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The NCEP Short-Range Ensemble Forecast (SREF) System for NAEFS_LAM

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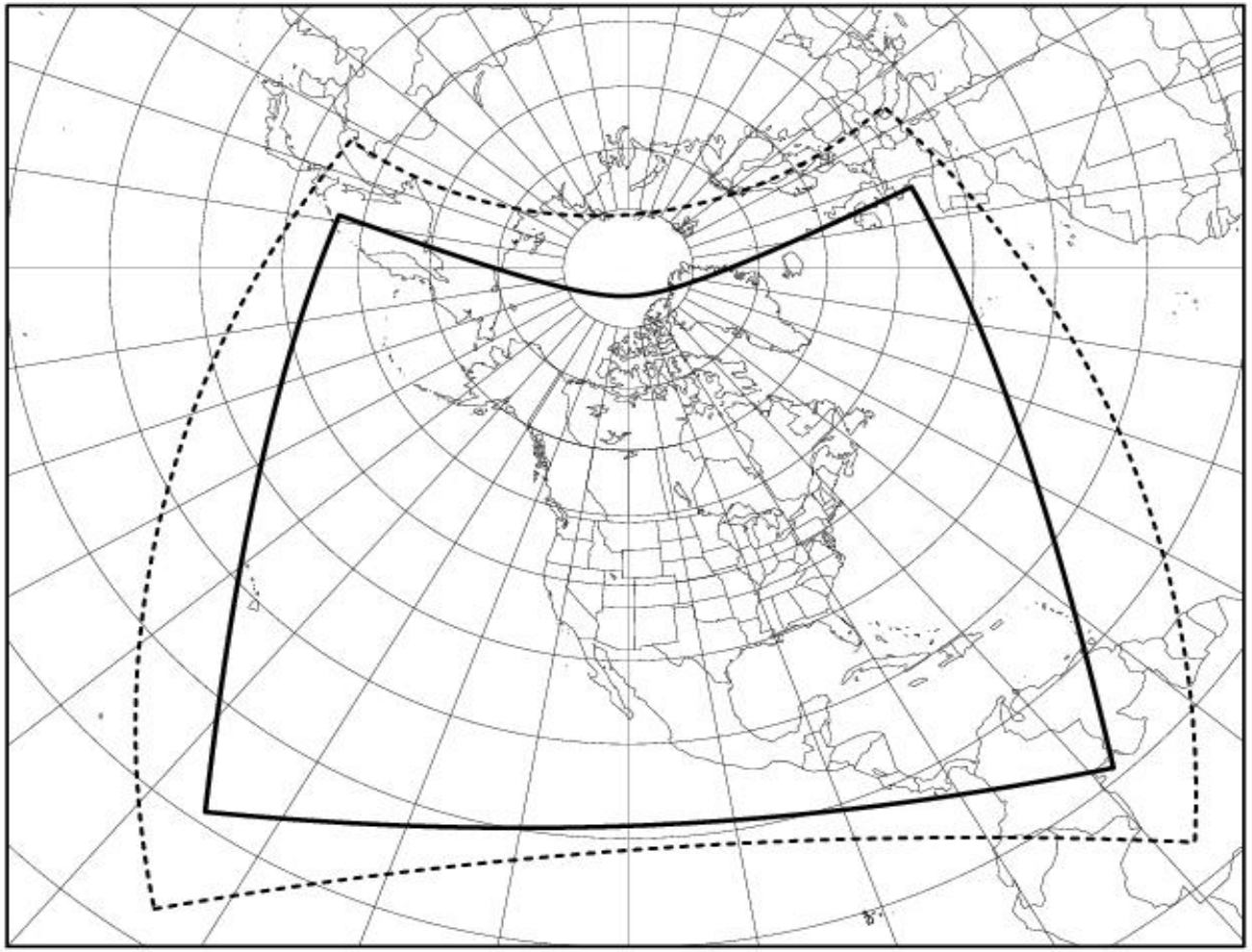
Motivation

- **Need** - Both countries need to run high-resolution regional ensembles for high-impact weather.
- **Problem** - Both countries are big in domain and don't have enough computing resources to run such a high-resolution ensemble with large enough ensemble size.
- **Benefit** - More resource can be spent on increasing model resolution but not on increasing ensemble membership as well as increasing forecast diversity.

Current Operational SREF

- Large North American domain
- 32km
- 21 members
- Output frequency: hourly to 39hr (1.5 day) then 3hrly to 87hr (3.5 day)
- Run 4 cycles per day (21, 03, 09, 15z)
- grib1 and grib2 format (in grid221, 30km)
- Regional bred+global ET, multi-analysis, multi-model, multi-physics, multi-LBCs
- Bias correction
- (Downscaled to 4km over CONUS only but could to 12km over NA)

SREF Domains

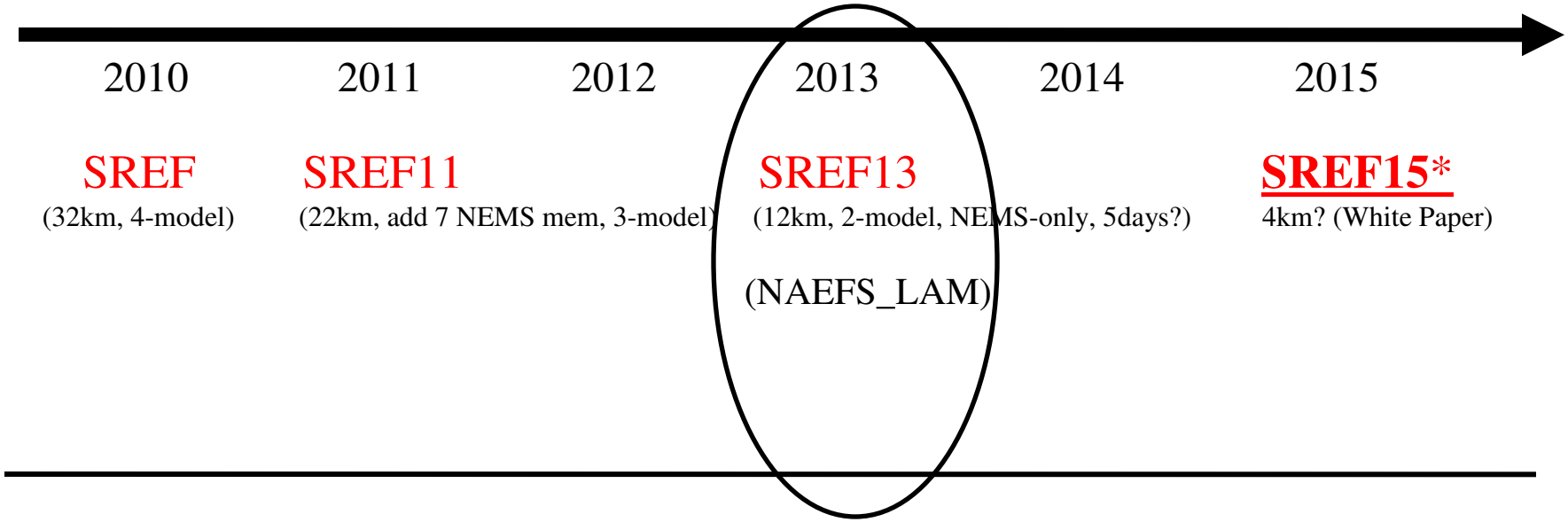


model domain (dash)
output domain (solid)

NCEP SREF System (21 members)

Model	Membership	Resolution	Forecast Hours	IC/IC perturbation	LBC/LBC perturbation	Output Frequency for pgrb files	Output Frequency for bufr soundings
Eta_BMJ	3 (ctl1, n1, p1)	32km	87hr (4 times, 3, 9, 15, 21z)	ndas/regional BV	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
Eta_KF	3 (ctl2, n2, p2)	32km	87hr (4 times, 3, 9, 15, 21z)	ndas/regional BV	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
RSM_SAS_ Ferrier	3 (ctl1, n1, p1)	32km	87hr (4 times, 3, 9, 15, 21z)	GFS 3hr fcst/regional BV	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
RSM_RAS_ Zhao	2 (n2, p2)	32km	87hr (4 times, 3, 9, 15, 21z)	GFS 3hr fcst/regional BV	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
NMM	5 (ctl, n1, p1, n2, p2)	32km	87hr (4 times, 3, 9, 15, 21z)	GFS 3hr fcst/global ET	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
ARW	5 (ctl, n1, p1, n2, p2)	35km	87hr (4 times, 3, 9, 15, 21z)	GFS 3hr fcst/global ET	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites

SREF Evolution

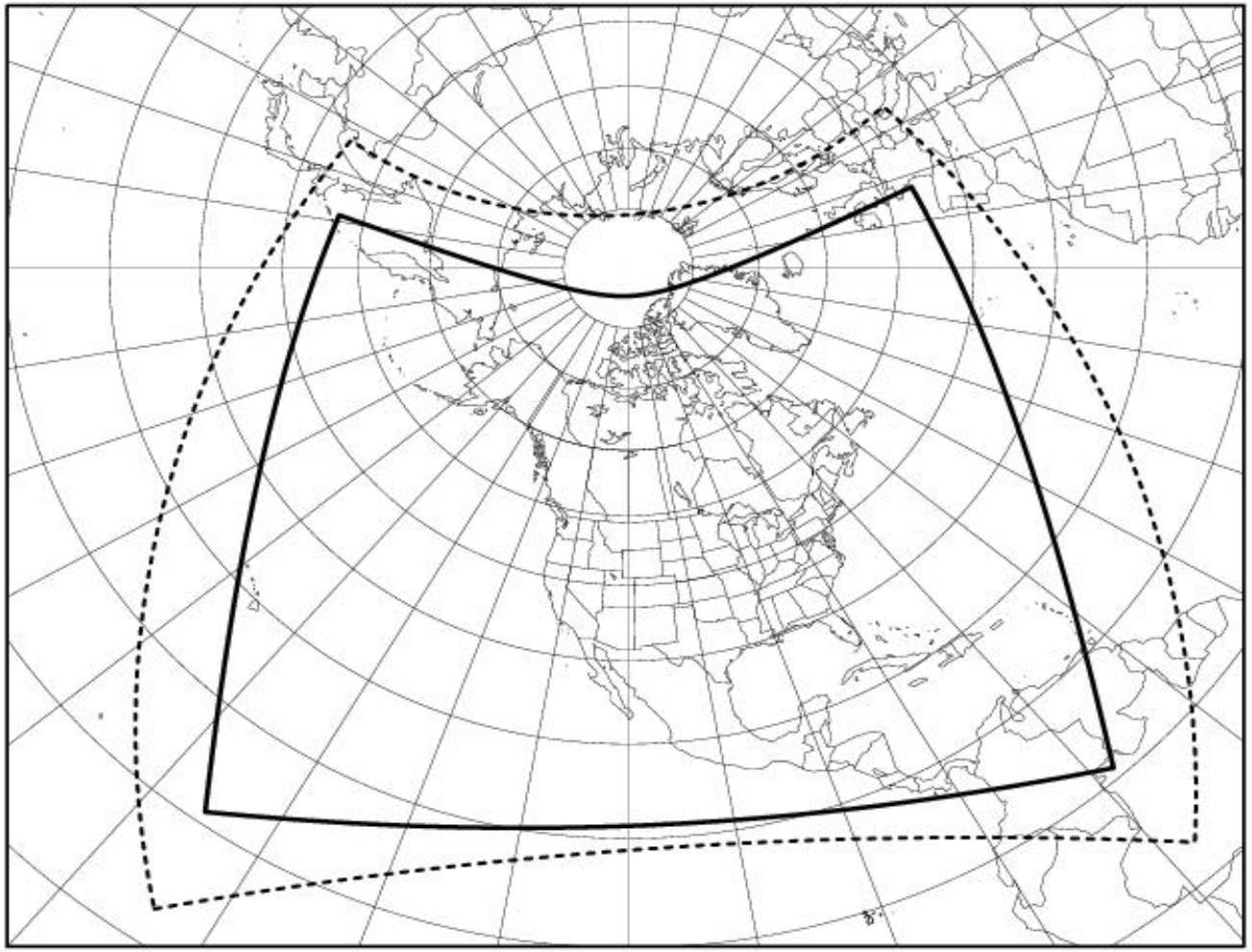


*NEMS = NOAA Environmental Modeling System (a unified modeling framework)
*SREF (32→22→12 →4km)

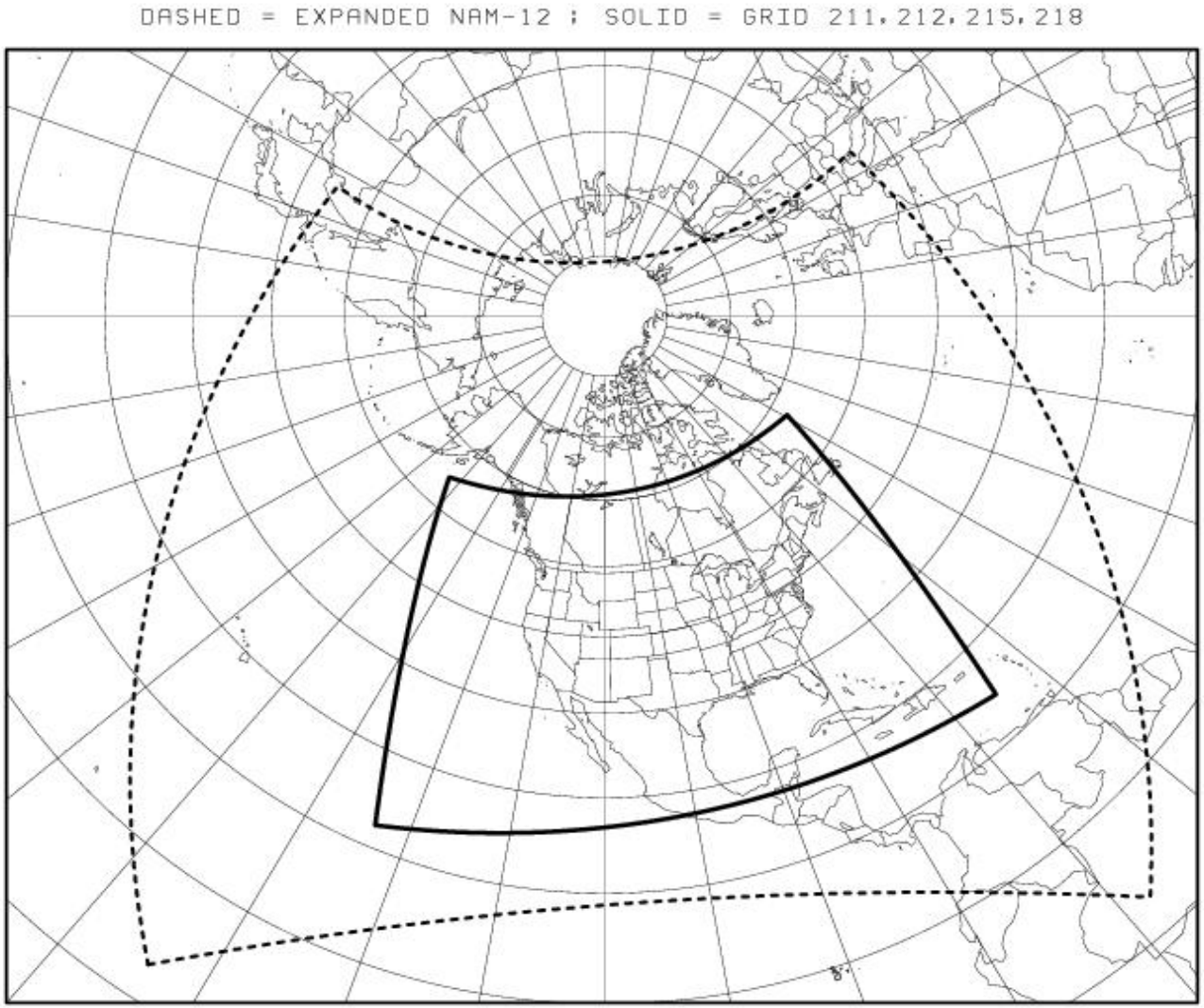
SREF for NAEFS_LAM

- 2010: research to see any benefit of combining the two systems (VC2010 Winter Olympic)
- 2011: (Assuming there is a benefit) resolve technical details about the data exchange
- 2012: one year real-time experiment to bring forecasters involved
- 2013: operational implementation at both centers

Output domain requirement: ideally North American domain (solid)



Output domain requirement: at least the CONUS domain (solid)



Thoughts on data exchange

- WMO-grib2 format
- Center-specific grid in production with grid-2-grid conversion tool such as “copygb” (more flexible and preferred)
- Output to a common grid (less flexible, extra work and data storage etc.)

Post processing and calibration

- Bias correction
- Downscaling?
- Spread/probability calibration?

System comparison

Appendix 2.2.1

DRAFT Information on NAEFS Regional EPS (REPS) systems

Parameter	CMC	NCEP
Ensemble	20 GEM	21 (NMM, ARW, Eta, RSM)
GRID		NA grid (grid221)
DOMAIN	Extended North America	Extended North America
FORMAT	WMO Grib2 Format	WMO Grib2 Format
HOURS	every 3 hours from 0 to 048 hours	hrly to 39h then 3hrly to 87h
GB	000-048 hours @ 3hours interval 0.72 GB	00-87 hours @ 3hours (hour) interval 2.4 GB (4.8GB)

Current data volume estimation

The estimated SREF data for the NAEFS_LAM (in grib2, 21 members, NA domain/221 grid, around 100 variables) as of today's system:

2.4GB/cycle (if output 3hrly to 87hr)

4.8GB/cycle (if output hourly for the first 39hr and then 3hrly to 87hr)

Upper air variables

Appendix 2.2.2 part 1 of 4

DRAFT			CMC RAW BC	NCEP RAW BC
NAEFS Upper Air Variables	**Levels**	**Comments**	**60 ??**	**?? ??**
Geopotential Height	200, 250, 500, 700, 850, 925, 1000 mb			
Temperature	200, 250, 500, 700, 850, 925, 1000 mb			
U component of wind	200, 250, 500, 700, 850, 925, 1000 mb			
V component of wind	200, 250, 500, 700, 850, 925, 1000 mb			
Relative Humidity	200, 250, 500, 700, 850, 925, 1000 mb			
Vertical motion	850 mb			

Surface variables

NAEFS Surface variables	Levels	Comments	CMC Raw Bc	NCEP raw bc
Surface model topography	Model topography	CMC provides at fhr=000 only		
Temperature	2m above ground			
U component of wind	10m above ground			
V component of wind	10m above ground			
Relative Humidity	2m above ground			
Surface Pressure	Surface			
Pressure MSL	Mean Sea Level			
Total Cloud	Surface			
Precipitable water	Surface			
? Tmin at 2m, 6 hr interval	2m above ground	Tmin in ? hour interval		
? Tmax at 2m, 6 hr interval	2m above ground	Tmax in ? hour interval		
Cape	layer	?		
Convective Inhibition	Layer	?		

Precipitation variables

NAEFS Precipitation variables	Levels	Comments	CMC Raw Bc	NCEP Raw Bc
Total Precipitation	Surface	NCEP 6hr interval CMC cumulative from 000hr		
Categorical rain	Surface	NCEP 6hr interval CMC-n/a		
Categorical snow	Surface	NCEP 6hr interval CMC-n/a		
Categorical ice	Surface	NCEP 6hr interval CMC-n/a		
Categorical freezing rain	Surface	NCEP 6hr interval CMC-n/a		
Cumulative precipitation type Rain	Surface	CMC cumulative from 00hr		
Cumulative precipitation type Snow	Surface	CMC cumulative from 00hr		
Cumulative precipitation type Ice Pellets	Surface	CMC cumulative from 00hr		
Cumulative precipitation type Freezing Rain	Surface	CMC cumulative from 00hr		
Temperature 0-10 cm below ground	0-10 cm below ground	? CMC TBD instantaneous		
Soil moisture 0-10 cm below ground	0-10 cm below ground	? CMC TBD instantaneous		
Snow water equivalent at surface	Surface	? CMC TBD instantaneous		
Snow depth at surface	Surface	? CMC TBD instantaneous		

Flux fields

NAEFS Flux variables Variable added to GRIB2 dataset fall 2009	Levels	Comments	CMC Raw Bc	NCEP Raw Bc
Latent heat flux at surface	Surface			
Sensible heat flux at surface	Surface			
Downward surface short wave radiation	Surface			
Downward surface long wave radiation	Surface			
Outgoing long wave top of atmosphere	Nominal Top of Atmosphere			
Upward short wave radiation at surface	Surface			
Upward long wave radiation at surface	Surface			

Future CMC REPS data growth

Estimated growth of the CMC NAEFS REPS dataset – for planning purposes

REPS RAW BC	REPS Fall 2010	REPS Fall 2011	REPS Fall 2012	REPS Fall 2013
Number of variables Raw BC	 80 40	 80 40	 100 50	 100 50
Number of time steps 1-2 days @ 3hrs intvl => 17 1-3 days @ 3hrs intvl => 25 1-4 days @ 3hrs intvl => 33	25	25	25	33
REPS Runs/day	? [06,18]Z	?? [00,06,12,18]Z	?? [00,06,12,18]Z	?? [00,06,12,18]Z
Grid resolution Polar Stero.	33km	33km	33km	33km
Number of members	21	21	21	21
Estimated GB/run Raw Bc GRIB2	 1.5 0.8	 1.5 0.8	 1.9 1.0	 2.5 1.3

Future NCEP SREF data growth

REPS RAW BC	REPS Fall 2010	REPS Fall 2011	REPS Fall 2012	REPS Fall 2013
Number of variables Raw BC	100 32	100 32	100 50	100 50
Number of time steps 1-2 days @ 3hrs intvl => 17 1-3 days @ 3hrs intvl => 25 1-4 days @ 3hrs intvl => 33	30(56)	30(56)	30(56)	30(56)
REPS Runs/day	4(21/03/09/15)	4	4	4(00/06/12/18?)
Output grid resolution	30km	20km	20km	12km
Number of members	21	21	21	21
Estimated GB/run Raw Bc GRIB2	2.4(4.8) 0.5	3.6(7.2) 0.8	3.6(7.2) 1.0	7.0(14.0) 1.8

Discussions

- Timeline?
- Need a common output grid?
- Hourly output for the first 36hr?
- Data exchange channel?
- Exchange variables?
- Output grid spatial resolution?
- Forecast length?
- Frequency of cycling?
- Post calibration besides bias correction?
- ……