Numerical Weather Prognosis (NWP)

for Canadian Fire Weather Professionals

(Kelowna, EC National Services Office, February 23-27)

Contents

Monday, Tuesday

NWP Basics and Model Components

- Coarse Overview
- NWP Basics (Terminology, model components, types, the 4 main models)
- GEM
- Model output (standard heights, 4 panels, XT, Tephis, Post Processing, Tons of Links)
- Links
- Your Own Forecasts and how they change over time. (Exercise)

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Contents

Wednesday, Thursday

Problems of the Components and :

- Components that fail (DA, initialization, precip/cloud paremterization)
- Differences due to model structure.
- Common problems (especially over mountains)
- Daily Model Discussions
- Typical Model behaviour case studies

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Friday

Contents

Post Processing:

- Statistical Post Processing
- More Model Specific Case Studies
- Buffer day (discuss, final questions, Q&A)

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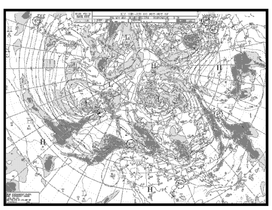
Why Weather Models?

One purpose of NWP is to create the same maps we have analyzed so far (e.g. a 700hPa chart with contours and moisture), that apply to a time in the future.

This way we can apply all the traditional tools to see what the weather will be in the future.



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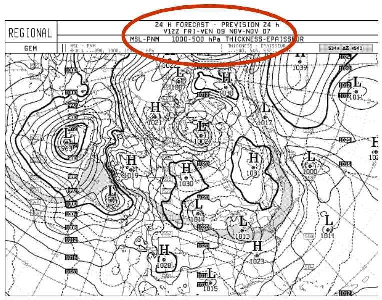
… like this surface chart



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How does this work?

1) **Analyze** the current weather (all levels all at the same time!)

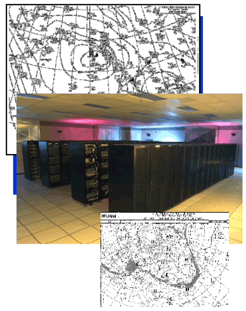
2) **Initialize** the computer (grid or spectrum) with the analysis so that it can read it and do its calculations.

3) **Run** the computer and the software

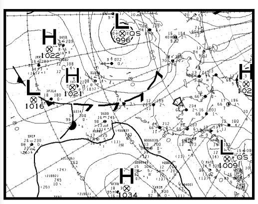
4) Wait …

5) Wait some more ...

5) When the computer is done: Tell it how to print/**output** the results (e.g. Print a 700hPa map with moisture and wind barbs valid in 48 hours)



The Analysis



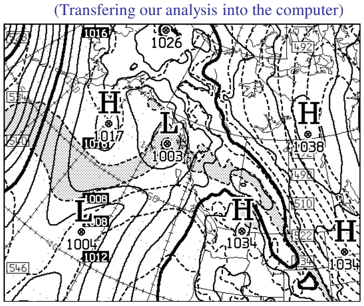
A Subjective Surface Analysis

- The drawing and interpretation of the patterns of various weather elements on a surface or upper-air chart. An analysis is typically done 4 times a day by national weather offices at 00Z, 06Z, 12Z and 18Z.
- Surface / Upper Analysis
- Objective / Subjective Analysis
- BUT: Initialization!

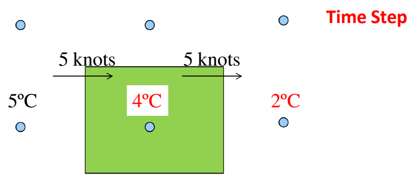
- http://www.weatheroffice.gc.ca/analysis/index_e.html

Initialization

(Transfering our analysis into the computer)



Horizontal Domains: Grid Points



Note: The locations between grid-points have no value assigned. For this reason, **Grid Points represent the average over the whole grip box**.

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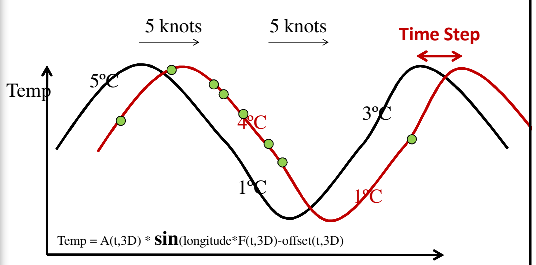
Horizontal Domains: Spectral



Note: Since there are no grid points, the spectral equation defines a value for every possible location.

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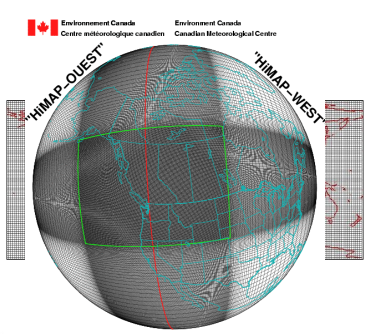
Horizontal Grids



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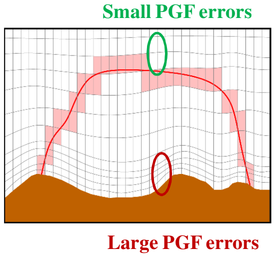
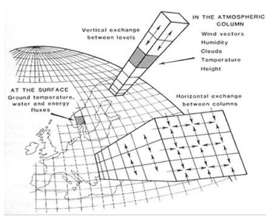
Vertical Grids

- Sigma
- Sigma – Pressure Hybrid
- Isentropic
- Isentropic-Sigma Hybrid
- Eta (old)

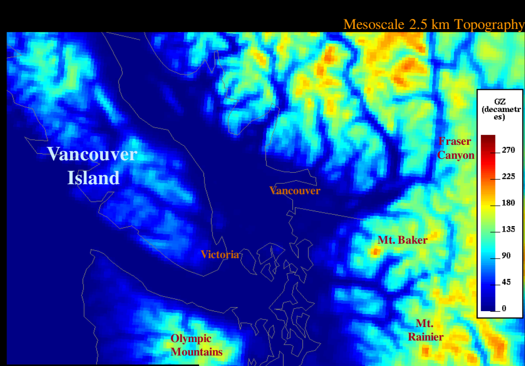


Weather Models

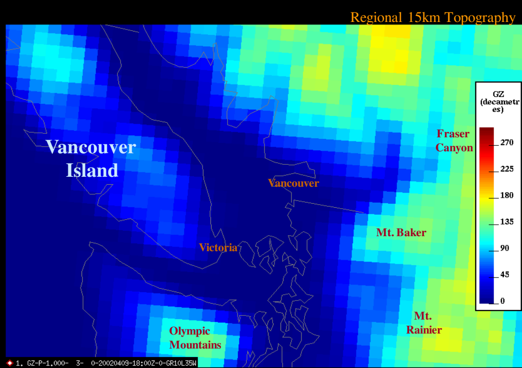
(Calculating on a 3D grid)



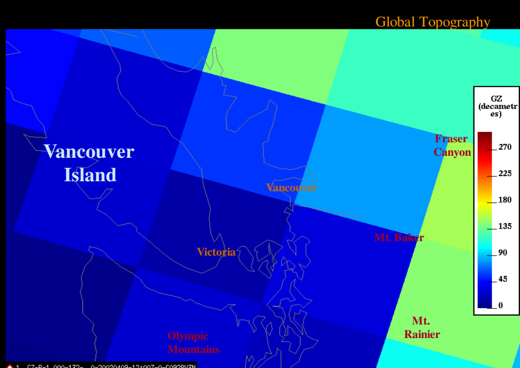
Weather Models Grids



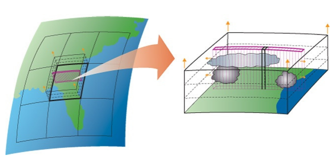
Weather Models Grids



Weather Models Grids



Parameterization



Most "physical" fields/effects in the PBL have to be parameterized:

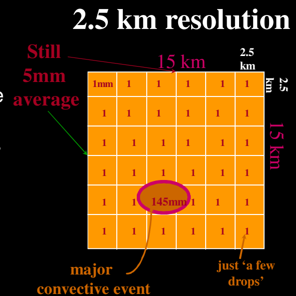
- Mesoscale or smaller Convection
- Soil Moisture/Evaporation
- Friction effects
- Land/Sea boundaries
- Radiation absorption
- Snow melt etc.

Precipitation: Coarse Model Grid

- The current (non mesoscale) regional model calculates all variables at locations that are 15km apart.
- That means: If the model predicts 5mm of rain over a location, it really means 'an **average** of 5mm over an area which is 15 km by 15 km (225 km^2) big'.

Precipitation: Small Model Grid

- If we had a model with a 2.5km resolution (LAM?) we could make **the same** prediction over these 225 km^2 ….
- But it is now accurate to 6.25 km^2. And thus adds important information.



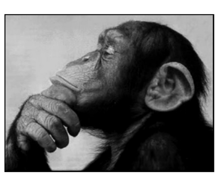
The Primitive Equations

$$\frac{dv}{dt} = -(1/\rho)\nabla p - g(r/r) + (1/\rho)\left[\nabla \cdot (\mu \nabla v) + \nabla(\lambda \nabla \cdot v)\right]$$

$$c_v \frac{dT}{dt} + p\frac{d\alpha}{dt} = q + f$$

$$\frac{dp}{dx} + \rho \nabla \cdot v = 0$$

$$pV = nRT$$



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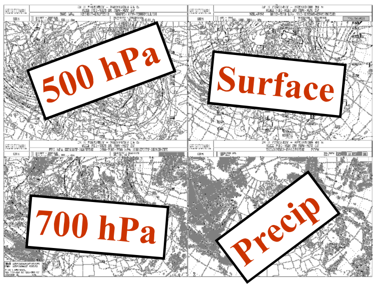
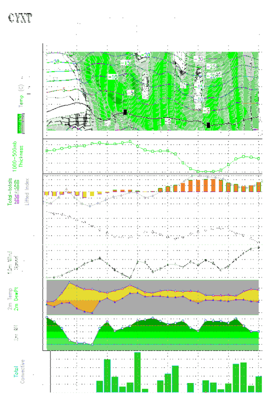
Computer Output: The 4 Panel Chart

(The same charts we always worked with except: for the future)

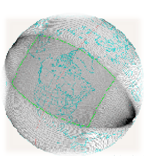


Other NWP output



- Thephigrams
- XT diagrams
- Meteograms
- Statistical Post Processing (MOS, UMOS, PP)

Regional and Global Models



Since weather systems in the mid-latitudes move from west to east at a certain speed, a frontal band that will give central Canada a headache in ten days may, at this point, be only a tiny cumulus over central Russia. To properly forecast this feature you need a model that covers both, Russia and Canada.

Thus, the further you want to forecast into the future, the larger your model domain has to be.

At the same time, to include all features and observations between Canada and Russia the computers will be stretched to their limits and we have to make concessions: **The most common concession: Decrease the model resolution and 'neglect' small weather details.**

Global Models make long range forecasts.

Regional/Mesoscale models make short/medium range forecasts.

The Big 4 North American Models

	US (NCEP)	Canada (CMC)
Global	GFS (Global Forecast System)	GEM Global (Global Environmental Multiscale)
Regional	WRF NAM (North American Mesoscale)	GEM Regional

Honourable Mention: ECMWF

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