Process Study and Model Improvement Panel

Mission

To reduce uncertainties in the general circulation models used for climate variability prediction and climate change projections through an improved understanding and representation of the physical processes governing climate and its variation.

Process Study and Model Improvement Panel

Breakouts at this year's Summit

- Teleconnections (joint w/ PPAI)
- High-latitude circulation (joint w/ POS)
- AMOC (joint w/ POS)
- TPOS2020
- Decadal variability (joint w/ PPAI)
- Stratosphere
- Panel business

Teleconnections: Arctic vs. tropical impacts on midlatitude predictability, including changing teleconn. in a warming climate

Guiding questions

What is the next step forward after the AML-Working Group white paper?

Arctic vs tropics: which one has larger impact on mid-latitude weather?

Continued discussion of morning's plenary session

Judah Cohen gave a review of Arctic-Midlatitude workshop, highlighting scarcity of observations in the Arctic and model deficiencies.

→ Recommendation: Need for boundary layer measurements focusing on energy fluxes, and coordinated modeling experiments.

Daniel Swain further discussed attribution of extremes and linkages to the nonuniform spatial pattern of lower tropospheric warming.

→ Recommendation: Explore potential linkages identified between the communities and the dynamics involved in studying drought and the adjacent upwelling system. International CLIVAR EBUS engagement, including synergy with meridional modes research.

Antonietta Capotondi used an example of a key model bias (persistence of coupling between wind and SST much stronger in obs. than models).

→ Recommendation: Use climate models to look at ENSO impacts along the US west coast; for Pacific decadal variability studies it is very important to understand model biases in the representation of the meridional modes and improve that representation.

Overall discussion focused on parametrizations: combining deterministic and stochastic approaches needed.

High Latitude circulations (with POS)

Alison Gray: SOCCOM biogeochemical floats observations suggest that the the previous ship based obs possibly missed winter outgassing

Taka Ito: The Southern Ocean CO_2 and other biogeochemical variables exhibit significant (multi-) decadal and interannual variability, and they are not uniform; different mechanisms may be at play at different regions, depths and timescales (from CMIP5)

Jamie Morrison: Arctic Ocean variability and AO: two way interaction

Recommendation:

Modelling challenges: improving parameterizations in sea ice models, role of ocean eddies sea ice albedo feedbacks

Utilizing autonomous observations in wintertime in the context of data assimilation efforts.

AMOC (with POS)

AMOC Modeling (Rong Zhang):
Most models simulate connection between meridional heat transport and AMOC, but have a strong SST cold bias in mid-latitude N. Atlantic

More realistic (i.e., stronger) Nordic Sea Overflow can lead to better AMOC (and reduce SST cold bias in models).

AMOC impacts:
AMV plays a role in multidecadal variations in Sahel rainfall, ITCZ and North Atlantic hurricanes. Winter Arctic sea ice in the Atlantic
Other climate impacts of AMOC exist (e.g., U.S. rainfall, drought, summer climate over N. America, etc.)

Modelling challenges: What processes (e.g., freshwater outflow) within marginal seas control AMOC variability. A wide range of representation in models was noted. Models with different structures (treatment of ocean) give different perspectives.

TPOS and Process Studies

Objectives

Brief overview and update of TPOS 2020 project

Description of TPOS related processes studies

Discussion including providing PSMIP feedback to TPOS leads regarding process and pilot studies.

Guiding question

What physical processes will be most important over the next decade *(e.g.* for model development, or to devise effective ongoing sampling strategies that will depict the processes from sustained monitoring)?

Billy Kessler gave a brief overview and update of the TPOS 2020 project
- The three goals of TPOS 2020 are (1) observe/understand ENSO, (2) support prediction systems and (3) understand physical and biogeochemical variability and predictability.
- Timeline: Now almost to the 2nd report; at 2020, there will need to be a handover to the agencies that will operate it.
- Backbone: Satellites (x,y), Moorings (t) and Argo (z)
- New understanding and issues: role of high-frequency (including diurnal cycle), focus on coupled boundary layers, physical-biogeochemical connections and impacts, maintaining a climate record.
- TPOS views the tropical Pacific as having four boundary layers: surface, equatorial, western and eastern. These are the hard parts. Focus on regimes and processes.

Discussion focused on process studies, primarily ones to measure and understand equatorial upwelling (global significance, almost unconstrained by observations, barrier to model development) as well as barrier layer beneath/east of the west Pacific warm pool. Also focus on OSSEs (relative lack of them, odd/surprising results from ones that have been done).

Impediment: Insufficient support for communication and interaction between observationalists designing TPOS 2020 and modelers/assimilation experts who will make use of the observing system.

Recommendations
- Establish support for conducting OSSEs to ensure most effective observing system design.
- Continue to leverage funded efforts like YMC toward TPOS 2020 objectives.
- Workshop in 2018 to bring together TPOS 2020 leads, observationalists and "modelers" (parameterization developers, assimilation practitioners, *etc.*) to ensure the most effective design of the next generation tropical Pacific observing system in support of related process studies. PSMIP offers to facilitate.
- Much interest in TPOS 2020 – potential for observing ocean biogeochemistry. (feedback for 2nd report)
- PSMIP may conduct webinars on pilot and process studies to give feedback as appropriate.

Decadal variability 5 yr ahead scale

6 presentations (Rob Burgman, Emanuel Di Lorenzo, Rong Zhang, Kevin Reed, Ben Kirtman, Erin Towler)

1. The ocean dynamics and AMOC is important from AMV representation. The key AMV features cannot be explained by slab ocean model or red noise processes.
2. Pacific Decadal Variability can be explained as an interaction between the meridional modes and ENSO. PDV appears to intensify due to intensification of meridional modes.
3. The initialized models give better prediction than non-initialized models. CMIP6 studies evaluating the hindcasts, forecasts, and process studies are continuing
4. Even on the decadal scale the high resolution in the atmosphere and in the ocean allows for better representation of important phenomena such as tropical cyclones climatology, currents and SST anomalies and air-sea interaction (ocean eddies important)
5. Decadal predictions can be used in water resource planning - the models beat climatology, however the forecasts have to satisfy certain conditions to be useful to decision makers (saliency, credibility, compatibility and contextual acceptability)

Action item: Emphasize and encourage exploration of high-resolution modeling when evaluating process studies in future webinars. Importance especially in Southern Ocean and WBC regions.

Role of stratospheric processes in climate

Guiding questions

What is the impact of stratospheric circulations on climate/extended weather prediction?

How good are models in predicting stratospheric circulations?

What processes are critical for these predictions?

What are the data /understanding gaps that should be addressed to represent these processes?

Are there any field projects current and planned that address these questions?

Presentations by John McCormack (NRL) and Craig Long (NOAA) followed by discussion

John McCormack addressed the impact of the stratosphere on weather and climate, how good the models are, and whether we have enough data to initialize and evaluate models.

- Stratospheric circulations are predictable and an important source at seasonal to interannual. The stratosphere is a large reservoir of angular momentum, much like the ocean is a large reservoir of heat.
- Coupled chemistry climate models simulate climatology reasonably well. Some seasonal skill in NWP systems extending to high altitudes. Predicting events still problematic (SSWs, QBO, etc).
- QBO driven by rich spectrum of convectively generated tropical waves (Kelvin, MRG [Yanai], small-scale gravity waves)Not spontaneously generated in models, yet necessary for good predictions
- Currently have enough data, but anticipating a major dropoff soon (satellite missions ending).
- Recommendation: Working *with* SPARC would be the way to go if CLIVAR is interested in pursuing.

Craig Long reviewed the rich history of measuring the stratosphere (from baloons to satellites) and reinforced the upcoming dropoff. In terms of processes, the stratosphere community thinking about many of the same/analogous questions we have discussed at the Summit for the troposphere/ocean.

Recommendations and action items

Working with SPARC would be the way to go if CLIVAR is interested in looking at these questions.
Encouraging follow-on missions to address upcoming data gaps
Explore potential for webinar on stratospheric process study with impact on S2S prediction and events.
Encourage connections between stratospheric scientists and climate model developers in typical CLIVAR realm.

Planned PSMI panel activities

Webinar Survey results:
In general our review process is not too burdensome for PI and useful. Some highlights
1. Helps in early project stages but it is also good to heave a feedback throughout the life of project
2. Often leads to further discussions
3. Effective for sharing best data sharing practices
4. Possibly extend the audience and include more representatives from the modeling centers (webinars from modeling centers?)
New process studies to review:

Action items:
- Get more information on process studies we identified and chose projects to review
- Take into account the SSC suggestion to pay more attention to decadal time scales
- Start planning for the panel meeting next summer
- Facilitate workshop for TPOS communication with modeling and atmospheric communities; OSSE planning
- Reach out to SPARC, scope webinars and joint *Variations* issue.
- Consider developing a best-practices white paper on data/product sharing/management
- Emphasize and encourage exploration of high-resolution modeling when evaluating process studies in future webinars. Importance especially in Southern Ocean and WBC regions.
- Coordinate with PPAI and POS on mutual action items