JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2015

Chile / Dirección Meteorológica de Chile (Chilean Weather Service)

1. Summary of highlights

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

- Implementation of a specialized forecast aimed to tackle the meteorological part of the national air quality forecast system using WRF as main numerical weather forecast model.
- Implementation of an air quality prediction system for Santiago area. PM10/PM2.5 forecast.
- Experimental implementation of an ash forecast system, based on WRF + Fall 3D coupled system.
- Expansion of the numerical prediction capability with the entry-in-service of a 48-core, 8 TB computing system.
- Increased geographical coverage of the NWP, now including every major population area with high-resolution regional model output.
- Increased availability of NWP-based products in our public website.

2. Equipment in use

[information on the major data processing units]

- Main computing system (in service since 2011/11):
  - 132 Xeon Westmere computing cores, 11 machines with 2 CPUs each, 6 cores per physical CPU.
  - 24 Xeon Westmere support cores, 2 machines with 2 CPUs each, 6 cores per physical CPU. Used for login and central storage unit.
  - QDR InfiniBand computing and storage access interconnect.
  - 30 TB storage, InfiniBand-based.
  - 576 GB in RAM memory.
  - 1 node equipped with 1 NVIDIA GPGPU card, for applications development and testing.
  - QDR InfiniBand switch.
  - Gigabit Ethernet switch.
  - Linux-based operating system.

- Secondary computing system (in service since 2014/09):
  - 48 Xeon E5 v2 (Ivy Bridge microarchitecture) computing cores, 2 machines with 2 CPUs each, 12 cores per physical CPU.
  - FDR InfiniBand computing and storage access interconnect.
  - 8 TB storage, InfiniBand-based.
  - 144 GB in RAM memory.
  - Shared network infrastructure with the main computing system.
  - Linux-based operating system.

3. Data and Products from GTS in use

- No data assimilation is being used to initialize the regional simulations.

4. Forecasting system

4.1 System run schedule and forecast ranges

[general structure of a prognostic system, models in operational use, run schedule, forecast ranges]

- Short to medium range forecast system:
  - WRF: 2 runs per day at 00-12 UTC. Forecast up to 120 hours.
  - MM5: 4 runs per day at 00-06-12-18 UTC. Forecast up to 120 hours.

- Medium range forecast system:
  - WRF ensemble: 1 run per day, 20 members plus control, ran at 12 UTC. Forecast up to 168 hours.
  - WRF meteorology for air quality management: 1 run per day, ran at 00 UTC. Forecast up to 120 hours.

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]

- No forecast-based data assimilation is in place. GFS or GEFS is used in order to initialize forecast.

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)]

- Both in WRF and MM5 implementations we use a local approach, based in the major cities in the country and also in our regional centers. Since 2010, we have operational centers with MM5-based NWP computing capabilities in our regional centers such as: Antofagasta (north), Santiago (central), Puerto Montt (south) and Punta Arenas (southern).
  - WRF central: up to 6 km, 120 hours forecast, 49 vertical levels.
  - WRF north, south and southern: up to 4 km, 120 hours forecast, 30 vertical levels.
  - MM5 central: up to 4 km, 120 hours forecast, 34 vertical levels.
  - MM5 north, south and southern: up to 4 km, 72 hours forecast, 34 vertical levels.

4.2.2.2 Research performed in this field

[Summary of research and development efforts in the area]

- Optimization of computational use, making the distribution of computational tasks resembles the geometry of the existing domain in order to get a better simulation.
- Implementation of regional operational simulations of WRF.
- Evaluation of localized WRF implementations.

4.2.3 Operationally available Numerical Weather Prediction Products

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

- Plots: meteograms, soundings, temperature, winds, precipitation, CAPE, divergence and geopotential, etc.
- Regional model GRIB output.
- Specialized products for agriculture, disaster risk management and air quality control, among others.

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]

- No statistical-based forecast technique is in place.

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)*

- WRF ensemble: 1 run per day, 20 members plus control, ran at 12 UTC. Forecast up to 168 hours in a single grid covering Chile with 20 km resolution. 30 vertical levels.
- No local perturbation, perturbation is given by the boundary and initial conditions, obtained from the Global Ensemble Forecast System of NOAA.
- Post-processing: probability-based plots, geopotential spaghetti plots.

4.2.5.2 Research performed in this field

[Summary of research and development efforts in the area]

- Evaluation of WRF implementation.

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

[Summary of research and development efforts in the area]

4.3.2 Model

4.3.2.1 In operation

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

4.3.2.2 Research performed in this field

[Summary of research and development efforts in the area]

4.3.3 Operationally available NWP products

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

4.3.4 Operational techniques for application of NWP products

4.3.4.1 In operation

[brief description of automated (formalized) procedures in use for interpretation of NWP ouput]
(MOS, PPM, KF, Expert Systems, etc..)

4.3.4.2 Research performed in this field

[Summary of research and development efforts in the area]

4.3.5 Ensemble Prediction System

4.3.5.1 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 domain, resolution, number of levels, main physics used, for post-processing: calculation of indices, clustering)*

4.3.5.2 Research performed in this field

[Summary of research and development efforts in the area]

4.3.5.3 Operationally available EPS Products

[brief description of variables which are outputs from the EPS

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.]

- Air pollution: air quality prediction system for Santiago area. PM10/PM2.5 forecast.
- Experimental ash transport and deposition system. Coupled forecast system using WRF and Fall 3D covering the most active volcanos along the country; primarily for emergency response. Up to 24 hours of forecast.
- UV forecast model, based on TUV (Tropospheric Ultraviolet and Visible Radiation Model). It forecasts the maximum radiation level for 75 locations in Chile, up to 3 days forecast.

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

[Summary of research and development efforts in the area]

4.5.2 Specific Models (as appropriate related to 4.5)

4.5.2.1 In operation

[information on models in operational use, as appropriate related to 4.5]

4.5.2.2 Research performed in this field

[Summary of research and development efforts in the area]

4.5.3 Specific products operationally available

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

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]

- Decommission of MM5 simulations due to lack of input data and model support.
- Experimental, satellite-based data assimilation development.
- High resolution modeling coverage for Easter Island and Antarctica.
- National air quality forecast system running as backup for the Chilean Ministry of the Environment.
- New main computing system in place (2016/02):
    - 384 Xeon E5 v3 (Haswell microarchitecture) computing cores, 12 machines with 2 CPUs each, 16 cores per physical CPU.
    - 40 Xeon E5 v3 (Haswell microarchitecture) support cores, 2 machines. Used for login and central storage unit.
    - FDR InfiniBand computing and storage access interconnect.
    - 50 TB storage, InfiniBand-based.
    - 896 GB in RAM memory.
    - 1 FDR InfiniBand switch.
    - 2 Gigabit Ethernet switch.
    - Linux-based operating 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

6.2.2 Planned Research Activities in Nowcasting

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)