ATInSAR HOLOGRAM OBSERVATIONS OF COASTAL WAVE REFARCTION

Maged Marghany
University College Science and Technology Malaysia
Institute of Oceanography(INOS)
21030 Mengabang Telipot, Kuala Terengganu
Malaysia
Email: magedupm@hotmail.com
mmm@kustem.edu.my

This study is introducing a new approach of ATInSAR hologram for modeling wave refraction spectra pattern. TOPSAR data with L_{HH} and C-vv bands utilized spatial variation of wave refraction. Based on the phase information in along track interferometry, and ATInSAR hologram the quantitative information such swell wave height and spectra energy have been modeled. The phase information in ATInSAR hologram images can be transferred to wave refraction The ATInSAR hologram can be used to investigate the wave refraction pattern along the coastal waters. The fringe information pattern was shown to be useful in modeling wave refaction spectra varaition. The hologram interferometry wave refraction model consists of two sub-models. The purpose of first sub-model is to determine the swell wave height by using ATInSAR. Second sub-model aims to generate the holographic interferometry from the information of two wave spectra which detected by ATInSAR technique. The azimuth cut-off variations along the fringe patterns will be estimated. As azimuth cut-off contains the wave height information which could be used the significant wave height variation in convergence and divergence zone.

Introduction

Here we explain how the quantitative information of swell and current can be used for shoreline change model from single AIRSAR data. According to Vachon et al., (1999) Airborne along track interferometry (ATI) has the potential of measuring ocean surface currents and waves with high spatial resolution. According to Fabrizio et al., (2002), two antenna SAR system should be used with ATI technique. The short time lag between complex SAR images is produced by the along –track baseline between the two antenna due to that each antenna received backscatter signal with different time. The phase difference between the images causes the mean short-term Doppler shift of the scattering from the ocean surface to be measured on pixel-by-pixel basis. In performance, the phase information along track interferometry (ATI) SAR images considers as measure of the Doppler shift of the backscattered signal and line of sight velocity scatterers. Duk et al., (2002) pointed that the interferometric velocity is the sum of the ocean surface currents, phase velocities of Bragg waves and the orbital motion of the water particles.

Hologram Interferometry Model

Based on the above perspectives, the hologram interferometry coastal erosion model consists of three sub-models. The purpose of first sub-model is to determine the swell wave height by using ATInSAR.

The wave pattern in first image happened to have a crest along the face of the shoreline plane, and the wave at the second image coming in an angle J similarly has crest at similar points along the shoreline due to the coherence time difference is less than 1 sec. These correspond to points where interferometry maxima will occur. We assumed that the two waves will remain in-phase at there points through will overlap trough and maxima will remain fixed at different point along the shoreline . Similarly, between these points, trough overlaps crest and minima exist. The relative phase J' of these two waves, which varies from point to point along the shoreline can be written as function of distance x. Following, Maged (2003), the phase spectra can be given as the two amplitudes of the radial velocities variation $U_{r_1} and U_{r_2}$ superimposed and interfere to form an interferometry intensity variation along the shoreline which may be given by

$$P(U_r) = 0.5\{(U_{r_1} + U_{r_2}) + U_{r1}U_{r_2}\cos(J_2 - J_1)\}t \quad (1)$$

The amplitude transmission profile of the processed hologram can be made proportional to $P(U_r)$. In that case, the final energy wave, $z(x, y)$ is proportional to the production of $P(U) * E_R(x, y)$ where $E_R(x, y)$ is the reconstruction of swell wave. The final wave pattern will be appear due to the hologram interferometry may be written as

$$E_R(x, y) = 0.5U_r(U_{r_1}^{\ 2} + U_{r_2}^{\ 2})\cos(2pw + J) + 0.5U_rU_{r_1}U_{r_2}\cos(2pw + 2J - J_0) + 0.5U_rU_{r_1}U_{r_2}\cos(2pw + J_0) \quad (2)$$

These term describe the fringe pattern from the hologram interferometry.

Results and Discussion

The phase of the interferogram wave refraction spectra confirms that the swell tends to converge along the Airport shoreline (Figure 1). It is clear that the convergence area located along the azimuth direction. This may be because of the ATI can imagine the highest spectra velocity by acquiring interferogram from different azimuth viewing angle. Figure 1 shown a phase change as approaching onshore.

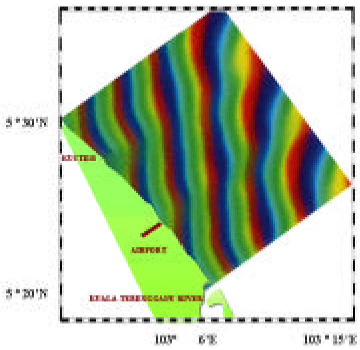

Figure 1. Interferogram phase of wave refraction.

Figure 2 shown a holographic interferometry phase change as approaching onshore. This is because of the fact that the scatter elevation varies from the reference; a differential phase is introduced into the interferogram, which induced phase change following the topography of sea. The radial velocities, which used to model the wave height depends on radar frequency. The change of horizontal current velocities is based on the change of the ocean bottom topography. This induces different change in the Bragg phase velocities. These results are agreed with Duk et al., (2002).

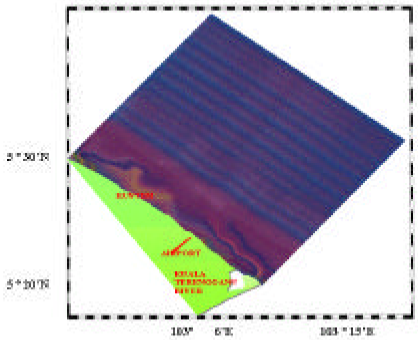

Figure 2. Hologram interferometry Fringes patterns

Conclusion

It can be concluded that ATInSAR provides a good map for swell wave propagation. The ATInSAR hologram can be used to investigate the wave refraction pattern along the coastal waters. The fringe information pattern was shown to be useful in modeling shoreline change rate.

References

Duk, J, W. Moon,D., Imail and D. Moller 2002. Remote sensing of Ocean waves and Currents Using AIRSAR Along-Track Interferometry (ATI). CD of Proceedings for the 2002 AIRSAR Earth Science applications Workshop March 4-6, 2000, Pasanda, California.

Fabrizio, L. and F. Bordoni, and F. Gini 2002. Enhanced and New possible Functionalities of ATI-SAR through multibaseline Acquisition and Modern Spectral Estimation Techniques. CD of Proceedings for the 2002 AIRSAR Earth Science applications Workshop March 4-6, 2000, Pasanda, California.

Maged, M., 2003 "Polarised AIRSAR Along Track Interferometry for shoreline Change Modelling" CD of Proceedings IGARSS 2003, 21-25 July, Centre de Congres Pierre Baudis, Toulous, France.

Vcahon, W. J.Camplell, A.L. gray and F.W. Dobsoon 1999. Validation of along –track interferometric SAR measurements of ocean surface waves. IEEE Trans. Geoscience and Remote sensing, 37:150-162.