Boundary Resolution of CO_2 Using Infrared (IR) and Near Infrared (NIR) Measurements

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Since CO_2 concentrations in the boundary layer (BL) are primarily sensitive to surface fluxes mixing within the BL, closing the global carbon budget is best achieved by discriminating between CO_2 in the BL from CO_2 in the free troposphere. From previous studies showing that adding CO_2 laser band increases sensitivity to lower troposphere and that NIR measurements can be used to obtain "column" CO_2 measurements with sufficient precision to obtain CO_2 sources and sinks, we used simulated retrieval approach using IR, NIR and combined radiances. In this method, joint estimates of the atmospheric temperature, water, surface temperature, emissivity and CO_2 using optimal estimation provided a fully characterization of errors and sensitivity of the estimate to a simulated "true" CO_2 distribution. A linear retrieval is used to examine the impact of using different spectral bands on a CO_2 estimate. The results show that combined radiance retrieval i.e. using NIR and IR have the potential to resolve the boundary layer CO_2 from free tropospheric CO_2 and therefore to increase sensitivity to surface fluxes and to reduce transport error in inverse estimates of global carbon budget.

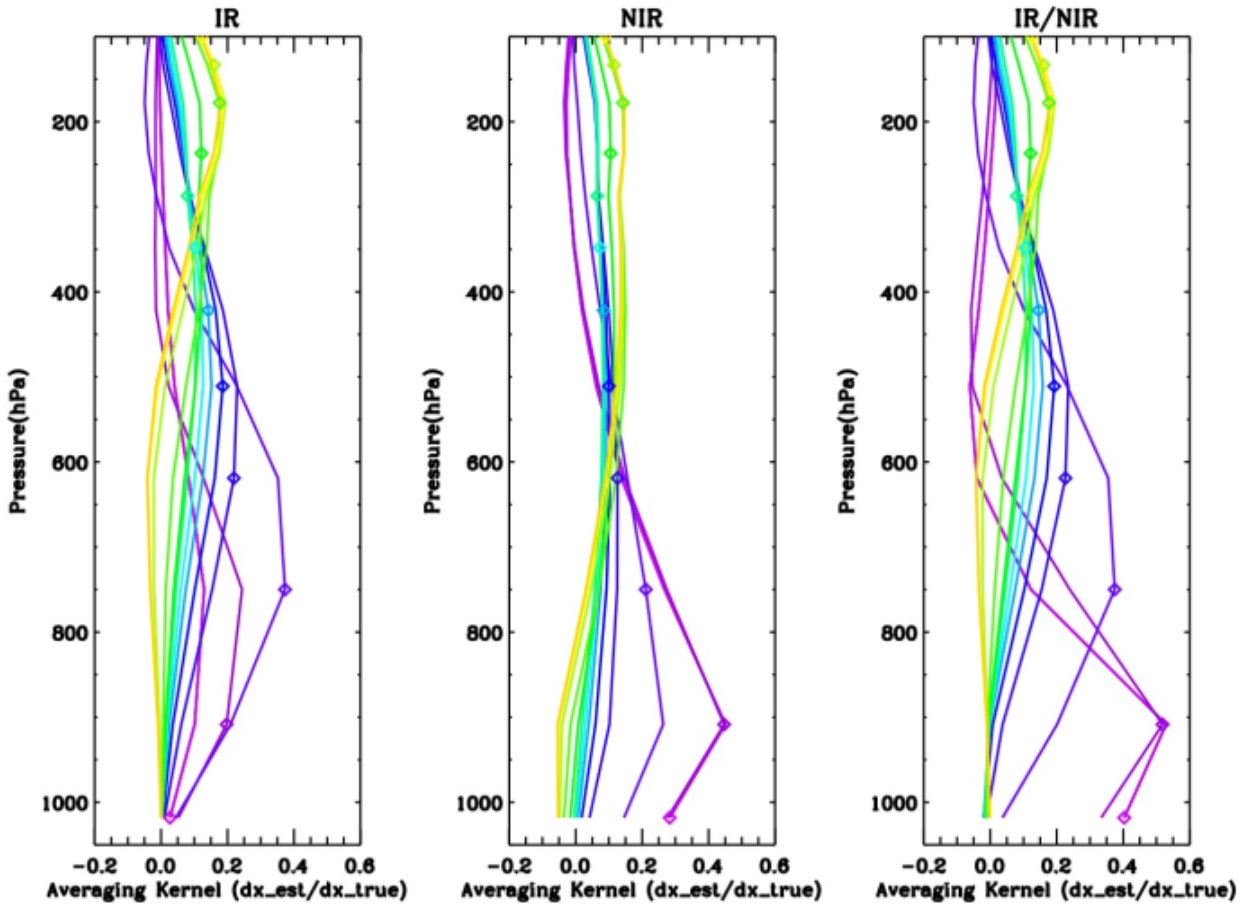

Figure 1. Averaging kernels representing the sensitivity of estimate to "true state" used in the "linear retrieval": $x_{retrieved} = x_a + A\,(x_{true} - x_a)$ and used to examine the impact of using different spectral bands on a CO_2 estimate. Combined radiances (IR/NIR) retrievals can resolve the boundary layer from lower troposphere.