ASSIGNMENT CE-608

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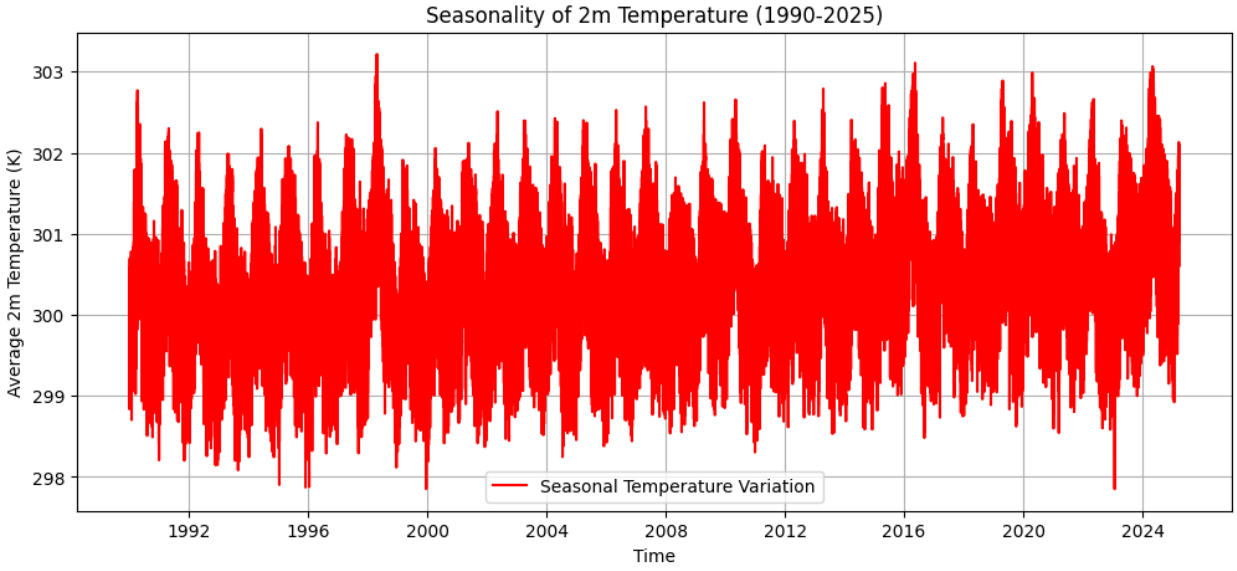
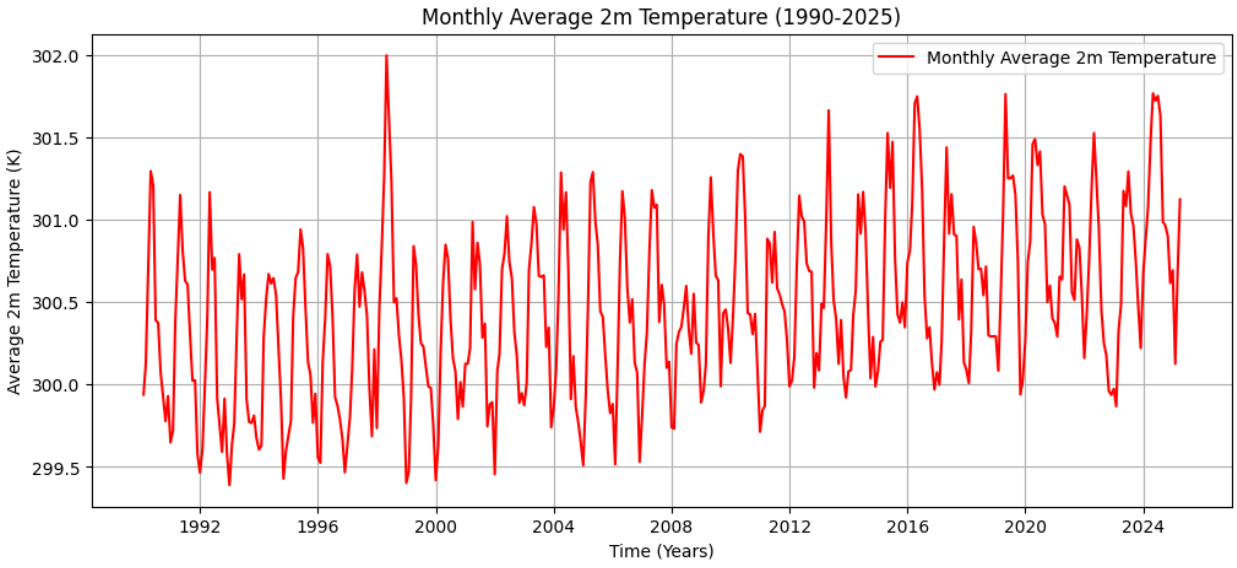
1) Seasonal Analysis

2m Temperature





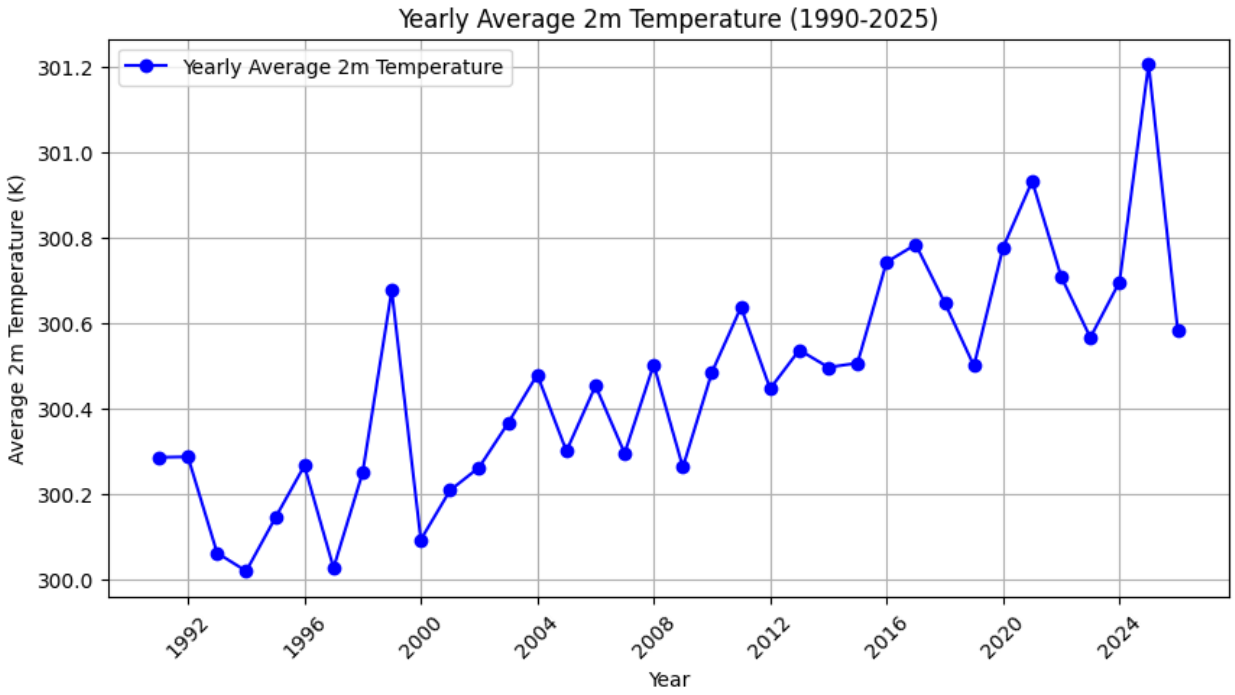
1. Seasonal Temperature Variability (First Graph)

- The temperature exhibits strong seasonal fluctuations over the years.

- The peaks and troughs indicate a consistent annual cycle, suggesting a clear seasonal pattern.
- There may be slight interannual variations, but the general trend appears to be stable, with no abrupt deviations.

2. Long-Term Monthly Average Trend (Second Graph)

- The monthly averaged temperatures show an overall increasing trend over the years.
- Some years exhibit spikes, suggesting occasional extreme temperature events.
- The upward trend could indicate gradual warming over time, which aligns with broader global climate change patterns.



Insights from Yearly Average 2m Temperature (1990-2025) for the Maldives

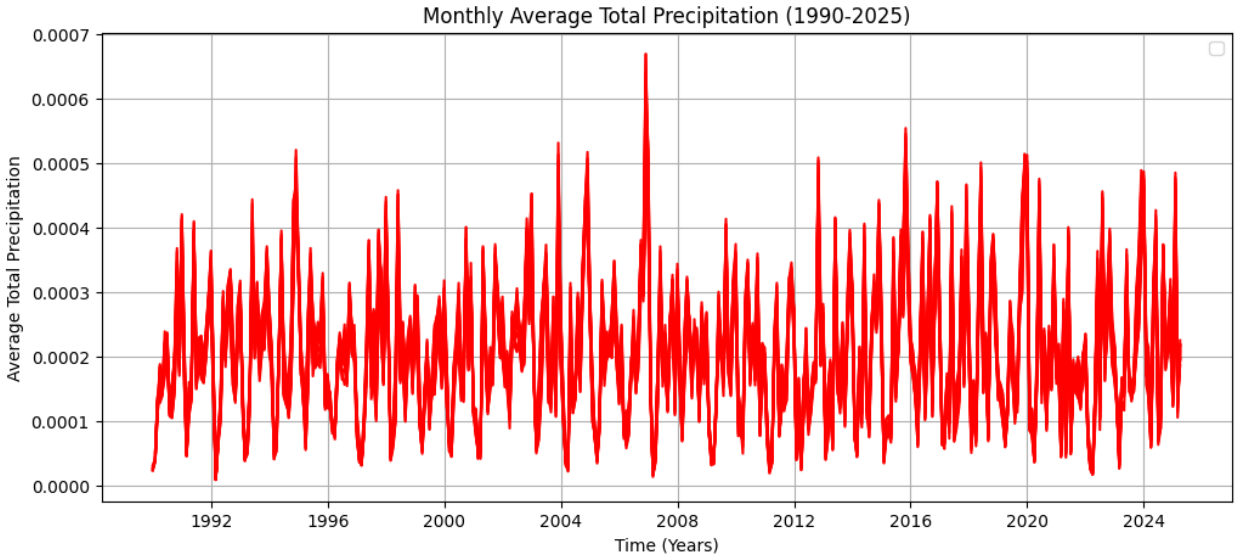
1. **Overall Increasing Trend**
   - The yearly average temperature appears to be rising gradually over time, indicating a warming trend in the Maldives.
   - The increase is not perfectly linear but shows an overall upward trajectory.

2. **Notable Temperature Spikes**
    - Some years, such as around 1999, 2016, and 2025, show significant spikes in temperature.
    - This could indicate years with particularly warm conditions, possibly due to El Niño events, climate anomalies, or local factors.
3. **Recent Years Show More Variability**
    - The fluctuations in yearly temperature appear more pronounced after 2015, suggesting increasing climate variability.
    - The highest recorded temperature in the dataset seems to occur in 2025.
4. **Potential Climate Change Impact**
    - The long-term warming aligns with global trends of increasing surface temperatures, possibly linked to climate change.
    - The Maldives, being a low-lying island nation, could face challenges like coral reef bleaching and increased heat stress due to rising temperatures.

Total Precipitation

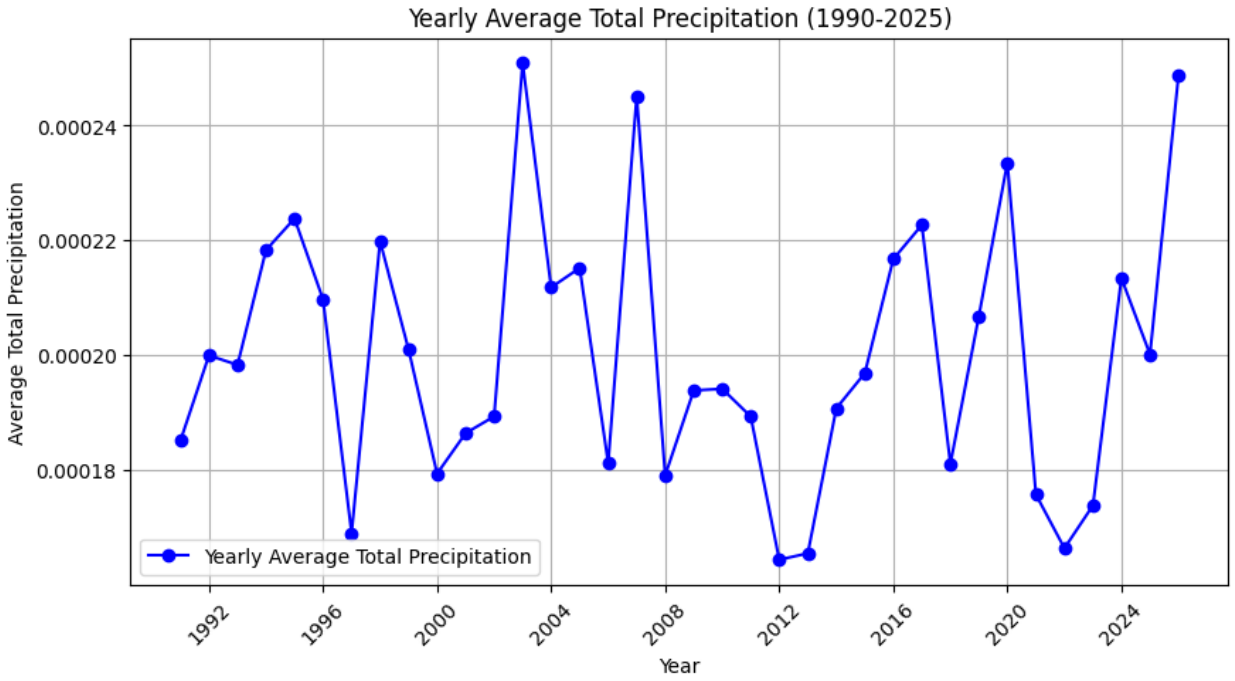
Monthly Average Total Precipitation (1990-2025)

The monthly precipitation data reveals significant variability over the years, with frequent peaks and dips. This suggests a strong influence of seasonal and interannual climate patterns, such as the monsoon cycle and El Niño-Southern Oscillation (ENSO). The high-frequency fluctuations indicate that precipitation is highly dynamic, with periods of intense rainfall followed by drier phases.



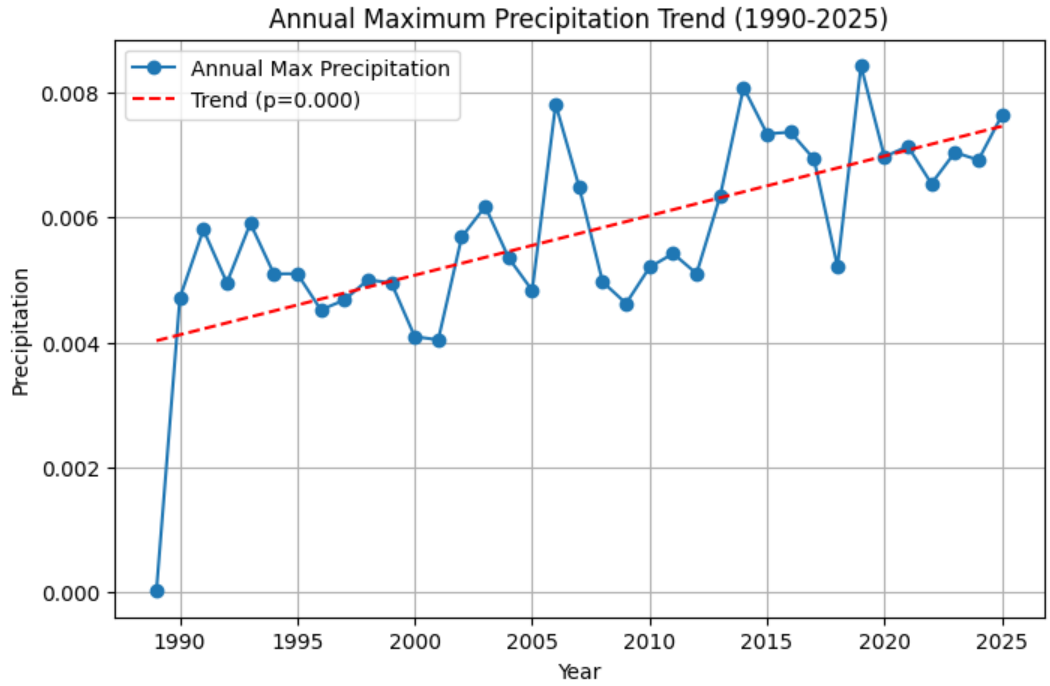
Yearly Average Total Precipitation (1990-2025)

The yearly average precipitation follows a fluctuating pattern with no clear long-term increasing or decreasing trend. Some years exhibit a noticeable drop, while others show spikes, indicating potential climate variability impacts. These fluctuations could be linked to large-scale atmospheric phenomena affecting rainfall distribution in the region.



Annual Maximum Precipitation Trend (1990-2025)

A positive trend in annual maximum precipitation indicates that extreme rainfall events have been increasing over time. The trend line, along with a statistically significant p-value, suggests that heavy rainfall events are becoming more frequent and intense. This could have serious implications for flood risk management and infrastructure resilience in the Maldives.



Inferences based on results

- Increased Rainfall Extremes: A rising trend in maximum precipitation suggests a growing risk of extreme rainfall events, which could lead to increased flooding.
- More Pronounced Dry Periods: The slight decline in minimum precipitation hints at longer or more intense dry spells, which could affect freshwater supply.
- Climate Variability: The overall precipitation trends highlight the impact of large-scale climate phenomena, necessitating further monitoring and adaptive water management strategies

Specific Humidity

1. Monthly Average Specific Humidity (1990-2025)

- The specific humidity shows high fluctuations on a monthly basis.
- There are periodic peaks and dips, indicating seasonal variations in humidity.
- The overall pattern suggests a recurring trend, likely influenced by monsoons and climate variability.

2. Yearly Average Specific Humidity (1990-2025)

- The yearly average humidity values do not show a strong increasing or decreasing trend.
- There are significant variations between different years, indicating that specific humidity is influenced by long-term climate changes or external factors such as El Niño and La Niña events.

3. Annual Maximum Specific Humidity Trend (1990-2025)

- The maximum specific humidity values fluctuate significantly over the years.
- The trend line suggests a relatively stable long-term pattern, with no significant upward or downward trend.
- A p-value of 0.884 indicates that there is no statistically significant trend in annual maximum specific humidity.

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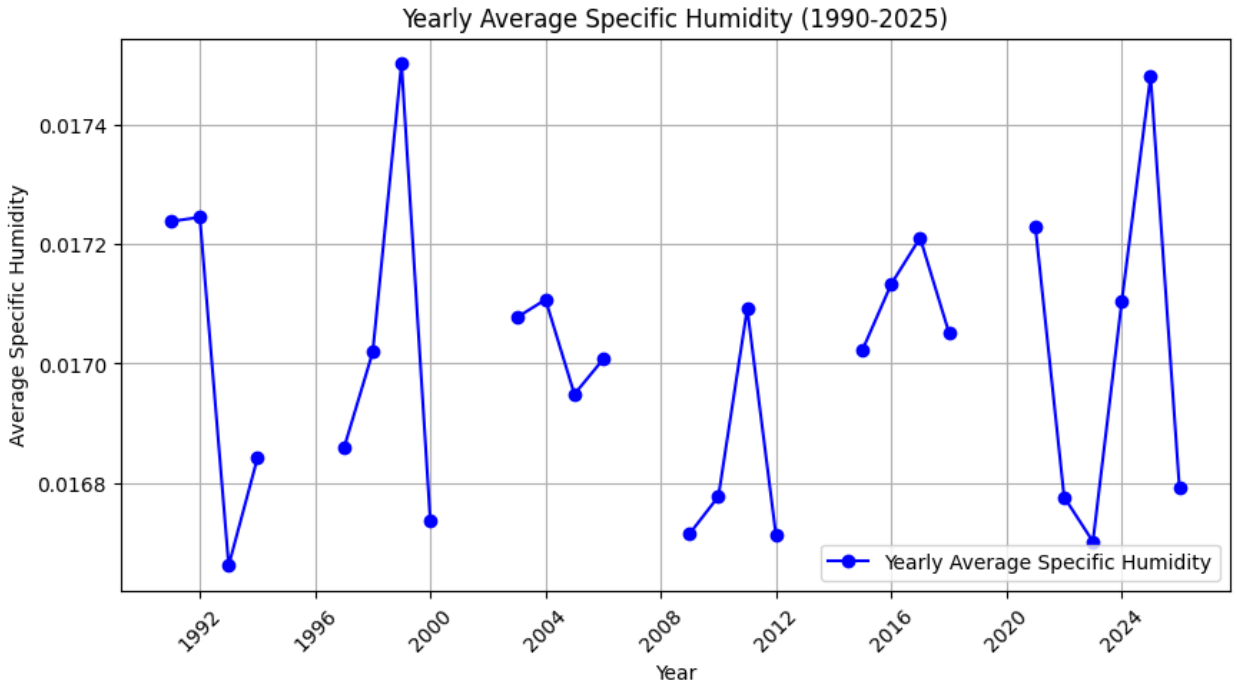
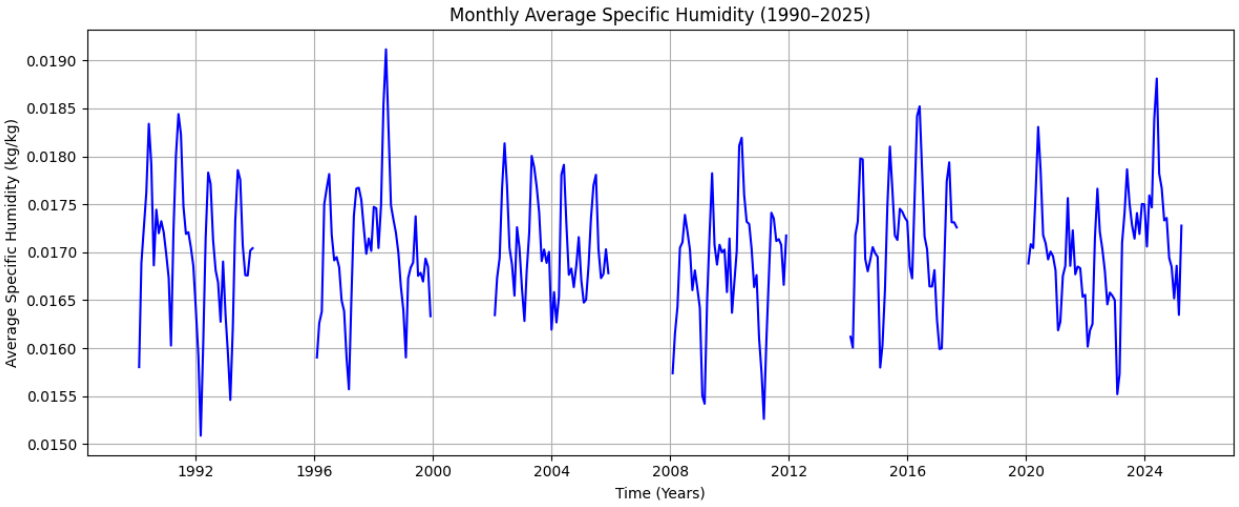
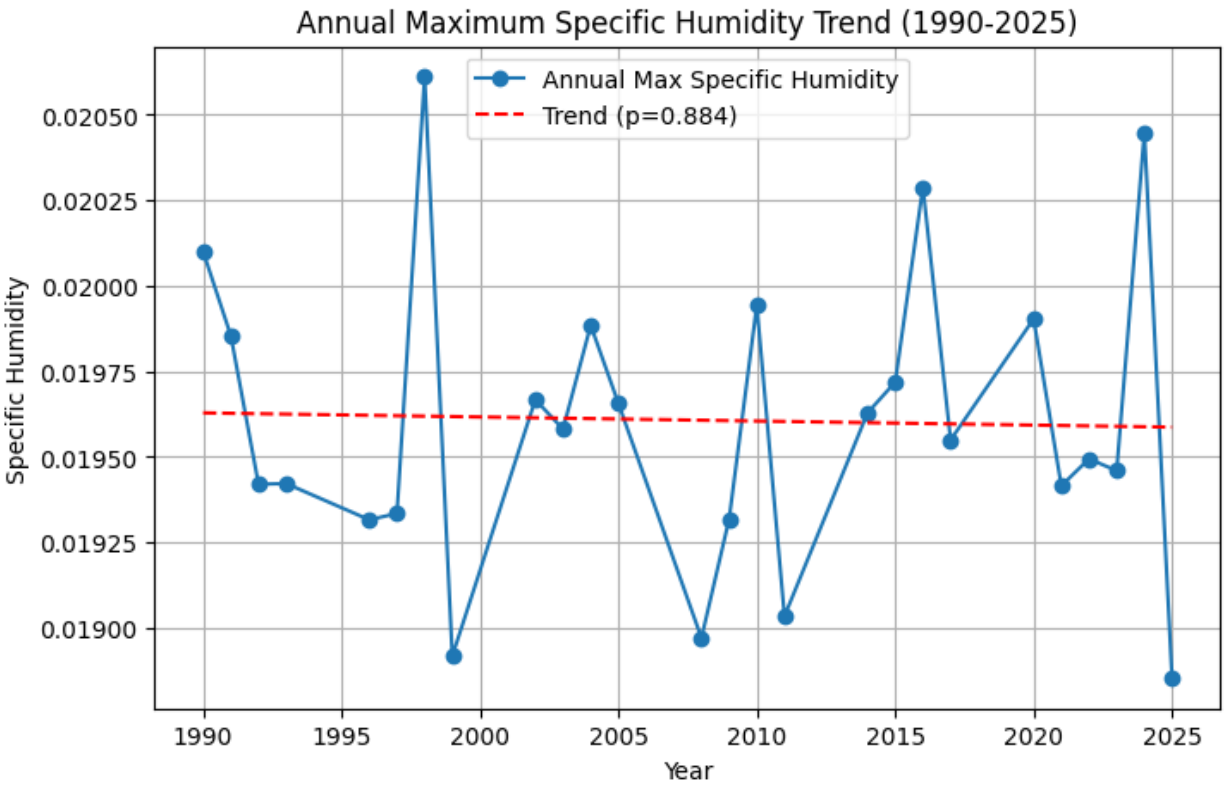
Overall Inferences:

- There is no strong increasing or decreasing trend in specific humidity over the years, but short-term fluctuations are noticeable.
- Seasonal patterns are evident in the monthly data, likely tied to monsoon cycles.
- While the minimum humidity appears to be slightly increasing, the overall trends in maximum and average humidity are not statistically significant.
- The Maldives' climate is heavily influenced by oceanic and atmospheric phenomena, which likely drive the observed variability.






Annual Maximum Specific Humidity Trend (1990-2025)
Annual Max Specific Humidity
Trend (p=0.884)
Specific Humidity
Year
0.02050
0.02025
0.02000
0.01975
0.01950
0.01925
0.01900
1990
1995
2000
2005
2010
2015
2020
2025

Relative Humidity

1. Monthly Average Relative Humidity (1990-2025)

- The monthly relative humidity fluctuates between 70% and 85%.
- There are seasonal variations, likely influenced by monsoon patterns.
- A gradual decline in relative humidity is noticeable in recent years, indicating possible changes in atmospheric moisture availability.

2. Yearly Average Relative Humidity (1990-2025)

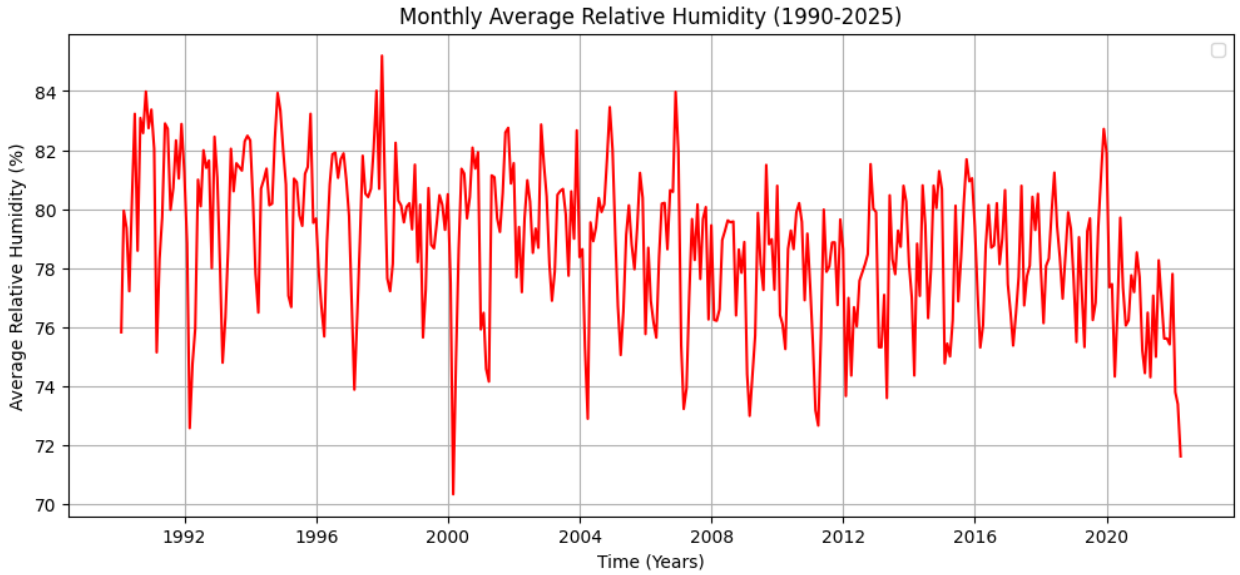
- The yearly average relative humidity shows a clear decreasing trend over time.
- From around 81% in the early 1990s, it has dropped to nearly 73% by 2025.
- This decline suggests a long-term shift in climate conditions, possibly linked to rising temperatures, changing precipitation patterns, or oceanic influences.

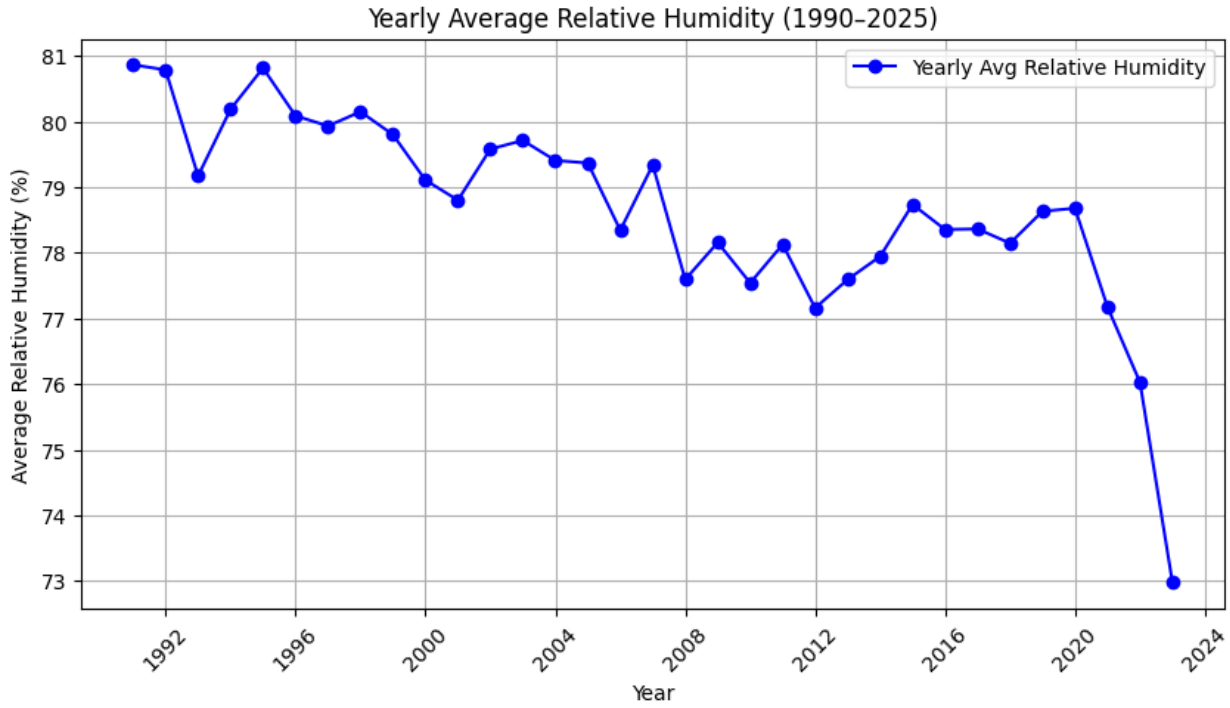
3. Annual Maximum Relative Humidity Trend (1990-2025)

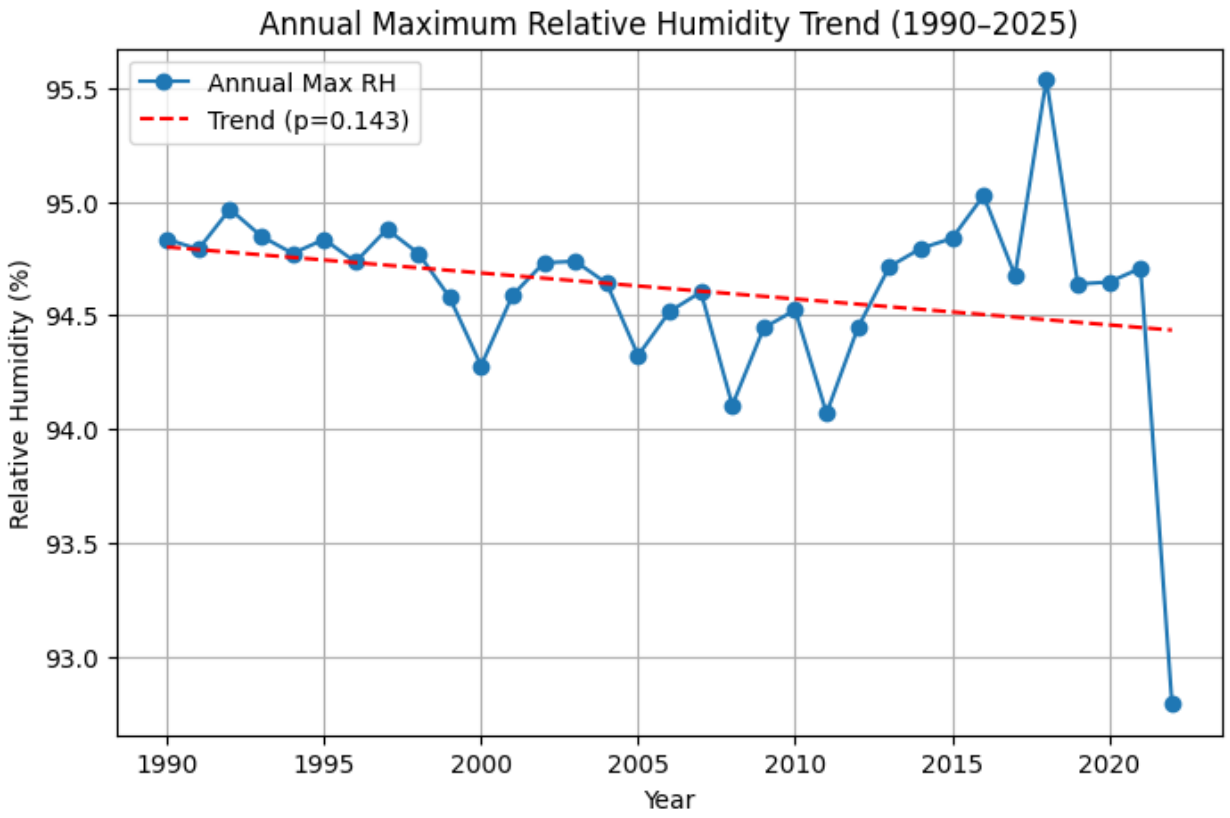
- The annual maximum relative humidity has shown a gradual decline over the years.
- The trend line is slightly downward, but the p-value (0.143) indicates no strong statistical significance.
- This suggests that while extreme humidity levels are still occurring, their intensity may be reducing over time.

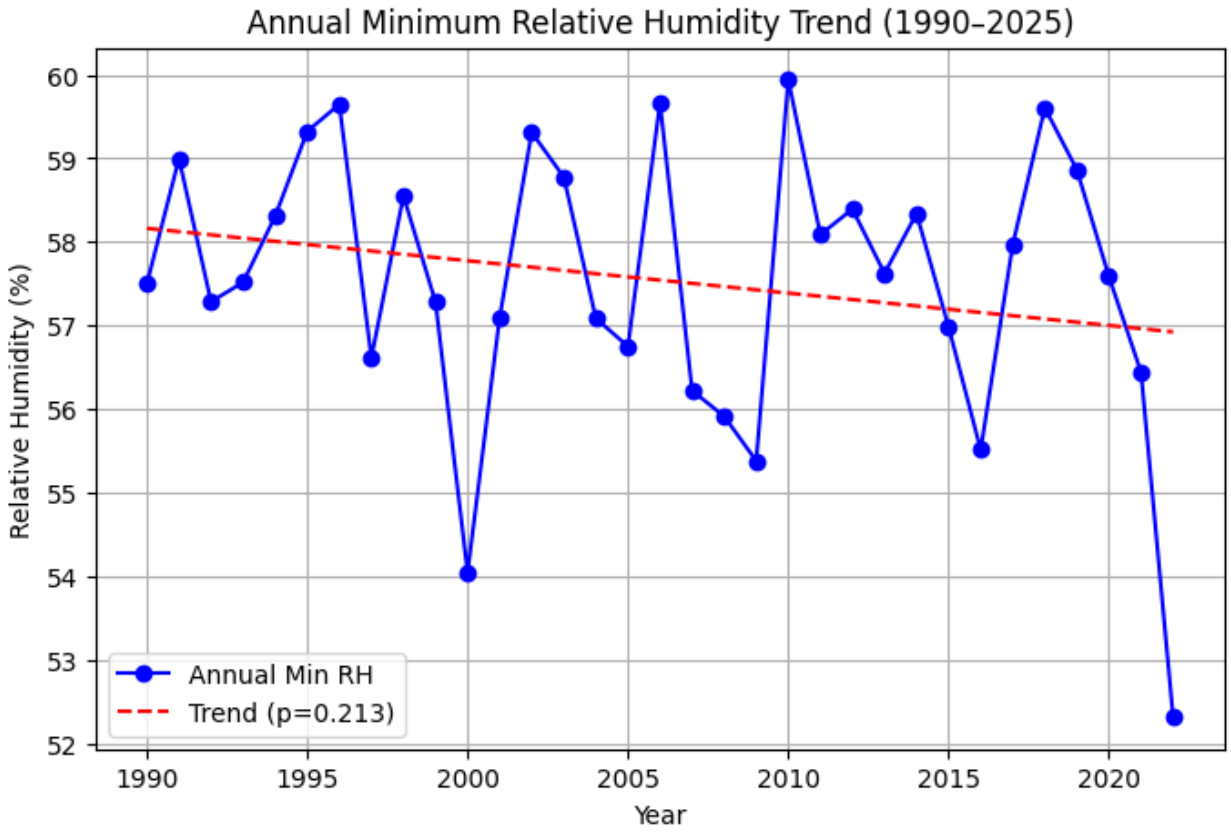
Overall Inferences:

- Relative humidity in the Maldives is decreasing over time.
- The yearly average has dropped significantly, indicating potential climate change impacts.
- Maximum and minimum relative humidity values are also trending downward, though not at a statistically significant level.
- The decline could be influenced by rising sea surface temperatures, reduced rainfall, or changes in atmospheric circulation patterns


Monthly Average Relative Humidity (1990-2025)
Average Relative Humidity (%)
84
82
80
78
76
74
72
70
1992
1996
2000
2004
2008
2012
2016
2020
Time (Years)


Yearly Average Relative Humidity (1990–2025)
Yearly Avg Relative Humidity
Average Relative Humidity (%)
81
80
79
78
77
76
75
74
73
1992
1996
2000
2004
2008
2012
2016
2020
2024
Year

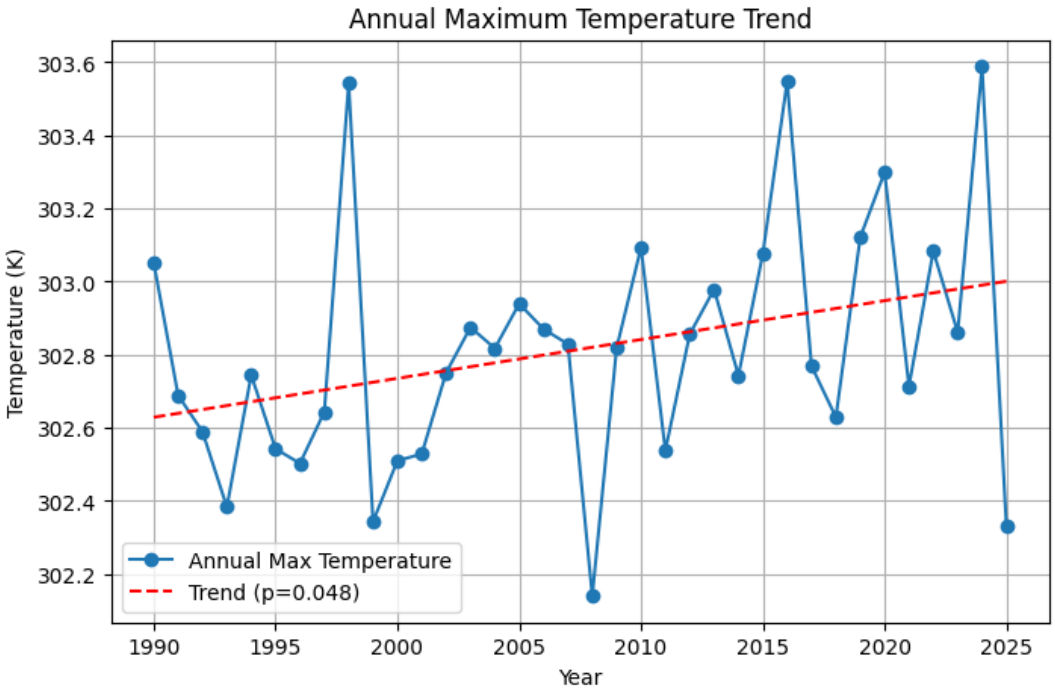

Annual Maximum Relative Humidity Trend (1990–2025)
Annual Max RH
Trend (p=0.143)
Relative Humidity (%)
95.5
95.0
94.5
94.0
93.5
93.0
1990
1995
2000
2005
2010
2015
2020
Year

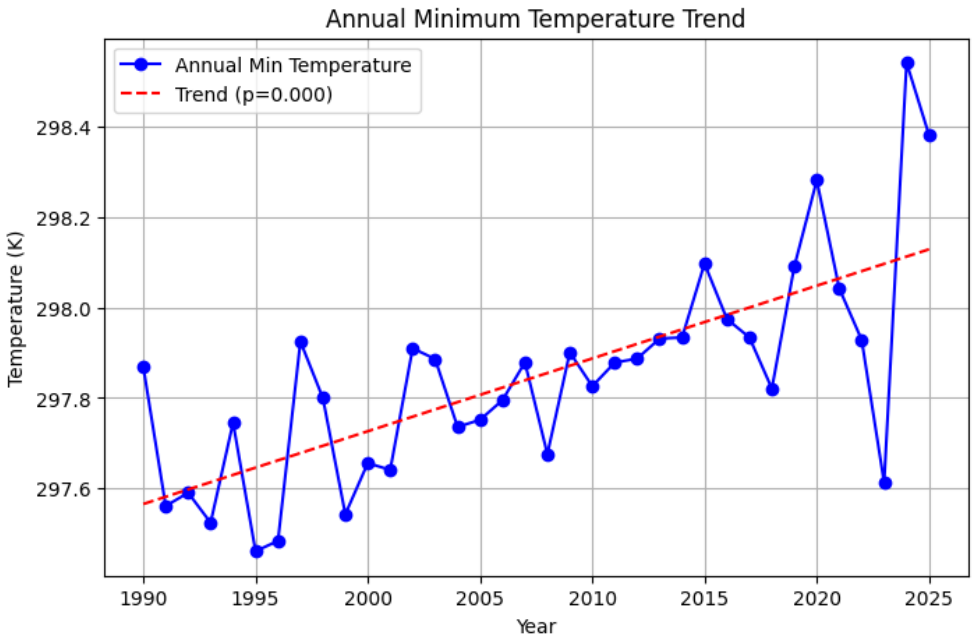

Annual Minimum Relative Humidity Trend (1990–2025)
Annual Min RH
Trend (p=0.213)
Relative Humidity (%)
60
59
58
57
56
55
54
53
52
1990
1995
2000
2005
2010
2015
2020
Year

2- Annual Maximum and Minimum Temperature Trends (1990-2025) Maldives

Temperature Trends (1990-2025)

- **Max Temperature:** Rising significantly, indicating hotter peak days and more frequent extreme heat events.
- **Min Temperature:** Gradually increasing, leading to warmer nights and reduced temperature variability.

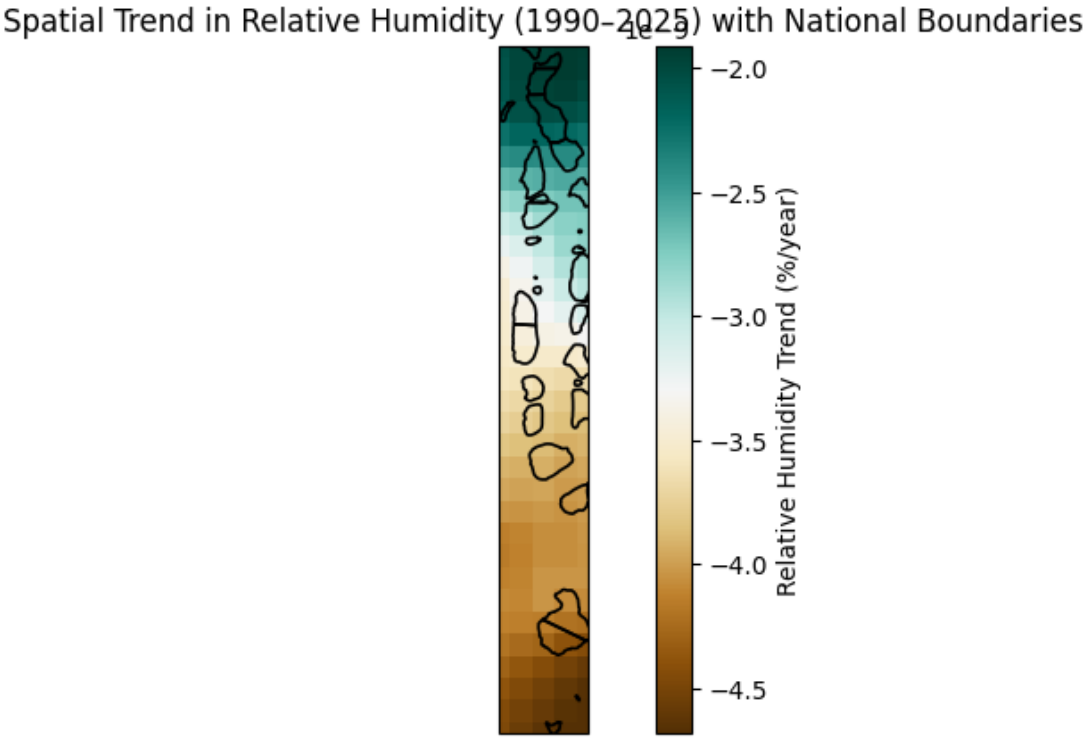


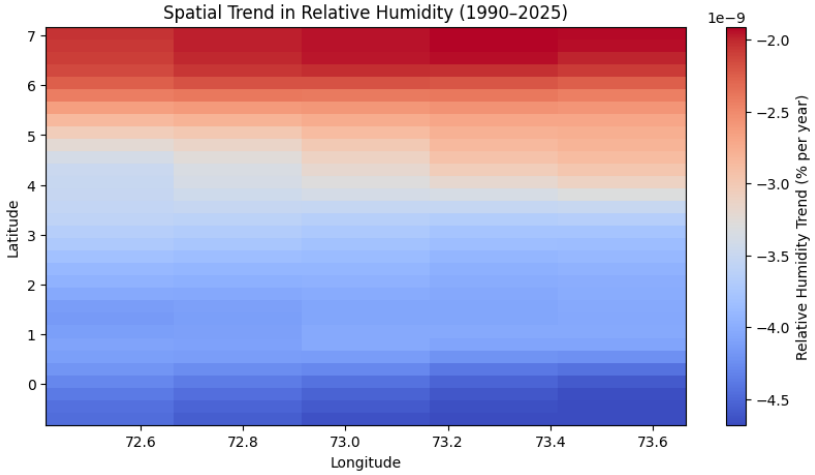


3)- Spatial Trend

Relative Humidity

From 1990 to 2025, relative humidity in the region shows a clear declining trend, with stronger reductions in the southern areas (up to -4.5% per year). This suggests increasing aridity, likely driven by rising temperatures, shifting atmospheric patterns, or reduced monsoon activity. The spatial variation, with higher RH loss in southern latitudes, may impact water availability, agriculture, and ecosystems—especially in coastal or island areas. These trends align with global climate change patterns and highlight potential risks such as droughts, reduced crop yields, and freshwater scarcity. Further study into oceanic and climate drivers is recommended





2m Temperature

The spatial trend of 2m temperature from GRIB data (1990–2025) shows clear warming, especially in lower latitudes near the equator, with rates up to 0.023 K/year. Northern areas show less warming or slight cooling. This latitudinal gradient suggests stronger surface heating in the south, possibly due to increased radiation absorption or shifting atmospheric circulation. The warming trend aligns with declining relative humidity in the same region, indicating a possible feedback loop of increased evaporation and reduced moisture. These changes can impact agriculture, water availability, ecosystems, and increase heat stress, particularly in coastal or urban zones. The pattern reflects broader global climate change trends, with potential implications for monsoons and regional weather systems**.**

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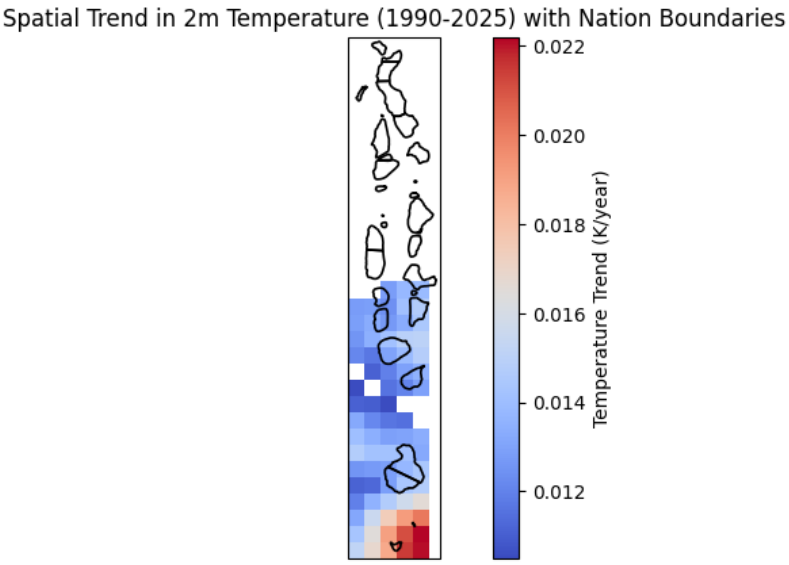
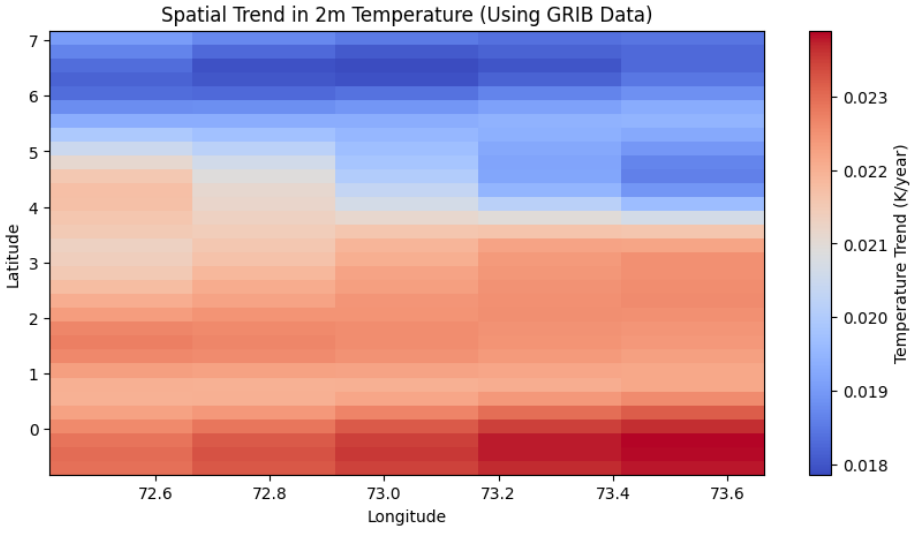
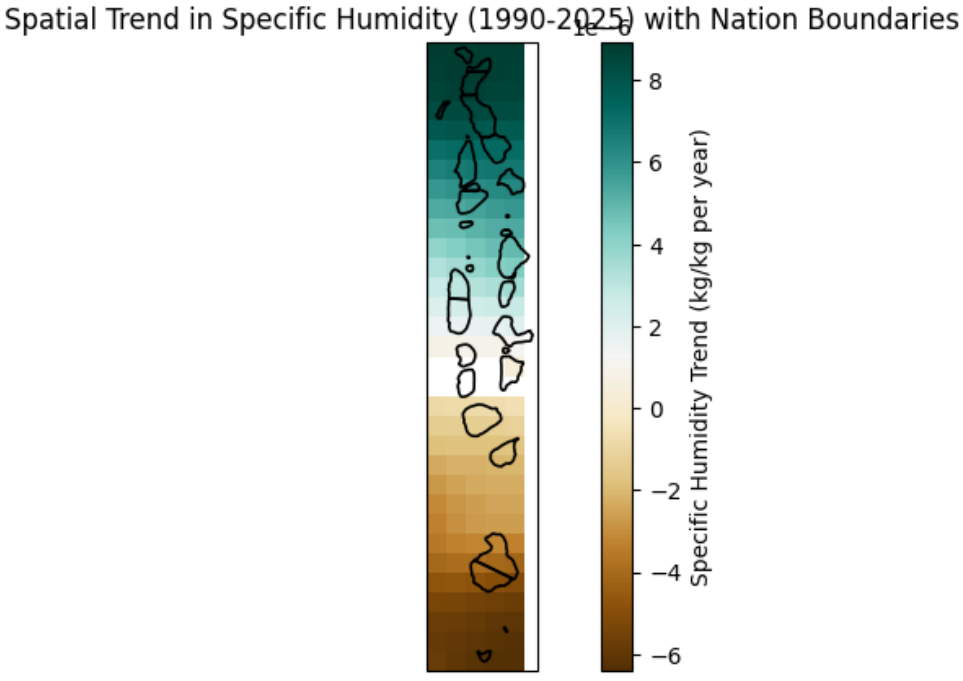
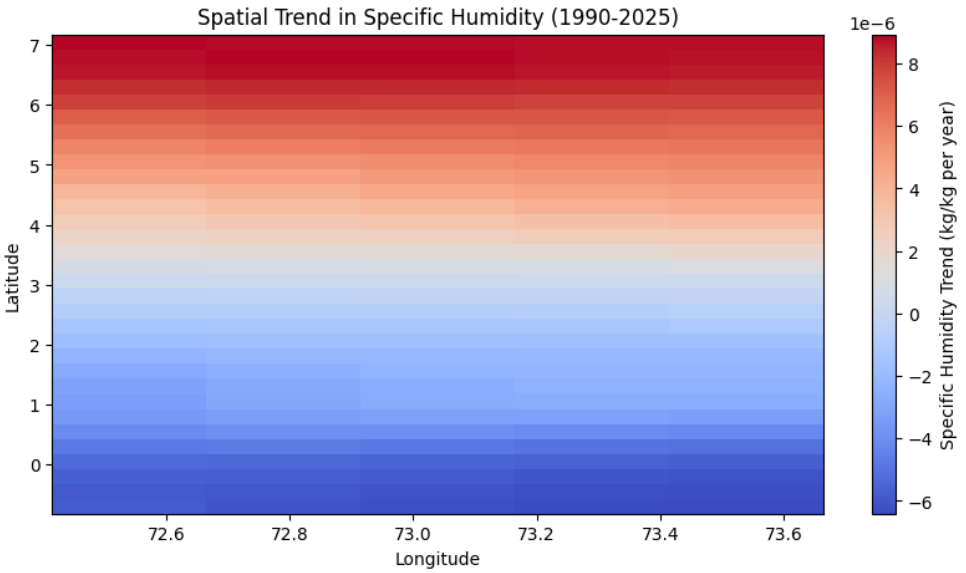




Specific Humidity

The analysis of specific humidity trends from 1990 to 2025 reveals a clear latitudinal contrast: the southern region is experiencing a drying trend, while the northern region is becoming more humid. Spatial patterns show decreasing specific humidity in southern latitudes (below ~3°) and increasing humidity in northern areas (above ~4°). This divergence aligns with earlier findings—southern areas are also warming faster and experiencing a drop in relative humidity, likely due to increased evaporation and reduced moisture retention. In contrast, the northern increase in humidity may result from enhanced oceanic moisture transport or shifting precipitation patterns. These opposing trends suggest shifting local climate dynamics, with the south facing higher aridity, potential droughts, and water stress, while the north may see more rainfall and associated impacts like heavy storms. These changes reflect broader shifts in atmospheric circulation and could be influenced by factors like monsoon variability or ENSO. Overall, the results point to a changing climate with significant implications for agriculture, ecosystems, and water security, especially if these trends continue.





Total Precipitation