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| WORLD METEOROLOGICAL ORGANIZATIONCOMMISSION FOR BASIC SYSTEMSOPAG on DPFS**MEETING OF THE CBS (DPFS) EXPERT TEAM ON OPERATIONAL WEATHER AND FORECASTING PROCESS AND SUPPORT**MONTREAL, CANADA09-13 MAY 2016 |  | DPFS/ET-OWFPS/Doc. 4.2(2)(2.V.2016)\_\_\_\_\_\_\_Agenda item : 4.2ENGLISH ONLY |

**Current status of the exchange and the publication of global EPS verification results**

*(Submitted by Haruki YAMAGUCHI, JMA)*

##### Summary and purpose of document

This document reports the current status of the exchange and the publication of global EPS verification results and the activities of the Lead Centre for EPS Verification.

##### Action Proposed

The meeting is invited to read the document and to open a discussion.

**Annex(es):** - Annex A: List of verification parameters and available periods with each centre

 - Annex B: A draft of the new guideline on the exchange and use of EPS verification reports

**Reference:** - Attachment II.7, Table F, Section II of the Manual on the Global Data-Processing Forecasting System (GDPFS) (WMO-No.485) (<http://www.wmo.int/pages/prog/www/DPFS/Manual/documents/485_Vol_I_en.pdf#page=142>)

1. **Introduction**

The Japan Meteorological Agency (JMA), as the Lead Centre for Ensemble Prediction System (EPS) Verification, promotes both exchanging of EPS verification reports and presenting skill of EPS for a better use of EPS products.

JMA has been operating two Internet sites, an FTP site and a Web site (<http://epsv.kishou.go.jp/EPSv/>), since January 2004. The FTP site is for the EPS producing centres to upload the statistic data for their EPS verification reports. The original verification statistics are replicated at the Web site and available to confirm after the registered centre puts them on the FTP site.

The Web site shows the original verification statistics, their update and contents information, and their visualized figures, indicating that it is possible to diagnose the skill of EPS of each EPS producing centre through comparison with those of other EPS. It is also expected that the activities contributes to improvement of the performance of each EPS.

1. **Verification measure and its exchanging**
2. Verification measure

It is defined in the Attachment II.7, Table F, Section III of the Manual on the Global Data-Processing Forecasting System (GDPFS) (WMO-No.45) that the standard verification measures of an EPS are monthly verification of the ensemble mean, spread and probability with respect to the analysis and/or climatology prepared by each centre.

1. Exchanging and publishing system

The guideline on the exchange and use of EPS verification reports is set by the Lead Centre (JMA) and is available openly to the National Meteorological and Hydrological Services (NMHSs) of WMO Members through the Web site (<http://epsv.kishou.go.jp/EPSv/guideline.pdf>). The latest guideline is dated on 30th November 2012.

The registered centres are as follows:

- CMA (China Meteorological Administration; Dec. 2009)

- CMC (Canadian Meteorological Centre; Sep. 2004)

- CPTEC (Centro de Previsão de Tempo e Estudos Climáticos; Dec. 2005)

- ECMWF (European Centre for Medium-Range Weather Forecasts; Jan. 2004)

- JMA (Jan. 2004)

- KMA (Korea Meteorological Administration; Jan. 2004)

- NCEP (National Centers for Environmental Prediction; Jun. 2012)

- RUMS (Hydrometeorological Centre of Russia; Dec. 2010)

- UKMO (United Kingdom Met Office; Jan. 2004)

Presently, the total size of all original reports is about 810 Mbytes. And, the Web site consists of about 40 pages and the size of all contents is about 5 Gbytes.

(c) Update of the Web site

For clear indication of Copyright, JMA will add the following sentences into the bottom of the top page of the Web site.

*a) All verification statistics in "deterministic table", "CRPS table" or "reliability table" made available on this website (epsv.kishou.go.jp) remain the property of the contributing EPS centre.*

*b) Except a), use conditions of information made available on this website comply with Japan Meteorological Agency Website Terms of Use.*

1. **Status of reports from EPS producing centres**

(a) Current status

JMA, ECMWF, KMA, CMC, CPTEC, CMA, RUMS, and NCEP started uploading the verification statistics to the FTP site in January 2004, July 2004, August 2004, February 2006, March 2006, January 2010, December 2010, and July 2012, respectively.

Annex A shows the list of verification parameters and available periods with each reporting centre as of March 2016. It is shown that the number of reporting centres is up to eight, indicating that most of EPS producing centres are participating. It is also shown that the elements named Z500, T850, and PMSL are well exchanged regardless of difference among deterministic and probabilistic classification.

(b) Action status

On a routine basis, JMA asks a reporting centre by e-mail to upload recent verification statistics when they are not reported. Presently, the recent reports from two centres are still unavailable.

Regarding the accuracy of the CPTEC reports, JMA is currently in the process of confirming with CPTEC about the following conditions of being unreasonable.

- CRPSs are not increased in longer lead-time in opposition to a general trend.

- CRPSs are the smallest of all reported centers in opposition to other scores.

1. **Verification reports for precipitation from ECMWF as some other centres’ proxy**
2. Background

ECMWF conducted precipitation verification using TIGGE archive data. Considering the discussion at the ET-EPS meetings in 2009 and 2011, the ET-OWFPS recommended at its first meeting (Oct. 2014) that the additional verification for surface parameters could be provided to the Lead Centre for EPS Verification by ECMWF. Although ECMWF offered the provision of the statistical verification results of precipitation, JMA showed its concern that the proxy verification, which is allowed in the current Manual on GDPFS, will not be acceptable in the new Manual on GDPFS that is now being revised thoroughly for the adoption at the 16th CBS session in November 2016. In February 2016, the Chair of ET-OWFPS, Dr David Richardson, and acting Chair of The Task Team on revision of the Manual on GDPFS, Mr Yuki Honda, discussed on this matter and agreed that the relevant draft text in the section II.2.1.3 of the new Manual should be revised appropriately to implicitly allow the proxy verification as follows:

*- Make verification statistics available to the Lead Centre(s) for EPS Verification according to the standard defined in Appendix A.II.2.3.2,*

1. Update of the Guideline

Following the above agreement, JMA now prepares a draft of the new guideline (see Annex B; updates are tracked) including the rule of verification reports by a certain centre as another centre’s proxy (hereafter, proxy report). Main updates are as follows:

 - Each verification table (one electronic file) should include results only for one EPS.

 - The file name for the proxy report differs from that for the current report.

This means that the change of all current reports are not needed and that verification results for both its own EPS and another EPS are not allowed to intermix in one file.

1. Publication of proxy report

ECMWF is preparing to send some proxy reports for precipitation to the LC. When ECMWF is ready to send them, JMA will contact EPS producing centres sending no report for precipitation by e-mail to ask whether the visualized data from the proxy report are welcome or not. After getting the agreement from the EPS producing centre, JMA will make its data open.

1. **Actions**

5.2.1 ET-OWFPS recognised that not all of the nine global EPS centres registered with LC-EPSV are sending all the requested verification data. ET-OWFPS decided that the following actions would help to address this:

1. NCEP and CMC could fill complementary parts of table with results from both centre.

In progress. NCEP is generating data for CMC from 2013 onward and will send to LC-EPS. CMC will be doing likewise with NCEP data.

**ANNEX A: List of verification parameters and available periods with each centre (as of 15th March 2016). • mark and gray cell represent no report and unexchange under the current Manual on the GDPFS, respectively. Red rectangle represents a mandatory parameter defined in the draft new Manual on the GDPFS. ( \* : only for NH , ^ : missing period from 201012 to 201102 )**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  Name of EPS reporting centre  Verification statistics | CMA | CMC | CPTEC | ECMWF | JMA | KMA | NCEP | RUMS |
| Deterministic parameter | Z500 (500hPa geopotential height) | **200911 –****201504\*** | **•** | **200601 –** **201602** | **200301 –****201602** | **200301 –****201603** | **200901 –****201601 ^** | **200906 –****201603** | **•** |
| T850 (850hPa temperature) | **200911 –****201504\*** | **•** | **200601 –** **201602** | **200301 –****201602** | **200301 –****201603** | **200901 –****201601 ^** | **200906 –****201603** | **•** |
| PMSL (pressure at mean sea level) | **•** | **•** | **200601 –** **201602** | **200301 –****201602** | **200301 –****201603** | **200901 –****201601 ^** | **200906 –****201603** | **•** |
| W850 (850hPa wind speed) |  |  |  |  |  |  |  |  |
| W250 (250hPa wind speed) |  |  |  |  |  |  |  |  |
| CRPS parameter | Z500 | **201110 –****201504\*** | **•** | **201201 –** **201603** | **200301 –****201602** | **200609 –****201603** | **201103 –****201601** | **200906 –****201603** | **•** |
| T850 | **201110 –****201504\*** | **•** | **201201 –** **201603** | **200301 –****201602** | **200609 –****201603** | **201103 –****201601** | **200906 –****201603** | **•** |
| PMSL | **•** | **•** | **201201 –** **201603** | **200301 –****201602** | **200609 –****201603** | **201103 –****201601** | **200906 –****201603** | **•** |
| W850 (850 hPa wind speed) | **•** | **•** | **•** | **200301 –****201602** | **200609 –****201603** | **201103 –****201601** | **•** | **•** |
| U850 and V850 (850 hPa u and v wind components) | **•** | **•** | **•** | **200301 –****201602** | **200609 –****201603** | **201306 –****201601** | **200906 –****201603** | **•** |
| U250 and V250 (250 hPa u and v wind components) | **•** | **•** | **•** | **200606 –****201602** | **200609 –****201603** | **201306 –****201601** | **201111 –****201603** | **•** |
| 24-hour accumulated precipitation | **•** | **•** | **•** | **201001 –****201602** | **•** | **•** | **•** | **•** |
| Probabilistic parameter | Z500 anomaly ±1, ±1.5, ±2 standard deviation with respect to a centre-specified climatology | **201112 –****201504\*** | **201001 –****201603** | **200708 –** **201602** | **200301 –****201602** | **200301 –****201603** | **200901/201103 –****201601 ^** | **•** | **201110 –****201503** |
| T850 anomalies with thresholds ± 1, ± 1.5, ± 2 standard deviation with respect to a centre-specified climatology | **201112 –****201504\*** | **201001 –****201603** | **200708 –** **201602** | **200301 –****201602** | **200301 –****201603** | **200901/201103 –****201601 ^** | **•** | **201110 –****201503** |
| PMSL anomaly ±1, ±1.5, ±2 standard deviation with respect to a centre-specified climatology | **•** | **201001 –201603** | **200708 –** **201602** | **200301 –****201602** | **200301 –****201603** | **200901/201103 –****201601 ^** | **•** | **201110 –****201503** |
| W850 with thresholds of 10, 15, 25 m s–1 | **•** | **201001 –****201603** | **•** | **200301 –****201602** | **200301 –****201603** | **•** | **•** | **201110 –****201503** |
| U850 and V850 with thresholds of 10th, 25th, 75th and 90th percentile points with respect to a centre-specified climatology | **•** | **201001 –****201603** | **•** | **200301 –****201602** | **•** | **•** | **•** | **•** |
| U250 and V250 with thresholds of 10th, 25th, 75th and 90th percentile points with respect to a centre-specified climatology | **•** | **201001 –****201603** | **•** | **200606 –****201602** | **•** | **•** | **•** | **•** |
| Precipitation with thresholds 1, 5, 10, and 25 mm/24 hours every 24 hours verified against observations | **•** | **•** | **•** | **201001 –****201602** | **•** | **•** | **•** | **201010 –****201503** |

**ANNEX B: A draft of the new guideline on the exchange and use of EPS verification reports.**

**Changed parts from the current revision are written in red.**

Guideline on the exchange and use of EPS verification results

Update date: 7 April 2016 (Draft version)

1. Introduction

 World Meteorological Organization (WMO) CBS-XIII (2005) recommended that the general responsibilities for a Lead Centre for Verification of EPS be added to *the Manual on the global data processing and forecasting system (GDPFS) (WMO-No.485; available at http://www.wmo.int/pages/prog/www/manuals.html)* and that the President designate RSMC Tokyo (Japan Meteorological Agency; JMA) as the Lead Centre.

 JMA hosts two Internet sites for the Lead Centre works; a Web site and a FTP site. The FTP site is used for EPS producing centres to upload their statistics of EPS verification and the Web site is used to publish them. The Internet sites enable EPS producers to make their own statistics of EPS verification open to the WMO Members. The Internet sites also enable the WMO Members to obtain not only the statistics but also their visualized images.

 This guideline is organized as follows. Section 2 describes definitions of the EPS verification. Section 3 describes how to record and read the statistics on the Internet sites for EPS producers and the WMO Members, respectively. Section 4 describes the rule of the report, and section 5 describes how to obtain the EPS verification scores. Section 6 describes how to post the statistics on the FTP site only for EPS producers.

2. Definition of standard EPS verification

It is defined at *the Attachment II.7, Table F, Section III of the Manual on the GDPFS* (See Appendix A) that standard verification of an EPS are exchanged monthly to measure the forecast skill of ensemble mean, spread and probability with respect to the analysis and/or climatology. The factors and definitions of the measure are also explained in Table 1.

3. The statistics of EPS verification

3.1 The verification table of ensemble mean and spread

The verification table, called the deterministic table here, is defined as follows:

A header line, which starts with “#”, should be put at the head of the deterministic table. The header line should consist of 5 elements as follows;

# <~~Center~~EPS centre name> <Element> <Year> <Month> <Area>

where <term> indicates a keyword which is listed up in Table 2.

 The first, second, third, fourth and fifth column of the table following the header line indicates the number, forecast time, anomaly correlation coefficient of the ensemble mean, root-mean-square (RMS) error of the ensemble mean and spread (standard deviation), respectively.

 Some spaces, at least one, are necessary among each column as a separator.

 A comment line, which starts with “!”, can be put anywhere.

3.2 Reliability table

The table is complied with Standardized Verification System (SVS) for long-range forecasts (LRF) (*Table 6 in Attachment II.8 of the Manual on the GDPFS*). The table is quoted as Table 3 in the document.

 A header line, which starts with “#”, should be put at the head of the reliability table. The header line should consist of 7 elements as follows;

# < ~~Center~~EPS centre name> <Element> <Threshold> <Year> <Month> <Area> <Forecast time>

where <term> indicates a keyword which is listed up in Table 2.

 The first, second, third, fourth and fifth column of the table following the header line indicates the bin number, the number of members forecasting occurrence of the event, the number of members forecasting non occurrence of the event, observed occurrences and observed non-occurrences, respectively.

 Some spaces, at least one, are necessary among each column as a separator.

 A comment line, which starts with “!”, can be put anywhere.

3.3 The verification table of continuous rank probability score (CRPS)

 The verification table, called the CRPS table here, is defined as follows: A header line, which starts with “#”, should be put at the head of the CRPS table. The header line should consist of 5 elements as follows;

# <EPS centre name> <Element> <Year> <Month> <Area>

where <term> indicates a keyword which is listed up in Table2.

 The first, second, third and fourth column of the table following the header line indicates the number, forecast time, CRPS for EPS forecast distribution, CRPS for the control forecast in EPS, respectively. CRPS for deterministic forecast is equal to the mean absolute error. If CRPS for the control forecast in EPS is not being reported, the fourth column has to be set “-1” instead.

 Some spaces, at least one, are necessary among each column as a separator.

 A comment line, which starts with “!”, can be put anywhere.

4. Rule of the report on the verification table

 The reliability table, the CRPS table and the deterministic table should include verification results only for one EPS ~~be~~ reported with an ascii file(s)(See Appendix B, C and D). The file name of the verification table should comply with the following rule;

 - in case of reporting verification results for own EPS,

<~~Center~~Reporting centre name>\_<Classification>\_<Year><Month>.txt

- otherwise,

<Reporting centre name>\_<Classification>\_<Year><Month>.txt.for\_<EPS centre name>

where <term> indicates a keyword which is listed up in Table 2.

 If EPS producer would like to add and/or update the verification table after reporting it, she/he has to overwrite it using the same file name.

5. How to get the verification table

 JMA operates a Web site for both exchanging the statistics and publishing them. The name and address of the Web site are EPSV and http://epsv.kishou.go.jp/EPSv/, respectively.

6. How to post the verification table

 JMA operates a FTP site which is used for EPS producers to report their statistics of EPS verification. The name and address of the ftp site are FTPEPSV and ftp://ftpepsv.kishou.go.jp, respectively.

6.1 Registration

 The ftp site is allowed to access only from the registered site. The EPS producer should notify the administrator  of the global IP address(es) (for example, 11.22.33.44) of her/his own site.

 JMA will send the EPS producer the login information of FTPEPSV, such as user name, at least in one month after the notification.

6.2 Post

 The EPS producer is able to login FTPEPSV with the user name and the password provided.　　She/He put the monthly verification table on her/his home directory of FTPEPSV.

 The verification table is available by accessing EPSV (see section 5) in a day after they are put on FTPEPSV. And, old date verification tables on FTPEPSV may be deleted due to the limitation of disk resources.

Table 1: Factors and definitions used in the EPS verification

|  |  |
| --- | --- |
| Area | Northern hemisphere extratropics (90N-20N)Tropics (20N-20S)Southern hemisphere extratropics (20S-90S) |
| Grid | Verifying analysis and climatology are the centre’s on a latitude-longitude grid 2.5x2.5, 1.5x1.5, or 1.25x1.25-Note that the next Manual on the GDPFS will specify only 1.5x1.5 as is currently described for the deterministic scores.-Note also that the climatology provided by the LC-DNV is on the 1.5x1.5 grid. |
| Ensemble mean |  |
| Spread (Standard Deviation) |  |
| Root Mean Square Error |  |
| Mean Absolute Error |  |
| Anomaly Correlation Coefficient |  |
| Brier Score |  |
| Continuous Rank Probability Score |  [[1]](#footnote-1)† |

where *Fi*: forecast value,  *Ai*: corresponding verifying value,

 *Ci*: corresponding climatological value,
*Pi*: probability, *Oi*: {observed:1, or not-observed:0},

*m* : the ensemble size,

*n* : the number of grid points in the verification area,

: cosine of latitude of grid point *i*



Table 2 : List of keywords

|  |  |  |
| --- | --- | --- |
| Element | Keyword (Bold) |   |
| <Reporting centre name> | **BOM,CMA,CMC,CPTEC,ECMWF,JMA,KMA,MF,NCEP,RUMS,UKMO** | Abbreviation of reporting centre |
| <~~Center~~EPS centre name> | **BOM,CMA,CMC,CPTEC,ECMWF,JMA,KMA,MF,NCEP,RUMS,UKMO** | Abbreviation of EPS producer |
| <Classification> | **RELTBL , ACCERRSPD or CRPS** | RELTBL | The reliability table |
| ACCERRSPD | The scores of ensemble mean forecast and the spread |
| CRPS | The continuous rank probability scores of ensemble forecast and deterministic forecast |
| <Element> | **Z500anm****T850anm****PMSLanm****Z500****T850****PMSL****W850****U850****V850****U250****V250****PR24** | Z500anm | Anomaly for 500hPa geopotential height (unit:m) |
| T850anm | Anomaly for 850hPa temperature (unit:K) |
| PMSLanm | Anomaly for mean sea-level pressure (unit:hPa) |
| Z500 | 500hPa geopotential height (unit:m) |
| T850 | 850hPa temperature (unit:K) |
| PMSL | Mean sea-level pressure (unit:hPa) |
| W850 | 850hPa wind speed (unit:m/s) |
| U(V)850 | 850hPa u(v) wind component (unit:m/s) |
| U(V)250 | 250hPa u(v) wind component (unit:m/s) |
| PR24 | 24-hour accumulated precipitation (unit:mm) |
| <Threshold> | Z500anm, T850anm or PMSLanm | **gt1sd,gt1.5sd,gt2sd,lt-1sd,lt-1.5sd** or **lt-2sd** | gt | Abbreviation of ‘greater than’ |
| lt | Abbreviation of ‘less than’ |
| sd | Abbreviation of ‘Standard deviation’ |
| W850 | **gt10mps,gt15mps** or **gt25mps** | mps | Abbreviation of ‘m/s’ |
| U850, V850, U250 or V250  | **gt10P, gt25P,gt75P** or **gt 90P** | P | Abbreviation of ‘percentile point of climatological chance (%)’ |
| PR24 | **gt1mm,gt5mm, gt10mm** or **gt25mm** | mm | Unit of precipitation |
| <Year> | **2003, 2004**, … | (Numeric) Target year |
| <Month> | **01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11** or **12**  | (Numeric) Target month |
| <Area> | **NH**, **SH** or **TR** | NH | Northern Hemisphere extratropics (20N-90N) |
| SH | Southern Hemisphere extratropics (20S-90S) |
| TR | Tropics (20S-20N) |
| <Forecast time> | **24, 48, 72, 96, 120**, … | (Numeric) forecast time (unit:hour) |

Table 3: The definition of reliability table (Source: *SVS for LRF of the Manual on the GDPFS*)



Appendix A : Latest standard verification measures of EPS (Source: *the Attachment II.7, Table F, Section III of the Manual of the GDPFS*) (To be modified to reflect the latest revision)

**III – STANDARD VERIFICATION MEASURES OF EPS**

EXCHANGE OF SCORES

Monthly exchanges:

**Ensemble mean**

For verification of ensemble mean, the specifications in this table of the attachment for variables, levels, areas and verifications should be used.

**Spread**

Standard deviation of the ensemble averaged over the same regions and variables as used for

the ensemble mean.

**Probabilities**

Probabilistic scores (excluding the CRPS) are exchanged in the form of reliability tables. Details of the format of the exchange of verification data are provided on the website of the Lead Centre for verification of EPS.

*List of parameters*

PMSL anomaly ± 1, ± 1.5, ± 2 standard deviation with respect to a centre-specified climatology. Verified for areas defined for verification against analysis.

Z500 with thresholds as for PMSL. Verified for areas defined for verification against analysis.

850 hPa wind speed with thresholds of 10, 15, 25 m s–1. Verified for areas defined for verification against analysis.

850 hPa u and v wind components with thresholds of 10th, 25th, 75th and 90th percentile points with respect to a centre-specified climatology. Verified for areas defined for verification against analysis.

250 hPa u and v wind components with thresholds of 10th, 25th, 75th and 90th percentile points with respect to a centre-specified climatology. Verified for areas defined for verification against analysis.

T850 anomalies with thresholds ± 1, ± 1.5, ± 2 standard deviation with respect to a centre-specified climatology. Verified for areas defined for verification against analysis.

Precipitation with thresholds 1, 5, 10, and 25 mm/24 hours every 24 hours verified over areas defined for deterministic forecast verification against observations.

Observations for EPS verification should be based on the GCOS list of surface network (GSN). Verification of precipitation may alternatively be against a proxy analysis i.e. short range forecast from the control or high-resolution deterministic forecast, e.g. 12-36h forecast to avoid spin-up problems.

NOTE: Where thresholds are defined with respect to climatology, the daily climate should be estimated.

*Scores*

Brier Skill Score (with respect to climatology) (see definition below\*)

Relative Operating Characteristic (ROC)

Relative economic value (C/L) diagrams

Reliability diagrams with frequency distribution

Continuous Rank Probability Score (CRPS)

NOTES: Annual and seasonal averages of the Brier Skill Score at 24, 72, 120, 168 and 240 hours for Z500 and T850 should be included in the yearly Technical Progress Report on the Global Data-processing System.

In the case of CRPS, centres are encouraged to submit this for both EPS and the deterministic (control and high-resolution) forecast as well – CRPS for deterministic forecast is equal to the mean absolute error.

Appendix B : A sample of the content of a deterministic table

--- start ---

# JMA PMSL 2003 10 NH

1 24 0.977 1.727 2.126

2 48 0.944 2.673 2.929

3 72 0.892 3.659 3.791

4 96 0.829 4.566 4.673

5 120 0.755 5.374 5.482

6 144 0.681 6.024 6.179

7 168 0.606 6.552 6.697

8 192 0.523 7.040 7.029

9 216 0.446 7.405 7.316

! comment

# JMA T850 2003 10 NH

1 24 0.969 1.032 1.104

2 48 0.936 1.477 1.493

3 72 0.893 1.893 1.907

4 96 0.840 2.283 2.338

5 120 0.774 2.671 2.726

6 144 0.705 3.008 3.054

7 168 0.634 3.293 3.295

8 192 0.567 3.509 3.451

9 216 0.506 3.676 3.563

--- end ---Appendix C : A sample of the content of a reliability table

--- start ---

# JMA PMSLanm gt1.5sd 2003 10 NH 24

1 0 25 22.05 55781.09

2 1 24 22.3 2227.46

3 2 23 26.95 1167.75

4 3 22 30.56 728.55

5 4 21 29.36 567.3

6 5 20 30.33 453.26

7 6 19 28.95 371.56

8 7 18 36.06 314.66

9 8 17 32.78 242.68

10 9 16 34.58 228.72

11 10 15 49.14 216.17

12 11 14 50.52 206

13 12 13 55.21 166.8

14 13 12 54.14 124.92

15 14 11 64.04 133.85

16 15 10 70.51 97.28

17 16 9 83.12 80.33

18 17 8 77.79 72.42

19 18 7 84.46 68.86

20 19 6 118.51 54.69

21 20 5 110.96 58.49

22 21 4 149.15 54.08

23 22 3 178.97 56.57

24 23 2 223.6 55.37

25 24 1 304.71 42.21

26 25 0 1706.48 57.91

# JMA PMSLanm gt1.5sd 2003 10 NH 48

1 0 25 44.16 53376.69

2 1 24 53.03 2873.91

3 2 23 49.89 1417.19

4 3 22 35.38 960.68

5 4 21 35.32 703.11

6 5 20 43.64 581.41

7 6 19 46.73 469.66

8 7 18 52.89 424.78

9 8 17 45.92 350.8

10 9 16 44.21 336.88

11 10 15 59.71 272.31

12 11 14 63.77 230.68

13 12 13 74.05 208.44

14 13 12 67.93 206.62

15 14 11 80.56 181.75

16 15 10 89.66 165.36

17 16 9 105.09 133.48

18 17 8 109.73 135.43

19 18 7 122.6 109.76

20 19 6 125.97 110.21

21 20 5 160.89 82.79

22 21 4 187.03 81.05

23 22 3 242.3 75.05

24 23 2 258.44 51.92

25 24 1 378.68 47.92

26 25 0 1097.7 41.37

--- end ---

Appendix D : A sample of the content of a CRPS table

--- start ---

# JMA Z500 2009 01 NH

1 24 5.328 7.095

2 48 9.639 13.141

3 72 14.797 20.579

4 96 20.439 28.571

5 120 26.131 36.681

6 144 31.698 44.742

7 168 36.586 51.677

8 192 40.981 57.883

9 216 44.582 63.157

!comment

# JMA Z500 2009 01 SH

1 24 4.657 -1

2 48 8.545 -1

3 72 12.980 -1

4 96 17.446 -1

5 120 22.148 -1

6 144 26.941 -1

7 168 31.453 -1

8 192 35.108 -1

9 216 37.920 -1

--- end ---

1. † E.g. H. Hersbach, 2000: Decomposition of the continuous ranked probability score for ensemble prediction systems. *Wea. Forecasting*, **15**, 559-570 [↑](#footnote-ref-1)