

Numerical modeling of Tohoku-Pacific Earthquake Tsunami (Ver.3)

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1. Tohoku-Pacific Earthquake

(1) USGS (<http://earthquake.usgs.gov/>)

NEAR EAST COAST OF HONSHU, JAPAN



11/03/11 5:46:23

Epicenter: 38.321 142.369
Mw 9.0

USGS/WPHASE CENTROID MOMENT TENSOR

11/03/11 05:46:23.00

Centroid: 38.321 142.969

Depth 24 No. of sta:256

Moment Tensor; Scale 10^{22} Nm

Mrr= 1.82 Mtt=-0.13

Mpp=-1.69 Mrt= 1.34

Mrp= 3.17 Mtp=-0.56

Principal axes:

T Val= 3.88 Plg=59 Azm=295

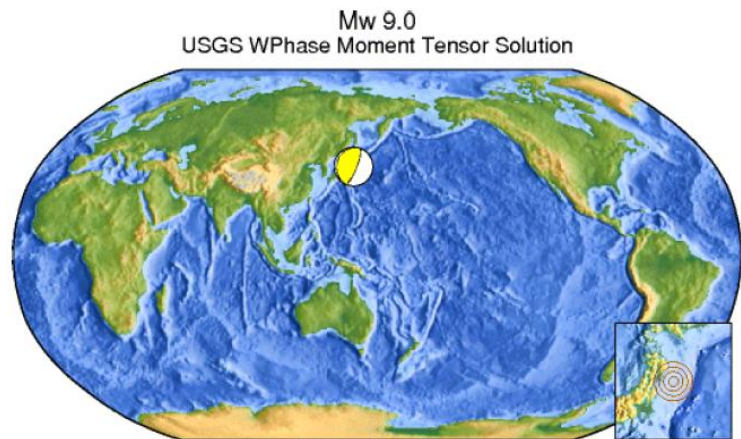
N = 0.03 2 201

P = -3.92 30 110

Best Double Couple:Mo= 3.9×10^{22}

NP1:Strike=193 Dip=14 Slip= 81

NP2: 22 76 92



Mw 9.0
USGS WPhase Moment Tensor Solution

Date: 11 MAR 2011
Time: 5:46:23
Epicenter: 38.321 142.369
Depth: 24 km

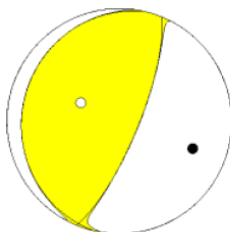
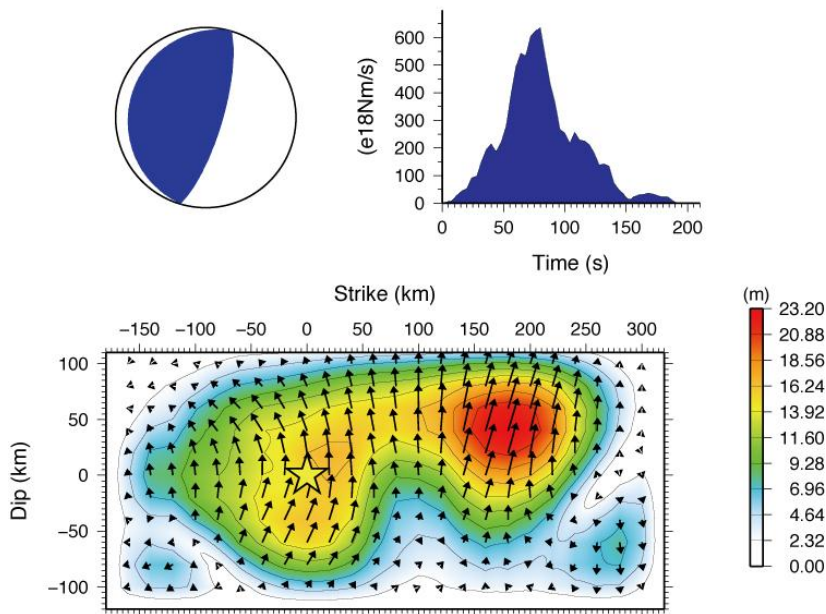


Diagram representation of the [style of faulting \(focal mechanism\)](#) derived from the estimated [moment tensor](#). Shaded areas show quadrants of the focal sphere in which the P-wave first-motions are away from the source, and unshaded areas show quadrants in which the P-wave first-motions are toward the source. The dots represent

(2) Dr.Yagi's model - version 2 (http://www.geol.tsukuba.ac.jp/~yagi-y/EQ/Tohoku/)

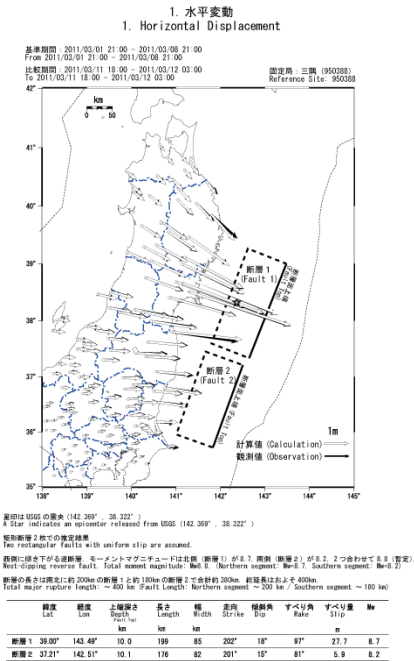
(Strike,Dip,Slip) = (195.0, 15.0, 88.6)
Moment = 0.3560E+23(Nm); Mw = 9.0
Variance = 0.18288
Depth = 30.00(km) ; Vmax = 2.50(km/sec)



(3) Geospatial information authority of Japan

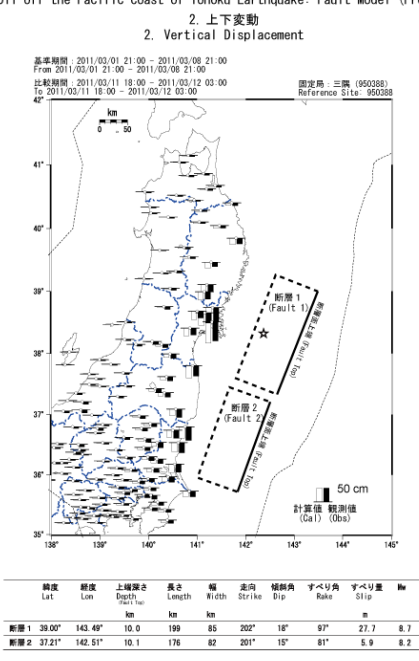
(http://www.gsi.go.jp/cais/topic110313-index.html)

平成 23 年 (2011 年) 東北地方太平洋沖地震の震源断層モデル (暫定)
The 2011 off the Pacific coast of Tohoku Earthquake: Fault Model (Preliminary)



国土地理院資料
Geospatial Information Authority of Japan

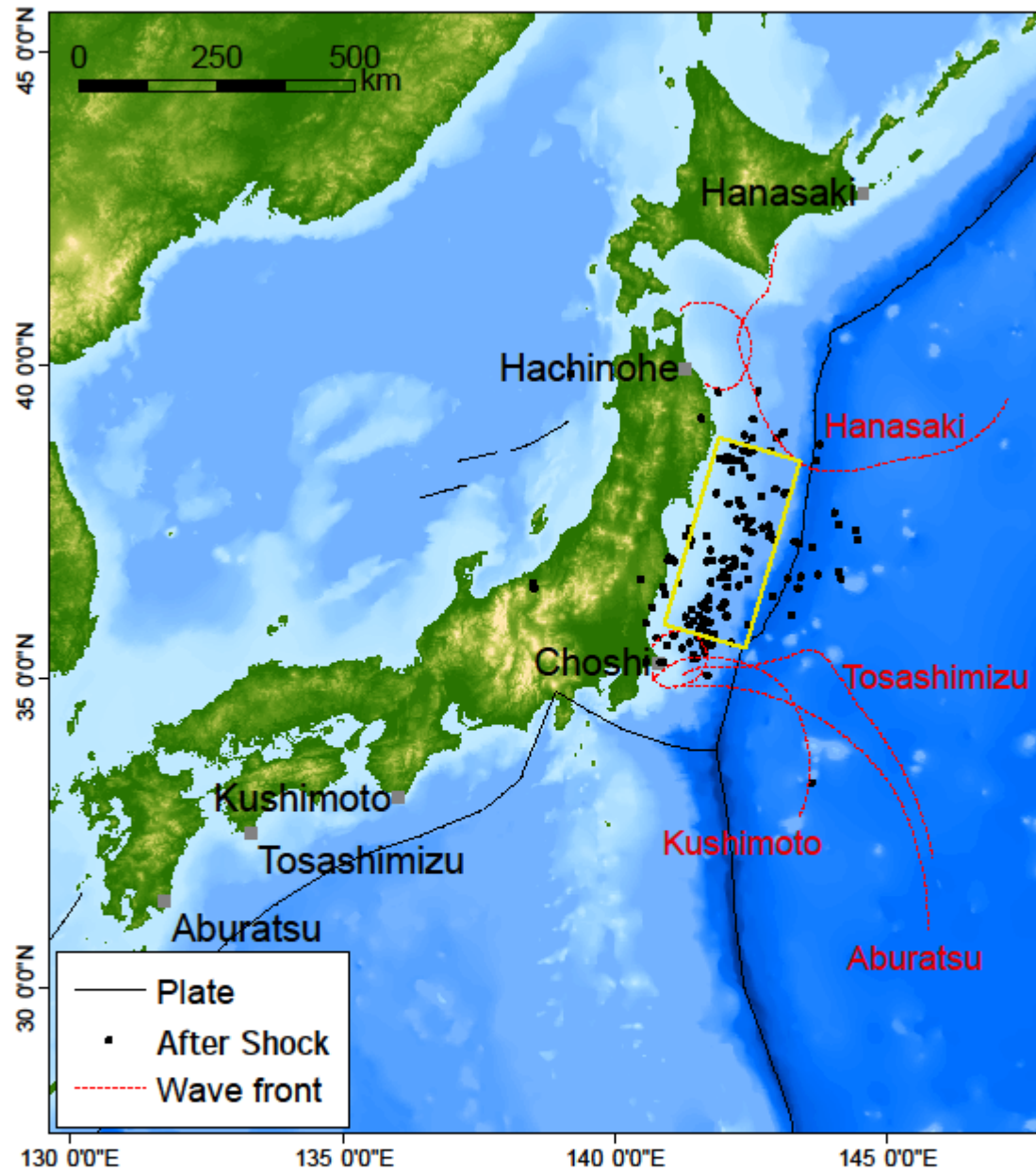
平成 23 年 (2011 年) 東北地方太平洋沖地震の震源断層モデル (暫定)
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2. Wave front inferred from the arrival time of tide gauges

- Wave-ray analysis
- Grid size ($\Delta x = 3250\text{m}$)



3. Fault Parameter

	Mw	Latitude	Longitude	D	L	W	strike	dip	slip	depth	note
Model 1	9.1	39.30	144.20	20	400	150	193	14	81	3	(1)
Model 2	9.0	37.18	143.12	21	150	150	195	15	88.6	10	(2)
		39.14	143.94	16	220	150	195	15	88.6	10	
Model 3	8.8	39.00	143.49	27.7	199	85	202	18	97	10	(3)
		37.21	142.51	5.9	176	82	201	15	81	10.1	

※ Reference

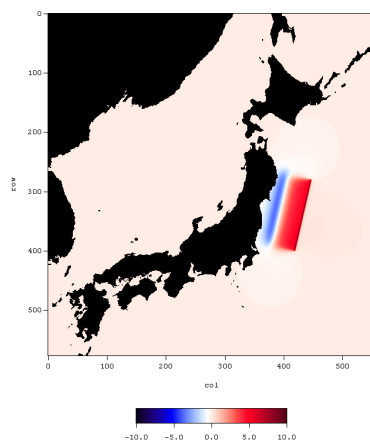
- (1) <http://iisee.kenken.go.jp/staff/fujii/OffTohokuPacific2011/tsunami.html>
- (2) <http://www.geol.tsukuba.ac.jp/~yagi-y/EQ/Tohoku/>
- (3) <http://www.gsi.go.jp/common/000059085.pdf>

4. Tsunami model

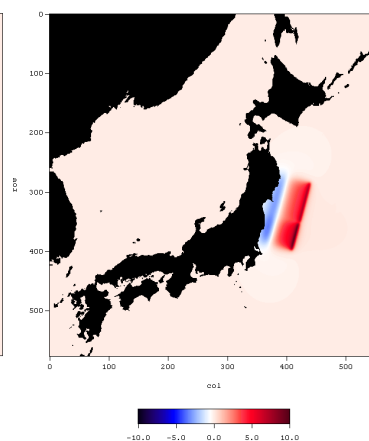
- Non-linear long wave equation
- Grid size for the model validation : $\Delta x = 3250\text{m}$
- Grid size for the tsunami propagation and inundation : $\Delta x = 50 - 1350\text{m}$

5. Initial water elevation of the tsunami

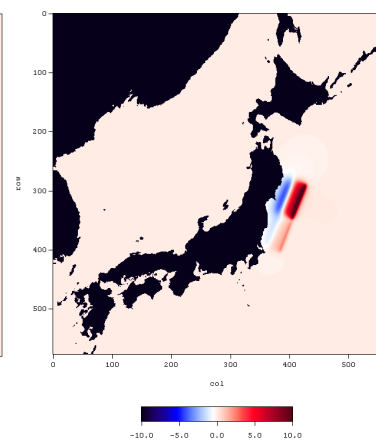
(Model 1)



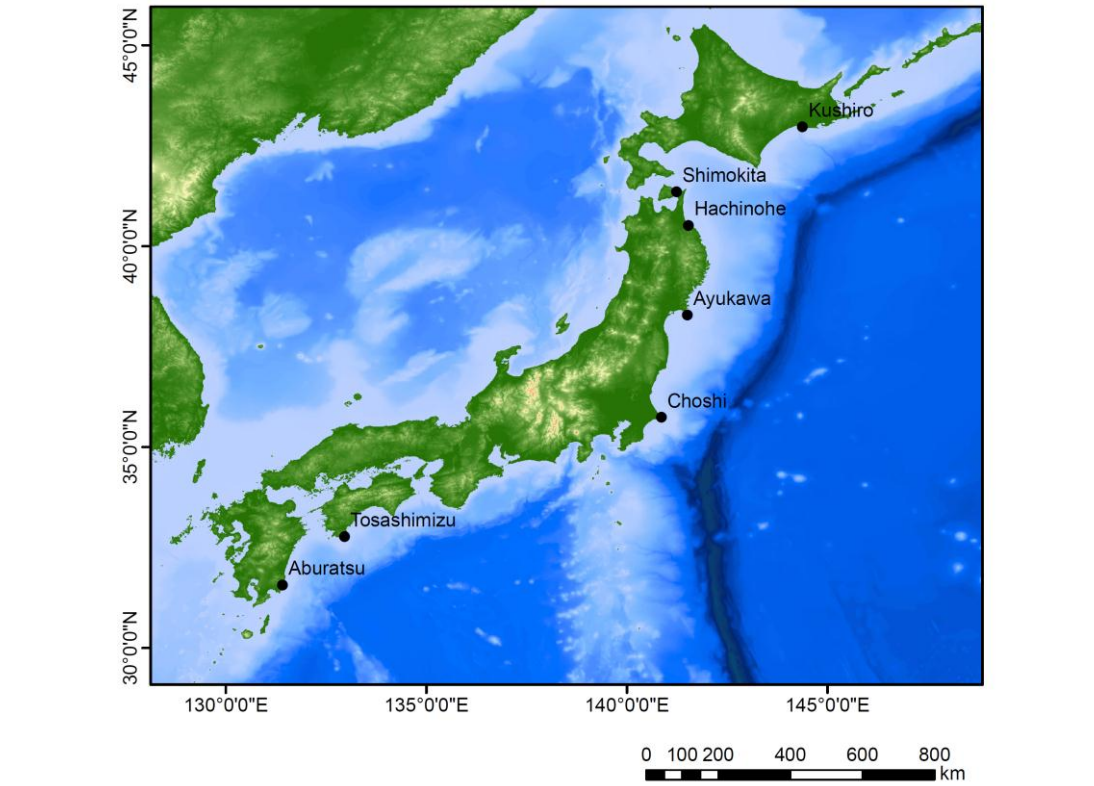
(Model 2)



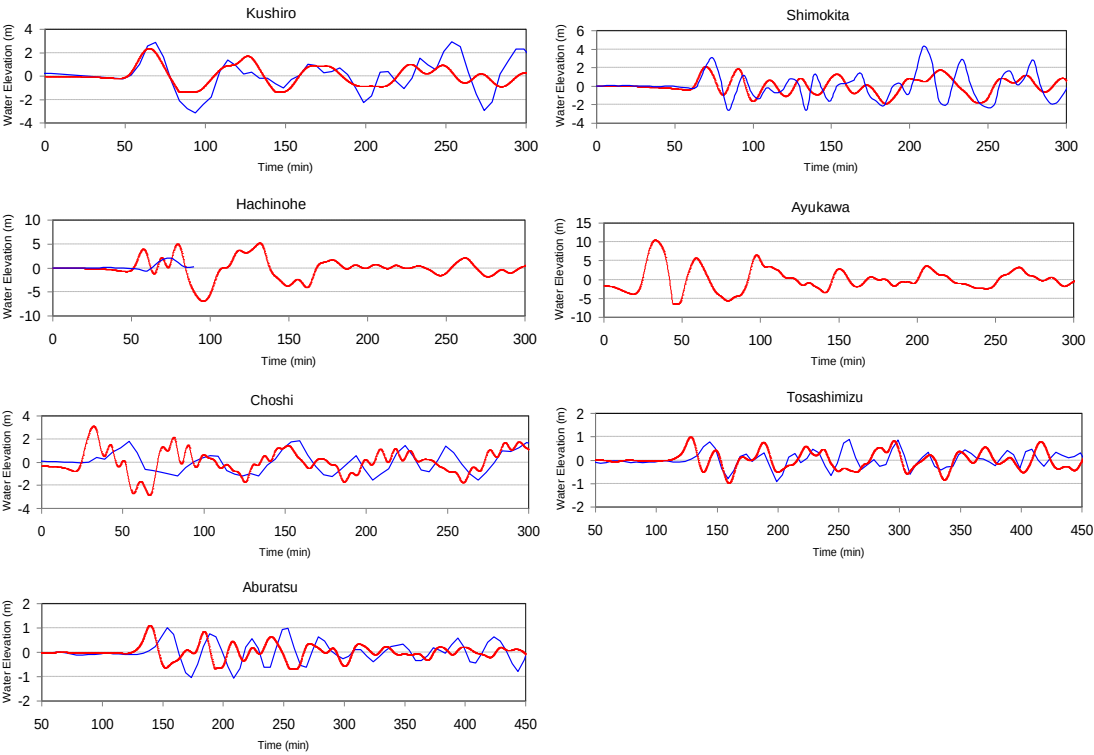
(Model 3)



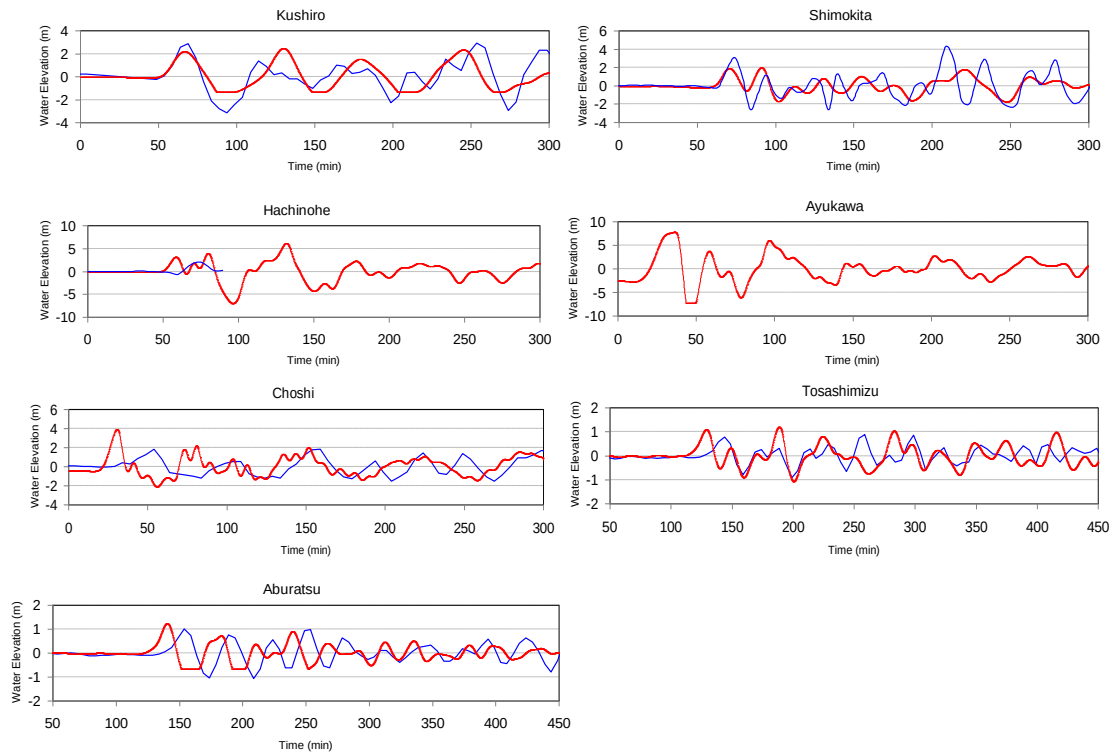
6 . Model Validation



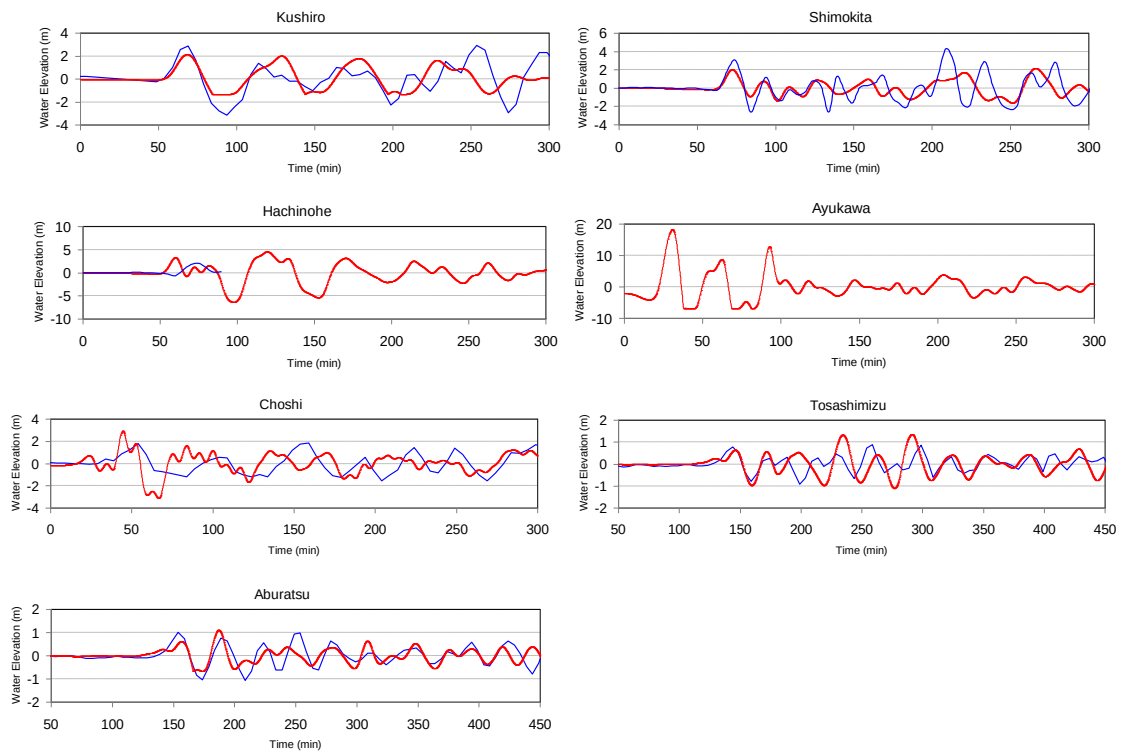
(1) Model 1



(2) Model 2



(3) Model 3

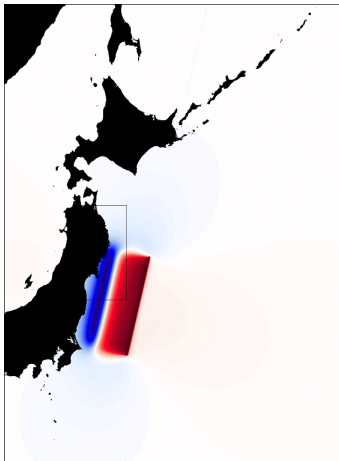


7. Tsunami propagation

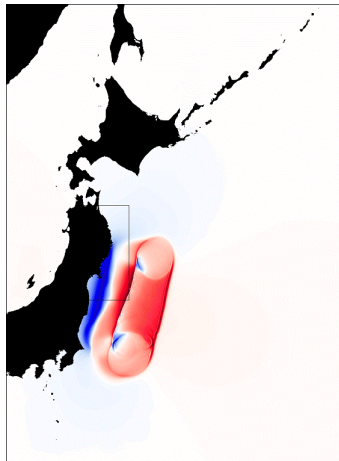
(1) Model 1

- Snapshots of the water level

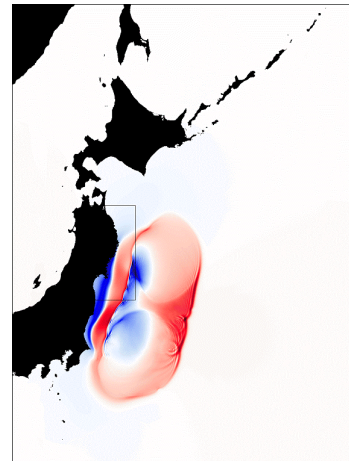
6min



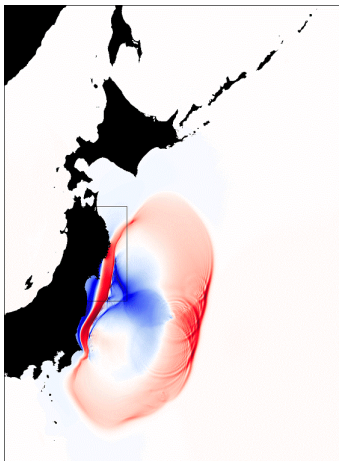
12min



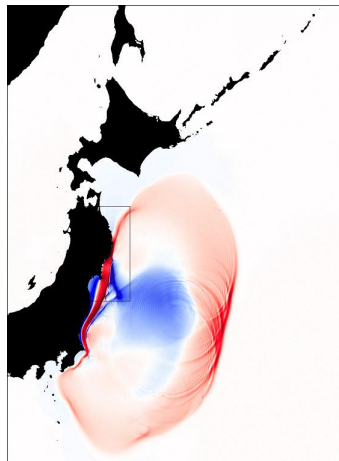
18min



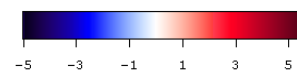
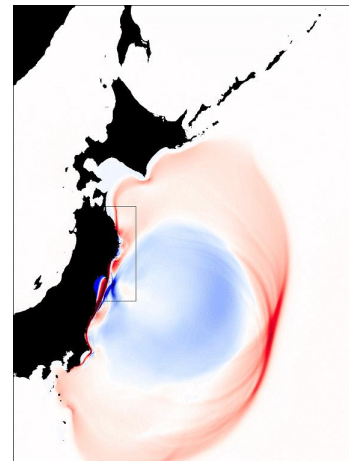
24 min



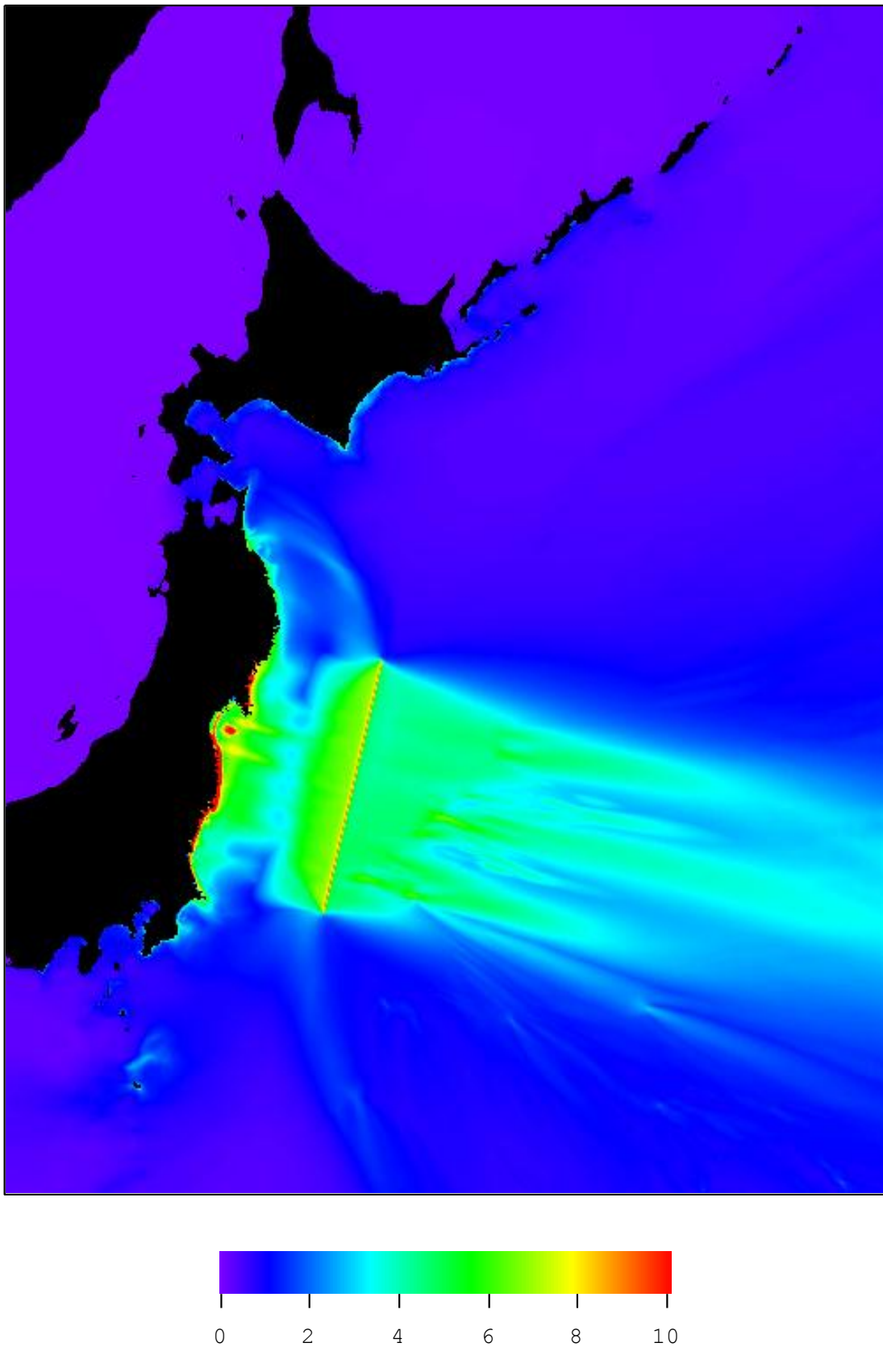
30 min



36 min



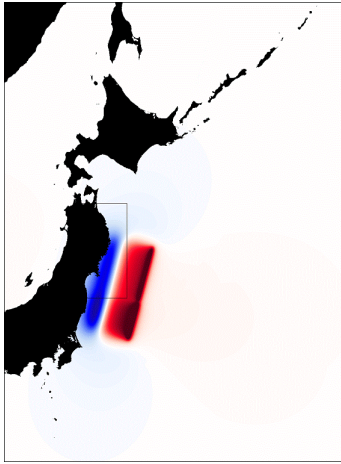
- Maximum tsunami height



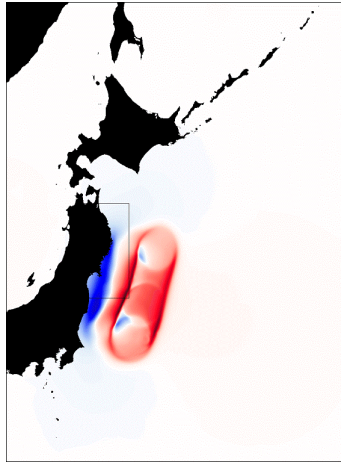
(2) Model 2

- Snapshots of the water level

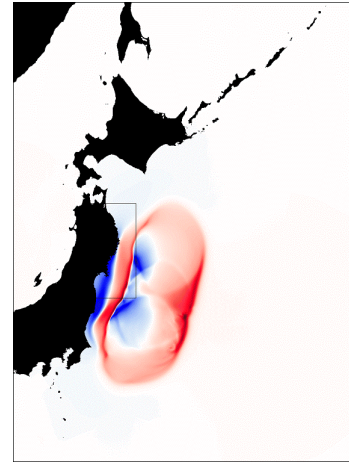
6min



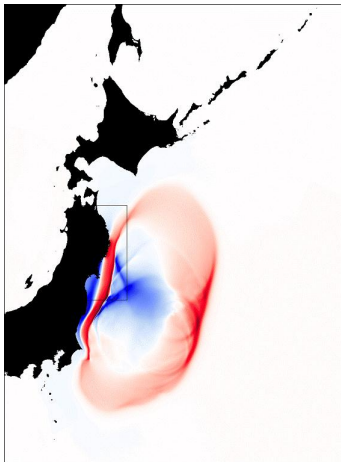
12min



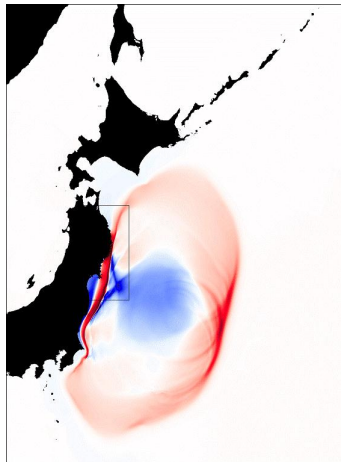
18min



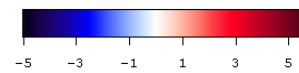
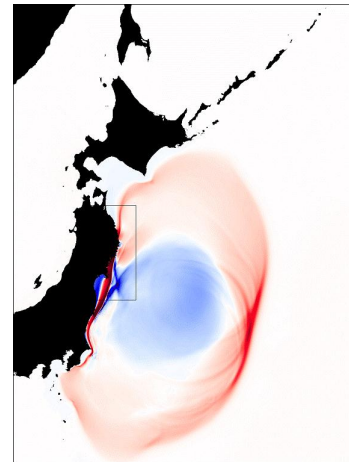
24 min



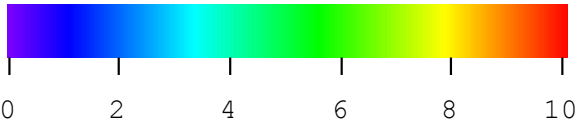
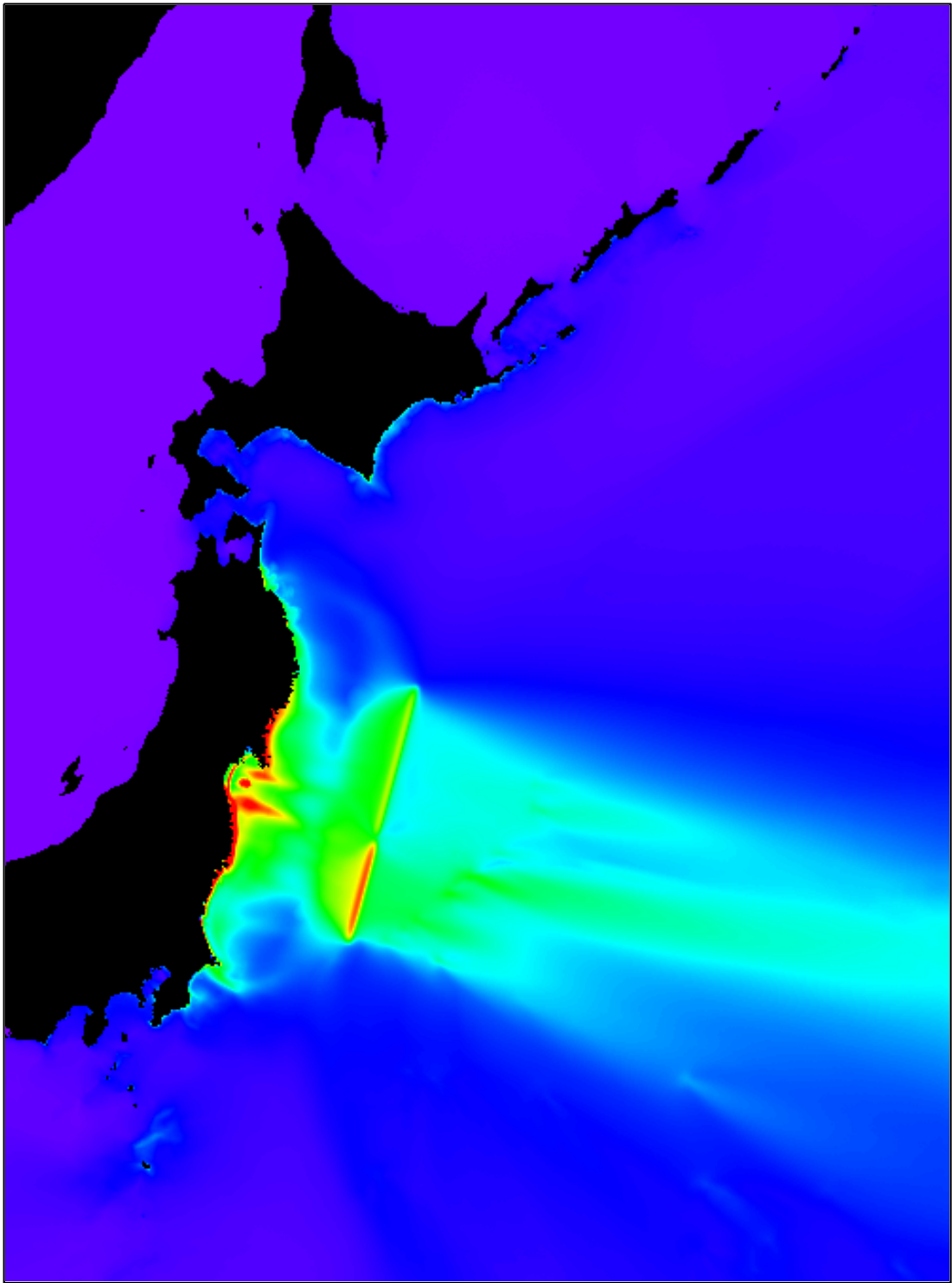
30 min



36 min



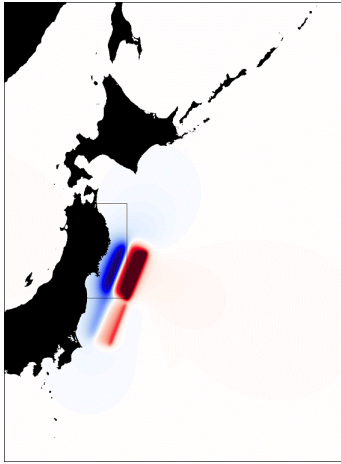
• Maximum tsunami height



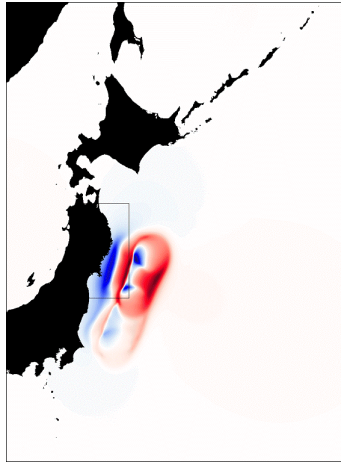
(3) Model 3

- Snapshots of the water level

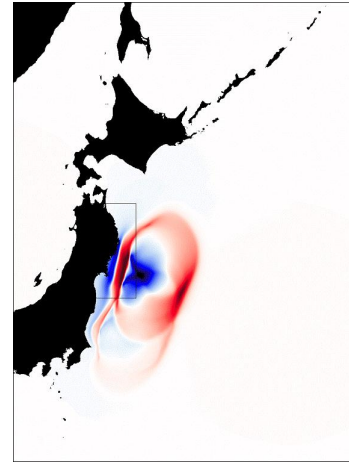
6min



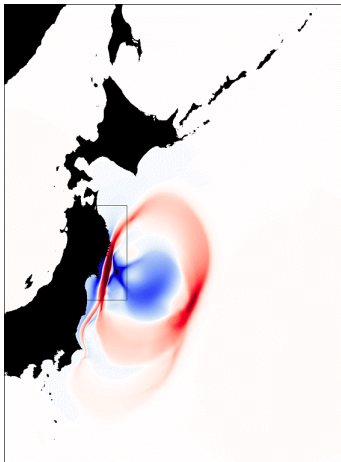
12min



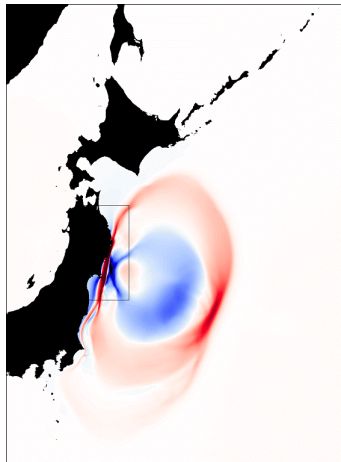
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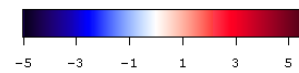
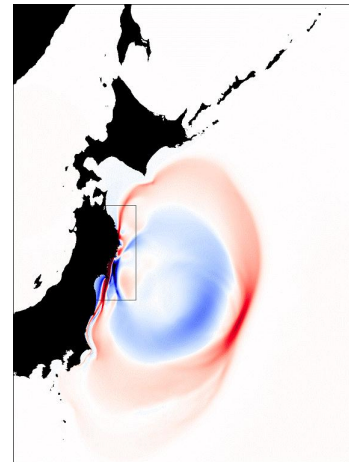
24 min



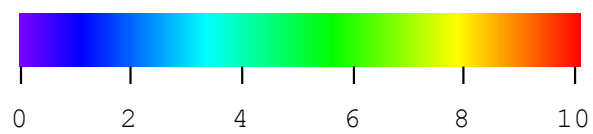
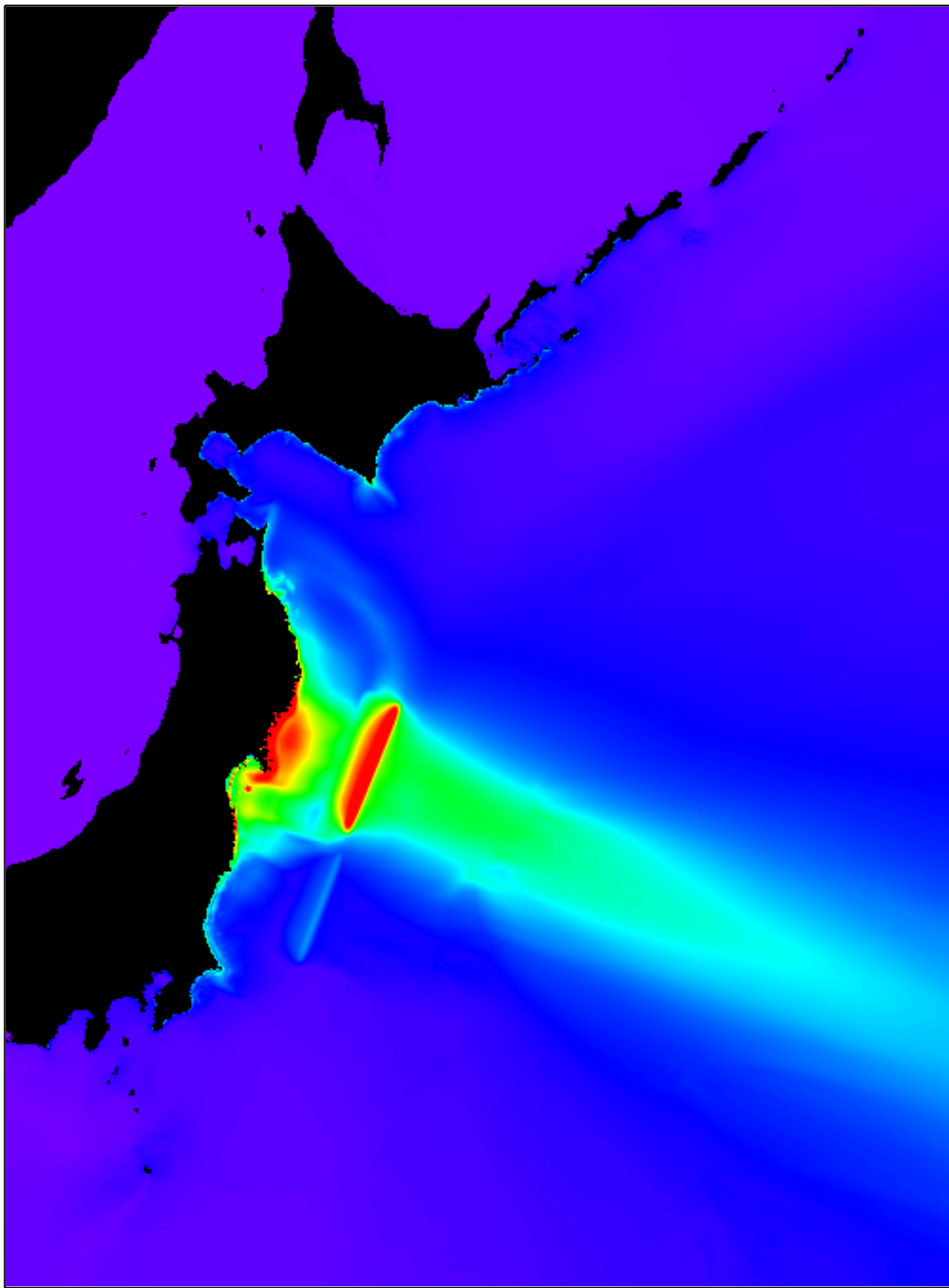
30 min



36 min



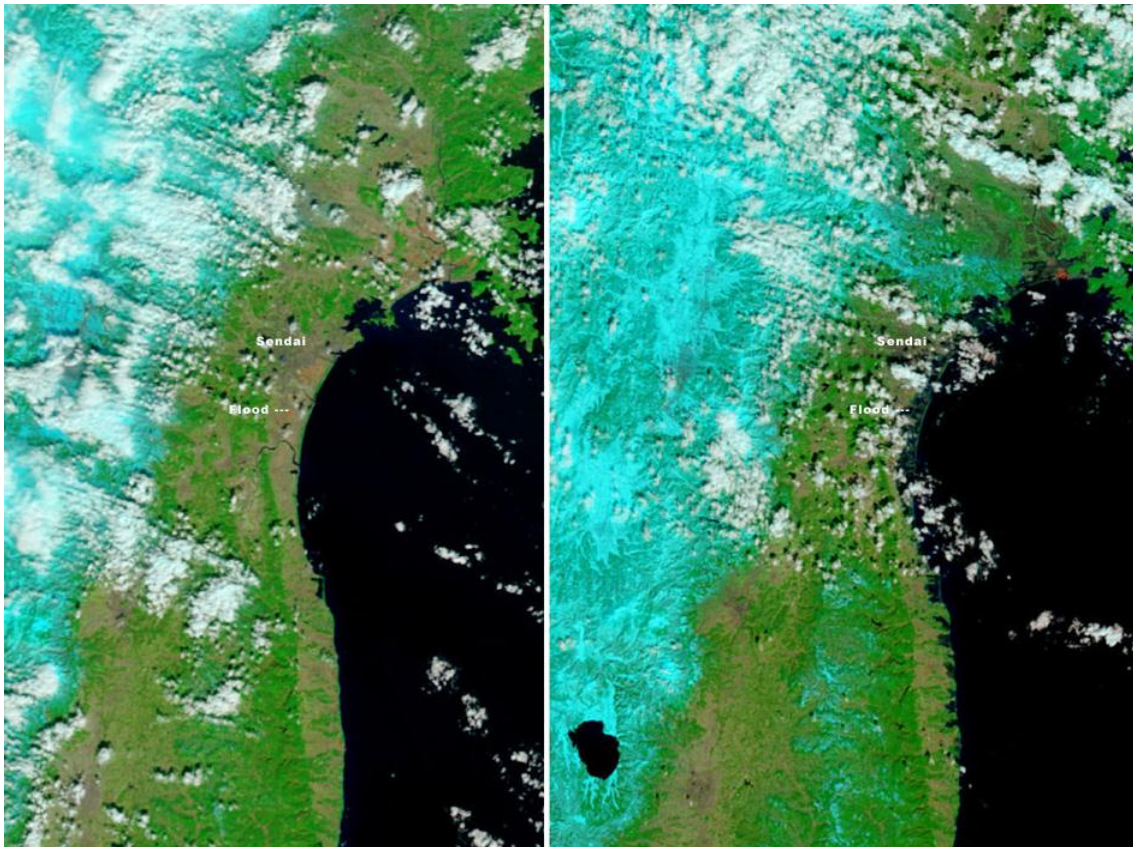
- Maximum tsunami height



9. Tsunami inundation in Sendai coast

(1) Satellite image before and after the tsunami

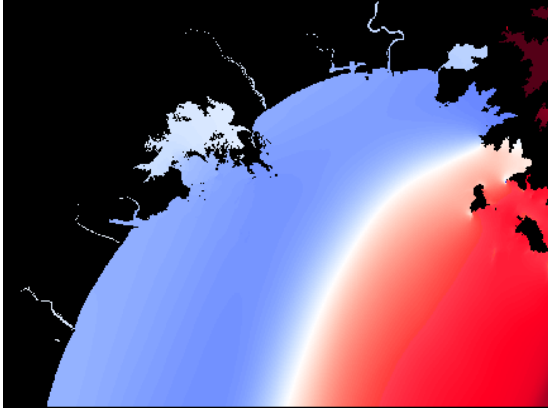
(http://www.nasa.gov/multimedia/imagegallery/image_feature_1892.html)



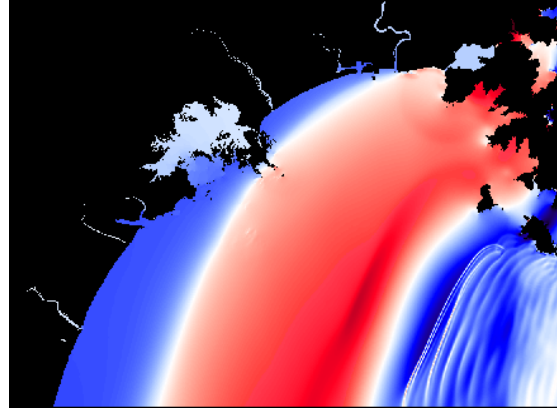
(2) Model 1

- Snapshots of the water level

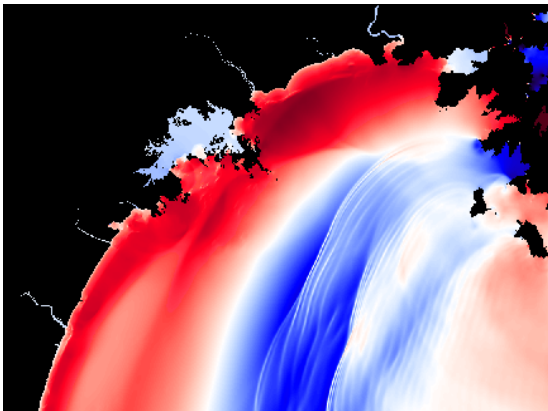
36 min



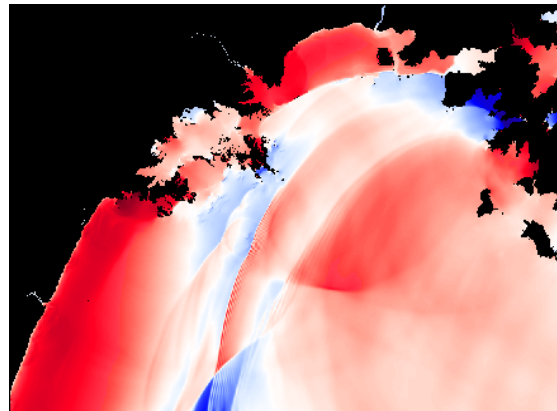
48 min



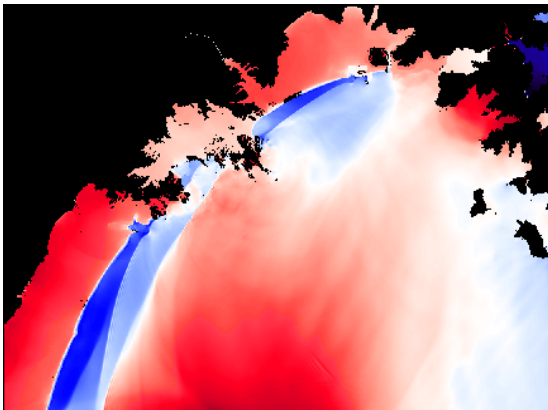
60 min



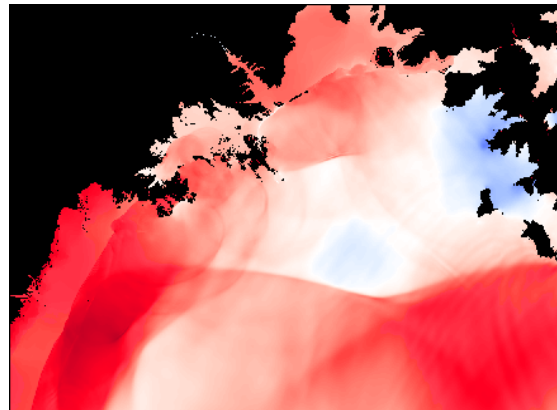
72 min

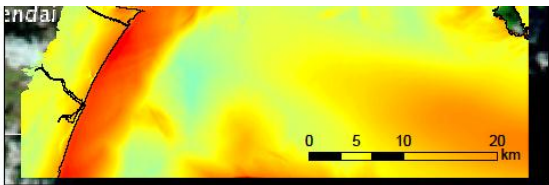
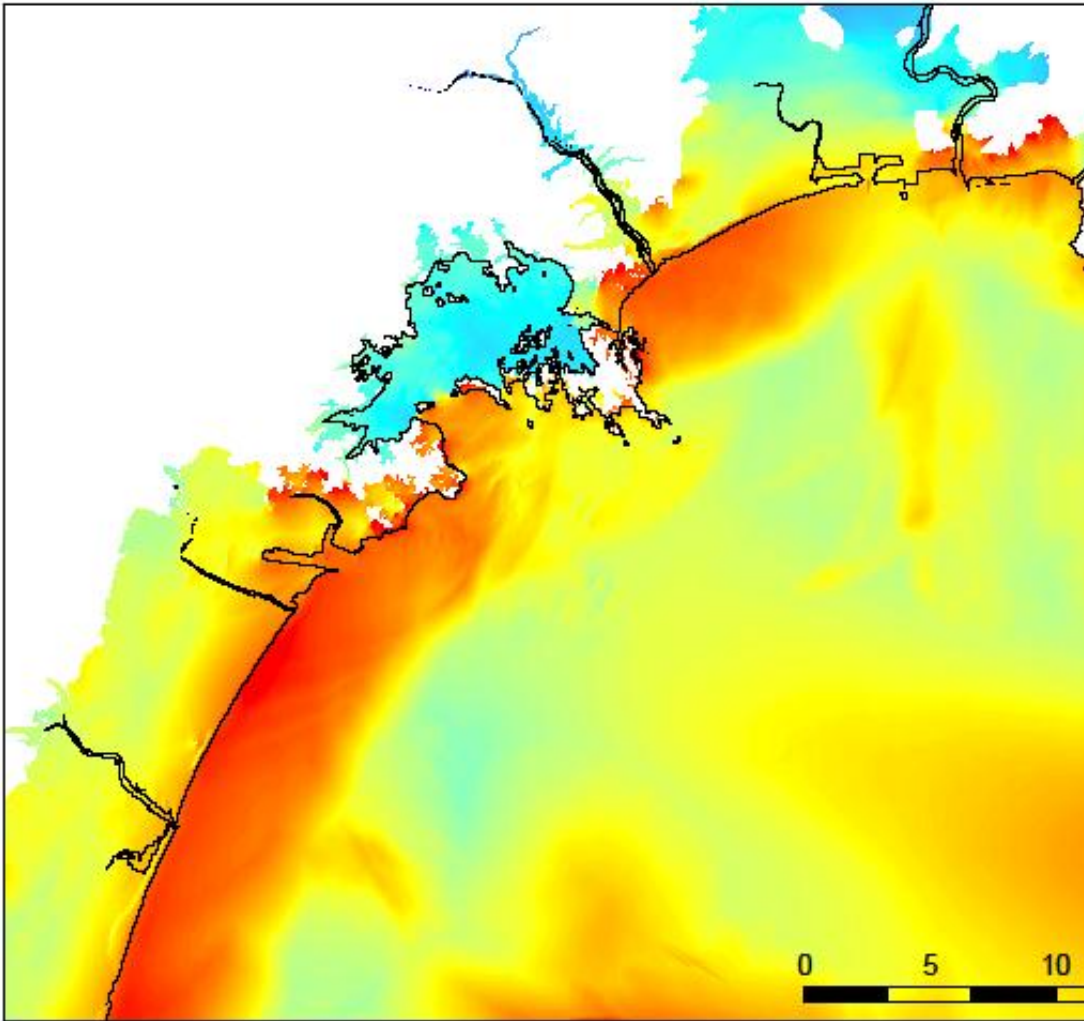
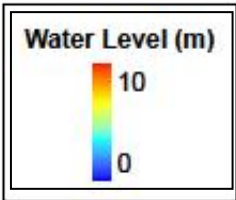
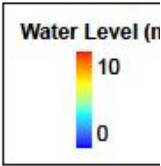


84 min

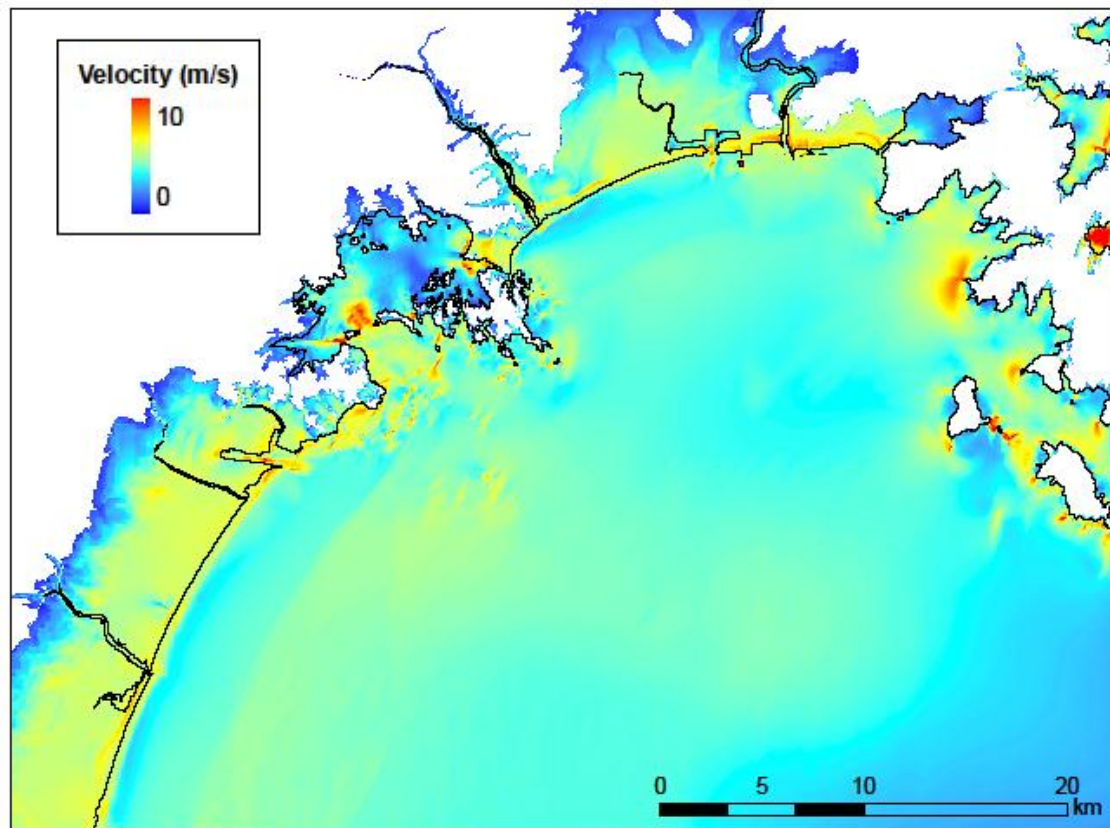


96 min





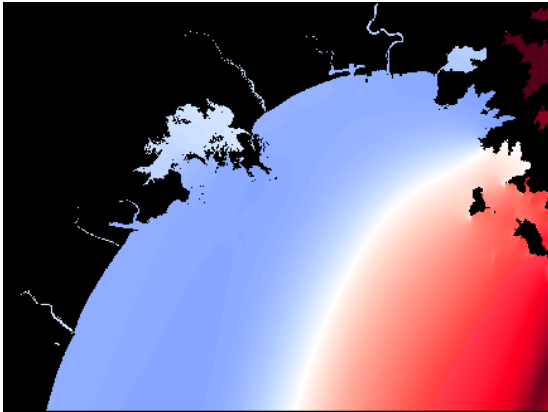
- Maximum tsunami velocity



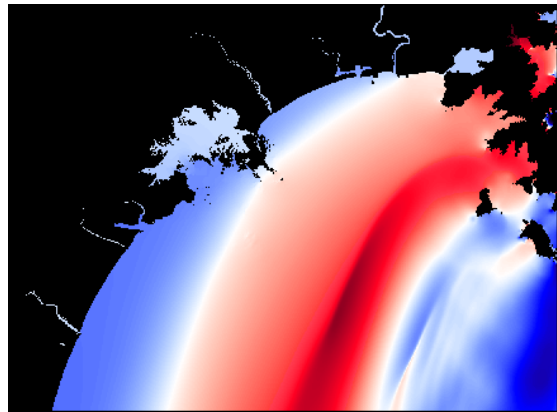
(2) Model 2

- Snapshots of the water level

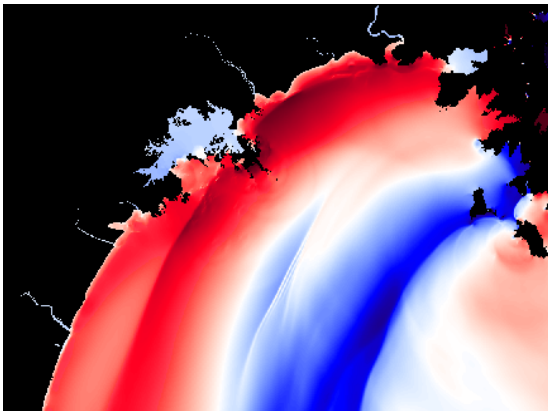
36 min



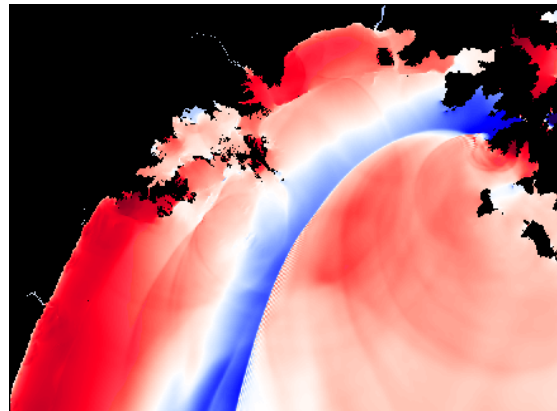
48 min



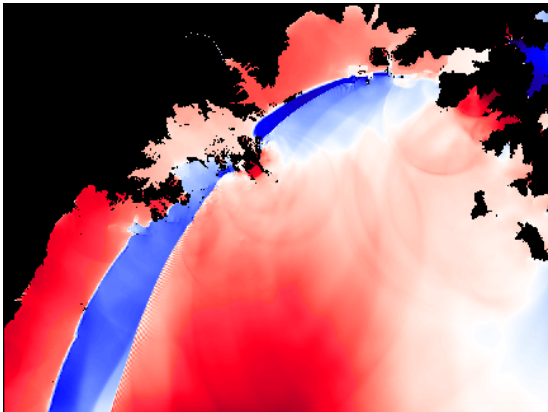
60 min



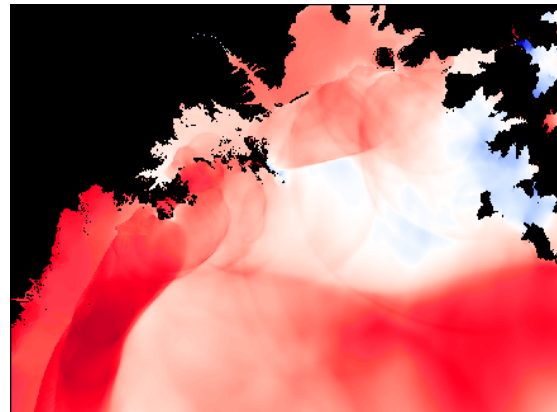
72 min



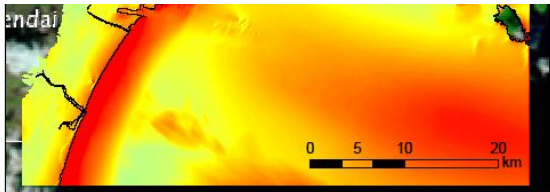
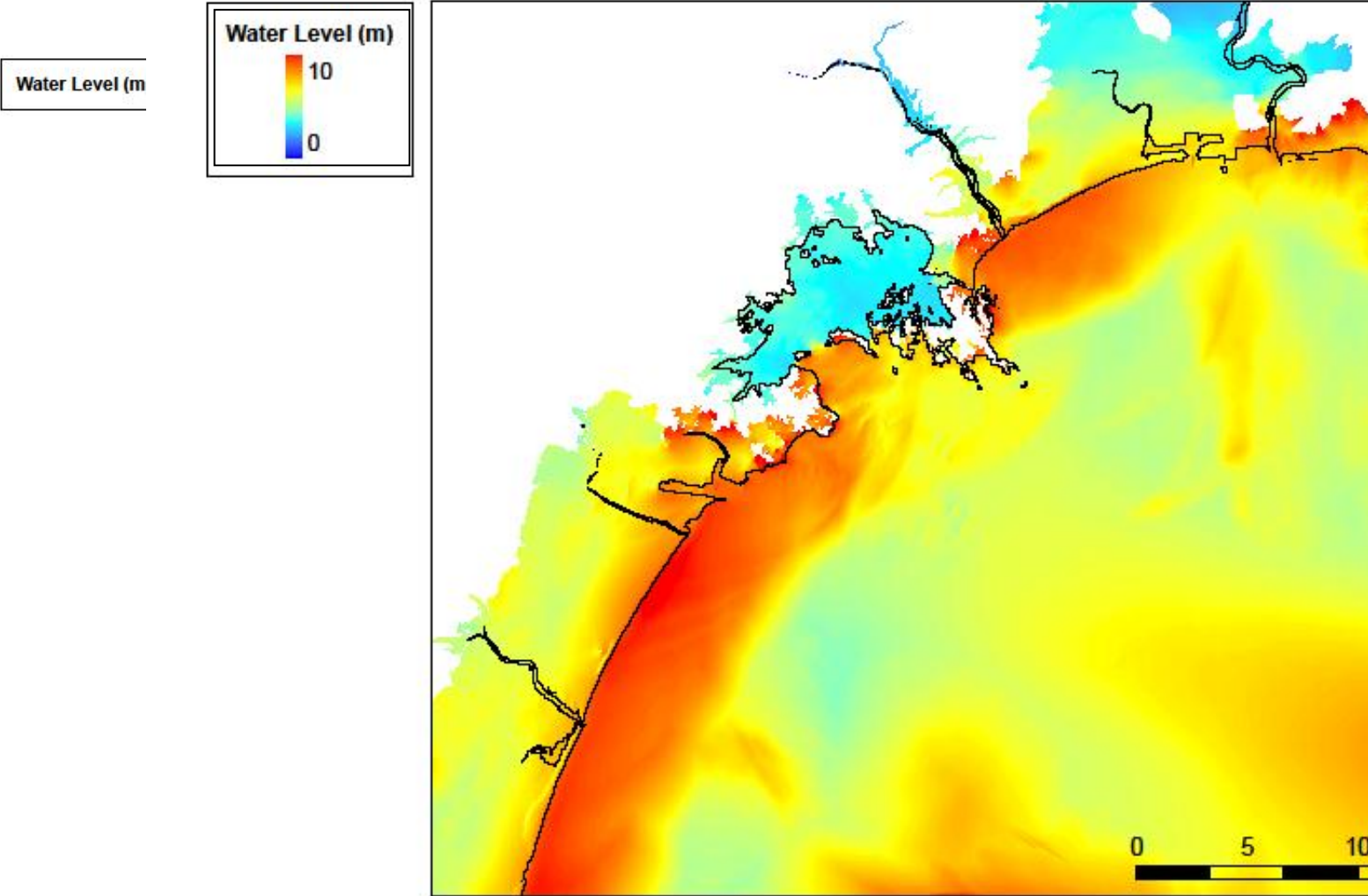
84 min



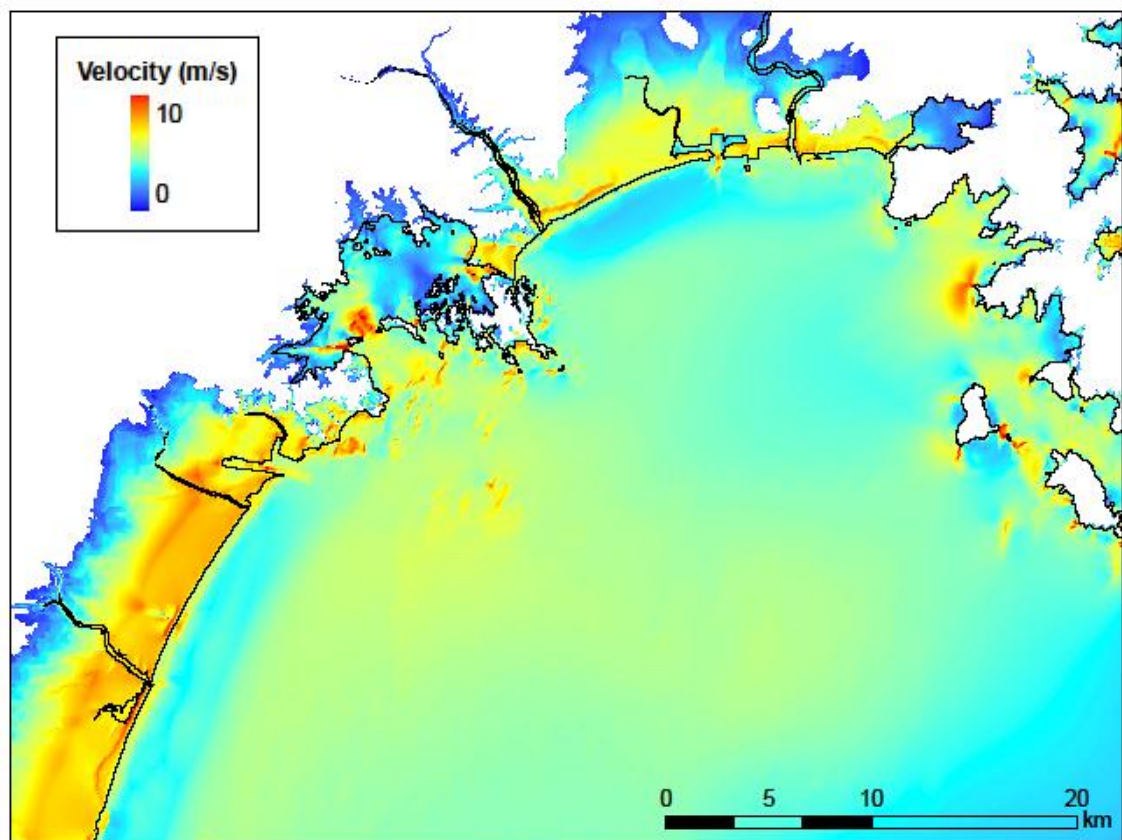
96 min



- Maximum tsunami height



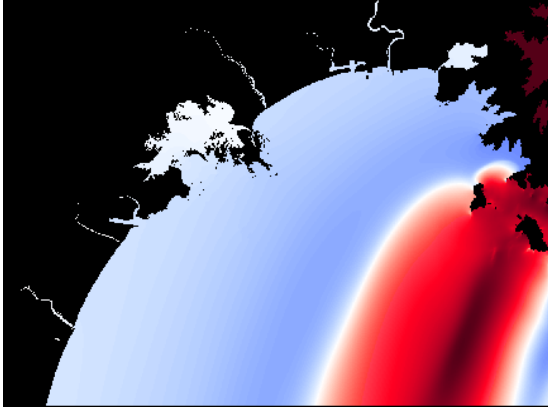
- Maximum tsunami velocity



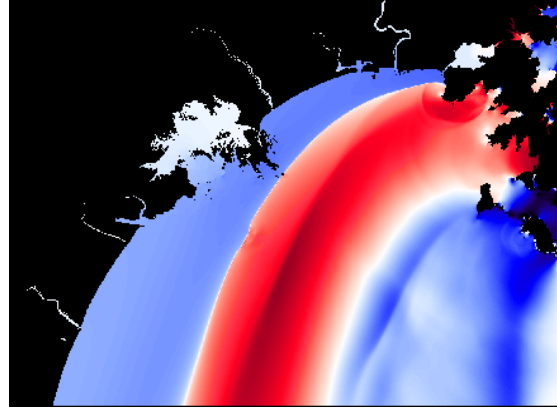
(3) Model 3

- Snapshots of the water level

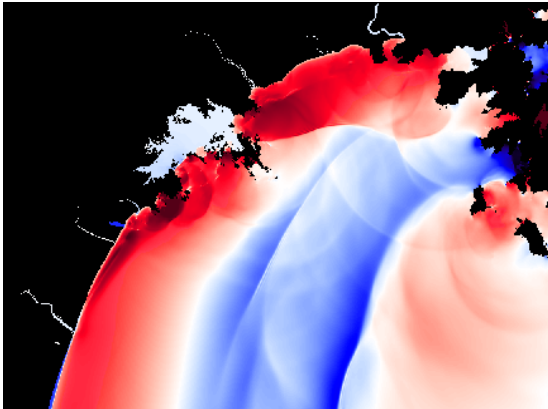
36 min



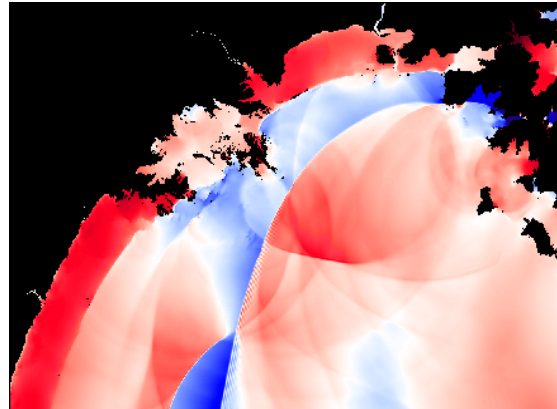
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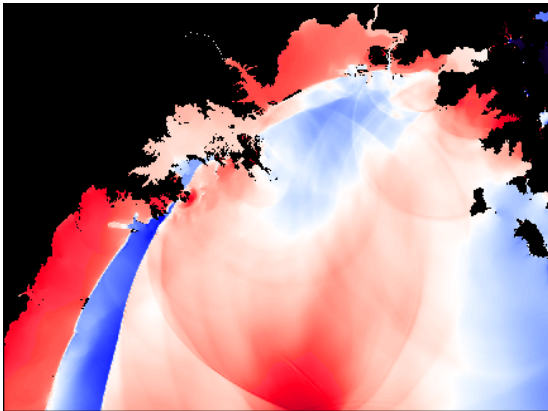
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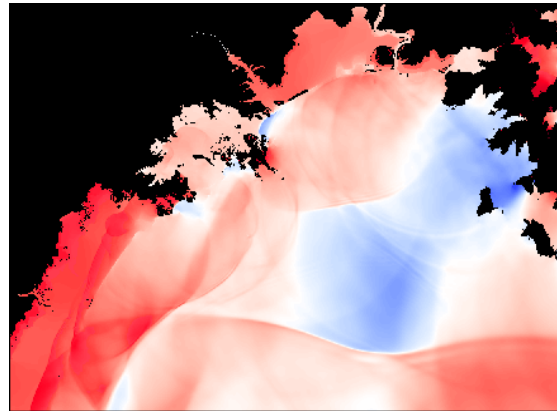
72 min

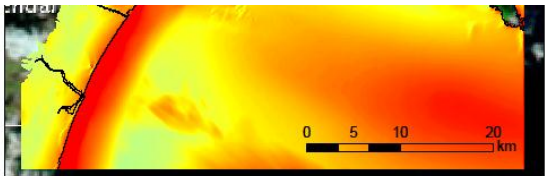
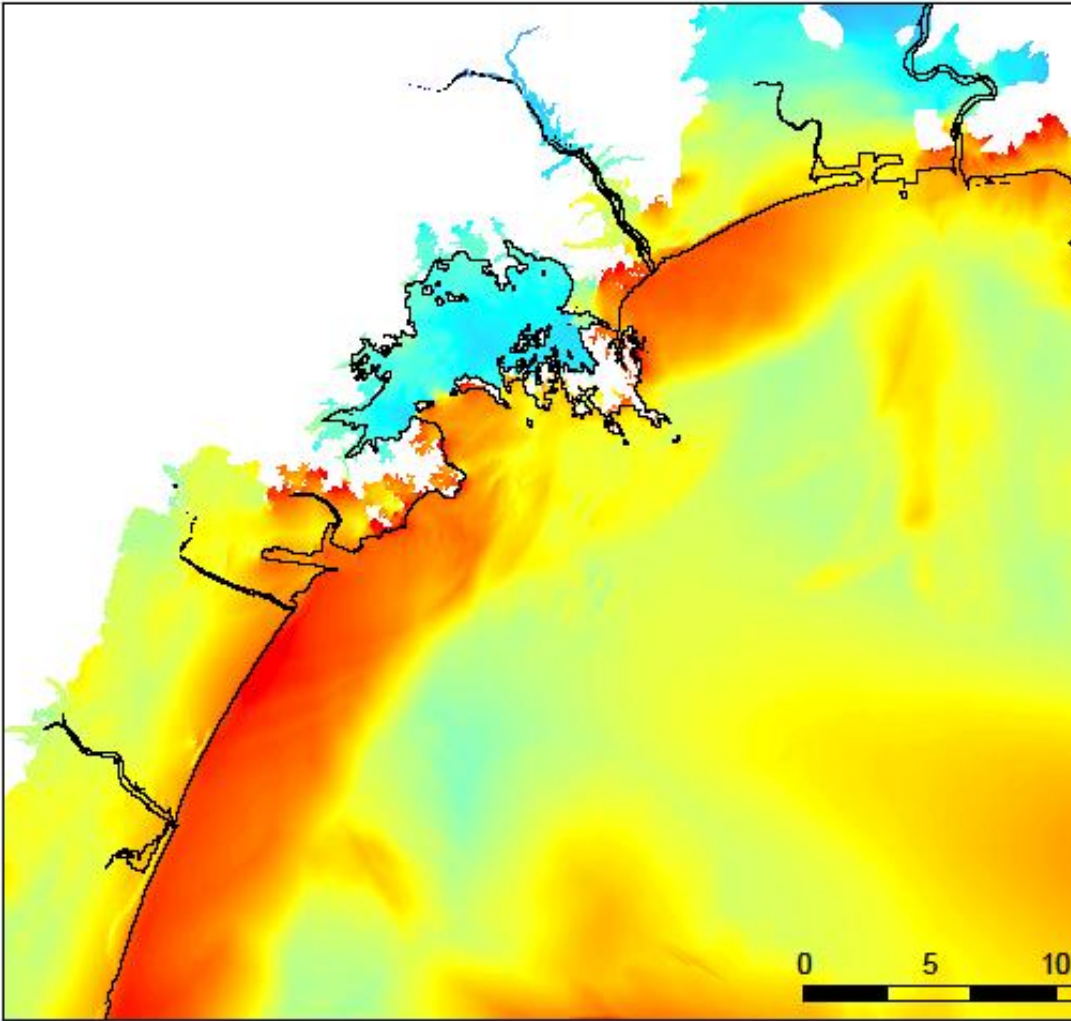
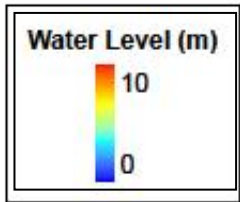


84 min



96 min





- Maximum tsunami velocity

