Workshop: Advancing Early Warning Methods (Michael Young Room) — Monday to Wednesday

Training session: Statistics of Early Warnings (Michael Young Room) — Wednesday to Friday

Time	Monday 16/2/2026	Tuesday 17/2/2026	Wednesday 18/2/2026 (Workshop)	Wednesday 18/2/2026 (Training session)	Thursday 19/2/2026	Friday 20/2/2026
8:00-9:00	Arrival	Breakfast, White Hart	Breakfast, White Hart	Arrival	Breakfast, White Hart	Breakfast, White Hart
9:00-9:30		Plenary Lecture 2 (K Lehnertz) Tipping elements in the human epileptic brain	Discussion and Report Back		Lecture 4 (V Elvira, V Volodina) Uncertainty Quantification for Mathematical and Computational Models	Lecture 7 (M Fadera) Hands-on introduction to Deep Learning and EWS
9.30-10:00						
10:00-10:30		Show and Tell	Break (West Wing Lounge)		Practical (Uncertainty Quantification)	Break (West Wing Lounge)
10:30-11:00			Discussion: Towards an operational EWS for SPG?			Practical (Machine Learning) and feedback
11:00-11:30		Break (West Wing Lounge)			Break (West Wing Lounge)	
11:30-12:00		Show and Tell/ Breakout discussions			Lecture 5 (P Ritchie) TPs in strongly forced systems, overshoots and rate-induced tipping	
12:00-12:30	Lunch, White Hart Registration, Michael Young Room		Lunch (White Hart)	Lunch (White Hart) Registration (Michael Young Room)		Discussion: Towards an operational EWS for SPG?
12:30-13:00		Lunch (White Hart)			Lunch (White Hart)	
13:00-13:30	Plenary Lecture 1 (S Ditlevsen) Estimating early warning signals and tipping points in climate		Collaboration Time	Lecture 1 (C Boulton, P Ashwin) Introduction to TPs and EWS		Lunch (White Hart) Finish
13:30-14:00		Plenary Lecture 3 (P Cox, AdvantTip) Tipping Points, Overshoots and Early Warning			Practical (Early Warning Signals)	
14:00-14:30	Show and Tell			Lecture 2 (S Ditlevsen) Inference for nonlinear SDEs		Discussion time/ Depart
14:30-15:00		Break (West Wing Lounge)				
15:00-15:30	Break (West Wing Lounge)	Breakout/ Walk and Talk	Break (West Wing Lounge)	Break (West Wing Lounge)	Break (West Wing Lounge)	
15:30-16:00	Show and Tell		Depart	Posters	Practical (UQ/EWS) and feedback	
16:00-16:30						
16:30-17:00				Lecture 3 (K Lehnertz) Time series analysis based detection of critical transitions	Lecture 6 (F Ragone) Rare Events	
17:00-17:30						
Evening	18:30 Dinner (White Hart)	18:30 Dinner (White Hart)		18:30 Dinner (White Hart)	18:30 Dinner (White Hart)	

Breakout Topics:
Linking models, stats and deep learning
Improving statistical skill and UQ
Predicting time to tipping
Data and code exchange

Workshop: Advancing Early Warning Methods

Plenary 1	**Susanne Ditlevsen (Copenhagen)**	*Estimating early warning signals and tipping points in climate*	Early warning signals for tipping are typically second order statistics, namely increasing variance (loss of resilience) and increasing autocorrelation (critical slowing down). However, it is statistically challenging to estimate these from non-stationary data, which is exactly the case for systems approaching tipping points. Moreover, the systems are typically highly non-linear and noisy, and this even more so, the closer to the tipping point. I will discuss such statistical challenges for estimating essential quantities and doing statistical inference related to tipping systems.
Plenary 2	**Klaus Lehnertz (Bonn)**	*Tipping elements in the human epileptic brain*	The human brain is an open, dissipative, and adaptive nonstationary dynamical system composed of a large number of interacting subsystems. Its complicated spatial-temporal dynamics is still poorly understood. Epilepsy is a malfunction of the brain that affects about 50 million people worldwide. Epileptic seizures are the cardinal symptom of the disease and often appear as a transformation of otherwise normal brain dynamics. The exact mechanisms underlying seizure generation are still as uncertain as are mechanisms underlying seizure spreading and termination. Identifying early warning signals of seizures from brain dynamics could drastically improve therapeutic possibilities and thus, the quality of life of people with epilepsy. Methods from nonlinear dynamics, statistical physics, synchronization and network theory are capable of identifying seizure precursors from recordings of brain dynamics in a large number of people with epilepsy and with high sensitivity and specificity. I will provide a brief overview of the current status of the field, will highlight shortcomings of recent approaches as well as unsolved issues, and will discuss possible research directions that may help to find better solutions.
Plenary 3	**Peter Cox (Exeter)**	*Tipping Points, Overshoots and Early Warning*	This is being delivered as an AdvanTip webinar: https://sites.exeter.ac.uk/tippingpointseminars/seminars/

Show and Tell presentations (10 min presentation + 10 minute discussion) (Extra offerings possible on the day!)	**Valeria Mascolo (Reading, Promote)**	I'm currently working in simulating a Subpolar Gyre weakening using a rare events algorithm coupled with UKESM. I have some preliminary results on how to define this weakening using different definitions.
	Bryony Hobden (Exeter)	I'd like to present some recent work going beyond AR(1), using VAR to characterise cases cases of generic tipping with more than one critical mode.
	Valerie Livina (NPL)	I can present one or two techniques of tipping point analysis with case studies.
	Chris Huntingford (CEH, AdvanTip)	A set of hypotheses associated with developing Early Warning Systems for climate tipping point prediction.
	Ruth Chapman (LSE, RobustAssess)	I am working with Larissa van der Laan on a paper looking at EWS from CSD in an ice sheet model timeseries, hoping to compare 2 different algorithms, and test the significance of the signal in a very non-idealised timeseries (does not fulfil CSD assumptions).
	Iacopo Longo (Exeter)	I show that nonautonomous saddle-node bifurcations provide a universal mechanism underlying tipping points in a broad class of scalar nonautonomous differential equations.
	Larissa van der Laan (Copenhagen, G-PREWS)	Initial results from EWS analysis on OGGM runs of Greenland glaciers
	Sneha Kachhara (Exeter, AdvanTip)	Early warnings and R-tipping thresholds
	Mark Williamson (Exeter, AdvanTip)	Something along the lines of EWS of mixed layer depth reduction
	Richard Chandler (UCL, VERIFY)	We do have a blueprint for the planned approach combining model simulations with statistical postprocessing for decision-relevant uncertainty quantification.

Training session: Statistics of Early Warnings

Lecture 1	**Peter Ashwin/Chris Boulton (Exeter)**	*Introduction to tipping points and early warnings*	We outline what a bifurcation is for a nonlinear system, how this links to tipping points and the fundamental ideas of how an early warning signal (EWS) can be obtained for a noise nonlinear system.
Lecture 2	**Susanne Ditlevsen (Copenhagen)**	*Inference for nonlinear stochastic differential equations*	Models for tipping points are highly nonlinear and often stochastic. This challenges statistical methods for parameter estimation. In this lecture, I will discuss how to do parameter estimation in nonlinear stochastic models relevant for modeling tipping points. In particular, I will discuss how to do pseudo-likelihood estimation using splitting techniques for such models, where the likelihood function is not available.
Lecture 3	**Klaus Lehnertz (Bonn)**	*Time-series-analysis-based detection of critical transitions: how to (and how not to)*	In this lecture, we will discuss ways to detect critical transitions in complex systems based on analyses of observations of their non-autonomous dynamics. Topics include segmentation techniques for investigating non-stationary dynamics, univariate and multivariate time-series-analysis techniques as well as surrogate-based concepts to evaluate reliability of detections. Special attention is paid to sources of errors and potential remedies.
Lecture 4	**Victor Elvira/Victoria Volodina (Edinburgh/Exeter)**	*Uncertainty Quantification for Mathematical and Computational Models*	Mathematical and computational models provide abstract representations of physical systems, enabling advanced analysis, simulation, optimisation, and prediction. With increasing computational power and growing data availability, such models are now widely used as decision-support tools across many application areas. A crucial aspect of this process is uncertainty quantification (UQ), which underpins model credibility and is essential for using model outputs to inform high-stakes decisions. Despite its importance, UQ remains one of the least well-understood components of computational modelling. In this talk, we will present a general classification of different sources of uncertainty and discuss approaches for linking computational models to reality using observational data, with examples drawn from climate science.
Lecture 5	**Paul Ritchie (Exeter)**	*Tipping points in strongly forced systems: overshoots and rate-induced tipping*	Tipping points are generally believed to be associated with a system bifurcation at some critical level of external conditions. When slowly changing external conditions across a critical level, the system undergoes an abrupt transition to an alternative state. In this lecture we will discuss phenomena that can arise when the external conditions change rapidly relative to the system timescale. This includes the possibility to overshoot a tipping point and not cause tipping, if the external conditions can be reversed quickly. On the other hand, rapid changes can lead to rate-induced tipping where an instability may occur without crossing any critical levels in the external conditions.
Lecture 6	**Francesco Ragone (Leicester)**	*Rare Events*	Extreme events like heat waves, floods or wind storms, as well as abrupt transitions associated with tipping elements of the climate system, can have severe impacts on human societies and ecosystems. Studying these events on a robust statistical basis is challenging, as only few events (if any) are available in observational data, and running complex numerical models for long enough in order to sample a sufficient number of them is usually computationally prohibitive. A possible approach to overcome these issues is given by rare event algorithms, computational techniques designed to oversample model trajectories leading to target rare events of interest, allowing to compute their probability with reasonable uncertainties and to identify their dynamical drivers. We will discuss the general challenges we face when dealing with rare extreme events and abrupt transitions in the climate system and how rare event sampling techniques can help overcome them. We will then discuss applications of these techniques to heat waves, extremes of Arctic sea ice reduction, and noise induced transitions associated to the weakening and collapse of the Atlantic Meridional Overturning Circulation. Finally we will discuss the potential of these techniques for new applications, in conjunction with classic statistical approaches like Extreme Value Theory and new developments in Machine Learning.
Lecture 7	**Muhammed Fadera (Exeter)**	*Hands-on introduction to Deep Learning for Early Warnings of Tipping points*	The aim of this session is to provide a hands of introduction to the deep learning and its application to early warnings for climate and complex systems. We will start with a general problem deep learning models are trying to solve and why they are suitable for EW on complex systems. We will then do a practical session on training a deep learning classifier in PyTorch to learn the probability a given time-series will tip and compare it to critical slowing down based methods at different lead times before tipping.

Practical 1	**Victor Elvira/Victoria Volodina (Edinburgh/Exeter)**	*Uncertainty Quantification*	
Practical 2	**Paul Ritchie (Exeter)**	*Calculating early warning signals in practice*	The aim of this practical is for you to get some hands-on experience of calculating early warning signals for some sample time series displaying different features. Each group will give a short presentation (~ 5 minutes) on their progress and challenges. Hopefully by the end of the project you will have a better understanding of using lag-1 autocorrelation and variance to detect approaching tipping points.
Practical 3	**Muhammed Fadera (Exeter)**	*Hands-on introduction to Deep Learning for Early Warnings of Tipping points*	The aim of this session is to provide a hands of introduction to the deep learning and its application to early warnings for climate and complex systems. We will start with a general problem deep learning models are trying to solve and why they are suitable for EW on complex systems. We will then do a practical session on training a deep learning classifier in PyTorch to learn the probability a given time-series will tip and compare it to critical slowing down based methods at different lead times before tipping.