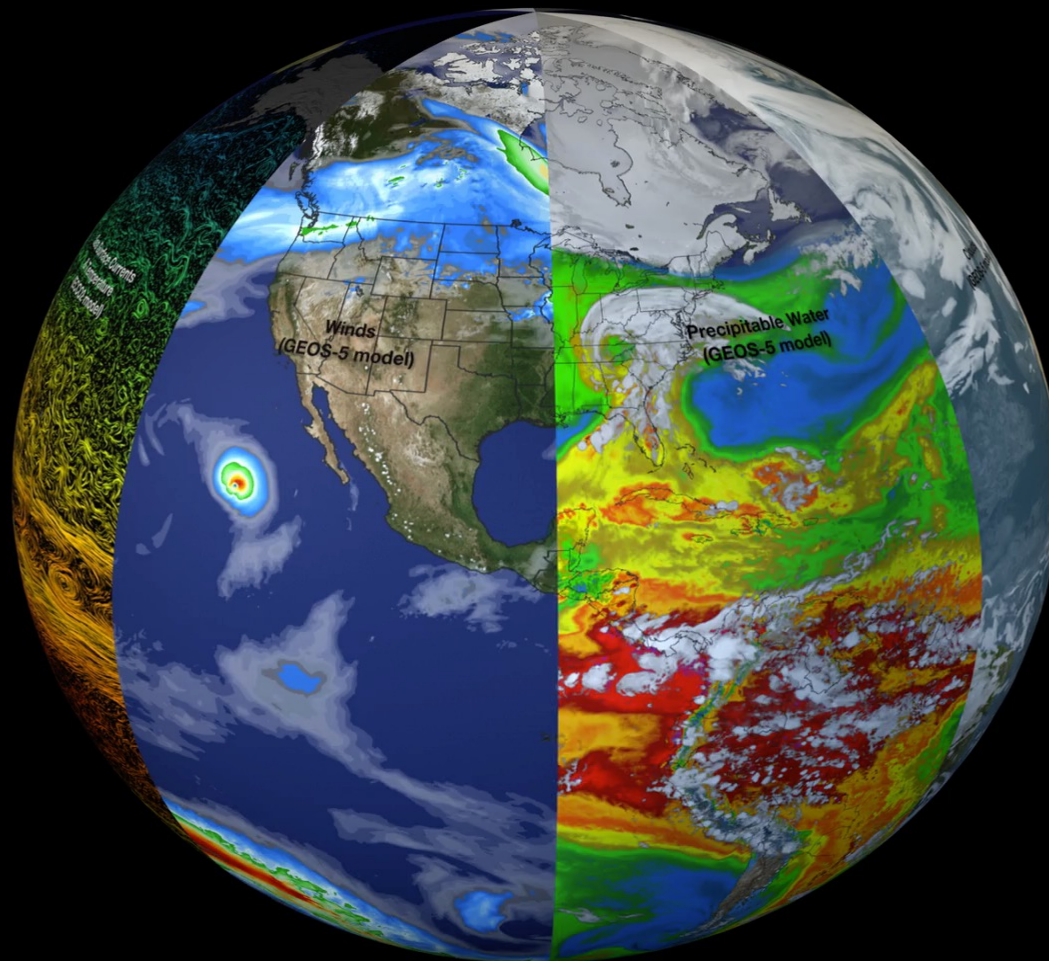


# Climate data and models

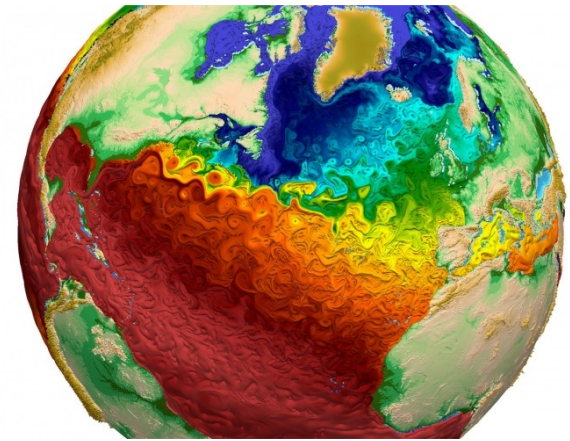
EDSML MSc – Imperial College London – **Environmental data**

Yves Plancherel - <https://www.linkedin.com/in/yves-plancherel/>



# Why discuss climate data and climate models?

- Growing/important field – with likely career opportunities
- Great playground to deliver learning objectives



## Learning objectives of the Environmental Data module

1. Understand common **data format** and **database** structures specific to representative fields of environmental science
2. Demonstrate technical **competency in handling common data types** routinely encountered in the environmental sciences and identify relevant open-source data repositories
3. **Identify and design suitable data analysis strategies** that consider data types, data distribution constraints, strength, benefits and limitations of statistical and modelling tools and environmental dynamics.
4. Understand **the limitation of available data and data analysis products**. Understand sources of errors and demonstrate **ability to comprehensively characterize uncertainties** and interpret results in the context of these uncertainties, including measurement errors, environmental uncertainties as well as errors stemming from the analytical procedure itself (e.g. calibration of analysis using synthetic data/models).



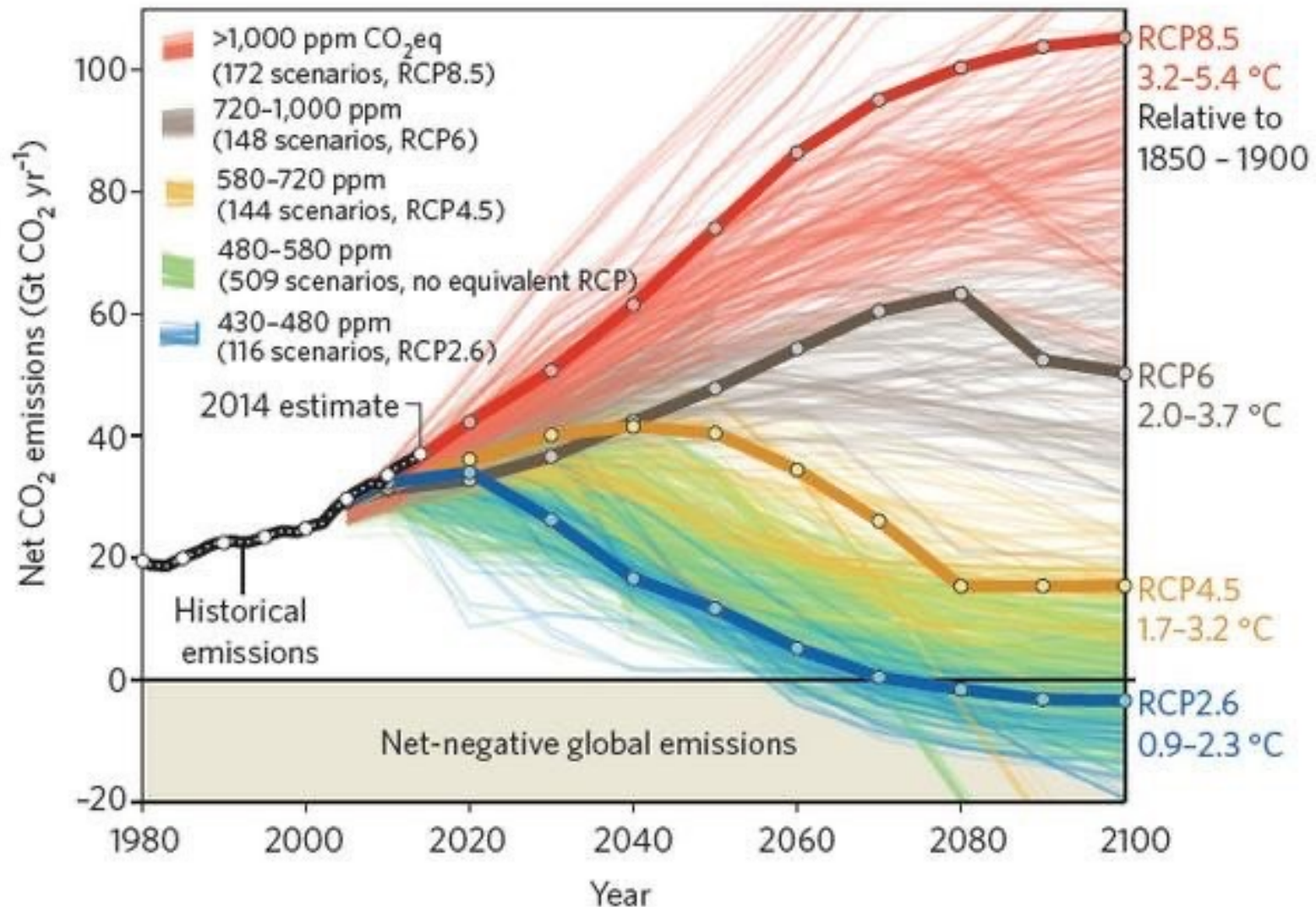
# Using climate models: quantification/forecasting (impacts, adaptation, mitigation)



A collage of typical climate and weather-related events: floods, heatwaves, drought, hurricanes, wildfires and loss of glacial ice.

(NOAA) <https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts>

# Using climate models: **design scenarios** (explore policy, technology options)





# Using climate models: variability (temporal, spatial)

You need high frequency data to make a high frequency prediction

Red line (experiment) is consistently decreasing over time. Based on this, we can be confident on the change over time but not confident on the magnitude (magnitude is not consistent).

Importance of experimental design!

Control  
+  
experiment

The difference between the control and experiment can be accurate even though the end state is not accurate.

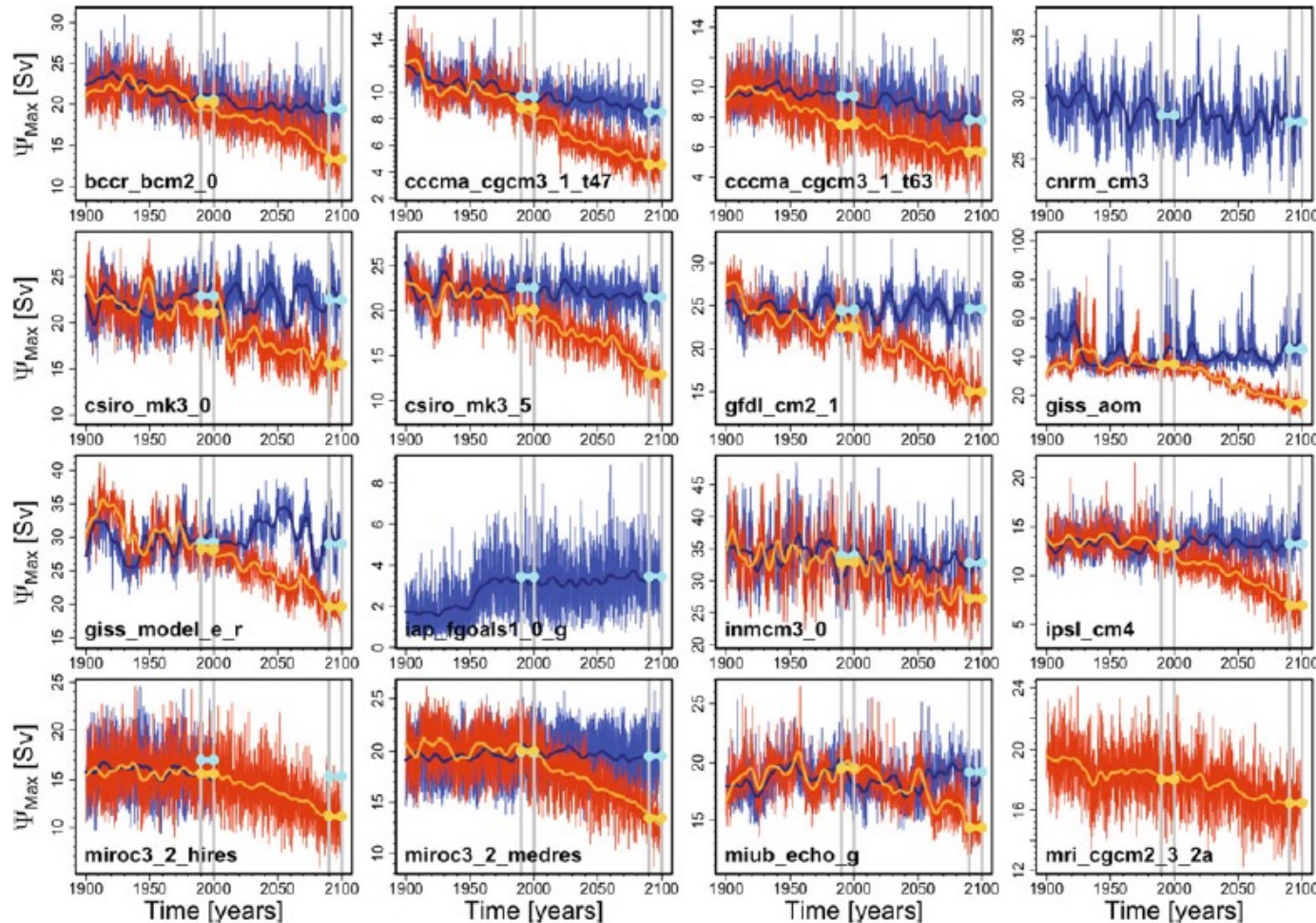
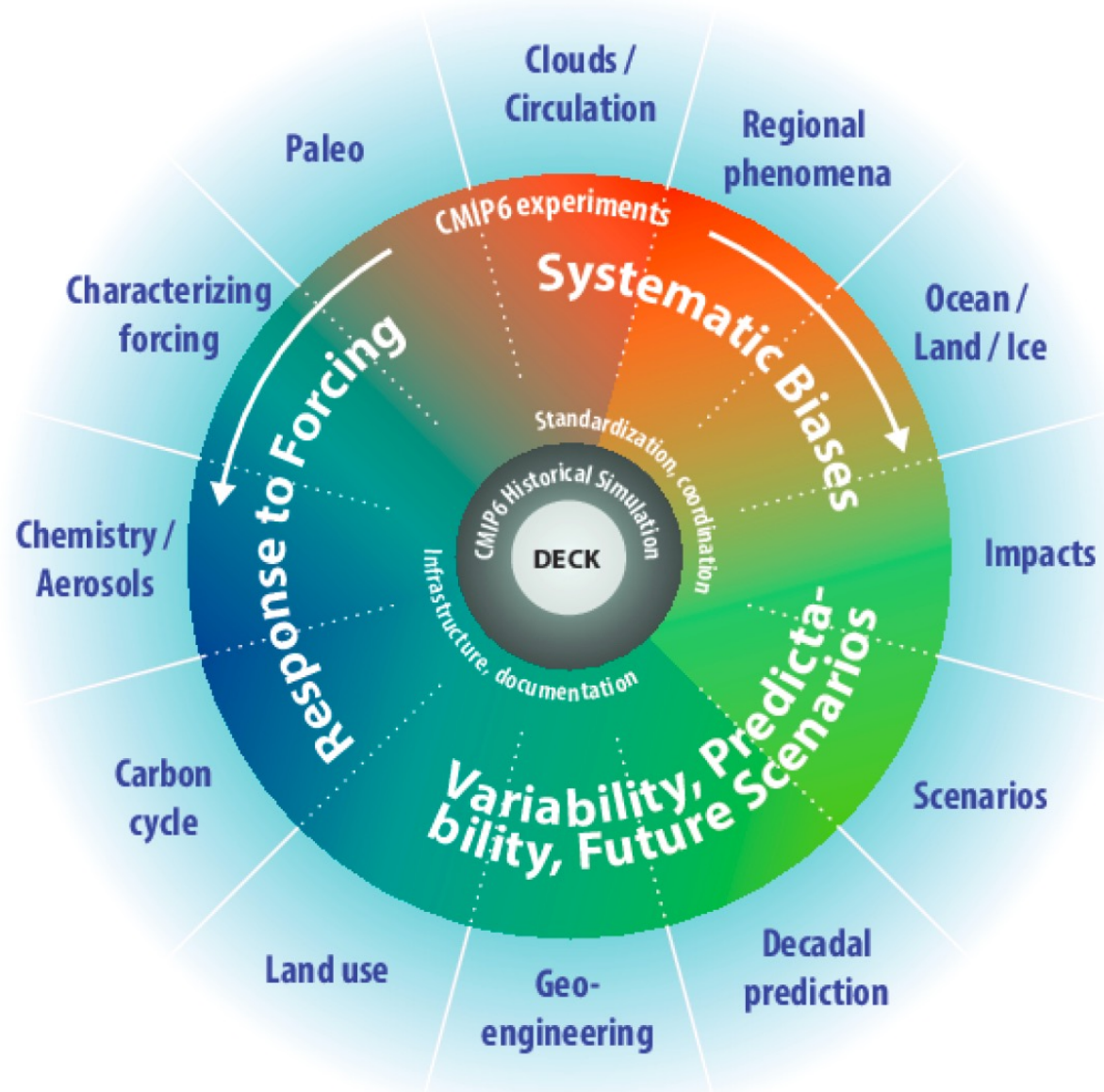


Fig. 3 Time series of the  $\Psi_{max}$  overturning index. Vertical grey lines mark the 1990s and 2090s. The mean values of the indices for these periods, isolated by predictions of linear fits, are shown as cyan

(PICNTRL) and gold (20C3M, SRESA2/A1b) line segments. The dark blue and orange solid lines are deseasonalized loess-filtered trend lines with span windows of 10 years

# Using climate models: **uncertainties and sensitivities**

**MIP = Model Intercomparison Project**



# Using climate models: **uncertainties and sensitivities**

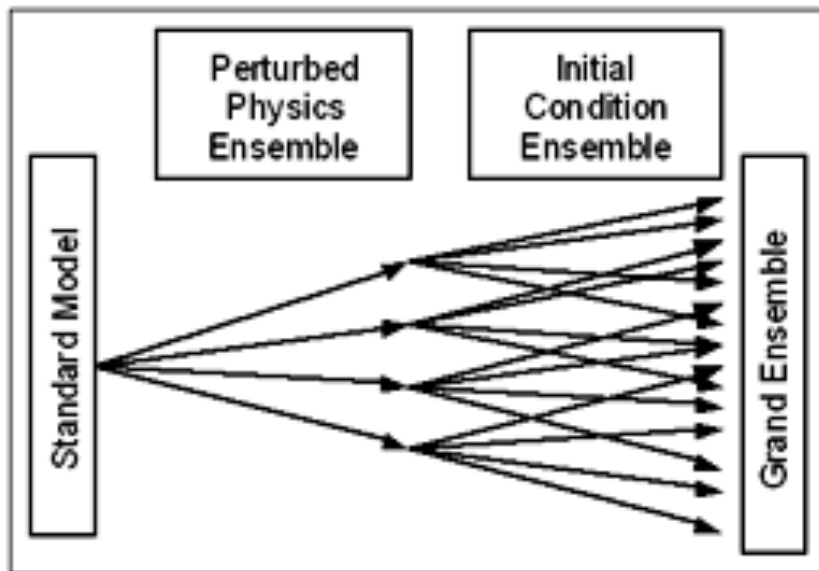
**Real world data:** we only have one Earth, ONE realization

**Model data:** we do what the @\$ we want 😊!

- ...as long as we can calculate it and analyze it
- ... and are **aware of model flaws!**

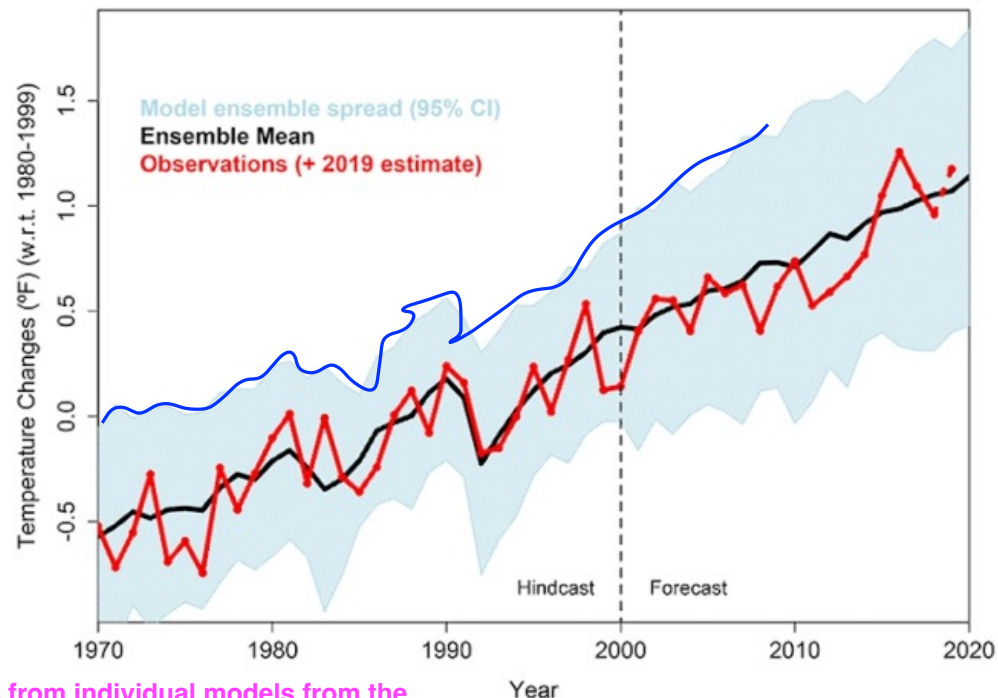
Different experiments  
with **many ensembles!**

Each one trying to account for  
sensitivity due to a source of error



[https://en.wikipedia.org/wiki/Climate\\_ensemble](https://en.wikipedia.org/wiki/Climate_ensemble)

Forecast evaluation for models run in 2004



The blue is the spread of values from individual models from the ensemble. If you only looked at 1 model, you might be unlucky and predict the extremes of the blue span (example blue line drawn). The black line is the black line which is very good. It agrees with the red observations. Adding the models suppresses the uncertainty in each one.



# Using climate models: attribution

Whose fault is it?



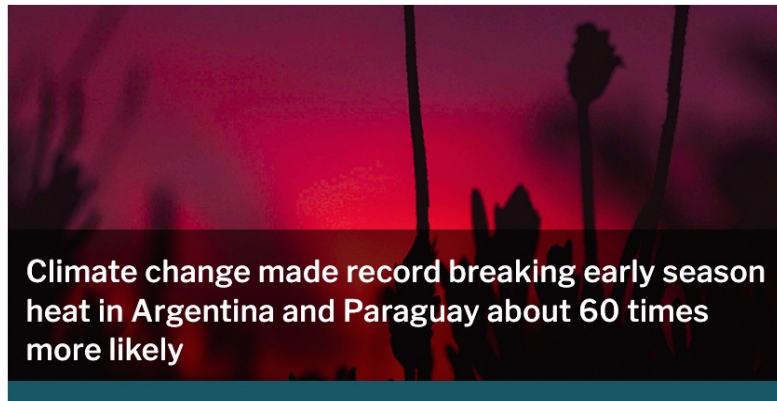
Who pays for it?



world weather attribution

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<https://www.worldweatherattribution.org>



## Cold spells

Unusual cold spells can occur even in a warming world, and cause disruption to transport, energy & food supplies.

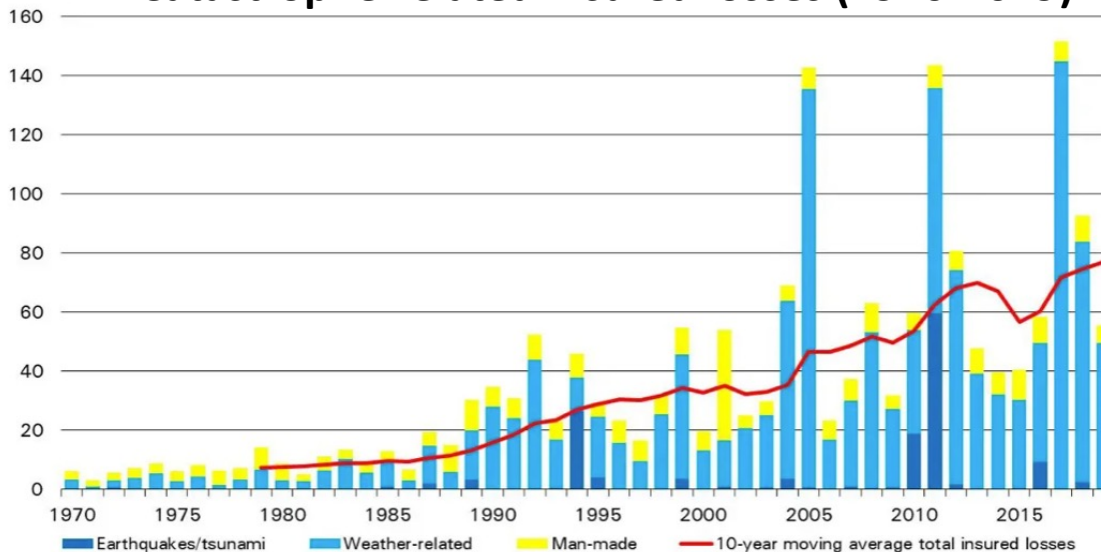


## Drought

Drought affects people in many ways, from reduced water & food supplies to increasing the risk of wildfires.

in USD bn,  
at 2019 prices

## Catastrophe-related insured losses (1970-2019)



Argentina, and also southern Bolivia, experienced record-breaking temperatures in early December 2022.

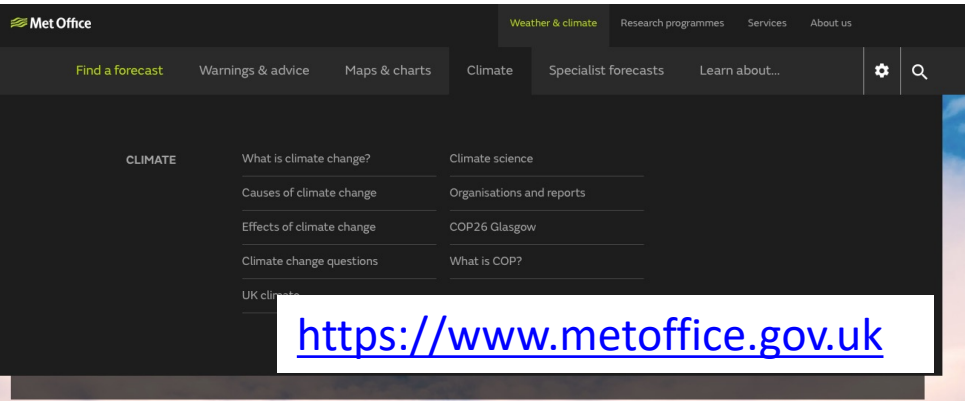
<https://www.swissre.com/media/news-releases/nr-20191219-global-catastrophes-estimate.html>



# Climate extremes and climate risk

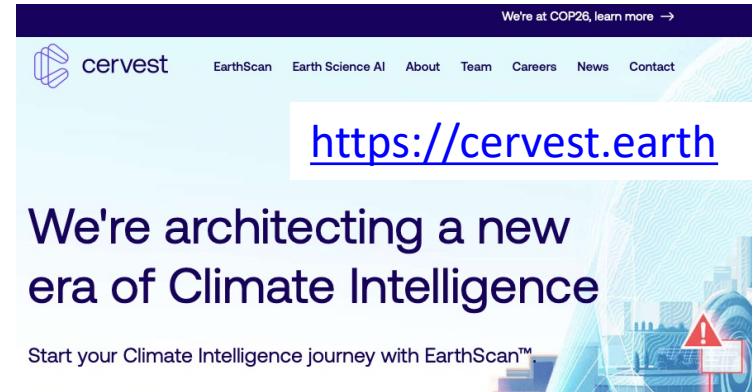
- Magnitude How many days go over X degC in a year? (a measure of magnitude)
  - Frequency How frequent were the days over X degC? Did they all happen in a short time period?
  - Duration How long did event X last for?
  - Spatial extent
  - What variable?
    - T, Precipitation, winds, sea level, etc.
- Humans
  - Infrastructures
  - Agriculture
  - Biodiversity
  - Landscape
  - GDP
  - Administration
  - Policy
  - ...

# The business (and opportunities) of climate



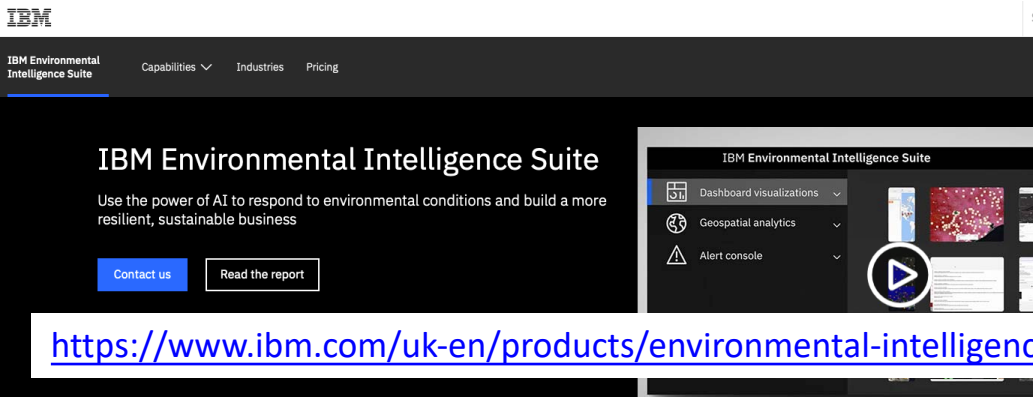
The screenshot shows the Met Office website with a dark theme. The navigation bar includes 'Weather & climate', 'Research programmes', 'Services', and 'About us'. A secondary bar has 'Find a forecast', 'Warnings & advice', 'Maps & charts', 'Climate', 'Specialist forecasts', and 'Learn about...'. The main content area is titled 'CLIMATE' and lists various topics like 'What is climate change?', 'Causes of climate change', 'Effects of climate change', 'Climate change questions', 'UK climate', 'Climate science', 'Organisations and reports', 'COP26 Glasgow', and 'What is COP?'. A URL box is overlaid at the bottom.

<https://www.metoffice.gov.uk>



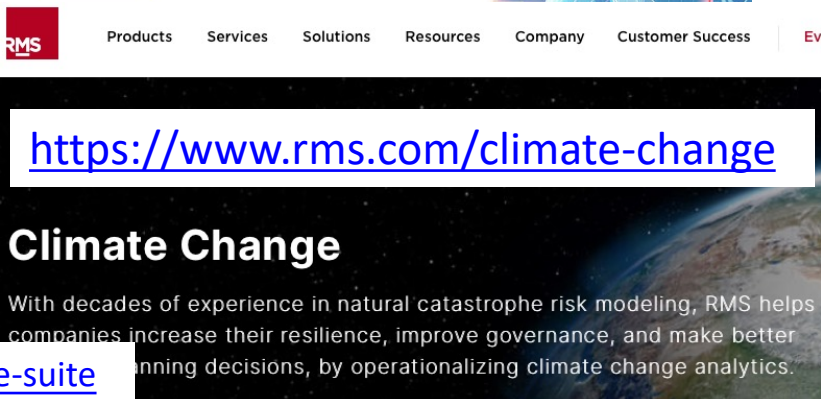
The screenshot shows the Cervest website with a light blue theme. The navigation bar includes 'EarthScan', 'Earth Science AI', 'About', 'Team', 'Careers', 'News', and 'Contact'. The main headline reads 'We're architecting a new era of Climate Intelligence'. Below it, a sub-headline says 'Start your Climate Intelligence journey with EarthScan™'. A URL box is overlaid at the top right.

<https://cervest.earth>



The screenshot shows the IBM Environmental Intelligence Suite website with a dark theme. The navigation bar includes 'Capabilities', 'Industries', and 'Pricing'. The main headline reads 'IBM Environmental Intelligence Suite'. Below it, a sub-headline says 'Use the power of AI to respond to environmental conditions and build a more resilient, sustainable business'. There are two buttons: 'Contact us' and 'Read the report'. A URL box is overlaid at the bottom.

<https://www.ibm.com/uk-en/products/environmental-intelligence-suite>



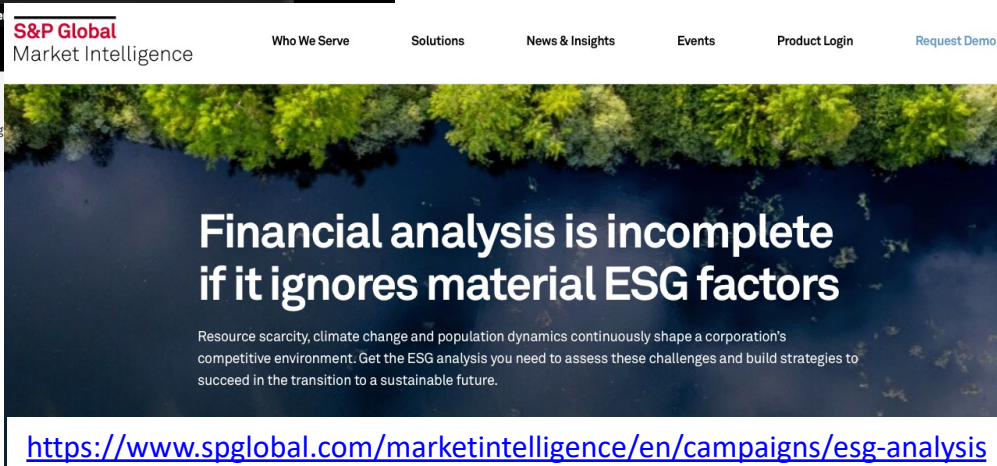
The screenshot shows the RMS website with a dark theme. The navigation bar includes 'Products', 'Services', 'Solutions', 'Resources', 'Company', and 'Customer Success'. The main headline reads 'Climate Change'. Below it, a sub-headline says 'With decades of experience in natural catastrophe risk modeling, RMS helps companies increase their resilience, improve governance, and make better planning decisions, by operationalizing climate change analytics.' A URL box is overlaid at the top.

<https://www.rms.com/climate-change>



The screenshot shows the UK Climate Risk website with a dark theme. The navigation bar includes 'HOME', 'ABOUT', and 'INDEPENDENT ASSESSMENT (CCRA3)'. The main headline reads 'Independent Assessment of UK Climate Risk (CCRA3)'. Below it, a sub-headline says 'Read our comprehensive assessment of the risks and opportunities facing the UK from climate change.' A URL box is overlaid at the top.

<https://www.ukclimaterisk.org>



The screenshot shows the S&P Global Market Intelligence website with a dark theme. The navigation bar includes 'Who We Serve', 'Solutions', 'News & Insights', 'Events', 'Product Login', and 'Request Demo'. The main headline reads 'Financial analysis is incomplete if it ignores material ESG factors'. Below it, a sub-headline says 'Resource scarcity, climate change and population dynamics continuously shape a corporation's competitive environment. Get the ESG analysis you need to assess these challenges and build strategies to succeed in the transition to a sustainable future.' A URL box is overlaid at the bottom.

<https://www.spglobal.com/marketintelligence/en/campaigns/esg-analysis>

# Business risk and climate analytics

... an emerging field! Get involved now – probably lots of good opportunities in that sector!

<https://www.nature.com/articles/s41558-020-00984-6>

nature  
climate change

PERSPECTIVE

<https://doi.org/10.1038/s41558-020-00984-6>



## Business risk and the emergence of climate analytics

Tanya Fiedler<sup>1</sup>, Andy J. Pitman<sup>2</sup>✉, Kate Mackenzie<sup>3</sup>, Nick Wood<sup>4</sup>, Christian Jakob<sup>5</sup> and Sarah E. Perkins-Kirkpatrick<sup>2</sup>

**Emerging awareness of climate-related financial risk has prompted efforts to integrate knowledge of climate change risks into financial decision-making and disclosures. Assessment of future climate risk requires knowledge of how the climate will change on time and spatial scales that vary between business entities. The rules by which climate science can be used appropriately to inform assessments of how climate change will impact financial risk have not yet been developed. In this Perspective, we summarize the demands by the business and finance community for reliable climate information, and the potential and limitations of such information in the context of what climate models can and cannot currently provide.**



## Climate services

Fiedler et al. 2021 advocate for a reorganization of climate science highlighting the need for **climate projection to be professionalized as an operational service (b)**

i.e. the way the field of climate science works will evolve in the next few years

**Fig. 1: Current and proposed connections between climate research and business.**

From: [Business risk and the emergence of climate analytics](#)

