Building Seasonal Predictions for Purpose: How the NMME Supports Early Warnings, Climate, Adaptation, and Commerce

Dr. Sarah Kapnick
Chief Scientist
National Oceanic and Atmospheric Administration

NOAA

Before NMME There was a Demand for Seasonal Outlooks

NOAA: 2000 Atlantic Hurricane Outlook

Issued 10 May 2000

An updated outlook will be issued in early August.

Realtime monitoring of tropical Atlantic conditions can be obtained here

Press Release

1. The current global-scale atmospheric circulation pattern is conducive to an above-average (active) Atlantic hurricane season during 2000, by favoring reduced vertical wind shear across the western tropical Atlantic and Caribbean Sea, and easterly winds from Africa that are conducive to the development of tropical storms and hurricanes.

2. Historically, when similar atmospheric conditions were present in an active hurricane era, 75% of the Atlantic hurricane seasons featured above-average activity.

3. The continuation of the current atmospheric anomalies depends partly on the ongoing La Ni&#65533;a in the tropical Pacific. A consensus of the latest numerical and statistical model forecasts indicate a continuation of La Ni&#65533;a conditions at least through July. Thereafter, the forecasts tend to diverge, but a majority indicate either near-normal or weak La Ni&#65533;a conditions continuing to the end of the year. However, we expect that even if La Ni&#65533;a fades by late summer, the existing tropical rainfall anomalies will not be totally destroyed, and therefore will not unduly impact the favorable large-scale atmospheric circulation pattern that currently exists. Another contribution to conditions favorable for an active season comes from the above-average sea surface temperatures that have persisted since 1995 across large portions of the North Atlantic.

4. Typical features of **active** (above-average) hurricane years:

Most of the above-average activity will occur during the peak months of the season: August– October.

The season often features at least two of the following three: a) at least eleven tropical storms, b) seven or more of which become hurricanes, and c) three or more of which become major hurricanes

	NOAA		
Year	June ENSO	Winter	Hurricanes
2000		Thu Oct 12	Wed May 10
2001	Mon Jun 11	Wed Oct 17	Mon May 21
2002	Thu Jun 6	Thu Oct 17	Mon May 20
2003	Thu Jun 12	Thu Oct 16	Mon May 19
2004	Mon Jun 10	Thu Oct 21	Mon May 17
2005	Thu Jun 9	Thu Oct 20	Mon May 16
2006	Thu Jun 8	Thu Oct 19	Mon May 22
2007	Thu Jun 7	Tue Oct 9	Tue May 22
2008	Thu Jun 5	Thu Nov 20	Thu May 22
2009	Thu Jun 4	Thu Oct 15	Thu May 21
2010	Thu Jun 3	Thu Oct 21	Thu May 27
2011	Thu Jun 9	Thu Oct 20	Thu May 19
2012	Thu Jun 7	Thu Oct 18	Thu May 24
2013	Thu Jun 6	Thu Nov 21	Thu May 23
2014	Thu Jun 5	Thu Oct 16	Thu May 22
2015	Thu Jun 11	Thu Oct 15	Wed May 27
2016	Thu Jun 9	Thu Oct 20	Fri May 27
2017	Thu Jun 8	Thu Oct 19	Thu May 25
2018	Thu Jun 14	Thu Oct 18	Thu May 24
2019	Thu Jun 13	Thu Oct 17	Thu May 23

Kirtman et. a. 2014

THE NORTH AMERICAN MULTIMODEL ENSEMBLE

Phase-1 Seasonal-to-Interannual Prediction; Phase-2 toward Developing Intraseasonal Prediction

BY BEN P. KIRTMAN, DUGHONG MIN, JOHNNA M. INFANTI, JAMES L. KINTER III, DANIEL A. PAOLINO, QIN ZHANG, HUUG VAN DEN DOOL, SURANJANA SAHA, MALAQUIAS PENA MENDEZ, EMILY BECKER, PEITAO PENG, PATRICK TRIPP, JIN HUANG, DAVID G. DEWITT, MICHAEL K. TIPPETT, ANTHONY G. BARNSTON, SHUHUA LI, ANTHONY ROSATI, SIEGFRIED D. SCHUBERT, MICHELE RIENECKER, MAX SUAREZ, ZHAO E. LI, JELENA MARSHAK, YOUNG-KWON LIM, JOSEPH TRIBBIA, KATHLEEN PEGION, WILLIAM J. MERRYFIELD, BERTRAND DENIS, AND ERIC F. WOOD

The North American Multimodel Ensemble prediction experiment is described, and forecast quality and methods for accessing digital and graphical data from the model are discussed.

After more than three decades of research into the origins of seasonal climate predictability and the development of dynamical model-based seasonal prediction systems, the continuing relatively deliberate pace of progress has inspired two notable changes in prediction strategy, largely based on multi-institutional international collaborations. One change in strategy is the inclusion of quantitative information regarding uncertainty (i.e., probabilistic prediction) in forecasts and probabilistic measures of forecast quality in the verifications (e.g., Palmer et al. 2000; Goddard et al. 2001; Kirtman 2003; Palmer et al. 2004; DeWitt 2005; Hagedorn et al. 2005; Doblas-Reyes et al. 2005; Saha et al. 2006; among many others). The other change is the recognition that a multimodel ensemble strategy is a viable approach for adequately resolving forecast uncertainty (Palmer et al. 2004; Hagedorn et al. 2005; Doblas-Reyes et al. 2005; Palmer et al. 2008), although other techniques such as perturbed physics ensembles (currently in use at the Met Office for their operational system) or stochastic physics (e.g., Berner et al. 2008) have been developed and appear to be quite promising. The first change in prediction strategy naturally follows from the fact that climate variability includes a chaotic or irregular component, and, because of this, forecasts must include a quantitative assessment of this uncertainty. More importantly, the climate prediction community now understands that the potential utility of climate forecasts is based on end-user decision support (Palmer et al. 2000; Morse et al. 2005; Challinor et al. 2005), which requires probabilistic forecasts that include quantitative information regarding forecast uncertainty. The second change in prediction strategy follows from the first, because, given our current modeling capabilities, a multimodel strategy is a practical and relatively simple approach for quantifying forecast uncertainty due to uncertainty in model formulation, although it is likely that the uncertainty is not fully resolved.

More recently, there has been a growing interest in forecast information on time scales beyond 10 days but less than a season. For example, the National Centers for Environmental Prediction Climate Prediction Center (NCEP/CPC) in the United

NOAA — National Oceanic and Atmospheric Administration, U.S. Department of Commerce

NCAR

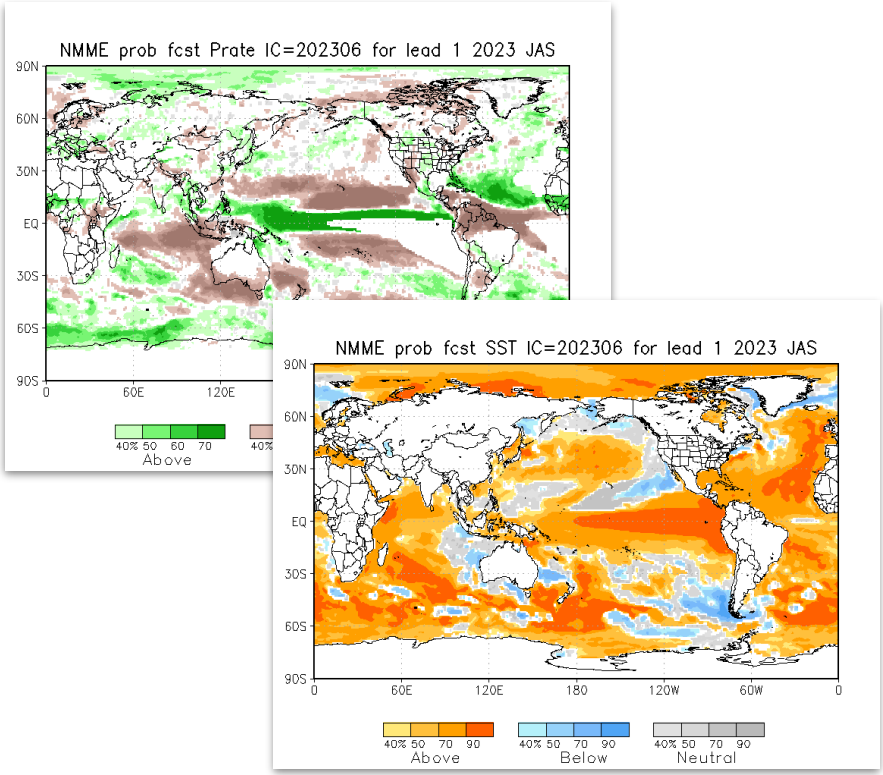
NCEP — National Centers for Environmental Prediction

NASA

GFDL — National Oceanic and Atmospheric Administration

Canada

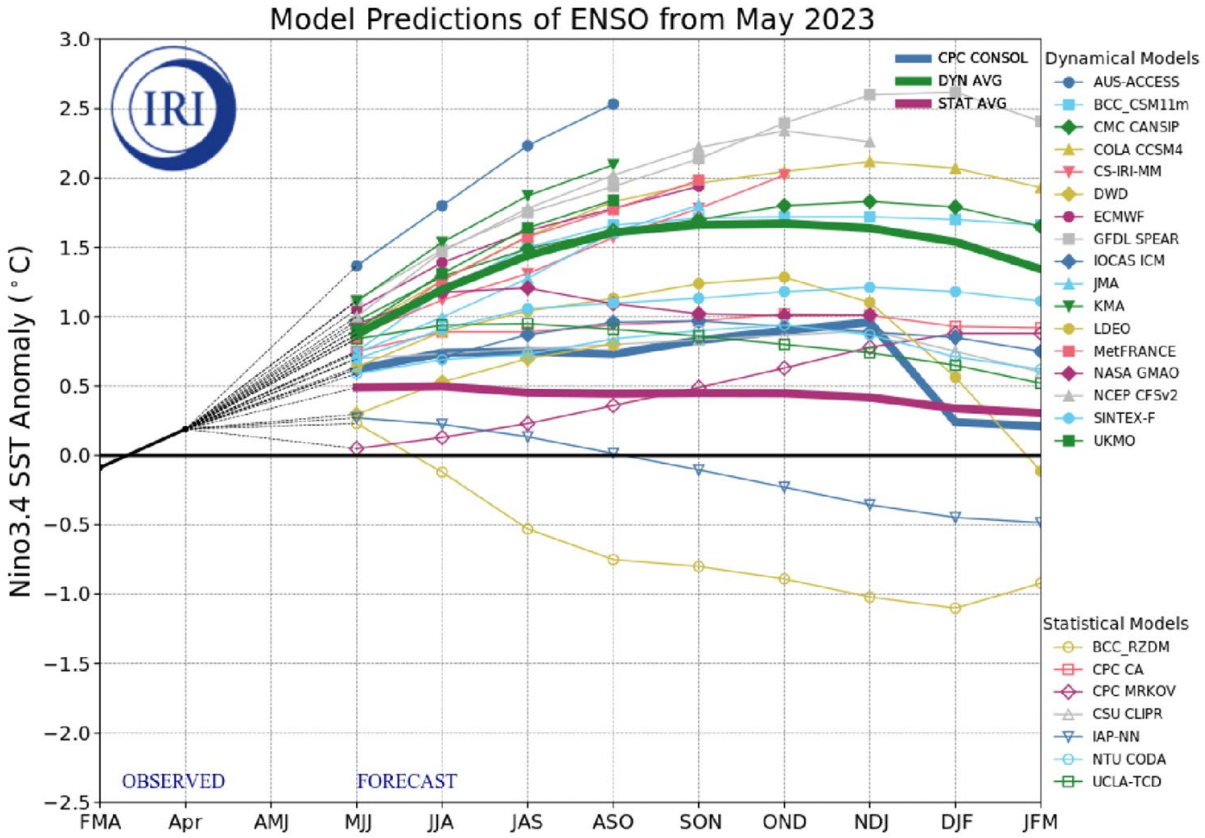
NMME has become Critical Infrastructure for Seasonal Outlooks

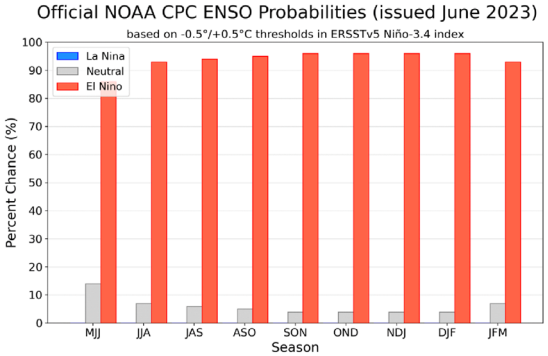


Monthly variables

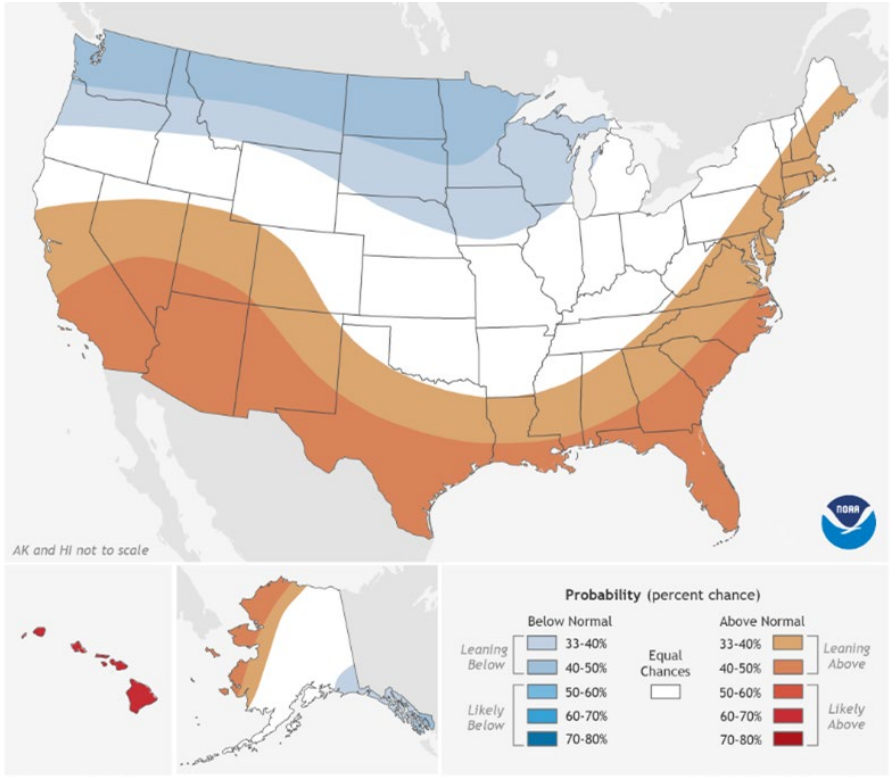
- 200 hPa Geopotential Height
- Total Precipitation
- Sea Surface Temperature
- Maximum Temperature
- Minimum Temperature
- Reference Temperature

Current Model Predictions for Nino3.4 Region



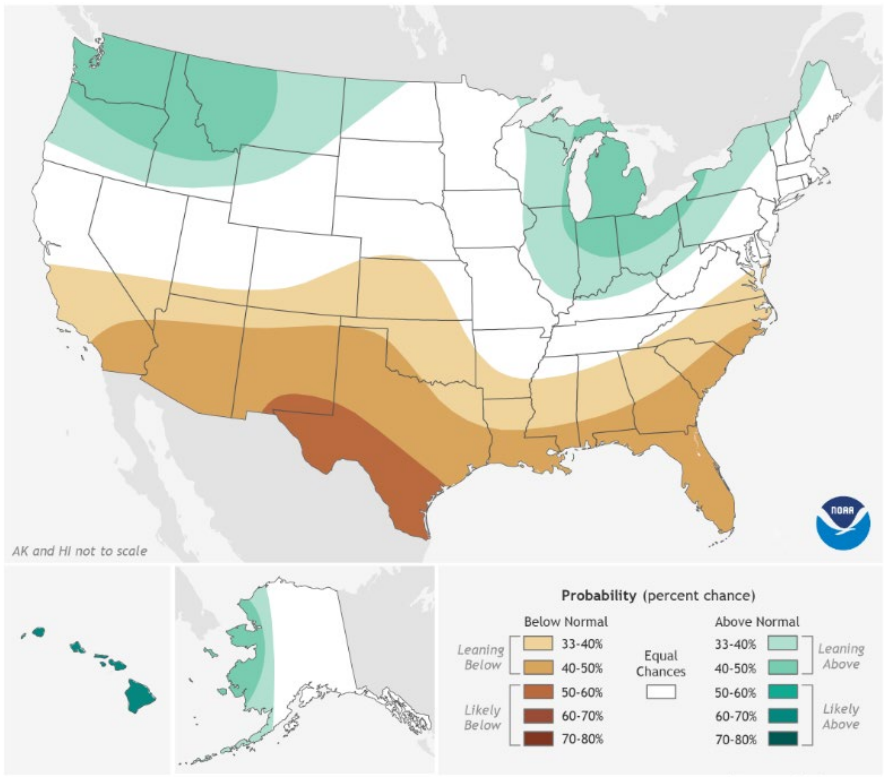


Winter Outlook (Dec-Jan-Feb)



Temperature Outlook
for December 2022 - February 2023
Issued 20 October 2022

NWS Climate Prediction Center
Map by NOAA Climate.gov

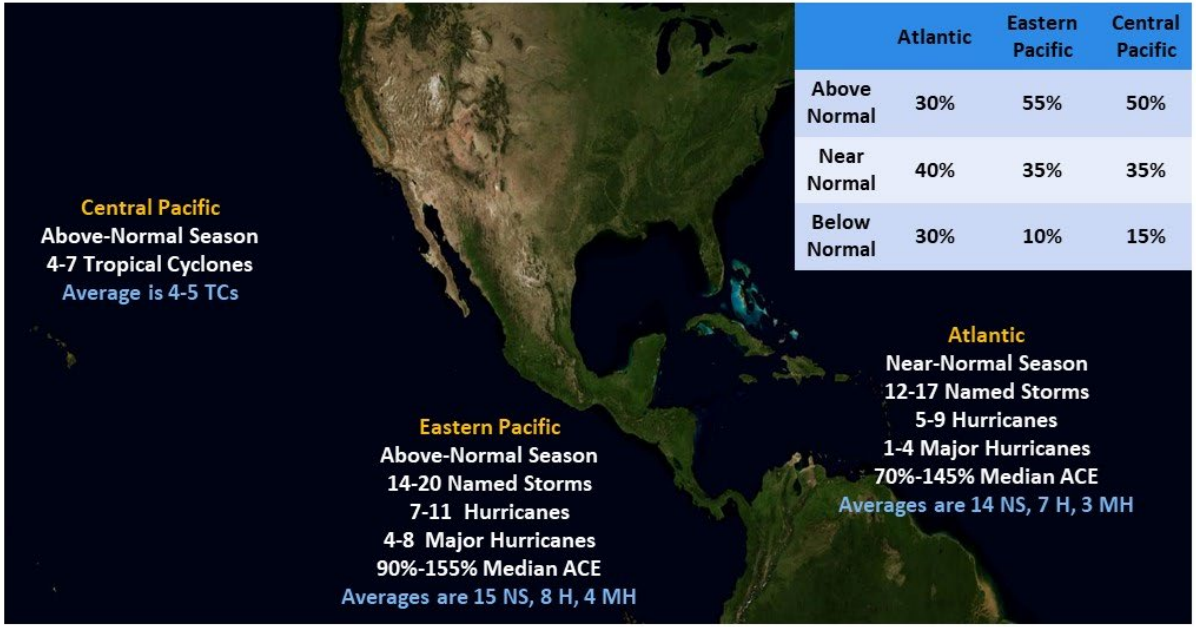


Precipitation Outlook
for December 2022 - February 2023
Issued 20 October 2022

NWS Climate Prediction Center
Map by NOAA Climate.gov

Hurricane Outlook

NOAA's 2023 Hurricane Season Outlooks



	Atlantic	Eastern Pacific	Central Pacific
Above Normal	30%	55%	50%
Near Normal	40%	35%	35%
Below Normal	30%	10%	15%

For the Atlantic hurricane region, the outlooks indicate a 40% chance of a near-normal season, a 30% chance of an above-normal season, and a 30% chance of an below-normal season.

These outlooks are for the overall seasonal activity. They are not a hurricane landfall forecast.

Climate Change increases the need for NMME in the Emerging Climate Economy

- Climate Economy = Mitigation + Adaptation activities shifting current and driving new financial flows
  - Reaching Net Zero goals by 2050 requires annualized flows of around USD 4 trillion
  - Estimates of future adaptation costs are more difficult to calculate and depend on the urgency and level of emissions reductions
- Responding to the dual challenge of mitigating and adapting to climate change will alter all economic sectors
- NMME serves an important function in the growing Climate Economy
  - Energy forecasting (optimizing mitigation)
  - Preparation for seasonal climate conditions (e.g. adaptation to drought, agriculture, storms)

Climate Intelligence & Risk Management

- Sector and system transformations are needed to minimize the impact of climate change
  - But climate information also opens up new opportunities
- **NOAA has a wide range of capabilities and is an authoritative source of global environmental data** that can inform and support risk management when used together.
- The NMME:
  - Seasonal predictions relying on observations and modeling
  - Pre-disaster support through early warning systems
  - Disaster and post-disaster support through rapid response and planning for restoration/coming conditions
  - Develop operations and investment planning (how to react when an event unfolds)

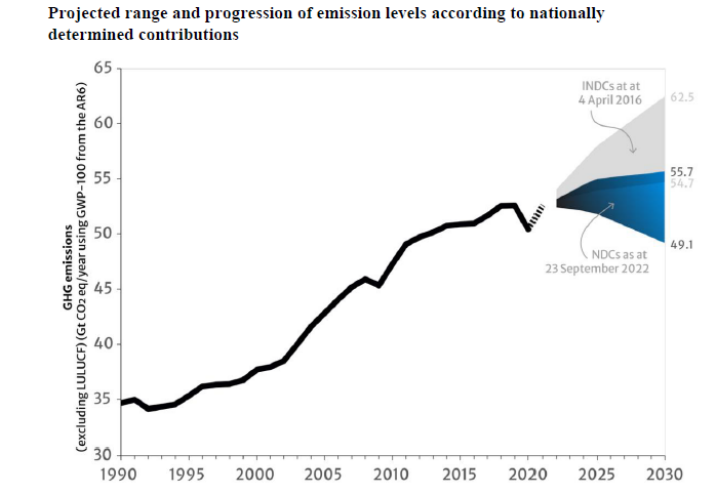
Growth Drivers for the Climate Economy

Growth in the Climate Economy is accelerated by traditional investment drivers:

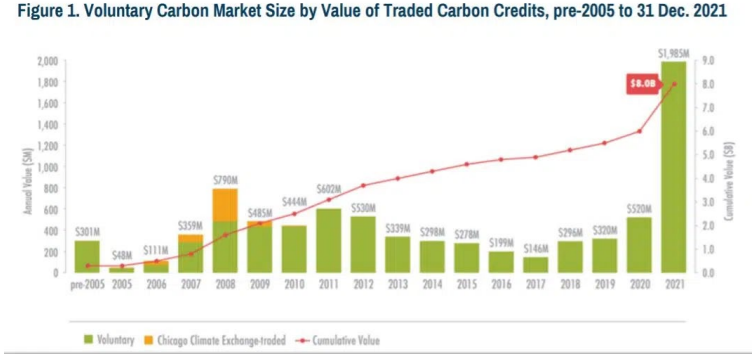
1) Regulation
2) Technological innovation
3) Demographics

New climate driver due to:

1) Rate of global warming
2) Associated impacts (chronic & extreme events)



Source: 2022 NDC Synthesis report



Source: carboncredits.com

Various Aspects of Information in the Climate Economy

Acquisition
observations (in situ and satellite) or models to monitor, forecast, predict, and project the Earth System

Access
integrating climate data from multiple sources or translating it into usable products

Application
products that derive new information from climate data to develop new insights

Federal

Commercial

Remote sensing, terrestrial, and ocean observations
Sector-specific environmental intelligence

Cloud computing
Mapping and imaging
Artificial intelligence and machine learning

Risk and asset management
Renewable energy development
Carbon markets and carbon dioxide removal

**Illustrative, non-exhaustive- adapted from Terrawatch Space

USAID FROM THE AMERICAN PEOPLE

What We Do | Where We Work | Results and Data | Partner with Us | About Us | Careers

USAID Invests in Early Warning Systems for Impending Climate-Related Disasters to Save Lives

Home › News & Information › Press Releases › USAID Invests in Early Warning Systems for Impending Climate-Related Disasters to Save Lives

For Immediate Release

Office of Press Relations
press@usaid.gov

Thursday, November 17, 2022

Press Release

Today at COP27, the U.S. Agency for International Development (USAID) announced $33 million to provide communities at risk of climate-prone disasters – including cyclones, droughts, and floods – with access to effective early warning systems. Increasing access to early warning systems translates to early action, allowing communities to prepare for disasters before they happen. Alternatively, lack of early warning systems can lead to a loss of lives and economic assets. To help communities prepare for impending climate hazards and adapt to climate change, USAID is partnering with the National Oceanic and Atmospheric Administration (NOAA), the World Meteorological Organization (WMO), and national authorities in vulnerable areas around the world to scale up early warning systems and build the capacities of their local-level meteorological and disaster management agencies.

The U.S. government has a long history of supporting the development of climate-related early warning systems around the world. For example, a flash flood guidance system that was developed and implemented by USAID, WMO, NOAA, and the Hydrologic Research Center enables national authorities to monitor and provide early warnings of flash flooding to more than three billion people in 67 countries.

These efforts are helping to deliver on the President's Emergency Plan for Adaptation and Resilience (PREPARE) that President Biden announced at COP26 last year, a whole-of-government effort, to help more than half a billion people in developing countries adapt to and manage the impacts of climate change. Investing in early warning systems around the world supports the goals of PREPARE by helping communities to reduce risks of climate- and extreme weather-related disasters and adapt to climate change.

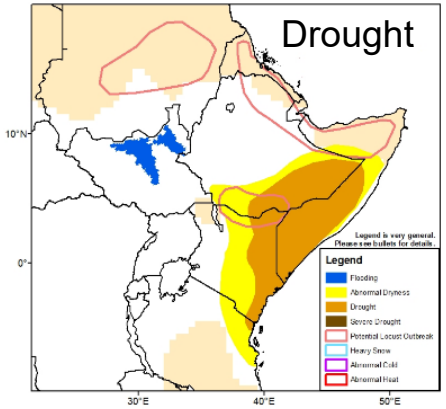
USAID stands with communities affected by climate change and extreme weather around the world and continues to work towards building more resilient communities through early warning and disaster risk reduction initiatives.

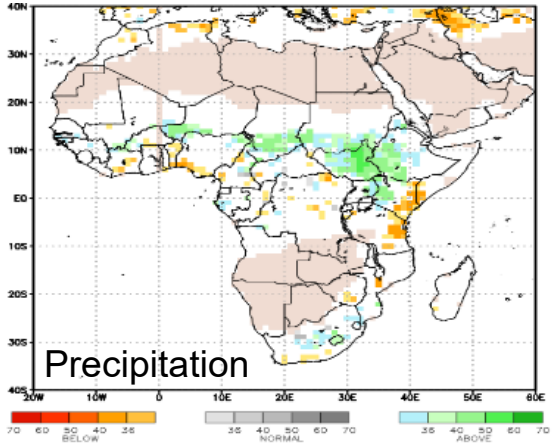
USAID AT COP27

The United States is working with countries around the world every day to advance climate ambition and ensure a strong outcome from COP27.

CPC International Desk: Building Capacity and Products Since 1995

- Use state of the art monitoring, modeling and forecasting capabilities at NCEP to train a cadre of meteorologists from around the world
- 300 trainees from 46 countries
- Global and regional multi-model ensemble sub-seasonal to seasonal prediction tools
- Host of WMO-Regional Climate Center (RA-IV): Tailored multi-model ensemble sub-seasonal to seasonal prediction tools
- Specific to USAID:
  - Family early warning system (FEWS)
  - Disaster risk reduction program (DRR)
  - Excessive heat forecasts

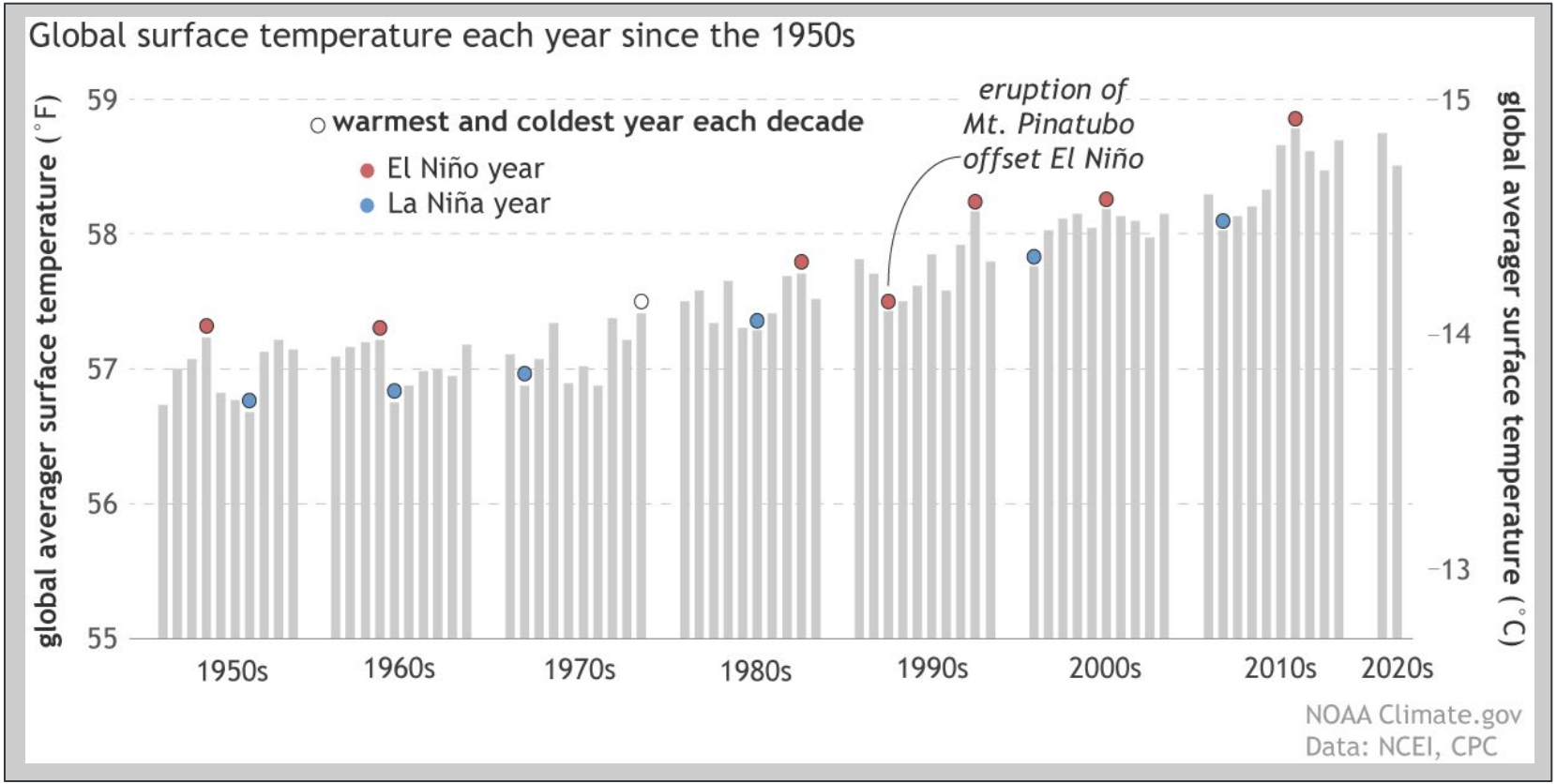




How will our use of NMME change into the future?

- Safe predictions: Improved Data Assimilation and models to improve skill
  - Critical investment in DA from IRA funding
- Likely upgrades that have already happened:
  - New models
  - More variables
- Where will future products and derivatives go?
  - Combination of multiple types of climate data (types of weather conditions like fire weather, agriculture productivity)
  - Combination with other models to product macroeconomic data? Potential damages using catastrophe models or empirical losses (e.g. billion dollar disaster program)?

El Niño and Global Temperature



QUESTIONS?

FIRST IMAGE FROM GOES-18 This composite color full-disk visible image is from May 5, 2022 and was created using the GOES-18 Advanced Baseline Imager (ABI) instrument. The image shows North and South America and surrounding oceans. Launched on March 1, 2022, GOES-18 is currently undergoing post-launch testing, validation, and calibration of its instruments and systems to prepare it for operations.