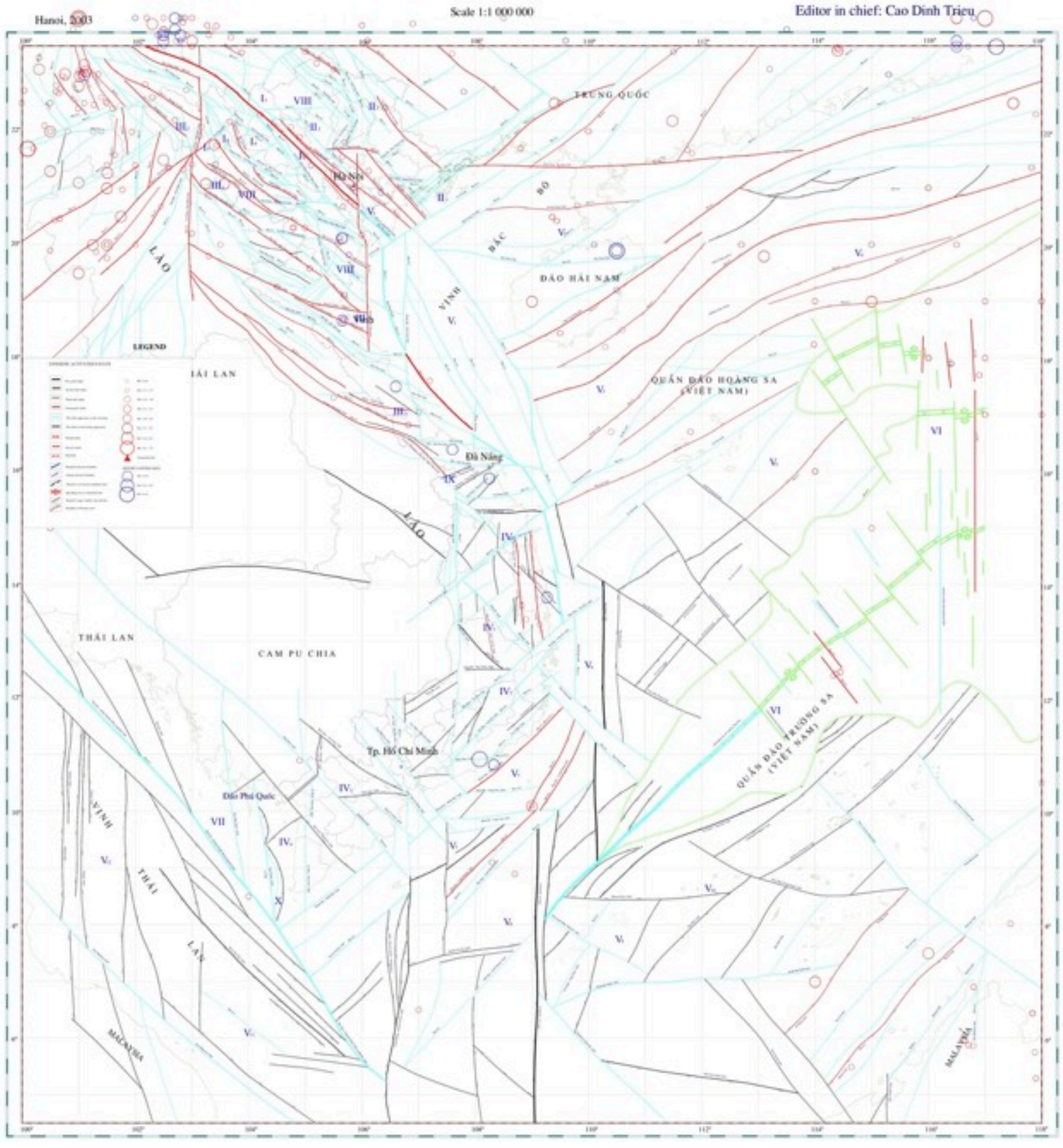
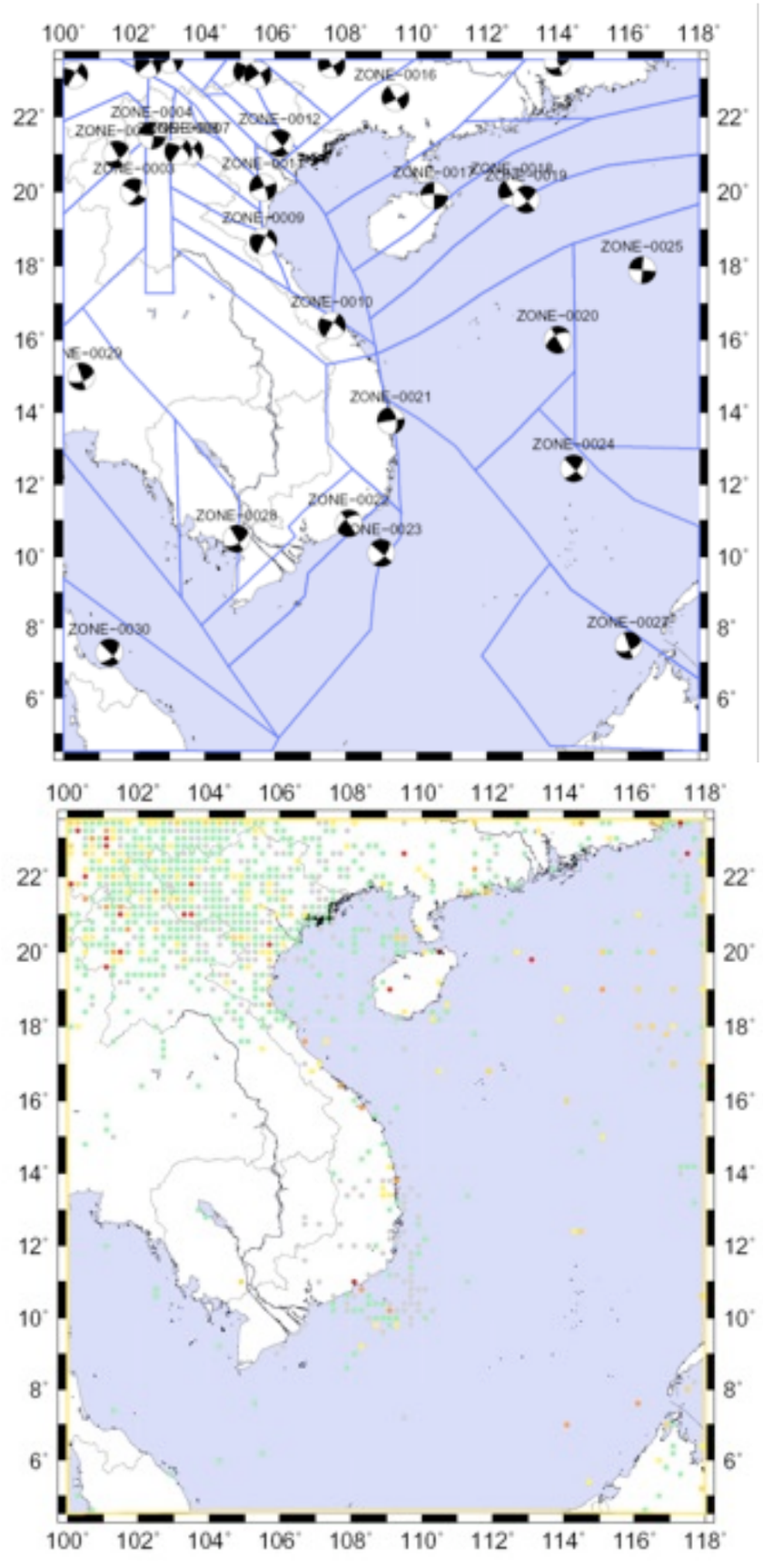
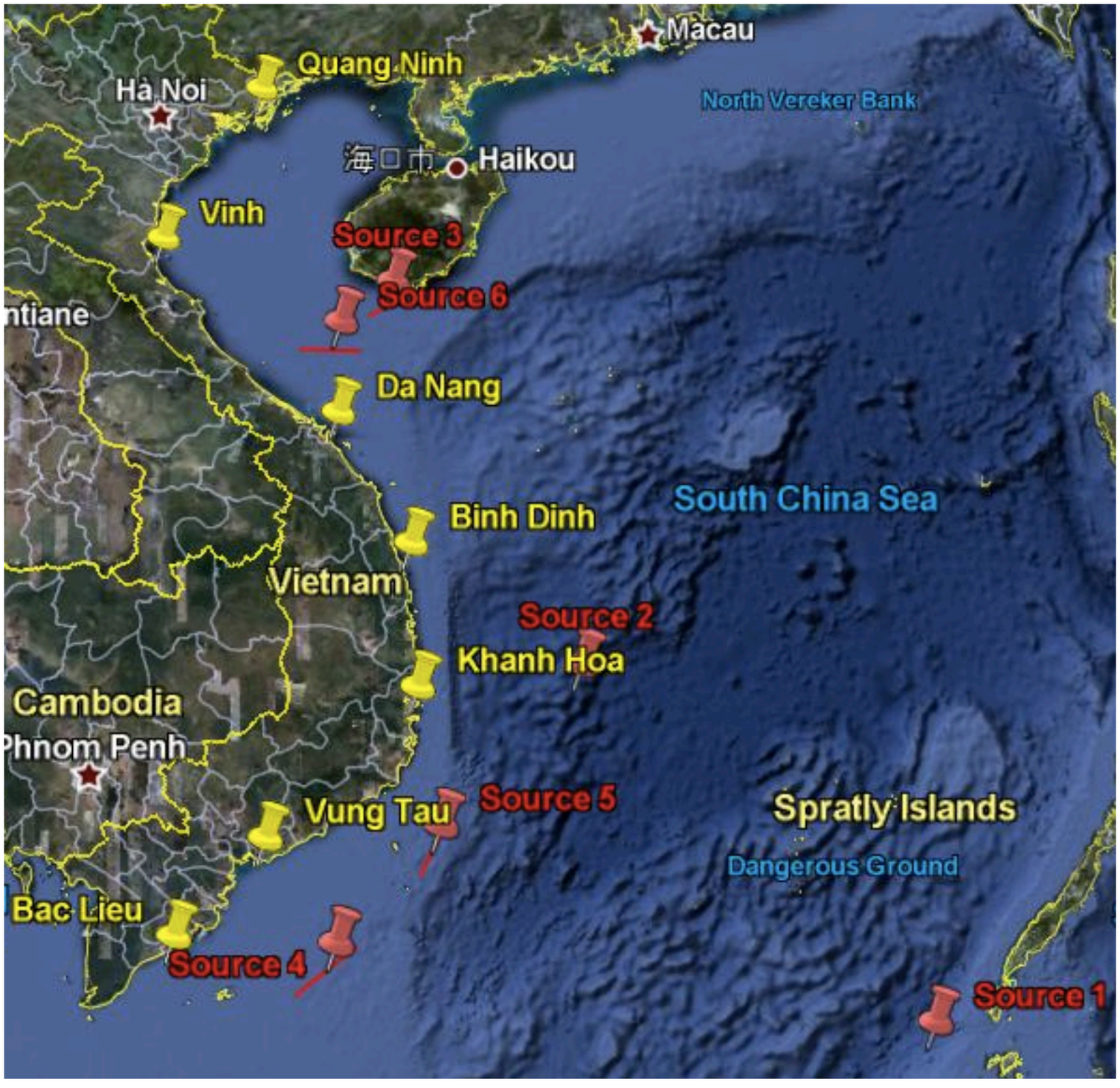
Seismotectonic map of Vietnam





Vietnam

Tsunami scenarios for the Vietnam's coasts

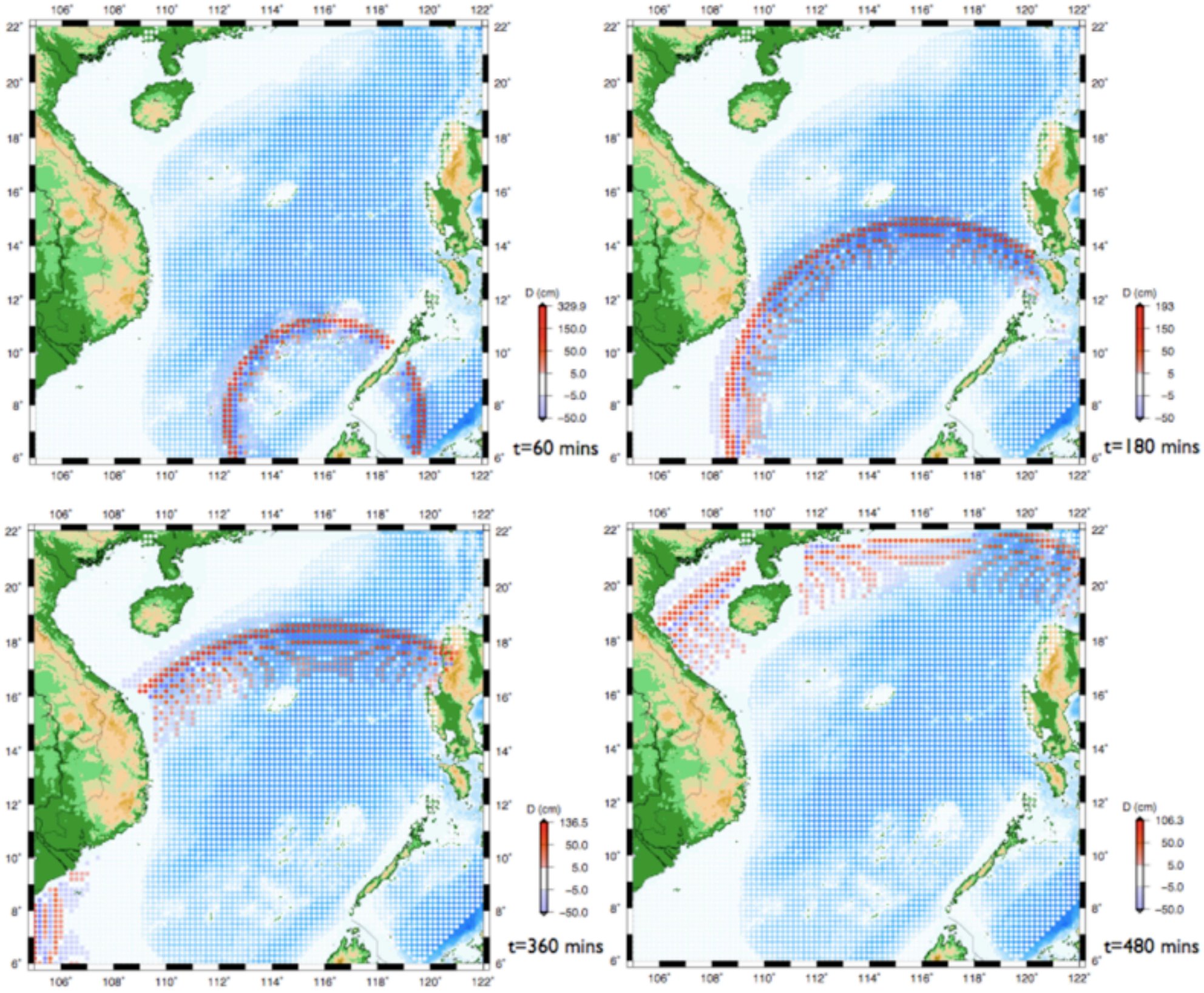


Map of the Southern Chinese Sea,

with the locations of the six selected tsunamigenic seismic sources (the red pins correspond to the epicenters),

and of the seven selected receiver sites (yellow pins) along the Vietnam coasts.

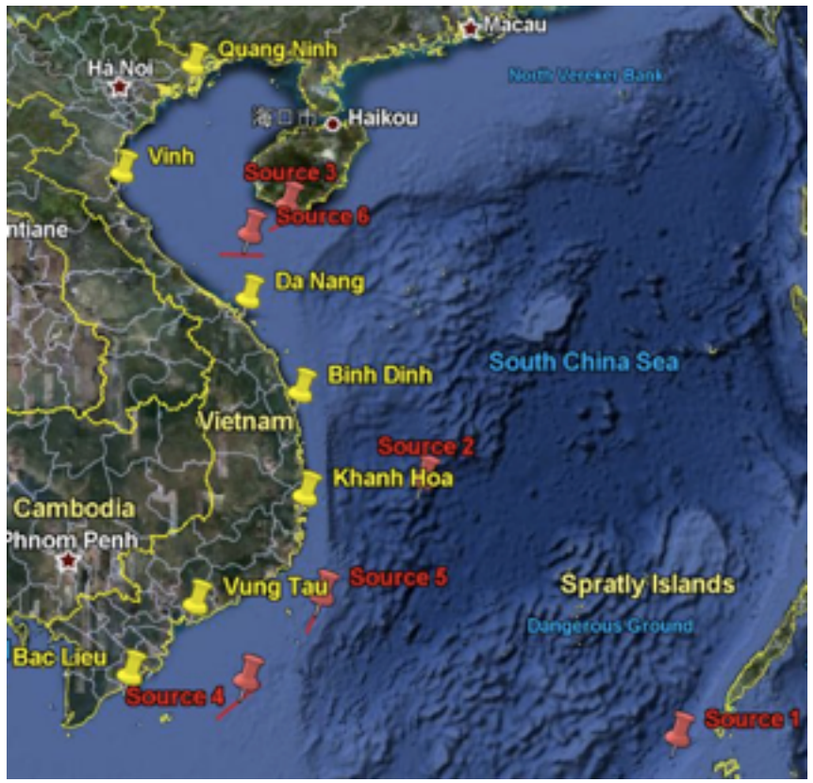
Tsunami computation - Snapshots for S1



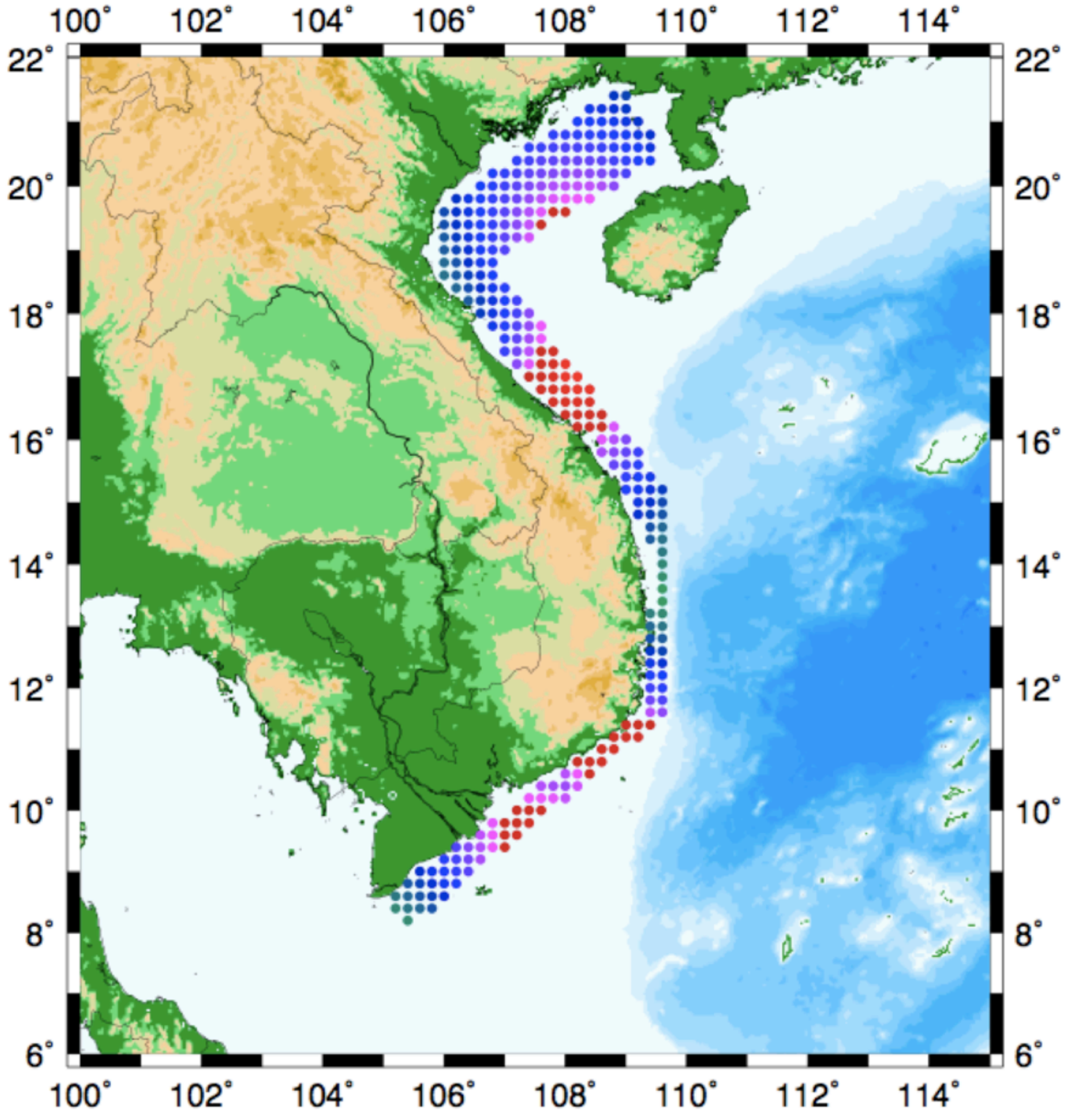
Vietnam

Snapshots of the tsunami wave height for a Mw=8.0 event located at Source 1 position

Tsunami computations - M_w=7.0

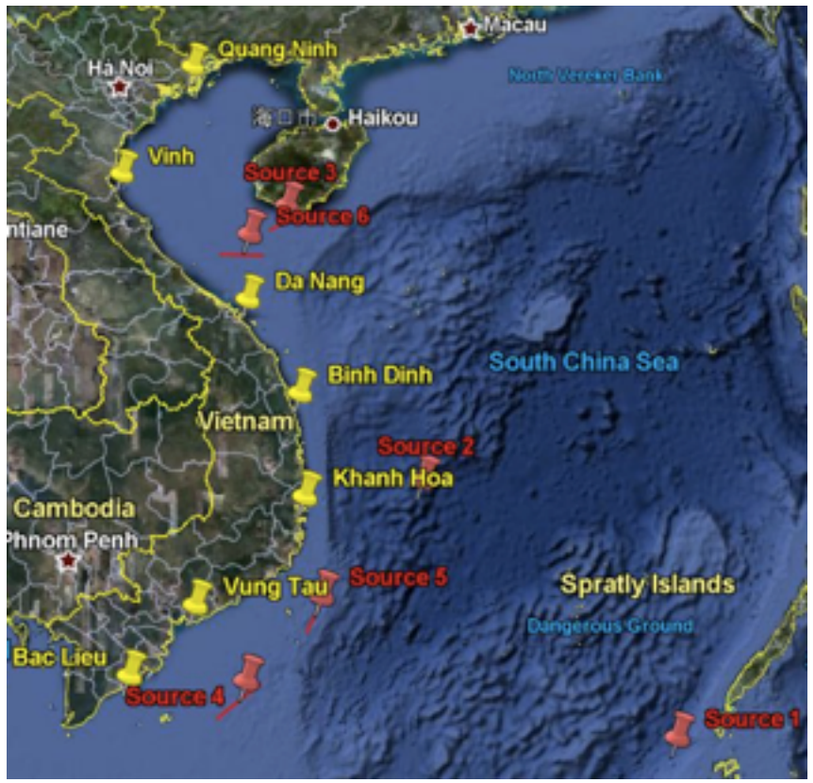


Distribution of the maximum positive tsunami wave heights along the Vietnam coasts computed considering the six sources for Mw=7.0

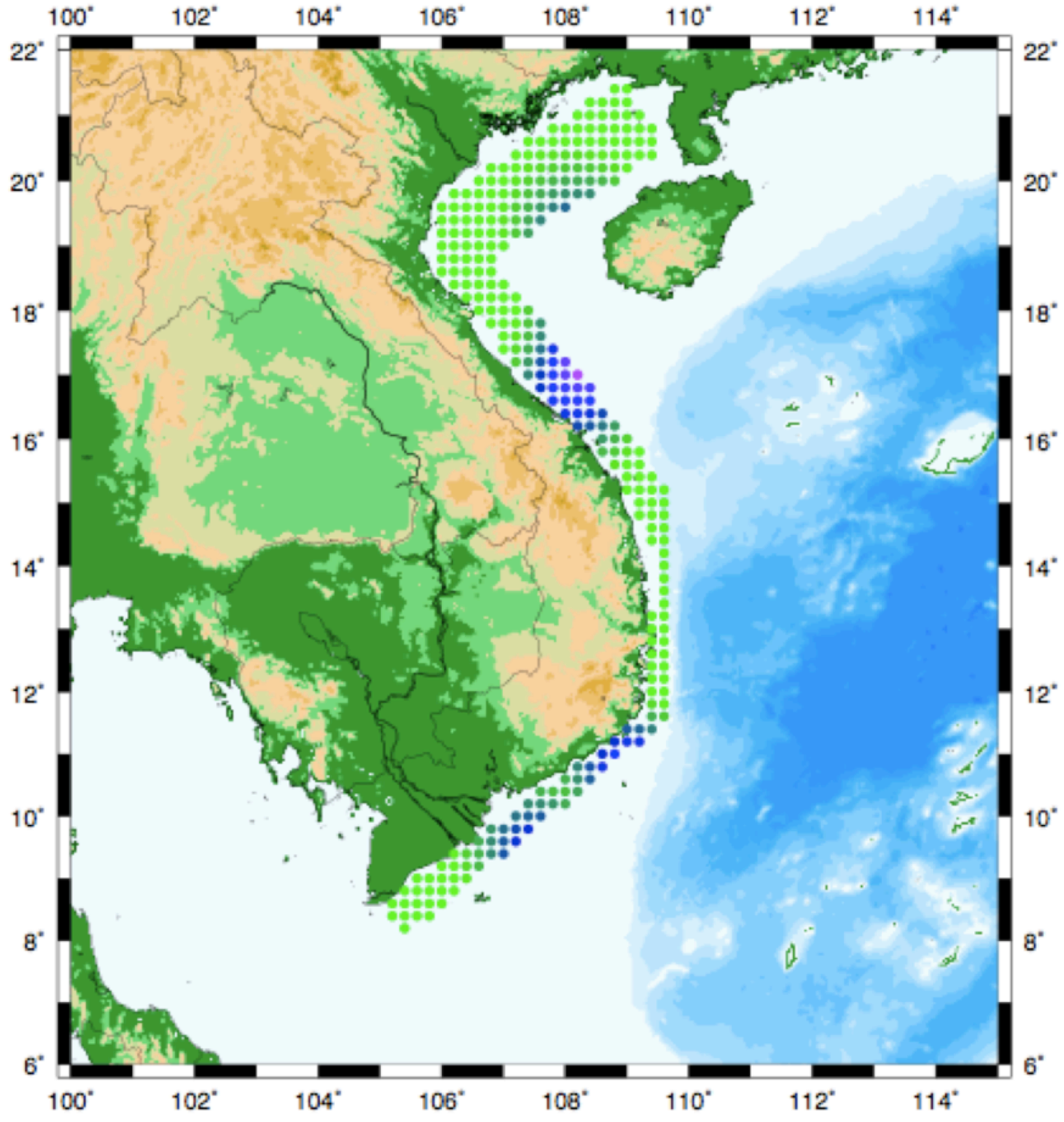


Vietnam

Tsunami computations - M_w=7.5

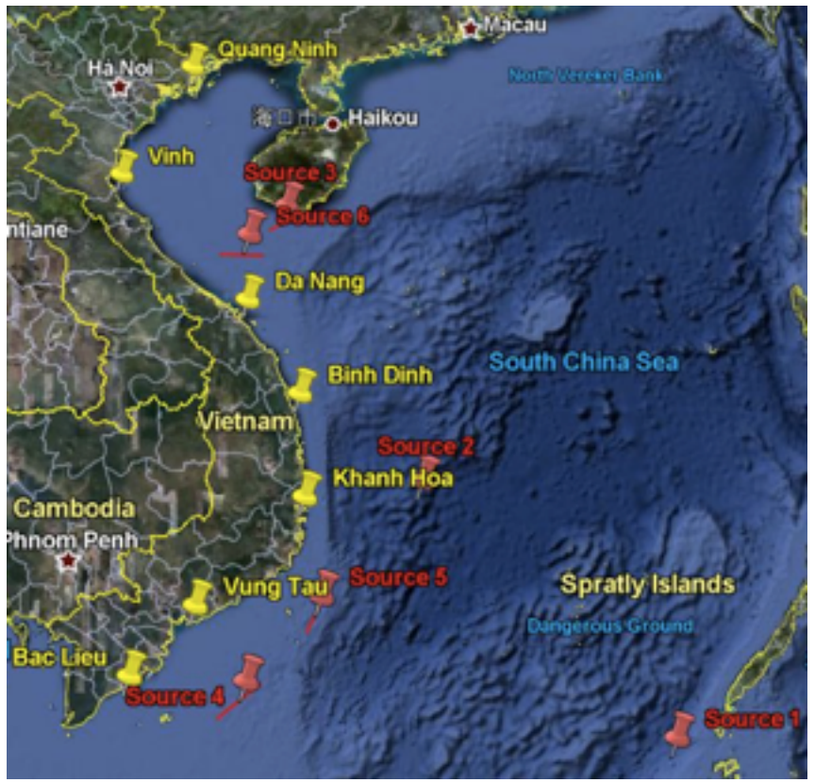


Distribution of the maximum positive tsunami wave heights along the Vietnam coasts computed considering the six sources for Mw=7.5

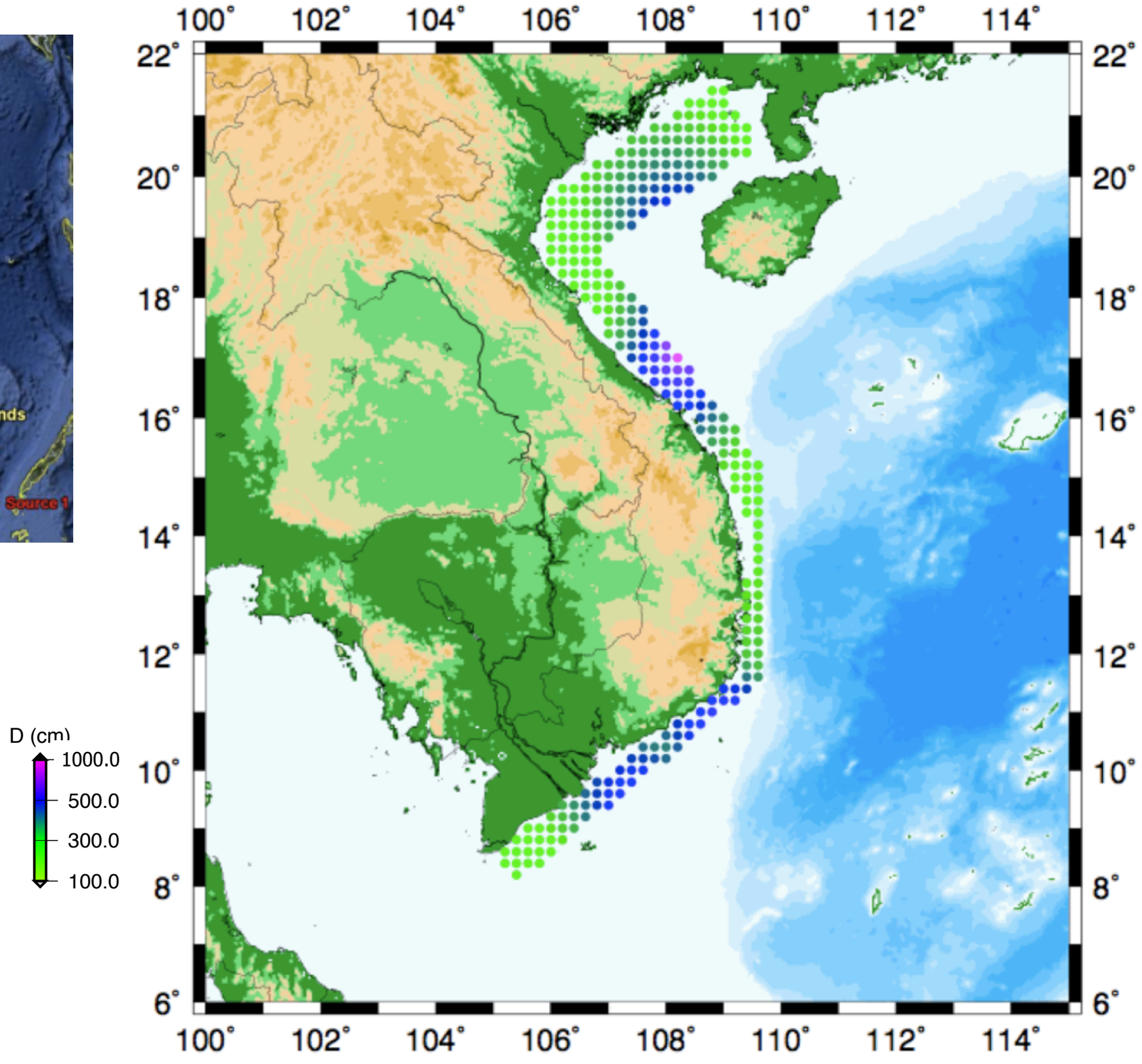


Vietnam

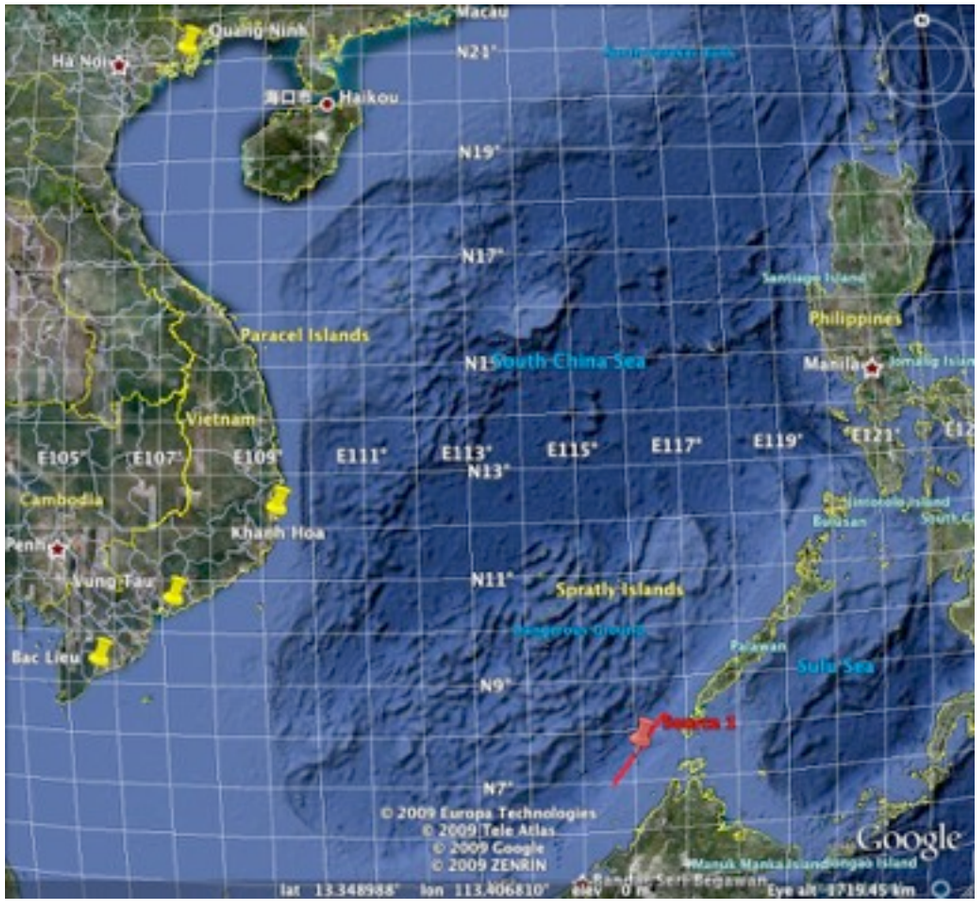
Tsunami computation - M_w=8.0

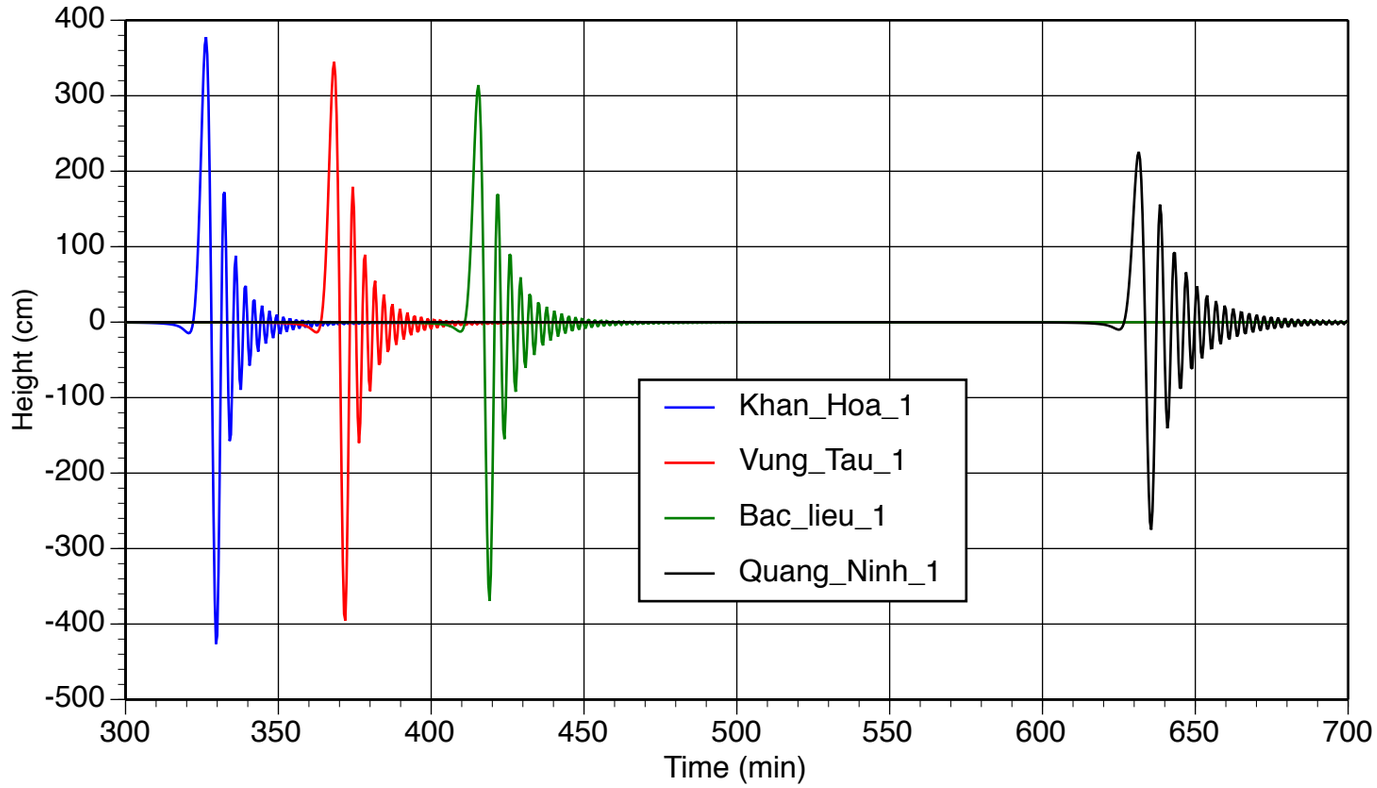


Distribution of the maximum positive tsunami wave heights along the Vietnam coasts computed considering the six sources for Mw=8.0



Tsunami scenarios - Source 1



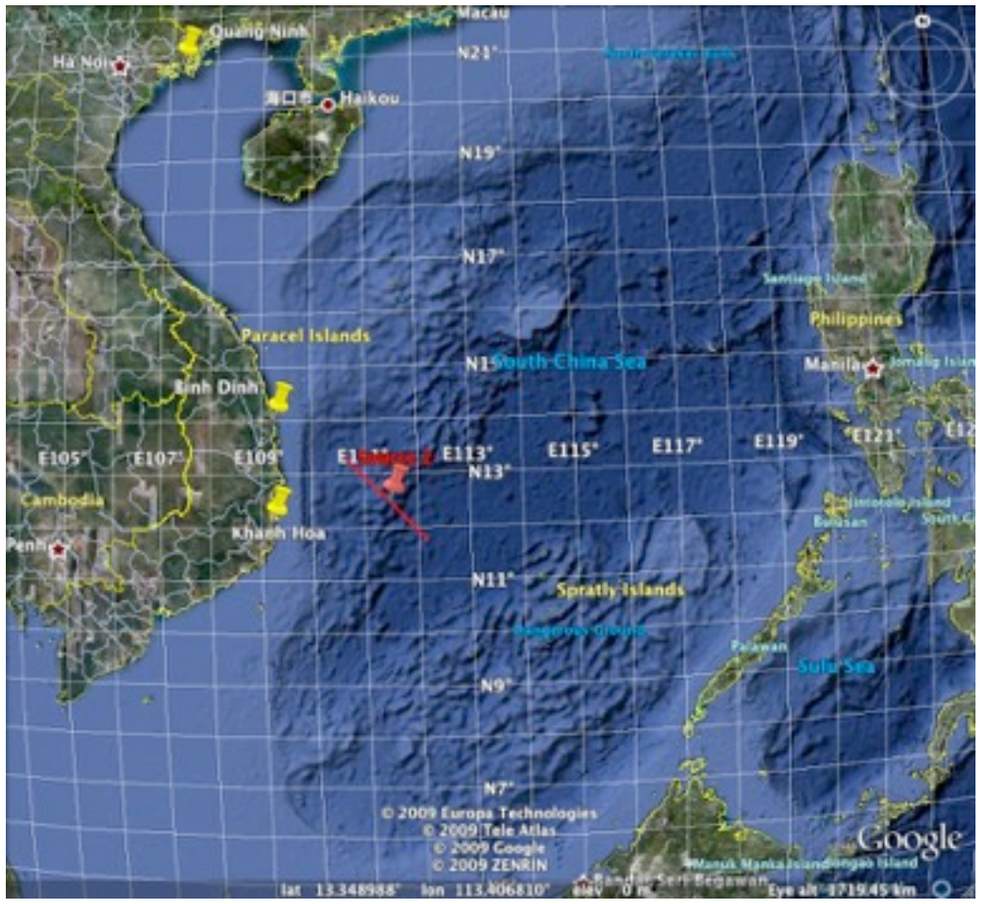


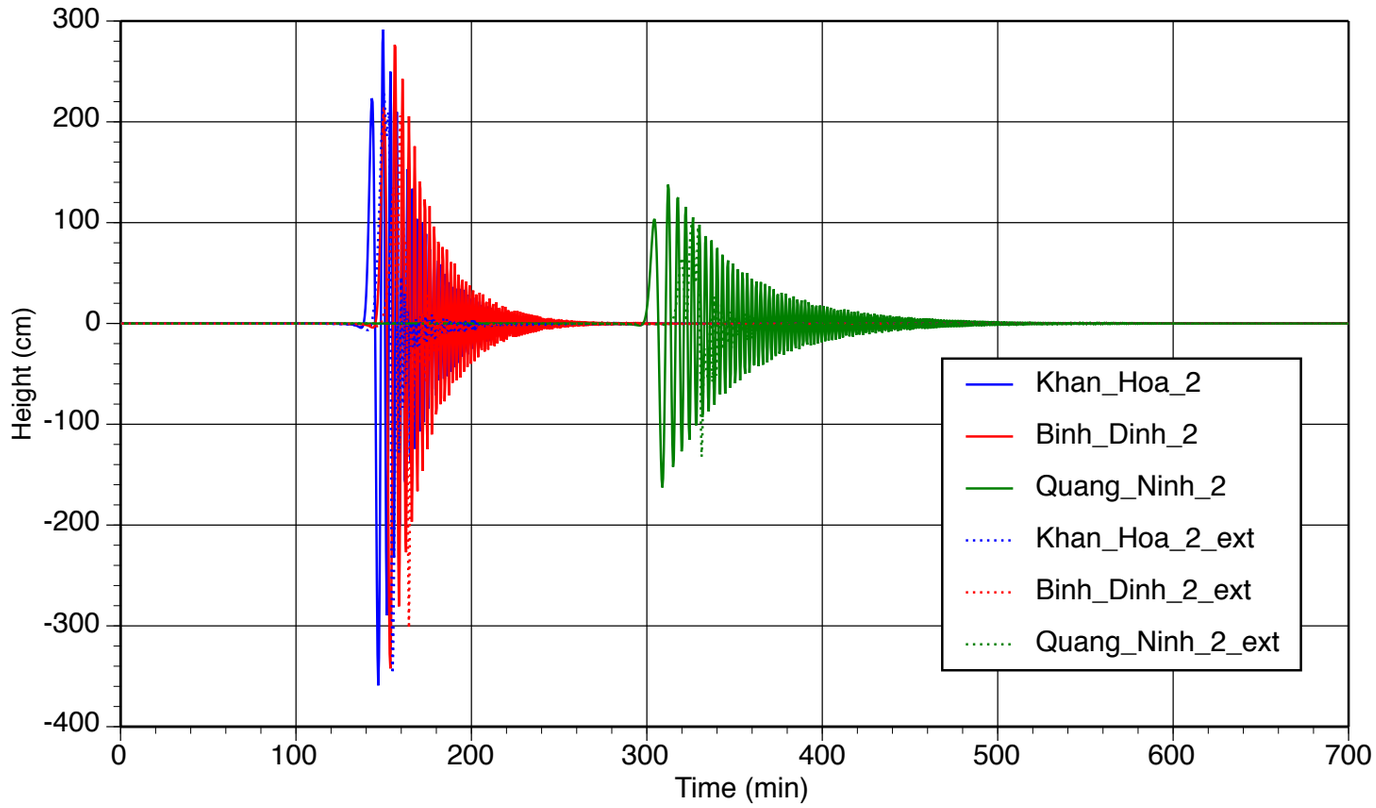
Synthetic tsunamigrams computed at the different sites for Source 1 scenario

Site	Khan Hoa	Vung Tau	Bac Lieu	Quang Ninh
Distance (km)	911	1028	1160	1736
Tmax (min)	205	229	261	397
Tmax − Tmin(min)	6	6	6	7
Strike max (°)	30	15	7.5	60
Max(cm) M=7	16	14	13	10
Max(cm) M=7.5	93	84	76	56
Max(cm) M=8	378	345	314	225

Vietnam

Tsunami scenarios - Source 2

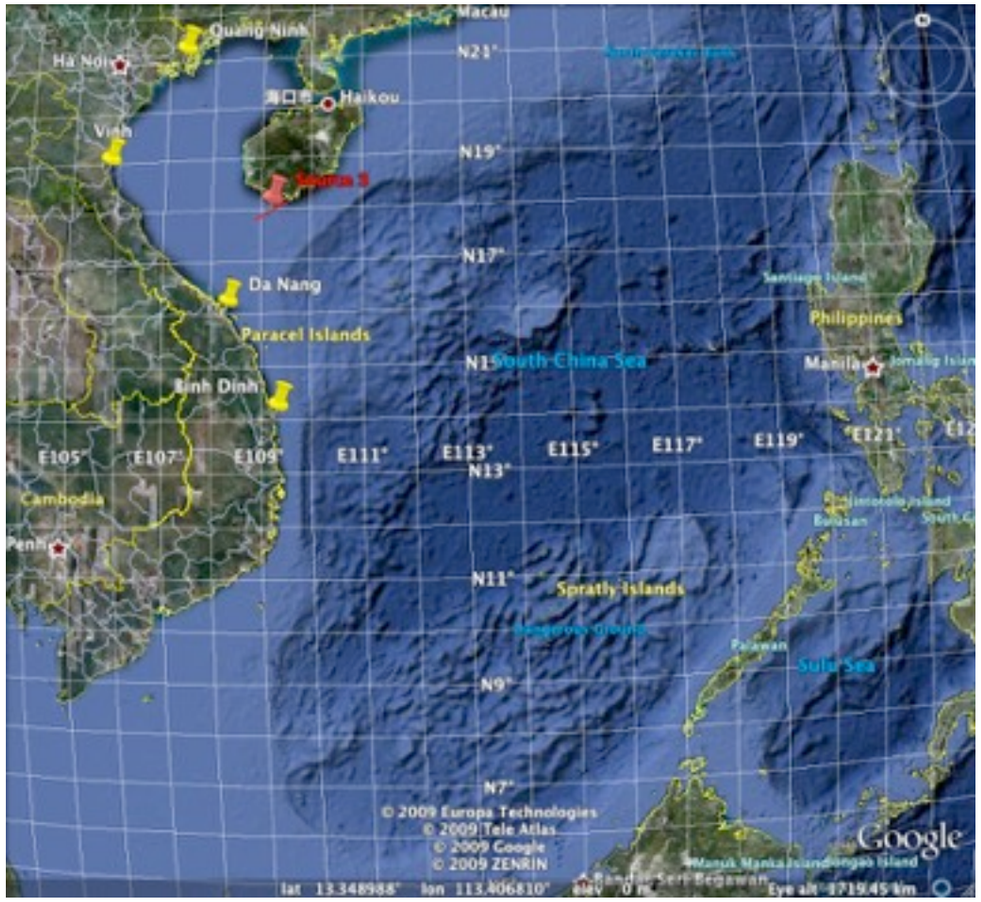


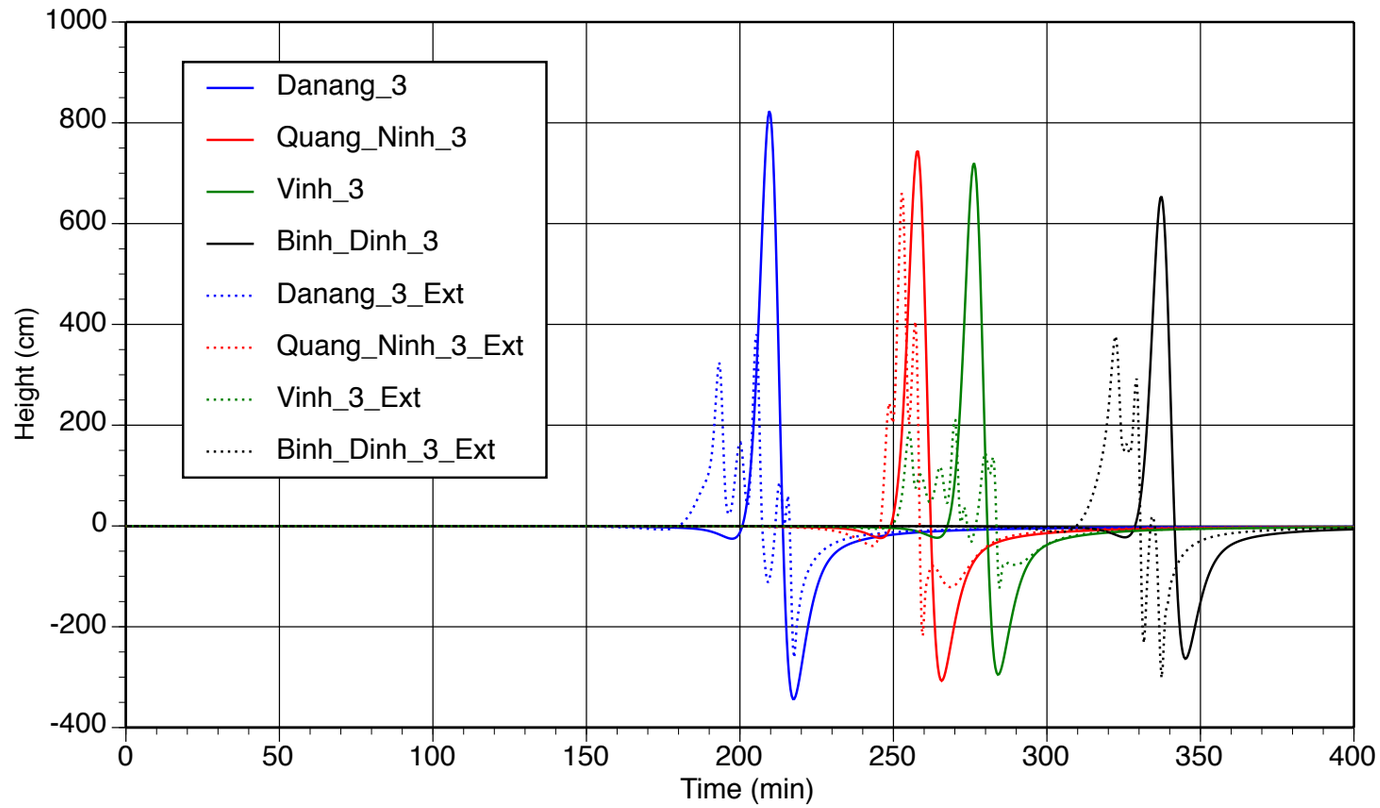


Synthetic tsunamigrams computed at the different sites for Source 2 scenario

Site	Khan Hoa	Bin Dinh	Quang Ninh
Distance (km)	571	598	1214
Tmax (min)	150	156	312
Tmax – Tmin(min)	3	3	4
Strike max (°)	0	15	52.5
Max(cm) M=7	11	11	5
Max(cm) M=7.5	64	60	30
Max(cm) M=8	290	276	150

Tsunami scenarios - Source 3

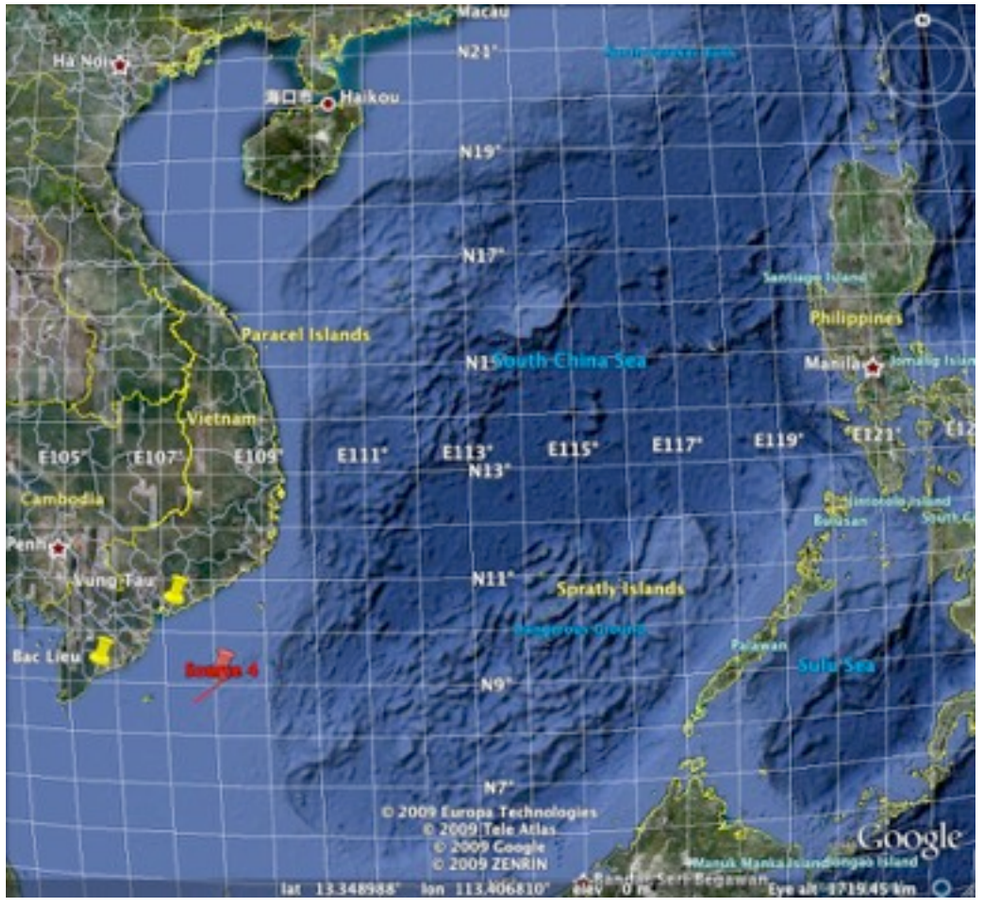


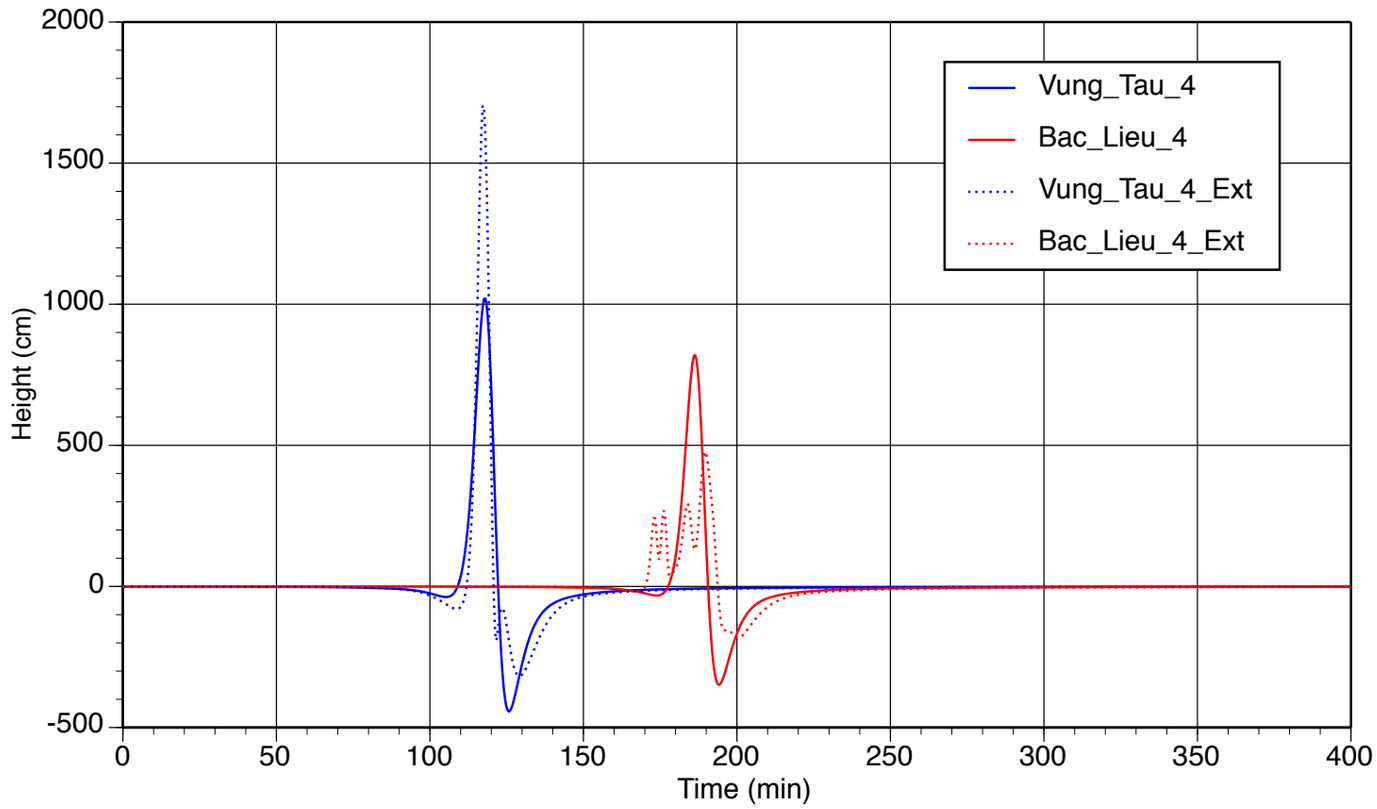


Synthetic tsunamigrams computed at the different sites for Source 3 scenario

Site	Da Nang	Quang Ninh	Vinh	Bin Dinh
Distance (km)	268	366	392	478
Tmax (min)	210	258	277	338
Tmax – Tmin(min)	12	13	12	12
Strike max (°)	120	52.5	0	90
Max(cm) M=7	56	50	49	44
Max(cm) M=7.5	314	285	276	250
Max(cm) M=8	823	744	720	654

Tsunami scenarios - Source 4



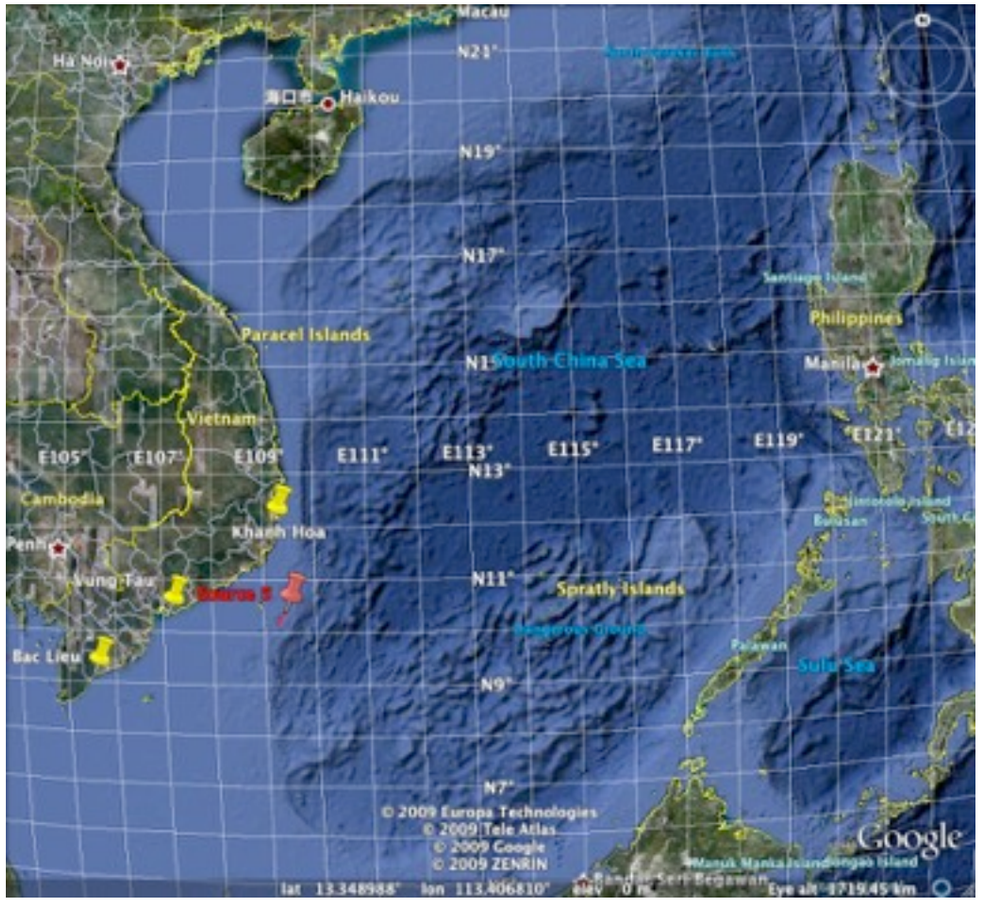


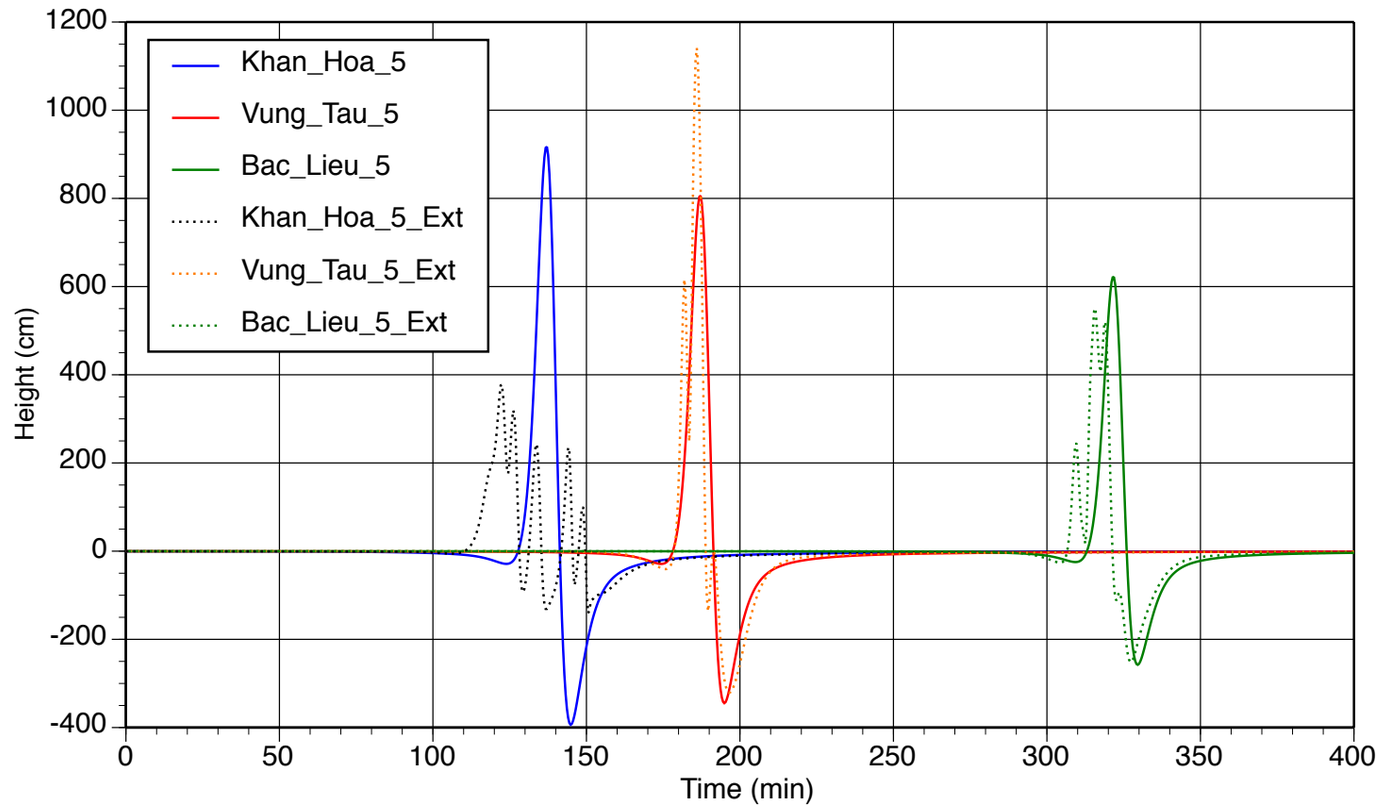
Synthetic tsunamigrams computed at the different sites for Source 4 scenario

Site	Vung Tau	Bac Lieu
Distance (km)	169	275
Tmax (min)	118	187
Tmax − Tmin(min)	13	13
Strike max (°)	60	0
Max(cm) M=7	68	54
Max(cm) M=7.5	384	308
Max(cm) M=8	1022	820

Vietnam

Tsunami scenarios - Source 5



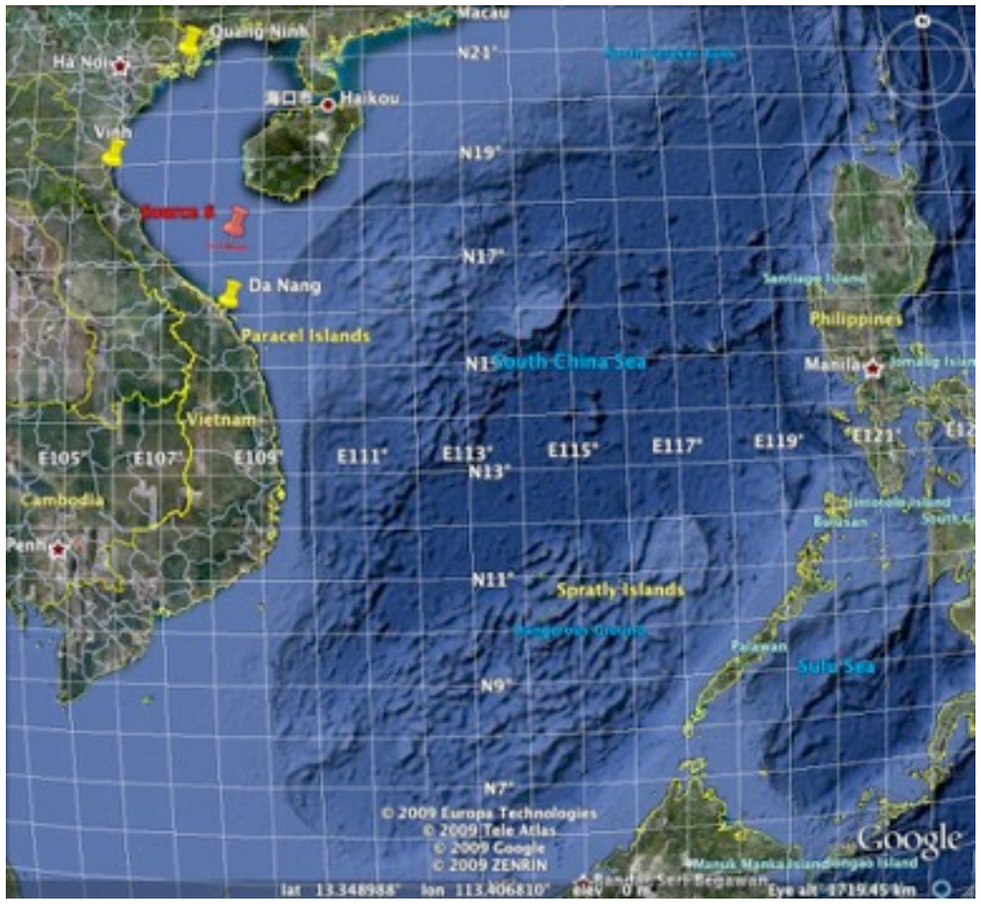


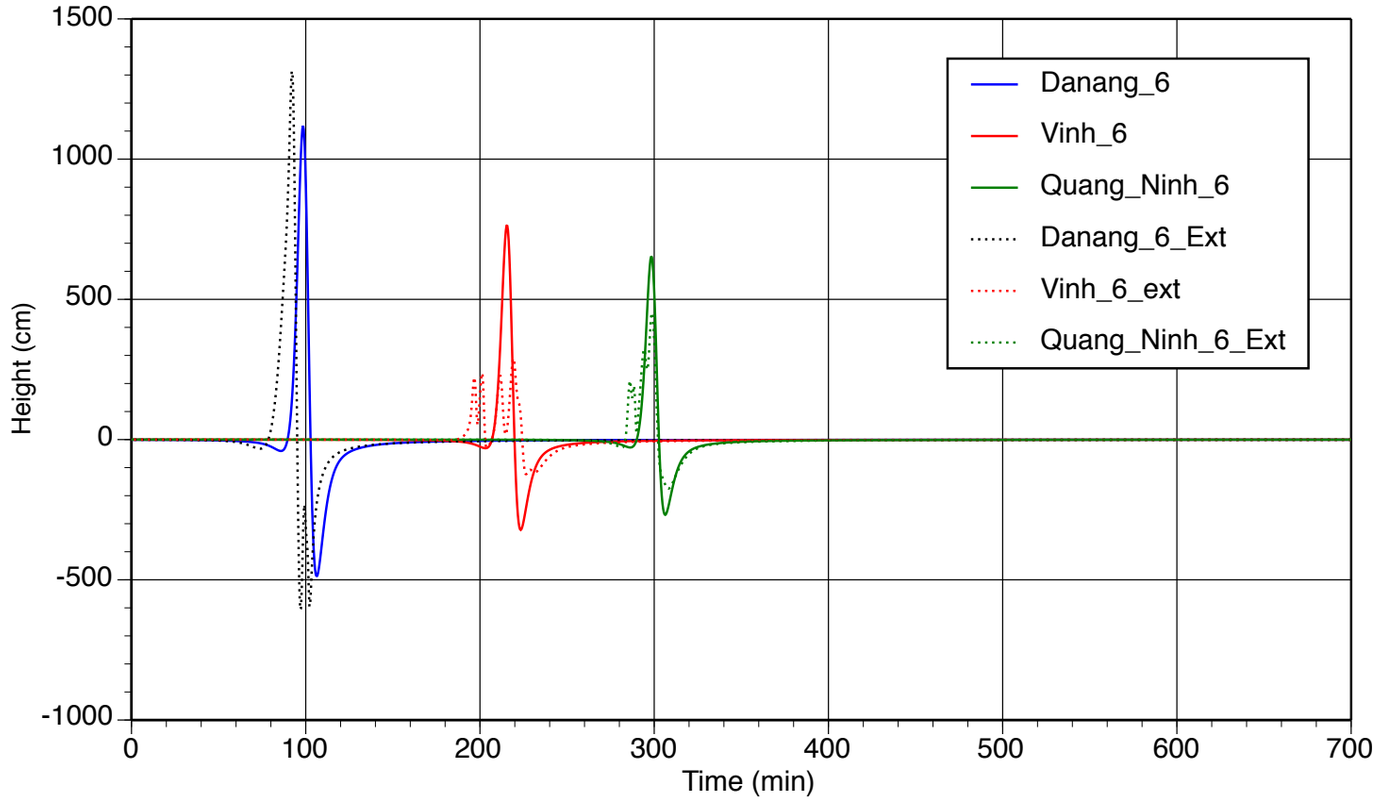
Synthetic tsunamigrams computed at the different sites for Source 5 scenario

Site	Khan Hoa	Vung Tau	Bac Lieu
Distance (km)	195	266	456
Tmax (min)	137	187	322
Tmax − Tmin(min)	13	13	13
Strike max (°)	60	0	157.5
Max(cm) M=7	61	54	42
Max(cm) M=7.5	342	305	235
Max(cm) M=8	917	806	622

Vietnam

Tsunami scenarios - Source 6





Synthetic tsunamigrams computed at the different sites for Source 6 scenario

Site	Da Nang	Vinh	Quang Ninh
Distance (km)	141	306	423
Tmax (min)	98	216	299
Tmax − Tmin(min)	13	13	13
Strike max (°)	90	30	75
Max(cm) M=7	74	51	43
Max(cm) M=7.5	419	287	243
Max(cm) M=8	1119	764	653

Remarks

- The shoaling and other amplification phenomena due to the local morphology, could increase that amplitude up to some factors, enough to cause small damages and inundations, specially if coinciding with the high tide or a sea storm.
- The larger is the focal depth the smaller is the maximum amplitude. According to the modal summation theory, when a source is located deeper inside the Earth interior it is less efficient in exciting the high frequencies, so their contribute to the total displacement at the sea bottom is reduced. It follows that shallow earthquakes are more capable than deep ones to generate tsunamis.
- Increasing the epicentral distance, the maximum amplitude decreases, if we exclude local effects. This is due to the fact that the radiation pattern is attenuated by the geometrical spreading as we move the site far from the source.
- The water layer thickness affects amplitude in two ways: i) Where the depth of the liquid layer is thicker tsunami waves are faster and the geometrical spreading is more intense. ii) Sources set under a thinner water layer are less effective in generating tsunamis

Remarks

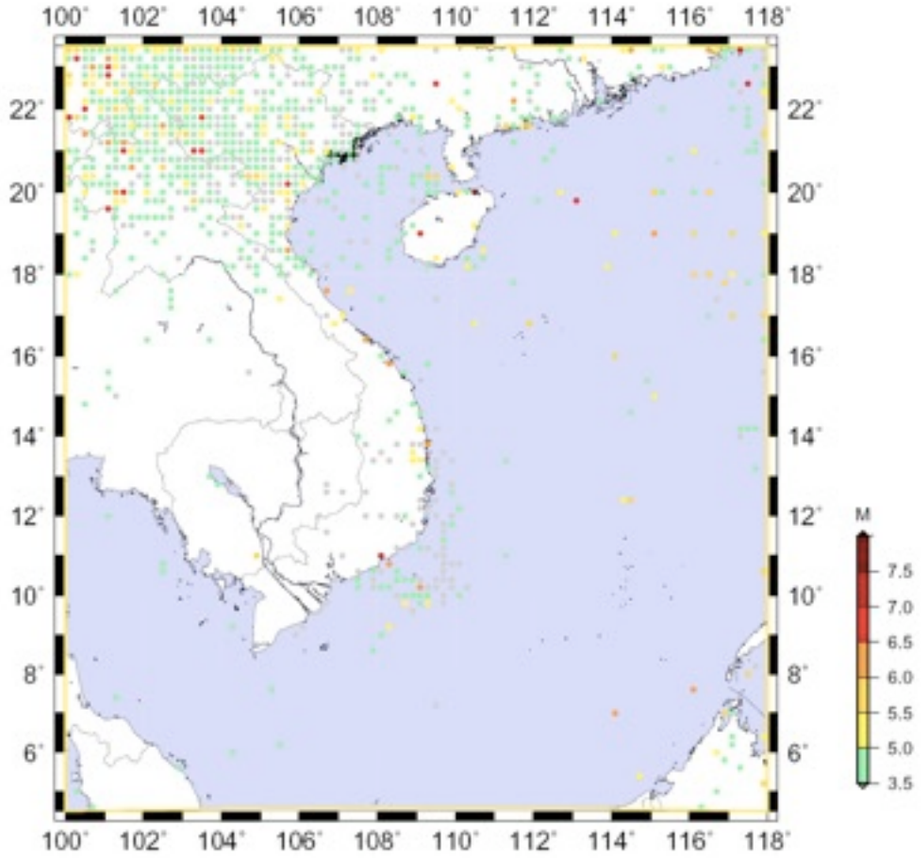
- Events with magnitude M=8.0 (which is nearly the maximum magnitude in many regions of the South China domain) could generate tsunamis with amplitudes of a few meters, in agreement with a number of historical events reported in the catalogues

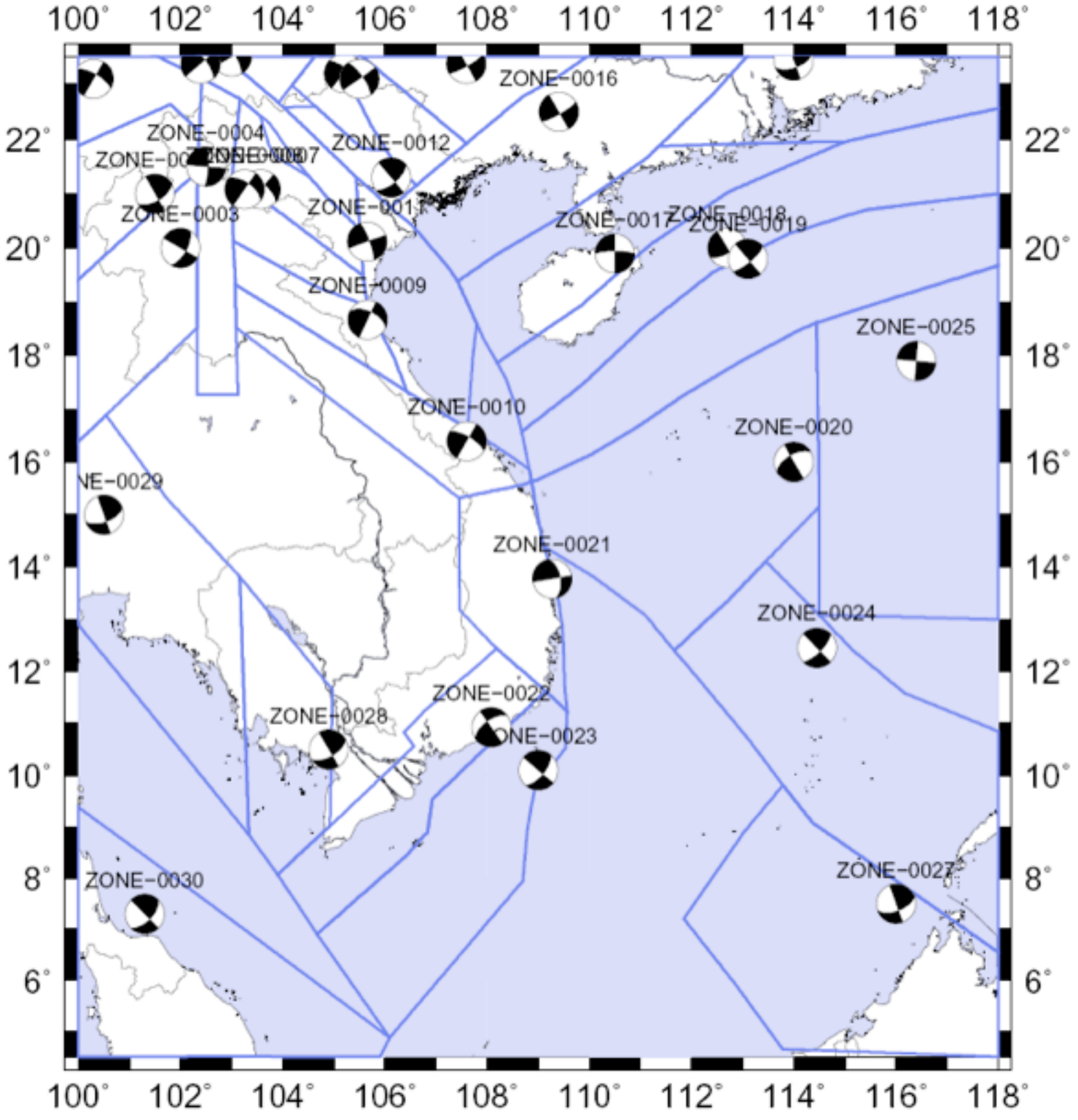
- The low level of monitoring of the South China Sea and the high degree of anthropization of the Vietnam coasts (and their high level of vulnerability) could make the risk quite high.

- We hope that the results can be used as a preliminary knowledge basis to: design early warning systems, reduce tsunami risk and plan land-use for the Vietnam coasts.

Seismic Zoning of Vietnam

- Definition of seismic zones
- Magnitude discretization

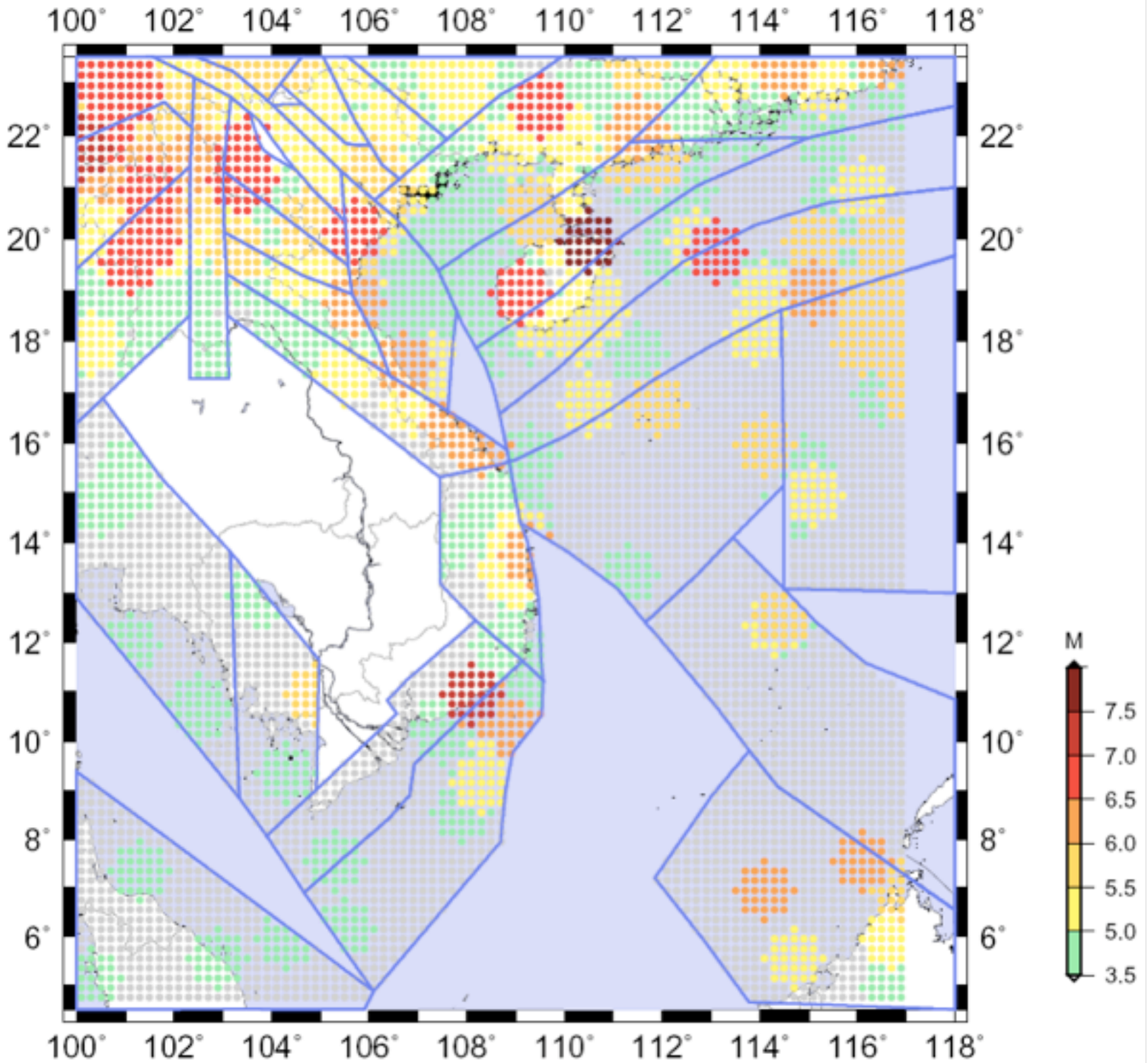




SH Vietnam

Seismic Zoning of Vietnam

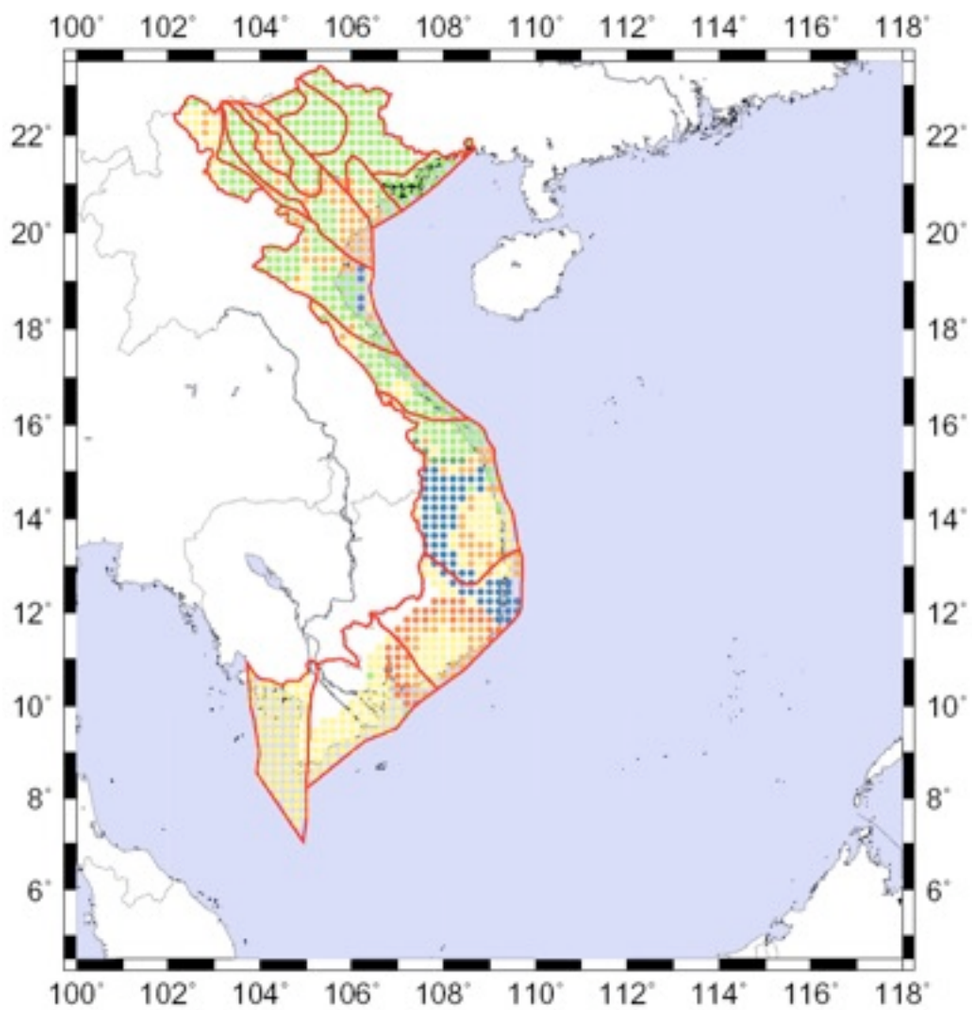
- Smoothing of magnitude
- Selection of grid points within seismogenic zones

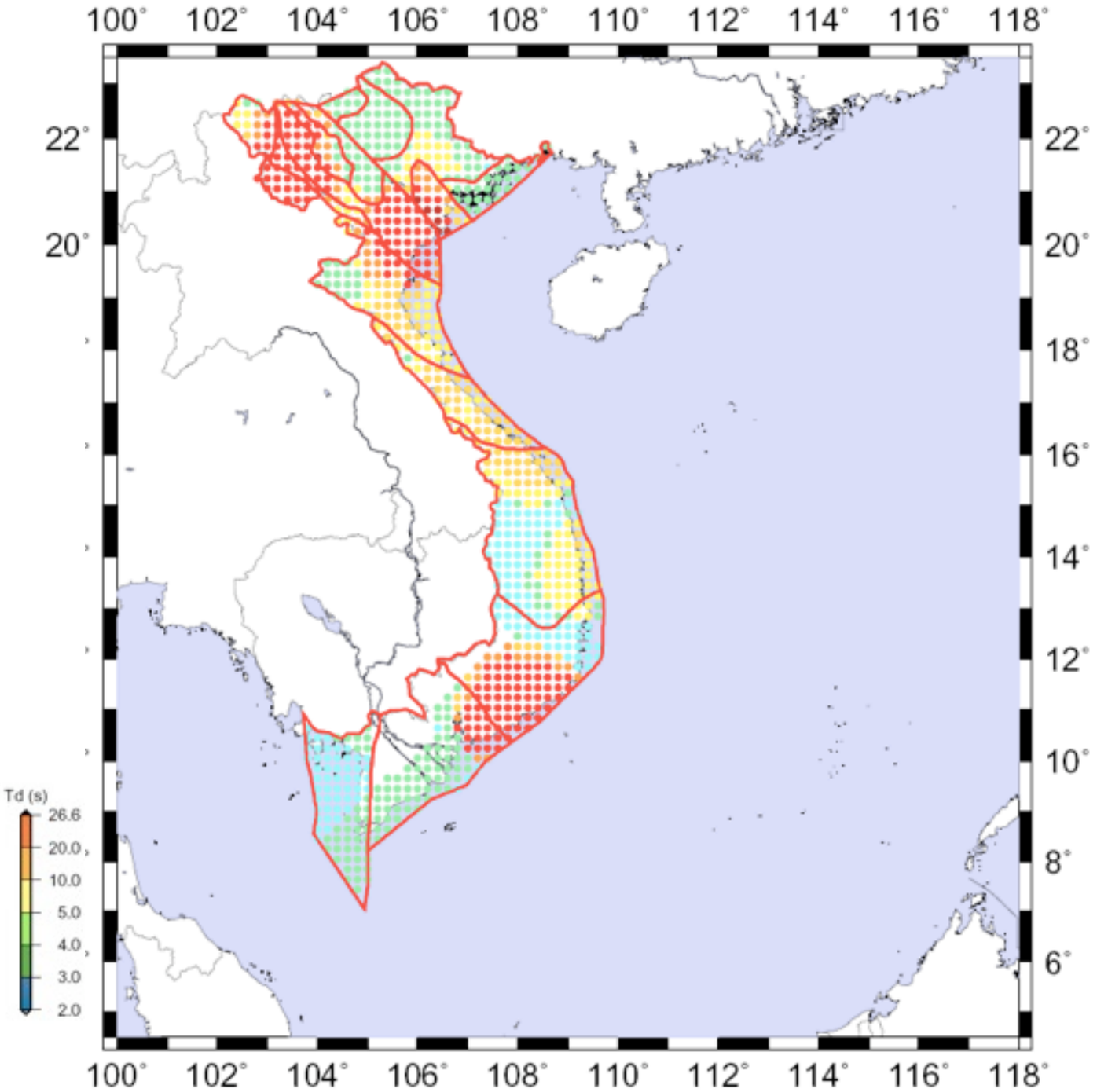


SH Vietnam

Seismic Zoning of Vietnam

- Distribution of peak displacements

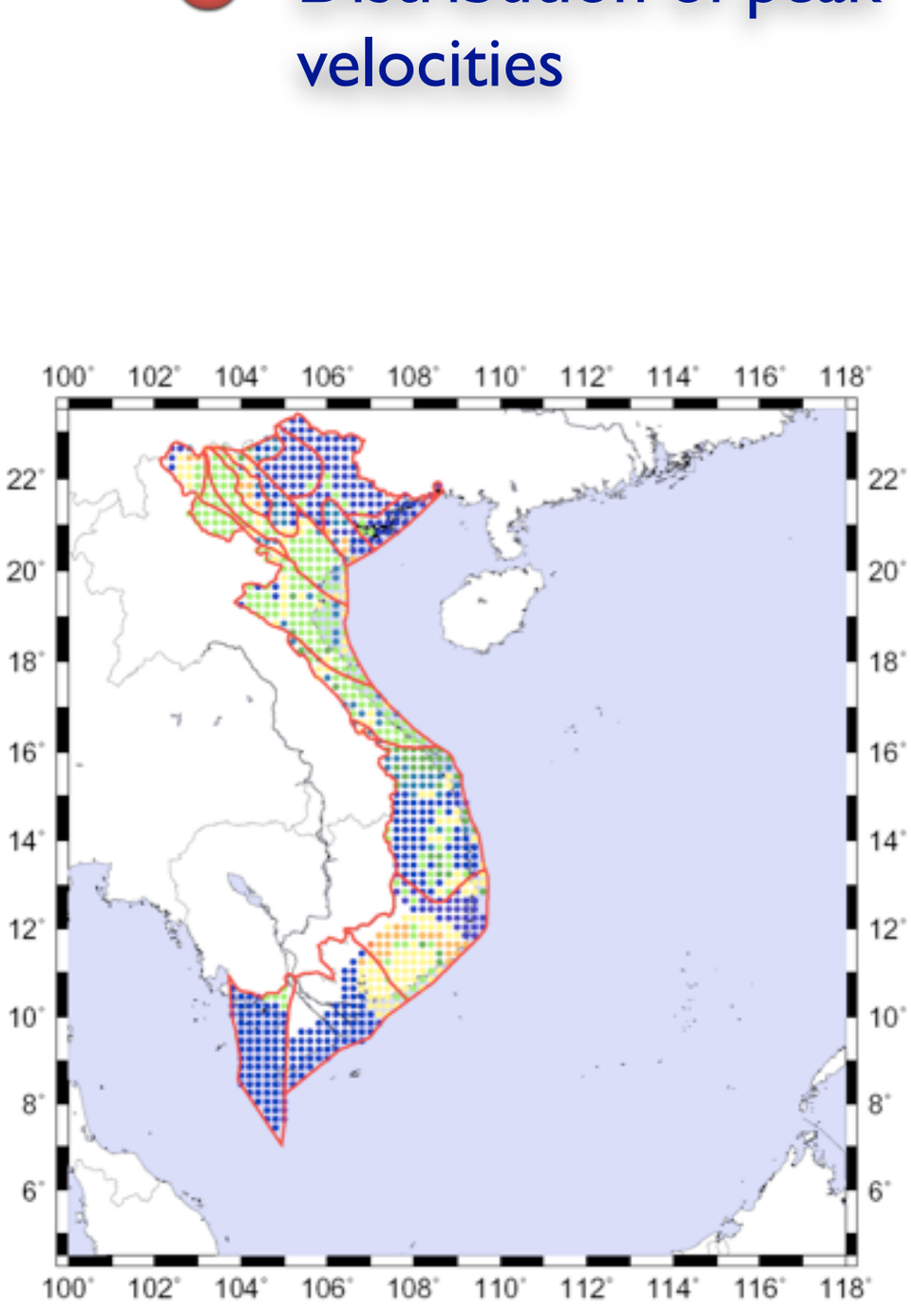


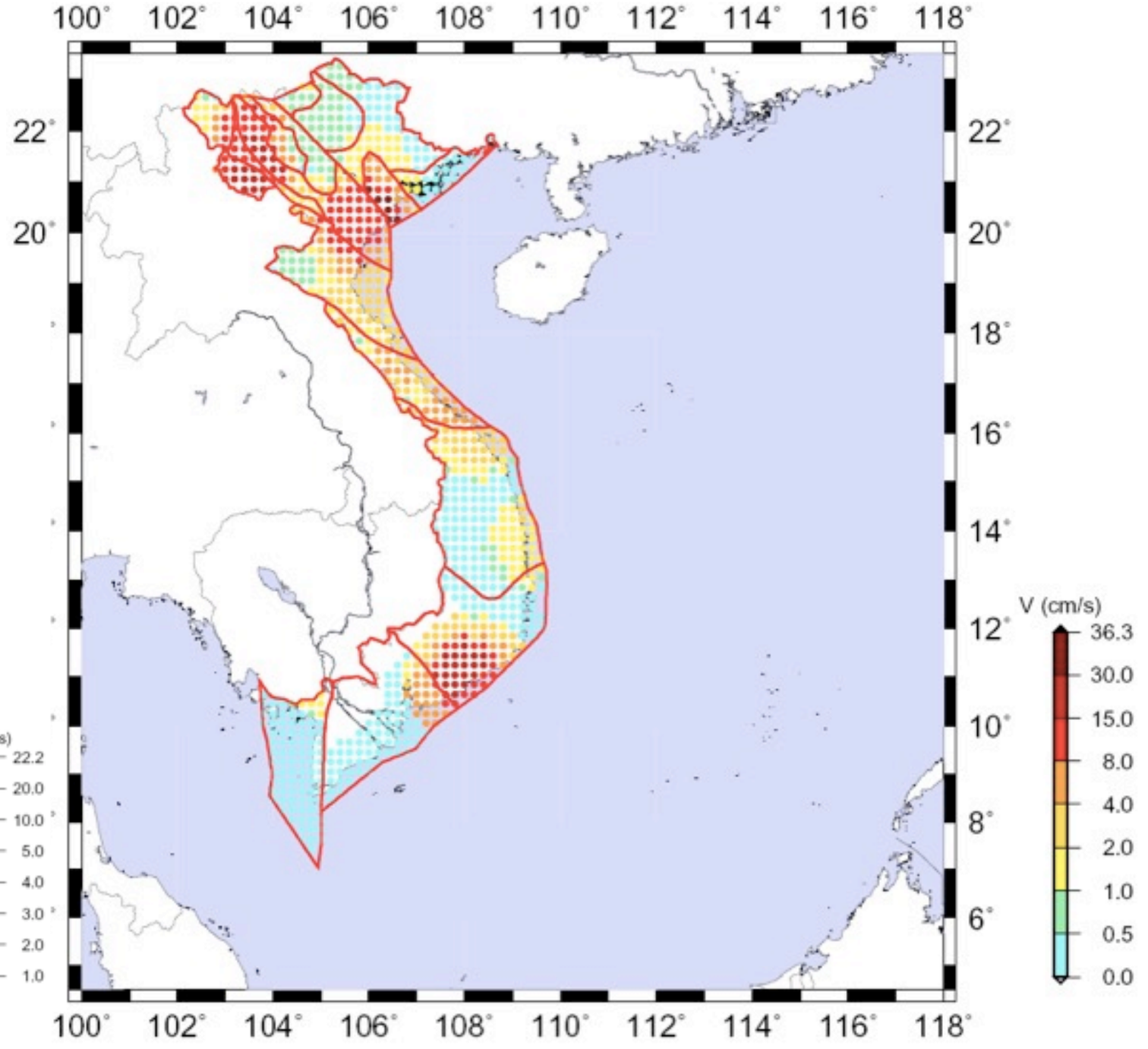


SH Vietnam

Deterministic Seismic Zoning of Vietnam

- Distribution of peak velocities

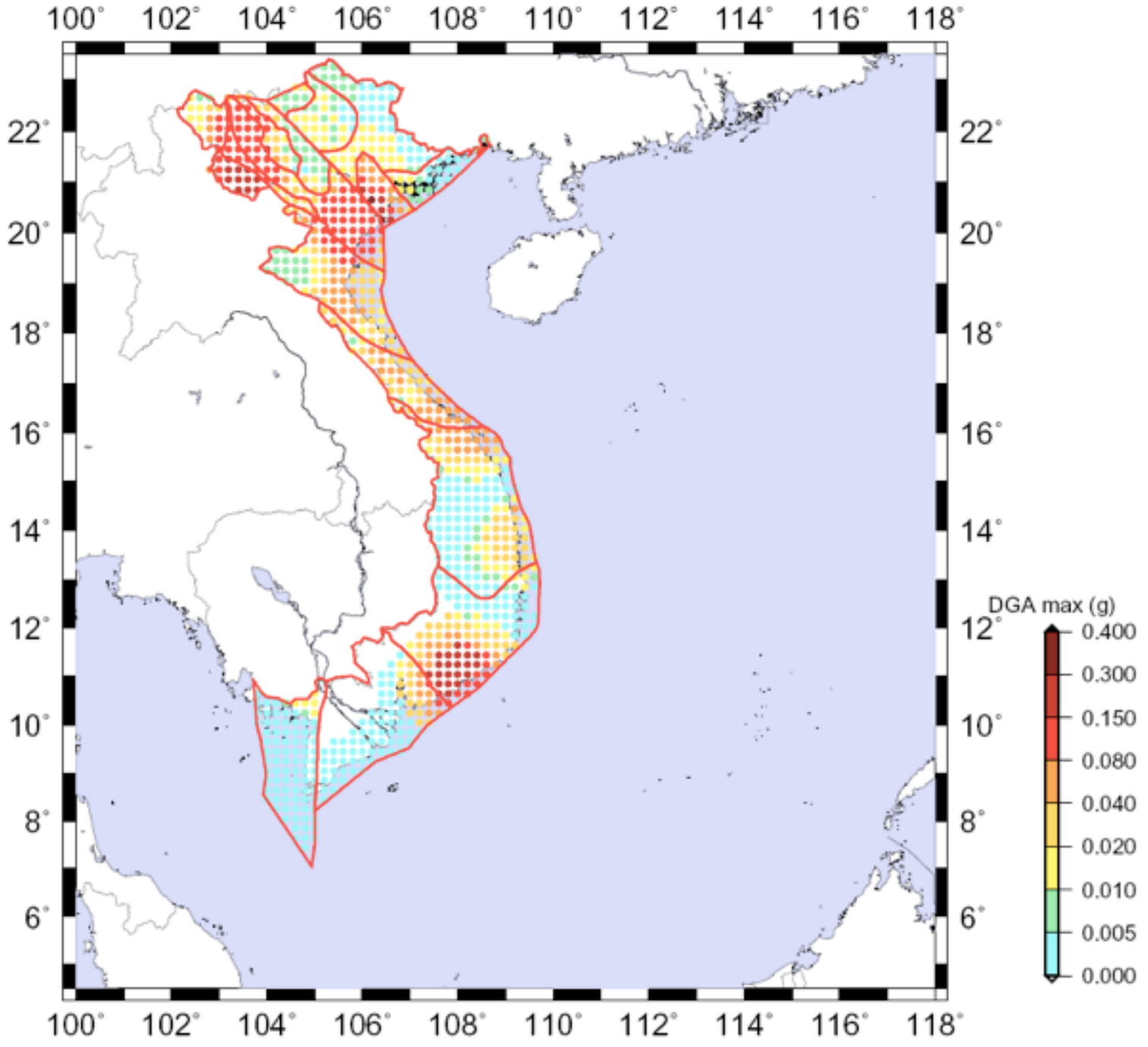




SH Vietnam

Deterministic Seismic Zoning of Vietnam

- Distribution of Design Ground Acceleration



SH Vietnam