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# Thermobaric convection: principles and some regions of interest

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## Effect of pressure on density

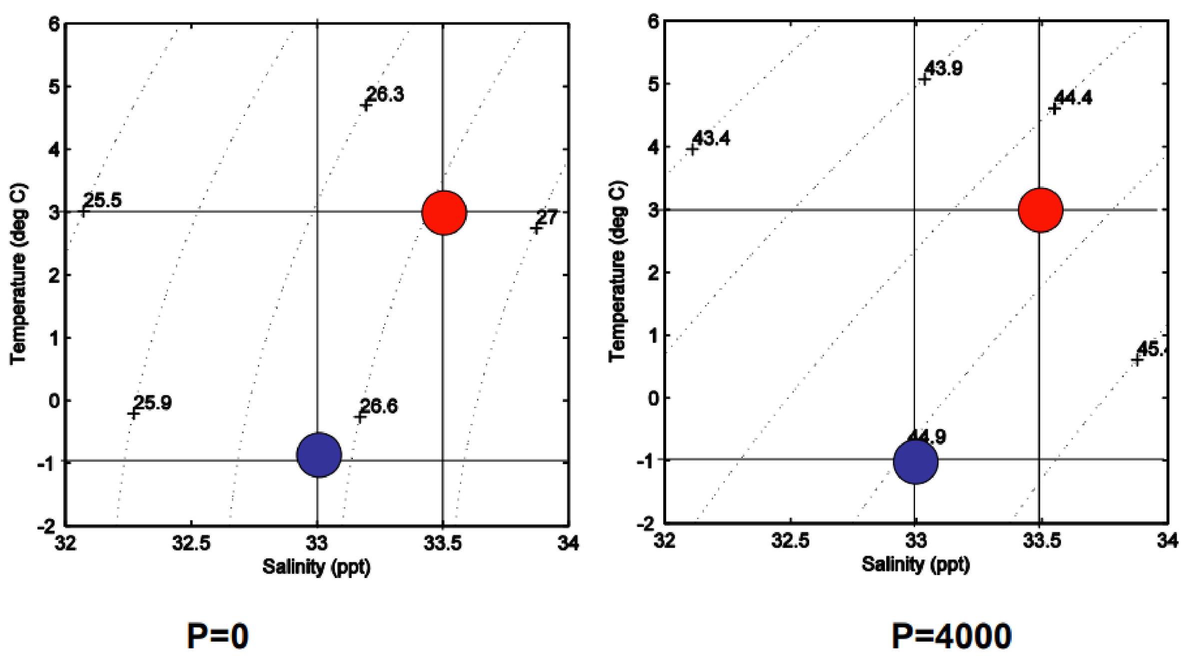
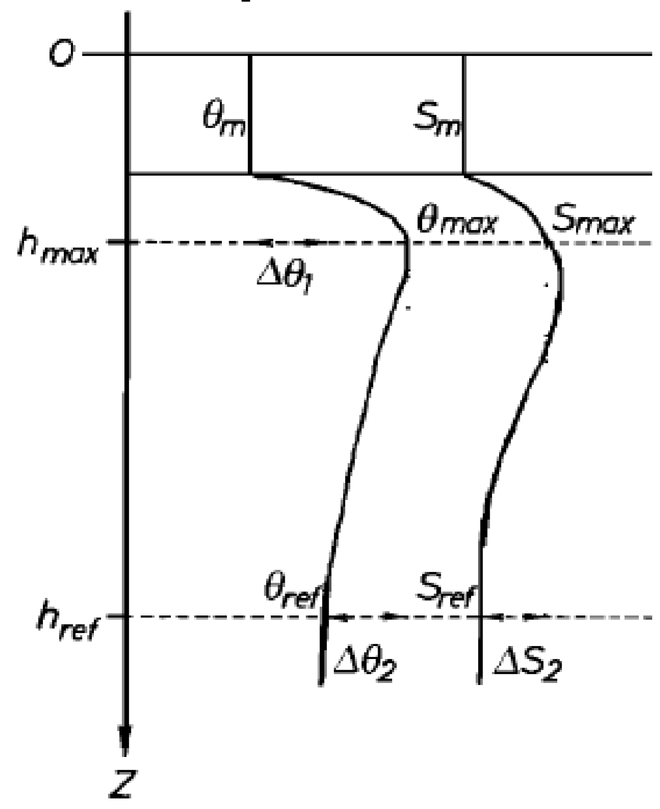



**Figure** Thermobaric effect in TS-space. Taken from Smedsrund, L.H., 2024.

Fresh and cold water gets denser under pressure than warm and saline water.

## Consequences for water column stability



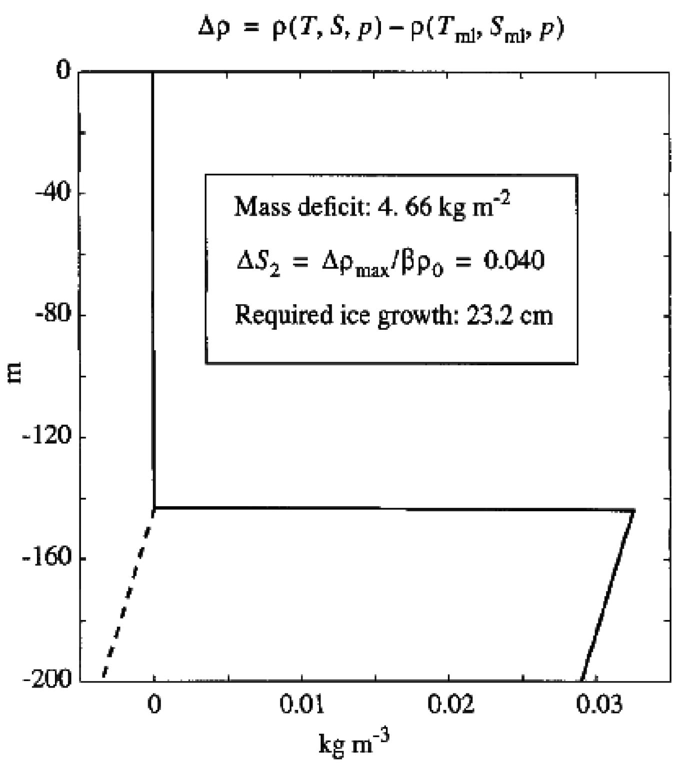



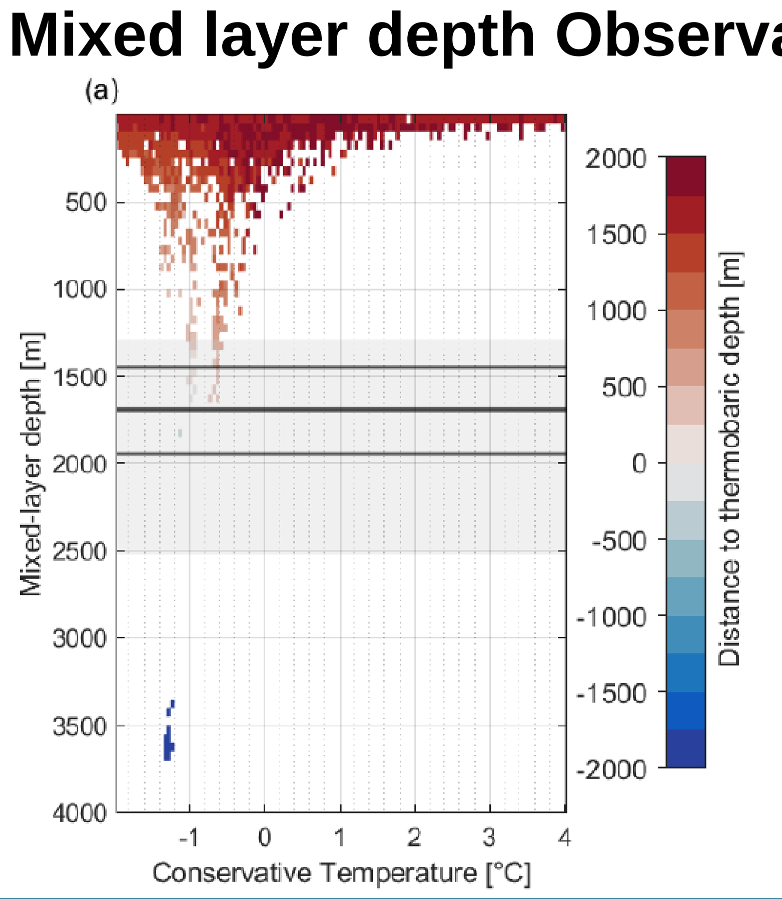

**Figure left** Schematic polar $\theta$ and S profiles. Taken from Akitomo, K. (1999).

**Figure right** Thermobaric density barrier in a two layer system. $\theta_{ml}, S_{ml}$: mixed layer temperature and salinity. $\beta$: Saline contraction factor. Taken from McPhee, M. G. (2000).

The strength of thermobaricity is given by $\theta_{plume} = \frac{\Delta\theta_1}{\Delta\theta_2}$. To get type II convection, it needs to be stronger than the background haline stratification.

$H_\alpha$= depth at which thermobaricity becomes effective.

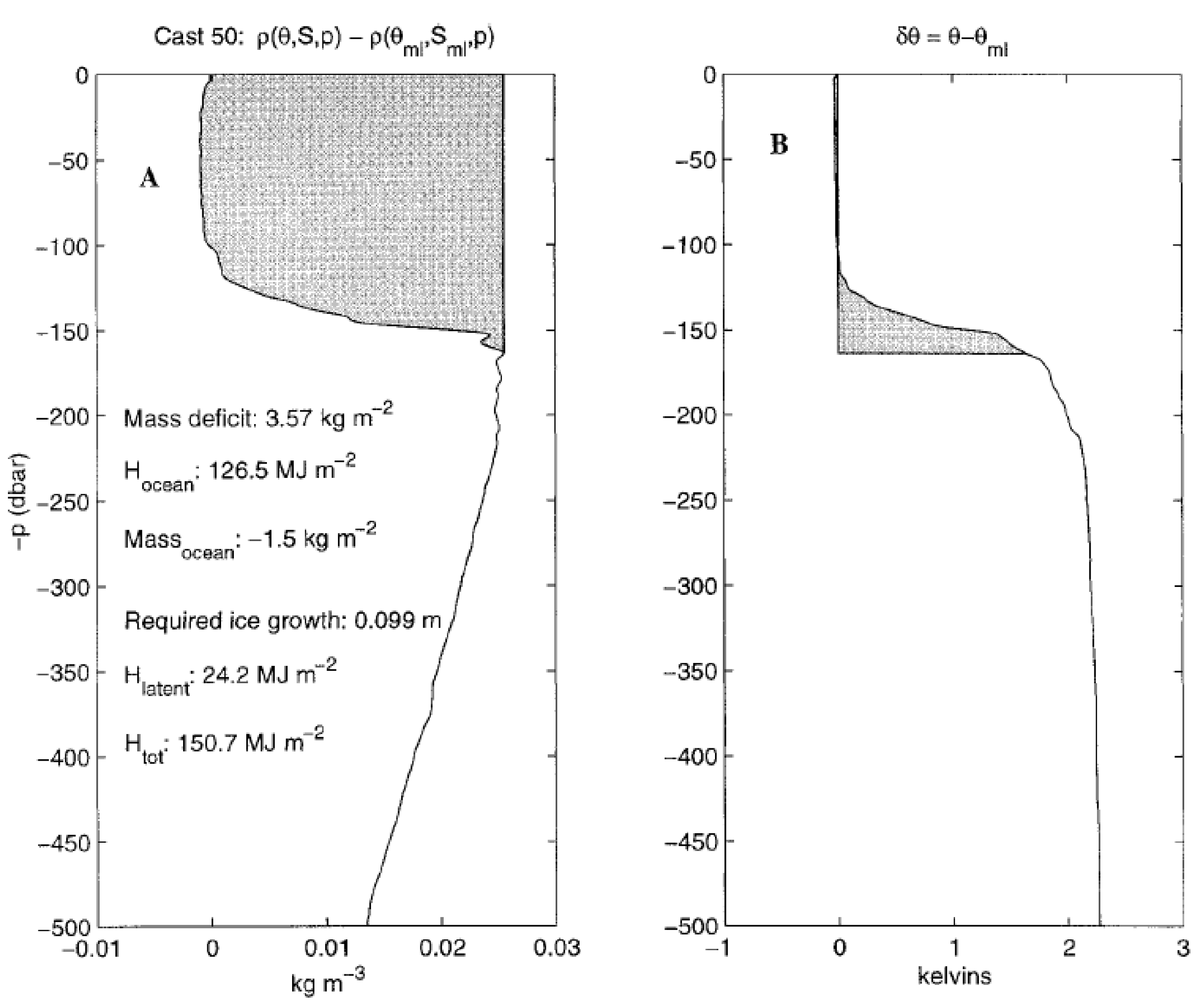
## Mixed layer depth Observations




Type II convection in the Greenland Sea mixes the entire water column. Mixed-layer depths that exceed the thermobaric depth reach to the bottom.

**Figure** Mixed-layer depth and hydrographic properties. Taken from Strehl et al. (2024, in Review).

## The ThermobaricBarrier




Type I convection needs to densify the water to reach the thermobaric depth. The density increase could be reached with ice growth. Therefore heat needs to be ventilated.

**Figure** Definitions of the thermobaric barrier. Shaded areas indicate A the mass that needs to be added to densify the water to $\rho_{max}$ and B the sensible heat in the water column that needs to be ventialted . Taken from McPhee, M. G. (2000).

## Maud's Rise

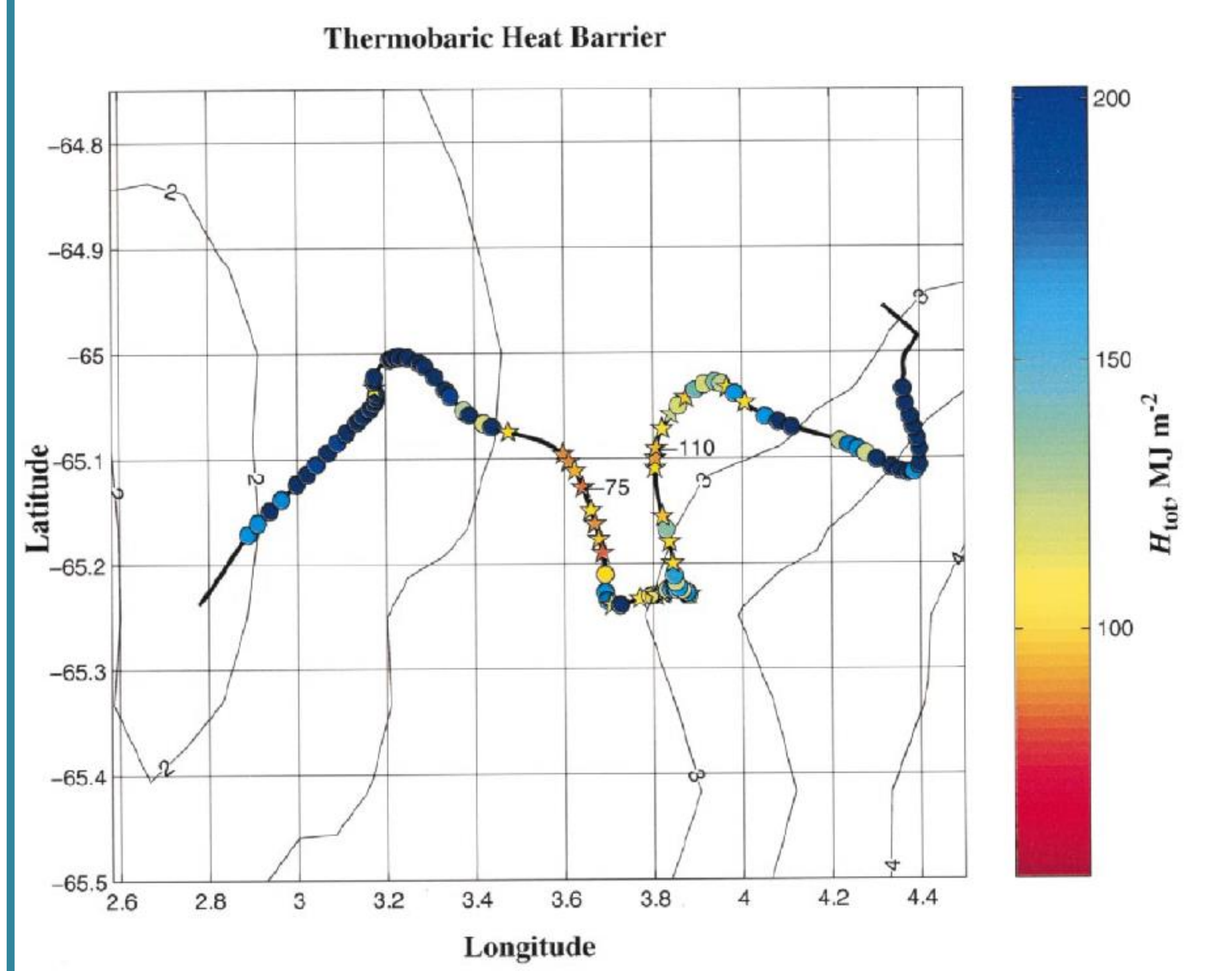



**Figure** Thermobaric barrier over Maud's rise. Pentagrams mark stations where thermobaricity was modelled to take place. Taken from McPhee, M. G. (2000).

Type II conection over Maud's Rise occurs for water columns with a low thermobaric barrier.

## Greenland Sea

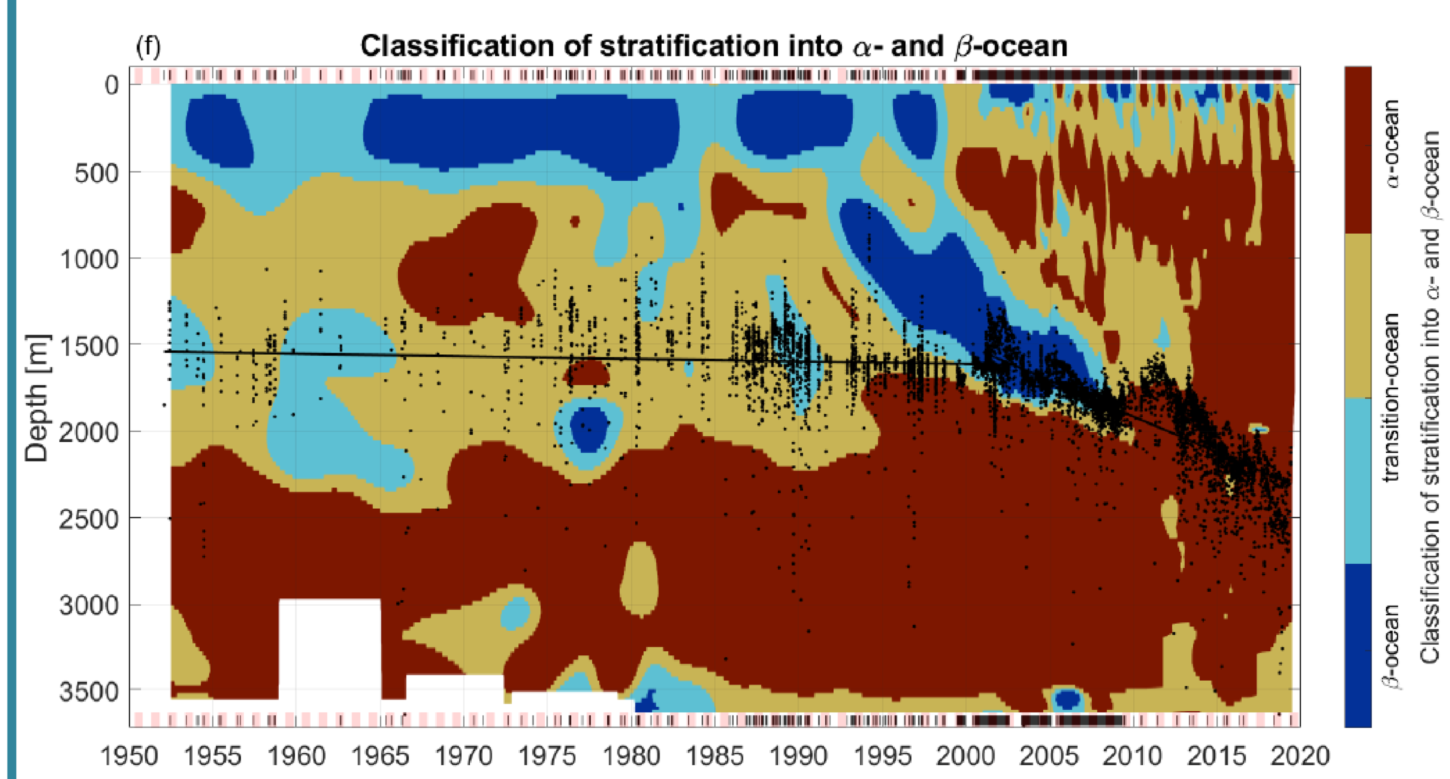



**Figure** Ocean stratification classification and thermobaric depth (black dots) in the Greenland Sea over time. Taken from Strehl et al. (2024, in Review).

$\alpha$ Oceans are stratified by temperature and $\beta$ oceans by salinity.
The ocean classification type in the Greenland Sea has changed.
Transition oceans are the most likely to be thermobarically unstable (Stewart, K.D. et al. , 2016).
The thermobaric depth in the Greenland Sea has increased.

## Conclusions

The strength of thermobaricity compared to the background stratification determines whether type II convection potentially can take place. The thermobaric barrier should be low enough so that it can be overcome and type II convection will take place.

A model shows Type II convection over Maud Rise for profiles with a lower thermobaric barrier.

Type II convection no longer occurs in the Greenland Sea.

## References

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