Supplementary Material for: Sea ice melt drives vertical pCO_2 variability modulating air-sea gas exchange

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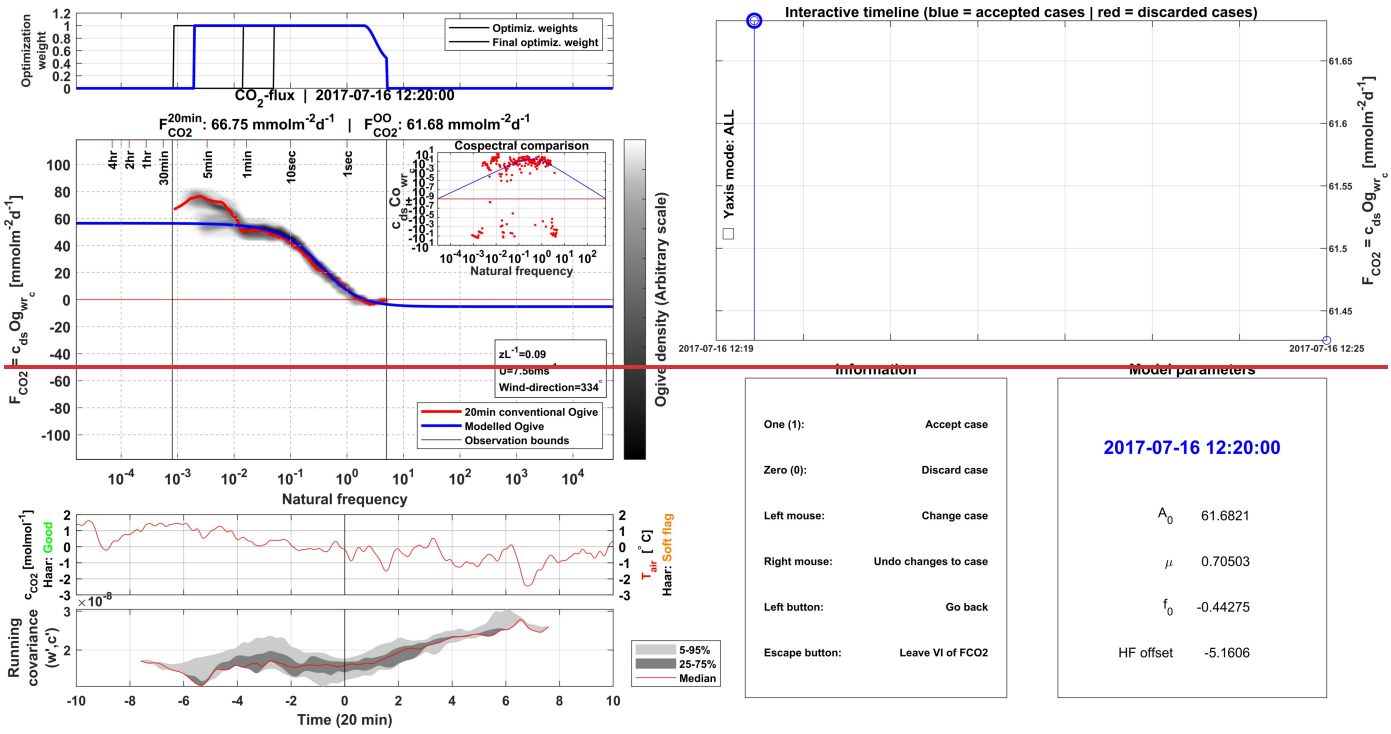

Figure S1. Example of OGIVE Optimization (OGM) analysis output illustrating modelled vs measured Cospectra amounting to a positive CO_2 flux (efflux). Cospectral Visual inspection of the cospectra can be done as part of the OGM method and after Haar analysis, where cospectral comparison is the summation of the molar concentration of dry air (c_{ds}) and the covariance of vertical windspeed and the CO_2 concentration (Co_{wr}).

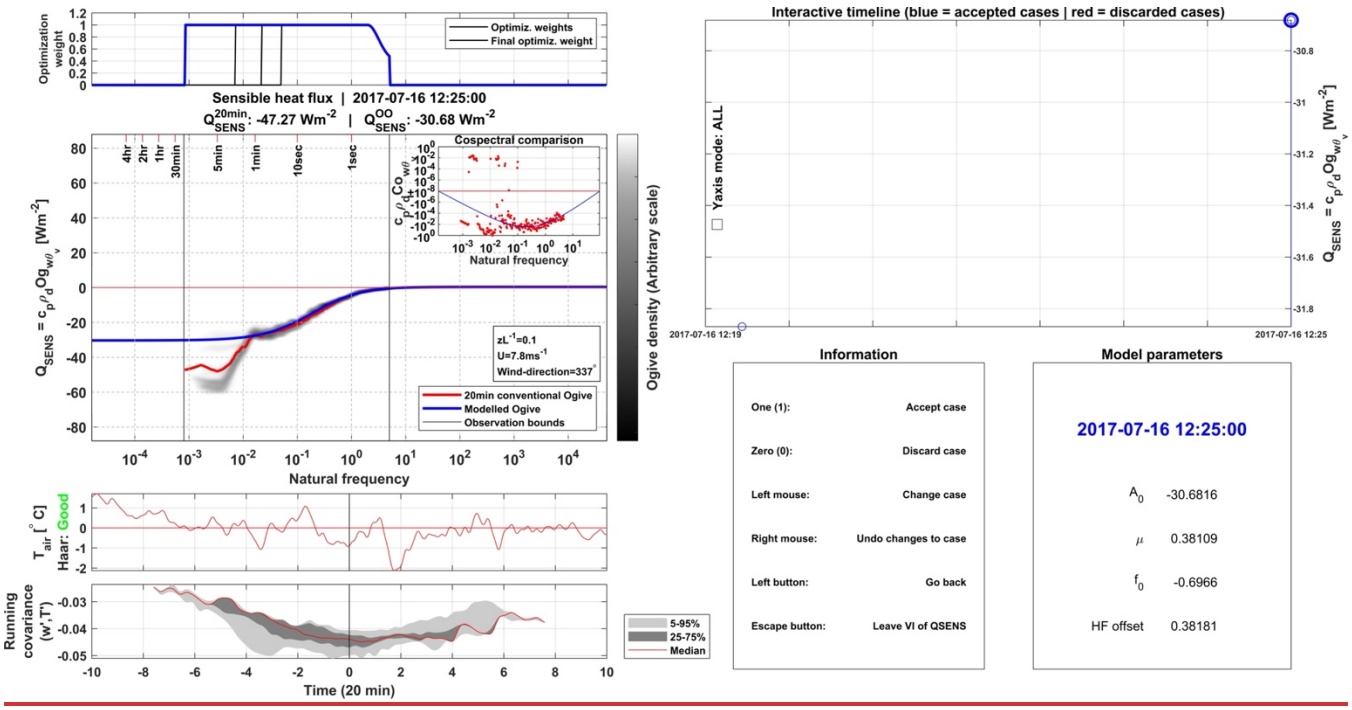

Figure S1. Example of OGIVE Optimization (OGM) analysis output illustrating modelled vs measured ogives and cospectra contributing to the sensible heat flux (Q_{SENS}). Visual inspection of the modelled and observed spectra can be performed as part of the OGM method after Haar analysis, where comparison of the cumulative ogive ($Og_{w\theta}$) and associated cospectra of vertical windspeed and temperature fluctuations is used to assess spectral consistency, stationarity, and flux quality. The sensible heat flux is calculated as $Q_{SENS} = \rho_d C_p \overline{w'\theta'}$, where ρ_d is the dry air density, C_p is the specific heat capacity of air, and $\overline{w'\theta'}$ is the covariance between vertical windspeed and temperature fluctuations. Supporting turbulence diagnostics and optimized model parameters are also shown.

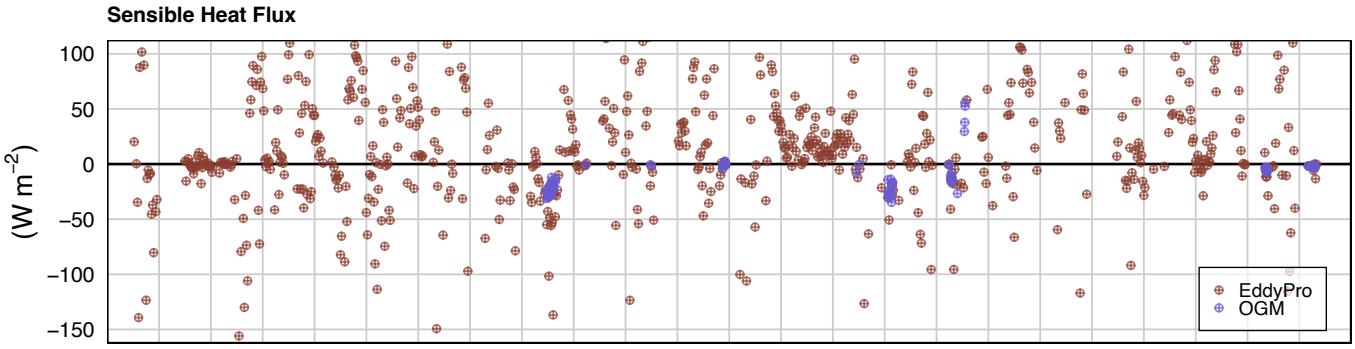

Figure S2. Comparison of two micrometeorological analysis techniques for flux estimation over Young Sound during the transition from sea ice breakup to open water from 16 July 2017 to 1 August 2017. The

standard eddy covariance (EC) method implemented in EddyPro software (Version 7.0.6, LI-COR Inc., 2019), and the ogive optimization method (OGM) described by Sievers et al. (2015).

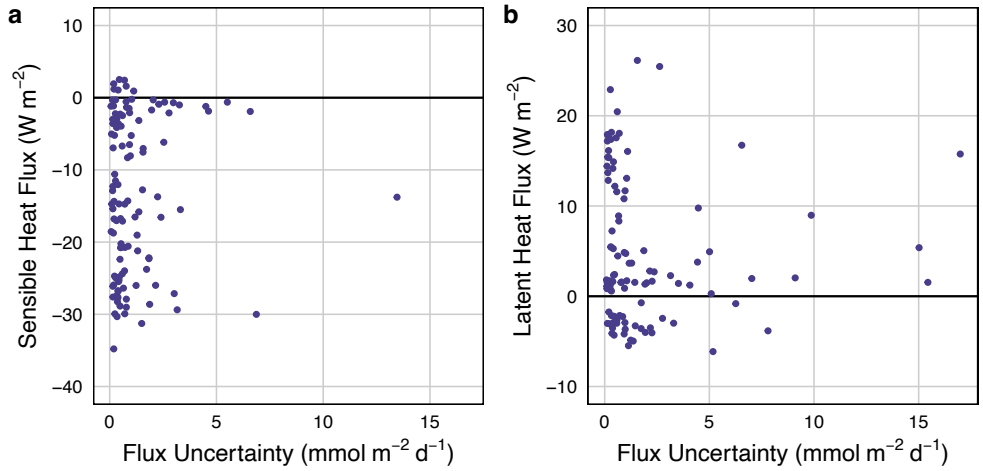

Figure S3. Sensible heat (a) and Latent heat (b) fluxes compared with their calculated uncertainties. Uncertainties were typically low compared with flux magnitudes demonstrating a good signal to noise ratio for those fluxes which were approved by OGM.

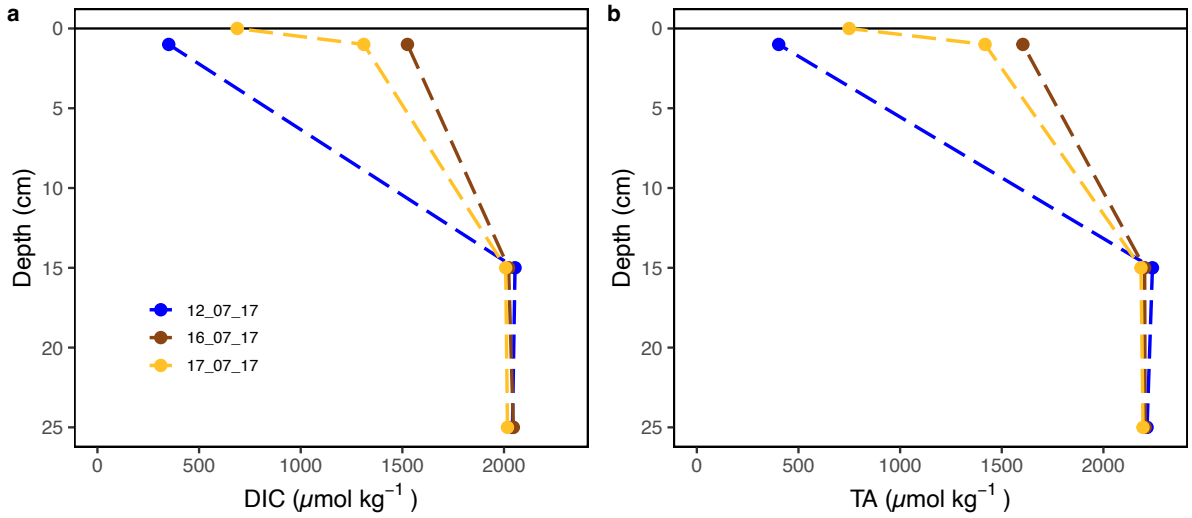

Figure S4. DIC (a) and TA (b) vertical profiles taken during July 2017.

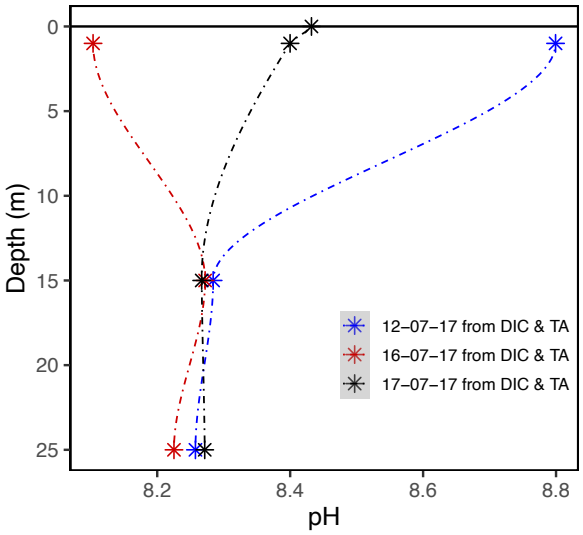

Figure S5. Calculated pH profiles based on measured carbonate chemistry parameters (dissolved inorganic carbon [DIC] and total alkalinity [TA]). The results illustrate that during both ice cover and sea ice breakup, surface water pH fluctuates significantly, influencing the distribution of inorganic carbon species (CO_2, HCO_3^-, CO_3^{2-}) and consequently pCO_2.

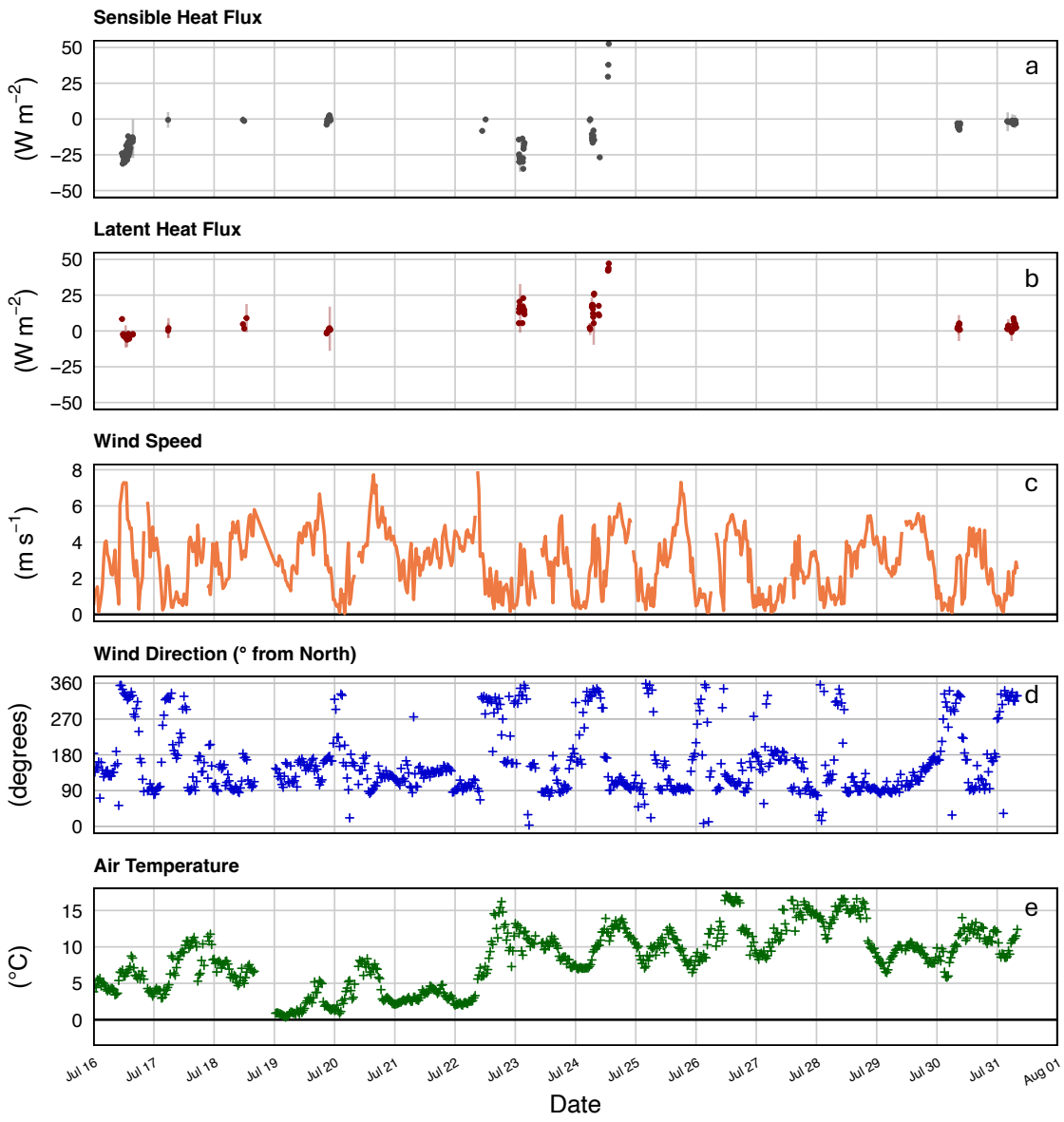

Figure S6. The 5 min averages of measured fluxes and meteorological conditions over Young Sound during July 2017. This time period reflects the transition between sea ice break up (30% ice cover) and open water (no sea ice present) from 16 July 2017 to 1 August 2017. (a) Sensible heat and (b) latent heat fluxes were estimated using the ogive optimization method with estimated uncertainty shown as vertical error bars. (c) Wind speed, (d) wind direction and (e) air temperature are shown for the same period.