Hydrographical measurements from the Storfjorden polynya in the Svalbard Archipelago from March 2008 document water close to freezing and an abrupt salinity front. The dense saline water was created by salt release in a classic polynya freezing event lasting for several days up to the field campaign. Standard current measurements and data from two microstructure clusters document tidal currents in excess of 1 m/s displacing the saline front ~12 km beneath the fast ice. The flow had strong vertical shear caused by residual tidal baroclinic currents, with supercooled water and frazil ice correlated with maximum tidal speed. The high supercooling was caused by "drops" in conductivity, but was amplified by ice nucleating on the different surfaces of our instrument electrodes. The corrected salinity, based on a microstructure instrument that never exhibited a conductivity drop, indicate in-situ supercooling of ~0.002°C, close to the accuracy of the instrument and the freezing point equation. The only plausible mechanism driving the supercooling is double diffusion. If turbulent diffusivities were the same for all scalars no supercooling would occur. Our results therefore directly challenges strict application of Reynolds analogy for scalar and momentum transfer in high Reynolds number flows, because the thermal eddy diffusivity exceeded haline eddy diffusivity. We have thus documented a novel supercooling mechanism that does not require surface heat and salt exchange, or large changes in pressure.