

Web Services for Comparative Data Analysis of Emissions Inventories

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Presentation Overview

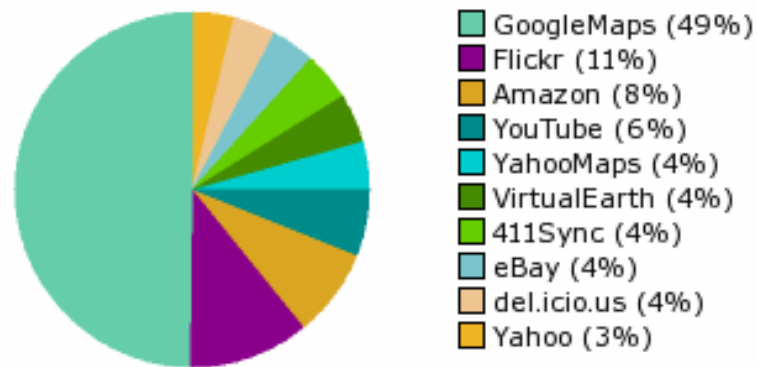
1. Web services approach
2. Emissions Comparison Web Application
3. Data services
4. Analysis services
5. Building web applications (bringing it all together)

<http://www.neisgei.org>

Web service frameworks

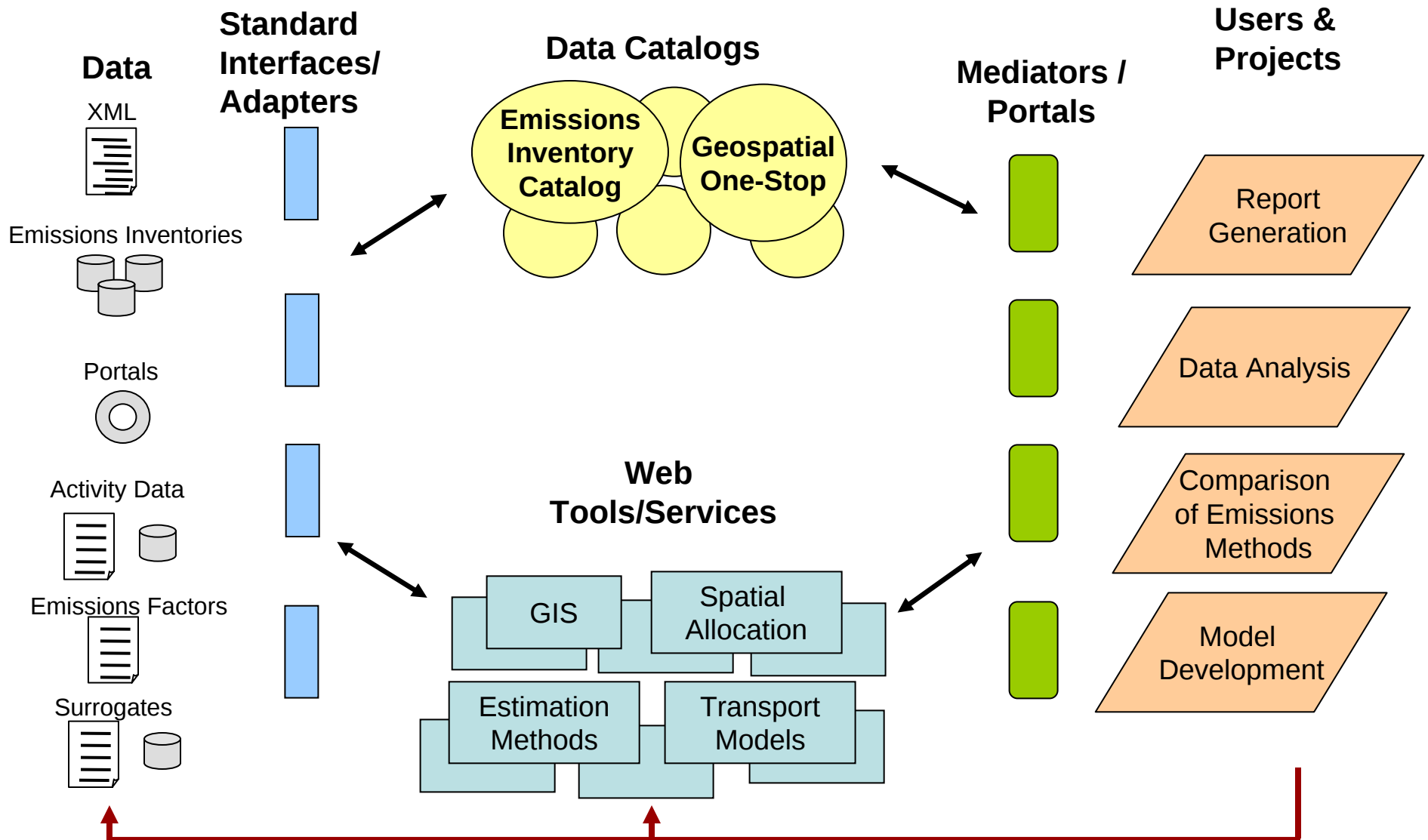
- User interaction with web has expanded from one-way information download to include user-driven information content – “Web 2.0”
- Within the science and engineering domains, this next phase of the web is referred to as **cyberinfrastructure**, **e-science**, and **service oriented science**.
 - new capabilities for sharing information, conducting research in a distributed environment, and achieving new insights that would have taken longer, or not occurred at all, in independent organizations.
- Web services approach uses **standards-based** interfaces for accessing and working with data. Our objective is to go beyond searching and visualizing data to include data processing and analysis services.
- **Mashups** - applications constructed by combining services from disparate sources.

Top Mashup APIs



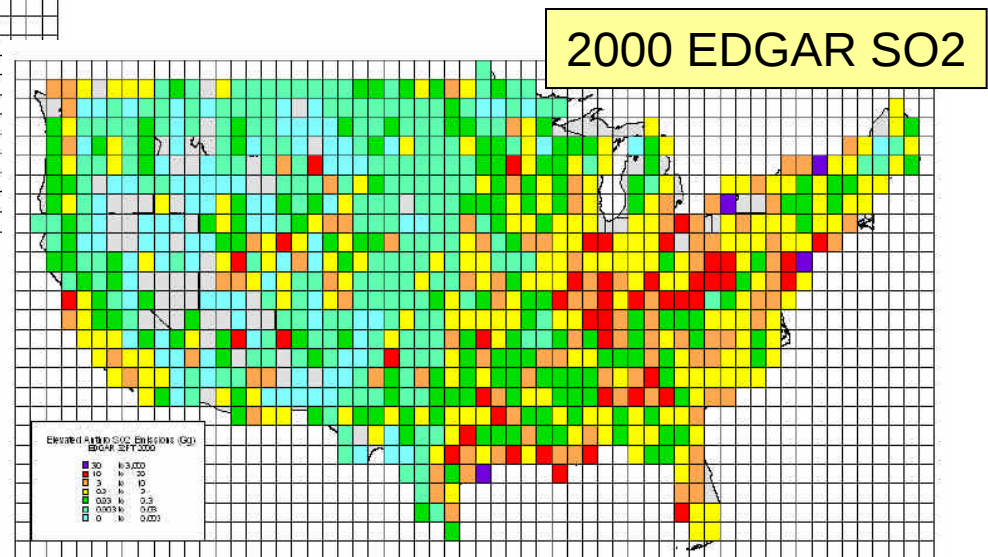
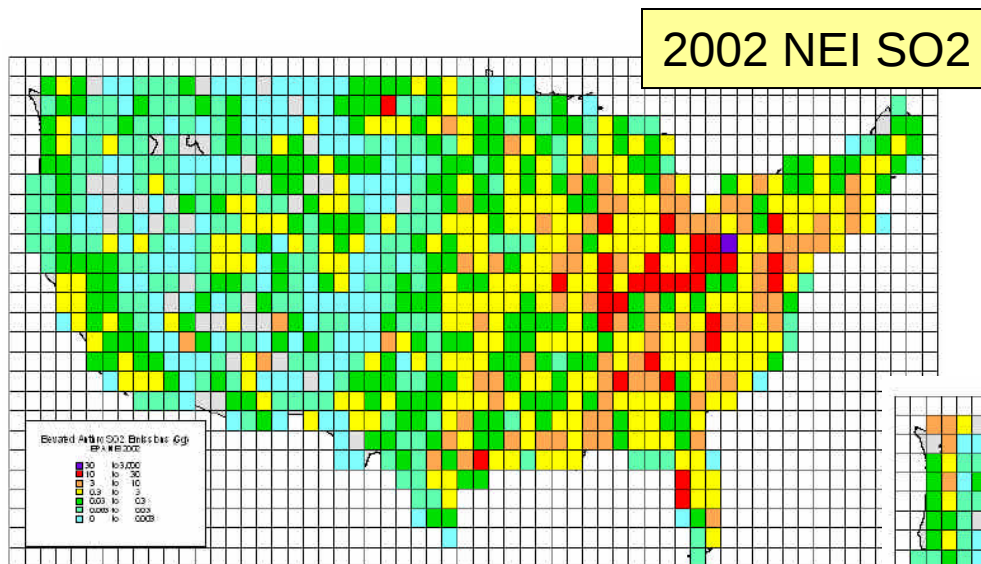
ProgrammableWeb.com 05/08/07

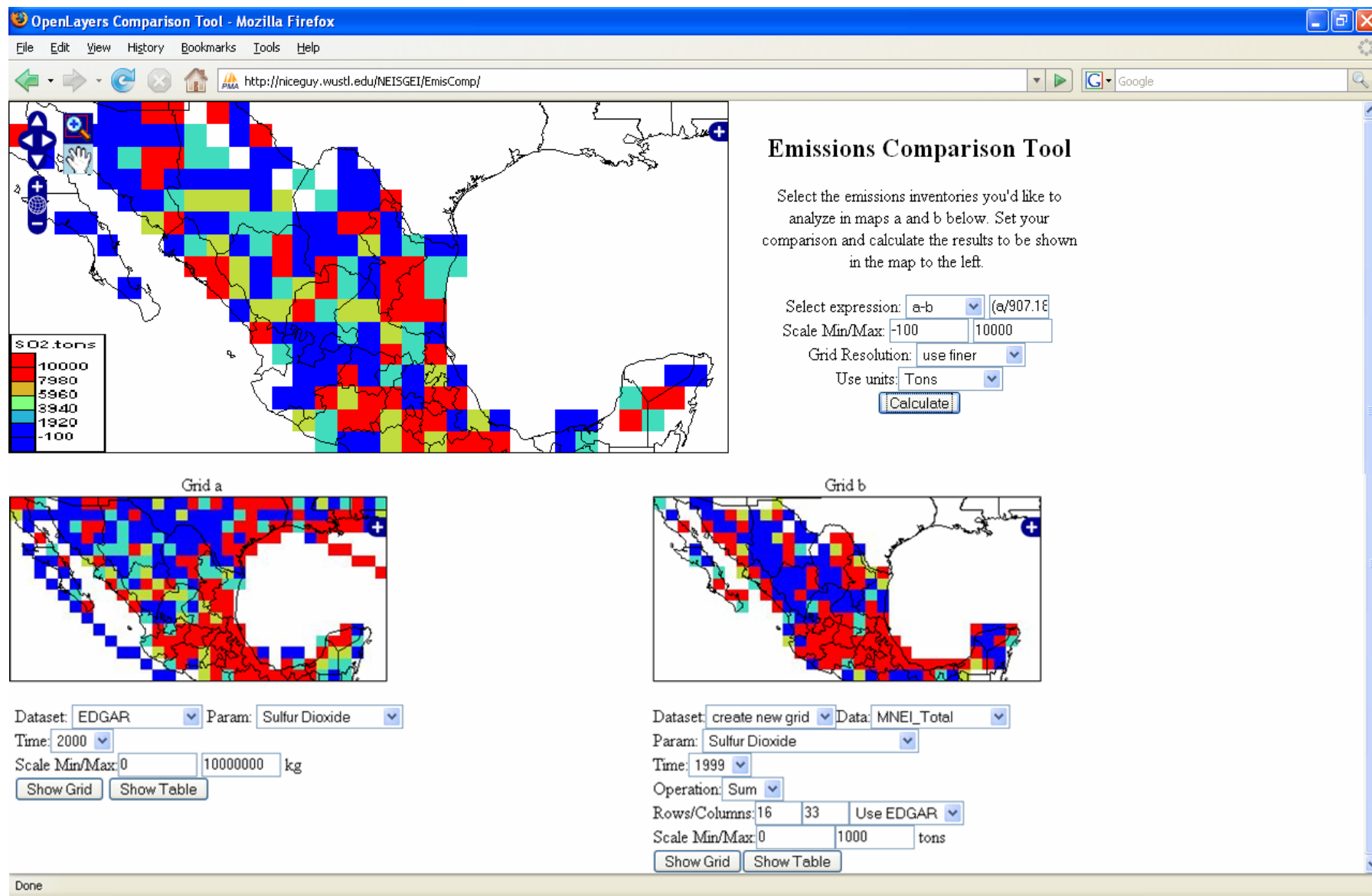
Components of Web Emissions Networks



Reconciliation of Regional and Global Emissions Inventories

- Greg Stella (2006) conducted a study with the objective of reconciling global inventories developed using “top down” methods with regional inventories developed using localized “bottom up” methods for a domain covering the continental United States.



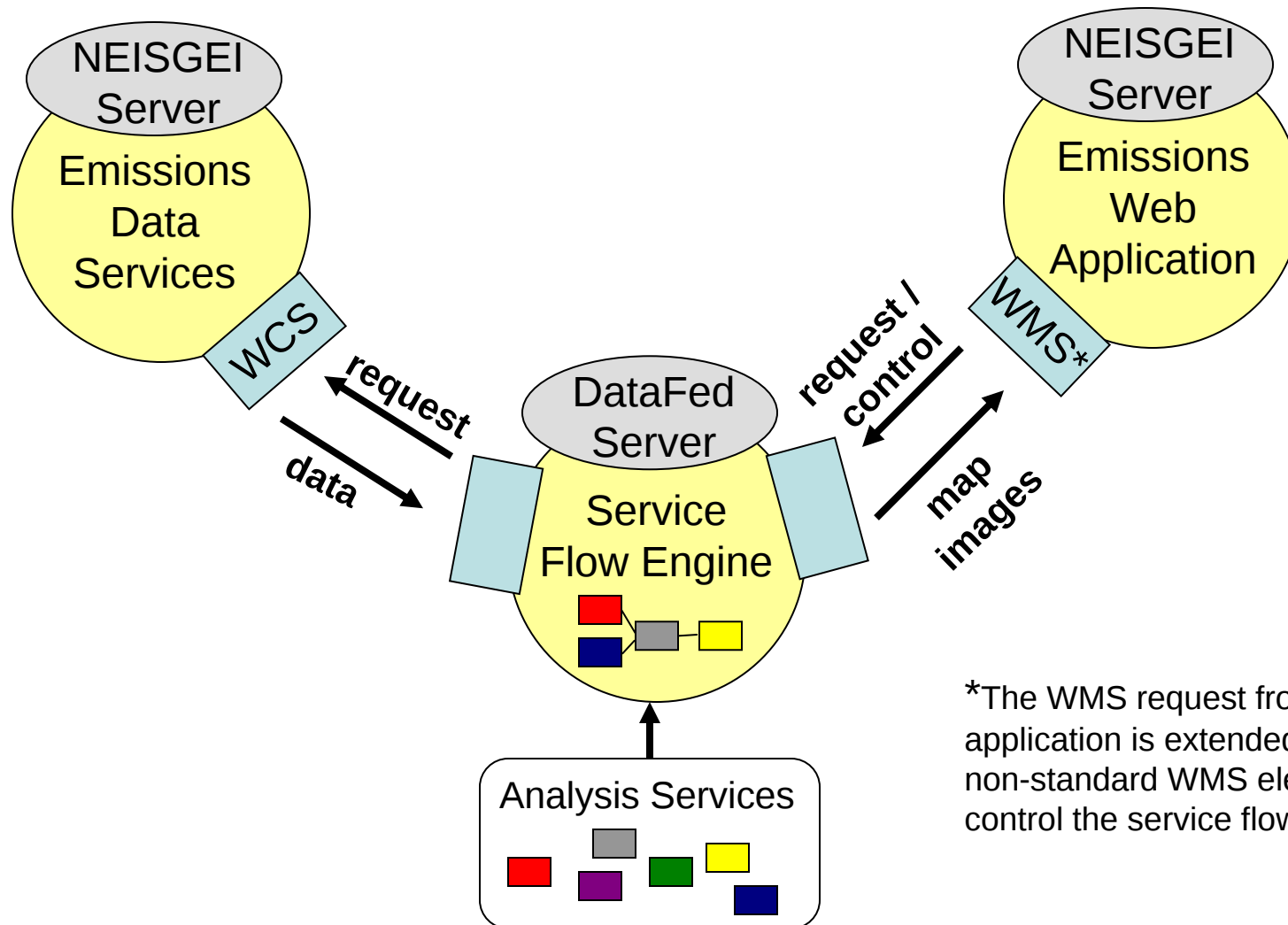


<http://niceguy.wustl.edu/NEISGEI/EmisComp/>

Web Application Framework

Web services are modular components that gain value when connected to form a **chain of services**, thereby creating a web application.

The services can be **geographically distributed** among servers. The services come together by way of a **workflow**, which constructs and manages a set of services chained together.



*The WMS request from the web application is extended to include non-standard WMS elements that control the service flow.

Data Access Services

Standards for finding, accessing, portraying, and processing geospatial data are defined by the **Open Geospatial Consortium (OGC)**.

- **Web Map Server (WMS)** for exchanging map images, but the
- **Web Feature Service (WFS)** retrieves discrete feature data
- **Web Coverage Service (WCS)** allows access to multidimensional data that represent coverages, such as grids.
- **Sensor Observation Service (SOS)** multidimensional access to measurement data

While these standards are based on the geospatial domain, many are designed to be extended to support non-geographic data “dimensions,” such as time and the many other dimension tables found in emissions inventories.

Geospatial One-Stop

The image illustrates the process of adding a service to the geodata.gov Map Viewer. It consists of three screenshots connected by red arrows:

- Screenshot 1:** The 'geodata.gov MAP VIEWER' window in Mozilla Firefox. The 'ADD SERVICES' dialog is open. The 'Map Server URL:' field is highlighted with a red box, containing the URL `http://webapps.datafed.net/dvoy_ser`.
- Screenshot 2:** The 'geodata.gov Map Viewer - Services Catalog...' window. The 'ADD SERVICES' dialog is open, showing a list of data layers to add. The layer 'BLM_FireHist(Acres Burned)' is highlighted with a red box.
- Screenshot 3:** The 'geodata.gov MAP VIEWER' window in Microsoft Internet Explorer. The 'ADD SERVICES' dialog is open, showing the 'DataFed' and 'geomac' layers selected. The map view on the right shows the resulting data layers overlaid on a topographic map of the western United States.

Web Coverage Service (WCS)



GetCoverage Request

```
http://webapps.datafed.net/ogc_EPA.wsfl
?SERVICE=wcs
&REQUEST=GetCoverage
&VERSION=1.0.0
&CRS=EPSG:4326
&COVERAGE=EPA_CAMD_HOUR.SO2_MASS
&FORMAT=NetCDF-table
&BBOX=-82.4606,42.9258,-82.4606,42.9258,0,0
&TIME=2002-04-01T15:00:00Z/2002-04-30T15:00:00Z
&WIDTH=700
&HEIGHT=350
&DEPTH=99
```

Emissions Data Access Services

We developed an OGC Web Coverage Service (WCS) interface for emission inventory data:

- **US NEI** - estimates of annual (1999, 2002) emissions of air pollutants for point, area and mobile sources.
- **Mexican NEI** – 1999 emissions estimates for point, area, motor vehicle, nonroad mobile, and natural.
- **Canadian NPRI** – annual emissions estimates (criteria pollutants started in 2001).
- **EDGAR** – gridded global emissions estimates at 1X1 degree resolution.
- **RETRO** – gridded global emissions estimates at 0.5X0.5 degree resolution.

Analysis Services

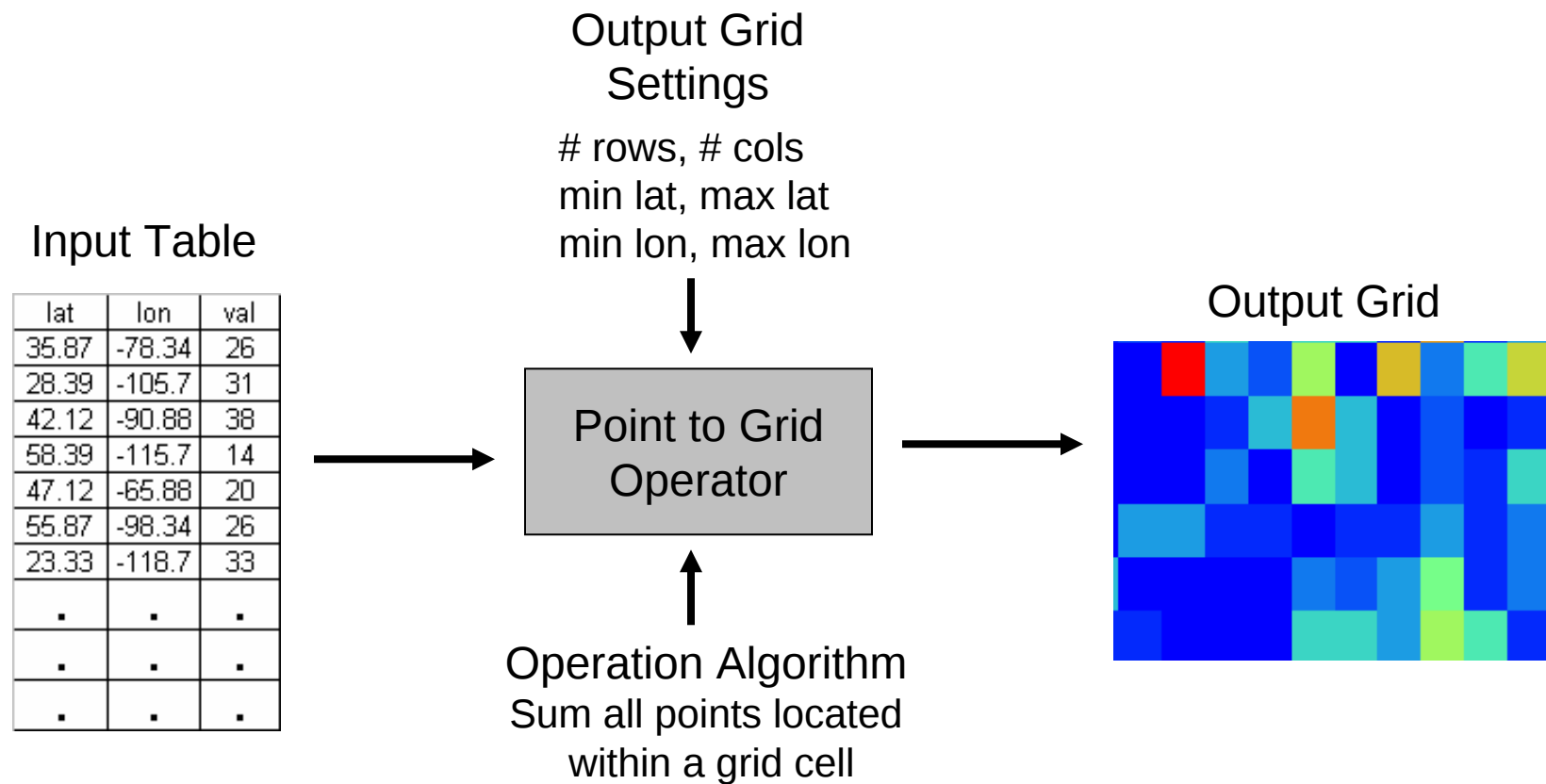
Most cyberinfrastructure research to date has focused on the exchange and interoperability of data. But making data readily accessible and more easily shared is just one step.

Services for using that data are a next step in adding value and increasing the capabilities available to data consumers.

From a service oriented perspective, the interoperability requirements for analysis services is that their **input and output interfaces adhere to OGC specifications**, but the actual **analysis algorithm can be implemented any way** the service provider wishes.

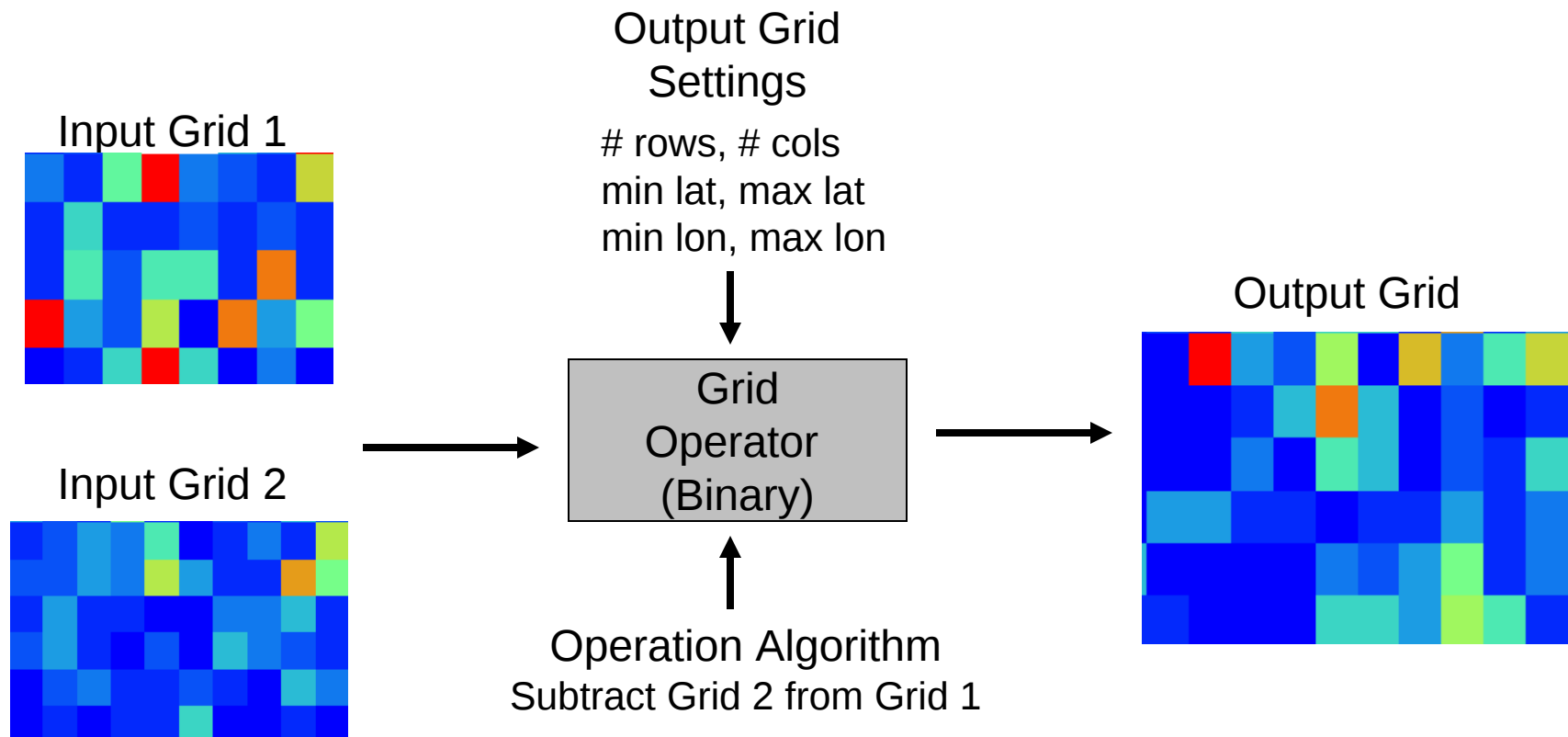
Point-to-Grid Service

takes a set of latitude, longitude points and sums the associated values for all points that fall within each grid cell of an output grid



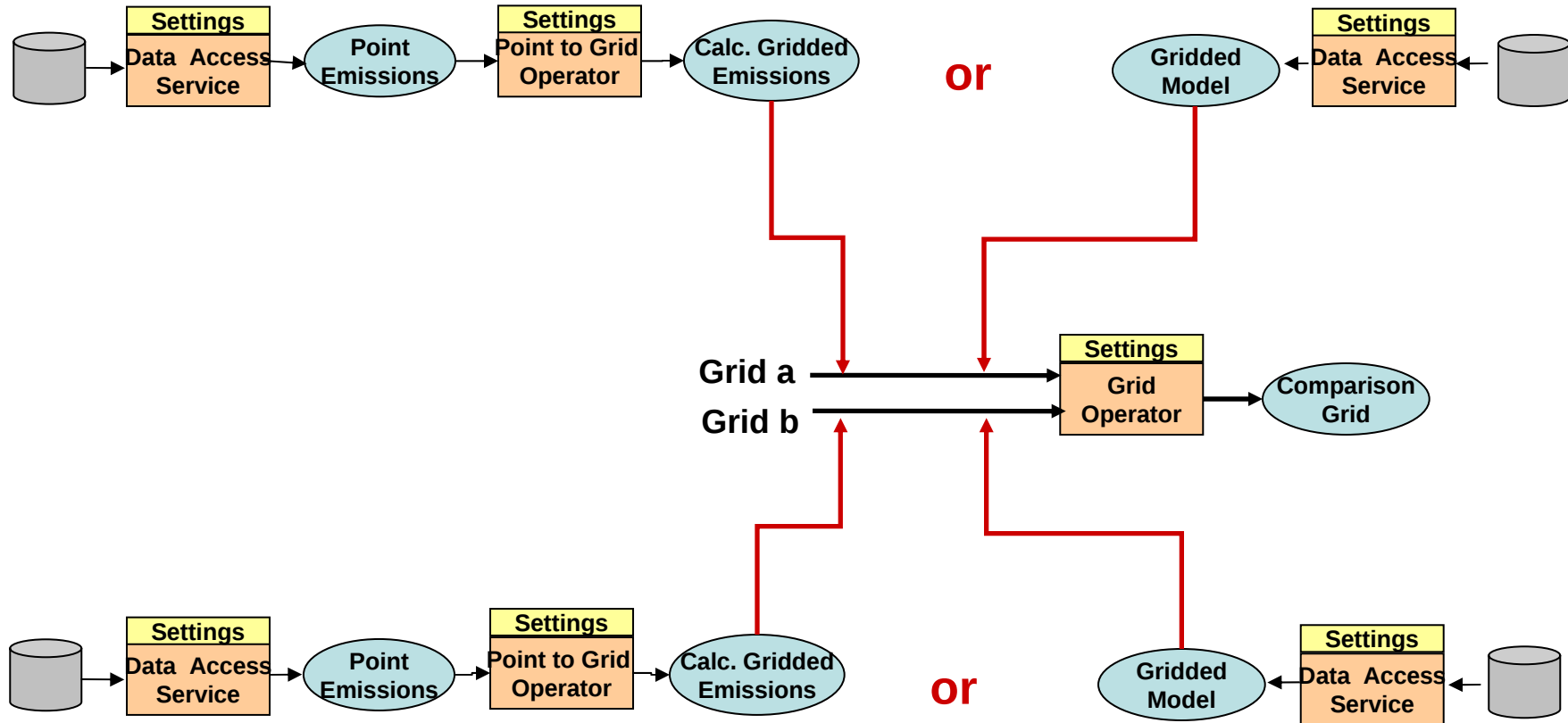
Grid Operator Service

takes two grids as input, conducts a mathematical operation using their values, and creates a single grid output



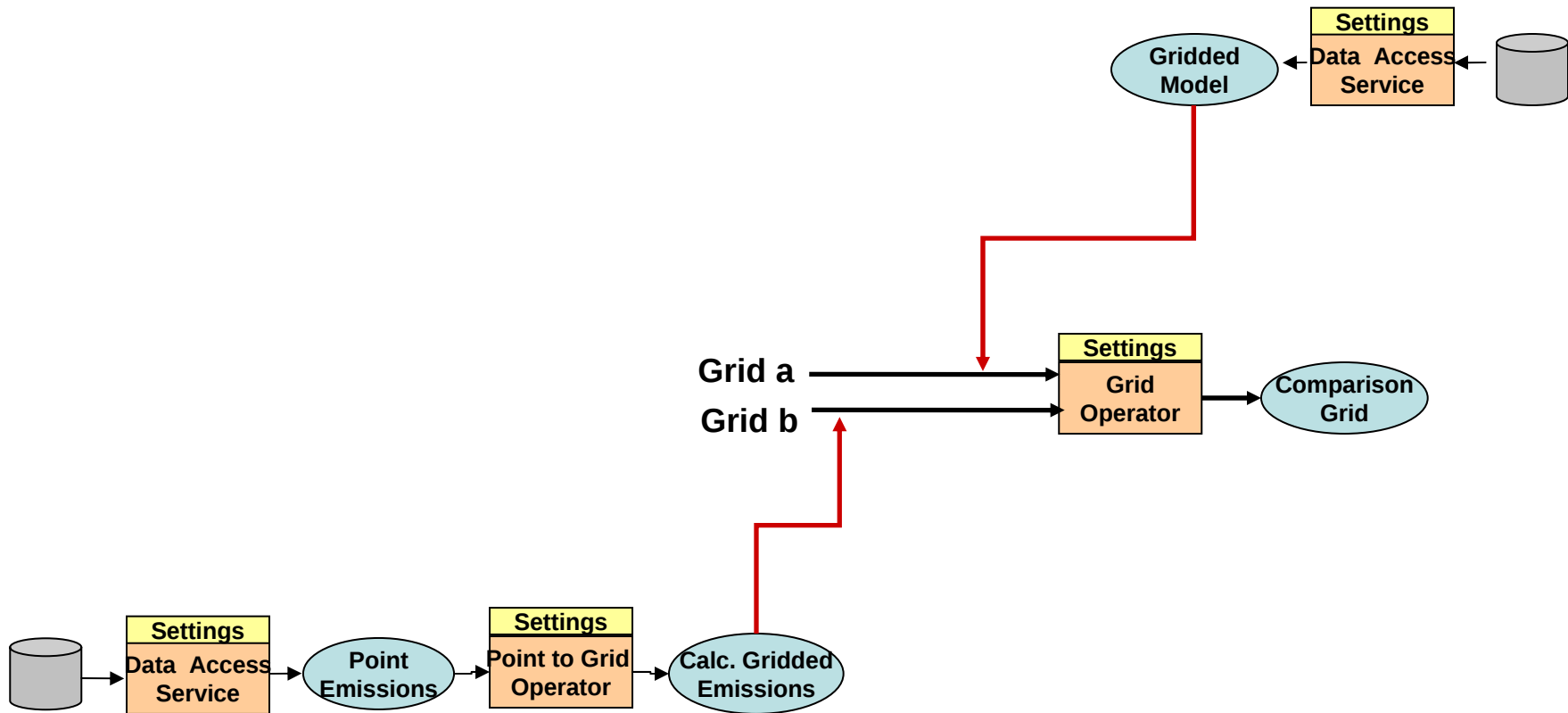
Emissions Analysis Process

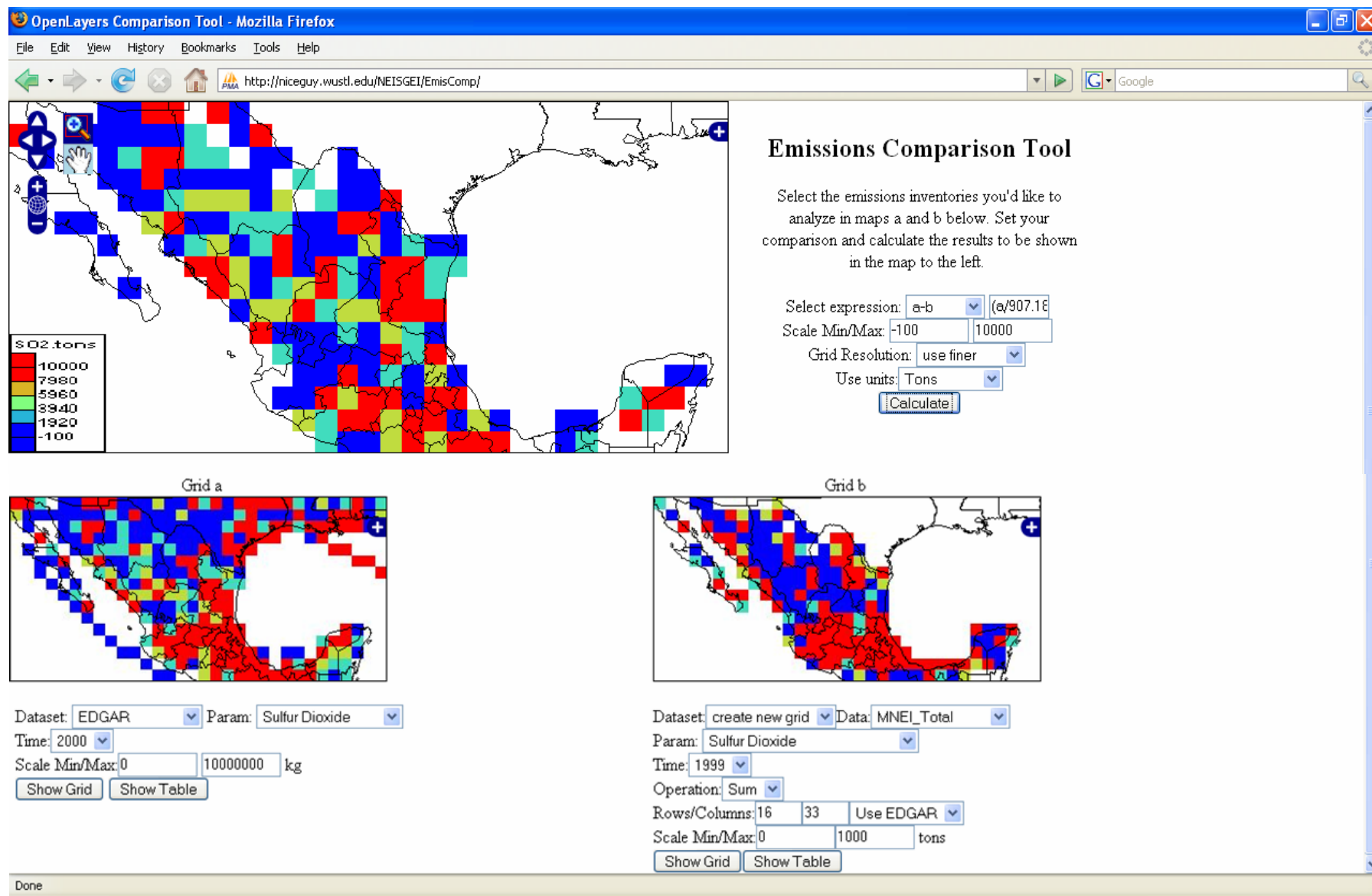
Connecting services: from distributed data to an emissions comparison



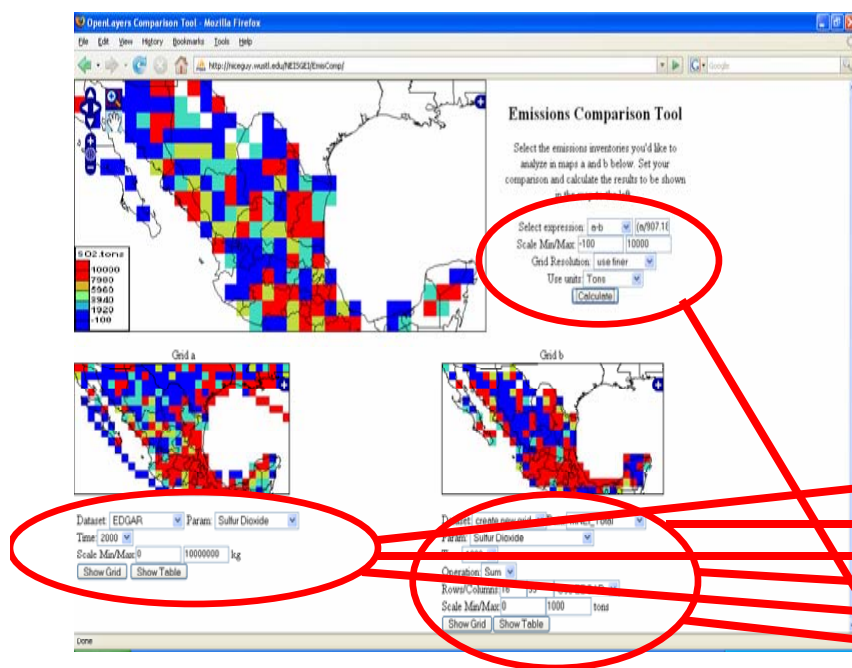
Emissions Analysis Process

Connecting services: from distributed data to an emissions comparison





<http://niceguy.wustl.edu/NEISGEI/EmisComp/>



http://datafed2.seas.wustl.edu/dvoy_services/ogc_views_NEISGEI.wsf?

```

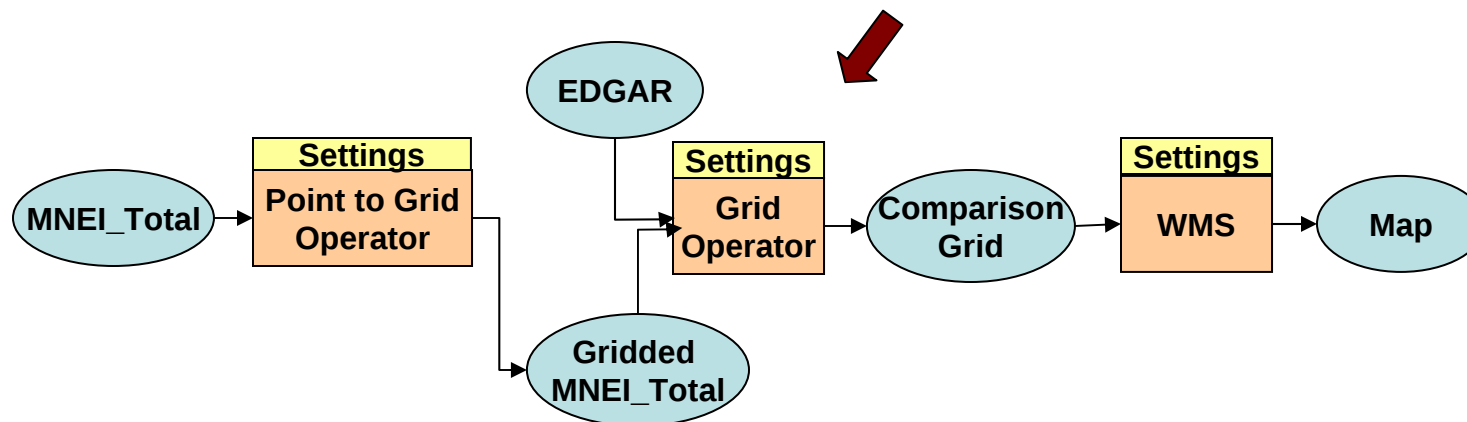
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```

WMS

Grid a

Grid b

Grid Operator



Acknowledgements

Ed Fialkowski developed the NEISGEI Web Coverage Service and the javascript, php and python code for the comparison web application.

Kari Hoijarvi provided key technical guidance on the data access and analysis services, the service flow engine and in working with netCDF.

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Emissions comparison application, data access services and analysis services are further described and accessible at:

<http://www.neisgei.org>

Backup Slides

