Are pattern scaling methods useful to inform about adaptation strategies?

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I Introduction

Pattern scaling methods are commonly used to generate scenarios of climate change for the quantification of its potential impacts on different subsystems. While generic limitations of the pattern scaling approach are well documented [1], the implications these hold for adaptation decision making are not always made clear. The goal of this work is to discuss the errors that are expected a priori and the extent to which pattern scaling is a reliable tool for the quantification of the likely impacts of climate change.

II Pattern scaling

Pattern scaling is used to generate climate change scenarios under changes in anthropogenic forcings that have not been simulated by full GCMs, but can be simulated quickly and cheaply by simpler energy balance climate models. It assumes that the anthropogenic climate change signal at any region and/or time horizon T*(x,y,t), is linearly related with the change in global mean temperature for the corresponding forcing scenario and period T(t), and that the spatial pattern of change P(x,y) remains constant at any time horizon or forcing scenario. That is:

(1)

P(x,y) is obtained using a full GCM run under a particular forcing, as the pattern that minimizes the distance between the simulated change T(x,y,t) and the pattern scaled change T*(x,y,t). Thus P(x,y) is the pattern that minimizes *:*

Pattern scaled changes for other forcings are generated using eq(1), where P(X,Y) is the previously calculated pattern, and the scaler T(t) is computed using for instance and energy balance model that can quickly generate global mean temperature changes for multiple forcing scenarios.

e bas c assu pt ons unde w h t s approac are

i. Local climate responses to changes in external forcing are linear in global mean temperature changes.
ii. Model simulated changes are robust.
iii. Responses to external forcing and natural internal variability are independent of each other, so that changes in anthropogenic forcing do not change the internal dynamics of the climate system.

If t ese assu pt ons do not o d t en t e approac s funda enta y flawed and ts use to pro ect c an es at re ona oca scales for dec s on support s ca led nto quest on

The first assumption fails when regional/local climate is determined by processes other than radiative transfer, for instance, if changes in hydrological cycle or atmospheric circulation are relevant [2].
The second assumption is clearly questionable for processes where changes in regional/local climate variables depend on initial state such as sea-ice and snow-albedo feedback and changes in circulation patterns [3]. More generally, it is not clear why, for a highly non-linear system, simulated changes could be robust in spite of model biases [4].
The third assumption is known to fail for simpler non-linear dynamical models than GCMs [5].

But even f we gnore t e fact t at re ona oca c an es are not necessar y near w t externa forc ng s we can st ask does pattern sca ng preserve t e ode nfor at on potent a y usefu re evant to adaptat on dec s on a h e d scuss t s quest on n t e rest of t e poster

I esults

To find out whether the pattern scaling technique preserves potentially useful climate model information, we calculate the spatial pattern P(x,y) using the ensemble mean for each ensemble. We then compute the "pattern scaled model run" (PSR) using eq(1) taking as T(t) the global mean temperature for each