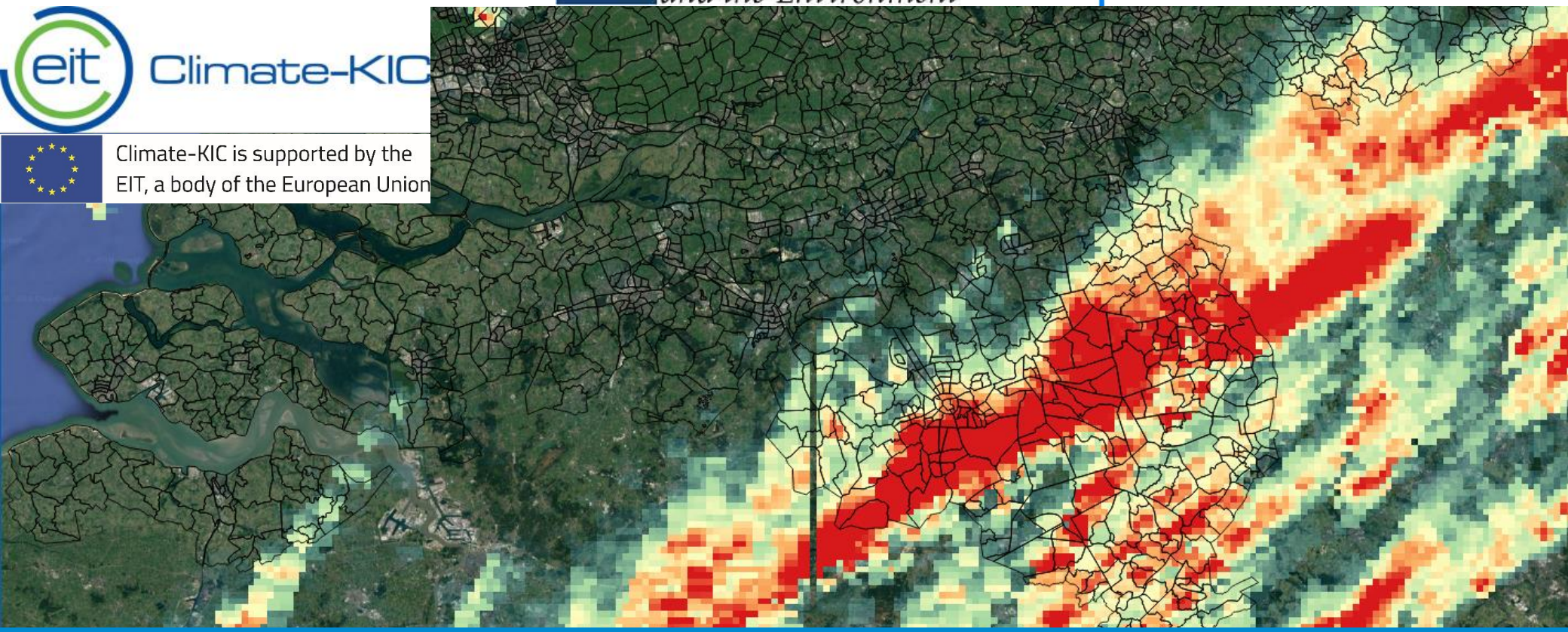
achmea

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

VU UNIVERSITY AMSTERDAM

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union



Hail Climatology for the Netherlands (and impact on solar panels)

Hans de Moel, Lucas Wouters, Bram van 't Veen, Maaike Boon, Demi van Putten, Elco Koks, Thirza Teule, and others.

Background

- Severe Hailstorms are in the Netherlands one (of not the) most damaging natural hazard
- Most damaging event was due to hail
- 6 events in the top 20 associated with hail
- …but there is actually little know about hail probabilities and geographic distribution

Tabel 1: Grootste schadegebeurtenissen in Nederland voor particuliere inboedel- en opstalschade in de periode 2000 t/m 2016

#	Schadedatum	Schade in mln euro	Omschrijving gebeurtenis
1	23 juni 2016	200	Hagel
2	18 januari 2007	175	Storm (Kyrill)
3	28 oktober 2013	115	Storm (Christian)
4	27 oktober 2002	75	Storm
5	28 juli 2014	75	Wolkbreuk, Amsterdam
6	13 mei 2000	66	Vuurwerkramp
7	30/31 augustus 2015	52	Hagel en regen
8	31 maart 2015	36	Storm
9	26 mei 2009	33	Onweer, regen, hagel
10	14 juli 2010	31	Valwinden en windhozen
11	28 juni 2011	29	Wolkbreuk
12	24 juni 2016	28	zie 23 juni 2016
13	10 juli 2010	27	Regen, hagel, windstoten
14	22 juni 2008	26	Hagel
15	25 juli 2015	24	Storm
16	26 augustus 2010	23	Langdurige regenval
17	12 juli 2010	22	Valwinden
18	30 mei 2016	21	Regen, hagel, onweer
19	5 december 2013	20	Storm
20	20 november 2016	20	Storm

Verbond van Verzekeraars, 2017

Objective

Develop a hail climatology for the Netherlands

- Derive return periods for hail events with certain hail stone sizes
- Derive spatial differences in hail occurrence within the Netherlands

Omroep Brabant

Schadeoplossing.nl

Climate-KIC

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

achmea

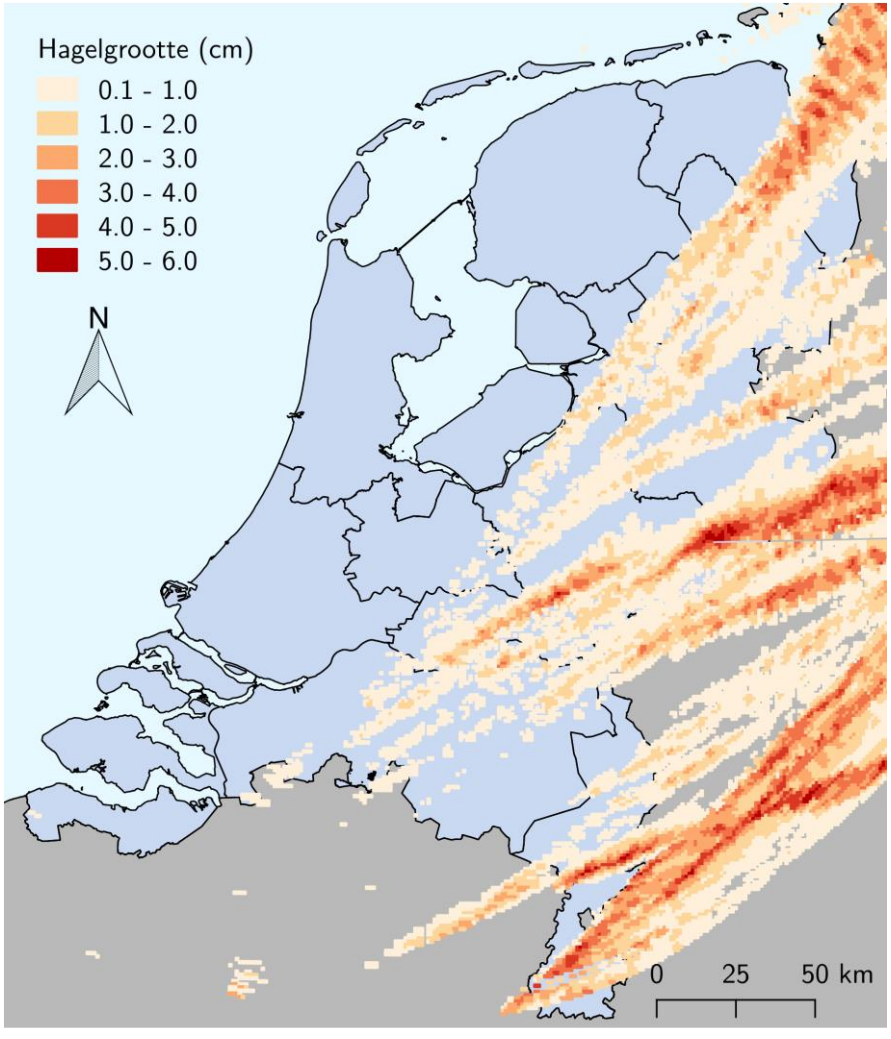
VU

Climate-KIC is supported by the EIT, a body of the European Union

How

Combine multiple sources

- Radar data from KNMI
- European Severe Weather Database
- Weerspiegel Magazine (back to 1975)



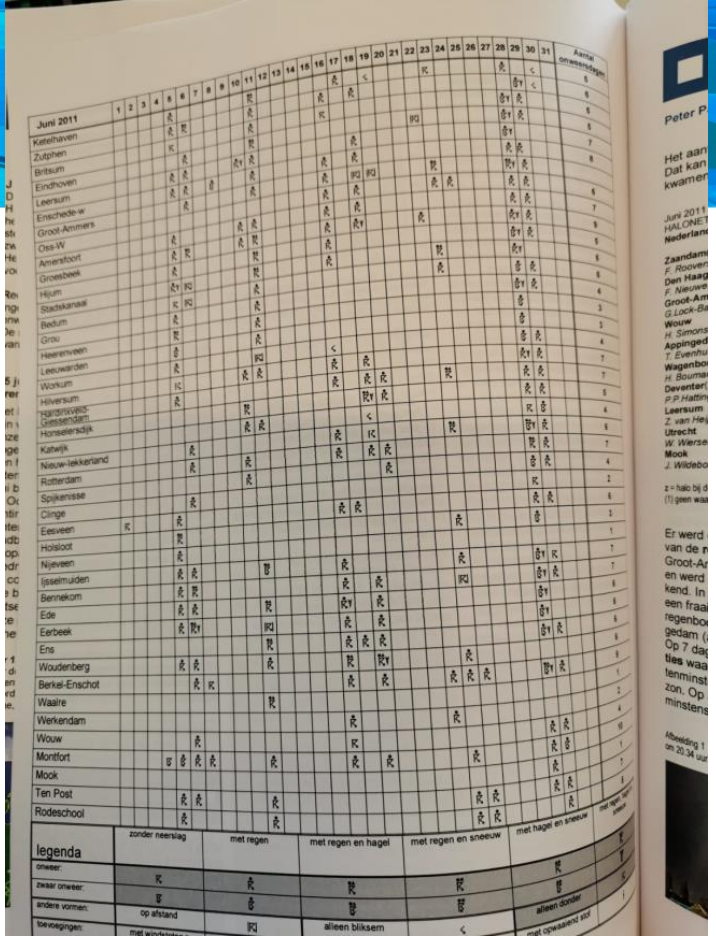
Climate-KIC
Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment
achmea
VU
Climate-KIC is supported by the EIT, a body of the European Union

Return Periods of Hailstone Sizes

- Total of ~650 observations of hail with hail stone sizes over period 1975-2019

Table 1. The total amount of observations included in the observed-hail dataset from Weerspiegel-magazine and the ESWD.

Source	Total observations	# of hail sizes	# of hail sizes ≥ 2 cm
Weerspiegel	7.393	503	173
ESWD	166	150	148



Weerspiegel

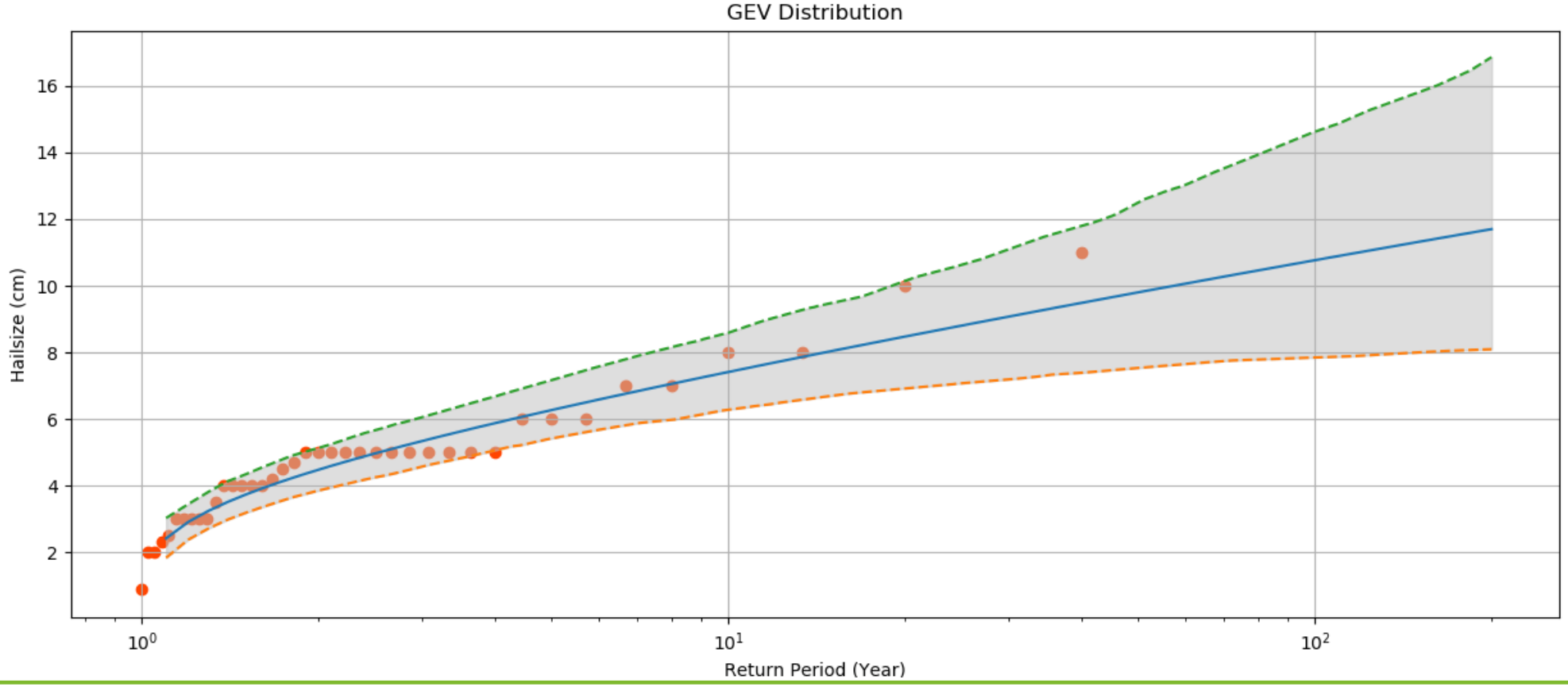
large hail to map	**Seiersberg** Steiermark **Austria** (47.00 N, 15.40 E) **30-06-2016** (Thursday) **19:40** UTC (+/- 5 min.)	based on information from : an eye-witness report , a report on a website , photo or video of the event maximum hail diameter : **2 cm** *2 cm Hagel in Seiersberg gemeldet, dazu Überflutungen via https://www.facebook.com/Wetterwarnung/ User Markus Schlote* *https://www.facebook.com/photo.php?fbid=1132449770130318&set=p.1132449770130318&type=3&theater* *https://scontent-vie1-1.xx.fbcdn.net/t31.0-8/13594854_1132449770130318_3753357191451981147_o.jpg* report status : **report confirmed by reliable source** (QC1) contact : Aktuelle Wetterwarnungen Österreich (AWÖ)
large hail to map	**Hitzendorf** Steiermark **Austria** (47.03 N, 15.30 E) **30-06-2016** (Thursday) **19:33** UTC	based on information from : an eye-witness report maximum hail diameter : **2.5 cm** event duration at place of observation : 30 minutes *Straßen stehen unter Wasser, Hageldeckenbildung* report status : **plausibility check passed** (QC0+) contact : Georg Wagner via SKYWARN Austria
large hail to map	**Kloboučky** South Moravian Region **Czech Republic** (49.13 N, 17.02 E) **30-06-2016** (Thursday) **18:50** UTC (+/- 15 min.)	based on information from : a report received by e-mail , an eye-witness report , photo or video of the event maximum hail diameter : **3 cm** *https://scontent-fra3-1.xx.fbcdn.net/t31.0-8/13502515_1751218861792213_7114408829629163788_o.jpg* report status : **report confirmed by reliable source** (QC1) contact : Czech Thunderstorm Research Association z.s.

ESWD

Return Periods of Hailstone Sizes

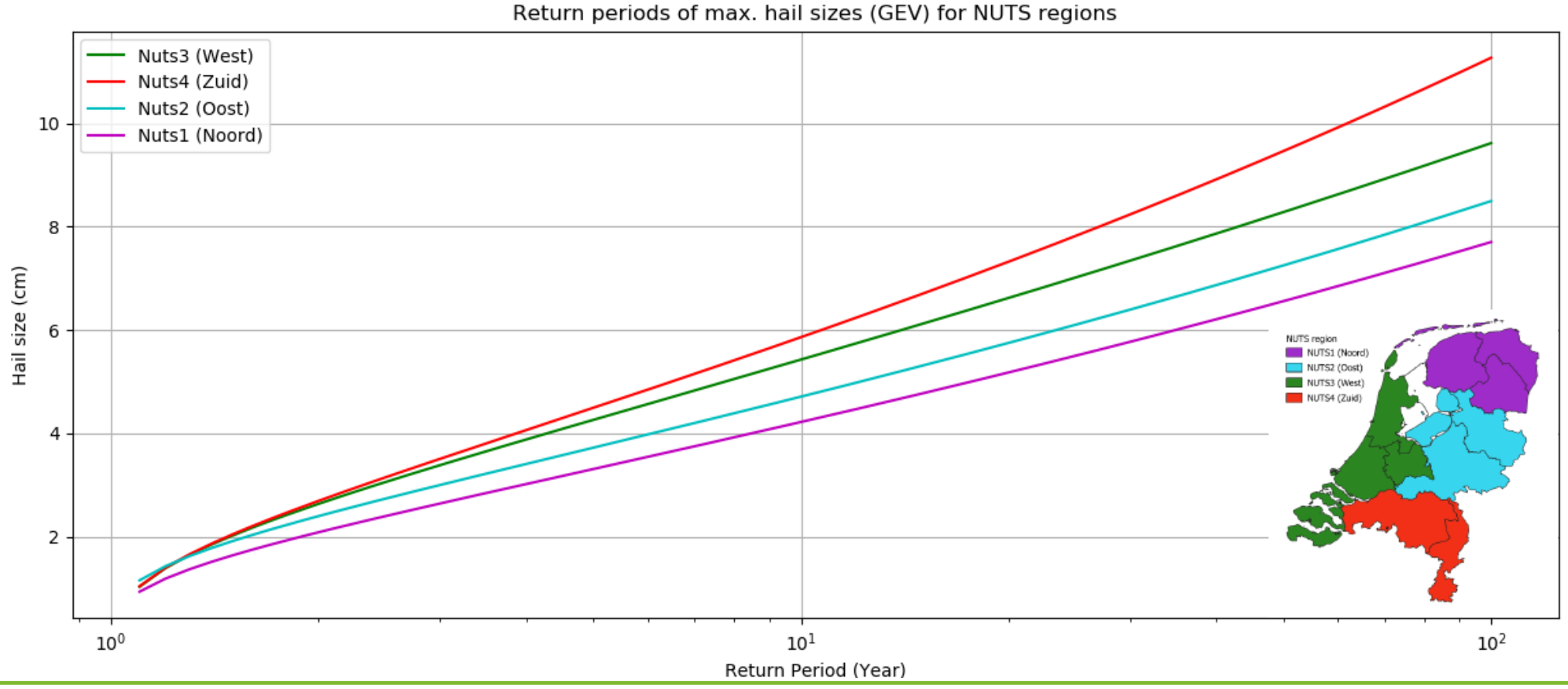
Probability of certain hail sizes for whole of the Netherlands

- 1/10 years return period is >7cm



Return Periods of Hailstone Sizes

South has highest probability, North the lowest



Climate-KIC

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

achmea

VU

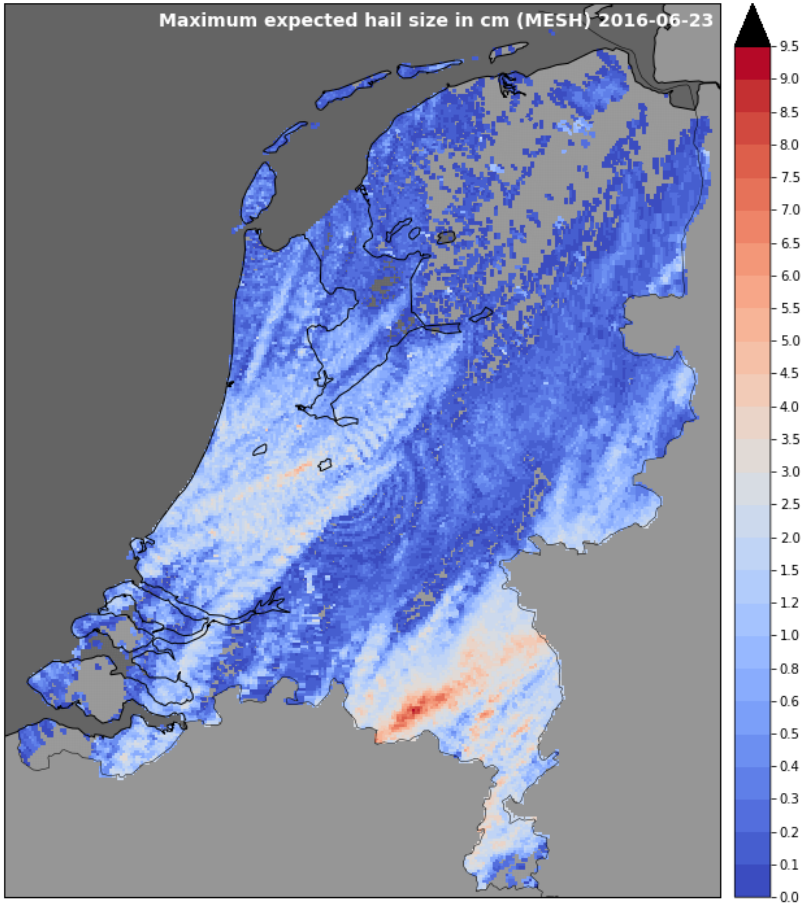
Climate-KIC is supported by the EIT, a body of the European Union

Spatial Distribution

- Doppler radar in two locations (reflection)
- HiRLAM NWP model (for temperature in atmosphere)
- Mazimum Estimated Hailstone Size (MESH) derived using method of Witt et al. (1998)

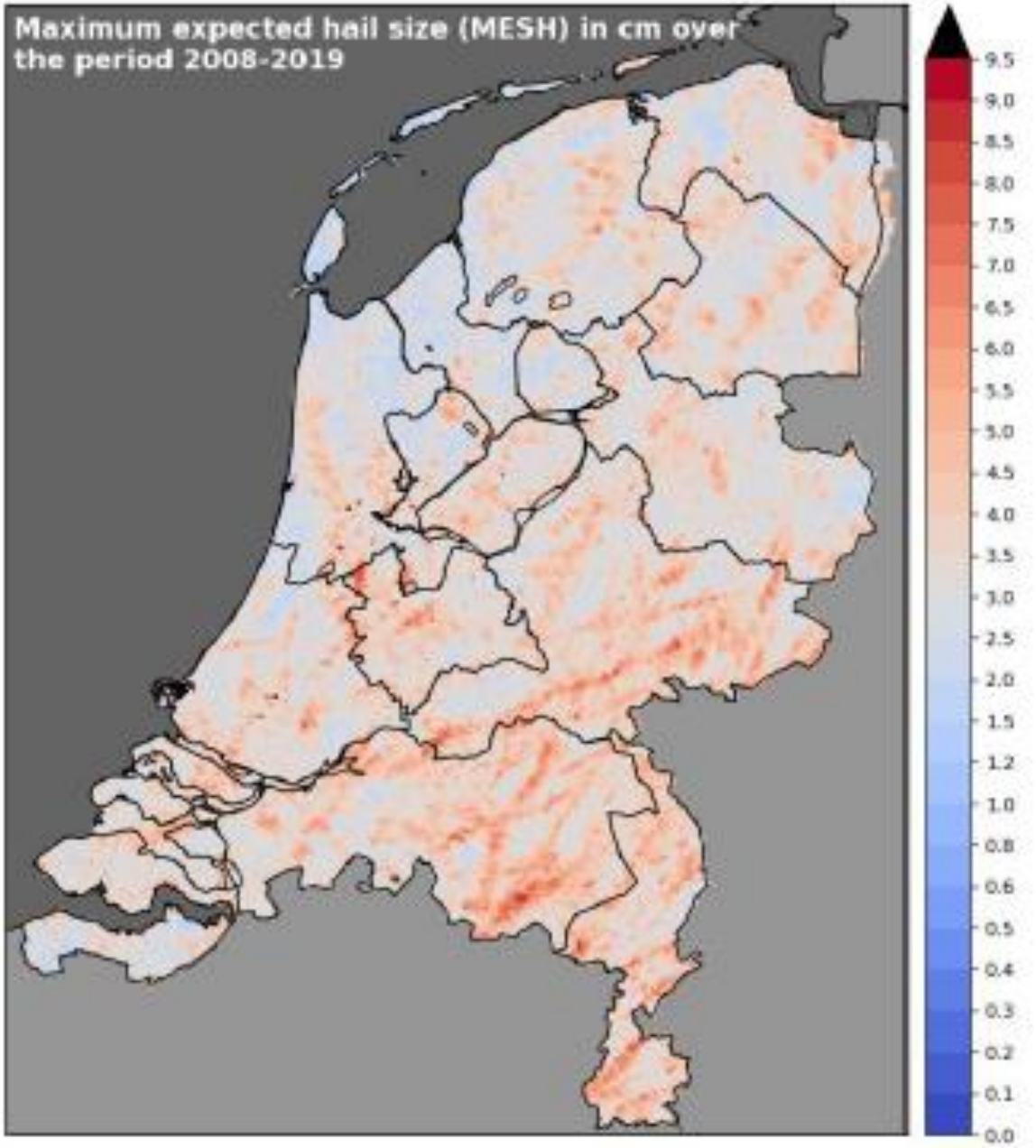
- Period 2008-2019
- 1 km^2 grid

MESH example 23 June 2016



Spatial Distribution

- Overall, 328 hail days selected



Climate-KIC

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

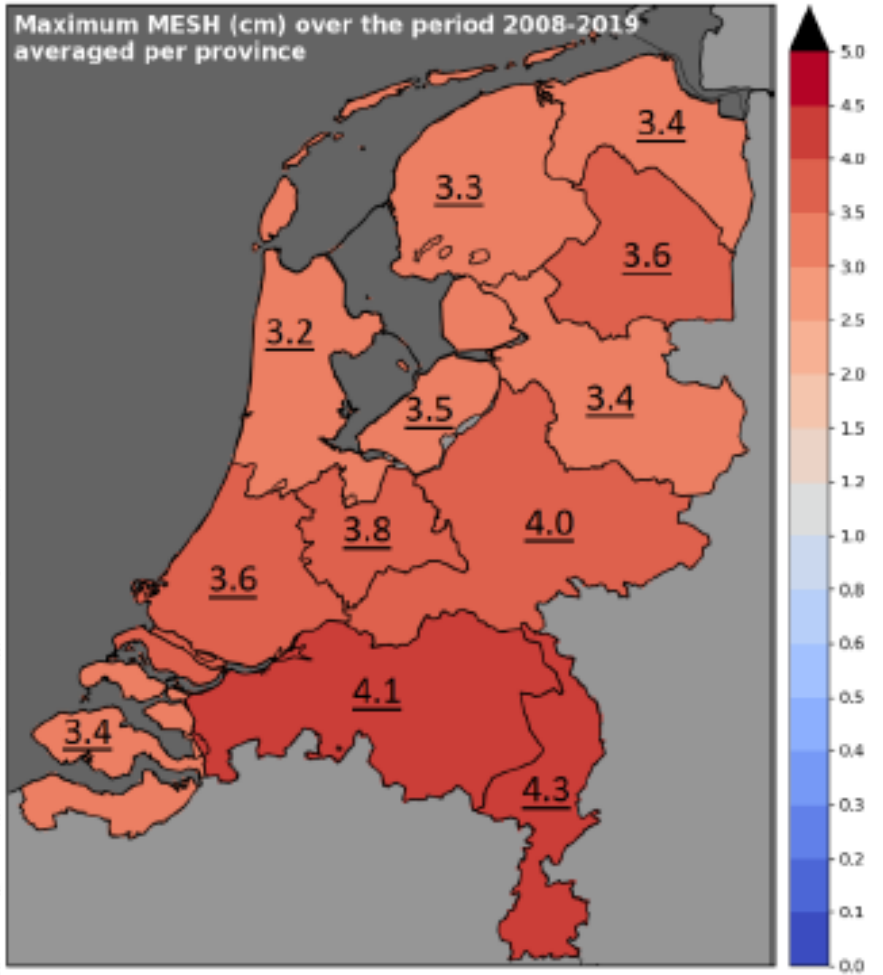
achmea

VU

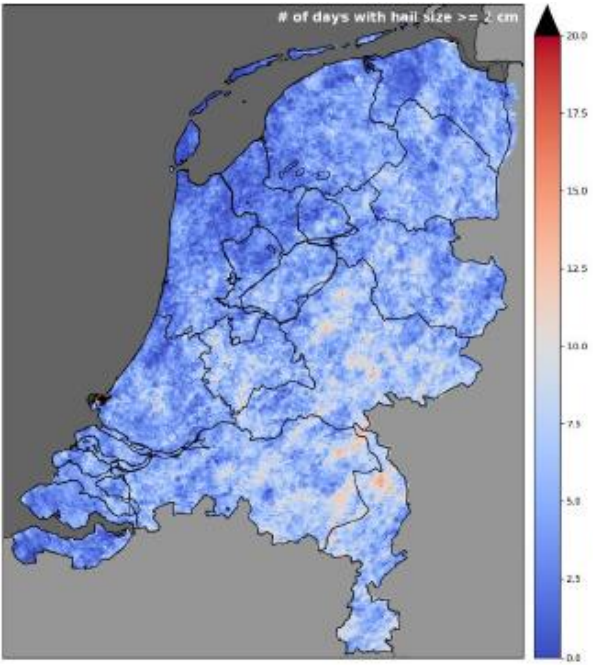
Climate-KIC is supported by the EIT, a body of the European Union

Spatial Distribution

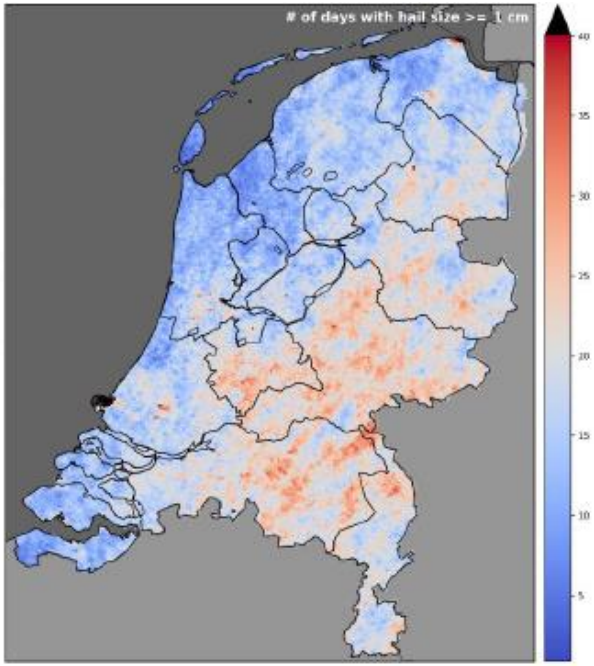
- South-eastern provinces have seen higher hailstone sizes as opposed to the North of the Netherlands
  - In line with the return periods found earlier



Days with size >2 cm



Days with size >1 cm



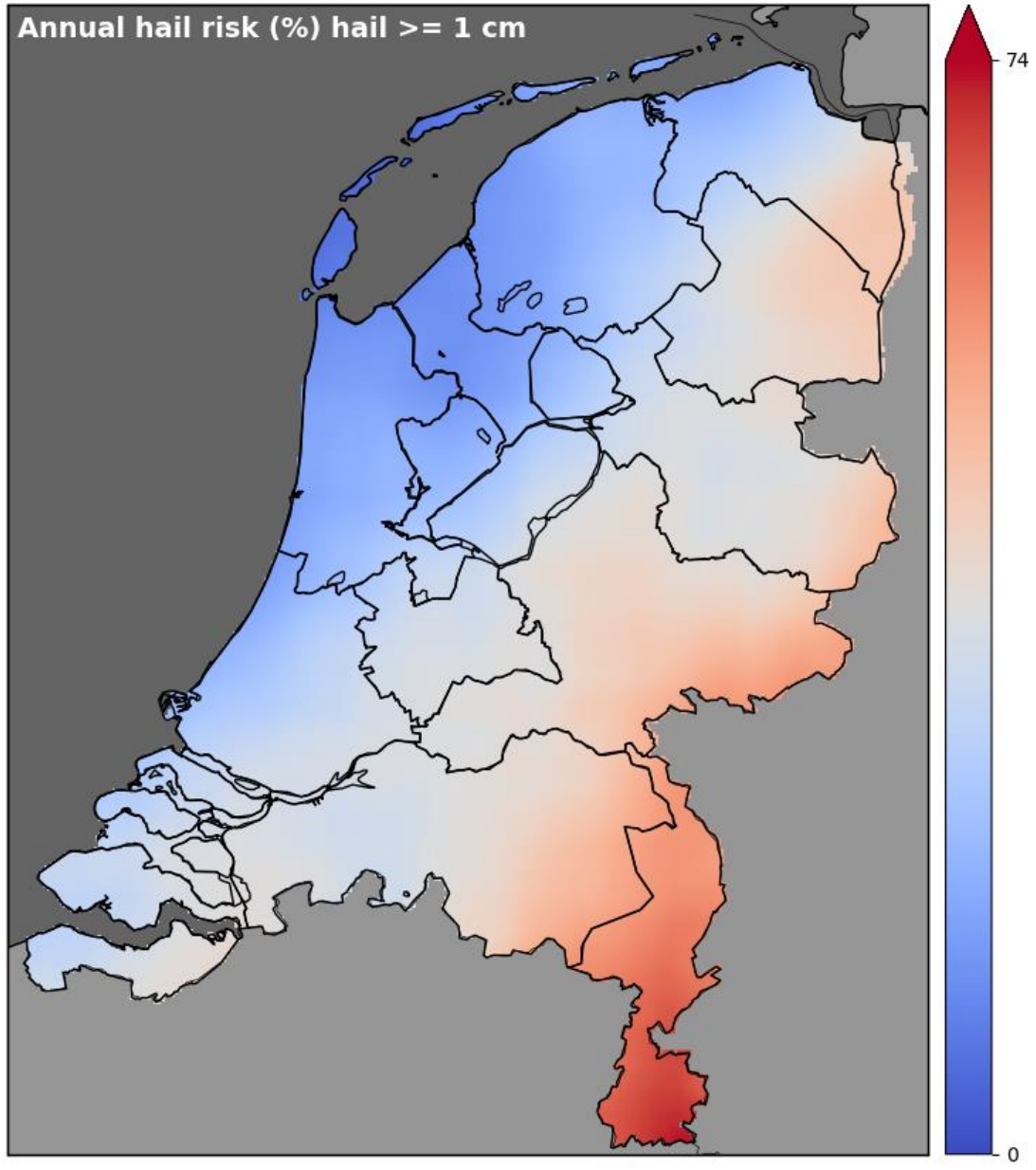
Climate-KIC is supported by the EIT, a body of the European Union

Spatial Distribution

Annual Hail Risk

> Using 50km radius due to limited length of time series

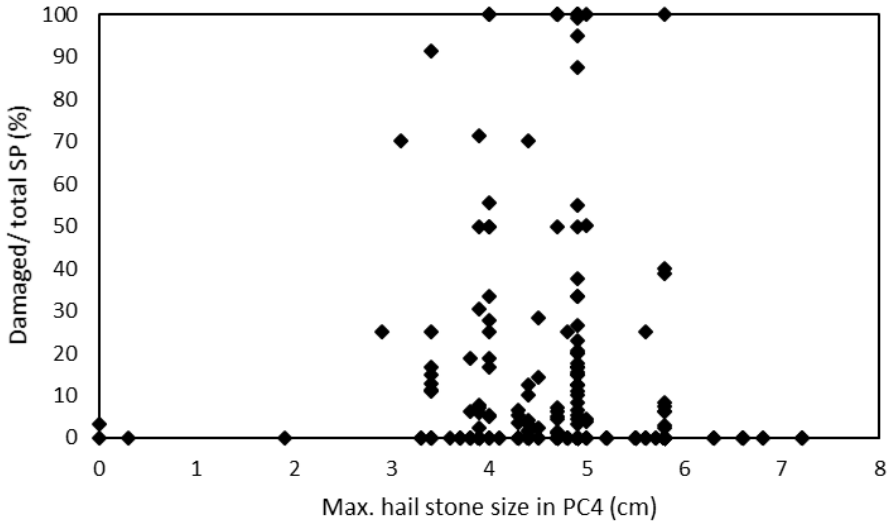
- Coastal regions clearly lower probability
- Probability increases towards the south-east
  > Again in line with return periods



Impact on Solar Panels

Damage starting at 2-3 cm hailstone size
- > Visible damage dominating from 4cm

- Larger angle indicates somewhat less damage
- Orientation is very important
  - > Orientation away from direction of the storm (SW) significantly reduces damage



Angle of solar panel

	Average damage / total SP (%)	Average mean hail size (cm)
Flat	18.1	4.2
Pitched	12.6	4.0

Orientation of solar panel

	Average damage / total SP (%)	Average mean hail size (cm)
S	17.0	4.1
SE	8.4	4.1
SW	13.6	3.7
W	15.7	4.4

Climate-KIC
Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment
achmea
VU
Climate-KIC is supported by the EIT, a body of the European Union

Concluding Remarks

- First hail climatology for the Netherlands created
- Return periods determined for various hailstone sizes
- Clear spatial pattern of hail occurrence
- Damage to solar panels linked to hail stone size, orientation and (to lesser degree) angle of solar panels

Climate-KIC
Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment
achmea
VU
Climate-KIC is supported by the EIT, a body of the European Union