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| --- | --- | --- |
| WEATHER CLIMATE WATER | **World Meteorological Organization**  **COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS**  **Second Session** 24 to 28 October 2022, Geneva | **INFCOM-2/Doc. 6.4(2)** |
| Submitted by: Chair  28.X.2022  **APPROVED** |

**AGENDA ITEM 6: TECHNICAL REGULATIONS AND OTHER TECHNICAL DECISIONS**

**AGENDA ITEM 6.4: Standing Committee on Data-Processing for Applied Earth System Modelling and Prediction (SC-ESMP)**

# Amendments to the *Manual on the Global Data-Processing and Forecasting System* (WMO-No. 485)



# DRAFT RECOMMENDATIONS

## Draft Recommendation 6.4(2)/1 (INFCOM-2)

### Amendments to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793)(WMO-No. 485) in alignment with WMO Unified Data Policy

THE COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS,

**Recalling:**

(1) [Decision 57 (EC-68)](https://library.wmo.int/doc_num.php?explnum_id=3166#page=186) – Strategy to assist Members in improving their use of high-resolution numerical weather prediction and implementing limited-area numerical weather prediction systems,

(2) [Resolution 18 (EC-69)](https://library.wmo.int/doc_num.php?explnum_id=3645#page=154) – Revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

(3) [Resolution 1 (Cg-Ext(2021))](https://library.wmo.int/doc_num.php?explnum_id=11113#page=9) - WMO Unified Policy for the International Exchange of Earth System Data,

**Reaffirming** that:

(1) General purpose activities of the Global Data-processing and Forecasting System (GDPFS) encompass essential data-processing required for a wide range of end use,

(2) Global deterministic numerical weather prediction (NWP), global ensemble NWP, global numerical sub-seasonal forecasts (SSF) and global numerical long-range prediction are already established as general purpose activities,

(3) Mandatory products are minimum set of products that designated GDPFS centre shall produce and make available via WIS,

(4) Core data include analysis and prediction fields provided by NWP systems of designated producing centres of the GDPFS specified in the [*Manual on the Global Data-processing and Forecasting System (GDPFS)*](https://library.wmo.int/index.php?lvl=notice_display&id=12793) (WMO-No. 485),

**Recognizing** that:

(1) The World Meteorological Congress requested INFCOM to initiate a process for amending the [*Manual on the GDPFS*](https://library.wmo.int/index.php?lvl=notice_display&id=12793) (WMO-No. 485) in light of the commitment to the free and unrestricted exchange of data and the requirements of Members for access to high-quality NWP and analysis products,

(2) Members requested better access to the high-resolution NWP for initial and boundary conditions of limited-area NWP,

(3) SERCOM requested to classify the tropical cyclone tracks output of deterministic and ensemble NWP models as mandatory data through [Resolution 5.1(1)/1 (SERCOM-2)](https://meetings.wmo.int/SERCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/SERCOM-2/English/1.%20DRAFTS%20FOR%20DISCUSSION/SERCOM-2-d05-1(1)-UPDATES-MANUAL-GDPFS-WMO-NO-485-draft1_en.docx&action=default) – Updates to the [*Manual on the GDPFS*](https://library.wmo.int/index.php?lvl=notice_display&id=12793#.YzrQrHZBw2w) (WMO-No. 485) proposed by SERCOM Standing Committees,

**Noting** that:

(1) The Standing Committee on Data-processing for Applied Earth System Modelling and Prediction (SC-ESMP) proposed to consider the mandatory products of RSMCs for general purpose activities as ‘core data’ products in the context of WMO Unified Data Policy,

(2) The draft list of core data in the weather and climate domains was developed and practical issues and technical challenges were identified *[Japan]* though the dialogue among Members, Technical Commissions and World Meteorological Centres at GDPFS Symposium on Requirements for NWP Data and Products (29–31 August 2022) as described in the report of the Symposium ([INFCOM-2/INF. 6.4(2.1)](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/InformationDocuments/INFCOM-2-INF06-4(2-1)-GDPFS-SYMPOSIUM-SUMMARY-REPORT_en.docx&action=default)),

(3) The GDPFS Symposium on Requirements for NWP Data and Products suggested the exploration of the possibility of a Lead Centre on coordinating medium-range forecast multi-model ensembles ([INFCOM-2/INF. 6.4(2.1)](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/InformationDocuments/INFCOM-2-INF06-4(2-1)-GDPFS-SYMPOSIUM-SUMMARY-REPORT_en.docx&action=default)), *[Hong Kong, China]*

(4) SC-ESMP has almost completed drafting new guidelines on high-resolution NWP ([INFCOM-2/INF. 6.4(2.2)](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/InformationDocuments/INFCOM-2-INF06-4(2-2)-DRAFT-GUIDELINES-ON-HIGH-RESOLUTION-NWP_en.docx&action=default)),

(5) SC-ESMP has confirmed with all contributing centres to the Lead Centre for Annual to Decadal Climate Prediction (LC-ADCP) that the access to data from the Lead Centre(s) for ADCP website(s) will not be needed to be protected with a password,

**Having examined** the following recommendations to introduce the concept of ‘core data’ into the [Manual on the GDPFS](https://library.wmo.int/index.php?lvl=notice_display&id=12793) (WMO-No. 485),

(1) For global deterministic NWP as per [Annex 1](#_Annex_1_to) and [Annex 5](#_Annex_5_to) to draft Resolution #/1(Cg-19),

(2) For global ensemble NWP as per [Annex 2](#_Annex_2_to) and [Annex 6](#_Annex_6_to) to draft Resolution #/1(Cg-19),

(3) For global numerical sub-seasonal to seasonal forecast as per [Annex 3](#_Annex_3_to) and [Annex 7](#_Annex_7_to) to draft Resolution #/1(Cg-19),

(4) For global numerical long-range prediction as per [Annex 4](#_Annex_4_to) and [Annex 8](#_Annex_8_to) to draft Resolution #/1(Cg-19),

**Having further examined:**

(1) The recommendation to remove the password protection of LC-ADCP websites as per [Annex 9](#_Annex_9_to) to draft Resolution #/1(Cg-19),

(2) Draft guidelines on high-resolution NWP as provided in [INFCOM-2/INF. 6.4(2.2)](https://meetings.wmo.int/INFCOM-2/InformationDocuments/Forms/AllItems.aspx),

(3) The GDPFS workplan to follow up WMO Unified Data Policy as provided in [INFCOM‑2/INF. 6.4(2.3)](https://meetings.wmo.int/INFCOM-2/InformationDocuments/Forms/AllItems.aspx),

**Recommends** to Congress the adoption of the *Amendments to the Manual on GDPFS (WMO‑No. 485) in alignment with WMO Unified Data Policy* throughthe draft Resolution provided in the [annex](#_Annex_to_draft_3) to the present Recommendation;

**Requests** SC-ESMP in close collaboration with the relevant subsidiary bodies of SERCOM *[P/SERCOM]* to further enrich the guidelines on high-resolution NWP considering the feedback from Members after their review;

**Further Requests** SC-ESMP in collaboration with the relevant subsidiary bodies of SERCOM, *[P/SERCOM]* WMCs and RSMCs:

(1) To review the list of the proposed core data products, in consideration of the outcomes of the GDPFS Symposium and on-going development of WIS 2.0, *[Japan]* and submit the draft Recommendation on the relevant amendment of the [*Manual on the GDPFS*](https://library.wmo.int/index.php?lvl=notice_display&id=12793#.YzrQrHZBw2w) (WMO‑No. 485) to INFCOM-3 (2024);

(2) To initiate a Seamless GDPFS Pilot Project to outline the requirements and feasibility to provide to Members the access to high-resolution NWP data for initial and boundary conditions of limited-area models;

**Authorizes** the INFCOM Management Group to finalize the guidelines on high-resolution NWP by Cg-19.

See [INFCOM-2/INF. 6.4(2.1)](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/InformationDocuments/INFCOM-2-INF06-4(2-1)-GDPFS-SYMPOSIUM-SUMMARY-REPORT_en.docx&action=default), [INFCOM-2/INF. 6.4(2.2)](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/InformationDocuments/INFCOM-2-INF06-4(2-2)-DRAFT-GUIDELINES-ON-HIGH-RESOLUTION-NWP_en.docx&action=default) and [INFCOM-2/INF. 6.4(2.3)](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/InformationDocuments/INFCOM-2-INF06-4(2-3)-GDPFS-WORK-PLAN-WMO-DATA-UNIFIED-POLICY_en.docx&action=default) for more information

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[Annex: 1](#_Annex_to_draft_3)

## Annex to draft Recommendation 6.4(2)/1 (INFCOM-2)

**Draft Resolution ##/1 (Cg-19)**

### Amendments to the *Manual on GDPFS* (WMO-No. 485) in alignment with WMO Unified Data Policy

THE WORLD METEOROLOGICAL CONGRESS,

**Recalling:**

(1) [Decision 57 (EC-68)](https://library.wmo.int/doc_num.php?explnum_id=3166#page=186) – Strategy to assist Members in improving their use of high-resolution numerical weather prediction (NWP) and implementing limited-area NWP systems,

(2) [Resolution 18 (EC-69)](https://library.wmo.int/doc_num.php?explnum_id=3645#page=154) – Revised Manual on the Global Data-processing and Forecasting System (WMO-No. 485),

(3) [Resolution 1 (Cg-Ext(2021))](https://library.wmo.int/doc_num.php?explnum_id=11113#page=9) - WMO Unified Policy for the International Exchange of Earth System Data,

**Noting** the finalization of guidelines on high-resolution NWP,

**Having examined** [Recommendation 6.4(2)/1 (INFCOM-2)](#draftrec1),

**Having agreed** the amendment to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793#.YzrQrHZBw2w) (WMO-No. 485), as provided in the Annexes 1 to 9 to the present resolution,

**Authorizes** the Secretary-General, in consultation with the president of INFCOM concerned to make editorial amendments to the [*Manual on Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793#.YzrQrHZBw2w)(WMO-No. 485).

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Note: This resolution replaces [Decision 57 (EC-68)](https://library.wmo.int/doc_num.php?explnum_id=3166#page=186) – Strategy to assist Members in improving their use of high-resolution NWP and implementing limited-area NWP systems, which is no longer in force.

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[Annexes: 9](#annex1)

## Annex 1 to draft Resolution #/1 (Cg-19)

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual.]*

***2.2.1.1 Global deterministic numerical weather prediction***

Regional Specialized Meteorological Centres conducting global deterministic NWP shall:

(a) Produce global analyses of the three‑dimensional structure of the atmosphere;

(b) Produce global forecast fields of basic and derived atmospheric parameters;

(c) Make available on WIS a range of these products; the list of ~~mandatory~~ core data and highly recommended global deterministic NWP products to be made available is given in Appendix 2.2.1;

(d) Produce verification statistics according to the standard defined in Appendix 2.2.34, and make them available to the Lead Centre(s) for DNV;

(e) Make available on a website up‑to‑date information on the characteristics of their global NWP systems. The minimum information to be provided is given in Appendix 2.2.2.

## Annex 2 to draft Resolution #/1 (Cg-19)

***2.2.1.3 Global ensemble numerical weather prediction***

Centres conducting global ensemble NWP shall:

(a) Produce global ensemble forecast fields of basic and derived atmospheric parameters;

(b) Make available on WIS a range of these products; the list of ~~mandatory~~ core data and highly recommended global ensemble NWP products to be made available is given in [Appendix 2.2.5](#_bookmark67);

(c) Make verification statistics available to the Lead Centre(s) for EPS verification according to the standard defined in [Appendix 2.2.35](#_bookmark132);

(d) Make available on a website up‑to‑date information on the characteristics of their global EPS; the minimum information to be provided is given in [Appendix 2.2.6](#_bookmark69).

## Annex 3 to draft Resolution #/1 (Cg-19)

***2.2.1.5 Global numerical sub‑seasonal forecasts***

2.2.1.5.1 Centres conducting global numerical SSFs (GPCs for Sub‑seasonal Forecasts (GPCs‑SSF)) shall:

Note: Functions are defined for the sub‑seasonal (10 days–4 weeks) forecasting activity.

(a) With at least weekly frequency, generate SSF products with global coverage;

(b) Make available on WIS a range of these products; ~~mandatory~~ core data and highly recommended products to be made available are listed in Appendix 2.2.41;

(c) Produce verification statistics according to the standard defined in Appendix 2.2.45, and make them available on a website;

(d) Provide an agreed set of forecast and hindcast variables (as defined in Appendix 2.2.43) to the Lead Centre(s) for Sub‑seasonal Forecast Multi‑model Ensemble (SSFMME);

(e) Make available on a website up‑to‑date information on the characteristics of their global numerical SSF systems; the minimum information to be provided is given in Appendix 2.2.42.

## Annex 4 to draft Resolution #/1 (Cg-19)

***2.2.1.6 Global numerical long‑range prediction***

Centres conducting global numerical long‑range prediction (GPCs for Long‑range Forecasts (GPCs‑LRF)) shall:

Note: Functions are defined for the seasonal (1–6 month) prediction activity.

(a) Generate LRF products with global coverage;

(b) Make available on WIS a range of these products; ~~mandatory~~ core data and highly recommended products to be made available are listed in [Appendix 2.2.9](#_bookmark75);

(c) Produce verification statistics according to the standard defined in [Appendix 2.2.36](#_bookmark136), and make them available on a website;

(d) Make available on a website up‑to‑date information on the characteristics of their global long‑range numerical prediction systems; the minimum information to be provided is given in [Appendix 2.2.10](#_bookmark77);

(e) Agree to provide forecast output to the Lead Centre(s) for LRF multi‑model ensembles (Lead Centre(s) for LRFMME), as detailed in [Appendix 2.2.17](#_bookmark91) (section 1).

## Annex 5 to draft Resolution #/1 (Cg-19)

**APPENDIX 2.2.1. ~~MANDATORY~~ CORE DATA AND HIGHLY RECOMMENDED GLOBAL DETERMINISTIC NUMERICAL WEATHER PREDICTION PRODUCTS TO BE MADE AVAILABLE ON THE WMO INFORMATION SYSTEM**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *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  10-m u, 10-m v  Total precipitation | Surface |

**Additional recommended products:**

– Tropical storm tracks (latitudinal/longitudinal locations, maximum sustained wind speed, MSLP).

## Annex 6 to draft Resolution #/1 (Cg-19)

**APPENDIX 2.2.5. ~~MANDATORY~~ CORE DATA AND HIGHLY RECOMMENDED GLOBAL ENSEMBLE PREDICTION SYSTEM PRODUCTS TO BE MADE AVAILABLE ON THE WMO INFORMATION SYSTEM**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Parameter* | *Level (hPa)* | *Thresholds* | *Resolution (lat/lon grid)* | *Forecast range* | *Time steps* | *Frequency* |
| Probability of precipitation | Surface | 1, 5, 10, 25, 50 and  100 mm/24 hours | 1.5° × 1.5° | 10 days (or the maximum range if less) | Every 12  hours | Once a day |
| Probability of 10-m sustained wind and gusts | Surface | 10, 15 and 25 m s–1 |
| Probability of temperature anomalies | 850 | ±1, ±1.5, ±2 standard deviations with respect to a reanalysis climatology specified by the Producing Centre |
| Ensemble mean + spread (standard deviation) of geopotential height | 500 |  |
| Ensemble mean + spread (standard deviation) of MSLP | Surface |  |
| Ensemble mean + spread (standard deviation) of wind speed | 850/250 |  |

**Additional highly recommended products:**

– Location-specific time series of temperature, precipitation, wind speed, depicting the most likely solution and an estimation of uncertainty (“EPSgrams”); the definition, method of calculation and the locations should be documented;

– Tropical storm tracks (latitude/longitude locations, maximum sustained wind speed, MSLP from EPS members).

## Annex 7 to draft Resolution #/1 (Cg-19)

**APPENDIX 2.2.9. ~~MANDATORY~~ CORE DATA AND HIGHLY RECOMMENDED GLOBAL NUMERICAL LONG‑RANGE PREDICTION PRODUCTS TO BE MADE AVAILABLE ON THE WMO INFORMATION SYSTEM**

**Global Producing Centre ~~mandatory~~ core data products (maps)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coverage* | *Forecast range or lead time* | *Temporal resolution* | *Output type* | *Issuance frequency* |
| 2-m temperature | Global | Any forecast | Averages over | (1) Ensemble mean anomaly |  |
| SST | Global oceans |
| range (lead | one month |  |  |
| Total precipitation | Global |
| time) between | or longer | (2) Probabilities | Monthly |
| zero and four | periods | for tercile forecast |  |
| months | (seasons) | categories (where |  |
|  |  | applicable) |  |

Note: Probabilities for extremes are not ~~mandatory~~ core data but are highly recommended.

**Global Producing Centre highly recommended products (maps)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coverage* | *Forecast range or lead time* | *Temporal resolution* | *Output type* | *Issuance frequency* |
| 500 hPa height | Global | Any forecast range (lead time) between zero and four months | Averages over one month  or longer periods (seasons) | (1) Ensemble mean anomaly  (2) Probabilities for tercile forecast categories | Monthly |
| MSLP |
| 850 hPa temperature |

**Global Producing Centre highly recommended products (SST indices)**

|  |  |  |
| --- | --- | --- |
| *Index* | *Description* | *Coordinates* |
| Pacific Ocean |  |  |
| Niño 1+2 | Region off coasts of Peru and Chile | 90°W–80°W, 10°S–0° |
| Niño 3 | Eastern/central tropical Pacific | 150°W–90°W, 5°S–5°N |
| Niño 3.4 | Central tropical Pacific | 170°W–120°W, 5°S–5°N |
| Niño 4 | Western/central tropical Pacific | 160°E–150°W, 5°S–5°N |
| Atlantic Ocean |  |  |
| TNA | Tropical North Atlantic | 55°W–15°W, 5°N–25°N |
| TSA | Tropical South Atlantic | 30°W–10°E, 20°S–0° |
| TAD | Tropical Atlantic Dipole | TNA-TSA |
| Indian Ocean |  |  |
| WTIO | Western tropical Indian Ocean | 50°E–70°E, 10°S–10°N |
| SETIO | South-eastern tropical Indian Ocean | 90°E–110°E, 10°S–0° |
| IOD (DMI) | Indian Ocean Dipole (Dipole Mode Index) | WTIO–SETIO |

Notes:

1. Extremes (products are highly recommended, not ~~mandatory~~ core data) – the recommended definitions to be used for extremes are below 20th percentile and above 80th percentile.

2. Output types – rendered images (for example, forecast maps and diagrams). ~~Note:~~ GPCs-LRF are encouraged to make available the retrospective forecast (hindcast) and forecast fields underlying the products. Gridded binary-2 (GRIB-2) format should be used for fields posted on FTP sites or disseminated through WIS. GPCs-LRF are also encouraged to provide hindcast and forecast fields, as listed in [Attachment 2.2.4](#_bookmark164) section 1, to the Lead Centre(s) for LRFMME.

3. Definition of lead time – for example, a three-monthly forecast issued on 31 December has a lead time of zero months for a January to March seasonal mean forecast, and a lead time of one month for a February to April seasonal mean forecast.

4. For all products, forecasts are to be expressed relative to a climatology using at least 15 years of retrospective forecasts.

5. Information on how category boundaries are defined should be made available.

6. Indices are to be displayed using “plumes” of individual ensemble members and/or the “climagram” approach.

7. Indications of skill will be provided in accordance with [Appendix 2.2.37](#_bookmark139).

## Annex 8 to draft Resolution #/1 (Cg-19)

**APPENDIX 2.2.41. ~~MANDATORY~~ CORE DATA AND HIGHLY RECOMMENDED GLOBAL NUMERICAL SUB‑SEASONAL FORECAST PRODUCTS TO BE MADE AVAILABLE ON THE WMO INFORMATION SYSTEM**

**~~Mandatory~~ Core data products (maps) of Global Producing Centres for Sub‑Seasonal Forecasts (GPCs‑SSF)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coverage* | *Forecast range or lead time* | *Temporal resolution* | *Output type* | *Issuance frequency* |
| 2-m temperature | Global | Any forecast range (lead time) between zero and four weeks | Averages over periods (one  day-four weeks) | (1) Ensemble mean anomaly  (2) Probabilities for tercile forecast categories (where applicable) | Weekly |
| SST | Global oceans |
| Total precipitation | Global |

Note: Probabilities for extremes, for the variables specified under ~~mandatory~~ core data products, are also highly recommended.

**Highly recommended products (maps) of GPCs‑SSF**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coverage* | *Forecast range or lead time* | *Temporal resolution* | *Output type* | *Issuance frequency* |
| 500 hPa height | Global | Any forecast | Averages | (1) Ensemble mean | Weekly |
| MSLP |  | range (lead | over | anomaly |  |
|
|  | time) between | periods | (2) Probabilities for |  |
| 850 hPa temperature |
|  | zero and four | (one | tercile forecast categories |  |
|  | weeks | day-four |  |  |
|  |  | weeks) |  |  |

Notes:

1. Output types – rendered images (for example, forecast maps and diagrams). GPCs-SSF are encouraged to make available digital data on the retrospective forecast (hindcast) and forecast fields underlying the products. Gridded binary-2 (GRIB-2) format should be used for fields posted on FTP sites or disseminated through WIS. GPCs-SSF shall provide daily fields of hindcasts and forecasts, as variables listed in [Appendix 2.2.43](#_bookmark152), to the Lead Centre(s) for SSFMME.

2. For all products, anomalies are to be expressed relative to a climatology using at least 15 years of retrospective forecasts.

3. Information on how category boundaries are defined should be made available.

4. Indications of skill will be provided in accordance with [Appendix 2.2.45](#_bookmark156).

**Highly recommended products (diagrams) of GPCs‑SSF**

Diagrams presenting forecasts of the tropical intraseasonal variability such as the Madden–Julian Oscillation (Wheeler and Hendon, 2004; Gottschalck et al., 2010) are highly recommended.

**References**

Gottschalck, J.; Wheeler, M.; Weickmann, K. et al. A Framework for Assessing Operational Madden– Julian Oscillation Forecasts: A CLIVAR MJO Working Group Project. *Bulletin of the American Meteorological Society* **2010**, *91* (9), 1247–1258. <https://doi.org/10.1175/2010BAMS2816.1>.

Wheeler, M. C.; Hendon, H. H. An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction. *Monthly Weather Review* **2004**, *132* (8), 1917–1932. https://doi.org/10.1175/1520-0493(2004)132<1917:AARMMI>2.0.CO;2.

## Annex 9 to draft Resolution #/1 (Cg-19)

2.2.2.4 Coordination of annual to decadal climate prediction

2.2.2.4.1 The centre(s) conducting coordination of ADCP (Lead Centre(s) for ADCP) shall:

(a) Select a group of modelling centres to contribute to the Lead Centre(s) for ADCP (the “contributing centres”) that meet the GPC‑ADCP designation criteria and have been approved by ET‑OCPS; and manage changes in the membership of the group, as and when they occur, to maintain sufficient contributions;

(b) Maintain a list of the active contributing centres and the specification of their prediction systems;

(c) Collect an agreed set of hindcast, forecast and verification data (Appendices 2.2.20 and 2.2.21) from the contributing centres;

(d) Make available ~~(on a password‑protected website, as needed)~~ agreed forecast products in standard format, including multi‑model ensemble products (Appendix 2.2.20);

(e) Make available on the website agreed hindcast verification products in standard format, including verification of the multi‑model ensemble products (Appendix 2.2.21);

(f) Redistribute digital hindcast and forecast data for those contributing centres that allow it;

(g) Maintain an archive of the real‑time forecasts from individual contributing centres and from the multi‑model ensemble system;

(h) Promote research and experience in ADCP techniques and provide guidance and support on ADCP to RCCs and NMHSs;

(i) Based on comparison among different models, provide feedback to the contributing centres on model performance;

(j) Coordinate, in liaison with relevant World Climate Research Programme activities, an annual consensus prediction product giving global prospects for the next 1–5 years.

2.2.2.4.2 Access to data and visualization products held by a Lead Centre for ADCP should follow the rules as detailed in Appendix 2.2.19.

Note: The bodies in charge of managing the information contained in the present Manual related to coordination of ADCP are specified in the table below.

SECTION: Chapter

Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

Appendix 2.2.19. Access to data and visualization products held by the Lead Centre(s) for annual to decadal climate prediction

(a) ~~As needed, access to data from the Lead Centre(s) for ADCP website(s) will be password protected.~~

(b) ~~Digital data will be redistributed only in cases where the contributing centre data policy allows it. In other cases, r~~Requests for contributing centre output should be referred to the relevant contributing centre in cases where the digital hindcast and forecast data from the relevant contributing centre is not archived at the LC.

(c) ~~Contributing centres, RCCs, NMHSs and institutions coordinating RCOFs are eligible for password‑protected access to information held and produced by the Lead Centre(s) for ADCP.~~

(d) ~~Institutions other than those identified in (c) above may also request access to Lead Centre(s) for ADCP products. These i~~Institutions, including research centres, except contributing centres, RCCs, NMHSs and institutions coordinating RCOFs may not use Lead Centre(s) for ADCP products to generate and display/disseminate independent products for operational forecasting. These institutions must agree with these restrictions ~~to be eligible for access. Prior to access being granted to an applicant institution, the Lead Centre(s) for ADCP will refer the application to the INFCOM/ET‑OCPS through the WMO Secretariat for final consultation and review. Decisions to allow access must be unanimous. The Lead Centre(s) will be informed by the WMO Secretariat of such new users accepted for access~~.

(e) ~~A list of users provided with password access will be maintained by the Lead Centre for ADCP and reviewed periodically by the INFCOM/ET‑OCPS, to measure the degree of effective use and also to identify any changes in status of eligible users, and determine further necessary follow‑up.~~

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## Draft Recommendation 6.4(2)/2 (INFCOM-2)

### Amendments to the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485) proposed by SERCOM

THE COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS,

**Recalling:**

(1) [Resolution 18 (EC-69)](https://library.wmo.int/doc_num.php?explnum_id=3645#page=154) - Revised Manual on the Global Data-processing and Forecasting System (WMO-No. 485),

(2) [Resolution 7 (Cg-18)](https://library.wmo.int/doc_num.php?explnum_id=9827#page=41) – Establishment of WMO Technical Commissions for the eighteenth financial period,

(3) [Resolution 8 (SERCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=10767#page=89) - Establishment of WMO Hydrological Centres in the Global Data-processing and Forecasting System ,

(4) [Resolution 12 (INFCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=11197#page=157) - Concept of the Global Data-processing and Forecasting System centres for hydrological services,

(5) Recommendation 7 of the Hydrological Assembly ([Cg-Ext(2021/INF 3.1(2)](https://library.wmo.int/doc_num.php?explnum_id=11001)), endorsed by Congress ([Resolution 5 (Cg-Ext(2021)](https://library.wmo.int/doc_num.php?explnum_id=11113#page=155)),

**Recognizing** that hydrological centres in GDPFS should be designed taking into account the single voice principle in provision of flood forecasts and warnings by NHSs ([Resolution 8 (SERCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=10767" \l "page=89), [Resolution 12 (INFCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=11197" \l "page=157)), *[Japan]*

**Noting** that:

(1) GDPFS covers the activities in all Earth system domains beyond weather and climate,

(2) SC-HYD, SC-ESMP and SG-CRYO developed the designation criteria of new GDPFS Centres for hydrological services according to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793#.YzrQrHZBw2w) (WMO-No. 485),

(3) SC-MMO is responsible for changes to activity specification of numerical ocean wave prediction, global numerical ocean prediction and marine environmental emergency response,

(4) SC-MMO confirms: *[Japan, Secretariat]*

(a) RSMC Indian National Centre for Ocean Information Services (INCOIS) (India) meets the requirements of RSMC for numerical ocean wave prediction, global numerical ocean prediction,

(b) RSMC Exeter (United Kingdom) meets the requirements of RSMC for numerical ocean wave prediction and global numerical ocean prediction,

(c) RSMC Montreal (Canada) meets the requirements of RSMC for global numerical ocean prediction,

**Having considered** [Resolution 5.1(1)/1 (SERCOM-2)](https://meetings.wmo.int/SERCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/SERCOM-2/English/1.%20DRAFTS%20FOR%20DISCUSSION/SERCOM-2-d05-1(1)-UPDATES-MANUAL-GDPFS-WMO-NO-485-draft1_en.docx&action=default) – Updates to the Manual on the GDPFS (WMO-No. 485) proposed by SERCOM Standing Committees,

**Having further considered** that the specific terms of reference of INFCOM includes the development and maintenance of WMO normative material related to data-processing and forecast systems as specified in WMO Technical Regulations,

**Having examined**

(1) The clarification of the role of Hydrological Adviser in the designation process of RSMCs relevant to operational hydrology and its application to water management as provided in [Annex 1](#_Annex_1_to_1) of the draft resolution,

(2) The new designation criteria of RSMCs for sub-seasonal to seasonal (S2S) hydrological prediction as general purpose activity as provided in [Annex 2](#_Annex_2_to_1) of the draft resolution,

(3) The new designation criteria of RSMCs for snow cover prediction as general purpose activity as provided in [Annex 3](#_Annex_3_to_1) of the draft resolution,

(4) The new designation criteria of RSMCs for flash flood forecasting as specialized activity as provided in [Annex 4](#_Annex_4_to_1) of the draft resolution,

(5) The updated designation criteria of RSMCs for numerical ocean wave prediction as provided in [Annex 5](#_Annex_5_to_1) of the draft resolution,

(6) The updated designation criteria of RSMCs for global numerical ocean prediction as provide in [Annex 6](#_Annex_6_to_1) of the draft resolution,

*[Res.5.1(1)/1(SERCOM-2)]*(7) The application for designation of:

(a) RSMC Indian National Centre for Ocean Information Services (INCOIS) (India) for numerical ocean wave prediction and global numerical ocean prediction, *[Res.5.1(1)/1(SERCOM-2)]*

(b) RSMC Exeter (United Kingdom) for numerical ocean wave prediction and global numerical ocean prediction,

(c) RSMC Montreal (Canada) for global numerical ocean prediction,

*[Res.5.1(1)/1(SERCOM-2)]*and their inclusion in Part III of the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793) as provided in [Annex 7](#_Annex_8_to_1) *[Res.5.1(1)/1(SERCOM-2)]* of the draft resolution,

(8) the inclusion of SC-ESMP as one of bodies responsible for the change of activity specification on all GDPFS activities as provided in [Annex 8](#_Annex_9_to_1) *[Res.5.1(1)/1(SERCOM-2)]* of the draft resolution,

**Requests** SC-ESMP to prepare the draft amendments to the *Manual on the GDPFS* (WMO‑No. 485) for any changes to activity specification of all GDPFS activities by jointly *[Japan]* working with other bodies responsible for the change of activity specification;

**Recommends** to Executive Council the adoption of Amendments to the *Manual on GDPFS* (WMO-No. 485) jointly proposed by INFCOM and SERCOMthroughthe draft resolution provided in the [annex](#_Annex_to_draft_4) to the present Recommendation.

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[Annex: 1](#_Annex_to_draft_6)

## Annex to draft Recommendation 6.4(2)/2 (INFCOM-2)

**Draft Resolution ##/2 (EC-76)**

### Amendments to the Manual on GDPFS (WMO-No. 485) jointly proposed by INFCOM and SERCOM

THE EXECUTIVE COUNCIL,

**Recalling:**

(1) [Resolution 18 (EC-69)](https://library.wmo.int/doc_num.php?explnum_id=3645#page=154) - Revised Manual on the Global Data-processing and Forecasting System (WMO-No. 485),

(2) [Resolution 7 (Cg-18)](https://library.wmo.int/doc_num.php?explnum_id=9827#page=41) – Establishment of WMO Technical Commissions for the eighteenth financial period,

(3) [Resolution 8 (SERCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=10767#page=89) - Establishment of WMO Hydrological Centres in the Global Data-processing and Forecasting System,

(4) [Resolution 12 (INFCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=11197#page=157) - Concept of the Global Data-processing and Forecasting System centres for hydrological services,

(5) Recommendation 7 of the Hydrological Assembly ([Cg-Ext(2021/INF 3.1(2)](https://library.wmo.int/doc_num.php?explnum_id=11001)), endorsed by Congress ([Resolution 5 (Cg-Ext(2021)](https://library.wmo.int/doc_num.php?explnum_id=11113#page=155)),

**Recognizing** that hydrological centres in GDPFS should be designed taking into account the single voice principle in provision of flood forecasts and warnings by NHSs ([Resolution 8 (SERCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=10767" \l "page=89), [Resolution 12 (INFCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=11197" \l "page=157)), *[Japan]*

**Noting** [Resolution 5.1(1)/1 (SERCOM-2)](https://meetings.wmo.int/SERCOM-2/English/Forms/AllItems.aspx?RootFolder=%2FSERCOM%2D2%2FEnglish%2F1%2E%20DRAFTS%20FOR%20DISCUSSION&FolderCTID=0x012000A60A2C5B5006AA41980F5F2A7BA92166&View=%7B1EB384EC%2D8FE1%2D4B79%2DB8F9%2DA0AEB19C9F87%7D) – Updates to the Manual on the GDPFS (WMO‑No. 485) proposed by SERCOM Standing Committees,

**Having examined** [Recommendation 6.4(2)/2 (INFCOM-2)](#draftrec2) – Amendments to the Manual on GDPFS (WMO-No. 485) proposed by SERCOM,

**Having agreed** the amendment to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793) (WMO-No. 485), as provided in the Annexes 1 to 8 *[Res.5.1(1)/1(SERCOM-2)]* to the present resolution.

**Authorizes** the Secretary-General, in consultation with the president of INFCOM, to make editorial amendments to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793) (WMO-No. 485).

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[Annexes: 8](#_Annex_1_to_1) *[Res.5.1(1)/1(SERCOM-2)]*

## Annex 1 to draft Resolution ##/2 (EC-76)

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual. In addition, the text will be updated reflecting the changes made to the Resolution 5.1(1)/1 (SERCOM-2) during SERCOM-2 (2022).]*

1.2.6.3 Requests for designation as a WMC or RSMC shall be put forward by the Permanent Representative of the country of the candidate centre, or, in the case of international organizations, by either the Permanent Representative of the country where the candidate centre is located or the president of the relevant regional association(s) (RA(s)).

Note: The Permanent Representative of the country consults with the Hydrological Adviser with respect to requests of the designation as a Centre relevant to operational hydrology and its application to water management as per Regulation 5 of General Regulations (WMO-No. 15).

## Annex 2 to draft Resolution ##/2 (EC-76)

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual. In addition, the text will be updated reflecting the changes made to the Resolution 5.1(1)/1 (SERCOM-2) during SERCOM-2 (2022).]*

**2.2.1.X Sub-seasonal to seasonal (S2S) hydrological prediction**

Centres conducting sub-seasonal to seasonal (S2S) hydrological prediction (Regional Specialized Hydrological Centres (RSHC) for S2S hydrological prediction) shall:

(a) Produce ensemble forecast fields of basic and/or derived hydrological variables;

(b) Provide forecast data and products to NMHSs *[Japan]* at spatial and temporal resolutions that are scientifically and technically appropriate given S2S predictability considerations;

(c) Produce, where applicable, related forecast information products including categorical probability forecasts (such as tercile forecasts comprising probabilities of above normal, normal, below normal conditions) relative to a reference climatology, in the form of maps, charts and tables;

(d) Make available on WIS in a manner agreed on with Members *[Japan]* a range of these products; the list of mandatory and highly recommended S2S ensemble hydrological products to be made available is given in Appendix 2.2.XX;

(e) To the extent possible, make verification statistics available according to the standards defined in Appendix 2.2.YY;

(f) Make available online up-to-date supporting information on the characteristics of their global S2S ensemble hydrological prediction system, including key datasets and model versions, summary description of important ancillary methods (such as data assimilation and post-processing), and key references and contacts; the minimum information to be provided is given in Appendix 2.2.ZZ.

Note: The bodies in charge of managing the information contained in the present Manual related to global ensemble NWP are specified in Table X

Table X. WMO bodies responsible for managing information related to   
global S2S hydrological prediction

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP | SERCOM/SC-HYD |  |
| To be recommended by: | INFCOM | SERCOM |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | SERCOM | INFCOM |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | SERCOM/SC-HYD |  |  |
| To be reported to: | INFCOM/SC-ESMP | INFCOM | SERCOM |

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**APPENDIX 2.2.XX. global ensemble S2S hydrological products**

1. Introduction

This appendix presents a list of core mandatory products (section 2) and recommended (section 3) global ensemble S2S hydrological products and services to be supported by qualifying centres. Additional information about the products is included in section 4, and related material describing product verification and system information is included in Appendices 2.2.YY and 2.2.ZZ, respectively.

2. Mandatory Products

Centres must operationally produce ensemble or probabilistic forecasts (including a central highly tendency and spread) for the variables listed in Table X1 for a global extent, where appropriate. Cryosphere-related products will not be valid over all land areas, though such data products may retain global dimensions. Expanded variable definitions are given in Section 4.6.

Table X1. Mandatory variables

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable Name** | **Spatial resolution** | **Temporal resolutions (time step)** | **Forecast lead times** | **Update Frequency** | **Latency** |
| Runoff (Discharge). See details in Section 4.6 | 5–25 km grids or mesoscale catchments | Between 1 day and 1 month | From 0 to 12 months with minimum range of 3 months | Between 1 day and 1 month | Between 1 and 10 days |

3. Highly Recommended Products

In addition to the core (mandatory) products, Centres are welcome and encouraged to provide probabilistic information products for other variables to give a fuller context to the primary forecast outputs listed above. Expanded variable definitions are given in Section 4.6.

Table X2. Additional variables

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable Name** | **Spatial resolution** | **Temporal resolution (time step)** | **Forecast lead times** | **Update Frequency** | **Latency** |
| River stage *[Argentina]* | 5–100 km reach lengths; Points | Between 1 day and 1 month | From 0 to 12 months with minimum range of 3 months | Between 1 day and 1 month | Between 1 and 10 days |
| Water table depth | 5–25 km or equivalent catchments |
| Evaporative variables | 5–25 km or equivalent catchments |
| Groundwater | 5–50 km or equivalent catchments |
| Surface precipitation and 2-meter air temperature | 5–25 km or equivalent catchments |
| Hydrologic indices | 5–25 km or equivalent catchments |
| Water Equivalent of Snow Cover (Snow Water Equivalent) *[Argentina, Secretariat]* | 5–25 km or equivalent catchments |
| Soil Moisture | 5–25 km or equivalent catchments |

4. Additional Supporting Information

4.1 Spatial Resolution

The spatial resolution of the information products shall be determined by factors including usefulness and usability for local, regional and global-scale stakeholders as well as scientific and technical considerations to ensure that products can be reliably generated, effectively disseminated, and exhibit statistical skill. The mandatory spatial unit of the forecasts is a regular grid, but centres are also encouraged to provide products for other spatial units including watersheds or other delineations (such as administrative units), provided that the formal spatial reference definition is accepted by the community and is publicly available and accessible. It is expected that most qualifying products will adopt an intermediate spatial scale resolution (25–1000 km2 or approximately 5–25 km grid spacing). Streamflow or discharge products would be provided for a channel network of commensurate resolution, but also strive to provide outputs for existing and available monitoring gages, which will enhance the products’ relevance to stakeholders.

4.2 Temporal Resolution and Lead time

The primary S2S outlook products are temporally coarse, with predictand durations of 1 day to 1 month for lead times of up to one year. Given the skill profile of S2S climate and hydrologic phenomena, shorter predictand durations (e.g., 1 or 2 weeks) are appropriate for short lead times (up to approximately two months), and longer durations are appropriate for longer lead times. In addition, for some types of forecast outputs, such as ensemble predictions of streamflow, higher time resolution sequences for each ensemble member are commonly provided for use as inputs to subsequent modelling analyses (e.g., reservoir simulation models that may require a daily or sub-daily time resolution inputs).

4.3 Issuance Frequency and Latency

The update frequency is related to the temporal resolution, such that products are updated with sufficiently low latency (the lag between the time for which the forecast is initialized and the release or publication of the final forecast) and high frequency that the first lead time is still valid at time of issuance. For example, Centres producing forecasts with a 1 week temporal resolution should strive for a latency of 3 days or less and an update frequency of one week or less, while those producing forecasts of 1 month time resolution should strive for a latency of 10 days or less and an update frequency of one month or less.

4.4 Uncertainty estimation (ensemble size)

S2S forecasts should quantitatively and reliably characterize uncertainty because the ratio of signal to noise at S2S lead times is often relatively low. Ensemble-based systems should use a sufficient number of ensemble members (*i.e.,* ensemble size) to estimate forecast central tendency well (with a suggested minimum of 30 members). Statistical forecast systems or methodologies, which are not uncommon for regional applications, should estimate uncertainty from analysis of rigorously cross-validated prediction error rather than from model calibration error.

4.5 Output Type and Formats

The S2S products will ideally be presented in multiple forms and formats. To facilitate interpretation by stakeholders, a primary form of communication should include the presentation of forecast anomalies (e.g., percentile, percent of average, difference from average) calculated with respect to a retrospective climatology (mean annual and/or monthly to seasonal). Forecast anomalies may be for a particular percentile (e.g., 10th, 50th, 90th) and/or statistic (e.g., ensemble mean). Forecasts of the most probable outlook category are also a common derived product, and such categorical forecasts are not limited to the common tercile formulation (i.e., normal, below and above normal categories). The reference forecast and observational climatology should be based on a long enough record to define robust statistical thresholds for defining different conditions – preferably two decades or longer. Forecasts often suffer from systematic mean and variability bias, and the presentation of forecasts in terms of anomalies can aid in circumventing bias as well as standardizing products across multiple sources or centres. The calculation of anomalies should be calibrated to account for variability biases between the observational reference and the forecast system. Additional forms of forecast output are encouraged, including the full value of the raw forecast, forecasts transformed into standardized or normalized index form, as well as supporting information (such as the climatology for each output) as described in Appendix 2.2.ZZ.

Products shall be made available by the Centre on public facing website(s) in multiple formats, including graphical products (maps) as well as raw or post-processed data files (in standard formats, including ascii/text or binary files, such as NetCDF or grib). Centres are encouraged to use data archive facilities that provide user-oriented functionality and web services for interactive and automated sub-setting and downloading of forecast data. Lastly, regular forecast product discussions are encouraged, highlighting areas of interest or potential concern for users (such as droughts or flood potential). The Centre shall also provide a listing of clear contact points and/or a mechanism for inquiries and feedback from users.

4.6 Expanded variable information

Table X3. Variable Definitions

|  |  |
| --- | --- |
| **Variable Name(s)** | Description |
| Runoff (Discharge) | Water input to the river channel network or streamflow. Runoff may be expressed as total runoff and/or one or more of its components, namely surface runoff and subsurface discharge (volume/time unit). Runoff also may be supplied in the form of streamflow (or discharge), which includes the effect of channel routing |
| Water Equivalent of Snow Cover (Snow Water Equivalent) *[Argentina, Secretariat]* | Water depth equivalent of the snow and glacier mass above the land surface (length unit) |
| Soil Moisture | Water depth within the hydrologically active range of the subsurface, typically ranging from 0 m to a maximum depth in the 2–20 m range (length unit) *[Argentina]* |
| Groundwater or Aquifer Storage | Water depth stored in aquifers below the active subsurface soil moisture layers (length unit) |
| River stage | Elevation of the free water surface of a water body (river) relative to a datum level. (length unit) *[Secretariat]* |
| Water table depth | Depth to the upper surface of saturated soil moisture zone (length unit) |
| Evaporation variables | Evaporation-related variables include actual and potential evapotranspiration (the evaporation that would occur from bare soil or a plant if sufficient water were available and absent any restriction), as well as lake and reservoir evaporation. (length/time unit) |
| Surface precipitation and 2-meter air temperature | Climate forecast variables provide additional context for understanding hydrologic forecast variables. While climate forecasts are available from S2S climate forecasting centres, they may differ in multiple respects from those used directly in producing the hydrologic forecasts. Hydrological forecast centres are encouraged to make available at least the primary climate forecast variables (precipitation and 2-meter air temperature) associated with the hydrologic forecasts. (length or mass/time unit for precipitation and degrees Celsius or Kelvin units for temperature) |
| Hydrologic and/or drought indices | Some management communities use common indices such as the PDSI to inform decision-making on drought and other extremes. (non-dimensional standardized or normalized units). WMO-No. 1173 provides a list of index definitions, including the following, though this list does not include all indices of interest.   Palmer Hydrological Drought Index (PHDI)   Standardized Reservoir Supply Index (SRSI)   Standardized Streamflow Index (SSFI)   Standardized Water-level Index (SWI)   Streamflow Drought Index (SDI)   Surface Water Supply Index (SWSI)   Aggregate Dryness Index (ADI)   Standardized Snowmelt and Rain Index (SMRI) |

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**APPENDIX 2.2.YY. STANDARDIZED VERIFICATION OF S2S HYDROLOGIC PREDICTIONS**

1. Introduction

This appendix describes procedures for the production and exchange of a standard set of verification scores for S2S hydrological prediction data and products generated by GDPFS centres for incorporation into the GDPFS. Such centres may generate other hydrological prediction data and products that are not integrated into the GDPFS and are not subject to this verification requirement. The goal is to provide consistent verification information on the S2S products of participating forecast centres that will assist users, including forecasters in regional and national centres who use the information to inform regional and national seasonal outlooks. It will provide quantitative benchmarks for documenting and intercomparing the skill of participating centres. The verification scores described are to be calculated based on retrospective forecasts (hindcasts). Producing centres will calculate and make the verification scores available via their centre websites. Skill measures recommended for use by participating centres in verification of S2S hydrological forecasts include those described here.

2. Verification Metrics and Skill Scores

The following metrics and skill scores are required for the mandatory prediction variable(s) and derived products.

 Measures of accuracy and skill for ensemble mean and median forecasts, including bias, relative bias, correlation and anomaly correlation, mean absolute error and mean squared error; and associated relative terms, where appropriate: e.g., relative bias, relative mean absolute error, expressed as a percentage.

 Measures of probabilistic skill, including the continuous ranked probability score (CRPS) and the ranked probability score (RPS), and their 3-part decompositions (including, e.g., the reliability terms).

 For categorical forecasts, such as tercile predictions, common categorical skill metrics shall be provided, such as hit rates, false alarm ratios, critical success indices, or multicategory Brier scores.

 These metrics should also be expressed in the form of a skill score using two separate references: (1) climatology; (2) persistence.

 The observational datasets for the validation of hydrologic predictions can be of two types. Official agency observations should be used where available, such as for an appropriate (e.g., naturalized or not) streamflow (discharge) value at a river location. Where such observations are not available, such as for sub-surface variables or spatially distributed runoff, a high-quality reanalysis may be used. The nature of the validating data set should be documented along with the presentation of results.

Provision of the statistical significance of scores and/or confidence intervals is not currently mandatory but is strongly recommended. Participating centres are free to choose the method of the calculation.

3. Application of Metrics and Skill Scores

The scores shall be calculated at the temporal and spatial resolution for which the forecasts are provided (e.g., gridded, reach-based, point-based) or as constrained by the available observations and reanalyses, depending on the type of validation being performed.

Forecast scores must be stratified by lead time (weekly or monthly) and initialization date or time of year (calendar month, or season), recognizing the seasonally varying nature of hydrologic prediction skill and its dependence on the influence of initial conditions versus boundary forcings.

Forecast centres are encouraged to provide regional summaries of verification metrics and skill scores, but this is not required. If they are provided, the centre should provide accompanying guidance on the interpretation of such regional summaries, given the heterogeneity of underlying hydrologic processes across catchments and sub-basins within the region. Innovative pooling strategies for increasing sample size are also encouraged, if they are well documented.

4. Variables

All mandatory variables listed in the first table of Appendix 2.2.50 and the derived categorical or anomaly products shall be verified. Verification is also required for recommended variable forecasts and associated products that are to be integrated with the GDPFS. A centre may produce recommended (but not mandatory) variables without verification, but they will not be integrated into the GDPFS.

5. Hindcast Data set

The hindcast period for the hindcast data set used in forecast verification shall be at least 20 years to provide a minimum sample size for assessing forecast performance. Hindcast initialization frequency shall be a minimum of once per month with a minimum ensemble size of 10 members, or an alternate strategy that provides at least 10 members per month shall be used (e.g., lagged/pooled members across multiple initialization dates within a month). Hindcast datasets shall be generated with the same prediction system that is used to generate the real-time forecasts to the extent possible. It is recognized that some aspects of real-time systems may differ (by necessity) from the hindcasting system, such as the data assimilation that is used, and the other details such as ensemble size and update frequency (and even resolution) may differ due to computational constraints. These differences, and their expected or potential impact on the validity of the performance scores calculated from the hindcasts, shall be briefly summarized in documentation available from the Centre website.

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**APPENDIX 2.2.ZZ. Supporting information on the S2S hydrological prediction system**

This appendix presents a listing of the information required to be made available by centres providing S2S hydrological predictions within the GDPFS, describing the nature of the system, datasets and methods used to produce the forecasts and other relevant metadata. The information must be updated in a timely fashion when system upgrades are implemented, and includes the following elements.

 Formal name and date of implementation of the current forecast system producing the S2S predictions.

 Summary of the configuration of the system, including the details of its major sub-components (e.g., ocean, land, sea-ice, atmosphere), their version numbers, horizontal and vertical resolutions and extent (e.g., number of levels if appropriate), and the coupling of those components.

 Summary of the forecast initialization approach, including key observational datasets used in initialization, and the method used for data assimilation (if any).

 Summary of the ensemble forecast generation approach and ensemble forecast details (including size or number of members, timestep of saved outputs, update frequency, latency, lead time range, and list of core output variables).

 Description of any major external boundary forcings or constraints, if appropriate.

 Summary of associated hindcasting activities, including hindcast period, ensemble size, frequency, ensemble construction approach, timestep of saved outputs, time/space extent of outputs, and other relevant details (such as list of core output variables, data format).

 Summary of verification activities or completed studies addressing the performance of the system for the variables being contributed to the GDPFS.

 Description of access points to forecasts and hindcasts provided for integration with the GDPFS (typically these are URLs).

 Point(s) of contact, including either personnel names and office information such as email, website, and/or telephone number. This should not be a general agency entry point but rather a programmatic or technical contact.

 List of key references or documentation on the forecast system and its sub-components and methods, if those are not included in the forecast system documentation.

## Annex 3 to draft Resolution ##/2 (EC-76)

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual. In addition, the text will be updated reflecting the changes made to the Resolution 5.1(1)/1 (SERCOM-2) during SERCOM-2 (2022).]*

**2.2.1.X Snow cover prediction**

**Centres conducting snow cover prediction (RSHCs for snow cover prediction) shall:**

(a) Prepare analyses of snow cover parameters over land surfaces at regional scale; *[Secretariat in response to Japan]*

(b) Make available on WIS a range of these products; the list of mandatory and highly recommended products to be made available is given in Appendix 2.2.XX;

(c) Produce verification statistics according to the standard defined in Appendix 2.2.YY and make them available on their website;

(d) Make available on a website up-to-date information on the characteristics of their snow cover prediction systems; the minimum information to be provided is given in Appendix 2.2.ZZ.

The Centres should:

(a) Prepare forecasts of snow cover parameters over land surfaces;

(b) Make available on WIS a range of these products; the list of products to be made available is given in Appendix 2.2.XX;

(c) Produce verification statistics according to the standard defined in Appendix 2.2.YY and make them available on their website.

Note: The bodies in charge of managing the information contained in the Manual related to snow cover prediction are specified in the table below.

**Table X. WMO bodies responsible for managing information related to snow cover prediction**

|  |  |  |  |
| --- | --- | --- | --- |
| *Responsibility* | | | |
| *Changes to activity specification* | | | |
| To be proposed by: | INFCOM/SC-ESMP | SERCOM/SC-HYD |  |
| To be recommended by: | SERCOM | INFCOM |  |
| To be decided by: | EC/Congress/ |  |  |
| *Centre designation* | | | |
| To be recommended by: | RA | SERCOM | INFCOM |
| To be decided by: | EC/Congress/ |  |  |
| *Compliance* | | | |
| To be monitored by: | SERCOM/SC-HYD |  |  |
| To be reported to: | INFCOM/SC-ESMP | INFCOM | SERCOM |

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**APPENDIX 2.2.XX MANDATORY AND HIGHLY RECOMMENDED SNOW COVER PREDICTION PRODUCTS TO BE MADE AVAILABLE ON THE WMO INFORMATION SYSTEM**

Snow cover analysis products are mandatory, but can be provided either on a grid or at the basin-scale (or both). Snow cover forecasts are highly recommended, but not mandatory. However, in all cases the same two parameters are mandatory: snow cover area and water equivalent of snow cover.

**(1) Mandatory products** *[Secretariat]*

**Gridded snow analysis products** *[Secretariat]*

|  |  |  |  |
| --- | --- | --- | --- |
| *Parameter* | *Spatial resolution* | *Frequency* | *Latency* |
| Snow cover area | 10 km | Once per day | Less than 12 hours |
| Wat Water equivalent of snow cover |

* Altitude at which parameters are valid must be provided
* Within a given grid cell, parameters can be provided for multiple combinations of altitude, slope, aspect and vegetation type, but a grid cell average should also be provided

**Basin-scale snow analysis products** *[Secretariat]*

|  |  |  |  |
| --- | --- | --- | --- |
| *Parameter* | *Spatial resolution* | *Frequency* | *Latency* |
| Snow cover fraction | Basin average | Twice monthly | Less than 7 days |
| Wat Water equivalent of snow cover |

**(2) Recommended products** *[Secretariat]*

**Gridded snow analysis products**

|  |  |  |  |
| --- | --- | --- | --- |
| *Parameter* | *Spatial resolution* | *Frequency* | *Latency* |
| *[Secretariat]* | 10 km *[Secretariat]* | Once per day *[Secretariat]* | Less than 12 hours  *[Secretariat]* |
| *[Secretariat]* |
| Snow depth |
| Vertical average of snowpack temperature profile |
| Liquid water content of snow [% of total mass] |
| Snowmelt runoff at the base of the snowpack |

* *[Secretariat]*Altitude at which parameters are valid must be provided
* Within a given grid cell, parameters can be provided for multiple combinations of altitude, slope, aspect and vegetation type, but a grid cell average should also be provided

**Gridded snow forecast products**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Parameter* | *Spatial resolution* | *Forecast range* | *Time steps* | *Frequency* | *Latency* |
| Snow cover area\* | 10 km *[Secretariat]* | Up to 3 days / Beyond 3 days, up to 32 days | 3 hours / 24 hours | Once per day *[Secretariat]* | Less than 12 hours *[Secretariat]* |
| Water equivalent of snow cover\* |
| Snow depth |
| Vertical average of snowpack temperature profile |
| Liquid water content of snow [% of total mass] |
| Snowmelt runoff at the base of the snowpack |

\*Required products for gridded snow cover forecast (if forecasts are provided)

* Altitude at which parameters are valid must be provided
* Within a given grid cell, parameters can be provided for multiple combinations of altitude, slope, aspect and vegetation type, but a grid cell average should also be provided

**Basin-scale snow analysis products**

|  |  |  |  |
| --- | --- | --- | --- |
| *Parameter* | *Spatial resolution* | *Frequency* | *Latency* |
| *[Secretariat]* | Basin average *[Secretariat]* | Twice monthly *[Secretariat]* | Less than 7 days *[Secretariat]* |
| *[Secretariat]* |
| Snow depth |
| Vertical average of snowpack temperature profile |
| Liquid water content of snow [% of total mass] |
| Snowmelt runoff at the base of the snowpack |

*[Secretariat]*

**Basin-scale snow forecast products**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Parameter* | *Spatial resolution* | *Forecast range* | *Time steps* | *Frequency* | *Latency* |
| Snow cover fraction\* | Basin average *[Secretariat]* | Up to 32 days | 24 hours | Twice monthly *[Secretariat]* | Less than 7 days *[Secretariat]* |
| Water equivalent of snow cover\* |
| Snow depth |
| Vertical average of snowpack temperature profile |
| Liquid water content of snow [% of total mass] |
| Snowmelt runoff at the base of the snowpack |

\*Required products for basin-scale snow cover forecast (if forecasts are provided)

\_\_\_\_\_\_\_\_\_\_

**APPENDIX 2.2.YY STANDARDIZED VERIFICATION FOR SNOW COVER PREDICTION PRODUCTS**

1. Introduction

This appendix presents detailed procedures for the generation of a standard set of verification scores for snow cover predictions. Standard verification methods are presented for the two mandatory parameters (snow cover fraction and water equivalent of snow on the ground) as well as one highly recommended parameter (snow depth). Different verification methods are also presented for deterministic and probabilistic snow cover predictions.

2. Verification metrics

For water equivalent of snow on the ground (SWE) and snow depth (SD), verification statistics shall include mean error (ME) and root mean square error (RMSE). These shall be provided for deterministic forecasts as well as for the mean of the predictive distribution (or ensemble mean) in the case of probabilistic forecasts.

The CRPS shall be used to evaluate probabilistic predictions of SWE and SD. The decomposition of CRPS into a potential CRPS and a reliability term shall be provided (see Hersbach, 2000, Weather and Forecasting).

For verification of deterministic predictions of snow cover area (SCA), a 2x2 contingency table shall be used in order to identify true positives (TP), true negatives (TN), false positives (FP) and false negatives (FN). Areas where modelled snow depth is lower than the detection threshold of the verifying observations shall be considered snow free.

In addition to the contingency table itself, summary statistics obtained from this contingency table shall be provided, and in particular accuracy, precision, recall and the F score (see Cooper et al., 2018, Atmospheric Measurement Techniques).

For verification of probabilistic predictions of SCA, the Brier score shall be provided, as well as its decomposition into uncertainty, reliability and resolution components (see Murphy, 1973, Meteorology and Climatology).

3. Verifying observations

Ideally, predictions shall be verified against independent in-situ or remotely sensed observations. Because of the persistence of snowpack in time, model errors are strongly correlated in time. Hence, observations from a given network or platform cannot generally be considered independent of model predictions made at an earlier time if the same observation network or platform was used to initialize the model.

Recognizing the challenge of obtaining independent observations for model verification, it is deemed acceptable to verify predictions through a data denial experiment. If such an approach is used, the details of the data denial experiment shall be provided by the centre together with the verification statistics.

When verification against independent observations or through data denial experiments is not possible, verifications shall be made against the centre’s own analysis as well as against at least one other analysis product. Differences between the scores obtained using the centre’s own analysis and using other analyses shall be provided.

When verifying gridded snow predictions, the difference between the model topography and the altitude of the verifying observation shall not exceed 400 m.

4. Temporal and spatial aggregation

Pooling of prediction/observation pairs in time and space shall be performed in order to obtain a sample size large enough to compute stable verification metrics as well as to provide summary statistics for regions and periods of interest.

Pairs valid during the same month shall be pooled together for reporting purposes. Pooling of prediction/observation pairs in space shall be done by basins and sub-basins and/or ecological zones and/or mountain zones. The details of the strategy used for spatial aggregation shall be provided by the centre.

Basin boundaries shall be obtained from the WMO Basins and Sub-Basins (WMOBB) database. Ecological zones shall be obtained from the Global Ecological Zones data set distributed by the FAO. Mountain zones shall be obtained from the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). Further stratification by altitude, slope and aspect can be considered.

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**APPENDIX 2.2.ZZ CHARACTERISTICS OF SNOW COVER PREDICTION SYSTEMS**

1. System

 System name and version

 Date of implementation

2. Configuration

 Domain*[Secretariat in response to Japan]*

 Horizontal resolution of the model, with indication of grid spacing in km:

 Number of snow layers:

 Forecast length and forecast step interval:

 Runs per day (times in UTC):

 Integration time step:

 Additional comments:

3. Initial conditions

 Data assimilation method:

 In-situ datasets assimilated:

 Remotely sensed datasets assimilated:

 Additional comments:

4. Boundary conditions

 List of atmospheric driving variables:

 Source of information for atmospheric driving variables:

 Timestep and horizontal resolution of atmospheric driving variables:

 Lower boundary conditions (to compute ground thermal flux):

 Additional comments:

5. Probabilistic predictions

 Are probabilistic predictions provided? If so, describe method briefly:

 Additional comments:

6. Other details of model

 List of prognostic variables:

 Is snow microstructure represented? If so, describe method briefly:

 Is blowing snow sublimation represented? If so, describe method briefly:

 Is wind-induced snow transport represented? If so, describe method briefly:

 Is interaction with tall vegetation represented? If so, describe method briefly:

 Are the effects of slope and aspect on incoming radiation represented?

 Additional comments:

7. Verification approach

 What verification approach is used to evaluate the analyses and the forecasts?

 In-situ datasets used for verification:

 Remotely sensed datasets used for verification:

 Additional comments:

8. Further information

 Operational contact point:

 URLs for system documentation:

 URL for list of products:

## Annex 4 to draft Resolution ##/2 (EC-76)

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual. In addition, the text will be updated reflecting the changes made to the Resolution 5.1(1)/1 (SERCOM-2) during SERCOM-2 (2022).]*

**2.2.2.XX Flash flood forecasting**

**Centres conducting flash flood forecasting (Regional Specialized Hydrological Centres (RSHCs) for flash flood forecasting) shall:**

**(d) Produce flash flood products and provide specific products to National Hydrological and Meteorological Services (NMHSs), which are agreed with participating countries in advance. The list of mandatory and highly recommended products is specified in Appendix 2.2.XX;**

**(e) Support NMHSs in the generation of flash flood forecasting information;**

**(f) Make a range of these products available on the WIS and/or another web-based platform;**

**(g) Prepare verification statistics and make them available on a website (Some recommendations on the verification are given in appendix 2.2.YY);**

**(h) Make available on a website up-to-date information on the characteristics of Flash Flood Forecasting System. The minimum information to be provided is specified in Appendix 2.2.ZZ.**

Note: The bodies in charge of managing the information contained in the Manual related to flash flood forecasting are specified in the table below.

**Table X. WMO bodies responsible for managing information related to flash flood forecasting**

|  |  |  |  |
| --- | --- | --- | --- |
| *Responsibility* | | | |
| *Changes to activity specification* | | | |
| To be proposed by: | INFCOM/SC-ESMP | SERCOM/SC-HYD |  |
| To be recommended by: | SERCOM | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| *Centre designation* | | | |
| To be recommended by: | RA | SERCOM | INFCOM |
| To be decided by: | EC/Congress |  |  |
| *Compliance* | | | |
| To be monitored by: | SERCOM/SC-HYD |  |  |
| To be reported to: | INFCOM/SC-ESMP | INFCOM | SERCOM |

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**APPENDIX 2.2.XX MANDATORY AND HIGHLY RECOMMENDED FLASH FLOOD FORECASTING PRODUCTS TO BE MADE AVAILABLE FOR THE PARTICIPATING COUNTRIES**

**Mandatory products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Parameter / Product / Variable* | *Forecast lead time* | *Issuance frequency* | *Temporal resolution* | *Spatial resolution* |
| *Flash flood risk (in categories)* (e.g., high, moderate, low) | *Up to 36 hours* | *As necessary for the region of interest and available forcing data, but not more than 6 hours* | *Temporal steps ranging from less than 1 hour to 6 hours, depending on modelling uncertainties and the source of available rainfall data* | *Basin areas / grid-cells size up to 200 km2, depending on input sources and modelled domain* |

**Highly recommended products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Parameter / Product / Variable* | *Forecast lead time* | *Issuance frequency* | *Temporal resolution* | *Spatial resolution* |
| *Peak discharge* | *Up to 36 hours* | *As necessary for the region of interest and available forcing data, but not more than 6 hours.* | *Temporal steps ranging from less than 1 hour to 6 hours, depending on modelling uncertainties and the source of available rainfall data.* | *Basin areas / grid-cells size up to 200 km2, depending on input sources and modelled domain.* |
| *Flash flood threshold* |

Products may be generated in a number of formats selected to facilitate their usage by different stakeholders and partners, and processing by other centres and decision support systems, compliant with approved WMO data exchange files formats.

The standard and recommended practices covering the format and content are described in the Technical Regulations, Volume III: Hydrology (WMO-No. 49).

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**APPENDIX 2.2.YY RECOMMENDATIONS ON VERIFICATION FOR FLASH FLOOD FORECASTING PRODUCTS**

This appendix presents procedures for the generation of a standard set of verification scores for mandatory products of the RSHC for flash flood forecasting based on available ground-truth data and whether flash flood flows or flash flood occurrences were forecasted by NMHSs based on flash flood forecasting products and information. The goal is to provide consistent verification information on the flash flood forecast products from different centres for forecasters in the hydrological forecast services and to help Regional Specialized Hydrological Centres for flash flood forecasting to compare and improve their forecasts. The RSHC shall create and maintain website for flash flood verification information, so that potential users will benefit from a consistent presentation of the results.

The standardized verification should provide key relevant information appropriate to the state of the art in flash flood forecasting, ensuring a consistent verification methodology applied to forecasts from different RSHCs, and the use of a common set of observations.

Appropriate forecast verification procedures and metrics will be used as allowed by the available ground-truth data and whether flash flood flows or flash flood occurrences are forecast. Contingency tables for the mandatory flash flood products provide the number of forecast products and actual events, linking the matches, false warnings and misses. The resulting table will produce statistics of the probability of detection, false alarm ratio and probability of a miss.

Other examples of verification metrics include second moment residual statistics and critical success index. Underlying hydrologic models will be verified by using usual metrics. For instance, the Nash-Sutcliffe efficiency criterion (NSE) and the index of volumetric fit (IVF).

Forecast verifications shall be made on an annual basis, with due consideration of the lack of reliability of the scores when computed on a reduced number of cases.

The model verification shall be initially made during the implementation of the system. Further verifications should be made on an annual basis or when there is evidence of poor performance. The model verification should be made in all basin outlets where observed data are available and with sufficient record length.

For systems allowing forecaster adjustments, verification will also be done on forecaster adjusted products and in the resultant warnings.

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**APPENDIX 2.2.ZZ CHARACTERISTICS OF FLASH FLOOD FORECASTING SYSTEMS**

1. System

 System name and version;

 Date of implementation:

2. Configuration

 Geographical coverage of the system;

 Horizontal resolution of the model;

 Forecast length and forecast step interval:

 Runs per day (times in UTC).

3. Other details of the system

 Hydrological modelling

 Soil moisture modelling

 Satellite and radar precipitation information

 Configuration and implementation of weather prediction models

4. Products

 Description of the products and methods for the calculation

 Other details, if necessary

5. Further information

 Operational contact point:

 URL for system documentation

 URL for list of products

## Annex 5 to draft Resolution ##/2 (EC-76)

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual. In addition, the text will be updated reflecting the changes made to the Resolution 5.1(1)/1 (SERCOM-2) during SERCOM-2 (2022).]*

**APPENDIX 2.2.11 MANDATORY AND HIGHLY RECOMMENDED**

**NUMERICAL OCEAN WAVE PREDICTION PRODUCTS TO BE MADE**

**AVAILABLE ON THE WMO INFORMATION SYSTEM**

Additional highly recommended products:

 U and v component of 10-meter wind or 10 m wind speed and direction;

 Full 2-D wave spectra at subset of grid points;

 Wind sea and swell split at all grid points, including swell partitioned parameters;

 Derived parameters including wave steepness, directional spreading and rogue wave potential.

## Annex 6 to draft Resolution ##/2 (EC-76)

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual. In addition, the text will be updated reflecting the changes made to the Resolution 5.1(1)/1 (SERCOM-2) during SERCOM-2 (2022).]*

***2.2.1.9 Global numerical ocean prediction***

**Centres conducting global numerical ocean prediction shall:**

**(a) Prepare global analyses of oceanographic variables ~~-parameters~~;**

**(b) Prepare global forecast fields of basic and derived oceanographic variables** **~~parameters~~**;

**(c) Make available on WIS a range of these products; the list of mandatory and highly recommended products to be made available is given in Appendix 2.2.13;**

**(d) Prepare verification statistics and make them available on a website;**

**(e) Make available on a website up‑to‑date information on the characteristics of their global numerical ocean prediction systems; the minimum information to be provided is given in Appendix 2.2.14.**

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***APPENDIX 2.2.13. MANDATORY AND HIGHLY RECOMMENDED GLOBAL NUMERICAL OCEAN PREDICTION PRODUCTS TO BE MADE AVAILABLE ON THE WMO INFORMATION SYSTEM***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Parameter* | *Level* | *Minimum resolution* | *Forecast range* | *Minimum time steps* | *Frequency* |
| Sea-surface elevation | Surface | ~~0.5~~~~0~~ ~~x 0.5~~~~o~~  0.250 x 0.250 | Up to 6 days | Every 24 hours | Once a day |
| SST | Surface (mixed layer) |
| Surface u, v | Surface |
| Sea-surface absolute salinity | Surface |
| u, v | Depth to be determined |
| Conservative Temperature | 10/50/100/250/500  (m) |
| Absolute Salinity | 10/50/100/250/500 (m) |
| Mixed layer depth\* |  |

 \*Mixed layer depth based on temperature and/or density criteria

**Additional highly recommended products:**

– ~~None~~.

– Tropical Cyclone Heat Potential (TCHP), defined as the integrated vertical temperature from the sea surface to the depth of the 26 Deg C isotherm *[Secretariat in response to Japan]*

– Ocean Initial Conditions for seasonal forecast

– Sea-ice thickness and sea-ice extent.

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***APPENDIX 2.2.14. CHARACTERISTICS OF THE GLOBAL NUMERICAL OCEAN PREDICTION SYSTEMS***

**1. System**

– System name (version):

– Date of implementation:

**2. Configuration**

– Horizontal resolution of the model, with indication of grid spacing in km:

– Number of model levels:

– ~~Bottom of model:~~Topography data of model:

– Forecast length and forecast step interval:

– Runs per day (times in UTC):

– Is model coupled to atmosphere, wave, sea-ice models? Specify which models:

– Atmosphere model characteristics (such as, but not limited to configuration, initial and boundary conditions):

– Wave model characteristics (such as, but not limited to configuration, initial and boundary conditions):

– Sea ice model characteristics (such as, but not limited to resolution, rheology, number of sea ice category):

– Integration time step:

- Horizontal and vertical coordinate system of the model:

– Additional comments:

**3. Initial conditions**

– Climatology data of the model:

– Data assimilation method, including brief description:

- Observations being assimilated:

- Assimilated window:

– Additional comments:

**4. Surface boundary conditions**

– Surface forcing, briefly describe method(s), frequency and origin of atmospheric surface forcing:

– Lateral boundary conditions (for example, river discharge)? If so, briefly describe method(s), frequency and origin of lateral boundary conditions:

– Additional comments:

**5. Other details of the model**

– What kind of mixing scheme is in use?

- List vertical and horizontal mixing, diffusion schemes and ad-hoc parameterization in use

- ~~How are radiations parameterized?~~

- Parameterization of surface boundary conditions (heat, freshwater, momentum)?

– What kind of large-scale dynamics is in use (for example, grid-point semi-Lagrangian)? Hydrostatic or non-hydrostatic?

~~- Data assimilation scheme?~~

– Quality control scheme?

– Verification approach?

– Other relevant details?

**6. Products delivered**

– Resolution of the products

– Interpolation method if products are post processed

– Frequency of the products

– Latency of the products (time between production and availability)

– Length of the time series available in the past

– Definition of the Tropical Cyclone Heat Potential

**~~6~~7. Further information**

– Operational contact point:

– URLs for system documentation:

– URL for list of products:

- Graphic and model data output:

## *[Res.5.1(1)/1(SERCOM-2)]*







## Annex 7 to draft Resolution ##/2 (EC-76) *[Res.5.1(1)/1(SERCOM-2)]*

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual. In addition, the text will be updated reflecting the changes made to the Resolution 5.1(1)/1 (SERCOM-2) during SERCOM-2 (2022).]*

**3. The Regional Specialized Meteorological Centres for general purpose activities are:**

Numerical ocean wave prediction

RSMC Exeter

RSMC INCOIS (India)

RSMC Melbourne

RSMC Montreal

RSMC Tokyo

RSMC Toulouse

Acronyms not previously defined: INCOIS – Indian National Centre for Ocean Information Services

Global numerical ocean prediction

RSMC Exeter

RSMC INCOIS (India)

RSMC Montreal

*[Res.5.1(1)/1(SERCOM-2)]*

## Annex 8 to draft Resolution ##/2 (EC-76) *[Res.5.1(1)/1(SERCOM-2)]*

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual.]*

Table 2. WMO bodies responsible for managing information related to global deterministic NWP

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | INFCOM/ET‑OWFS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

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Table 3. WMO bodies responsible for managing information related to limited‑area deterministic NWP

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | INFCOM/ET‑OWFS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

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Table 4. WMO bodies responsible for managing information related to global ensemble NWP

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | INFCOM/ET‑OWFS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

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Table 5. WMO bodies responsible for managing information related to limited‑area   
ensemble NWP

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | INFCOM/ET-OWFS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 6. WMO bodies responsible for managing information related   
to global numerical SSFs

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC‑ESMP~~ET‑OCPS~~ | INFCOM/ET‑OCPS |  |
| To be recommended by: | INFCOM | ~~SERCOM~~ |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OCPS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 7. WMO bodies responsible for managing information related to global numerical long‑range prediction

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC‑ESMP~~ET‑OCPS~~ | INFCOM/ET‑OCPS |  |
| To be recommended by: | INFCOM | ~~SERCOM~~ |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OCPS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 8. WMO bodies responsible for managing information related to ADCP

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC‑ESMP~~ET‑OCPS~~ | INFCOM/ET‑OCPS |  |
| To be recommended by: | INFCOM | ~~SERCOM~~ |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OCPS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 9. WMO bodies responsible for managing information related to numerical   
ocean wave prediction

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | ~~SERCOM/SC‑MMO~~INFCOM/SC-ESMP | SERCOM/SC‑MMO |  |
| To be recommended by: | INFCOM | SERCOM |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM | SERCOM |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | SERCOM/SC‑MMO |  |  |
| To be reported to: | INFCOM | SERCOM |  |

Table 10. Bodies responsible for managing information related to global numerical   
ocean prediction

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | ~~SERCOM/SC‑MMO~~INFCOM/SC-ESMP | SERCOM/SC‑MMO |  |
| To be recommended by: | INFCOM | SERCOM |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM | SERCOM |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | SERCOM/SC‑MMO |  |  |
| To be reported to: | INFCOM | SERCOM |  |

Table 11. WMO bodies responsible for managing information related to nowcasting

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | INFCOM/ET‑OWFS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 12. WMO bodies responsible for managing information related to regional climate prediction and monitoring

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | ~~SERCOM/ET‑CSISO~~INFCOM/SC‑ESMP | SERCOM/ET‑CSISO |  |
| To be recommended by: | INFCOM | SERCOM |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM | SERCOM |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | SERCOM/ET‑CSISO |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 13. WMO bodies responsible for managing information related   
to multi‑model ensemble SSFs

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC‑ESMP~~ET‑OCPS~~ | INFCOM/ET‑OCPS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OCPS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 14. WMO bodies responsible for managing information related to multi‑model ensemble prediction for LRFs

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC‑ESMP~~ET‑OCPS~~ | INFCOM/ET‑OCPS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OCPS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 15. WMO bodies responsible for managing information related to   
coordination of ADCP

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC‑ESMP~~ET‑OCPS~~ | INFCOM/ET‑OCPS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OCPS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 16. WMO bodies responsible for managing information related to regional severe weather forecasting

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC‑ESMP~~ET‑OWFS~~ | ~~SERCOM/SC‑DRR~~INFCOM/ET‑OWFS | SERCOM/SC‑DRR |
| To be recommended by: | INFCOM | SERCOM |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | RA | INFCOM | SERCOM |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | SERCOM/SC‑DRR |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM | SERCOM |

Table 17. WMO bodies responsible for managing information related to Tropical Cyclone forecasting

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | ~~SERCOM/SC‑DRR~~INFCOM/SC‑ESMP | SERCOM/SC‑DRR |  |
| To be recommended by: | INFCOM | Regional Tropical Cyclone committee | SERCOM |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM | Regional Tropical Cyclone committee | SERCOM |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | SERCOM/SC‑DRR |  |  |
| To be reported to: | INFCOM | SERCOM |  |

Table 18. WMO bodies responsible for managing information related to nuclear environmental emergency response

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑ERA~~ | INFCOM/ET‑ERA |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑ERA |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 19. WMO bodies responsible for managing information related to non‑nuclear environmental emergency response

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑ERA~~ | INFCOM/ET‑ERA |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑ERA |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 20. WMO bodies responsible for managing information related to atmospheric sand and dust storm forecasts

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | ~~RB/SDS‑WAS Steering Committee~~ INFCOM/SC‑ESMP | INFCOM/ET‑ERA | RB/SDS‑WAS Steering Committee |
| To be recommended by: | RB (WWRP/SSC) | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation\* | | | |
| To be recommended by: | RB (WWRP/SSC, SDS‑WAS Steering Group) | INFCOM | RA |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑ERA |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 21. Bodies responsible for managing information related to marine   
meteorological services

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | ~~SERCOM/SC‑MMO~~INFCOM/SC‑ESMP | SERCOM/SC‑MMO |  |
| To be recommended by: | SERCOM | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be approved by: | SERCOM | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | SERCOM/SC‑MMO |  |  |
| To be reported to: | INFCOM | SERCOM |  |

Table 22. Bodies responsible for managing information related to marine   
environmental emergency response

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | ~~SERCOM/SC‑MMO~~INFCOM/SC‑ESMP | SERCOM/SC‑MMO |  |
| To be recommended by: | SERCOM | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be approved by: | SERCOM | INFCOM |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | SERCOM/SC‑MMO |  |  |
| To be reported to: | INFCOM | SERCOM |  |

Table 23. WMO bodies responsible for managing information related to coordination of DNV

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | INFCOM/ET‑OWFS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 24. WMO bodies responsible for managing information related to coordination   
of EPS verification

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | INFCOM/ET‑OWFS |  |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 25. Bodies responsible for managing information related to coordination of WFV

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | ~~SERCOM/SC‑MMO~~INFCOM/ET‑OWFS | SERCOM/SC‑MMO |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

Table 26. WMO bodies responsible for managing information related to coordination of TCFV

TABLE: Table with lines

|  |  |  |  |
| --- | --- | --- | --- |
| Responsibility | | | |
| Changes to activity specification | | | |
| To be proposed by: | INFCOM/SC-ESMP~~ET‑OWFS~~ | ~~RB/JWGFVR~~INFCOM/ET‑OWFS | RB/JWGFVR, RB/WGNE |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Centres designation | | | |
| To be recommended by: | INFCOM |  |  |
| To be decided by: | EC/Congress |  |  |
| Compliance | | | |
| To be monitored by: | INFCOM/ET‑OWFS |  |  |
| To be reported to: | INFCOM/SC‑ESMP | INFCOM |  |

## Draft Recommendation 6.4(2)/3 (INFCOM-2)

### Designation of Global Producing Centres for Long-range Forecasts (GPC-LRF), Sub‑seasonal Forecasts (GPC-SSF) and Lead Centre for the coordination of multi‑model ensembles for sub‑seasonal forecasts (LC-SSFMME)

THE COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS,

**Recalling** [Resolution 23 (EC-73)](https://library.wmo.int/doc_num.php?explnum_id=11008#page=373) – Amendment to the Manual on the Global Data-Processing and Forecasting System (WMO-No. 485) and the designation of new Global Data-Processing and Forecasting System centres,

**Notes** the Expert Team on Operational Climate Prediction System (ET-OCPS) confirms:

(1) National Centre Pune (India) meets the requirements of GPC-LRF, and

(2) ECMWF meets the requirements of GPC-SSF and LC-SSFMME,

**Having examined**:

(1) The designation of Global Producing Centres for Long-range forecasts (GPC-LRF) and Sub-seasonal forecasts (GPC-SSF) and Lead Centre for the coordination of multi‑model ensembles for sub‑seasonal forecasts (LC-SSFMME) and their inclusion in Part III of the [Manual on the Global Data-processing and Forecasting System](https://library.wmo.int/index.php?lvl=notice_display&id=12793):

 GPC-LRF: Pune (India),

 GPC-SSF: ECMWF,

 LC-SSFMME: ECMWF,

(2) The update of the specification of the digital data from GPCs-SSF and the access of the GPC-SSF graphical products from LC-SSFMME,

**Recommends** to Executive Council the adoption of the designation of the above GDPFS centresthroughthe draft resolution provided in the [annex](#_Annex_to_draft_1) to the present Recommendation.

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[Annex: 1](#_Annex_to_draft_1)

## Annex to draft Recommendation 6.4(2)/3 (INFCOM-2)

**Draft Resolution ##/3 (EC-76)**

**Designation of Global Producing Centres for Long-range Forecasts (GPC-LRF), Sub-seasonal Forecasts (GPC-SSF) and Lead Centre for the coordination of multimodel ensembles for sub-seasonal forecasts (LC-SSFMME)**

THE EXECUTIVE COUNCIL,

**Recalling** [Resolution 23 (EC-73)](https://library.wmo.int/doc_num.php?explnum_id=11008#page=373) – Amendment to the Manual on the Global Data-Processing and Forecasting System (WMO-No. 485) and the designation of new Global Data-Processing and Forecasting System centres,

**Having examined** [Recommendation 6.4(2)/3 (INFCOM-2)](#draftrec3) - Designation of Global Producing Centres for Long-range Forecasts (GPC-LRF), Sub-seasonal Forecasts (GPC-SSF) and Lead Centre for the coordination of multimodel ensembles for sub-seasonal forecasts (LC-SSFMME),

**Having agreed** the amendment to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793) (WMO-No. 485), as provided in the [annex](#_Annex_to_draft_7) to the present resolution.

**Authorizes** the Secretary-General, in consultation with the president of INFCOM, to make editorial amendments to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793) (WMO-No. 485).

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[Annex: 1](#_Annex_to_draft_7)

## Annex to draft Resolution ##/3 (EC-76)

**Designation of Global Producing Centres for Long-range Forecasts (GPC-LRF), Sub-seasonal Forecasts (GPC-SSF) and Lead Centre for the coordination of multimodel ensembles for sub-seasonal forecasts (LC-SSFMME)**

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual.]*

SECTION: Chapter

Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

APPENDIX 2.2.43. Minimum information to be available from the Lead Centre(s) for SUB SEASONAL forecast multimodel ensembles

1. Global Producing Centre digital products

Global fields of forecast and hindcast *[Hong Kong, China]* ~~anomalies~~ as supplied by GPCs-SSF, including (for GPCs that allow redistribution of their digital data) ~~weekly~~ ~~mean anomalies for ensemble mean~~ daily fields from ~~in the~~ individual forecasts for at least each of the four weeks following the ~~week of submission~~forecast initialization date:

(a) Surface (2‑m) temperature;

(b) SST;

(c) Total precipitation rate;

(d) MSLP;

(e) 850 hPa temperature;

(f) 500 hPa geopotential height;

(g) 850 and 200 hPa wind (zonal and meridional);

(h) Outgoing long‑wave radiation at the top of the atmosphere;

(i) 10 hPa zonal wind.

Note: Definitions of the content and format for the supply of data to the Lead Centre(s) for SSFMME by GPCs and terms of exchange are available on the Lead Centre(s) website(s).

2. Graphical products

Plots and maps for each GPC forecast displayed in common format on the Lead Centre(s) website(s), for the variables listed in HYPERLINK: Paragraph <Appendix 2.2.41> and for selectable regions where appropriate,

for weeks 1, 2, 3–4 and 1–4:

(a) Ensemble mean anomalies;

(b) Probabilities for the tercile forecast categories;

(c) Model consistency plots, that is, maps showing the proportion of models predicting the same sign anomaly;

(d) Multi‑model probabilities for tercile forecast categories.

for intraseasonal variability:

(a) Diagrams presenting each GPC forecast of the tropical intraseasonal variability such as the Madden–Julian Oscillation.

\_\_\_\_\_\_\_\_\_\_

SECTION: Chapter

Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

APPENDIX 2.2.44. Access to Global Producing Centre for Sub‑seasonal Forecasts data and visualization products held by the lead centre(s) for sub‑seasonal forecast multi‑model ensembles

(a) Access to GPC‑SSF data ~~and graphical products~~ from the Lead Centre(s) for SSFMME website(s) will be password protected.

(b) Digital GPC‑SSF data will be redistributed only in cases where the GPC‑SSF data policy allows it. In other cases, requests for GPC‑SSF digital output should be directed to the relevant GPC‑SSF.

(c) Formally designated GPCs‑SSF, GPCs‑LRF and RCCs, NMHSs and institutions coordinating RCOFs are eligible for password‑protected access to information held and produced by the Lead Centre(s) for SSFMME. Entities that are in demonstration phase to seek designation as GPCs or RCCs are also eligible for password‑protected access to information held and produced by the Lead Centre(s) for SSFMME, provided a formal notification has been issued in this regard by the WMO Secretary‑General.

(d) Institutions other than, but providing contributions to, those identified in (c) may also request access to Lead Centre(s) for SSFMME products. These institutions, referred to as “supporting institutions”, which include research centres, require endorsement letters from: (i) the Permanent Representative of the country where they are hosted, and (ii) the executive manager of the entity they wish to provide contributions to (that is, RCCs, institutions coordinating RCOFs and NMHSs). The use by supporting institutions of products from the Lead Centre(s) for SSFMME is restricted to assistance of the organizations identified in (c) in their production of official forecast outputs. Supporting institutions may not use such products to generate and display or disseminate independent forecast products. Supporting institutions must agree with these restrictions to be eligible for access. Prior to access being granted to an applicant supporting institution, the Lead Centre(s) for SSFMME will refer the application to the INFCOM/ET‑OCPS through the WMO Secretariat, for final consultation and review. Decisions to allow access must be unanimous. The Lead Centre(s) will be informed by the WMO Secretariat of such new users accepted for access.

(e) A list of users provided with password access will be maintained by the Lead Centre(s) for SSFMME and reviewed periodically by the INFCOM/ET‑OCPS, to measure the degree of effective use and also to identify any changes in status of eligible users, and determine further necessary follow‑up.

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Chapter title in running head: PART III. GLOBAL DATA-PROCESSING AND FO…

PART III. Current designated Global Data‑processing and Forecasting System Centres

3. The Regional Specialized Meteorological Centres for general purpose activities are:

Limited-area ensemble numerical weather prediction:

RSMC Offenbach

RSMC Rome

Global numerical sub‑seasonal forecasts

GPC ECMWF

Global numerical long-range prediction:

|  |  |
| --- | --- |
| GPC Beijing | GPC Offenbach |
| GPC CMCC (Italy) | GPC Pretoria |
| GPC CPTEC (Brazil) | GPC Pune |
| GPC ECMWF | GPC Seoul |
| GPC Exeter | GPC Tokyo |
| GPC Melbourne | GPC Toulouse |
| GPC Montreal | GPC Washington |
| GPC Moscow |  |

Acronyms not previously defined: CMCC – Centro Euro‑Mediterraneo sui Cambiamenti Climatici; CPTEC – Centro de Previsão de Tempo e Estudos Climáticos.

4. The Regional Specialized Meteorological Centres for specialized activities are:

Coordination of multi‑model ensembles for sub‑seasonal forecasts

ECMWF

Coordination of multi‑model ensemble prediction for long-range forecasts:

Seoul and Washington (joint centre)

Coordination of annual to decadal climate prediction:

Exeter

## Draft Recommendation 6.4(2)/4 (INFCOM-2)

### Termination of Annual WMO Technical Progress Report on the Global Data-Processing and Forecasting System (GDPFS) and Numerical Weather Prediction (NWP) Research

THE COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS,

**Recalling**

(1) The request of the World Meteorological Congress at its seventeenth session (Cg-17) to the Commission for Basic Systems (CBS) to review the contents and the reporting method to facilitate the Members’ contributions to the WMO Technical Progress Report on the GDPFS and NWP Research (Report),

(2) [Recommendation 17 (INFCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=11197#page=389) - Amendment to the Manual on the Global Data-processing and Forecasting System (WMO-No. 485), reflecting the new WMO governance structure, that requests SC-ESMP, in collaboration with the Research Board and its relevant subsidiary bodies, to review the contents and the reporting method of the Report,

**Noting** that Members can acquire up-to-date information on the GDPFS, which is now available on the internet through various resources such as Members' websites,

**Having examined** the [GDPFS Web Portal](https://community.wmo.int/gdpfs-web-portal) launched in December 2021 and the updated information on [WMO Member Profiles](https://community.wmo.int/members/profiles) based on WMO Data Collection Campaign 2021,

**Recommends** to the Executive Council, the adoption of the termination of Annual WMO Technical Progress Report on the GDPFS and NWP Research throughthe draft resolution provided in the [annex](#_Annex_to_draft_5) to the present Recommendation and the related amendment to the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), as provided in the [annex](#_Annex_to_draft_8) to the draft resolution.

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[Annex: 1](#_Annex_to_draft_5)

## Annex to draft Recommendation 6.4(2)/4 (INFCOM-2)

**Draft Resolution ##/4 (EC-76)**

### Termination of Annual WMO Technical Progress Report on the Global Data-Processing and Forecasting System (GDPFS) and Numerical Weather Prediction (NWP) Research

THE EXECUTIVE COUNCIL,

**Recalling**

(1) The request of the World Meteorological Congress at its seventeenth session (Cg-17) to the Commission for Basic Systems (CBS) to review the contents and the reporting method to facilitate the Members’ contributions to the WMO Technical Progress Report on the GDPFS and NWP Research (Report),

(2) [Recommendation 17 (INFCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=11197#page=389) - Amendment to the Manual on the Global Data-processing and Forecasting System (WMO-No. 485) reflecting the new WMO governance structure, that requests SC-ESMP, in collaboration with the Research Board and its relevant subsidiary bodies, to review the contents and the reporting method of the Report,

**Having agreed** Recommendation 6.4(2)/1 (INFCOM-2) and the related amendment to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793#.YzrQrHZBw2w) (WMO-No. 485), as provided in the Annex to the present resolution,

**Invite** Members hosting designated GDPFS centres to check on the [GDPFS Web Portal](https://community.wmo.int/gdpfs-web-portal) for any missing product links of your centre(s), and take necessary actions to improve the accessibility of GDPFS products,

**Authorizes** the Secretary-General, in consultation with the president of INFCOM, to make editorial amendments to the [*Manual on the Global Data-processing and Forecasting System*](https://library.wmo.int/index.php?lvl=notice_display&id=12793) (WMO-No. 485).

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[Annex: 1](#_Annex_to_draft_8)

## Annex to draft Resolution ##/4 (EC-76)

### Termination of Annual WMO Technical Progress Report on the Global Data-Processing and Forecasting System (GDPFS) and Numerical Weather Prediction (NWP) Research

*[Proposed amendments are highlighted in addition or ~~deletion~~ to the Manual in the Global Data-processing and Forecasting System (WMO-No. 485) and the numbering of the text below refers to the Manual.]*

Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

APPENDIX 2.2.34. Standardized verification of deterministic numerical weather prediction products

5.9 Monthly and annual averaged scores

Where average scores are required over a defined period, the averaging shall be made using the following procedures:

– Linear scores (mean error, mean absolute error) – mean;

– Non‑linear scores shall be transformed to appropriate linear measure for averaging;

– Mean of mean square error (MSE);

– Z‑transform for correlation.

For a defined period, the average shall be computed over all forecasts verified during the period. Averages shall be computed separately for forecasts initiated at 0000 and 1200 UTC and both sets of average values provided.

Annual averages of the daily scores ~~are included in the yearly Technical Progress Report on the Global Data‑processing and Forecasting System ([https://community.wmo.int/activity‑areas/global‑data‑processing‑and‑forecasting‑system‑gdpfs](https://community.wmo.int/activity-areas/global-data-processing-and-forecasting-system-gdpfs) – GDPFS and NWP Annual Progress Reports). These statistics~~ are for the 24‑, 72‑ and 120‑hour forecasts and include the RMS vector wind error at 850 (tropics area only) and 250 hPa (all areas), as well as the RMS error of geopotential heights at 500 hPa (all the areas except for tropics). ~~A table of the number of observations per month should also be part of the yearly report.~~

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