Agenda

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AON

Section 1: Who are we?

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AON

Who are we?

- Catastrophe model development team fully owned by of Aon

- **Independent**, **transparent**, **open**, **modular** and **bespoke** models

- **Natural** (flood, earthquake, wind) and **man-made** perils

- Filling the gaps as well as main perils

- Products licensed to over 50 clients

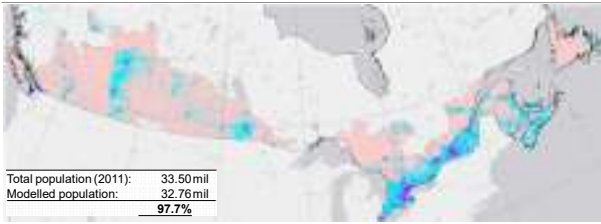- Canadian flood model since 2015 and still in development

Cat Model Developers

Cat model platform ELEMENTS

90 team members in 5 time zones

Natural and man-made hazards

Part of Aon (Benfield)

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AON

More than 100 models in over 60 countries

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Used by insurers, reinsurers and 3rd parties

- **15+** insurance companies (4 out of top 5)
- **4+** local and global reinsurers
- Partnerships established with Opta, Spatial Key and Pitney Bowes

- **Usage of our model**
  - 15+ licences for data
  - 6+ ELEMENTS licenses (out of that 2 large primaries) + 2 proposals

- **Committed to the Canadian market**
  - Pluvial (Q4 2016 and Q4 2017), tsunami (done) and storm surge
  - Additional tools available
  - 2015 and 2016 workshops
  - Bespoke projects and analyses

Logo	Signed
RSA	Signed
	Signed
	Signed
	Signed
	Signed
	Signed
	Signed

Insurance companies

SCOR TransRe
XL CATLIN

Reinsurance companies

Opta SpatialKey pitney bowes

Solution providers

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Section 2: Our offering

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Our model overview

Total population (2011):	33.50 mil
Modelled population:	32.76 mil
	97.7%

- <u>Fully probabilistic physically based</u>, covers **~98% of Canadian population**
- 2-dimensional hydrodynamic simulation used for **all modelled rivers**
- Supports **Lat & Lon; 6- and 3- digit postal codes**
- Vulnerability based on the **real Canadian flood claim** data (2013)
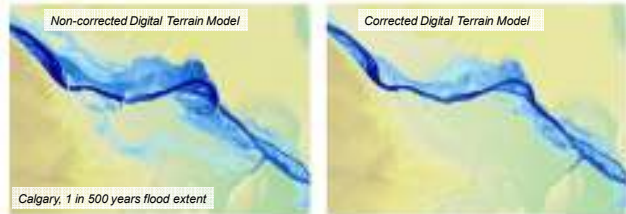
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Working with elevation data is time consuming

…but well worth it

- Different **D**igital **T**errain **M**odels used
- Many manual DTM corrections were essential

Depth [m]
Max: 6.0
Min: 0.0

Non-corrected Digital Terrain Model

Corrected Digital Terrain Model

Calgary, 1 in 500 years flood extent

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Flood models are very data hungry!

- Geographical data
  - River network (GeoBase)
  - LandCover (Environment Canada)
  - Postal codes (GFK, Canada Post)

- Hydrological data
  - Daily discharges of 1,526 locally sourced stations
  - Cleaned & checked
  - Used for event set generation

- Flood defence data
  - Significant effect on losses
  - Extensive research in their location and standard of protection
  - Manually checked and corrected

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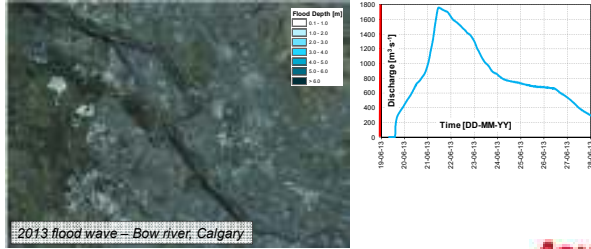
Physical based model

- **2D hydrodynamic model TUFLOW used for the entire modelled area**
  - Provides real (physical) flow of water
  - Computationally challenging: **835** days of runtime

2013 flood wave – Bow river, Calgary

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…so how can the model be used for pricing?

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Our "flagship" detailed product (for the actuaries)

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Our "flagship" detailed product (for the actuaries)

6-digit postal code			30 x 30m		
Postal code	Pure Premium		Latitude	Longitude	Pure Premium
T0J0V0	0.0053%		50.8784	-113.9893	0.0269%
T0L0X0	0.0016%		51.0017	-114.1802	0.1893%
T0L1W0	0.0069%		51.2532	-114.0001	0.0965%
T0M1L0	0.0015%		51.0139	-114.2182	0.1941%
T0M0S0	0.0019%		51.0797	-114.1798	0.0166%
T4B2M1	0.0011%		51.0123	-114.0632	0.0569%
T4B2V1	0.1296%		51.0989	-114.2458	0.2421%
T4B2Y1	0.1651%		50.9742	-114.0301	0.2081%
T4B3B5	0.0014%		50.9311	-114.1922	0.1222%
T4B3G5	0.0423%		50.9758	-114.0084	0.0000%
T4B3G6	0.0963%		51.0034	-114.1990	0.1673%
T4B3G7	0.1278%		51.0019	-114.2137	0.1496%
T4B3K8	0.0006%		50.9298	-113.9923	0.2061%
T4B3K9	0.0070%		51.3213	-114.0235	0.0636%
T4B3L1	0.0393%		51.0365	-114.0616	0.1790%
T4B3L2	0.0302%		51.0907	-114.1907	0.0003%
T2Y3T9	0.0928%		51.0056	-114.2109	0.1833%

Why is a probabilistic model better than a flood map?

Demo implementation

Demo implementation

Sample results

- Top 10, AAL and PMLs, **Use: rate calculation (basic)**

SiteNumber	PostalCode	Precision	TIV	GR_LOSSRP_100	GR_LOSS_AAL	GU_LOSSRP_100	GU_LOSS_AAL
711		PostalCode	127,528,682	4,111,506	293,222	4,115,918	293,563
1234		Coordinates	16,699,158	486,201	54,291	535,395	59,238
10868		Coordinates	6,062,284	1,889,337	43,175	2,068,970	48,054
7690		Coordinates	50,767,032	4,804	38,229	145,009	66,138
3071		Coordinates	20,617,011	132,083	35,452	132,084	35,879
1662		Coordinates	21,128,948	1,395,575	32,833	1,448,495	34,315
10051		Coordinates	17,438,828	2,133,889	29,399	2,445,418	34,908
7091		Coordinates	1,856,474	493,357	25,697	550,050	29,608
712		PostalCode	32,713,196	307,934	24,830	311,946	25,120
6892		Coordinates	11,084,001	1,596,345	22,340	1,645,467	23,185
8919		Coordinates	5,979,363	1,149,682	21,662	1,253,433	23,864
3397		Coordinates	6,350,209	162,509	20,883	198,904	25,385
8802		Coordinates	7,431,668	916,846	19,897	1,009,079	21,980
10174		Coordinates	18,159,715	358,246	18,057	528,765	27,159
2405		Coordinates	16,477,444	8,368	17,329	91,023	32,065
7533		Coordinates	4,953,009	647	17,270	33,261	21,661
9476		Coordinates	14,647,815	144,536	15,284	144,536	15,284
6978		Coordinates	16,525,937	243,174	14,851	249,351	15,245
11167		PostalCode	24,266,649	35,665	14,375	99,301	21,585
4946		Coordinates	8,241,706	35,347	12,765	51,995	14,411

1 in 100y   **AAL**   **1 in 100y**   **AAL**

Calgary, AB T2S 2T4, Canada

And our simplified product (for the underwriters)

Section 3: Lessons learned

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Lessons learned working with the Canadian insurers

For model developers

- **Lesson 1:** Make sure you have the right people at the meeting: 1. product, 2. risk manager and 3. pricing actuary. Reinsurance broker is optional

- **Lesson 2:** Make sure that you explain properly the difference between an actuarial model and a catastrophe model (loss data vs. "real" modelling)

- **Lesson 3:** Run some real sample data of that particular company through the model to illustrate how the model can be used

- **Lesson 4:** Be super conservative in terms of how long do your clients need to design the new flood product. Think 3rd parties

- **Lesson 5:** Be both receptive and critical to new ideas and requests from your client as some of them can be very innovative

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Lessons learned working with the Canadian insurers

For pricing actuaries and product developers

- **Lesson 1:** Cat modelling is like black magic, ask as many questions as you can, don't get discouraged by unknown words. Ask about distributions!

- **Lesson 2:** Make sure that you understand properly the difference between an actuarial model and a catastrophe model

- **Lesson 3:** Demand to have your sample data ran through the model, be creative when designing it, main purpose is: find limitations of the model

- **Lesson 4:** Be really conservative in terms of how long does a new product integration based on a cat model take to implement. Think 3rd parties

- **Lesson 5:** Request the model developers to create custom output and versions of the model if you know what you want
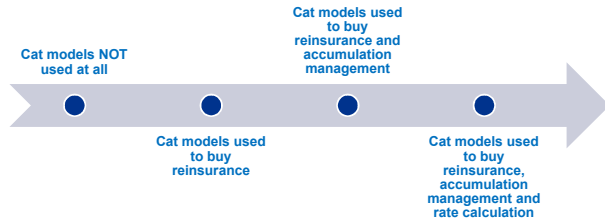
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Usage of Cat models in flood risk management

- Where are You in this timeline?

Cat models NOT used at all

Cat models used to buy reinsurance

Cat models used to buy reinsurance and accumulation management

Cat models used to buy reinsurance, accumulation management and rate calculation

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Use of flood cat model: Canada vs. US vs. UK

Use	Canada	US	UK	Czechia
Flood is peril #1	Mostly no but can be locally	Mostly no but can be locally	Mostly no but is frequent	Yes
Flood products available	Com always, Res now available	NFIP, slowly changing to private	Yes, always. Flood Re	Yes (from Communism era)
Presence of flood limits in the products	Mostly no, some for Com	Yes for Com and Res	No for Res	No for Res, Yes for Com
Reinsurance purchase using a flood model	Slowly starting to be part of the mix	Part of the mix, minimal effect	Part of the mix, wind dominant	Yes
Rate calculation using a flood model	Res – now yes, Com – sort of	NFIP – no, starting to be used	Yes, flood maps mainly	Yes, flood maps mainly
Accumulation control using a model	Little	Some	Some	Little
Models developed locally	No (little)	Yes (FEMA)	Yes, non gow.	Yes, non gow.

Section 4: Next steps

4 uses of a flood model: we covered 1

Rate Calculation	**New Product Design**
Accumulation Control	**Portfolio Modelling**

Flood model

Accumulation control: by region

- Existing: accumulate insured values

  OR

- Using our model: accumulate losses

Exposed TIV in Quebec, Manitoba, New Brunswick & BC bring proportionally more losses compared to their exposed TIV share

Zone Name	Exposed TIV	Exp. TIV as % of total	Pure Premium	PP as % of total	PP vs. ETIV
Newfoundland and Labrador	5,597,784,492	1.49%	239,232	0.35%	23%
Prince Edward Island	296,784,663	0.08%	4,671	0.01%	9%
Nova Scotia	9,046,791,873	2.41%	346,624	0.50%	21%
New Brunswick	5,763,710,234	1.53%	1,723,422	2.51%	164%
Quebec	109,931,790,013	29.24%	31,875,629	46.39%	159%
Ontario	146,964,970,963	39.09%	16,639,604	24.21%	62%
Manitoba	11,745,326,355	3.12%	5,307,024	7.72%	247%
Saskatchewan	1,205,095,988	0.32%	59,593	0.09%	27%
Alberta	51,042,498,272	13.58%	5,268,911	7.67%	56%
British Columbia	34,366,483,865	9.14%	7,252,256	10.55%	115%
Yukon	NA	NA	NA	NA	NA
Northwest Territories	NA	NA	NA	NA	NA
Nunavut	NA	NA	NA	NA	NA
Total	**375,961,236,718**	**100%**	**68,716,967**	**100%**	

Accumulation control: by river catchments

Watershed	Exposed TIV	Exp. TIV as % of Total	Pure Premium - Gross	PP -GR as % of total	PP vs. ETIV
Alberta and BC	374,865,242	1.0%	11,420	0.7%	69%
Alberta and upper Saskatchewan	7,781,072,113	21.6%	524,883	32.8%	152%
Around Ignace city	5,638,163	0.0%	64	0.0%	26%
Around Thunder Bay city	291,600,912	0.8%	2,269	0.1%	18%
Around Wabigoon Lake	7,668,596	0.0%	1	0.0%	0%
Fraser river	4,752,775,660	13.2%	506,080	31.7%	240%
Lower Ontario	10,991,317,759	30.5%	130,007	8.1%	27%
Manitoba and lower Saskatchewan	4,459,775,688	12.4%	194,288	12.2%	98%
Middle Ontario and Quebec	40,282,210	0.1%	208	0.0%	12%
New Brunswick and Nova Scotia	1,478,927,244	4.1%	5,786	0.4%	9%
Newfoundland	127,943,416	0.4%	31	0.0%	1%
Ontario around Lake Superior	61,307,203	0.2%	792	0.0%	29%
St.Lawrence river (Quebec)	3,656,425,585	10.1%	182,922	11.4%	113%
Upper BC and Alberta	1,079,083,825	3.0%	26,696	1.7%	56%
Upper Quebec	43,871,503	0.1%	10,914	0.7%	561%
Vancouver Island	528,428,122	1.5%	1,805	0.1%	8%
Others	344,893,580	1.0%	-	0.0%	0%
Total	**36,025,876,819**		**1,598,167**		

Accumulation control: by broker

Group	Total Insured Value		Charged Premium		Technical Premium		TechP vs TIV	TechP vs ChP	
Broker 1	747,385,991	39%	137,719	26%	79,842	16%	41%	61%	✓
Broker 2	310,480,028	16%	167,909	32%	123,829	25%	154%	78%	✓
Broker 3	531,090,895	28%	192,748	37%	228,745	46%	167%	125%	✗
Broker 4	338,843,715	18%	25,859	5%	66,228	13%	76%	269%	✗

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Accumulation control: constant monitoring

- Tracking
  - TIV
  - Charged premium
  - Technical premium
  - 1 in 100 years loss

- Quarterly, monthly

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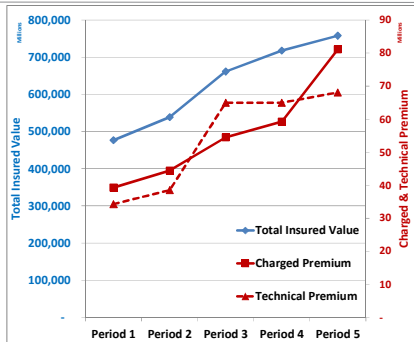
Questions?

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Thanks for your attention

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Appendix: Flood map vs. probabilistic model