

**CRUCIAL: Climate Risk and Uncertainty
Collective Intelligence Aggregation
Laboratory**

ANNUAL REPORT 2025



Foundation
for science

Introduction

CRUCIAL is an initiative based at Lancaster University's Management School that uses prediction markets, with expert participants, to predict climate-related risks. The prediction markets that it hosts on its Agora platform are not "pay-to-play". Instead, teams of experts from academia and the private sector are invited to take part and allocated on-platform credits with which to trade. These credits are backed by real cash, currently provided by the SCOR Foundation. When markets have settled participants can withdraw accumulated credits as cash or use the credits to trade in other markets. The Agora platform has been used to run markets for seasonal UK climate, Atlantic hurricane activity, crop yields and El Niño-Southern Oscillation (ENSO). Since obtaining funding from the SCOR Foundation CRUCIAL has run markets for Atlantic hurricane activity and the phase of ENSO.

Since receiving SCOR Foundation funding CRUCIAL has established a Scientific Advisory Committee. The Chair of this committee is Prof. Michael Meredith who is a Joint Director of the UK National Climate Science Partnership, facilitating links between CRUCIAL and UKNCSP which is an umbrella organisation for climate research centres in the UK funded by NERC. CRUCIAL has also formed a User Steering Group, consisting of organisations with an interest in using the collective forecasts generated by CRUCIAL's prediction markets and potentially funding future markets. The organisations are Aon, WTW, Howden and JBA Trust and a representative from the Bank of England has observer status.

CRUCIAL currently has 10 participating teams, mainly from British universities. It is hoped to expand this roster of teams over the next year including more teams from outside the UK and outside of academia. CRUCIAL has hosted a webinar event for market participants, and potential market participants. An Agora API has now been made available which allows participants to trade programmatically rather than via the user interface. This will be very useful when markets with two-dimensional outcome spaces and a much larger number of outcomes are introduced this year.

In the next phase (Phase II) CRUCIAL plans to run joint markets with two-dimensional outcome spaces for ENSO and the Indian Ocean Dipole (the analogue of ENSO in the Indian Ocean) as well as a joint market for Atlantic hurricane and Pacific typhoon numbers and a market for the All India Summer Monsoon Rainfall (AIMSR) anomaly.

IMPLIED FORECAST BY THE CRUCIAL ATLANTIC HURRICANE MARKET

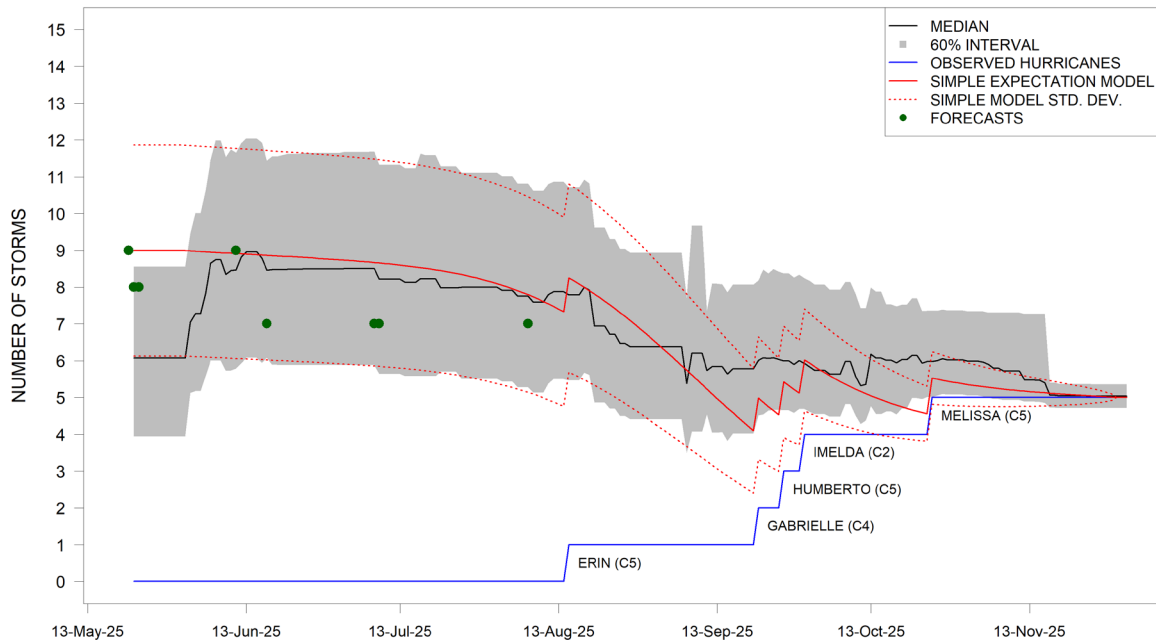


FIGURE 1: The evolution of the probability distribution implied by prices in CRUCIAL’s prediction market for the number of Atlantic hurricanes that would occur during the 2025 hurricane season.

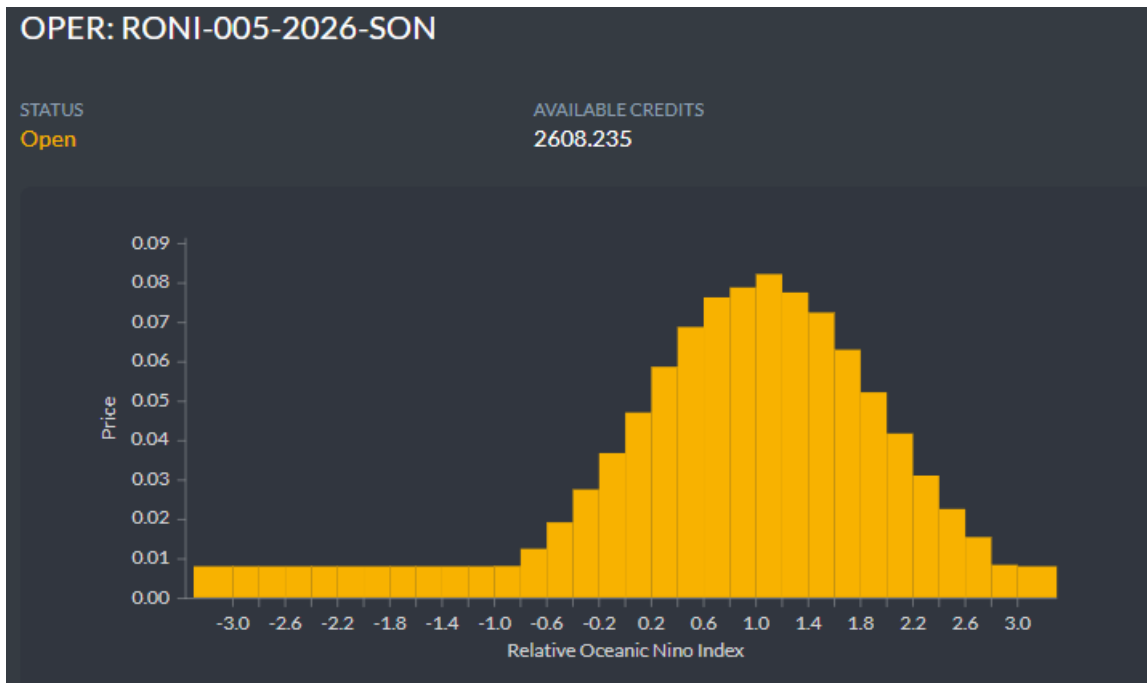


FIGURE 2: The market prices in CRUCIAL’s market for the average value of the Relative Oceanic Niño Index for the months of September, October and November 2026. These prices are a snapshot from April 30, 2026.

Criteria for Success and Deliverables (Phase I)

The table below lists the original criteria for success and deliverables for Phase I (the first year) of the CRUCIAL project as described in the original proposal to the SCOR Foundation. The outcomes and current status of these criteria is also described.

Criteria	Criteria for success and deliverables	Outcomes and current status
1	Recruitment of several dozen participating organisations with diverse and credible expertise in the prediction of physical climate-related risks. The organisations could include academic institutions, private sector companies, and not-for-profit bodies, such as think tanks.	<p>Only 10 teams have been recruited so far, with interest from several more. 45 individual team members have access to the Agora platform.</p> <p>Teams: Atmospheric G2, Colorado Boulder and Univ. of Hawaii Mānoa, Cardiff Univ., Imperial College, Newcastle Univ., Oxford Univ., Univ. of Bristol; Univ. of Exeter, Univ. of Glasgow, Univ. of Reading</p>
2	Successfully running orientation markets for short-term climate risks (with horizons of up to one year) that demonstrate participants can engage with the market platform.	CRUCIAL has run markets to predict the number of hurricanes in the 2025 hurricane season and markets to predict the phase of El Niño-Southern Oscillation (ENSO). Four ENSO markets are still active, forecasting the ENSO index out to February 2027.
3	Metrics that indicate the orientation markets function effectively to aggregate and accurately reflect the views of the participants. These will include measures of how market prices respond to new information, the speed with which price anomalies are corrected, smoothness of probability distributions for continuous quantities. Convergence of twin markets for identical predictions, but with different initial prices, can be used to test arbitrage efficiency. Qualitative feedback on the functioning of the markets will also be obtained through participant debriefings.	<p>Prices in the market to predict 2025 hurricane activity responded to observed hurricane activity (see FIGURE 1). The behaviour of this market for the 2024 season is described in a paper published in the Royal Meteorological Society’s <i>Weather</i> journal (Roulston et al. 2025).</p> <p>The ENSO markets are currently predicting a reasonable chance of an El Niño event this year, in line with other sources of ENSO forecasts (see FIGURE 2). The behaviour of these markets will be properly evaluated later this year when the winter’s ENSO state is known.</p>

		Convergence experiments are now planned using the ENSO markets and joint ENSO-IOD (Indian Ocean Dipole) markets with overlapping time horizons. This deliberately creates arbitrage opportunities which will allow us to study how well the ENSO market and ENSO component of the ENSO-IOD markets converge.
4	Metrics that show (as far as the limited sample size allows) that the forecasts generated by the orientation markets, when verified with observations, are consistent with good probabilistic calibration.	Roulston and Kaivanto (2024).
5	Establishment of a <u>Scientific Advisory Committee</u> . This committee will provide advice on the topic of markets and the choice of data used to settle them. They will also serve as arbitrators should any ambiguity or dispute arise concerning the settlement of a market.	<p>A Scientific Advisory Committee has been established consisting of:</p> <p>Michael Meredith, British Antarctic Survey, UK National Climate Science Partnership (Chair)</p> <p>Peter Atkinson, Lancaster Environment Centre</p> <p>Shi-Ling Hsu, Florida State University</p> <p>David Stainforth, LSE and Grantham Institute</p> <p>Philippe Trainar, SCOR Foundation for Science</p> <p>This group has convened online and has also been involved in the approval of new markets via email discussions.</p>
6	Establishment of a <u>Participants' Committee</u> consisting of representatives from each organisation taking part in the markets. This committee will provide advice on the structure and governance of markets.	A formal participants' committee has not been formed yet although most of the participating teams have taken part in an online webinar event to orient them and to discuss new markets.
7	Demonstration of interest from potential users of the forecasts produced by the prediction market mechanism. This should include a willingness to contribute to the funding pool.	A User Steering Group has been formed consisting of representatives from Aon, Willis Re, Howden, SCOR and JBA Trust. Members of this group are expected to consider funding future markets. This group has met online three times and also provided feedback on proposed markets by email.

CRUCIAL Markets

The table below summarizes the markets that have been hosted on CRUCIAL's Agora platform during 2025.

MARKET	DESCRIPTION	STATUS
OPER: CYCLONES-ATLANTIC-HURRICANES-2025	Number of Atlantic hurricanes in 2025	SETTLED
OPER: RONI-001-2025-SON	Average value of the Relative Oceanic Niño Index for Sept, Oct, Nov 2025.	SETTLED
OPER: RONI-002-2026-DJF	Average value of the Relative Oceanic Niño Index for Dec 2025, Jan, Feb 2026	SETTLED
OPER: RONI-003-2026-MAM	Average value of the Relative Oceanic Niño Index for Mar, Apr, May 2026	OPEN
OPER: RONI-004-2026-JJA	Average value of the Relative Oceanic Niño Index for Jun, Jul, Aug 2026	OPEN
OPER: RONI-005-2026-SON	Average value of the Relative Oceanic Niño Index for Sept, Oct, Nov 2026	OPEN
OPER: RONI-006-2027-DJF	Average value of the Relative Oceanic Niño Index for Dec 2026, Jan, Feb 2027	OPEN

Of the £35,000 in Phase I funding earmarked to support markets £23,491 is being used to back 23,491 credits on the Agora platform while £9,509 is available for new markets and £2,000 has been withdrawn by participating teams as cash after settlement of markets. Of the 23,491 outstanding credits 13,505 are held by participating teams, 2,608 are held by CRUCIAL's account used to set initial prices and the remaining 7,377 are held by CRUCIAL's automated market makers.

Peer-reviewed publications by CRUCIAL

[Roulston, Mark, and Kim Kaivanto. "Can expert prediction markets forecast climate-related risks?." *Bulletin of the American Meteorological Society* 105.10 \(2024\): E1898-E1914.](#)¹

[Roulston, Mark, Kim Kaivanto, and Ralf Toumi. "Tracking evolving views of the 2024 Atlantic hurricane season with an expert prediction market." *Weather* 80.8 \(2025\): 277-280.](#)

¹ This paper was published in October 2024, but we are including here as this was after the original proposal was submitted.

Conference and workshop presentations by CRUCIAL

July 3, 2025: Roulston, Mark and Kim Kaivanto. [CRUCIAL: Prediction markets for climate risk forecasting](#), *Royal Meteorological Society Conference 2025*

September 4, 2025: Roulston, Mark and Kim Kaivanto. Using Prediction Markets for Climate-Related Risks, *Climate, models and finance workshop*, University College London.

December 18, 2025: [SCOR Foundation Workshop: CRUCIAL](#), London

Appearances of CRUCIAL in the media

January 28, 2025: CRUCIAL mentioned in WTW's Natural Catastrophe Review.

April 10, 2026: CRUCIAL featured prominently in the Bloomberg article, [Weather Prediction Markets Are Booming. Can They Improve Forecasts?](#) As an exemplar of science-oriented prediction markets.

Other activities

March 12, 2025: CRUCIAL Co-I Mark Roulston appeared on the panel for the SCOR Live Event *Climate Blind: Uncovering the blind spots in the climate conversation*.