The Brúsi Experiment – Precipitation in the complex terrain of E-Iceland

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Abstract

During the summer of 2008 a precipitation measuring campaign, Brúsi, took place in E-Iceland. The total precipitation from July to September ranged from 125 to 481 mm. However, the precipitation gradients in individual cases are often much greater than these numbers indicate. In easterly flow, the mountains in the outer part of the fjord receive by far most precipitation, while in northwesterly flow the mountains in the innermost part of the fjord may receive considerable precipitation, leaving the outer part of the fjord almost dry. There is not a clear connection between the elevation of the observation points and the accumulated precipitation. This is presumably related to the small scale of the topography, giving much spillover at sea level. The representativeness of the permanent precipitation stations for precipitation in the nearby mountains is highly dependent upon the weather situation.

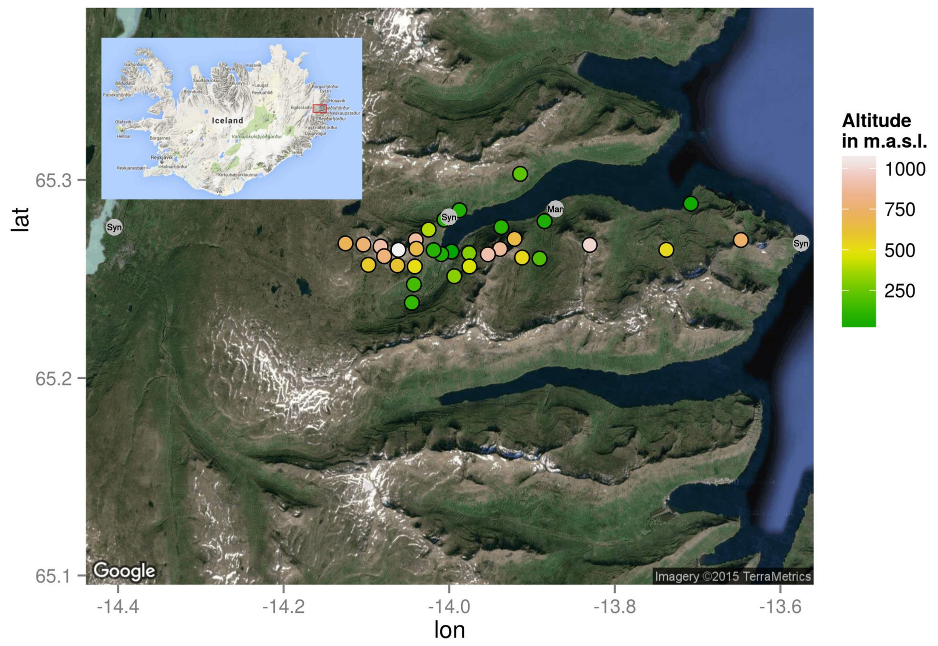

Figure 1. Left: Locations of rain gauges (coloured by altitude) in Seyðisfjörður-fjord, E-Iceland. Right: Looking eastward to sea from a rain gauge located at high altitude at the head of the fjord.

Seyðisfjörður

Seyðisfjörður is a narrow fjord in E-Iceland, about 20 km in length with an almost west-east direction (Figure 1). It is open to the North-Atlantic and surrounded by free standing mountains, mountain ridges and deep valleys resulting in complex orography with steep slopes.

Data

In total 35 precipitation gauges, of the type HOBO RG3_M, were placed in the fjord valley and up to more than 1000 m a.s.l. with a focus on the mountains at the head and south of the fjord (Figure 1). Most gauges where in place from the middle of June until December, but as the gauges cannot measure solid precipitation the measuring period extended from 15 June – 28 September 2008. In addition, there are three synoptic weather stations in the region that measure precipitation, all close to sea level.

Results

The summer of 2008 was relatively dry in E-Iceland, especially in August with only 50-75% of a long-term average according to ERA-Interim. The total accumulated precipitation during the period varies greatly, with lowest values at lower levels at the head of the fjord and highest values at altitude at the mouth of the fjord (Figure 2).

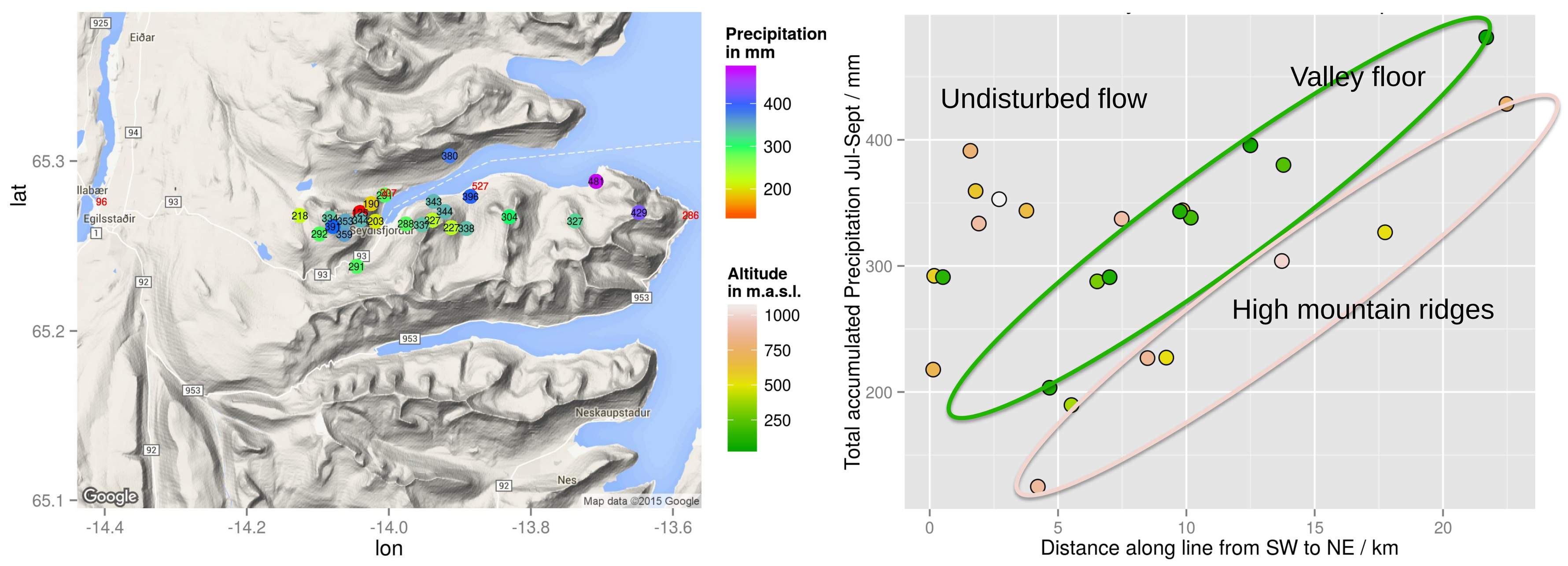

Figure 2.Total accumulated summer precipitation (mm). Right: Spatial distribution and Left: As a function of distance along a SW-NE line and altitude.

There is an almost linear increase in total precipitation along a SW-NE line, especially for rain gauges at the valley floor. Rain gauges at high mountain ridges captured 20-30% less precipitation than the valley ones. This is not a realistic precipitation pattern, with less precipitation in the mountains than at sea level, but more likely a result of wind induced undercatch (e.g. Duchon and Biddle, 2010).

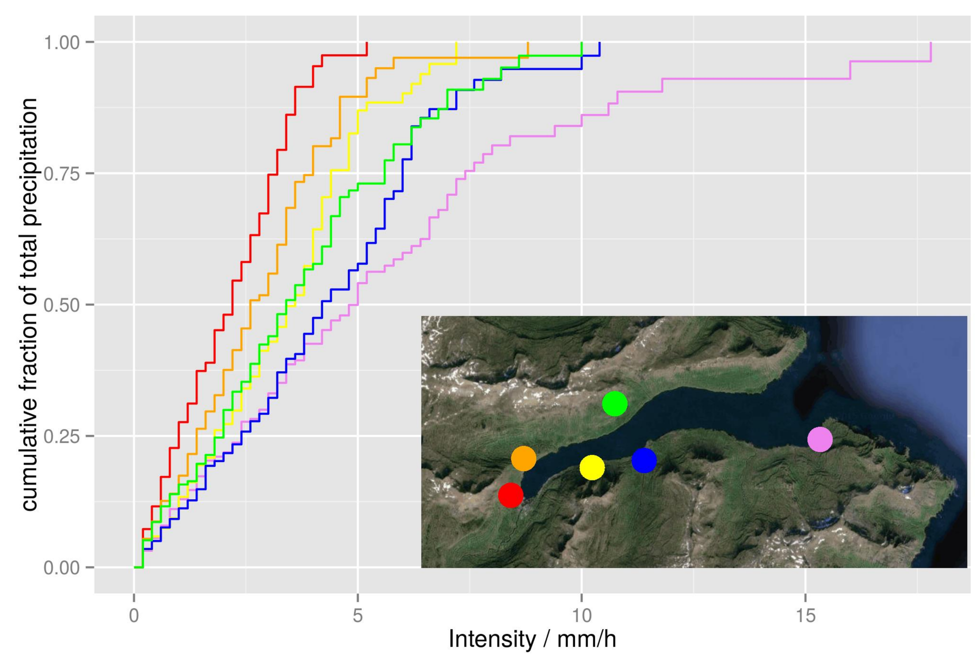

Figure 3. Cumulated fraction of precipitation as a function of the intensity for six gauges close to sea level.

An inspection of intensity spectra shows that the high intensity rain mainly occurs near the mouth of the fjord while precipitation is accumulated with low intensity at the head of the fjord (Figure 3).

The total summer precipitation is composed of distinct precipitation events, detected by most or all rain gauges, and longer periods of no or little precipitation in between. In total there were 19 precipitation events that can be divided into five groups, depending on the spatial or vertical distribution of the accumulated precipitation.

Precipitation patterns

1. **Precipitation gradient from west to east**
   In six events the precipitation at the fjord´s mouth was at least 1.5 times higher than at the head of the fjord. The winds aloft were fairly strong E-lies and the precipitation originated in occluded fronts.
2. **Precipitation gradient from east to west**
   Three events showed were of opposite character with the most precipitation at the head of the fjord. The winds aloft were W-ly or NW-ly and precipitation originated in occluded fronts.
3. **Precipitation gradient with altitude**
   In three events there was a strong vertical precipitation gradient in weak, mainly E-ly winds. These events can be seen as a combination of short and weak showers and some in-cloud drizzle.
4. **No precipitation gradient**
   In three minor events, the distribution of precipitation was homogeneous, possible due to weak winds and evenly distributed showers.
5. **Southerly spill over**
   Four short-lived events had a very local maximum at one site located in a valley, cutting into the mountain ridge to the south of the fjord, as well as some rain at a few sites on the southern slope of the fjord valley. These events were linked to quite strong S-ly winds and may be interpreted as spill over of precipitation.

Summary

The Brúsi campaign highlighted the extreme difficulties in measuring precipitation in complex orography. Undercatchment due to wind loss significantly impacts the measurements, with less total precipitation measured on windy mountain ridges than closer to seal level. The summer was in addition rather dry which means fewer events than expected and possibly less precipitation intensity.

The measured precipitation events can be divided into groups depending on the precipitation gradient, spatial or vertical. Most of the precipitation was linked to occluded fronts passing over E-Iceland. In strong E-ly winds aloft, the maximum rainfall was at the mouth of the fjord, while W-ly and NW-ly winds aloft resulted in maximum rainfall at the head of the fjord. There were few shower events during this rather dry summer, but some of them showed a clear orographic enhancement of precipitation.

The campaign also evokes a question regarding how representative precipitation measurements close to sea level are of the precipitation in the mountains given the high dependency on the large scale weather situation.

References

Duchon, CE, and CJ Biddle (2010): Undercatch of tipping-bucket gauges in high rain rate events. J. Adv. Geosci., **25,** 11-15.

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