On the Resolution of CO_2 Flux Estimations

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Flux estimation for CO_2 (and other atmospheric species) may be summarized as a comparison between model predictions of CO_2 with observations. The resulting discrepancy is used to deduce the distribution and strengths of fluxes. The success of such inverse modeling calculations is intrinsically related to how well the domain of interest is sampled. Current observational networks used to estimate fluxes are sparse, especially over the tropics, Boreal Eurasia, and some ocean regions. The ability of the current global observational network to inform on the global spatial distribution of fluxes is, therefore, fundamentally limited. Nevertheless, many recent flux estimation studies of CO_2 have attempted to invert the atmospheric observations for fluxes at scales ranging from continental/ocean basins to regions the size of the transport model grid boxes.

We will discuss the ability of a typical inverse model framework to resolve fluxes at various scales. The partitioning between the global oceans and land is well resolved (Figure 1). Zonal average fluxes for boreal, temperate, and tropical regions are also fairly well resolved with the caveat that the estimated fluxes are biased to measurement locations and may not represent true zonal averages. On continental scales, the resolution varies with temperate North America and Europe being very well resolved and some tropical regions not resolved at all. We also show that some observation sites do not constrain source regions as well as hoped. For example, the site located on Ascension Island does not help to resolve the tropical Atlantic very well, because it mainly samples air from the South Atlantic. In addition, some sites constrain source regions only during certain seasons. Boreal Eurasia, for example, is constrained by sites located in coastal Japan during the winter, but not during the growing season. The technique we use to study resolution of flux estimates is very useful for understanding the limitations of current flux estimates, and will also be of future use for planning locations of future observation sites.

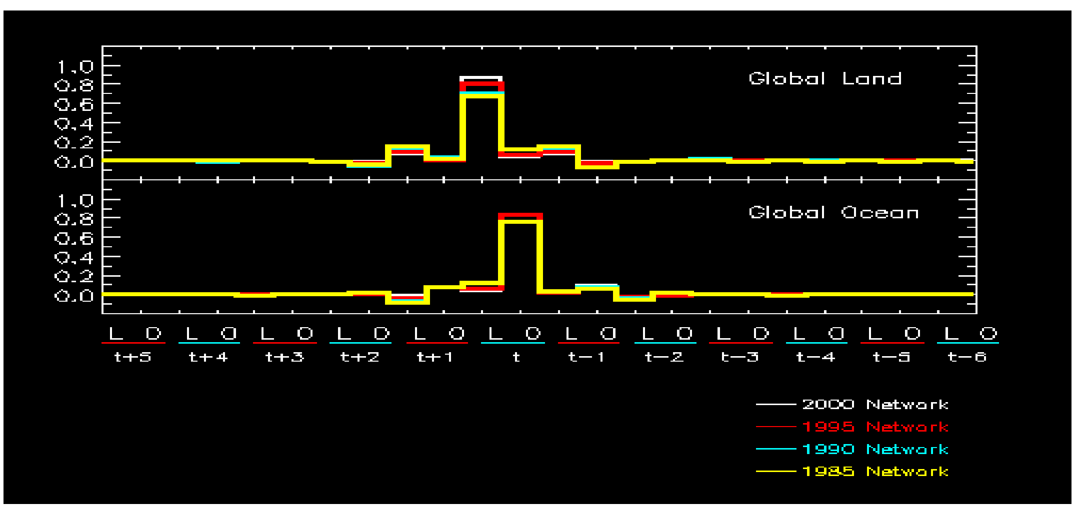

Figure 1. The resolution kernel for the global land and oceans in July, calculated by aggregating monthly average basis functions, prior flux uncertainties, and mismatch error to global scales. Note that the resolution kernel shows how well the global land and oceans are resolved within a particular month, as well as the degree to which the solution for July is confused with the solutions for global oceans and land from previous and successive months. The "L" and "O" on the horizontal axis denote the resolution of the month of interest from land and ocean regions from different time steps.