As one of the goals of UTCC PROES was to provide observational metrics to probe process understanding, it was initially meant to build a bridge between the GEWEX Panels GDAP (Data and Analysis) and GASS (Global Atmospheric System Studies). The Pan-GASS conference in July 2022 in Monterey, USA, gave us the opportunity to connect with the GASS community and UTCC PROES joins the GASS Panel as one of the working groups. These working groups are foreseen to last for a specific number of years, and we have to report progress every year (which we did already since the last 2 years).

There are also common interests with other working groups, in particular the WG on deep convective organisation led by Martin Singh and the GEWEX Aerosol Precipitation process study (GAP) led by Philip Stier and Susan van den Heever.

In the following you find a summary of our discussions we divided into 5 topics that we would like your inputs on.

1) Science Questions

The **leading science question** of UTCC PROES is:

How does convection affect UT clouds and then how do the clouds feedback on the convection?

Proposed & joint activities (build & expand upon UTCC PROES activities to date) include:

• ***review & fine-tune underlying scientific questions***

break up into **actionable questions**, and in a next step find out how much we know already (I attach also the report after our first meeting end of 2015, so you can compare what is new since then).

We have so far:

1. How much are anvil properties influenced by convective strength?

2. What types of cirrus are most responsible for heating the atmosphere and thus influential to climate sensitivity?

- ***How much of the heating can be traced to convectively generated cirrus?***
- ***How much of the variability of UT heating is governed by variability in areal coverage, emissivity and microphysics?***

3. How does the heating affect the convection?

4. How does the heating affect the large-scale atm. circulation?

5. How does convective organization affect the precipitation and the heating?

Xubin Zeng: my assumption is that the answers to these questions depend on the 3D atmospheric wind (or atmospheric circulation).

Blaz Gasparini: Drivers and climate feedbacks of UT clouds - small-scale processes (particularly microphysics, and its interaction with radiation and turbulence) vs. large-scale processes [I don't think we come very far by just following "first principle" ideas e.g. stability iris or Held&Soden mass flux arguments, mainly related to "large-scale environment/processes, I believe it's time to push the science beyond that and focus more on the small-scale processes]

2) Data

Specifically we want to ***identify, review & assess convection-cloud-precipitation-diabatic heating datasets*** that we propose to be a new initiative of GDAP.

Inventory of available datasets:

1. Mesoscale Convective System tracking datasets

i) TOOCAN MCS tracking database (30N-30S, regional segmented, 0.04°, 30min, 2012-2016)

available at : https://toocan.ipsl.fr/ & https://doi.org/10.14768/20191112002.1 *(Fiolleau & Roca, 2013, doi: 10.1109/TGRS.2012.2227762)*

The TOOCAN dataset will be soon extended up to 2020.

ii) Global MCS database (60N-60S, 10km, 1h, 2000-2019)

(Feng et al., 2021, doi:10.1029/2020JD034202) this dataset is available if you have access to the NERSC High Performance Storage System at /home/f/feng045/GPM/

it would be nice if this dataset was made available in a more accessible place in the same manner as TOOCAN

iii) Long-term tropical MCS dataset (30N-30S, 30km, 3hr, 1985-2008, CLAUS IR)

available at : https://doi.org/10.1007/s00382-018-4071-0 & https://doi.pangaea.de/10.1594/PANGAEA.877914 (*Huang et al. 2018*)

iv) ISCCP-NG (CLOUD+) MCS tracking database

will be created by NOAA in the future

2. Mesoscale convective system datasets from polar orbiting satellites

i) 3D UT Cloud Systems from Synergistic Satellite Observations & Machine Learning

(30N-30S, 0.5°, 4 obs per day, 2008-2018) *(Stubenrauch et al., 2021, doi:10.5194/acp-21-1015-2021, Stubenrauch et al., 2022, ACPD, in revision)*

Based on IR Sounder observations (AIRS & IASI) to get information on cirrus, includes radiative heating rates, rain rate classification (no/light/heavy), cloud top height, vertical extent, cloud layering, cloud system approach using cloud height & emissivity

distribution in preparation via UTCC PROES website https://gewex-utcc-proes.aeris-data.fr/

We started to use our data to study different metrics of convective organization (*Stubenrauch et al., 2022*, ACPD, in revision) ; this links to one topics of Martin Singh's working group on deep convective organization

Currently matching this database with the TOOCAN dataset 1) for coherence studies (convective core fraction within system as proxy for life stage) and 2) for combining complementary information (how many TOOCAN convective systems are contained in the CIRS UT cloud systems ?)

ii) Convective mass flux dataset

at present on narrow nadir tracks of CloudSat (*Masunaga & Luo, 2016*, doi:10.1002/2016JD024753; *Jeyaratnamet al., 2021*, doi:10.1029/2020GL090675)

is this dataset available ?

it is aimed to expand this dataset via machine learning & geostationary data

iii) Convective object database from A-Train measurements

Global coverage along CloudSat track with objects detected at two times of day (1:30 pm/am local time between 2006-2018). Database includes all convective objects with an identified convective core, so not exclusively MCSs. It incorporates metrics of vertical intensity, convective core sizes, anvil length and thickness, precipitation characteristics (e.g., rain rates, precipitating area of cloud), mass detrainment (e.g., IWP), radiative fluxes and CREs, and environmental statistics from reanalyses (SST, CAPE, shear, aerosols, and vertical motion at 500 hPa).

More details and initial analyses using the database in *Pilewskie and L'Ecuyer, 2022* (https://doi.org/10.1029/2022JD036438).

Database is not yet publicly available, but will be likely within this year

Currently working on matching the convective objects to TOOCAN-detected MCSs to supply lifecycle and spatial context, as well as combine multiple perspectives on what convection looks like.

3. Future observations for convective transport

EarthCare Doppler radar and INCUS mission

4. Microphysical data bases from field campaigns & satellites

Data base of field campaigns (*Kraemer et al. 2020*, doi: 10.5194/acp-20-12569-2020);

DARDAR-Nice (*Sourdeval et al. 2010*, doi:10.1029/2009JD01216)

Review of coherent fallspeed – ice crystal dimension (supplement of *Stubenrauch et al. 2019*, doi:10.1029/2019MS001642)

5. tropical cold pool characterization

There is also a recent dataset available which identifies and characterizes tropical oceanic mesoscale cold pools using spaceborne scatterometer winds (2007-2018, *Garg et al. 2020*, doi :10.1029/2019JD031812)

We also discussed the need for statements of uncertainties expressed in the datasets and guidance to use the datasets.

Xubin Zeng: I hypothesize that atmospheric dynamics (i.e., 3D horizontal wind) should play some role, and perhaps reanalysis wind could be used.)

Indeed, we may add variables which describe the thermodynamic and dynamic properties of the atmosphere and surface which come from reanalysis.

3) A proposed workshop

A **joint NASA(AOS) – GEWEX convection tracking workshop** will be organized for **end of summer 2023** in part to prepare an ***assessment of these data bases*** and ***specifically techniques used for convection tracking / analysis***.

suggestions / thoughts on what you might like addressed in such a workshop:

Xubin Zeng: get some groups work together first on relatively simple tasks, and take the workshop as an opportunity to further work together (and discuss other activities).

Ross Dixon: It's awesome that there are so many tracking methodologies that have been/are being developed, it would be helpful to understand the strengths and weaknesses of these different approaches and communicate them to users. It would also be helpful to understand what aspects of convection are sensitive to choice of methodology and which are not (for example, characterizing the diurnal cycle of MCSs might be similar regardless of the technique while distributions of extreme events, precipitation, etc might depend on the methodology/thresholds).

In the meantime, we are invited to participate in the workshop on tracking to be held 17 – 21 April 2023 in Oxford, UK, (and online) which is organzied by Philip Stier's group, and which also promotes the use of the open source tool tobac (*Heikenfeld et al. 2019*, doi :105194/gmd-12-4551-2019)

registration at : https://cloud-tracking-2023.eventbrite.com

4) Model – data activities

We want to exploit recent ***simulations at km-scale*** (e g. DYAMOND (DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains) as well as ***GCM climate simulations*** as a basis to develop ***collaborations that exploit the use of the data to advance the development of convectively resolving & climate modeling*** (GASS). Topics might include ***ice microphysical processes, convective transport, influence of aerosols and convective organization***.

Another topic is the *Inventory of data & model analysis methods (diagnostics)*.

Please offer your thoughts on possible activities around a few key topics relating to high clouds and convection and to the questions called out above. These activities ought to reflect the wider interests of the group:

Xubin Zeng: first step could be to simply use what the OBS-based data show (processes, relationships) to evaluate the corresponding model results – to hopefully identify major model deficiencies.

Greg Elsaesser: Convective systems can be identified and tracked in GCRMs. Lifecycle analyses of the GCRM systems, how quickly they grow and decay, and how that ties to identified convective area in the system, etc., and how results compare to new observational life cycle analyses being published in the literature would be a very tractable thing to do in a GCRM. Would only require running an MCS tracking algorithm on the GCRM, and extracting all the fields for identified MCS stages (much easier than satellite analyses, where different satellites/orbital datasets have to be collected and co-located).

We may start to analyze some of the DYAMOND simulations, but for cloud system reconstruction we need model output which includes cloud optical depth or emissivity as well as cloud top height (pressure), IR brightness temperature. Rain rate and radiative heating rate profiles would also be great. Daniel Klocke made note of this during the last GASS Panel meeting.

Chris Bretheron: There is a literature of CRM and GCRM simulations focused on tropical cirrus, their simulated realism, and their climate feedback in RCE, regional km-scale simulations and GSRMs. This literature shows ice microphysical parameterizations are a dominant source of inter-model differences, causing wide scatter around observed cirrus properties, and that different numerical schemes and grid resolutions also affect deep convection and upper tropospheric wave motions that maintain cirrus clouds. A modern synthesis of this literature could help more tightly frame PROES.

Who would be interested to participate in writing such a review ?

Claudia Stubenrauch: I submitted a review on available ice crystal size – fall speed parameterizations from field campaigns for GCMs as part of an observational evaluation in 2019, but it was not accepted as such, so I added this review in the supplement of (Stubenrauch et al. 2019, doi:10.1029/2019MS001642) Therefore, before starting such an effort, one should be sure that it will be accepted (choose well the journal and make an inquiry if such a review is welcome).

The mesoscale convective cloud system data as well as the developped reconstruction tools make it also possible to study and assess different metrics for convective organization. This is a topic which also concerns the GASS deep convection working group led by Martin Singh and he will organize a sub-group to work more closely on this topic. This topic will be a bridge between our working groups. If you intend to work or are actually working on this topic, please contact him (martin.singh@monash.edu).

5) Communication within the group

Since we want to have an active WG, we also discussed ways to communicate; one option is slack

Do you have other suggestions?

Xubin Zeng: prefer emails (say, every couple of months), followed by other approaches (e.g., slack) when more frequent discussion on a specific topic is needed.

Ross Dixon: I have a love-hate relationship with Slack, but agree that it could be helpful for organizing and connecting sub-activities within this group. (I believe there is a new cost associated with using slack if you want to access files/discussions past 30 days, which has led to us moving away from using it.)

At present we stay with emails every couple of months for information, and everyone has the possibility to contact others of the group to build collaborations.

Near Future :

It would also be profitable to build sub-groups to advance on the specific science questions.

A UTCC PROES break up meeting is foreseen during the combined CFMIP / GASS meeting, to be held from 10 to 13 July in Paris, France.
https://sites.google.com/view/cfmip2023/

This will give an opportunity to discuss also the topic of active sub-groups.

Dear colleagues,

Just before the first month of 2023 ends, I want to wish you all a happy and successfull New Year and provide you with information on upcoming meetings, so that you can save the dates.

1) The joint NASA – GDAP – UTCC PROES workshop on the assessment of the mesoscale convective systems will be prepared for 2024
In the meantime, we are invited to participate in the
workshop on tracking to be held **17 – 19 April 2023 in Oxford, UK,**
which is organzied by Philip Stier's group, and which also promotes the use of the open source tool tobac (Heikenfeld et al. 2019, doi :105194/gmd-12-4551-2019).
I will send you the link to the workshop website once it is ready.

2) A UTCC PROES break up meeting is foreseen during the
combined CFMIP / GASS meeting, to be held **10 - 13 July 2023 in Paris, France**.
More information will be found at https://cfmip2023.sciencesconf.org/

3) For those who want to combine the CFMIP / GASS meeting with the **IUGG conference in Berlin, Germany** : I am co-organizing the **JG03 Remote Sensing and Modelling of the Atmosphere** (IAG, IAGA, IAMAS, IAVCEI) symposium, which involve the following sessions :
1. Upper Atmosphere: Ionosphere, Thermosphere, Plasmasphere, Magnetosphere
2. From Ionosphere to Troposphere
3. Lower Atmosphere: Monitoring the Earth by Global Navigation Satellite Systems and other measurement systems
4. Lower Atmosphere: Water Vapour, Clouds, Precipitation and Radiation
5. Lower Atmosphere: Monitoring of anthropogenic and natural aerosols and their radiative forcing
The session will most probably **start on 15 July in the afternoon**. More information :
https://www.iugg2023berlin.org/922-2/#IACS, scroll to JG03
Deadline for abstract submission is 14 Feb 2023.

I also have updated our action document which we have started last year. You find a pdf version attached and the link to the corresponding google document is here again :
https://docs.google.com/document/d/1wiHBikVNwG87LNRsHsJ3gekWQlRh7PwqwRGZXf9uxfI/edit

Best wishes
Claudia