Steady-state solutions of clouds topped boundary layer in a perturbed climate

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Introduction and motivations

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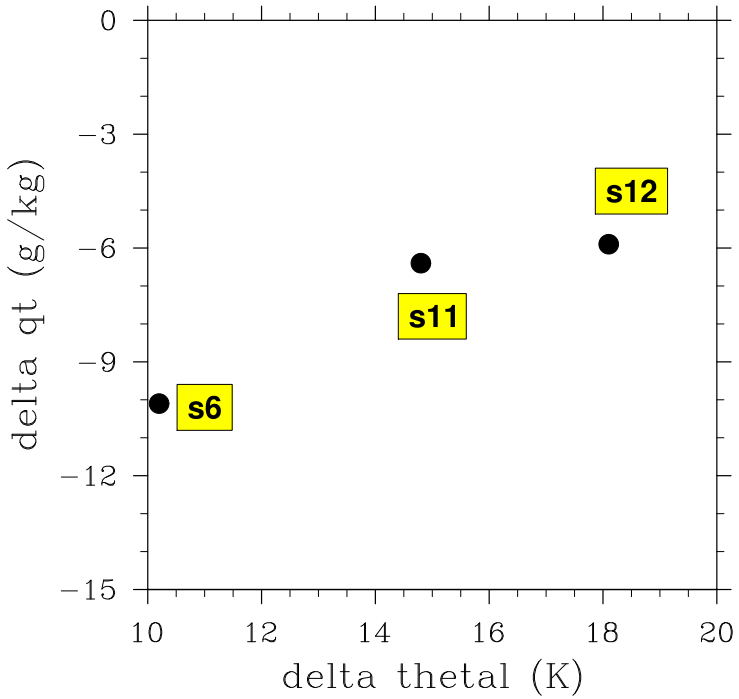

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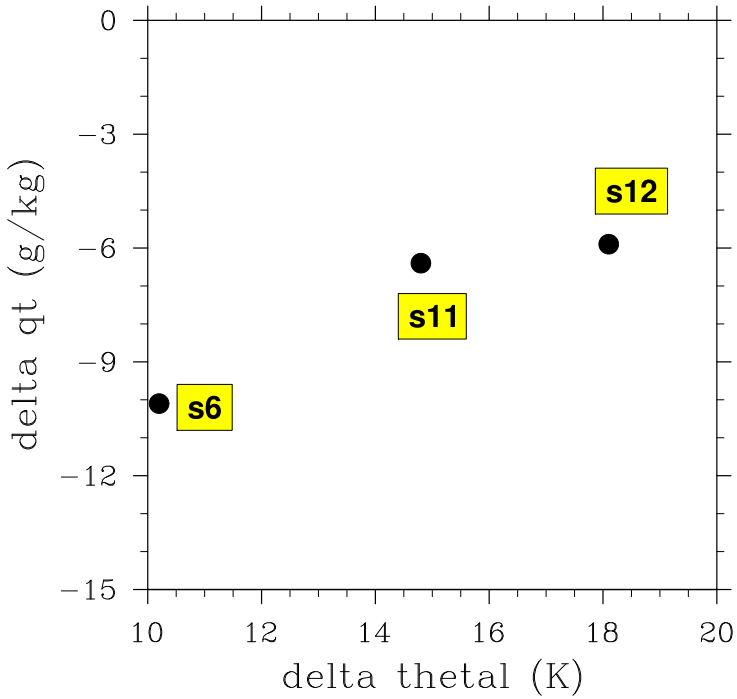


New framework based on CGILS for mapping the entire phase space.

Scientific questions

1. Which are the physical mechanisms which arise marine boundary layer clouds deepening or breakup?
2. What is the role of free atmospheric conditions?
3. How do the entrainment parametrizations influence model results?
4. What is the effect of perturbed large scale conditions which are intended to mimic climate changing?

Outline

- description of the framework;
- preliminary sensitivity study;
- perturbed climate;
- summary and outlook.

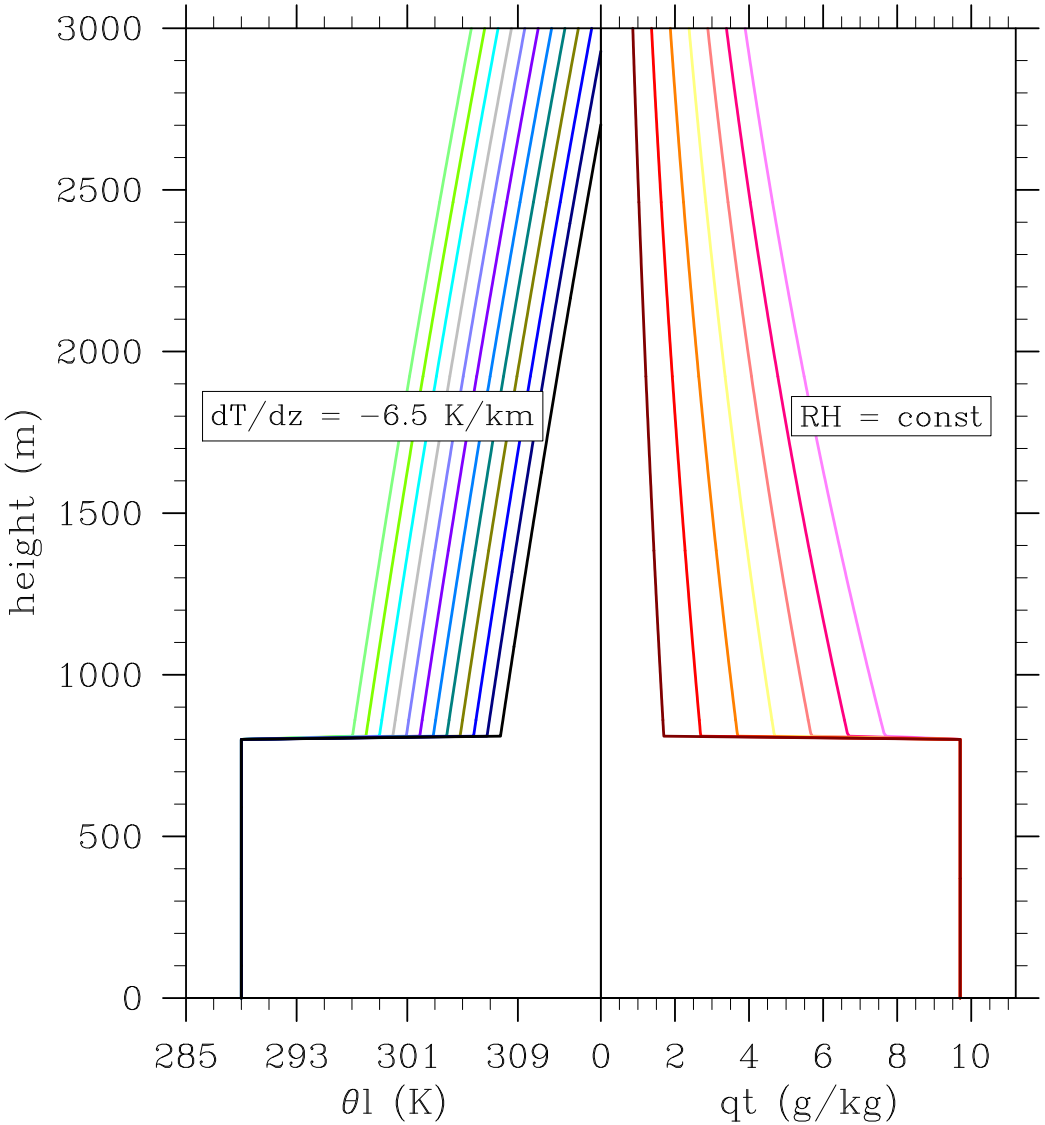
Large-scales forcings

- SST $= 292.5$ K
- subsidence:

$$\overline{w} = \begin{cases} D \cdot z \quad \text{where} \quad D = 5 \cdot 10^{-6} s^{-1} & z \leq 2000.m \\ w_{const} \quad \text{where} \quad w_{const} = D \cdot 2000.m & z > 2000.m \end{cases}$$

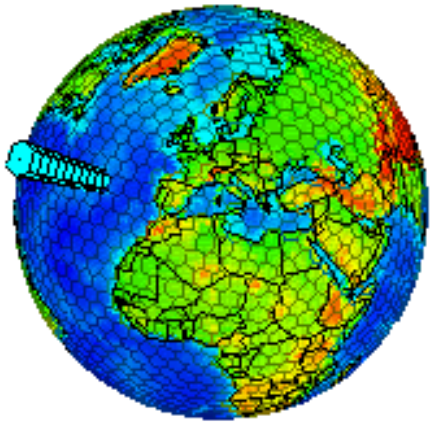
- nudging above cloud layer
- no diurnal cycle, constant zenith angle (52.0)

Initial conditions



$$\Delta\theta_l \in [5.; 16.]K$$
$$\Delta q_t \in [-8.; -2.]g/kg$$

Preliminary sensitivity study



Duration: 100 days
Vertical grid: L80

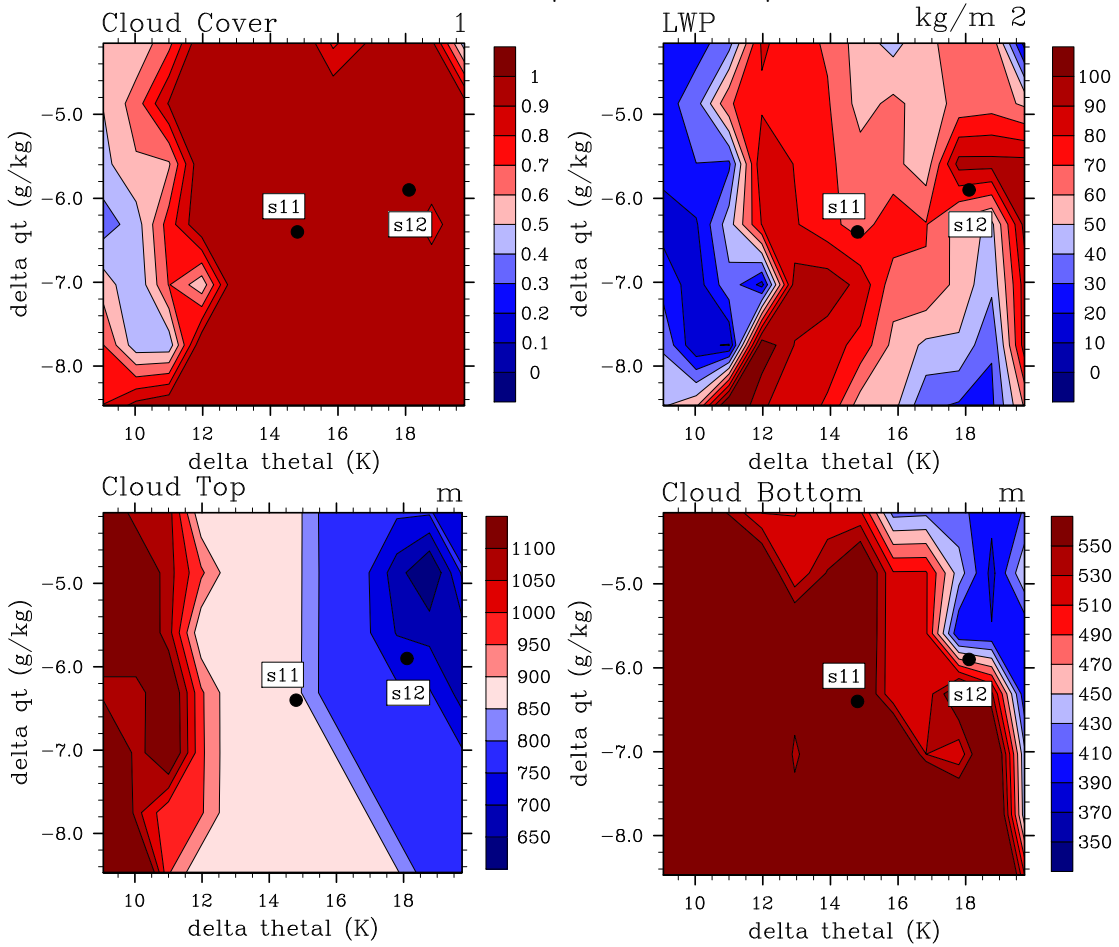
Ec-Earth (k-prof)	RACMO (TKE)
k-profile	TKE
$k = w_e \Delta z$	$k = f(TKE)$
w_e *Lock and MacVean 1999*	

k-prof results

$$\Delta\theta_l = \theta_l|_{2000m} - \theta_l|_{surface} \sim LTS + 6.5$$

$$\Delta q_t = q_t|_{2000m} - q_t|_{surface}$$

dry



wet

cold warm

TKE results

$$\Delta\theta_l = \theta_l|_{2000m} - \theta_l|_{surface} \sim LTS + 6.5$$

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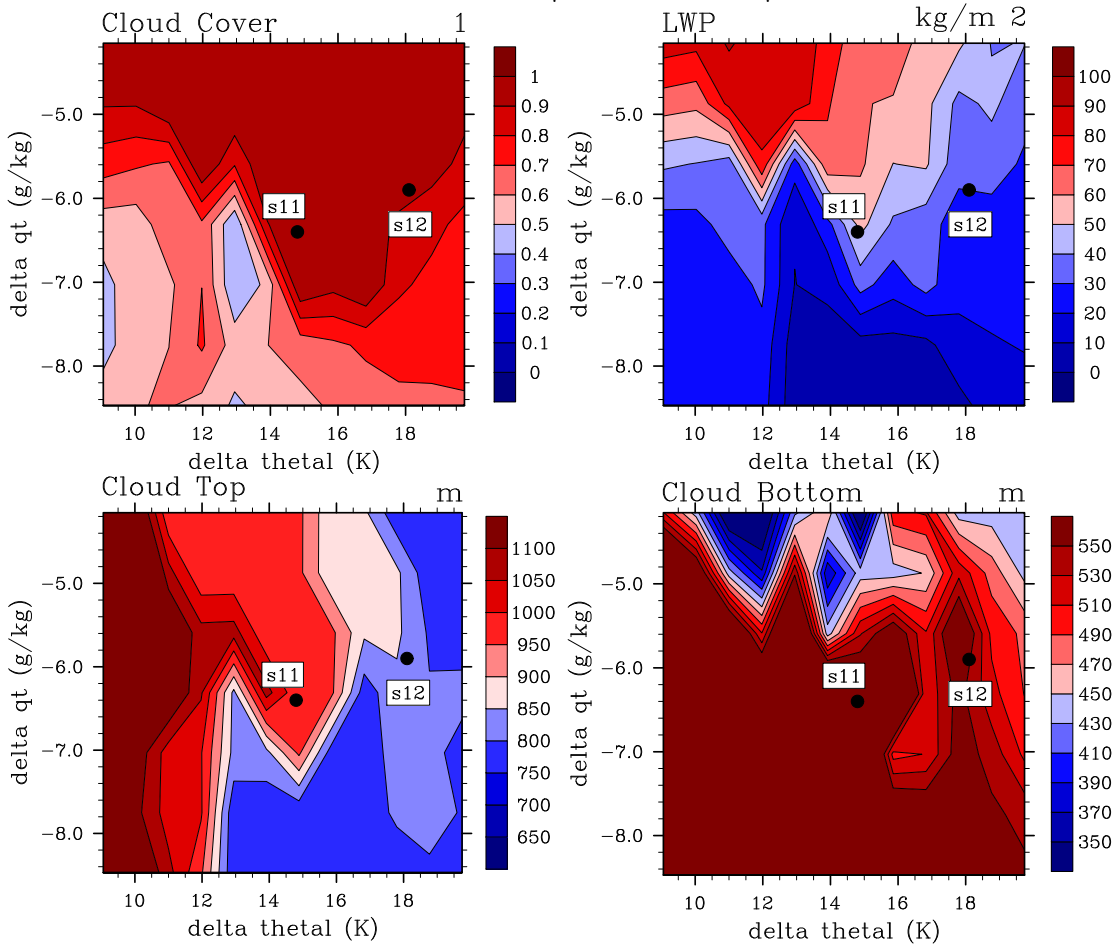
dry

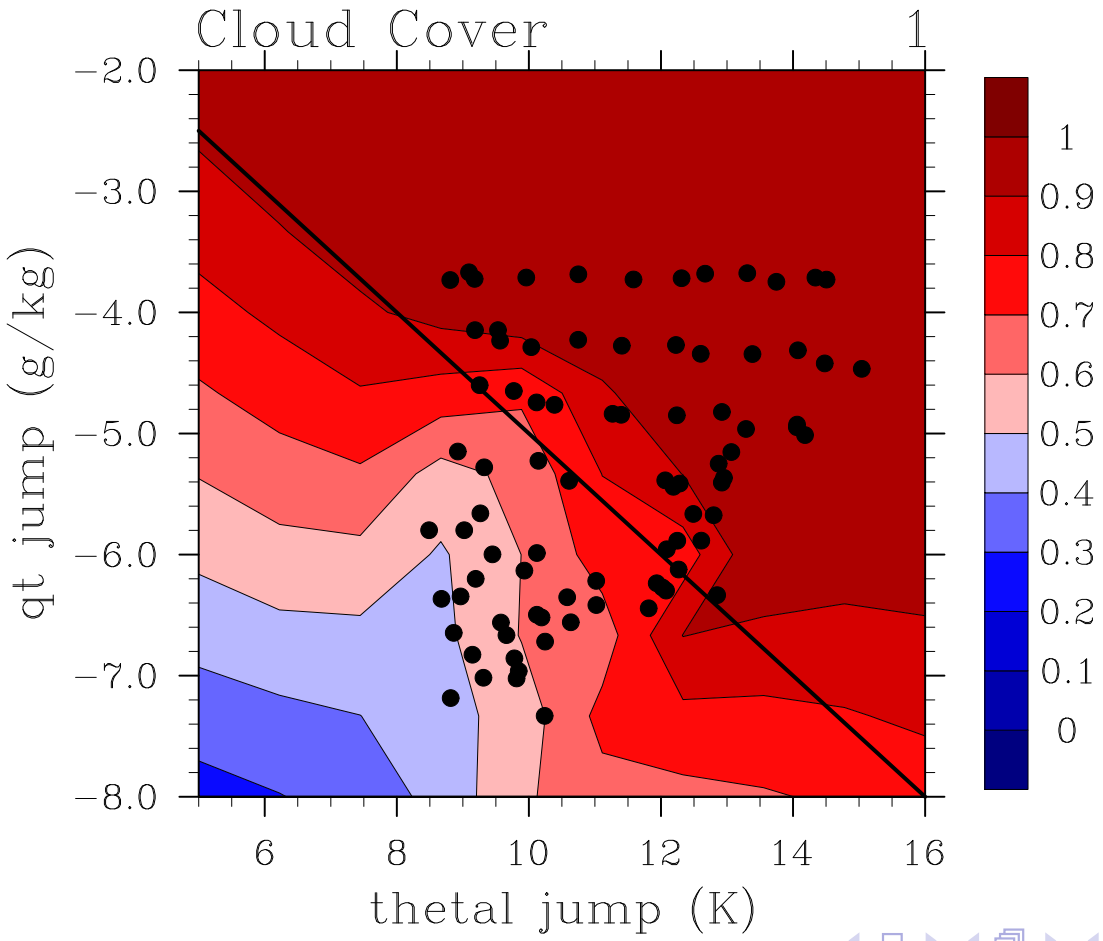


wet

cold warm

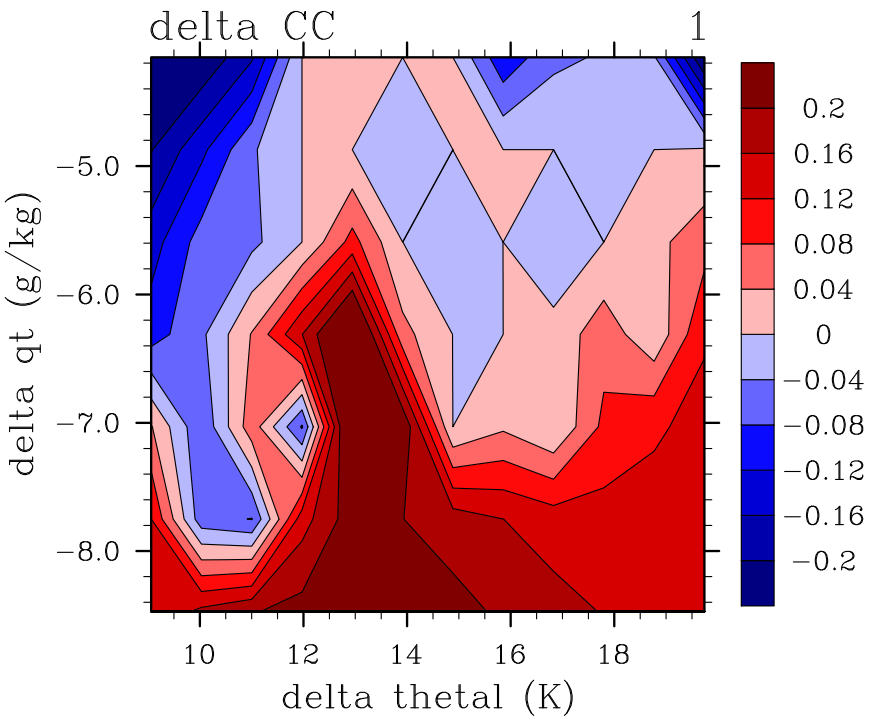
TKE results

actual jumps

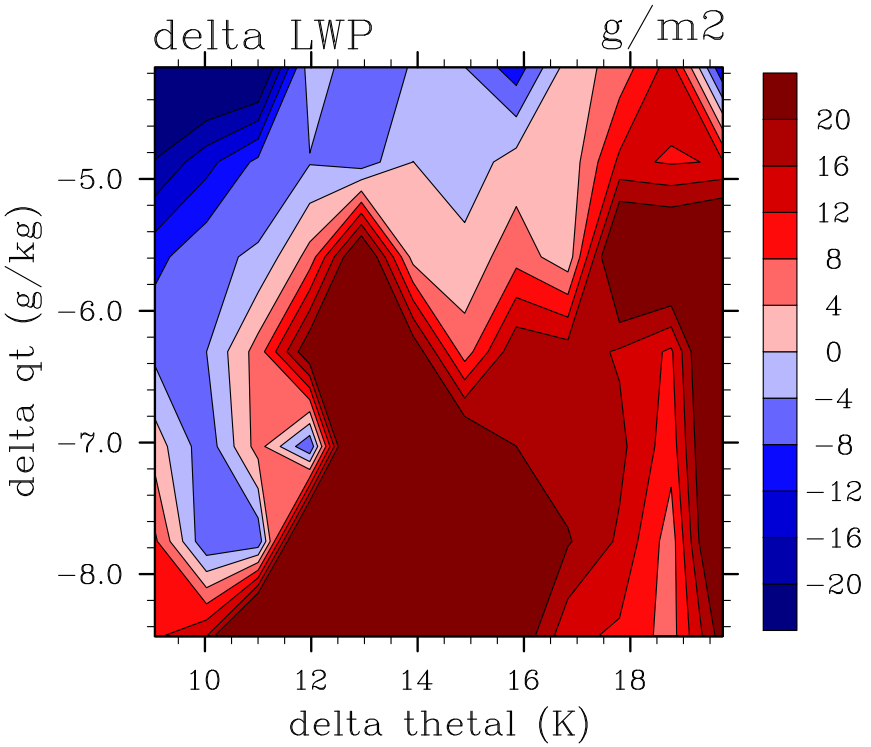


Scheme influence

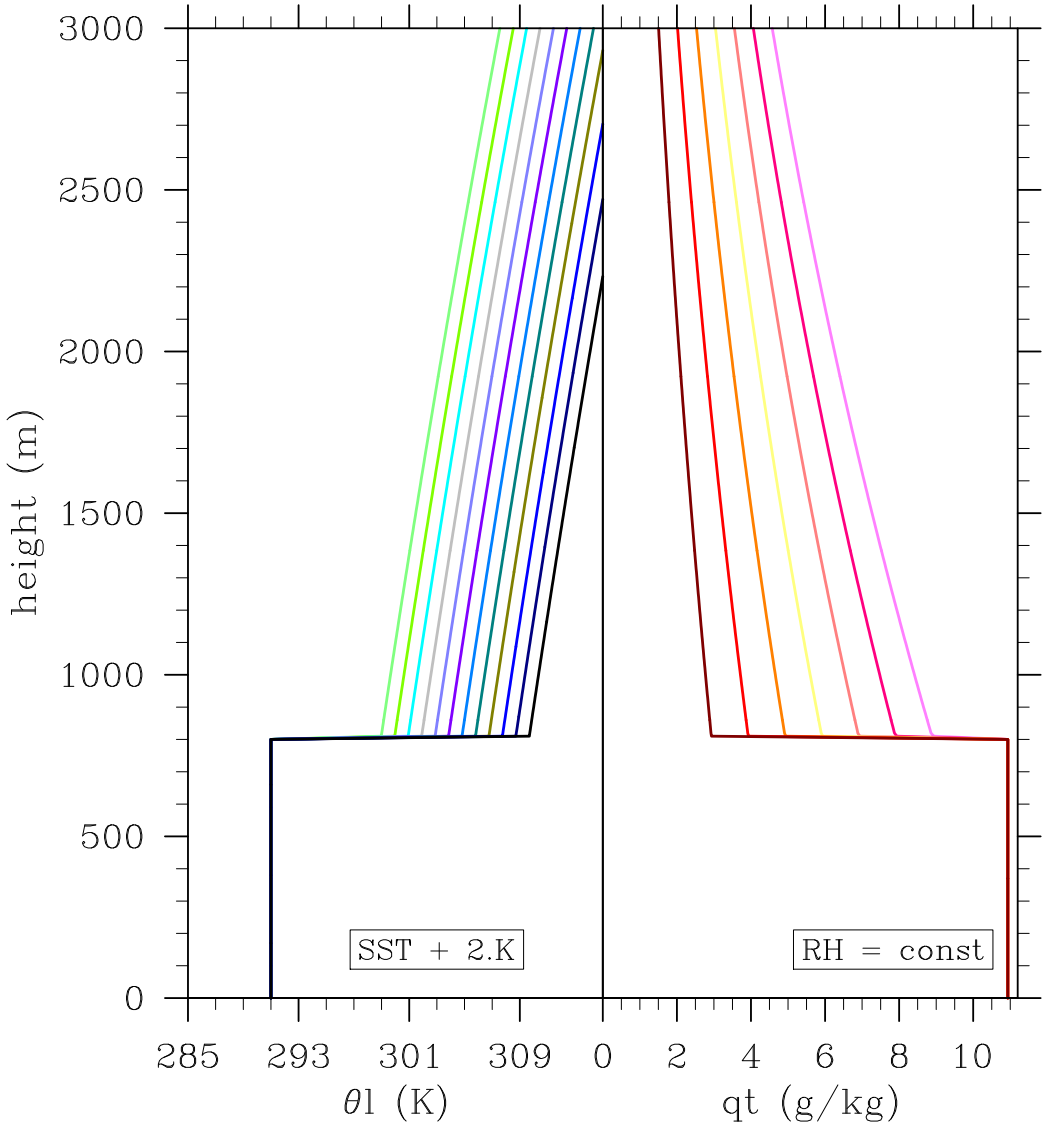
$$\Delta CC = CC|_{k-prof} - CC|_{TKE}$$



$$\Delta LWP = LWP|_{k-prof} - LWP|_{TKE}$$



Large-scale forcings perturbation



$$\begin{cases} \overline{w'} = \overline{w} \cdot 0.9 \\ SST' = SST + 2.K \end{cases}$$

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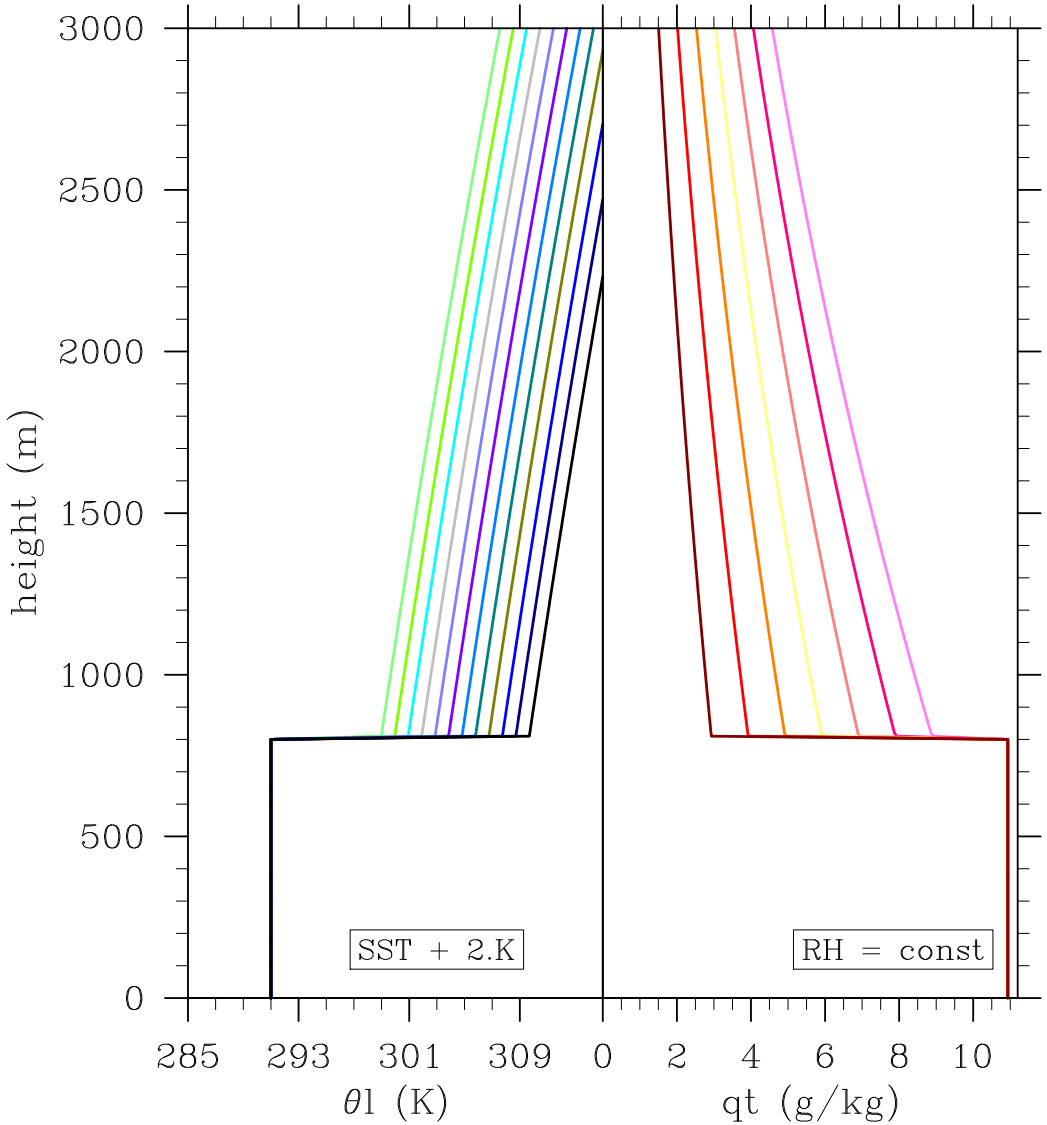

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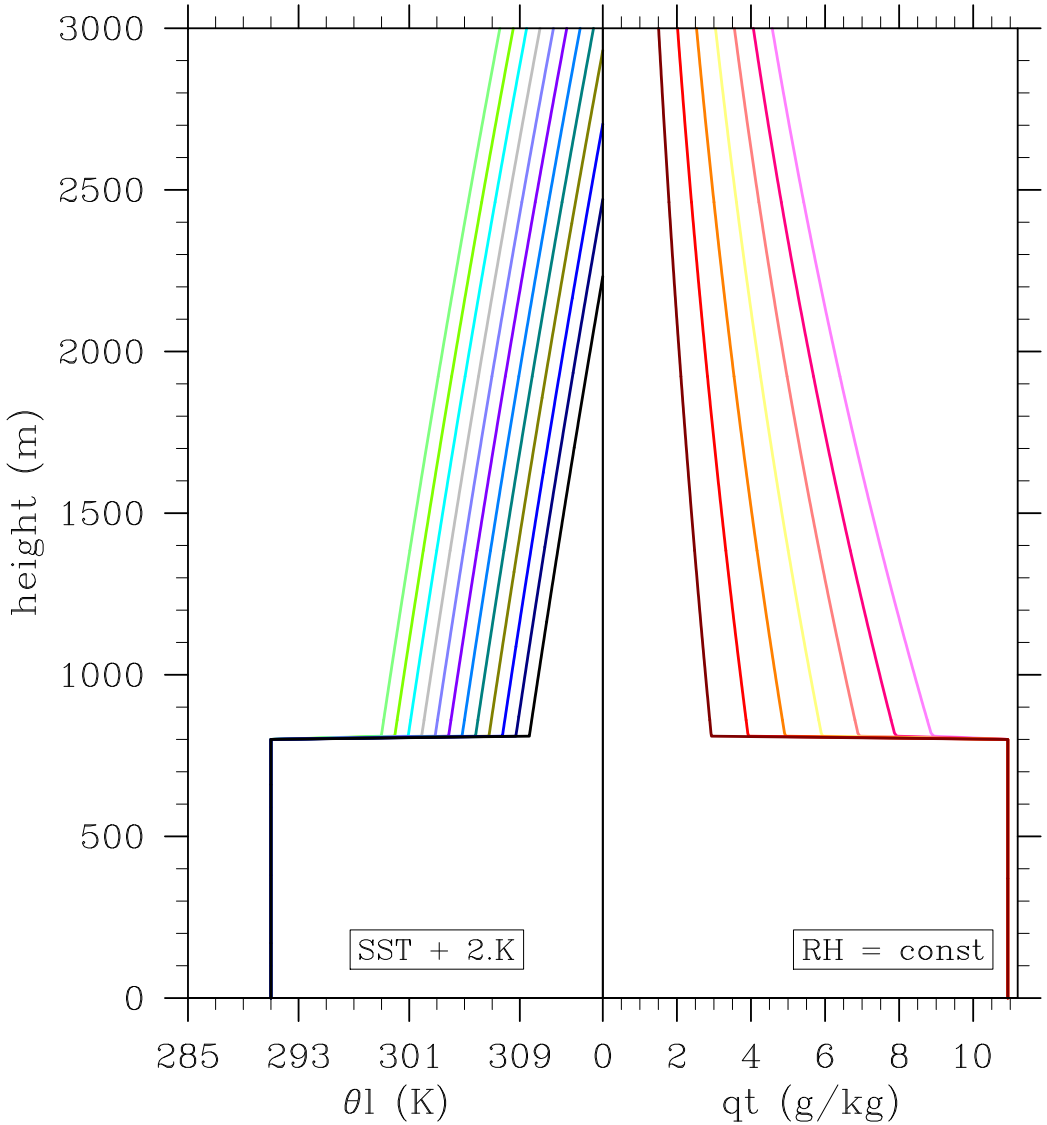

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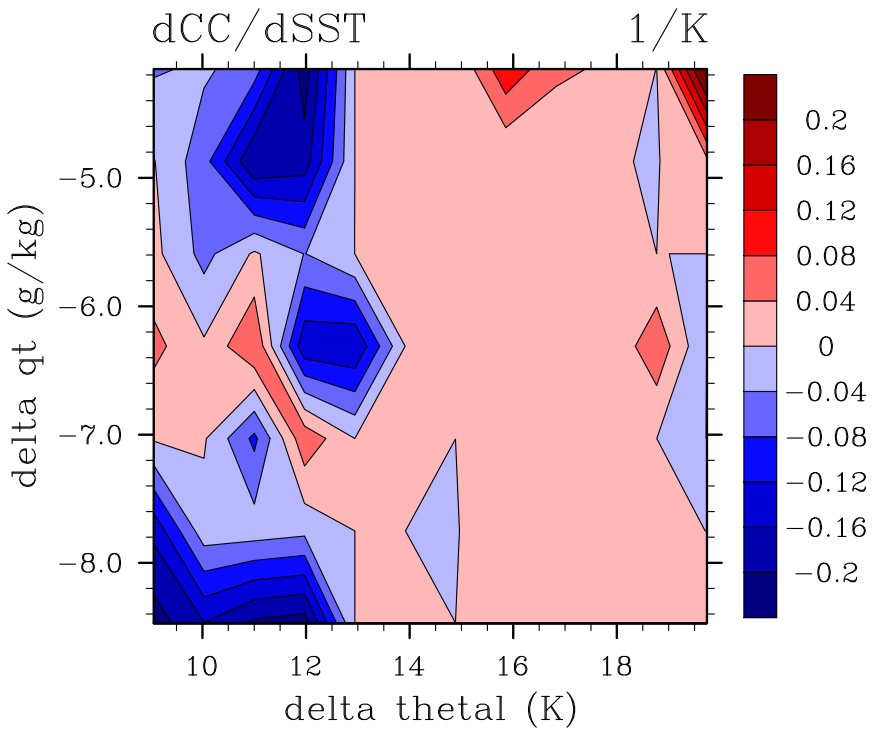
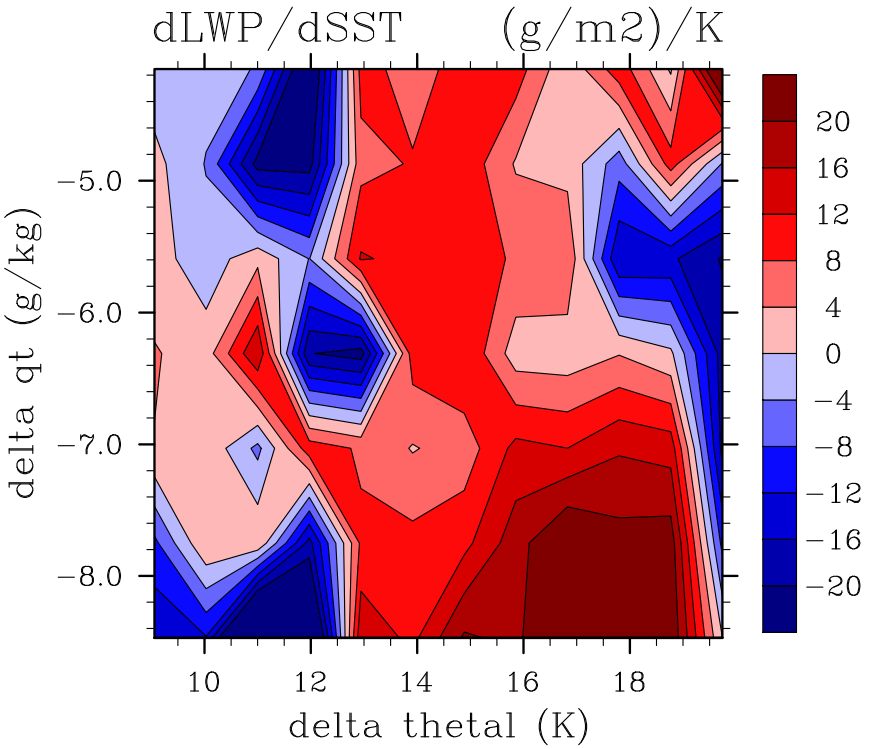
$$RH = const \Longrightarrow q_t'$$

k-prof results

$$\frac{dCC}{dSST} = \frac{(CC|_{PC} - CC|_{CTL})}{\Delta SST}$$

$$\frac{dLWP}{dSST} = \frac{(LWP|_{PC} - LWP|_{CTL})}{\Delta SST}$$





TKE results

$$\frac{dCC}{dSST} = \frac{(CC|_{PC} - CC|_{CTL})}{\Delta SST}$$

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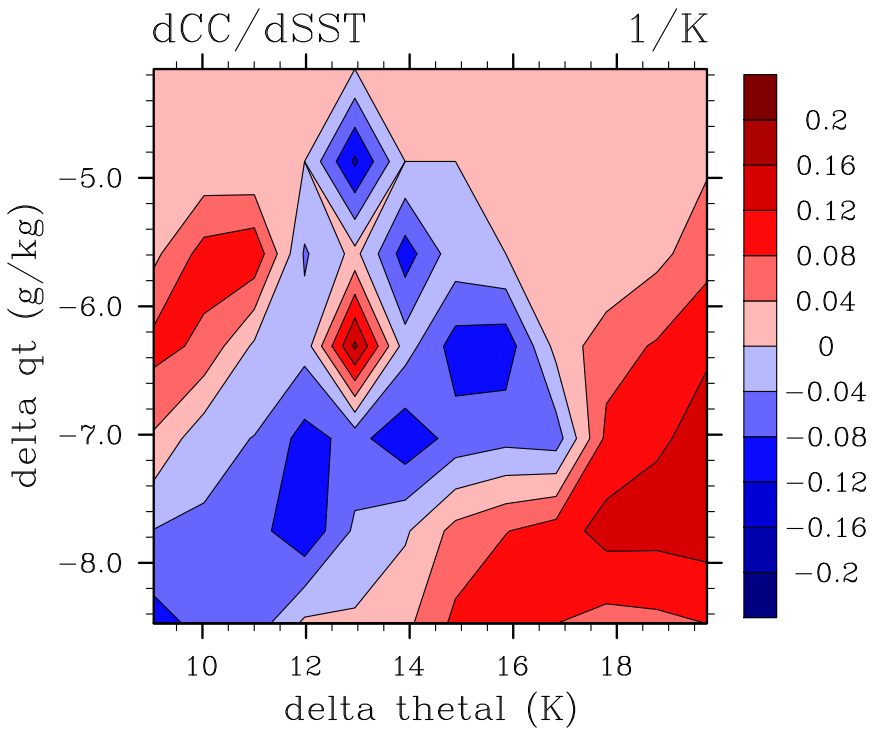

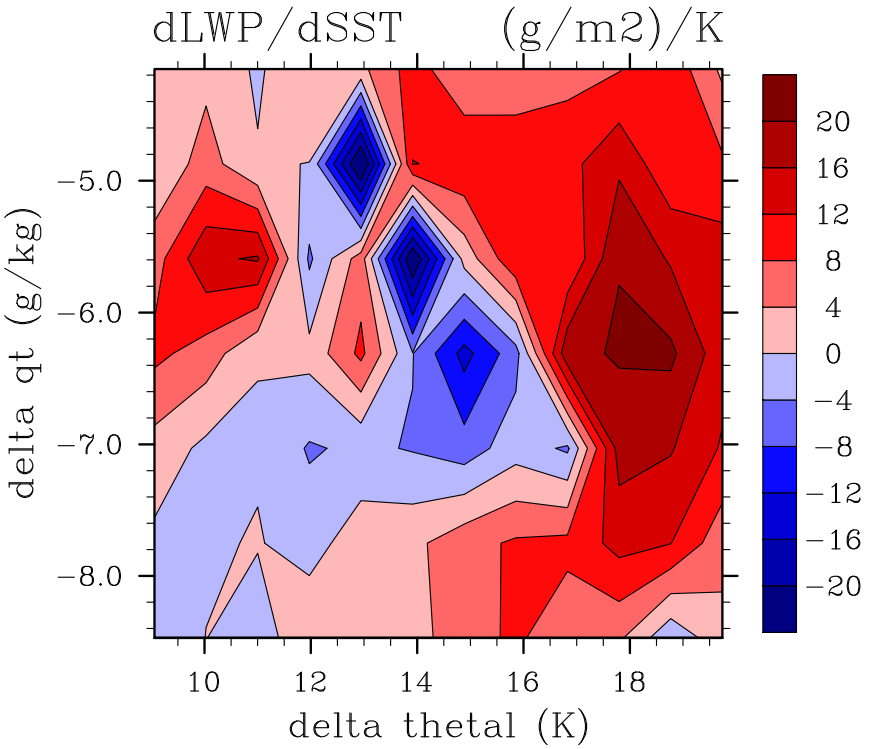

Summary and outlook

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new framework for mapping the entire phase space: advantages:

- ➜ comprehension of physical mechanisms
- ➜ gain of knowledge about transition and break-up
- ➜ understand and evaluation of different BL parametrizations

Preliminary conclusion:

- ✓ negative feedback in the stratocumulus dominated region of the phase space

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Outlook:

- ⇛ sensitivity study: different entrainment parametrization
- ⇛ comparison with MLM and LES results
- ⇛ could it be a good framework also for other EUCLIPSE models?

Thank you!