Estimating the low-cloud climate feedback through steady-state analysis of single column models

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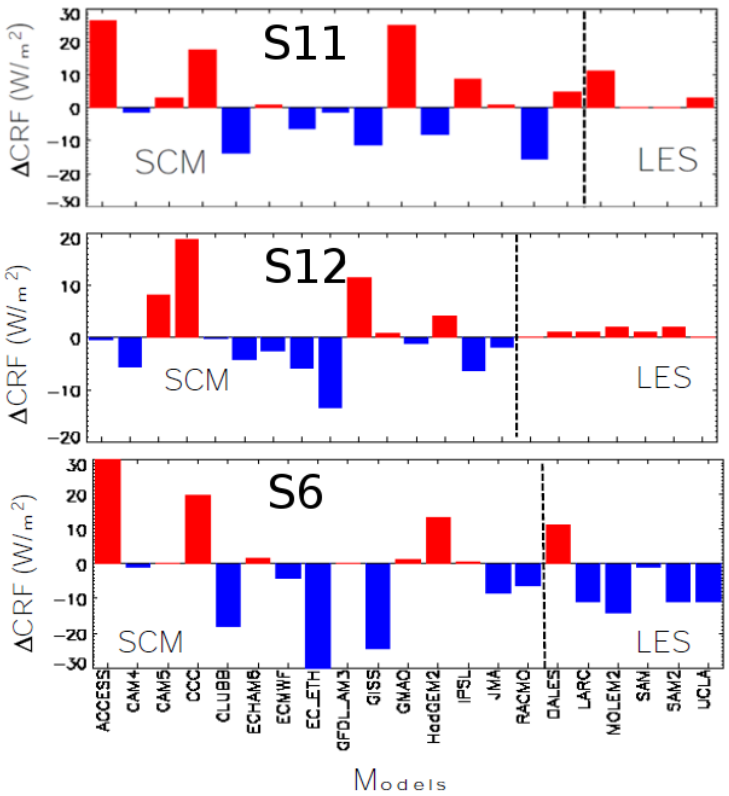
EUCLIPSE/CFMIP meeting - MPI Hamburg
12 June 2013

A CGILS extension



Zhang et al., 2013

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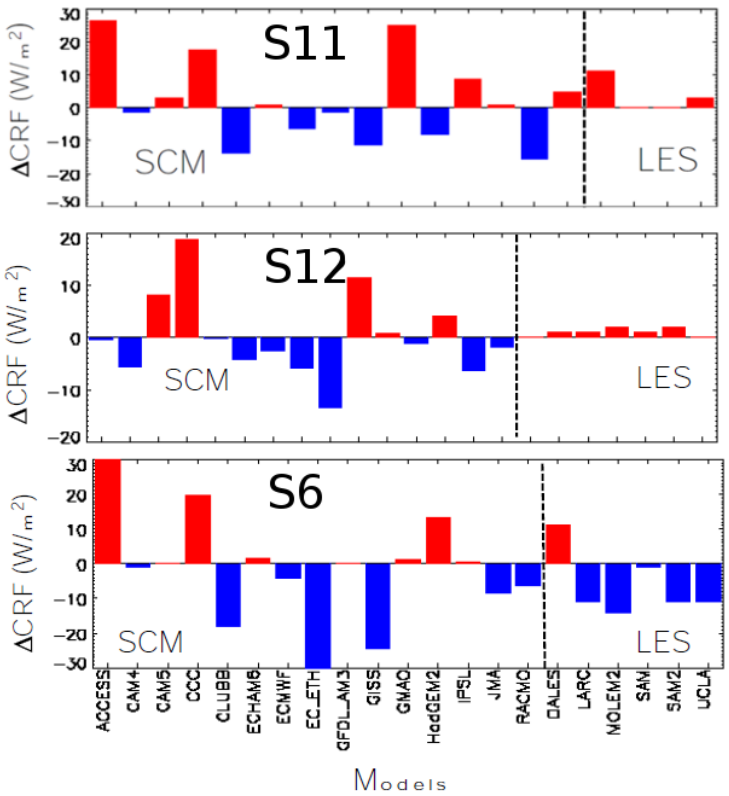

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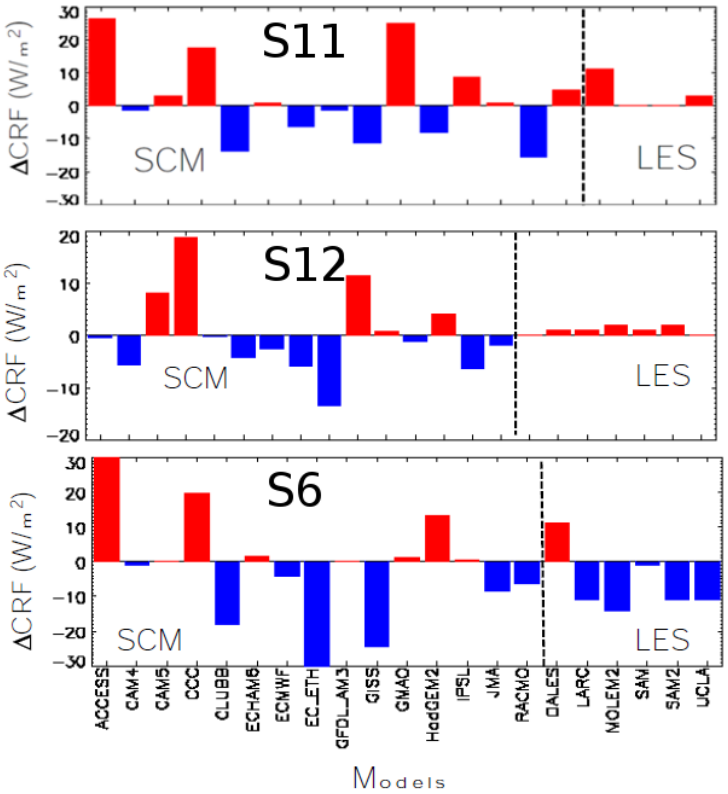

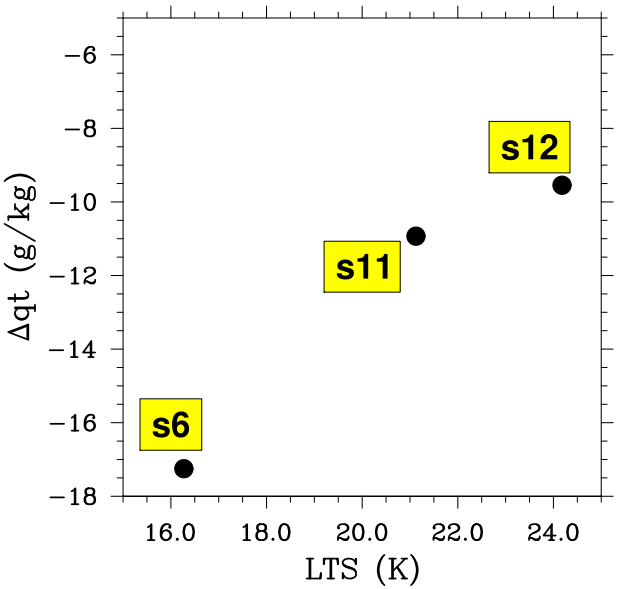

Zhang et al., 2013

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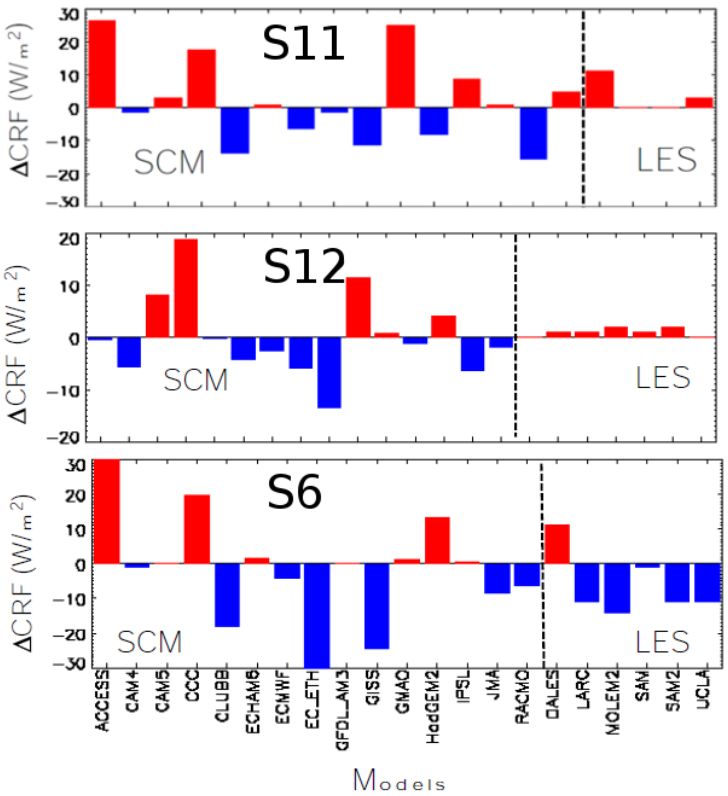
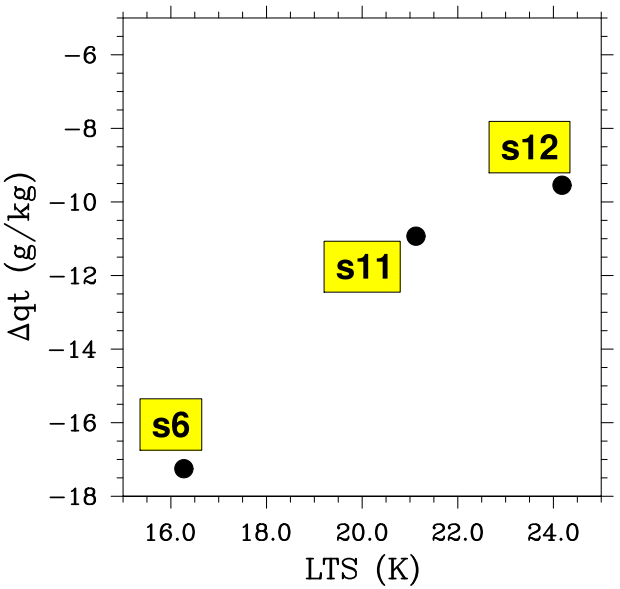
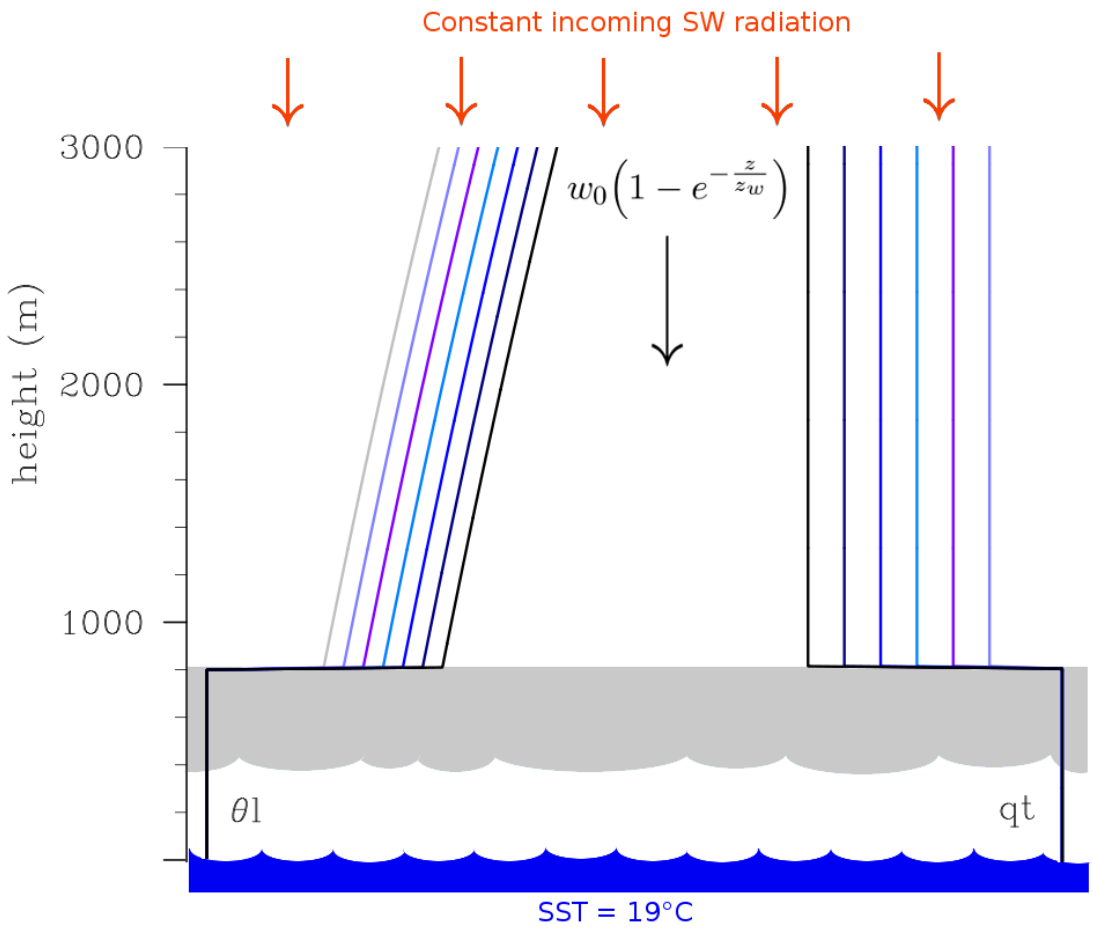


Zhang et al., 2013



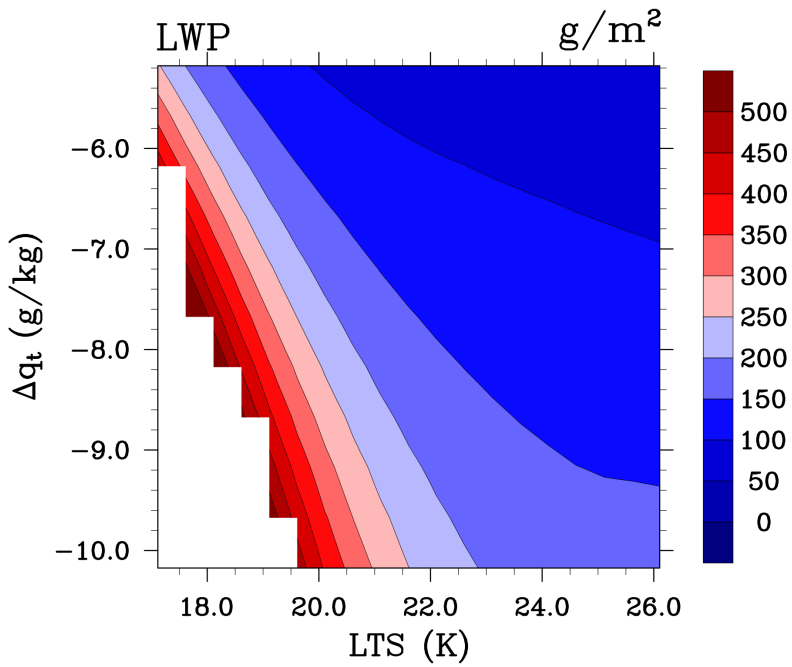
Idea: extend the Mixed-Layer Model study to Single Column Models.

Experiment set-up

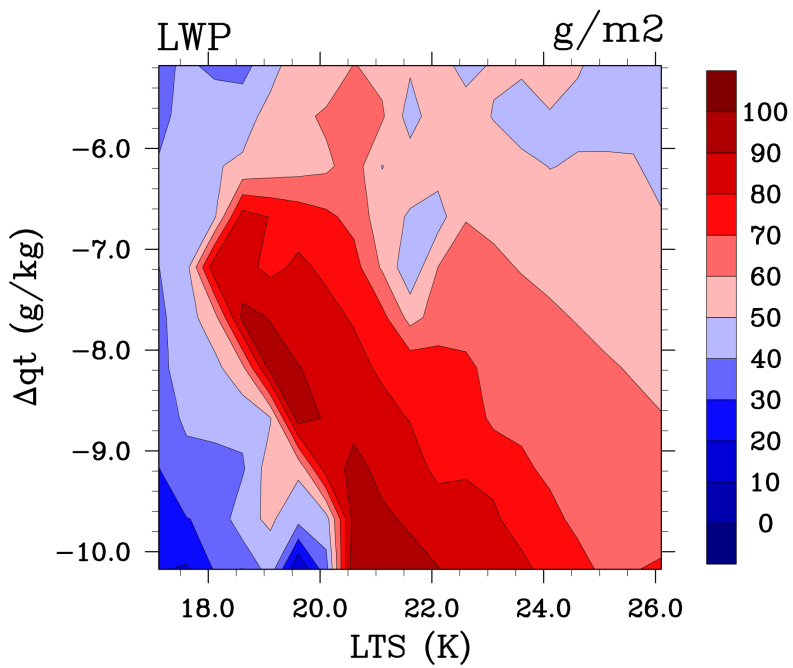


Control climate: LWP

MLM



EC-EARTH + dualM



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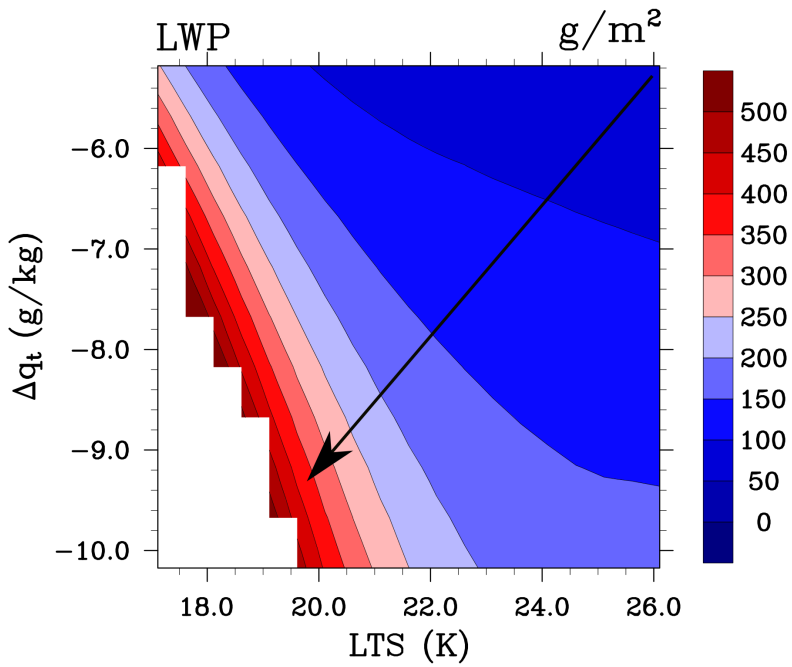

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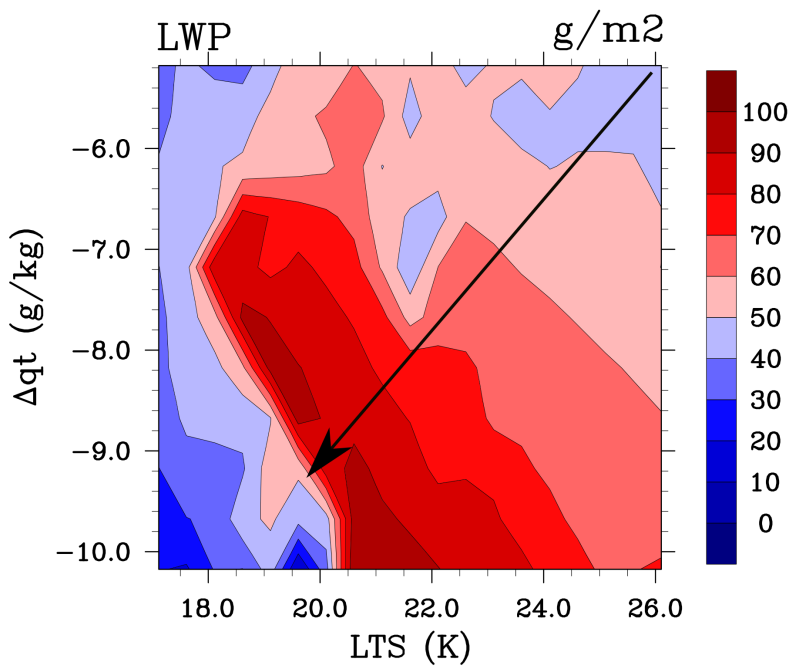

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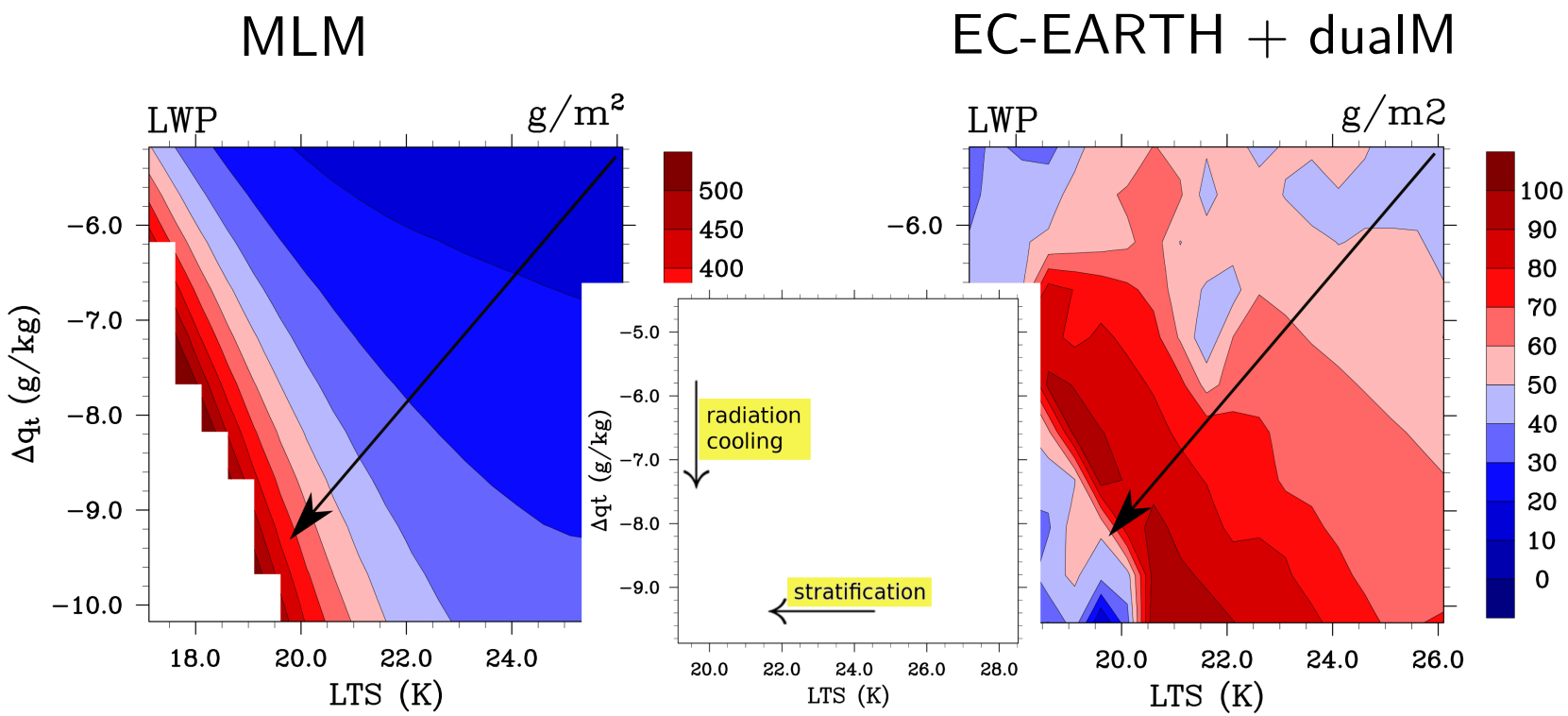
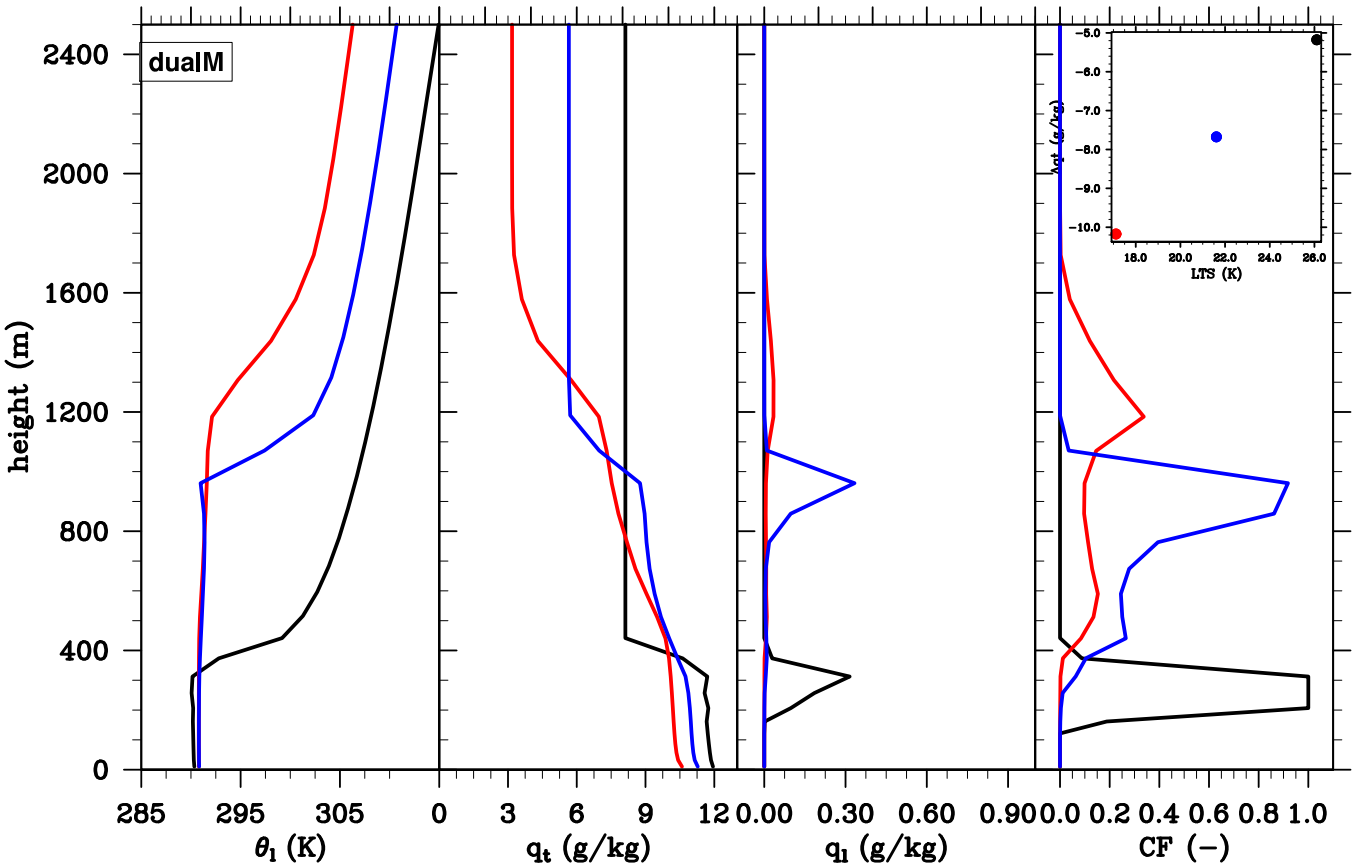
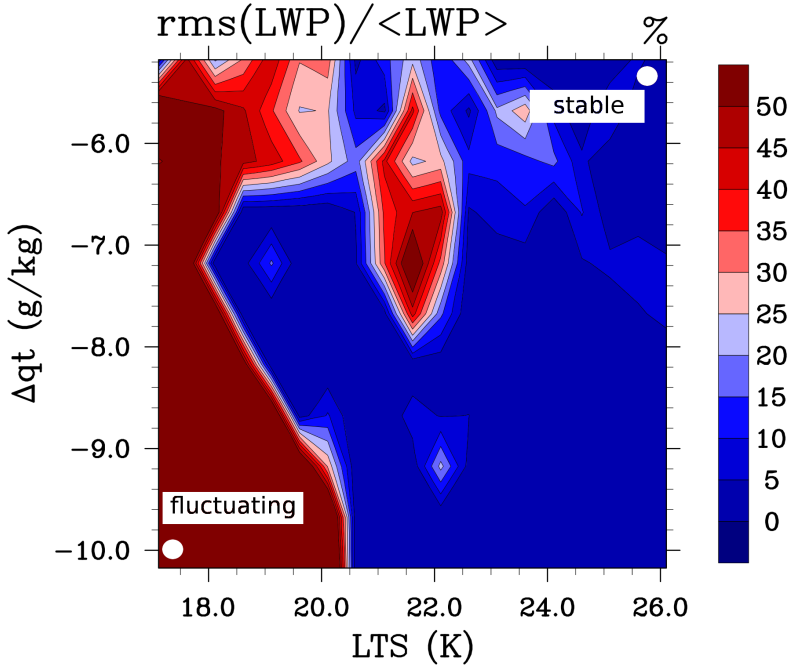


Control climate: vertical profiles



Stratocumulus to cumulus transition.

How steady are our steady states?



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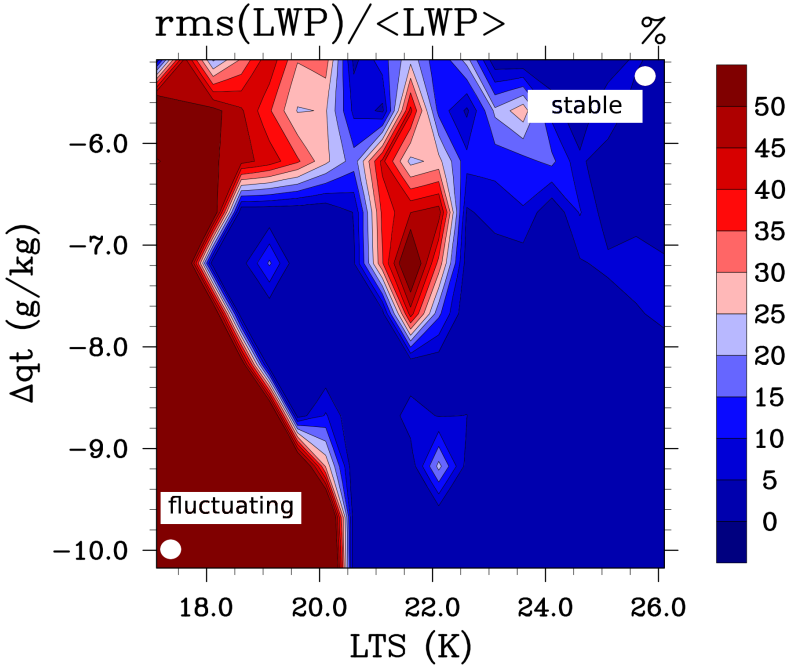
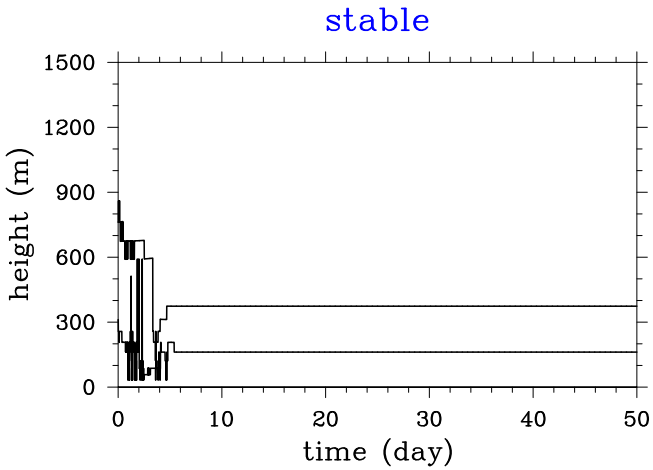
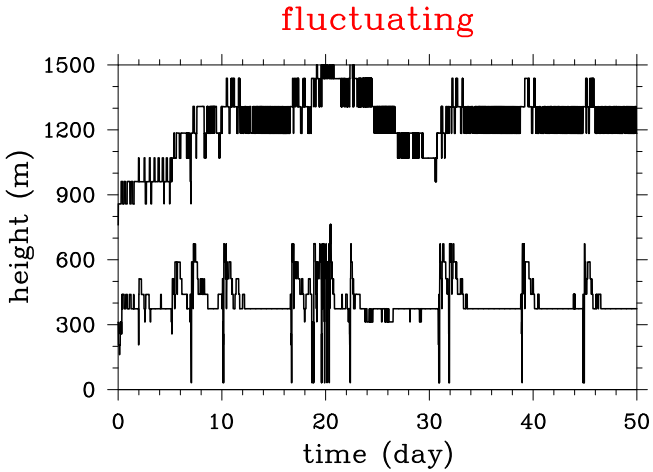
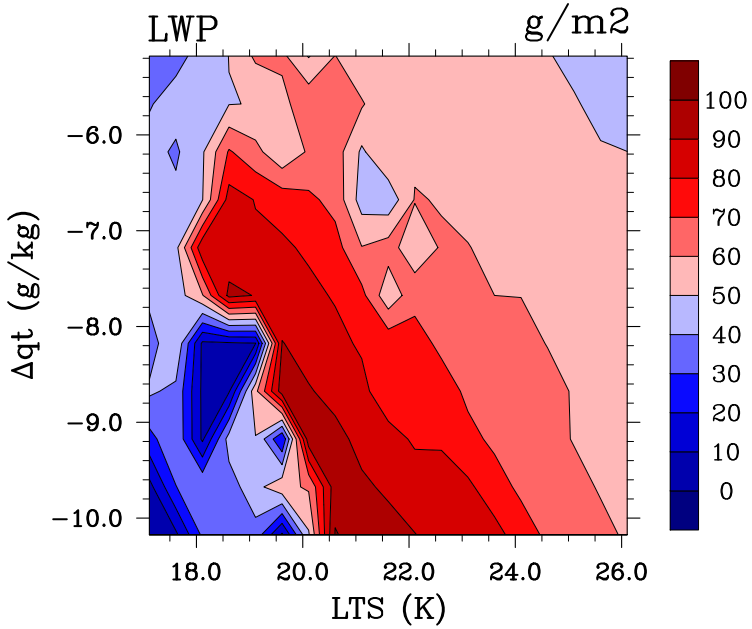






How important are the initial conditions?

Clear sky initial condition



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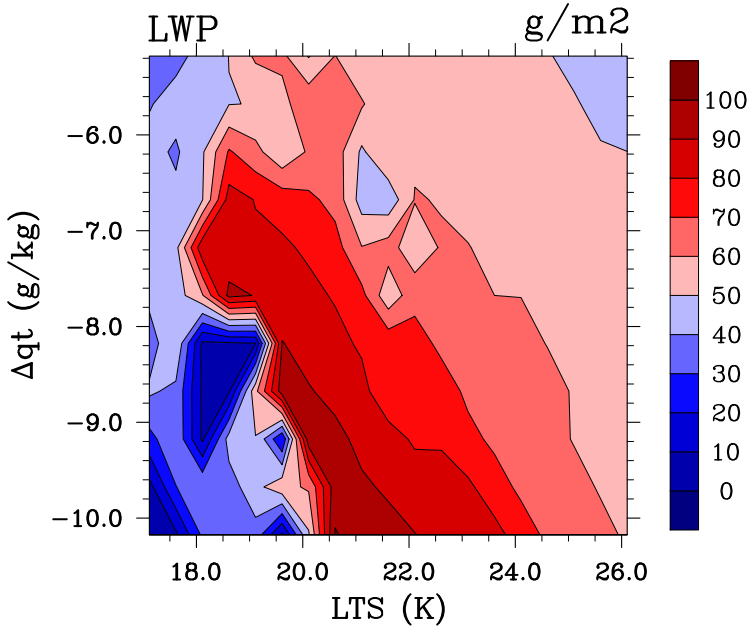
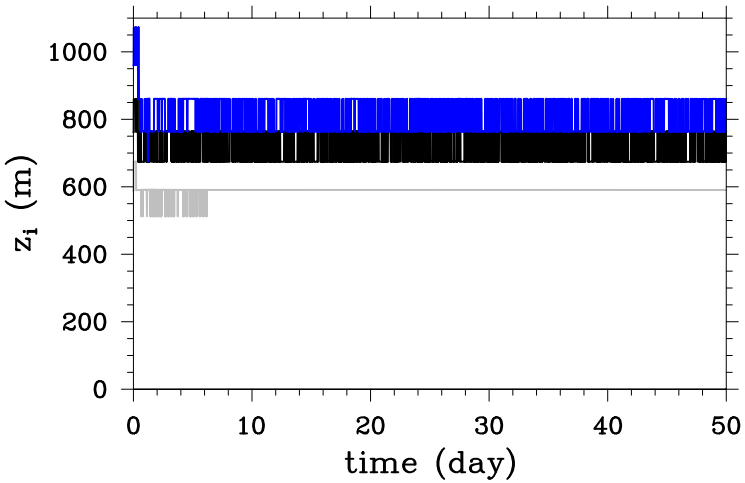


Different initial ABL height



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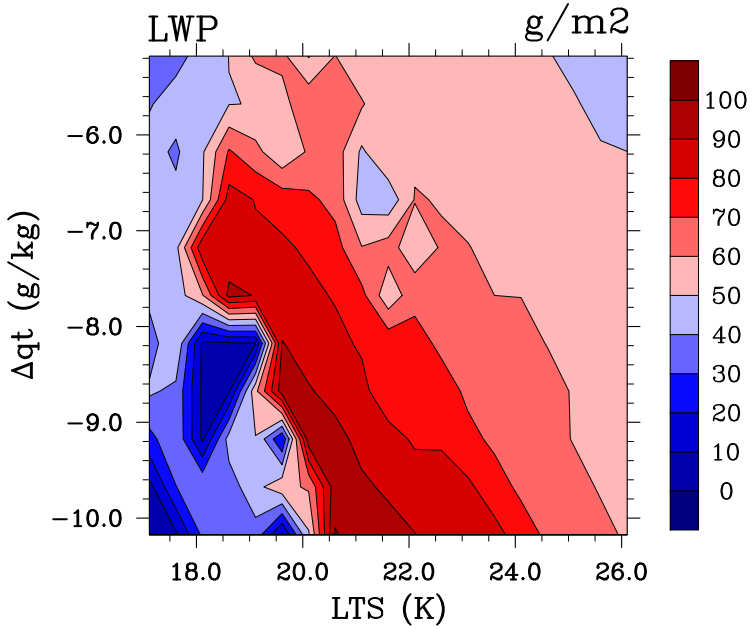

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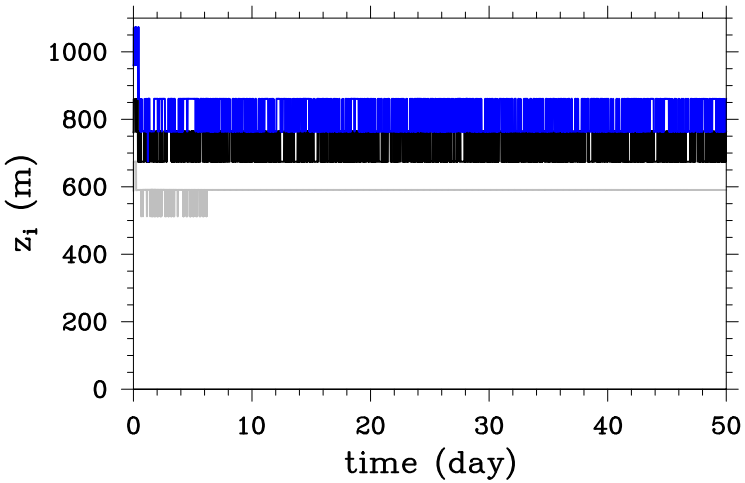
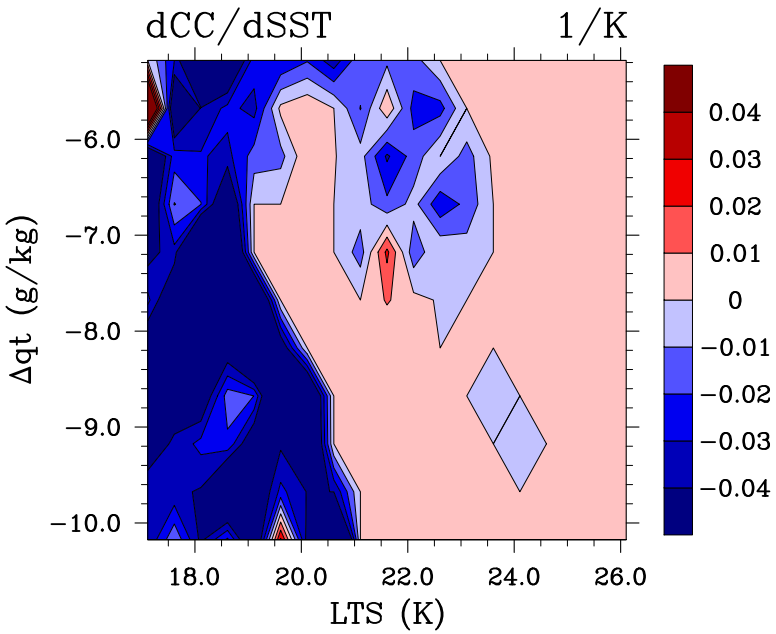


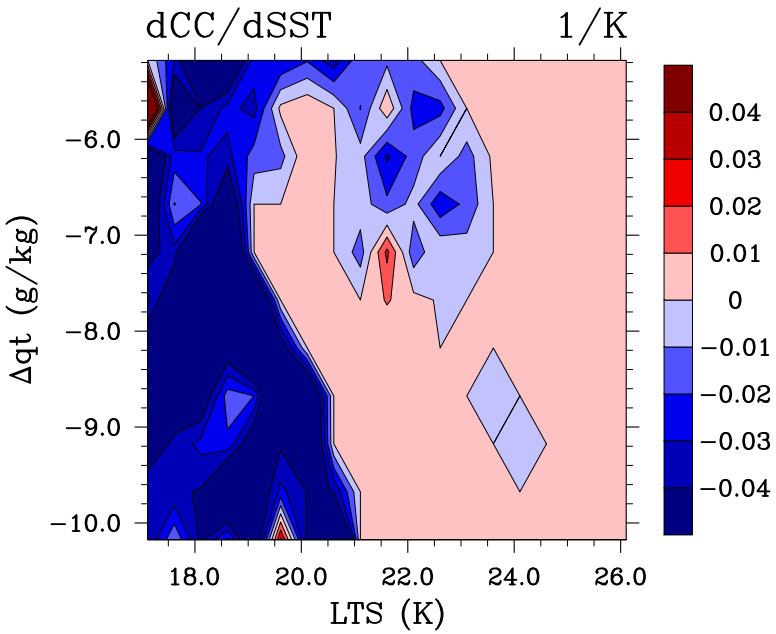
The qualitative pattern is not affected while the quantitative results are influenced by the initial conditions.

Response to a climate perturbation



Increase in broken-cloud regime: in line with MLM.

Response to a climate perturbation



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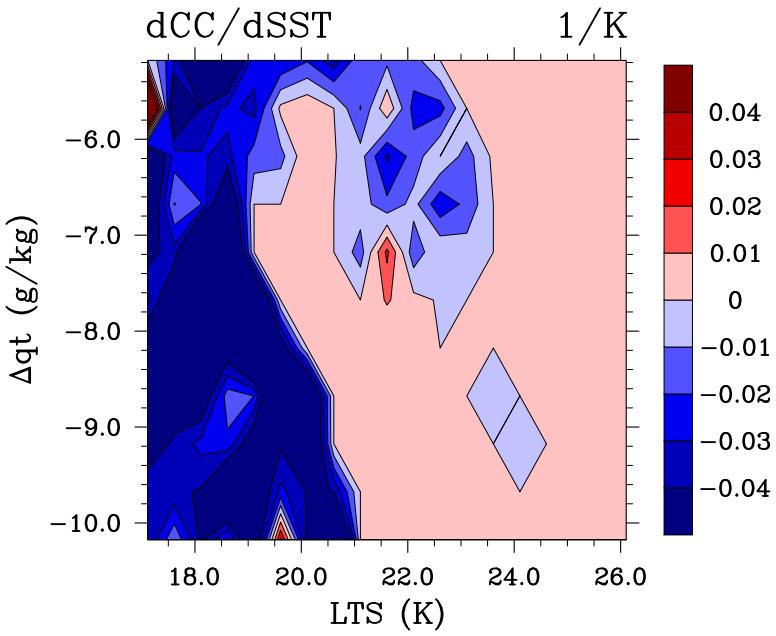
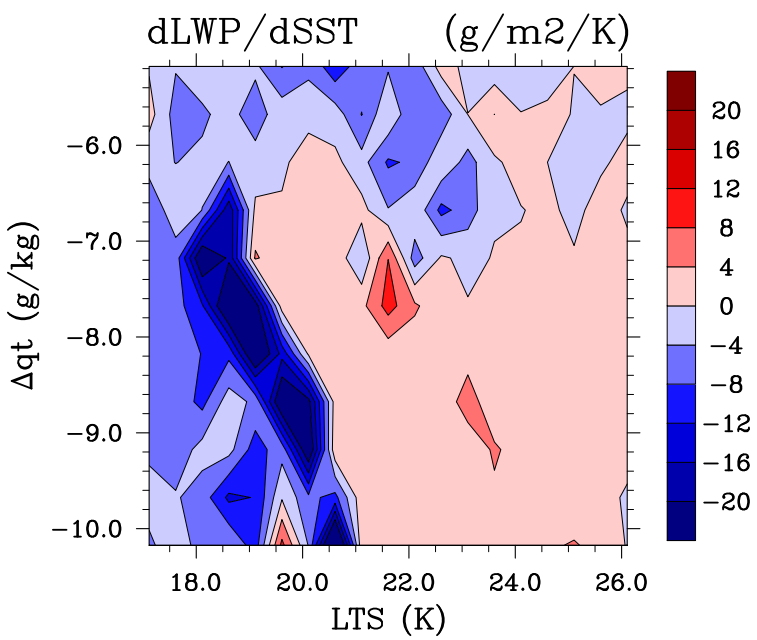
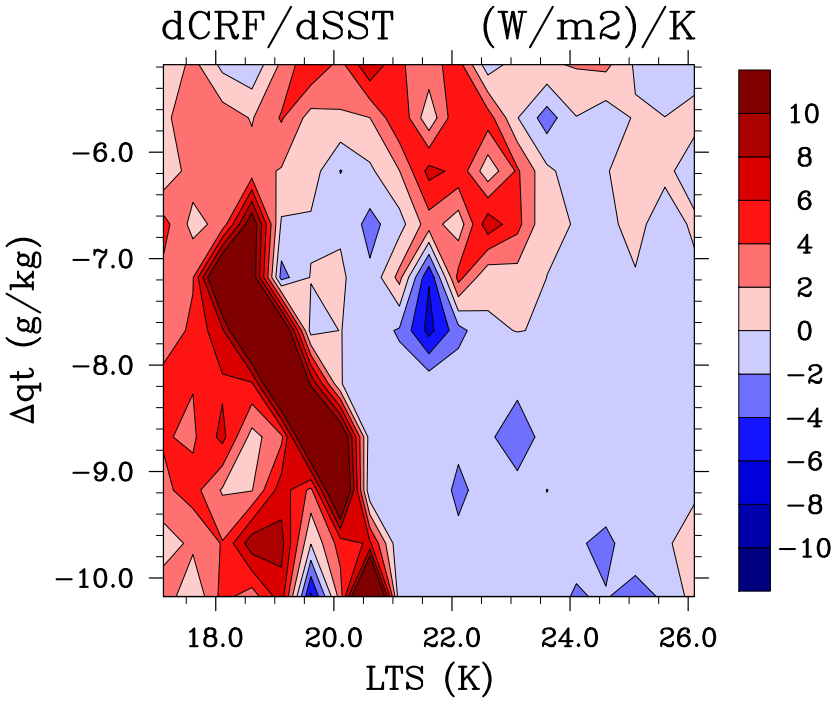




Increase in broken-cloud regime: in line with MLM.

Increase in LWP: NOT in line with MLM.

Response to a climate perturbation



- Scu is a very robust system in our model;
- increase in broken-cloud regime overcompensates the Scu thickening $\longrightarrow$ positive feedback.

Conclusions and outlook

Conclusions:

- for **present climate** the LWP pattern in the phase space is in good agreement with MLM;
- the beginning of a Scu to Cu transition is found with broken cloud regime in the region where MLM predicts decoupled ABL;
- for the considered **perturbed climate** Scu gets slightly thicker (not in line with MLM);
- the increase in the broken-cloud regime area is the dominating effect leading to a positive feedback.

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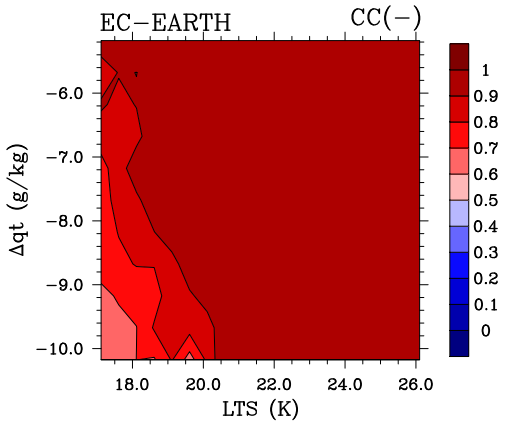
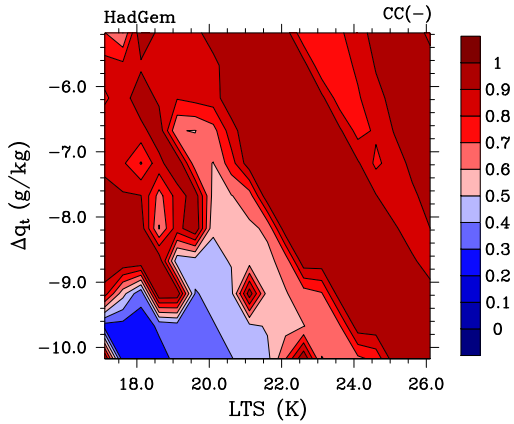
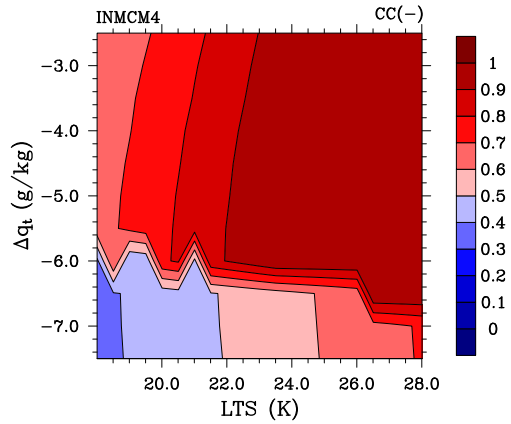
Outlook:

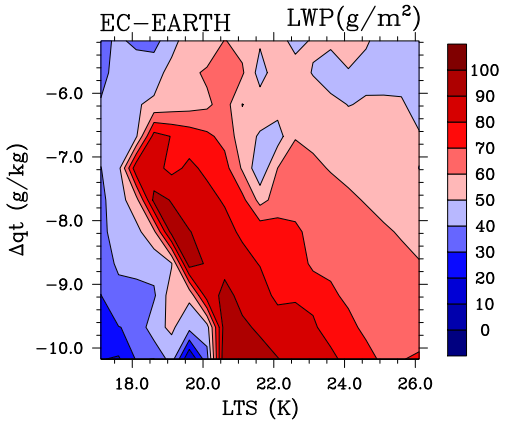
- SCM intercomparison study;
- LESs for some of the considered experiments.

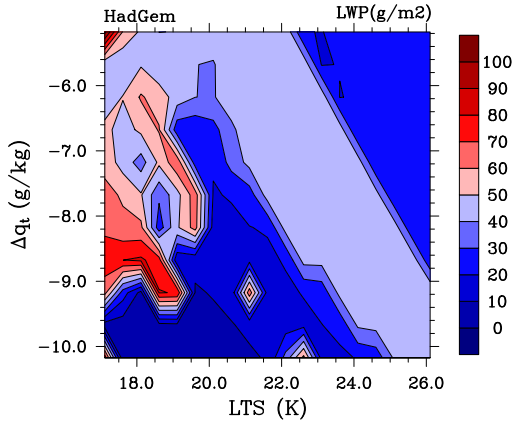
Outlook: SCM intercomparison study

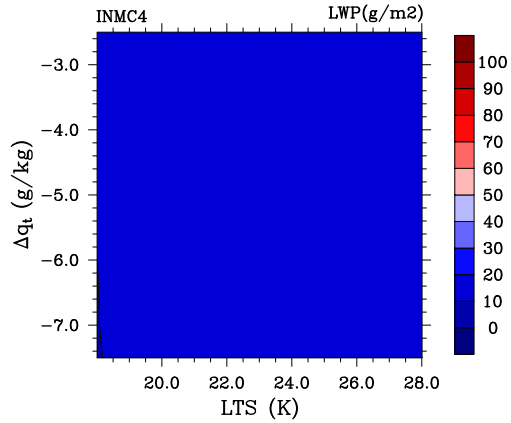




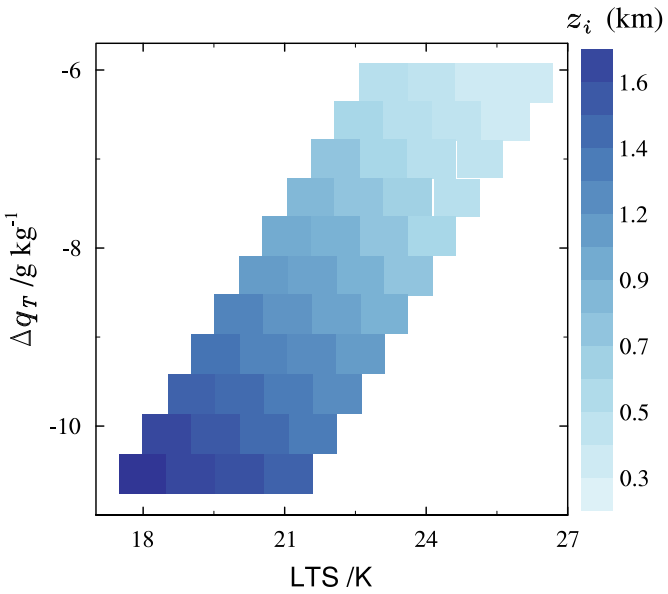


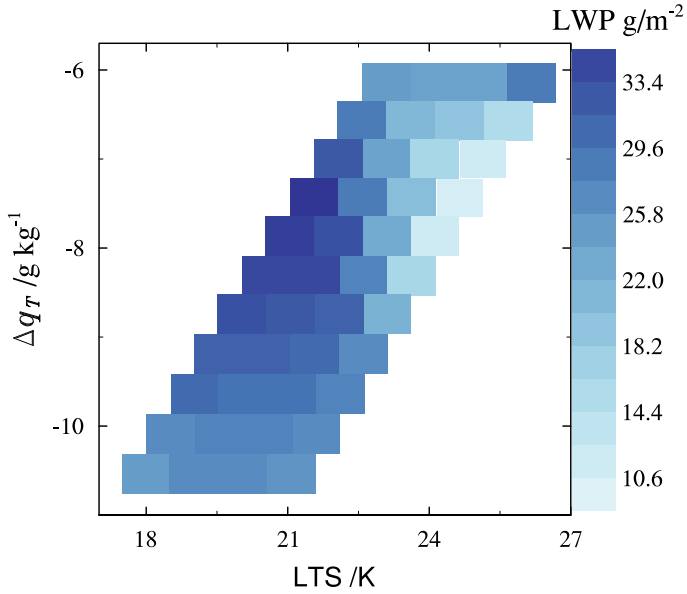






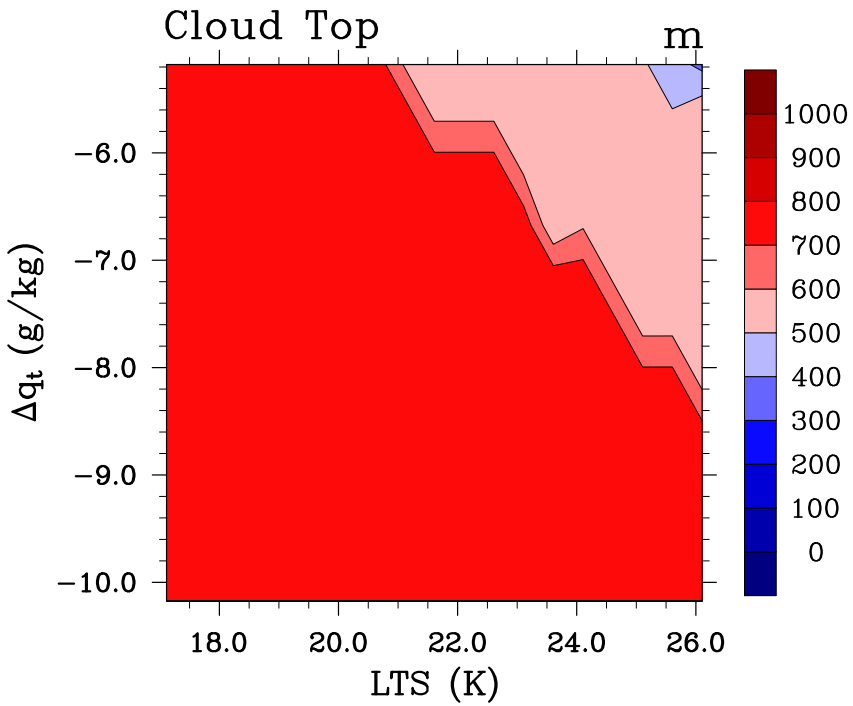
Outlook: DALES results





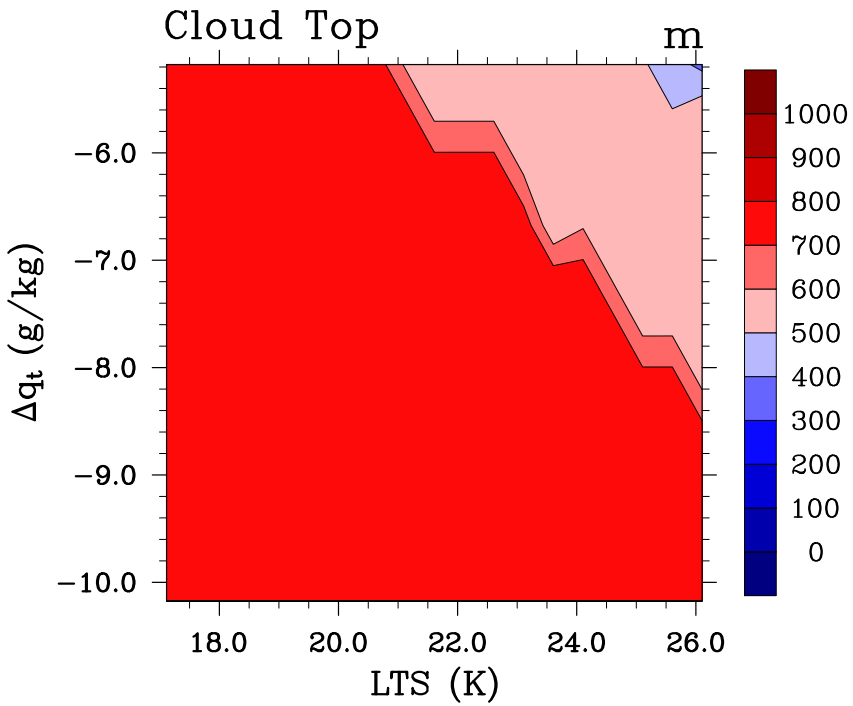
Thank you!

Grid-locking



- standard EC-EARTH suffers from grid-locking (tested for different initial conditions);
- EC-EARTH with dualM does not present this problem: model issue and not set-up issue.

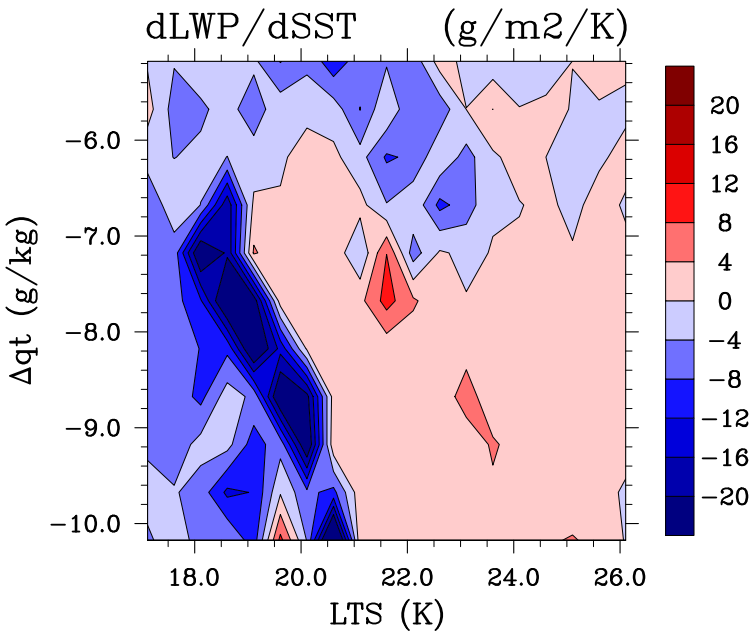
Grid-locking



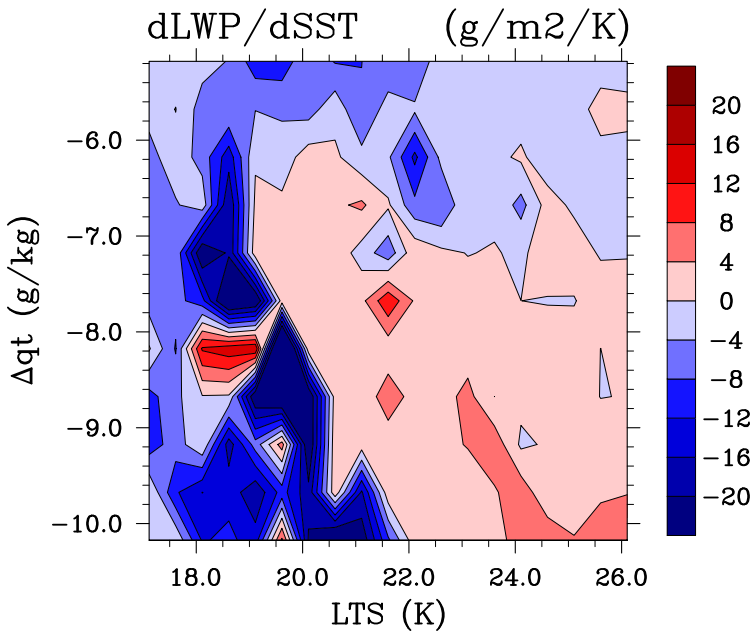
- standard EC-EARTH suffers from grid-locking (tested for different initial conditions);
- EC-EARTH with dualM does not present this problem: model issue and not set-up issue.

Influence of the initial conditions on the cloud feedback

Standard set-up



Clear sky intial condition



The qualitative pattern is independent to initial conditions (tested also for different initial ABL height).