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An observing system to monitor the ACC's baroclinic transport through Drake Passage: first lessons

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Monitoring the transport of the Antarctic Circumpolar Current (ACC) through Drake Passage has been the goal of a number of international programmes owing to its key role in inter-ocean exchange. Thanks to this large observational effort, today we know that an overwhelming fraction ($> 90\%$) of the ACC "mean" (i.e. near the low end of the observed frequency spectrum) transport resides in the baroclinic component. This suggests that perturbations to the external forcing of the ACC will drive variability in its baroclinic transport if they persist for periods comparable to or longer than a characteristic ACC spin-up time scale, which theory and numerical models suggest to be on the order of months to a few years. Since this is close to the shortest time scale at which we expect the variability in oceanic fluxes to be climatically significant, we propose that monitoring the baroclinic transport through Drake Passage may be an efficient way to determine the climate-relevant band of ACC transport variability. An advantage of focussing on the baroclinic component of the transport is that the ocean dynamics acts as a natural filter, averaging out undesired fast transport fluctuations occurring mostly in the barotropic mode.

In this paper, we design an observing system to monitor the baroclinic transport through Drake Passage by combining gridded satellite altimetric measurements of the sea level drop across the passage with ten repeats of the WOCE SR1b hydrographic transect conducted annually by U.K. scientists. Using spatial and temporal filtering techniques and carefully matching the altimetric sea level records with geopotential height measurements from the hydrographic sections, we are able to derive a 12-year time series of the ACC's baroclinic transport through the passage. The assumptions implicit in this derivation are tested with a parallel analysis of the $\frac{1}{4}^o$-resolution OC-CAM model. The derived baroclinic transport time series shows a range of ~ 30 Sv

with a standard deviation of ± 7 Sv and an uncertainty of ± 3.5 Sv. We evaluate the degree to which Drake Passage baroclinic transport variability is indicative of baroclinic adjustment of the ACC beyond the passage. Finally, we discuss the likely forcing of the observed variability and raise the possibility that much of it is internally forced by resonant interactions of the flow with the topography of the passage.