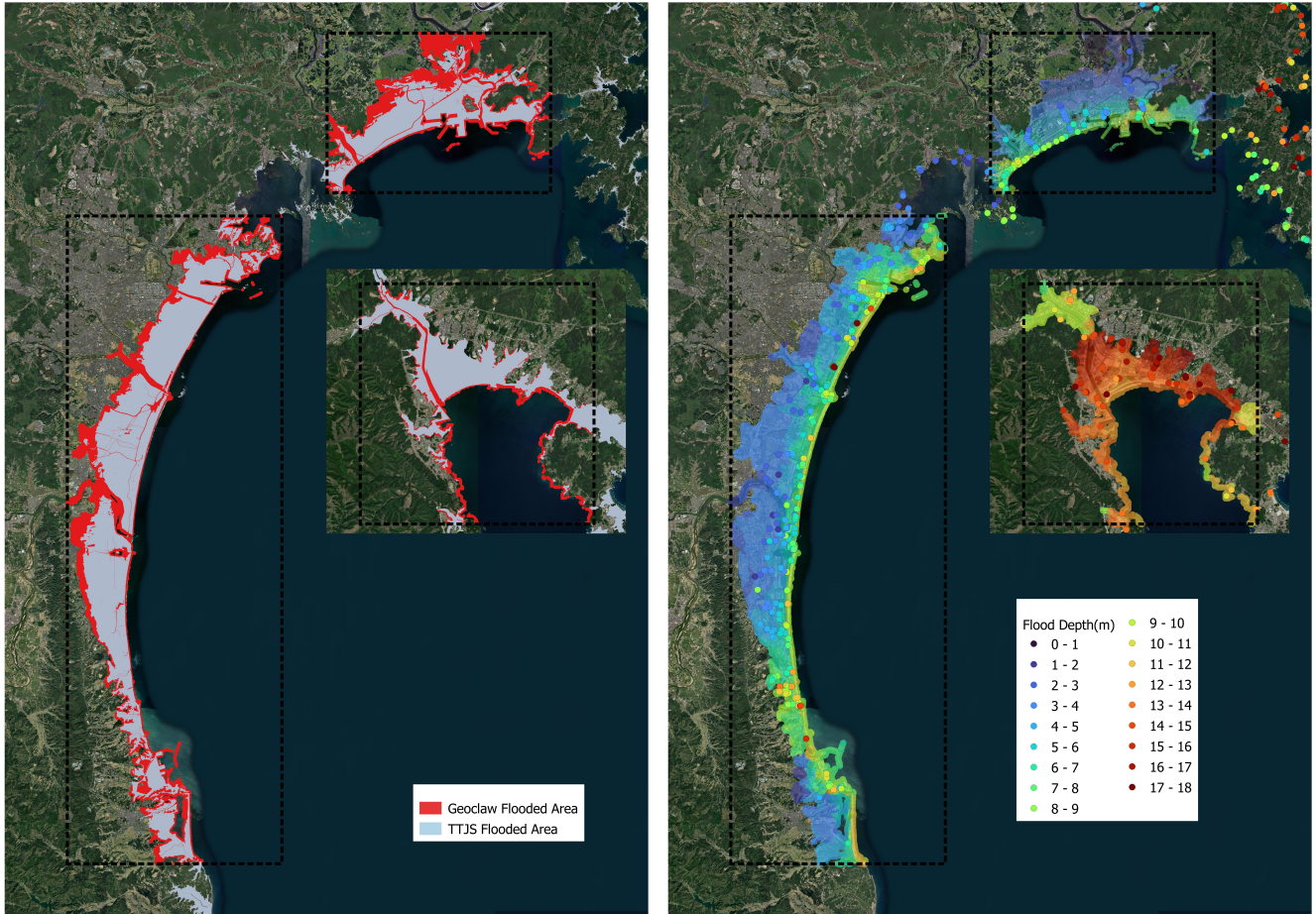(a) Initial Displacement

(b) Waveforms at gauge site marked in figure 3a

Figure S1. Plots of simulated tsunami inundation using source (Fujii et al., 2011) compared to the actual observation for the 2011 Tohoku tsunami event

(a) Flooded Area

(b) Flooded Depth

Figure S2. Plots of simulated tsunami inundation using source (Fujii et al., 2011) compared to the actual observation for the 2011 Tohoku tsunami event.(Basemap from ESRI World Imagery)

680 Surrogate architecture and configuration

Table S1. Model Parameters of the VED network - Nearshore

Layer Number	Layer Type	Input Channels or Size	Output Channels or Size	Activation	Pooling Operation
Offshore Encoder					
1	Conv1d	input	64	Leaky ReLU (0.5)	MaxPool1d (2x2)
2	Conv1d	64	64	Leaky ReLU (0.5)	MaxPool1d (2x2)
3	Conv1d	64	128	Leaky ReLU (0.5)	MaxPool1d (2x2)
4	Conv1d	128	128	Leaky ReLU (0.5)	MaxPool1d (2x2)
5	Linear	[8192]	[2 x Zdim]		
Variational Encoding					
6	Reparametrise	[2 x Zdim]	[Zdim]		
Nearshore Decoder					
7	Linear	[Zdim]	[128 x 64]		
8	ConvTranspose1d	128	128	Leaky ReLU (0.5)	MaxPool1d (2x2)
9	ConvTranspose1d	128	64	Leaky ReLU (0.5)	MaxPool1d (2x2)
10	ConvTranspose1d	64	64	Leaky ReLU (0.5)	MaxPool1d (2x2)
11	ConvTranspose1d	64	output	Leaky ReLU (0.5)	MaxPool1d (2x2)

Table S2. Model Parameters of the VED network - Onshore

Layer Number	Layer Type	Input Channels [Size]	Output Channels [Size]	Activation	Pooling Operation	Other Operations
			Offshore Encoder			
1	Conv1d	input	64	Leaky ReLU (0.5)	MaxPool1d (4x4)	BatchNorm1d
2	Conv1d	64	64	Leaky ReLU (0.5)	MaxPool1d (4x4)	
3	Conv1d	64	128	Leaky ReLU (0.5)	MaxPool1d (4x4)	
4	Conv1d	128	128	Leaky ReLU (0.5)	MaxPool1d (4x4)	Dropout (0.1)
5	Linear	[512]	[2 x Zdim]			
			Variational Encoding			
6	Reparametrise	[2 x Zdim]	[Zdim]			
			Onshore Decoder			
7	Linear	[Zdim]	[64]			
8	Linear	[64]	output			

Performance metrics for the generalisation test using historic events

Table S3. Model performance statistics for different events at various sites using the mean prediction from the nearshore surrogate.

Site	Event	G	R^2	MSE	L2Norm
Rikuzentakata	FUJI2011_42	0.106	0.18	10.196	125.919
	SANRIKU1896	0.17	0.508	0.246	22.612
	SANRIKU1933	0.2	0.419	0.717	35.587
	TOKACHI1968	0.046	0.895	0.201	44.266
	YAMAZAKI2018_TPMOD	0.058	0.566	4.044	106.158
Ishinomaki	FUJI2011_42	0.099	0.562	1.727	83.648
	SANRIKU1896	0.433	0.378	0.012	4.404
	SANRIKU1933	0.145	0.777	0.037	13.236
	TOKACHI1968	0.173	0.672	0.012	6.189
	YAMAZAKI2018_TPMOD	0.066	0.836	0.533	60.553
Sendai	FUJI2011_42	0.068	0.759	1.395	80.902
	SANRIKU1896	0.506	0.251	0.02	5.292
	SANRIKU1933	0.325	0.431	0.1	13.566
	TOKACHI1968	0.312	0.441	0.022	6.322
	YAMAZAKI2018_TPMOD	0.144	0.507	1.724	61.162

Table S4. Model performance statistics for different events at various sites using the mean prediction from the onshore surrogate.

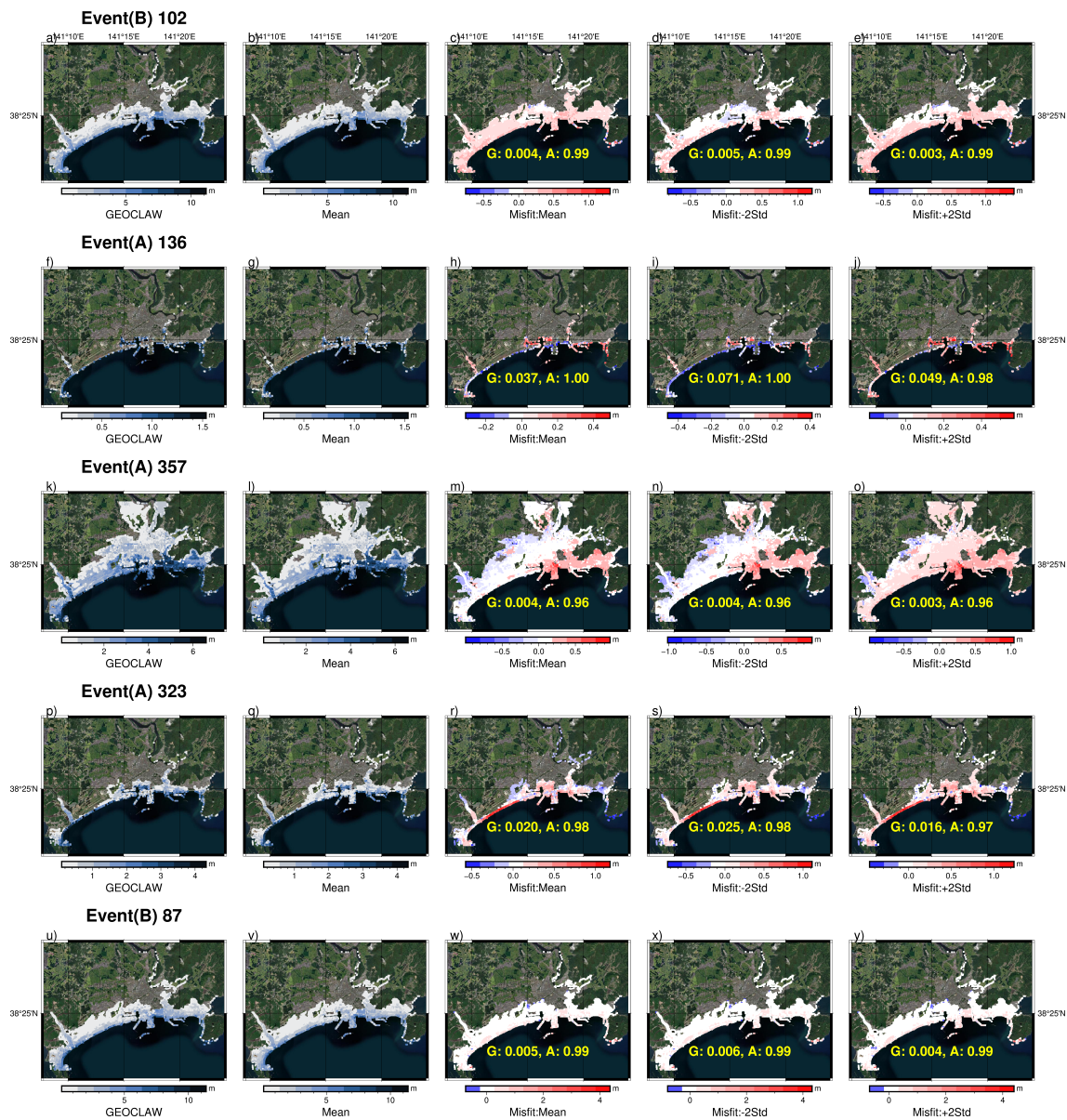| Site	Event	G	R^2	MSE	L2Norm
Rikuzentakata	FUJI2011_42	0.028	0.842	3.774	706.438
	SANRIKU1896	0.147	0.683	0.051	33.559
	SANRIKU1933	0.246	0.102	0.474	61.982
	TOKACHI1968	0.464	0.461	0.105	37.078
	YAMAZAKI2018	0.017	0.918	1.213	511.5
Ishinomaki	FUJI2011_42	0.285	0.262	3.712	747.957
	SANRIKU1896	0.275	-0.684	0.001	6.475
	SANRIKU1933	0.097	0.691	0.003	24.125
	TOKACHI1968	0.161	0.48	0.001	9.82
	YAMAZAKI2018	0.041	0.896	0.158	337.745
Sendai	FUJI2011_42	0.153	0.429	2.575	1233.79
	SANRIKU1896	0.178	0.688	0.004	39.573
	SANRIKU1933	0.06	0.879	0.004	61.973
	TOKACHI1968	0.105	0.679	0.001	14.827
	YAMAZAKI2018	0.166	0.528	2.256	1108.09

Figure S3. Prediction examples from the onshore surrogate at Ishinomaki for the test events.(Basemap from ESRI World Imagery)
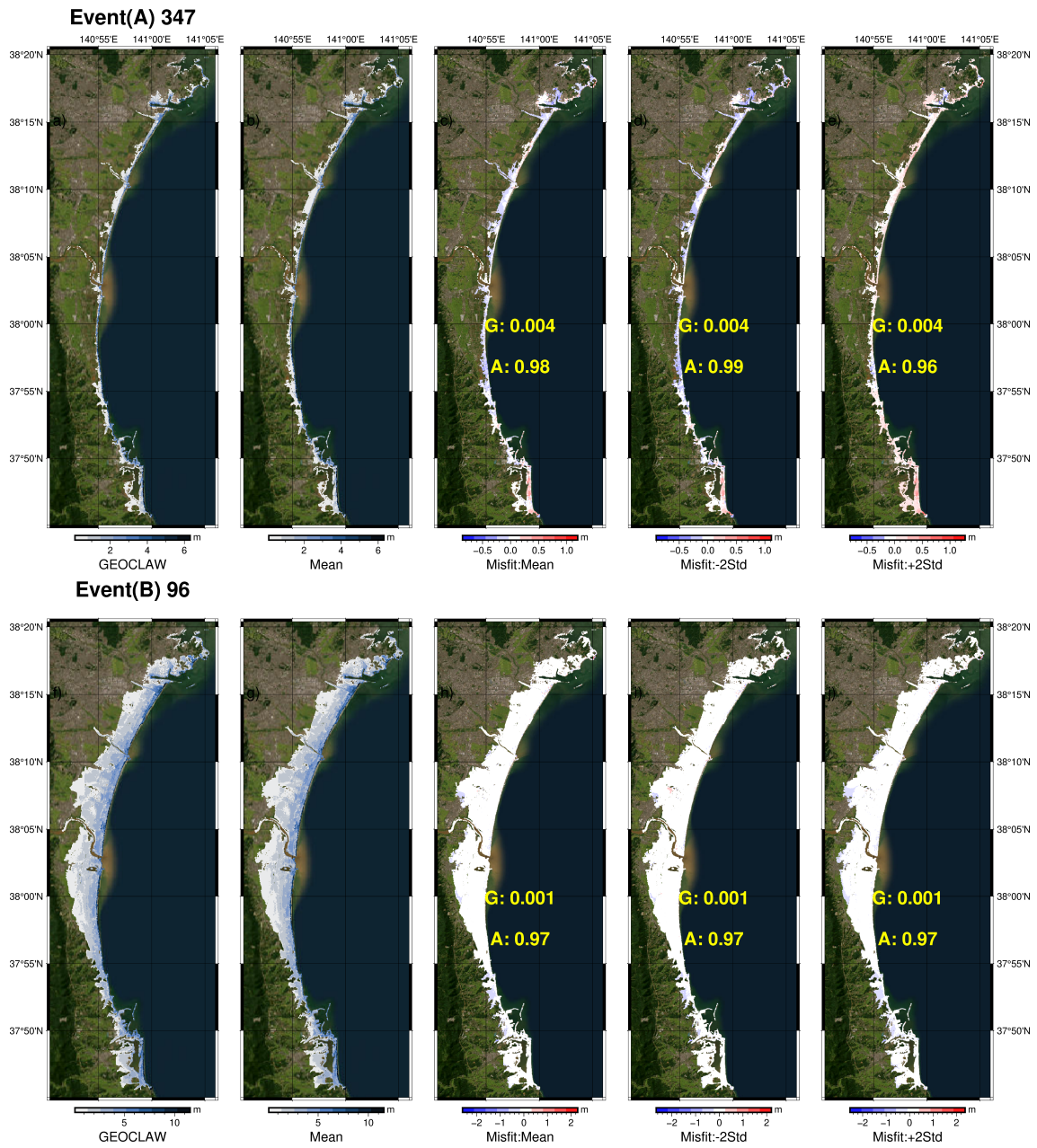
Figure S4. Prediction examples from the onshore surrogate at Sendai for the test events.(Basemap from ESRI World Imagery)
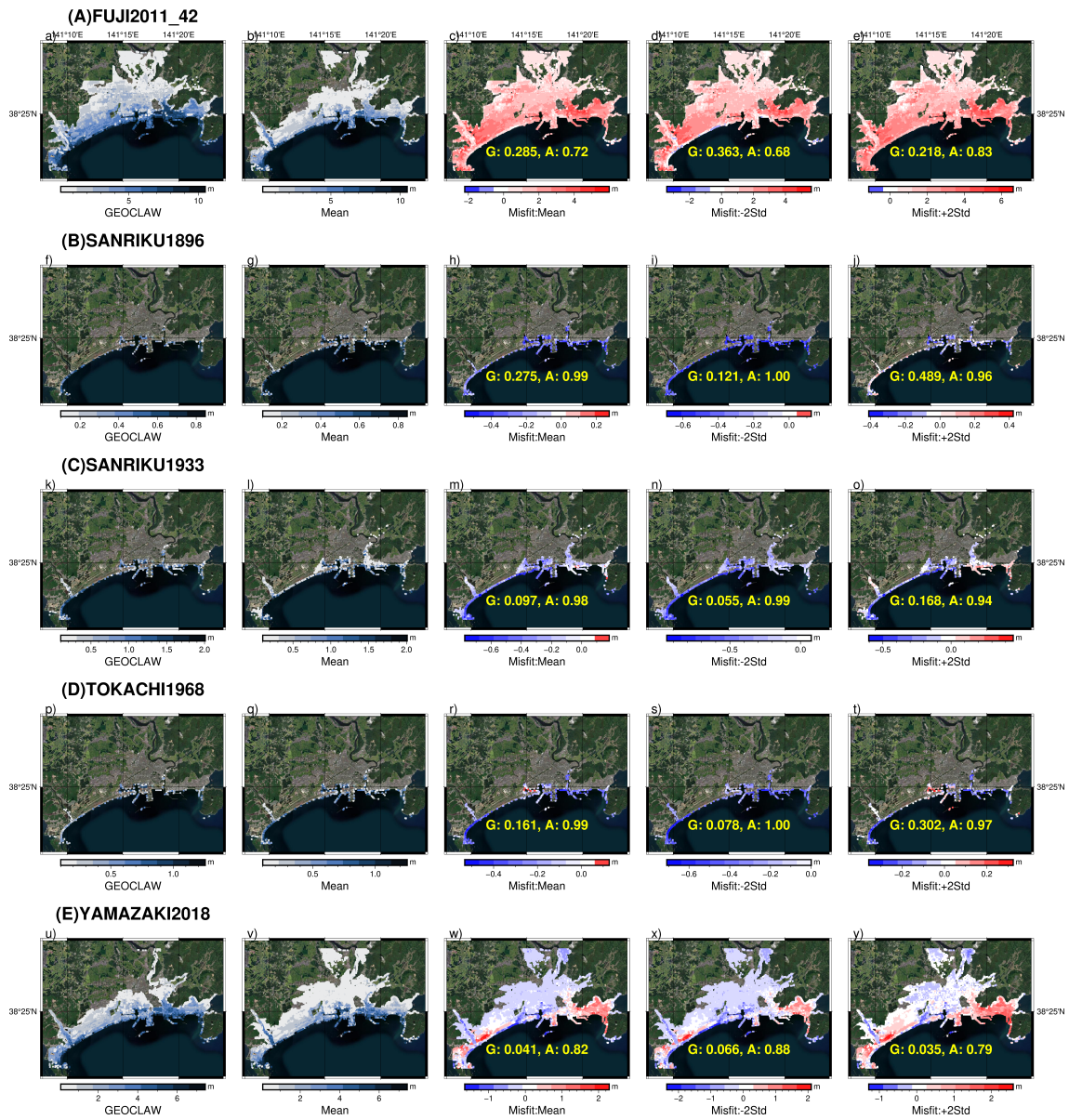
Figure S5. Historical prediction from the onshore surrogate at Ishinomaki.(Basemap from ESRI World Imagery)
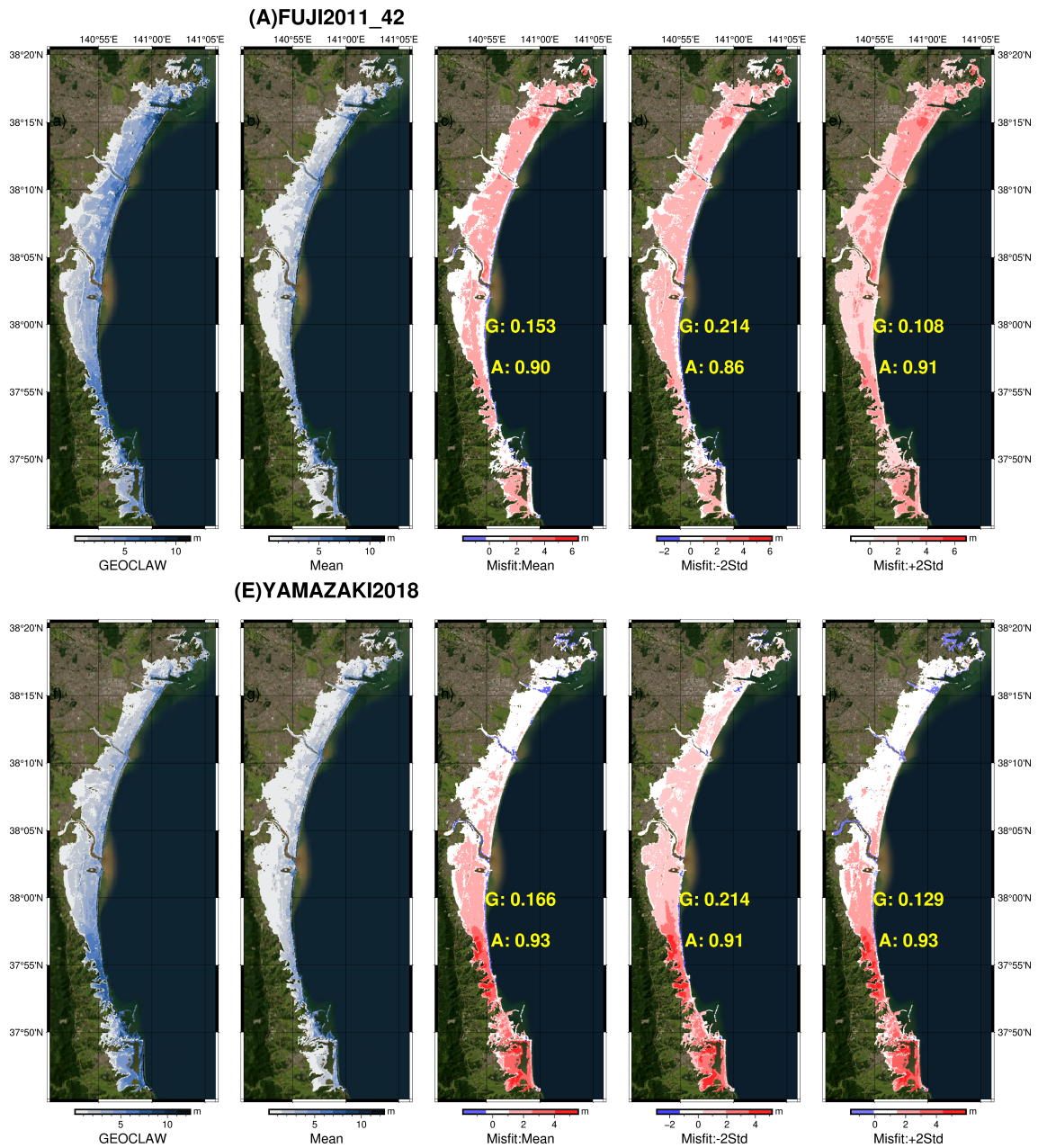
Figure S6. Historical prediction for 2011 Tohoku events from the onshore surrogate at Sendai.(Basemap from ESRI World Imagery)
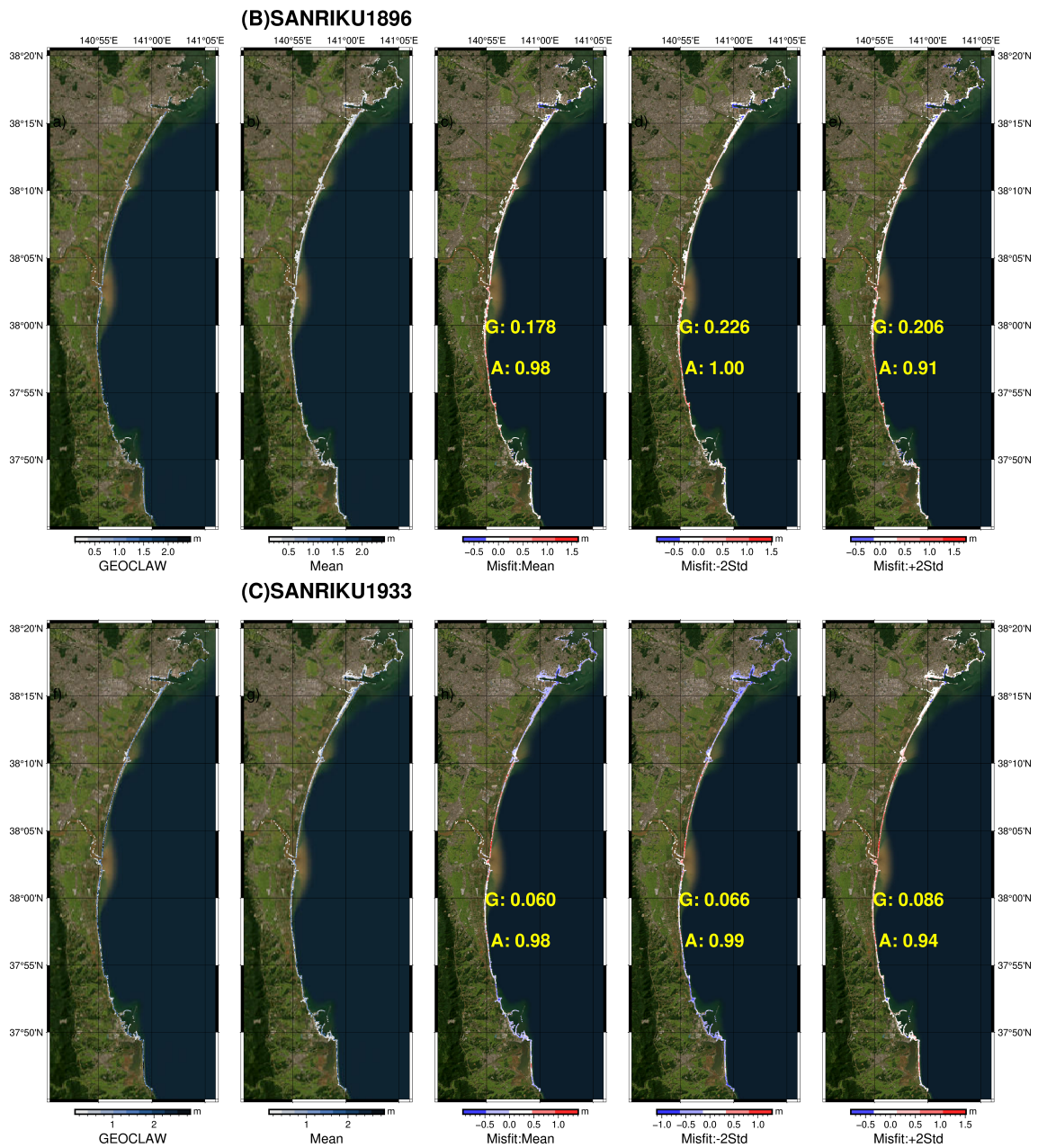
(B)SANRIKU1896

(C)SANRIKU1933

Figure S7. Historical prediction for the Sanriku events from the onshore surrogate at Sendai.(Basemap from ESRI World Imagery)
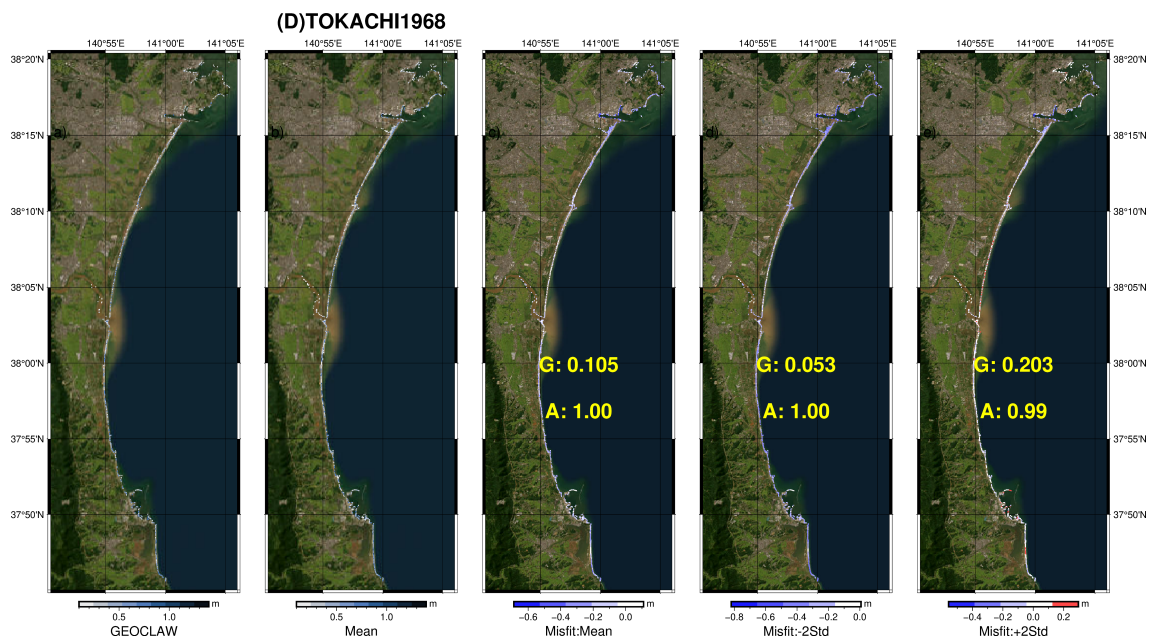
Figure S8. Historical prediction for the Tokachi-Oki event from the onshore surrogate at Sendai.(Basemap from ESRI World Imagery)

Run time information for the tsunami numerical simulation and machine learning training

Below results are based on runs using CPU device - Intel Xeon Silver 4216 CPU @2.1 Ghz, 313 GB RAM and GPU device
685 - NVIDIA A100 80GB. We do not consider and quantify the compute time for simulation and training runs conducted for
calibration and tunning of the numerical and machine learning models.

Table S5. GeoClaw simulation

Total Cell Updates	Device type	Parallelisation	Time taken	No of events	Total compute time(hrs)
0.531×10^{11}	CPU	10 CPU threads	3.45 hrs	564	1945

Table S6. Machine Learning training

	Region	Max epoch	Time taken(sec)	No of folds	Total training time(min)
Nearshore Surrogate	Rikuzentakata	3000	54	5	4.5
	Ishinomaki	3000	72	5	6
	Sendai	4000	73	5	6
Onshore Surrogate	Rikuzentakata	20000	156	5	13
	Ishinomaki	20000	167	5	14
	Sendai	20000	177	5	15
				Total	58.5