



NOAA



Informing Major Pattern Change Key Messaging at the Climate Prediction Center via the Regime Change Prognostic Tool

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21st Climate Prediction Applications Science Workshop

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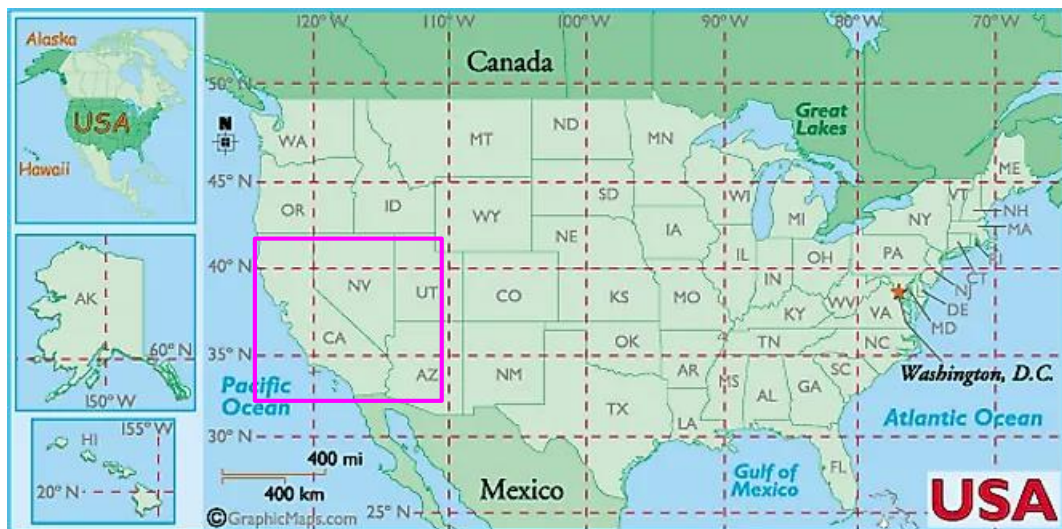
Project Background & Motivation

Regime Change Prognostic Tool

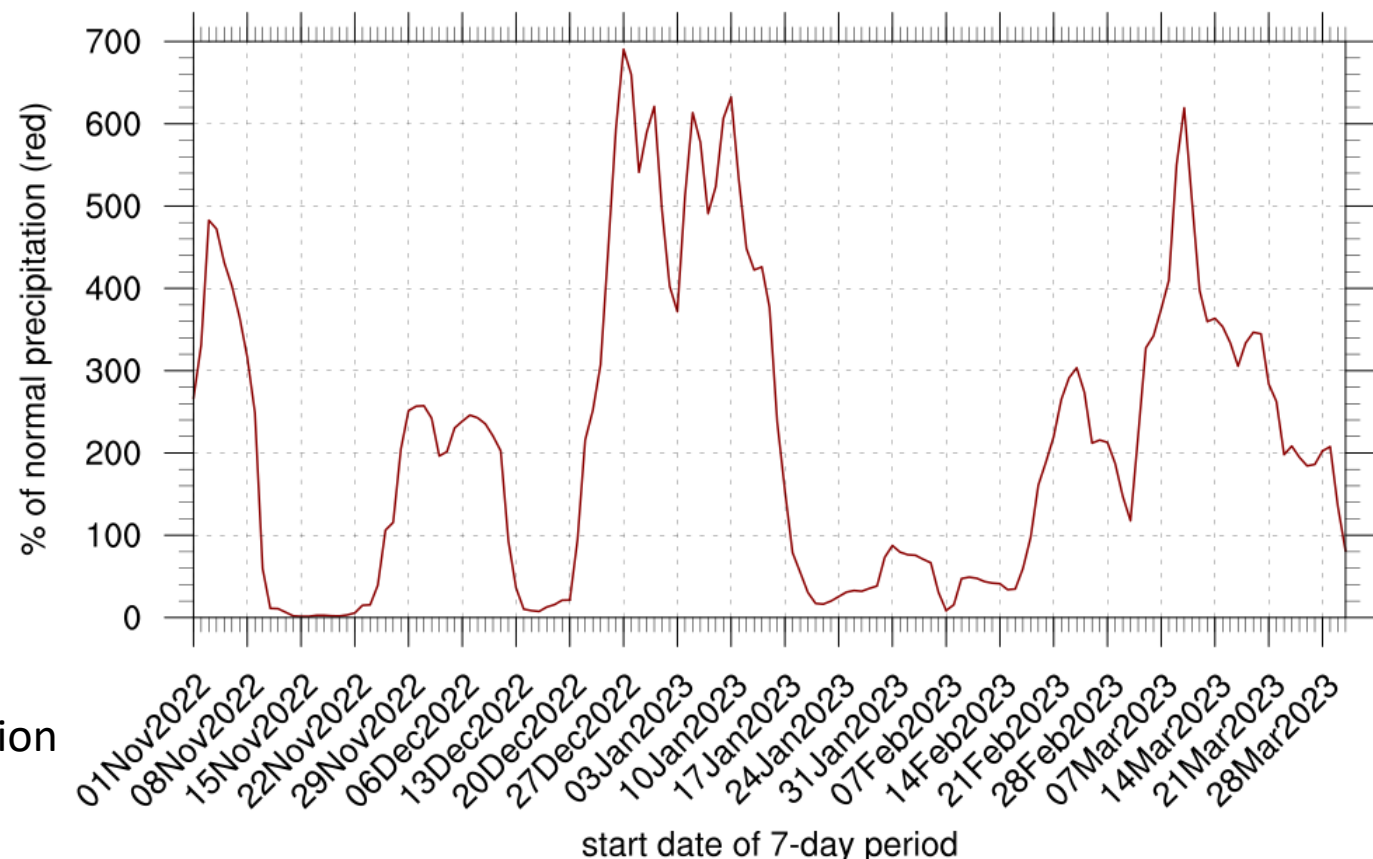
- **Motivation:** Most of CPC's forecast tools provide little to no probabilistic information on the timing, duration, and magnitude of impactful pattern changes. Rather, most of CPC's tools show probabilistic information for weekly averages, etc. Stakeholders greatly desire pattern change information because they are often accompanied by major, newsworthy changes in sensible weather. The Regime Change Prognostic Tool aims to address this gap.
- **Goal:** Enhance Key Messages; Provide enhanced messaging of the timing, magnitude, and duration of major, impactful pattern changes for both temperature and precipitation.
- **Target audience/stakeholders:** All users of CPC's outlooks: Days 6-10, Week 2, Weeks 3-4, Monthly, Hazards, Drought, and **Key Message** products.
- **Collaborators:** CPC staff / NWS regions / stakeholders
- **Use Case Study:** December 2022 - January 2023 California deluge – preliminary tool results for onset and cessation



Winter of 2022-2023: Southwest Precipitation



Regional % of Normal 7-day Precipitation (01Nov2022 to 31Mar2023)



regional box: 32N to 42N and 235E to 251E

% of normal of area-weighted 7-day summed precipitation across the domain for non-ocean CONUS grid points (7-day climatologies are calculated over 1991-2020)



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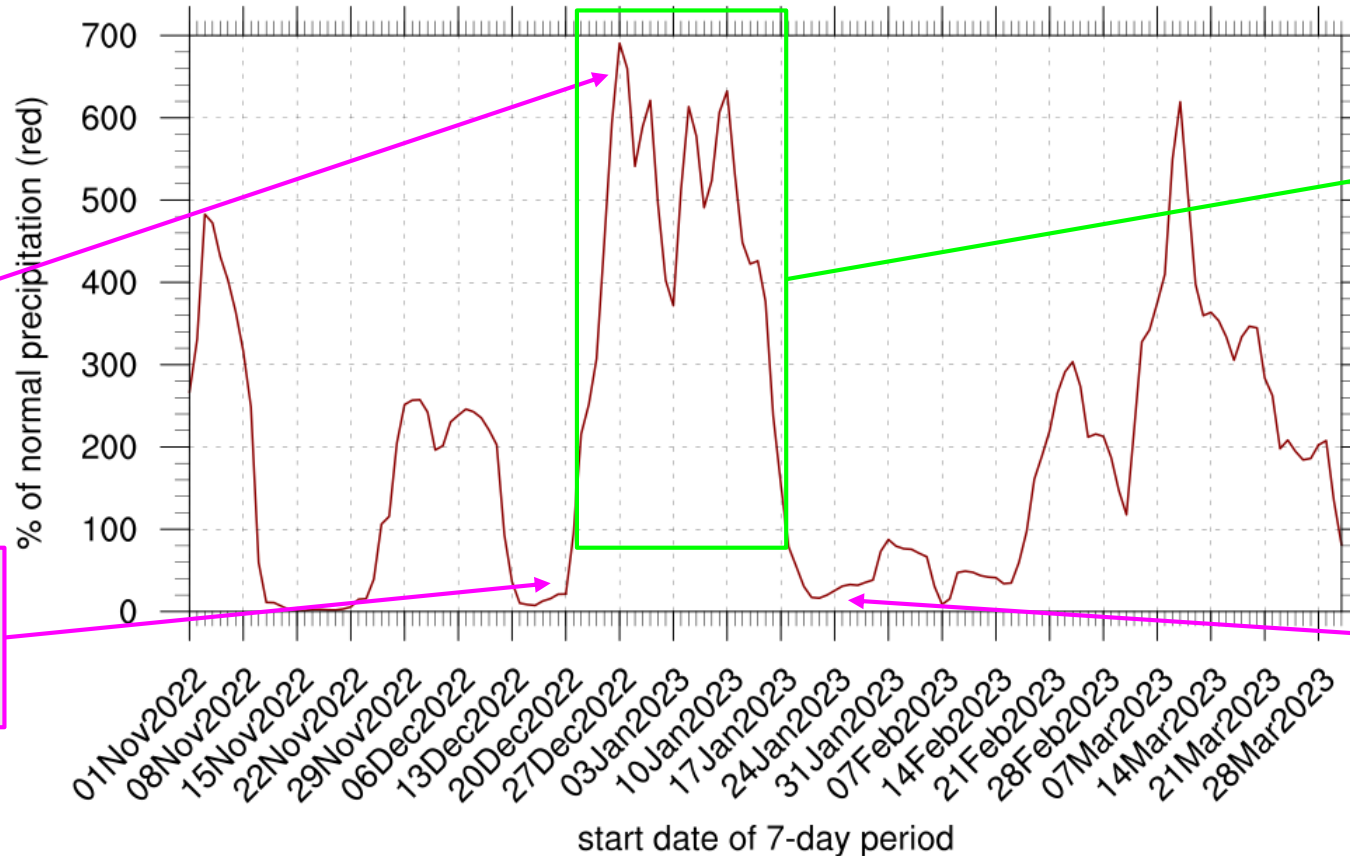
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Abrupt Precipitation Regime Changes

Regional % of Normal 7-day Precipitation (01Nov2022 to 31Mar2023)



**Week beginning
December 27, 2022:**
near 700% of normal
precipitation

**Week beginning
December 20, 2022:**
near zero precipitation

Next ~3 Weeks:
atmospheric rivers
and heavy
precipitation continue

**Week beginning
January 20, 2023:**
near zero precipitation

start date of 7-day period
regional box: 32N to 42N and 235E to 251E

Precipitation Onset

**Could we see and message the pattern change
toward more precipitation?**

Lead Week 2:
Beginning December 20



Lead Week 3:
Beginning December 27



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Messaging the Onset

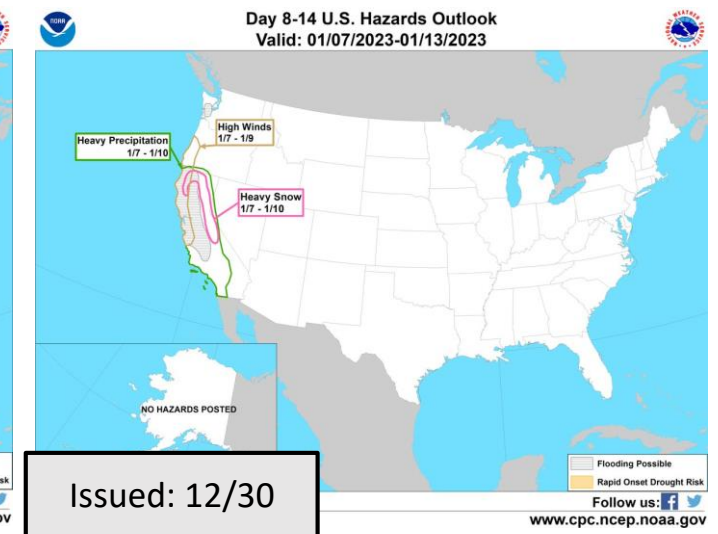
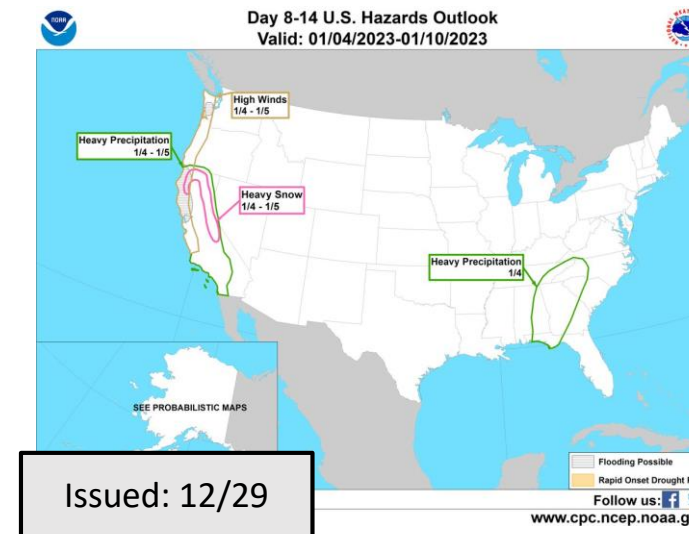
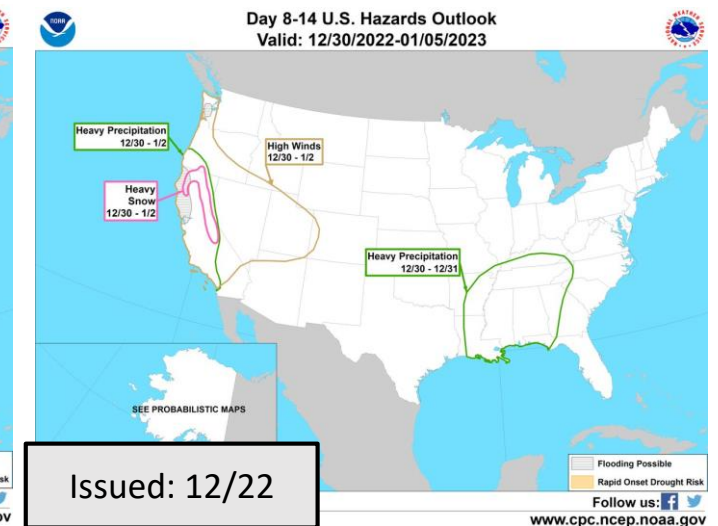
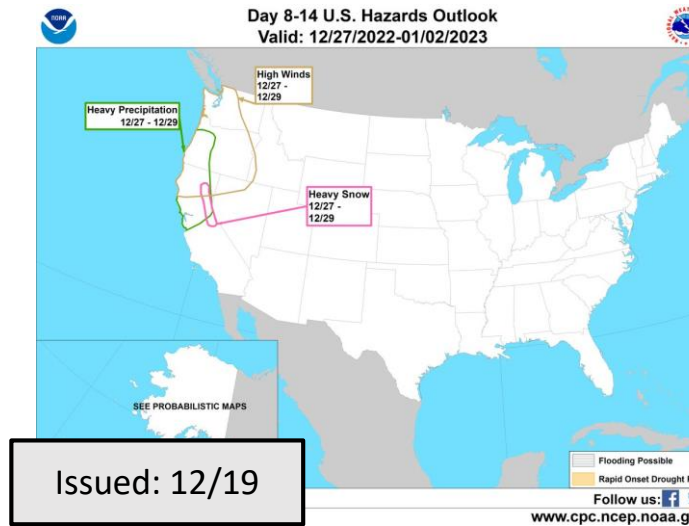
Hazards Outlooks for Heavy Precipitation in California

Issued: Second half of December

No Key Message yet.

Rain is beneficial, especially with long-term drought conditions in place.

Could we have improved our messaging? If we had confidence in the onset, duration, and intensity of this pattern change, we likely would have issued a Key Message.



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Hazardous Winds, Snow, and Rain Forecast to Continue over the West Coast, Possibly Exacerbating Flooding Risk

Issued January 4, 2023

Effective January 12 - 16, 2023

KEY MESSAGES

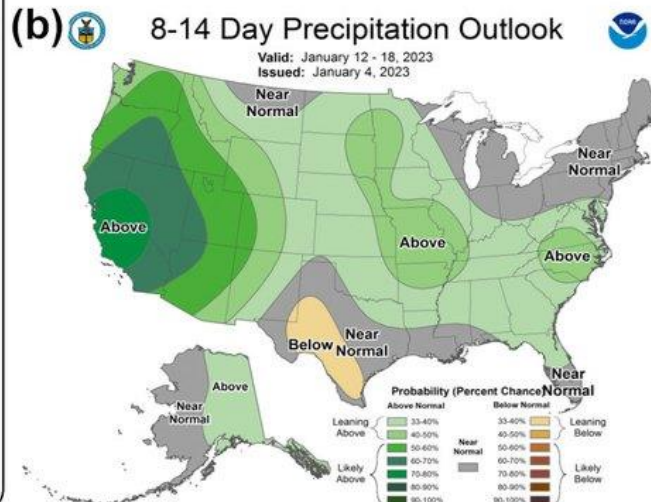
Persistent mid-level low pressure anchored over the North Pacific has led to a series of atmospheric rivers producing heavy low elevation rain and high elevation snow, high winds, and flooding along the West Coast over the past couple of weeks. This pattern is expected to continue throughout week-1 (January 5-11) and is likely during week-2 (January 12-18), as several more impactful atmospheric river events are expected.

Heavy rain is likely over much of the lower elevations of California. Heavy snow is likely over the higher elevations of northern and central California. High winds are likely over parts of coastal California and Oregon. Flooding is possible for parts of California (a).

Prolonged heavy rain and accumulated impacts from the series of storms has led to saturated soils and flooding across portions of the Western U.S. High chances of above normal precipitation along the West Coast (b) are expected to increase the risk of prolonged flooding and the potential for shallow landslides in some areas. High winds could lead to coastal erosion and may exacerbate localized flooding.

Timing: Hazardous conditions are expected to continue through at least January 12-16, 2023*.

* For short-term forecasts (prior to January 12), visit www.wpc.ncep.noaa.gov and weather.gov.



Key Message for the Continuation of Hazardous Precipitation in California

Issued: January 4, 2023

While the rain was beneficial, it became too much of a good thing.

At this point in time, we were being asked by Western Region and others: "When will this end?"

However, we included no messaging about the end of the event in the key message.



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***Key messages are subject to change due to changes in forecast information and tools.



Regime Change Prognostic Tool

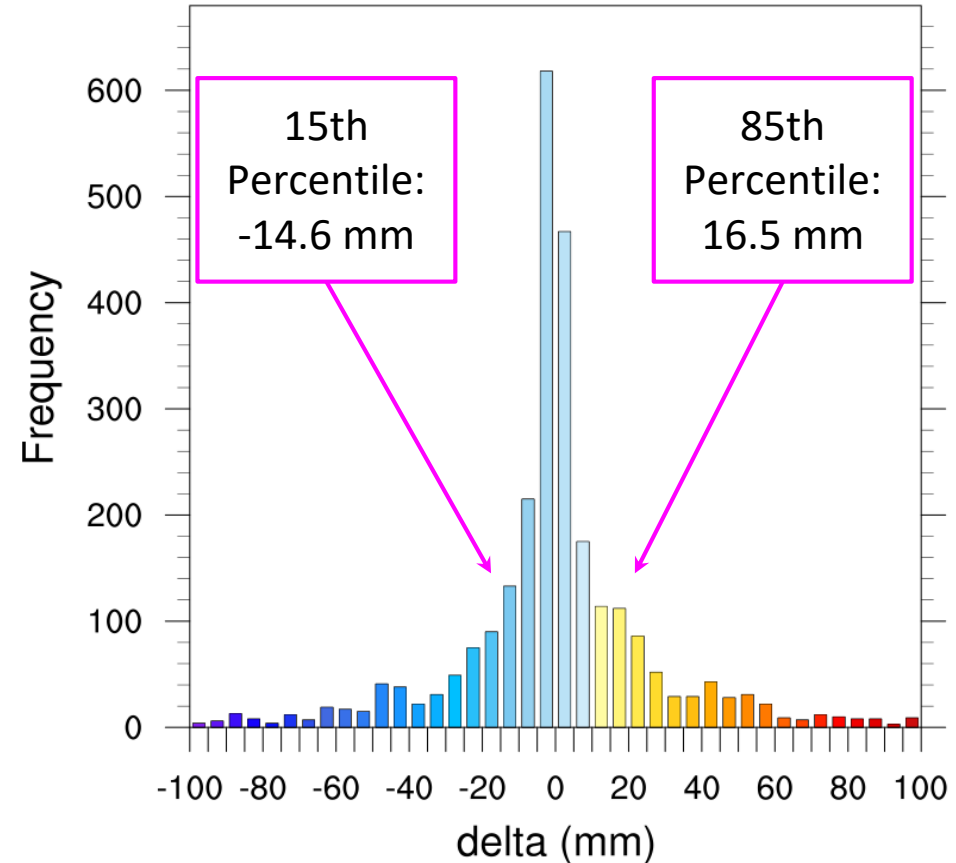
Observational Study

- For each grid point and season, calculate the observed consecutive, non-overlapping week-to-week change in precipitation anomaly during 1991-2020.
- Similar statistics were calculated for other timescales (1-Day, 3-Day, 5-Day, 14-day, etc.) and variables (temperature, etc.)
- Examine the underlying distributions to identify the 15th and 85th percentiles of week-to-week precipitation anomaly changes.
- **Example (right):** Distribution of week-to-week precipitation anomaly changes in Los Angeles, CA.

The Tool

- From probabilistic, dynamical model ensemble guidance, determine the percent chance of exceeding (or not exceeding) the percentile thresholds derived from observations.

Los Angeles: Histogram of Observed Week-to-Week Change in Precipitation Anomaly



DJF; 1991-2020; Std. Dev.: 29.4833
consecutive periods; Lat: 35N, Lon: 241E



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Atmospheric Administration

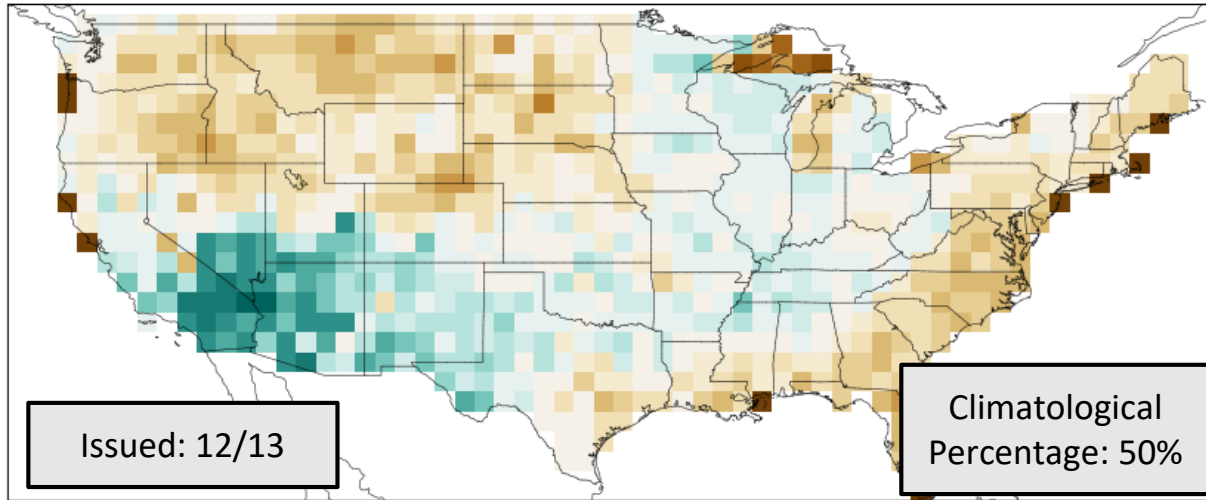
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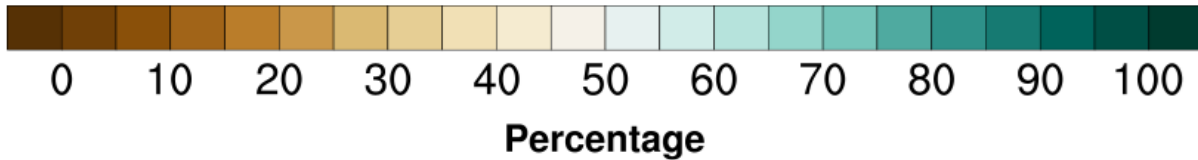


Regime Change Prognostic Tool: Precipitation Onset

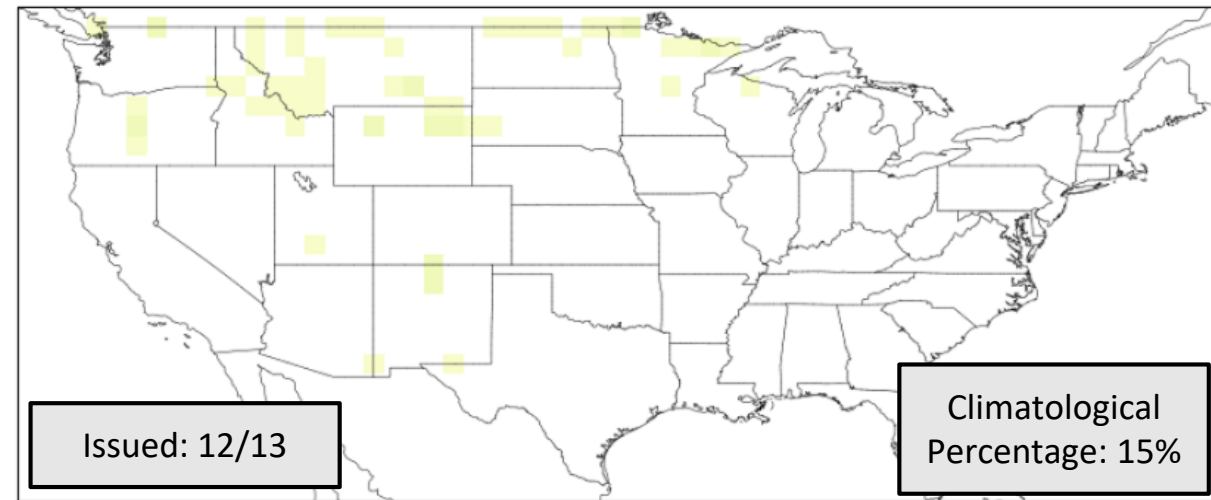
Percentage of ECMWF ensemble members with a wetter anomaly (> 50th percentile) in Week 3 than Week 2



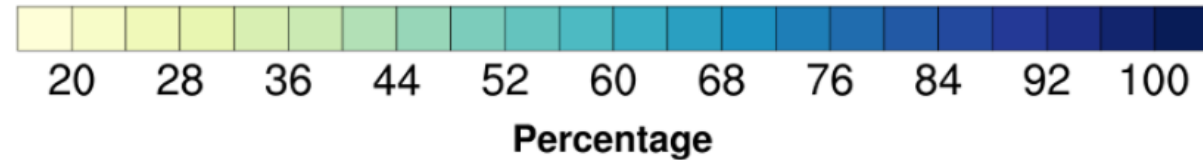
Climate Normal: 1991-2020



Percentage of ECMWF ensemble members with a MUCH wetter anomaly (> 85th percentile) in Week 3 than Week 2



Climate Normal: 1991-2020



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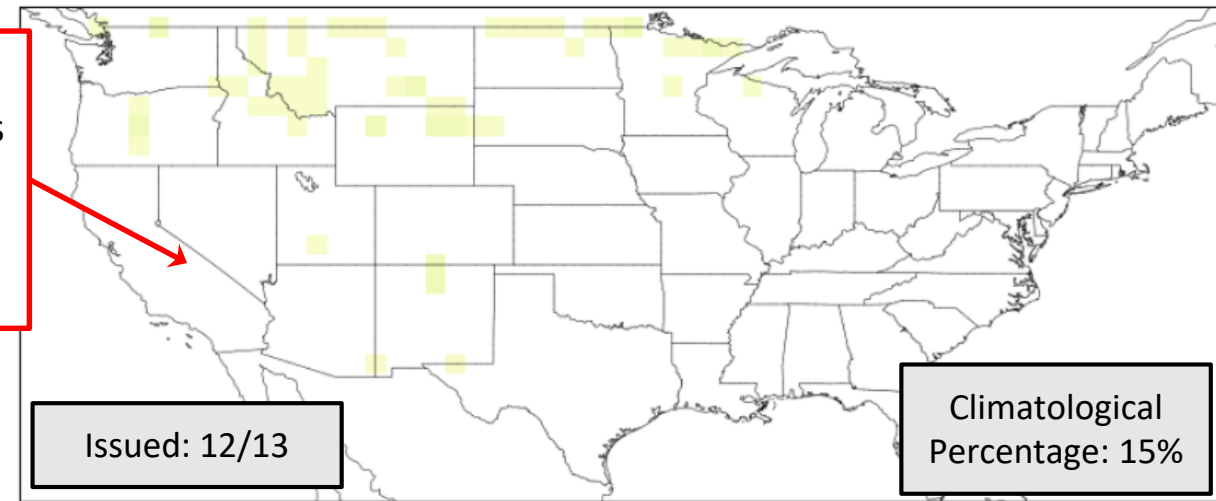
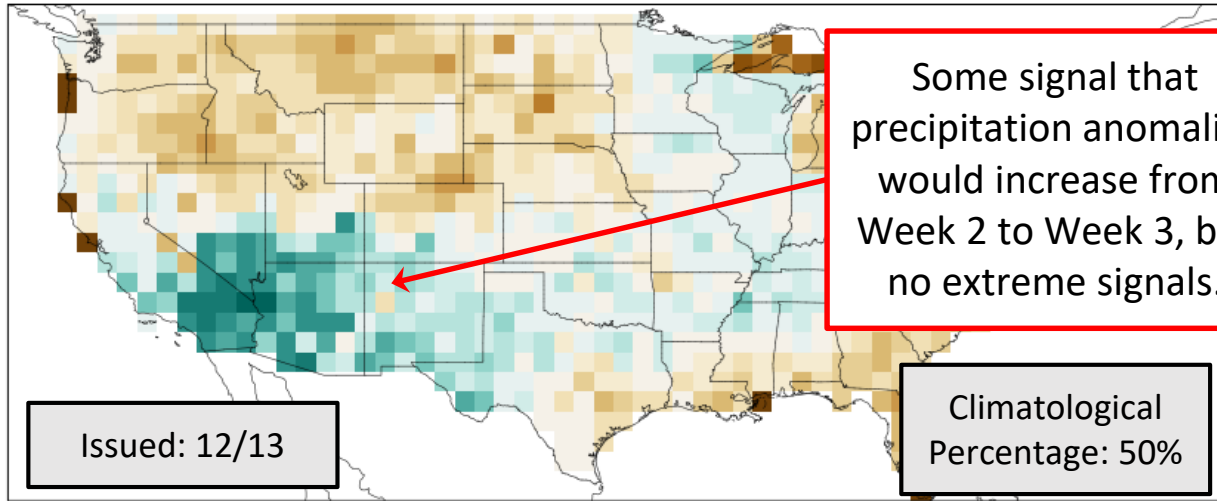
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Regime Change Prognostic Tool: Precipitation Onset

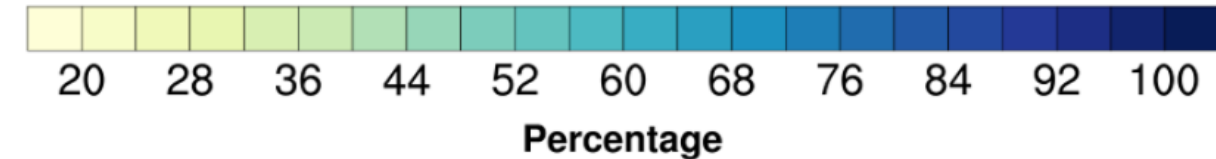
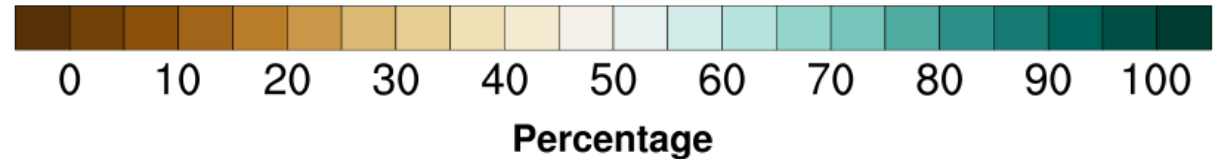
Percentage of ECMWF ensemble members with a wetter anomaly (> 50th percentile) in Week 3 than Week 2

Percentage of ECMWF ensemble members with a MUCH wetter anomaly (> 85th percentile) in Week 3 than Week 2



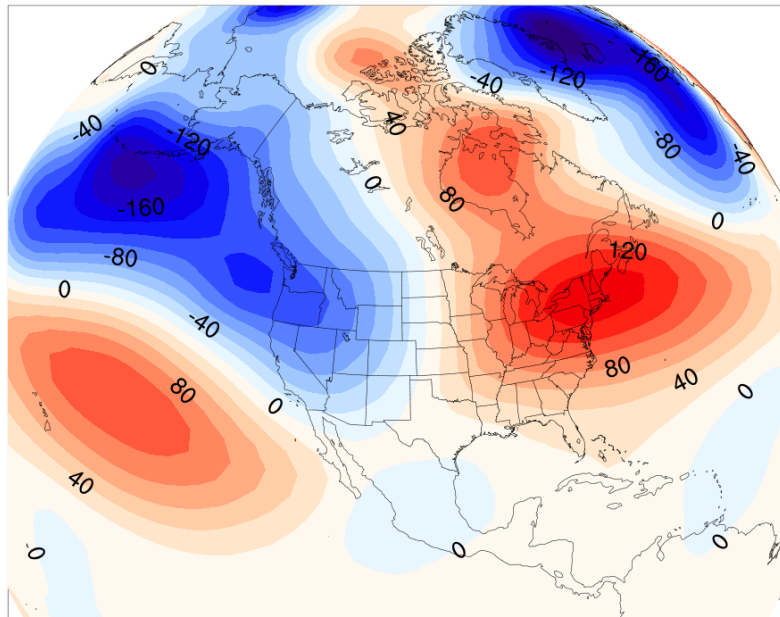
Climate Normal: 1991-2020

Climate Normal: 1991-2020

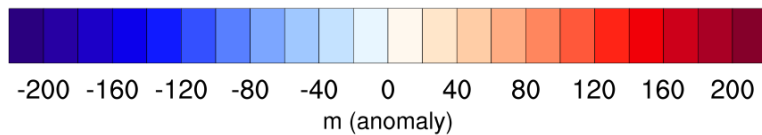


Observed vs Modeled: 500-hPa Height Patterns: Precipitation Onset

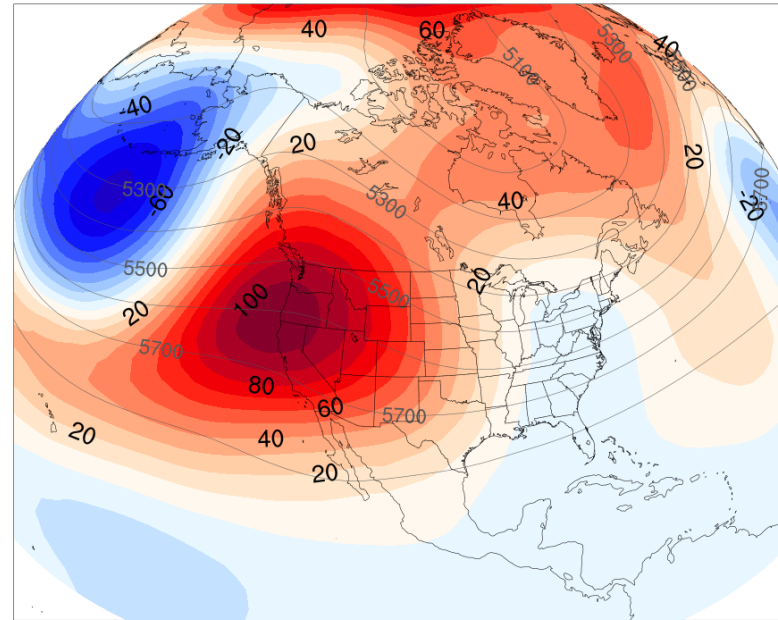
**Observed:
Week beginning
December 27, 2022**



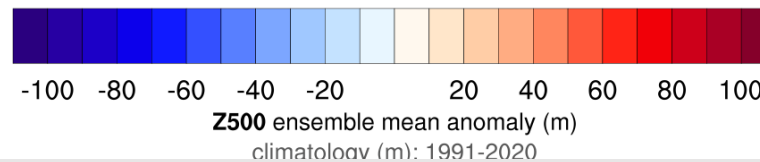
Climate Normal: 1991-2020



**ECMWF Week 3 Forecast Issued
12/13:
Week beginning December 27, 2022**



n = 51 members



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Precipitation Cessation

**Could we see and message the pattern change
toward less precipitation?**

Lead Week 2:
Beginning January 13



Lead Week 3:
Beginning January 20



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Decreased Impacts from Hazardous Winds, Snow, Rain Expected over the West Coast by Late Next Week

Issued January 4, 2023
Updated January 9, 2023

Effective January 17 - 18, 2023

KEY MESSAGES

Following an extended period of persistent mid-level low pressure anchored over the North Pacific that led to a series of atmospheric river events, there is increasing confidence that mid-level high pressure will be positioned over the West Coast as early as January 20th, leading to a potential break in hazardous conditions.

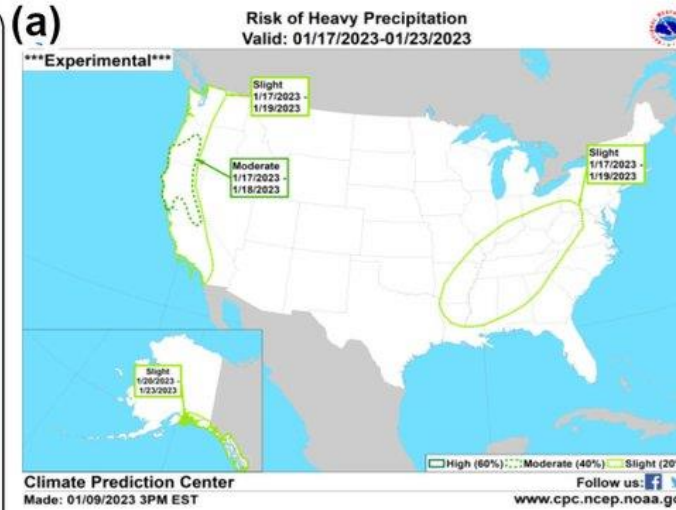
Timing: Hazardous conditions are expected to continue through January 18, 2023*.

(a) Moderate risk of heavy rain is highlighted for northern California and southwestern Oregon January 17 to 18.

(b) In addition to heavy rain, heavy snow is likely over the Sierra Nevada and the southern Cascades. High winds are likely over parts of California, Oregon, Idaho, and Nevada. Flooding is possible for western California.

Prolonged heavy rain and accumulated impacts from the series of storms has led to saturated soils and flooding across portions of the Western U.S. Heavy rain along the West Coast is expected to increase the risk of prolonged flooding and the potential for shallow landslides in some areas. High winds could lead to coastal erosion and may exacerbate localized flooding.

* For short-term forecasts (prior to January 17), visit www.wpc.ncep.noaa.gov and weather.gov.



Key Message for the Cessation of Hazardous Precipitation in California

Update: January 9, 2023

We've included messaging about the "potential" end of the event "as early as January 20th."

Could we have improved our messaging here? Confidence level? Better timing?



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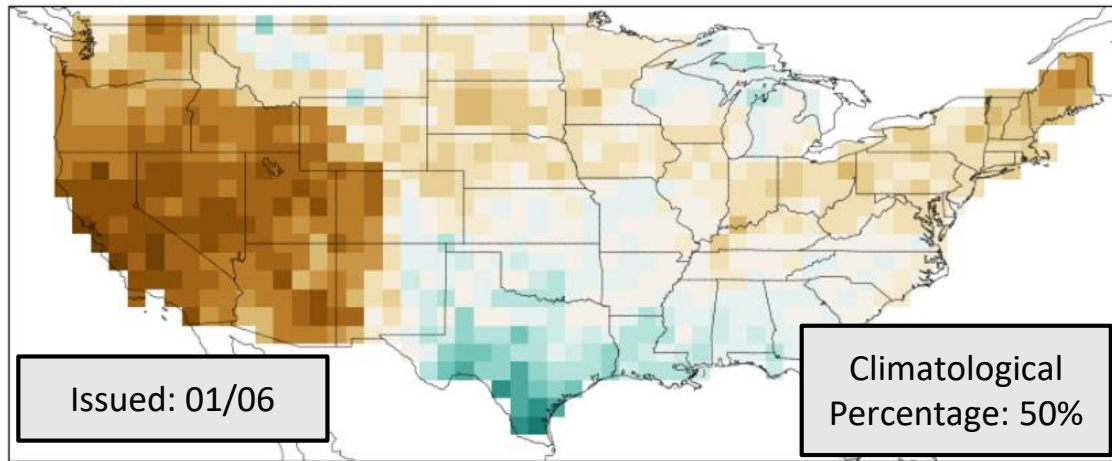
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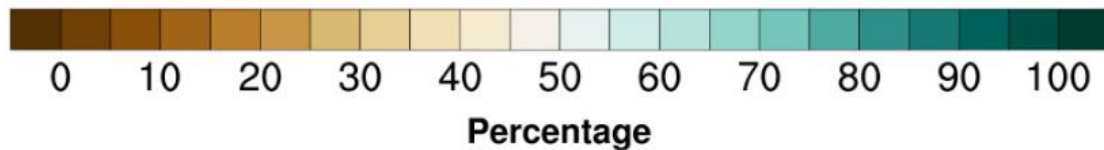


Regime Change Prognostic Tool: Precipitation Cessation

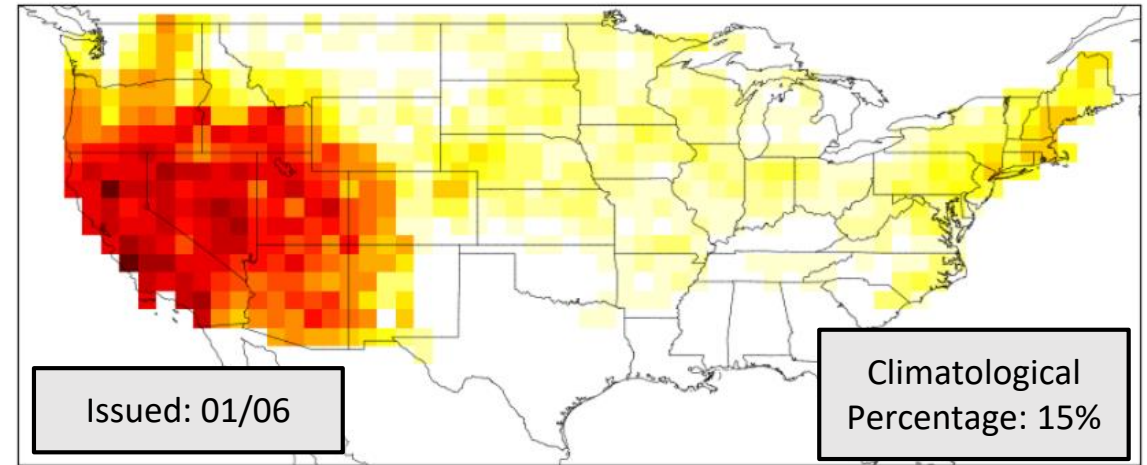
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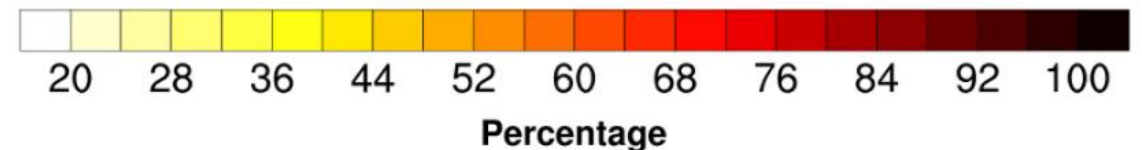
Climate Normal: 1991-2020



Percentage of ECMWF ensemble members with a MUCH drier anomaly (< 15th percentile) in Week 3 than Week 2



Climate Normal: 1991-2020



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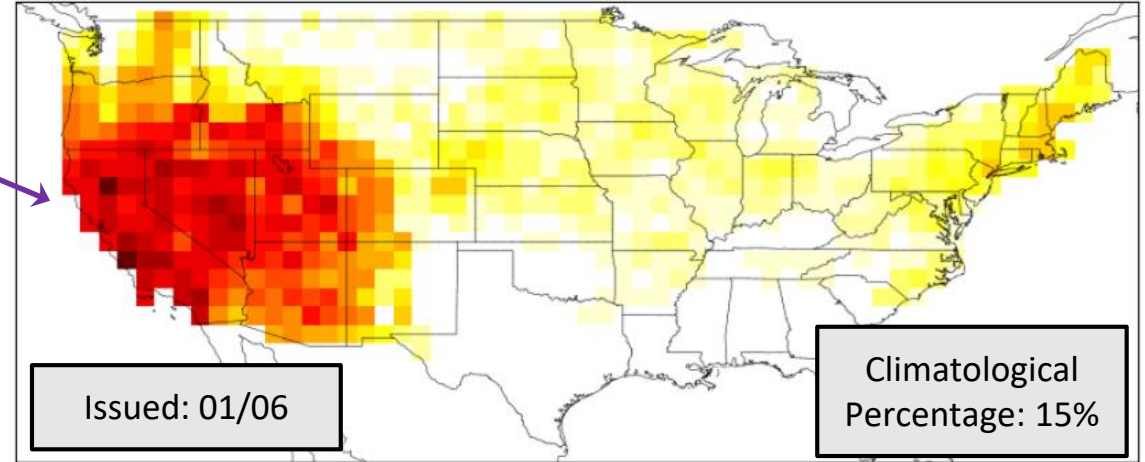
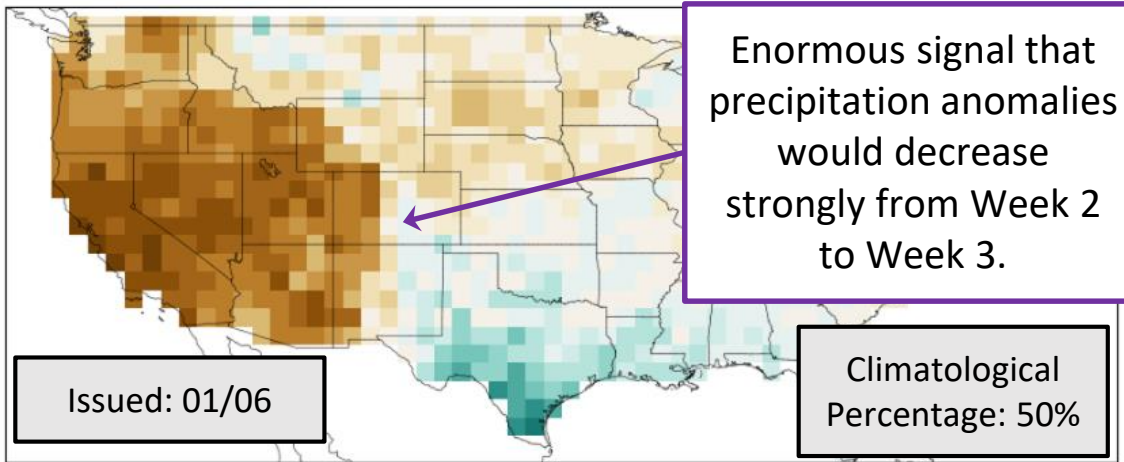
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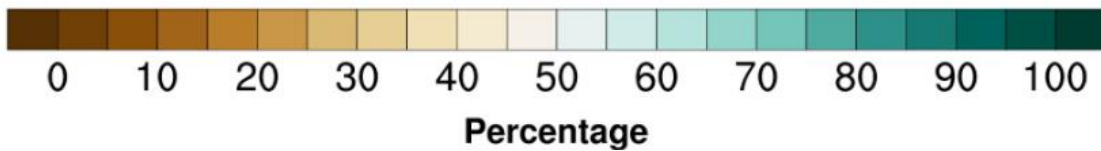
Regime Change Prognostic Tool: Precipitation Cessation

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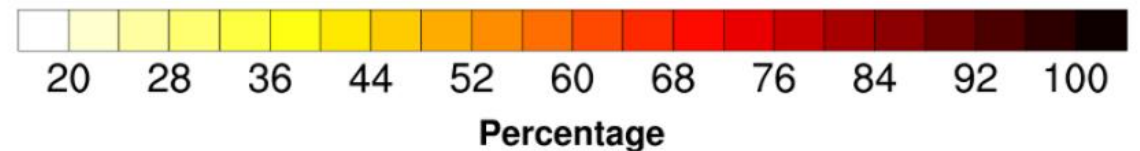
Percentage of ECMWF ensemble members with a MUCH drier anomaly (< 15th percentile) in Week 3 than Week 2



Climate Normal: 1991-2020



Climate Normal: 1991-2020



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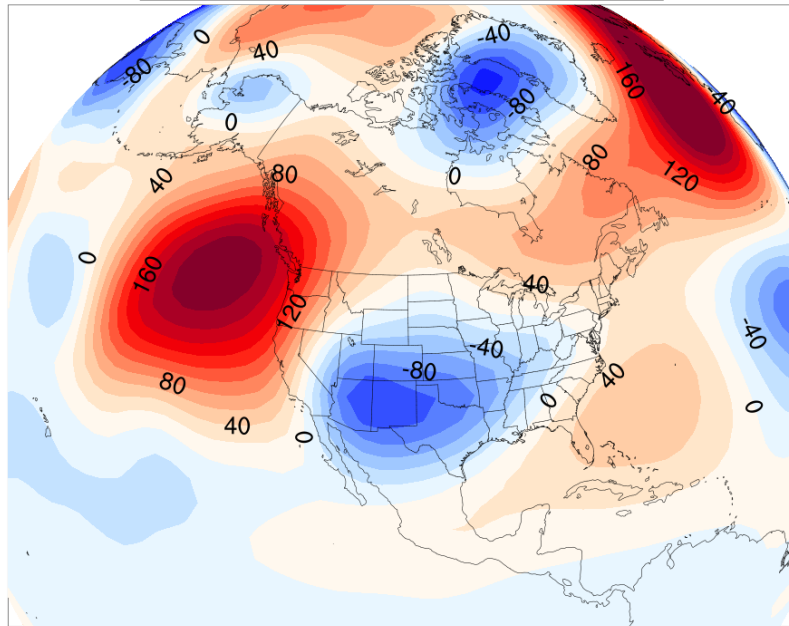
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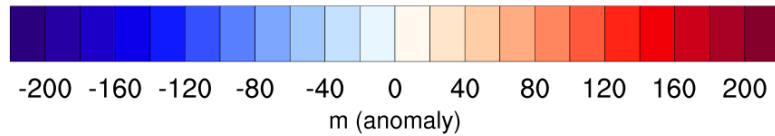


Observed vs Modeled: 500-hPa Height Patterns: Precipitation Cessation

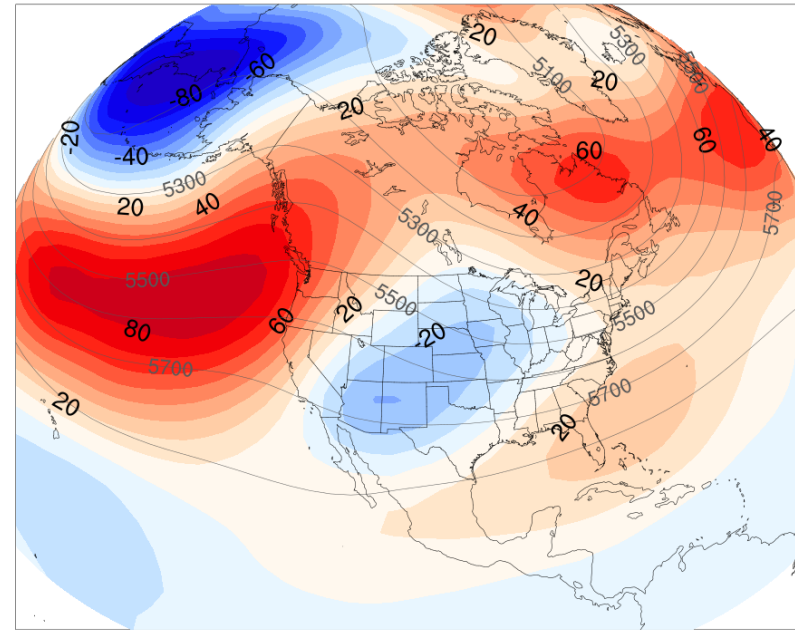
**Observed:
Week beginning
January 20, 2023**



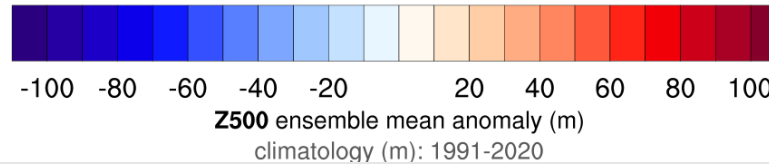
Climate Normal: 1991-2020



**ECMWF Week 3 Forecast Issued 01/06:
Week beginning
January 20, 2023**



n = 51 members



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Upcoming Activities and Summary

- Continue the observational study by compositing the frequency of extreme regime changes conditioned on the background climate state (ENSO, MJO, etc.)
- Continue to develop code to calculate the regime changes in the ensemble suite of dynamical models (across all lead times and timescales) and perform a retrospective verification.
- Begin prototyping the prognostic tool in an experimental framework to enhance forecast discussions and Key Messages to NWS regions and stakeholders
- Make plans to operationalize the tool in Fiscal Year 2025

Please visit our poster! We present results on the December 2022 Arctic Air Outbreak.

We'd like to receive feedback from the scientific and stakeholder communities to tailor the tool toward addressing specific needs.

Please e-mail Cory.Baggett@noaa.gov or Emerson.LaJoie@noaa.gov with any questions or feedback.

Thank you!



Extra Slides



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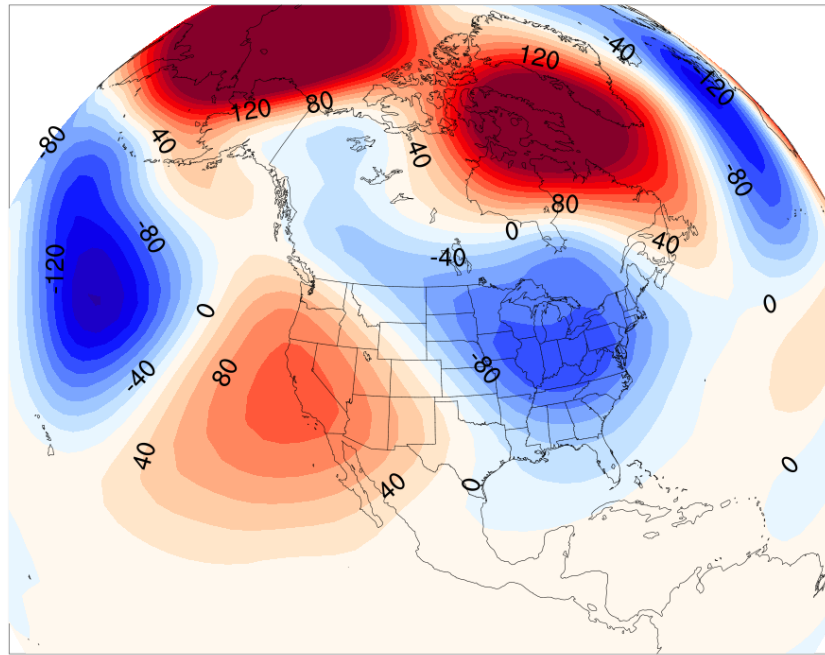
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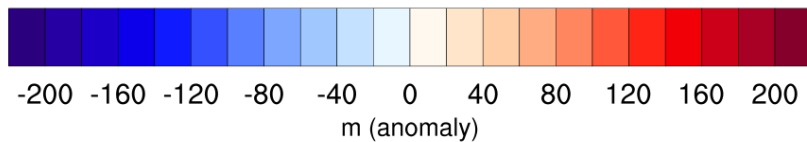


Observed 500-hPa Height Patterns: Precipitation Onset

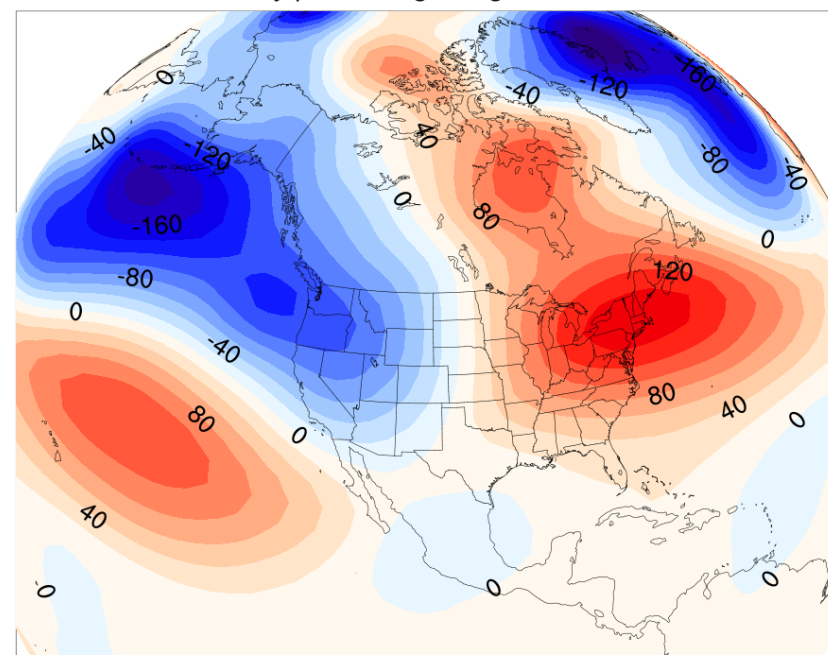
**Observed:
Week beginning December 20, 2022:**



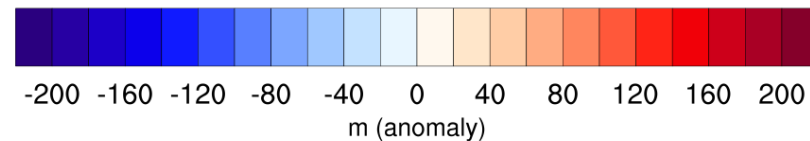
Climate Normal: 1991-2020



**Observed:
Week beginning December 27, 2022:**



Climate Normal: 1991-2020



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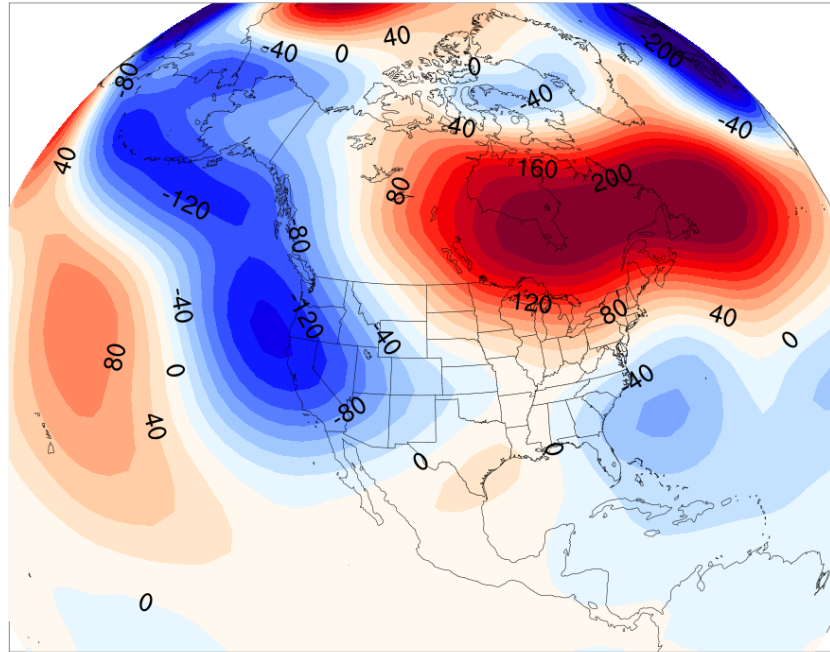
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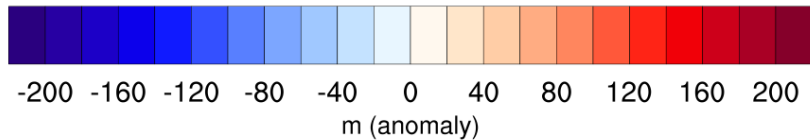


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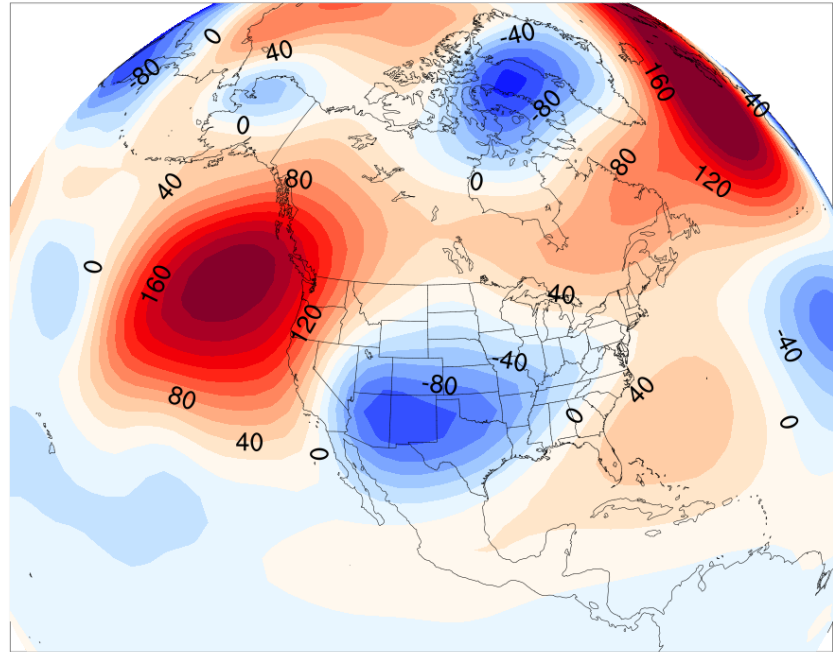
**Observed:
Week beginning January 13, 2023:**



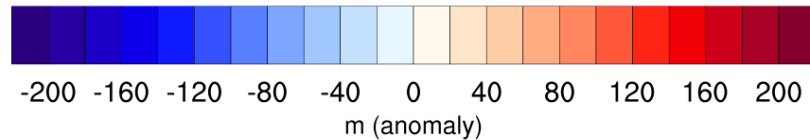
Climate Normal: 1991-2020



**Observed:
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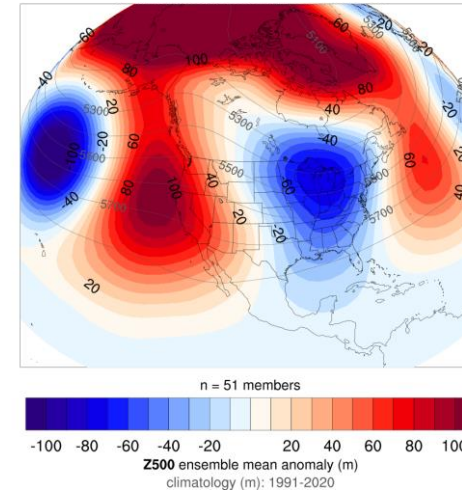
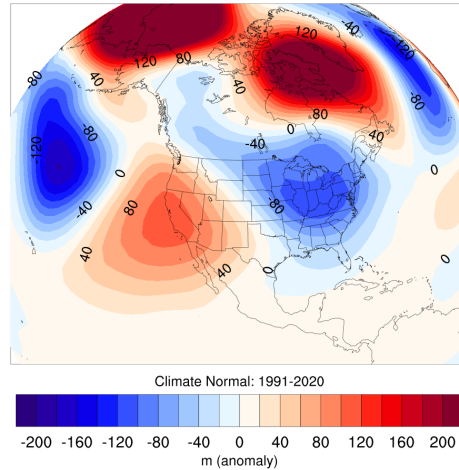


Climate Normal: 1991-2020



Observed vs Modeled: 500-hPa Height Patterns: Precipitation Onset

**Observed:
Week beginning
December 20, 2022**



**ECMWF Week 2 Forecast
Issued 12/13:
Week beginning
December 20, 2022**



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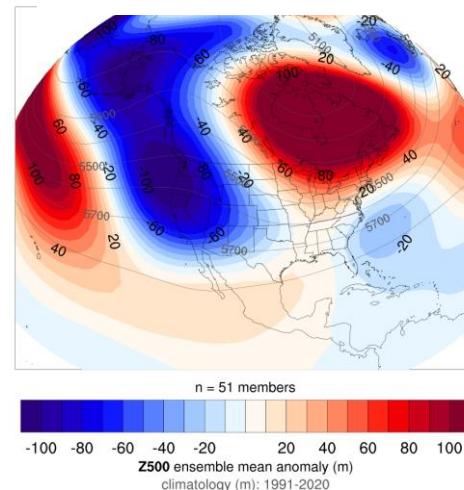
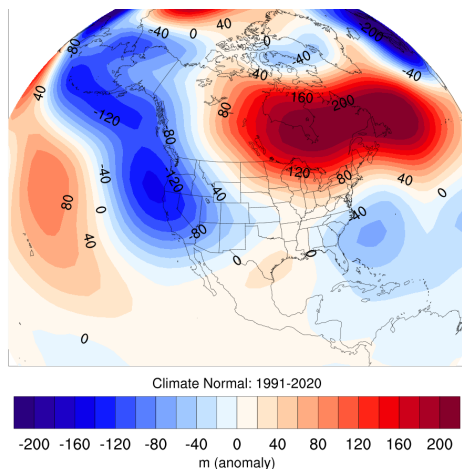
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