The regional value of global forecast precipitation predictions in the Waikato River catchment, New Zealand

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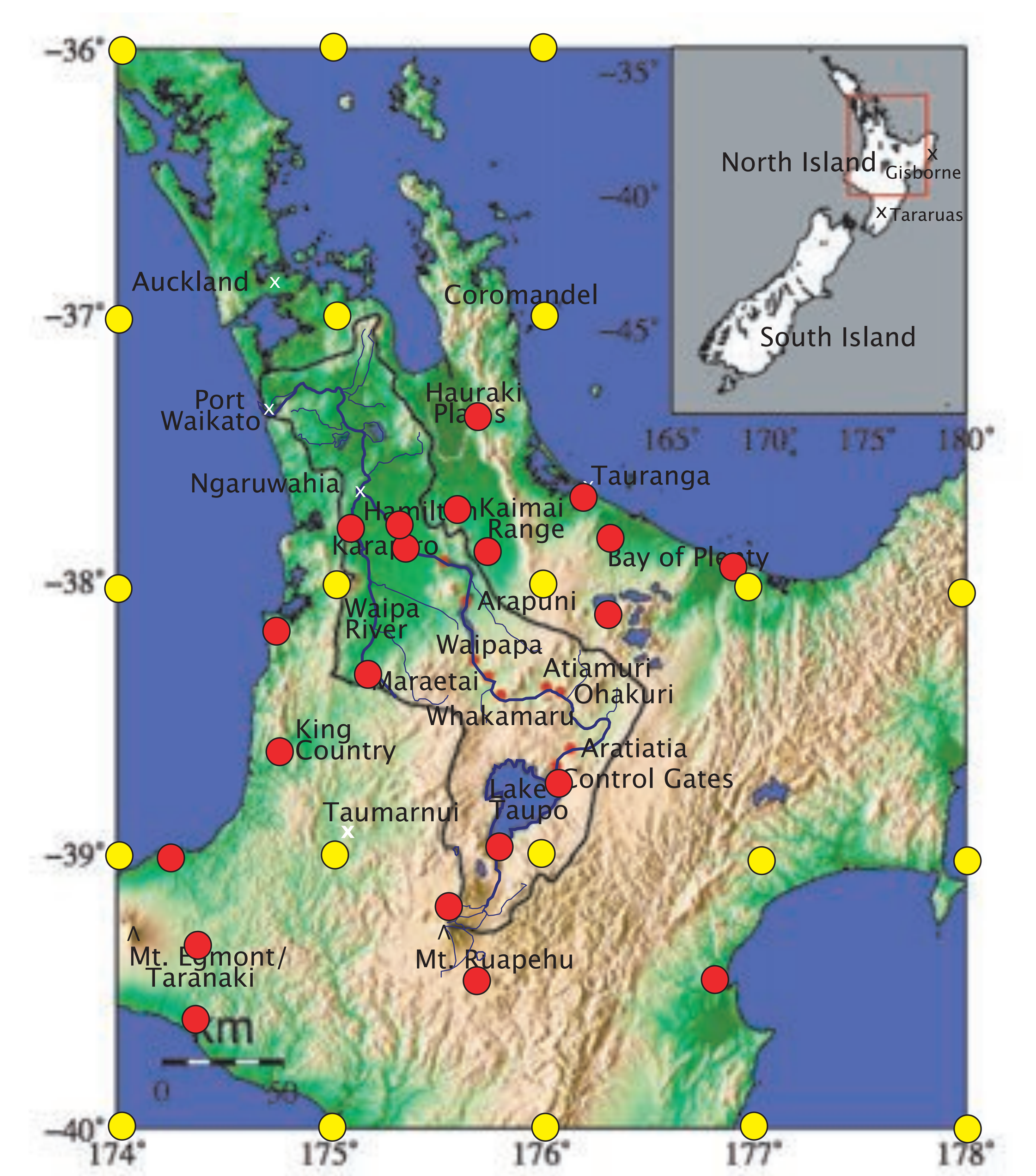

Figure 1: The location of the Waikato River catchment and hourly precipitation rain gauge stations (in red) in relation to the grid points where GFS data is provided (yellow dots).

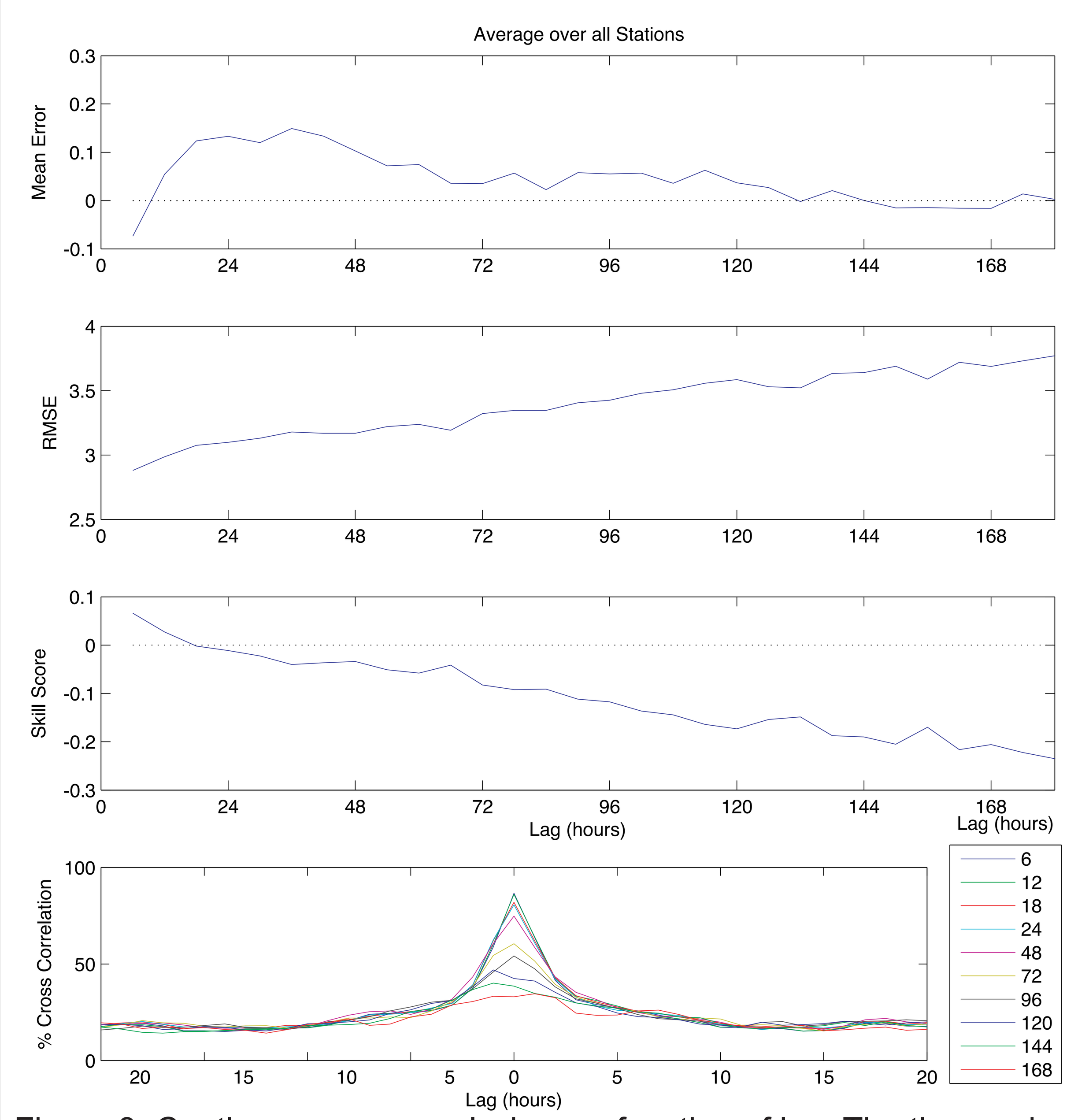

Figure 3: Continuous error analysis as a function of lag. The time series comparision accuracy measures (mean error, root mean square error, skill score (compared to a climatological constant), and the cross correlation) were calculated for each individual station at each lag separately. The plots show the average value across all stations for each forecast lag time.

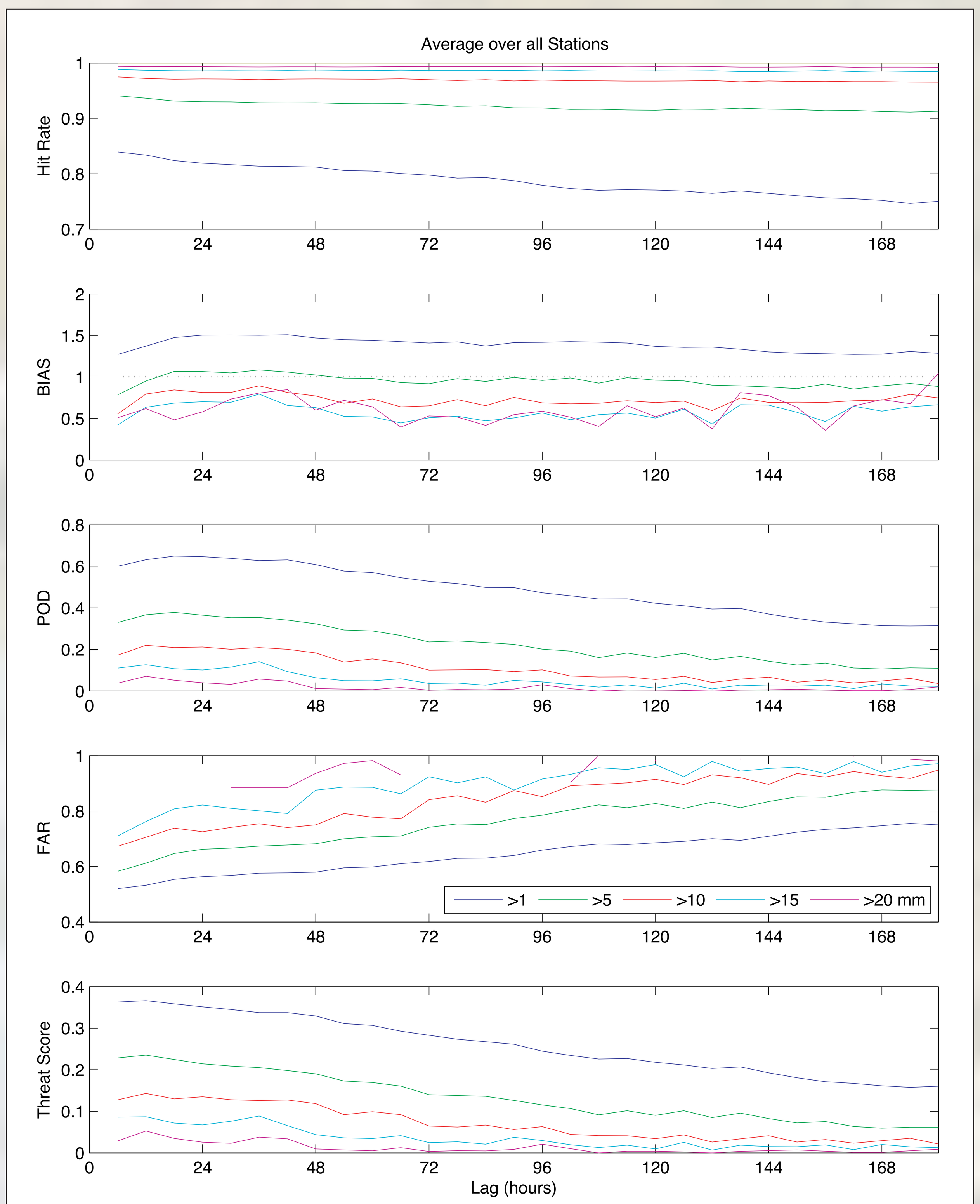

Figure 2: Categorical error analysis as a function of lag (hours). The five categorical accuracy measures (hit rate, bias, probability of detection, false alarm rate, and threat score) were calculated for each individual station at each lag separately for a series of precipitation exceedance thresholds. The plots show the average value across all stations for each forecast lag time series at each threshold. These show that accuracy is better for lower precipitation threshold and for shorter lag times.

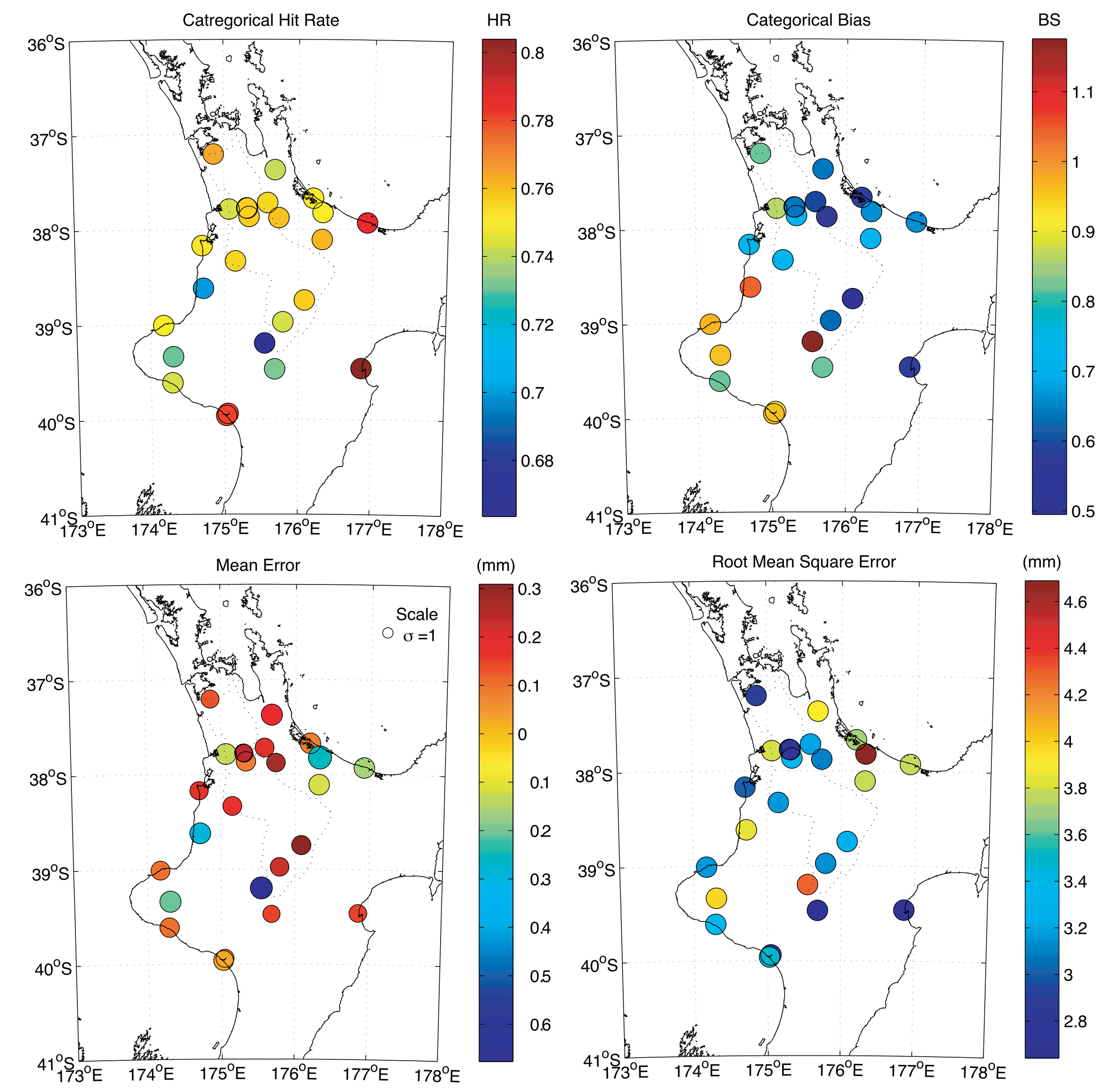

Figure 4: a) Categorical hit rate at each station, b) categorical bias for predicting rain, c) average mean error, d) average RMSE over all lags. Each calculation contains 87,600 forecast/observation pairs.

The hydroelectric system on the Waikato River provides 13% of New Zealand's electricity. Hydroelectric operations can be optimised and floods mitigated if predictions of precipitation inputs can be improved. The Global Forecast System (GFS) model provides valuable information, but is limited in model resolution, containing only one grid point within the 12,000 km river catchment. To verify these precipitation forecasts, we have compared the six-hourly precipitation forecast runs to rain gauge data from 23 stations near the Waikato.

Forecast verification statistics were calculated over a two-year period of forecasts out to 180 hours. Discrete categorical analysis calculated hit rates of 0.8 for a 6-hour lag and 0.72 for a 180-hour lag forecast. The bias scores also showed that light precipitation was over-predicted and heavy precipitation was under-predicted. This could result from a lack of orographic enhancement at the resolution of the model. In moderate to high precipitation categories, the false alarm rate is high and probability of detection is low. Stations around the Waikato have average mean errors between -0.3 and 0.7 mm over the lags and root mean squared errors range between 2.8 and 4.5 mm. Dry periods account 85% of data periods are therefore it is statistically more skillful to assume it will be dry.

The timing and consistency of predicted precipitation were investigated as a lag ensemble. Precipitation predictions were simplified to either: a binary wet or dry, or with precipitation falling into one of six precipitation categories. Once again, this showed that the model is more skilful in predicting dry periods and the probability of receiving heavy precipitation increased as the number of ensemble members predicting an extreme increased. In some model runs, the mesoscale meteorological features were miss-located, while in other runs, the precipitation features did not develop. The largest variations obviously occur at longer lags.

The GFS model is valuable as an extended range forecast because it is skilful at predicting fine weather and indicating the presence of a precipitating mesoscale feature although the features are not well constrained at the longer lags. The improved accuracy at the shorter lags indicates that this model is appropriate in most cases for initialising and constraining the mesoscale model which can determine the surface interactions and therefore reduce the under-prediction error found here.

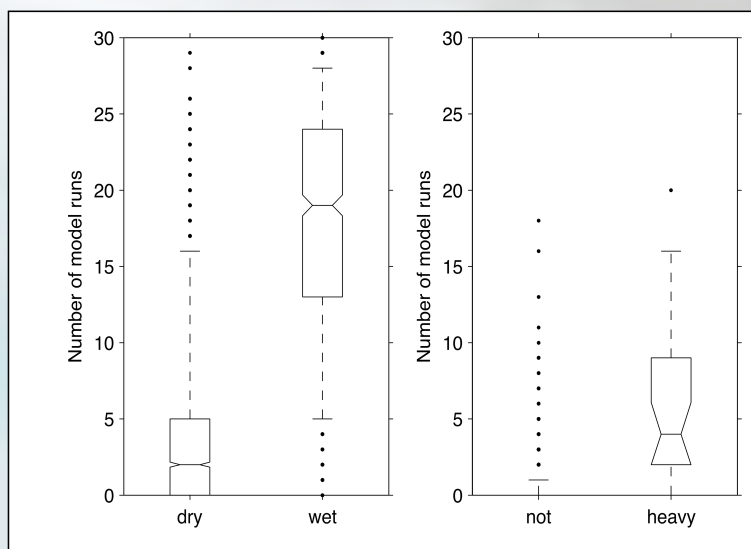

Figure 5: The spread of model runs correctly identifying precipitation or heavy precipitation. These box and whisker plots show the number of models that (a) predicted precipitation on observed 'wet' (>1 mm) and 'dry' (<1 mm) days; and (b) predicted heavy (>10 mm) of precipitation on days that observed heavy precipitation and those that did not. These show that precipitation is more probable the more frequently predicted when it occurs.

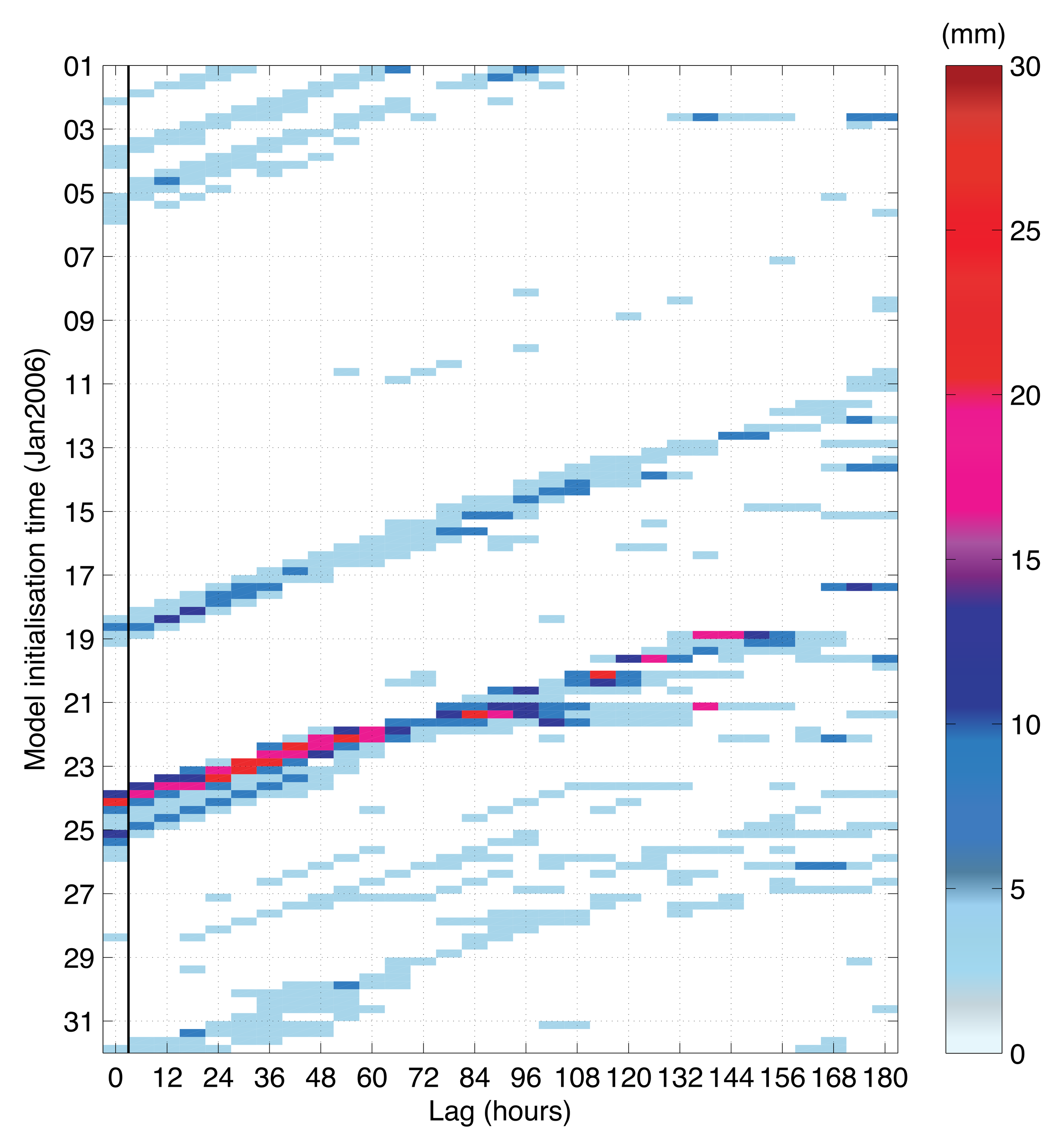

Figure 6: The average amount of precipitation predicted for each six-hour period during each model run in January 2006. Each line represents a single model run. On the left at '0' lag is the observed precipitation accumulation at the initialisation time of the model run.

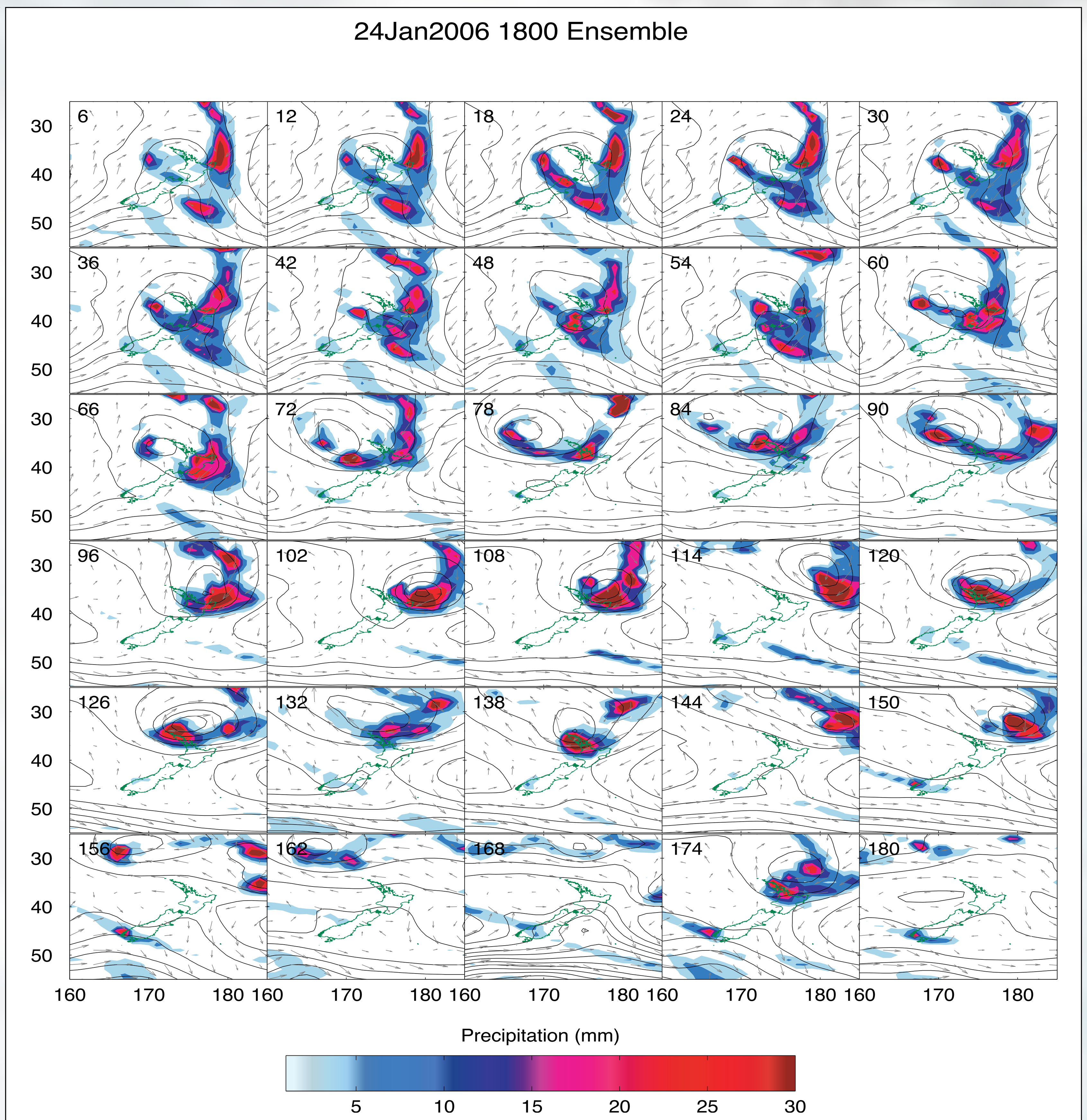

Figure 7: The time lag ensemble members for the valid time of 1800 UTC 24 January 2006 from each of the thirty model runs that included this valid time. The lag is shown in the top left of the panel and each figure shows the forecast pressure, winds and precipitation.

Acknowledgements
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