

ASTIN - 2008

**HURRICANES IN THE NORTH ATLANTIC, SHOULD INSURANCE PRICING
BE BASED ON LONG-TERM AVERAGES?**

14 July 2008

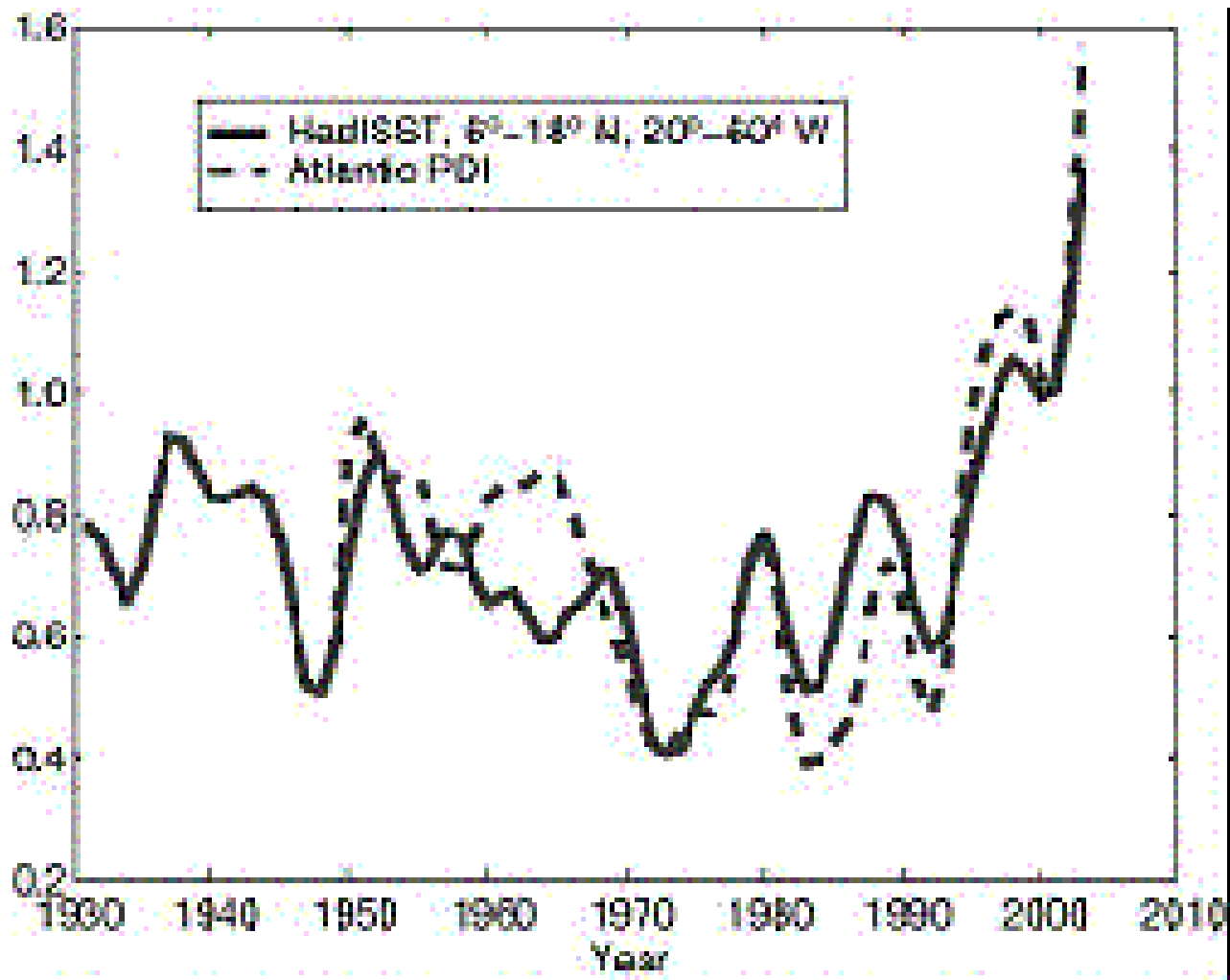
TREVOR MAYNARD

**THE VIEWS EXPRESSED IN THIS PRESENTATION ARE THOSE OF THE
AUTHOR AND DO NOT NECESSARILY REPRESENT THOSE OF MY
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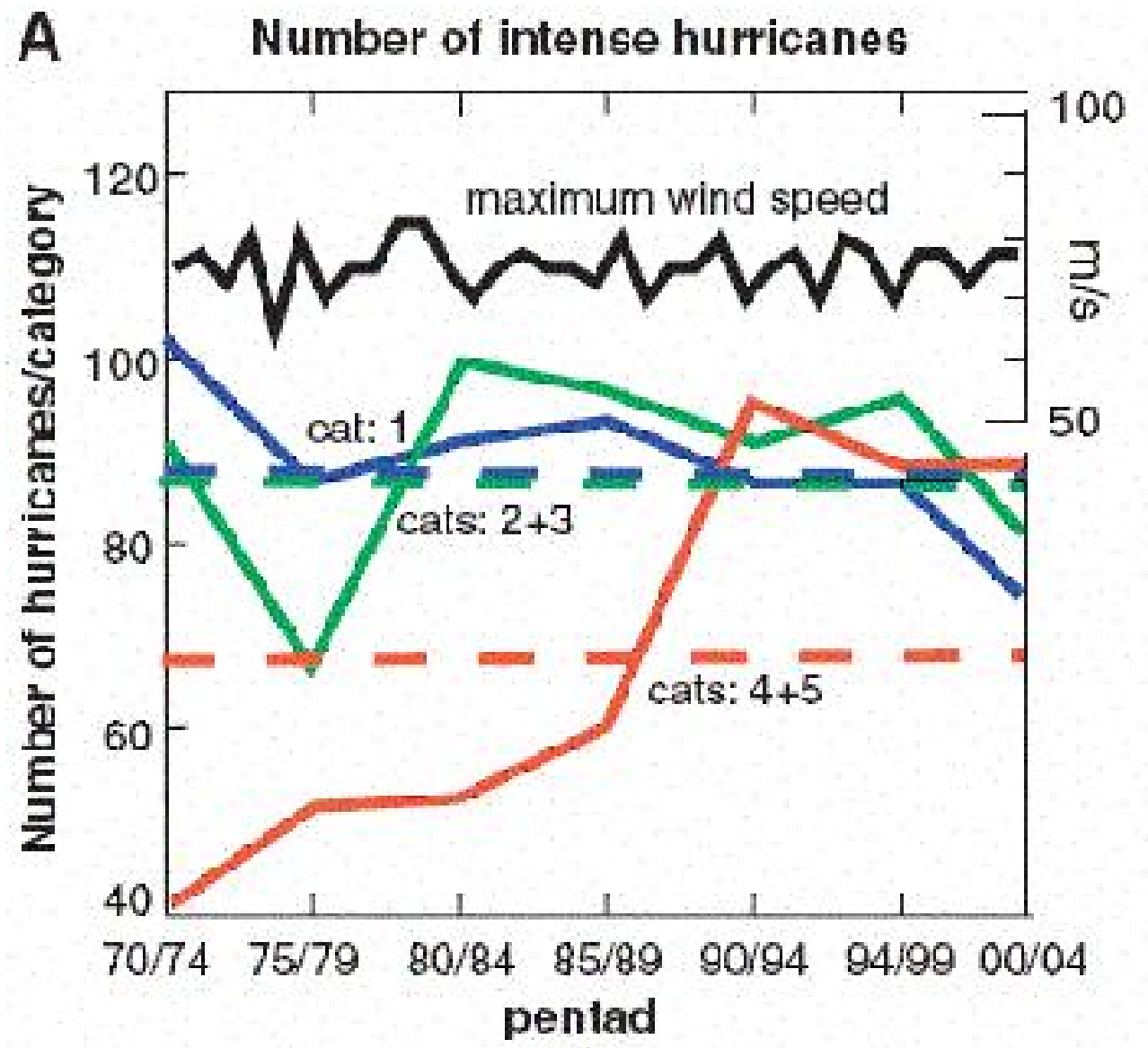
Agenda

- (Mini) review of published papers
- Analysis
- Why we cant trust landfalling data alone
- Data issues
- Questions

(MINI) REVIEW OF PUBLISHED PAPERS



Emanuel , K.A. (2005) Increasing destructiveness of tropical cyclones over the past 30 years. Nature, 436, 686-688



Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment
 (2005) P. J. Webster,¹ G. J. Holland,² J. A. Curry,¹ H.-R. Chang¹

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“For a given forecast year, a **predicted hurricane count is conditional on a sampled predicted value of Atlantic SST.**

Thus forecasts are samples of hurricane counts for each future year. Model skill is evaluated over the period (1997–2005) and compared against climatology, persistence, and other multiseasonal forecasts issued during this time period.

Results indicate that the algorithm will *likely improve on earlier efforts and* **perhaps carry enough skill to be useful** *in the long-term management of hurricane risk...*

...Statistical **analysis confirms that over the Atlantic basin warmer SST tends to result in more and stronger**

hurricanes. *Saunders and Harris (1997) using linear regression showed that SST over the tropical Atlantic is the dominating influence behind the interannual variance in Atlantic hurricane numbers.....”*

Improving multiseason forecasts of North Atlantic hurricane activity James B. Elsner, Thomas H. Jagger, Michael Dickinson, and Dail Rowe

*“TC number has a large and well known dependency on SST: **there are 45% more TCs in the hot years than cold, a difference which is highly significant compared to random sampling**....Landfall rates on the Florida and northern U.S. Gulf Coasts are higher in hot years than cold,.... our results show a significant increase of North American TC landfall with tropical SST in rough proportion to the increase in TC number. The implication is clear for higher TC landfall risk with future SST increases.”*

SST and North American Tropical Cyclone Landfall: A Statistical Modeling Study Timothy M. Hall NASA Goddard Institute for Space Studies, New York, NY Stephen Jewson Risk Management Solutions, London, U.K.

“we found that **climate conditions prior to a hurricane season provide information** about possible future insured hurricane losses.”

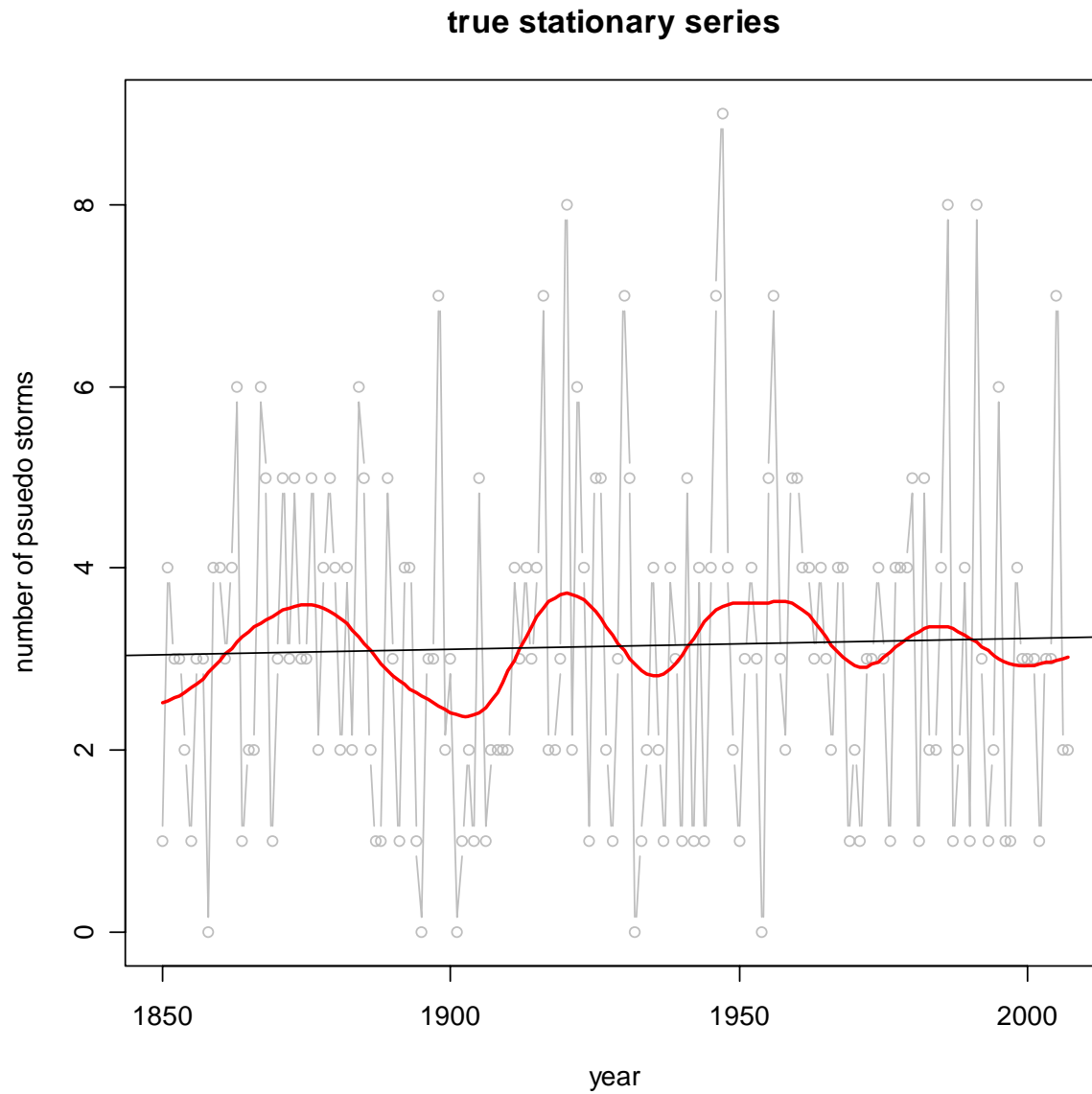
Forecasting US insured hurricane losses THOMAS H. JAGGER, JAMES B. ELSNER, AND MARK A. SAUNDERS

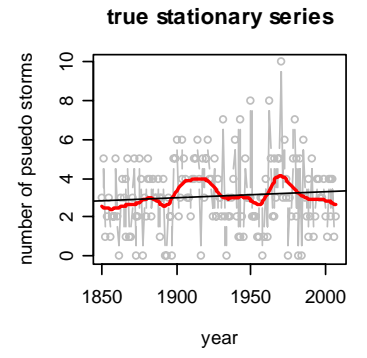
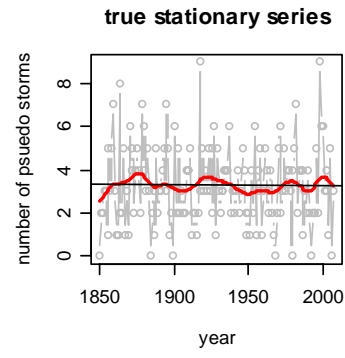
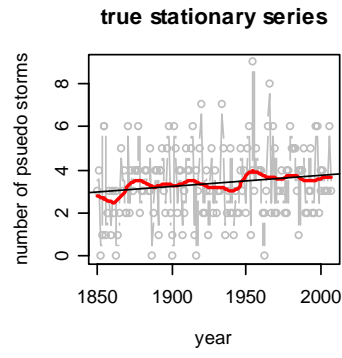
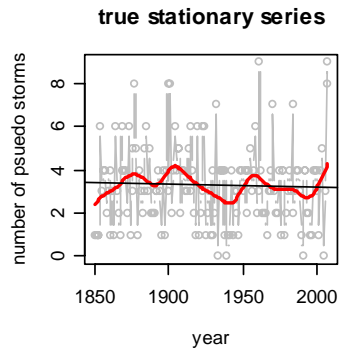
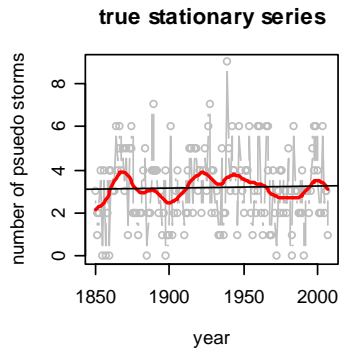
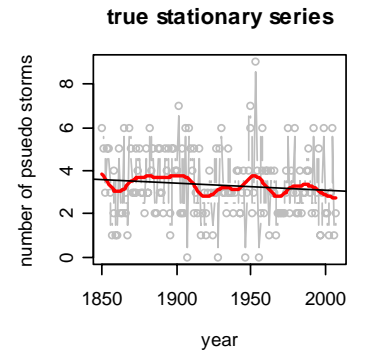
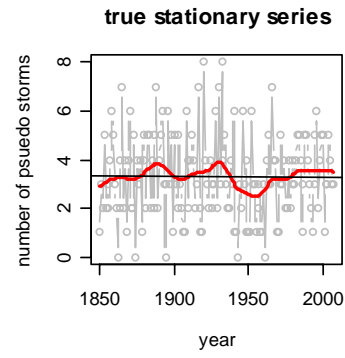
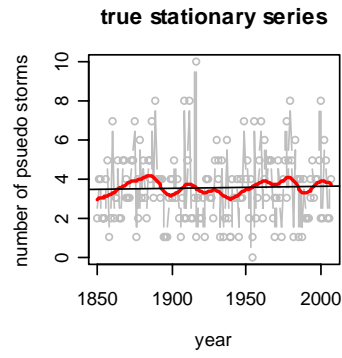
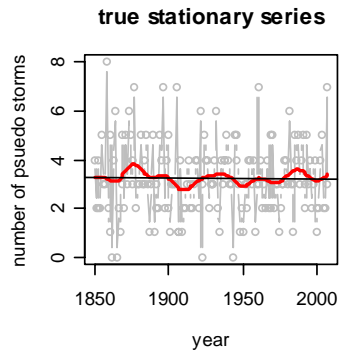
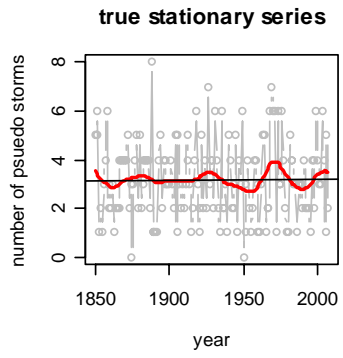
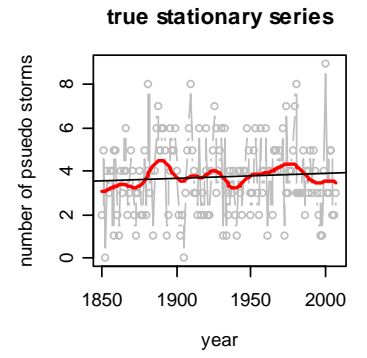
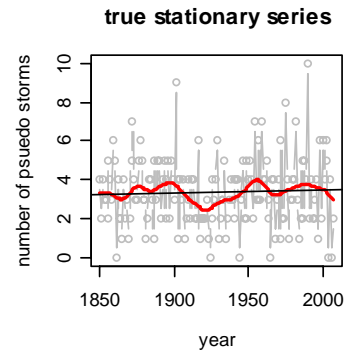
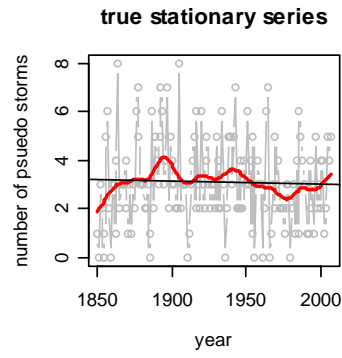
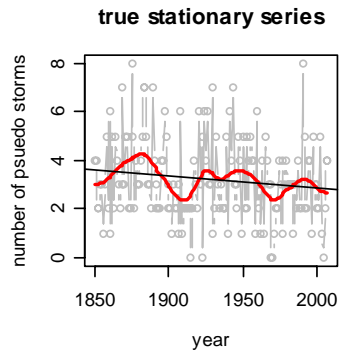
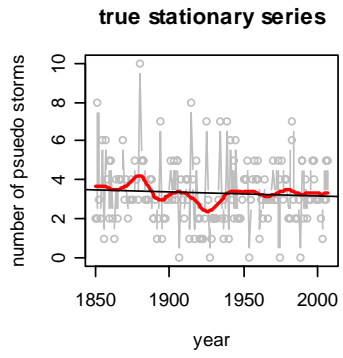
My summary

- General agreement, in the North Atlantic we are in a period of elevated hurricane genesis frequency;
- Some attribute this to global warming, some to the, so called, Atlantic Multidecadal Oscillation of sea surface temperatures;
- Many but not all of them are predicting more intense storms in future;
- Some argue that, due to the greater numbers being generated, we will also see more making landfall.

ANALYSIS

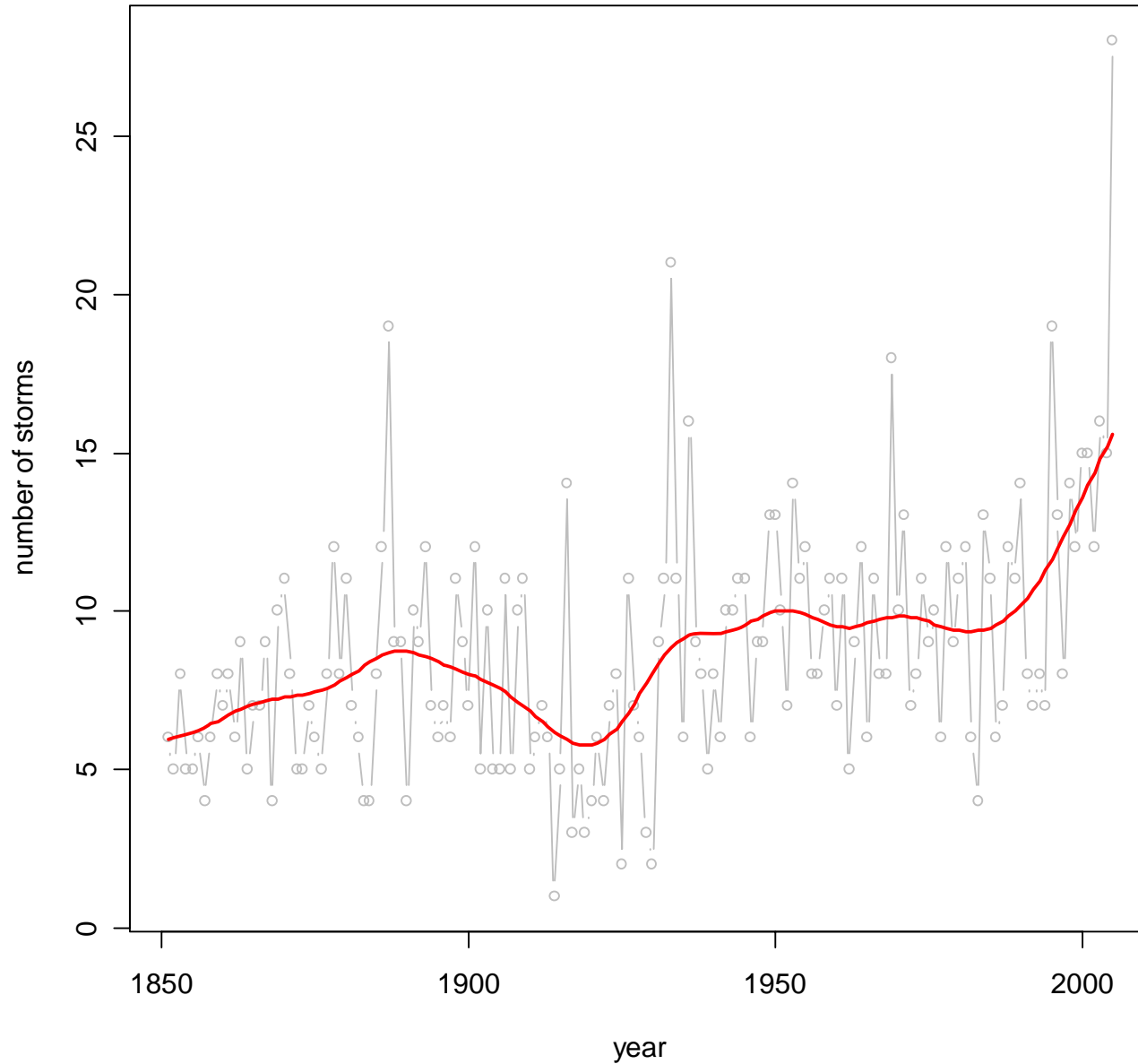
True Stationary Series





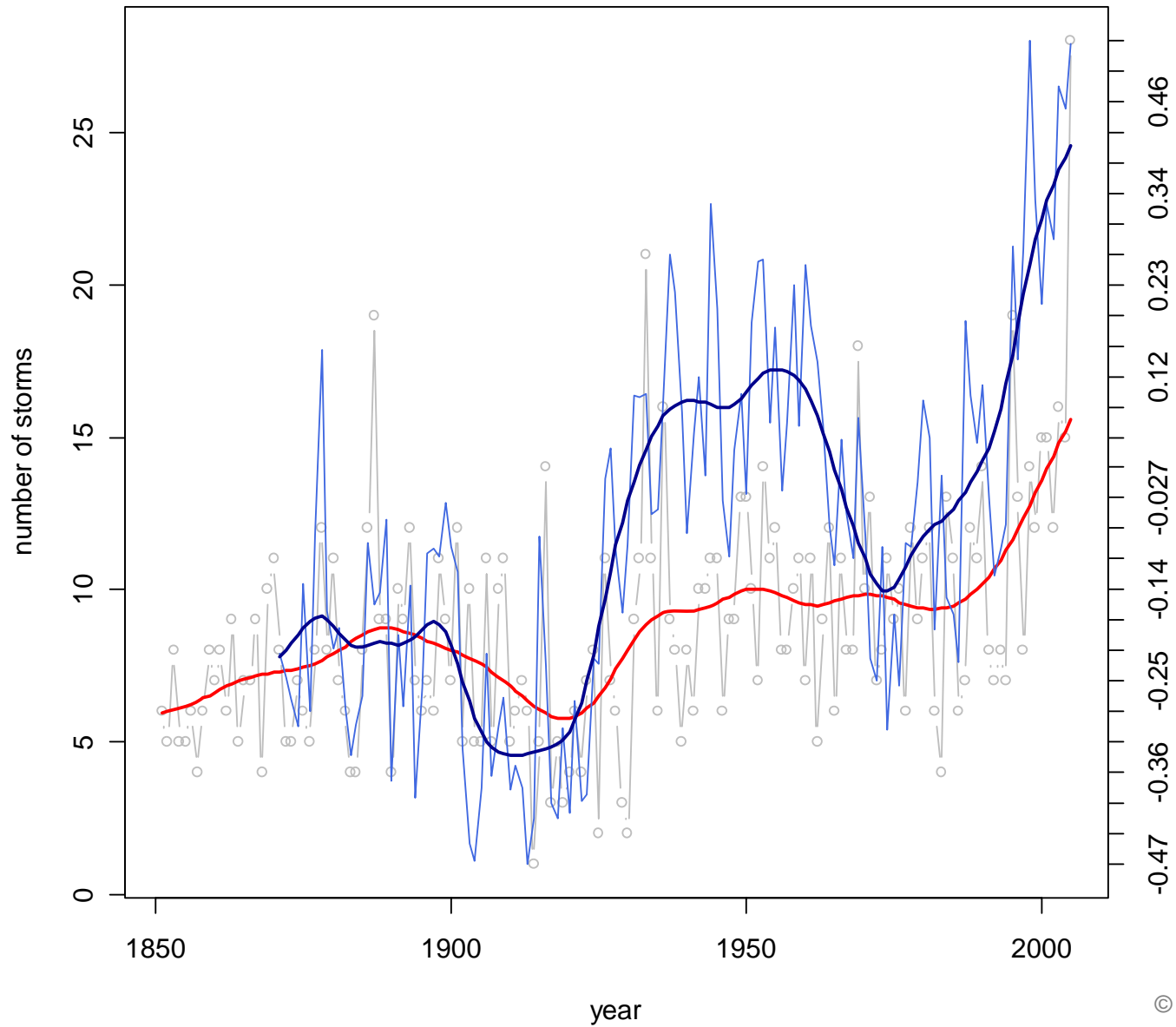
Genesis frequency

Category 0+ storms over time



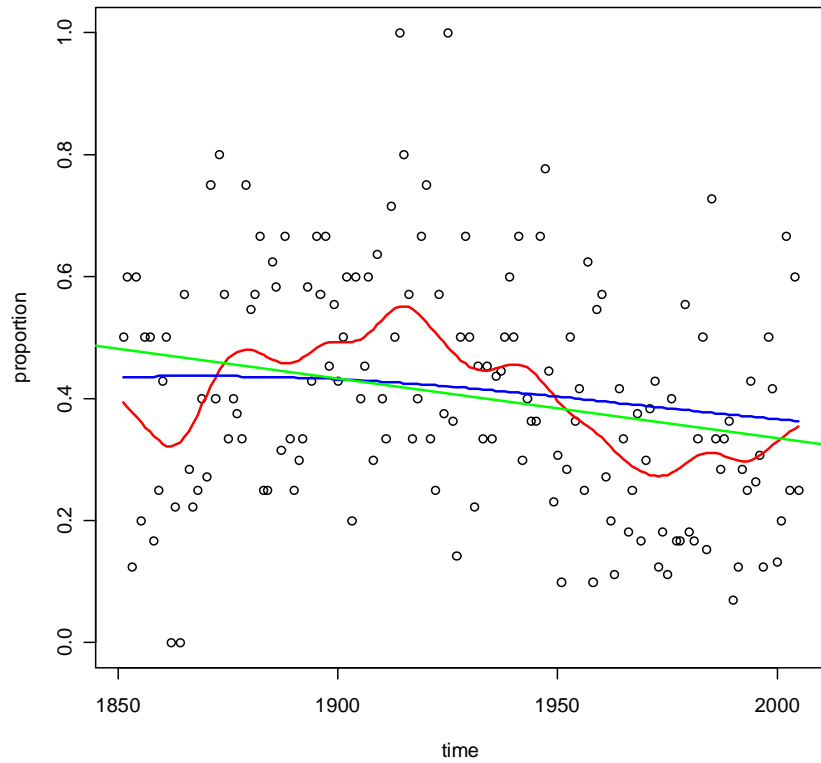
Genesis frequency + AMO

Category 0+ storms over time

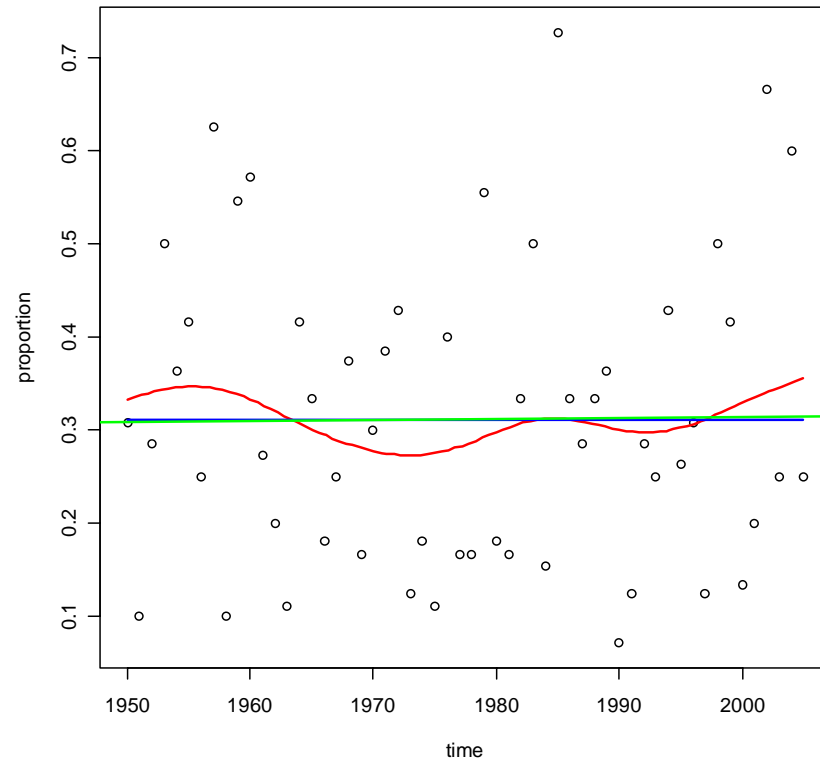


Proportion making landfall

Proportion of landfalling storms from all storms

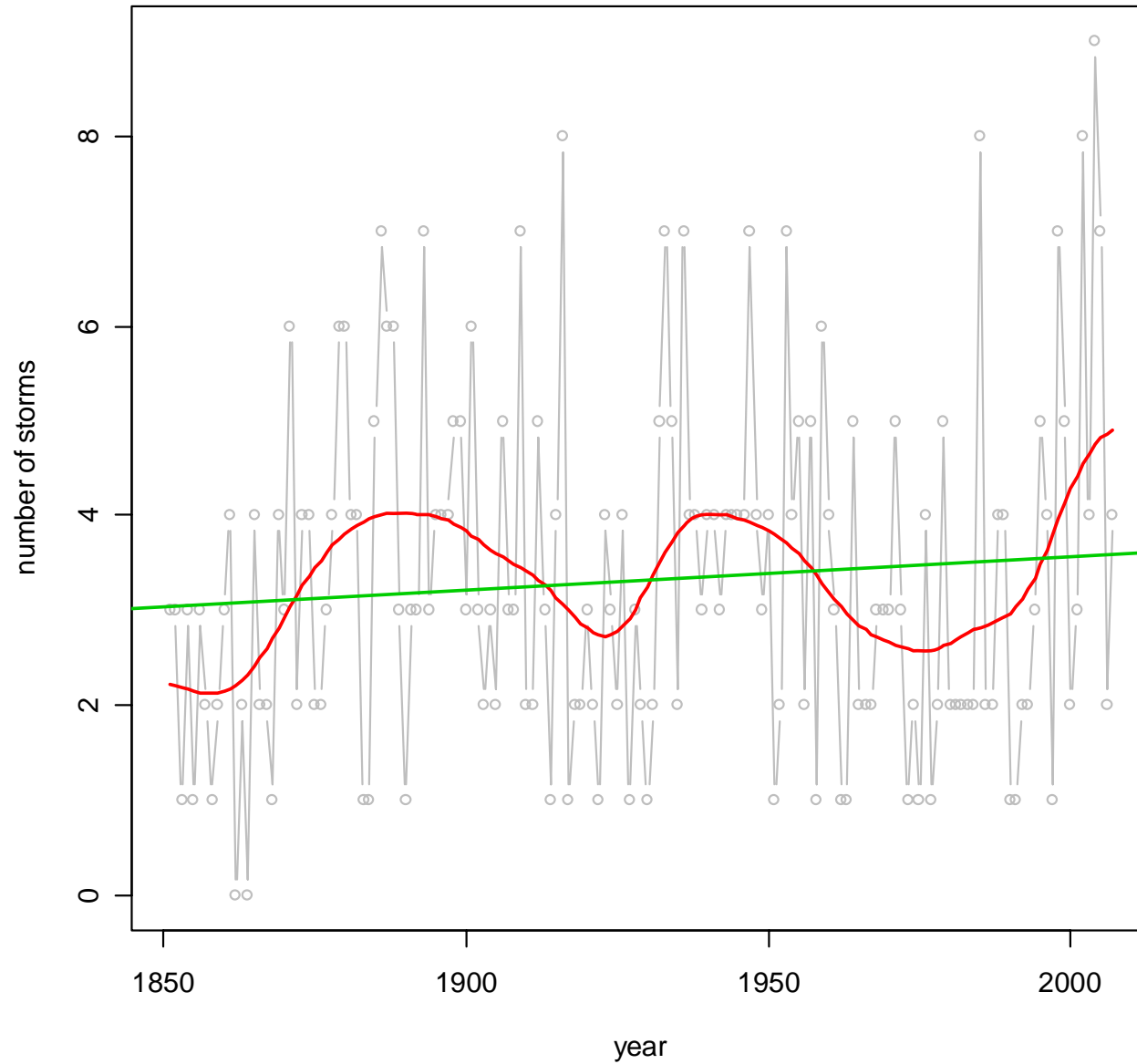


Proportion of landfalling storms from all storms



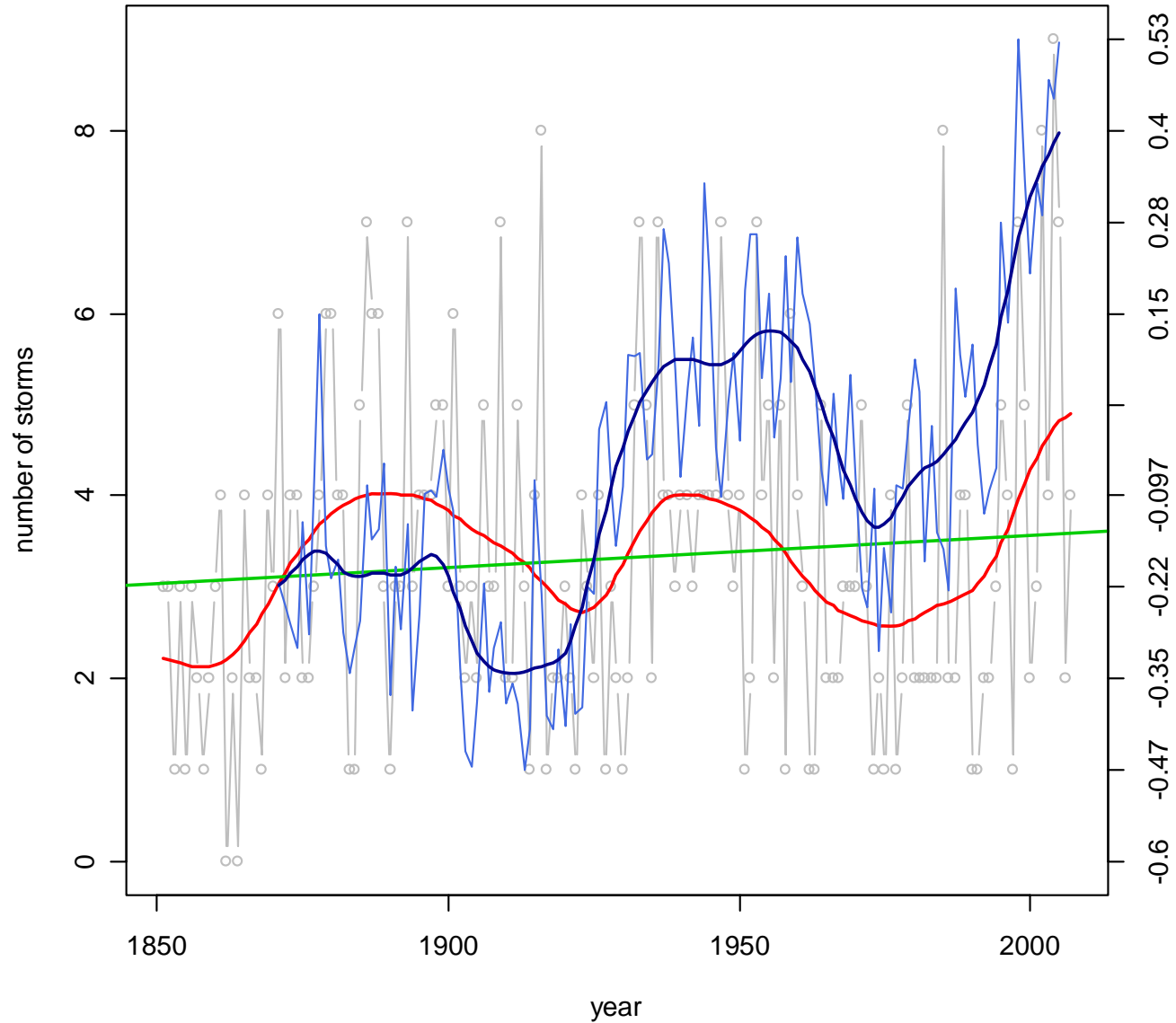
Landfalling storms – all categories

Category 0+, landfalling



Landfalling storms – all categories +AMO

Category 0+, landfalling



Interim conclusions

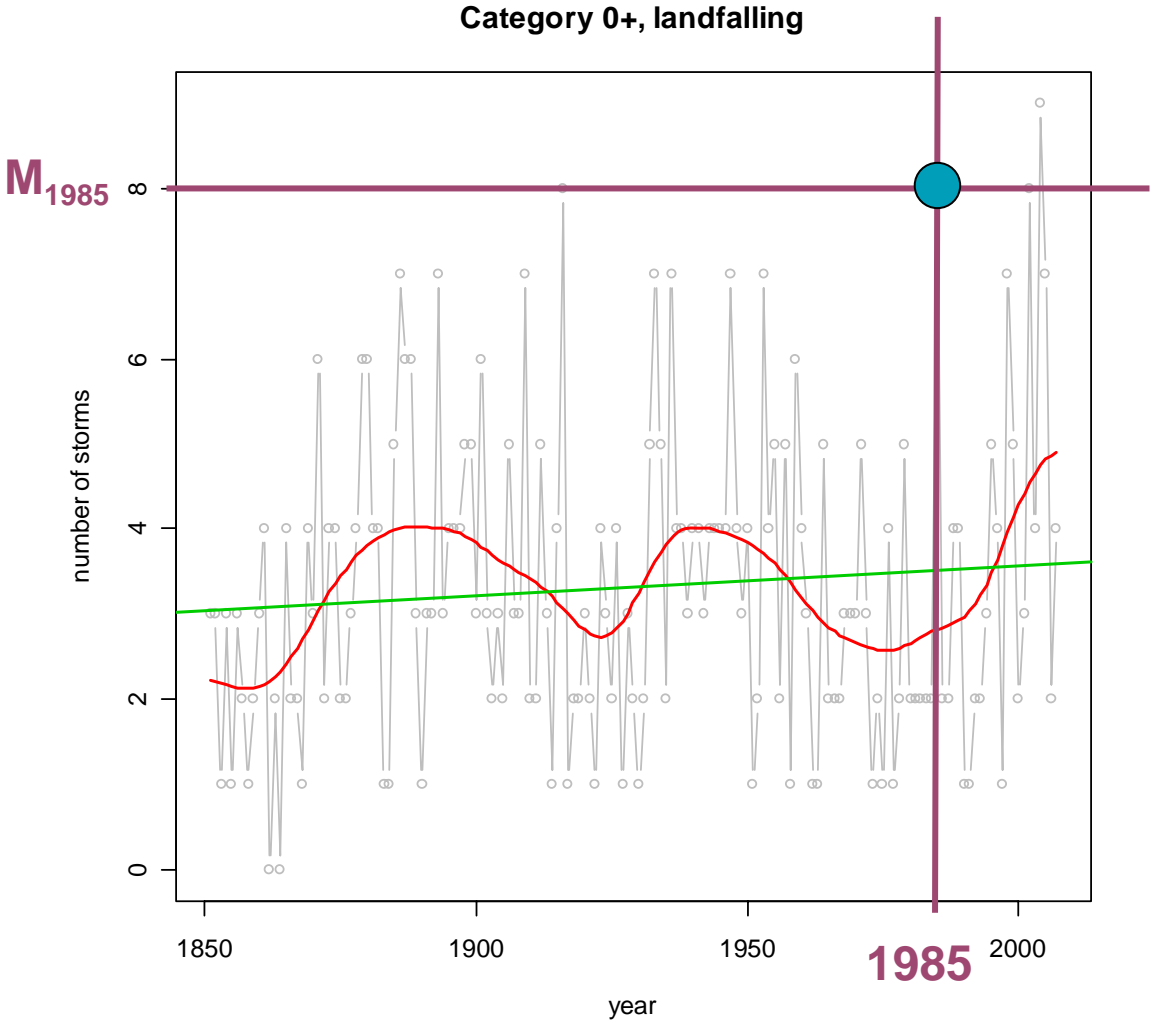
- The number of cat 0+ storms generated in the north Atlantic is not stationary....
...and has an increasing trend and a degree of correlation with SSTs
- The proportion of storms that become landfalling appears constant since 1950s
- Landfalling cat0+ storms appear to be correlated with smoothed SSTs.....
....and are not stationary.
- Current levels exceed long term averages

**WHY WE
SHOULDN'T USE
LANDFALLING DATA
ALONE**

Re-sampling approach

- Take the actual data for category 0+ storms as a base point....
... => given the number of landfalling storms in the year from empirical data. (Say this is M_i in year i)
- Assume that each landfalling (cat 0+) storm in a given year had a probability of being a hurricane (of category N or above)....
.... and that this probability (p_N) is not changing over time.
- denote “pseudo $N+$ ” as pseudo data for category N or above....
...we have: $\text{pseudo}N+ \sim \text{Bin}(M_i, p_N)$
- Then we can test how stable this pseudo data is and whether it is safe to draw conclusions from landfalling time series alone.

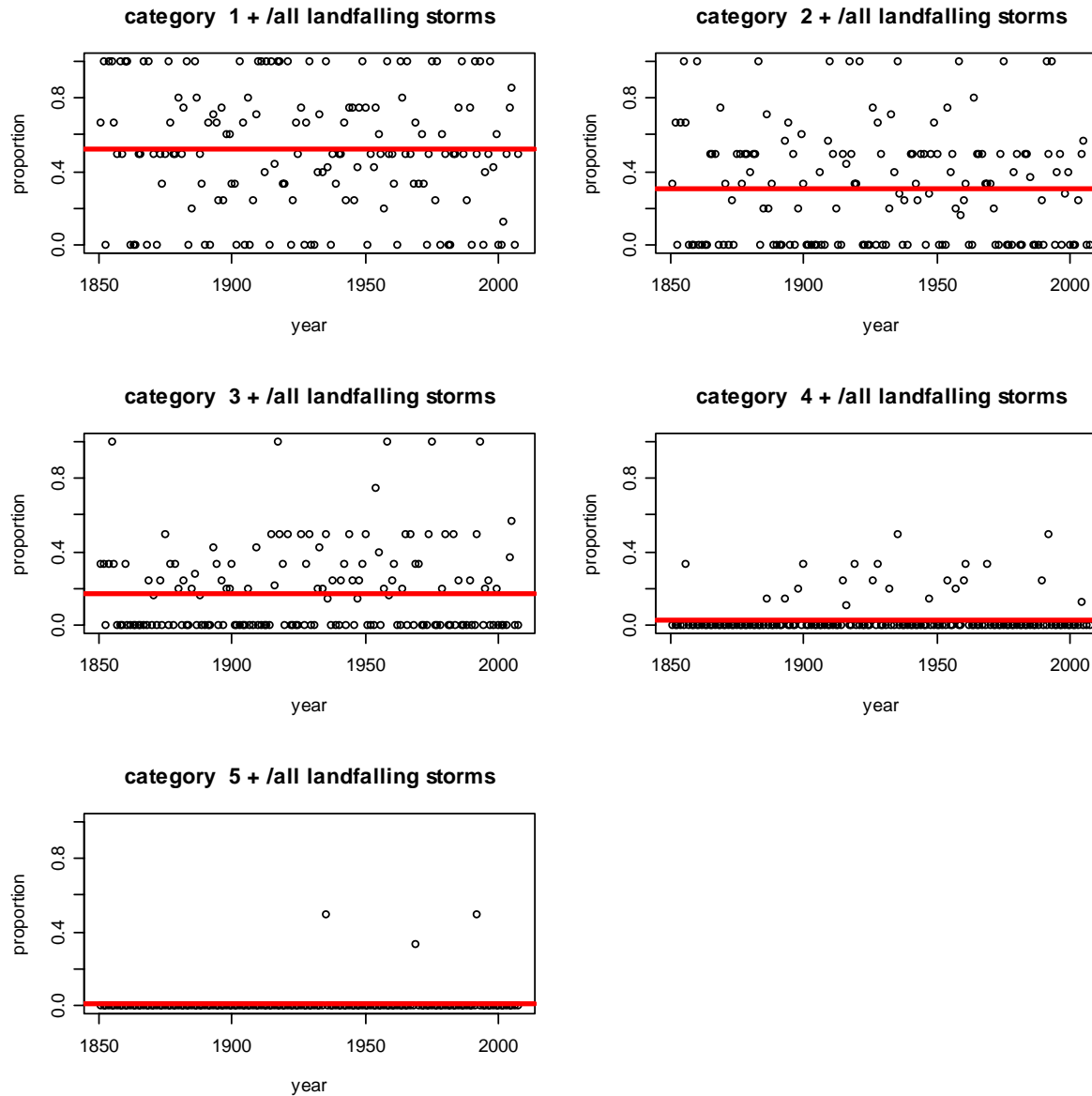
Take the actual data (M_i in year i) for category 0+ storms as a base point....



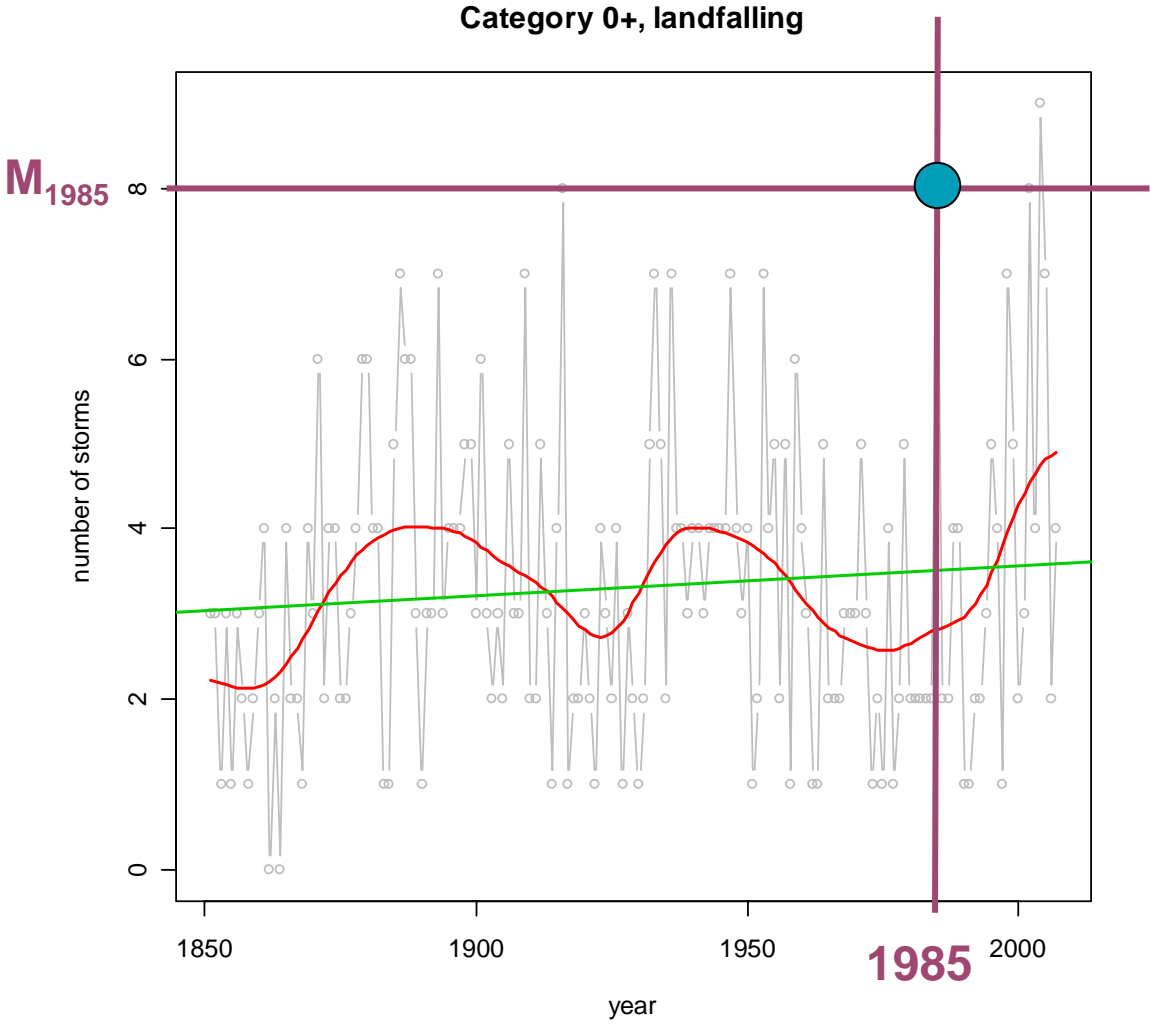
Assume that each landfalling (cat 0+) storm in a given year had a probability of being a hurricane (of category N or above)....
.... and that this probability (p_N) is not changing over time.

Category	Proportion of landfalling reaching (or exceeding) category
1	0.5302
2	0.3155
3	0.1799
4	0.0388
5	0.0096

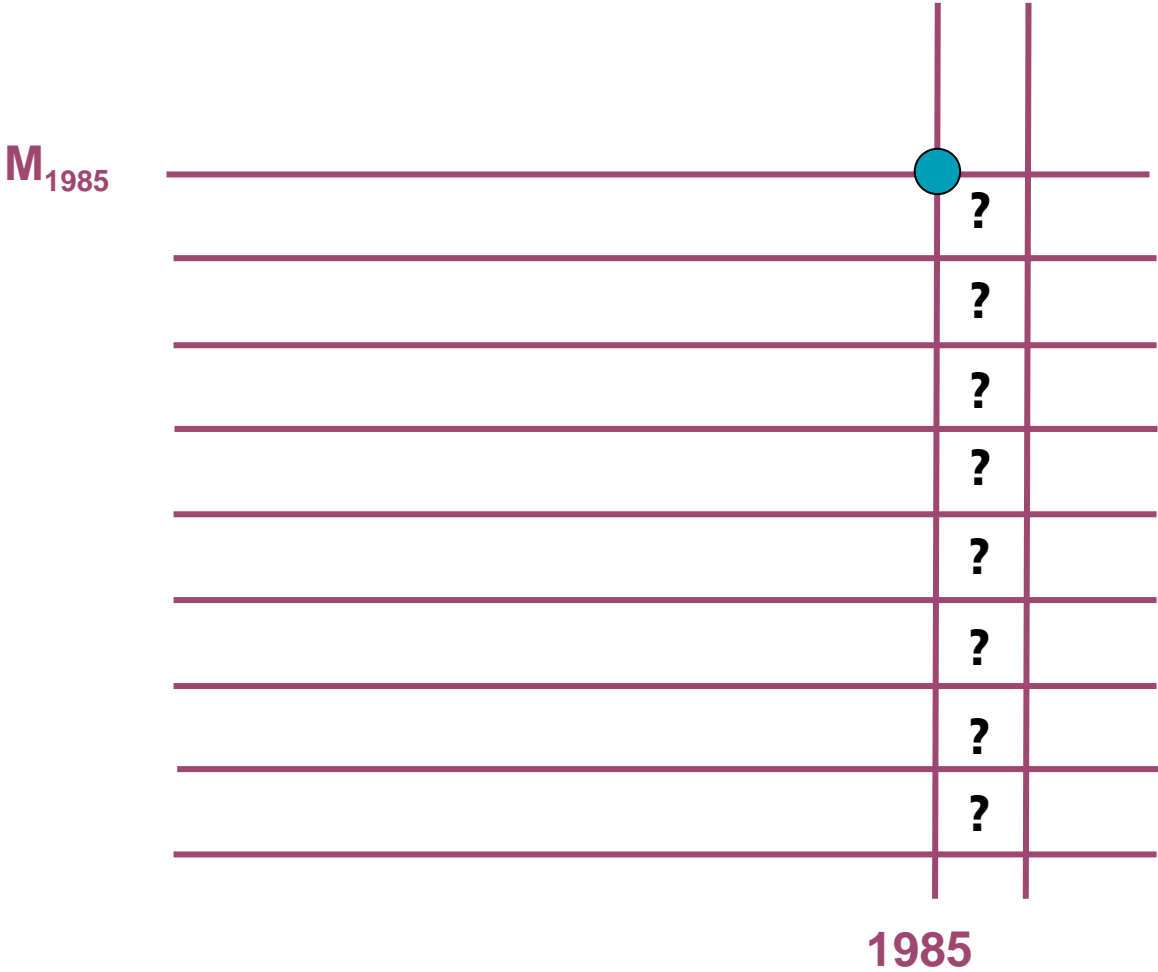
.... and that this probability (pN) is not changing over time.



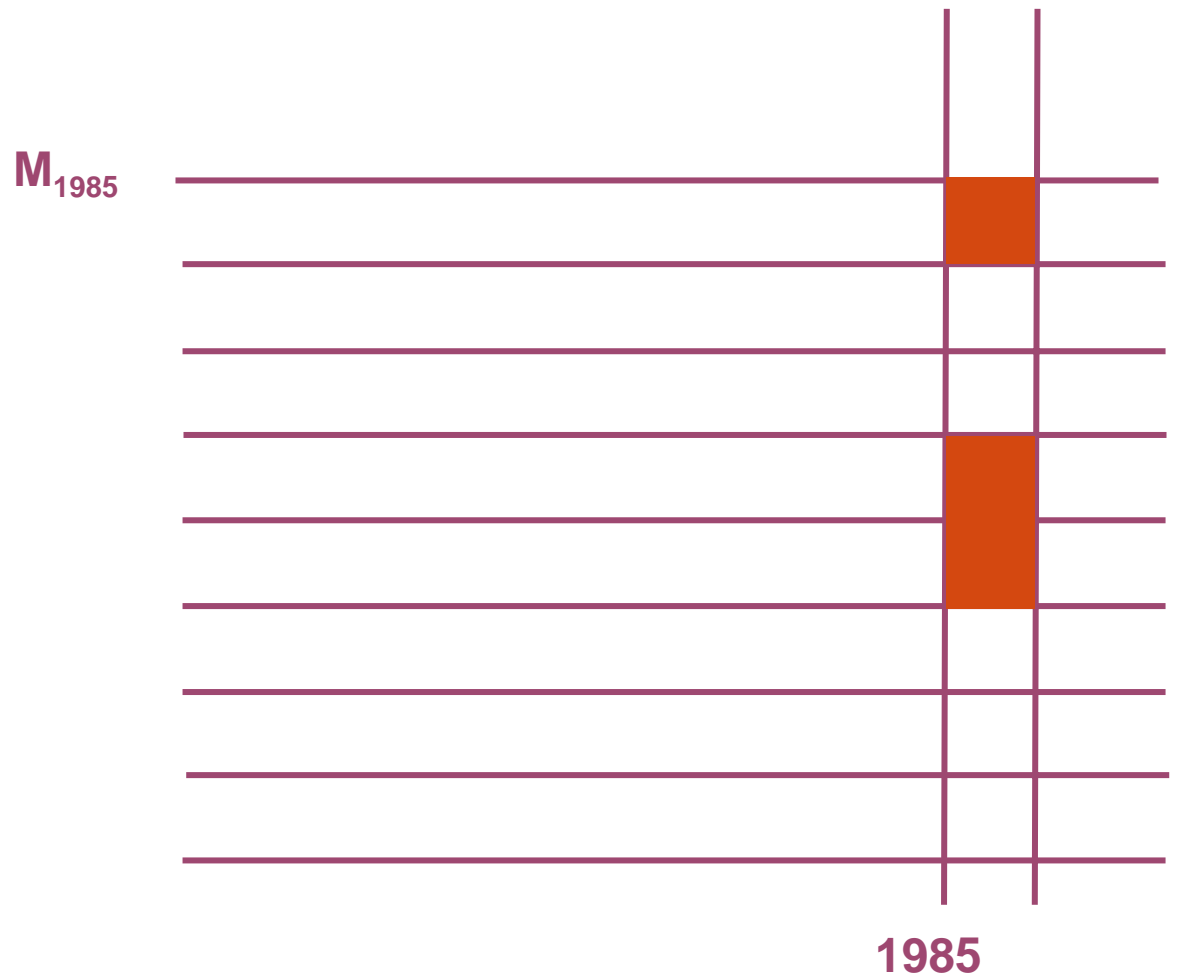
Take the actual data (M_i in year i) for category 0+ storms as a base point....



$\text{pseudoN+} \sim \text{Bin}(M_i, pN)$

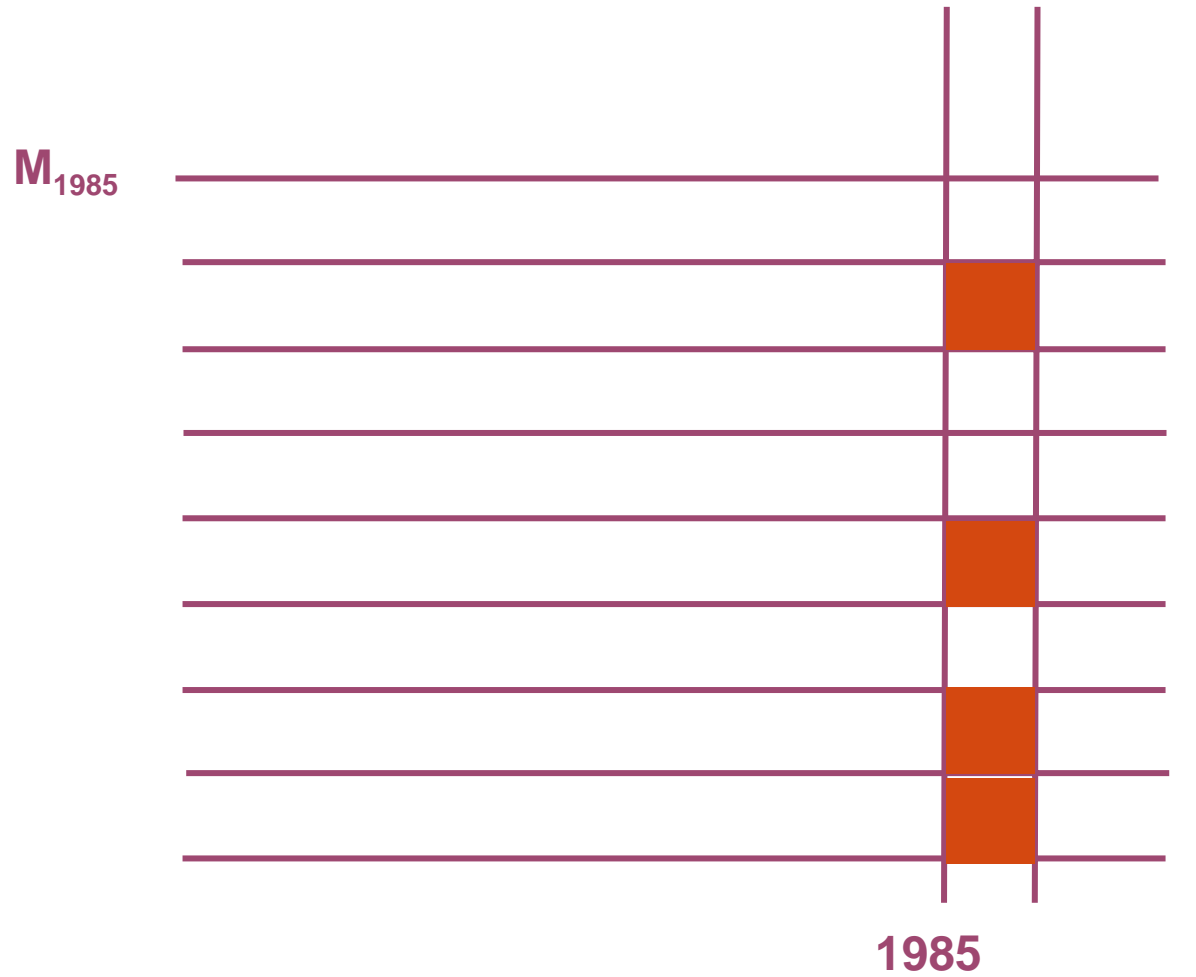


pseudoN+ ~ Bin(Mi, pN)



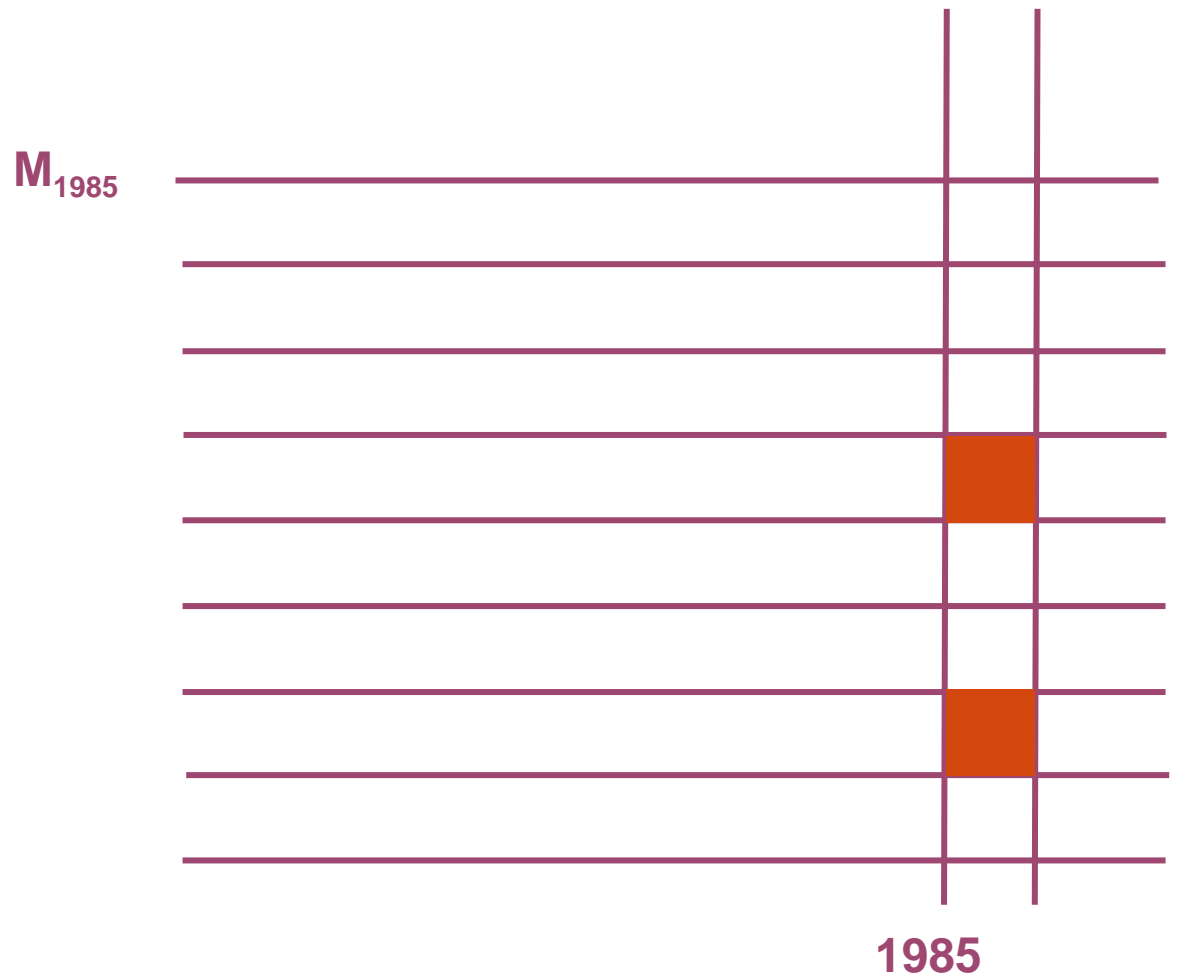
pseudoN+=3

$$\text{pseudoN+} \sim \text{Bin}(M_i, pN)$$



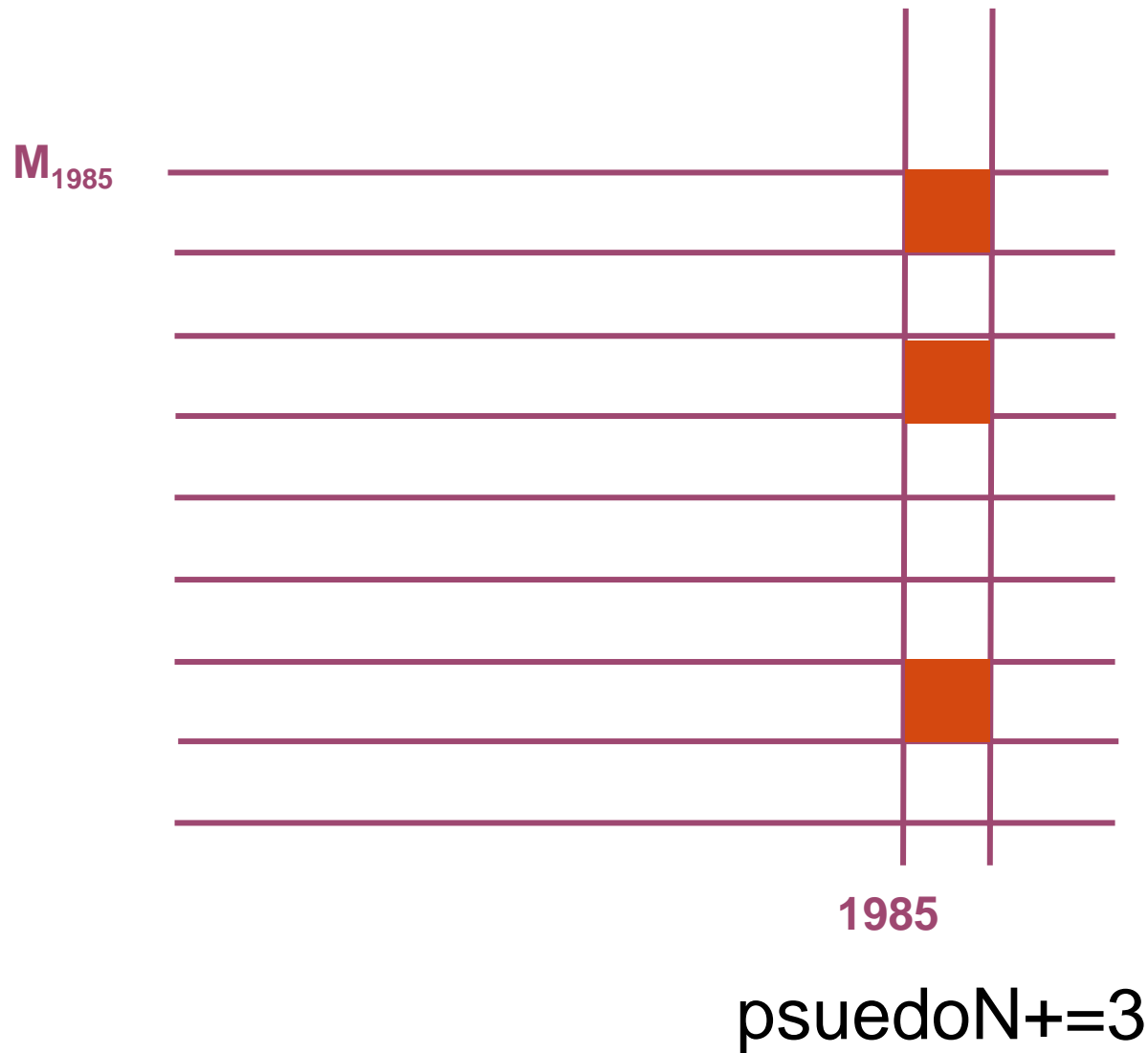
$\text{psuedoN+}=4$

$$\text{pseudoN+} \sim \text{Bin}(M_i, pN)$$

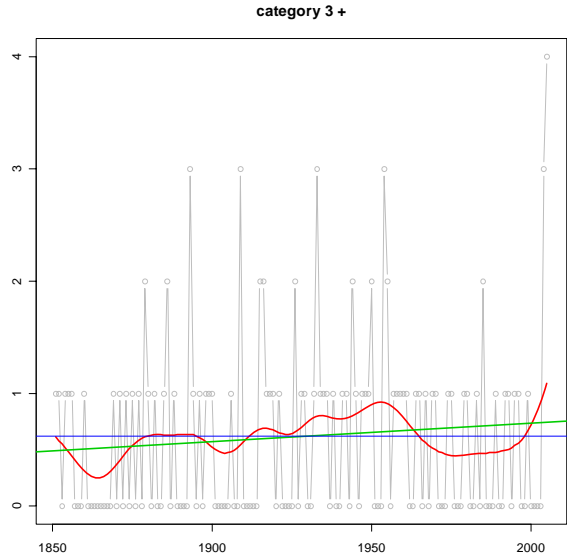
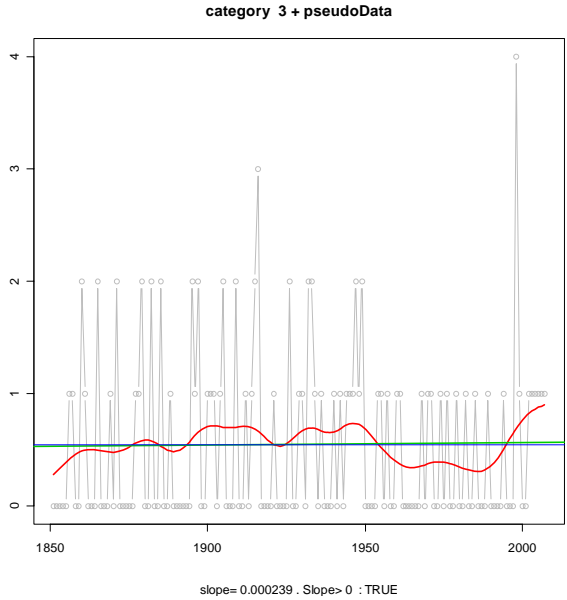


$$\text{psuedoN+=2}$$

pseudoN+ ~ Bin(Mi, pN)

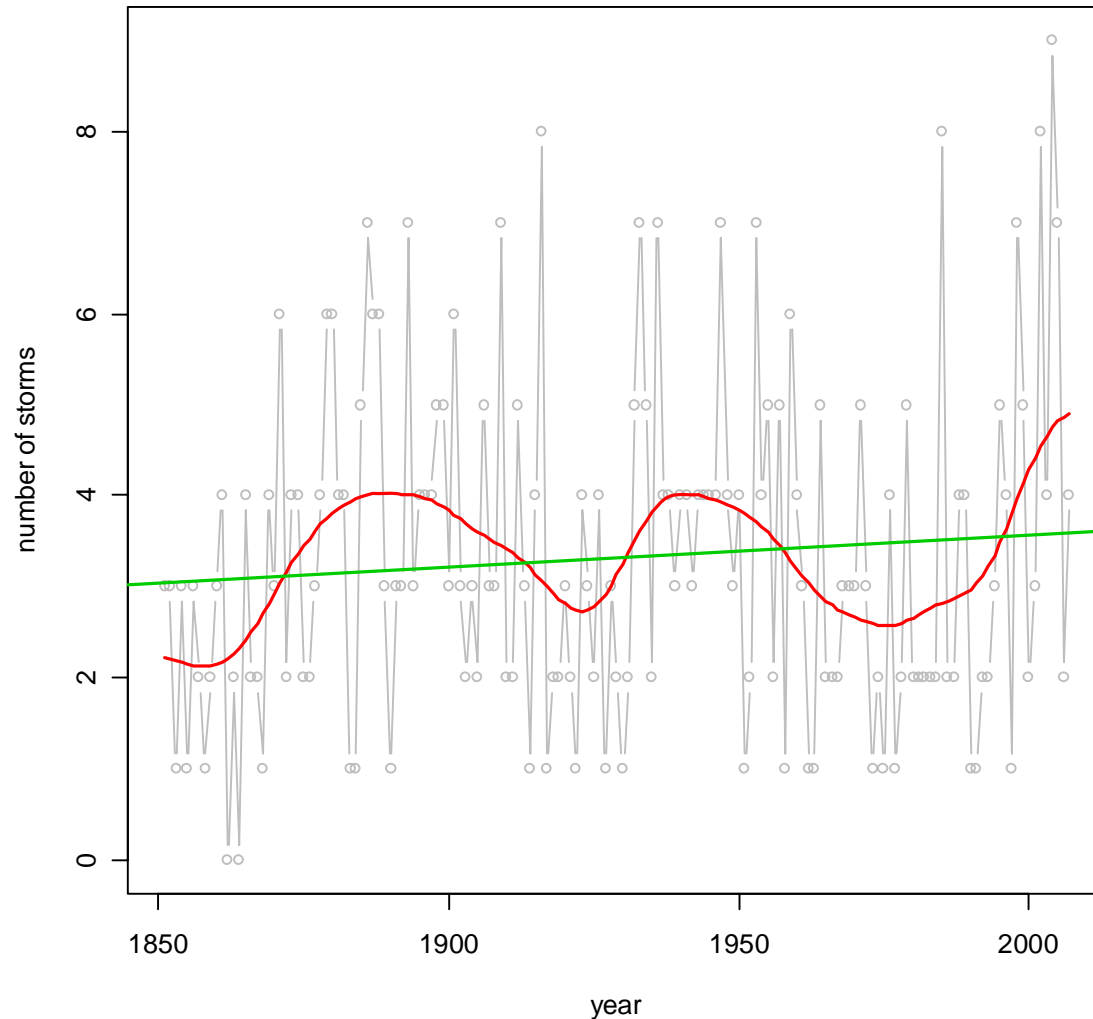


pseudoN+ ~ Bin(Mi, pN)



Remember we know the underlying data has a positive trend.....

Category 0+, landfalling



...yet the psuedo data has a high probability of not showing this trend.

Category	Proportion of psuedo data sets with negative slope
1	0.105
2	0.216
3	0.296
4	0.426
5	0.489

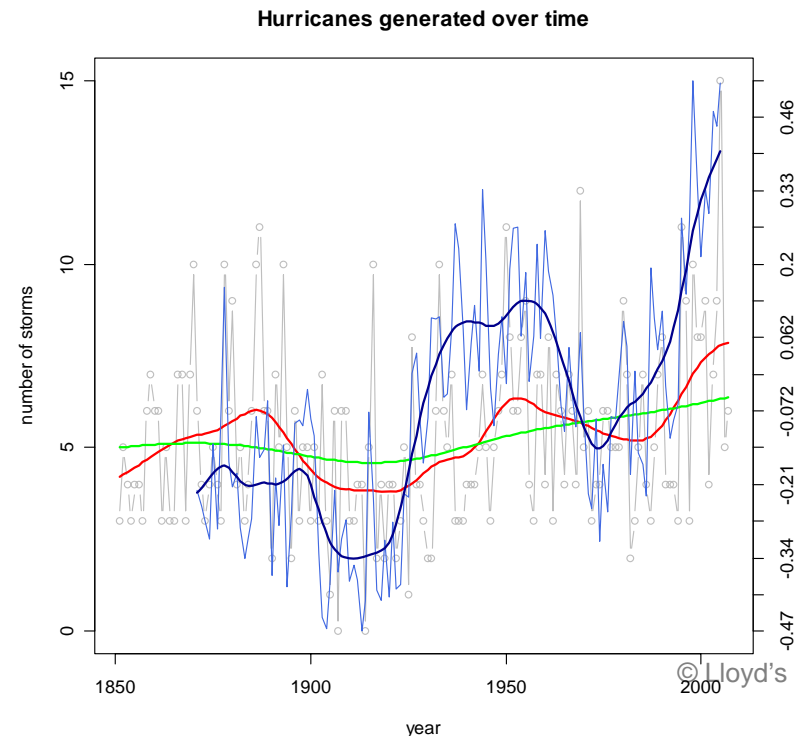
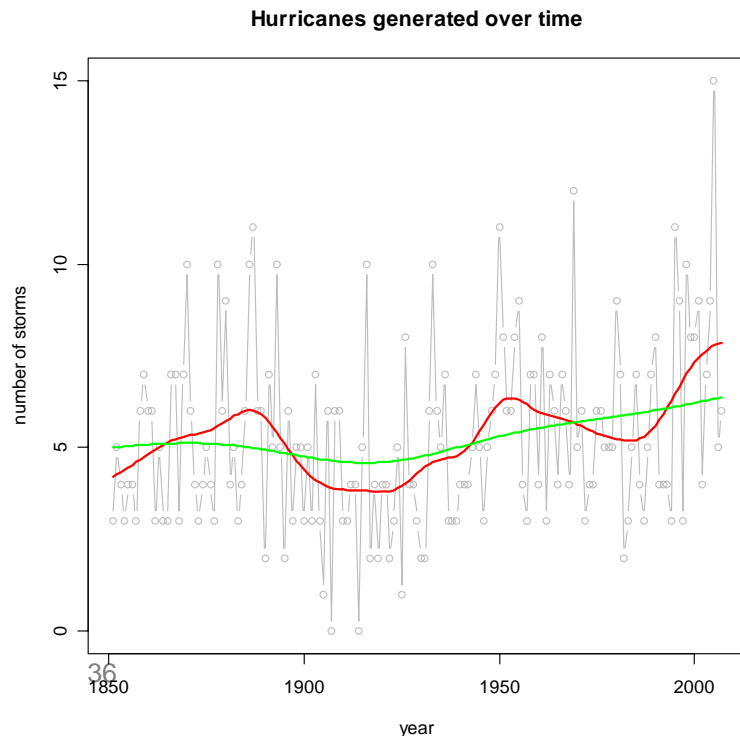
Conclusions

- Scientists are clear, genesis frequency increased over time and particularly since 1995. The simple analysis in this paper agrees with their findings. This series is not stationary.
- Some scientists are of the view that the number of landfalls is a non-stationary time series.
- The proportion of all storms that make landfall appears to be stable since the 1950s; hence an increasing trend in all storms would infer a trend in landfalling storms. We believe this is observed.
- For landfalling hurricanes we believe that the data is too sparse to derive direct conclusions
- It is better to use other more credible data sets to infer risk levels.

DATA ISSUES

Garbage in = Garbage out?

- There are issues with the data sets
- Some storms are being counted as cat 0s now that wouldn't have been recognised before (better satellite images etc)
- In early C20 storms in Atlantic were missed.
- Focus on hurricanes rather than cat 0+?



Uncertainty = risk

- there do seem to have been a lot of “most since records began” headlines:
 - Latest end to the season (Jan 2005)
 - Brazil hurricane/ Portugal
 - Fastest intensifying to cat 5 (Felix)
 - Lowest central pressure recorded (Wilma)
 - Highest two season average number landfalling 04/05
- Focus on PDI?
- Uncertainty premium – financial markets price for uncertainty

“Eight Cat 5's in five years is an awful lot of severe storms in such a short period. Climate change may be indeed be changing Atlantic hurricanes for the worse.”

Jeff Masters Wunderblog

<http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=791&tstamp=200709>

QUESTIONS?

