2022 US CLIVAR Summit
POS Recommendations

POS

The Phenomena, Observations, and Synthesis Panel's (POS) mission is to improve understanding of climate variations in the past, present, and future, and to develop syntheses of critical climate parameters while sustaining and improving the global climate observing system.

Agency Updates

- Various US agencies and institutions are pursuing disparate and adhoc digital twins
  - Promote a US Agency Plan for digital twins → definition, focus/purpose, etc
    - Workshop? Working Group?
- Promote "observation" within Earth System Modelling and Observations (one of WCRP core projects)
  - Invite ESMO member to give a POS webinar

The Air-Sea Transition Zone

Goal of the Study: To develop a well-defined strategy to advance observing and modeling capabilities and understanding of air-sea interaction at all required scales for harnessing ESP

Expected outcomes from POS panel

- Identify an action item for the panel that can leverage and/or assist study team activities
- Provide a specific recommendation for the 1-year study team.

- What is right balance between a widely-distributed (sustained) observing system and a few "supersites" that improve process-level understanding?
- Promote leveraging and augmentation of existing and planned observations and modeling output for air-sea transition zone studies
- Promote use of inverse modeling and reanalyses to advance understanding of mechanisms and regional differences
- *Suggestion:* Focus initial activities under "A07: Review of ocean observing systems" on component(s) most relevant to air-sea interactions

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Cloud Processes in the Climate System

Questions to the POS panel:

In what ways do the uncertainties in cloud processes influence ocean variability?

What are the current capabilities of our sustained observing system for understanding

Recommendations/ideas:

- Combine atmospheric cloud observations with dedicated air-sea transition zone campaigns (e.g., SMODE)
- Improve overall flux estimates over ocean
- Leverage upcoming satellite cloud observations (e.g., NASA AOS; PACE Polarimeters)

Diversity, Equity, and Inclusion

- POS Panel member involvement in US CLIVAR DEI task force
  - Development of an actionable DEI statement
- Foster/promote research priorities that touch on DEI and Environmental Justice (EJI)
  - E.g., climate at the coasts → sea level rise
- Promote geographical diversity in US CLIVAR meeting locations and engagement with local communities
- Continue to offer hybrid formats to foster diversity and inclusivity
- Require there be a section about DEI in workshop or working group proposals

Enabling Open Science in the Age of Big Data

Question to the POS Panel: How can open science advance panel goals?

- Promote clarification / best practices on "reproducibility" (data & software) of project/funding requirements, requirements from journals, costs
  - Models raise the greatest issue with respect to reproducibility & storage
- POS panel member involvement in EarthCube RCN "What About Model Data?" Determining Best Practices for Preservation and Replicability
  - Workshop 25-27 July 2022 @ University of North Dakota, Grand Forks
- Promote alternate incentivization methods for open science within agencies/institutions, such as job promotion and proposal selection criteria
- Promote interagency and inter-institution coordination
  - Co-location of multiple datasets (e.g., in situ, remote sensing, model solutions, reanalyses) from different data providers
  - Consistent, reduced data latencies for open access
- Create a US CLIVAR Github page to promote open science practices and projects, etc

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Sea Level and Coastal Flood Risk Prediction

- Foster research on climate mode impacts on coastal sea level; related to ocean heat transports and thus air-sea interactions
- Consideration of spatio-temporal scales for coastal drivers (sea level rise, flood hazards - storm surges, tsunamis) and their responses (coastal inundation, coastal flooding, saltwater intrusion) for improved observation, modeling, and prediction at local, state, and national levels
  - Promote coastal SWOT applications
  - POS Panel member involvement / attendance at CLIVAR/GOOS - From Global to Coastal Ocean Observing Workshop (summer 2022)

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Stratosphere-Troposphere Interactions

- Are observations limiting?
- Support the observations needed for the stratosphere-troposphere coupling?
- Model/reanalysis intercomparisons needed?

Hybrid Physics-AI Forecast Models

- US CLIVAR should act as a link between the AI-focused projects and the rest of the research communities linked to climate
- Could the US CLIVAR Data Science working group help?
- POS panel summer session to further develop topic with observations, scoping workshop?

PSMIP Breakout Report

Outcomes of summer 2021 meeting

- Coupled cross-scale interactions
  - Encourage process studies to focus on cross-scale interactions and large-scale impacts during design.
  - Host PSMIP webinar on USVs, other autonomous assets (May 2022 TPON workshop recommendation; potentially supportive of Transition Zone Study Group)
- Extracting value from high-resolution global cloud resolving simulations
  - Organize webinars focused on long-term data archival
  - Liaise with Model Uncertainty - Model Intercomparison Project (MU-MIP).
- Arctic ocean-sea ice-atmosphere transition layer
  - Catalyze a US CLIVAR Working Group on Arctic surface fluxes in models
  - More robust collaboration between US CLIVAR and IARPC (AGU 2021 Town Hall)
- Ocean BGC process studies and model improvement
  - Focus area for 2022 PSMI webinars

Air-Sea Transition Layer Session

Discussion topics:

- A supersite for studying the air-sea transition layer: Use cases
- Role of the ocean circulation in modulating heat and momentum transfer
- Investigate deficiencies in the bulk flux schemes: systematic study using benchmark cases from available process studies

Potential Actions:

- Host process study webinars relevant to the study team’s charge
- Catalyze a high latitude surface flux working group: leveraging new observations and spuruing model improvements

Recommendation to the Air-Sea Transition Study Team:

- Recommendation to revisit the Brunke et al. (2003) study (comparison of bulk flux schemes and other new algorithms with eddy covariance measurement)
- Take a hypothesis testing perspective to the observing system strategy
- Consider the necessary balance of global long-term and regional small-term observations

Enabling Open Science session

Discussion Topics:

- Close connection between Open Science and DEIJAB, training is important
- Need to promote and INCENTIVIZE improved practices around code sharing and documentation
- Need clear demarcations between:
  - computing in the cloud (e.g., running a model),
  - performing data analysis in the cloud (e.g., calculating a time series from ERA5 data),
  - long-term archival of such data.

Potential Actions:

- US CLIVAR statement to federal agencies to
  - support open science initiatives (e.g. NASA TOPS)
  - encourage agencies to work out a funding model for cloud compute resources
- US CLIVAR to promote engagement with “hackathons” or other such training
- Panel members to take TOPS training

Cloud Processes in the Climate System

Discussion Topics:

- Synergistic use of observation and modeling approaches:
  - Cloud controlling factors
  - Use of models and observations to diagnose cloud processes:
    - LES to diagnose cumulus entrainment
    - LES and AC obs + ML to build cloud-aerosol emulators (do we have enough data under enough conditions?)

Potential Actions, Recommendations:

- Encourage coordinated use of LES and cloud-permitting simulations (based on observations) to test ESM parameterizations
- Engage with the Cloud Feedback Model Intercomparison Project (CFMIP)
- Collect “parameterization development” stories via panel discussions to learn about
  - Parameterization development: how does it work? Are there best practices?
  - How process study observations are (or are not) used in this process

Sea Level and Coastal Flood Risk Prediction

Discussion Topics:

- Panel discussed sea level with Dr. Holly Michaels (U. of Delaware) on impact of coastal flooding on groundwater:
- Infiltration of saltwater and salinification of groundwater can significantly affect the coastal flora, causing, e.g., deaths of trees and marshes to migrate. Focus has been on these impacts, but they can potentially have climate feedbacks.
- There is a very large range of parameters to consider. Models trained on observations collected by Michaels's group can be used to train models, and then use the models to explore parameter space. These models can be used to determine parameterization to include these processes in coarser resolution ESMs.
- Most important data for this problem are salinity data to clearly identify the boundary between saltwater and freshwater.

Potential Actions, Recommendations:

- Encourage the collection and sharing of salinity data along coastlines
- Promote in-depth analyses of climate models to assess their fidelity in simulating the key large-scale processes, and their coastal expressions, relevant for coastal risk prediction.

Stratosphere-Troposphere Interactions

Discussion Topics:

- Need for more continuous high vertical/horizontal resolution atmospheric measurements in order to better constrain gravity wave parameterizations. Balloon studies are very valuable but intermittent. Satellite data is limited.
- Region near tropopause may be key region to improve ST-coupling processes (a focus both for modelling/forecasting and observing)
- What are the considerations for researching climate interventions and impacts? Key points from Simone Tilmes: we're not where we need to be to achieve Paris targets. Climate intervention could be part of a portfolio in addition to mitigation/adaptation. Models however currently show factor of 2 uncertainty in temperature response to stratospheric aerosol injection; and few models can adequately simulate aerosol processes.

Potential Actions:

- Survey program managers about potential for funding SAI research; or issue statement about need for stratospheric aerosol research
- Engage with the Geoengineering Modelling Research Consortium

Hybrid Physics-AI Forecast Models

Discussion Topics:

- Challenges and opportunities with ML/AI techniques to inform process studies and observation needs?
    - Gaps exist in understanding parametric uncertainty, how to evaluate observational targets with data denial, experiments, etc.
- Non-linearities and compensating errors can be roadblocks in model development/improvement
- Very atmosphere-heavy, what are the ongoing efforts in ocean/coastal prediction?

Potential Actions:

- Focused session for summer panel meeting to gather information on how ML/AI hybrid approaches may change or inform the data needs from process studies and cross-scale feedbacks
- Encourage researchers using interpretable ML/AI methods through webinars and promoting conference sessions
- Monitor agency-defined ML/AI initiatives and liaise

Reflections and action items from 2022 Summit sessions

- DEI, Potential Actions:
  - DEI session at summer panel meeting (and future US CLIVAR Summits)
  - Arrange Role Model Training for PSMIP and/or US CLIVAR panels
  -

PPAI Climate and Health session: *initiatives*, *examples*, *challenges*, *opportunities*

- **Lee Hall and Lawrence Fine**: NIH's strategic plan framework: intersections and climate
- **John Neilsen-Gammon**: How climate scientists think about climate prediction: presentation and discussion
- **Anjuli Bamzai**: NSF efforts in climate and health
- **Ben Zaitchik**: Climate and Health: A GeoHealth perspective

National Institutes of Health

"There is perhaps no greater opportunity for NIH to fulfill its mission than by providing global leadership in the response to the burgeoning climate change and health crisis."

~NIH Climate Change and Health Initiative Framework Document

Learn more: https://www.nih.gov/climateandhealth

Governance Structure for CCH Initiative

Executive Committee

- Composed of: NIEHS, FIC, NIMHD, NIMH, NINR, NICHD, NHLBI
- Governance

Steering Committee

- Representatives of all EC ICs
- Planning, strategy, and implementation

Climate Change and Health Working Group

- 18 ICs, 4 Offices
- 140+ participants
- Interest group, engagement, and ideas

Characterizing 2011-2020 CCH Portfolio

Most Common Weather and Health Outcome RCDC Concepts

NIH Portfolio Analysis

Weather Related Concepts

(233 awards)

- Extreme heat/weather/temperature
- Drought/flood/rain/precipitation
- Hurricane
- Climate variability/seasons
- Fire/wildfire
- Humidity

Outcome Concepts

(215 awards)

- Respiratory
- Epidemic
- Birth/Premature Birth
- Maternal Health
- Occupational Health
- Malaria
- Heat Stress
- Dengue

Climate and Health: Next step

- Continue the dialog with NIH and AGU GeoHealth
- Facilitate scientists from the climate (e.g. Kris Karnauskas at CU Boulder) and health communities to develop an US CLIVAR working group proposal together

PPAI discussions: The air-sea transition zone

- A careful comparison of turbulent **heat/momentum** fluxes between previous/planned observational campaigns and widely used reanalysis products (particularly those that are high-resolution)

- Obtaining more high frequent observations to better resolve **diurnal variations** within the atmospheric and oceanic boundary layers

PPAI discussions: open science/big data

Make large hindcast and forecast data sets more accessible to the community:

- **Agency support** for long-term cloud data hosting (combined government/commercial)
- **New tools** that could allow end users with limited resources to evaluate forecast skill of quantities that are relevant to them
- Make hindcasts products **tailored to end users' needs**

PPAI discussions: Sea level & coastal flood risk prediction

A**ssess and identify low-freq** modes and how they affect **the forecast skill** of storms and high tides

Optimal messaging for coastal inundation (tercile probability forecasts, user/regional defined thresholds, or median values with confidence ranges)

Study direct impacts to the **coastal human and marine ecosystems** (e.g., flooding of roads/properties, beach erosion, salinization of forests and ag field due to surge overtopping)

Modeling of groundwater flooding also requires a significant amount of information (data) about the **geology of the environment**

PPAI discussions: Hybrid physics-AI forecast models

Establish some **best practices** for use and development of ML/AI **climate forecast** models (ie, ML models constructed from observations)

- **Test overfitting** with strict and transparent cross-validation
- **Evaluate techniques** using long model datasets, which also allows identification of how it works for nonstationary climate
- Need for white paper? Is Data science WG working/interested in this topic?

Develop **trustworthy AI**

- Needs to be able to **characterize forecast uncertainty**, including identifying periods of both high skill ("forecasts of opportunity") and low skill (skill dropouts)
- Use the technique for **real-time forecasts**, which forecasters use and evaluate over longer periods of time
- Need to be able to **explain forecast technique** and sources of skill **to end-users**

US CLIVAR
Climate Variability & Predictability

Proposed new activities

- Webinar organizers (work with the panel to pick webinar topics, invite speakers, organize the seasonal discussions)

- Add a 30min panel discussion session during each webinar theme (~every 3 months) to discuss the current/emerging core priorities

- Produce a short priority list & form some small teams of 3-4 members

2022 spring-summer webinar topics

John Callahan/Matt Newman: sea level/coastal flood predictions; also include coastal land (eg salinity)

Tentative PPAI Summer Session Topics

- ML use in climate prediction (ML, JF, SK)
- Connected extremes (ET, DA, Bao, HT, QD)
- Climate prediction for everyone (prediction science & equity, we may think about writing a report for BAMS or EOS or Variations based on our discussion) (MN, ML)
- hydroclimate S2D predictions (SK, JC)
- Impact of Convection Permitting resolution/initialization on prediction/predictability (VG, Bao)

Report progress /discuss

- Discuss where climate/health is in terms of WG proposal (DA)
- Sea level/coastal flood risk predictions (MN, JC, ND)

actions

Climate & Health working group

Coastal climate prediction working group

Focus teams for webinars and summer meeting

Meet with AI/ML Data Science working group

Develop Equity in Climate Prediction initiative

Reach out to HBCUs; possible summer panel meeting at Howard U



Thank you!