Climate Services Development: Experiences from Taiwan

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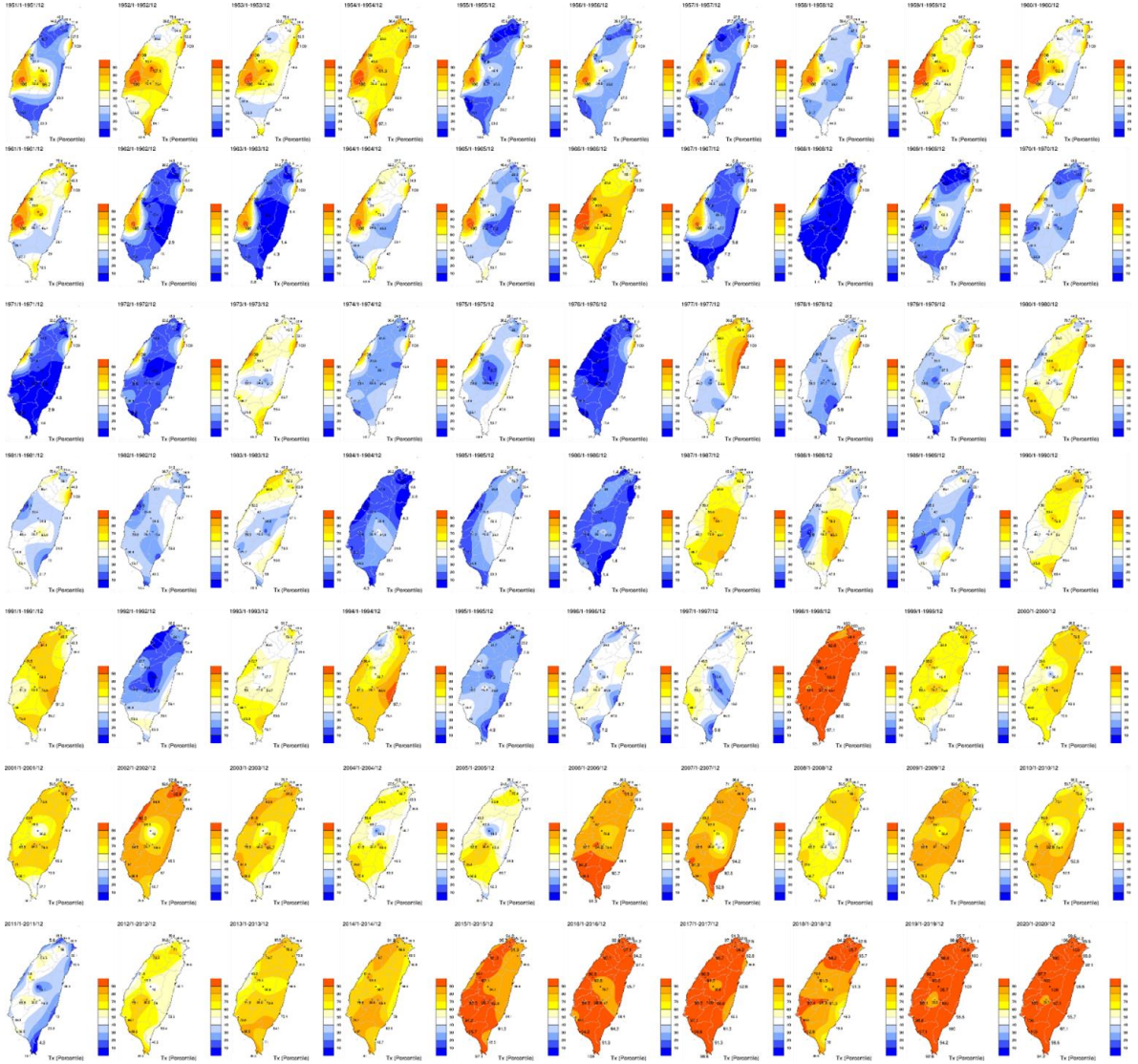
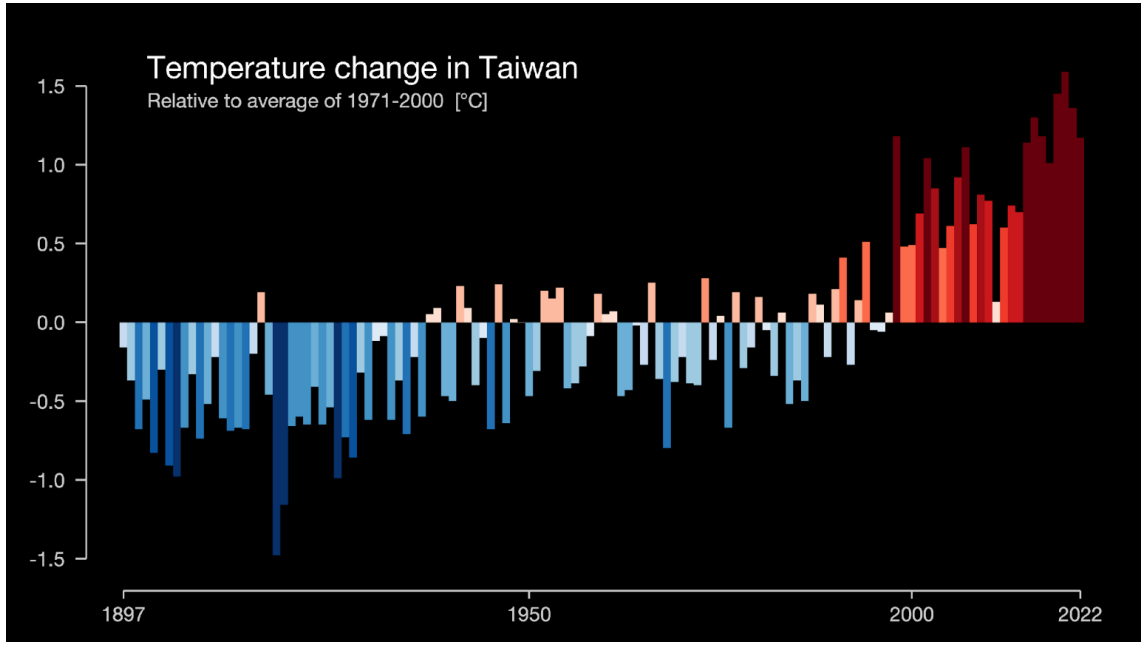
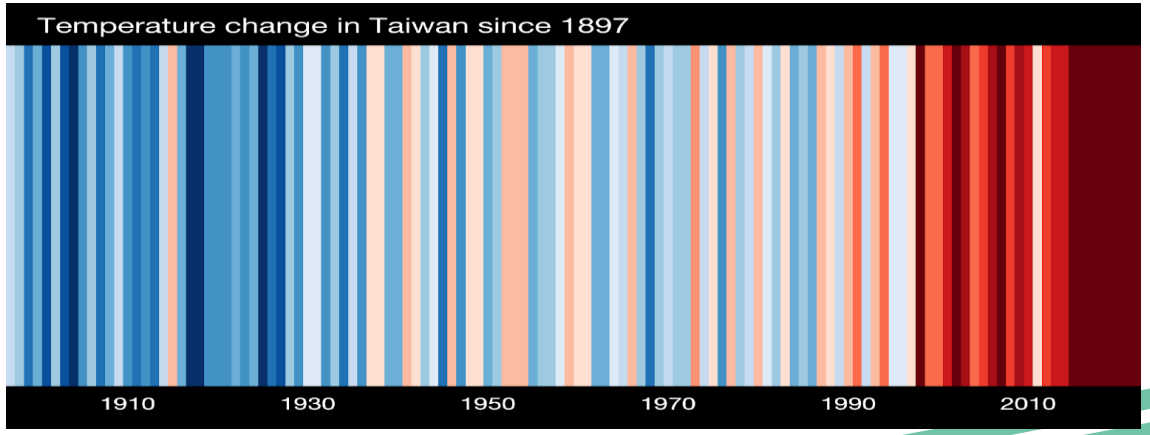
交通部中央氣象局 Central Weather Bureau → 交通部中央氣象署 Central Weather Administration

Taiwan’s Warming Trend



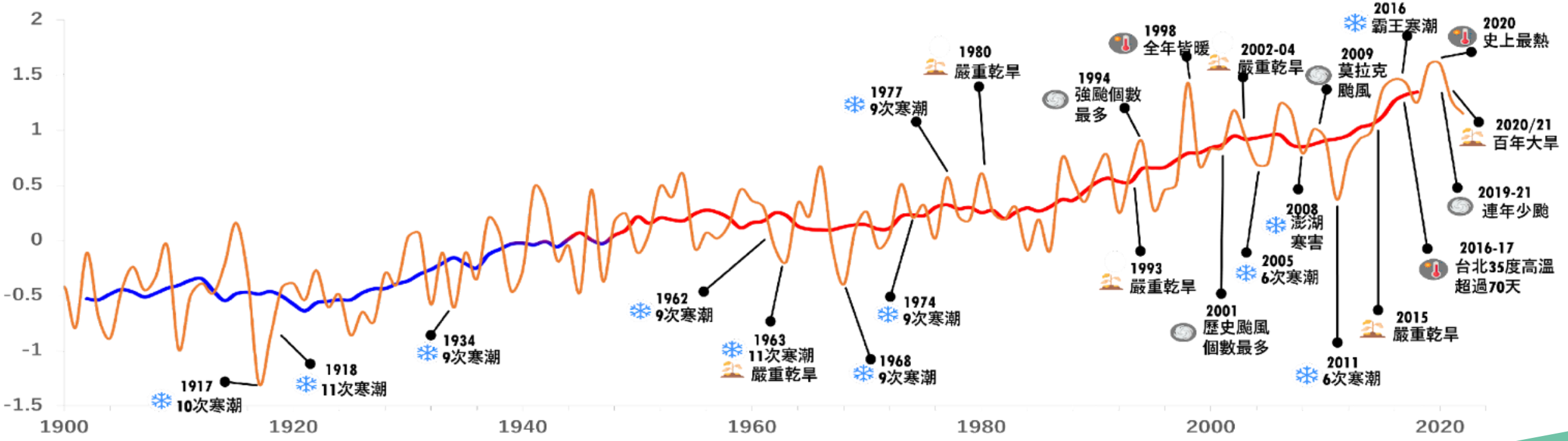




https://showyourstripes.info/l/asia/taiwan/all

More Climate Hazards

- More heat waves
- More heavy rainfall
- Fewer but stronger tropical cyclones
- Fewer but stronger cold surges
- More severe droughts



Helping Various Sectors Deal with the Challenge of Climate Change

Agriculture

Water

Green Energy

Climate Services

Disease

Disaster Risk Reduction

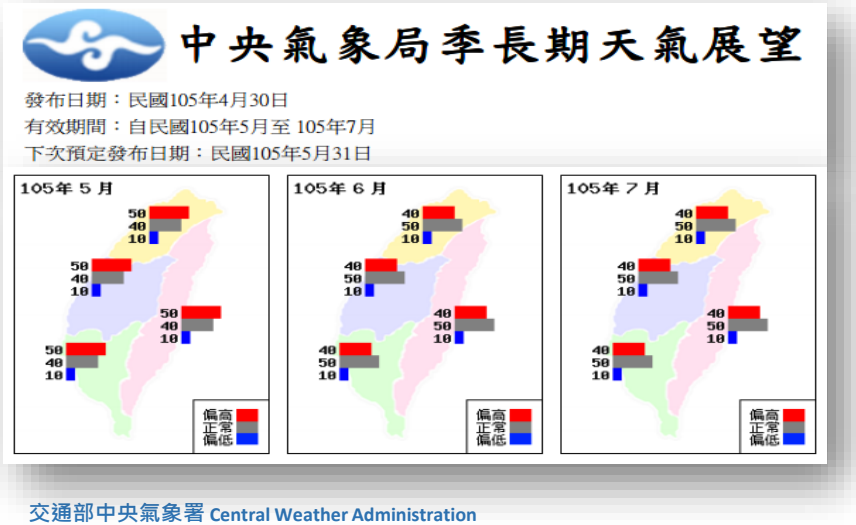
Human Health

Others

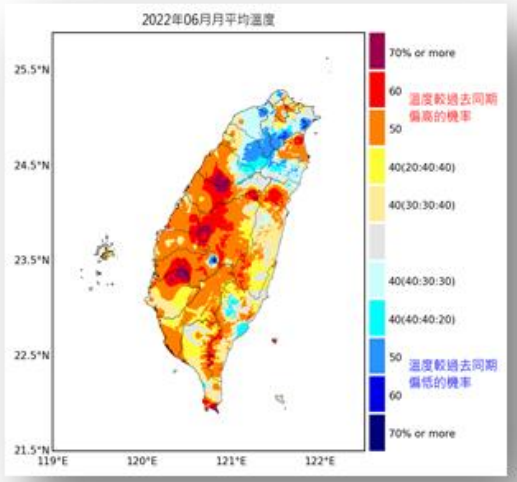
CWA's current monthly and seasonal outlooks do not meet user requirements

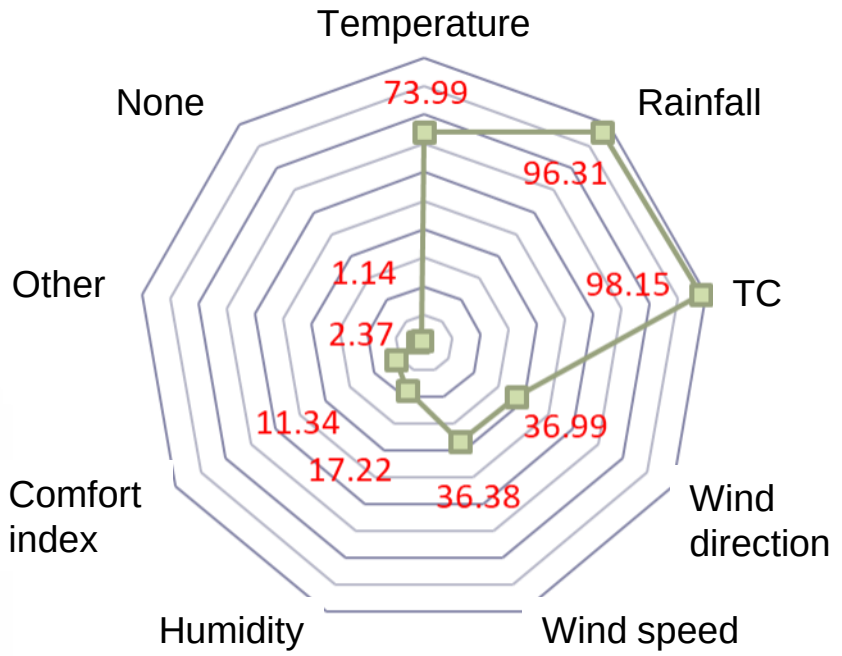
Issues to be addressed:

- Farmers need local climate forecast information.
- Surveys show that the most needed forecast information are tropical cyclones, rainfall and temperature.
  - Soil moisture, sunshine duration, frost are also needed.



From regional to local





How do we provide local forecast information?
Generate science-based downscaling forecast guidance

Air-sea coupled models

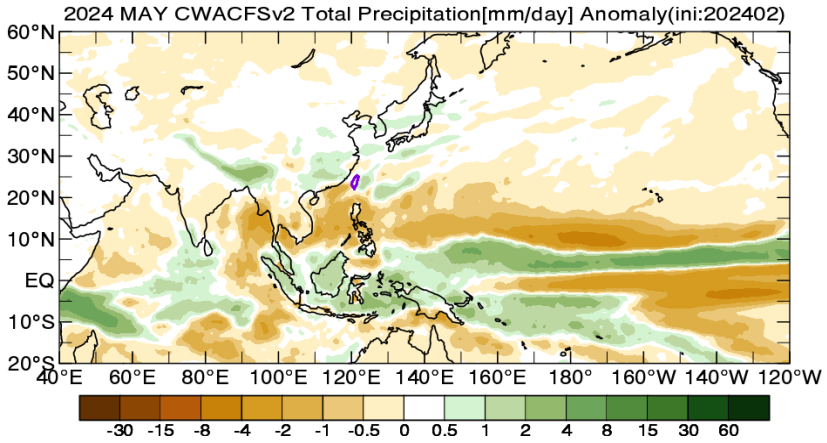
Increasing model resolution
Updating dynamic and physical frameworks
Improving data assimilation

Statistical post-processing technique

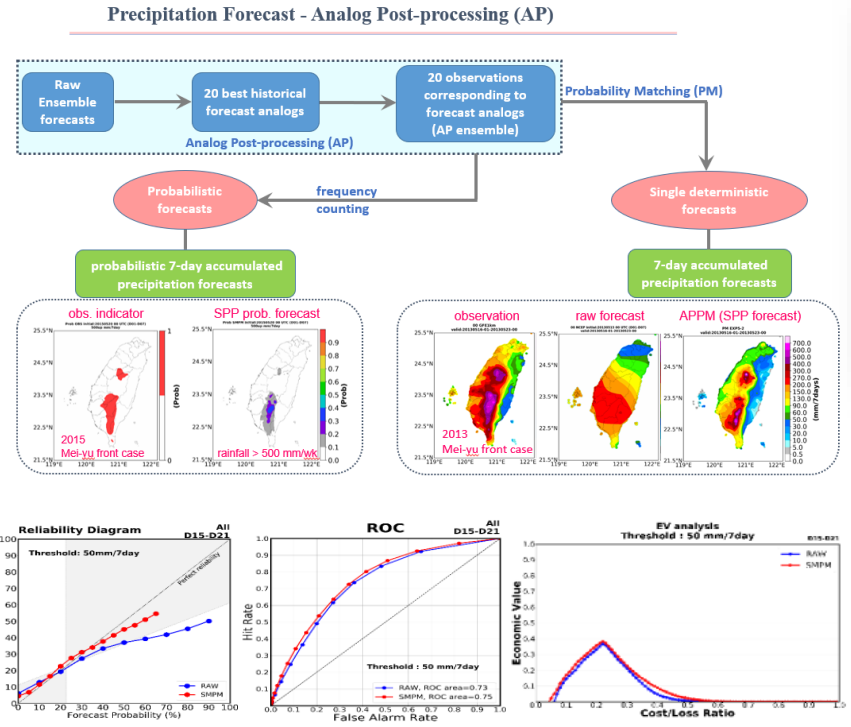
Bias correction
Downscaling
Multi-model ensemble

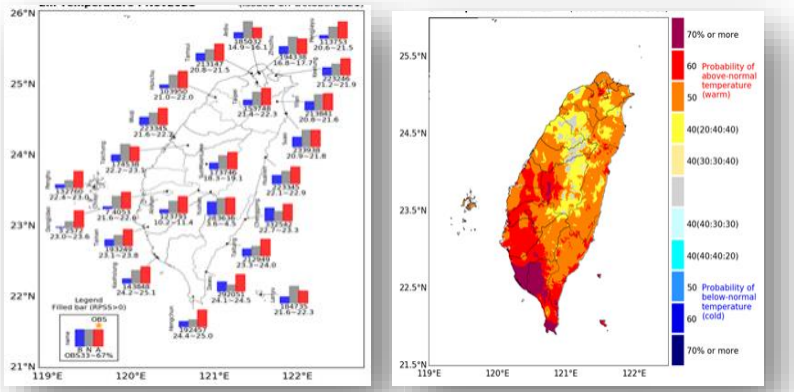
Tailored products

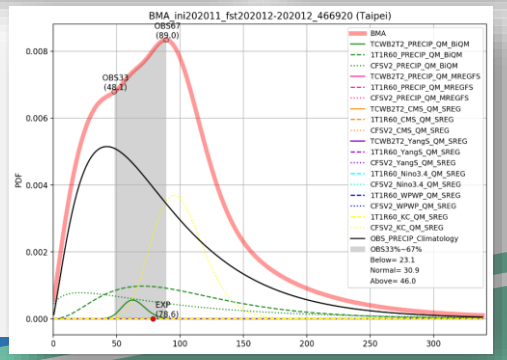
Decision-making support
Calibration and evaluation



CWACFSv2	Atmospheric model		Ocean model	Sea ice model
	CWAGFS	RSM	MOM5	SIS
	Horizontal: T_L359 (~55km) Vertical: 60 levels	Horizontal: 12 km Vertical: 60 levels	Horizontal: 0.5° Vertical: 40 levels	Horizontal: 0.5° Vertical: 3 levels





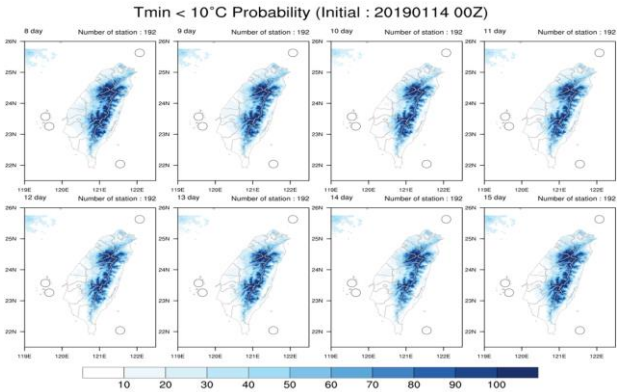


Variety of Statistical Post-processing Products

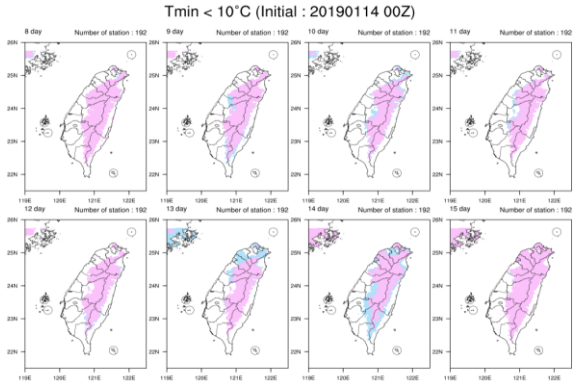
Chang, Hui-Ling et al. (2021)：Statistical post-processing of 1-14 day precipitation forecasts for Taiwan. AOGS2021

Chang, Hui-Ling et al. (2022)：Statistical post-processing of 1-14 day probabilistic forecasts for cold extremes over Taiwan. AOGS2022

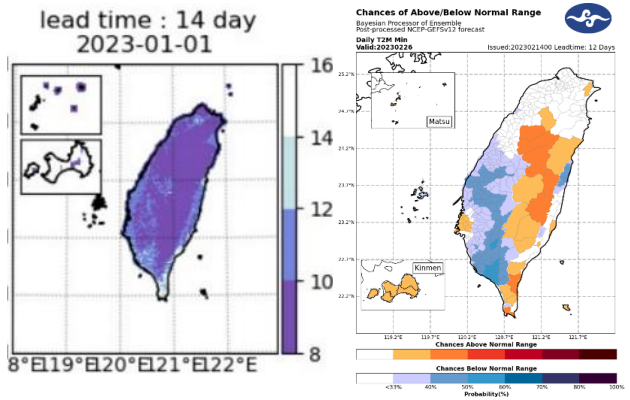
Day 8-14 T min<10°C probability (EKDMOS)



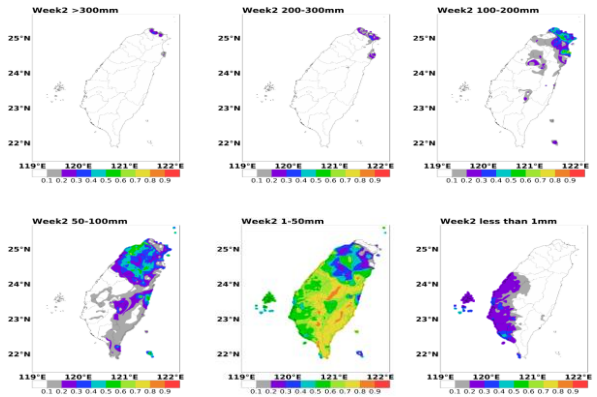
Day 8-14 T min<10°C guidance (EKDMOS)

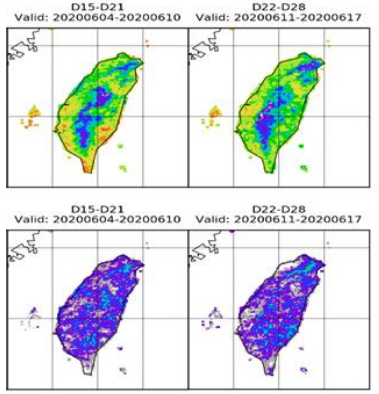


Day 8-14 T min (Bayesian Processor of Ensemble)

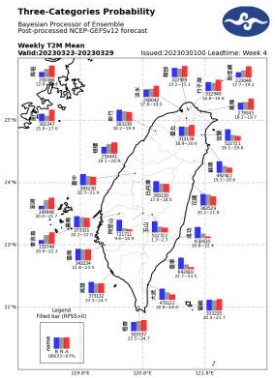


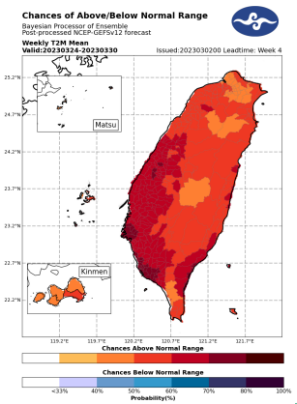
Week 2-4 Probability of Quantitative Precipitation Forecast (Analog)





Week 3-4 Above/Below Temperature Prob. (BPE)

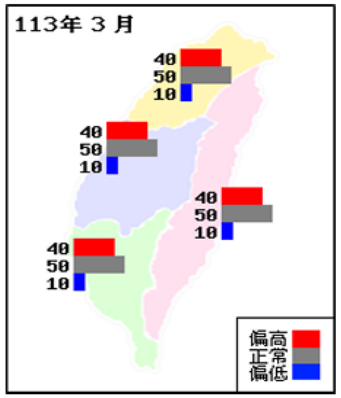




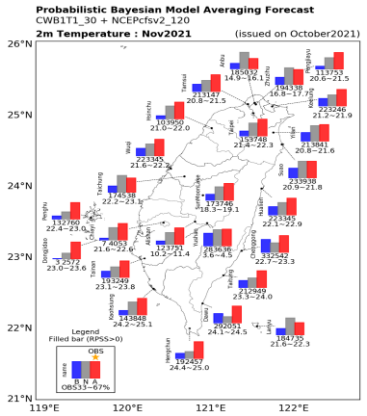
Users are not familiar with probability forecasts?
Translate probability forecasts into tailored products

Meteorological perspective

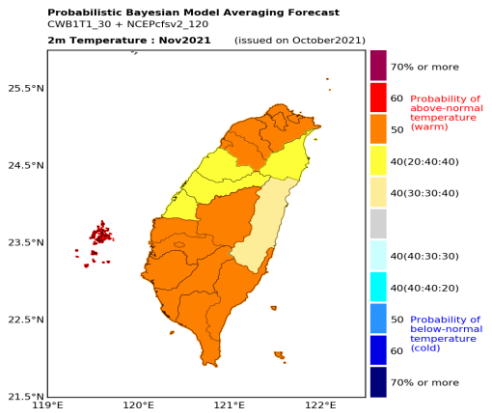
Region



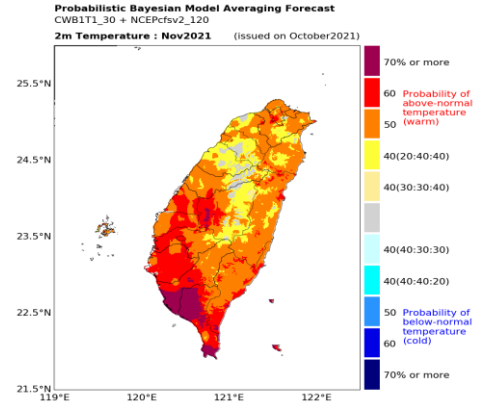
Station



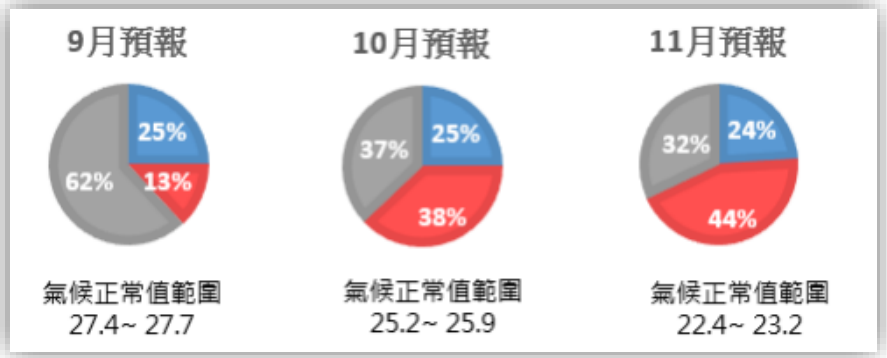
County



Local



User's perspective

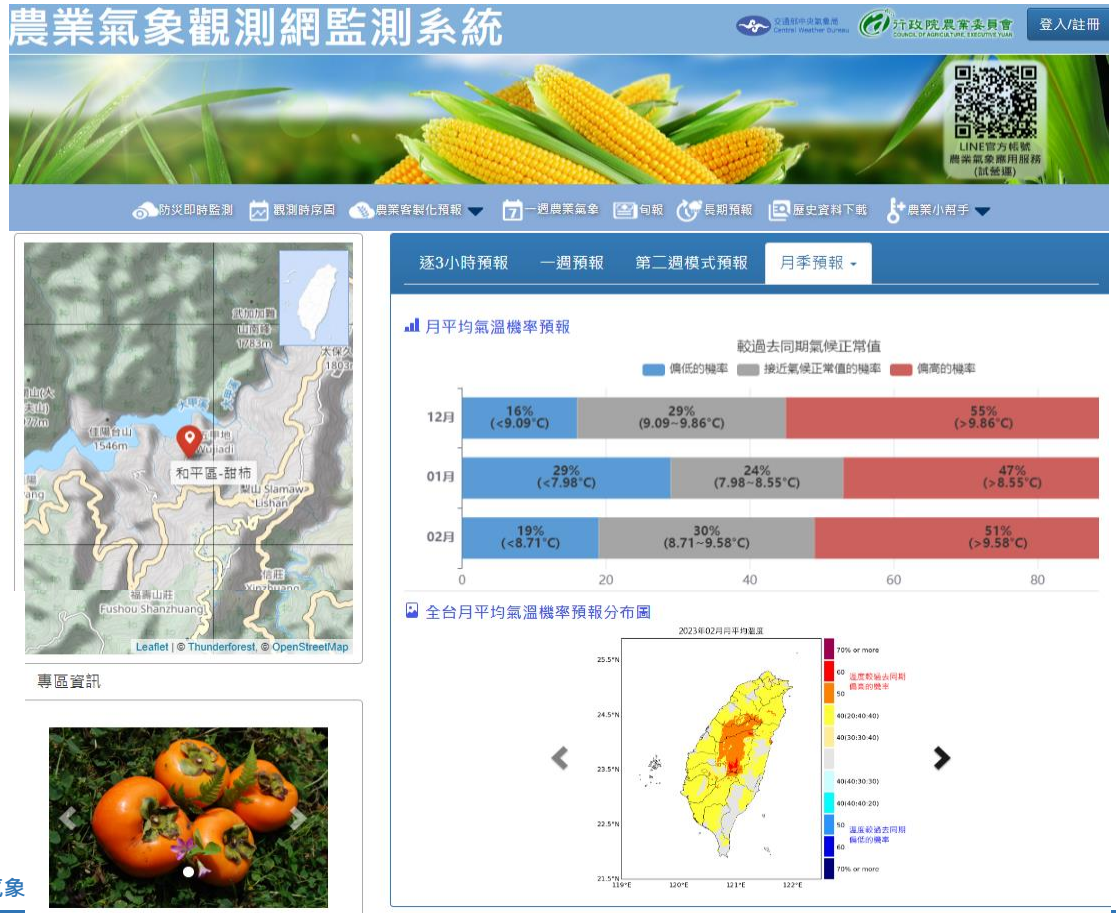


Warning Signal is expected

Dissemination Through Multiple Channels

- Surveys show that most farmers' actions are based on information from TV, own experience, talk with others, crop cultivation calendar, mobile phone, radio, internet and newspaper.

https://agr.cwa.gov.tw



APP

(iOS版)

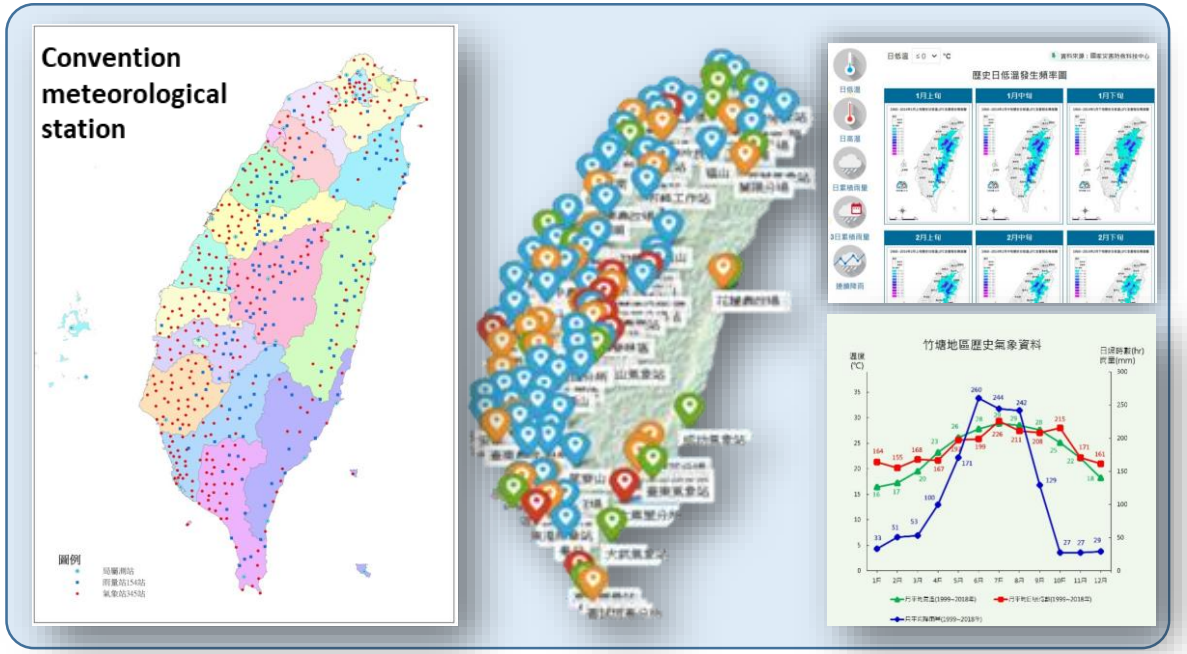
(Android版)

Line

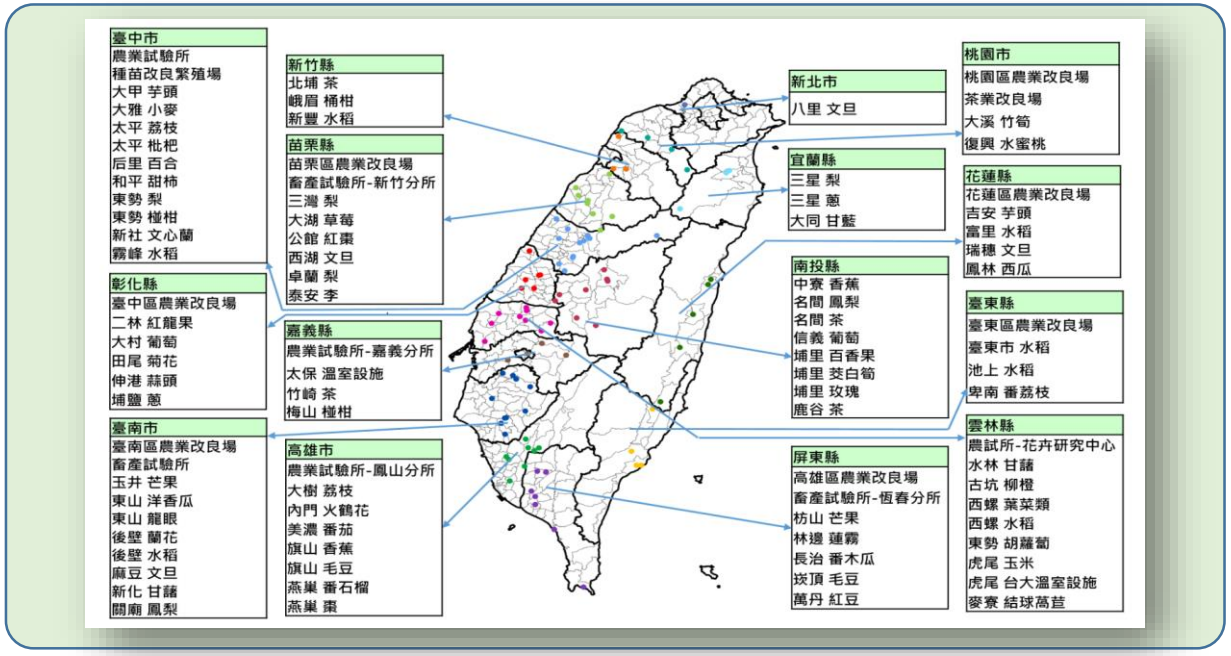
LINE官方帳號
農業氣象應用服務
(試營運)

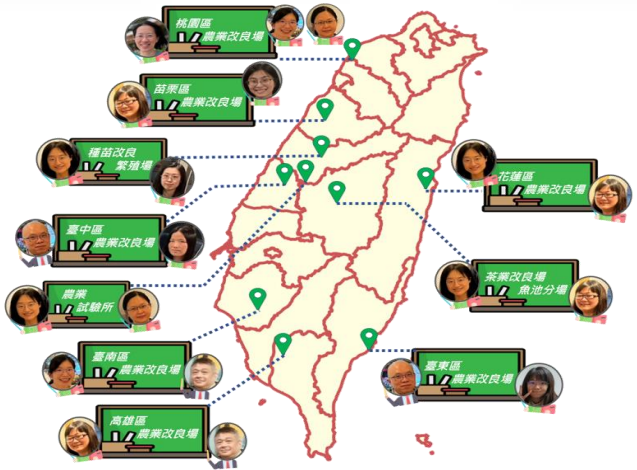
Outreach to promote/translate climate information to farmers

Enhancement of agriculture observatory and forecast guidance



Establishing agriculture disaster early warning system for 41 crops at 92 locations





Smart Climate Services for Agriculture and Cross-Sector

Public-Private Partnership

Central Weather Administration

Climate data

Science-based technology
- Bias correction
- Downscaling

Climate information

Cross-sector information

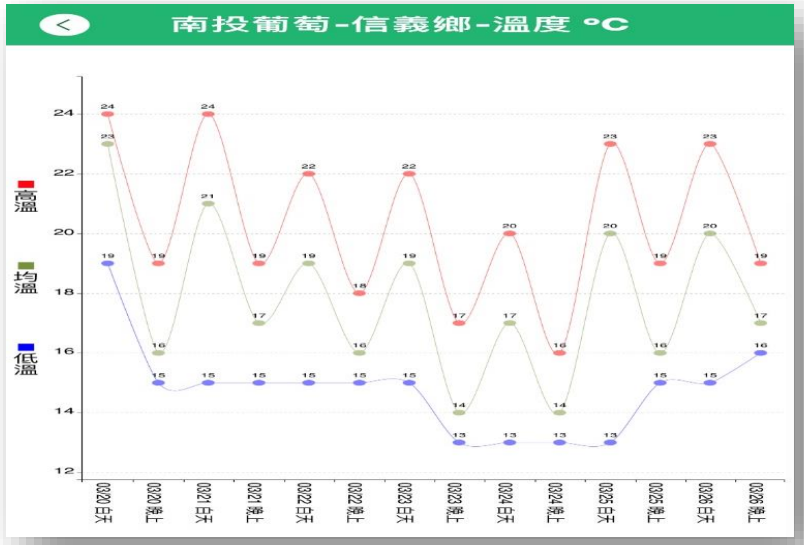
Tailored product and decision-making tools

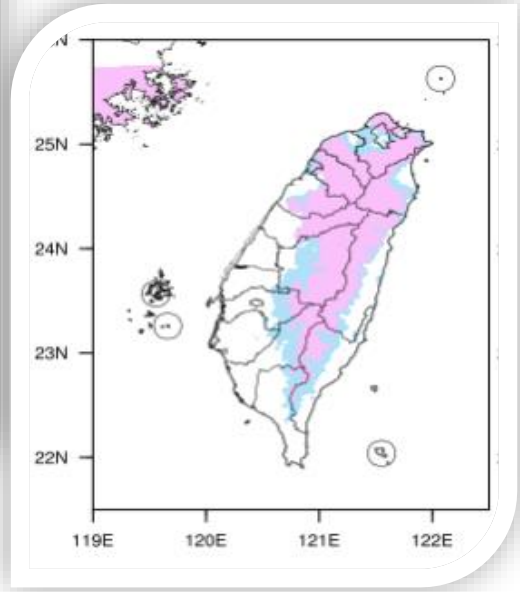
Ministry of Agriculture

Agriculture information

Private sector
(Translator)

Services for farmers



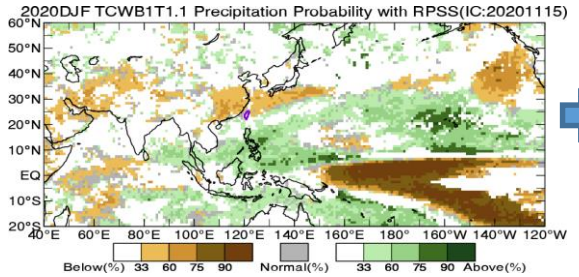


Seamless Climate Services for Drought Mitigation

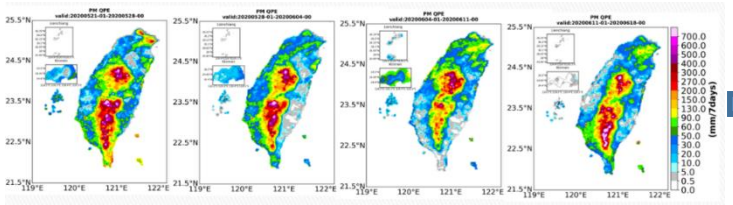
- Close communication between meteorological and hydrological agencies
  - Water management and working group meetings every week (46 and 38 times respectively during mega drought)
- Different periods within a drought require different rainfall forecasts
  - Reservoir recharging at the beginning of dry season (TC frequency forecasts)
  - Irrigation suspension in December (first and second seasonal forecasts)
  - Spring rain arrival in February (MJO/S2S forecasts)
  - Water rationing in March/April (Day 1-7/S2S/seasonal forecasts)
  - Plum rain arrival in May (EASM onset forecasts)

- Seasonal (season 1-2) → Monthly (month 1-3)→ Weekly (week 1-4) → Daily (day 1-7)
- Global → Regional → National → Local
- Qualitative → Quantitative

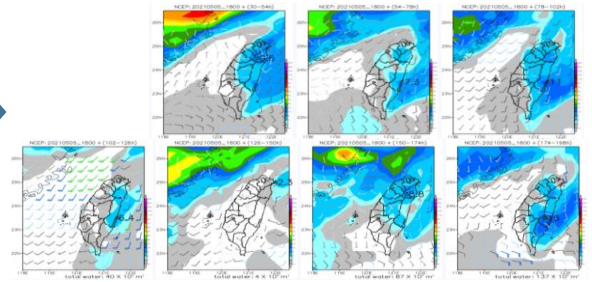
3-month and 2nd seasonal forecasts



Week 1-4 forecasts

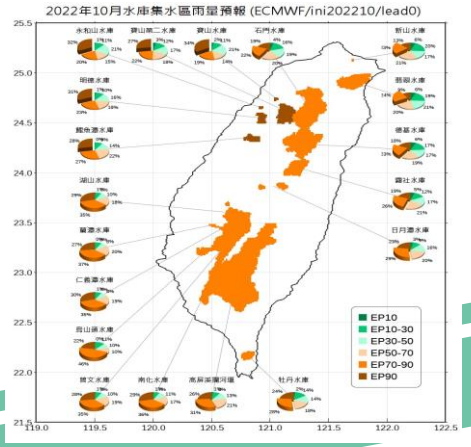


Day 1-7 Quantitative Precipitation



Tailored products for reservoirs

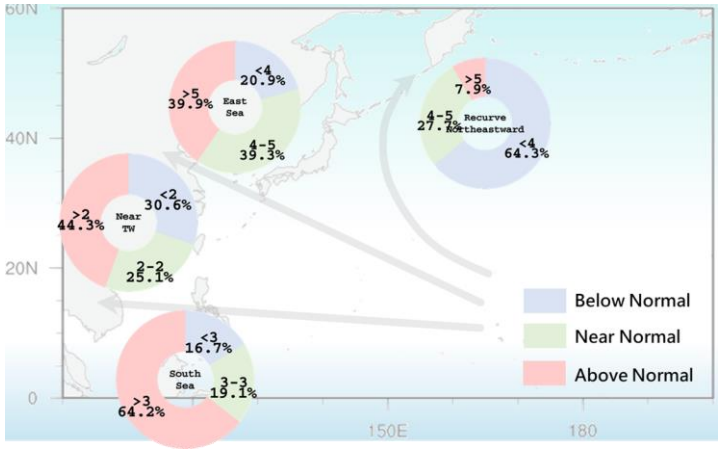
Probability of Exceedance



Seamless Forecasts of Tropical Cyclone for Disaster Risk Reduction

Early Warnings for All

TC seasonal forecasts



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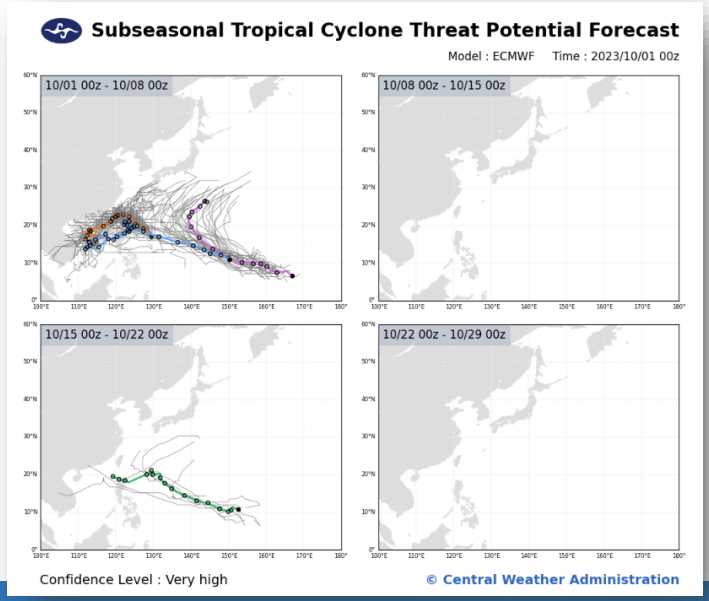
TC Week 1-4 forecasts



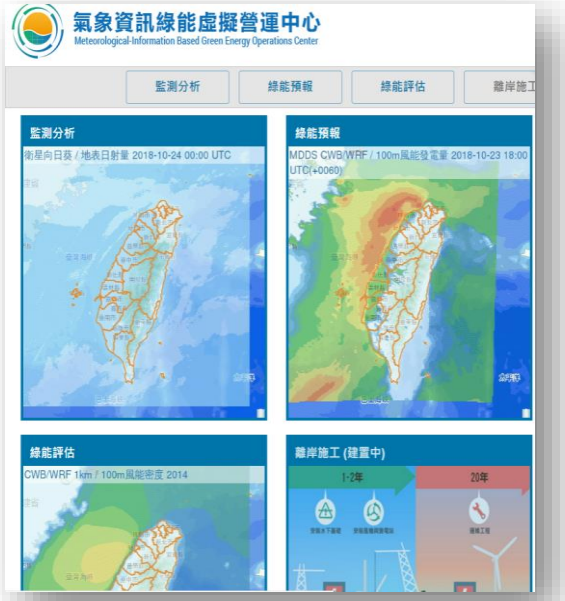
TC warning

Climate Service Information System

https://agr.cwa.gov.tw/

https://qpeplus.cwa.gov.tw/WRA/

https://greenmet.cwa.gov.tw/



Agriculture

Hydrology Water Resource

Green Energy

Disease

Partnership and Cooperation

Disaster Risk Reduction

Health

Others

iPhone 用戶
App Store
DOWNLOAD APP FROM APPLE STORE

Android 用戶
Google Play
DOWNLOAD APP FROM PLAY MARKET

Climate Service Portal (Under development)

- Climate Science
- Climate Services
  - Examples for adaptation
  - Examples for mitigation
- Real-time monitoring
- Climate Prediction
- Climate Data
- Partnership

Summary

- From CWB to CWA, extending forecast time scale from sub-seasonal, seasonal to inter-annual.
- In order to achieve the goal of Net-Zero Emissions by 2050, provide climate services to assist various sectors in adapting to climate change.