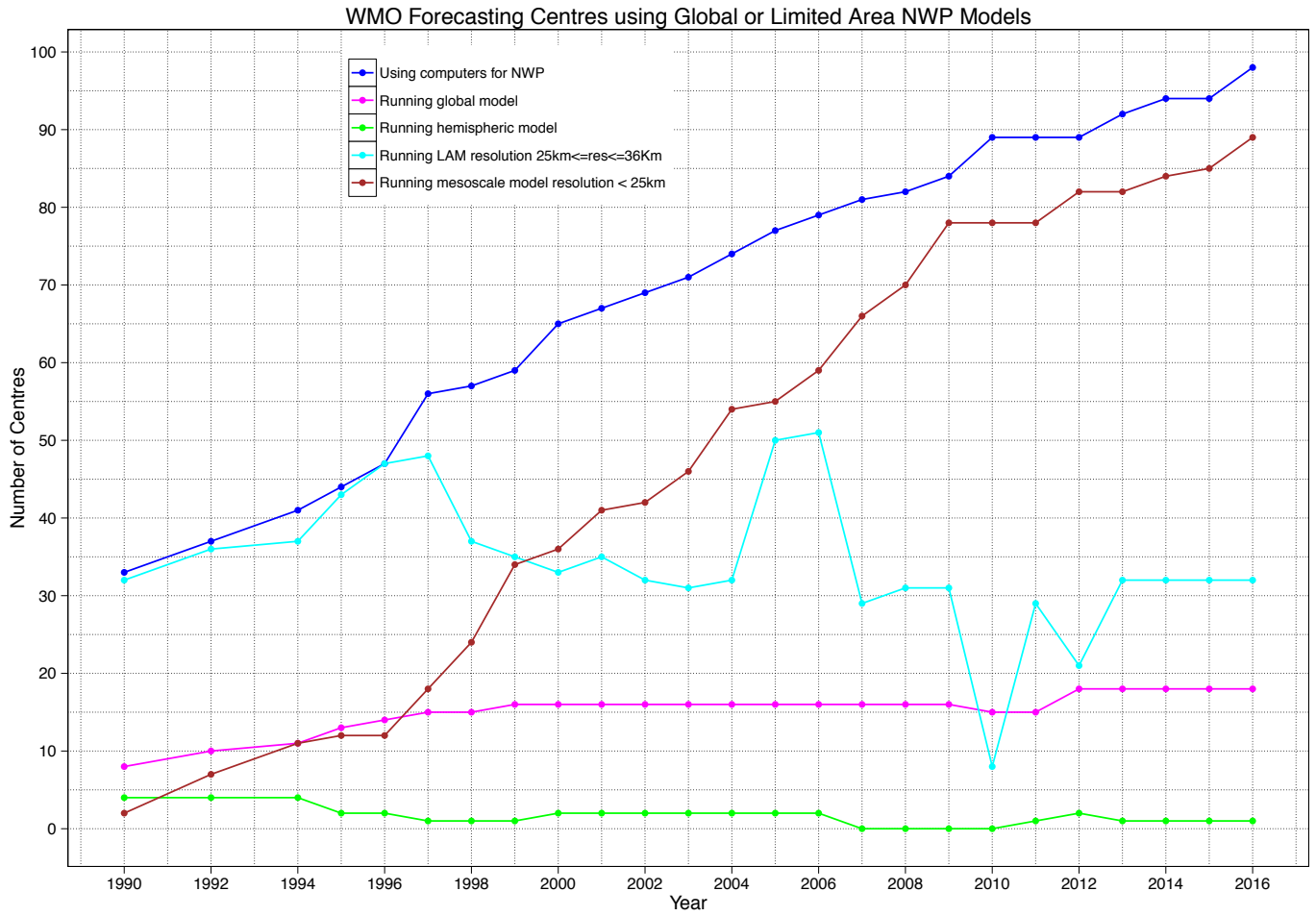
STATUS OF WMO FORECASTING CENTRES RELATIVE TO NUMERICAL MODELS for 2016

The status of WMO Forecasting Centres relative to Numerical Models is summarized based on the information available at the Secretariat.

The number of Centres running numerical weather prediction models has increased to 98 Centres (including 67 NMCs over 191). Centres are also increasing the resolution of their models, for global or limited area domains. Many Centres are running nested systems of models with increasing resolution.



GENERAL SUMMARY

GM = Global Model
LAM = Limited Area Model
NMC= National Meteorological Centre
RMC= Regional Meteorological Centre (also called Geographical RSMC = Geographical Regional Specialized Meteorological Centre)
RTCC= Regional Tropical Cyclone Centre (also called RSMC for Tropical Cyclone)
RCATM= Regional Centre for Atmospheric Transport Model (also called RSMC for Transport Model)
WMC= World Meteorological Centre
GMC= Global Model Centre (one is also called RSMC for Medium-Range Forecast)
GPC= Global Producing Centre for Long-range Forecasts (LRF)
EPS = Ensemble Prediction System

Ten RMCs, two NMCs, two special Centre and twelve GPCs run their own Global Model for Medium-range forecasts. Twelve Centres run GM EPS. 98 countries (out of 189) are reporting running Limited Area Models using boundary conditions obtained either from their own GM or from GM of other Centres like Exeter (used by 5 centres), Moscow (GSM) (used by 1 Centre), Offenbach (GME) (used by 23 Centres), Tokyo (GSM) (used by 5 Centres), Toulouse (ARPEGE) (used by 16 Centres), Washington (GFS) (used by 45 Centres), ECMWF (used by 27 Centres), Beijing used by 1 Centre, GEM Canada used by 1 Centre, GASP Australia used by 1 Centre and Seoul GDAB used by 1 Centre. Fifty three countries have reported running non-hydrostatic model. Twenty two Centres reported making use of (through consortium) or running LAM EPS (22 Centres). Thirty-five centres have reported running wave models. Thirteen centres have reported running storm surge models. Twenty seven centres have reported running transport model (air quality; sand and dust storm). One centre has reported running an oil spill model. Sixteen Centres run GM for LRF (twelve coupled with ocean model).

REGIONAL SUMMARY

Region I:

Twelve countries (out of 53) are now reporting running LAM using boundary conditions obtained from GM either from Exeter (UM) (used by 1 Centre), Offenbach (GME) (used by 5 Centres), Toulouse (ARPEGE) (used by 4 Centres) or Washington (GFS) (used by 6 Centres) . Five countries have reported running non-hydrostatic model. Three countries has reported running a wave model. Two countries have reported running atmospheric transport and dust-sand model.

Region II:

Three RMCs and two NMC run their own Global Model. Three Centres run GM EPS. Twenty five countries (out of 35) are reporting running Limited Area Models using boundary conditions obtained either from their own GM or from GM of other Centres like Offenbach (GME) (used by 5 Centres), Tokyo (GSM) (used by 4 centres), Washington (GFS) (used by 13 Centres), Exeter (used by 3 Centres) and ECMWF (used by 2 Centres). Thirteen countries have reported running non-hydrostatic model. Five countries have reported running a LAM EPS. Six countries have reported running a wave model. Six countries have reported running storm surge models. Four countries have reported running atmospheric transport and dust-sand model. Five Centres run GM for LRF (three with coupled ocean model).

Region III:

One Centre CPTEC (Brazil) runs Global Models; it also runs GM EPS. Eleven countries (out of 12) are now reporting running LAM using boundary conditions obtained from GM either from Offenbach (GME) (used by 2 Centres) or Washington (GFS) (used by 9 Centres). Seven countries have reported running non-hydrostatic model. Two countries have reported running a wave model. One NMC and CPTEC (Brazil) run GM for LRF.

Region IV:

Two RMCs run Global Model and GM EPS. Six countries (out of 25) are reporting running Limited Area Models using boundary conditions obtained either from their own GM or from Washington GM (GFS) (used by 4 Centres) or GEM Canada (used by 1 Centre). Four countries have reported running non-hydrostatic model. Two countries have reported running wave and storm surge models. Three Centres run GM for LRF (two with coupled ocean model). Two countries have reported running air quality and environmental emergency response models.

Region V:

One RMC runs a Global Model and runs GM EPS. Five countries (out of 18) are reporting running Limited Area Models using boundary conditions obtained either from their own GM or from GM of other Centres like Offenbach (GME) (used by 2 Centres) or Washington (GFS) (used by 4 Centres), Tokyo (GMS) (used by 1 Centre), Exeter (used by 1 Ccntre) or ECMWF (used by 2 Ccntres). Three countries have reported running non-hydrostatic models. Three countries have reported running wave models. Three countries have reported running atmospheric transport model. One Centre run GM for LRF coupled with ocean model.

Region VI:

Three RMCs and four GMCs run their own Global Model. Three RMCs and four GMC run GM EPS. Thirty nine countries (out of 50) are reporting running Limited Area Models using boundary conditions obtained either from their own GM or from GM of other Centres like ECMWF (IFS) (used by 23 Centres), Moscow (GSM) (used by 1 Centre), Offenbach (GME) (used by 9 Centres), Toulouse (ARPEGE) (used by 12 Centres) or Washington (GFS) (used by 9 Centres). Twenty one countries have reported running non-hydrostatic model. Eleven countries reported making use of (in consortium) or running LAM EPS . Fourteen centres reported running atmospheric transport models. Nineteen Centres reported running a wave model. Four centres reported running storm surge models. Five centres reported running ocean circulation models. One centre reported running an oil spill model. Five Centres run GM for LRF coupled with ocean models.

Note: It's worth to note that 28 countries are not reporting beyond 2008.

ANNEX: DETAILED STATUS OF WMO FORECASTING CENTRES RELATIVE TO NUMERICAL MODELS

(date of information as indicated) (last update 11/2015)

GM = Global Model
LAM = Limited Area Model
EPS = Ensemble Prediction System
Perturbation technique for ensemble prediction systems: SV = Singular Vectors, BGM = Breeding of Growing Modes, LAF = Lagged Average Forecasts, StoP = Stochastic Physics, OP = Observation Perturbations, ETKF = Ensemble Transform Kalman Filter, EDA= Ensemble of Data Assimilations
NMC= National Meteorological Centre
RMC= Regional Meteorological Centre (also called Geographical RSMC = Geographical Regional Specialized Meteorological Centre)
RTCC= Regional Tropical Cyclone Centre (also called RSMC for Tropical Cyclone)
RCATM= Regional Centre for Atmospheric Transport Model (also called RSMC for Transport Model)
WMC= World Meteorological Centre
GMC= Global Model Centre (one is also called RSMC for Medium-Range Forecast)
GPC= Global Producing Centre for Long-range Forecasts (LRF)
(*) = Last report at 2008 or before

REGION I

CENTRE	*STATUS*	*MODELS*	*Resol.*	*Levels*	*Range*	*Boundary*	*Domain*
ANTANA-NARIVO (2008)(*)	NMC	LAM (HRM)	14 km	50	72 h	GME (DWD)	7.5-32.5S / 35-60E
DAR ES SALAM (2012)	NMC	Access to GM and LAM (SWFDP)					
		LAM (WRF)	5-15 km		48-72 h	GFS (NCEP)	
		LAM (WRF-TC) – TC track (during TC season)	10 km		48-72 h	GFS (NCEP)	
		LAM (COSMO)	7 km		48-72 h	GME (DWD)	
GABARONE (2010)	NMC	Access to GM and LAM (SWFDP)					
		LAM (WRF-EMS)	15 km	35	48 h	GFS (NCEP)	12-37.5S; 7.5-44E
		LAM (HRM)	12 km	61	72 h	GME (DWD)	144S-0N; 10W-56E
MAPUTO (2015)	NMC	NWP group was dissolved. Rely on the output from Global Production Centres and SWFDP project webpage.					
ACMAD (2007)(*)	Special Centre	access to GM					
HARARE (2007) (*)	Special Centre	Draught monitoring					
LA REUNION (2010)	Regional Tropical Cyclone Centre (RTCC)	full access to GM					
		full access to LAM (ALADIN)	8 km	70	54 h	ARPEGE	Indian Ocean
ALGIERS (2013)	Regional Met Centre (RMC)	LAM (AROME	3 km	49	48 h	ALADIN/Algérie	31 27 N – 37 40 N 02 50 W - 08 40 E

		LAM (ALADIN-Algérie)	12 km	46	48 h	ARPEGE/IFS	15–48 N; 20W-20E
		Wave Model (WAM)	12 km		48 h		15–48 N; 20W-20E
		Dust transport					
		LAM (WRF-Algérie- non-hydros.)	16 km	40	48 h	GFS (NCEP)	
CAIRO (2016)	RMC	• LAM (ETA) hydrostatic	0.24 deg	45	120 h	GFS (NCEP)	
		• LAM (ETA) non-hydrostatic	0.08 deg	45	96 h	Nested on 0.24 deg	
		• Dust model coupled with WS_ETA hydrostatic	0.5 deg		96 h		1S to 62N , -12W to 77E
		• WRF	0.15 deg 0.05 deg			Nested on 0.15 deg	19.12 N to 42.8 N, 15.76 E to 45.16E 21.53 N to 32.44N, 23.22 E to 41. E
		• MOZART (Ozone and chemical tracers)	2.8 deg	28	96 h		Global
		• EMA-RegCM4 (Regional Climate Model) Dust model	45 km	18	72 h		Egypt and Arabic countries
		• EMA-RegCM4 (Regional Climate Model) Air Quality model	20 km	18	72 h		
		• RegCM4-Agro	40 km	18	96 h		
		COSMO	13.75 km			GFS (NCEP)	20N-23N and 20E to 40E
		Wave Model • Mediterranean	0.33 deg				30.2N to 45.N, -5.5W, 35.42E
		• Red sea	0.33 deg				12.5N to 29N, 32.3 E to 42.52E
		• Suez Gulf	0.39 deg				27N to 29.96N, 32E to 36 E
		CPT (Climate Prediction Tools) LRF precip and temperature			30 days to 2 years		North Africa and Nile basin
CASABLANCA (2006) (*)	RMC	LAM (ALADIN-NORAF)	31 km	37	72 h	ARPEGE (France)	*See domain*
		LAM (ALADIN/ALBACHIR) 3D-VAR	16 km	37	72 h	ALADIN-NORAF	Morocco
DAKAR (2007) (*)	RMC	LAM (ETA)	22 km	50	72 h	COLA, USA)	Senegal?
		LAM (HRM)	22 km	40	72 h	GME (DWD)	Senegal?
NAIROBI (2016)	RMC	Access to GM					
		LAM (COSMO) – non hydrostatic	7 km	30-60	72 h	GME (DWD)	12S-12N; 26-51E
		LAM (WRF) – non-hydrostatic.		47		GFS (NCEP)	
PRETORIA (2008) (*)	RMC and GPC	LAM (UM) non-hydrostatic	12 km	38	48 h	GM(UM) UKMO	Southern Africa
		GM (ECHAM) Ens. 12 members LAF	T42	L19	6 month		

TUNIS (2003) (*)	RMC	LAM (ALADIN)	12.5 km	L41	48 h	ARPEGE (France)	27.41-44.16N/2.07-18.36E
			15 km		54 h	NCEP	
TANZANIA (2014)	NMC	WRF – non hydrostatic	5 km		48 h	Nested on WRF 15Km	
			14 km		72 h	DWD	
		COSMO	7 km		48 h	NCEP	
		WRF bogus (TC track)	10 km		72 h		
		WWIII (Wave model)	15 km		72 h	NCEP	SW Indian Ocean and Lake Victoria
LIBYA (2016)	NMC	Synergie System from Meteo-France used for forecasting. The data is received in hashing format and divided into many parts, then assembled in special servers to be ready for viewing in Synergie System. Models used: • ALA.NMC/0.1 res=11.1Km, 14 levels up to 48 h • ARP.NMC/1.5 res = 166.5 km, number of levels = 16 levels, up to 96 h • ARP-AFRO/1.5 res = 166.5Km, number of levels = 16 levels, up to 96 h • ECMWF 2.5 res = 3,052.5Km, number of levels = 5 levels, up to 168 h Waves Models: • ALADIN/0.05 (res = 5.55Km, up to 48 h • ALADIN/0.1 (res= 11.1Km, up to 48 h • ARPEAG/0.25 (res= 27.75Km, up to 48 h • ARPEAG/1.0 (res= 111Km, up to 72 h					
KHARTOUM (2016)	NMC	WRF-EMS	7 km	26	120 h	GFS	Sudan

REGION II

CENTRE	*STATUS*	*MODELS*	*RESOL.*	*Levels*	*RANGE*	*Boundary*	*Domain*
ABU DHABI (2008) (*)	NMC	LAM (WRF) 3D-VAR	40 km	38	120 h	GFS (NCEP)	Arabic peninsula and Gulf
		LAM (NCEP-ETA-non-hydrostatic) 3D-VAR	13.3 km	38	120 h		Gulf
			4.4 km	38	120 h		Emirates
		LAM (HRM)				GME (DWD)	
ALMATY (2015)	NMC	Access to NCEP, ECMWF and Moscow products					
		WRF non hydrostatic	13 and 18 km 4 km		36 to 168 h	GFS (NCEP)	Central Asia
ASTANA (2012)	NMC	WRF			36 h	GFS	
BANGKOK (2015)	NMC	GM (Unified UKMO)	100 km	19	168 h		Global
		LAM (South East Asia) hydrostatic	48 km	19	72 h	UM	South East Asia
		LAM (Thailand Model) non-hydrostatic	17 km	31	72 h	nested	Thailand
COLOMBO (2010)	NMC	Access to GM (JMA, NCEP, China Meteorological Administration, Indian Meteorological Department, NCMRWF etc.)					
DOHA (2012)	NMC	Access to ECMWF (0.5, 2.5), UKMO (1.25), GME (1.5) and ARPEG (0.5, 1.5) products,GFS (0.5 , 1.0) HRM hydrostatic	0.0625°	60	78 h	GME	
		WRF-ARW / NCAR non hydrostatic				GFS	
HANOI (2010)	NMC	LAM (ETA) 3 DVAR ?	22 km	?	48 h	GFS (NCEP)	?
		LAM (HRM) 3 DVAR?	14 km	31	48 h	GME (DWD)	?
		LAM non-hydrostatic?	2-5 km?				
		LAM Ens. 15 members multi-model			60 h		Global?
		LAM Ens. 21 members HRM			120 h	21 members of NCEP EPS	?
HONG KONG (2016)	NMC	Access to GM ECMWF, JMA, NCEP, CMA, KMA and UKMO	0.125°, 0.25° , 1° and 2.5°		7 days		
		Atmospheric Integrated Rapid-cycle (AIR) LAM - non-hydrostatic 3 D-VAR Meso-NHM	10 km	50	72 h	ECMWF since Apr 2013 & JMA	0.91°N, 84.42°E-37.48°N, 168.13°E
		3D-VAR RAPIDS-NHM	2 km	60	15 h	Meso-NHM	19.5-25.0N 111.2-117.1E
		AVM-PRD (Aviation Model – WRF)	600 m	42	9 h	Rapids-NHM	20.8-23.8°N; 112.2-115.6°E
		AVM-HKA	200 m	42	9 h	AVM-PRD	22.0 – 22.8 °N, 113.7 – 114.5 °E
		MEPS (LAMEPS) 20 members	10 Km		72 h	NCEP GEFS	

		Wave Model (WAVEWATCH III)	1.25° 0.25°		72-120 h 30 h		5-35°N/105-135°E 21.25-22.5; 113.75-115E
		SLOSH (Storm Surge Model) JRODOS (Java based RODOS-(Real-time Online DecisiOn Support) Nuclear contamination tracker FLEXPART (FLEXible PARTicle dispersion model) installed in 2016 Global-regional spectral climate model adapted from Experimental Climate Prediction Center, USA	1-7 km 1-8 km		30 h	ECMWF, NCEP GFS	
KARACHI (2016)	NMC	• Access to Global models: ICON (DWD), GFS and CMA • LAM COSMO is temporarily suspended					
MACAO (2006) (*)	NMC	LAM	54/18 km	22	60 h		?
MUSCAT (2015)	NMC	Access to Global Models" ECMWF, UKMO, DWD					
		LAM ORM14 LAM ORM07 COSMO	14 km 7 km	40 40	120 h 120 h	GME GME	30.0 E, 7.0 N /78.0E, 35.25 N
		LAM (ORM_07 Cosmo) non-Hydrostatic LAM (ORM_2.8 Cosmo) non-Hydrostatic HWRF for Tropical Cyclones	7 km 2.8 km 27, 9 and 3 km	40 40	120 h 150 h 120 h	GME GME	30.0 E, 7.0 N /78.0E, 35.25 N 16.5N-26.5N, 52E-60E
		WAM Wave Model WAM COMCOT (Cornell Multi-grid Coupled Tsunami Model) Strom Surge model	14 km 3.5 km		78 h	ORM 14	Arabian Sea, gulf of Oman and Arabian gulf Nested with the previous Oman Sea and India Ocean region
KUALA LUMPUR (2011)	NMC	MM5v3 non hydrostatic	36,km 12 km 4 km 4 km	23	72 h	NCEP GFS and JMA GSM	85°E – 135°E ,20°S – 30°N 98°E – 121.5°E , 1.8°S – 12°N 99°E – 105.5°E , 1°N – 8°N 109°E – 120.5°E, 0.5°N – 8.5°N

		WRFV3.1.1 hydrostatic	36,km 12 km 4 km 4 km	30	72 h	NCEP GFS and JMA GSM	85°E – 135°E ,20°S – 30°N 98°E – 121.5°E , 1.8°S – 12°N 99°E – 105.5°E , 1°N – 8°N 109°E – 120.5°E, 0.5°N – 8.5°N
		HRMv2.8 hydrostatic	12 km	60	120 h	DWD GME	98°E – 121.5°E, 1.8°S – 12°N

PYONGYANG (2006) (*)	NMC	Hemispheric Model (HM)?	T42	14	96 h		
		LAM –Regional Spectral Model	100 km	14	48 h		
		LAM	50 km	18	24 h		
SEOUL (2016)	NMC and GPC	GM (GDAPS) hybrid Ensemble 4D-VAR GloSea5 (Seasonal)	N768 N216	L70 L85	288 h 7 months		Global Global
		LAM (RDAPS) 3D-VAR UM non hydrostatic	12 km	70	87 h	GDAPS	East Asia
		LAM (LDAPS) 3DVAR	1.5	70	36 h	GDAPS	Expanded from Korean Peninsula to Far East Asia
		LAM (KLAPS)	5 km	40	12 h	GDAPS	Korean Peninsula
		EPSG EPS 49 members LENS (LAMEPS) 13 members	N400 32 km 3 km	70 70	288 h 69 h	 EPSG	Global Korea
		Wave Model: (WaveWatch-III) GoWW3	30 km		288 h	GDAPS	Global
		ReWW3	8 km		87 h	RDAPS	20-50N/115-150E
		CoWW3	1 km		72 h	RDAPS	6 local domains
		POM Storm surge: • RTSM (Regional) • CTSM (Coastal) UM-ADAM2 Asian dust prediction system DBAR Tropical cyclones	 1/12 deg 1/120 deg 25 km 35 km	 47	 87 h 87 h 72 h 72 h	RDAPS	115 °E-150 °E, 20 °N-52 °N E. Asia Regional
TEHRAN (2006) (*)	NMC	LAM (MM5)	30 km	23	102 h	GFS (NCEP)?	?
ULAANBATAR (2006) (*)	NMC	LAM (MM5)	80 km	35	48 h	GFS (NCEP)?	?
NCMRWF - INDIA (2010)	Special Centre	GM - NCMRWF (GFS) 3 DVAR	T382	64	10 days		
		UM (UKMO) N512L70 (non-hydrostatic)	N512	70	10 days	UKMO	
		LAM (WRF) nested 3DVAR	27 km	38	72 h		
		Wave Watch Model	1°		4 days	NCMRWF	77.50S to 77.50N
		GM LRF 2 tiers for monsoon	?	?	4 months		
BEIJING (2014)	RMC, RCATM, GMC and GPC	GM	T639	60	10 days		Global
		GM (GRAPES) non-hydrostatic semi-lagrangian	0.5°	36	10 days		
		GM-(TTFS_SSI). Typhoon Track	T213	31	240 h		
		LAM-(GRAPES-MESO) 3D-VAR non-hydrostatic	10 km	50	72 h	GM	70 - 145.15E 15 - 64.35N
		LAM (NMC-MM5) nested, D.A. = nudging method, non-hydrostatic?	27/9/3 km	36	48 h		China, North-China, Beijing area
		GM EPS Ens. 15 members BGM, 3 DVAR T639-GEPS 15 members BGM GEPS with GRAPES_GFS SV 31 members	T213 60 km T639 0.5°	31 60 36	10 days 15 days 10 days		

		LAM Ens. (MEPS-WRFV2.2) 3 DVAR 15 members, BGM	15 km	35	60 h	GM EPS	North China (95°E-130°E / 25°N-53°N)
		LAM Ens. (REPS-GRAPES) 21 members, BGM	15 km	31	48 h	GM EPS	North China
		LAM TC track ensemble system, 15 members, BGM, perturbed vortex	T213	31	72 h	GM	
		GM AGCM/BCC" 2 tiers Ens. 40 members 20 SV, 20 LAF	T63	16	1 month		
		GM CGCM/BCC 1 tier Ens. 48 members LAF coupled OGCM (perturb ocean) Nested: East Asian Regional Climate Model with higher resolution (RegCM/BCC)	T63 GT63	16 30	Season		
		Environmental emergency response system				GMT213	
		Regional Environmental emergency response system	15/5 km			WRF model	
		Global WAVEWATCH III model	1°		10 days	GMT213L31	
		Western Pacific Wave Model	11 km		72 h	WRF	
		Bohai and Yellow Sea	5 km		48 h	"	
		Sand storm (from MM5)			72 h		China
		CUACE Sand/Dust storm forecasting system CUACE Haze-Fog			72 h 84		Asia China
JEDDAH (2008) (*)	RMC	LAM (WRF) non-hydrostatic	30 km	26	72 h	GFS (NCEP)	Saudi Arabia
			9 km	26	48 h		Province
		LAM (ETA)	60 km	26	72 h	GFS (NCEP)	Saudi Arabia
KHABAROVSK (2010)	RMC	LAM non-hydrostatic	50 km	22	72 h	GM(UKMO)	Four regions
		LAM (WRF-ARV) non-hydrostatic			72 h	GFS (NCEP)	Far East
NOVOSIBIRSK (2010)	RMC	GM (SLAV-2008)	0.72x0.9	28	120 h		
		GM	T40	15	72 h		
		LAM (Sib- SRHMS)	50 km	30	48 h	SLAV	Siberia
		LAM (WRF-ARV)			72 h	GFS (NCEP)	Siberia
		LAM (COSMO-RuSib)	14 km	40	78 h	GME (DWD)	West and East Siberia
TASHKENT (2015)	RMC	Access to ECMWF, GFS and CMA products LAM WRF	 2.5 °		 48 h	 GFS (NCEP)	
NEW DELHI (2011)	RMC and RTCC	GM GFS (based on NCEP) T574L64 3DVAR (exp) GM GFS (based on NCEP) T382L64 3DVAR	30 km 45 km	64 64	168 h 168 h		
		MME (IMD GFS T 382, ECMWF T799, JMA T899, UKMO NCEP GFS T-382) used also for cyclone track	0.25°		5 days		
		LAM (WRF-ARW) nested 3-DVAR	27 km 9 km 3 km	38	72 h 36 h	GFS	20S-45N, 40-115E India 11 regions within Indian
		Storm surge					Indian coast
		For TC: Quasi-Lagrangian model (QLM) 3 D-VAR	40 km	16	72 h	GFS	Arabian Sea and Bay of Bengal
		(in Pune) GM LRF T62L28, Ens. 10 members LAF, persistent NCEP SST	T62	28	4 months		

TOKYO (2016)	RMC, RCATM, RTCC, GMC and GPC	GM (GSM1603) 4D-VAR	TL959 0.1875°	100	264 h		Global
		• LAM (MSM-JMA-NHM) 4 D-VAR, non-hydrostatic • LAM (LFM) 3DVAR from LA, non-hydrostatic	5 km 2 km	48 58	39 h 9 h	GSM (JMA) MSM	Japan Japan and its surrounding areas
		GMEPS twice a day 27 members (54 members/day) SV, stochastic physics Monthly GMEPS resolution updated 2014	TL479 TL319	60 60	264 h 1 month		Global Global
		GM ERF 50 members 25 BGM and 25 members LAF on 2 days 2 tiers with fixed COBESST anomalies	T159	60	816 h		North Hemisphere (20-90N) Tropics (20S-20N)
		GM LRF 51 members, BGM, LAF, upgraded in June 2015 coupled with Ocean model MOVE/MRI.COM-G2	TL159 0.3°	60 52	120/210 days, 15 months		Global
		Typhoon (EPS) Ens. 25 members SV	TL479	60	132 h	GSM	20N-60N, 100E-180E
		Kosa (sand-dust storm) prediction model	T106	20	96 h	GSM	Global
		MOVE/MRI.COM-G2 (Global Ocean Data Assimilation System) upgraded June 2015	1°x1°	50			Global oceans 75˚N–75˚S
		SSTs daily sea surface temperature Sea-ice forecasting model	¼ ° x ¼ ° 12.5 km		 168 h		Global oceans Seas around Hokkaido
		Wave Models: • Global (GWM) • Coastal Japan (CWM) • Shallow water (SWM) • Wave ensemble system (WENS)	 0.5° 0.05° 1’ 1.25°		 264 h 84 h 39 h 264 h	 GSM GSM+GWM MSM winds WEPS 27 members	 Global 75˚N–75˚S 20˚–50˚N,120˚–150˚E Local bays Global 75˚N–75˚S
		Storm surge Model Storm surge Model (Asia)	45’’ to 12’, 45’’ to 8’ (lon/lat) 2’		39 h 72h	MSM GSM	20˚–50˚N,117.4˚–150˚E 0-46N, 95E-160E
		Marine Pollution Transport Model (3D)	2-30 km				
		Chemical transport model (3D)	T106	64	48 h	GSM	
		GATM Global Atmospheric Transport Model for volcanic ash RATM Regional Atmospheric Transport Model for volcanic ash			18 h 18 h	GSM MSM	

MYANMAR (2015)	**NMC**	Access to some fields of ECMWF, JMA and UKMO WRFV3.7.1	 30 km 9 km		 72 h	 NCEP, JMA, ECMWF	 80°E – 102°E, 6°N – 30°N

REGION III

CENTRE	*STATUS*	*MODELS*	*RESOL.*	*LEVELS*	*RANGE*	*Boundary*	*Domain*
BOGOTA (2007) (*)	NMC	LAM (WRF)	25 km	27	84 h	GFS (NCEP)	?
			7 km	27	84 h		?
LA PAZ (2010)	NMC	Use GFS (NCEP), no LAM					
LIMA (2007) (*)	NMC	LAM (ETA)	32 km	36	120 h	GFS (NCEP)	?
		LAM (ETA-SENAMHI))	22 km	38	120 h	GFS (NCEP)	?
		CCM3 En. 12 members, SST (forecast by NCEP and perturbed)	T42	32	9 months	SST, USA	Global
MONTEVIDEO (2008) (*)	NMC	LAM (WRF) (non-hydrostatic)	36 km	36	84 h	GFS (NCEP)	Part of South America
			7 km	36	84 h		Around Uruguay
QUITO (2008) (*)	NMC	LAMs (MM5 and WRF) (non-hydrostatic) 3 Domains	36/12/4 km	26	78 h	GFS (NCEP)	Ecuador and Galapagos / Continental Ecuador/ Special local areas
		LAMs (MM5 and WRF) 2 Domains	36/12 km	26	90 days	IRI Model	Ecuador and Galapagos/ Continental Ecuador
SANTIAGO (2016)	NMC	• WRF central (Santiago) • WRF north, south and southern (Antofagasta, Puerto Montt and Punta Arenas) • WRF Antarctica and Easter island • MM5 decommissioned March 2016	6 km 4 km 1 km	49 49 49	120 h 120 h 120 h	GFS (NCEP) GFS GFS	Areas around mentioned locations
		LAM WRF ensemble 20 members + Control PM10/PM2.5 Air quality Ash transport and deposition system UV forecast model, based on TUV	20 km	45	168 h 24 h 72 h	GFS WRF WRF	Chile Santiago Chile 75 locations in Chile
INPE/CPTEC -SAO PAULO (2008) (*)	GPC	GM AGCM CPTEC/COLA	T299	42	7 days	GFS (NCEP)	
		GM AGCM Ens, 15 members (Random plus Orthogonal Empirical Functions =Optimum Perturbation)	T126	28	15 days	GFS (NCEP)	
		LAM (ETA)	40-20-10 km	38	120 h	GFS (NCEP)	South America
		Non-hydrostatic	5 km	50	72 h		Serra do Mar
		SREPS - ETA Ens. 5 members chosen – physic perturbation	40 km	38	96 h		
		GM Coupled, Ens. 30 members (Random OP)) Fixed and predicted SST	T62	28	Six months	GFS (NCEP)	
BRASILIA (2016)	RMC	COSMO non hydrostatic	7 km	60	174 h	GME(DWD)	South America: 60S-15N/95W-20W
		COSMO non hydrostatic					
			2.8 km	60	27 h	COSMO 7 km	Local areas within Brazil Northeast, Southeast and South

BRAZIL - CHM RIO DE JANEIRO (2016)	CHM	HRM	10 km	60	120 h	GME(DWD)	METAREA V
		HRM	15 km	60	120 h	GME(DWD)	Antarctic Peninsula, Drake Passage and extreme south of South America.
		COSMO non hydrostatic	10 km	60	78 h	GME(DWD)	Same domain of HRM
		HYCOM Sea temperature and salinity from SSH and SST data				HYCOM+NCODA 1/12 deg	METAREA V
		WAVEWATCH III™ basin model	100 km		168 h		Indian, Atlantic and Pacific Oceans.
		WAVEWATCH III™ regional model	30 km		120 h		METAREA V and South/SouthEast Brazilian Coast
		WAVEWATCH III™ regional model	60 km		168 h		Antarctica
		WAM basin model	100 km		168 h		Atlantic Ocean
		WAM regional model	10 km and 60 km		78 h		METAREA V and Antarctica
BRAZIL – Brazilian Air Force (2016)		WRF non hydrostatic	36 and 12 km	28	72 h	GFS	(80 - 48W/21S - 12N) & (66 - 55W/09S - 02N)
			45 and 15 km	28		GFS	(56 - 20W/24S - 09N) & (39 - 30W/12S - 03N)
			36 and 12 km	28		GFS	(60 - 32W/35 - 10S) & (49,5 - 44W/26.5 - 20S)
			18 and 6 km	28		GFS	(55 - 34W/12.5S - 08N) & (47.5 - 41.5W/5.5S - 0.5N)
		MM5 non hydrostatic	Same as WRF	23	72 h	GFS	Same as WRF
ASUNCION (2016)	NMC	WRF	40 km		72 h	GFS	South America
			7 km		72 h	GFS	Paraguay

BUENOS AIRES (2016)	RMC	ARPE model (for analysis help only)	150 km	10	36 h		
		LAM (ETA SMN) ETA SMN, non-hydrostatic nested	25 km 10 km	38 38	168 h 48 h	GFS (NCEP) Nested ETA SMN	South America/ Around Argentina
		WRF-ARW model	24 km		72 h		South America
		BRAMS model	8 and 2 km	50	18 h	ETA	Local areas in Argentina
		Wave model (SMARA/WAM)	1°, 0.25°			GFS (NCEP)	South-Western Atlantic Around Argentina
		SMARA Storm surge model				SMARA/WAM	Rio de La Plata
		Wave model Austral -WWIII	0.5°			GFS (NCEP)	South Atlantic and Southern Oceans
		HYSPLIT model (volcanic ash)				ETA-SMN	
		FALL3D (dispersion of atmospheric particles)				GFS, WRF, ETA SMN	
		MBLM (meso-scale boundary layer)	High res = 0.025°	Low layer	72 h	ETA-SMN	
		HIRHYLTAD (dispersion) coupled with MBLM	2.5 km	Low layer	72 h		

REGION IV

CENTRE	*STATUS*	*MODELS*	*RESOL.*	*LEVELS*	*RANGE*	*Boundary*	*Domain*
SAN JOSE (2015)	NMC	WRF-8 WRF-Sarapiqui	30 km 19, 6 and 1.8 km		8 days	GFS (NCEP)	Central America and Caribbean Costa Rica
IRI (USA) (2007) (*)	Special Centre	Ens. multi-models, over 30 members, LAF			6 months		
MEXICO (2006) (*)	NMC	LAM (MM5) non-hydrostatic	45km	20?	72 h	GFS	Central America?
MONTREAL (2014)	RMC, RCATM and GPC	GDPS 4D-VAR	0.35° Long. - 0.225° Lat.	80	240 hours at 00 360 hours at 00 on Sundays 144 hours at 12		Global
		GM NAEFS Ens. 20 members (CMC and NCEP) (Random OP taken among, 256 ETKF analyses) REPS Regional EPS 20 members	50 km. 15 km	74 48	16 days 32 days Thurs at 00 72 h	 GEPS	Global North America and adjacent oceans
		GEM Regional-RDPS 3D- VAR	10 km	80	54 h	GEM	North America
		LAM (GEM - non-hydrostatic)	15 km 2.5 km 1 km	80 58 58	24 h 24 h 24 h		15 km: North America and adjacent seas, North Pole, Arctic 2.5 km: Southern British Columbia/ Southern Ontario-Quebec/ Baffin Island (Arctic) / Atlantic provinces 1 km: Vancouver (winter)
		CanSIPS (MME based on CanCM3 and Can CM4) 20 members	T63 / T95	40	1 month to 1 year		

		Wave Model (WAM)	0.5° (0.15 N. Atlantic, 0.05° for Great Lakes and Gulf St Lawrence)		120 h 48-54 h	GDPS RDPS	Eastern Pacific, Western Atlantic/ 4 Great Lakes Atlantic and Great Lakes
		Storm Surge Model (DalCoast) forced by winds RDPS	0.08°		48 h		North West Atlantic, Gulf of St Lawrence and the Labrador Shelf
		Regional coupled atmosphere-ocean-ice system	15 km 5 km		48 h		St Laurent
		Air Quality and transport Model GEM-MACH15	10 km	80 up to 65km	48 h	GEM Regional	North America
		Environmental Emergency Response Models CANERM 3D (transp pollutants in atm) MLDP0 3D (dispersion) MLCD 3D (disp.) up to 10km f. source MLDP1 (disp) up to 100-200km f. source			10 days	GEM (GM and Regional)	

MIAMI (2007) (*)	RMC and RTCC	full access to GM and LAM					
		HCN (hurricane)	0.16°	18	72 h		Tropical Atlantic
WASHINGTON (2013)	WMC, RMC, RCATM, GMC and GPC	GFS (3D-VAR)	T574	64	168 h		
			T190	64	168 to 384 h		
		Global Ens. 21 members (GEFS) BV-Ensemble Transform with Rescaling (ETR)	T254 T190	42 42	216 h 216 h to 30 days	GFS	
		GM NAEFS Ens. 20 members (NMSM, CMC and NCEP) (Random OP taken among, 96 ETKF analyses)	0.9 deg.	28	360 h	GFS	North America and Mexico
		NAM ((HiRes) 3D-VAR (Meso-ETA) non hydrostatic	6-12 km	60	84 h	GFS	Some regions in USA
		LAM ((HiResM) 3D-VAR (Meso-ETA) over some regions non hydrostatic	3-6 km	60	48 h	Nested	4km N.America, 6 km Alaska, 3 km Hawaii and Puerto Rico
		RAP Rapid Refresh Analysis and Forecast System	13 km	50		GFS	North America and adjacent oceans
		HRRR High-Resolution Rapid Refresh Analysis and Forecast System	3 km	50		Nested in RAP	CONUS
		GFDL Operational Hurricane Prediction System HWRF Hurricane Weather Research and Forecast	0.5 deg 3-9 km.	42 42	120 h	GFS GFS+Ocean	Pacific-Atlantic Tropics: Indian, Pacific and Atlantic
		HRESW High Resolution Window Ensemble	3-4.2 km	40	48 h	GFS	North America (including Canada, USA and Mexico)
		SREF Short Range Ensemble 21 members 2 NEMS-NMMB models and WRF-ARW model NARRE N. America Rapid Refresh Ensemble	16 km		87 h	GFS	USA, Alaska and Hawaii
		Ens. 40 members, (GFS) coupled, Modular Ocean Model ,MOM 3, LAF	T62	64	7 months		
		CFSv2 Climate Forecast System Version 2	1/3 ° T126	40 64	9 months and beyond		
		Wave Model WAVEWATCH III /Storm surge					Pacific-Atlantic/ Great lakes

REGION V

CENTRE	*STATUS*	*MODELS*	*RESOL.*	*LEVELS*	*RANGE*	*Boundary*	*Domain*
JAKARTA (2009)	NMC	Access to GM and LAM LAM-ARPEGE, non-hydrost TXLAPS, non-hydrostatic	 0.5° 0.375°	 15 16	 72 h 48 h		Indonesia Region (40S-15N; 90-170E)
		LAM (MM5) non-hydrostatic	50km, 30km , 5-10 km	23	72 h	GFS (NCEP)	?
		CCAM	27 km	18	96 h		
			9 km	18	96 h		
		Wave Model			168 h	GFS (NCEP)	
KUALA-LUMPUR (2011)	NMC	LAM (MM5) and LAM (WRF), both non-hydrostatic and nested, 3 D-VAR	36 km	23/30	72 h	GFS (NCEP), GSM (JMA)	20S-30N; 85-135E
			12 km	23/30			1.2S-12N; 98-121.5E
			4 km	23/30			1-8N; 99-105.5E
			4 km	23/30			0.5-8.5N; 109-120.5E
		LAM (HRM)	12 km	60	120 h	GME (DWD)	98-121.5E; 1.8S-12N
		LAM MMD-EPS Ens. 20 members,10 MM5, 10 WRF, BGM	12 km	23/30	120 h	GFS (NCEP), GSM (JMA)	1.2S-12N; 98-121.5E
		Wave Model	0.5°		72 h	MM5	Straight of Malacca and South China Sea
MANILA (2006) (*)	NMC	LAM (MM5)	20 km	36	72 h	GFS (NCEP)	?
		LAM(HRM)	?	?	?	GME(DWD)	?
SINGAPORE (2015)	NMC and *ASEAN Specialised Meteorological Centre (ASMC)*	Adquired ECMWF catalogue April 2014					
		WRF WRF (nested)	4.5 km 1.5 km		36 h 36 h	ECMWF	5.7S-8.1N, 94.6E-109.3E 0.9S-3.6N, 101.5E-106.1E
		WaveWatch 3 Global WaveWatch 3 nested Wave Watch 3 nested	0.5 ° 1/6 ° 1/20°		72 h 72 h 72 h		Global 15S-30N, 90E-145E 4S-6N, 99E-109E
		WAM	1/12 °		168 h		9S-24N, 99E-121E
		Southeast Asia Ocean Model (SEAOM) NWP/Nowcasting system based on UKMO UM	1/12 °		168 h	WAM	9S-24N, 99E-121E
DARWIN (2008) (*)	RMC	full access to GM and LAM					
		full access to LAM-(TCLAPS)	0.10°	51	72 h	GASP	*See domains*
NADI (2010)	RTCC	Access to GM Access to MM5?				ECWMF, UKMO, JMA, GFS	
WELLINGTON (2016)	RMC	MSNZ WRF MSNZ WRF MSNZ WRF MSNZ WRF	4 km 8 km 8 km 8 km		60 h 84 h 84 h 84 h	GFS GFS UKMO ECMWF	

		Volcanic ash dispersion models: • PUFF • HYSPLIT in Ensemble mode	1°			GFS ECMWF, GFS, 4 km WRF	NZ VAAC region

MELBOURNE (2009)	WMC, RMC, RCATM and GPC	GM (GASP) OI-1D-VAR	T239	60	240 h		*See domains*
		LAM (LAPS) 1D-VAR	0.375°	61	72 h	GASP	"
		LAM (TX-LAPS)	0.375°	61	72 h	LASP	"
		LAM (MALAPS)				LASP	"
		LAM (MESO-LAPS)	0.125°	29	36 h	LAPS	"
		LAM (MESO-LAPS) 5 domains in South)	0.05°	29	36 h	LAPS	"
		TC-LAPS	0.10°	51	72 h	GASP	"
		Ens. GM, GASP -EPS, 33 members, SV (GASP-EPS)	T119	19	10 days		
		Ens. 30 members, GM (POAMA) coupled with Ocean model ACOM2, LAF	T47 0.5°-1.5°	17 25	10 months		
		Atmospheric Transport Model - EER System					
		Microscale dispersion system: ADMS3 (Atmospheric Dispersion Model Version 3)				MESO_LAPS	
		Wave Models	1°		96 h	GASP (10m)	*See domain*
			0.5°		48 h	LAPS_PT375 (10m)	"
			0.125°		48 h	MESO_LAPS_PT125 (10m)	"

REGION VI

CENTRE	*STATUS*	*MODELS*	*RESOL.*	*LEVELS*	*RANGE*	*Boundary*	*Domain*
ANKARA (2009)	NMC	full access to GM (ECMWF)					
		LAM (MM5V3) non-hydrostatic	13.5 km	36	72 h	ECMWF	?
		LAM (MM5V3) non-hydrostatic	4.5 km	36	72 h	Nested	?
		LAM (ALADIN-ALARO)	4.5 km	60	48 h	ARPEGE (France)	?
		Wave Model METU-3	9 km 3 km 1 km		72 h	ECMWF	Mediterranean S. Marmara Sea Black Sea
ATHENS (2013)	NMC	full access to GM (ECMWF)					
		LAM (ETA-NMC) nudging, non hydros..	0.062°	32	72 h	ECMWF	East Atlantic and Europe
		LAM (LM COSMO-GR) non hydros.	0.0625	40	72 h	GME	Mediterranean and Black Sea
		LAM COSMO	0.025deg	60	48 h	COSMO-GR	*Greece*
		LAM (RAMS) nested, non hydros.	48 km, 12 km, 3 km	32	36 h	ECMWF	Europe, North Africa, Black Sea/ Balkan/ Central Greece
		Sea-wave model (WAM) coarse WAM 1st nest WAM 2nd nest SWAN	0.04x 0.04 0.02 x 0.02 0.01 x 0.01 0.01 x 0.01		36 h	RAMS Nested COSMO (hourly) Nested COSMO (hourly) Nested COSMO (hourly	Mediterranean Sea -6W - 42E 29N - 47 N Greek seas 19.4W - 30E 30.2 N - 41 N Saronicos Gulf 22.4W – 24.2E 30.2 N - 41 N Saronicos Gulf 22.4W – 24.2E 30.2 N - 41 N
BELGRADE (2015)	NMC	full access to GM (ECMWF) NMMB global NMMB regional non hydrostatic NMMB regional nested NMMB regional LAM- (ETA 95) 3D-VAR	 0.47°*0.33° 12 km 4 km 4 km 26 km	 64 64 64 64 32	 240 h 120 h 72 72 h 120 h	 GFS NMMB-global NMMB-regional ECMWF GME (Offenbach)	 Global 20W-35E, 32N-67N 40N-48N, 11.5E-26E 36N-50N, 3E-31E 40W-55E, 24N-70N
		LAM (WRF-NMM) non-hydrostatic	10 km 10 km 4 km	38 38 45	192 h 120 h 72 h	GFS DWD ECMWF	20W-35E , 32N-63N 20W-35E , 32N-63 40N-48N ,11.5E-26E

		DREAM dust model	10 km 0.025° x 0.025°	38	120 h 72 h	DWD NCEP/NMM regional model	20W-35E , 32N-63N Northern Africa, Europe and Middle East
BET DAGAN (2012)	NMC	Access to all ECMWF products LAM (HRM)	 0.125°	 38	 78 h	 GME (Offenbach)	
		Wave Model (WAM)			72 h	UKMO	?
BRATISLAVA (2016)	NMC	• Access to ECMWF products • LAM (ALADIN/SHMU) hydrostatic • CALLPUFF Air quality • RODOS (Real-time On-line Decision Support system) operated by the Nuclear Regulatory Authority • HYPOS (Hydrological Flood Forecasting System) • METRo (Model of the Environment and Temperature of Roads)	9 km	37	72 h	ARPEGE ALADIN/SHMU ALADIN, ECMWF ALADIN	33.99N-55.63N, 2.19E-39.06E
BRUSSELS (2008) (*)	NMC	full access to GM (ECMWF)					
		LAM (ALADIN Belgium - ALARO)	7 km	41?	60 h	ALADIN-France /ARPEGE	*See domain*
		LAM (ALADIN Belgium - ALARO)	4 km	41?	60 h	"	*See domain*
BUCHAREST (2015)	NMC	Access to all ECMWF products					
		ALARO-RO (Aladin hydrostatic)	6.5 km	60	78 h	ARPEGE	
		ALADIN-RO (Aladin hydrostatic)	10 km	41	78 h	ARPEGE	39.29-51.08N; 16.86-33.92E Black Sea
		COSMO-RO non hydrostatic	7 km	40	78 h	GME	
		COSMO-RO non hydrostatic	2.8 km	50	78 h	COSMO-RO 7 km	
		Wave Model (VAGROM) INPUFF (Integrated PUFF) dispersion model	0.25°/ 0.25° 7 km		48 h	ARPEGE COSMO 7 km	Black Sea/ coastal zone in Western part Black Sea.
BUDAPEST (2016)	NMC	Access to all ECMWF products LAM (ALADIN/HU) – 3DVAR hydrostatic AROME 3DVAR non hydrostatic WRF-ALPHA WRF-BETA	 8 km 2.5 km 2.5 km 1.2 km	 49 60 37 37	 48 h 48 h 36 h 3 h	 ECMWF ECMWF ECMWF, GFS WRF-ALPHA	 Continental Europe Carpathian basin 43°-52°N-15°-24°W
		LAMEPS Ens. 11 members	8 km	49	60 h	PEARP (Toulouse)	Continental Europe

		• FLEXTRA 4.0 trajectory model • FLEXPART 8.0 Lagrangian particle dispersion model • CHIMERE chemistry-transport model			24-48 h 24-48 h 24-48 h		Local areas Local areas Local areas
COPENHAGEN (2010)	NMC	full access to GM (ECMWF)					
		LAM (DMI-HIRLAM-T15 North Atlantic -Artic) 3D-VAR	0.15°	65	60 h	ECMWF	*See domain*
		LAM (DMI-HIRLAM-M09)	0.09°	65	54 h	T15	
		LAM (DMI-HIRLAM-S03 NW Europe) non-hydrostatic	0.03°	65	54 h	ECMWF	*See domain*
		LAM (DMI-HIRLAM-K05 Greenland) non-hydrostatic	0.05°	65	48 h	ECMWF	*See domain*
		LAM Ens. 25 members - HIRLAM 7.3 physics, Different initial states and stochastic physics, two different convection schemes and two different surface schemes	5 km	40	54 h	ECMWF	*Limited area*
		Emergency Response Models • DERMA (dispersion model) • DACFOS (chemistry transport) • RIMPUFF (dispersion) • Air quality models (chemistry aerosol model)					
DE BILT (2016)	NMC	full access to GM (ECMWF)					
		LAM HIRLAM 3-DVAR	11 km	60	24 to 60 h	ECMWF	Europe/ North-Atlantic
		HARMONIE-AROME	2.5 km	60 to 65	48 h		Netherlands/ North Sea
		NEDWAM wave model	32 km		48 h	HIRLAM	North Sea
		WAQUA/DCSMv5 storm surge	8 km		240 h	ECMWF	North Sea
DUBLIN (2015)	NMC	full access to GM (ECMWF)					
		LAM (HIRLAM 7.2) 4D-VAR hydrostatic	0.1°	60	54 h	ECMWF	rotated latitude-longitude grid with the South-Pole at (-30° longitude, -30° latitude)
		LAM (HARMONIE 37h1.1) non hydrostatic	2.5 km	65	54 h	ECMWF	

HELSINKI (2016)	NMC	full access to GM (ECMWF)					
		LAM (RCR-HIRLAM 7.4) 4D-VAR	0.068° 7.5 km	65	54 h	ECMWF	Transformed lat/lon with the South Pole at 30° S-0° E
		LAM (HARMONIE-AROME) 3DVAR non-hydrostatic	2.5 km	65	54 h	ECMWF	Scandinavia
		Dispersion models • SILAM (aerosol) • FAS (fire) • HILATAR (SOx, NOx, NHx, toxic metals, dust) • DMAT (dust) • Road weather model (ROADSURF)			48 h	HIRLAM	
		Storm surge model (OAAS, HANSEN and WETEHINEN 2D water level models)			54 h 120 h	HIRLAM-RCR ECMWF	Baltic Sea level at the Finnish coast
		Wave model (WAM) forced by winds from Hirlam and ECMWF	4 nmi nested 0.5 nmi		54 h to 120 h	ECMWF forcing	Baltic sea Archipelago Sea
		Circulation model HBM	1 nmi for the Baltic Sea, nested grid at the Danish Straits with 0.5 nmi resolution		54 h	ECMWF forcing	Baltic sea
KIEV ?	NMC	LAM	?	?	?	?	?
LISBOA (2011)	NMC	full access to GM (ECMWF) LAM (ALADIN-Portugal)	9 km	46	72 h	ARPEGE-Meteo-France	Iberian Peninsula and part of Atlantic Ocean
		LAM(AROME-Portugal)	2.5 km	46	48 h	ARPEGE	Portugal, Azores and Madeira
		Wave Model SWAN-Portugal	0.05°		72 h	ALADIN, ECMWF	14N-36N, 14W-6W
LJUBLJANA (2012)	NMC	ACCESS to all ECMEF products LAM (ALADIN) hydrostatic LAM (ALADIN) hydrostatic LAM (ALADIN) 3DVAR + OI	 9.5 km 9.5 km 4.4 km	 43 43 43	 72 h 72 h 54 h	 ARPEGE ECMWF ARPEGE	
MADRID (2016)	NMC	Full access to GM (ECMWF)			240 h		

		LAM (HIRLAM-ONR) 3DVAR	16 km	40	72 h	ECMWF	North Atlantic and Mediterranean Sea
		LAM (HIRLAM-HNR) 3DVAR	5 km	40	48 h	ECMWF	Iberian peninsula and Balearic Islands/Canary islands
		LAM (HARMONIE/AROME) LAM (HARMONIE/AROME) AEMET/gSREPS (LAM EPS) (HARMONIE-AROME, HARMONIE-ALARO, WRF-ARW and WRF-NMM) 20 members GLAMEPS Grand LAM EPS project	2.5 km 1 km 2.5 km 8 km	65 65 65 40	48 h 48 h 36 h	ECMWF ECMWF ECMWF, ARPEGE, GFS, GSM and CMC Hirlam, Arome and subset of ECMWF EPS	Iberian Peninsula and Balearic/ Canary Islands 4 domains in coastal areas, 3 on Iberian peninsula & 1 on Canary islands Iberian Peninsula and Canary Islands Europe, part of Atlantic Ocean including Canary islands
		Wave Model (WAM)	16 km		72 h	HIRLAM-ONR	Atlantic Ocean/Mediterranean Sea
		Nested			72 h	HIRLAM-ONR/WAM	Cantabrian coast/ Gulf of Cadiz/Canary Islands
		WW3				HIRLAM-ONR/WAM	Strait of Gibraltar
		• Transport models (air quality/UV) • FLEXTRA (trajectory model) • MOCAGE (chem. transp. model) • NMMB/BSC-Dust	 0.16° 0.5°/0.1° 0.1°/0.1°	 40	24 h 72 h	 HIRLAM ONR GFS	Europe and Atlantic Area
MINSK (2005) (*)	NMC	LAM	75 km	15?	48 h	Moscow	?
NICOSIA (2015)	NMC	Access to GM UKMO Access to GM GFS			120 h 168 h		
		WRF-ARW V3.4, non-hydrostatic	18 km 6 km 2 km	80	120	GFS	
		Wave model (WAM)	0.25°		72 h	WRF	

NORRKOPING (2015)	NMC	Full access to GM (ECMWF)					
		LAM (HIRLAM) 4D-VAR (C11)	11 km	40	60 h	ECMWF	*See domain*
		LAM (HIRLAM) E-05 3DVAR	5.5 km	65	48 h	ECMWF	*See domain*
		HARMONIE-AROME 3DVAR-RUC non hydrostatic HIRLAM GLAMEPS (LAM EPS) MEPS (MetCoOp Ensemble Prediction System) 10 members	2.5 km 8 km	65 40	66 h	ECMWF Hirlam, Arome and subset of ECMWF EPS	*See domain*
		Wave model. SWAN				HIRLAM	
		HIROMB Oceanographic model NemoNordic Oceanographic model				MEPS/HIRLAM MEPS/HIRLAM	
		MATCH. Transport and Dispersion model				HIRLAM	
		HBV model. Hydrological run-off model				HIRLAM	Different catchment areas
OSLO (2006) (*)	NMC	full access to GM (ECMWF)					
		LAM (HIRLAM)	0.5°	31	48 h	ECMWF	?
		LAM (HIRLAM)	0.1°	31	48 h		?
PODGORICA (2008) (*)	NMC	LAM (NMM-WRF)	0.04°	??	84 h	ECMWF	*See domain*
		Wave Model					
PRAGUE (2016)	NMC	Full access to ECMWF products LAM (ALADIN) hydrostatic	 4.7 km	 87	 54 h	 ARPEGE	*See domain*
		High resolution EPS forecast is based on ALADIN/LAEF system of the RC LACE consortium	20.7 km		72 h		
		MEDIA model of radioactive air pollutant dispersion developed by Météo-France				ALADIN	Czech Republic
		TRAJEK For transport of air pollution from a more remote source simple trajectory model using wind data AQUALOG and HYDROG River catchment models				ECMWF winds ALADIN	
SARAJEVO (2008) (*)	NMC	LAM (HRM)	14 km	40	72 h	GME (DWD)	?
		LAM (WRF-NMM)	10 km	35	48 h	GSM NCEP	?
			4 km	35	48 h		?
		LAM (WRF-ARW)	6 km	35	48 h	GSM NCEP	?
RIGA (2013)	NMC	Access to DWD GME, ECMWF and Norwegian HIRLAM					
SKOPJE (2010)	NMC	LAM (WRF-NMM) non-hydrostatic	12 km		120 h	GSM NCEP	Europe

			2 km		48 h		Macedonia
SOFIA (2006) (*)	NMC	LAM (HRM)	9 km	31	48 h	GME (DWD)	?
		LAM (ALADIN)	12 km	41	48 h	ARPEGE	?
		VAGBUL, WAM and WW3	0.25°			ALADIN	Black Sea 40-47N /27-42E

TALLINN (2008) (*)	NMC	LAM(HIRLAM -3 DVAR- ETA)	11 km	60	54 h	ECMWF	*See domain*
		LAM (ETB)	3.3 km	60	36 h	ETA	*See domain*
VIENNA (2016)	NMC	Access to ECMWF products					
		LAM ALARO5-AUSTRIA LAM-AROME non hydrostatic	4.8 km 2.5 km	60 90	72 h 60 h	ECMWF ECMWF	
		LAMEPS ALADIN-LAEF – NCSB 17 members (non-Cycling Surface Breeding)	11 km	47	72 h	ECMWF-EPS	Europe and North Atlantic
VILNIUS (2016)	NMC	Access to all ECMWF products LAM (HIRLAM) 3 D-VAR hydrostatic LAM (HARMONIE-AROME) non hiydrostatic	 4 km 2.5 km	 60 65	 60 h 54 h	 ECMWF ECMWF	 Lithuania + neighbours Lithuania + neighbours
WARSAW (2015)	NMC	LAM (COSMO-LM) non-hydrostatic LAM COSMO-28 nested COSMO-EPS 20 members	7 km 2.8 km 2.8 km	40 50 50	78 h 36 h 36 h	ECMWF COSMO-LM COSMO	Central Europe Poland Poland
		ALARO non hydrostatic AROME Meso-NH • REMOTA Dispersion of pollutants • SHAWrt – Simultaneous Heat and Water Transfer (road temperature) • FOGMOD_PL – visibility and type precipitation type model Wave Watch III forced by COSMO	4 km 2 km	60 60	66 h 30 h	ARPEGE ALARO COSMO COSMO COSMO COSMO	Central Europe Poland
YEREVAN (2015)	NMC	Access to GM (ECMWF, DWD)			120 h		
		WRF ARW non hydrostatic WRF no hydrostatic nested	18 km 6 km	60 60	168 h 36 h	GFS, DWD WRF	33-48N; 32-56E 33-48N; 32-56E
ZAGREB (2015)	NMC	Full access to all ECMWF products LAM (ALADIN-Croatia HR88)	8 km	37	72 h	ECMWF-ARPEGE	SW (36.18N,3.90E)-NE (50.68N,26.90E)

		LAM (ALADIN-Croatia HR44) LAM (ALADIN – NH HR22) non hydrostatic WWM Wave model forced by ALADIN	4 km 2 km	73 37	72 h 24 h 36 h	ECMWF ALADIN HR88 ALADIN	SW(40N,11E)-NE(48N,22E) Adriatic and Istrian region
		ALADIN-LAEF (LAMEPS) 17 members	18 km	37	72 h	ECMWF EMEP nested	SW (36.18N,3.90E)-NE (50.68N,26.90E)
		EMEP (Air quality model) EMEP4HR	50 km 10 km	20		NCEP	
		HYSPLIT (Lagrangian Integrated Trajectories)					
		RegCM4 (Regional Climate model) SOM ocean surface currents MIKE11 hydrological-hydrodynamic	12.5 km				
ZURICH (2016)	NMC	Full access to ECMWF products					
		LAM (LM – COSMO7 consortium) LAM(COSMO2 nested) non-hydrostatic, nudging LAM(COSMO1 nested) non hydrostatic	6.6 km 2.2 km 1.1 km	60 60 60	72 h 45 h 45 h	ECMWF COSMO7 COSMO2	Most of western Europe
		Use of COSMO-LEPS Ensemble 21 members	2.2 km	60	5.5 days	ECMWF (EPS)	
		FLEXPART (trajectory and dispersion model) COSMO-ART (numerical dispersion model) LAGRANTO – trajectories computation				COSMO2 and 7	
OBNINSK (2007) (*)	RCATM (for RA II)	full access to GM – HM and LAM					
UKRAINE (2015)	NMC	WRF ARW/NMM v.3.3.1 Coupled system WRF NMM/SWAN sea waves				GFS WRF	Carpathian Mountains Region Basins of Black and Azov Seas

ECMWF (2015)	GMC and GPC	GM (IFS), Ensemble of Data Assimilations (EDA- *see Note below)*, 4D-VAR, coupled to Ocean model	Tco1279 (9 km)	137	240 h		Global
		GM (IFS) Ens.- 51 members, EDA+ SV+StoP coupled with NEMO at 1 degree 42 layers	Tco639 (18 km) D1 to D10	91	15 days		Global
		GM (IFS) Ens. 51 members EDA+SV+StoP, coupled with NEMO at 1 degree 42 layers	Tco319 (36 km)	91	10 days to 46 days		Global
		Seasonal Forecast S4 51 members coupled NEMO at 1 degree 42 layers IFS suite includes: • EDA[25] 25 members • ORAS4[5] 5 members Ocean Analysis • ERA-I ERA-Interim reanalysis	Tco255(80 km) 18 km 1 degree 80 km	62 137 42 60	7 to 13 months		Global Global Global Global
		Wave Model: ▪ Coupled to HRES ▪ Coupled to ENS ▪ Coupled to Seasonal	0.125 deg 0.25 deg 1 deg				Global Global Global
Note: The EDA system. The EDA system consists of an ensemble of independent, lower-resolution 4D-Var assimilations that differ by perturbing observations and sea-surface temperature fields according to their perceived accuracy. Model uncertainties are also simulated. Analysis uncertainty estimates are difficult to obtain by other means and will provide very valuable guidance for forecasters about the quality of ECMWF's short-range forecasts. Using EDA information in the deterministic assimilation system is expected to increase the forecast accuracy through improved use of observations resulting in reduction of the analysis error, in particular in regions that contain quickly developing circulation structures such as tropical cyclones and mid-latitude storms.							

TOULOUSE (2016)	RCATM, GMC and GPC	Full access to ECMWF products GM (ARPEGE-IFS) (4 D-VAR) Variable mesh	Tl1198C2.2 (7.5 to 36 km)	105	102 h		
		GM PEARP Ens. 35 members, SV, 4D-VAR	T798 var mesh 2.4 (10 km Western Europe)	90	108 h		Global but with mesoscale resolution over Europe-North Atlantic
		• LAM (ALADIN-France) 3 D-VAR • For Trop. Cyclone (Réunion) Caribbean, Guyana, New Caledonia, Polynesia	7.5 km 8 km	70 70	72 h 84 h	ARPEGE/IFS ARPEGE/IFS	33°66-54°95N/ 11°18W-19°64E South Indian Ocean, etc.
		LAM (AROME) 3D-VAR, non-hydrostatic	1.3 km	90	42 h	ARPEGE	France
		GM (ARPEGE-Climat) Ens. 51 members – LAF 8 atmos. x 5 ocean initial states, GELATO sea-ice model	75 km 0.5 – 2 deg.	91 31	7 months	ECMWF	Global
		Wave Models: • MFWAM-GLOB-ARPEGE • MFWAM-GLOB-ECMWF	 0.2° 0.2°		 102 h 120 h	 ARPEGE winds ECMWF winds	 Global Global
		• MFWAM-REG-ARPEGE	0.1°		102 h	ARPEGE winds	European Seas : 72N-20N-32W-42E
		• MFWAM-REG-ECMWF	0.1°		120 h	ECMWF winds	European Seas : 72N-20N-32W-42E
		• MFWAM-CARIBBEAN-AROME • MFWAM-INDIAN OCEAN-AROME	0.1° 0.1°		54 h 42 h	AROME winds AROME winds	28N-5S-75W-45W 0S-32S-31.5E-88.5E
		• MFWAM-REUNION-ALADIN • MFWAM-POLYNESIAN-AROME • MFWAM-New-Caledonia-AROME • MFWAM-France-AROME • WW3-France-ARPEGE nested • WW3-France-ECMWF nested • WW3-France-AROME nested • WW3-AG-AROME nested in MFWAM-CARIBBEAN-AROME	0.25° 0.1° 0.1° 0.025° 200 m 200 m 200 m 200 m		84 h 42 h 54 h 30 h 72 h 72 h 42 h 42 h	ALADIN winds AROMEwinds AROME winds AROME winds AROME winds ECMWF winds AROME winds AROME/ECMWF winds	0S-32S-31.5E-88.5E 1S-31S-196E-232E 10S-30S-156E-174E 41N-51.5N-6W-10.5E French Atlantic, Channel and North Sea coasts Same as before French Mediterranean Sea coasts West Indies and french Guyana
		MOCAGE 3D Chemistry and transport model (air quality, sand and dust, UV index)					
		MOCAGE Pollutant transport and dispersion model					

		OPA 7 Ocean circulation model	1/3 °	17	1 month?	ARPEGE surface flux	Atlantic
		Storm Surge model Hycom2D	1 km				Coastal France, New Caledonia, French Polynesia, French Antilles
		Oil spill model MOTHY					Global
		• SAFRAN / CROCUS /MEPRA ensemble snow and avalanches • SIM (Safran-Isba-Modcou) hydrology • SIR (Safran-Isba Route) Roads fcst	8 km			ALADIN/France	Alps and the Pyrenees France

EXETER (2015)	RMC, RCATM, GMC and GPC	GM Access to all ECMWF products GM (Unified Model) 4D-VAR	17 km	70	144 h		Global
		LAM Euro4 3D-VAR	4 km	70	36 h	UM	70º N to 30º N, 20º W to 50º E
		LAM o UKV 3D-VAR non hydrostatic	1.5 km	70	36 h	UM	62º N to 46º N, 13º W to 5º E
		Ens. 12 members GM, MOGREPS-15, *run at ECMWF*, ETKF	33 km	70	15 days		Global
		MOGREPS LAM EPS 12 members. ETKF non hydrostatic	2.2 km	70	36 h	GM. Ens.	North Atlantic and Europe
		GM HadGEM3-GLOSEA 4, Ens. 42 members, LAF, coupled, OI ocean, 40 random OP of SST	0.833 × 0.556 Ocean: 0.25°	85 75	7 months		Global
		Global Ocean Model NEMO - FOAM (Forecasting Ocean Assimilation Model)	0.25° 1/12°	50	144 h?	GM	Global oceans North Atlantic, Mediterranean, Indian Ocean
		• Global Wave model (WW3) • Regional WW3 : North Atlantic, Mediterranean, Indian Ocean, Persian Gulf • Regional WW3 UK • Regional WW3 • Atlantic ensemble	35 km 8 km 4 km 4 km		144 h 66 h, 144 h Europe and Persian Gulf 66 h 66 h 168 h	GM GM GM GM MOGREPS	Global Lake Victoria and most of East Africa
		Regional Ocean Models FOAM	1/12°	20	144 h?	Global NEMO	North Atlantic (20-80N; 90W-20E) Mediterranean (30-47.5N;5.5W-42E) Indian Ocean (25S-31N; 38-106E)
		Shelf seas forecast model –24 h hincast	7 km	33	144 h	GM. NEMO	North West European continental shelf – 40-65N/20W-13E

		Nested coastal ocean models POLCOMS	Lon 1/15°; lat 1/10° Lon 1/40; lat 1/60°				NW European shelf seas Irish Sea
		• Storm Surge Model • Various mesoscale tide-surge models. Driven by MOGREPS-15	1/9°x1/6°		36 h		48-63N/12W-13E British isles
		Transport and dispersion models (NAME) Air Quality Model	12 km				UK

OFFENBACH (2016)	RMC and GMC	Full access to GM (ECMWF)					
		GM (ICON) 3DVAR ICON-EPS 40 members	13 km 40 km	90	180 h 180 h		Global Global
		ICON-EU non hydrostatic LAM (COSMO-EU – nested in ICON- non-hydrostatic) nudging	6.5 km 0.0625° (7 km)	60 40	45 h 78 h	ICON GME	*Europe and surroundings* *See domain*
		LAM (COSMO-DE) nudging, non-hydros., convection resolving.	2.8 km	50	27 h	ICON-EU	*See domain*
		COSMO-LEPS Ens, 16 members	7 km	62	120 h	ECMWF	*See domain*
		COSMO-DE-EPS Ens, 20 members GCFS1.0 German Climate Forecast System 30 members, hindcast 15 members	2.8 km 1.9° atmosphere 1.5 ° ocean	50	27 h 1 to 5 months	ECMWF, GME, GFS, GSM, COSMO ERA interim, ECMWF, ORAS4	Germany Global
		SRNWP-PEPS (poor man 16 European LAM models)	7 km		30 h – 48 h		*See domain*
		GWAM forced by GME 10m winds EWAM forced by COSMO-EU 10m winds CWAM	0.25 x0.25° 0.05x0.10° 30’’x50’’ ~900 m		174 h 78 h		Global South of 66N, East of 10.5W South of 53°N~6°-15°E
		Trajectory models Lagrangian Particule Dispersion Model (LPDM) GME, COSMO-EU/COSMO-DE ICON-ART (dispersion of volcanic ash and mineral dust) COSMO-ART (dispersion of volcanic ash and mineral dust)	13 km 7 km		168 h 72 h	ICON COSMO-EU ICON COSMO	Global Europe/Global Global
ROME (2016)	RMC	full access to GM (ECMWF)					
		COSMO-ME LAM non-hydrostatic	7 km	40	72 h	CNMCA EnKF and IFS	Mediterranean-European region
		COSMO-IT LAM non-hydrostatic nudging COMET-LETKF LAMEPS 40 members + Control	2.8 km 10 km	65 45	24 h 72 h	COSMO-ME COSMO	Italian region

		Wave Model (NETTUNO) WAM HRES driven by COSMO-IT NETTUNO-EPS driven by COSMO-ME-EPS 41 members FLEXPART dispersion and trajectories	0.05° 1’		72 h	COSMO-ME COSMO-IT COSMO-ME-EPS ECMWF	Mediterranean Basin Mediterranean
MOSCOW (2015)	WMC, RMC and GPC	GSM 3DVAR T339L31 GSM 3DVAR T169L31	0.56° T169	31 31	240 h 240 h		Global Global
		GM SLAV-2008	Lat.-Lon. 0.72x 0.9°	28	240 h		Global
		LAM (non-hydrostatic)	50 km	30	48 h	GSM	Atlantic-Europe
		LAM (non-hydrostatic)	10 km	15	36 h	LAM	Moscow and St Petersburg regions
		LAM COSMO-RU7 non hydrostatic LAM COSMO-RU2 non hydrostatic LAM COSMO-RU13-ENA	7 km 2.2 km 13.2 km	40 40	78 h 48 h	GME (DWD)	East Europe and European part of Russia Central Federal District of Russia Europe and Northern Asia (whole Russia and adjacent areas)
		Global EPS 12 T169L31 disturbed members + 2 undisturbed fcst from T169L31 and SLAV-2008	T85	31	240 h		
		LAMEPS COSMO-RU2 10 members	T85 2 km	31	30 days/ season	COSMO-S14 EPS 7 km	
		GM Ens. 15 members, BGM	T169	31	10 days		
		GM (SLAV-2008) and T42L14 Ens.	T42	14	30 days		
		GM Ens. 10 members, SLAV, coupled, Ocean Model.	T85	31	Season		
		Sea wave model WaveWatch III	1.25°x1.25° 1.2°x1.2°		240 h	T169L31 SLAV-2008, GFS	Global Baltic sea, Caspian sea, Barents sea and White sea

GROUPING OF COUNTRIES		Resolution	Levels		Using:
COSMO_LEPS:	LAM non-hydrostatic nested in ECMWF EPS model, 16 Ens. members. selected from 102 ECMWF ens. members **Germany, Greece, Italy, Poland, Romania, Russia, Switzerland**	10 km	32	120 h	ECMWF EPS
High resolution EPS forecast based on ALADIN/LAEF system. The RC LACE consortium:	LAM non-hydrostatic nested in ECMWF EPS model **Austria, Croatia, Czech Republic, Hungary, Romania, Slovakia, Slovenia**	20.7 km			ECMWF EPS
ALADIN library:	**Developed jointly by Météo-France and of: Algeria, Austria, Belgium, Bulgaria, Croatia, Czech Republic, Hungary, Morocco, Poland, Portugal, Romania, Slovakia, Slovenia, Tunisia, Turkey**				ARPEGE
HRM of DWD used by:	**Armenia, Bosnia-Herzegovina, Botswana, Brazil-INMET, Brazil-Navy, Bulgaria, Georgia, Indonesia, Iran, Israel, Italy, Jordan, Kenya, Libya, Madagascar, Malaysia, Mozambique, Nigeria, Oman, Pakistan, Philippines, Romania, Spain, Tanzania, United Arab Emirates and Vietnam**	7 to 25 km	40 to 60		GME (DWD)
Consortium for Small Scale Modeling (COSMO)	**Germany, Greece, Italy, Poland, Switzerland, Romania and Russian Federation**				GME (DWD)
HIRLAM consortium:	**Denmark, Estonia, Finland, Iceland, Ireland, Lithuania, the Netherlands, Norway, Spain and Sweden.**				ECMWF

- COMPUTERS USED FOR DATA PROCESSING AT RSMCs AND NMCs -

REGION I

CENTRE	*MAINFRAME (number cruncher)*	*SECONDARY COMPUTER(S)*	*WORK STATIONS*
ANTANANARIVO		Serveur quad core, PC dual core	PCs
ACMAD		INTEL based servers (AMEDIS system) – SUN SPARC	PCs
DAR-ES-SALAAM		2 Linux PC cluster	HP XW4400
GABARONE		24 nodes HP Linux PC cluster, Dual quad core Dell Linux	
HARARE			IBM PSs - PCs
ALGIERS	IBM	30 Pentium IV	30 + workstations
CAIRO	Sun Cluster 12x2x 2218 AMD dual core	Dell Precision, 2 IBM workstations, Dec Alpha station	8 intel Xeon workstations
CASABLANCA	IBM RS 6000 SP 12 nodes	SUNSPARK 1000	SGI - 3 DEC ALPHA - MOTOROLA
DAKAR			PCs
MAPUTO		NETSYS	SYNERGIE, CLICOM and PCs
NAIROBI	Integrated Meteorological Information System (IMIS)	Linux Cluster with 24 nodes	8 nodes WSs
LA REUNION			Work Stations
PRETORIA	NEC SX8	2 SGI Origin 200, 2 SGI Indigo –- SUN Enterprise 3000	PCs
TUNIS	Super calculator	2 DELL Xeon, HP715/80, HP 755/80	
TANZANIA	Cluster with 16 computing nodes. 2.6 GHz processors	IBM DS3500 Storage Subsystem 25.2 TB	PCs
LIBYA	Synergie System	MSG system, SADIS	
KHARTOUM	Early warning unit with 4 x 8 cores, 2 threads per core and 16 GB RAM with CPU power of 800 MHZ under Ubuntu 12.4 O. S		PCs

REGION II

CENTRE	*MAINFRAME (number cruncher)*	*SECONDARY COMPUTER(S)*	*WORK STATIONS*
ALMATY	8 clusters XEON-5500	3 servers on two AMD Athlon 64x2 Core Processor 4200+	PCs
ASTANA	8 clusters XEON-5500 (64 processors)	2 AMD Athlon 64x2 Core Processor 4200+	PCs
BANGKOK	IBM RS/6000SP 12.96 GFlops	2 RS 6000 595	PC Cluster WRF, WSs
COLOMBO		PCs Cluster	
DOHA		Intel core -i7 desktop 8 cpu , 8 GB ram	
HANOI		PC Cluster	

HONG-KONG	IBM S814 Server, 3 Dell HPC Clusters 18, 119 and 74 CPU, IBM SP Cluster 24 CPU	HP Clusters 16 CPU and 21 CPU, Dell R510 Server 8 CPU, IBM BladeCenter JS23 4 CPU, Dell R710 Cluster 16 CPU, IBM BladeCenter JS22 4 CPU, IBM BladeCenter JS22 12 CPU	WSs
KARACHI	Cluster 1.7 TFlops Dell Power Edge M600 Intel Blade Servers 32 nodes	2 HP Proliant DL 380 with 9 and 4 nodes, 2 PowerEdge R720 and R930 Rack Servers	PCs
MUSCAT		PC Cluster of 72 nodes with total of 144 processors. Dual AMD Opteron 3.2, Dell PowerAdge 2600 New PC Cluster 0f 80 nodes	PCs
PYONGYANG		Pentium III	PC/AT – PS/2
SEOUL	CRAY XC40, 5808 nodes, 5.8 PFlops	HP V2500 (48PE)	SUN 2000
TEHRAN	2 PC Cluster Systems 8 and 32 Nodes	IBM 370 (2x 4381)	PCs
ULAANBATAR		PC Cluster System	MICRO VAX 3400
NCMRWF-INDIA	IBM Power 6 HPC		DEC Alpha WSs, SUN Ultra Sparc II WSs, SGI ORIGIN 200 and O2 WSs
BEIJING	IBM Flex System P460 1759 TFlops, Sunway 4000A	IBM Flex System SS1-SS7	WSs
DOHA		Intel core -i7 desktop 8 cpu , 8 GB ram	Synergie system from MFI/COROBOR
JEDDAH		DELL 670 Precision with 2 Processors	WSs
KHABAROVSK		XEON-2, COMPAREX, COMPLEX GIS Meteo	PC Pentium IV, PCs
NOVOSIBIRSK	VKR-RN 104 processors 640 GFlops	XEON-2	PCs
TASHKENT		HP 9000	PCs
NEW DELHI	IBM 28 nodes POWER-6 14.4 TFlops *In Pune*: HP RP7400	10 Altix-350 (28 nodes), SGI ORIGIN 200, 2CDC 4680 IBM X3400	IBM P5/595 (64 processors)
TOKYO	Hitachi: SR16000 model M1(54 nodes) 423.5 TFlops	3 HITACHI EP8000/750	29 HITACHIs HA 8000/130W
KUALA LUMPUR	SGI ALTIX 4700 SMP machines (SGI-A and SGI-B)	Altair PBS Professional 8.0	SGI ALTIX 4700
MYANMAR	CPU - Intel® Xeon ® E5-4607 @ 2.20GHZ machines, four are CPU -Intel® Xeon ® E-3430 @ 2.40GHZ		PCs

REGION III

CENTRE	*MAINFRAME (number cruncher)*	*SECONDARY COMPUTER(S)*	*WORK STATIONS*
BOGOTA		DELL Precision WKS 490 Dual Core	
LA PAZ		IBM SIAPAD, HP Compaq, DELL	HP, Supermicros
LIMA	HP 8 nodes, MU 330, MU 350	4 SUN FIRE	

MONTEVIDEO			33 WSs
QUITO		Dell Power Edge 6400, Dell Cluster	PCs
SANTIAGO	384 Xeon Haswell computing cores, 12 machines with 2 CPUs each, 16 cores per physical CPU 40 Xeon Westmere support cores, 2 machines with 2 CPUs each, 6 cores per physical CPU	48 Xeon E5 v2 (Ivy Bridge microarchitecture) computing cores, 2 machines with 2 CPUs each, 12 cores per physical CPU.	PCs
INPE(CPTEC - SA O PAULO)	NEC SX 6/32M4, NEC SX 4/8A	2 SUN 280 R, 1 SUN FIRE 6800	62 WSs (DEC, Compaq), 41 PCs
BRASILIA RIO JANEIRO BRAZIL AIR FORCE	SGI ALTIX, SGIAltix ICE 8400, SGI Altix ICE X, SGI UV 2000 SGI ALTIX, SGIAltix ICE 8400, SGI Altix ICE X, SGI UV 100, 2 SGI Altix 450 4 HP Proliant (DL360 G7)	HP Blade System, NetAPP, CAS System 1 Dell Power Edge 2950, 2 Dell Power Edge 1950, 8 Dell Power Edge R-410, 1 Dell Power Edge R720	PCs PCs PCs
BUENOS AIRES	Cluster of 5 ML350 HP Proliant nodes, SG ALTIX 3700	HP Proliant ML350G4 server	PCs
ASUNCION			

REGION IV

CENTRE	*MAINFRAME (number cruncher)*	*SECONDARY COMPUTER(S)*	*WORK STATIONS*
MEXICO		SGI Origin 2000	
MIAMI			WSs
MONTREAL	2 IBM P Series 775+ (8192, Cores)	2 Quantum 662 Meta Data Controlers, Dell M610 blade, Intel E5530 @ 2.4 Ghz, 1280 cores, 8 IBM System x3650 M2 I/O servers, 128 cores + 14 7870 blades 224 cores	100 Dell Power-Edge
WASHINGTON	IBM CCS (2816 processors)	2 SGI Origin 2000/32, SGI ORIGIN 3000/16	

REGION V

CENTRE	*MAINFRAME (number cruncher)*	*SECONDARY COMPUTER(S)*	*WORK STATIONS*
JAKARTA		Linux PCs Cluster 6 CPU (dual core) and 4 HP Xeon Server 2x Quad core	
KUALA-LUMPUR		2 SGI ALTIX 4700 128 (dual core Montecito) Itanium series 9000 1.42GHz processors with 533MHz FSB	
MANILA		PCs Cluster SGI ORIGIN 2000	
SINGAPORE	Cray XC-30 HPC 336 Intel Xeon 2.6GHz (8 Cores, Sandy Bridge) processors and 10.7TB of total system memory HP computing cluster with 22 nodes	Set of p-series and x-series IBM servers	WSs
DARWIN			WSs
NADI		2 IBM P5+ 2 550 Servers (9133-55A) , 6 HPs	WSs, PCs
WELLINGTON	QDR Infiniband Linux Intel cluster 12 nodes, 144 core	Linux Intel blade servers, IBM Storwize v7000 Unified Storage System	WSs
MELBOURNE	NEC SX-6 Multi-Nodes (28) 8 cpu/node	NEC TX7/i9510, 9 HP, 2 IBM p570, 2 SGI, 6 DELL	

REGION VI

CENTRE	*MAINFRAME (number cruncher)*	*SECONDARY COMPUTER(S)*	*WORK STATIONS*
ANKARA	IBM pSeries 690, SGI Altix 4700 with 512 cores - Intel Itanium II 1.67GHz	SGI Onyx 2, SGI 2200, 2 IBM p630	10 INTEL P4, PCs
ATHENS	IBM Cluster 1600 28 Computer Nodes 7039-651 pSeries 655	HP 28 RX 2600	HPs
BELGRADE	HPC Cluster 32 Blade servers BL 2x220c HPC Cluster 16 HP Blade servers BL 2x220c	HP ProLiant Server DL380 x2, Windows Server 2008, HP Storageworks MSA 500,Messir-Comm (Corobor)	HP Workstation Z400, PCs
BET DAGAN		SGI Origin 350 300, 2xSGI Origin 200	8 SGI WSs
BRATISLAVA	10 nodes of IBM p755 with 4x 8-core 3.3 GHz POWER7, IBM Flex System p460, 12 nodes of 4x Power7+ 8core CPUs	IBM Tivolli Storage 3310, HP Integrity RX6600, 2xHP Proliant DL 160G6	PCs
BRUSSELS		SGI Altix 4700 with Itanium II processors - 192 CPU / HP servers	WSs
BUCAREST	IBM LINUX BLADE cluster (28 nodes)	Linux/Unix servers, Windows HP Proliant server	PCs
BUDAPEST	IBM iDataPlex (280 Intel Xeon X5550 processors), SGI Altix 3700 server with 200 Itanium2 processors (1,5 GHz processors)	SGI Altix 350, HP L3000 HPRX7640, DEC 600	HP, DEC, SUN WS – PCs Linux and Microsoft
COPENHAGEN	CRAY XT5 38 TFlops	2 Linux Servers, IBM power 52A	WSs

DE BILT		SGI Power Challenge, SGI Origin 2000	Compaq clusters - WSs
DUBLIN	SGI Altix ICE 8200EX with 3840 Intel Xeon X5650 processors in ICHEC [Irish Centre for High-End Computing]	8 Core Linux	WSs
HELSINKI	CRAY XC30 with 2x3420 cores peak power 70 TFlops	SGI ALTIX 3700 BX 294 processors, VAX 6240	VAX Clusters - WSs
KIEV		EC-1061	PCs
LISBOA	HPC IBM10 x p5-575 (10 Power 5+ dual-core processors at 1.9 GHz)	DELL PowerEdge 2950 cluster (10 nodes, 2 Intel Xeon X5355 Quad-core)	PCs
LJUBLJANA	IBM p755 with 4x 8-core 3.3 GHz POWER7 10 nodes	IBM Tivolli Storage 3310, HP Integrity RX6600, Cluster 2xHP Proliant DL 160G6	PCs
MADRID	Bull DLC B700 Intel Xeon 2697 V2 Ivy Bridge processors (12 cores) at 2.7 GHz with 64 GB DDR3 of memory per node. The system has 144 nodes and 3456 cores. NMMB/BSC-Dust runs at the MareNostrum III supercomputer	Cluster of nodes of EMS, and ISILON One FS.	SUN WSs and PCs
MINSK		2 Intel Celeron 600	3 Intel PIII, 2 Intel P-II
RIGA		2 servers HP ML 370 G4, processor XEON 3.2GHz	Workstation "METVIEW", workstation “SmartMet”
NICOSIA	IBM Linux cluster 20 processing cores	CyTera (35TF)	
NORRKOPING	Bifrost 10600 core Linux cluster, based on Intel Xeon E5 eight-core processors and Intel Truescale Infiniband QDR (National Supercomputer Centre at the University of Linköping, Sweden)	Linux Cluster, SGI 3800 DEC Alpha servers	29 VAX (Clusters) - 7 DEC – SUN WSs, PCs
OSLO	CRAY T3E	2 IBM RS6000 3 SGI Origin 2000, 200	VAX 4000-200/3300 DEC3100 Alpha-200
PODGORICA		Beowulf cluster with 32 node, with quad core CPU E5440 2.83GHz	50 PCs
PRAGUE	NEC SX9 with 2 nodes with 16 processors	Cluster of Oracle T5-8 serversSun M8000, 6900, 6 Sun Fire	WSs
SARAJEVO		Intel 2 Quad	
SOFIA	CYBER 31 FLOP1	MOTOROLA SYSTEM	
TALINN		32 nodes GNU/Linux PC cluster	
VIENNA	SGI ICE X (252 nodes a 16 cores)	10 Linux (a 8-16 cores)	PCs
VILNIUS	SGI Altix ICE	12-node Linux PC cluster	
YEREVEN	IIAP Cluster MSI X2-108-A4M Intel Quad Core Xeon E5420 2.5 GHz	CPU Intel Xeon Dual core 2.66GHz 633 MHz FSB, MSI X2-108-A4M Intel Quad Core Xeon E5420 2.5GHz (6 nodes)	PCs
WARSAW	Linux cluster grad – 145 HP BL460c Gen8 servers (139 computational nodes, 2700 cores) Linux cluster called “euros” – 97 computational HP BL460c Gen8 nodes	Linux virtual machines (6 units)	PCs

ZAGREB	SGI UV 2000 228 cores	Quantum scalar i500, OS SUSE Linux server	PCs
ZURICH	CRAY XE6 with AMD Opteron 12-core processors sustained performance 270 GFlops on 1079 cores	SUNs Solaris, HP Cluster, Linux servers	Windows 7 SP 1 / Office 2010 based HP desktops and Dell laptops
ECMWF	2 CRAY XC40, compute nodes with two Intel Xeon EP E5-2695 V4 “Broadwell” processors each with 18 cores.	Most servers are now Intel-based running RHEL6 (MARS and most HPSS data handling)	SGIs, PCs running Linux
EXETER	Cray XC40 High Performance Computer system	New hardware (MASS4G) supplied by Oracle , UNIX servers	HP WSs
TOULOUSE	BULL (bullx DLC) (1000 nodes of 24 processors).	TRANSMET computers (2 Dell PowerEdge6850, operating with Linux RHEL AS 4 and RDBMS Postgres)	Synergie Workstations
OFFENBACH	2 CRAY XC40 clusters 796 nodes with 17648 cores	2 CRAY/Megware clusters, 2 NEC/Oracle/NetApp clusters, IBM System x3650 cluster, Windows 2008 R2 server, Linux server	SGI WSs
ROME	HPCF COMET 194 nodes Hewlett Packard Linux Cluster arranged in three different groups. HPC HAL composed by 55 DL380G9 computing nodes and 2 DL380G9 management nodes.	DL 385 G2 2 nodes, AMD OPTERON 2218 4 cores, DL 380 G5 4 nodes, INTEL XEON 5160 4 cores	HP WSs
MOSCOW	2 ASOOI servers 32 CP(4x8 cores) Intel Xeon E7-4830 2.13 GHz	Cluster XSK 96 knots each of them 2x8 cores Intel Xeon E5-2690 2.9 GHz, Cluster ICEX 30 knots each of them 2x10 cores Intel Xeon E5-2670-v2 2.5 GHz	2 HP 735 WSs
UKRAINE	Intel Xeon E5 2660 Unix server having 16 cores, operated by CentOS operating system. Intel Xeon E5 5660 Unix server having 12 cores, operated by CentOS operating system . Intel Xeon E3 1220 Unix server having 4 cores		

ANNEX: Information on nowcasting

Several countries/Centres, mention in the update of 2013 report, techniques used in the nowcasting (up to 6 hours) focusing on the forecast of extreme weather. These techniques involve the usage of expensive equipment such as Doppler radars and more affordable equipment such as lightning networks together with high resolution mesoscale models.

Summary on nowcasting techniques used

(i) Extrapolation of radar echoes (Doppler mode)

(ii) Lightning networks

(iii) Mesoscale high resolution models

(iv) Latest conventional observations (surface, radiosondes, Amdar, lidar, Profilers).

(v) Combination of the above mentioned techniques

Systems

- **Hong Kong**

(i) SWIRLS

- Radar echoes tracking with extrapolating algorithms and lightning network.
- ROVER (Real-time Optical flow by Variational methods for Echoes of Radar) which tracks radar-echo motion.
- GTrack which identifies and tracks thunderstorm cells embedded in the radar echoes.
- Tephigrams analysis using CAPE and different instability indexes
- High resolution mesoscale models output
- SIP Swirls Integrated Panel provides a consolidated view of tools supporting rainstorm nowcast warnings.
- DELITE (detection of electrification and lightning based on isothermal thunderstorm echoes) .

- ARROW (Automated Rainstorm Related Objective Warning).
- Multi-Sensor module: nowcast for a extended period 6 to 9 hours
- TC module.
- A community version of SWIRLS (com-SWIRLS) was developed and assembled in 2015.
- The Probabilistic Quantitative Precipitation Nowcast (PQPN) products operational in 2015.

(ii) RAPIDS (Rainstorm Analysis and Prediction Integrated Data-processing System) : QPF for the next 6 hours at 2 km resolution. The system blends the outputs from SWIRLS and RAPIDS-NHM at 6-minute intervals with respective weightings determined from real-time verification of their precipitation predictions.

(iii) ATNS : Aviation Thunderstorm Nowcasting System

(iv) ATLAS: Airport Thunderstorm and Lightning Alerting System

(v) LINS: Lightning Nowcasting System

- **LDAPS (Seoul)**

(i) Mesoscale model (res 1.5 km L70) up to 24 h 4 times/day

- KONOS (KOrea NOwcasting System) (Seoul) AWS-RADAR window matching, and merging with a NWP model after 3-hr forecast. KONOS extrapolates radar data from 0 to 6-hr with 1km horizontal resolution at every 10-min.
- SWAN (Severe Weather Automatic Nowcasting system) (Beijing) MCSs (Mesoscale Convective Systems) identification, tracking, and forecasting (0-2h) system was operated in CMA, providing areas, minimum TBBs, average TBBs, eccentricities, boundaries, moving directions and boundaries of MCSs based on specified thresholds in real-time.

- **Tokyo**
    - High-resolution Precipitation Nowcasts (incorporating forecasts of 5-minute cumulative precipitation, 5-minute-interval precipitation intensity and error range estimation based on extrapolation and spatially three-dimensional forecasting covering the period up to 60 minutes ahead)
    - Precipitation Nowcasts: predict 10-minute accumulated precipitation and 5-minute-interval precipitation intensity by extrapolation up to one hour ahead
    - Thunder Nowcasts: thunder and lightning activity up to one hour ahead. Initial activity distribution is derived from lightning detection network system observations obtained at 10-minute intervals.
    - Hazardous Wind Potential Nowcasts: hazardous wind conditions such as tornadoes up to one hour ahead. Initial probability distribution is established using radar measurements including Doppler radar data obtained at 10-minute intervals and severe weather parameters calculated from Numerical Weather Prediction.
    - Radar/Raingauge-Analyzed Precipitation (R/A): precipitation distribution analysis with a resolution of 1 km, derived on a half-hourly basis. Radar data and raingauge precipitation data are used to make R/A.
    - Very-Short-Range Forecasts of precipitation (VSRFs): MSM and the LFM are merged into the Very-Short-Range Forecast of precipitation (VSRFs). The merging weight of the MSM/LFM forecast is nearly zero for a one-hour forecast, and is gradually increased with forecast time to a value determined from the relative skill of MSM/LFM forecasts.
- **Argentina**
    - COTREC (Continuity Tracking of Radar Echoes by Correlation) method (Argentina): radar echo prediction, this information is mixed up with direct observation of operational radar products and satellite images.
- **Canada**
    - INCS Integrated Nowcasting System (Canada): uses surface observations), north American radar composite images and lightning data from the Lightning Detection Network. These observations are used to feed short term forecast models.
- **New Zealand**
    - TITAN (New Zealand): Thunderstorm Identification, Tracking, Analysis and Nowcasting. Software suite incorporating the capability to handle data from radars, satellite imagery, lightning sensors, surface observations and NWP models.

- **Israel, Slovakia, ZAMG Austria, Croatia**
  - INCA (Integrated Network through Comprehensive Analysis) (Israel, Slovakia, ZAMG Austria, Croatia)
- **Hungary**
  - MEANDER-WRF (Hungary): Model and radar extrapolations. The non linear segment is based on the WRF model. The linear segment (MEANDER) runs every 15 minutes for 3 hours forecasts using surface observations, radar reflectivity and WRF-BETA outputs.
- **Sweden**
  - MESAN (Sweden): analysis of weather parameters not normally analysed by meteorological models such as fresh snow-cover, visibility and 10 meter winds. Used for diagnostic and now-casting purposes
- **Czech Republic**
  - COTREC – areal radar echo extrapolation up to 180 minutes
  - CELLTRACK – convective cells are approximated by radar reflectivity cores
  - INCA – temperature, wind and precipitation analyses
  - JSWarnView – gives warning of precip, hail and lightning activity above normal levels
- **Switzerland**
  - TRT (Thunderstorms Radar Tracking) : severe thunderstorms nowcasting, warning and in-formation system.
  - QPE (Quantitative precipitation estimation by radar product RAIN)
  - NowPAL (Automatic precipitation alerts)
  - Flash-O-matic (Automatic heavy thunderstorm alerts)
  - Context and Scale Oriented Thunderstorm Satellite Predictors Development (project COALITION): merges severe convection predictors retrieved from different sources (MSG, Weather Radars, NWP, lightning climatology and orographic gradients) with evolving thunderstorm properties. The heuristic model calculates probabilistic information about time, space and intensity evolution of severe convection for use by decision makers.

- Real-time radar-raingauge merging (project CombiPrecip): combines raingauges and radar data in real-time coupled with innovative engineering to mitigate artifacts in the extrapolation regime and in the presence of strong convective cells.

- Integrated Nowcasting through Comprehensive Analysis (INCA)

- **France**

  - RDT(Rapidly Developing Thunderstorm): Sat cloud tracking, identifies those that are convective, and provides some descriptive attributes of their dynamics, also incorporate lightning data .

  - CONO (Convection Nowcasting Objects): Same as before on composite reflectivity radar, also incorporate lightning data.

  - SIGOONS (Significant Weather Object Oriented Nowcasting system): CONO generated convective cells are further qualified regarding gust, rainfall intensity and risk of hail, using various sources, and extrapolated.

- **UK**

  - UKPP - UK Post Processing System for Nowcasting and Product generation: produces analyses and nowcasts of precipitation and other surface weather parameters. refreshed on a sub-hourly or hourly cycle. Nowcasts are produced by blending current observations with forecasts from the most recent run of a convection permitting configuration of the Unified Model (currently, the 1.5 km grid length UKV).

- COTREC, CETRAC, INCA (Czech Republic)

- LAPS (Local Analysis Prediction System) Serbia, Finland

  - Radar, lidar, surface observations, radiosondes and Amdar.

- **Germany**

  - COSMO-DE and KONRAD (Germany): Model plus radar tracking convective cells.
  - CellMOS: MOS-based system for thunderstorm tracking and related severe weather warnings. Using radar reflectivities, observations of lightning and GME model data over Germany all cells having a maximum reflectivity greater than 37 dBZ, an area size greater than 9 km² and at least one lightning are detected.

  - NowCastMIX : Integrated, optimised set of automatic warnings for the next hour for thunderstorms, torrential rain, snowfall and freezing rain.