Return values for extreme precipitation in Norway

- a comparison of estimates from a new approach combining ensemble data and gridded observations to PMP

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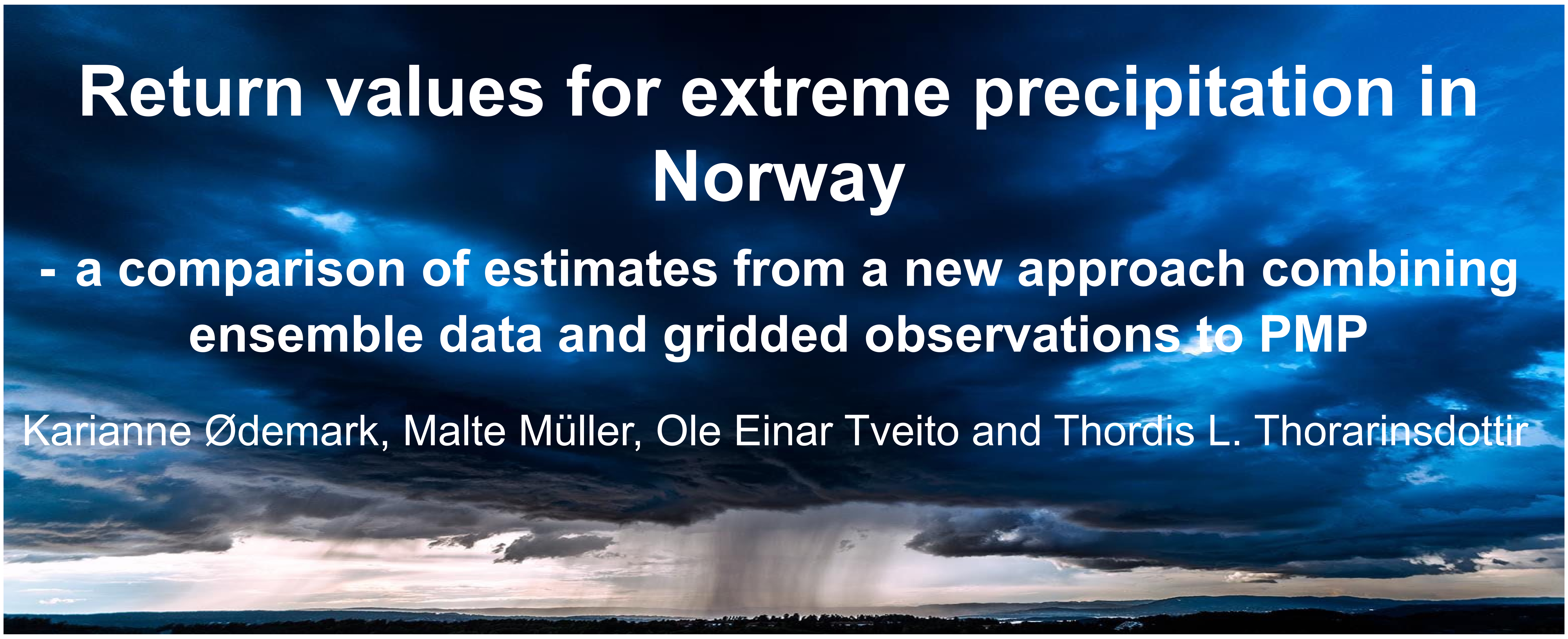


Introduction

The occurrence of extreme precipitation events causing surface water excess and flooding is becoming a significant societal expense due to the rise in precipitation levels. It is crucial to understand these events to predict their likelihood and frequency, as well as to estimate design values for critical infrastructure and constructions. This requires knowledge of the distributional properties of extremes. Studying distributional properties of extreme precipitation events requires long time series, which can be challenging using conventional or relatively short observational data records. A goal in this study is to establish robust estimates of long return period values, comparable to PMP estimates.

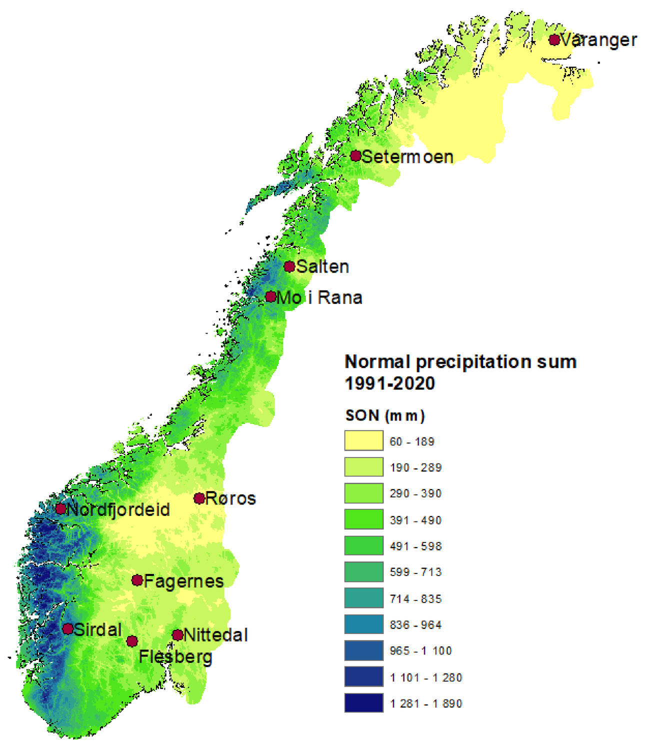


Figure 1: Seasonal (SON) normal precipitation sum for the standard reference period 1991-2020. Red dots indicate locations used in the analysis. Data from seNorge, a observational gridded dataset with 1x1 km resolution.

Increasing sample size with data from SEAS5

The SEAS5 seasonal re-forecast consists of 25 members initiated monthly, and each member spans over 7 months for the years 1981 to present. In this study we use the hindcast data from 1981 to 2018. we analyse the autumn season (September, October and November; SON), and, thus 4 initialization months (May, June, July, August) which span over the SON months are used. The events for the seasonal 3-day maximum precipitation values are used. This yields 100 seasonal weather realizations for each year between 1981 and 2018, in total 3800 weather realizations representing the current climate.

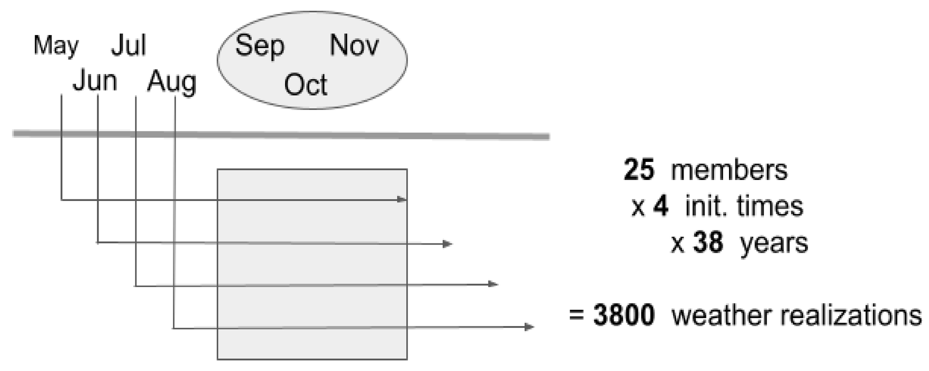


Figure 2: Illustration of how members and initialization times are selected and retrieved from SEAS5, a seasonal ensemble prediction system with a horizontal resolution of ~35x35 km.

Method and analysis: reparameterization of the GEV distribution

- We reparameterize the GEV distribution by using the median as a parameter insted of the location parameter
- To reduce the dependency between the parameters, we transform the scale parameter to a new transformed scale parameter
- This reparameterization is sometimes referred to as the growth curve, which only depends on two parameters; the transformed scale and the shape, and determines the tail behaviour of the distribution. The growth curve is combined with the median to express the return value.
- Here, we investigate combining the spatially detailed information in seNorge to estimate the bulk of the distribution and the longer SEAS5 data series to estimate the tail behavior. This can be done in two ways:
  - an independent estimation of the median parameter η based on the seNorge data and the growth curve based on the SEAS5 data
  - estimating the shape parameter ξ based on the SEAS5 data, while the location and scale are estimated based on the seNorge data

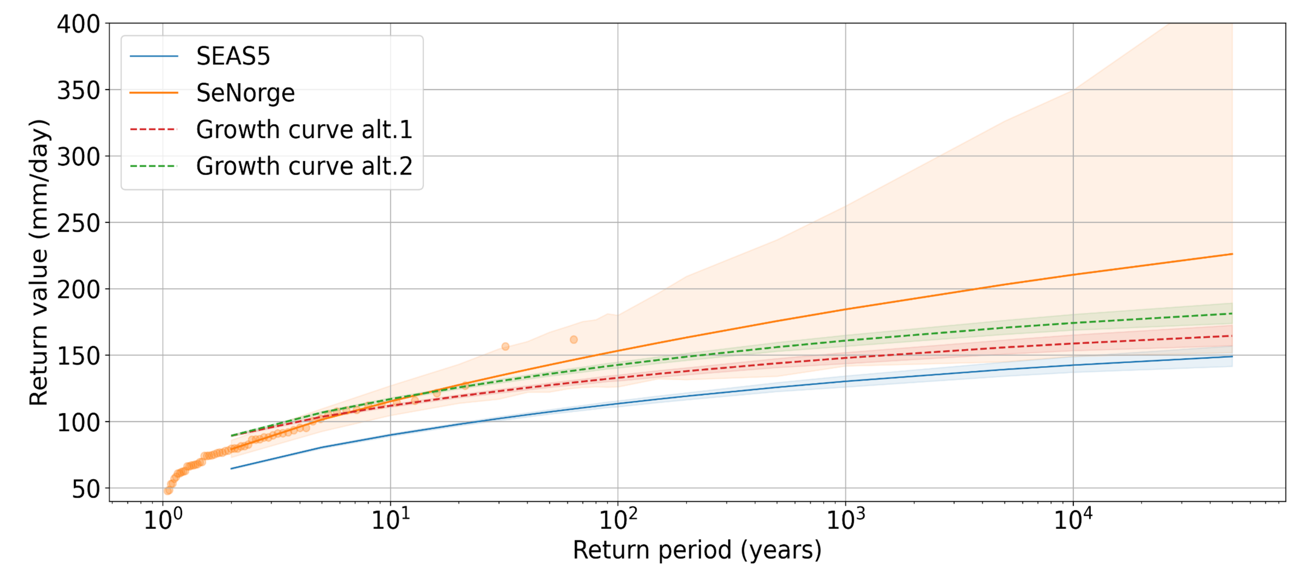
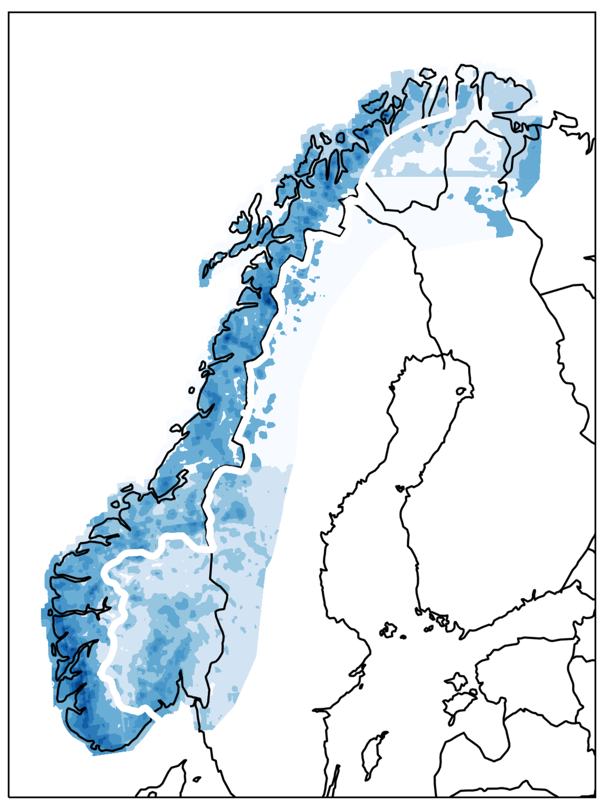


Figure 3: 3-day precipitation maximum in September-October-November at a point on the North West coast of Norway from SEAS5 in blue and seNorge in orange fitted to the Generalised Extreme Value (GEV) distribution. Shaded areas indicate the 95th confidence interval.



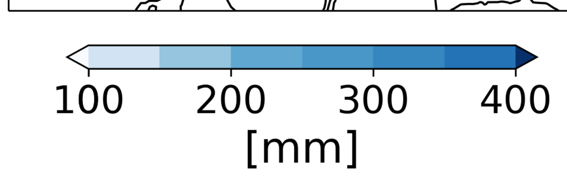


Figure 4: The 50 000 year return value from the re-parameterized GEV, where shape (ξ) is from the SEAS5 data set, while the median (η) and scale (σ) are from seNorge. The white line indicates the boundary between regions dominated by large scale and convective precipitation.

Results

- The new return value estimates are considered to be more robust than previous calculated estimates, due to the inherited small confidence interval from SEAS5.
- Due to the robust estimate of the shape parameter based on the large sample size in SEAS5, we are able to calculate return value estimates for return periods reaching the level of PMP.
- PMP are point estimates, and spatial consistency is not guaranteed, in contrast to the new spatially consistent approach.
- The fraction between the estimates (in the left panel in Figure 5) normalized to the normal precipitation sum for SON, indicate that the differences between the estimates are connected to the climatology.

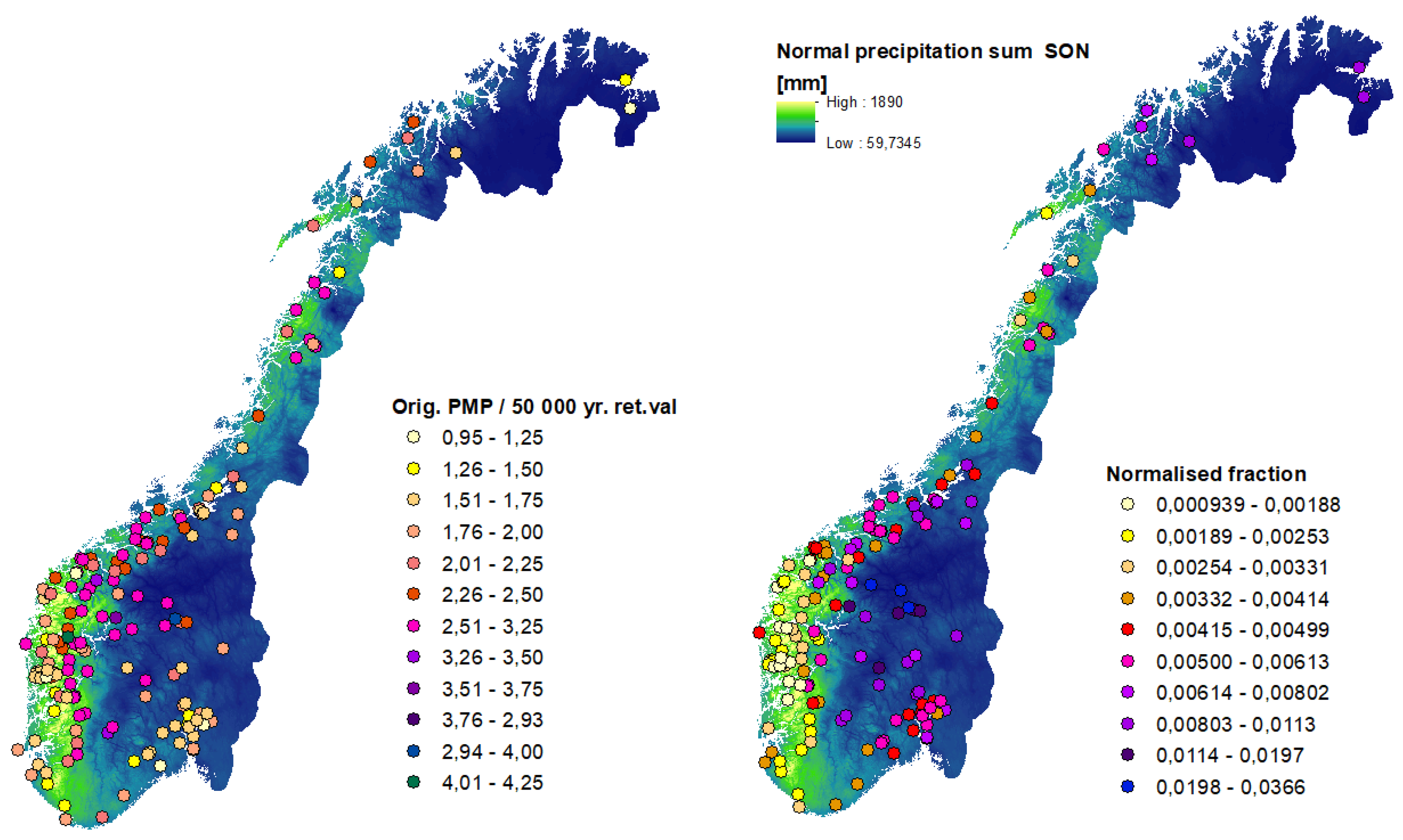


Figure 5: Left panel: A comparison of original PMP estimates and the new estimated return values shown as a fraction between the original PMP and the 50 000 year return value for points in Norway. Both the original PMP values and the return values are for 72 hours duration, in September-October-November. Right panel: The fraction showed in the left panel normalised to the normal seasonal (SON) precipitation sum. The normal period 1991-2020 is used.

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