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SPECIAL SECTION ON STATISTICS IN THE ATMOSPHERIC SCIENCES

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With the possible exception of gambling, meteorology, particularly precipitation forecasting, may be the area with which the general public is most familiar with probabilistic assessments of uncertainty. Despite the heavy use of stochastic models and statistical methods in weather forecasting and other areas of the atmospheric sciences, papers in these areas have traditionally been somewhat uncommon in statistics journals. We see signs of this changing in recent years and we have sought to highlight some present research directions at the interface of statistics and the atmospheric sciences in this special section.

Two of the papers in this section relate to statistical approaches to precipitation modeling. The stochastic modeling of precipitation goes at least back to the introduction of Markov chains by Quetelet (1852) to describe dependent events of daily rainfall. In modern precipitation modeling there are three major strands: extensions of the Markov chain structure to hidden Markov models, a point process approach and spatial models based on Gaussian processes. Among these, the point process approach is most closely related to the physical structure of cyclonic storms.

The structure of cyclonic storms was studied in detail by Hobbs and Locatelli (1978). Each frontal system contains a sequence of rain bands, each containing rain cells of higher local precipitation intensity. In northern mid-latitudes the frontal systems in winter arrive at about a three day time scale. The systems are of a synoptic spatial scale of order of magnitude 10^3 km, while the ensuing precipitation occurs on a mesoscale, 10^2 km or less.

Le Cam (1961) assumed a directing measure M that generates the random rate of another random measure N. The actual rainfall is then taken as a smoothing of the measure N. The point process approach was applied (in less generality than that of Le Cam) to precipitation data by Rodriguez-Iturbe, Cox, Foufoula-Georgiou and others in the 1980s. A more general approach was developed by Phelan (1996), who considered a stochastic flow to represent the atmosphere, within which rain cells were born and died according to birth and death processes. While this approach has the potential to describe precipitation on a synoptic scale, the statistical tools (as well as the appropriate data) were not available at the time.

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