Seasonal Carbon Dynamics in the Southern Ocean

based on a Neural Network Mapping of Ship Measurements

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Climate-Carbon Interactions in the Current Century
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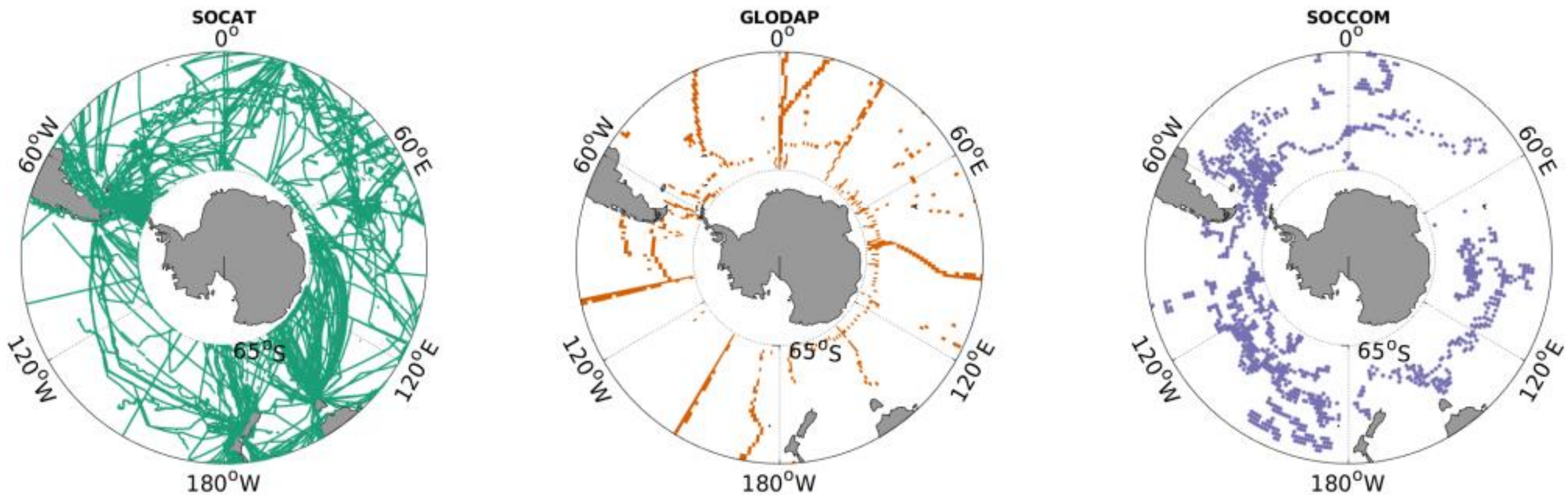
Carbon measurements are sparse

Location of recent Southern Ocean carbon measurements between 35°S and 65°S



SOCATv2019 (at the surface, from 2004 through 2017) | GLODAPv2.2019 (at 10 m, from 2004 through 2017) | SOCCOM floats (at 10 m, from 2014 through 2017)

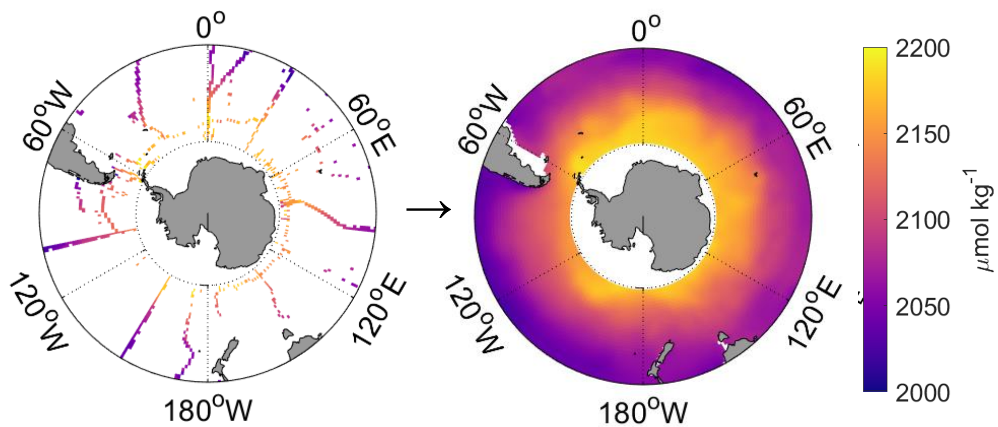
→ even less data when considering individual months

→ special tools needed to resolve the seasonal cycle of Southern Ocean DIC at regional scale

Figures from Keppler, 2020 (PhD thesis, submitted)

SOM-FFN mapping of DIC

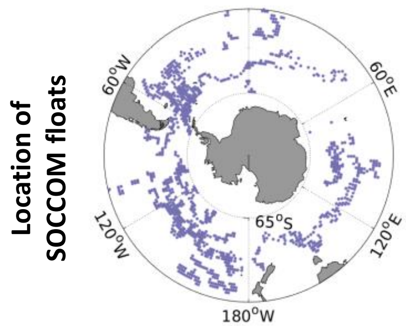
- We adapt the SOM-FFN method by Landschützer et al. (2013) who mapped the monthly surface pCO_2 at global scale
- We map shipboard measurements of DIC (from GLODAPv2.2019)
- Step 1: cluster the global ocean into BGC regions using self-organizing maps (SOM), Step 2: run feed-forward network (FFN) in each cluster to obtain gap-filled DIC fields
- Output: Monthly climatology of DIC from the surface until 2000 m, on a 1°x1° grid from 65°N to 65°S (based on the period 2004 through 2017)
- Southern Ocean: Here, we use our monthly climatology south of 35°S

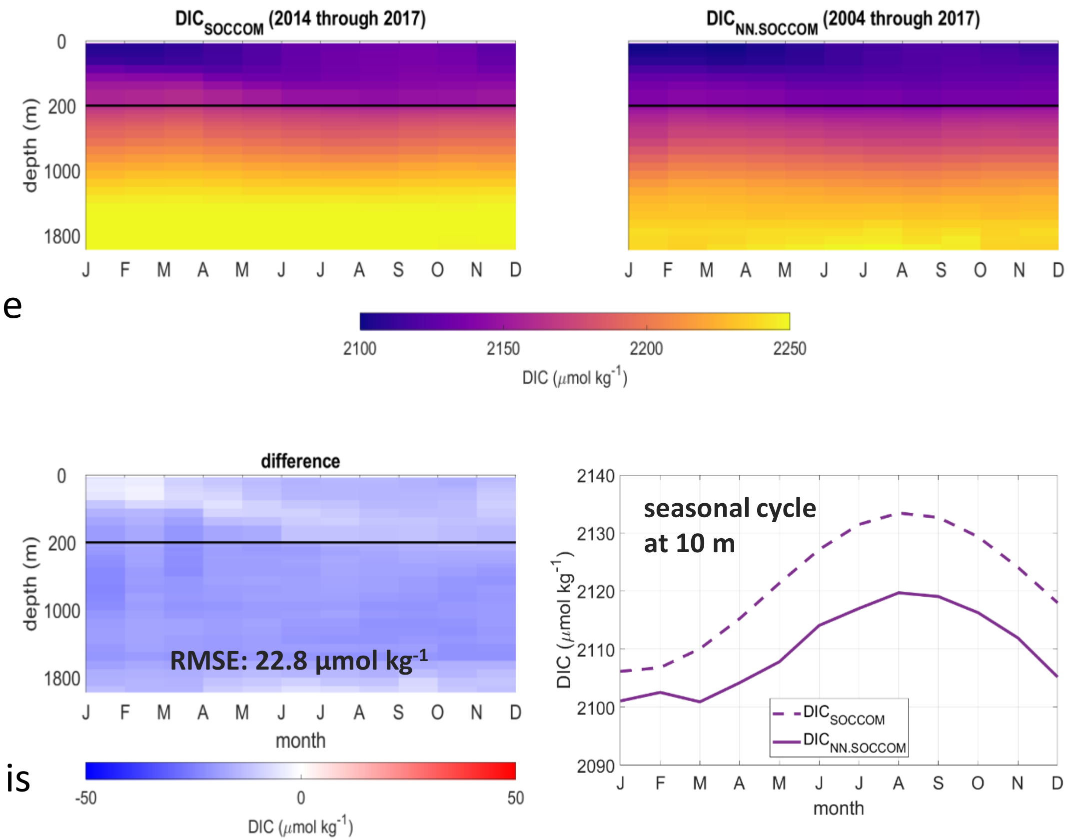


- DIC_{NN}: Our neural network derived climatology of DIC
- showing the time-mean here

Figures adapted from Keppler et al. (under revision), Global Biogeochemical Cycles

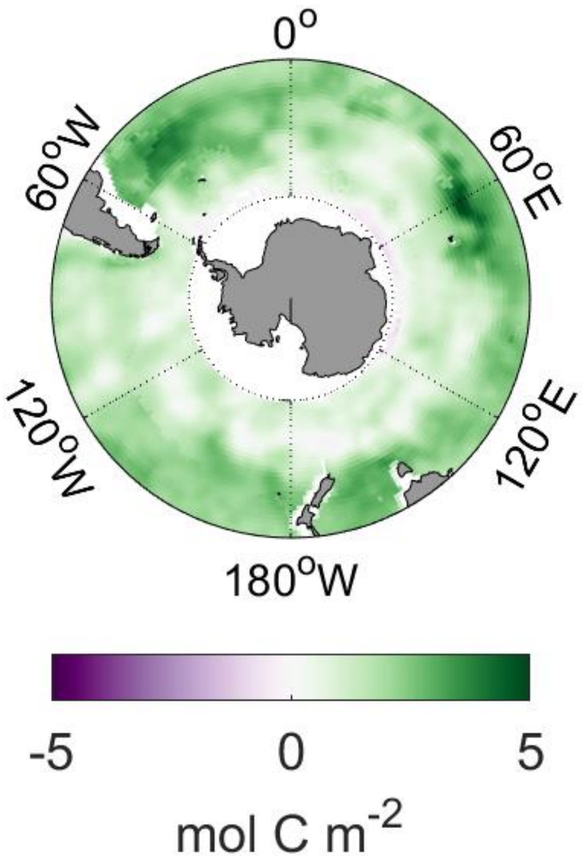
Validation with independent observations: SOCCOM floats





- DIC_{SOCCOM}: monthly mean values of the DIC calculated from SOCCOM float measurements from 2014 through 2017
- $DIC_{NN.SOCCOM}$: DIC_{NN} at the month and location of the SOCCOM measurements
- $DIC_{NN.SOCCOM}$ tends to be lower than DIC_{SOCCOM} by ~10-20 µmol kg^{-1}, which is in line with previous findings that SOCCOM floats report higher DIC or more outgassing than ship data (e.g., Gray et al, 2018; Williams et al., 2017)

Summer NCP



- Using DIC_{NN}, we compute the seasonal draw-down of DIC by biological activity, i.e. the summer net community production (NCP)
- Integrated over the Southern Ocean, we estimate a summer NCP of 1.7±0.3 PgC (~half compared to our estimate for the global extra-tropics of 3.5±0.5 PgC per summer)
- Most biological draw-down of carbon in the Southern Ocean occurs north of the ACC (an area of subduction and mean carbon uptake)

More Details

- **Look out for our upcoming paper at global scale:** Seasonal carbon dynamics in the global ocean based on a neural-network mapping of observations (under revision), Global Biogeochemical Cycles
- **Full length presentation** with additional information on the method, validation, and results available here