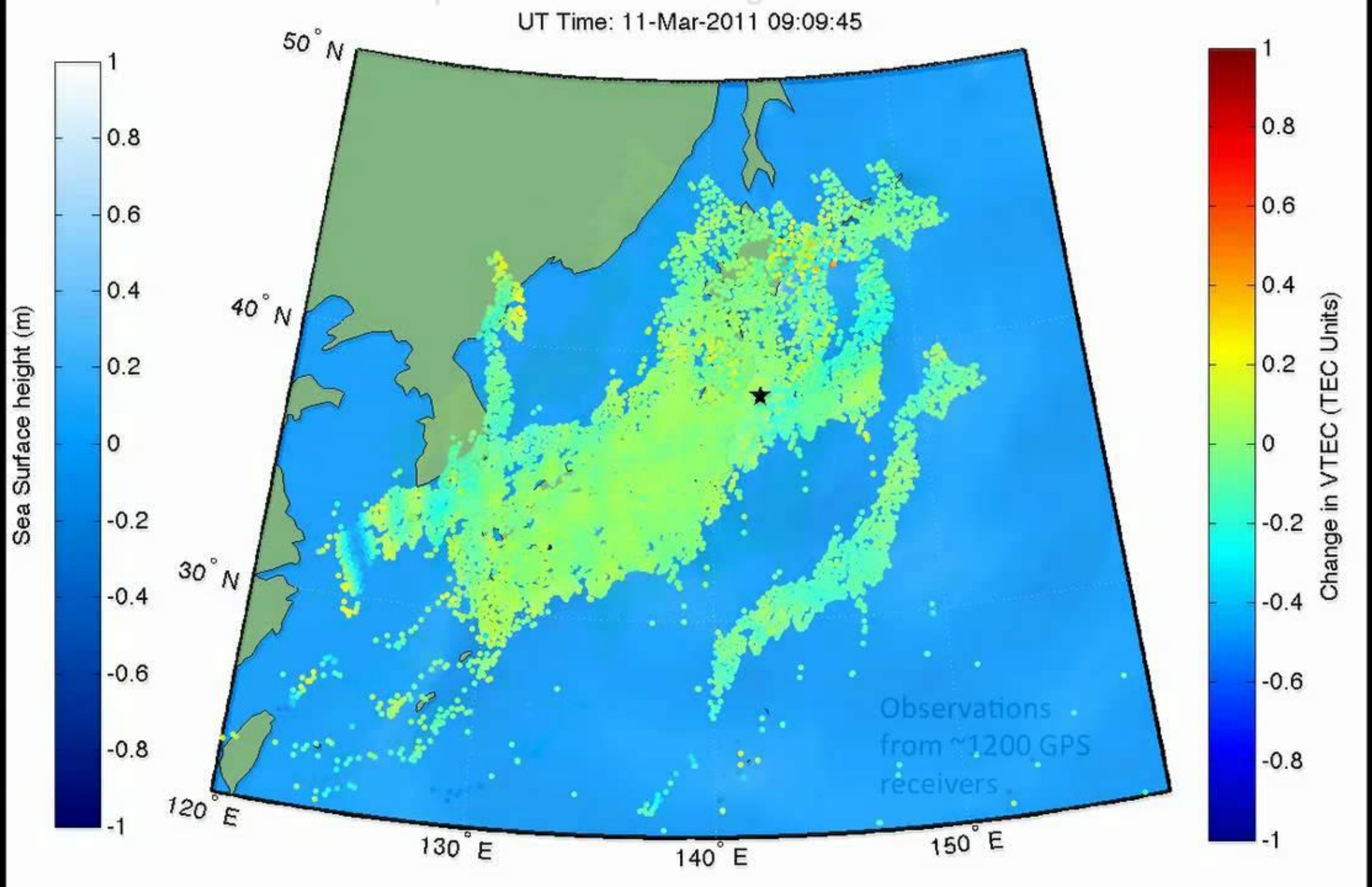
UT Time: 11-Mar-2011 09:09:45
50° N
40° N
30° N
120° E
130° E
140° E
150° E
Sea Surface height (m)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Change in VTEC (TEC Units)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Observations from ~1200 GPS receivers

1
00:00:04,000 --> 00:00:08,000
The March 11, 2001 earthquake and tsunami disturbed the upper atmosphere in a way

2
00:00:08,000 --> 00:00:13,000
that was detectable by our GPS receivers. In this map showing the region around Japan,

3
00:00:13,000 --> 00:00:18,000
we see color dots representing the point at which a radio signal sent by a GPS satellite

4
00:00:18,000 --> 00:00:22,000
in space passes through the atmosphere on its way to GPS receivers on the ground.

5
00:00:22,000 --> 00:00:26,000
Each clump of color dots represents one satellite in communication

6
00:00:26,000 --> 00:00:29,000
with all 1200 receivers on the ground in Japan.

7
00:00:29,000 --> 00:00:33,000
The clumps move across the sky just as the GPS satellites move overhead.

8
00:00:33,000 --> 00:00:39,000
And when they get too far away from Japan, they disappear as the GPS satellite goes over the horizon.

9
00:00:39,000 --> 00:00:42,000
The color of these dots, represent the disturbance in the upper atmosphere

10
00:00:42,000 --> 00:00:44,000
caused by the earthquake and tsunami below.

11
00:00:44,000 --> 00:00:49,000
Now that we've explained the map, let's take a look at the actual signals.

12
00:00:49,000 --> 00:00:54,000
Immediately after the earthquake, you can see two waves moving out toward the left, west on this map;

13
00:00:54,000 --> 00:00:57,000

A Rayleigh wave and an acoustic wave moving away from the epicenter.

14
00:00:57,000 --> 00:01:02,000
You can also see slower moving gravity waves also caused by the earthquake and the tsunami.

15
00:01:02,000 --> 00:01:05,000
Notice that these gravity waves align quite well with a model

16
00:01:05,000 --> 00:01:09,000
of the ocean tsunami itself represented in blue and white on the right of the screen.

17
00:01:09,000 --> 00:01:12,000
The fact that these upper atmospheric disturbances are aligned well

18
00:01:12,000 --> 00:01:15,000
with the ocean tsunami, imply that they are causally related.