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Space-time structure of extreme precipitation in Europe over the last century: a climate perspective

F. Cioffi (1), E. Rus (2), C.K. Krishnamurthy (3), C. Karamperidou (4), and U. Lall (4)

(1) university of rome ' la sapienza', civil structural and environmental engineering, rome, Italy (francesco.cioffi@uniroma1.it), (2) Department of Civil and Environmental Engineering, University of Cantabria , (3) Center for Environmental and Resource Economics, Umea University, Sweden, (4) Department of Earth and Environmental Engineering, Columbia University,New York

We analyze over a century of continuous rainfall data available from the ECA&D archive for spatio-temporal trends in extreme precipitation. The data base includes 515 stations with records longer than 100 years. For each station, we identify daily rainfall events in the winter 6 months (Oct-Mar) that exceed the 90th and 95th percentile of daily rainfall. An annual time series of the frequency of such events is created, as well as an annual time series of the average daily rainfall in these events. Space and time analyses of the variation of the frequency and intensity time series are then pursued using both multivariate time and frequency domain (multi-taper method) methods and pricipal component analysis (PCA). The key trends and organized spectral modes identified are related to potential anthropogenic change and to well established climate indices (e.g., NAO, EAWR and SL). The analysis shows that there is compelling evidence for statistically significant trends for increasing frequency and intensity of exceedance of daily rainfall extremes in the Oct-Mar season over North and Western Europe, where the highest station density is located. From a Principal Component Analysis and from a MTM-SVD analysis, these trends are seen to be spatially coherent. Furthermore, the influence of NAO and ENSO is seen through the significance of the frequency spectra of the associated climate indices and the leading PC of each series analyzed. The ENSO connection is prominent at a frequency of ~ 0.2 cycles/year, and for NAO at a frequency of ~ 0.15 cycles/year.