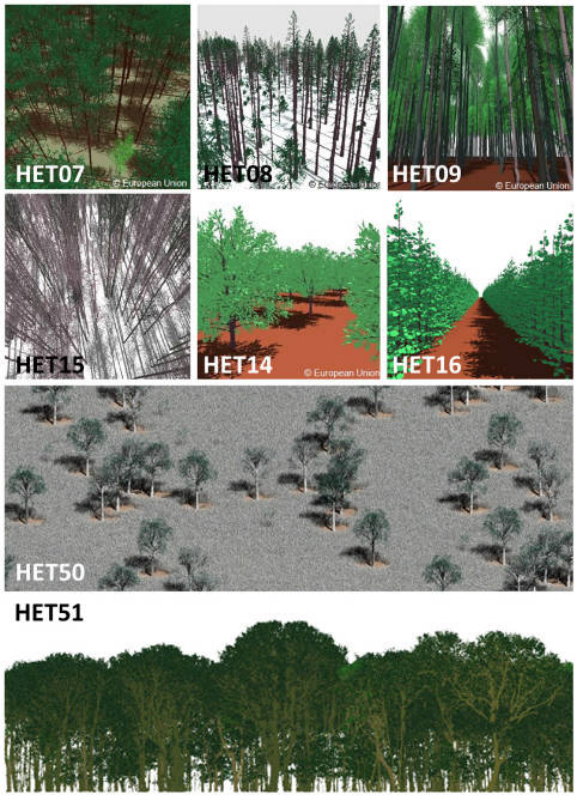
RAMI-V: bridging the gap in radiative transfer models for remote sensing

GA, UNITED KINGDOM, September 3, 2025 /EINPresswire.com/ -- The latest phase of the Radiation Transfer Model Inter-comparison (RAMI-V) aimed to improve the accuracy of radiative transfer models (RTMs) used for simulating radiation measurements over plant canopy surfaces. By including both abstract and actual vegetation scenarios, RAMI-V built on previous phases, incorporating new realistic scenes such as savannas and Wytham Woods forests. This study evaluated various models, focusing on key metrics like Bidirectional Reflectance Factor (BRF) and Hemispherical Reflectance (DHR). Results revealed that several models now agree within 2% uncertainty thresholds for most virtual measurements, setting a new benchmark for the community.



Rendering of the eight actual scenes issued with RAMI-V experiment.

The RAMI series, launched in 1999, provides the Earth Observation community with essential tools for validating and improving radiative transfer models (RTMs). Over successive phases, the initiative has focused on benchmarking these models against increasingly complex canopy scenarios, from simple 1-D to intricate 3-D representations. Radiation Transfer Model Inter-comparison (RAMI-V), the most recent phase, builds upon its predecessors by introducing new realistic vegetation scenarios to address gaps in previous testing. The goal is to align model simulations with real-world measurements, improving the accuracy of remote sensing products like those from Sentinel-2 and Sentinel-3 missions. These models are crucial for enhancing environmental monitoring and climate change assessments.

The RAMI-V experiment, detailed in the recent paper published (DOI: 10.34133/remotesensing.0663) in Journal of Remote Sensing in 2025, is the fifth phase of a long-running international initiative to benchmark RTMs. The study was led by researchers from various institutions, including the European Commission's Joint Research Centre (JRC), University College London, University of Toulouse, and Beijing Forestry University, among others. This

phase involved the submission of data from 14 different models, some of which had not participated in earlier phases. The focus was on simulating measurements of Bidirectional Reflectance Factor (BRF), Directional Hemispherical Reflectance (DHR), and radiant flux transmission and absorption through and below the canopy. The findings from RAMI-V will influence future model development and remote sensing methodologies.

RAMI-V included both well-established and newly introduced actual canopy scenarios. Among the key additions were a savanna and a modified Wytham Woods forest, which provided real-world challenges for model simulations. The study focused on a set of measurements critical for remote sensing, including BRF, DHR, and canopy flux transmission. The inclusion of Copernicus mission bands such as Sentinel-2 and Sentinel-3 and the use of MODIS data expanded the scope of the experiment to include both optical and middle-infrared spectral bands. Notably, the integration of consistency checks early in the process helped identify and rectify major errors in the models, which significantly improved the dataset's quality. By the end of the project, models such as dart, raytran, and spartacus demonstrated excellent performance, showing agreement within 2% for several scenarios. The study also revealed that specific model formats (e.g., Rayshade vs. OBJ) contributed to discrepancies in results, suggesting that future model development should standardize 3D scene representations to reduce such errors.

According to Dr. Nadine Gobron from the European Commission's JRC, "RAMI-V has made significant strides in improving the consistency and accuracy of RTMs. This phase has demonstrated that the collaboration between model developers can reduce uncertainties and enhance the relevance of remote sensing products. By incorporating real-world scenarios and using a rigorous feedback mechanism, RAMI-V has set a new standard for future modeling efforts, which will be crucial for environmental monitoring, including the monitoring of vegetation health and climate change."

The findings from RAMI-V have important implications for remote sensing applications, particularly in environmental monitoring. With more accurate and consistent model simulations, satellite-based measurements of vegetation cover, biomass, and energy balance will become more reliable. This is particularly relevant for the Copernicus program, which relies on data from Sentinel-2 and Sentinel-3 satellites. The improved RTM accuracy can also aid in refining models used for climate predictions, land-use mapping, and agricultural monitoring. Furthermore, the RAMI-V results encourage further integration of machine learning and deep learning models with traditional RTMs, potentially improving predictive capabilities for global sustainability efforts.

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