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The Ups and Downs of a Newly Qualified RNIO Weather Forecaster at Sea

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Weather has affected military operations since time immemorial and is well documented; the destruction of the Spanish Armada and the timing of the D-Day landings, are just two examples. Accurate forecasts are instrumental to the planning of warfare, the optimum deployment of assets, weapons and sensors and to the safety of military personnel. Unlike the Army and Royal Air Force who still use civilian forecasters from the UK Meteorological Office, the RN needed forecasters afloat and in the early days selected officers to be trained by the Meteorological Office. Once the Naval Meteorological Service was established (1937) the Navy began its own training programme for personnel to become meteorological officers. Later, in the 1960s, with the increasing significance of Anti-Submarine Warfare (ASW), oceanography was added to the course so that the forecasters could predict conditions both above and below the sea surface in order to tactically exploit the whole environment.

In late August 1976, I was appointed to the Guided Missile Destroyer, HMS *Kent*. I had qualified as a meteorological and oceanographic (METOC) officer at the end of June and then had only six weeks of rotary and fixed wing aviation forecasting experience at HMS *Daedalus* in Lee-on-Solent. I was very much a rookie forecaster when I joined the ship, excited to be going back to sea and eager to apply my new skills. *Kent* was getting ready to come out of refit and my early days on board were spent equipping the “met” office between doing the Flight Deck Officers’ Course at Portland, the Ships’ Fire Fighting Course (again) in HMS *Phoenix* and the Security Officers’ Course at Royal Marines, Poole.

I have a large fund of memories and anecdotes from my time in *Kent*, but here I will concentrate on my personal, real-life weather forecasting experiences on board. Although I also occasionally supplied oceanographic data and sonar range predictions to the ASW department, my oceanography output on board was relatively limited.

Wind

In principle, wind forecasting for a ship over the open sea is fairly straightforward even for an inexperienced forecaster. I would heavily depend on my Leading Airman (LA) Meteorology (Met) to plot the analysis chart using the data from the network of ship and shore weather observations that were broadcast over the communications channels by Commander-in-Chief Fleet (CINCFLEET) HQ in Northwood. I would then analyse the chart (i.e., study his plotted observations, position the highs, lows, and fronts, and draw the isobars) and subsequently prepare my forecast based upon that analysis and any other available data. In *Kent*, the Captain liked me to brief him during his breakfast about an hour prior to the main briefing on the bridge at 0800 hours. The forecast would include any warnings of meteorological hazards, a brief description of the general synoptic picture, wind, weather, visibility, sea and swell conditions plus a concise longer-term outlook.

Isobars are lines of equal pressure and in essence, the greater the density of isobars, the stronger the winds. A simple nomogram (printed on the analysis charts) enabled wind strength determination by measuring the distance between isobars. The pattern and path of the isobars would give the wind direction. The ship forecast would use the descriptive terms as shown in the following table based on the Beaufort wind scale. The scale was empirically derived by Francis Beaufort in 1805, based on how the wind affected the appearance of a frigate’s sails.

Beaufort Number	*Description*	*Wind Speed (knots)*	*Sea State*	*Sea Height (feet)*	*Sea Description*
0	Calm	< 1	0	0	Glassy
1	Light air	1-3	1	0-1	Rippled
2	Light breeze	4-6	2	1-2	Smooth
3	Gentle breeze	7-10	3	2-4	Slight
4	Moderate wind	11-16	4	4-6	Moderate
5	Fresh wind	17-21	4	6-10	Moderate
6	Strong wind	22-27	4	9-13	Moderate
7	Near gale	28-33	5	13-19	Rough
8	Gale	34-40	6	18-25	Very rough
9	Severe gale	41-47	7	25-32	High
10	Storm	48-55	8	29-41	Very High
11	Violent storm	56-63	8	37-52	Very high
12	Hurricane	64 +	9	>45	Phenomenal

The scale shown is a modernised version with the descriptions as used in the RN in the 1970s and 1980s. The sea state numbers are a different scale known as the Douglas scale after an RN Captain who introduced it in 1921. The scales do not correlate exactly, and the sea heights may vary dependent on prevailing conditions such as currents and tides relative to the wind direction, and any local effects from nearby terrain, but the values given provide a rough guide.

If the Wessex 3 helicopter was conducting flying operations, I would also present an aviation forecast at the briefing. This would be similar to the ship forecast but tailored to flight requirements and include any warnings of adverse flying conditions such as thunderstorms, aircraft icing, and turbulence, a synopsis of the wider weather picture, a route forecast if the aircraft was heading to a destination other than returning to the ship, and, if applicable, a destination forecast. Also, the wind and weather conditions at the flight level if significantly different to near the surface could be provided.

Ships of frigate size and larger will handle most wind and sea conditions, and *Kent* was a class of ship renowned for its seaworthiness. However, wind strength and sea state can have significant effects on ship operational capabilities. This subject in any detail, is beyond the scope of this blog but it is worth mentioning that near gale force winds (force seven) and above will severely curtail crew activities. The effects on personnel are subjective (some people will suffer sea sickness in as little as moderate conditions) but the ship will shut down all upper deck activities and minimise those below decks in really rough weather. The ship motion will cause lack of sleep and fatigue if prolonged, and, if violent, may cause physical injury. Even though hurricane force winds could likely be handled by the vessel, Captains would avoid encountering such extremes because of the dangers involved. These include superstructure damage in heavy seas as well as the aforementioned injuries to personnel, but most dangerous of all is the excessive number of miles that a ship can be blown off course, necessitating a vital need for sufficient sea room to avoid being driven aground in high seas with potentially catastrophic consequences.

During a visit to Bermuda in 1977, the island was threatened by a tropical cyclone that was forecast to strengthen and come close. We were in company with HMS *Hermes*, HMS *Arrow* and HMS *Antrim*, a sister ship to *Kent*. *Hermes* was the senior ship with a relatively large forecasting team on board. There was a lot of discussion on whether to sail or not. My Captain was reluctant to leave unless it was absolutely necessary, and he let me know it. The *Antrim* forecaster and I both felt we could delay the decision for another 12 hours before making a final pronouncement. However, *Hermes* and *Arrow* decided to sail immediately, leaving us to make our own decisions. I stayed on watch in the met office on board all night, examining the tropical cyclone forecasts being issued by Miami, and monitoring our own and local observations of wind and pressure falls. The wind at our berth got up to near gale force with gusts up to nearly 40 knots, which was not exactly encouraging, but in the end, the storm did not reach hurricane status and veered away from Bermuda.

My Captain was extremely happy, as was *Antrim*'s. Nevertheless, in retrospect, and having later had three years of tropical cyclone forecasting experience in Hong Kong, I realised we should have advised our respective Captains to sail with the *Hermes*. The channels in and out of Bermuda are quite testing and would not have been easily navigable in very strong winds. If the storm had not changed course and we had been forced to sail 12 hours later than *Hermes*, I fear we may not have been able to gain sufficient sea room for safe manoeuvring. I had allowed my Captain to pressure me and, as things turned out, we got away with it. About 18 years later the Captain, then a three-star Admiral, (he actually went on to make First Sea Lord) visited the Supreme Allied Commander, Atlantic (SACLANT), in Norfolk, Virginia and spotted me across the room. He called me over and told the British Deputy SACLANT the tale of how the fleet sailed from Bermuda, but that *Kent* remained in harbour, based on my excellent advice. He was so proud of his story, that I could not tell him that my original advice was not excellent but flawed. The scenario provided some good instructional points when I was teaching meteorology in the early 1980s.

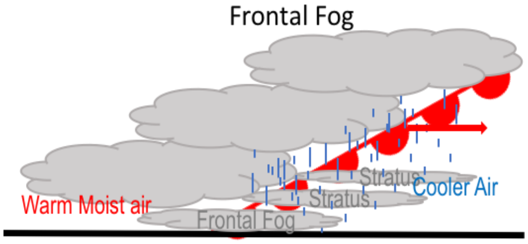
Fog

Fog forecasting is more problematic for inexperienced forecasters. Ships (and pilots) dislike fog unless they are trying to hide from airborne reconnaissance. In the open ocean, with no diversion airfields within range, launching the helicopter with fog threatening is to be avoided in most situations. The scenario of the helicopter being unable to find the ship, let alone land on it, while running low on fuel, is particularly alarming, even though there are measures that can be taken. Back in the 1970s these included launching flares, switching on all upper deck lighting and dropping floating flares in the ship's wake all of which hopefully the helicopter would see visually, once it was guided in close by the helicopter control officer, and by using its own Instrument Flight Rules (IFR) flight plan.

For aviation purposes, fog is generally defined as visibility less than one kilometre (km). If visibility is greater than one but less than five km, it is called *mist* when the relative humidity is greater than 95% and *haze* if it is less. Meteorologically, fog forms when the air temperature cools to the *dew point*. The dew point is defined as the temperature to which air must be cooled to become saturated with water vapour. Sea fog forms when the sea temperature is cooler than the dew point of the air above it and is fairly straightforward to forecast.

There are several different types of fog, but I want to limit this article to two types that gave rise to some ups and downs during my time in *Kent*. The most dreaded sound aboard for me was that of the foghorn, particularly if I had not forecast fog. In this case the foghorn blast would inevitably be followed by the equally daunting broadcast "*Met Officer Bridge*"!

Frontal Fog



A Simple Depiction of Frontal Fog

Frontal fog may also be known as *mixing fog* and *precipitation fog*. The diagram above shows a simple vertical cross-section of a warm front over the sea. Frontal fog forms ahead of warm fronts when rain falls into and through a cooler, drier layer of air ahead of the front. The rain initially evaporates, adding its water vapour to the colder air, eventually saturating it to its dew point, especially near the surface where the fog forms. Saturation a little higher up produces layered stratus clouds (essentially, fog is cloud at the surface). The mechanism is, thus, warm moist air mixing with cooler drier air, to cause saturation of the latter. A good natural example on a cold day is the warm moist breath in a person's mouth being exhaled into and mixing with cold air, creating condensation and fog.

Initially when forecasting a warm frontal passage, and particularly if sea fog in the warmer air astern of the front was unlikely, I did not bother to forecast frontal fog, which is often only transient anyway. After a couple of the dreaded foghorn experiences, I learned to always mention the possibility of fog during the passage of the front. It did not always occur, particularly when the contrast between the air masses was small, but declaring the prospect saved me having to explain myself when it did.

Radiation Fog

Radiation fog is normally a land phenomenon, commonly occurring at airfields when the land after dark radiatively cools to its dew point. A light breeze is required to lift and mix the condensed water droplets into fog, otherwise it merely manifests itself as dew. I experienced a thick radiation fog problem during Kent's visit to Hull in 1977. It was our last morning and we were sailing at 1030. Thick fog was already evident when I got up to analyse the midnight chart plotted by my ever-dependable LA (Met), which I would be using to present my morning weather forecast during the pre-sailing brief at 0800 on the Bridge. The early risers with their own vested interests kept popping their head into the met office beforehand to inquire about the fog.

Using my trusty Forecasters' Reference Book, and meteorological observations taken on board and at local weather stations, I applied the data and came up with a fog clearance time of about 1030. I therefore briefed a fine day ahead with any fog clearing prior to sailing, to a highly sceptical audience at 0800 (weather is always the first part of the briefing) and retired to my office when it was over. At 0900 the fog was still thick. At 1000 it was still foggy but getting brighter. At 1015 blue sky was breaking through and the fog cleared prior to sailing. I got a few "well done!" and "how did you manage that?" comments and I confess to wallowing a little in my success as we sailed down the Humber towards the North Sea.

My euphoria proved to be short-lived, however, as a brief while later the foghorn went off just as we entered the North Sea and headed north along the coast. I was duly summoned to the bridge and, due to my inexperience, I was a little perplexed as to why the fog was there, because the sea temperature was warmer than the dew point. It took a couple of minutes before I realised that this was not normal sea fog, but radiation fog that had drifted from land to the sea. Whereas the land had warmed up quickly and had "burned" off the fog, the sea was cool enough to maintain it for a bit longer. I immediately briefed the Captain that moving farther from the coast should find us clear water and sure enough it did. By early afternoon all the fog closer inshore had also cleared. This incident was all part of the learning curve for an inexperienced forecaster.

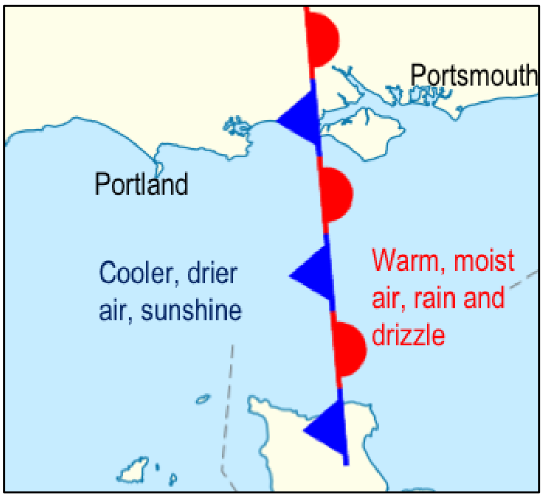
A similar situation happened in 1978, when I gave my final briefing on board. We were off Portland and heading to Portsmouth where I was to leave the ship. The local forecast from Royal Naval Air Station, Portland (HMS *Osprey*) was for radiation fog clearing later, and this was already clearly visible over the land. With the light northerly winds prevailing at the time, I briefed that some of the fog could drift over the sea but would be limited to coastal waters only and should clear before our arrival in Portsmouth. We kept out of the fog, but it persisted along the coast and fortunately cleared about an hour before we berthed in Portsmouth harbour. I had learned my lesson from my Hull experience some 12 months or so earlier and had delivered a correct final forecast!

Precipitation

Precipitation is the generic term used by meteorologists to cover water that precipitates out of the atmosphere during condensation of saturated air. Technically, this includes cloud and fog, but in general it is used as the all-encompassing term for rain, drizzle, snow, sleet and hail, i.e., water that reaches the ground.

In *Kent* I discovered that the word caused some mirth among my briefing audience, except for the helicopter aircrew who were familiar with the term. On one occasion, very early in my time on board, I was summoned to the bridge, whereupon the Captain directed me onto the starboard wing in heavy rain and clipped the door shut behind me. He then held up a notice on which he had written "Is that Precipitation?". After I nodded in acquiescence, I was let back in, somewhat bedraggled!

In June 1977, we were building up for the Fleet Review at Spithead to honour the Queen's Silver Jubilee. The Jimmy (First Lieutenant), a senior Lieutenant Commander, was desperate to get *Kent* looking ship-shape and pristine and needed dry weather to clean and paint the ship. We were operating in an exercise area just south of the Isle of Wight. An air mass boundary, a quasi-stationary old occlusion in this case, was lying more or less north-south between us and Portland, as simply and horizontally depicted in the following figure. The air to the east of the front was moist with intermittent rain and drizzle, but dry to the west. The Jimmy asked me what time the front would pass through our area and was not pleased when I said it probably wouldn't, as it was very slow moving. He asked when I could guarantee him fine weather and my reply was one to two days if we stayed where we were, but if we were permitted to sail west, we would be in dry weather once we were past the Needles (western point of the Isle of Wight).



Air Mass Boundary

It transpired that, after the briefing, the Captain requested permission from CINCFLEET, to leave our exercise area and travel towards Portland, which was granted. Once off the Dorset coast, the "clag" (naval slang for fog and low cloud) cleared, the sun came out and the sounds of chipping and painting could be heard on the upper deck. The Jimmy was overjoyed and effusive in his praise of me, but this also proved to be short-lived. During the early afternoon the ship was summoned back to its exercise area. The rain and drizzly conditions were still present, and the First Lieutenant was livid. All his sparkling new wet paint was ruined and, for some inexplicable reason, I was to blame for it. For the remainder of his time on board he saw me as the villain who'd ruined his preparations for the Fleet Review, and ribbed me remorselessly, albeit mostly tongue-in-cheek a little after the event.

He did eventually manage to get the ship cleaned and painted in time and the Fleet Review went magnificently.

Ceramic Kent Jubilee Mug

My experiences in HMS *Kent* very much improved my meteorological knowledge and skills as did all my subsequent appointments in the field. However, meteorological forecasting remains a complex process to this day. Some people like to call it a 'black art,' but weather forecasting is an attempted prediction of what is an imprecise science. Why imprecise? In the laboratory a scientist can experiment in a controlled environment, but the meteorologist does not have this luxury. He or she must accept events as they are and, unlike in the laboratory, it is not possible separate one effect from others going on at the same time. It is necessary to consider only those developments that are thought to be significant, extrapolate their effects and provide a reasoned opinion of what the future holds while racing against the clock to meet scheduled deadlines.

Weather forecasting can never be simple because atmospheric physics is incredibly complex as air is subject to a plethora of dynamic and thermodynamic effects. It is a fluid in constant motion with numerous eddies and vortices, all continually interacting with one another. In the huge scale of Earth's atmosphere, the forecaster must assess where the air is rising, sinking, converging, diverging, becoming moister or drier and then predict its future trends. From a mathematical perspective there are too many variables and not enough equations to solve them, resulting in an exact forecast being out of the question even for a supercomputer. Advances in computing allow many more calculations today and attendant improvements in forecasts, but they still cannot take into account all of the factors which affect the weather because associated mathematics is inadequate. Forecasting is, and always will be to some extent, a compromise, a prediction based on probabilities; on what is most likely to happen.

In summary, quality forecasts are vital to military operations, but meteorology is complicated and inevitably forecasts can attract criticism. I have often been blamed for the weather when it is bad, but rarely praised for it when it is good! I have been moaned at and even sworn at, but I still love the subject and would not change a single aspect of my career. In December 1975, just before I set off to do the long METOC course, my immediate supervisor at HMS *Sultan* (Lt Cdr Brian Beel – see the service stories page) told me I would need a thick skin to be a 'met man.' HMS *Kent* certainly proved him right, but his terminology was an understatement. A skin like rhino-hide would have been more appropriate!