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REPORT ON FORECASTING AT NEW PLYMOUTH DURING 1943.

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Introduction:

During the first few months of 1943 considerable difficulty was experienced in producing accurate local forecasts and this difficulty I attribute largely to a false assessment of the factors governing New Plymouth weather, in that I placed too much importance on local and orographical effects. This attitude was a direct result of my experience at Woodbourne where conditions were dependent more on the local topography than on the broad synoptic situation. At New Plymouth, however, the local effects, although striking enough, produce only modifications, not major alterations, in weather types. Underestimation of the sensitivity of New Plymouth conditions to changes in the synoptic situation explains, I believe, the majority of forecasting errors still made here, and emphasises the necessity for sound synoptic analysis and prognosis.

The major part of this report will deal with the modifications produced by local effects at New Plymouth on surface winds, air mass and frontal weather, etc. It must be understood throughout that my experience covers only one year which may or may not have been exceptional and that any general statements I make with respect to New Plymouth weather are hypothetical.

Surface Winds:

Surface winds at New Plymouth are best classified according to season and time of day. Unless otherwise stated the terms summer and winter are to be taken as referring roughly to the six-months periods centred on January and July, respectively.

A. At Night.

(i) Winter. Except when the gradient wind is strong and from some other quarter, a SE katabatic wind almost invariably sets in by shortly after sunset. Its speed is normally 5-10 m/h. unless reinforced by the gradient. When it is reinforced in this way it has much the same strength as with the same gradient during the day, the katabatic effect compensating for the normal diurnal lull.

(ii) Summer. When the sky is clear and the gradient weak a SE-ESE katabatic breeze of 2-5 m/h is usual by about 1900 hours. When the sky is cloudy, however, and the gradient weak the sea breeze (see below) gradually dies to a calm by 1930-2000 hours, after which the wind is variable and less than 5 m/h., with a tendency to ENE or E.
With a strong gradient a SE wind stays SE and decreases slightly, while winds from other directions decrease considerably but retain their original direction.

B. During Day.

(i) Winter. The sea breeze effect is only slight during the winter months and is usually insufficient to overcome the gradient. If, however, the gradient is very weak a NW sea breeze occurs by noon. When there is a moderate W to NW gradient the NW breeze is assisted by the sea breeze and replaces the SE katabatic somewhat earlier, probably by 1100 hours.

(ii) Summer. The commonest afternoon wind at this type of year is WNW and it owes about 10 m/h of its speed to the sea breeze. Light winds in the early morning are almost invariably followed by this wind. If, as is common, their direction is from an easterl, quarter the change occurs through N, reaching NNW by an hour depending on the wind strength - usually by

B. During Day.

(ii) (Cont'd).
0930 hours - and turning gradually to WNW. This direction is thus retained from 1200-1300 hours until at least 1800 hours. If the wind is strong in the morning it is likely to continue from much the same direction during the afternoon, increasing if it has a westerly component, decreasing in the case of a southeasterly.

C. General Remarks on Surface winds.

(i) Uncommon directions are
between WSW and SSE
and between SE and NE.

(ii) The following table gives approximately the surface wind directions to be expected with the various gradient wind directions, neglecting the katabatic and sea breeze effects discussed above:

Gradient	Surface Wind.
SW	WSW - W
W	WNW - NW
NW	NNW - N
N	NNE - NE
NE	SE
E	SE - SSE
SE	SSE
S	Variables

(iii) Set out below are the problems confronting the forecaster of surface winds for night flying. This usually consists of cross-country flights beginning about an hour after sunset and lasting about 3 hours. Before the flare path is laid there is almost invariably a long discussion with the Officer-in-Charge, flare path, and for convenience the summary below will take the form of an enumeration of the decisions which have been reached in different situations and which have proved most satisfactory.

(a) Winter. As the katabatic wind has usually begun by the time the flare path has to be laid, little difficulty is experienced at this time of year. If, however, a wind from another direction remains there are two possible courses of action. Either lay the flare path for the present wind direction and change it if necessary during the evening, or lay for a SE wind if the forecaster expects the unfavourable wind to have decreased to less than 4 m/h by the time of take-off.

(b) Summer. During these months great difficulty is experienced on account of the variable nature of the night winds. Four guiding rules follow:-

(i) If SE expected lay flare path for this wind unless it is expected that the present wind will be more than 4 m/h for the take off.

(ii) If light variable winds expected select one of the longest runways. One of these is conveniently WNW-ESE.

(iii) If a WNW wind is being experienced and it is doubtful whether this or some easterly direction will prevail for the take off, lay the flares along the WNW-ESE runway but postpone until the last possible moment the siting of those elements of the path, e.g., chance light, which vary with the sense of the take off direction.

(iv) If a wind stronger than 4 m/h is expected for the take off, lay the flare path for this direction, changing it during the evening if this proves necessary.

Cloud and Weather.

New Plymouth weather is noted for a combination of high rainfall and high sunshine records. Three factors contribute to this result:

(a) while rainfall with fronts may be very intense it is followed by a rapid clearance.
(b) There appears to be a tendency for a maximum of rainfall at night, particularly in the late summer and autumn.
(c) The sky is most often clear or almost clear in the afternoon.

The above three points require further discussion.

(a) If it is ever intended to build concrete runways at this aerodrome the intensity of the rainfall will certainly require consideration when the drainage scheme is being planned. Note further that during the most intense rain experienced here the visibility may be reduced below 1000 yards without there being a zero ceiling.

(b) During the late summer and autumn there is often a build up in the afternoon of large cumulonimbus inland with heavy precipitation in the Inglewood-Stratford area. These showers do, on a few occasions, move down over New Plymouth during evening. I have been unable to determine a reliable rule for forecasting the evening movement of these showers but it appears more assistance is required than that available from the SE katabatic wind which is very weak at this time of the year. It is probable that assisting upper winds are necessary to bring the showers over New Plymouth. A similar build up occurs in the spring and early summer but the clouds tend to pass to the E of the aerodrome in the early evening, and in any case showers rarely develop. After sunset in this case the cloud rapidly decreases and spreads into stratocumulus which dissipates before midnight.

(c) While the normal diurnal variation in cumulus and cumulonimbus occours inland, the opposite is often found at the aerodrome. The afternoon towering cloud inland amounts to only a trace or 1/10 at New Plymouth and extends in a line over the high country from the Albatross Point area to the NE round through the E to Mt. Egmont.

At New Plymouth cumulonimbus and showers (sometimes with thunderstorms) occur in the evening as mentioned in (b) above. In addition, at any season light showers may occur during the forenoon when there is a light or moderate gradient wind from a westerly quarter. The cloud in these cases may be up to 8 or 9 tenths and often forms immediately after the issue of morning forecasts. The clearance begins in summer with the advent of the sea breeze, i.e. 0930-1000 hours and in winter somewhat later, i.e. 1000-1200 hours. Then follows a clear sky except for the cumulus and cumulonimbus described in (b) and (c) above. With old anticyclones broken altocumulus often forms at the subsidence inversion in the second half of the afternoon but this cloud almostinvariably becomes scattered or dissipates during the evening.

Air Masses:

The behaviour of the weather with different air masses is along classical lines with only minor orographical modification. This is most marked with winds from an easterly quarter where precipitation is completely absent. (N.B. this refers to air masses and not to fronts which will be treated later).

With winds from a westerly quarter a sufficiently fine classification of air masses is (a) warm air masses and (b) cold air masses. These will now be considered in turn.-

Air Masses (Cont'd).:

(a) Warm air mass. While the expected low cloud and drizzle may occur in the morning, the afternoons are clear or almost clear. In summer sea fog may drift in towards the aerodrome, being most evident in the late afternoon. The ceiling is zero on the coast but rarely either continuous or below 300 ft. over the aerodrome. In any case the fog usually dissipates with the collapse of the sea breeze in the evening.

(b) Cold air mass. The frequency and intensity of the showers are increased greatly to the south about Egmont but only slightly at the aerodrome itself. Cumulonimbus and showers which are formed by orography or increased convection over the land become effective some 10 to 20 miles further inland. The only showers affecting the aerodrome are those which were already existent over the sea. As the view is unrestricted to the W and WSW and as the visibility is usually good in these conditions, it is possible, when no shower is in sight in this direction, to state definitely that no precipitation will occur for one or two hours and probably longer.

Although this area is close to the coast it is well sheltered. Moreover, there is a high frequency of clear evening skies. As a result the land is intensely cooled after sunset and frosts are not uncommon.

Fronts:

Orographical modifications are fairly well marked, notably in the intensity and duration of the precipitation with cold fronts and in the raising of the ceiling which is experienced with some warm fronts.

A. Cold Fronts: With all cold fronts, except those from between S and SE the weather closes in up to 6 hours before the frontal passage. Low stratus occurs with drizzle and rain which gradually become heavier. A NNE to N wind sets in and freshens. This last is so common that it may be taken as a fairly reliable indication of deteriorating conditions in the absence of a sound analysis.

Owing to the extensive low cloud before the front the cumulonimbus of the front is rarely seen approaching. This has an obvious and unfortunate significance in the teaching of Meteorology at this station.

Whenever the low cloud has been broken, altocumulus and altostratus have been seen above, sometimes preceded by cirrus and cirrostratus. This evidence would suggest that most, if not all meridional fronts have weak warm frontal characteristics in advance. I have been unable to determine the origin of this - whether it represents a survival of the occlusion structure of the fronts from the Indian Ocean, or whether it is due to an occlusion process somewhat closer, e.g. in the Tasman Sea, where a weak warm front may be derived from the lifting of tropical air over the modified polar air behind the previous meridional front. In support of this last theory a few cases have been noted where the warm front cloud has been followed by an identifiable warm sector before the passage of the cold front. In any case the additional precipitation attributable to the warm front is rarely heavy enough nor of sufficient duration to affect the forecasts seriously.

This evidence of warm front cloud in a western district in advance of a cold front should provide an explanation of some at least of the middle cloud experienced with Fohn winds in eastern districts in the same situation, although geostrophic convergence in southward-moving air streams may be sufficient explanation on many occasions.

The character of individual cold fronts at New Plymouth appears to depend largely on the direction and speed of the gradient wind behind the front.

(i) Cold fronts from north of W.

This type is rarely fast moving and is usually weak or moderate. The speed is further reduced as the front lingers along the coast from Raglan to Cape Egmont and the intensity is much increased by orographical lifting. The result is moderate rain for a period of about 12 hours. Useful information regarding the time of the clearance at New Plymouth may be had by consultation with Cape Egmont - a further 2 to 3hours are required after the improvement there. The cloud behind such a front is broken slightly but rarely clears significantly in less than 18 hours.

(ii) Slow-moving cold fronts from between W and SW.

Despite the fact that the front lies over the South Island before reaching Taranaki, difficulty is found in the correct placing of the front in the area west of New Plymouth. An error of 50 miles in position is easily made and with a front advancing at 10m/h or less the resulting error in forecast is 5 or more hours.

These cold fronts give 6 to 8 hours precipitation, the extremely heavy rain accompanying the front itself occurring within 2 to 3 hours of the clearance and lasting 1 to 2 hours. As with type (i) above the time of clearance at Cape Egmont is useful information. The clearance is fairly sudden but considerable altocumulus is likely for about 12 hours.

(iii) Fast-moving (i.e. 15m/h or more) cold fronts from between W and SW.

The precipitation with this type lasts 4 to 8 hours, depending on the speed and intensity of the front. The heavy rain lasts ½ to 1 hour and is within 1 hour of the sudden clearance.

(iv) Cold fronts from between S and SE.

These are preceded usually by more or less clear conditions and a moderate WNW to WSW wind which dies to a calm. The low cloud with the front is mainly stratocumulus or stratus but occasional convective types are sometimes present. The cloud bank forms over the high country between E and S and begins to move towards the N. At New Plymouth the wind becomes SE and gradually freshens over a period of 2 to 3 hours. Occasionally showers pass to the E but more often no precipitation or clouding over is experienced. Divergence north of Cook Strait leads to only slight precipitation even in South Taranaki.

Such fronts are commonly followed by at least 2 days of fair or fine weather but the SE wind may be strong and turbulent, with a marked fall in temperature.

B. Warm Fronts and Occlusions: The effect of these may be classified according to the preceding wind direction.

(i) Wind direction NW to NE.

Weather follows classical lines with moderate orographical intensification of the rain. The ceiling often falls below 600 ft.

(ii) Wind direction between NE and E, i.e. locally SE at New Plymouth.

The upper clouds follow the classical scheme and the SE wind becomes very strong. Most of the low cloud and precipitation, however, are confined to the area to the E, and even when rain does fall at New Plymouth the ceiling remains above 1000 ft., although it may slope down to 300 ft. or less on the sea 5 to 10 miles offshore.

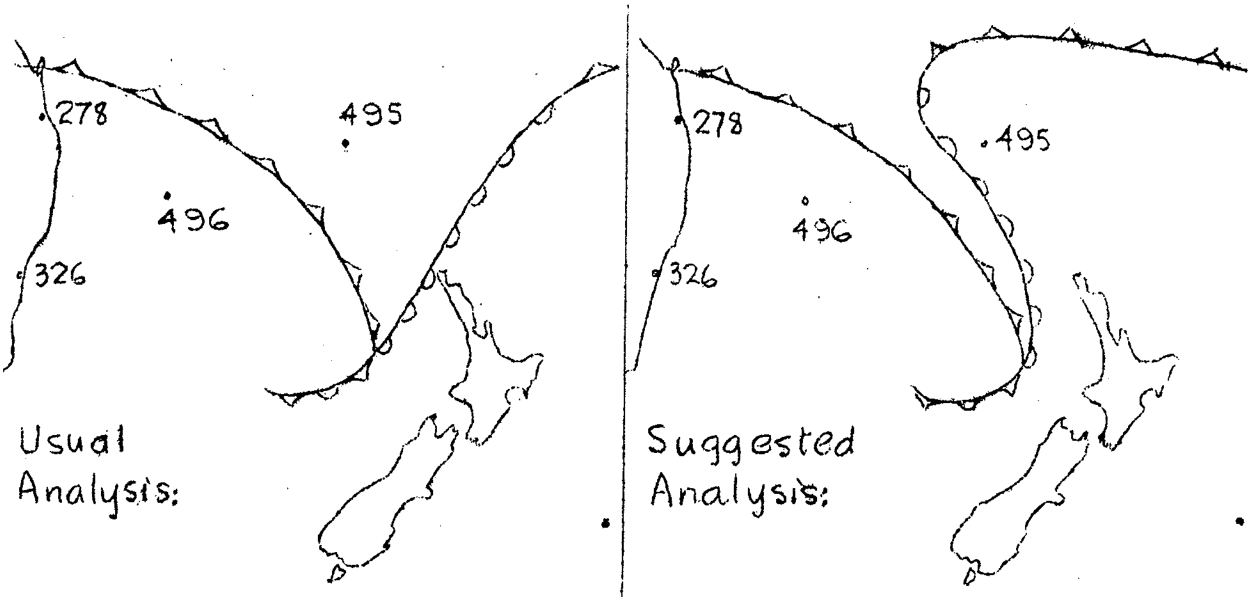
C. Note on Analysis:

Difficulty has been had on occasions with the analysis when wave depressions have formed in the region between Lord Howe Is. and the Queensland coast and have moved towards the SE with warm front cloud extending over the North Island from the NW. Using the usual frontal analysis (see diagram) it seems likely that the Auckland Peninsula will be first affected. Rain has, however, been experienced first in Taranaki although it is difficult to explain this fact by considerations of orography. Further difficulties experienced with this usual analysis are:-

(i) Evidence of frontal activity between Norfolk Is. and Noumea. This has usually to be explained by recourse to the tropical, quasi-stationary portion of the previous meridional front.

(ii) At a later stage a warm front is found to pass Norfolk Is. This appears at first sight to confirm the usual analysis but only one warm front, not two, passes over northern New Zealand.

It would appear then that this form of analysis is both complicated and open to suspicion. In view of the fact that such waves form after the front has advanced beyond Norfolk Is. and Kermadec Is., and that winds with an easterly component persist in that region at least for some time after the wave's formation, it seems reasonable to assume that the front remains almost stationary between Norfolk Is. and Noumea and that it advances only in the region of NW winds, i.e. towards Taranaki. (suggested analysis shown).



Fogs and Visibility:

The visibility at New Plymouth is generally good, except where reduced by precipitation at the aerodrome itself or in the surrounding districts. The largest proportion of the visibility code figures used in weather reports are 8 or 9. With winds from an easterly quarter the visibility is often reduced to 5 to 10 miles towards the E but remains good in other directions. Fogs of all types appear to be rare.

(i) Sea fogs. As mentioned above in the section on warm air masses, sea fogs do on occasions occur, but have usually broken and lifted by the time they have drifted in as far as the aerodrome.

(ii) Radiation fogs. These are extremely common in the surrounding districts, especially in valleys, at all seasons apart from summer. At the aerodrome itself they occur on a very few occasions during autumn and spring but in winter the katabatic wind flow is too strong for their formation. In any case they appear most unlikely to form before 2 or 3 a.m., and therefore have not as yet proved a danger to night-flying aircraft.

Area Forecasting:

Apart from a few overland flights, for example to Rotorua, nearly all the navigation flights from this school occur in the sea area limited by the 171st meridian east and the following points:- Kaipara, Cape Egmont, Ohakea, Stephens Is., Farewell Spit. Most flights occur in the portion of this area which lies north of Egmont.

As is to be expected there are no very unusual features about the weather in this area, but a few guiding rules have been evolved.

(i) With winds from a westerly quarter the weather is generally better more than 10 miles offshore than along the coast, except where a front is encountered offshore.

(ii) With winds from an easterly quarter and with no warm front to the north, the weather is fine but possibly turbulent inshore, and fair to fine offshore.

(iii) With winds from an easterly quarter and with a warm front to the north, rain and low ceilings may be encountered 20 miles offshore and also inshore N of Kawhia. As the winds are strong it will be extremely turbulent inshore.

Because of the nature of the exercises carried out several other points arise. While the Meteorological Officer is not permitted to advise on the suitability of the weather, it is an advantage for him to make himself so familiar with the various exercises that he can discuss the selection of exercise and area of operation intelligently with the Chief Instructor. In this respect the following are some of the points which commonly arise.-

(i) Particularly in some of the earlier exercises pupils are required to observe the direction of the wind lanes. Will the surface wind over the sea be strong enough to make the wind lanes obvious to inexperienced navigators?

(ii) Pupils have to find winds by the drift and wind lane method. Will aircraft on the proposed tracks encounter winds near to head or tail? In these cases the method is open to large errors (in ground speed) Note that a change of height to find more favourable winds destroys the efficacy of the method.

(iii) Should plans be made to carry out tomorrow (or later) an exercise involving cooperation with a launch or will the sea be too rough? This is a difficult matter to decide as the captain of the launch usually makes his decision at the last moment and appears to base it purely and simply on the state of the sea at New Plymouth itself at that moment. Both swell and sea may cause cancellation and the following should be noted:-

(a) with persistent westerlies both sea and swell are prohibitive and the swell decreases only slowly after the wind drops.

(b) with southeasterlies accompanied by southwesterlies in the South Tasman Sea both sea and swell may be prohibitive and the swell may continue after the wind and sea have decreased.

(c) with southeasterlies and no southwesterly in the South Tasman Sea the sea may prove too rough but the swell is negligible and in any case the sea decreases rapidly when the wind drops.

(iv) Certain daylight flights are designed as practice in astro-navigation. In this case the amount and density of upper cloud layers must be considered, and also the possibility that extreme turbulence may destroy the value of the "shots.

Area Forecasting (Cont'd):

(v) As pupils are required to take a minimum number of astro-sights in the air at night it must always be borne in mind that the decision to fly at night depends not merely on the suitability of the weather for flight but on the suitability of conditions for astro-work. This refers to D.R. Exercises as well as to those designed primarily for astro-navigation.

(vi) Patches of low ceiling or poor visibility should be particularly noted when they are expected to coincide with turning points on a navigation flight as several aircraft may be manoeuvring in these positions at the one time. In thesame way attention should be given to the conditions at a point on which all aircraft will converge after following different and optional tracks, as most aircraft will be ignorant of the positions and tracks of the others.