An Heuristic Freezing Spray Model of Vessel Icing

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ABSTRACT

An heuristic model of vessel spray icing is presented. A spray/air heat balance is applied under one of two assumptions: the first, that the spray supercools; and the second, that the spray is nucleated. The nucleated spray model produces theoretical icing rates 300% to 400% greater than the supercooled version. In this way, a mechanism for severe icing is proposed. The environmental conditions leading to nucleated spray are not certain but near-freezing sea-surface temperatures, low air temperatures, and snow are suspected. The supercooled and nucleated models perform well against data and other icing models.

INTRODUCTION

In January 1955, the loss of the trawlers Lorella and Roderigo to freezing spray in the fishing grounds north of Iceland (Hay, 1956) signalled the beginning of over three decades of investigation into the vessel icing problem. The need for effective vessel icing forecasts continues to increase with activity in high-latitude oceans. Various methods of vessel spray icing prediction have been developed over the years, including those of Kachurin et al. (1974), Stallabrass (1980), Overland et al. (1986), Zakrzewski and Lozowski (1987), Horjen (1989) and Blackmore et al. (1989).

Most spray icing algorithms may be categorized as either statistical models (SM), statistical-physical models (SPM), or physical-empirical models (PEM). The SM does not account for the physics of the icing process except insofar as the wise choice of input parameters is a matter of physics. Like the SM, the SPM assumes that forecast icing events will differ little from events in the data set. However, the SPM uses a physical model around which the statistics are organized, hoping thereby to produce a better predictor. These core physical models have, in some cases, been surprisingly complex, with little to demonstrate that such complexity is essential to model performance. The PEM is typically a more recent approach, with a fuller overview of the physical processes of vessel icing and reduced dependence on icing data sets. The modeler may have a greater sense of control but may need to invoke a proliferation of model assumptions, and possibly may end with as much or more empirical dependence as the SPM. Blackmore and Lozowski (1992) provide further comments on some of these modelling issues.

The present work introduces a PEM based on a framework of vessel icing physics, and yet more concise than many simple SPMs or PEMs. The empirical component of the model describes the vessel’s spray generation and is based on field data. As an heuristic model it has been conceived for the purpose of investigating as many aspects of ship icing as possible. In this paper the model is described, its performance compared with data and other models, its sensitivity examined, and finally a mechanism for severe icing postulated and explored.

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