

The development of the new **Toronto Heat –Health Alert System**



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Problem

- On average, it is estimated that there are at least **42** heat-related deaths in Toronto each year
- Ill effects are felt by thousands more
- How can one best forecast the occurrence of oppressive heat before it happens?

Toronto's Original Heat Alert System

- Utilized until 2000.
- Based on Humidex exceeding 40°C, and temperature exceeding 30°C.
- Not adjusted for local climate.
- Did not take into account how people have responded in the past.

“Synoptic” Systems

- Examine how people have responded in the past to different weather conditions.
- Are “relative” to the local climate.
- Involve the classification of days into different “weather types”, which represent a **holistic** view of the weather.

Where synoptic-based systems are used

- Philadelphia (1995)
- Washington (1996)
- Dayton / Cincinnati (2000)
- Rome (2000)
- Toronto (2001)
- Shanghai (2001)
- Phoenix (2001)
- Southeastern US (2001)

Development of the Toronto HHA System

- 46 years of meteorological data
 - Categorized into “weather type” categories.
- 17 years of daily totals of mortality
 - Total mortality used as considerable subjectivity used in determining a “heat-related death”.
 - Data standardized to account for population growth.
- Analysis limited to May 15 – September 30.

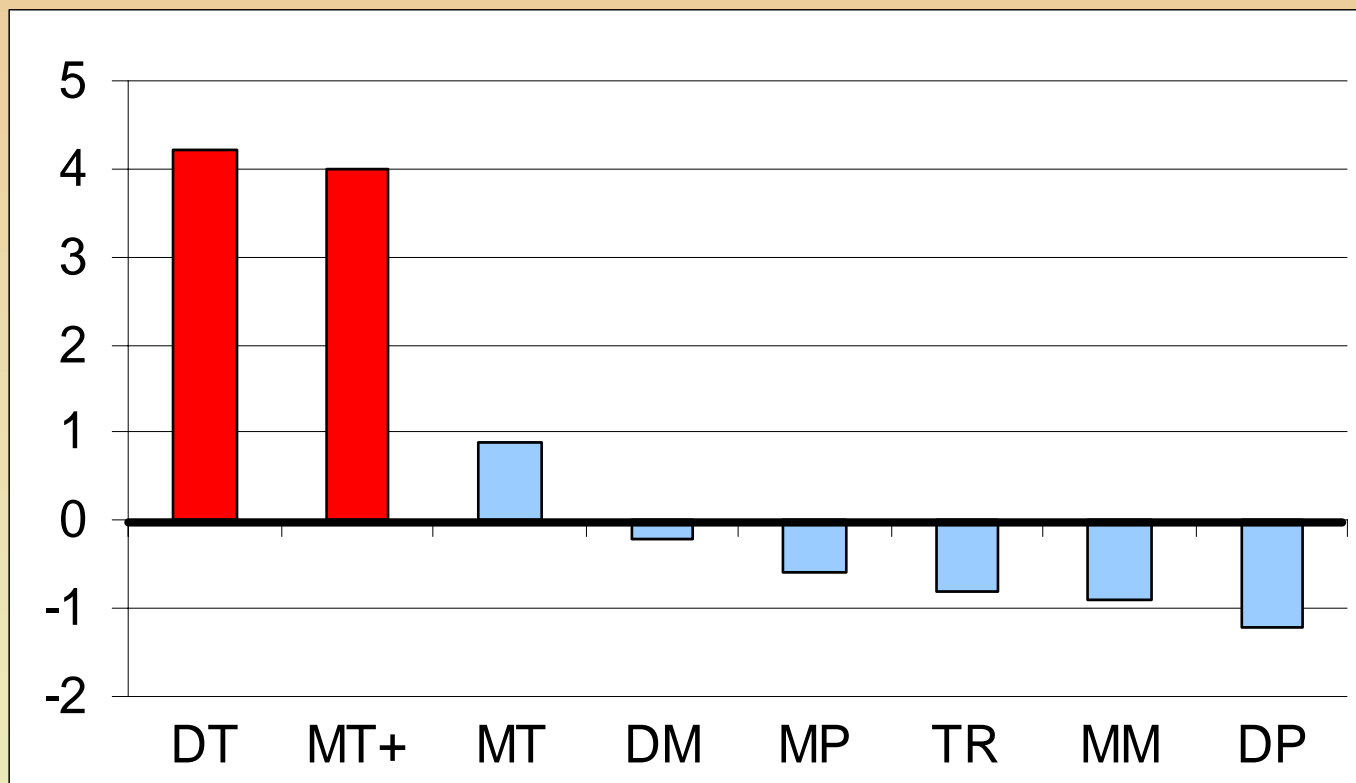
Offensive weather types

- Two weather types are associated with increased mortality
 - **Dry Tropical (DT)**
 - Afternoon temperatures over 32°C
 - Dew point 14-16°C
 - Low cloud cover
 - **Moist Tropical Plus (MT+)**
 - Afternoon temperatures 29-31°C
 - Overnight temperatures over 20°C.
 - Dew point 20-23°C
- Both weather types relatively rare (< 5%).

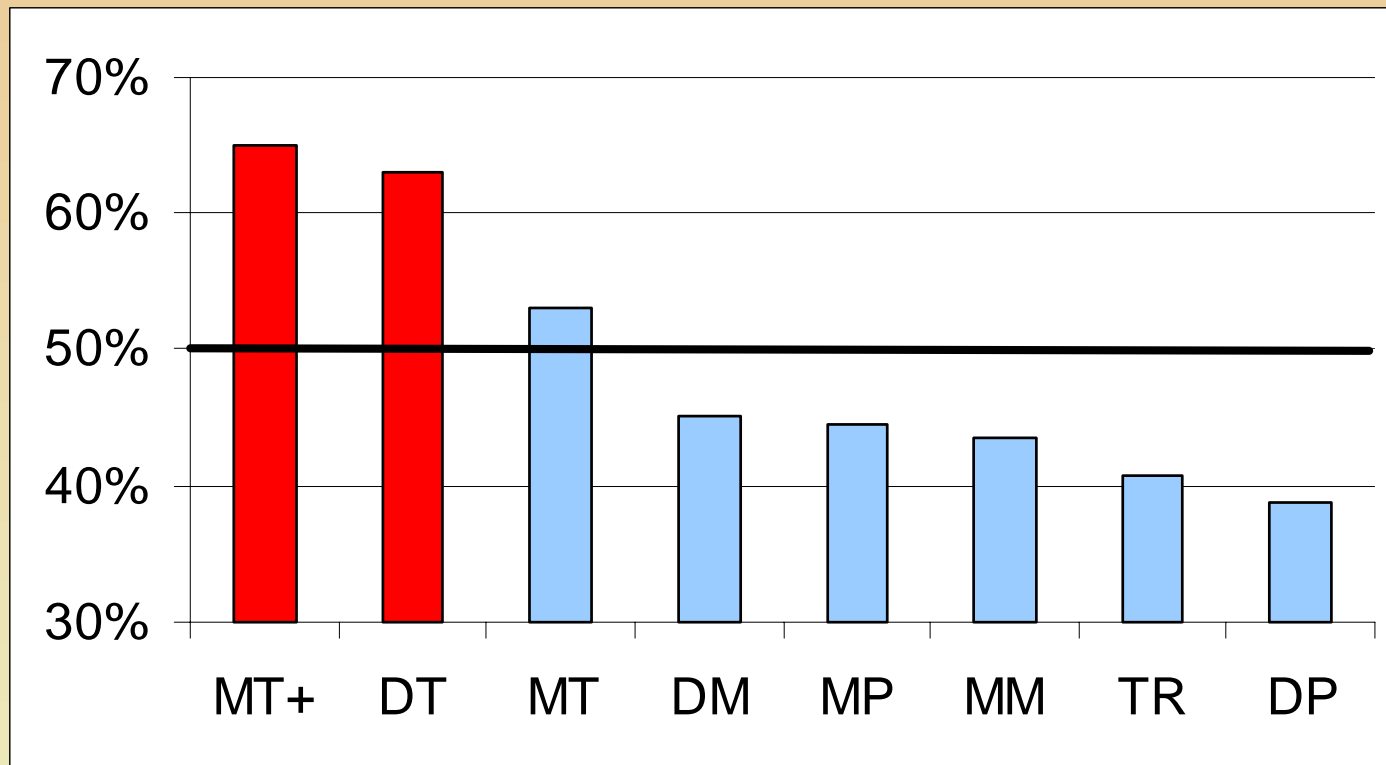
Urban Heat Island

| Weather Type | ΔT_{min} Downtown - Pearson |
|-------------------------|---|
| DT | +2.2°C |
| MT+ | +1.5°C |
| All other weather types | +2.9°C |

Mean anomalous mortality by air mass



Likelihood of greater than normal mortality



Excess mortality probabilities are preferred to the total number of deaths as they are less biased by individual days.

Within an air mass, what other factors make mortality more or less likely?

- Persistence of an air mass
- Time of season
- Air Mass character
 - Morning or evening temperatures
 - Dew point
 - Cloud Cover

Seasonal Acclimatization

**Chance of excess mortality
decreases throughout summer**

| Air Mass | May-July | Aug.-Sep. |
|-----------------|-----------------|------------------|
| MT+ | 70% | 57% |
| DT | 67% | 33% |

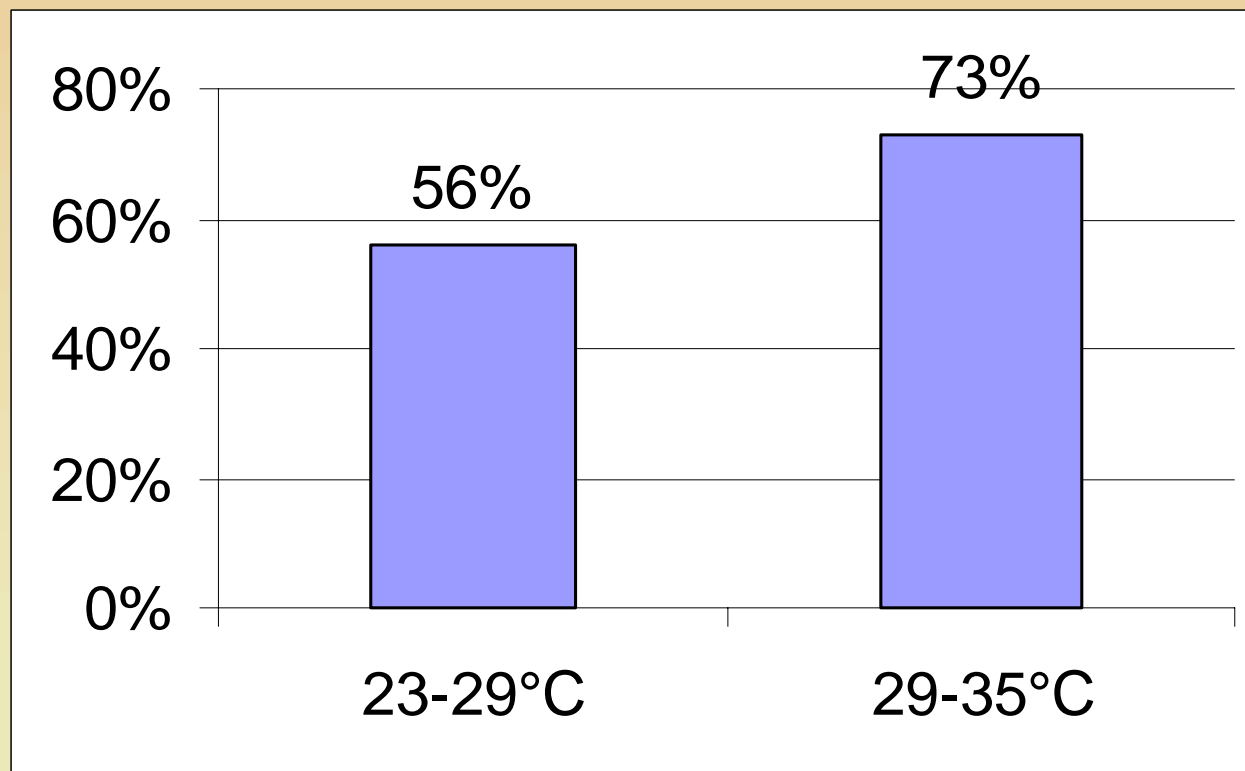
Air Mass Persistence

Mortality increases as air masses persist

| Day in Row | DT | MT+ |
|-------------------------|-----------|-----------|
| 1st | +2 | +3 |
| 2 nd | +3 | +3 |
| 3 rd | +7 | +7 |
| 4 th | +14 | +8 |
| 5 th or more | +27 | +7 |

Other Weather Parameters

**Chance of excess mortality on MT+ days
With different 5 PM temperatures**



Forecast Algorithm Development

- For MT+ air mass, chances of excess mortality depend on:
 - Day in sequence of MT+ (persistence)
 - 5 PM Temperature
- For DT air mass, chances of excess mortality depend on:
 - Time of season (acclimatization)
 - Mean Humidex

System Levels

EMERGENCY

The likelihood of excess mortality exceeds 90 percent.

1.4 mean occurrences per year

ALERT

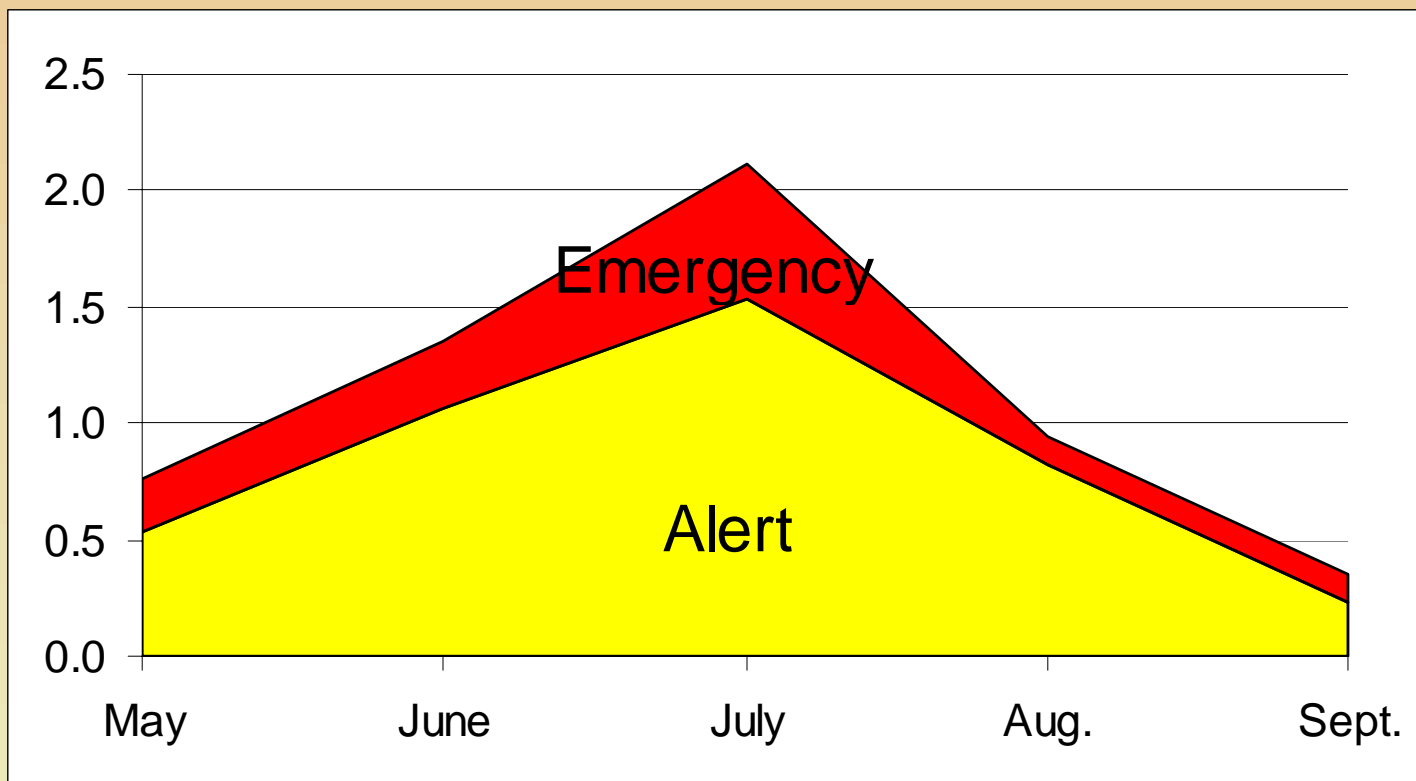
The likelihood of excess mortality is between 65 and 90 percent.

4.2 mean occurrences per year

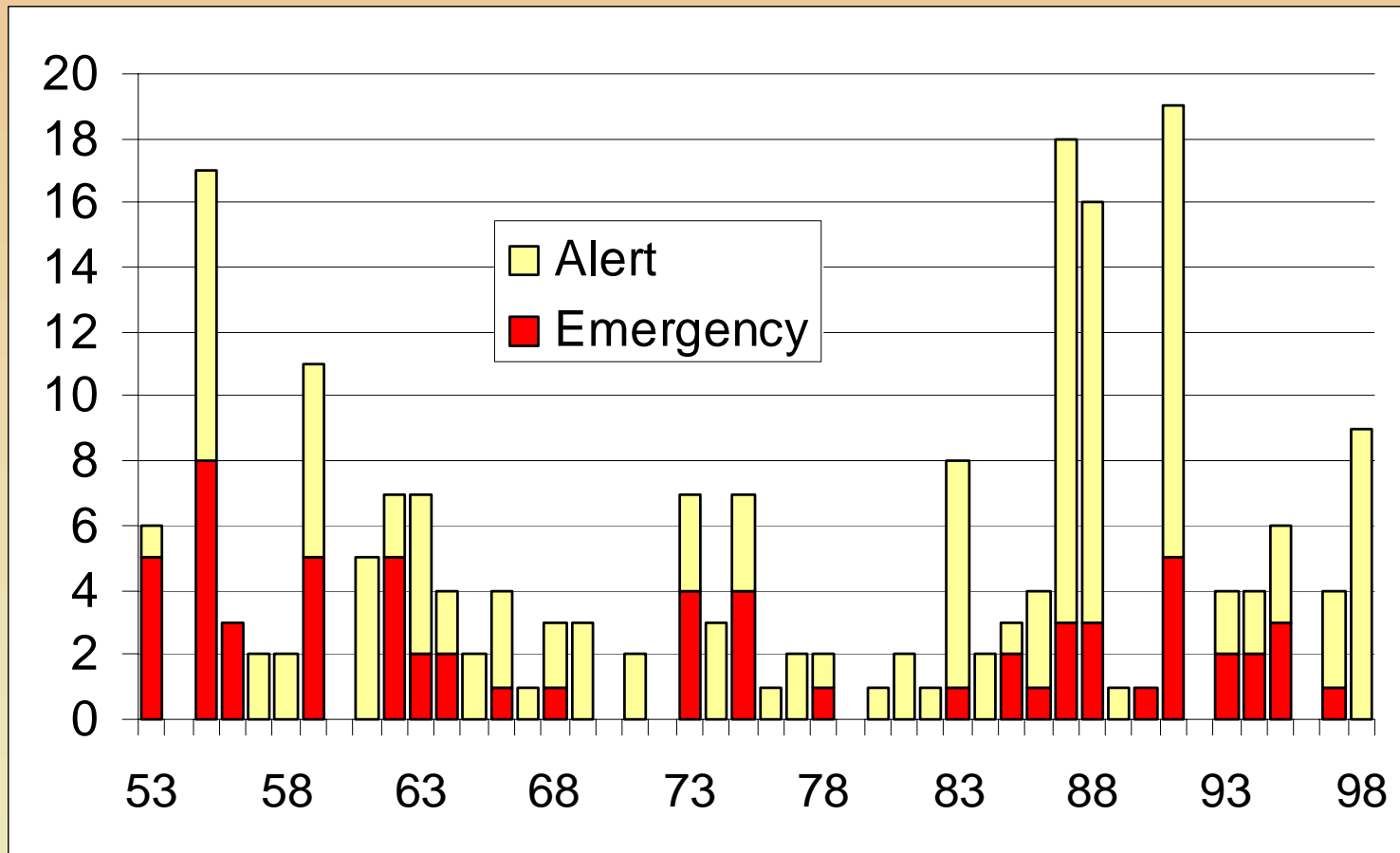
ROUTINE MONITORING

An oppressive air mass is not forecast for the area.

Mean calls by month



Year-to-Year variability



System Verification

- Based on 1981-97 data:
 - On 83% of days in which an emergency would have been called, excess mortality occurred
 - On 76% of days in which an alert would have been called, excess mortality occurred
 - On 88% of days with weather-related excess mortality, an alert or emergency would have been issued

System Implementation

- Environment Canada's **Toronto Regional Weather Centre** automatically sends forecast data every morning and afternoon
- MORNING FORECAST (3:30 am)
 - **For today, tomorrow, and next day**
- AFTERNOON FORECAST (3:30 pm)
 - **For tomorrow and next day**

System Implementation

- Forecasters alerted if conditions are near or above oppressive levels
- If forecast changes, forecasters at Environment Canada can manually update forecast at any time
- Forecasters will consult with Toronto Public Health regarding modifications
- System will then re-run and re-evaluate conditions

Summer 2001

- THHA identified 5 days of emergency and 4 days of alert.
- Actually called 3 days of emergency and 6 days of alert.
- THHA identified 4 consecutive emergency days (August 6th-9th). In 46 years of historical weather data, this would only have occurred on 2 other occasions.