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Weather radars' role in biodiversity monitoring

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Workers clear debris in the Chamoli district of Uttarakhand, India, after a glaciated ridge failed on Ronti mountain on 7 February, causing massive flooding.

Edited by Jennifer Sills

Seismological rockslide warnings in the Himalaya

On 7 February, a glaciated ridge of Ronti mountain in the western Himalaya failed at 5600 m above sea level, causing a rockslide that induced a debris flow and flooding in the tributaries of the river Ganga (1). The events destroyed two hydroelectric projects and claimed more than 100 lives. Himalayan countries urgently need a robust early warning mechanism for rockslides and triggered flow cascades such as debris flow and flash floods. These flows move at up to tens of meters per second. In contrast, the elastic waves they generate have speeds of a few kilometers per second [(2), p. 59], arriving quickly at different seismic stations and potentially providing advance notice of disasters. A dense seismological network could be the key to a successful early warning system.

Satellites are conventionally used to detect rockslides and cascading events, but the time gaps between satellite data acquisitions limit their utility for real-time monitoring [e.g., (3)]. Seismic stations can record several data samples per second [(2), p. 385], but the use of seismic data for this purpose strongly depends on the availability and proximity of a dense seismic

network. The network would need several dozen stations within about 100 km of the area prone to hazard (4). The arrival time of various phases of a seismic wave at different stations in such a network could provide a close to real-time alert of a rockslide and could pinpoint when a rockslide transitions to a debris flow and where flood risks might increase (5). If the stations were connected by satellite to a monitoring center, seismic data could support automated detection, location, and early warning of hazardous flash floods.

In the Indian state of Uttarakhand, the Council of Scientific & Industrial Research–National Geophysical Research Institute, Hyderabad, operates a dense network of more than 80 seismic stations (6). The individual phases of the 7 February event are likely identifiable in the records at these stations. Efforts are currently under way to develop a rockslide and flood early warning system for the Himalayan region by using dense networks for seismic monitoring (5, 6), coupled with interpretation of satellite data, numerical modeling, and geomorphic analysis. Such a system could potentially provide crucial warning information shortly after initiation of an event, enabling evacuation at downstream locations. With climate change playing a major role in accelerating ice loss in the mountain glaciers (7), likely leading to increased frequency of flash floods, real-time seismic monitoring may

become the key to minimizing damage and casualties caused by these events.

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Reimagining aquaculture in the Global South

Aquaculture has existed for millennia, reaching industrial scales in recent decades, and will play an increasingly

important role in feeding the world (1–6). As this industry grows, we must ensure that it is ecologically and socially sustainable. However, the current production process for the food given to farmed fish still threatens coastal ecosystems and the livelihoods of local fishers, especially in the Global South (2–7). Before aquaculture is scaled up further, its global environmental and socioeconomic footprint should be carefully reimagined.

Because small fishes are at the bottom of the trophic pyramid, overharvesting can lead to the collapse of local ecosystems (8, 9). In many places, these small fish also serve as vital, local food sources. Small fish caught in the Global South are increasingly used for fish meal production for livestock and aquaculture rather than for direct human consumption. These practices have disrupted food security in places such as Bangladesh, Gambia, and Ghana (7, 10), as affordable protein has shifted from poorer coastal communities to richer markets. Widespread illegal, unreported, and unregulated fisheries support unsustainable, large-scale fish meal production for regional use or for growing global markets.

To achieve the goals of the United Nations Decade of Ocean Science for Sustainable Development, we must develop strategies to make aquaculture truly sustainable in the Global South and beyond. This will require concerted support for technological advances such as new water recirculation and offshore innovations to efficiently rear species ranging from algae to large predator fish. To meet UN goals within a decade, we also need faster development of environmentally and socially responsible ingredients for fish feed (2–6) and effective policies to support sustainable development production schemes and human nutrition initiatives in affected coastal communities. Fisheries and aquaculture policies should include environmental governance strategies focused on seawater quality and biodiversity protection (such as farm level sustainability certification), comprehensive sustainability assessments, socioeconomic dimensions, capture fisheries, and improved feed ingredient production (1–6, 11, 12).

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Weather radars' role in biodiversity monitoring

Biodiversity is changing at an unprecedented rate, and long-term monitoring is key to quantifying these changes and identifying their drivers (1, 2). Weather radars are an essential tool for meeting these goals. However, recent policy changes make vital data unavailable. Data policy should be adjusted to take into account the broad role that weather radars play beyond meteorology.

In addition to providing essential meteorological data for weather forecasts, flood risk planning, storm warnings, and atmospheric and climatological research (3, 4), weather radars detect trillions of insects, bats, and birds in the air (5, 6). By collecting such data, they could provide an unrecognized service to society: long-term standardized monitoring of aerial biomass flows (7). In the United States, weather radar data have already been used at a continental scale for these purposes (6, 8). However, similar efforts in Europe (9, 10) are now fundamentally threatened.

The Operational Programme for the Exchange of Weather Radar Information (OPERA) coordinates the exchange of radar data among European national meteorological services (11). It serves as a central hub for accessing weather radar data in Europe, allowing those in search of data to make one request instead of contacting each meteorological service separately. However, because of budget cuts and resulting prioritization of meteorological products, OPERA now requests that national meteorological services submit cleaned rather than uncleaned

polar volume radar data (12). Uncleaned radar data include both meteorological and biological signals, whereas cleaned data exclude biological signals.

OPERA is currently establishing new centers for European weather radar data that could serve as ideal access points for diverse users and stakeholders. Access to uncleaned polar volume data at these data centers would boost their utility for aerial biodiversity monitoring and other multidisciplinary applications. To make this possible, OPERA should revise its data exchange policy to require that all countries submit uncleaned radar data, and Europe must build adequate data infrastructure to transfer and store the full data. National and international funding schemes and policy-makers such as the EU Commission should recognize and stimulate diverse applications of weather radar data, and OPERA should establish an open access data archive, which would facilitate long-term multidisciplinary research and biodiversity monitoring. If all regional associations of the World Meteorological Organization adopted similar policies, weather radars could be used for aerial biodiversity monitoring worldwide.

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TECHNICAL COMMENT ABSTRACTS

Comment on "Circadian rhythms in the absence of the clock gene *Bmal1*"

Elan Ness-Cohn, Ravi Allada, Rosemary Braun Ray *et al.* (Reports, 14 February 2020, p. 800) report apparent transcriptional circadian rhythms in mouse tissues lacking the core clock component BMAL1. To better understand these surprising results, we reanalyzed the associated data. We were unable to reproduce the original findings, nor could we identify reliably cycling genes. We conclude that there is insufficient evidence to support circadian transcriptional rhythms in the absence of *Bmal1*.

Full text: [dx.doi.org/10.1126/science.abe9230](https://doi.org/10.1126/science.abe9230)

Response to Comment on "Circadian rhythms in the absence of the clock gene *Bmal1*"

Sandipan Ray, Utham K. Valekunja, Alessandra Stangherlin, Steven A. Howell, Ambrosius P. Snijders, Gopinath Damodaran, Akhilesh B. Reddy Ness-Cohn *et al.* claim that our observations of transcriptional circadian rhythms in the absence of the core clock gene *Bmal1* in mouse skin fibroblast cells are supported by inadequate evidence. They claim that they were unable to reproduce some of the original findings with their reanalysis. We disagree with their analyses and outlook.

Full text: [dx.doi.org/10.1126/science.abf1930](https://doi.org/10.1126/science.abf1930)

Comment on "Circadian rhythms in the absence of the clock gene *Bmal1*"

Katharine C. Abruzzi, Cédric Gobet, Felix Naef, Michael Rosbash

Ray *et al.* (Reports, 14 February 2020, p. 800) recently claimed temperature-compensated, free-running mRNA oscillations in *Bmal1*^{-/-} liver slices and skin fibroblasts. We reanalyzed these data and found far fewer reproducible mRNA oscillations in this genotype. We also note errors and potentially inappropriate analyses.

Full text: [dx.doi.org/10.1126/science.abf0922](https://doi.org/10.1126/science.abf0922)

Response to Comment on "Circadian rhythms in the absence of the clock gene *Bmal1*"

Sandipan Ray, Utham K. Valekunja, Alessandra Stangherlin, Steven A. Howell, Ambrosius P. Snijders, Gopinath Damodaran, Akhilesh B. Reddy

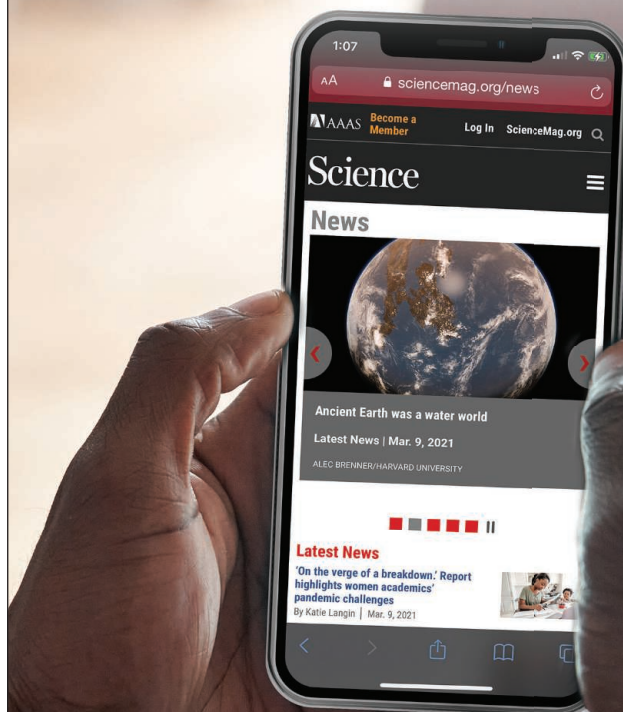
Abruzzi *et al.* argue that transcriptome oscillations found in our study in the absence of *Bmal1* are of low amplitude, statistical significance, and consistency. However, their conclusions rely solely on a different statistical algorithm from what we used. We provide statistical measures and additional analyses showing that our original analyses and observations are accurate. Further, we highlight independent lines of evidence indicating *Bmal1*-independent 24-hour molecular oscillations.

Full text: [dx.doi.org/10.1126/science.abf1941](https://doi.org/10.1126/science.abf1941)

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Weather radars' role in biodiversity monitoring

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