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

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.
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
- $T_a$, 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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