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Baltic - C

# **Participant 5, Uppsala University**: Atmospheric forcing, air-sea interaction, atmospheric deposition of acidic components, climate scenarios

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Maria Norman (PhD student)

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# Deliverables:

D26: Acidic deposition of the Baltic Sea drainage basin (done)

**D25: Climate scenarios for present and future conditions (done – Björn Carlsson is analysing).**

D24: Measurement from the first 12 month from Östergarnsholm (database is being developed).

**D23: Improved parameterisations of air-sea gas transfer velocity.** Done – implementation in model is ongoing. (Anna Rutgersson and Maria Norman).

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# Flux measurements

$$F_{CO2} = \overline{w'c'} \quad \text{(directly measured fluxes, Eddy-Cov. techn.)}$$

$$F_{CO2} = kK_0(pCO_{2w} - pCO_{2atm})$$

$$k = \frac{\overline{w'c'}}{K_0(pCO_{2w} - pCO_{2atm})}$$

$$k_{660} = \frac{\overline{w'c'}}{K_0(pCO_{2w} - pCO_{2atm})}\sqrt{\frac{Sc}{660}}$$

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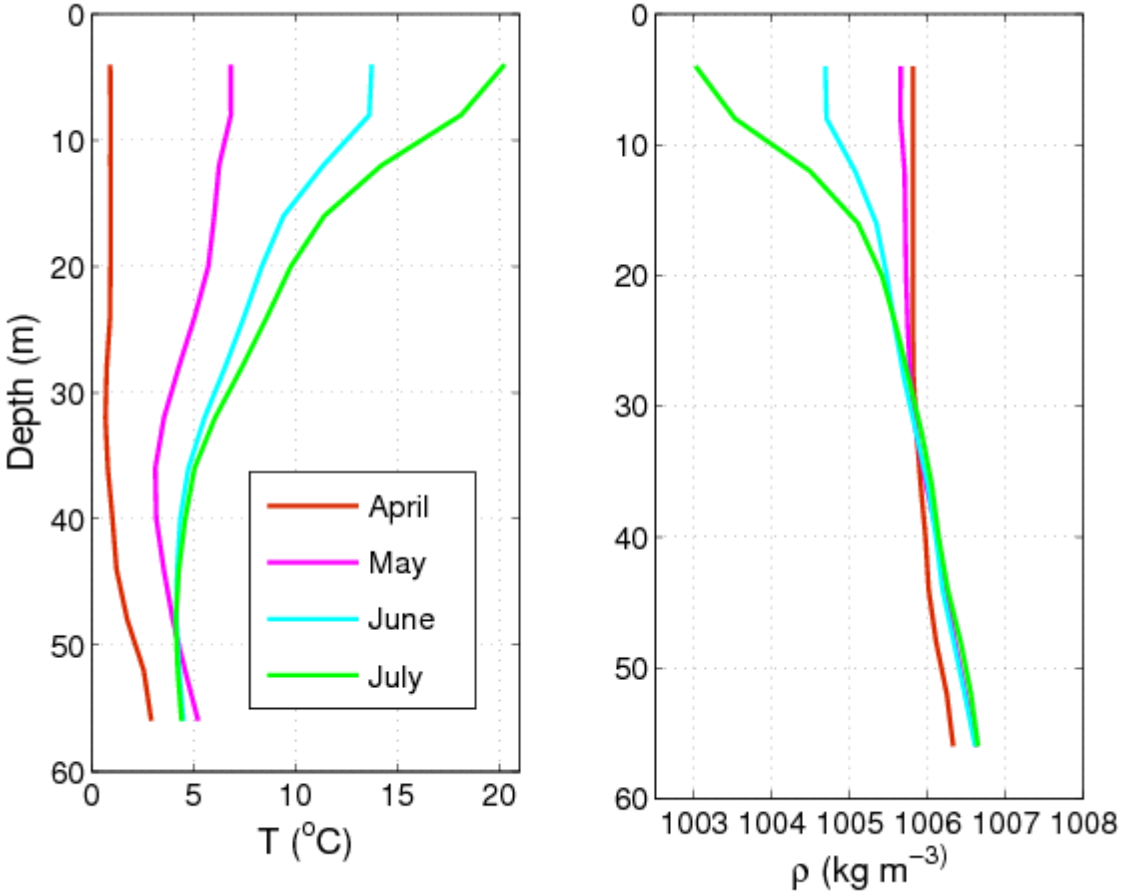
# Mixed layer depth

Period I: April to May ($z_{ml}$>40m)

Period II: June to July ($z_{ml}$<20m)

- Mixed layer depth from HIROMB (3D ocean model for Baltic Sea)



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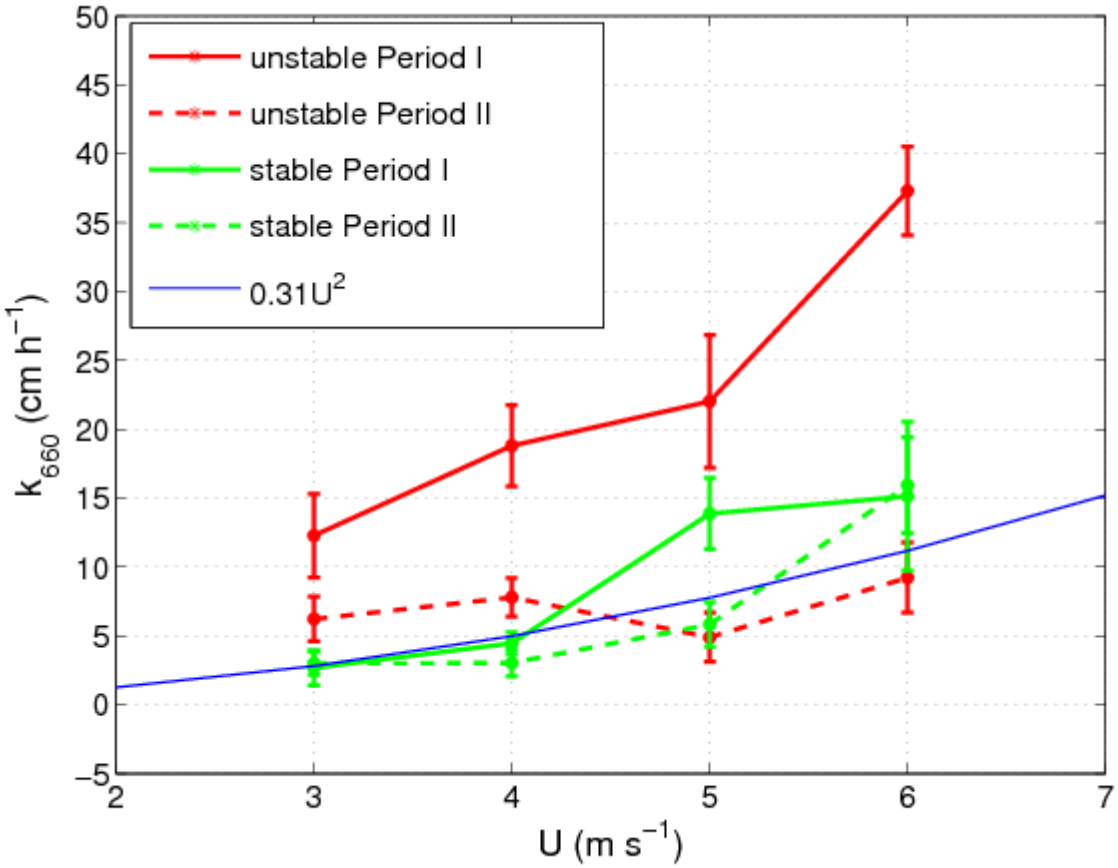
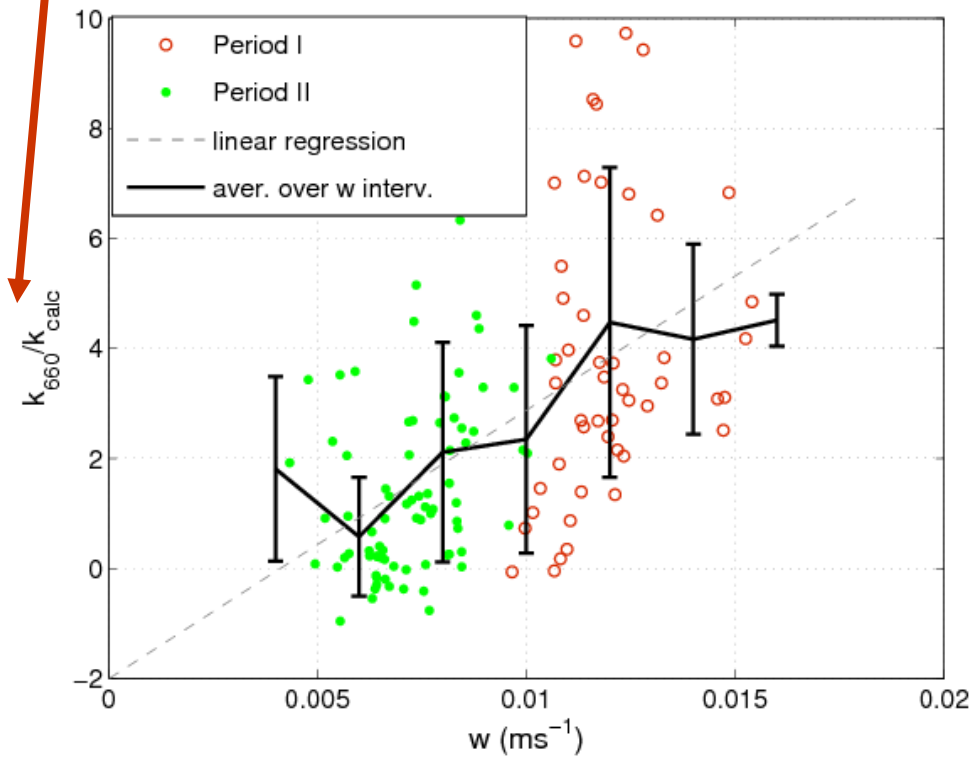
# Larger transfer velocity for larger mixed layer depth



# Convective velocity scale

Transfer velocity normalised by wind speed



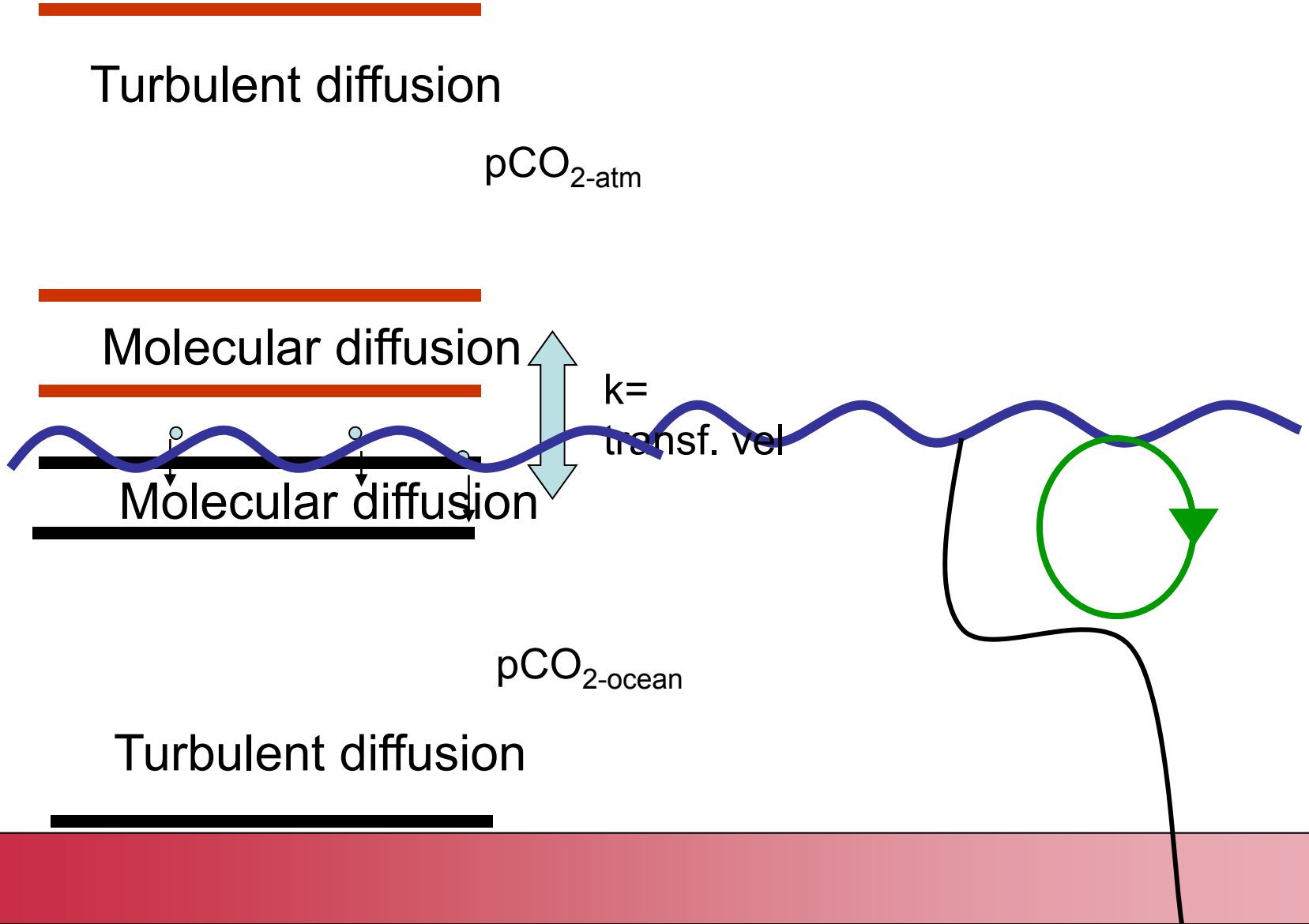

$$w = \left(z_{ml} B\right)^{1/3}$$

$$B = buoyancy\ at\ the\ surface$$

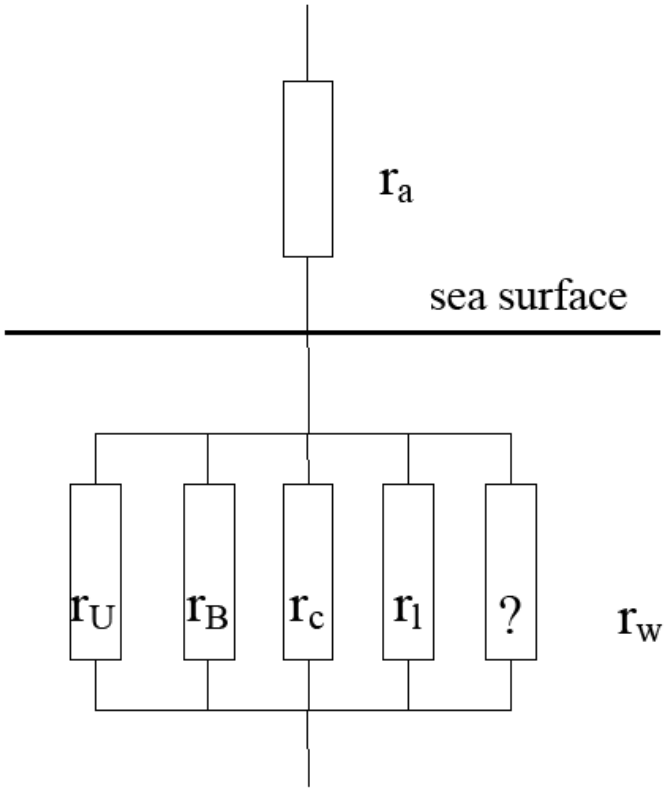
$$z_{ml} = mixed - layer\ depth$$

B refers to the buoyancy in the water due to cooling and evaporation (colder saltier water is heavier)

# Water-side convection



# Concept of resistances




$$k = \frac{u_{*a}}{r_w + r_a \alpha}$$

$$k_x = \frac{1}{r_x},\ x = w, w0, b, c, l$$

$$k_w = k_{w0} + k_b + k_c + k_l$$

$$k_{w0} = \textit{shear generated turbulence}$$

$$k_b = \textit{enhancement by bubbles}$$

$$k_c = \gamma \sqrt{\frac{w}{u_{*w}}} = \textit{enhancement by convection}$$

$$k_l = \textit{enhancement by Langmuir}$$

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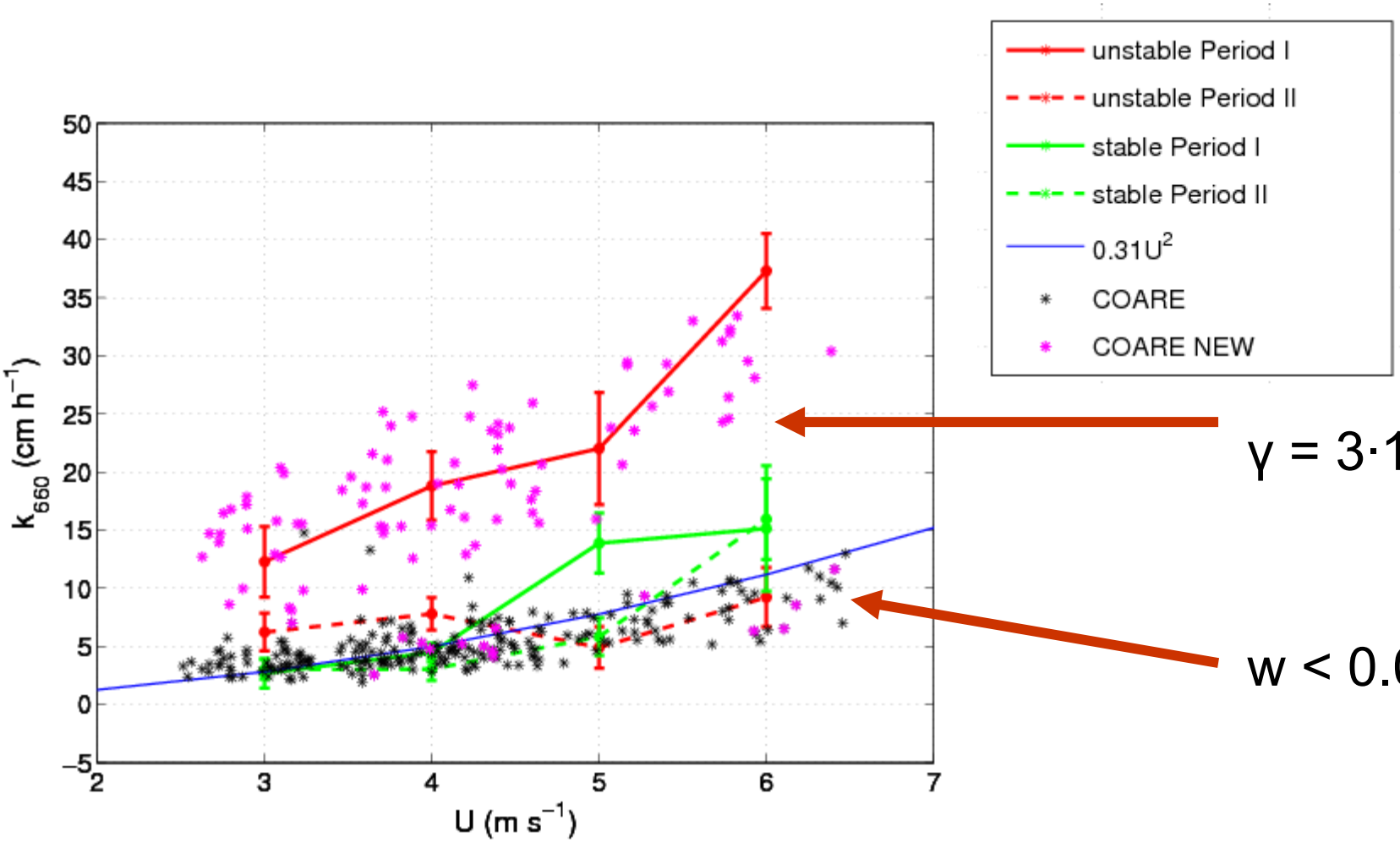
# Additional resistance in the water




$\gamma = 3 \cdot 10^{-6}$

$w < 0.006$

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# Conclusions

- During convection at the surface and a deep mixed layer, the efficiency of transfer is strongly enhanced.
- This can be expressed by adding a resistance in parallell with the other water-side resistances.
- Potentially strong impact on the distribution of oceanic uptake in time (diurnal cycle) and space.
- Implementation in Baltic-Sea model ongoing.