





#### Interactive Data Exploration for Geoscience

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### **Motivation**

NASA





Modified Copernicus Sentine (2016), processed by ESA

data



Justin Hobson

### Introduction: Data-Driven Research

- Enabled by data availability
  - satellites, sensors and observations...
- Visualization often triggers new scientific ideas





## **Explorative Workflows**



- Users explore data and various kinds of processing steps
  - Multiple paths are followed  $\rightarrow$  separate workflows
- Requirements:
  - Low latency visualizations
    - Data abstraction and generalization
  - Citations + reproducibility



# Challenges

- Visualization
  - Big / heterogeneous data
  - Identify relevant data / quality issues
- Explorative workflows
  - Explorative usage
  - Data lineage / citations
- Time as an integral dimension
  - Data changes over time
  - Detect temporal patterns





### Our Approach: VAT - Architecture Overview





## WAVE: VAT's Graphical User Interface





## Visualization: Raster Data



- Parallel requested as tiles
- Aggregation to match map resolution





### Visualization: Vector Data



- Polygons and lines: Simplification
- Points: Clustering



## Visualization: Identify Relevant Data



- Non-overlapping clustering
  - $\rightarrow$  Allows pattern recognition + data reduction



### Visualization: Identify Relevant Data



- Linked table view:
  - Aggregated numeric attributes
  - Representative text attributes



### Visualization: Quality Issues





## Workflow: Combining Data

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## Workflow: Combining Data





# (Explorative) Workflows: Lineage Tracking





### Workflows: Citations





# Support for Temporal Operations





### Time as an Integral Dimension





### Time as an Integral Dimension



### Time as an Integral Dimension



## **User Evaluation**

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• Use-cases with 15 domain experts in biodiversity

➔ Overall positive feedback, minor changes



# Conclusion / Future Work

- Our approach to interactive data exploration for geoscience
  - Low latency visualization
  - Explorative workflows
  - Time as an integral dimension
- Future Work
  - Adaptive applications / Application builder
  - Connectivity to external tools e.g. R
  - Support for complex time patterns / aggregation
     e.g. Average; Jan-Apr; 1995-2000;

