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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of diurnal variability in sea surface temperature on the atlantic air-sea CO_2 flux" *by* H. Kettle et al.

Anonymous Referee #1

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Review of acpd-2008-0417

General comments:

1. This paper describes results of a comprehensive regional study of the Atlantic to evaluate the importance of diurnal variations in sea surface temperature on air-sea flux of CO2. The authors combine large scale satellite measurements, various climatologies, and meteorological forcing fields with state-of-the-art gas transfer models. The paper is detailed, well written, interesting, and of general interest to those working on the global carbon cycle.

Specific comments:

2. The authors find that including detailed diurnal 'thermal pumping' effects over the

SEVIRI region increases the CO2 efflux by (a whopping) factor of 3. The reason for this is that the annual average net flux is found to be a relatively small percentage of the annual average gross flux (see Figure 5a). In other words, there is a lot of CO2 entering and leaving this region of the ocean over the seasons, but averaged over the region and over the annual cycle there is a relatively small loss of CO2 from the ocean. Thermal pumping effects enhance CO2 evasion, adding to this net loss of CO2. This is a significant finding from this regional CO2 flux study, even though it turns out that this net loss is rather small in terms of the global average from Takahashi et al. (2002). In their introduction to the paper, the authors suggest that covariability effects in the CO2 gas flux drivers might be important (page 15828, top paragraph). But it turns out that the authors find the covariability effects to be very small, changing the net flux from 30.4 to 31.2, or a change of less than 3%. The authors do not appear to pursue the reason for this finding (page 15839, lines 1-2). The discussion section does focus on biological covariability which, although very relevant, is not included in the present model study via parameterization. I would encourage the authors to provide a physical explanation for the finding that covariability effects are small. Perhaps a simple statistical analysis of the gas flux forcing functions (SST, U10) would help here?

3. I suggest including a figure that shows a detailed time series of the key model inputs and outputs. One expects that the model pCO2w will, at a given location, rise during a period of falling wind speed and increasing SST, and that the air-sea flux CO2 is modified by these effects. This is the basis of the model study and it would be good to show this information, graphically, to the reader. It may be possible to also compare model time series results in contrasting environments, specifically a region that IS significantly influenced by covariability effects, and a region that IS NOT significantly influenced by covariability. Without time series figures it is hard to evaluate the dynamics of the model. Ideally, of course, one would like to see a comparison of the model time series inputs and outputs to time series observations of SST/pCO2/flux data from a buoy. This would provide a means to validate the model. Have the authors made any such comparisons?

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Interactive Comment

4. Please provide more descriptions and explanations of Figure 2. I assume these are model results for steady state conditions? I see that the 'solubility' curves follow a -4.23% per oC change, solubility decreasing by a factor of ˜2 over the temperature range in the plot. Is the reason that 'pCO2air' falls because of water vapor dilution effects in the air? Please explain in the text. Please also explain in the text why 'transfer vel' increases by a factor of about 20 over the temperature range. This increases seems very large.

Technical comments:

5. Page 15839, line 13: please include an explanation for this model result. 6. Eqn 28, consider changing '=' to '˜' because it becomes an approximation to the original equation when the terms are dropped. 7. Page 15842, line 1: apparent contradiction here, the figure shows satellite observations in every month. 8. Page 15831, line 13-14: please mention this earlier on page 15830, line 13.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 15825, 2008.

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