

## A report on forecasts of tsunami driftage location

28th, March, 2014

Ministry of the Environment, Government of Japan

Issues on marine driftage generated by the Great East Japan Earthquake are addressed through cooperation among relevant ministries under the coordination of the Secretariat of Headquarters for Ocean Policy.

MOEJ has been conducting forecasts of tsunami driftage location since 2011 to ascertain the status of the driftage. The result for this year is provided below.

### 1 . Prediction method

- Simulations are conducted by using drifting speed obtained by adding the speed of the ocean current and the speed of the wind(leeway).
- Ensemble forecasts are conducted for Standard driftage ( above : beneath sea surface = 1 : 1 ) and Subsurface driftage ( above : beneath sea surface = 0 : 1 )
- The initial conditions were established by analyzing images obtained by JAXA ' s Advanced Land Observing Satellite(ALOS), " Daichi. "

### (Major change from the last simulation in 2013)

**Conducted ensemble forecasts with measured values obtained until Sep 2013.**

\* Please see attached 1 for details of the basic prediction method.

### 2 . Summary

Comparatively high density part for Standard driftage is predicted to start to reach the west coast of the North American continent around April 2013 on a report announced on 15<sup>th</sup> March 2013.

On the other hand, according to forecasts of tsunami driftage location this year using meteorological and ocean data based on measured values until Sep 2013, arrival of tsunami driftage to the west coast of the North American continent in 2013 resulted in reaching a peak on Feb 2013 starting from the previous December. Furthermore, the amount to reach was found to be about one third of the result last year. This is attributed to the forecasts of tsunami driftage last year, which was calculated based on measured values until Sep 2012 unaffected so much from the effect of Aleutian low and back flow of Westerlies that occurred in the following winter.

The press release this year also includes Subsurface driftage, which was not expected to reach the west coast of the North American continent last time but expected to reach this time. According to the result of forecasts this time, both type of tsunami driftage will start reaching the west coast of the North American continent by February 2014, and the amount will start to increase substantially from April to fall. However, the forecasts might develop into some gap in terms of time and amount to reach just like last year as the forecasts do not include measured value after October 2013.

\*Please see attached 2 for details of the prediction result.



## Attachment 1 . Forecasting method of marine driftage

<prediction model>

Marine driftage locations were simulated using the following hybrid system model on the Earth Simulator at JAMSTEC: the JMA-MRI 3D-Var ocean data assimilation systems (MOVE-WNP for the energetic western North Pacific with 10km horizontal resolutions and MOVE-NP for the entire North Pacific with 50km horizontal resolutions), JAMSTEC 4D-Var coupled atmosphere-ocean data assimilation system (K7 for the global atmospheric and oceanic general circulation with 100km horizontal resolutions), and the JAEA particle-tracking model (SEA-GEARN). In the driftage location forecasting, a 6-hourly mean atmospheric reanalysis data (JCDAS: JMA Climate Data Assimilation System) were used for the atmospheric fields from the earthquake to September 30, 2013 and subsequently the K7 forecasted field was adopted for the atmospheric fields after September 30, 2013.

<calculation scheme>

A simulation was carried out for the 2 types (see below) influenced by both surface winds and surface ocean currents, in which we took into account the effect of windage based on the experimental information of Japan Coast Guard.

Subsurface driftage above-:beneath- sea surface = 0:1	Standard driftage above-:beneath- sea surface = 1:1
<ul style="list-style-type: none"> <li>● Mostly below the ocean's surface</li> <li>● Lumber containing seawater, driftwood, etc.</li> <li>● Rarely unaffected by Westerlies</li> </ul>	<ul style="list-style-type: none"> <li>● Nearly half is under water</li> <li>● Lumbers derived from broken houses, flooded vessels, etc.</li> </ul>
	

<initial conditions>

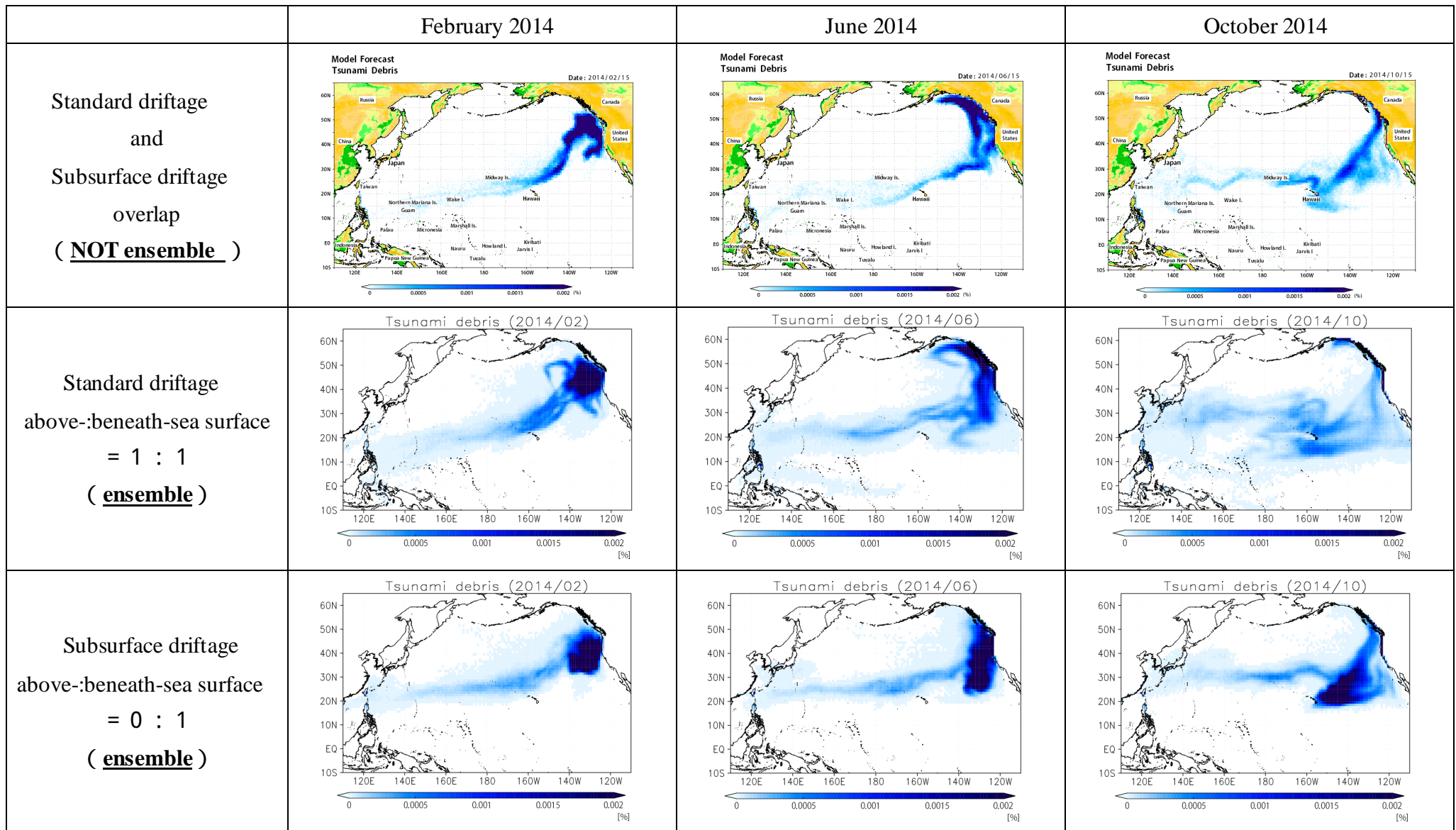
For initial conditions, satellite images obtained from ALOS (Advanced Land Observing Satellite)/PALSAR (phased array L-band synthetic Aperture Radar) from March 13 to 26, 2011, were analyzed to estimate location clouds of driftage flashed out from Iwate to Fukushima Prefectures associated with the earthquake.

Based on observational information, particles were released from the coastal seas of Iwate, Miyagi, and Fukushima Prefecture after the earthquake and the spread is calculated using our hybrid system model. Satellite-image analyses exhibited that the driftage tended to remain near the coastline as the initial phase. Thus, the release of particles was continued during the period of 20 days from March 12 to 31, 2011.

From the earthquake to September 30, 2013, particle tracking was made using the hybrid system model.

**Attachment 2 Forecast results**

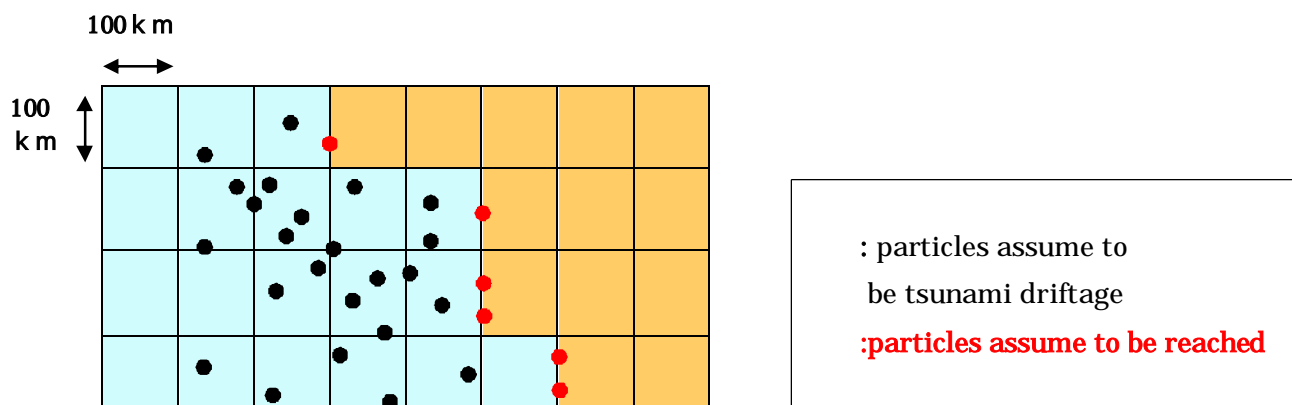
	February 2013	June 2013	October 2013
<p>Standard driftage and Subsurface driftage overlap ( <u>NOT ensemble</u> )</p>	<p>Model Hindcast Tsunami Debris Date: 2013/02/15</p>	<p>Model Hindcast Tsunami Debris Date: 2013/06/15</p>	<p>Model Forecast Tsunami Debris Date: 2013/10/15</p>
<p>Standard driftage above-:beneath-sea surface = 1 : 1 ( <u>ensemble</u> )</p>	-	-	<p>Tsunami debris (2013/10)</p>
<p>Subsurface driftage above-:beneath-sea surface = 0 : 1 ( <u>ensemble</u> )</p>	-	-	<p>Tsunami debris (2013/10)</p>



shows weight density distribution of total amount of about 1.53 million tons ( Standard driftage: about 1.33 million tons, Subsurface driftage: about 0.20 million tons )

and show weight density distribution of each driftage

Accumulated amount of tsunami driftage to reach the west coast of the North American continent (within the area of 100km) in 2014 (estimated)



Estimating under the following condition (done by MOE), estimated amount of tsunami driftage reached the west coast of the North American continent (within the area of 100km) from February 2013 to October 2014 can be seen in Table 1.

<condition>

- Estimated in the case of Standard and Subsurface driftage
- Total amount of tsunami driftage is assumed to be about 1,530 thousand tons
- Coverage area are from northern latitude of 35 degrees to 55 degrees of the west coast of the North American continent
- Estimated the amount of tsunami driftage reached the west coast, after calculating ratio of “number of particles located on the side of continental areas beyond coastline of the west coast of the North American continent” and “total particles flowed out” based on the result of simulations, multiplying the ratio by the above total amount of tsunami driftage
- Estimate amount of tsunami driftage to reach the west coast of the North American continent (within the area of 100km) is in table 1.

As tsunami driftage to reach coastal area is affected by ocean currents and winds, coastal circumstances of the moment and so on, all of them do not necessarily arrive at the coast. Furthermore, the result of simulations at this time might not accurately reflect the effect of intricate change of meteorological and marine phenomenon within a small area near the coast. For, the simulation was performed on range of 100km x100km as a unit on the assumption that meteorological and marine conditions are always same within this range.

Consequently, attention should be paid to that the estimated amount of tsunami driftage reached in the following table 1 is NOT equal to the estimated amount of tsunami driftage beached on the west coast of the American continent.

Additionally, actual amount of tsunami driftage reached is expected to be smaller than the estimation given the fact that the degradation, breakdown and sedimentation of driftage of time (diffusion and disappearance during drift) have not been taken into account at the simulation.

Table 1. accumulated amount to reach on forecasts of tsunami driftage in 2013  
( black: total, green: Standard driftage, blue: Subsurface driftage )

	Feb 2013	Jun 2013	Oct 2013	Feb 2014	Jun 2014	Oct 2014
Amount of tsunami driftage reached (thousand tons)	68+0 (68)	69+0 (69)	71+0 (71)	76+1 (77)	170+50 (220)	343+59 (402)

For reference accumulated amount to reach on forecasts of tsunami driftage in 2012  
( Standard driftage Only )

	Feb 2013	Jun 2013	Oct 2013
Amount of tsunami driftage reached (thousand tons)	2	105	221