Coastal Tropical Convection

an outline for a stochastic modeling approach

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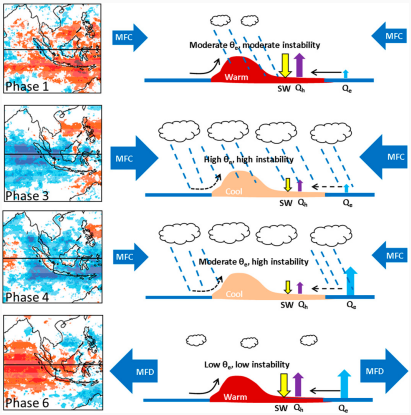
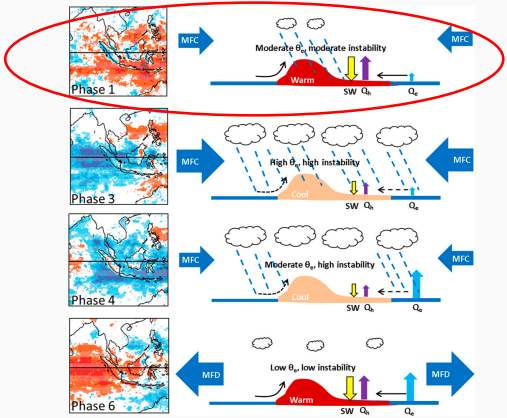
MJO ↔ MC rainfall



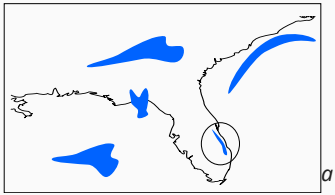
Birch et al. (J Clim 2016)

MJO ↔ MC rainfall



Birch et al. (J Clim 2016)

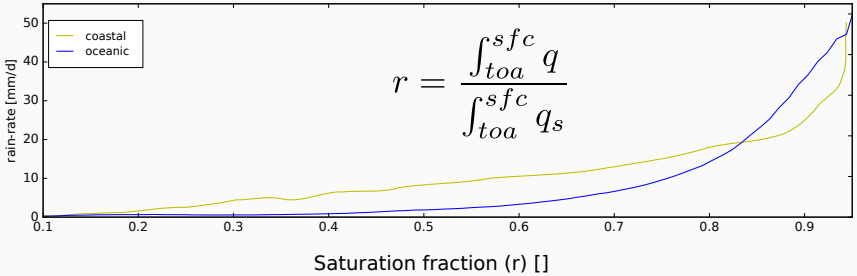
Rainfall ⟷ Humidity



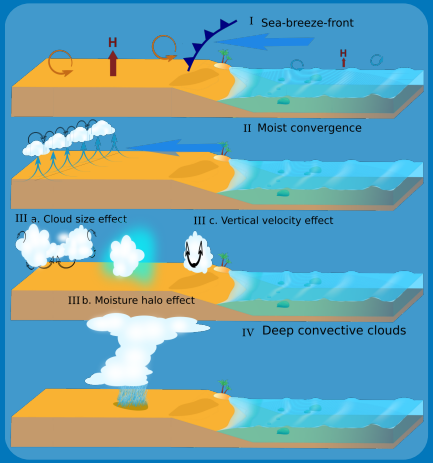
[a]Bergemann et al. 2015, JClim

Detect rainfall patterns:

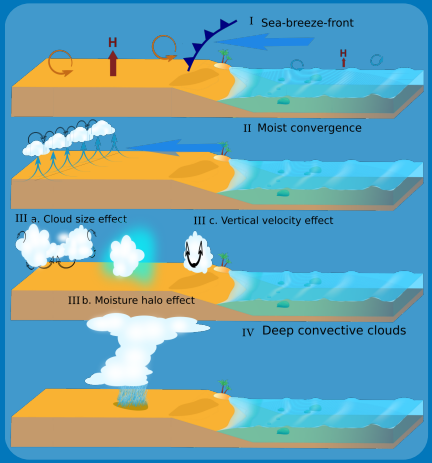
- occur in coastal areas
- are not synop scale
- are aligned with the coastline



$$r = \frac{\int_{toa}^{sfc} q}{\int_{toa}^{sfc} q_s}$$


I Sea-breeze-front
H
H
II Moist convergence
III a. Cloud size effect
III c. Vertical velocity effect
III b. Moisture halo effect
IV Deep convective clouds

When are coastal effects present?



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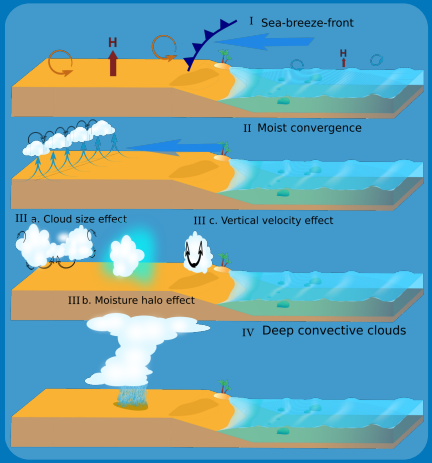
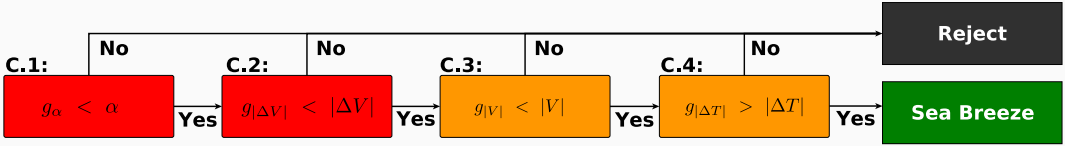


How to change the cu. param.?

Identification of sea-breeze conditions



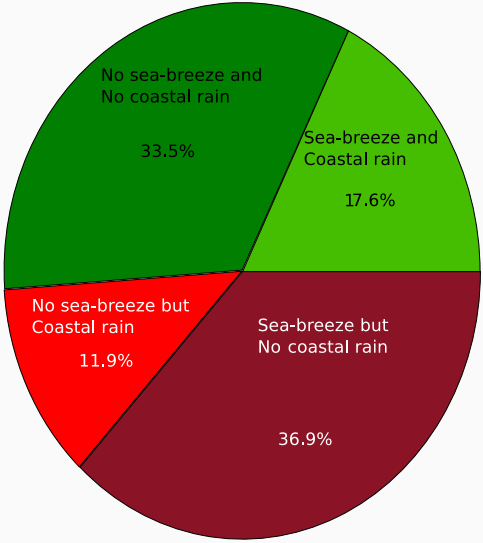
large-scale conditions only (Borne et al. 1998, Int J Clim)

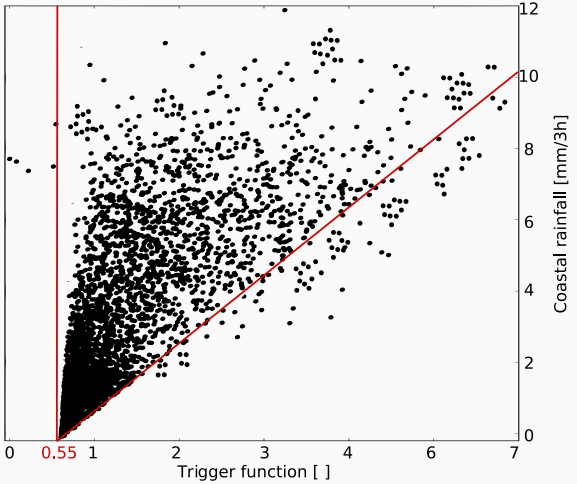
Binary (yes/no):

Scale the output by $|V|$ and $|\Delta T|$

$$f(t) = \begin{cases} 0 & \text{if } f(t) = 0 \\ \underbrace{\frac{|g_{\Delta T}(t)|}{\Delta T}}_{>0} \cdot \underbrace{\frac{|\vec{V}| - g_{|\vec{V}|}(t)}{|\vec{V}|}}_{>0} & \text{if } f_B(t) = 1 \end{cases}$$

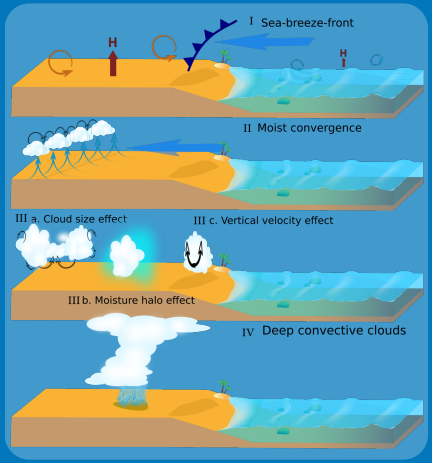
Performance test with coastal rainfall





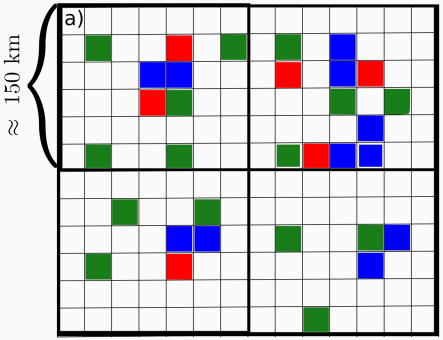
$$\Delta T = 1.75\ \mathrm{K}\ |\vec{V}| = 11\ \frac{\mathrm{m}}{\mathrm{s}}\ \Delta|\vec{V}| = 6\ \frac{\mathrm{m}}{\mathrm{s}}\ \Delta\alpha = 90^{\circ}$$

When are coastal effects present?



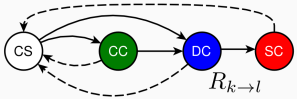
How to change the cu. param.?

The stochastic multi-cloud model (SMCM - Khouider et al. 2010)



b) Congestus Deep Stratiform

c)



$$R_{k\to l} = F\left(X_k, E(q,c), U_k\right)$$

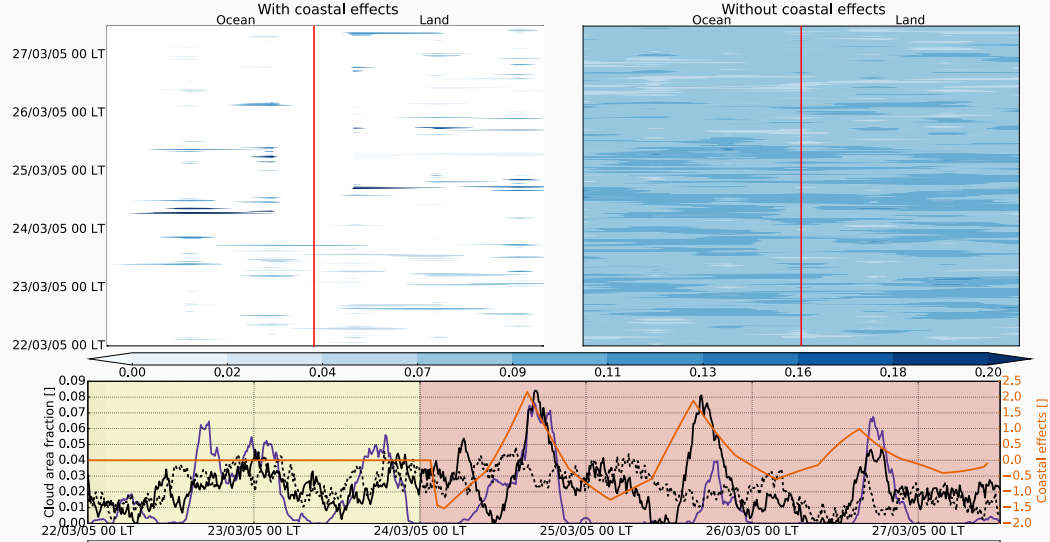
State — Background atmosphere — Neighbors

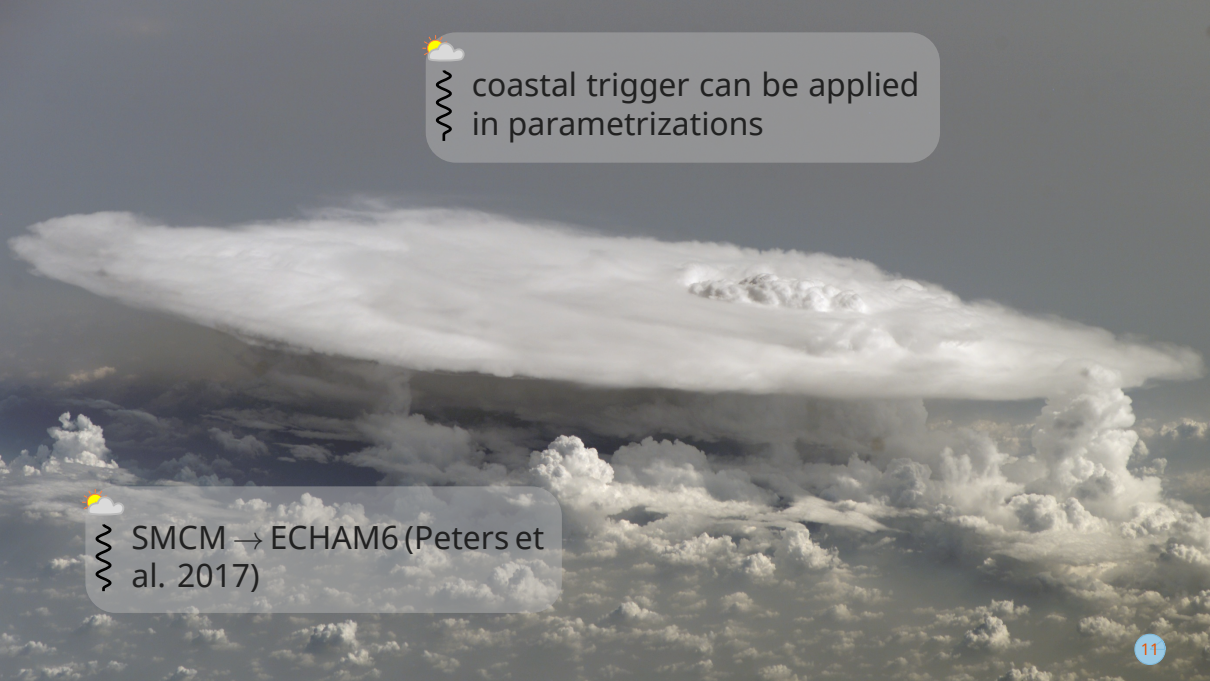
$$CAF_k = \Pi_k^l P(k|l)$$

calculate transition rates R_{kl} of 3 cloud types

Increase/decrease occurrence of convection according coastal effects.

A real world example-Darwin, Australia




coastal trigger can be applied in parametrizations
SMCM → ECHAM6 (Peters et al. 2017)