Discussion on atmospheric CO_2 data

- **current value and future potential**

- **inclusion into SOCAT database as a measurement (not as meta data)**

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ICDC SOCAT side event

Value of atmospheric CO_2 from pCO_2 measurement systems

1. Oceanic regions remain severely under-sampled for atmospheric CO_2 – **Blue Sky Goal**
2. **Inversions**. Recent modelling analyses show that currently available atmospheric CO_2 from pCO_2 systems is useful to atmospheric inversion modellers.
3. This is despite the fact that the accuracy of atmospheric CO_2 data from most ship-based **underway CO_2 systems** ($uwCO_{2atm\text{-}dry}$) does not currently meet the rigorous standards of the atmospheric community, as set out in the World Meteorological Organization recommendations.
4. Improving and validating the quality of $uwCO_{2atm\text{-}dry}$ data will most likely provide mutual benefits to both the oceanic and atmospheric communities.
5. Improve prior estimates **for airborne studies**
6. Southern Ocean—**improve understanding of seasonal cycle away from land.**
7. Improve **OCO2** BL understanding

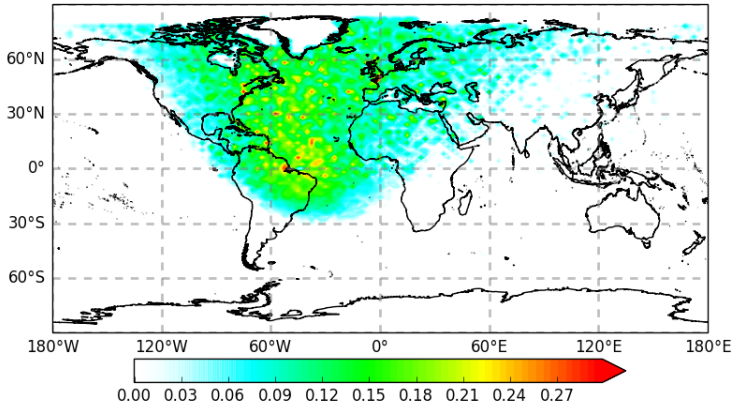

Figure 1 – atmospheric CO_2 data uncertainty from pCO_2 system <0.5 ppm

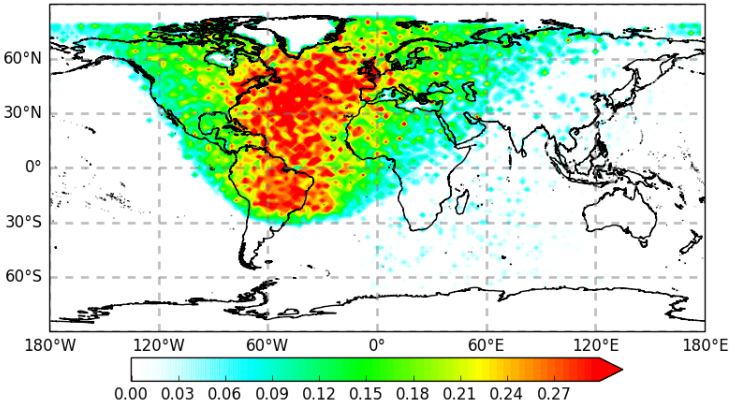

Figure 2 – atmospheric CO_2 data uncertainty from pCO_2 system 0.1 ppm

Figures courtesy of Zhaohui Chen and Parv Suntharalingham

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Adding atmospheric CO_2 to SOCAT as a measurement

- Does the oceanic community want this?

(The atmospheric community do want this)

- If so, a set of atmospheric flags will be required:
  - Flags should be future proofed
  - Atmospheric flags should be independent of seawater flags
  - The hierarchy of flags should indicate to PIs how atmospheric CO_2 data quality can be improved (i.e. what is the next step to achieving a higher level flag).
  - The focus generally will be on validating and improving accuracy, with improvements in precision coming later.

Moving forwards

- A set of atmospheric flags should only be implemented after full consultation with both the oceanic and atmospheric measurement communities.
- Great opportunity for our two communities to work closer together (we could both learn a lot from each other)
- There are lots of fine details to be discussed another time (e.g. drying issues, inlet lines, number of calibration gases, participation in intercomparison programs, etc.)

Example of what flagging system could look like

A3(viii)	**Low/undefined accuracy, moderate precision** · No target tank measurements, intercomparison activities or companion flask measurements made so accuracy is undetermined. · Hourly ±1σ standard deviation on 'low variability sample air' is ≤ **XXXX** but ≥ **XXXX**. Dataset does not contain evidence of step changes/leaks. · No specific calibration protocols followed for atmospheric CO_2 data (i.e. no limited range on calibration scale, no requirement for dry cylinders in natural air, or less than three PSSes).

Many pCO_2 systems would currently qualify for this type of flag

A1(i)	**High accuracy, high precision** · Compatibility of dataset meets WMO NH/SH goal as quantified by Target tank and/or intercomparison activities (NH = ± 0.1 ppm; SH = ± 0.05 ppm). · Hourly ±1σ standard deviation on 'low variability sample air' is ≤ **XXXX** and on target tank or other cylinder air is ≤ **XXXX**. Dataset does not contain evidence of step changes/leaks. · Regular calibration of measurement system using a suite comprising a minimum of three NOAA scale Primary Secondary Standards (PSSes) of dry, natural air. PSSes span the ambient range of atmospheric CO_2 values by not more than ± 50 ppm (i.e. for atmospheric CO_2 of 400 ppm in 2017, maximum scale range does not exceed 350-450 ppm). · Air that is not fully dried is being corrected for H_2O dilution effects, and water correction is robust.

This one is probably quite daunting right now, but is the highest possible flag, and is designed to be future proofed (and is determined by what the ultimate atmospheric scientific goals are)

We want to hear from you!

- Thoughts, opinions, ideas, positive and negative feedback, etc…

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Input wanted on:

1. Is this worth your consideration?
2. How much data is there already?
3. How many ppl are needed for QC?
4. Include all data or just some?
5. Timeline: flagging, software automation…
6. Same flags as for pCO2 or not?
7. Would audience like to look at our flagging recommendations?