WGNE – WIPPS – EW4AII

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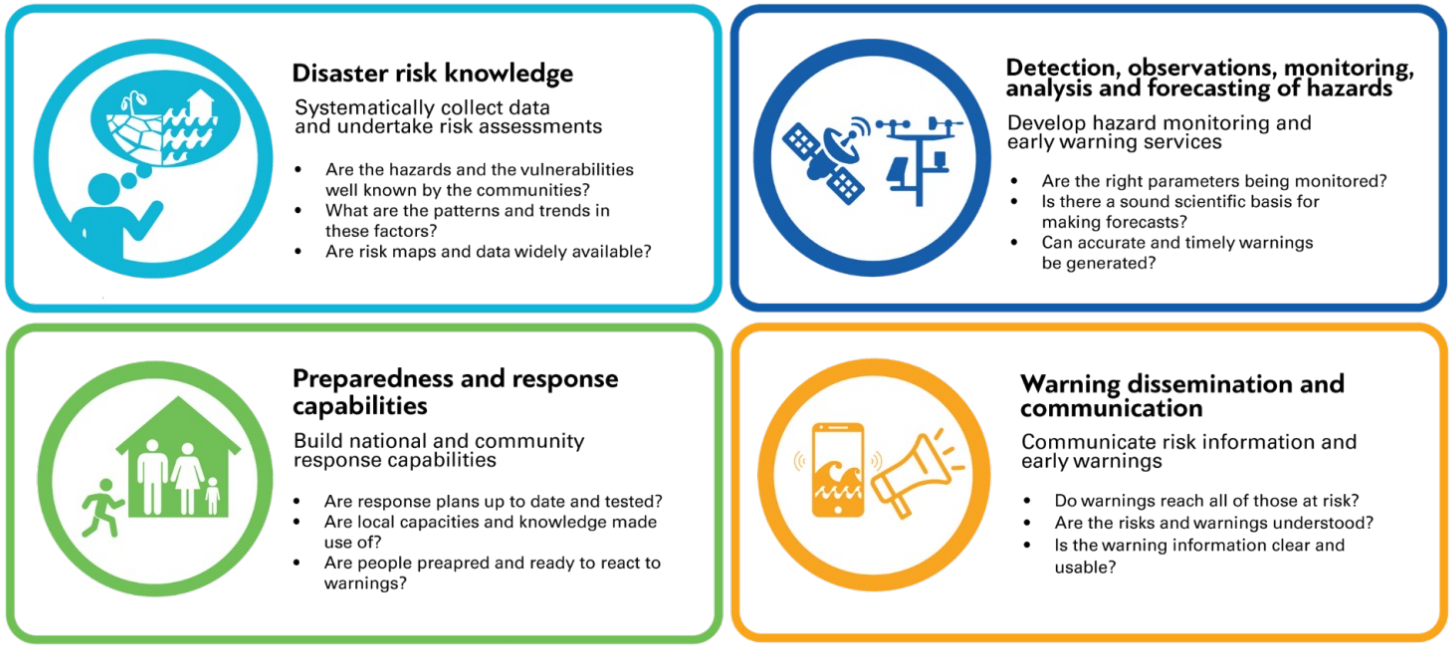
WMO | 1873 2023 IMO-WMO

- EW4All Initiative

Early Warnings for All

- The "Early Warnings for All" initiative is a groundbreaking effort to ensure that everyone on Earth is protected from hazardous weather, water, or climate events through life-saving early warning systems by the end of 2027.
- The Early Warnings for All initiative is built around four key pillars:



Please find more information here.

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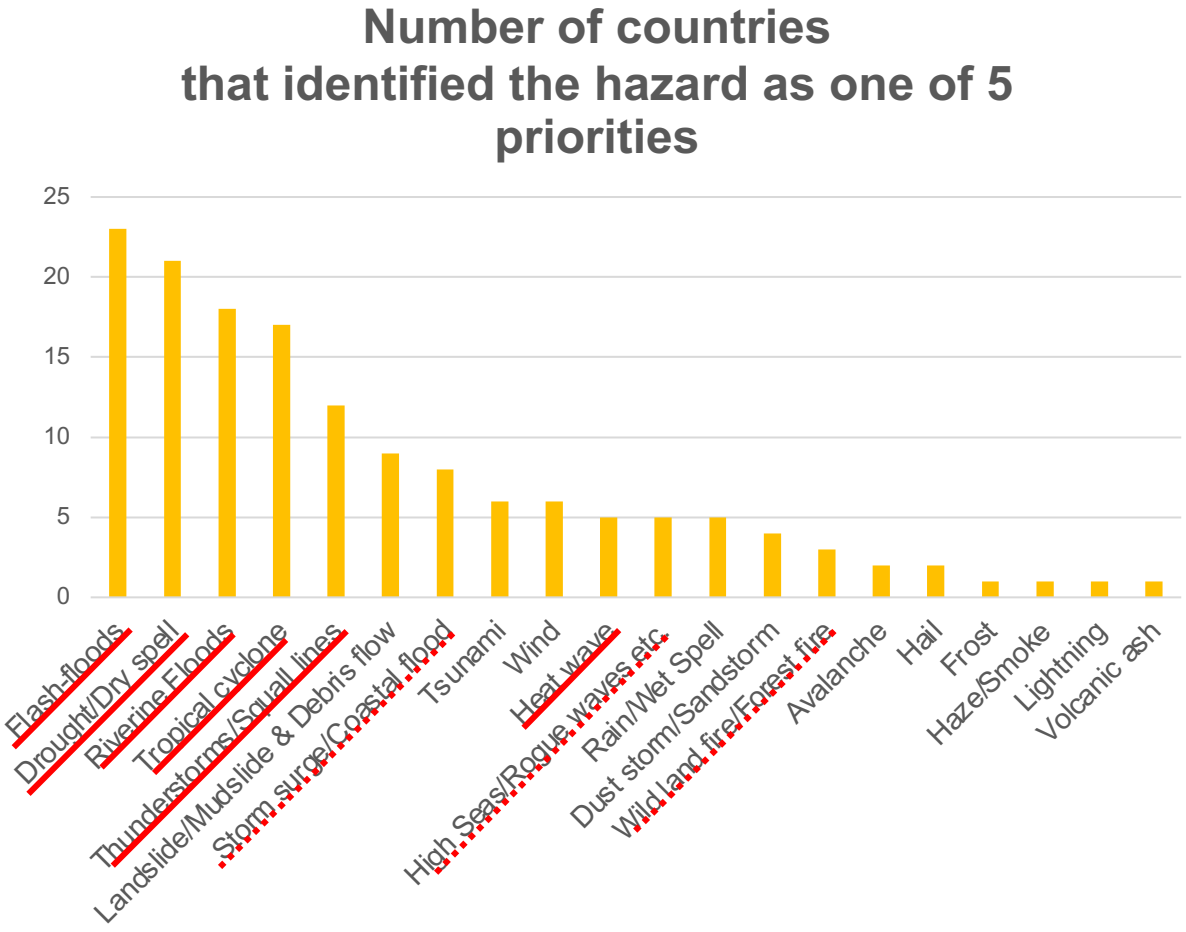
- EW4All Initiative: **Approach to identify priority hazards**

- For the short-term activities of INFCOM, the six hazards were identified, mainly based on the hazards that were most frequently identified as “priority hazards” by the 30 countries.
  - Flash-floods
  - Drought/Dry spell
  - Riverine Floods
  - Tropical cyclone
  - Thunderstorms/Squall lines
  - Heat wave
- List of hazard types: defined by the implementation plan of the WMO Catalogue of Hazardous Events.



Agenda 6

- Please provide information on emerging opportunities for EW4All from an Earth System Approach: *view of research*
- Agenda
  - **6.1** WMO SI EW4All initiative
  - **6.2** WGNE – evolution of systematic errors in Earth system modelling
  - **6.3** Activities under WWRP/HIWeather
  - **6.4** Activities under WCRP (ESMO, with contribution from EPESC)
  - **6.5** Activities under GAW
  - **6.6** WIPPS/WWRP/SERCOM Pilot Project on TCs

https://community.wmo.int/en/meetings/wipps-workshop-second-world-meteorological-centres-workshop-geneva-switzerland

Contents

1. Earth system modelling
2. Review from 6th WGNE workshop
3. Weather parameters and high-impact weather indicators
4. WGNE members, current & planned Earth system products
5. EW4All Conclusions

Systematic Errors in Weather and Climate Models

Selected qualitative conclusions for the 2024-2027 time-scale:

Constraining errors on troposphere-stratosphere coupling and improved predictability

Amplitude of diurnal cycle of precipitation over land remains a challenge

Reduction in systematic errors of upper ocean (SST, salinity, Gulf stream separation) and of some deep ocean properties

Substantial errors in high-latitudes remain

Substantial MJO simulation errors (and convective boundary layers in coupled models) remain

Substantially improved tropical cyclone track and intensity forecasts, in part through improved air-sea coupling

Improved hydrological and flood prediction and improved representation of vegetation and soil, and snow, in part based on more up-to-date mapping information

Increased complexity of very-high resolution simulations within coupled ocean-atmosphere-land systems give also rise to new systematic errors…

Bias correction of systematic errors through ML/AI advances

Recommendations to advance on systematic error reduction including data assimilation, machine learning, and a hierarchy of models supported by standardised and widely available observational data.

Forecast Errors in Weather and Climate Models 2013 → 2023

Met Office

Tim Graham & colleagues

Based on a range of global models

Area	Parameter	Forecast range								
		T+24 RMSE	T+24 10-year RMSE change	% difference	T+72	T+72 10-year RMSE change	% difference	T+120	T+120 10-year RMSE change	% difference
NH	pmsl	82,4417	67,0675	-22,9	211,6148	173,4242	-22,0	398,8079	354,9571	-12,4
	500 hPa GPH	6,5992	5,244	-25,8	20,7134	17,0331	-21,6	41,8865	37,211	-12,6
	250 hPa wind	3,3205	2,8675	-15,8	7,5864	6,7353	-12,6	12,5156	11,6188	-7,7
	250 hPa temp	0,6437	0,5743	-12,1	1,4889	1,3209	-12,7	2,3724	2,1715	-9,3
TR	850 hPa wind	1,6936	1,5059	-12,5	2,643	2,4518	-7,8	3,2955	3,1333	-5,2
	250 hPa wind	3,0121	3,1105	3,2	5,3702	5,5818	3,8	7,0235	7,3234	4,1
	250 hPa temp	0,3827	0,4454	14,1	0,6646	0,7205	7,8	0,8236	0,8538	3,5
SH	pmsl	96,6029	69,2929	-39,4	266,07	206,771	-28,7	507,1582	435,204	-16,5
	500 hPa GPH	8,343	6,1211	-36,3	26,2052	20,1679	-29,9	51,8982	44,0892	-17,7
	250 hPa wind	3,3525	2,952	-13,6	8,1274	6,9988	-16,1	13,6093	12,2837	-10,8
	250 hPa temp	0,665	0,5999	-10,9	1,5812	1,3605	-16,2	2,5117	2,2335	-12,5

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Forecast Errors in Weather and Climate Models 2013 → 2023

High Impact weather error reduction

Thomas Haiden

Feature	Current error or score (2023)	Error or score 10 years ago (2013)	Approximate improvement in 10 years	Comments
Tropical cyclone position	MAE (D+3) = 160 km MAE (D+5) = 250 km	MAE (D+3) = 180 km MAE (D+5) = 350 km	11% 29%	
Tropical cyclone intensity (central pressure)	MAE (D+3) = 11 hPa	MAE (D+3) = 15 hPa	27%	
Strong wind	ROCS (D+5) = 0.77	ROCS (D+5) = 0.72	6%	EFI (95th percentile) ROC skill in Europe
Significant wave height	SI (D+3) = 20% SI (D+5) = 30%	SI (D+3) = 23% SI (D+5) = 33%	13% 9%	SI = Scatter Index (error standard deviation divided by obs) in %
High temperatures	ROCS (D+5) = 0.92	ROCS (D+5) = 0.88	5%	EFI (95th percentile) ROC skill in Europe
Heavy rainfall	ROCS (D+5) = 0.68	ROCS (D+5) = 0.63	8%	EFI (95th percentile) ROC skill in Europe
Heavy rainfall	ETS (D+3) = 0.155 ETS (D+5) = 0.100	ETS (D+3) = 0.125 ETS (D+5) = 0.075	24% 30%	Equitable Threat Score (ETS) for >50mm/24h in N. Extratropics

Systematic Errors in Weather and Climate Models

Open data

https://www.ecmwf.int/en/forecasts/datasets/open-data

Includes ensemble data on wave products, SST, tropical cyclone tracks, heavy precipitation and strong wind events

Coupled NWP system for ocean-wave-atmosphere-land with 50-member ensemble @ 9km

Coupled extended-range and seasonal system

Systematic Errors in Weather and Climate Models

Fanglin Yang

NCEP Environmental Modeling Center is working with the community to develop a fully coupled ESM, including atmosphere, ocean, ice, wave and aerosols, for applications including global medium-range weather (GFS), ensemble sub-seasonal (GEFS), ensemble seasonal (SFS) forecasts. These applications are scheduled to be **implemented into operation in 2026** with new products available for the user community from these newly added component models of the ESM, including ocean, sea-ice, wave, and aerosols.

NCEP forecast products will be made available for download free of charge to the worldwide user community through publicly accessible ftp sites e.g. *https://ftp.ncep.noaa.gov/data/nccf/com/*

Met Office

Tim Graham

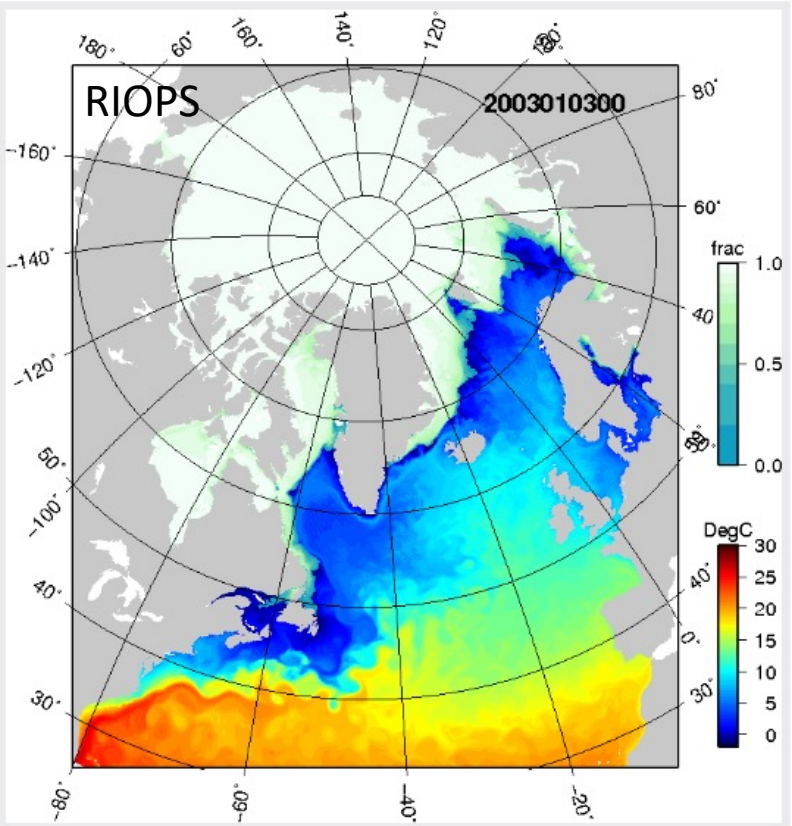
Systematic Errors in Weather and Climate Models

Recently implemented coupled NWP system with the potential to provide output from the ocean and sea-ice components. One example from sea-ice forecasting was a trial contribution to predicting the position of the MOSAIC ship when it was moored alongside an ice flow in the Arctic. A wave model is to be implemented in the system in the next few years but unlikely operational before 2027.

Cryosphere Products for Weather Scales

Ron McTaggart-Cowan

- Sea ice analysis for Canadian waters
- Sea ice forecasts from the Regional Ice-Ocean Prediction System (RIOPS; 1/12°)
- Global ensemble coupled sea ice forecasts
- Pan-Canadian snow analysis and forecast (2.5 km)
- Planned coupled high resolution (3 km) coupled atmosphere-ocean-ice polar system
- Preparation for Terrestrial Snow Mass Mission: Ku-band radar for snow mass at 500 m, in collaboration with the Canadian Space Agency



Animation showing sea surface temperature and ice cover over the Arctic and North Atlantic Oceans

Environment Canada

Cryosphere Products for Longer Time-Scales

Ron McTaggart-Cowan

- Global seasonal predictions of snow water equivalent
- Seasonal Arctic sea ice forecast products, currently provided twice annually to the WMO Arctic Climate Forum (ECCC dissemination under development):
  - Deterministic and probabilistic freeze-up and ice-free dates
  - Probabilistic forecasts of sea ice concentration
- Sea ice reforecasts for the Gulf of St. Lawrence
- Development of a land-surface and terrestrial ecosystem model (CLASSIC) for improved simulation of active-layer depth for Arctic carbon cycle and permafrost thaw modelling

Systematic Errors in Weather and Climate Models

Conclusions for 2024-2027 timeframe

1. **Significant improvements over last decade** on high-impact weather and multi-model hemispheric scores
2. Identified hazards **benefit from progress in land-surface modelling, higher horizontal resolution and integration with hydrological modelling** within land-surface schemes
3. **ML/AI bias correction can improve systematic errors**, **timeliness and uncertainty estimation**
4. Only some institutes ready to make available **open Earth-system data**

Identified hazards:

- Flash-floods
- Drought/Dry spell
- Riverine Floods
- Tropical cyclone
- Thunderstorms/Squall lines
- Heat wave

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Thank you

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