WMO Integrated Processing and Prediction System (WIPPS) & Integration of AI-ESP into WIPPS

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WIPPS section, WMO

WORLD METEOROLOGICAL ORGANIZATION

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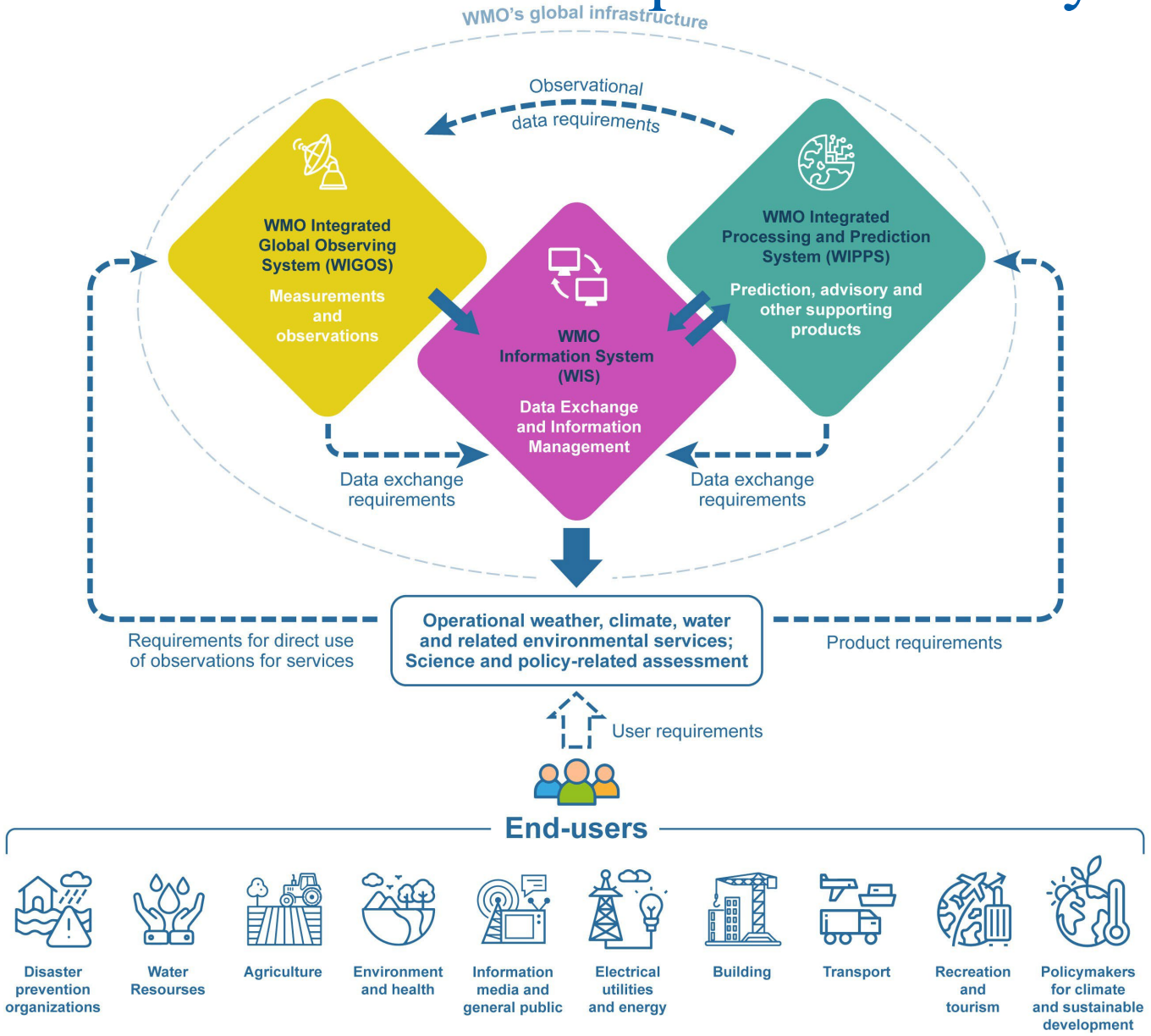
I. WIPPS Introduction

WIPPS in WMO Operational System



- **WIGOS**: WMO Integrated Global Observing System
- **WIS**: WMO Information System (Data exchange)
- **WIPPS**: WMO Integrated processing and **Prediction** System

WIPPS is

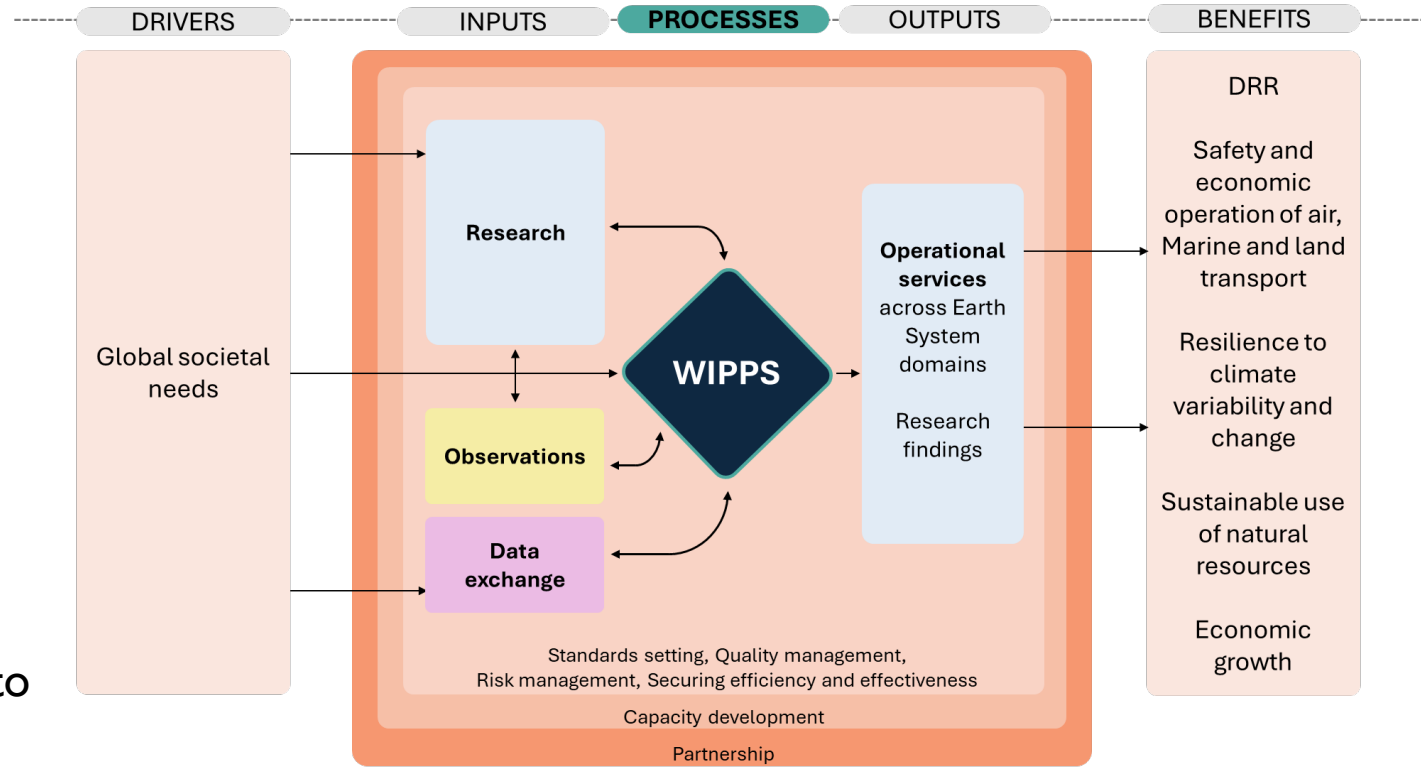
WIPPS is a worldwide network of **operational centres** **operated by WMO Members** and partner organizations.

PURPOSE

- to make **operationally available** among WMO Members and relevant operational organizations **defined products and services** for applications related to weather, climate, water and environment .

ROLE

- **to add value** to the observation based on science and technology
- **to generate** analysis and forecast products to meet users' needs.



the heart of the WMO operational system

WIPPS provides

- **Defined products**
  - Analysis, forecast, including probabilistic information
  - Specialized products tailored for specific applications
- **Operational centres** that produce the defined products
  - **WIPPS Designated Centres** (WIPPS DCs) and National Meteorological Centres (**NMCs**)
    - WIPPS Centres consist of WIPPS DCs and NMCs
    - WIPPS DCs encompass different names, such as World Meteorological Centre (WMC), Global Producing Centre (GPC), Regional Specialized Meteorological Centre (RSMC), Reginal Climate Centre (RCC) (RCC-Network), Regional Specialized Hydrological Centre (RSHC) and Lead Centre (LC)
- **Modalities** for delivering the products
  - WIS –*mandatory products defined in the Manual on the WIPPS (WMO-No. 485) (minimum set)*
  - Websites of WIPPS Centres
    - Direct download from the WIPPS Centres – ftp, API and …
  - Other platforms such as Copernicus

WIPPS Activities : Categories

1_General purpose activities
to encompass essential data processing required for a **wide range of end-usage**

2_Specialized activities
to make forecasting products, which may include guidance based on **human interpretation**, **tailored for a specific type of application** or user community.

3_Non-real-time activities
mainly for **verification**

- ✓ The activity specifications are defined for each type of WIPPS activities.
- ✓ The **minimum list of mandatory products** is defined for each type of WIPPS activities (If defined).
- ✓ A Centre that can fulfil the responsibilities of one of WIPPS activities is **designated** as a WIPPS Designated Centre (WIPPS-DC) **by EC or Congress upon Members' application**.

WIPPS Activities : Full list

General purpose activities (14)

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

GPC

Specialized activities (15)

- Regional climate prediction and monitoring (RCC)
- **Coordination of multi-model ensemble for sub-seasonal prediction**
- **Coordination of multi-model ensemble for seasonal prediction**
- **Coordination of annual to decadal climate prediction**
- **Coordination of assessment of multiple climate reanalysis**
- 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
- Vegetation fire and smoke pollution forecasts
- Volcano watch services for international air navigation
- Marine meteorological services
- Marine environmental emergency response
- Flash flood forecasting

LC

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

34 activities

2024 updated

WIPPS Web Portal: Exploring WIPPS Designated Centres

WMO Regions

Selectable list of all WIPPS activities

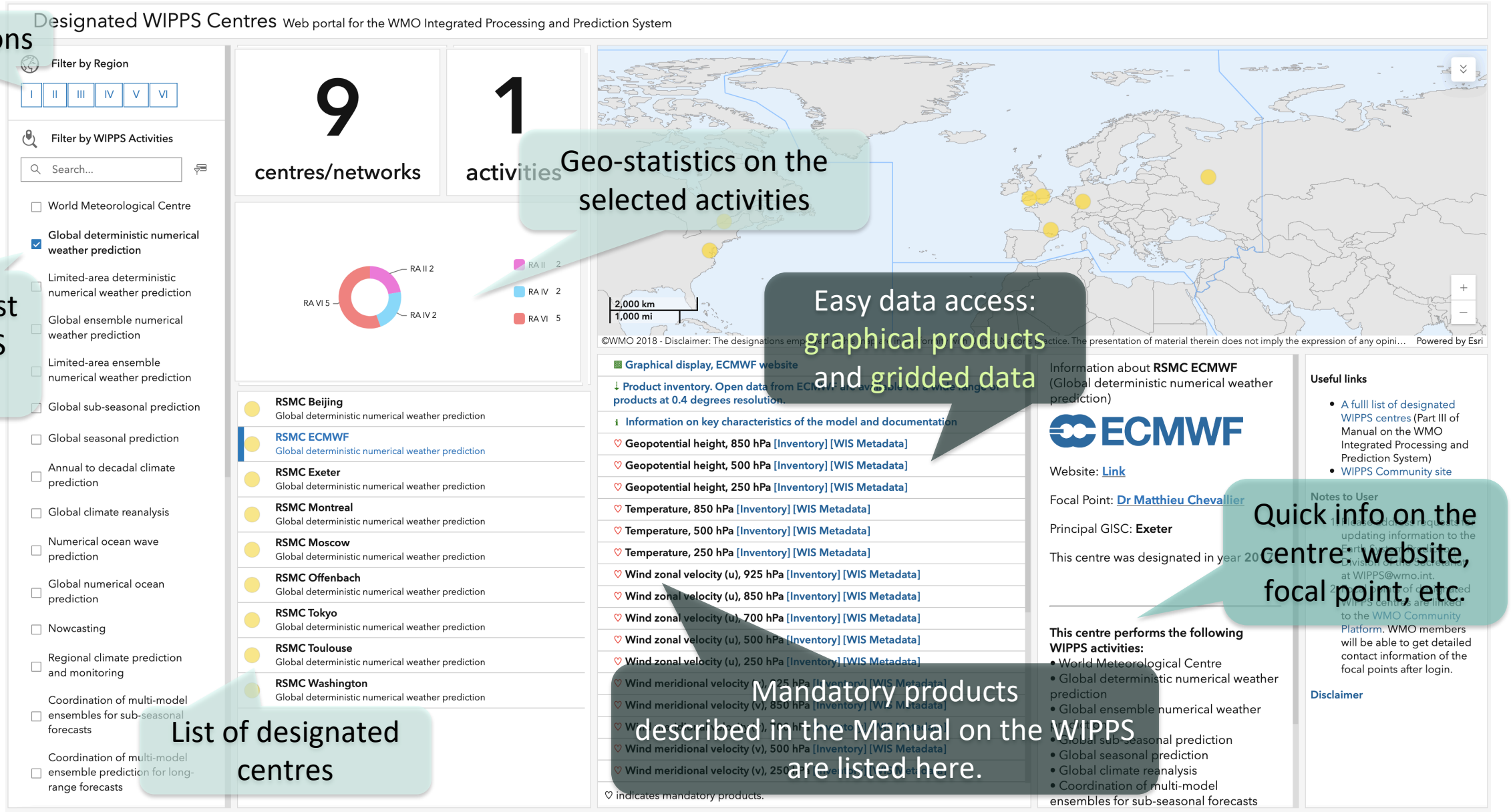
Geo-statistics on the selected activities

Easy data access: graphical products and gridded data

Quick info on the centre: website, focal point, etc.

List of designated centres

Mandatory products described in the Manual on the WIPPS are listed here.



WIPPS Centres : Working mechanism

WMCs are advanced NWP centres that can carry out the following activities:
- Global deterministic NWP;
- Global ensemble NWP;
- Global numerical seasonal prediction.

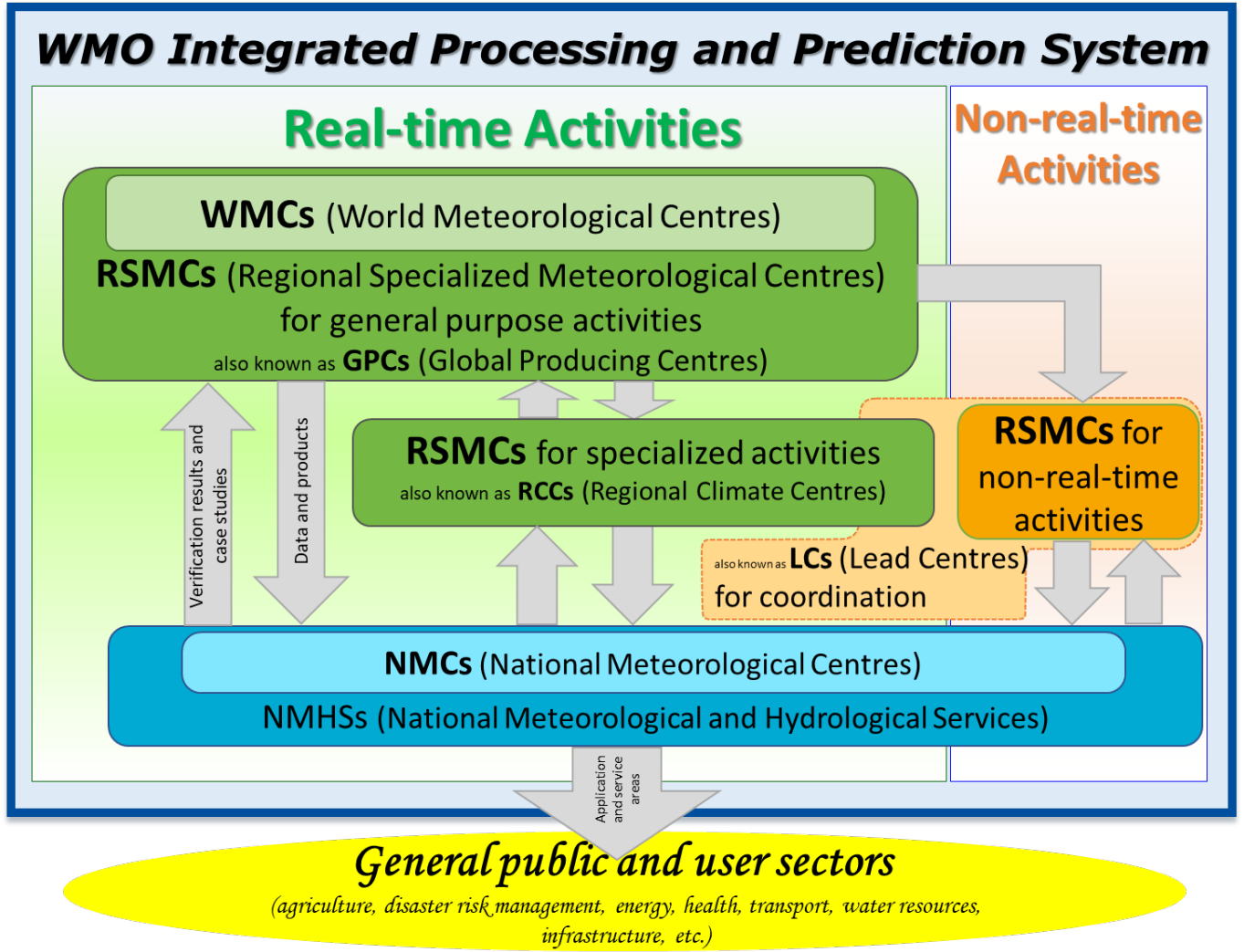
RSMCs (Three types)

(1) for **general purpose activities**: essential data processing for a wide range of end use.

(2) for **specialized activities**: tailored for a specific type of application and user community.

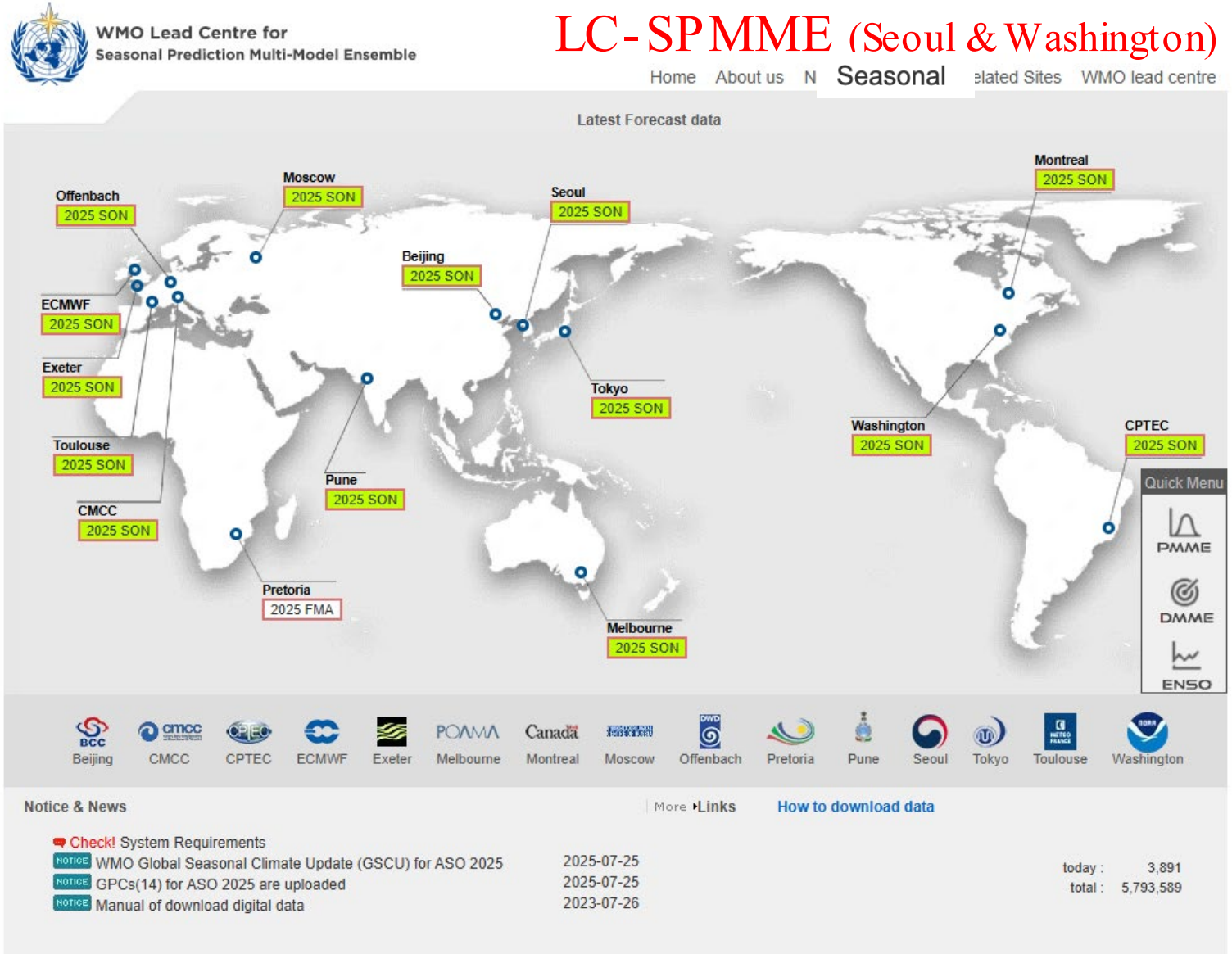
(3) for **non-real-time activities**: to coordinate verification activities to support Members in using RSMCs' products.

NMCs prepare **forecasts and warnings** at all forecasting ranges necessary to meet the requirements of the Member.



Lead Centre and Global Producing Centres

Seasonal Prediction



Functions

1. Collect an agreed set of forecasts and hindcasts data from GPCs-SP.
2. Generate a **multi-model ensemble** of GPCs-SP forecasts.
3. Generate **verification** for GPCs-SP forecasts and multi-model ensemble products.
4. Display the aforementioned data and products in a **standard graphic format**.
5. Archive and distribute the aforementioned **digital data and products** in a standard format (GRIB and NetCDF).

15 GPCs-SP

WMO SPMME (wmolc.org)

LC-SPMME products

Deterministic MME

- Simple composite method
- Regular multiple regression
- Singular value decomposition
- Generic Algorithm

Verification: Hindcast

- Deterministic: ACC, RMSE, MSSS, GSS
- Probabilistic: ROC and reliability map
- Indices: ACC, RMSE

Verification: Forecast

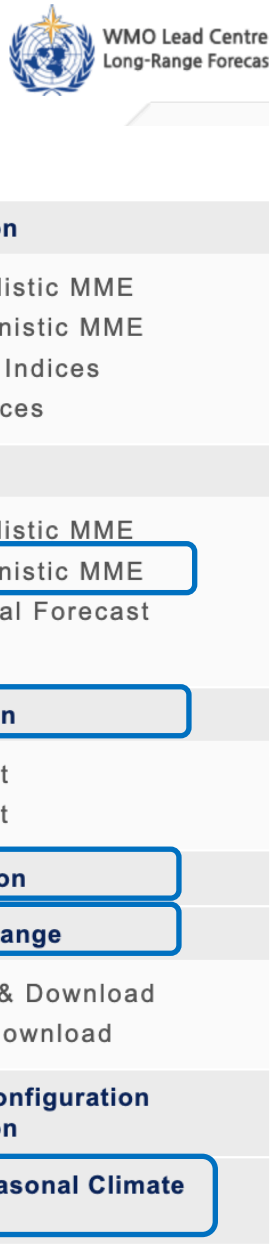
- Deterministic: ACC, RMSE
- Probabilistic: ROC, REL, BS, BSS
- Indices: TCC, RMSE

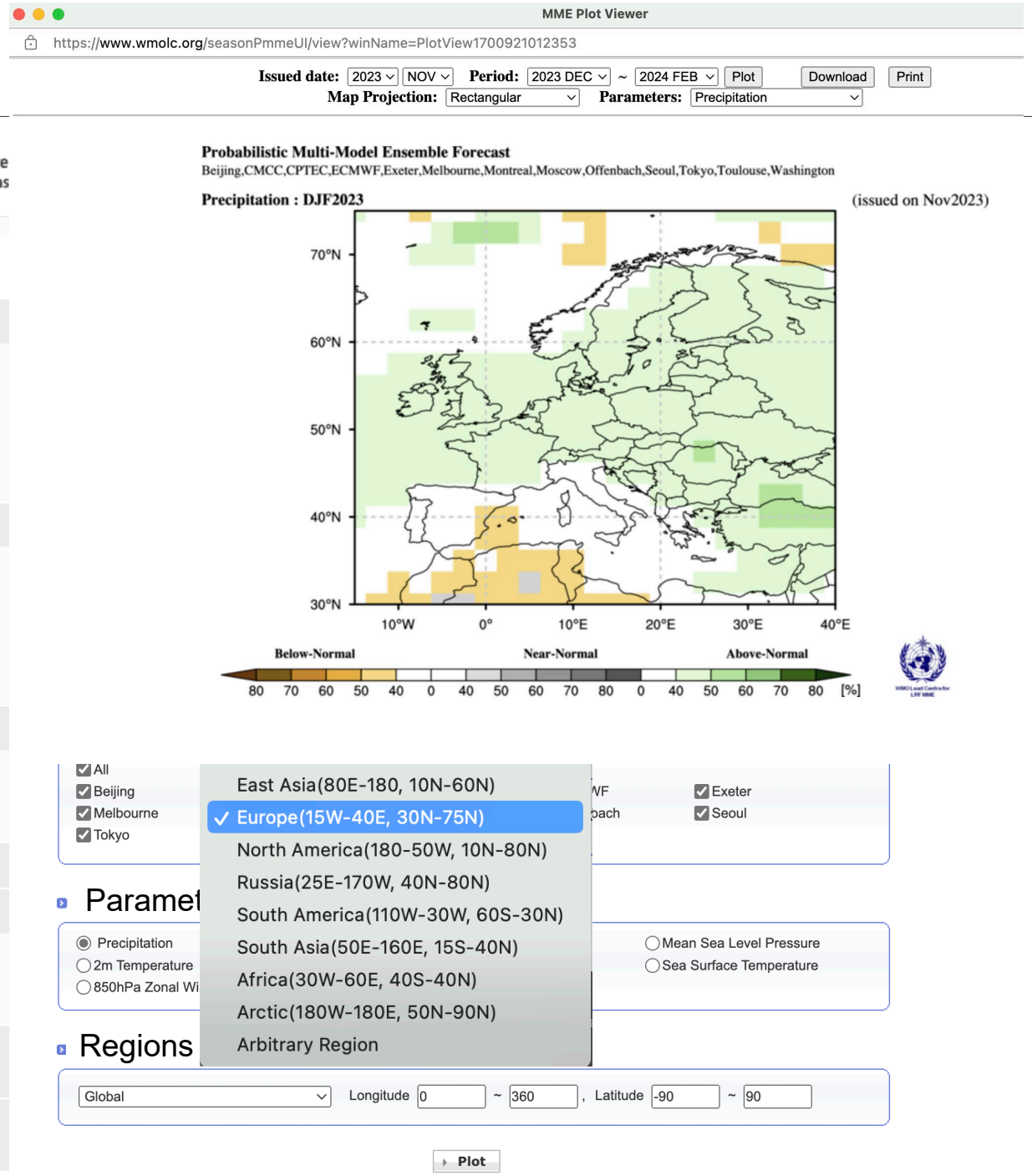
Observation

- ERA-5 anomaly relative to the chosen period

Data Exchange

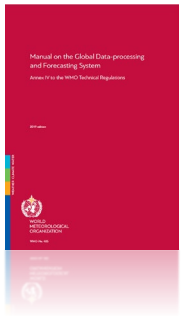
- Hindcast, forecast
- GRIB & NetCDF





Key WIPPS Documents: Manual, Guide, and Guideline

The **Manual** provides detailed information on WIPPS activities: mandatory/recommended functions including production, verification and documentation etc.



Manual on the WMO Integrated Processing and Prediction System (WMO-No. 485) (2023 edition, updated in 2024) - available in English, French, Russian, Spanish, Arabic, Chinese

Guide to the WMO Integrated Processing and Prediction System (WMO-No. 305) (2023 edition, updated in 2024) - available in English (2023 edition is available in French, Russian, Spanish, Arabic, Chinese)

Guidelines on/for

- Ensemble Prediction Systems and Forecasting (WMO-No. 1091)
- Ensemble Prediction System Postprocessing (WMO-No. 1254)
- Nowcasting Techniques (WMO-No. 1198)
- Operational Practices for Objective Seasonal Forecasting (WMO-No. 1246)
- Verification of Operational Seasonal Climate Forecasts (WMO- No. 1220)
- Satellite-based Nowcasting in Africa (WMO-No. 1309)
- High-resolution Numerical Weather Prediction (WMO-No. 1311)

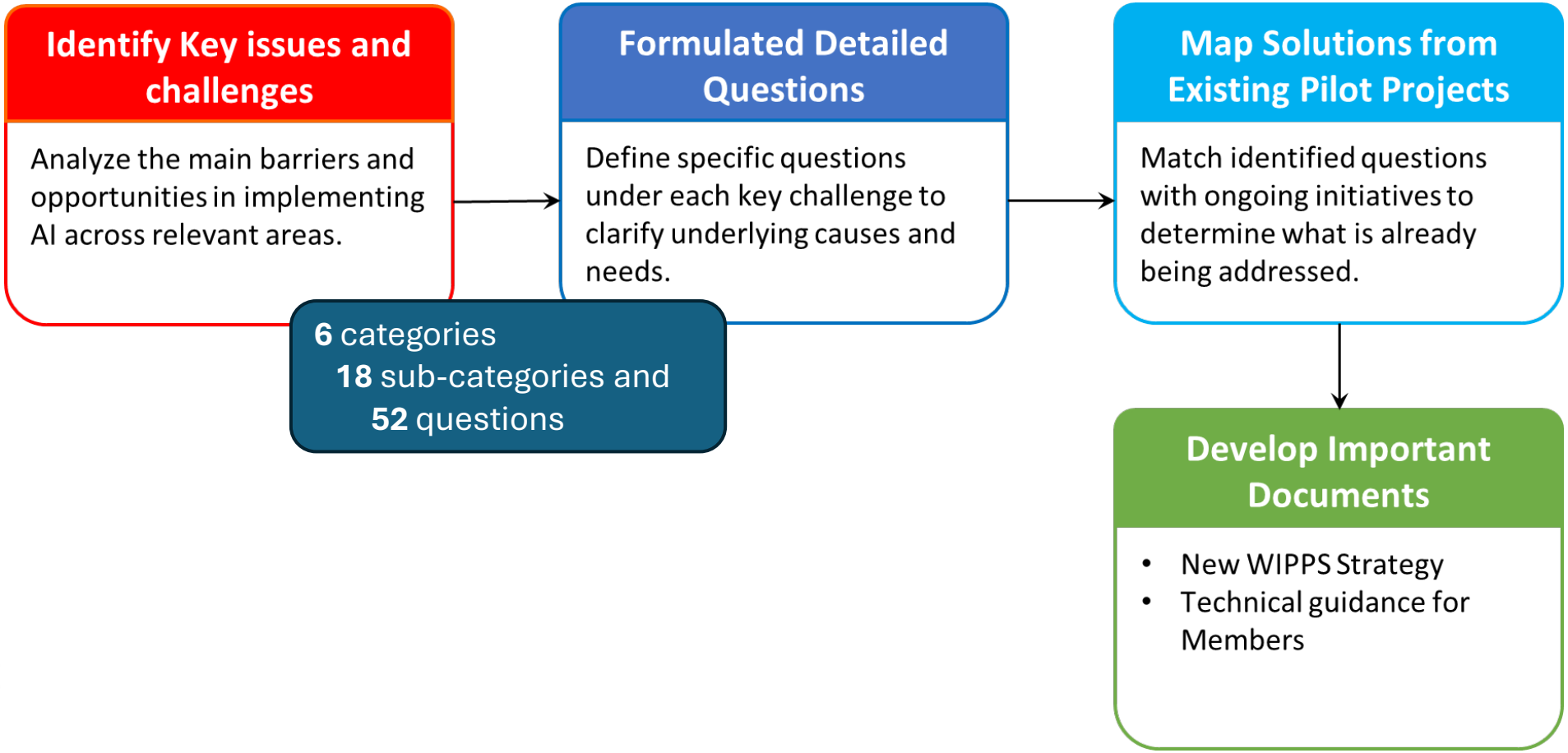
II. WIPPS AI Plan toward new strategy plan and pilot projects

WIPPS Exploration AI Roadmap

- WIPPS Exploration AI Roadmap full version

Primary Objective

- Provide WMO Members with **guidance regarding the potential and limitations of new AI technologies** and;
- Identify **good approaches** for integrating these technologies into their operational practices.



Formulated Detailed Questions

Challenges and specific questions to be addressed

1. Data Availability and Quality

a. Provision of long-term observation/(re)analysis dataset for AI training and verification
b. Observation requirements for high-impact forecasting
c. Quality control of observations

2. Prediction and post-processing

a. Benefit and applicability of AI-ESP for nowcasting and forecasting
b. High-resolution AI-based forecasts for local area
c. Compatibility between initial fields and training dataset
d. High-resolution data-driven models
e. Benefit and necessity of post-processing

3. Verification

a. WIPPS standard verification of AI-ESP model outputs
b. Verification of AI-ESP model outputs for local weather elements and extremes
c. Verification of meteorological consistency between variables of AI-ESP model outputs
d. Verification of forecast scenarios

4. NMHS infrastructure and capacity requirements

a. Use of AI-ESP model outputs in operational forecasting and warning
b. Implementation and maintenance of AI-based systems

5. Model Explainability and Transparency

a. Guidelines on the use and interpretation of AI-ESP model outputs
b. Guidelines on developing explainable AI-ESP

6. WIPPS Framework and Technical Regulations

a. Expansion of WIPPS activities to accommodate AI-ESP model outputs
b. Impact of AI on the WIPPS cascading process

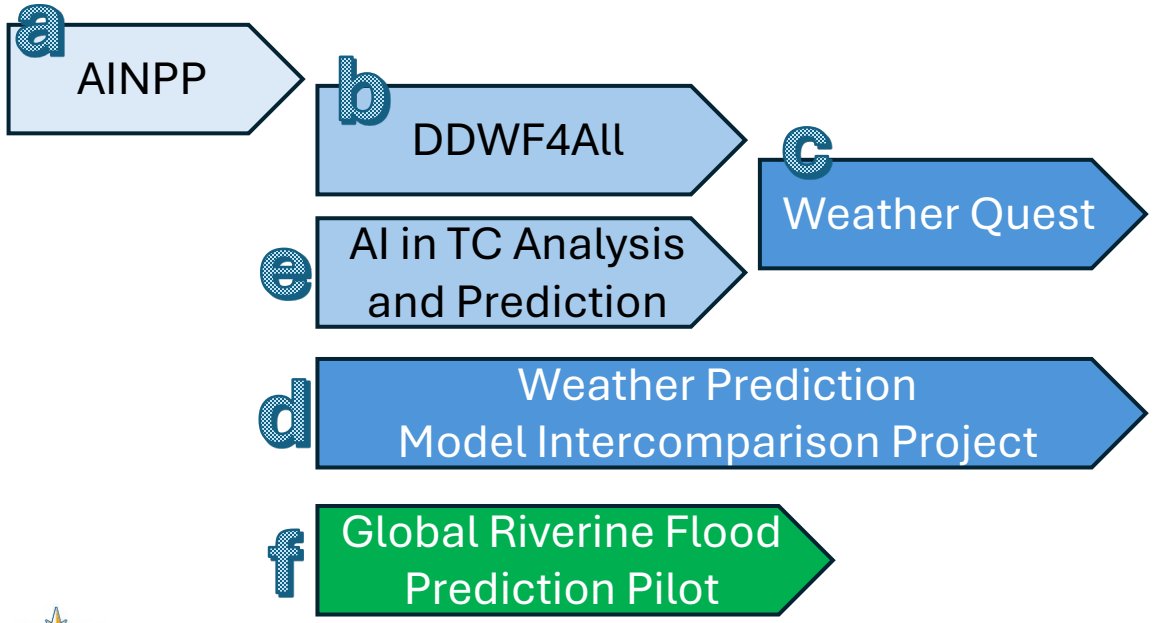
6 categories
18 sub-categories and
52 questions

Map Solutions from Existing Pilot Projects

Testing through WIPPS Pilot Project

Key issues and challenges identified will be addressed through pilot projects. Each of these pilot projects will serve as a proof of concept for broader AI integration into WIPPS and will be designed to test the scalability and effectiveness of AI solutions in operational settings.

Nowcast **Short to Medium** **Sub- to Seasonal**



			4.1 AI-related projects					
			a. AINPP	b. DDWF4All	c. AI Weather Quest	d. WP-MIP	e. AI-TC	f. Global Flood
3. Issues and challenges	1	a		x	x			
		b	x	x				
		c	x	x				
	2	a	x	x	x	x	x	x
		b		x			x	x
		c		x	x	x	x	
		d		x			x	
		e			x	x	x	x
	3	a	x		x	x		
		b	x	x		x	x	
		c	x			x		
		d	x	x		x	x	
	4	a	x	x		x	x	
		b	x	x	x	x		
	5	a		x		x	x	
		b		x	x	x		x
	6	a						
		b	x	x	x	x	x	x

WMO OMM

Develop important documents

- *Draft Resolution 2.3(1)/1* (Cg-Ext(2025))

- **A New WIPPS Strategy**,
  - **including the incorporation of AI into WIPPS**, to replace the WIPPS Collaborative Framework and WIPPS Roadmap (2022–2026),
- Guidelines on the use of AI-based Earth System Prediction (AI-ESP)
  - Maintain these technical Guidelines as an **online** resource.
  - Propose list of Guidelines
    - **General Guidelines on the use of AI**
    - Guidance on specific topics
      - **Guidelines on nowcasting technique**
      - **Guidelines on tropical cyclone forecasting**
      - **Guidelines on short to medium-range prediction**
- Timeline
  - INFCOM-4 (Q4 2026)

PP: Data-Driven Weather Forecasting for All – Met Norway

Objective: To enhance the capacity of NMHSs, particularly LDCs and SIDS, to provide accurate, reliable, and localized multi-hazard early warnings by deploying AI- and data-driven forecasting systems, tailored to local conditions, and building technical capacity through training and knowledge sharing.

Forecast-in-a-Box: a prototype system by ECMWF aimed at packaging a forecasting workflow (including AI models deployed flexibly (cl

Prepare Initial Conditions

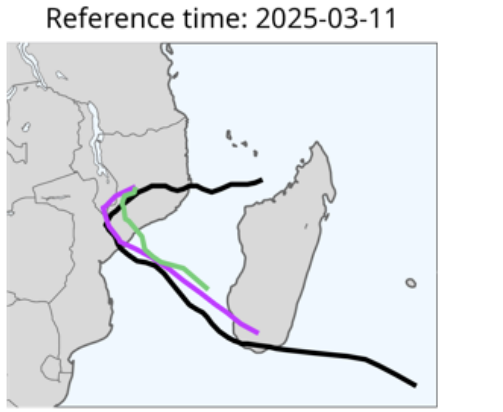
anemo
Run the Mo

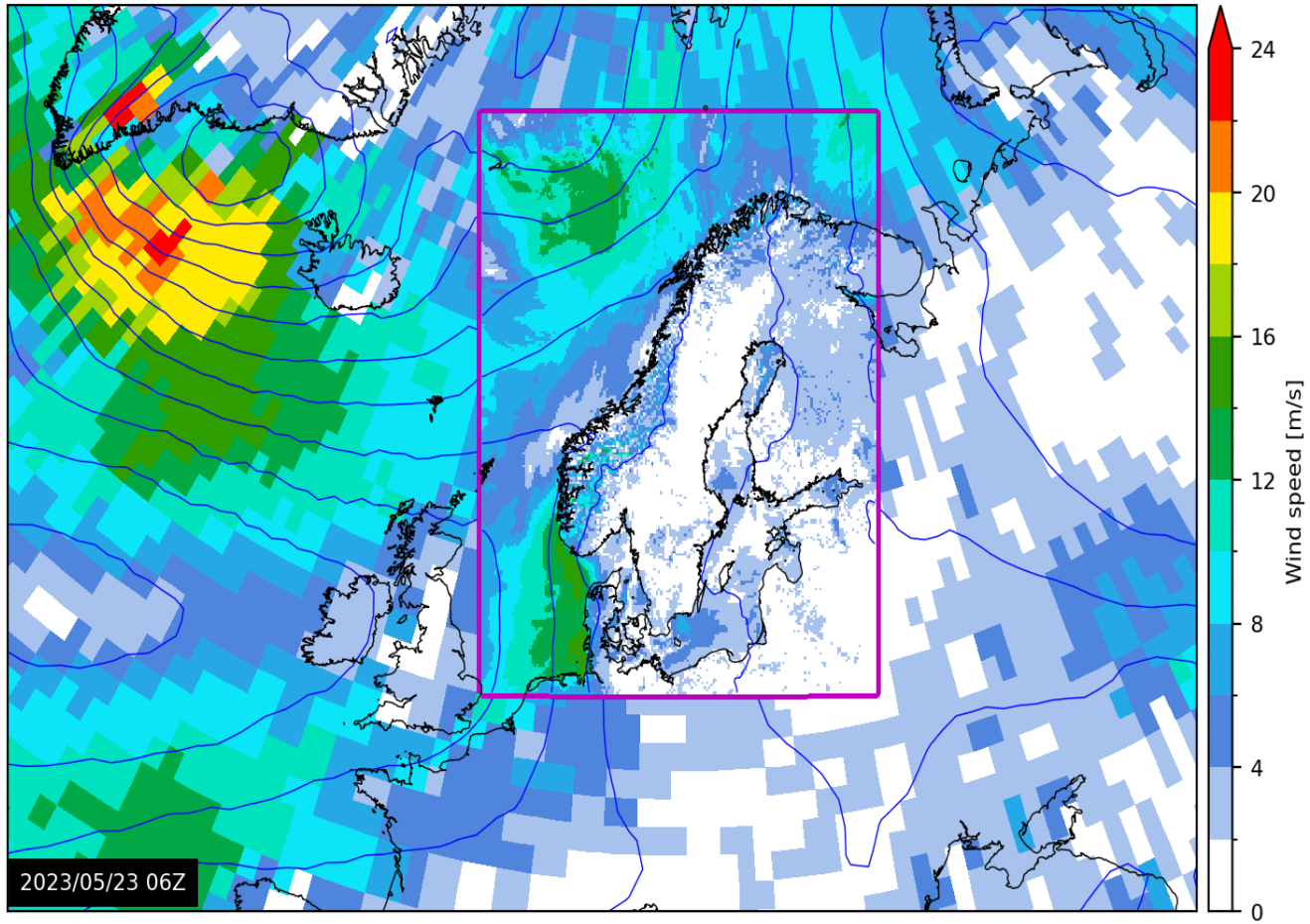
Anemoi: an open-source, M forecasting system centers across Eur

over Malawi.

- Mac Studio (Apple M4 Max, 128G memory)
- Run time: 19 minutes

Cyclone Jude track





PP: AI Weather Quest - ECMWF

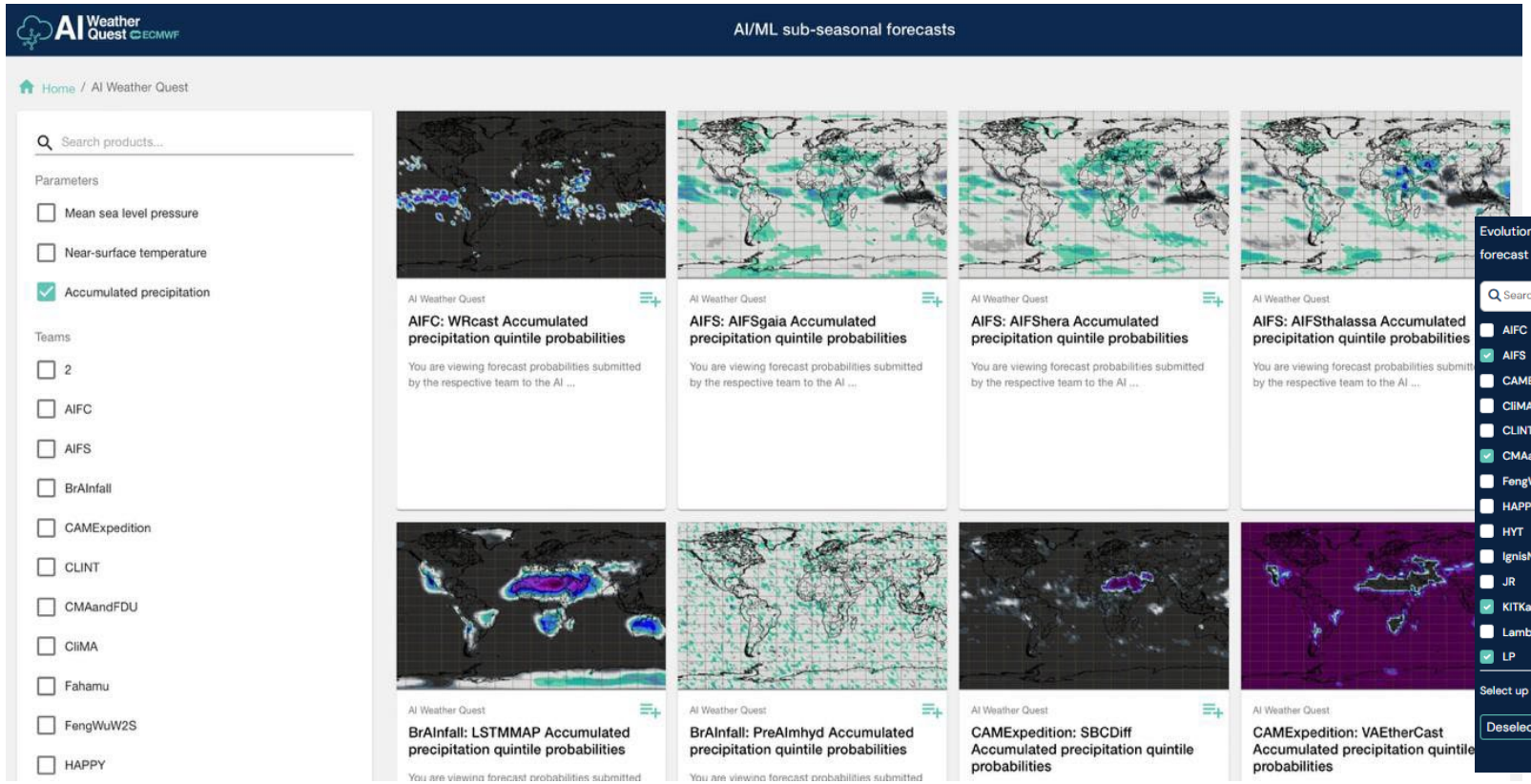
https://aiweatherquest.ecmwf.int/

A **global competition,** organised by ECMWF and endorsed by WMO, for the **best-performing AI/ML models for sub-seasonal predictions**.

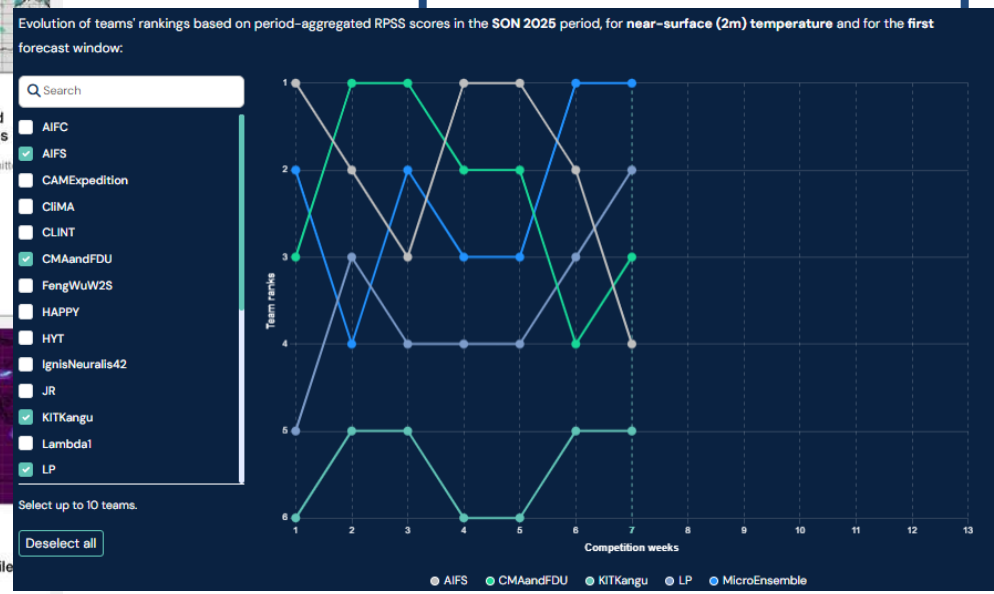
17/03/25 — 15/05/25 — 14/08/25 — 13/11/25 — 12/02/26 — 14/05/26 — 06/08/26

Initial Training Phase:
Develop / refine your models

Competition Phase:
Submit weekly, real-time forecasts over as many 13- week periods as you choose.



Selected teams who agree to public display



More information on WIPPS including AI

- WMO Integrated Processing and Prediction System (WIPPS)
- New Web Portal Eases Access of Forecast Products
- WIPPS Webinar
- WIPPS Pilot Project
- WIPPS Newsletter No. 3-2025 (2)

  1.2 Operationalizing AI-Driven Forecasting at World Meteorological Centres

III. Development of Skills & Knowledge Framework for WIPPS products: Weather & Climate

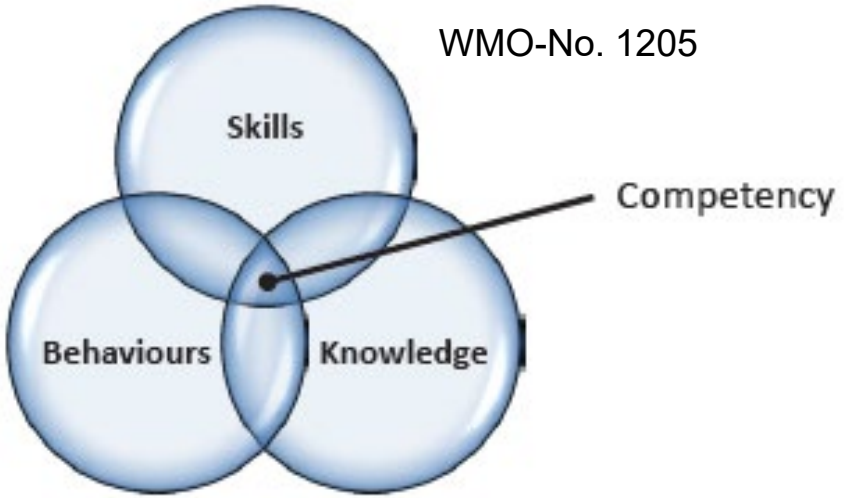
Compendium of WMO Competency Framework (WMO-No. 1209)

To develop a **Skills and Knowledge Framework** to enhance the **interpretation of WIPPS products** related to;

- ***Weather (Phase I)*** *and*
- ***Climate (Phase II).***

Skills and Knowledge Framework for Weather

- **Purpose**
  - To enhance the capacity of the **operational forecasters** **in NMHSs** of WMO Members to effectively and confidently understand and interpret **WIPPS products**.
- **This is aligned with WMO's frameworks and initiatives**
  - WMO Strategic and Operating Plan 2024-2027 (Recommendation 11 (EC-76)), particularly Long-Term Goals (LTGs) 2 and 4, which focus on fully accessing and utilizing the WIPPS products and closing the capacity gap.
  - WMO Capacity Development Framework (WCDF) (Resolution 36 (Cg-19)), which provides an overarching strategic framework for capacity development.
  - United Nations Early Warnings for All initiative, as outlined in Resolution 2 (EC-78) – WMO Road Map for the Early Warnings for All Initiative.
  - *Guide to Competency* (WMO-No. 1205), which describes 'NWP Skills and Knowledge for Forecasters', is one of the three Skills and Knowledge Framework to be developed or prepared.



Skills and Knowledge Framework for Weather

- Further focus and consideration
  - **Probabilistic forecast** and associated tools/products
  - **AI (Data-driven model products)**

Draft Resolution 2.3(1)/1 (Cg-Ext(2025))

Requests INFCOM, in consultation with the Research Board and SERCOM:

(2) To develop a draft new WIPPS strategy, including the incorporation of AI into WIPPS, to replace the WIPPS Collaborative Framework and WIPPS Roadmap (2022–2026), considering the **technical guidelines on the use of artificial intelligence-based Earth System Prediction** (**AI-ESP**), for consideration at the fourth session of the INFCOM-4 in 2026;

Further requests INFCOM, in coordination with SERCOM, the Research Board and the EC Capacity Development Panel with the contribution of Regional Training Centres (RTCs), to **enhance the capacity development on the use of AI** under WIPPS for low- and middle-income countries, LDCs and SIDS;

Implementation procedure in WMO ETRP Moodle Platform

- ***I:*** Designated Working Group
- ***I, III, IV, V:*** an instructional/learning designer.

I. In the Framework

Skill 1. Assess recent model performance by interpreting verification statistics;
Skill 2. Analyse observations and apply conceptual models to the current weather;
Skill 3. Determine level of confidence in NWP output;
Skill 4. Diagnose causes of model departure from observations;
Skill 5. Determine possible future outcomes;
Skill 6. Formulate forecast policy and products
Skill 7. AI (under development)

II. During the gap analysis

Unit 1. Introduction of WIPPS
Unit 2. Access to WIPPS products
Unit 3. …

Added to Moodle as pre-requisite

Unit 4 - Skill 1. **Assess recent model performance by interpreting verification statistics**;
…
Unit 10. Skill 7. Use/Interpret AI-based products (TBD)
Unit 11. Introduction to Case Study Development

III. Training Development Plan

Designed for targeted audience's learning objectives/outcomes, scope, constraints…

IV. Storyboard

Mapping existing online materials

Illustrated the blueprint of the **course**, including exact the narration, media, quizzes, interactions, and sequencing.

V. Moodle

ETRP Moodle Site

A Glance at the planned WIPPS Learning Portal

In WMO ETRP Moodle Platform

WMO Integrated Processing and Prediction System (WIPPS)

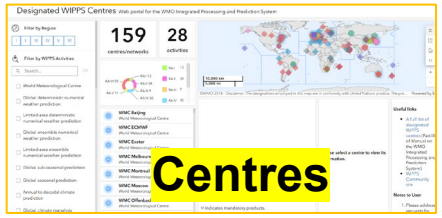
MODEL

As a worldwide network of operational centres operated by WMO Members, the **WMO Integrated Processing and Prediction System (WIPPS)** makes defined products and services operationally available among WMO Members and relevant operational organizations for applications related to weather, climate, water and the environment.

High-quality products and services are generated using advanced science and technology such as Numerical Weather Prediction (NWP) and Earth system modelling, better observations, improved data assimilation, increased computing power, and enhanced knowledge of weather dynamics and physics.

These advancements have led to more accurate predictions, benefiting operational

WORLD METEOROLOGICAL ORGANIZATION

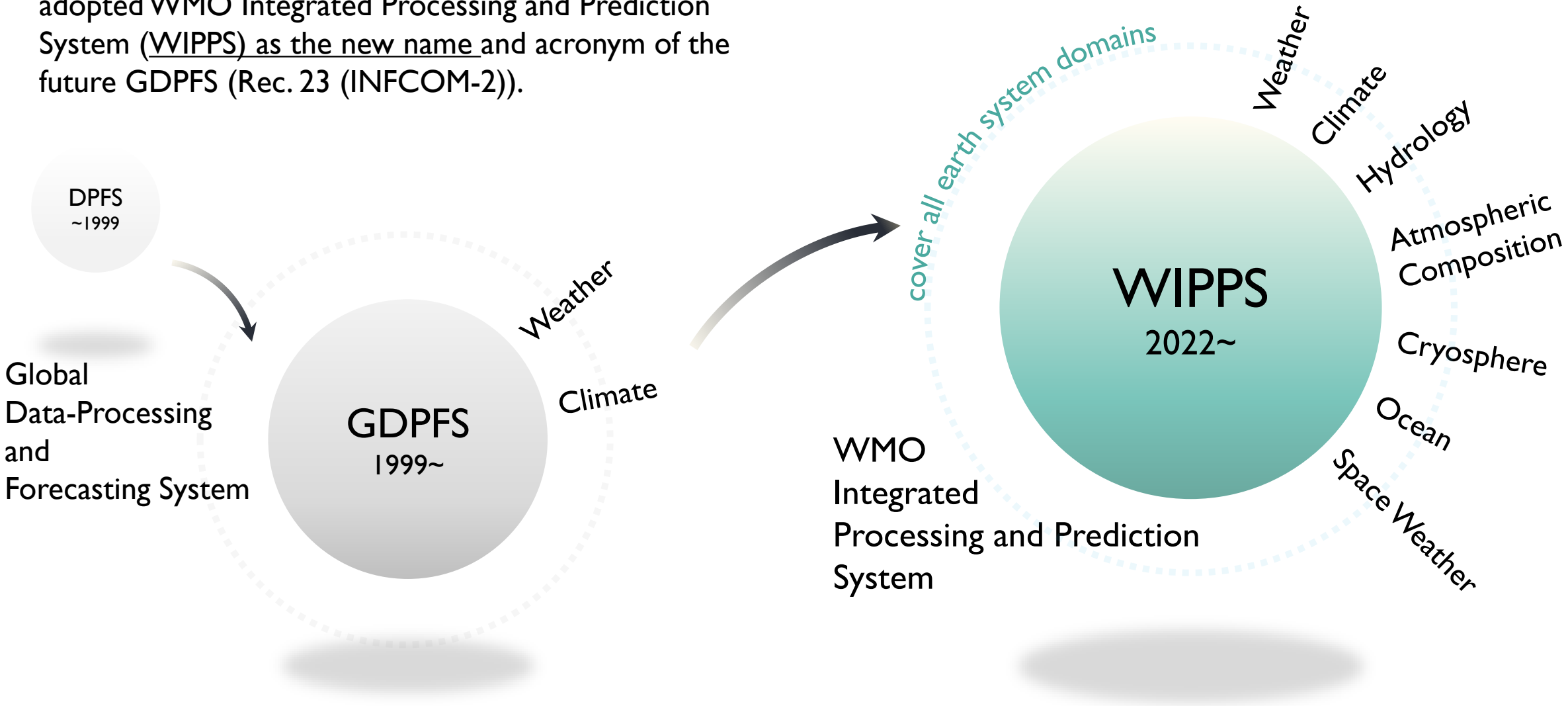


We plan to develop the Training part.

Thank you

WIPPS from GDPFS

In 2022, the Commission for Observation, Infrastructure and Information Systems (INFCOM) adopted WMO Integrated Processing and Prediction System (WIPPS) as the new name and acronym of the future GDPFS (Rec. 23 (INFCOM-2)).



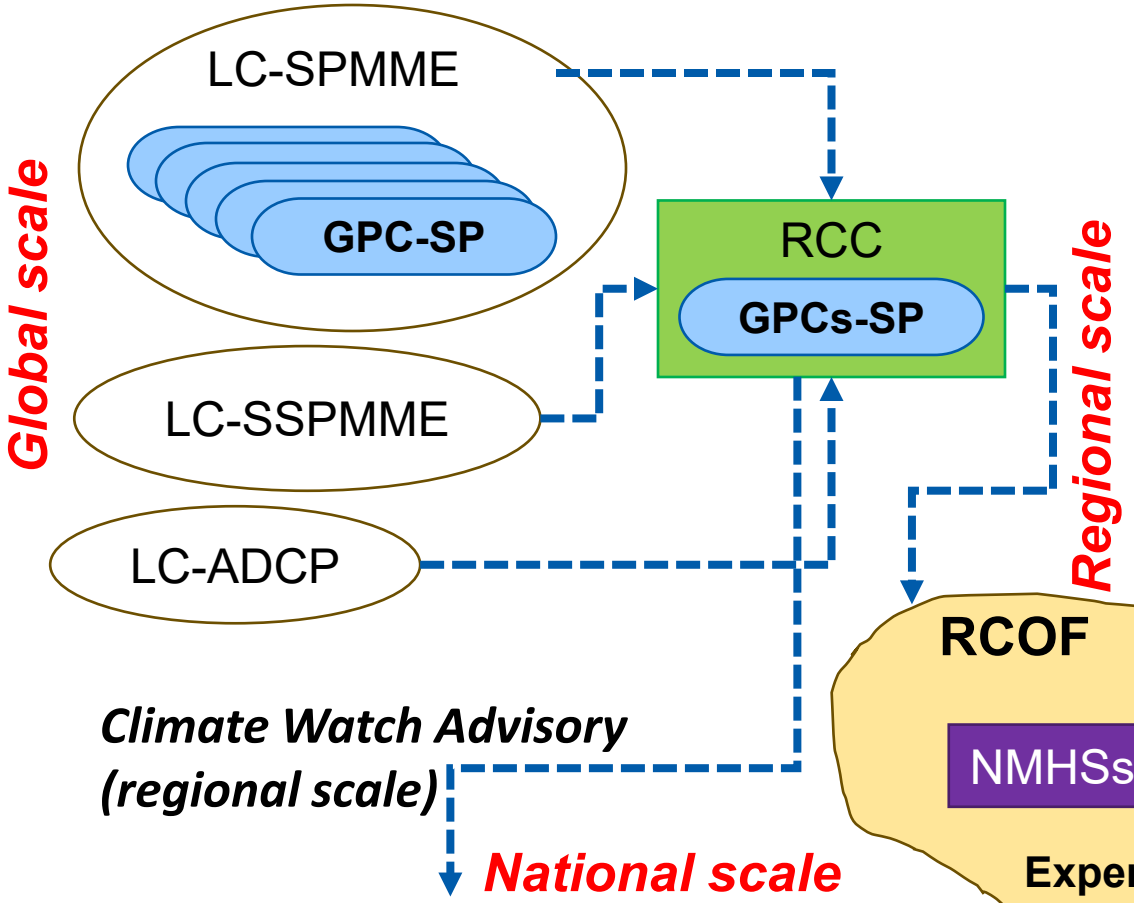
Roles of LCs and GPCs : Seasonal prediction

LC-SPMME

1. Collect an agreed set of forecasts and hindcasts data from GPCs-SP.
2. Generate a **multi-model ensemble** of GPCs-SP forecasts.
3. Generate **verification** for GPCs-SP forecasts and multi-model ensemble products.
4. Display the aforementioned data and products in a **standard graphic format**.
5. Archive and distribute the aforementioned **digital data and products** in a standard format (GRIB and NetCDF).

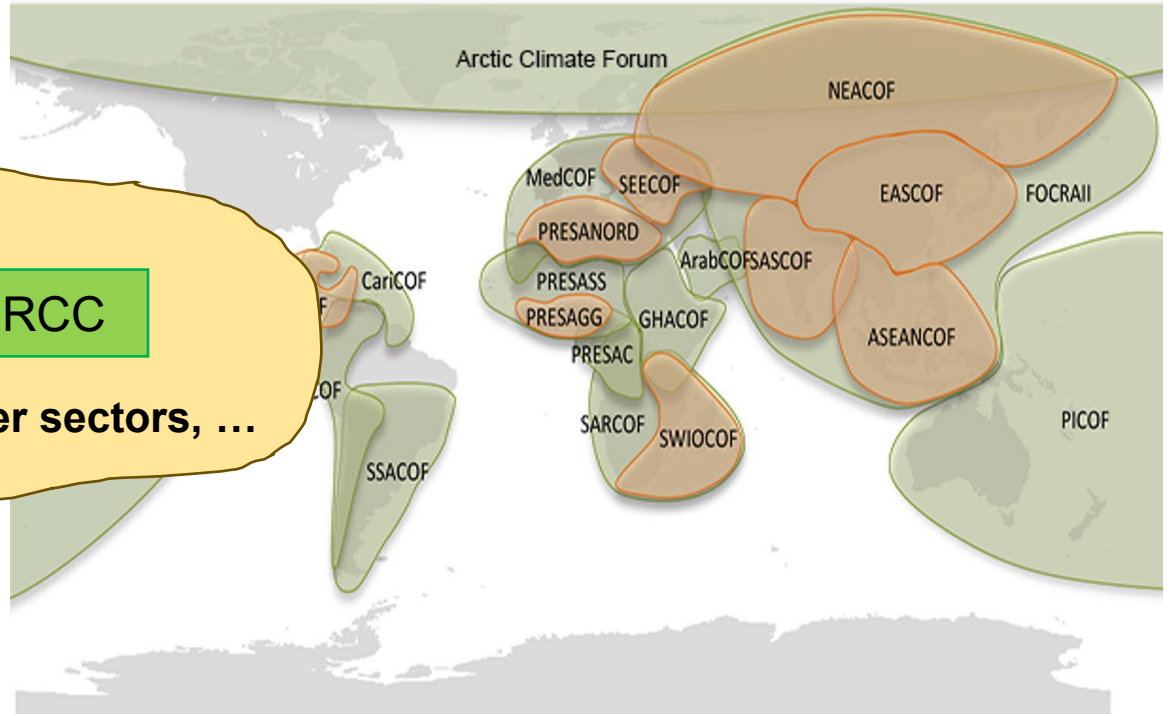
Each GPC-SP is required to send its ensemble forecast to LC-SPMME by the 15th of each month.

ROCF's composition, functions and products



Functions:

Regional Climate Outlook Forums (RCOFs) produce **consensus-based**, user-relevant **climate outlook products** in real time in order to reduce climate-related risks and support sustainable development for the coming season in sectors of critical socioeconomic significance for the region in question.



NMHSs participating in RCOF should consider how the results of the RCOF in their region should be integrated into the **Climate Watch Advisory** issued by the NMHSs