



Environnement  
Canada

Environment  
Canada

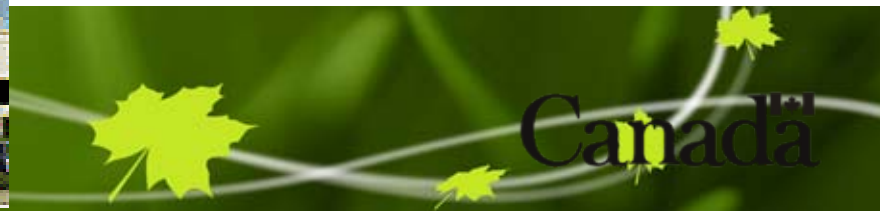
Canada

# High Performance Computing at the Canadian Meteorological Center (CMC)

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RPN/CIOB      Environment Canada



Reading, UK  
November 3, 2008



# Outline

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- Current supercomputing situation
  - IBM Power5+ system upgrade
- Current activities involving supercomputing
- Future needs



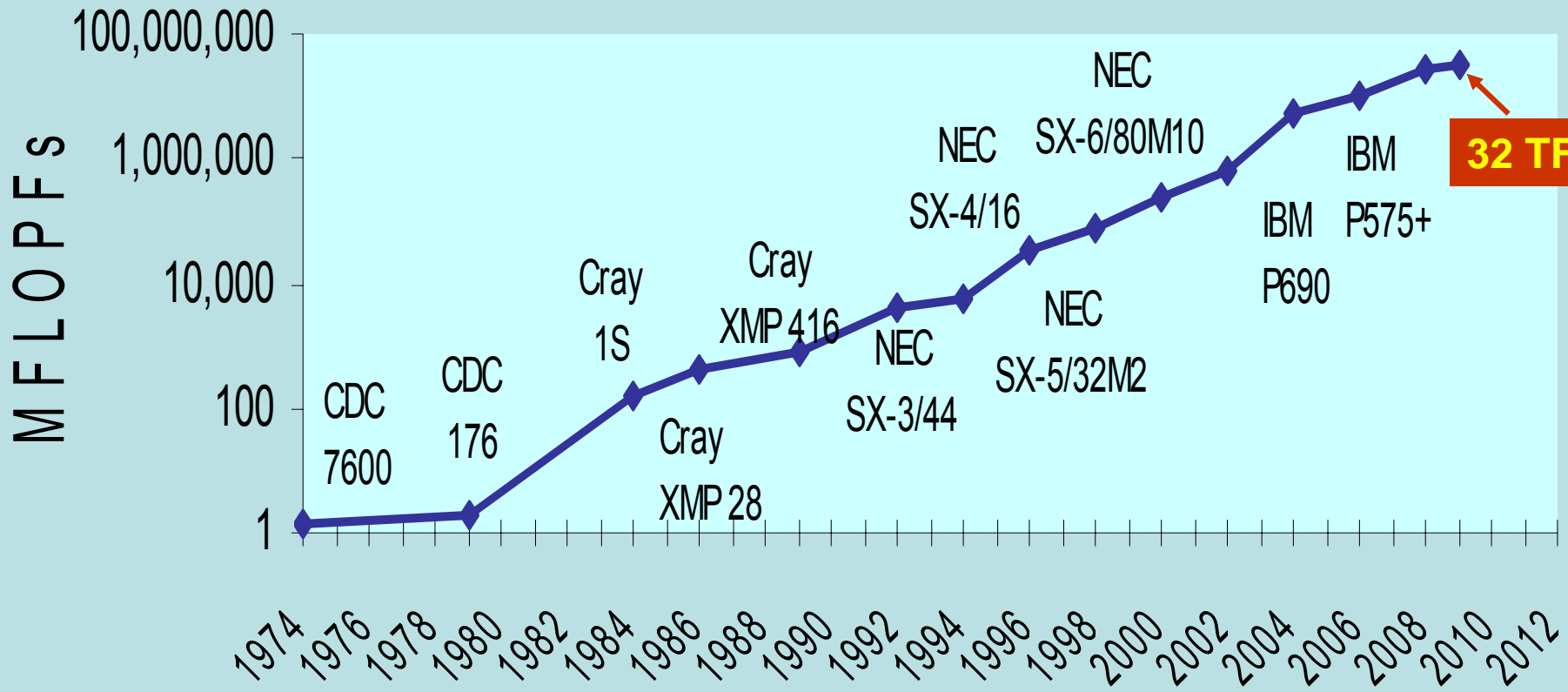
# Current Hardware

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- Supercomputer contract with IBM started in Dec. 2003
  - Azur, p690, 960 cpus, Power4 1.3GHz
- Upgrade 1 accepted Dec. 2006
  - Maia(608-944) / Naos(608), p575+,  
1216-1552 cores, Power5+ dual-core 1.9GHz
- Upgrade 2 was optional, exercised in September 2007
- Contract ends in December 2011
  - Procurement needed for 2012 and beyond



# CMC's History of FLOPS



Project Phase	Delivery Dates	Additional Nodes	Total node count	Total Contract nodes (based on CSP)
Upgrade 1 – Phase 1 and 2 (Maia / Naos)			91	73
Upgrade 2 - Phase 1	Dec 2007	19	110	73
Upgrade 2 - Phase 2	Sept 2008	127	237	73
Upgrade 2 - Phase 3	June 2009	45	282	167

# EC accepted IBM Power5+ offer

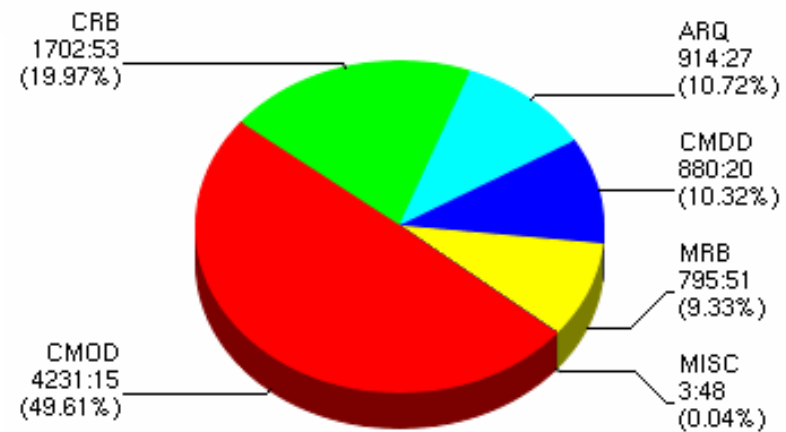
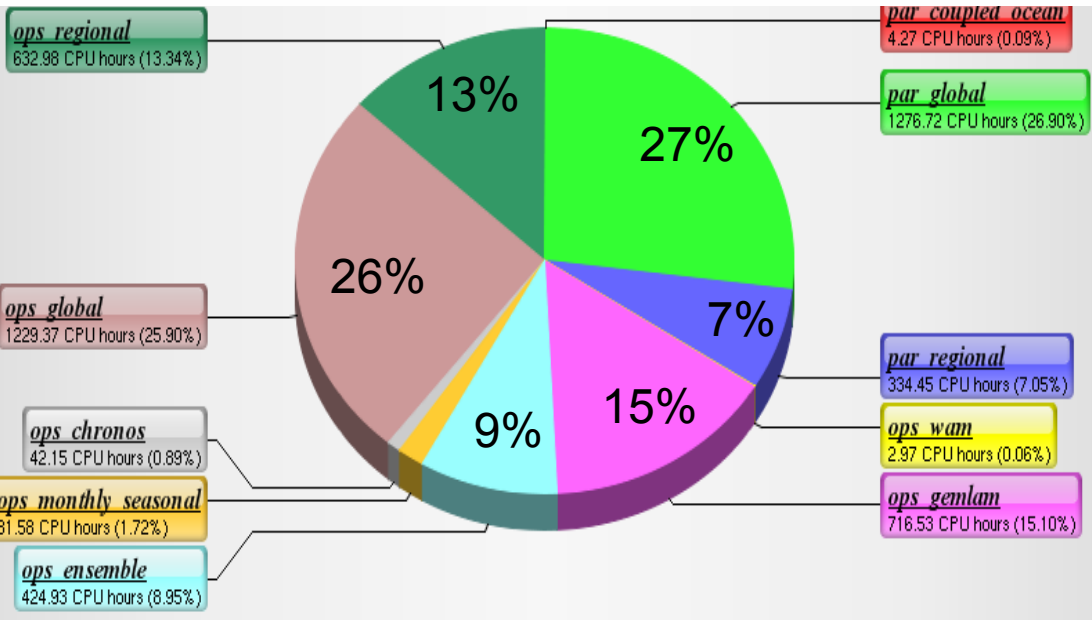
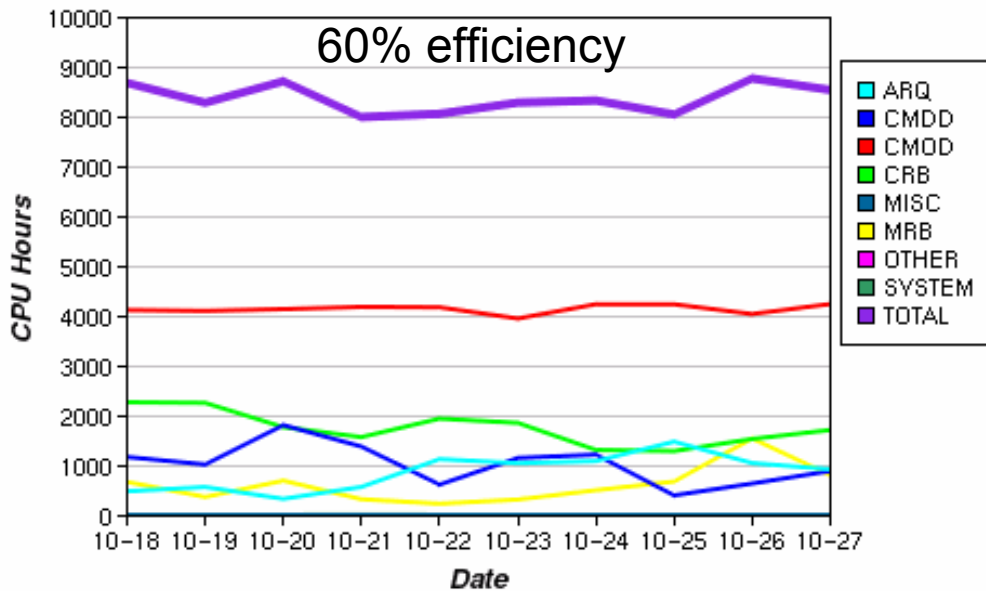
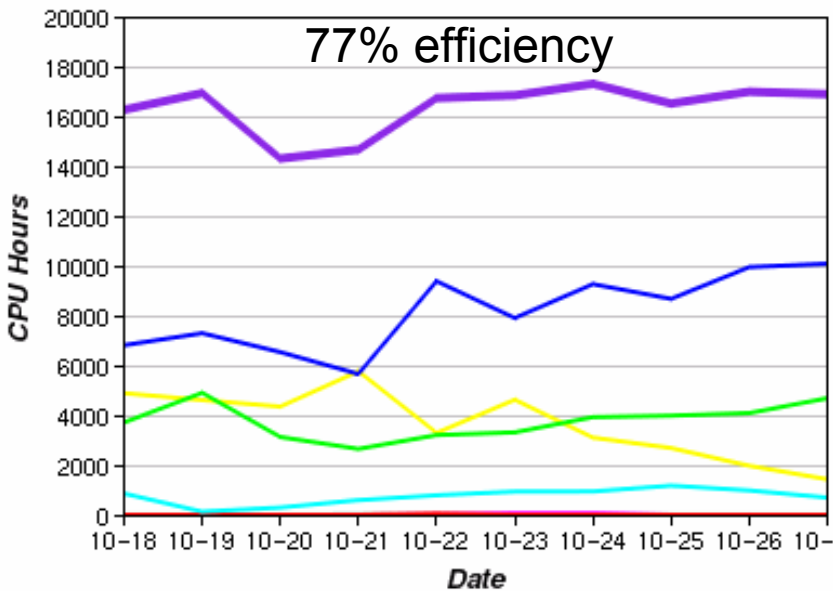
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- Pros
  - IBM will deliver ~1.7X the minimum contractual performance
  - Avoid heavy procurement costs (human and \$\$)
  - More computing power materializing sooner
  - Upgrade path much easier for users
- Cons
  - Same technology for 5 years (until December 2011)
  - Hardware failures likely to increase
    - IBM still contractually committed to 99% availability
    - Redundancy level is high
  - Serial or quasi-serial applications will not see a gain



# MAIA - Accounting Trend - last 10 Days

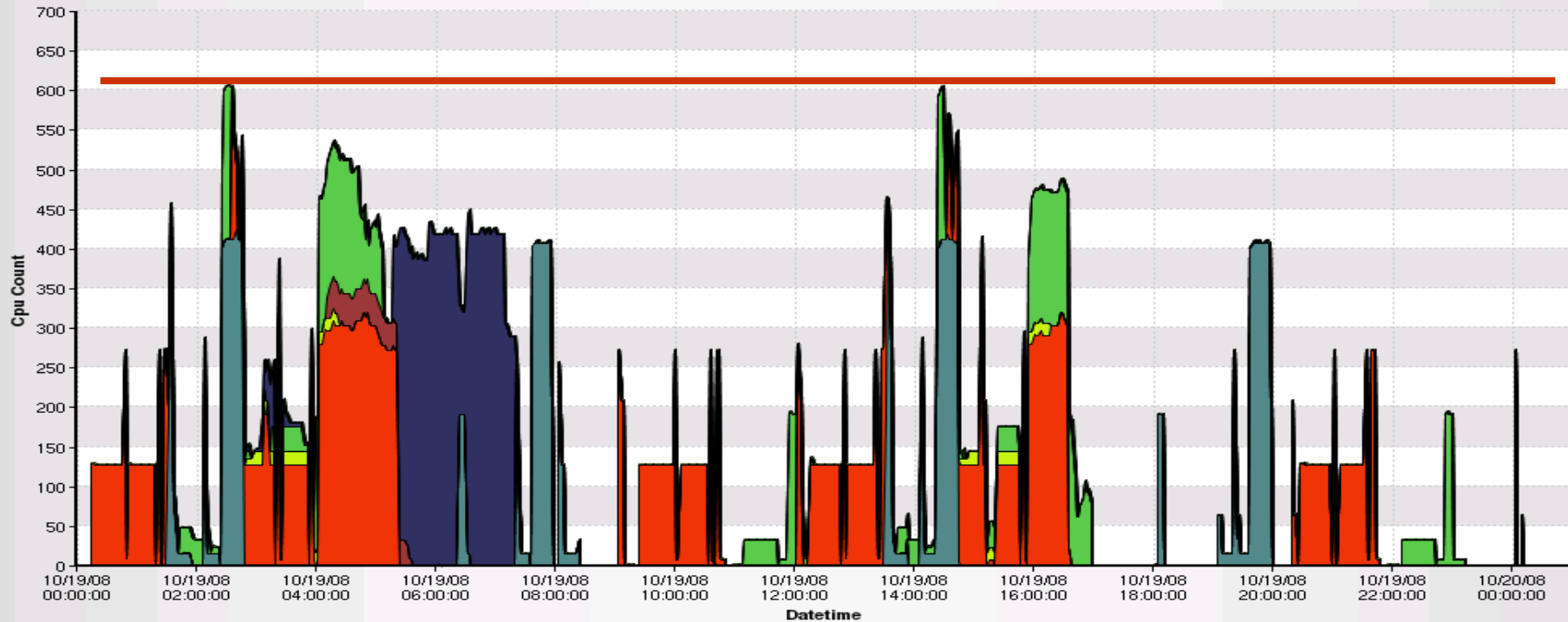
# NAOS - Accounting Trend - last 10 Days



**Global 52.8 %**  
**Regional 20.3 %**  
**LAM 15.1 %**  
**EPS 09.0 %**

*IBM Production class usage 2008-10-19  
Operational : Total Cpu Hours 3082.38*

regional_641h	global_1226h	chronos_42h	monthly_seasonal_42h	ensemble_424h
gemlam_705h	wam_3h			

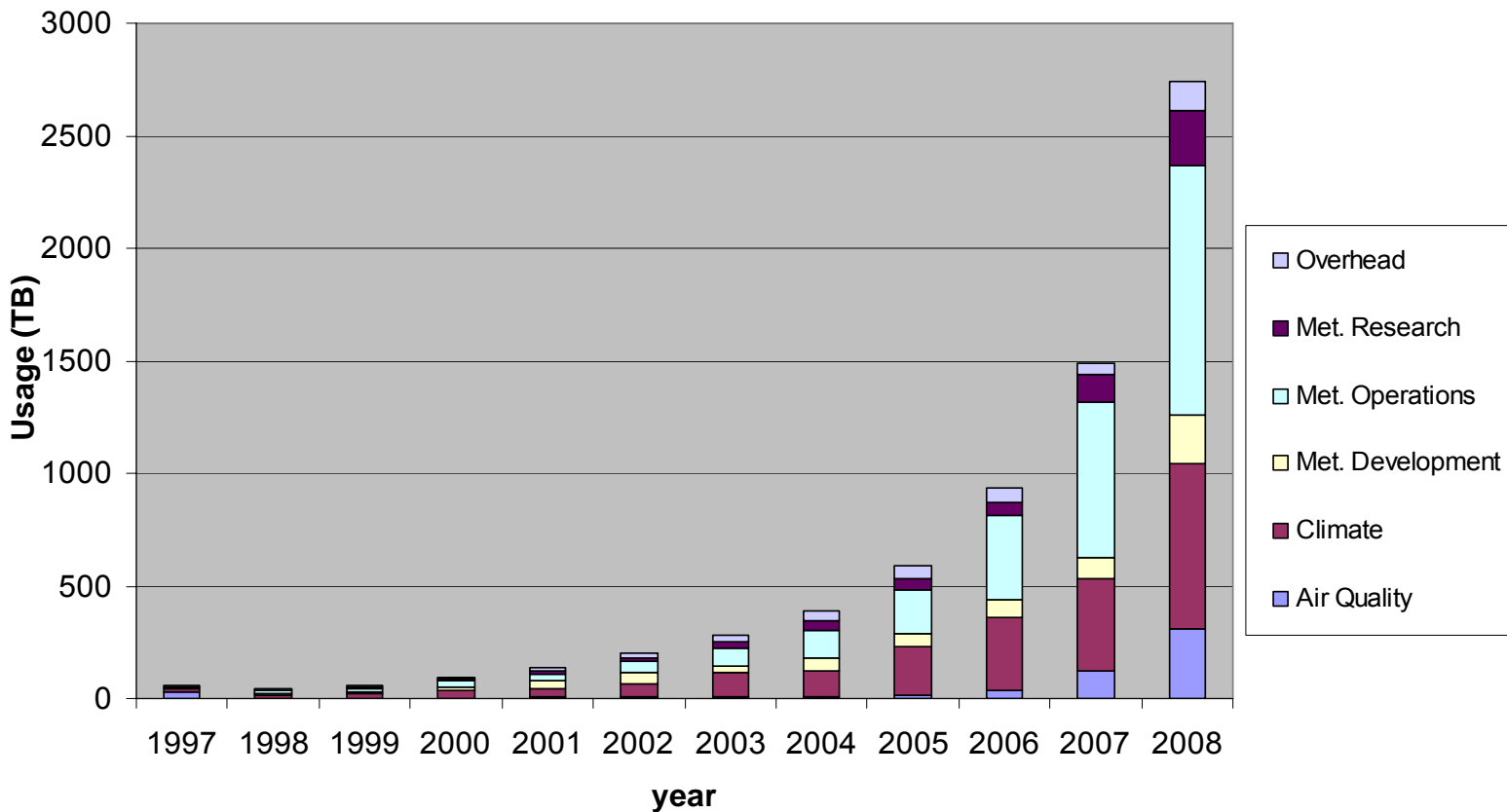


# CFS: Archiving

- Usage: 1.4 PB (= 1400 TB) (single copy)
- Capacity: 6k tapes 3 PB (single copy)
- Daily: Write: 7.5 TB / Read: 4.5 TB

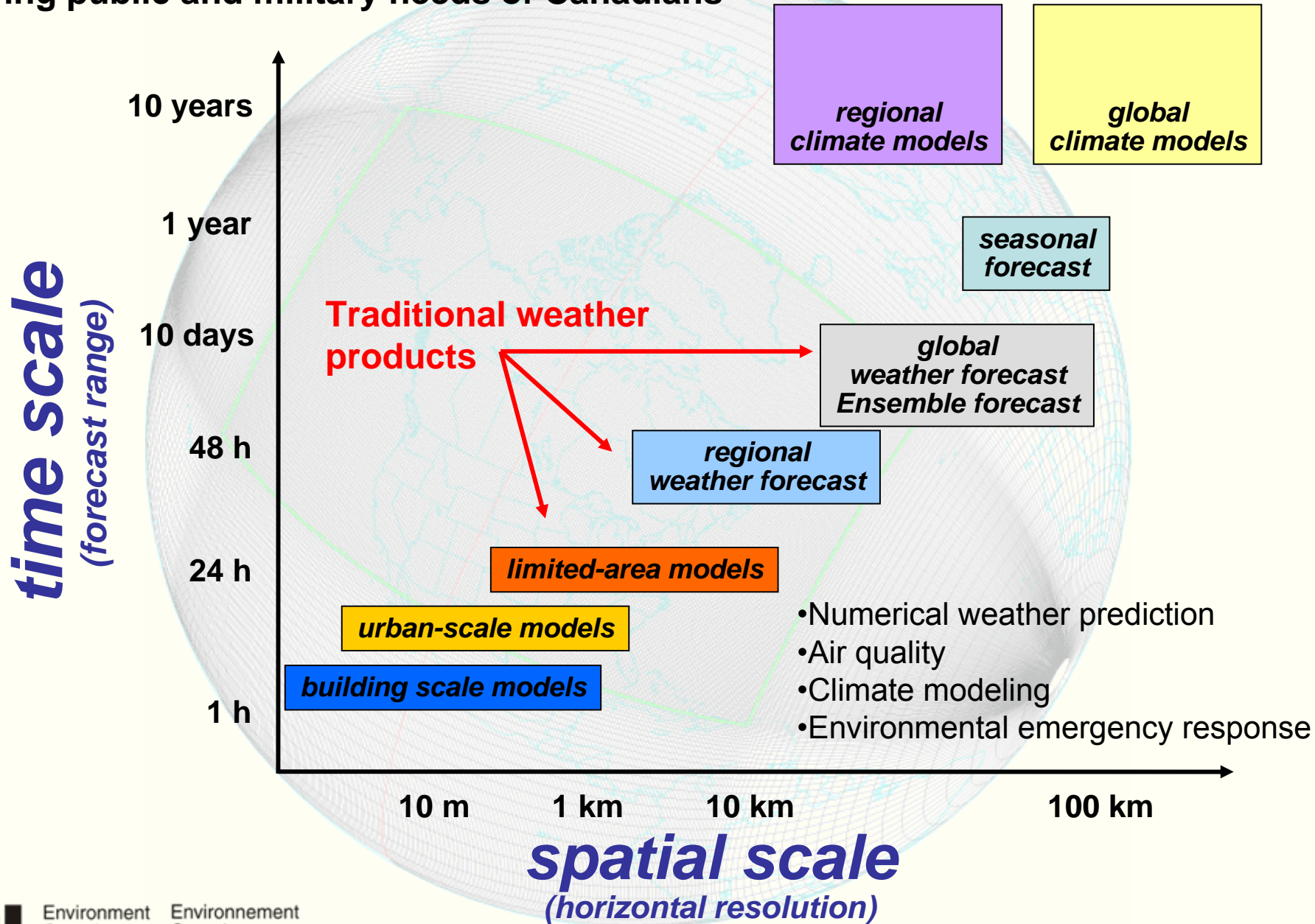


Space usage on cfs





# Uninterrupted (24/7, year-round) weather and environmental forecasts, serving public and military needs of Canadians





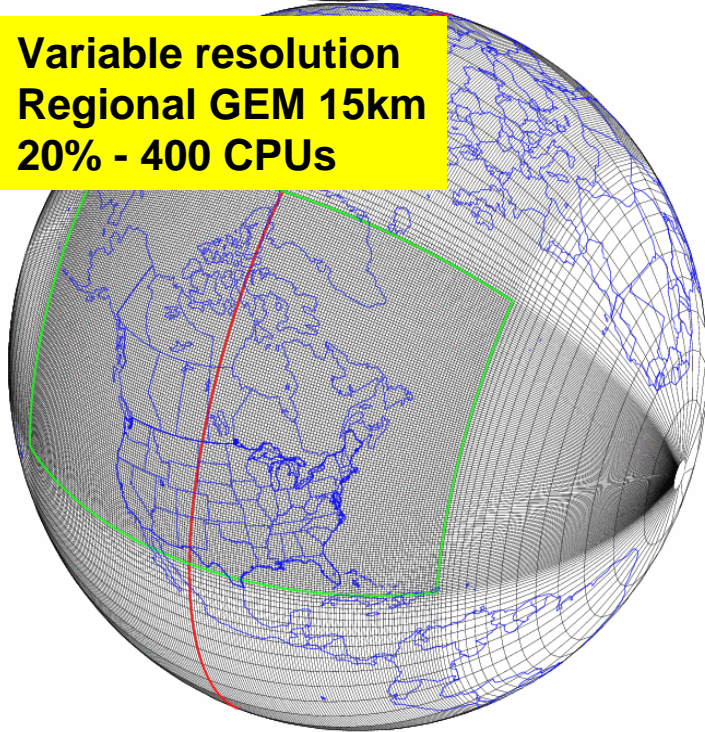
# CMC Operational NWP model

Global Environmental Multiscale (GEM) model

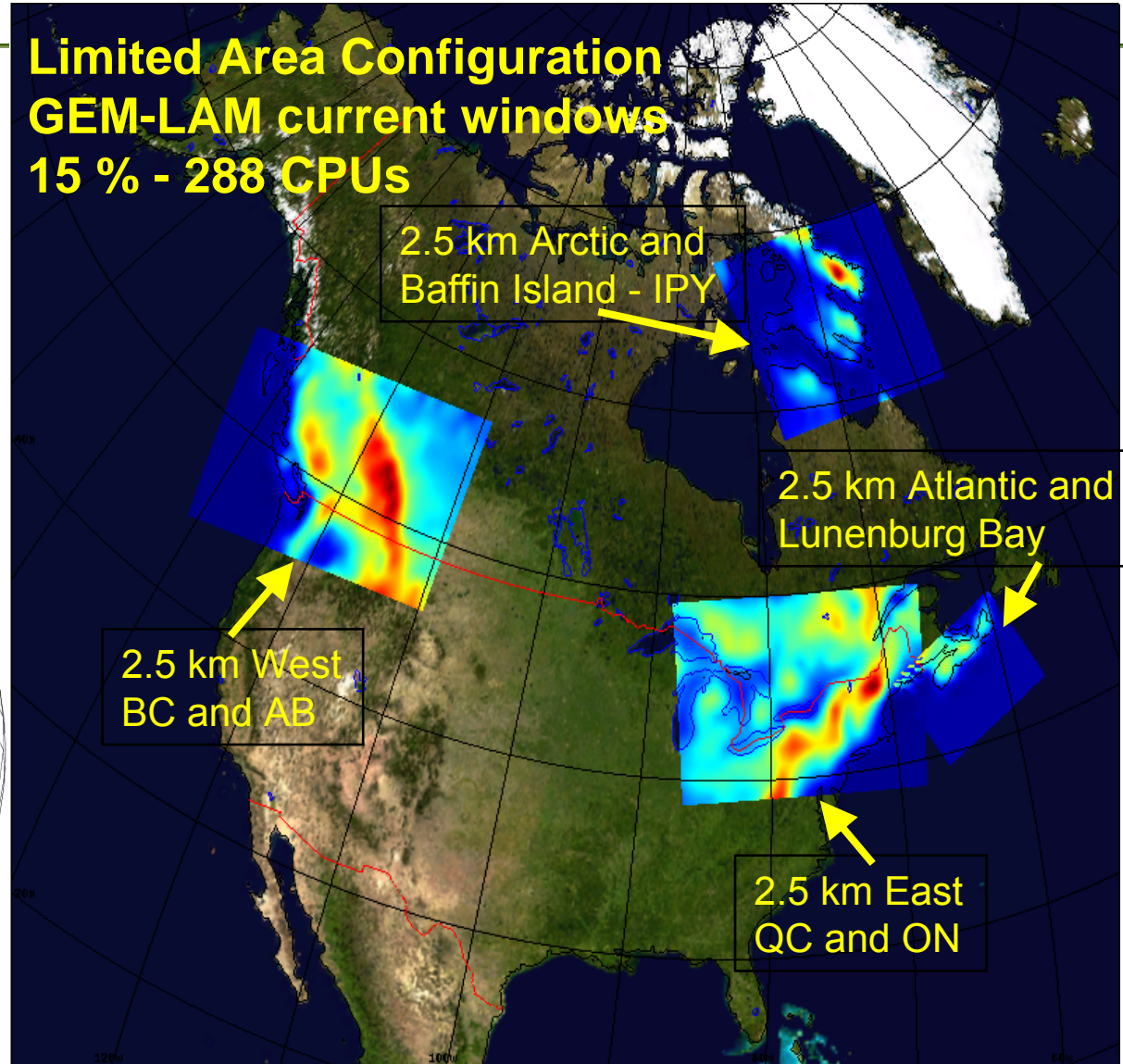
**Uniform resolution  
Global GEM 33km  
53% - 272 CPUs**



**Variable resolution  
Regional GEM 15km  
20% - 400 CPUs**



**Limited Area Configuration  
GEM-LAM current windows  
15% - 288 CPUs**



2.5 km Arctic and  
Baffin Island - IPY

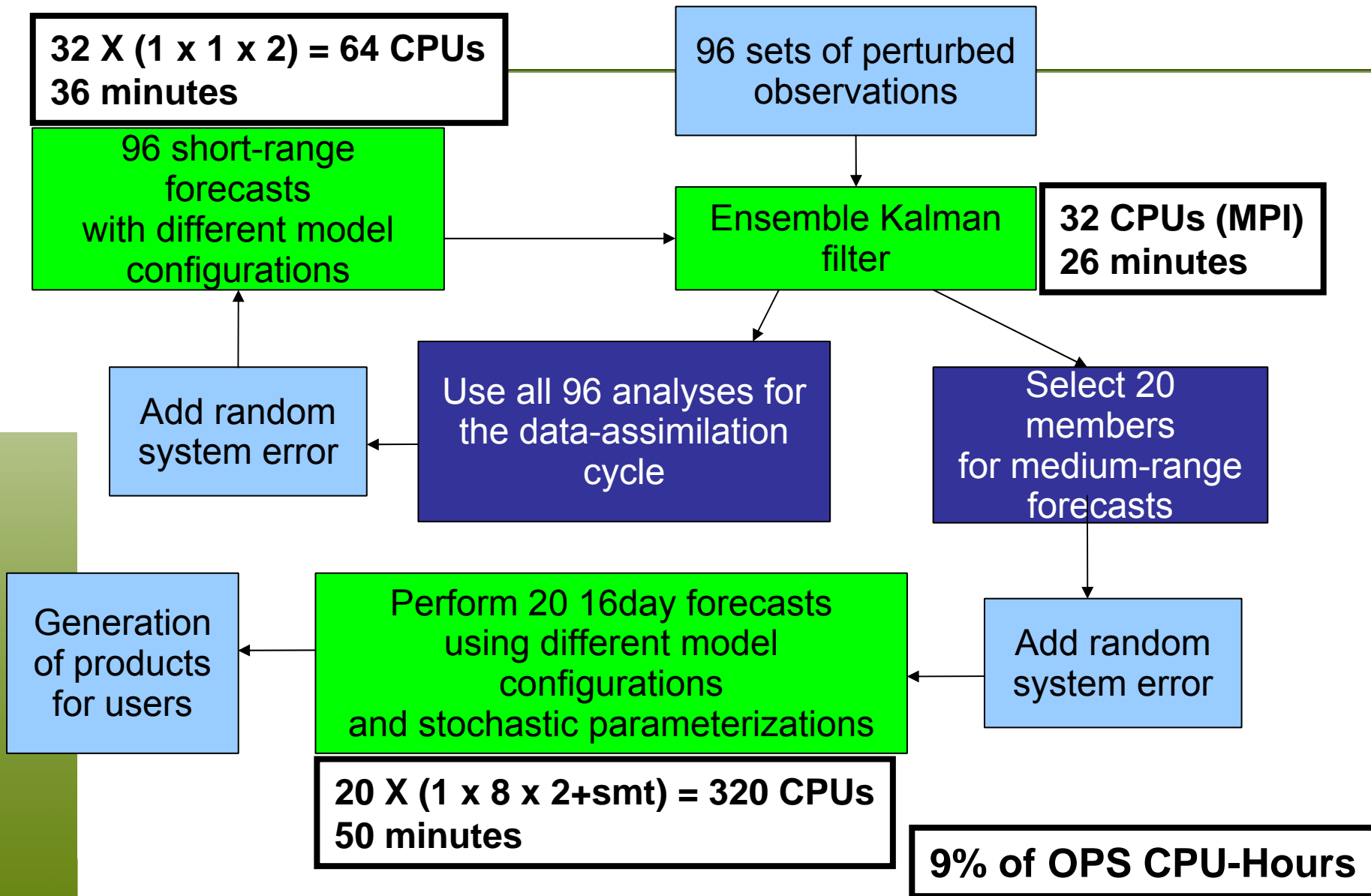
2.5 km Atlantic and  
Lunenburg Bay

2.5 km West  
BC and AB

2.5 km East  
QC and ON

# The Global Ensemble Prediction System

Monte Carlo methods are used to estimate the uncertainty in the forecast.





# Air Quality Modeling: GEM-MACH15

Feb 3rd, 2006 in Montreal



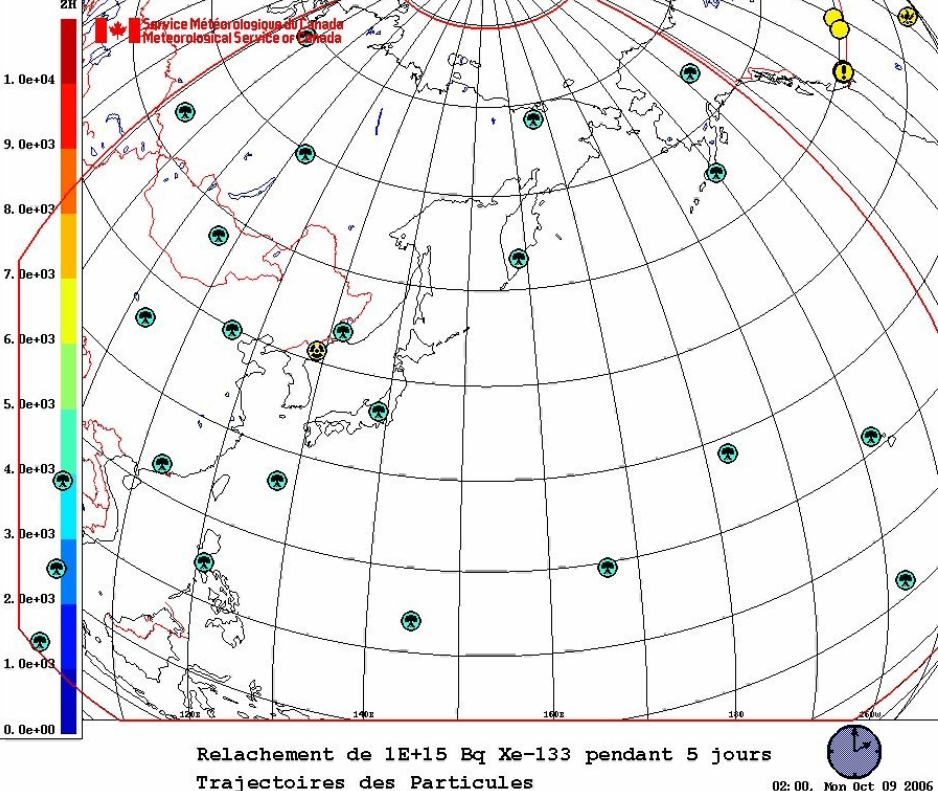
GEM 15 km  
with an in-line  
Chemistry Model

AURAMS

To be implemented  
late 2008

Thanks to Richard Hogue





Relachement de  $1E+15$  Bq Xe-133 pendant 5 jours  
Trajectoires des Particules  
02:00, Mon Oct 09 2006

# Environmental Emergency Response at CMC

## Nature of Hazardous Releases

- Natural disasters
  - Volcanic eruptions, Forest fires, Dust
- Radiological agents
  - Nuclear Emergencies
  - Part of Canadian Authority for CTBT (Nuclear Test Ban Treaty)
- Toxic industrial chemicals
- Chemical warfare agents
- Biological agents/toxins
- Fires



St. Helens



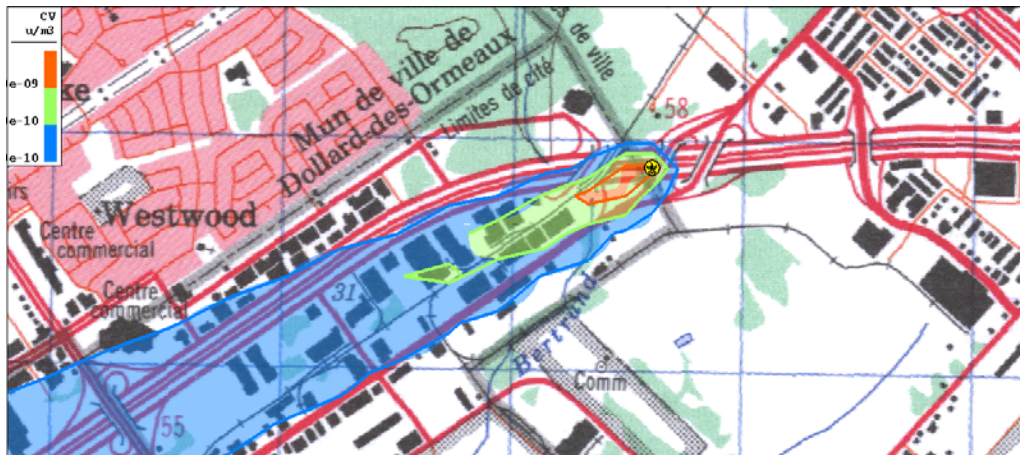


# Environmental Emergency Response at CMC Truck Accident near Dorval



Accident: Oct. 12, 2005,  
Highway 40 near Dorval

Semi-trailer containing  
30 tons of Sodium  
Hydrosulfite



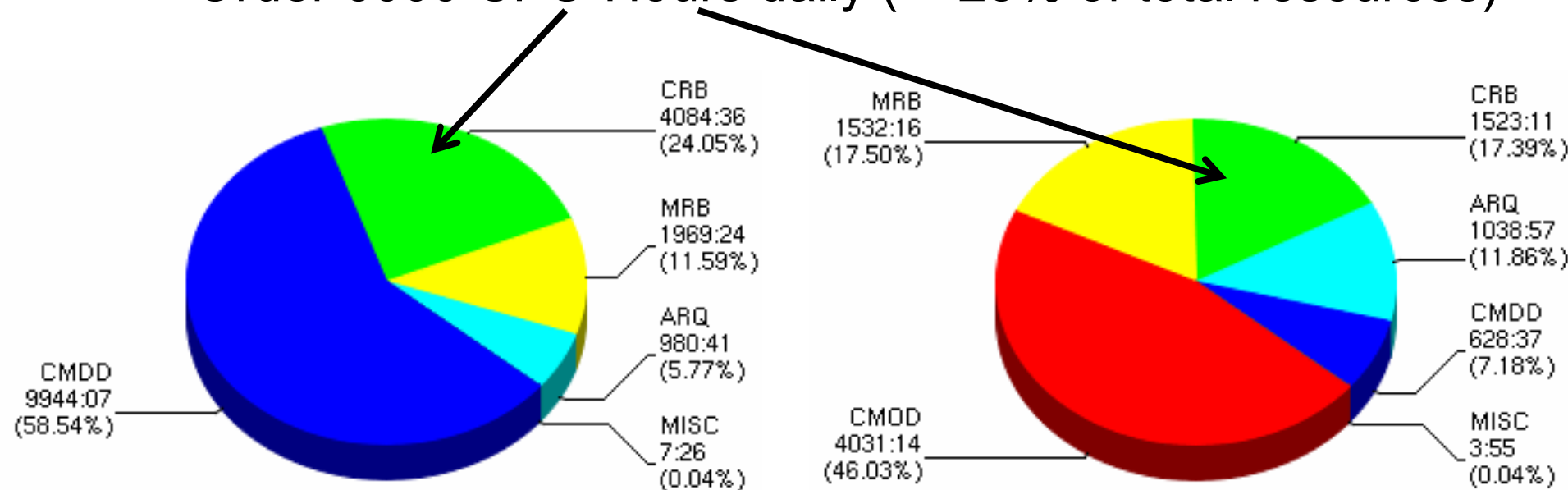
Mercredi 12 Octobre 2005 à 20:15Z

1:13119 Metres  
0 180 360 540 720

Hazard area extends  
~ 500 m downwind

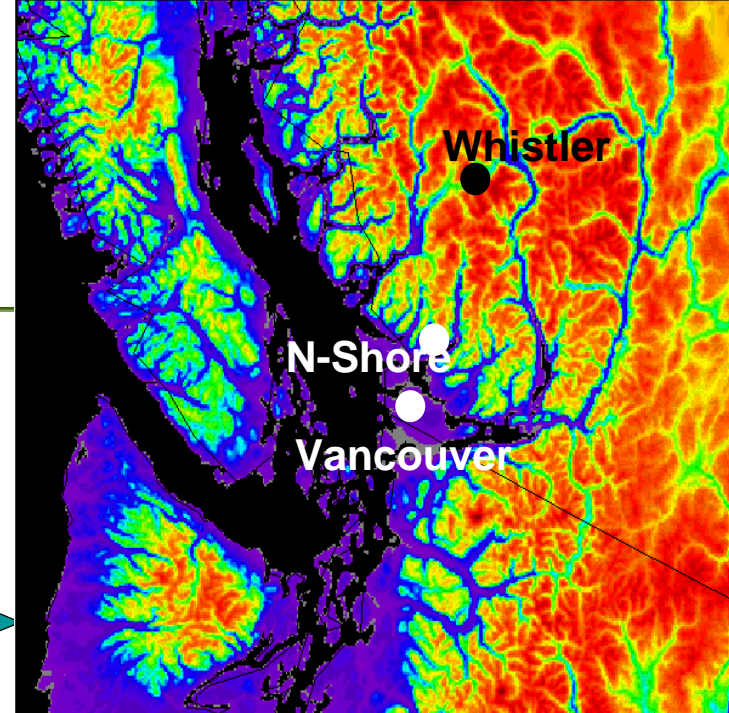
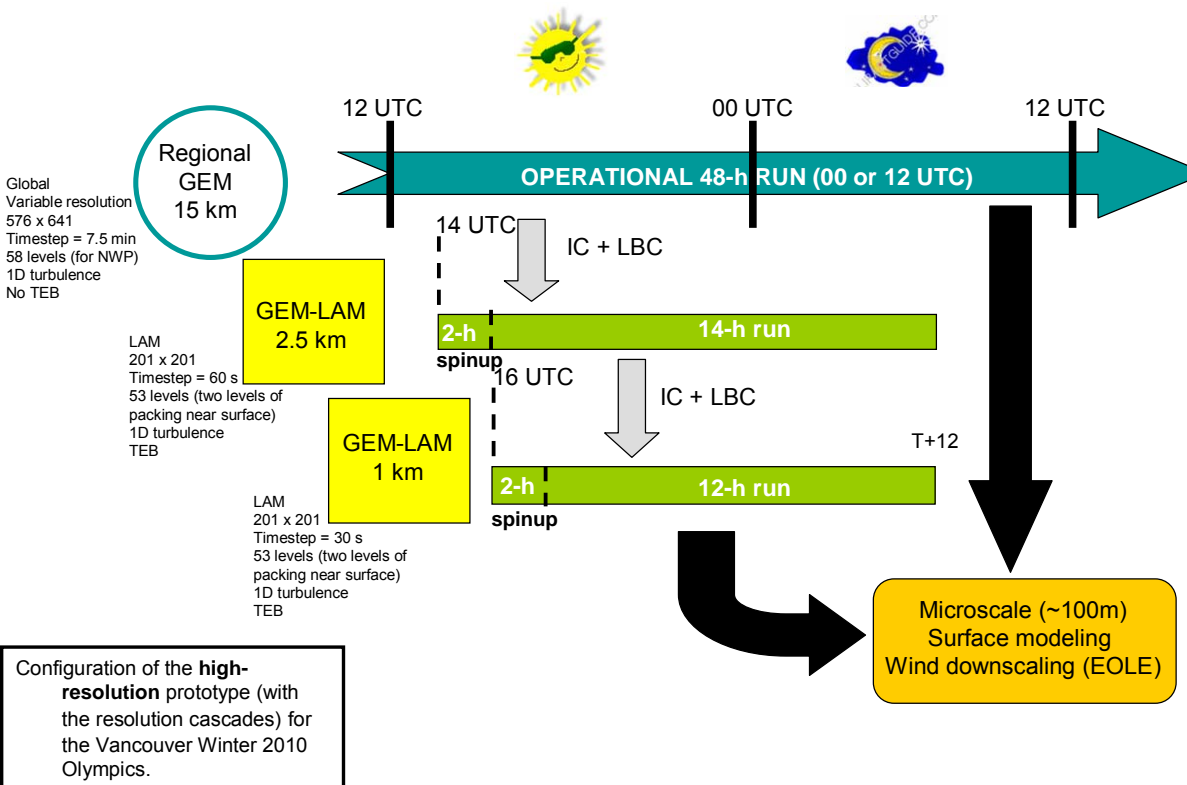
# Climate modeling

- Understanding Regional and Global climate changes
- GCM spectral models
- Contributor to the IPCC report (So I can say I won (a small tiny piece) of a Nobel Prize!)
- Order 6000 CPU-Hours daily ( ~ 25% of total resources)



# Vancouver 2010 Olympics forecasting project

## From Mesoscale to Microscale



- Triply-nested GEM LAM 15 km, 2.5 km and 1 km
- Surface model 100 m res. over the Olympics region

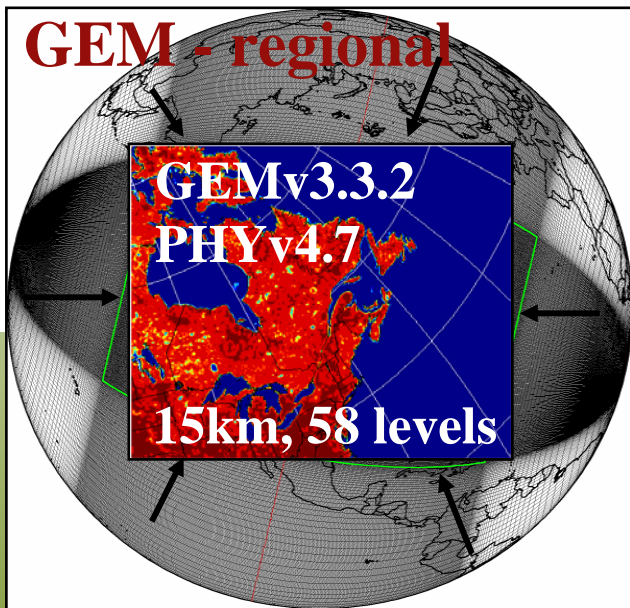




# Atmosphere-Ocean Coupling

## OASIS3 - Gossip2

SST, ice fraction, mask  
ice temperature & thickness



4 applications at once  
Co-scheduling, an option

MIMD with MPI  
The current  
solution

One single mpirun

## MoGSLv5.3.3

- 3D Ocean
- 2D sea-ice: dynamic-thermodynamic

5km, 73 levels

Timestep = 450s

## OASIS3 - Gossip2

Air & dew point temp., wind  
solar & IR flux, precipitation

Timestep = 225s

# Operational Targets for next 10 years

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- Resources have increased by a factor of 5 in the last 5 years
- Considering a factor of 7-10 in the next 5 years we expect to be able to provide:
  - Global 20-25 km uniform resolution, 90 levels
  - Regional 8-10 km, 90 levels
  - In Operation by 2015
- Considering another factor of 5 in the following 4-5 years we expect to be able to provide:
  - Global 10-15 km uniform resolution, 110 levels
  - Regional 4-5 km, 110 levels
  - In Operation by 2020



# Future

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- Key decisions on the facility
  - Power and space constraints
- Preparing applications for future architecture
- Increase NWP model resolution (and improve modeling)
- Managing insane amount of data
- More collaboration with non-traditional partners
- More data available to the public