

Paper 030 / Application 007

Planetary Intelligence Sensor Fusion for Water, Agriculture, Infrastructure, and Risk

A local-first JMP0X1B architecture for EO, field sensors, scoring, and simulation

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Abstract

This paper proposes a Planetary Intelligence application stack aligned with JMP0X1B development vectors. It fuses Earth-observation imagery, field sensors, hydrometeorological data, infrastructure observations, and operator reports into decision products for agriculture, water stress, terrain change, disaster monitoring, and operational risk. The architecture is local-first and resilient under weak connectivity.

Status. Draft manuscript for review and revision. This paper is not an empirical claim of new physics or field-ready technology. It is a structured proposal, theory note, protocol, or application architecture intended to be auditable, falsifiable, and publishable with source.

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1 Problem

Many Earth systems need decisions under incomplete, delayed, or low-trust data. Central cloud workflows fail in remote fields, disaster zones, and infrastructure corridors with weak connectivity. The problem is to fuse heterogeneous data into useful decisions while preserving provenance, uncertainty, and local operability.

2 Model

The stack uses typed observation frames, spatial indexes, uncertainty envelopes, simulation models, and policy outputs. Data products are scored by decision utility and confidence, not just model accuracy. Local agents can operate offline and synchronize artifact digests later.

$$z_t = f(x_t^{EO}, x_t^{sensor}, x_t^{report}, x_t^{model}), \quad r_t = \text{Risk}(z_t, \sigma_t, C_{\text{action}}).$$

$$U(a) = \mathbb{E}[B(a, z) - C(a) - L(a, r)].$$

3 Claims

1. **Claim 1.** Planetary intelligence systems should optimize operational decisions, not only predictive accuracy.
2. **Claim 2.** Local-first execution is essential for agriculture, disaster, and infrastructure contexts with degraded connectivity.
3. **Claim 3.** Typed sensor-fusion contracts reduce ambiguity between observation, model, and human report.
4. **Claim 4.** The same architecture prepares Earth systems for off-world autonomy constraints.

4 Evidence Plan

Prototype evidence should include three pilots: irrigation-risk scoring, infrastructure change detection, and disaster-access assessment. Each pilot reports data latency, missingness, uncertainty calibration, operator correction rate, and action value.

5 JMP0X1B Implementation Surface

JMP0X1B packages for EO ingest, geospatial core, sensor fusion, change detection, risk models, telemetry, and provenance can define the application surface. Field nodes should degrade gracefully and sync signed summaries when connectivity returns.

Illustrative JMP0X1B-style contract

```
record Observation<T> { value: T, location: GeoCell, time: Time, uncertainty: Uncertainty, source: String }
fn fuse(frames: List<Observation<Any>>) -> DecisionSurface effects{SensorFusion, Geo, Audit}
```

6 Release And Review Plan

Release a reference data schema, synthetic pilot datasets, uncertainty scoring notebooks, and operator-facing decision reports.

7 Open Questions

- Which first pilot has the highest value per sensor deployed?
- How should local operator corrections update the model without corrupting provenance?
- Can risk scores remain useful under severe cloud cover?
- What data products should be small enough for low-bandwidth synchronization?

8 Conclusion

Planetary Intelligence is a grounded application track: Earth usefulness first, off-world discipline in the architecture.

References

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