GPEX (Global Precipitation Experiment) Concept and Status

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Acknowledgement:
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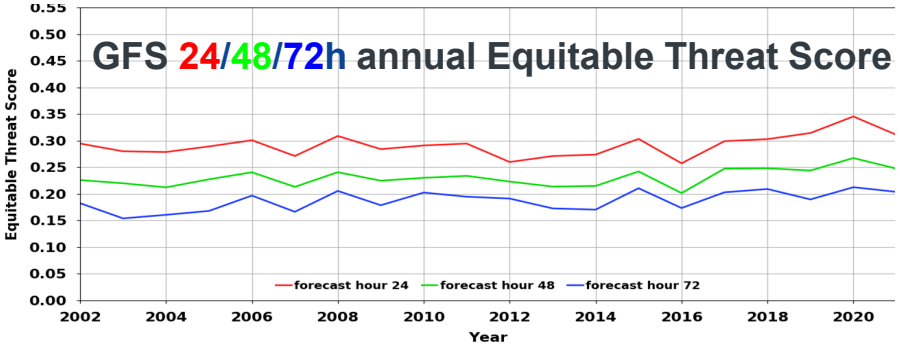
Imperative to Improve Precipitation Predictions

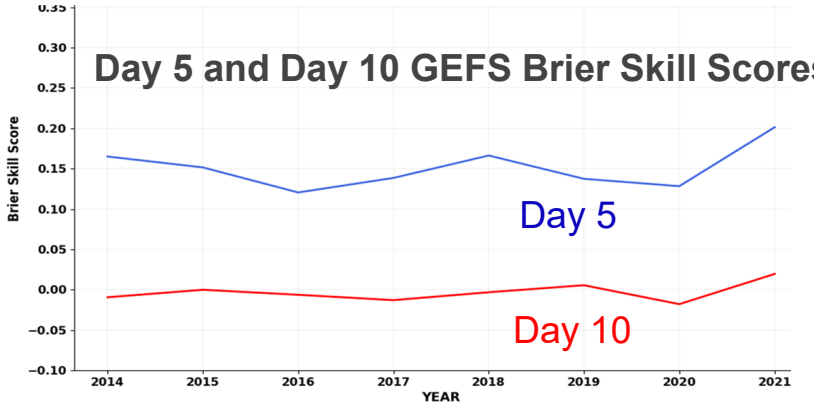
Deadly and damaging threat from too much or too little water - exacerbated by climate change

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

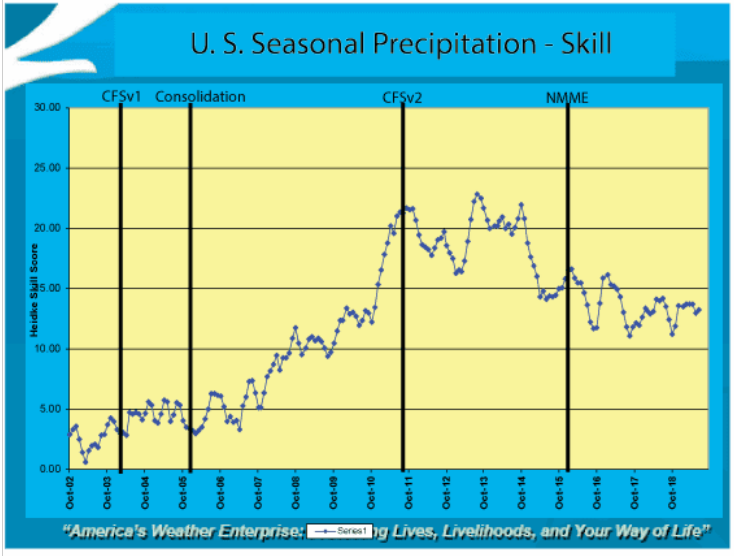
Slow Improvement in Precipitation Forecasts over past 20 years

Weather Forecast Skills (2002-2022)





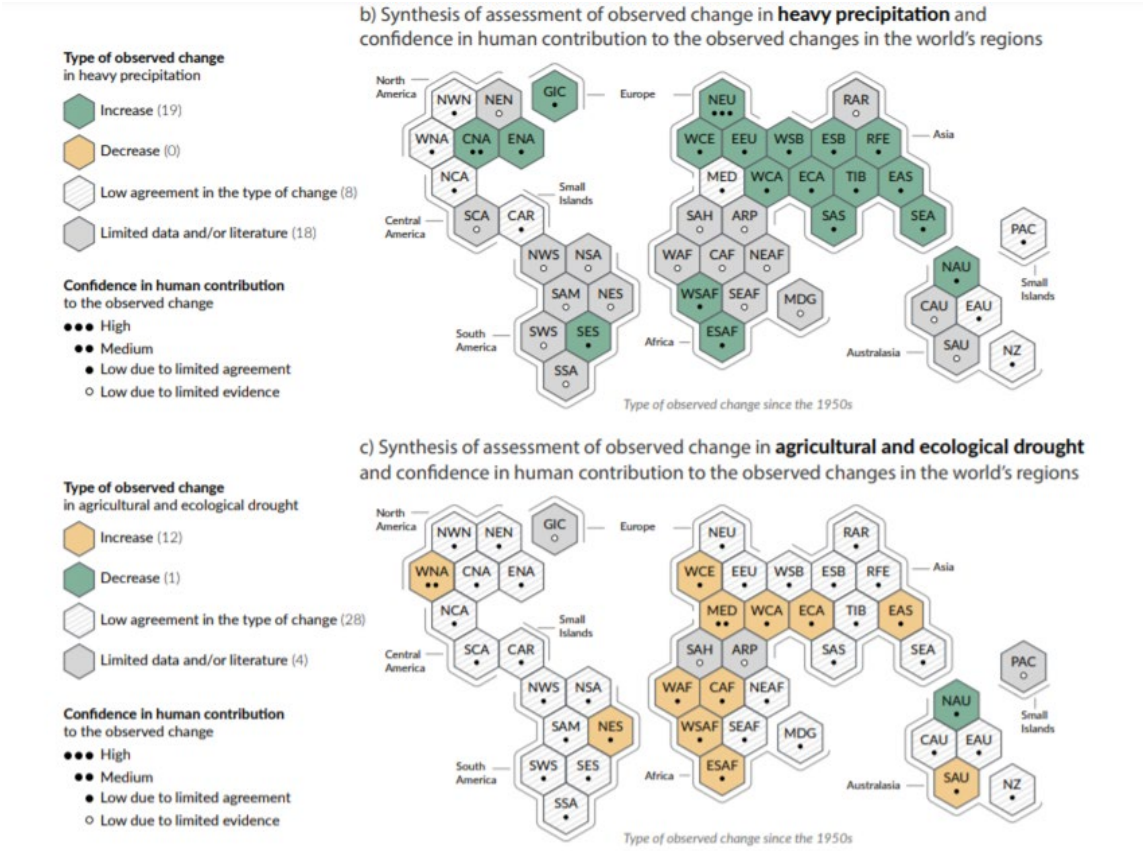
Seasonal Forecast Skills (2002-2018)



Uncertainties in Precipitation and Drought Projections

The IPCC AR6 Report indicated that the state of art climate models have high uncertainty in precipitation projections and little confidence in the attribution of human-caused impacts on precipitation and droughts.

[IPCC Working Group I: Summary for Policymakers](#) (AR6, 2021)



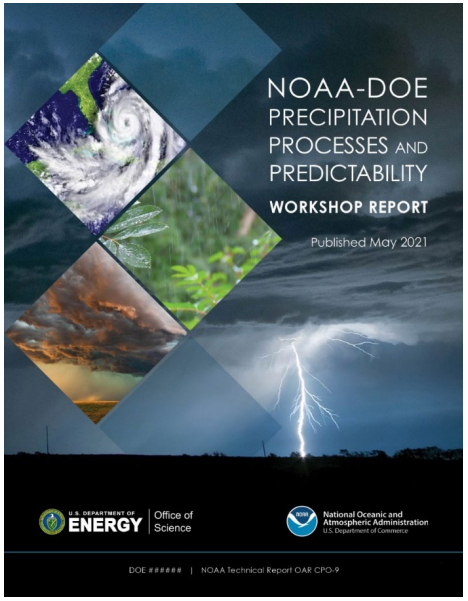
Common Model Systematic Errors

- Underestimation of heavy rain & overestimation of light rain
- The diurnal cycle of precipitation, with 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)

Similar systematic errors exist in both weather model and climate models. Improving key processes associated with precipitation can provide benefits for information on timescales of weather through climate change.

NOAA-DOE Precipitation Processes and Predictability Workshop

(with multi-agency and broad community participation)



NOAA-DOE Precipitation Processes and Predictability Workshop
Thematic Questions and Key Findings

Q1 What are the sources of predictability that have the biggest influences on precipitation at weather, subseasonal-to-seasonal to multi-decadal timescales, including extremes?

Q2 What are the key physical processes that have the strongest imprint on the model biases and precipitation predictions and projections?

Q3 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?

Q4 What are the gaps and needs for targeted observations and process studies to improve understanding and model representations of those key processes?

Q5 How do we benefit from national and international collaboration to make significant progress?

Sources of Predictability Influencing Precipitation

Session 1: Sources and limits of predictability

- ✓ Large-scale Variability (e.g., MJO, NAO, ENSO, AMV, PDO)
- ✓ Slowly varying processes (e.g. SST, soil moisture, vegetation, sea ice)
- ✓ Phenomena (e.g., cyclones, atmospheric rivers, mesoscale convective systems)

Physical Processes Representation and Biases

Session 2: Key processes critical to precipitation biases

- ✓ Improving representation of local (e.g. aerosol-cloud interactions) and remote (e.g. tropical diabatic heating) processes
- ✓ Systematic characterization of model biases

Modeling and Observational Strategies

Session 3: Interdisciplinary processes

Session 4: Regional precipitation

- ✓ Global storm resolving models
- ✓ Hierarchical modeling
- ✓ Phenomena-based model evaluation
- ✓ Community modeling infrastructure
- ✓ Enhance model observation integration
- ✓ More observations to constrain models
- ✓ Collaboration between modeling and observation teams
- ✓ ML/AI

Stakeholder Engagement & Interagency Collaboration

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/AL, coupled data assimilation

User engagement

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

Envisioned Partners

USGCRP agencies proposed the **initial concept of GPEX**

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

Status 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 is under review by WCRP
- WCRP will appoint a **GPEX Planning Group** to prepare the GPEX Science and Implementation Plan after the GPEX white paper is accepted

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

GPEX White Paper

1. Organizational structure

- **Two options for GPEX**
  1) a WCRP Lighthouse Activity
  2) a WCRP Project
- **Two options for staff support**
  1) expanding existing WCRP staff
  2) a new Int'l Project Office
- **GPEX Planning Group** to prepare the GPEX Science and Implementation Plan

2. 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
  - Improved prediction and projection of precipitation at different temporal and spatial scales.
  - Enhanced regional and local capacity building

GPEX White Paper – cont.

3. Key activities

- **Existing activities(ongoing, scheduled or planned)**

  e.g., observational campaigns; modeling experiments; process studies; capacity development activities; stakeholder engagement

- **New Activities**

  1) Support the establishment and/or expansion of global and regional **precipitation databases**
  2) Support the establishment of **multi-model databases** along with common evaluation metrics
  3) support the **research on precipitation predictability, prediction techniques and applications** on multi-year to multi-decadal timescales
  4) support **existing national/regional activities** and **capacity building**

- **Activity Period**

  - GPEX will be a 5-year, and possibly 10-year, project
  - A flagship activity of GPEX is to organize the WCRP Year of Precipitation (YoP)
  - GPEX could be part of International Precipitation Decade (IPD) or International Water Decade (IWD)

Your feedback and participation are important!