



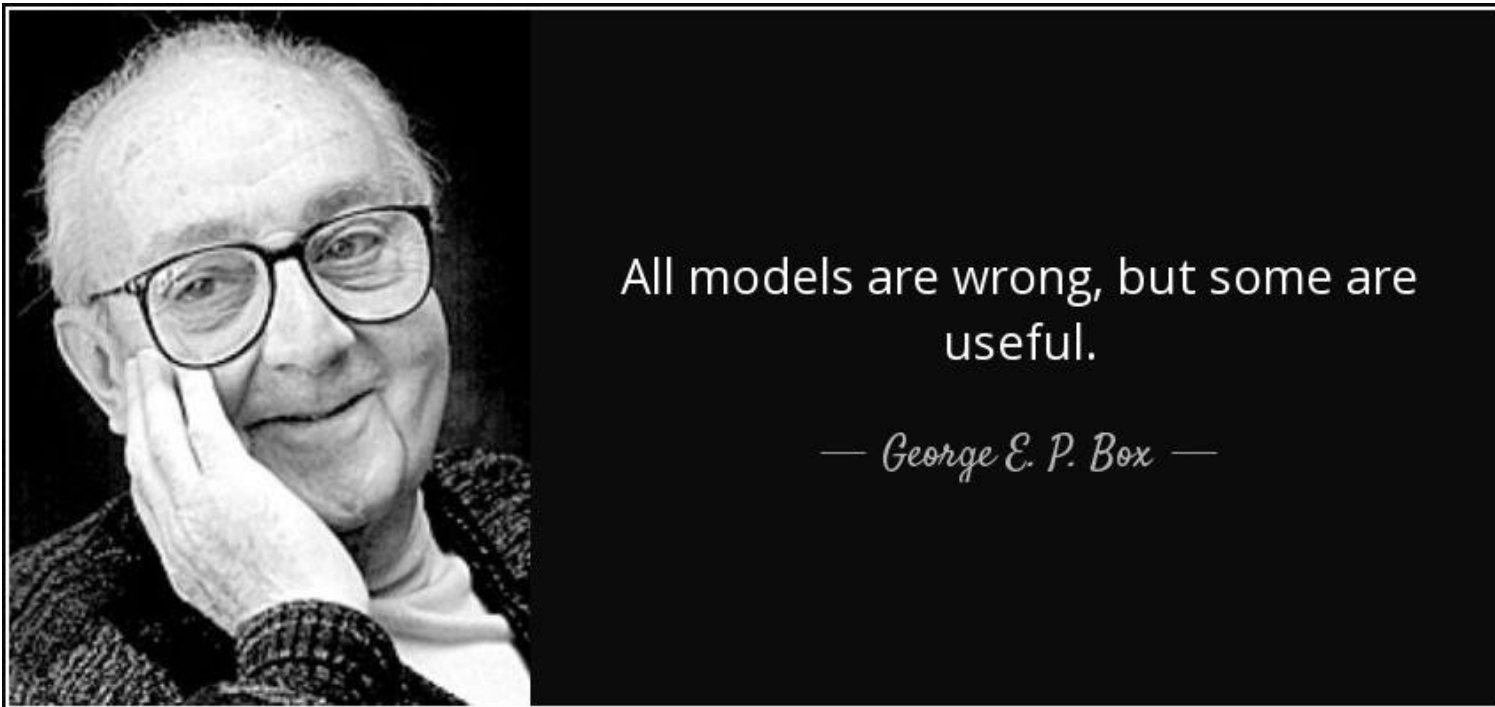
LPTs and ADCs for Risk Management

Dustin Loeffler, FCAS

Prepared by Aon Reinsurance Solutions
Presentation to 2018 CAS Loss Reserve Seminar



Before we get started, keep this in mind...



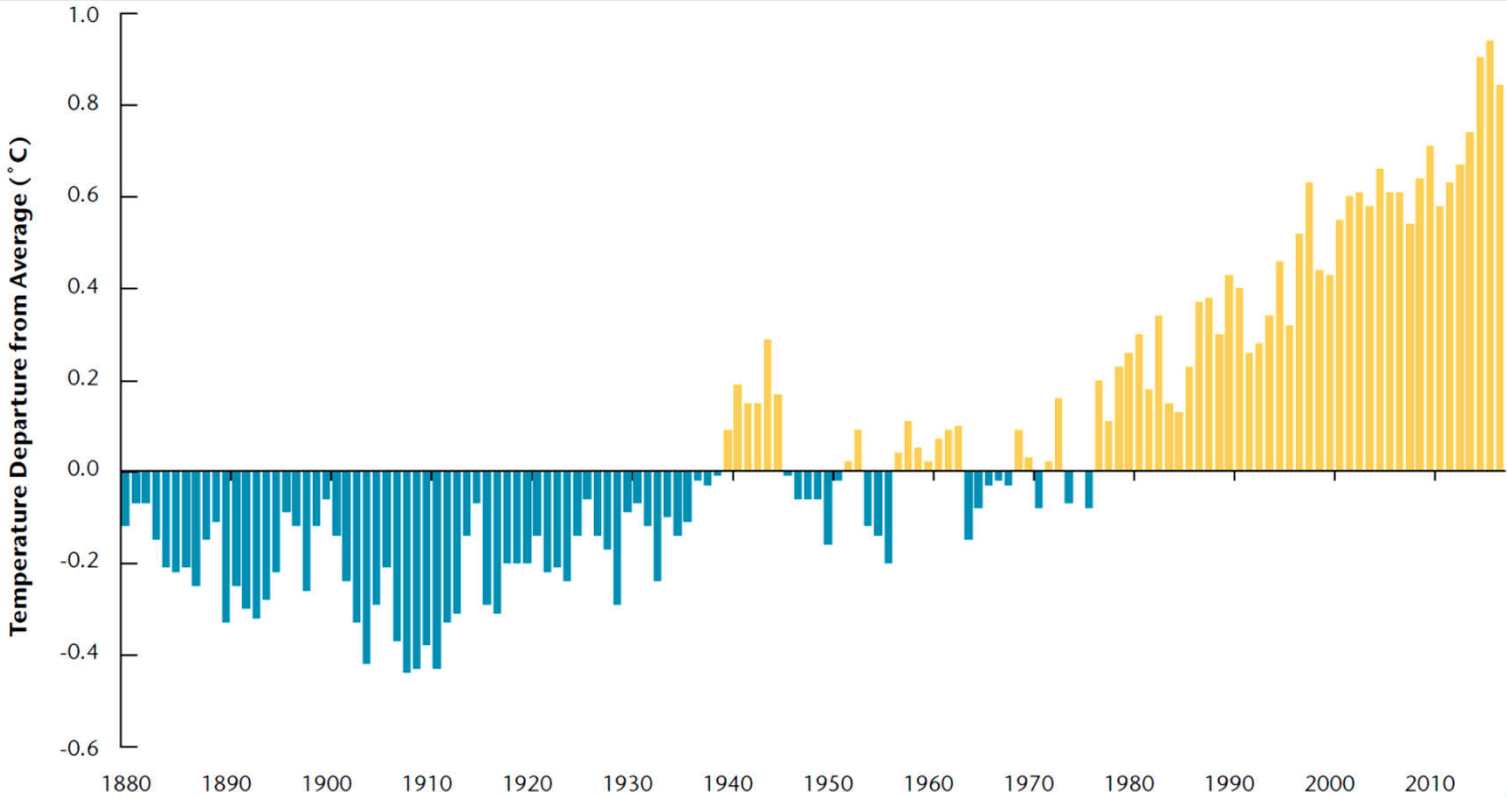
Agenda

- Section 1** Property Quick Hit - Climate & Weather Trends
- Section 2** Weather Loss Trends
- Section 3** People Trends
- Section 4** State of Casualty Catastrophe Modeling
- Section 5** Stochastic Reserving Methods
- Section 6** The Point



Section 1: Property Quick Hit - Climate & Weather Trends

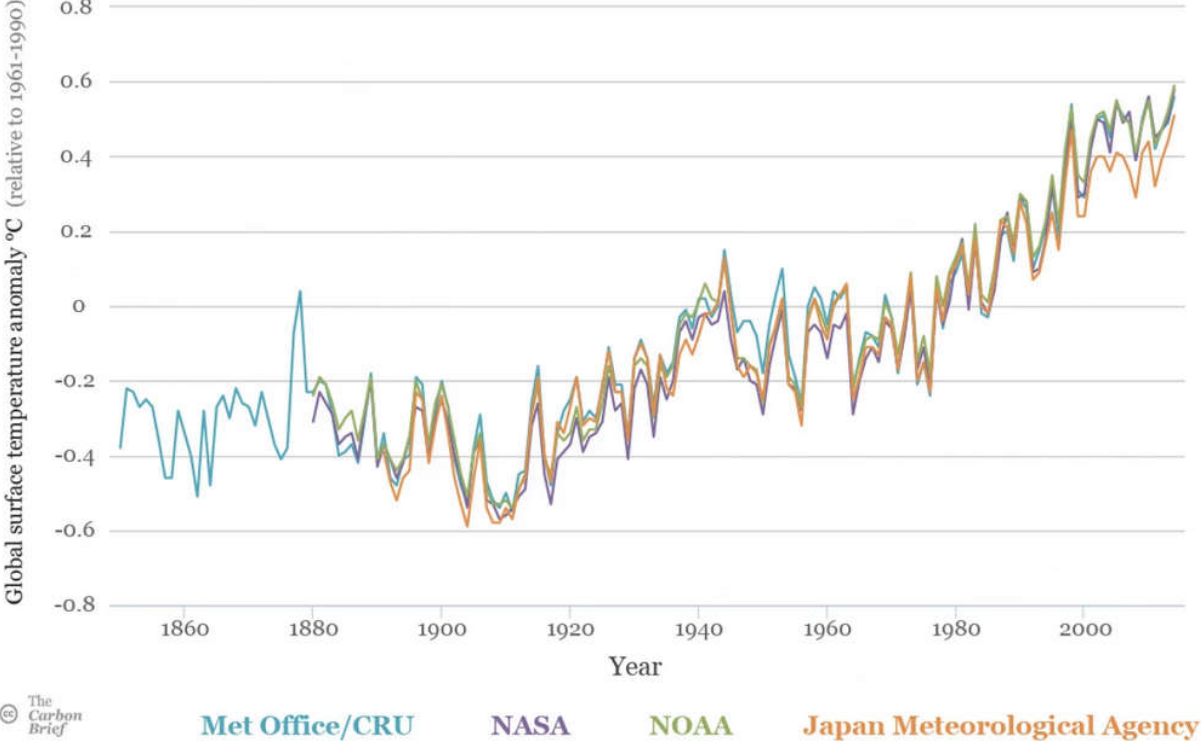
Fact: Global Temperatures are Rising



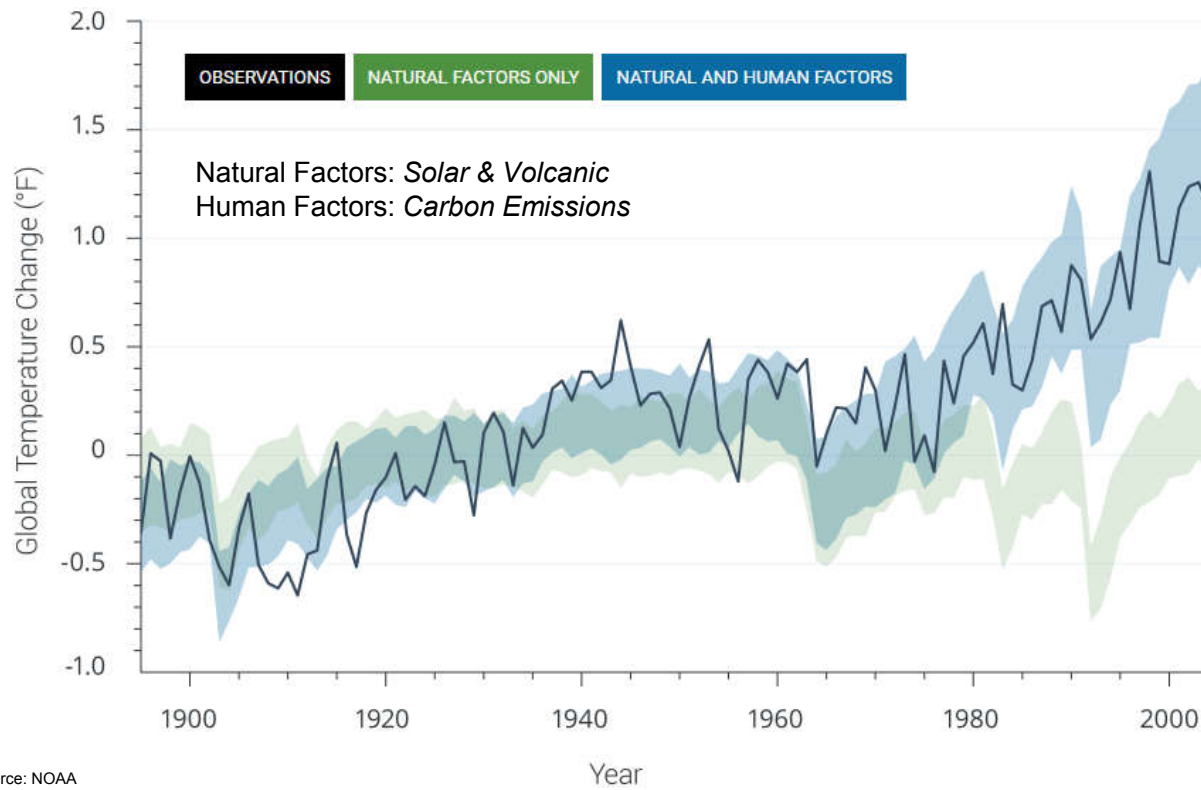
Source: NOAA



...a fact we all agree on

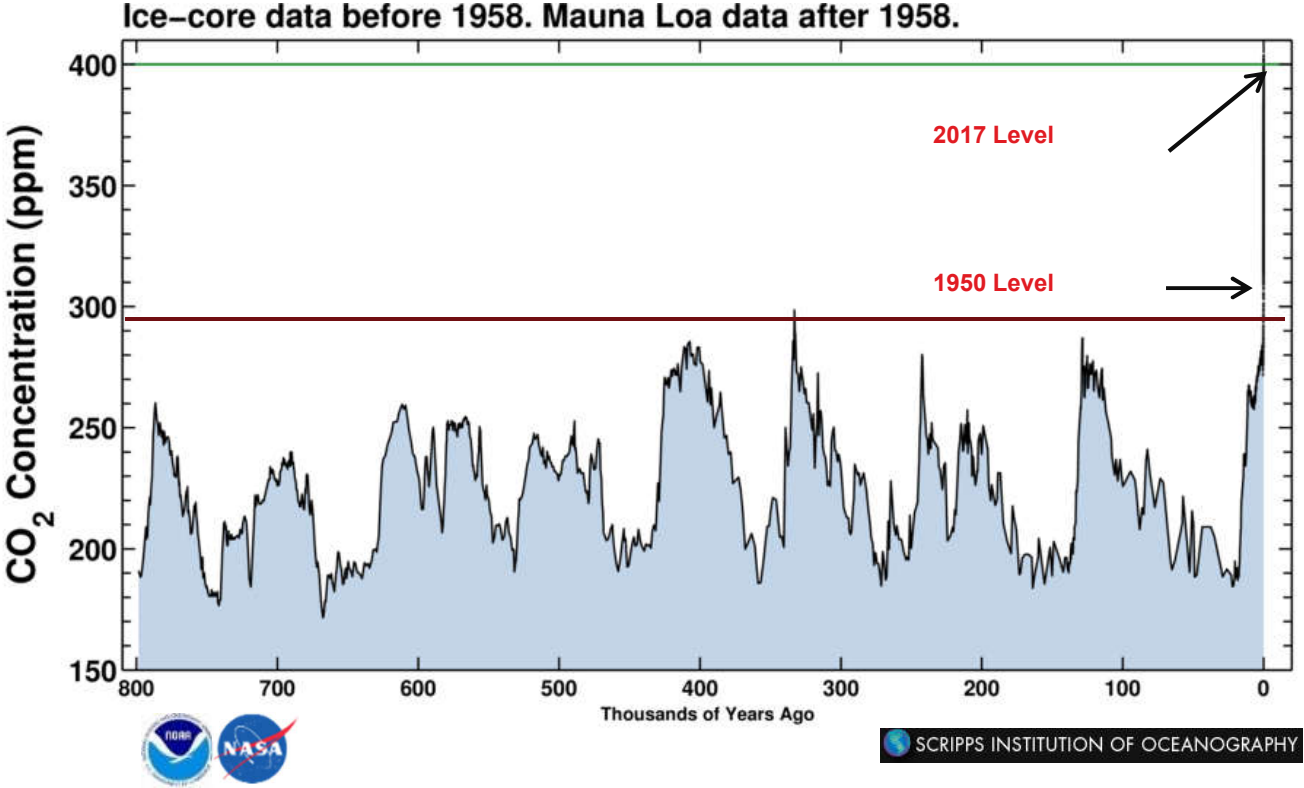


Fact: Causes of temperature rise



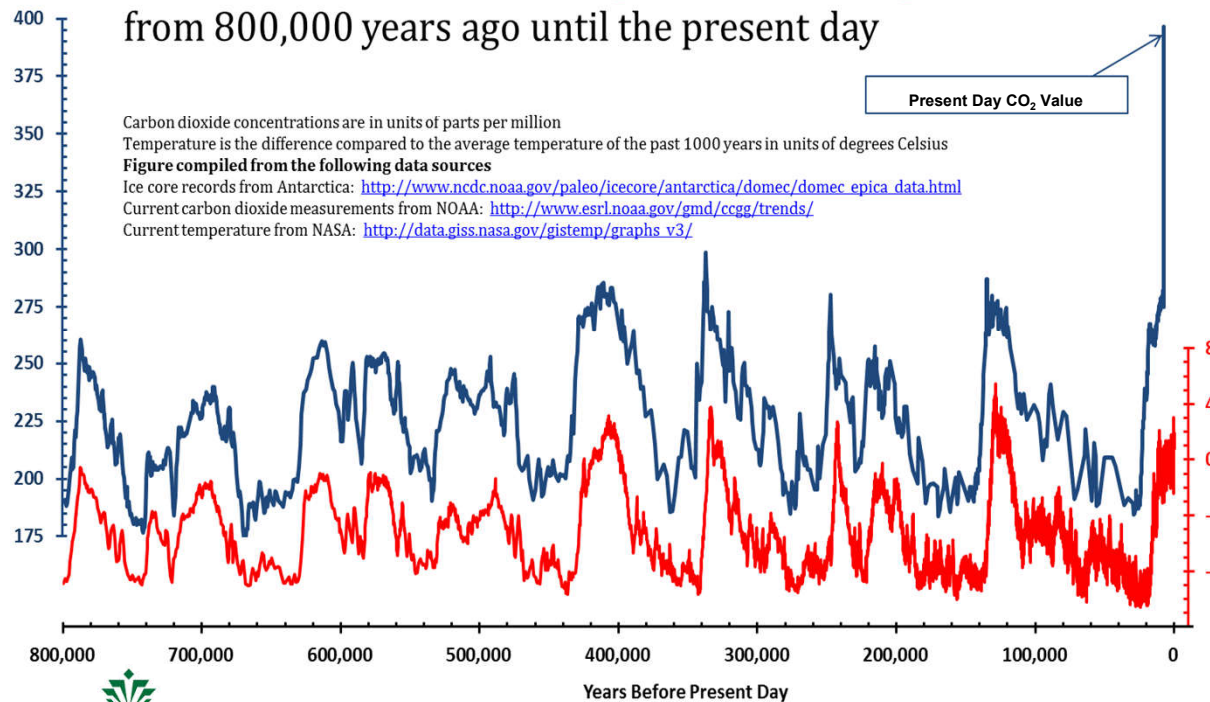
Source: NOAA

Fact: Carbon dioxide levels are rising



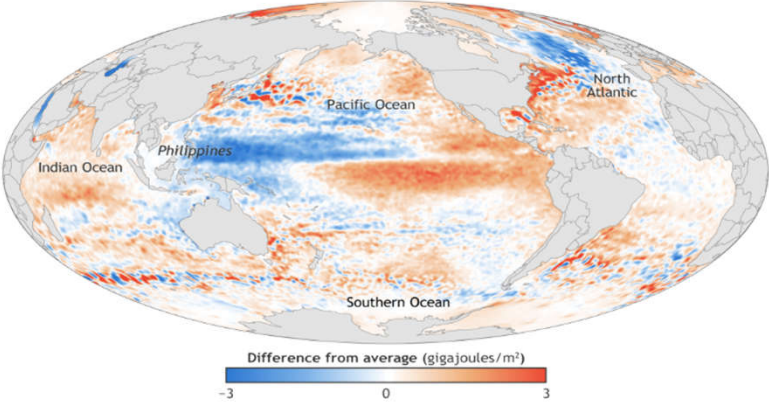
Fact: Correlation Between CO₂ & Temperatures

Carbon dioxide and the temperature of our planet from 800,000 years ago until the present day

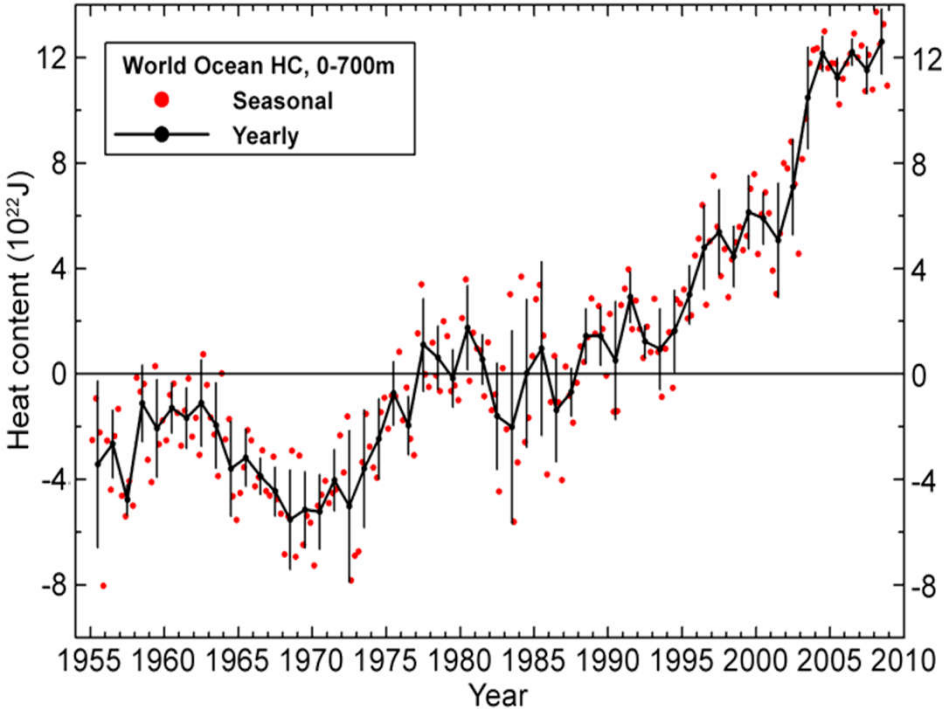
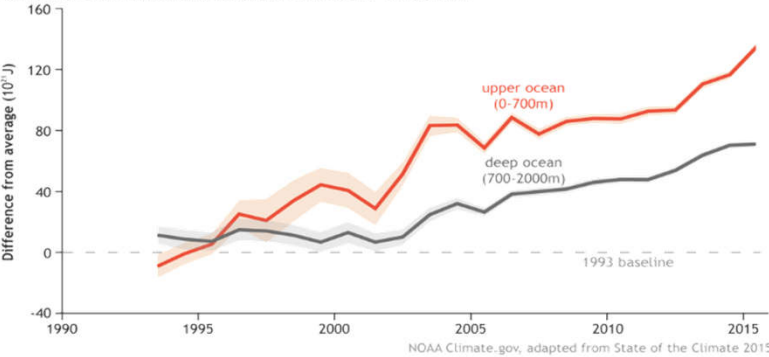


Fact: Oceans Getting Warmer

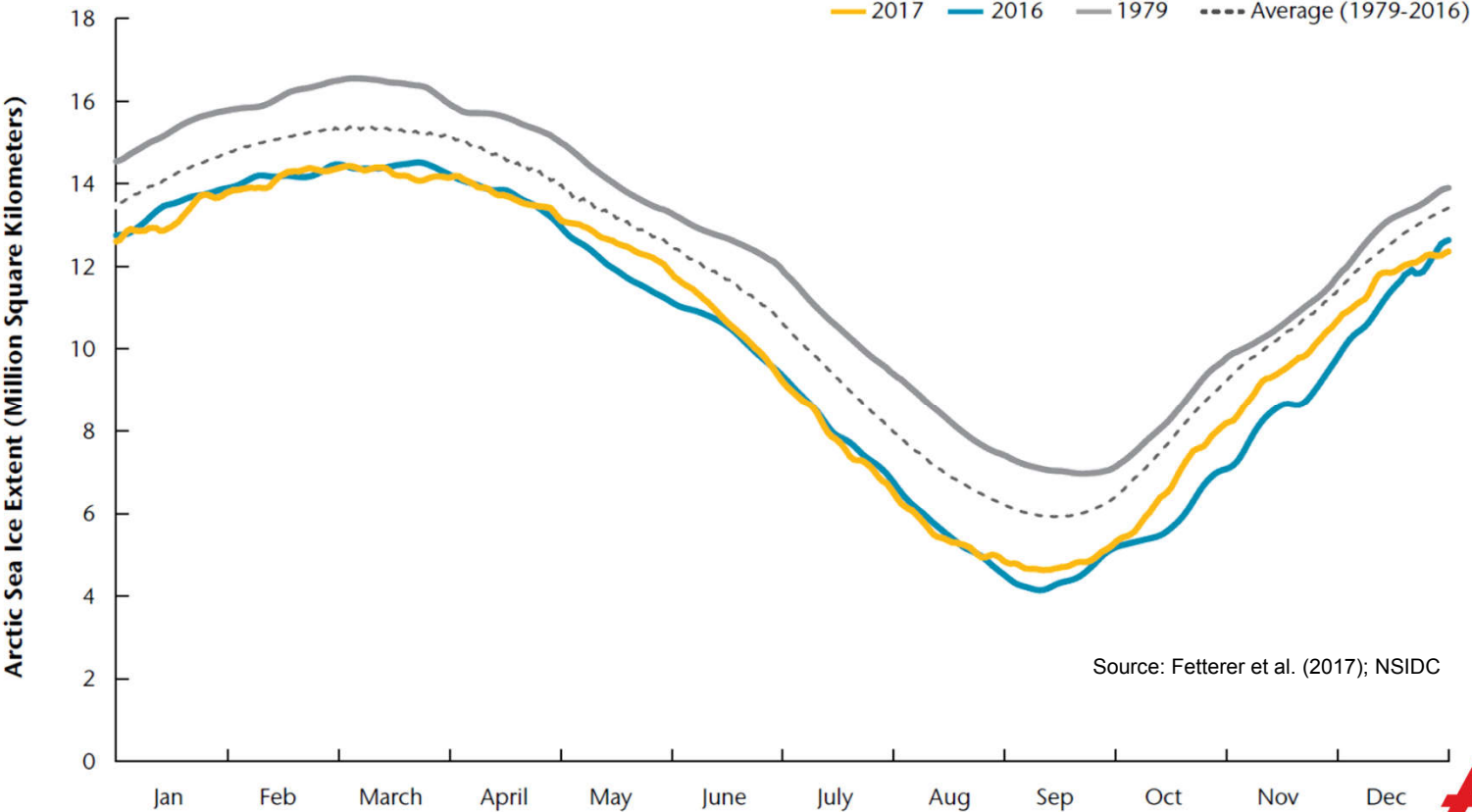
UPPER OCEAN HEAT CONTENT HITS RECORD HIGH IN 2015



UPPER OCEAN WARMING FASTER THAN DEEPER OCEAN



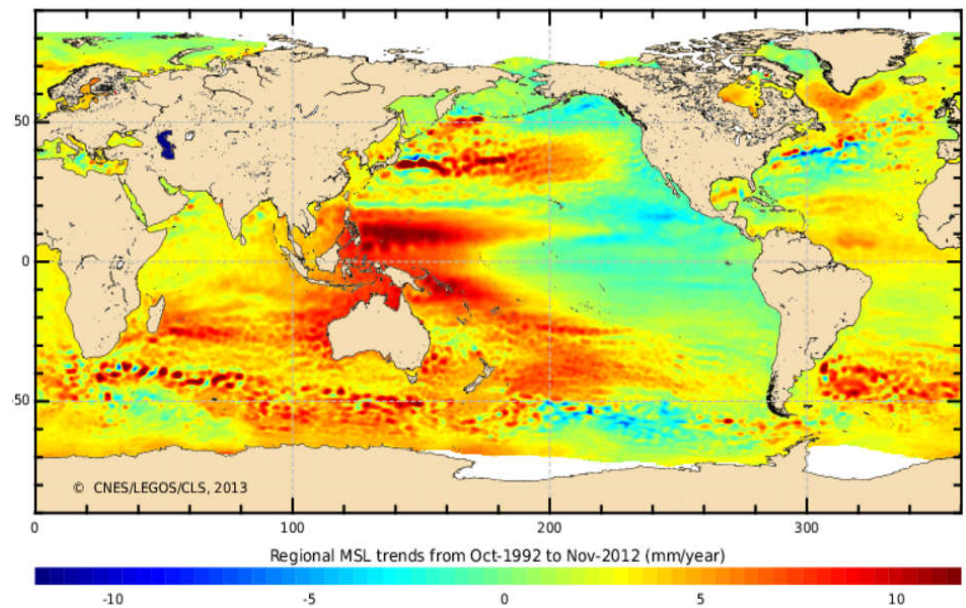
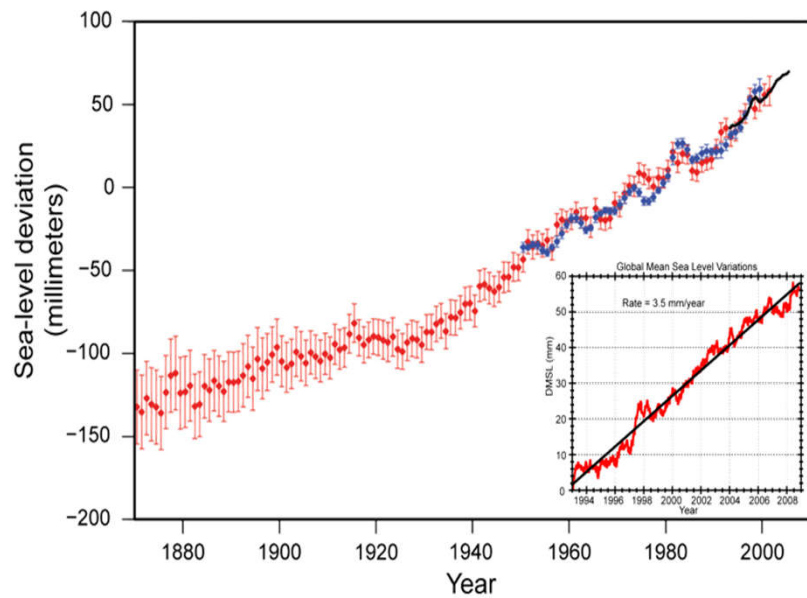
Fact: Sea ice is melting



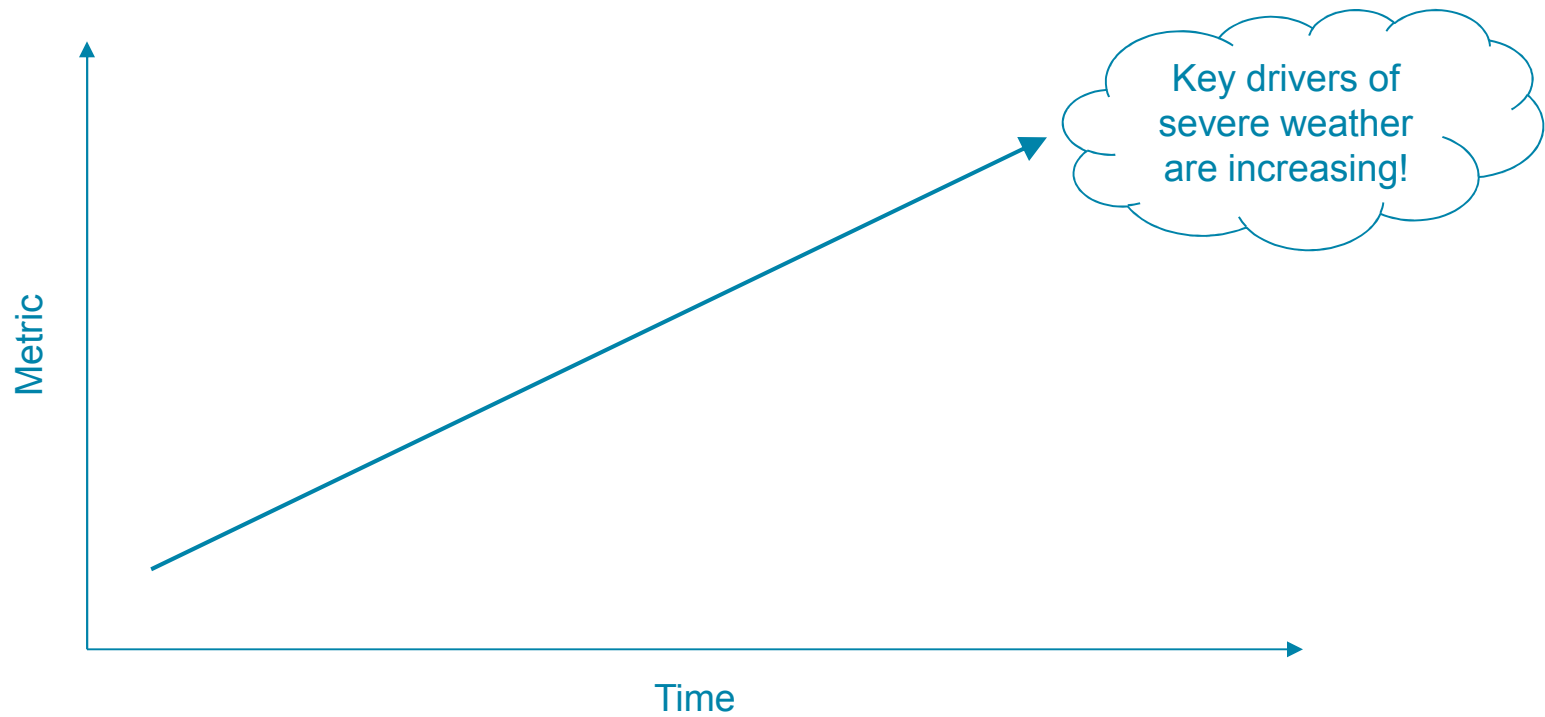
Source: Fetterer et al. (2017); NSIDC



Fact: Sea Levels Rising



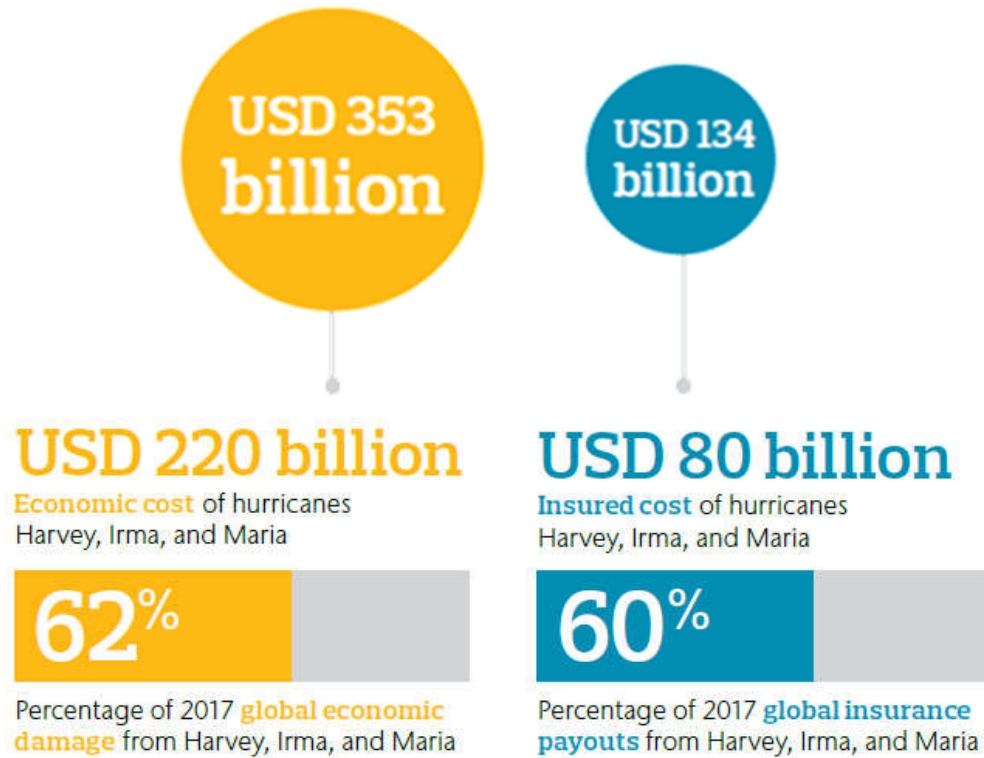
See any common themes?





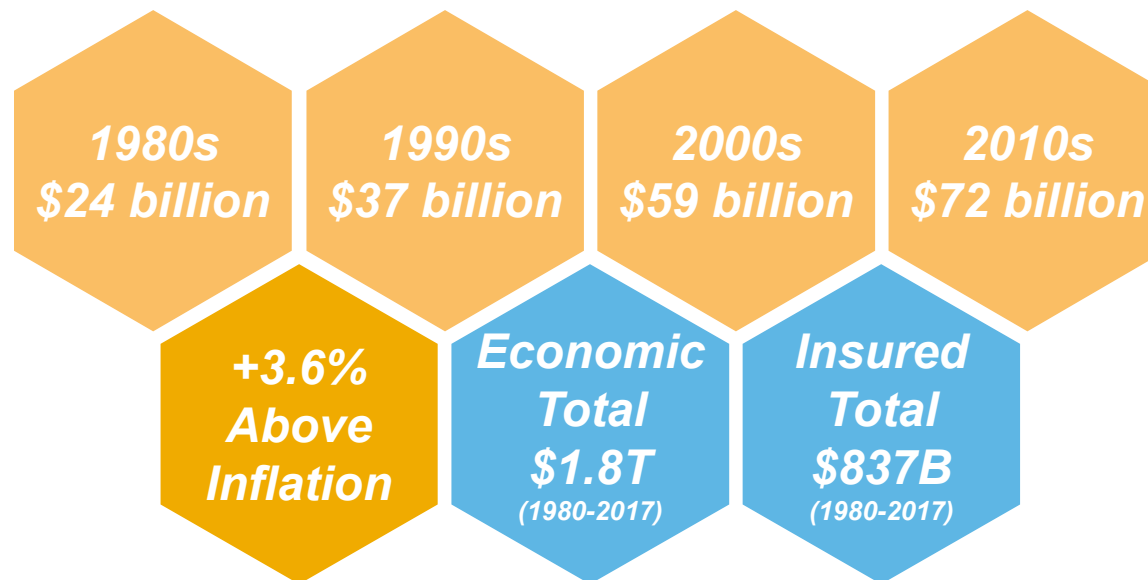
Section 2: Weather Loss Trends

But first...2017



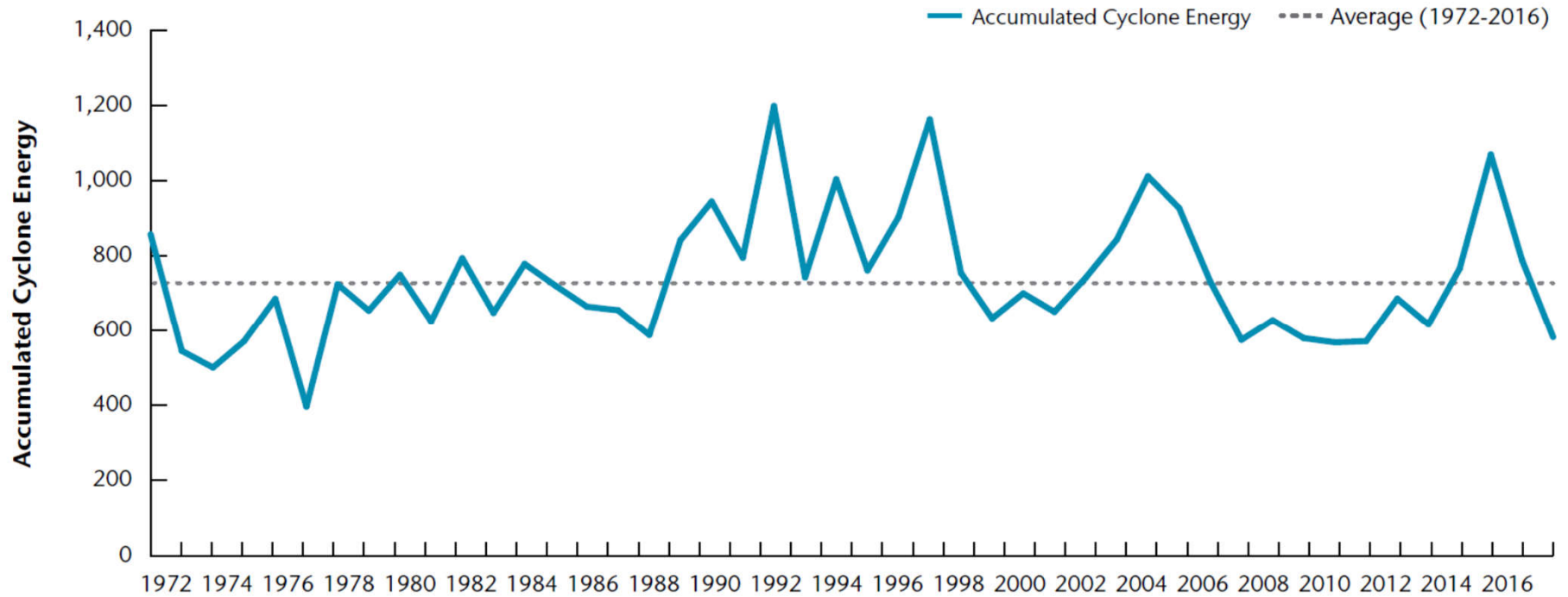
U.S. Economic Loss: Weather Events

Average Annual Economic Loss (current USD)



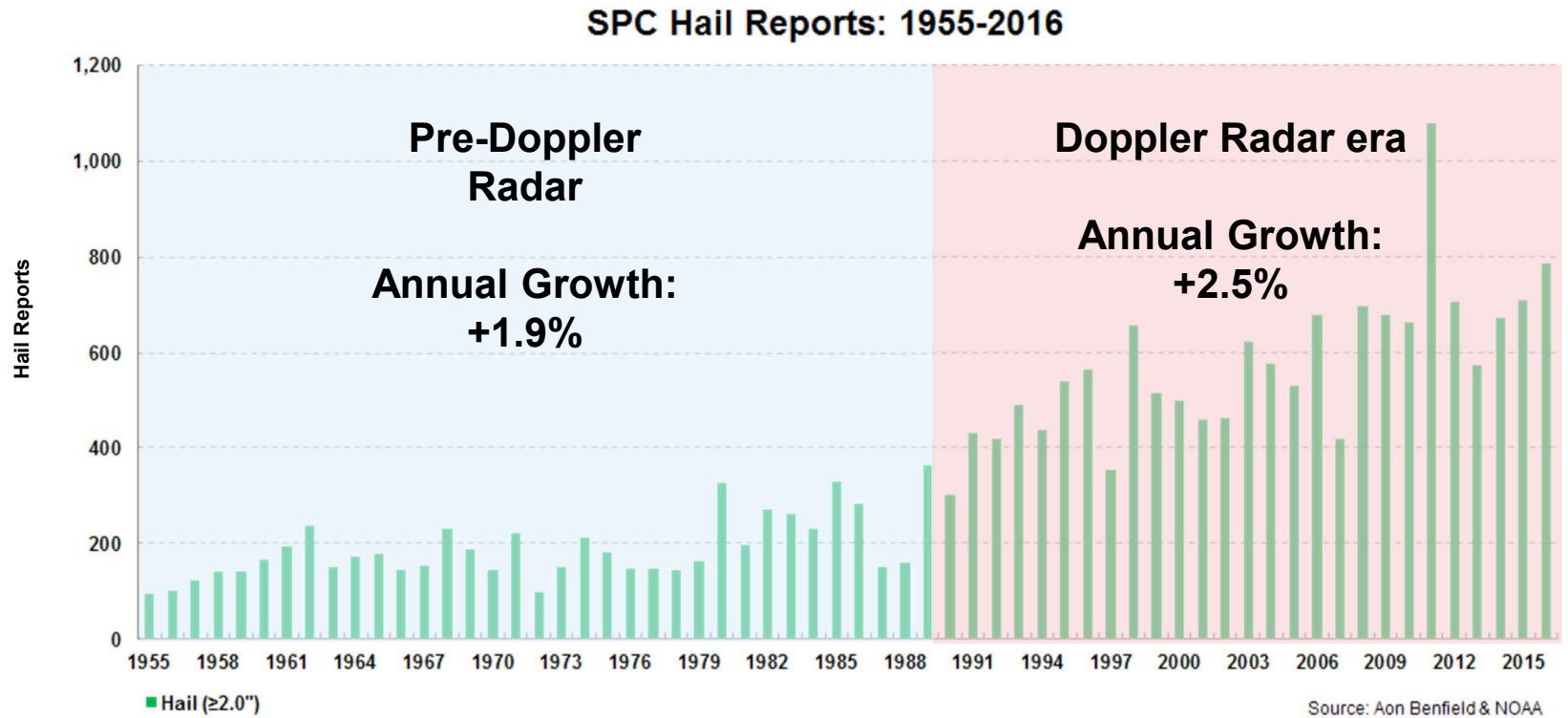
Source: Impact Forecasting

Loss Driver: Atlantic Hurricanes



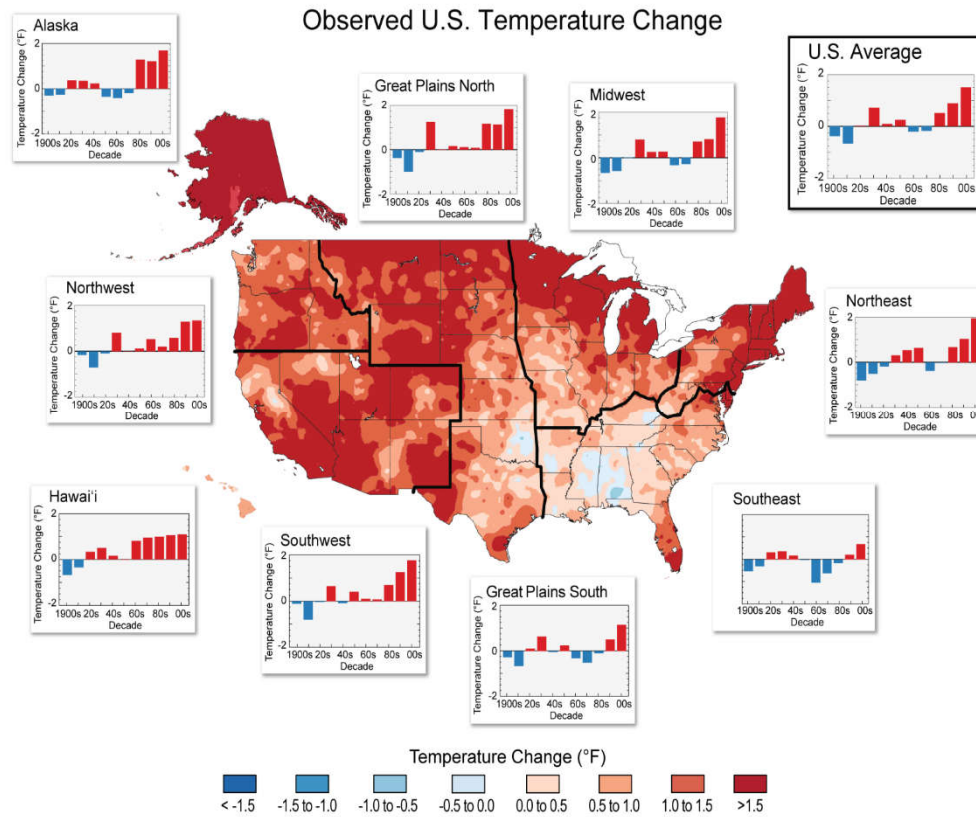
Source: Aon Benfield & Colorado State University

Loss Driver: Hail

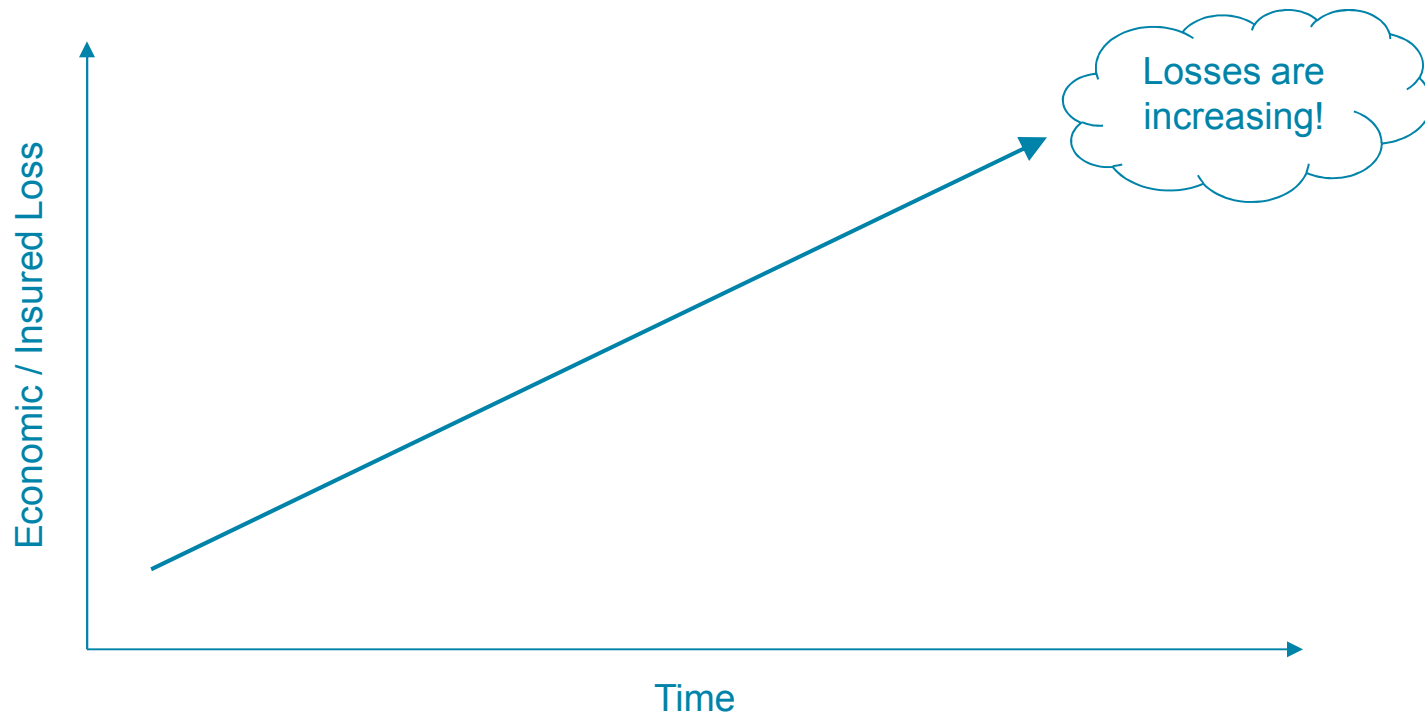


Loss Driver: Drought & Wildfire

- Temperature change from 1991 to 2012 compared to 1901 to 1960 average and the 1951 to 1980 average for AK and HI



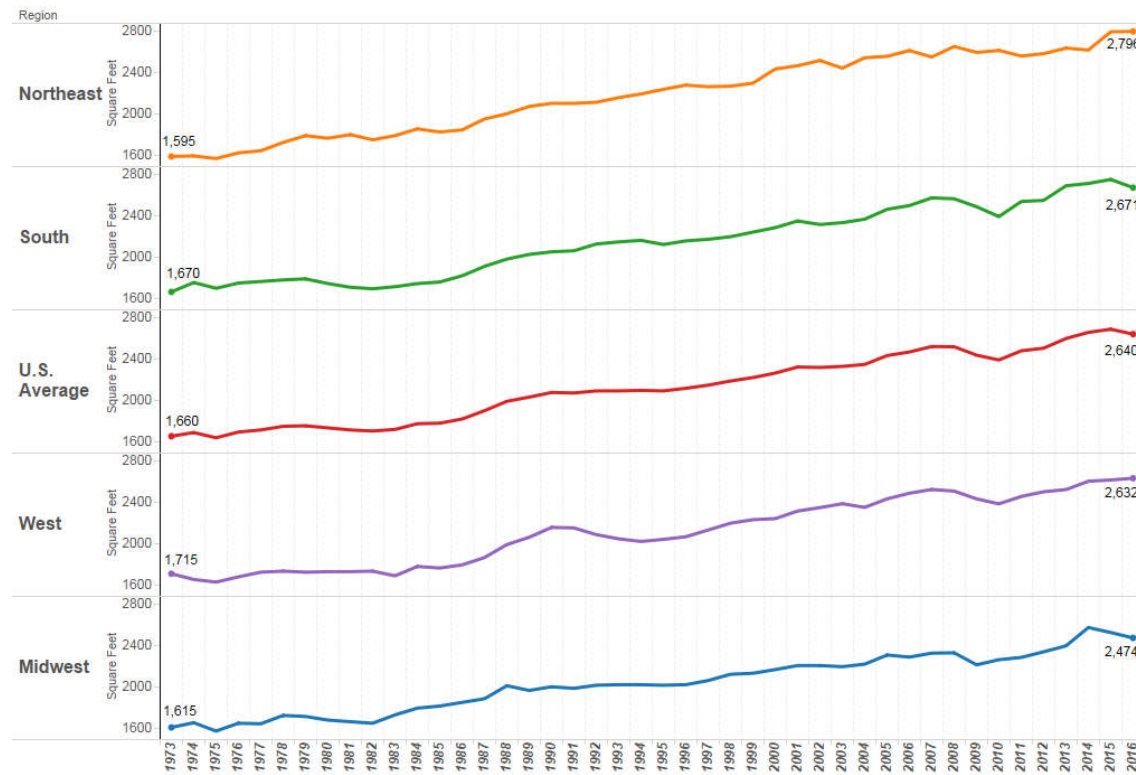
Again, do you see any common themes?





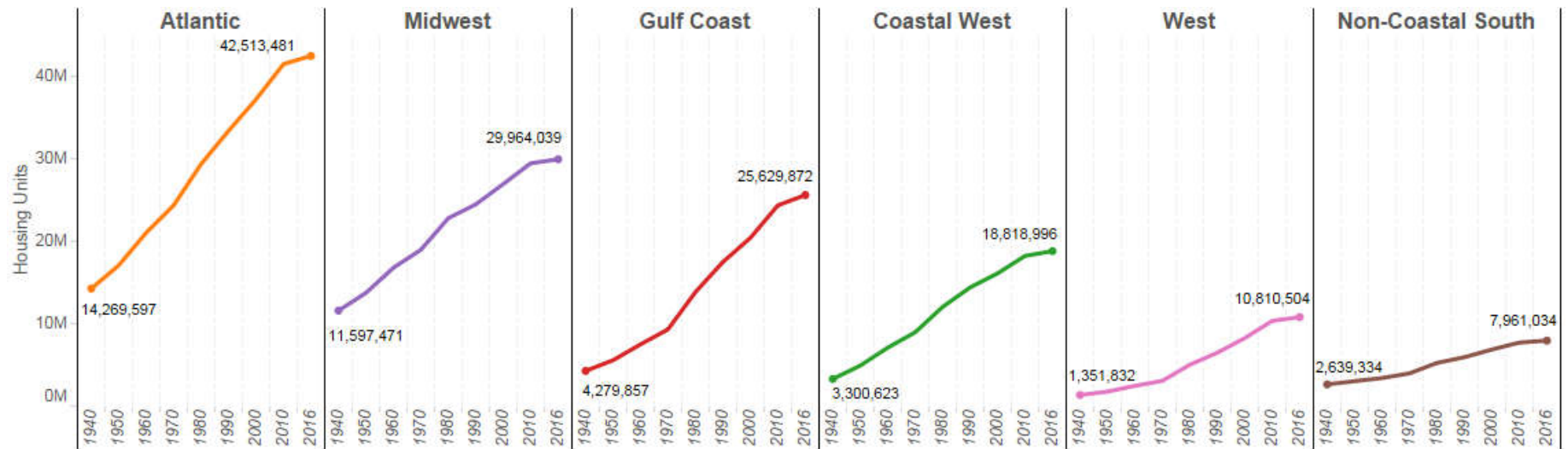
Section 3: People Trends

Loss Driver: Bigger & Costlier Homes



Source: U.S. Census

Loss Driver: More Homes



Source: U.S. Census

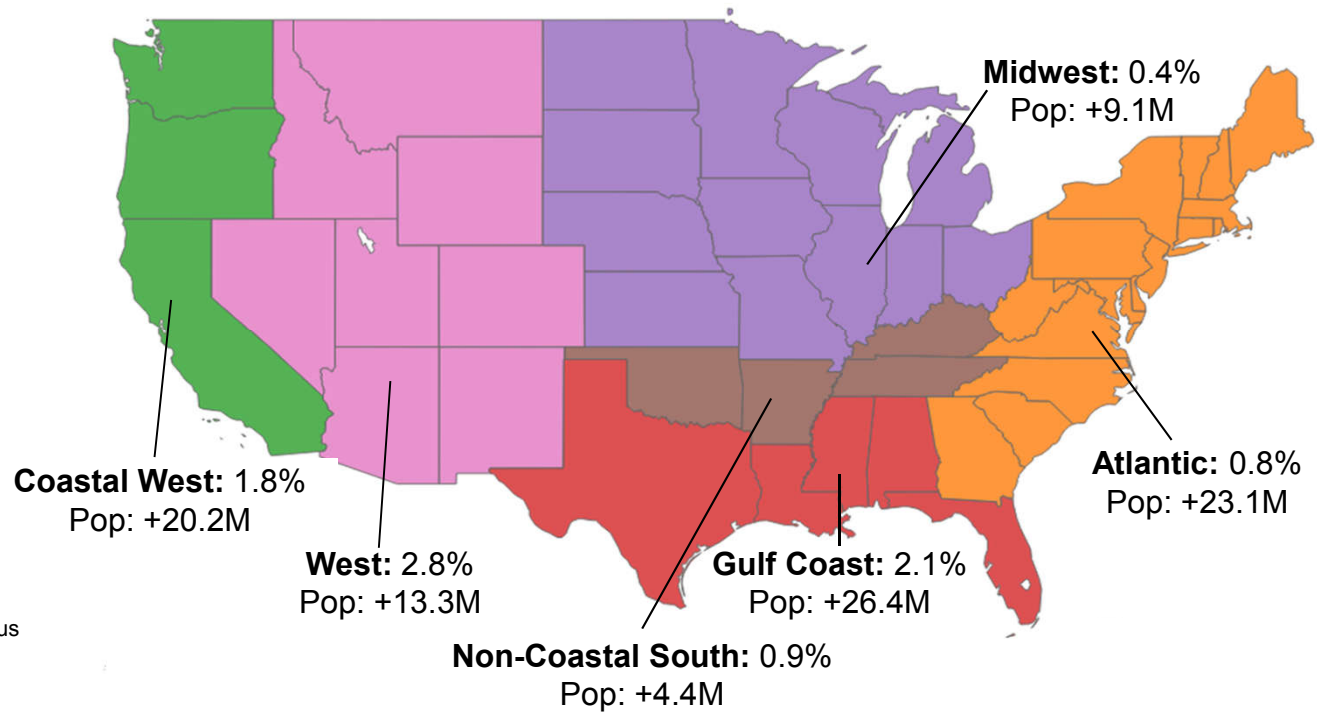
The USA with Evil Dictator...



All U.S. Citizens:
You **MUST** move to the
most dangerous areas
in America!

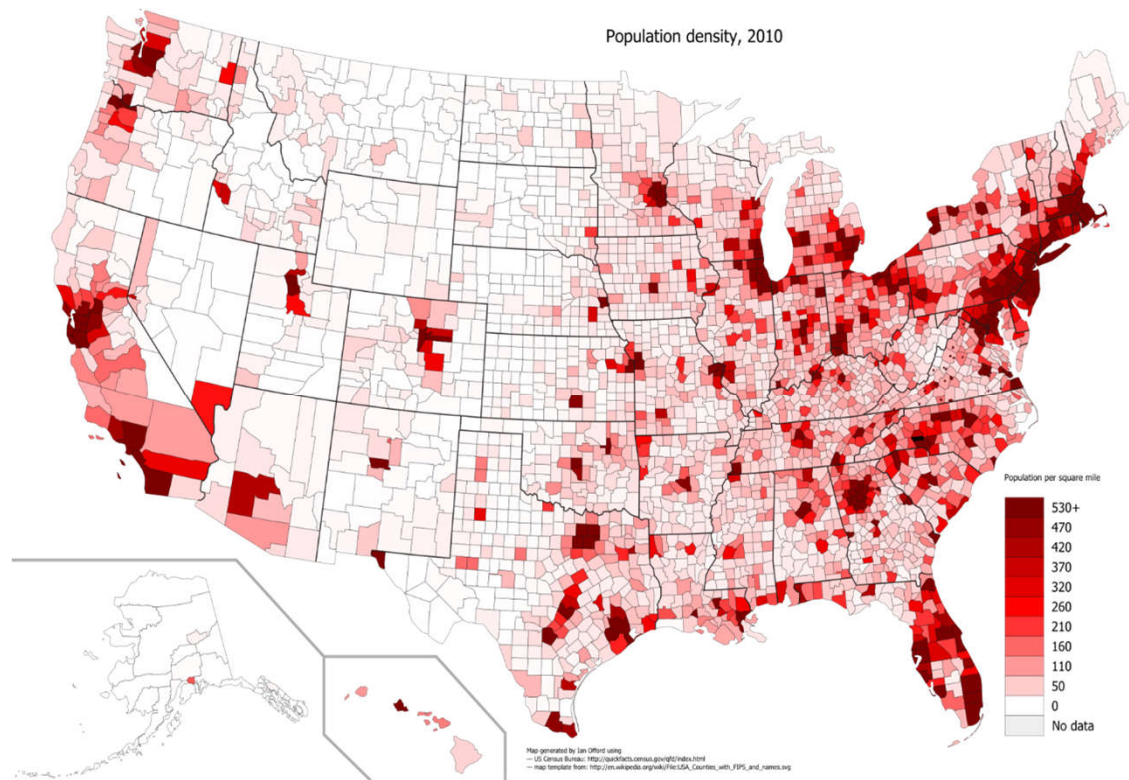
Loss Driver: U.S. Population Growth Rates

1980-2016: 72% of population increase found in ocean-bordering states



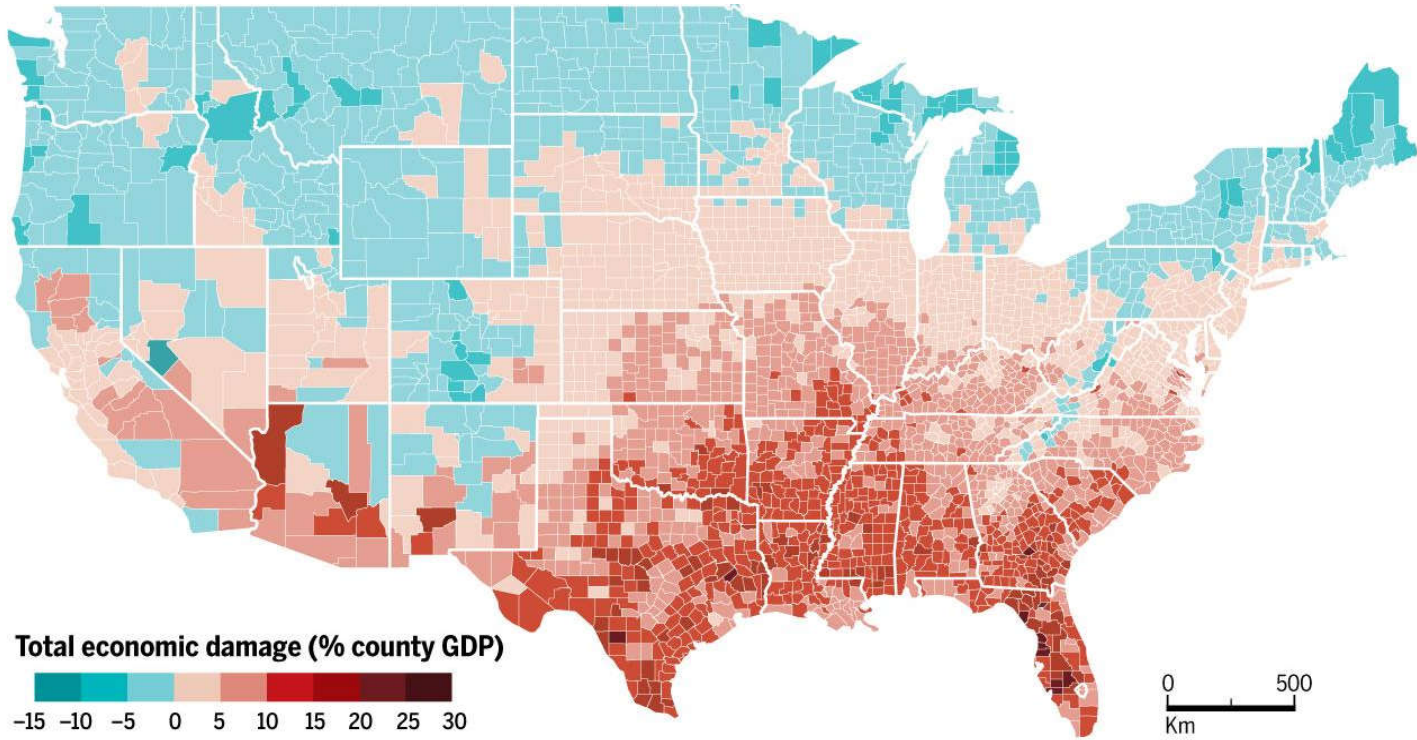
Source: U.S. Census

Loss Driver: U.S. Population Patterns



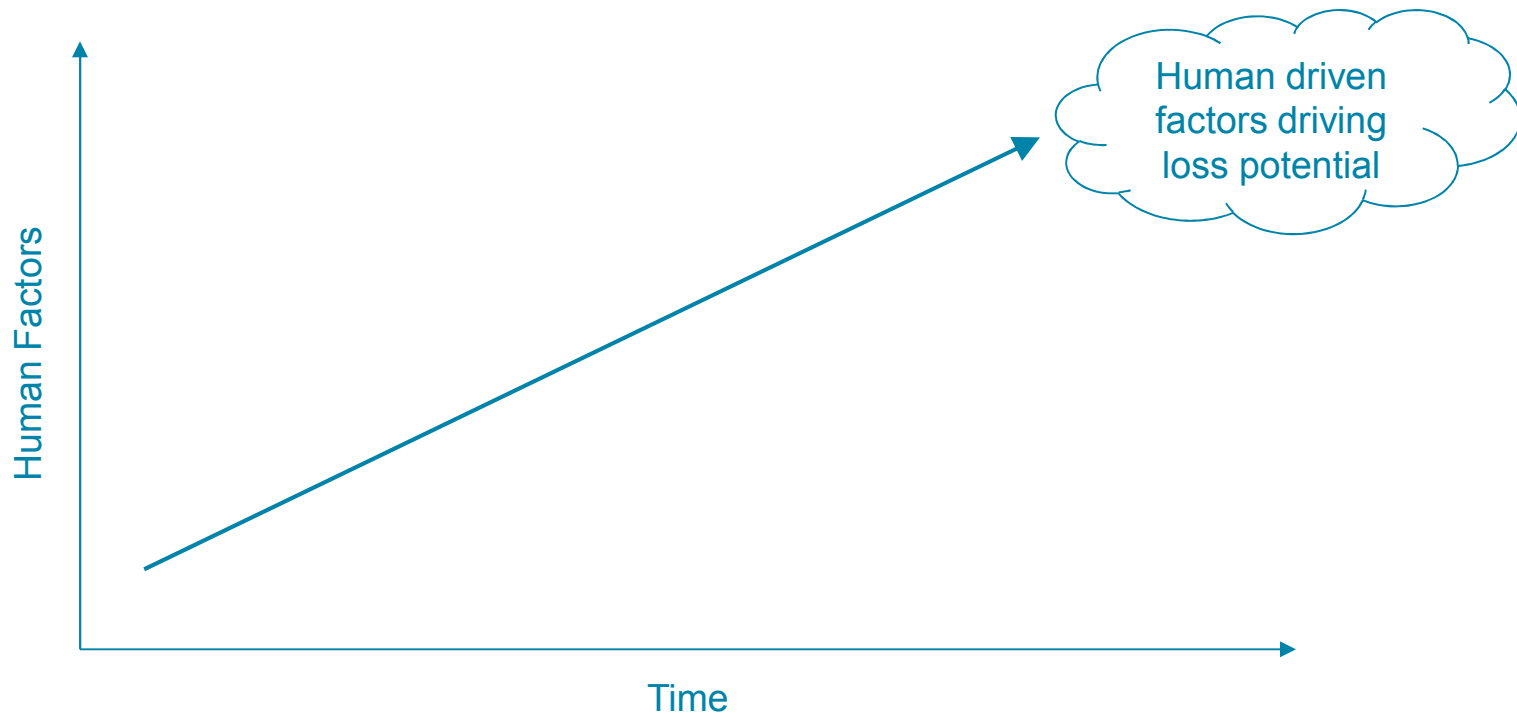
Greatest Risk Areas

Study: For every +1°C increase in global mean temperature, cost impact to US GDP increases by +1.2%

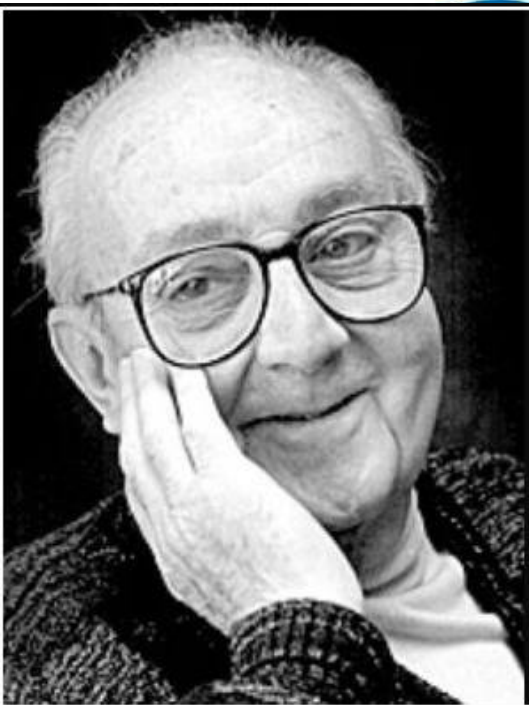


Hsiang, Kopp, Jina, Rising, et al. (2017)

One last time...is there a theme?



Why are most weather related perils insurable?



But wait, let's not forget...

All models are wrong, but some are useful.

— *George E. P. Box* —



- While again
- Cata trans
- Limited historical loss data with low credibility



Section 4: State of Casualty Catastrophe Modeling

What is a Casualty Catastrophe?

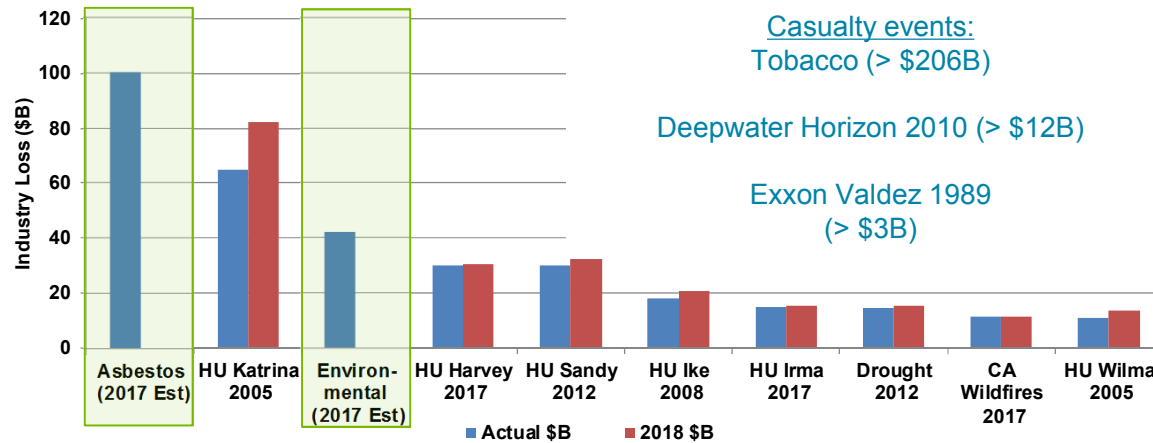
A.M. Best defines a casualty catastrophe as "an event, activity, or product that results in a large number of lawsuits from multiple plaintiffs alleging damages that impact multiple insureds, coverages, and/or time periods." (A.M. Best SRQ)

Question	Property	Casualty
What?	Event (not man-made)	Event, activity, or product (man-made)
Who?	Multiple claimants (first party)	Multiple plaintiffs (third party)
How?	Multiple insureds and coverages	Multiple insureds, coverages and/or time periods Potential for cascading losses across industries
Also:	Fortuitous Loss	Fortuitous Loss ? ? ? ?

Fortuitous: happening or produced by chance

Why Focus on Casualty Catastrophe?

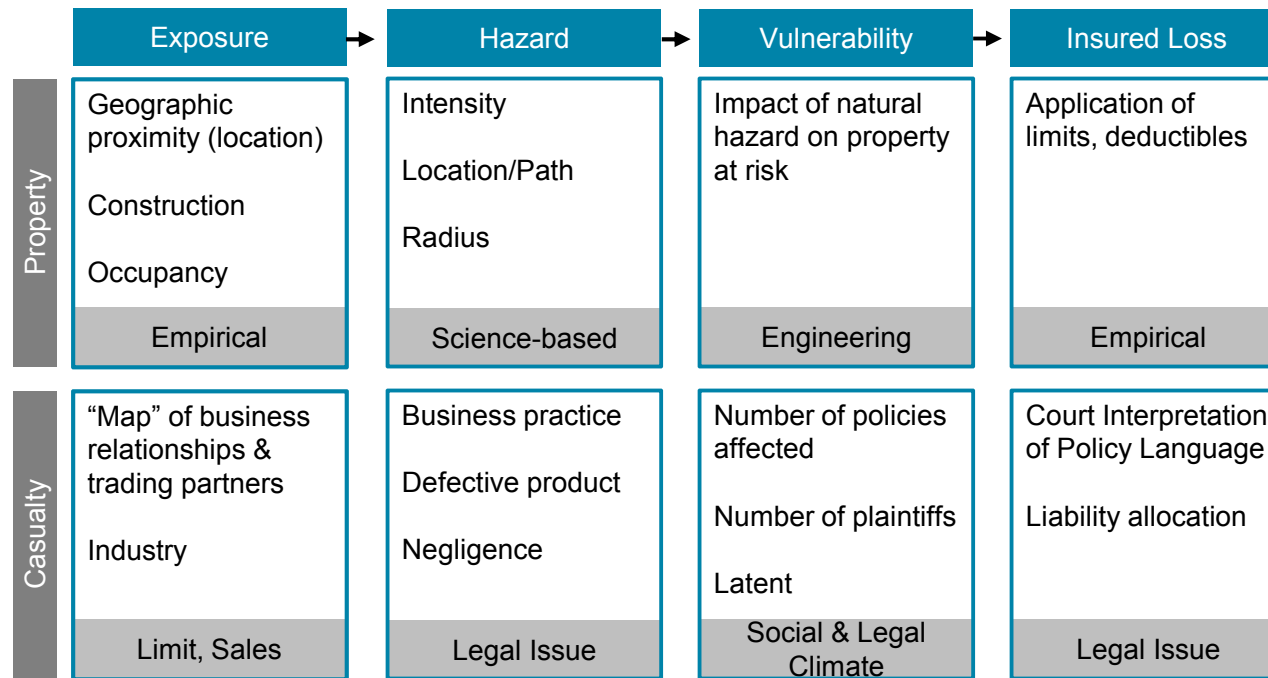
Significant Insurance Industry Loss Events



- Although few, casualty catastrophes are large
 - Two of the three largest insured catastrophe events in the US have been casualty catastrophes!!
- Inadequate reserves have been a significant contributor of insolvencies
- Exposure to casualty catastrophes of growing importance from a capital perspective
 - Explicit casualty clash risk charges for IAIS and Solvency II
 - AM Best adding more casualty clash disclosures (five scenario impacts) to SRQs

Source: Estimates of casualty catastrophe from AM Best (2017), property catastrophes from PCS, only property catastrophes from the last 20 years considered.

Conceptual Similarities



- > Casualty accumulation risk involves complex interactions among socio-economic, environmental, health and legal environments

Contrasts Between Property & Casualty Catastrophes

Characteristic	Property	Casualty
Emergence	Sudden	Gradual
Duration	Short (days)	Lengthy (Years/Decades)
Financial Recognition of Losses	Immediate	Deferred

Challenging Aspects of Casualty Catastrophes

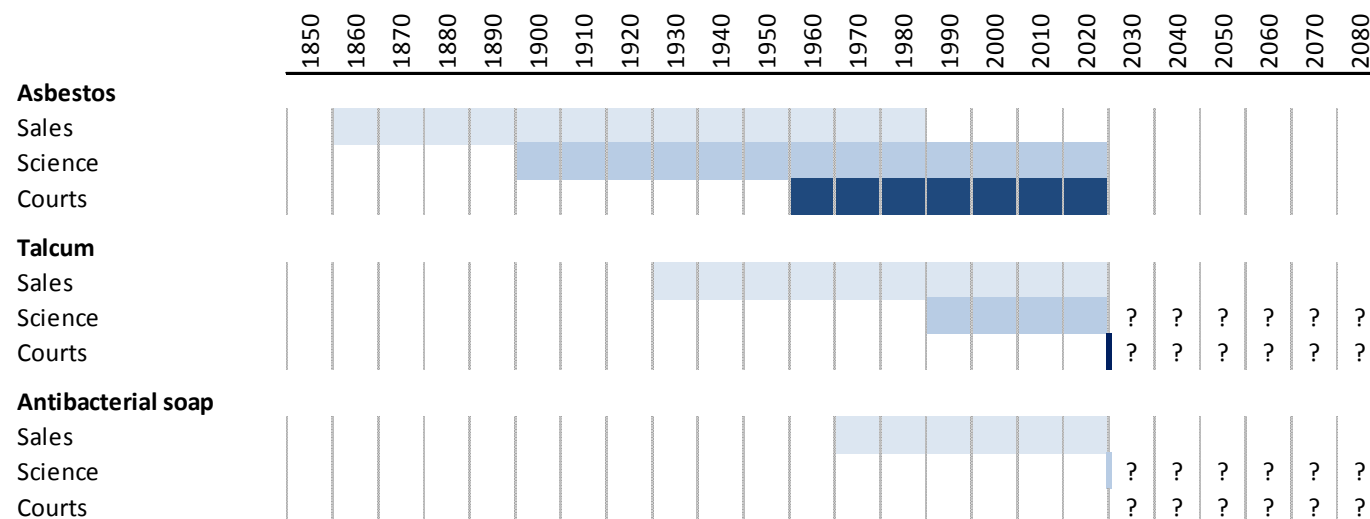
- Infrequency of events
- Singular nature of past events relative to possible future events
 - No two are the same
- Complexity of modeling legal dynamics and social trends
- Diversity of causes
- Inaccessible data
- Lack of mechanism for systematic identification and aggregation of casualty catastrophe insured loss across insurers
- Uncertainty as to the location of the casualty event
- Historical casualty events tend to get 'excluded' from insurance coverage once able to 'parametrize'

> Greater uncertainty in parameterization of casualty versus property modeling

Source: D'Arcy, Stephen P., Casualty Catastrophe Analytics: Where we are now and where we should be on this critical risk, March 2016.

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Emergence of Casualty Accumulation Risk



- There are many other emerging risks in casualty
 - Sugar
 - Cell phones
 - Neonicotinoids
 - Opioids
- Are the exposures to these risks increasing in today's rapidly evolving world?

Proprietary Models

- Several insurers, consultants, and InsurTech companies have produced proprietary casualty catastrophe models
 - Models vary in their approach, data source(s), complexity, reliance on historical experience

Company	Affiliations	Model	Data	Source of data
Willis Re	Towers Watson	eNTAIL	30 years of historical losses 300 casualty catastrophes	Willis Re Towers Watson
Guy Carpenter	n/a	GC ForCas	300,000 historical losses	Advisen
Aon Benfield	n/a	ReMetrica	60 scenarios evaluated across 1,000+ industry classes (NAIC / SIC)	Aon Benfield
Lloyd's / Arium	AIR	Arium	300,000 historical losses	Advisen
Praedicat	RMS	Oortfolio	Text mining of 10,000 journals	Praedicat

- Several models use historical losses to develop industry loss parameters which then can be modeled across an insurance portfolio

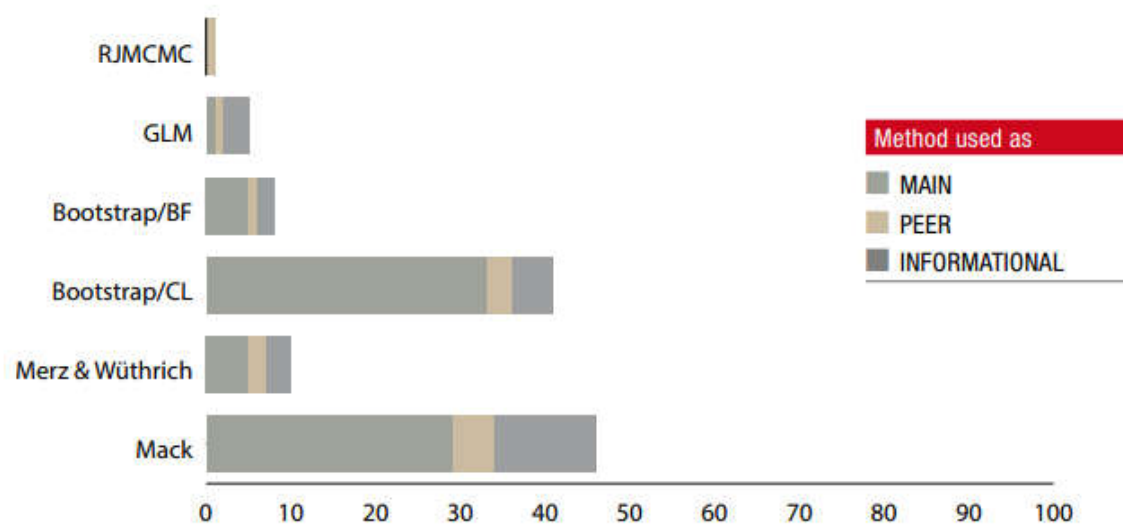
Source: D'Arcy, Stephen P., Casualty Catastrophe Analytics: Where we are now and where we should be on this critical risk, March 2016.



Section 5: Stochastic Reserving Methods

Most popular stochastic reserving methods today...

Main stochastic methods used



Mack-derived analytical methods are slightly behind the algorithmic Bootstrap methods, the other methods following far behind. On average a little more than one out of two insurers on two use a stochastic method (either being Bootstrap or Mack-derived).

Source: 2016 ASTIN Non-life Reserving Practices Report

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...first introduced in the 1990s

Mack Method

DISTRIBUTION-FREE CALCULATION OF THE STANDARD ERROR
OF CHAIN LADDER RESERVE ESTIMATES

BY THOMAS MACK
Munich Re, Munich

ABSTRACT

A distribution-free formula for the standard error of chain ladder reserve estimates is derived and compared to the results of some parametric methods using a numerical example.

KEYWORDS

Claims reserving; chain ladder; standard error.

1993

ODP Bootstrap



Insurance: Mathematics and Economics
Volume 25, Issue 3, 10 December 1999, Pages 281-293

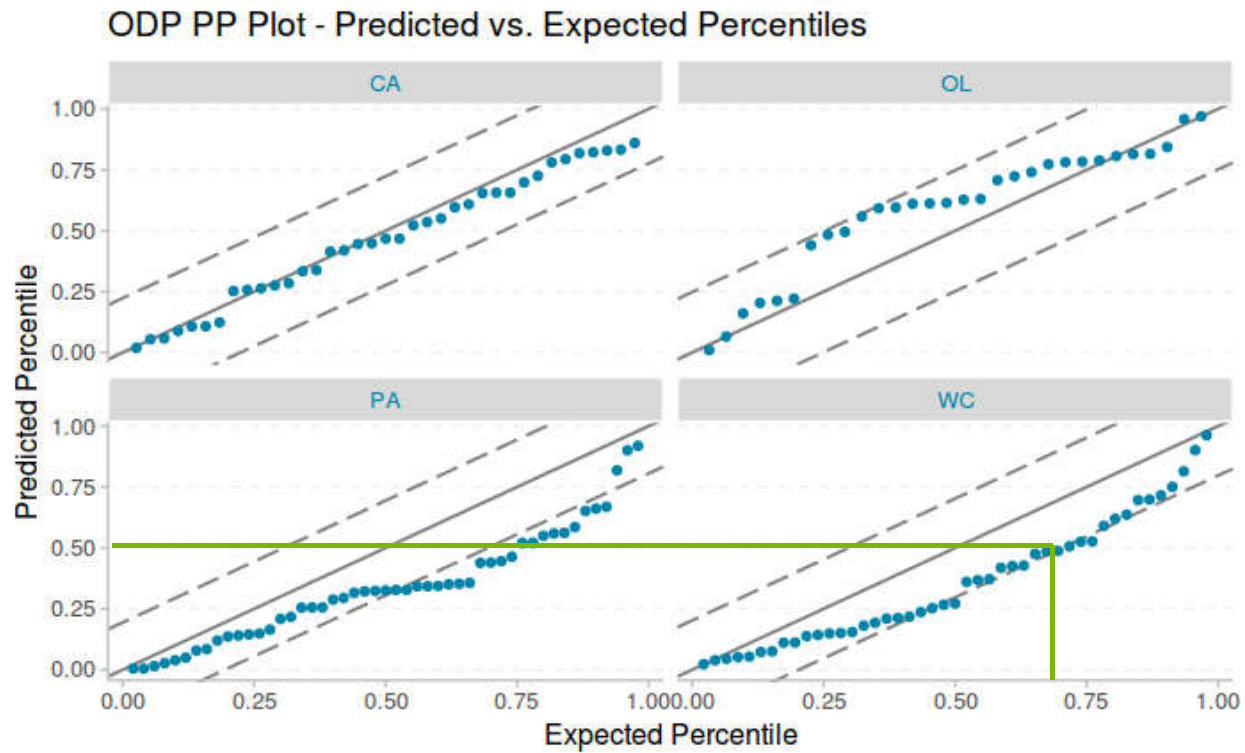


Analytic and bootstrap estimates of prediction errors in claims reserving ☆

Peter England ^a, Richard Verrall ^b

1999

Back-testing results of ODP



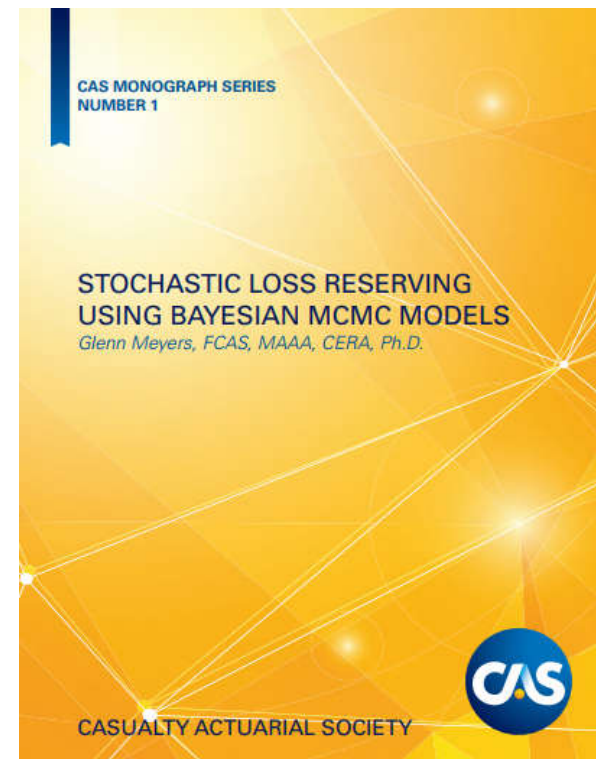
Bayesian MCMC Changing Settlement Rate (CSR) Method

As described in the literature

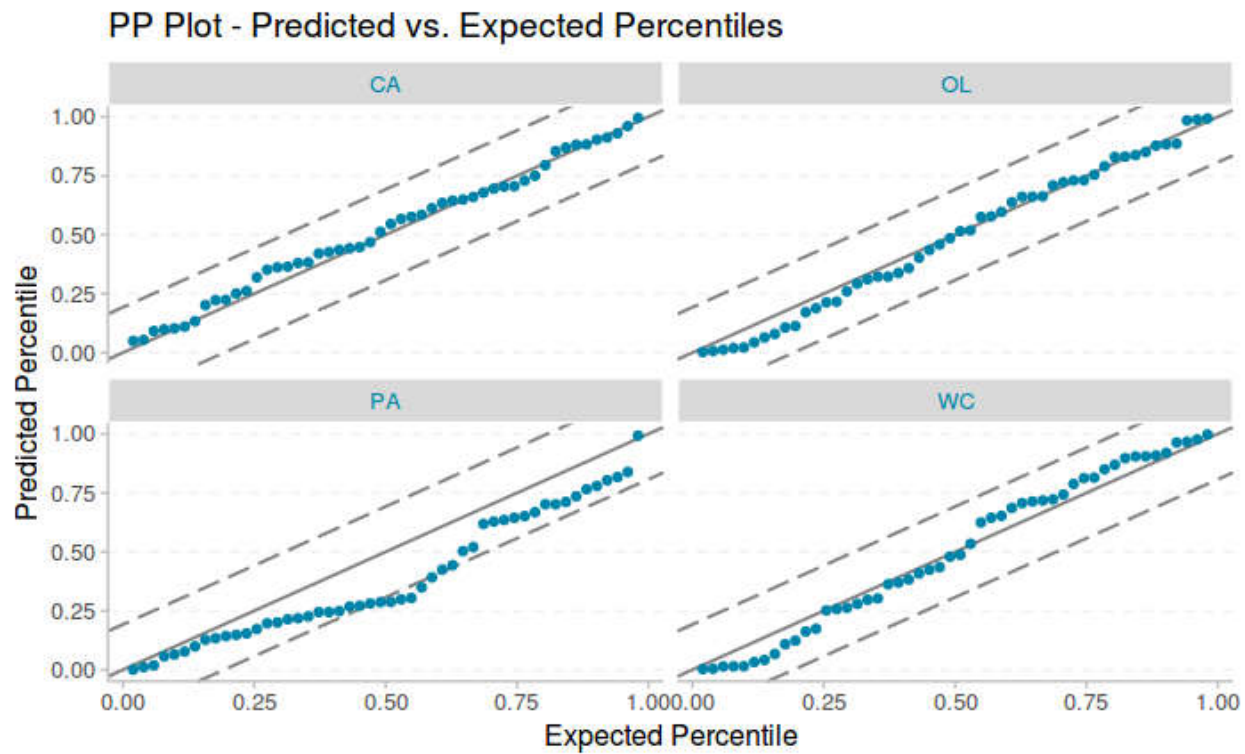
- Dependencies in Stochastic Loss Reserve Models.
<http://www.casact.org/pubs/forum/16wforum/Meyers.pdf>
- STOCHASTIC LOSS RESERVING USING BAYESIAN MCMC MODELS.
<http://www.casact.org/pubs/monographs/papers/01-Meyers.PDF>
- http://ar.casact.org/actuarialreview/july_august_2017/MobilePagedArticle.action?articleId=1130425#articleId1130425

Benefits of method

- Removes independence assumptions across accident years and development years
- Bayesian method also reflects uncertainty in parameter estimates (esp. for small samples)
- Allows for full distribution of posterior simulations
- Back tests well against Casualty Actuarial Society Loss Triangle database (http://www.casact.org/research/index.cfm?fa=loss_reserves_data)



Back-testing results for CSR method



Compare results of ODP and CSR

Using CAS Triangle database, CSR method produces CVs 1.6x – 2.2x higher than ODP Bootstrap

Summary of CSR and ODP CoVs on CAS Triangle Database

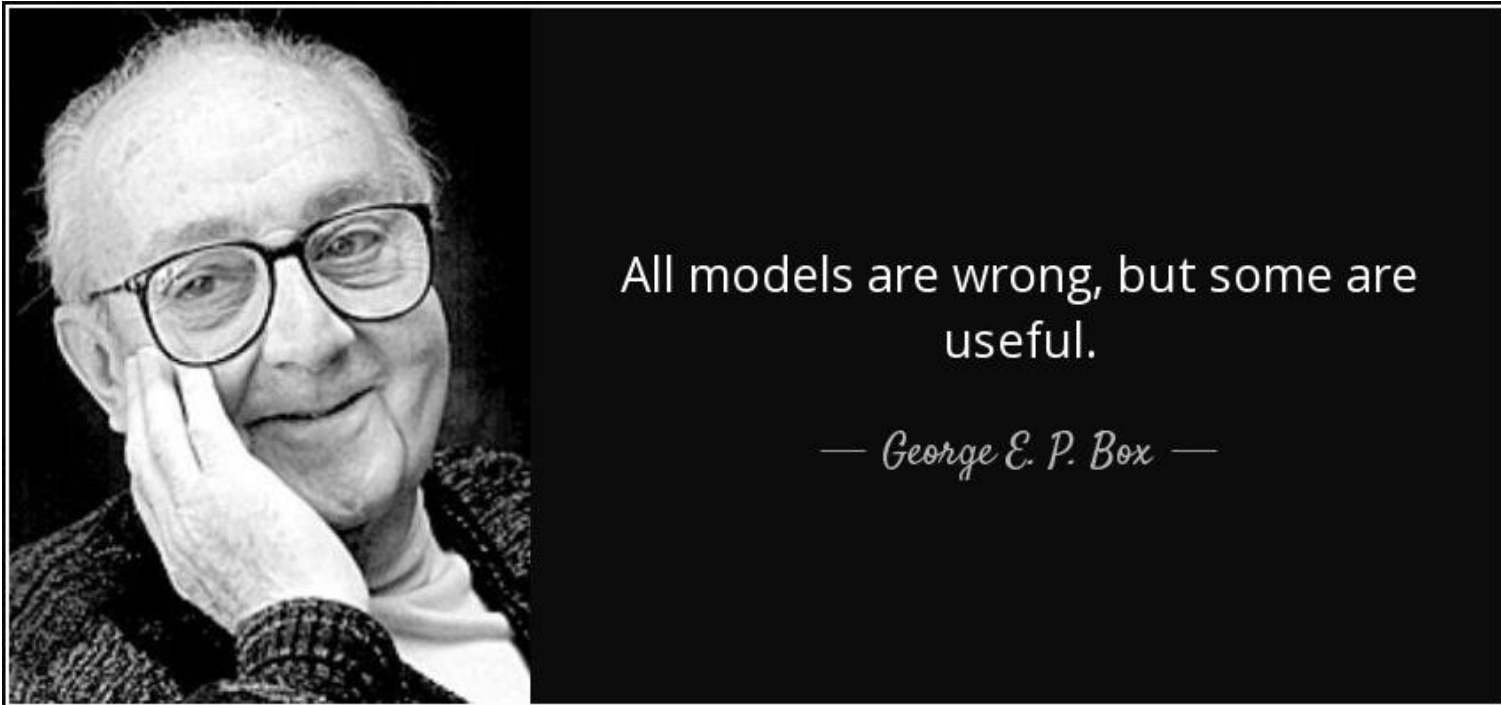
Line	# of triangles	ODP Bootstrap CoV		CSR CoV		Ratio of CSR to ODP	
		Median	Wtd Avg	Median	Wtd Avg	Median	Wtd Avg
CA	37	22%	11%	48%	25%	2.1	2.1
OL	30	33%	14%	56%	38%	1.8	2.7
PA	49	11%	5%	22%	8%	2.2	1.6
WC	45	12%	10%	24%	18%	1.9	1.9

- Using Other Liability as an example, a the 99th percentile of a LogNormal distribution using a 14% CV would be the 85th percentile of a LogNormal distribution based on a 38% CV



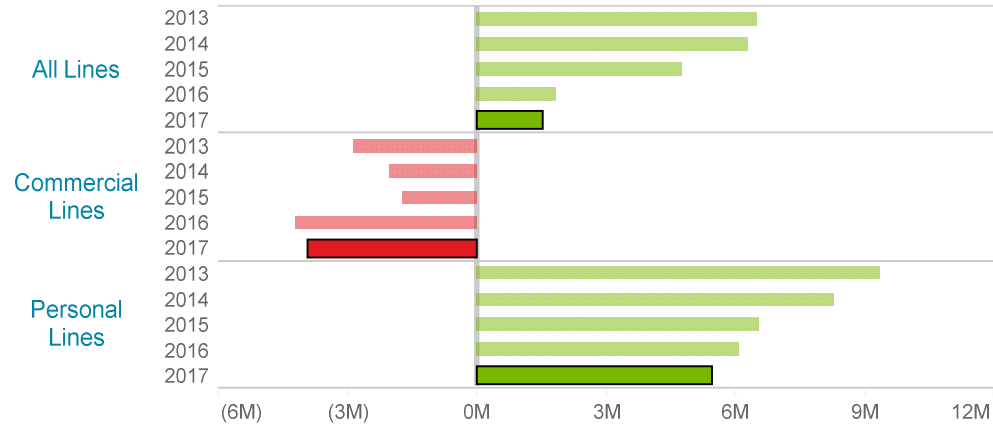
Section 6: The Point

It all comes back to this!



Industry Reserve Study Highlights

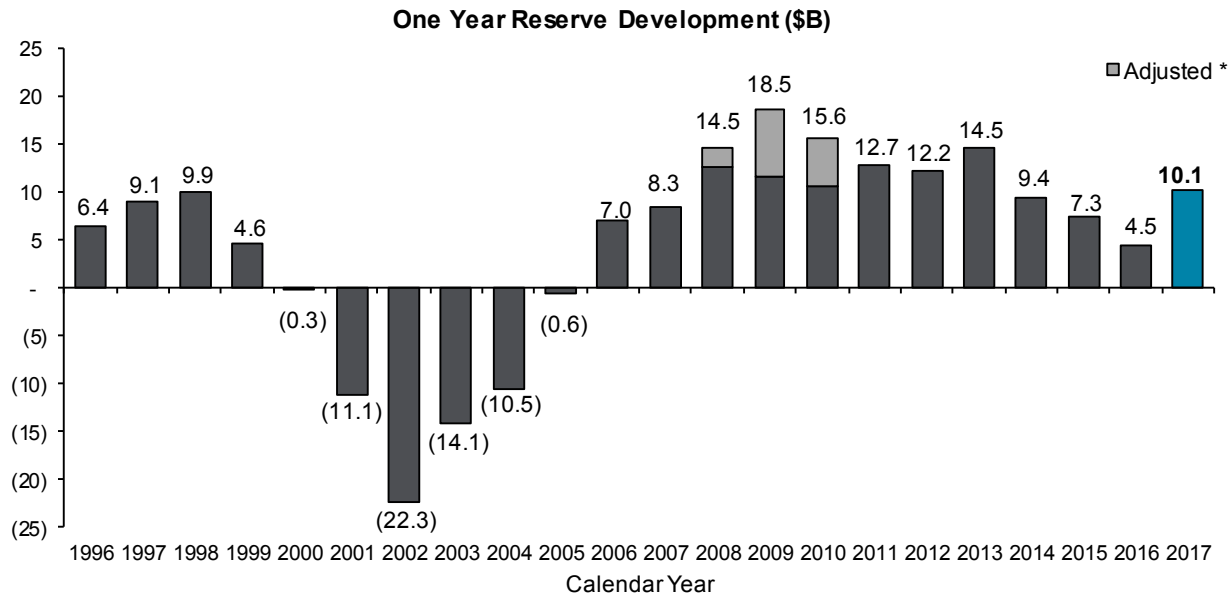
Historical Industry Reserve Redundancy/(Deficiency)



	2016	2017
All Lines	1.8 B	1.5 B
Commercial Lines	(4.2) B	(3.9) B
Personal Lines	6.1 B	5.4 B

- Overall industry redundancy at year end 2017 of USD1.5 billion – equivalent to 0.2 percent of booked reserves
- Commercial lines improved marginally with an overall deficiency position of USD3.9 billion at year end 2017 compared to an estimated USD4.2 billion deficiency at year end 2016
- Personal lines continued to show a redundancy of USD5.4 billion at year end 2017, though not as strong as the redundancy of USD6.1 billion at year end 2016

US P&C Industry Reserve Development (1996 – 2017)

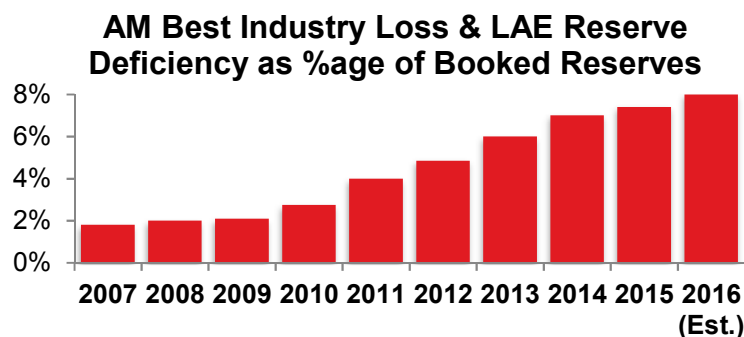


*Adjustments include Financial Lines development in 2008-2009, and AIG adverse development in 2010.

- 2017 development per P&C Industry data as compiled by SNL through July 31, 2018
- Total favorable development in 2017 of USD10.1 billion

Rating Agency Concern over Reserve Adequacy Trends

Since 2007, AM Best's estimate of industry deficiency has grown from $\approx 2\%$ to 8%



Increased Inflation What-If Scenarios

Based on CY Inflation Increase of:

LOB	+1%		+3%	
	% Impact on Deficiency	% Impact on PHS	% Impact on Deficiency	% Impact on PHS
Property Lines	2%	-1%	6%	-2%
Other Liability (Occurrence)	5%	-7%	16%	-22%
Workers Compensation	6%	-10%	20%	-32%

Source: AM Best Review Preview conference materials 2017

A.M. Best cites ongoing concerns of:

- Loss development factors continuing to increase
- Uncertainty of inflation on loss costs increasing
- Premium/rates continue to soften in commercial lines
- Increasing number of companies reporting overall adverse development
- Significant amount of companies strengthening commercial casualty reserves in 2016

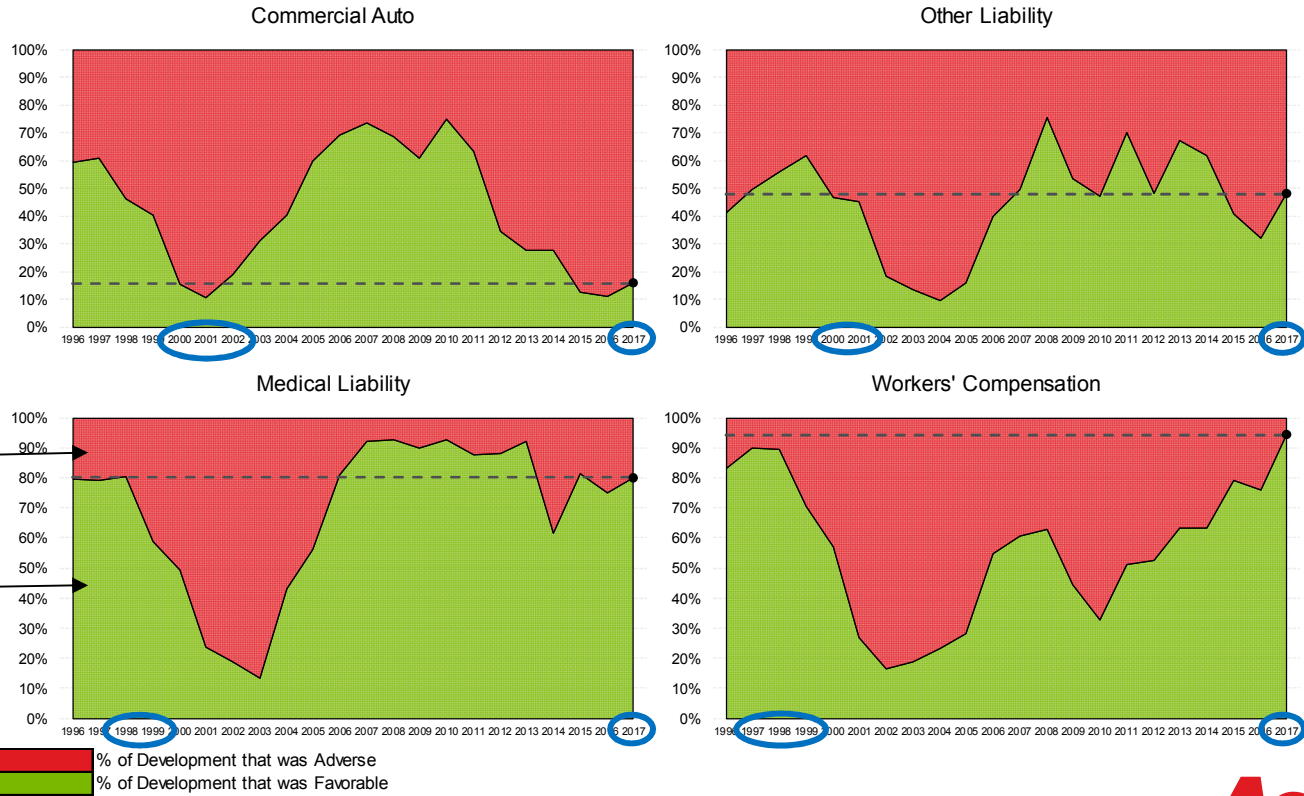
*Note: Includes statutory discount as a deficiency

*Source: AM Best 2017 Review Preview conference materials

The Reserve Cycle by Line – Will History Repeat Itself?

Percentage of Industry Reserve Development by Year: Adverse vs. Favorable

Percentage of Reserve Development Adverse vs Favorable by Calendar Year: 1996 to 2017

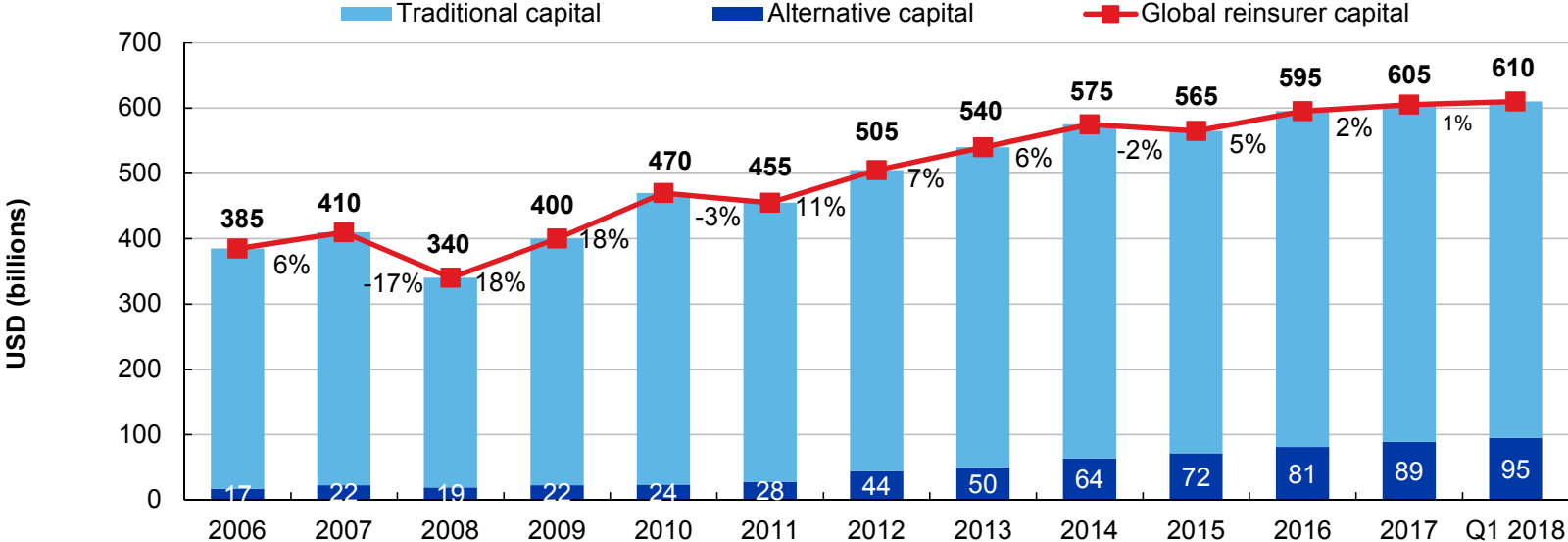


Percentage of Adverse Development Reported
 Percentage of Favorable Development Reported

Source: Analysis of SNL Financial Data

Red: % of Development that was Adverse
 Green: % of Development that was Favorable

But global reinsurer capital is still at all time highs



Source: Aon Benfield Analytics

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Quick Overview of LPT/ADC's

Retroactive covers are fairly straightforward

- Insurer seek to cap off the risk of adverse development on all or a sub-segment of their unpaid liabilities.
- Ceding companies can either pay a pure premium for coverage attaching either at current carried or above some additional retained buffer.
- Alternatively the coverage can attach below the carried which results in an immediate cession of both premium (assets associated with loss reserves) and losses. Coverage above current carried is still provided and can be “paid” for by the interest income the reinsurer can earn on the ceded reserves.

LPT

Loss Portfolio Transfer (“LPT”) :
A cession of all or part of a company’s reserves to a Reinsurer who assumes financial responsibility for ceded reserves.

ADC

Adverse Development Cover (“ADC”):
Provides reinsurance above net carried reserve level (existing reserves are not transferred)

➤ An LPT is frequently done in combination with an ADC so that the time value of money embedded in the ceded carried reserves funds the ADC layer

Structure Options Summary

Attachment at Carried

Attachment Above Buffer

Adverse
Development
Cover

1

A pure adverse development cover attaching at carried reserve amount

- In many ways the simplest cover. Insurer pays a premium and receives coverage for any adverse development above current carried
- This option will have good coverage but will have the most immediate cost impact

2

An adverse development cover with a retained underlying buffer

- Less effective coverage due to the additional retained loss but will have the lowest pure economic costs. As with the first option the cost of this option will impact current year income statements

Partial Loss
Portfolio
Transfer with
ADC Limit

3

A hybrid cover that attaches below carried and involves immediate cession of a portion of reserves and losses.

- The coverage beyond carried is paid for by the interest on the ceded assets associated with the ceded reserves
- This structure will provide coverage beyond carried and mitigate the current year expense issues. Instead the economic cost is reflected in lower investment income in future years

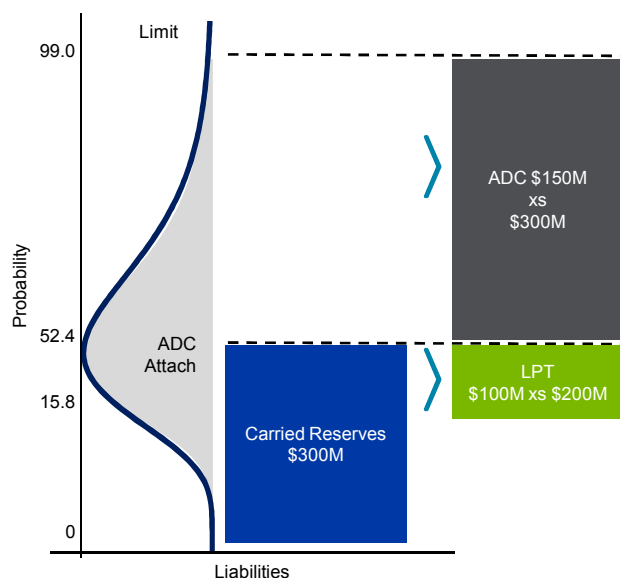
4

A hybrid cover that attaches below carried and involves cession of a portion of reserves above an underlying retained buffer.

- The coverage beyond carried is paid for by the interest on the ceded assets associated with the ceded reserves
- This structure will require a smaller cession of carried reserves since the cedant is retaining a buffer layer before the reinsurer's adverse development layer attaches

Partial Loss Portfolio Transfer with Adverse Development Cover

Protection is provided by a partial LPT of \$100M of carried reserves plus \$2.5M above carried as an additional risk premium for AY's 2017 and prior, combined with an ADC with \$150M of limit attaching at carried reserves



Pros

- Embedded discount in the held reserves may fully fund the ADC
- Use of held reserves for funding reduces or eliminates income hit at inception
- Draws strong interest from Reinsurers which value cash flow (float)

Cons

- Reinsurers will generally price transactions using the duration matched risk free rate, which is lower than most company's investment yield
- May require liquidation of material amount of assets to fund the premium
- Large LPT cession introduces additional reinsurer credit risk
- Funds held structure can mitigate the above three cons
- Execution is challenging, if market view of reserves is materially higher than carried

Execution

- At inception would require a transfer of assets equal to \$100M + \$2.5M additional risk premium
- Reinsurer would be responsible for \$100M of in-the-money loss and ALAE plus \$150M of adverse development above carried reserves, which protects to 99th percentile

Partial LPT with ADC Attaching at Carried Reserves BCAR Impact

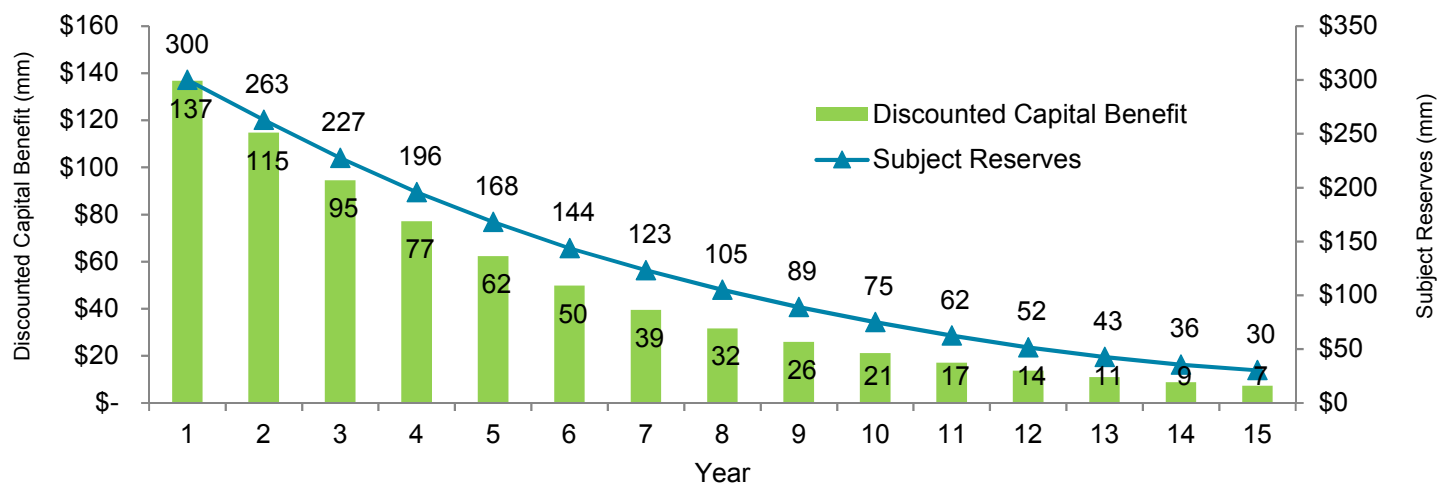
ABC Insurance Group		
A.M. Best - Baseline BCAR (\$ thousands)		
	VaR 99.6	
	YE 2017	ADC - LPT Impact
B1 Fixed Income Securities	40,000	39,275
B2 Equity Securities	244,000	244,000
B3 Interest Rate	27,000	27,000
B4 Credit	98,000	111,000
B5 Loss and LAE Reserves	445,000	340,000
B6 Net Premiums Written	269,000	269,000
B7 Business Risk	5,000	5,000
B8 Catastrophe Risk	20,000	20,000
Unadjusted Required Capital	1,148,000	1,055,275
Covariance Adjustment	525,697	507,994
Net Required Capital	622,303	547,281
Reported Surplus	1,000,000	998,025
UPR Equity	50,000	50,000
Loss Reserve Equity	10,000	19,000
Fixed Income Equity	24,000	24,000
Schedule F Provision	8,000	8,000
Adjusted Policyholder Surplus	1,092,000	1,099,025
New Capital Adequacy Ratio (APHS - NRC) / APHS	43%	50%

LPT ADC Components				
ADC Attachment	ADC Limit	Rate on Line	Reserves Transferred	Buffer Layer
\$300.0M	\$150.0M	1.7%	\$100M	N/A

- Decrease in surplus is from the post-tax cost of the program
 - LPT significantly reduces ROL as most of ceded premium is for transferred reserves
 - Reduction in cash decreases Fixed Income Risk (B1) (not material)
- Increase in Credit Risk (B4):
 - All reserves associated LPT increases reinsurance recoverables
 - A.M. Best view of deficiency in reserves adds expected reinsurance recoverables from ADC into Credit Risk (B4)
- ADC increases Loss Reserve Equity but is offset from LPT as ceded reserves are no longer discounted; overall positive impact
- ADC/LPT with no buffer mitigates exposure to reserving errors, thus reducing Reserve Risk (B5)
 - Reduction in Reserve Risk has the greatest impact on BCAR
- Estimated BCAR score still eligible for highest “Balance Sheet Strength” assessment in rating methodology

Partial LPT with ADC Attaching at Carried Reserves Capital Benefit

Reinsurance Terms		Additional Considerations		Cost of Capital	
Subject Reserves	\$300.0M	Deficiency Factor	7.5%	15 Year Cumulative Capital Benefit	\$ 810,000
ADC Attachment	\$300.0M	Risk Free Rate	3%	15 Year Discounted Capital Benefit	\$ 715,000
Buffer	\$0	Reserves Transferred	\$100.0M	Expected Cost of Reinsurance (Post-tax)	\$ 25,000
ADC Limit	\$150.0M	Reinsurer Margin	\$102.5M	Ceded Return On Equity	3.5%
ROL	1.7%	Tax Rate	21.0%		
Assets Transferred	\$ 102.5M	Commute Option	Year 15		



Note: Capital Benefit calculated assuming no adverse development

Pricing and Placement

Given our market scope and leverage we feel that Aon Benfield is well positioned to deliver the best terms and conditions that are available. Here are what we see as some of the key issues we will encounter during the course of placement:



State of the market - A combination of new entrants and established markets looking to expand their writings, has made for a dynamic marketplace for retroactive reinsurance.



Class of business - Markets like liability lines due to the long pay-out pattern



Age of subject reserves – Depending on what accident years the cover protects, this could be a pro or a con. Older accident year's, e.g., 2015 and prior, are more mature and predictable and could result in better pricing. More recent accident year's have more IBNR and more volatility, thus including them could make the transaction larger for reinsurers, however, these years are very green and highly uncertain which will be reflected in the reinsurer's pricing.



Size of portfolio - A portfolio in excess of \$50M to \$100M is large enough to attract a lot of market interest, especially for a large, in-the-money last-to-pay loss portfolio transfer of at least \$50M. The larger the asset transfer or up front premium, the stronger the competition



Market's opinion of adequacy – The market's opinion of the adequacy of the carried reserves will make or break the viability of the placement in the marketplace. Can additional long-tail reserves be used to help close a gap due to difference of opinion in adequacy?

National Indemnity Major Adverse Development and Loss Portfolio Transfer Transactions

Transaction	Date	Limit (\$B)	Cost (\$B)	ROL	Break Even Yield for Avg Payout Duration of:				Comment
					6 Yrs	9 Yrs	12 Yrs	15 Yrs	
ACE-Brandywine	Jul-99	2.5	1.3	50.0%	12.2%	8.0%	5.9%	4.7%	
One Beacon	Mar-01	2.5	1.3	52.8%	11.2%	7.4%	5.5%	4.3%	
Equitas	Oct-06	15.1	7.2	47.7%	13.1%	8.6%	6.4%	5.1%	Included Reinsurance Recoverable Credit Risk
CNA	Jul-10	4.0	2.2	55.0%	10.5%	6.9%	5.1%	4.1%	Included Reinsurance Recoverable Credit Risk
AIG	Apr-11	3.5	1.7	47.0%	13.4%	8.8%	6.5%	5.2%	Included Reinsurance Recoverable Credit Risk
Liberty Mutual	Jul-14	6.5	3.0	46.2%	13.8%	9.0%	6.7%	5.3%	A&E sublimited to 3.1B (2.4x transferred A&E reserve)
Hartford	Dec-16	1.5	0.7	46.7%	13.5%	8.8%	6.6%	5.2%	Reinsurance recoverables not covered, retained claims handling
AIG v2	Jan-17	20.0	10.2	51.0%	11.9%	7.8%	5.8%	4.6%	Retained claims handling
Average				49.5%	12.5%	8.1%	6.0%	4.8%	

Sources: SNL Financial, company financial disclosures, Aon Benfield research

Other Deal of Note

In 2009, Swiss Re purchased a 5B Swiss Franc limit cover for 2B Swiss Francs, but there also was an agreement for Swiss Re to issue \$2.5B preferred shares at a 12% coupon

Assuming full limit loss,
yield at which NICO return
is >\$0, by duration of the
assumed liabilities

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About Aon Benfield

Aon Benfield, a division of Aon plc (NYSE: AON), is the world's leading reinsurance intermediary and full-service capital advisor. We empower our clients to better understand, manage and transfer risk through innovative solutions and personalized access to all forms of global reinsurance capital across treaty, facultative and capital markets. As a trusted advocate, we deliver local reach to the world's markets, an unparalleled investment in innovative analytics, including catastrophe management, actuarial and rating agency advisory. Through our professionals' expertise and experience, we advise clients in making optimal capital choices that will empower results and improve operational effectiveness for their business. With more than 80 offices in 50 countries, our worldwide client base has access to the broadest portfolio of integrated capital solutions and services. To learn how Aon Benfield helps empower results, please visit aonbenfield.com.

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