DeCUSO: Decadal predictions of Carbon Uptake in the Southern Ocean and impact of the biological carbon pump uncertainty

Description

The recent COP21 Paris agreement on climate ties the participating countries (Spain and the whole EU among them) to take actions to reduce anthropogenic carbon emissions in order to contain global warming within 2o C by the end of this century. This translates into the necessity to precisely estimate the compatible CO_2 emissions well ahead of time to make sure targets are met. However, precision in the estimate of compatible CO_2 emissions can be achieved only if all sources and sinks of atmospheric carbon are known with the highest possible accuracy.

The ocean represents one major sink as it takes up about 25% of the anthropogenic carbon emitted by human activities providing an essential service to society.

Particularly, the Southern Ocean is estimated to absorb up to 50% of the anthropogenic carbon entering the ocean. However, because of its remoteness, this area is sparsely observed and it stands out as a data desert, particularly in the winter time. Although physical mechanisms are commonly assumed to be the drivers of most anthropogenic carbon uptake, a set of mechanisms involving ocean biogeochemical processes (the so-called Biological Carbon Pump, BCP) are key to maintain most of the vertical gradient of dissolved inorganic carbon which ultimately drives the flux of CO_2 between atmosphere and ocean. The BCP is particularly poorly constrained in the Southern Ocean and the uncertainty in the estimate of its strength is large enough to confound accurate estimates of carbon uptake. Moreover, in addition to complex dynamics specific to the ocean carbon cycle and its interactions with a highly dynamical environment, the Southern Ocean is characterized by marked decadal oscillations linked to global- scale climate modes of variability. This characteristic has hampered past attempts to detect trends in carbon uptake but, at the same time, could represent a source of predictability on decadal timescale.

Motivated by these challenges, the activities proposed within DeCUSO have as objective to provide an extensive assessment of our ability to predict the ocean carbon uptake on timescales ranging from one month to one decade ahead. Moreover, this proposal aims at improving our understanding of how uncertainty in the carbon uptake mediated by the BCP is propagated to the total carbon uptake estimate. To achieve these ambitious objectives three work packages are planned. First, members of DeCUSO will implement the Transport Matrix Method (TMM) to be used with the Earth System Model (ESM) EC-Earth. This will allow to equilibrate the biogeochemical component of EC-Earth in a fraction of the time it would take if the actual ESM was used. The equilibration of the biogeochemical component of an ESM is an essential prerequisite before performing any model evaluation, test or sensitivity study. This first work package will provide the tools to produce initial conditions for the decadal predictions of carbon uptake to be performed in the second work package.

Finally, in the third work package, modeling activities using the TMM will be directed at evaluating the impact of the uncertainty in the representation of the BCP on total carbon uptake.