Signatures of low-dimensional intraseasonal motion in the data of a German climate station

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Climatic motions during the extended boreal summer season (256 days, from March 1 to November 11) have been studied in daily resolution using the surface air temperature (SAT) series of climate station Lindenberg (Mark) since the beginning of the record in 1906. It was surprising to see signals in these local data that sometimes closely correspond to the global behavior of a tropospheric General Circulation Model (GCM) of very low spatial resolution (i.e., a model of “intermediate complexity”) – which nevertheless shows a qualitatively correct intraseasonal motion of the planetary-scale monsoon system, notably its 30-60 day activity cycle. In attractor studies of the GCM, this cycle was shown to represent the minor (poloidal) circumference of a torus segment in phase space. It displays a complete yet backwards running “route to chaos” in global integrals of motion, starting from out of fixpoint dynamics in spring via the passage of a subcritical Hopf bifurcation in early summer, with a hard jump into a chaotic July regime that is left then as the season advances into period doubling and period-one cycles. The latter stretches further toward a lately degenerate, very slow motion that develops from a fault into a ‘scar’ on the torus mantle and disappears to give way to the autumn fixpoint.

Though it is well-known that the monsoons on Earth are representatives of a global climatic subsystem, it was not expected to see even details of this GCM-scenario in local data at European midlatitudes. The year 2013 shows an archetypal example of period doubling in the station’s SAT data, with a strong heat wave in midsummer flanked by weaker ones about 50 days apart each. Chaotic motions in the time-frequency plane, period doubling and stretching were also part in 2018 of the system’s evolution into the strong heat wave that could be foreshadowed more than 30 days in advance, based in part on the qualitative, topological knowledge drawn from the GCM simulations. In addition to a couple of historical case studies, the contribution announced here displays analyses and projections of the evolving boreal summer 2019. The present abstract is written at the height of the heat wave end of June, which is speculated to be the stronger one in another period doubling regime and to be followed by a weaker pulse around about mid-August. If the major monsoon activity cycle is maintained this summer, the phase relation to the seasonal cycle reached might result in a relatively early termination of the 2019 boreal summer season. Two further, intriguing scenarios appear to be borne in the data by end of June, however. We shall better see by the date of the conference which one the system has chosen, and how the seasonal transition might proceed …