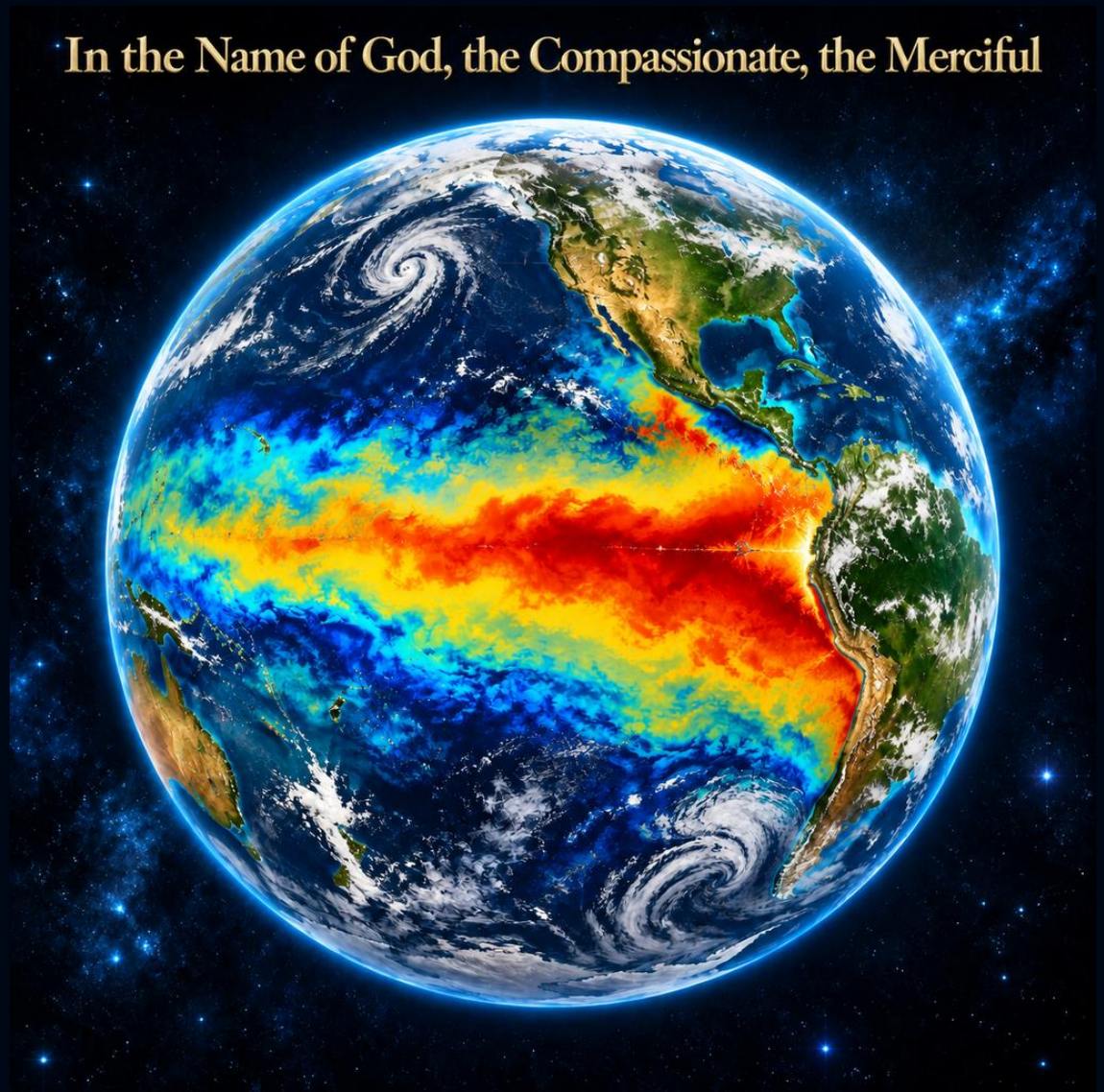
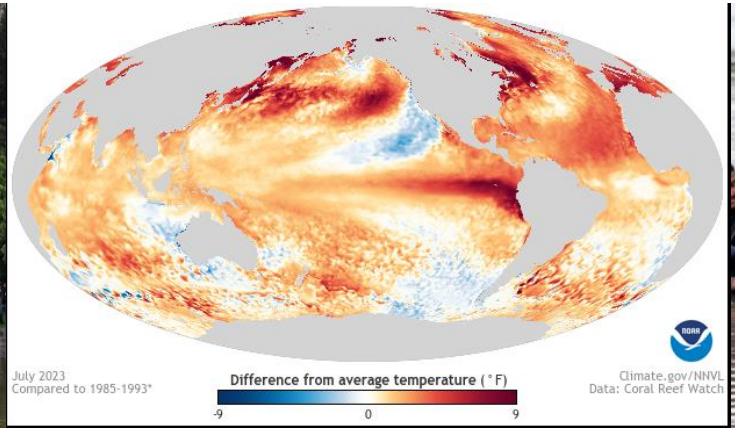
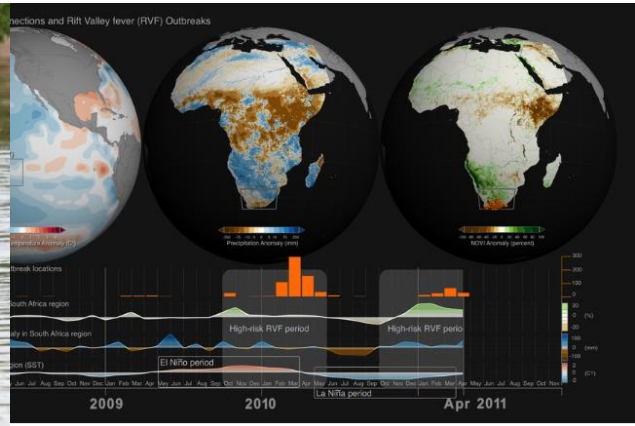
بسم الله الرحمن الرحيم



Teleconnections and their impacts on water resources forecasting





سازمان هواشناسی کشور

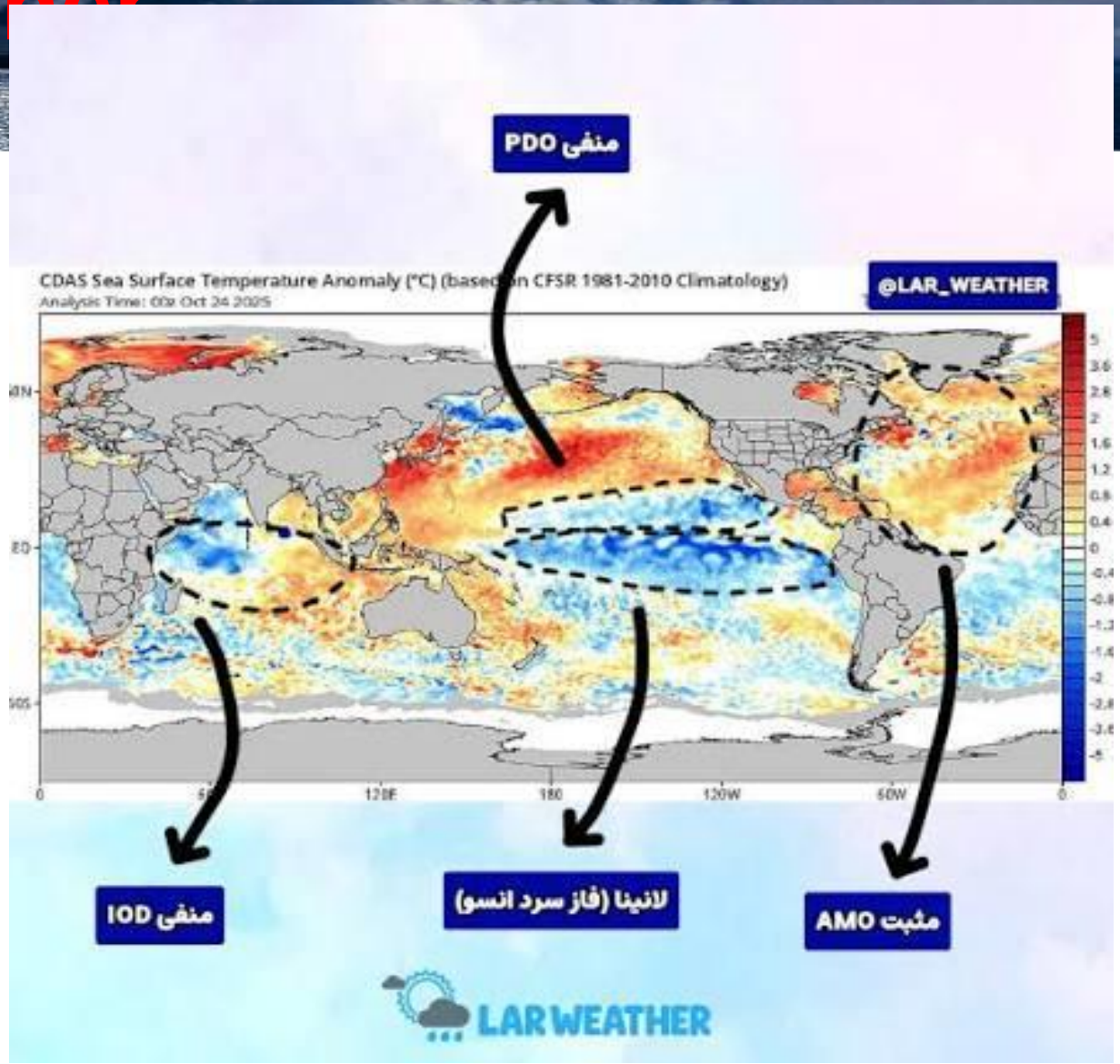
تیر ماه ۱۴۰۵

Teleconnections and their combined effect on weather

- There are many teleconnections phenomena can be effected Iran weather such as ENSO, NAO, MJO, IOD, and MONSOON.

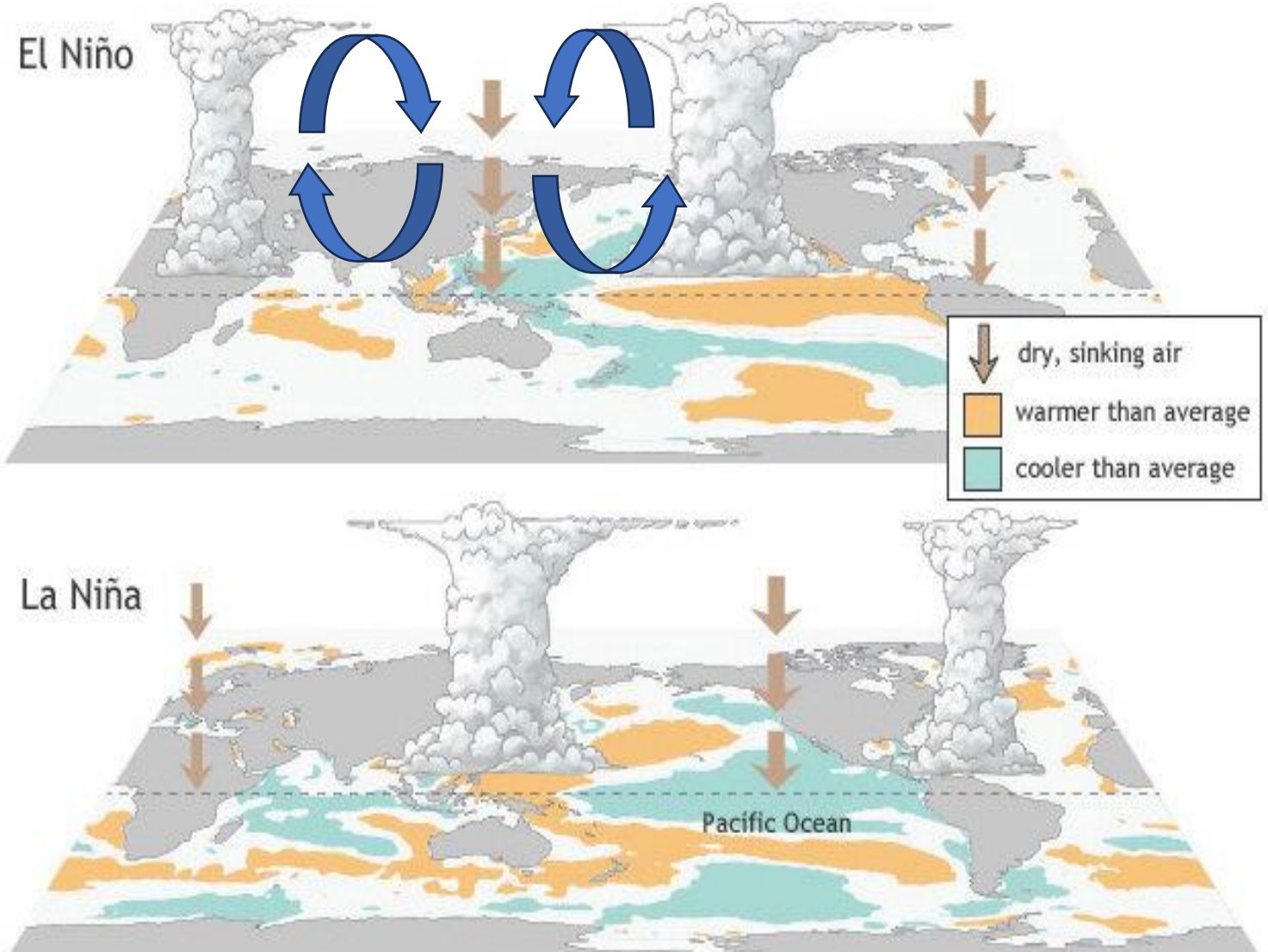
- Decadal, seasonal, annual, monthly, and sometimes weekly weather forecasting is involved with the effect of teleconnections, and their forecasting should be better understood and examined; how will teleconnections behave given expected climate changes?

- Teleconnection phenomena benefit from the long life and durability of the oceans, and how will teleconnection phenomena—with regard to the (MONSOON) and (PNA), etc., in the Northern Ocean or other regions—behave?

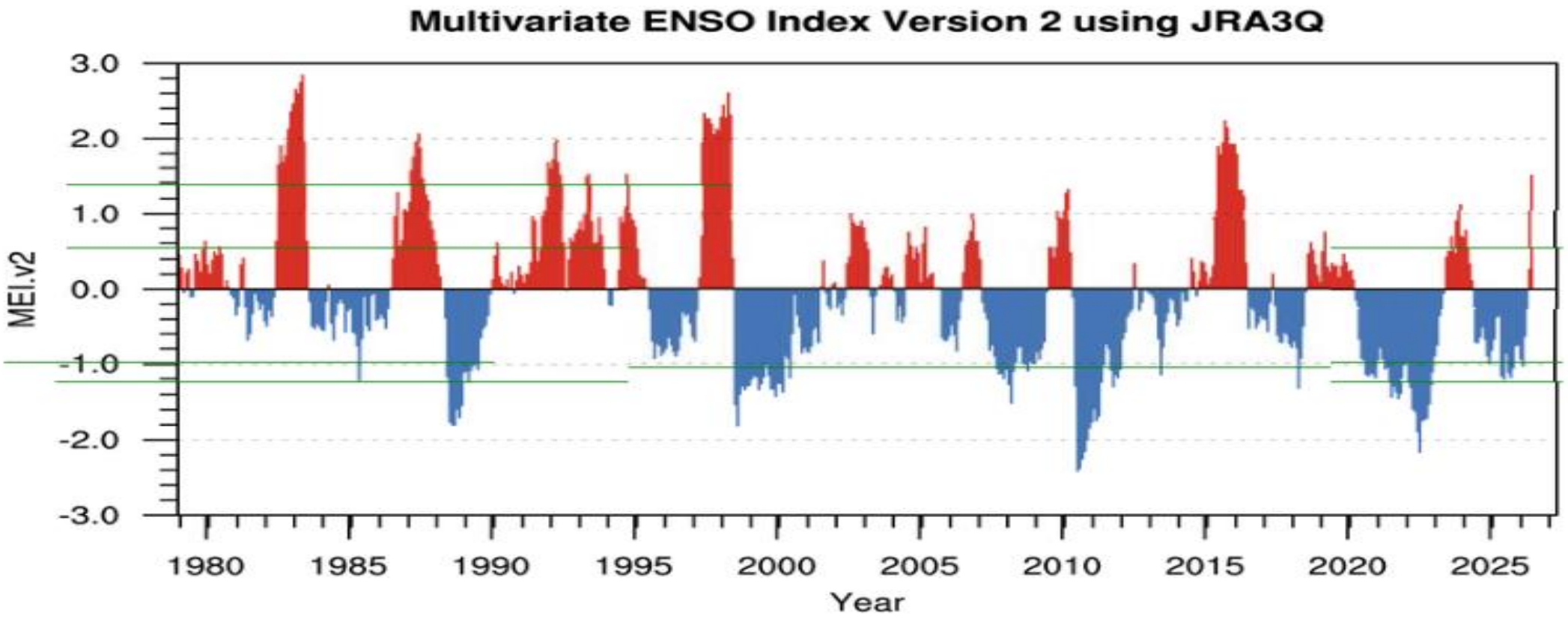


El Niño and La Niña(ENSO)

El Niño/La Niña is a recurring cycle of climate changes that repeats every few years. This phenomenon forms a complete cycle on average every few years, and the phases of this cycle appear as warm and cold in the Pacific Ocean. These changes cause various pressures on weather patterns and are accompanied by various thermal conditions. Processes in the west and east of the Pacific Ocean are accompanied by differences and form the warm or cold phases of the climate structure. For a more complete explanation, please refer to the relevant scientific sources on El Niño and La Niña.

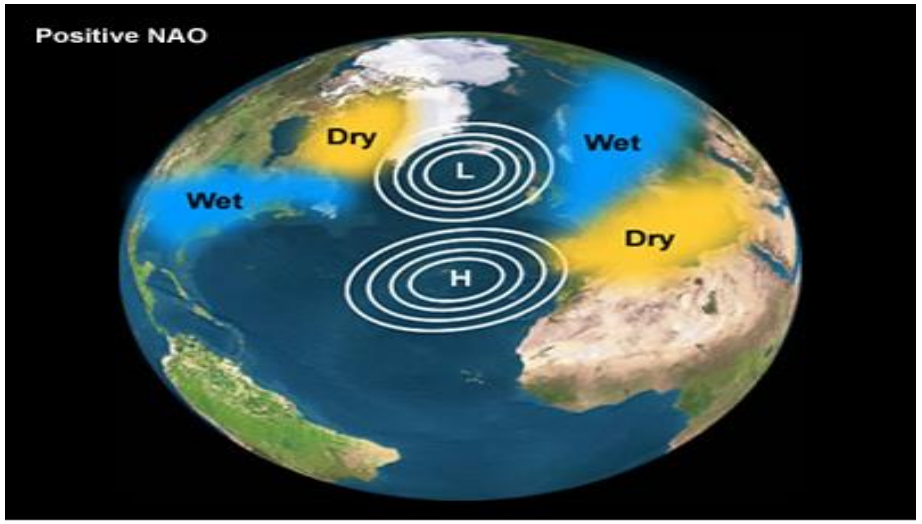


ENSO oscillation Index from 1980 to 2025

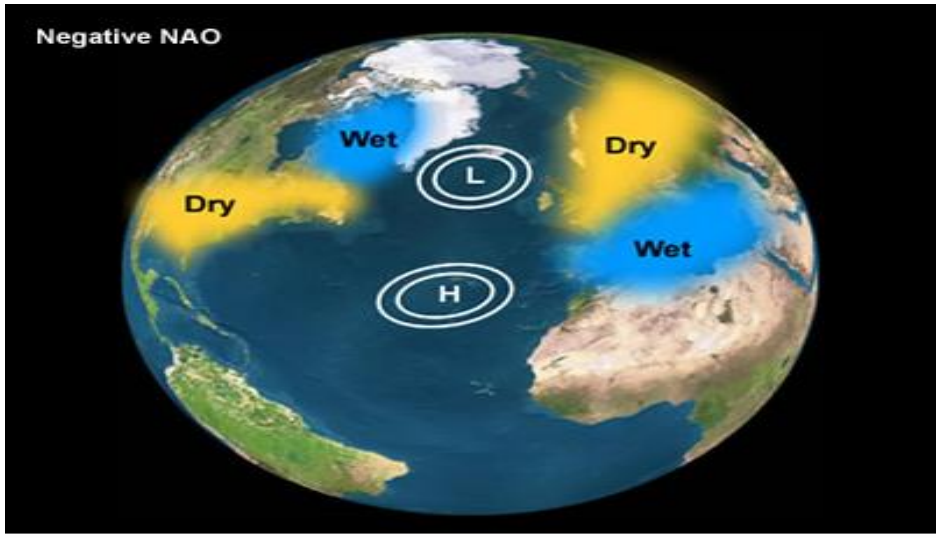


Three very strong El Niño events and two very strong La Niña events occurred between 1980 and 2025.

North Atlantic Oscillation (NAO)



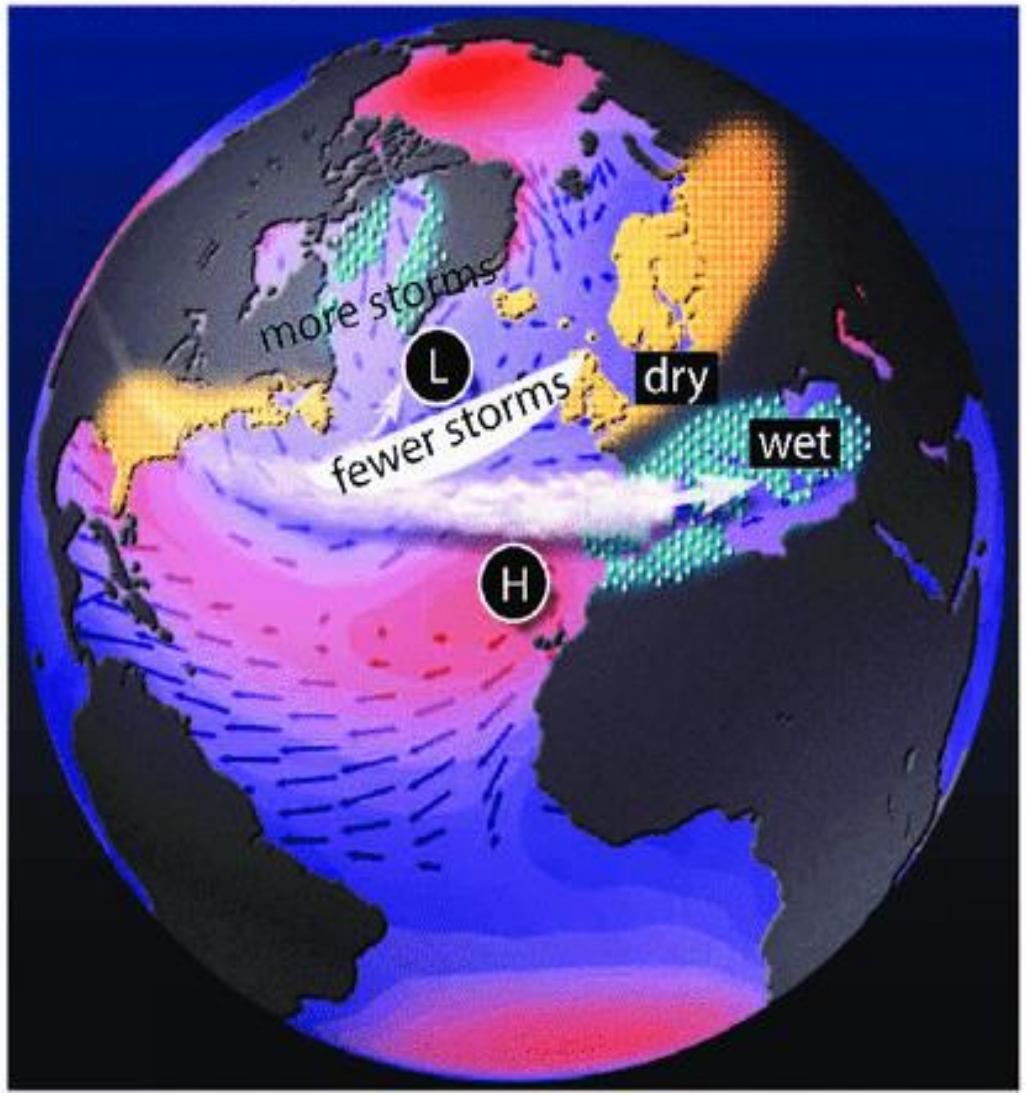
During a positive NAO, a large pressure gradient across the North Atlantic creates strong westerly winds that drive winter storms across the Atlantic and into Northern Europe



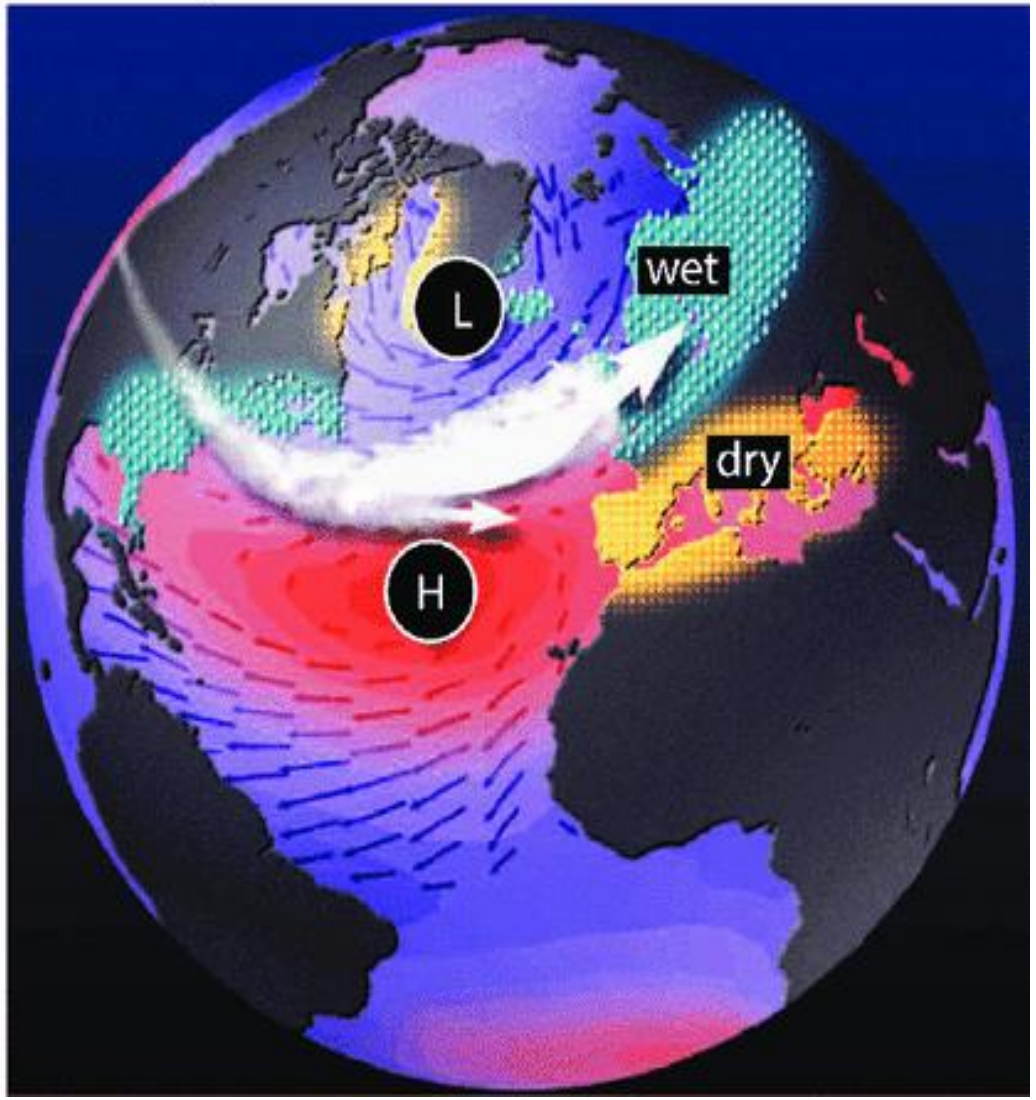
During a negative NAO, only a weak pressure gradient exists and Southern Europe and Africa receive weak winter storms while Northern Europe and the Eastern United States are cold

- A characteristic feature of this oscillation is the pressure difference between the Icelandic Low and the Azores High. When these two pressure patterns intensify, the westerly winds over the North Atlantic tend to shift toward higher latitudes, causing Northern Europe to be more frequently exposed to the tracks of precipitation-bearing weather systems. Under these conditions, the polar jet stream becomes split into two branches. This situation is known as the positive phase of the North Atlantic Oscillation (NAO).
- A weakening of these two pressure patterns causes the tracks of weather systems to shift toward southern Europe and the western Mediterranean, a situation known as the negative phase of the NAO.
- The NAO can persist for months in any of its positive, neutral, or negative phases. However, during each phase, Rossby waves with a periodicity of approximately one week and varying intensity are generated.
- The influence of this teleconnection pattern on Iran is particularly pronounced during the rainy season, namely from autumn through winter and into mid-spring.

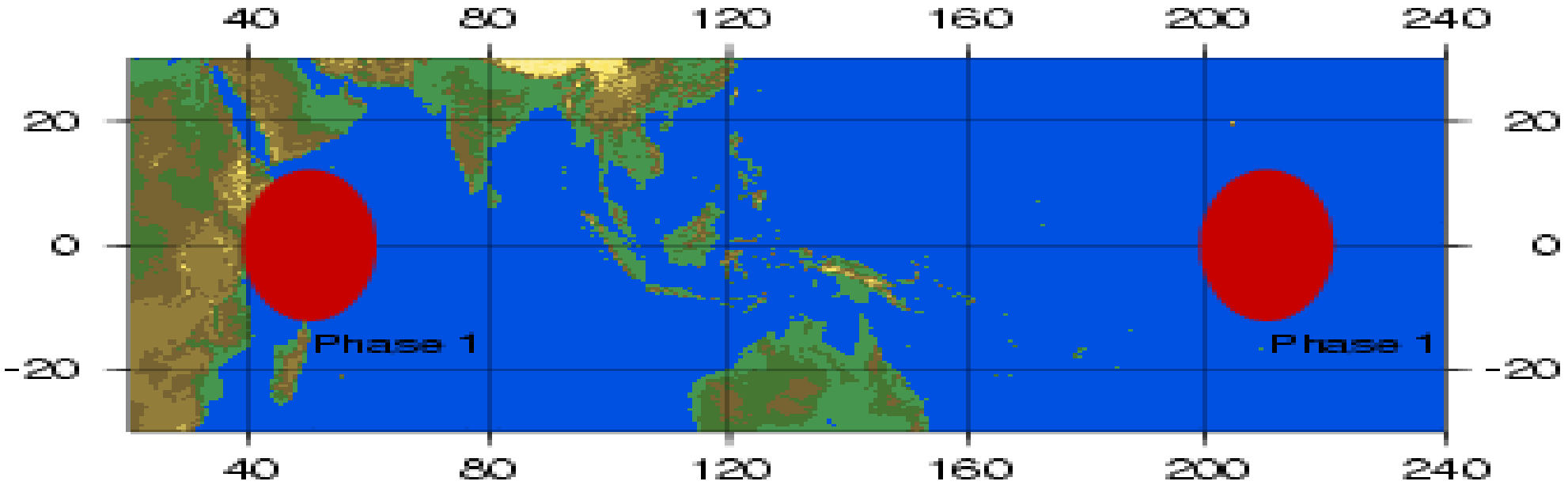
a) NAO negative-mode



b) NAO positive-mode

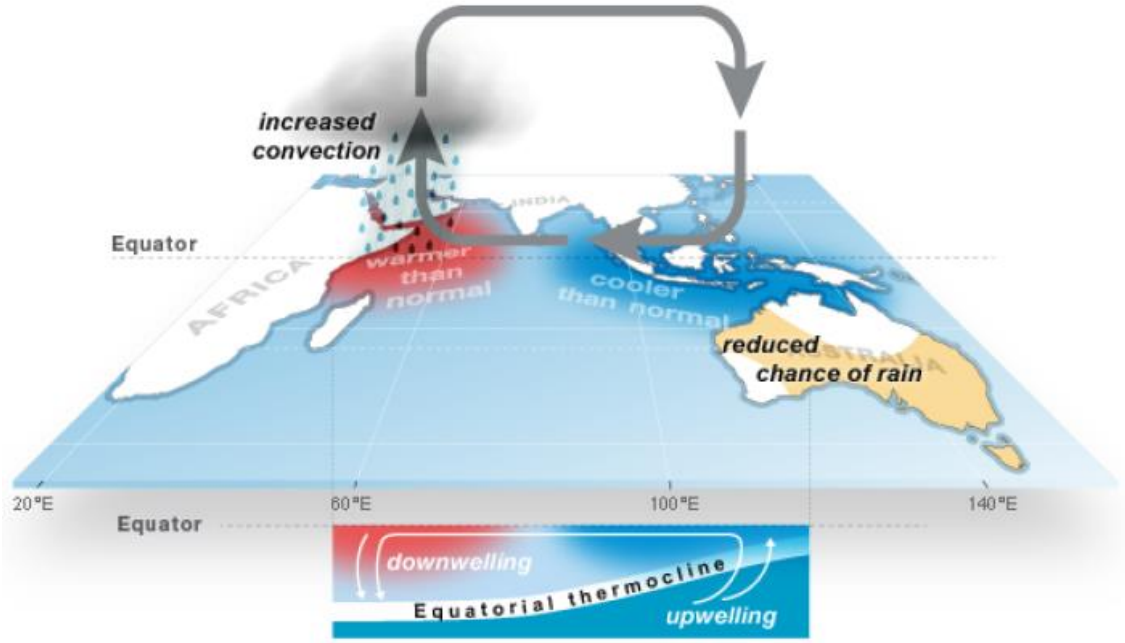


(Madden – Julian Oscillation)



1. A large-scale atmospheric oscillation over the tropical Indian and Pacific Oceans
2. Onset of the oscillation: the western Indian Ocean and East Africa
3. Propagation speed: eastward at approximately 5 m/s over the Indian Ocean
4. Weakening over the central Pacific Ocean, followed by an increase in propagation speed to approximately 8 m/s
5. Period: 30 to 60 days (average of 45 days)
6. Eight phases in each complete oscillation

Indian Ocean Dipole (IOD)



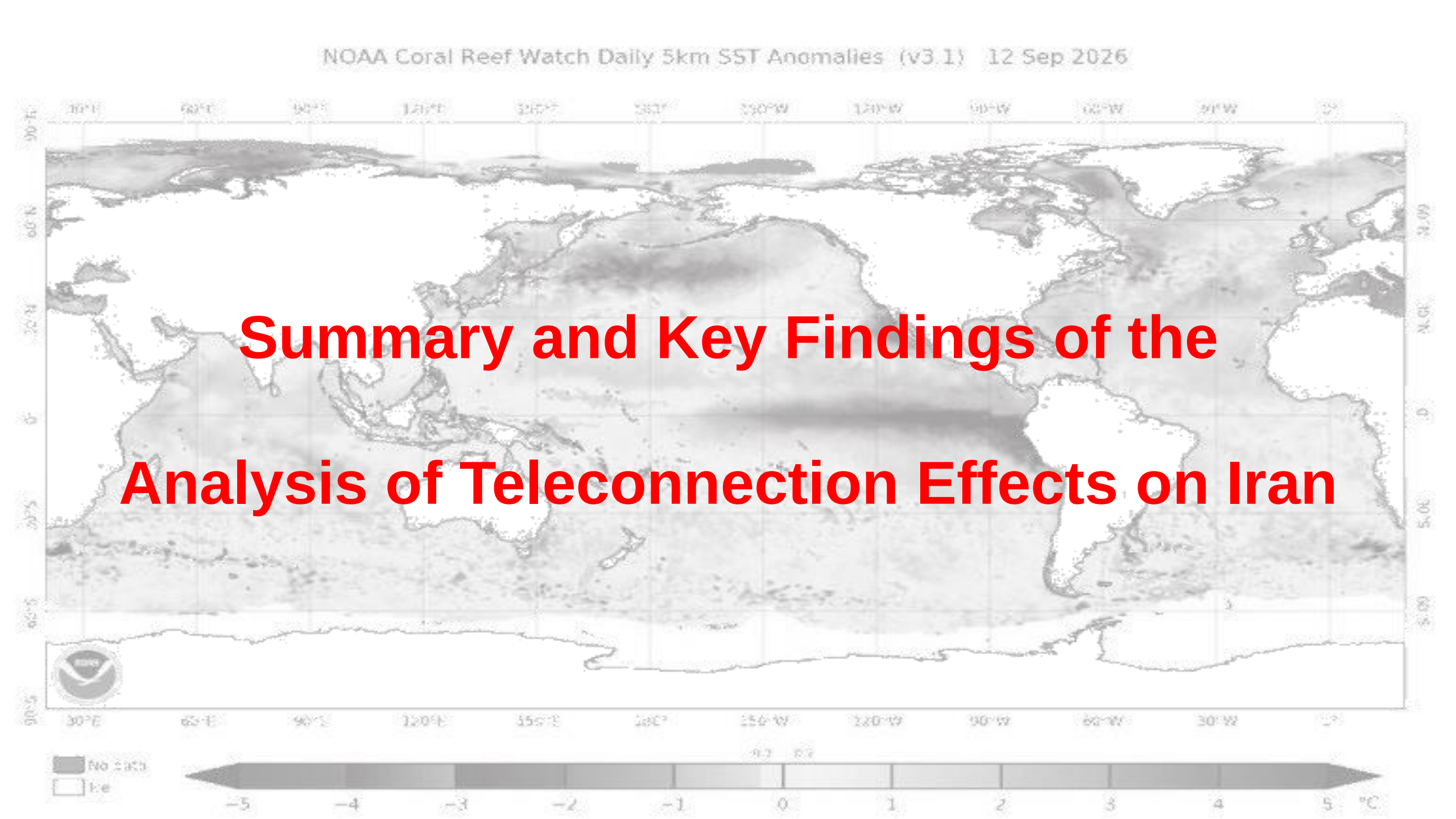
Indian Ocean Dipole (IOD): **Positive phase**

General atmospheric and oceanic circulation over the Indian Ocean during the positive phase of the IOD

During the positive phase of the Indian Ocean Dipole (IOD), the eastern Indian Ocean and Oceania are cooler than the western part of the basin. This temperature contrast strengthens subsiding air motion over the east and enhances rising motion over the western Indian Ocean, particularly along the east coast of Africa. An increasing frequency of positive IOD events has been observed over the past 50 years, which is attributed to the warming of the western tropical Indian Ocean.

Stronger easterly trade winds and enhanced upwelling along the western coast of Australia, together with downwelling in the western Indian Ocean, are associated with this phase.

- During the negative phase of the IOD, the conditions are reversed.



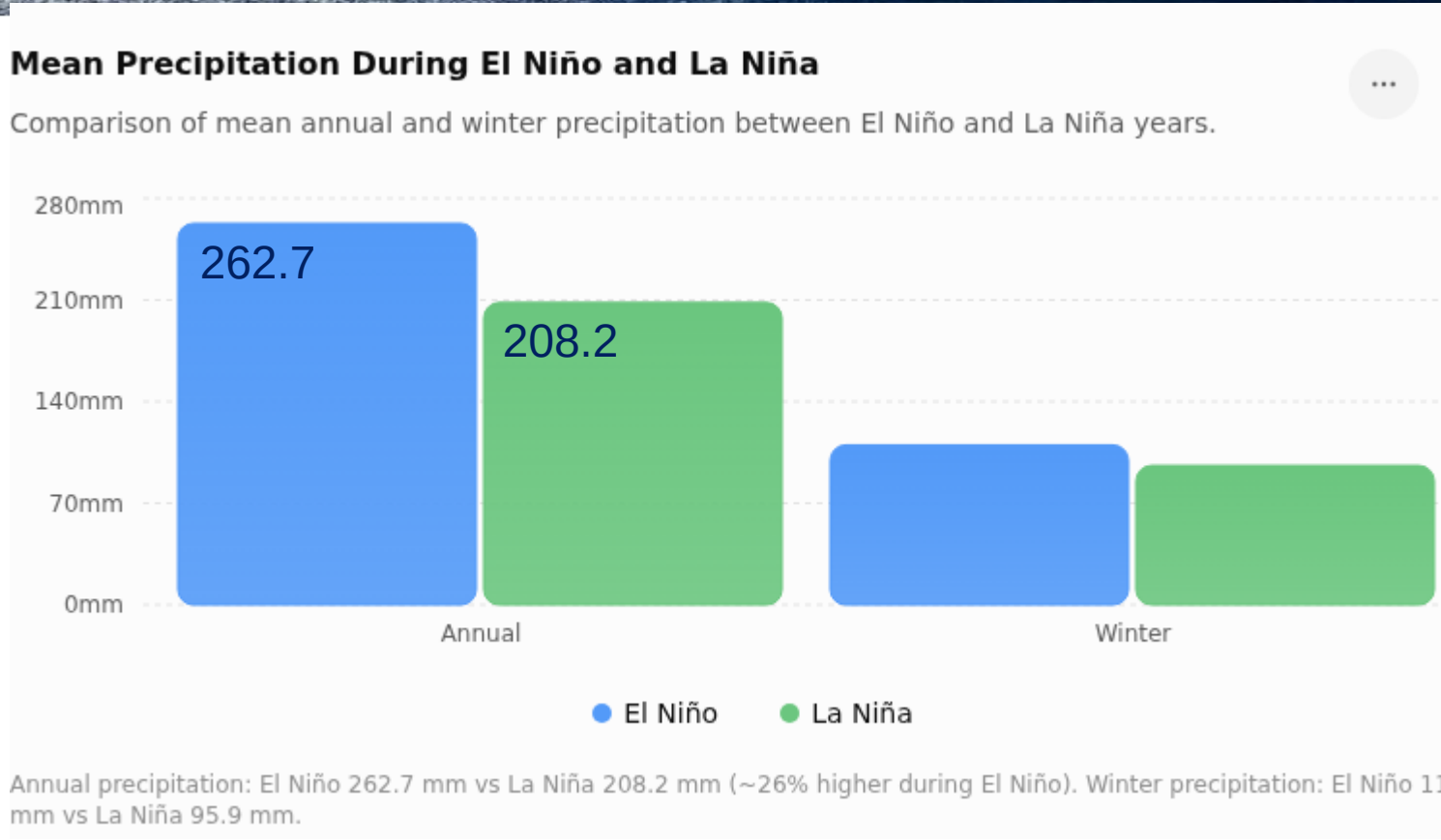
Summary and Key Findings of the Analysis of Teleconnection Effects on Iran

Analysis of the Effects of the ENSO Teleconnection Based on Precipitation and ENSO Data for the Period 1951–2025

- ENSO–Annual Precipitation Relationship: The ENSO Index (ONI) shows a positive and statistically significant correlation with annual precipitation ($r = 0.344$, $p \< 0.01$). During El Niño years, the mean annual precipitation was 262.7 mm, compared with 208.2 mm during La Niña years, indicating approximately 26% higher precipitation in El Niño years.

Seasonal-Scale Relationships:

- Autumn: This season exhibits the strongest response to the indices. Autumn precipitation has a correlation of $r = 0.491$ ($p \< 0.001$) with ONI and $r = 0.419$ with DMI.
- Spring: A significant positive correlation with ONI was observed ($r = 0.358$).
- Winter: Although mean precipitation is higher during El Niño years (110.1 mm versus 95.9 mm during La Niña years), the direct linear correlation is weaker ($r = 0.118$).
- Summer: A weak inverse relationship was found with the AO and NAO indices ($r \\approx -0.23$).



Role of Other Indices

The DMI (Indian Ocean Dipole) index shows a strong correlation with precipitation during the autumn season. The AO (Arctic Oscillation) and NAO (North Atlantic Oscillation) indices show weak correlations with precipitation at monthly and annual timescales; however, a positive influence has been observed during autumn.

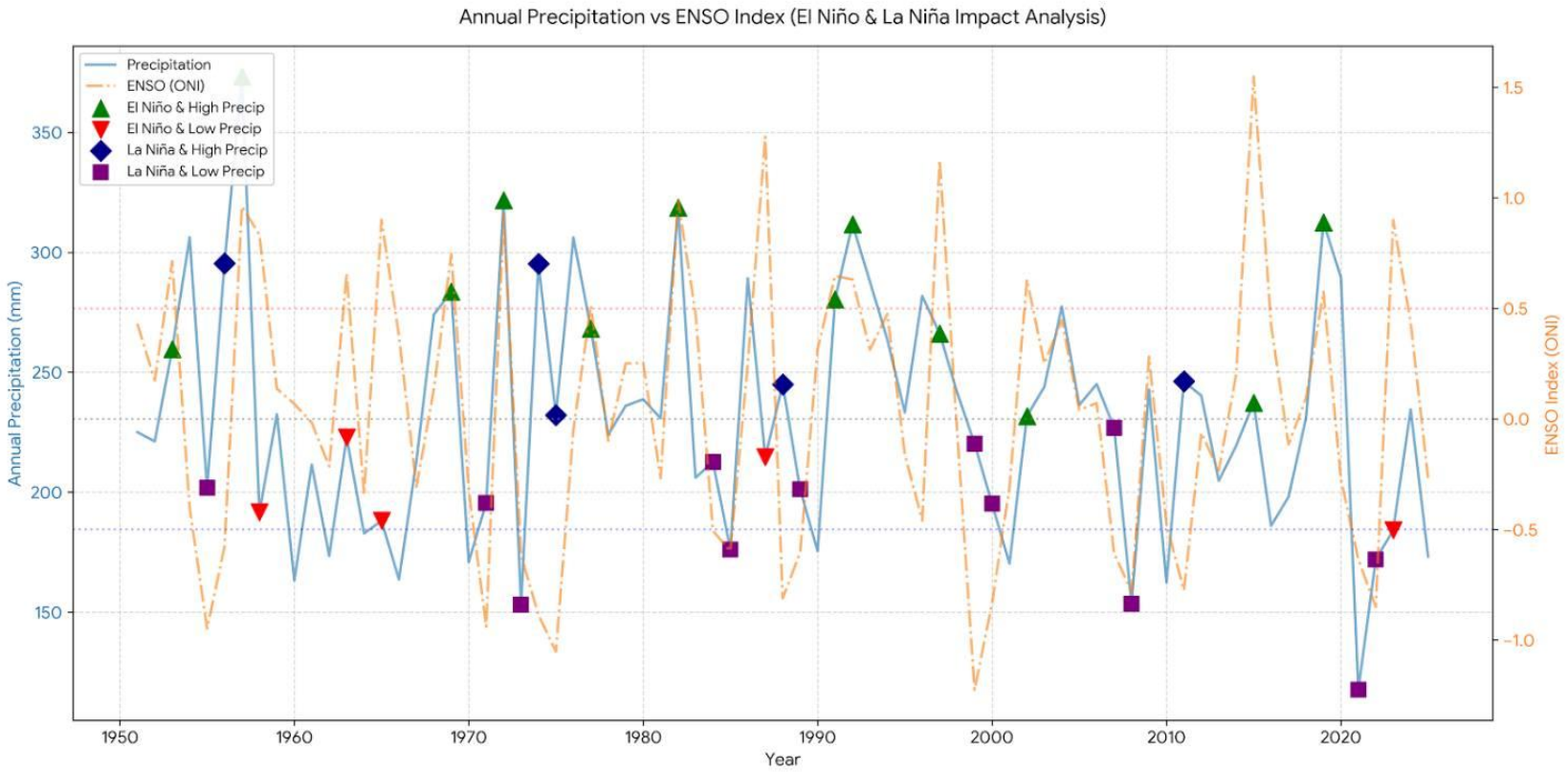
Table of Precipitation Statistical Indices for ENSO Phases Based on Precipitation and ENSO Data for the Period 1951–2025

Annual Precipitation

Maximum Precipitation (mm)	Minimum Precipitation (mm)	Median (mm)	Standard deviation (std)	Average precipitation (mm)	Number of Years	ENSO Phase
373.24	184.11	266.11	54.10	262.70	17	El Niño
306.24	162.31	230.83	41.19	226.96	41	neutral
295.39	117.60	201.83	47.48	208.18	17	La Niña

Monthly Correlation (Heatmap Summary)

- At the monthly scale, October (Mehr–Aban) and November (Aban–Azar) show the highest sensitivity to the ENSO and DMI indices:
- October (Month 10): The correlation between precipitation and ONI is $r = 0.569$, while the correlation with DMI is $r = 0.439$.
- November (Month 11): The correlation between precipitation and ONI is $r = 0.334$, while the correlation with NAO is $r = 0.407$.
- May (Month 5): The correlation between precipitation and ONI is $r = 0.360$.



- Blue line (left vertical axis): Total annual precipitation (in millimeters).

- Orange dashed line (right vertical axis): Variations in the ENSO Index (ONI).

- ▲ Green triangles: Represent years in which El Niño occurred and precipitation was high (above normal).

- ▼ Red triangles: Represent years in which El Niño occurred but precipitation was low (below normal).

- ◆ Navy diamonds: Represent La Niña years with high precipitation.

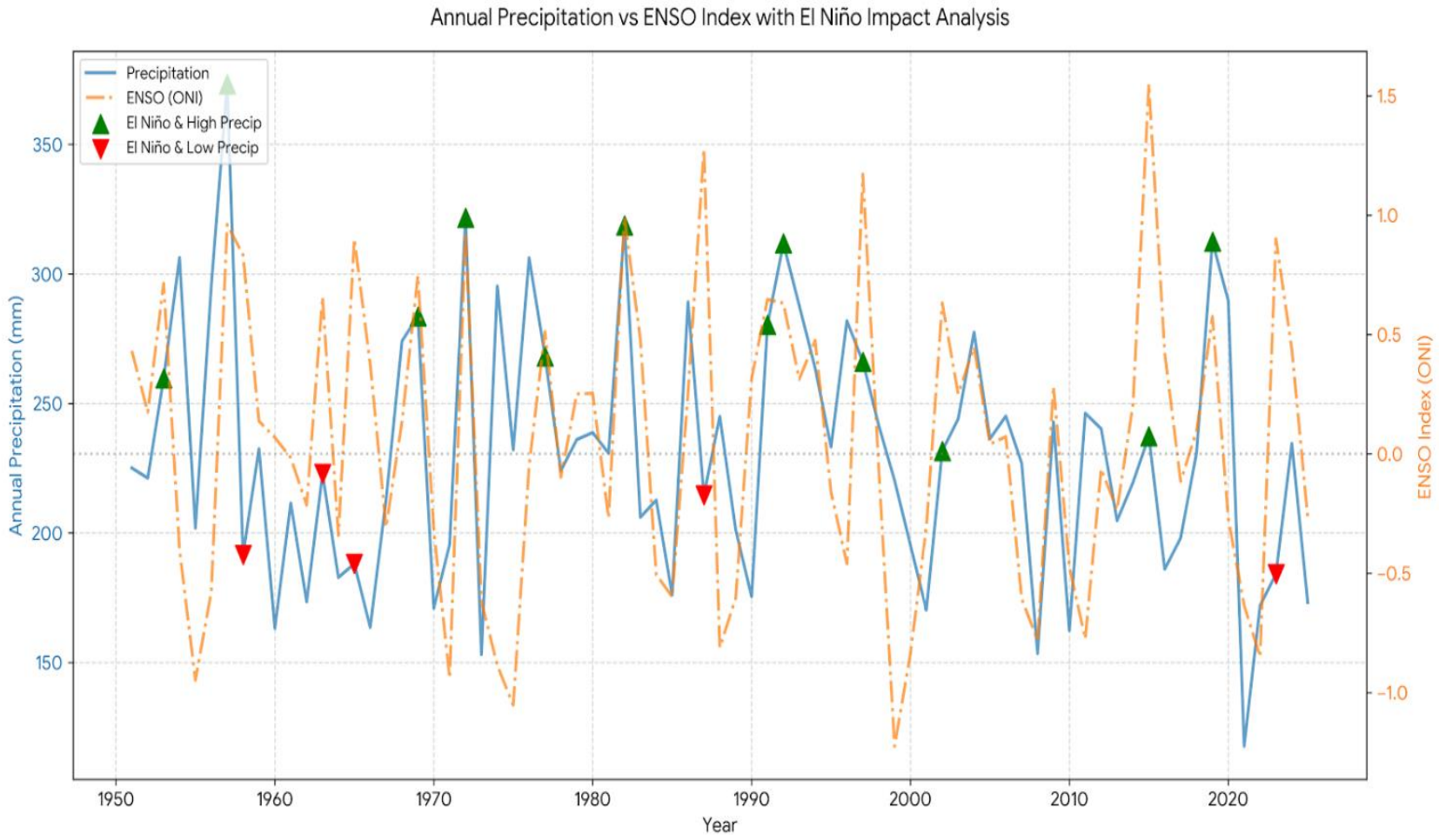
- ■ Purple squares: Represent La Niña years with low precipitation.

- La Niña Years with High Precipitation (Navy Diamonds): 5 years
- 1956, 1974, 1975, 1988, 2011

- In these years, despite the occurrence of La Niña, annual precipitation was above the long-term mean.

- La Niña Years with Low Precipitation (Purple Squares): 12 years
- 1955, 1971, 1973, 1984, 1985, 1989, 1999, 2000, 2007, 2008, 2021, 2022

- In most La Niña years, as expected based on the prevailing climatic conditions, annual precipitation was below normal and below the long-term mean.



- Blue line (left vertical axis): Total annual precipitation (in millimeters).

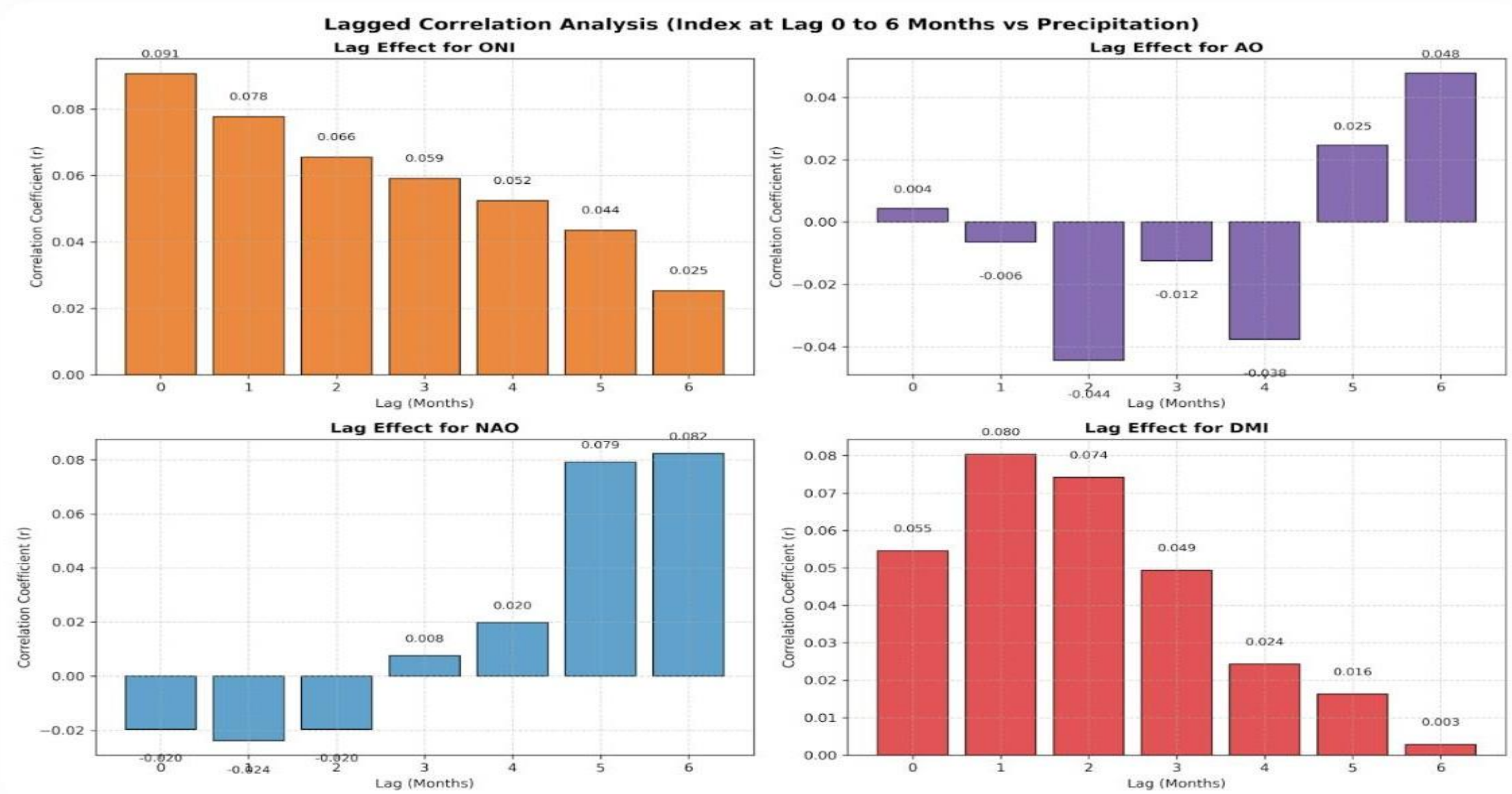
- Orange dashed line (right vertical axis): Variations in the ENSO Index (ONI).

- ▲ Green triangles: Represent years in which El Niño occurred and precipitation was high (above normal).

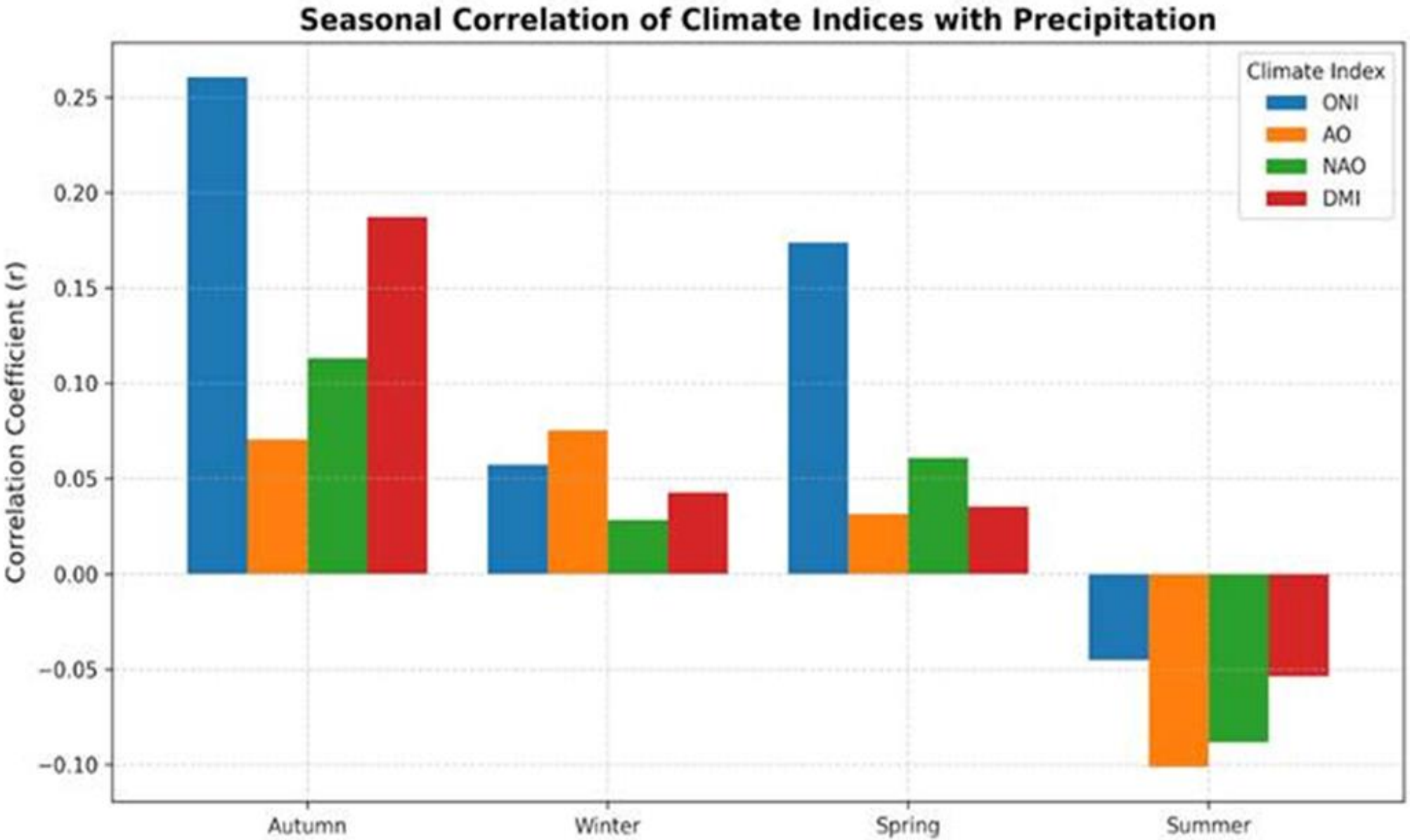
- ▼ Red triangles: Represent years in which El Niño occurred but precipitation was low (below normal).

- El Niño Years with High Precipitation (Green Triangles): 12 years
- 1953, 1957, 1969, 1972, 1977, 1982, 1991, 1992, 1997, 2002, 2015, 2019
- In these years, El Niño exerted its typical influence on increasing precipitation, particularly in 1957, which recorded the highest amount of precipitation.
- El Niño Years with Low Precipitation (Red Triangles): 5 years
- 1958, 1963, 1965, 1987, 2023
- These years exhibited behavior contrary to expectations. For example, in 2023, despite the occurrence of a strong El Niño event, precipitation decreased.

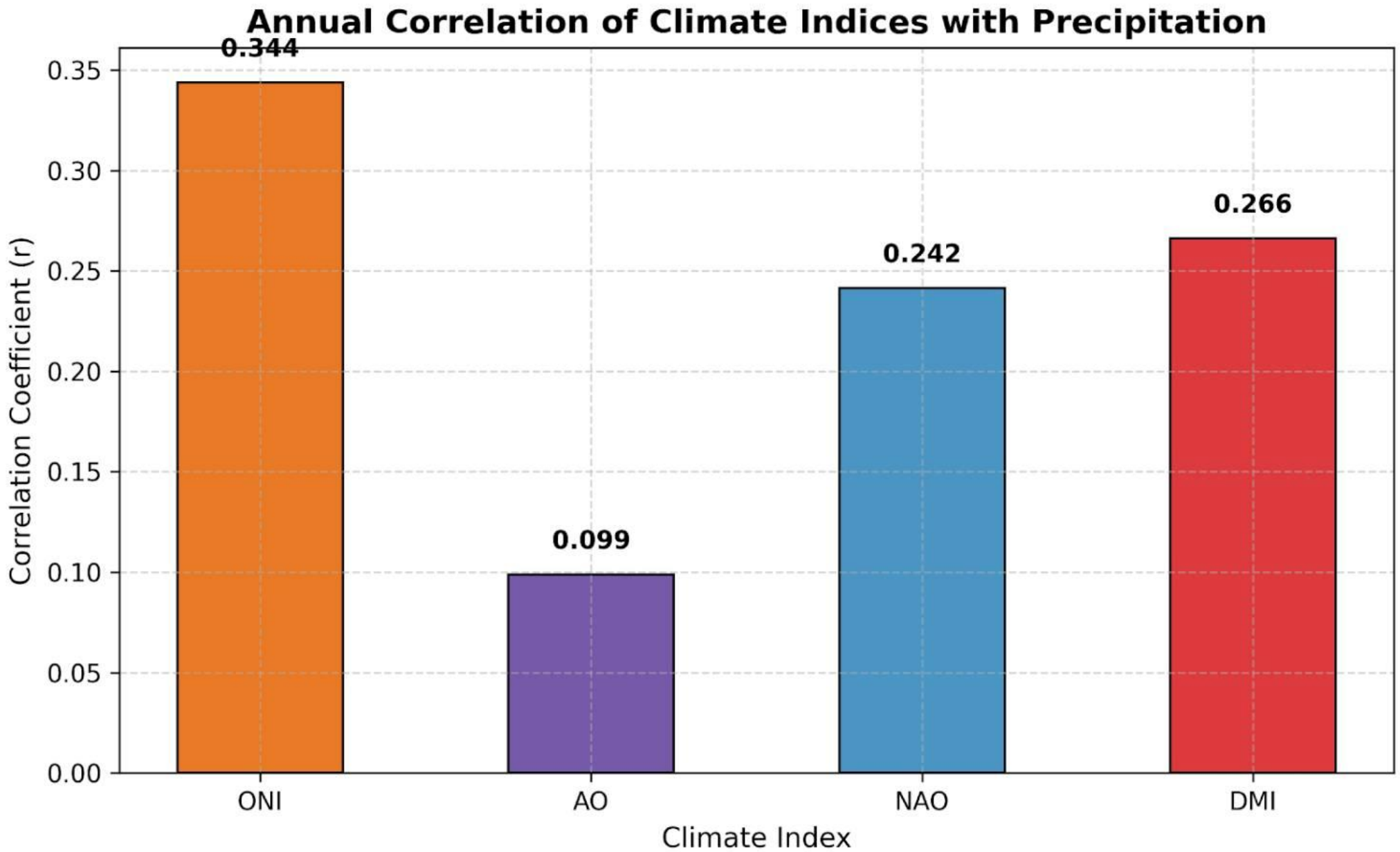
Analysis of the Lag Effect of Teleconnection Indices (ONI, AO, NAO, and DMI) on Precipitation at Time Lags of 0 to 6 Months

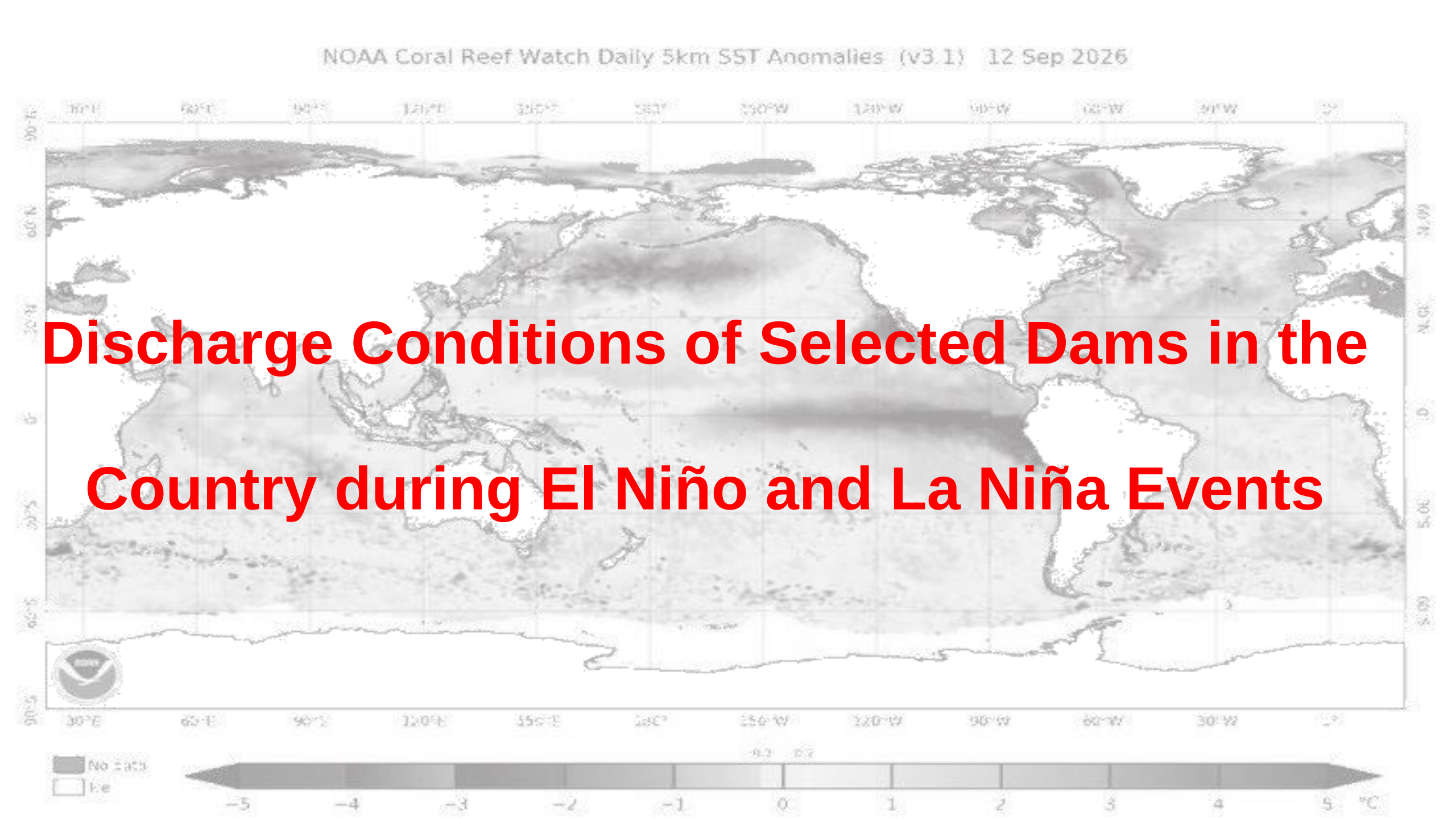


Seasonal Variations in the Correlation Coefficients (r) of Teleconnection Indices (ONI, AO, NAO, and DMI) with Precipitation during Autumn, Winter, Spring, and Summer



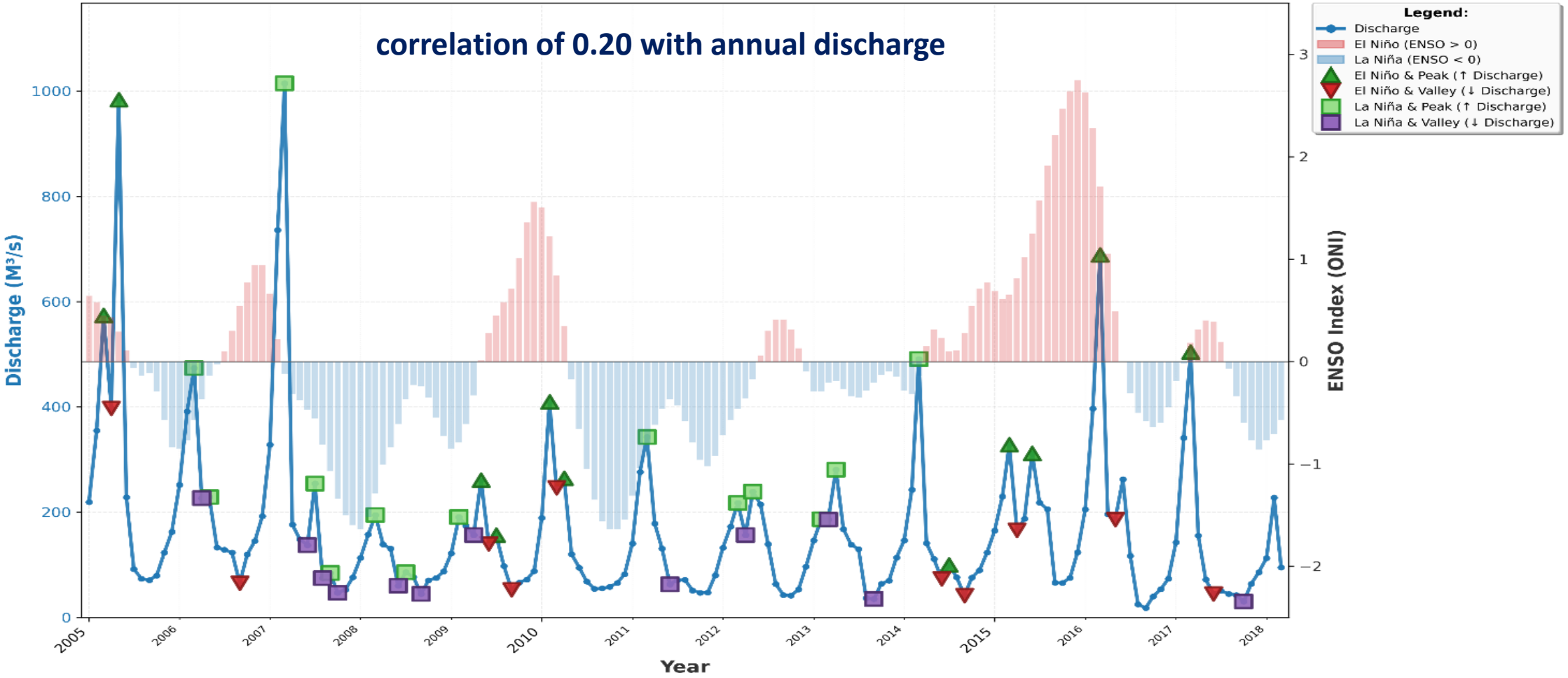
Annual Correlation Analysis of Teleconnection Indices (ONI, AO, NAO, and DMI) with Precipitation





Discharge Conditions of Selected Dams in the Country during El Niño and La Niña Events

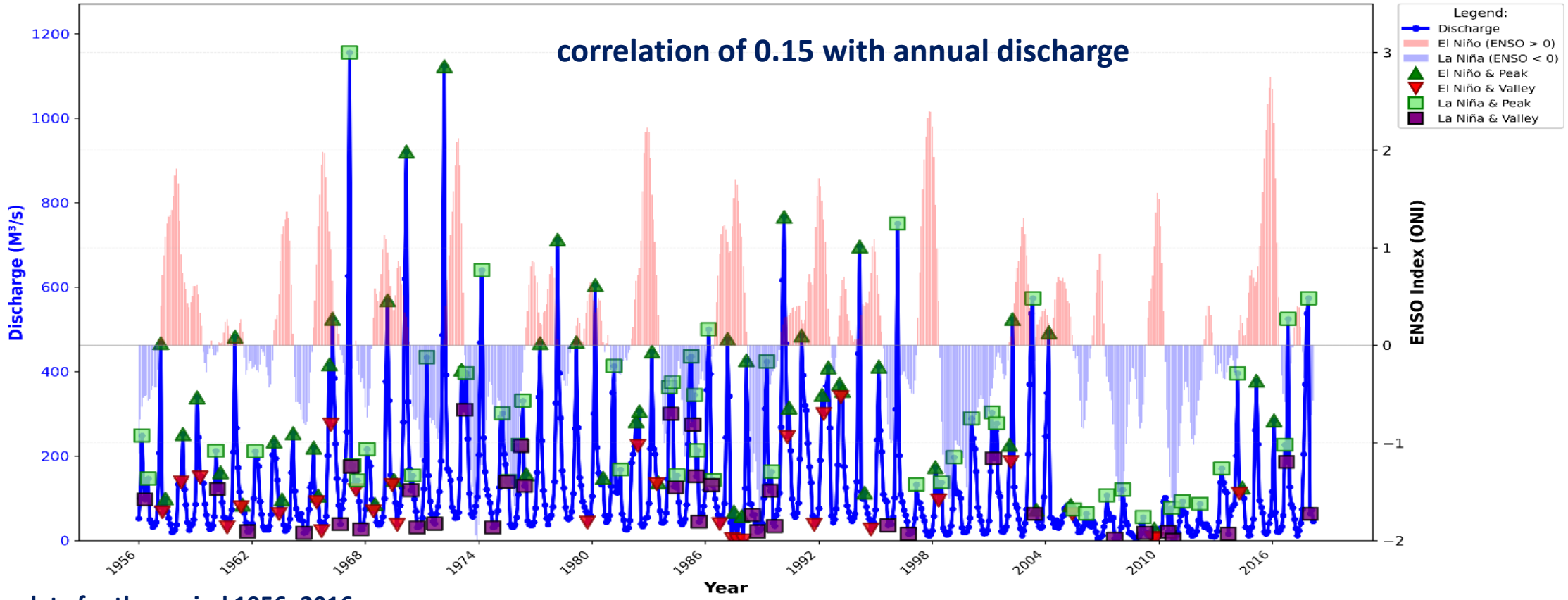
Inflow Discharge Conditions of Dez Dam in Khuzestan during El Niño and La Niña Events



Based on data for the period 2005–2018:

- **ENSO–Annual Discharge Relationship: The ENSO Index shows a correlation of 0.20 with annual discharge. During El Niño years, the mean annual discharge was 188.5 m³/s, whereas during La Niña years, it was 142 m³/s.**
- **Number of Events Based on the Chart: El Niño: 2 years; La Niña: 5 years; Neutral: 7 years.**

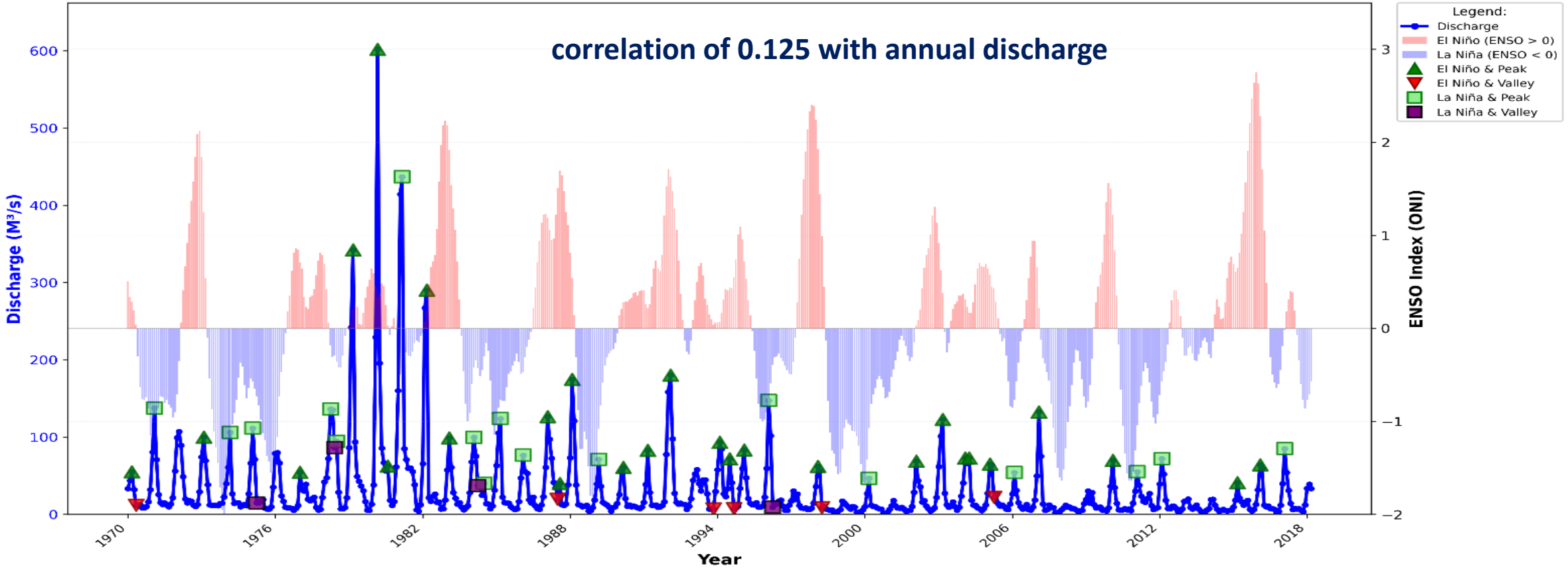
Inflow Discharge Conditions of the Karon 3 in Khuzestan during El Niño and La Niña Events



Based on data for the period 1956–2016:

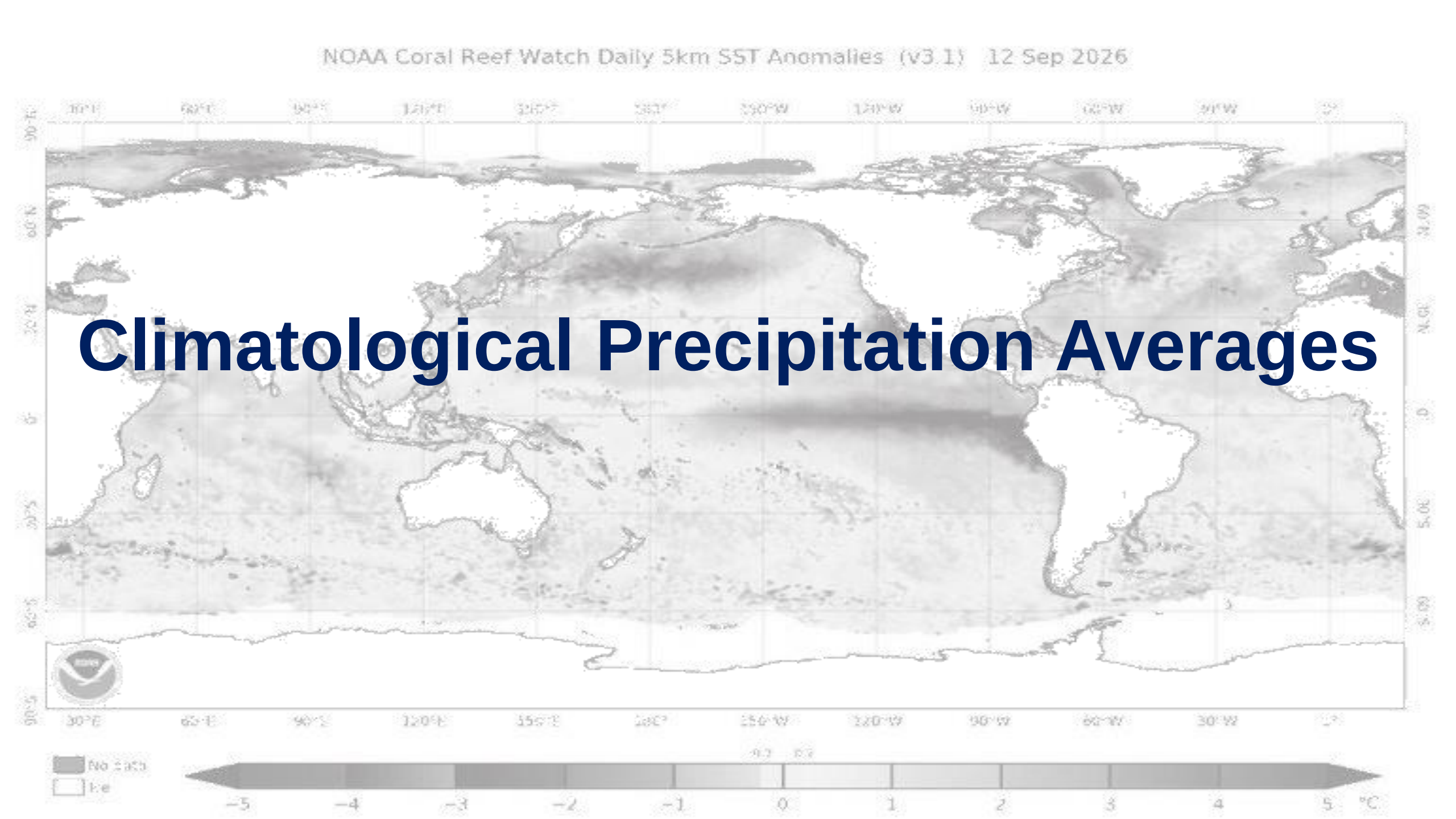
ENSO–Annual Discharge Relationship: The ENSO Index shows a correlation of 0.15 with annual discharge. During El Niño years, the mean annual discharge was 149 m³/s, whereas during La Niña years, it was 130 m³/s.

Inflow Discharge Conditions of Manjil Dam in the Sefidrud Basin during El Niño and La Niña Events



Based on data for the period 1970–2018:

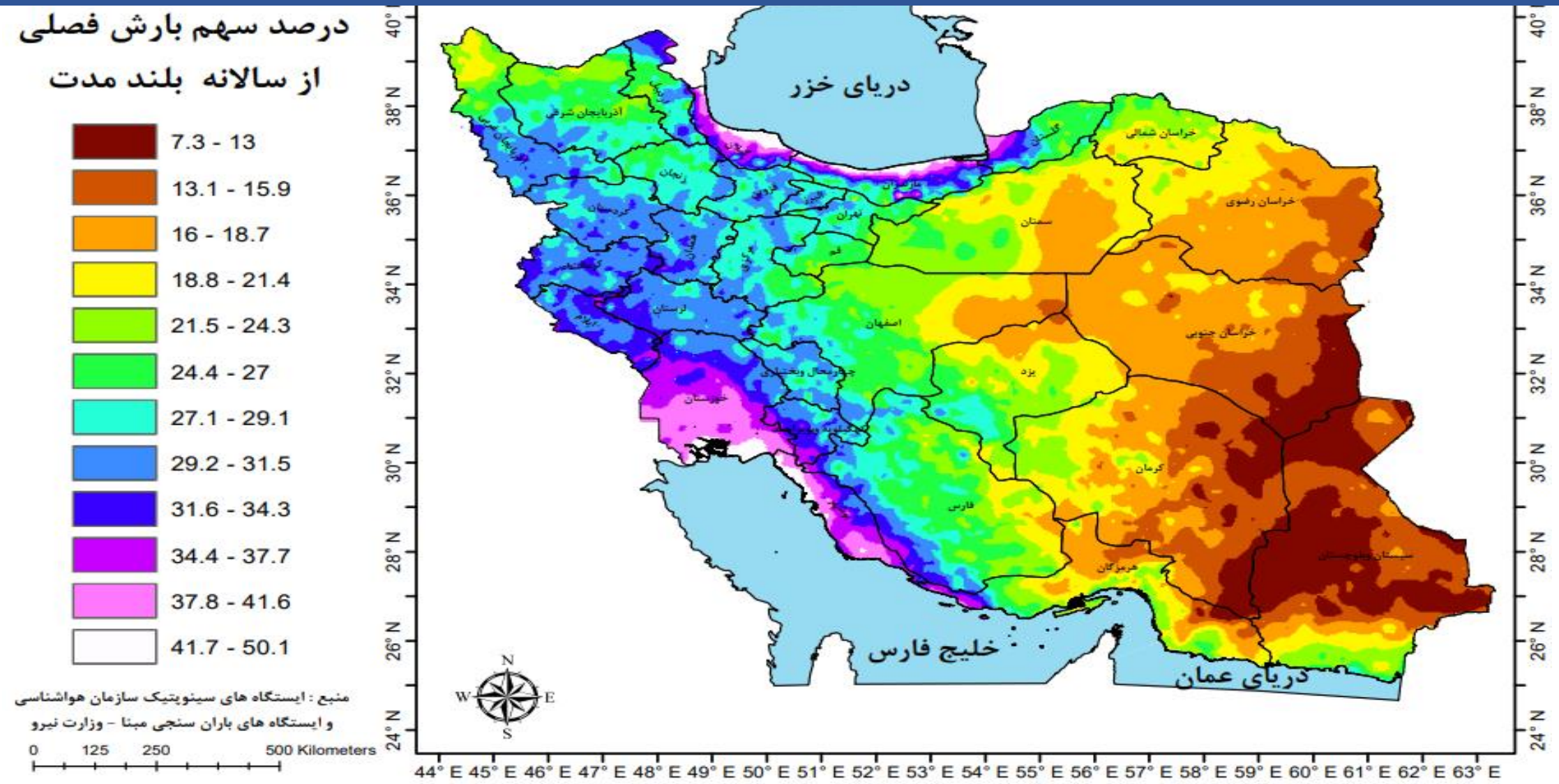
- **ENSO–Annual Discharge Relationship: The ENSO Index shows a correlation of 0.125 with annual discharge. During El Niño years, the mean annual discharge was 31.5 m³/s, whereas during La Niña years, it was 25.7 m³/s.**
- **Number of Events Based on the Chart: El Niño: 15 years; La Niña: 18 years; Neutral: 16 years.**



Climatological Precipitation Averages

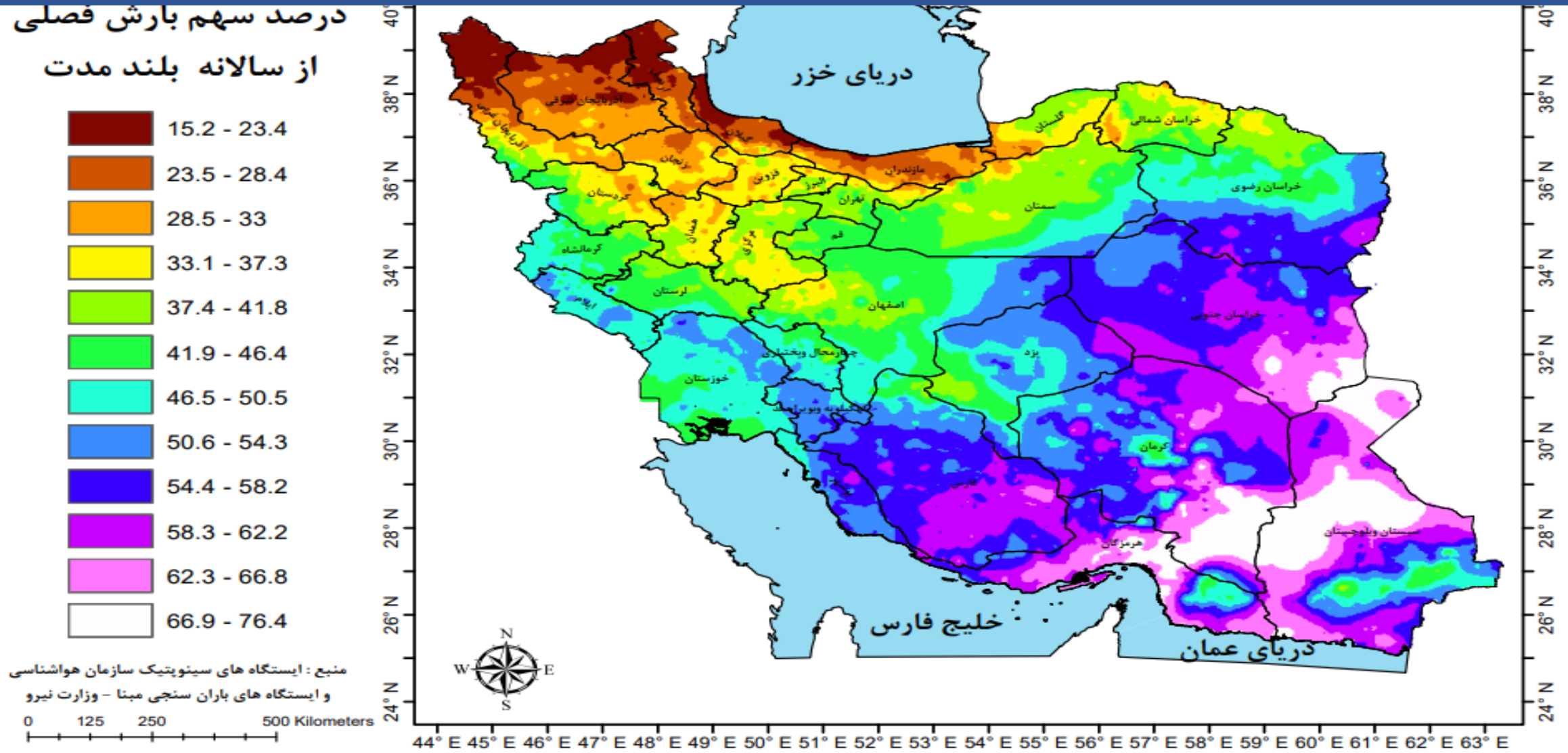
Long-term seasonal contribution of autumn precipitation to annual precipitation

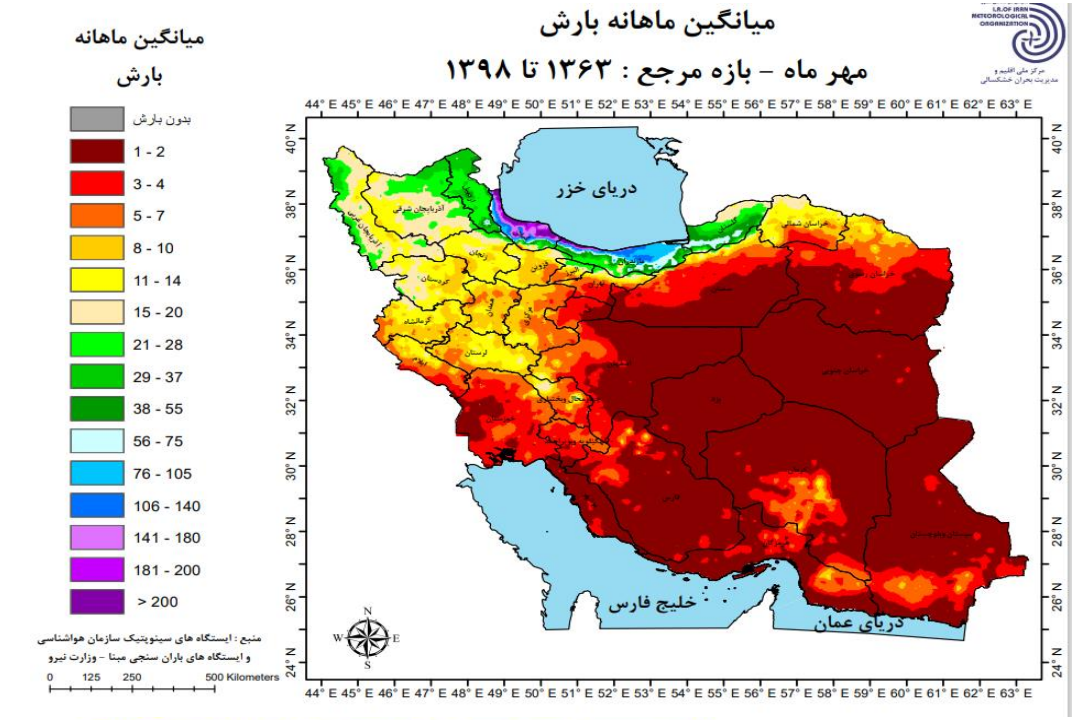
Autumn, 1984–2019

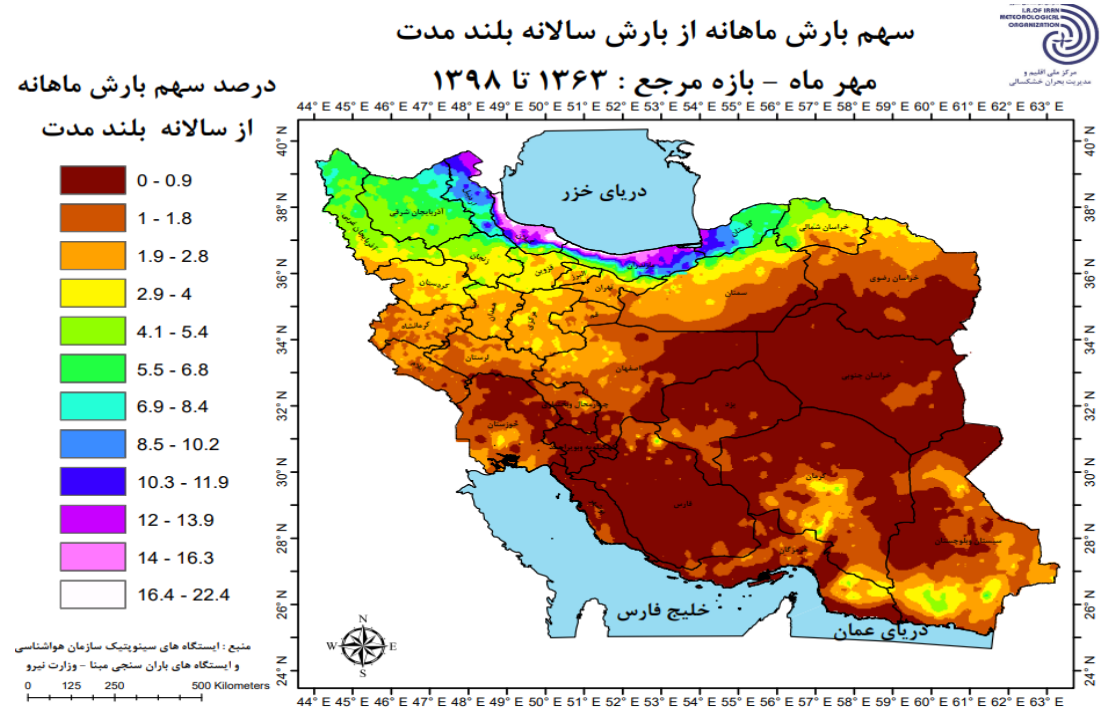


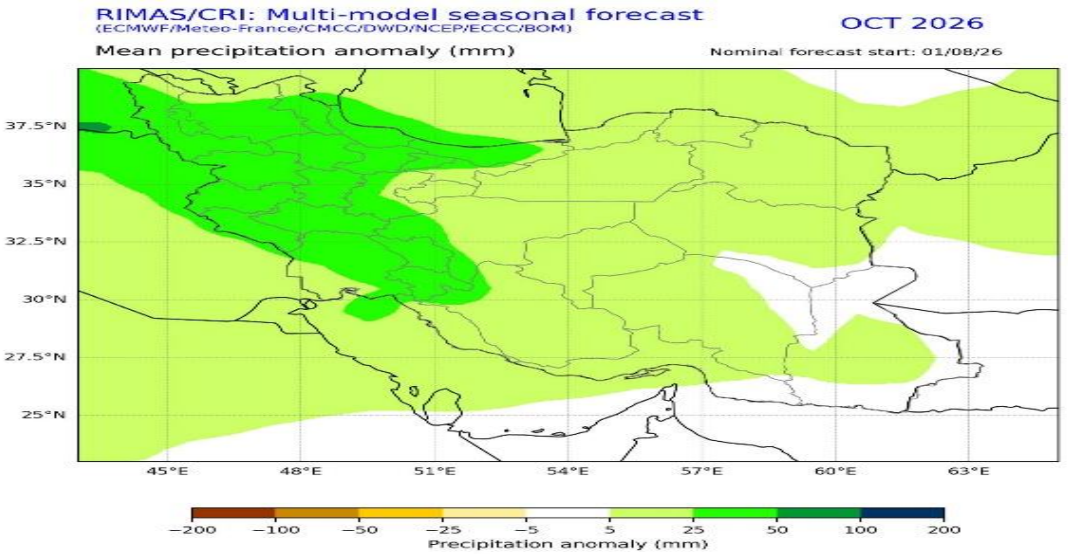
Long-term seasonal contribution of Winter precipitation to annual precipitation

Winter, 1984–2019



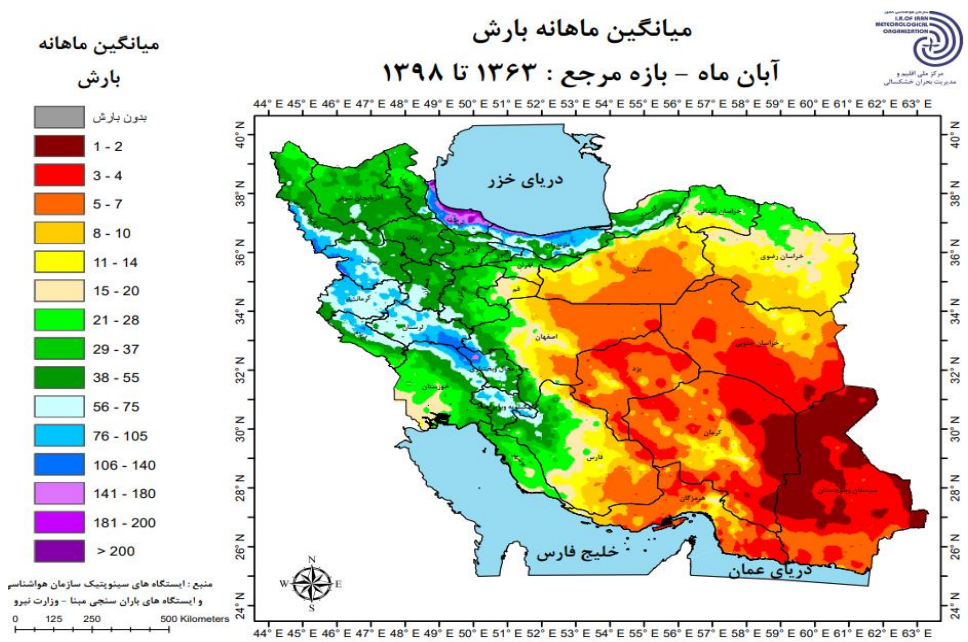


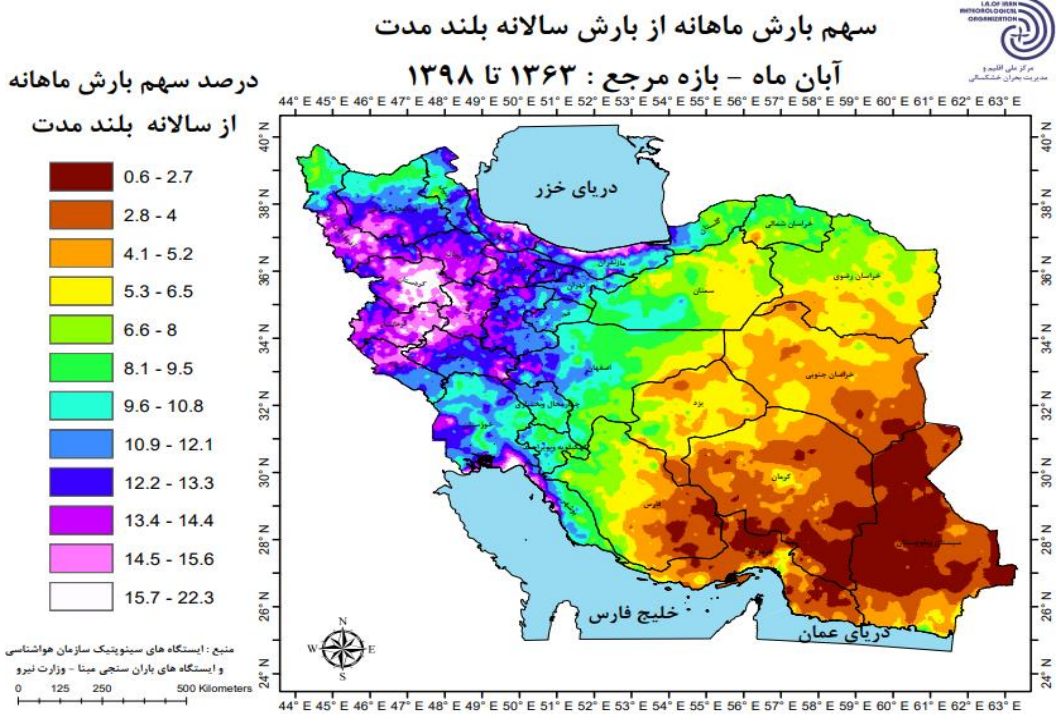


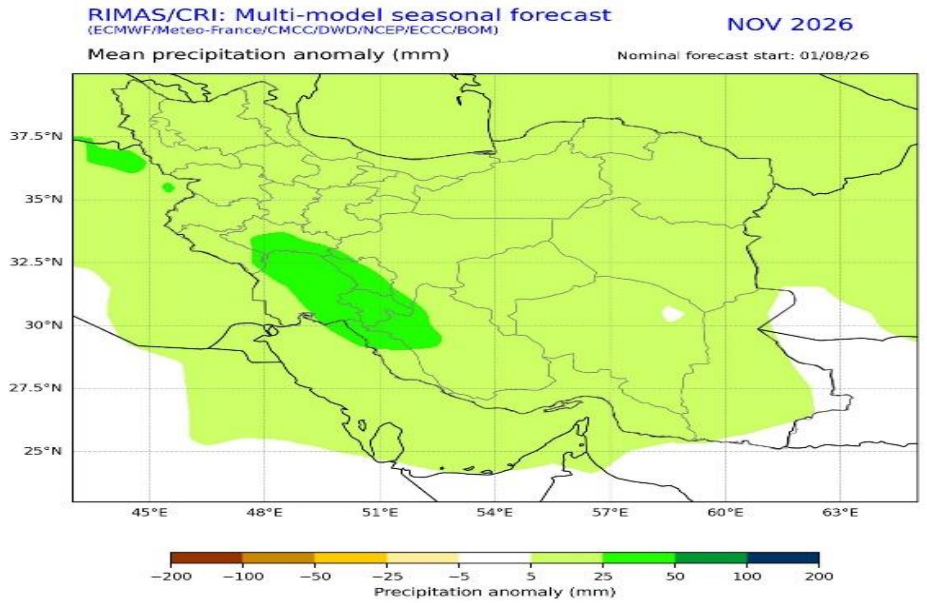


Precipitation Anomaly across the Country
October 2026

October: Average precipitation is forecast to be above normal across most parts of the country, except for some areas in the southeast. The increase in precipitation is particularly pronounced over the northern and central Zagros. Although relatively significant increases in precipitation are expected in some areas during this month, they will still remain within the range of normal climatic variability.

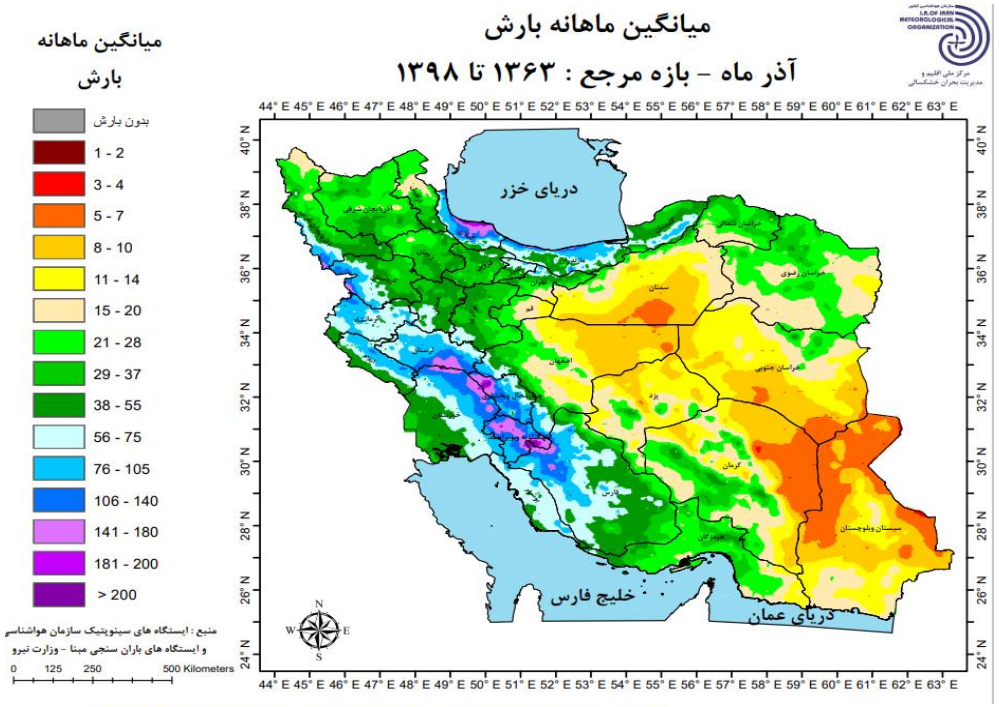


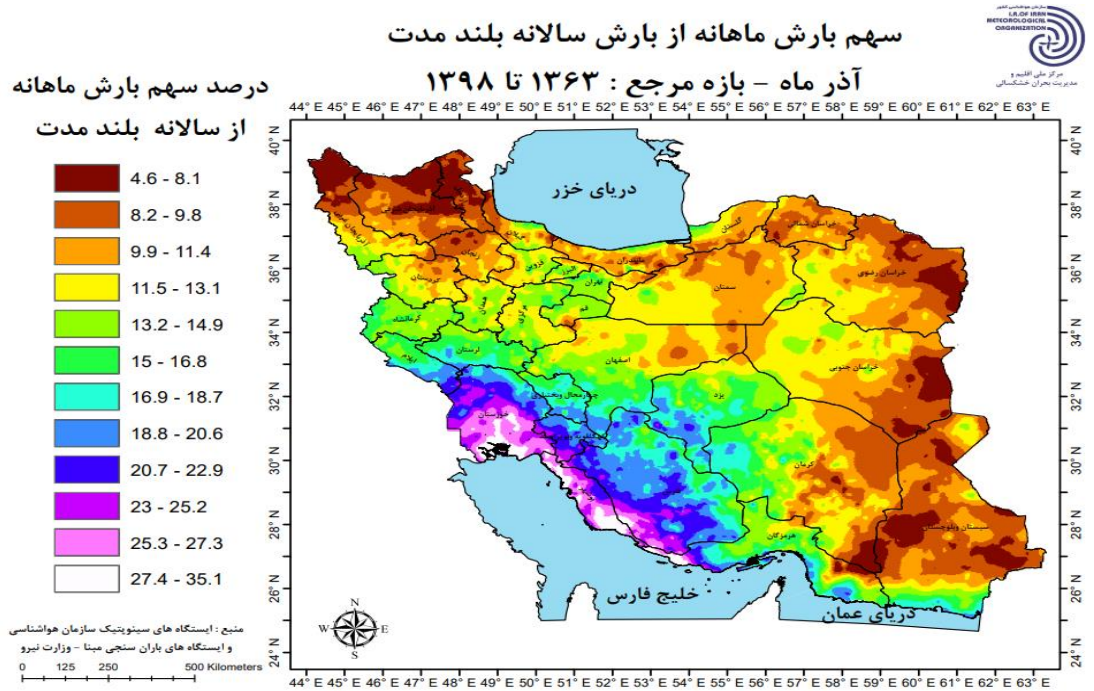


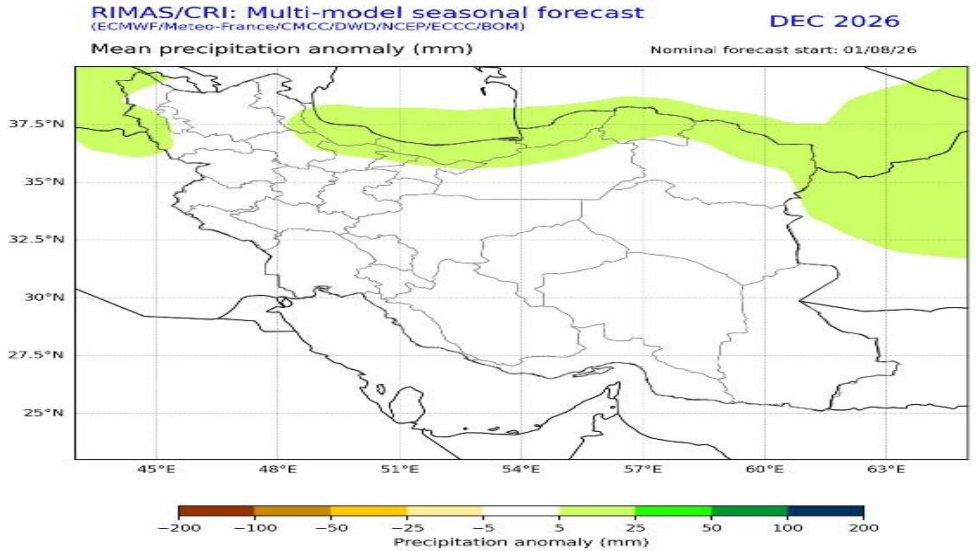


Precipitation Anomaly across the Country
November 2026

November: Average precipitation is forecast to be above normal across most parts of the country, except for some areas in the southeast. The increase in precipitation is particularly pronounced in the southwestern parts of the country.

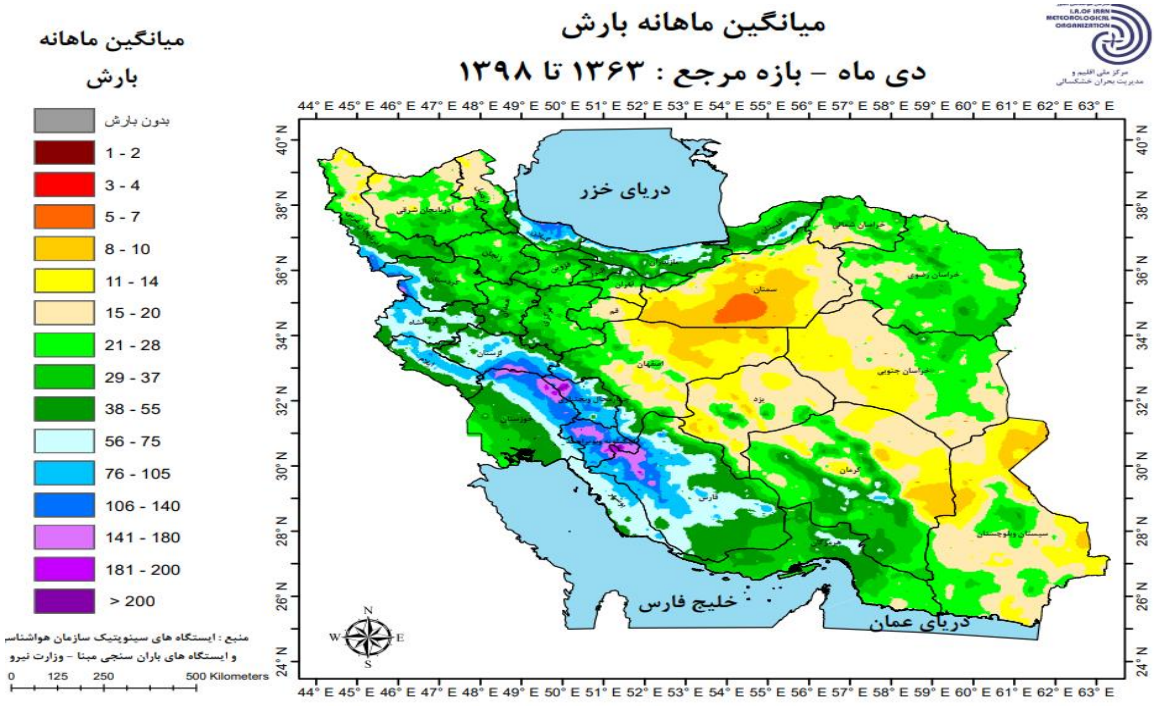


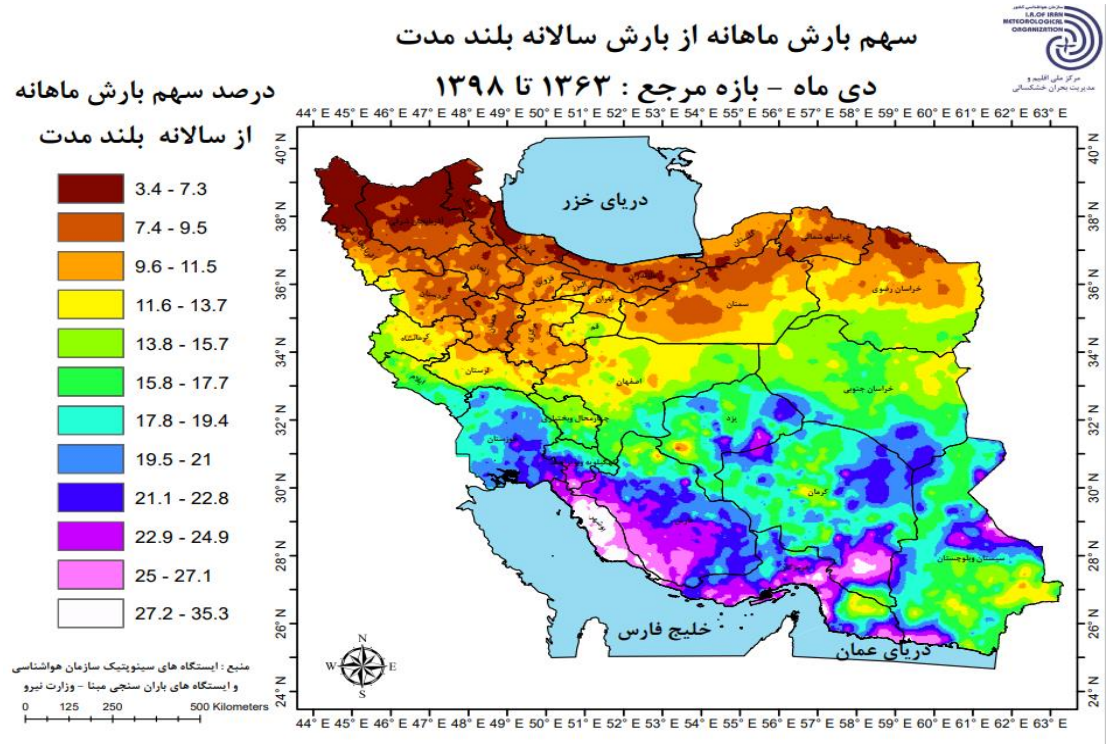


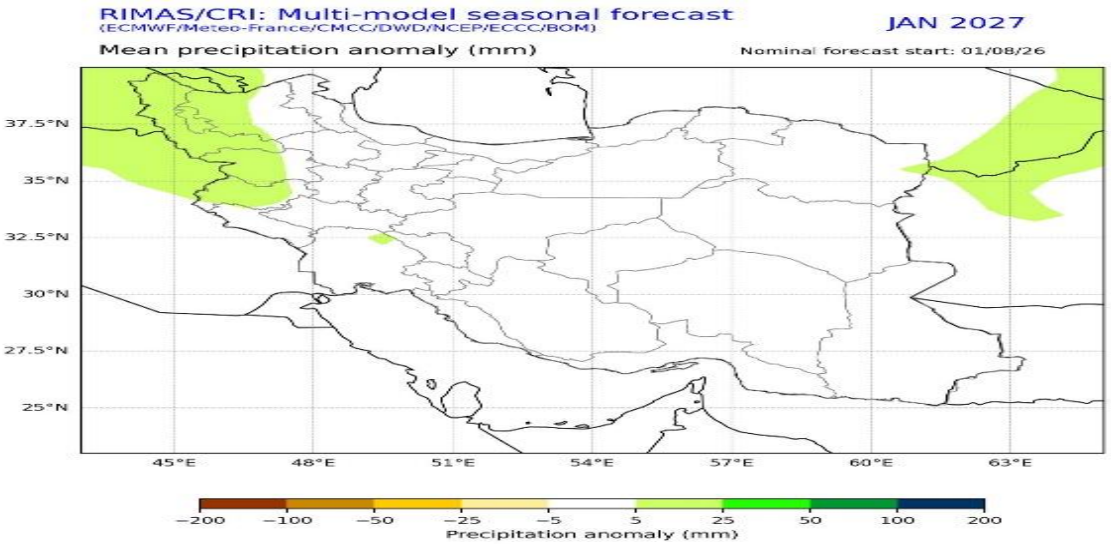


Precipitation Anomaly across the Country
December 2026

December: During this period, the country's average precipitation is estimated to be within the normal range. Precipitation is expected to be above normal across the northern parts of the country and along the southern slopes of the Alborz Mountains.

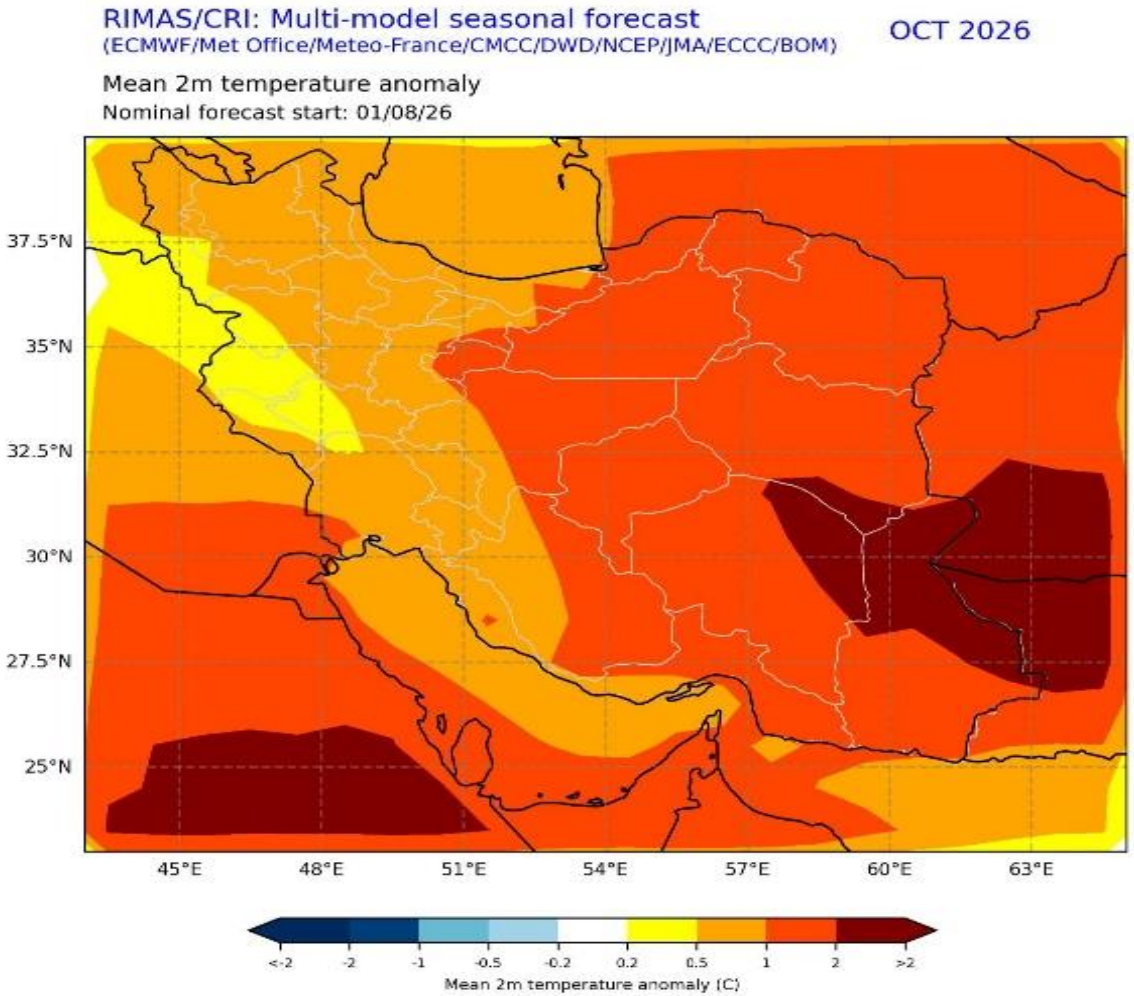




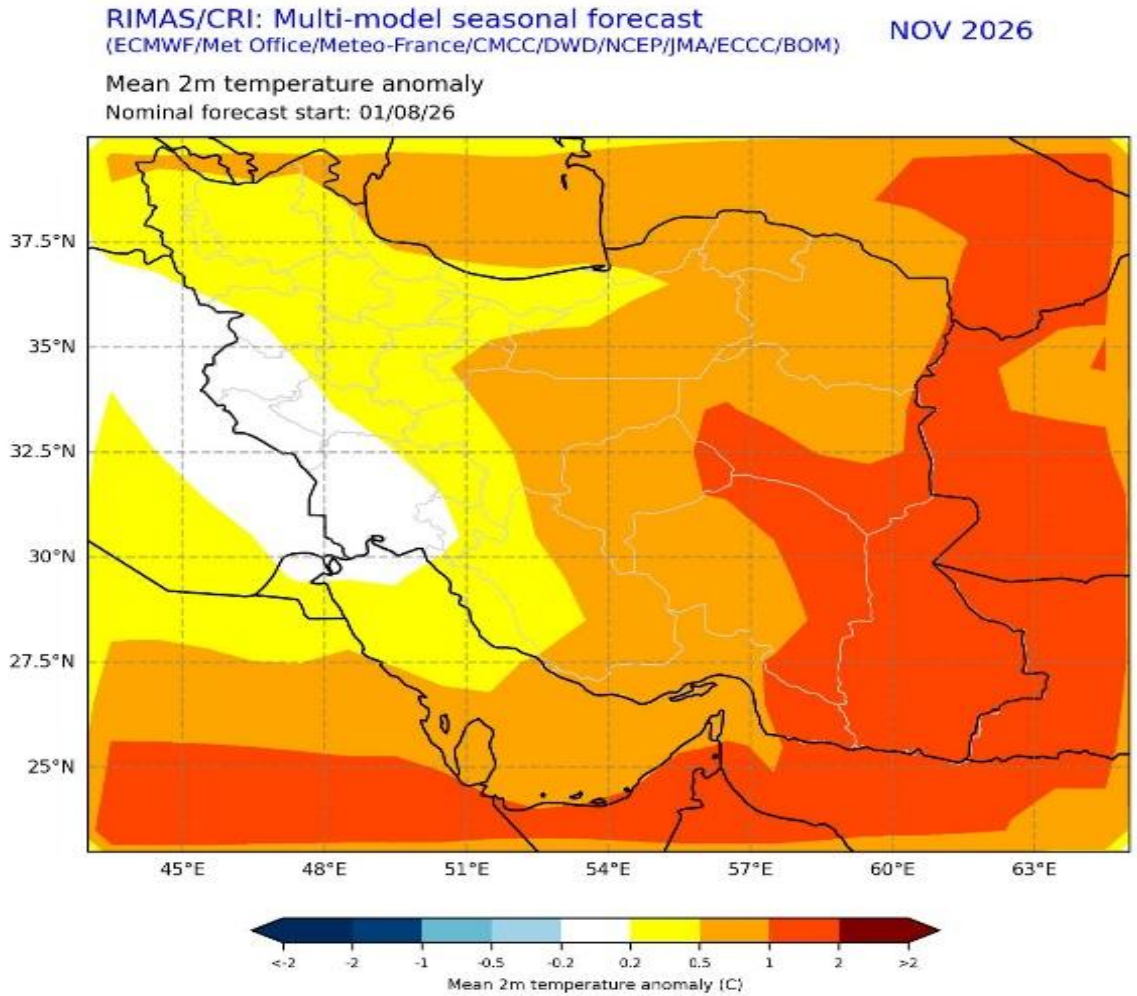


Precipitation Anomaly across the Country
January 2027

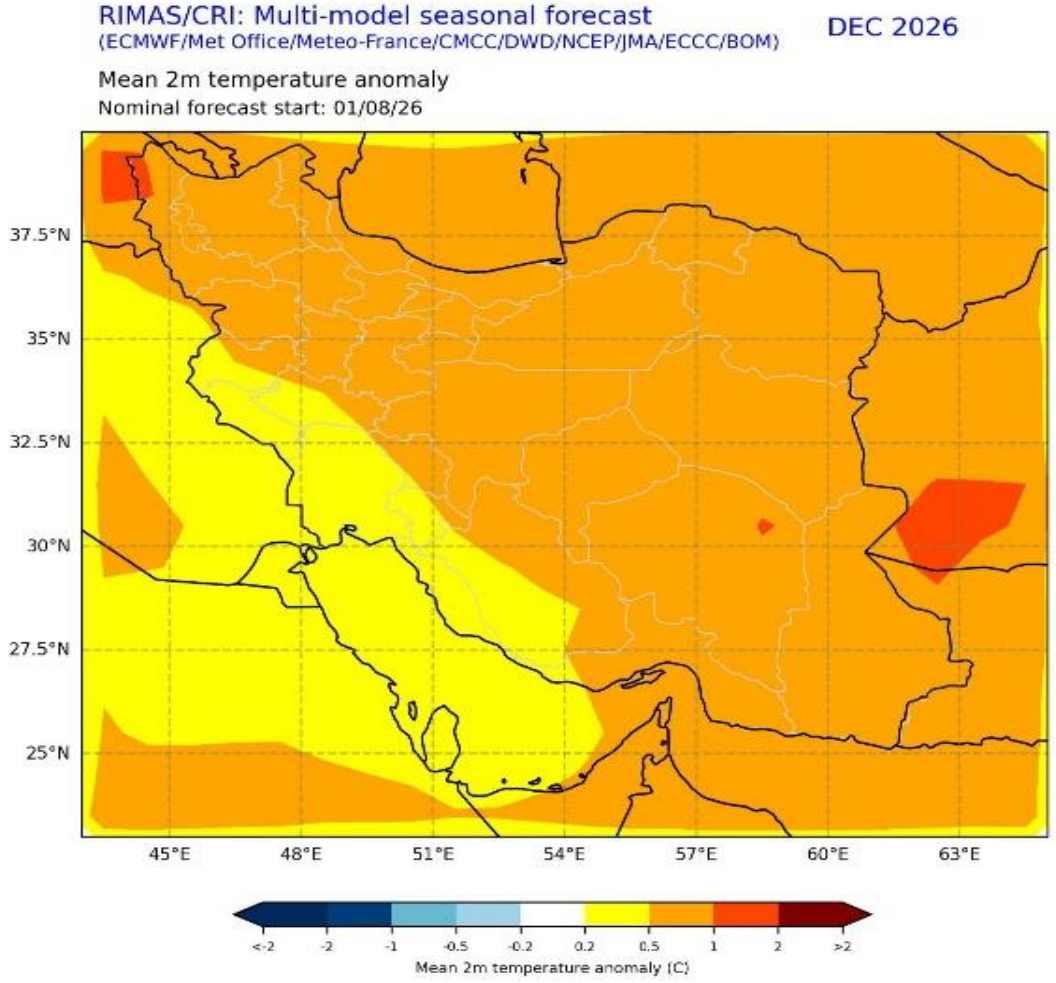
January: During this period, the country's average precipitation is estimated to be within the normal range. Precipitation is expected to be above normal across the western half of the northwestern parts of the country, the northern Zagros, and limited areas of the central Zagros and the northeast.



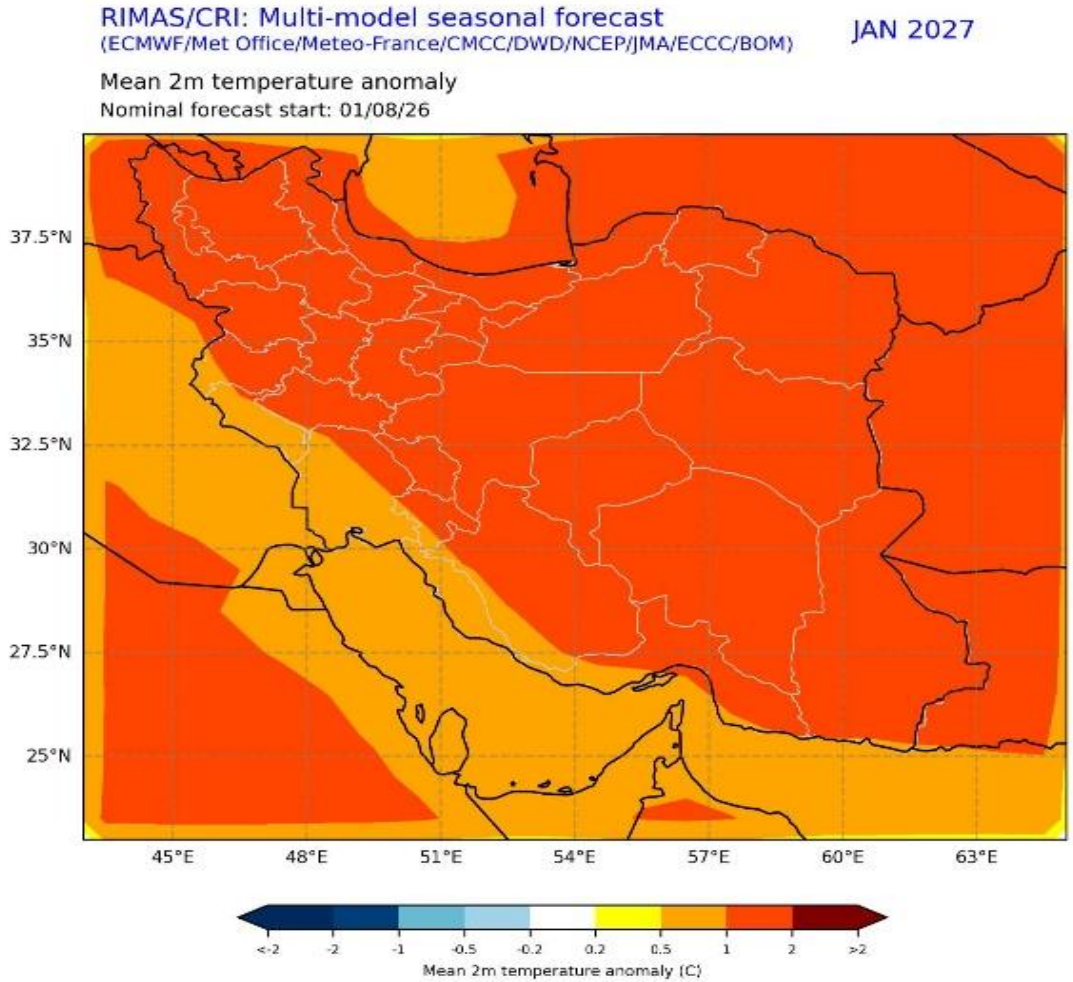
Temperature anomaly across the country October 2026.



Temperature anomaly across the country November 2026.



Temperature anomaly across the country December 2026.



Temperature anomaly across the country January 2027.

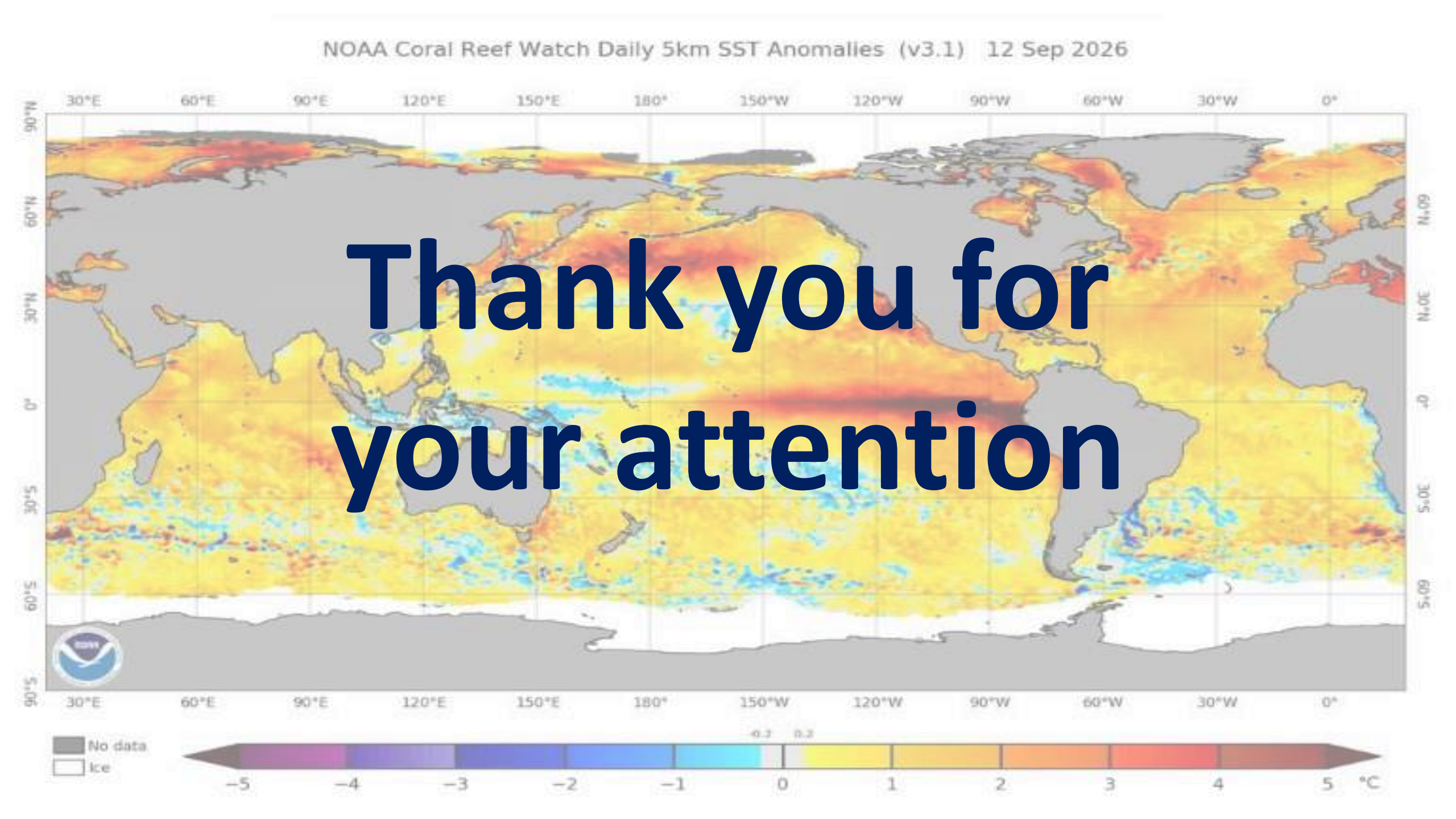
Summary

The outlook for Iran’s water resources in autumn 2026 is generally positive, but it is accompanied by risks.

Above-normal precipitation across large parts of the country, particularly in the Zagros Mountains, northwestern and southwestern regions, and the Alborz foothills, could lead to increased runoff, improved inflow into reservoirs, and favorable opportunities for groundwater recharge.

However, above-normal temperatures and a reduced proportion of snowfall mean that increased precipitation may not necessarily result in a proportional increase in long-term water storage; instead, the risk of rapid runoff and flooding may increase.

Therefore, the main water-resources management strategy during this period should be to maximize the conversion of autumn precipitation and runoff into usable water storage while effectively managing flood risks.


NOAA Coral Reef Watch Daily 5km SST Anomalies (v3.1) 12 Sep 2026
Thank you for your attention
No data
Ice
−5 −4 −3 −2 −1 0 1 2 3 4 5 °C