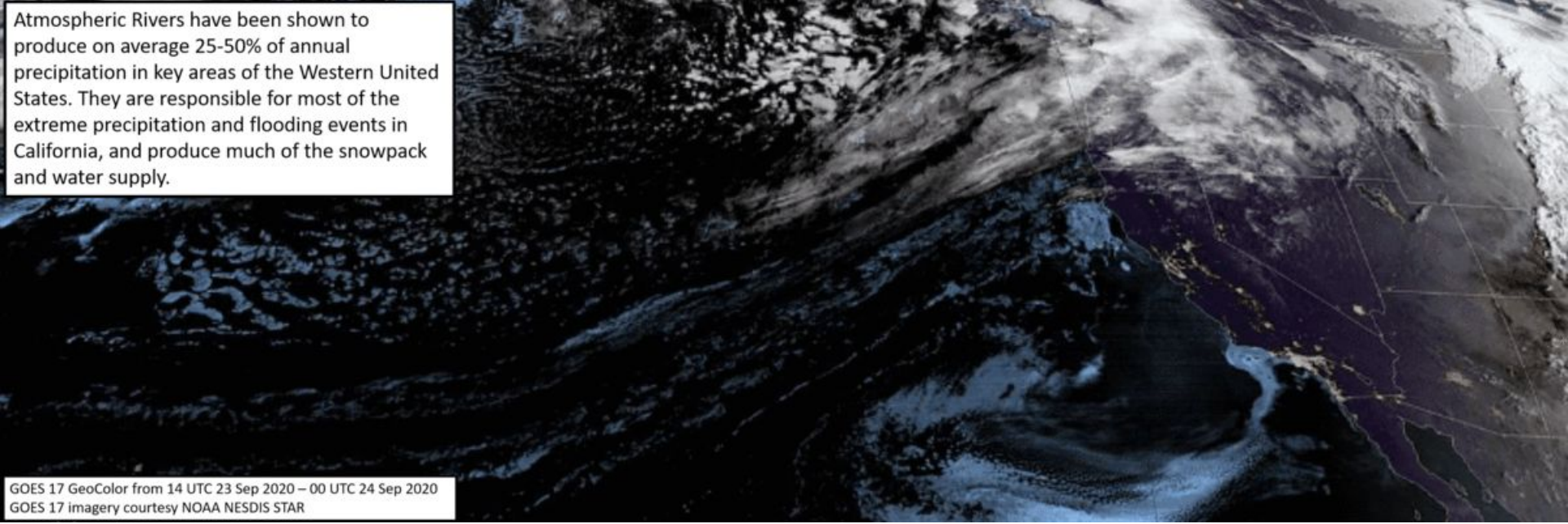


Winter 2023-2024

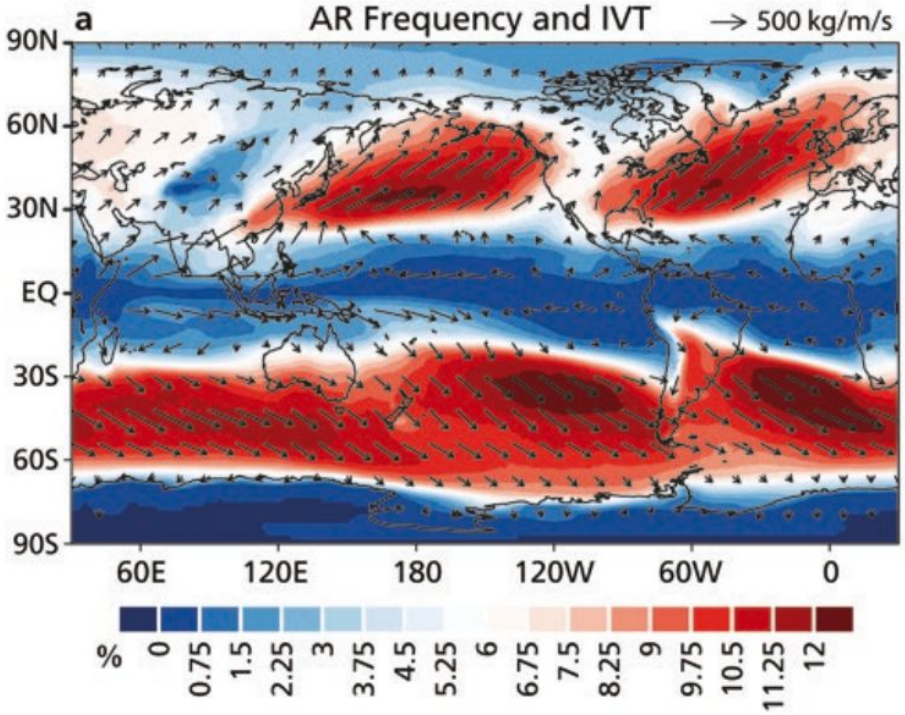
Paul Iñiguez
Meteorologist - UCSD/SIO/CW3E

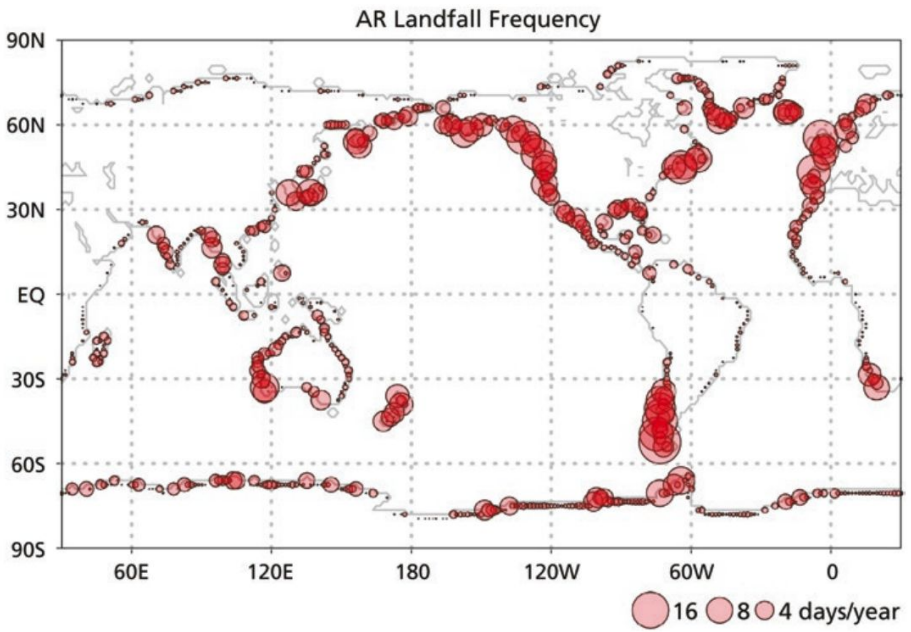
About CW3E

Marty Ralph, PhD
CW3E Director

Atmospheric Rivers (ARs)

AR Climatology





Source: Ralph et al., *Atmospheric Rivers*, 2020; Updated from Guan and Waliser 2015)

AR Climatology

While the West Coast gets most of its precipitation from ARs, the relative frequency of AR precipitation is higher in the Southwest.

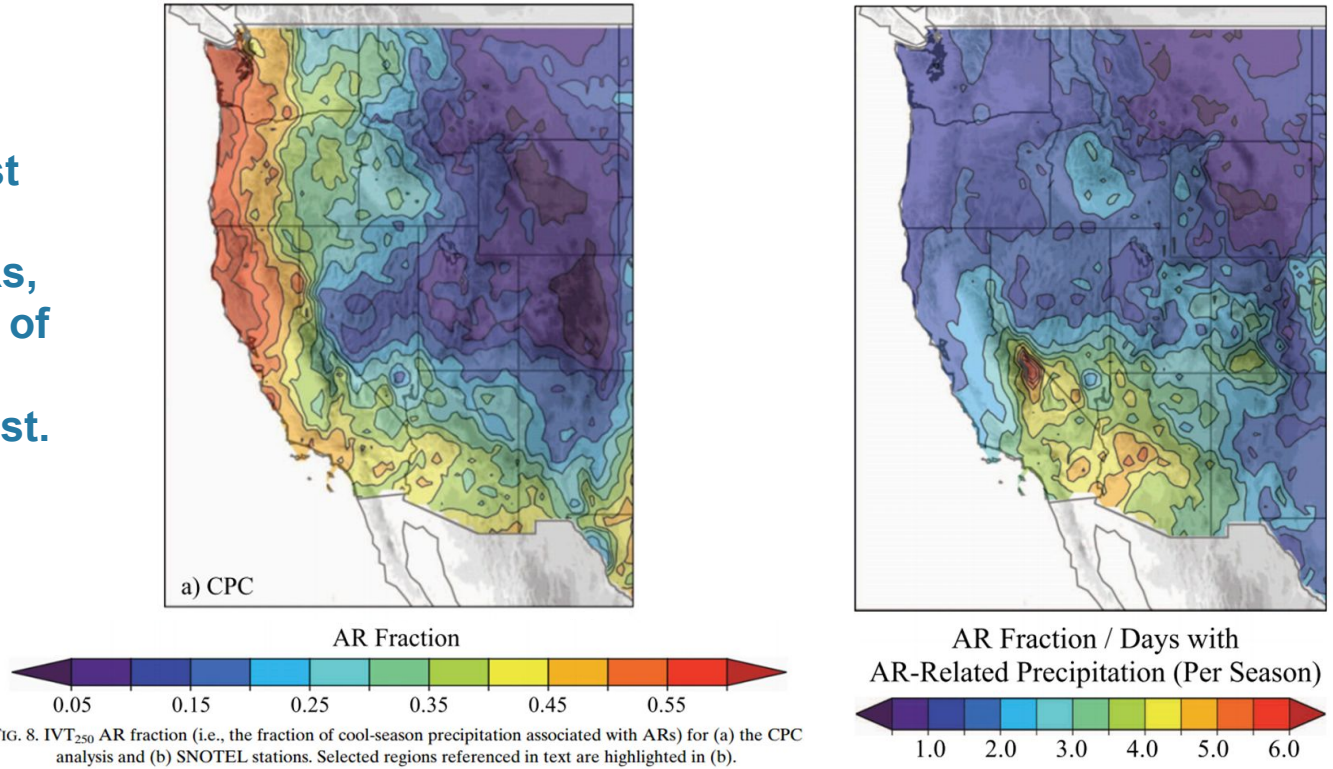


FIG. 8. IVT_{250} AR fraction (i.e., the fraction of cool-season precipitation associated with ARs) for (a) the CPC analysis and (b) SNOTEL stations. Selected regions referenced in text are highlighted in (b).

Source: Rutz et al. 2014

AR Climatology

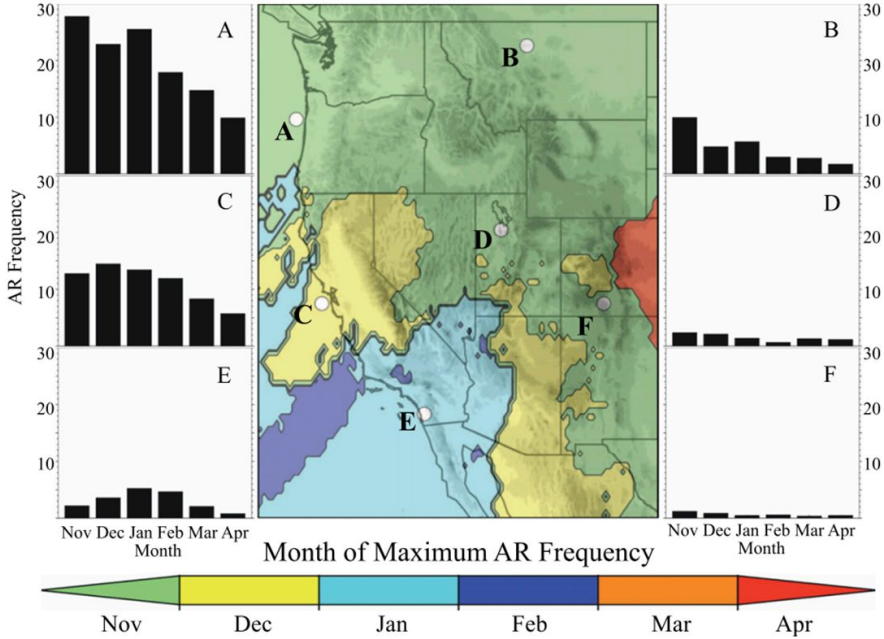
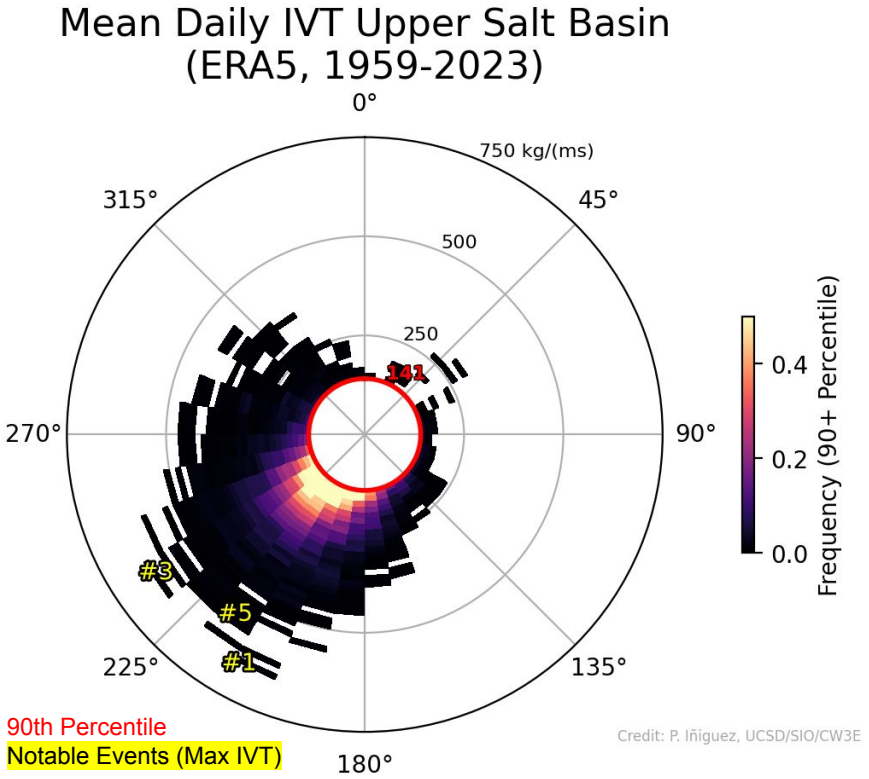
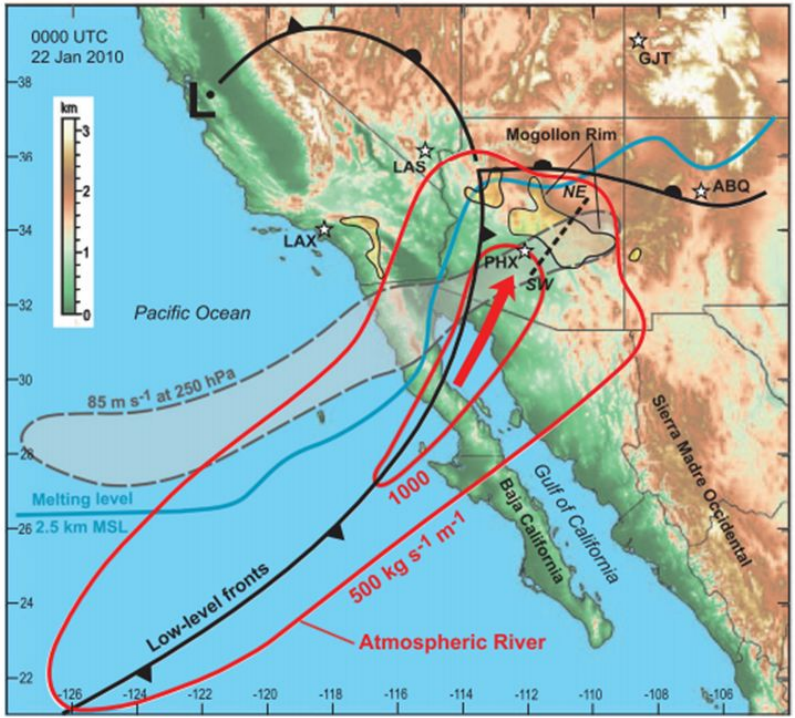


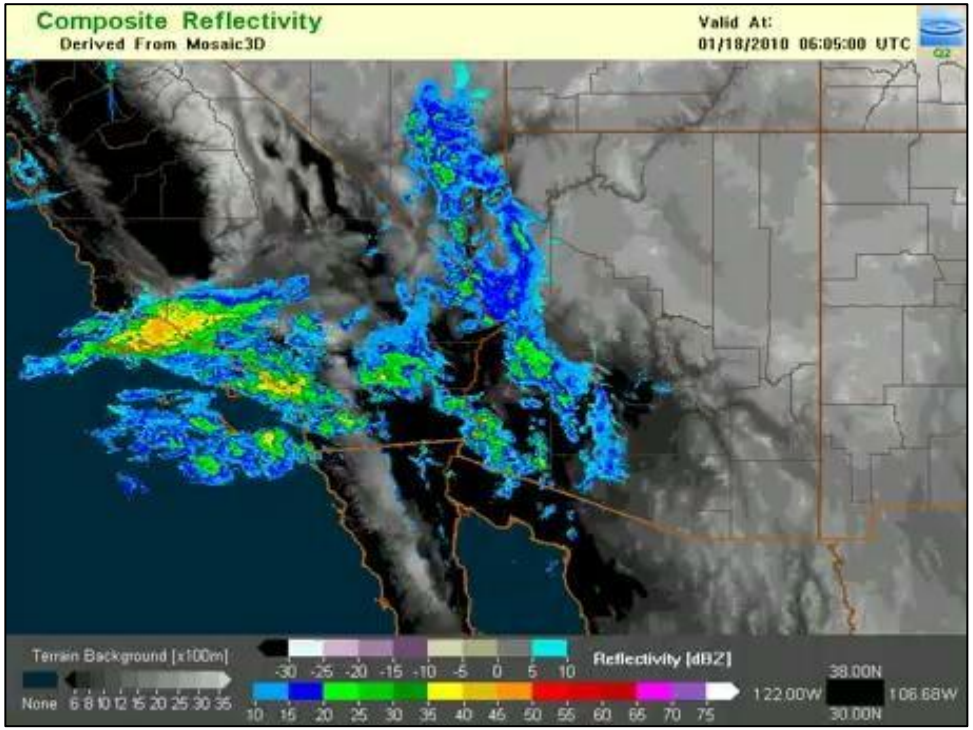
FIG. 6. Month of maximum AR frequency based on IVT_{250}. Histograms of IVT_{250} AR frequency by month at selected (left) coastal and (right) interior locations.

Source: Rutz et al. 2014



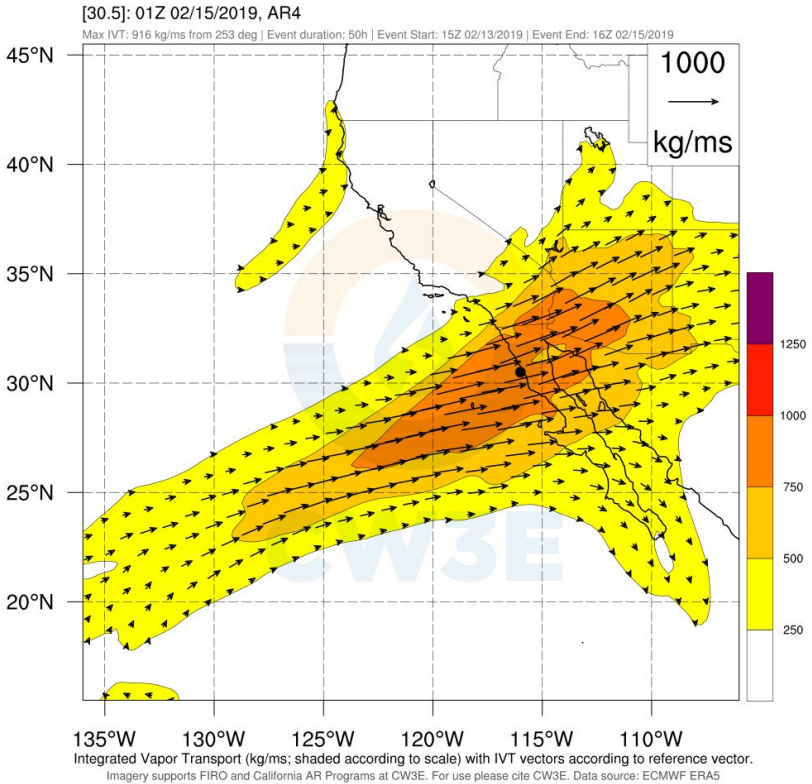
Significant AZ ARs - 22 Jan 2010 (#3)

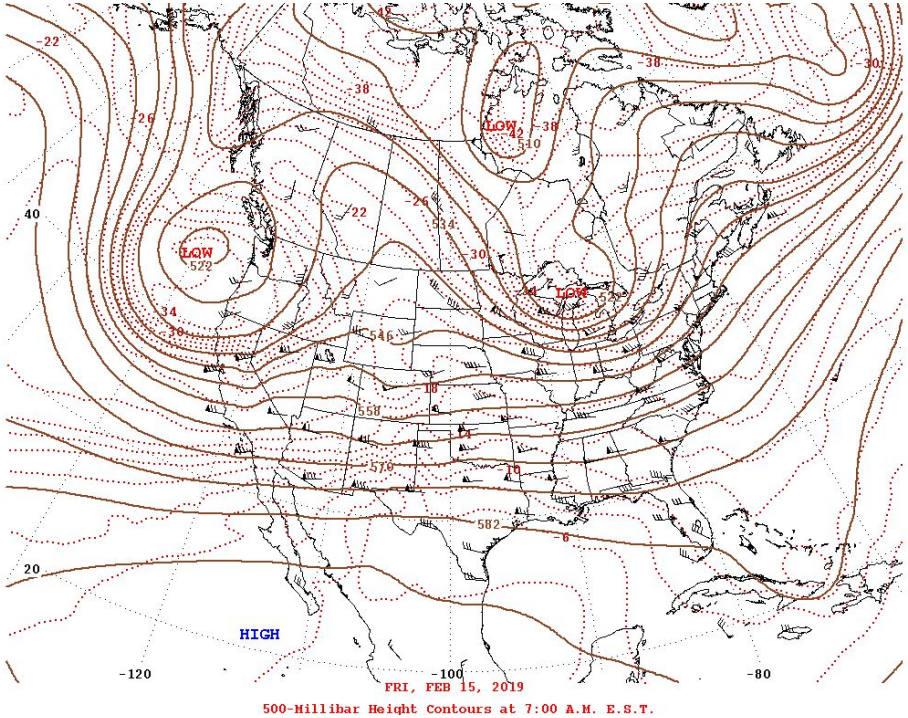




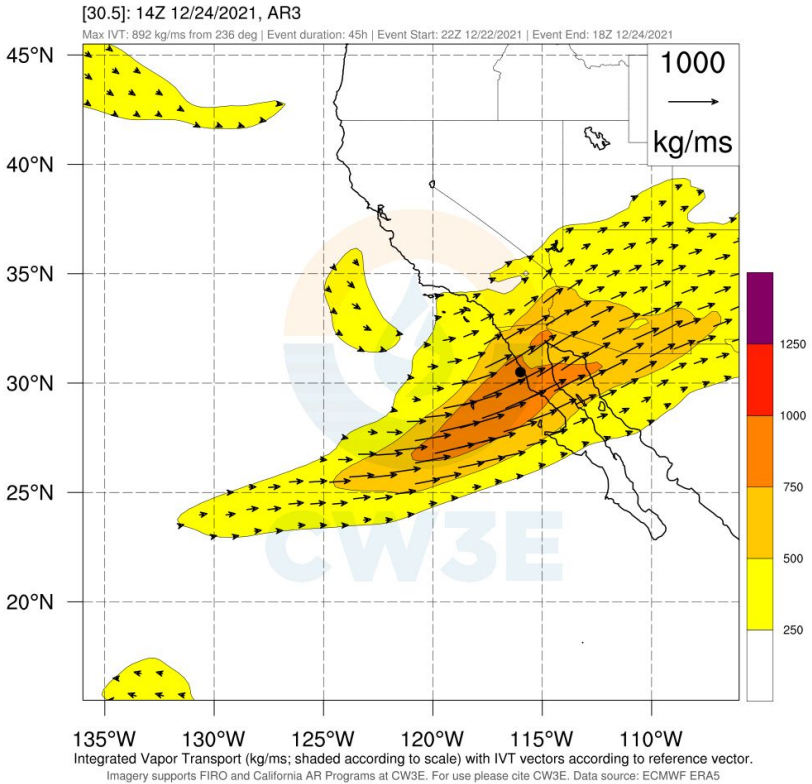
Source: Neiman et al. 2013

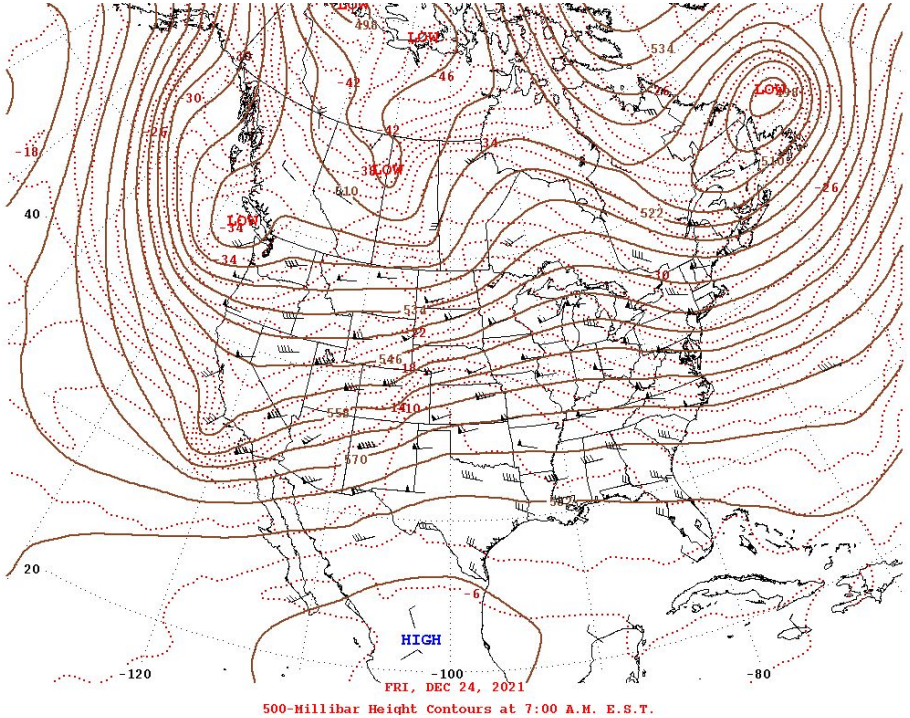
Significant AZ ARs - 15 Feb 2019 (#1)





Significant AZ ARs - 24 Dec 2021 (#5)

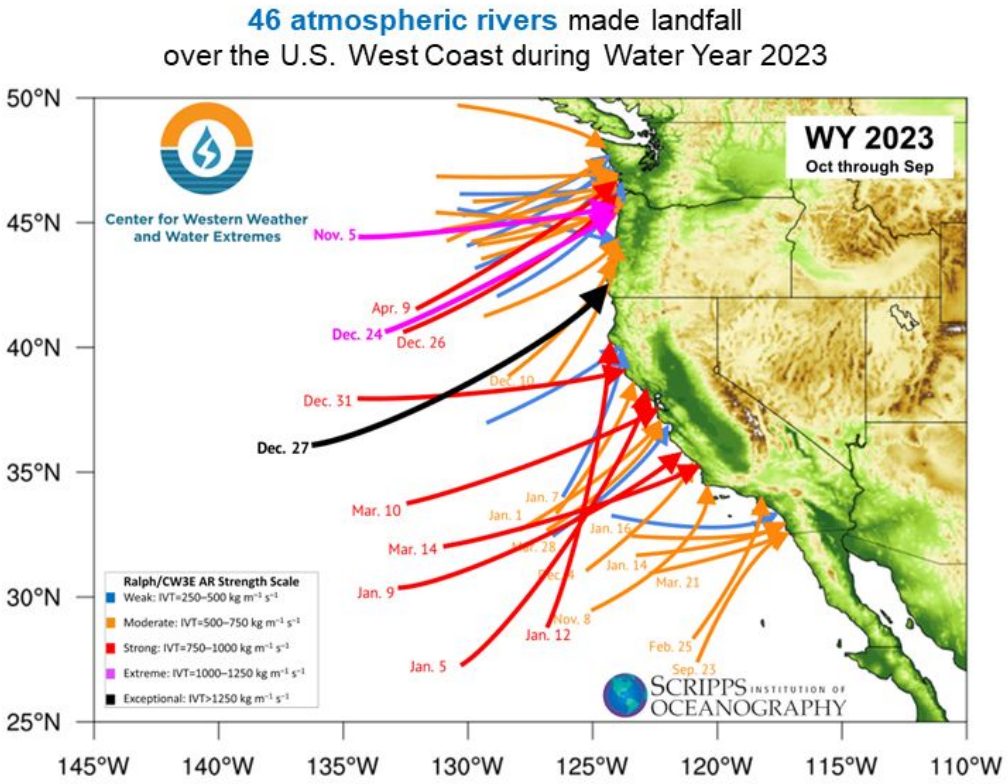




WY2023 Landfalling ARs

AR Strength	AR Count
Weak	12
Moderate	22
Strong	9
Extreme	2
Exceptional	1

Regions Impacted by Each AR	
State/Region	AR Conditions
Washington	34
Oregon	37
Northern CA	32
Central CA	21
Southern CA	17



Tools to Forecast ARs

Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

About | Observations | AR Reconnaissance | **Forecasts** | FIRO | News & Publications | CW3E North

Atmospheric River Forecast Products

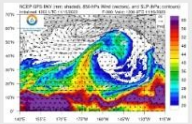
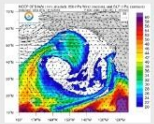
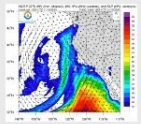
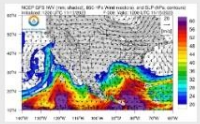
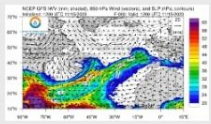
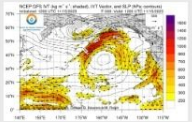
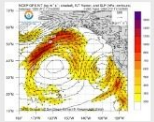
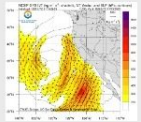
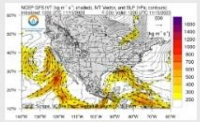
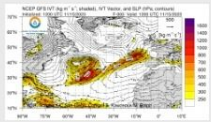
The products are provided "as is" and are intended for research purposes only (disclaimer).

This page contains graphics designed to forecast the presence and strength of Atmospheric Rivers using data from the NCEP Global Forecast System (GFS), North American Mesoscale Forecast System (NAM), Global Ensemble Forecast System (GEFS – v12) and the European Centre for Medium-Range Weather Forecasts (ECMWF) models. The Ensemble based products are produced by Dr. Jason Cordeira at Plymouth State University as a cooperative effort with CW3E. For more information on ARs visit the AR FAQs or watch this informational video about ARs.

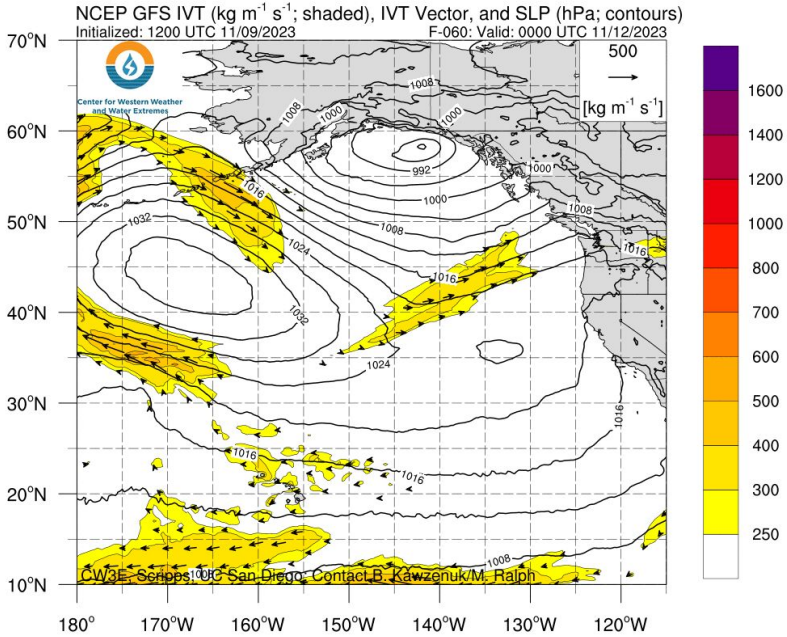
Deterministic Models: | IWV | IVT | Time-Integrated IVT | Meteograms | Cross Sections |
Ensemble Models: | Landfall Tool | IVT Plume Diagrams | AR Scale |Thumbnails | IVT Probability | Subseasonal Outlooks |
West-WRF: | Integrated Water Vapor | Integrated Vapor Transport |
Interactive Maps: | California Observations | AR Analyses and Forecasts | Watershed Precipitation Forecasts | Watershed Freezing Level Forecasts | Subseasonal to Season Forecasts |

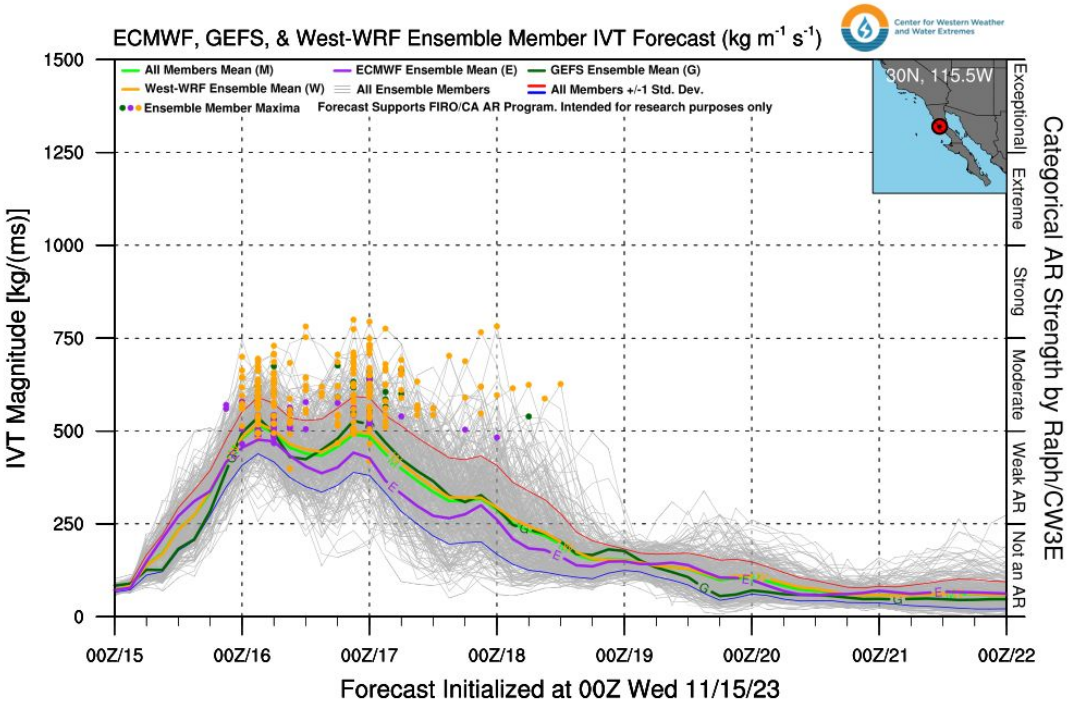
Deterministic Model Forecasts

IWV, IVT, and Time-Integrated IVT Click on an image to see forecasts out to 180 hours from the GFS, ECMWF, and NAM

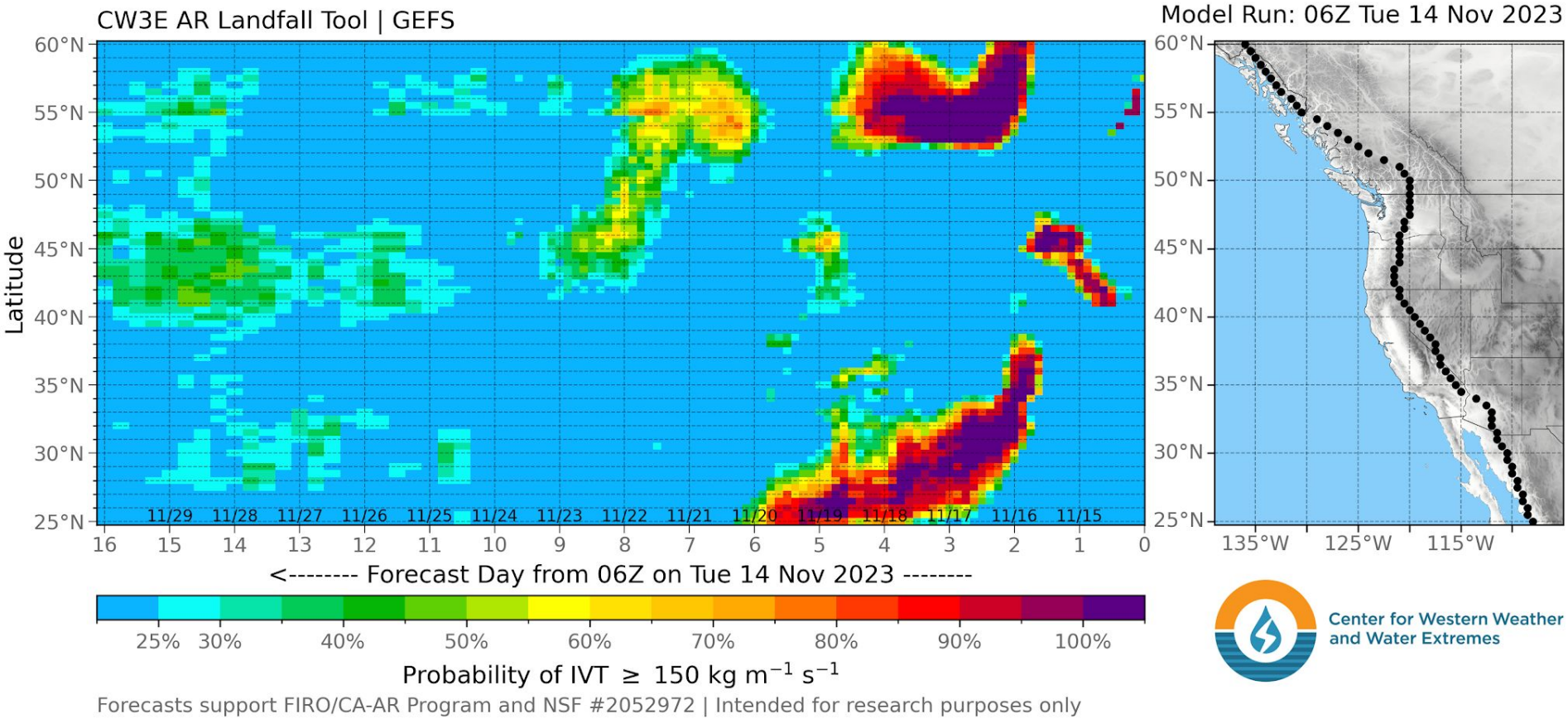
	North Pacific	Northeast Pacific	U.S. West Coast	North America	North Atlantic
IWV					
IVT					

Tools to Forecast ARs





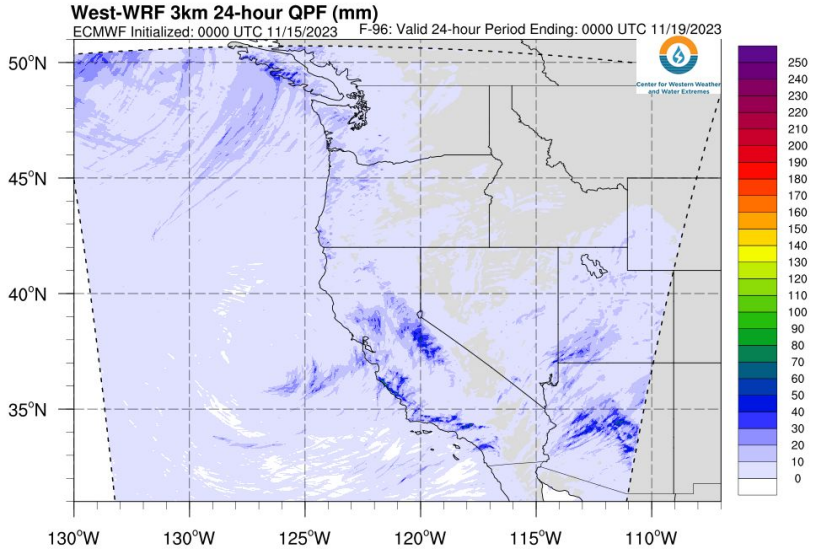
Tools to Forecast ARs

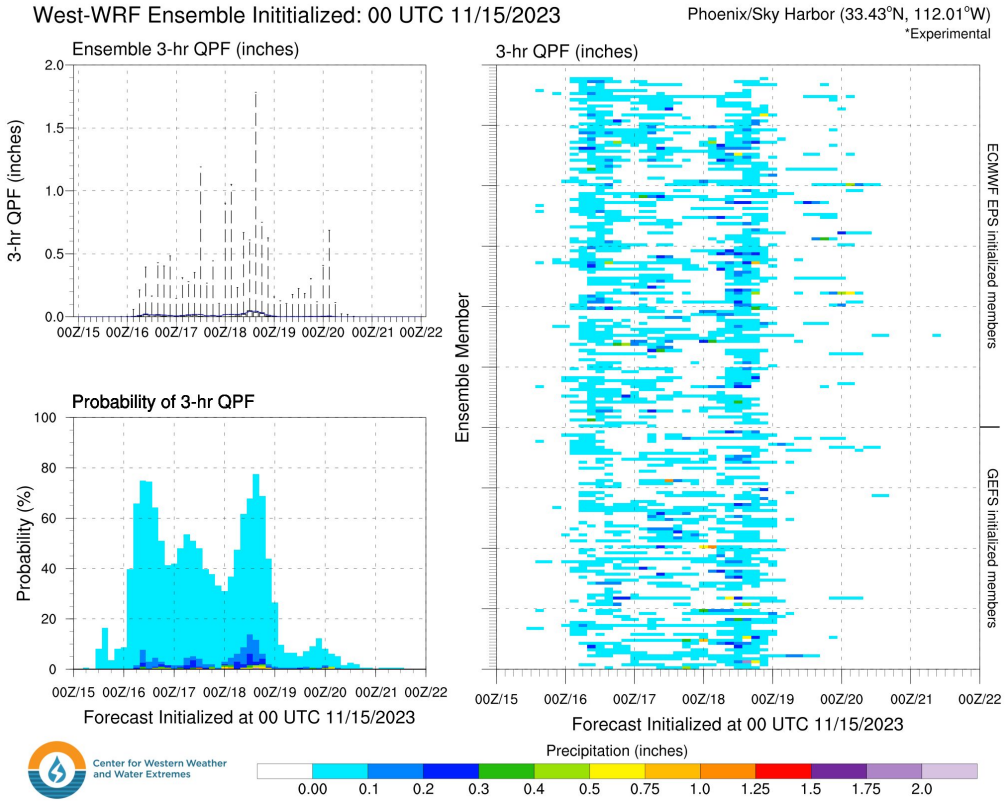


Center for Western Weather and Water Extremes

Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

Tools to Forecast ARs

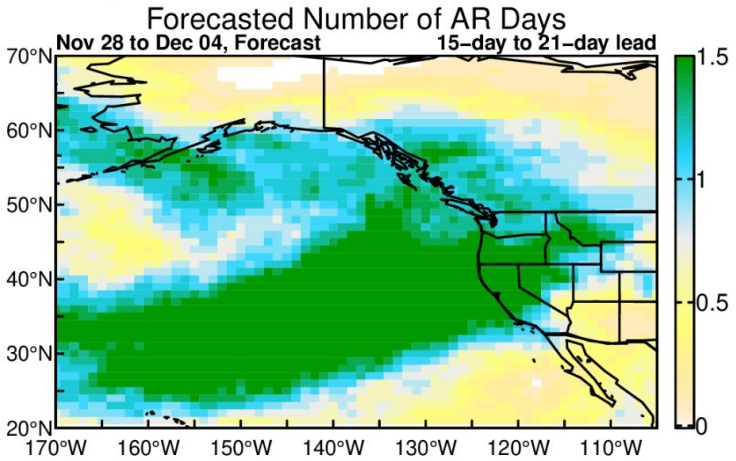


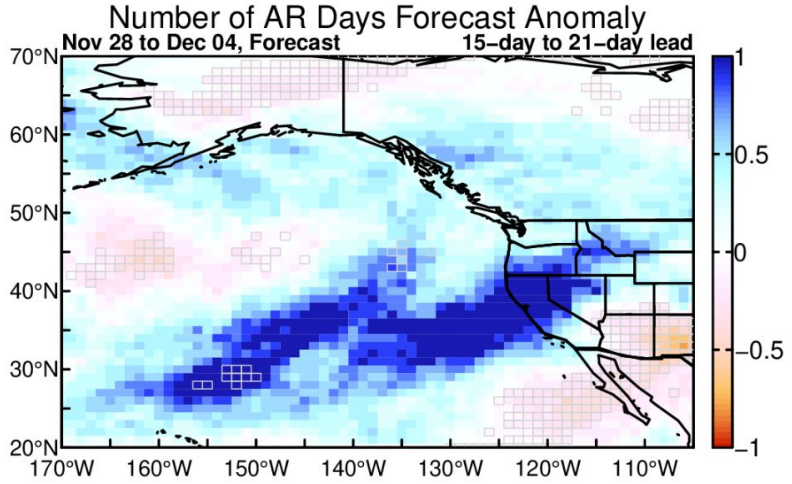


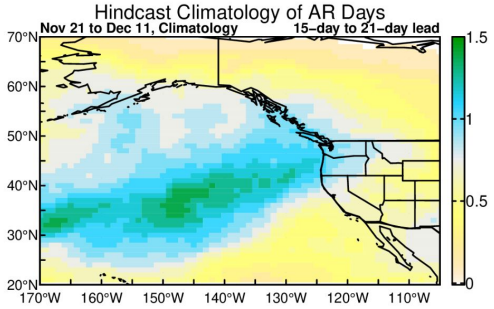
West-WRF High-Resolution Model & 200 Member Ensemble

CW3E S2S Forecasts

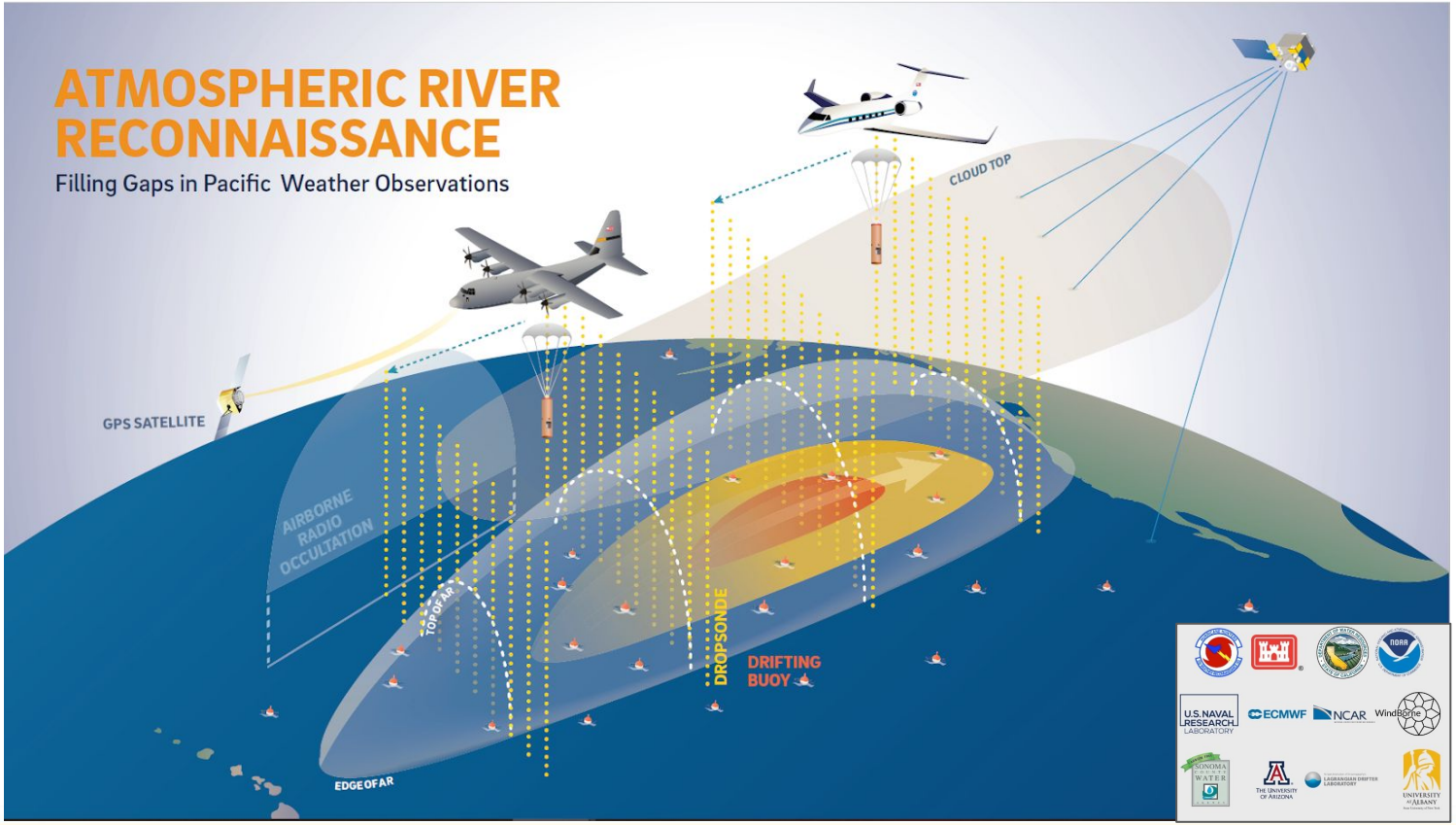
NCEP Experimental Forecast Initialized: Nov 13, 2023







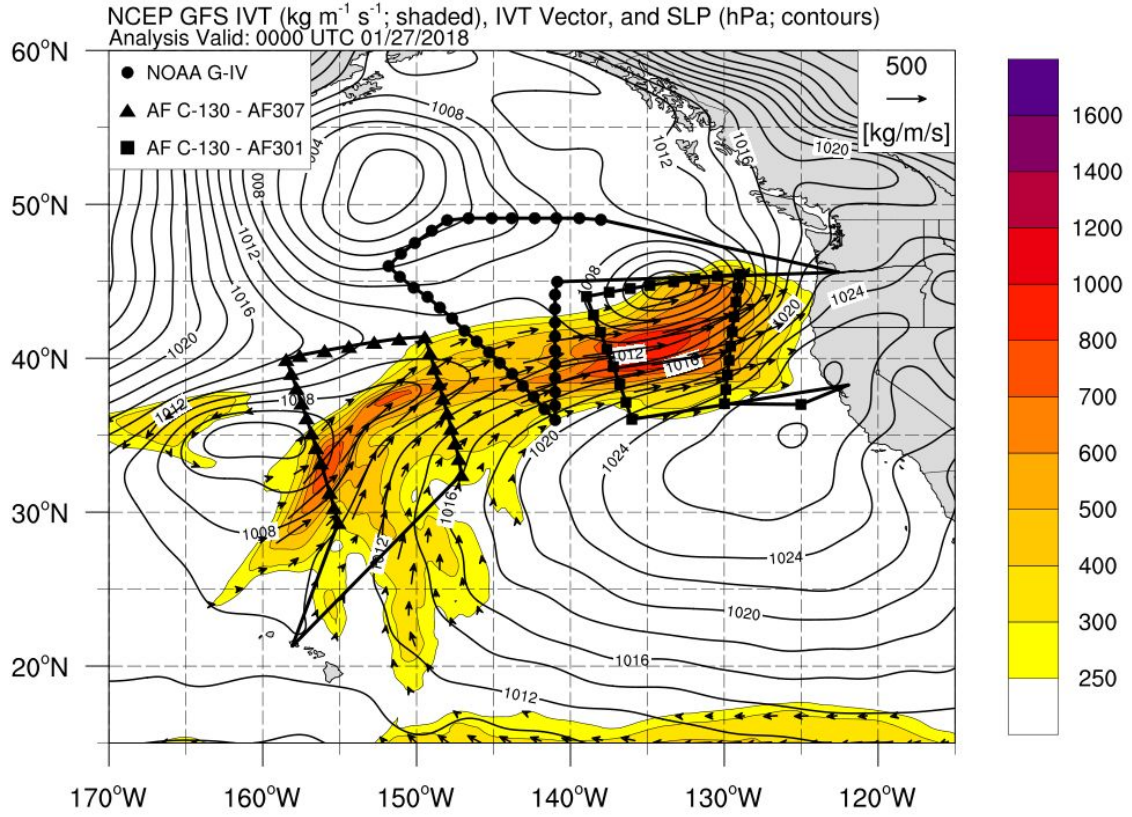
AR Recon



Winter 2023-2024

Mather, CA
Honolulu, HI
Guam

AR Recon



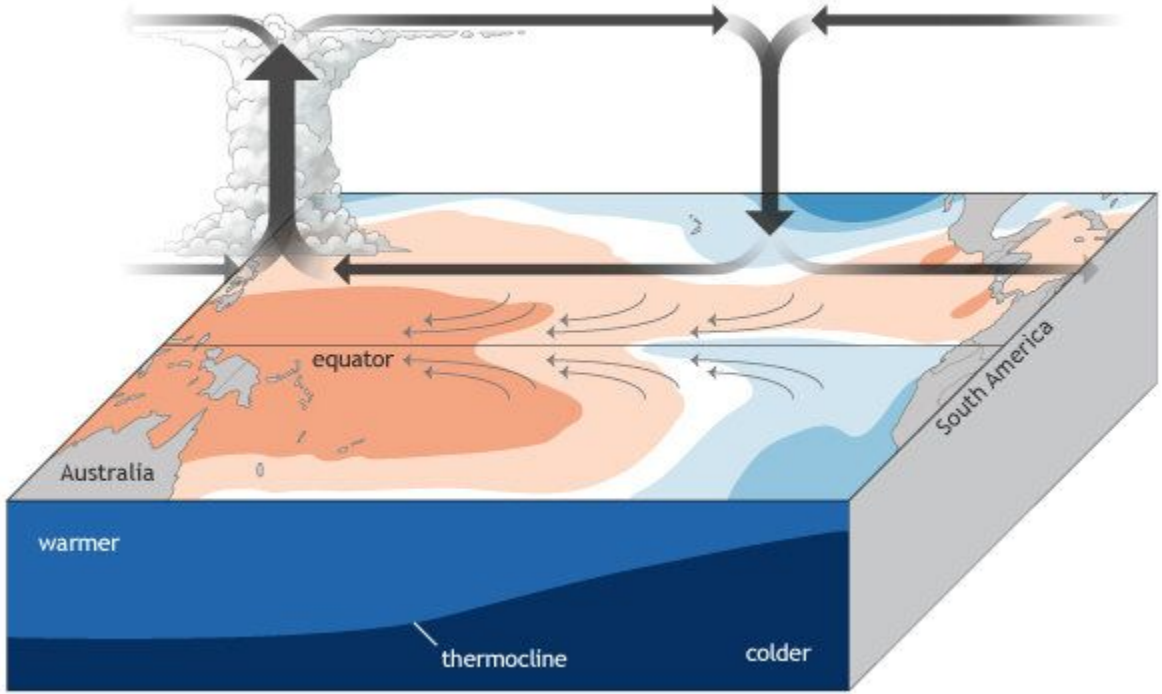
Example

IOP1 on 27 Jan 2018

ENSO

Atmosphere-ocean feedbacks during El Niño-Southern Oscillation

Neutral

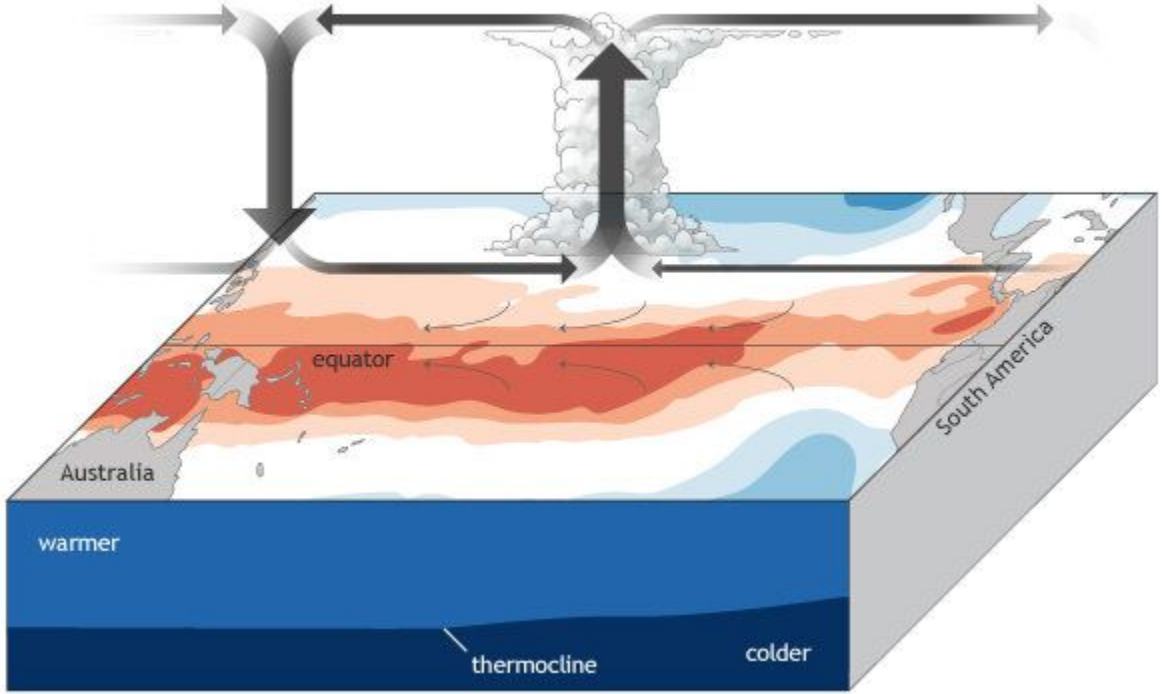


NOAA Climate.gov

ENSO

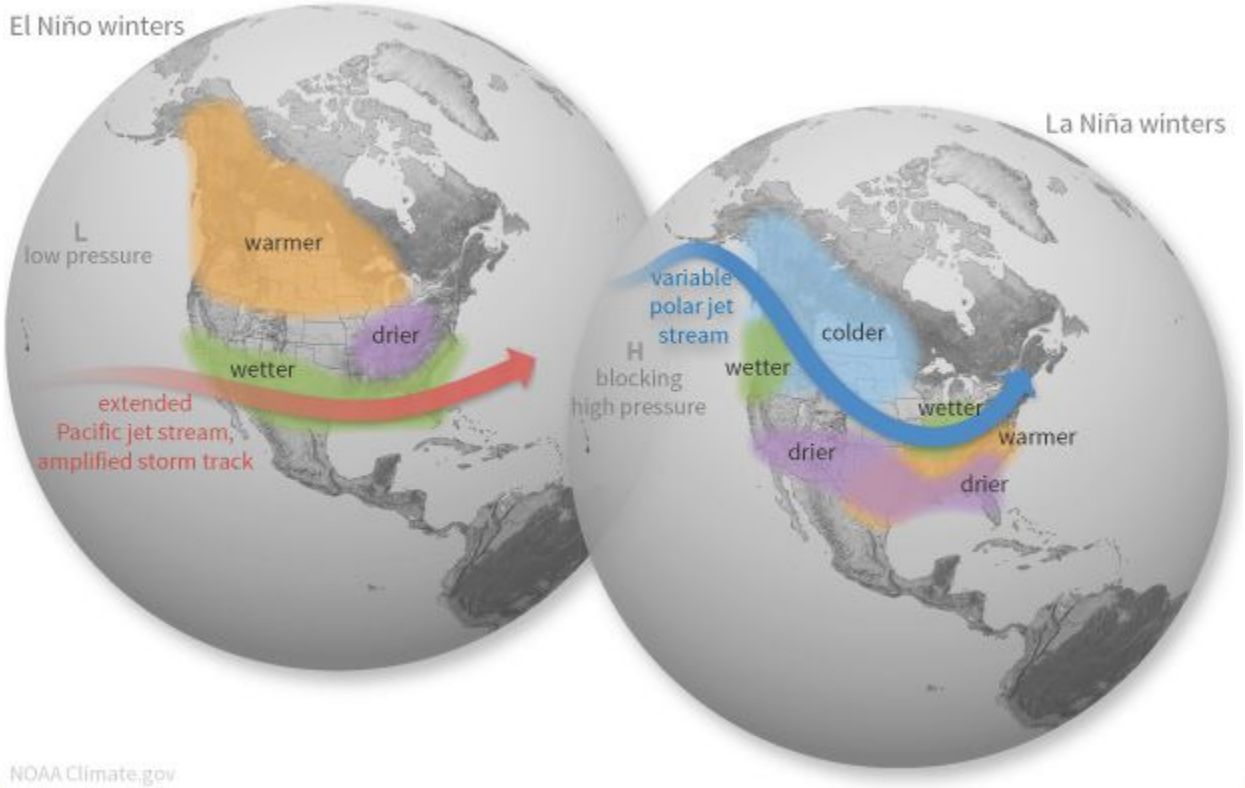
Atmosphere-ocean feedbacks during El Niño-Southern Oscillation

El Niño

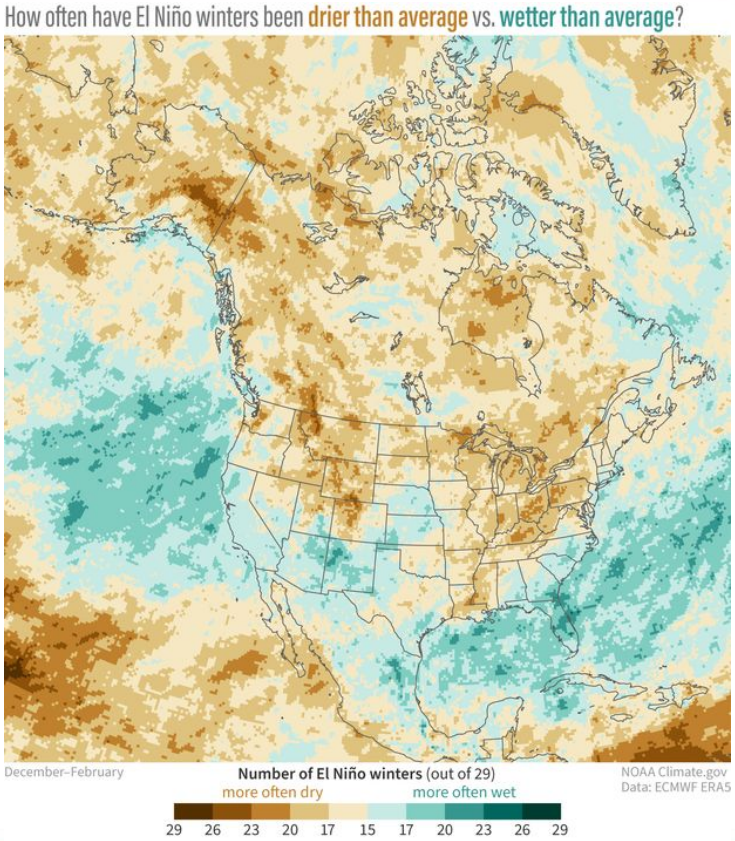


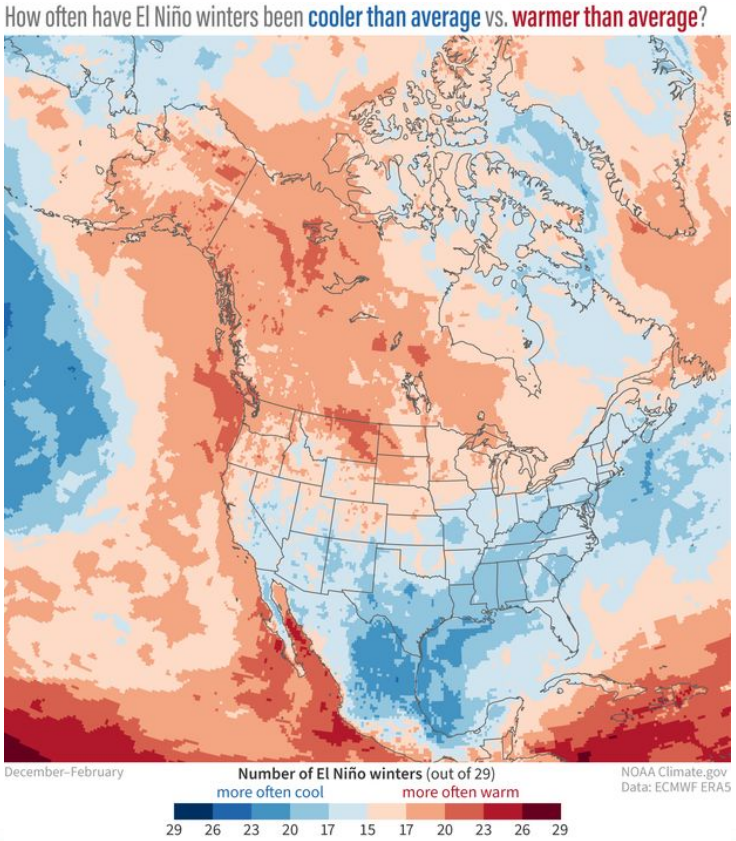
NOAA Climate.gov

ENSO Impacts

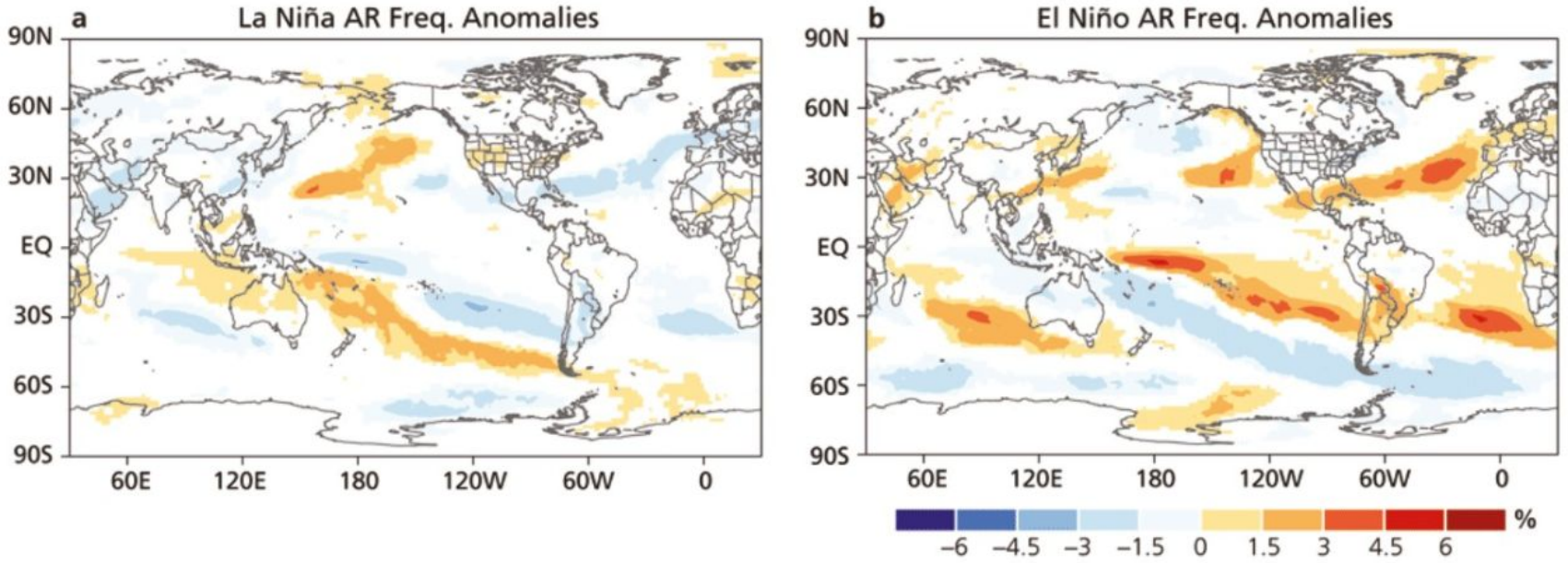


ENSO Impacts





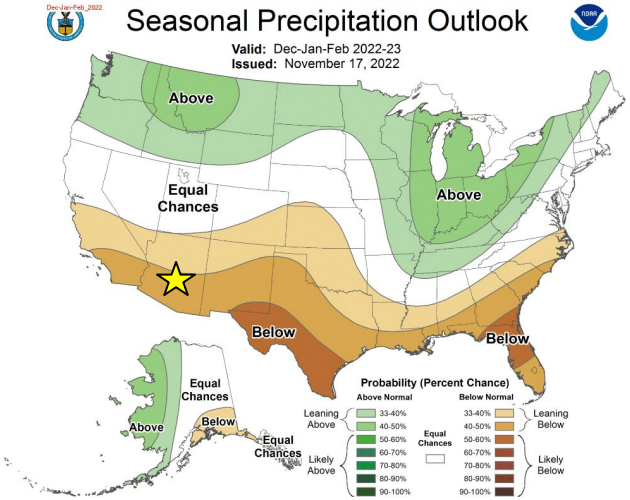
ARs & ENSO

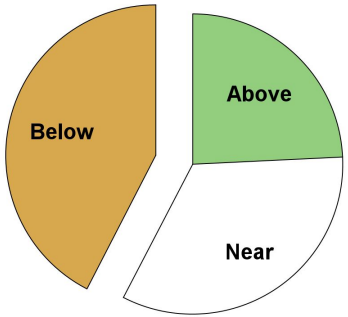


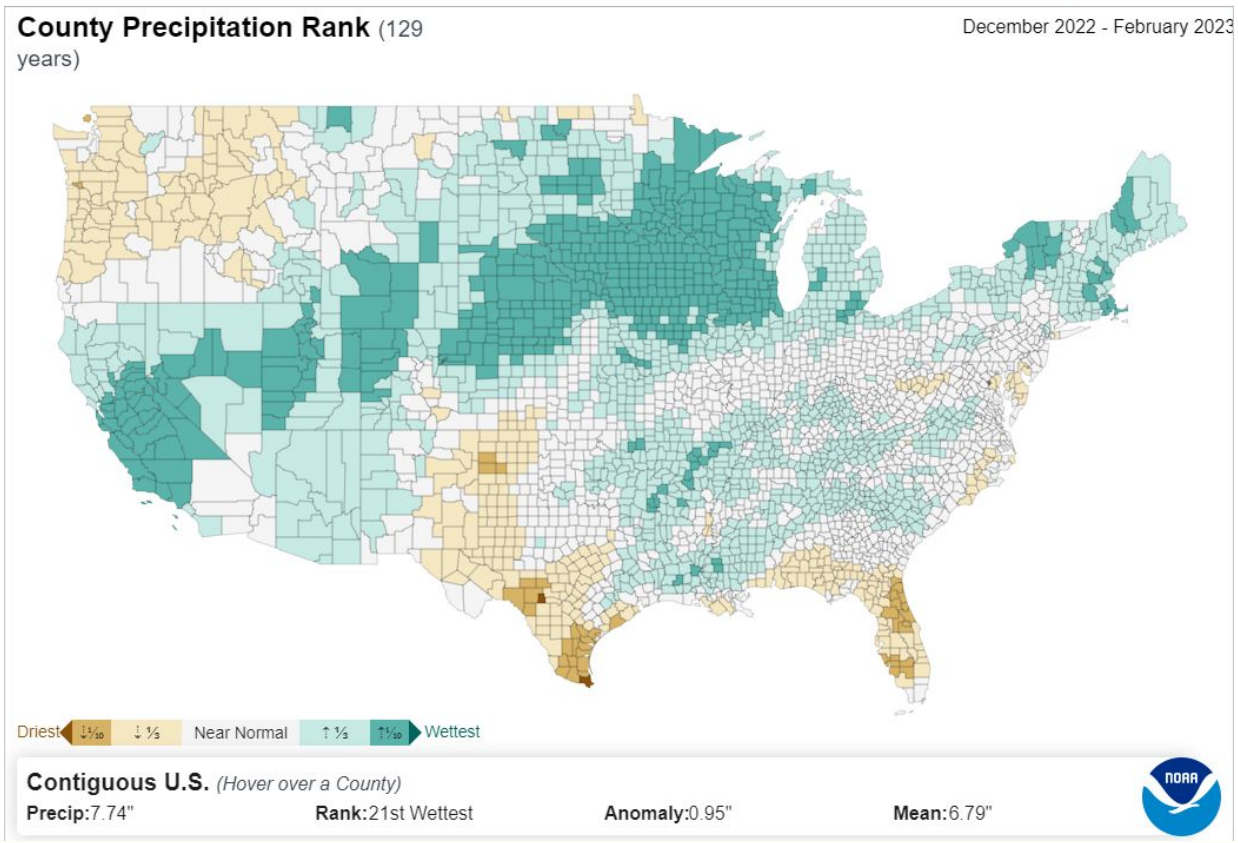
El Niño (La Niña) can increase (decrease) AR frequency across the N. Pacific but impact on precipitation across the Southwest is less robust. Other climate influences (MJO, PNA) must be considered.

Source: Huffman et al. 2001 (Updated from Guan and Waliser 2015

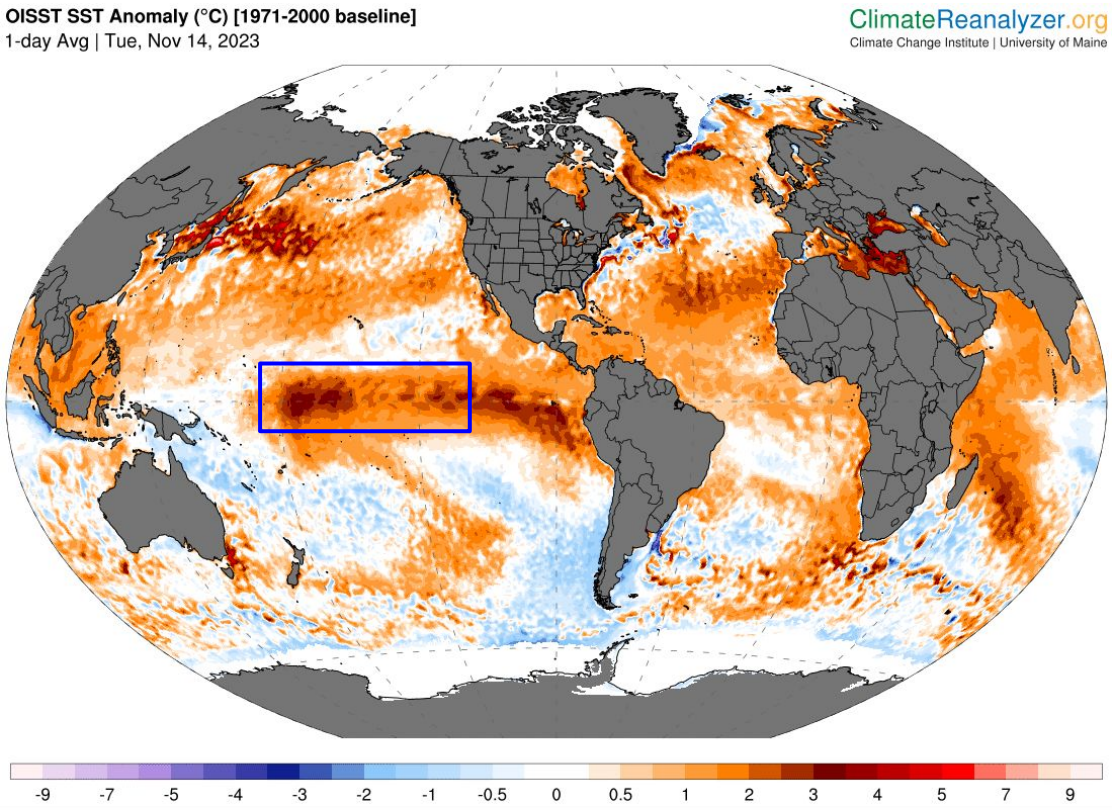
Look Back at Winter 2022-2023

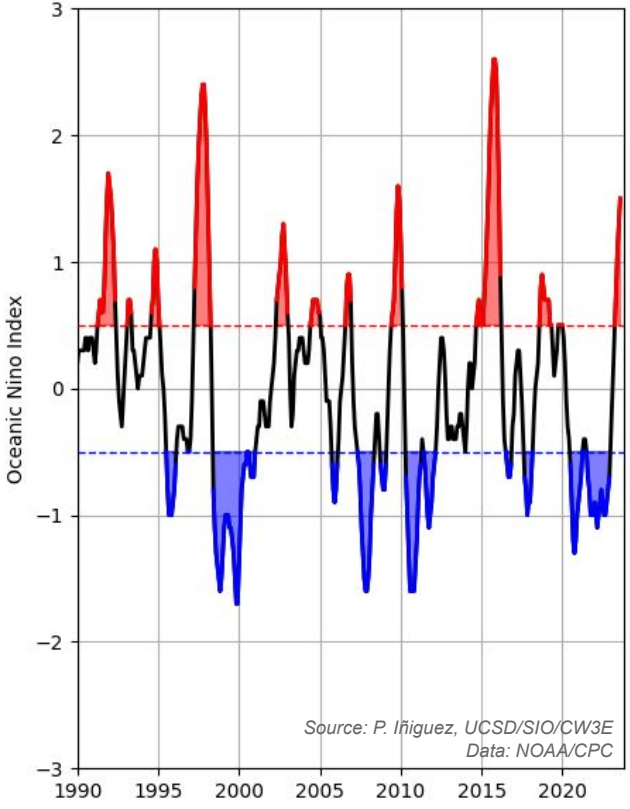




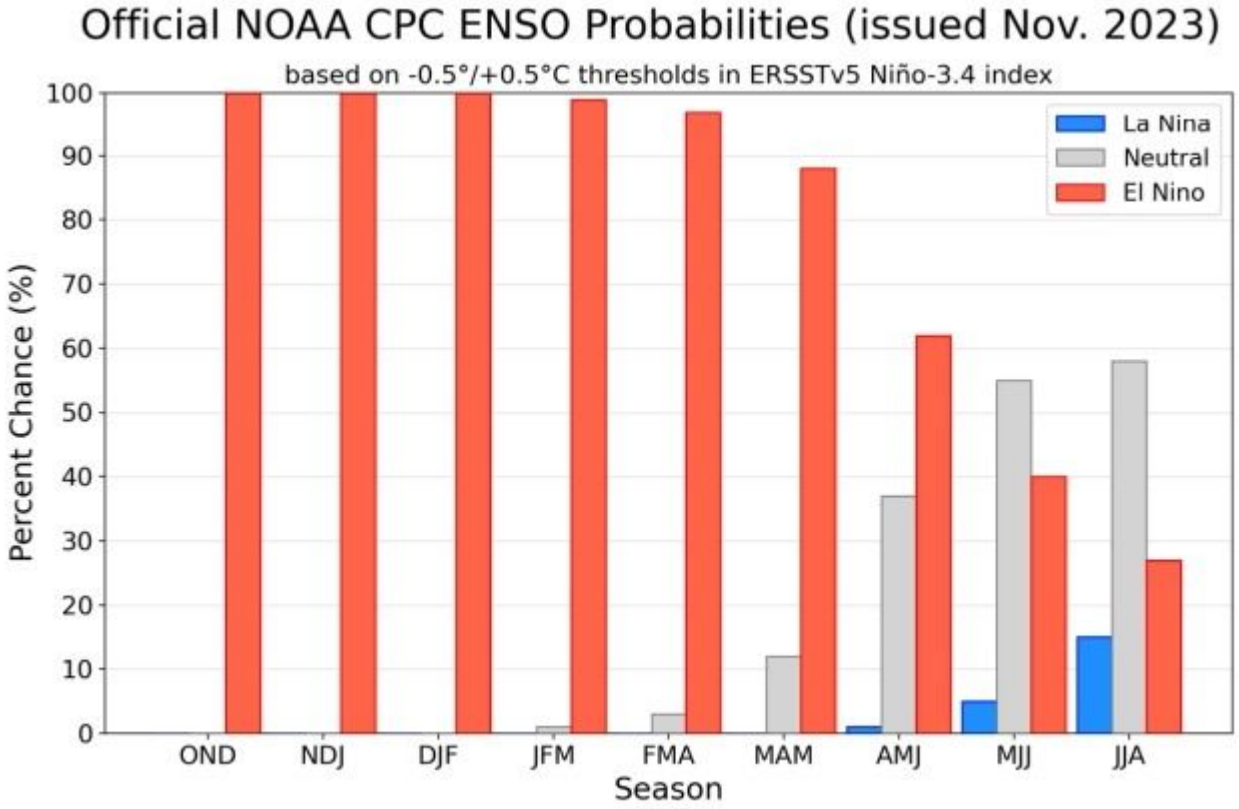


ENSO Status


OISST SST Anomaly (°C) [1971-2000 baseline]
1-day Avg | Tue, Nov 14, 2023
ClimateReanalyzer.org
Climate Change Institute | University of Maine
-9 -7 -5 -4 -3 -2 -1 -0.5 0 0.5 1 2 3 4 5 7 9

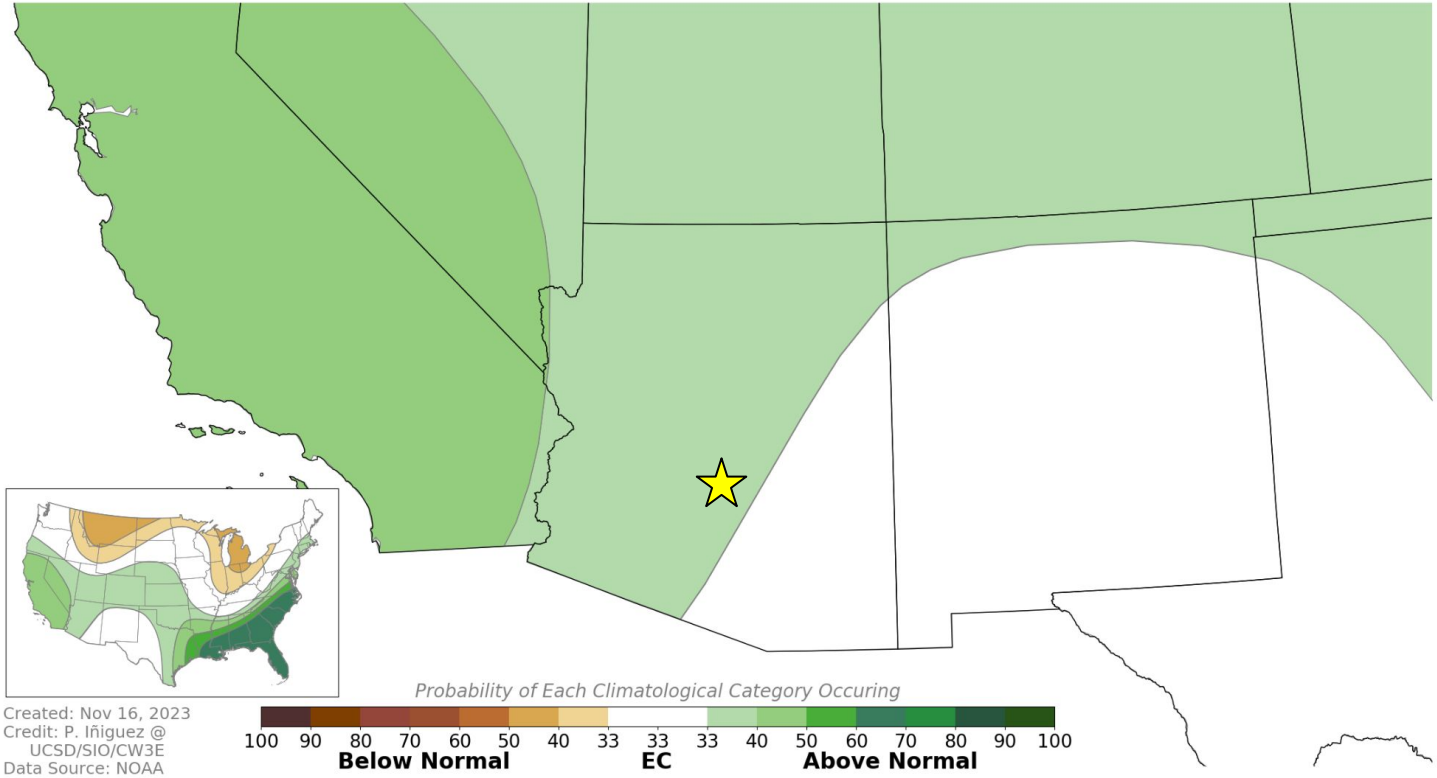

Oceanic Nino Index
3
2
1
0
−1
−2
−3
1990
1995
2000
2005
2010
2015
2020
Source: P. Iñiguez, UCSD/SIO/CW3E
Data: NOAA/CPC

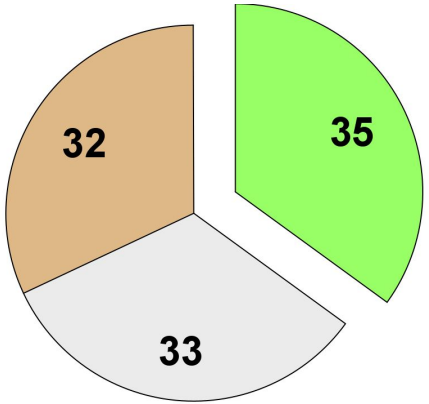
CPC ENSO Forecast



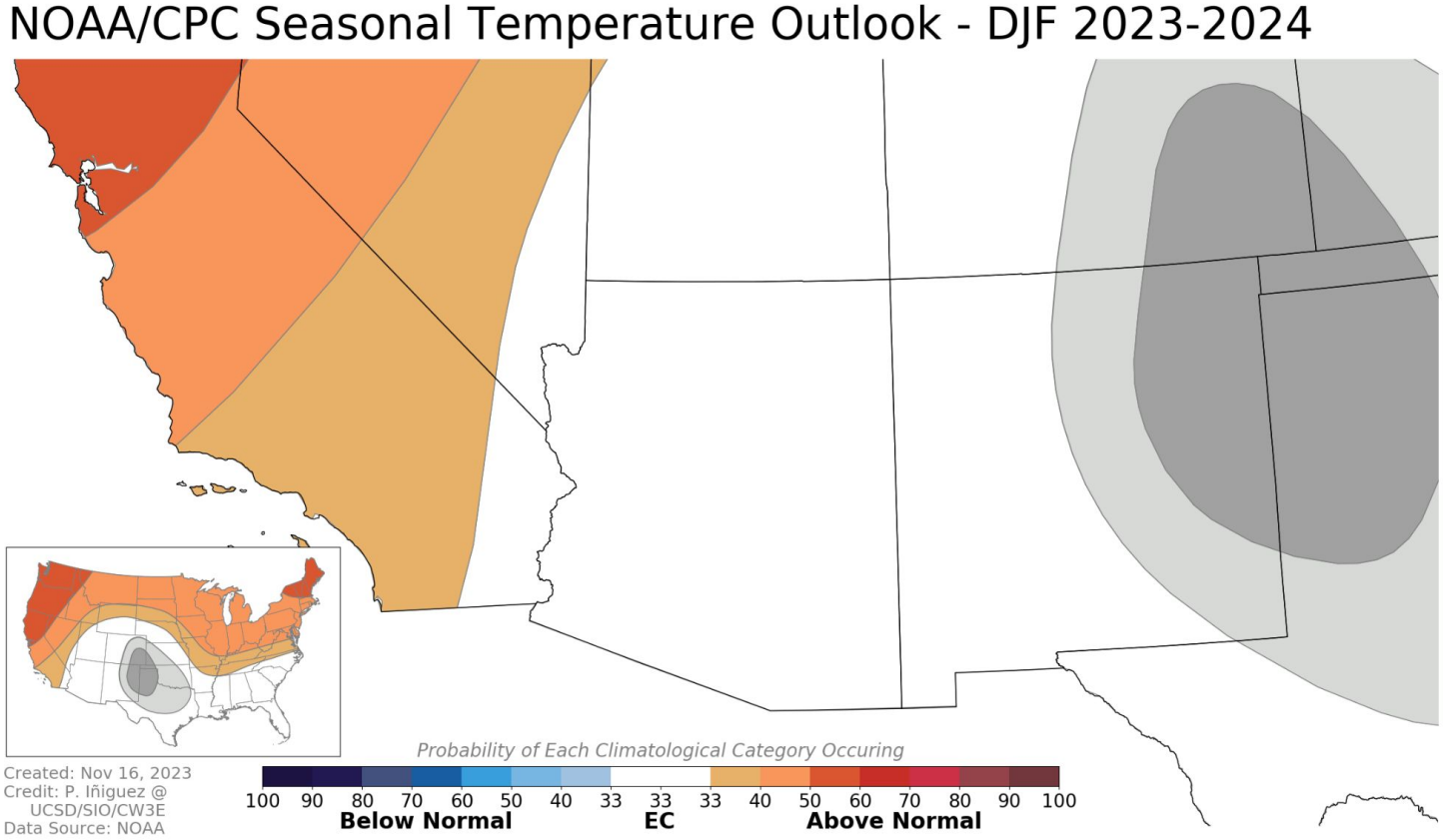
CPC Outlook

NOAA/CPC Seasonal Precipitation Outlook - DJF 2023-2024

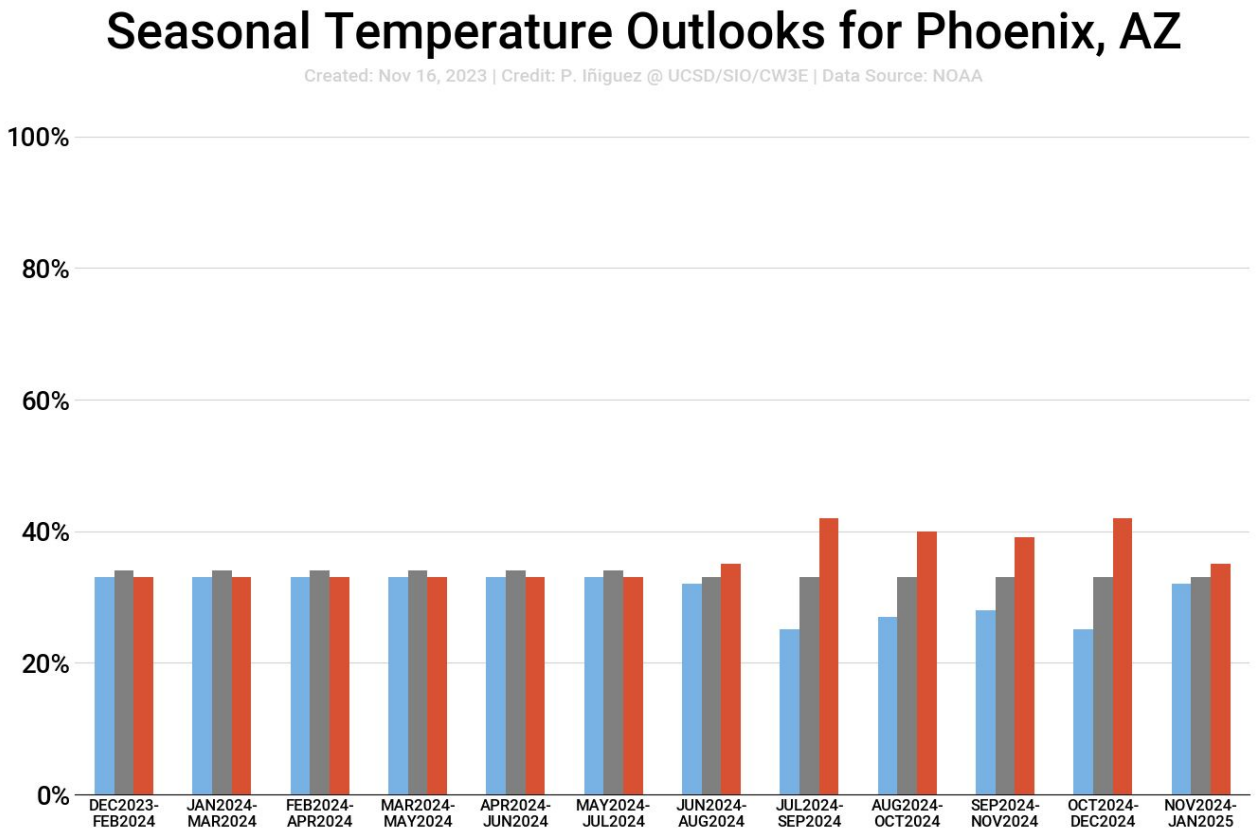


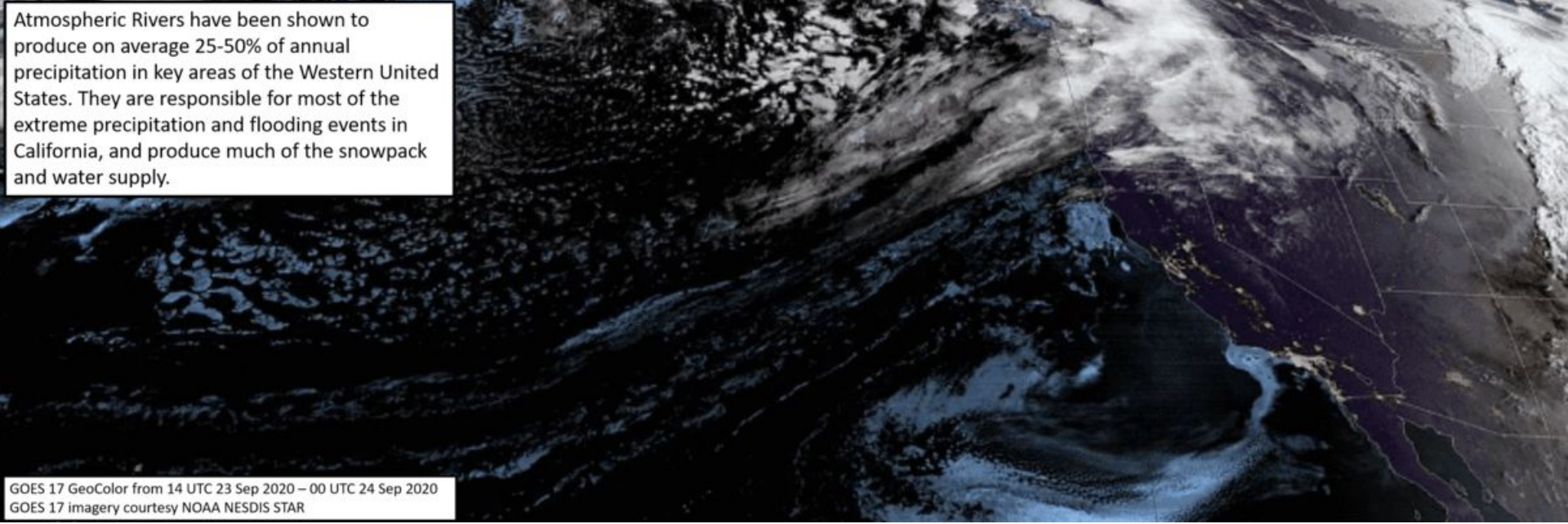


CPC Outlook


NOAA/CPC Seasonal Temperature Outlook - DJF 2023-2024
Probability of Each Climatological Category Occuring
100 90 80 70 60 50 40 33 33 40 50 60 70 80 90 100
Below Normal
EC
Above Normal
Created: Nov 16, 2023
Credit: P. Iñiguez @ UCSD/SIO/CW3E
Data Source: NOAA

CPC Outlook


Seasonal Temperature Outlooks for Phoenix, AZ
Created: Nov 16, 2023 | Credit: P. Iñiguez @ UCSD/SIO/CW3E | Data Source: NOAA
100%
80%
60%
40%
20%
0%
DEC2023-FEB2024
JAN2024-MAR2024
FEB2024-APR2024
MAR2024-MAY2024
APR2024-JUN2024
MAY2024-JUL2024
JUN2024-AUG2024
JUL2024-SEP2024
AUG2024-OCT2024
SEP2024-NOV2024
OCT2024-DEC2024
NOV2024-JAN2025



Winter 2023-2024

Paul Iñiguez
Meteorologist - UCSD/SIO/CW3E