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VALIDATION OF NCEP'S OCEAN WINDS FOR THE USE IN WIND WAVE MODELS*

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The quality of analyzed ocean surface winds from the Global Data Assimilation System (GDAS) and forecasted winds from the early or 'aviation' cycle of the global medium range forecast model (AVN) of the National Centers for Environmental Prediction (NCEP) is assessed as part of a validation study of a new wave forecast system. This validation is performed using conventional buoy data and satellite retrieved wind speeds from the ERS1 altimeter and scatterometer. Both GDAS and AVN wind fields are shown to include moderate systematic biases, for which statistical corrections based on both satellite and buoy data are presented. Furthermore, buoy data are shown not to be representative for a global validation study.

The altimeter data are potentially of significant importance for wave model validations, as they include collocated wind and wave measurements. The altimeter winds, however, are shown to be seriously contaminated by the development stage of the wave field. As it does not appear to be possible to remove this contamination, altimeter wind data should not be used in the validation of wave models.

Keywords: NCEP winds; wave model; altimeter wind/waves

1. INTRODUCTION

This paper presents the first part of a validation study of a new ocean wind-wave forecast system at the National Centers for Environmental Prediction (NCEP). Wave forecast systems consist of two parts; a model for near-surface winds, and a model to predict waves based on these winds. The new NCEP forecast system takes its wind from NCEP's operational Global Data Assimilation System (GDAS, Derber *et al.*, 1991; Parish and Derber, 1992)

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and from the early or 'aviation' cycle of the operational medium range forecast system (generally denoted as AVN, Kanamitsu 1989; Kanamitsu *et al.*, 1991). The wave model is a recent version of WAVEWATCH (Tolman, 1991). This paper presents the validation and statistical correction of the wind fields. Subsequent papers will present a validation of the wave model and of the entire forecast system.

Wave heights approximately scale with the square of the wind speed. This implies that an error of 10% in the wind speed leads to an error of 20% in the wave height. Wave forecast errors therefore are often dominated by errors in the wind fields, and it is thus important for both the forecast system and for an intercomparison of wave models to obtain the best possible wind fields. Here, the GDAS and AVN wind fields are validated and where possible corrected using buoy observations and remotely sensed wind speeds from satellites. These data cover a three month period from Dec. 1994 through Feb. 1995.

Wind fields are generally validated with *in situ* measurements from buoys. Unfortunately, buoy data do not provide global coverage (Fig. 1), and hence the corresponding validation cannot claim global validity. Global validation can only be obtained with satellite data. Of particular interest for the present study are altimeter data, as they provide collocated wind and wave estimates. Such collocated data can potentially be used to separate wind input errors from wave model errors in a wave forecast system. However, satellite-retrieved winds are generally inferred rather than direct

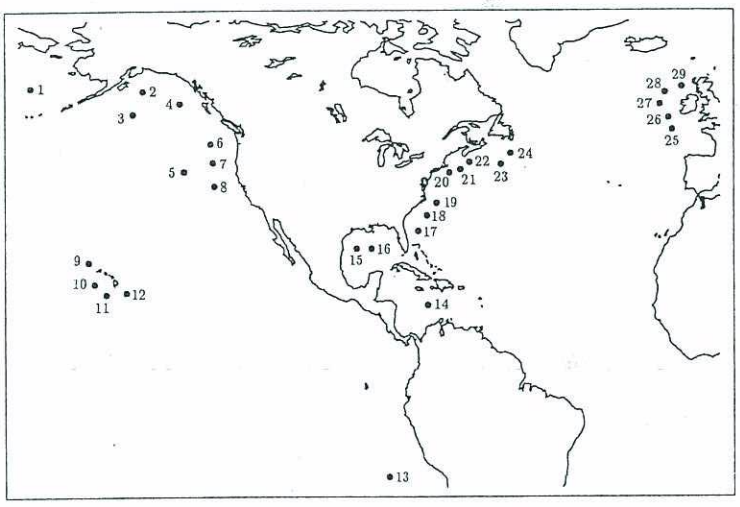

FIGURE 1 Buoy locations. Numbering as in Table I.

measurements. Because the algorithms are tuned or validated with buoy data, their global validity is also in question. This is particularly true for the altimeter wind speeds, as they are potentially contaminated by swell. the present study therefore also includes scatterometer data from ERS1.

The wind driving the wave model is inherently a vector quantity. The present study, however, concentrates on the scalar wind speed for several reasons. (i) Potential impact: wind speed correction has a potentially large impact on a wave model due to the roughly quadratic scaling behavior. Wind directions are more or less uniformly distributed over its entire domain, and are therefore expected to incorporate random rather than systematic errors. (ii) Data availability: the altimeter does not provide an estimate of the wind direction, whereas the scatterometer wind directions require (subjective) ambiguity removal (up to four solutions). This makes it difficult or even impossible to consider the full wind vector A consistent analysis considers the same parameter for all instruments, *i.e.*, the wind speed. (iii) Ease of correction: wind speeds are easily corrected. For the GDAS winds, the underlying assumption of such a correction could be that the weather patterns are generally well analyzed, but that the corresponding wind speeds have systematic biases. This is consistent with the experience of NCEP's operational forecasters (personal communication). Vector wind corrections are much more complicated. The additional complication is not justified by the expected small impact of correcting wind directions. Note that scalar wind speeds from GDAS and AVN at buoy locations and satellite tracks are obtained by vector interpolation unless specified differently.

The layout of this paper is as follows. In Section 2 the wind fields and data are discussed. In Section 3 analysis techniques are described briefly.

In Section 4, the GDAS and AVN wind fields are validated against the buoy data. In Section 5 the GDAS and AVN wind fields are validated with satellite data. The latter validation includes bias corrections and an assessment of global validity of altimeter and scatterometer winds. In the final discussion in Section 6 systematic and random errors of the GDAS and AVN winds are separated, and statistical corrections for systematic errors are suggested. Furthermore, the quality of altimeter wind speeds is considered for the use in subsequent parts of this study.

2. WINDS

As described in the introduction, the wind fields of the wave forecast system are obtained from NCEP's GDAS and AVN. The 48 h forecast will be