Trans Weather Patterns – an extended outlook for the future climate

A. Spekat, F. Kreienkamp, W. Enke

Climate & Environment Consulting Potsdam GmbH

COST733, Vienna, 21–24 November 2010
Themes

- Development
- New paths in the TWP study
- Results
- Outlook
Background

- We are associated with the COST733 activity that addresses the identification of circulation patterns.
- Our tool is WETTREG, a statistical downscaling method.
- In a learning phase, the environment-to-circulation approach is applied and patterns are identified in the current state of the climate system.
- Enter pattern recognition, using a similarity measure to see if these patterns can be re-identified in a future climate, as modelled in GCM simulations.
- But is the collection of patterns the same in a future climate?
- Maybe other patterns emerge which we do not yet see?
There are signs...

- Experience: The frequency distribution of the patterns increasingly degenerates in the scenario simulations over time.
- i.o.w. initial resemblance of normal distribution develops into an accumulation in the high-temperature classes.

<table>
<thead>
<tr>
<th>WL</th>
<th>2001</th>
<th>2011</th>
<th>2021</th>
<th>2031</th>
<th>2041</th>
<th>2051</th>
<th>2061</th>
<th>2071</th>
<th>2081</th>
<th>2091</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.4</td>
<td>1.0</td>
<td>0.0</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2</td>
<td>4.2</td>
<td>3.5</td>
<td>1.7</td>
<td>2.7</td>
<td>1.7</td>
<td>0.5</td>
<td>1.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>3</td>
<td>12.3</td>
<td>9.5</td>
<td>8.8</td>
<td>9.0</td>
<td>5.9</td>
<td>3.4</td>
<td>2.8</td>
<td>3.2</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>4</td>
<td>22.0</td>
<td>21.0</td>
<td>19.3</td>
<td>16.1</td>
<td>17.6</td>
<td>12.2</td>
<td>10.9</td>
<td>10.2</td>
<td>5.0</td>
<td>4.5</td>
</tr>
<tr>
<td>5</td>
<td>20.7</td>
<td>24.7</td>
<td>20.2</td>
<td>17.8</td>
<td>21.1</td>
<td>21.7</td>
<td>17.9</td>
<td>19.1</td>
<td>13.8</td>
<td>14.8</td>
</tr>
<tr>
<td>6</td>
<td>13.0</td>
<td>17.2</td>
<td>17.1</td>
<td>15.4</td>
<td>17.5</td>
<td>21.2</td>
<td>18.2</td>
<td>17.5</td>
<td>21.2</td>
<td>18.5</td>
</tr>
<tr>
<td>7</td>
<td>12.3</td>
<td>11.2</td>
<td>12.6</td>
<td>12.8</td>
<td>13.8</td>
<td>15.2</td>
<td>14.2</td>
<td>13.3</td>
<td>12.8</td>
<td>16.4</td>
</tr>
<tr>
<td>8</td>
<td>5.3</td>
<td>5.8</td>
<td>5.7</td>
<td>10.9</td>
<td>11.3</td>
<td>9.6</td>
<td>13.3</td>
<td>13.8</td>
<td>17.9</td>
<td>16.5</td>
</tr>
<tr>
<td>9</td>
<td>4.9</td>
<td>3.2</td>
<td>7.4</td>
<td>8.6</td>
<td>5.8</td>
<td>7.5</td>
<td>7.5</td>
<td>10.0</td>
<td>10.4</td>
<td>9.0</td>
</tr>
<tr>
<td>10</td>
<td>4.9</td>
<td>3.2</td>
<td>7.2</td>
<td>6.4</td>
<td>5.2</td>
<td>8.7</td>
<td>13.8</td>
<td>12.8</td>
<td>17.5</td>
<td>19.3</td>
</tr>
</tbody>
</table>

- Another experience – increasing number of days in which the similarity measure indicates suboptimal fit.
- Hypothesis: There is a development of circulation patterns which leave the current "event horizon", let us call them **Trans Weather Patterns (TWP).**
TWP: A precursory study

- Strategy, learning from the experience:
- There are days in which a pattern is assigned, all right, but with a low similarity.
- Do those days have something in common?
- Build an “extra pool of misfits”, i.e. of days when the similarity measure is above a threshold.
- Perform separate pattern search just for this pool.
TWP I

- Number of “misfits” is larger in summer than in other seasons
- Figure: Number of members of the extra pool (low similarity with known patterns) 2011–2040 (grey) and increase of this number from 2011–2040 to 2071–2100 (red); Region Central Germany
TWP II

- Two new patterns (7% of all days); both with SW air current
- Comparison of frequency distribution of relative topography 100/850 hPa (top) and relative humidity 850 hPa (bottom). Summer
TWP III

- Illustration of the characteristics of both TWP.
- Frequency distribution of relative topography 1000/850 hPa (top) and relative humidity 850 hPa (bottom). Summer. Shaded: Range of Standard WETTREG results.
Accumulating knowledge...

- TWP probably are not new atmospheric configurations with other positions of steering centers.
- TWP are distinct and extreme “cousins” of the – so far – warmest class.
- As shown earlier: There is a reduction of diversity in the classes towards the end of the 21st century.
- We were applying the environment-to-circulation approach, so: Cold classes die out, warm classes accumulate more and more members.
- Another rationale for the existence of new structures.
What do TWP look like?

- In a coconutshell: TWP classes 11 and 12 are *amplified relatives* of Class 10.
- Both are added to the pool of patterns → objective pattern recognition in ECHAM5 data now uses 12 instead of 10 patterns.
- A little aside: Now that we know what to look for – TWP can indeed be found in 20C simulations of the current climate, but they are rather rare and do not form a distinctive class of their own.
Temperature signal – no TWP

- Average over Germany, from study of the Umweltbundesamt in Dessau in 2007.

<table>
<thead>
<tr>
<th>$\Delta T_{mit}$ [K]</th>
<th>A1B</th>
<th>A2</th>
<th>B1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+2.3</td>
<td>+2.1</td>
<td>+1.8</td>
</tr>
</tbody>
</table>
Temperature signal directly from ECHAM5 – no downscaling

- The magnitude of the signal as produced by a GCM.

(a) Summer  
(b) Winter
Temperature signal of WETTREG with TWP

- Regional signal SW Germany: Same order of magnitude as GCM signal.
What’s to be expected?

- Clearly stronger orientation towards the GCM results, as compared to previous WETTREG studies
  - Stronger temperature signals
  - Stronger extremes, particularly for temperature
  - Cannot be ruled out: Potential influence of model-specific signals!

- Source for new regional studies
• Painting by Cezanne: Bridge and Three Sources
• May give you an idea that sometimes things are recognizable, yet not completed.
Besten Dank, habe die Ehre for your attention

frank.kreienkamp@cec-potsdam.de

anne.spekat@cec-potsdam.de