UNSEEN-trends

1. Using hindcasts, we can generate 100 ‘alternate realities’ of the last 35 years

2. We can do this because the forecasts are **independent** and **stable** over lead times

3. Our results **highlight the strength** of UNSEEN-trends in **quantifying and explaining** rare climate extremes

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Introduction

Climate change **intensifies** the hydrological cycle

Understanding past changes in extreme events **is critical**

Analysis is **limited** by the **brevity and sparsity** of observations

Ensemble approaches **boost** the sample size and have **global coverage**

A recent flood near Loughborough.

Ensemble Approaches

Because **weather is stochastic**, the observed record is only a **single occurrence** out of the many that could have happened

Archived weather forecasts (hindcasts) can be used as '**alternative realities**' – different versions of the past (Brink, 2004; 2005)

Called **UNSEEN:** UNprecedented Simulated Extreme Ensemble – see the UK Met Office infographic or YouTube video

Research framing

UNSEEN has **reduced uncertainty** in estimates of storm surge levels[1,2], global ocean wind and wave extremes[3,4,5], and losses from windstorms[6,7]

UNSEEN enhances food security through better drought exposure estimates[8,9] and helped policy makers by **anticipating unprecedented extremes**, such as floods in the UK[10] and heatwaves in China[11]

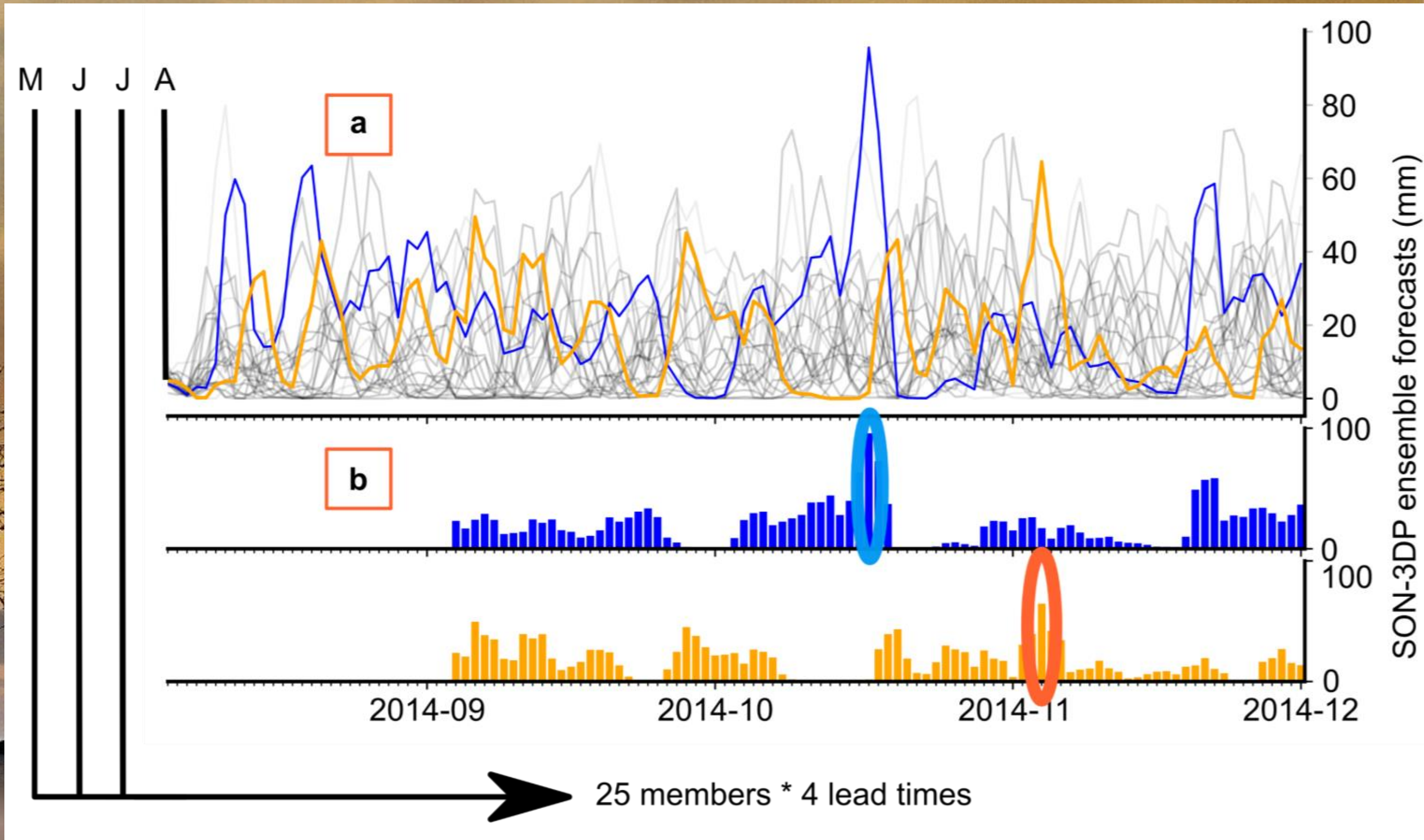
Gap: UNSEEN has not yet been applied to **detect trends** in climate extremes over the last decades

RQ: How have 100-year extremes changed over the last 35 years?

UNSEEN data

Case study: Norway and Svalbard extreme precipitation, but the **approach is transferable** globally also to other climate variables!

We pool **25-member** seasonal forecasts and **four lead times** (ECMWF SEAS5) to **boost** the sample size



Generating the UNSEEN ensemble. a, August 2014 initialized 25-member seasonal forecasts of spatial averaged 3-day precipitation time series over the September-November (SON) forecast horizon. Ensemble members 0 and 1 are shown in blue and orange, respectively. **b**, From the forecast members 0 and 1, the SON maximum value for the 2014 season is selected. This process is repeated for all members and lead times. The initialization months May-August (MJJA) are indicated in the top left.

Pooling justification

1. *Independence (i.e. is each event **unique**?)*:

   In these regions, precipitation has low predictability after two weeks -> we removed the first month of the forecasts

2. *Model stability*:

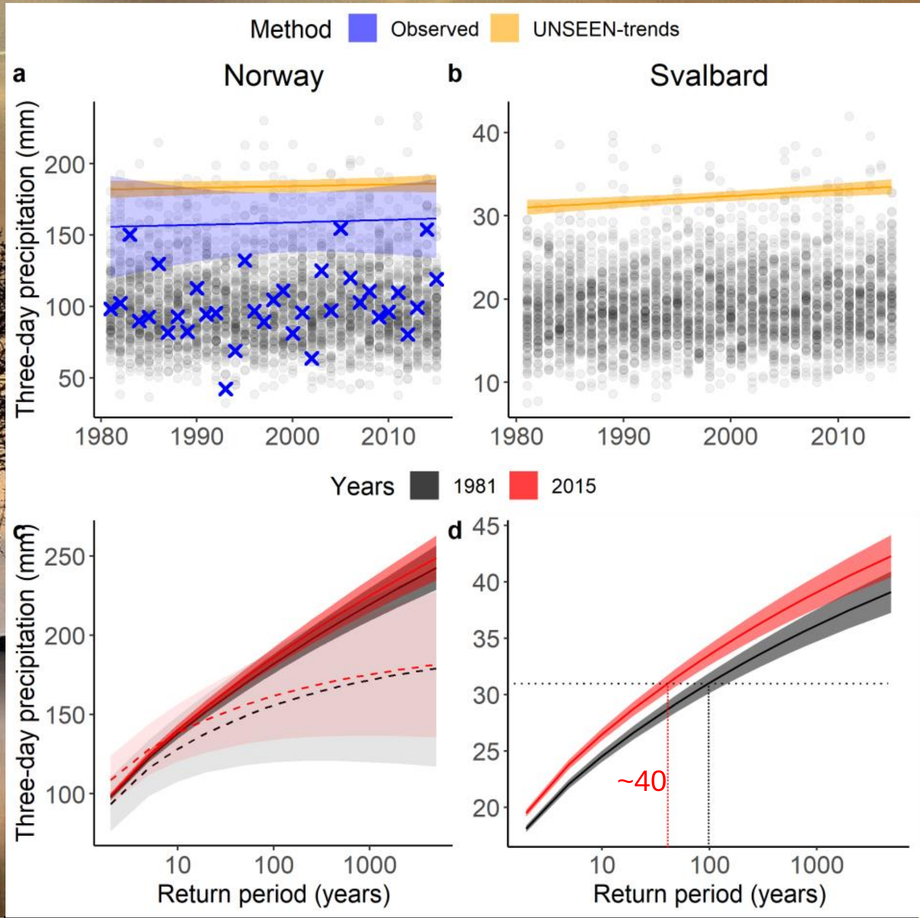
   We do not find a difference in the 3-day Autumn extreme **precipitation distribution** between different lead times

Results: UNSEEN-trends

Norway: large reduction in uncertainty compared to observed

Observed: 4%
(−27% to 34%)

UNSEEN-trend: 2%
(−3% to 7%)



Svalbard: trend could not be constrained before

UNSEEN-trend: 8%
(4% to 12%)

100-year event in 1981 -> 40 years in 2015

a,b, The change in 100-year autumn maximum spatial averaged 3-day precipitation over 1981-2015 is shown for (a) Western Norway and (b) Svalbard. The data points show the events in the observed record (blue crosses) and in the UNSEEN-ensemble (black circles). Note, for Svalbard no gridded precipitation record is available.

Unseen-trends in extreme precipitation, as compared to trend analysis based on the precipitation record.

Method**:** GEV distribution including time covariate.

c,d, In addition to the change in 100-year precipitation, the entire GEV distribution is plotted for the covariates 1981 and 2015 over (c) Western Norway and (d) Svalbard. Solid lines and dark shading indicate the trend and uncertainty of the UNSEEN-trends approach and dashed lines with light shading (in c) indicates the trend and uncertainty range based on observations.

Take home message

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