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Actuaries Climate Index

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Outline

- Resource and Environment Board
- Actuaries Climate Index



Resource and Environment Board



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Recent activities

- Sustainability and the financial system
- Climate change: Chatham House, FCO and PRA
- Stranded assets
- CPD and networking events
- Newsletter



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Actuaries Climate Index



Progress

- CIA, SoA, CAS, AAA
- Phase I: research report
<https://www.soa.org/Research/Research-Projects/Risk-Management/research-2012-climate-change-reports.aspx>
- Phase II: develop Actuaries Climate Index and Actuaries Climate Risk Index
- Expected release: 2015

Aims

- Easy to understand
- Compelling in its illustration of climate change
- Serves and educates public
- Enhance profession



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What does it measure?

- Components: high and low temperature, precipitation, drought, high winds, sea level
- Public data sources
- Canada & USA
- Base period: 1961-1990, five year moving average



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Combining components

- Components have different units and levels of noise
- Change (“anomaly”) relative to 1961-1990 base period
- Normalise anomaly wrt standard deviation over base period:
Eg: $TX90' = \Delta TX90 / \sigma_{ref}(TX90)$
- The “Common Sense Climate Index”

The ACI defines “normal” climatic variations as falling within $\pm 1\sigma$ of the seasonal mean reference period value



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Temperature

- Data from the Global Historical Climatological Network (GHCN)
- GHCNDEX Indexes based on the data:
 - TX90: % of warm days exceeding 90%ile base period T
 - TN90: % of warm nights exceeding 90%ile base period T
 - TX10: % of cold days less than 10%ile base period T
 - TN10: % of cold nights exceeding 10%ile base period T

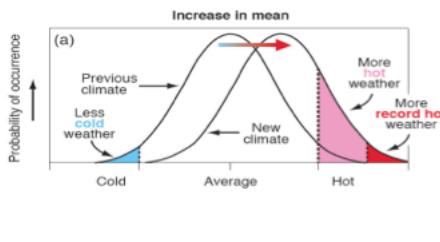


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Temperature

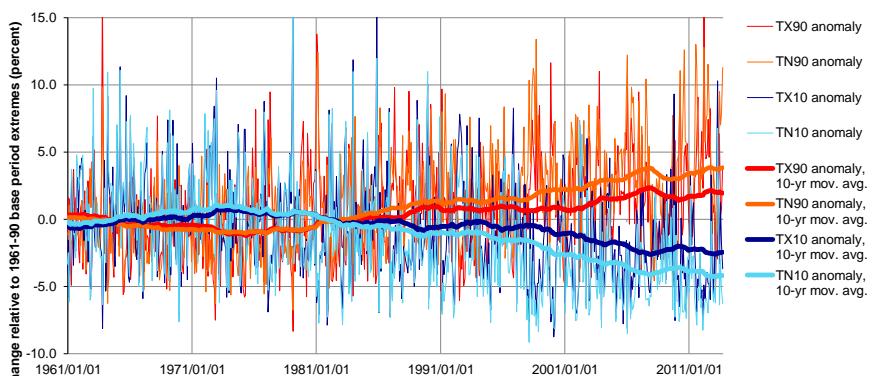
- Change (“anomaly”) relative to 1961-1990 base period
- Composite index to express changes in all extremes:

$$\Delta T_X = 0.5 * (\Delta TX90 + \Delta TN90) - 0.5 * (\Delta TX10 + \Delta TN10)$$



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Changing Temperature Extremes since 1960



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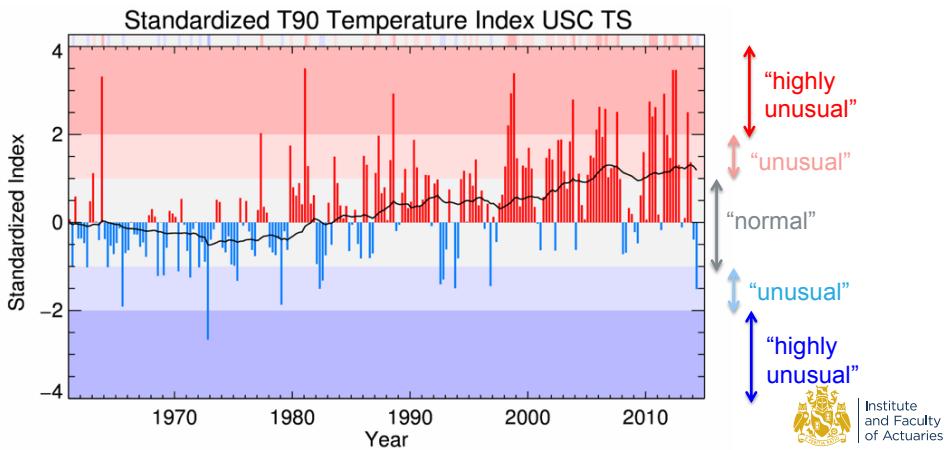
Composite Temperature Index, ΔT_X



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Index T90: Excess frequency of warm days and nights

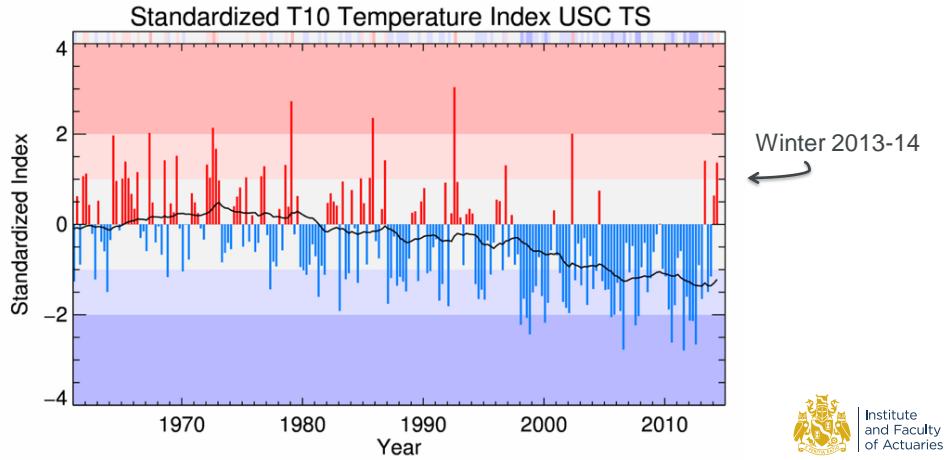
$$T90' = \frac{\Delta TX90}{2 \times \sigma_{ref}(TX90)} + \frac{\Delta TN90}{2 \times \sigma_{ref}(TN90)}$$



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Index T10: Excess frequency of cool days and nights

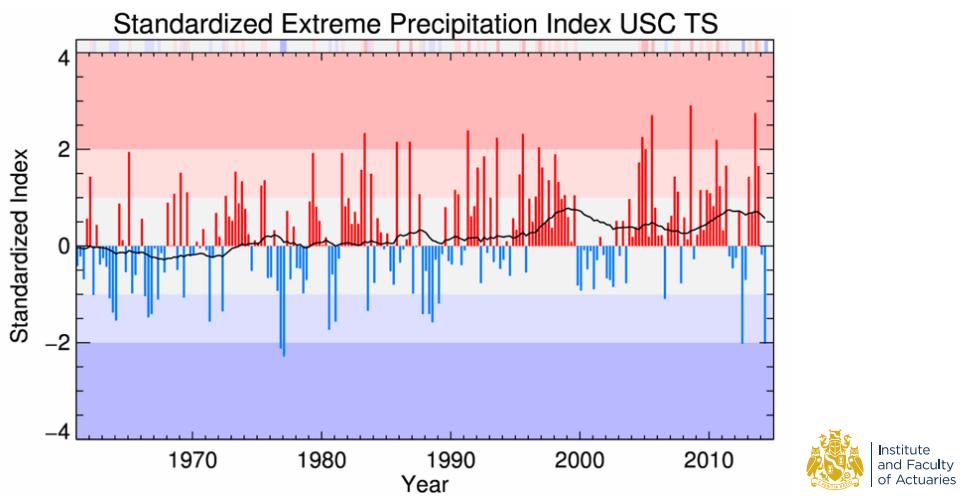
$$T10' = \frac{\Delta TX10}{2 \times \sigma_{ref}(TX10)} + \frac{\Delta TN10}{2 \times \sigma_{ref}(TN10)}$$



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Extreme precipitation

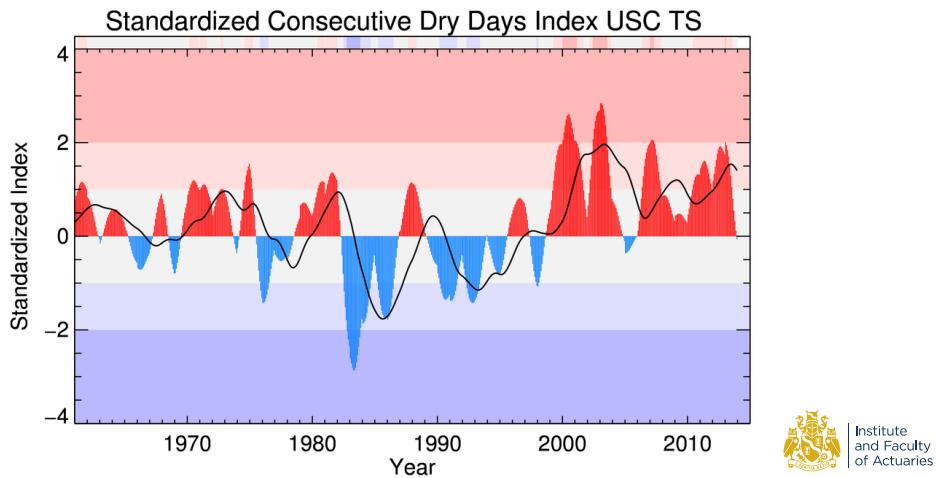
GHCNDEX maximum 5-day precipitation amount in a month: P_X



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Drought

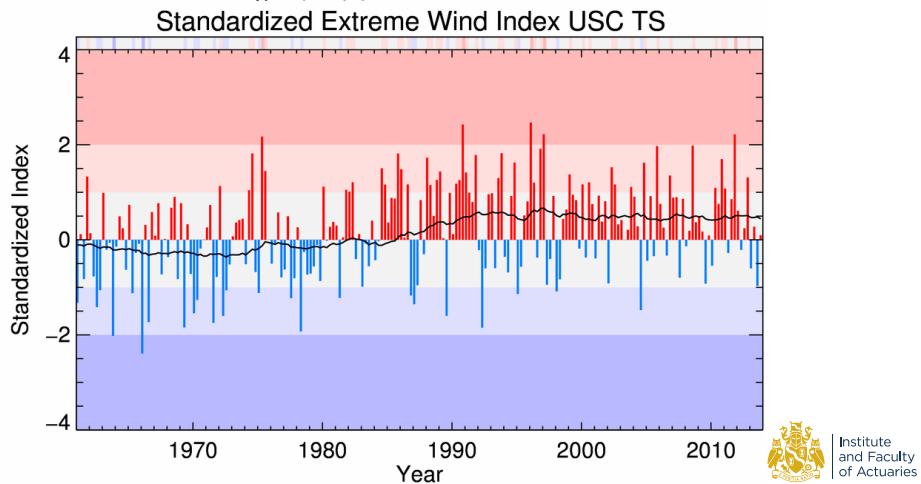
GHCNDEX consecutive dry days in a calendar year: D'_X



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Wind

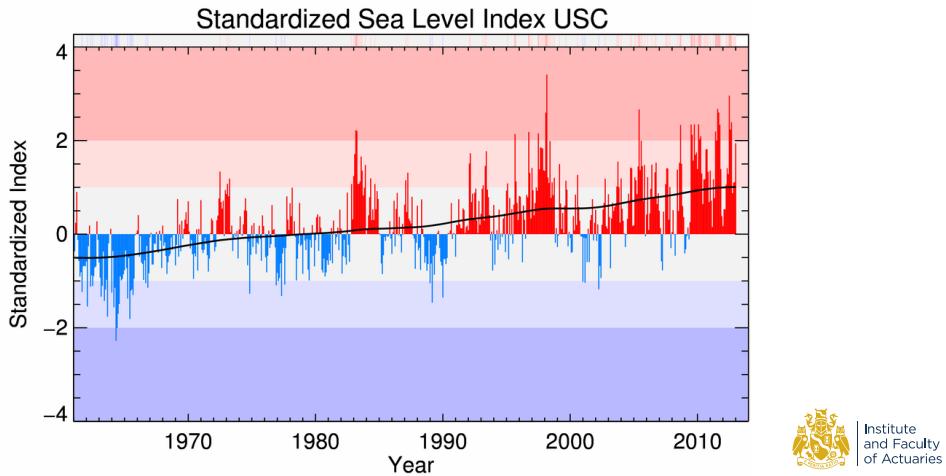
NCEP Reanalysis 90th percentile monthly wind power/destructiveness, derived from daily wind speed (v):
 $W'_X = (1/2) * \rho * v^3$



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Sea level

Monthly tide gauge (sea level)
measurements from 76 stations with 40-year
minimum records over U.S. and Canada: S'



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Composite ACI: Putting it all together

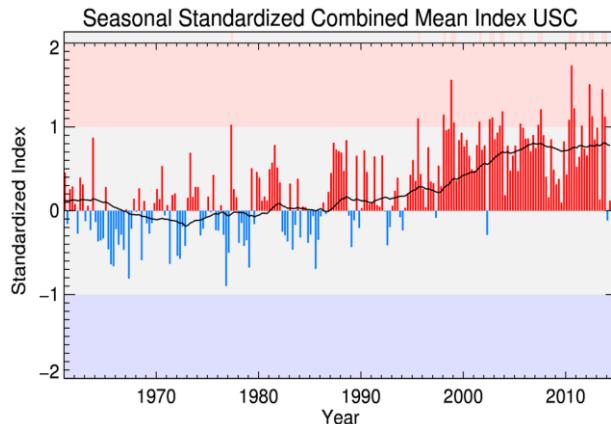
$$ACI = \text{mean}(T90' - T10' + P'_X + D'_X + W'_X + S')$$

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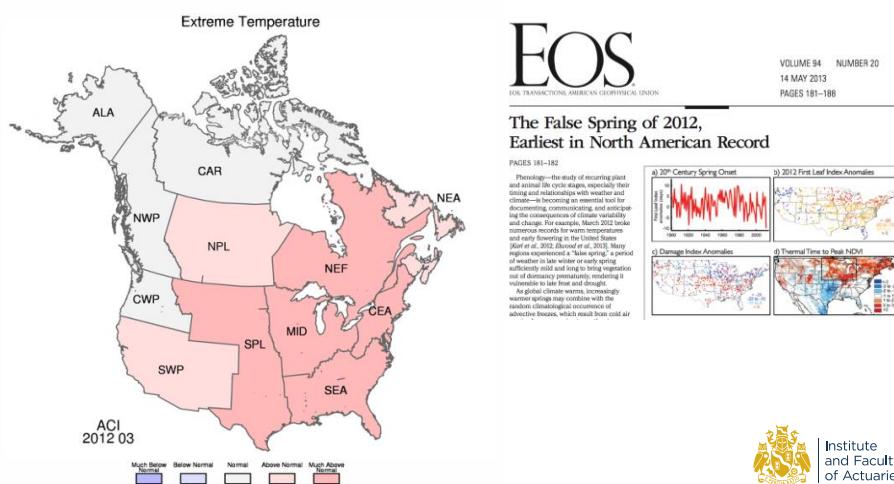
Composite seasonal ACI



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ACI: Validation and regional breakdown

Example from prototype website for March, 2012



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ACI summary

- Supports scientific consensus on climate change:
- Monitoring tool
- Website
- Quarterly updates



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Actuaries Climate Risk Index (ACRI)

- Incorporating the effects of changes
- Goal is to provide an index that is especially useful to the insurance industry
- Relationships between climatic and socioeconomic factors



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ACRI framework

In the language of risk, ACI represents hazard (H). By adding population/ economic exposure (PE) and vulnerability (V) components, can transform the ACI into the ACRI:

$$K = C f(H) g(P) s(V),$$

$$K = C \times (PE)^\alpha \times V_1^{\alpha 1} \times V_2^{\alpha 2} \times V_3^{\alpha 3} \times \dots$$

$$\ln(K) = \ln(C) + \alpha \ln(PE) + \alpha_1 \ln(V_1) + \alpha_2 \ln(V_2) + \dots$$

K : risk index (ACRI),

H : hazard (ACI),

P : population/assets

PE : physical exposure, $= H \times P$

V : vulnerability factors; e.g., GDP/capita, percentage cropland, etc.

C : proportionality constant

α_i : regression coefficients

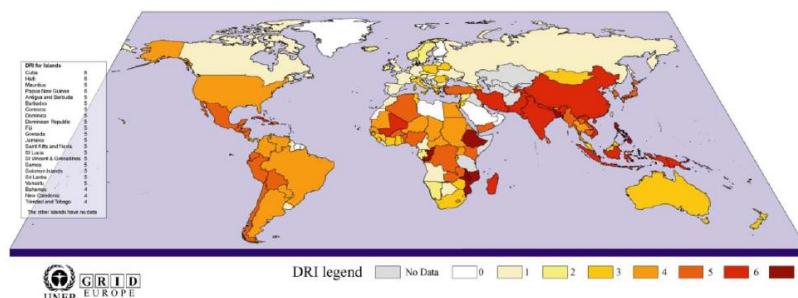


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Disaster risk index

An example of this approach is the Disaster Risk Index of Peduzzi et al. (2009):

The Disaster Risk Index (DRI)



Peduzzi et al. (2009), Assessing global exposure and vulnerability towards natural hazards: the Disaster Risk Index. *Nat. Hazards and Earth Sys. Sci.*, 4, 1149.



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What about us?

- Feasibility study for extending to UK/Europe
- Is the data available?
- Is the methodology suitable?
- Separate website or separate section of existing website?
- IP and branding issues



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Discussion

- Do you envisage using the ACI in your work? How?
- How useful would it be to extend it to other territories?
- How useful will the ACRI be?
- What would you like to see the R&E Board doing?



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