NAEFS
REPS and GEPS datasets

NAEFS workshop May 17-19, 2010, Cuernavaca

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Overview

- Quick review of NAEFS GEPS variables
  - Raw and Bias Corrected (BC)
- Possible NAEFS REPS dataset
- Possible NAEFS GEPS day 17-35 dataset
- Sample estimates of NAEFS datasets

Sept 2004
52 NAEFS variables – GRIB1 format

Upper Air	Levels
HGT	200, 250, 500,700, 850 , 925, 1000
TEMP	200, 250,500,700, 850 , 925, 1000
UGRD	200, 250, 500,700, 850 , 925, 1000
VGRD	200, 250, 500,700, 850 , 925, 1000
DEPR	200, 250, 500, 700, 850, 925, 1000 - CMC
RH	200, 250, 500, 700, 850, 925, 1000 - NCEP

Surface
UGRD, VGRD, 10m
TEMP, DEPR, 2m
TMAX, TMIN 2m
APCP Surface
HGT Surface as seen by the model

Moisture
TCDC Total cloud
PWAT Surface **NOTE: Prior to Sept 14, 2004 CMC labeled this variable CWAT**

PMSL MSL
PRES Surface

Precipitation
Categorical Rain, Snow, Ice, Freezing – NCEP
Accumulated Rain, Snow, Ice, Freezing rain – CMC
Info: http://journals.ametsoc.org/doi/full/10.1175/1520-0434%282000%29015%3C0583%3AAMTDPT%3E2.0.CO%3B2

CAPE

May 2010 – GRIB2
80 NAEFS Raw variables

HGT **10,50,100,** 200, 250, 500,700, 850 , 925, 1000
TEMP **10,50,100,** 200, 250,500,700, 850 , 925, 1000
UGRD **10,50,100,** 200, 250, 500,700, 850 , 925, 1000
VGRD **10,50,100,** 200, 250, 500,700, 850 , 925, 1000
RH **10,50,100,** 200, 250, 500, 700, 850, 925, 1000 (CMC + NCEP)
VVEL 850 mb

UGRD, VGRD, 10m
TEMP, DEPR, 2m
TMAX, TMIN 2m
APCP Surface
HGT Surface as seen by the model

TCDC Total cloud
PWAT Surface

PMSL MSL
PRES Surface

Precipitation
Categorical Rain, Snow, Ice, Freezing – NCEP
Accumulated Rain, Snow, Ice, Freezing rain – CMC

CAPE

Snow water equivalent Surface
Snow depth Surface
Temperature, Soil moisture 0-10 cm below ground

CINH Convective Inhibition

Latent heat flux Surface
Sensible heat flux Surface

Downward short wave radiation Surface
Downward long wave radiation Surface

Updard short wave radiation Surface
Upwdard long wave radiation Surface

Outgoing long wave top of atmosphere

NAEFS Bias Corrected (BC) variables
May 2010 [47,49] variables, GRIB2

HGT 10,50,100, 200, 250, 500,700, 850 , 925, 1000 mb
TEMP 10,50,100, 200, 250,500,700, 850 , 925, 1000 mb
UGRD 10,50,100, 200, 250, 500,700, 850 , 925, 1000 mb
VGRD 10,50,100, 200, 250, 500,700, 850 , 925, 1000 mb
VVEL 850 mb – NCEP only

UGRD, VGRD, 10m
TEMP 2m
TMAX, TMIN 2m

PRES Surface
PMSL MSL

Upward long wave radiation Surface – NCEP only

Notes – (Bias Correction w.r.t. originating center analysis)

- Centers now bias correct their own data and share it with other centers
- CMC using NCEP generated bias-corrected data
- NCEP soon to be using CMC generated bias corrected data

Bias correction against NCEP reanalysis still done by each center

May 2010 NAEFS upper air variables

(description could be included in NAEFS document)

			CMC RAW BC	NCEP RAW BC	FNMOC RAW BC
NAEFS GEPS Upper Air Variables	**GRIB Abbreviation**	**Levels**	80 47	80 49	69 n/a
Geopotential Height	HGT	10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 mb	10 10	10 10	10 n/a
Temperature	TEMP	10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 mb	10 10	10 10	10 n/a
U component of wind	UGRD	10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 mb	10 10	10 10	10 na/
V component of wind	VGRD	10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 mb	10 10	10 10	10 n/a
Relative Humidity	RELH	10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 mb	10 n/a	10 n/a	10 n/a
Vertical motion	VVEL	850 mb	1 n/a	1 1	1 n/a

May 2010 NAEFS GEPS Surface Variables
(description could be included in NAEFS document)

	GRIB Abbreviation	Levels	Comment	CMC Raw Bc	NCEP raw bc	FNMOC raw bc
Surface model topography	HGT	Model topography		Raw n/a	Raw Bc	Raw n/a
Temperature	TEMP	2m above ground		Raw Bc	Raw Bc	Raw n/a
U component of wind	UGRD	10m above ground		Raw Bc	Raw Bc	Raw n/a
V component of wind	VGRD	10m above ground		Raw Bc	Raw Bc	Raw n/a
Relative Humidity	RELH	2m above ground		Raw Bc	Raw Bc	Raw n/a
Surface Pressure	PRES	Surface		Raw Bc	Raw Bc	Raw n/a
Pressure MSL	MSL	Mean Sea Level		Raw Bc	Raw Bc	Raw n/a
Total Cloud	TCLD	Surface	NCEP 6 hr average CMC instantaneous	Raw n/a	Raw n/a	Raw n/a
Precipitable water	PWAT	Surface		Raw n/a	Raw n/a	Raw n/a
Tmin at 2m, 6 hr interval	TMIN	2m above ground	Tmin observed in 6 hour interval	Raw Bc	Raw Bc	Raw n/a
Tmax at 2m, 6 hr interval	TMAX	2m above ground	Tmax observed in 6 hour interval	Raw Bc	Raw Bc	Raw n/a
Cape	CAPE	layer	NCEP: first 180mb above ground CMC sfc-top of atm.	Raw n/a	Raw n/a	Raw n/a
Convective Inhibition	CINH	layer	NCEP: first 180mb above ground CMC sfc-top of atm.	Raw n/a	Raw n/a	Raw n/a

May 2010 NAEFS GEPS Precipitation	GRIB Abbreviation	Levels	Comment	CMC Raw Bc	NCEP Raw Bc	FNMOC Raw Bc
Total Precipitation	APCP	Surface	NCEP, FNMOC @ 6 hr interval CMC cumulative from 000hr	Raw n/a	Raw n/a	Raw n/a
Categorical rain	CRAIN	Surface	NCEP, FNMOC @ 6 hr interval CMC-no	Raw n/a	Raw n/a	Raw n/a
Categorical snow	CSNOW	Surface	NCEP, FNMOC @ 6 hr interval CMC-no	Raw n/a	Raw n/a	Raw n/a
Categorical ice	CICE	Surface	NCEP, FNMOC @ 6 hr interval CMC-no	Raw n/a	Raw n/a	Raw n/a
Categorical freezing rain	CFRZ	Surface	NCEP, FNMOC @ 6 hr interval CMC-no	Raw n/a	Raw n/a	Raw n/a
Cumulative precipitation type Rain	ARAIN	Surface	CMC only, cumulative from 00hr NCEP no	Raw n/a	n/a	n/a
Cumulative precipitation type Snow		Surface	CMC only, cumulative from 00hr NCEP no	Raw n/a	n/a	n/a
Cumulative precipitation type Ice Pellets		Surface	CMC only, cumulative from 00hr NCEP no	Raw n/a	n/a	n/a
Cumulative precipitation type Freezing Rain		Surface	CMC only, cumulative from 00hr NCEP no	Raw n/a	n/a	n/a
Temperature 0-10 cm below ground	TEMP	0-10 cm below ground	? CMC instantaneous NCEP instantaneous	Raw n/a	Raw n/a	Raw n/a
Soil moisture 0-10 cm below ground	SMOIST	0-10 cm below ground	? CMC instantaneous NCEP instantaneous	Raw n/a	Raw n/a	Raw n/a
Snow water equivalent at surface	WEASD	Surface	? CMC instantaneous NCEP instantaneous	Raw n/a	Raw n/a	Raw n/a
Snow depth at surface	SNOD	Surface	? CMC instantaneous NCEP instantaneous	Raw n/a	Raw n/a	Raw n/a

May 2010 NAFS Flux Variables

(description could be included in NAEFS document)

May 2010 NAEFS GEPS Flux variables	GRIB Abbreviation	Levels	Comments	CMC Raw Bc	NCEP Raw Bc	FNMOC Raw Bc
Latent heat flux at surface	LHTFL	Surface	NCEP 6hr average CMC cumulative from 00hr	Raw n/a	Raw n/a	n/a n/a
Sensible heat flux at surface	SHTFL	Surface	NCEP 6hr average CMC cumulative from 00hr	Raw n/a	Raw n/a	n/a n/a
Downward surface short wave radiation	DSWRF	Surface	NCEP 6hr average CMC cumulative from 00hr	Raw n/a	Raw n/a	n/a n/a
Downward surface long wave radiation	DLWRF	Surface	NCEP 6hr average CMC cumulative from 00hr	Raw n/a	Raw n/a	n/a n/a
Outgoing long wave top of atmosphere	OLR	Nominal Top of Atmosphere	NCEP 6hr average CMC cumulative from 00hr	Raw n/a	Raw n/a	n/a n/a
Upward short wave radiation at surface	USWRF	Surface	NCEP 6hr average CMC cumulative from 00hr	Raw n/a	Raw Bc	n/a n/a
Upward long wave radiation at surface	ULWRF	Surface	NCEP 6hr average CMC cumulative from 00hr AIRU	Raw n/a	Raw n/a	n/a n/a

Fall 2010 - NAEFS GEPS datasets

	CMC	NCEP	FNMOC	CMC	NCEP	FNMOC
	RAW	RAW	RAW	Bias Corr.	Bias Corr.	Bias Corr.
Number of variables	80	80	69	47	49	
Number of members	21	21	21	21	21	
Start forecast hour	0	0	0	0	0	
End forecast hour	384	384	384	384	384	
Hours per time step	6	6	6	6	6	
Number of time steps	65	65	65	65	65	
Number of files per run	1365	1365	1365	1365	1365	
Size of NAEFS dataset by center GB / [00,12]Z run	**5.1**	**4.1**	**3.5**	**2.7**	**3.2**	
Format	grib2	grib2	grib2	grib2	grib2	grib2

Total GB: **CMC 7.8 GB** **NCEP 7.3 GB** **FNMOC=3.5 GB**

Possible future changes to CMC GEPS NAEFS dataset

CMC NAEFS –**GEPS**- RAW/BC datasets

Day 1 to day 16

GEPS 1-16 days RAW Bias Corrected (BC)	GEPS Fall 2010	GEPS Fall 2011	GEPS Fall 2012	GEPS Fall 2013
Number of variables Raw BC	80 47	100 50	100 55	125 60
Number of time steps 65 = 6hr time steps 129 = 3hr time steps	65	65	129	129
Grid resolution lat-lon	1 x 1	1 x 1	0.5 x 0.5	0.5 x 0.5
# of members	21	21	21	21
Estimated GB/run Raw BC GRIB2	5.1 2.7	6.5 2.7	51.2 25.1	64.1 27.4

GEPS day 1-16 RAW BC	GEPS Fall 2010	GEPS Fall 2011	GEPS Fall 2012	GEPS Fall 2013
Number of variables Raw BC	80 47	100 50	100 55	125 60
Number of time steps 65 = 6hr time steps 129 = 3hr time steps	65	65	129	129
Grid resolution lat-lon	1 x 1	1 x 1	0.5 x 0.5	0.5 x 0.5
# of members	21	21	21	21
Estimated GB/run Raw BC GRIB2	4.1 3.2			

Possible future changes to FNMOC GEPS NAEFS dataset

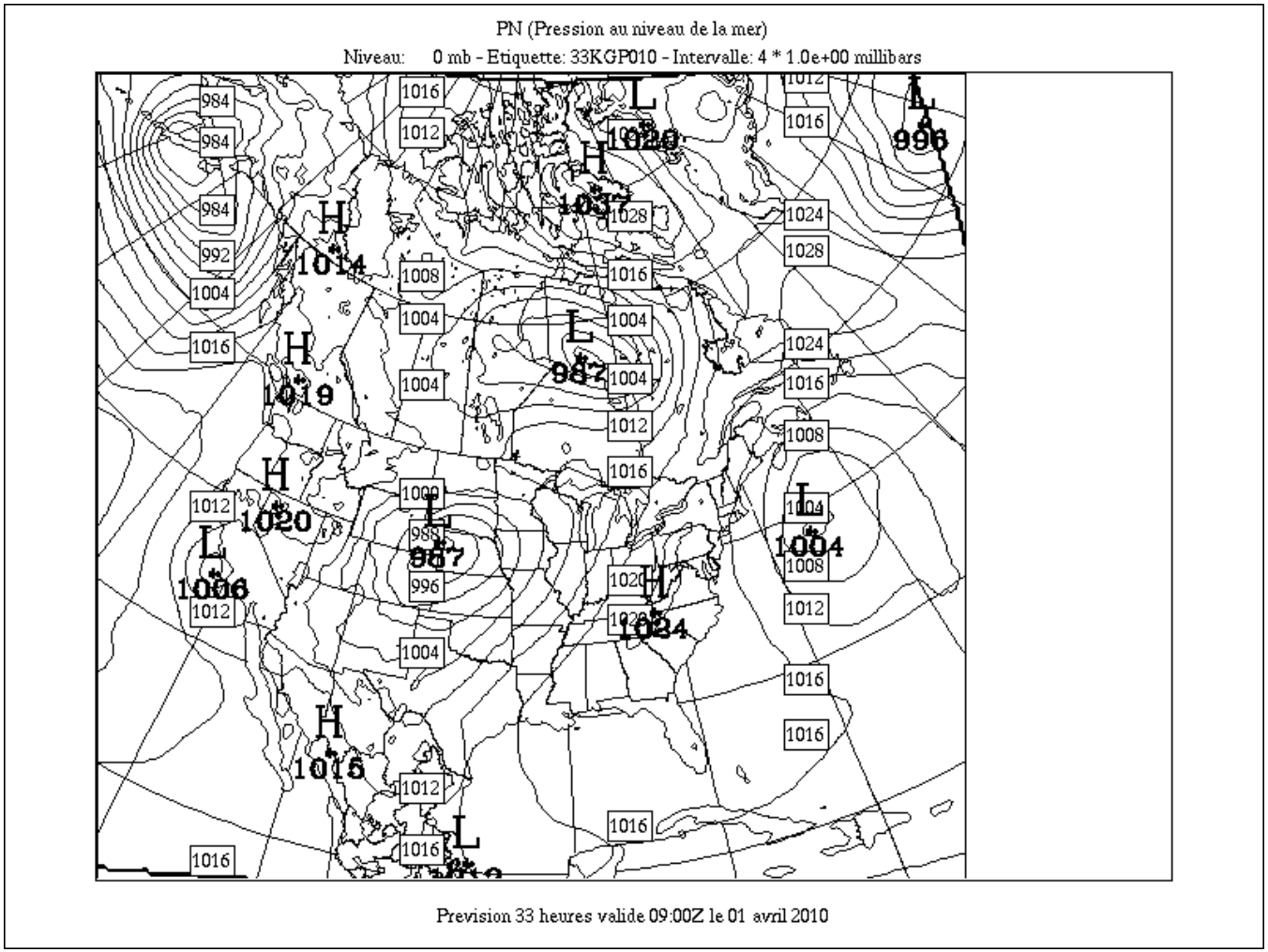
FNMOC NAEFS –**GEPS**- RAW/BC datasets

Day 1 to day 16 - DRAFT

GEPS day 1-16 RAW Bias Corrected (BC)	GEPS Winter 2009- 2010	GEPS Fall 2010	GEPS Fall 2011	GEPS Fall 2012	GEPS Fall 2013
Number of variables Raw BC					
Number of time steps 65 = 6hr time steps 129 = 3hr time steps	65	65	65	129	129
Grid resolution lat-lon	1 x 1	1 x 1	1 x 1	0.5 x 0.5	0.5 x 0.5
# of members	21	21	21	21	21
Estimated GB/run Raw Bc GRIB2					

Adding Regional EPS to NAEFS

Sample CMC REPS grid 247x 229, PS, 33km



Sample only – subject to change

Possible future changes to CMC NAEFS REPS dataset

CMC NAEFS –**REPS**- RAW/BC datasets

Day 1 to day [2,3,4]

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**

Possible future changes to CMC NAEFS REPS dataset

NCEP NAEFS –**REPS**- RAW/BC datasets

Day 1 to day [2,3,4]

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**

* - for dataset with hourlv forecast variables 000-036 hours

GEPS extended to day 17-35

New **CMC – GEPS Day 17-35** - RAW/BC datasets

CMC - 12 hr time steps, once/week

CMC GEPS Day 17-36	**fall 2010**	**fall 2011**	**fall 2012**	**fall 2013**
Number of variables **About ½ of CMC NAEFS** **Raw** **BC**	 40 20	 50 25	 50 25	 64 32
Number of time steps **396 to 840 hours** **@12hr interval**	32	32	32	32
Grid resolution **latitude-longitude**	1 x 1	1 x 1	.5 x .5	.5 x .5
Number of members	21	21	21	21
Estimated GB/run **Raw** **Bc** **GRIB2**	 1.5 0.8	 1.9 0.8	 7.5 3.7	 9.4 4.0

Summary possible growth - NAEFS data

GEPS day 1-16 RAW Bias Corrected (BC)	**Fall 2010**	**Fall 2011**	**Fall 2012**	**Fall 2013**
GEPS CMC NCEP	**Raw+BC 5.1+2.7 = 7.8 4.1+3.2 = 7.3**	**Raw+BC 6.5+2.7 = 9.2 9.2?**	**Raw+BC 51.2+25.1 =76.3 76?**	**Raw+BC 64.1+27.4 = 91.5 91?**
REPS CMC NCEP	**1.5+0.8 = 2.3 2.4+0.5 = 2.9**	**1.5+0.8 = 2.3 3.6+0.8= 4.4**	**1.9+1.0 = 2.9 3.6+1.0= 4.6**	**2.5+1.3 = 3.8 7.0+1.8= 8.8**
GEPS day 17-35 CMC / NCEP	**1.5+0.8 = 2.3**	**1.9+0.8=2.7**	**7.5+3.7=11.2**	**9.4+4.0=13.4**
Total GB / Run CMC NCEP ** Excluding day 17-35	**10.1 10.2**	**11.5 13.6**	**79.2 80.9**	**95.3 99.8**
Assume ideal transfers? Mbps estimated ➔	**10GB / 60 min 22.7 Mbps**	**12GB / 60 min 27.3 Mbps**	**80GB / 60 min 182 Mbps**	**100 GB / 60 min 227 Mbps**

Draft Recommendations

- REPS considerations
  - Define NAEFS REPS common grid, variables, time step
  - At CMC the REPS makes use of GEPS infrastructure
    - which should help adding REPS to NAEFS exchange
  - REPS dataset would appear to be small compared to NAEFS GEPS
  - Keep working on 1-5 year plan
  - Ensure main NAEFS document updated regularly

- GEPS Day 17-35? Considerations
  - Define NAEFS GEPS extended forecast period
  - Grid: same as NAEFS 1-16 day? Or stay at 1x1 deg, or coarser?
  - Define time step: /6hr? /12hr?
  - Define runs per week (CMC one 00Z run per week proposed)
  - GEPS extended dataset could be kept small compared to 1-16 day
  - Keep working on 1-5 year plan
  - Ensure main NAEFS document updated regularly

Draft recommendations

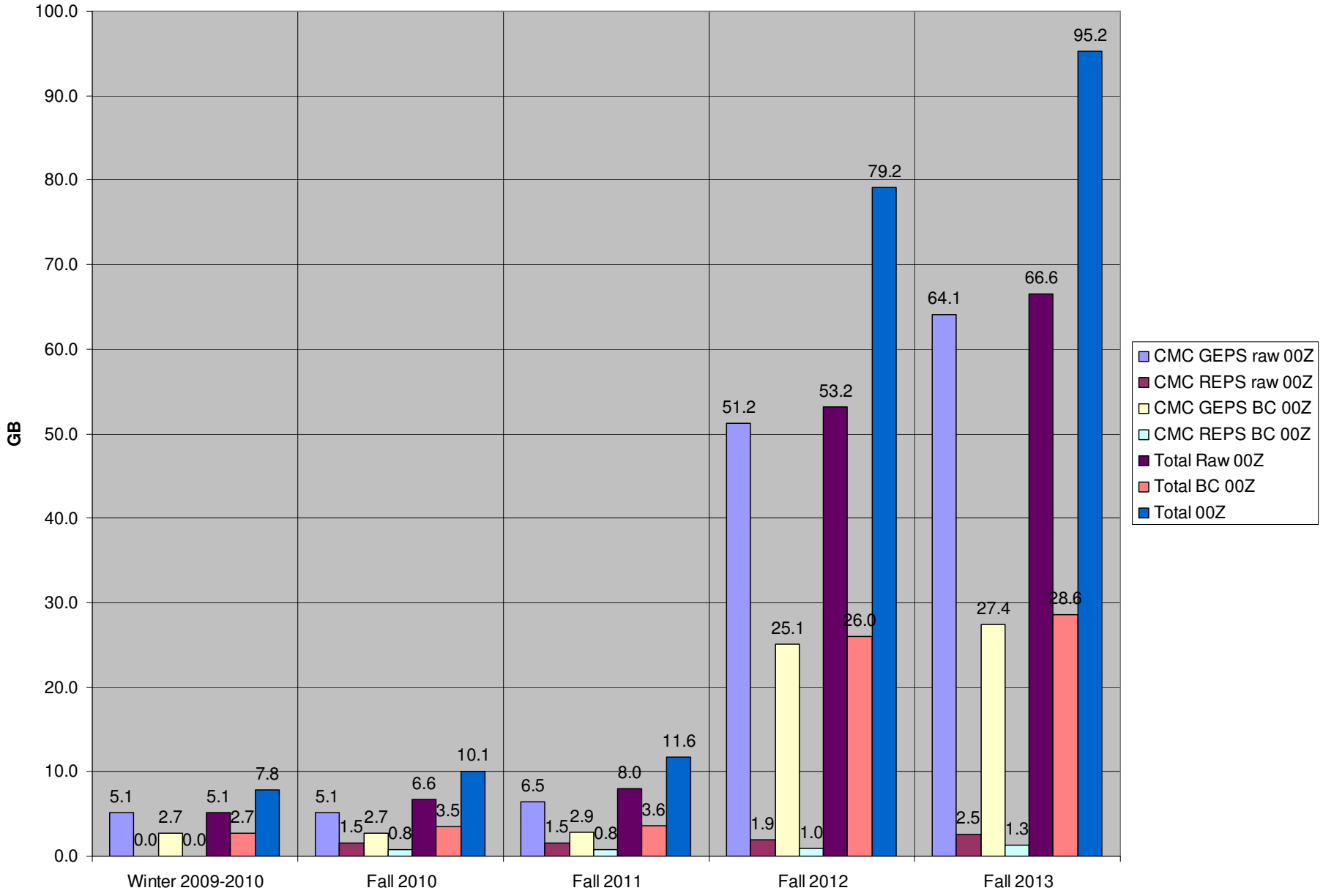
- **NAEFS variables**
  - Update plans for future NAEFS [Raw, BC] [G,R]EPS variables
  - Bias correction with respect to analysis done by originating centers
  - Update plans for future time interval of data – presently GEPS forecast variables are for 000-384 @ 6hr interval
- **NAEFS exchange grid**
  - Update plans for future NAEFS [G,R]EPS exchange grids
- **Various Documentation**
  - Prepare a 1-5 year plan w.r.t. variables and grids
  - Provide a central depot of information on NAEFS variables, include information on how variables are calculated at originating center
- **Access to each center NAEFS data**
  - Confirm each center to arrange public access to NWP data
  - Confirm data formats to be made available to the public?
  - Confirm each center to arrange public access to NAEFS derived products
- **Update NAEFS main document regularly**

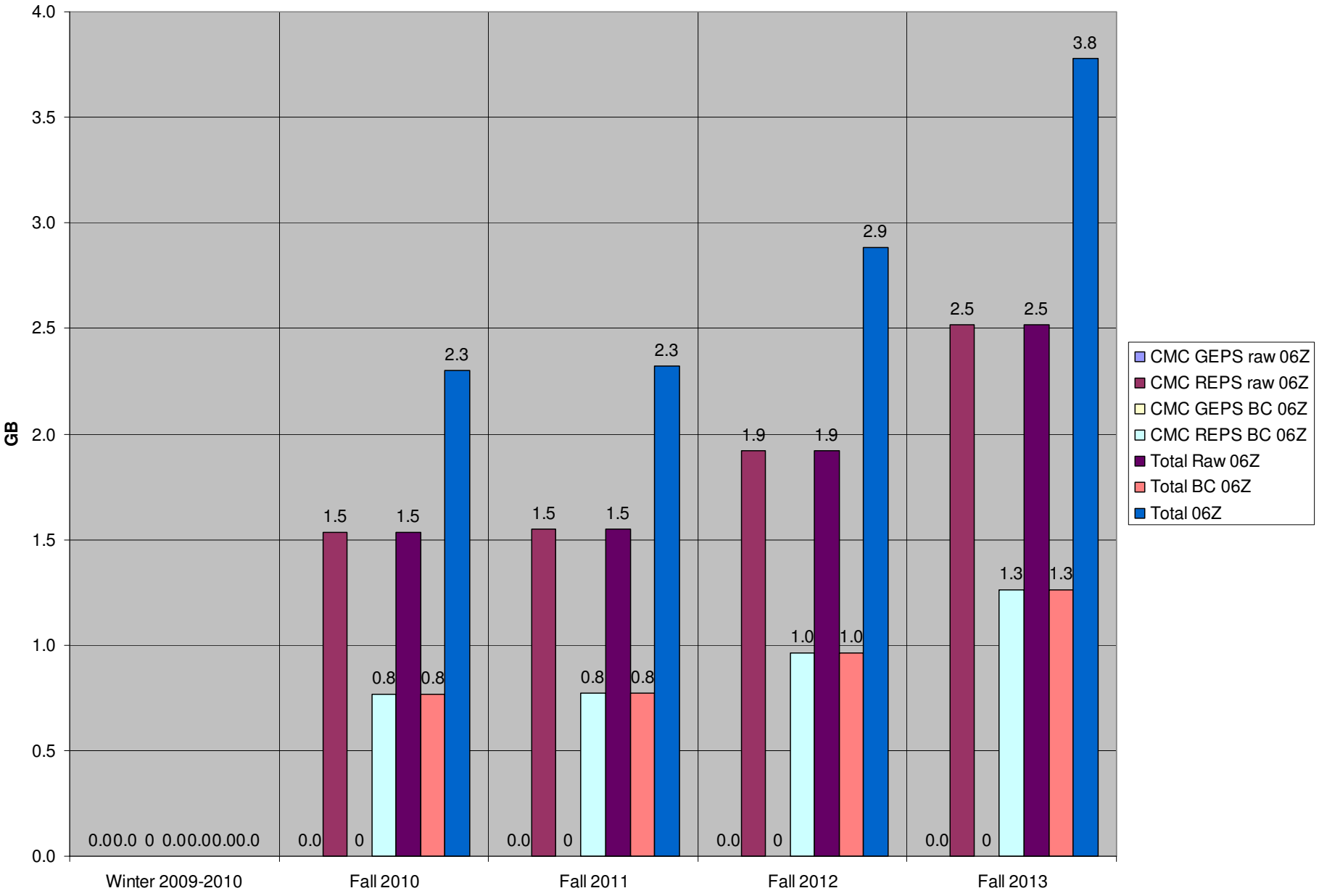
Thank you

Questions?

Where to find NAEFS information?

- MSC
  - English: http://www.weatheroffice.gc.ca/ensemble/index_naefs_e.html
  - French: http://www.weatheroffice.gc.ca/ensemble/index_naefs_f.html
  - CMC Product Guide
  - http://collaboration.cmc.ec.gc.ca/cmc/CMOI/product_guide/docs/naefs/NAEFS_Overview.xls
- NCEP
  - http://www.emc.ncep.noaa.gov/gmb/ens/NAEFS/NAEFS-prods.html
- FNMOC: coming soon
- NMSM: coming soon

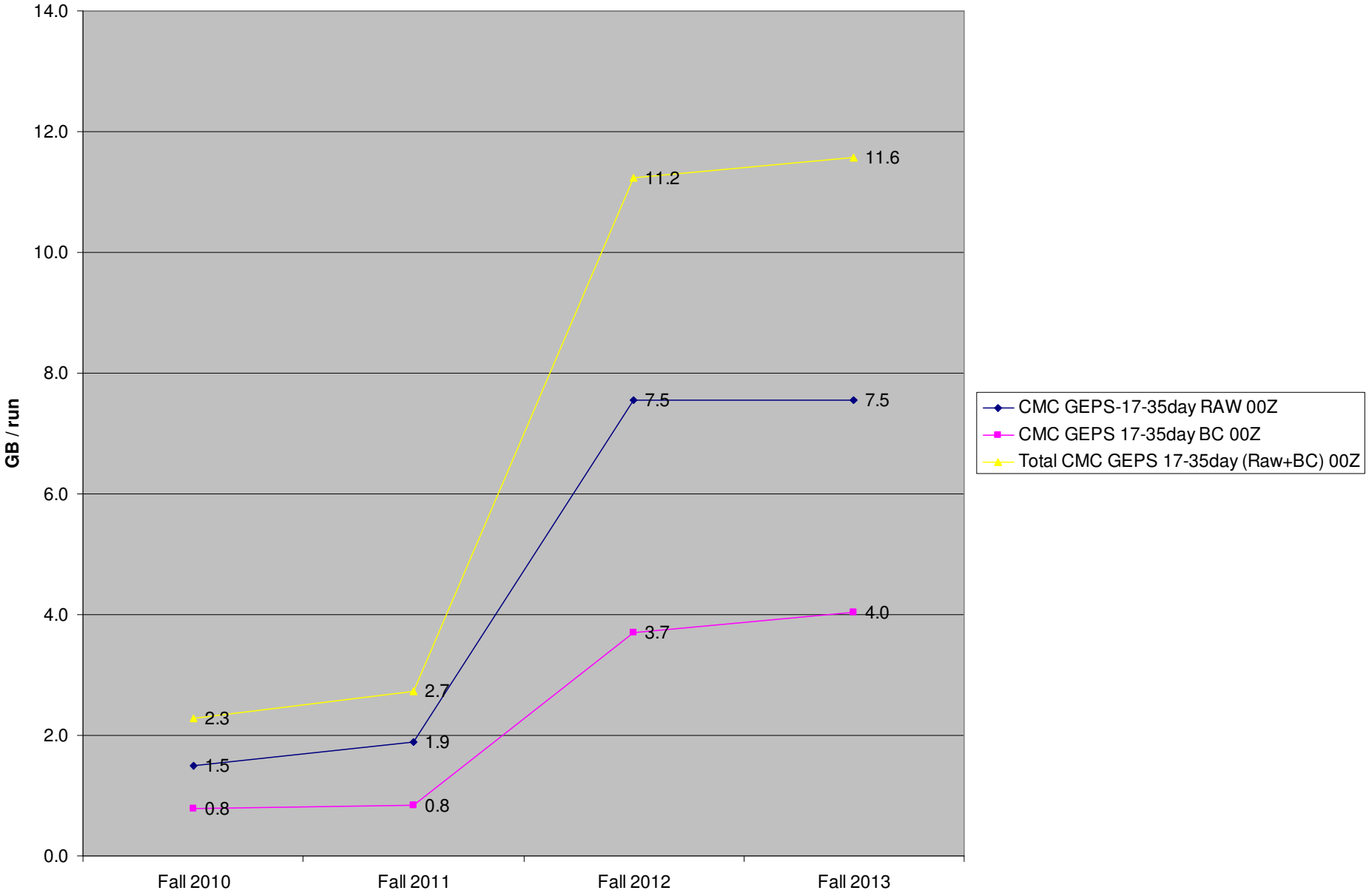

Estimated Growth CMC GEPS GRIB2 dataset for [00,12]Z runs
GB
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Winter 2009-2010
Fall 2010
Fall 2011
Fall 2012
Fall 2013
5.1
0.0
2.7
0.0
5.1
2.7
7.8
5.1
1.5
2.7
0.8
6.6
3.5
10.1
6.5
1.5
2.9
0.8
8.0
3.6
11.6
51.2
1.9
25.1
1.0
53.2
26.0
79.2
64.1
2.5
27.4
1.3
66.6
28.6
95.2
CMC GEPS raw 00Z
CMC REPS raw 00Z
CMC GEPS BC 00Z
CMC REPS BC 00Z
Total Raw 00Z
Total BC 00Z
Total 00Z

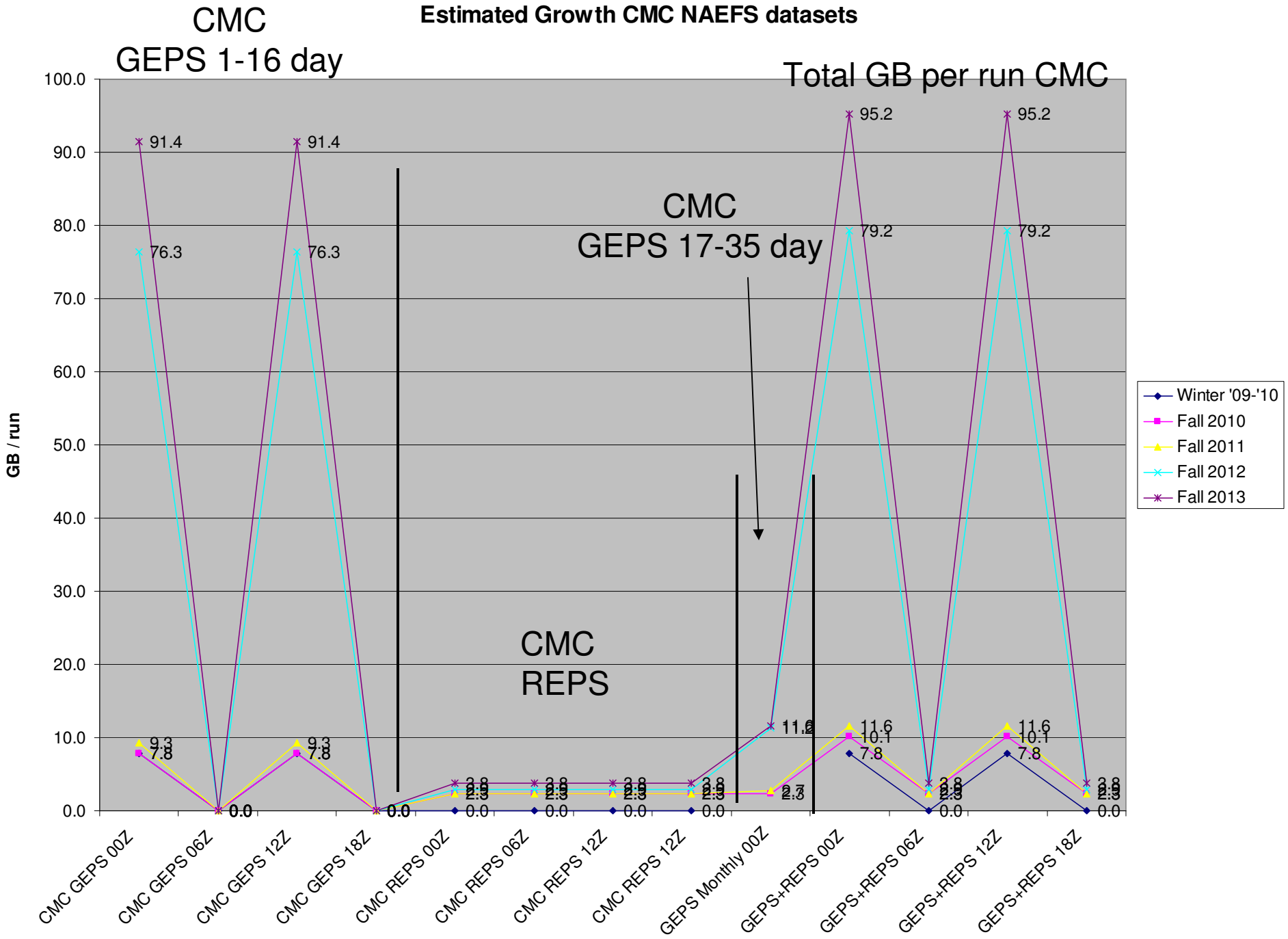

Estimated Growth CMC NAEFS GRIB2 [06,18]Z runs
GB
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0 0.0 0 0.0 0.0 0.0 0.0
0.0 1.5 0 0.8 1.5 0.8 2.3
0.0 1.5 0 0.8 1.5 0.8 2.3
0.0 1.9 0 1.0 1.9 1.0 2.9
0.0 2.5 0 1.3 2.5 1.3 3.8
Winter 2009-2010
Fall 2010
Fall 2011
Fall 2012
Fall 2013
CMC GEPS raw 06Z
CMC REPS raw 06Z
CMC GEPS BC 06Z
CMC REPS BC 06Z
Total Raw 06Z
Total BC 06Z
Total 06Z

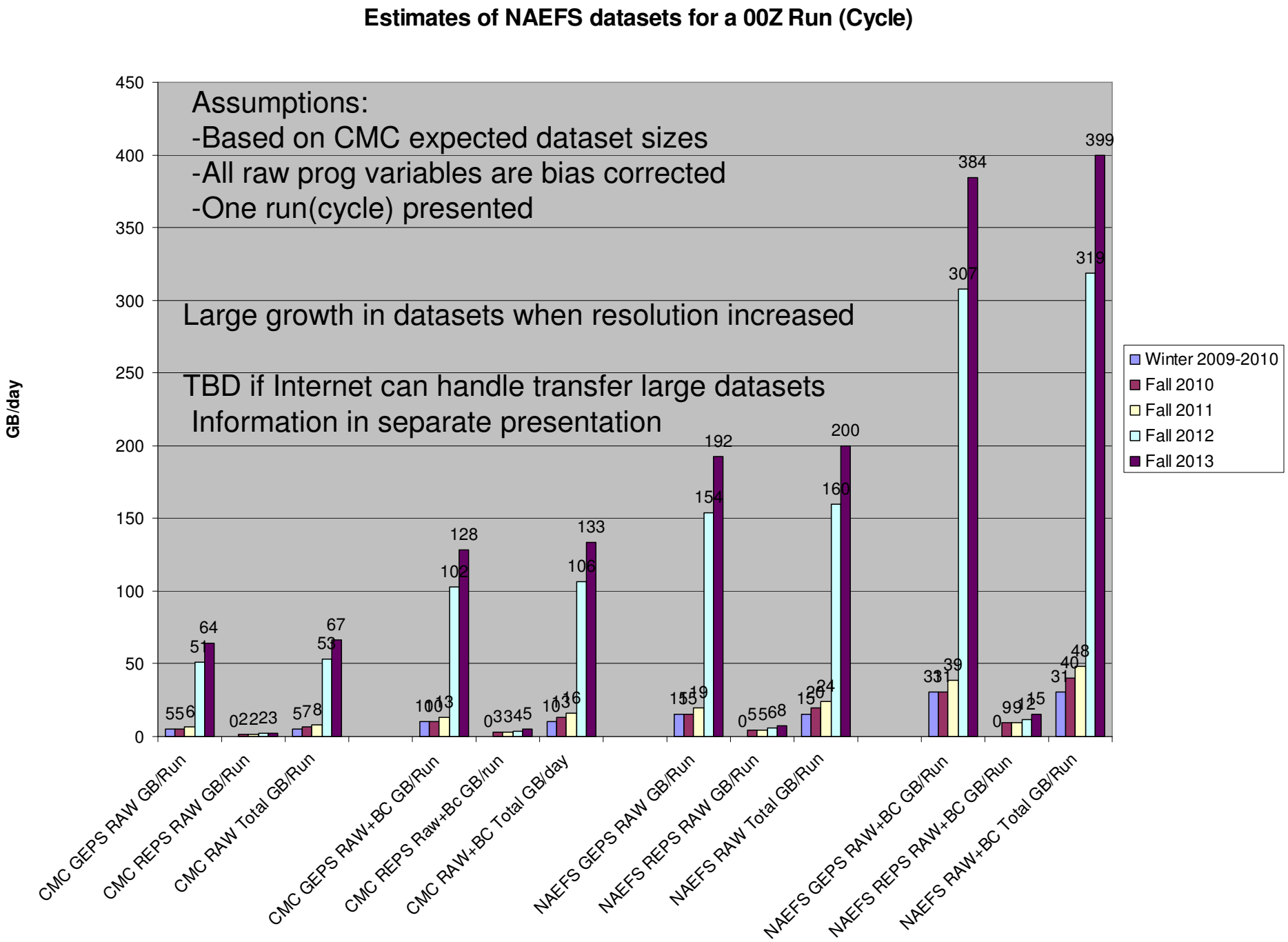
Adding GEPS day 17-35 to NAEFS

- Add GEPS 17-35 day forecasts to NAEFS
- CMC-Same infrastructure as 1-16 day GEPS except it runs out to 35 days
- If we make use of present variables used in NAEFS 1-16 day, then adding to data exchange is easier
- CMC considering running day 17-35 only once/week
- More planning, coordination required

Estimated GB for CMC GEPS 17day to 35day forecast data
Run only once per week at CMC




Estimated Growth CMC NAEFS datasets
CMC
GEPS 1-16 day
CMC
GEPS 17-35 day
CMC
REPS
Total GB per run CMC
GB / run
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
91.4
76.3
95.2
79.2
11.6
10.1
9.3
7.8
3.8
2.5
2.3
0.0
CMC GEPS 00Z
CMC GEPS 06Z
CMC GEPS 12Z
CMC GEPS 18Z
CMC REPS 00Z
CMC REPS 06Z
CMC REPS 12Z
CMC REPS 12Z
GEPS Monthly 00Z
GEPS+REPS 00Z
GEPS+REPS 06Z
GEPS+REPS 12Z
GEPS+REPS 18Z
Winter '09-'10
Fall 2010
Fall 2011
Fall 2012
Fall 2013


Estimates of NAEFS datasets for a 00Z Run (Cycle)
GB/day
Assumptions:
-Based on CMC expected dataset sizes
-All raw prog variables are bias corrected
-One run(cycle) presented
Large growth in datasets when resolution increased
TBD if Internet can handle transfer large datasets
Information in separate presentation
Winter 2009-2010
Fall 2010
Fall 2011
Fall 2012
Fall 2013
CMC GEPS RAW GB/Run
CMC REPS RAW GB/Run
CMC RAW Total GB/Run
CMC GEPS RAW+BC GB/Run
CMC REPS Raw+Bc GB/run
CMC RAW+BC Total GB/day
NAEFS GEPS RAW GB/Run
NAEFS REPS RAW GB/Run
NAEFS RAW Total GB/Run
NAEFS GEPS RAW+BC GB/Run
NAEFS REPS RAW+BC GB/Run
NAEFS RAW+BC Total GB/Run

CMC test grid for REPS

- GRILLE="GRILLE(PS,247,229,123.4,254.4,33000.,3.0,NORD)«
- GRILLE_DESCR="ps33kmres"