# TRENDS IN WEATHER RELATED LOSS EVENTS – INCREASING EVIDENCE OF A CONTRIBUTION OF GLOBAL WARMING

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ECSS 2011, OCTOBER 6, 2011, PALMA DE MALLORCA

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## Munich Re

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- Founded 1880
- The largest reinsurance company
- Annual premium ca. € 25 bn
- Leading role in covering risks of natural hazards
- Since 1974 scientific analyses of natural perils

# World Economic Forum 2011

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Economic risks
Geopolitical risks
Environmental risks
Societal risks
Technological risks

- Survey of 580 leaders and decision makers across the globe
- Supported by 18 workshops
- Assessment of 37 global risks for the next 10 year period

# 2010 one of the warmest years since 1880

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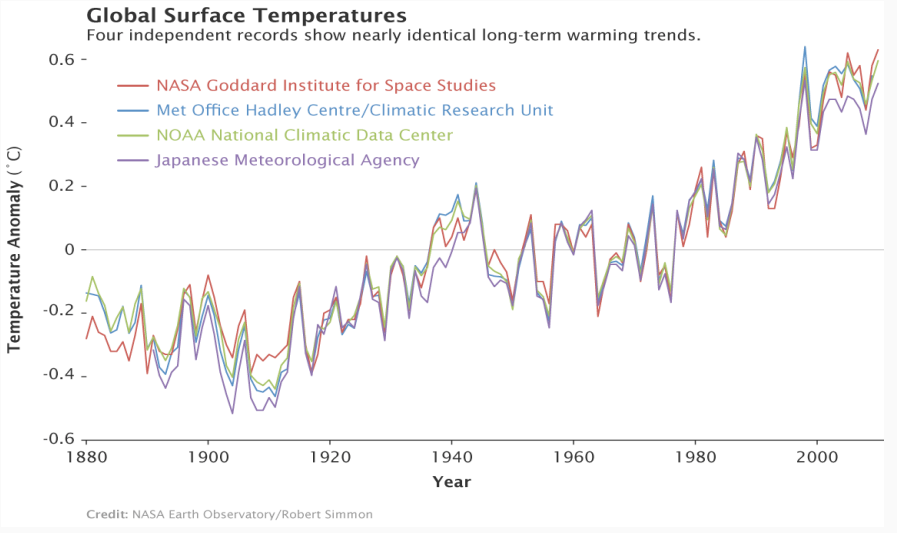

## 2011 a year with extremely low arctic sea ice extent

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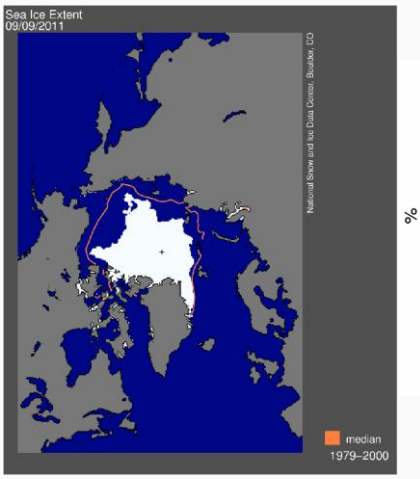


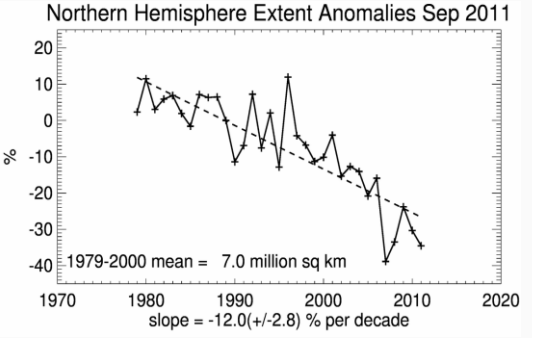


Source: The National Snow and Ice Data Center, Boulder CO (2011)

## Observed changes in sea surface temperature in tropical ocean basins with TC activity

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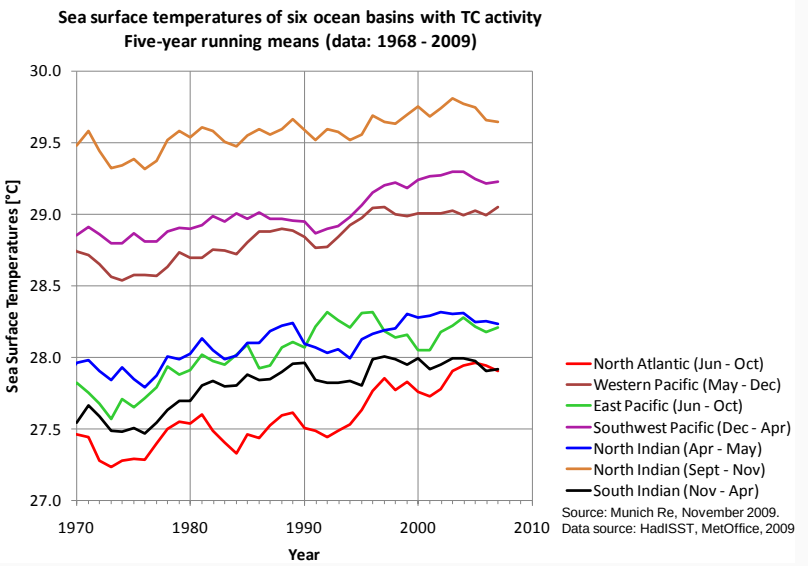

## Munich Re NatCatSERVICE – The most comprehensive database of natural loss events

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| Year | Number of data sets |
|---|---|
| 0079 - 999 | 35 |
| 1000 - 1499 | 200 |
| 1500 - 1899 | 1 000 |
| 1900 - 1949 | 1 200 |
| 1950 - 1979 | 2 900 |
| 1980 - 2010 | 23 900 |

**29,000 data sets**



## 960 loss relevant events in 2010

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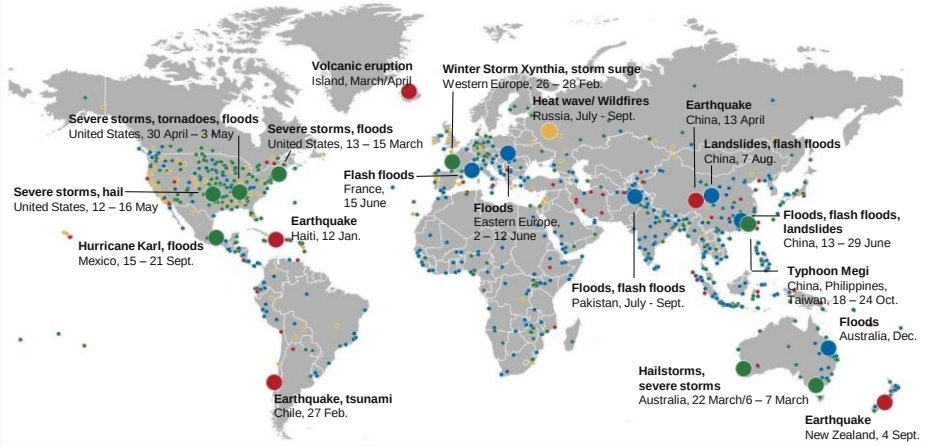


- **Natural catastrophes**
- **Selection of significant loss events (see table)**
- **Geophysical events** (earthquake, tsunami, volcanic activity)
- **Meteorological events** (storm)
- **Hydrological events** (flood, mass movement)
- **Climatological events** (extreme temperature, drought, wildfire)

# Floods, Queensland, Australia
## December 2010 to January 2011

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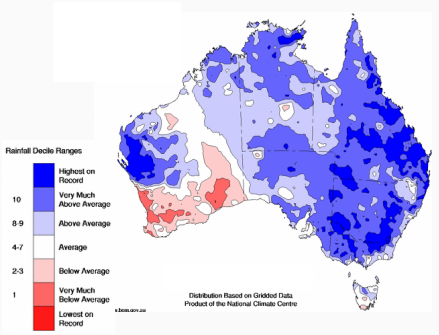
Australia rainfall anomalies (Oct-Dec 2010)




Reuters

| Region | Overall losses | Insured losses | Fatalities |
|---|---|---|---|
| Queensland, Australia | US$ 7,800m | US$ 2,570m | 29 |



# Queensland floods – is there a link to climate change?

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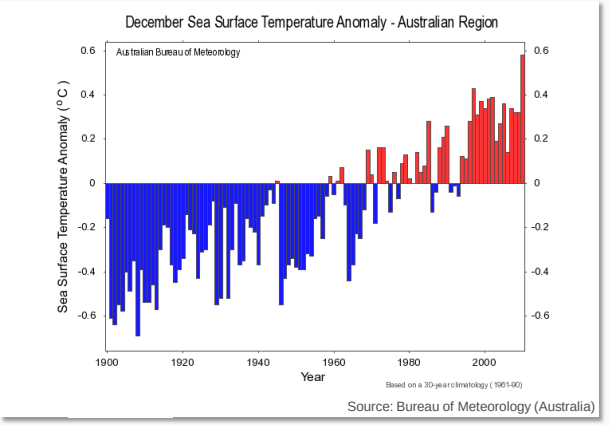



Source: Bureau of Meteorology (Australia)

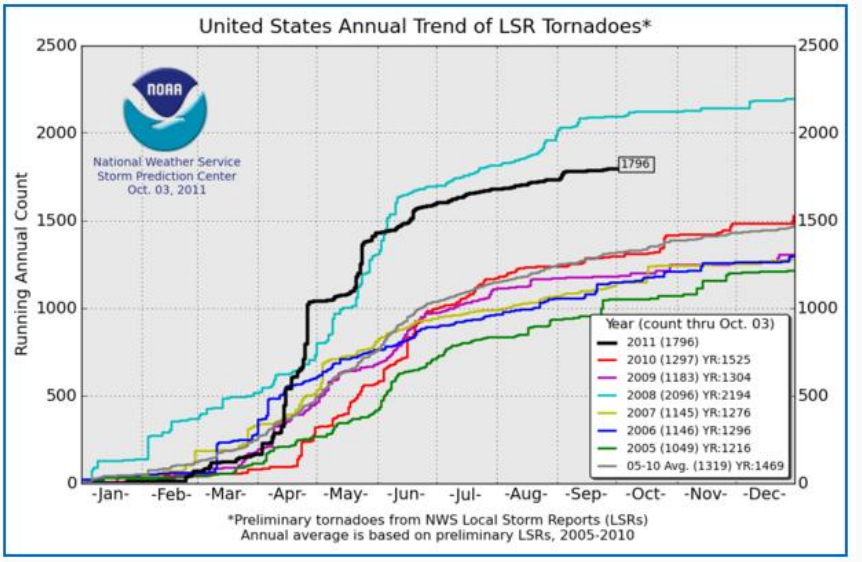
- December sea surface temperature in the Australian region has been the highest on record
- There is a relation between precipitation and the sea surface temperature in Australia

**Sea surface temperature is rising due to climate change**



Source: RAHMSTORF, S. (2011): Überschwemmungen in Queensland. WISSENSlogs.de

## 2011 U.S. Tornado Count



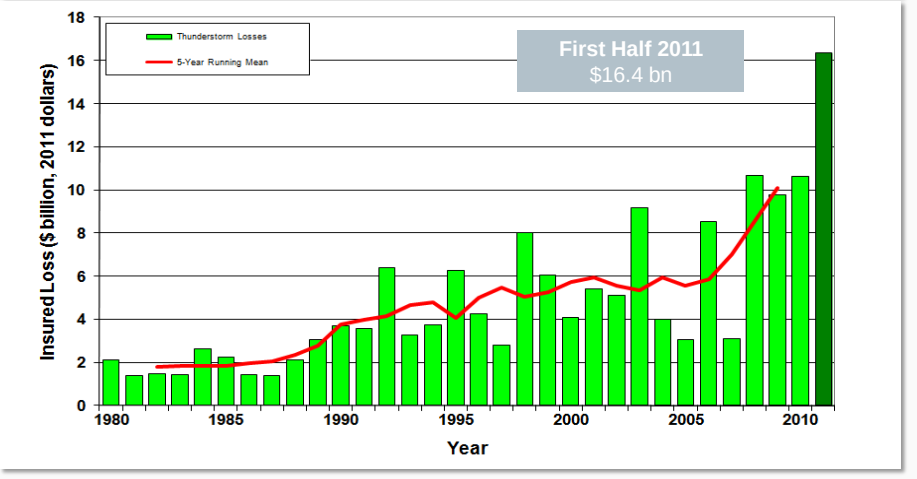






## U.S. Thunderstorm Loss Trends
## Annual Totals 1980 – 2010 vs. First Half 2011

Average thunderstorm losses have increased fivefold since 1980.

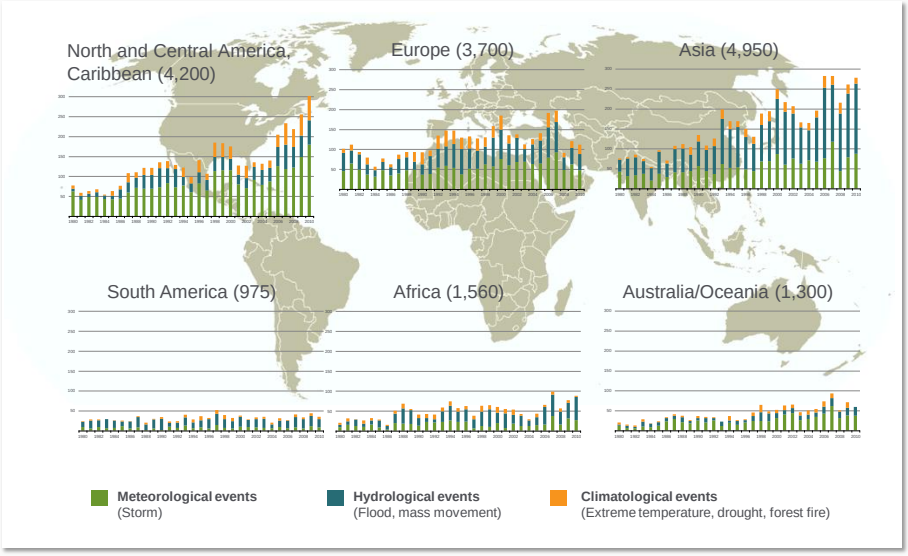



Source: Property Claims Service
MR NatCat*SERVICE*

NatCatSERVICE

## Weather catastrophes worldwide, 1980 – 2010

Number of weather-related events per continent

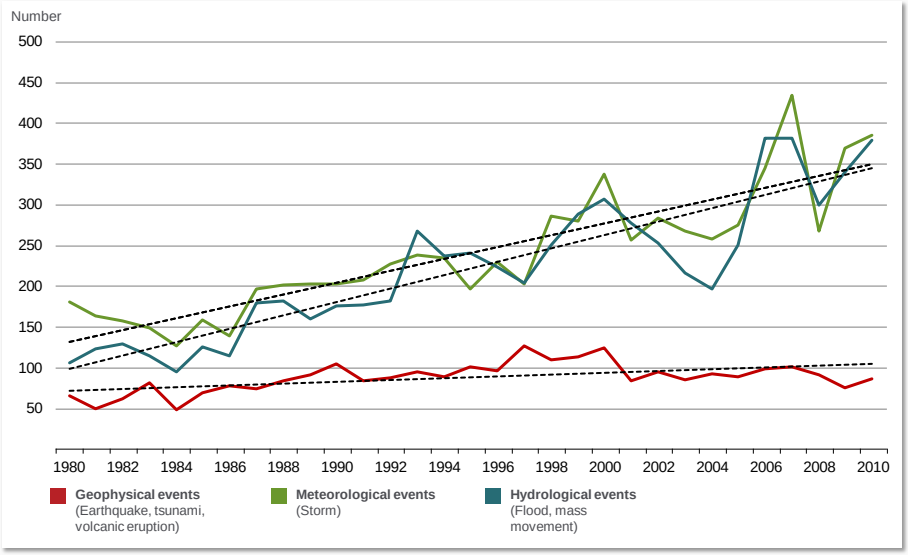





NatCatSERVICE

## Natural catastrophes worldwide, 1980 – 2010

Number of events by peril with trend



## Climate change and extreme weather events (IPCC, 2007)

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| Phenomenon[a] and direction of trend | Likelihood that trend occurred in late 20th century (typically post 1960) | Likelihood of a human contribution to observed trend[b] | Likelihood of future trends based on projections for 21st century using SRES scenarios |
|---|---|---|---|
| Warmer and fewer cold days and nights over most land areas | *Very likely*[c] | *Likely*[d] | *Virtually certain*[d] |
| Warmer and more frequent hot days and nights over most land areas | *Very likely*[e] | *Likely (nights)*[d] | *Virtually certain*[d] |
| Warm spells/heat waves. Frequency increases over most land areas | *Likely* | *More likely than not*[f] | *Very likely* |
| Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas | *Likely* | *More likely than not*[f] | *Very likely* |
| Area affected by droughts increases | *Likely* in many regions since 1970s | *More likely than not* | *Likely* |
| Intense tropical cyclone activity increases | *Likely* in some regions since 1970 | *More likely than not*[f] | *Likely* |
| Increased incidence of extreme high sea level (excludes tsunamis)[g] | *Likely* | *More likely than not*[f,h] | *Likely*[i] |

very likely > 90% likely >66% more likely than not > 50%



## New studies show causal associations between climate change and weather extremes

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Human contribution to more-intense precipitation extremes

Seung-Ki Min, Xuebin Zhang, Francis W. Zwiers & Gabriele C. Hegerl

Affiliations | Contributions | Corresponding authors

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Published online 16 February 2011 | *Nature* **470**, 316 (2011) | doi:10.1038/470316a

News

### Increased flood risk linked to global warming

**Likelihood of extreme rainfall may have been doubled by rising greenhouse-gas levels.**

Quirin Schiermeier

The effects of severe weather — such as these floods in Albania — take a huge human and financial toll. REUTERS/A. CELI

Climate change may be hitting home. Rises in global average temperature are remote from most people's experience, but two studies in this week's *Nature*[1,2] conclude that climate warming is already causing extreme weather events that affect the lives of millions. The research directly links rising greenhouse-gas levels with the growing intensity of rain and snow in the Northern Hemisphere, and the increased risk of flooding in the United Kingdom.

"… Here we show that human-induced increases in greenhouse gases have contributed to the observed intensification of heavy precipitation events found over approximately two-thirds of data-covered parts of Northern Hemisphere land areas. ..Changes in extreme precipitation projected by models and thus the impacts of future changes in extreme precipitation, may be underestimated because models seem to underestimate the observed increase in heavy precipitation with warming".

## Normalisation of nat cat losses

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- Normalisation accounts for the fact that population and wealth per capita increases over time and that past disasters would have caused more damage if they occurred nowadays
- Increasing trend of normalised damages could point in the direction that anthropogenic climatic changes may be the driving force

## Normalised overall and insured losses from US thunderstorms All events

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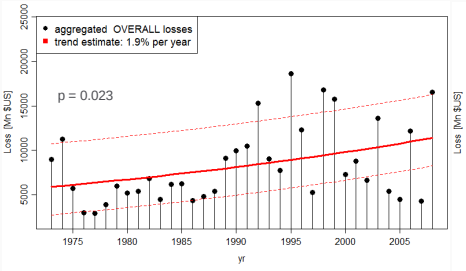
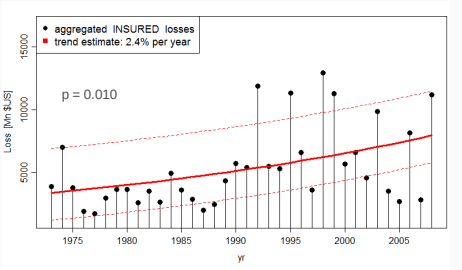
**Overall losses**

Normalised overall losses: **all events**
Wealth proxy: **housing stock**
Estimated Trend: **1.9% p.a.**




**Insured losses**

Normalised insured losses: **all events**
Wealth proxy: **housing stock**
Estimated Trend: **2.4% p.a.**



## Current study* on link between increasing convective losses and changes in the convective potential

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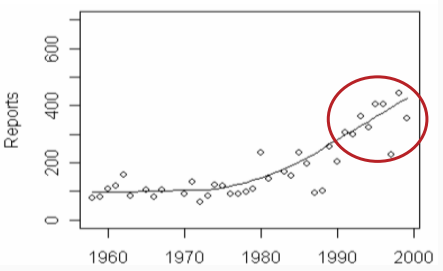
There has been an increase in normalized economic and insured losses caused by convective events in the US.

➔ Are these increases associated with corresponding changes in the physical environment like frequency or intensity of thunderstorm events?




Annual number of US hail reports (hail ≥ 7 cm in diameter)

Source: Brooks & Dotzek (2008)

*Collaboration between German Aerospace Center (DLR) and Munich Re.
Work in progress. to be published by J. Sander et al., soon.

## Convective Parameters

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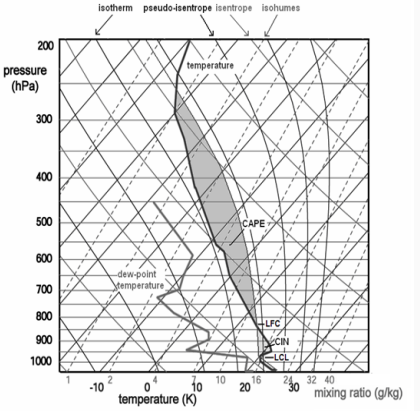


$$w_{max} = \sqrt{2 \cdot CAPE}$$

CAPE = Convective Available Potential Energy
DLS = Deep-layer windshear

**T**hunderstorm **S**everity **P**otential

$TSP = w_{max} \times DLS$

**(Sander 2011)**

Work in progress by J. Sander, 2011

## Current study* on link between increasing convective losses and changes in the convective potential

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**Stanley A. Changnon** on causes for increasing major hail losses in the U.S.:
„*First, would be more frequent occurrences of major cases of strong atmospheric instability… However, this has not been measured and cannot be verified.*“
(Climatic Change 96, 2009:161-166)

→ This study investigates the driver of increasing losses by identifying a link between the change in normalised US thunderstorm-related losses and a corresponding change in a relevant parameter of meteorological observation (“fingerprint“-approach).

*Collaboration between German Aerospace Center (DLR) and Munich Re.
Work in progress. to be published by J. Sander et al.

## Data and Methods

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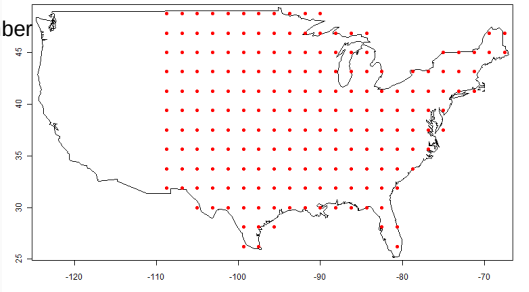
**NCAR/NCEP Reanalysis data:**
- Focus on domain east of the Rockies.
-Spatial resolution: 1.8° x 1.8°
- Integration over 28 vertical layers
- Temporal resolution: 6 hours
- Focus on months: March to September
- Period of investigation: 1970-2009




Two datasets:
- NCEP-TSP-values on each gridpoint (red dots)
- NatCat severe convection event (lat, lon, date, insured loss)

Work in progress by J. Sander et al., Munich Re / DLR, 2011

## Results

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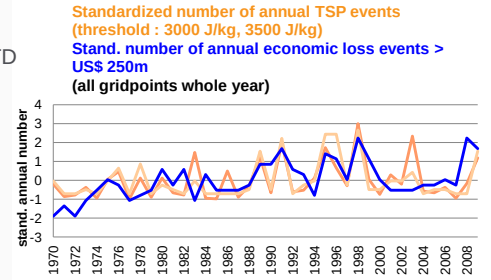
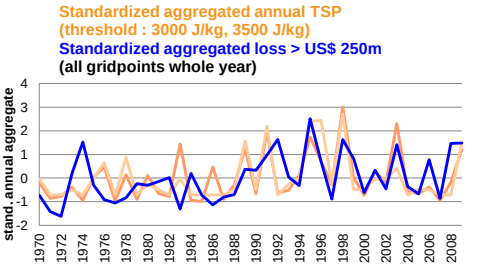
Standardisation:
(value – mean)/STD




Work in progress by J. Sander, J. Eichner and E. Faust, Munich Re / DLR, 2011.

## Conclusion of first results

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There is a suggestion that meteorological changes have contributed to the increased convective losses as there has been an observable increase in severe-thunderstorm forcing.

The “fingerprint” of the meteorological signal of change is very likely reflected within the loss signal. Hence the normalisation procedure is sensitive enough to reflect the climate signal.

**Outlook:**

We will have a closer look at the inter-annual variability and volatility, as well as we will investigate other areas in the world.

We are already reproducing this study by using different reanalysis datasets to underline our results.

## Evaluating the economics of climate risks & opportunities in the insurance sector

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Collaboration between Munich Re and the London School of Economics


**Trend analysis of normalised insured damage from natural disasters**
First study of this kind!
Paper submitted to „Climatic Change“ by Fabian Barthel and Eric Neumayer, LSE, London

**Normalisation by insurance premiums**
Insurance premiums used: subset of property and engineering premiums plus motor physical damage, which are affected by natural disasters

## Normalised insured losses of non-geophysical disasters in the U.S.

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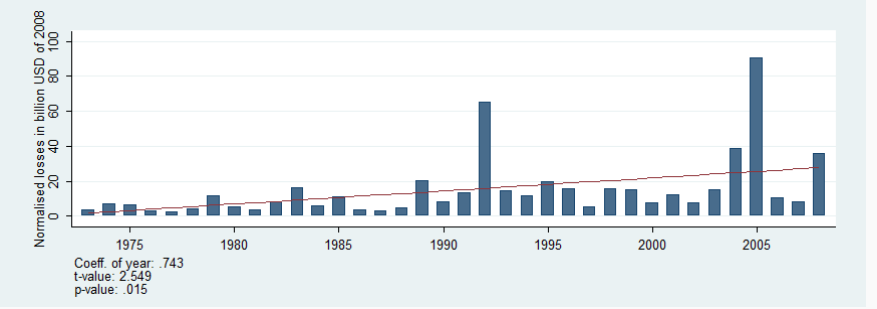

## Normalised insured losses from convective events in the United States

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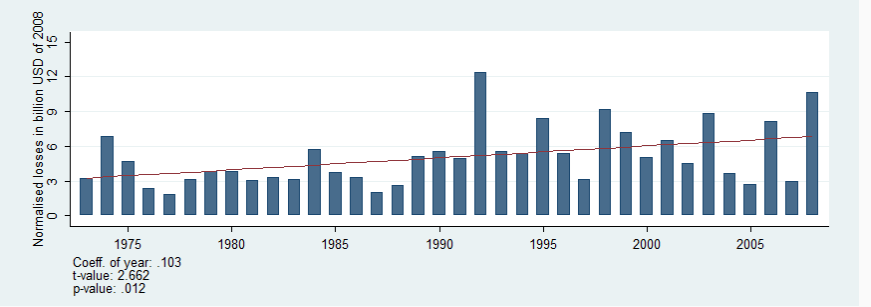


## Normalised insured losses from hurricanes in the United States

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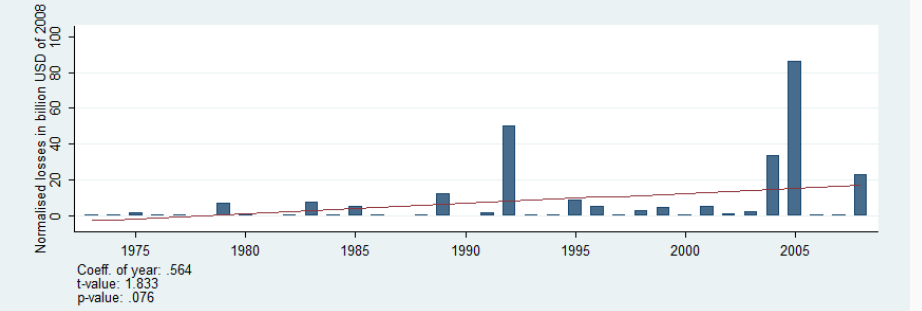

## New GDV-study on future nat cat losses based on climate modelling

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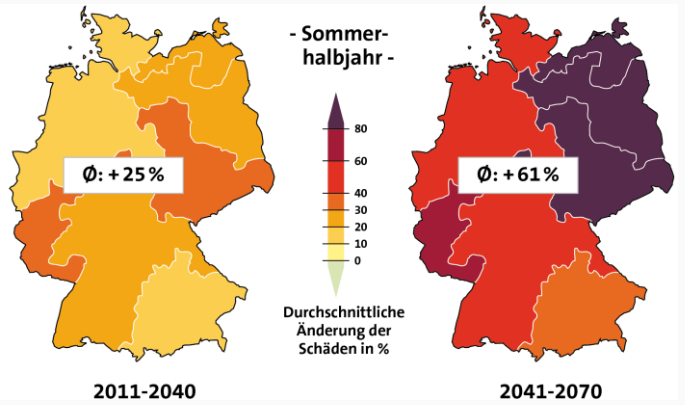
Statistical loss model storm/hail of PIK:
Regional distribution of changes in losses in a A1B-scenario relative to the average of the past 25 years




## New GDV-study on future nat cat losses based on climate modelling

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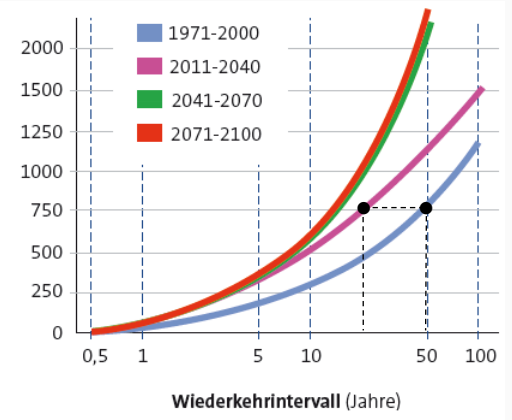
Flood model of PIK:
Mean loss in dependence on return period (values in million EUR)



## Conclusions

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- Natural catastrophes, especially weather-related events, are increasing in number and intensity in many regions, but also globally.
- There is more and more scientific evidence for causal links between climate change and increasing frequencies and intensities of natural catastrophes.
- The literature on trends of normalized losses caused by extreme weather events is controversial, most studies not finding significant trends – problems with GDP as standard and no consideration of prevention measures.
- A new study of Munich Re and DLR on convective events in the US shows a clear trend to increases in the last decades and a close association to the normalised losses caused by these perils there.
- A new study of GDV in cooperation with PIK, FU Berlin and University Köln shows robust results that global warming will increase the losses in Germany caused by wind storms and floods already in the next 30 years significantly.
- Putting these pieces of evidence together there is quite some probability that nat cat losses are driven already by anthropogenic climate change.