Project: **1231**

Project title: **CAMELOT: CO_2 And Methane Emissions via Lidar and Other Techniques**

Principal investigator: **Julia Marshall**

Report period: **2021-11-01 to 2022-10-31**

This report covers only the period from approximately April, 2022, when Levante became available, through October 2022, when the report had to be submitted. Because 1231 was a new project, no simulations were carried out under this project on mistral.

Following the outline of the original proposal, the reporting is separated into three WPs.

WP1: Regional inversion simulations within the H2020 project $CoCO_2$ (coco2-project.eu), targeting anthropogenic and biogenic fluxes of CO_2 from facility to national scale.

The planned plume simulations were carried out with WRF, and submitted to the project as part of a "library of plumes" to be used for further scientific analysis. These datasets are now stored at the ICOS Carbon Portal, where they can be accessed online for further analysis within the CoCO2 project. The comparison of the simulations from several different models is underway, and is part of a deliverable that is being prepared for the end of the year. A similar comparison (making use of simulations that were completed before the 1231 project came into being) was recently submitted to ACP, and is now in open discussion (Brunner et al., 2022).

The development work on to integrate the WRF model in the Community Inversion Framework (CIF, Berchet et al., 2021) continued over the year, but is not yet fully complete. While the WRF-CIF interface itself is ready, the development of the Ensemble Kalman Filter approach itself is not yet mature, and as such the model cannot yet be used for full experiments. This is dependent on work on the side of French colleagues, which has experienced some delays over the past months.

As such, the European-scale inversions themselves have not yet begun. As the deliverable deadline is approaching next year, we are considering using the WRF-CTDAS system instead. (This has no effect on the resource request for the next year.)

Also planned within Task 1 was the preparation of high-resolution biospheric fluxes with the VPRM model, as an input for the CoCO2 project (Mahadevan et al., 2008). Originally planned was output only for the years 2018 and 2021, but based on requests from project partners, this has been extended from 2017 through 2021. These fluxes are being distributed with the DKRZ's swift storage (with the link https://swiftbrowser.dkrz.de/public/dkrz_713c5812-40a6-4d9c-a938-50cfce20c44f/CoCO2_VPRM_fluxes_${YYYY}/, where YYYY is replaced with the year in question), which has made it possible to distribute such a large dataset easily. The data are hourly and at ~1 km resolution for the European domain, containing both respiration and GPP fluxes, resulting in almost 5 GB per day. These data are currently being used by several European research groups for simulations both within the CoCO2 project and beyond it.

WP2: Global methane inversions using various TROPOMI XCH_4 retrievals (part of the ESA projects GHG-CCI+ and Methane+) as well as inversions aiming to optimize OH and the wetland drivers of methane, as part of the CAMELOT Young Researcher's Group.

Global methane inversions were carried out as planned for both the GHG-CCI+ and Methane+ projects, and documented in project reports. They were also presented at the ESA Living Planet Symposium and the ESA ATMOS conference. The results from the Methane+ project are currently being prepared for a peer-reviewed publication.

The work to develop an optimization of OH within the model has not yet begun, partly due to not yet hiring the appropriate personnel. This is expected to take place over the next year.

WP3: Development of AI methods for plume detection and biogenic flux estimation as part of a proposed BMWi project CO2KI with a planned start date of January 1, 2022 (*Methoden der künstlichen Intelligenz zur skalen- und prozessübergreifenden Erfassung von Quellen und Senken von Kohlendioxid*).

The project did officially begin on January 1st, but personnel were not hired until May. The work on the upscaling of fluxes is progressing nicely, and reasonable results are now available for GPP, as shown in the summary in Figure 1. A systematic underestimation of high GPP values is clear in this figure, but this has already been improved by adjusting the weighting of the training data to better match the distribution around the world – not just at flux tower sites (i.e. there are very few flux towers in deserts). NEE is proving to be more difficult to match with the current setup, for reasons that are not entirely clear at present, but is the focus of ongoing research. The ANN-approach that is currently being used would be a good candidate for running on GPUs to speed up the approach, but this has not yet been possible. GPGPU node hours have been added to our resource allocation request for 2023.

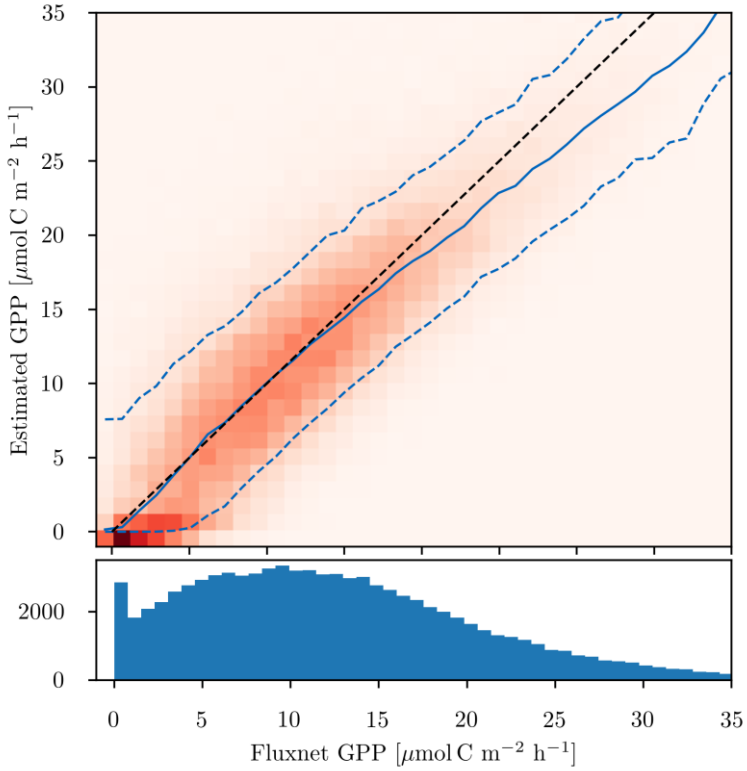

Figure 1: First results from the GPP upscaling approach using remote sensing data.

References

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