1. INTRODUCTION

1.1 Objectives

The acronym COMKISS stands for COnveying Met-ocean Knowledge Into Shipping Safety. However the project objectives were somewhat wider than this description might imply.

The main objective of the COMKISS was:

- *to demonstrate to major segments of the European marine transport industry the benefits of integrating satellite-derived information on sea state with more conventional methods.*

A secondary objective lay in the method of demonstration. Since the project involved close co-operation of industrial partners from beginning to end, their endorsement of the usefulness of satellite data counts much more than any claim made by EO value-added companies. Separate demonstration modules have been created to record the separate tasks and chronicle the improvements made through the introduction of satellite-derived information where it was not used before. Thus COMKISS had a secondary objective:

- *to raise awareness of the usefulness of satellite data in increasing the safety and overall efficiency of shipping operations (by using EWSE as the channel for communicating progress.)*[1]

COMKISS aimed to demonstrate the extent to which the introduction of space-derived information on sea-state into three major marine operations would benefit their daily activities. The objective was to bring about a change of attitude, not by convincing operators to use EO data where it is inappropriate, but to demonstrate that space-derived information can at the very least act as a control on the quality of the data they presently depend on and, at best, replace it.

Three main offshore industry sectors were selected for the study, chosen because of their previous lack of exposure to satellite data. These were: ***ship design and certification,*** the ***transport of very large loads*** such as dock cranes and offshore platforms, and the operation of ***high speed craft***.

COMKISS was a two year programme, with ambitious goals. Within the general objective of demonstrating marine applications of satellite data to the offshore industry were eight individual applications studies — aimed at testingthe potential benefit, in terms of improvements to safety and economy, of specific applications of satellite data. These applications fell into two general categories: provision of ***near real-time*** data to operational offshore activities, and application of ***climatological databases*** for planning and design. This report lays out how far these ambitious aims have been satisfied, and indicates where further work is required.

1.2 Context

Europe s maritime heritage

Over many centuries Europe s close involvement with the seas which surround it has been fundamental to its prosperity. Europe s economic development is inextricably linked to its seafaring heritage; today over 90% of its external trade and nearly 30% of its internal trade is carried by sea. Maritime industries across Europe employ over 2.5 million people.

The sea still represents a real hazard, however, and mariners retain a healthy respect for its sudden changes of mood. Despite the most modern technological advances, the number of vessels of over 500 tonnes that are claimed *every year* by the sea remains at a remarkably constant 150 - over a third in weather-related incidents. Delays and damage to ships are relatively common, and large financial losses are incurred each year.

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[1] During the period since the COMKISS proposal was submitted EWSE has been replaced by INFEO (http://www.infeo.org). At the same time the COMKISS team agreed that the Demonstration Module structure within INFEO was too restrictive to allow a good representation of the COMKISS applications studies. Hence new format DMs have been placed at the IFREMER web site (http://www.ifremer.fr/metocean/shipping/shipping.htm).

The paradox that shipping is the most environmentally friendly transport system, yet potentially the most dangerous, is recognised by the Commission. A Maritime Task Force was established by the EC to help the European maritime industry rise to this challenge. It was designed to provide a marine focus to individual European programmes - including Industrial Materials & Technologies (IMT), Information Technologies, Transport, Telematics, Marine Science, Fishing & Aquaculture, and Energy.

Satellite Measurements of Sea State

Sensors for measuring the state of the sea in terms of surface wind speed and direction, and the height, direction and period of waves, have been employed from satellites for over 20 years. It was first demonstrated by Seasat, in 1978, that a suite of microwave sensors that included a Synthetic Aperture Radar (SAR), a wind scatterometer, and a radar altimeter could estimate these parameters to useful accuracies from polar-orbiting satellites.

In the case of the scatterometer, wind speed can be measured to – 2m/s and direction to 020¡. The altimeter provides estimates of significant wave height (equal approximately to the height of the highest third of waves) to – 0.5m. It can also measure wind speed but not direction along the satellite s track. The SAR, with a spatial resolution of around 30m, provides images of surface waves from which the direction and period (wavelength) of wave trains can be extracted provided care is taken to allow for non-linear distortions. The SAR on ERS-2 operates a wave mode which produces 5 x 5km imagettes of surface wave fields at 200km intervals around the globe.

Since 1985, when the US Navy launched the radar altimeter satellite Geosat, there has been an almost continuous string of scientific satellites which have provided global measurements of sea state. ERS-1 was launched by the European Space Agency (ESA) in 1991, carrying an altimeter, scatterometer and SAR (amongst other instrumentation), and was followed by its (similarly instrumented) successor ERS-2 in 1995. In addition the USA and France launched the TOPEX/Poseidon altimeter satellite in 1992, primarily to monitor small changes in ocean circulation. Both TOPEX/Poseidon and ERS-2 operate to this day. A follow-on to the US Navy s Geosat was launched early in 1998 but has experienced early teething problems, and has only recently been accepted by the US Navy (November 2000). More missions are to follow. In February 2001 the successor to TOPEX/Poseidon, JASON, is scheduled for launch, and in June 2001 ESA plan to launch ENVISAT. In the meantime global directional wind field measurements are now provided by the US scatterometer mission QuikScat.

These satellite missions have provided observations which, subject to proper quality control, validation and calibration, have been archived into a global database from which statistics on wave behaviour can be extracted. However, each of these missions has scientific (and technical) rather than operational goals. Thus the sampling regimes are selected to study scientific problems of major interest rather than ensure that measurements are provided at a sufficient spatial and temporal density to provide useful operational information to offshore operators.

We should also note that a number of radar imaging satellites (such as RADARSAT), which have the potential to provide seastate information are also now operational. However, data from these latter satellites have not been included in COMKISS applications studies.

Wave Models

Another significant activity, which equals the emergence of satellites in the speed of its development, has been the improvements to wind/wave models made possible by modern computer technology, and by advances in the understanding of the physics of ocean waves.

Most numerical models provide deterministic predictions and hindcasts. Such results are difficult to use by the industry, which in any case wants to know the probability that reality will divert from the prediction by a given extent. Some agencies are now developing new techniques to establish the uncertainty in deterministic forecasts, though the use of ensemble forecasts (Janssen, 2000). In addition, through the theoretical developments carried out from COMKISS at the

University of L nd (Baxenavi et al, 2000a and 2000b), we have seen how direct use of satellite measurements in stochastic models can enable the calculation of risk probabilities that may then be used in the decision making process, whether at the design stage or in NRT (Near Real Time).

Summary

The objective of the project was to investigate the combined use of satellite data and wave models, not to advocate one against the other. The output of a model, no matter how sophisticated, can only be as good as the quality of the input data, which may be sparse in some areas. The satellite data therefore represents a valuable check on the model outputs. Models can provide estimates of those wave parameters which are difficult to measure reliably from satellites (for example period and direction, especially at wavelengths less than 100m).

To provide near real-time information to assist in the day-to-day planning of maritime operations represents a formidable challenge. The simple reason is that even if a higher degree of co-ordination between the separate missions can be introduced, the number of spacecraft will still fall short the ideal requirement to match the rate of change of sea-state in any one area. One of the objectives of COMKISS is to establish the coverage required by end-users.

COMKISS set out to identify applications where satellite data could have a positive impact, but is not yet exploited fully, and to inform the offshore industry of the capabilities of these data.

1.3 The Partnership

There were six partners in the COMKISS programme, including a strong end-user representation covering three sectors of the offshore marine industry. The two industrial full partners, ***Dockwise*** (a Belgian company specialising in the transport of unusually large loads) and ***Bureau Veritas*** (a major shipping design and certification organisation), guided the investigations in their own area of interest and adjudicated the results. A further unfunded partner, ***Corsica Ferries*** (which operates fast ferries between France, Corsica and Italy), co-operated on a voluntary basis allowing an important analysis of High Speed Craft operations. There were four scientific partners: ***IFREMER***, the French national marine research organisation; the Department of Mathematics and Statistics at the ***University of L nd***, specialists in wave statistics; ***Optimer***, an engineering Metocean studies company; and ***Satellite Observing Systems***, a leading EO value-added company specialising in providing satellite-derived marine information. The partners responsibilities within the COMKISS project are given below:

- Project Manager, Wave Statistics — **University of L nd**, Sweden,
- Project Co-ordinator, Wave climate databases — **Satellite Observing Systems**, UK
- Science Partner, MetOcean Analyses — **IFREMER** (MetOcean Group), France
- Science Partner, MetOcean Analyses — **OPTIMER**, France
- End User Partner, Large load transportation — **Dockwise**, Belgium
- End User Partner, Ship Design / Certification — **Bureau Veritas**, France
- External End User, High Speed Passenger Ferries — **Corsica Ferries**, France

The consortium brought together to carry out this programme represents a very well-balanced mix of marine industries, European national interests, research/university experience in the measurement and behaviour of surface waves, and EO value-added companies specialising in the marine environment. The programme of work adheres to the CEO philosophy of being driven not by the EO data providers but by the industrial partners actively engaged in marine commerce.