Has a decade of Climate Process Teams strengthened U. S. climate model development?

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What is a climate process team?

My operational definition: A climate process team brings together a focused group of process experts and climate model developers to improve the simulation of some particular high-impact process within the climate model(s).

- Concept evolved around 2000 out of US CLIVAR committee meetings which lamented the slow path from expensive new process observations to demonstrably improved climate models.
- Partly inspired by ECMWF, which often invited in process experts to work with their parameterization developers for novel model-obs comparisons or testing of new approaches.
- The GEWEX Cloud System Study (GCSS) was promoting international LES-SCM-GCM intercomps.

CPT liaisons

- An important design concept of CPTs was to insert support staff within modeling centers to facilitate their interaction with the external PIs, e. g. through making simulations or helping implement new ideas in code.
- Another concept was that the modeling centers should help select priority processes needing CPTs.

CPTs I have helped lead

- 2003-2006: Low-Latitude Cloud Feedbacks on Climate Sensitivity (NSF/NOAA; NCAR, GFDL, GFSC, 7 external PIs)
- 2010-2013: Improving the subtropical Sc-Cu transition (NOAA; NCEP, NCAR, 3 external PIs + 1 Co-I)
- 2014-2017: Cloud and boundary layer processes (NOAA; NCEP, GFDL, 2 external PIs)

These have become increasingly smaller and more focused on implementing a particular new parameterization approach (e. g. EDMF) into a model (e. g. NCEP GFS/CFS), since this is easier to accomplish on the 2-3 year timescale needed to demonstrate success in the US funding environment.

Some other notable atmospheric CPTs

2010-2015: (PI: V. Larson) Cloud macrophysical parameterization and its application to aerosol indirect effects

(NCAR, GFDL, 4 external PIs)

2014-2017: (PI: S. Krueger) Turbulence and Cloud Processes

(NCEP, NCAR, 3 external PIs)

Other important CPT-like efforts I'm a part of …

2006-2016: CMMAP

Center for Multiscale Modeling of Atmospheric Processes

(CSU/ PI D. Randall; substantial ties to NCAR and CESM)

Large multi-institution NSF STC using cloud resolving models in place of cumulus parameterizations to advance global climate modeling – 'superparameterization'.

1989- : DOE ARM/ASR

Use of state-of-the-art long-term 'supersite' measurements of clouds, aerosols and radiation to improve process understanding and climate model parameterizations. Involves NCAR, GFDL, NCEP, PCMDI…. and a diverse community of external PIs loosely organized in WGs.

Do you see a cloudy theme here?

- Atmospheric CPTs been warm cloud mixing centric. Why?
- Has this benefitted US climate modeling?
- Has this been an optimal use of resources?
- Are there other topics that might have made logical CPTs?

Why warm-cloud centric?

- Clouds, moist convection and turbulence are everyone's climate modeling whipping boys. Thus it was easy for them to repeatedly be prioritized by modeling institutions.
- CPTs build on related experience and social structures, which GCSS built for clouds in the 1990s. These established effective ways for process modelers and parameterization developers to learn from each other (design of observational cases, what/how to compare).
- Current boundary layer and shallow cumulus parameterizations first at UKMO and ECMWF, and now at NCAR, GFDL, and NCEP can all be traced back to people and ideas from GCSS.

Have CPTs benefitted US climate modeling?

- CPTs have implemented new parameterizations and catalyzed new approaches
  - Process focus on cloud feedbacks/CGILS
  - CAM-CLUBB
  - EDMF scheme and climate diagnostics in GFS/CFS

- Similar impact might have happened through less organized and expensive efforts, but…
- CPTs have strengthened the network of external collaborators with major modeling groups, esp. NCEP.
- CPT liaisons have developed careers in climate model development e. g. Ming Zhao (GFDL), Cecile Hannay and Pete Bogenschutz (NCAR).

Has this been an optimal use of resources?

- Atmospheric CPTs have attacked a related set of hard problems.
- GCM low cloud parameterizations are significantly more skillful now than in 2000 – CPTs have helped, so have many other things.
- CPTs explicitly try to reduce institutional barriers to progress by seeding external collaborations with modeling centers, so their success is dependent on fostering a welcoming, open, efficient culture at those centers. The liaisons who stay after the CPT help accomplish this.
- CPTs also educate process geeks about climate modeling.
- Especially when viewed holistically, the atmospheric CPTs have been a good use of limited resources.

Topical focus of CPTs

- To me, the biggest issue with atmospheric CPTs has been whether they should have a broader topical range.
- Topics like land/atmosphere interaction, orography and drag, ice microphysics, aerosol lifecycle incl. cloud-precipitation interactions, intrinsic predictability on many scales, exploiting weather-climate simulation synergies, model tuning, data assimilation, etc., also seem ripe for broader collaborations between modeling centers and the broader US science community.
- The process of prioritization and selection, as well as the appropriate size and time horizon of individual CPTs, needs discussion.