

Influence of polynyas on deep water formation

GEOF338 : Polar Oceanography

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Formation of 2 types of polynyas

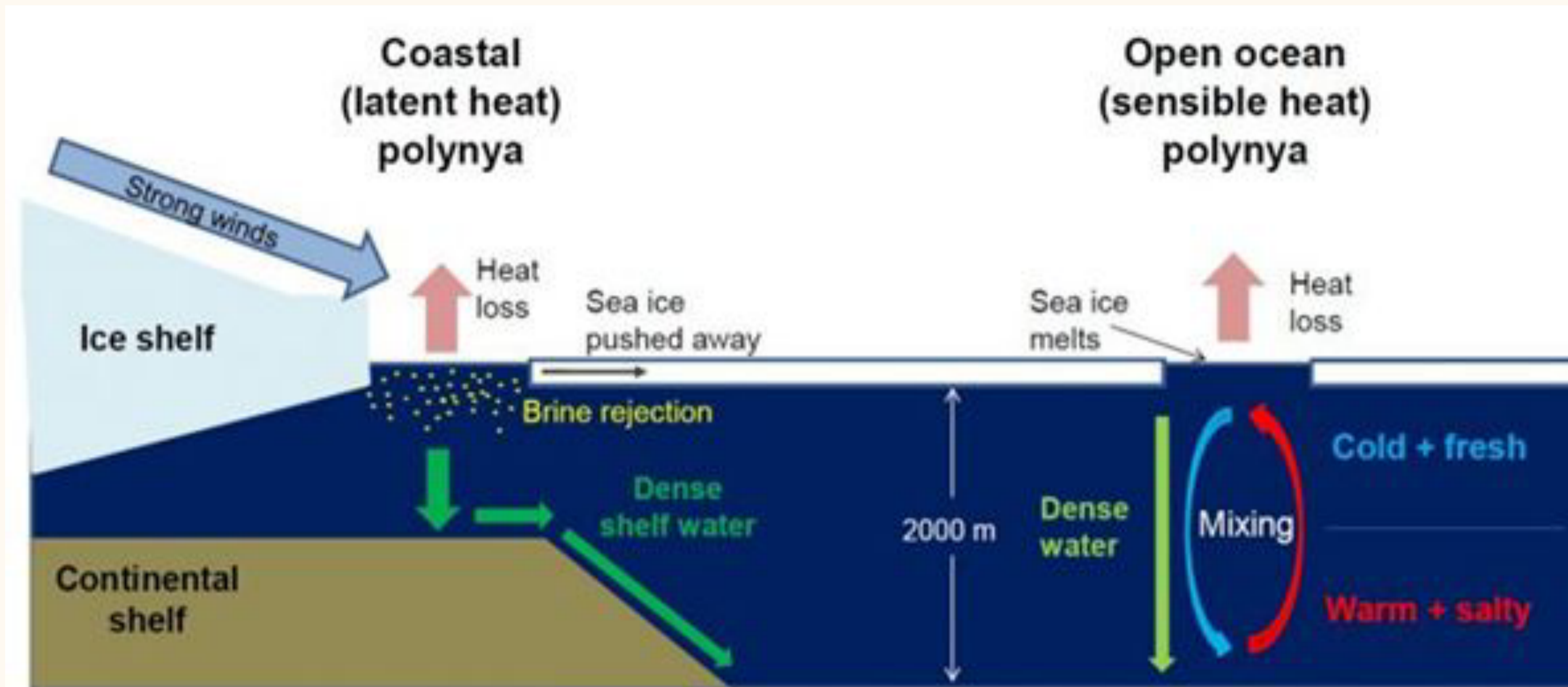


Figure : A schematic representation of what causes polynyas to open [Credit: Céline Heuzé]

Sensible heat (open water) polynyas

- **Thermally driven** polynyas : They are formed because of **convection cells**. The warm water rises to the surface, then cools because of heat transfer between the ocean and the atmosphere and then sinks to be replaced by more rising warm water. There is a **balance between ice melt and ice advection**.
- Localisation : They are formed in **regions of upwelling, vigorous vertical mixing** or in **regions where there is a strong interaction between ocean currents and topographic features**
- **Deep convection area**
- Exemple : Weddell Sea polynya in Antarctica

Latent heat (coastal) polynyas

- Thin ice or open water areas formed by winds and/or oceanic currents driving away the ice
- Ice factories + dense water formation areas thanks to brine rejection

Antarctic Bottom Water (AABW)

- In Antarctica: mostly coastal polynyas (latent heat) with a high production rate of sea ice
- AABW is the densest water mass in the world's abyssal layer
- sea ice formation is essential for AABW
- AABW originates as Shelf Water (DSW)
- Weddel & Ross sea + Adélie coast: the three main are for the formation of AABW

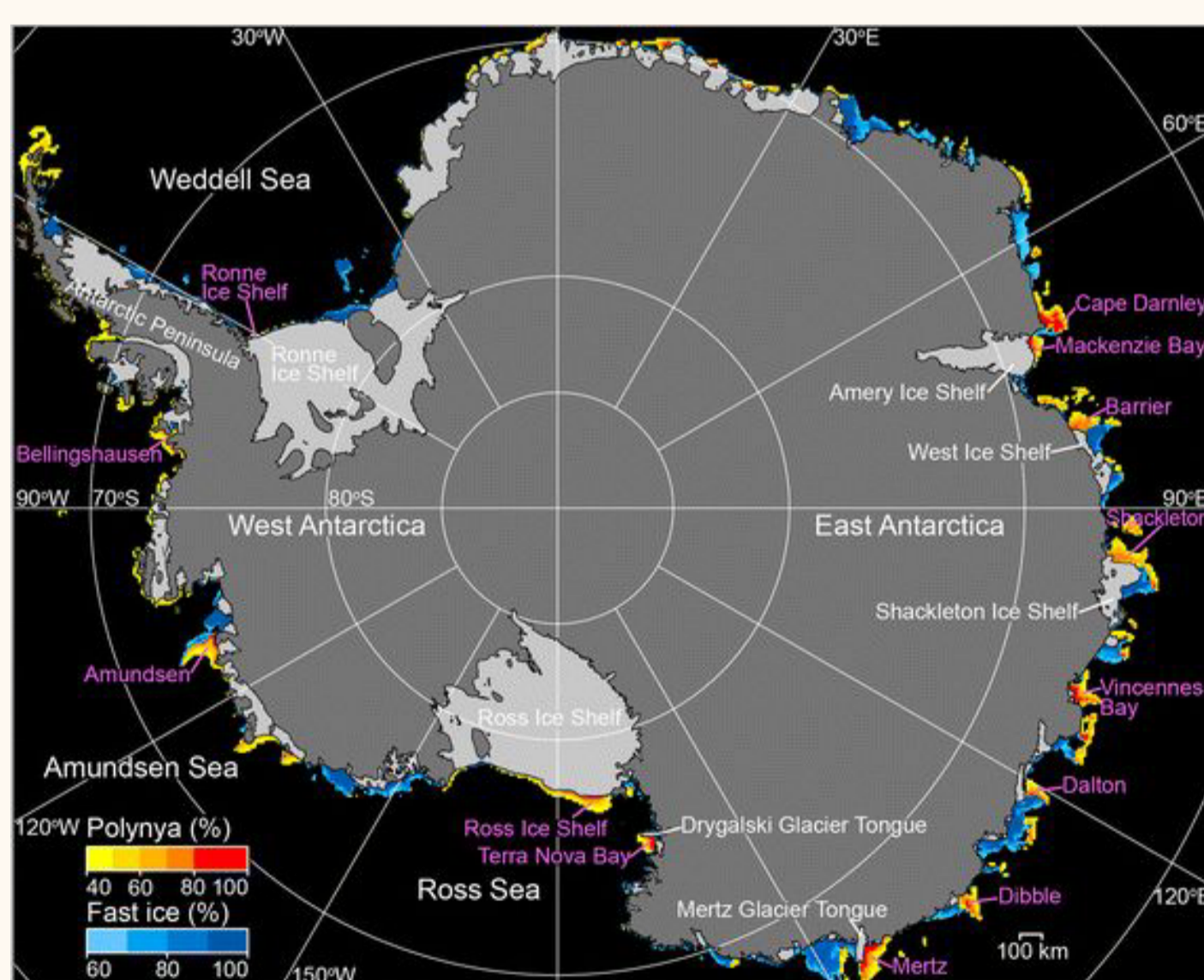


Figure: Map of coastal polynyas and landfast sea ice in the Southern Hemisphere, [2].

North Atlantic Deep Water/ Arctic

- Sensible heat polynya of Whaler's bay (North of Svalbard) : where the warm inflowing Atlantic Water goes into the Arctic
- Latent heat polynya of Storfjorden (Svalbard) supplies between 5 and 20% of the formation of dense water that enters the Arctic Ocean
- Ice growth and super-cooling in coastal polynyas << sensible heat polynyas in Arctic

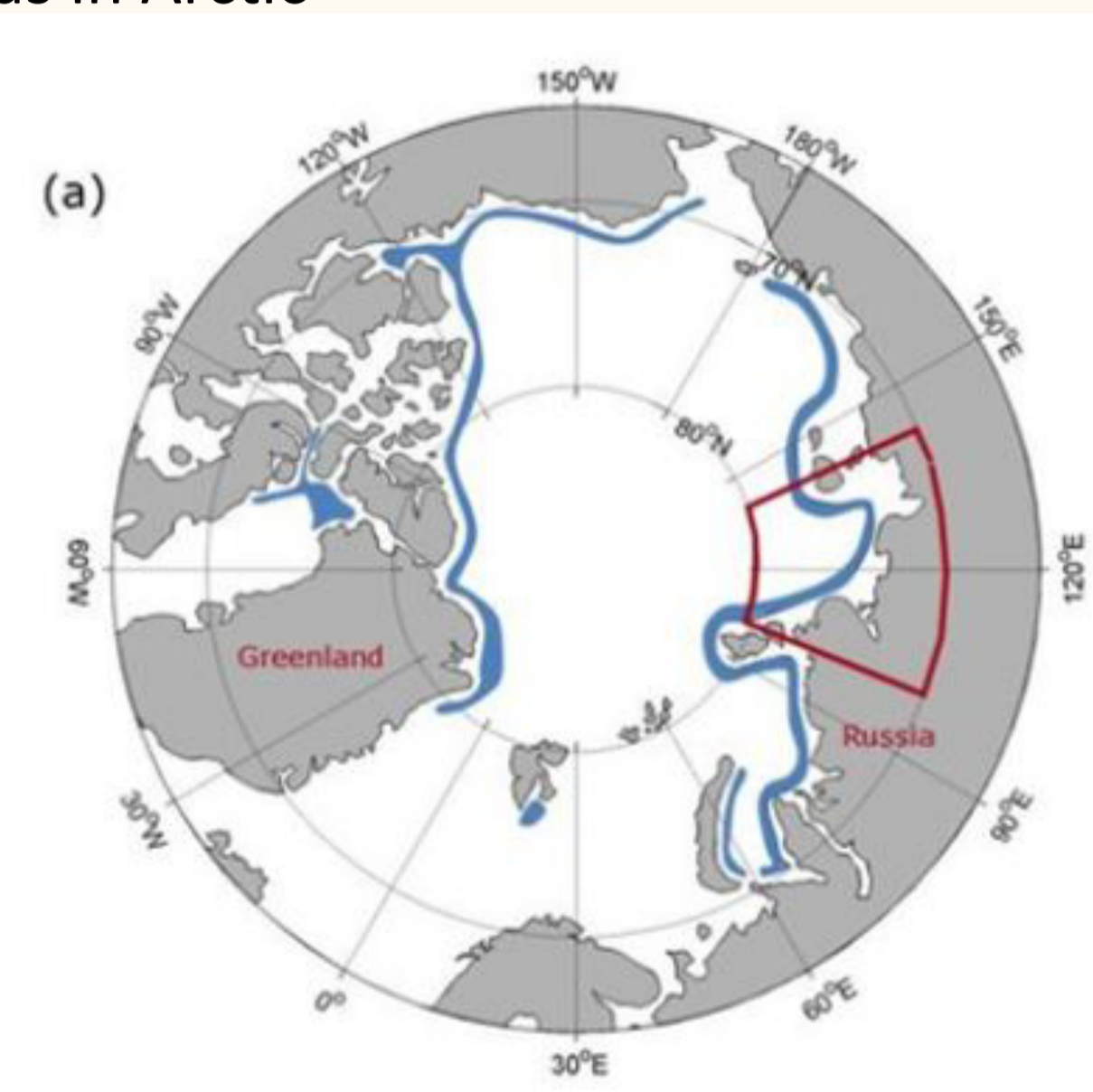


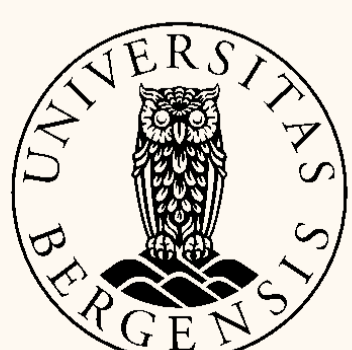
Figure: Map of the Arctic polynyas, [3]

Conclusion:

- Polynyas = ice free area that allow deep water formation
- The densest water masses are formed within the open-ocean polynyas rather than on the continental shelves

References:

- [1] Hyein Jeong et al.; Southern Ocean polynyas and dense water formation in a high-resolution, coupled Earth system model (2023)
- [2] Ohshima, K.I., Nihashi, S. & Iwamoto, K. Global view of sea-ice production in polynyas and its linkage to dense/bottom water formation. *Geosci. Lett.* **3**, 13 (2016).
- [3] Adams, Susanne. (2012). Monitoring of thin sea ice within polynyas using MODIS data.
- [4] Sea ice book from David N. Thomas



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