Outline

- Resource and Environment Board
- Actuaries Climate Index
Resource and Environment Board

Actuaries Climate Index
Progress

• CIA, SoA, CAS, AAA
• Phase I: research report
• 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
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

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:
  \[ TX90' = \Delta TX90 / \sigma_{\text{ref}}(TX90) \]
- The “Common Sense Climate Index”

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

Temperature

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

\[ \Delta T_X = 0.5(\Delta TX90 + \Delta TN90) - 0.5(\Delta TX10 + \Delta TN10) \]
Changing Temperature Extremes since 1960

Composite Temperature Index, $\Delta T_x$
Index T90: Excess frequency of warm days and nights

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

Index T10: Excess frequency of cool days and nights

\[ T10' = \frac{\Delta TX10}{2 \times \sigma_{\text{ref}(TX10)}} + \frac{\Delta TN10}{2 \times \sigma_{\text{ref}(TN10)}} \]
Extreme precipitation

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

Drought

GHCNDEX consecutive dry days in a calendar year: $D_X$
Wind

NCEP Reanalysis 90th percentile monthly wind power/destructiveness, derived from daily wind speed ($v$):

$$W' = \frac{1}{2} \rho v^3$$

Sea level

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

Monthly soil moisture anomaly from NOAA Climate Prediction Center: $M'$

Composite ACI: Putting it all together

$$ACI = \text{mean}(T_{90}' - T_{10}' + P'_X + D'_X + W'_X + S')$$
Composite seasonal ACI

ACI: Validation and regional breakdown

Example from prototype website for March, 2012
ACI summary

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

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
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:

\[ K = C f(H) g(P) s(V), \]

\[ K = C \times (PE)^{\alpha_1} \times V_1^{\alpha_2} \times V_2^{\alpha_2} \times \ldots \]

\[ \ln(K) = \ln(C) + \alpha_1 \ln(PE) + \alpha_2 \ln(V_1) + \alpha_2 \ln(V_2) + \ldots \]

- \( K \): 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
- \( \alpha \): regression coefficients

Disaster risk index

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

The Disaster Risk Index (DRI)

Discussion

• Do you envisage using the ACI in your work? How?

• How useful would it be to extend it to other territories? Is this something the IFoA should get involved in?

• How useful will the ACRI be?

• What would you like to see the R&E Board doing?