

Introduction

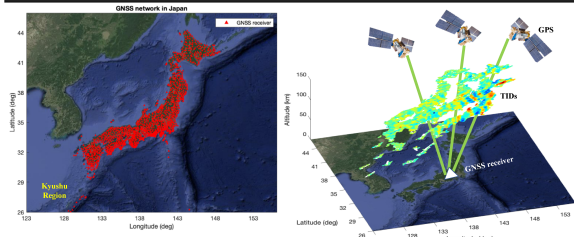
This study firstly proposes the detection and characterization of traveling ionospheric disturbances (TIDs) due to meteorological tsunamis (meteotsunamis).

Meteotsunamis' Characteristics :

- Definition : $> 6^*$ std sea level variation. Generating 30-300 cm walls of water.
- Driven by air pressure perturbations. e.g. tropical cyclone, cold front, atmospheric pressure jumps, etc.
- Usually takes place in coastal areas and lakes.
- > 100 events/yr including ~ 25 > 1 -meter-wave events/yr.

Understanding of meteotsunamis' characteristics such as the ionospheric total electron content (TEC) disturbance magnitude and propagation speed will enable the development of detection and forecasting techniques as well as early warning systems.

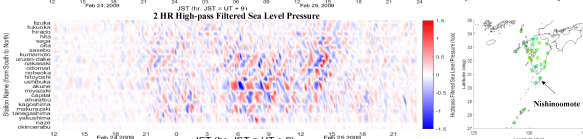
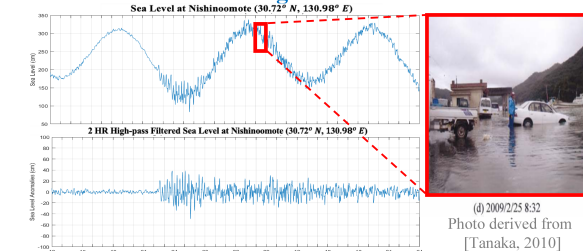
Dataset and Methodology



- The TEC is derived from 1200+ ground-based GNSS receivers of Geospatial Information Authority in Japan.
- The ionospheric height for converting slant TEC to vertical TEC is at 150 km altitude.
- Fifth-order Butterworth bandpass filter was applied on the derived TEC.

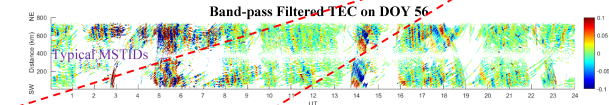
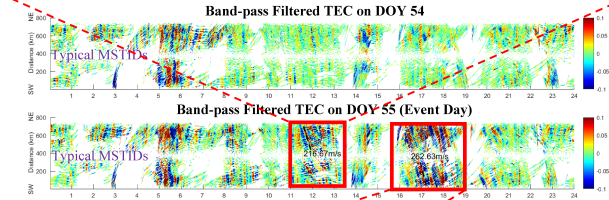
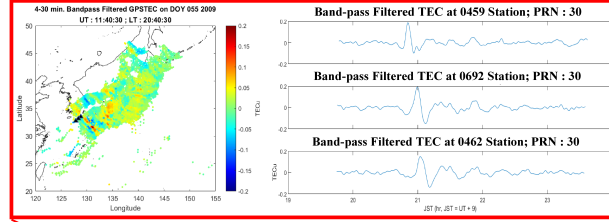
Characteristics of Kyushu Event

Oceanic and Meteorological Observations



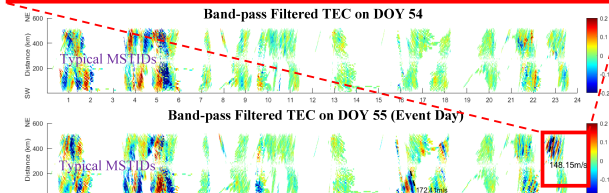
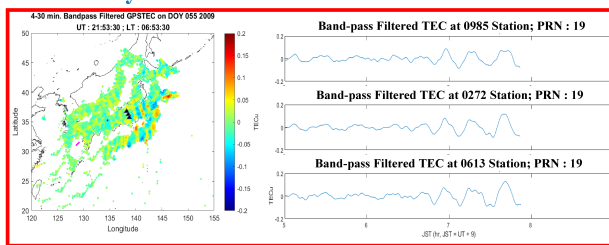
Period	22:25 JST on 24 Feb ~ 24:00 JST on 25 Feb, 2009 (13:25 UT) (DOY 55) (15:00 UT) (DOY 56)
Sea Level Anomaly	~50 cm walls of water
Sea Level Pressure Anomaly	~2.0 hpa
Propagation Direction	NE-ward

TIDs Observations

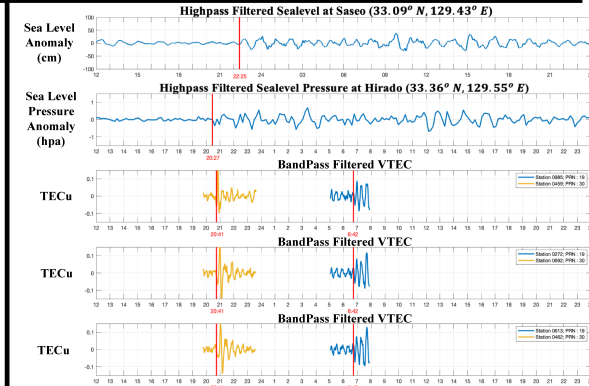


- SW-ward TIDs, with ~ 217 m/s phase velocity and ~ 0.2 TECu perturbation, can only be observed over Kyushu on event day.
- This TIDs occurred ~ 100 min. earlier than meteotsunami likely are triggered by the deep convection instead.
- The Gravity Waves (GWs) might play as a seed to accelerate the Perkins instability and generate clear nighttime Medium-Scale TIDs (MSTIDs).

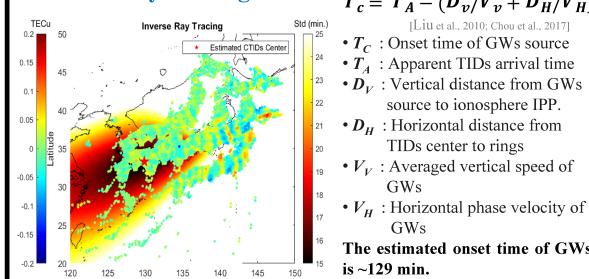
Secondary TIDs Observations



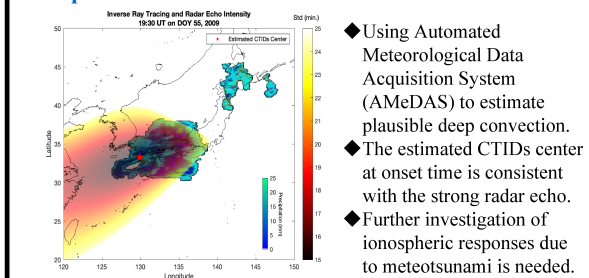
Concentric TIDs (CTIDs), with ~ 148 m/s phase velocity and ~ 0.15 TECu perturbation, can only be observed on event day.



Inverse Ray Tracing



Deep Convection Estimation



Summary

	Sea Level	Sea Level Pressure	TEC Perturbations
Anomaly	~50 cm	~2.0 hpa	0.15-0.20 TECu
Occurred Time	~22:25 JST on 24 th	~20:27 JST on 24 th	1 st case: ~20:41 JST on 24 th (SW TIDs) 2 nd case: ~06:42 JST on 25 th (CTIDs)

- The first TIDs is likely a manifestation of GWs triggered by deep convection. Such GWs play as a seed to generate clear Perkins-type nighttime MSTIDs.
- The CTIDs is only discernable on the event day where the estimated concentric center locates at near-coastal region.
- The generation mechanism of CTIDs could be meteotsunami or deep convection. This suggests further investigation of ionospheric responses due to meteotsunami is needed.