

# GPEX (Global Precipitation Experiment) Concept and Status

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## Imperative to Improve Precipitation Predictions

Deadly and damaging threat from too much or too little water is exacerbated by climate change.



Progress in flood and drought prediction is largely dependent on improved precipitation prediction.

## GPEX White Paper

### Organizational Structure

- Options: WCRP Lighthouse Activity and WCRP Project
- Two options for staff support: expanding existing WCRP staff and new International Project Office
- GPEX Planning Group to prepare the GPEX Science and Implementation Plan

### Vision, Mission, and Key Goals

- Vision:** Understanding and prediction of precipitation in a changing climate to support resilience and sustainable development
- Mission:** To accelerate advances in precipitation knowledge and prediction at different temporal and spatial scales, to enhance public access to relevant datasets, and to benefit the society, all by coordinating national and international activities
- Key Goals**
  - Better measurements of precipitation
  - Improved understanding of the complex precipitation processes and their interactions with the environment
  - Reduced model biases in the global coupled models for improved prediction and projection of precipitation at different temporal and spatial scales.
  - Enhanced regional and local capacity building

### Key Activities

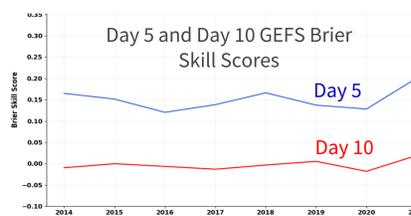
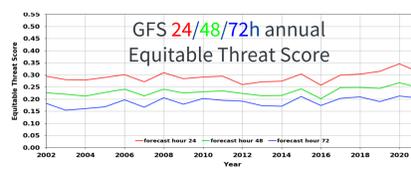
- Existing Activities:** Observational campaigns, modeling experiments, process studies, capacity development activities, stakeholder engagement
- New Activities**
  - Establish/expand precipitation databases
  - Support the establishment of multi-model databases along with common evaluation metrics
  - Coordinate modeling and research on precipitation predictability, prediction methods and applications on multi-year to multi-decadal timescales
  - Support existing national/regional activities and capacity building
- Activity Period**
  - GPEX will be a 5-year, and possibly 10-year, project
  - Organize the WCRP Year of Precipitation (YoP)
  - GPEX could be part of International Water Decade

## Acknowledgements

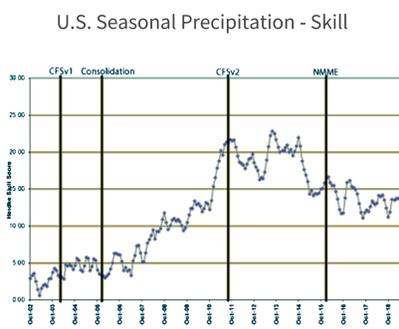
I would like to thank the GPEX Tiger Team for developing the GPEX White Paper, WCRP and agencies in USGCRP and USCLIVAR for discussions and support as well as Clara Deck for preparing the poster.

## Slow Improvement in Precipitation Forecasts Over Past 20 Years

### Weather Forecast Skills (2002-2022)



### Seasonal Forecast Skills (2002-2018)



## Global Precipitation Experiment (GPEX)

GPEX will systematically and comprehensively reduce model biases in global coupled models and improve precipitation prediction using an integrated observations and modeling strategy and targeting critical processes and phenomena.

### Predictability and Processes studies

Predictability and Processes studies including field experiments and hierarchical model experiments

### Optimizing observations and datasets

Optimize observations and datasets for prediction initialization, evaluation and process understanding

### Improving coupled prediction models

Improving coupled prediction models by improved physics, high-resolution modeling, ML/AI, coupled data assimilation

### User engagement

User engagement throughout the entire process as an input to guide future research needs and requirements for improvements

NOAA and USGCRP agencies proposed the initial concept of GPEX

GPEX is part of NOAA Precipitation Prediction Grand Challenge (PPGC) Initiative implementation

GPEX is envisioned to be a multi-year project with national and international participation and collaboration.

### Envisioned Partners



## Status and Next Step of the GPEX Planning

WCRP has adopted GPEX as an international activity across WCRP

WCRP has appointed the GPEX Tiger Team to prepare a GPEX White Paper

The draft GPEX White Paper has been developed and reviewed by WCRP

After WCRP Joint Science Committee (JSC) accepts the GPEX White Paper, WCRP will appoint a GPEX Planning Group to prepare the GPEX Science and Implementation Plan

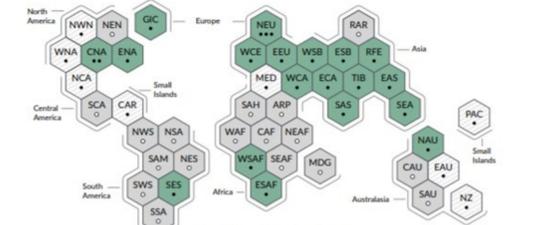
### GPEX Tiger Team

Member	WCRP Core Project
Dr. Xubin Zeng	GEWEX & Chair
Dr. Paquita Zuidema	CLIVAR
Dr. Annalisa Cherchi	Monsoons Panel
Dr. Sara Pryor	Rifs co-chair
Dr. Lincoln Alves	Rifs and works in Brazilian National Institute for Space Research (INPE)
Dr. Stefan Pieter Sobolowski	Rifs and NORCE Climate & the Bjerknes Centre for Climate Research
Dr. Takeshi Horinouchi	SPARC
Dr. Thamban Meloth	CLiC
Dr. Jin Huang	NOAA and USGCRP

## Uncertainties in Precipitation and Drought Projections

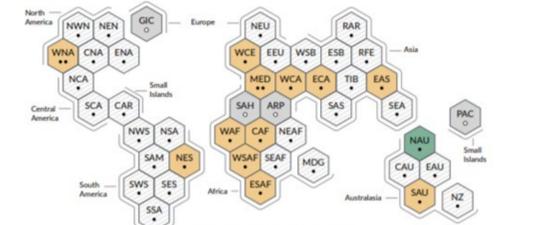
The IPCC AR6 Report indicates state of art climate models are uncertain in precipitation projections and low confidence in attribution of human impacts on precipitation and drought. IPCC Working Group I: Summary for Policymakers (AR6, 2021)

Observed change in heavy precipitation and confidence in human contribution to the observed changes in the world's regions



Type of observed change in heavy precipitation: Increase (19), Decrease (0), Low agreement in the type of change (5), Limited data and/or literature (18)

Observed change in agricultural and ecological drought and confidence in human contribution to the observed changes in the world's regions



Type of observed change in agricultural and ecological drought: Increase (12), Decrease (1), Low agreement in the type of change (26), Limited data and/or literature (4)

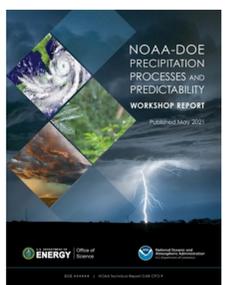
## Common Model Systematic Errors

- Underestimating heavy rain & overestimating light rain
- Estimating diurnal precipitation maxima too early in the day
- Initiation of convective precipitation, often due to errors in representation of boundary layer & convective parameterizations
- Slow or non-physical propagation of convection
- Phase speed of mid-latitude troughs
- Sub-seasonal tropical variability (MJO representation)

These errors exist in weather model and climate models. Improving key precipitation processes benefits prediction on timescales of weather through climate change.

## NOAA-DOE Precipitation Processes and Predictability Workshop

This multi-agency workshop focused on advancing understanding of precipitation predictability and physical processes key to precipitation biases. The workshop brought together the observational, modeling, and research communities to address the following questions:



- What are the sources of predictability that have the biggest influences on precipitation at weather, subseasonal-to-seasonal to multi-decadal timescales, including extremes?
- What are the key physical processes that have the strongest imprint on the model biases and precipitation predictions and projections?
- How can we most effectively take advantage of existing observations and data (satellite and in-situ) to advance process-level understanding of the key processes and predictability?
- What are the gaps and needs for targeted observations and process studies to improve understanding and model representations of those key processes?
- How do we benefit from national and international collaboration to make significant progress?