Earth Syst. Dynam. Discuss., 2, C158–C161, 2011
www.earth-syst-dynam-discuss.net/2/C158/2011/

Earth System Dynamics Discussions

Interactive comment on "The energetics response to a warmer climate: relative contributions from the transient and stationary eddies" *by* D. Hernández-Deckers and J.-S. von Storch

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Received and published: 6 June 2011

We want to thank Referee #1 for the helpful comments. One minor point was raised regarding the weaker dissipation in the 2xCO_2 conditions, and how this would be expected to be associated to weaker surface winds. However, it is not possible to conclude from our vertical-cross section plots of K_m and K_e (Fig. 3 in the manuscript) if there are indeed weaker surface winds or not. From K_m one could infer stronger winds in the Southern Hemisphere (around 50S-60S), but from K_e one would maybe infer somewhat weaker winds elsewhere. To verify this, we have plotted here the zonal-mean change in 10m wind speed (Fig. 1). We do not find any global weakening

or strengthening of the surface winds. The most prominent feature is a strengthening along 50-60S, and a weakening around 40S. Furthermore, the globally integrated change of this 10m wind speed yields a slight increase of 0.009 m/s, i.e., just 0.1%, which is not significant. In other words, we cannot attribute the weaker global dissipation to weaker near-surface winds based on our experiments.

Lucarini et al. (2010) show a very similar plot for the change in mean squared wind velocity between 1000 ppm CO_2 and 350 ppm CO_2 conditions ($\approx$ 3xCO_2 difference). Just as in our case, from that plot one cannot really deduce an overall weakening or strengthening of the near-surface winds. Lucarini et al. only find such a weakening when comparing a 1000 ppm with a 100 ppm situation (a 10xCO_2 difference). But for smaller increases in CO_2 concentration, changes in near surface winds do not explain the decrease in dissipation. Hence, the most straight-forward candidate for explaining weaker dissipation—weaker surface winds—does not work.

Although boundary layer dissipation accounts for most of the global dissipation of kinetic energy, other processes also contribute, like gravity wave drag, for instance (Pascale et al. 2011). Physically, the actual dissipation takes place at molecular scales, so that it is not explicitly simulated in any climate model. Diagnosing dissipation rates from climate models is therefore a very difficult task, and trying to trace the cause of the 2xCO_2-weakening in terms of dissipation would be a research question on its own. Unfortunately, it lies out of the scope of our work. However, we consider important to include in the revised manuscript the statement that our results do not show weaker near-surface winds, and hence one cannot assume that weaker dissipation when doubling CO_2 concentrations implies weaker surface winds.

References

Lucarini, V., Fraedrich, K., and Lunkeit, F.: Thermodynamics of climate change: generalized sensitivities, Atmos. Chem. Phys., 10, 9729–9737, doi:10.5194/acp-10-9729-2010, 2010.

Pascale, S., Gregory, J. M., Ambaum, M., and Tailleux, R.: Climate entropy budget of the HadCM3 atmosphere-ocean general circulation model and of FAMOUS, its low-resolution version, Clim. Dynam., 36, 1189–1206, doi:10.1007/s00382-009-0718-1, 2011.

Interactive comment on Earth Syst. Dynam. Discuss., 2, 355, 2011.

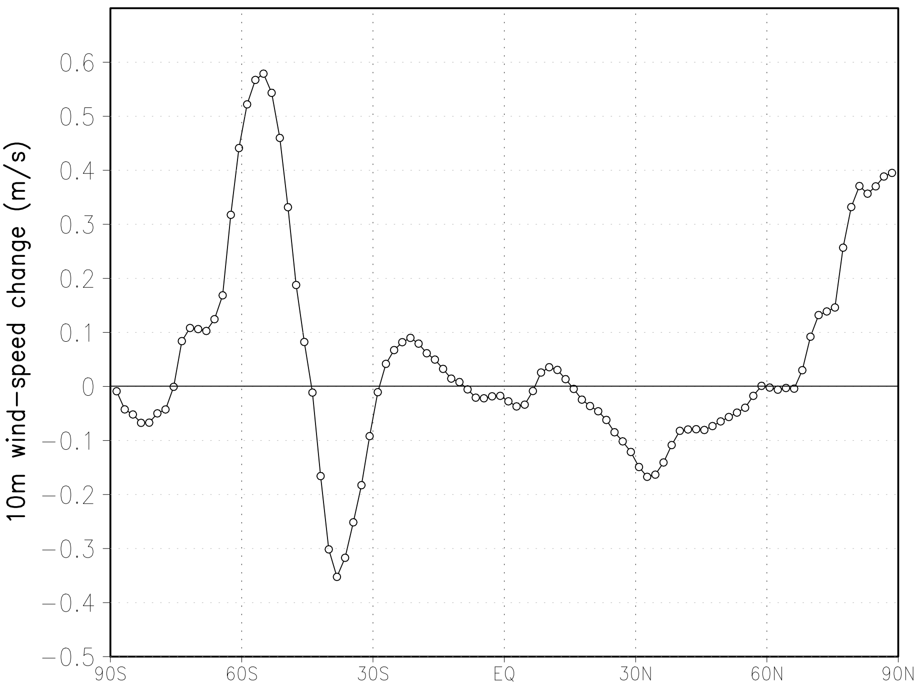

Fig. 1. Change in zonal-mean 10m wind speed due to CO$_2$ doubling in the ECHAM5/MPI-OM coupled model.