

WMO Integrated Process and Prediction System (WIPPS)

Yuki Honda

Head, Earth System Prediction Division, Infrastructure Department
WMO



The Value Chain

Successful application of weather and climate services depend on a functioning meteorological value chain

Global Meteorological Infrastructure

- Centralized governance
- Decision making at global level
- Standardization of technologies
 - Instruments, metrology, data format, communication standards
- Regulatory approach through WMO's Technical Regulations
 - What to observe, exchange and how
- Capacity development and training



Weather and climate-related infrastructure - must be designed and managed globally

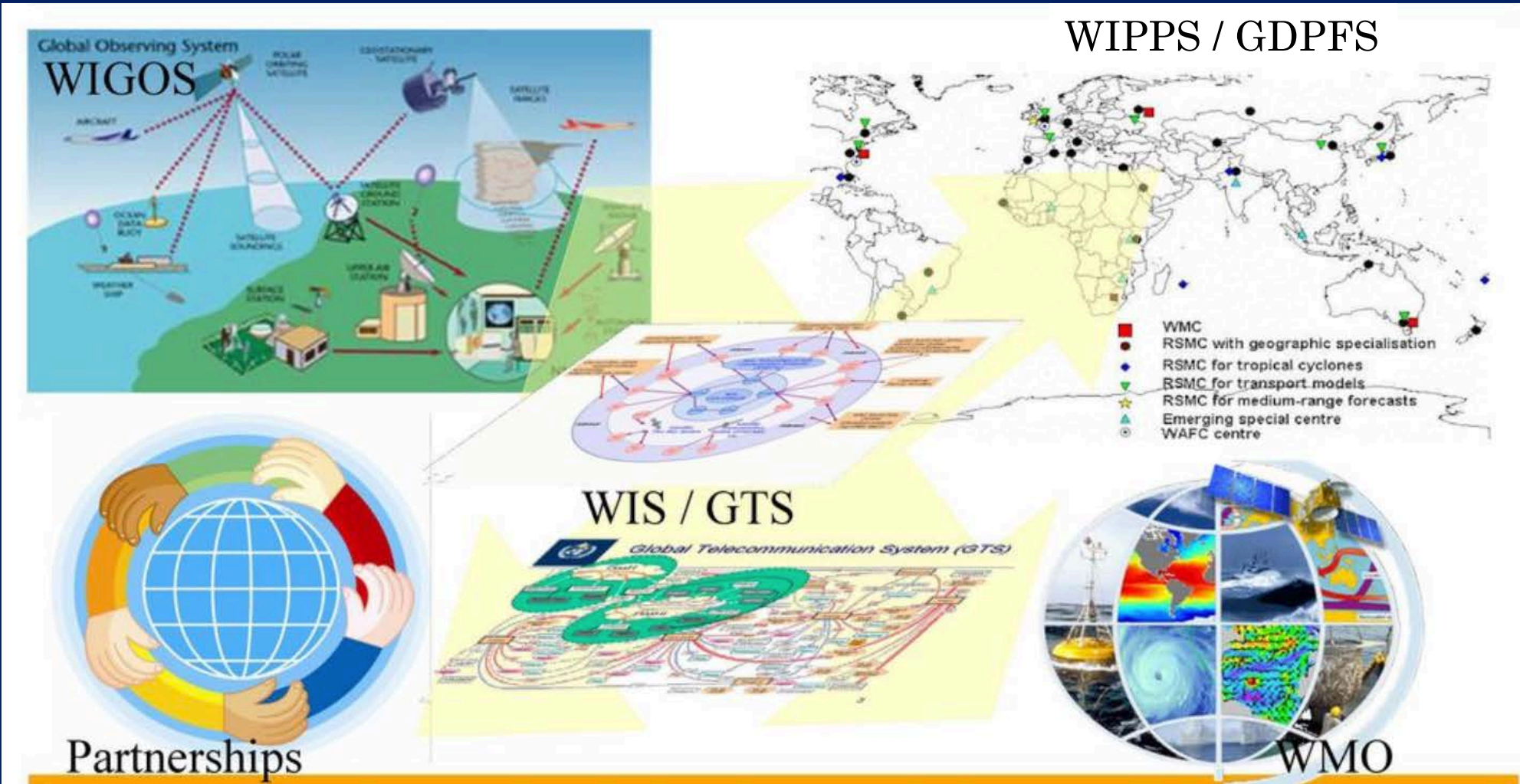
Last-mile activities undertaken primarily at regional, national and local level



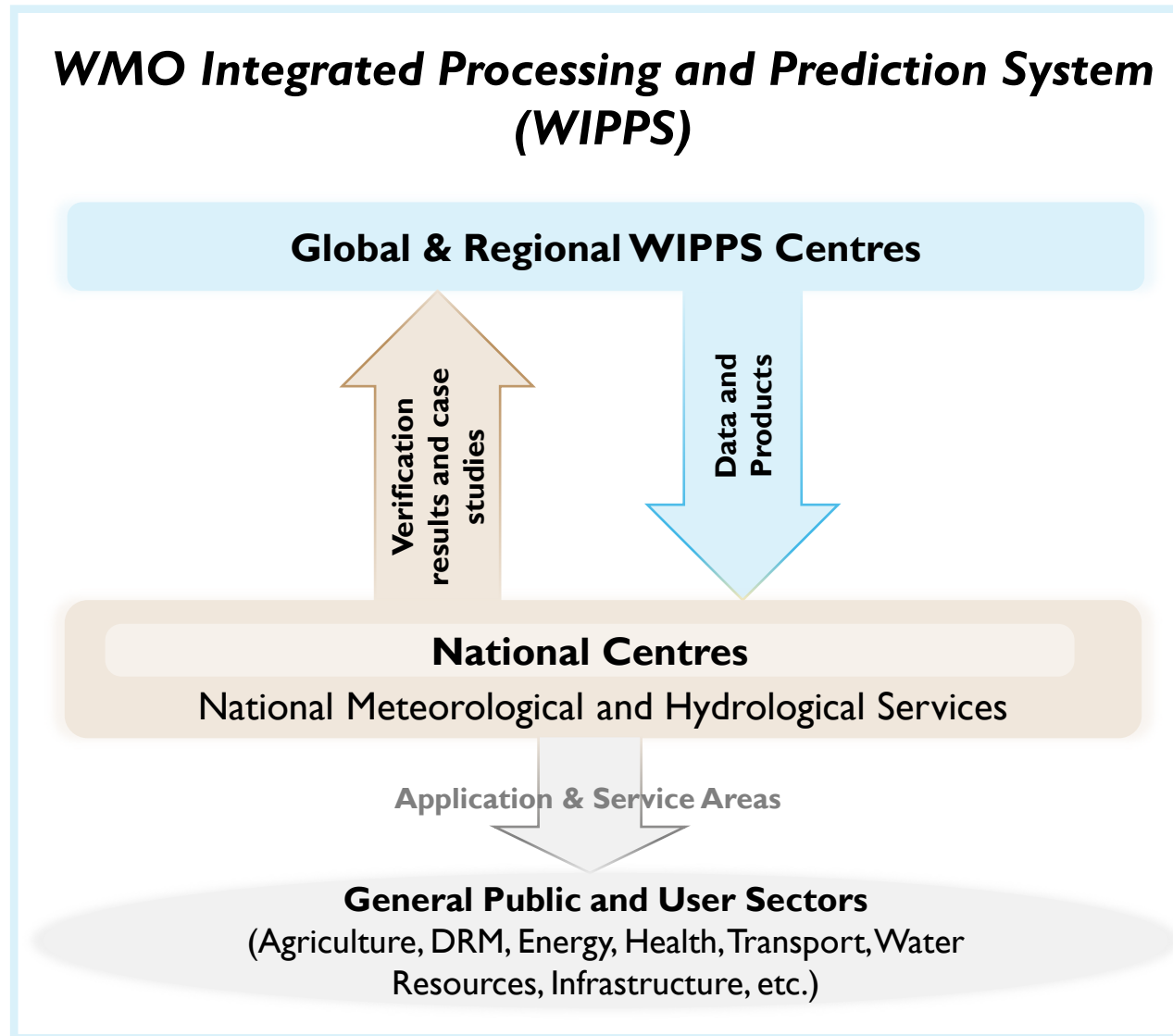
- Decentralized governance and implementation
- Decision making at local, national and regional levels
- WMO: less regulatory approach with guidelines and sharing of best practices
- WMO: Capacity development and training

Regional, National and Local Early Warning Services

Global Infrastructure The WMO World Weather Watch architecture



GDPFS/WIPPS Structure - simplified



WIPPS activities

General purpose activities (12)

- Global deterministic numerical weather prediction
- Limited area deterministic numerical weather prediction
- Global ensemble numerical weather prediction
- Limited area ensemble numerical weather prediction
- Global numerical long-range prediction
- Global numerical sub-seasonal forecasts
- Annual to decadal climate prediction
- Numerical ocean wave prediction
- Global numerical ocean prediction
- Nowcasting
- Sub-seasonal to seasonal hydrological prediction
- Snow cover prediction

Specialized activities (13)

- Regional climate prediction and monitoring
- Coordination of multi-model ensemble prediction for long-range forecasts
- Coordination of multi-model ensemble for sub-seasonal forecasts
- Coordination of annual to decadal climate prediction
- Regional severe weather forecasting
- Tropical cyclone forecasting, including marine-related hazards
- Nuclear environmental emergency response
- Non-nuclear environmental emergency response
- Atmospheric sand and dust storm forecasts
- Volcano watch services for international air navigation
- Marine meteorological services
- Marine environmental emergency response
- Flash flood forecasting

Non-real-time activities (5)

- Coordination of deterministic numerical weather prediction (NWP) verification
- Coordination of ensemble prediction system (EPS) verification
- Coordination of wave forecast verification
- Coordination of tropical cyclone forecast verification
- Coordination of observation monitoring

RSMC for global deterministic NWP

Activity specification

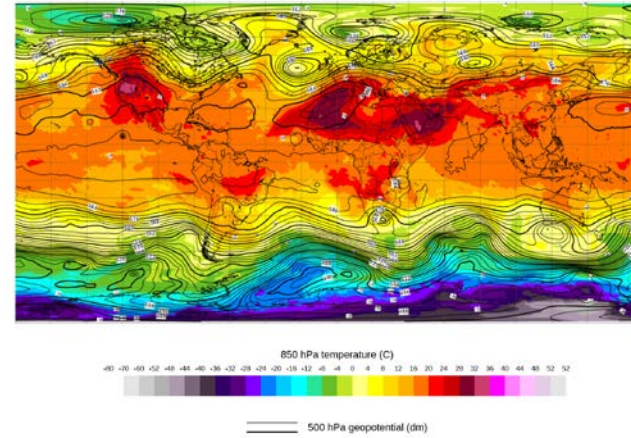
- Produce global analyses of the three-dimensional structure of the atmosphere;
- Produce global forecast fields of basic and derived atmospheric parameters;
- Make available on WIS a range of these products; the list of mandatory and highly recommended global deterministic NWP products to be made available is given in Appendix 2.2.1;
- Produce verification statistics according to the standard defined in Appendix 2.2.34, and make them available to the Lead Centre(s) for DNV;
- Make available on a website up-to-date information on the characteristics of their global

Minimum list of mandatory products

Parameter	Level (hPa)	Resolution	Forecast range	Time steps	Frequency
Geopotential height	850/500/250	1.5° × 1.5°	Up to 3 days/ Beyond 3 days up to 6 days	Every 6 hours/ Every 12 hours	Twice a day (0000 and 1200 UTC)/ Once a day
Temperature	850/500/250				
Wind zonal velocity (u) and meridional velocity (v)	925/850/700/500/250				
Relative humidity	850/700				
Divergence, vorticity	925/700/250				
MSLP	Surface				
2-m temperature	Surface				
10-m u, 10-m v					
Total precipitation					

Geopotential 500 hPa and temperature at 850 hPa

Base time: Fri 06 Aug 2021 00 UTC, Valid time: Mon 16 Aug 2021 00 UTC, - T+240 h, Area: Global

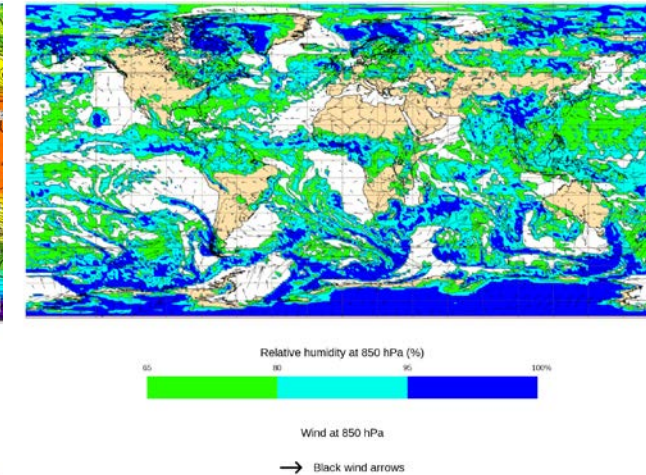


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Wind and relative humidity at various pressure levels

Base time: Fri 06 Aug 2021 00 UTC, Valid time: Mon 16 Aug 2021 00 UTC, - T+240 h, Area: Global, Level: 850



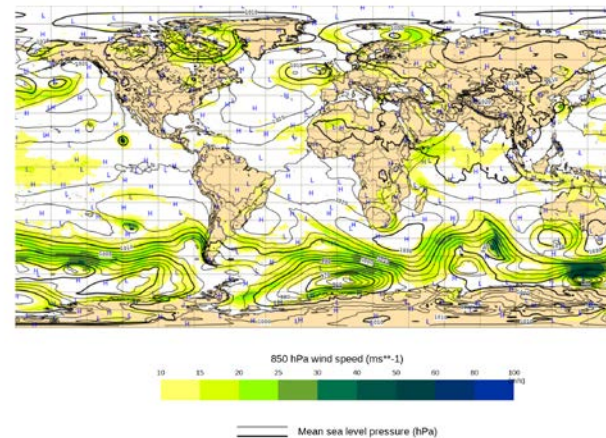
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Some products of RSMC ECMWF for global deterministic NWP

Mean sea level pressure and wind speed at 850 hPa

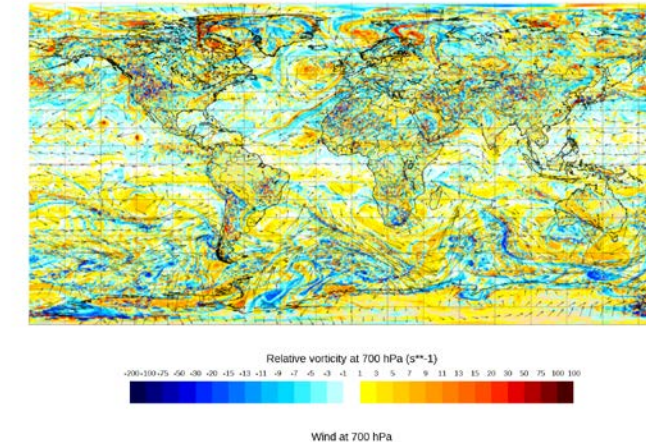
Base time: Fri 06 Aug 2021 00 UTC, Valid time: Mon 16 Aug 2021 00 UTC, - T+240 h, Area: Global



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Vorticity and wind at 700 hPa

Base time: Fri 06 Aug 2021 00 UTC, Valid time: Mon 16 Aug 2021 00 UTC, - T+240 h, Area: Global, Parameter: Relative vorticity



The products are distributed via WIS in the GRIB format.

WIPPS web portal

✓ The web portal has been designed to improved data discoverability and accessibility

The screenshot shows the WIPPS web portal interface. At the top, it says "Designated WIPPS Centres Web portal for the WMO Integrated Processing and Prediction System".

Annotations:

- 141 centres/networks** and **23 activities** are displayed in large numbers.
- An **interactive map** shows the global distribution of designated WIPPS centres, with a scale bar for 2,000 miles.
- geo-statistics on the selected activities** are shown in a donut chart with categories: RA I 13, RA II 26, RA III 8, RA IV 26, RA V 11, and A VI 50.
- A **selectable list of all GDPFS activities** is shown on the left, including: World Meteorological Centre, Global deterministic numerical weather prediction, Limited-area deterministic numerical weather prediction, Global ensemble numerical weather prediction, Limited-area ensemble numerical weather prediction, Global numerical long-range prediction, Annual to decadal climate prediction, Numerical ocean wave prediction, and Global numerical ocean wave prediction.
- A **list of designated centres** is shown in the middle, including: WMC Beijing, WMC Exeter, WMC Melbourne, WMC Montreal, WMC Moscow, WMC Offenbach, and WMC Tokyo.
- easy access to data products** is shown in the bottom right, listing products like Geopotential height, 850 hPa, 500 hPa, and 250 hPa, and Temperature, 850 hPa, and 500 hPa.
- quick info on the centre, incl. focal point** is shown in the bottom right, providing information about the RSMC ECMWF (Global deterministic numerical weather prediction), website link, principal GISC (Exeter), and focal point (Mr. David Richardson).

Mandatory products depicted by the Manual are listed here. Each links to a GISC of the WIS.

Provision of high-resolution NWP grid data from WMCs

WMC Washington (NCEP): Provision of high-resolution NWP grid data

Modeling System	Cadence/ Forecast Length	Products/Resolution of NWP data
GFS (Global weather and waves, deterministic, 13 km);	4 cycles, 16 days	0.25 ⁰ , 0.5 ⁰ and 1 ⁰ data, 743 variables (surface and upper air); Available in GRIB2 via ftp ; Available in GRIB2 via https ; Available in GRIB2 via AWS
GEFS (Global weather and waves, 31-member ensembles, 25 km)	4 cycles, 16 days except 35 days at 00z	0.25 ⁰ , 0.5 ⁰ and 1 ⁰ data, 505 variables, raw and bias corrected (surface and upper air); Available in GRIB2 via FTP ; Available in GRIB2 via HTTPS ; Available in GRIB2 via AWS
		(...stry); Available in GRIB2 via
		(...per air); Available in GRIB2
		(...ed products at 3 km
		(...nd bias corrected); Available
		(...pper air), TC track and
		GRIB2 via https
WAM-IPE (Whole Atmosphere, Space)	4 cycles a day, 48 hrs	Available in netCDF via FTP ; Available in netCDF via HTTPS

Plan to update soon

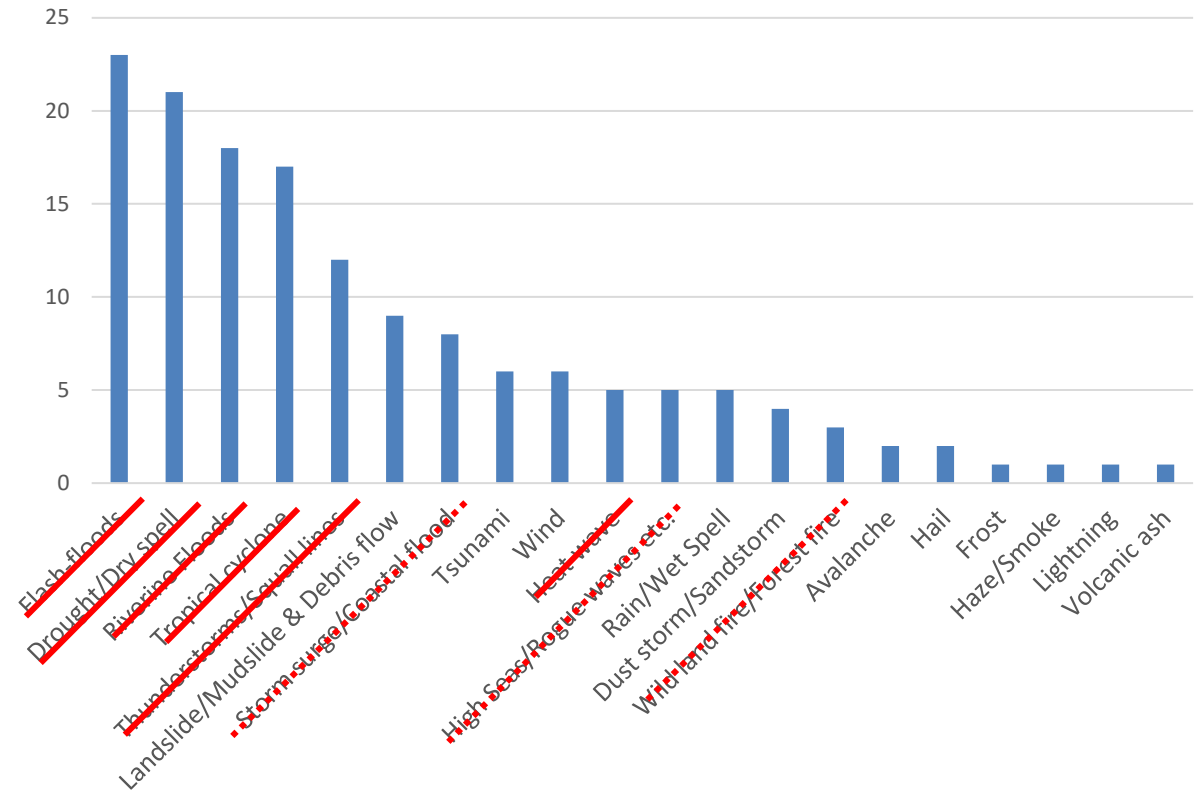
- All data freely available through FTP, HTTPS, and selected data on AWS (with longer retention time) in real-time, including unrestricted global observations in BUFR format for analysis and data assimilation. Longer archives are available through [NCEI](#) with additional filtering capabilities.
- Widely used worldwide for downscaling, initializing limited-area models (IC/BC), and various forecast applications
- GFS full resolution (C768L127) native model data available through AWS for running FV3 based NWP models
- Output from several high-resolution limited area deterministic models (NAM, RAP, HRRR) and ensemble models (SREF, HREF) are also available for North American Domain and other selected domains including Alaska, Hawaii, Guam and Puerto Rico
- Complete inventory of all NCEP operational models and their data availability is listed [here](#).

Information for all presenters

- 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.

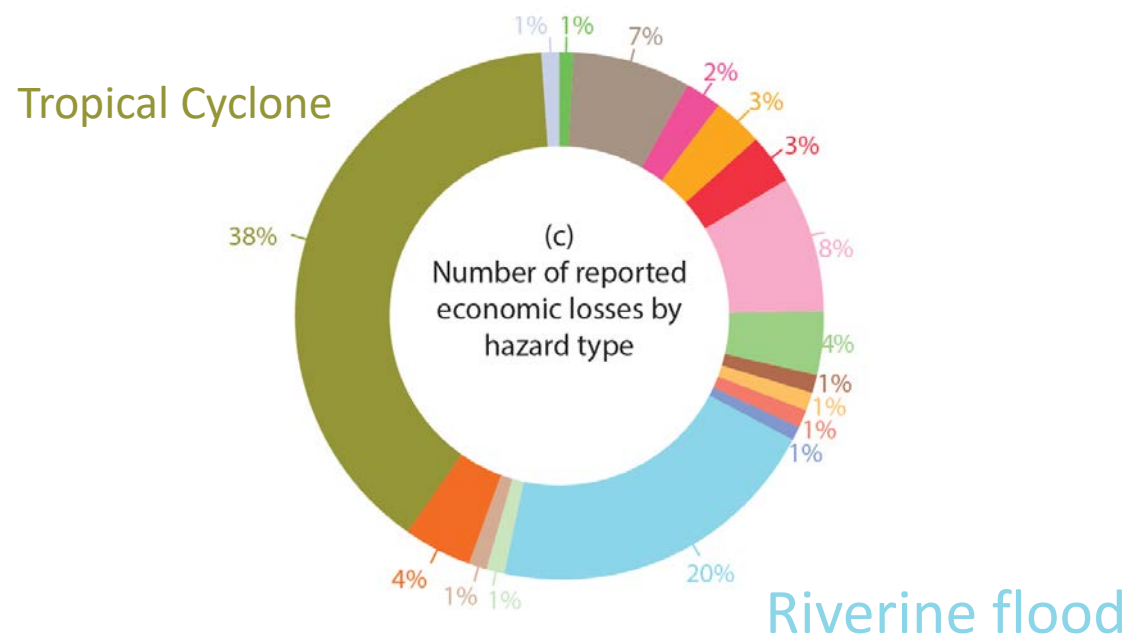
Number of countries that identified the hazard as one of 5 priorities



Inclusion of hydrology in WIPPS (ET-OHPS and HydroSOS)

- **EC-76 (2023) Resolution 3.2(13)/1**
- Establishment of Regional Specialized Hydrological Centres (RSHC):
 - - RSHCs for S2S hydrological prediction
 - - RSHCs for snow cover prediction
 - - RSHCs for flash flood forecasting
- **ET-OHPS** → **Riverine flood, drought**
- First meeting from 28 to 30 Nov. 2023
- **HydroSOS**
- The Hydrological Status and Outlook System

Riverine flood is the second hazardous type in terms of economic losses.

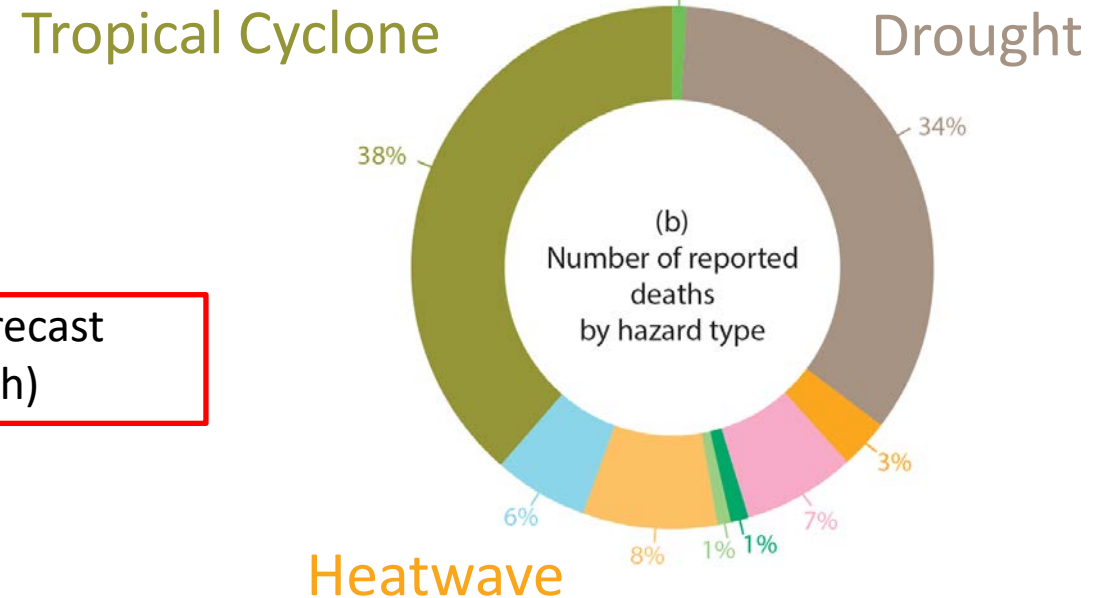
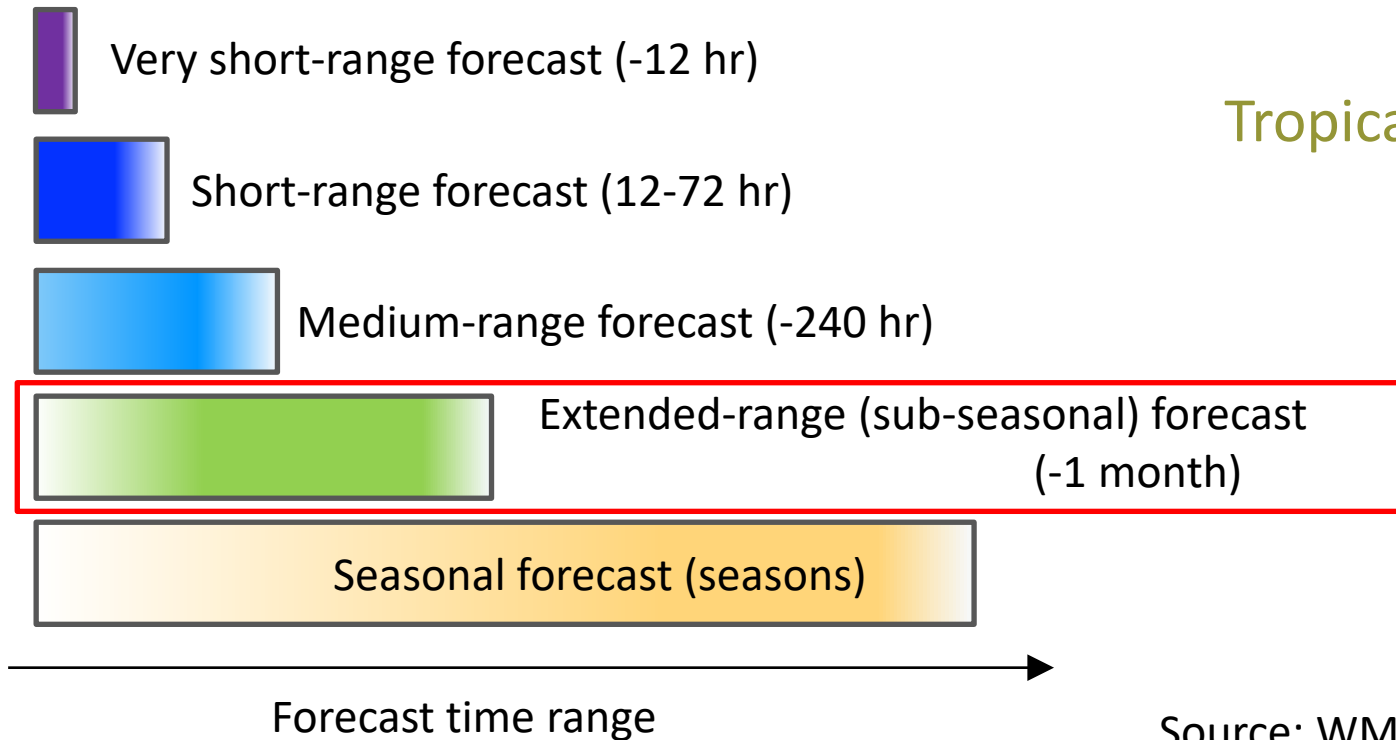


Source: WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019)

Seamless early warning services (LC-SSFMME, GPC-SSF)

GPC-SSF and LC-MMESSE have been established to fill the gap of forecast time ranges.

A drought and heatwave can persist a long period (weeks-months), impacting the society.



Source: WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019)

WIPPS Workshop as the 2nd WMC Workshop (14-16 Nov. 2023, Geneva, Switzerland)

The Workshop sought to facilitate the implementation of new requirements to meet user needs for the "Early Warnings for All" initiative.

Slide 1: Gaps in WIPPS, especially NWP data
David Richardson, Chair of Standing Committee on Data Processing for Applied Earth System Modelling and Prediction, ECMWF. WMO 150th Anniversary logo.

Slide 2: EW4All Initiative: Identified 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. Number of countries that identified the hazard as one of 6 priorities. Hazards: Flash-floods, Drought/Dry spell, Riverine Floods, Tropical cyclone, Thunderstorms/Squall lines, Heat wave.

Slide 3: Areas of WIPPS to be improved for EW4All
1. Accessibility and discoverability of WIPPS products
2. Availability of WIPPS products
3. Guidance for accessing and utilising WIPPS products. Early Warnings for All logo.

Slide 4: Gaps in WIPPS for Flash Floods
WMO has promoted the Flash Flood Guidance System with Global Coverage (FFGS) since 2007. FFGS has been implemented through various regional and national projects in more than 70 countries, providing coverage to 3 billion people, i.e., 40% of the world's population and enhancing early warning capabilities at the national and regional levels. As EC-76 (2023), Regional Specialized Hydrological Centre for Flash Flood forecasting was established as a new WIPPS activity to support hydrological services. This Centre shall produce flash flood forecasting products such as flash flood risk categories and if possible, peak discharge and flash flood thresholds. Additionally, the Centre shall support WIPPS in the generation of flash flood forecasting information. **Gaps in WIPPS: No Centre is designated yet as RSMC for flash flood forecasting.**

Slide 5: Gaps in WIPPS for Drought/Dry Spell
The principal goal of Integrated Drought Management Programme (IDMP) is to develop a global coordination of efforts to strengthen drought monitoring, risk identification, drought prediction and early warning services. (Res. 21 (Co-VII)). Members are requested to use Standardized Precipitation Index (SPI) to characterize meteorological drought. (Res. 21 (Co-VII)). WMO published the comprehensive "Standardized Precipitation Index User Guide" (WMO-106-109). In addition, more releases can be considered. - Standardized Precipitation Evapotranspiration Index (SPEI). **Gaps in WIPPS: Identify cascading process to support Members in drought prediction and monitoring. Do you request RSMCs/GPCs to provide SPI or other indexes to Members? RSMC for subseasonal to seasonal hydrological prediction can make a good contribution, but no Centre is designated yet.**

Slide 6: Gaps in WIPPS: Tropical Cyclone
Tropical cyclones cause multi-hazards such as wind, storm surge, high waves etc. WMO has supported its Members through Tropical Cyclone Programme for 40 years. Many types of RSMCs provide useful products to support Members in issuing warnings for tropical cyclones. Especially, RSMCs for "tropical cyclone forecasting and marine-related hazard" play a crucial role in the WIPPS. However, these RSMCs missed the needs of availability and usability of NWP products of tropical cyclone vortex parameter file. **Gaps in WIPPS: Tropical low/cyclone vortex parameter files are available operationally from all RSMCs for global deterministic and ensemble NWP. More details will be given in the presentation of Item 2.4 by Ken Nishio (Chair of ET-OWFS) and Item 3.3a (the Secretariat), and Item 6.6 by Jason Duran.**

Slide 7: Gaps in WIPPS: Riverine Floods
Gaps in WIPPS: No activity to provide riverine flood prediction products is established yet in WIPPS. RSMC for snow cover prediction can make a good contribution. But no Centre is designated yet. A Task Team under SC-ESMP is now identifying required riverine flood prediction products to be integrated into WIPPS. More detailed information will be provided in the next presentation (Item 2.3) by Andy Wood, Chair of this Task Team.

Slide 8: Gaps in WIPPS: Thunderstorms/Squall lines (1/2)
Thunderstorms occur in a cumulonimbus, characterized by the presence of lightning. They are meso-gamma scale phenomena. A squall line is a line of thunderstorms, often forming along or ahead of a cold front. These phenomena contain heavy precipitation, hail, frequent lightning etc. The products of global deterministic and ensemble NWP are not useful to predict thunderstorms and squall lines although the grid spacing of global NWP systems are approaching 10km. (Please note that CAPE will be added as a new variable of mandatory products from RSMCs for global NWP). The mandatory and recommended products of RSMCs for limited-area deterministic and ensemble NWP is being reviewed and updated. It is essential to **monitor those phenomena using forecasting products and provide them using high-resolution limited-area NWP. RSMCs for operation and for limited-area deterministic and ensemble NWP are established as WIPPS activities in 2017 when the Manual on WIPPS (WMO-No.445) was thoroughly renewed.**

Slide 9: Gaps in WIPPS: Thunderstorms/Squall lines (2/2)
RSMCs for limited-area deterministic NWP, RSMCs for limited-area ensemble NWP, RSMCs for reforecasting. Locations: Moscow, Novosibirsk, Offenbach, Rome, Offenbach, Rome, Hong Kong, China, Offenbach, Tokyo. Many Members operate their own limited-area NWP systems. Some regional centres of (Severe Weather Forecasting Programme) also share their high-resolution NWP products with other Members within the framework of SWPP. **Gaps in WIPPS: Adequate number of RSMCs are not designated yet to cover the regions where Members require RSMC products.**

Slide 10: Gaps in WIPPS: Heatwave (1/2)
Heatwave intensity is essential, which is the local cumulative excess heat/heatwave intensity is not available. Only around 1% of Members access this information. Local cumulative excess heat/heatwave intensity is not available. Only around 1% of Members access this information. **Heatwave intensity = Duration (Time) * local significant threshold.** Tmax and Tmin are already considered in the new draft list of mandatory products from RSMCs from global deterministic NWP. "local significant threshold" is the value of 95 percentile of (max - min)/2 temperature for the fixed period of 30 years. 85 percentile of calculated heatwave intensity over 30-50 years is required for warnings. It can be calculated using Climate Reanalysis data. Once calculated, the threshold doesn't have to be updated. A new WIPPS activity for Climate Reanalysis is being developed aiming to propose to INFCOM-3 (2024). **Gaps in WIPPS: Proposed new mandatory products of Tmax and Tmin and proposed new activity for Climate Reanalysis.**

Slide 11: More WIPPS activities to support EW4A for specific hazards
Table with columns: Hazard, WIPPS activity, RSMC, Status, Comments. Includes: Marine Emergency Response, Global Numerical Storm Surge Prediction, Numerical Ocean Wave Prediction. **RSMCs for Marine Emergency Response, and Global Numerical Storm Surge Prediction are being developed as new WIPPS activities. Also, there could be an opportunity to improve the RSMC for Numerical Ocean Wave Prediction.** NB: This is an initial analysis done by the Secretariat and will be further updated.



Thank you



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