# Interplay between **diurnal warm layers** and **convection**
## in high resolution global coupled simulations

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### Motivation

- **Convection** is sensitive to fluxes (and thus to **SST fluctuations**): [1], [2]
- Correct representation of **convection** is essential to accurately capture Earth's **climate** and **energy balance**: [3]

### Background

Diurnal warm layers (DWL): areas of ocean with high daily SST fluctuations

- vertical extent: O(10m).
- amplitude depends on solar radiation and wind speed

Possible impact: increase the cloud amount through

- higher latent heat flux
- differential heating at the boundary

### This study

**1. Diurnal warm layers (DWL) in *global, coupled, high resolution* model simulations**

**2. Impact of DWL on convection in such simulations**

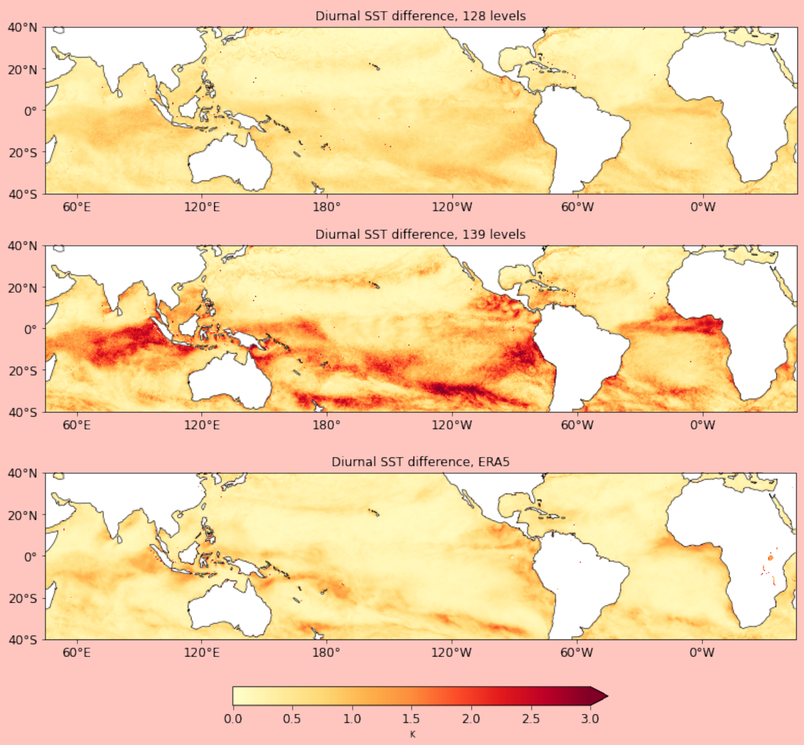
**Model**: ICON (Sapphire configuration), global, coupled model, 5 km horizontal resolution:

- *ICON Sapphire: simulating Earth System's components and their interactions at kilometer and subkilometer scales* [4]

## 1. How are diurnal warm layers represented in ICON?

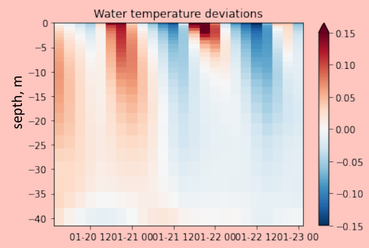
Experiment idea: increase the vertical resolution in the ocean from ~2m near the surface (128 levels in total) to ~0.5m near the surface (139 levels in total)

Average amplitude (10 days): thicker levels, thinner levels and ERA5:



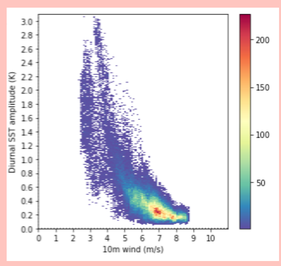

correct locations; amplitude is too strong in simulations with thin levels

Vertical structure (regional average in the tropical Atlantic), debiased, thin levels:



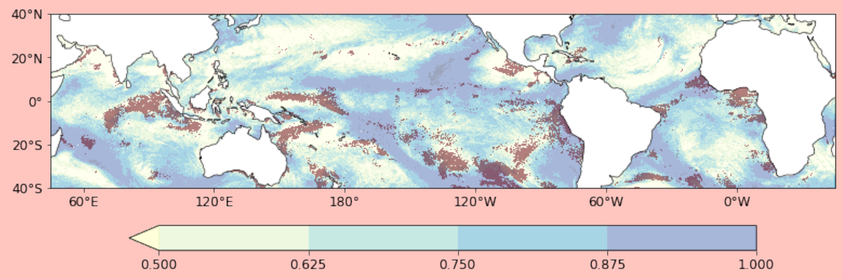

correct representation of the diurnal cycle

Magnitude vs near-surface wind speed (histogram):




polynomial dependence

Diurnal warm layers and cloud cover on a particular day:



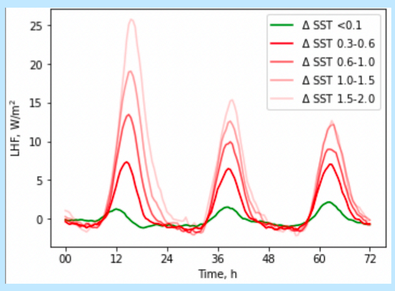

DWL avoid clouded regions

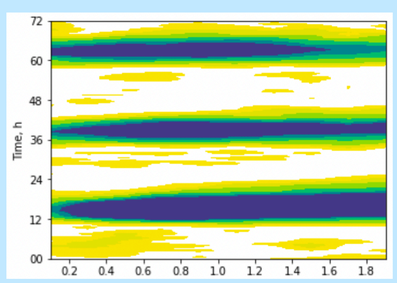
## 2. How large is the impact of DWL on convection?

Experiment idea:

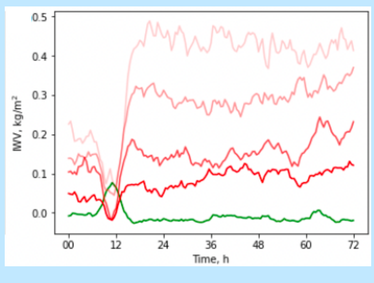
- conduct simulations over 4 days from identical (realistic) initial conditions with thicker (128) and thinner (139) layers (→ small natural variability)
- divide the ocean into 0.25° x 0.25° squares, consider 2 categories (no DWL develop vs DWL of a certain amplitude develop *within a day*) and compare convection related quantities across these categories

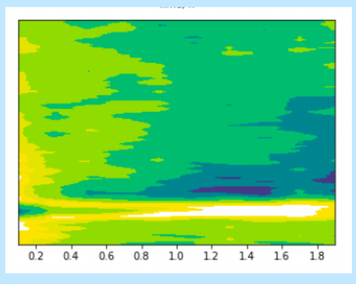
**Moisture** related quantities: differences and P values in a t test (as a function of time and amplitude) for **latent heat flux** and **integrated water vapour**



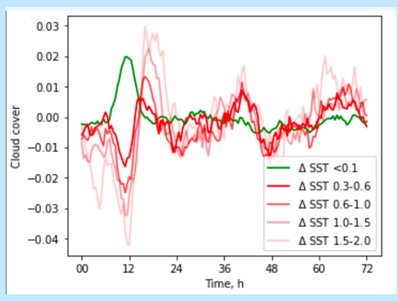

Yellow, green or blue areas: P value is below 0.05

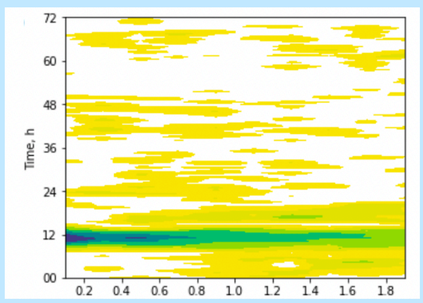


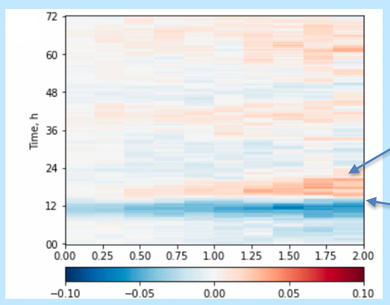



**Highly significant** differences from the onset, but **small magnitude**

**Cloud cover**:




Impact of the DWL

DWL is formed

For comparison: diurnal cloud cover amplitude over tropical Atlantic: 0.2-0.3

**Barely significant** effect, **very small magnitude**

**Conclusion**: In spite of **overrepresented amplitudes**, DWL have **very small impact on moisture** and, as a consequence, **barely any impact on the cloud amount.**

[1] J. Vial et al. (2017) *Mechanisms and Model Diversity of Trade-Wind Shallow Cumulus Cloud Feedbacks: A Review.* Surv Geophys 38:1331–1353
[2] P.-E. Brilouet et al. (2021) *A Case-Study of the Coupled Ocean-Atmosphere Response to an Oceanic Diurnal Warm Layer.* Q J R Meteorol Soc. 147:2008-2032
[3] B. Medeiros et al. (2008) *Aquaplanets, Climate Sensitivity, and Low Clouds.* Journal of Climate 21:4974-4991
[4] C. Hohenegger et al. (2022) *ICON Sapphire: simulating Earth System's components and their interactions at kilometer and subkilometer scales.* GMD Preprint.

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