First Regional Workshop on Tsunami Inundation Modelling in the Northwest Indian Ocean

Storm surge model:

ADCIRC (Advanced Circulation) Model

ADCIRC is a shallow water hydrodynamic finite-element-based (FEM) storm surge model which works on unstructured grid.

ADCIRC has been developed at the University of North Carolina at Chapel Hill, Institute of Marine Sciences and at the University of Notre Dame, Department of Civil Engineering and Geologic Sciences.

ADCIRC applications include modeling tides, seiches and storm surges and their associated inland inundation.

Key capabilities - wetting and drying algorithm to compute inland penetration of water from storm surge

FEMA (Federal Emergency Management Agency) in 2002 accepted the robustness of ADCIRC

Model is configured at High Performance Computing system at INCOIS.

Detailed description of the model can be obtained at https://adcirc.org/

Computational Efficiency

Algorithmic and code design criteria

– Very low numerical damping - allows model parameters to be based on physically relevant values

– At least second order accurate

– Robust and stable

Highly Efficient Code

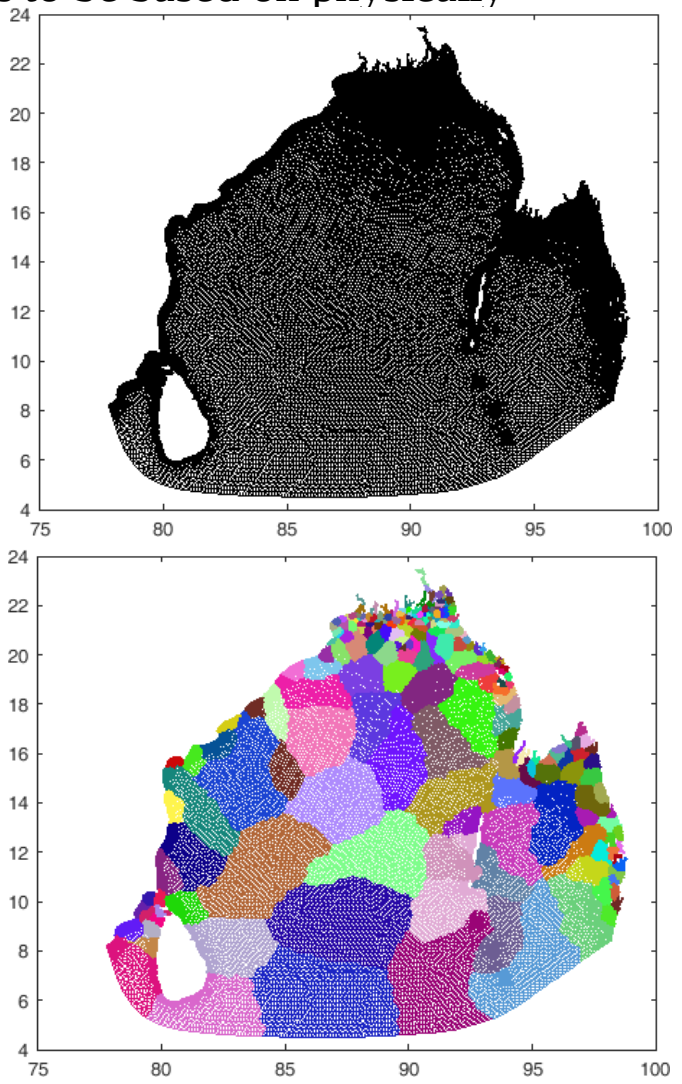
– Loop-level Optimization (increasing execution speed)

– Parallel Computing

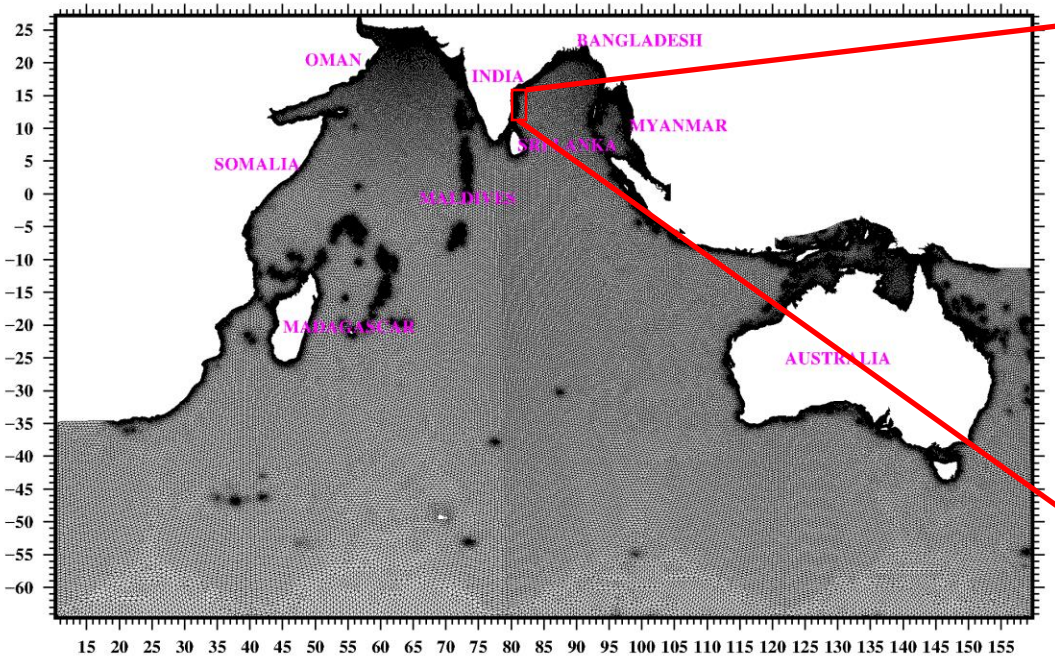
– Domain Decomposition

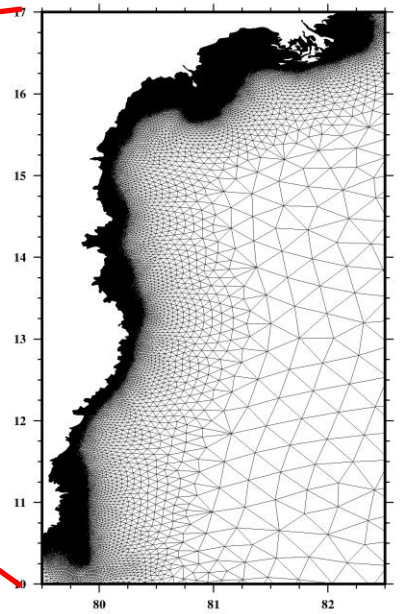
– MPI based communication

– Linear speed up or better on 256+ processors



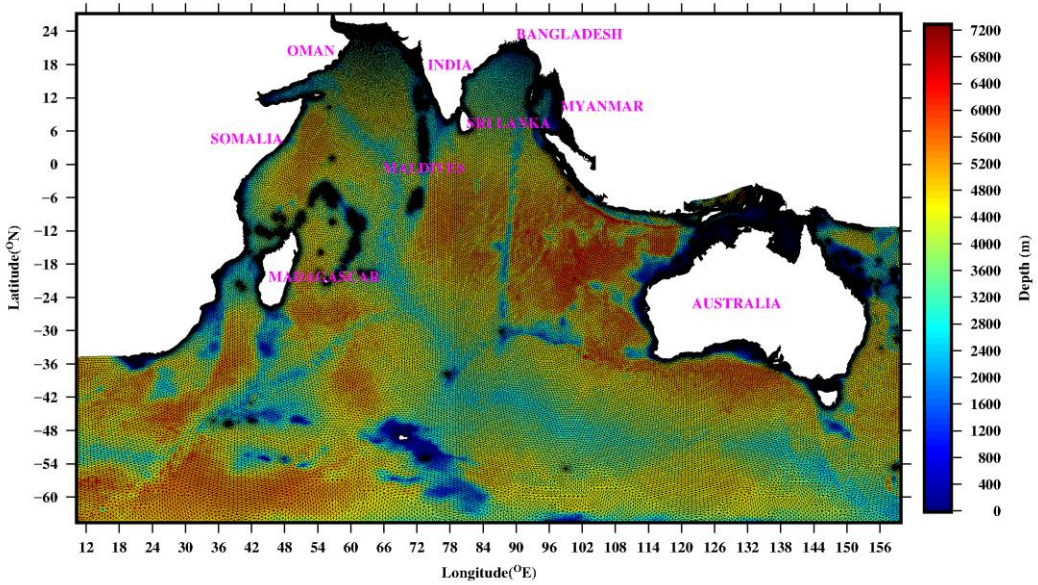
Tsunami modelling using FEM with mpi Model domain and Mesh

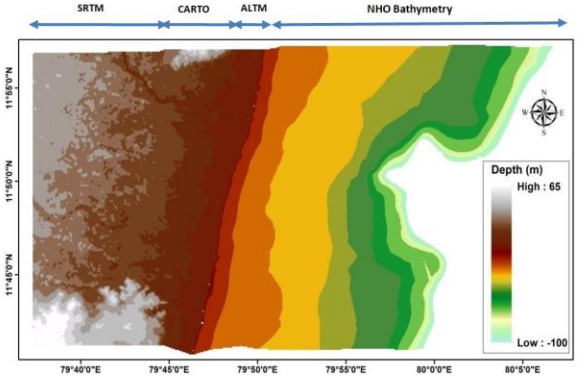




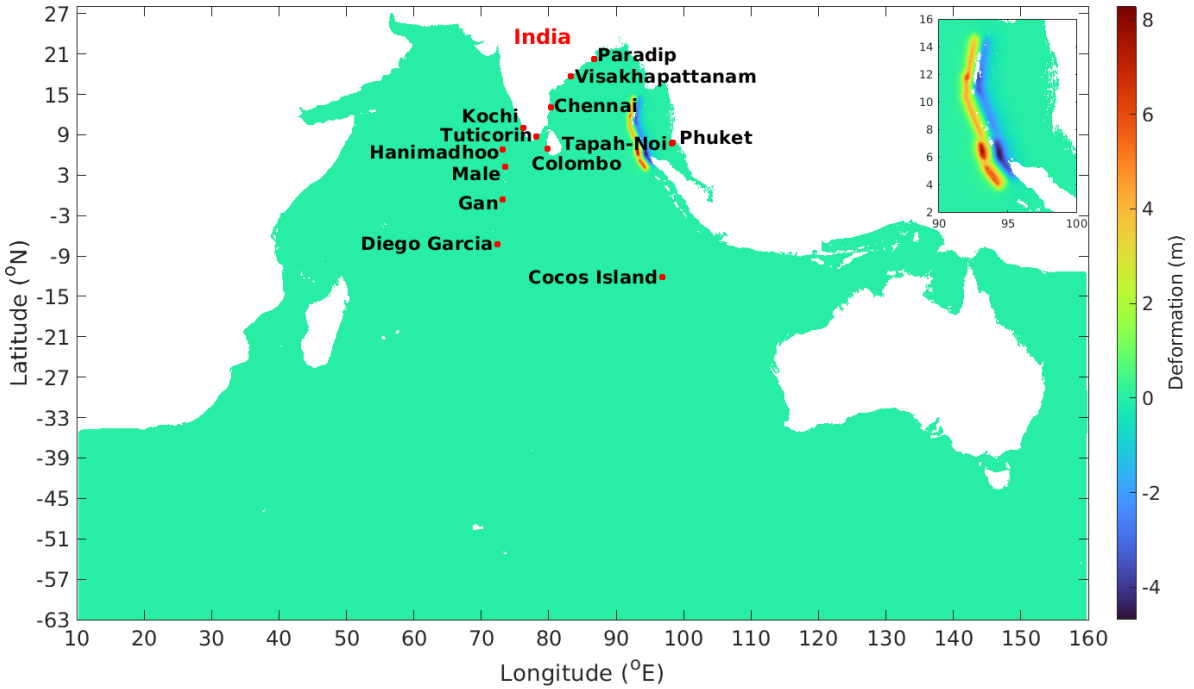
7,07,016 elements
3,77,747 nodes

Model mesh and Bathymetry





Generation/Initial deformation

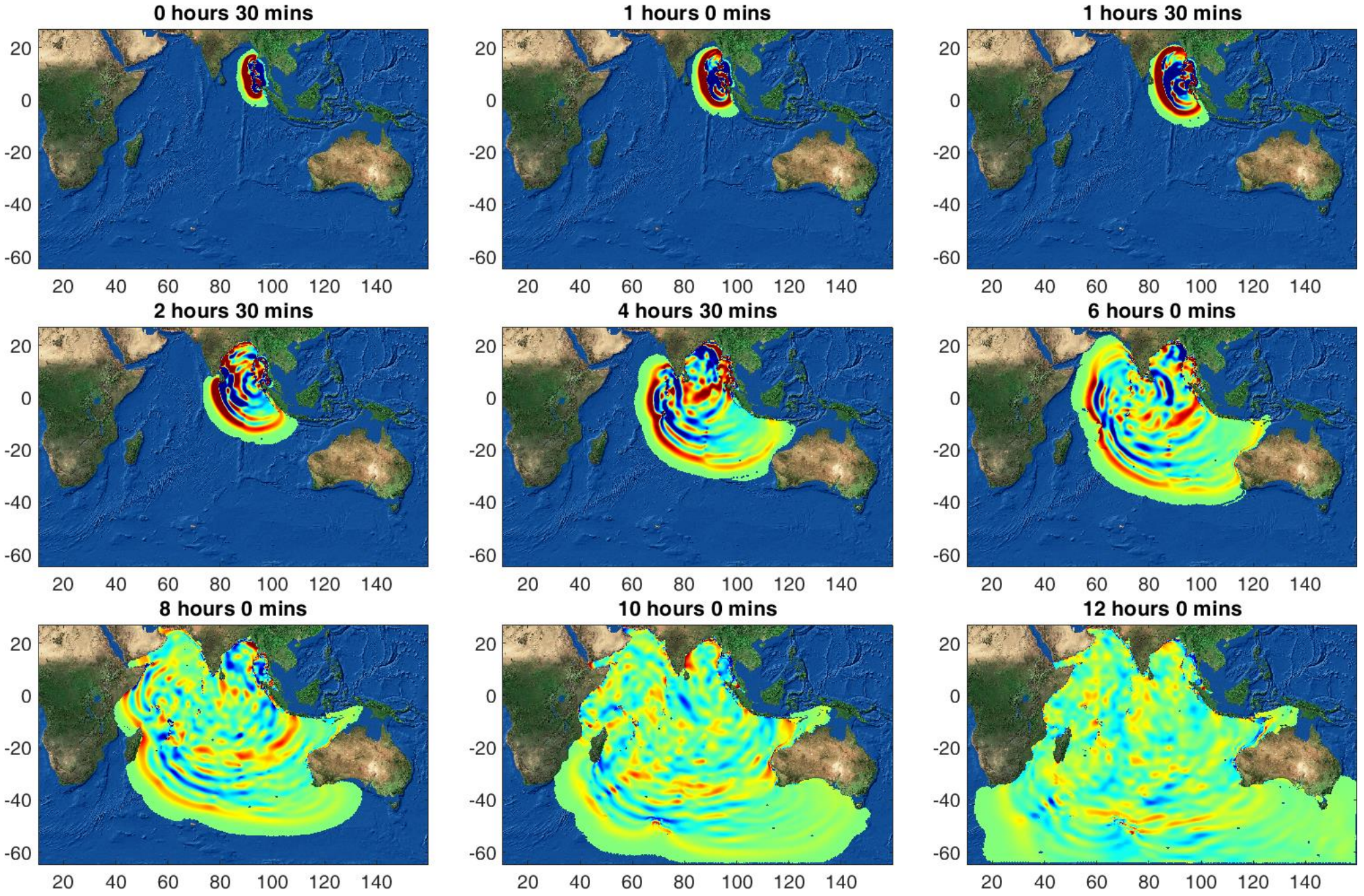


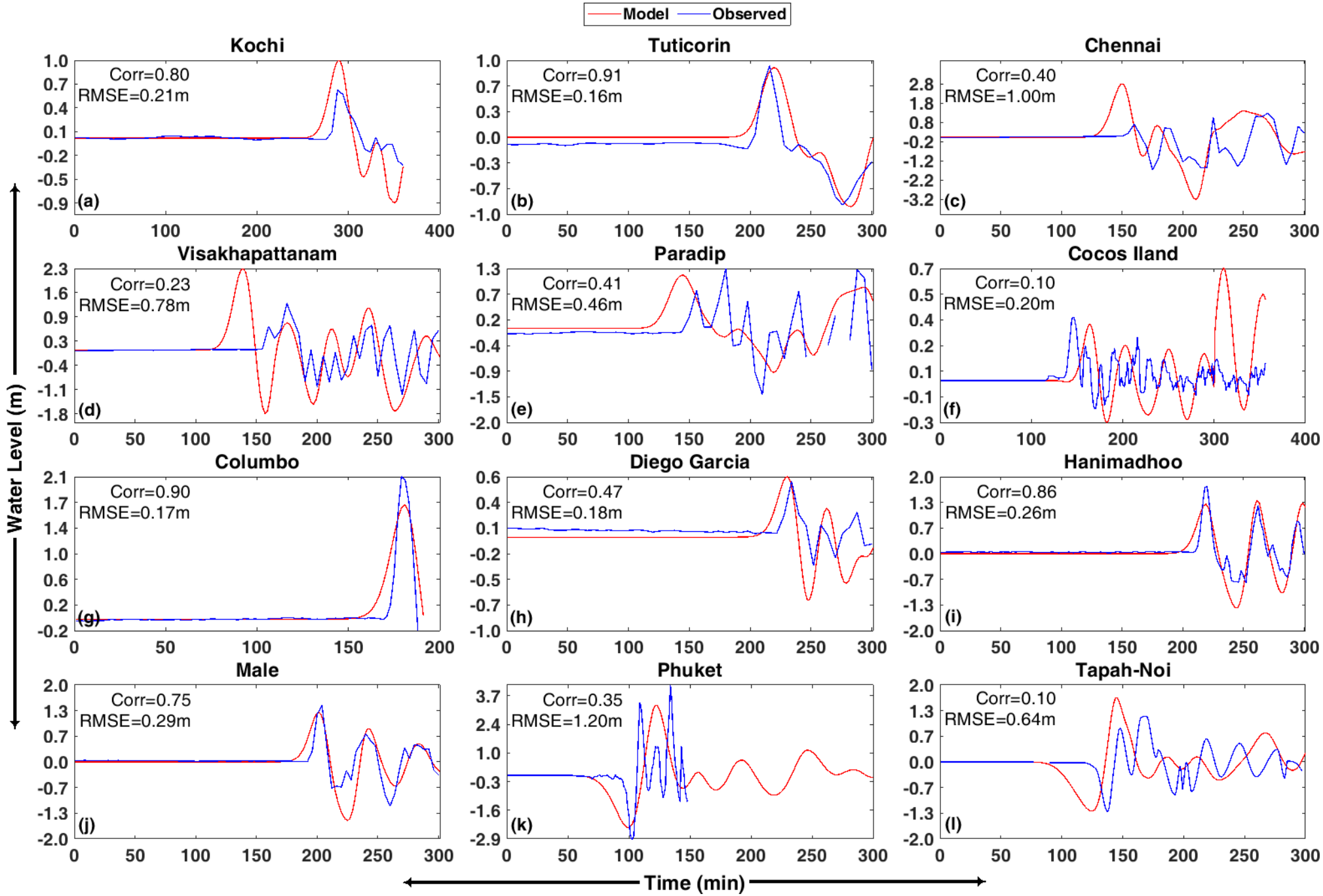
Computed initial deformation due to December 26, 2004, Great Sumatra Earthquake

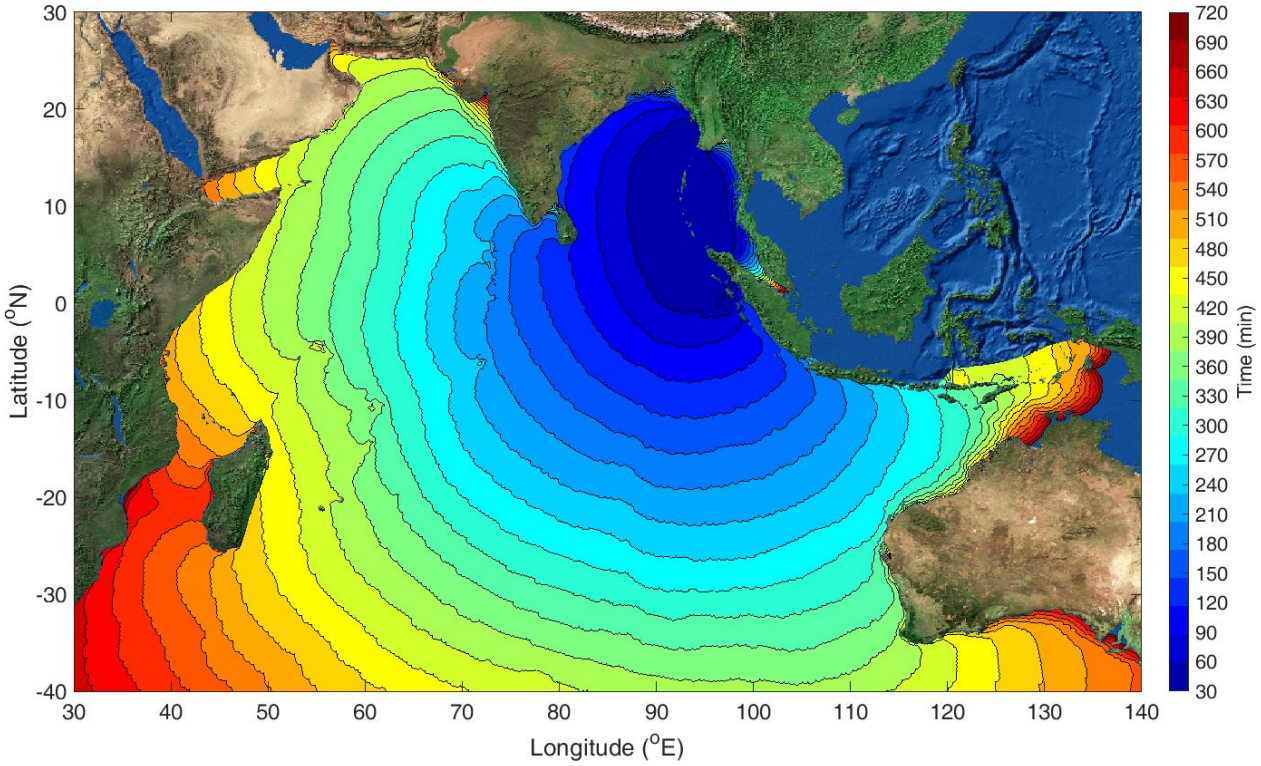
Parameters	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
x_o (longitude)	94.57	93.90	93.21	92.60	92.87
y_o(latitude)	3.83	5.22	7.41	9.70	11.70
d (km)	25	25	25	25	25
φ (degrees)	323	348	338	356	10
λ (degrees)	90	90	90	90	90
δ (degrees)	12	12	12	12	12
Δ (m)	18	23	12	12	12
L (km)	220	150	390	150	350
W (km)	130	130	120	95	95

Earthquake fault parameters of December 26, 2004 Great Sumatra Earthquake used to compute initial deformation
(Source: Grilli et al., 2007)

Propagation

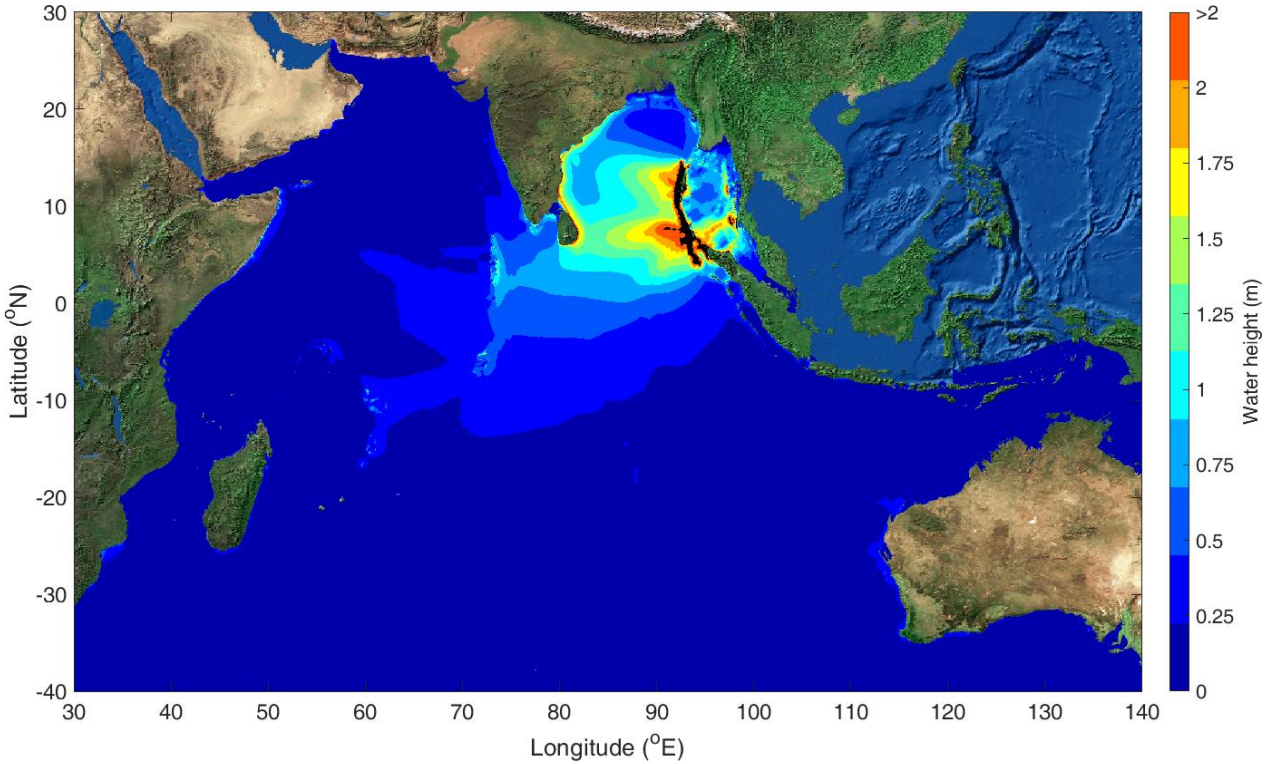


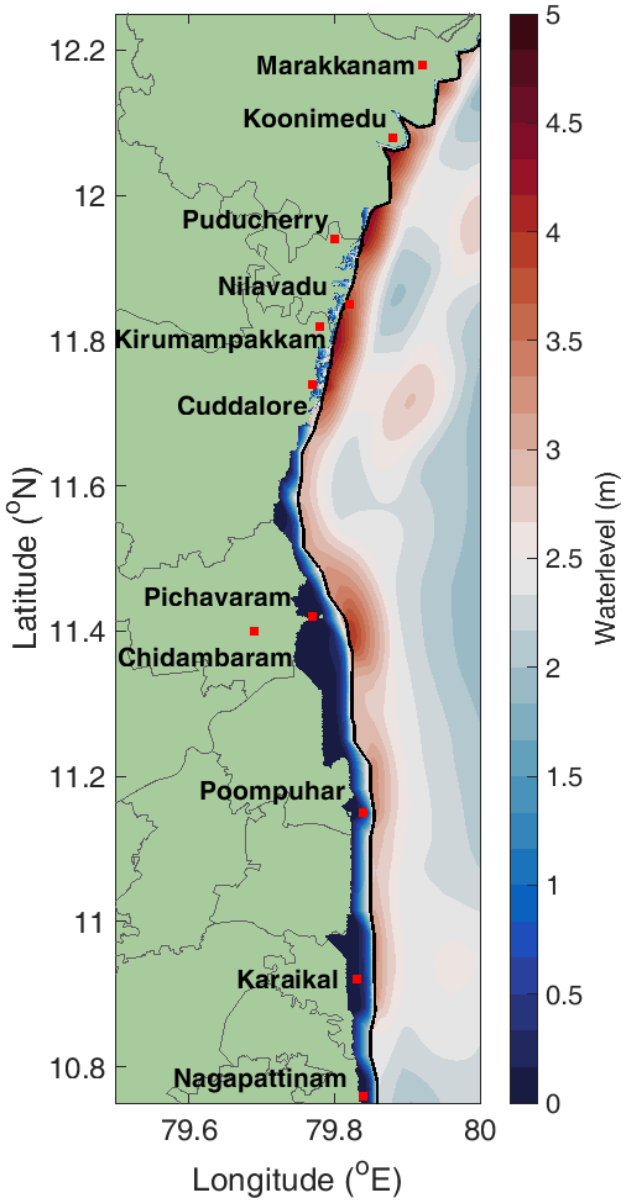

Model
Observed
Kochi
Corr=0.80
RMSE=0.21m
(a)
Tuticorin
Corr=0.91
RMSE=0.16m
(b)
Chennai
Corr=0.40
RMSE=1.00m
(c)
Visakhapattanam
Corr=0.23
RMSE=0.78m
(d)
Paradip
Corr=0.41
RMSE=0.46m
(e)
Cocos Iland
Corr=0.10
RMSE=0.20m
(f)
Columbo
Corr=0.90
RMSE=0.17m
(g)
Diego Garcia
Corr=0.47
RMSE=0.18m
(h)
Hanimadhoo
Corr=0.86
RMSE=0.26m
(i)
Male
Corr=0.75
RMSE=0.29m
(j)
Phuket
Corr=0.35
RMSE=1.20m
(k)
Tapah-Noi
Corr=0.10
RMSE=0.64m
(l)
Water Level (m)
Time (min)



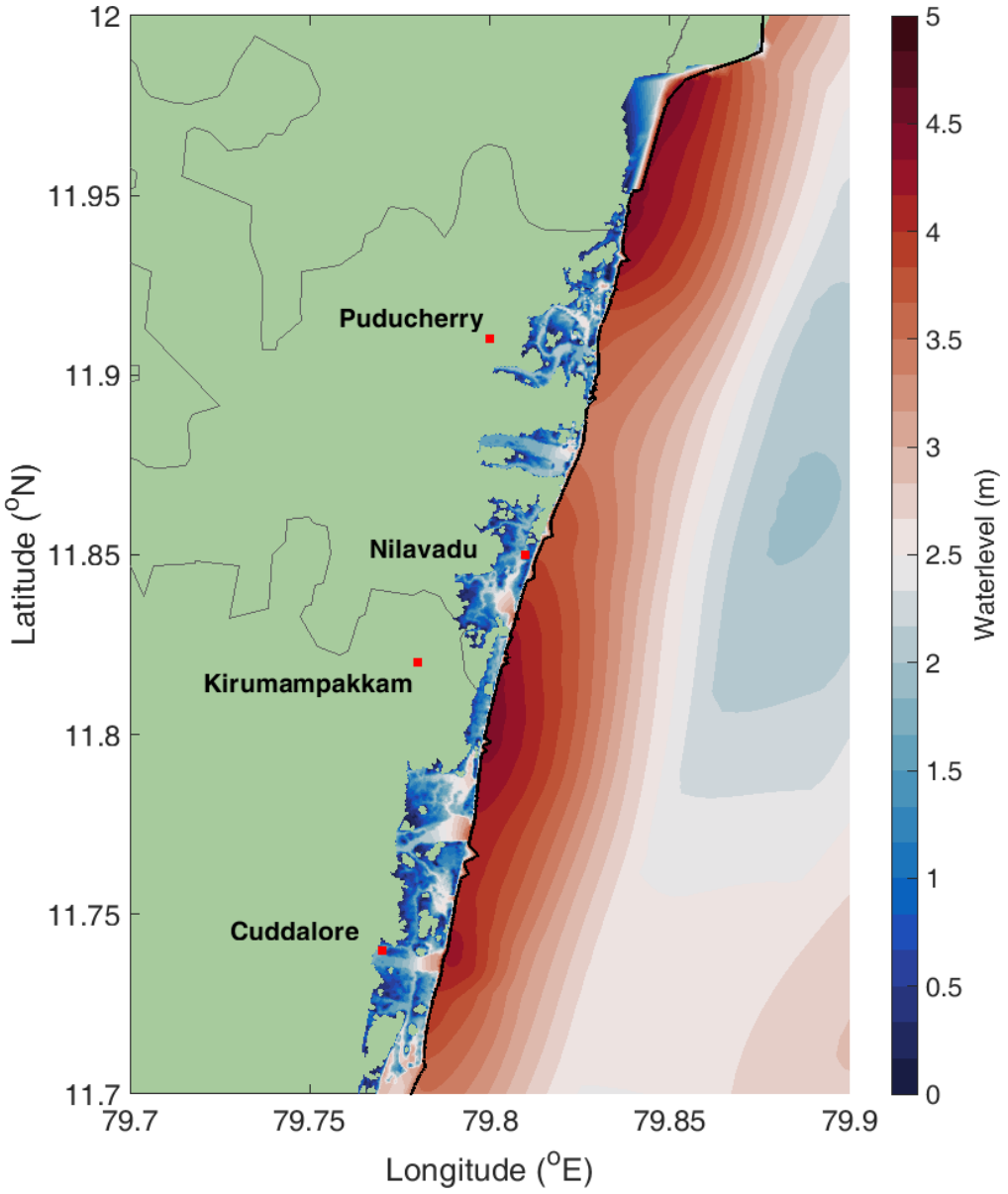
Travel time contours of tsunami wave associated with 26th December 2004 Sumatra Earthquake.

Directivity Plot (Wave height in meters)



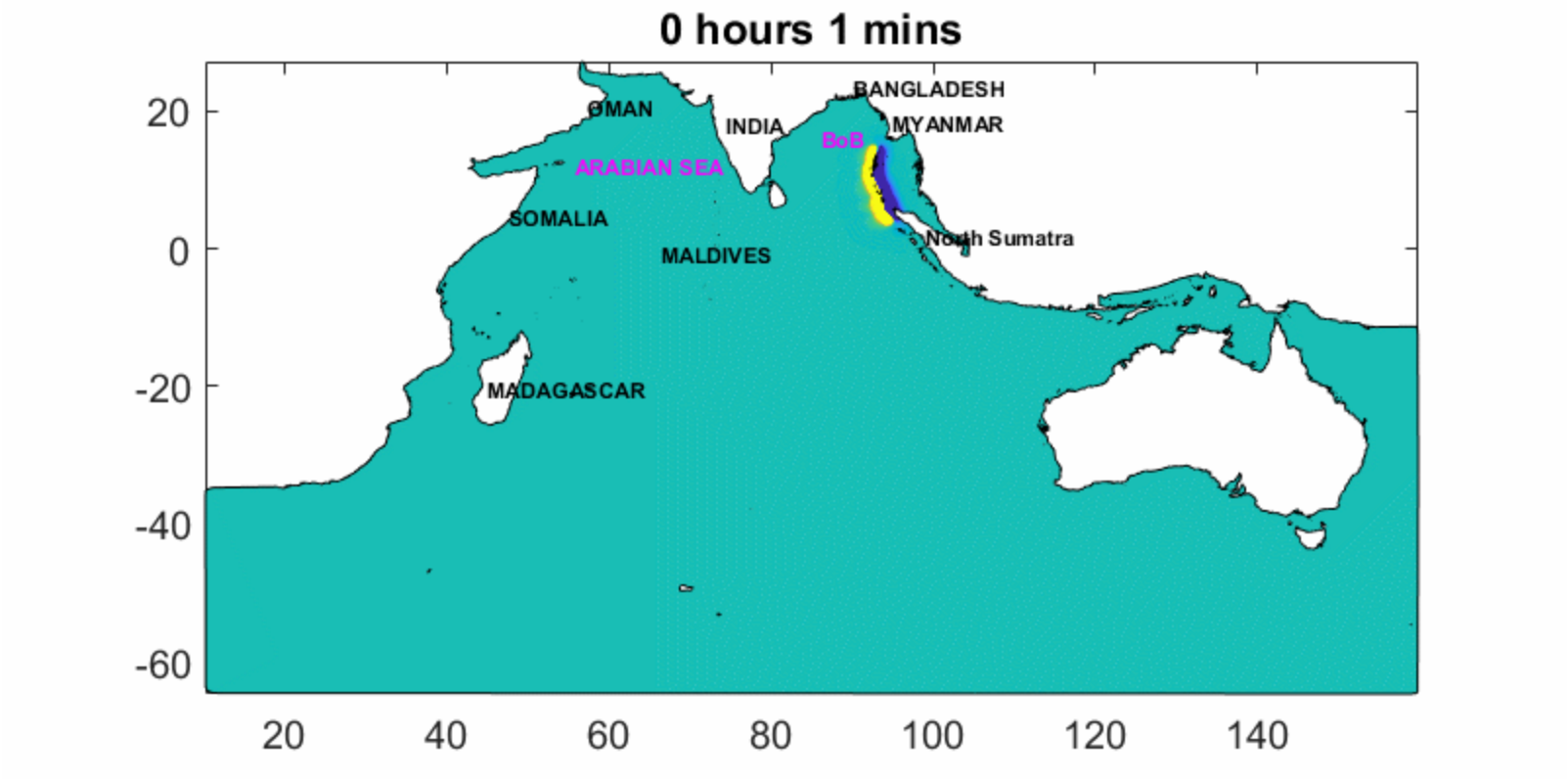


Spatial depiction of inundation extent along the coastal region of southern Tamil Nadu

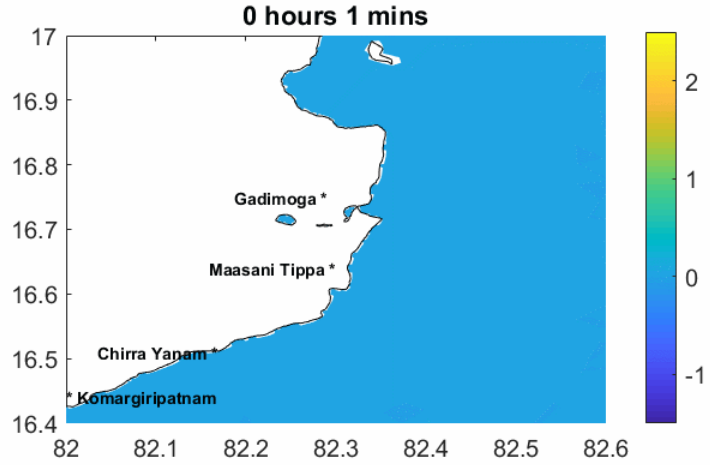


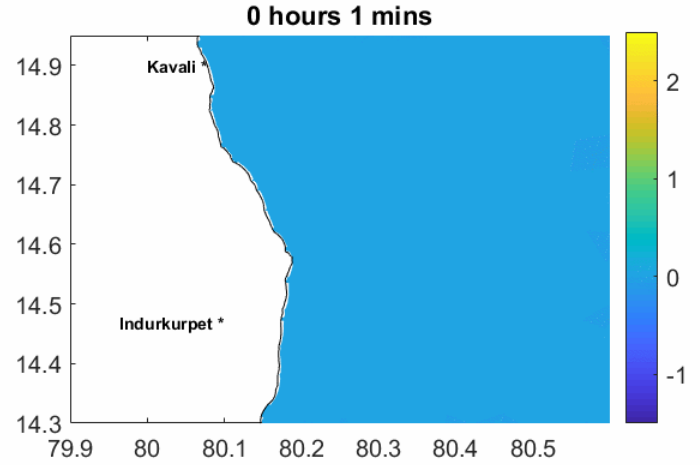
Enlarged portion of depicting inundation where the merged bathymetry and topography data were used

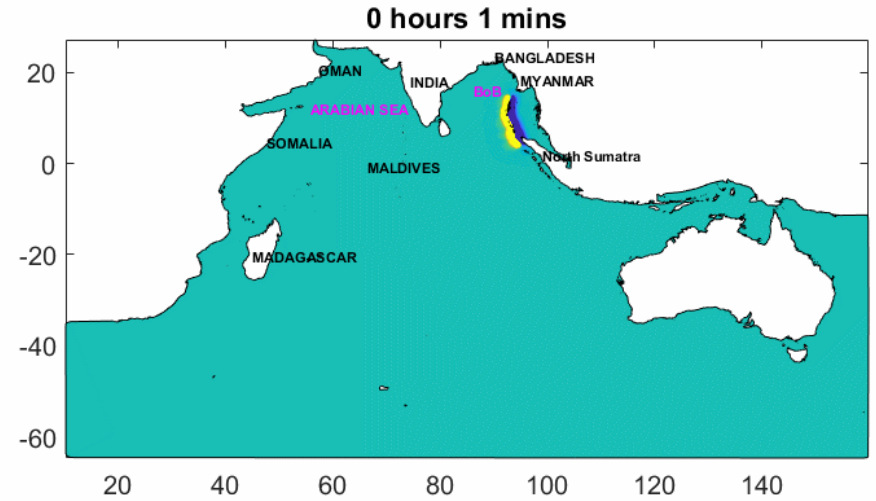
Computed tsunami propagation due to December 26, 2004 Great Sumatra Earthquake

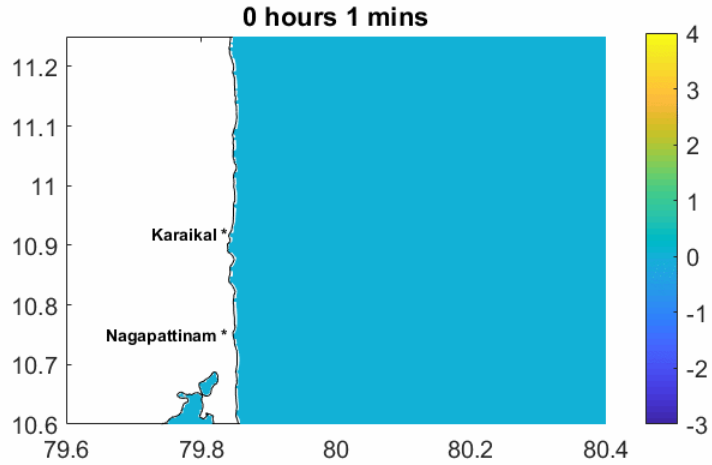


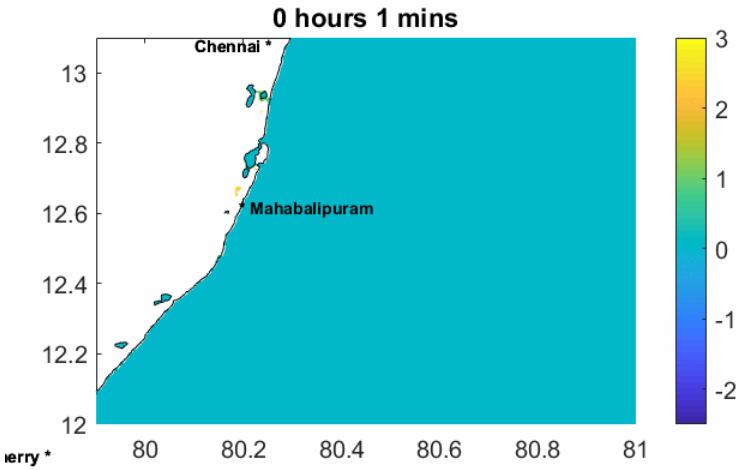
Simulation length	12 hr
CPU time	6 min
No of processors	480


0 hours 1 mins
Gadimoga *
Maasani Tippa *
Chirra Yanam *
* Komargiripatnam


0 hours 1 mins
Kavali *
Indurkurpet *


0 hours 1 mins
OMAN
INDIA
BANGLADESH
MYANMAR
BoB
ARABIAN SEA
SOMALIA
MALDIVES
North Sumatra
MADAGASCAR


0 hours 1 mins
Karaikal *
Nagapattinam *


0 hours 1 mins
Chennai *
Mahabalipuram