



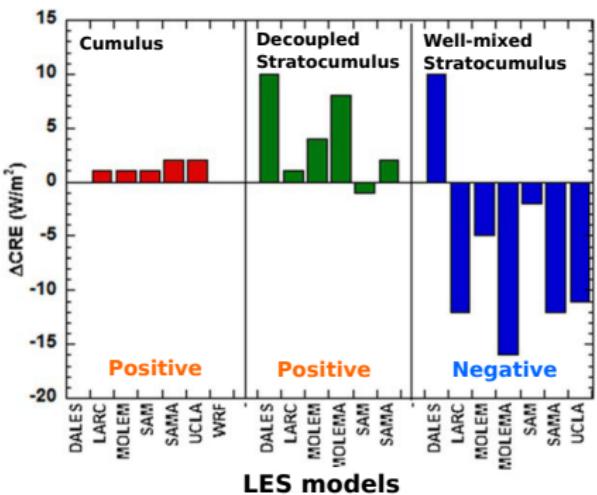
## A Single-Column Model intercomparison on the stratocumulus representation in present-day and future climate

S. Dal Gesso, J. J. van der Dussen, A. P. Siebesma,  
S. R. de Roode, I. Boutle, Y. Kamae, R. Roebrig, J. Vial

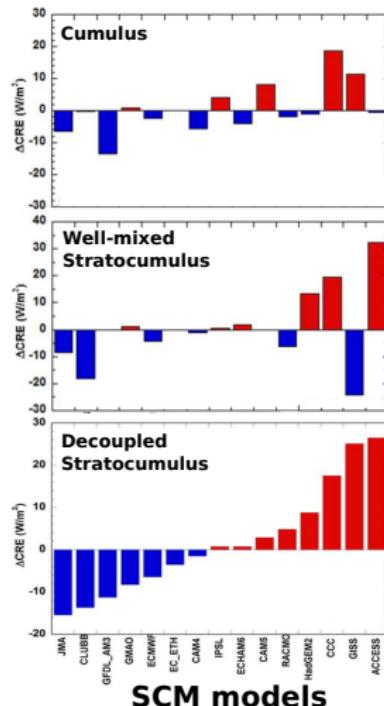
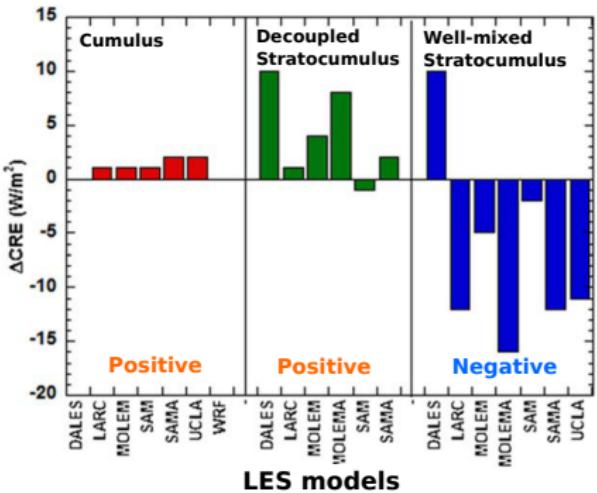
IGMK, University of Cologne

CFMIP meeting  
9 June 2015

# The CGILS lesson

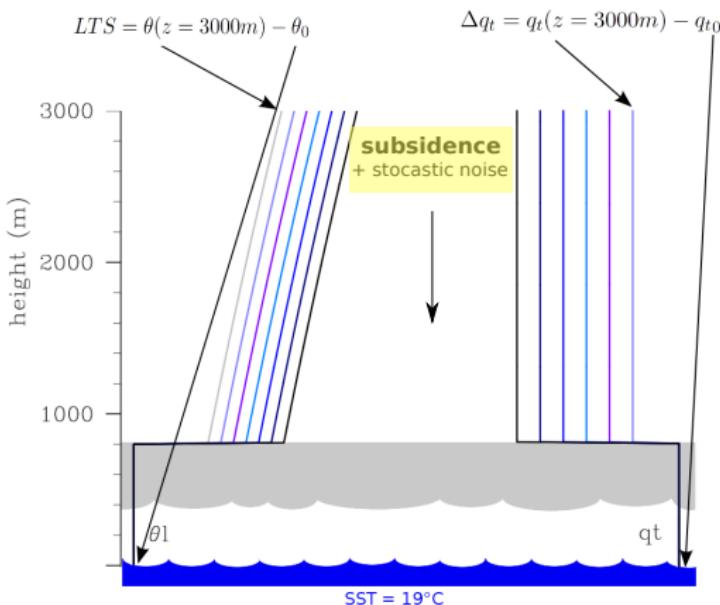


# The CGILS lesson



Zhang et al., 2013

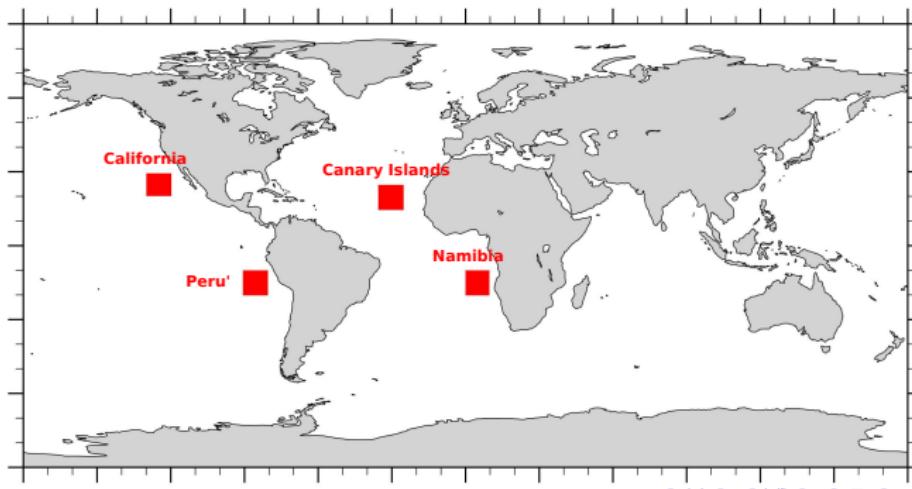
# A new SCM intercomparison study



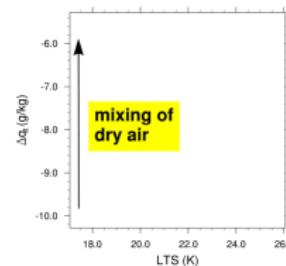
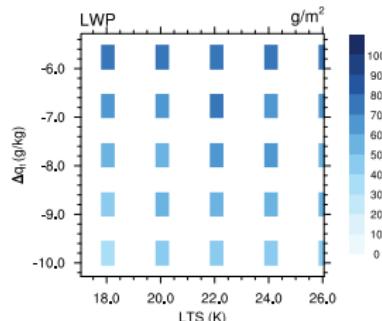
- 6 SCMs:  
EC-EARTH,  
HadGEM2,  
HadGEM3,  
LMDZ-AR4,  
CNRM-CM5,  
MIROC5
- 1 LES: DALES

# Comparison to GCM outputs

- 5 GCMs: all SCMs except HadGEM3;
- AMIP experiment, four “Scu regions” in the sub-tropics;
- the outputs are binned according to LTS- $\Delta q_t$  and averaged for each bin.

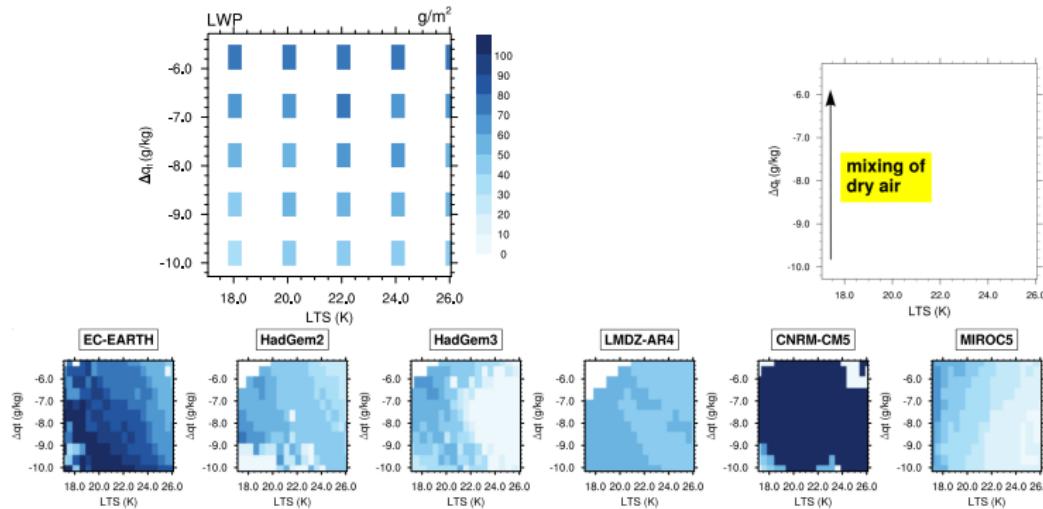


# Scu regime in the phase space



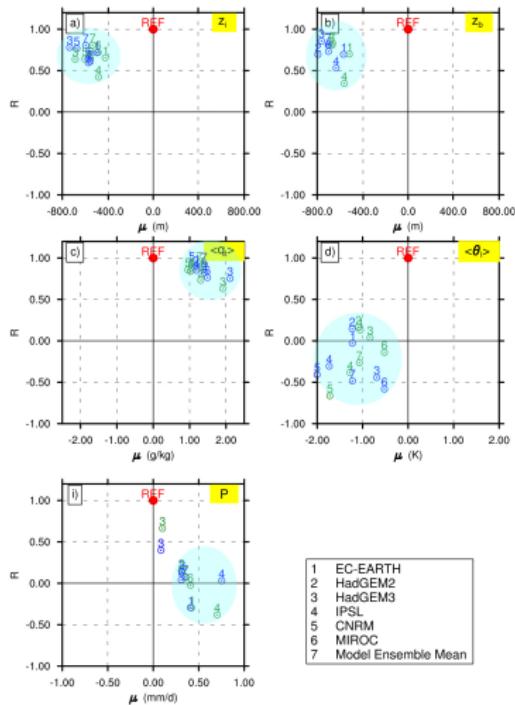
- **LES:**  $\text{CC} = 1$  and LWP decreases for drier free tropospheric conditions;

# Scu regime in the phase space



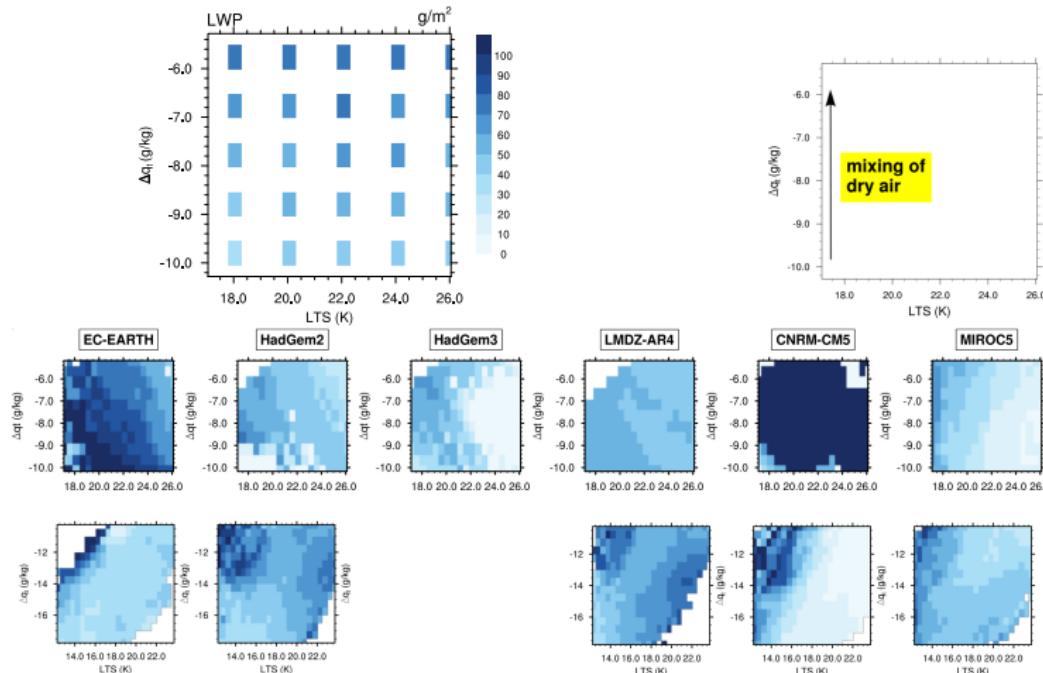
- **LES:**  $CC = 1$  and LWP decreases for drier free tropospheric conditions;
- **SCM:** large variety of patterns for both CC and LWP, none of them is in line with DALES results.

# SCM common biases



- Dependence of  $z_i$ ,  $z_b$  and  $\langle q_t \rangle$  on LTS and  $\Delta q_t$  are well described, too large variation of  $\langle \theta_i \rangle$  in the phase space.
- The Scu-topped ABL is too shallow, too cool, too moist. Systematic underestimation of CC and overestimation of P.

# Correspondence to the host GCM



A clear correspondence in the LWP pattern is not found.



# Scu response in DALES

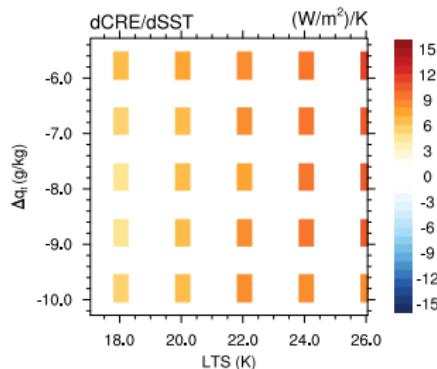
## Climate perturbation

- SST + 2K  $\Rightarrow$  warming and moistening of the atmosphere (RH unperturbed).
- No change in the subsidence and horizontal wind velocity;
- **GCM:** AMIP4K experiment.

# Scu response in DALES

## Climate perturbation

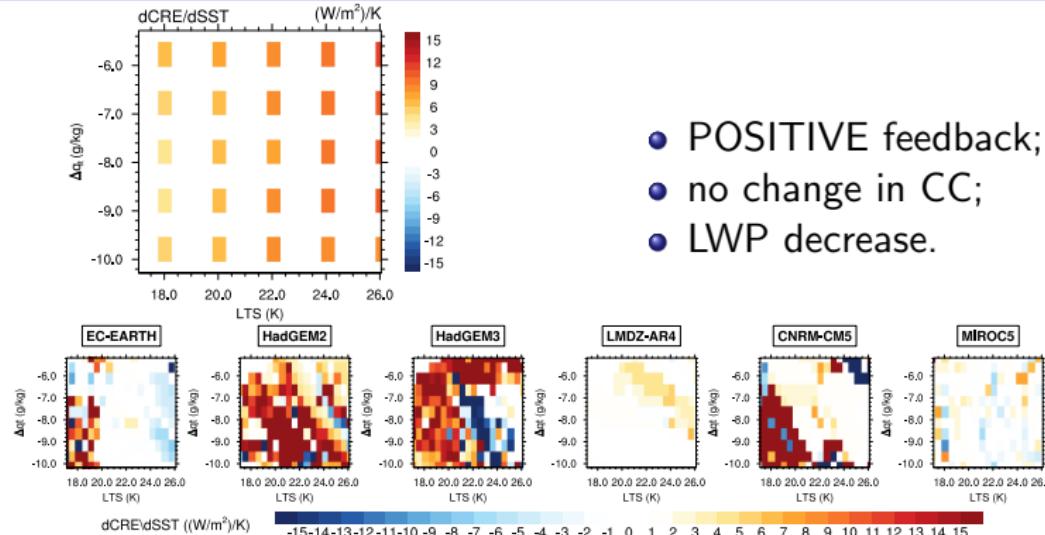
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Change in CRE as an estimate of the feedback:

- POSITIVE feedback;
- no change in CC;
- LWP decrease.

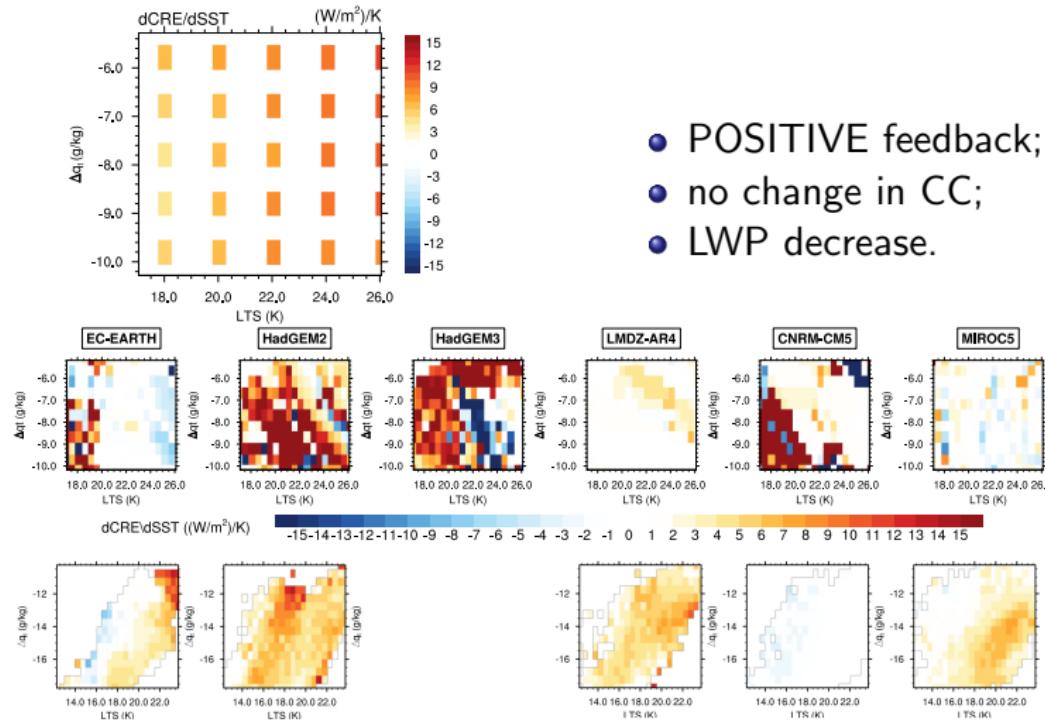
# Scu response in SCMs



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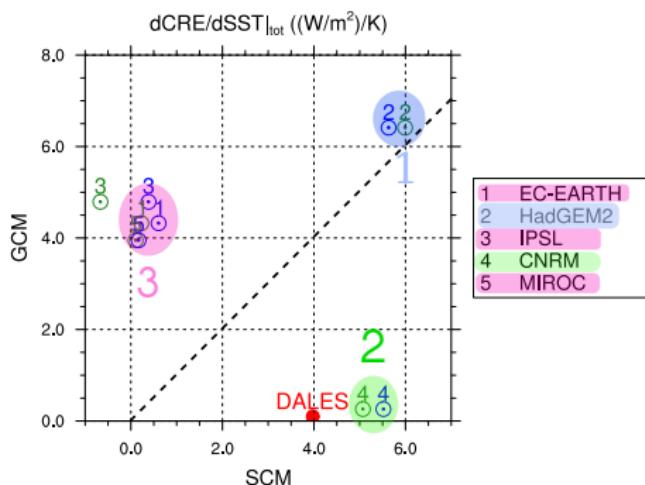
- noisy patterns, no distinct dependence on LTS and  $\Delta q_t$ ;
- overall POSITIVE feedback;
- the SCMs reproduce the feedback through a CC change.

# Correspondence to the host GCM

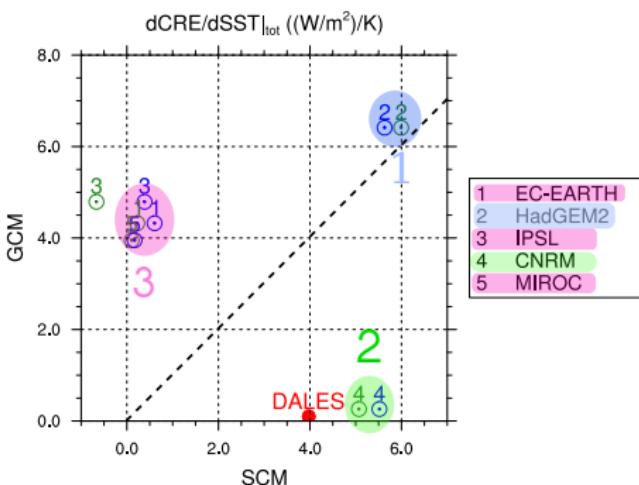


- POSITIVE feedback;
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# Interpretation of the SCM-GCM differences

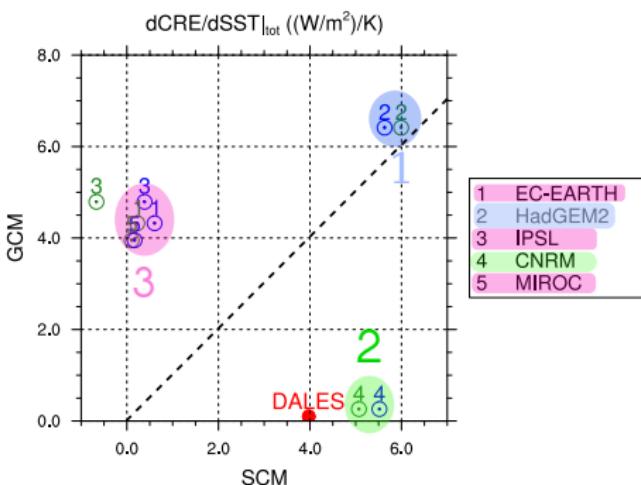


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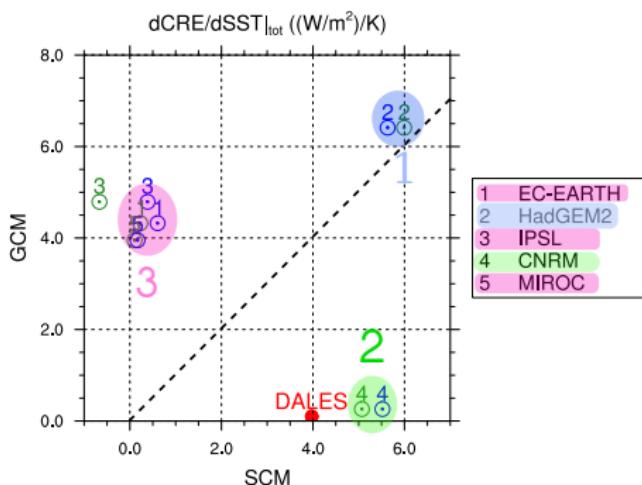
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circulation changes are likely to offset the effect of the SST increase;
- ③  $\text{SCM} < \text{GCM}$ :  
the response to the SST increase is small compared to the one due to other factors.

# Summary

## Control climate

- variety of dependencies of LWP on LTS and  $\Delta q_t$ ,
- none of the SCMs agrees with the LES results;
- common biases: Scu-topped ABL is too shallow, too cool and too moist, lack of clouds and excess of precipitation;
- the SCM results do not capture the dependence of LWP on LTS and  $\Delta q_t$  in GCMs.

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- the SCM results do not capture the dependence of LWP on LTS and  $\Delta q_t$  in GCMs.

## Perturbed climate

- both LES and SCMs predict an overall POSITIVE feedback;
- SCMs present noisy patterns, no distinct dependence on LTS and  $\Delta q_t$ ;
- difference between SCM and GCM responses might be due to different contributions of other factors.



# Thank you!

Dal Gesso, S., J. J. van der Dussen, A. P. Siebesma, S. R. Roode, I. A. Boutle, Y. Kamae, R. Roehrig, and J. Vial (2015), *A single-column model intercomparison on the stratocumulus representation in present-day and future climate*, J. Adv. Model. Earth Syst., 07, doi:10.1002/2014MS000377.

## Recommendations

- considering a higher SST, to spam up the same area of the phase space as the GCMs and to increase the latent heat flux;
- including horizontal advection of cold air, to increase the sensible heat flux and to help the reformation of clouds once the clouds dissolve;
- including a stronger stochastic noise into the subsidence.