

# Continuous carbon isotope measurements of CO<sub>2</sub> and CH<sub>4</sub> along the coast of NW Africa and SW Europe demonstrate a variety of greenhouse gas sources.



## High-precision cavity ringdown measurements of $\delta^{13}\text{C}\text{O}_2$ and $\delta^{13}\text{C}\text{CH}_4$ along the Eastern North Atlantic onboard the sailing research vessel *Fleur de Passion*

Magdalena E. G. Hofmann<sup>1\*</sup>, Donis, Daphne<sup>2\*\*</sup>, Ordóñez, César<sup>2</sup>, Bent, Jonathan D.<sup>1</sup>, Lucic, Gregor<sup>1</sup>, McGinnis, Daniel F.<sup>2\*\*</sup> and crew of *Fleur de Passion*  
<sup>1</sup>Picarro, Inc., Santa Clara, USA  
<sup>2</sup>University of Geneva, Switzerland  
<sup>3</sup>Foundation Pacifique, Sailing for Science & Sustainability, Carouge, Switzerland

\* Contact: [mhofmann@picarro.com](mailto:mhofmann@picarro.com)  
 \*\* Contact: [daphne.donis@unige.ch](mailto:daphne.donis@unige.ch), [daniel.mcginis@unige.ch](mailto:daniel.mcginis@unige.ch)

### INTRODUCTION

- Differentiating microbial, anthropogenic, and thermogenic sources of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) in background air is an important element of understanding upper ocean ecosystem processes.
- Here we present isotopic data of carbon dioxide and methane from the *Fleur de Passion* sailing research vessel which traveled from Dakar (Senegal) to Carbo Verde, the Azores, and to France between April and October 2019 as part of the larger Ocean Mapping Expedition by the Geneva based NPO *Fondation Pacifique*.

### INSTRUMENTATION

#### Picarro G2201-*i* analyzer (near infrared)

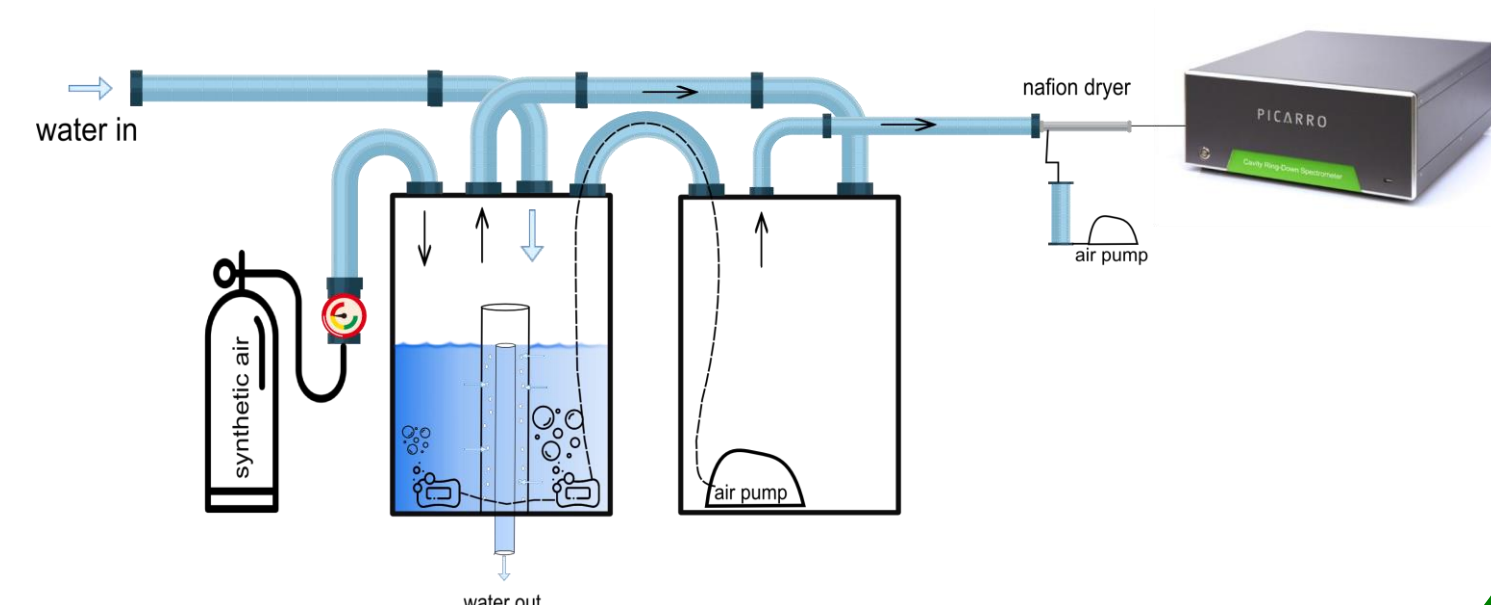
- Field-deployable analyzer for simultaneous high-precision  $\delta^{13}\text{C}$  analysis of CH<sub>4</sub> and CO<sub>2</sub>.
- Precision (1- $\sigma$ , 1-hour window, 5-minute averages):  
 $\delta^{13}\text{C}\text{-CO}_2 < 0.16\text{‰}$ ,  $\delta^{13}\text{C}\text{-CH}_4 < 1.15\text{‰}$



#### Dissolved gas analysis with the dual carbon isotope analyzer G2201-*i*

- In this study, the isotopic composition of carbon dioxide and methane was measured on the mast of the sailing boat. However, source apportionment of aquatic systems can also require to measure the isotopic composition of dissolved gases. Currently, Picarro does not provide a complete solution for dissolved gas analysis but the Picarro analyzers can be coupled with gas extraction or equilibrators devices (see Becker et al., 2012; Maher et al., 2013; Webb et al., 2016; Pohlman et al., 2017; Becker et al., 2018).

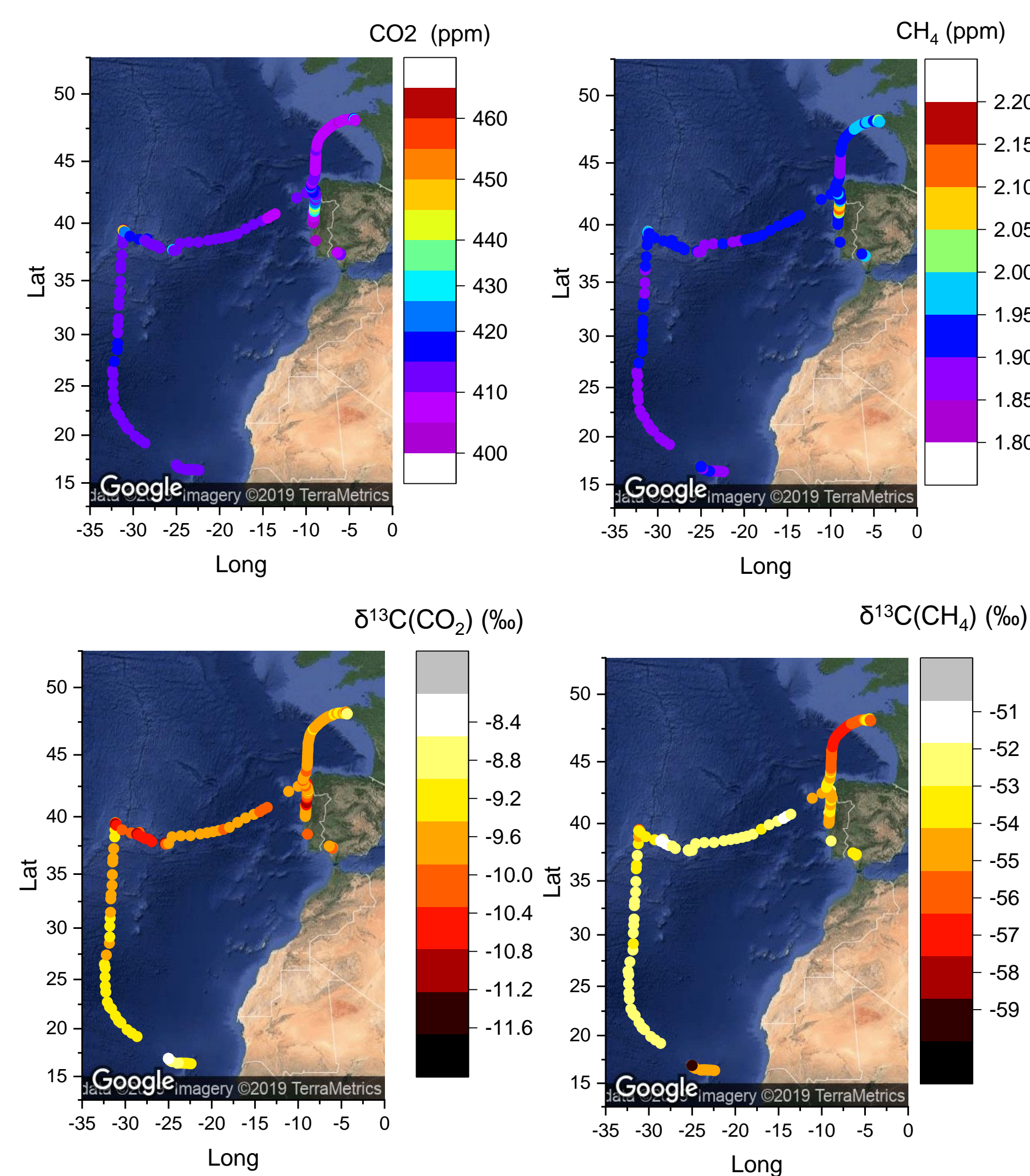
- As an example of a setup for dissolved gas analysis, this schematic shows a bubble type equilibrator that is currently being tested by César Ordóñez, Daphne Donis and co-workers (University of Geneva).



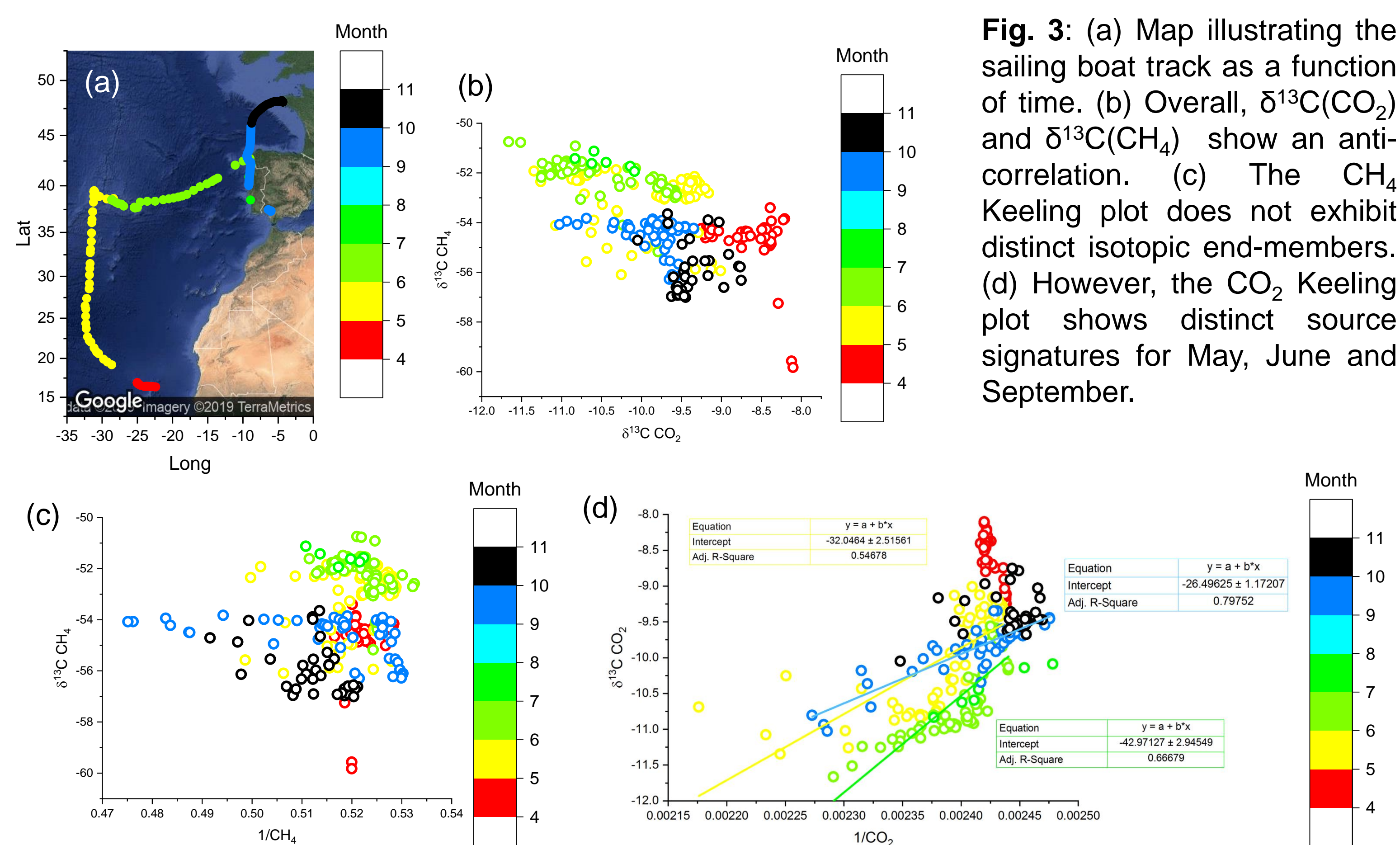
### REFERENCES

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### RESULTS



**Fig. 1:** Carbon dioxide and methane concentration measured onboard the sailing boat *Fleur de Passion*. The cruise started in April in Dakar and ended in October in France. On the open sea, the concentrations were close to background concentrations. Close to the coastland and the Azores concentrations were enriched.



**Fig. 3:** (a) Map illustrating the sailing boat track as a function of time. (b) Overall,  $\delta^{13}\text{C}(\text{CO}_2)$  and  $\delta^{13}\text{C}(\text{CH}_4)$  show an anti-correlation. (c) The CH<sub>4</sub> Keeling plot does not exhibit distinct isotopic end-members. (d) However, the CO<sub>2</sub> Keeling plot shows distinct source signatures for May, June and September.

### CONCLUSIONS

- The Picarro G2201-*i* analyzer onboard the research sailing vessel *Fleur de Passion* functioned extremely well under challenging thermal and repetitive motion conditions, allowing researchers to measure one of the most extensive carbon dioxide and methane isotope records ever taken along the coast of Africa.
- The continuous data show distinct variations in the isotopic composition that may relate to seasonal, geographic and sourcing differences. Further work on these new data is underway!

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