Reassessment of precipitation return levels in Iceland

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Aðventuþing Veðurfræðifélagsins

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Flood in Neskaupstaður
December 28th, 2015
(photo: Kristín Hávarðsdóttir)

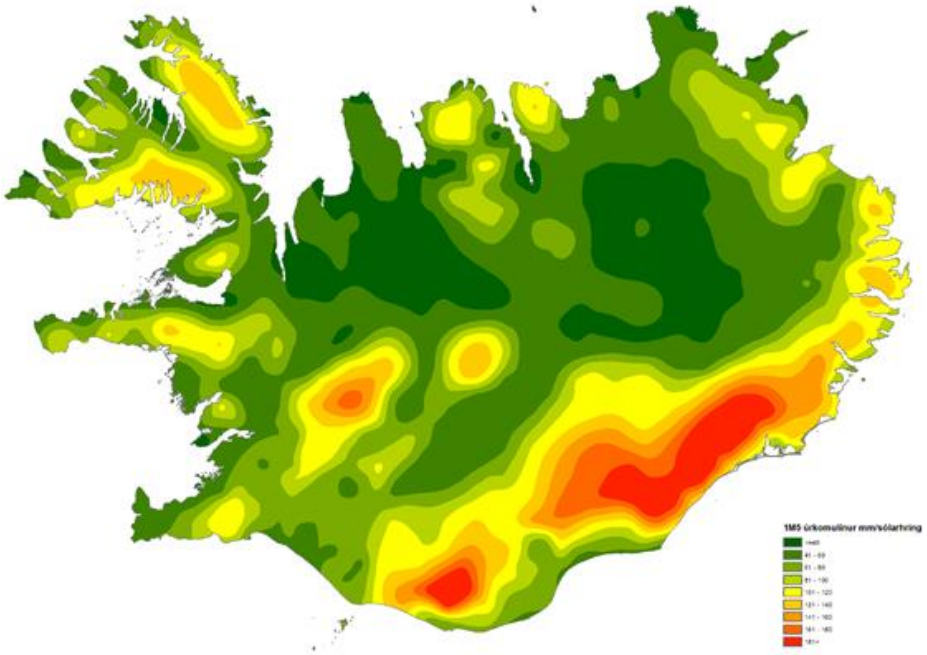
Introduction
Background

Veðurstofa Íslands

Estimates of precipitation extremes are an important measure for assessing the **spatial and temporal variability of precipitation.** Also used as the basis for **flood warnings** and in the **design of infrastructure.**

1M5 map (*) based on data from a NWP model with **8x8 km** horizontal grid for the **time period 1961—2006,** with precipitation output every **6 hours.**

***(*)1M5:** daily precipitation return levels with a 5-year return period.*



Elíasson et al., 2009

Introduction
Aims

Veðurstofa Íslands

Main objectives:

- **Update and reassess precipitation return levels** using a higher resolution model and an appropriate Extreme Value Analysis (EVA) method.

- Present those results graphically on a **new 1M5 map** and on **intensity-duration-frequency curves.**

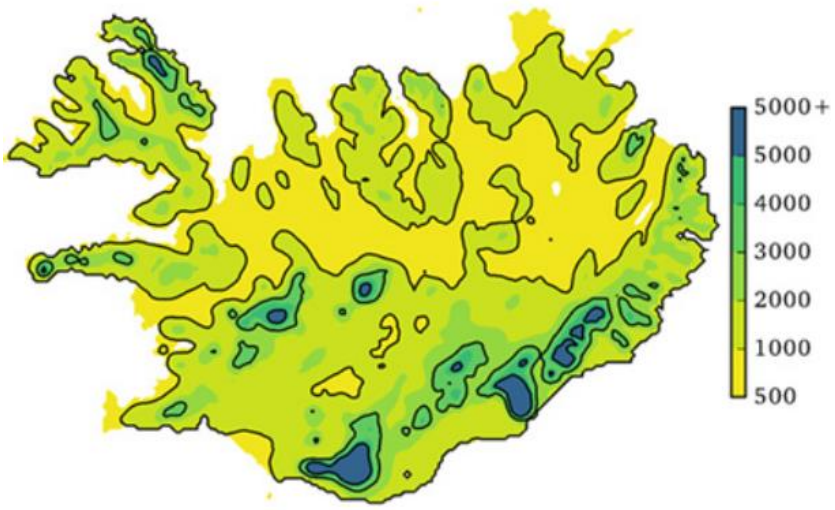
Flood in Eskifjörður June 23rd, 2017

1 Data
1.1 Reanalysis

Hourly simulated precipitation from **the ICRA dataset** (**IC**elandic **Re**A**n**alysis) using the non-hydrostatic HARMONIE-AROME mesoscale model with a **horizontal resolution of 2.5 km.**

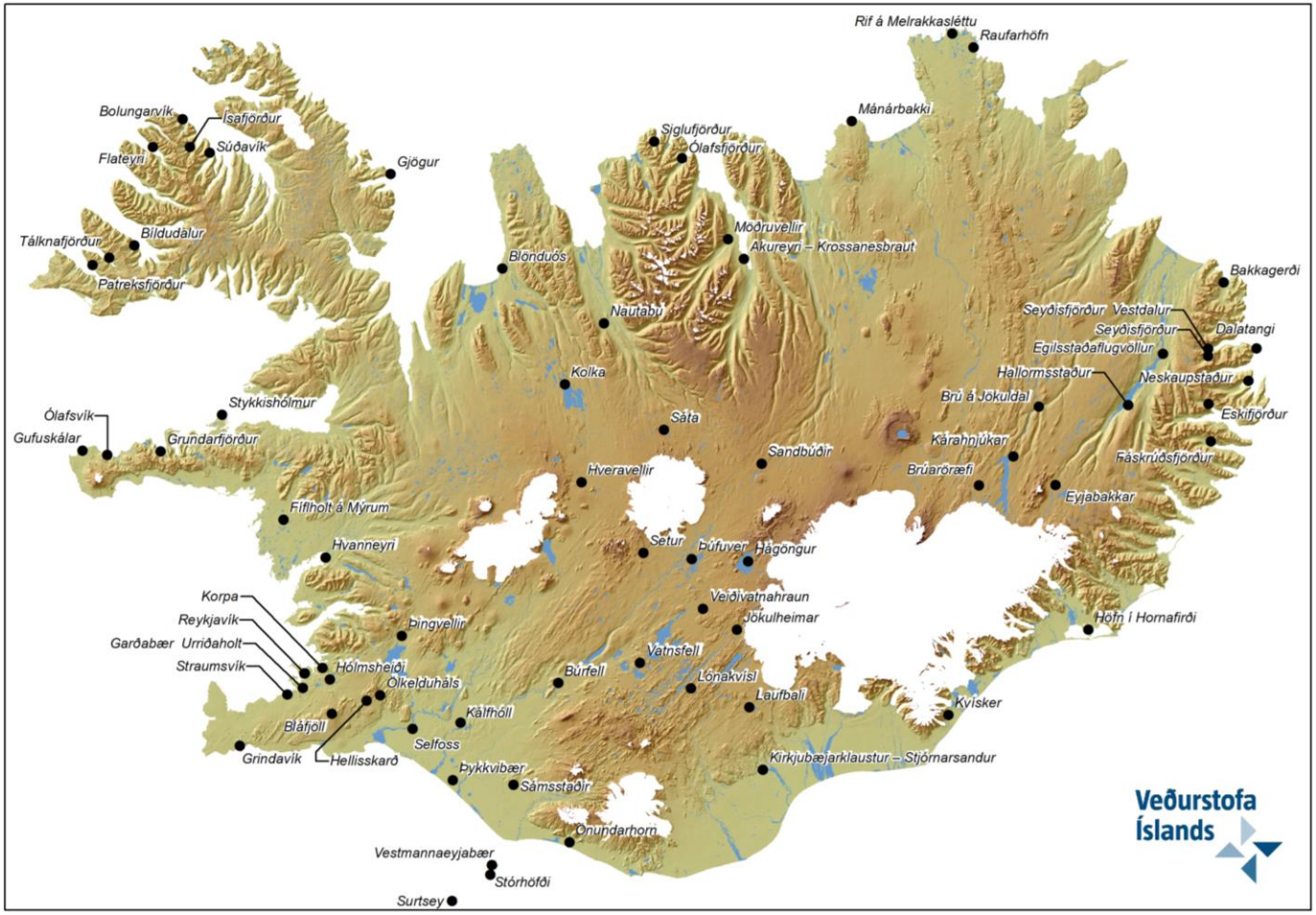
Reanalysis performed between Sept. 1979 and Dec. 2016

--> **38 complete years.**



Annual precipitation distribution based on the ICRA dataset (Björnsson et al., 2018)

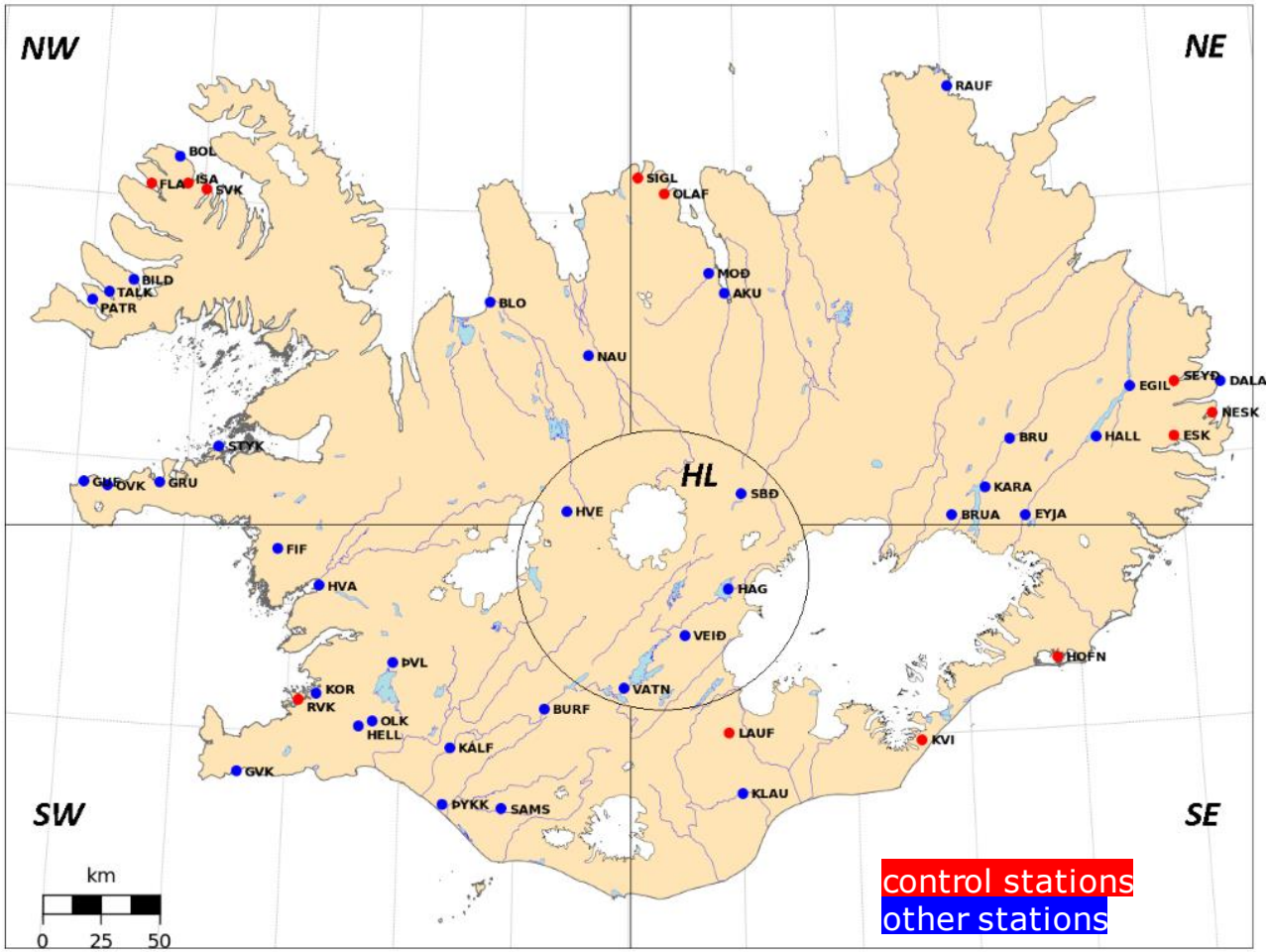
1 Data
1.2 Precipitation measurements



As of 2020, IMO operates more than 70 automatic stations.

Only stations that have recorded for **more than 10 years** and with **less than 1000 missing days** of data were selected.
--> 49 stations.

1 Data
1.2 Precipitation measurements

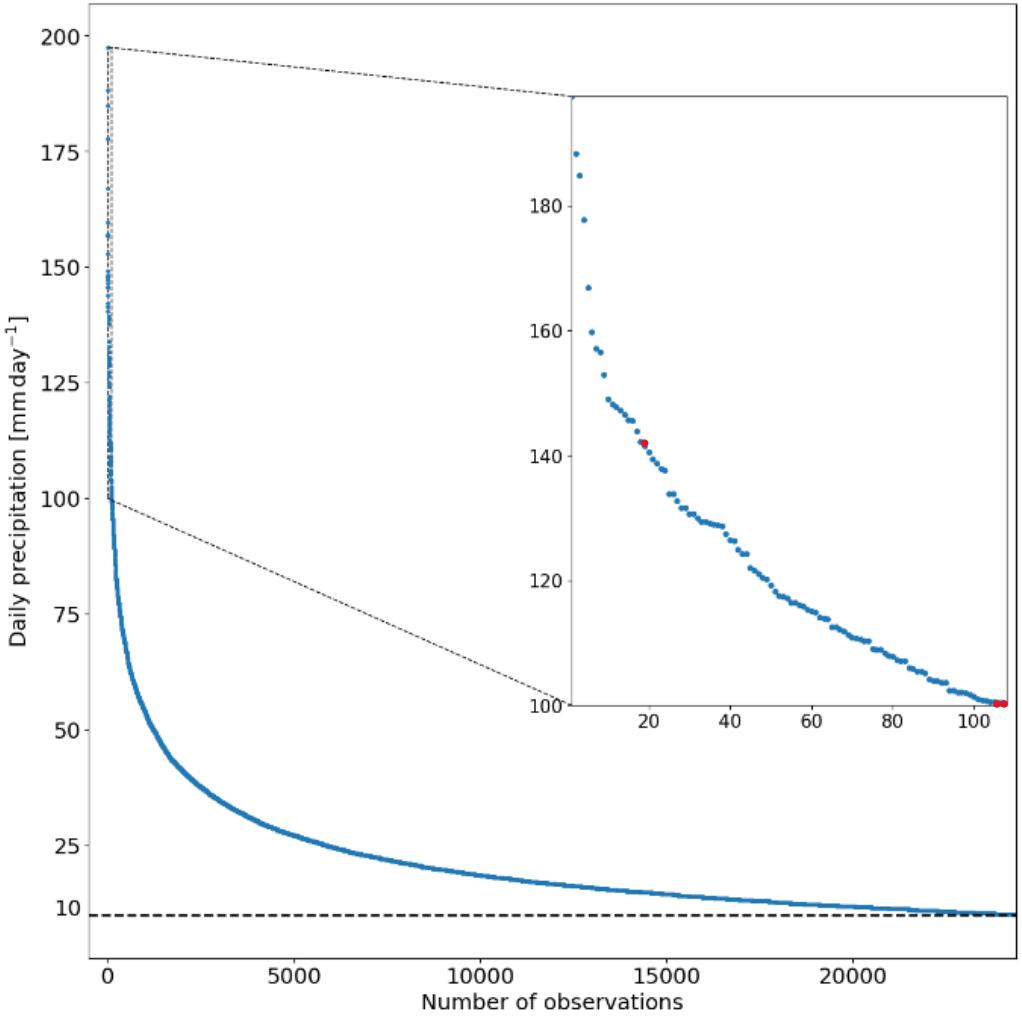


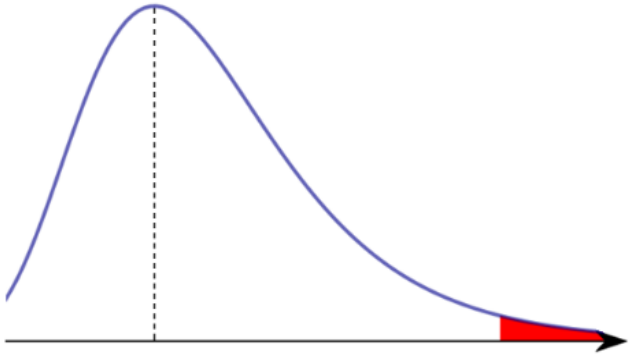
12 control stations picked for comparison purposes:

Eskifjörður
Flateyri
Höfn í Hornafirði
Ísafjörður
Kvísker
Laufbali
Neskaupstaður
Ólafsfjörður
Reykjavík
Seyðisfjörður
Siglufjörður
Súðavík

After further investigation **--> 43 stations.**

1 Data
1.2 Precipitation measurements





Recent floods caused by heavy precipitations:

**** Neskaupstaður:**
- 27 Nov. 2002, 146 mm day^{-1}
- 28 Dec. 2015, 102 mm day^{-1}

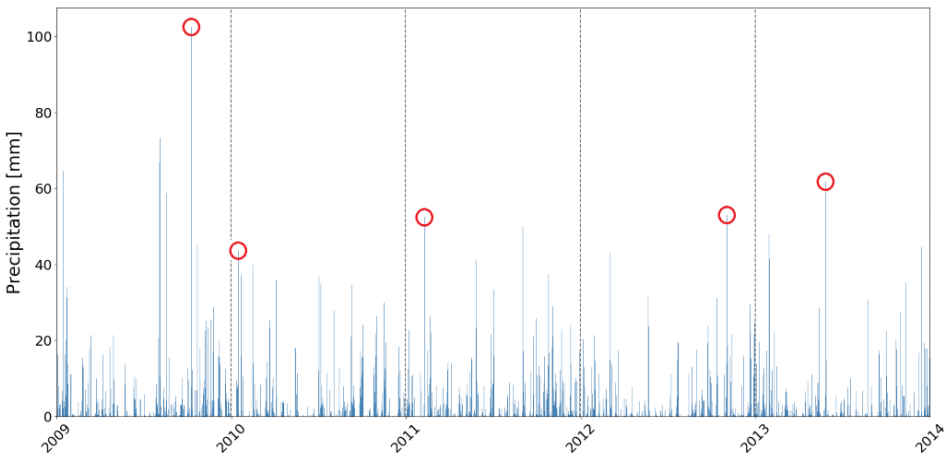
**** Siglufjörður:**
- 28 Aug. 2015, 101 mm day^{-1}

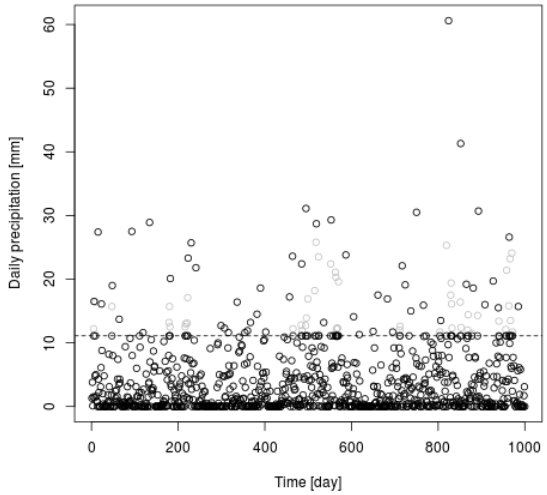
2 Extreme Value Analysis
2.1 Theory

Veðurstofa Íslands

In **Extreme Value Analysis**, two approaches:

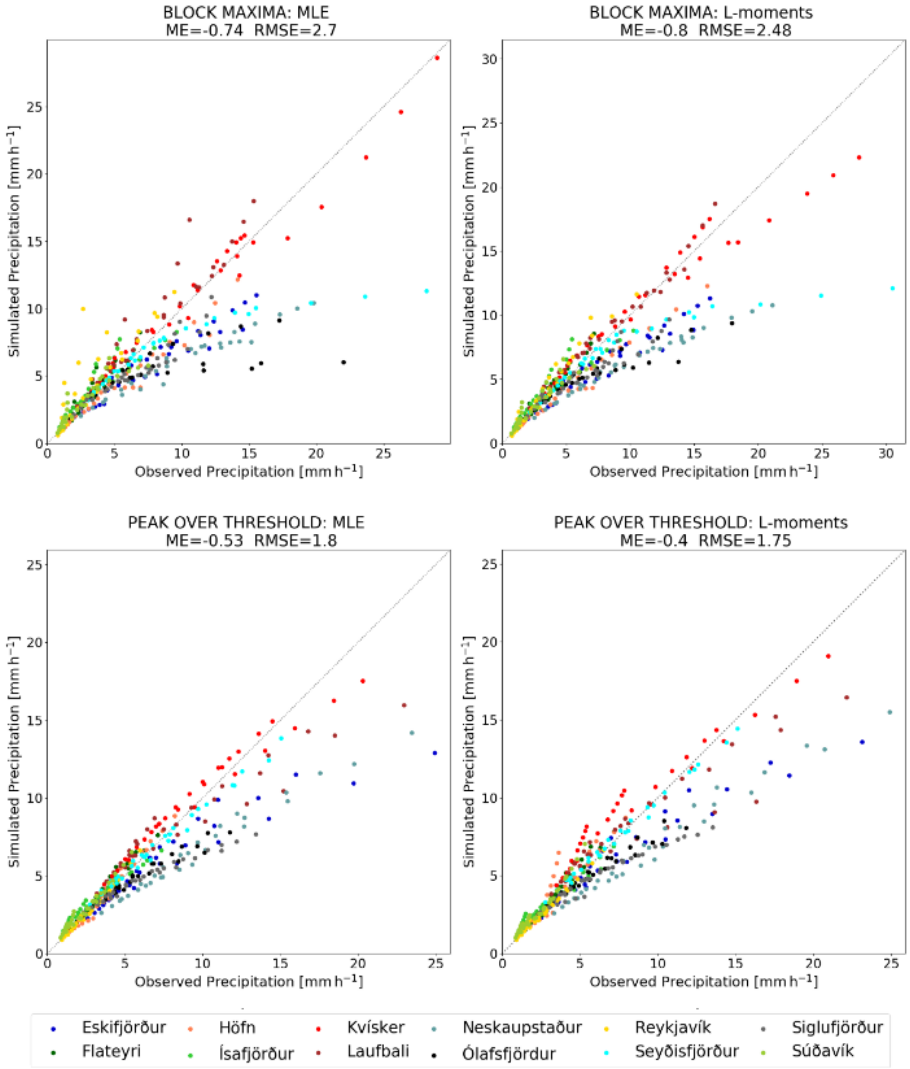
- **Block Maxima (BM):** only keep annual maximum values.
- **Peak-over-Threshold (POT):** keep all values above a threshold.





In this study, two methods to determine the parameters have been considered: **Maximum Likelihood Estimation (MLE)** and **L-moments**.

2 Extreme Value Analysis
2.2 Method selection



It was decided to pick the method that gives **closest results between observed and simulated datasets.**

Scatterplots for the control stations (shown here) and further results for all 43 stations gave closer values with the **Peak-over-Threshold method with MLE.**

3 Return levels
3.1 New 1M5 maps

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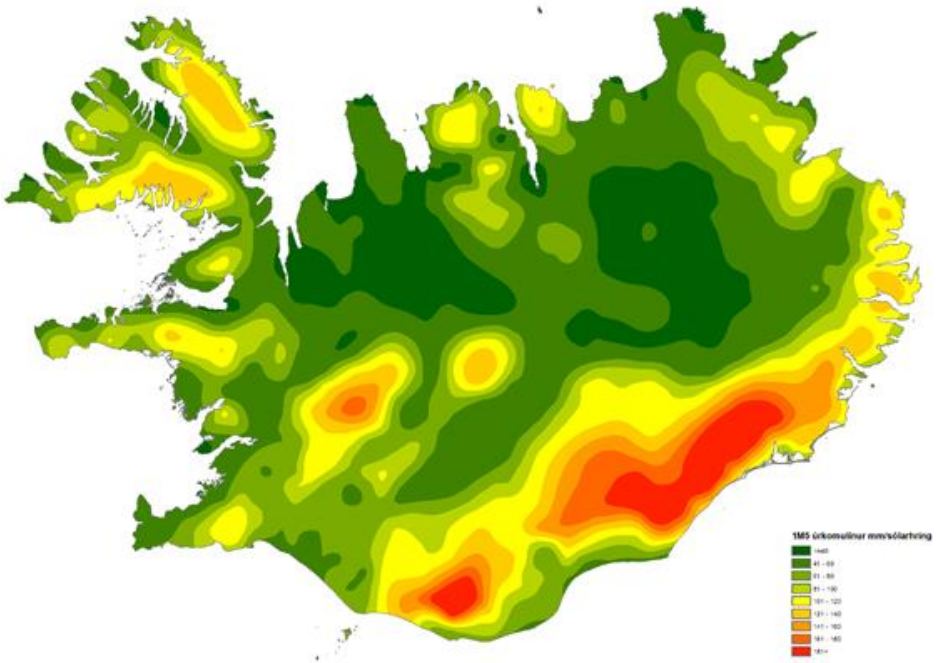
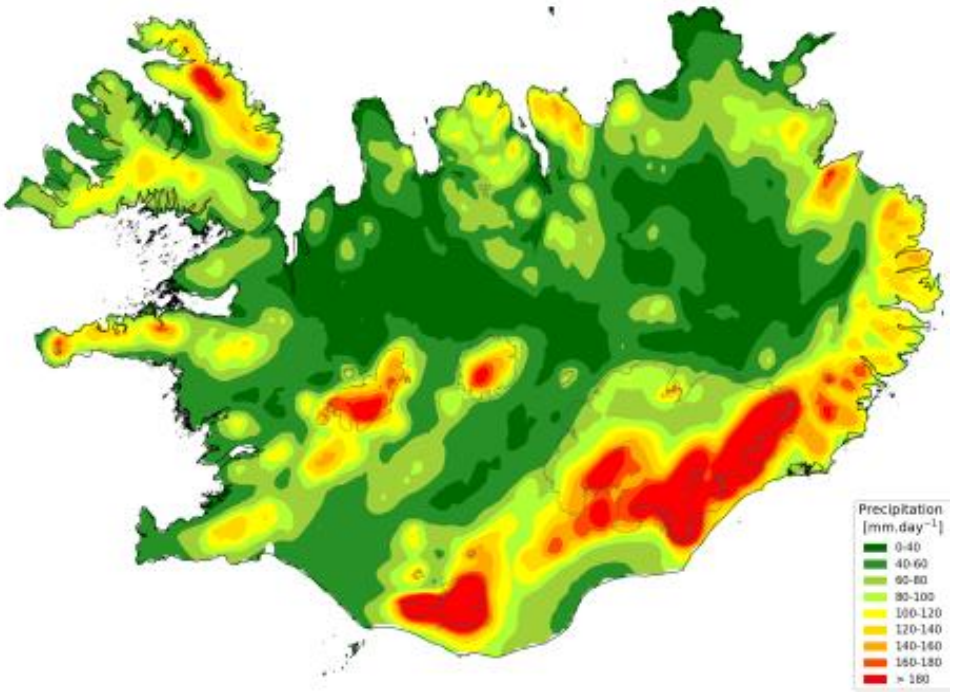
Elíasson, 2009



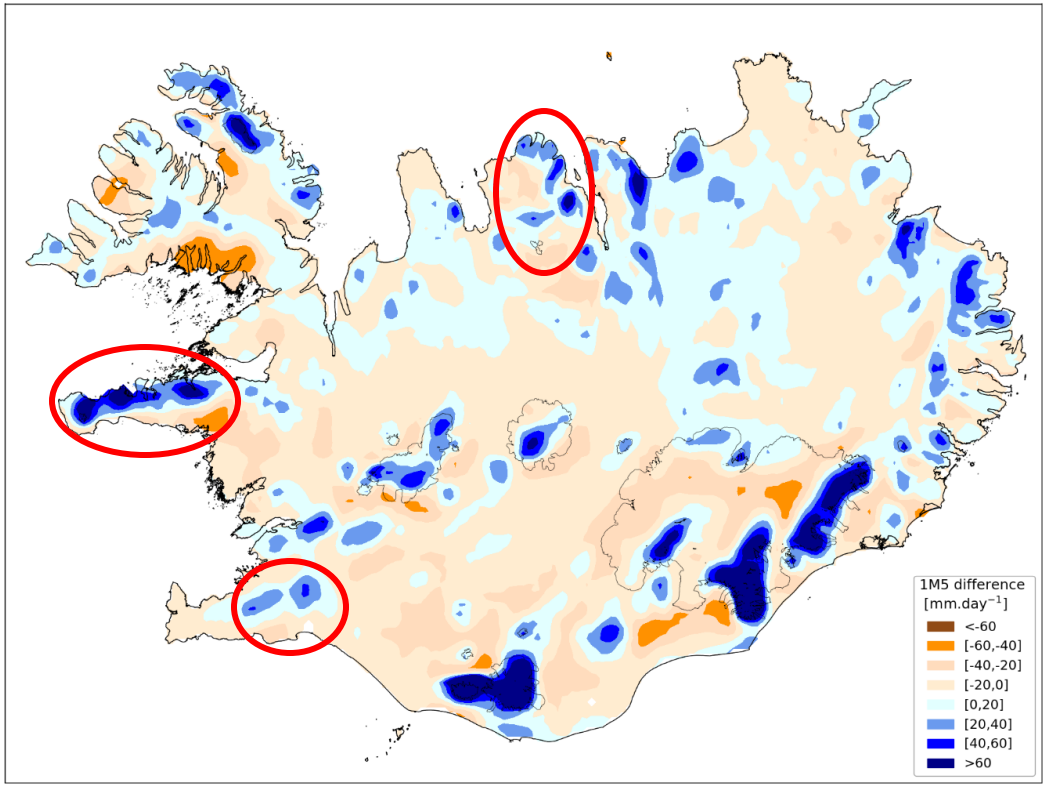
New 1M5 map

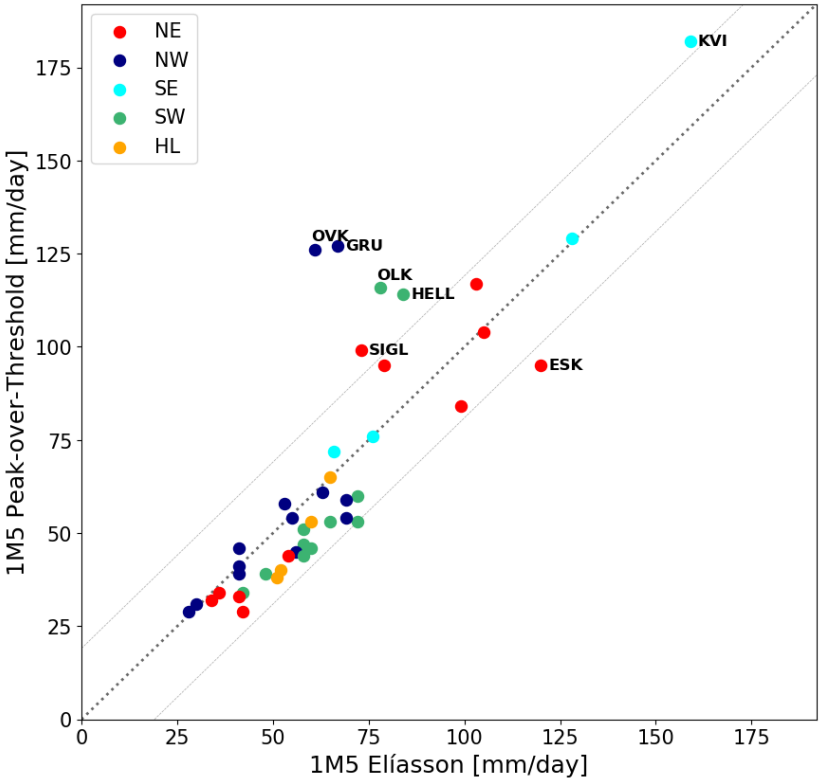


New 1M5 map showing daily return level values with a 5-year return period for direct comparison with the currently used map.

Results in the same range, but the new map is **more physically detailed.**

3 Return levels
3.1 New 1M5 maps





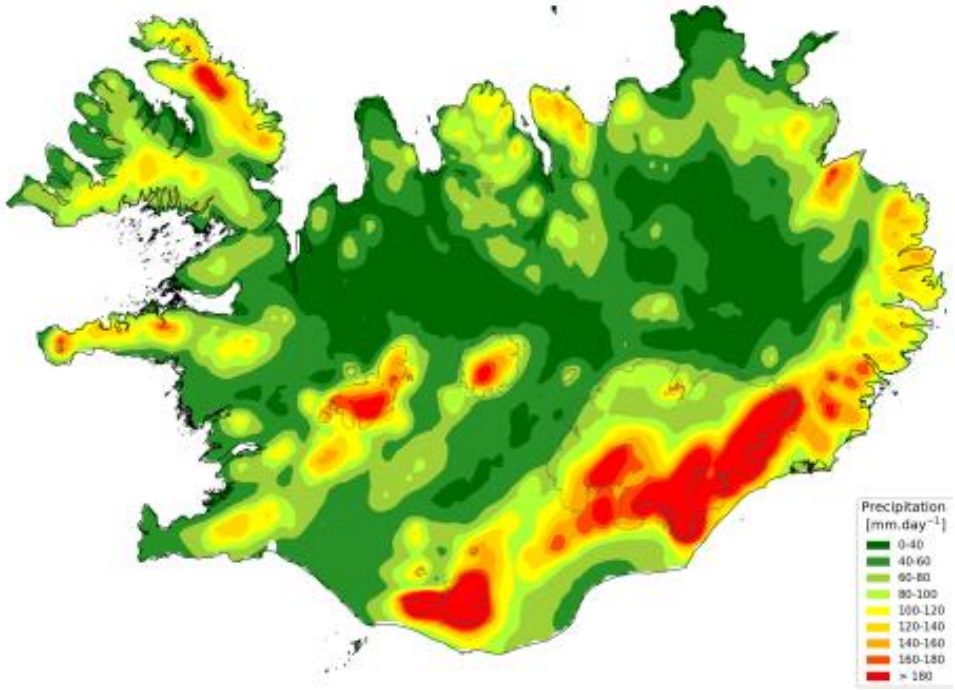
Overall, in the country, values are **slightly higher** in Elíasson.

Largest differences appear at stations located in regions that were **underestimated in Elíasson:** *Tröllaskagi, Bláfjöll, Snæfellsness*

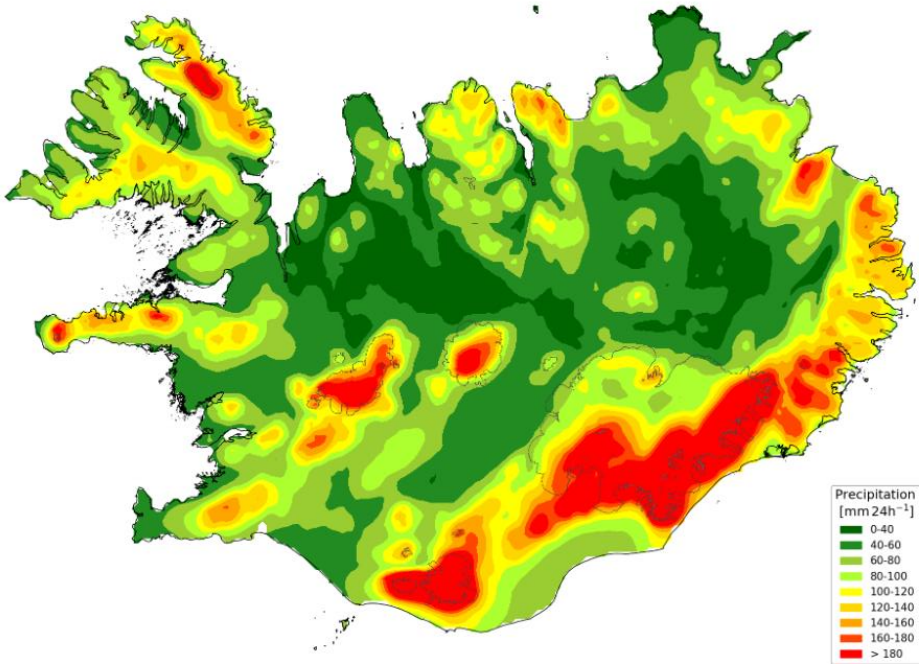
3 Return levels
3.1 New 1M5 maps

Veðurstofa Íslands

Daily precipitation



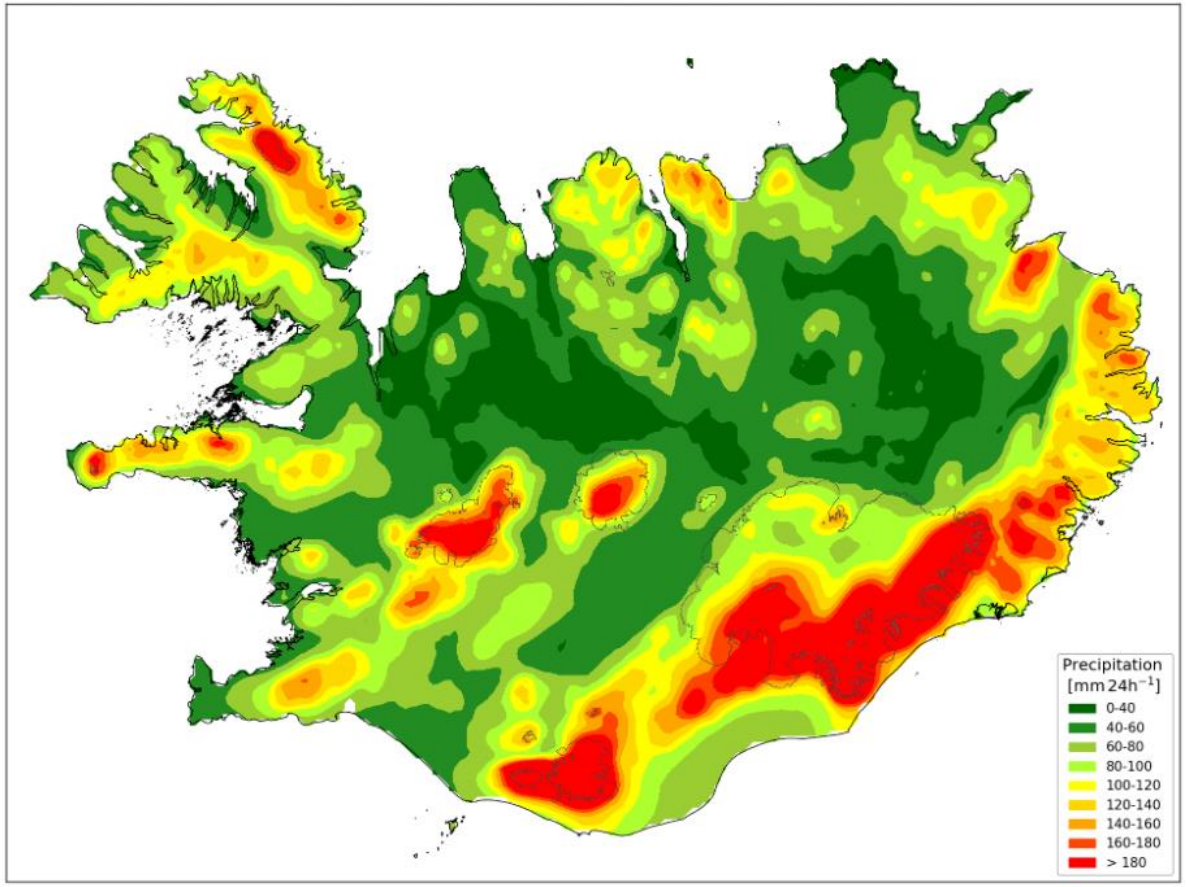
24-hour precipitation



Another 1M5 map was made, this time based on **24-hour accumulated values.**

3 Return levels
3.1 New 1M5 maps

Veðurstofa Íslands

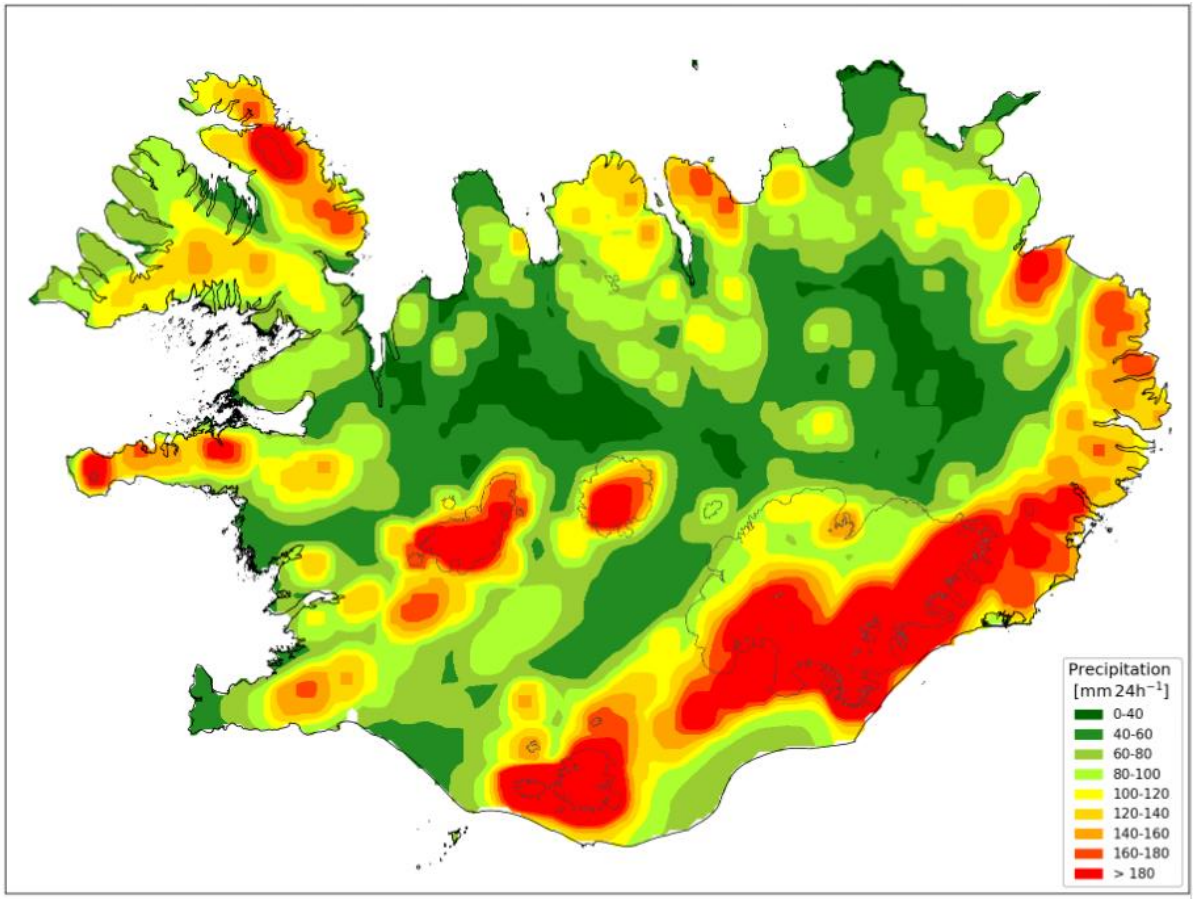


	1M5 values		
	daily	24-h	diff
Eskifj.	95	103	8%
Flateyri	62	70	25%
Höfn	76	87	14%
Ísafj.	58	67	16%
Kvísker	182	205	13%
Laufbali	129	153	19%
Neskaup.	104	117	13%
Ólafsfj.	95	130	37%
Reykjavík	34	42	24%
Seyðisfj.	117	134	15%
Siglufj.	99	108	9%
Súðavík	41	48	17%

1M5 map based on 24-hour accumulated values.

Overall, **results are increased by 14%.**

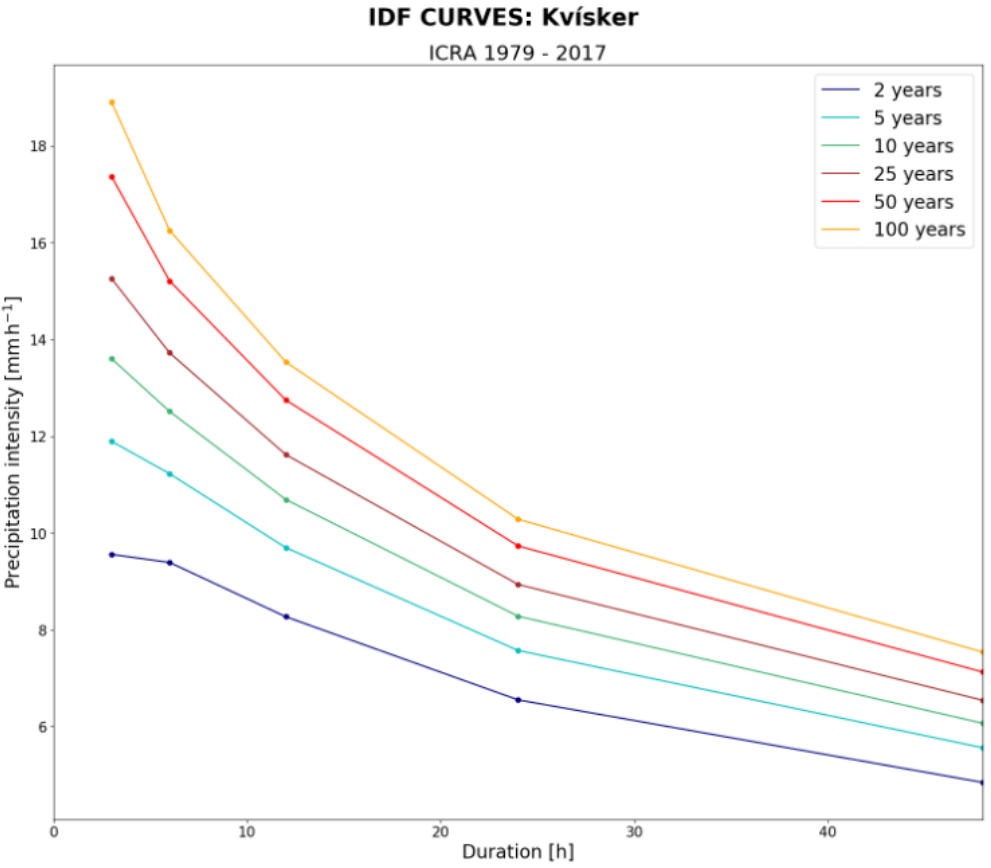
3 Return levels
3.1 New 1M5 maps



1M5 map based on 24-hour accumulated values with **maximum filter among the nearest gridpoints.**

This map has more of a **practical use** and **correct the steep gradient** observed previously near some of the coastlines.

3 Return levels
3.2 IDF Curves



Return level for station Kvísker

Return levels values shown graphically on **IDF (intensity-duration-frequency) curves** based on the complete ICRA dataset.

Values are given for **3-, 6-, 12-, 24-, 48-hour duration with a 2-, 5-, 10-, 25-, 50-, 100-year return period.**

	2 years	5 years	10 years	25 years	50 years	100 years
3 hours	29	36	41	46	52	57
6 hours	56	67	75	82	91	97
12 hours	99	116	128	139	153	162
24 hours	157	182	199	215	234	247
48 hours	233	267	291	314	342	362

Conclusions

Main results:

- **Peak-over-Threshold method with MLE** was selected to reassess the precipitation return levels.

- **Several 1M5 maps** were produced and are more physical, especially in region of complex orography.

- Results were also shown on **IDF curves** for engineering purposes.

Ongoing and future works:

- Methodology and new results are continued in a **new project about flash-floods.**

- **Climatological projection** could be tested to see how the return values would be affected.