Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

A Reduced Order Model for Wake Surface-Wave Interaction

LAURA PAULEY, AMIR MEHDIZADEH, Penn State University — Surface waves can change the radar and optical signatures initially produced by the wake of a towed or self-propelled object on the sea surface. To date, most investigations considered the effects of the wake on the surface waves. Here our intention is to study how surface waves affect the wake. The wake of a moving object can persist thousands of diameters downstream. Due to the extensive domain, a reduced order method (2D+t) is often used to sweep downstream through the wake development. The 2D+t computation approximates the development of the wake at a fixed location as an object moves past but applies cyclical boundary conditions in the streamwise direction. A modified (Parabolized) Navier-Stokes (PNS) method has the same numerical efficiency as the classical 2D+t method but includes additional streamwise gradient terms derived in the transformation from a moving reference frame to a fixed reference frame. The present paper aims to assess the capability of the 2D+t and PNS methods for a laminar/turbulent wake interacting with a surface wave described by the Stokes drift velocity distribution. Results from 3D simulations will be used for validation to find criteria where 2D+t and PNS methods deliver results with an acceptable level of accuracy.

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Date submitted: 28 Jul 2015 Electronic form version 1.4