

**Verification of Subjective  
Maximum/Minimum Temperature  
Forecasts  
December 1982 – November 1983**

**J.A. Renwick**

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VERIFICATION OF SUBJECTIVE MAXIMUM/MINIMUM  
TEMPERATURE FORECASTS, DECEMBER 1982 - NOVEMBER 1983

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Abstract

Subjective forecasts of maximum and minimum temperatures are issued daily for thirty-two localities. Objective forecasts, derived statistically, are available as guidance. Forecasts issued twice daily during the year ending November 1983 have been verified in terms of root-mean-square error and skill relative to guidance and climatological forecasts. Average root-mean-square errors were 1.87°C for forecast maximum "today", 2.44°C for forecast minimum "tonight" and 2.22°C for forecast maximum "tomorrow".

On average, subjective forecast accuracy was similar to that of objective guidance for forecasts of maximum today and minimum tonight, but was poorer than guidance for forecasts of maximum tomorrow.

FOREWORD

Following this study, operational verification of maximum and minimum temperature forecasts will be done on a routine basis. Accuracy figures will be combined into the regular compilation of forecast verification statistics.

INTRODUCTION

Data

Subjective maximum and minimum temperature forecasts have been issued regularly for thirty-two stations since December 1981. Forecasts verified were those issued during the year December 1982 to November 1983 inclusive

using computer archived forecast and actual temperatures. Since mid-1984 a verification scheme has also been running in real time. Issue times for subjective forecasts during the verification period were at about 6 a.m. for forecasts of maximum temperature today, and about 4:15 p.m. for forecasts of minimum temperature tonight and maximum temperature tomorrow. Objective guidance forecasts (Renwick, 1980) are calculated four times daily, after each standard run of the Numerical Weather Prediction (NWP) model (Trenberth, 1973). Latest guidance forecasts available are calculated from twelve hour prognoses for the 6 a.m. issue and twelve and twenty-four hour prognoses for the 4:15 p.m. issue, for minimum and maximum respectively. Only those forecasts issued from the National Weather Forecasting Centre at Kelburn are available from the computer archives. Forecasts for all thirty-two stations are available for maximum temperature tomorrow, but for maximum today and minimum tonight only eleven central New Zealand stations are available (Table 1).

### Scoring

The accuracy of all forecasts was calculated in terms of the mean-square error (mse) or root-mean-square (rms) error. Skill is measured as a percentage, either over forecasts based on climatology or over objective guidance forecasts:

$$\text{SKILL} = \left[ 1 - \frac{\text{mse}(\text{subjective fcst})}{\text{mse}(\text{control fcst})} \right] \times 100 \quad \text{percent}$$

Results are presented for the year as a whole and by three month seasons (Spring centred on October, and so on).

Table 1. Availability of forecasts

Station Name	Abbreviation
Kaitaia	KT
Dargaville	DG
Whangarei	WR
Auckland	AK
Tauranga	TG
Hamilton	HN
Rotorua	RO
Taupo	AP
Taumarunui	TM
Gisborne	GS
* Napier	NR
* Dannevirke	DV
* Masterton	MS
New Plymouth	NP
* Wanganui	WU
* Palmerston North	PM
* Levin	LV
* Kelburn	KL
* Nelson	NS
* Westport	WS
Hokitika	HK
Milford Sound	MF
* Blenheim	BM
* Kaikoura	KI
Christchurch	CH
Ashburton	AS
Timaru	TU
Oamaru	OU
Dunedin	DN
Queenstown	QN
Gore	GC
Invercargill	NV

Forecasts for those stations marked with an asterisk were verified for maximum today and minimum tonight.

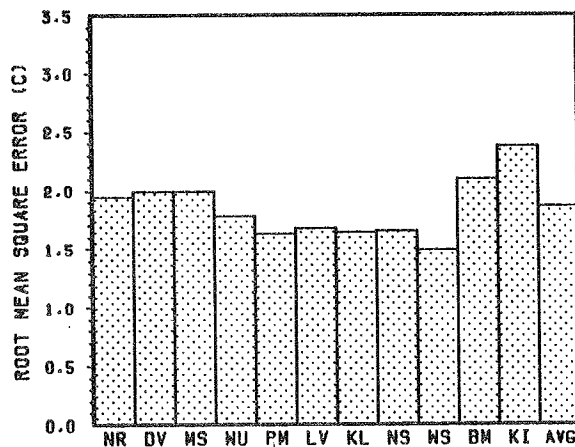
### RESULTS

In the following text, the term "average" is taken to mean an average of all forecasts together, from all available stations, rather than a mean of individual figures from each station.

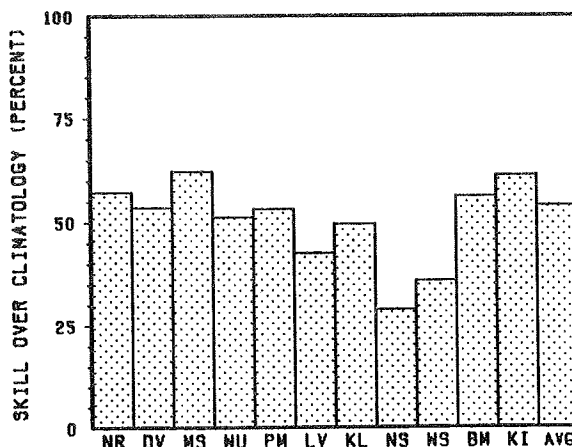
### Maximum today

Root-mean-square errors for forecasts of maximum today were mostly below 2°C (Fig. 1a), apart from the two east coast South Island stations, where the predictand temperatures have the highest variance. The average rms error was 1.87°C, i.e. 84 percent of forecasts had absolute errors of 2°C or less. Forecasts show greatest positive skill against climatology for east coast stations (Fig. 1b) where forecasts based on climatology perform very poorly. The average skill of 53.9 percent is similar to that achieved by objective guidance forecasts. The last bar in Fig. 1c shows small positive skill overall compared to objective forecasts. The large variations in scores for individual stations are partly caused by the variations in skill of guidance forecasts from station to station. Large positive scores for Masterton and Kelburn reflect poor objective forecasts for those stations.

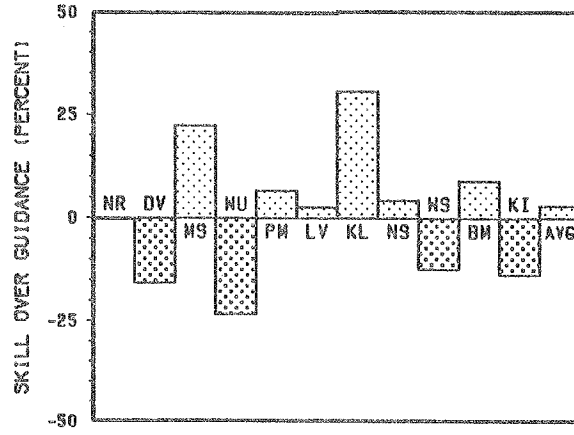
Fig 1. Forecasts of maximum temperature today; a) root-mean-square error, b) skill relative to climatology, c) skill relative to guidance.



a

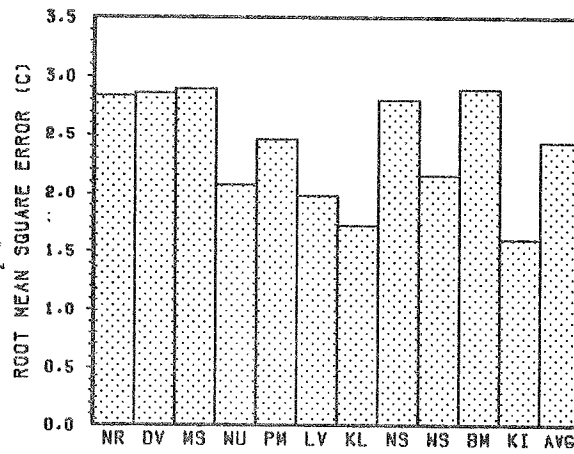


b

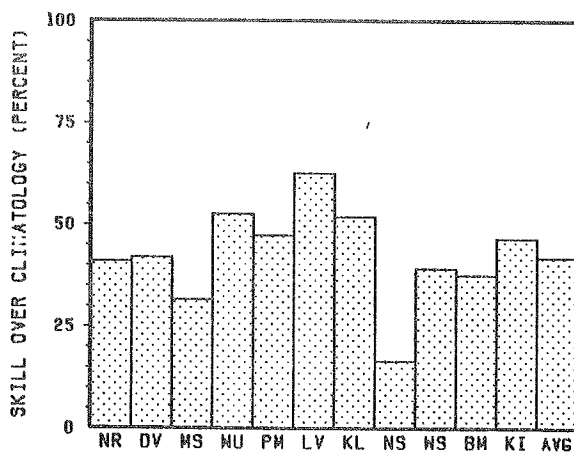


c

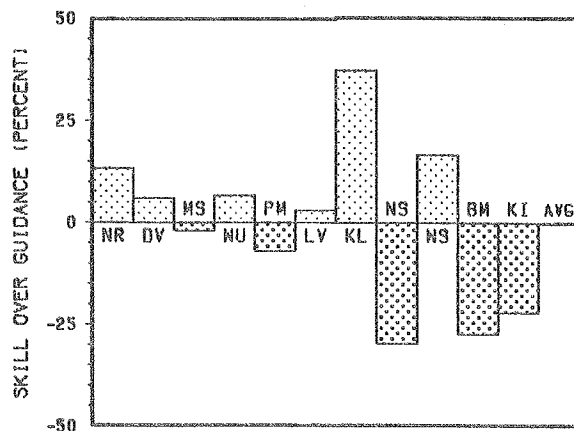
Fig 2. As for Fig. 1, for forecasts of minimum temperature tonight.



a



b



C

### Minimum Tonight

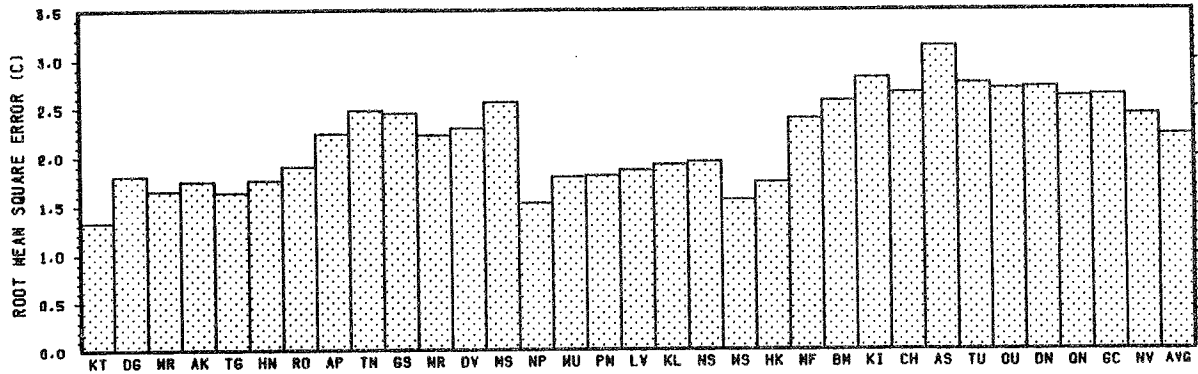
Root-mean-square errors for forecasts of minimum temperature tonight averaged  $2.44^{\circ}\text{C}$ , from a low of  $1.61^{\circ}\text{C}$  for Kaikoura to a high of  $2.89^{\circ}\text{C}$  for Masterton and Blenheim (Fig. 2a). In general, these forecasts were a little less skilful relative to climatology than the maximum today forecasts, possibly because of the longer forecast period for minimum tonight (about twelve hours compared with about eight hours for maximum today). Figure 2b shows skill scores compared to climatology. The lowest score, 16.8 percent, was for Nelson - the station with the highest incidence of air frosts in the period considered. Compared to guidance forecasts, average skill was once again near zero with the lowest score again for Nelson, (Fig. 2c). Poor guidance for Kelburn shows up again in the high score (large improvement) for that station.

### Maximum Tomorrow

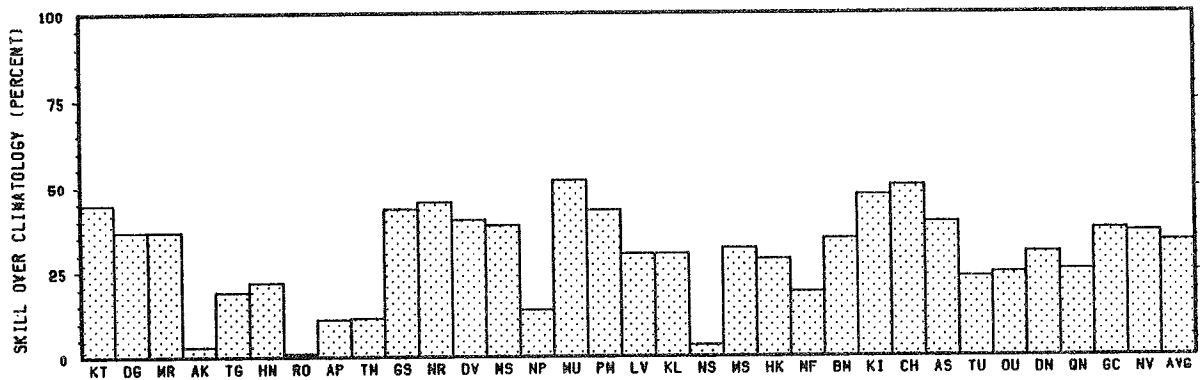
New Zealand topography gives rise to the pattern of rms errors for maximum tomorrow seen in Fig. 3a. The largest rms errors were obtained for east coast South Island stations which have the largest predictand variances. The average rms error was  $2.22^{\circ}\text{C}$  - 77 percent of forecasts had absolute errors of  $2^{\circ}\text{C}$  or less. Average skill over climatology was thirty-four percent. There is no obvious pattern in the scores for individual stations (Fig. 3b).



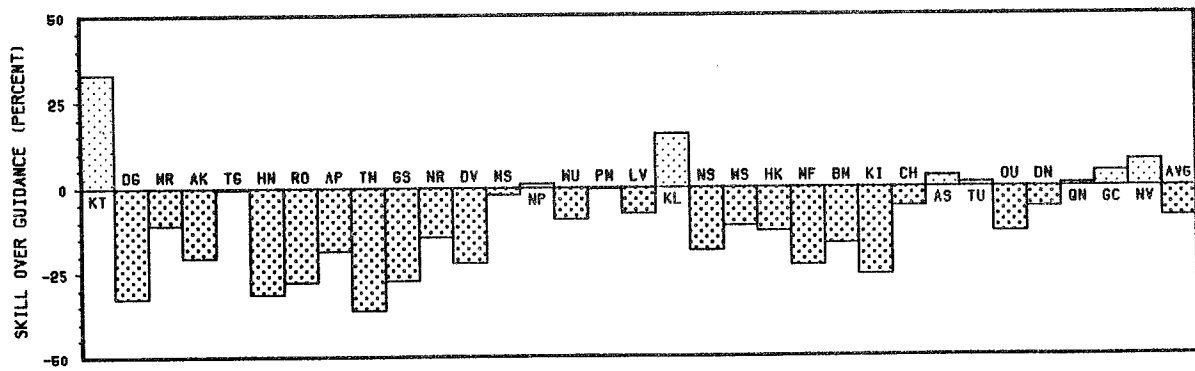
Fig 3. As for Fig. 1, for forecasts of maximum temperature tomorrow.



a



b



c

Subjective forecasts were generally worse than guidance with an average skill of -8.9 percent (Fig. 3c). A persistent bias in guidance for Kaitaia gave rise to a high guidance rms error and hence to the large positive skill obtained there. The average skill for forecast maximum today was +2.9 percent, averaged over the eleven stations available. The average skill of forecast maximum tomorrow, averaged over the same eleven stations, was -10.2 percent. This decrease suggests that perhaps more reliance should be placed on the guidance forecasts for maximum tomorrow.

#### Seasonal Comparison

The seasonal distribution of averaged root-mean-square errors is shown in Fig. 4. Maximum temperature forecasts for today and tomorrow vary in a similar fashion with lowest errors for winter when predictand variance is lowest. Minimum temperature errors are lowest in spring, perhaps due to greater boundary layer mixing during the period of increased westerly flow over the country. However, this does not show up in the autumn error statistics.

In terms of skill over climatology, scores for maximum today and minimum tonight both increase through the year from summer 1982/83 to spring 1983 (Fig. 5). Skill for maximum temperature tomorrow was lowest in autumn, the season when guidance forecasts were least reliable. Figure 6 shows the seasonal skill compared to guidance. The relatively poor guidance forecasts for autumn show up with a peak in skill for that season for all three sets of forecasts.

All types of subjective forecasts were less skilful than guidance for the summer season, and maximum tomorrow forecasts were less skilful than guidance for all four seasons.

Fig. 4. Average of all forecasts by three month seasons, centred on January, April, July and October.

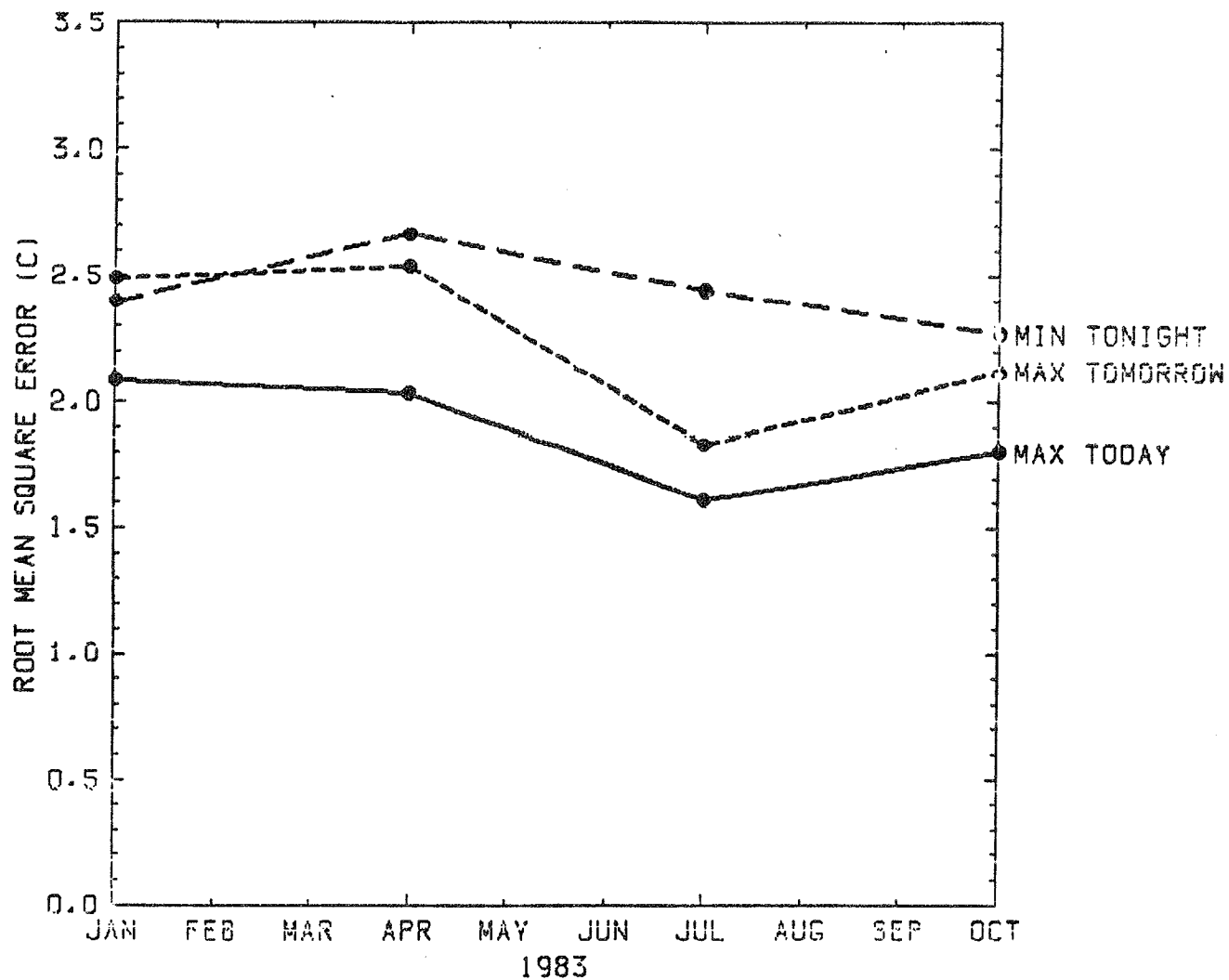


Fig. 5. As for Fig. 4, for skill relative to climatology.

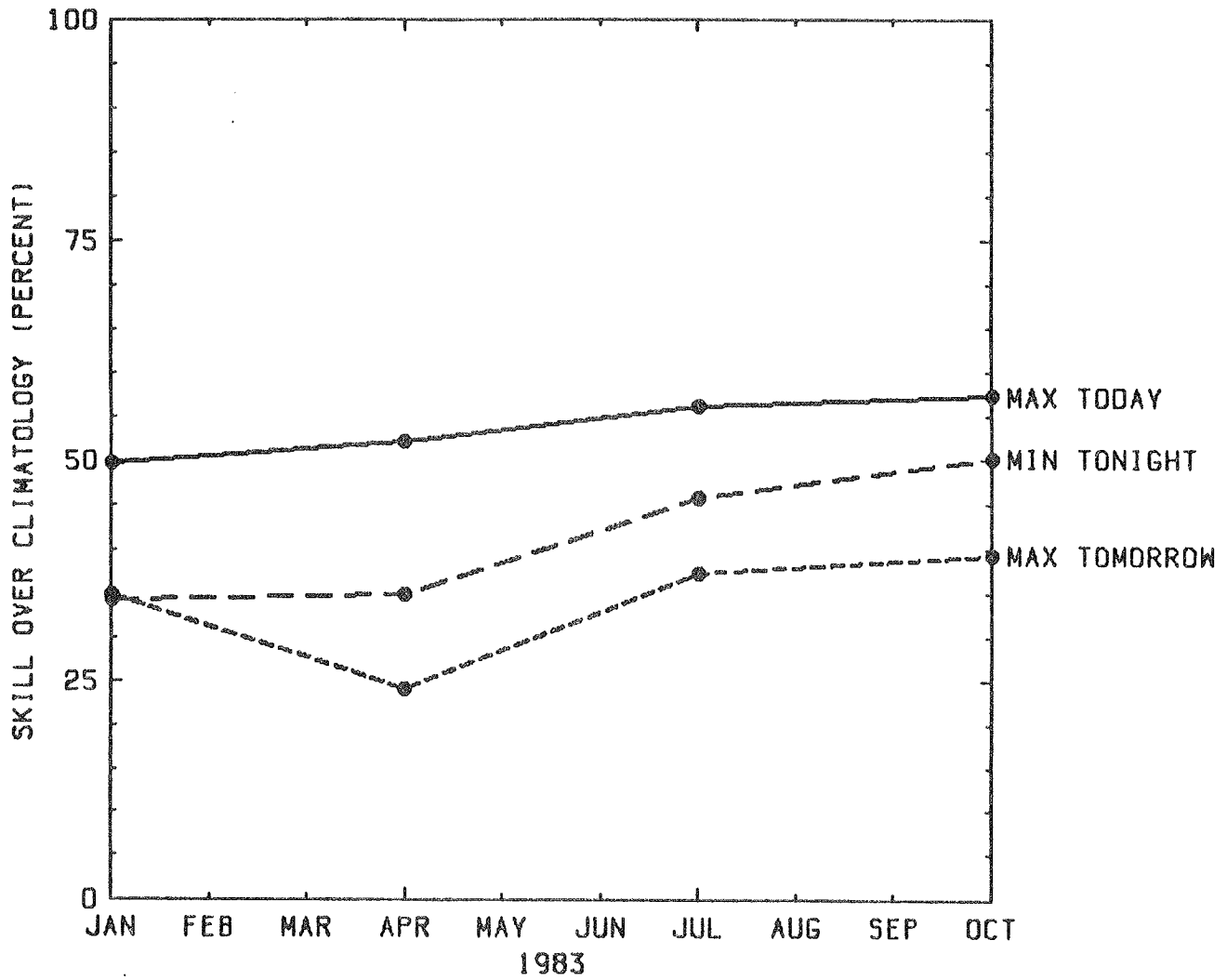
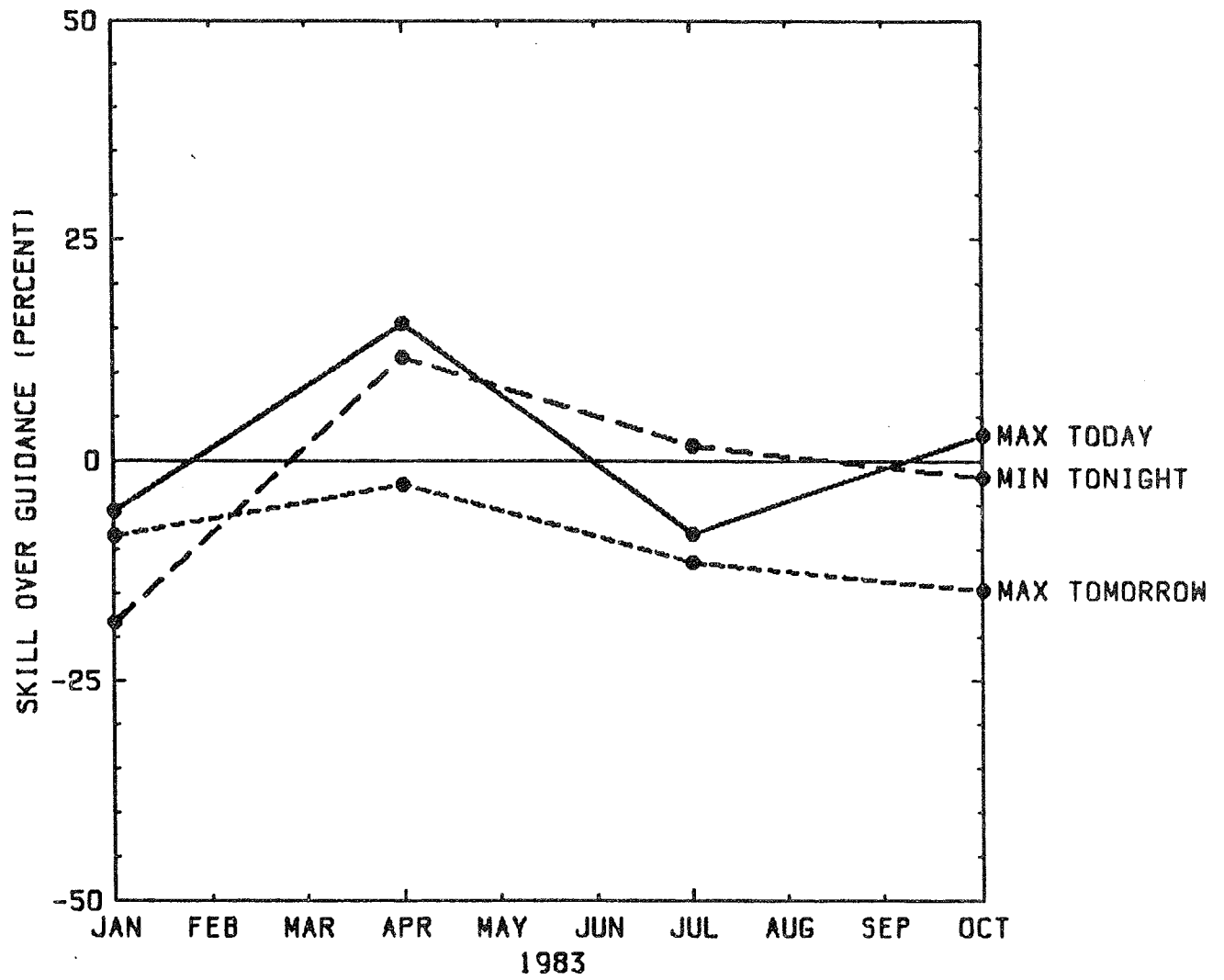


Fig. 6. As for Fig. 4, for skill relative to guidance.



## DISCUSSION AND CONCLUSIONS

The maximum and minimum temperature forecasts verified here have average rms errors similar to those of objectively calculated guidance forecasts. It may be expected, a priori, that forecasts issued with the aid of objective guidance would be at least as accurate as that guidance. This was the case for forecasts of maximum temperature today and minimum temperature tonight (forecast period less than twelve hours), with some exceptions for individual stations. For forecasts of maximum temperature tomorrow, subjective forecasts were less skilful on average than the available guidance. It may be worth concentrating on modifying guidance forecasts for only those stations where positive skill has been demonstrated.

The accuracy of objective guidance forecasts is totally dependent on the accuracy of the NWP prognoses used. An accurate NWP prognosis should lead to a reliable set of guidance temperatures, hence modification of the guidance forecasts should be limited to cases where the forecaster feels the NWP prognosis is in error. For the year studied, approximately sixty percent of subjective forecasts differed from comparable guidance forecasts, mostly by less than 2°C. As a test, all differences of 2°C or less were artificially eliminated by setting appropriate subjective forecasts to guidance values. This resulted in increases in skill for those stations where subjective forecasts were worse than guidance.

In August 1984 the objective scheme was updated and made more accurate than that available in 1983 (Renwick, 1985). The new objective forecasts should be more reliable and hence harder to improve upon than those available in 1983.

References

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