

Greenhouse gases measurements in Southern Ocean on board the Marion Dufresne



Marion Dufresne Atmospheric Program - Indian Ocean

www.mapio.re

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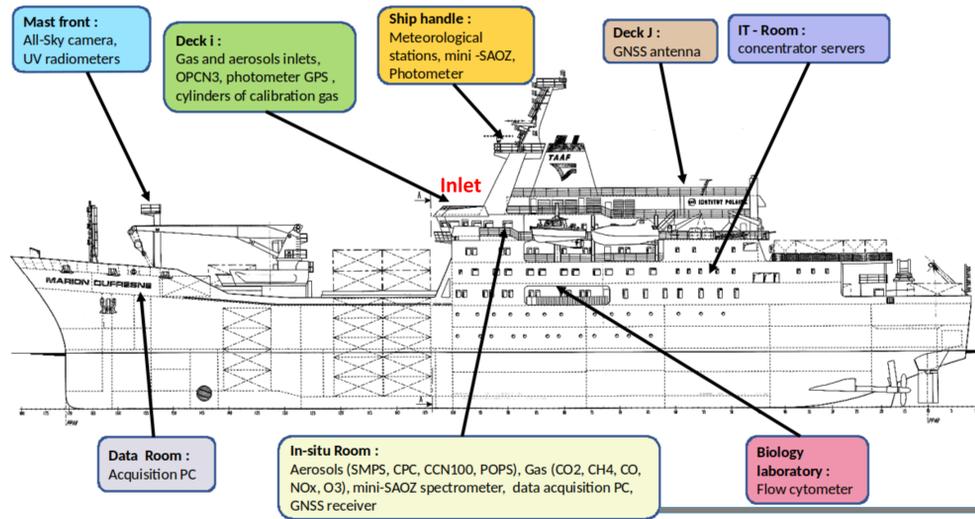


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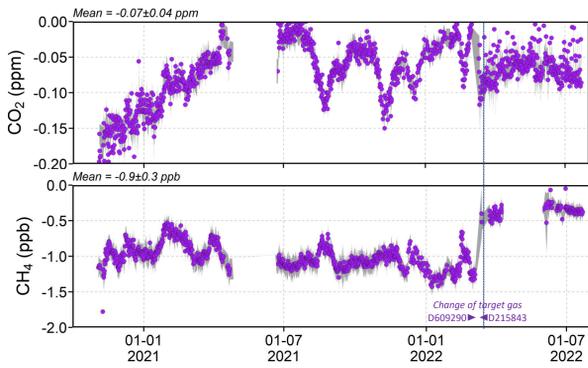
The MAP-IO project (Marion Dufresne Atmospheric Program Indian Ocean) launched in Autumn 2020, with the aim of studying the atmospheric composition and the ocean-atmosphere processes, represents a unique opportunity for greenhouse gases monitoring over the Indian Ocean.

The French oceanographic vessel Marion Dufresne has been equipped with a set of instruments dedicated to long term atmospheric monitoring. As part of this full instrumental package, a complete greenhouse gases (GHG) equipment set has been including a continuous high precision analyzer (providing CO₂, CH₄, CO measurements), a calibration and quality control setup and intake line and a GPS positioning system.

The project is funded for 3 years, and in 2024 will submit its application to the CNRS for the European research infrastructures ICOS and AETRIS.

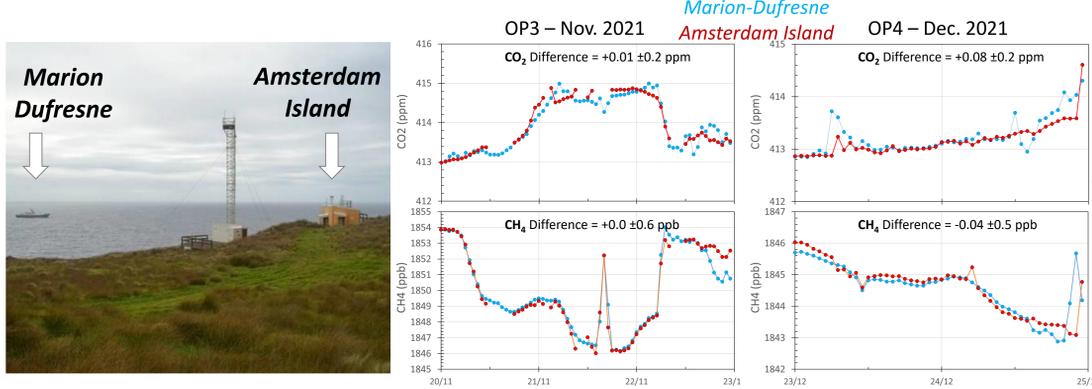


Quality control of the GHG measurements using a target gas

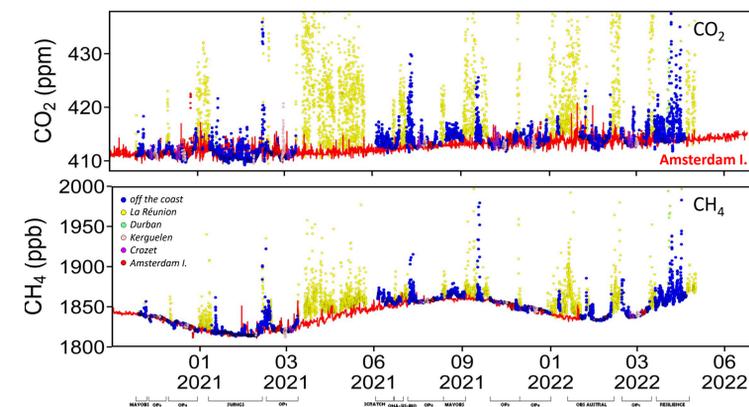


The analyzer is calibrated once a month with 4 cylinders previously calibrated at LSCE (Reference scales: WMO-CO₂-X2019, WMO-CH₄-X2004A, WMO-CO-X2014A). A target gas is measured daily for 30mn, in order to estimate the repeatability of the measurements. The ship's stopovers at Amsterdam Island in 2021 made it also possible to verify the very good agreement with the CO₂ and CH₄ measurements.

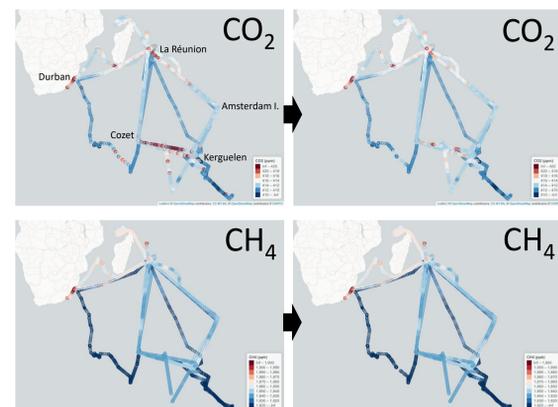
Comparison to the measurements at Amsterdam I. observatory



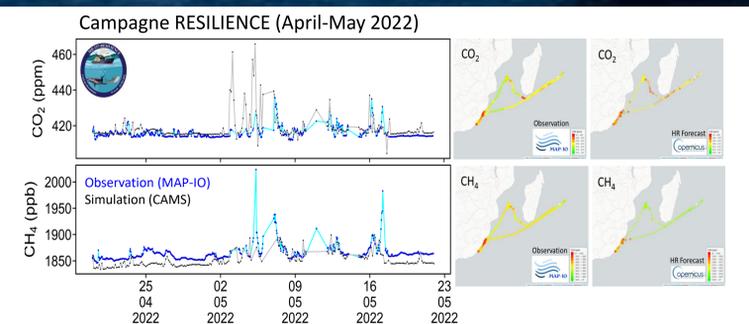
Atmospheric CO₂ and CH₄ measurements



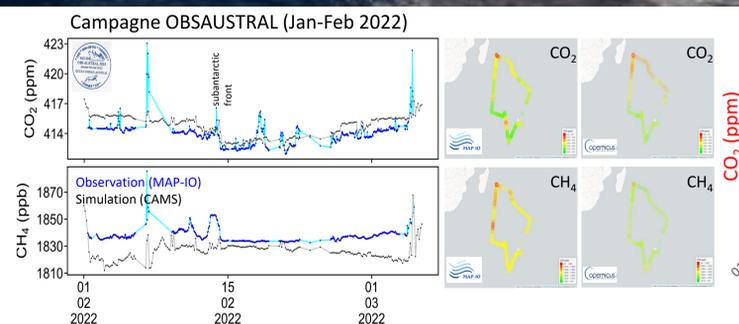
The instrument has operated without major interruption since November 2020. Observations show a very high variability when the ship is in a port, and when it sails along the African coasts. El Yazidi et al. (2018) method to detect spikes is applied to filter the major contaminations from the ship's chimney, based on the CO variability. The maps of CO₂, CH₄ concentrations show that several high CO₂ concentrations have been suppressed on the transect between Crozet and Kerguelen. If the detection of these episodes by the statistical method based on the standard deviation of CO makes it possible to isolate the main part of the contaminations, it seems despite everything that a part is not correctly identified. An additional step of filtering the data will therefore be necessary, based on the relative wind speed.



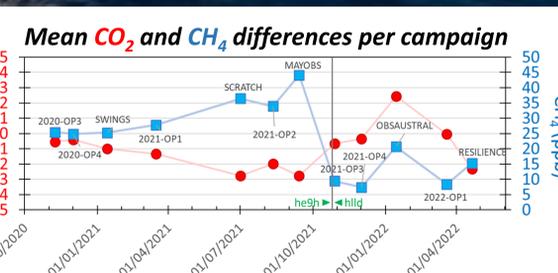
Evaluation of the CAMS high resolution CO₂ and CH₄ forecasts



RESILIENCE cruise shows a good phasing of the pollutant peaks off the coast of S.Africa, but their amplitude is overestimated for CO₂, and underestimated for CH₄, suggesting a problem with surface emissions of these gases in this part of the world.



OBSAUSTRAL cruise highlights an overestimation of the latitudinal gradient of CH₄ in this area (20°S - 55°S). The CAMS forecast indicates a gradient of ~15 ppb with lower concentrations at low latitudes. The subantarctic CO₂ front is well represented.



Overall, the comparison shows an overestimation of CO₂ concentrations and an underestimation of CH₄ concentrations. The biases increase gradually till the reinitialization of the CAMS experiment in Nov.2021. Only OP cruises corresponds to similar transects.

