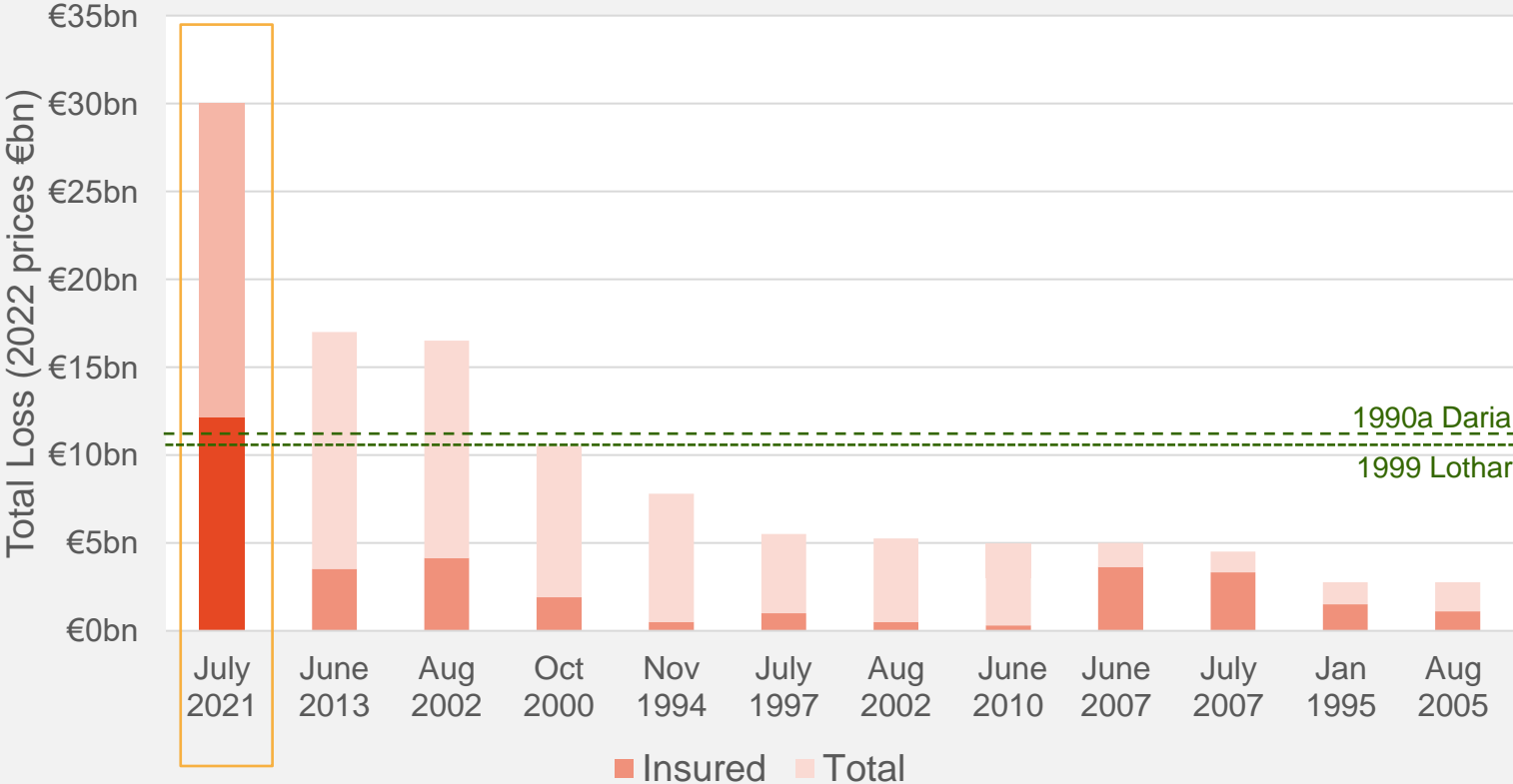# Return periods for extreme events

Tim Edwards BSc ACII CCRMP
June 15th

'Bernd' was the largest insured loss event for 30+ years but what RP was this?
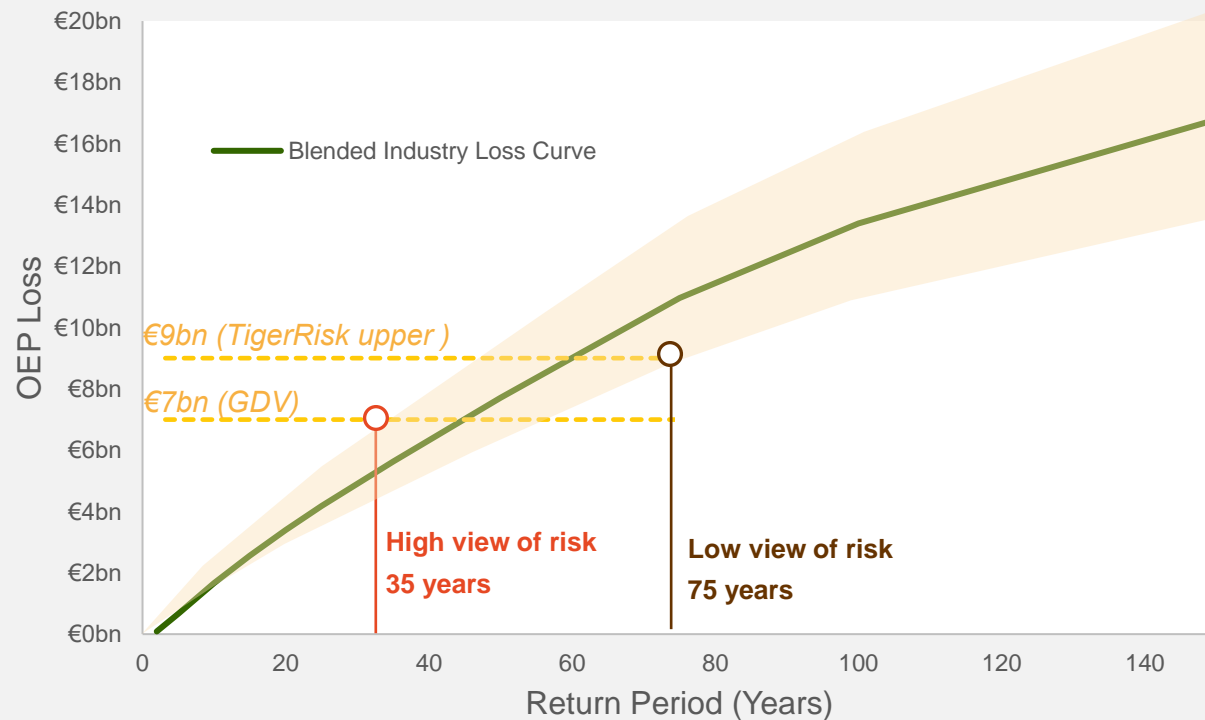

An empirical analysis framework

- July 2021 'Bernd' is the largest insured flood event since the 1990's, when expressed in terms of 2021 prices.

- **Significant non-stationary impacts to consider** when referring to historical events: exposure change, insurance market terms and changes to flood hydrology and run-off conditions all need to be taken into account when indexing losses.

2021 'Bernd' floods were the largest European flood event in 30+ years:

Insured and total losses, source: Swiss Re, CRESTA Clix, Munich Re Nat Cat Service

The challenge in **estimating loss return periods** – *its importance in reinsurance pricing*
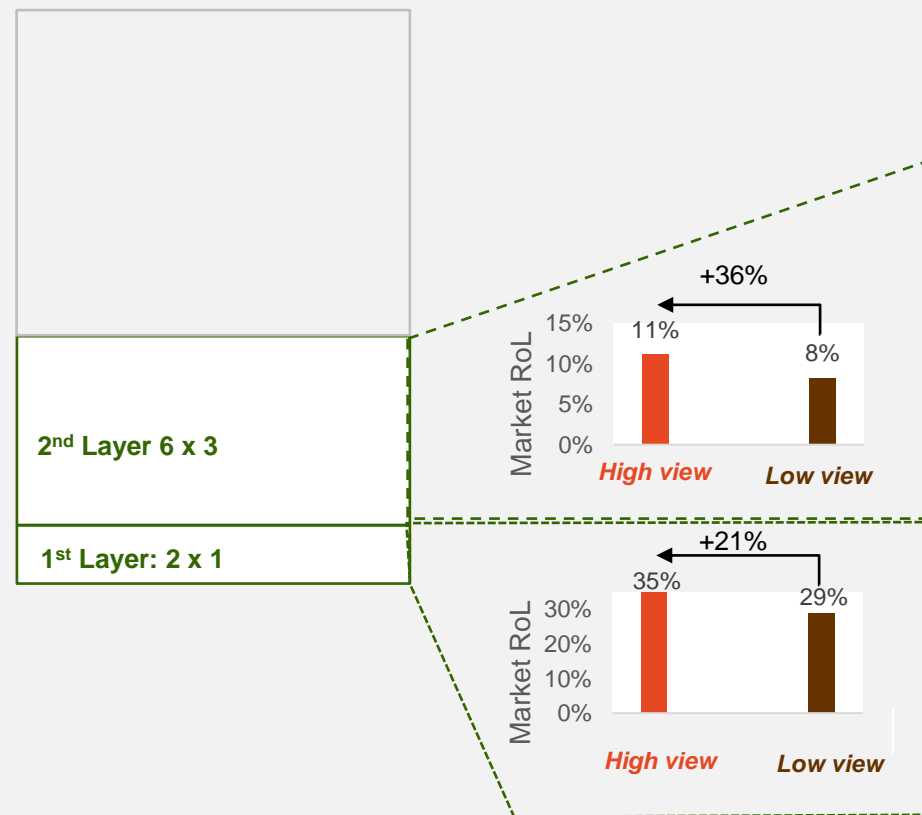
Loss into second or third layers – 35 to 75 years is a potential loss return period for the industry

€9bn (TigerRisk upper)

€7bn (GDV)

Blended Industry Loss Curve

High view of risk
35 years

Low view of risk
75 years

OEP Loss

Return Period (Years)

A wide range of loss return periods are being discussed in the market – there is a significant price impact from adopting the upper or lower range of these.
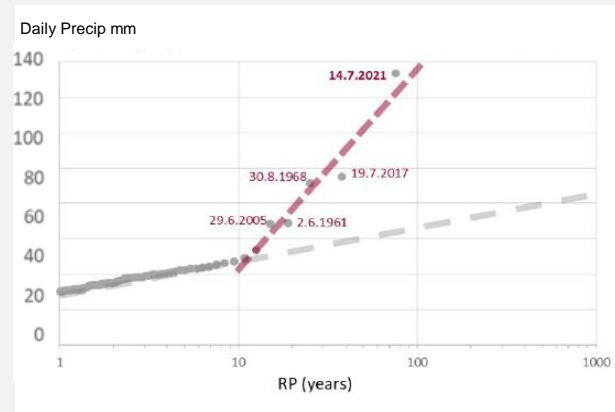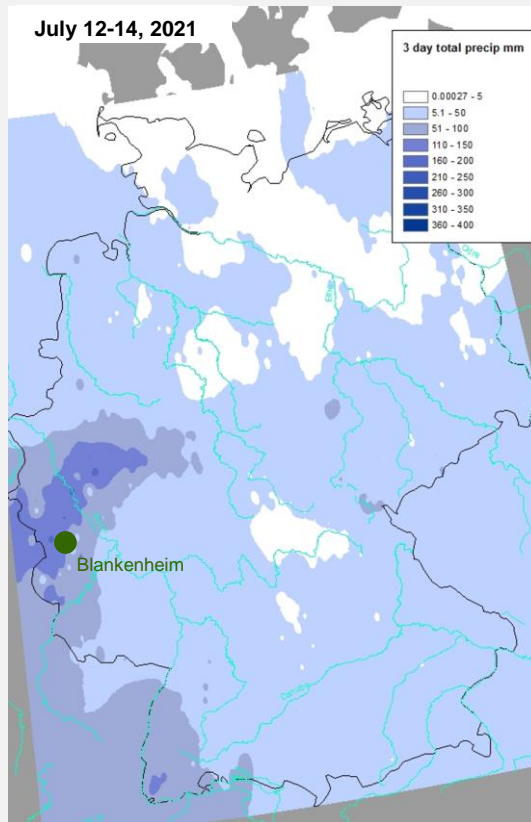
2021 'Bernd' insured losses in Germany between a 35 and 75 loss return period.

That the risk is being re-assessed impacts pricing – changes to the technical view could have a material change in pricing

2nd Layer 6 x 3

1st Layer: 2 x 1

+36%

Market RoL

11%

8%

High view   *Low view*

+21%

Market RoL

35%

29%

High view   *Low view*

TigerRisk® 3

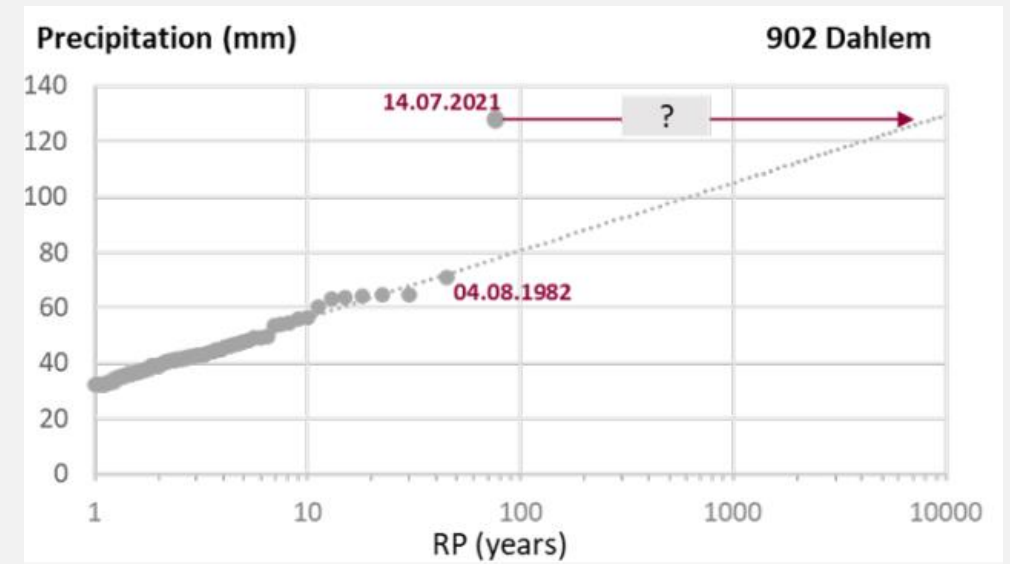# Rainfall from 'Bernd' – frequentist approaches to *hazard* return period estimation

Here a frequentist representation of extreme local rainfall not seen in history, for that region, 1.8 times higher than previous levels seen in 1982.

And a **variation of the frequentist approach using logarithmic** divided abscissa (X axis) grouped around a logarithmic compensation line

July 12-14, 2021

3 day total precip mm
- 0.00027 - 5
- 5.1 - 50
- 51 - 100
- 110 - 150
- 160 - 200
- 210 - 250
- 260 - 300
- 310 - 350
- 360 - 400

Blankenheim

Daily Precip mm

14.7.2021
30.8.1968   19.7.2017
29.6.2005   2.6.1961

Date	Daily Precip	Empirical RP
14/07/2021	129.2	?
04/08/1982	70.8	45
06/10/1988	64.5	30
04/11/1940	64.4	22.5
04/07/1937	64.1	18
27/09/2007	63.7	15
01/07/1942	63	12.9
24/07/1947	60	11.3
29/05/1956	56.5	10

2021 'Bernd' floods peak rainfall: 3 day total precipitation in mm (data:https://cdc.dwd.de/portal/202204011005/mapview).

Precipitation (mm)   902 Dahlem

14.07.2021   ?

04.08.1982

RP (years)

The probability of a 10,000-year event occurring during the 90-year observation period is less than 1 percent – is this credible?

TiGERRISK® 4

Frequentist approaches are of limited use – *we also need* *physically based cat models*

2 separate flood perils? - Summer vs Winter rainfall climatology, evidence suggests summer events may be more intense. Mann, M., Rahmstorf, S., Kornhuber, K. et al. Influence of Anthropogenic Climate Change on Planetary Wave Resonance and Extreme Weather Events. Sci Rep 7, 45242 (2017).
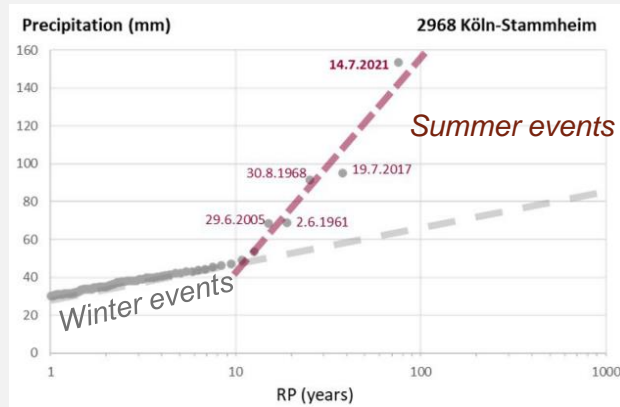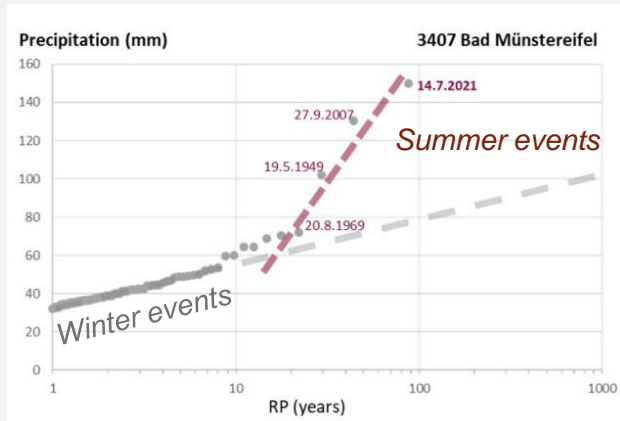
Historical rainfall return periods using empirical frequencies (ie not modelled): Frequency analyses of daily precipitation at the stations Bad Münstereifel and Köln-Stammheim (DWD data). Source: KA Köln.Assekuranz Agentur, 2021

Catastrophe models are required to capture all the potential climate regimes, their unique frequency-severity distributions
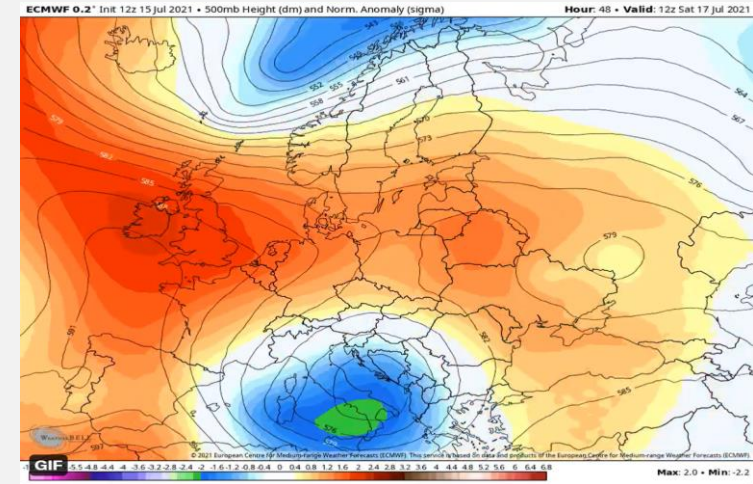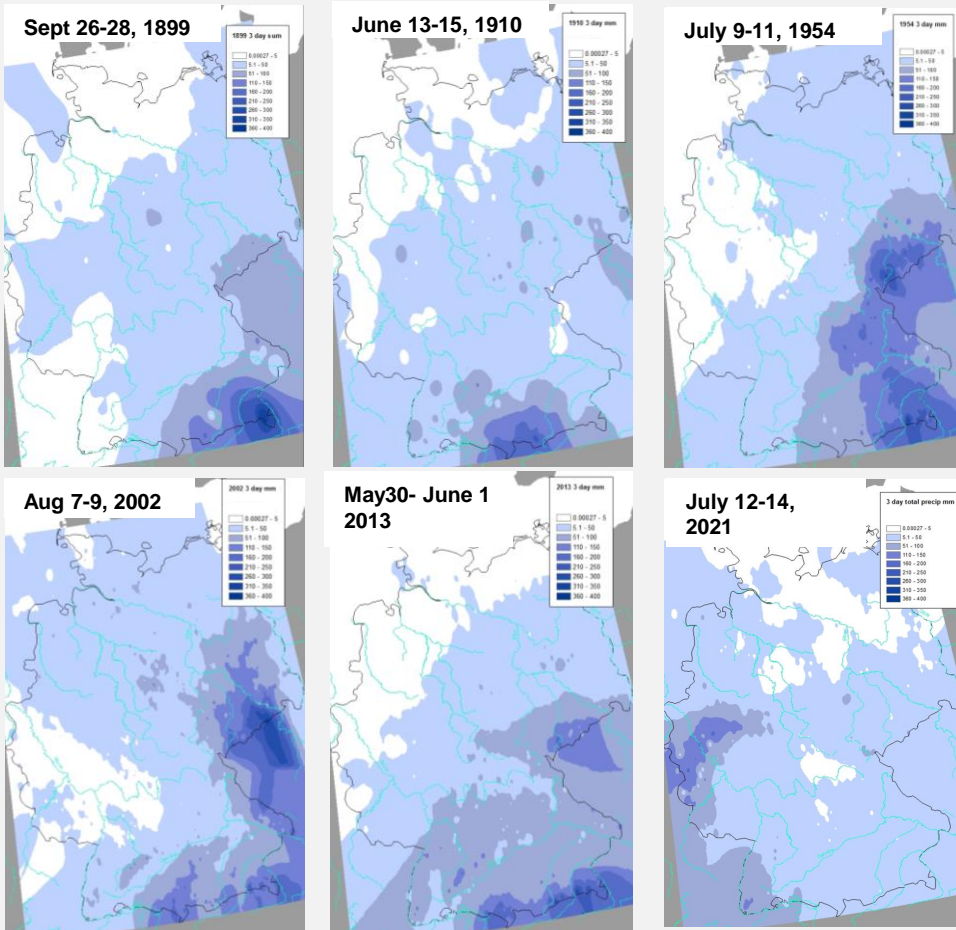

Severe blocking from an anomalous wavy jet stream resulted in a cut off low over Central Europe south of a bridged ridging situation. This occurred for the 2002 event, also.
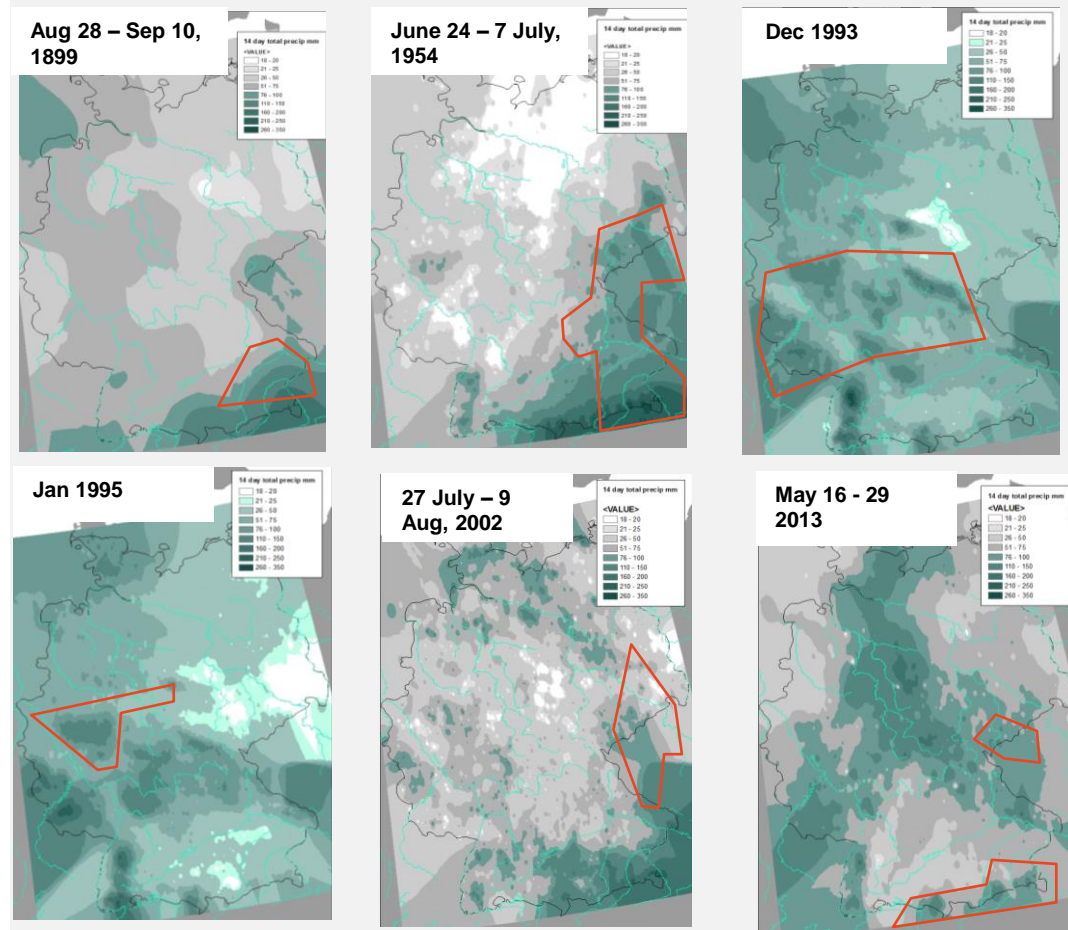
500mb height (dm) and norm anomaly (sigma) Jeff Berardelli WFLA-TV (Tampa Bay) Chief Meteorologist and Climate Specialist

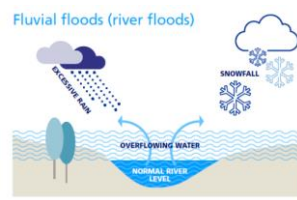# An example of an *empirical physically derived cat model* for rainfall

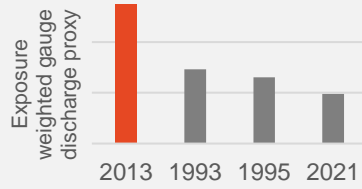## Comparing daily rainfall amounts to other events in history

Sept 26-28, 1899

June 13-15, 1910

July 9-11, 1954

Aug 7-9, 2002

May30- June 1 2013

July 12-14, 2021

A comparison to antecedent conditions from other events

Aug 28 – Sep 10, 1899

June 24 – 7 July, 1954

Dec 1993

Jan 1995

27 July – 9 Aug, 2002

May 16 - 29 2013

And a **model for river discharge**

Fluvial floods (river floods)

May30- June 1 2013

Dec 1993
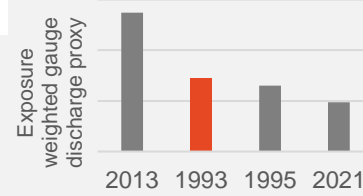
Jan 1995

July 12-14, 2021

100 tp 250 year RP flow
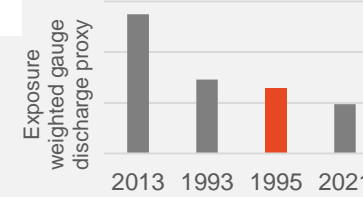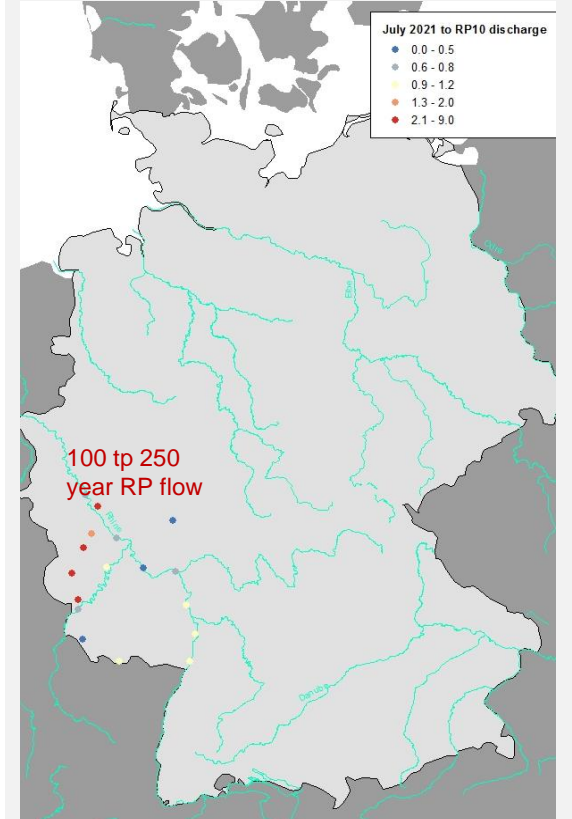
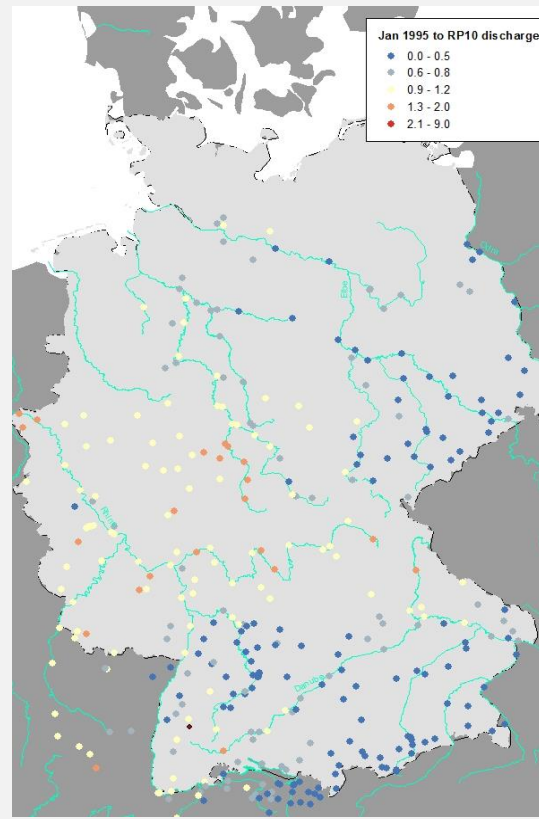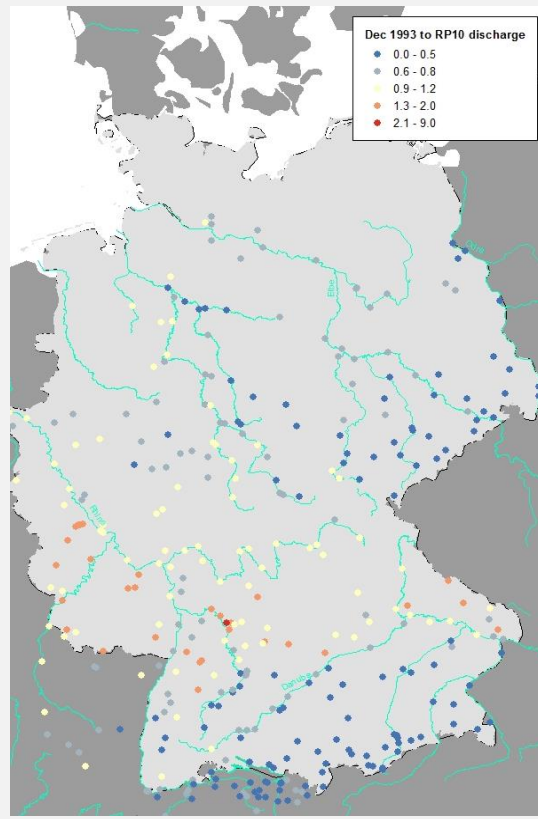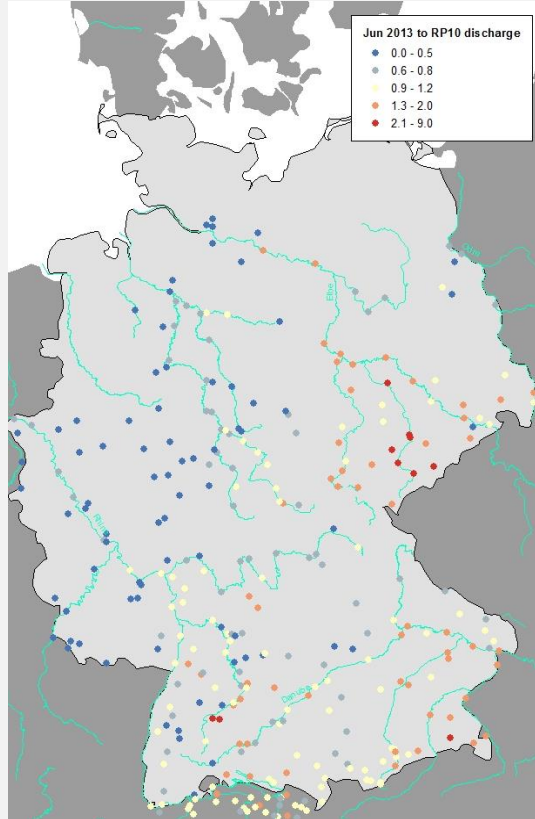***Exposure weighted river discharge index:*** *peak monthly discharge relative to 10 year RP discharge (above), this ratio squared weighted by exposure shown (top). (Source data: German Federal Waterways and Shipping Administration (WSV), German Federal Institute of Hydrology (BfG))*
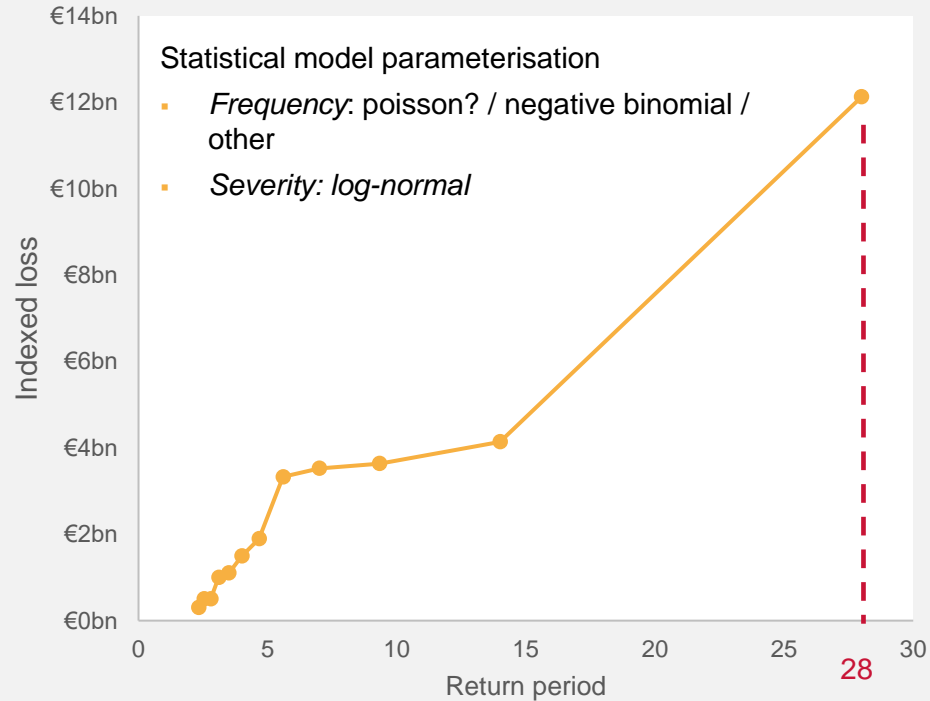
Largest loss proxy

The river discharge index suggests the 2021 Bernd flood was the fourth largest 'river flood' loss event in 70+ years

Smallest loss proxy

Contrasting a Frequentist vs Bayesian loss model for use in pricing and capital setting

Frequentist

Statistical model parameterisation
- *Frequency*: poisson? / negative binomial / other
- *Severity: log-normal*

A simple loss ranking gives a 1 in 28 year loss return period

Bayesian

Proxy loss index in Germany shows Bernd was ~ 1 in 45 year event for the industry insured loss