German Aerospace Center
in the Helmholtz Association
Microwaves and Radar Institute

WP 4430 Ground Based System

Microwaves Systems Department

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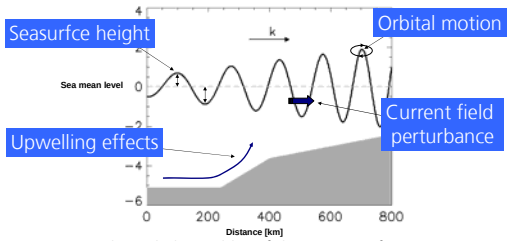
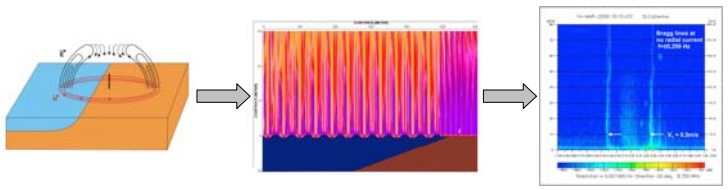
Abstract: The WP 4430 investigates the requirements of a possible ground based tsunami early warning radar system as required for a continuous observation over a large ocean area. Here, the observable interaction of a High Frequency field HF (3–30 MHz) with ocean waves is of particular interest. The spatial propagation of a tsunami is done in such a way that all the water particles of the water column undergo an elliptical orbital motion. The tsunami-induced horizontal water column motion and upwelling effects in the coastal area offshore Indonesia will give an additional horizontal water flow superimposed to the actual surface current field. In this contribution we present the potential of a ground based HF-Radar along the coast of northern Sumatra as part of a possible Tsunami Early Warning System (TEWS). The presentation consists of the following steps:

1. Estimation of the ocean surface current.
2. Numerical calculation of a realistic ocean surface and its Radar signature.
3. Configuration of a ground based system for northern Sumatra.



Geophysical observables of the ocean surface

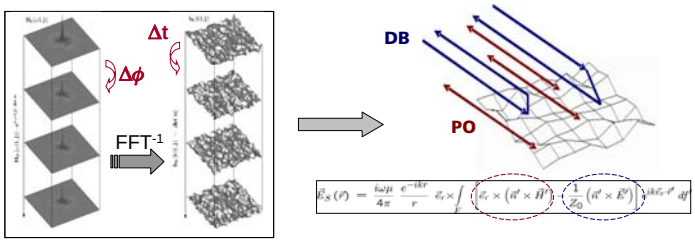
1. Measurement Principle



A shore-based vertically oriented dipole radiates electromagnetic waves propagating along the ocean surface. Bragg scattering occurs because of ocean wave crests spaced half an electromagnetic wavelength apart ($\lambda_{Bragg}=\lambda_{inc}/2$).

Ocean waves travelling towards and away from the radar are responsible for the observed positive and negative shifted peaks. An additional shift of the overall pattern is given by the locally present surface current (v=0.5 m/s)

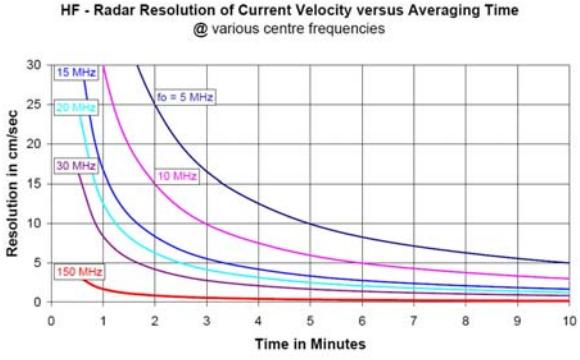
2. Radar Signature

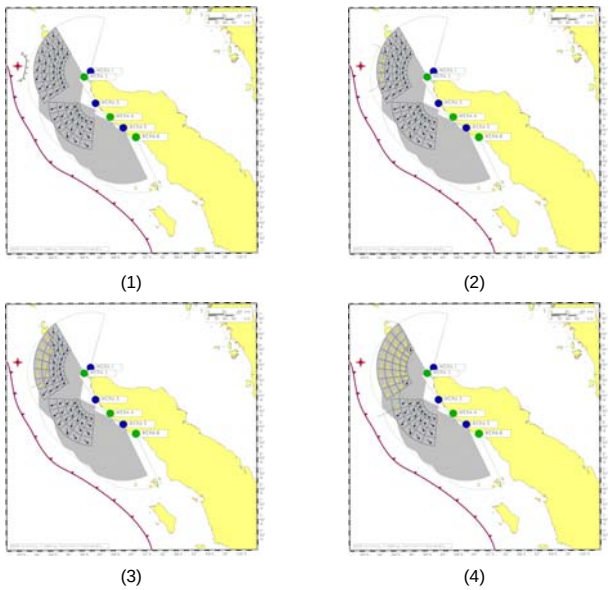


The temporal variation of the sea surface is calculated by a direct phase modulation in the wave number space instead of sequential computed time steps in the time domain. The total field is given by the *P*hysical *O*ptic field (PO) for the double bounced waves (DB) for a monostatic transmitter-receiver alignment.

3. Configuration for Banda Aceh

The WERA system (*W*av*E* *RA*dar) is a shore-based HF radar to monitor ocean surface currents, waves and wind direction. The system is manufactured by Helzel GmbH. The vertically polarised radiated wave couples to the conductive ocean surface and propagates as a surface wave with a maximum range of about 200 km and a field of view of about 120°. Radar performance depends on site geometry, system configuration and environmental conditions. There is a trade-off between Doppler resolution and Integration time. In order to detect a tsunami induced perturbation front in the present current field front offshore of northern Sumatra, the system is switched in the continuous detection mode and updates the current maps every Δt~2-3 min [see Fig. (1) - (4)] if e.g. a horizontal water flow of about ~40 cm/s is induced by a propagating tsunami front.





Possible WERA configurations for Northern Sumatra. After a hypothetical seaquake (red dot marks the epicenter) the tsunami alters the local surface current field. The tsunami-induced pattern can be observed over time (1– 4).