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The predictability analysis of the annual temperature reconstructions

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We use different annual temperature reconstructions (Moberg, Jones, Ammann) in order to measure predictability of the temperature data. We use recurrence plot (RP) analysis, which is suitable for short and non-stationary time series analysis. These plots show behavior of the trajectory segments in a phase space, where we use time-delay embedding to reconstruct the phase space from the scalar, temperature data. Namely, black dot is marked in the RP when trajectory segment for time "i" comes close to trajectory segment for time "j". If there is no recurrence of the trajectory for these times , white dot is marked in the RP instead. Diagonal, horizontal, vertical lines and dots are typical patterns in an RP, and all of them describe different dynamical regimes (chaotic, periodic, laminar, or random behavior). For the purpose of our analysis, we define a measure for predictability Γ, which is an inverse of the mean diagonal line length in an RP. Diagonal lines in an RP for the time series from the chaotic systems, measure for how long time two trajectory segments run together, and Γ, in this case, approximately measures inverse Lyapunov exponent. On the other hand, Γ for colored noises measures time correlations (existence of the long memory in the data), and has the same function as self-similarity exponent. Thus, Γ is a measure for predictability and is more universal than Lyapunov exponent or Hurst exponent, since it can be applied to both dynamical or stochastic systems. Γ is, further, used in temperature analysis, and preliminary results indicate higher predictability in temperature data around big temperature changes (Maunder minimum, around 1940, or around green-house effect which occurs now).