UNESCO IOC / NOAA
International Tsunami Information Centre
Tsunami Training Video, August 2022

unesco
Intergovernmental Oceanographic Commission

National Oceanic and Atmospheric Administration

Servicio Hidrográfico y Oceanográfico de la Armada de Chile

International Tsunami Information Centre

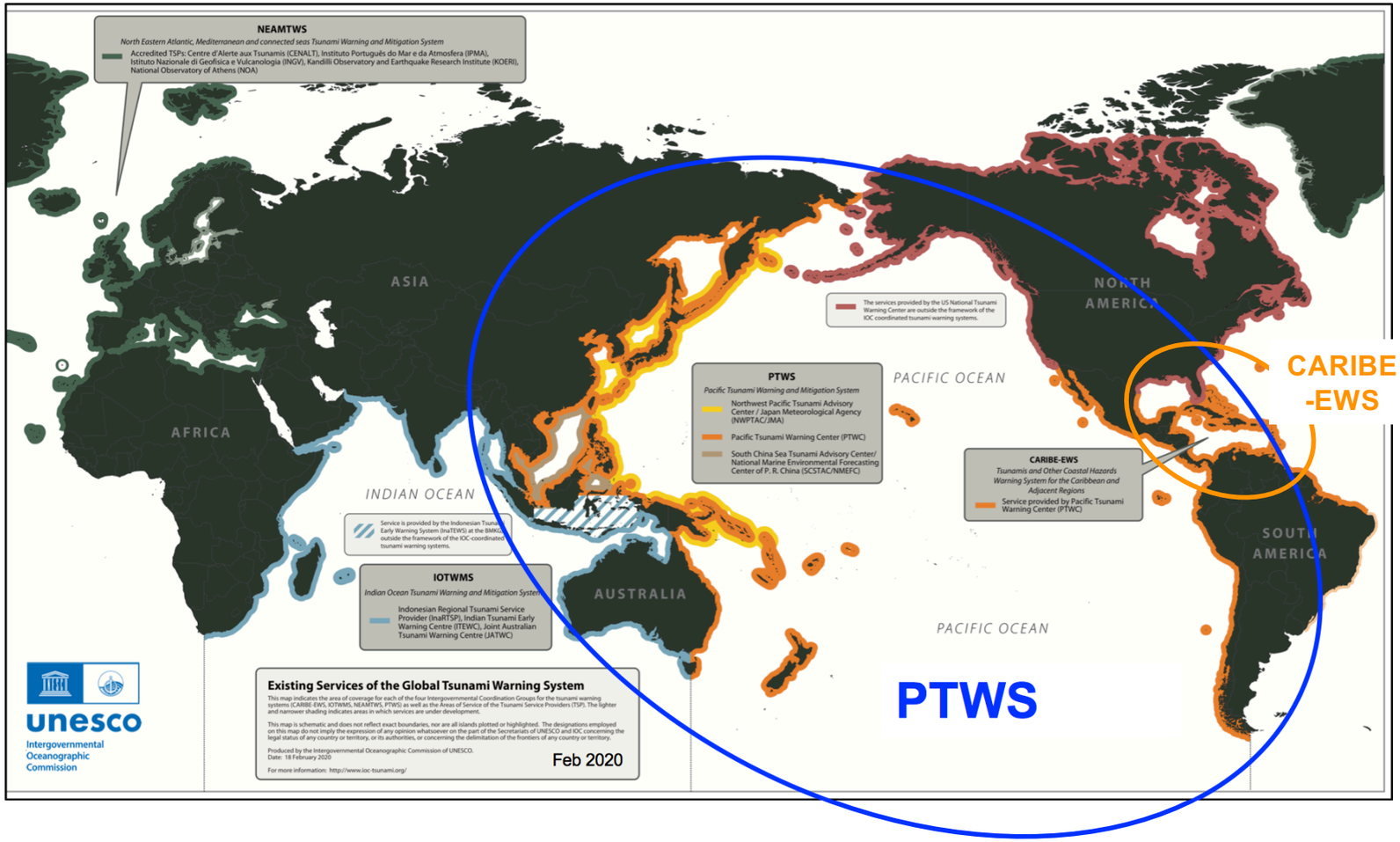
Pacific Tsunami Warning Center (PTWC)

Product Staging from the earthquake, through data collection and analyses, to tsunami forecasting, and product generation and dissemination

Dr. Charles “Chip” McCreery
Director, PTWC

Video view/download: https://vimeo.com/showcase/8956022 (pw training)

Global Tsunami Warning and Mitigation System



PTWC

is

Tsunami Service Provider

for the

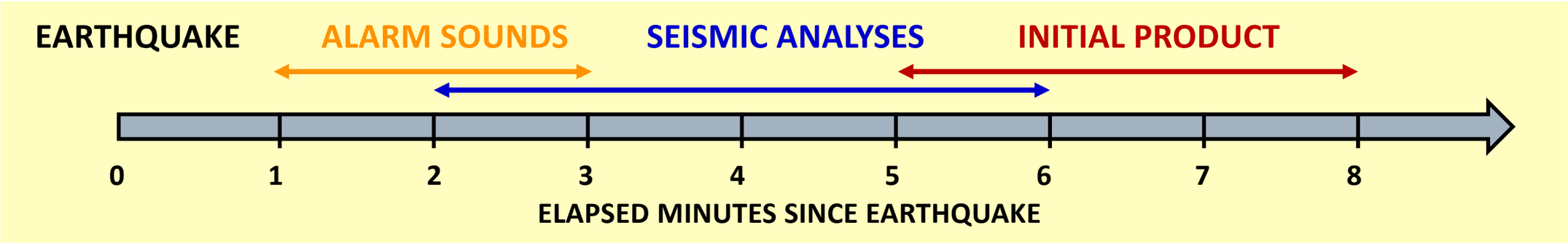
PTWS

(*Pacific Tsunami Warning and Mitigation System*)

CARIBE-EWS

(Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions)

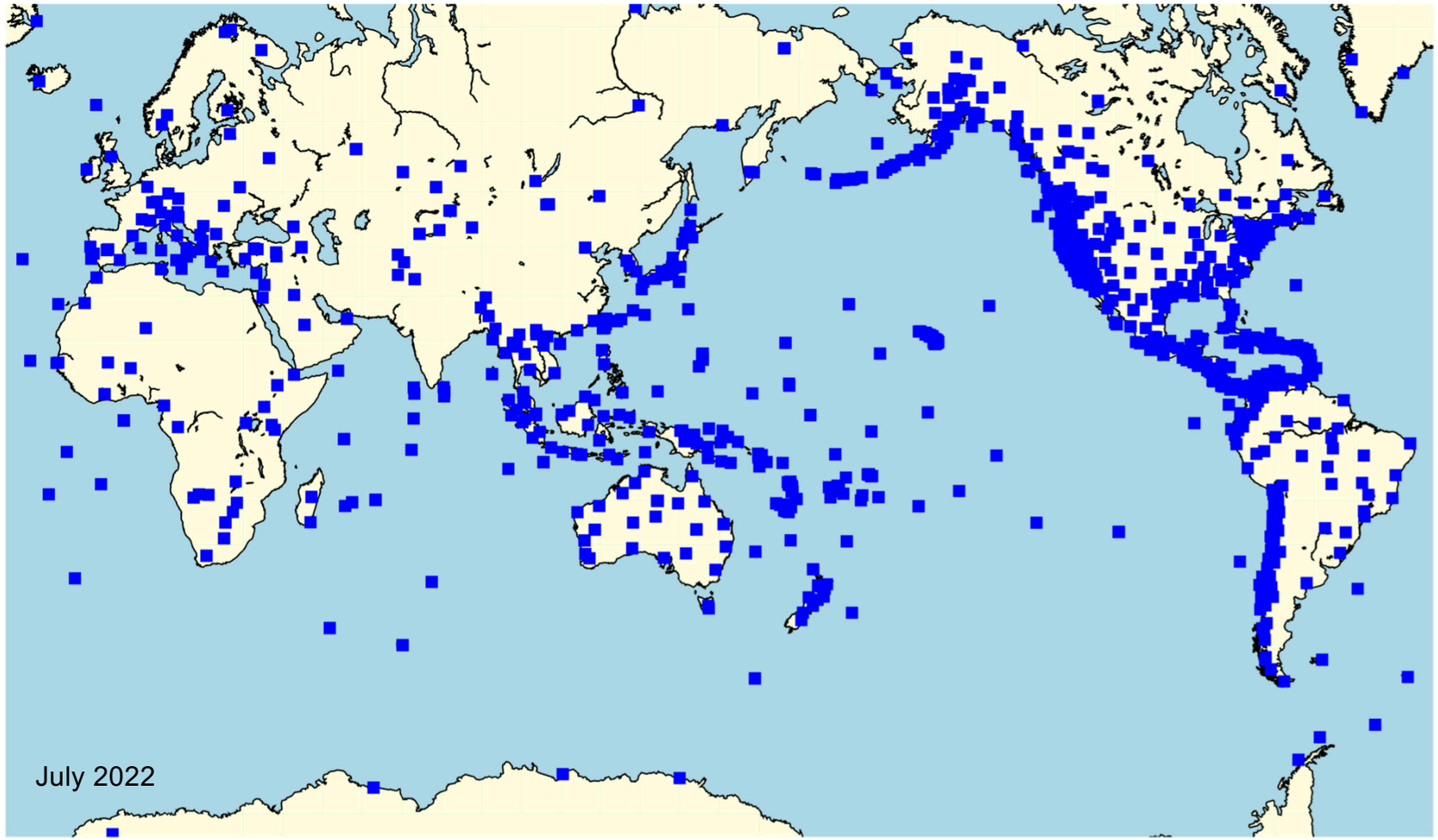
PTWC Typical Timeline for an Earthquake / Tsunami



0 min	A large earthquake occurs.
1 - 3 min	Vibrations from earthquake reach seismic stations near earthquake epicenter, triggering event alarms at PTWC. Duty analysts respond to operations center and begin to analyze event. PTWC currently monitors ~ 600 seismic stations from around world, with data collected usually reaching PTWC within minute of when collected.
2 - 6 min	Using combination of automatic and interactive analyses, duty analysts complete their preliminary determination of the earthquake epicenter, depth, and magnitude.
5 - 8 min	If pre-determined criteria met, then initial text product issued that is either Tsunami Information Statement or Tsunami Threat Message. For Threat Message, estimated time of the tsunami first arrival is included in message for key coastal locations.

Video of Pwave

PTWC Global Seismic Network monitored by PTWC



Text Message - Initial: Tsunami Threat Message

ZCZC
WEPA40 PHEB 050640
TSUPAC

TSUNAMI MESSAGE NUMBER 1
NWS PACIFIC TSUNAMI WARNING CENTER HONOLULU HI
0640 UTC MON NOV 5 2018

... PTWC TSUNAMI THREAT MESSAGE ...

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

THIS MESSAGE IS ISSUED FOR INFORMATION ONLY IN SUPPORT OF THE UNESCO/IOC PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM AND IS MEANT FOR NATIONAL AUTHORITIES IN EACH COUNTRY OF THAT SYSTEM.

NATIONAL AUTHORITIES WILL DETERMINE THE APPROPRIATE LEVEL OF ALERT FOR EACH COUNTRY AND MAY ISSUE ADDITIONAL OR MORE REFINED INFORMATION.

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

PRELIMINARY EARTHQUAKE PARAMETERS

* MAGNITUDE 8.5
* ORIGIN TIME 0634 UTC NOV 5 2018
* COORDINATES 36.1 SOUTH 72.9 WEST
* DEPTH 23 KM / 14 MILES
* LOCATION NEAR THE COAST OF CENTRAL CHILE

EVALUATION

* AN EARTHQUAKE WITH A PRELIMINARY MAGNITUDE OF 8.5 OCCURRED NEAR THE COAST OF CENTRAL CHILE AT 0634 UTC ON MONDAY NOVEMBER 5 2018.
* BASED ON THE PRELIMINARY EARTHQUAKE PARAMETERS... WIDESPREAD HAZARDOUS TSUNAMI WAVES ARE POSSIBLE.

TSUNAMI THREAT FORECAST

* HAZARDOUS TSUNAMI WAVES FROM THIS EARTHQUAKE ARE POSSIBLE WITHIN THE NEXT THREE HOURS ALONG SOME COASTS OF

CHILE AND PERU

RECOMMENDED ACTIONS

* GOVERNMENT AGENCIES RESPONSIBLE FOR THREATENED COASTAL AREAS SHOULD TAKE ACTION TO INFORM AND INSTRUCT ANY COASTAL POPULATIONS AT RISK IN ACCORDANCE WITH THEIR OWN EVALUATION... PROCEDURES AND THE LEVEL OF THREAT.
* PERSONS LOCATED IN THRE
FOR INFORMATION AND FOLL
LOCAL AUTHORITIES.

ESTIMATED TIMES OF ARRIVAL

* ESTIMATED TIMES OF ARRIV
FOR PLACES WITH A POTENT
TIMES MAY DIFFER AND THE
LARGEST. A TSUNAMI IS A
WAVES CAN BE FIVE MINUTE

REGION	LOCATI			
CHILE	TALCAHUANO	36.7S	73.1W	0710 11/05
	VALPARAISO	33.0S	71.6W	0719 11/05
	JUAN FERNANDEZ	33.6S	78.8W	0734 11/05
	COQUIMBO	29.9S	71.4W	0740 11/05
	CORRAL	39.8S	73.5W	0743 11/05
	CALDERA	27.1S	70.8W	0800 11/05
	SAN FELIX	26.3S	80.1W	0825 11/05
	ANTOFAGASTA	23.3S	70.4W	0825 11/05
	IQUIQ			
	GOLFO			
	ARICA			
PERU	MOLLEN			
	SAN JU			

POTENTIAL IMPACTS

* A TSUNAMI IS A SERIES OF
CAN VARY FROM 5 MINUTES
FOR MANY HOURS OR LONGER
* IMPACTS CAN VARY SIGNIFI
THE NEXT DUE TO LOCAL BATHYMETRY AND THE SHAPE AND ELEVATION OF THE SHORELINE.
* IMPACTS CAN ALSO VARY DEPENDING UPON THE STATE OF THE TIDE AT THE TIME OF THE MAXIMUM TSUNAMI WAVES.
* PERSONS CAUGHT IN THE WATER OF A TSUNAMI MAY DROWN... BE CRUSHED BY DEBRIS IN THE WATER... OR BE SWEPT OUT TO SEA.

NEXT UPDATE AND ADDITIONAL INFORMATION

* THE NEXT MESSAGE WILL BE ISSUED IN ONE HOUR... OR SOONER IF THE SITUATION WARRANTS.
* AUTHORITATIVE INFORMATION ABOUT THE EARTHQUAKE FROM THE U.S.

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Text Message – Initial: Tsunami Threat Message

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TSUNAMI MESSAGE NUMBER 1
NWS PACIFIC TSUNAMI WARNING CENTER HONOLULU HI
0640 UTC MON NOV 5 2018

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RECOMMENDED ACTIONS
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    SHOULD TAKE ACTION TO INFORM AND INSTRUCT ANY COASTAL
    POPULATIONS AT RISK IN ACCORDANCE WITH THEIR OWN
    EVALUATION... PROCEDURES AND THE LEVEL OF THREAT.

  * PERSONS LOCATED IN THREATENED COASTAL AREAS SHOULD STAY ALERT
    FOR INFORMATION AND FOLLOW INSTRUCTIONS FROM NATIONAL AND
    LOCAL AUTHORITIES.


ESTIMATED TIMES OF ARRIVAL
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    TIMES MAY DIFFER AND THE INITIAL WAVE MAY NOT BE THE
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    WAVES CAN BE FIVE MINUTES TO ONE HOUR.

    REGION            LOCATION          COORDINATES     ETA(UTC)
    ------------------------------------------------------------
    CHILE             TALCAHUANO        36.7S  73.1W    0710 11/05
                      VALPARAISO        33.0S  71.6W    0719 11/05
                      JUAN FERNANDEZ    33.6S  78.8W    0734 11/05
                      COQUIMBO          29.9S  71.4W    0740 11/05
                      CORRAL            39.8S  73.5W    0743 11/05

    PERU


POTENTIAL IMPAC
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  * PERSONS CAU
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NEXT UPDATE AND ADDITIONAL INFORMATION
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  * THE NEXT MESSAGE WILL BE ISSUED IN ONE HOUR... OR SOONER IF
    THE SITUATION WARRANTS.

  * AUTHORITATIVE INFORMATION ABOUT THE EARTHQUAKE FROM THE U.S.
    GEOLOGICAL SURVEY CAN BE FOUND ON THE INTERNET AT
    EARTHQUAKE.USGS.GOV.

  * FURTHER INFORMATION ABOUT THIS EVENT MAY BE FOUND AT
    WWW.TSUNAMI.GOV.

  * COASTAL REGIONS OF HAWAII... AMERICAN SAMOA... GUAM... AND
    CNMI SHOULD REFER TO PACIFIC TSUNAMI WARNING CENTER MESSAGES
    SPECIFICALLY FOR THOSE PLACES THAT CAN BE FOUND AT
    WWW.TSUNAMI.GOV.

  * COASTAL REGIONS OF CALIFORNIA... OREGON... WASHINGTON...
    BRITISH COLUMBIA AND ALASKA SHOULD ONLY REFER TO U.S.
    NATIONAL TSUNAMI WARNING CENTER MESSAGES THAT CAN BE FOUND
    AT WWW.TSUNAMI.GOV.

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NNNN
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ESTIMATED TIMES OF ARRIVAL

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REGION	LOCATION	COORDINATES	ETA(UTC)
CHILE	TALCAHUANO	36.7S 73.1W	0710 11/05
	VALPARAISO	33.0S 71.6W	0719 11/05

Criteria for PTWS PTWC Initial Products

Earthquake				Product	
Region	Location	Depth	Magnitude	Type	Tsunami Threat
Pacific Ocean and its Marginal Seas	under the sea	any	< 6.5	none	none
			6.5 – 7.0	Information Statement	none
	inland		≥ 6.5	Information Statement	none
	under the sea	≥ 100 km	≥ 7.1	Information Statement	none
		< 100 km	7.1 - 7.5	Threat Message	Potential Threat within 300 km
			7.6 – 7.8	Threat Message	Potential Threat within 1000 km
			≥ 7.9	Threat Message	Potential Threat if ETA ≤ 3 hours

PTWC Typical Timeline for an Earthquake / Tsunami

15 – 20 min	Seismic analyses continue as data from additional seismic stations arrive and are processed. If earthquake parameters change significantly based on these analyses then appropriate supplemental text product issued, using procedures above.
20 – 45 min	If there is a tsunami threat, W-phase Centroid Moment Tensor (WCMT) analysis is triggered with results typically available about 20 - 30 minutes after earthquake. WCMT analysis not only gives a more accurate estimate of earthquake's location, depth and magnitude, but also estimate of the earthquake's faulting mechanism – the geometry of fault and amount of slip across fault.
	From these fault parameters an estimate of seafloor deformation is computed that drives run of RIFT tsunami forecast model. This model provides estimate of tsunami amplitudes for all coasts covered by run. Area of ocean covered by run may a region near earthquake (for speed) or entire ocean basin.
	Follow-up Tsunami Threat Message based on RIFT results then issued that refines and quantifies threat to coastal areas. Products are Public Text Message and TWFP/NTWC-only products graphical forecast maps, statistics table, and KMZ file of forecast amplitudes for region covered by RIFT run.

Text Message: Updated Magnitude

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ZCZC
WEPA40 PHEB 050700
TSUPAC

TSUNAMI MESSAGE NUMBER 2
NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI
0700 UTC MON NOV 5 2018

...PTWC TSUNAMI THREAT MESSAGE...


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**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

THE TSUNAMI FORECAST IS UNCHANGED IN THIS MESSAGE.

PRELIMINARY EARTHQUAKE PARAMETERS
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  * MAGNITUDE      8.8
  * ORIGIN TIME    0634 UTC NOV 5 2018
  * COORDINATES    36.1 SOUTH  72.9 WEST
  * DEPTH          23 KM / 14 MILES
  * LOCATION       NEAR THE COAST OF CENTRAL CHILE

EVALUATION
----------

 * AN EARTHQUAKE WITH A PRELIMINARY MAGNITUDE OF 8.8 OCCURRED
   NEAR THE COAST OF CENTRAL CHILE AT 0634 UTC ON MONDAY
   NOVEMBER 5 2018.

  * BASED ON ALL AVAILABLE DATA...HAZARDOUS TSUNAMI WAVES ARE
    FORECAST FOR SOME COASTS.

TSUNAMI THREAT FORECAST...UPDATED
---------------------------------

  * TSUNAMI WAVES REACHING MORE THAN 3 METERS ABOVE THE TIDE LEVEL
    ARE POSSIBLE ALONG SOME COASTS OF

      CHILE.


  * TSUNAMI WAVES REACHING 1 TO 3 METERS ABOVE THE TIDE LEVEL
    ARE POSSIBLE ALONG SOME COASTS OF

      PERU.


  * TSUNAMI WAVES REACHING 0.3 TO 1 METERS ABOVE THE TIDE LEVEL
    ARE POSSIBLE FOR SOME COASTS OF

     ANTARCTICA... COLOMBIA... AND ECUADOR.
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 *  ACTUAL AMPLITUDES AT THE COAST MAY VARY FROM FORECAST
    AMPLITUDES DUE TO UNCERTAINTIES IN THE FORECAST AND LOCAL
    FEATURES. IN PARTICULAR MAXIMUM TSUNAMI AMPLITUDES ON ATOLLS
    AND AT LOCATIONS WITH FRINGING OR BARRIER REEFS WILL LIKELY
    BE MUCH SMALLER THAN THE FORECAST INDICATES.

  * FOR OTHER AREAS COVERED BY THIS PRODUCT A FORECAST HAS NOT
    YET BEEN COMPUTED. THE FORECAST WILL BE EXPANDED IF
    NECESSARY IN SUBSEQUENT PRODUCTS.


 RECOMMENDED ACTIONS
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  * GOVERNMENT AGENCIES RESPONSIBLE FOR THREATENED COASTAL AREAS
    SHOULD TAKE ACTION TO INFORM AND INSTRUCT ANY COASTAL
    POPULATIONS AT RISK IN ACCORDANCE WITH THEIR OWN
    EVALUATION... PROCEDURES AND THE LEVEL OF THREAT.

  * PERSONS LOCATED IN THREATENED COASTAL AREAS SHOULD STAY ALERT
    FOR INFORMATION AND FOLLOW INSTRUCTIONS FROM NATIONAL AND
    LOCAL AUTHORITIES.

ESTIMATED TIMES OF ARRIVA
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  * ESTIMATED TIMES OF AR
    FOR PLACES WITHIN TH
    ARRIVAL TIMES MAY DI
    LARGEST. A TSUNAMI IS
    WAVES CAN BE FIVE MI

    LOCATION          REGI
    ------------------------
     CHILE            TAL
                      VAL
                      JUA
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                      SAN
                      ANT
                      IQUIQUE              20.2S  70.1W   0852 11/05
                      GOLFO DE PENAS       47.1S  74.9W   0858 11/05
                      ARICA                18.5S  70.3W   0907 11/05
                      PUERTO MONTT         41.5S  73.0W   1038 11/05
                      EASTER ISLAND        27.1S 109.4W   1153 11/05
     PERU             MOLLENDO             17.1S  72.0W   0918 11/05
                      SAN JUAN             15.3S  75.2W   0935 11/05
                      LA PUNTA             12.1S  77.2W   1025 11/05
                      TALARA                4.6S  81.5W   1114 11/05
                      CHIMBOTE              9.0S  78.8W   1117 11/05
                      PIMENTAL              6.9S  80.0W   1142 11/05
     ECUADOR          LA LIBERTAD           2.2S  81.2W   1136 11/05
                      ESMERELDAS            1.2N  79.8W   1223 11/05
                      BALTRA ISLAND         0.5S  90.3W   1319 11/05
     COLOMBIA         TUMACO                1.8N  78.9W   1242 11/05
                      BAHIA SOLANO          6.3N  77.4W   1315 11/05
                      BUENAVENTURA          3.8N  77.2W   1328 11/05
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POTENTIAL IMPACTS
-----------------

  * A TSUNAMI IS A SERIES OF WAVES. THE TIME BETWEEN WAVE CRESTS
    CAN VARY FROM 5 MINUTES TO AN HOUR. THE HAZARD MAY PERSIST
    FOR MANY HOURS OR LONGER AFTER THE INITIAL WAVE.

  * IMPACTS CAN VARY SIGNIFICANTLY FROM ONE SECTION OF COAST TO
    THE NEXT DUE TO LOCAL BATHYMETRY AND THE SHAPE AND ELEVATION
    OF THE SHORELINE.

  * IMPACTS CAN ALSO VARY DEPENDING UPON THE STATE OF THE TIDE AT
    THE TIME OF THE MAXIMUM TSUNAMI WAVES.

  * PERSONS CAUGHT IN THE WATER OF A TSUNAMI MAY DROWN... BE
    CRUSHED BY DEBRIS IN THE WATER... OR BE SWEPT OUT TO SEA.

NEXT UPDATE AND ADDITIONAL INFORMATION
--------------------------------------

  * THE NEXT MESSAGE WILL BE ISSUED IN ONE HOUR... OR SOONER IF
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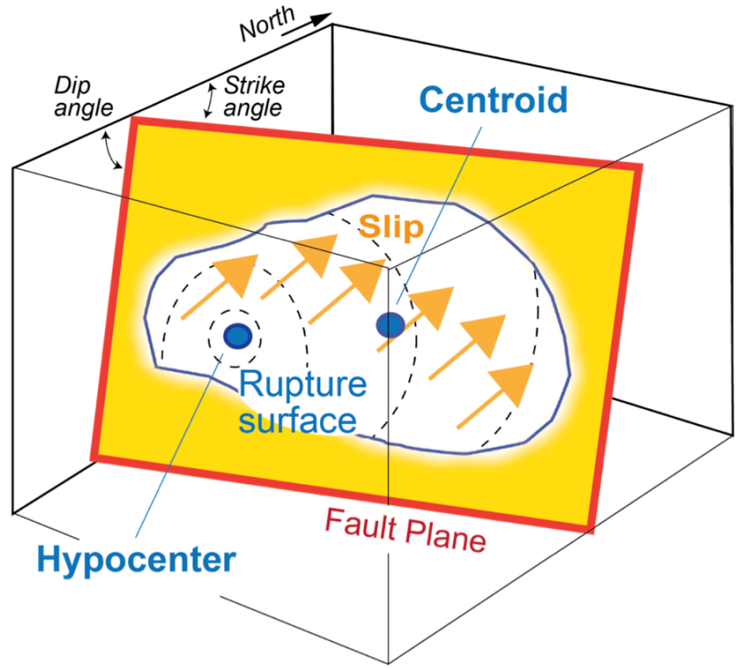
PRELIMINARY EARTHQUAKE PARAMETERS
---------------------------------

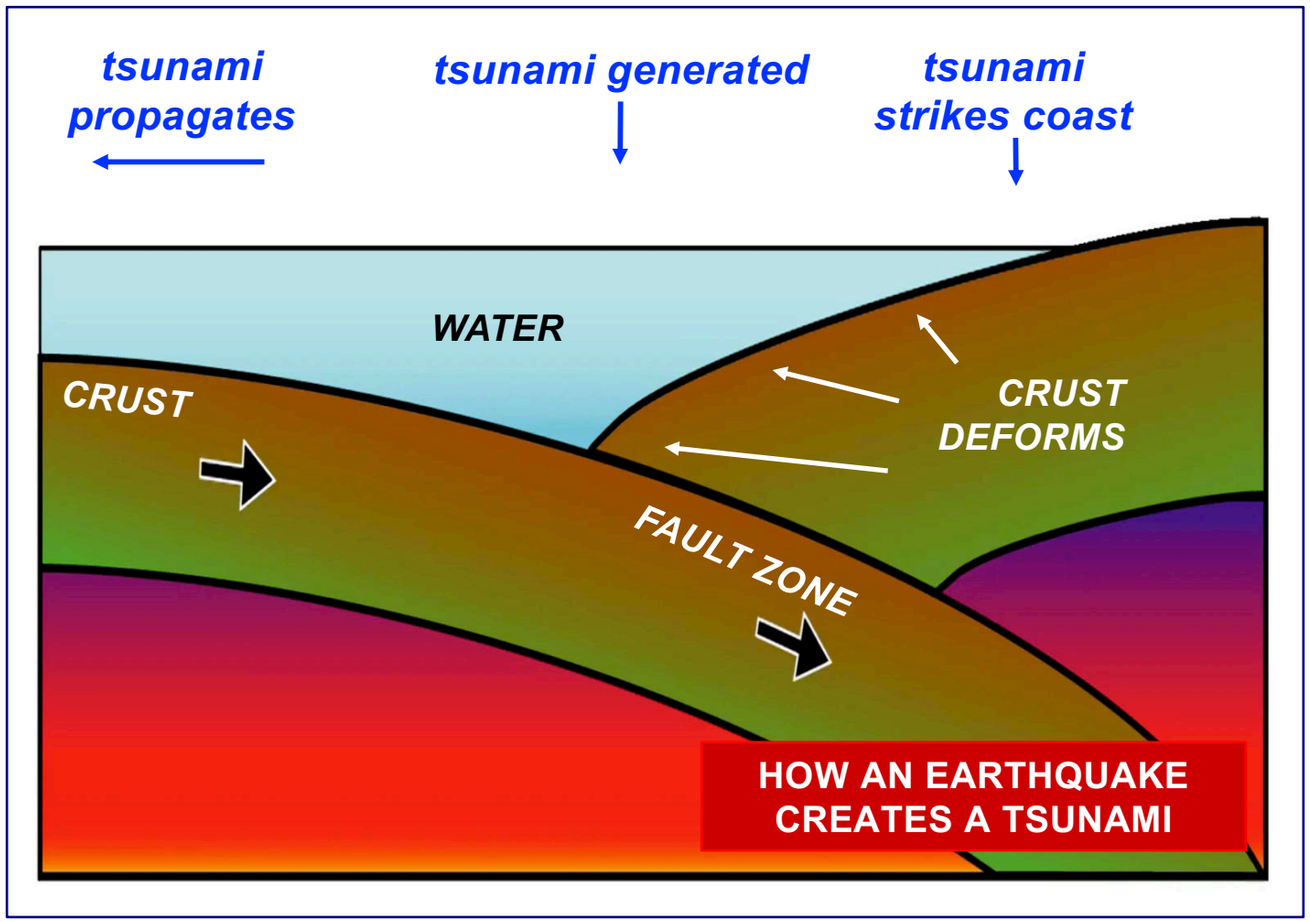
  * MAGNITUDE      8.8
  * ORIGIN TIME    0634 UTC NOV 5 2018
  * COORDINATES    36.1 SOUTH  72.9 WEST
  * DEPTH          23 KM / 14 MILES
  * LOCATION       NEAR THE COAST OF CENTRAL CHILE
```

W-Phase Centroid Moment Tensor (WCMT)

- **The WCMT provides estimate of earthquake rupture mechanism**
  - Direction of fault line on Earth's surface
  - Dip angle of fault going into Earth
  - Direction Earth moved on either side of fault
- **The WCMT also provides**
  - Centroid location representing center of rupture
  - Accurate earthquake Moment Magnitude (Mw)
- **Mw leads to an estimate of**
  - Fault rupture dimensions
  - Slip amount across fault



RIFT Tsunami Model uses Earthquake WCMT

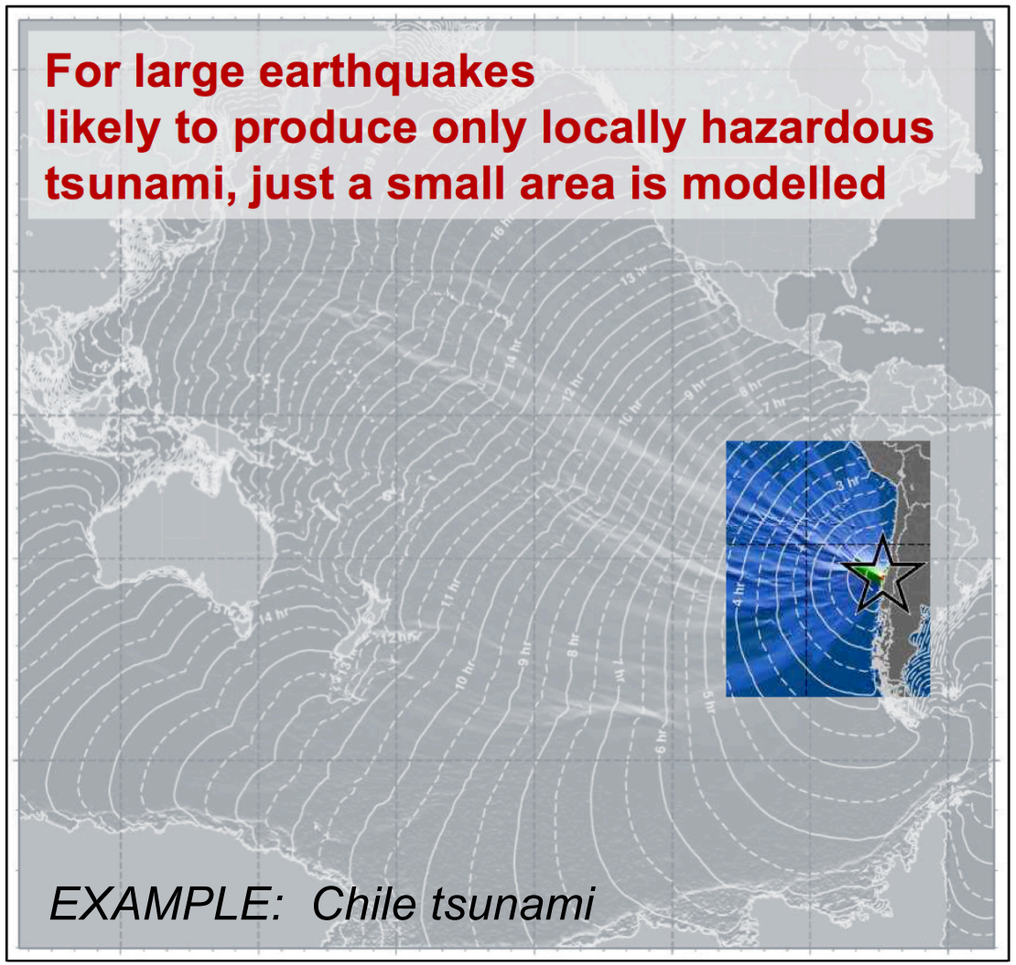


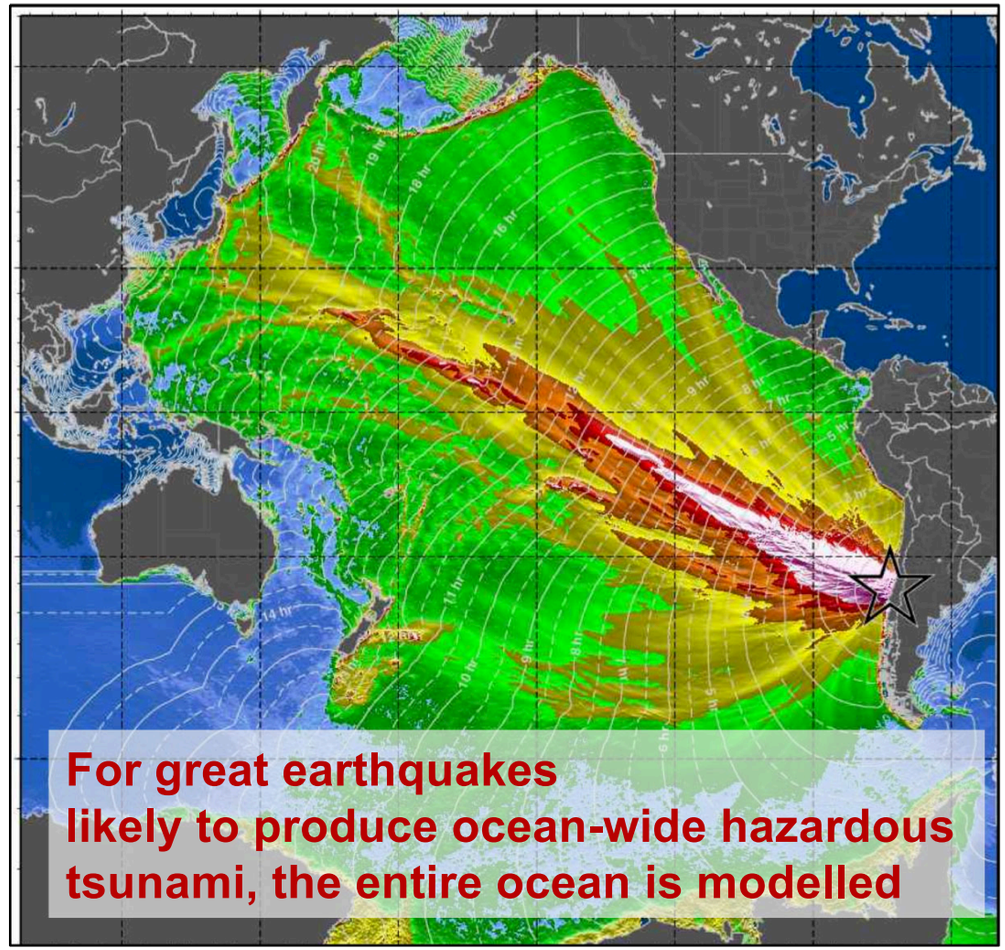
1. Earthquake occurs.
   WCMT fault parameters describe how Earth's surface (crust) deformed

2. Tsunami created.
   Deformed crust displaces overlying water

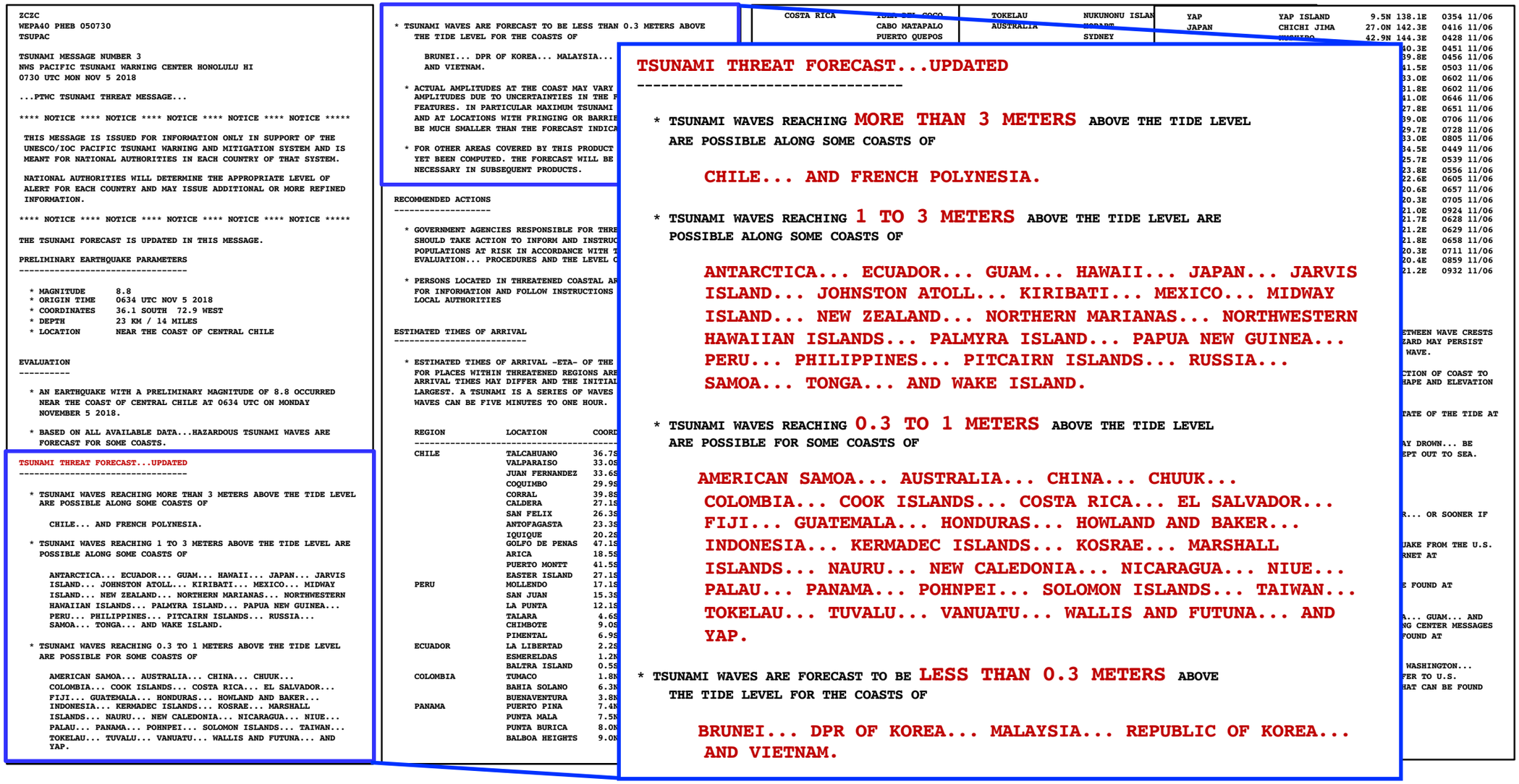
3. Tsunami Forecast.
   RIFT simulates tsunami :
   a. generation
   b. propagation across ocean, and
   c. height striking coast

RIFT Forecast Runs – Small and Large Model Domains





Text Message - Updated Forecast (Pacific-wide)



ZCZC
WEPA40 PHEB 050730
TSUPAC

TSUNAMI MESSAGE NUMBER 3
NWS PACIFIC TSUNAMI WARNING CENTER HONOLULU HI
0730 UTC MON NOV 5 2018

...PTWC TSUNAMI THREAT MESSAGE...

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THE TSUNAMI FORECAST IS UPDATED IN THIS MESSAGE.

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EVALUATION

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* BASED ON ALL AVAILABLE DATA...HAZARDOUS TSUNAMI WAVES ARE FORECAST FOR SOME COASTS.

TSUNAMI THREAT FORECAST...UPDATED

* TSUNAMI WAVES REACHING MORE THAN 3 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE ALONG SOME COASTS OF

  CHILE... AND FRENCH POLYNESIA.

* TSUNAMI WAVES REACHING 1 TO 3 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE ALONG SOME COASTS OF

  ANTARCTICA... ECUADOR... GUAM... HAWAII... JAPAN... JARVIS ISLAND... JOHNSTON ATOLL... KIRIBATI... MEXICO... MIDWAY ISLAND... NEW ZEALAND... NORTHERN MARIANAS... NORTHWESTERN HAWAIIAN ISLANDS... PALMYRA ISLAND... PAPUA NEW GUINEA... PERU... PHILIPPINES... PITCAIRN ISLANDS... RUSSIA... SAMOA... TONGA... AND WAKE ISLAND.

* TSUNAMI WAVES REACHING 0.3 TO 1 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE FOR SOME COASTS OF

  AMERICAN SAMOA... AUSTRALIA... CHINA... CHUUK... COLOMBIA... COOK ISLANDS... COSTA RICA... EL SALVADOR... FIJI... GUATEMALA... HONDURAS... HOWLAND AND BAKER... INDONESIA... KERMADEC ISLANDS... KOSRAE... MARSHALL ISLANDS... NAURU... NEW CALEDONIA... NICARAGUA... NIUE... PALAU... PANAMA... POHNPEI... SOLOMON ISLANDS... TAIWAN... TOKELAU... TUVALU... VANUATU... WALLIS AND FUTUNA... AND YAP.

* TSUNAMI WAVES ARE FORECAST TO BE LESS THAN 0.3 METERS ABOVE THE TIDE LEVEL FOR THE COASTS OF

  BRUNEI... DPR OF KOREA... MALAYSIA... AND VIETNAM.

* ACTUAL AMPLITUDES AT THE COAST MAY VARY
  AMPLITUDES DUE TO UNCERTAINTIES IN THE F
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  AND AT LOCATIONS WITH FRINGING OR BARRIE
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REGION	LOCATION	COORD
CHILE	TALCAHUANO	36.7S
	VALPARAISO	33.0S
	JUAN FERNANDEZ	33.6S
	COQUIMBO	29.9S
	CORRAL	39.8S
	CALDERA	27.1S
	SAN FELIX	26.3S
	ANTOFAGASTA	23.3S
	IQUIQUE	20.2S
	GOLFO DE PENAS	47.1S
	ARICA	18.5S
	PUERTO MONTT	41.5S
	EASTER ISLAND	27.1S
PERU	MOLLENDO	17.1S
	SAN JUAN	15.3S
	LA PUNTA	12.1S
	TALARA	4.6S
	CHIMBOTE	9.0S
	PIMENTAL	6.9S
ECUADOR	LA LIBERTAD	2.2S
	ESMERELDAS	1.2N
	BALTRA ISLAND	0.5S
COLOMBIA	TUMACO	1.8N
	BAHIA SOLANO	6.3N
	BUENAVENTURA	3.8N
PANAMA	PUERTO PINA	7.4N
	PUNTA MALA	7.5N
	PUNTA BURICA	8.0N
	BALBOA HEIGHTS	9.0N
COSTA RICA	CABO MATAPALO	
	PUERTO QUEPOS	
TOKELAU	NUKUNONU ISLAN	
AUSTRALIA	SYDNEY	
YAP	YAP ISLAND	9.5N 138.1E 0354 11/06
JAPAN	CHICHI JIMA	27.0N 142.3E 0416 11/06
		42.9N 144.3E 0428 11/06
		40.3E 0451 11/06
		39.8E 0456 11/06
		41.5E 0503 11/06
		33.0E 0602 11/06
		31.8E 0602 11/06
		41.0E 0646 11/06
		27.8E 0651 11/06
		39.0E 0706 11/06
		29.7E 0728 11/06
		33.0E 0805 11/06
		34.5E 0449 11/06
		25.7E 0539 11/06
		23.8E 0556 11/06
		22.6E 0605 11/06
		20.6E 0657 11/06
		20.3E 0705 11/06
		21.0E 0924 11/06
		21.7E 0628 11/06
		21.2E 0629 11/06
		21.8E 0658 11/06
		20.3E 0711 11/06
		20.4E 0859 11/06
		21.2E 0932 11/06

ETWEEN WAVE CRESTS
ZARD MAY PERSIST
WAVE.

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HAPE AND ELEVATION

TATE OF THE TIDE AT

AY DROWN... BE
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R... OR SOONER IF

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WASHINGTON...
FER TO U.S.
HAT CAN BE FOUND

TSUNAMI THREAT FORECAST...UPDATED

* TSUNAMI WAVES REACHING MORE THAN 3 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE ALONG SOME COASTS OF

  CHILE... AND FRENCH POLYNESIA.

* TSUNAMI WAVES REACHING 1 TO 3 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE ALONG SOME COASTS OF

  ANTARCTICA... ECUADOR... GUAM... HAWAII... JAPAN... JARVIS ISLAND... JOHNSTON ATOLL... KIRIBATI... MEXICO... MIDWAY ISLAND... NEW ZEALAND... NORTHERN MARIANAS... NORTHWESTERN HAWAIIAN ISLANDS... PALMYRA ISLAND... PAPUA NEW GUINEA... PERU... PHILIPPINES... PITCAIRN ISLANDS... RUSSIA... SAMOA... TONGA... AND WAKE ISLAND.

* TSUNAMI WAVES REACHING 0.3 TO 1 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE FOR SOME COASTS OF

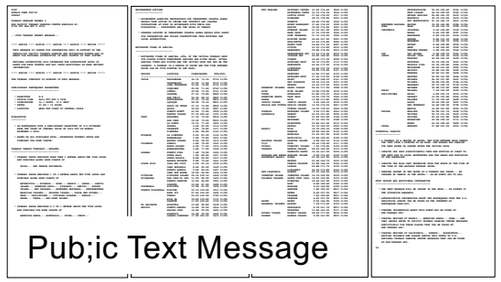
  AMERICAN SAMOA... AUSTRALIA... CHINA... CHUUK... COLOMBIA... COOK ISLANDS... COSTA RICA... EL SALVADOR... FIJI... GUATEMALA... HONDURAS... HOWLAND AND BAKER... INDONESIA... KERMADEC ISLANDS... KOSRAE... MARSHALL ISLANDS... NAURU... NEW CALEDONIA... NICARAGUA... NIUE... PALAU... PANAMA... POHNPEI... SOLOMON ISLANDS... TAIWAN... TOKELAU... TUVALU... VANUATU... WALLIS AND FUTUNA... AND YAP.

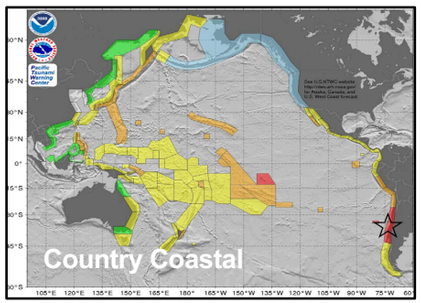
* TSUNAMI WAVES ARE FORECAST TO BE LESS THAN 0.3 METERS ABOVE THE TIDE LEVEL FOR THE COASTS OF

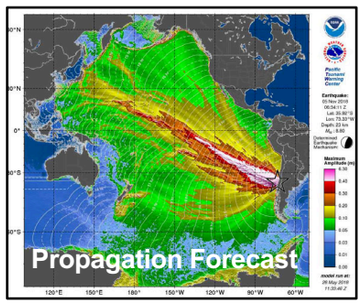
  BRUNEI... DPR OF KOREA... MALAYSIA... REPUBLIC OF KOREA... AND VIETNAM.

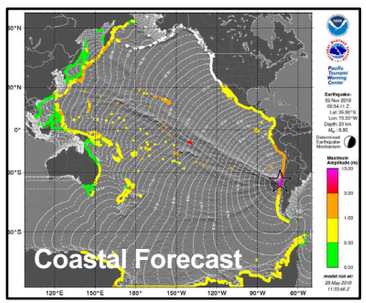
PTWC Tsunami Forecast Products

- Based on RIFT tsunami propagation forecast
- Needs WCMT earthquake rupture mechanism (in 15-30 min)
- Validated based on tsunami observations
- 1 Public Text product
- 5 TWFP/NTWC-only products
  (3 maps, 1 KMZ file, 1 table)









Forecast Statistics

PTWC TABLE OF FORECAST STATISTICS FOR REGIONAL POLYGONS - RUN ID 2018052811346
(for internal use only - not for distribution)

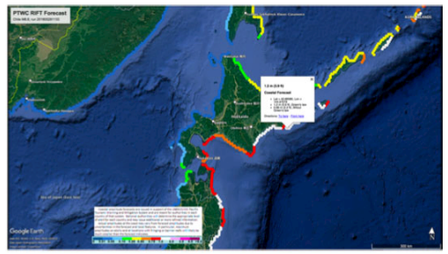
Earthquake - Origin: 11/05/2018 06:34:11 UTC Coordinates: 35.95 73.3W Depth: 023km Magnitude: 8.8

This table is issued for information only in support the UNESCO/IOC Pacific Tsunami Warning and Mitigation System and is meant for national authorities in each country of that system. National authorities will determine the appropriate level of alert for each country and may issue additional or more refined information.

Actual amplitudes at the coast may vary from forecast amplitudes due to uncertainties in the forecast and local features. In particular, maximum tsunami amplitudes on atolls will likely be much smaller than the forecast indicates.

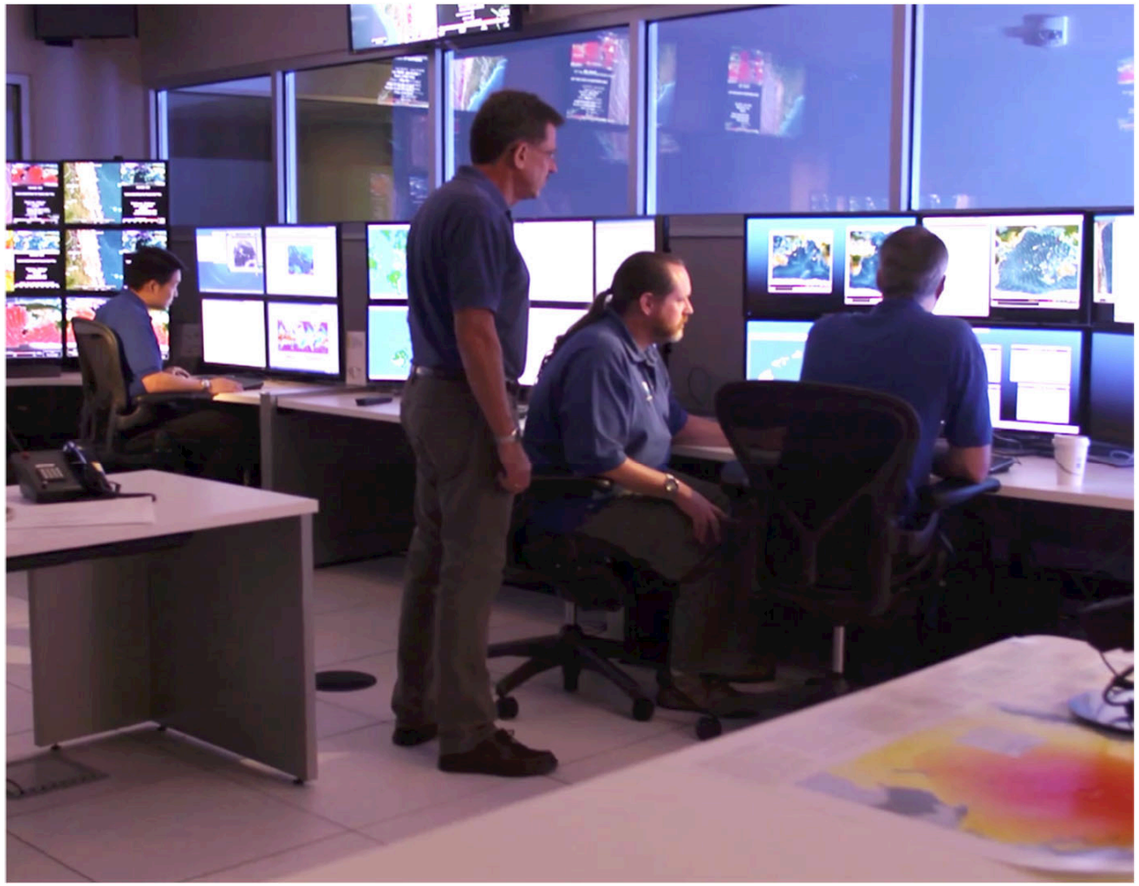
	Coastal Forecast (meters)				Offshore Forecast (meters)				
Region_Name	Maximum	Mean	Median	STD	Maximum	Mean	Median	STD	Total Points
South_Central_Chile	13.	5.70	2.70	4.50	6.3	2.30	2.00	1.40	150
Juan_Fernandez_Archipelago	11.	9.00	8.80	1.10	4.5	3.10	3.30	1.20	5
North_Central_Chile	5.5	2.20	1.90	1.00	2.8	0.86	0.62	0.53	121
Marquesas_Islands	4.2	2.70	2.40	0.74	1.3	0.59	0.55	0.25	24
Palmyra_Island	2.7	2.70	2.70	0.00	0.41	0.41	0.41	0.00	1
San_Felix_Islands	2.1	2.00	2.00	0.05	0.74	0.52	0.50	0.12	5
Southern_Peru	2.0	1.50	1.40	0.15	1.0	0.51	0.48	0.11	86
Society_Islands	1.9	1.30	1.20	0.27	0.50	0.27	0.26	0.07	35
Hawaii	1.8	1.10	1.00	0.32	0.84	0.32	0.29	0.14	147
Line_Islands_Kiribati	1.8	1.20	1.20	0.43	0.34	0.20	0.17	0.10	3
Izu_and_Ogasawara_Islands_Japan	1.7	1.40	1.40	0.30	0.38	0.29	0.29	0.09	2
Pacific_Coast_of_the_Philippines	1.6	0.66	0.66	0.27	1.5	0.28	0.24	0.19	350
East_Coast_of_Japanese_Main_Islands	1.6	0.94	0.93	0.22	1.6	0.53	0.46	0.28	484
Central_Peru	1.6	1.00	0.96	0.23	0.90	0.56	0.54	0.11	110
Northern_Chile	1.5	1.10	1.10	0.14	1.2	0.36	0.32	0.16	118

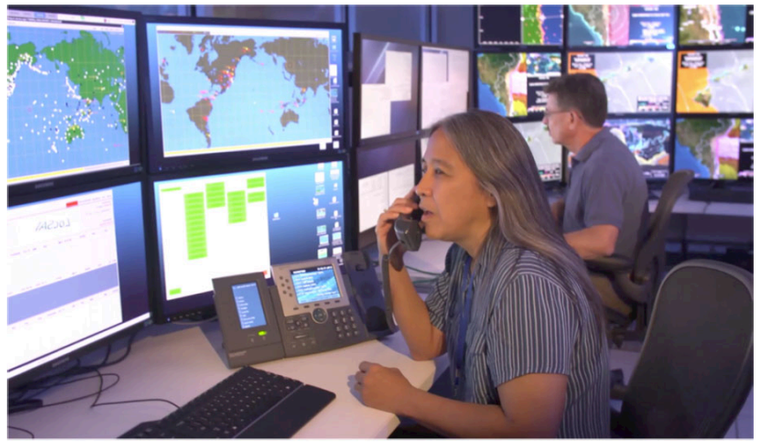
Forecast KMZ

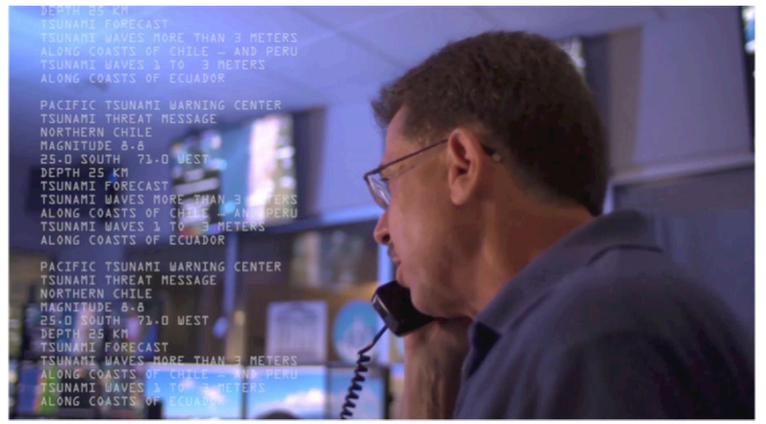


REFERENCE: *User's Guide for the Pacific Tsunami Warning Center Enhanced Products for the Pacific Tsunami Warning System. IOC Technical Series No 105. UNESCO/IOC 2014, rev 2022*

Assessing and Communicating Tsunami Threat



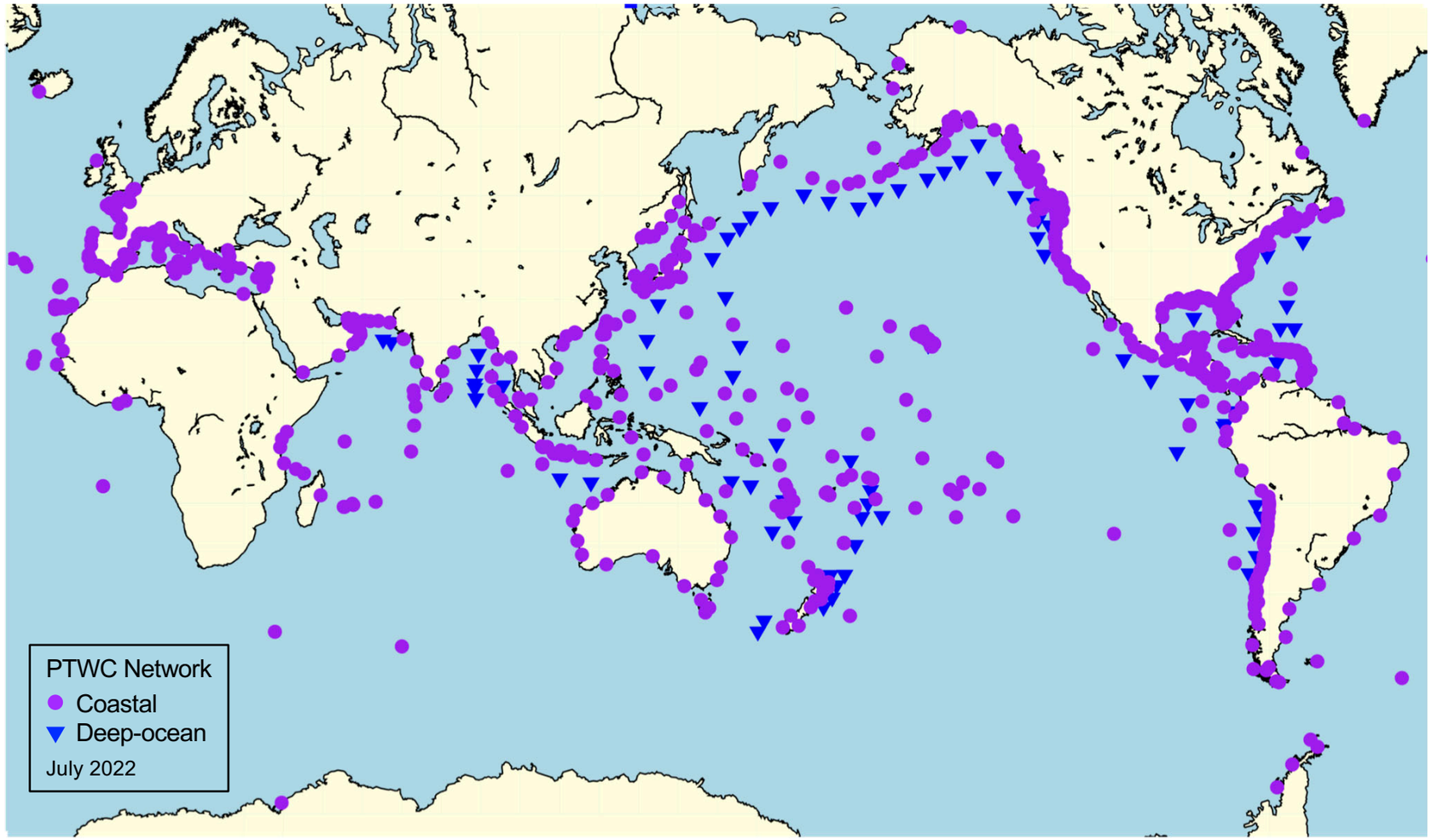




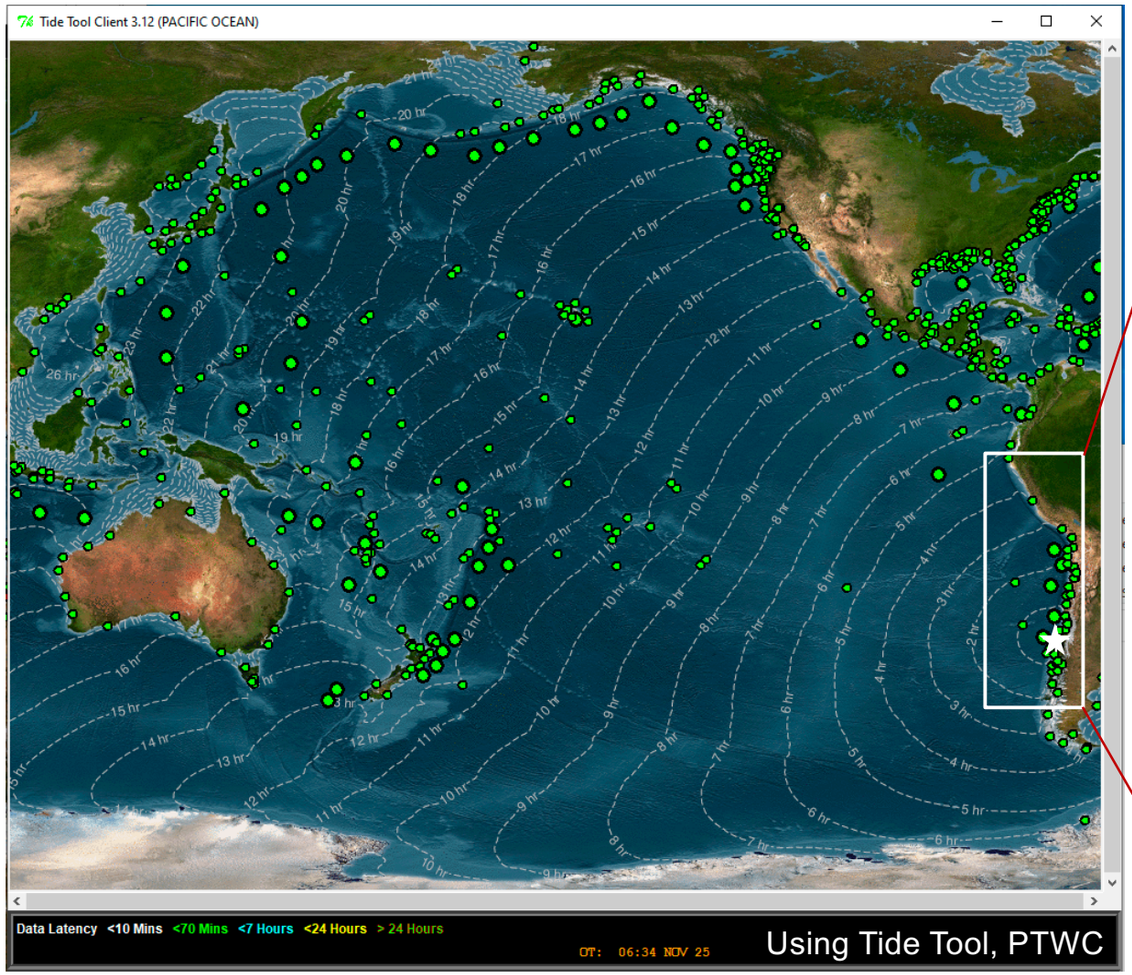
PTWC Typical Timeline for an Earthquake / Tsunami

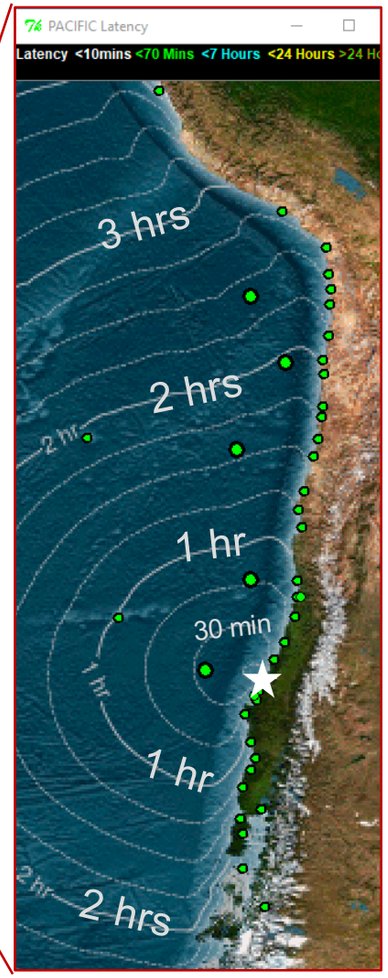
15 min to 2 hours	**Sea level gauges are monitored for tsunami signals. Within first 30 minutes to an hour, tsunami may arrive on nearest one or two coastal gauges and one or two deep-ocean gauges. Tsunami amplitudes are measured and compared, when possible, with forecast amplitudes produced by models.** **Model forecast may be adjusted to be more consistent with observations.**
Beyond 2 hours	**The process of refining earthquake parameters and collecting additional sea level observations continues, with that information used to constrain forecast if necessary. The tsunami is monitored as it advances.** **When it is likely that there is no longer a significant continuing tsunami threat for most areas, then final product issued.** **Due to resonances in enclosed bays, and to tsunami energy that gets trapped around islands and along continental shelves or is re-energized by reflections, some areas may continue to experience hazardous sea level oscillations.** ***It is up to local officials to determine when coasts are safe, persons can return to evacuated areas, and normal activities may resume.***

PTWC Global Sea Level Network monitored by PTWC

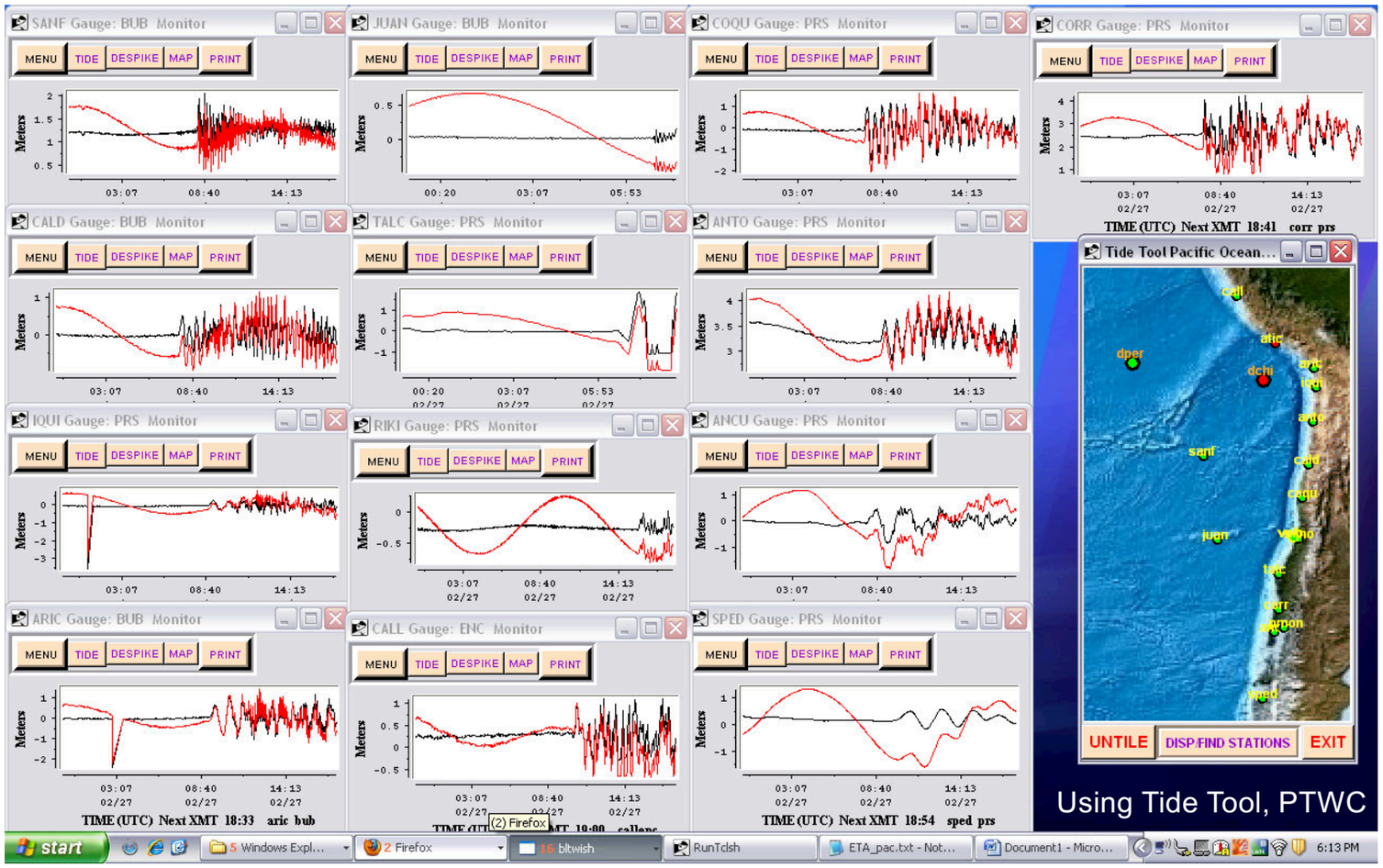


Tsunami Travel Time map – 27 February 2010, Chile





Tsunami monitoring – 27 February 2010, Chile

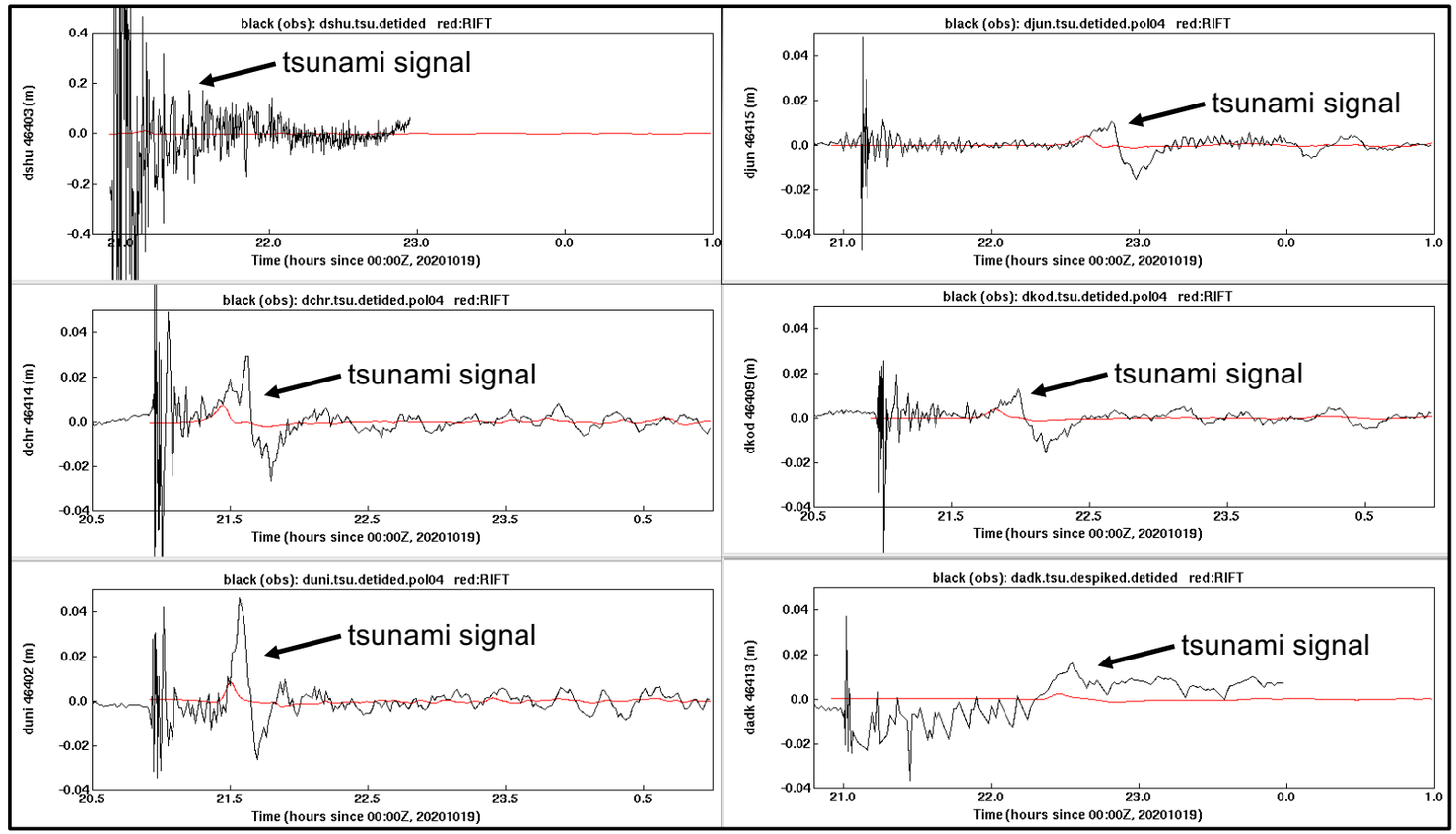


RIFT Forecast with Observations - Validation

- **Compare RIFT forecast with observations**
- **If waveforms and amplitudes are <u>similar</u>, then forecast is validated**

RIFT Forecast
DART Observation

19 Oct 2020 Mw 7.6 Alaska Earthquake and Tsunami

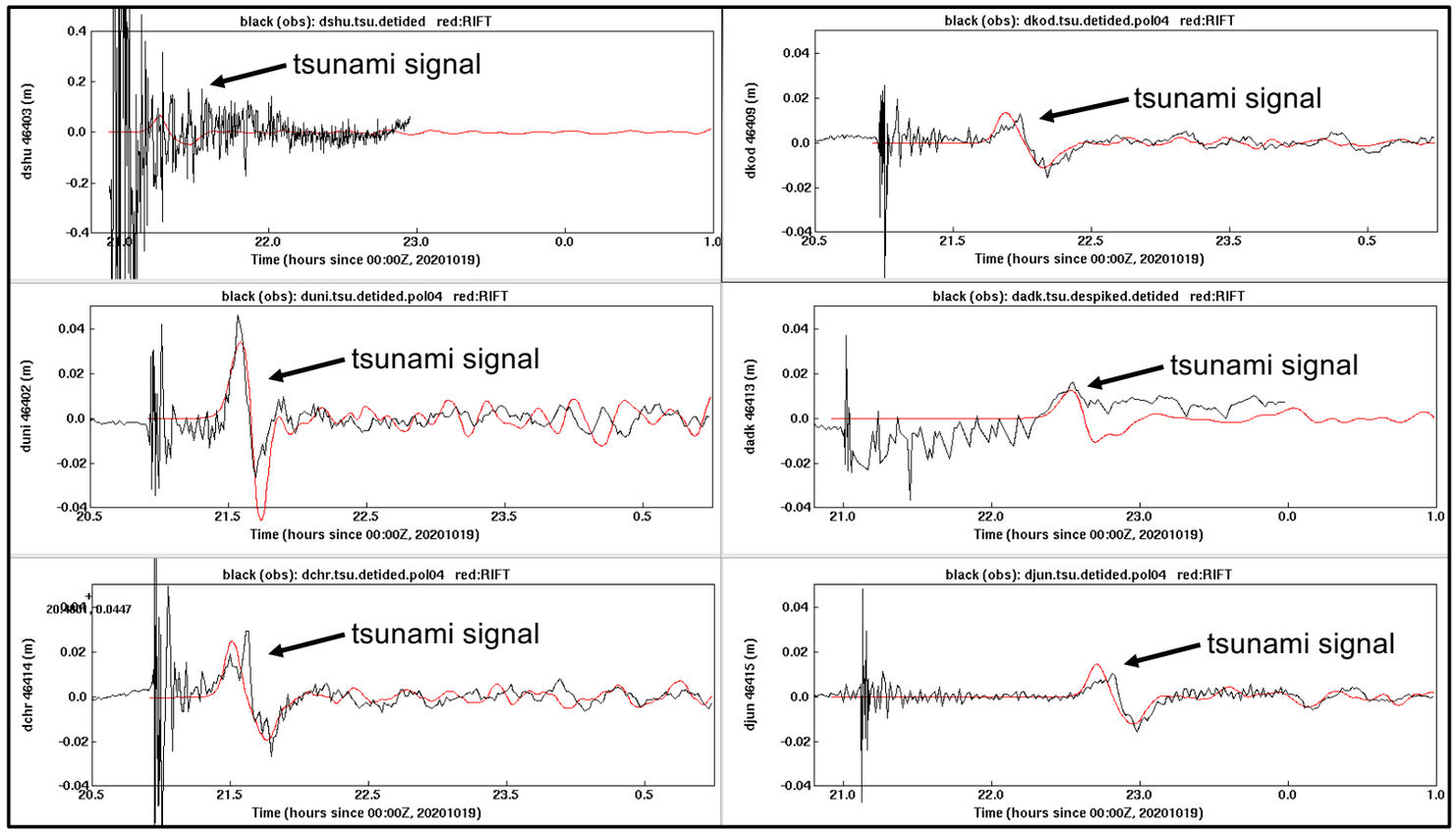


RIFT Forecast with Observations - Updated

- **Compare RIFT forecast with observations**
- **If waveforms and amplitudes are similar, then forecast is validated**

RIFT Forecast
DART Observation

19 Oct 2020 Mw 7.6 Alaska Earthquake and Tsunami



Text Message – Tsunami Observations (Pacific-wide)

TSUNAMI OBSERVATIONS

* THE FOLLOWING ARE TSUNAMI WAVE OBSERVATIONS FROM COASTAL AND/OR DEEP-OCEAN SEA LEVEL GAUGES AT THE INDICATED LOCATIONS. THE MAXIMUM TSUNAMI HEIGHT IS MEASURED WITH RESPECT TO THE NORMAL TIDE LEVEL.

GAUGE LOCATION	GAUGE COORDINATES LAT	LON	TIME OF MEASURE (UTC)	MAXIMUM TSUNAMI HEIGHT	WAVE PERIOD (MIN)
ADAK AK	51.9N	176.6W	0412	0.35M/ 1.1FT	12
DART 52401	19.3N	155.7E	0355	0.08M/ 0.3FT	28
DUTCH HBR UNALASKA	53.9N	166.5W	0325	0.18M/ 0.6FT	12
APRA HARBOR GUAM US	13.4N	144.7E	0307	0.16M/ 0.5FT	12
WAKE US	19.3N	166.6E	0259	0.26M/ 0.9FT	12
MIDWAY	28.2N	177.4W	0137	0.28M/ 0.9FT	12
SITKA AK	57.1N	135.3W	0111	0.08M/ 0.3FT	12
KAWAIHAE HAWAII	20.0N	155.8W	2211	0.52M/ 1.7FT	32
HONOLULU OAHU	21.3N	157.9W	2200	0.25M/ 0.8FT	12
BARBERS PT HI	21.3N	158.1W	2157	0.12M/ 0.4FT	48
KAHULUI MAUI	20.9N	156.5W	2147	0.98M/ 3.2FT	48
SANTA BARBARA CA	34.4N	119.7W	2115	0.53M/ 1.7FT	24
SAN DIEGO CA	32.7N	117.2W	2036	0.13M/ 0.4FT	12
SANTA MONICA CA	34.0N	118.5W	2035	0.41M/ 1.3FT	16
MONTEREY HARBOR CA	36.6N	121.9W	2031	0.32M/ 1.0FT	32
PAGO PAGO AS	14.3S	170.7W	2027	0.70M/ 2.3FT	12
NUKUALOFA TO	21.1S	175.2W	2024	0.10M/ 0.3FT	48
APIA UPOLU WS	13.8S	171.8W	2007	0.16M/ 0.5FT	12

INDONESIA... KERMADEC ISLANDS... KOSRAE... MARSHALL ISLANDS... NAURU... NEW CALEDONIA... NICARAGUA... NIUE... PALAU... PANAMA... POHNPEI... SOLOMON ISLANDS... TAIWAN... TOKELAU... TUVALU... VANUATU... WALLIS AND FUTUNA... AND YAP.

	TAITUNG	22.7N	121.2E	0629 11/06
	CHILUNG	25.2N	121.8E	0658 11/06
	KAOHSIUNG	22.5N	120.3E	0711 11/06
	HOMEL	24.2N	120.4E	0859 11/06
CHINA	WENZHOU	27.8N	121.2E	0932 11/06

POTENTIAL IMPACTS

* A TSUNAMI IS A SERIES OF WAVES. THE TIME BETWEEN WAVE CRESTS CAN VARY FROM 5 MINUTES TO AN HOUR. THE HAZARD MAY PERSIST FOR MANY HOURS OR LONGER AFTER THE INITIAL WAVE.

* IMPACTS CAN VARY SIGNIFICANTLY FROM ONE SECTION OF COAST TO THE NEXT DUE TO LOCAL BATHYMETRY AND THE SHAPE AND ELEVATION OF THE SHORELINE.

* IMPACTS CAN ALSO VARY DEPENDING UPON THE STATE OF THE TIDE AT THE TIME OF THE MAXIMUM TSUNAMI WAVES.

* PERSONS CAUGHT IN THE WATER OF A TSUNAMI MAY DROWN... BE CRUSHED BY DEBRIS IN THE WATER... OR BE SWEPT OUT TO SEA.

TSUNAMI OBSERVATIONS

* THE FOLLOWING ARE TSUNAMI WAVE OBSERVATIONS FROM COASTAL AND/OR DEEP-OCEAN SEA LEVEL GAUGES AT THE INDICATED LOCATIONS. THE MAXIMUM TSUNAMI HEIGHT IS MEASURED WITH RESPECT TO THE NORMAL TIDE LEVEL.

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WAKE US	19.3N	166.6E	0259	0.26M/ 0.9FT	12
MIDWAY	28.2N	177.4W	0137	0.28M/ 0.9FT	12
SITKA AK	57.1N	135.3W	0111	0.08M/ 0.3FT	12
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APIA UPOLU WS	13.8S	171.8W	2007	0.16M/ 0.5FT	12
EAST CAPE NZ	37.6S	178.2E	1934	0.15M/ 0.5FT	24
ACAPULCO MX	16.8N	99.9W	1931	0.62M/ 2.0FT	36
DART 46412	32.5N	120.6W	1931	0.06M/ 0.2FT	36
RAROTONGA CK	21.2S	159.8W	1918	0.32M/ 1.0FT	12
CABO SAN LUCAS MX	22.9N	109.9W	1833	0.36M/ 1.2FT	12
PAPEETE TAHITI	17.5S	149.6W	1810	0.16M/ 0.5FT	04
NUKU HIVA MARQUESAS	8.9S	140.1W	1745	0.95M/ 3.1FT	24
HIVA OA MARQUESAS	9.8S	139.0W	1741	1.79M/ 5.9FT	12
MANZANILLO MX	19.1N	104.3W	1705	0.32M/ 1.0FT	24
DART 43412	16.0N	107.0W	1611	0.07M/ 0.2FT	32
RIKITEA PF	23.1S	135.0W	1559	0.15M/ 0.5FT	48
BALTRA GALAPAGS EC	0.4S	90.3W	1452	0.35M/ 1.1FT	08
QUEPOS CR	9.4N	84.2W	1416	0.24M/ 0.8FT	08
EASTER CL	27.2S	109.4W	1205	0.35M/ 1.1FT	04
CALLAO LA-PUNTA PE	12.1S	77.2W	1029	0.36M/ 1.2FT	48
ARICA CL	18.5S	70.3W	1008	0.94M/ 3.1FT	40
ANTOFAGASTA CL	23.7S	70.4W	0941	0.49M/ 1.6FT	28
DART 32412	18.0S	86.4W	0941	0.24M/ 0.8FT	36
IQUIQUE CL	20.2S	70.1W	0907	0.28M/ 0.9FT	16
COQUIMBO CL	30.0S	71.3W	0852	1.32M/ 4.3FT	16
CALDERA CL	27.1S	70.8W	0843	0.45M/ 1.5FT	20
ANCUD CL	41.9S	73.8W	0838	0.62M/ 2.0FT	96
SAN FELIX CL	26.3S	80.1W	0815	0.53M/ 1.7FT	12
CORRAL CL	39.9S	73.4W	0739	0.90M/ 3.0FT	08
VALPARAISO CL	33.0S	71.6W	0708	1.29M/ 4.2FT	12
TALCAHUANO CL	36.7S	73.1W	0653	2.34M/ 7.7FT	16

POTENTIAL IMPACTS

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NEXT UPDATE AND ADDITIONAL INFORMATION

* THE NEXT MESSAGE WILL BE ISSUED IN ONE HOUR... OR SOONER IF THE SITUATION WARRANTS.

* AUTHORITATIVE INFORMATION ABOUT THE EARTHQUAKE FROM THE U.S. GEOLOGICAL SURVEY CAN BE FOUND ON THE INTERNET AT EARTHQUAKE.USGS.GOV.

* FURTHER INFORMATION ABOUT THIS EVENT MAY BE FOUND AT WWW.TSUNAMI.GOV.

* COASTAL REGIONS OF HAWAII... AMERICAN SAMOA... GUAM... AND CNMI SHOULD REFER TO PACIFIC TSUNAMI WARNING CENTER MESSAGES SPECIFICALLY FOR THOSE PLACES THAT CAN BE FOUND AT WWW.TSUNAMI.GOV.

* COASTAL REGIONS OF CALIFORNIA... OREGON... WASHINGTON... BRITISH COLUMBIA AND ALASKA SHOULD ONLY REFER TO U.S. NATIONAL TSUNAMI WARNING CENTER MESSAGES THAT CAN BE FOUND AT WWW.TSUNAMI.GOV.

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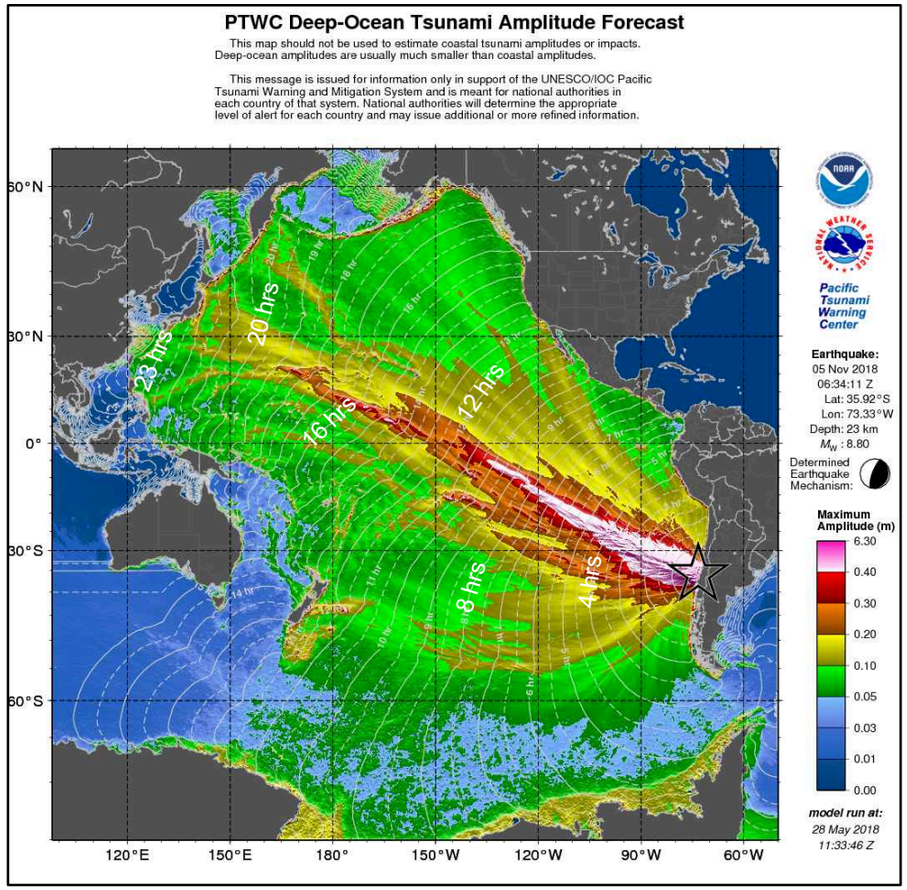
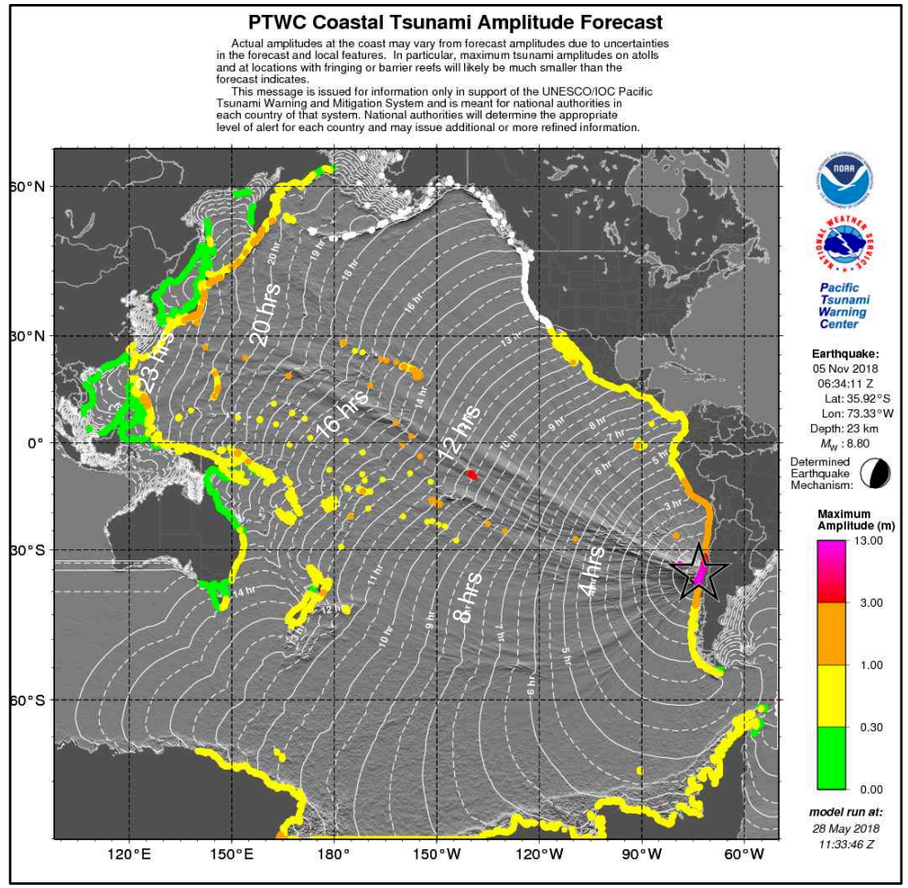
Pacific-wide tsunami – RIFT Forecast



Deep-Ocean Maximum Amplitude



Coastal Amplitude

Text Message - Final

ZCZC
WEPA40 PHEB 060600
TSUPAC

TSUNAMI MESSAGE NUMBER 26
NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI
0600 UTC TUE NOV 6 2018

...PTWC FINAL TSUNAMI THREAT MESSAGE ...

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

THIS MESSAGE IS ISSUED FOR INFORMATION ONLY IN SUPPORT OF THE UNESCO/IOC PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM AND IS MEANT FOR NATIONAL AUTHORITIES IN EACH COUNTRY OF THAT SYSTEM.

NATIONAL AUTHORITIES WILL DETERMINE THE APPROPRIATE LEVEL OF ALERT FOR EACH COUNTRY AND MAY ISSUE ADDITIONAL OR MORE REFINED INFORMATION.

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

THE TSUNAMI FORECAST IS UNCHANGED IN THIS MESSAGE.

PRELIMINARY EARTHQUAKE PARAMETERS

* MAGNITUDE 8.8
* ORIGIN TIME 0634 UTC NOV 5 2018
* COORDINATES 36.1 SOUTH 72.9 WEST
* DEPTH 23 KM / 14 MILES
* LOCATION NEAR THE COAST OF CENTRAL CHILE

EVALUATION

* AN EARTHQUAKE WITH A PRELIMINARY MAGNITUDE OF 8.8 OCCURRED NEAR THE COAST OF CENTRAL CHILE AT 0634 UTC ON MONDAY NOVEMBER 5 2018.

*** BASED ON ALL AVAILABLE DATA... THE TSUNAMI THREAT FROM THIS EARTHQUAKE HAS NOW PASSED.**

TSUNAMI THREAT FORECAST...UPDATED

*** THE TSUNAMI THREAT HAS NOW LARGELY PASSED.**

RECOMMENDED ACTIONS

* GOVERNMENT AGENCIES RESPONSIBLE FOR ANY IMPACTED COASTAL AREAS SHOULD MONITOR CONDITIONS AT THE COAST TO DETERMINE IF AND WHEN IT IS SAFE TO RESUME NORMAL

*** PERSONS LOCATED NEAR IMPACTED COASTAL AREAS SHOULD STAY ALERT FOR INFORMATION AND FOLLOW INSTRUCTIONS FROM LOCAL AUTHORITIES.**

* REMAIN OBSERVANT AND EXERCISE NORMAL CAUTION NEAR THE SEA.

POTENTIAL IMPACTS

* MINOR SEA LEVEL FLUCTUATIONS OF UP TO 0.3 METER ABOVE AND BELOW THE NORMAL TIDE MAY CONTINUE OVER THE NEXT FEW HOURS.

TSUNAMI OBSERVATIONS ...

* THE FOLLOWING ARE TSUNAMI WAVE OBSERVATIONS FROM COASTAL AND/OR DEEP-OCEAN SEA LEVEL GAUGES AT THE INDICATED LOCATIONS. THE MAXIMUM TSUNAMI HEIGHT IS MEASURED WITH RESPECT TO THE NORMAL TIDE LEVEL.

GAUGE LOCATION	GAUGE COORDINATES LAT	LON	TIME OF MEASURE (UTC)	MAXIMUM TSUNAMI HEIGHT	WAVE PERIOD (MIN)
OFUNATO HONSHU JP	39.0N	141.8E	0559	0.41M/ 1.3FT	32
ADAK AK	51.9N	176.6W	0412	0.35M/ 1.1FT	12
DART 52401	19.3N	155.7E	0355	0.08M/ 0.3FT	28
DUTCH HBR UNALASKA	53.9N	166.5W	0325	0.18M/ 0.6FT	12
APRA HARBOR GUAM US	13.4N	144.7E	0307	0.16M/ 0.5FT	12
WAKE US	19.3N	166.6E	0259	0.26M/ 0.9FT	12
MIDWAY	28.2N	177.4W	0137	0.28M/ 0.9FT	12
SITKA AK	57.1N	135.3W	0111	0.08M/ 0.3FT	12
KAWAIHAE HAWAII	20.0N	155.8W	2211	0.52M/ 1.7FT	32
HONOLULU OAHU	21.3N	157.9W	2200	0.25M/ 0.8FT	12
BARBERS PT HI	21.3N	158.1W	2157	0.12M/ 0.4FT	48
KAHULUI MAUI	20.9N	156.5W	2147	0.98M/ 3.2FT	48
SANTA BARBARA CA	34.4N	119.7W	2115	0.53M/ 1.7FT	24
SAN DIEGO CA	32.7N	117.2W	2036	0.13M/ 0.4FT	12
SANTA MONICA CA	34.0N	118.5W	2035	0.41M/ 1.3FT	16
MONTEREY HARBOR CA	36.6N	121.9W	2031	0.32M/ 1.0FT	32
PAGO PAGO AS	14.3S	170.7W	2027	0.70M/ 2.3FT	12
NUKUALOFA TO	21.1S	175.2W	2024	0.10M/ 0.3FT	48
APIA UPOLU WS	13.8S	171.8W	2007	0.16M/ 0.5FT	12
DART 51426	23.1S	168.3W	2003	0.40M/ 1.3FT	12
EAST CAPE NZ	37.6S	178.2E	1934	0.15M/ 0.5FT	24
ACAPULCO MX	16.8N	99.9W	1931	0.62M/ 2.0FT	36
DART 46412	32.5N	120.6W	1931	0.06M/ 0.2FT	36
CABO SAN LUCAS MX	22.9N	109.9W	1833	0.36M/ 1.2FT	12
RAROTONGA CK	21.2S	159.8W	1918	0.32M/ 1.0FT	12
PAPEETE TAHITI	17.5S	149.6W	1810	0.16M/ 0.5FT	04
NUKU HIVA MARQUESAS	8.9S	140.1W	1745	0.95M/ 3.1FT	24
HIVA OA MARQUESAS	9.8S	139.0W	1741	1.79M/ 5.9FT	12
MANZANILLO MX	19.1N	104.3W	1705	0.32M/ 1.0FT	24
DART 43412	16.0N	107.0W	1611	0.07M/ 0.2FT	32
RIKITEA PF	23.1S	135.0W	1559	0.15M/ 0.5FT	48
BALTRA GALAPAGS EC	0.4S	90.3W	1452	0.35M/ 1.1FT	08
QUEPOS CR	9.4N	84.2W	1416	0.24M/ 0.8FT	08
EASTER CL	27.2S	109.4W	1205	0.35M/ 1.1FT	04
CALLAO LA-PUNTA PE	12.1S	77.2W	1029	0.36M/ 1.2FT	48
ARICA CL	18.5S	70.3W	1008	0.94M/ 3.1FT	40
ANTOFAGASTA CL	23.7S	70.4W	0941	0.49M/ 1.6FT	28
DART 32412	18.0S	86.4W	0941	0.24M/ 0.8FT	36
IQUIQUE CL	20.2S	70.1W	0907	0.28M/ 0.9FT	16
COQUIMBO CL	30.0S	71.3W	0852	1.32M/ 4.3FT	16
CALDERA CL	27.1S	70.8W	0843	0.45M/ 1.5FT	20
ANCUD CL	41.9S	73.8W	0838	0.62M/ 2.0FT	96
SAN FELIX CL	26.3S	80.1W	0815	0.53M/ 1.7FT	12
CORRAL CL	39.9S	73.4W	0739	0.90M/ 3.0FT	08
VALPARAISO CL	33.0S	71.6W	0708	1.29M/ 4.2FT	12
TALCAHUANO CL	36.7S	73.1W	0653	2.34M/ 7.7FT	16

NEXT UPDATE AND ADDITIONAL INFORMATION

* THIS WILL BE THE FINAL STATEMENT ISSUED FOR THIS EVENT UNLESS NEW INFORMATION IS RECEIVED OR THE SITUATION CHANGES.

* AUTHORITATIVE INFORMATION ABOUT THE EARTHQUAKE FROM THE U.S. GEOLOGICAL SURVEY CAN BE FOUND ON THE INTERNET AT EARTHQUAKE.USGS.GOV.

* FURTHER INFORMATION ABOUT THIS EVENT MAY BE FOUND AT WWW.TSUNAMI.GOV.

* COASTAL REGIONS OF HAWAII... AMERICAN SAMOA... GUAM... AND CNMI SHOULD REFER TO PACIFIC TSUNAMI WARNING CENTER MESSAGES SPECIFICALLY FOR THOSE PLACES THAT CAN BE FOUND AT WWW.TSUNAMI.GOV.

* COASTAL REGIONS OF CALIFORNIA... OREGON... WASHINGTON... BRITISH COLUMBIA AND ALASKA SHOULD ONLY REFER TO U.S. NATIONAL TSUNAMI WARNING CENTER MESSAGES THAT CAN BE FOUND AT WWW.TSUNAMI.GOV.

Tsunami Damage – 2009, 2010, 2011 local tsunamis

2nd wave, Pago Pago, American Samoa, 2009
(credit: G. Yamasaki, NOAA)

Dichato, Chile 2010 (credit: K. Bergen, USGS)

Ofunato, Japan, 2011 (credit: L. Kong, ITIC)

Harbor impacts from strong, unusual currents

Tsunami damage in Crescent City, CA, USA from 11 March 2011 Japan tsunami (credit: L. Dengler)

Intergovernmental Oceanographic Commission

National Oceanic and Atmospheric Administration

Servicio Hidrográfico y Oceanográfico de la Armada de Chile

International Tsunami Information Centre

Thank You

For more information, contact ITIC

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National Oceanic
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Servicio Hidrográfico y
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International
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Centre