

SPOOKIE: The Selected Process On/Off Klima Intercomparison Experiment

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Selected Process On/Off Klima Intercomparison Experiment (SPOOKIE) - phase II

Motivation

- Convective parameterization alone is not the sole cause of inter-model spread in low-level cloud feedbacks over stratocumulus regions and at global scale (SPOOKIE phase I: Webb et al., 2015)
- Cloud schemes might be important too (Qu et al., 2014; Geoffroy et al. 2017)

Aim

- Quantify the contribution of standard cloud schemes to the inter-model spread in cloud feedbacks
- Understand interactions with other processes (shallow convective mixing is still a good candidate!)

Approach

- Repeat CFMIP-CMIP6 *amip*, *amip-4k* and *amip-4xco2* experiments,
... switching off shallow convection & implementing a simple cloud scheme in a range of models

SPOOKIE phase 2

Simplifying cloud schemes and switching off shallow convection

Protocol

1. A simple cloud scheme for radiation only

- All clouds seen by radiation are liquid (effective radii of 10 μm above freezing and 20 μm at and below freezing)
- Homogeneous in-cloud water content, defined as a linear function of atmospheric pressure (from 1 g/kg at 1000 hPa to 3e^{-4} g/kg at 200 hPa)
- Stratiform cloud fraction is a simple function of relative humidity (used elsewhere in the model – based on either liquid or ice saturation):

$$SCF = \text{MAX} \left(0, \text{MIN} \left(1, \frac{RH - RH_c}{1 - RH_c} \right) \right)$$



A critical relative humidity: linear function of pressure (from 0.7 at 1000 hPa to 0.3 at 200 hPa)

- Convective cloud fraction: $\text{CCF} = 0.2$ where convective condensation occurs
- Total cloud fraction: $\text{CF} = \text{MAX}(\text{SCF}, \text{CCF})$
- Overlap: maximum-random (if possible)

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Protocol

2. Switching off shallow convection

- Turn off shallow convection scheme if it is separated from deep convection scheme, and
- Turn off deep convection whenever the top of the convection remains below 700 hPa
- In both *standard* and *simple-cloud* experiments

3. A tuning procedure for both experiments

- To correct for strong TOA imbalances and CRE biases in models
 - Tuning of RHc at 1000 hPa should affect CRE_{SW}
 - Tuning of RHc at 200 hPa should affect CRE_{LW}



Summary

- SPOOKIE provides sensitivity experiments in a range of models for investigating and testing hypotheses on mechanisms contributing to inter-model spread in cloud feedbacks
- Based on previous studies' findings, the 2nd phase of SPOOKIE proposes two experiments in a multi-model framework:
 - Implement a simple cloud scheme
 - Switch off shallow convection
- The aim of SPOOKIE II is to quantify the contribution of cloud schemes to inter-model spread in cloud feedbacks and to investigate the interactions between subtropical low-level clouds and shallow convection.

