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Earthquake Prediction Methodology for Indonesia and Caribbean Region

Prakash Pillai S[1]*, Chandramohan R[2] and Ravichandran AT[3]
[1]Seismology Researcher and NDT Consultant, Tiruchirappalli, Tamilnadu, India
[2]Research Advisor, Vidhyaa Giri College of Arts and Science, Puduvayal, Tamilnadu, India
[3]PG and Research Department of Physics, National College, Tiruchirappalli, Tamilnadu, India

***Corresponding author:** Prakash Pillai S, Seismology Researcher and NDT Consultant, Tiruchirappalli, 620101, Tamilnadu, India; Email: apaprakash@yahoo.co.in

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Abstract

It is the most arduous and challenging task to observe and record the geological coordinates of earthquake precursor locations and the corresponding epicenter zones, in Indonesia - the largest archipelago in the world and Caribbean regions. For the convenience of observational earthquake prediction study, active seismological regions of Indonesia have been divided into 10 major epicenter zones- Northern Sumatra, Southern Sumatra, Sunda Strait, Jawa, Kalimantan, Northern Sulawesi, Southern Sulawesi, Maluku and Irian Jaya, Papua and Nusatenggara. Indonesia is in the Indian and Pacific Ocean, whereas the Caribbean regions are in the Atlantic Ocean side, though they are in three entirely different regions but all the seismically active regions are having the same generation process of all form of atmospheric weather and earthquakes, is the most significant findings in this observation study since 1985. This wonderful observation study over 35 years confirms strongly confirms the strong generational process scientific relation between atmospheric weather and seismic anomalies. Observational data for different Ocean regions simply identifies the impending earthquake locations based on rainfall locations.

Keywords: Orbital motion of the earth; Centrifugal force; Stable and unstable epicenter zones; Major and minor epicenter zones; Direction of epicenter zones; Tectonic plates; Onshore precursors; Earthquake and earthquake prediction

Introduction

From ancient times to modern times, earthquakes have been the leading cause of death from natural disasters and have imposed dramatic cultural, economic, and political impacts on society. Most quakes are small. As many as 500,000 detectable earthquakes occur each year. Nearly 100,000 of them are strong enough to be felt, and only about 100 of them cause damage. They usually occur in the upper 10 miles or so of the Earth's crust, and they're concentrated along the boundaries where tectonic plates meet.

Earthquakes killed over 923,000 people worldwide between 1900 and 2010 according to USGS. Greece has over 2500 years of earthquake investigation, Italy 1500 years and New Zealand over 600 years. Both deadly seasonal weather and earthquakes are billion-dollar disasters. It is imminent to understand the generation process of earthquakes before to predict reliably and successfully. Global earthquakes have uniform generation process- orbital motion of the earth, generation of centrifugal force, drive the tectonic plates, generation of atmospheric weather anomalies and earthquakes. The earth crust comprises 7 major plates and 7 minor plates. Each seismic region comprises one or more major epicenter zones,and each major epicenter zone comprises one or more minor epicenter zones. Epicenter zones are earthquake zones, comprises one or more movable tectonic plates. Epicenter zones are in permanent position and they do not tend to shift from one place to other. So, the direction of epicenter zones would be the direction of earthquakes. All earthquakes are occurring in a repeatable manner at the pre-existing epicenter zones with respect to the position of the orbital motion of the earth.

This observational earthquake prediction study fourth in series of Austin Journal of Publications (AJES), focuses on understanding the generation process of atmospheric weather anomalies and generation process of earthquake phenomena. All forms of generation process of atmospheric weather anomalies are the part of the generation process of earthquakes. In this way all forms of atmospheric weather anomalies are the diagnosable earthquake precursors.

This observational study further enhanced the detection techniques of impending earthquakes by introducing new concept of major and minor epicenter zones. There are over 250 major and minor epicenter zones have been identified. Every seismic region contains one or more major epicenter zones and every major epicenter zones contains one or more minor epicenter zones. For instance, main islands of Indonesia are Sumatra, Jawa, Kalimantan, Sulawesi and Papua. Most of the main Islands are seismically contains several active major epicenter and minor epicenter zones. So, earthquakes are occurring at one or more minor epicenter zones. In this paper minor epicenter zones of Northern and Sumatra regions have been recorded for other seismic regions range of minor epicenter zones recorded. Epicenter zones are permanent in their position and have direction. In this way, this observational earthquake prediction study. So, the basic parameters for earthquakes prediction include direction of epicenter zones from precursor location in addition to location frame, time frame and magnitude frame.

It would be impossible to estimate precise time of earthquake occurrence of particular magnitude because several earthquakes of lower magnitude earthquakes could have been occur before the expected magnitude. Tectonic plates are behaves like metals, so , each

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regions of tectonic plates have different yield point, tensile point and break point. Experts should focus on understanding the mechanical properties of tectonic plates of different seismically active epicenter zones. For instance, earthquakes occur within 10 days after rainfall (earthquake precursor) but in other regions it takes usually within two weeks or sometimes takes over two weeks. Simultaneous break of more than one tectonic plate of more than one minor epicenter zones of a particular major epicenter zone of seismological regions may be the reason for strong earthquakes.

The amount of energy expended for the generation process of atmospheric weather anomalies and the energy released in the corresponding earthquakes would be different for different regions.

Methodology

Both atmospheric weather anomalies and earthquakes are origin wise strongly inter-related; both events are repeating every year at same place to the corresponding epicenter zones with respect to the position of the orbital motion of the earth. Without tectonic plate motion of the epicenter zones there will be no generation of atmospheric weather anomalies and earthquakes. All form of atmospheric weather anomalies are the precursor to earthquakes. There is different form of weather anomalies at different location of epicenter zones. Every epicenter zone generated more than one atmospheric weather anomalies. Most common weather anomalies are heat, rainfall associated with strong winds. Among the all form of weather anomalies rainfall or snowfall location best to identify the future earthquake location.

The essential earthquake prediction parameters in this empirical observation study based on six main steps:

- Number of Islands
- Number of major and minor epicenter zones
- Types of seasonal variations
- Geological coordinates of both of onshore precursor area and epicenter zones.
- Samples of both events in recent times
- The magnitude of the resulting earthquakes usually M4-6 are established based on observation of entire epicenter zones different seismically active regions.

Earthquake prediction strategy

On the rainfall/snow fall map (Table 1 - 3), the star icons represent the rainfall amount equal or greater than 50mm and location. Identify the direction of epicenter location based on observation. In this observation data table left column for precursor location and right column for corresponding earthquakes location.

Time, magnitude, location and Direction of future earthquake location:

There are different directions of epicenter zone of different seismic regions for Indonesia.

- The direction from which onshore earthquake precursor (all form of atmospheric seasonal weather anomalies) originated would the direction of earthquake epicenter zone.
- **Location:** Equal or within 5° latitude and within 15° longitude or 15° longitude and within 15° latitude from onshore earthquake precursor location. It varies region to region.
- Distance from onshore earthquake precursors: usually within 15°
- Time lag between onset of precursor and earthquake occurs: within 15 days
- **Magnitude:** usually 4-6. Precise time of earthquakes occurrence not possible because minor to strong earthquakes is having same generation process. In general, based on strength of cyclone, severity of rainfall and snow fall in this observation study it is estimated within 15 days after rainfall.

However, based on yield point, tensile point and break point of tectonic plates of epicenter zones of different seismically active regions to be studied for precise time of tectonic plates break.

Daily rain fall/snow fall map used in this observational study of earthquake prediction

In this observational study of earthquake prediction several weather web sites have been referred. Among them https://severeweather.wmo.int/rain/b6/index.html map is extensively used in this earthquake prediction observation study. The amount (severity of the atmospheric weather anomalies) and geological coordinates of rainfall/snowfall is very much helpful to identify the geological coordinates of corresponding earthquake location and to estimate the size of the impending earthquakes. So, this website is primarily used for the entire regions of the world only additional confirmation other weather web sites have been referred.

There are three series of frames of wmos as “A” series frames, “B” series frames and “C” series frames. Each series has 6 frames and there are totally 18 frames. The star icons are the representation of rainfall/snowfall location. The rainfall amounts equal or greater than 50mm and coordinates location.

Results

Indonesia

Every year, more than 1000 earthquakes with varying magnitudes occur in Indonesia, ranging from minor to great earthquakes.

Indonesia:

Number of Islands: Indonesia is the largest archipelago in the world. It consists of five major islands, Sumatra,

Java, Kalimantan (Indonesian Borneo), Sulawesi, Papua and about 30 smaller groups. There are total numbers of 17,508 islands of which about 6000 are inhabited.

The largest islands are

Seasons: Weather in Indonesia can be split into two seasons - wet and dry - with warm tropical temperatures averaging 28°C during the day, throughout the year. In most regions, the dry season spans from May to September, with the rains falling between October and April. There are some regional exceptions.

Number of Islands: The region, situated largely on the Caribbean Plate, has more than 700 islands, islets, reefs and cays (see the list of

Figure 1: Indonesia Geological map: Geological coordinates of Indonesia is within 10N -10S 90-140E.

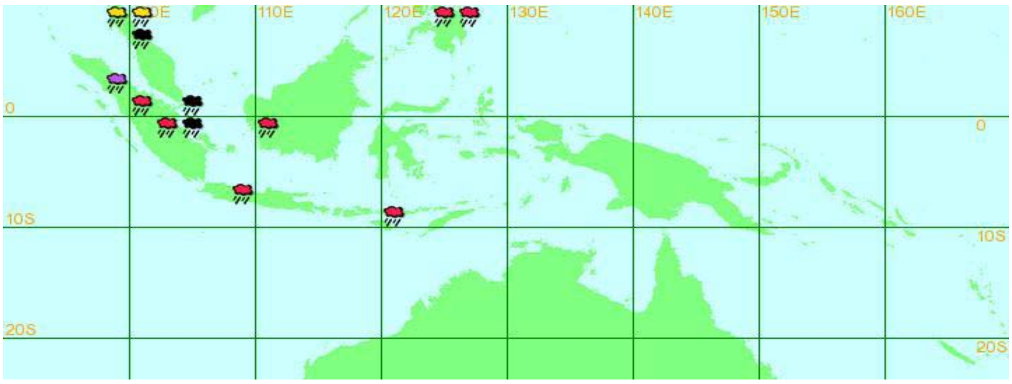


Figure 2: Star indication representation of Rainfall (equal or greater than 50mm) /snow location map, (10 degree longitude study offers best result).

Caribbean islands).

Number of epicenter zones

Season: In terms of seasons, these are divided into two main types; the high season which runs roughly from mid-December through mid-April, and the low season which runs from June through November. In addition there are two shoulder seasons in the spring and autumn. The low season is also the hurricane season in the Caribbean.

Most of the Caribbean experiences hot and humid weather with heavy rain all year round. During certain times of year, the low-pressure zones of the eastern Caribbean Sea help create hurricanes that often damage the coast and low-lying parts of the region's islands.

Conclusion

The most significant findings in these observational studies are successfully identified the permanent major and minor epicenter zones and their directions. This only possible by observational study.

There are more than 250 permanently positioned major and minor epicenter zones have been identified at different continents.

Researchers missed to link atmospheric anomalies with seismic anomalies. Actually, the generation process of atmospheric anomalies is part of the generation process of earthquakes and generated prior to earthquakes.

Monitoring onshore earthquake precursors connection with earthquakes at same place of observations of many individual and populations of earthquakes were analyzed for a complete understanding of these phenomena.

To verify the correctness of observed results, same epicenter zone concept has been applied for different epicenter zones of different continents produce similar satisfactory results.

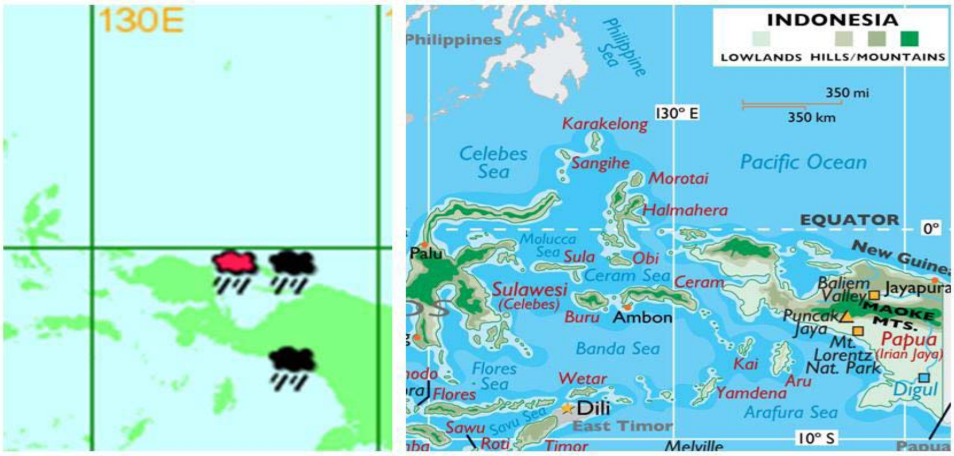
Epicenter zones generated onshore earthquake precursors are identifiable, observable, verifiable and testable repeatedly for any seismic regions.

There are variety of epicenter zone generated precursors of various severity and earthquakes of size of earthquakes; variety of

Figure 3: Northern Sulawesi.

Figure 4: Nusatenggara (8-10S 110E-120E).

Figure 5: Maluku and Irian Jaya and Papua.



Rainfall location map Geological co-ordinates map

Figure 6: Papua 130-140E.

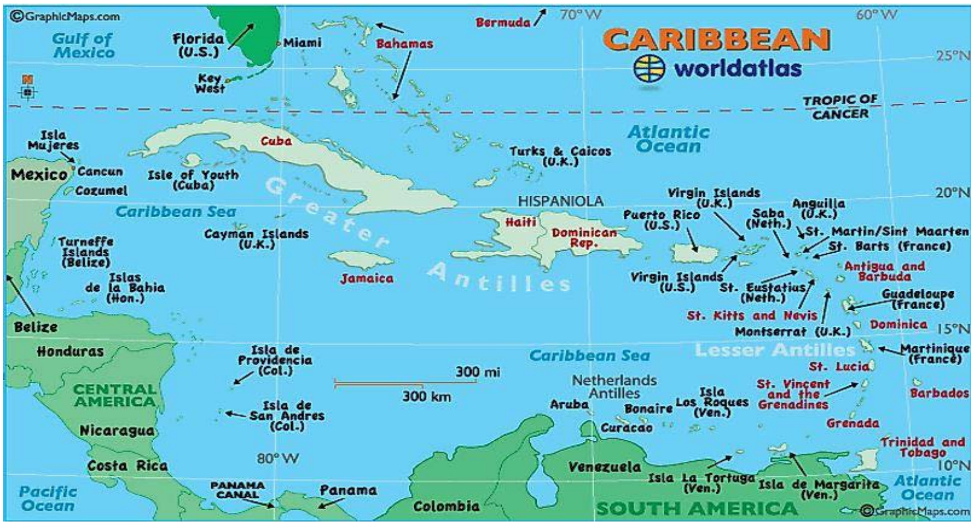


Figure 7: Caribbean Regions.

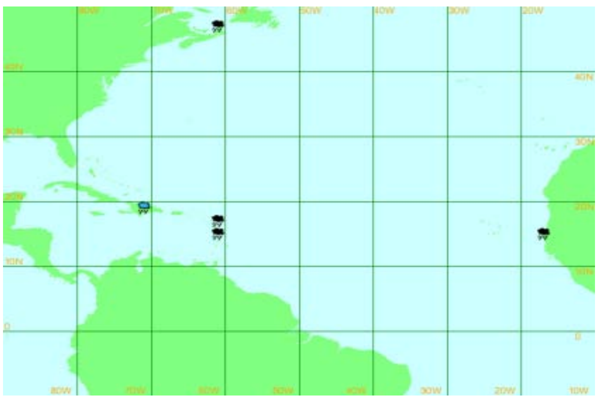


Figure 8: Rainfall location coordinates of Caribbean Regions.

individual or populations of earthquakes from permanent epicenter zones of different parts of the world.

This empirical research based on observed and measured phenomena from actual experience.

Seismically highly hazardous and risky different regions have been studied that reveals uniform unstable epicenter zones generated onshore earthquake precursors and earthquakes, time lag between precursor and earthquakes; direction frame; distance frame; time frame and magnitude frame.

So, the disaster management authorities have enough time to plan to mitigate the loss of life and property.

It should be scientifically more appropriate that earthquake prediction study should be the combined with Astrophysics and Geophysics, rather than seismology a part of the Geology.

Except precise time of earthquake occurrence all others generation process of onshore earthquake precursors and earthquakes generating epicenter zones have been identified is the major significant of this empirical observation of earthquake prediction.

The answer to the large earthquakes and tsunami is relying on the position of the orbital motion of the earth. World of Earthquake prediction research centers can improve earthquake prediction methodology with the advanced technology.

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We could not do this historic landmark achievement beneficial to the entire humanity without the support data source of the websites:

(http://severe.worldweather.wmo.int/rain/b5/),

(http://www.emsc-csem.org/Earthquake/world/M4/),

www.wunderground.com/hurricane.

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Table 1: "A" series frames (https://severeweather.wmo.int/rain/b6/index.html). Definition of Heavy Rain/Snow: Rainfall/Snowfall (Star icons represents) greater than or equal to 50mm in past 24 hours.

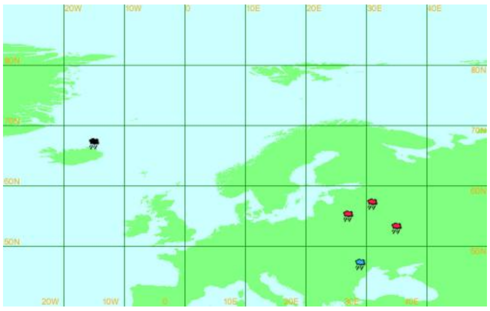
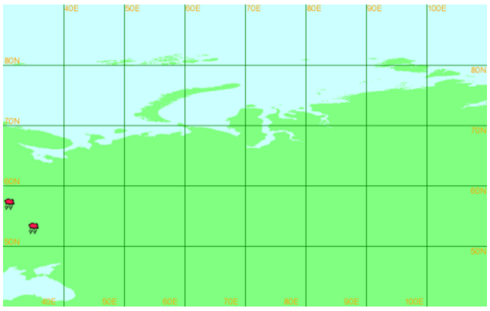
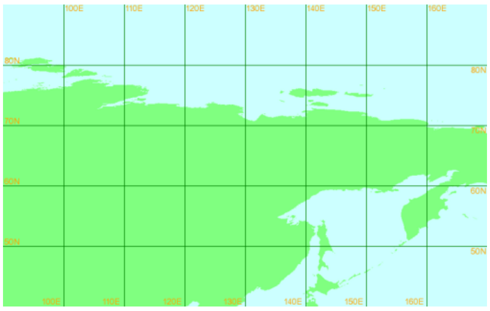
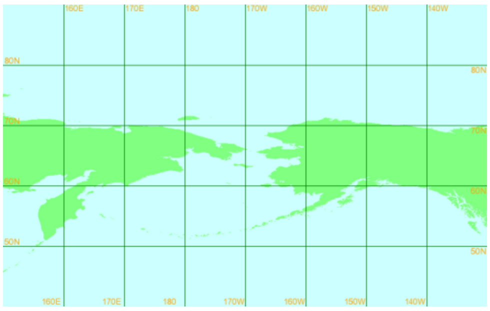
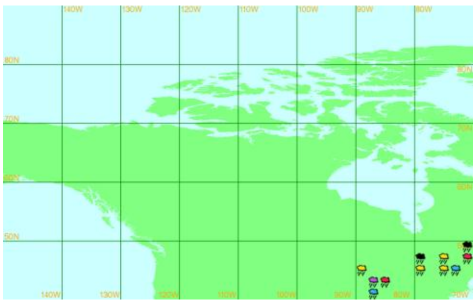
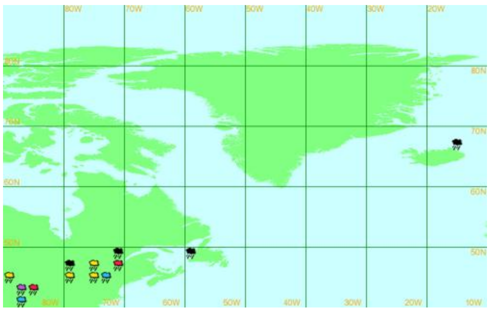
a1/index.html	a2/index.html
	
a3/index.html	a4/index.html
	
a5/index.html	a6/index.html
	

Table 2: "B" series frames (http://severeweather.wmo.int/rain/b1/index.html).

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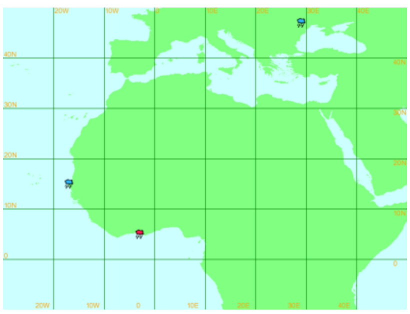
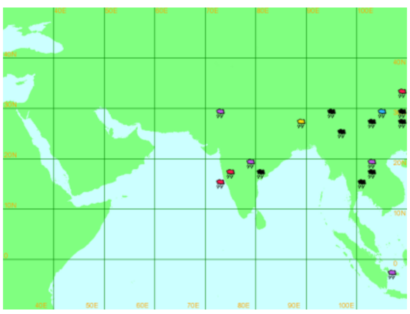
	

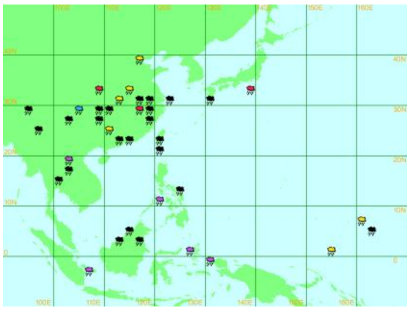
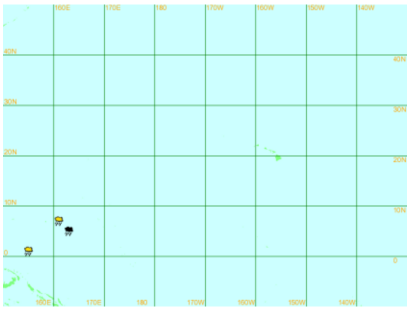
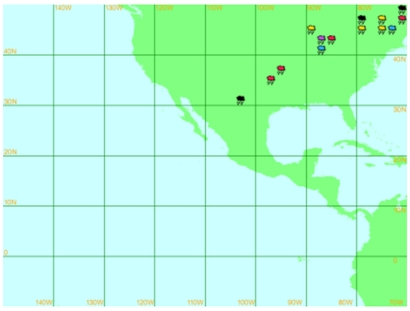
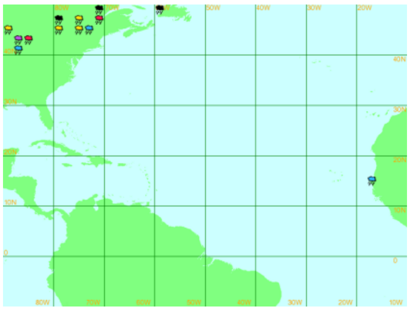
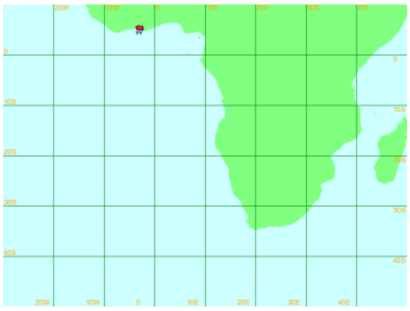
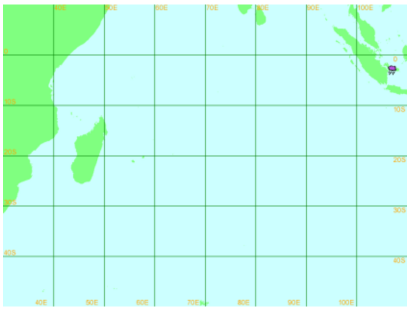
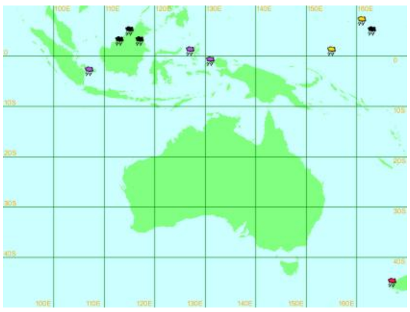
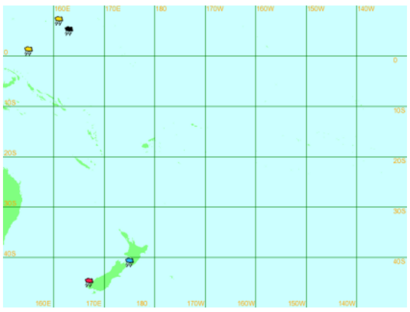
b3/index.html 	b4/index.html 
b5/index.html 	b6/index.html 

Table 3: "C" series frames (http://severeweather.wmo.int/rain/c1/index.html).

c1/index.html 	c2/index.html 
c3/index.html 	c4/index.html 

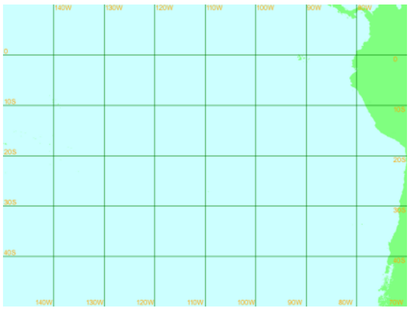
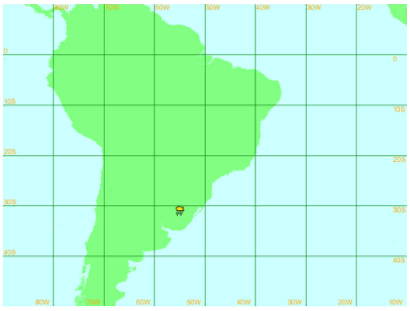
c5/index.html	c6/index.html
	

Table 4: Epicenter zones of Java and Kalimantan, Sulawesi, Maluku and Irian Jaya.

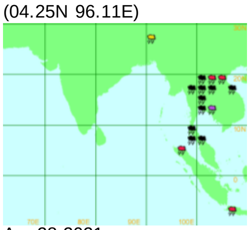
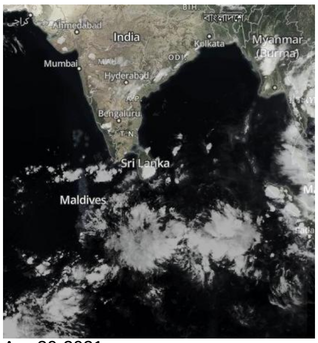
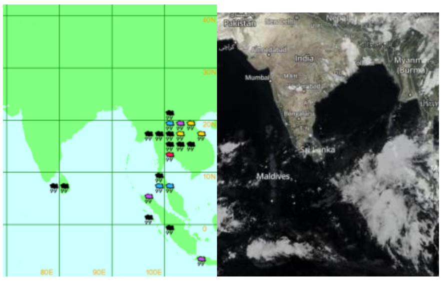
Kalimantan 110-120E c3/index.html	**Java E stretch 120-130E** c3/index.html
Kalimantan, Indonesia 4N Makassar Strait, Indonesia 1.48 N ; 119.77 E Celebes Sea Banda sea	Java Sea Jawa South of Java South of Java, Indonesia Sunda Strait, Indonesia **Nusatenggara** South of Bali, Indonesia Lombok, Indonesia South of Lombok, Indonesia Sumbawa region, Indonesia 119E South of Sumba region, Indonesia Sumba region, Indonesia 119E Kepulauan Batu, Indonesia 8S 116E Savu Sea East Timor region 8.44 S ; 127.84 E Kepulauan Barat Daya, Indonesia 127E
Sulawesi 120-130E c3/index.html	**Maluku and Irian Jaya 130-140E** c3/index.html
Sulawesi NE North of Halmahera, Indonesia 3N Minhasa Sulawesi, Indonesia 0.30N Sulawesi Molucca Sea, 0.17 S ; 124.48 E Buru, Indonesia 3.60 S ; 126.73 E Kepulauan Talaud, Indonesia 3-4N 127E Halmahera, Indonesia 0.38 -1N Seram, Indonesia 3S Flores region,8.22 S ; 119.45 E Biak region, Indonesia	Kepulauan Sangihe, Indonesia Kepulauan Aru region, Indonesia 5S 134E Kep. Tanimbar region, Indonesia 6S 132E Near N Coast of Papua, Indonesia, 2.67S; 139.17E Papua, Indonesia 139E

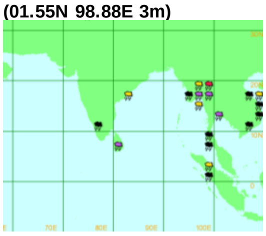
Table 5: Northern Sumatra: Major and minor Epicenter Zones: Direction of epicenter zones: West.

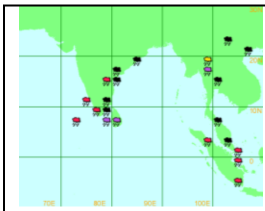
Northern Sumatra c3/index.html	
Major Epicenter zones	**Minor Epicenter zones**
Northern Sumatra, Indonesia 1- 4N Off W coast of Northern Sumatra, Indonesia 4.67N Simeulue, Indonesia 2.67N Nias region, Indonesia 1.14 N Kep. Mentawai region, Indonesia 2S North Indian Ocean 2N	Northern Sumatra, Indonesia 5.43 N ; 94.66 E 4.54 N ; 95.56 E 1.65 N ; 99.63 E 0.52 N ; 99.67 E 0.85 N ; 99.12 E Off West coast of Northern Sumatra, Indonesia 3.87 N ; 93.00 E Simeulue, N Sumatra 2.22 N ; 96.04 E 2.40 N ; 95.68 E Nias, Indonesia 1.35 N ; 97.10 E 1.97 N ; 97.71 E 1.11 N ; 96.86 E 1.38 N ; 96.89 E 0.24 N ; 96.54 E 0.18 N ; 96.64 E 0.97 N ; 98.83 E 0.26 N ; 96.61 E 0.16 N ; 96.65 E

	0.25 N ; 96.79 E 0.26 N ; 96.78 E 0.16 N ; 96.63 E 0.10 N ; 96.40 E 0.34 N ; 96.65 E 0.45 N ; 96.79 E 0.19 N ; 96.47 E

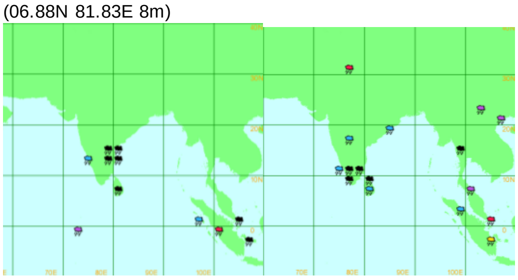
Table 6: Northern Sumatra, Indonesia. Present observed data 2021 (few samples): Epicenter Zone Direction: South.

Apr.29,2021 N Sumatra (04.25N 96.11E)  Apr.28,2021 NW Sumatra  Apr.30,2021 May.05,2021 Northern Sumatra, Indonesia  May.08,2021 N Sumatra (05.86N 95.31E 126m)  May.16,2021 Banda Aceh, N Sumatra (05.51N 95.41E 21m)	May.02,2021 Northern Sumatra, Indonesia M5.0/ 5.43 N ; 94.66 E  May.13,2021 Northern Sumatra, Indonesia M4.1/ 0.85 N ; 99.12 E  May.13,2021 Nias region, Indonesia M6.6; 4.7;4.6;4.5;4.4;4.0/ 0.16 N ; 96.65 E  May.15,2021 M4.3/ 0.25 N ; 96.79 E May.16,2021 Nias region. Indonesia M4.2/0.26 N ; 96.78 E  May.19,2021 Nias region, Indonesia M4.0/ 0.16 N ; 96.63 E M4.5;4.3/ 0.10 N ; 96.40 E May.23,2021 Nias region, Indonesia M4.1/0.34 N ; 96.65 E

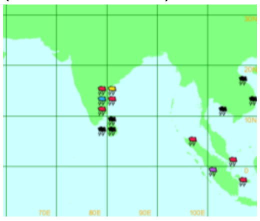
	 Off west coast of N Sumatra, Indonesia M4.4/3.87 N ; 93.00 E  May.24,2021 Northern Sumatra, Indonesia M4.8/ 4.54 N ; 95.56 E  May.27-28,2021 Nias, N Sumatra, Indonesia M4.0/ 1.11 N ; 96.86 E M4.4/ 0.45 N ; 96.79 E M4.6/ 0.19 N ; 96.47 E 
Oct.19,2021 **N Sumatra** **(00.46N 101.45E 31m)** Oct.24,2021 Kodaikanal, S India (10.23N 77.46E 2343m) Oct.24,2021 Thailand (07-08.43N 99.50E 30m) **N Sumatra, Indonesia** **(01.55N 98.88E 3m)**  Nov.02,2021 Sri Lanka (08.98N 79.91E 3m) Maldives (06.73N 73.16E 2m)	Nov.01-12,2021 **Nias region, Indonesia** M6.0'5.1;4.7;4.6;4.5;4.2;4.1;4.0;4.3 and more/ 0.28 N ; 96.71 E Nov.10,2021 M4.1/ 0.21 N ; 96.52 E  Nov.12,2021 **Northern Sumatra, Indonesia** M5.0/ 1.28 N ; 98.91 E

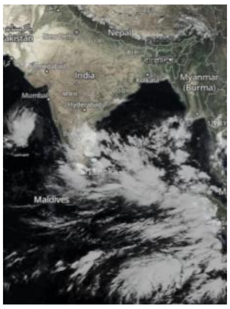


Nov.02,2021
N Sumatra, Indonesia
(03.80N 98.70E 3m)
Nov.02,2021
Sri Lanka
(06.88N 81.83E 8m)

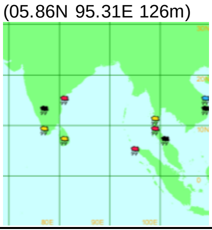


Nov.03-04,2021
(06-08.58N 80-81.25E 79m)
Nov.08,2021
(06-09.26N 79-81E 2m)
N Sumatra
(03.56N 98.68E 25m)
N Sumatra, Indonesia
(04.25N 96.11E)
Nov.11-13,2021
N Sumatra
(01.55N 98.88E 3m)





Nov.16,2021
N Sumatra
(05.86N 95.31E 126m)



Nov.11-12,2021
Simeulue, Indonesia
M4.8/ 2.09 N ; 96.79 E
M4.7/ 2.18 N ; 96.23 E

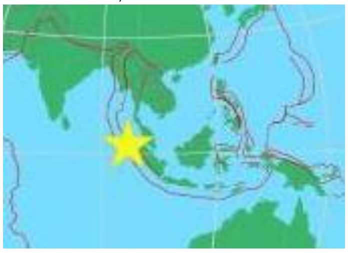
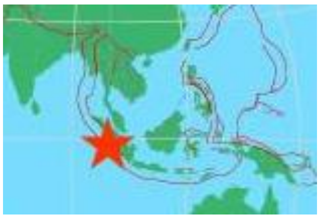
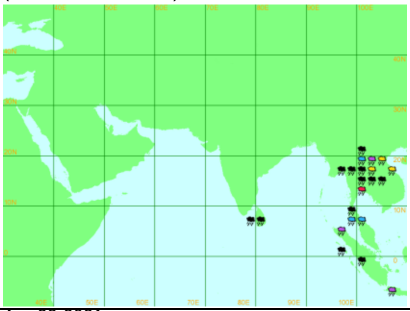
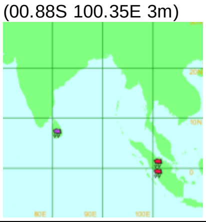
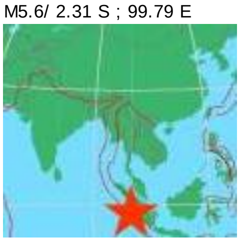
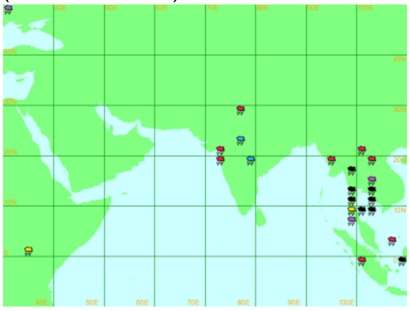
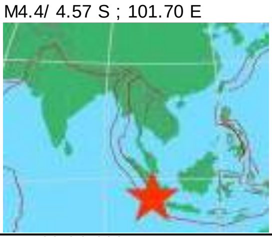
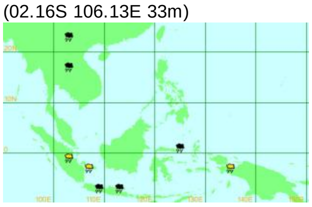
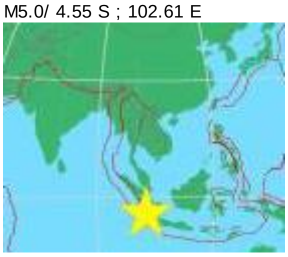
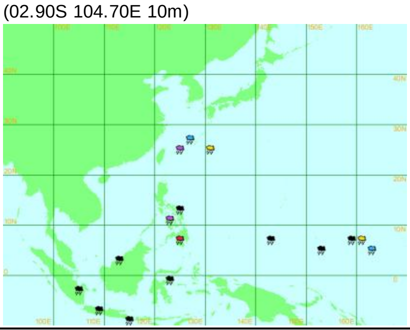
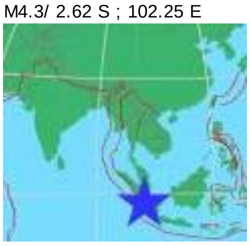
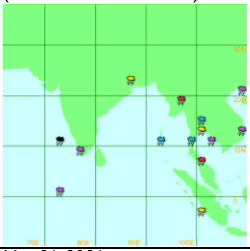
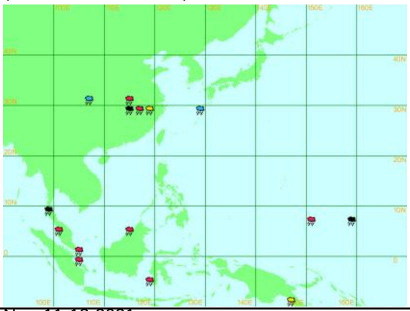
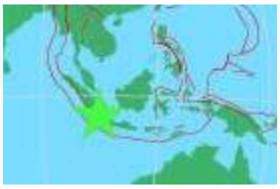
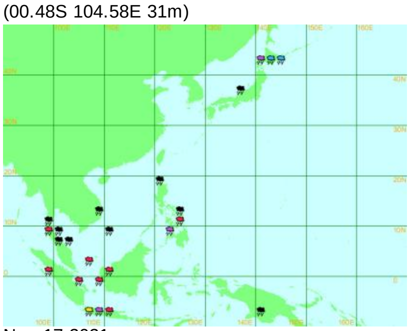
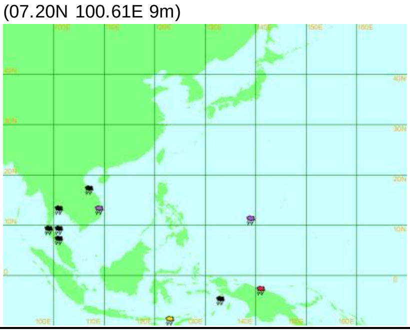
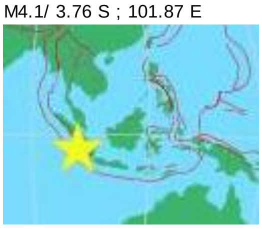


Table 7: Southern Sumatra, Indonesia. Epicenter Zone Direction: South.

Mar.04,2021 S Sumatra (02.76S 101.36E 782m) Mar.07,2021 S Sumatra (01.63S 103.65E 25m) (00.88S 100.35E 3m) (02.76S 101.36E 782m)  Mar.18,2021 S Sumatra (00.33S 102.31E 46m)	Mar.27,2021 Kep. Mentawai region, Indonesia M4,7/ 1.97 S ; 99.34 E 
Apr.27,2021 Thailand, Laos, Viet Nam (07-10N 15-17N 98,100,104-108E) W Malaysia (03.11N 101.55E 22m) Apr.29,2021 Thailand, Laos & Viet Nam (06,08,14-19N 98-102E) Apr.30,2021 Myanmar (16.75N 97.66E 10m) Laos (21.05N 101.46E 644m) (15.11N 105.16E 102m) Thailand (14-17N 99-102E) (01.50N 97.63E 6m) (00.88S 100.35E 3m) May.05,2021 Thailand (06.78N 101.15E 9m) S Sumatra (00.88S 100.35E 3m) 	May.05,2021 Kep. Mentawai region M5.9;5.0/ 1.95 S ; 99.77 E 
Apr.22,2021 Sumatra S (00.46N 101.45E 31m) (00.88S 100.35E 3m) 	May.02,2021 Kep. Mentawai, Indonesia M5.6/ 2.31 S ; 99.79 E 
Sep.01,2021 Thailand (14.00N 99.96E) (10.48N 99.18E 5m) (07.96N 98-99E 10m) S Sumatra	Sep.05,2021 Kep. Mentawai region, Indonesia M4.9/ 2.09 S ; 99.67 E

(00.88S 100.35E 3m) 	 Sep.07,2021 Southern Sumatra, Indonesia M4.6/ 3.15 S ; 102.40 E  Sep.09,2021 Southern Sumatra, Indonesia M4.0/ 4.96 S ; 102.36 E Sep.10,2021 M4.4/ 4.57 S ; 101.70 E 
Mar.21,2021 S Sumatra (01.63S 103.65E 25m) (02.16S 106.13E 33m)  Mar.25,2021 E Malaysia (S Sumatra) (03.78N 103.21E 16m) Thailand (06.80N 100.40E 25m) 	Mar.28-29,2021 Southern Sumatra M4.1/ 1.40 S ; 100.51 E M5.0/ 4.55 S ; 102.61 E 
Feb.13,2021 S Sumatra (02.90S 104.70E 10m) 	Feb.28,2021 Southern Sumatra M4.6/ 4.22 S ; 102.44 E Mar.01,2021 M4.3/ 2.62 S ; 102.25 E 

May .06,2021 Thailand (06,12,14N 100-101E) S Sumatra (02.76S 101.36E 782m) 	May .08,2021 Southern Sumatra M4.4/ 4.21 S ; 102.44 E 
Mar.31,2021 S Sumatra (01.11N 104.11E 24m) (00.48S 104.58E 31m) 	Apr.12,2021 Southern Sumatra M5.2/ 5.21 S ; 104.86 E 
Nov.11-13,2021 Thailand (06-10, 18N 98-101E) S Sumatra (00.48S 104.58E 31m)  Nov.17,2021 Thailand 12.68N 100.98E 18m) (09.46N 100.05E 7m) (08.53N 99.95E 9m) (07.20N 100.61E 9m) 	Nov.10,2021 Southern Sumatra, Indonesia M4.4/ 4.74 S ; 101.93 E  Nov.16,2021 Southern Sumatra M4.2/3.77 S ; 101.60 E Nov.17,2021 M4.9/ 3.54 S ; 101.59 E Nov.18,2021 Southern Sumatra M4.1/ 3.76 S ; 101.87 E 
Feb.09,2021 Thailand (12-13,19N 99-103E)	Feb.10,2021 Southwest Sumatra M6.2/ 5.62 S ; 101.73 E

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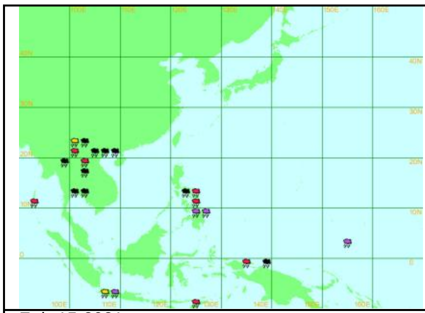
<td></td>
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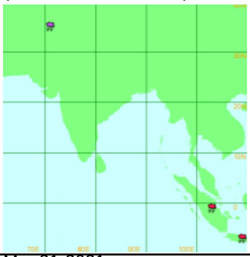
<td>Feb.15,2021
Southern Sumatra
(02.76S 101.36E 782m)
(05.10S 105.18E 96m)
Feb.24,2021
Southern Sumatra
(00.33S 102.31E 46m)
</td>
<td>Mar.02,2021
Southwest of Sumatra, Indonesia
M4.8;4.1/ 5.70 S ; 101.70 E
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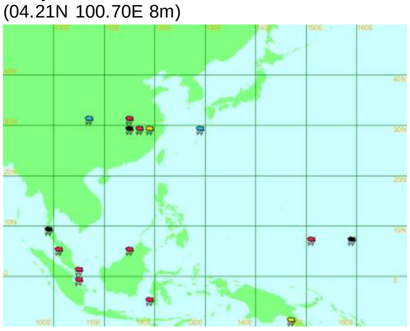
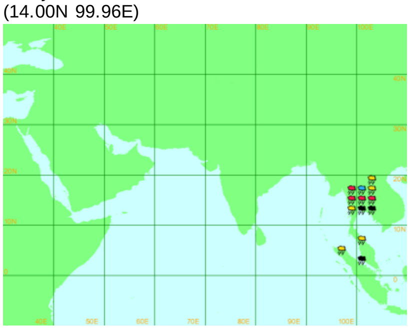
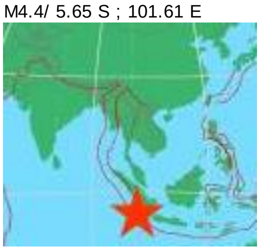
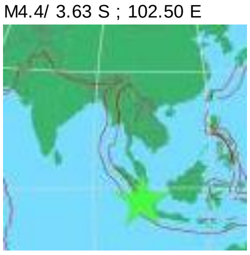
Thailand
(09.11N 99.35E 11m)
Malaysia W
(04.21N 100.70E 8m)


Apr.04,2021
Thailand (for S Sumatra)
(12-17N 99-102E)

Apr.04-05,2021
Laos
(18.46N 102.40E 179m)
Thailand
(12-17N 98-102E)
Malaysia W
(14.00N 99.96E)


Apr.17,2021
Laos
(20.96N 105.76E)
(20.41N 104.23E 913m)</td>
<td>Apr.21,2021
Southwest of Sumatra
M4.0/ 6.64 S ; 102.72 E
M4.4/ 5.65 S ; 101.61 E


Apr.21,2021
Southern Sumatra
M4.4/ 3.63 S ; 102.50 E
</td>
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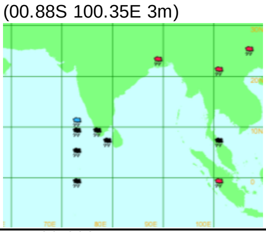
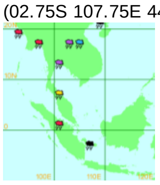
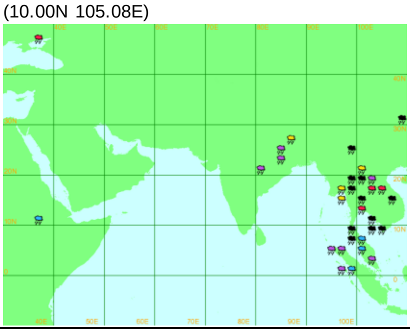
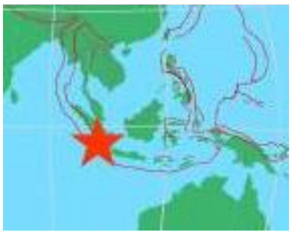
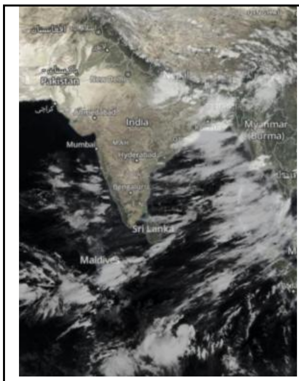
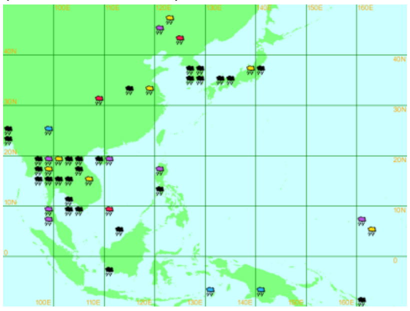
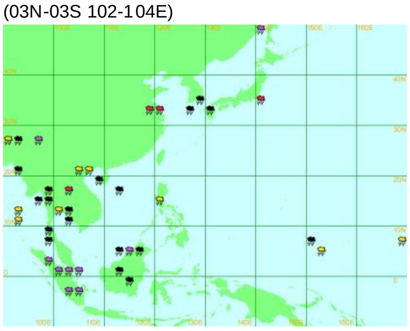
Thailand (07,17N 98-101E) Apr.17,2021 S Sumatra (02.75S 107.75E 44m) (00.15S 109.40E 3m) 	
May.11,2021 Southern Sumatra (00.33S 102.31E 46m) May.12,2021 Thailand (06.65N 100.08E 6m) S Sumatra (00.88S 100.35E 3m) 	May.12,2021 Southwest Sumatra M4.1/ 1.09 S ; 95.91 E May.14,2021 SW of Sumatra M5.0/ 0.09 S ; 96.67 E 
Jun.30,2021 Southern Sumatra (00.46N 101.45E 31m) (02.75S 107.75E 44m) 	Jul.01,2021 Sothern Sumatra M4.5;4.7;4.2/ 5.46 S ; 104.61 E 
July 06,2021 Thailand (06-09N 98-100E) July 07,2021 China (25.13N 99.21E 1655m) (21.50N 101.58E 633m) Thailand and (07-11N13-17N 98-104E) Viet Nam (10.21N 103.96E 4m) (09.18N 105.15E 2m) (10.00N 105.08E) 	July 07,2021 Southern Sumatra M4.0/ 4.48 S ; 102.29 E 



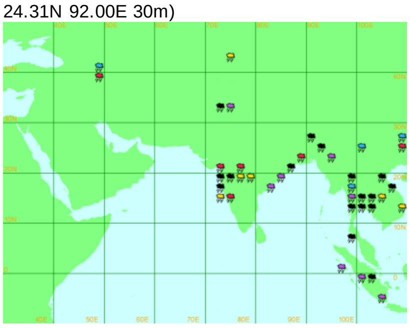
July 08,2021
Thailand
(10-19N 99-104E)
Lao
(18.46N 102.40E 179m)
(19.88N 102.13E 305m)
Viet Nam
(09.28N 103.46E)
(10.00N 105.08E)
(09.18N 105.15E 2m)



Sep.02,2021
S Sumatra, Indonesia
(03N-03S 102-104E)



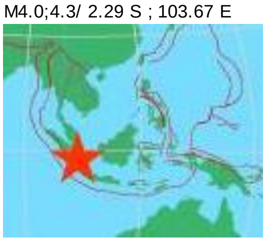
Sep.07-08,2021
S Sumatra
(01.63S 103.65E 25m)
(26.61N 92.78E 79m)
24.31N 92.00E 30m)



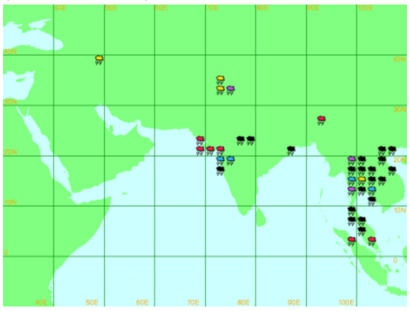
Sep.09,2021

Sep.12,2021
Southern Sumatra, Indonesia
M5.0/ 0.49 S ; 99.69 E

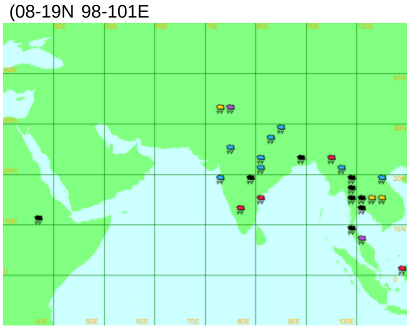
Oct.04,2021
S Sumatra,
M4.0;4.3/ 2.29 S ; 103.67 E



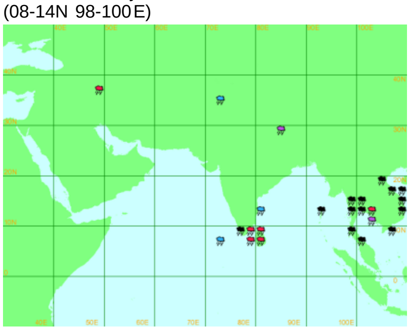
Thailand, Myanmar
(06-18N 98-103E)



Sep.21-22,2021
Thailand
(08-19N 98-101E



Oct.06,2021
Thailand and Myanmar
(08-14N 98-100E)



Oct.06,2021
Southwest Sumatra, Indonesia
M4.5/ 6.05 S ; 102.95 E

Oct.26,2021
Southern Sumatra, Indonesia
M4.3/ 3.45 S ; 101.58 E

Oct.30,2021
SW of Sumatra, Indonesia
M4.3/ 0.01 S ; 96.70 E

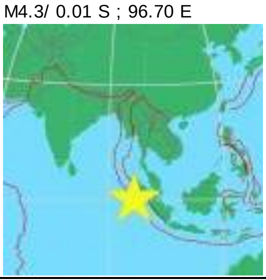


Table 8: Kalimantan Makassar Strait, Indonesia. Epicenter Zone Direction: North.

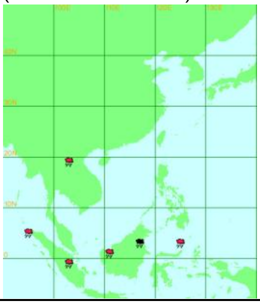
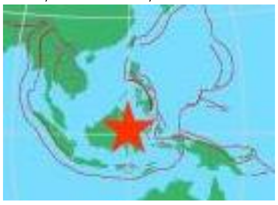
Mar.19,2021 Kalimantan NE (02.11N 117.45E 26m) 	Apr.25,2021 Makassar strait, Indonesia M4.3;4.2/ 1.16 N ; 119.88 E 

Table 9: Sunda Strait, Indonesia. Epicenter Zone Direction: South.

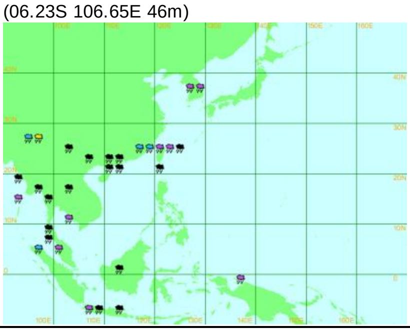
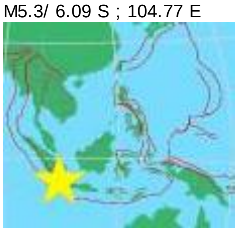
Apr.01,2021 Jawa (06.85S 109.15E 10m) 	Apr.08,2021 Sunda Strait, Indonesia M4.6/ 6.64 S ; 104.58 E 
May .18,2021 (06.23S 106.65E 46m) (06.10S 106.86E 2m) (06.18S 106.83E 8m)	May .23,2021 Sunda Strait M5.2;5.0/ 6.24 S ; 105.59 E 
Aug.01,2021 Jawa (06.23S 106.65E 46m) 	Aug.06,2021 Sunda strait M5.3/ 6.09 S ; 104.77 E 

Table 10: Java, Indonesia. Epicenter Zone Direction: South.

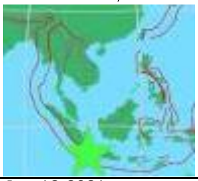
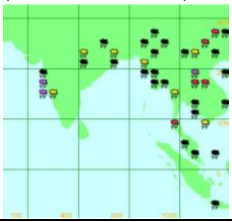
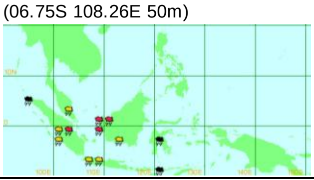
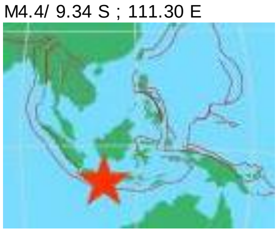
May.18,2021 Jawa (06.98S 110.38E 3m)	May.24-25,2021 Java Sea M4.3/ 5.20 S ; 109.91 E Java M4.4/ 7.20 S ; 106.38 E 
Jun.11,2021 Jawa (06.23S 106.65E 46m) 	Jun.13,2021 Java M4.0/ 8.02 S ; 107.33 E 

Table 11: South of Java. Epicenter Zone Direction: South.

Feb.20,2021 Jakarta: 52 short-finned pilot whales found dead on Indonesian beach. At least 52 among dozens of short-finned pilot whales stranded on a beach in Indonesia's East Java province.  Mar.05,2021 Jawa (08.21S 114.38E 5m) Nusatenggara (08.75S 115.16E 1m)  Mar.07,2021 Kalimantan (01.76N 109.30E 15m) (01.48N 110.33E 27m) 00.15S 109.40E 3m) Jawa (06.18S 106.83E 8m) (06.75S 108.26E 50m) 	Mar.14,2021 Jawa M4.2/ 8.73 S ; 107.25 E South of Jawa M4.4/ 9.34 S ; 111.30 E  Mar.18,2021 South of Java, Indonesia M4.8/ 10.90 S ; 110.58 E 
Jun.23-24,2021	Jun.30,2021

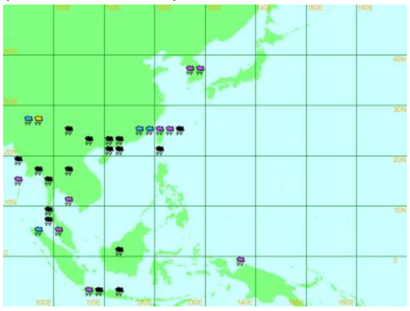
Jawa (06.70S 106.93E) (07.36S 112.76E 3m) (07.73S 109.01E 6m) 	South of java M4.1/ 10.19 S ; 111.56 E  July 08,2021 South of Java M4.1/ 9.02 S ; 111.78 E M4.8/ 9.11 S ; 112.91 E 

Table 12: Bali Sea and South of Bali Sea. Epicenter Zone Direction: South.

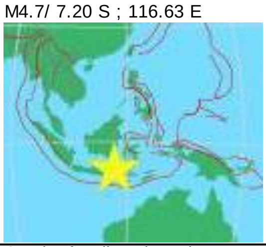
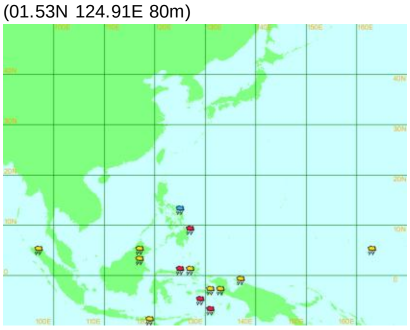
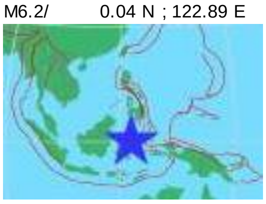
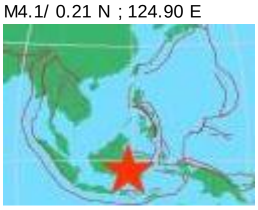
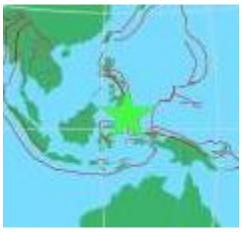
Nov.06,2021 Raging floodwaters in Indonesia Severe flooding overwhelmed parts of the Indonesian island of Java this week. The city of Batu, located in the province of East Java	Nov.07,2021 Bali Sea, Indonesia M4.7/ 7.20 S ; 116.63 E 
Jawa (08.21S 114.38E 104 mm)	South of Bali, Indonesia; 9.33 S ; 115.40 E
Oct. Kalimantan (00.11N 111.53E 65 mm),(01.26S 116.90E 95 mm)	Oct. / M 5.8 Bali Sea ; 7.00 S ; 117.56 E Oct. / M 4.3 Sumbawa region, Indonesia ; 8.41 S ; 118.78 E .

Table 13: Northern Sulawesi. Direction of ECZ: East.

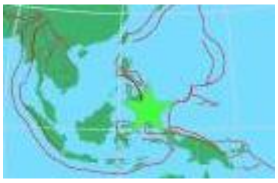
Jan.17,2021 N Sulawesi (01.53N 124.91E 80m)  Jan.16,2021 Sulawesi N (01.53N 124.91E 80m)	Jan. 06,2021 Minhasa Sulawesi M6.2/ 0.04 N ; 122.89 E  Jan.14, Minhasa Sulawesi M4.1/ 0.21 N ; 124.90 E 

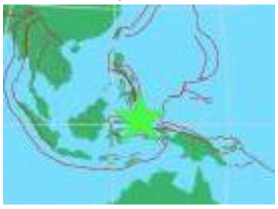
<table>
<tr><td></td><td></td></tr>
<tr><td>Jan.16,2021
Maluku and Irian Jaya
(00.76N 127.36E 23m)
(01.81N 127.83E)
(00.93S 131.11E 3m)</td><td>Jan.16,2021
Halmahera
M4.0/0.70 N ; 129.30 E

Jan. 20,2021
Kep. Tanimbar region, Indonesia
M4.8/ 6.00 S ; 131.78 E</td></tr>
<tr><td>Feb.13,2021
Sulawesi N
(00.90S 122.78E 2m)


Feb.18,2021
Sulawesi N
(01.01N 120.80E 2m)
(01.53N 124.91E 80m)
</td><td>Feb.18,2021
Kepulauan Talaud, Indonesia
M4.6/ 3.61 N ; 126.44 E


Feb.17,2021
Kepulauan Barat Daya, Indonesia
M4.1/ 7.59 S ; 127.68 E


Feb.21,2021
Kepulauan Talaud, Indonesia
M4.5/ 4.94 N ; 127.53 E


Feb.21,2021
Halmahera, Indonesia
M4.4/ 1.46 N ; 127.24 E


Feb.22,2021
Molucca Sea
M5.1/ 2.31 N ; 127.33 E</td></tr>
</table>

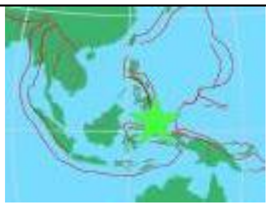
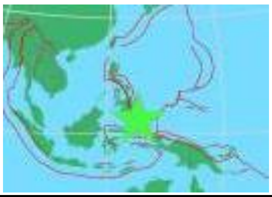
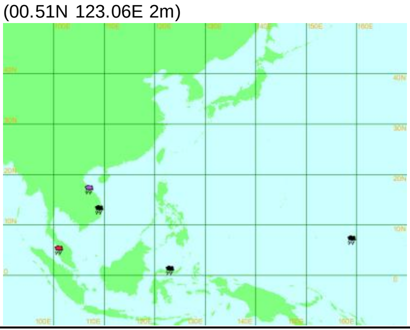
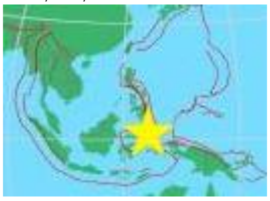
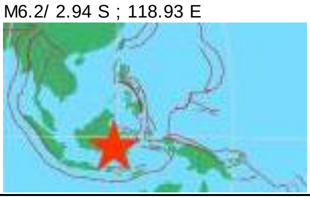
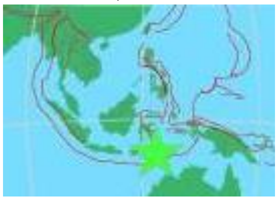
	 Mar.02,2021 Kepulauan Talaud, Indonesia M4.3/ 3.47 N ; 127.98 E 
Nov.13,2019 N Sulawesi (00.51N 123.06E 2m) 	Nov.14 -15,2019 Molucca Sea M7.1; 5.9;5.5 and numerous 4-5/1.62 N ; 126.42 E 

Table 14: Southern Sulawesi.

Jan. 08,2021 S Sulawesi (04.30S 121.53E 3m) (05.06S 119.55E) 	Jan.14,2021 Sulawesi M6.2 ;5.7/ 2.98 S ; 118.94 E Jan.15,2021 Sulawesi M6.2/ 2.94 S ; 118.93 E 
Feb.24,2021 Sulawesi (01.38S 120.73E 2m) 	Feb.22,2021 Flores region, Indonesia M4.9/ 8.78 S ; 123.44 E  Feb.25,2021 Banda Sea M4.1/ 7.37 S ; 123.85 E

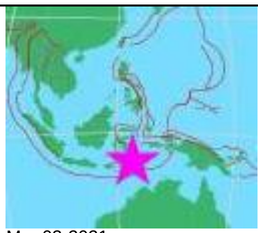
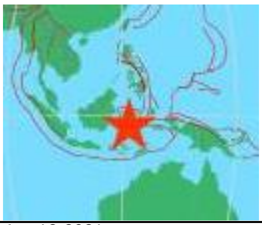
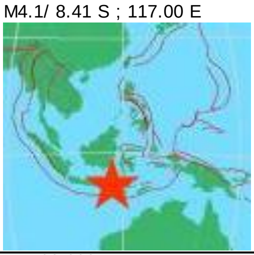
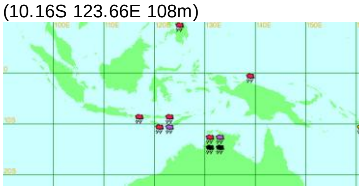
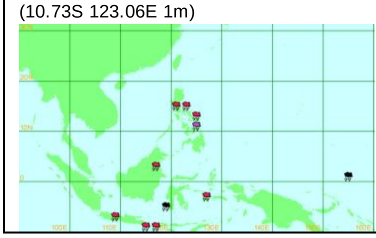
	 Mar.03.2021 Sulawesi M4.3/ 2.79 S ; 122.07 E 
Apr.05,2021 S Sulawesi (05.06S 119.55E)	Apr.12,2021 Sulawesi M4.4/ 5.05 S ; 120.57 E 

Table 15: Nusatenggara. Epicenter Zone Direction: South.

Mar.14,2021 Nusatenggara (08.63S 120.45E 1170m) 	Mar.18,2021 Sumbawa region, Indonesia M4.1/ 8.41 S ; 117.00 E 
Feb.21,2021 Nusatenggara (08.53S 116.06E 3m) (08.43S 117.41E 3m) (08.26S 122.96E) (08.26S 122.96E) (10.16S 123.66E 108m)  Feb.23,2021 Nusatenggara (08.75S 115.16E 1m) (08.53S 116.06E 3m) (10.73S 123.06E 1m) 	Mar.03.2021 Sumba M4.0/10.25 S ; 119.10 E 

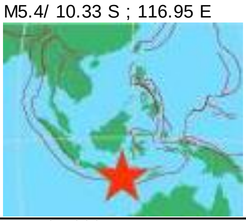
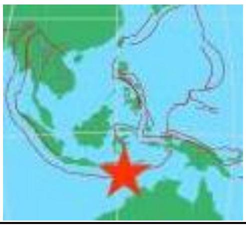
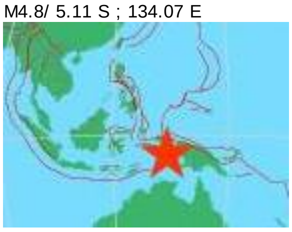
Feb.25,2021 Nusatenggara (08.43S 117.41E 3m) (08.63S 120.45E 1170m) SE Sulawesi (04.10S 122.43E 50m) 	
Apr.03,2021 Nusatenggara (08.21S 114.38E 5m) 	Apr.15,2021 South of Sumbawa M5.4/10.40 S ; 117.07 E Apr.16,2021 South of Sumbawa M4.4;4.7/ 11.37 S ; 117.81 E  Apr.16,2021 South of Lombok, Indonesia M5.4/ 10.33 S ; 116.95 E 
Mar.26,2021 Nusatenggara (08.63S 120.45E 1170m) 	May.07,2021 Savu Sea M4.5/10.65 S ; 121.88 E 
Australia (For E Timor) (12 38S 130 22E 50.4 mm)	Nov. /M 5.8 Timor region, Indonesia : 10.08 S ; 123.77 E.

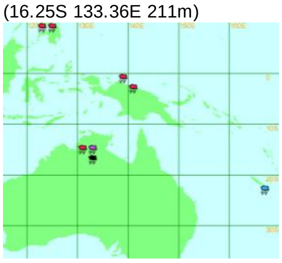
Table 16: Maluku and Irian Jaya, Indonesia.

Feb.15-16,2021 Maluku and Irian jaya (4.53S 129.90E) (05.00S 137.45E 3m) Northern Australia (12.23S 131.88E 1m) (13.66S 134.33E 103m)  Feb.21,2021 Maluku and Irian Jaya (01.83S 138.71E 3m)	Mar.02,2021 Kepulauan Aru region, Indonesia M4.8/ 5.11 S ; 134.07 E  Mar.02,2021 Kep. Tanimbar region, Indonesia M4.6/ 6.61 S ; 132.26 E

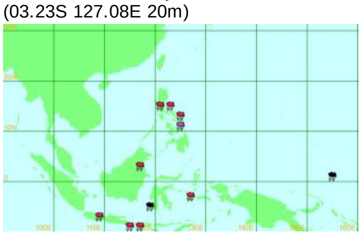
Feb.21,2021
Australia NC
(13.83S 131.18E 44m)
(13.33S 133.08E 416m)
(14.95S 130.80E 76m)
(15.75S 131.91E 222m)
(14.51S 132.36E 135m)

Feb.22,2021
Maluku and Irian Jaya
(01.83S 138.71E 3m)
(02.56S 140.48E 99m)

Feb.22,2021
NC Australia
(14.95S 130.80E 76m)
(16.25S 133.36E 211m)

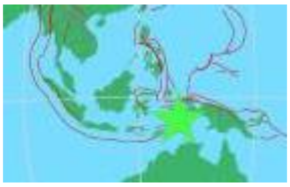


Feb.23,2021
Maluku and Irian Jaya
(03.23S 127.08E 20m)

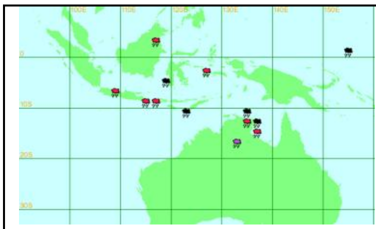


Feb.23,2021
Australia N (for Maluku and Irian Jaya)
(12.00S 135.56E 9m)
(12.11S 134.90E 5m)
(13.98S 136.46E 14m)
(15.75S 136.80E 13m)
(16.25S 133.36E 211m)

Mar.02.2021
Banda Sea
M4.7/ 6.12 S ; 130.34 E



Mar.02.2021
Seram
M4.2/ 2.91 S ; 129.76 E

<table>
<tr><td>
Feb.25,2021
Australia (S of Maluku and Irian Jaya)
(11.05S 132.98E 2m)
(11.05S 132.98E 2m)
(12.63S 130.36E 4m)
(12.23S 131.88E 1m)
(11.01S 136.75E 19m)
(12.11S 134.90E 5m)

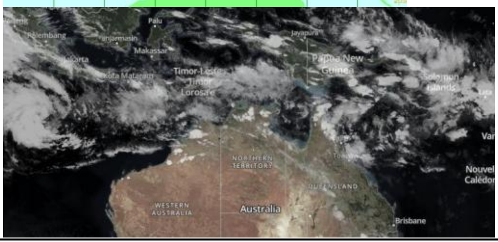
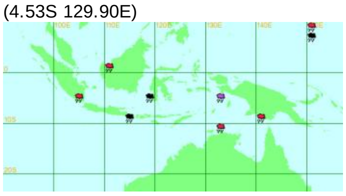
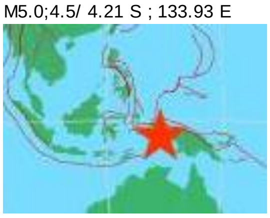
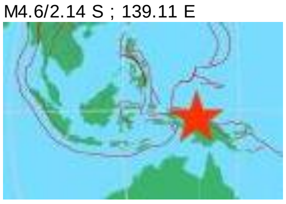
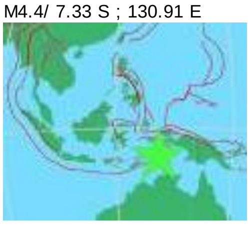
</td><td></td></tr>
</table>

Table 17: Papua, Indonesia. Epicenter zone direction: North.

<table>
<tr><td>Mar.04,2021
Maluku and Irian Jaya
(05.68S 132.75E 12m)
</td><td>Mar.18,2021
Papua, Indonesia
M4.5/ 4.45 S ; 137.29 E
</td></tr>
<tr><td>Mar.05,2021
Maluku and Irian Jaya
(05.68S 132.75E 12m)
(08.46S 140.38E 3m)
Australia
(11.05S 132.98E 2m)
Mar.06,2021
(4.53S 129.90E)

Mar.09,2021
Maluku and Irian Jaya
(02.56S 140.48E 99m)
(05.00S 137.45E 3m)
(06.10S 140.30E 16m)</td><td>Mar.18,2021
Near S coast of Papua, Indonesia
M5.0;4.5/ 4.21 S ; 133.93 E

Mar.26,2021
Near N coast of Papua, Indonesia
M4.6/2.14 S ; 139.11 E

Papua, Indonesia
M4.0/3.96 S ; 134.05 E</td></tr>
</table>

 Mar.14,2021 Maluku and Irian Jaya (03.91S 136.36E 1770m) (05.00S 137.45E 3m) 	
Mar.18,2021 Maluku and Irian Jaya (03.66S 133.75E 3m) Mar.21,2021 Maluku and Irian Jaya (03.33S 135.50E 3m) 	Mar.27,2021 Papua, Indonesia M4.1/ 3-4 S ; 139.62 E 
Mar.27,2021 Maluku and Irian Jaya N (01.83S 138.71E 3m) Maluku and Irian Jaya S (08.46S 140.38E 3m) 	Apr.02,2021 Papua, Indonesia M4.2/ 2.66 S ; 138.62 E 
Mar.29,2021 Maluku and Irian Jaya (03.80S 130.83E 3m) (4.53S 129.90E) 07.98S 131.30E 24m) (05.00S 137.45E 3m)  Mar.31,2021 NC Australia (11.05S 132.98E 2m) (11.01S 136.75E 19m) (12.00S 135.56E 9m) (12.28S 136.81E 53m)  Apr.03,2021 Maluku and Irian Jaya (03.80S 130.83E 3m)	Apr.12,2021 Kep. Tanimbar region, Indonesia M4.4/ 7.33 S ; 130.91 E 

(02.88S 132.25E 130m) (02.36S 140.71E 3m) (05.00S 137.45E 3m) N Australia (11.05S 132.98E 2m) (11.01S 136.75E 19m) (12.05S 134.23E) 	
Sep.05,2021 Maluku and Irian Jaya (00.93S 131.11E 3m) (03.80S 130.83E 3m) (02.88S 132.25E 130m) (05.68S 132.75E 12m) (4.53S 129.90E) 	Sep.09,2021 Papua, Indonesia M5.0/ 3.97 S ; 134.96 E  Sep.12,2021 Near N Coast of Papua, Indonesia M4.6/ 2.67 S ; 139.17 E 

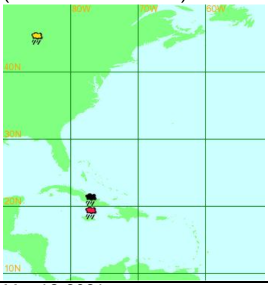
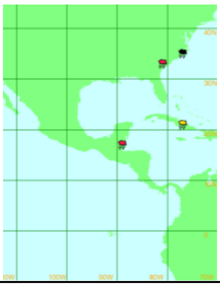
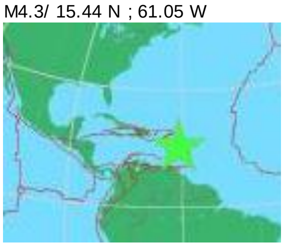
Table 18: Caribbean Regions.

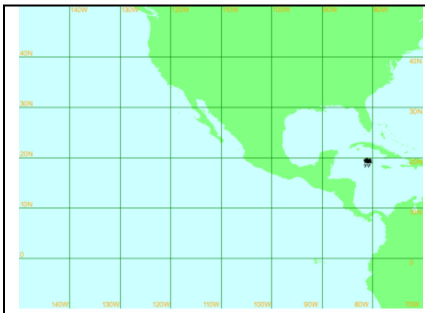
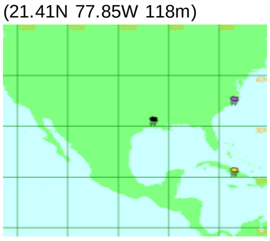
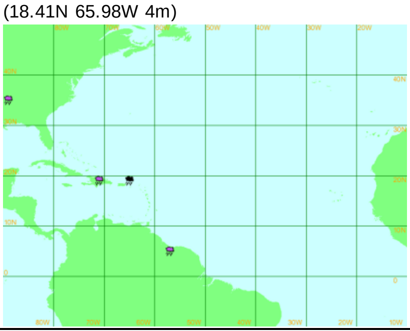
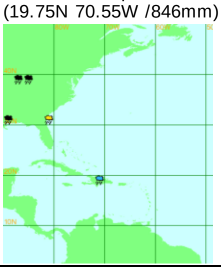
Number of Epicenter Zones
Caribbean (16)
Cuba Virgin Islands Northern Colombia Dominican Republic region Haiti Dominican regions Leeward Isl. Isla de Margarita, Venezuela rg. Gulf of Paria, Venezuela Carabobo, Venezuela Anguilla, Leeward Isl. Martinique region, Windward Isl. Northern Mid-Atlantic ridge East of Guadeloupe, Leeward Isl. Guadeloupe region, Leeward Isl. Barbados region, Windward Isl. Antigua and Barbuda region Trinidad, Trinidad and Tobago

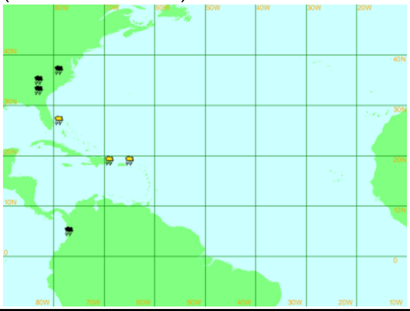
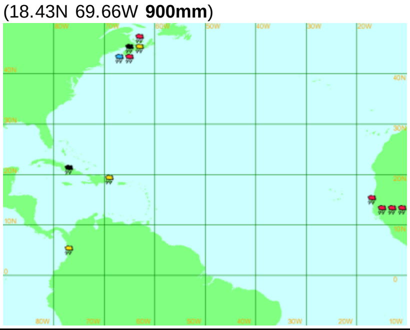
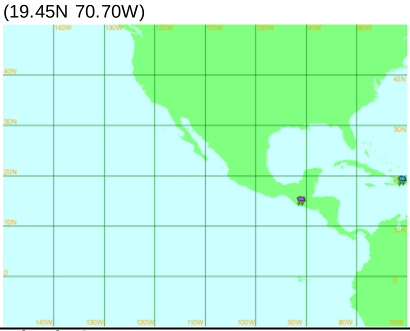
Table 19: Caribbean: Puerto Rico and Dominican Republic. Epicenter zone direction: North and South.

Netherlands Antilles and Aruba (18.03N 63.11W 61.0 mm) Anguilla (18.20N 63.05W 92.1mm)	M 5.8 Antigua and Barbuda ; 17.01 N ; 60.29 W.
Dominican Republic (17-19N 62,64-65,68,70W)(65-988mm at 5 stans).	Dominican Republic ; 18.51 N ; 68.98 W .
Puerto rico (18N 64-65W)	May / M 5.8 Mona Passage, Dominican republic; 18.13 N ; 68.39 W.
Netherlands Antilles and Aruba (17.48N 62.98W 988.9 mm) Saint Lucia (13-14N 60-61W)	Martinique region, Windward Isl.; 14.29 N; 60.18 W.
Guyana (06.25N 57-58W)(56.4-127mm)	July/M 6.5 Barbados region, Windward Isl. ; 13.83 N ; 58.64 W

Table 20: Caribbean Sea. Epicenter zone Direction: South.

Jun.13,2021 Cuba (21.41N 77.85W 118m) (18.50N 77.91W 8m) NC. (34.26N 77.90W 10m) SC. (32.88N 80.01W 15m)  	Jun.29,2021 Cuba M4.7/ 22.83 N ; 82.90 W 
Mar.13,2021 Dominica (15.53N 61.30W 14m)	Mar.26,2021 Guadeloupe region, Leeward Isl. M5.8/ 16.68 N ; 60.79 W  Mar.27,2021 Dominican regions Leeward Isl. M4.3/ 15.44 N ; 61.05 W  Mar.29,2021 Barbados region, Windward Isl. M5.5/ 13.84 N ; 58.45 W  Mar.31,2021 Dominican Republic M4.1/ 19.14 N ; 69.05 W 
May.28,2021 Cayman Islands (19.28N 81.35W 3m)	May.30,2021 Cuba M4.1/19.58 N ; 77.99 W

 May .30,2021 Cuba (21.41N 77.85W 118m) 	
Jun.05,2021 Cuba (21.41N 77.85W 118m)  Jun.10,2021 Dominican Republic (19.45N 70.70W) Puerto Rico (18.41N 65.98W 4m) 	Jun.10,2021 Puerto Rico M4.2/19.04 N ; 66.12 W  Jun.17,2021 Mona passage, Dominican republic M4.4/ 18.15 N ; 68.44 W 
Jun.18,2021 Dominican Republic (19.75N 70.55W /846mm) 	Jun.28,2021 Puerto Rico M4.0/ 19.01 N ; 66.92 W 
Aug. 01,2019 Dominican Republic (18.43N 69.88W 14m) Puerto Rico Caribbean area	Aug. 05,2019 Cuba M 4.3 / 19.56 N ; 74.22 W

<table>
<tr><td>(18.33N 64.96W 67m)
</td><td></td></tr>
<tr><td>Aug. 30,2019
Dominican Republic
(18.43N 69.66W 900mm)
</td><td>Aug. 31,2019
Virgin Islands region
M 4.8 / 19.02 N ; 64.05 W
</td></tr>
<tr><td>Sep.15-16,2019
Dominican republic
(19.45N 70.70W)
</td><td>Sep.16,2019
Dominican republic region
M 4.2/19.54 N ; 69.79 W
</td></tr>
<tr><td>Atlantic Ocean
Sep.22-24,2019
Tropical Storm Karen (Caribbean region)
Location: 11.9°N -60.2°W
Wind:40mph
Sep.23-24,2019
Tropical Storm Lorenzo (S Africa to UK)
Location: 10.8°N-20.9°W
Wind:50mph at 11.6°N-26.7°W
Sep.17-24,2019
Hurricane 2 Jerry (Caribbean to NE)
Location: 12.9°N-44.9°W
Wind:105mph at 18.4°N-58.7°W</td><td>Sep.24-25,2019
Puerto-Rico
M 6.0; 4.7; 4.6; 4.9; 4.6; 4.2/18.95 N ; 67.40 W
</td></tr>
<tr><td>Sep.16,2019
Guadeloupe
(16.26N 61.60W 11m)
St Lucia
(14.01N 61.00W 2m)</td><td>Sep.16,2019
Cayman Islands
M 4.4/17.63 N ; 82.32 W</td></tr>
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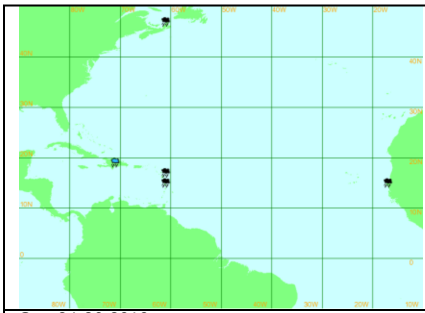
<td></td>
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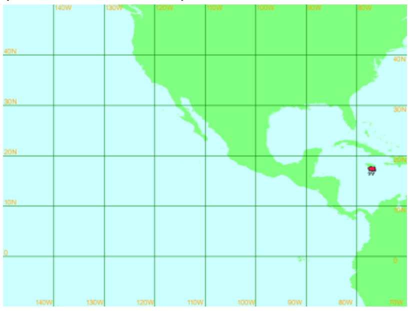
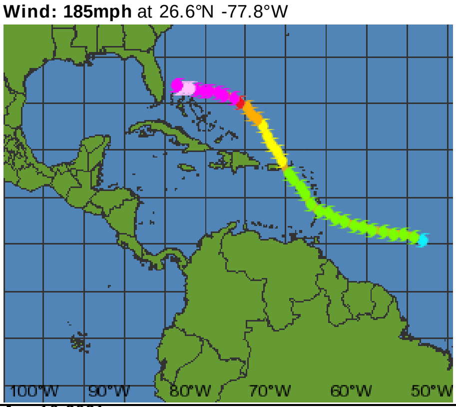
<tr>
<td>Sep.24-26,2019
Jamaica
(17.93N 76.78W 14m)
</td>
<td>Sep.25,2019
Haiti
M 4.6/17.93 N ; 73.60 W
</td>
</tr>
<tr>
<td>Aug. 24-27,2019
Tropical Storm Dorian
Location: 10.4°N -47.9°W
Wind:90mph at 11.9°N -56.4°W
Aug. 30,2019
Location: 23.3°N -68.4°W
Wind:105mph
Sep.01-02,2019
Category 5 Hurricane Dorian
Location: 26.5°N -77.0°W
Wind: 185mph at 26.6°N -77.8°W

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<td>Sep.09,2019
Offshore Anzoategui, Venezuela
M 5.5/ 10.60 N ; 64.75 W
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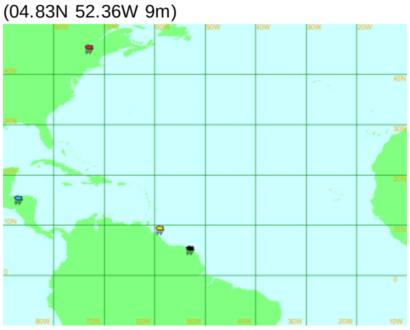
<tr>
<td>Jan.10,2021
Guyana
(08.20N 59.78W 50m)
French Guiana
(04.83N 52.36W 9m)


Jan. 31,2021</td>
<td>Jan. 31,2021
Guyana
M5.7;4.3;4.3;4.2/ 2.72 N ; 59.66 W
</td>
</tr>
</table>

Suriname (05.81N 55.18W 7m) French Guiana (04.83N 52.36W 9m)