conditions for wildfires, etc. Because models with strong similarities in construction produced quite different results it is important to identify why some produced good forecasts while others were significantly in error. Separating out the roles of initial conditions, ocean physics, the atmospheric physics and the coupling is a challenge, but essential to consistently improve predictions in the future.

A major advantage of dynamic climate models is that a natural output of ensemble predictions (repeated integrations with slightly different starting conditions in the atmosphere) is probabilistic information about likely future events. Information on changing probabilities of future events is very useful for risk management, particularly the management of low-frequency extreme events that are the basis of natural disasters. The value of probabilistic climate information for risk management is now just beginning to be appreciated across a range of sectors.

An example of probabilistic forecasts is the "net assessment" forecasts produced by the International Research Institute for Climate Prediction (IRI). The net assessment forecasts are a combination of model predictions and statistical inputs, and are expressed in terms of probabilities of the respective season's rainfall being in the wettest third, driest third and the third centred upon the climatological median. The probabilities express the level of confidence in the forecast. An example of a net assessment is in Figure III.3.

Not all of the extreme weather events and climate anomalies that occur during an El Niño event should be attributed to El Niño. Many of the extremes and anomalies are but part of the broader natural variability of the climate system. Ensemble forecasts are being made with different boundary forcing (e.g. with and without the anomaly of equatorial sea surface temperature) in an attempt to separate El Niño teleconnections from the background variability.

The apparently unusual behaviour of El Niño events over the past 20 years, with a tendency for more El Niños and fewer La Niñas, highlights the need for more comprehensive models that can handle changes in the deeper ocean circulations and in atmospheric composition. Greenhouse gases and aerosols from human activity and debris from volcanic eruptions are additional forcings that are likely to modify the climate response to an El Niño

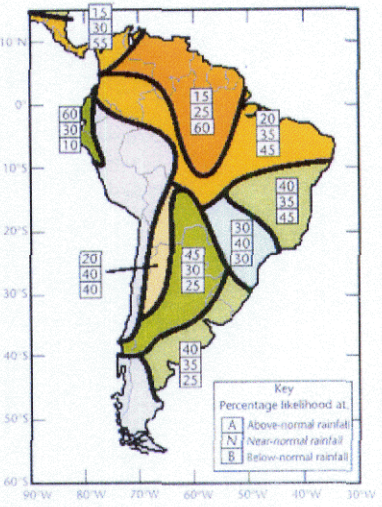

Figure III.3
The format of seasonal forecasts produced by the International Research Institute for Climate Prediction (IRI). For each region a probability is given of rainfall in the wettest third, the driest third or the third of years about the climatological median. The example shown is South America, January to March 1998. (IRI)

event and need to be included in forecast models.

The warmest and second warmest years since the 1860s, when reliable instrument records began, were 1998 and 1997 respectively. 1998 was the twentieth consecutive year with an annual global mean surface temperature that exceeded the 1961–90 average. Whether the warmth was at least partly due to the unusually high El Niño activity or whether the global warming is contributing to the frequency and size of El Niño events is a question to be resolved. The issue is a key consideration of the Intergovernmental Panel on Climate Change. Research and model development within the framework of the World Climate Research Programme are fundamental to understanding and responding to human influence on climate change, and adapting to natural trends in climate.

Applications of forecasts

A forecast is an estimate of the characteristics of a future event. The value from a forecast is realized when estimates of the characteristics of the future event are integrated into decision-making to create beneficial outcomes. Therefore, the potential benefit of climate forecasts in a particular application relates to how the estimates of future climate characteristics can be used to improve decisions, the outcome of which are sensitive to climate variability. Realizing the potential benefit from a climate forecast