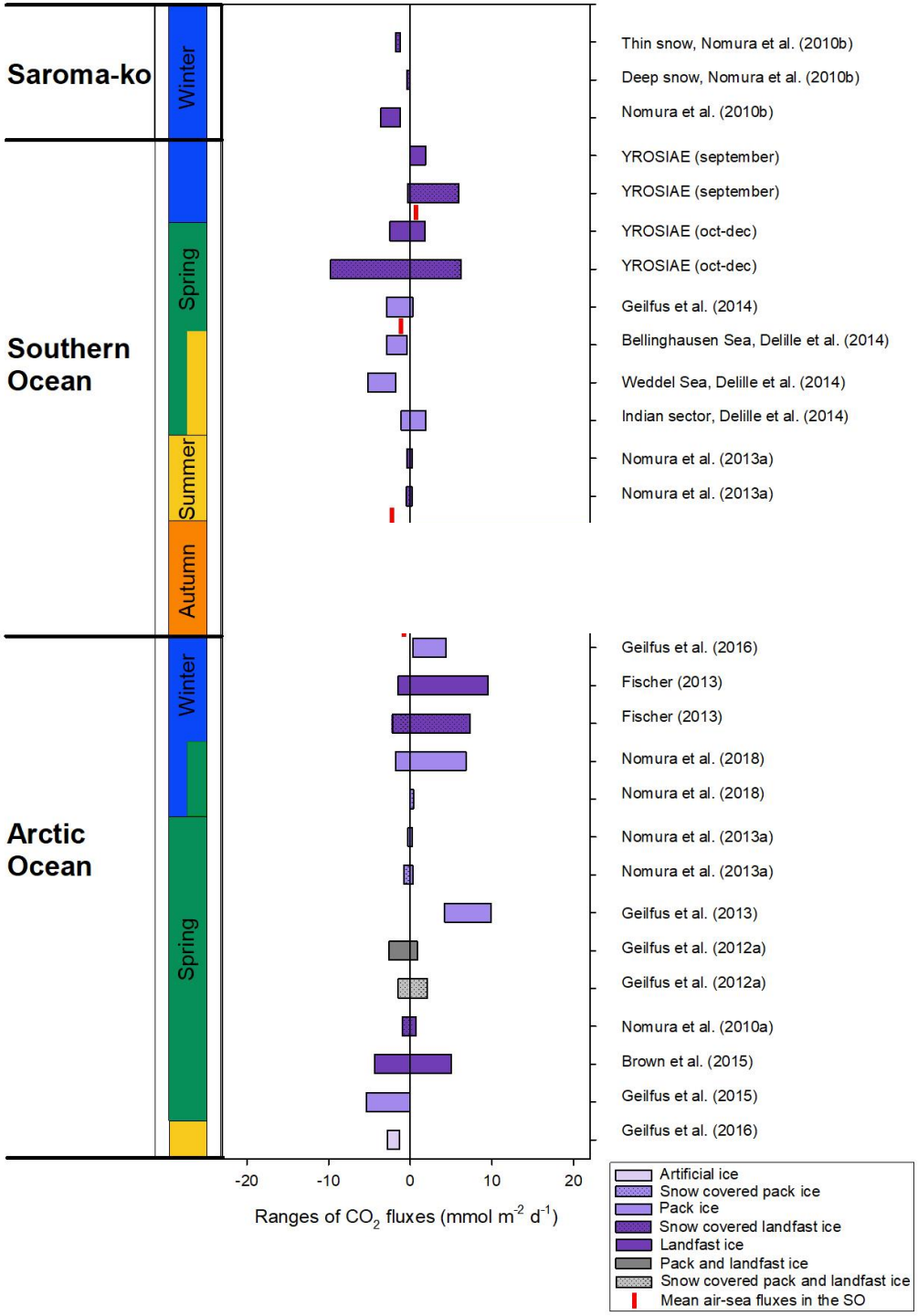
Improving air-ice CO2 budgets in polynia or MIZ during freezing ?

How to bugdet air-ice CO2 fluxes in thin ice covered areas taking into account sea ice temporal and spatial variability (including different ice type)

Bruno Delille, Fanny Van der Linden, Steve Ackley, Jean-Louis Tison…

LIÈGE université


Saroma-ko
Winter
Southern Ocean
Spring
Summer
Autumn
Arctic Ocean
Winter
Spring
Thin snow, Nomura et al. (2010b)
Deep snow, Nomura et al. (2010b)
Nomura et al. (2010b)
YROSIAE (september)
YROSIAE (september)
YROSIAE (oct-dec)
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Geilfus et al. (2014)
Bellinghausen Sea, Delille et al. (2014)
Weddel Sea, Delille et al. (2014)
Indian sector, Delille et al. (2014)
Nomura et al. (2013a)
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Geilfus et al. (2016)
Fischer (2013)
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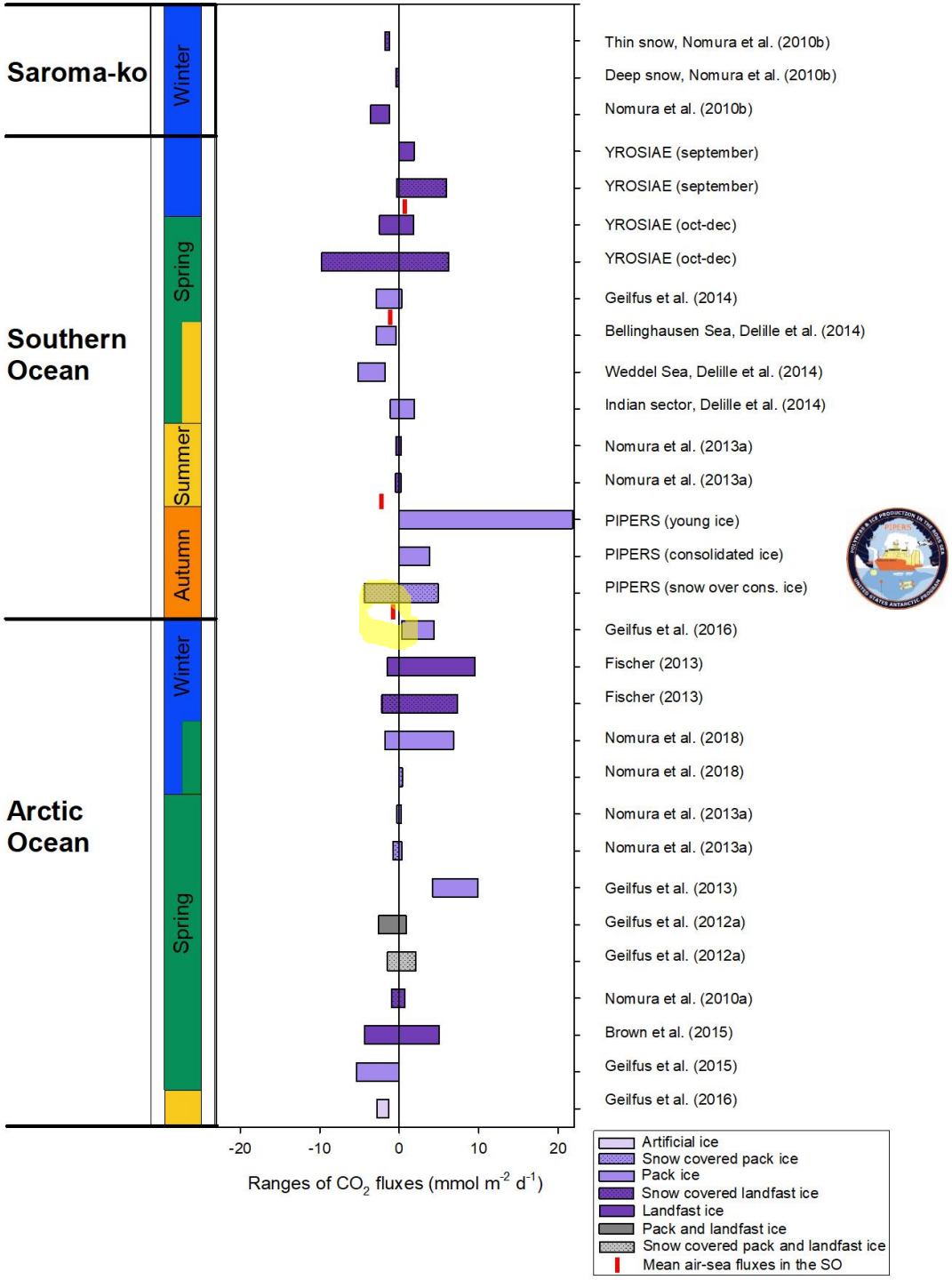
Nomura et al. (2010a)
Brown et al. (2015)
Geilfus et al. (2015)
Geilfus et al. (2016)
-20
-10
0
10
20
Ranges of CO2 fluxes (mmol m-2 d-1)
Artificial ice
Snow covered pack ice
Pack ice
Snow covered landfast ice
Landfast ice
Pack and landfast ice
Snow covered pack and landfast ice
Mean air-sea fluxes in the SO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Nomura et al. (2013a)
PIPERS (young ice)
PIPERS (consolidated ice)
PIPERS (snow over cons. ice)
Geilfus et al. (2016)
Fischer (2013)
Fischer (2013)
Nomura et al. (2018)
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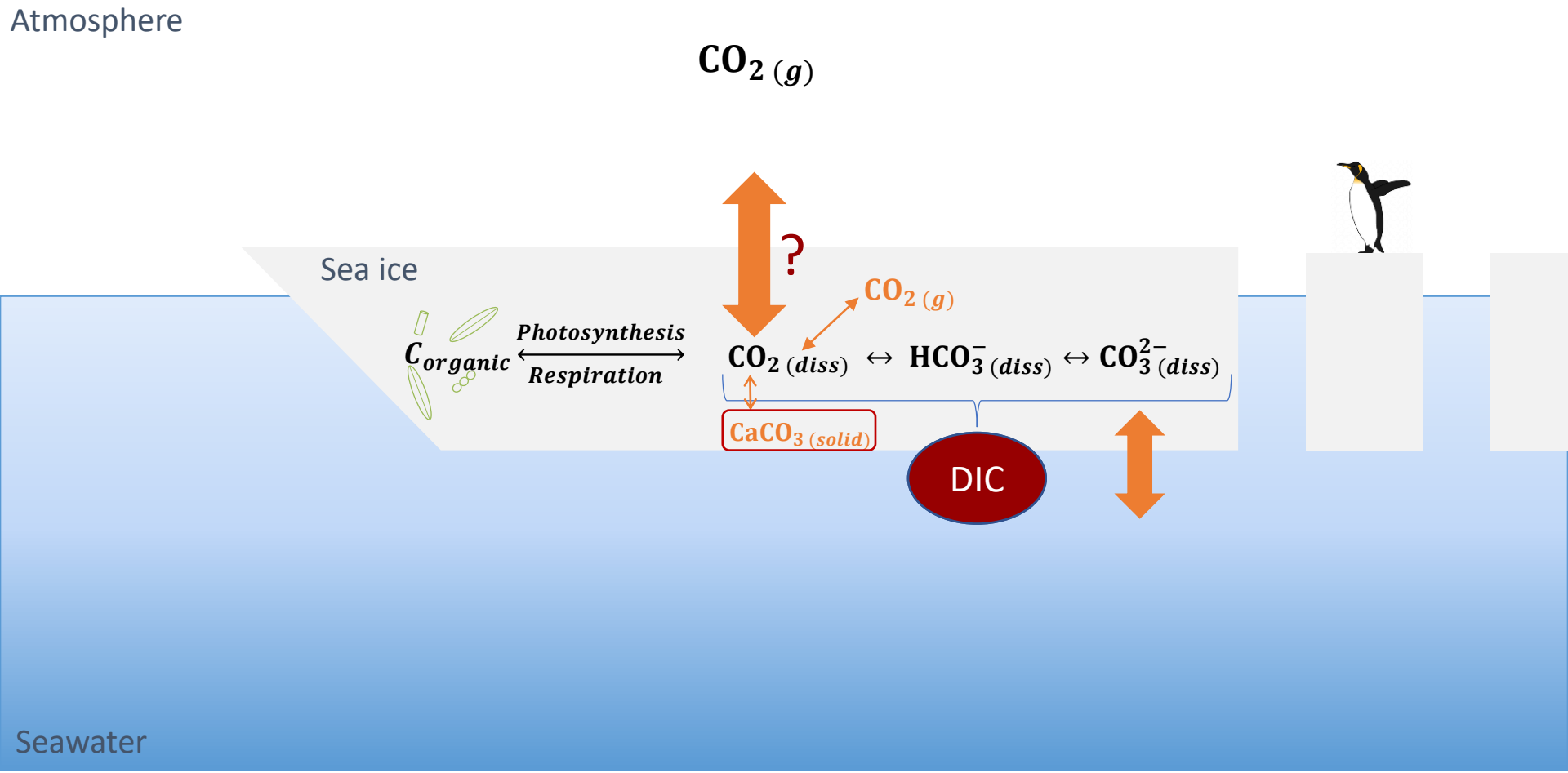
Sea ice: source or sink of CO_2?



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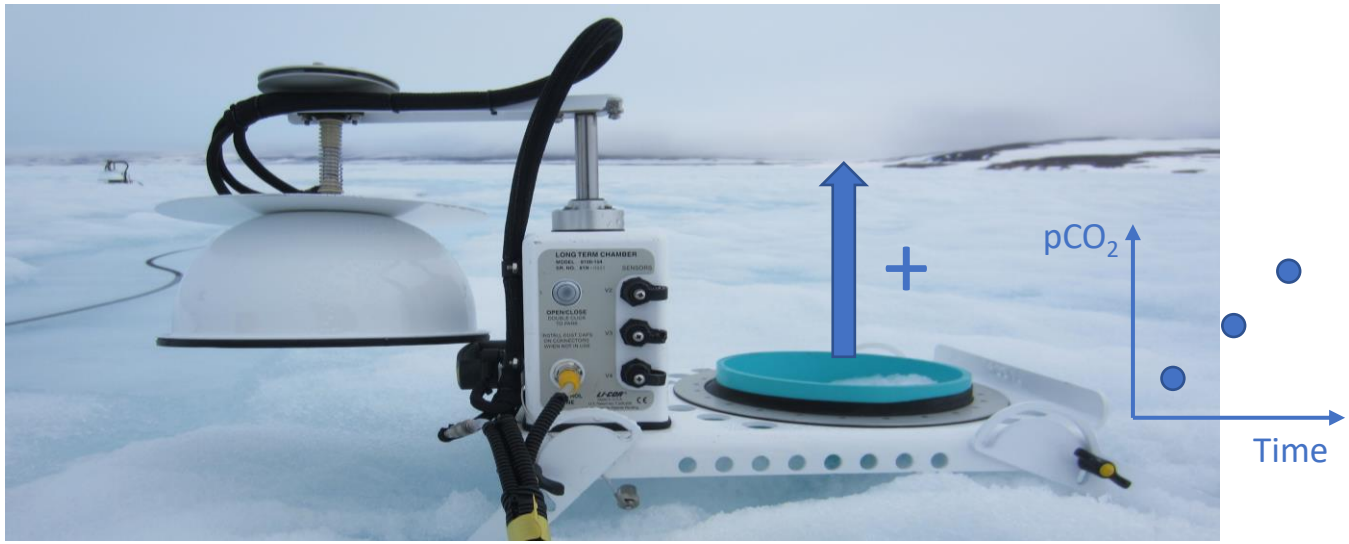

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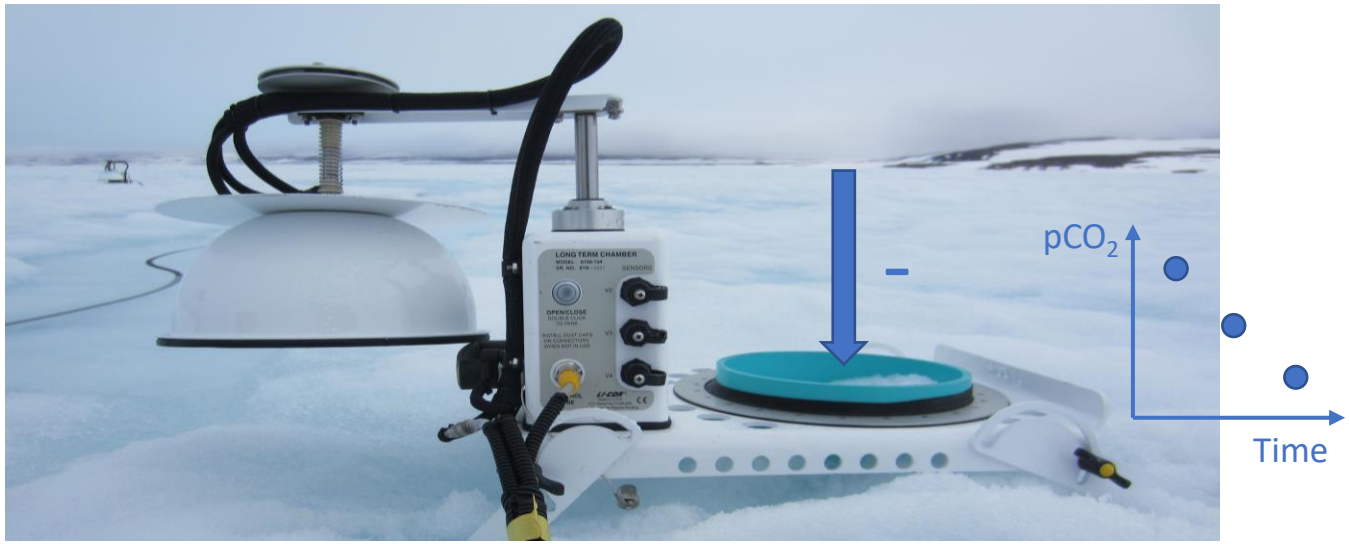
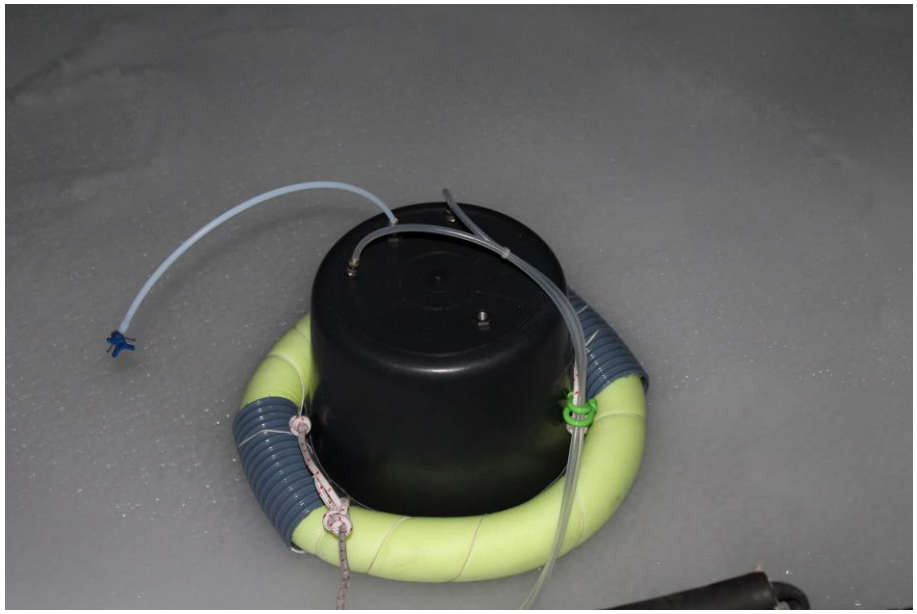
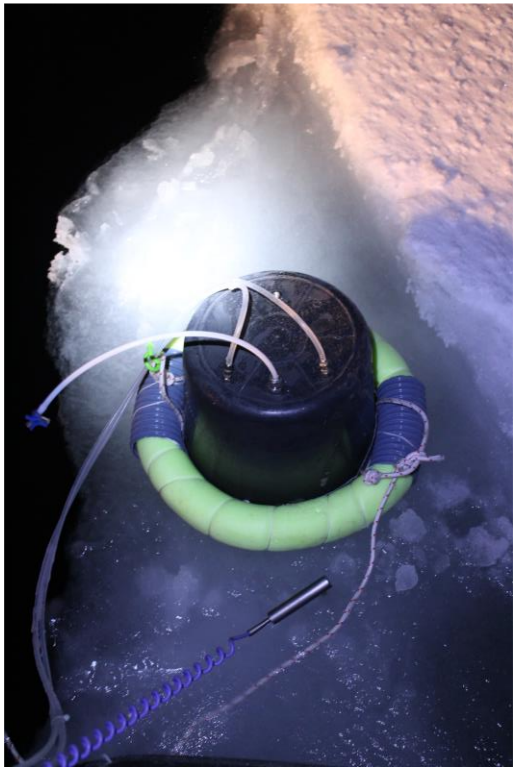
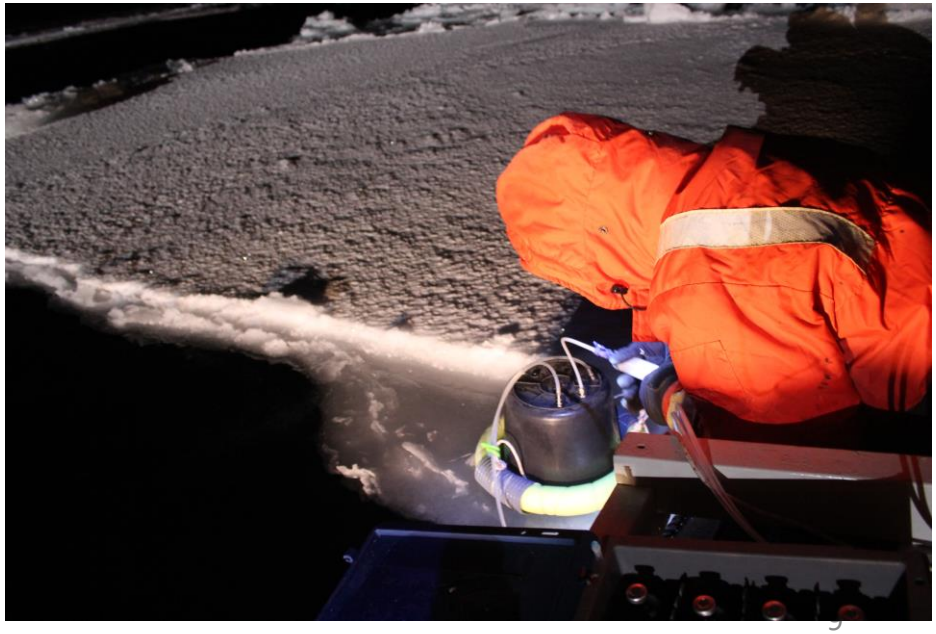
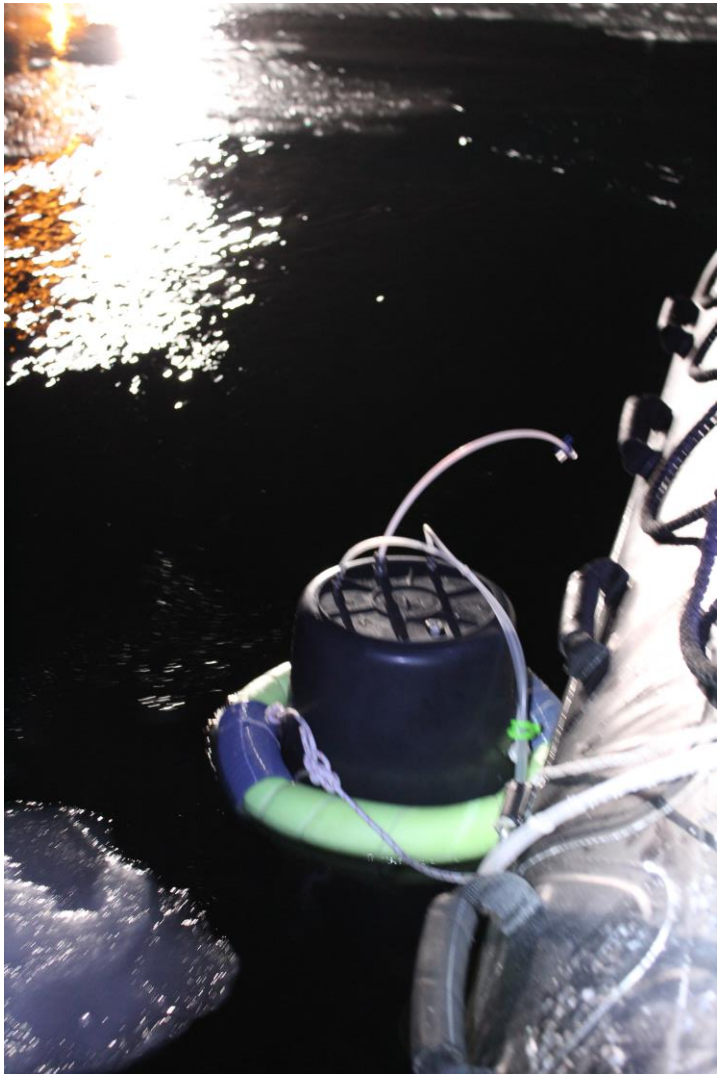


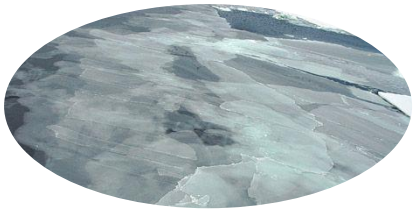


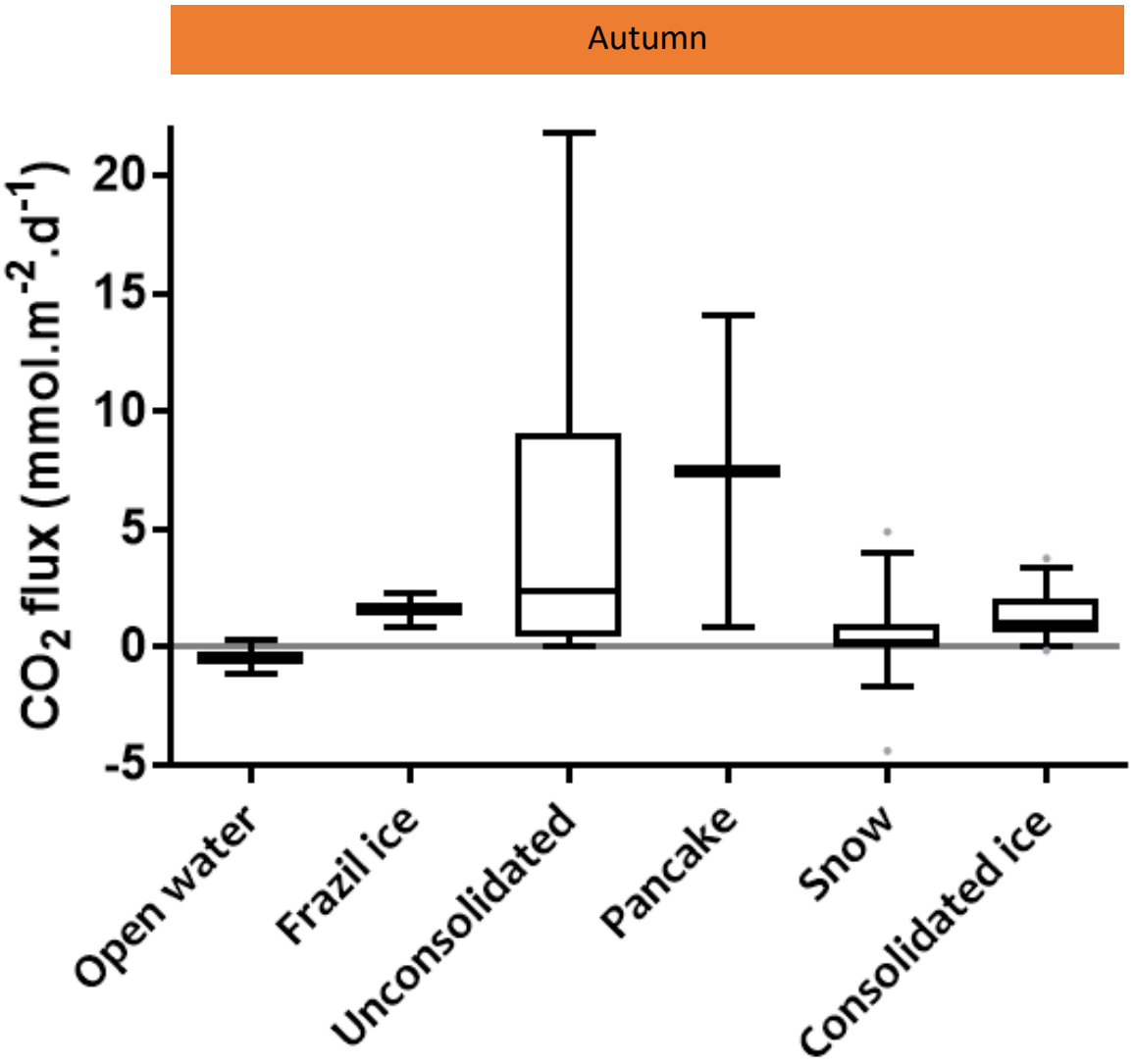






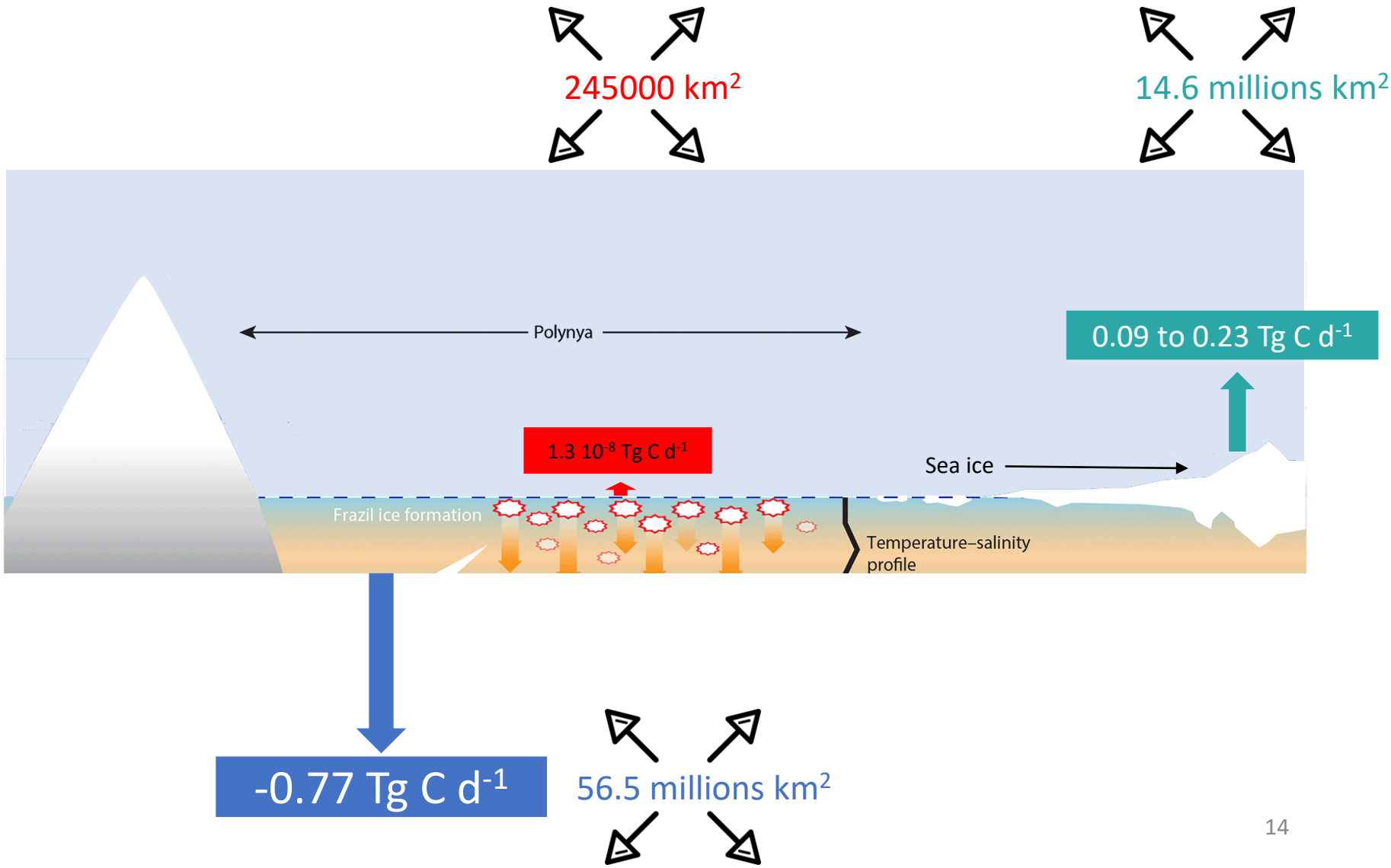
Largest fluxes over young ice





Ice types	Sampling procedure
Unfilered or filtered Frazil ice	Frazil ice collected with polyethyle bag (unfiltered) or filtered with handheld sieve (filtered)
Unconsolidated	Grey ice or proto-pancake grabbed by hand. Less than 10 cm thick
Bucket	Frazil ice
Pancake	Ice coring
Consolidated ice	Ice coring

Autumnal CO_2 fluxes over polynyas vs consolidated ice in the SO



Underway measurement of ice concentration during in TNBP during the PIPERS cruise (%)	0.85	Thompson et al. (2020)
Duration of katabatic wind event (wind speed > 17 m s^{-1}) vs wind relaxation period during the PIPERS cruise (%)	21	Ackley et al. (2020)
Coastal polynya extent (km^2)	245000	Kern et al. (2009)
SO sea ice extent (km^2)	14600000	Parkinson and Cavalieri (2012)
Mean CO_2 fluxes (mmol m^{-2} d^{-1})		
Open water south of 45°S from April to June	-0.82	Landschützer et al. (2019)
Open water in TNBP measured with the floating chamber	-0.49	
Frazil ice	1.57	
Unconsolidated ice	5.42	
Pancake ice	7.45	
Fluxes in TNBP (integrating frazil, unconsolidated ice, pancake ice and open water)	4.55	
Consolidated ice	1.35	
Snow covered consolidated ice	0.51	
Integrated CO_2 fluxes (Tg C d^{-1})		
Fluxes over polynyas	1.3 10^{-8}	
Fluxes over snow covered consolidated ice	0.09	
Fluxes over bare ice	0.23	
Air-sea fluxes April to June south of 46°S	-0.77	Takahashi et al. (2009)

Assumptions:

- during catabatic wind: 100% frazil ice
- Lower wind speed: 50% unconsolidate ice, 50% pancake ice

No consolidated ice

15% open water