Generating extreme weather event sets from very large ensembles of regional climate models

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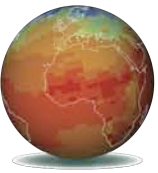

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Extreme weather events

- Definition: events that lie in the tail of the distribution of the corresponding meteorological variable and cause damage
- Examples:
  - High wind speeds / extra-tropical storms
  - Heat waves
  - Prolonged cold temperatures (cold snaps)
  - High precipitation
  - Prolonged low precipitation (drought)
- Can be split into two parts:
  - Meteorological hazard
  - Impact

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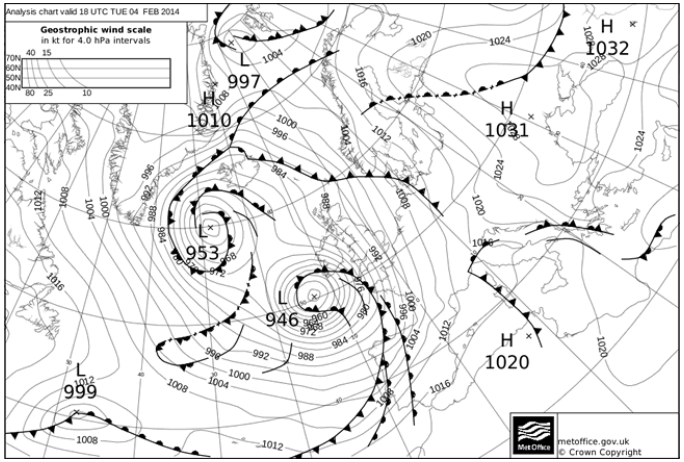
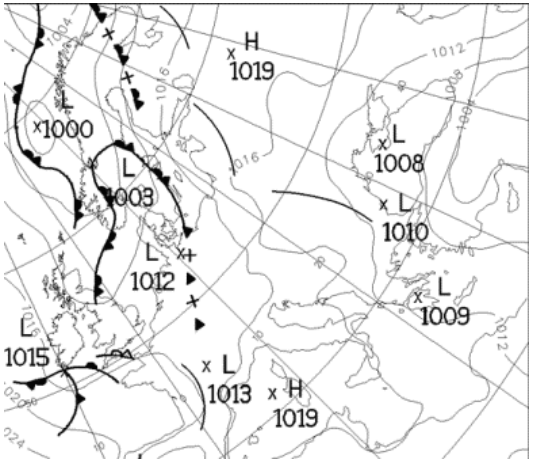
Extreme weather events

Storm surge UK Feb 2014 (Met. Office)
Collapse of railway embankment in Dawlish

Russian heat wave Aug 2010 (Met. Office). Pollution caused by forest fires





Meteorological hazard

- weather@home provides the spatial and temporal resolution to model the meteorological component of the extreme events
- 25km regional model embedded in a 1.875°x1.25° global model with up to 6 hourly diagnostic output
- Sufficient to drive impact models, although experiments may need to be targeted due to data volume constraints
- Atmosphere-only models, so the lower boundary has to be forced by prescribed sea-surface temperatures (SSTs) and sea-ice fraction (SIF)
- Initial condition perturbations and large ensembles allow the modelling of many events consistent with the climate forcing (i.e. the events which could happen)

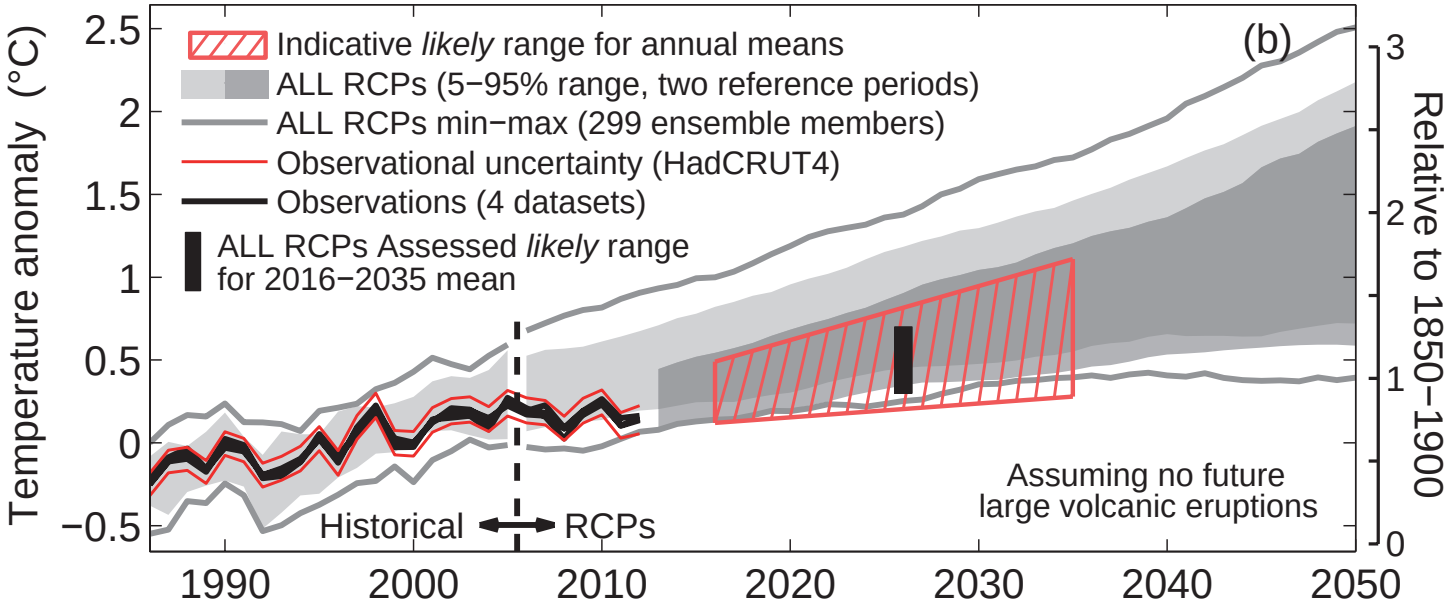
Outline

- Projections: Derivation of SSTs and sea ice as boundary conditions
- Example 1: drought events (MaRIUS)
- Example 2: wind storms (CREDIBLE)

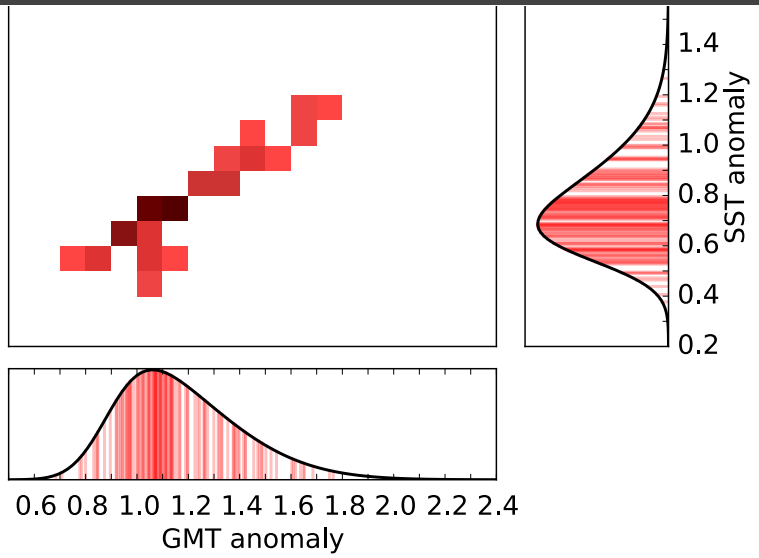
Projections: SST and sea ice

Likely range of GMSST projections

- Easiest method: calculate a number of warming anomalies from CMIP5 ensemble at a particular date
- Problem: the CMIP5 ensemble does not span the indicative likely range in the AR5 WG1 Ch 11 for near term projections

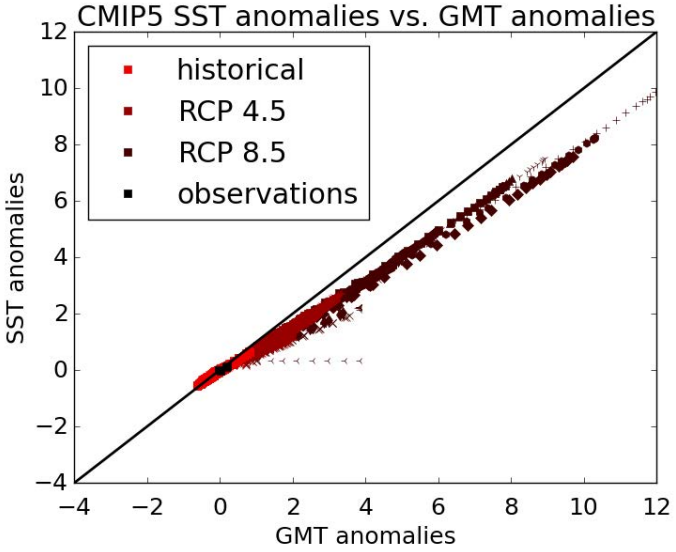


CMIP5 SST response



Uneven sampling of the GMSST response to elevated GHG / GMT

Response of GMSST is linearly proportional to response of GMT

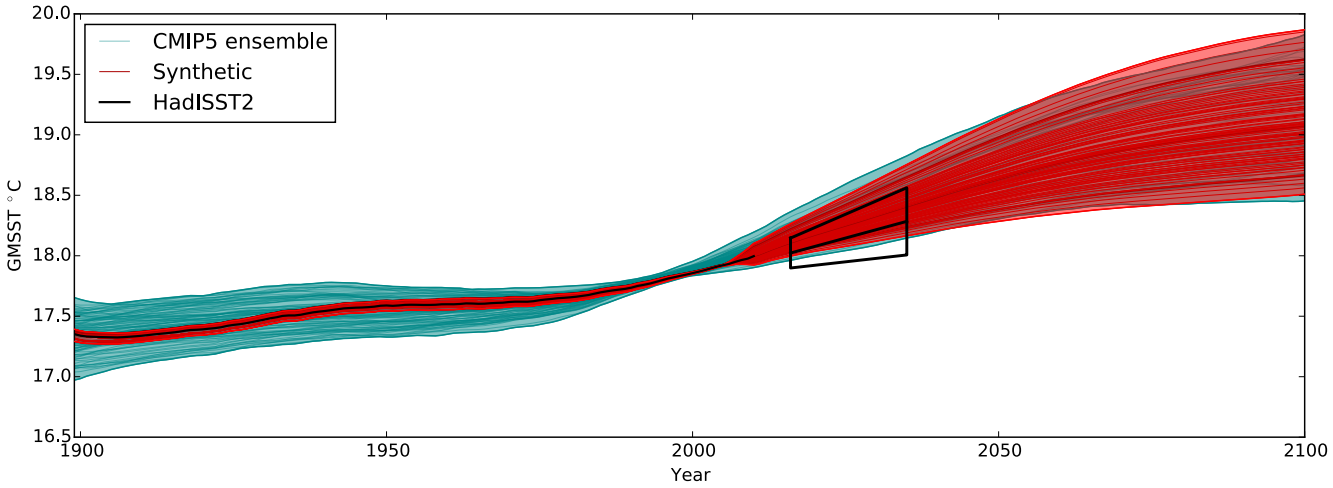


Projections into the future

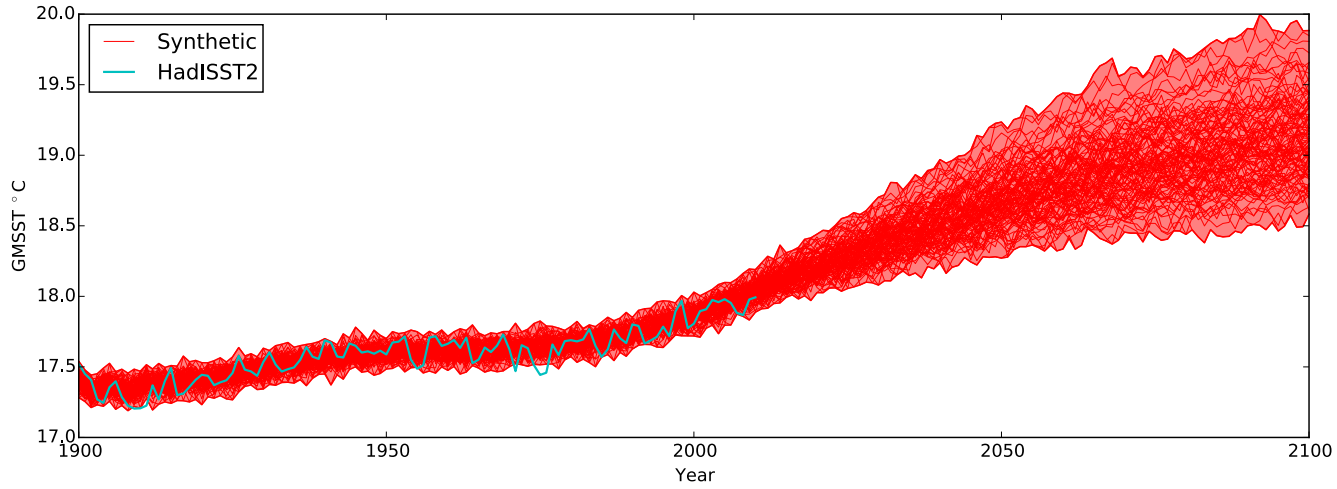
- To determine the changes in extreme events in the future, need projections of SST and SIF
- SSTs – split into 3 components:
  - Long term trend / warming signal: HadISST2 (historical) & CMIP5 models (future)
  - Inter-annual variability (stochastically generated based on HadISST2)
  - Annual cycle (HadISST2)

Reconstructed SSTs

Without internal variability RCP4.5



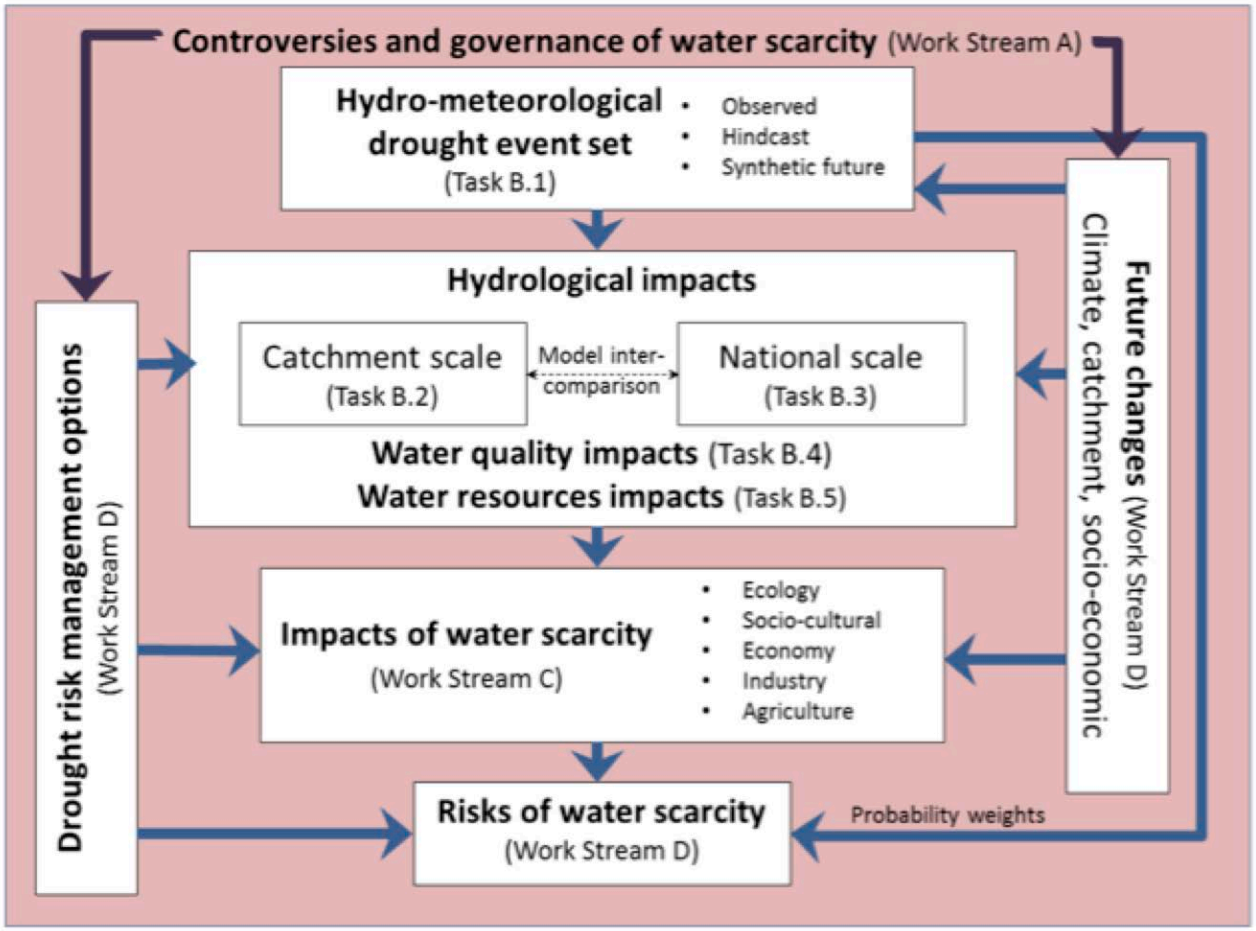
With internal variability RCP4.5



MaRIUS: Managing the Risks, Impacts and Uncertainties of drought and water Scarcity

Synthetic drought events

MaRIUS: Managing the Risks, Impacts and Uncertainties of droughts and water Scarcity (NERC, UK)



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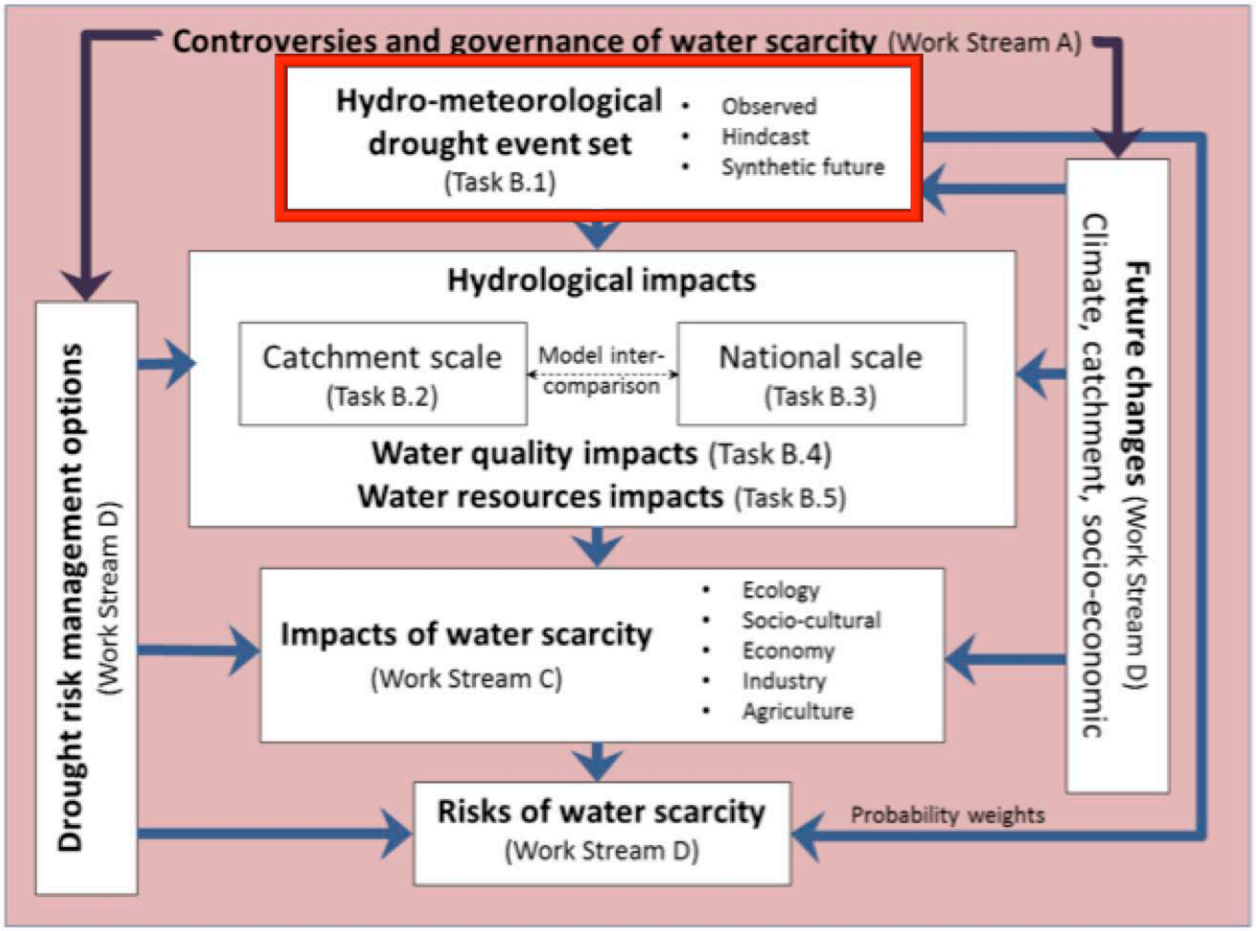

Drought event sets

HadRM3P over EU, 25km, MOSES 2 land-surface scheme

1. Hindcast of past-droughts: 20CR-driven runs from 1850-present

2. Synthetic event sets, with boundary conditions from HadAM3P
   a. Present: 1900-2014
   b. Future: 2030s and 2080s

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Synthetic drought event sets
Model

GCM

- HadAM3P with MOSES 2
- Observed SST/sea ice from HadISST2 (10 realizations)
- Initial conditions perturbations

RCM

- HadRM3P with MOSES 2

Synthetic drought event sets Experimental design

Multiple runs starting each year (1900-2014)

- Initial 2 years simulations
- Identification of “drying” simulations (SPI over the UK)
- Extension of “dry” cases to 5-10 years long runs (drying, drought, recovery)

-> Large number of multi-year drought events that could have occurred given the boundary forcing (GHG, solar…)

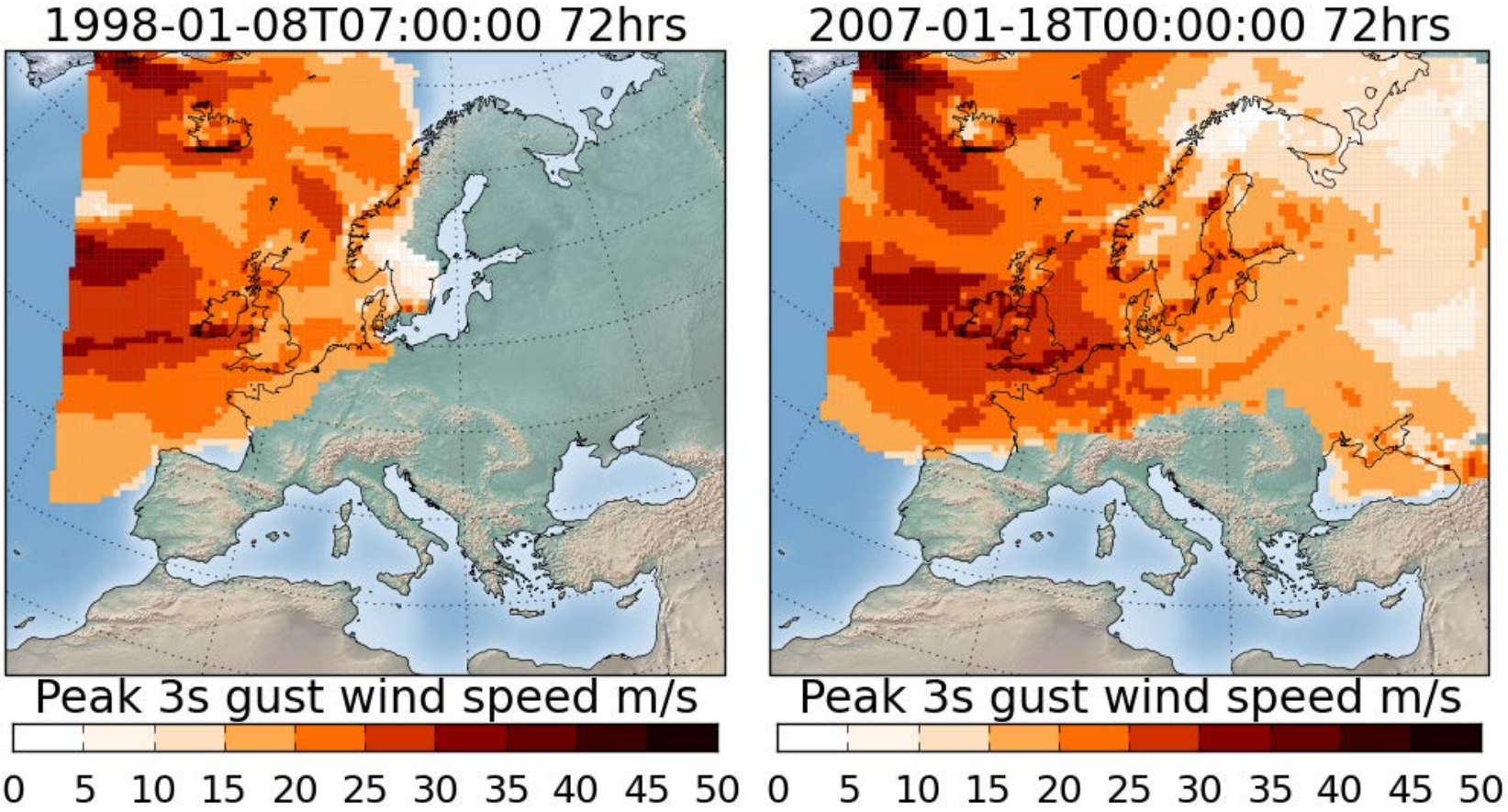
CREDIBLE: windstorms

Synthetic drought events

Analysis of synthetic windstorms

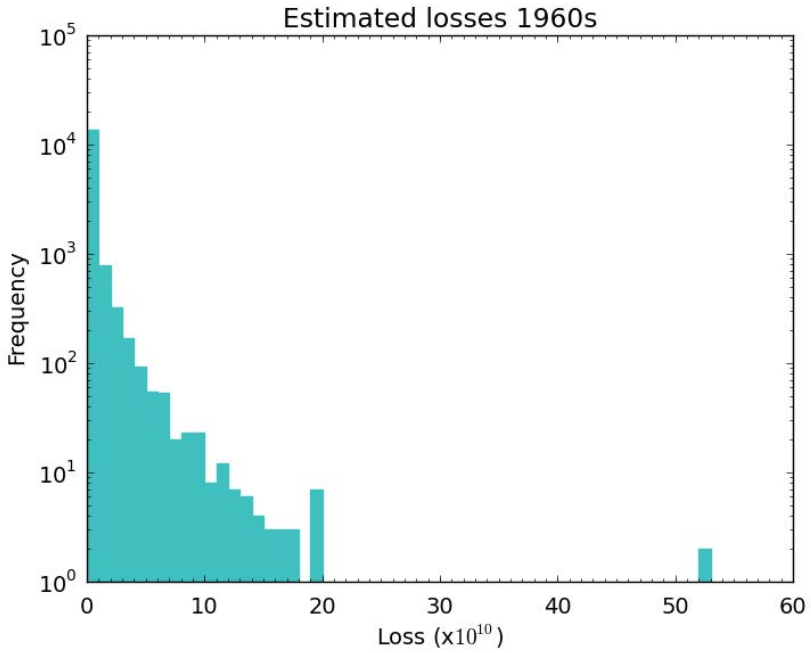
- Large ensemble of w@h runs from 1960 to 2010
- Objective feature detection and tracking algorithm applied to low-pressure systems over the North Atlantic and Europe
- Storm footprints defined as max winds over 72 hour period
- A simple population based loss model gives some indication as to the destructiveness of each storm
- Data reduction – 12TB of data transformed to <100GB, by selecting only events of interest (windstorms) and reducing the temporal resolution
- ~80,000 windstorms

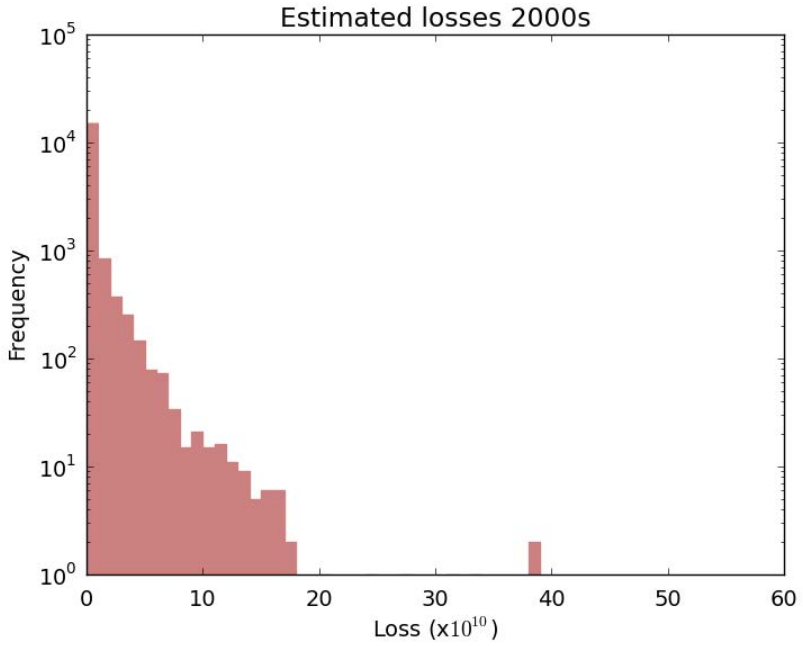
Synthetic windstorms



Synthetic windstorms

- Estimation of losses 1960s vs 2000s





	Sum	Mean	σ	Median	5th	95th
1960s	7277	0.48	1.42	0.11	0.00038	2.20
2000s	8788	0.52	1.44	0.12	0.00036	2.58

Thank you for your attention

Contact

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MaRIUS (drought events):
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