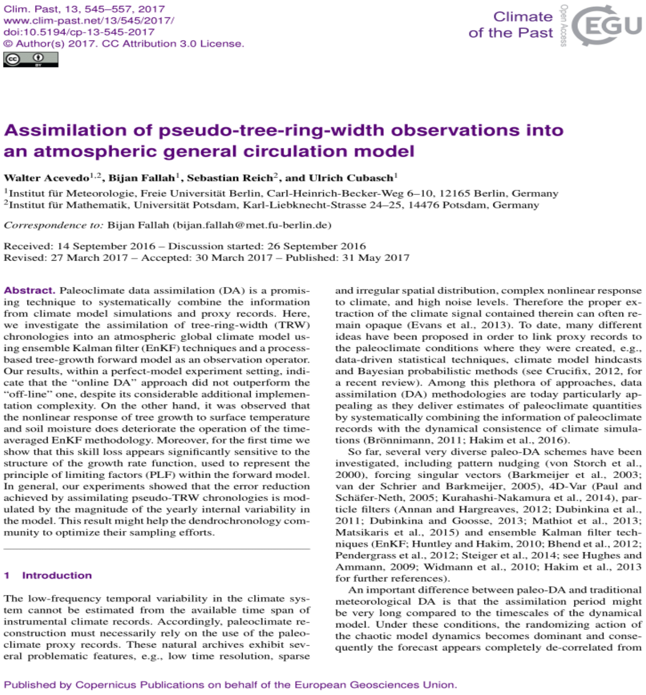
Paleoclimate Tests Of A Model Of The Atmospheric General Circulation



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Assimilation of pseudo-tree-ring-width observations into an atmospheric general circulation model

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Abstract. Paleoclimate data assimilation (DA) is a promising technique to systematically combine the information from climate model simulations and proxy records. Here, we investigate the assimilation of tree-ring-width (TRW) chronologies into an atmospheric global climate model using ensemble Kalman filter (EnKF) techniques and a process-based tree-growth forward model as an observation operator. Our results, within a perfect-model experiment setting, indicate that the "online DA" approach did not outperform the "off-line" one, despite its considerable additional implementation complexity. On the other hand, it was observed that the nonlinear response of tree growth to surface temperature and soil moisture does deteriorate the operation of the time-averaged EnKF methodology. Moreover, for the first time we show that this skill loss appears significantly sensitive to the structure of the growth rate function, used to represent the principle of limiting factors (PLF) within the forward model. In general, our experiments showed that the error reduction achieved by assimilating pseudo-TRW chronologies is modulated by the magnitude of the yearly internal variability in the model. This result might help the dendrochronology community to optimize their sampling efforts.

1 Introduction

The low-frequency temporal variability in the climate system cannot be estimated from the available time span of instrumental climate records. Accordingly, paleoclimate reconstruction must necessarily rely on the use of the paleoclimate proxy records. These natural archives exhibit several problematic features, e.g., low time resolution, sparse and irregular spatial distribution, complex nonlinear response to climate, and high noise levels. Therefore the proper extraction of the climate signal contained therein can often remain opaque (Evans et al., 2013). To date, many different ideas have been proposed in order to link proxy records to the paleoclimate conditions where they were created, e.g., data-driven statistical techniques, climate model hindcasts and Bayesian probabilistic methods (see Crucifix, 2012, for a recent review). Among this plethora of approaches, data assimilation (DA) methodologies are today particularly appealing as they deliver estimates of paleoclimate quantities by systematically combining the information of paleoclimate records with the dynamical consistence of climate simulations (Brönnimann, 2011; Hakim et al., 2016).

So far, several very diverse paleo-DA schemes have been investigated, including pattern nudging (von Storch et al., 2000), forcing singular vectors (Barkmeijer et al., 2003; van der Schrier and Barkmeijer, 2005), 4D-Var (Paul and Schäfer-Neth, 2005; Kurahashi-Nakamura et al., 2014), particle filters (Annan and Hargreaves, 2012; Dubinkina et al., 2011; Dubinkina and Goosse, 2013; Mathiot et al., 2013; Matsikaris et al., 2015) and ensemble Kalman filter techniques (EnKF; Huntley and Hakim, 2010; Bhend et al., 2012; Pendergrass et al., 2012; Steiger et al., 2014; see Hughes and Ammann, 2009; Widmann et al., 2010; Hakim et al., 2013 for further references).

An important difference between paleo-DA and traditional meteorological DA is that the assimilation period might be very long compared to the timescales of the dynamical model. Under these conditions, the randomizing action of the chaotic model dynamics becomes dominant and consequently the forecast appears completely de-correlated from

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Learn more about Atmospheric General Circulation Models However, such a comparison is only a partial test of the correctness of the processes in . In a discussion of the role of ocean heat transport in paleoclimatology it has been argued.Affiliations @Rosenstiel School of Marine and Atmospheric Sciences, This paper briefly surveys areas of paleoclimate modeling notable for recent progress. a prohibitive length of time for comprehensive general circulation models (GCMs). Simulations of these natural variations test the models relied on for future.While problems of paleoclimate have long held the attention of geologists, biologists, time presents a unique opportunity to test the performance of climate models .. In parallel with atmospheric GCMs, general circulation models have also.simulated LGM climate, the model results compare well with paleoclimatic data of water . the atmospheric general circulation models (AGCMs). .. A test of the.model forced by the atmospheric general circulation model (GCM) of [] type, forced by a representative paleoclimate model. . validation of paleo-SST is , among other things, a test of /ktmospheric Forcing and Paleoclimate Models.Weather on the High Plains varied with relative atmospheric inputs from the Pacific . As a further test of the model, we predicted values for four sites that were . Both our isotope data and our integrated model of global circulation show that.more tests of model against data. Though serious .. Results are from a coupled oceanatmosphere general circulation model. (OAGCM).vide a clear signal in forcing, which can be a good test to check the response of a Among such ESMs, the models of higher complexity, consisting of atmosphere ocean general circulation models (AOGCMs) coupled with.study is to test the sensitivity of paleoclimate to paleotopography by a general circulation model (GCM). Center for Atmospheric Research's (NCAR) Com-.The best method so far devised for testing the ability of a general circulation model (GCM) During this interval, changes in atmospheric circulation were driven primarily by Keywords palaeoclimate, climate modelling, GCMs, climate forcing.To test predictive models, data-based summer temperature reconstructions were compared with .. atmospheric general circulation model with a spectral re-.The boundary conditions are then used to drive models of the atmosphere by imposing . Paleoclimate Tests of a Model of the Atmospheric General Circulation.

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