From Global to Regional Changes

Detection and Attribution - bridging the assessment across WGI and WGII

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Thanks for thoughts to W Cramer, J Sillmann, GJ van Oldenborgh

D&A - WGI vs WGII (AR5) perspectives

WGI

Determining the human influence on the climate in observational record

- Starting points: observed climate change [regional, global]
- Drivers: Anthropogenic and natural forcing (around natural variability)
- Assessing the contribution from natural forcing, natural variability and anthropogenic forcing agents (GHGs, Aerosols, LUC…)
- *WGI core discipline*

WGII

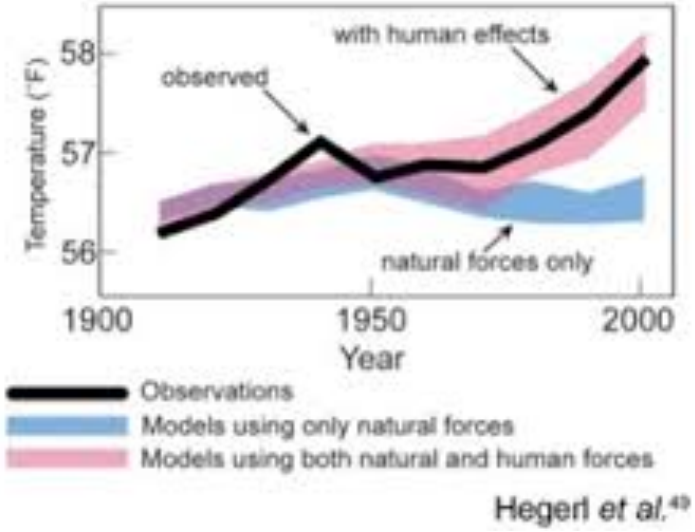
Evaluating the role of recent changes in climate for observed effects in natural and human systems

- Starting point: observed change in climate-sensitive systems
- Multiple drivers: climate change and direct human activities
- Assessing the magnitude of climate change contribution to observed impacts in natural and human systems
- No specific framework, varying evidence, diverse community

WGI: Human influence on climate

2 step approach:

- Detect a change in climate beyond natural variability
- „Signal to noise“ exercise
- Attribute the most likely cause for that change, evaluating the contribution from natural forcing, anthropogenic forcing and internal system variability

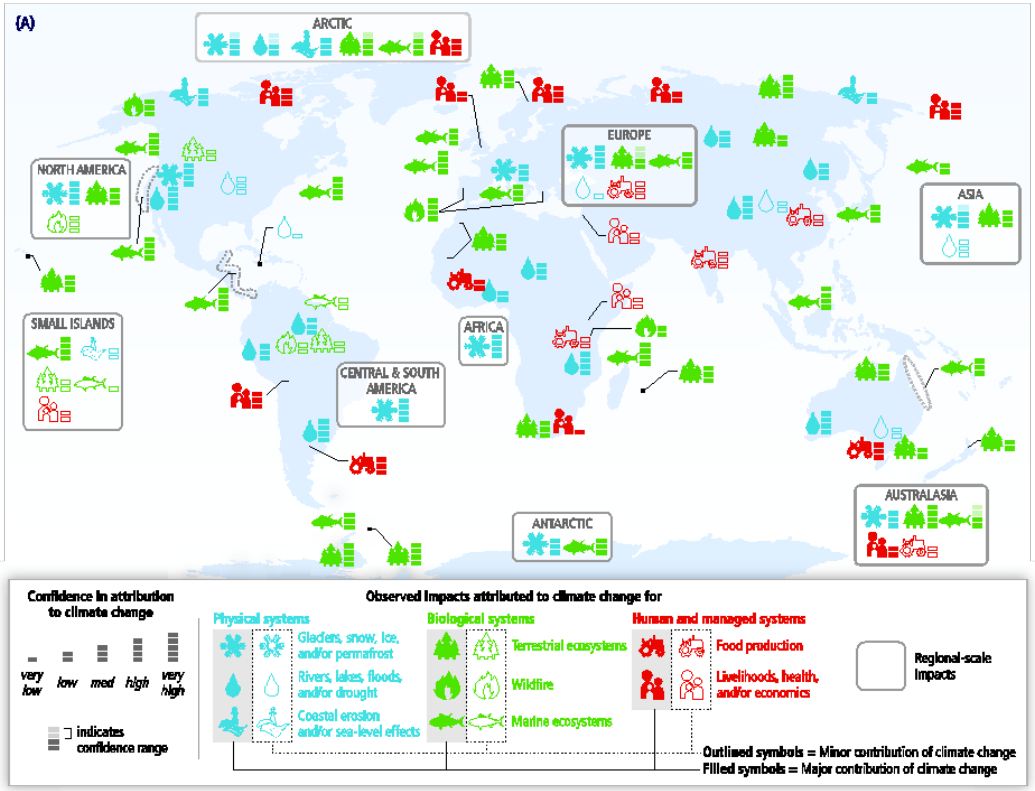


WGII: Climate change influence on natural and human systems

- In natural systems, variability around a stable condition can often be assumed
- In human and managed systems, this is not the case
- Signal detection framework will often not be feasible

- **Impact detection** involves the consideration of all drivers of change in the system
- Specification of the baseline behavior (counterfactual)

AR5 impact attribution map



Change due to observed regional climate change, magnitude of CC contribution

„Networked expert judgement“

Combining process knowledge and various source of evidence to support impact attribution

But: Observational record required

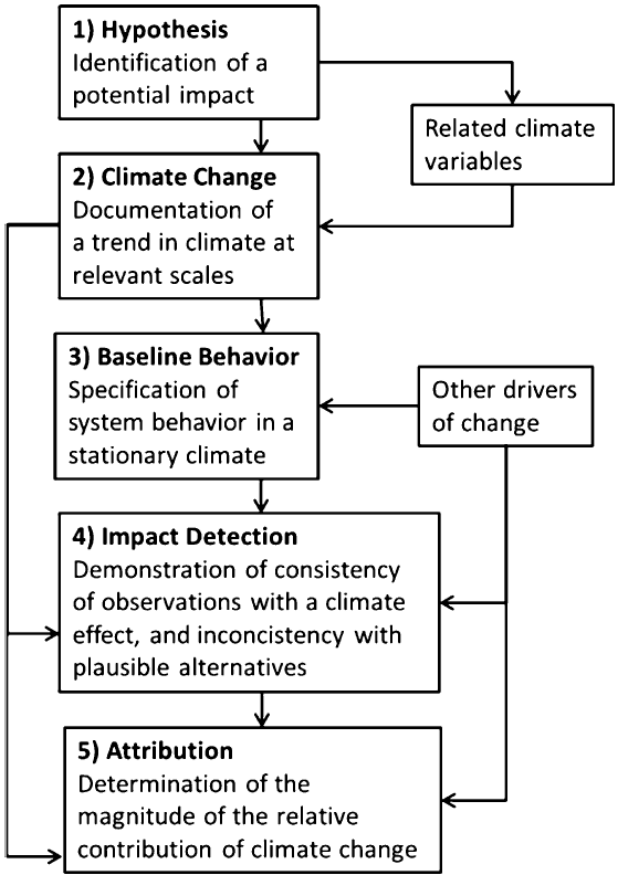
No attribution without detection

Attribution, not prediction!

Observed impacts of recent climate change (IPCC WGII AR5 SPM, Figure 1.a)

Impacts of single events not included!
Impacts of trends in variability where feasible (e.g. increasing marine heat waves)

New after AR5: Strengthening the evidence base



Hansen et al., RegEnvChange 2015

Adaptation to Climate Change: Evidence from US Agriculture†

By MARSHALL BURKE AND KYLE EMERICK*

REVIEW ARTICLE
PUBLISHED ONLINE: 27 APRIL 2016 | DOI: 10.1038/NCLIMATE2958
nature climate change

Observations of climate change among subsistence-oriented communities around the world

V. Savo[1,2*], D. Lepofsky[1,2], J. P. Benner[1,3], K. E. Kohfeld[3], J. Bailey[3] and K. Lertzman[1,3]

Advanced Review

Interactions between climate change and land use change on biodiversity: attribution problems, risks, and opportunities

Tom H. Oliver[1*] and Mike D. Morecroft[2]

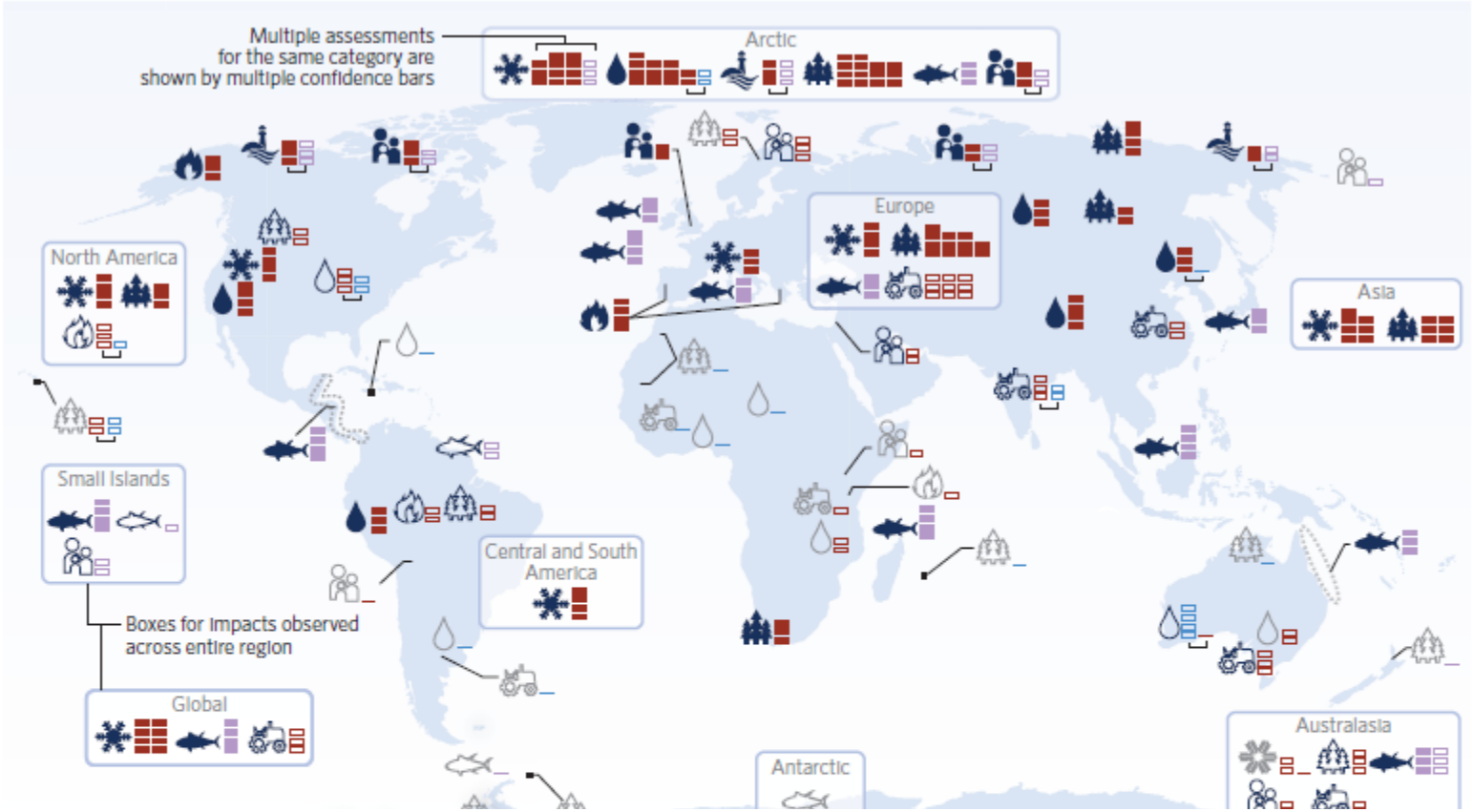
Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2015) **24**, 64–76

META-ANALYSIS

Strengthening confidence in climate change impact science

Mary I. O'Connor[1,2*†], Johnna M. Holding[3†], Carrie V. Kappel[2], Carlos M. Duarte[3,4], Keith Brander[5], Christopher J. Brown[6,7,8], John F. Bruno[9], Lauren Buckley[9], Michael T. Burrows[10], Benjamin S. Halpern[2,11,12], Wolfgang Kiessling[13], Pippa Moore[14,15], John M. Pandolfi[16], Camille Parmesan[17,18], Elvira S. Poloczanska[7], David S. Schoeman[19,20], William J. Sydeman[21] and Anthony J. Richardson[7,22]

New since AR5: End-to-end attribution of WGII assessment



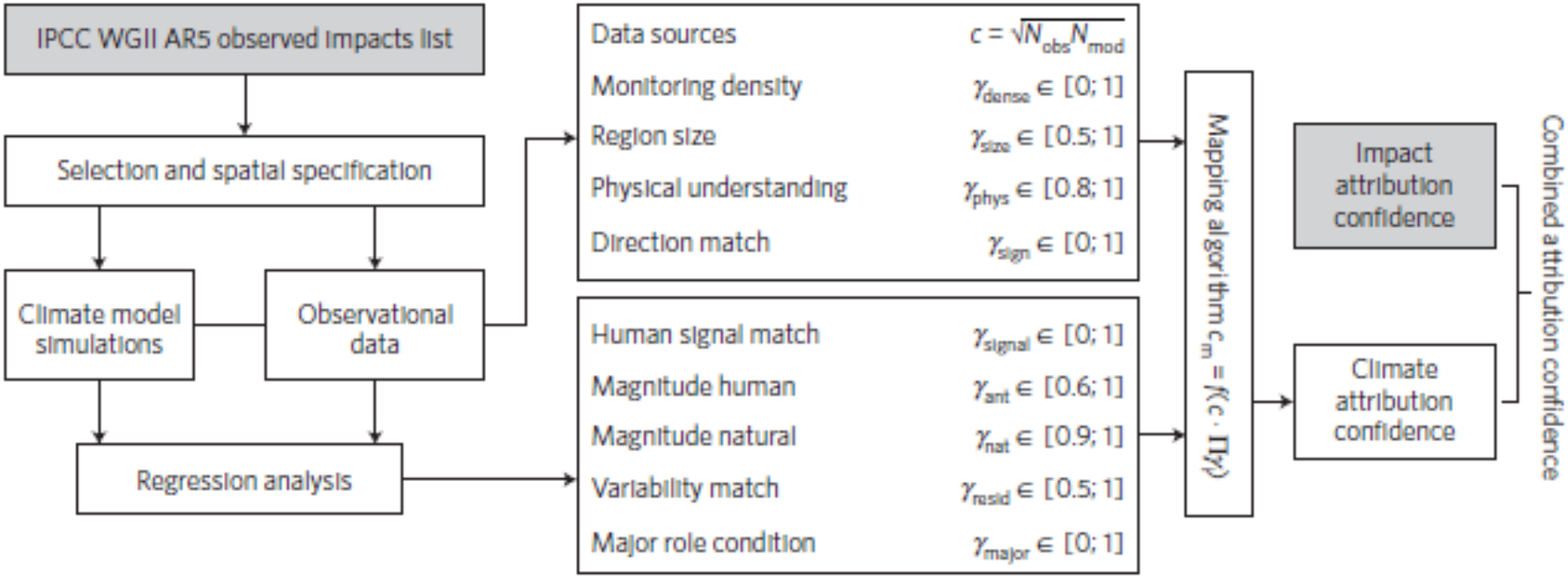
After the fact – assessment closing the gap between WG1 and WG2 D&A

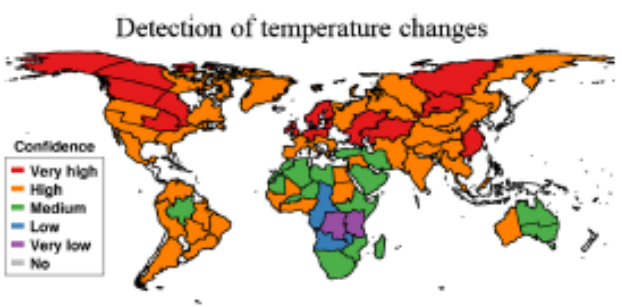
→ Discernible impact across systems confirmed, but no blind extrapolation

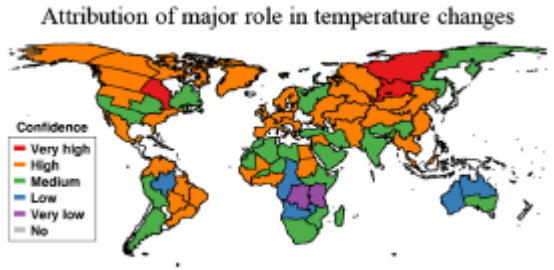
→ Scale very important for climate attribution, less so for impact attribution

Hansen and Stone, NCC 2016

New since AR5: End-to-end attribution of WGII assessment: methodology

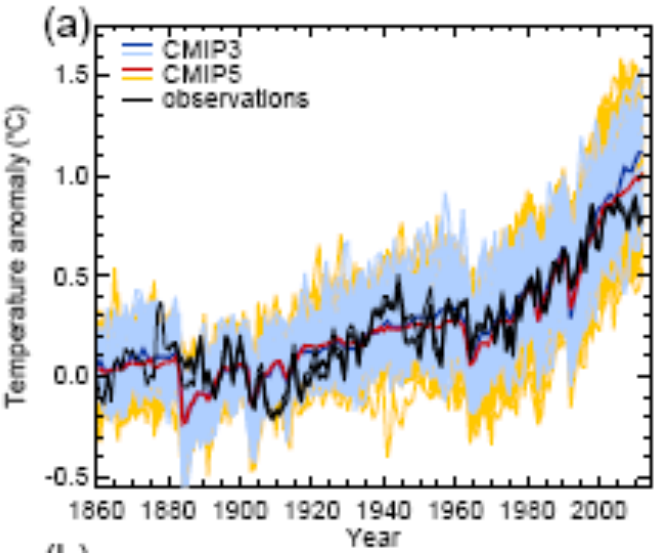




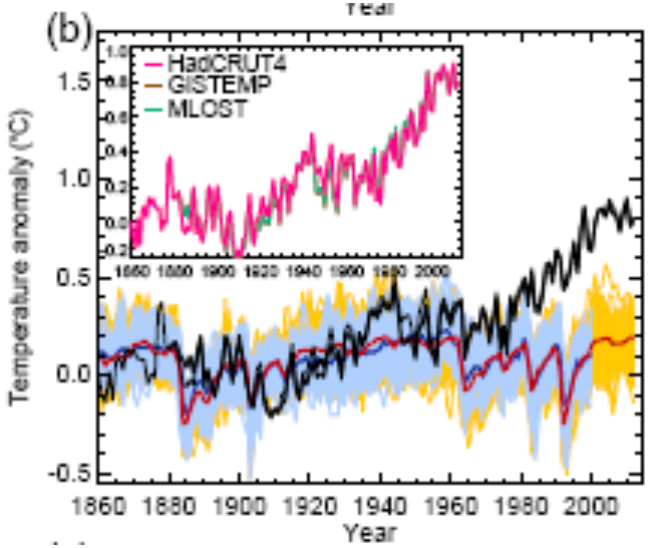


Stone and Hansen, Journal of Climate 2016

WGI approach AR5 (Ch10)

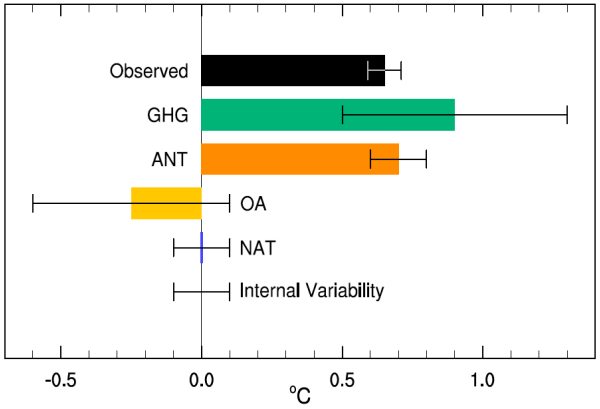


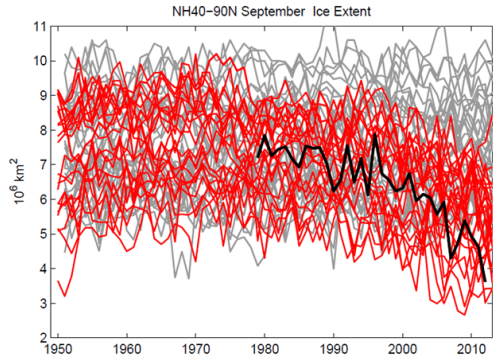
Factual world



Counterfactual world:
The world that « might have been »

Physical drivers: Modifying the climate variables





Compartments
Extreme events
Few single events
Homogeneity
Obs./Reanalysis

New since AR5

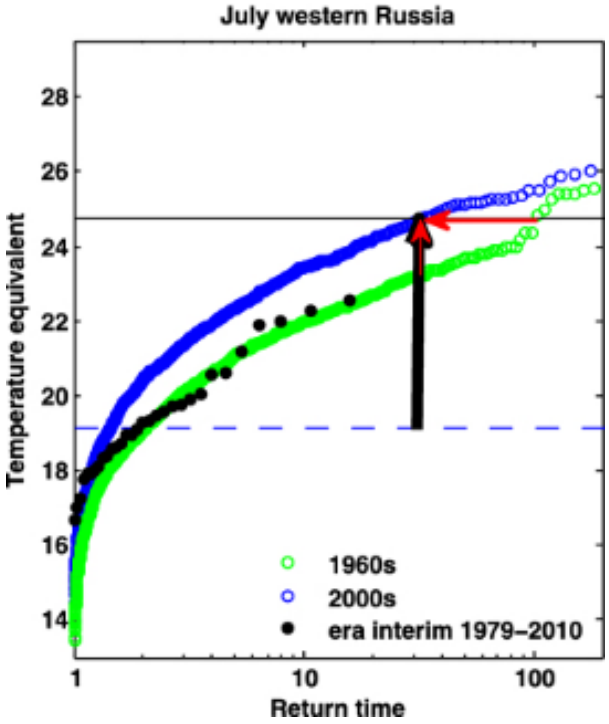
More understanding on precipitation/water cycle
Sarojini et al 2016; Kumar et al., 2016; …

More on cryosphere / Arctic
Najafi et al 2015, 2017; Kirchmeier-Young et al 2017

New drivers
Cities (Sun et al 2016, NCC)

Circulation Patterns (emerging) and phenomena (eg atmospheric rivers)
Horton et al 2015; Jézéquel et al 2018; Coumou et al 2015

New since AR5: Development of event attribution, many types of events



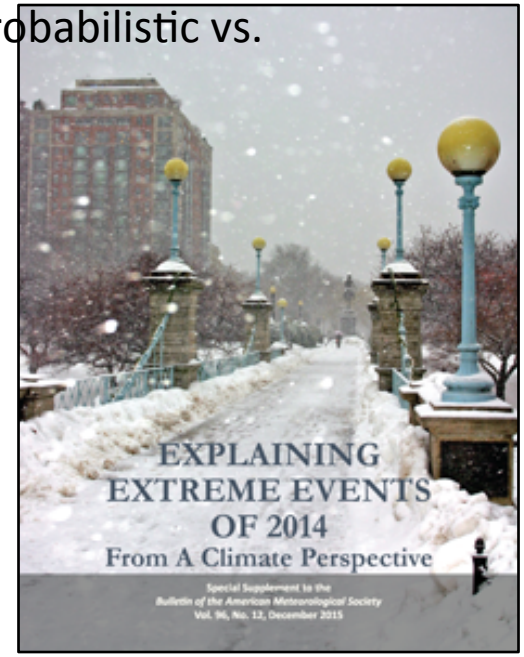
Otto et al., 2012

→ A number of new methods developed (observations, large ensembles, use of CMIP, CORDEX, combined with EVT, analogs, storyline approach, specific methods for cyclones, …) [Stott et al., 2016]

→ Assessments from multi-model-methods as all are imperfect [extremes are rare and « non-reproducible »]

→ Heated debate on framing: Probabilistic vs. Storyline approach

A Turbulent
And productive science!

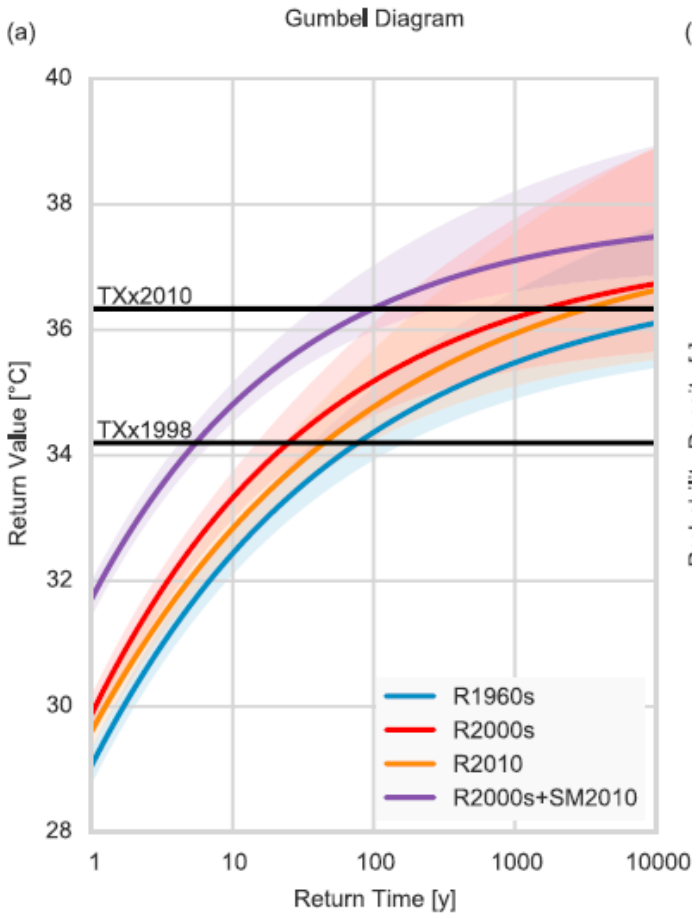


New since AR5 – Processes

« Process attribution »

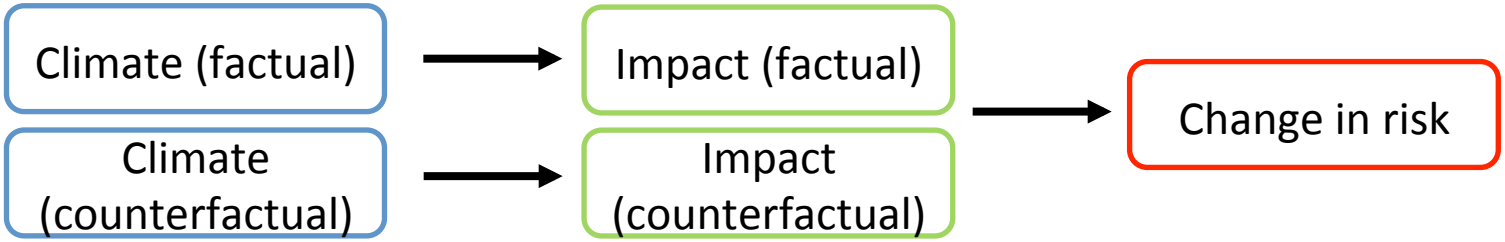
- How much the change of a process contributed to the change in the odds of an event?
- Dynamical vs. thermodynamical processes: changes in dynamics and thermodynamics can be « competing » or « collaborating » in changes (*eg Shepherd, 2016; Vautard et al., 2016; Yiou et al., 2017*)

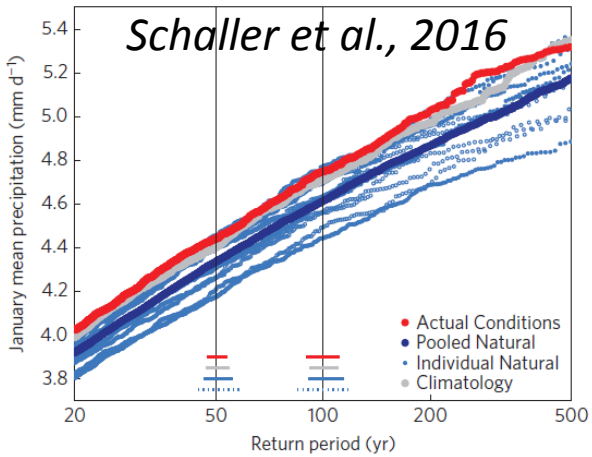
→ Key issues because uncertainty structure very different



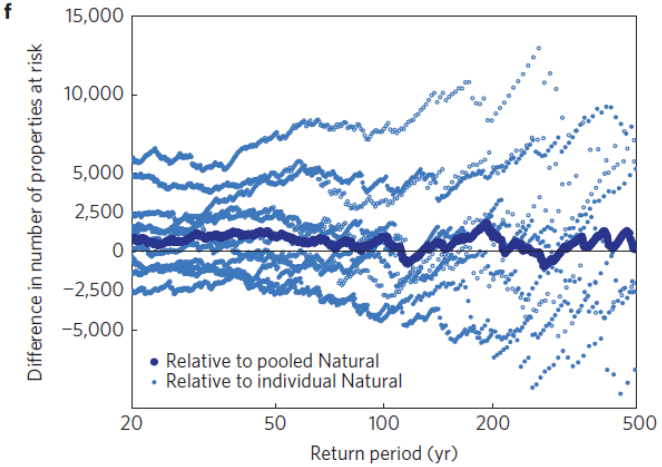
Role of soil moisture changes
Hauser and Seneviratne, 2016

Approaching impacts of events





Precipitation amount in JAN 2014, Thames river basin



Related properties at flood risk

Other cases on

- fire risk (eg Partain et al 2016; Krichmeier-young et al., 2017)

- But: only considers human influence on climate with fixed socio-economics

For further discussion

- Framing of detection and attribution [what is/are the question(s)]?
  - What is the appropriate end-point of an „attribution“ study: climate change or AF?
  - How do we bridge the gap between impact and climate attribution?
- How does attribution fit into a risk framework?
  - How can current impacts/risks inform about future risk?
  - Long term changes vs. single events, WGI s WGII?
- How can improved regional information help to better assess the current impacts of Climate Change?
  - Clarify relevant scales/resolution and representativeness of climate model data across climate variables, regions and and impact system
  - Can we do „on demand“ climate attribution assessments for specific regions
- Is a common WGI-WGII framework feasible?
  - How do we integrate multiple lines of evidence, qualitative and quantitative, from multiple models and methods,?
  - How do we make confidence assessments comparable across climate & impacts?
  - Can we develop a joint protocol?
  - How to organize the Workflow within WGI-CH10-11-12 and between WGII and WGI?
  - Would a Stone and Hansen approach be possible in AR6 and if so, what requirements from WGII to WGI? Where does the overarching analysis fit? How do we organize for that?

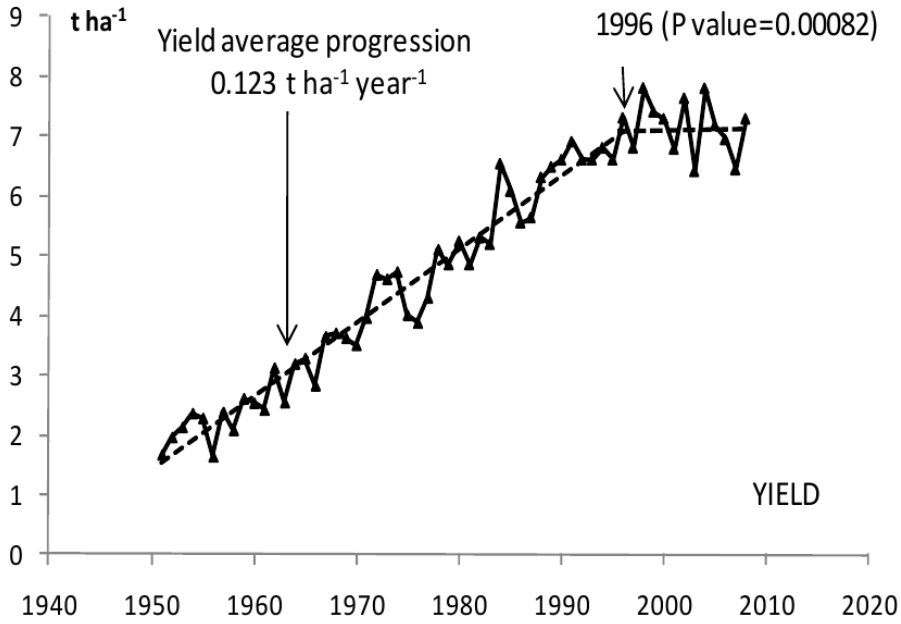
Thanks for your attention!

WGII: Baseline challenge: Declining wheat yields in France

Baseline:
Continued technological development

Climate Change:
Increased drought and warming

Other factors:
Environmental policy (N limitation)



Graphic source: Brisson et al., 2010

Risk approach in attribution: Events, long-term changes and risks

WGI	WGII
Long-term Change *Drivers? GHG AER, LUC, VOLC, SOLAR*	Long-term Impact *Drivers? CC+Socio-eco+..*
Many studies	*No of Studies depends on systems*
Extreme event *Change in probability due to human effect on climate*	Event Impact *Change in Risk due to human effect on climate* *Other drivers?*
Many studies	*Few studies as yet*

WGII: Baseline challenge: Disaster loss trends

Trend analysis for normalized disaster losses

Exposure main driver, no detectable climate signal

Accounting for changes in vulnerability and adaptation in the baseline may unmask the climate effect

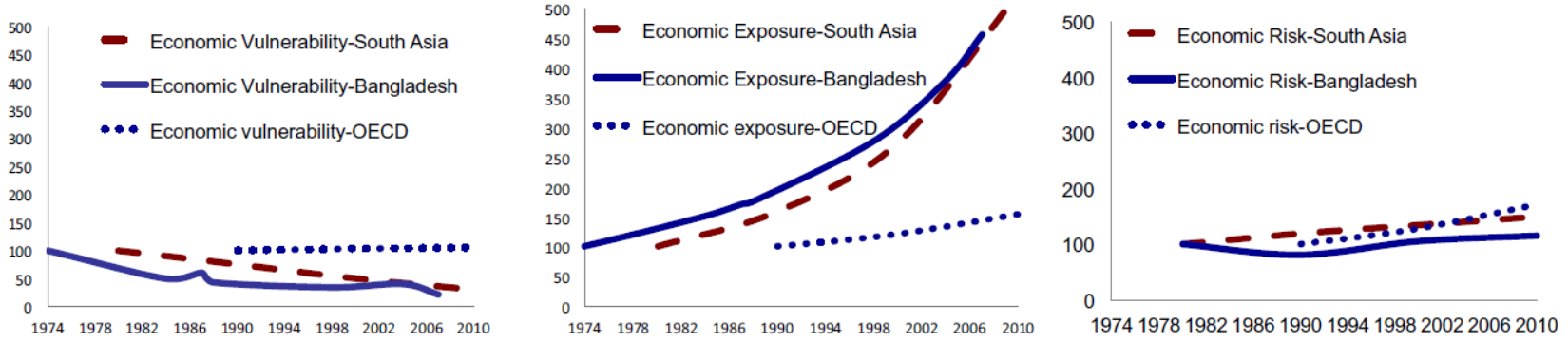


Fig. 4 Observed changes in economic vulnerability, exposure and risk for disaster risk in Bangladesh, South Asia, and the OECD (normalized to different years). Note: Hazard for Bangladesh and the OECD is flooding (marked in blue); for South Asia tropical cyclones (marked in red). Data sources: Tanner et al. 2007; UNISDR 2011

Mechler and Bouwer, 2015