

Funded Postdoctoral Position

Geospatial Foundation Models for Dynamic Earth Observation

Université Bretagne Sud / IRISA, Vannes, France

Expected starting date: October 2026 - December 2026

Keywords: satellite image time series, dynamic embeddings, geospatial foundation models, adaptation

Context

During the last decades, the number and diversity of imaging sensors on board satellites have steadily increased, providing access (often freely) to large volumes of Earth observation data. Modern constellations offer frequent revisits at high spatial resolution. For instance, the Sentinel-2 satellites cover all land surfaces every five days at the equator, with a spatial resolution of up to 10 meters. The resulting data cubes, commonly referred to as satellite image time series (SITS) [Simões et al., 2021], combine spectral, spatial, and temporal information, enabling detailed monitoring of landscape dynamics [Inglada et al., 2017]. The transformation of these data into meaningful information (*e.g.*, deforestation or land use maps) has traditionally relied on supervised learning, with recent advances driven by deep learning methods. In particular, temporal neural networks have demonstrated strong performance in modeling sequential data, leading to significant progress in time series classification across domains, including remote sensing [Miller et al., 2024].

More recently, there has been growing interest in geospatial foundation models trained using self-supervised learning on large volumes of unlabeled Earth observation data. Building on advances in representation learning from computer vision and multimodal learning, these models increasingly incorporate multiple data modalities (optical, radar, and text) as well as temporal information, moving beyond purely spatial and single-image representations. Recent work has also begun to address robustness across spatial resolutions, from medium-resolution to very high resolution imagery and cross-scale settings, although this remains an open challenge. These approaches aim to learn generic, transferable Earth embeddings, as illustrated by models such as Tessera [Feng et al., 2025] or Google AlphaEarth [Brown et al., 2025], which are specifically designed for SITS.

Although the resulting representations have demonstrated strong performance across a range of downstream tasks [Feng et al.,], they are typically trained on large but static pretraining data. Consequently, their effectiveness remains tightly coupled to the pretraining distribution, limiting their robustness to domain shifts across time, geography, and sensor characteristics. This lack of adaptability constrains their use in monitoring and forecasting scenarios, and more generally in settings involving future data or evolving data distributions. The objective of this postdoctoral position is to develop dynamic Earth embeddings that adapt continuously to evolving environmental and geographical data distributions.

Objectives

The main objective of this postdoctoral project is to leverage the usability of Earth embeddings for tasks involving sequences of Earth observation data, including monitoring, forecasting, and other predictive settings over future unseen observations. The work will focus on two complementary directions: (i) developing a framework to leverage Earth embedding for temporal and spatio-temporal downstream applications, and (ii) designing continual adaptation strategies to update representations over time in response to distribution shifts induced by changes in geography, seasonality, and sensor properties. The research will have applications in real-time environmental monitoring, including agriculture, forest and disaster monitoring.

Activities and expected outcomes

The main expected outcome is the implementation of a framework to leverage Earth embeddings and the development of new adaptation strategies for evolving data distribution. The resulting code will be released as open-source software (Python/PyTorch) to ensure reproducibility of the results, with possible integration into dedicated toolboxes for time series analysis or existing libraries for end-users, like R-SITS. The results will be disseminated through peer-reviewed publications in major international conferences and journals in machine learning and computer vision (*e.g.*, ICML, CVPR, ICLR, ECCV, NeurIPS, ICCV), as well as in remote sensing venues (*e.g.*, IEEE TGRS, ISPRS Journal of Photogrammetry and Remote Sensing, Remote Sensing of Environment).

Beyond these activities, the postdoctoral researcher will also contribute to collaborative research efforts within ongoing projects, notably ANR DECOL and the CAPES-COFECUB project, including participation in project meetings, reporting activities, and the preparation of deliverables when relevant. The selected candidate is also expected to take part in and help organize group seminars and reading groups, fostering exchange within the team and with external collaborators. Active participation in the research community through conference attendance and presentations is also expected from the candidate. Finally, the postdoctoral researcher will be involved in academic supervision and mentoring activities, including the supervision of Master's students and potential co-supervision of PhD candidates.

Teaching activities (approximately 30 hours) may be conducted, but are not mandatory.

Candidate profile and skills

We are looking for a candidate

- with a computer science, (geo)data science, or statistics PhD degree (or equivalent),
- with strong data analysis, machine learning, and computer vision knowledge,
- very familiar with deep learning techniques and the latest advances in computer vision, including self-supervised learning,
- with excellent programming skills in Python,
- with good oral and written communication skills in English,
- with interest in Earth observation applications.
- Knowledge of time series analysis and remote sensing techniques will be appreciated.

Supervision, collaboration, and environment

The postdoctoral researcher will work closely with Assoc. Prof. Charlotte Pelletier (UBS-IRISA), who leads the ANR JCJC DECOL project on deep continual learning for satellite image time series, under which this position is funded. The work will be conducted at Université Bretagne Sud, IRISA, in Vannes, France. The postdoctoral researcher will be part of an international team, collaborating with leading researchers in the field of AI for EO. In addition, strong interactions with Brazilian researchers from INPE are planned, including a possible research stay through the CAPES-COFECUB project.

Application

To apply for this position, please send a resume, a motivation letter explaining your understanding and interest in the topic, a submitted or published paper, and the name of two referees to charlotte.pelletier@univ-ubs.fr. **Application deadline:** until the position is filled. Applications will be reviewed on a continuous basis. Please check the following website to know if the position is still open: <https://www-obelix.irisa.fr/job-offers/>.

We encourage applicants to bring their own perspectives to the project. The topic of dynamic Earth embeddings is intended to be flexible and can be further refined based on the candidate's expertise and personal interests. We are open to discussing how these areas can be shaped to align with your specific skills and career goals, ensuring a mutually beneficial research trajectory.

References

- [Brown et al., 2025] Brown, C. F., Kazmierski, M. R., Pasquarella, V. J., Rucklidge, W. J., Samikova, M., Zhang, C., Shelhamer, E., Lahera, E., Wiles, O., Ilyushchenko, S., et al. (2025). Al-phaearth foundations: An embedding field model for accurate and efficient global mapping from sparse label data. *arXiv preprint arXiv:2507.22291*.
- [Feng et al., 2025] Feng, Z., Atzberger, C., Jaffer, S., Knezevic, J., Sormunen, S., Young, R., Lisaius, M. C., Immitzer, M., Jackson, T., Ball, J., et al. (2025). Tessera: Temporal embeddings of surface spectra for earth representation and analysis. *arXiv preprint arXiv:2506.20380*.
- [Feng et al.,] Feng, Z., Atzberger, C., Jaffer, S., Knezevic, J., Sormunun, S., Young, R., Lisaius, M., Immitzer, M., Jackson, T., Ball, J., et al. Applications of the tessera geospatial foundation model to diverse environmental mapping tasks. *Available at SSRN 6142416*.
- [Inglada et al., 2017] Inglada, J., Vincent, A., Arias, M., Tardy, B., Morin, D., and Rodes, I. (2017). Operational high resolution land cover map production at the country scale using satellite image time series. *Remote Sensing*, 9(1):95.
- [Miller et al., 2024] Miller, L., Pelletier, C., and Webb, G. I. (2024). Deep learning for satellite image time-series analysis: A review. *IEEE Geoscience and Remote Sensing Magazine*, 12(3):81–124.
- [Simões et al., 2021] Simões, R., Camara, G., Queiroz, G., Souza, F., Andrade, P. R., Santos, L., and Ferreira, K. (2021). Satellite image time series analysis for big earth observation data. *Remote Sensing*, 13(13):2428.