



# Wetlands

What they are, where they are  
and what they do

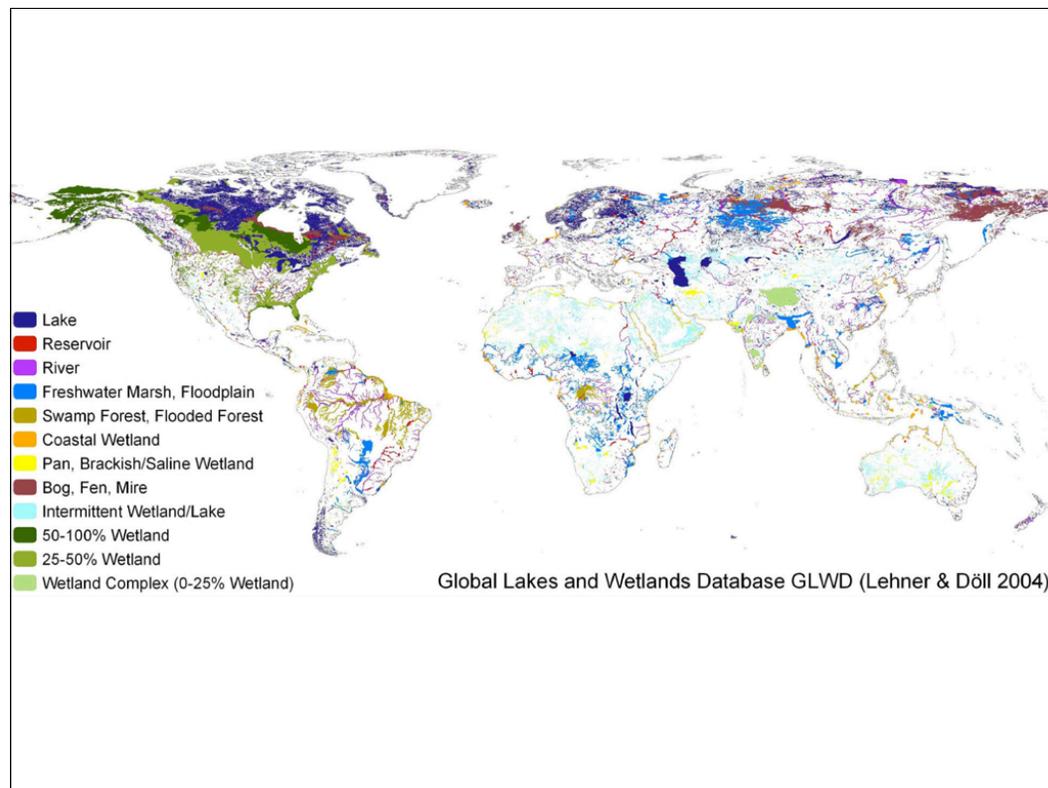


Parker Kraus

# What are wetlands?

- Land that is wet.
- Places with distinct biological and physical characteristics determined by hydrology.
- Substantial stores of carbon, and sources of moisture and methane to the atmosphere.

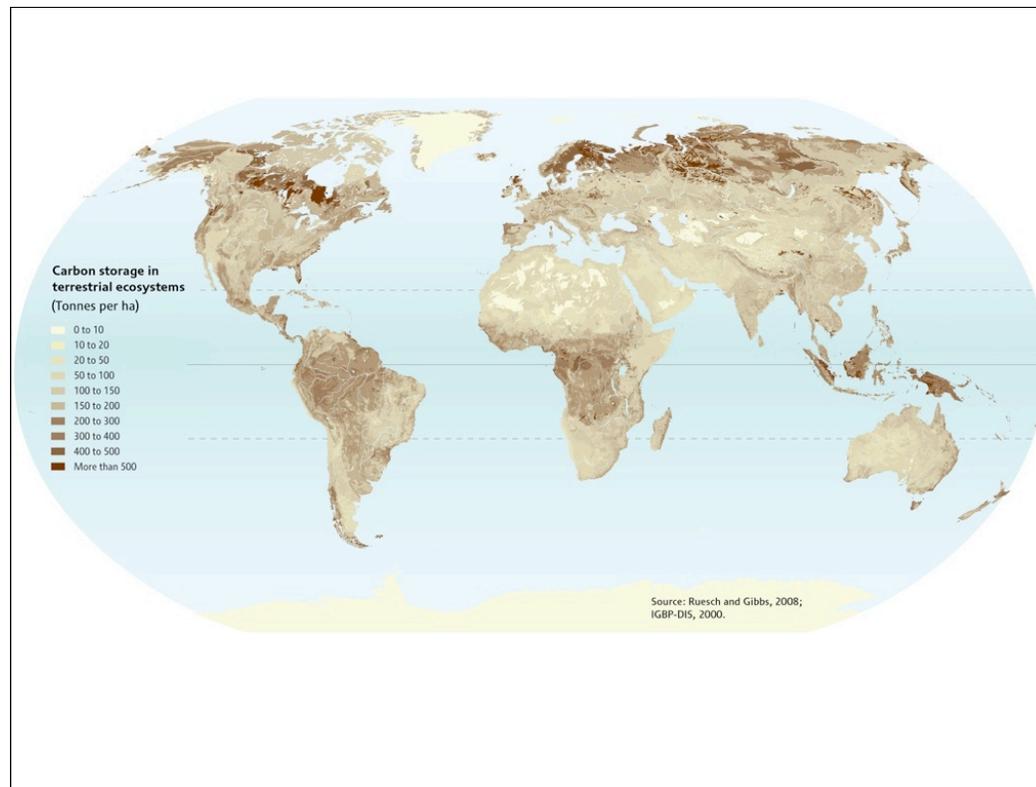
To illustrate these last points >



30 arc-second resolution.

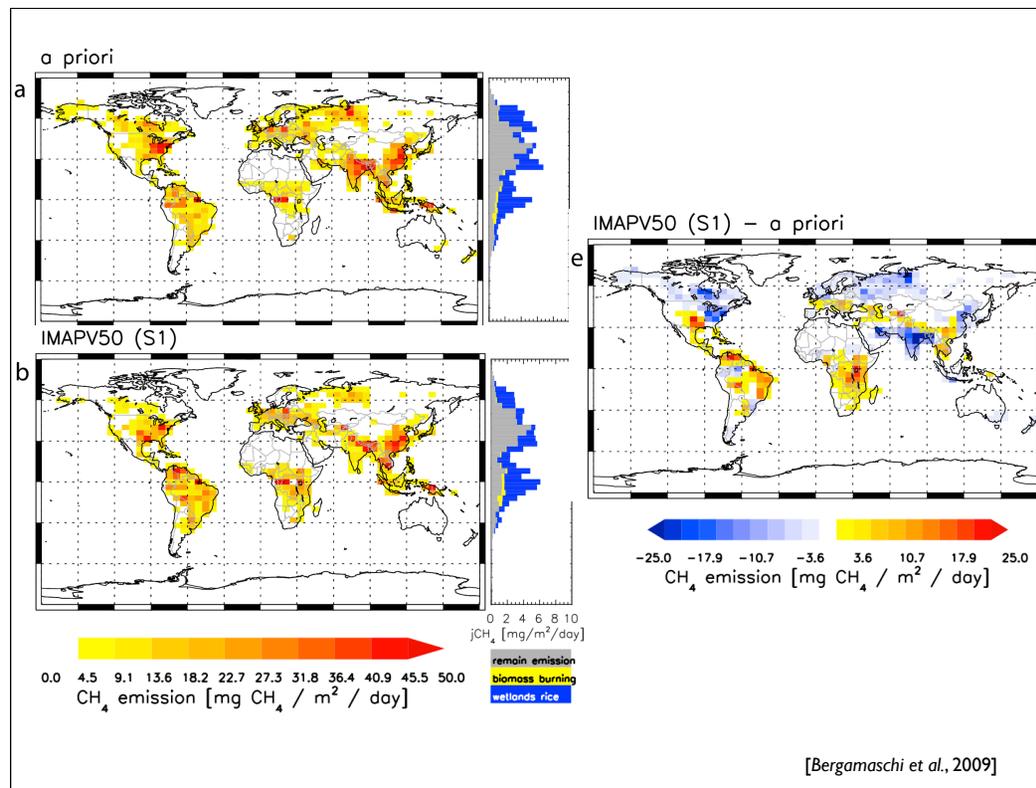
Note the predominance of wetlands at high latitudes in boreal Canada, Scandinavia and Siberia.

As well as wetland complexes in the tropics, the Pantanal, the Okovango and in parts of Indonesia and New Guinea.

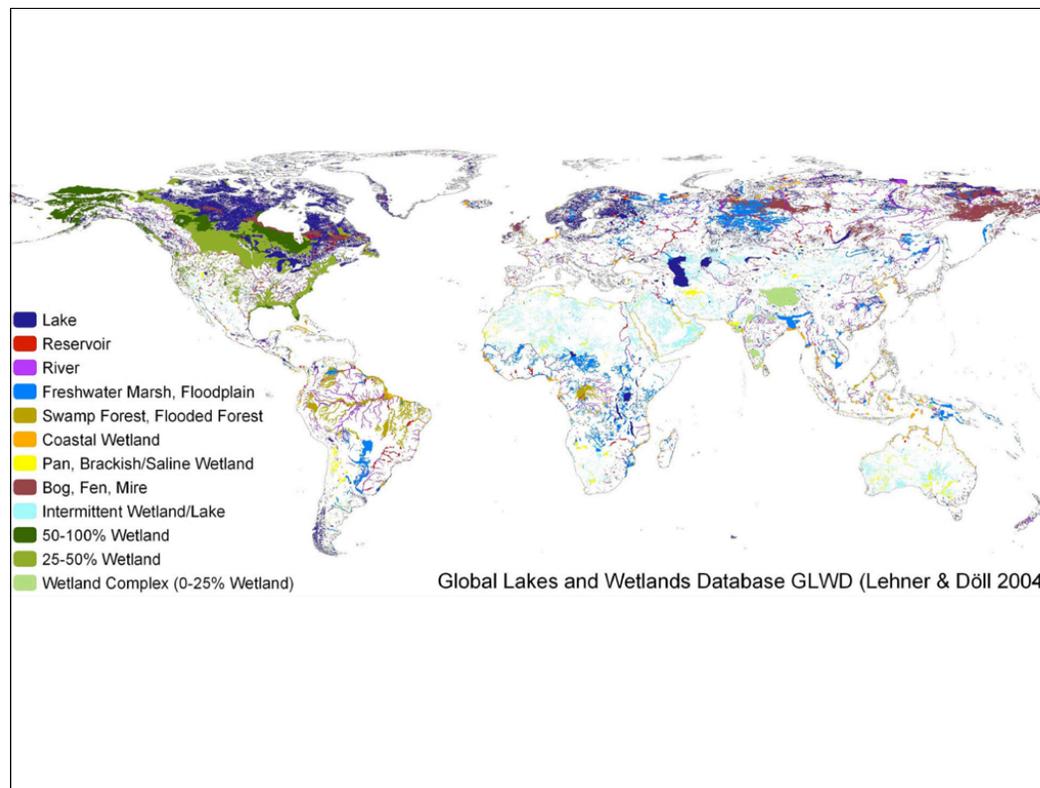


These features are conspicuously reflected in estimates of terrestrial carbon storage, making wetlands important components of the carbon cycle. Also perhaps precarious components given warming trends at high latitudes.

Carbon accumulates in wetland soils because decomposition is inhibited in saturated soils by anoxia resulting from the limited exchange of oxygen through stagnant water. >

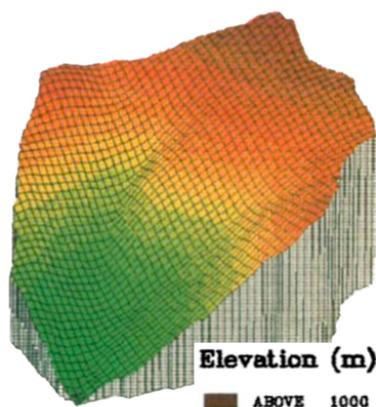


These conditions also favor the production of methane in wetland soils. This inversion of the SCIAMACHY observations uses the TM5-4dVar system at 6 x 4 degrees to estimate annual mean terrestrial sources of methane. Again, wetland regions can be identified in the maps, with the blue bars at left indicating the relative contribution of wetlands to the total methane source, which includes combustion, fossil fuel extraction, and emissions from ruminants and landfills. As you can see the wetland source is substantial, particularly in the tropics. Let me go back to this map >



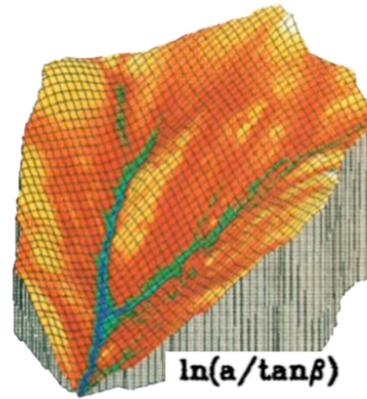
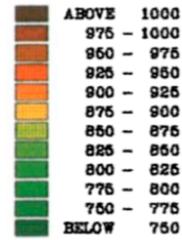
Note that even at this resolution about 1km x 1km at the equator, substantial land areas are described with fractional coverage. At the scale of most GCMs even full cells in this map would be sub-grid scale features. Furthermore, there is seasonal and inter-annual variability in inundated extent that is not captured with a static map of wetland area. \*Button\*, transition to methods.

# Topographic Index

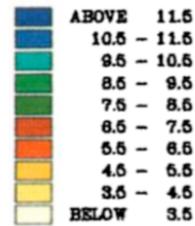


Ambroise et al., 1996

**Elevation (m)**

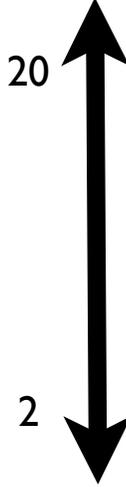


**$\ln(a/\tan\beta)$**



Wet:  
low-lying & flat

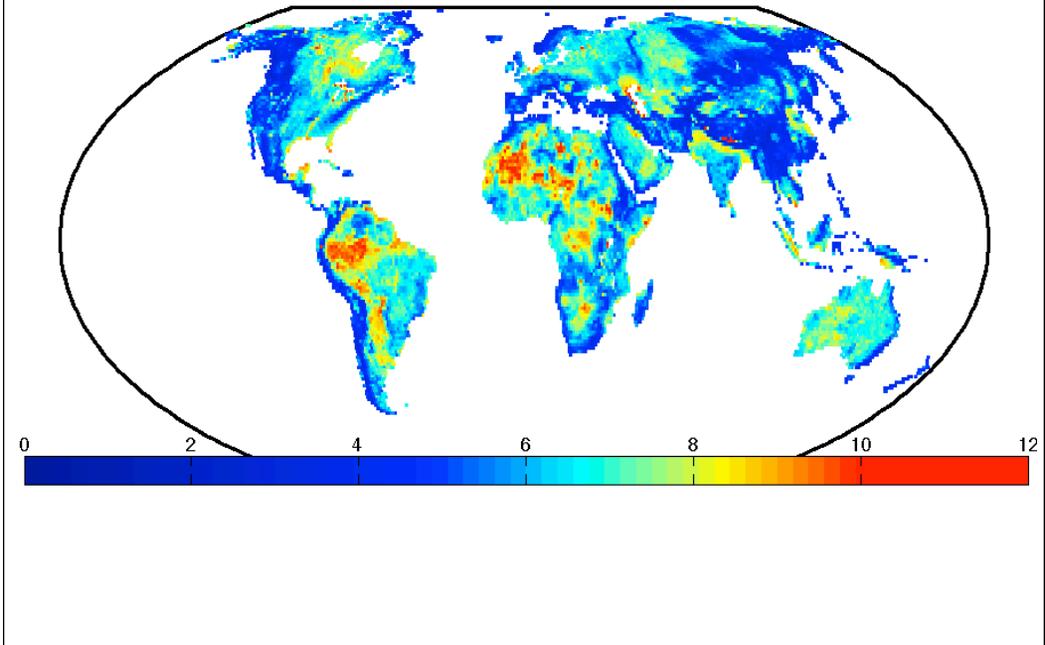
20

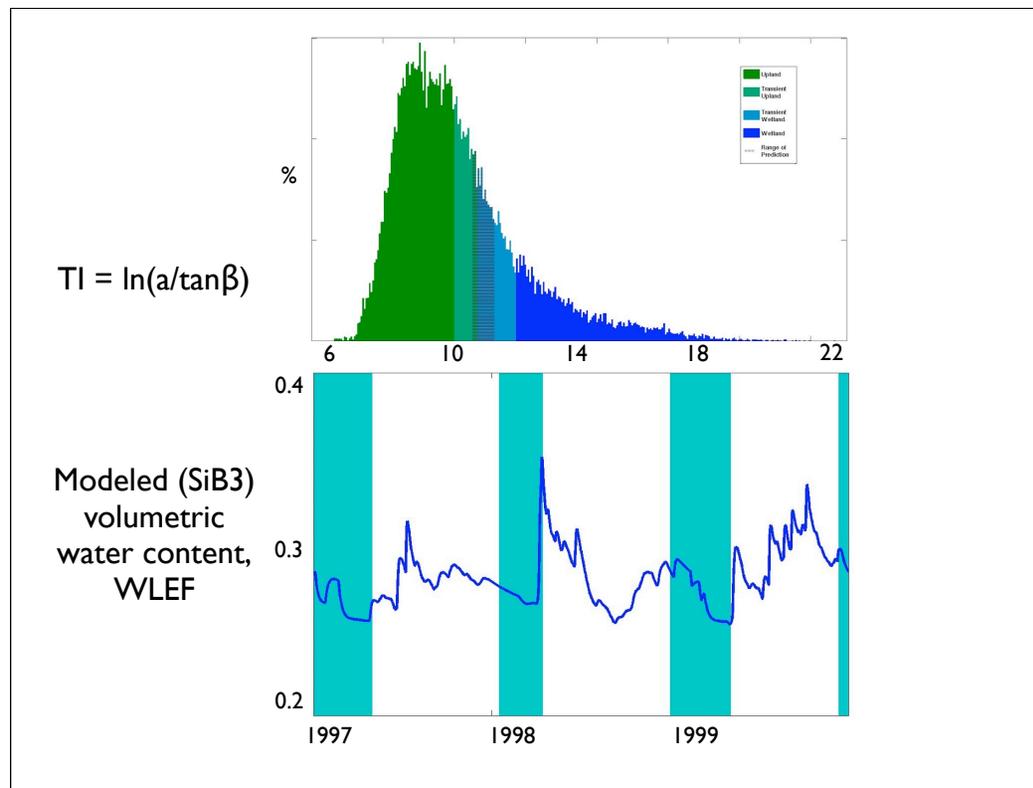


2

Dry:  
elevated & steep

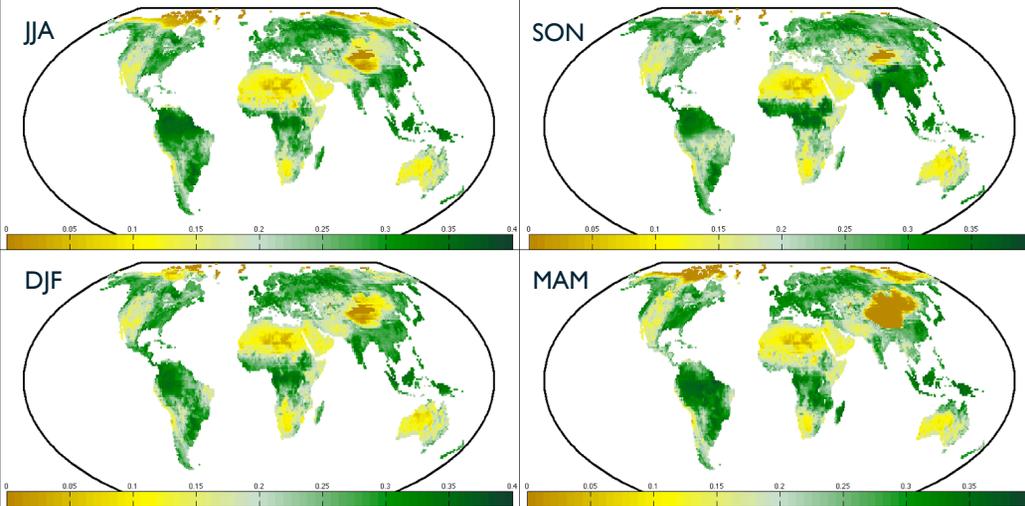
# Mean Topographic Index



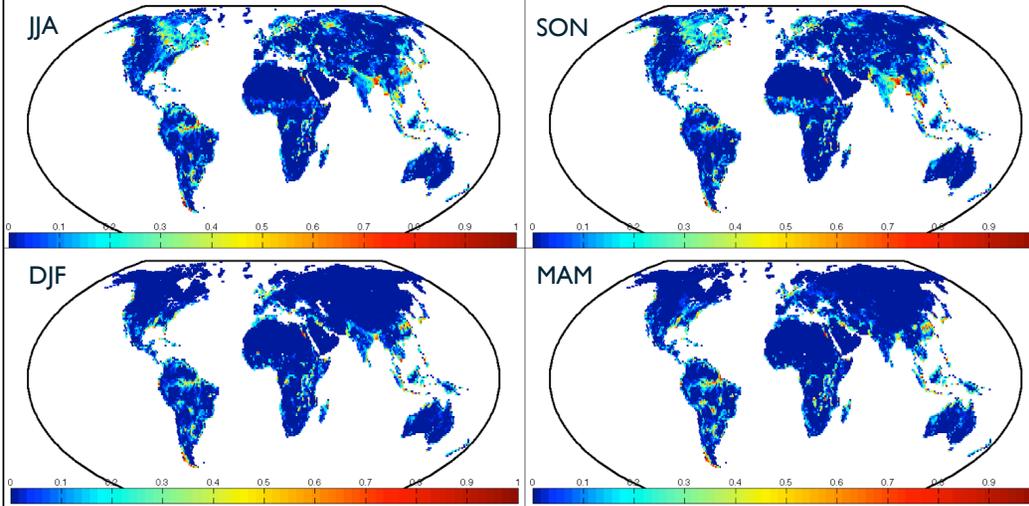


The utility of the topographic index is that points with equal indices are hydrologically identical, so histograms of the index may be used in place of spatially explicit information. I relate values of the topographic index to estimates of the volumetric water content in SiB to estimate wetland area as a fraction of the model gridcell over time.

Seasonal mean (1993-2004)  
Modeled, SiB layer-5, soil moisture

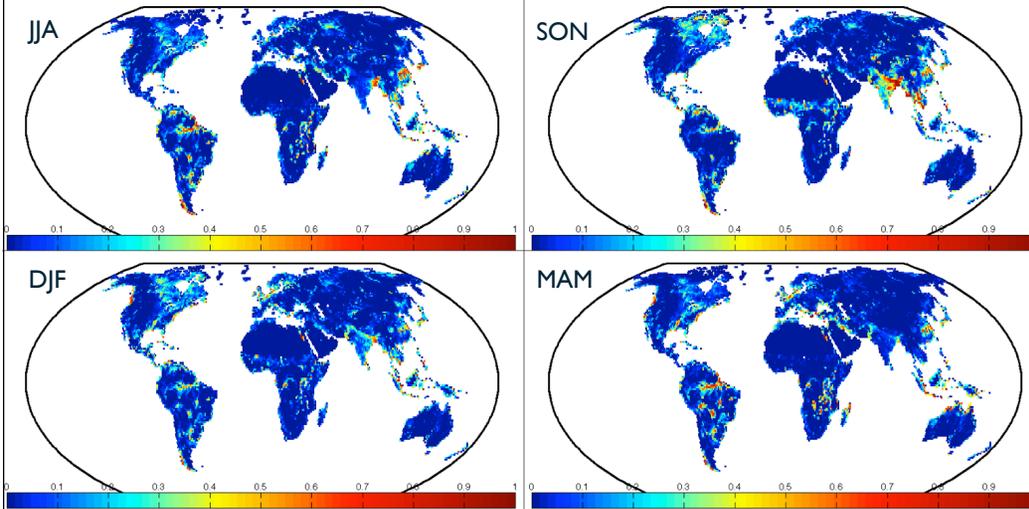


Seasonal mean (1993-2004)  
 $\mu\lambda$  backscatter estimated inundation

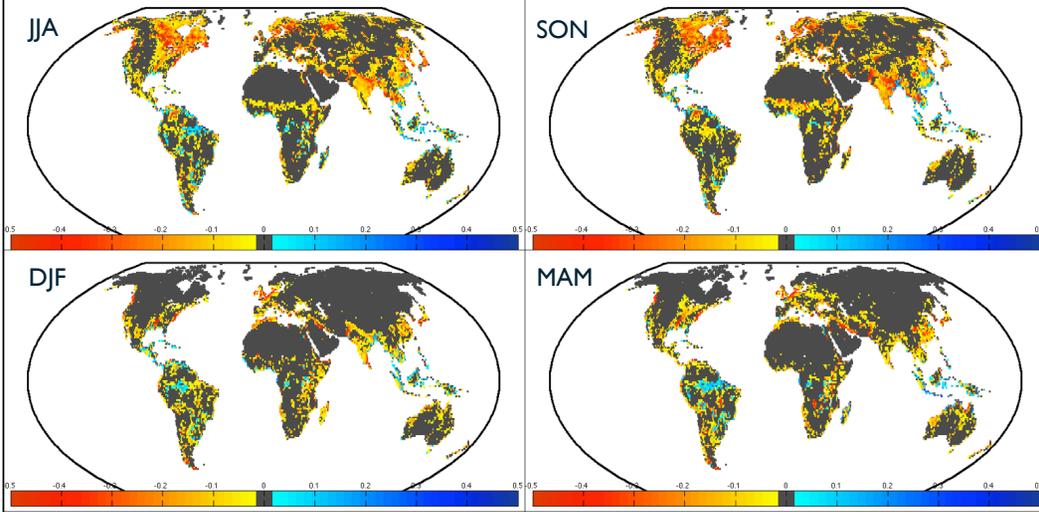


Papa et al., 2010

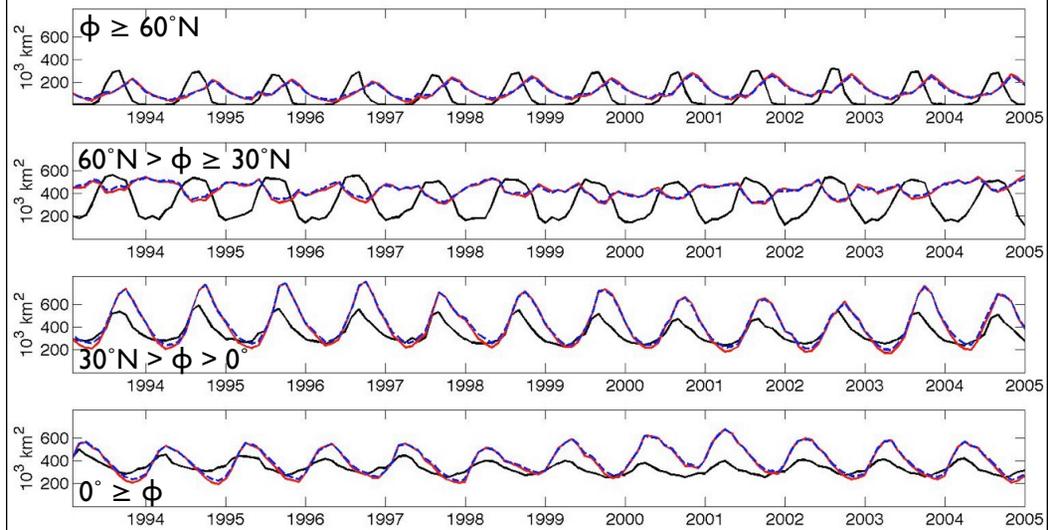
Seasonal mean (1993-2004)  
Model estimated inundation



Seasonal mean (1993-2004)  
Model -  $\mu\lambda$  estimated inundation



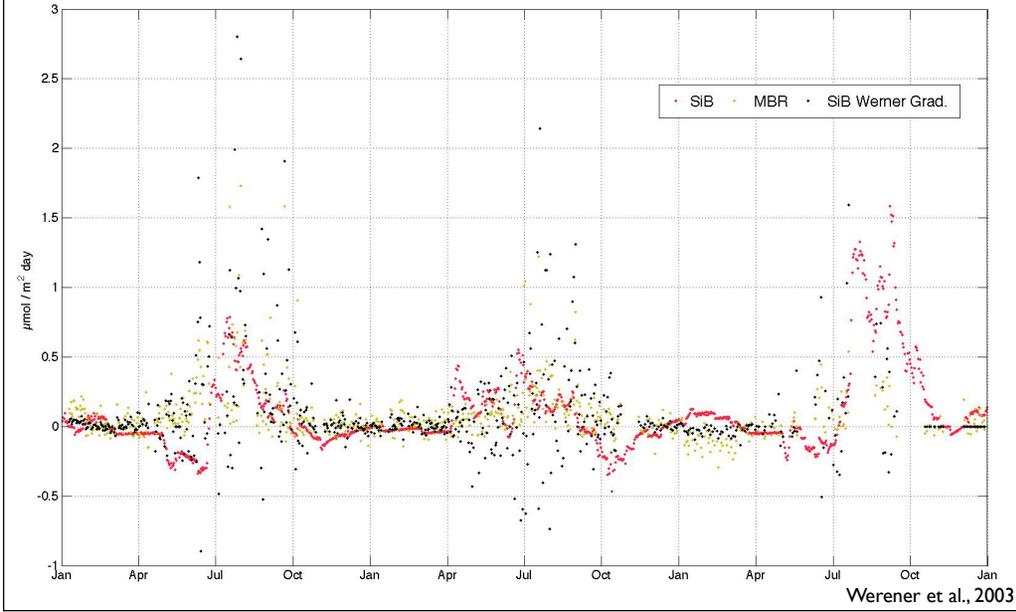
# Inundated area by latitude band



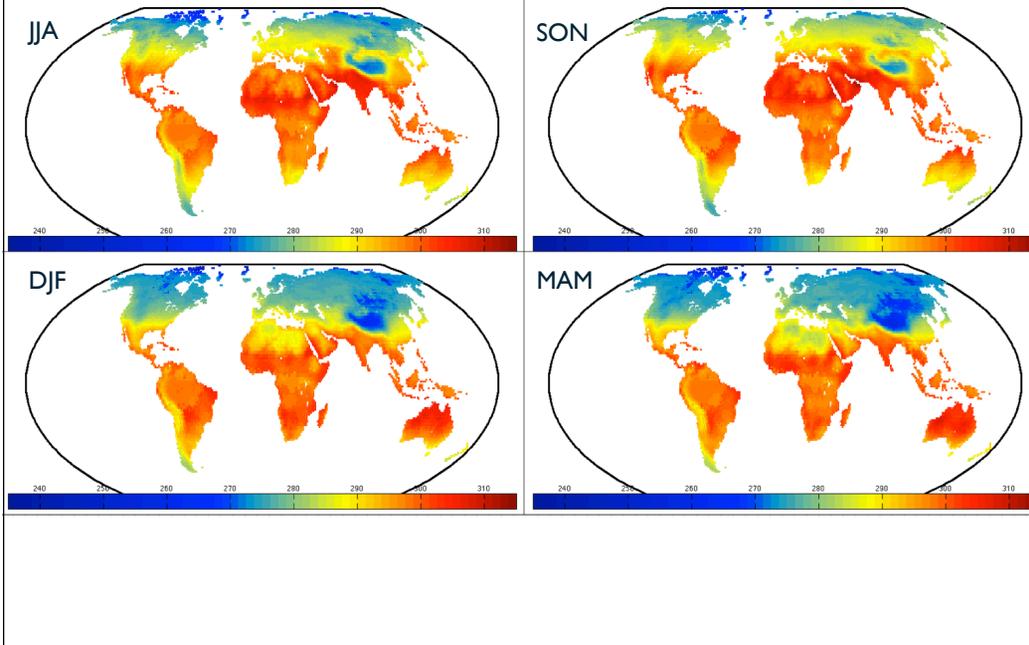
Black, observations;  
Blue and Red, model estimates

$$CH_4 \text{ production} = WF \cdot Q_{10P}^{\left(\frac{td_6 - 273.15}{10}\right)}$$

$$CH_4 \text{ consumption} = (1 - WF) \cdot Q_{10C}^{\left(\frac{td_6 - 273.15}{10}\right)}$$

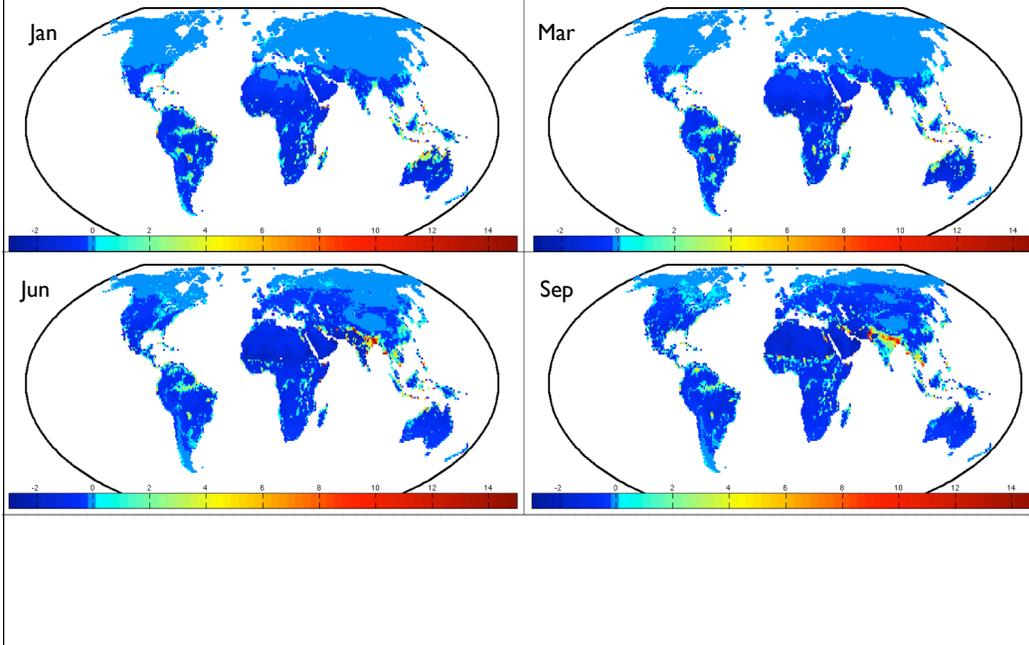


Seasonal mean (1993)  
Modeled, SiB layer-5, soil temperature



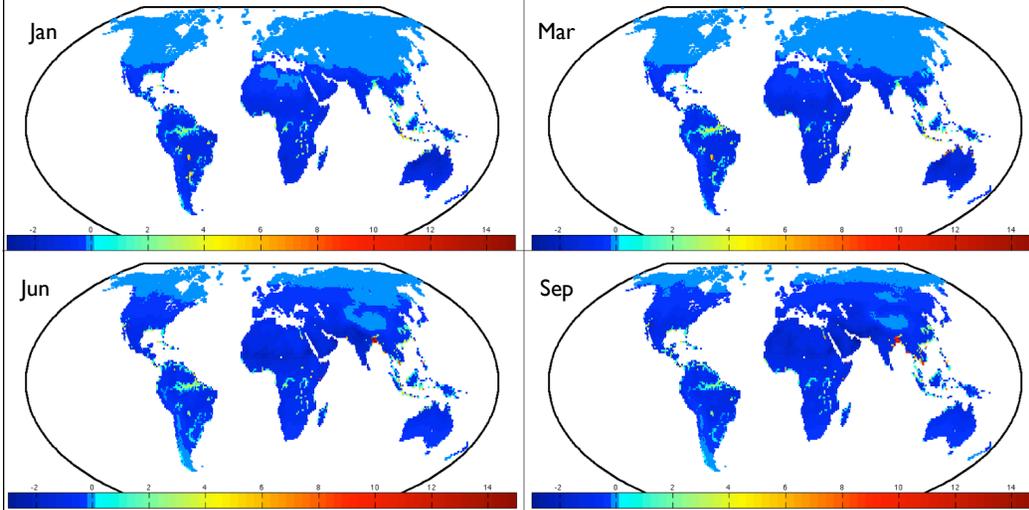
About 2/3 of a meter below the surface.

Methane Flux  
 $\mu\lambda$  estimated wetland fraction



Intentionally omitted the units, which I believe to be incorrect.

# Methane Flux SiB estimated wetland fraction



## References

Ambrase, B., K. Beven, and J. Freer (1996), Toward a generalization of the TOPMODEL concepts. *Water Resour Res*, 32(7), 2135-2145.

Bergamaschi, P., et al. (2009), Inverse modeling of global and regional CH<sub>4</sub> emissions using SCIAMACHY satellite retrievals, *Journal of Geophysical Research*, 114(D22).

Global Soil Data Task Group. 2000. Global Gridded Surfaces of Selected Soil Characteristics (IGBP-DIS). [Global Gridded Surfaces of Selected Soil Characteristics (International Geosphere-Biosphere Programme - Data and Information System)]. Data set. Available on-line [<http://www.daac.ornl.gov>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Lehner, B., and P. Döll (2004), Development and validation of a global database of lakes, reservoirs and wetlands, *J Hydrol*, 296(1-4), 1-22.

Papa, F., C. Prigent, F. Aires, C. Jimenez, W. B. Rossow, and E. Matthews (2010), Interannual variability of surface water extent at the global scale, 1993-2004, *J Geophys Res-Atmos*, 115,-.

Werner, C., K. Davis, P. Bakwin, C. X. Yi, D. Hurst and L. Lock (2003), Regional-scale measurements of CH<sub>4</sub> exchange from a tall tower over a mixed temperate/boreal lowland and wetland forest, *Global Change Biol*, 9(9), 1251-1261.