Hail Risk Areas in Austria,
on the basis of reports 1971-2011
and Weather Radar Images 2002-2011

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Phenomenon Hail

NEEDS:
- Reliable observation and documentation
- Detection of thunderstorm and hail intensity
- \textit{\textendash} creating a hazard map

\textit{\textendash} CLIMATE problem\textquotedblright: full coverage of hailstorms (in Austria)
PR: the wrong way of documentation

- „Horror Weather in May“   - „Hail devasted Austria“

320-km/h-Tornado in den USA
Hagel verwüstet Österreich

Horror-Wetter im Mai

Schule zerstört
Zwei Kinder beten vor ihren zerstörten Elternhäusern in Moore.

24 Tote bei Sturm in Oklahoma
Riesige Hagel-Schäden bei uns

Ein Meter Hagel
Viele Schneepflüge mussten in Salzburg Straßen räumen.
Hail detection, according to the intensity

Source:
the annual severe weather summaries of ZAMG

Damage patterns of individual hailstorms are assigned an intensity level.

Classification according to the TORRO - Hailstorm Intensity Scale

www.torro.org.uk / site / hscale.php
## TORRO Hailstorm Intensity Scale

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Intensity Category</th>
<th>Typical Hail Diameter (mm)*</th>
<th>Probable Kinetic Energy, J-m^2</th>
<th>Typical Damage Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0</td>
<td>Hard Hail</td>
<td>5</td>
<td>0-20</td>
<td>No damage</td>
</tr>
<tr>
<td>H1</td>
<td>Potentially Damaging</td>
<td>5-15</td>
<td>&gt;20</td>
<td>Slight general damage to plants, crops</td>
</tr>
<tr>
<td>H2</td>
<td>Significant</td>
<td>10-20</td>
<td>&gt;100</td>
<td>Significant damage to fruit, crops, vegetation</td>
</tr>
<tr>
<td>H3</td>
<td>Severe</td>
<td>20-30</td>
<td>&gt;300</td>
<td>Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored</td>
</tr>
<tr>
<td>H4</td>
<td>Severe</td>
<td>25-40</td>
<td>&gt;500</td>
<td>Widespread glass damage, vehicle bodywork damage</td>
</tr>
<tr>
<td>H5</td>
<td>Destructive</td>
<td>30-50</td>
<td>&gt;800</td>
<td>Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries</td>
</tr>
<tr>
<td>H6</td>
<td>Destructive</td>
<td>40-60</td>
<td></td>
<td>Bodywork of grounded aircraft dented, brick walls pitted</td>
</tr>
<tr>
<td>H7</td>
<td>Destructive</td>
<td>50-75</td>
<td></td>
<td>Severe roof damage, risk of serious injuries</td>
</tr>
<tr>
<td>H8</td>
<td>Destructive</td>
<td>60-90</td>
<td></td>
<td>(Severest recorded in the British Isles) Severe damage to aircraft bodywork</td>
</tr>
<tr>
<td>H9</td>
<td>Super Hailstorms</td>
<td>75-100</td>
<td></td>
<td>Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open</td>
</tr>
<tr>
<td>H10</td>
<td>Super Hailstorms</td>
<td>&gt;100</td>
<td></td>
<td>Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open</td>
</tr>
</tbody>
</table>
“Severe thunderstorm with hail passed Vienna on May 13 2003. 20 minutes lasting hailstorm with hailstones up to 4 cm diameter caused damages on roofs, glasses and vehicles.”
The recently established thunderstorm tracking and nowcasting algorithm

**A-TNT (Austrian Thunderstorm Nowcasting Tool)**

has been used to identify and track intense precipitation cells based on MaxCAPPI radar data and to map potential hail regions.

**ZAMG, Section Remote Sensing, Vera MEYER**
INPUT DATA: 2-dim Radar-precipitation data maximum projection composites maps (MaxCAPPI)
- from 2002: time/space resolution: 10 min / 2 km x 2 km, 7 Levels
- from 2004: time/space resolution: 5 min / 2 km x 2 km, 14 levels
- from 2008: time/space resolution: 5 min / 1 km x 1 km, 14 levels

CELL IDENTIFICATION:
- threshold value 38 dBZ (~ 9 mm/h)
- min. cell size 50 pixels (~ 50 km²)

TRACKING:
based on the detection of overlapping areas between detected cells in two consecutive radar-images.
Cell identification and tracking

RADAR CELL TRACKS 20100722 1610h
comp Min(area)/ pix^2 50, missing radars: \

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Example: 23.07.2009, cell-nr. 30040 (16:05-21:50 UTC)
HAIL DETECTION: quantitative and comprehensive

First approach:
for each station is the ratio of the average annual number of days with hail to the average annual number of days with thunderstorms calculated (study period 1951-1985)
Terrain profile around hail risk areas
435 classified hail cases within 310 communities
2002-2011, 46 cases TORRO 4 radar cell tracks, and frequency
2002-2011, 35 cases TORRO 5 radar cell tracks, and frequency

Häufigkeit der Zelltracks mit Torro 5 je Gitterpunkt

Anzahl
2002-2011
0 1 2 3 4 5

Hagelereignis
1971-2011
2002-2011, 18 cases TORRO 6 radar cell tracks, and frequency
2002-2011, 6 cases TORRO 7 radar cell tracks, and frequency

Häufigkeit der Zelltracks mit Torro 7 je Gitterpunkt

Anzahl 0 1 2 3 4 5
2002-2011

Hagelereignis 1971-2011
Häufigkeit der Zelltracks mit Torro 4 bis Torro 7 je Gitterpunkt

Anzahl 2002-2011

Hagelereignis 1971-2011
All detected tracks
Intersection Chronicle and radar values

local damage information

Radar:
Tracking the associated maximum intensities

Zugbahnen der Hagel-Zellen

Torro 4 5 6 7
Spatial distribution of all 435 Torro-classified hail cases

Hagelpotential in Österreich
Daten 1971 - 2011

Altitude < 1500 m
Spatial distribution of the 162 Torro-classified "radar cases"

Hagelpotential in Österreich
Daten 2002 - 2011

Altitude < 1500 m
classified cases were not completely within the computed distribution of the hail intensities
Solution: back to the good old “handmade”

Altitude < 1500 m
Hagelgefährdungskarte Österreich

TORRO
- T6 und T7
- T5
- T4
- T0-3

Altitude < 1500 m

ECSS 2013, 3 - 7 June 2013
Juni 14, 2013 Folie 26
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Salzburg, in detail, and hail on 2013 05 20

Description of hail risk areas within the country Salzburg:
- rund um die Stadt Salzburg und im Flachgau;
- weiter im Pongau im Ennstal von Eben bis Radstadt;
- im Pinzgau im Bezirk Zell am See, nämlich im Saalbachtal, in Saalfelden

Movement of the hailing cell 2013 05 20
2013 05 20, Hail over capital town Salzburg
Description of hail risk areas within the country
Styria:
Hier treten Hagelschläge am häufigsten und intensivsten auf, mit den Schwerpunkten unmittelbar östlich und südöstlich der abfallenden Bergzüge. Weitere schwere Hagelschläge finden sich südlich der Mürzsteger Alpen im Mürztal, besonders im Raum Kapfenberg. Schwere Hagelschläge traten wiederholt in den Bezirken Hartberg, Weiz, Graz- Umgebung, Feldbach und Radkersburg auf.

Movement of the hailing cell 2013 05 20
2013 05 20, Hail over the district Gleisdorf, Styria
The severe weather events 2013-05-20 confirm

RADAR CELL TRACKS 20130520 0000 - 20130521 0000
compo Min(area) 5 pix2, Min-Max(lifetime) 5-inf min, No.track 2100

Reflectivity >38dBZ

Triangles: reported damages
The presented map „Hail Risk Areas in Austria“

**Hagelgefährdungskarte Österreich**


**TORRO**
- T6 und T7
- T5
- T4
- T0-3
THANK YOU FOR YOUR ATTENTION, ready for questions

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Danke!
Kiitos