

"Analyze nature, plan for the future"

EarthBloom.

Nasa Space App Challenge 2025 Guadalajara.

4-5 October 2025.

**Introduction.**

EarthBloom is a scientific platform designed as a tool for researchers dedicated to the study of plant phenology and its responses to climate change. Its main objective is to offer predictive and visual mapping of wild blooms using satellite data, meteorological data and verified observations, in order to optimize the planning and execution of fieldwork in ecological research projects.

Through spatio-temporal machine learning models, EarthBloom generates dynamic heat maps that indicate the probability of flowering by species and coordinate. This allows researchers to focus their resources on the points of greatest ecological interest, improve the efficiency of data collection and increase the accuracy of their analyses of the effects of climate on plant cycles.

The purpose of this tool is not commercial, but scientific and to support research: it seeks to reduce sampling logistics costs, expand the spatial and temporal coverage of observations, and facilitate the study of large-scale phenological patterns. With this, EarthBloom contributes to strengthening the analytical capacity of researchers on issues of ecology, climate change, conservation and environmental management.

**Problem**

Monitoring wild blooms faces multiple limitations for researchers:

**High logistical and sampling costs:** Collecting phenological data through field observations requires technical personnel, equipment, cameras, and constant travel. These elements represent a high cost, especially in studies that demand wide spatial coverage or long-term monitoring. As a result, many studies have incomplete time series or limited geographic representation.

**Temporal and spatial uncertainty in phenology:** Blooms vary significantly between years and regions, depending on microclimatic conditions and environmental changes. This variability makes it difficult to accurately plan sampling campaigns and compare results between different periods or areas, reducing the reliability of scientific analyses.

**Effects of climate change on phenological patterns:** Numerous studies have documented that the increase in temperature and the alteration of rainfall modify the dates and durations of flowering. These changes have a direct impact on the availability of resources for pollinators and on the dynamics of ecosystems, but the lack of continuous and spatially extensive data prevents quantifying and anticipating these effects in a robust way.

These three issues are interrelated: the lack of consistent and comprehensive data increases scientific uncertainty, and climate change accelerates the need for tools that integrate diverse and accurate information for research decision-making.

**Solution**

EarthBloom proposes a tool based on machine learning models and geospatial analysis that integrates sources of satellite, meteorological and field observations information validated by researchers. Its objective is to predict the probability of flowering by species and coordinate at defined time intervals (e.g. weekly or monthly).

The main scientific functions are:

**Predictive modelling:** Training of spatio-temporal models with multi-source data (satellites, weather stations, historical observations and phenological records).

**Geographic Visualization:** Generation of dynamic heat maps that show the spatial distribution of blooms, helping researchers decide where and when to conduct fieldwork.

**Sampling optimization:** Reduction of unnecessary field visits by identifying priority areas, which improves data efficiency and representativeness.

**Scientific data governance:** The system prioritizes the transparency and traceability of sources, ensuring the quality and reproducibility of information.

With this solution, EarthBloom becomes an analytical tool that supports research work in ecology and environmental sciences, facilitating the observation, comparison and modeling of phenological phenomena at different scales.

**Technologies to use**

For the development and operation of EarthBloom, various technologies and sources of scientific data obtained by the researchers themselves are integrated, as well as from NASA databases

Geojson, chatgpt, leaftlet, open streetmaps, html, css, python, javascript.

**Impact**

EarthBloom offers a direct impact on scientific research:

**Support for ecological monitoring:** It allows expanding the spatial and temporal coverage of observations, integrating information from different sources in a single visual environment.

**Reduction of research costs:** Predictive models direct field efforts to the most relevant points, making planning and resource allocation more efficient.

**Strengthening scientific evidence:** Generates reproducible, verifiable and transparent data, useful for studies on climate change, biodiversity and conservation.

**Evidence-based decision tool:** Facilitates early detection of phenological changes and supports the formulation of hypotheses about the relationship between climate and phenology.

With this, EarthBloom is positioned as a reference platform for the observation, modelling and analysis of wild blooms, contributing to the understanding of the impacts of climate change on ecosystems.

**Scalability**

EarthBloom's technical architecture is designed to grow as more data and study regions are integrated.

**Technical scalability:** The model can be extended to include new species, regions, and data sources without compromising performance. It relies on Cloud-optimized GeoParquet geospatial data structures (GeoTIFF) and cloud processing to handle large volumes of information.

**Scientific scalability:** The platform can be used by different research teams in ecological, agricultural or climate fields. Its modularity allows the models to be adapted to various biogeographical regions and ecosystems, while maintaining methodological coherence.

The long-term goal is to turn EarthBloom into a reliable scientific infrastructure for predictive phenological analysis, available to researchers from different disciplines who need to visualize or model blooms as an environmental study variable.

Team

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**Call to action**

EarthBloom invites the scientific community to use the platform as a tool for analysis and research in studies related to plant phenology, climate change and population ecology.

The purpose is not institutional collaboration or commercialization, but to provide a reliable, reproducible and scientifically sound information system for the planning and evaluation of field projects.

Interested researchers will be able to access the platform to visualize flowering patterns, analyze trends, validate hypotheses, and generate knowledge about environmental effects on flowering cycles.

**References (APA)**

Balázs, B., Mooney, P., Nováková, E., Bastin, L., & Arsanjani, J. J. (2021). Data quality in citizen science. En V. Hecker, S. Haklay, A. Bowser, M. Makuch, J. Vogel & A. Bonn (Eds.), *The Science of Citizen Science* (pp. 139–157). Springer. https://doi.org/10.1007/978-3-030-58278-4\_8

Baker, E., Drury, J. P., Judge, J., Roy, D. B., Smith, G. C., & Stephens, P. A. (2021). The verification of ecological citizen science data: current approaches and future possibilities. *Citizen Science: Theory and Practice, 6*(1), Article 12. https://doi.org/10.5334/cstp.351

Beranek, C. T., Southwell, D., Jessop, T. S., Gillespie, G. R., et al. (2024). Comparing the cost-effectiveness of drones, camera trapping and passive acoustic recorders in detecting changes in koala occupancy. *Ecology and Evolution*. https://doi.org/10.1002/ece3.11659

Descamps, C., Quinet, M., & Jacquemart, A.-L. (2021). Climate change–induced stress reduce quantity and alter composition of nectar and pollen from a bee-pollinated species (Borago officinalis, Boraginaceae). *Frontiers in Plant Science, 12*, 755843. https://doi.org/10.3389/fpls.2021.755843

Enciclovida / CONABIO. (n.d.). *Laelia speciosa* — May flower. Encyclovida. Retrieved from https://enciclovida.mx/especies/158711-laelia-speciosa

Enciclovida / CONABIO. (n.d.). *Bougainvillea* (Bougainvillea). Encyclovida. Retrieved from https://enciclovida.mx/especies/139472-bougainvillea

Flores-Tolentino, M., García-Valdés, R., Saénz-Romero, C., Ávila-Díaz, I., Paz, H., & López-Toledo, L. (2020). Distribution and conservation of species is misestimated if biotic interactions are ignored: the case of the orchid *Laelia speciosa*. *Scientific Reports, 10*, 9542. https://doi.org/10.1038/s41598-020-63638-9

Inoue, Y. (2025, 26 de marzo). Hanami season to have record ¥1.39 trillion economic impact on Japan. *The Japan Times*. Recuperado de [https://www.japantimes.co.jp/news/2025/03/26/japan/cherry-blossoms-economic-impacts/](https://www.japantimes.co.jp/news/2025/03/26/japan/cherry-blossoms-economic-impacts/?utm_source=chatgpt.com)

Kosmala, M., Wiggins, A., Swanson, A., & Simmons, B. (2016). Assessing data quality in citizen science. *Frontiers in Ecology and the Environment, 14*(10), 551–560. https://doi.org/10.1002/fee.1436

Moore, H. A. (2023). Comparing the cost and power of monitoring programs to detect occupancy changes: camera traps vs live trapping. *Conservation Science and Practice*. https://doi.org/10.1111/csp2.12881

Oré, D. (2025, 13 de marzo). Early jacaranda bloom sparks debate about climate change in Mexico. *Reuters*. Recuperado de [https://www.reuters.com/business/environment/early-jacaranda-bloom-sparks-debate-about-climate-change-mexico-2024-02-25/](https://www.reuters.com/business/environment/early-jacaranda-bloom-sparks-debate-about-climate-change-mexico-2024-02-25/?utm_source=chatgpt.com)

Parmesan, C., & Yohe, G. (2003). A globally coherent fingerprint of climate change impacts across natural systems. *Nature, 421*, 37–42. https://doi.org/10.1038/nature01286

Piao, S., Liu, Q., Chen, A., Janssens, I. A., Fu, Y., Dai, J., Liu, L., Lian, X., Shen, M., & Zhu, X. (2019). Plant phenology and global climate change: current progresses and challenges. *Global Change Biology, 25*(6), 1922–1940. https://doi.org/10.1111/gcb.14619

Smith, J., et al. (2024). Man versus machine: cost and carbon emission savings of automated classification in long-term wildlife monitoring programs. *Scientific Reports*. https://doi.org/10.1038/s41598-024-65179-x

Walther, G.-R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T. J. C., Fromentin, J.-M., Hoegh-Guldberg, O., & Bairlein, F. (2002). Ecological responses to recent climate change. *Nature, 416*, 389–395. https://doi.org/10.1038/416389a

World Wildlife Fund (WWF). (n.d.). Camera trap Q&A. WWF. Retrieved from <https://www.worldwildlife.org/pages/camera-trap-q-a>