



Evaluating CRM simulations – Where are the gaps and how do we fill them?

Christian Jakob (BMRC)

Some statements for discussion

1. The use of CRMs as parameterizations **raises the bar** for their performance requirements.
2. The good news is that **they will finally get looked at with the same scrutiny** as standard parameterizations have been for the last 10 years.
3. CRMs and climate models are **perfect partners** since their evaluation has so far mostly been done **qualitatively**.

If you put tomfoolery into a computer, nothing comes out but tomfoolery. But this tomfoolery, having passed through a very expensive machine, is somehow ennobled and no one dares criticize it.

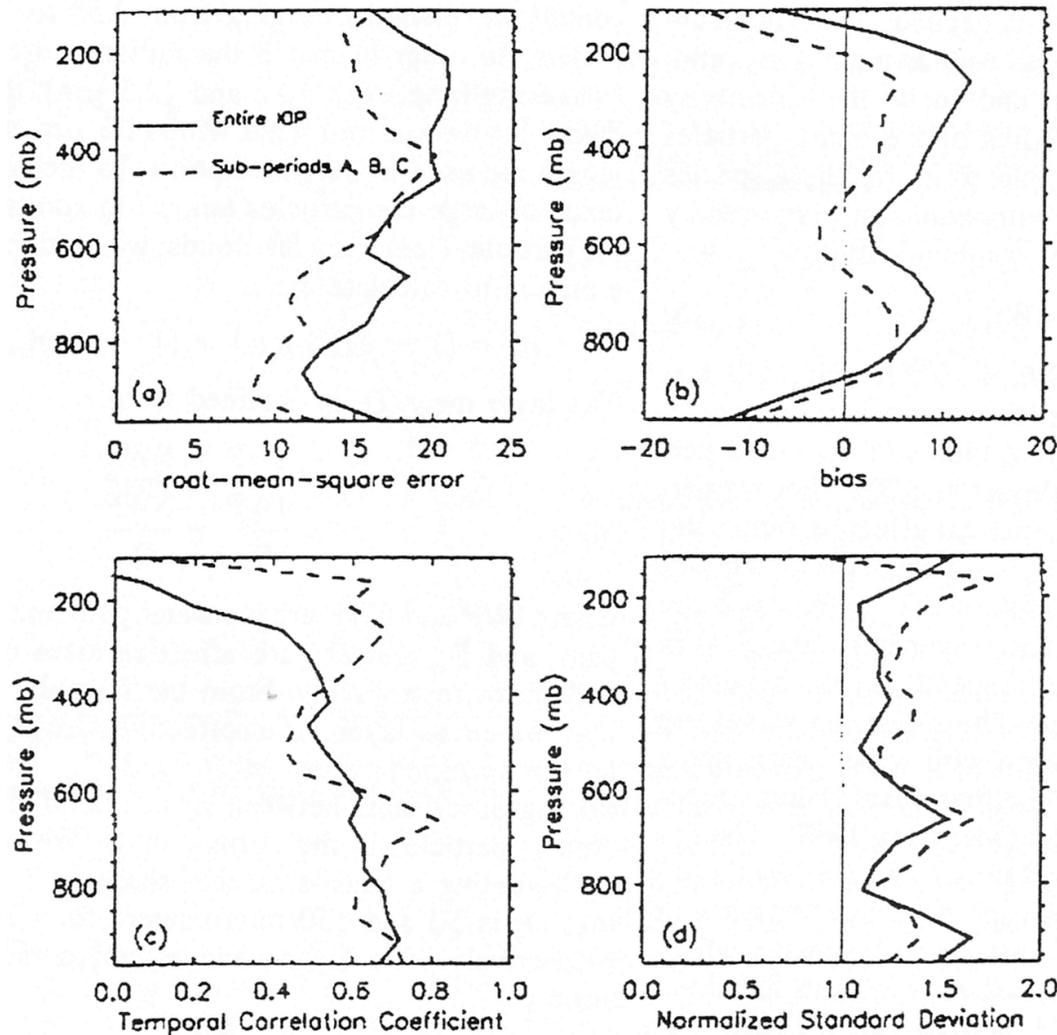
PIERRE GALLOIS

Careful and systematic model evaluation is what
will prevent tomfoolery!

How do we do that?

At the moment – not very well!

Bad validation example 1

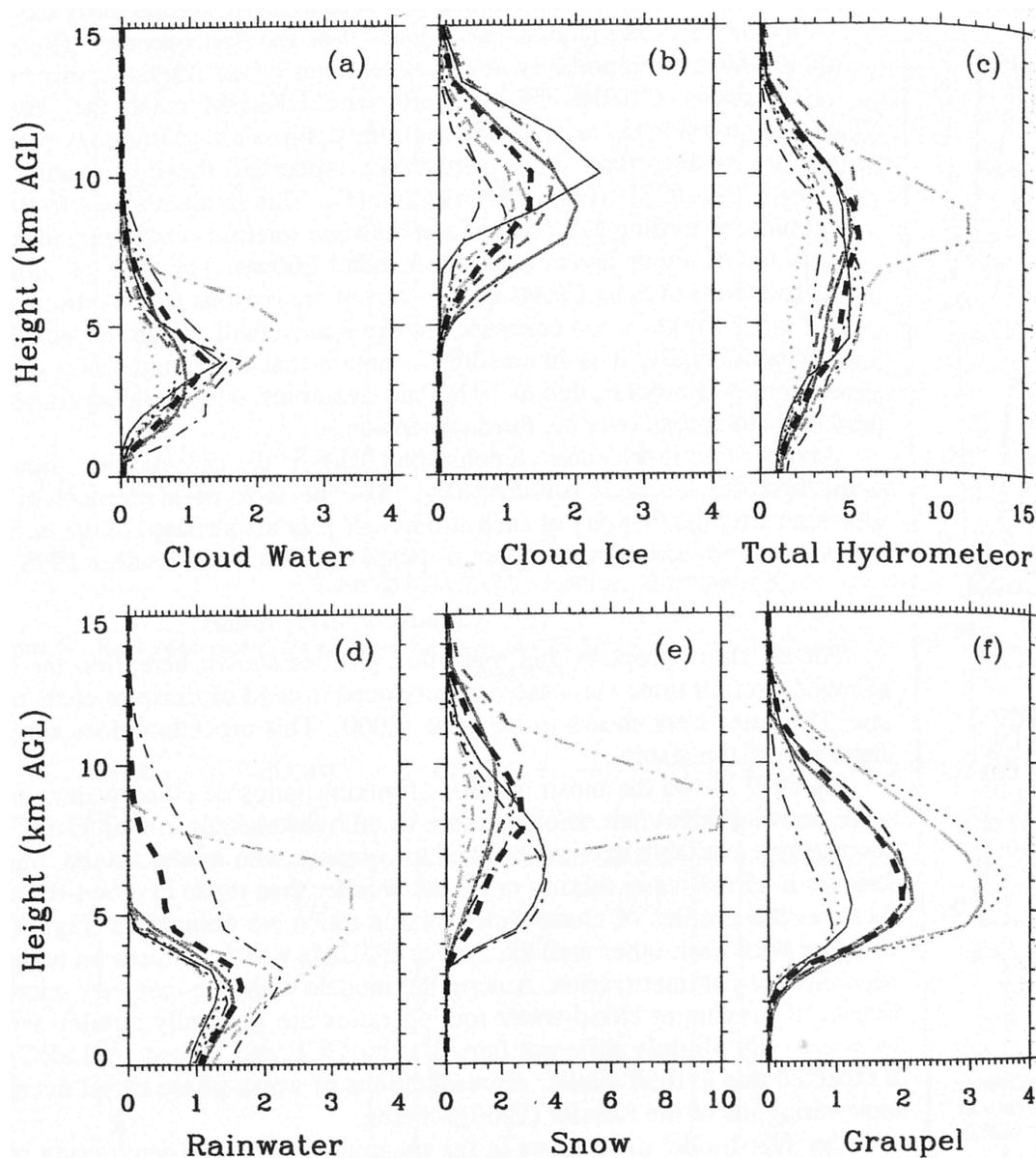


Luo et al., 2003

29-day ARM 1997

“These results suggest that the relative humidity is predicted relatively well by the model.”

Bad “validation” example 2



Xu et al., 2002

29-day ARM 1997 – 3
subperiods

9 CRMs

No observations

“The ensemble profiles of hydrometeor mixing ratios from CRMs (black dashed lines in Fig. 9) are probably trustworthy as a surrogate for observations.”

Problem 1

The validation is often **not cloud and/or radiation oriented!**

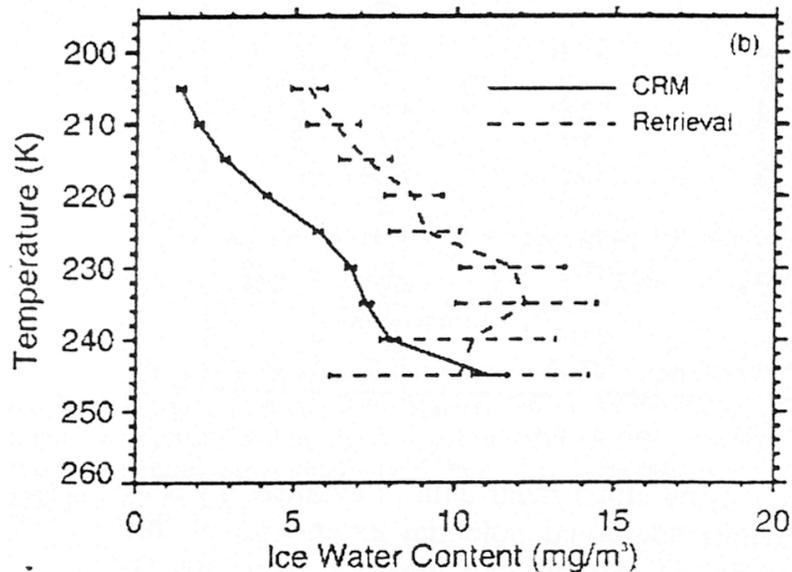
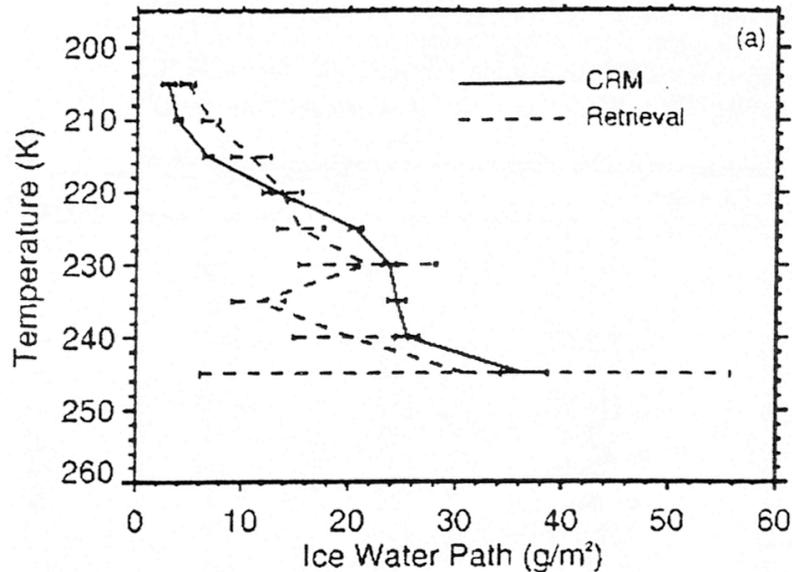
More often than not **radiation is even prescribed!**

Solutions

Focus evaluation on clouds and radiation (this requires to do simulations with radiation active)

Develop observation **“simulators”** (e.g., ISCCP, radar etc.)

Good “validation” example 1

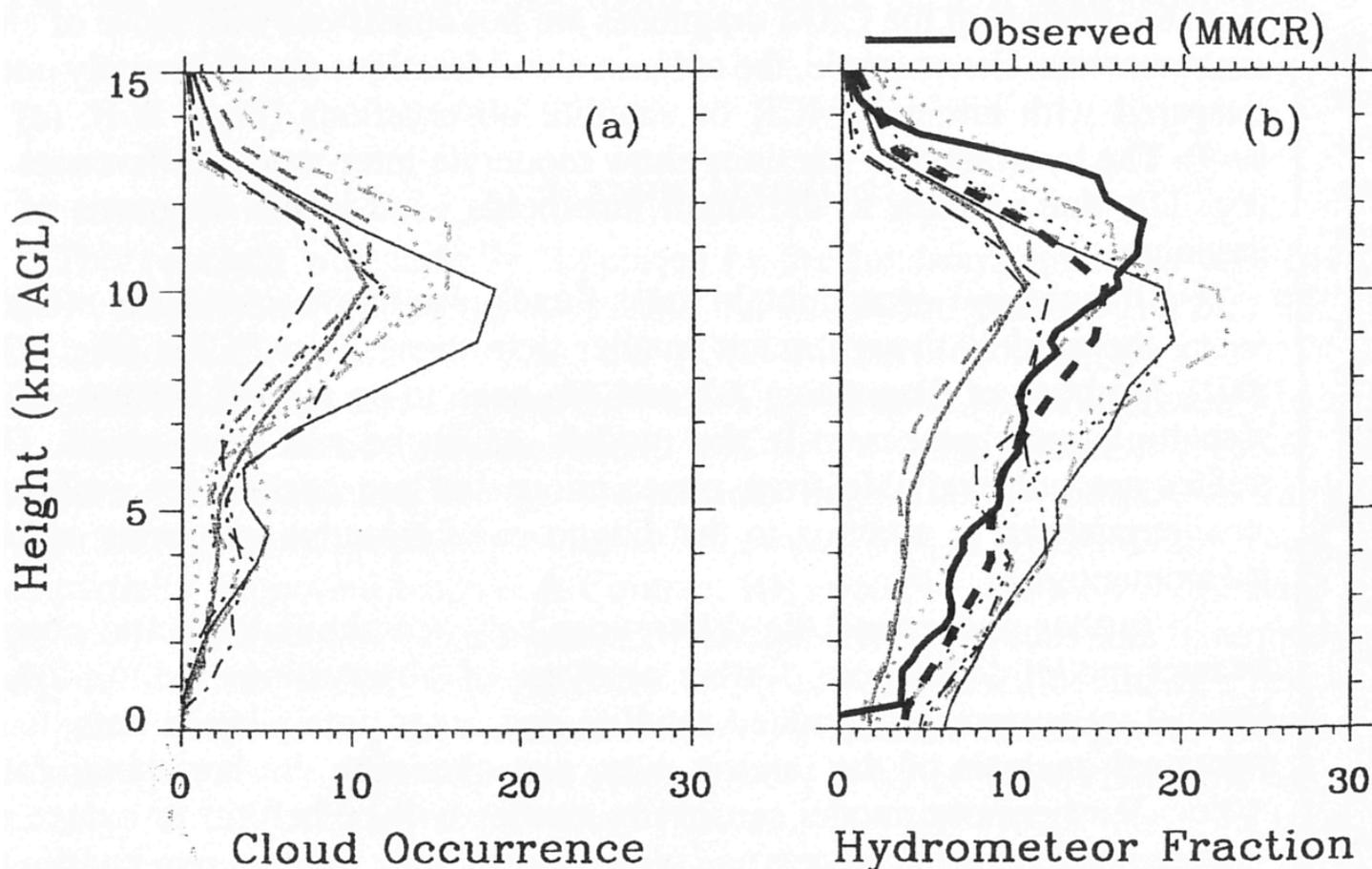


Luo et al., 2003

29-day ARM 1997

“... the CRM thin cirrus is about the same as for the retrieved thin cirrus clouds but the CRM thickness is greater.”

Good “validation” example 2



Xu et al., 2002 - 29-day ARM 1997 – 3 subperiods- 9 CRMs

“A diagnosis that is consistent with the MMCR retrievals is needed to pinpoint the significance of the model biases ... and to suggest improvement for cloud microphysics representations in CRMs.”

Problem 2

There **isn't enough data** for a thorough model evaluation.

Solutions

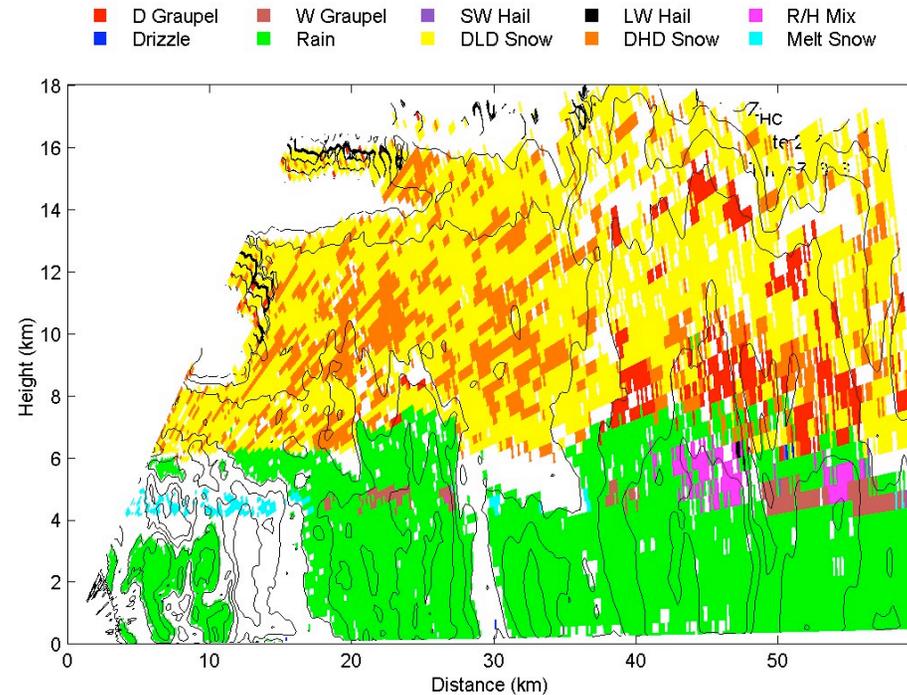
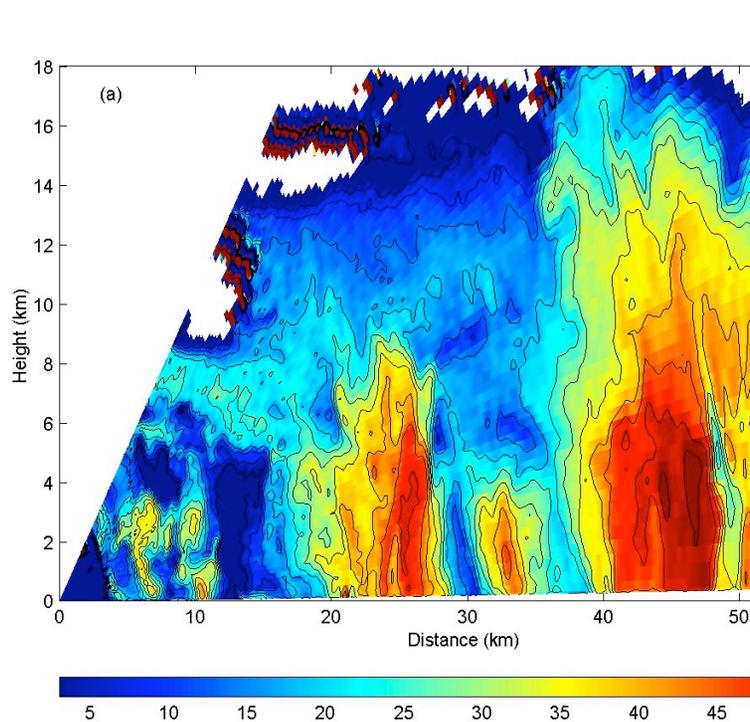
This is a **“pseudo”-problem**.

Between ARM and other ground-based data and the satellite data available now (e.g., ISCCP, CERES) and in the future (e.g., CloudSat) **there is enough data**.

However, we **sorely lack methodologies to use this data** well and in a quantitative fashion!

Hence there is a **need for methodology research!** The **ISCCP simulator** is a success of such research for parameterization evaluation.

An example for unused data



Microphysical classification of hydrometeors based on polarimetric radar measurements.

Routine product.

Problem 3

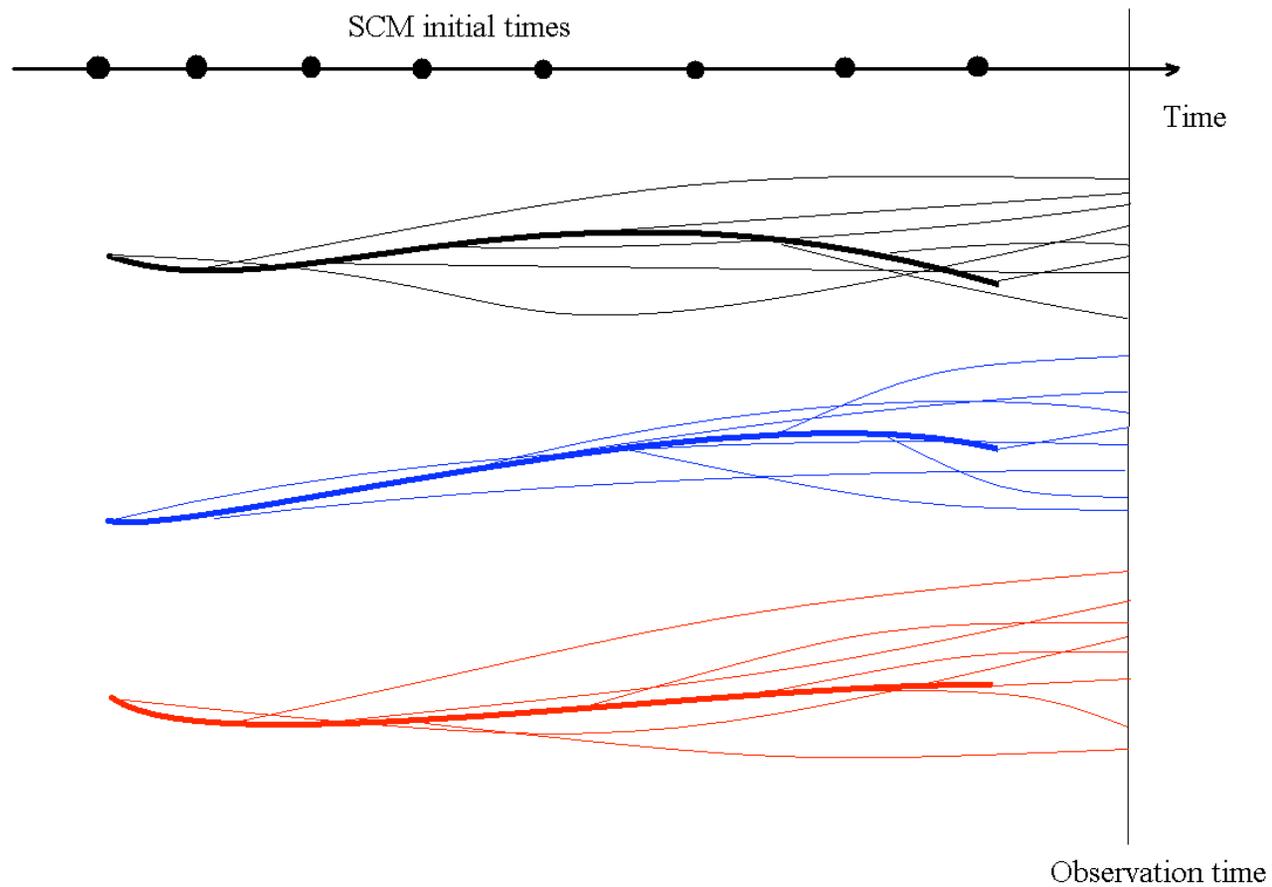
Whenever something is found to be wrong in the simulation, we
blame the forcing.

Recently, the most popular excuse is the **lack of hydrometeor
advection.**

Solutions

1. **Own up** to the fact that we will never have perfect forcing and **develop techniques to deal with the uncertainty**, e.g., ensemble techniques.
2. **Don't run** offline simulations of CRMs **in highly advective situations.**
3. For those situations **use NWP with embedded super-parameterization.** – see CAPT talk on how

CRM/SCM Ensemble simulations



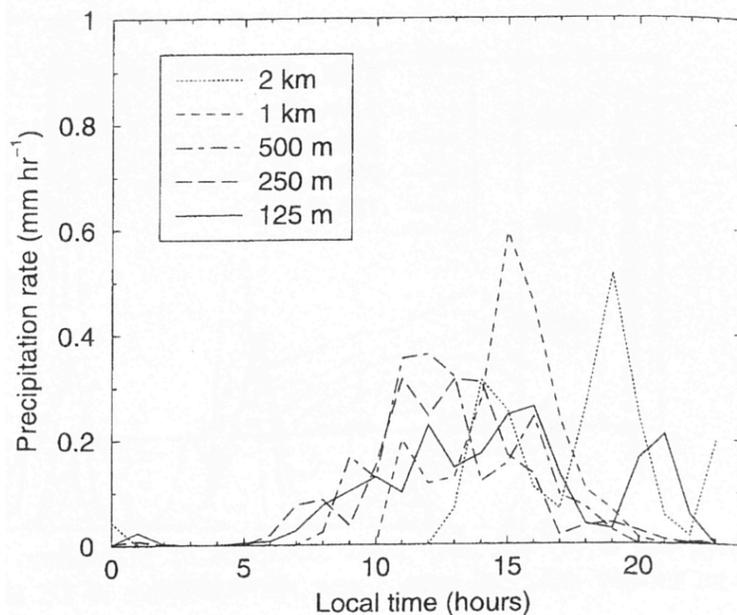
Problem 4

CRMs are **configured depending on the case** that is run. (e.g., resolution, 2D vs 3D).

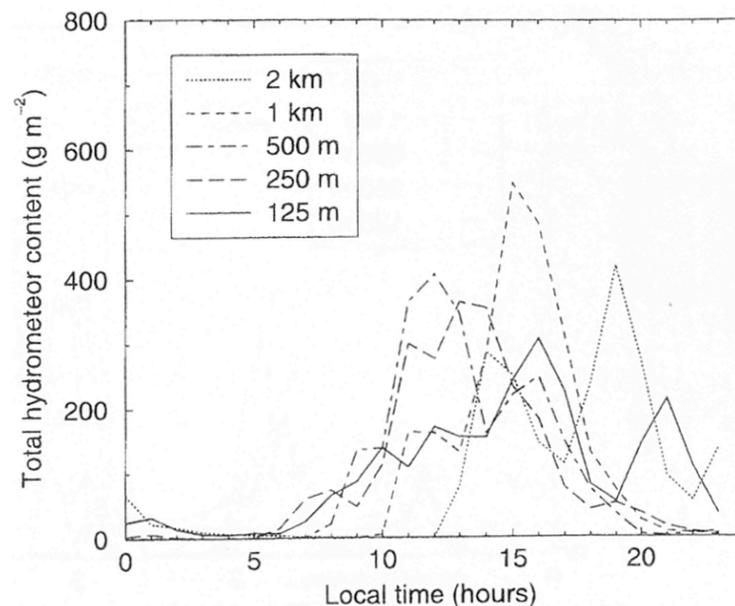
Embedded in a global model they will have to work in **one configuration in all situations**.

Resolution dependence

Precipitation



Vertically integrated hydrometeor content



Petch et al., 2002 - 2-D UKMO CRM

Idealized diurnal cycle of precipitating convection

Strong resolution dependence of the results.

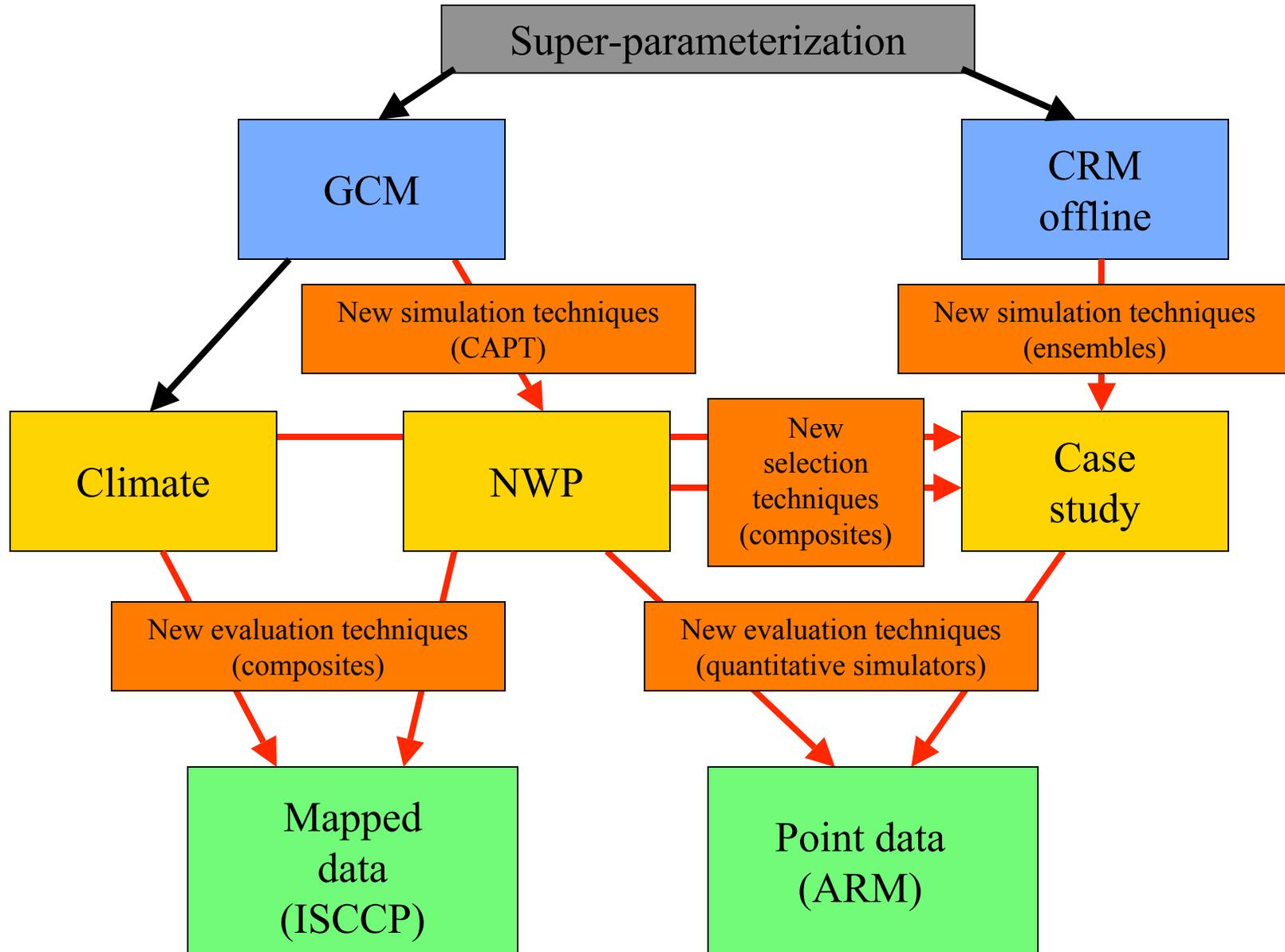
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Embedded in a global model they will have to work in **one configuration in all situations**.

Solutions

1. The CRM embedded in the GCM needs to be **evaluated in the configuration it is run in the GCM in as many situations as possible**. – **NWP** is the easiest solution, but offline case studies will also be useful.
2. It is almost certain that **sub-grid parameterizations** in the CRMs **need to be improved**.



Recommendations

1. Success in super-parameterization will critically depend on the availability of well evaluated CRMs. Hence **evaluation needs to be an integral component** of the proposal.
2. **Clouds and radiation** need to become a focus point of that evaluation (e.g., ISCCP and other simulators for CRMs).
3. New **quantitative evaluation methodologies** need to be developed.
4. We need to **face up to uncertainties** in the forcing and develop methods to deal with them by developing ensemble techniques.
5. Super-parameterization needs **NWP capabilities** (CAPT).