SEASONAL CIRCULATION AND VOLUME TRANSPORT IN THE GERLACHE STRAIT

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INTRODUCTION

The Gerlache Strait is a narrow strait limited by Anvers and Brabant Islands on the west and by the western Antarctic Peninsula (wAP) on the east (*Fig. 1*). It is a **key location** for the water mass **exchanges** that occur along the wAP between the comparatively warm Bellingshausen Sea (Transitional Bellinghausen Water, TBW) transported by the Gerlache strait Current (GSC) flowing northeastward, and the colder Weddell Sea (Transitional Weddell Water, TWW) by the Antarctic Coastal Current (CC) flowing southwestward (Rodriguez et al., 2001; Parra et al., 2020).

In this context, achieving a **better understanding** of the seasonal and interannual water mass exchanges along the strait is **crucial** for **biological and glacier retreat** research. To this regards, Wang et al. (2022) observed significant interannual **variability** in **winter** dynamics between 2008 and 2009 in their model simulations. Their findings indicated a pronounced southward intrusion of TWW into the Gerlache Strait driven by the CC in 2009 compared to 2008.

Our **aim** is to outline the **seasonal** ocean **dynamics** in 2008 and 2009, focusing on **confirming** a southward **intrusion** of the CC in the Gerlache Strait, as observed in direct velocity measurements.

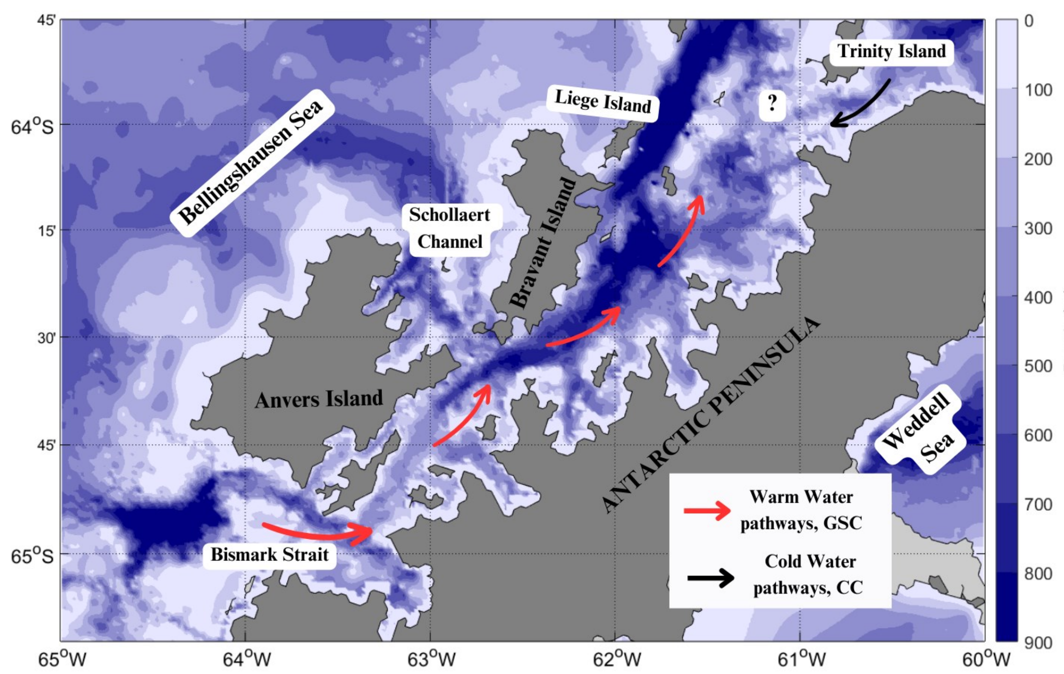

Fig 1. Bathymetric map of the Gerlache Strait with the main cold and warm pathways driven by GSC and CC. GSC and CC state for Gerlache Strait Current and Antarctic Coastal Current, respectively. This scheme is based on the findings by Sangrà et al., 2011, Kerr et al., 2018, Lencina-Avila et al., 2018, Parra et al., 2020, Su et al., 2022.

DATA AND METHODS

R/V Nathaniel B. Palmer
R/V Laurence M. Gould

SADCP

379 cruises

1999 - 2016

Direct velocity measurements

We use the above datasets to construct a 18-year seasonal climatology but focus on this work on the seasonally-averaged velocity fields of 2008 and 2009 to explore further interannual variations.

RESULTS AND DISCUSSION

There is a visible seasonal variability in the GSC in 2008 and 2009, which is consistent with Su et al. (2022) climatology. In **summer** 2008 (*Fig. 2a*), the surface signal of the GSC ceased halfway through Bravant (64º20'S) where it encountered an opposing flow that we attribute to the CC. The signal of the CC is coherently shown departing from Bransfield Strait. Differently, the GSC displays a stronger surface signal in summer from Bravant I. to Liege I. (*Fig. 3a*), reaching as far north as 63º 40'S, well into the entrance to Bransfield Strait. Upstream this point, the CC becomes visible. During **autumn** 2008 (*Fig. 2b*), the GSC was particularly stronger in the Schollaert Channel as compared to 2009 (*Fig 3b*). In both cases, the CC did display a clear pathway. In **winter** 2008 and 2009 (*Fig. 2c* and *3c*), the season subject of comparison with modelling results reported in Wang et al. (2022), the CC appears flowing into the Gerlache Strait in 2009 as far south as the Schollaert Channel. South of this location, the GSC is shown weaker and less evident as compared to winter 2008, where the GSC is stronger and exhibited a clear northeastward pathway up to of Bravant I. This is in agreement with major flooding of Weddell Waters in the Gerlache Strait during winter 2009, as modelled in Wang et al (2022). During **spring** 2008 and 2009 (*Fig. 2d* and *3d*), we observe the pattern follows logically from what it was observed in the previous winter. The GSC is stronger and better defined as a coastal jet in 2008, with a weaker intrusion of CC into the strait. The opposite occurs in spring 2009, where the GSC becomes weaker and less prominent due to the stronger flooding of the CC. However, we note the strength of the CC is less during this season. Lastly, it is worthwhile noting an intense northeastward flow between Trinity Island and the wAP in spring 2009, contrary to literature suggesting a flow in the opposite direction. Without data from other stations and years, we cannot affirm anything with this map. A more in-depth study would be needed to discern whether this was a singular anomaly or a recurring pattern.

When we refer here to relatively strong flows, we normally mean values exceeding 10 cm/s, as the climatological estimates by Su et al. (2022) did not surpass this value at any season.

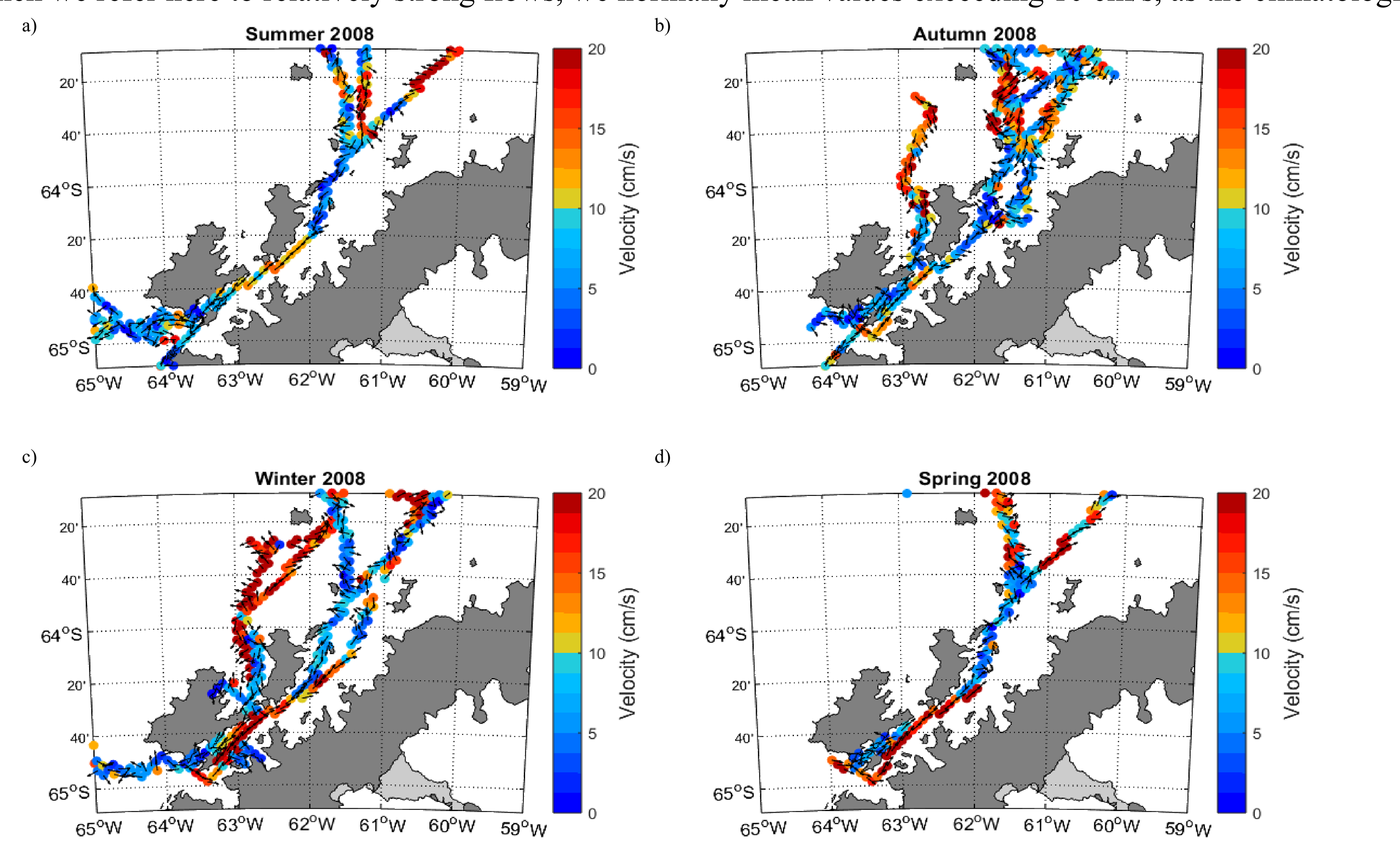

Fig 2. Seasonally-averaged surface velocity field (unitary vectors) in 2008 for: a) summer, b) autumn, c) winter and d) spring. The velocities are averaged from 49m to 59m of depth. Shades of colors indicate the magnitude in cm/s. Seasons are defined as follows (Veny et al., 2022): summer (January, February and March), autumn (April, May and June), winter (July, August and September) and spring (October, November and December).

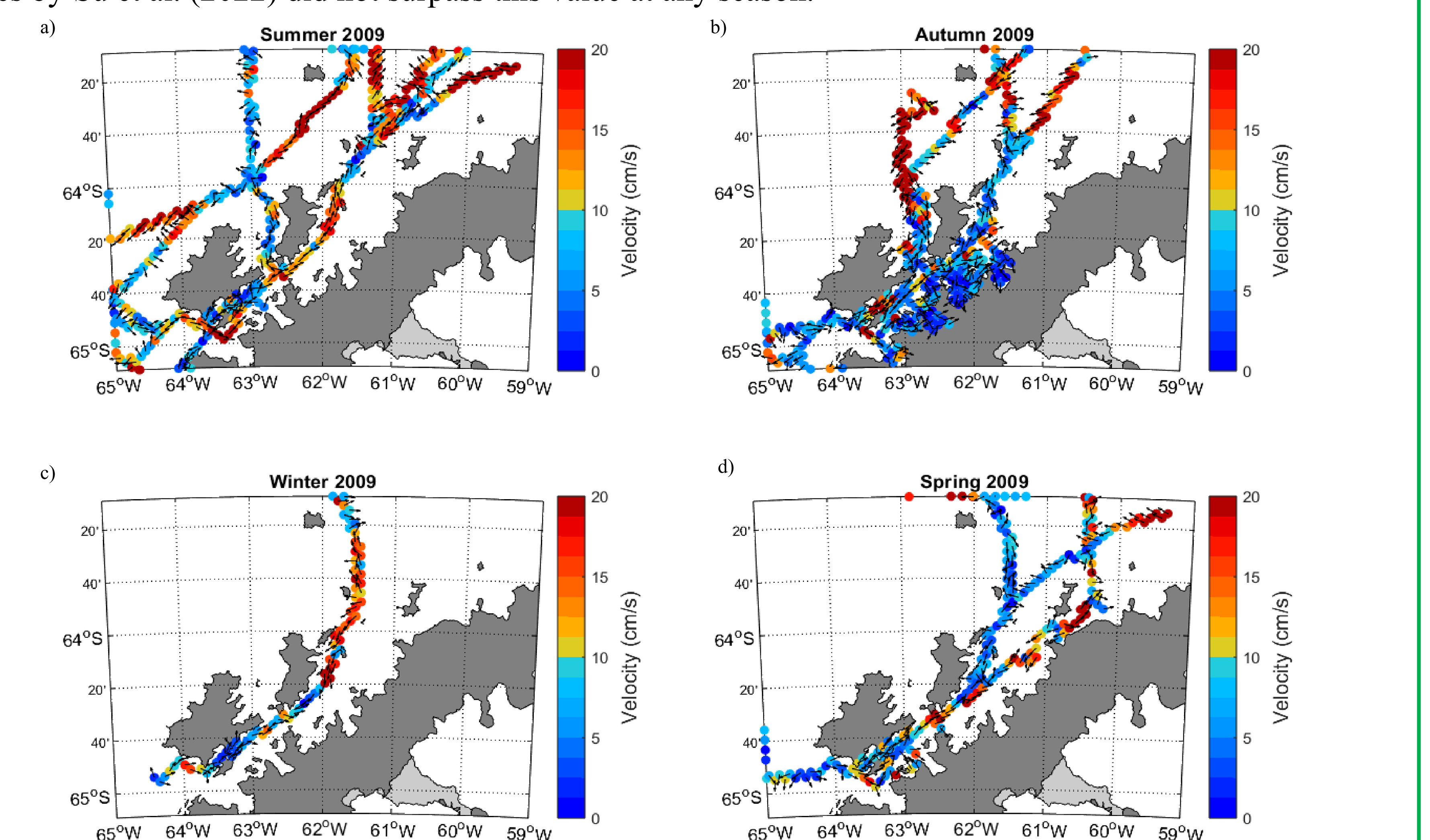

Fig 3. Seasonally-averaged surface velocity field (unitary vectors) in 2009 for: a) summer, b) autumn, c) winter and d) spring. The velocities are averaged from 49m to 59m of depth. Shades of colors indicate the magnitude in cm/s. Seasons are defined as follows (Veny et al., 2022): summer (January, February and March), autumn (April, May and June), winter (July, August and September) and spring (October, November and December).

CONCLUSIONS

- Our findings, derived from direct velocity measurements, validate the significant interannual variability observed in winter dynamics between 2008 and 2009 along the Gerlache Strait. This supports the previous modeling simulations conducted by Wang et al. (2022), which identified a greater southward intrusion of the CC in 2009.
- The seasonal patterns of the GSC observed in the dynamics of 2008 and 2009 are consistent with the patterns depicted in the velocity climatologies by Su et al. (2022). In our study, the presented climatologies encompass a wider range of flows within the strait and within the bays' interiors.
- Future work will focus on providing a thorough characterization of the seasonal and interannual variations of the GSC and CC. This will involve computing the associated volume transport and considering both along-strait and cross-strait transects to ensure a comprehensive understanding of the entire dynamics.

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