOE:** Investigation of the Magnitudes and Probabilities of Abrupt Climate Transitions (IMPACTS)
- ▶ **PNNL:** Integrated regional earth system modeling (iRESM) Initiative
- ▶ **DOE:** Climate Science for a sustainable energy future (CSSEF)



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