## Relevance of multi-case SCM simulations for climate and weather-forecast model improvement

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1D/LES workshop – 15 June 2020 – Video conference

### **SCM/LES-CRM** framework

#### A GCSS strategy (GEWEX Cloud System Study) from the early 1990s

Browning et al. (1993): The GEWEX Cloud System Study (GCSS), Bull. Amer. Meteor.

Randall et al. (1996): Single-column models and cloud ensemble models as links between observations and climate models. Journal of Climate.

European EUCREM (1996-1997) and EUROCS (2000-2003) projects

EUROCS special issue, QJRMS, 2004.

Field campaign

#### Several case-studies and intercomparisons :

Krueger et al. (2016) : Cloud-Resolving Modeling: ARM and the GCSS Story. Meteor. Monogr.

#### **Boundary-layer** :

DYCOMS, FIRE, ARM, ASTEX, BOMEX, RICO, SANDU, GABLS, ...

#### **Deep Convective clouds** :

TOGA-COARE, LBA, EUROCS, AMMA, TWP-ICE, DYNAMO,...

#### **Polar clouds** :

SHEBA, ISDAC, MPACE, ...

# To what extent are those existing case-studies used in model development teams ?

Neggers, R. A. J. (2015) : Attributing the behavior of low level clouds in large-scale models to subgrid-scale parameterizations, J. Adv. Model. Earth Syst.

Gettelman et al. (2019): The Single Column Atmosphere Model version 6 (SCAM6): Not a scam but a tool for model evaluation and development, J. Adv. Model. Earth Syst.





3D explicit simulations (LES/CRM)



#### **Development and Evaluation of PHYsical parameterizations for atmospheric models DEPHY** : French national LEFE project (2010-2017) Since 2019 : National Research Group (supported by CNRS and Météo-France)

- Bring closer the communities of observation, high-resolution, weather-forecast and climate modelling
- Coordinate the pooling of codes, tools, methodologies within the French model development community
- → Achieve tangible and significant improvements in weather forecasting and climate models



One of the deployed strategies :

Mean occurrence of low clouds averaged over january to march obtained from CloudSat/calipso (Chepfer et al, 2008)

Base parameterization development on a close comparison between SCM and LES/CRM



a) GOCCP low  $90^{\circ}N$  $60^{\circ}N$  $30^{\circ}N$ 0°  $30^{\circ}S$  $60^{\circ}S$ 90°*S* 180°  $60^{\circ}E$  $120^{\circ}W$  $60^{\circ}$  $120^{\circ}E$  $180^{\circ}$ **0**°



Large-scale coud scheme based on lognormal

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K-diffusion + counter-gradient term



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K-diffusion + Thermal plume model coupled with a bi-gaussian cloud-scheme





LMDZ5A

Madeleine et al., JAMES, 2020





Madeleine et al., JAMES, 2020



Madeleine et al., JAMES, 2020

#### **Tuning of uncertain parameters**

Formulation of the exchange coefficient at the inversion in ARPEGE :



#### Representation of the diurnal cycle of continental deep convection



#### Highlighting error compensations : an exemple from the stable boundary-layer

Development of a new mixing length depending on wind shear in AROME



Improvement on one case may highligth **compensation errors** at other locations over the globe due to other misrepresented processes like orography, bounday-layer/surface coupling, ... *(Sandu et al., JAMES, 2013)* 

Importance of having a variety of cases

#### Conclusions

The **SCM/LES-CRM** approach promoted by GCSS/GASS since almost 30 years is still very relevant nowadays.

Improve parameterizations at the process level to assure model improvement for good reasons and avoid compensating errors.

Maybe it is **under-used** in the development strategy of climate and weather-forecast modelling groups

A lot can be done with 1D cases to :

- → Test parameterization development
- → Identify reasonable parameter range to be used for the tuning of 3D models

Importance of having multiple diverse cases

**Revisit** set-ups (coupling with the surface, radiation, large-scale,...)

Among **DEPHY** targets :

Develop a common input format for all existing 1D cases

- → clean our codes of all existing if (case==) then ...
- → formalize 1D/LES forcing
- → facilitate future implementation of new cases
- → facilitate the **systematic use** of 1D cases in the development stage of atmospheric models