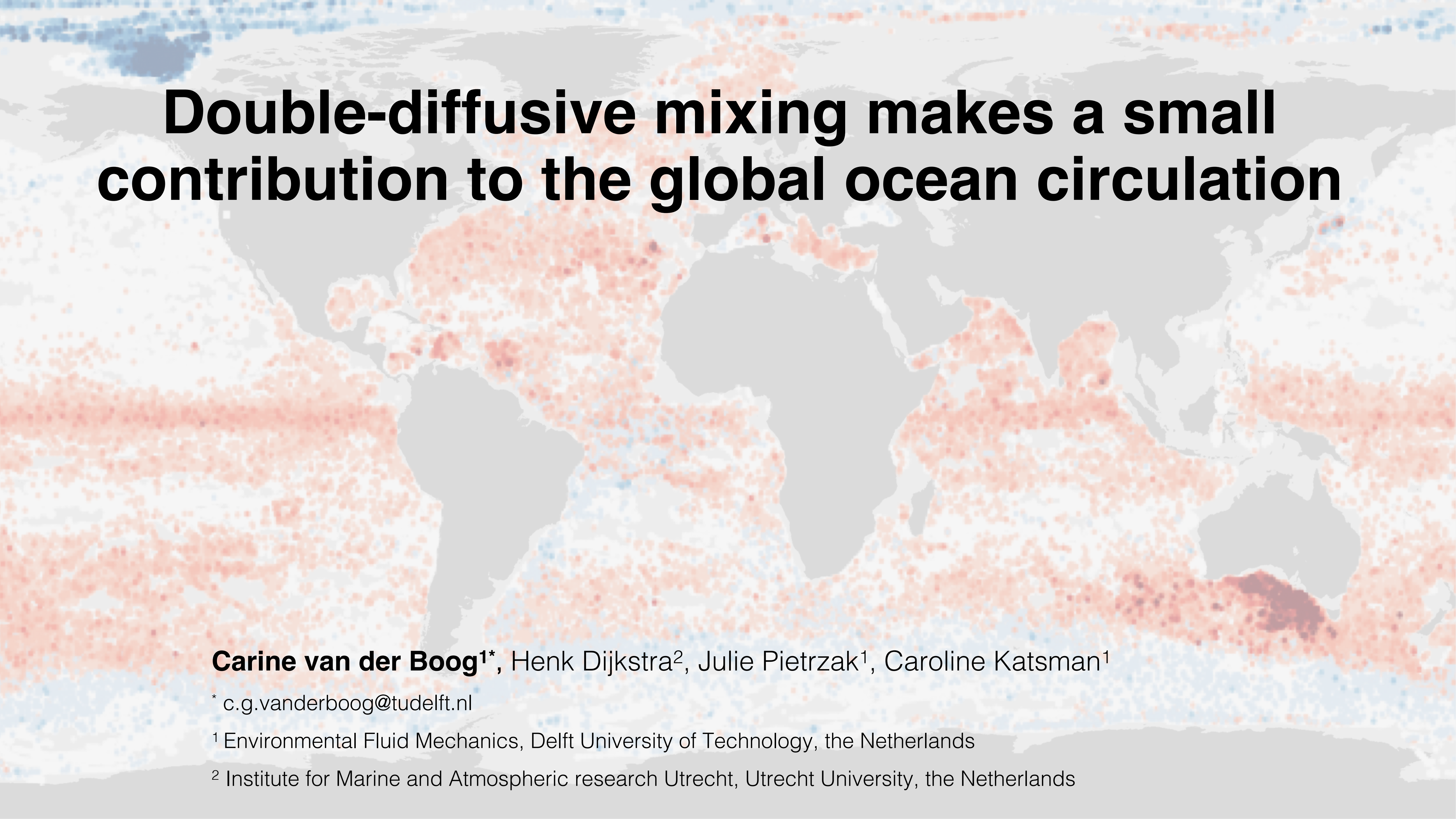

Double-diffusive mixing makes a small contribution to the global ocean circulation

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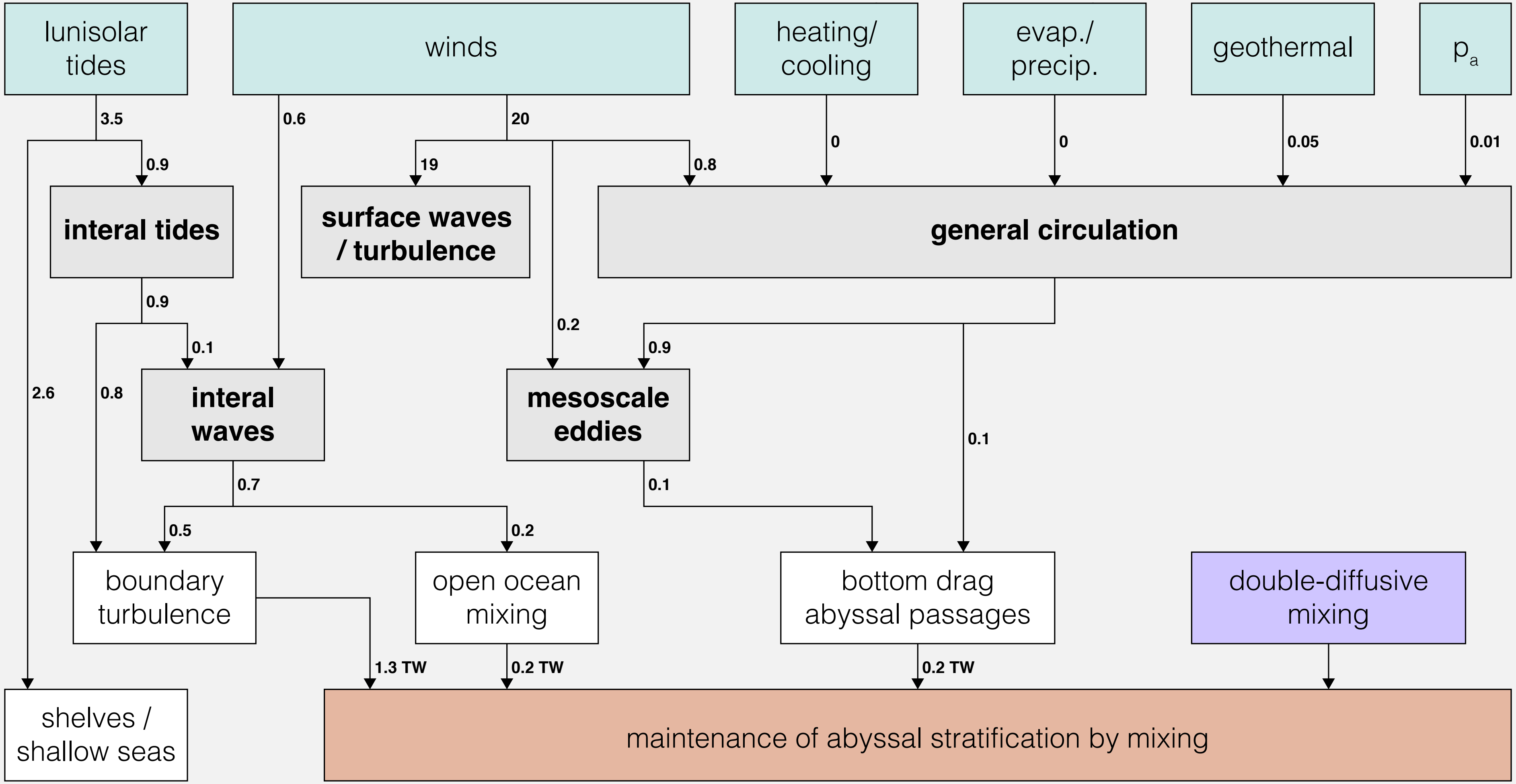
Energy budget for the global ocean



adjusted from Wunsch & Ferrari (2004)

Can we use thermohaline staircases to estimate the impact of double diffusion?

Yes, why not?

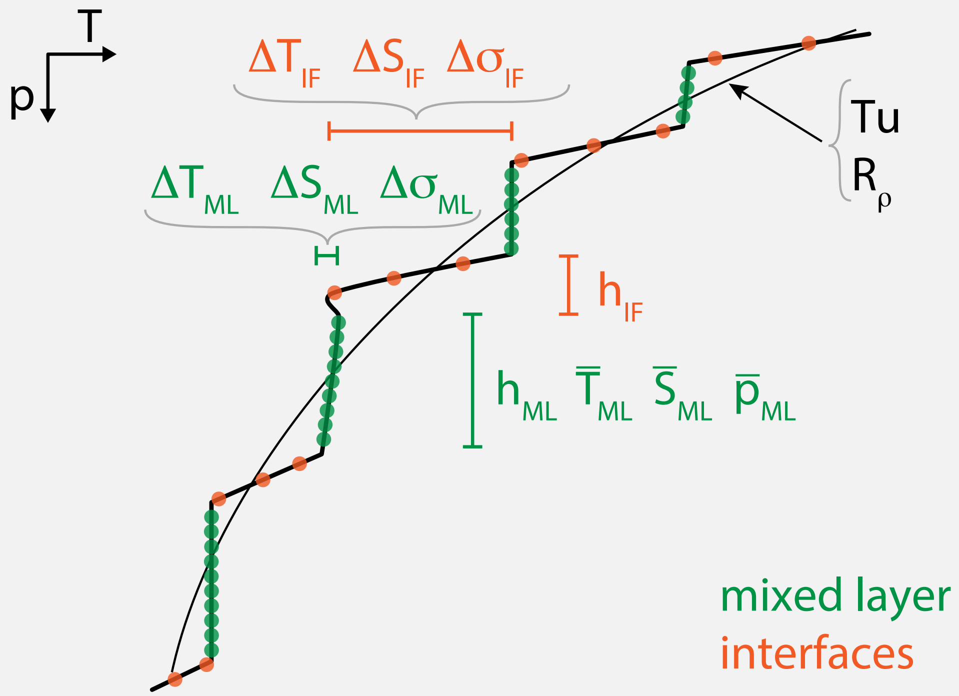
What do we need?

- Global overview of thermohaline staircases
- Estimate the effective diffusivities using the staircases

Staircase detection algorithm

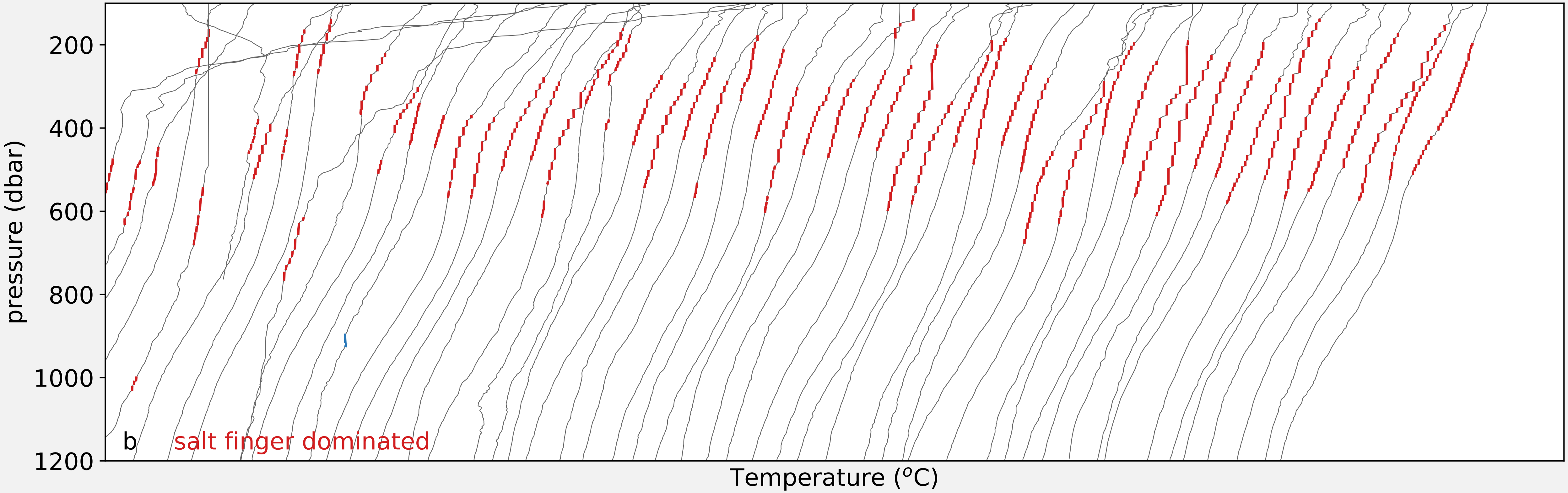
Algorithm steps:

1. Mixed layers
2. $\Delta T,S,\sigma$ interface > $\Delta T,S,\sigma$ mixed layer
3. Interfaces should be thin
4. Salt finger or diffusive convection
5. Sequence of interfaces



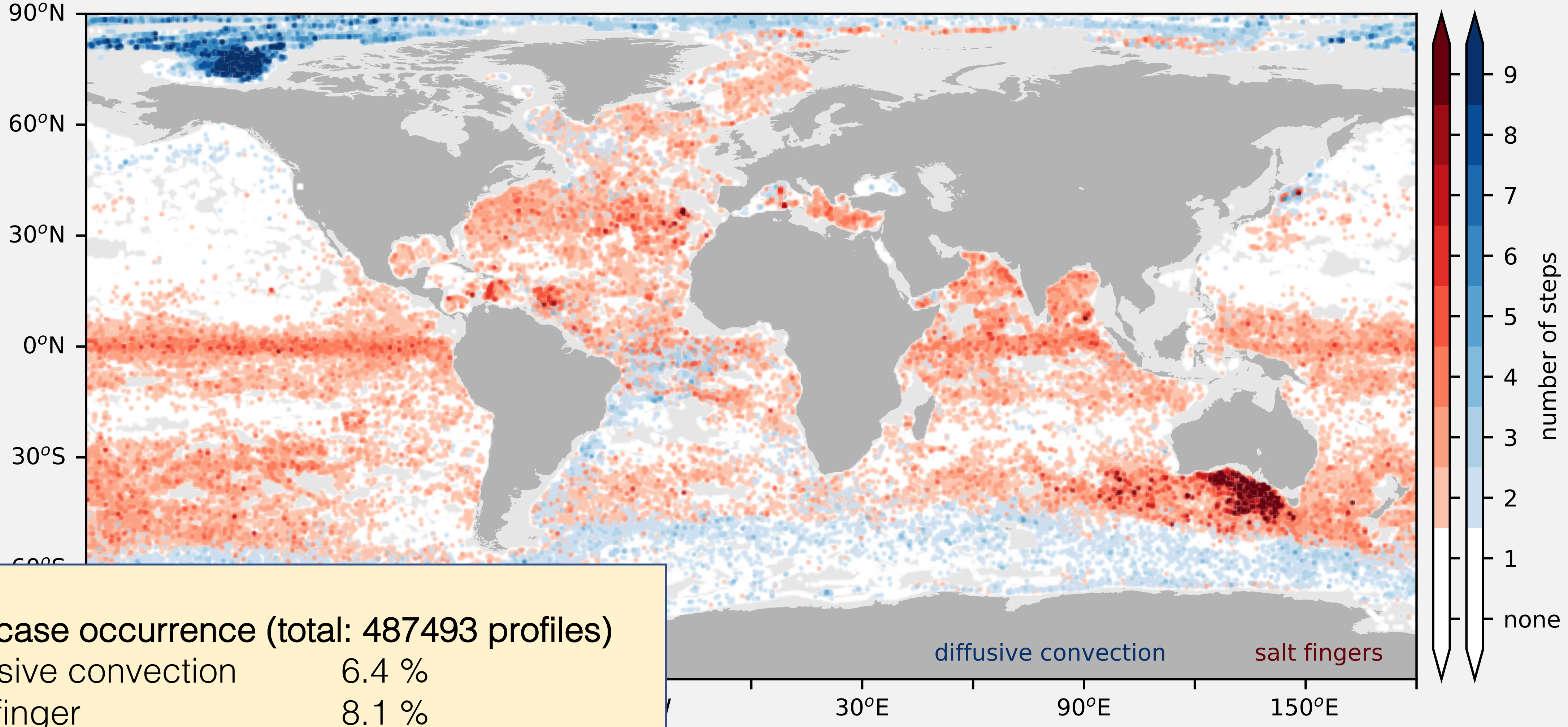
Van der Boog et al., (2021a)

Results of detection algorithm - examples



Van der Boog et al., (2021a)

The global overview of thermohaline staircases



Staircase occurrence (total: 487493 profiles)

Diffusive convection	6.4 %
Salt finger	8.1 %

Van der Boog et al., (2021b)

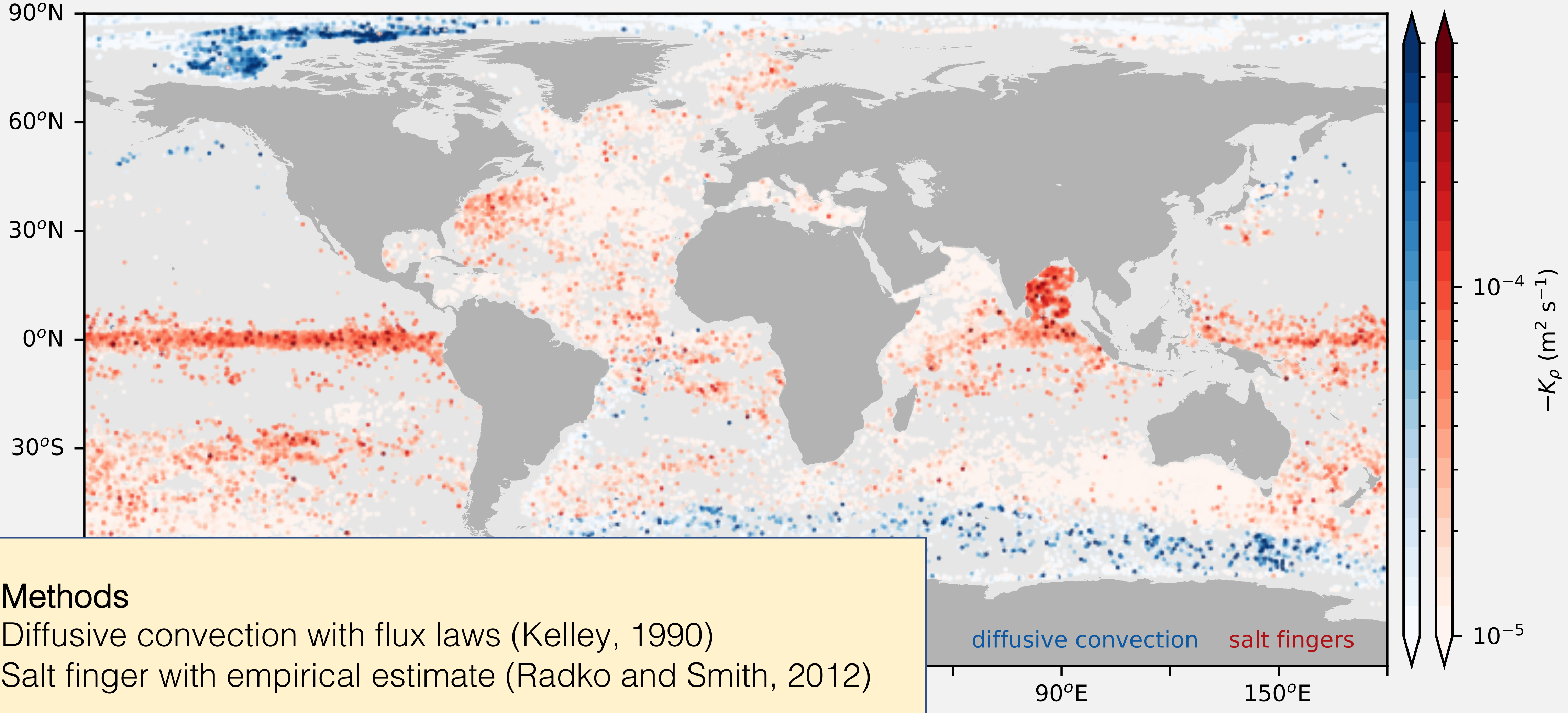
Global estimate

$$D = \Gamma^{-1} \kappa_\rho \, g \, A \, \Delta\rho \, n$$

		SF	DC
Γ^{-1}	= mixing efficiency	-1	-1
κ_ρ	= effective diffusivity of density		
g	= gravitational acceleration	9.8 m s^{-2}	
A	= area of the ocean	3.6×10^{14} m^2	
$\Delta\rho$	= density difference over interface	1 kg m^{-3}	
n	= staircase occurrence		
D	= dissipation		

Equation altered from Munk and Wunsch (1998)

Effective diffusivity of density



Methods
Diffusive convection with flux laws (Kelley, 1990)
Salt finger with empirical estimate (Radko and Smith, 2012)

Global estimate

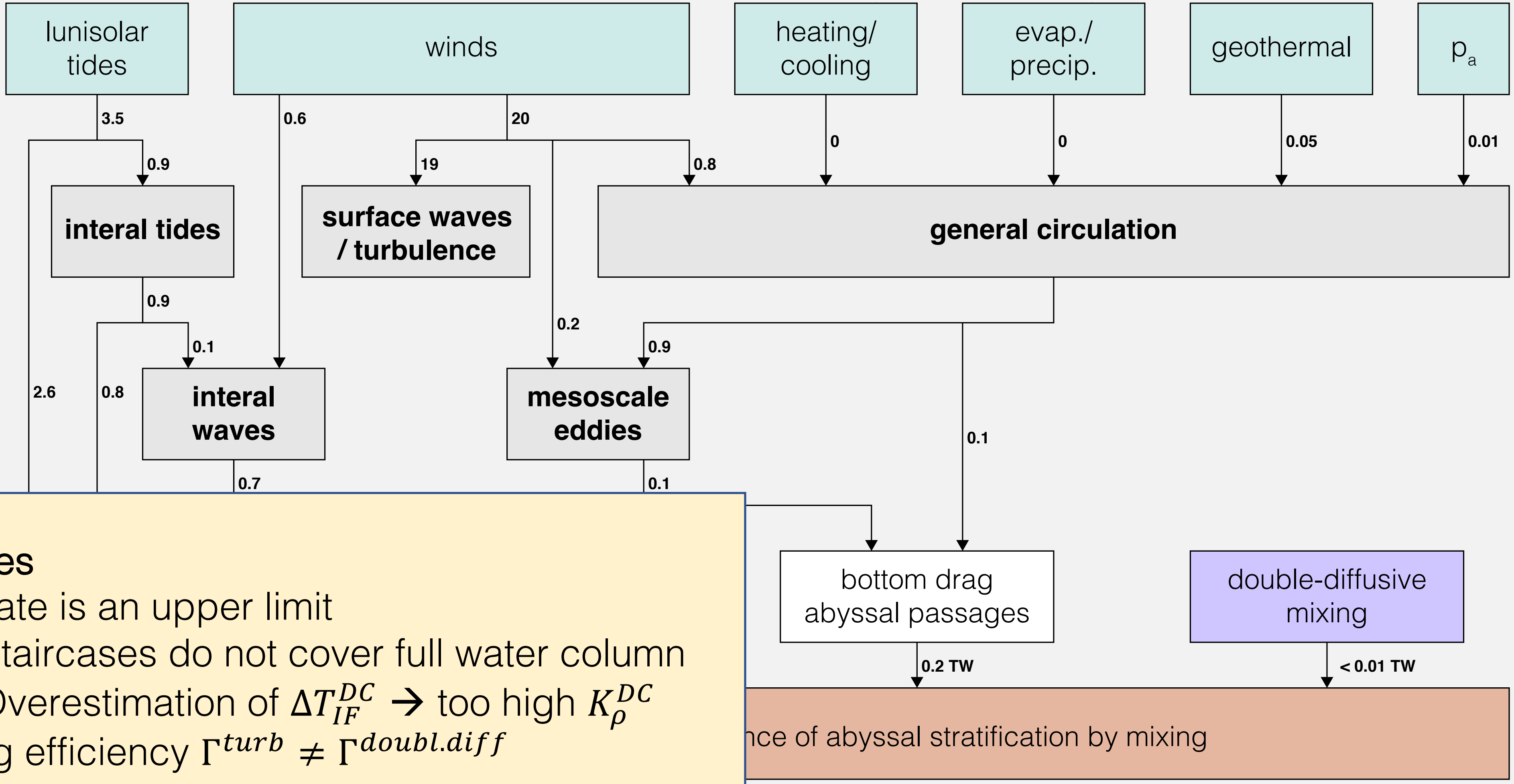
$$D = \Gamma^{-1} \kappa_\rho \, g \, A \, \Delta\rho \, n$$

		SF	DC
Γ^{-1}	= mixing efficiency	-1	-1
κ_ρ	= effective diffusivity of density	-1.5×10^{-5} m^2 s^{-1}	
g	= gravitational acceleration	9.8 m s^{-2}	
A	= area of the ocean	3.6×10^{14} m^2	
$\Delta\rho$	= density difference over interface	1 kg m^{-3}	
n	= staircase occurrence	8.1%	6.4 %
D	= dissipation	**4.2 GW**	**3.3 GW**

Total contribution < 0.01 TW

Equation altered from Munk and Wunsch (1998)

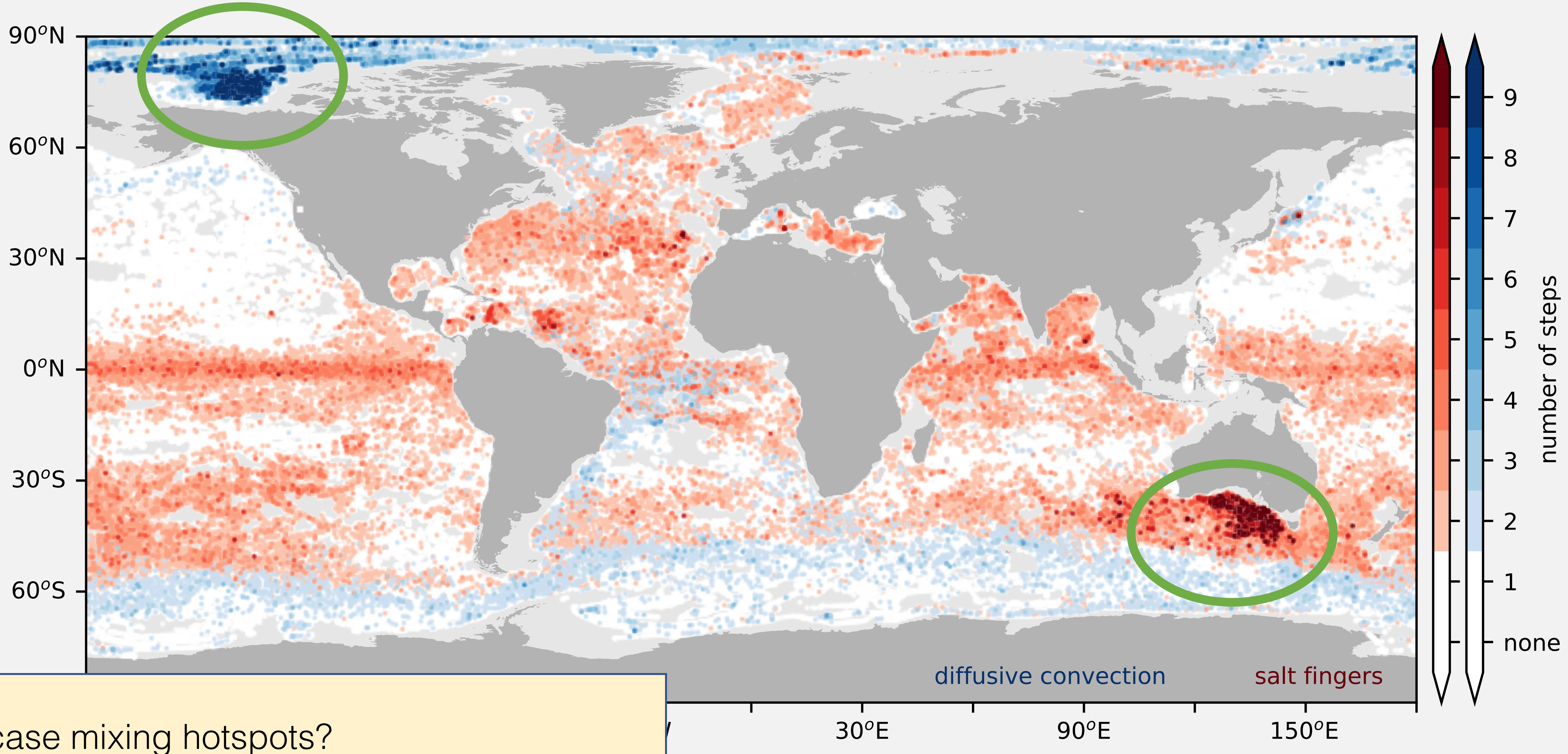
Total estimate



Side notes
- Estimate is an upper limit
  - Staircases do not cover full water column
  - Overestimation of ΔT_{IF}^{DC} → too high K_{ρ}^{DC}
- Mixing efficiency $\Gamma^{turb} \neq \Gamma^{doubl.diff}$
- Regional variations

adjusted from Wunsch & Ferrari (2004)

Regional variations



Staircase mixing hotspots?

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