EGU25-11097, updated on 10 Sep 2025
https://doi.org/10.5194/egusphere-egu25-11097
EGU General Assembly 2025

A Unified Framework for Trend Uncertainty Assessment in Climate Data Record: Application to the Analysis of the Global Mean Sea Level Measured by Satellite Altimetry

Kevin Gobron[1,2], Roland Hohensinn[3], Claire E. Bulgin[4,5], Xavier Loizeau[6], Emma R. Woolliams[6], Christopher J. Merchant[4], Jon Mittaz[4], Adam C. Povey[7], Mary Langsdale[8], Wouter Dorigo[9], Maurice G. Cox[6], Michael Ablain[10], Anna Klos[11], Alexander Gruber[9], and Janusz Bogusz[11]

[1]Université Paris Cité, Institut de physique du globe de Paris, CNRS, IGN, F-75005 Paris, France (gobron@ipgp.fr)
[2]Univ Gustave Eiffel, ENSG, IGN, F-77455 Marne-la-Vallée, France
[3]International Space Science Institute (ISSI), Hallerstrasse 6, 8012 Bern, Bern, Switzerland
[4]University of Reading, Whiteknights, Reading, RG30 6ET, United Kingdom
[5]National Centre for Earth Observation, Reading, RG30 6ET, United Kingdom
[6]National Physical Laboratory (NPL), Teddington, Middlesex, TW11 0LW, United Kingdom
[7]National Centre for Earth Observation, University of Leicester, Leicester, LE4 5SP, United Kingdom
[8]National Centre for Earth Observation, King's College London, London, WC2B 4BG, United Kingdom
[9]Department of Geodesy and Geoinformation, Technische Universitaet Wien (TU Wien), Vienna, Austria
[10]Magellium, 31250 Ramonville Saint-Agne, France
[11]Military University of Technology, Faculty of Civil Engineering and Geodesy, Warsaw, Poland

Estimating trends from Climate Data Records (CDRs) of Essential Climate Variables (ECVs) is necessary to detect persistent changes in Earth's climate and geophysical processes and states. Accurately describing trend uncertainty is also essential to determining the significance of observed changes and attributing drivers. However, despite the importance of uncertainty, no established trend assessment approach properly accounts for all known sources of trend uncertainty. Most approaches either neglect part of known measurement uncertainty, such as measurement system instability, or ignore the influence of natural climate variability on trend estimation. Such neglect can result in over-confidence in trend estimates.

With the intent of providing the most realistic uncertainty intervals for climate data record time series data, this study discusses problems and limitations of current approaches. It emphasizes the need to account for the combined influence of measurement uncertainties (i.e., stability of the observational system) and natural climate variability on trend uncertainty. This study proposes a novel trend-uncertainty assessment approach unifying available measurement uncertainty information with empirical modelling of natural climate variability within the same trend-estimation framework. As a proof of concept, the proposed approach is applied to the analysis of trends in a Global Mean Sea Level (GMSL) time-series. This GMSL application demonstrates that combining available measurement uncertainty assessment with variance modelling is expected to lead to more realistic uncertainty evaluations in sea-level trends. This unified approach is

potentially applicable to virtually any CDR and could enhance the reliability of climate change analysis through an improved trend uncertainty assessment in climate studies.