Methodology for statistical detection of climate change

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According to the IPCC 2001 report, "detection is the process of demonstrating that an observed change is significantly different (in a statistical sense) than can be explained by natural internal variability".

The climate is represented by a $p$-dimensional random vector $\psi$, which takes one value per year. The $p$ dimensions correspond to the $p$ observation stations taken into account. In order to compute an efficient detection test for an observation $\psi_{n+1}$, we use the following framework and hypothesis:

- $(\psi_i)_{i \in \llbracket 1, n \rrbracket} \in \mathbb{R}^p$ are random variables, independent and identically distributed, of distribution $N(0, C)$
- $\psi_{n+1} \in \mathbb{R}^p$ is a random variable, independent of the $(\psi_i)_{i \in \llbracket 1, n \rrbracket}$, of distribution $N(\mu g, C)$

where $\psi$ corresponds to the climate vector studied, $g \in \mathbb{R}^p$ is the climate change vector, $\mu \in \mathbb{R}$ is an amplitude coefficient, and $C \in M_p(\mathbb{R})$ is the covariance matrix of $\psi$.

A detection algorithm has to test the hypothesis $H_0 : \mu = 0$, versus $H_1 : \mu > 0$. We investigate here the construction of a detection test which is efficient, relatively to a very simple one, particularly in the case "$n$ and $p$ are of the same order". We then illustrate this method with some climate applications.