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

Egyptian Meteorological Authority
Cairo Numerical Weather prediction centre

1. Summary of highlights

The physical and numerical research department as a part from the Central Administration for Meteorology and Climate Research Supervises the operation and follow-up of the following numerical models.

- High-resolution run of WRF (NMM core), 6km grid distance.
- Running WS_Eta as a dust forecast model
- Running MOZART Model for Ozone and related chemical Tracers.
- Running RegCM4,20km resolution as an air quality model.
- Running Flex part and Hysplit4 air dispersion Model.
- Issue of seasonal forecast over North Africa and Arab world
- Running WAM Model for marine forecast over Mediterranean sea, red sea and Suez gulf
- New website for NWP products (www.nwp.gov.eg).

2. Equipment in use

Table 1: Computer equipment in use for operational models

Machine	Processors	Memory (GB)	Storage
Huawei rh5885H v3	Xeon E7-4800 24 cores	6 TB (using 64 GB DIMMs)	6 X 1.8 TB 10K
2 Lenovo TD350 think server	2 x 2.6GHz Intel Xeon E5-2630 v3	64GB 2,133MHz DDR4	4 X 2 TB 7200rpm
Dell Precision	8× 3.2GHz	12 GB	4.5TB
IBM workstation	32 × 1.2 GHz	32 GB	2 TB
IBM Workstation	32 ×1.2 GHZ	32 GB	2 TB
Workstations	8 Intel Xeon workstations	8×2.4 GHZ dual core	8 ×1 TB
IBM x3650 M4	2 X 2.4 GHZ/ 8-core/ 20MB cache	32 GB, DDR3 RAM	
HP Elite 7500 series	MT 8 processors CORE I7	8 GB	1 TB
DELL Power Edge	T630 16 processors	16 GB	8 TB

3. Data and Products from GTS in use

- GFS data set
- FNL data set
- SYNOP
- TEMP
- BUOY
- SHIP
- METAR

4. Forecasting system

4.1 System run schedule and forecast ranges

The general structure of a prognostic system of our NWP system is illustrated in figure 1. In our system there are three operational models used for short range and medium range forecasts; WRF, Workstation ETA, RegCM. They run twice per days, based on initial conditions at 00 UTC and 12 UTC. As illustrated in the figure there some modules and models coupled with our limited area models; Dust module to predict dust, WAM model used to predict the sea waves over Mediterranean and red sea.

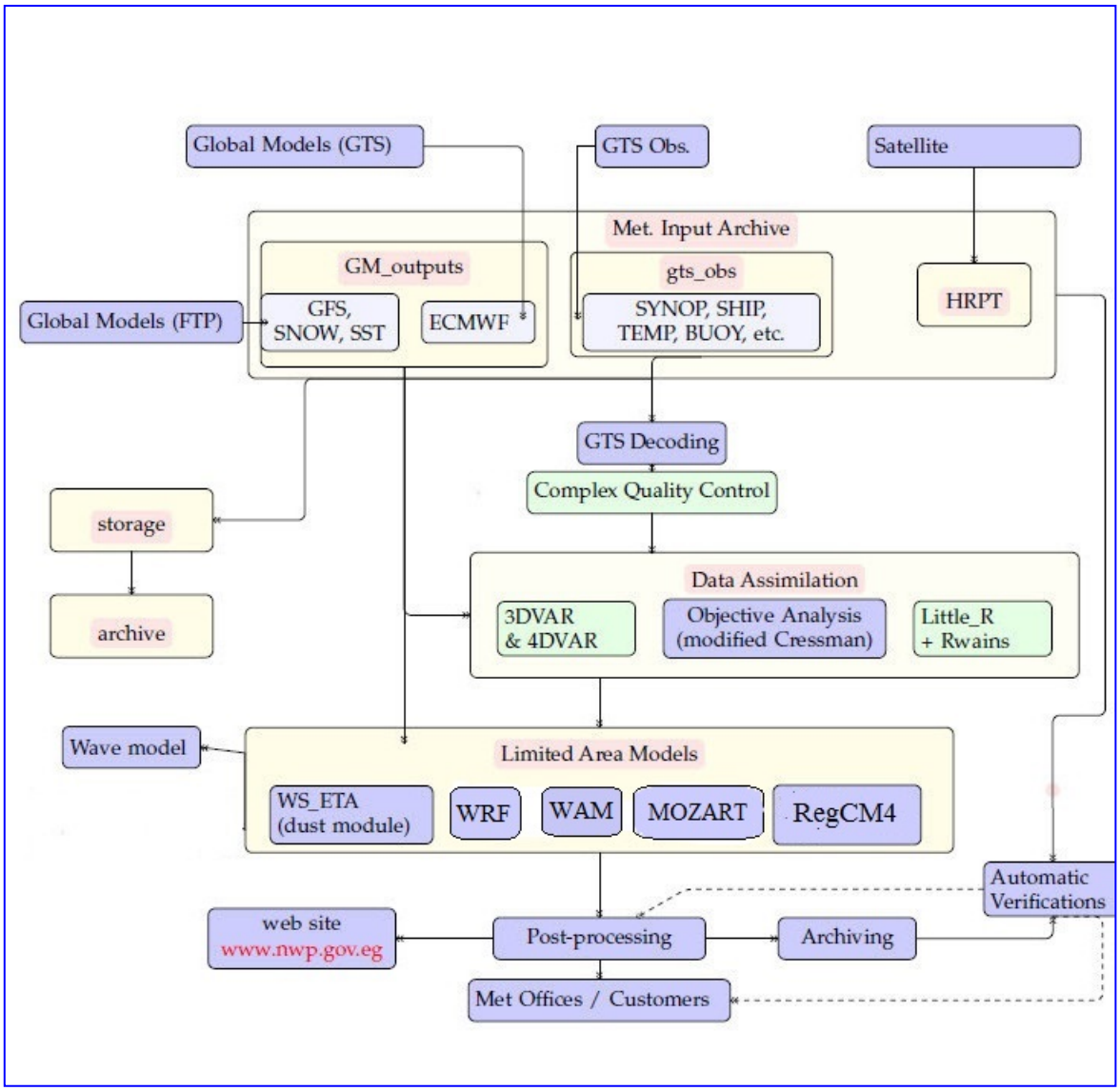


Figure 1: Operational NWP

4.2 Medium range forecasting system (4-10 days)

As result of limitation of our computational power, our medium range forecast covers only 5 days forecasts by using the models, described in section 4.3

4.3 Short-range forecasting system (0-120 hrs)

4.3.1 Data assimilation, objective analysis and initialization

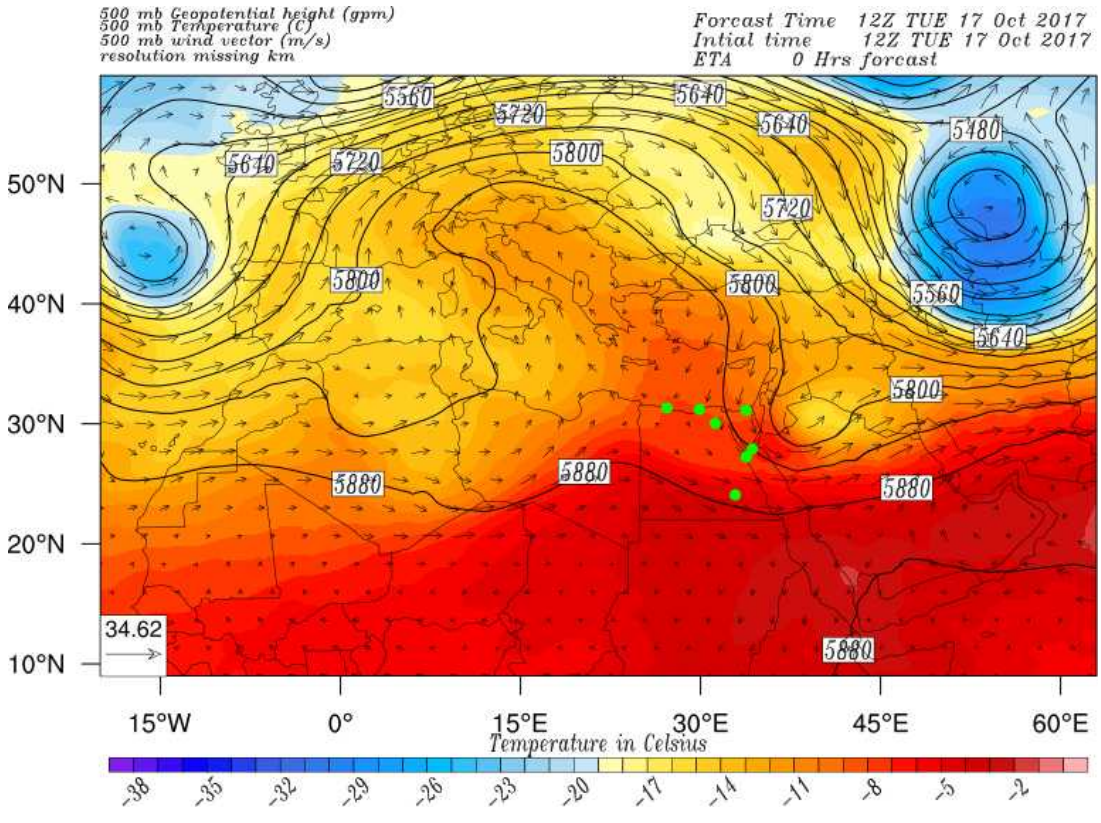
WRF 3DVAR (in experimental Mode)

4.3.2 Model

4.3.2.1 In operation

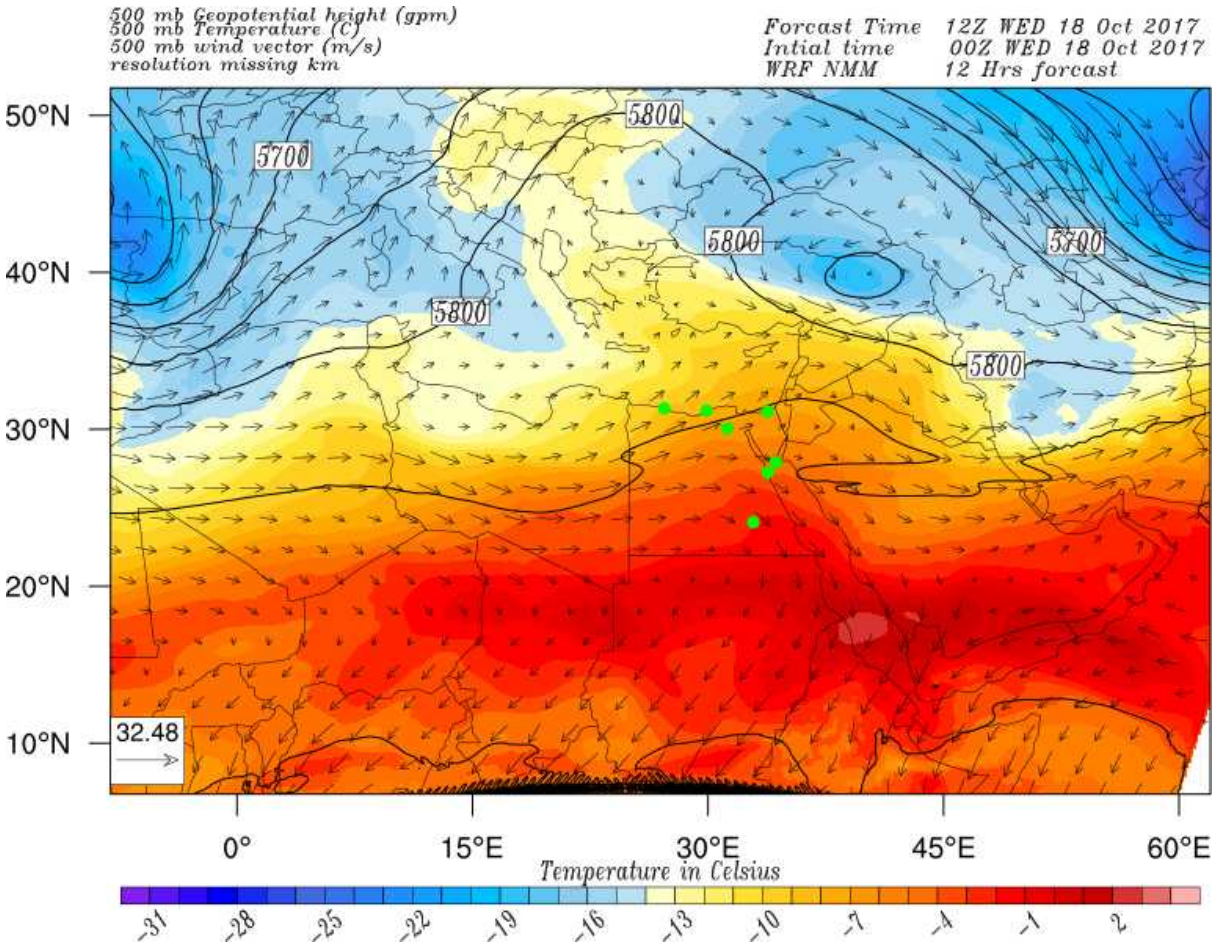
Workstation ETA

Parameter	Value	Value
Nesting		One way nesting
Hydrostatic/Non-hydrostatic	Hydrostatic	Non-Hydrostatic
Vertical coordinate	ETA	ETA
number of vertical layers	45	45
Zonal grid distance	0.24 deg.	0.08 deg.
Meridional grid distance	0.24 deg.	0.08 deg.
Time step	65 seconds	20 seconds
cumulus parameterization scheme	Betts-Miller-Janic scheme	Betts-Miller-Janic scheme
output frequency	one hour	one hour
Forecast length	120 hours	96 hours
output pressure levels	from 1000 mb to 50 mb every 25 mb	from 1000 mb to 50 mb every 25 mb



WRF Model (NMM CORE)

Microphysics : Eta microphysics
radiation scheme : GFDL scheme
Land surface scheme : Unified NCEP/NCAR/AFWA scheme
Boundary Layer scheme: Mellor-Yamada-Janjic scheme
Cumulus Parameterization: Betts-Miller-Janjic scheme
Mother Domain: (19.12 N to 42.8 N, 15.76 E to 45.16E, Resolution = 0.15 deg.)
Nested Domain: (21.53 N to 32.44N, 23.22 E to 41. E, Resolution=0.05 deg.)



4.3.3 Operationally available NWP products

- The Geopotential height at the standard levels
- Mean sea level pressure.
- Horizontal wind components (U.V).
- Temperature (T).
- Specific Humidity (q).
- Surface pressure (Ps).
- Soil temperature.
- Soil moisture content.

- Surface temperature.
- Connective precipitation.
- Layer cloud amount.
- Vertical velocity.
- Thunderstorm and sandstorm

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

Our now casting and very short-range forecasting depend on models on section 4.3 and on some subjective methods, which used both model products and observations.

4.5 Specialized numerical predictions

Sea Wave, dust prediction, and air quality system

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

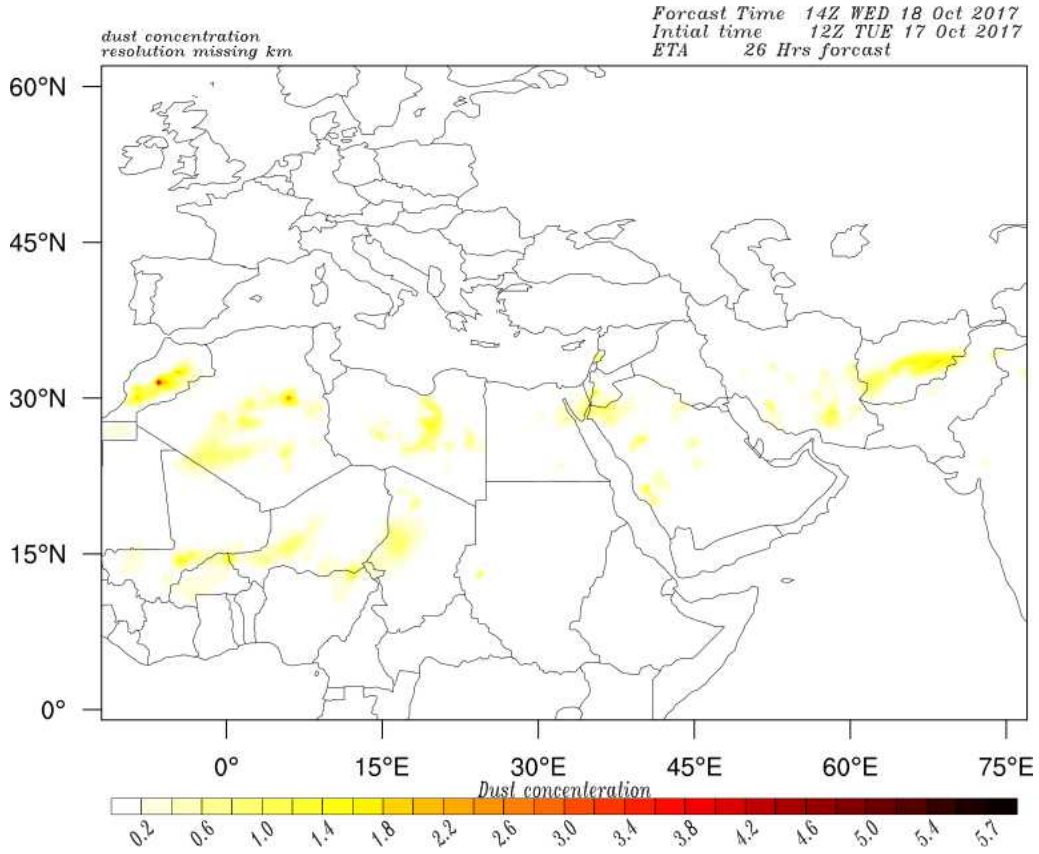
The initial and boundary fields for sea wave prediction are provided by the output from workstation ETA and WRF models (described in section 4.3).

4.5.2 Specific Models (as appropriate related to 4.5)

4.5.2.1 **In operation**

Dust Module coupled with WS_ETA

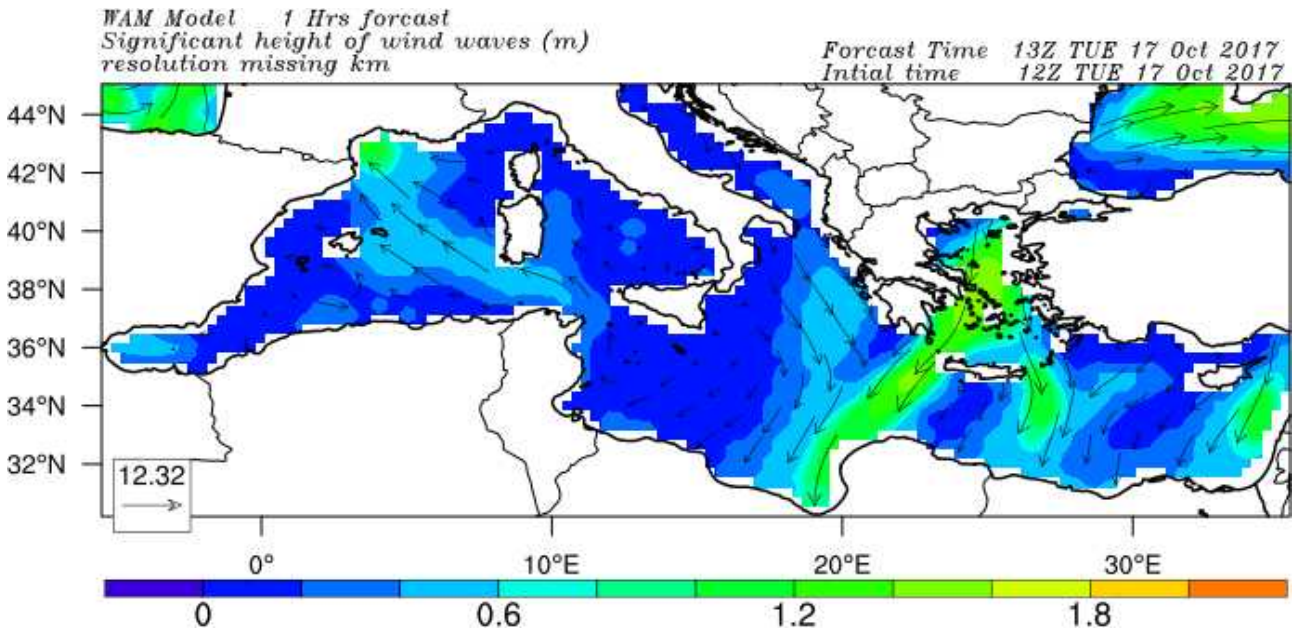
This dust module is based on scheme developed by S. NICKOVIC (from Athens University).
The area coverage is : (-1S to 62N , -12W to 77E, with resolution 0.5 deg.)



Parameter	Value
Hydrostatic/Non-hydrostatic	Hydrostatic
Vertical coordinate	SIGMA
zonal grid pints	181
Meridional grid pints	217
number of vertical layers	45
center latitude	33
cneter longitude	33
Zonal grid distance	0.33 deg.
Meridional grid distance	0.33 deg
Time step	72 seconds
cumulus parameterization scheme	Betts-Miller-Janic scheme
output frequency	6 hours
Forecast length	96 hours
model diffusion parameter	0.35
accumulating precipitation period	6
land sea mask resolution	4 minutes

WAM Model

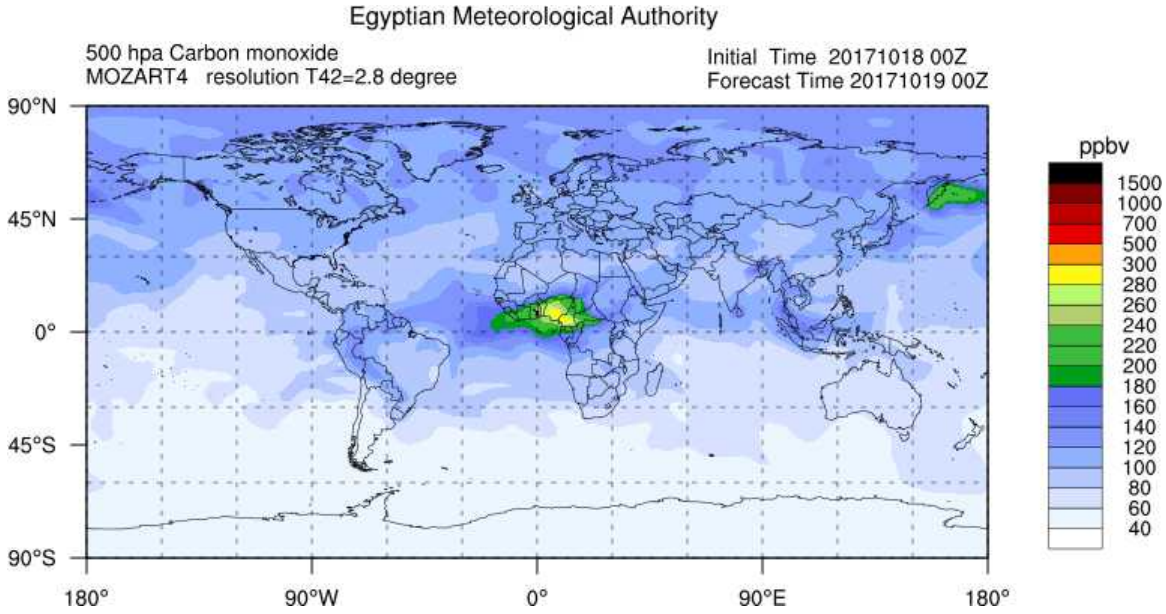
Used to predict significant wave heights, swell, wave periods, and wave spectrum over
Mediterranean (30.2N to 45.N, -5.5W, 35.42E, with resolution 0.33 deg),
Red Sea (12.5N to 29N, 32.3 E to 42.52E, with resolution 0.33 deg), and
Suez Gulf (27N to 29.96N, 32E to 36 E, with resolution 0.039deg)



MOZART (Model for Ozone and Related chemical Tracers)

A chemistry transport model used to predict the concentrations of atmospheric gases and aerosols over the globe, with resolution 2.8 deg.

Parameter	Value
Vertical coordinate	Hybrid
Zonal grid points	128
Meridional grid points	64
Zonal grid distance	2.8 deg
Number of Vertical layers	28
Time step	20 minutes
Output frequency	6 hours
Forecast length	96 hours

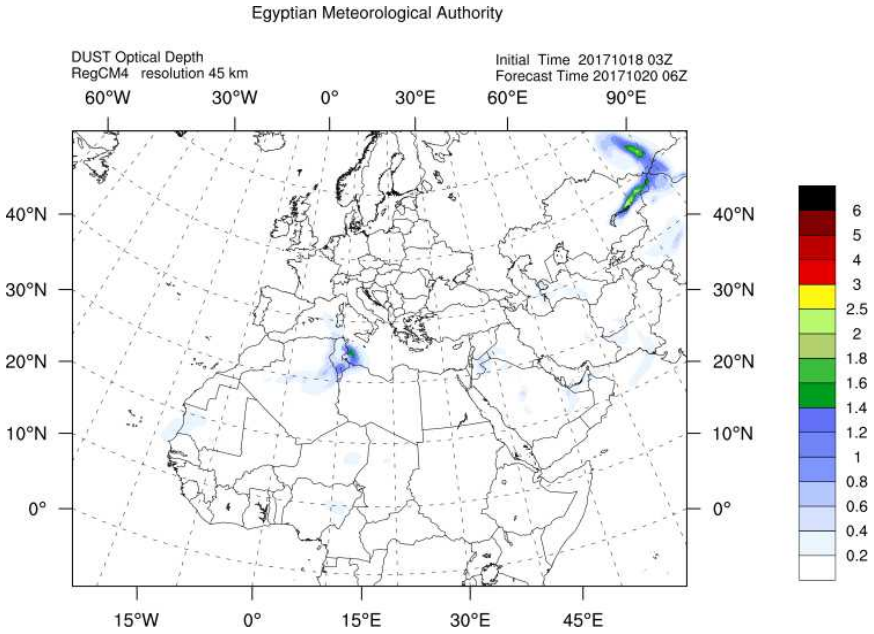


RegCM4 (Regional Climate model)

Our group modified the RegVM4 to be used as an air quality model, and to predict the concentrations of dust and atmospheric gases over Egypt, Arabic countries and North Africa.

EMA-RegCM4 (Dust model)

Parameter	Value
Vertical coordinate	Sigma
Zonal grid points	240
Meridional grid points	180
Zonal grid distance	45 km
Number of Vertical layers	18
Center latitude	34 N
Center longitude	17 E
Time step	150 seconds
Output frequency	3 hours
Forecast length	120 hours



EMA-RegCM4 (Air quality model)

Parameter	Value
Vertical coordinate	Sigma
Zonal grid points	140
Meridional grid points	100
Zonal grid distance	20 km
Number of Vertical layers	18
Canter latitude	30 N
Center longitude	31 E
Time step	60 seconds
Output frequency	3 hours
Forecast length	72hours

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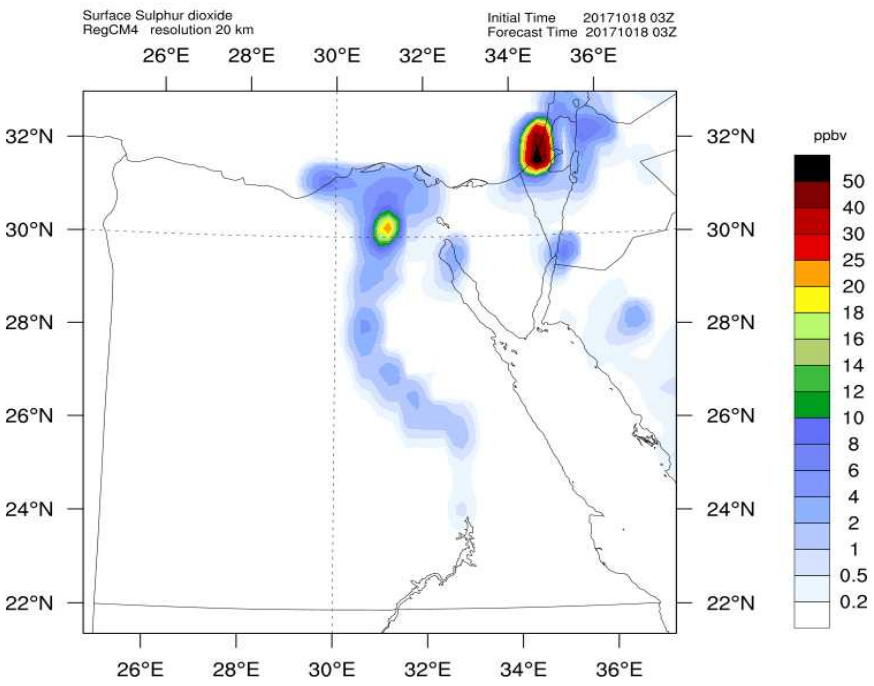
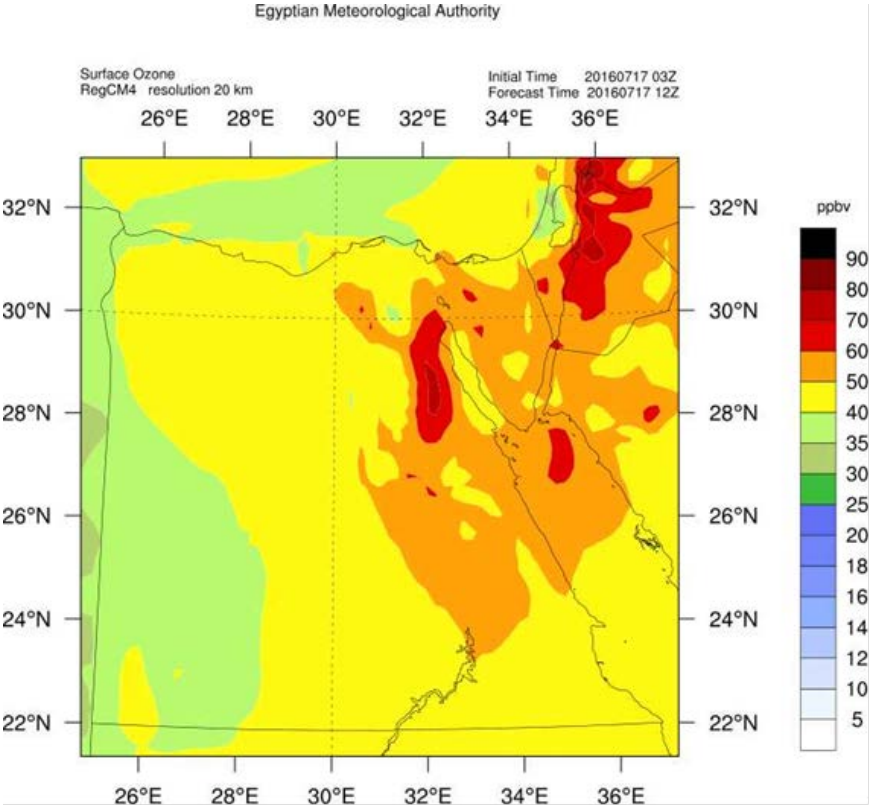
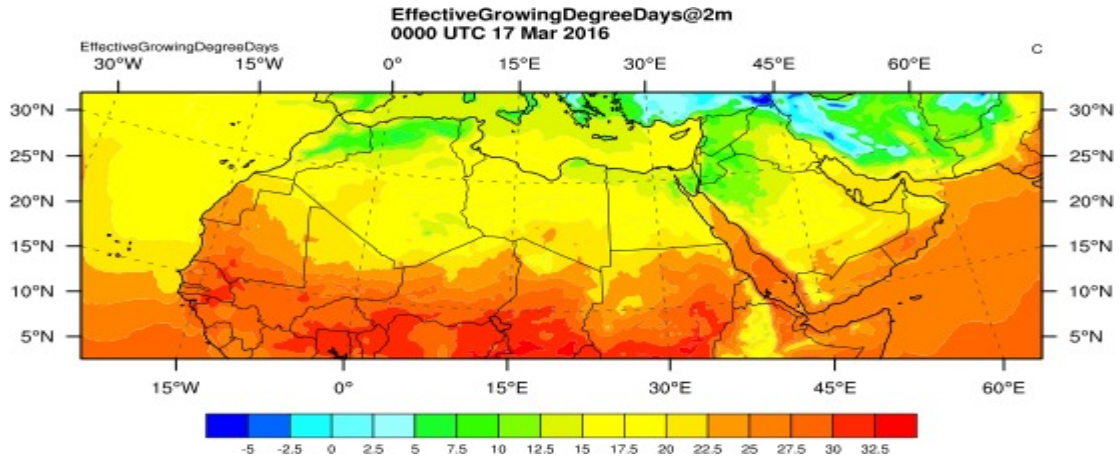


Egyptian Meteorological Authority



RegCM4-Agro

Parameter	Value
Vertical coordinate	Sigma
Zonal grid points	280
Meridional grid points	80
Zonal grid distance	40 km
Number of Vertical layers	18
Canter latitude	20 N
Center longitude	25 E
Time step	120 seconds
Output frequency	3 hours
Forecast length	96hours



4.5.3 Specific products operationally available

ETA with Dust module predicts the dust load (gram per meter square) over the domain.
WAM model predicts significant wave height, wave period, and directions of wind wave and swell, also provide us with wave spectrum over some specified locations.
MOZART predicts the concentration of gases (O3, CO, SO2, NOx) and aerosols (sulphate, black carbon, secondary organic aerosols) over the globe.
RegCM4 predicts the dust load, dust optical depth, the concentrations of dust, and gases (O3, CO, SO2, NOx) over Egypt. Arabic countries, and North Africa.
HYSPLIT4 predicts the trajectories for the Egyptian stations
RegCM4-Agro predicts agrometeorological elements such as potential evapotranspiration, effective growing degree day and diurnal temperature range.

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

We don't provide ERF as an operational product.

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

4.7.1 In operation

We use a statistical model using Climate Prediction Tools (CPT) to predict the precipitation and temperature over the North Africa and Nile basin. We produce a probabilistic map for the precipitation and temperature using the WMOLC GPCs products.
Our long range forecast is periodically publish on website (www.nwp.gov.eg/index.php/rcc)

Research performed in this field
Using the regional climate model (ICTP-RegCM4) to downscale over our region by using the initial field from the climate forecast system model version 2 (CFSv2).
Implementing different auto-conversion schemes in RegCM4 to study the aerosols indirect effects on the precipitation over West Africa.
Studying the impact of prescribed against leaf area index : impact on regional climate of Africa using RegCM4 model.

4.7.2 Operationally available EPS LRF products

We use the EPS LRF from the WMOLC GPCs.

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

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

6.2.1 Planned Research Activities in NWP

- Developing Multi-model ensemble Prediction system to be used in our system.
- Reinstalls Cosmo model with high resolution.
- Development of the Dust and air quality forecast using RegCM4 and MOZART
- Studying the impact of dust storms on the incident solar radiation using RegCM4
- Using the dispersion models of FLEXPART and HYSPLIT to forecast the dispersions of chemical and radioactive air pollutants resulting from the fires, industry, and nuclear accidents.
- Studying the impact of high resolution on simulation of mean, maximum and minimum temperature using RegCM4-CLM45 model for agrometeorological applications against available observations.

6.2.4 Planned Research Activities in Specialized Numerical Predictions

Now we start a climate change study using the RegCm 4.6.1 with the following parameters

Parameter	Value
Vertical coordinate	Sigma
Zonal grid points	232

Meridional grid points	118
Zonal grid distance	50 km
Number of Vertical layers	18
Canter latitude	19.5 N
Center longitude	24.5 E
Time step	120 seconds
Output frequency	3 hours
Forecast length	96hours

We start WRF Model (ARW CORE) as a research model with the following configurations.

Microphysics : Eta microphysics, CESM-NCSU prescribed RCP4.5 climatological aerosol data
radiation scheme : GFDL scheme, RRTMK.
Land surface scheme : Unified NCEP/NCAR/AFWA scheme
Boundary Layer scheme: Mellor-Yamada-Janjic scheme
Cumulus Parameterization: Betts-Miller-Janjic scheme
Mother Domain: (45 N to 7 S, 76 E to 27 W, Resolution = 0.1 deg.)
Nested Domain: (33 N to 20N, 23.22 E to 39. E, Resolution=0.05 deg.)

This is a suggested Shemes, maybe modified according to routins needs