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Weather Forecast Data
An Important Input into Building
Management Systems

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ICEBO 2013, Montreal, Qc
October 10 2013

Version 2013-09-27

Acknowledgements

Concordia University
Dr. Radu Zmeureanu, Dr. Andreas K. Athienitis

Environment Canada
Meteorological Service of Canada - Canadian Meteorological Centre
Richard Hogue, Nicole Bois, Jacques Hodgson,
Dov Bensimon, Martin Fradette

Environment Canada
RPN – Recherche en Prévision numérique
Dr. Wei Yu, Dr. Paul Vaillancourt, Dr. Sylvie Leroyer

Natural Resources Canada – Canmet Energy
Dr. José A. Candanedo

2

Overview

- Building management and weather information

- Numerical weather forecast production 101

- From deterministic to probabilistic forecasts

- Some MSC weather forecast (NWP) datasets
  - Finding the appropriate data for the appropriate forecast

- Preparing for probabilistic forecasts

The building
Canadian Meteorological Centre (CMC)
2121 Transcanada service road, Doval, Qc

Research Divisions: Assimilation, Models, Cloud Physics

Development Division: Data assimilation, Numerical Weather Prediction, Weather Elements, Scientific Applications

Computer: Supercomputing Telecommunications, Network, Help Desk

Implementation & Services

Operations: Analyses & Prognostics, Environmental Emergency Response, Air Quality, Implementation et Operational Services, External Clients

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Weather impacts on building operations

Main weather impacts

- Winds > 50kph, risk of power outages, book help in advance (OT)
- Major snowstorms – be ready for cleanup activities
- Major rainstorms – keep an eye on drainage
- Extreme temperature episodes -30 C (-22 F)   /   30+ C (86 F)

Prevent weather related safety issues

- Weather forecast is checked 4 times per day
  - (At CMC – onsite meteorologists available)
- Follow weather forecast, be ready to manage on site conditions

Planning, Project Management, Contractors

- Weather forecasts are critical in planning
- Must book contractors 3+ days ahead of time, depends on weather

Weather is processed manually, reading forecast, maps

- Info not ingested into building controls directly

A typical challenge
Planning work with contractors

- Planning work for a Saturday

- Requires it be planned on Wednesday prior

- Outside work is dependant on weather

- Weather forecast is important

- But details not always available

- Let's try an example

6

Ex: Decide on Wednesday about contract work Saturday

	Wednesday	Thursday	Friday	Saturday	Sunday
Weather					
Low / High	+6 C	-2 C / + 8 C	+1 C / +10 C	+ 2 C / + 8 C	+ 3 C / + 6 C
Comments	Sunny	Sunny	Sunny	Rain early? Or later?	Clearing? What time?

Would you plan work for Saturday?

Not much detail for Saturday and Sunday

With more info could be easier to decide go, no go

From deterministic to probabilistic

- Forecast presented as a single scenario
  - One scenario presented is known as deterministic forecast
  - But what if that one scenario is wrong?
  - Should we plan using only one scenario?

- 21 models (ensembles) provide statistical details
  - Allow production of probabilistic forecasts
  - To help in the decision making process
  - Provide higher quality information for advance notice
  - New emerging tools for managing activities, risks

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With 21 models (or members)

Each member slightly different

Allows calculation of statistics from its 21 forecasts (members)
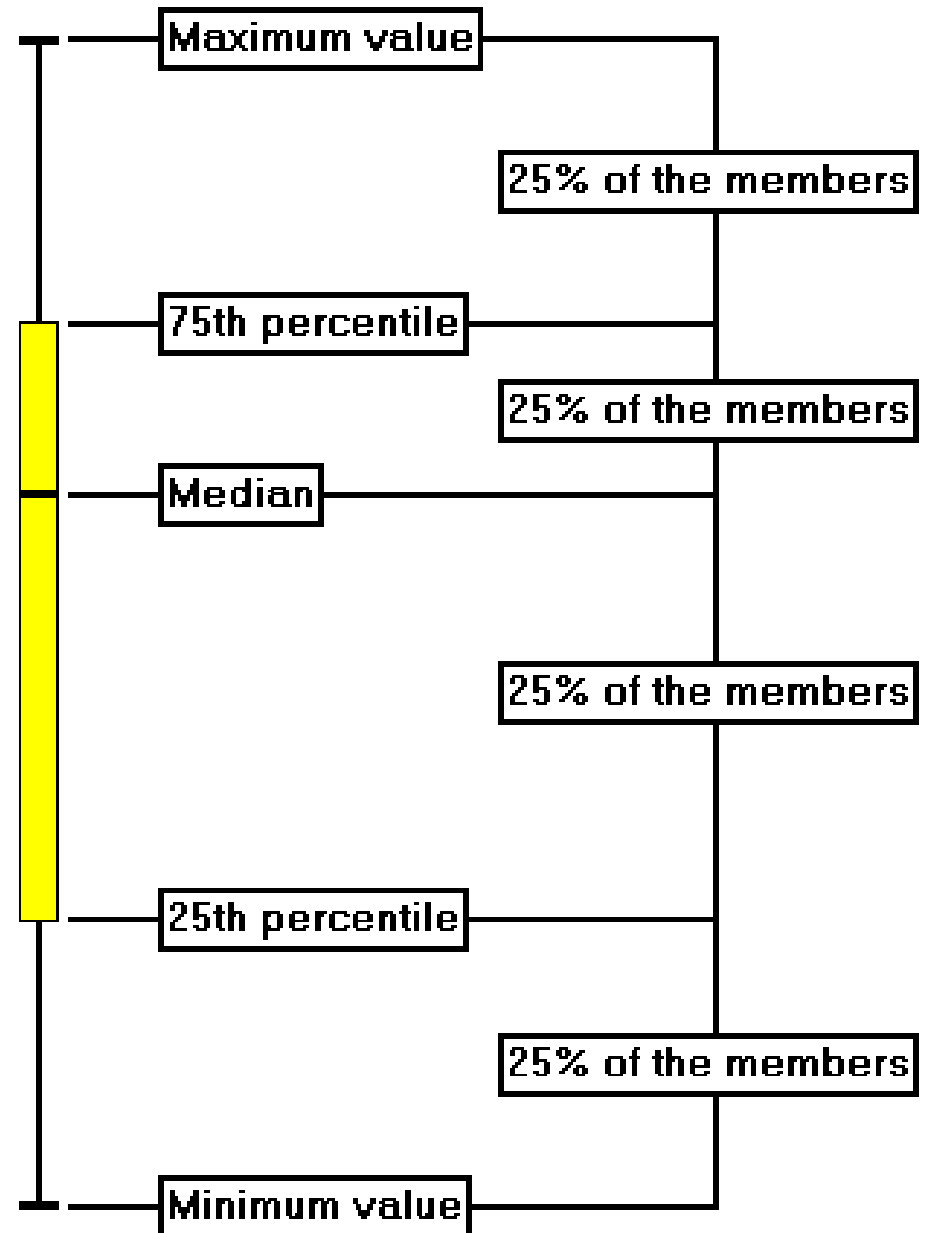
If 21 forecasts converge
        More confidence in forecast

If 21 forecasts differ greatly
        Less confidence in forecast
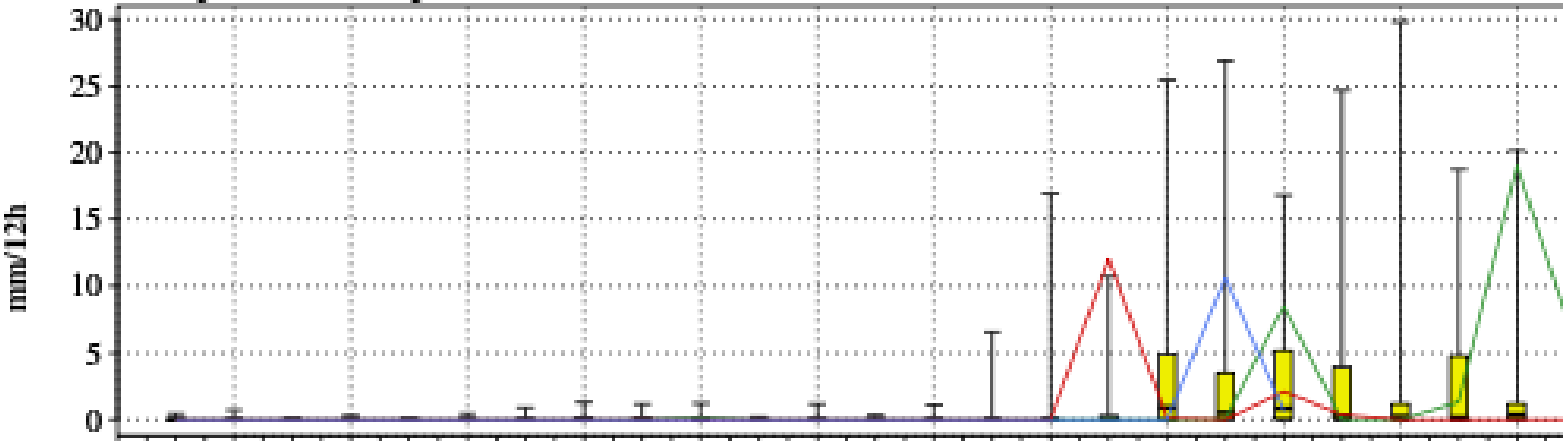
Data can be presented as a box plot

Let's go back to our example

Maximum value

25% of the members

75th percentile

25% of the members

Median

25% of the members

25% of the members

25th percentile

25% of the members

Minimum value

Decide on Wednesday about contract work Saturday

	Wednesday	Thursday	Friday	Saturday	Sunday
Weather					
Low / High	/ +6 C	-2 C / + 8 C	+1 C / + 10	+ 2 C / + 8 C	+ 3 C / + 6 C
Comments					

Here precipitation forecast shown as a box plot

Precipitation/Précipitations

mm/12h

	Very small inter-quartile range	Very small inter-quartile range	Very small inter-quartile range	Broader inter-quartile range	Very broad inter-quartile range

Images of probability of threshold events

Users could also design their own threshold events

Sample – 6 days in future: Probability of more than 25mm rain in 24 hours
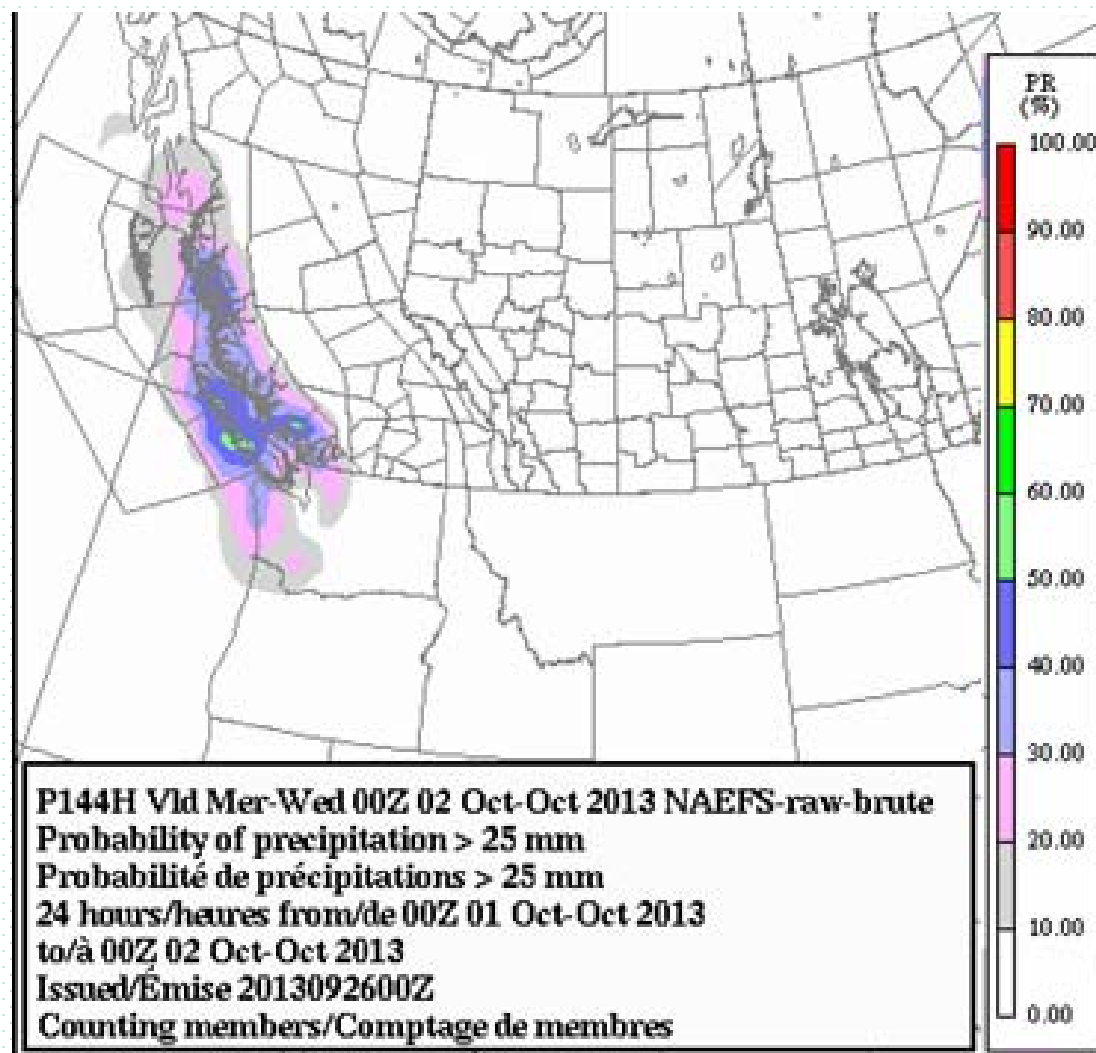
Sample - 3 days in future: Probability of more than 50mm rain in 24 hours

P96H Vld Lun-Mon 00Z 30 Sep-Sep 2013 NAEFS-raw-brute
Probability of precipitation > 50 mm
Probabilité de précipitations > 50 mm
24 hours/heures from/de 00Z 29 Sep-Sep 2013
to/à 00Z 30 Sep-Sep 2013
Issued/Émise 2013092600Z
Counting members/Comptage de membres

13
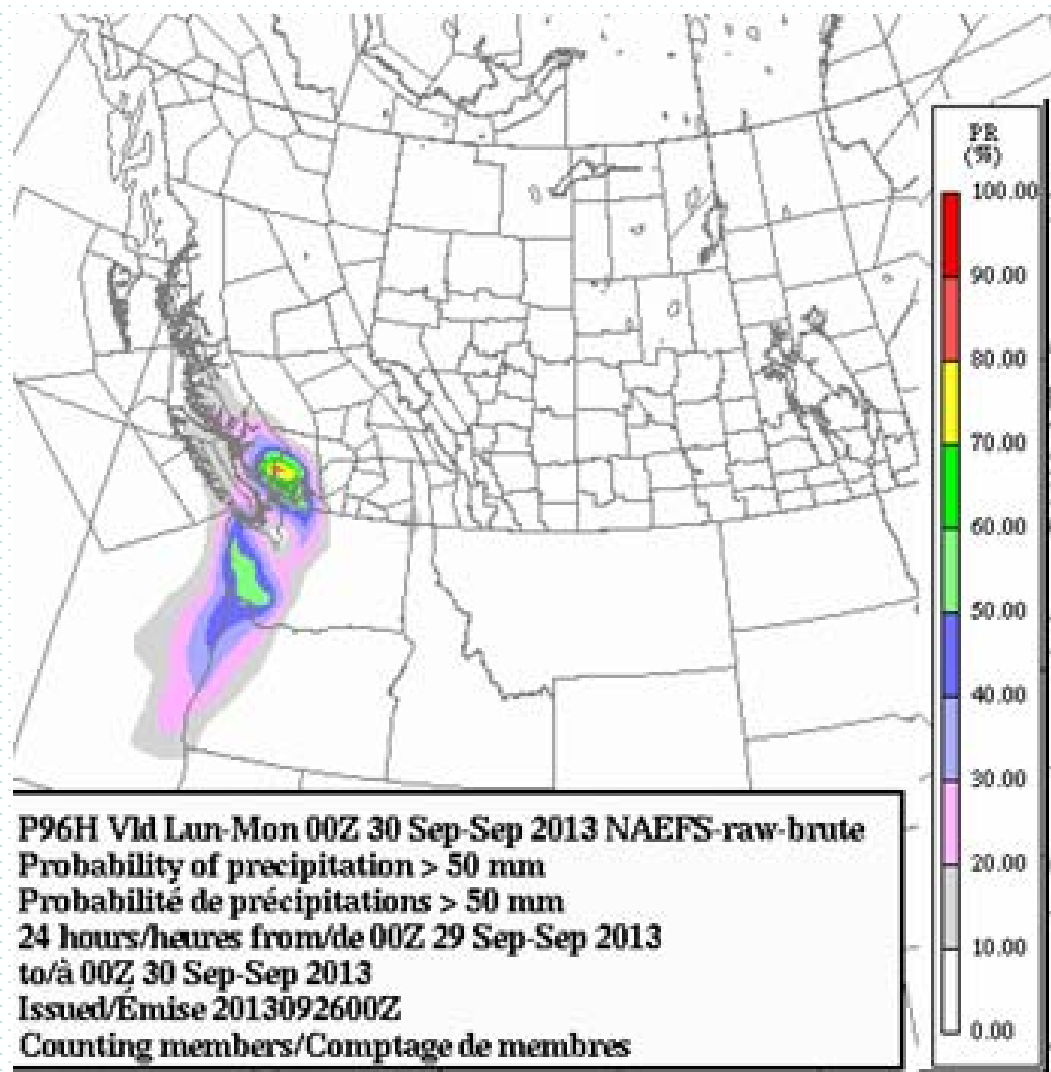
Sample – A Day 2 forecast - Probability of winds greater than 65 kph
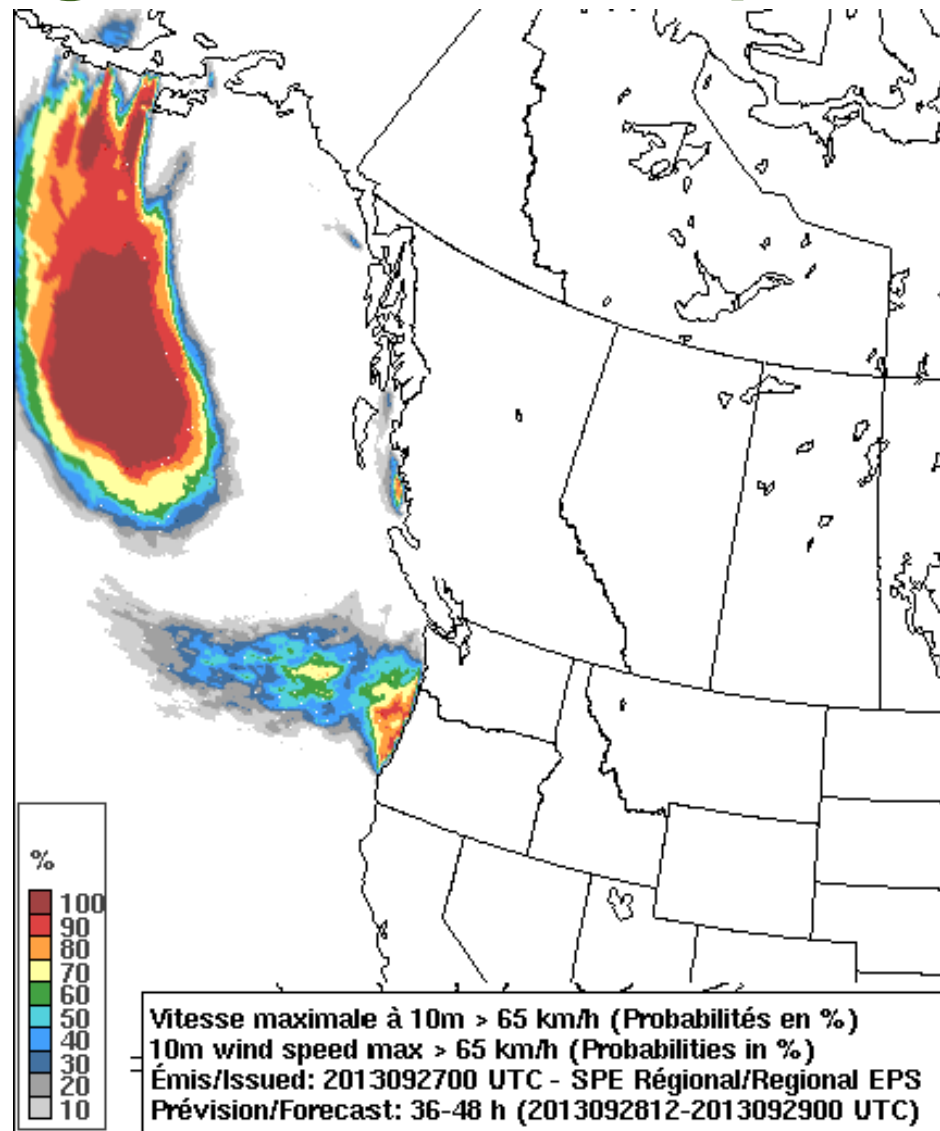
Why were ensembles developed?

Numerical Weather Prediction (NWP) 101

Simplified steps in producing a weather forecast

Observations

Reception, processing

NWP models & assumptions
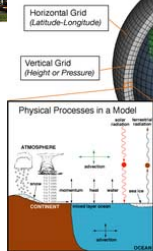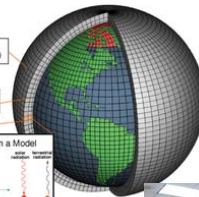
Computing

Post processing
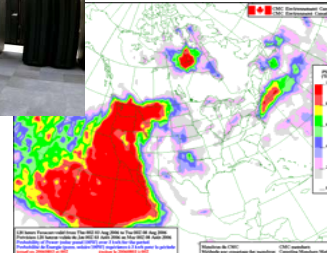
Decision time
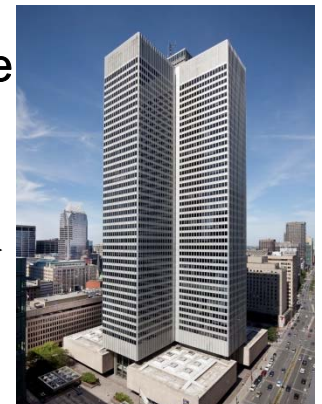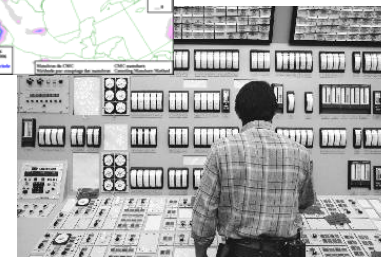
Modeling a complex, chaotic atmosphere with sophisticated yet imperfect tools

- **NWP uses incomplete, simplified parameterization schemes**

- **Land surface and ocean processes not fully understood**

- **Model grids don't capture all weather events, numerical errors**

- **Sparse weather observations provide incomplete picture of the atmosphere**

- **Models are not perfect**

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Simplified steps in producing a weather forecast – sources error

Glitches possible, missing data, instrument problems

QC, data issues, analysis of atmosphere incomplete

Simplifications, imperfect analysis used by the model
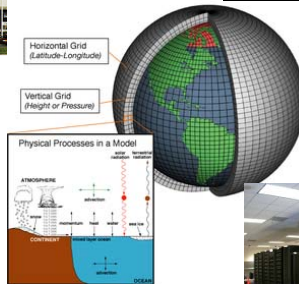
Numerical, compaction, rounding errors

Post processing filtering, compaction
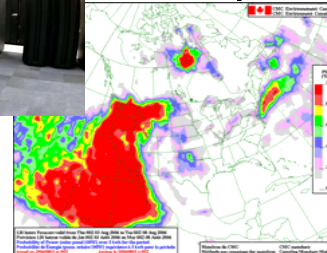
Decision time
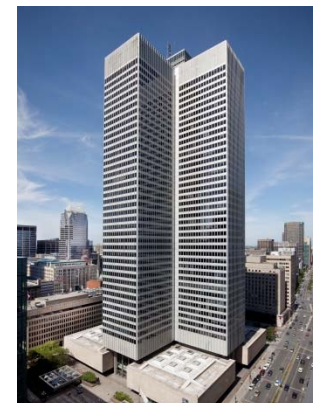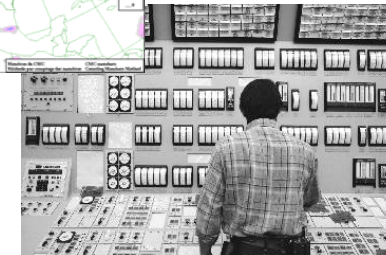
NWP forecasts – some bottom line considerations

- Forecasts for today and tomorrow (Day 1 and Day 2)
  - Use of detailed deterministic model often captures appropriate details

- Forecasts for days beyond tomorrow (Day 3 and beyond)
  - Ensemble of models provide envelope or range of forecast data
  - Allows statistical post processing of forecast data
  - **More appropriate for decision making, scenario management, probability of events, risk management for longer term forecasts**

- **Digital data available for input into decision control systems**
  - **Should allow for more sophisticated decision making, risk management**

- Caution: a bias can exist between model weather and real world weather, be aware of limitations and model limitations, biases

19

Acronyms of MSC NWP datasets

Deterministic

- HRDPS – High Resolution Deterministic Prediction System
- RDPS   – Regional Deterministic Prediction System
- Scribe Regional – Automated forecast from RDPS data
- GDPS – Global Deterministic Prediction System
- Scribe global – Automated forecast from GDPS data

Probabilistic

- REPS – Regional Ensemble Prediction System
- GEPS – Global Ensemble Prediction System

Appropriate deterministic datasets for the appropriate forecast

Dataset	Day 1	Day 2	Day 3	Day 4-5	Day6-10	Day 10+
HRDPS 2.5km	Yes					
RDPS 10km	Yes	Yes				
Scribe Regional	Yes	Yes				
GDPS 25km	Yes	Yes	Yes			
Scribe Global	Yes	Yes	Yes			

Appropriate Probabilistic datasets for other lead times

Dataset	Day 1	Day 2	Day 3	Day 4-5	Day6-10	Day 10+
REPS 15km	Yes	Yes	Yes			
GEPS 100 - 50 km		Yes	Yes	Yes	Yes	Yes
NAEFS		Yes	Yes	Yes	Yes	Yes

CMC NWP datasets from which to Compile appropriate weather forecasts

- **Day – 1**
  - Scribe matrix from RDPS and GDPS data – includes UMOS post processed model data
    - (supplemental matrix has DSWRF but not post processed by UMOS
  - HRDPS raw model data
  - RDPS raw model data
  - Coming soon REPS (21 members)

- **Day – 2**
  - Scribe matrix from RDPS and GDPS data - – includes UMOS post processed model data
    - (supplemental matrix has DSWRF but not post processed by UMOS)
  - HRDPS for early part of day 2
  - RDPS raw model data
  - GDPS raw model data
  - Coming soon REPS (21 members)

- **Day – 3**
  - Scribe matrix from GDPS data
  - GDPS raw model data
  - Coming soon REPS 21 members
  - CMC GEPS 21 members

- **Day 4-[7-10+] days**
  - GDPS raw model data
  - CMC GEPS data
  - NAEFS (CMC+NCEP) GEPS – complete dataset available from NOMADS server (NCEP)

CMC NWP datasets for Day 1 Forecasts

- **High Resolution Deterministic Prediction System (HRDPS)**
  - 2.5 km resolution, better modeling of features in the boundary layer, topography
  - Limited Area Model (LAM) domain
  - Raw model data available at: http://www.weatheroffice.gc.ca/grib/grib2_HRDPS_HR_e.html
  - Developing to become main model for Day 1

- **Regional Deterministic Prediction System (RDPS)**
  - 10 km resolution, Principal model for Day1 and Day2 forecasts,000-054 hr
  - Domain mainly over north America
  - Raw model data available at: http://www.weatheroffice.gc.ca/grib/grib2_reg_10km_e.html

- **Scribe matrix from RDPS model**
  - Variables like Temperature, humidity statistically post processed by UMOS
  - Supplemental matrix has DSWRF but this not post processed by UMOS
  - See: http://collaboration.cmc.ec.gc.ca/cmc/cmoi/SolarScribe/SolarScribe/

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CMC NWP datasets for Day 2 Forecasts

- **Regional Deterministic Prediction System (RDPS)**
  - RDPS raw model data – 10 km resolution, North America, 000-054 forecasts
  - Data at: http://www.weatheroffice.gc.ca/grib/grib2_reg_10km_e.html

- **Global Deterministic Prediction System (GDPS)**
  - GDPS raw model data – 25 km, global domain, 000-240 hour forecasts
  - For larger scale features but still competitive with higher res models

- **Scribe matrix from RDPS and from GDPS**
  - includes UMOS post processing
  - Variables like Temperature, humidity statistically post processed by UMOS
  - Supplemental matrix has DSWRF, this is not post processed by UMOS
  - See: http://collaboration.cmc.ec.gc.ca/cmc/cmoi/SolarScribe/SolarScribe/

CMC NWP datasets for Day 3 Forecasts

- **Global Deterministic Prediction System (GDPS)**
  - GDPS raw model data, 25 km resolution, 000-240 hour forecasts

- **Coming soon REPS 21 members**
  - ~15 km resolution, will provide probabilistic forecasts

- **Global Ensemble Prediction System (GEPS)**
  - CMC GEPS 21 members
  - Provides probabilistic forecasts
  - Can give useful outlooks for longer term weather forecasts

- **Scribe matrix from GDPS**
  - includes UMOS post processed model data
  - Variables like Temperature, humidity post processed by UMOS
  - See: http://collaboration.cmc.ec.gc.ca/cmc/cmoi/SolarScribe/SolarScribe/

CMC NWP datasets for Day 4-10 Forecasts

- **GDPS** **raw model data**
  - – 25 km resolution, global domain
  - – Recall – this is a deterministic model

- **CMC GEPS data**
  - – 21 members, allows probabilistic forecasts
  - – CMC GEPS available in grib2 format:
    http://www.weatheroffice.gc.ca/grib/grib2_ens_naefs_e.html
  - – And also in xml format

- **NAEFS (CMC+NCEP) GEPS**
  - – 42 members
  - – complete dataset available from NOMADS server (NCEP)

Appropriate Probabilistic datasets for longer lead times

Dataset	Day 1	Day 2	Day 3	Day 4-5	Day6-10	Day 10+
HRDPS 2.5km	Yes					
RDPS 10km	Yes	Yes				
Scribe Regional	Yes	Yes				
GDPS 25km		Yes	Yes	Yes	Yes	
Scribe Global		Yes	Yes	Yes	Yes	
REPS 15km	Yes	Yes	Yes			
GEPS 100-50 km			Yes	Yes	Yes	Yes
NAEFS			Yes	Yes	Yes	Yes

Some NWP data formats

- GRIB2
  - Gridded Binary version 2.
  - *(General Regularly-distributed Information in Binary form)*
  - Encoded grids of NWP data, using table driven coding standards
  - An international standard
  - http://en.wikipedia.org/wiki/GRIB - technical knowledge required

- BUFR
  - Binary Universal Form for the Representation of meteorological data (BUFR)
  - To encode location specific data like surface observations, upper air soundings,
  - http://en.wikipedia.org/wiki/BUFR
  - International standard
  - Technical knowledge required

29

Some Scribe variables available in ascii format

http://collaboration.cmc.ec.gc.ca/cmc/cmoi/product_guide/docs/scribe-matrix_e.html

FT   UTC Cumulative forecast valid time in hours.
ZT   UTC forecast valid time in hours.

CLD Cloud coverage (in tenth).
P06, P12   Pop over 6,12 hr period.
P10   Probability of getting 10.0 mm or more over 12 hr period.
QPS   Precipitation amount (in tenth of mm).
TYP   Conditional precipitation type.

DPD Surface dew point depression.
DD   Wind direction in degrees.
FF   Wind speed in km/h.

P6M Diagnostic probability of precipitation over a 6 hours period.
P2M Diagnostic probability of precipitation over a 12 hours period.
TSM Surface temperatures (in Celsius).
QPC Convective precipitation quantity amount (in tenth of mm).

SOG Snow on ground (in cm.)

Scribe data tested as input into controls of a NetZero building

- 2006 – Collaboration with Concordia (SNEBRN)
- Test MSC Scribe forecast data in decision control systems for NetZero homes
- Focus on next day's weather using deterministi (CMC Regional) Scribe
- Automated inputs into control system
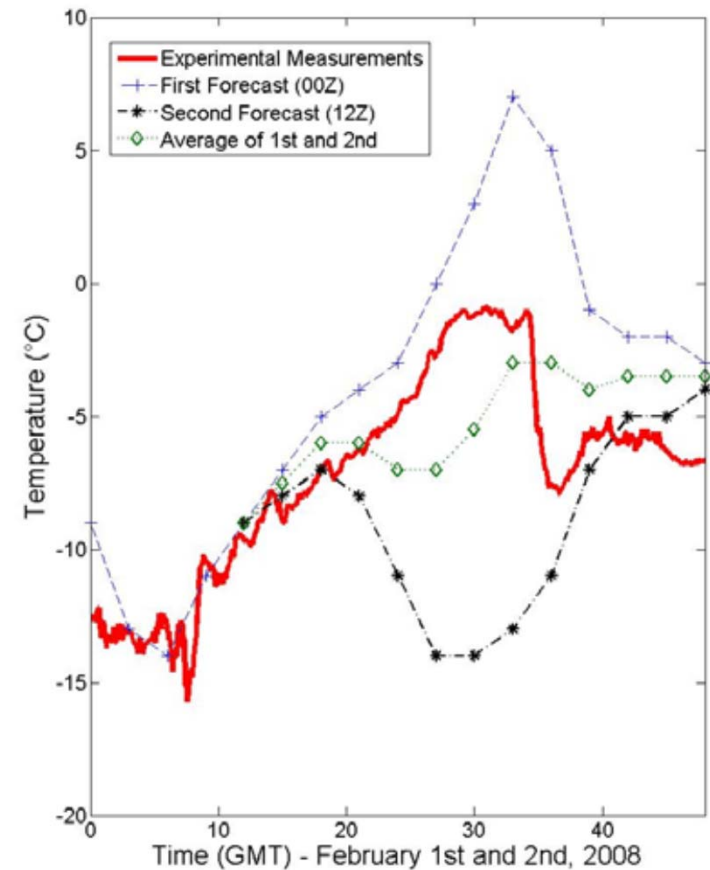
Figure 1: Comparison of 00Z and 12Z 2m temperature forecasts for Lac Memphemagog, Québec against measurements at a nearby location (Eastman, QC) for the 48 hour period ending at 00Z February 3, 2008.

NWP also available in xml format ex: Ensemble NAEFS data

Documentation:

- http://dd.weatheroffice.ec.gc.ca/ensemble/doc/naefs/

Example for Montreal:

- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_**RELH-SFC**_000-384.xml
- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_**TMP-SFC**_000-384.xml
- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_**WDIR-SFC**_000-384.xml
- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_**WIND-SFC**_000-384.xml

- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_HGT-500HPA_000-384.xml
- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_LAYER-1000-500HPA_000-384.xml
- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_MSLP_000-384.xml
- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_TCDC_000-384.xml
- 2013041400_GEPS-NAEFS-RAW_MONTREAL_DORVAL_QC_CA_WIND-200HPA_000-384.xml

- xml data is source data for these ensemble box plots

- Temperature at surface ➔

- Precipitation mm/12hr ➔

Wind km/hr ➔

Cloud cover ➔

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NAEFS SPENA

Ensemble and Deterministic Forecasts issued 27 September 2013 00 UTC
Prévision d'ensemble et déterministe émises le 27 Septembre 2013 00 UTC
for/pour   NAEFS / SPENA

MONTREAL (DORVAL) (YUL) 45.47 N 73.75 W/O

Surface Air Temperature/Température de l'air à la surface

Precipitation/Précipitations

Surface Wind Speed/Vitesse du vent à la surface

Total Cloud Cover/Couvert nuageux total

September/Septembre 2013   October/Octobre 2013

max
75%
median/médiane
25%
min

Global Model / Modèle global CMC
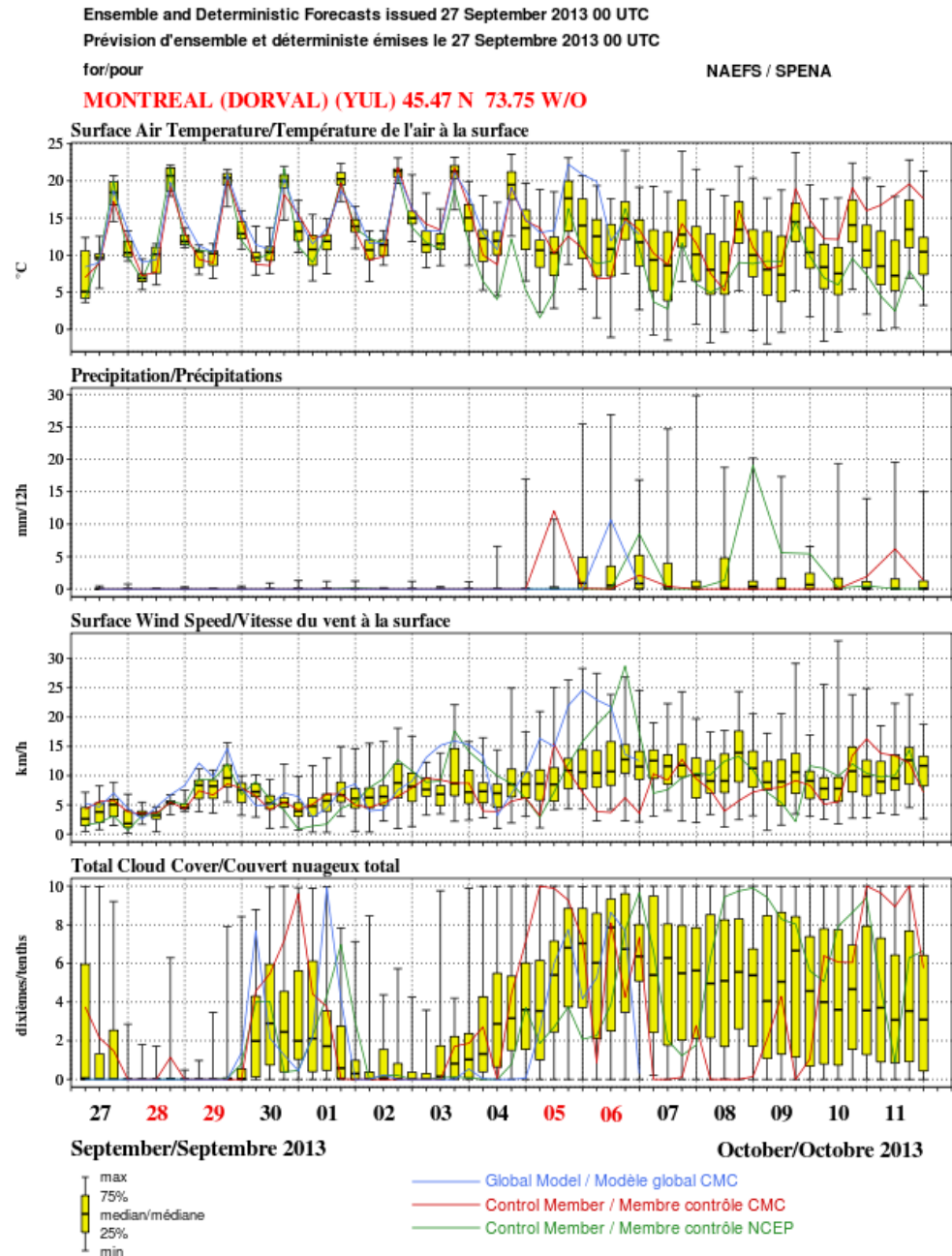Control Member / Membre contrôle CMC
Control Member / Membre contrôle NCEP

- xml data is source data for these ensemble box plots

- Temperature at surface ➔

- Precipitation mm/12hr ➔

Wind km/hr ➔

Cloud cover ➔

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NAEFS
SPENA

Ensemble and Deterministic Forecasts issued 27 September 2013 00 UTC
Prévision d'ensemble et déterministe émises le 27 Septembre 2013 00 UTC
for/pour   NAEFS / SPENA

MONTREAL (DORVAL) (YUL) 45.47 N 73.75 W/O

Surface Air Temperature/Température de l'air à la surface

Precipitation/Précipitations

Surface Wind Speed/Vitesse du vent à la surface

Total Cloud Cover/Couvert nuageux total

September/Septembre 2013   October/Octobre 2013

max
75%
median/médiane
25%
min

Global Model / Modèle global CMC
Control Member / Membre contrôle CMC
Control Member / Membre contrôle NCEP

Convenient links to the various NWP dataset formats

Dataset	Day 1	Day 2	Day 3	Day 4-5	Day6-10	Day 10+
HRDPS 2.5km	GRIB2					
RDPS 10km	GRIB2	GRIB2				
Scribe Regional	Ascii	Ascii				
GDPS 25km		GRIB2	GRIB2	GRIB2		
Scribe Global		Ascii	Ascii			
REPS 15km	*Soon GRIB2*	*Soon GRIB2*	*Soon GRIB2*			
GEPS 100 km			GRIB2 xml	GRIB2 xml	GRIB2 xml	
NAEFS			GRIB2 xml	GRIB2 xml	GRIB2 xml	GRIB2 xml

GRIB2 getting started
Retrieving & viewing grib2 data

Retrieving data

- wget – can be used to retrieve grib2 and other files
- wingridds – windows/pc based grib viewer
- wgrib2 – powerful utility to manipulate grib2 data

Viewing data

- GrADS - built on wgrib2, with image production
- Wingridds – windows/pc based grib viewer
- GEMPAK – University tool
- Most of these require some technical expertise

36

Variables of interest in in CMC GRIB2

- Generally available
  - Wind speed and direction at 10m
  - Temperature 2m
  - Relative humidity 2m
  - Total cloud (column)
  - Precipitation amounts

- More information on variables in grib2:
- HRDPS 2.5km: Click here for HRDPS grib2 variables
- RPDS 10km: Click here for RDPS grib2 variables
- GDPS 25km: Click here for GDPS grib2 variables
- GEPS ~100km: Click here for GEPS grib2 variables

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37

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NWP Flux variables available in CMC Radiation parameterization

- Many flux variables are calculated by the models

- Flux variables of interest for building controls of solar and NetZero buildings

- DSWRF: Downward Short Wave Radiative Flux
- Also Beam flux and Diffuse flux are available

Images of Probabilities of Events

MSC NAEFS ensemble images

- http://weather.gc.ca/ensemble/naefs/index_e.html

- Probability images can be combined as a quilt to help operations quickly notice weather details

- Link to experimental 7-day quilts
  - http://collaboration.cmc.ec.gc.ca/cmc/cmoi/cmc-prob-products/

- Link to experimental 3-day outlook of REPS quilts
  - http://collaboration.cmc.ec.gc.ca/cmc/cmoi/cmc-prob-products.reps

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Users can also make their own products from ensemble forecast data?

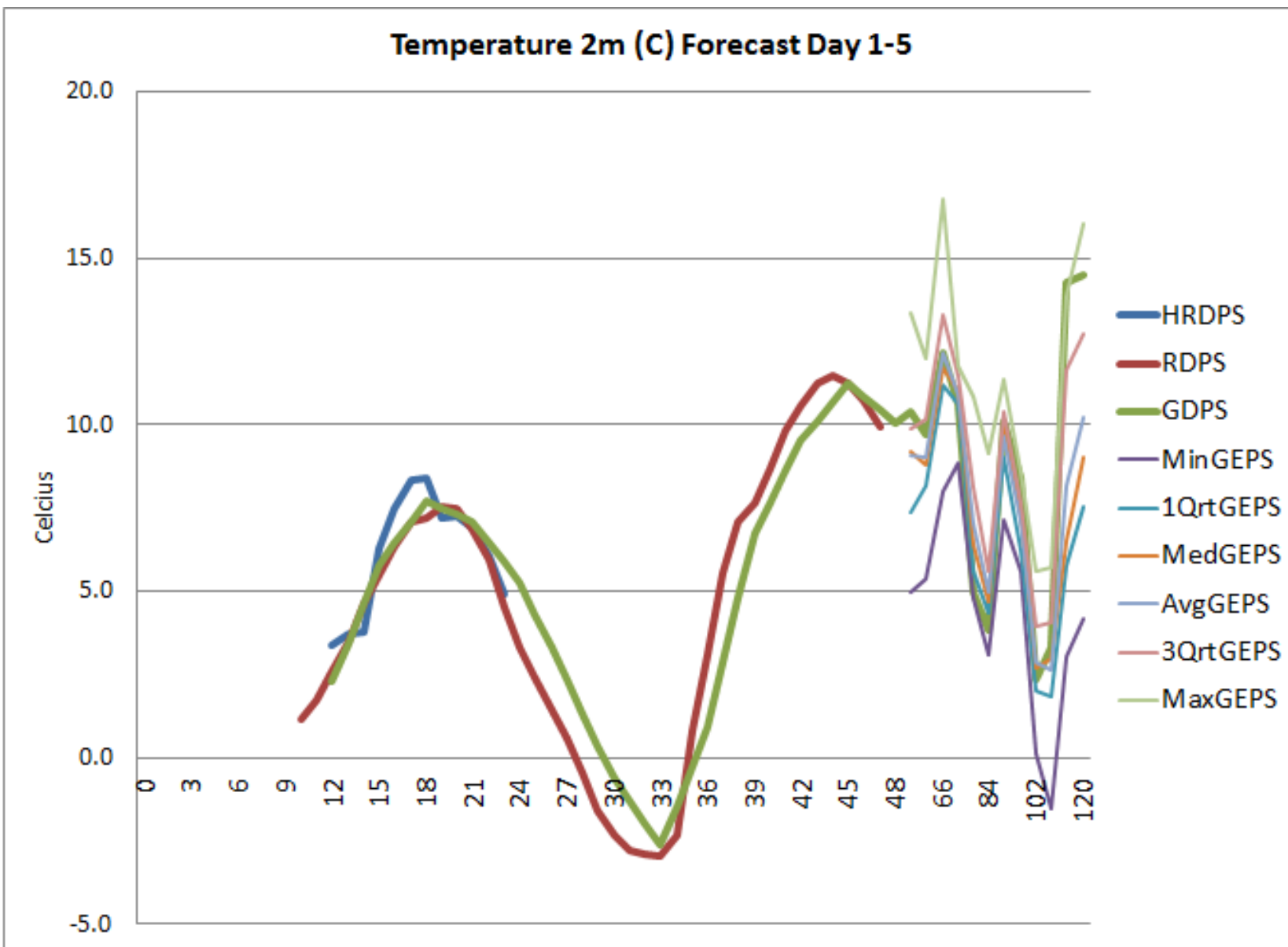# Sample ascii matrix of 2m temperature could be fed into building control system

DATE	FHR	HRDPS	RDPS	GDPS	REPS MBR[0,1,2,..,20]	GEPS MBR[0,1,2,..,20]
2013041200	0		274.7	274.6	275,276,275,..	273,272,275,...
2013041200	1		272.6			
2013041200	2		271.8			
2013041200	3		271.3	271.3		
2013041200	4		270.4			
2013041200	5		270.4			
2013041200	6		270.5	270.4		271.3
2013041200	7		270.8			
2013041200	8		270.6			
2013041200	9		270.3	270.3		
2013041200	10		270.4			
2013041200	11		270.9			
2013041200	12	269.9	271.5	271.6		271.8
2013041200	13	270.8	272.2			
2013041200	14	271.7	272.9			
2013041200	15	271.9	273.8	273.9		
2013041200	16	271.6	274.4			
2013041200	17	272.0	274.9			
2013041200	18	272.8	274.8	274.7		273.0
2013041200	19	273.7	274.8			

41

Temperature 2m (C) Forecast Day 1-5

Temperature 2m (C) Forecast Day 1-2

Temperature 2m (C) Forecast Day 3-5 GEPS

Legend:
- MinGEPS
- 1QrtGEPS
- MedGEPS
- AvgGEPS
- 3QrtGEPS
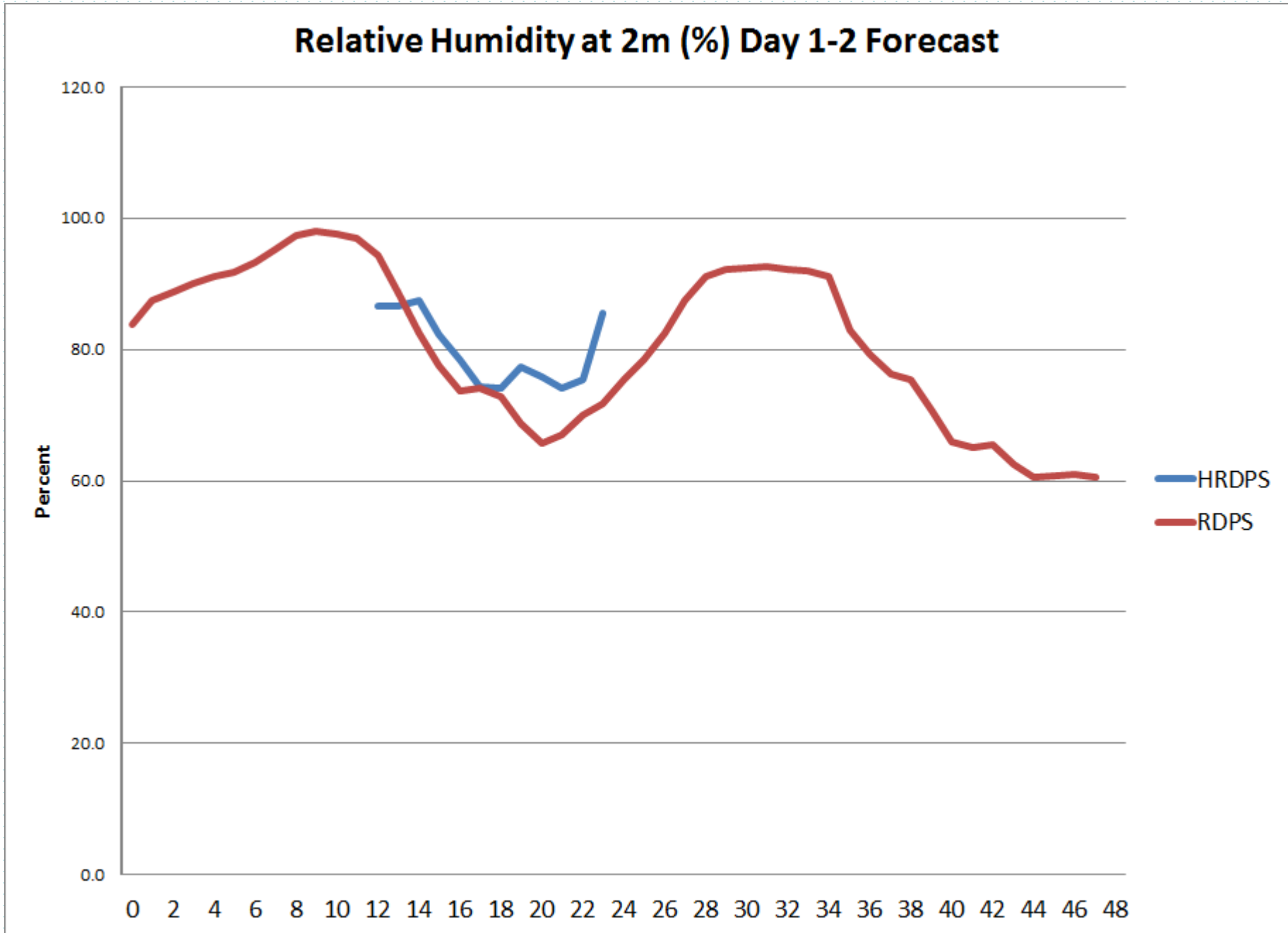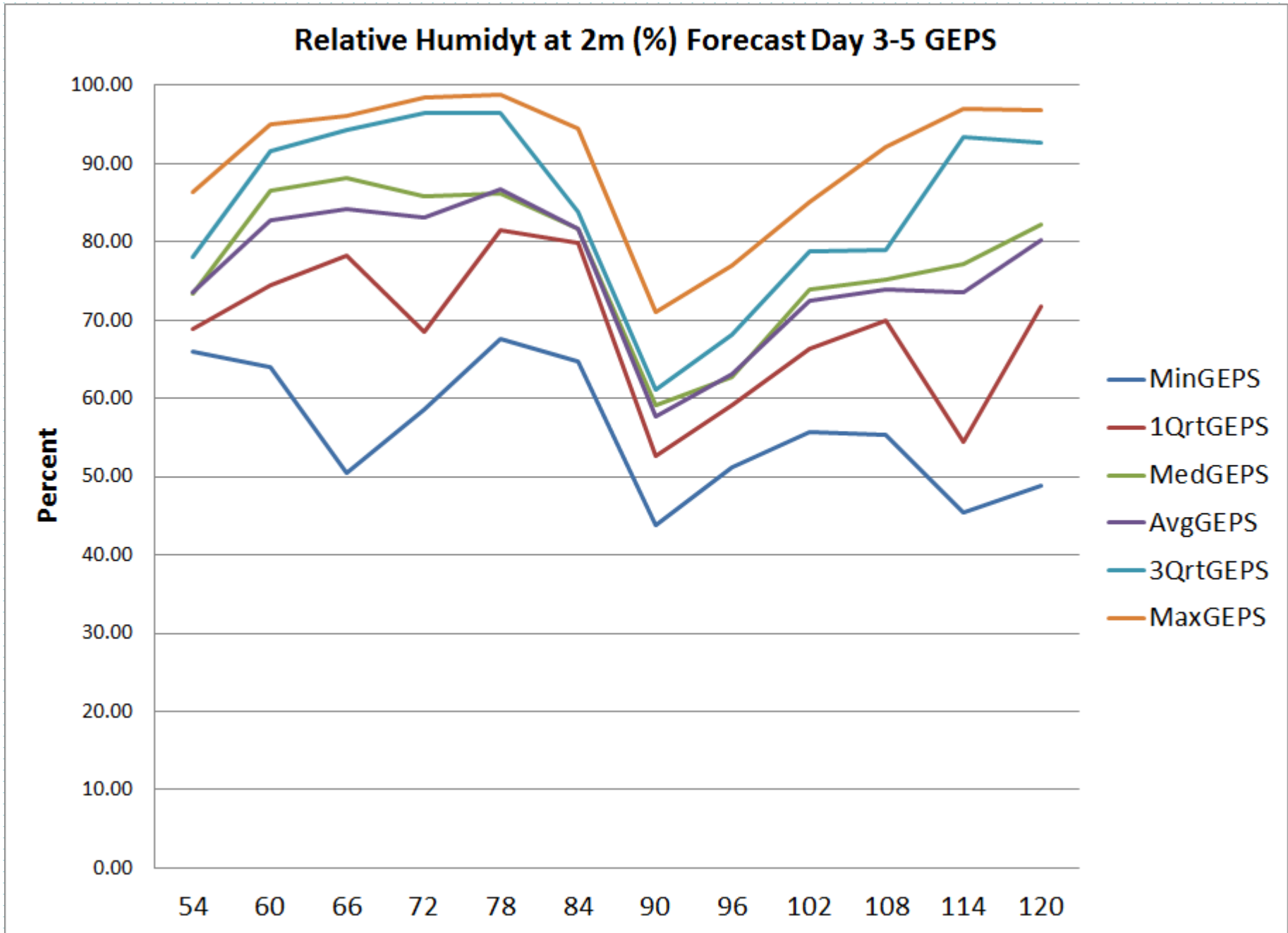- MaxGEPS
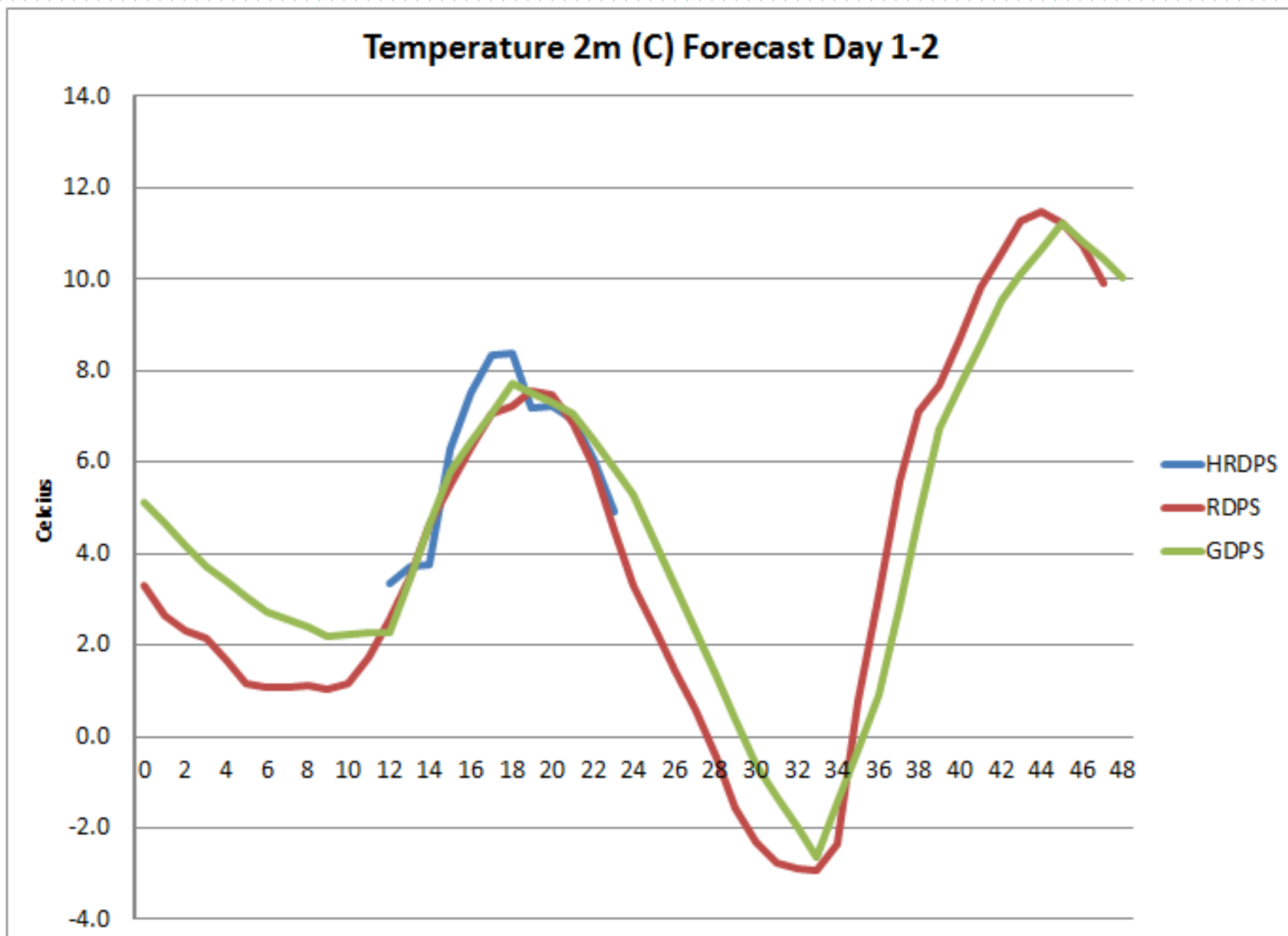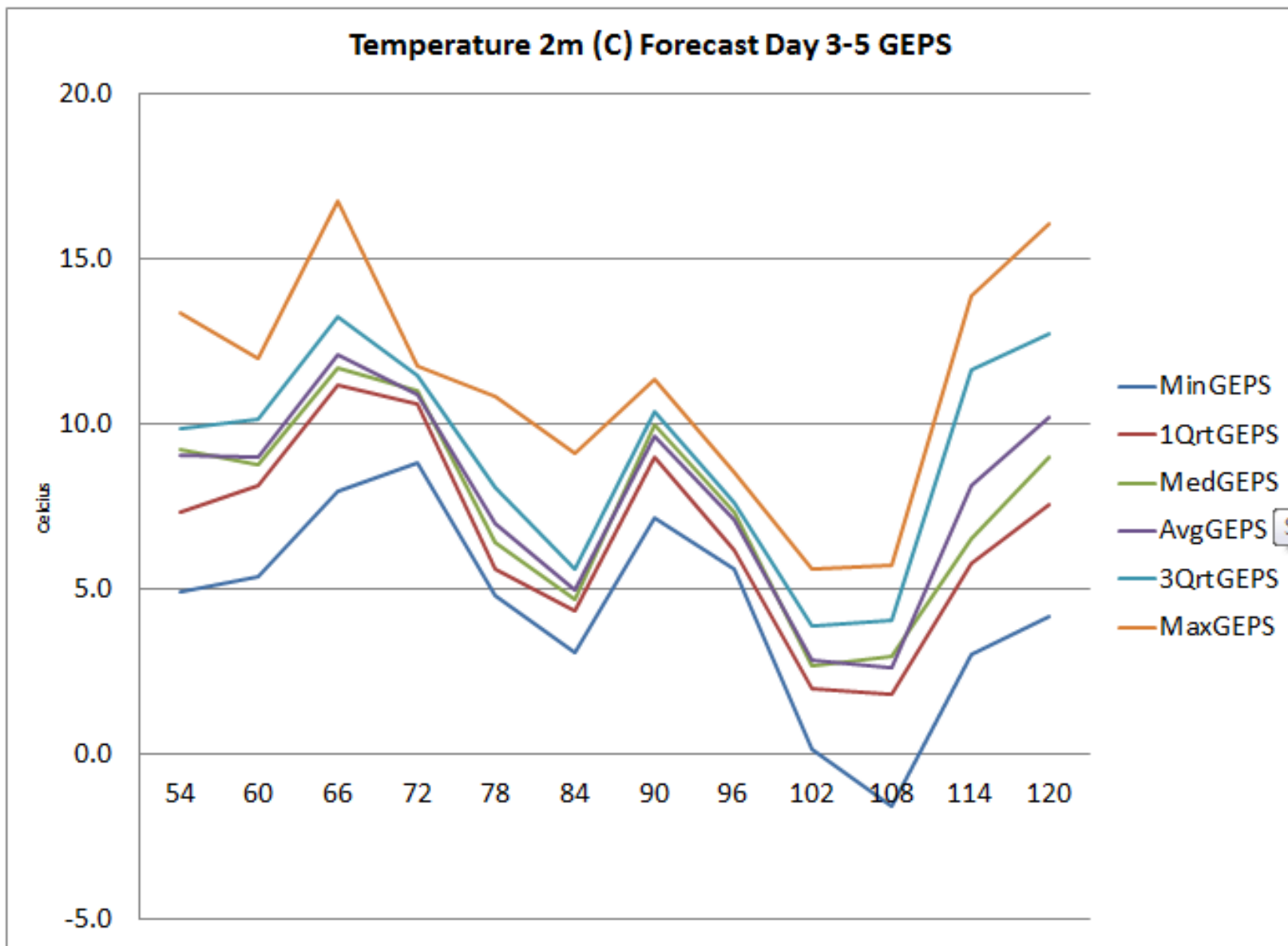
Matrix of Relative Humidity at 2m
Could be fed into building control systems

DATE	FHR	HRDPS	RDPS	GDPS	GEPSMBR00	GEPSMBR01	GEPSMBR02	∎ ∎ ∎
2013041200	0		49.1		46.0	47.1	42.9	
2013041200	1		52.1					
2013041200	2		51.2					
2013041200	3		49.2					
2013041200	4		56.6					
2013041200	5		57.5					
2013041200	6		56.2		54.2	54.9	49.5	
2013041200	7		58.8					
2013041200	8		60.7					
2013041200	9		64.2					
2013041200	10		64.8					
2013041200	11		65.0					
2013041200	12	67.7	67.5		68.5	64.6	59.0	
2013041200	13	58.5	69.7					
2013041200	14	52.8	71.4					
2013041200	15	51.7	72.1					
2013041200	16	50.9	72.3					
2013041200	17	47.4	73.2					
2013041200	18	45.7	78.1		84.4	83.4	73.3	
2013041200	19	45.5	82.4					
2013041200	20	46.5	86.0					
2013041200	21	45.8	88.5					
2013041200	22	43.5	91.3					
2013041200	23	46.8	92.3					
2013041200	24	52.7	93.9		89.7	92.7	91.3	
2013041200	25		93.7					

45

Relative Humidity at 2m (%) Day 1-2 Forecast

Relative Humidyt at 2m (%) Forecast Day 3-5 GEPS

Some ways to prepare probability type forecasts in support of planning beyond tomorrow

1. Define weather dependant scenario & needs

2. Access Ensemble forecast data

3. Process data into probabilities – ex: counting of members, PDF

4. Interpret probabilities ➔ suggest priority action plans, options

(1) Define weather dependant scenario & needs

- **Active solar building ex: Alstonvale house – a Net-Zero building**
  - Active solar building, over 1 year it can generate as much or more energy that it needs

- **Building activities need N kWhrs per day (solar panels, heating, etc)**
  - Harvested from solar panels & passive solar. Amount depends on weather

- **NWP models forecast DSWRF @ surface (MJ/m2)**
  - *Downward Short Wave Radiation Flux (DSWRF) at the surface*
  - Flux on a horizontal surface, MJoules/m2, accumulated, 6-hr average
  - MJ/m2 forecasts ⬅ ➡ kWhrs forecasts, 3.6 MJ = 1 kWhr

- **NWP forecasts of DSWRF provide outlook of RE in next 1-10 days**
  - To better plan activities next 1-10+ days

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(3) Pre-process NWP data for decision making

Note - the example here for grib files, similar for other types ex: xml

1. Get data files with DSWRF for forecast intervals of interest

2. Extract DSWRF from data files (ex: using wgrib2 for grib2 files)

3. Parse Ensemble members into forecast hour intervals
   - 21 members DSWRF forecast valid at fhr=024
   - 21 members DSWRF forecast valid at fhr=048
   - …
   - 21 members DSWRF forecast valid at fhr=240
   - 7 day forecast – 21 members * 7 days = 147 grib2 files for 7-day forecast

4. Process DSWRF by 24hr period to create planning options

5. More details on how to do this in the complete PowerPoint

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Sample probability product from NWP ensemble system
Probability of more than 3kWhr in 5 days from 1-100W panel

CMC Environment Canada
CMC Environment Canada

PS (%)

100

80

60

40

20

0

120 hours Forecast valid from Thu 00Z 03 Aug 2006 to Tue 00Z 08 Aug 2006
Prévision 120 heures valide du Jeu 00Z 03 Août 2006 au Mar 00Z 08 Août 2006
Probability of Power (solar panel 100W) over 3 kwh for the period
Probabilité de Énergie (pann. solaire 100W) supérieure à 3 kwh pour la période
issued on 20060803 at 00Z   émises le 20060803 à 00Z

Membres du CMC   CMC members
Méthode par comptage des membres   Counting Members Method

Sample GEPS DSWRF data

CMC GEPS Forecast of MJ / m2 /day
raw data, not calibrated, from 2012-05-25-00Z

Spread of values of DSWRF at surface
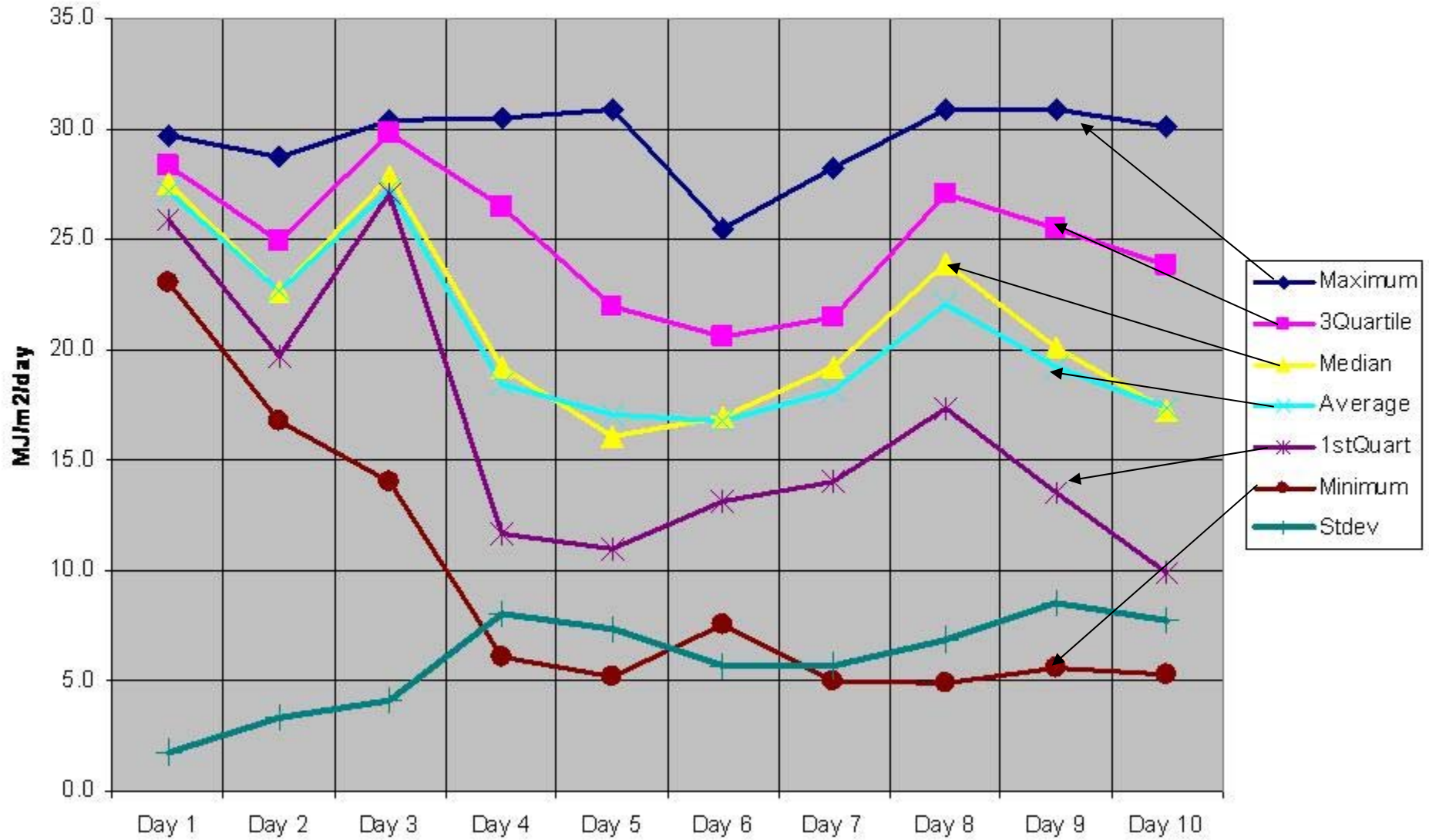
Sample GEPS DSWRF data

CMC GEPS Forecast of MJ / m2 /day
raw data, not calibrated, from 2012-05-25-00Z

Spread of values of DSWRF at surface
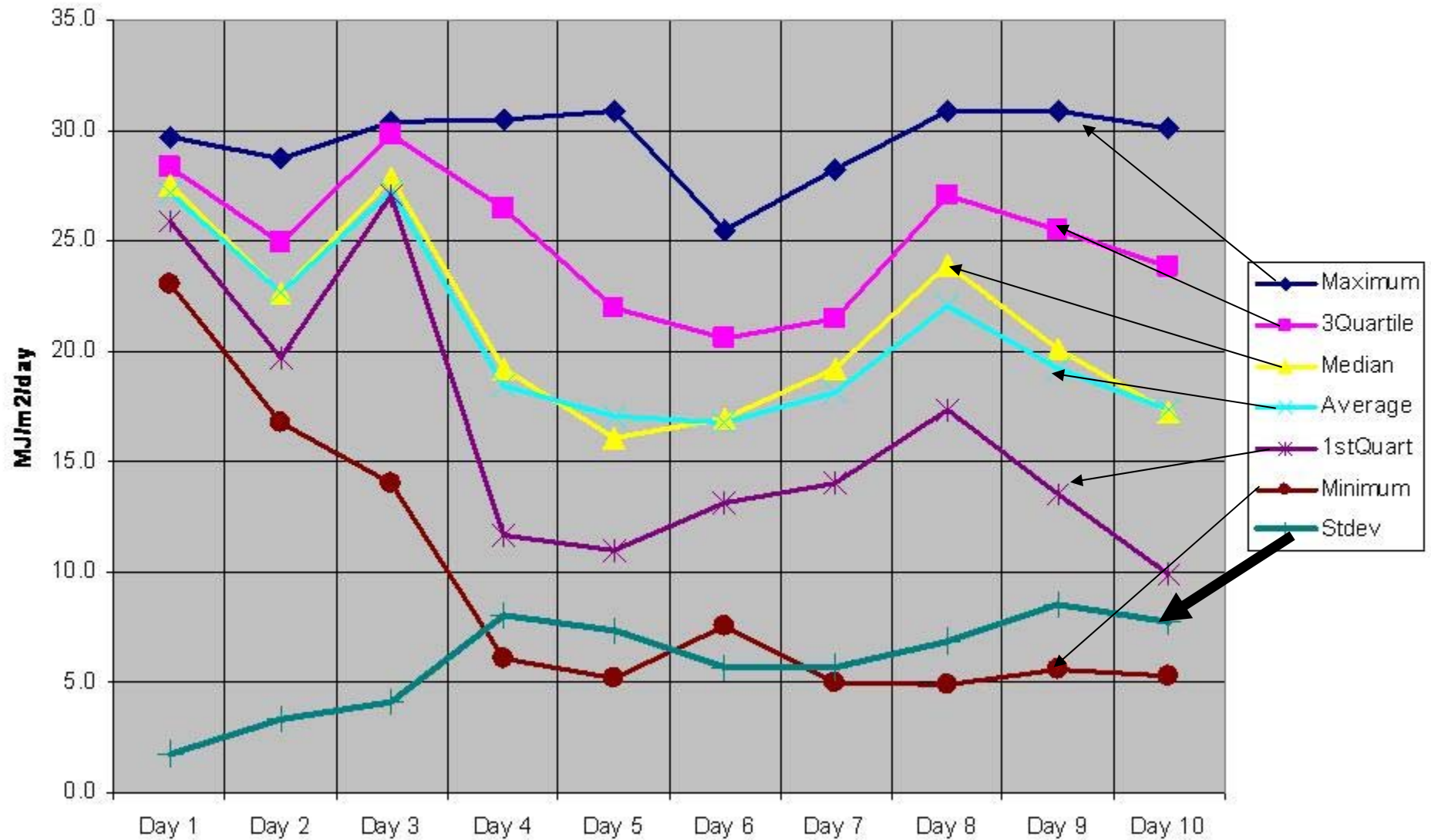
4.2 Making flux probability forecasts using the counting members method

- **Define bins or categories of MJ/m2 of interest**
  - Ex: bins = [10, 15, 20, 25, 30] MJ / m2 /day

- **Count # of GEPS members who forecast MG in bins**, for ex:
  - [3, 5, 10, 2, 1] members that each forecast
  - [10, 15, 20, 25, 30] MJ / m2 / day respectively

- **Express this count of members as percentage of total # of members**
  - [3/21, 5/21, 10/21, 2/21, 1/21] % probability forecast of
  - [10, 15, 20, 25, 30] MJ / m2 / day respectively

- **This is the probability**
  - [14, 23, **48**, 9, 5] % probability forecast of
  - [10, 15, 20, 25, 30] MJ/m2/day respectively

  - Here highest percentage ➔ 48% members forecast ~20 MJ / m2 / day
  - Plan activities based on probabilities detected by system

Day 7 Forecast of MJ / m2 / day

Here:
29% of members forecast ~20MJ/m2
19% members forecast ~23 MJ/m2

Day 7 GEPS

bins of MJ / m2 / day
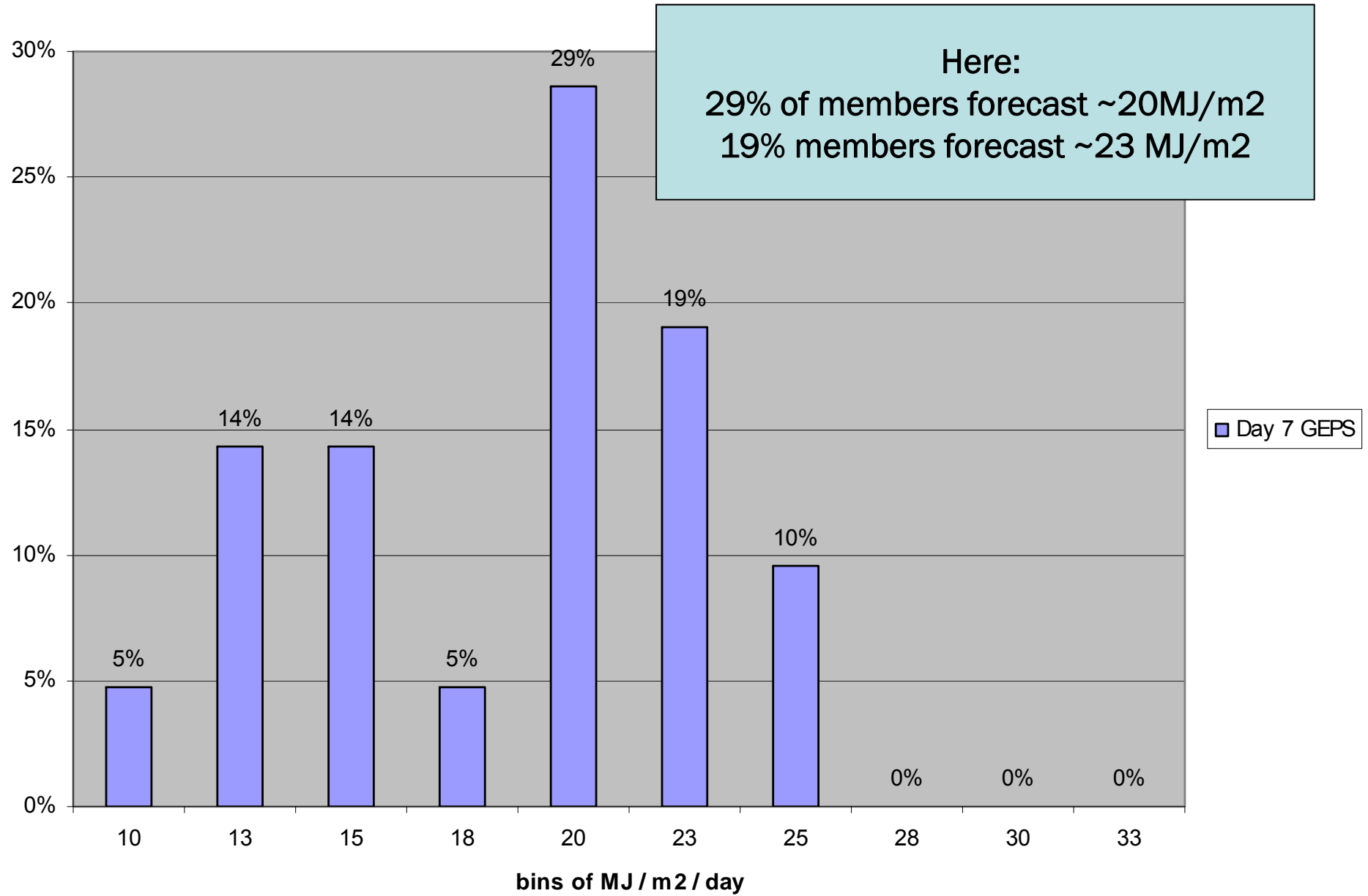
What if - A buildings weather forecast data matrix?

- Would it help building managers if:

- A matrix of building related weather forecast information was available, could include:
-
- **Locations of interest** defined by latitude, longitude

- Forecast **production times and valid times** (decipher UTC and local times)

- **Wind forecast information**
  - Wind speed and direction – surface, above the surface
  - Ambient ventilation information

- **Precipitation forecast information**
  - Forecast of various precipitation amounts (.2, 1,5,10,20, ..) mm in the interval
  - Probability of occurrence precipitation

- **Surface temperature and humidity forecast information**

- **Once defined, could be more easily fed into decision control systems**

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Coming soon
Modeling of the urban environment

- Very high resolution models are being developed for urban settings

- In the future, these models could provide useful inputs into building control applications

MODELING over MONTREAL

Comparison with MODIS
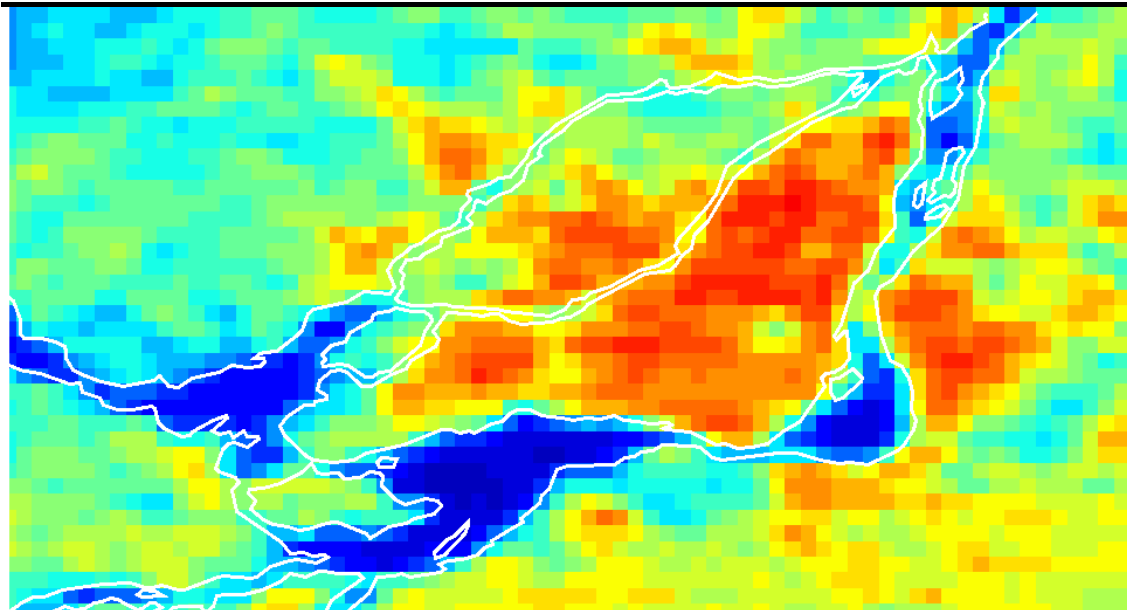
MOD11A1 product
Resolution: 1km
(exactly 928 m)
■ Atmospheric effects corrected
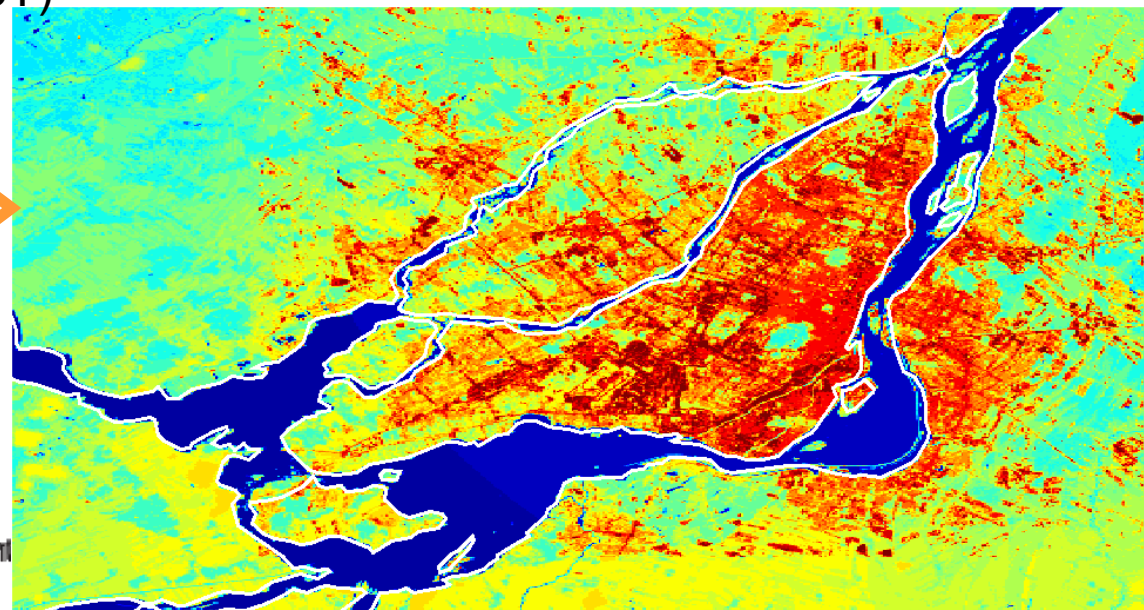■ Satellite View Angle : 15°

• **Radiative Surface Temperature (°C)**

18 20   25   30   35   40   45

July 6th 2008 (10:54 LST)
Warm and Sunny

Urban off-line modeling system
Resolution: **120 m**

Z_{0h}: **Kanda (2007)**

(Leroyer et al., 2011)

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The Canadian Urban Dispersion Modeling (CUDM) System

- Complex wind flow around buildings is explicitly modeled.

- Environment Canada's Environmental Emergency Response section (EERS*), has developed a prototype to model dispersion of CRBN pollutants in urban areas under funding from DRDC's CRTI.

- Extensive tests have been made for several Canadian cities

- For more information contact:
  Pierre.Bourgouin@ec.gc.ca
  Chief, EERS, CMC
  (514) 421-4614
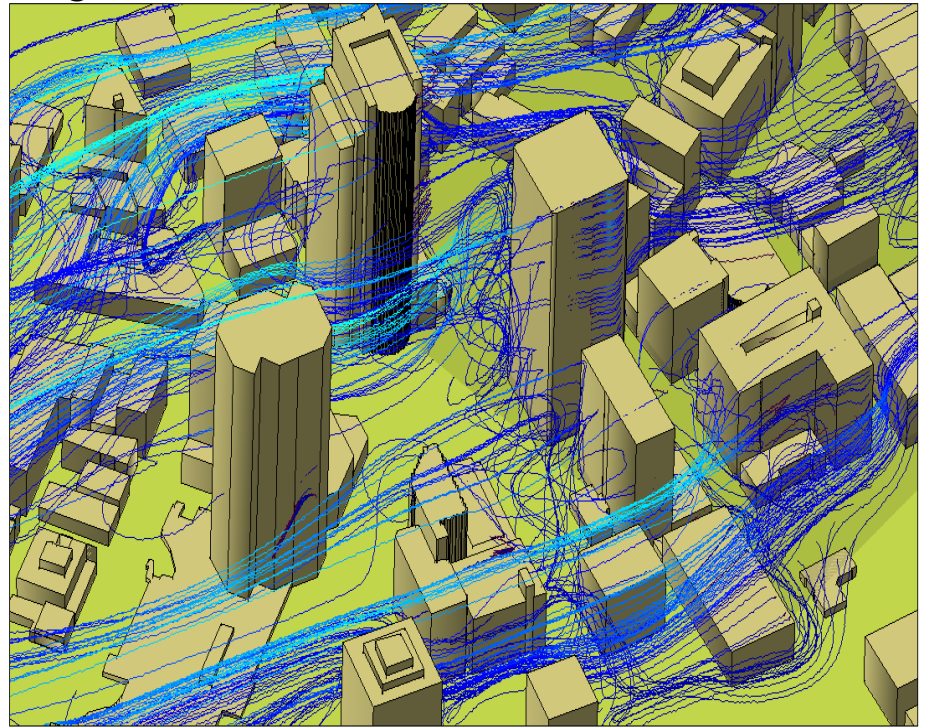
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Conclusion

- Deterministic weather forecast models are still appropriate for Day 1&2 forecasts

- Ensemble models offer probability approach to forecasting
  - They are product of choice for Day 3 and beyond forecasts

- Weather forecast data available in ascii, xml, GRIB2
- Digital data can be input into decision control systems

- Are building control systems ready for ensemble data?

60

Conclusions

- Ensemble forecast data could make the planning of your next 2 to 7 days more reliable, improve decision making and enhance how you manage risks

- A building weather forecast data matrix
  - Defining common set of weather variables for buildings may spur development of apps or tools to assist building managers
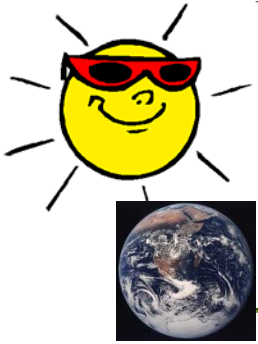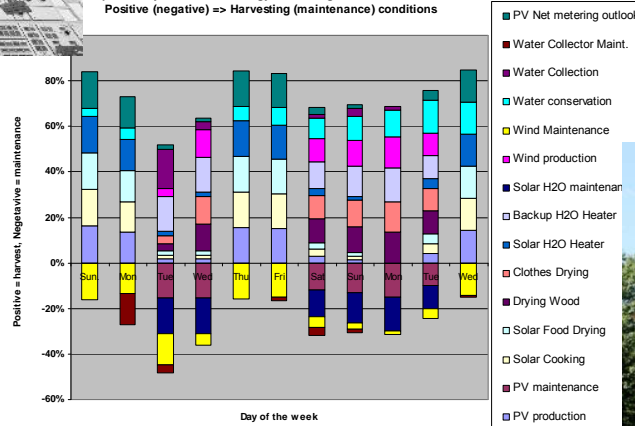
61

Thank You

Questions?

References

- MSC GRIB data

- CMC Product Guide

- "Renewable Energy forecasts for Solar Powered Applications"
  - Poster - 2006 Solar Buildings Research Network (SRBN) conference and at the 2008 CMOS congress

- Renewable Energy Forecasts for Solar Water Heaters
- Concordia's Solar Laboratory preliminary use of forecast flux data in solar buildings applications
  - Publications in the CMOS Bulletin

- Alstonvale Net-Zero House

References

- Solar and photovoltaic forecasting through post-processing of the Global Environmental Multiscale numerical weather prediction model

- Photovoltaic potential and solar resource maps of Canada

- National Climate Data and Information Archive

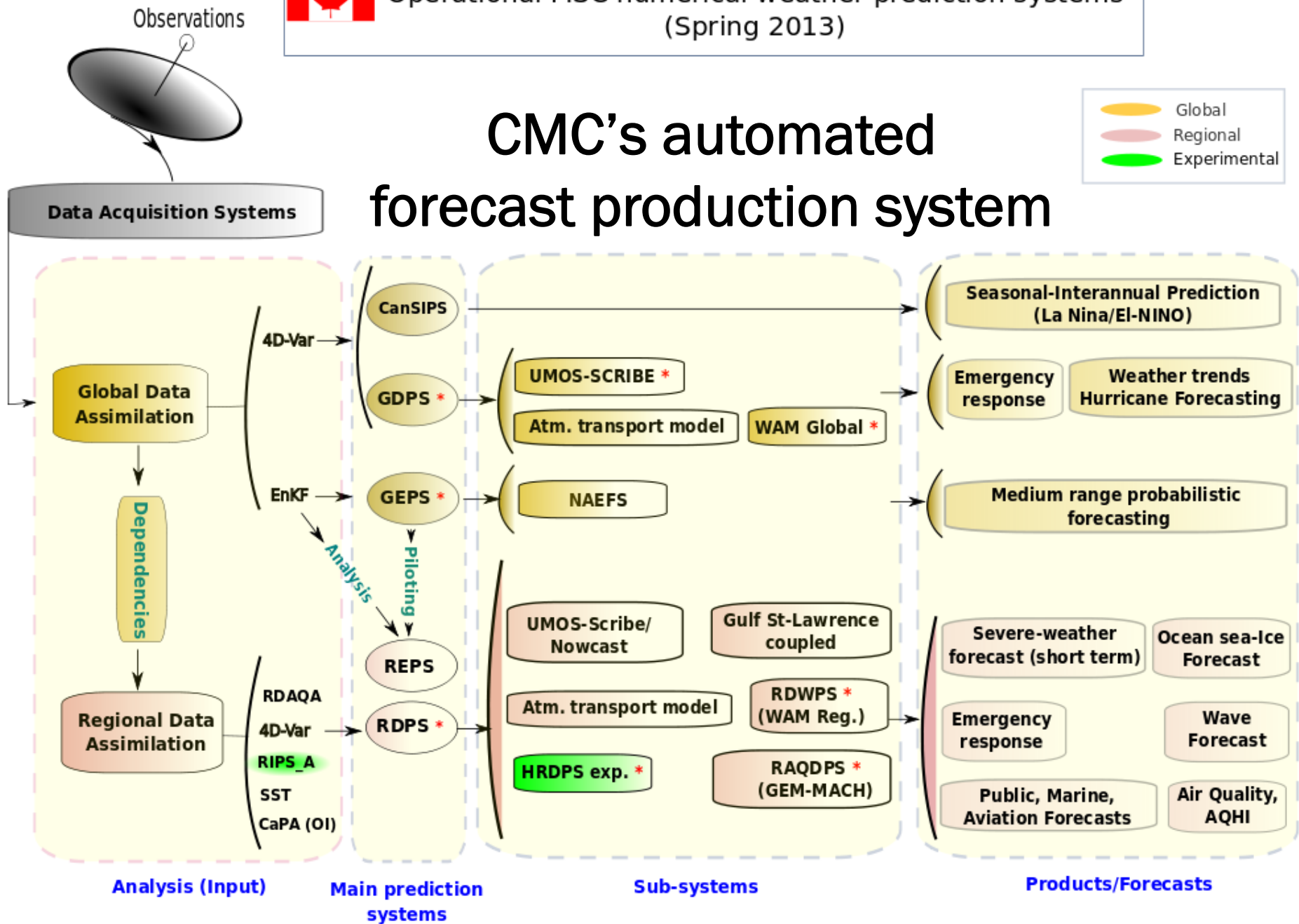Environment Canada   Environnement Canada

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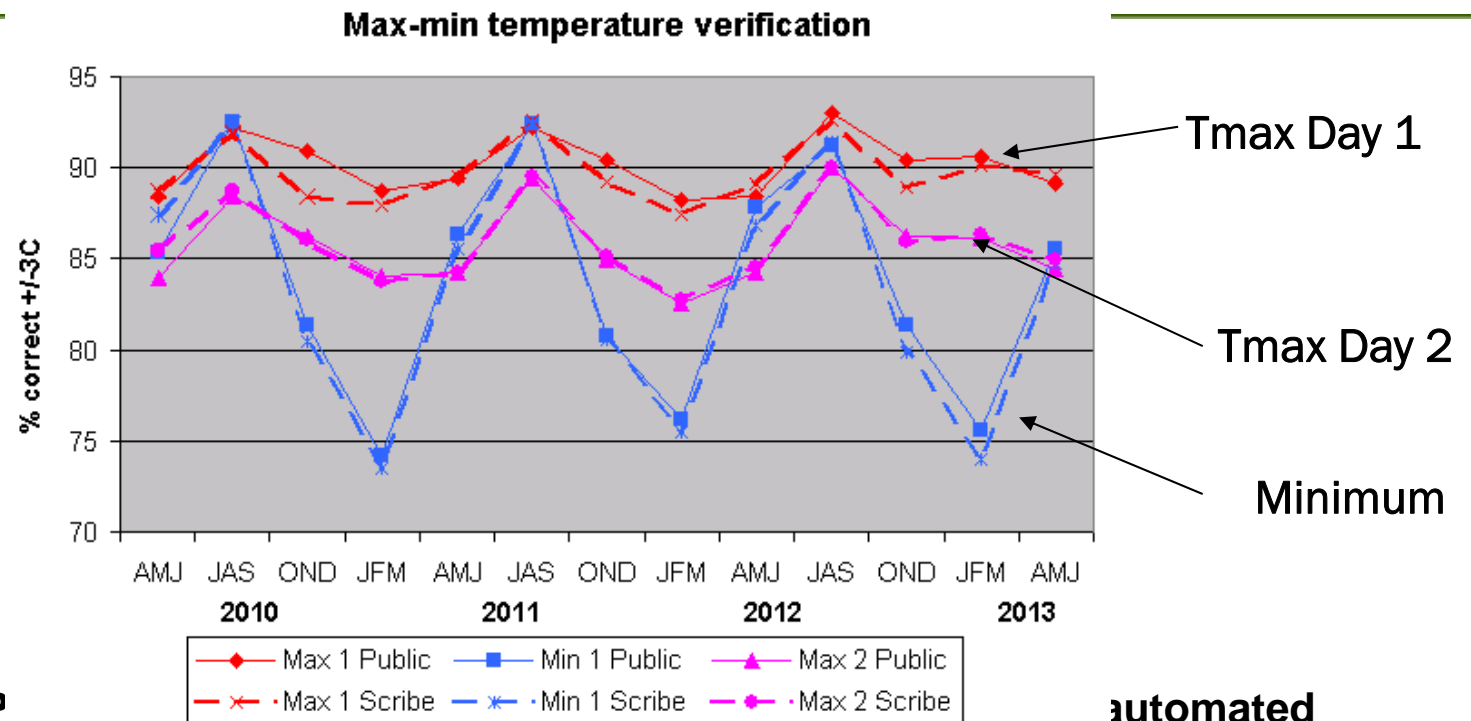
Extra slides

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Proceedings of the 13th International Conference for Enhanced Building Operations, Montreal, Quebec, October 8-11, 2013

Verification info

Figure 4: P ~~~~~~~~~~~~~~~~~~~~~~ automated
SCRIBE and official public forecast temperatures, by quarter. Errors are based
on the 00 UTC regional model run and are averaged over the period based on
the number of observations from approximately 118 Canadian observation
sites.