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Technical Deep Dive

Why Satellite Imagery Isn't Just Another Computer Vision Problem?

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Satellite imagery ≠ ordinary images

Satellite images are not just photos taken from above. The sensors capture far beyond visible light from near-infrared to shortwave infrared and beyond. Each additional band unlocks new signal, but also multiplies data complexity, demanding models that reason across dozens of wavelength dimensions simultaneously.

Below are notable differences in terms of data preparation and modelling

	NORMAL IMAGES	SATELLITE IMAGES
SPECTRAL BANDS	There are only 3 bands RGB on which models are trained	They have hyper spectral bands which can range from 10-200+
SPATIAL SCALE	Uniform resolution	Varies from 10m to 60m and model needs to learn across scales
LABEL SCARCITY	Labelled datasets are available	Domain expertise required to label, ground truth needed to validate
DISTRIBUTION SHIFTS	Reasonably stable	Cloud cover and atmospheric conditions can change data

2

Why CNNs are not enough?

- **CNNs see locally, but climate systems behave globally**

Floods, droughts, and ecosystem changes often span entire river basins and coastlines, far beyond the local context captured by convolutional filters.

- **Physical processes matter as much as visual patterns**

A flood is not merely a collection of blue pixels; it is the interaction of rainfall, topography, soil, and infrastructure.

- **The Earth operates at multiple scales simultaneously**

Satellite applications require reasoning across pixels, landscapes, and entire ecosystems, whereas CNNs are optimized for fixed-scale image understanding.

- **Models trained in one geography often fail in another.**

Differences in climate, vegetation, sensors, and seasonality create significant distribution shifts that limit the transferability of CNN-based models.

3

How earth foundation models are bridging the gap

Foundation models are to Earth observation what GPT and ImageNet models were to language and computer vision: a reusable intelligence layer that can be adapted to hundreds of downstream applications with far less labeled data.

These are the top 5 foundation models (with their key differentiators) that have changed the landscape of remote sensing.

SatMAE

Learns from unlabeled satellite imagery through self-supervised masking. Applied in land use cover and change mapping..

Prithvi

Understands how landscapes evolve through time by leveraging multi-temporal data
Heavily used in flood mapping and agricultural applications.

Clay

Integrates multiple Earth observation modalities into a common embedding space.
Used primarily for nature based solutions, MRV and ecosystem monitoring

DOFA

Integrates multiple Earth observation modalities into a common embedding space.
Used primarily for nature based solutions, MRV and ecosystem monitoring

AlphaEarth Foundations (Google Deepmind)

Builds a unified representation of the planet using massive Earth observation datasets..
The embeddings are massively used for climate risk analytics, biodiversity monitoring

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Next Frontier : GeoAI

“The next frontier of GeoAI is transforming satellite imagery, weather, and geospatial data into latent representations of the Earth system that can be reused across multiple tasks and domains.

As the foundation models mature, satellite imagery will increasingly power climate risk analytics, insurance pricing, nature-based solutions, and financial decision-making, transforming Earth observation from a monitoring tool into a planetary intelligence layer.”

5

What does this mean for insurance?

- Product Innovation : GeoAI can enable new insurance products based on observed physical risks, including parametric covers for floods, heat stress, agriculture, and nature-based resilience.

- Dynamic Portfolio Monitoring: Near real-time Earth observations and digital twins can help insurers monitor portfolios as risks evolve rather than relying solely on static annual assessments.

- Better CAT Modelling : Natural catastrophe modelling research can speed up to create more ensemble models of physics based and simulation models

Follow me for emerging risk insights and applied AI use cases for insurance

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