Robust attribution and projection of extreme heat events to human influence on the climate

Nicholas J. Leach

St. Cross College
University of Oxford

A thesis submitted for the degree of
Doctor of Philosophy

Trinity 2022

Abstract

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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Supervised by

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Institutional

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List of Abbreviations

SST . . . . . . Sea surface temperatures.

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Quote

— author

1

Introduction

In this chapter I introduce the problem of attribution of individual extreme weather events to anthropogenic climate change. I review the current methodologies and frameworks that address this problem, in particular the contrasting storyline and probabilistic approaches to attribution. Although these frameworks are gaining acceptance and maturity, I suggest that a weather forecast-based approach could further increase the trustworthiness of attribution studies. Finally, I provide a conceptual sketch of these various attribution frameworks within a simple non-linear dynamical system.

Author contributions: This chapter is based on the the following publication [*]

Surname, I1. I2., Surname, I1. I2. (year). **Title**. *Journal*, **vol**(issue), pages. DOI

Contents

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[*]with the author contributing as follows.

1.1 Section

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Quote

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2

Conventional probabilistic attribution

Here I present a probabilistic extreme event attribution of the 2018 European heatwave. Whilst demonstrating the methodologies behind this framework, I examine how one particular aspect of probablistic event attribution – the definition of the event – projects strongly onto the quantitative results. In the closing remarks, I reflect on potential issues with the approach taken within the chapter, and suggest ways in which these could be overcome.

Author contributions: This chapter is based on the the following publication *

Leach, N. J., Li, S., Sparrow, S., van Oldenborgh, G. J., Lott, F. C., Weisheimer, A., & Allen, M. R. (2020). **Anthropogenic Influence on the 2018 Summer Warm Spell in Europe: The Impact of Different Spatio-Temporal Scales**. *Bulletin of the American Meteorological Society*, **101**(1), S41-S46. https://doi.org/10.1175/BAMS-D-19-0201.1

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*with the author contributing as follows. Conceptualisation, Data curation, Formal analysis, Investigation, Methodology, Resources, Visualisation and Writing – original draft.

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Quote

— author

3

Attribution and projection

Chapter description.

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Leach, N. J., Watson, P. A. G., Sparrow, S. N., Wallom, D. C. H., & Sexton, D. M. H. (2022). **Generating samples of extreme winters to support climate adaptation**. *Weather and Climate Extremes*, **36**(), 100419. https://doi.org/10.1016/j.wace.2022.100419

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*with the author contributing as follows. Data curation, Formal analysis, Investigation, Methodology, Visualization and Writing – original draft.

3.1 Section

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Quote

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4

Partial forecast-based attribution

Chapter description.

Author contributions: This chapter is based on the the following publication [*]

Leach, N. J., Weisheimer, A., Allen, M. R., & Palmer, T. (2021). **Forecast-based attribution of a winter heatwave within the limit of predictability**. *Proceedings of the National Academy of Sciences*, **118**(49), . https://doi.org/10.1073/pnas.2112087118

Contents

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[*]with the author contributing as follows. Conceptualisation, Data curation, Formal analysis, Investigation, Methodology, Resources, Visualisation and Writing – original draft

4.1 Section

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Quote

— author

5

Forecast-based attribution

Chapter description.

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5.1 Section

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6
Discussion

Chapter description.

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6.2   Concluding remarks

Appendices

The first kind of intellectual and artistic personality belongs to the hedgehogs, the second to the foxes ...

— Sir Isaiah Berlin [1]

References

[1] Isaiah Berlin. *The Hedgehog and the Fox: An Essay on Tolstoy's View of History*. English. Ed. by Henry Hardy. 2nd. Princeton University Press, June 2013.