Military Meteorology and the New Zealand Defence Force Strategic Vision

Matthew Ruglys

Royal New Zealand Navy

Correspondence to Matthew Ruglys, Headquarters Joint Force New Zealand, 2 Seddul Bahr Road, Trentham, 5018. Email: Matthew.Ruglys@NZDF.mil.nz

Introduction

A tsunami has obliterated villages of a Pacific Island nation, rendering hundreds homeless and without the basics for survival. Debris litters the runway of the local airport rendering it unusable. HMNZS CANTERBURY (Figure 1) anchors off the coast, under clear skies and no wind, to provide humanitarian assistance. Yet the ship and her company are unable to help those ashore because the calm air and the swell rolling in from the south have put the ship out of limits for launch and recovery of both the helicopter and the landing craft. The METOC (meteorologist and oceanographer) forecasts the wind to pick up and the swell to ease by midnight, but until moonrise at 0340 it will be too dark for night vision goggle operations. The METOC identifies two possible sites for the landing craft to beach that will not be subject to dangerous surf.

Navies have long exploited METOC information. In the early years the emphasis was on ship safety, and then with the advent of naval aviation, aeronautical safety was included in this growth area. The discipline has now matured into a war-fighting tool where 'failure to acknowledge the importance of environmental conditions has played a role in many failed military operations that were otherwise well planned and executed' (Committee on Environmental Information for Naval Use, 2003).

Strategic Vision

In response to a Defence White Paper the New Zealand Defence Force has articulated its intent that:

"By 2035, the NZDF will be able to:

Project and sustain a sizeable combat force offshore.

Independently deploy amphibious forces in the Pacific" (New Zealand Defence Force, 2011).

A capability in meteorological and oceanographic forecasting will be essential to achieve this vision.

METOC

The term METOC is a NATO designation that encompasses both the disciplines of meteorology and oceanography as well as the practitioners. METOCs are required, and trained, to forecast environmental conditions for anywhere in the world from the seabed to the tropopause. Many forecasts are of what may be called "conventional" meteorological parameters such a wind, weather, cloud and visibility. But the particular nature of naval and military operations imposes unique demands for additional products such as surf, night illumination levels, radar and radio propagation and sonar range prediction. In addition the METOC must have a high degree of familiarity with naval operations, weapon systems and their limitations.

Figure. 1. HMNZ Canterbury in the tropics.

Meteorology and the RNZN

The Royal New Zealand Navy presently has two METOCs but it is not the first time that meteorologists have served. Lt Cdr Lawrence Hogben, who joined the Royal Navy at the outbreak of the Second World War but later transferred to the RNZN, was one of the Admiralty team responsible for the forecasts for D-Day in June 1944 for which he was awarded the US Bronze Star.

As might be expected for such a small specialisation we have to rely upon the support of other agencies such as the Royal Australian Navy, the Defence Technology Agency and MetService. The RNZN has a Memorandum of Understanding with the RAN in which the RNZN sends an officer to Australia for training with the BoM and the Navy and who then spends two years working for the RAN before returning to New Zealand. In return the RNZN gets year round METOC support for ships at sea. This is primarily for ships that are outside the New Zealand home waters. In home waters we have a contract with MetService to use their MetJet service. MetJet allows us to set up packages of data to be emailed to ships on a customisable schedule. Given that we have no internet at sea this is invaluable.

The two RNZN METOCs are then free to be able to deliver tailored operational support for specific exercise and operations as required. For example we have been involved in forecasting for ships going to the Antarctic, for assisting the Defence response to the Christchurch earthquake and the grounding of the RENA. Other activities include compiling climatology reports for areas of interest and delivering instruction in meteorology.

The specialisation is still in its early stages but it is envisaged that there will be three METOC billets:

Joint METOC
Fleet METOC
Training/RAN

As already indicated the basic training is done at the Bureau of Meteorology with additional military skills added by the RAN. The newly trained METOC is then posted to a forecasting billet in the RAN. This may be as an aviation forecaster for the Fleet Air Arm at HMAS ALBATROSS or to the Operational METOC Centre at Garden Island Sydney from where they will deploy to sea as required. Once the individual in Australia returns to New Zealand they will be posted as the Fleet METOC to Devonport. Here they will be responsible for direct METOC support to the RNZN fleet. As the senior position, the Joint METOC will be responsible for delivering METOC support to all three Services as well as determining and implementing METOC policy and standards.

Much of the early work in establishing METOC as a discipline within the RNZN was done by Sally Garrett at the Defence Technology Agency (DTA). Sally conducts research and development in the METOC sphere for the Navy.

Specialist Products

The routine basics of weather forecasts such as wind, weather, cloud, visibility, sea and swell can often be satisfied from MetService or BoM products. But METOC has a requirement for specialist products.

Night Illumination

Night vision goggles (NVGs) allow the user to see clearly at night but they do have limits. Under certain conditions of cloud and moon state there can be insufficient light for the NVGs to work (or, indeed, it may be too bright). Night illumination is dependent upon both the state of the moon and the amount, type and height of cloud. Thus it falls to the forecaster to predict the hourly light levels throughout the night for an operation and the result may dictate when the operation can and cannot take place.

Surf

Amphibious operations, as the lessons of the 6th June 1944 have taught us, are very sensitive to the surf on the proposed landing beaches. Too high, too frequent or of the wrong type and landing craft will not be able to put soldiers onto the beach. The nature of surf is determined by the beach profile as well as the incoming swell height, period and direction coupled with the wind speed and direction. Although the beach profile can be taken from published charts, there is not usually sufficient detail. High resolution data can be gathered by military hydrographic surveyors and divers. There are numerous sophisticated 4D wave models but they are generally not suitable for naval operational use because of their complexity and the data requirements. Instead it is more usual to use a simpler 2D model for a Go/No Go decision (Figure 2).

EM Propagation

The thermal structure of the atmosphere has a profound influence on the propagation of electro-magnetic radiation and as a result radars do not necessarily detect all that they might be expected to. The refractive structure of the atmosphere is determined by variations in the rates of change of:

Pressure
Temperature
Humidity

Although the absolute value of pressure varies considerably; the vertical lapse rate is surprisingly constant and thus the variations are usually of little impact operationally. Temperature lapse rates, on the other hand, vary considerably. In general lapse rates greater than normal will tend to favour Sub-Refraction and lapse rates less than normal will favour Super-Refraction and, ultimately, ducting (Figure 3). Humidity also varies considerably with height and hydrolapses favour Super-Refraction. The humidity lapse rate dominates that of temperature such that it is the humidity that largely controls the refractive structure of the atmosphere except at very low temperatures.

Marked hydrolapses may be found at subsidence inversions, above a layer of fog or low cloud and in near surface layers over the ocean. Knowledge of refractive effects and the ability to forecast ranges and counter detection ranges at the surface and aloft allows force commanders to exploit them to gain an advantage over opposing forces.

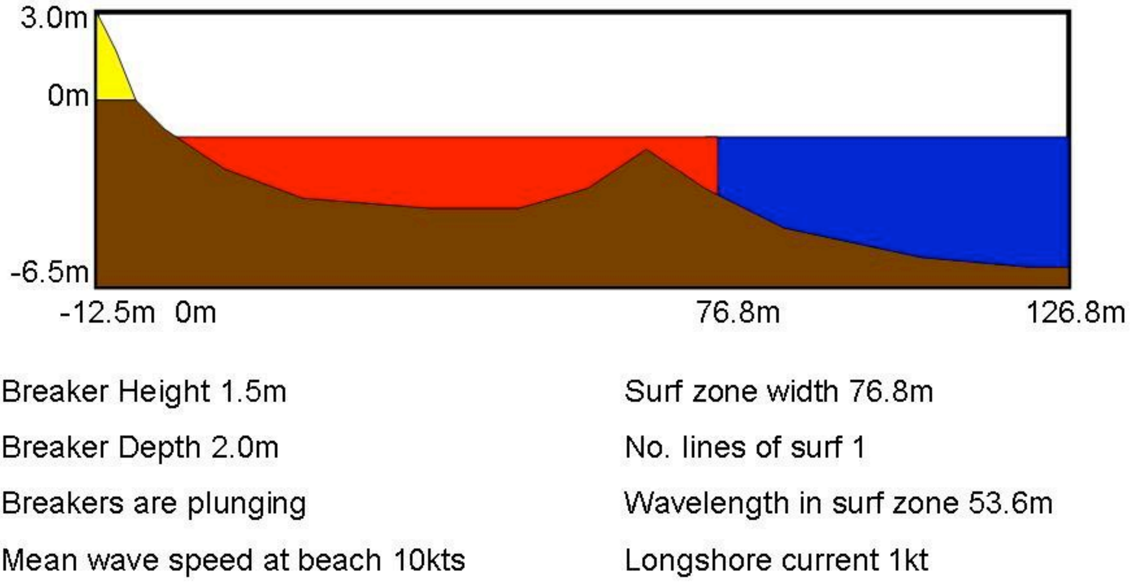

Figure 2. 2D surf model output

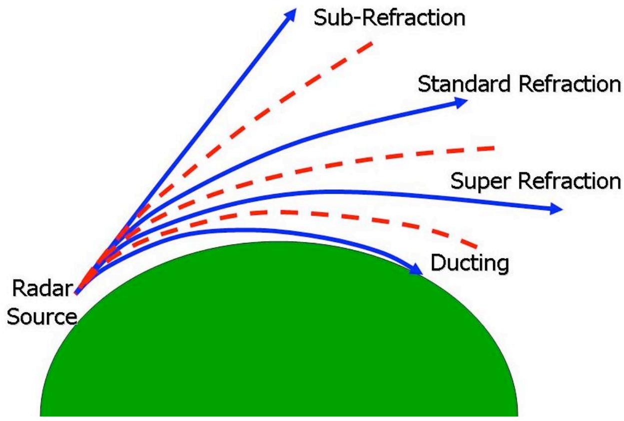

Figure 3. Illustration of sub-refraction, standard refraction, super-refraction and ducting.

Electro-optical systems such as the Forward Looking Infra-red (FLIR) carried in the Navy's SeaSprite helicopters are also subject to environmental effects. These depend mainly on the suspended particles between sensor and target such as smoke, dust and water droplets and are generally categorised as:

Extreme - Large numbers of water droplets
Major - Large amounts of water vapour
Fair - Cloud cover, moist haze, smoke
Minor - Surface wind, dry haze, smoke

Sonar Propagation

In much the same way as the atmospheric effects on EM propagation so the properties of the ocean affect the transmission of sound and sonars do not necessarily detect all sub-surface objects. Sound speed varies with temperature, salinity and pressure (depth). Submarines will endeavour to use oceanic features such as ocean fronts or eddies to remain concealed from opposing submarines, ships and helicopters whilst attempting get close enough to attack. The opposing forces will, in a similar fashion, try to avoid detection or to confound the submarine's attempts to get close enough for a firing solution. In order to do this the forces require detailed knowledge of the ocean structure and its evolution over time. Figure 4 shows an example where a submarine at 50m depth will

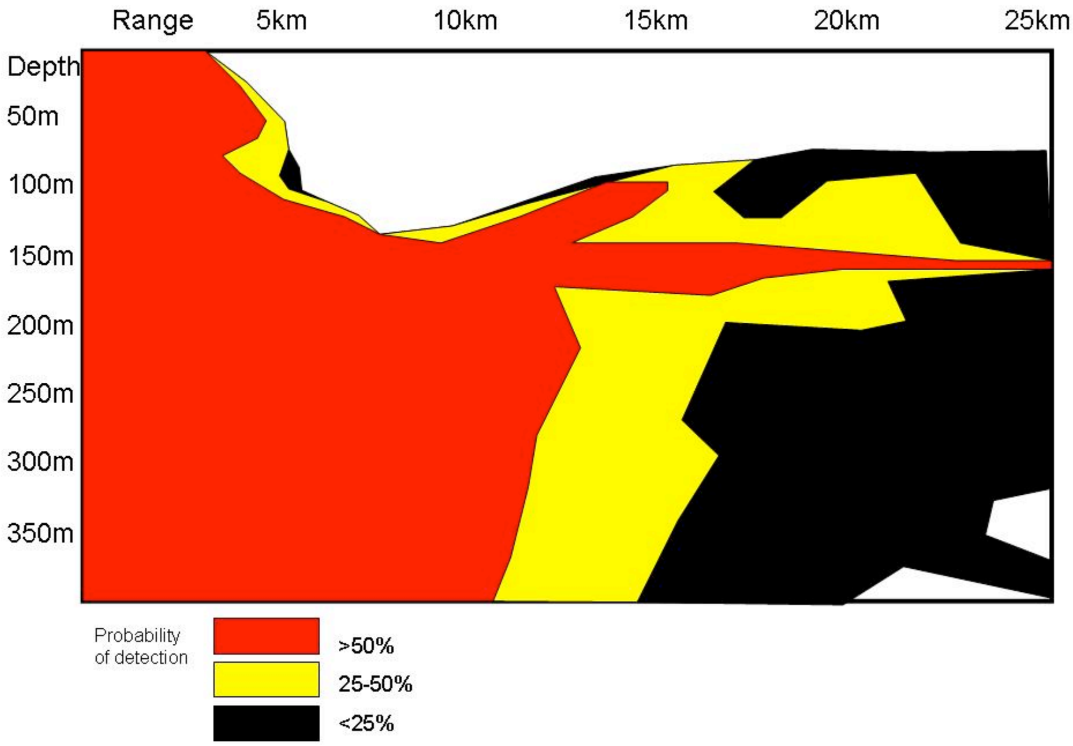

Figure 4. Sonar probability of detection diagram.

not be detected beyond 5km range but if it were at 150m it could be detected at ranges in excess of 25km.

Modelling
Much of the foregoing is supported by numerical modelling ashore. The operational METOC at sea often requires robust systems that are fast, reliable, simple to use and which require no connection to a shore network. The answer usually needs to be "good enough" rather than too precise.

Conclusion
METOC is part of the modern information battlespace providing the warfighter with an essential component for situational awareness. 'Whilst none of these innovations (in METOC data provision) makes quite the impact of a new ship class or major weapon or sensor, they lie right at the heart of our future ability to maximise the effectiveness of our fighting capability. Without them we might just get by, but we will be squandering agood part of our investment in top quality ships, aircraft and their sensors and weapons. Knowledge of and adapting to the environment puts the cutting edge on the sword' (Essenhigh, 1995).

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