NCM
المركز الوطني للأرصاد
National Center of Meteorology

ديوان الرئاسة
PRESIDENTIAL COURT

NCM's Climate Services:

Bridging Science and Society

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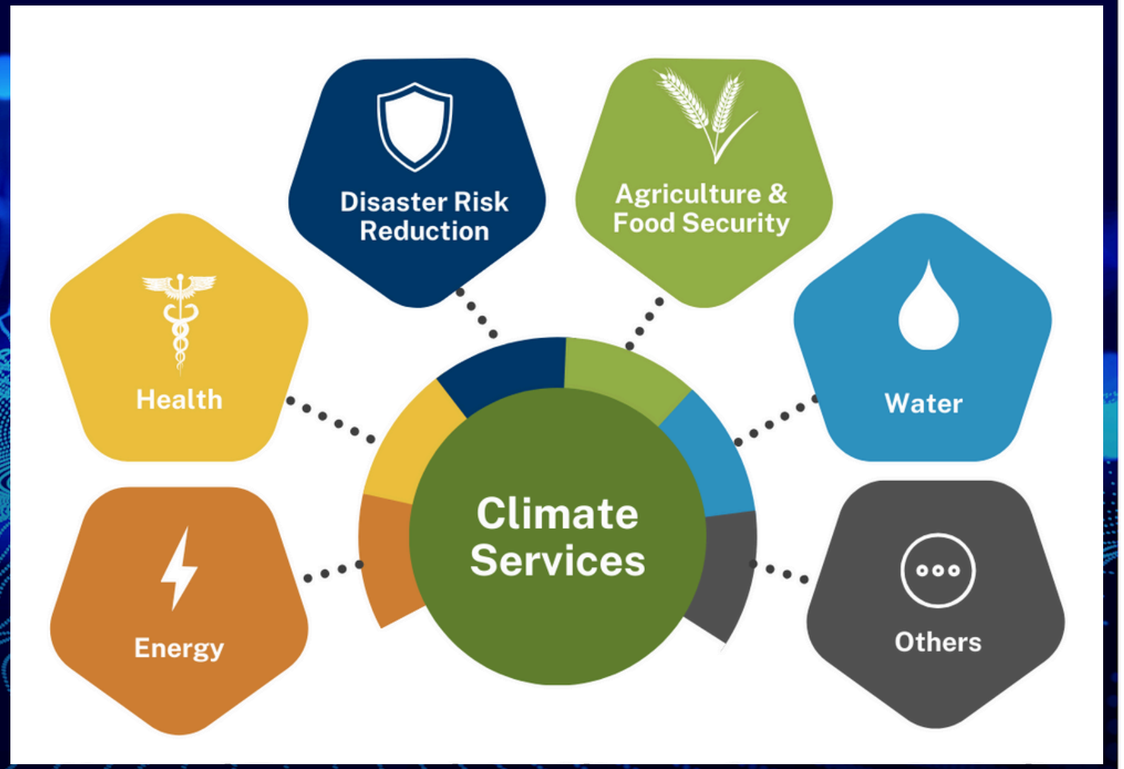

Thanks to
Dr. Mohamed Alebri (Director of Meteorology, NCM)
Mrs. Noora Al Hameli (Head of Climate & Hydrology Section, NCM)

NCM’s weather and climate services

National Center of Meteorology

NCM is the official agency responsible for providing operational weather and climate information for the country

- Weather Forecasting
- Early Warning Alerts
- Cloud Seeding Operations
- Climate Data and Observations
- Climate Monitoring and Analysis
- Climate Predictions and Projections
- Sector-Specific Climate Information
- Dissemination Platforms
- Research and Innovation
- WMO RTC (Capacity Building and Outreach)

NCM's weather and climate services

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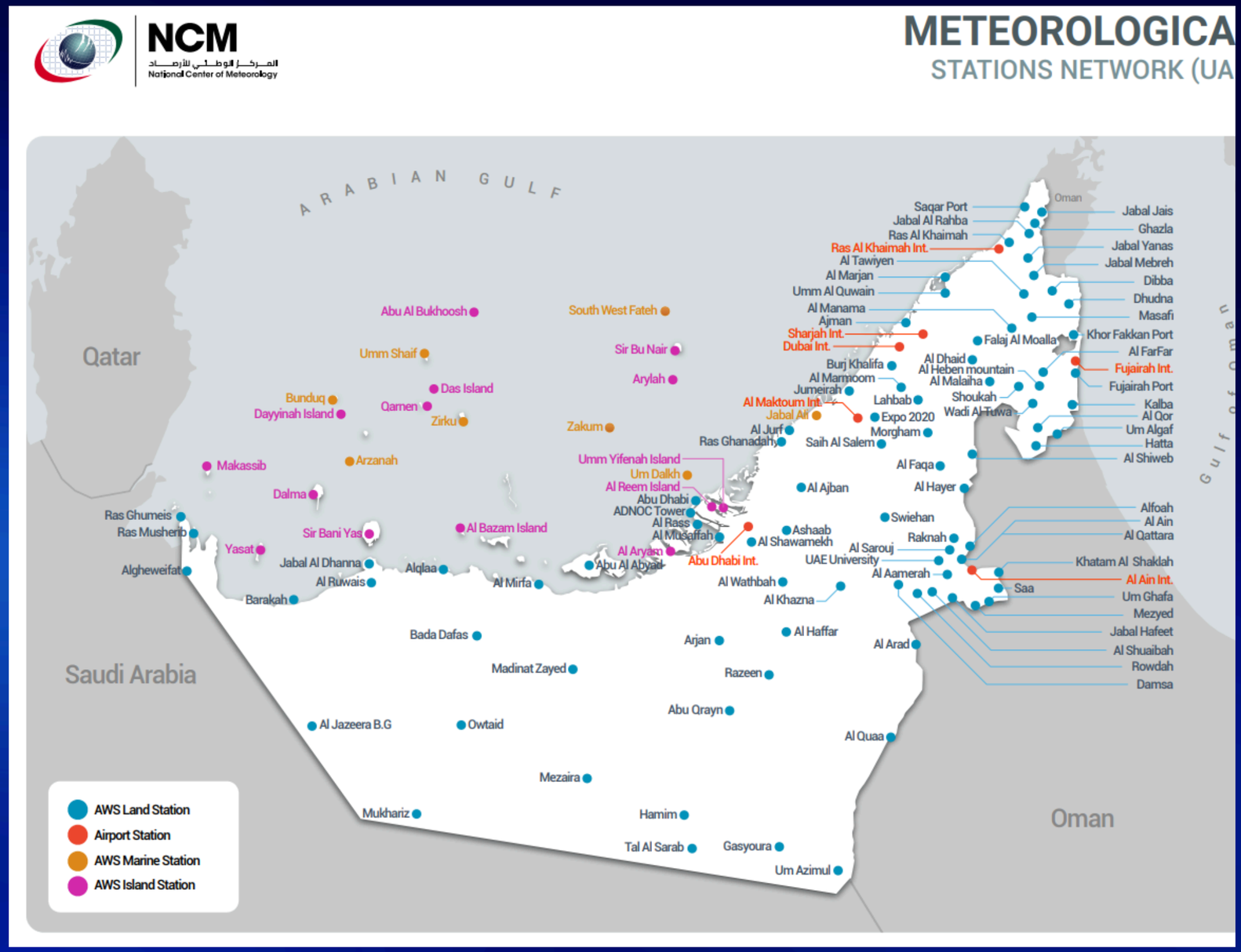
- NCM is providing weather and climate information and related products to improve decision making in key development sectors since long.
- NCM has been carrying out many specific climate related activities like Climate Data Management, Climate Monitoring and Analysis, Climate Prediction (Seasonal Forecasts), Climate Research and Climate Applications.
- With an objective to expand its services activity across Arabian Peninsula, NCM has also taken up additional responsibility to work as WMO recognized Regional Training Centre (RTC) for the Arabian Peninsula.

Observational Network at NCM

- The NCM operates and maintain a wide range of observational network that support weather and climate applications in accordance with the WMO as part of its updated requirements review process.

- The Center has strengthened the national observation networks with a group of 130 AWS, 8 Airports, 30 marine stations, and FIVE radars, and has established partnerships with several other national entities (https://www.ncm.gov.ae/maps-radars/gcc-radars-network?lang=en).

- **The National Air Quality Platform with a group of 14 stations measuring pollutants** (https://airquality.ncm.gov.ae)



Seamless Forecasting Strategy

Issuing daily forecast with state-of-the-art weather models

- NCM has a seamless forecasting strategy with FIVE days forecast well in advance.
- Issuing operational forecasts with different lead times.
- Providing alerts about severe weather phenomena like thunderstorms, dust storms, heavy rain, heat waves, coastal weather alerts etc.
- These forecasts are used by various sectors in taking proactive measures.

TYPES OF FORECASTS

- Nowcasting up to six hours
  - Thunderstorms, dust storms, Aviation Services
- Very short range
  - Transport, Aviation
- Short-range forecasts: up to 3 days
  - Disaster Management, General Public, Agro-met Advisories, Bulletins, Cyclones Warnings, Non-conventional Energy Sectors
- Medium-range forecasts:
  - Agromet Advisories, Cyclones Warnings
- Extended range forecasts:
  - Farmer's Outlooks, Commercial Crops, Industries, Hydrology and Health Departments
- Seasonal Forecasts:
  - Governmental Officials, Policy Makers, Planners

CLIMATE SERVICES: BACKGROUND

Climate services are the delivery of useful and reliable weather and climate information that helps people make better decisions for various sectors (e.g., agriculture, health, water, energy).

These services aim to transform complex weather/climate information into actionable insights for society.
These services acts as a bridge between
Weather/Climate information: observations and forecasts

Practical use: Farmers can decide the best time to plant crops.

- Governments can prepare for disasters like floods or droughts.
- Businesses, like energy companies, can plan for renewable energy production.

Advices based on the knowledge about the past, present and future climate and its impacts on natural and human systems.

Climate Services: Examples

- Do I need to plant drought-resistant seeds next season based on the likely impact of forecast rainfall and temperature?
- How much wind and solar resources can we expect to get in various areas in the coming months, seasons and years to establish new renewable power plants?
- Is our city's infrastructure resilient to projected changes in extreme rainfall under a changing climate?
- How might sea level rise impact coastal communities and infrastructure in the coming decades and what investments are needed to adapt?

In short, **climate services turn complex scientific data into practical advice** that everyone can use to make safer, smarter decisions.

CLIMATE SERVICES: BACKGROUND

Core Components of Climate Services

- **Observation & Monitoring :** Long-term observations, satellite data, reanalysis.
- **Modelling & Prediction:** Modeling, forecasting, interpretation.
- **User Interface Platforms:** Dashboards, early warning systems.
- **Capacity Development:** Education, training, co-development with users.
- **Climate Services Information System:** Policies, national adaptation plans.

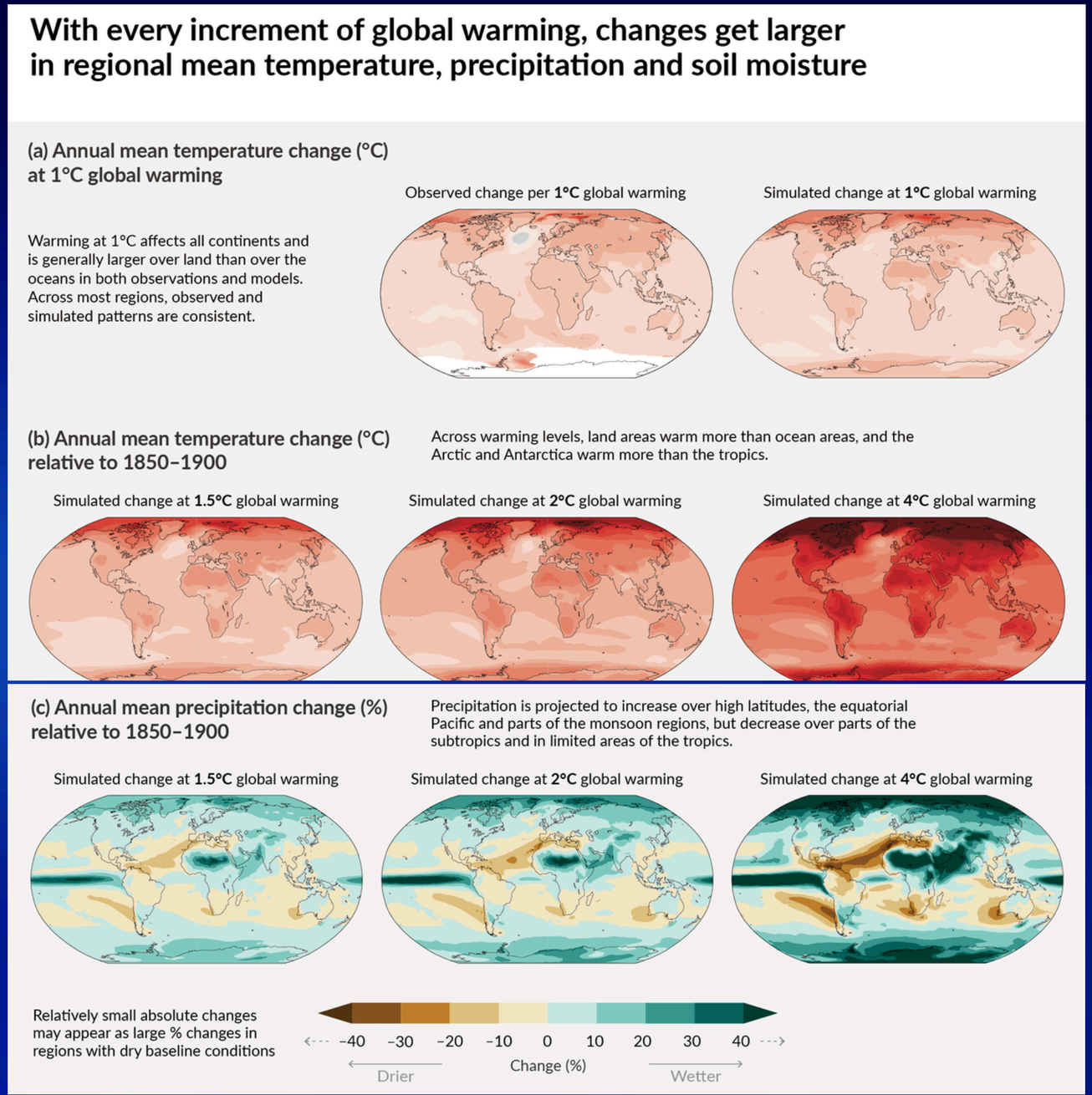
Goals of Climate Services

- Support **climate-resilient development**
- Improve **disaster preparedness**
- Inform **agriculture, water, health, and energy** sectors
- Contribute to **early warning for All**

Rising Extreme Weather Events: The Growing Need for Climate Services

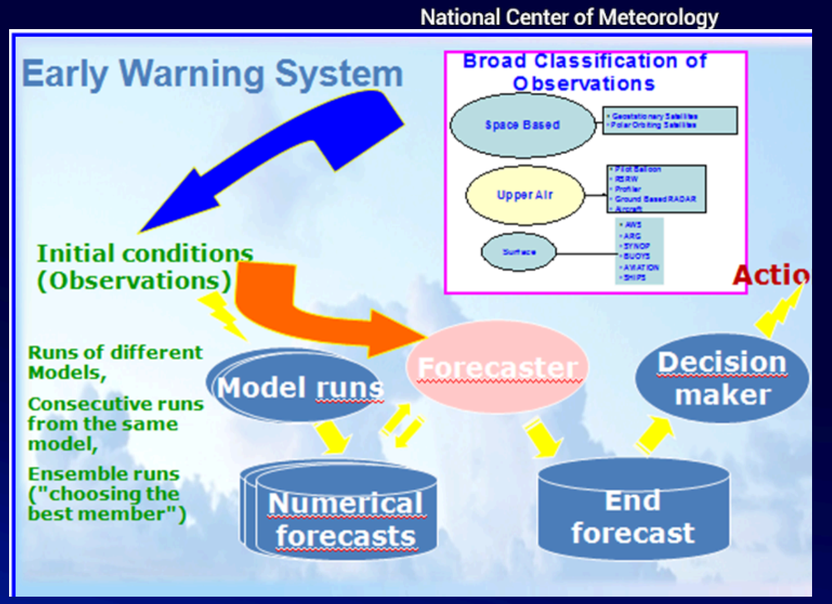
National Center of Meteorology

- Extreme weather events such as heatwaves, heavy rainfall, droughts, and cyclones have become more frequent and severe in recent decades.
- Scientific studies indicate more extreme weather events in the coming years due to global warming.
- Disruptions to agriculture, water resources, infrastructure, and public health are growing challenges.



How can climate service help?

- Provide early warnings to save lives and reduce economic losses.
- Enable better planning and decision-making in sectors like agriculture, energy, water, and disaster management.
- Help communities adapt to changing weather and climate patterns.



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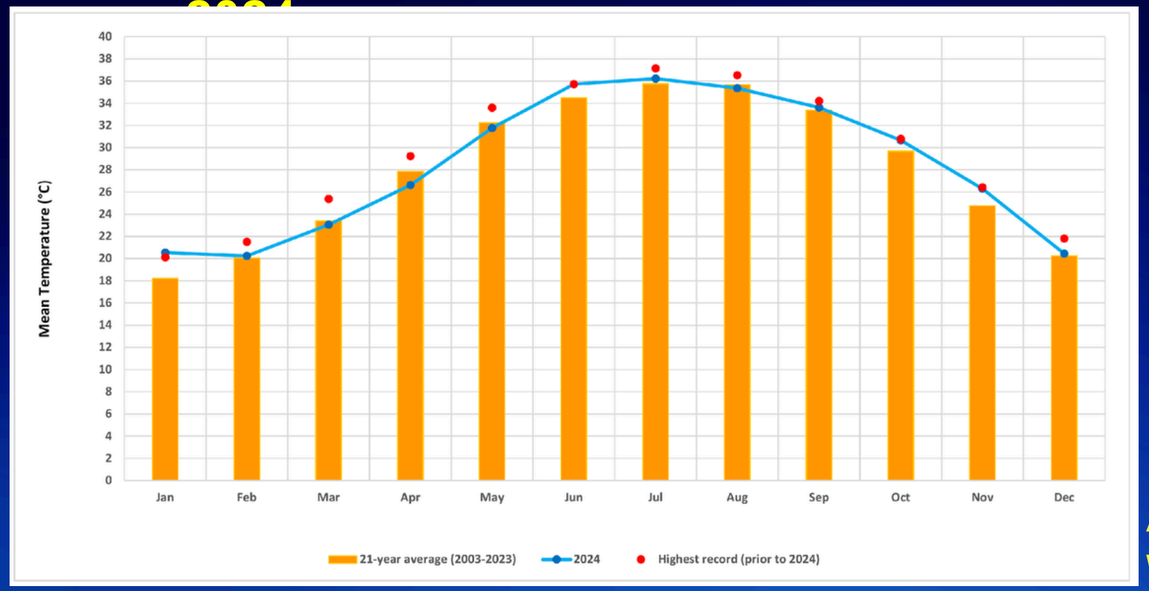
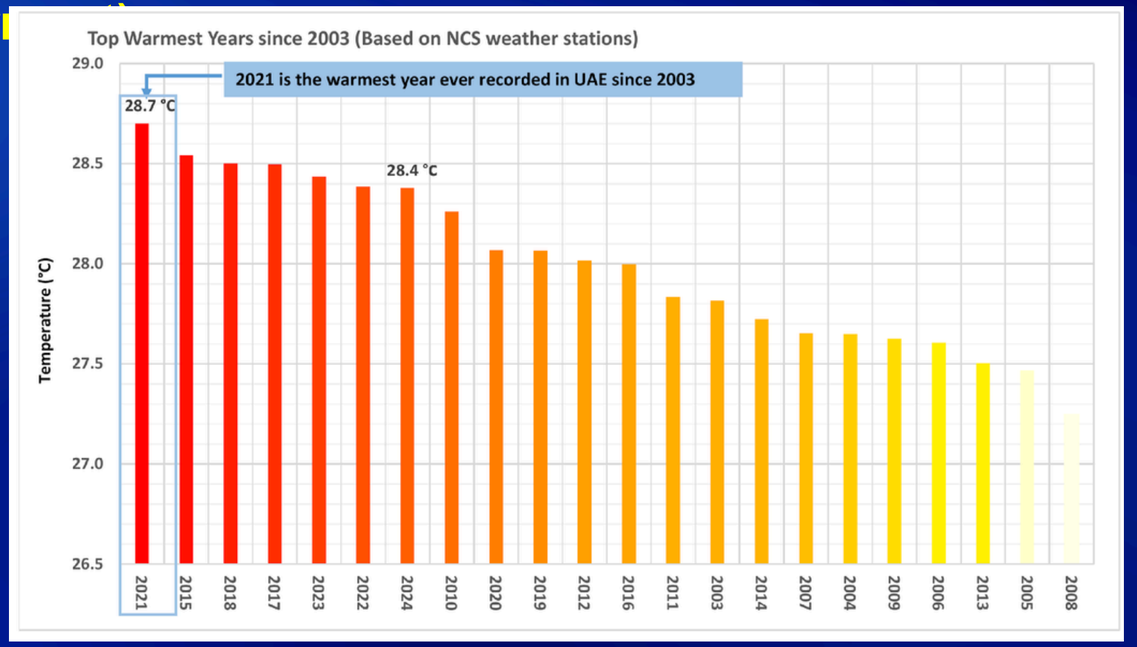
ANNUAL CLIMATE ASSESSMENT 2024 (UAE)

National Center of Meteorology

Monthly Mean Temperature for



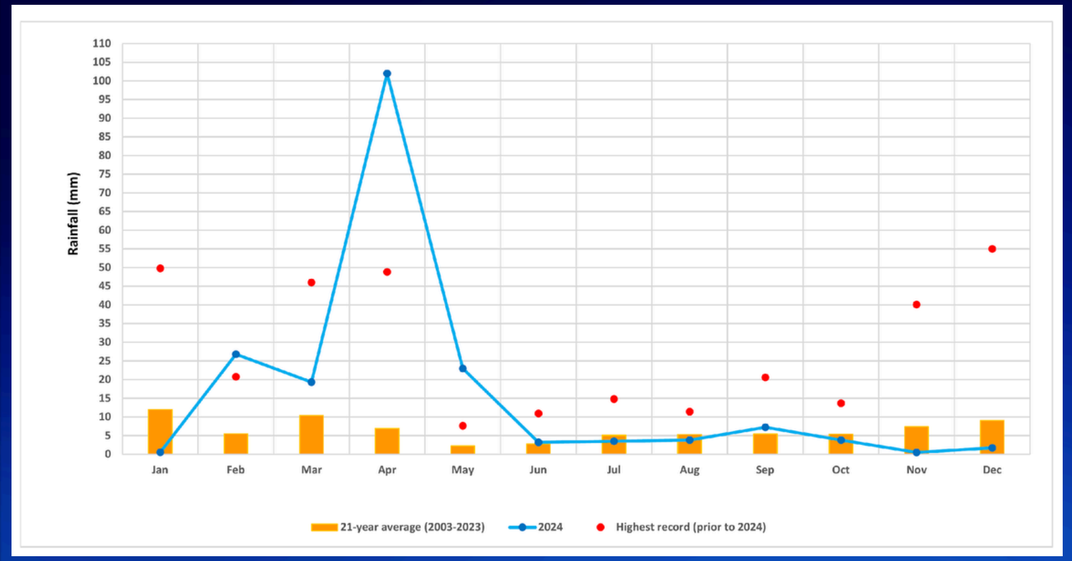
Annual mean temperature from 2003 to 2024 (Top War



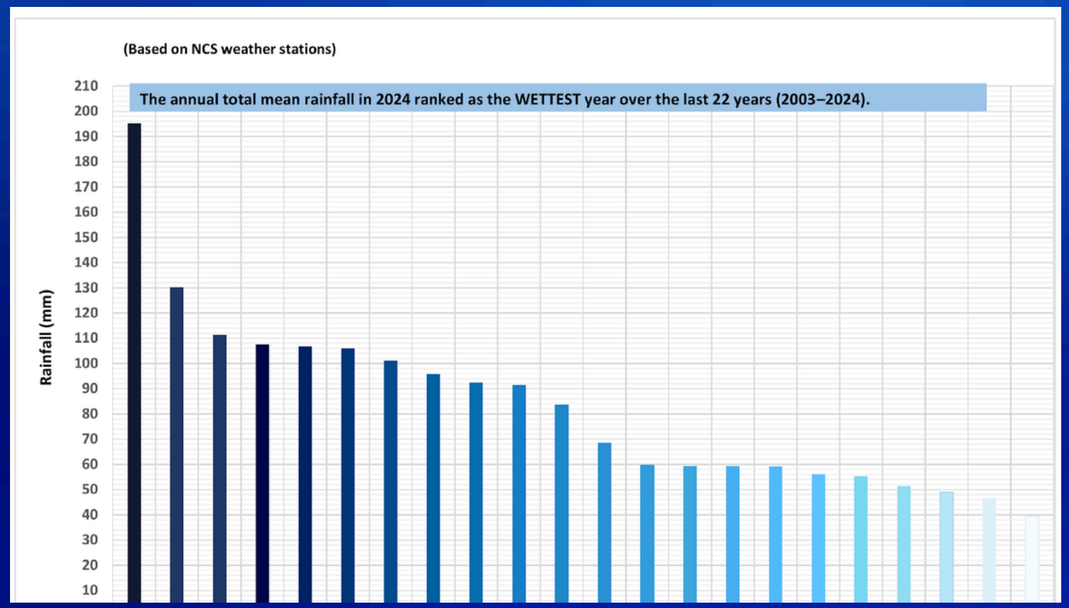
ANNUAL CLIMATE ASSESSMENT 2024 (UAE)

National Center of Meteorology

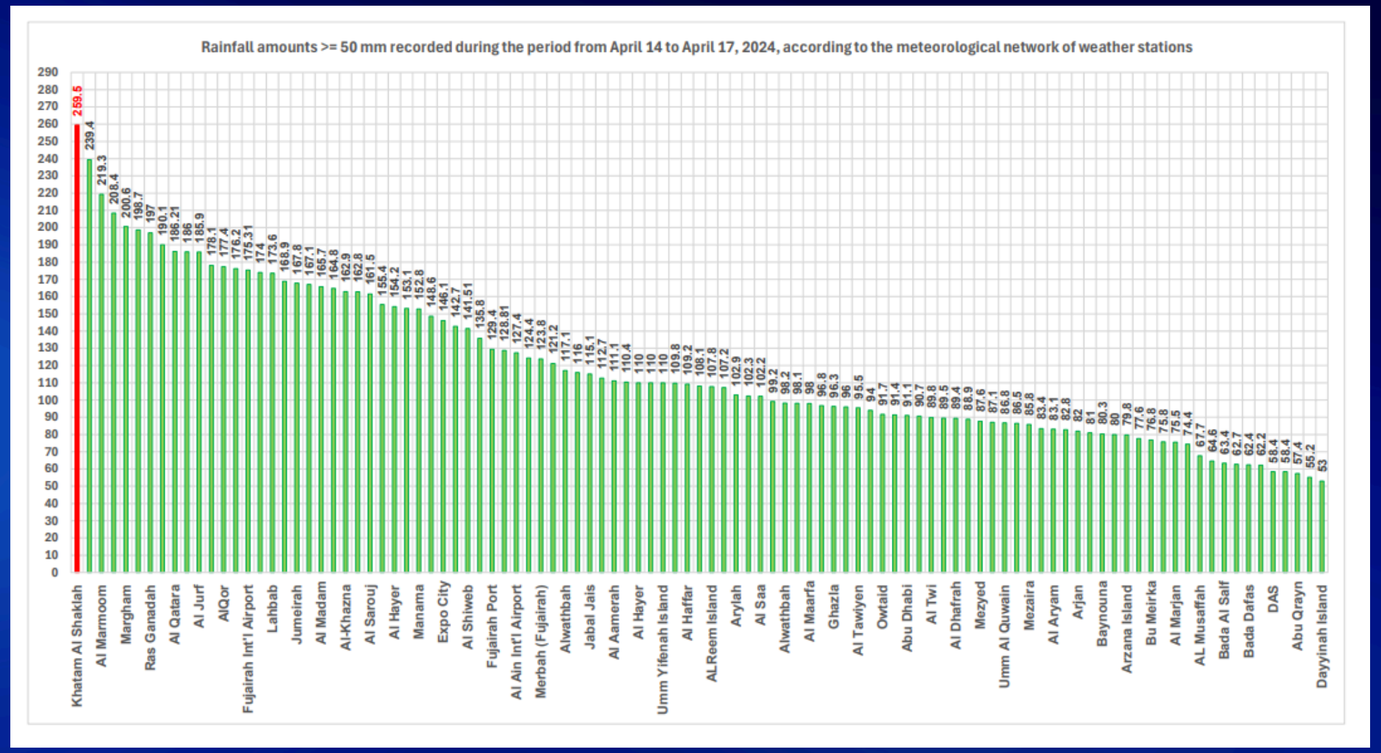
Monthly Total Rainfall for 2024



Annual total rainfall from 2003 to 2024 (Top Wettest)



Rainfall amounts > 50mm during the period April 14 to 17, 2024



ANNUAL CLIMATE ASSESSMENT 2024 (UAE)

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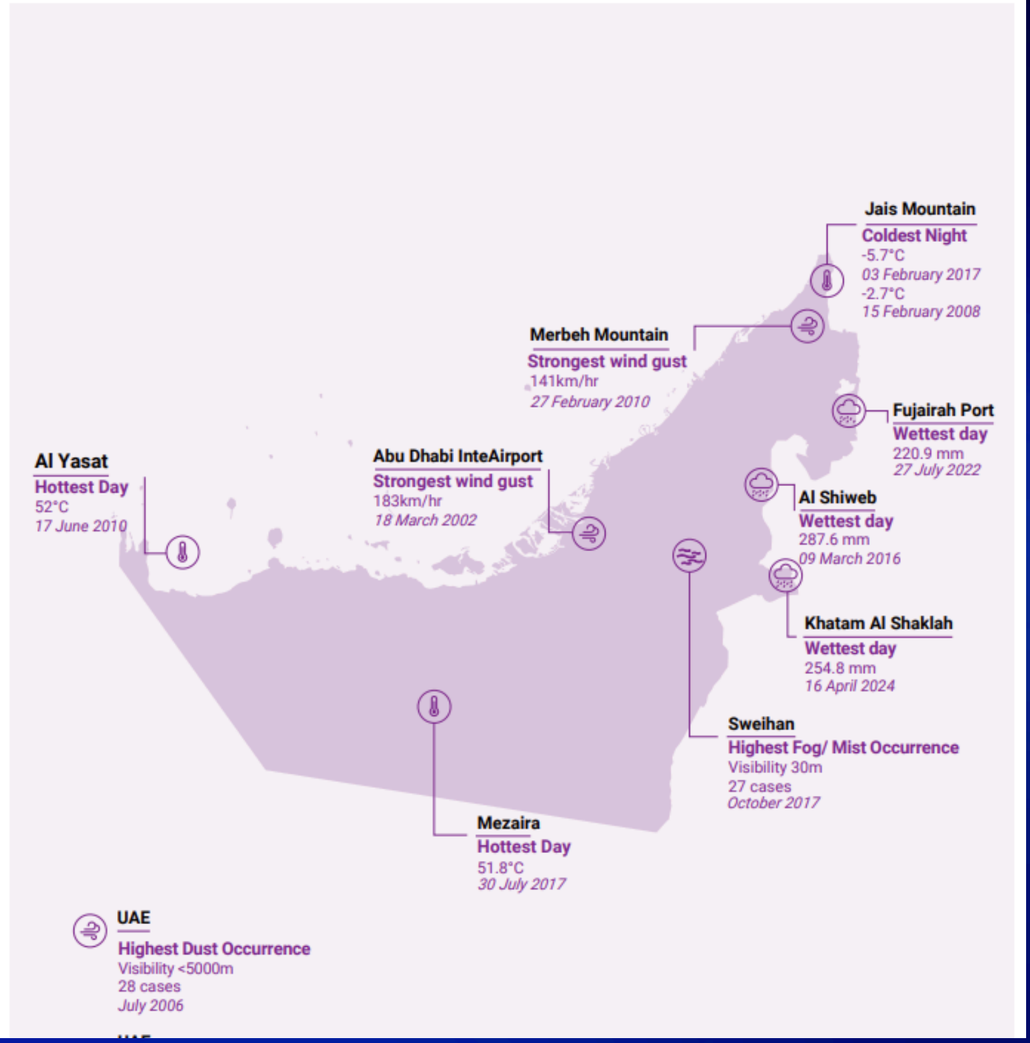
Extreme Weather Events in UAE



Challenges in climate services

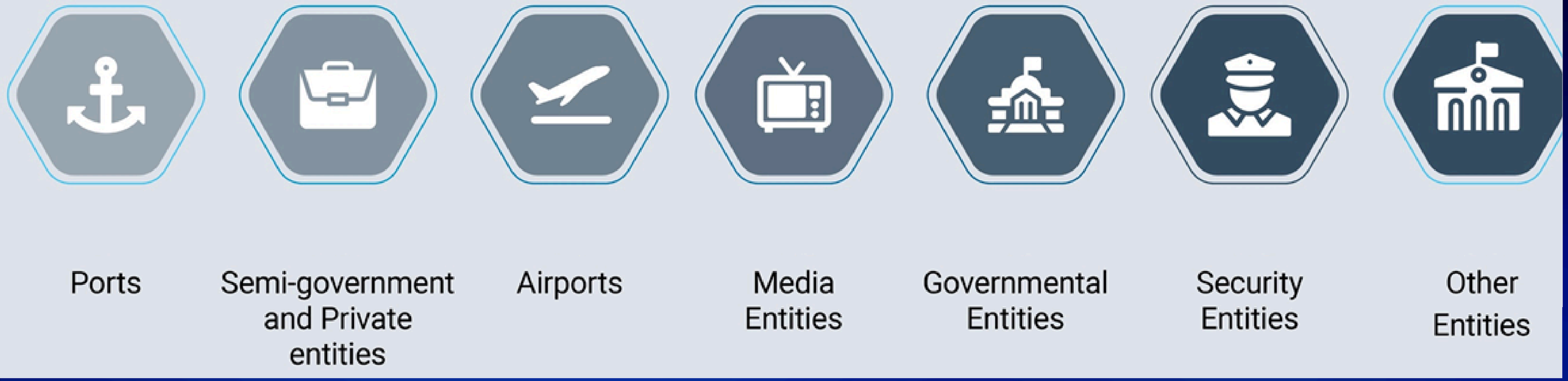
- **Gap between service provider and users:** Important to assess the requirements of users will help to develop scientific policy (user specific identification of parameters, their spatial and temporal resolution, etc.)
- **Uncertainty of data (e.g. model output):** Important to convey the uncertainty of data to take into account in the decision-making for various user sectors
- **Effective communication** of information to diverse users
- **Lack of loss and damage data:** crucial to understand the impacts, assess vulnerabilities and for adaptation strategies. Analysing such data helps understanding the economic, social, and environmental costs, enabling better risk management

Severe Weather Alerts

Knowledge sharing products

- Annual Climate Assessment Reports
- Monthly/Seasonal Climate Outlooks
- Monthly Air Quality and Ozone Outlooks
- WMO's Annual State of Climate Asia Reports
- Hydrology and Renewable energy Reports
- Climate Change Reports

Entities that receive our Services



Introduction – Why AI in Weather?

“Physics-based models are excellent, but AI offers speed and flexibility. The global community is now taking up this new frontier.”

Traditional NWP: Physics-based, computationally intensive

AI/ML: Data-driven, efficient, and fast

Global shift: Major centers are testing AI for operational use

NCM Readiness & Motivation

“We have the data, infrastructure, and expertise. It’s our responsibility to evaluate these tools for UAE's benefit.”

Strong HPC infrastructure

Gridded data: Global Reanalysis (GFS), Regional Reanalysis (ERA5), Forecasts (ICON), Observations (NCM)

National responsibility to evaluate cutting-edge tools

Transforming Weather and Climate Predictions

- The Combining of **artificial intelligence** (AI) and meteorology is transforming how weather and climate forecasting are conducted.
- With unprecedented advancements in computing power, data collection, and machine learning algorithms, AI is helping scientists and meteorologists make predictions faster, more accurately, and with deeper insights into complex atmospheric systems.
- AI offers transformative opportunities for climate services, especially impact-based forecasts, climate risk assessments and future climate projections.
- AI enables us to tailor climate services and products to the specific needs of clients in different sectors, including the water, energy, agriculture, and finance sectors.

The Foundation of AI in Meteorology

Weather forecasting relies on analyzing huge amounts of atmospheric data, including temperature, humidity, wind speed, and pressure.

Traditionally, numerical weather prediction (NWP) models simulate these variables using complex equations that describe the physical processes in the atmosphere.

However, these models require significant computational resources and are limited by their
reliance on assumptions and approximations.

AI, particularly **machine learning** (ML), offers a complementary approach by learning patterns directly from observational and historical data.
This capability enables AI systems to generate predictions without explicitly modelling every physical process.
With access to satellite imagery, ground sensors, and radar data, AI can identify correlations and anomalies in ways that traditional models cannot.

Key Applications of AI in Weather Forecasting

1. Short-Term Weather Predictions
2. Severe Weather Alerts
3. Climate Modeling
4. Data Integration and Analysis

Short-Term Weather Predictions: AI algorithms are excelling in nowcasting predicting weather conditions over a short timeframe (0–6 hours). Tools like deep neural networks analyze real-time radar and satellite data to identify developing storm systems or precipitation patterns.

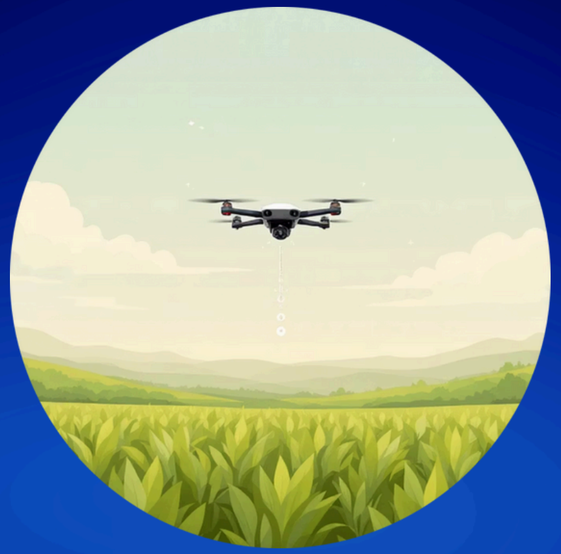
Severe Weather Alerts: AI is instrumental in predicting extreme weather events such as hurricanes, tornadoes, and floods. By analyzing historical and real-time data patterns, AI models can issue early warnings, allowing communities to prepare and minimize damage.

Climate Modeling and Long-Term Predictions: Climate modelling involves simulating Earth's climate system over decades or centuries. AI augments these models by reducing computational time and improving the resolution of simulations.

Real-World Applications

Disaster Risk Reduction

Early warning systems powered by AI for floods, cyclones, and extreme weather events



Agriculture

Precision farming using AI-driven weather forecasts and crop monitoring

Urban Resilience

AI-powered urban planning for climate adaptation and urban heat island mitigation

Insurance

Risk assessment and pricing models based on AI climate projections

Challenges & Limitations

These models are trained mostly on global data. For local extremes custom tuning is needed.

Data Assimilation

Memory & compute requirements

Lack of regional tuning

Future Roadmap @ NCM

- Deploy existing global AI weather models (Pangu-Weather, Graph Cast, AIFS) in a controlled environment at NCM.
- Improve AI model accuracy over the UAE by training or fine-tuning them with UAE-specific historical data.
- Develop a **hybrid prediction system** that leverages the strengths of both physics-based NWP and data-driven AI models.
  - *Correct biases in GLOBAL MODEL outputs (post-processing).*
  - *Predict specific variables like rainfall using AI+NWP inputs.*

Stay Connected

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