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Interactive comment on "Interannual-to-decadal variability of North Atlantic air-sea CO_2 fluxes" *by* S. Raynaud et al.

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Spell out what is meant by "atmospheric inversions"

Indeed this is a confusing term for the non-initiated. We now avoid using it throughout the text and have better explained the essence of the atmospheric inverse approach both in the abstract and in the Introduction.

Importance of constant Redfield ratios?

This is a most interesting question but remains difficult to address. As far as we are aware, in all applications where an ocean biogeochemistry model has been coupled to a global-scale, ocean general circulation model, the Redfield ratio has been assumed constant. Certainly this constancy of elemental ratios is a simplification of the real system and an ongoing area of research. And further research is necessary before we will be able to implement realistic formulations for variable nutrient ratios in coupled biogeochemical-ecosystem-circulation models of the global ocean in order to understand how such may affect interannual variability. Furthermore, previous studies suggest that both seasonal and interannual variability in the subtropics are governed essentially by changes in temperature (Takahashi et al., 2002; Le Quere et al., 2000). In that region then, variable Redfield ratios would presumably have little affect on simulated interannual-to-decadal variability. In subpolar waters where ocean biology plays a larger role, particularly for the spring bloom, variable Redfield ratios might be important especially if they vary over time.

For this study, our aims were to develop a better understanding of why atmospheric inverse approaches simulate much larger variability in the basin-wide air-sea CO2 flux in the North Atlantic than do existing ocean models and to examine individual modes of variability in detail. The cause for the lower variability in ocean models (e.g., compensation between the subtropical and the subpolar gyres) will not disappear simply by increasing the complexity of ocean biogeochemical models. The same order of variability is found in all ocean models used to date, whose biogeochemical component varies in complexity from the simplest phosphate restoring approach to the present state of the art, which includes 25 tracers. The latter, PISCES, is what we use in this study. Further research is necessary to determine how improvements to both physical and biogeochemical models will alter simulated air-sea CO2 fluxes.

Justify weights of active and passive variables

The revised text now justifies the weighting scheme. All previous work involving MSSA has weighted all variables equally. Here though, we have taken a new approach: we weigh variables differently because we know for physical reasons that some variables drive the evolution of others. It is not appropriate to base the weighting scheme here on the degree of accuracy of measurements because our analysis concerns only model output. That is, all variables have equally good accuracy, which is essentially just numerical precision. For weighting, we use a simple approach, reducing the normalised amplitude of passive variables by a factor of ten relative to that for active variables. And since our analysis is based on covariances, the magnitude for passive variables

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is actually 100 times less than for active variables. Despite its simplicity, this weighting scheme is adequate to ensure that the passive variables will only weakly influence active variables, while also ensuring that they still remain numerically significant.

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