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Modeling and forecasting Arctic sea ice cover

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Abstract

In recent years, Arctic sea ice has been declining with potentially wider climatic implications. NASA satellite records of Arctic ice cover extend from 1979 to 2011 (with T=396 monthly observation), and are disaggregated tonine Arctic sub-regions. These records show a 13% decline in annual average Arctic sea ice overall, but there are important regional differences in ice patterns and trends according to location (Arctic core vs. periphery) that are relevant to statistical analysis and forecasts. Core regions (the Arctic Ocean proper and Canadian Archipelago) retain partial ice cover throughout the year, and in winter months show complete ice cover. A time series representation needs to express this annual reversion to complete cover together with the irregular trend for declining extent in non-winter months. A generalized beta representation is developed for the monthly time series of ice extent in core regions, with ceiling C (in millions sq km) representing the total winter extent. This is obtained by scaling a beta time series regression with ceiling 1 (a one inflated beta regression). For non-core regions (such as the Sea of Okhotsk and Hudson Bay), there is either no ice cover in the summer, or summer ice extent is reducing and close to being totally absent. For these regions a gamma time series with excess zeroes (representing summer sea ice absence) is developed. Bayesian methods are used with performance assessed by cross-validation, with the first T0=372 monthly observations (1979 to 2009) used for estimating models, and with forecasts compared to known data for 2010 and 2011.

Biography

Peter Congdon is a quantitative geographer with particular interests in environmental and spatial statistics and related statistical modelling issues, especially Bayesian methods. He is affiliated to the QMUL Centre for Statistics and since 2001 he has been a Research Professor in the School of Geography. He is the author of a range of articles and books, including the recent CRC publication ‘Applied Bayesian Hierarchical Methods’ and a second edition of ‘Bayesian Statistical Modelling’.