Non-equilibrium Collective Processes in Far from Equilibrium Distributed Systems.  
Theory and Practice.  
George P. Pavlos(1), A.C. Iliopoulos(1), L.P. Karakatsanis(1), V.G. Tsoutsouras(1), M.A. Athanasiou(2), E. G. Pavlos(3)  
(1) Democritus University of Thrace, Department of Electrical and Computer Engineering, Xanthi, (2) Technical University of Serres, Department of Mechanical Engineering, Serres, (3) Aristotle University of Thessaloniki, Department of Physics, Greece.  
gpavlos@ee.duth.gr  
The far from equilibrium dynamics of physical distributed systems reveals universal properties. Some of the highlights of the phenomenology of such systems are power law scaling, (multi)fractal space or time coherent structures, (spatio)temporal chaos, intermittent turbulence, critical dynamics, phase transitions, self organized criticality (SOC), nucleation processes, long range spatiotemporal correlations and clustering etc. These characteristics can be concluded from many studies of spatially distributed systems such as space plasma processes, solar activity, earthquakes and brain dynamics. The dynamics of the far for equilibrium distributed systems, as the above refereed physical systems, also belong to the type of driven nonlinear threshold dynamics. Both types of input-output and driven threshold dynamics include the possibility of critical point and phase transition phenomena, where avalanche and nucleation events can happen. Such characteristics can be the theoretical base for the physical explanation of the emergence of sporadic and localized coherent structures such as magnetospheric substorms, solar flares at the sun’s surface, earthquakes and seismic clustering in the earth’s lithosphere and epileptic seizures in the brain system. In this study, experimental evidence of chaotic and SOC dynamics is shown, obtained by the nonlinear analysis of time series concerning the space plasmas, solar activity, earthquakes and brain dynamics.  
Keywords: Nonequilibrium processes, Distributed systems, Coherent Structures, Nonlinear Time Series Analysis, Chaos, SOC.