Abstract View

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An Ice Breeze Mechanism for an Ice Divergence-Convergence Criterion in the Marginal Ice Zone

P.C. Chu

Department of Oceanography, Naval Postgraduate School. Monterey, CA 93943

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ABSTRACT

A coupled air-ice-ocean theoretical model for the marginal ice zone (MIZ) is developed and used to show that an off-ice and divergent wind field not only produces a dilation of the MIZ (as is generally thought), but also generates a compaction of MIZ for some circumstances. An ice divergence-convergence criterion in the MIZ is found and used to help explain some features, such as ice edge bands, and the formation and maintenance of polynyas and leads.

The model contains three parts: a thermally forced boundary layer air flow, a mechanically driven ice drift, and a reduced gravity ocean. The three components are linked through the surface temperature gradient and various interfacial stresses. Model results show that in the MIZ, a thermally generated surface wind blowing from ice to water (ice breeze) is generally divergent over ice owing to the maximum surface temperature gradient located at the ice edge. Such divergent local winds can make the ice flow either divergent or convergent depending on the properties of ice and water underneath. For thin ice and a relatively deep surface water layer, the ice turning angle (angle between the direction of surface wind and ice flow) is small and the ice flow is divergent. In contrast, for thick ice and a relatively shallow surface water layer, the turning angle is large and the ice flow is convergent.

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Headquarters: 45 Beacon Street Boston, MA 02108-3693
DC Office: 1120 G Street, NW, Suite 800 Washington DC, 20005-3826
amsinfo@ametsoc.org Phone: 617-227-2425 Fax: 617-742-8718
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