What determines the coupling strength between convection and the land surface?

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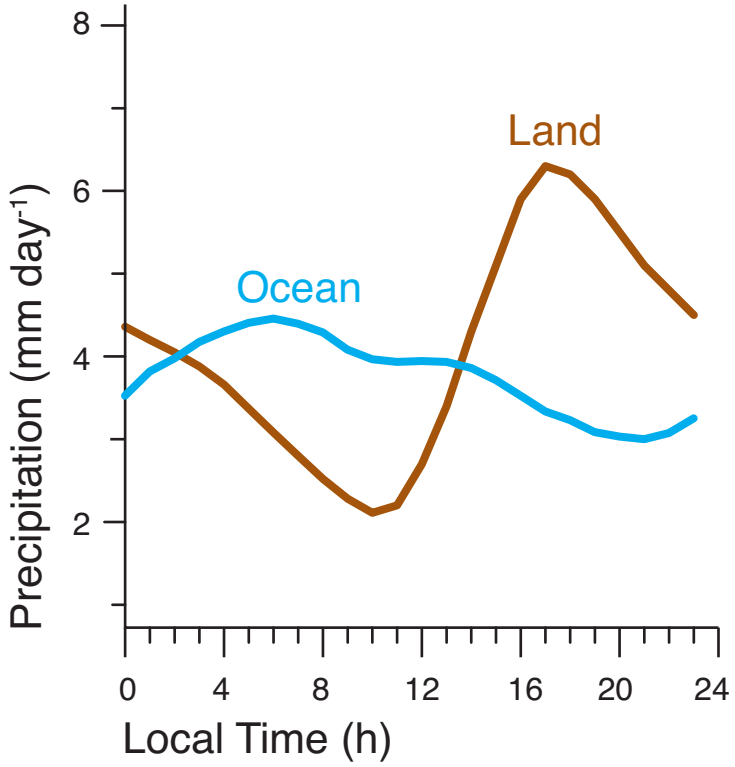
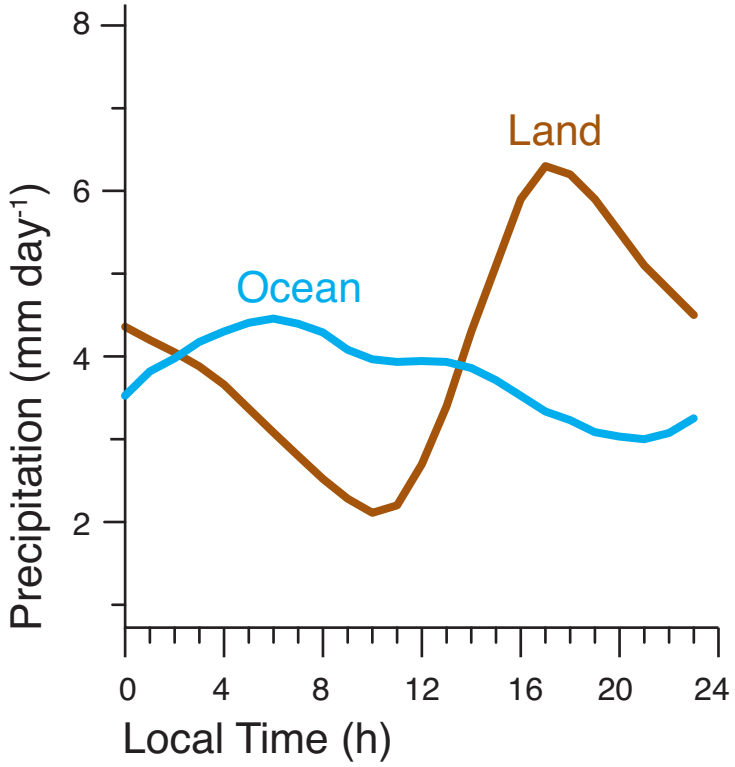
Why caring about the land surface?

Precipitation diurnal cycle

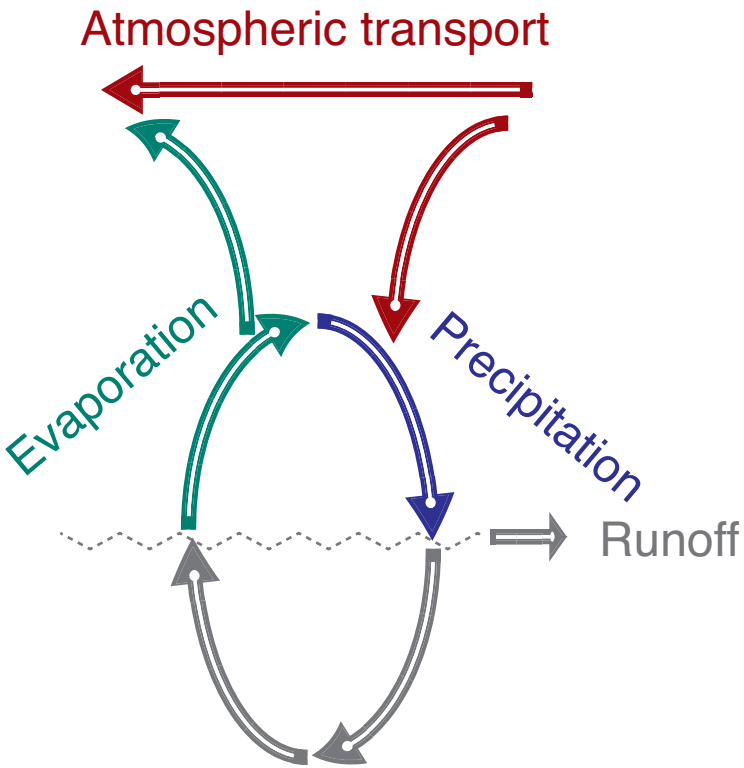


Why caring about the land surface?

Precipitation diurnal cycle



Precipitation recycling



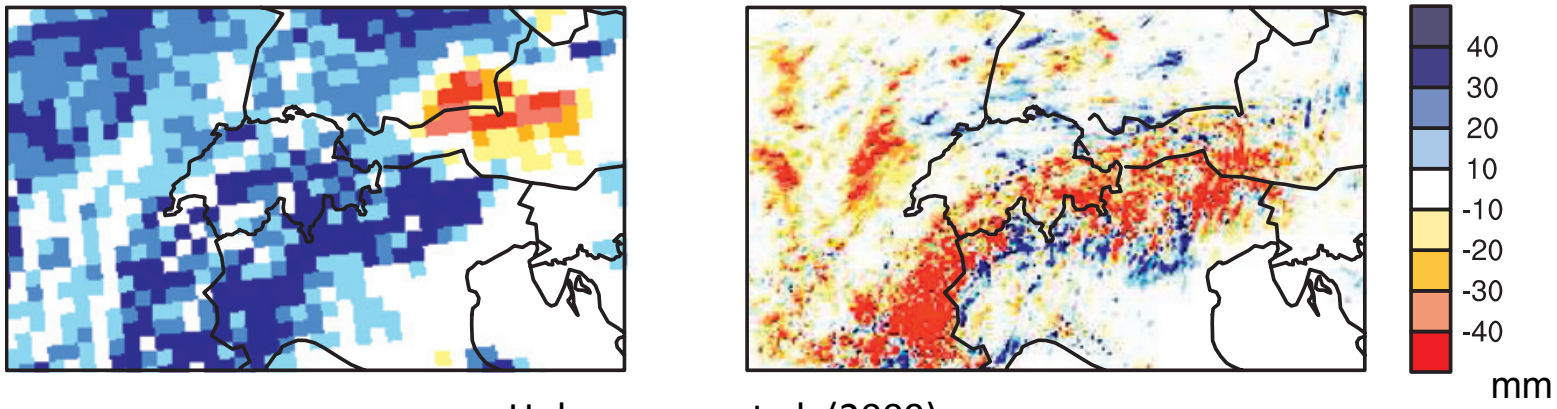
after Eltahir and Bras (1996)

How strong is the coupling?

Change in precipitation due to a change in soil moisture:

Parameterized convection

Convection permitting



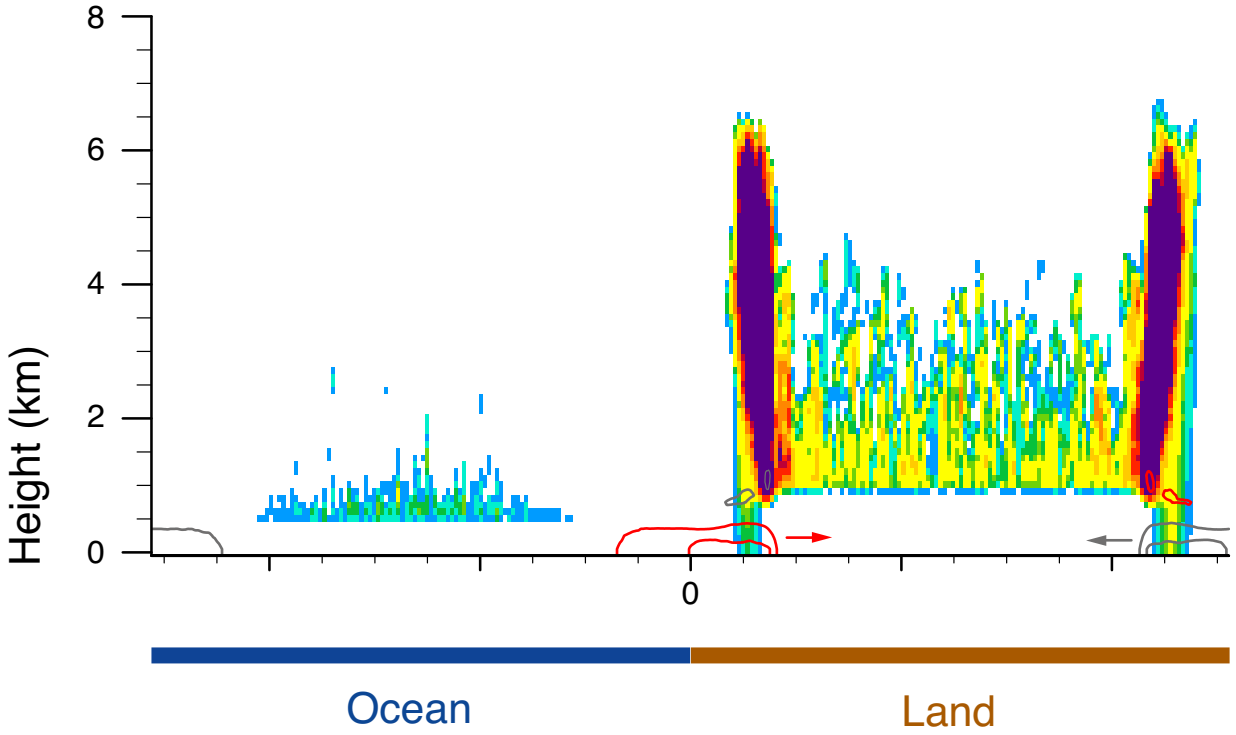
Hohenegger et al. (2009)

Coupling mainly determined by the representation of convection!?

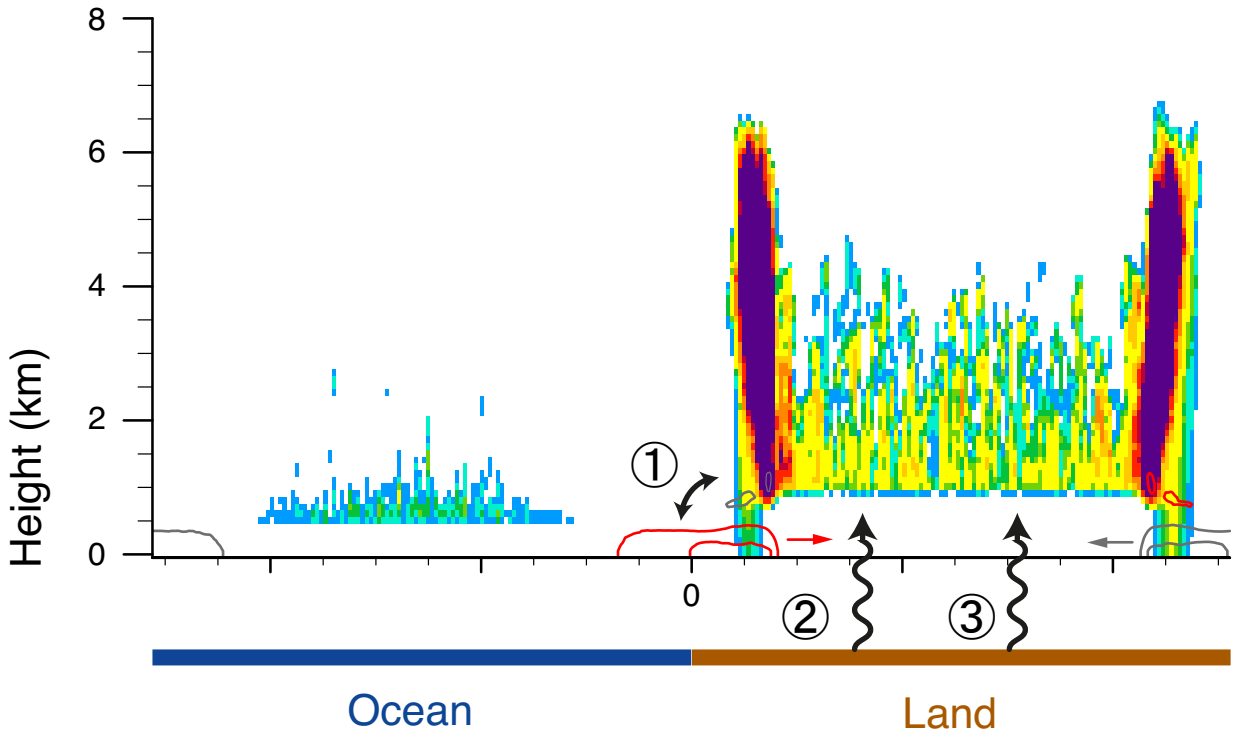
Exciting prospects by using a multi-resolution approach…

- Set up a prototype problem
- Simulate it at
  - LES resolution O(200 m) fully explicit convection
  - Convection-permitting O(2 km) partly explicit convection
  - Coarse resolution O(10 km) parameterized convection
- How does the land surface couple with the atmosphere??

Idealized land-sea breeze as a prototype problem



Idealized land-sea breeze as a prototype problem



Coupling with:

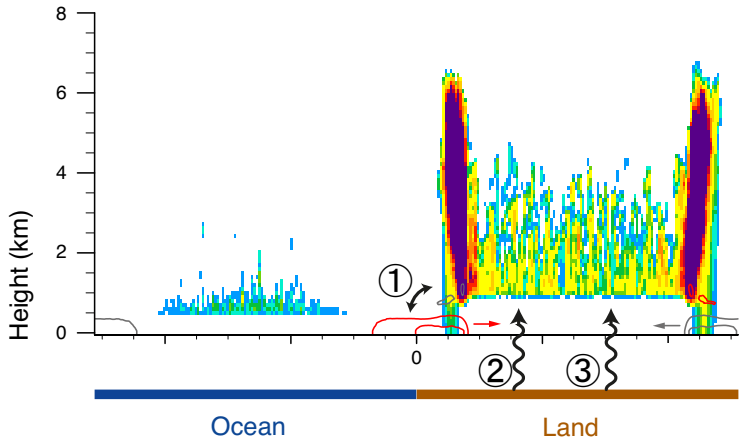
① circulation strength ② sensible heat flux ③ latent heat flux

Experimental set-up

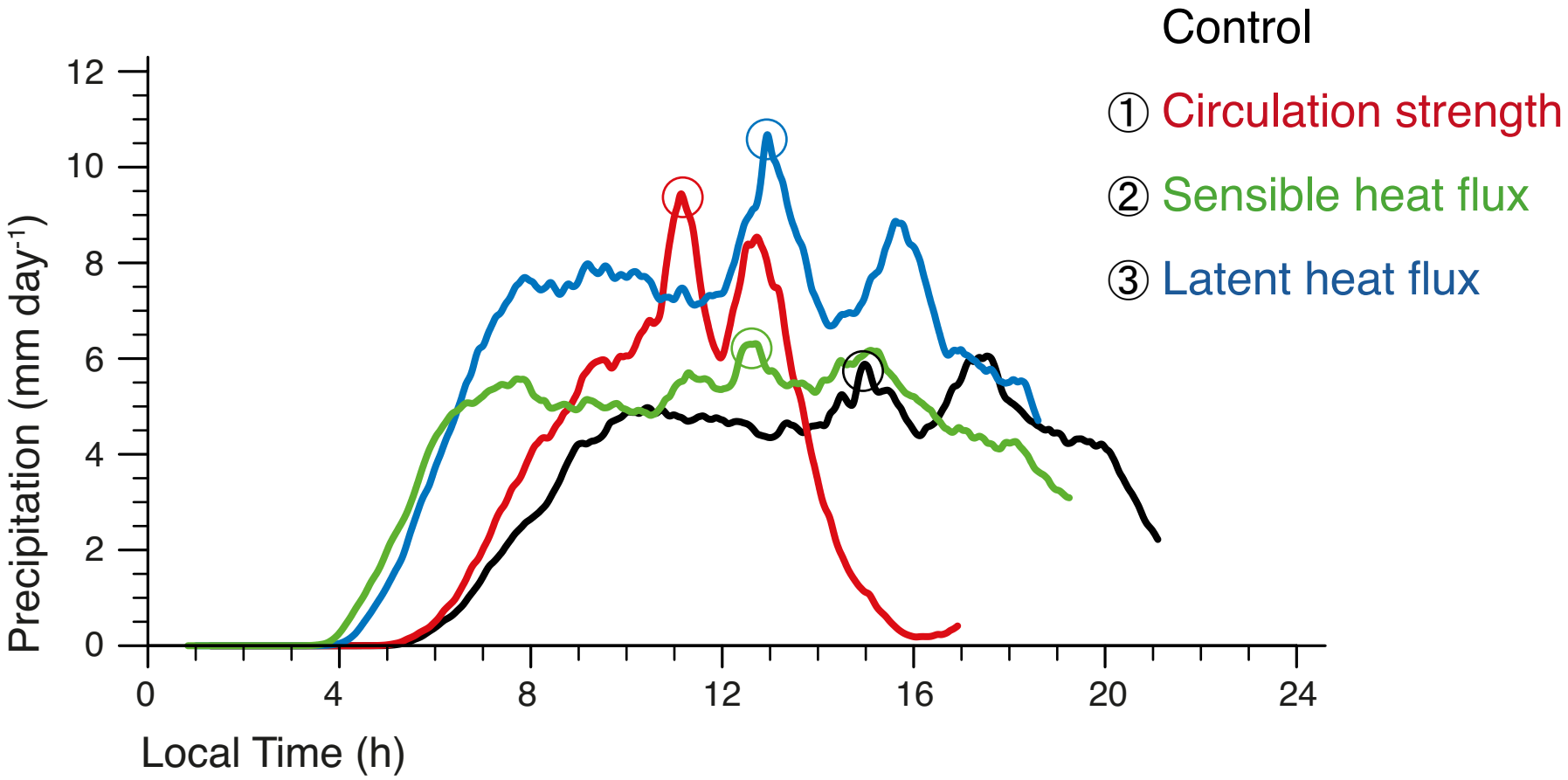
- Domain half-ocean (400 km) half-land (400 km)
  No radiation, fixed surface fluxes

- Different resolutions
  - Fully explicit 0.4 km UCLA
  - Partly explicit 1.6 km UCLA
  - Partly explicit 2.2 km COSMO
  - Parameterized 11 km COSMO

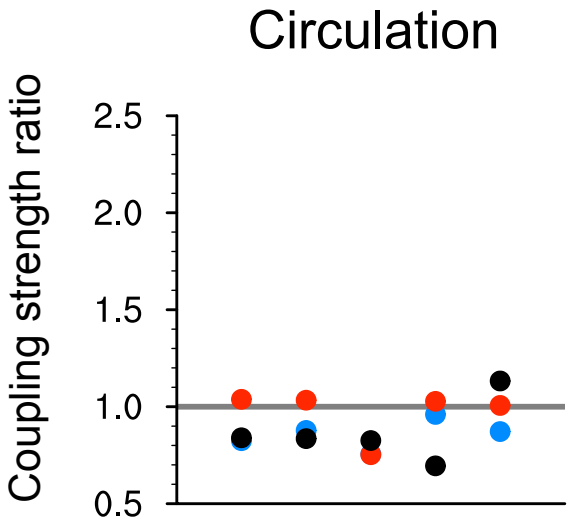
- Sensitivity experiments
  - Different patch size ①
  - Different sensible heat flux ②
  - Different latent heat flux ③



Sensitivity of precipitation, LES results



Coupling strength as function of model resolution



Coupling strength

$$\psi_{\mathrm{model}} = \frac{\mathrm{RR}^{\mathrm{pert}}_{\mathrm{max}}}{\mathrm{RR}_{\mathrm{max}}}$$

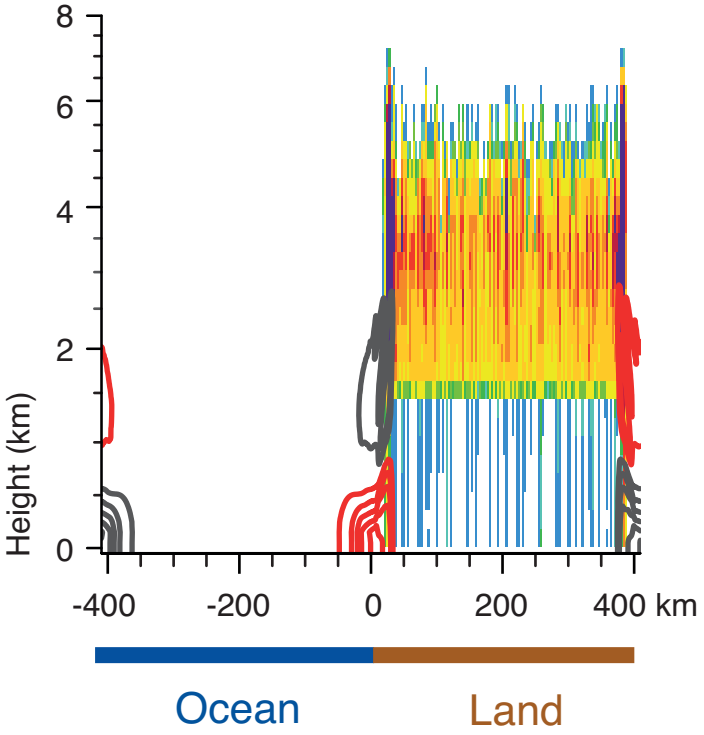
Coupling strength ratio

$$\frac{\psi_{\mathrm{model}}}{\psi_{\mathrm{les}}}$$

1.6 km UCLA
2.2 km COSMO
11 km COSMO

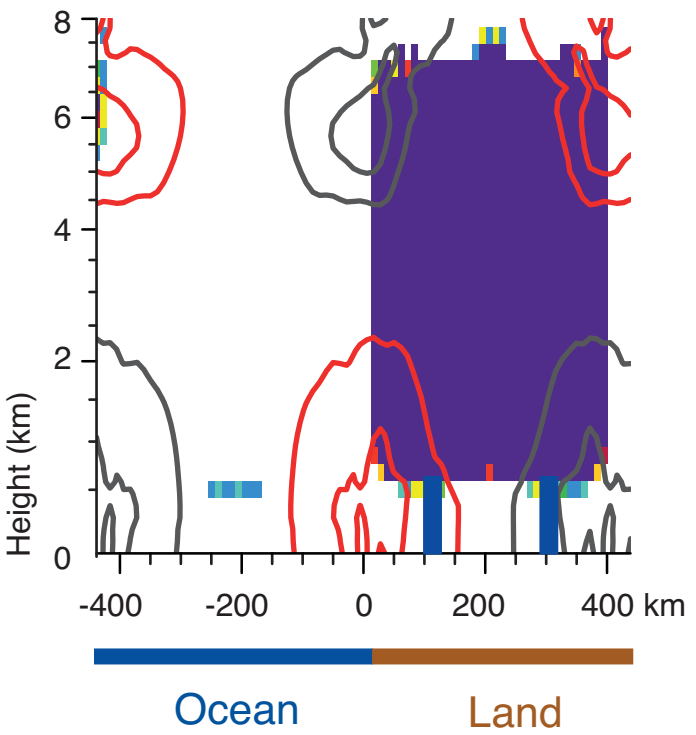
Convective parameterization destroys the interaction with the mesoscale circulation

UCLA 0.4 km



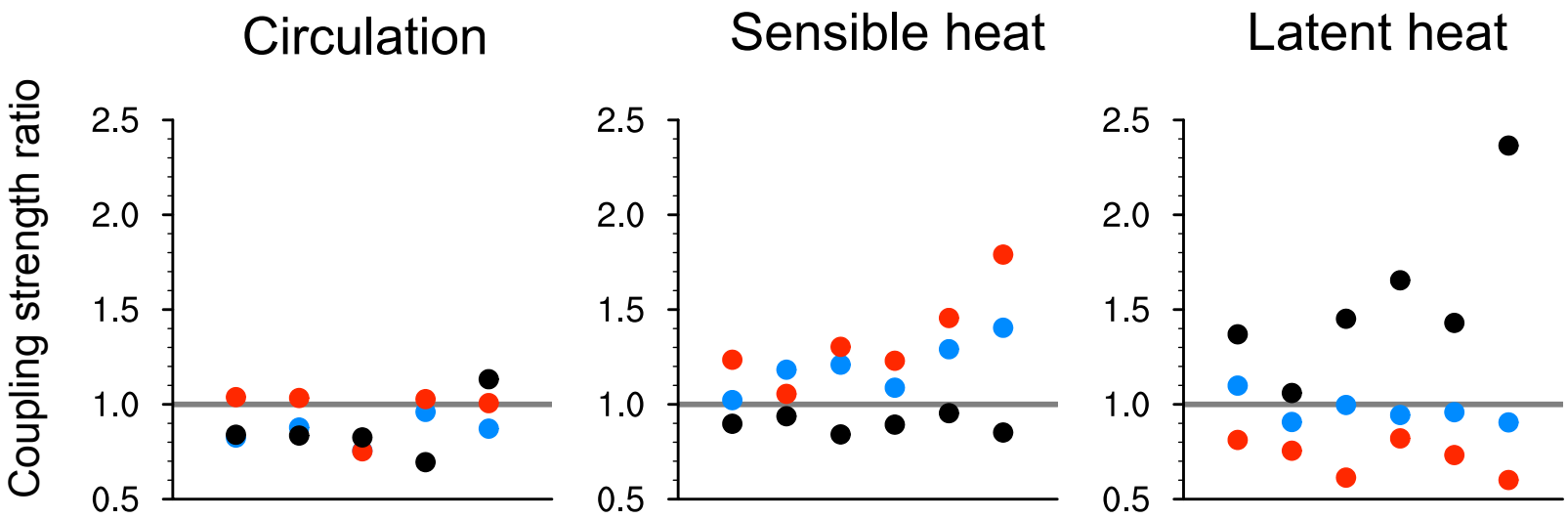
0.2 mm day^{-1}

COSMO 11 km



6.5 mm day^{-1}

Coupling strength as function of model resolution



1.6 km UCLA
2.2 km COSMO
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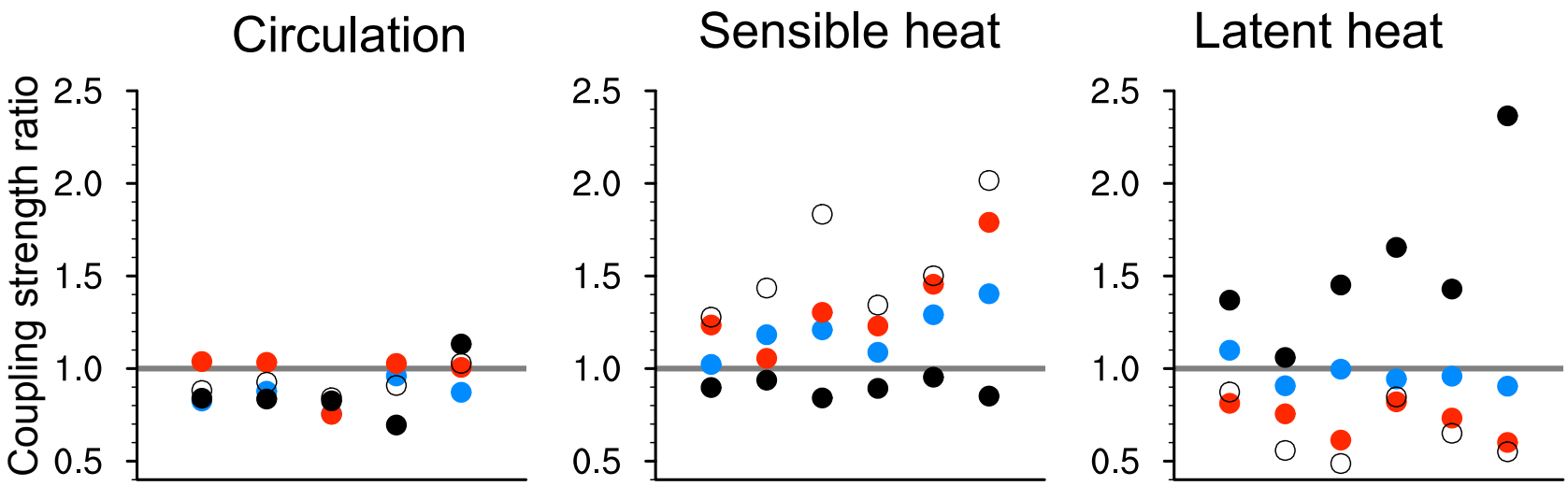
Coupling strength as function of model resolution



1.6 km UCLA
2.2 km COSMO
11 km COSMO

Summary

What determines the coupling strength between convection and the land surface ?

- Promising prospects using a multi-resolution approach
- Convection-permitting models too strongly coupled to sensible heat flux
- Coarse-resolution model underestimates the coupling to the mesoscale circulation and overestimates the coupling to evaporation
- Convective parameterization destroys the interaction between convection and the mesoscale circulation