



Ask, Retrieve, Analyze: A Multi-Agent DGGS Framework for GenAI-Driven Methane Data

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Meeting Host

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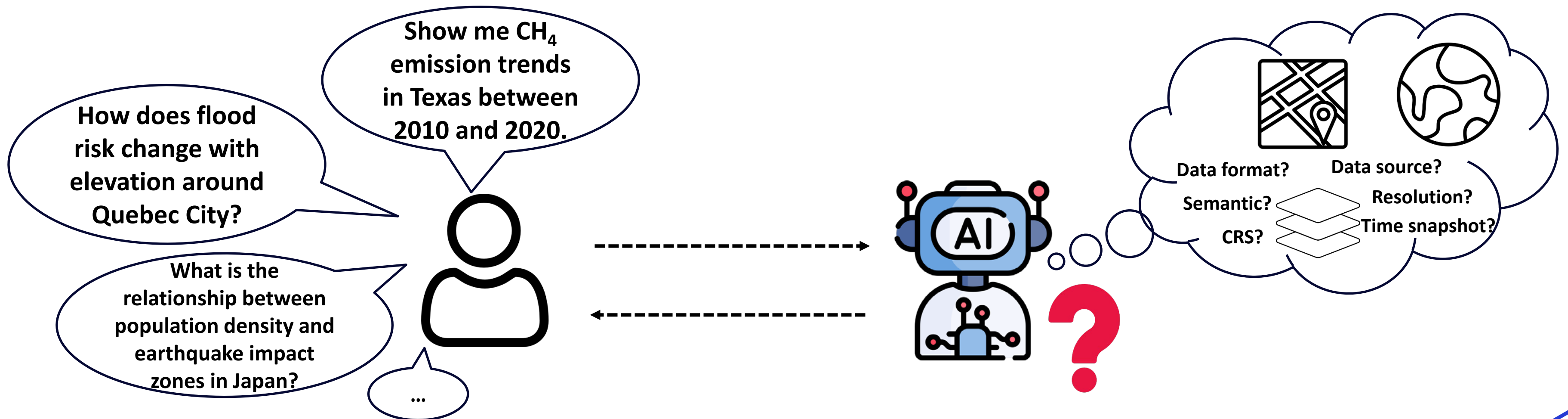
KONGSBERG GEOSPATIAL

Enabling Mission Critical Decisions

Motivation

Multi-source spatial data fragmentation

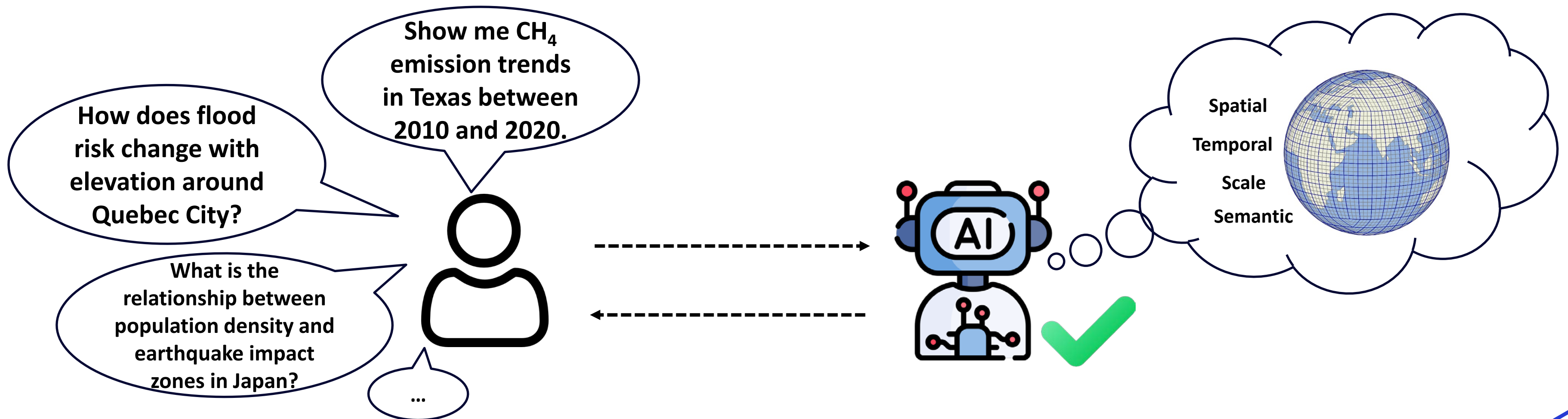
- Spatial data today sits across multiple platforms.
- Inconsistent CRSs, file formats, spatial resolutions, time snapshots, semantics, etc.
- Data chaos slows analysis and decisions before/during/after events.
- AI models struggle to reason over such inconsistencies - **standardization is the core.**



Motivation

DGGS as a standardized reference system

- **Spatial**: Equal-area global grid with cell index.
- **Temporal**: Enables consistent change analysis with fixed cell locations.
- **Scale**: Hierarchical structure supports zooming and aggregation.
- **Semantic**: Common feature schema & attribute alignment.



Research objective

Assumption

*AI has tremendous potential, but only when built on a foundation of standardized, high-quality data. Emerging standards such as **DGGS** provide the **spatial and semantic infrastructure** needed to unlock that potential.*

Objective

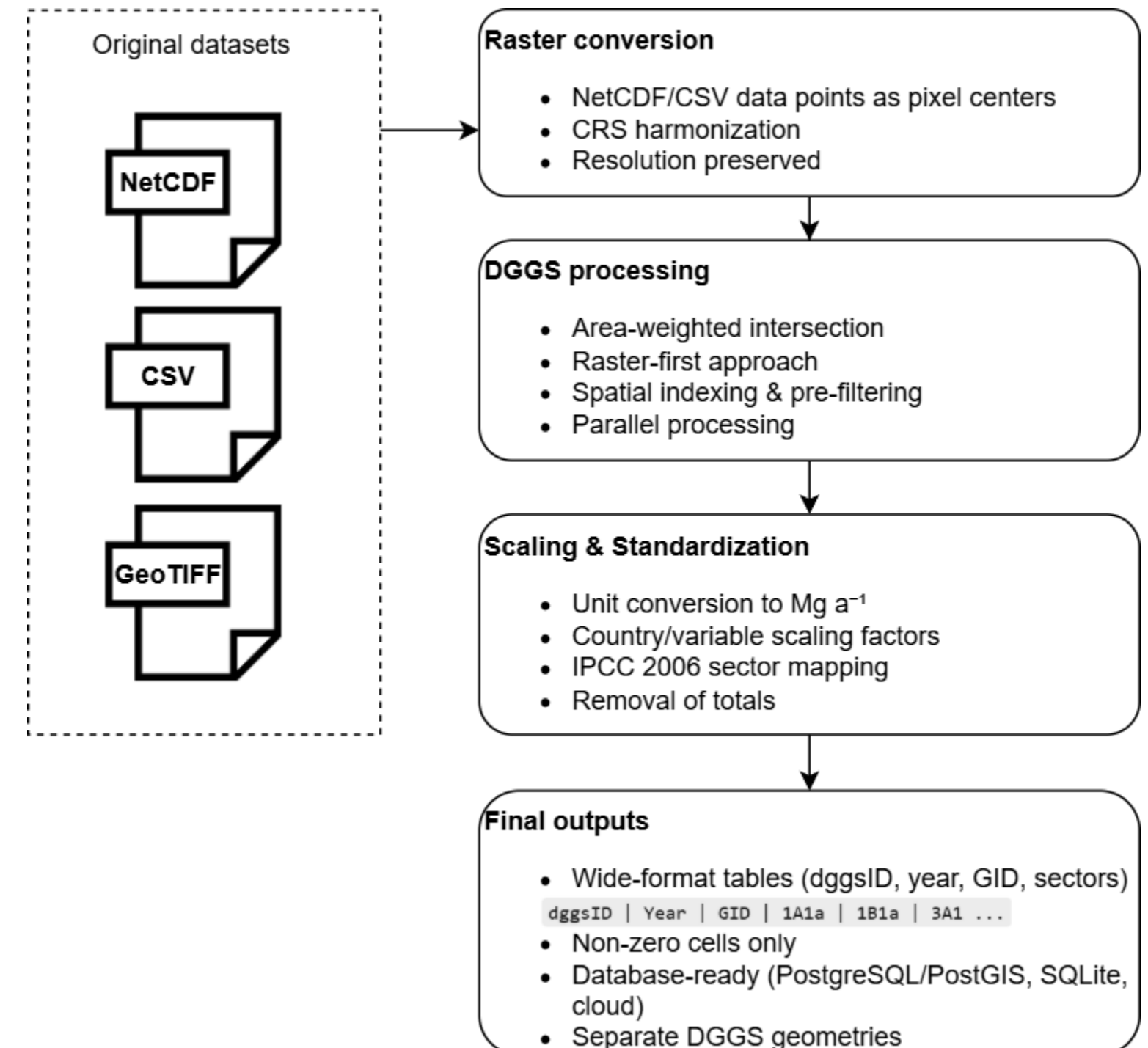
*To develop a scalable geospatial intelligence framework that integrates DGGS and generative AI for automated extraction, normalization, spatial indexing, and visualization of environmental data from heterogeneous sources, demonstrated through a **methane emissions** use case.*



Two-Part Work Structure

Part 1 – Data harmonization

- Convert multiple emission inventories onto **rHEALPix DGGs** using **DGGAL** (<https://github.com/ecere/dggal>).
- Standardize **spatial structure**, **sectoral semantics** (to IPCC 2006 scheme), and **reporting units** (to Mg a^{-1}).
- Apply **scaling factor** (close to one) to ensure conservation of total emissions.
- Store data in DGGs-indexed **relational backend**.
 - Li, M., & Liang, S. (2025). Harmonized Global to Regional Gridded Methane Inventories on rHEALPix DGGs (V1.0) [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.17362125>

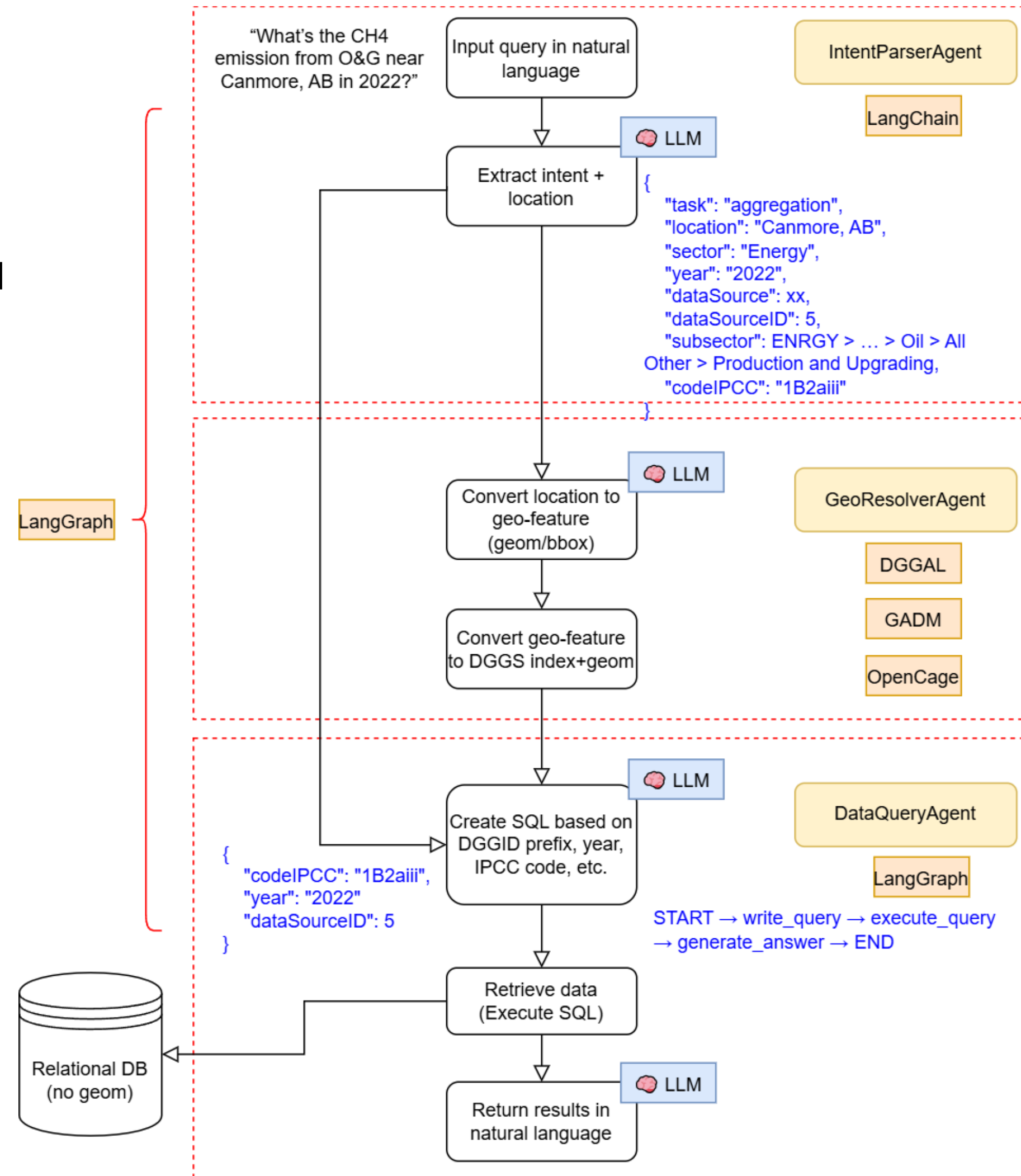


Two-Part Work Structure

Part 2 – Intelligent query system

- Turns natural language into DGGIS-aware queries and answers
 - **IntentParserAgent** extracts task + variables
 - **GeoResolverAgent** maps text location → DGGIS IDs
 - **DataQueryAgent** generates SQL → retrieves results → explains answer
- Orchestrated by **LangGraph**

```
├─ intent_parsing
├─ geo_resolver
├─ data_querying
│   ├── _write_query
│   ├── _execute_query
│   └── _generate_answer
└─ generate_final_response
```



Methane Query – Streamlit Pro

localhost:8501

GoogleGoogle MapsGoogle DriveGoogle ChatGoogle PhotosG R UNB UCalgary USherbrooke PDF Online Course Job Journal Visa Vacation133rd Member Mee...

Deploy

Multi-Agent Methane Data Query Systems

End session

Map Visualization



No data available for download

Ask about methane emissions, anywhere, any sector, and any year between 1970 and 2022...>

Key outcomes

- **Harmonized gridded inventories:** Developed a global to regional methane emissions dataset (DOI:10.5281/zenodo.17362125), standardized by IPCC sector codes and DGGS spatial index.
- **End-to-end DGGS + AI workflow:** Demonstrated how DGGS-indexed data can directly power generative AI query and analysis pipelines.
- **Explainable and traceable analytics:** Each AI-generated result can be traced back to DGGS cells and original data sources, ensuring transparency.
- **Modular multi-agent design:** Agents are reusable and adaptable to other domains such as flood monitoring, air quality, etc.

Future work

- **Domain-agnostic expansion:** Extend the framework to other greenhouse gases, pollutants, and climate-related hazards.
- **More agentic architecture:** Introduce planner–executor loops and potential human-in-the-loop interaction for dynamic reasoning using LangGraph.
- **Quantitative evaluation:** Establish performance metrics to assess accuracy, efficiency, interpretability, and reliability of agent responses.





THANK YOU



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