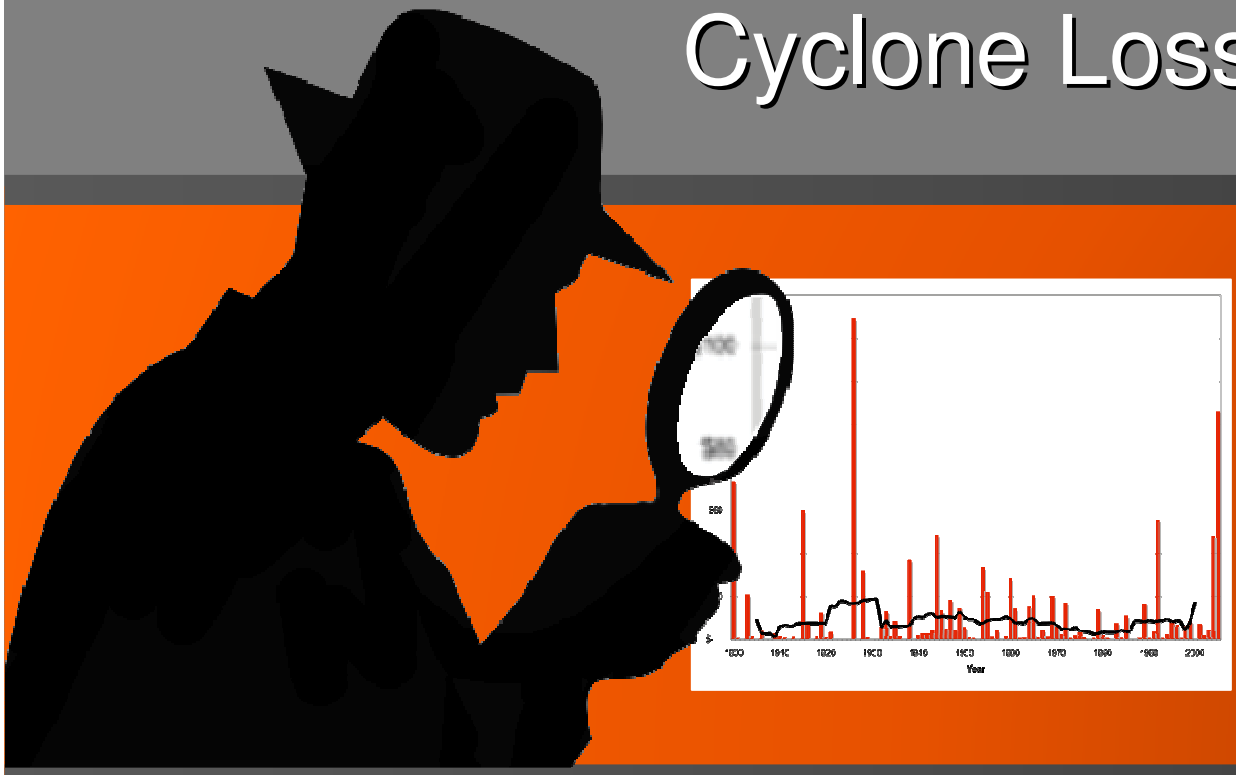
When will Anthropogenic Climate Change Signals be Detected in US Tropical Cyclone Loss Data?



by Ryan Crompton

Questions?

260 years!

Range: 120 – 550 years

Crompton, R. P., Pielke Jr, R. A., and K. J. McAneney. Emergence timescales for detection of anthropogenic climate change in US tropical cyclone loss data. *Environ. Res. Lett.* (in review).

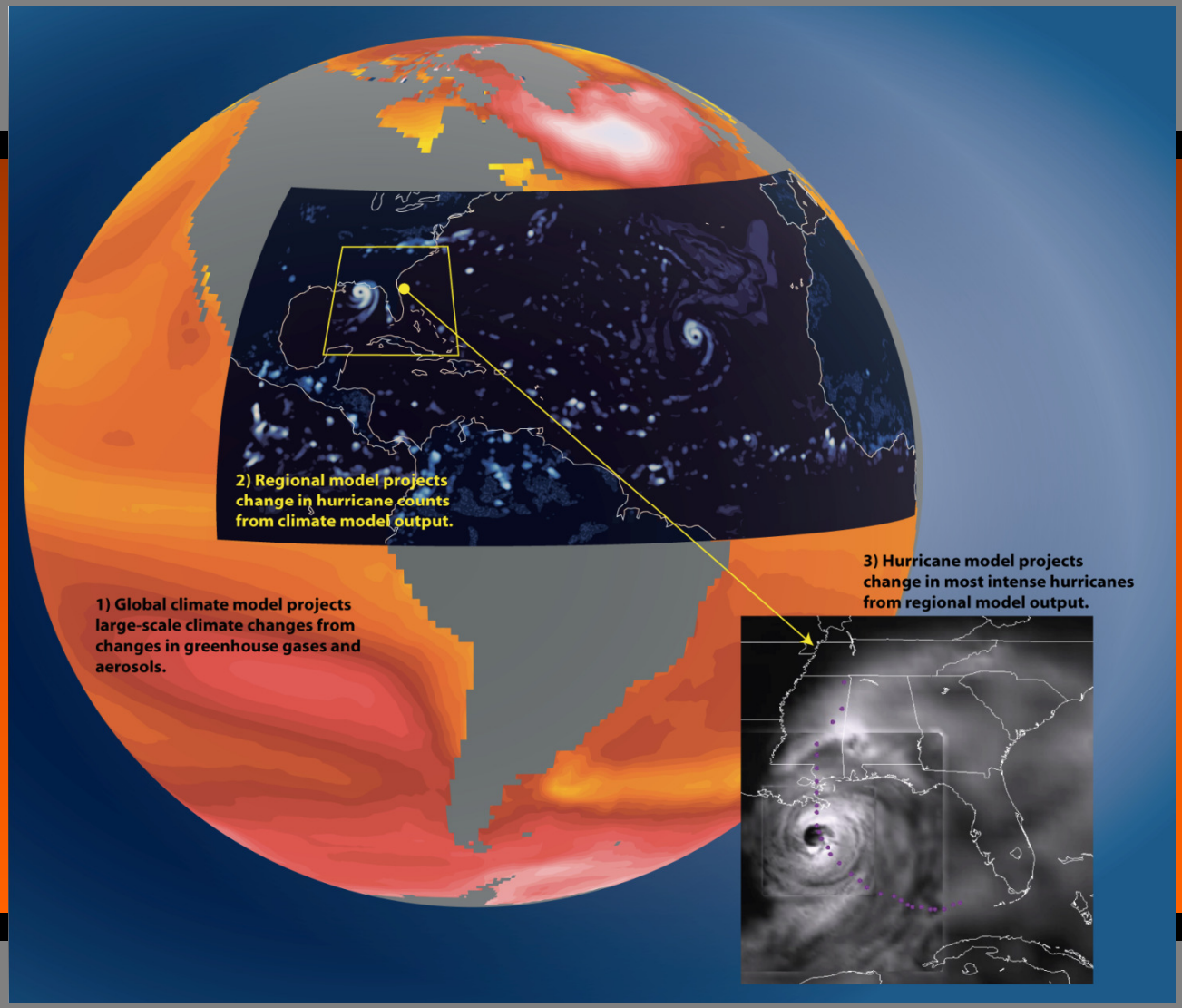
US TC Activity & Damage

- An ACC influence on Atlantic TC behaviour is yet to be detected
- Same applies to normalised Atlantic TC damages
- BUT,
  - such an influence cannot be ruled out in the future
- THE QUESTIONS,
  - how big and when will it be detected?

Signal Detection in US TC Loss Data

- Projected ACC influence on Atlantic basin TCs
  - Bender et al. 2010
- US TC loss data
  - Pielke et al. 2008
- Emergence timescale methodology
  - Crompton et al. submitted
- Implications for global weather-related losses

Projected Anthropogenic Climate Change Influence on Atlantic Basin TCs



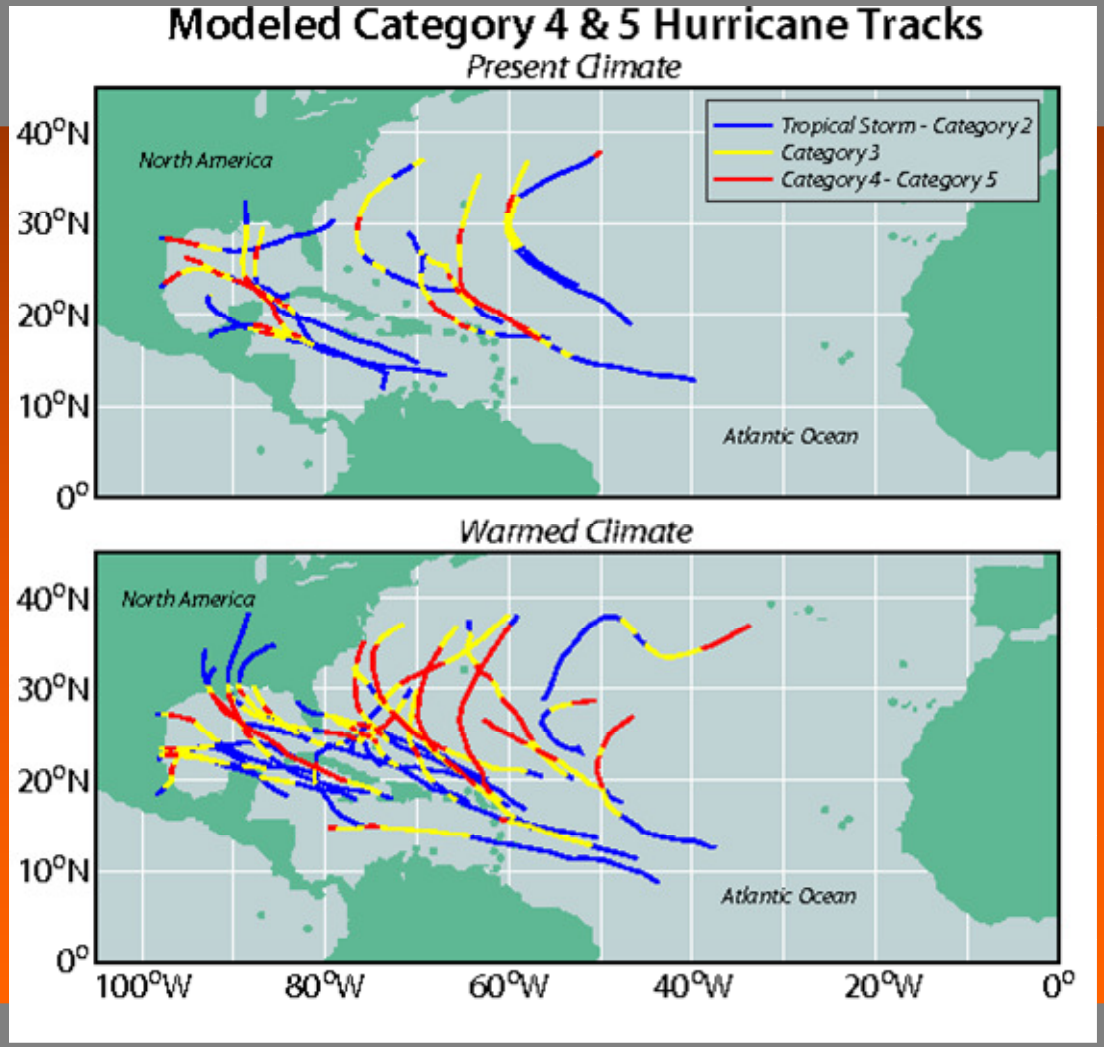
http://www.gfdl.noaa.gov/pix/user_images/ih/misc/test_blue5.png

Projected Anthropogenic Climate Change Influence on Cat 4 and 5's

Tracks for all storms reaching category 4 or 5 intensity, for the control and the warmed 18-model ensemble conditions (CMIP3).

Projected increase:
81% increase in 80 years

Emergence timescale:
≈ 60 years



http://www.gfdl.noaa.gov/21st-century-projections-of-intense-hurricanes

Projected Anthropogenic Climate Change Influence on Atlantic Basin TCs

	Projected percent changes over 80 years (warm vs. control)				
Saffir-Simpson Storm Category	CMIP3 ensemble	GFDL CM2.1	MRI	MPI	HadCM3
Tropical	-13	+4	-16	-14	-14
1	-52	-40	-45	-48	-66
2	-17	-15	-28	-36	-53
3	-45	+9	-34	-51	-64
4	+83	+100	+72	+17	-56
5	+200	+400	+800	+100	0

Source: Bender et al. 2010

Normalised Atlantic Hurricane Damage

(year 2005 societal conditions)

Saffir-Simpson Storm Category (at landfall)	Count	Count per year	Percent of total loss	Av. loss (USD $bn)	St. dev. losses (USD $bn)
Tropical	57	0.54	2.0	0.4	1.0
1	44	0.42	5.0	1.2	3.7
2	34	0.32	7.4	2.4	2.6
3	53	0.50	35.6	7.3	13.3
4	14	0.13	42.5	33.2	41.7
5	3	0.03	7.4	27.1	28.2

Emergence Timescale Inputs

	Damage		**Projected percent changes over 80 years (warm vs. control)**	**Change in damage potential after 80 years (%)**
Saffir-Simpson Storm Category	Count per year	Percent of total (1)	CMIP3 ensemble (2)	(1) × (2)
Tropical	0.54	2.0	-13	-0.3
1	0.42	5.0	-52	-2.6
2	0.32	7.4	-17	-1.3
3	0.50	35.6	-45	-16.0
4	0.13	42.5	+83	+35.3
5	0.03	7.4	+200	+14.9
				+30

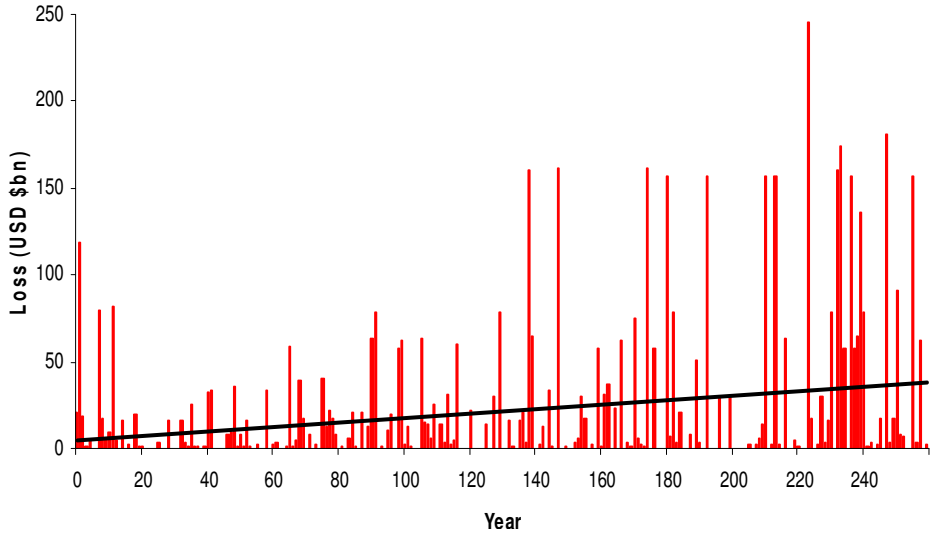
Source: Crompton et al. submitted

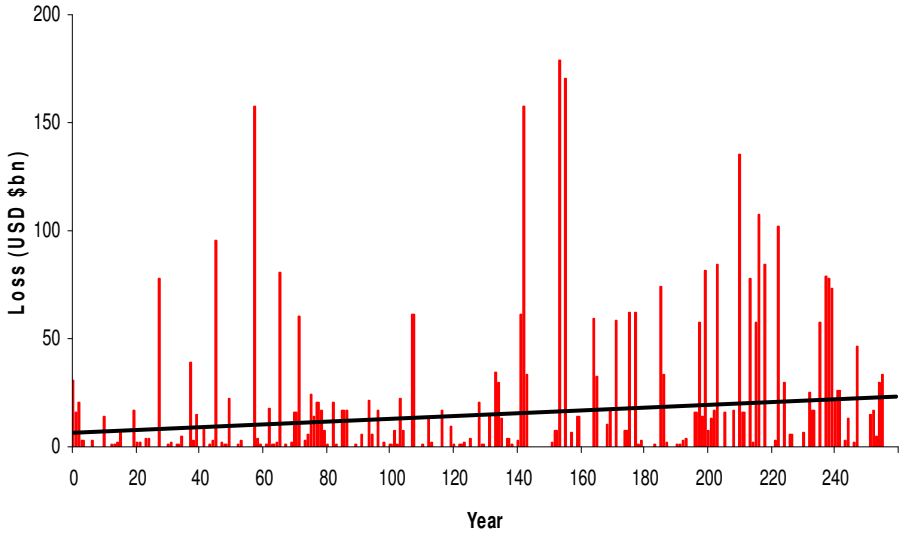
Emergence Timescale Methodology

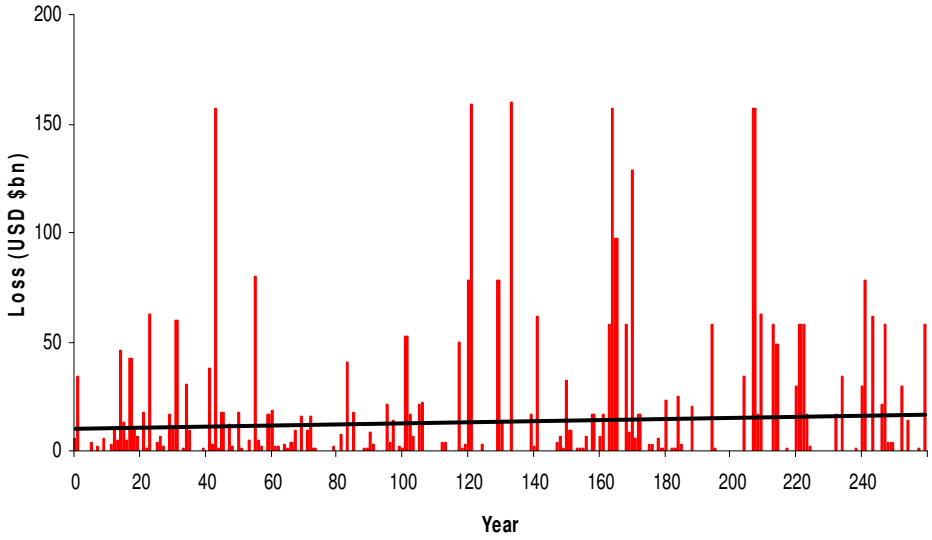
- Synthetic loss time series construction
  (e.g. 260 years)

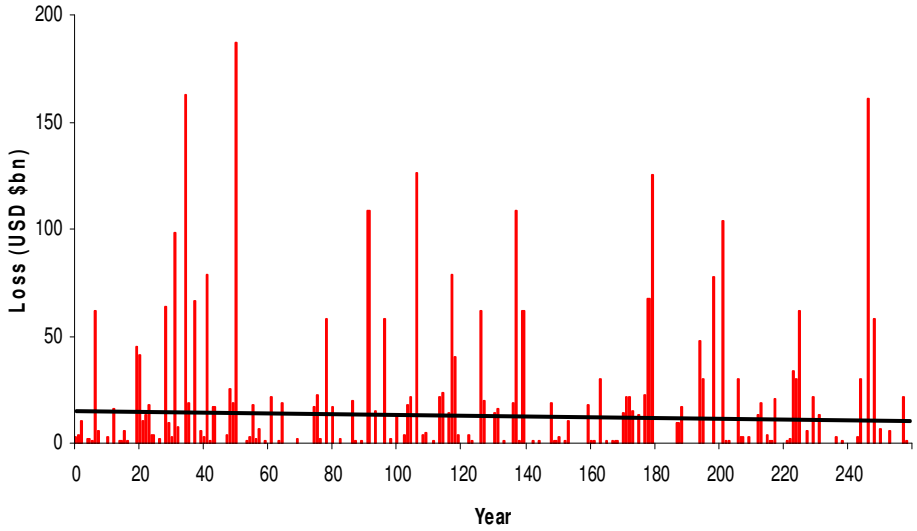
  1) annual TC loss freq by S-S category
  2) apply S-S category projections (annual linear trend) to loss freq
  3) no. TC losses in S-S categories → *Poisson*
  4) bootstrap sampling of TC losses
  5) losses aggregated annually
  6) generate losses for years 1 to 260

Synthetic Loss Time Series (260 years, CMIP3)









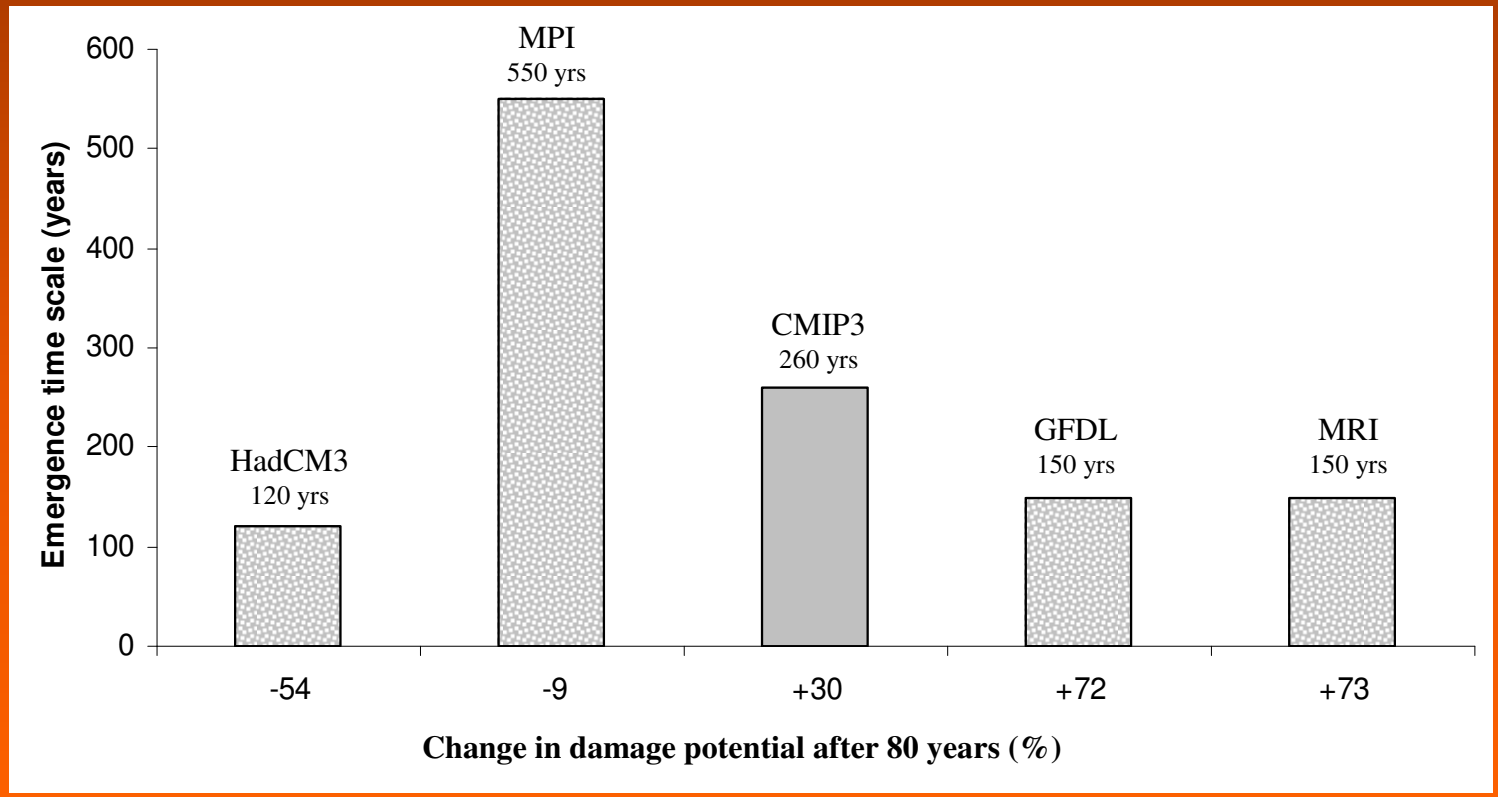
Emergence Timescale Methodology

- Synthetic loss time series testing
  (e.g. 260 years)

  7) calculate gradient of least-squares line fitted to time series
  8) repeat process many (10,000) times

- *Emergence timescale* is the earliest end year of a time series that has > 95% of positive or negative gradients

Results



Source: Crompton et al. submitted

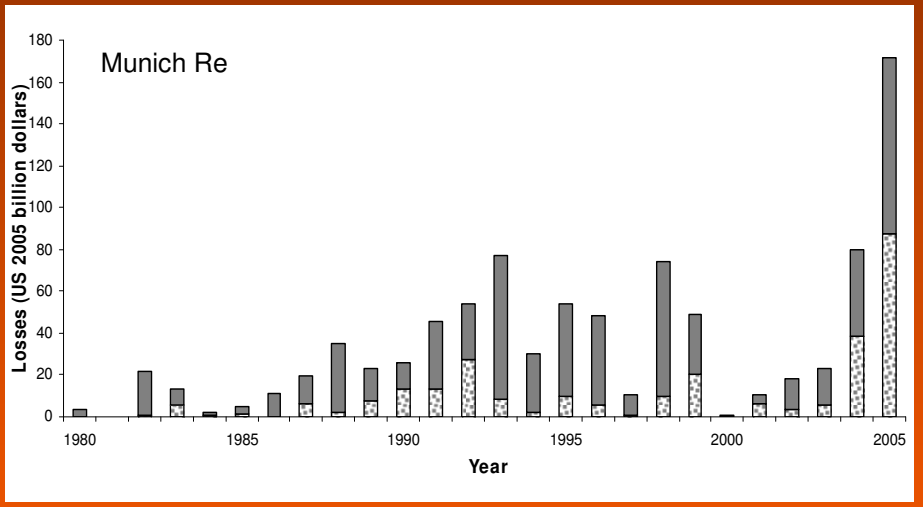
Assumptions

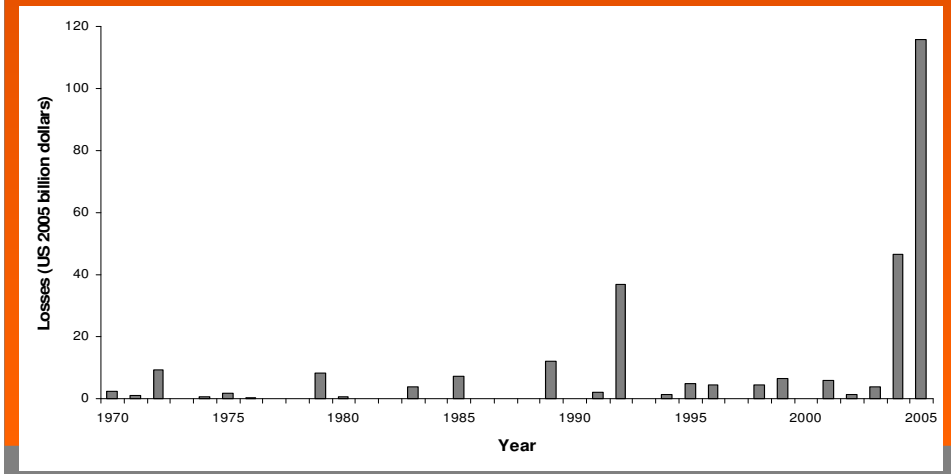
- Only one emission scenario (A1B) considered
- Accept limitations of all models
- Landfalling storms are representative of Atlantic basin
- Ignore future sea-level rise and related adaptation
- ENSO and other cycles not preserved

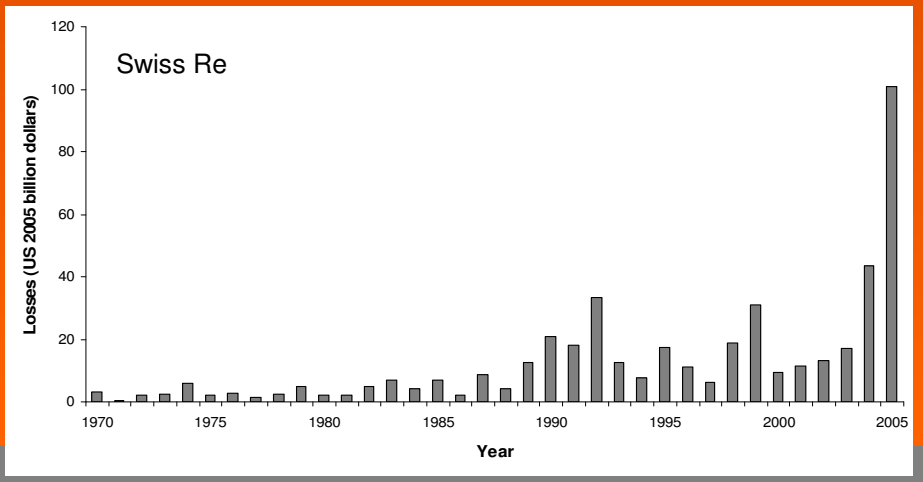
Implications for Global Weather-Related Losses

Correlation coefficients between inflation-adjusted (2005 dollars) losses. Numbers in brackets are for original losses.

	Munich Re Global Weather (1980-2005)		**Swiss Re Global Weather** (1970-2005)
	Economic	Insured	Insured
US TC Economic	0.82 (0.89)	0.97 (0.98)	0.93 (0.96)







Source: Crompton et al. submitted

Conclusions

- Emergence timescale of ACC signals in losses between 120 and 550 years!
  - Likely longer in global weather-related losses
  - Correlation will weaken over time
- Better to seek to detect signals in geophysical data directly
- Caution against attributing short term trends in losses to ACC
- Better justifications for action on GHG emissions