Joseph CLARKE

I am a Postdoctoral Research Associate at the University of Exeter, who researches climate science. I have expertise in nonlinear dynamics, focusing on bifurcation and rate induced tipping points. I am interested in early warning signals for tipping points, particularly when the system is forced rapidly compared to its own timescale. I have a particular focus on using spatial data for early warning signals. My research on the climate system has focused on tipping points in the land carbon cycle such as the compost bomb and Amazon dieback.

PERSONAL INFORMATION

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EDUCATION

2019–2023 | PhD in Mathematics, **University of Exeter**,

PhD Thesis: 'Tipping Points and Early Warning Signals in the Climate-Carbon System', supervised by Professor Peter Cox and Professor Peter Ashwin.

2015–2019 | MPhys Physics (1st Class), **Brasenose College, Oxford University**,

Specialising in: The Physics of Atmospheres and Oceans and Condensed Matter Physics
Master's Thesis: 'Heat-engine based representation of convection with phase change in exoplanet atmospheres' with Professor Raymond Pierrehumbert.

EMPLOYMENT AND WORK EXPERIENCE

2023– | Postdoctoral Research Associate

At the univeristy of Exeter, I investigate early warning signals and the stability of the climate-carbon system

2019–2023 | Postgraduate Teaching Assistant.

Assisted teaching in the following modules: 'Probability, Statistics and Data', 'Mathematics of Climate Change', 'Ordinary Differential Equations', 'Partial Differential Equations', 'Fluid Dynamics'

2018 | Summer Project with Dr Hannah Christensen, University of Oxford.

Took a dynamical systems approach to constraining climate sensitivity. I worked with Linear Inverse Models, Empirical Orthogonal Functions, autoregressive models, Python,the Fluctuation Dissipation Theorem and undertook analysis of CMIP data

2017 | Summer Intern at the Earth Observation Data Group, University of Oxford.

Developed a website to display observations of atmospheric anomalies in near real time. This involved processing the large amount of data generated and converting it to an understandable form.

POSITIONS OF RESPONSIBILITY

2024	**Pint of Science Organiser**
	Outreach activity arranging science talks for the public. Involved working with speakers, operating AV equipment and running the events.
2017–2019	**Web Officer, Physics Joint Consultative Committee (PJCC)**
	Responsible for maintaining the PJCC website using the Django framework. Liaising with the physics department to represent student interests
2016	**Producer and Sound Technician, The Importance of Being Ernest, Brasenose Arts Week**
	Responsible for operating microphones and playing music during performance. Designed and produced posters as well as acquired props. Assisted with rehearsals

RESEARCH SKILLS

Scientific programming using Python, Fortran, C and R. Linux computer systems including the JASMIN platform. Bifurcation and rate induced tipping. Linear Response. Spectral analysis. CMIP6 data analysis. Experience with complex models (JULES). Analysis of conceptual models with dynamical systems techniques. Fluctuation Dissipation Theorem. Emergent Constraints. Carbon Cycle biogeochemistry.

PUBLICATIONS

2024	**Clarke**, **J** (2024). "Tipping Points and Early Warning Signals in the Climate-Carbon System". PhD thesis. University of Exeter. URL: https://hdl.handle.net/10871/134880.
	My thesis which examined tipping points in the carbon cycle and investigated early warning signals.
	Huntingford, Chris, Peter M Cox, Paul DL Ritchie, **Joseph J Clarke**, Isobel M Parry, and Mark S Williamson (2024). "Acceleration of daily land temperature extremes and correlations with surface energy fluxes". In: *npj Climate and Atmospheric Science* 7.1, p. 84. URL: https://doi.org/10.1038/s41612-024-00626-0.
2023	**Clarke**, **Joseph J**, Chris Huntingford, Paul DL Ritchie, and Peter M Cox (2023). "Seeking more robust early warning signals for climate tipping points: the ratio of spectra method (ROSA)". In: *Environmental Research Letters* 18.3, p. 035006. URL: https://doi.org/10.1088/1748-9326/acbc8d.
	Conventional early warning signals make assumptions about the noise the system experiences, which can make them ineffective when those assumptions are not satisfied. I introduced a new early warning signal which still works well for more general, time correlated noise. I applied this to Amazon dieback in CMIP6.
2022	Huntingford, Chris, Peter M Cox, Mark S Williamson, **Joseph J Clarke**, and Paul DL Ritchie (2022). "Emergent constraints for the climate system as effective parameters of bulk differential equations". In: *Earth System Dynamics Discussions* 2022, pp. 1–15. URL: https://doi.org/10.5194/esd-14-433-2023.
	Ritchie, Paul DL, Isobel Parry, **Joseph J Clarke**, Chris Huntingford, and Peter M Cox (2022). "Increases in the temperature seasonal cycle indicate long-term drying trends in Amazonia". In: *Communications Earth & Environment* 3.1, pp. 1–8. URL: https://doi.org/10.1038/s43247-022-00528-0.

2021 | **Clarke**, **Joseph**, Chris Huntingford, Paul Ritchie, and Peter Cox (2021). "The compost bomb instability in the continuum limit". In: *The European Physical Journal Special Topics*, pp. 1–7. URL: https://doi.org/10.1140/epjs/s11734-021-00013-3.
I derived a conceptual model for the compost bomb, showing that the diffusion of heat does not suppress the compost bomb instability. I demonstrated that compost bombs could be caused by hot summers and not just rapid global warming.

Ritchie, Paul DL, **Joseph J Clarke**, Peter M Cox, and Chris Huntingford (2021). "Overshooting tipping point thresholds in a changing climate". In: *Nature* 592.7855, pp. 517–523. URL: https://doi.org/10.1038/s41586-021-03263-2.

TALKS

2024 | Conditions for stability in the Carbon-Climate System, **Dynamics Days Europe 2024**
Invited to present my work on bifurcations in the climate-carbon system

2023 | Spatial Early Warning Signals for Rapidly Forced Systems, **EGU 2023**
Presented my work on how spatial information can be helpful for giving early warning signals when the system is forced quickly compared to its own timescale

2022 | Early Warning Signals for Tipping Points, **XCS Seminar, University of Exeter**
Presented my research to a more general audience on early warning signals, looking at time correlated noise and spatial early warning signals

Early Warning Signals: Beyond White Noise, **EGU 2022**
Presented my work on early warning signals with time correlated noise and early warning signals for Amazon dieback to the Nonlinear Processes Division

2021 | Early Warning Signals: Beyond White Noise, **Tipping Points Seminar, Potsdam Institute for Climate Impact Research**
Invited to present on early warning signals for systems subject to time correlated noise

The The Compost Bomb in the Continuum Limit, **Dynamics Internal Seminar, University of Exeter**
Discussed rate and bifurcation induced tipping for the simple compost bomb system I had derived for a mathematical audience

2020 | The Compost Bomb in the Continuum Limit, **Emergent Constraints and Tipping Points Workshop**
Took part in workshop developing connections between tipping points and emergent constraints

REFEREES

PROFESSOR PETER COX: p.m.cox@exeter.ac.uk
PROFESSOR PETER ASHWIN: p.ashwin.exeter.ac.uk
DR PAUL RITCHIE: paul.ritchie.exeter.ac.uk