CARIBBEAN AND ADJACENT REGIONS
INTERIM TSUNAMI ADVISORY SERVICE

In order to take steps to establish a coordinated early warning system for tsunamis and other coastal hazards, countries of the Caribbean region formed the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions (ICG/CARIBE-EWS) in 2006. At that time, it will realized that it would likely be some time before the required infrastructure could be put in place, training was complete, and the region able to fully provide warning services for itself.

In the interim, following discussions that began at the International Conference for the Development of a Tsunami and Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions 1-3 June 2005 in Mexico City, Mexico (organized by the UNESCO IOC IOCARIBE Sub-Commission jointly with the UN-ISDR, WMO, UNEP CAR-CU) and continued at the 1st Session of the ICG/CARIBE-EWS in January 2006, the US NOAA Pacific Tsunami Warning Center (PTWC) agreed to provide limited early warning services to the countries in the Caribbean Sea and Adjacent Regions (CARIBE-EWS). The West Coast/Alaska Tsunami Warning Center provides warning services for the continental United States, eastern Coast of Canada, Puerto and the US and British Virgin Islands, and serves as the backup to the PTWC.

Currently, real or near real-time sea level data are insufficient to quickly detect if a tsunami exists nor measure its size from all the potential Caribbean source regions. However, new deep ocean gauges were deployed in 2007 and 2008 and new coastal gauges are being planned for installation to improve detection coverage.

PACIFIC TSUNAMI WARNING CENTER
(as of June 2006, Communications Plan)

1. Introduction.

Since 2006, the PTWC has provided interim tsunami advisory services to countries of the Caribbean region. It issues "Tsunami Information Statements" for large earthquakes that may cause concern but do not have significant tsunamigenic potential, and "Tsunami Watch Messages" for large potentially tsunamigenic earthquakes, as well as for confirmed teletsunamis.

2. Product Issuance Criteria

There are three key earthquake parameters that can be determined quickly from seismic waveform data for the evaluation of an earthquake's tsunamigenic potential. They are: 1) location - whether the earthquake is located under or very near the sea, 2) depth - whether the earthquake is located close enough to the earth's surface to have caused a significant deformation of that surface and consequently a movement of the sea, and 3) magnitude - the size of the earthquake. Table 1 shows various combinations of these parameters and the types of products that will be issued for the CARIBE-EWS by PTWC for each case. These criteria are similar to what PTWC uses in the Pacific and Indian Oceans.

Table. Seismic criteria for PTWC's issuance of products in the CARIBE-EWS.

Earthquake Depth	Earthquake Location	Earthquake Magnitude (Mw)	Description of Tsunami Potential	Product Type
< 100 km	Under or very near the sea	6.0 to 7.0 Caribbean	Very small potential for a destructive local tsunami	Tsunami Information Statement
		6.5 to 7.8 Atlantic	Very small potential for a destructive ocean-wide tsunami	Tsunami Information Statement
		7.1 to 7.5 Caribbean	Potential for a destructive local tsunami	Local Tsunami Watch Message
		7.6 to 7.8 Caribbean	Potential for a destructive regional tsunami	Regional Tsunami Watch Message
		≥ 7.9 Caribbean & Atlantic	Potential for a destructive ocean-wide tsunami	Ocean-wide Tsunami Watch Message
	Inland	≥ 6.0 Carib ≥ 6.5 Atlan	No tsunami potential	Tsunami Information Statement
≥ 100 km	All Locations	≥ 6.0 Carib ≥ 6.5 Atlan	No tsunami potential	Tsunami Information Statement

Earthquake Magnitude: The magnitude used by PTWC is the moment magnitude, Mw. It is more accurate for large earthquakes than the more common Richter magnitude. The moment magnitude determined by PTWC for initial products is Mwp, based on the first arriving seismic P waves. Subsequent estimates of Mw may be made by methods based on later arriving seismic waves.

Local Tsunami: A local tsunami is one with destructive or life threatening effects usually limited to within 100 km of the epicenter.

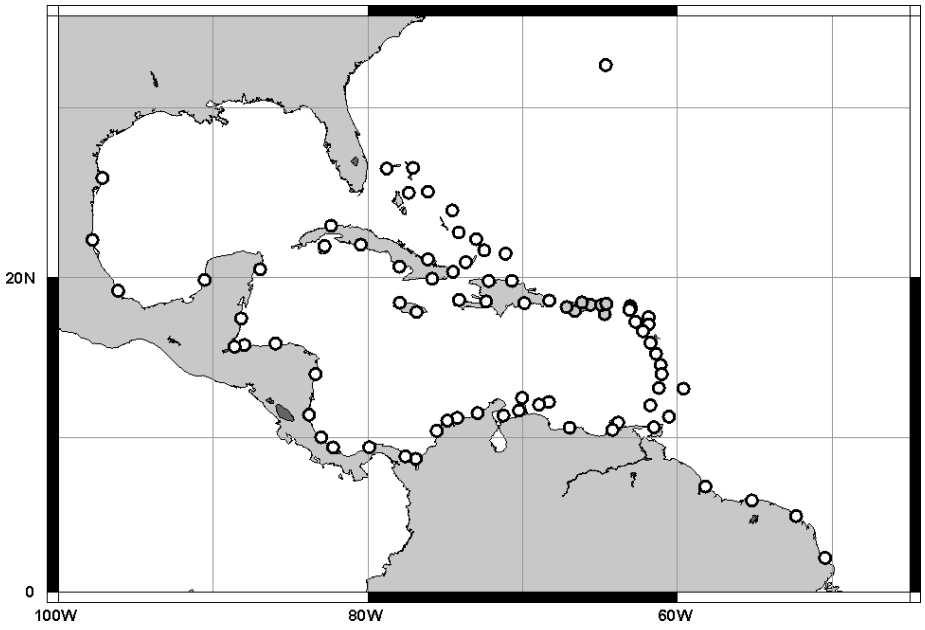
Regional Tsunami: A regional tsunami is one with destructive or life threatening effects usually limited to within 1000 km of the epicenter.

Ocean-wide Tsunami: An ocean-wide tsunami is one with destructive or life threatening effects that can extend across an entire ocean basin.

3. Message Content

Products are divided into just a few general sections. A **header** gives the product number. It starts at 1 for each event and is incremented if subsequent products are issued for the same event. The header also indicates who issued the product, in this case PTWC, and the time the product is issued. The header is followed by a statement about **who the product is intended for** -- all areas of the Caribbean. The next line is a banner indicating the **type of product**, a Tsunami Information Statement or a Tsunami Watch Message. If a Tsunami Watch is in effect, the countries in a watch are indicated. This is followed by the **preliminary earthquake parameters** including the origin time, coordinates, location name, and earthquake magnitude. If any **sea level observations** are available, they are provided next. Until more real time reporting sea level gauges are installed, however, such observations will be very limited or non-existent. The next section is the **evaluation**. It contains descriptive language about the potential for a destructive tsunami. If a Tsunami Watch is issued, **estimated arrival times** for forecast points (Figure) within the Watch area are provided. Last is a statement about **if and when a subsequent product** will be issued for the event.

Figure. Preliminary forecast points for countries in the Caribbean region. Tsunami Watch Messages provide estimated times of arrival for forecast points in the region of the Tsunami Watch.



4. Product Dissemination and Communication Tests

The following circuits and methods will be used to disseminate products:

1) Global Telecommunications System of the World Meteorological Organization (WMO/GTS)
2) Internet Email
3) Telefax
4) U.S. NOAA Weather Wire
5) U.S. Advanced Weather Information Processing System (AWIPS)

The GTS is the backbone of the international dissemination system, but telefax and email are also widely utilized. The NOAA Weather Wire facilitates making all these products available to independent subscribers such as the media through the U.S. National Weather Service's Family of Services. AWIPS distributes the products to all U.S. Weather Forecast Offices.

Two levels of product are distinguished and given separate World Meteorological Organization (WMO) identifiers (Table).

Table. PTWC CARIBE-EWS Product IDs for WMO/GTS and AWIPS.

WMO/GTS ID	AWIPS ID	Product Type
WECA41 PHEB	TSUCAX	Tsunami Watch Message
WECA43 PHEB	TIBCAX	Tsunami Information Statement

Communications Tests

PTWC will conduct communications tests approximately four times per year to verify that communications links to designated contact points are functioning properly. The test will be issued with the product identifier of a Tsunami Watch Message (WEIO21 PHEB and TSUIOX), but it will only be a test.

5. Bulletin Interpretation and Action

It is the responsibility of the contact point for each country, where PTWC products are received, to establish procedures for acting on them in a way to save lives and reduce property damage. These procedures should include:

1) Rapid notification of decision-making authorities
2) Decision-making regarding the ordering of evacuations and other protective measures
3) If warranted, rapid and comprehensive notification of the public at risk
4) Procedures for evacuations including establishment of evacuation zones and routes
5) Response procedures in case of a tsunami disaster

A significant challenge associated with these procedures is the decision-making about evacuations, particularly since evacuations can be very costly and disruptive and there is a significant probability of false alarms owing to the current lack of adequate sea level data from the source region. Procedures can include pre-determined decisions, such as automatically notifying the media and public for nearby events when time is very limited.

6. Example Statements

PTWC Sample Tsunami Information Statements, Local, Regional, and Ocean-wide Tsunami Watch Bulletins and Communication Test messages are provided in the Communications Plans for the Caribbean (June 2006),\.

PACIFIC TSUNAMI WARNING SYSTEM
PTWS OPERATIONAL USERS GUIDE, SECTION 5.
West Coast/Alaska Tsunami Warning Center (WC/ATWC)
(as of October 2008)

5.1 Introduction

The West Coast/Alaska Tsunami Warning Center (WC/ATWC) is operated by the Alaska Region of the National Weather Service and is located in Palmer Alaska. The Center's area-of-responsibility (AOR) consists of all Canadian coastal regions, Puerto Rico and the U.S. Virgin Islands, and the ocean coasts of all U.S. States except Hawaii. The center collaborates with the Pacific Tsunami Warning Center PTWC to provide tsunami warning service, and mutual backup, to tsunami threatened areas throughout the United States and many other countries throughout the world.

To accomplish its mission of providing accurate and timely tsunami bulletins to its AOR, the center detects, locates, sizes, and analyzes earthquakes throughout the world. Earthquakes that activate the center's alarm system initiate an earthquake and tsunami investigation which includes the following four basic steps: automatic locating and sizing the earthquake; earthquake analysis and review; sea level data analysis to verify the existence of a tsunami and to calibrate models; and disseminating information to the appropriate emergency management officials.

The WC/ATWC staff level has recently been increased such that the center operates 24 hours every day with two watchstanders on duty. The center began 24x7x2 operations on April 23, 2006.

5.2 Warning Criteria

WC/ATWC procedures are organized by the source's geographic region and magnitude. The basic procedures are summarized in the bar chart in Figure 5.1. The actions shown in Figure 5.1 indicate the first message (and in many cases the only message) to be issued. Follow up actions are based on observed wave amplitudes, tsunami models, historical data, and earthquake parameters. Supplemental warning or watch bulletins for events within the AOR are issued every 30 minutes, though may be less often during later times of an event.

5.3 Message Definitions

There are four basic types of messages issued by the WC/ATWC. The definitions have been recently updated within the U.S. Tsunami Warning System and will be in effect in fall, 2007.

Communication Test: Communication tests are conducted monthly. Two tests are conducted: one for primary recipients in the Atlantic basin and one for primary recipients in the Pacific basin. Time that it takes to reach recipient is noted and those who do not receive the test are queried for a response. An example monthly summary sheet is attached.

Information Statement: An Information Statement is issued to inform emergency management officials and the public that an earthquake has occurred. In most cases, Information Statements are issued to indicate there is no threat of a destructive tsunami affecting the issuing Tsunami

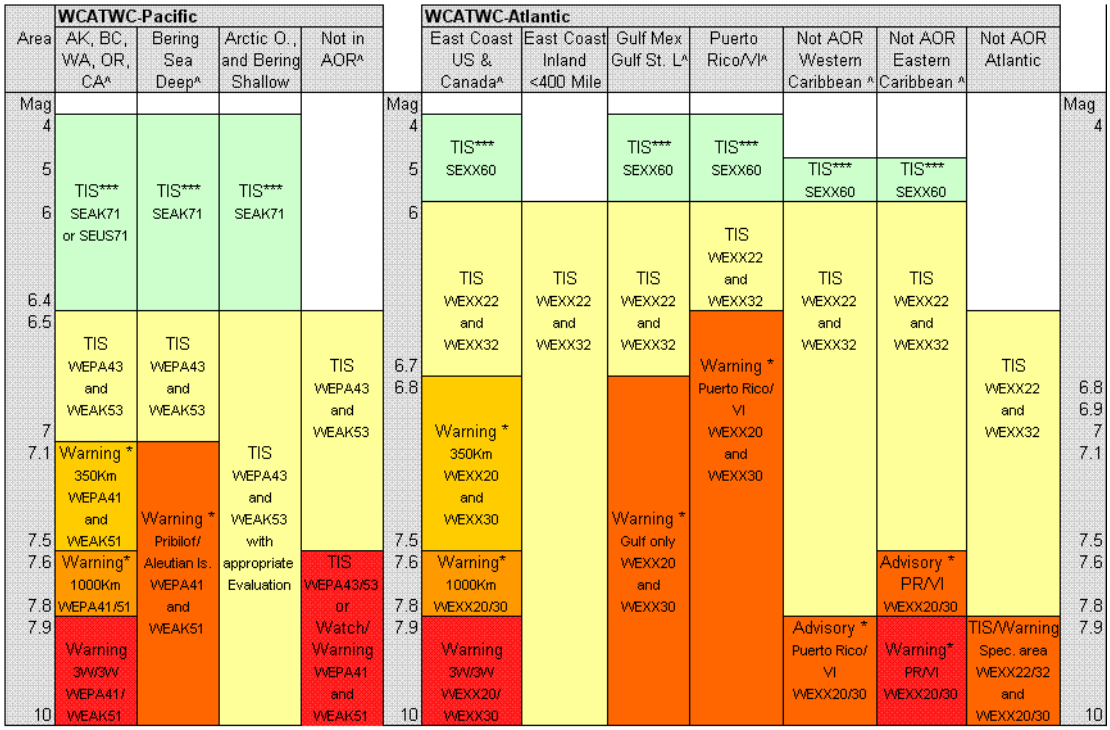
Warning Center's Area of Responsibility and to prevent unnecessary evacuations as the earthquake may have been felt in coastal areas. An Information Statement may, in appropriate situations, caution about the possibility of destructive local tsunamis. Information Statements may be re-issued with additional information, though normally these messages are not updated. However, a Watch, Advisory or Warning may be issued for the area, if necessary, after analysis and/or updated information becomes available.

Tsunami Advisory: A Tsunami Advisory is issued by the Tsunami Warning Centers due to the threat of a potential tsunami which may produce strong currents or waves dangerous to those in or near the water. Coastal regions historically prone to damage due to strong currents induced by tsunamis are at the greatest risk. The threat may continue for several hours after the arrival of the initial wave, but significant widespread inundation is not expected for areas under an Advisory. Appropriate actions to be taken by local officials may include closing beaches, evacuating harbors and marinas, and the repositioning of ships to deep waters when there is time to safely do so. Advisories are normally updated to continue the Advisory, expand/contract affected areas, upgrade to a Warning, or cancel the Advisory.

Tsunami Watch: A Tsunami Watch is issued by the Tsunami Warning Centers to alert emergency management officials and the public of an event which may later impact the Watch area. The Watch area may be upgraded to a Warning or Advisory (or canceled) based on updated information and analysis. Therefore, emergency management officials and the public should prepare to take action. Watches are normally issued based on seismic information without confirmation that a destructive tsunami is underway.

Tsunami Warning: A Tsunami Warning is issued by the Tsunami Warning Centers when a potential tsunami with significant widespread inundation is imminent or expected. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after arrival of the initial wave. Warnings also alert emergency management officials to take action for the entire tsunami hazard zone. Appropriate actions to be taken by local officials may include the evacuation of low-lying coastal areas, and the repositioning of ships to deep waters when there is time to safely do so. Warnings may be updated, adjusted geographically, downgraded, or canceled. To provide the earliest possible alert, initial warnings are normally based only on seismic information.

Figure 5.1. WC/ATWC procedural chart



Area	WCATWC-Pacific					WCATWC-Atlantic							
	AK, BC, WA, OR, CA^	Bering Sea Deep^	Arctic O., and Bering Shallow	Not in AOR^		East Coast US & Canada^	East Coast Inland <400 Mile	Gulf Mex Gulf St. L^	Puerto Rico/VI^	Not AOR Western Caribbean ^	Not AOR Eastern Caribbean ^	Not AOR Atlantic	
Mag					Mag								Mag
4	TIS*** SEAK71 or SEUS71	TIS*** SEAK71	TIS*** SEAK71		4	TIS*** SEXX60		TIS*** SEXX60	TIS*** SEXX60				4
5					5					TIS*** SEXX60	TIS*** SEXX60		
6					6	TIS WEXX22 and WEXX32	TIS WEXX22 and WEXX32	TIS WEXX22 and WEXX32	TIS WEXX22 and WEXX32	TIS WEXX22 and WEXX32	TIS WEXX22 and WEXX32		
6.4													
6.5	TIS WEPA43 and WEAK53	TIS WEPA43 and WEAK53	TIS WEPA43 and WEAK53 with appropriate Evaluation	TIS WEPA43 and WEAK53					Warning * Puerto Rico/ VI WEXX20 and WEXX30			TIS WEXX22 and WEXX32	
6.7					6.7								
6.8					6.8	Warning * 350Km WEXX20 and WEXX30		Warning * Gulf only WEXX20 and WEXX30					6.8
6.9													6.9
7													7
7.1	Warning * 350Km WEPA41 and WEAK51	Warning * Pribilof/ Aleutian Is. WEPA41 and WEAK51											7.1
7.5					7.5								7.5
7.6	Warning* 1000Km WEPA41/51			TIS WEPA43/53 or Watch/ Warning WEPA41 and WEAK51	7.6	Warning* 1000Km WEXX20/30					Advisory * PR/VI WEXX20/30		7.6
7.8					7.8								7.8
7.9	Warning 3W/3W WEPA41/ WEAK51				7.9	Warning 3W/3W WEXX20/ WEXX30				Advisory * Puerto Rico/ VI WEXX20/30	Warning* PR/VI WEXX20/30	TIS/Warning Spec. area WEXX22/32 and WEXX20/30	7.9
10					10								10

*** Based on magnitude and distance from the coast. ^ if deeper than 100km and <7.9, use TIS * No Watch
No TIS for Alaska if less than magnitude 5 and West of 155W
3W/3W => warning for area impacted within 3 hours and watch for area 3 to 6 hours away
TIS = Tsunami Information Statement
WMO product IDs listed under message type

5.4 Message Identifiers

WC/ATWC tsunami bulletins are National Weather Service products. All NWS products are described by both a World Meteorological Organization (WMO) Header and a National Weather Service AWIPS ID. The following table describes the products. For watch, warning, advisory, and information statements (with the WExxxx distribution), there are two products. The standard products (WEPA41, WEPA43, WEXX20, and WEXX22) are segmented within the bulletin with the watch, warning, and information only sections separated by Universal Generic Codes (for watch and warning messages). The new public products (WEAK51, WEAK53, WEXX30, and WEXX32) are in a format intended for the general public and contain action statements and information highlighting the dangers of tsunamis. Experimental web-based products are created and issued by the WC/ATWC to its web site and through RSS feeds. The web-based products are written in an html format with embedded links to related information and are similar in format to the public products.

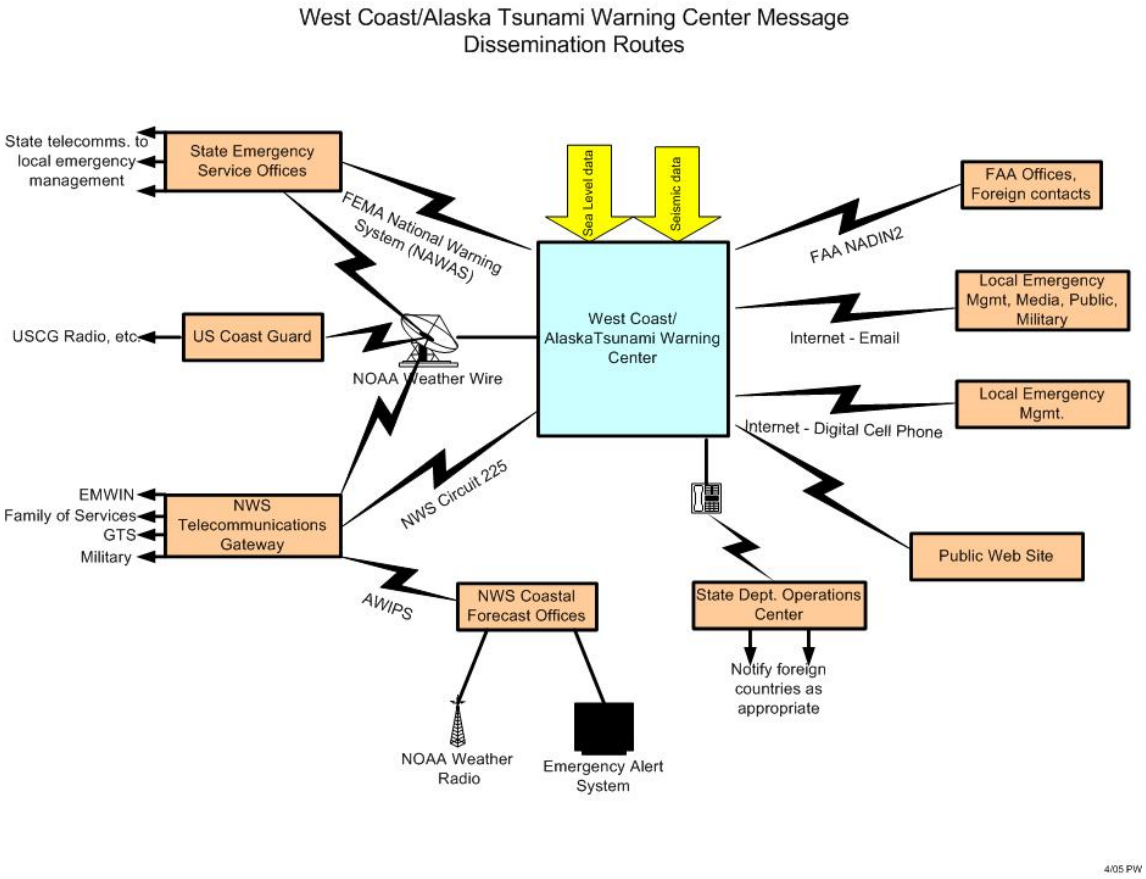
WC/ATWC issues monthly communication test message using the WEPA41 and WEXX20 product headers.

WMO Header	NWS AWIPS ID	Explanation
WEPA41 PAAQ	TSUWCA	Tsunami Warnings, Watches, and Advisories AK, BC, and US West Coast
WEPA43 PAAQ	TIBWCA	Information Statements AK, BC, and US West Coast
WEAK51 PAAQ	TSUAK1	"Public" Tsunami Warnings, Watches, and Advisories AK, BC, and US West Coast
WEAK53 PAAQ	TIBAK1	"Public" Information Statements AK, BC, and US West Coast
SEAK71 PAAQ	EQIAKX	Information Statements Alaska (M<6.5)
SEUS71 PAAQ	EQIWOC	Information Statements BC and US West Coast (M<6.5)
WEXX20 PAAQ	TSUAT1	Tsunami Warnings, Watches, and Advisories PR/VI, US East, Gulf, and Canadian Maritime Provinces
WEXX22 PAAQ	TIBAT1	Information Statements PR/VI, US East, Gulf, and Canadian Maritime Provinces
WEXX30 PAAQ	TSUATE	"Public" Tsunami Warnings, Watches, and Advisories PR/VI, US East, Gulf, and Canadian Maritime Provinces
WEXX32 PAAQ	TIBATE	"Public" Information Statements PR/VI, US East, Gulf, and Canadian Maritime Provinces
SEXX60 PAAQ	EQIAT1	Information Statements (M<6) PR/VI, US East, Gulf, and Canadian Maritime Provinces

5.5 Message Dissemination Routes

Message dissemination routes used by the WC/ATWC are summarized in Figure 5.2. Primary routes are the National Warning System (NAWAS), the NOAA Weather Wire (NWWS), NWS private circuits to the NWS Telecommunications Gateway, and the Federal Aviation Administration's (FAA) NADIN2 communication system. The NWS Telecommunications Gateway is the conduit to WMO's Global Telecommunications System. Secondary routes are the web site, email, RSS feeds, cell phone text messaging, USGS dissemination systems, and telephone calls.

Figure 5.2 – WC/ATWC message dissemination



5.6 Example Messages

WC/ATWC Sample messages can be found in the PTWS Operational Users Guide.