Salinity and temperature variations at James Bay eelgrass beds in relation to an under-ice river plume

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Eelgrass (*Zostera marina)* in James Bay declined in the 1990s and today remains far depleted from its historic extent. Eelgrass is the dominant seagrass in the Northern Hemisphere and is globally recognized as an important habitat for juvenile fish and birds. Eelgrass beds provide a number of ecosystem services such as nutrient recycling, sediment trapping and carbon sequestration (1). There are several possible factors that may contribute to the recent decline but prominent among them is a freshening of coastal waters due to climate change and/or hydroelectric development and regulation. Eelgrass thrives in saline conditions and is intolerant of very low salinities. In the Chisasibi region of northeast James Bay (Figure 1), a possible contributor to reduced salinity at eelgrass beds is the enlarged under-ice freshwater plume of the La Grande River (2). Hydroelectric developments have reportedly more than doubled the average annual discharge of the La Grande River and shifted the peak discharge from spring (June) to the winter months (3). The under-ice freshwater plume of the La Grande deflects northwards as it enters James Bay (4) and then flows towards southeast Hudson Bay (5), consistent with the coastal circulation of Hudson Bay. In association with the Arctic Eider Society and the Cree Nation of Chisasibi, a field campaign was launched to investigate the effect of the modified discharge of the La Grande River in relation to salinity variations at nearby eelgrass beds.

Methods

- Conductivity, temperature and depth (CTD) measurements were collected at various locations extending northwards of the La Grande River.
- There was a particular focus on two bays that historically contained eelgrass beds, Bay of Many Islands and Paul Bay.
- Moorings were deployed in both nearshore and offshore environments to collect current direction and speed, tidal amplitude and temperature and salinity readings.
- Data was collected in both the summer and winter months of 2016 and 2017.

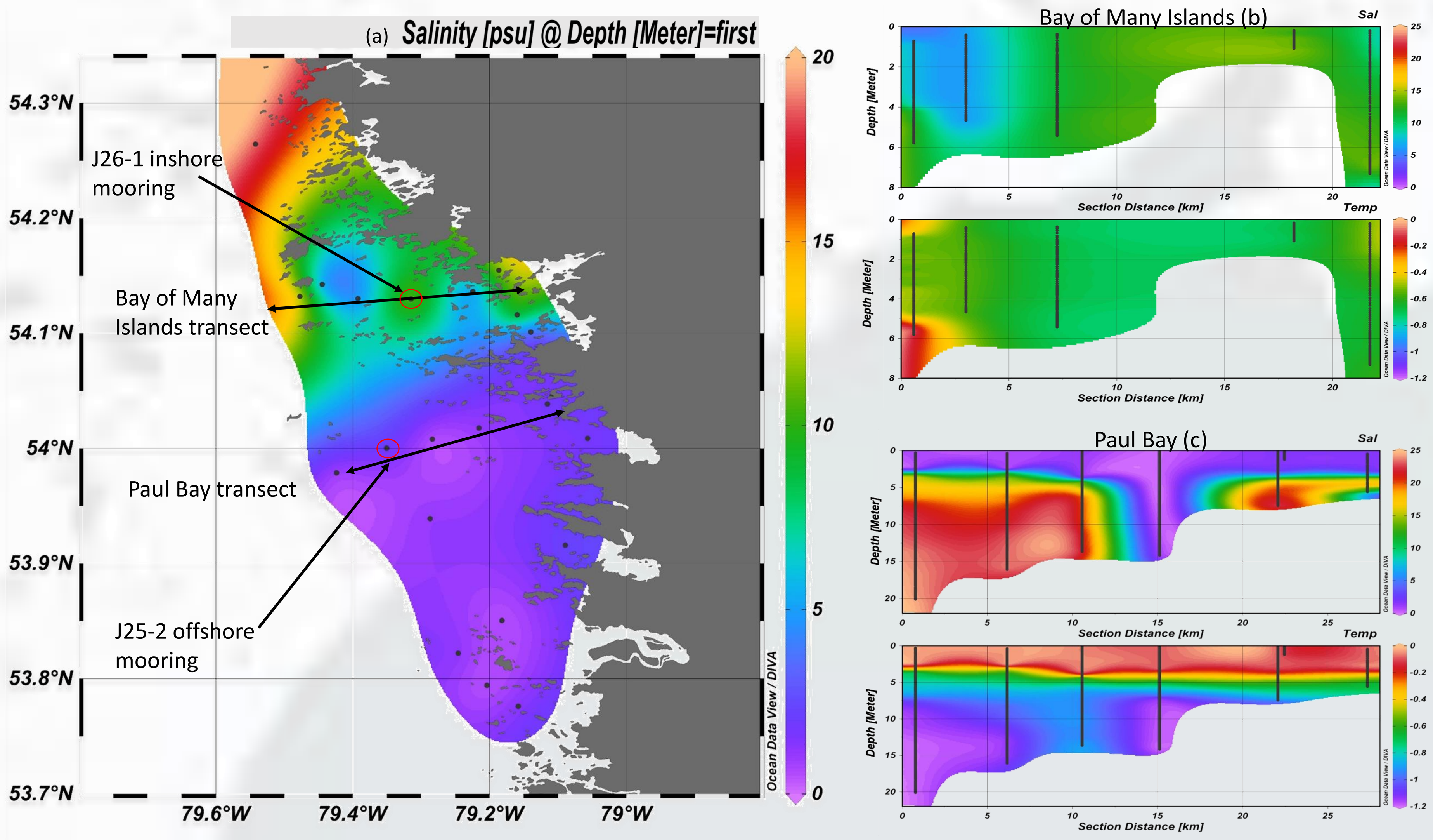

Figure 2: Surface salinities along the northeast coast of James Bay (a) and water column profiles of salinity and temperature along sections into the Bay of Many Islands (b) and Paul Bay (c) collected in January 2017.

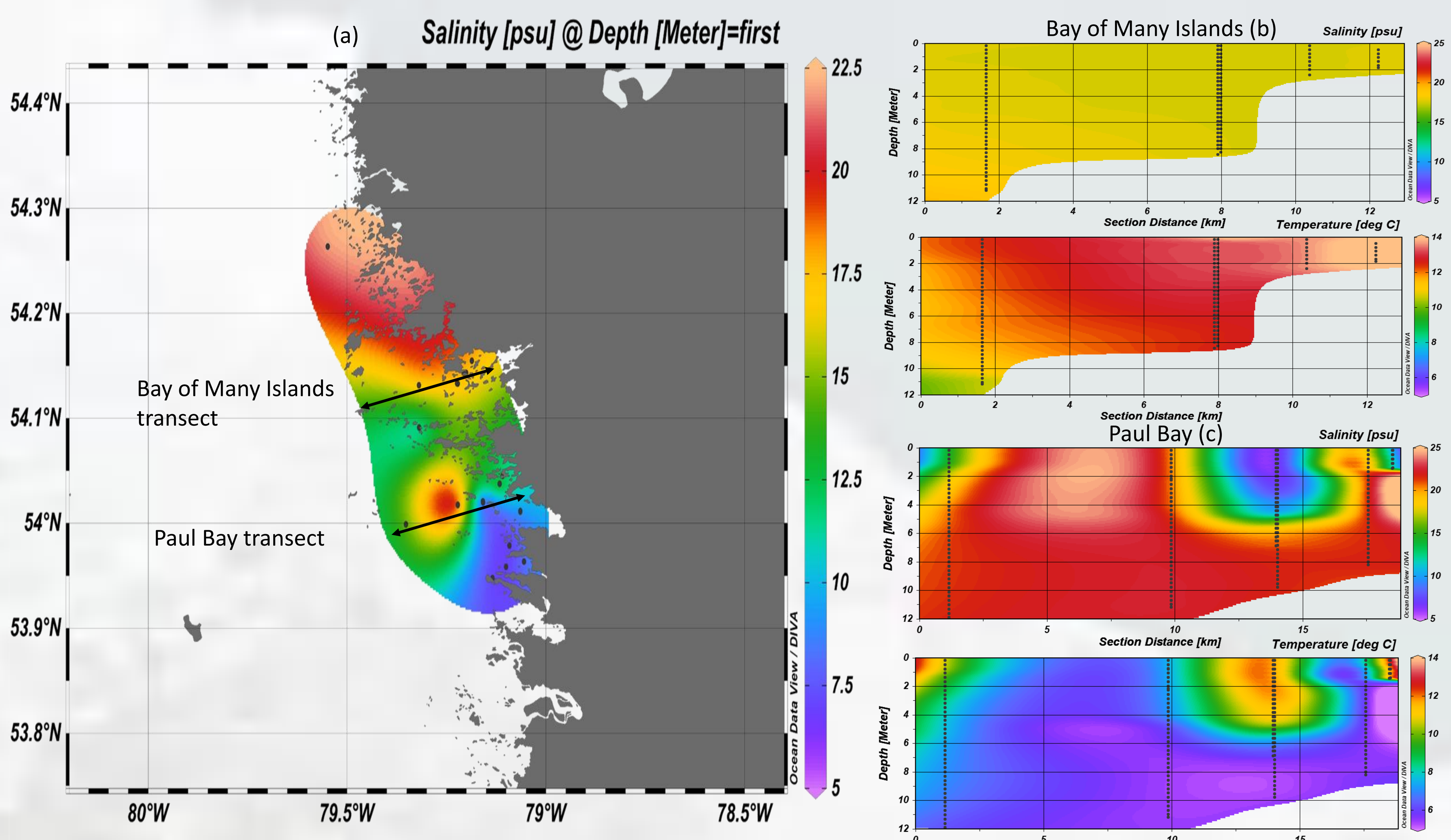

Figure 3: Surface salinities of the North East coast of James Bay (a) and the water column profiles of Paul Bay (b) and the Bay of Many Islands (c), collected in August 2017.

Interpretation

- Preliminary interpretation suggests that whereas very fresh surface waters from the offshore river plume circulate freely into Paul Bay, brackish waters produced by vertical mixing of fresh surface waters and saline deep waters circulate into Bay of Many Islands.
- The water column is more weakly stratified and salinities are higher during the summer in both Bays. Both greater river discharge during the winter and reduced wind mixing under the landfast ice likely contribute to these differences.
- The offshore islands surrounding Bay of Many Islands seem to act like a barrier to the circulation of fresh surface waters to inshore sites hosting eelgrass in this area, but there do seem to be some channels to allow the plume to enter to bay.
- Storm events in the winter were associated with increases in the salinity of the surface layer and decreases in the salinity of the deeper layer in the offshore plume, implying enhanced vertical mixing during those periods. Variations in salinity in this area may thus be caused by both climate and river runoff and their interactions.

Acknowledgements

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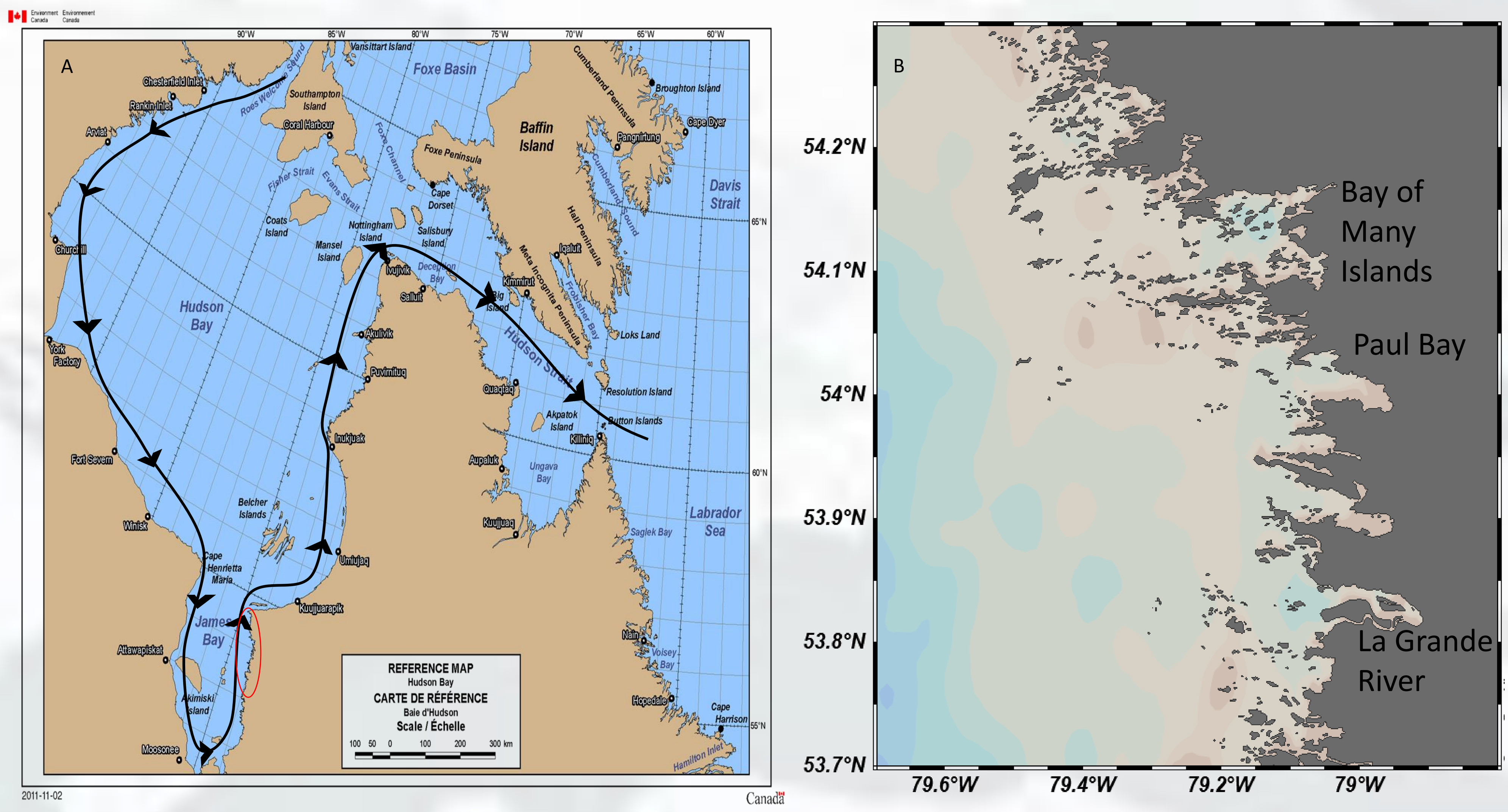

Figure 1: Hudson Bay circulation (a) and the Northeast Coast of James Bay (b), the study area for the field campaign.

Results

- In both winter and summer, the surface salinity is low (0-2psu) around Paul Bay and the Mouth of the La Grande River (Fig. 2 and 3). In the Bay of Many Islands, the salinity is generally higher (10psu).
- Offshore from Paul Bay, the winter water column is generally strongly stratified; a relatively thick (5m), low salinity (0psu) surface layer overlies salty water (25psu) (Fig. 2c). In the Bay of Many Islands, the winter water column is well mixed throughout. The salinity is higher than that found immediately outside the Bay where stratification is present and surface salinity is about 5psu (Fig. 2b).
- During the summer, both Bays show a higher salinity than during winter and Paul Bay shows weaker stratification than during the winter. In general, during the summer, the water column is more weakly stratified and surface salinities are higher throughout the river plume (compare Fig. 2 and Fig. 3).
- Time series measurements collected at two sites along these sections (see Fig. 2) in winter 2017 show that the inshore location (Fig. 4a) shows more short-term variation in temperature and salinity than the offshore location (Fig. 4b) and higher salinities at all depths. The water column was typically stratified offshore but a period of higher surface salinity after a period of low pressure implies a period of enhanced vertical mixing.

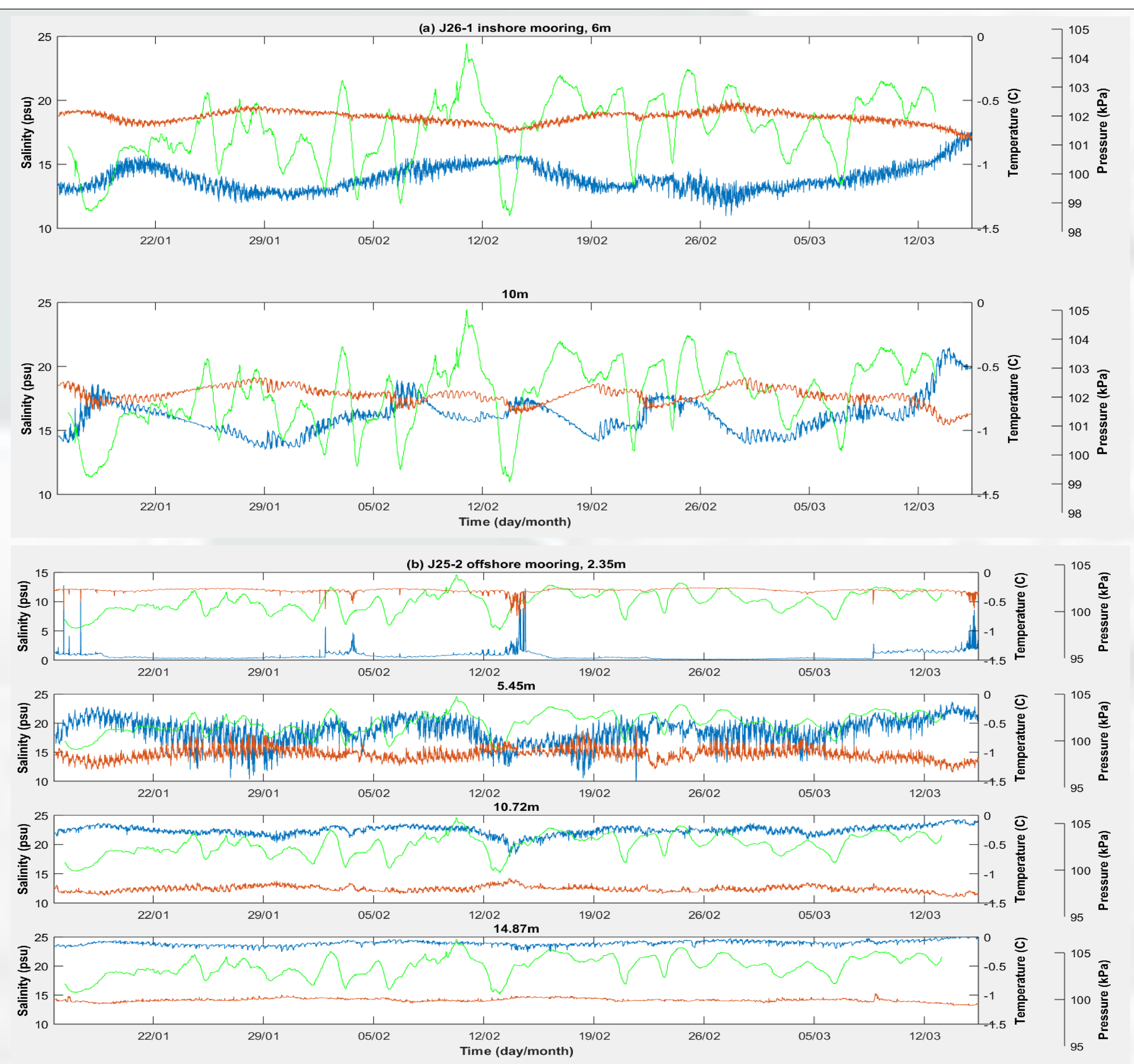

Figure 4: Salinity (blue), temperature (orange) and atmospheric pressure data (green) collected from inshore (a) and offshore moorings (b). The location of the moorings are shown in Fig 2.

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