



Recent activities related to EPS (operational aspects)

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With contributions from WGNE members

32nd WGNE

Exeter, United Kingdom, 9-12 October 2017

GLOBAL

Operational global (weather) EPS

Center	Resolutions	FC Range	Members	Initial perturbation, DA	Model Uncertainty	B.C.	Note
ECMWF (Europe)	TCo639L91 TCo319L91 18/32km	15d 46d	51	SV(Total energy norm) + EnDA	SKEB (plan to terminate) and Stochastic physics (SPPT) (plan to use same pert. Both in EDA and ENS),SPP	coupling to ocean model, EDA-based land-surface pert. in ENS Ics	Hindcast dataset increased
Met Office (UK)	20kmL70	7d	17+1 44 for DA 100+ for DA	ETKF En-4D-EnVar	Random Parameters (RP2) and SKEB2.	SST, Soil moisture and deep soil temperature	
Meteo France (France)	T798(C2.4) L90	4d	35	SV (Total Energy Norm)+ EnDA	A new set of 10 physical packages, new model pert.	N SURFEX and pert.	
HMC (Russia)	T169L31 25-30km	10d	12+1+1	Breeding EnDA or LETKF	N SPPT	N SST random pert.	
NCEP (USA)	TL574L64 TL382L64	8d +8d 35d	41	Ensemble Kalman Filter + Tropical storm relocation	stochastic pert. to account for random model errors SKEB, SPPT, SHUM	N Stochastic pert. of land, couple with ocean	Dynamical core: Euler to Semi- Lgrangian
NRL/FNMOC (USA)	T159L42 T359L60	16d	20	local ET	SKEB-mc	N SST initial pert. ocean, ice, wave coupling	
CMC (Canada)	0.6° L40	16d	20	Ensemble KF	stochastic pert. of physical tendencies and SKEB, further pert. to the physics	new method to evolve SST and sea- ice	
DWD (German)	40km	180h	40	LETKF	Physics parameter pert.	SST random pert.	Operation by the end of 2017

Black: current, Red: recent upgrade, green: planned or research

Operational global (weather) EPS

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CPTEC/INPE (Brazil)	T126 L28 TQ213L42	15d 30d	15	EOF-based perturbation EnKF	N	N	Couple with earth system model
BoM (Australia)	~60kmL70	10d	24	ETKF	Random Parameters (RP2) and SKEB2.	N	
JMA (Japan)	TL479L100 TL479L100 TL319L100	11d 18d 34d	27 13 13	SV(Total energy norm) +LETKF Reduce tropical initial SV pert.	Stochastic perturbation of physics tendency	Rev, SST and sea ice Pert. on SST	
CMA (China)	T213 L31	10d	15	SV	SPPT	N	
KMA (Korea)	~40kmL70 32km (p)	12d	24 44	ETKF Hybrid Ensemble 4D-Var	Random Parameters (RP2) and SKEB2.	N	

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Model resolution upgraded / plan

- Upgraded
 - JMA
 - Increase number of vertical layers from 60 to 100 (top of 0.1hPa to 0.01hPa)
 - Unify 3 systems (for TC forecast, weekly forecast and 1month forecast) into 1 system
- Plan
 - Meteo France
 - Increase horizontal resolution from T798C2.4 to T1198C2.2
 - DWD
 - Start of operational production by the end of 2017
 - Increase ensemble size from 40 to 80 for LETKF
 - CPTEC
 - Increase model resolution to TQ0213L42
 - Extend the forecasts to the sub-seasonal range

- At its current version, the atmospheric model lacks of computing efficiency:
- It takes up to 50 min to forecast up to 15 days in TQ0126L028
- It takes more than 3 hours to forecast up to 15 days in TQ0299L064
- The implemented version of Bias Correction feature requires a history of forecasts of the past 60 days
- It takes too much time to compute in the operation

Operational regional EPS

Center	Resolutions	FC Range	Members	Initial perturbation, DA	Model Uncertainty	B.C.	Note
Met Office (UK)	2.2kmL70 1.5kmL70-120	54h	11+1 18/24	High Resolution Analysis + global EPS Convective ensemble DA	Stochastic physics using random parameter	Perturbing parameters in JULES	UM Hourly operation
Meteo France (France)	2.5km	42h	11+1	Rescaled and centered from global EPS EDA or B-based random noise	SPPT	perturbations of surface	AROME
DWD (German)	2.8km	27h 45h	20 40	IFS, GMS, GME, GSM Ensemble DA based on LETKF	Increase Pert. Parameters	Terminate to use IFS, GMS, GME, GSM, start to use Global ICON EPS, soil moist pert.	COSMO For renewable energy
HMC (Russia)	2.2km	48h	10	COSMO-S14-EPS	N SPPT	COSMO-S14-EPS	COSMO
JMA (Japan)	5kmL76	39h	10+1 20+1	SV(Total energy norm) Hybrid DA	N Pert. tendency	JMA global EPS Perturbed SST	asuca, Test-operation
NRL/FNMOC (US)	27/9/3km	120h	10+1	Perturbed synoptic scales Perturbed Rankine Vortex	N	GEFS/NAVGEN with synoptic perturbations	COAMPS-TC
NRL/FNMOC (US)	45/15/5km	72h	20+1	ETKF	Parameter variations	NAVGEN ensembles	COAMPS
CMC (Canada)	15km	72h	20+1	Interpolated from global EPS Improved by global EPS	Stochastic pert. of physics	Global EPS Improved by global EPS	GEM
CMA (China)				Multi Scale Blending (GEPS and LETKF)	RP	Global EPS	UM
KMA (Korea)	3kmL70	45h	23+1	Downscale from Global EPS LETKF	RP	Global EPS	UM

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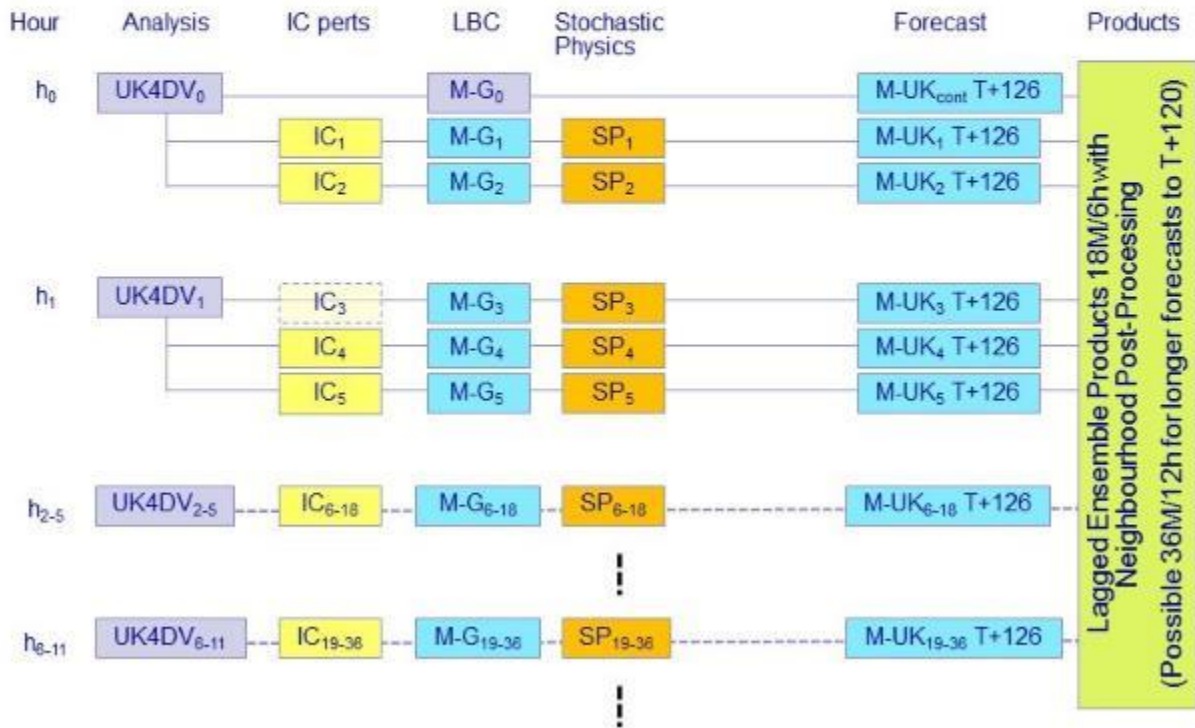
Model resolution upgraded / plan

- Upgraded
 - DWD
 - LETKF-based ensemble data assimilation with 40 members in assimilation cycle and 20 members in forecast
 - Met Office
 - Domain size increase
 - Forecast length increase from 36hours to 54 hours
 - JMA
 - Change model to use same as the deterministic model
 - Increase number of vertical layers from 48 to 76
- Plan
 - DWD
 - Resolution increase from 2.8 to 2.2 km, combined with larger model domain and increased number of model levels from 50 to 65
 - Met Office
 - Run a small ensemble (3members) every hour and use time-lagging
 - Increase resolution from 2.2km to 1.5km (same as deterministic model)
 - Meteo France
 - From 12-hourly to 6-hourly productions, later increase ensemble size & resolution

Future upgrades

- Studies have shown increasing ensemble size is of greater benefit to MOGREPS-UK than increasing the resolution (Hagelin et al 2017)
 - Implementing this would create large spike in computer use
- > Proposed alternative
- Run a small ensemble (3 members) every hour and use time-lagging to create a larger ensemble (18 members per 6h cycle, there are 12 members per 6h cycle in the current setup)
 - This is planned to run as demonstration suite later in the year to assess the differences more thoroughly and give time for downstream systems to adapt
 - Resolution also planned to increase to 1.5 km (same as deterministic model) and the run length to t+120h

Hourly ensemble schematic



- Takes advantage of UKV now running hourly 4DVar and the recent increase in number of global ensemble members