HIGH-RESOLUTION FORECASTS OF THE THERMAL COMFORT IN THE URBAN AREA OF TRENTO

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First International Conference on Anticipation
Numerical weather forecasts

Weather forecasts are based on the results of numerical meteorological models
Vilhelm Bjerknes (1904):

Atmospheric evolution controlled by physical laws.

To predict atmospheric evolution we need to know:

- initial conditions
- physical laws
Numerical weather forecasts

Lewis Fry Richardson

First attempt of a weather forecast (1910):

6-h forecast of the pressure, no success.

Weather Prediction by Numerical Process (1922)
Numerical weather forecasts

The first numerical weather forecast: march 1950 in Princeton.

- grid over the United States

ENIAC: Electronic Numerical Integrator And Computer
How can meteorological forecasts be used?

Lazo et al. (2009)

![Bar Chart showing the use of meteorological forecasts]

- Simply knowing what the weather will be like: 72%
- Planning how to dress yourself or your children: 55%
- Planning weekend activities: 42%
- Planning travel: 40%
- Planning to do yard work or outdoor house work: 38%
- Planning social activities: 32%
- Planning how to get to work or school: 30%
- Planning job activities: 20%

Responses by frequency:
- Usually or always
- More than half the time
- About half the time
- Less than half the time
- Rarely or never
- Not applicable to me

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High-resolution forecasts of the thermal comfort in the urban area of Trento
How can meteorological forecasts be used?
Numerical weather forecasts: uncertainty


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Numerical weather forecasts: uncertainty

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Why urban meteorology?

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Urban heat island

Temperature inside cities is generally higher than in surrounding rural areas.

(Voogt 2000)
Urban heat island: history

Luke Howard

*The climate of London* (1833)

Luigi de Bartolomeis

*Notizie topografiche e statistiche sugli stati sardi* (1840-47)

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*High-resolution forecasts of the thermal comfort in the urban area of Trento*
Thermal comfort in urban areas

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High-resolution forecasts of the thermal comfort in the urban area of Trento
Thermal comfort in urban areas

COM4CAST

“High-resolution forecasts of the thermal comfort in the major urban areas of the Province of Trento”

Project funded by

FONDAZIONE
CASSA DI RISPARMIO
DI TRENTO E ROVERETO
Thermal comfort in urban areas

High-resolution (1 km) forecasts with the WRF model in the Province of Trento
Weather forecasts: Province of Trento

High-resolution forecasts of the thermal comfort in the urban area of Trento

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Thermal comfort in urban areas

Downscaling to 100 m on the major urban areas of the Province of Trento

Lowest WRF level

T_{rf_i} \{ \]

H_{rf}

H_{top}

H_{rf}

T_{rf_i}

H_{w_{i,1}}

H_{w_{i,2}}

H_{w_{i,3}}

H_{w_{i,4}}

H_{r_1}

H_{r_2}

Q_v

T_{can}

T_{can}

T_{i_bld}

T_{i_bld}

T_{w_{i,1}}

T_{w_{i,2}}

T_{g_{rn}}

Giovannini et al. (2013)

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High-resolution forecasts of the thermal comfort in the urban area of Trento
Urban morphology

Lidar data

$\lambda_p$

$\lambda_b$

Buildings height

Urban fraction

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Thermal comfort in urban areas

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High-resolution forecasts of the thermal comfort in the urban area of Trento
The UTCI assesses the outdoor thermal environment for biometeorological applications.

- Dependent on temperature, radiation, humidity and wind
- Accounts for the heat exchange between human body and environment

<table>
<thead>
<tr>
<th>UTCI (°C) range</th>
<th>Stress Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>above +46</td>
<td>extreme heat stress</td>
</tr>
<tr>
<td>+38 to +46</td>
<td>very strong heat stress</td>
</tr>
<tr>
<td>+32 to +38</td>
<td>strong heat stress</td>
</tr>
<tr>
<td>+26 to +32</td>
<td>moderate heat stress</td>
</tr>
<tr>
<td>+9 to +26</td>
<td>no thermal stress</td>
</tr>
<tr>
<td>+9 to 0</td>
<td>slight cold stress</td>
</tr>
<tr>
<td>0 to -13</td>
<td>moderate cold stress</td>
</tr>
<tr>
<td>-13 to -27</td>
<td>strong cold stress</td>
</tr>
<tr>
<td>-27 to -40</td>
<td>very strong cold stress</td>
</tr>
<tr>
<td>below -40</td>
<td>extreme cold stress</td>
</tr>
</tbody>
</table>
Thermal comfort in urban areas

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**Conclusions**

**Meteorology and weather forecasts:**

- Meteorologists try to forecast the future weather
- Weather forecasts can be used to take important decisions
- Be aware of uncertainty

**Case study:**

- High-resolution forecasts of the thermal comfort in urban areas
- Support decision tool for issuing alerts in critical situations
THANKS FOR YOUR KIND ATTENTION!