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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Climatic responses to systematic time variations of parameters: A dynamical approach" *by* Catherine Nicolis

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I appreciate the Referee's positive assessment of my manuscript and her/his constructive comments.

A revised version of the manuscript is currently being prepared in which the comments and suggestions formulated by Referee #2 are addressed. To this end the Conclusions section has been augmented and three new references have been added. Specifically:

Referee #2 Comment 1

For general dynamical systems different types of tipping have been defined, such as purely bifurcation related tipping (corresponding to the 'static' case described here) and rate-dependent tipping (where a parameter varies in time), see Ashwin et al. 2012,

http://doi.org/10.1098/rsta.2011.0306. I would suggest to relate the systems described here to these cases, at least in the discussion.

Answer

In the second paragraph of the Conclusions the following statement has been added:

"As it turned out for sufficiently small rates epsilon of parameter change a universal, epsilon-independent regime is reached in which the transition occurs at a parameter value depending entirely on the initial value and the critical value corresponding to the limit epsilon=0. But as epsilon is increased one observes rate-dependent deviations from this regime as illustrated in Figs 2, 6 and 11. Rate dependent behaviour was also reported by Ashwin et al. (2012)."

Referee #2 Comment 2

Moreover, linear response theory has recently been explored to determine the transient climate response from idealized experiments where the parameter (CO2) is instantaneously doubled (e.g. Lucarini 2012, http://doi.org/10.1007/s10955-012-0422-0). Would it be possible to derive from the setting described in this article conditions under which such a linear response would be valid?

Answer

The following paragraph has been added between the 2nd and 3rd paragraph of the Conclusions section of the original version:

"The extended stability analysis followed in this work belongs to the class of linear response theories, in the sense that it is focusing on the conditions under which perturbations, initially assumed to be small, will at some stage start to grow in time. On the other hand it is purely deterministic, as random external perturbations or intrinsic fluctuations have not been incorporated in the description. A different class of linear response theories was recently developed in climate literature (see e.g. Lucarini, 2012; Nicolis and Nicolis, 2015) in which the change in the fluctuation properties of a system due to the presence of noise and the response of the noise free system to deterministic forcings were linked. Implicit in these approaches is the existence of a well-defined invariant probability measure of the reference system with respect to which statistical averages are carried out. Our analysis suggests that this can be so under the conditions that the system is operating around a well-defined, single stable regime, i.e. that (a) the range of variations of the forcing is nested between two successive bifurcation points; and (b), that the rate epsilon is sufficiently small so that the instantaneous perturbation to the invariant probability brought by the forcing remains small. "

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