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A Simple Shelf Circulation Model - Intrusion of Atlantic Water on the West Spitsbergen Shelf

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Barotropic flow along depth contours is found, in accordance with standard geostrophic theory. A numerical model is developed that studies the deviation from such a flow. The model gives a good approximation of the dynamical processes on the West Spitsbergen Shelf (WSS) and shows that the West Spitsbergen Current (WSC), the main gateway of Atlantic Water (AW) towards the Arctic, connects more easily to the Isfjorden Trough than anywhere else along the shelf. The circulation of AW in the troughs along the WSS is here named the Spitsbergen Trough Current (STC). From hydrographical and ocean current observations it is evident that the STC is primarily barotropic and driven by the Sea Surface Height. A connection between the along-coast wind stress and the STC is established, and it is demonstrated how the increased occurrence of winter cyclones in Fram Strait during January-February accelerates and widens the WSC. Ultimately, this results in a strengthened STC and dominance of AW on the WSS. The STC represent a slower route of AW towards the Arctic Ocean and a large heat transport towards the West Spitsbergen fjords during winter (0.2-0.4 TW towards Isfjorden). Heat flux estimates show that half of the AW heat loss in the Isfjorden Trough is due to heat loss to the surrounding water masses, while the rest is lost to the atmosphere. Sea ice production along West Spitsbergen has been reduced, or even non-existent in some fjords since 2006. Here, we argue that this is a consequence of the strong southerly wind periods along the WSS during winter.