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Supplement of

A dataset for investigating socio-ecological changes in Arctic fjords

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Supplementary

S1. Numeric relationships between drivers

The relationship between seawater temperature and sea ice cover was somewhat consistent across all sites (except Young Sound), with an increase of 1° C equating to a mean change (± standard deviation) in annual sea ice cover of -12% ± 0.22% (Fig. S1). This relationship allows us to project this value into the future given different emissions pathways (Section S2). Another robust comparison available within this dataset is seawater temperature and species count, which shows a positive trend for most sites, with Young Sound again providing outliers (Fig. S2). Note again that the calculation of these values is not meant to be taken as an indicator of changes within the fjord, but rather demonstrates that the data in their current state are able to be used for numeric comparisons.

Figure S1: Boxplots showing the values for the slope of linear models that compare an independent and dependent variable within multiple sites, as shown in Table 3. The colour of the dots shows the site, which may have more than one dot as multiple depths were compared between variables.

S2 Future change of drivers/relationships

The projections of the relationships found between drivers into the future were made possible with the use of the NORWegian ECOlogical Model system (NORWECOM; Aksnes et al., 1995; Skogen et al., 1995; Skogen & Søiland, 1998). This model couples physical, chemical, and biological systems in the Arctic (as well as other regions) and contains multiple representative carbon pathway (RCP) projections at multiple depths for five of the seven study sites at ~10 km resolution, with projections beginning to change from historic data from 2015 onwards. The two missing sites are from West Greenland, and while there are data available for Young Sound, none of it overlaps with the data present in this product. Because this model is on a ~10 km grid it generally does not contain data within the fjords, excepting the larger Isfjorden and Storfjorden. Therefore, one must note that the future projections of the driver relationships detailed below are generally for data over the shelf mouth of the fjords, and not for the inner fjord processes.

The Arctic model contains six overlapping variables with the data product detailed here: seawater temperature, salinity, *p*CO_2, nitrate (NO_3), phosphate (PO_4), and silicate (SiO_4). As a first step to see how similar the data between the model and the amalgamated dataset are, the RMSE for monthly data were made between sites at the same depths (Fig. S2). We then looked at the differences in the trends of the data where possible (Table S1).

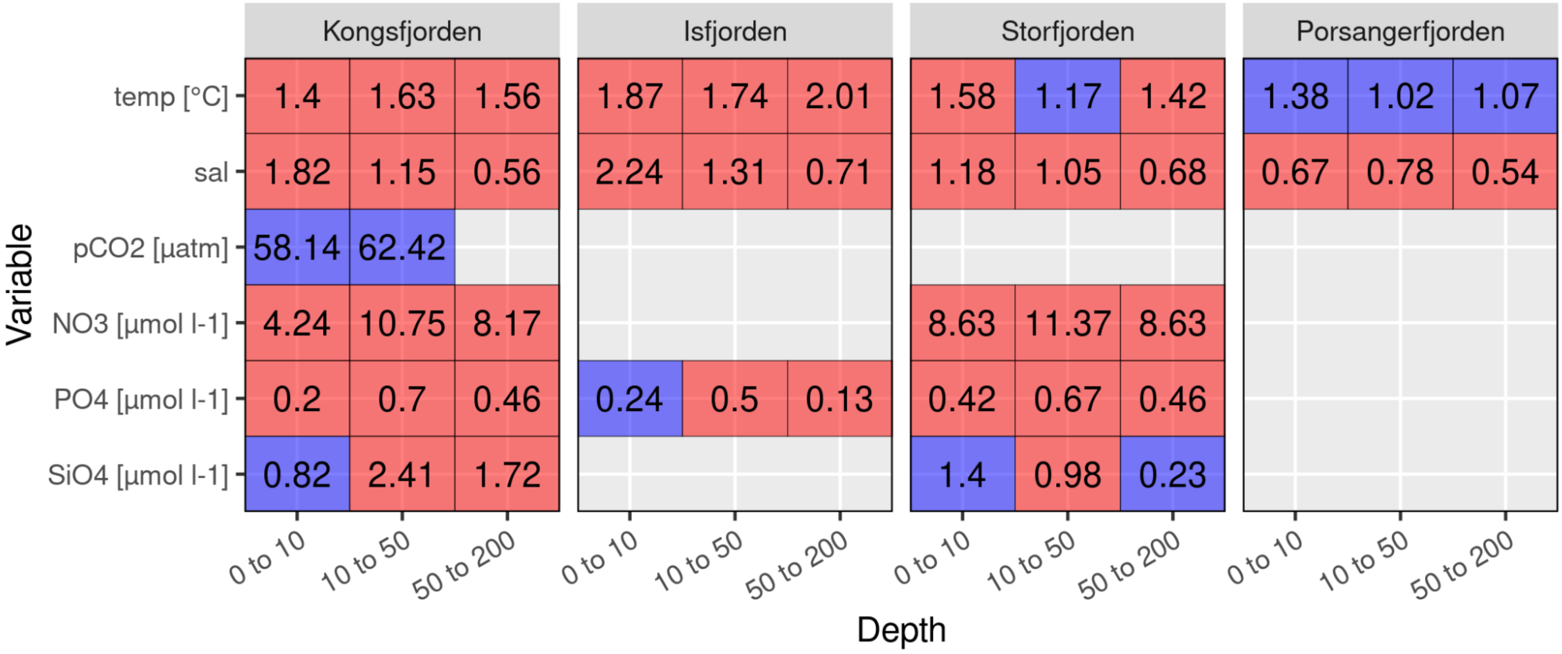

Figure S2: Heatmap showing the difference in mean monthly values between the NORWECOM model and amalgamated data at matching depths. These values were calculated with the RMSE (root mean square of errors) statistic. Red squares show when the model values are greater than the amalgamated data. Note that only RMSE for temperature comparisons to *in situ* sampled data are shown, not the remotely sensed products.

Table S1: The projected changes to seawater temperature (temp [°C]) and salinity (sal) in four sites and 3 depth ranges with overlapping data to the NORWECOM model. Values shown are for decadal trends calculated over 1982-2020 for the *in situ*, OISST, and CCI seawater temperatures. The RCP projection trends are calculated from 2000-2099. NB: the decadal trends for *in situ* sampled temperature and salinity at most sites are clearly incorrect. This issue is caused by unequal sampling in the base data, which then expresses itself as anomalous values when grouped analyses are performed across different types of data (i.e. *in situ* vs remote vs model. One should therefore not take these values as representative of *in situ* changes in the fjords, but rather are indicative of challenges for using these data.

site	**variable**	**depth**	**in situ**	**OISST**	**CCI**	**RCP 2.6**	**RCP 4.5**	**RCP 8.5**
Kongsfjorden	temp [°C]	0 to 10	-0.7	0.15	0.39	-0.02	0.06	0.18
Kongsfjorden	temp [°C]	10 to 50	-0.48	NA	NA	-0.02	0.08	0.21
Kongsfjorden	temp [°C]	50 to 200	-0.27	NA	NA	-0.02	0.08	0.21
Kongsfjorden	sal	0 to 10	0.32	NA	NA	0.01	0.02	0.02
Kongsfjorden	sal	10 to 50	0.02	NA	NA	0.01	0.01	0.02
Kongsfjorden	sal	50 to 200	-0.01	NA	NA	0.01	0.01	0.02
Isfjorden	temp [°C]	0 to 10	0.22	0.22	0.42	-0.01	0.07	0.2
Isfjorden	temp [°C]	10 to 50	0.08	NA	NA	-0.01	0.08	0.22
Isfjorden	temp [°C]	50 to 200	0.16	NA	NA	-0.01	0.07	0.21
Isfjorden	sal	0 to 10	0.77	NA	NA	0.01	0.02	0.02

Isfjorden	sal	10 to 50	0.48	NA	NA	0.01	0.01	0.02
Isfjorden	sal	50 to 200	0.18	NA	NA	0.01	0.01	0.02
Storfjorden	temp [°C]	0 to 10	3.49	0.1	0.29	0.01	0.08	0.2
Storfjorden	temp [°C]	10 to 50	5.96	NA	NA	0	0.07	0.18
Storfjorden	temp [°C]	50 to 200	3.04	NA	NA	0	0.06	0.15
Storfjorden	sal	0 to 10	NA	NA	NA	0.01	0.03	0.04
Storfjorden	sal	10 to 50	NA	NA	NA	0.01	0.02	0.02
Storfjorden	sal	50 to 200	NA	NA	NA	0.01	0.01	0.02
Porsangerfjorden	temp [°C]	0 to 10	0.35	0.32	0.1	0.03	0.1	0.24
Porsangerfjorden	temp [°C]	10 to 50	0.29	NA	NA	-0.01	0.08	0.2
Porsangerfjorden	temp [°C]	50 to 200	0.63	NA	NA	-0.01	0.08	0.19
Porsangerfjorden	sal	0 to 10	-0.07	NA	NA	-0.01	0	0
Porsangerfjorden	sal	10 to 50	-0.01	NA	NA	0	0	0.01
Porsangerfjorden	sal	50 to 200	0.03	NA	NA	0	0	0.01

Even though the model data may be warmer than the *in situ* data for most sites (Fig. S2), the positive decadal trends in the remotely sensed data tend to be steeper than the RCP 8.5 projections. This is because the model data does not capture the cold winter temperatures as well as the remotely sensed data do. Therefore, even though the summer high temperatures in the model data may be increasing apace with the remotely sensed temperature, the model does not capture the same winter time lows, thereby allowing the remotely sensed data to tilt upwards more aggressively due to the more pronounced winter time warming. One may note that there is a pronounced difference between seawater temperature and salinity trends between the model and amalgamated data. This is an artefact created by the coarse aggregation of these values in the amalgamated dataset across time (monthly averages), space (averages for all data points within a fjord), and depth (Table S1). These *in situ* values should therefore not be taken as indicative of any changes in the fjord. They are included here as a note of caution when aggregating these data further for analyses.

Even though we have demonstrated that the projections of the amalgamated data differ, sometimes dramatically, from the modelled data, the differences within the model for the three RCPs (i.e. 2.6, 4.5, and 8.5) are still interesting. In particular it is worth noting that the model projections for RCP 2.6 show that no further sea ice may be lost, and seawater temperature may no longer continue to rise (Fig. S3). In accordance with this, many of the current drivers of change within fjords would otherwise stabilise as these two drivers tend to be at the top of any downard cascade of changes. Were it only the case that human society was able to meet this scenario. Projections suggest that sea ice cover decreases dramatically with the somewhat extreme RCP8.5 scenario (Fig. S2). This is of course not surprising, and is very much consistent with the literature (Möller et al., 2022).

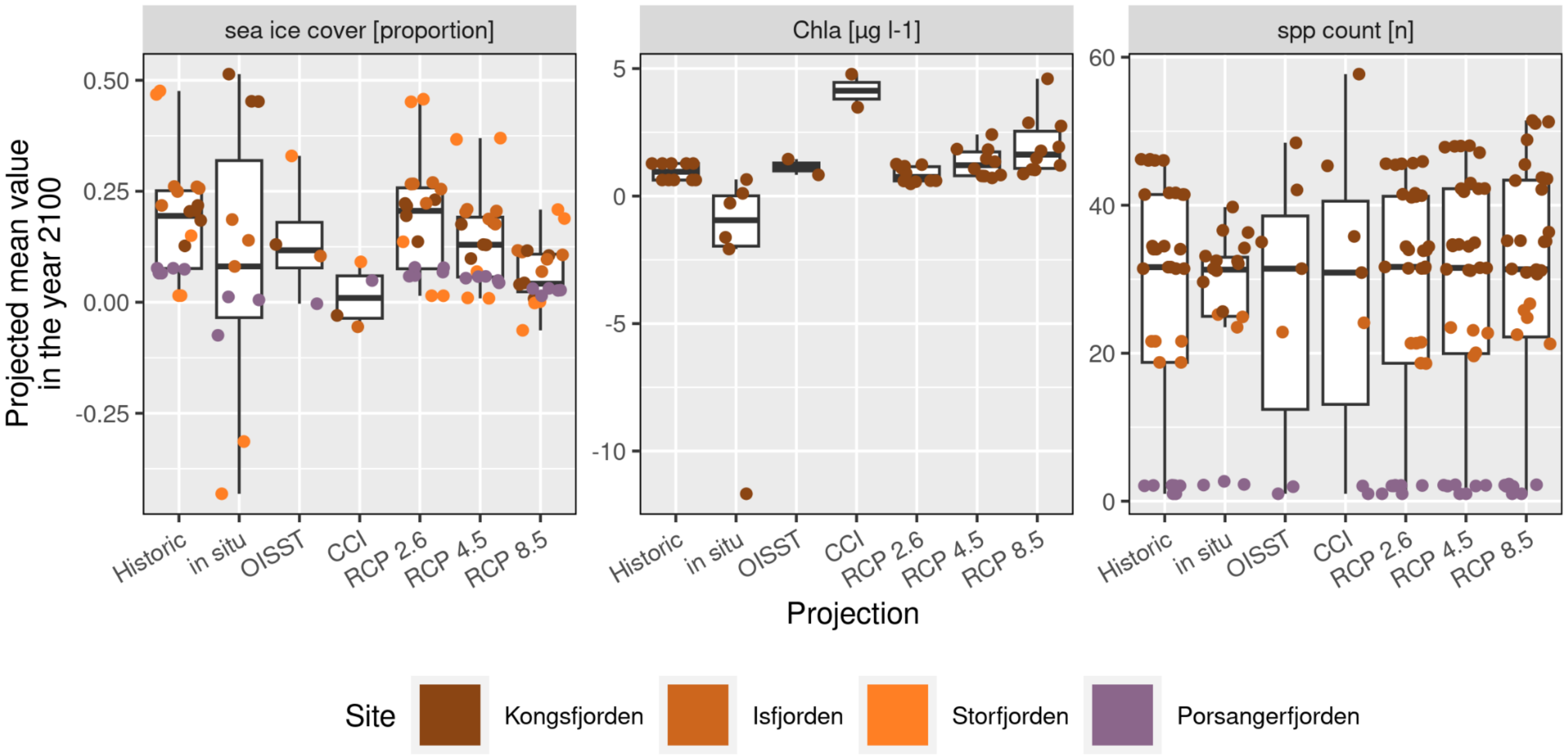

Figure S3: The historic values for sea ice cover, chlorophyll *a*, and species count in the amalgamated dataset across multiple sites and depths are shown in the first boxplot to the left of each panel. These values are then projected to 2100 using their relationships with seawater temperature determined from historic *in situ*, NOAA OISST, or CCI remotely sensed data. This was also calculated for the RCP 2.6, 4.5, and 8.5 projections from the NORWECOM model.