



Heat Forecasting

Advancing our Capabilities and Knowing our Limitations

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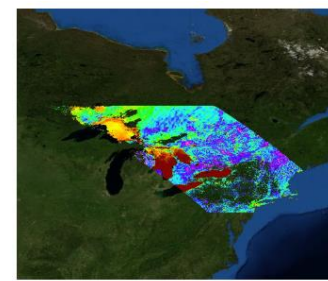
Overview

- Heat Forecasting – Observations and Local Effects
- Heat – Indices and Thresholds
- Scale – Spatial and Temporal
- Forecast Models
 - Deterministic, Probabilistic, Ensemble Prediction Systems
 - Other Modeling Advances
- Sector Specific Heat Forecasting
- Canada's Heat Warning Modernization experience

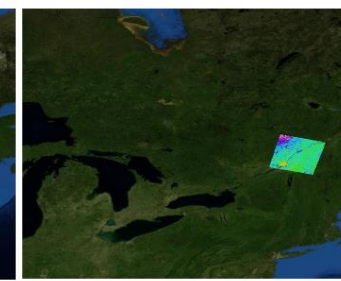
Heat Forecasting

Observation

- Ground Based Methods
 - Data Source
 - Type of observation
- Satellite Based Methods
 - Advanced Very-High Resolution Radiometer (AVHRR)
 - Limited Observations (Sea Surface Temperature, Arctic)
 - Limitations: cloud-free conditions, resolution, frequency of observations



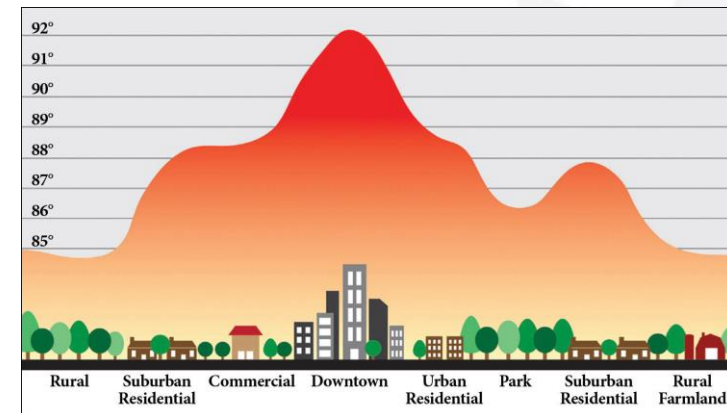
MODIS



Landsat

Local Effects

- Geography/Topography
- Bodies of Water
- Climatology
- Urban vs. Rural environment
 - Urban Heat Island (UHI)
 - Population distribution and available services



Heat – Indices and Thresholds

- Heat Indices – “Feels Like Temperature”
 - Various forms using multiple parameters:
 - Air Temperature, Humidity, Wind, Solar Radiation
 - Global variation and sector specific
- Threshold Development Considerations:
 - Epidemiology – health evidence
 - Warning Fatigue
 - Operationalization – balance of forecasting resources and capabilities
 - Partner requirements
- Type of Threshold
 - Temperature or Index based, combination?
 - Overnight component – no relief from heat?
 - Duration considerations
 - Tiered System (action, different populations, early/late season criteria)



Scale

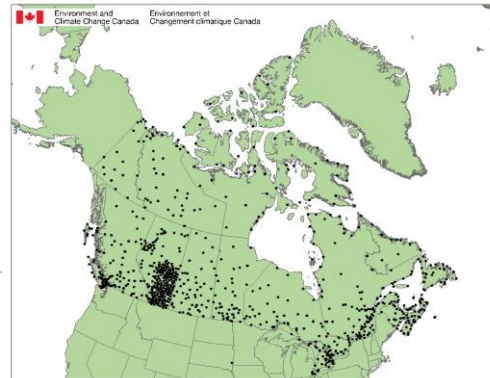
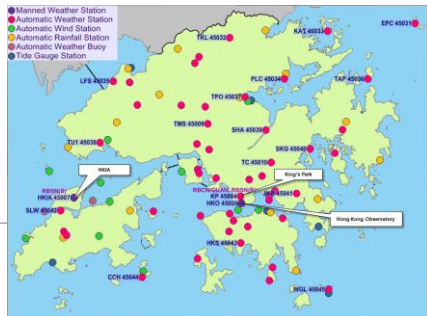
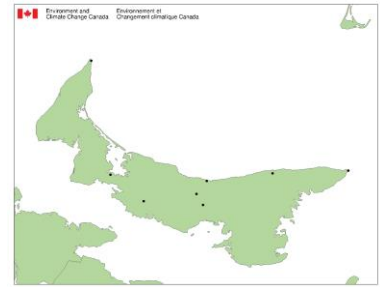
Spatial

- Area of coverage vs. resource availability
 - Population density
 - Funding Resources (travel, maintenance)
 - Effects Weather Observation Networks and Forecast Production



Temporal

- Day 1 vs. Day 2 Forecast
- Early Notification vs. Uncertainty
- Duration vs Extreme Single Day Event



Forecast Models

- Deterministic
 - Initial Conditions + Physics = a single **accurate** forecast
 - Forecasters want to create a **perfect** deterministic forecast

- Error and Uncertainty

- Initial Conditions (Observations)
- Initialization (interpolation, assimilation)
- Model Error

- Probabilistic

- Complete set of various solutions with probability = **probability forecast**
- We need to learn how to **weigh the probability** appropriately

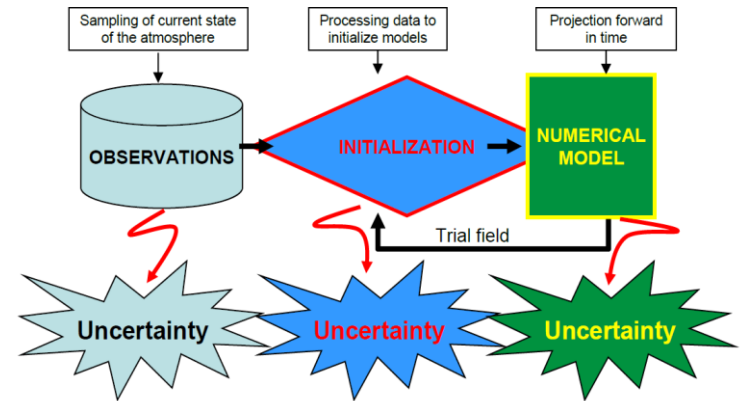
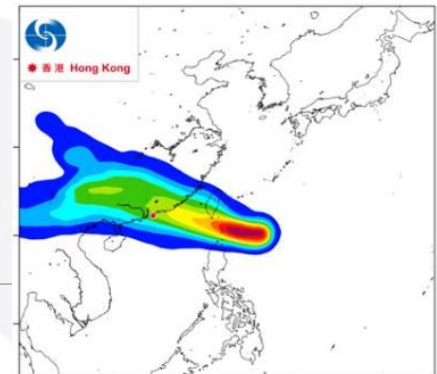
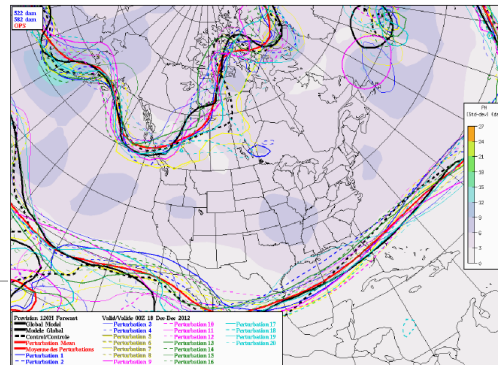


Figure 6. sources of uncertainty in the numerical forecast process. (R. Verret)

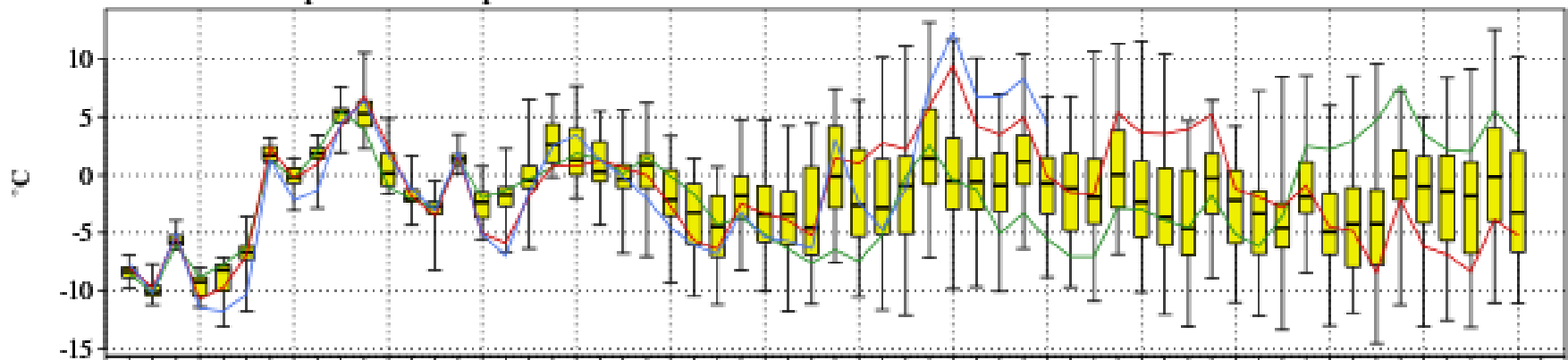


Ensemble Prediction Systems (EPS)

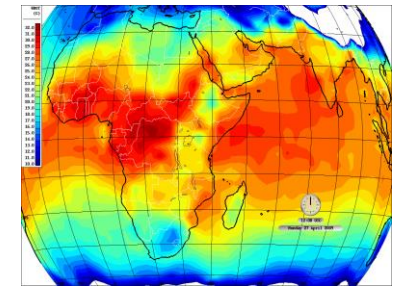
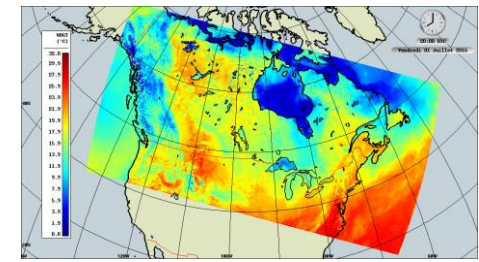
- EPS simulate the inherent uncertainties in weather models
- Resolution decreased to balance computational needs and time
- Ensemble mean can be considered as the deterministic solution
 - Smaller spread = deterministic solution may be reliable
 - Larger spread = deterministic solution may be more unreliable
- Different Ensemble Prediction Systems
 - Different versions of the same model.
 - Different versions of the initial conditions.

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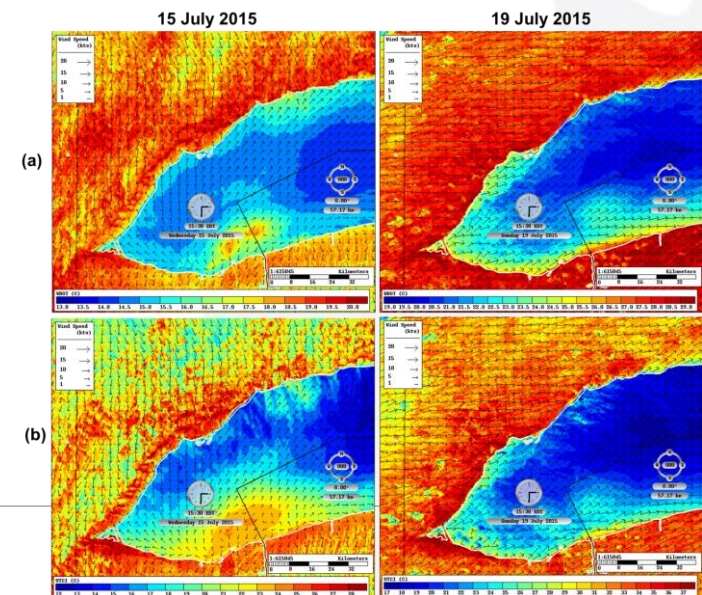
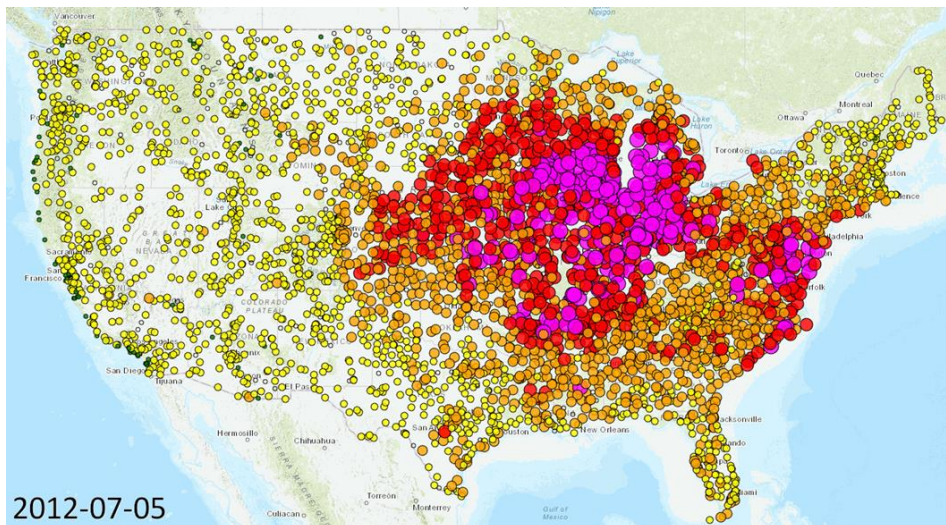
Surface air temperature/Température de l'air à la surface



Other Modelling Advances



- Developments in High Resolution modeling
 - Urban Heat Island effect
 - Urban planning processes (City greening, canopy)
- Modelling Thermal Comfort Indices (Canada)
 - Development in preparation of the 2015 PanAm Games
 - Humidex, Wind Chill, UTCI, WBGT
 - Evaluated using the denser PanAm Games Mesonet
- HeatRisk Product (US) - Identify Potential Heat Risks
 - Experimental, gives forecasts a climatological context based on location & time of year.

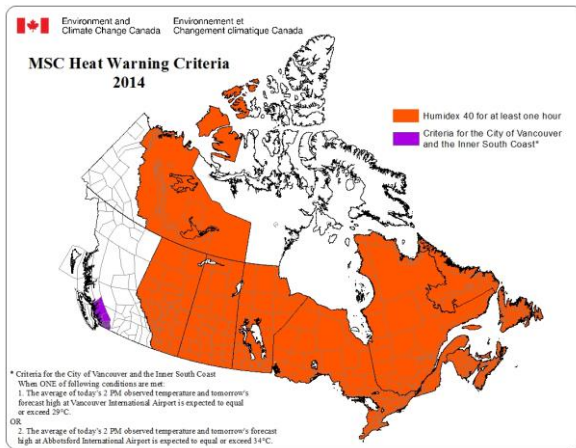


Sector Specific Heat Forecasting

- Various Sectors, various needs:
 - Health Partners
 - Emergency Management
 - Infrastructure
 - Mass Gathering Events
 - Public
 - Vulnerability Groups



Canada's Heat Warning Modernization



Heat-health analysis by

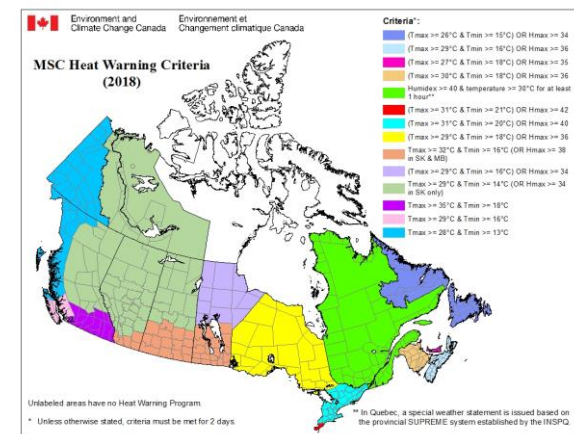
Health Canada

OR

95th Percentile guidance

Criteria Decisions:

- Duration
- Relief from heat overnight
- T_{eq} , best modelled predictor



Why

- Single national climatological based criteria
- Recent heat-related mortality and Public Health interest in communicating heat risk and reducing those risks (**HeatAlertResponseSystem**)

Engagement

- Partnership with Health Canada and Public Health

Results

- An evidence based heat warnings service
- Coherent communications
- Part of a chain of actions to reduce heat-health risk
- Early Notification system to support partners' needs

Development Considerations

- Warning Fatigue
- Operationalization – balance of forecasting resources with partner demand
- Communicating the changes to the public and partners
- Developing a National Standard level of service
- Integrating the system into current HARS

Question Time

Thank you!

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