Session 3: Emerging AI Trends in Earth Observation

Foundation Models, Self-Supervised Learning, and Explainable AI

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Agenda & Pacing

- **Duration:** 2 hours (120 minutes)
- **Plan:**
  - 0–10: Session goals & context
  - 10–50: Foundation Models (GeoFMs)
  - 50–80: Self-Supervised Learning (SSL)
  - 80–110: Explainable AI (XAI)
  - 110–120: Discussion & next steps

Learning Objectives

- Define foundation models and list major GeoFMs (Prithvi, Clay, SatMAE, DOFA)
- Explain SSL and its value for unlabeled satellite data
- Apply XAI concepts (SHAP, LIME, Grad-CAM) to EO tasks
- Decide when to use FM/SSL/XAI in PH contexts

Foundation Models (GeoFMs)

What & Why

- Pre-trained on massive EO archives → transferable to many tasks
- Fewer labels needed (100–500 vs 10,000+)

Examples

- Prithvi (temporal ViT, HLS)
- Clay (multi-modal S1/S2/DEM)
- SatMAE (masked autoencoding)
- DOFA (generalist optical + SAR)

How FM Works

```mermaid
flowchart TB
  A[Massive Archive] --> B[Self-Supervised Pre-training]
  B --> C[Foundation Model]
  C --> D[Fine-tune (100–500 labels)]
  D --> E[Downstream Task]
```

- Pre-train once (expensive), fine-tune many times (cheap)

Self-Supervised Learning

Why SSL for EO

- 99.99% of satellite data unlabeled
- SSL leverages unlabeled data to learn useful representations

Techniques

- Masked autoencoding (reconstruct hidden patches)
- Contrastive learning (positive vs negative pairs)
- Temporal tasks (ordering, prediction)

Explainable AI (XAI)

Why XAI

- Operational trust: disaster, agriculture, enforcement
- Debug bias and regional drift

Techniques

- SHAP: feature contributions
- LIME: local surrogate models
- Grad-CAM: spatial attention on CNNs

PH Integration & Roadmap

- Disaster response (floods), national agriculture monitoring, mangroves
- 4-phase roadmap: Assess → Fine-tune → Deploy → Scale
- Platforms: DIMER, AIPI, Space+ Dashboard, NAMRIA, PAGASA

Discussion & Q&A

- Where can FM/SSL/XAI help your agency most?
- Data readiness and labeling strategies
- Risks, governance, and explainability