Event attribution

from research to climate service

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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 = $1 - p_{alt}/p_{now}$.
- The change in the **Risk Ratio** RR = p_{now}/p_{alt} is much easier to communicate.
- Compute uncertainty margins on RR to see whether RR ≠ 1 at some confidence level.

Procedure

1. What happened? Event definition.
2. Selection criteria: go / no go decision.
3. Analyse observations for return time and trend.
4. Evaluate models.
5. Analyse models for trend or difference, attribution.
6. Synthesise ⇒ attribution statement.

Example: flooding in France end of May 2016

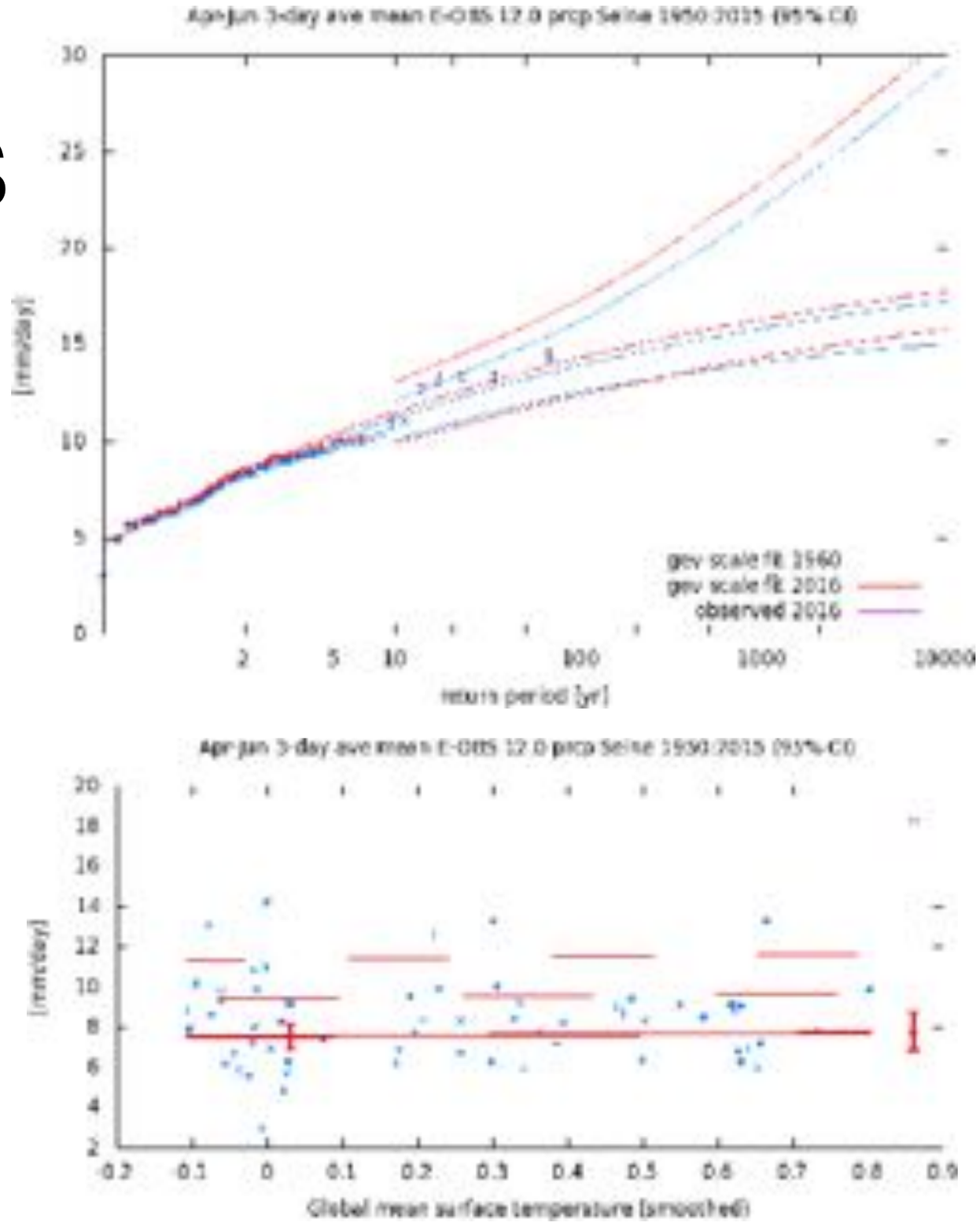
- Extreme rainfall in the Seine and Loire basins led to flooding. Relevant time scale ~3 days (no hydrological models yet)
- Important enough to do analysis
- Involve local experts
- GCMs, RCMs available
- We had time to do it

Climate service would need

- Actual and compatible historical observations (now on Climate Explorer).
- Expertise on the local weather and climate, which factors were important.
- Access to GCM and RCM data that physically could be expected to describe the phenomena.
- Criteria when to do this.

Observations

- Return time Seine >100 year (65 yr obs)
- Positive trend in observations, not significant
- Describe PDF (GEV) by fit parameters μ, σ, ξ

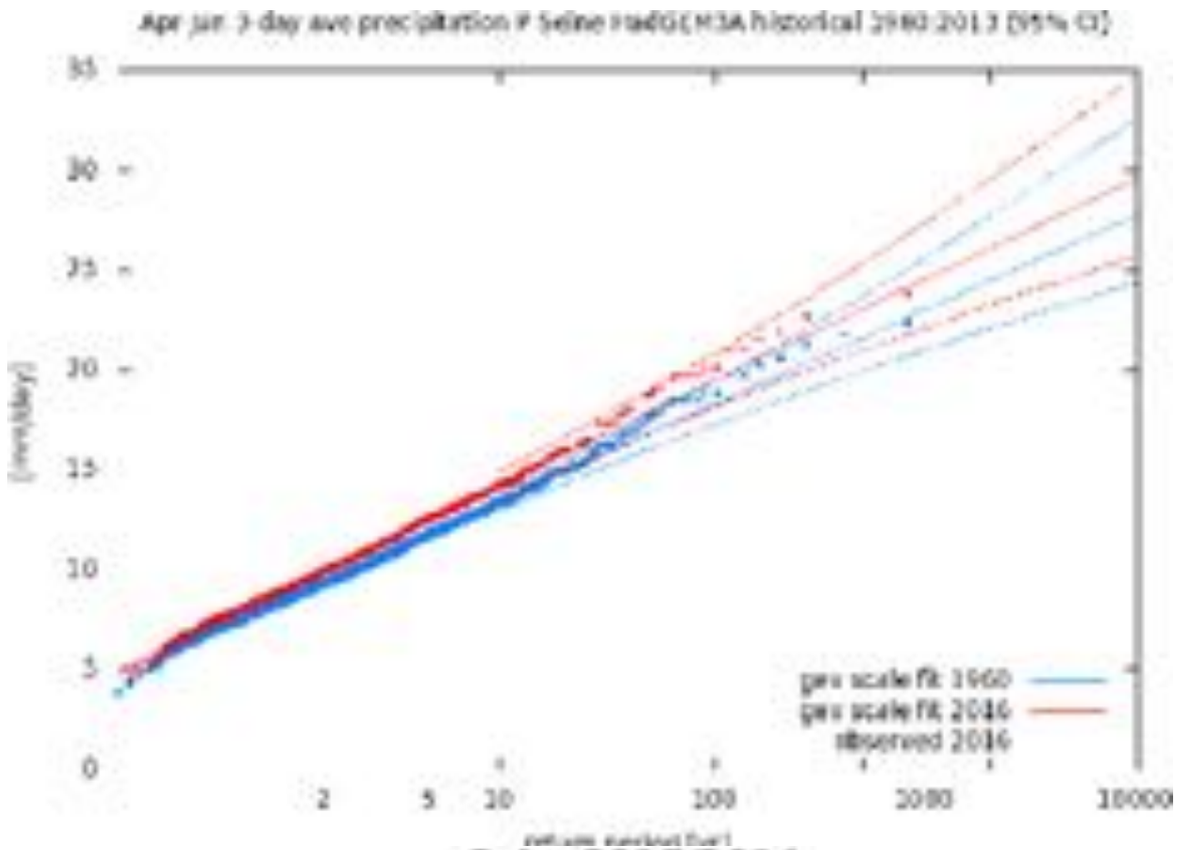


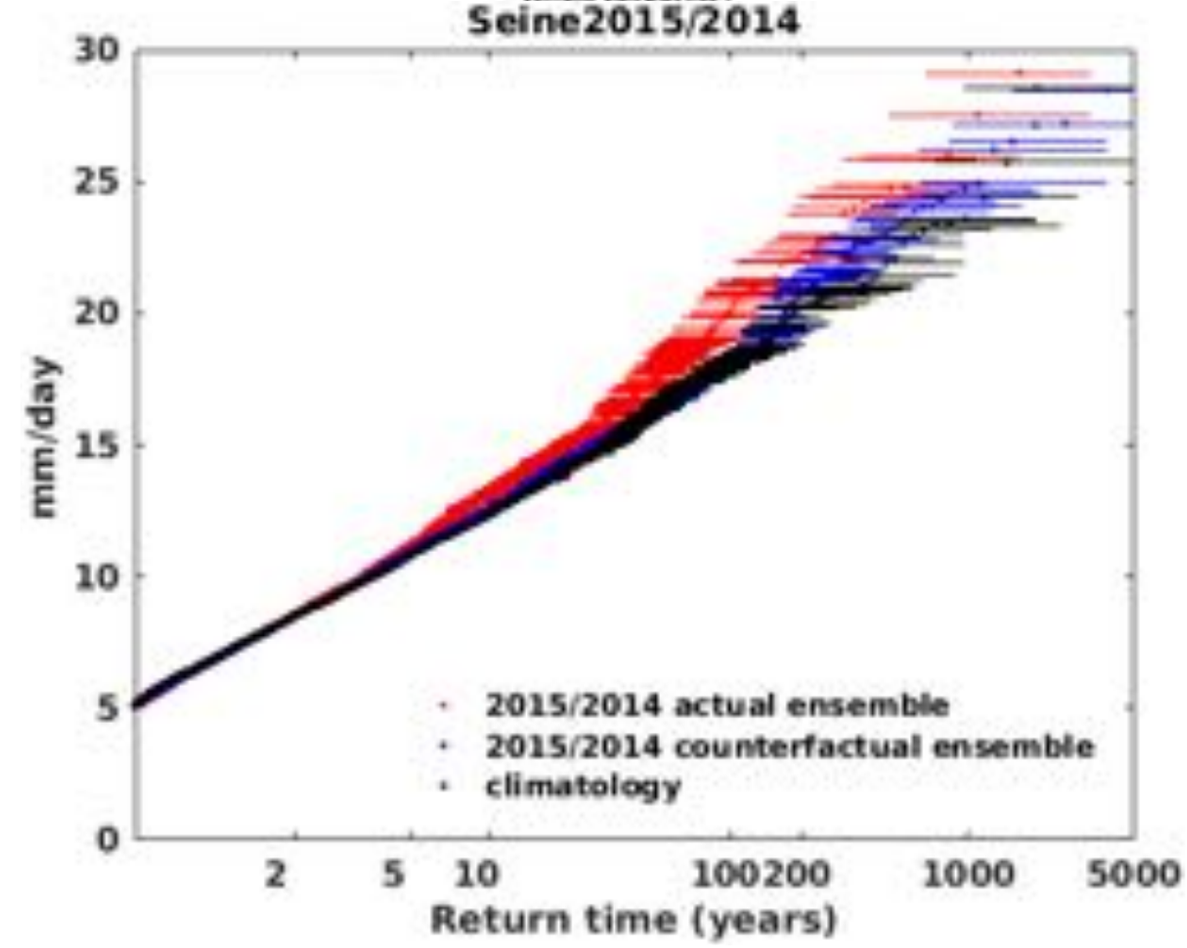
Requirements

- Evaluate quality of observations.
- Perform relevant extreme-value function fit (R, Climate Explorer).
- Assess whether the fit is good enough.
- Note results, compare with return times from other sources (eg hydrological tables)

Models

- Consider quite a few to sample model spread (uncertainty)
- Evaluate on PDF, physics, (discard some models)
- Compute trend in historical runs and/or
- Compare with counterfactual runs





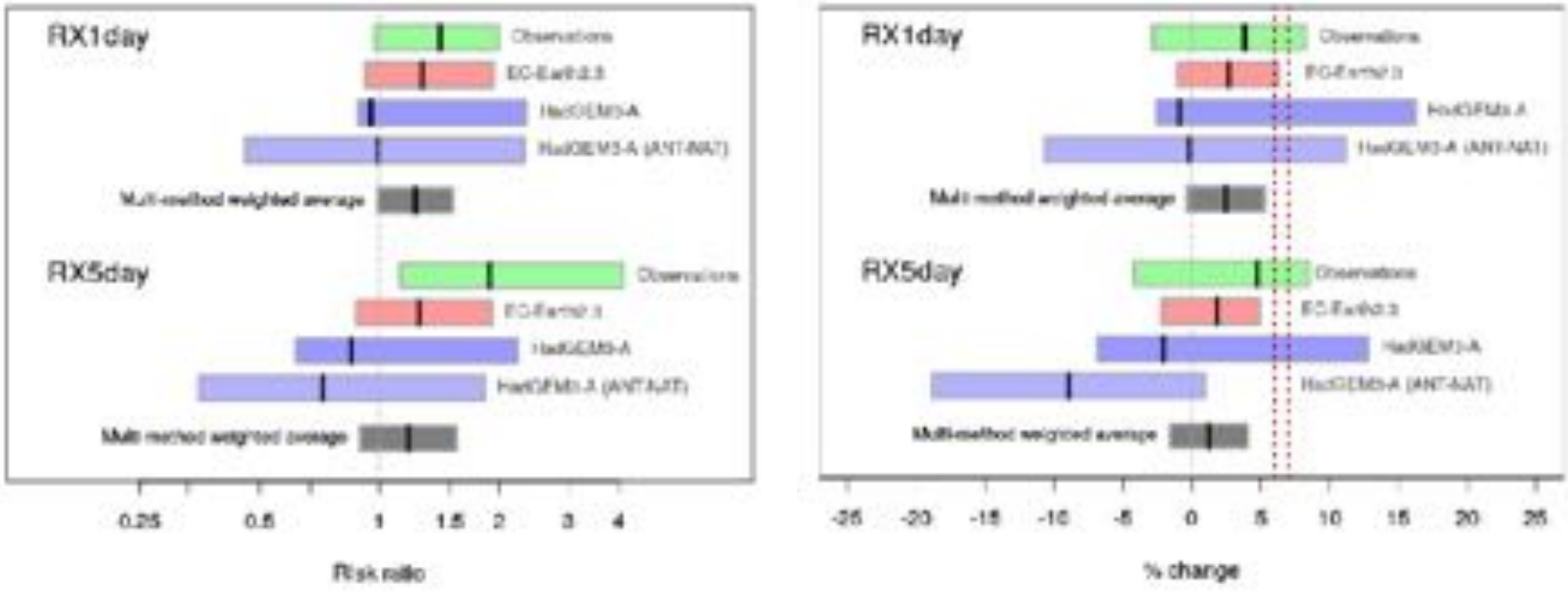
Requirements

- Quick enough access to model data archives (eg Climate Explorer, other on-line data archives with subsetting facilities).
- Fit to extreme value distribution, judge agreement.
- Consider physical agreement between model and observations.
- Apply bias corrections.
- Note results.

Synthesis

Seine	1960–2016	natural–2016
HadGEM3A	1.9 (1.1…3.4)	2.5 (1.1…6.3)
HadGEM3A Nat		2.0 (0.6…7.2)
Weather@Home		2.1 (0.6…5.0)
RACMO	2.0 (1.3…4.9)	2.8 (1.4…11)
CORDEX	1.6 (0.5 to 4.9)	2.0 (0.3…11)
Combined		2.3 (>1.6)

Synthesis



"The probability of extreme precipitation in Boulder has not changed significantly, less than Clausius-Clapeyron"

Requirements

- Convert to common measure (eg pre-industrial vs now)
- Judge agreement between methods: χ^2/dof ~ 1, compatible with natural variability?
- Compare trends of models with observed trends.
- Compute multi-method interval (or give up).
- Craft attribution statement (or justify giving up).

Will be supported on Climate Explorer in near future.

User groups

- Media — if timely (days to weeks depending on size event)
- Decision makers — if timely (decisions how to rebuild are often taken within months) and trustworthy.
- Insurance companies — if trustworthy (NMAs).
- Litigation lawyers — if extremely trustworthy.

Obstacles

- Need a lot of meteorological, climatological & some statistical knowledge (same as in seasonal forecasting).

- The event definition requires input from impacts community, hopefully later also analysis.

- Model biases are often large, also in parameters that cannot easily be corrected (variability, trend); how to handle those cannot be put in procedure.

Plans

- Move attribution of simple extremes to operations in NMAs, support with development (observation and model data availability, fitting tools, synthesis tools).

- Do research on more complicated extremes: hurricanes, snow, ... , hail, tornadoes, ...

However, what are simple extremes? (cf NAS report)

- heat waves: model trends often disagree with observations,

- cold waves: bad signal/noise ratio, circulation trends uncertain

- winter rain extremes: circulation trends uncertain,

- summer rain extremes: for small-scale need convection-permitting models.