Eucleiα

EUropean CLimate Events:
Interpretation and Attribution

Partners:
UK Met Office, U Oxford, LCSE, KNMI, HZG,
ETHZ, IC3, DMI, U Reading, UVSQ, U Edinburgh

Extreme weather events

How rare was it?
Was it due to climate change?

- This is called "event attribution", an off-shoot of the traditional IPCC "Detection & Attribution", which results in statements like "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century."

- Time frame now is months to years, scientific articles, BAMS special report.

- Aiming for a few days to meet demand for attribution statements in the media, based on science.

How rare was the event?

- Usually expressed in a **return time**, "this was a 1 in 100 year event"

- Does not mean that it occurs once every 100 years, but that every year there is a 1/100 = 1% chance.

- For small-scale events there are two definitions, "how often does it occur at a given location" and "how often does it occur anywhere in the region".

- Can change with time.

Was it due to climate change?

No.

Has the probability changed due to climate change?

- Compute probability in the present climate, p_{now}.
- Compute probability in a past climate or in a counter-factual climate without anthropogenic influences, p_{alt}.
- The **Fraction of Attributable Risk** is then defined as $FAR = 1 - p_{alt}/p_{now}$.
- Compute uncertainty margins on FAR to see whether $FAR \neq 0$ at some confidence level.

Stakeholders

Outcome of workshop in Oxford before start of the project: two very interested user groups:

- Litigation lawyers; timescale irrelevant, quality very high
- Media: timescale ~3 days, quality irrelevant

Other interested parties notice that often they need projections, not attribution. Socially very important to make projections acceptable

Stakeholders

Challenges

- Gap between user expectations and scientific possibilities
- Gap between scientific language and popular accounts

Many possible event definitions

- From Detection & Attribution: take a box/time that maximises the signal/noise ration $\Longrightarrow$ large area, long time.

- From impact: take area/time that had the largest impact $\Longrightarrow$ river catchment, urban area, short time.

Data is a problem

- For the fast-track attribution we'll need a good first guess of what happened within a day or so.

- Preferably within the context of a >50-yr series.

- Seasonal time scale attribution, scientific articles have more relaxed timing requirements but higher quality requirements.

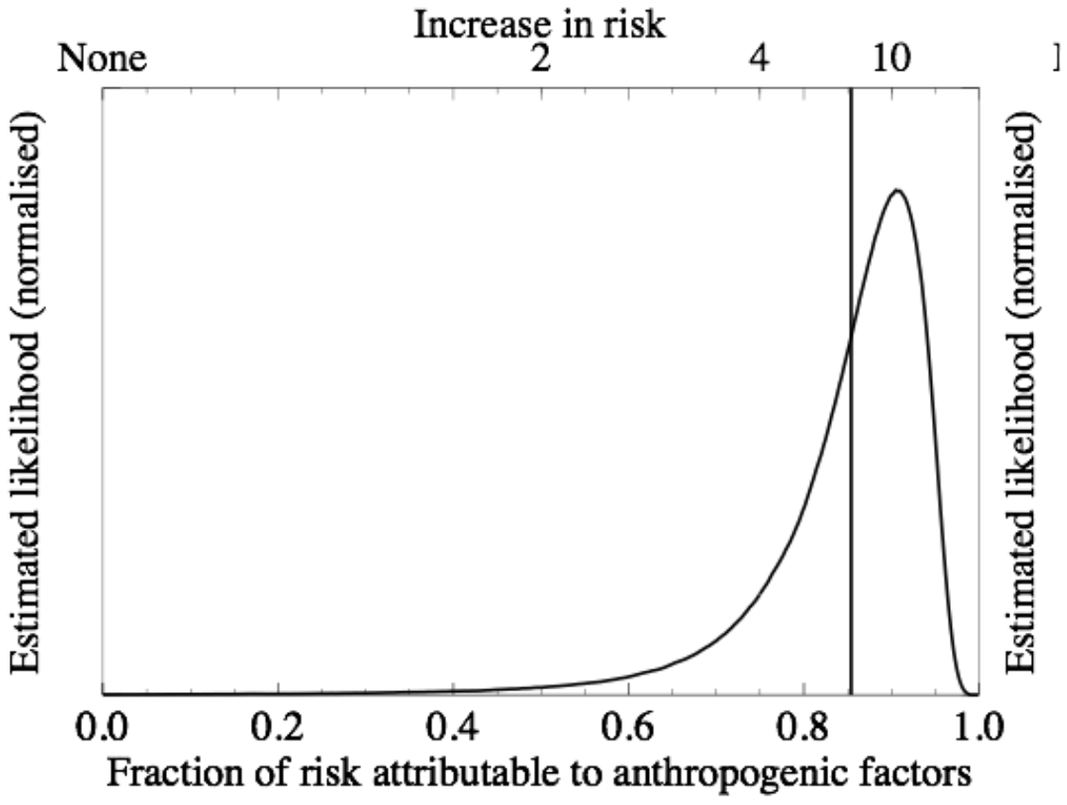
- Many events are small-scale in time and space, often not only meteorological (floods, droughts, heat waves)

Methods

- SST-forced models: UK Met Office system, U Oxford Weather@home system, IC3 EC-Earth
- Coupled climate models: CMIP5, other ensembles
- Trend analysis of observations (detection only, attribution in two-step process)

1: SST-forced models

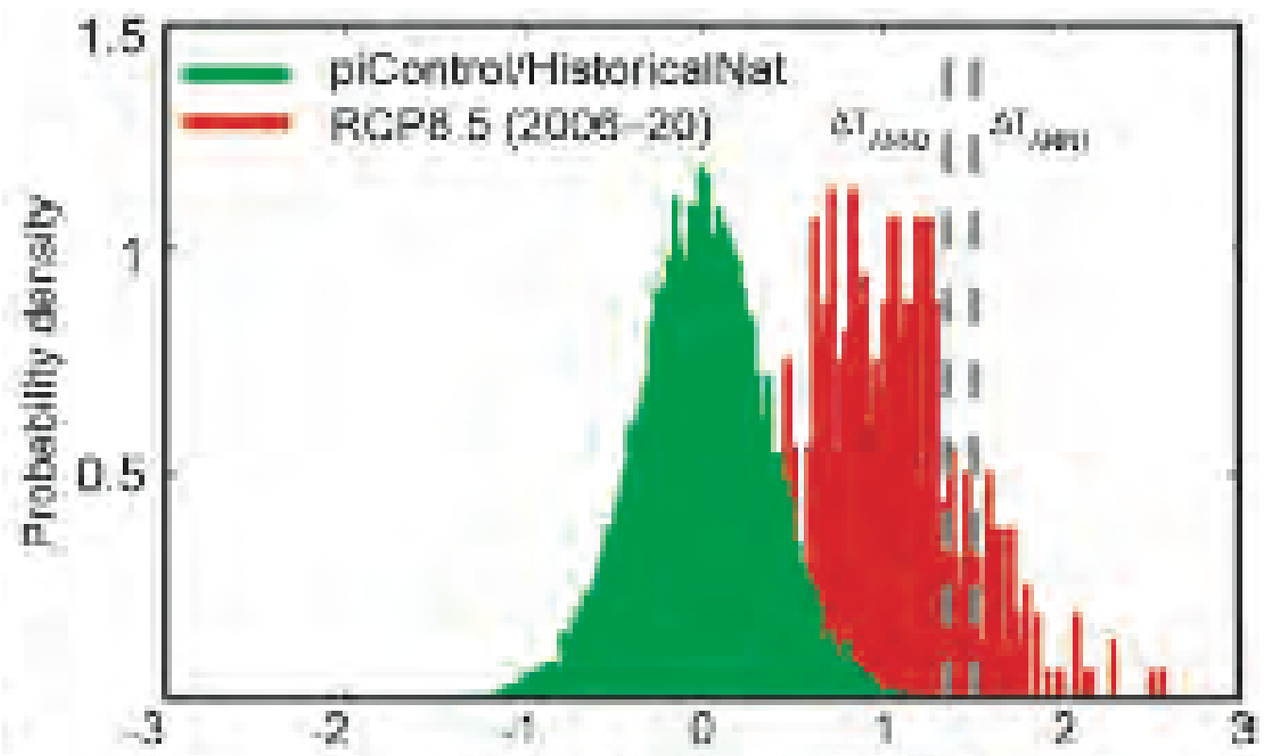
- One set of runs for the current SST / atmospheric composition / sea ice.
- One set of runs with the difference to pre-industrial SST subtracted, sea ice added, and atmospheric composition set to pre-industrial.
- Need verification of relevant model properties, beware of model biases in mean, variance, ...



Stott et al, Human contribution to the European heatwave of 2003, Nature, 2004.

2: Coupled models

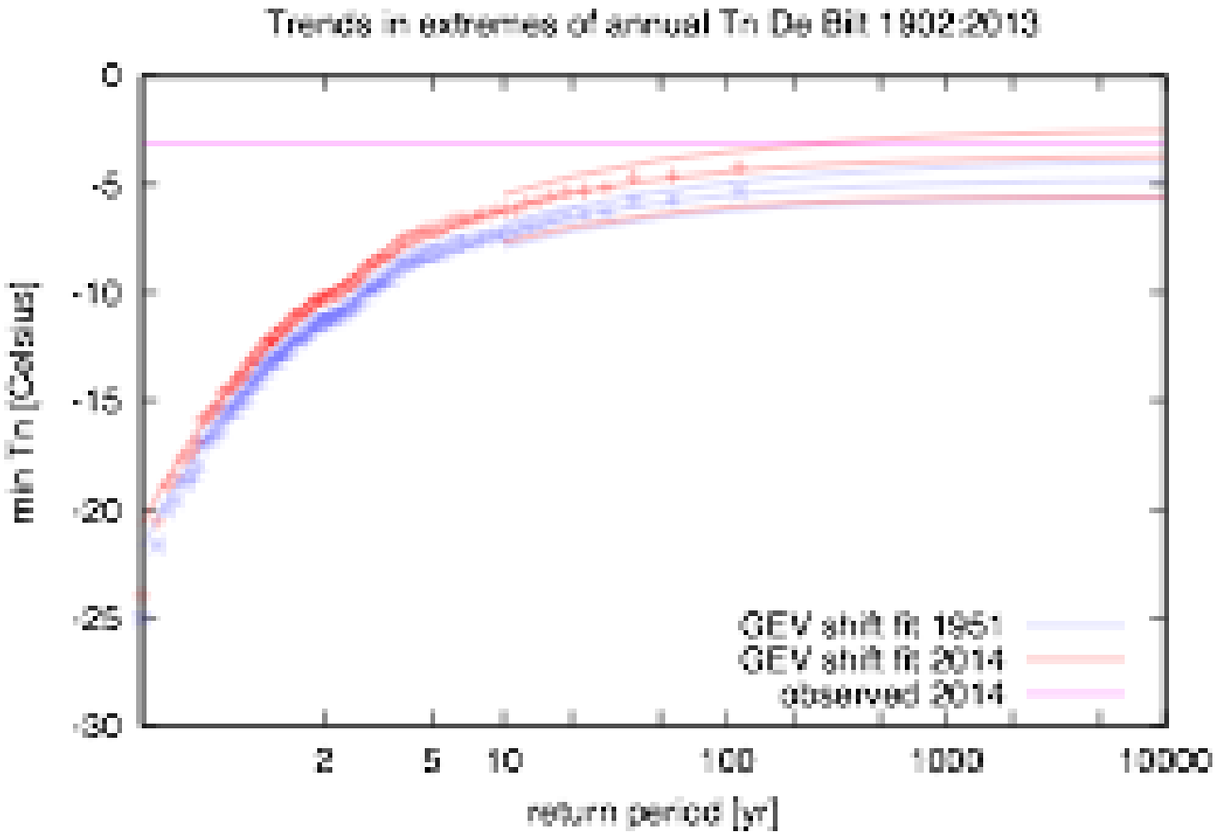
- Take the CMIP5 pre-industrial control run, natural-forcing runs or the early part of the historical runs.
- Compare with present-day control run or historical/RCP runs.
- Model biases are larger than in the SST-forced case, but all data are already available so bias corrections can be done in advance.



Lewis and Karoly, The role of anthropogenic forcing in the record 2013 Australia-wide annual and spring temperatures, BAMS, 2014.

3: Past observations

- Take past observations, fit an extreme-value distribution that depends on a measure of global warming (e.g., Tglobal).
- This gives a FAR due to the trend, to make an attribution to anthropogenic factors this has to be related to a warming trend that has been attributed (two-step attribution).
- Small systematic errors when homogenised data are used, larger random errors.



van Oldenborgh et al, Cold extremes in North America vs. mild weather in Europe: the winter 2013/2014 in the context of a warming world, BAMS 2014.

Trust building

- Reliable data: make inventory of data that is available for event attribution on various time scales with a quality assessment.

- Diagnostics and model evaluation: understand the development of the events, compare observed and modelled events, trace impact of climate change on extreme events

- Reliability assessments methods: use seasonal forecasting skill assessment (especially reliability) for event attribution.

Examples

- High European temperatures 2014: good data, large-scale, easily represented by models
- Malay floods December 2014: probably small-scale, data problems, unreliable models

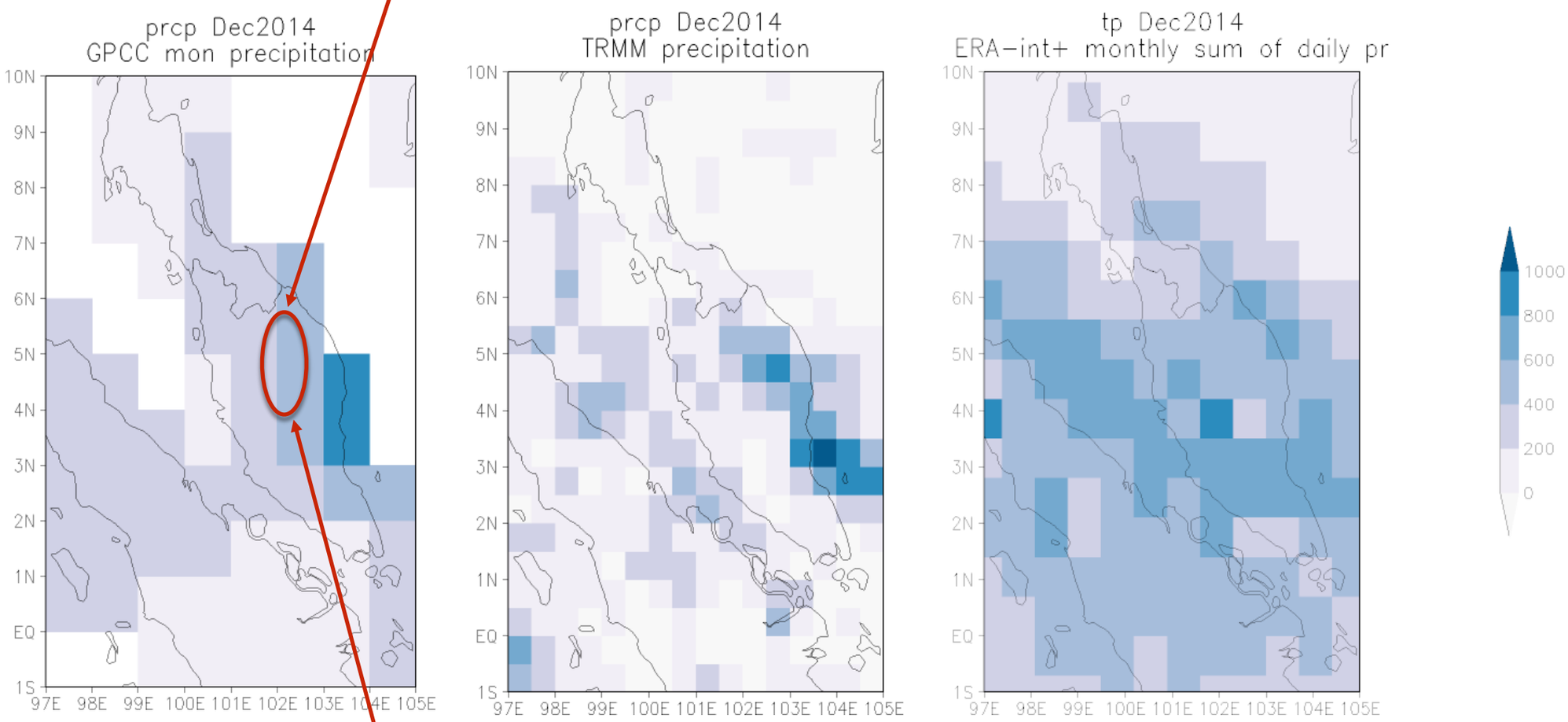
Worst floods in the north east of Malaysia, river was higher than in 2004, 1967.

NSC secretary Datuk Mohamed Thajudeen Abdul Wahab blamed the floods and landslides on the extensive (and in many cases illegal) logging and land clearing in Pahang, according to Malaysian Media.

In her article in Free Malaysia Today, Mariam Mokhtar says: *The reason for the flooding in Kelantan is not just the extensive logging, nor is it God's wrath or climate change or PAS or Umno Baru. The real reason for the disastrous floods in Kelantan is decades of neglect and under-investment by the government – both state and federal. It is also the people's lack of will to force Putrajaya to provide the badly needed national funds to build flood defences and develop the state.*

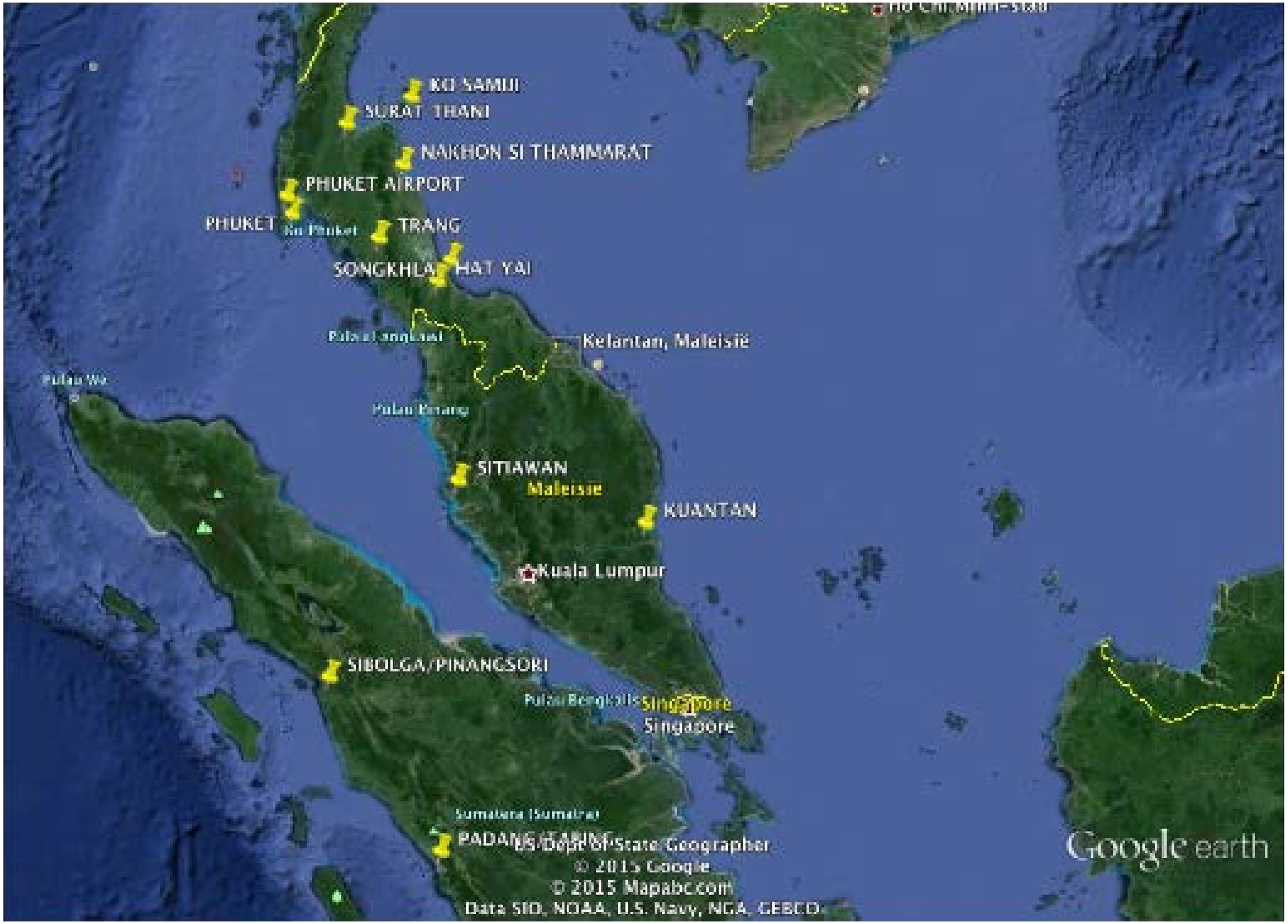
1) What happened?

Kota Bahru (flooding)

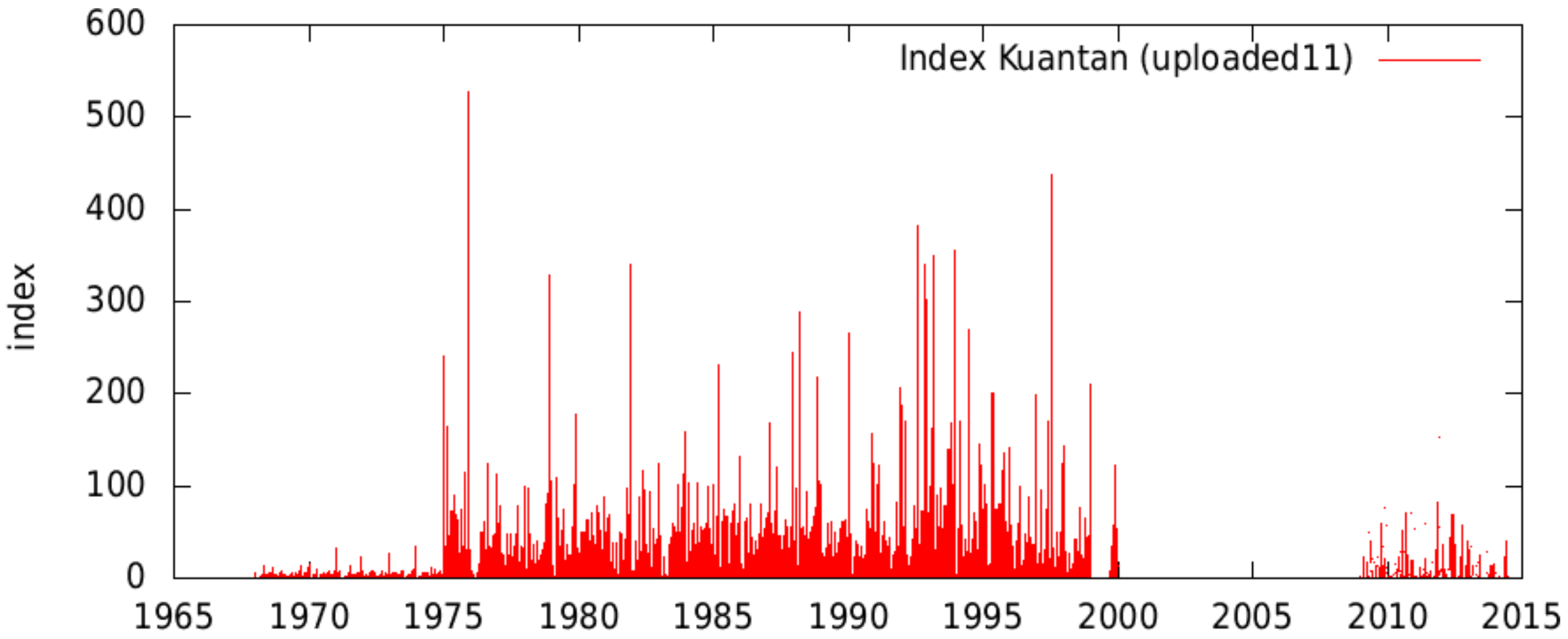


Upstream area (roughly)

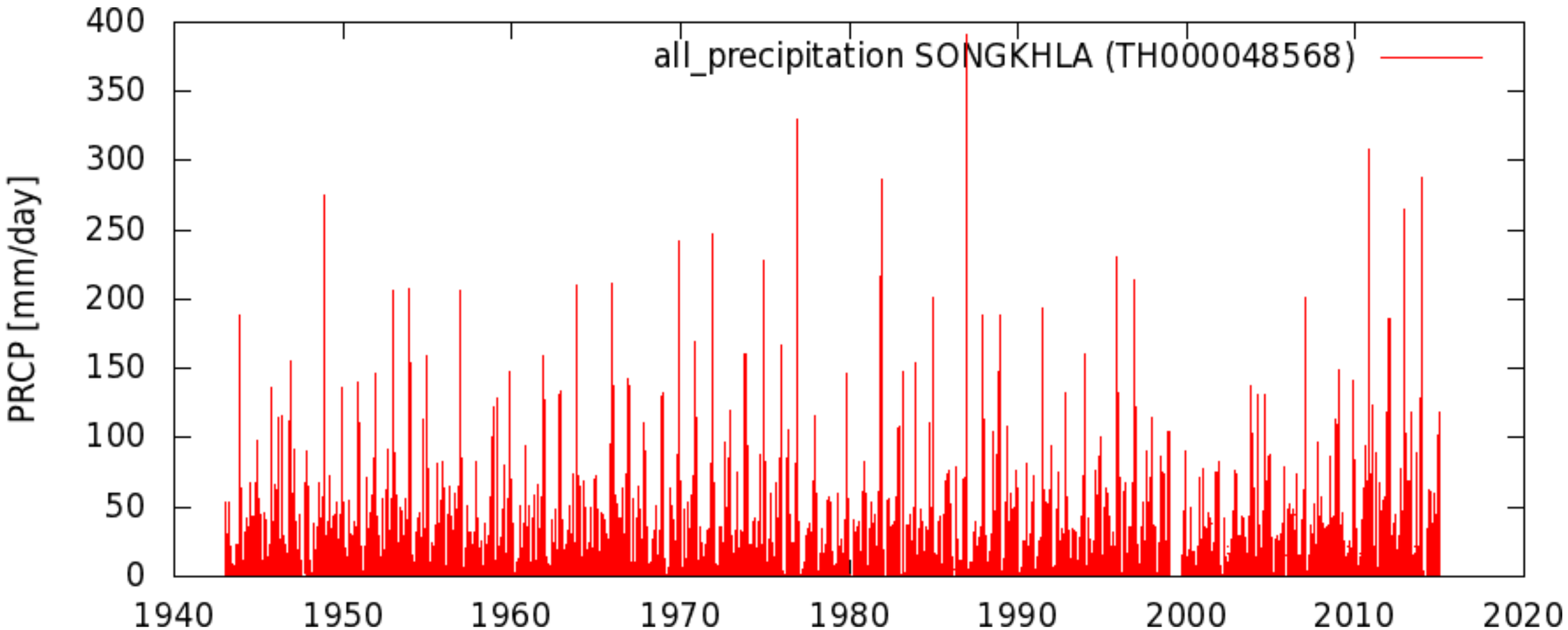
GHCN-D daily station data



SACA&D station Kuantan is not so good

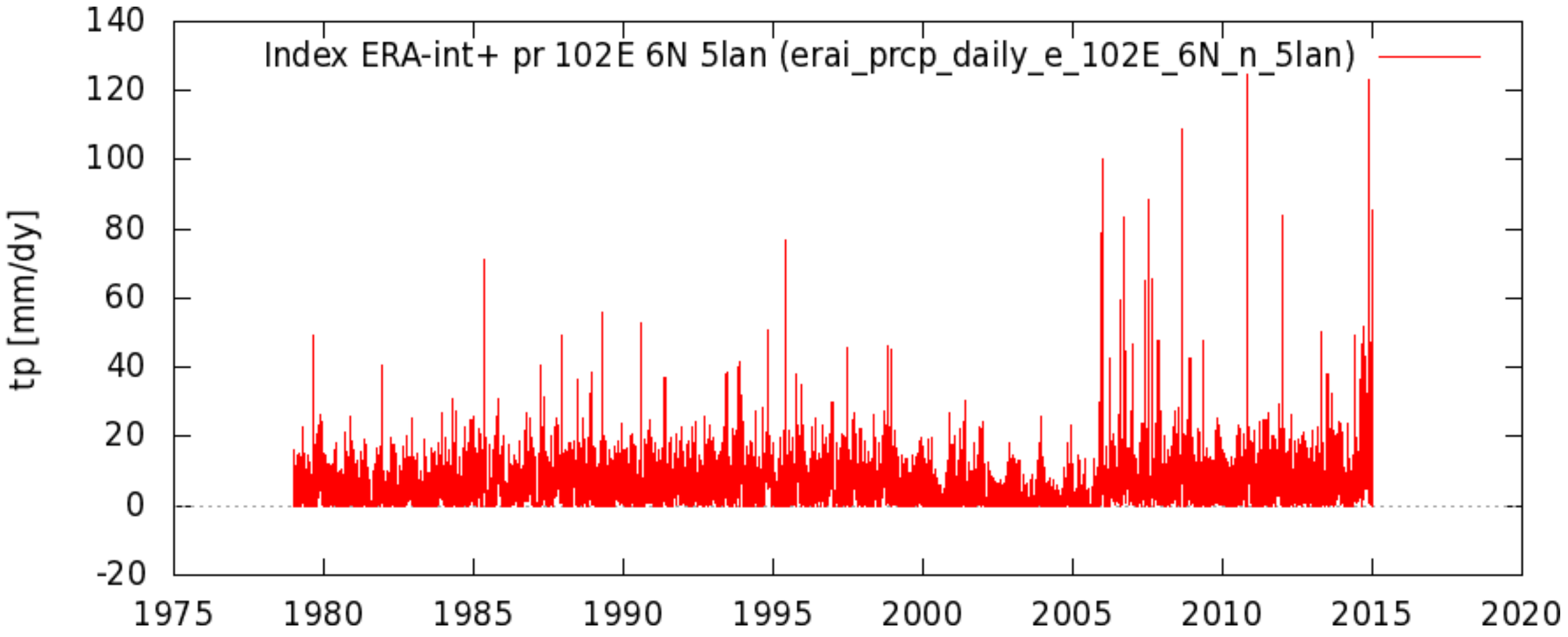


GHCN-D station Songkhla (Thailand) looks better

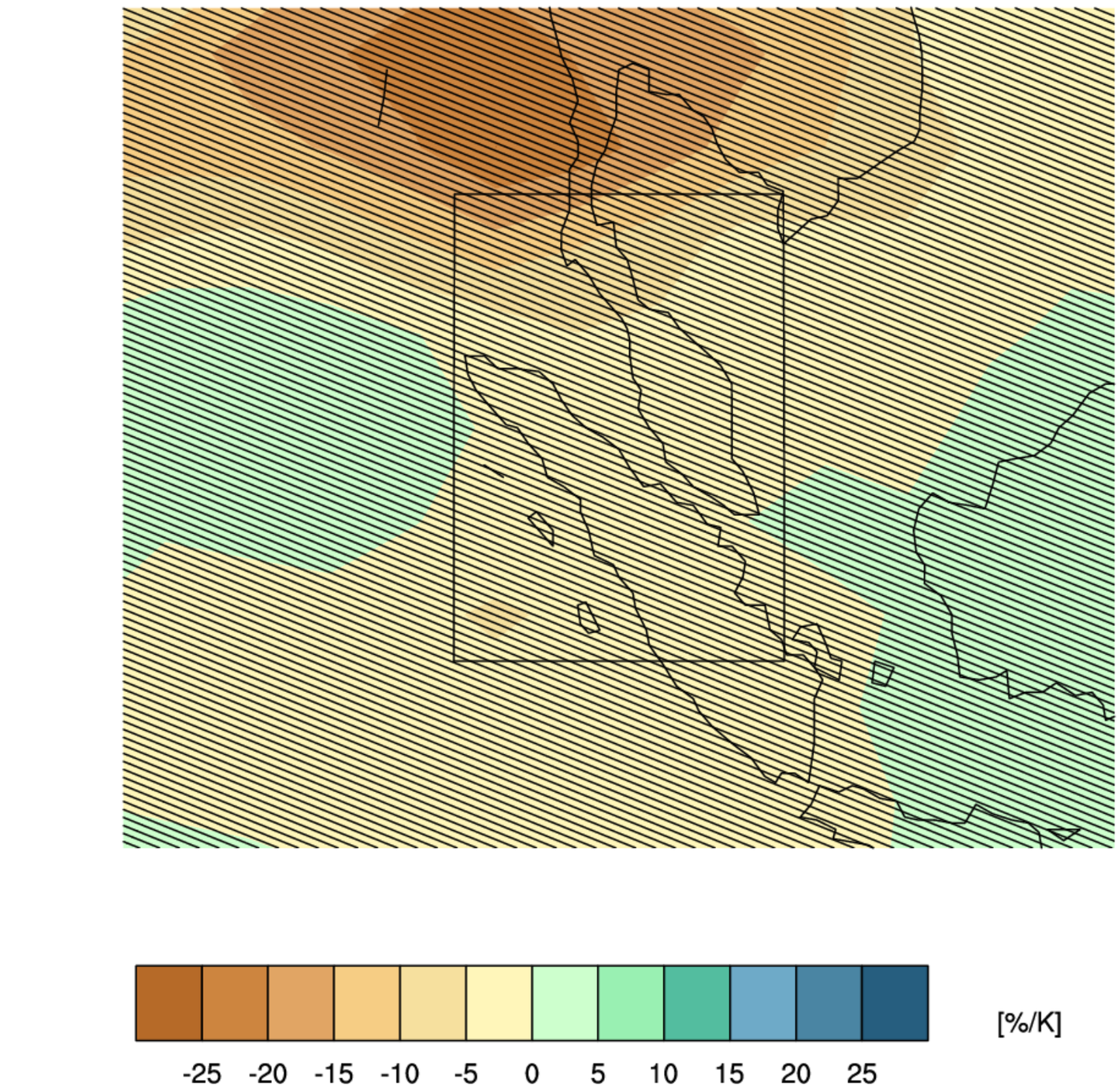


But this hides lots of missing data.
Also not extreme in December 2014

ERA-interim is very inhomogeneous here



Do models simulate a trend up to now?



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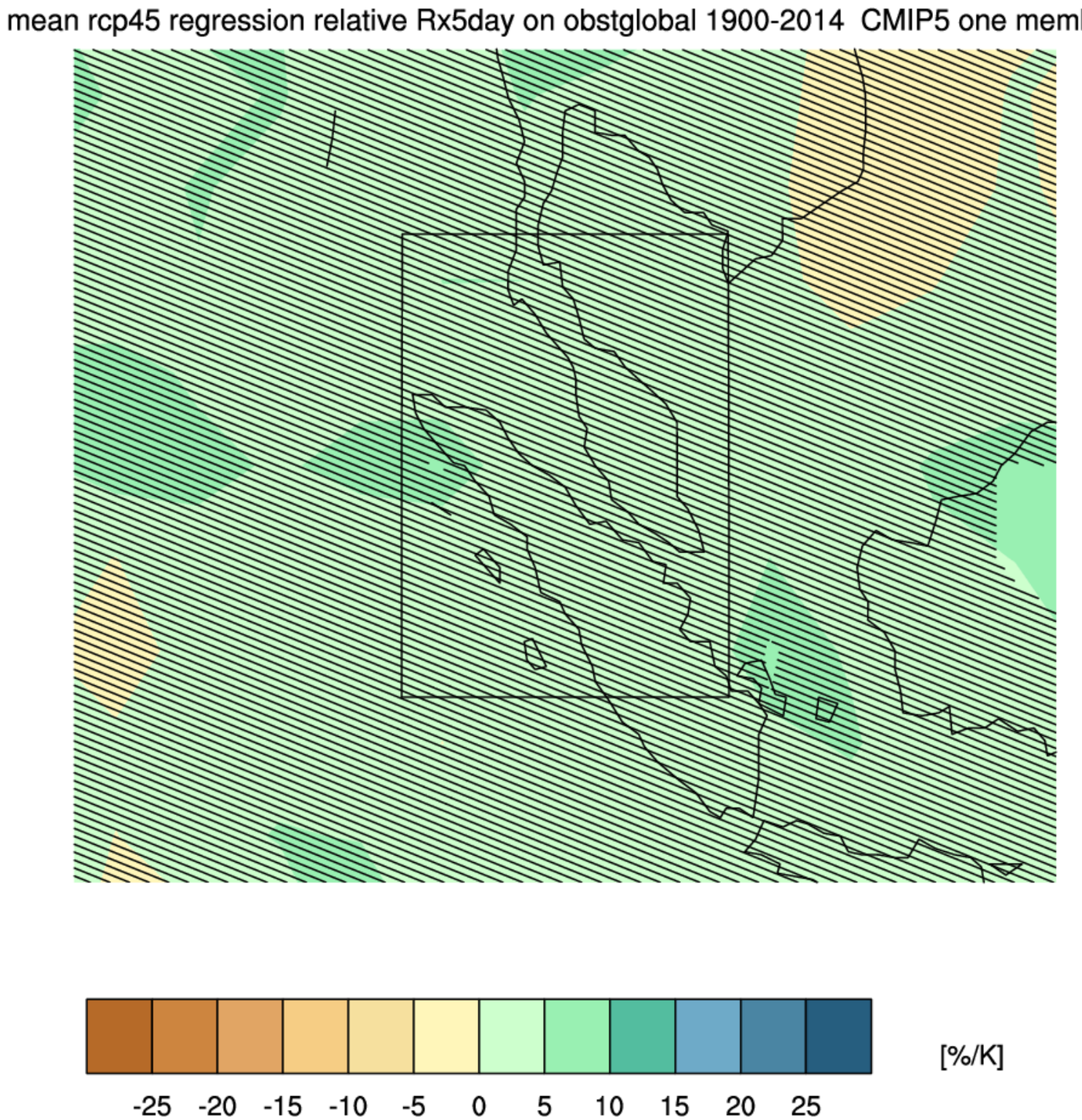

Stay tuned

- September 2015: BAMS Explaining Extreme Events 2014
- Scientific publications on methods and events.
- Fast-track attribution starting in 2015.