DUNIA: Pixel-Sized Embeddings via Cross-Modal Alignment for Earth Observation Applications

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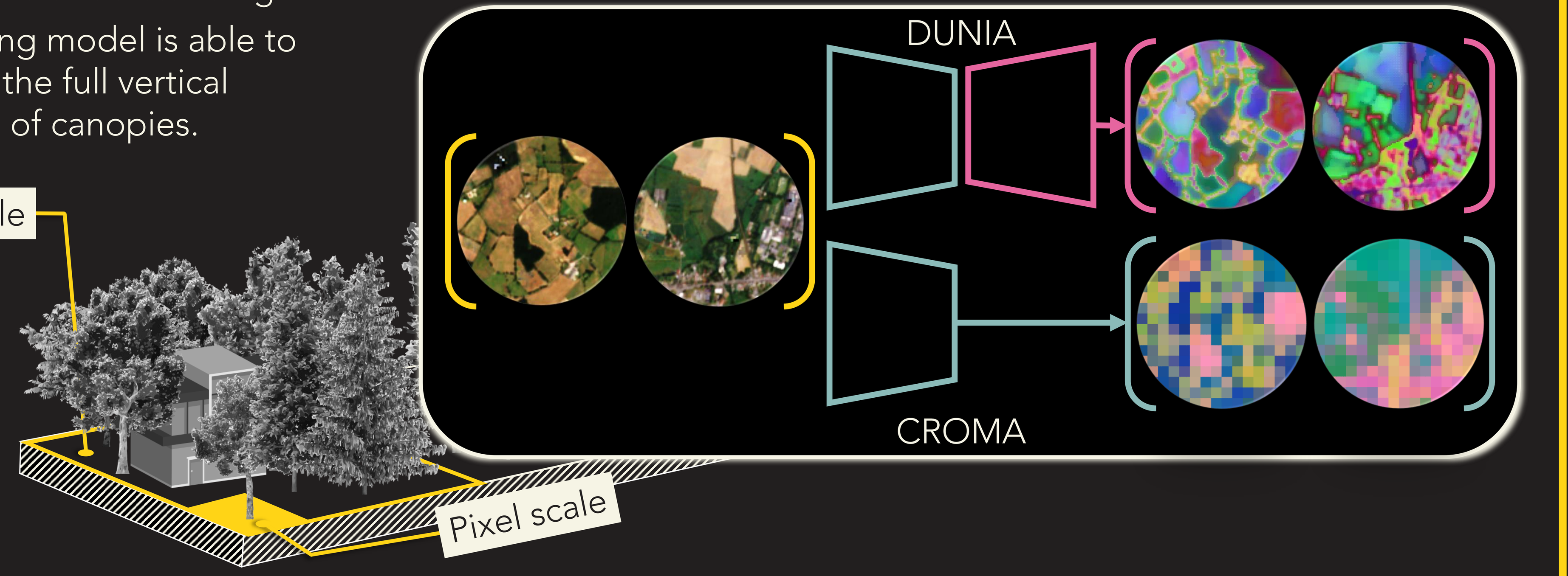
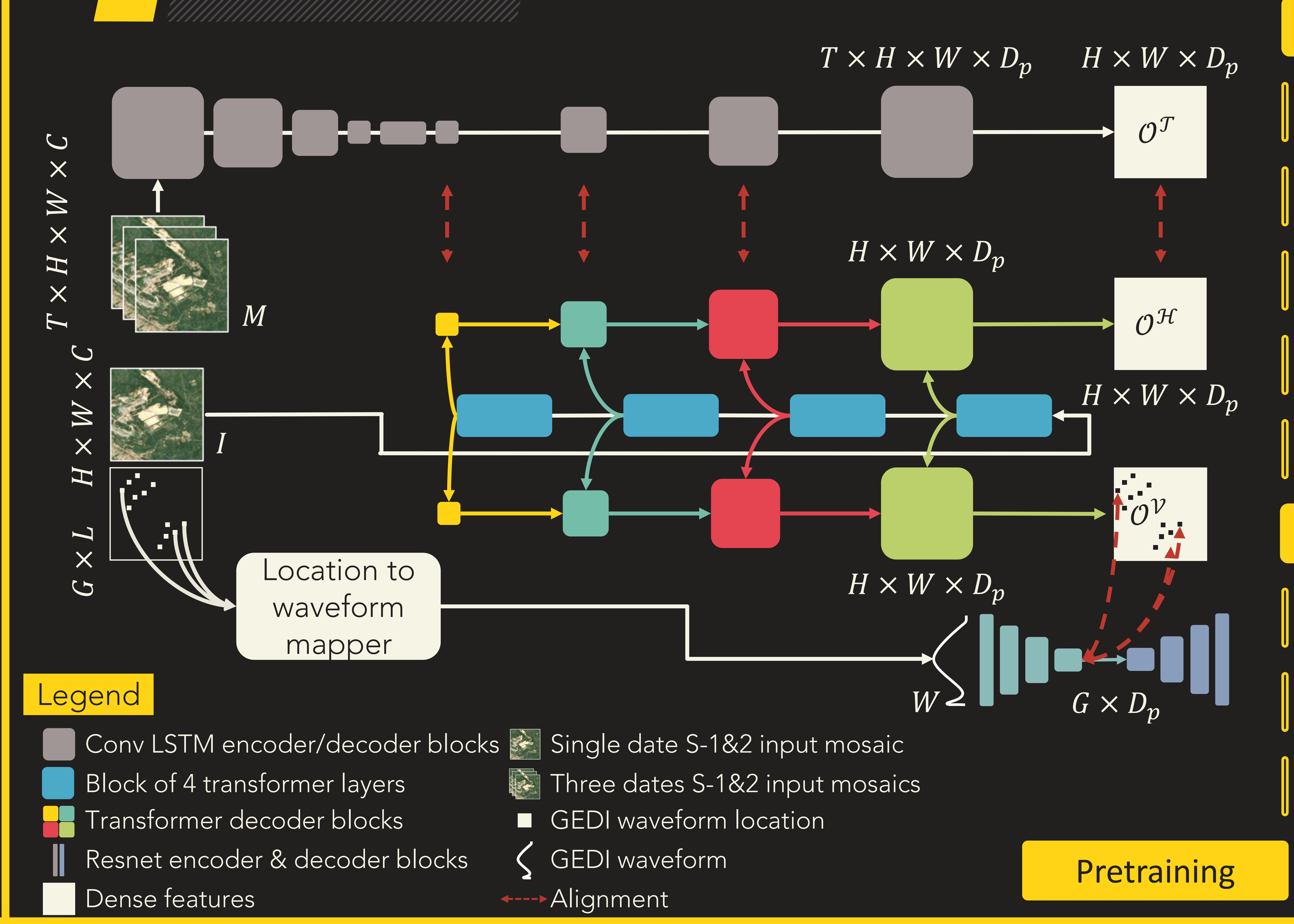
1 LSCE 2 KAYRROS 3 ZIB 4 WWU Münster 5 Inria

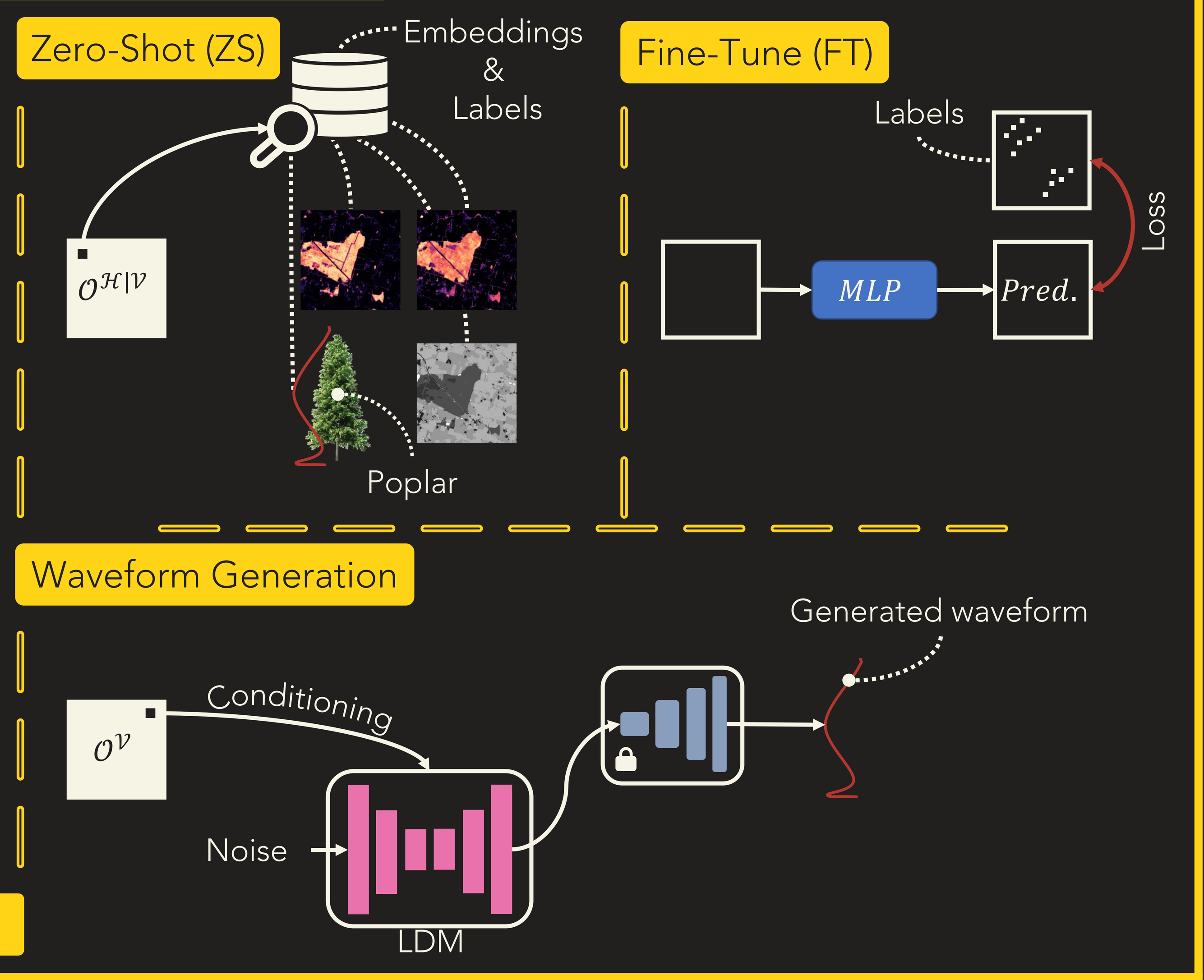
1. Motivation

1. Labels which are a fundamental part for training any ML model, are few and far between for EO applications.
2. Several self-supervised earth observation models currently exist, however:
   - 2.1 The majority operates at the patch scale, which results in embeddings that are not readily useable.
   - 2.2 They do not/cannot leverage LiDAR data (e.g., GEDI), essential for applications requiring vertical structure understanding.
3. No existing model is able to estimate the full vertical Structure of canopies.

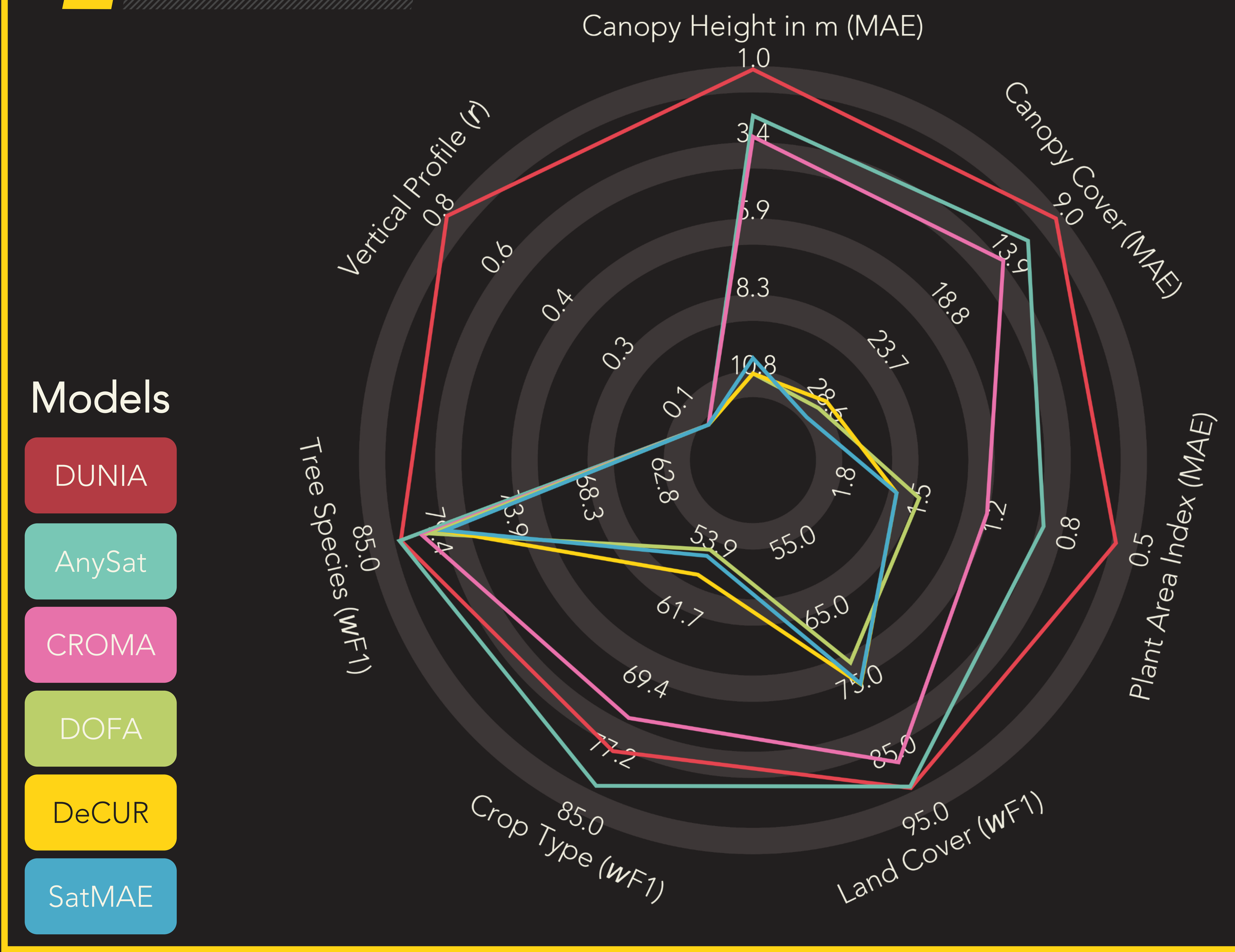


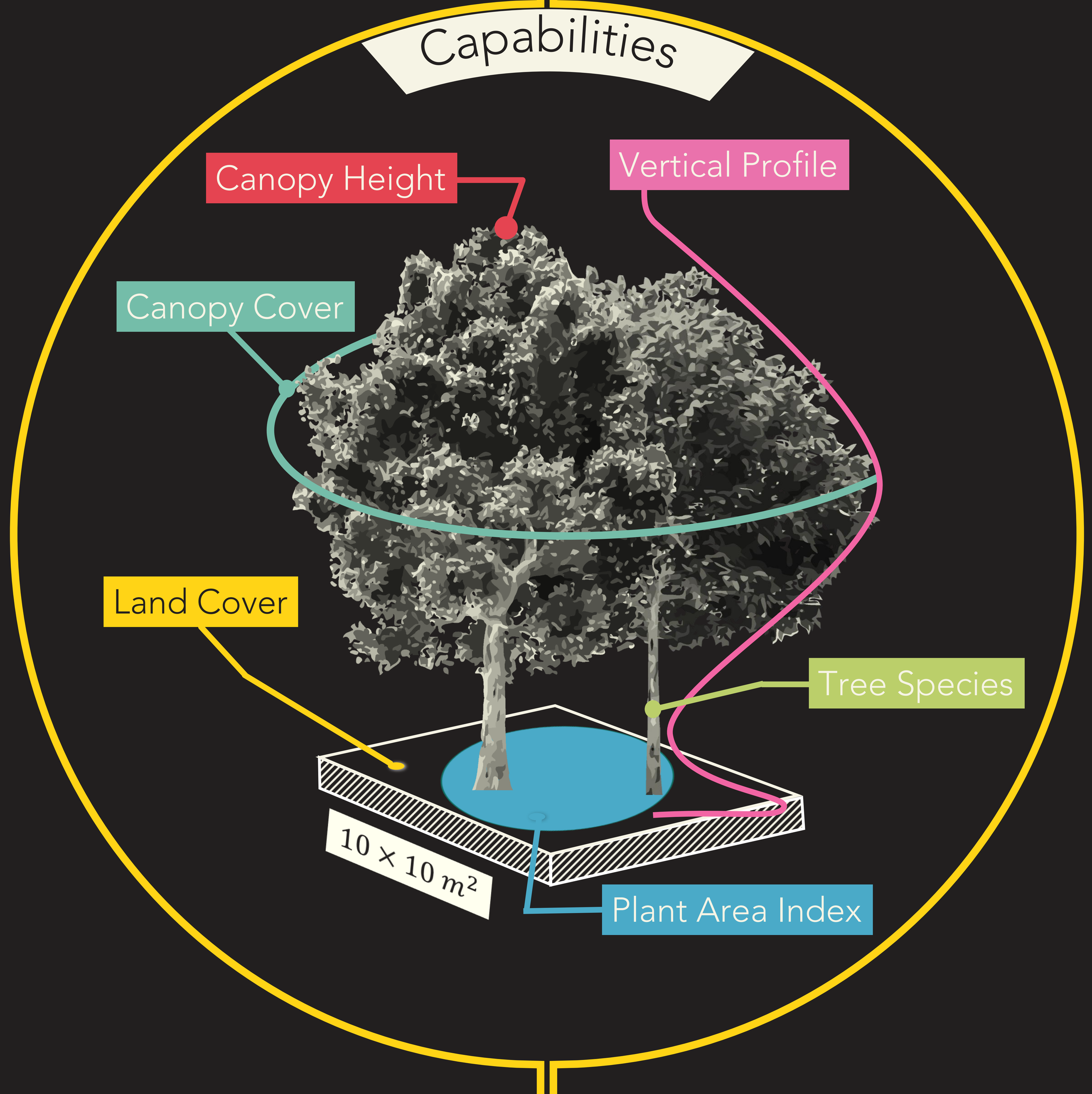
2. Method

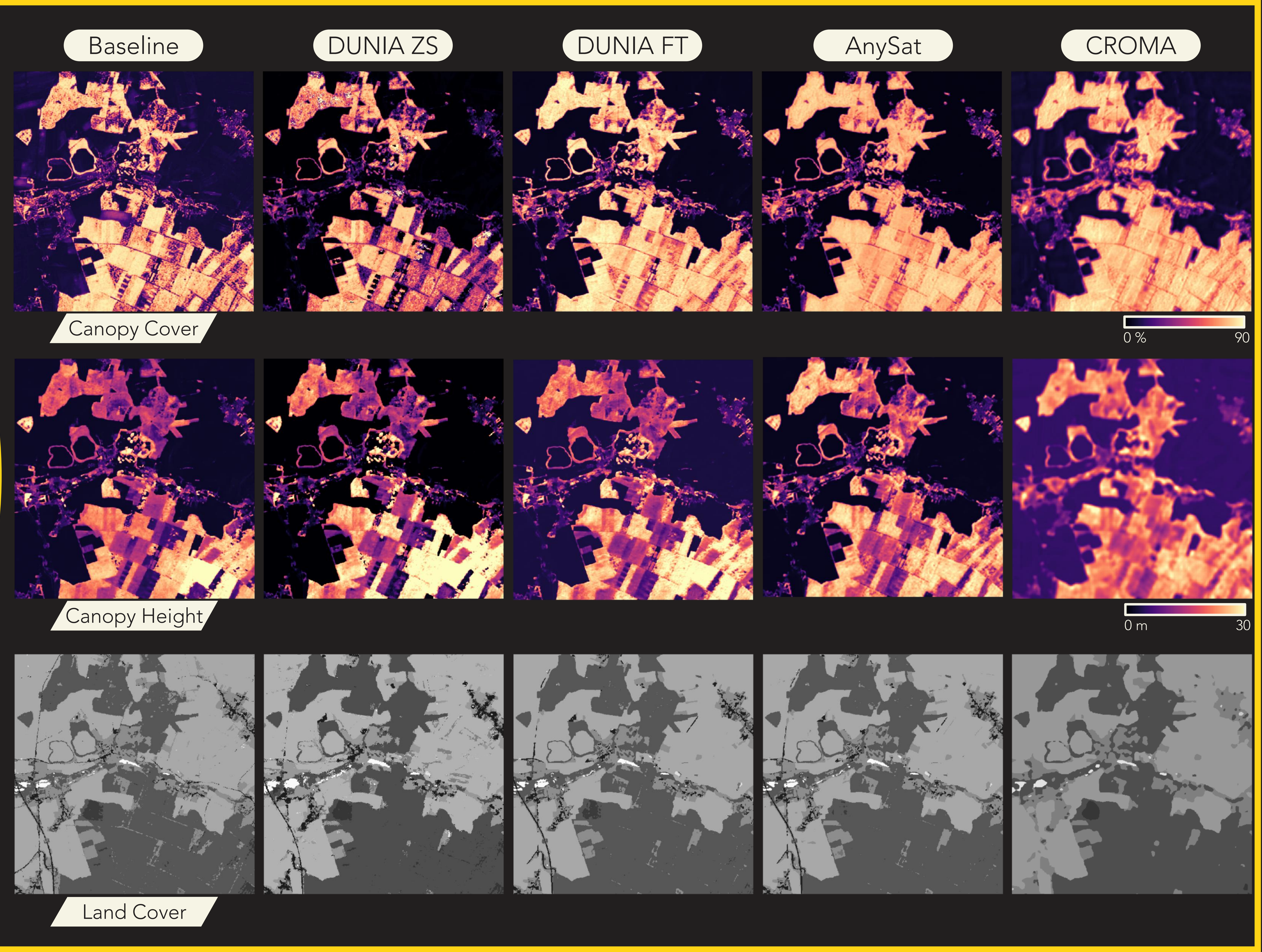




3. Results







4. Conclusions

1. Contrasting at the pixel level enables zero-shot capabilities that in many cases outperform specialist models.
2. By integrating LiDAR data, we recover the full vertical vegetation profile; our approach is the first to achieve complete canopy vertical profiling in a self-supervised framework.
3. Dual vertical and horizontal alignment equips the model for tasks demanding both spectral and structural understanding (e.g., biomass estimation, species delineation).
4. Compositing cuts out the need for time-series storage, lightening data burdens, though certain applications (e.g., crop type mapping) would greatly benefit from temporal dynamics.
5. The architecture is computationally efficient and can be trained with limited compute.

5. References

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6. Acknowledgements

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