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Biodiversity Data Cubes for Cross-Cutting Science and Policy

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Biodiversity and the Earth climate system are coupled through multiple biotic and abiotic feedbacks. Although there are clear links between the two systems, there is a lack of integrative research to evaluate them. One reason is that both systems operate on different scales, impacting integration efforts. In addition, the state of the art for each has evolved at different rates over recent decades. The growing number of satellite missions has made it possible to measure Earth system variables on a global scale and with great frequency. This enormous amount of data, captured even on an hourly basis, in tandem with a network of gauging stations, and open-access policies have boosted Earth system modeling and projections, and thus increased our understanding of one of the Earth's components (i.e. climate). Biodiversity data has also increased, albeit at a slower rate. Citizen science, along with the application of different technologies such as camera traps, phenocams, bioacoustics and, more recently, eDNA, are enabling scientists to obtain data more efficiently. However, there are still large gaps in geographic and taxonomic coverage.This is partially related to abrupt biodiversity gradients and insufficient explanatory variables that hinder modeling biodiversity as smooth gradients in climate systems. Another reason is the difference between data formats and approaches among fields; for example,

biodiversity data are often recorded as spatial points, in contrast to gridded satellite data. All these pose numerous challenges for a more coordinated and cross-cutting research. As a starting point, it is our task to reach other scientific communities and offer harmonized solutions for data integration and analysis. Specifically, in the Biodiversity Building Blocks for Policy project (B-Cubed) we are developing informatics workflows to facilitate the analysis of species occurrence information in a data cube format. We are using, though are not limited to, the world's largest biodiversity database, the Global Biodiversity Information Facility (GBIF), to provide species occurrence information in a more interoperable format. Furthermore, we are also leveraging the concept of data cubes to standardise access to biodiversity data using the Essential Biodiversity Variables framework. Currently, the implementation of species occurrence cubes is aimed at analyzing invasive species, improving species distribution modeling techniques, and developing effective indicators for informing policy. We strongly believe that data cubes will facilitate both data sharing and processing, and the co-development of tools and approaches between biodiversity and Earth sciences, which will undoubtedly benefit cross-cutting research. Synergies between biodiversity and Earth system sciences are urgently needed for better informing decision makers about feedbacks in both systems that can respond to adopted and upcoming policies.

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