Which days of hot weather are identified as dangerous by Heat-Health Warning Systems?

A comparison of the predictive capacity of different approaches

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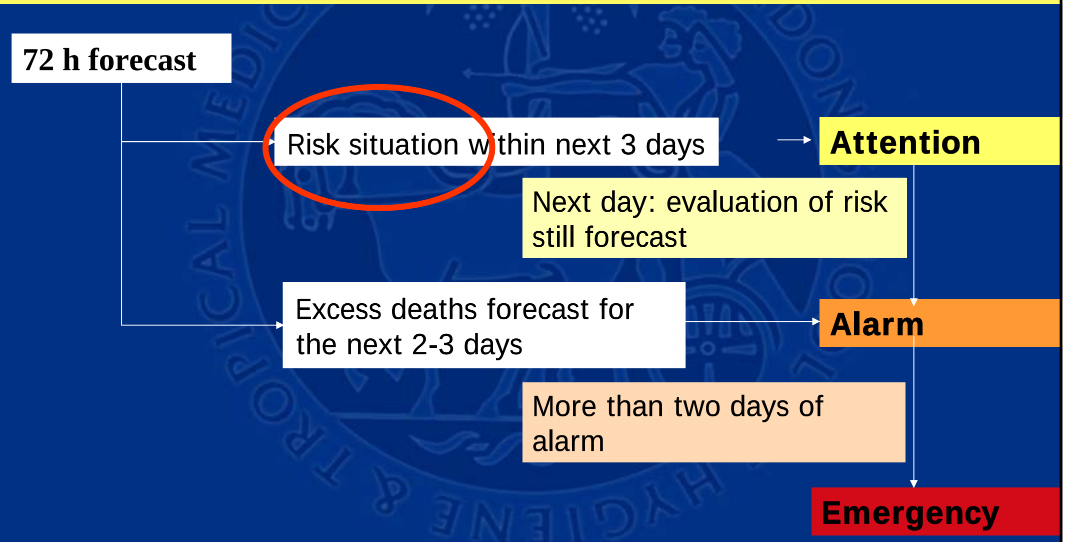
Example of Heat Health Warning System (HHWS): Rome



System type:	System (1): Synoptic classification	System (2): Epidemiological analysis of retrospective temperature and mortality data	System (3): Temperature and humidity indices (e.g. Humidex)	System (4): Physiologic approach (e.g. Environmental Stress Index)
Theoretical basis:	Categorizes a variety of weather parameters into air mass types. Health response within each air mass type is determined epidemiologically using historical mortality data to identify 'oppressive' air mass types	Thresholds based on temperature-mortality relationship estimated epidemiologically. French approach seeks to identify days with >50% excess mortality in big cities and optimizes sensitivity and specificity of thresholds	Temperature and humidity integrated into one number to reflect a perceived temperature	Heat loads identified using physiologic principles from heat budget equations which take into account mechanisms of heat exchange of the human body with its thermal environment
Examples where system is currently in operation:	Philadelphia, Rome, Shanghai, Toronto, Budapest, many other cities across US	France, England, Montreal	Humidex used across Canada	Germany

What this study aims to do:

- Assess the degree to which the same 'heat-adverse' days are identified by different HHWS

What this study does not do:

- Evaluate the (cost-) effectiveness of different HHWS
- Identify a gold standard

Each partner: Method to identify heat-adverse days

Data: Chicago, US (1985-2004); London, UK (1984-2003); Madrid, Spain (1987-2006); Montreal, Canada (1983-2002)

Each 20 year dataset

10 years
(1st, 3rd, 5th,…,19th hottest summers)

Calibration dataset
-Mortality
-Weather

(This stage not necessary for Humidex and ESI)

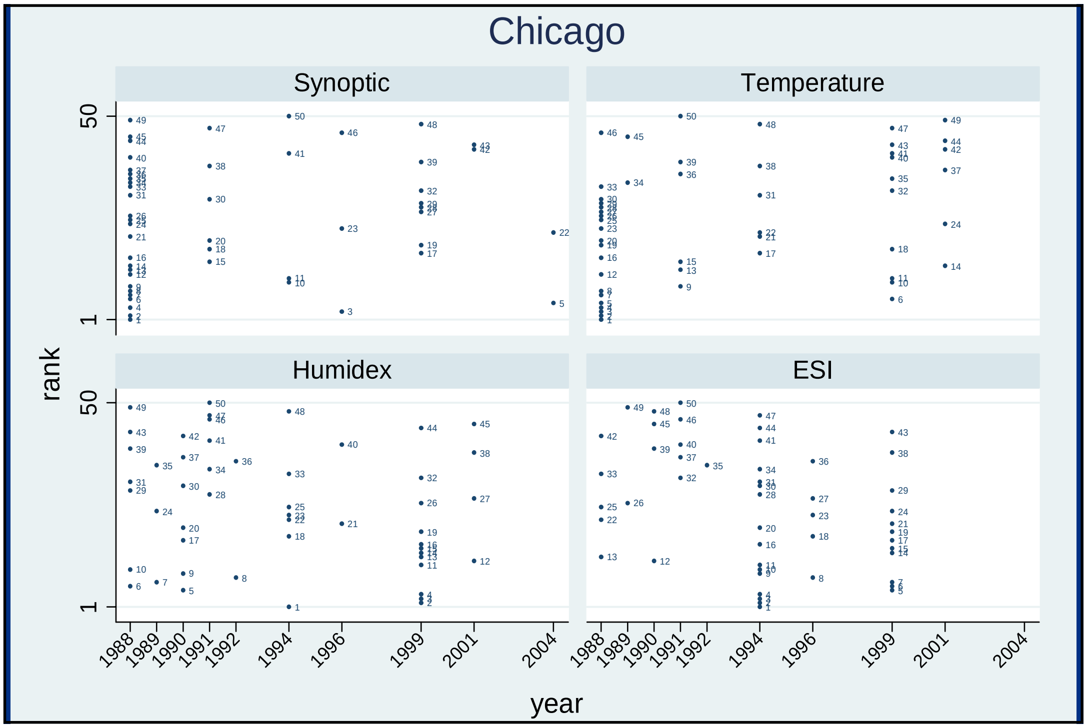
10 years
(2nd, 4th, 6th,…,20th hottest summers)

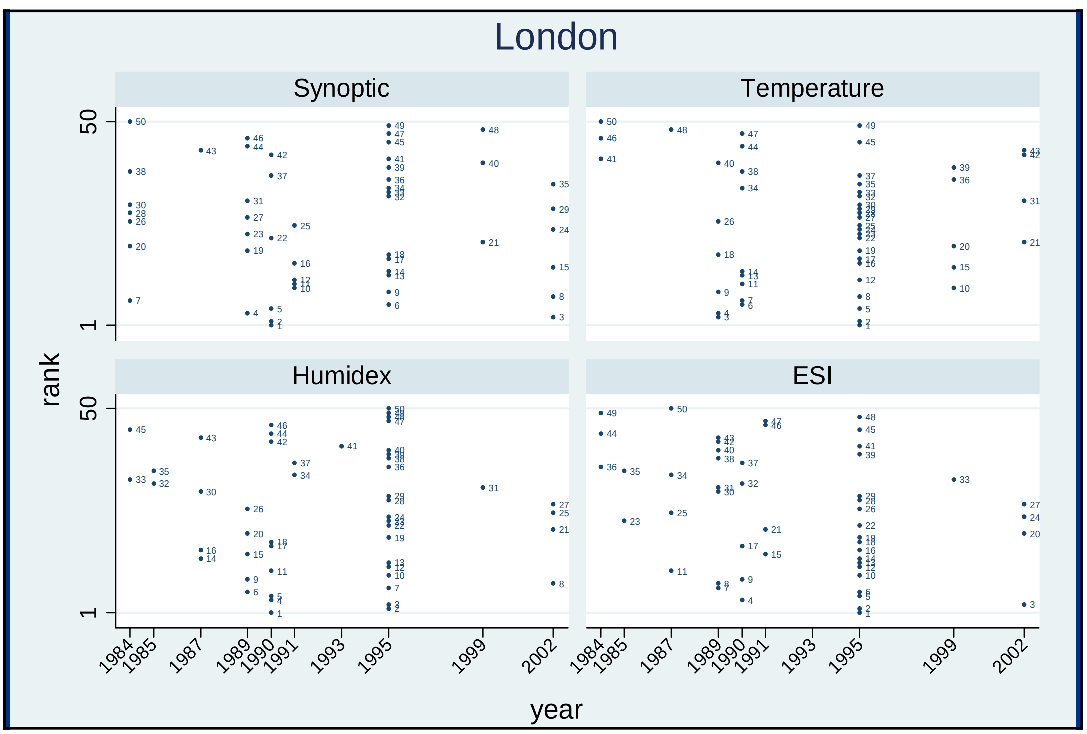
Test dataset
-Weather

Provide a ranking of the top 50 most 'heat-adverse' days

Centrally: Compare the heat-adverse days identified by each system

- Describe the ranking and extent of overlap of identified heat-adverse days between HHWS
- Compare mean temperature and total observed deaths on identified days (observed death counts were available centrally)
- Calculate excess deaths and % excess on identified days


Chicago
Synoptic
Temperature
Humidex
ESI
rank
year
50
1
1988 1989 1990 1991 1992 1994 1996 1999 2001 2004


London
Synoptic
Temperature
Humidex
ESI
rank
year
50
1
1984 1985 1987 1989 1990 1991 1993 1995 1999 2002

Summary so far

In terms of agreement across summers:

– Not good for Chicago (and Madrid)

– Better for London (and Montreal)

What about agreement of actual dates?

Rank	(1) Synoptic		(2) Temperature		(3) Humidex		(4) ESI	
	Chicago	London	Chicago	London	Chicago	London	Chicago	London
1	08-Aug-88	03-Aug-90	03-Aug-88	03-Aug-95	05-Jul-94	03-Aug-90	05-Jul-94	**01-Aug-95**
2	17-Aug-88	**04-Aug-90**	04-Aug-88	**02-Aug-95**	30-Jul-99	10-Jul-95	15-Jun-94	10-Jul-95
3	01-May-96	15-Aug-02	02-Aug-88	23-Jul-89	29-Jul-99	**01-Aug-95**	14-Jun-94	29-Jul-02
4	20-Jun-88	**22-Jul-89**	17-Aug-88	24-Jul-89	22-Jul-99	**02-Aug-90**	18-Jun-94	**04-Aug-90**
5	02-Aug-04	**02-Aug-90**	21-Jun-88	04-Aug-95	04-Jul-90	**04-Aug-90**	29-Jul-99	**31-Jul-95**
6	08-Jul-88	**01-Aug-95**	01-Jul-99	**04-Aug-90**	16-Aug-88	**22-Jul-89**	30-Jul-99	**02-Aug-95**
7	09-Jul-88	30-Jul-84	22-Jun-88	03-Aug-90	10-Jul-89	**31-Jul-95**	22-Jul-99	06-Jul-89
8	06-Aug-88	30-Jul-02	16-Jul-88	**01-Aug-95**	09-Aug-92	29-Jul-02	07-Aug-96	**22-Jul-89**
9	15-Aug-88	**31-Jul-95**	22-Jul-91	**22-Jul-89**	27-Aug-90	06-Jul-89	20-Jul-94	21-Jul-90
10	18-Jun-94	10-Aug-91	27-Jul-99	02-Aug-99	17-Aug-88	**02-Aug-95**	17-Jun-94	30-Jul-95
11	20-Jun-94	11-Jul-91	26-Jul-99	05-Aug-90	05-Jul-99	21-Jul-90	04-Jul-94	29-Jun-87
12	15-Jul-88	09-Jul-91	18-Aug-88	**31-Jul-95**	07-Aug-01	20-Jul-95	04-Jul-90	20-Jul-95
13	04-Aug-88	**02-Aug-95**	20-Jul-91	**02-Aug-90**	21-Jul-99	30-Jun-95	16-Aug-88	28-Jun-95
14	07-Jul-88	10-Jul-95	05-Aug-01	21-Jul-90	23-Jul-99	29-Jun-87	05-Jul-99	21-Jul-95
15	16-May-91	29-Jul-02	21-Jul-91	01-Aug-99	04-Jul-99	23-Jul-89	24-Jul-99	05-Jul-91
16	10-Jul-88	21-Aug-91	16-Aug-88	12-Aug-95	28-Jul-99	21-Aug-87	16-Jun-94	11-Aug-95
17	25-Jul-99	28-Jul-95	16-Jun-94	30-Jun-95	06-Sep-90	15-Jul-90	21-Jul-99	**02-Aug-90**
18	22-Jul-91	30-Jun-95	02-Jul-99	25-Jul-89	15-Jun-94	01-Aug-90	05-Aug-96	29-Jul-95
19	13-Jul-99	23-Jul-89	14-Aug-88	20-Aug-95	24-Jul-99	30-Jul-95	23-Jul-99	03-Aug-95
20	21-Jul-91	31-Aug-84	15-Aug-88	03-Aug-99	18-Aug-90	24-Jul-89	06-Jul-94	17-Jun-02

Summary so far

In terms of agreement across dates:

– Little overlap across the 4 approaches in terms of which days were identified as heat-adverse

– For Chicago (and Madrid) there was not one date common to top 20 rankings of all systems

Which system is identifying the more 'dangerous' days?

	(1) Synoptic				(2) Temperature				(3) Humidex				(4) ESI			
Days	Av mean temp	Av daily mort	Av daily excess	Av % excess	Av mean temp	Av daily mort	Av daily excess	Av % excess	Av mean temp	Av daily mort	Av daily excess	Av % excess	Av mean temp	Av daily mort	Av daily excess	Av % excess
Chicago																
Top 1	29.2	201	38.7	23.9	31.1	174	13.7	8.5	28.3	188	24.0	14.6	28.3	188	24.0	14.6
Top 3	23.9	191	30.2	18.7	31.3	190	29.1	18.0	23.8	187	26.0	16.2	29.3	174	7.4	4.5
Top 5	24.3	179	18.6	11.6	31.0	186	24.6	15.3	25.6	170	8.9	5.5	26.6	176	10.9	6.6
Top 10	25.5	179	17.3	10.7	30.1	180	20.5	12.8	27.4	171	10.8	6.8	25.6	173	9.4	5.8
Top 15	26.0	177	15.0	9.2	29.7	177	18.1	11.4	26.5	168	8.3	5.2	26.5	171	8.3	5.1
Top 20	26.3	172	10.9	6.7	29.3	174	14.8	9.3	26.7	166	6.2	3.9	26.7	169	7.4	4.6
Top 30	25.6	173	12.5	7.7	29.1	173	13.0	8.1	26.6	169	8.4	5.2	26.6	170	8.7	5.5
Top 40	26.0	175	14.4	8.9	28.7	171	10.7	6.7	26.9	169	7.8	4.9	26.6	170	8.3	5.2
Top 50	25.4	174	12.9	8.0	28.5	169	8.2	5.1	26.9	167	6.4	4.0	26.4	170	7.3	4.6
London																
Top 1	27.4	221	61.8	38.8	26.1	214	65.3	43.9	27.4	221	61.8	38.8	26.6	178	27.1	18.0
Top 3	25.6	191	35.3	22.1	26.3	201	45.1	29.4	26.0	190	35.9	23.0	25.3	172	21.5	14.3
Top 5	26.0	192	33.2	20.6	25.0	198	41.9	26.9	26.2	193	37.2	23.6	25.6	185	32.8	21.5
Top 10	25.0	188	31.1	19.9	25.8	197	41.3	26.5	26.0	194	37.0	23.5	25.5	188	31.8	20.3
Top 15	24.5	183	26.5	17.0	25.3	193	36.8	23.6	25.3	190	31.7	19.9	24.6	184	27.1	17.2
Top 20	24.0	179	22.2	14.3	24.7	188	32.4	20.8	24.9	187	28.2	17.7	24.5	182	26.5	17.0
Top 30	23.0	175	16.6	10.7	24.1	181	25.1	16.1	24.2	181	23.2	14.6	24.0	178	21.7	13.9
Top 40	23.1	173	15.9	10.3	23.8	175	19.7	12.7	24.0	177	19.1	12.0	23.9	179	21.5	13.6
Top 50	22.7	172	14.4	9.3	23.5	173	17.1	11.0	23.8	178	19.3	12.2	23.7	177	18.0	11.4

Conclusions

- No gold standard (our method to calculate excess mortality may favour one approach)
- Little overlap in identified days between the systems
- Agreement better in cooler cities of London and Montreal, less so in Chicago and Madrid
- Closer agreement between synoptic and temperature approaches, and similarly between ESI and Humidex
- Triggering of alert days (and ultimately the initiation of emergency responses) is very dependent on the particular approach adopted to establish thresholds

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