JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2011

Country: Kazakhstan **Centre: Kazhydromet**

1. Summary of highlights

The new forecasting computation technology using the non-hydrostatic hydrodynamic model WRF is developed. Currently the runs of the model are conducted daily.

2. Equipment in use

The new computer equipment is installed. It includes 2 computational clusters: eight servers XEON-5500 four-core processor (16 processors, 2.83 GHz each) and three servers on two 12-core-processor AMD Phenom II X4 955 (6 processors, 3200MHz each). These clusters are installed for the quasi-operative integration of mesoscale WRF model and regional climate models.

MTS	- Intel Pentium IV, 3 000 MHz.
UniMAS	- Intel Pentium IV, Dual CPU 2 400 MHz.
AWS-weather	- Intel Pentium IV, Dual CPU, 2 400 MHz.
GIS Meteo	- Intel Pentium IV, Dual CPU 2000 MHz.
E-mail server	- Intel Xeon 3 200 MHz.
Satellites	- Intel Pentium IV, Dual CPU, 2 400 MHz.
E-mail	- Pentium IV, 3 000 MHz.

Switch 2512, SAS 2224, DSR 2216, Cisco SLM224P, D-Link DES-1024D, TP-Link SII 1024.

Server	- Intel Xeon 3 200 MHz.
Server	- Intel Xeon 3 200 MHz.
Modems	- M-144, TAINET, Zyxel.

The soft- and hardware for weather maps preparation – Pentium IV, 3 000 MHz, Color Laser Jet 5550 n.

3. Data and Products from GTS in use

SYNOP
TEMP
ECMWF Reading
WMC Washington

4. Forecasting system

4.1 System run schedule and forecast ranges

Conventional methods or weather forecasting are applied in Kazhydromet based on analysis of actual information using baric fields forecast, which is being received from the Word Meteorological Centre (Washington), European Centre for Medium Range Weather Forecasts (Reading), and Moscow Centre.

Every day meteorological, sea, hydrological and agrometeorological forecasts are made up. Regularly the week, decade weather forecasts are issued for all the regions of Kazakhstan. One of the main tasks of Kazhydromet is to make forecasts of the dangerous and natural phenomena, reports of the weather changes and distribute to customs and user.

Kazhydromet's activities in medium range forecasting are based on ECMWF operational model. This means 10 days forecasts twice a day with 00 and 12 GMT starting

time are available to Kazhydromet. Short range NWP modelling is based on mesoscale WRF model.

4.2 Medium range forecasting system (4-10 days)

Products from ECMWF are used for medium range forecasting. Operations concentrate mainly on deterministic products.

4.2.1 Data assimilation, objective analysis and initialization

4.2.1.1 In operation

4.2.1.2 Research performed in this field

4.2.2 Model

4.2.2.1 In operation

4.2.2.2 Research performed in this field

4.2.3 Operationally available Numerical Weather Prediction Products

10-day deterministic forecasts are available at Kazhydromet. Charts from the Word Meteorological Centre (Washington), European Centre for Medium Range Weather Forecasts (Reading), and Moscow Centre are used for making up forecasts. Some of the products are downloaded as images and displayed on internal website.

- mean sea level pressure analysis and forecast
- 6h accumulated precipitation (amount and phase) forecast
- 2 m temperature analysis and forecast
- 10 m wind analysis and forecast
- temperature analysis and forecast on 1000/925/850/700/500/400/300/250/200/150 mb pressure levels
- geopotential height analysis and forecast on 1000/925/850/700/500/400/300/250/200/150 mb pressure levels
- specific humidity analysis and forecast on 1000/925/850/700/500/400/300/250/200/150 mb pressure levels
- wind components analysis and forecast on 1000/925/850/700/500/400/300/250/200/150 mb pressure levels
- multi-layer cloudmap in false colours forecast
- sea surface temperature
- sea ice cover

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

4.2.4.1 In operation

NWP products are used to pre-fill site forecast information in selected points.
The information is later over-viewed by duty forecaster.

4.2.4.2 Research performed in this field

4.2.5 Ensemble Prediction System (EPS)

4.2.5.1 In operation

EPS products from ECMWF are available and used at Kazhydromet.

4.2.5.2 Research performed in this field

4.2.5.3 Operationally available EPS Products

EPS products from ECMWF are available at Kazhydromet. Following products are prepared at ECMWF as images and downloaded and displayed on internal website for one week period ahead.

- probability that cloud cover
- probability that precipitation exceeds 1/5/10/20 mm per 12 h
- probability that wind gusts exceed 15/20/25/ m/s
- probability that temperature °C

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

Charts from the Word Meteorological Centre (Washington), European Centre for Medium Range Weather Forecasts (Reading), and Moscow Centre are used for making up forecasts. For drawing of atmospheric fronts are analyzed initial GRID data base, SYNOP, TEMP and results of SYNOP and TEMP objective analysis, and satellite information.
The new forecasting computation technology using the non-hydrostatic hydrodynamic model WRF is developed. Currently the runs of the model are conducted daily.

4.3.1 Data assimilation, objective analysis and initialization

4.3.1.1 In operation

Boundary conditions for the new forecasting computation technology using the non-hydrostatic hydrodynamic model WRF are provided by GFS.

4.3.1.2 Research performed in this field

4.3.2 Model

4.3.2.1 In operation

The regular daily automated calculation of 72-hour forecasts using the WRF mesoscale model is realized at the computational complex Altruix 4700. The system skims GFS data in GRIB2 format from NCEP server (forecasts starting at 12 UTC), starting pre-processing programs WPS (ungrib, geogrid, metgrid) with these data, starting WRF ARW model (using 16 processors). Forecasting results are presented in NetCDF format with meteorological fields visualization and development of meteograms is performed in IDV system. Starting time is 00 UTC.

4.3.2.2 Research performed in this field

4.3.3 Operationally available NWP products

In addition to weather maps, meteograms and upper atmosphere diagrams of selected locations are provided.

- mean sea level pressure forecast
- 3h accumulated precipitation (amount and phase) forecast
- 2 m temperature forecast
- 10 m wind forecast
- 850 mb temperature forecast
- multi-layer cloudmap in false colours forecast

4.3.4 Operational techniques for application of NWP products

4.3.4.1 In operation

4.3.4.2 Research performed in this field

4.3.5 Ensemble Prediction System

4.3.5.1 In operation

4.3.5.2 Research performed in this field

4.3.5.3 Operationally available EPS Products

4.4 Nowcasting and Very Short-range Forecasting Systems (0-6 hrs)

4.4.1 Nowcasting system

4.4.1.1 In operation

4.4.1.2 Research performed in this field

4.4.2 Models for Very Short-range Forecasting Systems

4.4.2.1 In operation

4.4.2.2 Research performed in this field

4.5 Specialized numerical predictions

The water level fluctuations at the Caspian Sea northeastern part depend from the following factors: relief, wind regime and background sea level position. During the period especially dangerous wind setup phenomena the sea level over the short period (a few hours) can rise up to 3.0 m at east most gently sloping seaside, therefore the low territories are flooded up to 30 km. The losses from the coastal zone flooding are estimated to millions dollars. Therefore, at designing and protection of hydraulic engineering and civil constructions the water level forecasts on basis of numerical modelling are put forward to one in the central places. The preliminary warning (forecast) of these phenomena allows to considerably reduce the damage.

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

4.5.1.1 In operation

An operational storm surge model has been established at the Kazakh Republican State Enterprise "Kazhydromet". The model is based on DHI's 2D hydrodynamic model, MIKE 21 (Denmark, DHI).This model is a structural element of the automatic transfer line of the Caspian Sea operational system level forecasting with lead-time till 120 hours. The system allows to receive the meteorological information from the European Center for Medium-Range Weather Forecasts (ECMWF, UK); hydrological information - from the Kazakhstan's stations on the Caspian Sea via the communicate channels, to process it and to make necessary forecasts in the shortest possible time. On the basis of digital meteorological data received from the ECMWF carry out daily computer simulations of storm surge forecasts for the Kazakh coast of the Caspian Sea. The model is forced with the meteorological forecast wind and air pressure data.

Adaptation of the HD module to the shallow conditions of the Northern Caspy was made by the Kazakh executives over creation the bathymetric models of all sea (grid spacing 10 km) and its northern part (grid spacing 2.0 km), selection of the check-up factors: bed resistance, wind friction and others. System allows expecting hourly water level fluctuations in any point of the Caspian Sea. Initial sea level is defined according to network observation, acting by communicate channels. Adapt the storm surge warning model to take account of seasonal particularities such as ice cover, river inflows,

evaporation and precipitation. During the winter period the northern shallowest part of the Caspian Sea is covered by ice. An effect of such ice cover is that the water level fluctuations are dampened. This effect also was implemented in the operational storm surge model.

The water level forecasts are made for the different regions of the Kazakhstan's coast of the Caspian Sea. Representation form of the forecast: text, water level fluctuations' graph, Warnings of the dangerous consequences (flooding, dams' destruction, deterioration of navigation conditions).

4.5.1.2 Research performed in this field

4.5.2 Specific Models (as appropriate related to 4.5)

4.5.2.1 In operation

4.5.2.2 Research performed in this field

4.5.3 Specific products operationally available

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

4.5.4.2 Research performed in this field

4.5.5 Probabilistic predictions (where applicable)

4.5.5.1 In operation

4.5.5.2 Research performed in this field

4.5.5.3 Operationally available probabilistic prediction products

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

4.6.1 Models

4.6.1.1 In operation

Synoptic-statistics method is used for making up forecast for month. There are mean monthly temperature, temperature and precipitation anomaly, plots of the mean daily temperature and weather phenomena.

4.6.1.2 Research performed in this field

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

Long-range Weather Forecast Department of Kazhydromet makes up forecast for 6 month two times per year. There are mean monthly temperature and precipitation anomaly.

An experimental exploitation of Regional Climate Model (RegCM, Version 3, ICTP) is being carried out for seasonal forecasts for the entire territory of Kazakhstan.

4.7.2 Research performed in this field

By using Regional Climate Model meteorological fields on season and month were simulated in hindcast mode for 10 years (1991-2000 years). The NCEP reanalysis and OISST data set are used in RegCM as initial and boundary conditions. Meteorological

fields were compared with observed fields (UKMO/CRU data sets). Systematic biases were found. Experiments were carried out with different type of cloud parameterization and different domain size.

4.7.2 Operationally available EPS LRF products

5. Verification of prognostic products

5.1 The verification of short- and middle-range weather forecasts of general purpose is made according to manual on a weather service accepted in Kazhydromet centre and added in 1993. This is not a computing method and calculations are manually made up. The average verification of our forecast is around 80-90%. As of WRF products verification we just making compare simulated meteorological fields with actual charts.

5.2 Research performed in this field

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]"

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

Further development of NWP in Kazahstan using different models. Improving of technical resources, creating of new forecasting system using NWP operationally. Applying of 3 and 4D-Var assimilation and system of verification output product. Development of climate problem researching.

6.2.1 Planned Research Activities in NWP

6.2.2 Planned Research Activities in Nowcasting

6.2.3 Planned Research Activities in Long-range Forecasting
Appling Regional Climate Models in the real time operation mode for seasonal forecasts.
Appling PRECIS for future climate forecast.

6.2.4 Planned Research Activities in Specialized Numerical Predictions

7. References

http://www.kazhydromet.kz/