Successes and barriers of community model intercomparison exercises

- **GCSS (*Global Energy and Water Cycle Experiment Cloud System Study*) provided early leadership (starting in 1992):**

- **Four different working groups covering various cloud regimes. (boundary layer, cirrus, frontal, deep precipitation convection)**
- **Organized model intercomparison studies of LES/CRMs and SCMs relevant to cloud parameterization.**

- **First GCSS model intercomparison (Moeng et al. 1996; Bechtold et al. 1996) was an idealized cloud-topped well-mixed PBL case for LES/CRMs and SCMs.**

- **Many subsequent intercomparisons were centered on observationally-based cases.**

ARM and GCSS formed a "natural" partnership given ARM's focus on data collection related to radiation and clouds and related atmospheric properties.

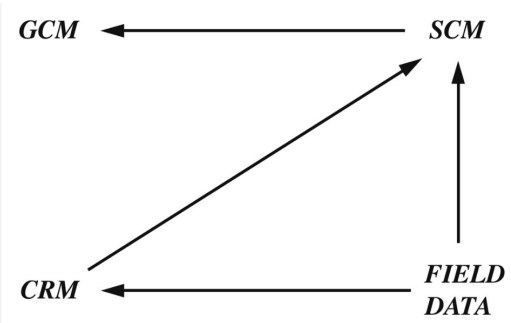
--> Randall et al. (1996) proposed to use such field data collected at long-term fixed sites to test cloud and radiation parameterizations in SCMs and CRMs.

Some earlier ARM activity independent of GCSS, e.g., SCM IOP based on ARM SGP data from 1994-1998 (see Zhang et al. 2016).

ARM and GCSS came together for the summer 1997 SGP intercomparison (Xu et al. 2002, Xie et al. 2002), co-organized by GCSS working group 4.

--> showed better results with the CRMs than SCMs (e.g., T and qv profiles, cloud fraction, precipitation).

These early intercomparison activities established the basic approach and protocol: *"GCSS-type" intercomparisons*.



Randall et al.
(1996), *J. Climate*

Many subsequent joint GCSS-ARM intercomparisons, e.g.:

- **Diurnal cycle of shallow cumulus over SGP (Brown et al. 2002, Lenderink et al. 2004).**
- **Mid-latitude frontal clouds over SGP (Xie et al. 2005, Xu et al. 2005)**
- **Deep convection and tropical cirrus during TWP-ICE (Davies et al. 2013, Variable et al. 2011, Fridlind et al. 2012, Zhu et al. 2012, Lin et al. 2012, Varble et al. 2014a,b, Petch et al. 2014).**
  --> SCMs, CRMs, LAMs, and global models
- **Arctic mixed-phase clouds during MPACE (Klein et al. 2009; Morrison et al. 2009), SHEBA (Morrison et al. 2011), and ISDAC (Ovchinnikov et al. 2014).**

About 10 years ago, a reorganization of GCSS to Global Atmospheric System Studies (GASS).

- → https://www.gewex.org/panels/global-atmospheric-system-studies-panel/gass-projects/

Overall less coordination of modeling activities with ASR since, with some exceptions, e.g. CAUSES:

→ Using SGP data to evaluate weather and climate models (Ma et al. 2014, Morcrette et al. 2018, van Weverberg et al. 2018)

Connection of ARM/ASR to WMO International Cloud Modeling Workshop (every 4 years, in conjunction with ICCP). Examples of joint projects:

- Morrison et al. 2011 – SHEBA
- Muhlbauer et al. 2012 - SPARTICUS

Recent "independent" model intercomparison studies (not under auspices of GASS, ARM/ASR, or WMO)

→ DYNAMO (Li et al. 2018).

Based on almost 3 decades history of observationally-based model intercomparisons, what are the key successes?*

- **Promoted the use of LES/CRMs as a tool to better understand processes that must be parameterized in GCMs, and helped build a community of modelers working on this.**
- **Established a baseline for new models or parameterizations to credibly simulate a suite of observationally-based cases.**
- **Coordination across groups, gets modelers talking to each other...**
- **Observationally-based model intercomparison projects do not necessarily lead to improved parameterizations directly, but have often identified key process-level biases or model differences that have been explored in further studies (e.g. sensitivity of Arctic mixed-phase clouds to IN and vapor diffusional growth).**
- **Valuable not only for direct model evaluation, but past cases have been widely used for subsequent studies. For example, at least 24 subsequent papers were based on the TWP-ICE intercomparison.**

see Krueger et al. (2016), *Meteor. Monog.

The barriers (and some possible discussion points)

There has been an evident decline in model intercomparison activity coordinated jointly between ARM/ASR and other entities (GCSS/GASS in particular). *Why?*

- **Broader objectives of GASS compared to GCSS, less coordination with ARM/ASR?**
- **GCSS-type intercomparisons simply outliving their usefulness?**
- **Challenge and time commitment for people leading projects?**

Some thoughts:

- **Develop an infrastructure (within ARM/ASR) that can support model intercomparison activities to lessen the burden on case leaders.**
- **A more formalized process can also increase participation in projects and increase their visibility in the broader community.**
- **Focus on specific science questions rather than general evaluation of models. This may also help coordination with GASS, WMO CMW, etc. *What are the key process deficiencies?***
- **Flexibility in project design, e.g., coordinate observationally-based cases and more idealized ones to improve synergy.**

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> ***"What may not be so obvious is that observationally based intercomparison projects do not necessarily lead directly to parameterization improvements…There are many examples of first trying a realistic case, then simplifying and idealizing it. Insights that led most rapidly to parameterization improvements were almost always obtained from the idealized cases."***
>
> **Krueger et al. (2016), *Meteor. Monog.***

- **Flexibility in project design, e.g., coordinate observationally-based cases and more idealized ones to improve synergy.**