



## **Earth Systems Model biases in the ocean carbon cycle: what are we learning from new high resolution observations and modelling experiments in the Southern Ocean?**

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Over the past 10 years the global ocean carbon community has made enormous progress in coordination of observations and data quality (Bakker et al., 2016) that enabled improved constraints of the mean annual ocean carbon budget (Le Queré et al., 2016). In parallel, the modelling community has developed climate models to Earth Systems models with a prognostic capabilities for the ocean carbon cycle as well as empirical modelling approaches to enable the sparse observational data sets to be used to derive seasonal and interannual variability and trends of CO<sub>2</sub> fluxes and storage (Landschutzer et al., 2015).

These improved observational constraints of air-sea CO<sub>2</sub> fluxes have helped to identify new ES and OBGC model biases (Anav et al., 2015; Lenton et al 2013; Mongwe et al., 2016) which could be important in correctly predicting the decadal and century scale evolution of ocean carbon – climate feedbacks. The question is whether these biases are linked to the resolution limitations or process parameterizations in the models.

Recent high resolution observational analyses of remote sensing data (Thomalla et al., 2011; Carranza and Gille, 2015), surface floats (Resplandy et al., 2014) profiling floats (Williams et al, 2017) and gliders (Swart et al., 2014; Monteiro et al., 2015; Du Plessis et al., 2017) have enabled the ocean carbon community to examine more closely the role that fine scale dynamics might play in explaining the apparent model biases. Of particular interest is the underestimated role of storms, through their interaction with ocean mesoscale and sub-mesoscale, having a disproportionate impact on the mixing, vertical transport of DIC, stratification, nutrient supply and subduction of phytoplankton carbon (Lévy et al., 2012; Whitt et al., 2017). Here, we overview this work and examine how it might explain the apparent model biases and point to where we need new areas of community coordinated research in both observational experiments and model development towards improved prediction of ocean carbon – climate feedbacks.

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