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Report on the 2025 IEEE GRSS Data Fusion Contest: All-Weather Land Cover and Building Damage Mapping

Over the past two decades, the annual Data Fusion Contest (DFC) has emerged as a platform that invites researchers worldwide to advance data fusion and image analysis methodologies. The contest focuses on the challenges of handling large-scale, multisensor, multimodal, and multitemporal data, fostering innovation in remote sensing research. The past editions have introduced novel and demanding problem settings, thereby creating benchmarks that have shaped progress in the field. The contest has been hosted annually since 2006 by the Image Analysis and Data Fusion Technical Committee (IADF TC) of the IEEE Geoscience and Remote Sensing Society (GRSS) [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21]. This year's contest focus was all-weather land cover and building damage mapping.

THE 2025 DATA FUSION CONTEST

With rapid advances in small synthetic aperture radar (SAR) satellite technology, Earth observation (EO) now provides submeter-resolution all-weather mapping with increasing temporal resolution. While optical data offer intuitive visuals and fine detail, they are limited by weather and lighting conditions. In contrast, SAR can penetrate cloud cover and provide consistent imagery in adverse weather and nighttime, enabling frequent monitoring of critical areas—valuable when disasters occur or environments rapidly change. Effectively exploiting the complementary properties of SAR and optical data to solve complex remote sensing image analysis problems remains a significant technical challenge.

The contest comprises two tracks focusing on land cover types and building damage, respectively, and presents two main technical challenges: effective integration of multimodal data and handling of noisy labels.

- Track 1: All-Weather Land Cover Mapping
- Track 2: All-Weather Building Damage Mapping

Both tracks were co-organized by the IADF TC, the University of Tokyo, RIKEN, and ETH Zurich, with an aim to foster the development of innovative solutions for all-weather land cover and building damage mapping using multimodal SAR and optical EO data at submeter resolution.

Track 1, based on the OpenEarthMap-SAR dataset [22], focuses on developing methods for land cover mapping in all-weather conditions using SAR data. The training data consist of multimodal submeter-resolution optical and SAR images with eight-class land cover labels. These labels are pseudo-labels derived from optical images based on pretrained models. During the evaluation phase, models will rely exclusively on SAR to ensure that they perform well in real-world all-weather scenarios. The objective is to improve the accuracy of land cover mapping under varying environmental conditions, demonstrating the utility of SAR data in monitoring land cover. Performance was evaluated using the mean intersection over union (mIoU) metric.

Track 2, based on the BRIGHT dataset [23], aims to develop methods for assessing building damage using bi-temporal multimodal images. The training data contain optical images from before the disaster and SAR

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images after the disaster, all at submeter resolution, labeled with four classes: background, intact, damaged, and destroyed buildings. Mapping building damage from multimodal image pairs presents unique challenges due to the different characteristics of optical and SAR imagery. During the evaluation phase, models will be applied to predisaster optical and post-disaster SAR image pairs to produce accurate assessments of building damage, showing the extent and severity of building damage, which are essential for effective disaster response and recovery planning. Performance was evaluated using the mIoU metric.

The 2025 DFC emphasized the effective integration of optical and SAR data for land cover mapping and building damage assessment (Figure 1). This task is challenging due to the distinct characteristics of each image type. Notably, while both optical and SAR images were used to train models for land cover mapping (Track 1), the evaluation phase solely relied on SAR images. This approach ensures that the models perform well in real-world, all-weather scenarios. For building damage assessment, contestants used pairs of predisaster optical images and post-disaster SAR images for both training and evaluation. In addition, the evaluation of the algorithms for building damage assessment includes images from unseen disasters to ensure generalization to new events. The contest also focused on developing robust algorithms to handle noisy labels. The training labels for land cover mapping were generated using pretrained models on optical images, resulting in pseudo-labels. These labels are often noisy or imperfect, so the contestants needed to create effective methods that could learn an efficient representation despite the inaccuracies and uncertainties of the labels.

A baseline that shows how to use the DFC25 data to train models, make submissions, etc., is provided next for both tracks.

- Baseline code and other stuff for Track 1: https://github.com/cliffbb/DFC2025-OEM-SAR-Baseline
- Baseline code and other stuff for Track 2: https://github.com/ChenHongruixuan/BRIGHT

OUTCOME OF THE CONTEST

Both tracks saw the overwhelming participation of a large number of teams from all over the world. Track 1 saw 507 teams register for the contest, out of which 207 teams successfully submitted their entries. Track 2 also saw a similar trend: 423 teams registered for the contest, and 188 teams had successful submissions.

The top two teams from each track with a valid submission were awarded as winners of the contest and presented their solutions during the DFC Community Contributed Session (CCS) at the 2025 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) in Brisbane, Australia. All the teams in this year's contest also released their code publicly to ensure reproducibility.

In the following, we list the winning teams of the DFC 2025 in Track 1:

- *First place:* the liuwang20144623 Team: Wang Liu, Zhiyu Wang, Xin Guo, Puhong Duan, Xudong Kang, and Shutao Li from Hunan University, China, "Learning From Noisy Pseudo-Labels for All-Weather Land Cover Mapping" [24]; code: https://github.com/StuLiu/DFC2025Track1
- *Second place:* the ZheWang Team: Zhe Wang, Jiarui Hu, and Yuxuan Guo from Wuhan University, China. "Robust All-Weather Land Cover Mapping via InternImage and Cross-Modal Pseudo Supervision" [25]; code: https://github.com/zxqyiyang/DF2025

In the following, we list the winning teams of the DFC 2025 in Track 2:

- *First place:* the Henryljp Team: Jiepan Li, He Huang, Yu Sheng, Yujun Guo, and Wei He from Wuhan University, China, "Building-Guided Pseudo-Label Learning for Cross-Modal Building Damage Mapping" [26]; code: https://github.com/Henryjiepanli/Building-Guided-Pseudo-Label-Learning-for-Cross-Modal-Building-Damage-Mapping
- *Second place:* the zzzbnu Team: Xiangqiang Zeng and Ying Qu from Beijing Normal University, China, "Building Damage Mapping Through Heterogeneous Feature Consistency and Knowledge Integration" [27]; code: https://github.com/CarryHJR/dfc2025

FIGURE 1. The banner image for the 2025 IEEE GRSS Data Fusion Contest.

At the conclusion of the competition, all winning teams submitted papers outlining their approaches, which were then peer-reviewed by the organizing committee of the DFC. These papers were included in the technical program of IGARSS 2025 and presented during a CCS focused on the DFC at the symposium. Each winning team received an IEEE GRSS Certificate of Recognition during the Award Ceremony held at IGARSS 2025 and a travel grant to support their attendance at the conference, kindly provided by the sponsor Mitsubishi Electric. An extended article discussing the winning solutions of the first- and second-ranked teams of both tracks will be submitted for peer review to the open access *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* (*JSTARS*).

For the past two decades, the annual DFC has attracted participants from various disciplines, including machine learning and remote sensing, to develop innovative solutions for EO image analysis. This diverse participation fosters the development of novel interdisciplinary approaches to addressing technical challenges in the remote sensing and geoscience communities. Additionally, it promotes a collaborative effort to tackle global issues by integrating knowledge from different fields. The winning teams are mostly student-led, and their extraordinary efforts have led to dramatic advances in technology for the new problems addressed in this competition and to the formation of a vibrant community. The final code for all the winning teams was released publicly, along with the baseline models developed by the organizers to ensure reproducibility of the results and encourage wider adoption of the dataset.

For more information about using the DFC 2025 data, see "Additional Details About DFC 2025." In addition, for more information about contacting and joining the IADF TC, see "Contacting and Joining the IADF TC."

Additional Details About DFC 2025

The 2025 DFC Codalab evaluation website[1] with the public leaderboard will remain available to the GRSS community for benchmarking algorithms and publishing research works. The data of DFC 2025 are available at Zenodo.[2] The data are usable free of charge for scientific purposes, but the contest terms and conditions on the contest webpage remain applicable. Please read them carefully at https://www.grss-ieee.org/community/technical-committees/2025-ieee-grss-data-fusion-contest/.

[1]Track 1: https://codalab.lisn.upsaclay.fr/competitions/21121; Track 2: https://codalab.lisn.upsaclay.fr/competitions/21122.
[2]Track 1: https://zenodo.org/records/14622047; Track 2: https://zenodo.org/records/14619797.

Contacting and Joining the IADF TC

You can contact the IADF TC chairs at grss-iadf@ieee.org. If you are interested in joining the IADF TC, please fill in the form on our website at https://www.grss-ieee.org/technical-committees/image-analysis-and-data-fusion. Members receive information regarding research and applications on IADF topics and updates on the annual DFC and on all other activities of the IADF TC. Membership in the IADF TC is free! Also, you can join the LinkedIn IEEE GRSS Data Fusion Discussion Forum (https://www.linkedin.com/groups/3678437/) and the X(Twitter) channel (@GrssIadf).

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SPACE-AGENCIES (*continued from p. 456*)

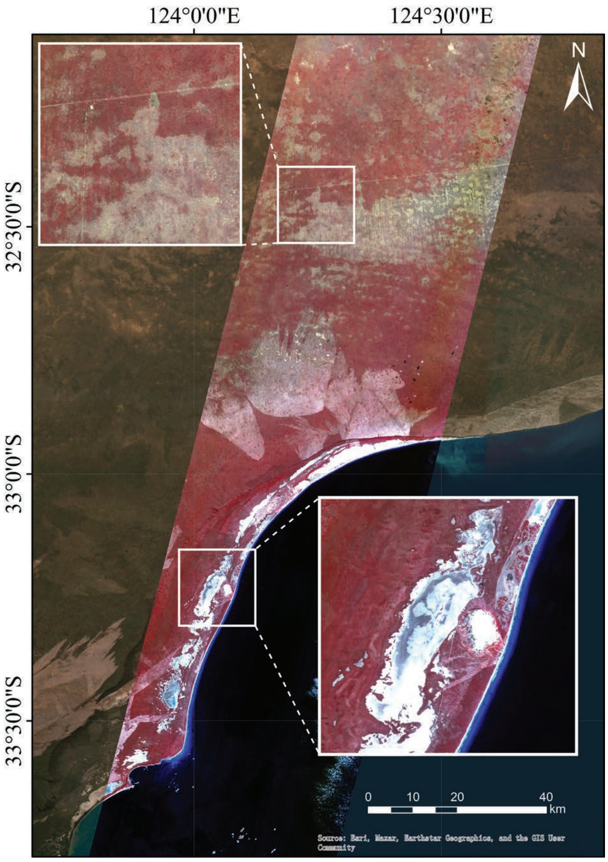

FIGURE 3. The first batch of remote sensing images received by the *Geology-1* satellite was false-color composites generated using data from the 850-, 680-, and 550-nm spectral bands.

ADVANCED MAPPING PRODUCTS FROM *GEOLOGY-1* SUPPORT MINERAL EXPLORATION AND ECO-ENVIRONMENTAL ASSESSMENT

At the advanced product level, remote sensing thematic outputs are tailored to key geological and environmental elements by leveraging the shortwave infrared and hyperspectral capabilities of *Geology-1* in combination with auxiliary information such as terrain and texture. These professional and application-oriented products are designed for scene-specific generation and iterative updates, forming a comprehensive suite of thematic maps that support core geological workflows.

- *Mineral alteration:* The first workflow involves targeting remote sensing identification and mapping of typical alteration minerals, leveraging *Geology-1*'s spectral design to overcome complex geological backgrounds and assist mineral exploration and ore genesis studies.
- *Lithology classification:* The next workflow includes focusing on subtle spectral and textural differences among lithologies to achieve high-precision classification and outcrop boundary detection, providing essential data for structural interpretation, geological mapping, and regional surveys, thereby enhancing understanding of surface lithology distribution.
- *Water quality:* The third workflow consists of using hyperspectral data and multiindex inversion methods to quantitatively retrieve key water quality parameters, particularly suitable for dynamic monitoring and assessment of water environments in heavily impacted mining areas, supporting water resource management and ecosystem health research.
- *Soil property:* The next workflow involves combining hyperspectral response features and spatial data to identify and evaluate specific soil properties such as heavy metal pollution risk areas, effectively extracting sensitive environmental zones even in complex conditions influenced by vegetation and urban structures.
- *Mine environmental:* The fifth workflow entails emphasizing shortwave infrared spectral sensitivity to analyze anomalies in vegetation, water quality, and soil around mining areas, identifying ecologically sensitive zones and disturbance boundaries, applicable for mine impact monitoring, ecological restoration assessment, and management zoning.

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