JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2017

The Netherlands/KNMI

1. Summary of highlights

[Major changes in the data processing and forecasting system during the last year]

2. Equipment in use

[information on the major data processing units]

3. Data and Products from GTS in use

- SYNOP-500 (please modify according to your situation)
- ……
- ……..……

4. Forecasting system

4.1 System run schedule and forecast ranges

- The medium-range forecasts are based on the ECMWF model output (2 times/day, up to +15 days).
- The KNMI short-range and nowcasting forecasting system is based on the Hirlam and Harmonie-Arome models. The KNMI Hirlam domain covers Europe and the North-Atlantic and runs 4 times a day up to 48h. The KNMI Harmonie-Arome domain covers Western Europe and the Southern North Sea and runs 8 times per day up to 48h.
- Special purpose forecasts are also produced for Mali (Harmonie-Arome) and the Dutch Caribbean islands (Hirlam).

4.2 Medium range forecasting system (4-10 days)

4.2.1 Data assimilation, objective analysis and initialization

4.2.1.1 In operation

[information on Data assimilation, objective analysis and initialization]

4.2.1.2 Research performed in this field

[Summary of research and development efforts in the area]

4.2.2 Model

4.2.2.1 In operation

[Model in operational use, (resolution, number of levels, time range, hydrostatic?, physics used)]

4.2.2.2 Research performed in this field

[Summary of research and development efforts in the area]

4.2.3 Operationally available Numerical Weather Prediction Products

[brief description of variables which are outputs from the model integration]

4.2.4 Operational techniques for application of NWP products *(MOS, PPM, KF, Expert Systems, etc..)*

4.2.4.1 In operation

[brief description of automated (formalized) procedures in use for interpretation of NWP ouput]

4.2.4.2 Research performed in this field

[Summary of research and development efforts in the area]

4.2.5 Ensemble Prediction System (EPS)

4.2.5.1 In operation

[Number of runs, initial state perturbation method, perturbation of physics?] *(Describe also: time range, number of members and number of models used: their resolution, number of levels, main physics used, perturbation of physics, post-processing: calculation of indices, clustering)*

4.2.5.2 Research performed in this field

[Summary of research and development efforts in the area]

4.2.5.3 Operationally available EPS Products

[brief description of variables which are outputs from the EPS

4.3 Short-range forecasting system (0-72 hrs)

4.3.1 Data assimilation, objective analysis and initialization

4.3.1.1 In operation

[information on Data assimilation (if any), objective analysis and initialization,] *(Indicate boundary conditions used)*

4.3.1.2 Research performed in this field

Within the Hirlam-Aladin consortium KNMI puts effort in getting Harmonie-Arome 4DVAR suitable for operational use.

4.3.2 Model

4.3.2.1 In operation

[Model in operational use, (domain, resolution, number levels, range, hydrostatic?, physics used)]

Model		Mesh size (km)	Number of gridpoints	Number of levels	Initial times & Forecast ranges (h)		Type of data assimilation	Model providing LBC data	LBC update interval (h)
HIRLAM	CIS (7.2)	11	726 × 550	60	00/06/12/18	+48 h	3D-VAR	ECMWF/IFS	3h
	E11 (7.2)	11	306 × 290	40	00/03/06/../18/21	+60h	3D-VAR	ECMWF/IFS	1h
	C11 (7.2)	11	306 × 290	40	00/03/06/../18/21	+24h	3D-VAR	HIRLAM/CIS	3h
	H11 (7.4)	11	306 × 290	40	00/01/02/../22/23	+24h	3D-VAR	ECMWF/IFS	1h
	BES (7.4)	7.7	438 × 301	65	00/06/12/18	+48h	3D-VAR	ECMWF/IFS	1h
Harmonie-Arome	HA36 (36h1.4)	2.5	800 × 800	60	00/03/06/../18/21	+48h	3D-VAR	HIRLAM E11	1h
	HA40 (40h1.1.1)	2.5	800 × 800	65	00/03/06/../18/21	+48h	3D-VAR	ECMWF/IFS	1h
	MALI (38h1.2)	3	600 × 1080	65	00/03/06/../18/21	+48h	3D-VAR	ECMWF/IFS	1h

	VAR-test (36h1.4)	2.5	300 × 300	60	00/12 06/18	+24 h +6h	3D-VAR	ECMWF/IFS	3h

4.3.2.2 Research performed in this field

A new turbulence scheme (HARATU) has been implemented in Harmonie-Arome. Next attention will be given to the cloud physics.

4.3.3 Operationally available NWP products

There are many parameters available from HIRLAM and Harmonie-Arome such as the prognostic parameters T, U, V, TKE, cloud water, specific and relative humidity, surface pressure. There are also many postprocessing parameters available from the model such as time series at 50+ stations in and around the Netherlands, time series of upper air profiles at these locations and many model fields including the TKE-based instantaneous and maximum wind gust, minimum and maximum temperatures, precipitation, snow depth, CAPE, CIN, LFC and LNB, pseudo visible, infrared and water vapour images, cloud cover, precipitation type (rain, wet snow, snow, freezing rain, frozen rain).

4.3.4 Operational techniques for application of NWP products

4.3.4.1 In operation

MOS is used to produce TAF guidance forecasts and probability forecasts for the lightning intensity. Further the results of the models and observations are combined in MOS forecasts for the standard parameters like minimum and maximum temperatures.

4.3.4.2 Research performed in this field

The MOS system for the lightning intensity forecasts are still being studied for further improvement while the MOS system for the TAF-guidance is regularly updated with training data from the previous period so it follows the evolution of the model on which it is based.

4.3.5 Ensemble Prediction System

4.3.5.1 In operation

The Harmonie-Arome ensemble KEPS comprises 11 members (including the unperturbed control). The ensemble generation technique is based on SLAF and no physics perturbations are used. The domain is 800x800 gridpoints. The forecasts are performed at a horizontal resolution of 2.5km with 65 levels and lead time 48 hours.

4.3.5.2 Research performed in this field

Testing of Harmonie-Arome ensemble forecasting has started (HarmonEPS). Initial suite will be based on a SLAF technique.

4.3.5.3 Operationally available EPS Products

[brief description of variables which are outputs from the EPS

The following parameters are available (for different thresholds): CAPE, CIN, precipitation intensity, lightning intensity, wind, wind gusts, cloud base, visibility.

Area probabilities (e.g. provinces) are also available for wind gusts and precipitation intensity, also for different thresholds.

4.4 Nowcasting and Very Short-range Forecasting Systems (0-12 hrs)

4.4.1 Nowcasting system

4.4.1.1 In operation

[information on processes in operational use, as appropriate related to 4.4]

(Note: please also complete the CBS/PWS questionnaire on Nowcasting Systems and Services, 2014)

4.4.1.2 Research performed in this field

[Summary of research and development efforts in the area]

4.4.2 Models for Very Short-range Forecasting Systems

4.4.2.1 In operation

[information on models in operational use, as appropriate related to 4.4]

4.4.2.2 Research performed in this field

[Summary of research and development efforts in the area]

4.5 Specialized numerical predictions

[Specialized NP on sea waves, storm surge, sea ice, marine pollution transport and weathering, tropical cyclones, air pollution transport and dispersion, solar ultraviolet (UV) radiation, air quality forecasting, smoke, sand and dust, etc.]

4.5.1 Assimilation of specific data, analysis and initialization (where applicable)

4.5.1.1 In operation

[information on the major data processing steps, where applicable]

4.5.1.2 Research performed in this field

The implementation of the following data source is being tested:
(slant) GNSS, RADAR (reflectivity and Doppler wind), InSAR and AMSUA/B

4.5.2 Specific Models (as appropriate related to 4.5)

4.5.2.1 In operation

Storm surge model

	WAQUA/DCSMv5
basic equations	shallow water equations
Independent variables	x, y, t
Dependent variables	z, u, v
Numerical technique	alternating direction implicit method
Integration domain	201x173 grid points
Forecast period	240 hours on ECMWF input
Resolution	1/8°WE, 1/12°NS (±8km)
Time step	10 minutes
Boundaries	Wind and pressure at the sea surface, astronomical tide at the open boundaries

4.5.2.2 Research performed in this field

The optimal (one-way) coupling of Harmonie-Arome to models for storm surges and waves at the North Sea.

4.5.3 Specific products operationally available

WAQUA/DCSMv5 provides sea level probability forecasts for the skew surge for 8 locations along the coast of the Netherlands.

4.5.4 Operational techniques for application of specialized numerical prediction products *(MOS, PPM, KF, Expert Systems, etc..)* (as appropriate related to 4.5)

4.5.4.1 In operation

"[brief description of automated (formalized) procedures in use for interpretation of specialized NP output]"

4.5.4.2 Research performed in this field

[Summary of research and development efforts in the area]

4.5.5 Probabilistic predictions (where applicable)

4.5.5.1 In operation

"[Number of runs, initial state perturbation method etc.]" *(Describe also: time range, number of members and number of models used: their resolution, main physics used etc.)*

4.5.5.2 Research performed in this field

[Summary of research and development efforts in the area]

4.5.5.3 Operationally available probabilistic prediction products

"[brief description of variables which are outputs from probabilistic prediction techniques]"

4.6 Extended range forecasts (ERF) *(10 days to 30 days)*

4.6.1 Models

4.6.1.1 In operation

[information on Models and Ensemble System in operational use, as appropriate related to 4.6]

4.6.1.2 Research performed in this field

[Summary of research and development efforts in the area]

4.6.2 Operationally available NWP model and EPS ERF **products**

[brief description of variables which are outputs from the model integration]

4.7 Long range forecasts (LRF) *(30 days up to two years)*

4.7.1 In operation

[Describe: Models, Coupled? (1 tier, 2 tiers), Ensemble Systems, Methodology and Products]

4.7.2 Research performed in this field

[Summary of research and development efforts in the area]

4.7.2 Operationally available EPS LRF products

[brief description of variables which are outputs from the model integration]

5. Verification of prognostic products

5.1 [annual verification summary to be inserted here]

5.2 Research performed in this field

[Summary of research and development efforts in the area]

6. Plans for the future *(next 4 years)*

6.1 Development of the GDPFS

6.1.1 [major changes in the Operational DPFS which are expected in the next year]

Introduction of an ensemble system at the meso-scale based on HARMONIE-AROME. Use of flow-dependent information in the data-assimilation system.

6.1.2 [major changes in the Operational DPFS which are envisaged within the next 4 years]

6.2 Planned research Activities in NWP, Nowcasting, Long-range Forecasting and Specialized Numerical Predictions

"[Summary of planned research and development efforts in NWP, Nowcasting, LRF and Specialized Numerical Predictions for the next 4 years]"

6.2.1 Planned Research Activities in NWP

i) Adding more observations, notably GNSS (slant) and Radar, to 3d/4dvar.

ii) Investigate overlapping windows in 4dvar and role of model error

iii) Improve the representation of clouds.

6.2.2 Planned Research Activities in Nowcasting
see also 6.2.1

6.2.3 Planned Research Activities in Long-range Forecasting

6.2.4 Planned Research Activities in Specialized Numerical Predictions

7. References

[information on where more detailed descriptions of different components of the DPFS can be found]
(Indicate related Internet Web sites also)