Thermal Comfort Analysis in the Alpine Region

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PLAN

• Motivation
• What is the UTCI?
• How to display field distributions in complex terrain?
• Conclusion and outlook
Meteorological data/fields – predicted as well as observed - are increasingly used for a wide variety of technical as well as (human-)biological applications.

Besides basic variables a large number of complex/derived quantities are used for this purpose.

Some of those complex variables are Indices for thermal comfort/ discomfort of humans or animals.

Well known Indices are e. g. the windchill (equivalent) temperature, the heat index or the Universal Thermal Climate Index (UTCI), derived in the framework of COST Action 730 (see e. g. http://www.utci.org/cost.php).

In the Alpine region both, cold and heat stress are present seasonally and may exert a significant threat for the population.
The computation of the UTCI requires air temperature, wind, humidity and short wave radiation.
How to deal with the spatio-temporal variability of basic or derived parameters?

→ High resolution prognostic models

Over complex terrain like the Alps the spatial model resolution must be at least 1km for „smooth“ parameters like temperature but much less (100m/10m?) for „rough“ parameters like wind to resolve main topographic features realistically

→ Diagnostic modeling

High quality mesonet must be available

Variability especially of wind and radiation field does not permit to analyse a realistic distribution of UTCI even with mesonet data

→ 1) compute UTCI separately for shade and representative wind speed
   2) focus on valleys and lowlands (where majority of population lives)
      „minimum topography“
How to define the minimum topography?

1) Determine the characteristic width (D) of major valleys
2) Determine the minimum elevation within a circle with radius D around each grid point
3) Smooth (arithmetic mean) of all minimum elevations within a circle with radius D
ALPINE ELEVATION PROFILE AND MINIMUM TOPOGRAPHY ALONG 10°E

msl

km

Allgäu
Bregenzer Wald
Klostertal
Montafon
Oberengadin
Valtellina
Lago d'Iseo

June 7, 2013

ICAM 2013 KRANJSKA GORA
R. Steinacker
Temperature analysis with 500m horizontal resolution

Poster by Dieter Mayer
Temperature analysis at „minimum topography“
Classes of discomfort and comfort of the UTCI (°C)

<table>
<thead>
<tr>
<th>extreme</th>
<th>strong</th>
<th>moderate</th>
<th>light</th>
<th>light</th>
<th>moderate</th>
<th>strong</th>
<th>extreme</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comfortable</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**Cold stress**
- <-39
- -39 to -26
- -26 to -13
- -13 to 0

**Heat stress**
- 0 to 20
- 20 to 32
- 26 to 32
- 32 to 38
- >38

Images of cold and heat stress situations.
Since 1.1.2012 hourly real time UTCI analyses are being computed (for shady conditions)
Montag, 03. Juni 2013, 14:00 UTC, Europa (16 km Gitter)

Thermophysiological Beanspruchung (Wärmindex) (Farbfächen), Einheit: °C [1], Beobachtungen: 1241, Symbol: o, Min: 3.81, Max: 8.3, μ: 5.32, σ²: 0.29
Mean temperature 1.1.2013, 0000 – 3.6.2013, 2300 on minimum temperature
Mean UTCI 1.1.2013, 0000 – 3.6.2013, 2300 on minimum temperature
### Thermal stress distribution in Austria’s province capitals in 2012

<table>
<thead>
<tr>
<th>City</th>
<th>Province</th>
<th>extreme cold stress</th>
<th>strong cold stress</th>
<th>moderate cold stress</th>
<th>light cold stress</th>
<th>comfortable</th>
<th>light heat stress</th>
<th>moderate heat stress</th>
<th>strong heat stress</th>
<th>extreme heat stress</th>
<th>weighted stress</th>
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<tbody>
<tr>
<td>Eisenstadt</td>
<td>Burgenland</td>
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<td>1,21</td>
<td>4,30</td>
<td>21,66</td>
<td>55,80</td>
<td>11,77</td>
<td>4,37</td>
<td>0,89</td>
<td>0,00</td>
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<td>Bregenz</td>
<td>Vorarlberg</td>
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<td>0,26</td>
<td>2,85</td>
<td>17,06</td>
<td>68,62</td>
<td>9,68</td>
<td>1,50</td>
<td>0,03</td>
<td>0,00</td>
<td>36,31</td>
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<tr>
<td>Sankt Pölten</td>
<td>Lower Austria</td>
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<td>0,22</td>
<td>4,37</td>
<td>22,94</td>
<td>60,52</td>
<td>9,03</td>
<td>2,74</td>
<td>0,18</td>
<td>0,00</td>
<td>47,39</td>
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<td>0,00</td>
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<td>18,39</td>
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<td>11,43</td>
<td>3,48</td>
<td>0,16</td>
<td>0,00</td>
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<tr>
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<td>Salzburg</td>
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<td>0,02</td>
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<td>16,64</td>
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<td>0,00</td>
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<tr>
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<td>Wien</td>
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<td>5,24</td>
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<td>4,00</td>
<td>0,55</td>
<td>0,00</td>
<td>55,39</td>
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Normalized Thermal Comfort UTCI for 2012
Conclusion and Outlook

Monitoring of thermal comfort is an interesting extension of conventional meteorological field distributions

Especially during cold and heat waves meteorological information should relate to thermal comfort rather than to conventional temperature

As an addition to the UTCI distribution at the minimum topography analyses for higher levels, e.g. peak levels (envelope topography) may be carried out

The strictly diagnostic VERA Analyse may also be used for model validation

http://www.univie.ac.at/amk/veraflex/test/public/
http://www.univie.ac.at/amk/veraflex/op/
VERA: see also Steinacker et al, 2006, Mon Wea Rev
Thank you for your attention