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Carbon budgets from global to regional scales: current challenges and future perspectives

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To fulfill the international objective "*…to reach global peaking of greenhouse gas emissions as soon as possible … and to undertake rapid reductions thereafter in accordance with best available science…to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century*", the Paris Agreement implemented the Global Stocktake Process to assess regularly the world's collective progress towards achieving the purpose of the agreement and its long-term goals.

National greenhouse gas (GHG) inventories report only anthropogenic fluxes. However, many GHG sources are difficult to separate from the natural fluxes. Moreover, inventories cannot easily be scaled to the globe given the use of different approaches for GHG budgeting but, more importantly, because the states of the natural ocean and land sinks are not considered. Fast developments in the scientific capabilities to quantify GHG budgets and their trends consistently from the global to the national scale as well as accurate attribution of budgets to natural and anthropogenic processes are needed.

In Global Carbon Budgets top-down and bottom-up estimates still show large discrepancies at regional or country scale, due to large and multiple sources of uncertainty. Reducing these uncertainties and improving regional GHG budgets is currently the focus of the second "REgional Carbon Cycle Assessment and Processes" (RECCAP-2) initiative supported by the Global Carbon Project. This effort is fueled by an ever-expanding constellation of and in-situ and satellite-based GHG observations, and by increased process-based and data-driven modelling capabilities.

Here, I will discuss some of the elements that still challenge our ability to robustly link global to the regional and country carbon budgets, and their implications for the Global Stocktake. I will then show recent examples on how multi data-stream approaches can be used to identify and understand sources of discrepancies between top-down and bottom-up estimates and to improve attribution of regional carbon budgets to specific natural and anthropogenic processes.