Ship wakes and ship-generated internal waves observed on an Envisat ASAR and an ERS-2 SAR image of the Yellow Sea on 21 April 2006: A case study

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Abstract

Two synthetic aperture radar images acquired over the Yellow Sea southeast of Qingdao have been analyzed which show a large number of radar signatures of ship wakes and ship-generated internal waves. These radar images were acquired on 21 April 2006 at 2:06 UTC by the ASAR onboard the Envisat satellite and on the same day at 2.34 UTC by the SAR onboard the ERS-2 satellite.

In-situ measurements of the density stratification of the water column was measured by CTD casts from the Chinese research vessel Dong Fang Hong 2. These measurements reveal that on 21 April a sharp thermocline was present at a depth of 14 meters, where the water temperature dropped from 9 to 7 degrees Celsius. This density stratification was unexpected since in April the Yellow Sea waters should be well mixed vertically and there should be no thermocline.

On 21 April 2006, there was heavy ship traffic in the sea areasouth east of Qingdoa which included ships travelling at high speed of 12 m/s. The ship speed was determined by 1) comparing the positions of the ship on both radar images acquired with a time separation of 28 minutes, 2) measuring the displacement of the position of the ship relative to its turbulent wake, and 3) measuring the wavelength of the transverse wave behind the ship.

Several ships with a large draught generated internal wakes by pushing water downward by the hull of the ship and thus causing a distortion of the very shallow thermocline. By measuring the wake angle of the internal wake it was possible to determine the ship speed.

Furthermore, by comparing the displacement of internal wave patterns on both radar images, information on the propgation velocity of internal waves is obtained.