RIMS:
Rapid Integrated Mapping and Analysis System

(Online GIS tools for data visualization, analysis, manipulation, and education)

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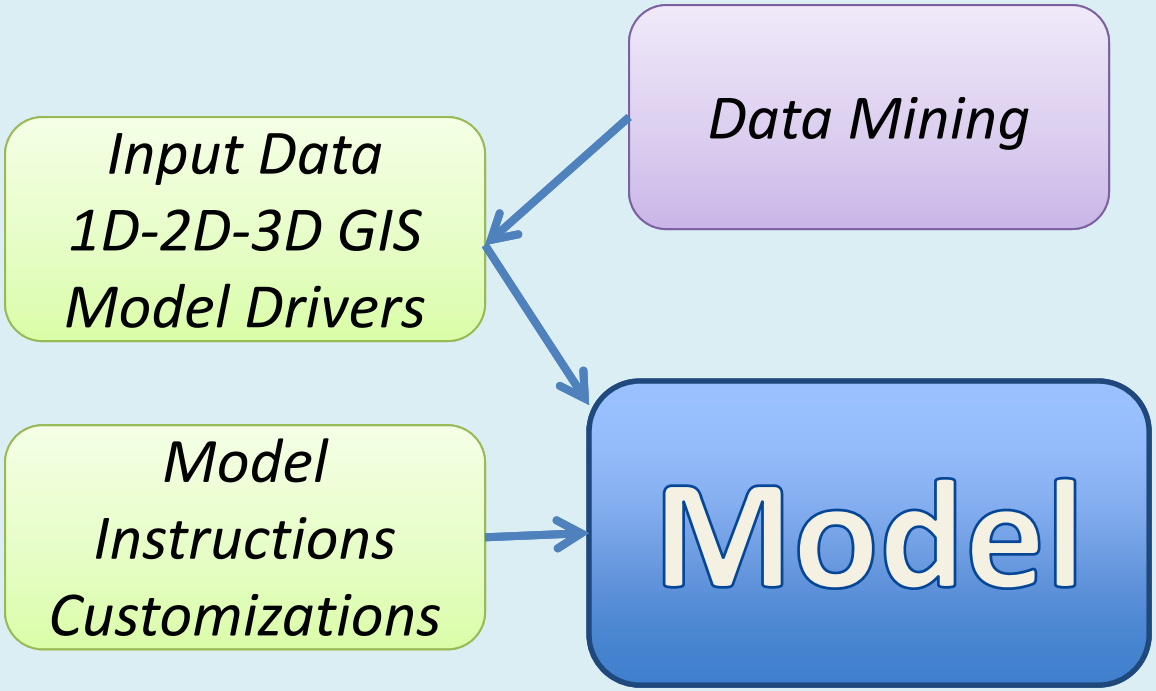
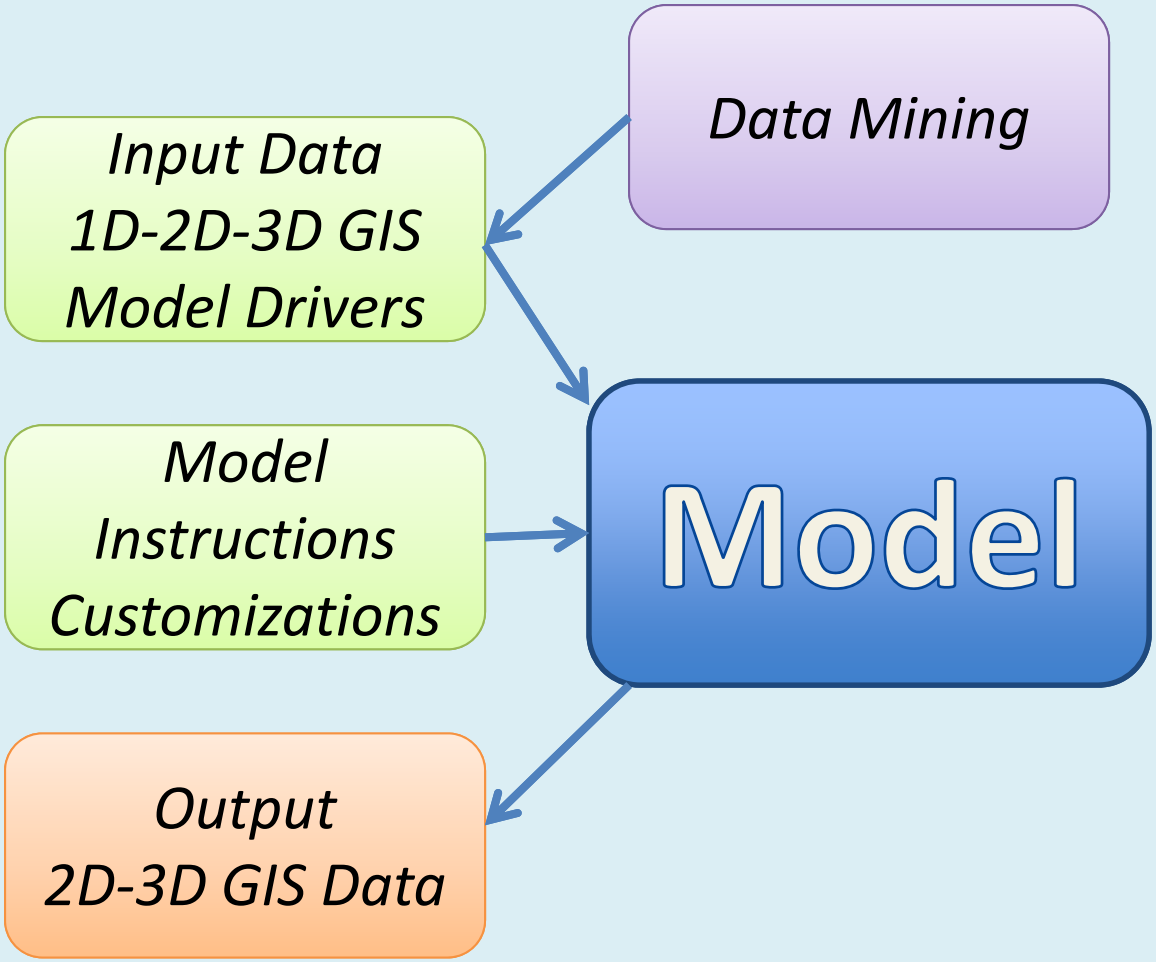
http://earthatlas.sr.unh.edu/maps
http://neespi.sr.unh.edu/maps
http://nh-rims.sr.unh.edu/maps
http://www.riverthreat.net/maps
http://riceghg.sr.unh.edu/maps


Model


Data Mining
Input Data
1D-2D-3D GIS
Model Drivers
Model
Instructions
Customizations
Model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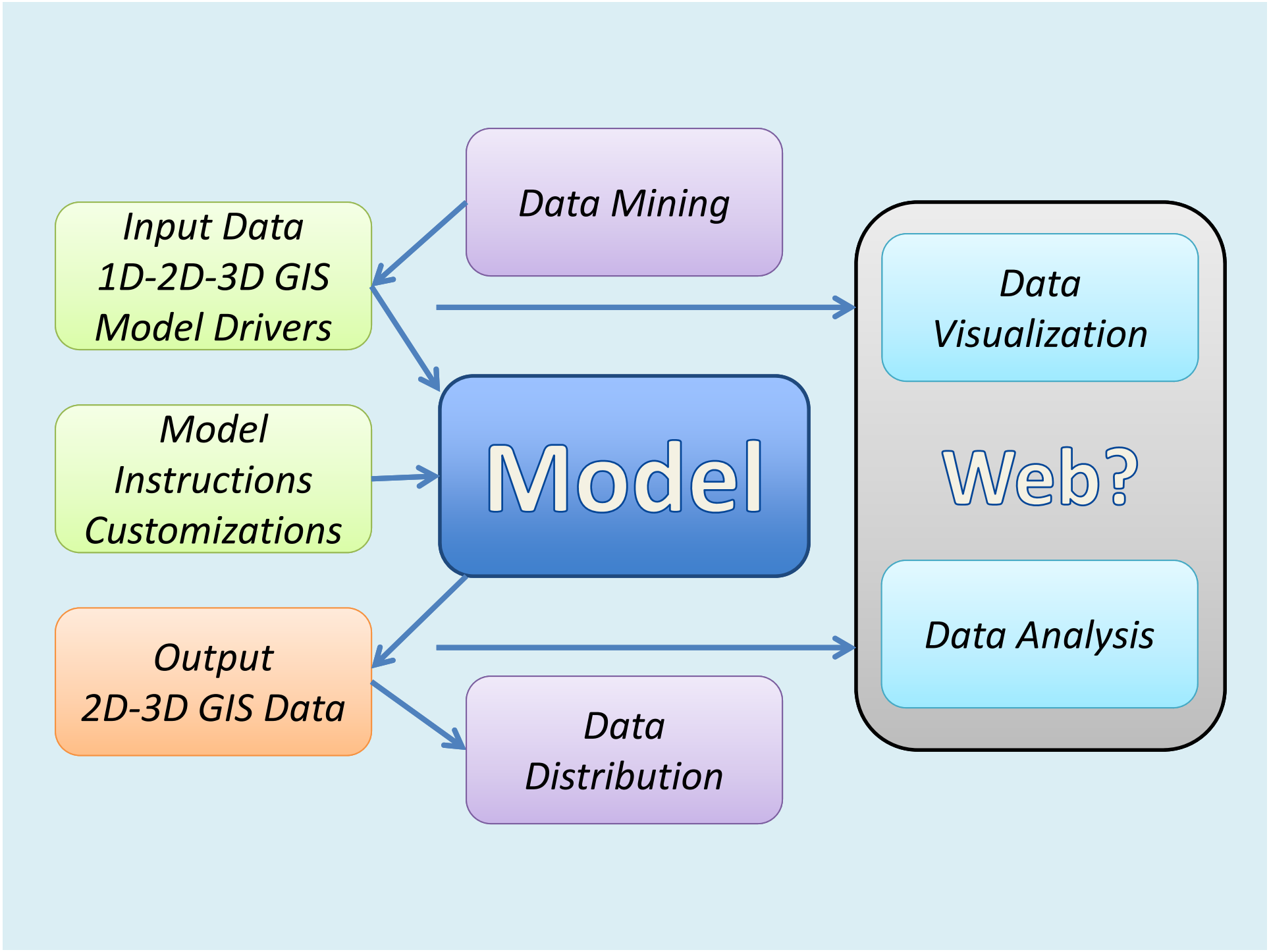
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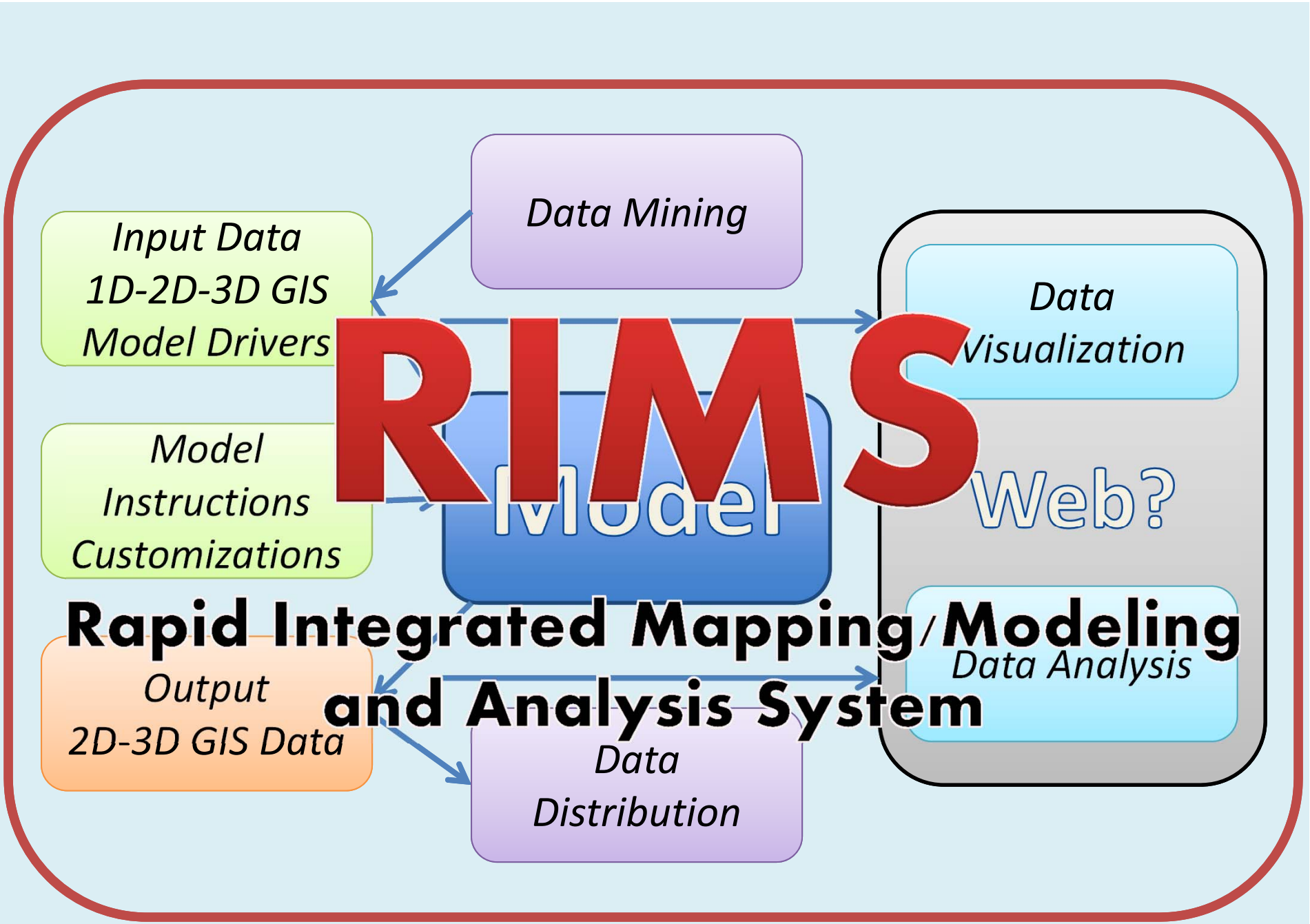
Web?
Data Analysis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1D-2D-3D GIS
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Data
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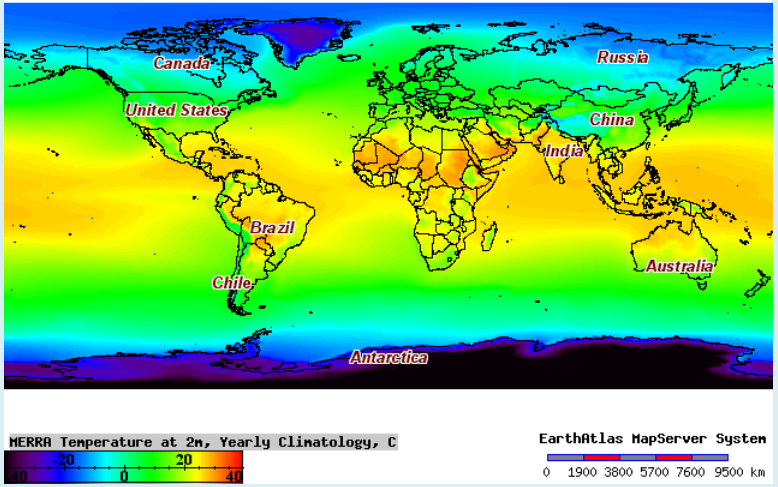
RIMS
Model
Web?
Model
Instructions
Customizations
Rapid Integrated Mapping/Modeling
and Analysis System
Data Analysis
Output
2D-3D GIS Data
Data
Distribution

Core Functions of the RIMS

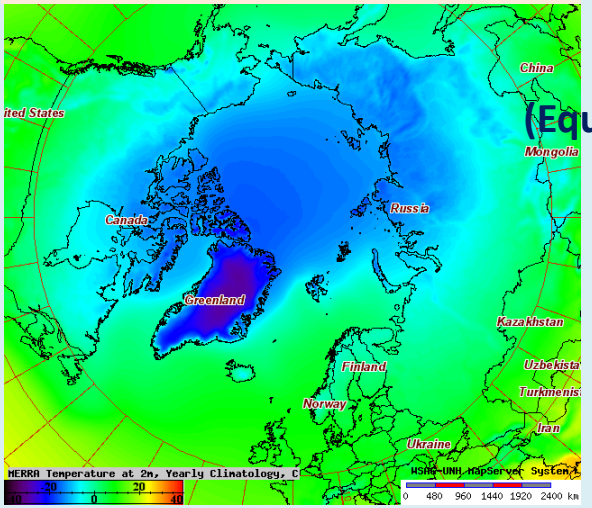
Data management	Data acquisition, aggregation, production	Data visualization, exploration	Data manipulation
Offline Access- Command line, GUI Interfaces		**Online Access- Web Client Interface to Web Services**	
• Create **abstraction data access** by Data ID that allows on-the-fly spatial re-projection, re-gridding, sub-setting, etc. • Distributed LAN storage and onsite and offsite backup • Data distribution and sharing (FTP)	1. Data mining- • On demand • Scheduled or automated 2. Data aggregation- • Temporal • Spatial • Downscaling 3. Modeling- • Manual • Batch runs • Scheduled runs	• Mapping • Graphing • Animations • Queries • Data access • Station/Point data access • Data masking • Etc.	• Web GIS • Advanced data queries • Data manipulation • Data calculations • Data integration • Time series integration

Illustration of a Dataset Abstraction with Web Map Services (WMS)

earthatlas.sr.unh.edu/maps



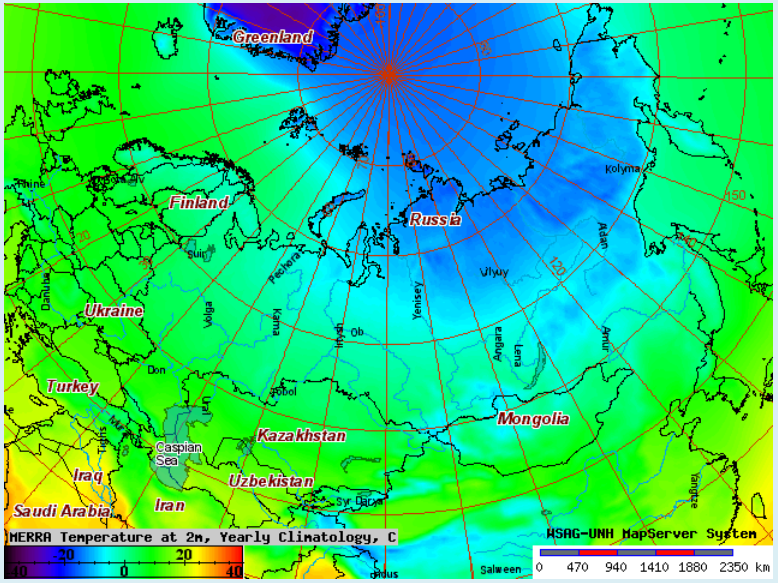
nh-rims.sr.unh.edu/maps

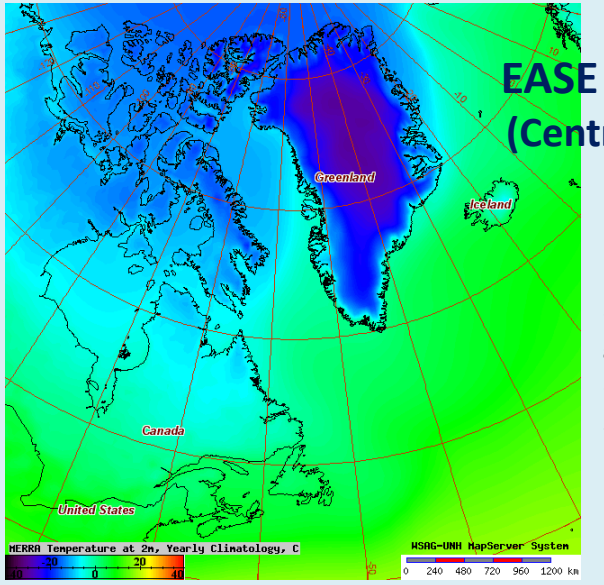


EASE projection
(Equal Area Scalable Earth)
Polar view

In fixed projection like this zooming to Alaska will result in showing it upside down (North down and South up).

neespi.sr.unh.edu/maps

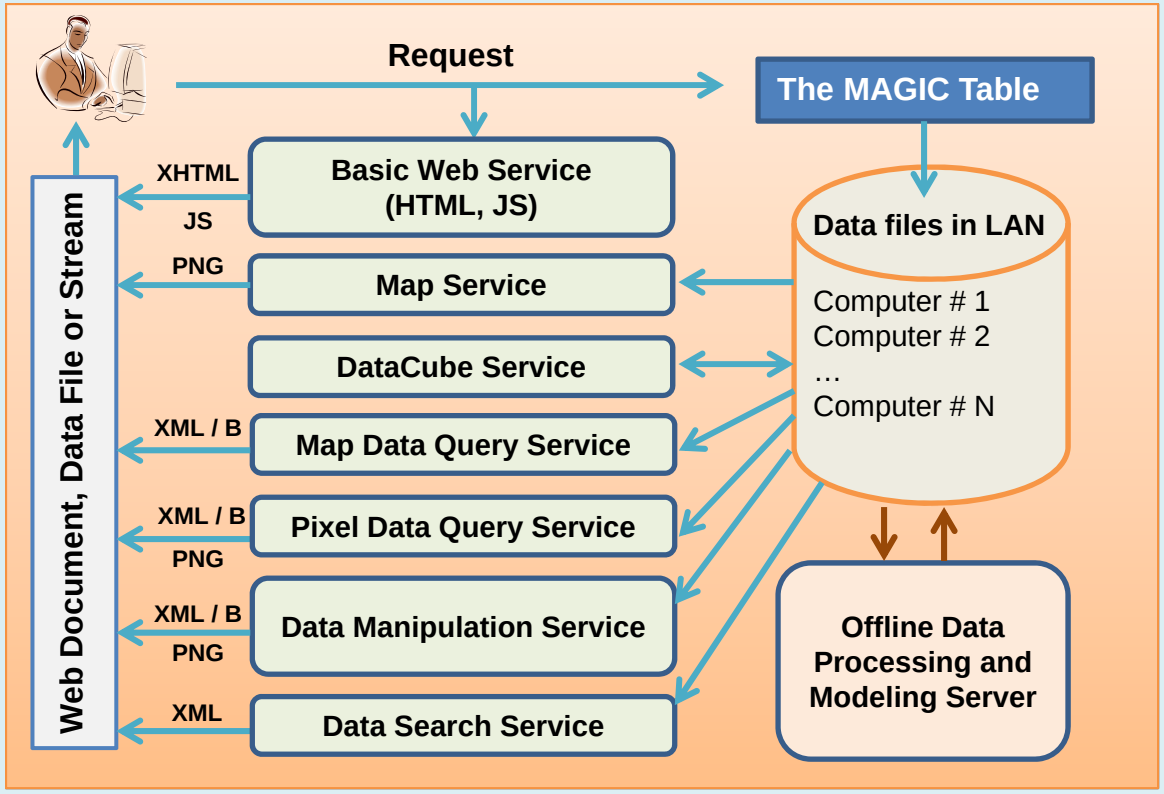


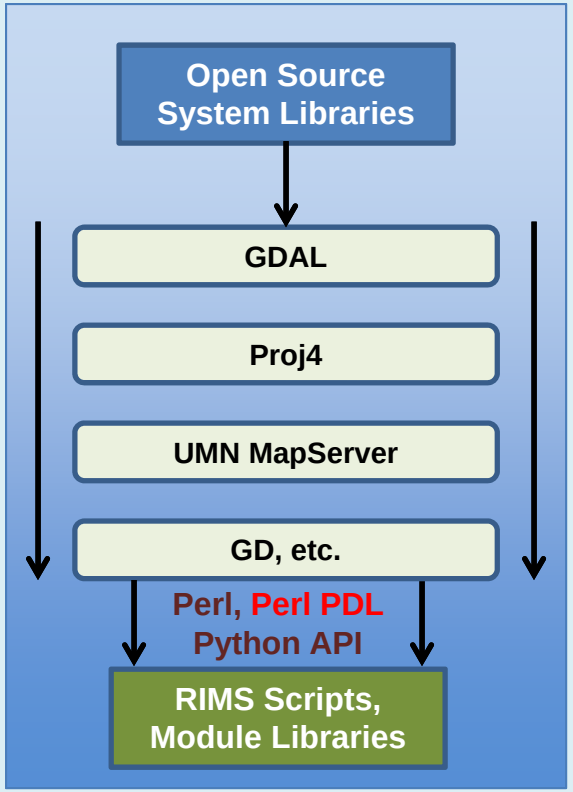


EASE adaptive projection
(Central Meridian to North)

In adaptive projection like this zooming or panning to any geographical area will automatically rotate map view so that North always positioned upward.

Conceptual software design for the RIMS





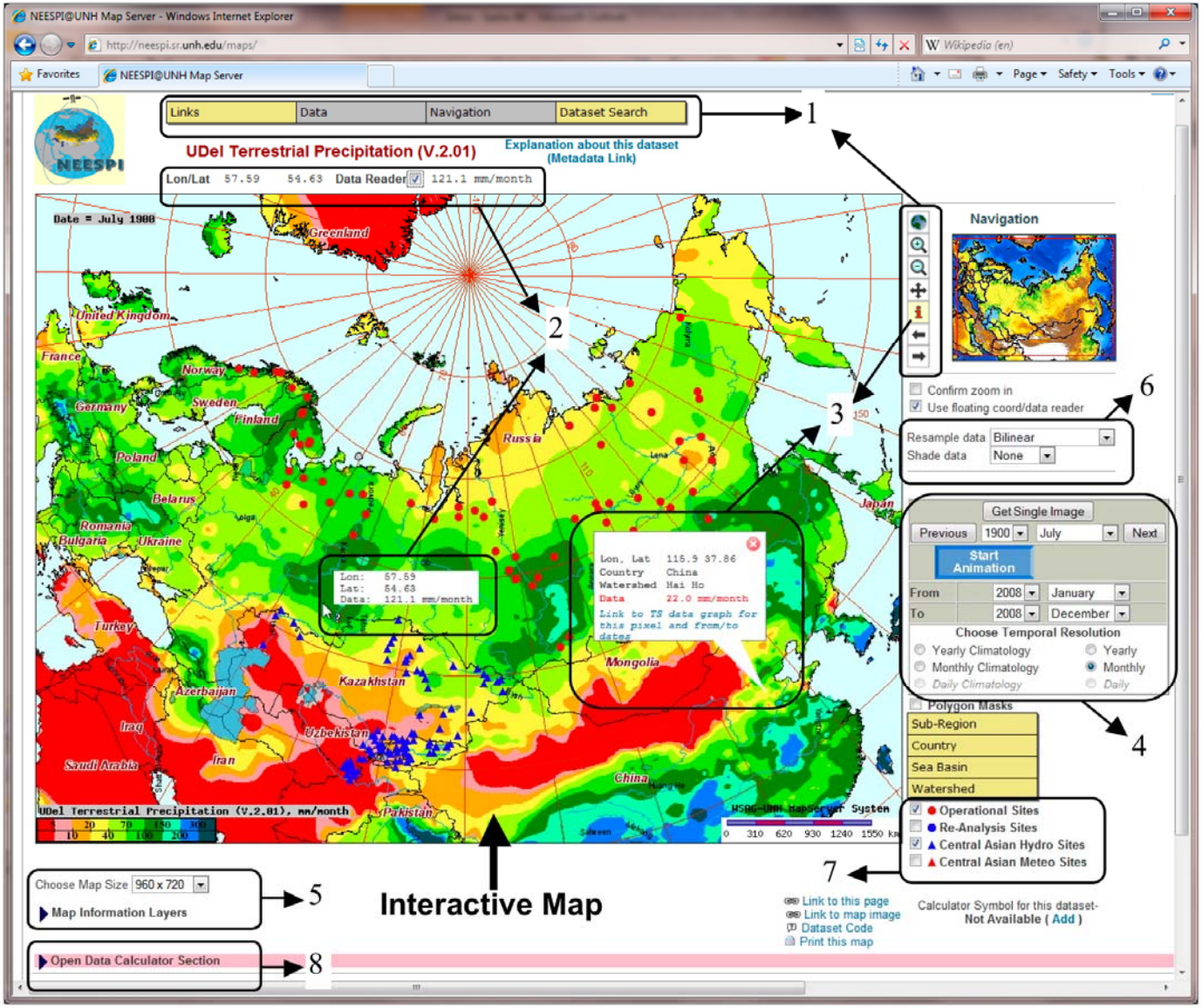
A Web user generates a sequence of requests to the RIMS system which are evaluated, processed and assembled to a document, graphics or data file utilizing a number of stand-alone services that use the same pool of raw data which, in turn, has all its metadata summarized in the Manipulation and Geographic Inquiry Control (MAGIC) Table. New data becomes immediately available to a user as soon as its metadata is added.

Conceptual structure of the Manipulation and Geographic Inquiry Control (MAGIC) Table

Block (Size)	Fields & Headers	Function
ID (4)	Data ID, DataCube ID, Project ID, Data Group ID	Unique IDs to identify data
Time Series (3)	TS type, steps, lists, Start/End dates	Time Series (TS) descriptors
Legend & Color Palette (3)	Legend, Palette	Value/Color lookup table and Legend bar image. Static or dynamic. Data attribute table locator.
Web Labels and Links (5)	Data name, Graph label, Units	Web names, labels, data units, data credit links
Unit conversion (2)	Scale, Offset	Unit conversion on-the-fly
GIS Projection (1)	Projection	EPSG or full proj+ projection definition for the source data
MapServer & GDAL options (12)	Sampling, Scaling, Central Meridian, Rounding, etc.	Map and data processing specific instructions
Data Locator (3)	File Path, Variable Name, Number of bands	Description of file organization to locate TS band within a file and within LAN file system.
Spatial Aggregation (3)	Aggregation path, Mask translation keys, Attributes	Information about spatial aggregation by given masks. Supports any number of masks per dataset
Site Specs (N)	Calculator symbols, others	Customization of a web site specific features

Summary of RIMS data holdings

Earth System Science Data Category	Key Sources	Examples of Major Parameters	Current Dataset Count	
			Source	Source + DataCube
Hydrology	UNH, CCNY	Discharge, runoff, river networks, irrigation, dams	200	250
Past and Present Climate	NASA, NOAA, UDel, Princeton U.	Temperature, precipitation, evapotranspiration (ET), heat radiation, pressure, wind	70	210
	NCEP, MERRA		62	160
Future Climate and Hydrology	IPCC, UNH	Temperature, precipitation, ET, snow, runoff, discharge	680	4100
Remote Sensing	MODIS, UNH, UOklahoma	Vegetation indices, soil moisture, clouds	48	60
Physical Geography	NASA, USGS, UNH	Elevation, bathymetry, Blue Marble, Lon/Lat	28	22
Oceanography	NOAA, NCOF	SST, sea ice	3	4
Land Cover	UM, NASA, USGS	Land cover, vegetation, permafrost, freeze/thaw	60	80
Sociology and Economics	CIESIN, World Bank, US CIA, UNH	Population, GDP, industry, mortality/birth/malnutrition rates	30	60
Agriculture	UWisc, Various	Crop land, crops, fertilizer loads, greenhouse emissions	160	200
Polygon Masks	UNH	Watershed, sea/ocean catchments, continents, countries, administrative units	18	18
Station Data	UNH, AGS	Hydrology, climate, public health	8	8
		Total	~1400	~5100



Web Client application for the RIMS system

1) data search/selection, spatial navigation, metadata link, etc.;

2) coordinate and map data value reader;

3) pixel query tool (i-tool) gets coordinates, country, watershed, and map data value;

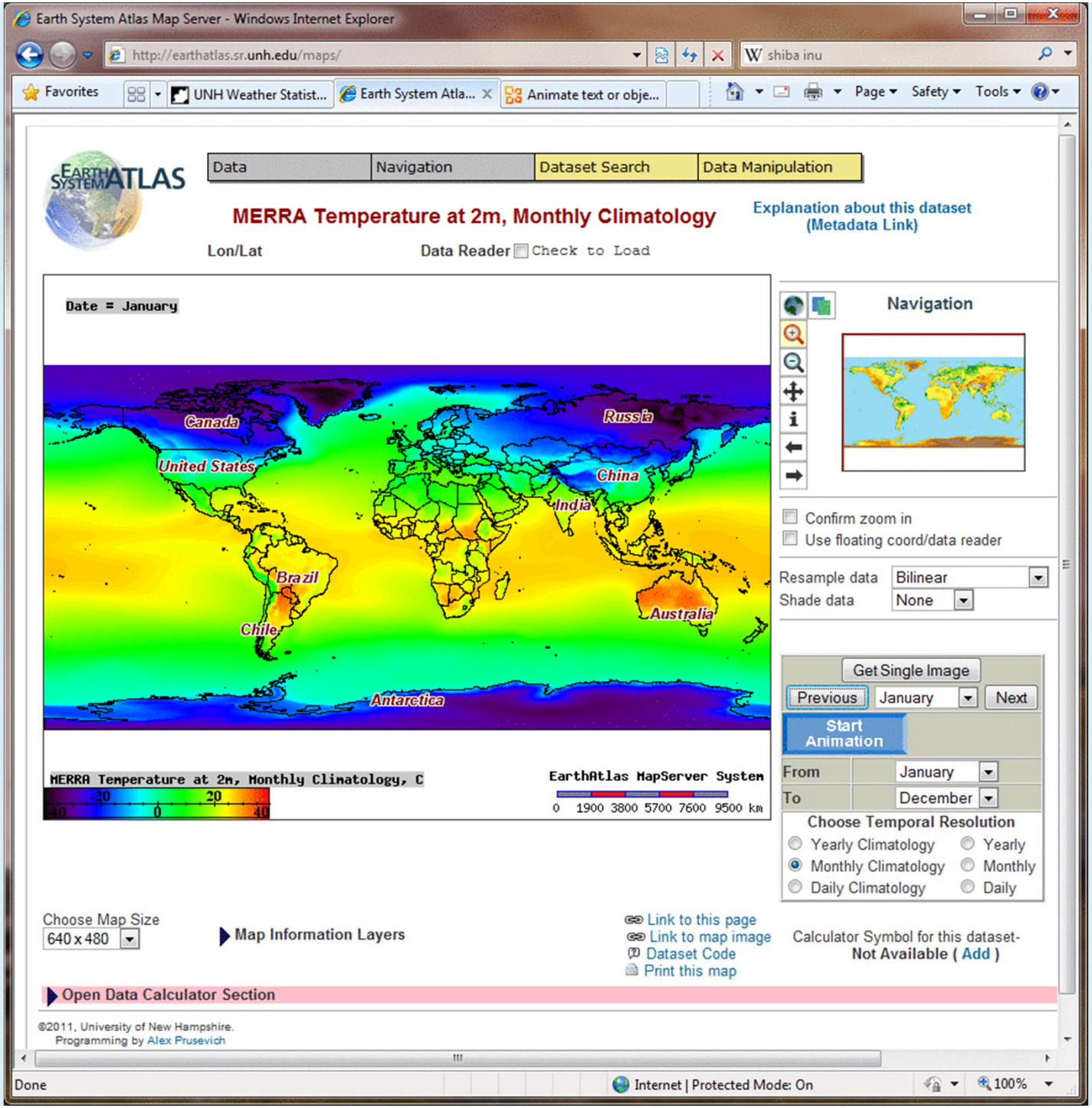
4) time series navigation tool;

5) map size and base layer choices;

6) data interpolation and shading tools;

7) point/station data list with clickable symbols that open station pages in a separate browser window;

8) fold-out section to run the Data Calculator application to perform mathematical and logical functions over gridded or vector datasets;.


Earth System Atlas Map Server - Windows Internet Explorer
http://earthatlas.sr.unh.edu/maps/
shiba inu
Favorites
UNH Weather Statist...
Earth System Atla...
Animate text or obje...
Page
Safety
Tools
EARTH SYSTEM ATLAS
Data
Navigation
Dataset Search
Data Manipulation
MERRA Temperature at 2m, Monthly Climatology
Explanation about this dataset
(Metadata Link)
Lon/Lat
Data Reader
Check to Load
Date = January
Canada
Russia
United States
China
India
Brazil
Australia
Chile
Antarctica
MERRA Temperature at 2m, Monthly Climatology, C
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-20
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20
40
EarthAtlas MapServer System
0 1900 3800 5700 7600 9500 km
Navigation
Confirm zoom in
Use floating coord/data reader
Resample data
Bilinear
Shade data
None
Get Single Image
Previous
January
Next
Start Animation
From
January
To
December
Choose Temporal Resolution
Yearly Climatology
Yearly
Monthly Climatology
Monthly
Daily Climatology
Daily
Choose Map Size
640 x 480
Map Information Layers
Link to this page
Link to map image
Dataset Code
Print this map
Calculator Symbol for this dataset-
Not Available (Add)
Open Data Calculator Section
©2011, University of New Hampshire.
Programming by Alex Prusevich
Done
Internet | Protected Mode: On
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Point/Station data linked to RIMS system

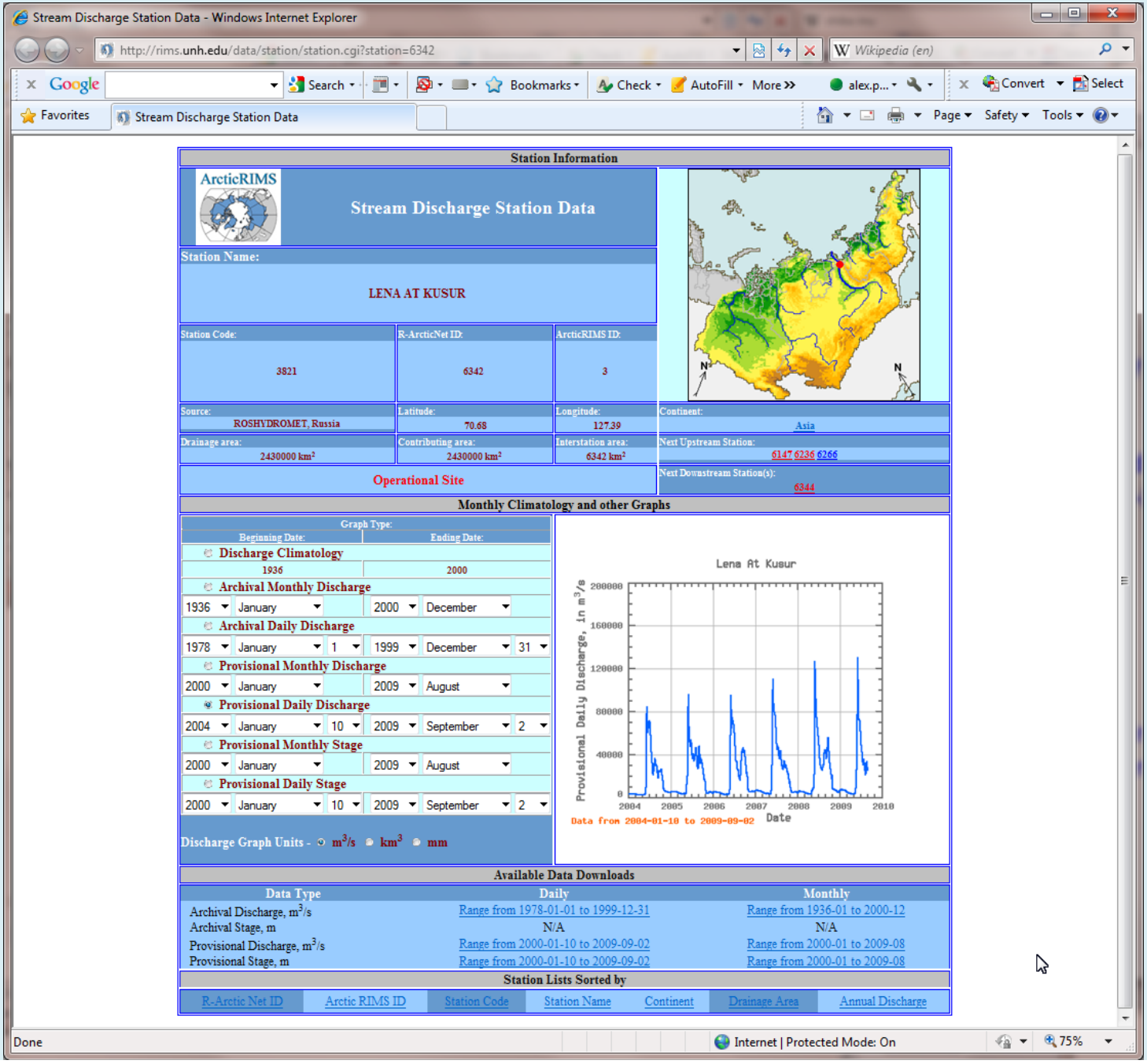
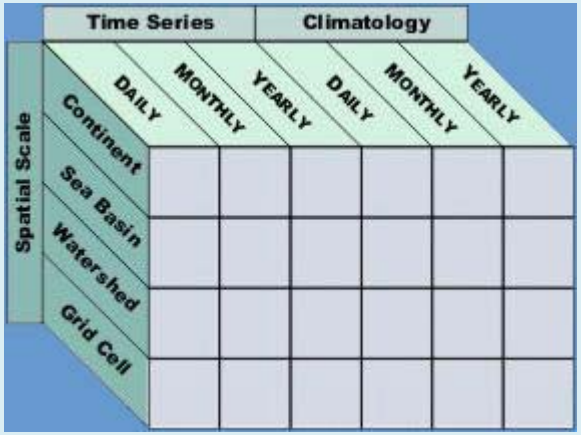


Illustration of DataCube Data Aggregation Concept Used in RIMS



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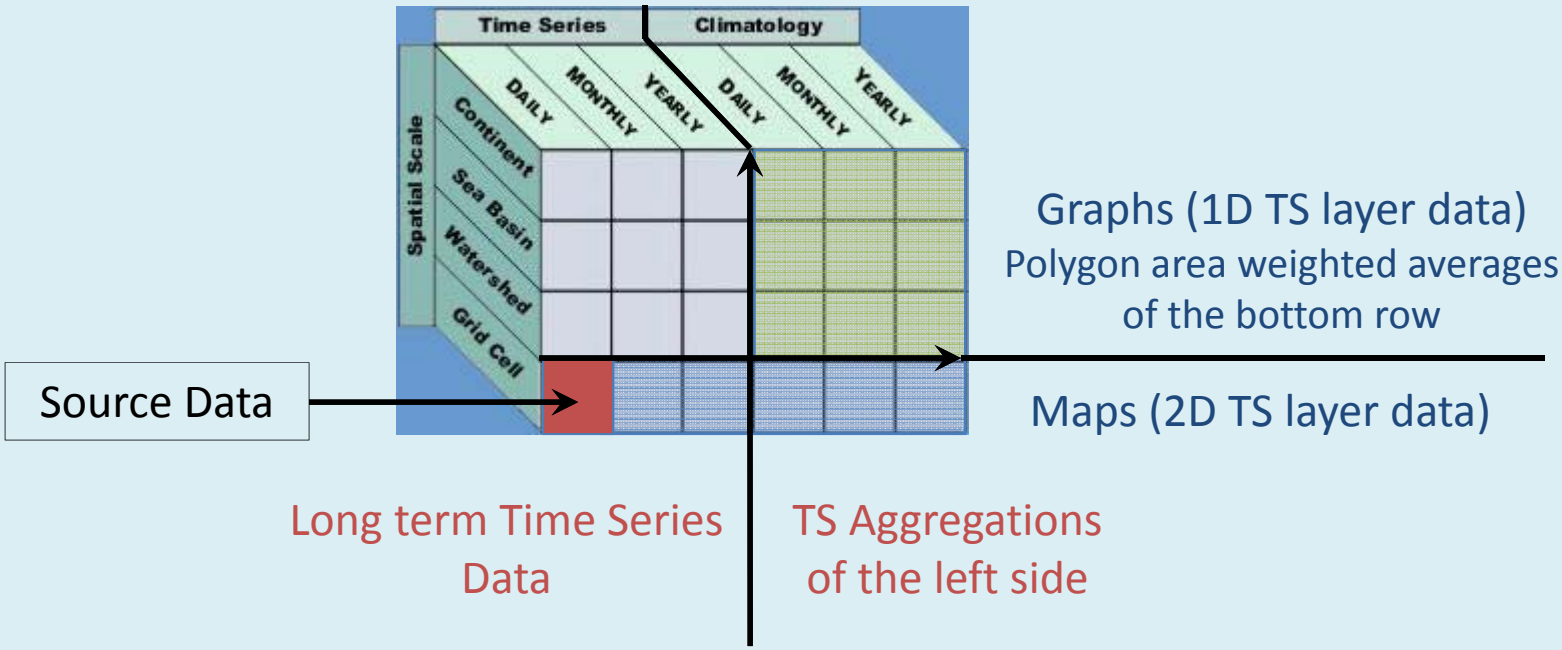
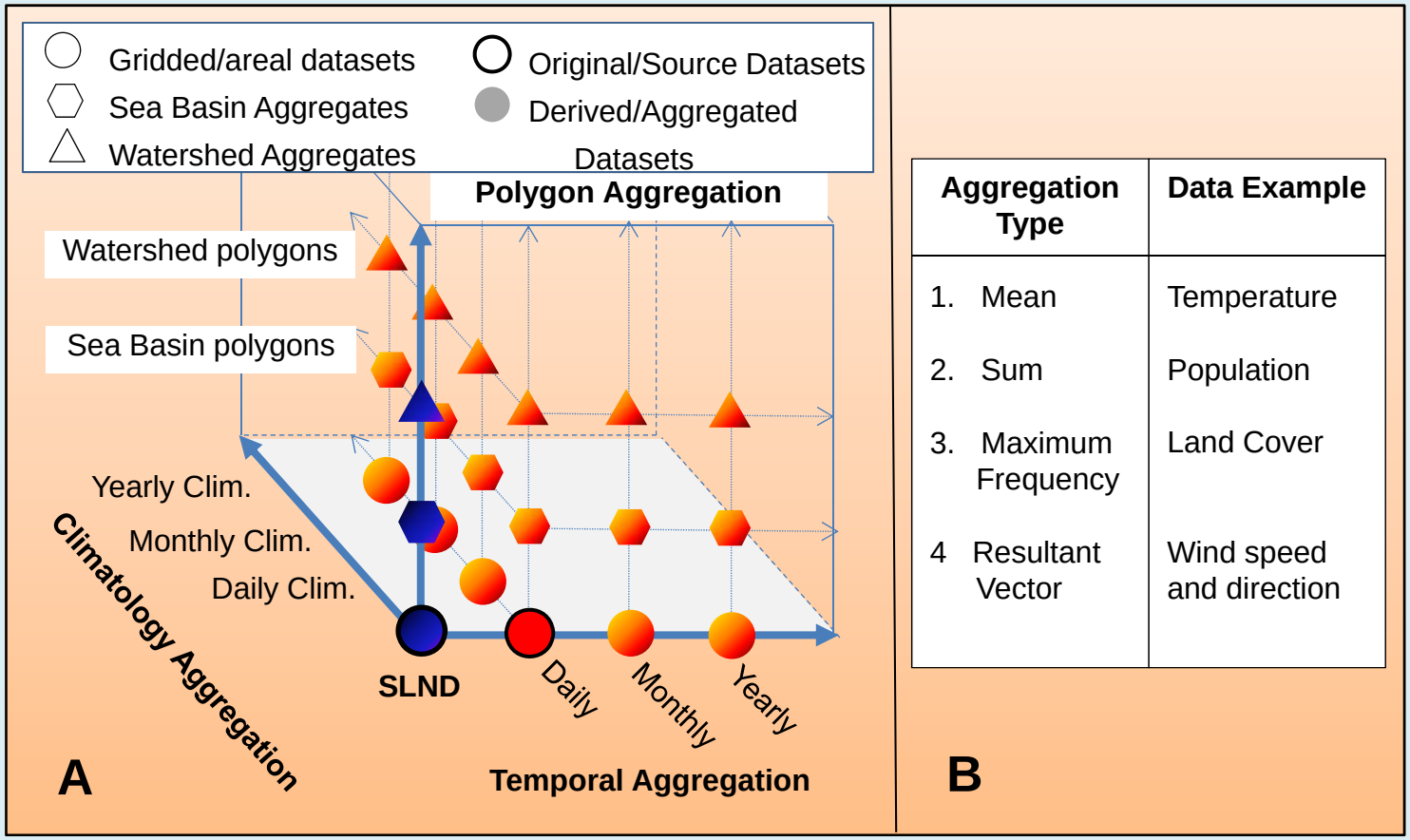


DataCube aggregation scheme used in RIMS

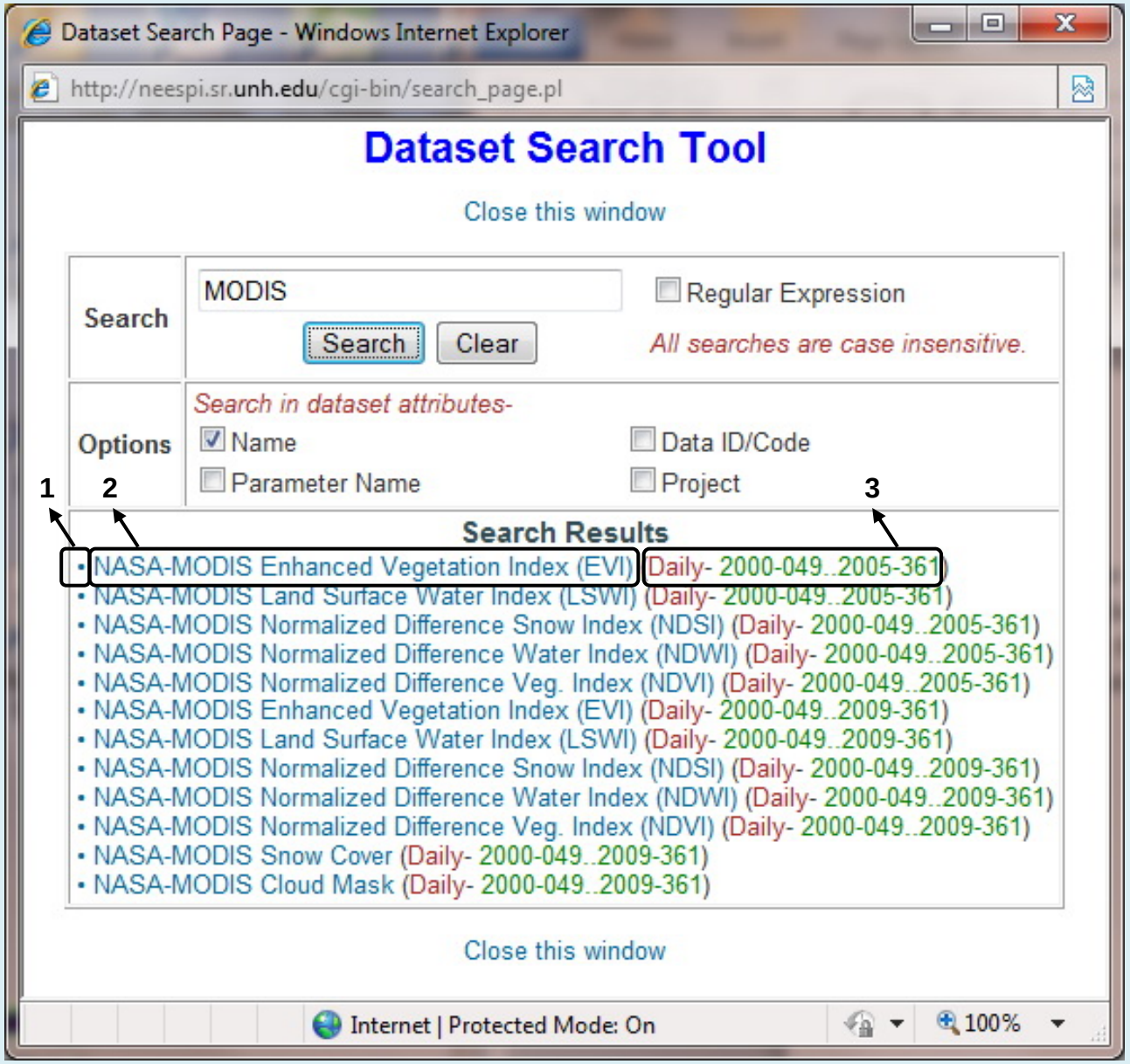


Aggregation Type	Data Example
1. Mean	Temperature
2. Sum	Population
3. Maximum Frequency	Land Cover
4 Resultant Vector	Wind speed and direction

(A) Original Daily dataset (e.g. NCEP daily temperature at 2 m) can be aggregated along the temporal scale to monthly and yearly derivative datasets, and along the climatology scale to daily, monthly and yearly climatology (long-term averages) derivative sub-datasets. In turn, each of these can be aggregated by any number of polygon sets (on the polygon aggregation scale) to polygon averages or cumulatives (e.g. average temperature per country). Single layer non-dated datasets (e.g. elevation) can be aggregated only along the polygon aggregation scale (e.g. average elevation of a watershed).

(B) Aggregation method can be one of the following types- (1) average, e.g. temperature; (2) cumulative, e.g. population; (3) max frequency, e.g. land cover; (4) vector average, e.g. wind

Web based Dataset Search Tool that uses DSS service

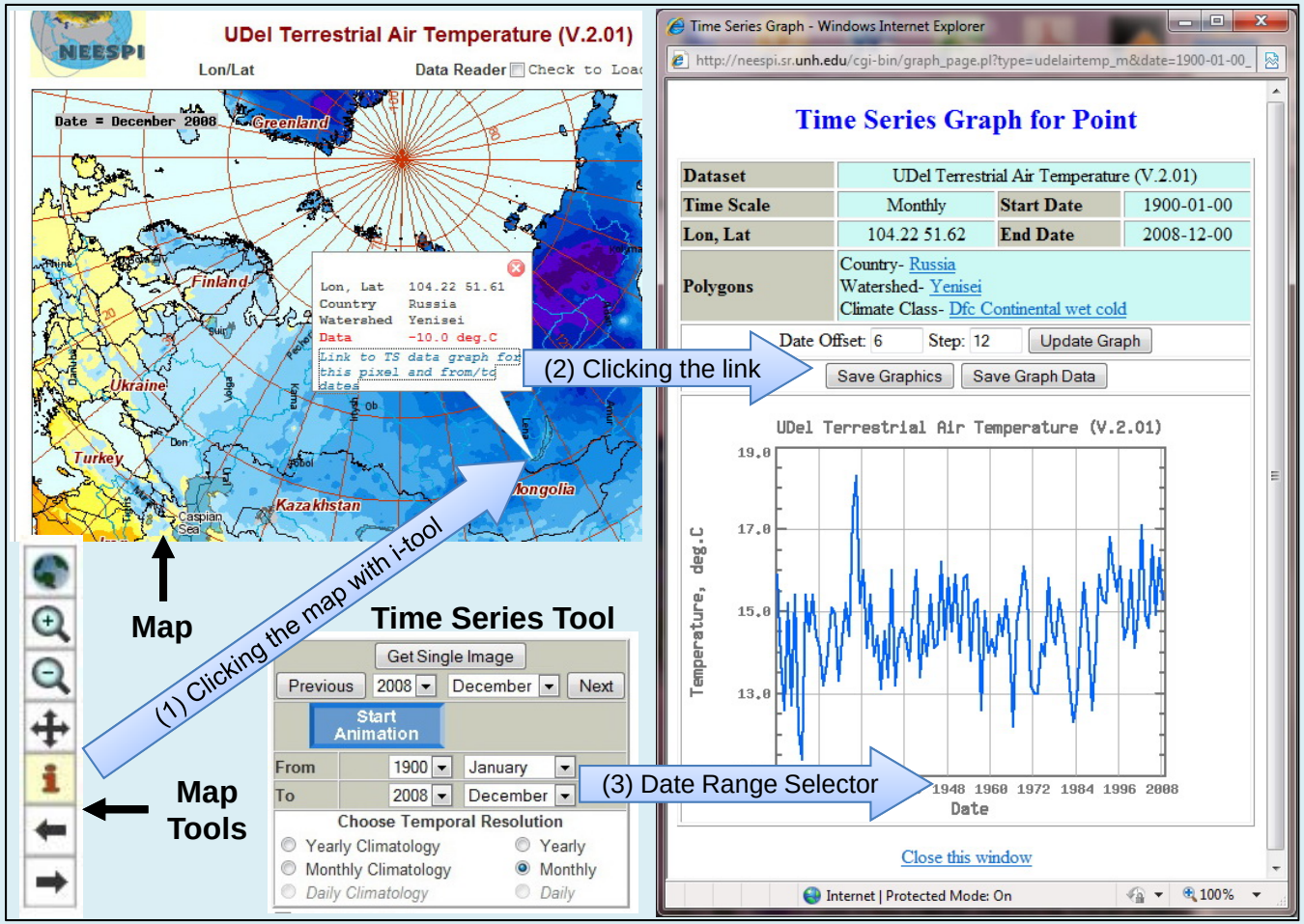


(1) Link to full metadata information.

(2) Link to the dataset visualization and manipulation in the parent Map page.

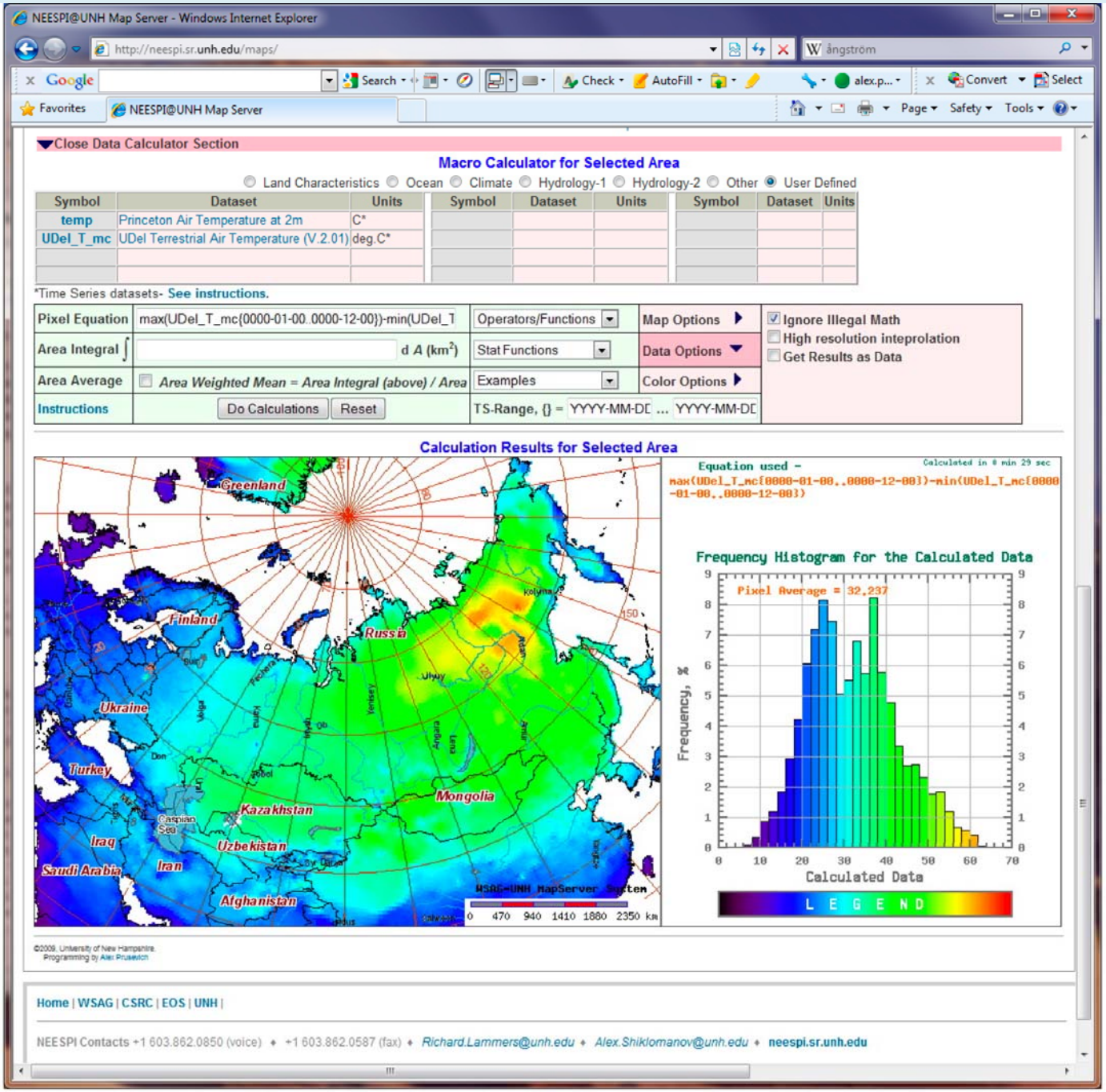
(3) Time series metadata information.

Components of RIMS Web client applicationthat utilize Pixel Data Query Service



In this example a time series graph for city of Irkutsk for summer month of July is displayed over a date range from 1900 to 2008. (1) Clicking the map with i-tool selected on the map toolbox brings a pixel information call-out box where basic data for the pixel is displayed such as coordinates, country, watershed, data value along with a link to time series data.

(2) Clicking the link brings a pop-up window for pixel time series data display where a user can choose options of a) data selector with date offset and step, b) saving graph with full information, c) saving graph data in a spreadsheet compatible format for analysis outside of the system, d) switch to polygon data and graphs where the selected pixel is present (in this example it is a country polygon for Russia, watershed polygon for Yenisei, and climate type polygon for Dfe class). (3) The date range for the graph is taken off the Time Series Tool on the map page (Figure 2), and a user can set a Date offset and Step in a Web form above the graph to plot any specific month or day of the year over a given range of years.



"Data Calculator" Web application that uses RIMS Data Manipulation Service.

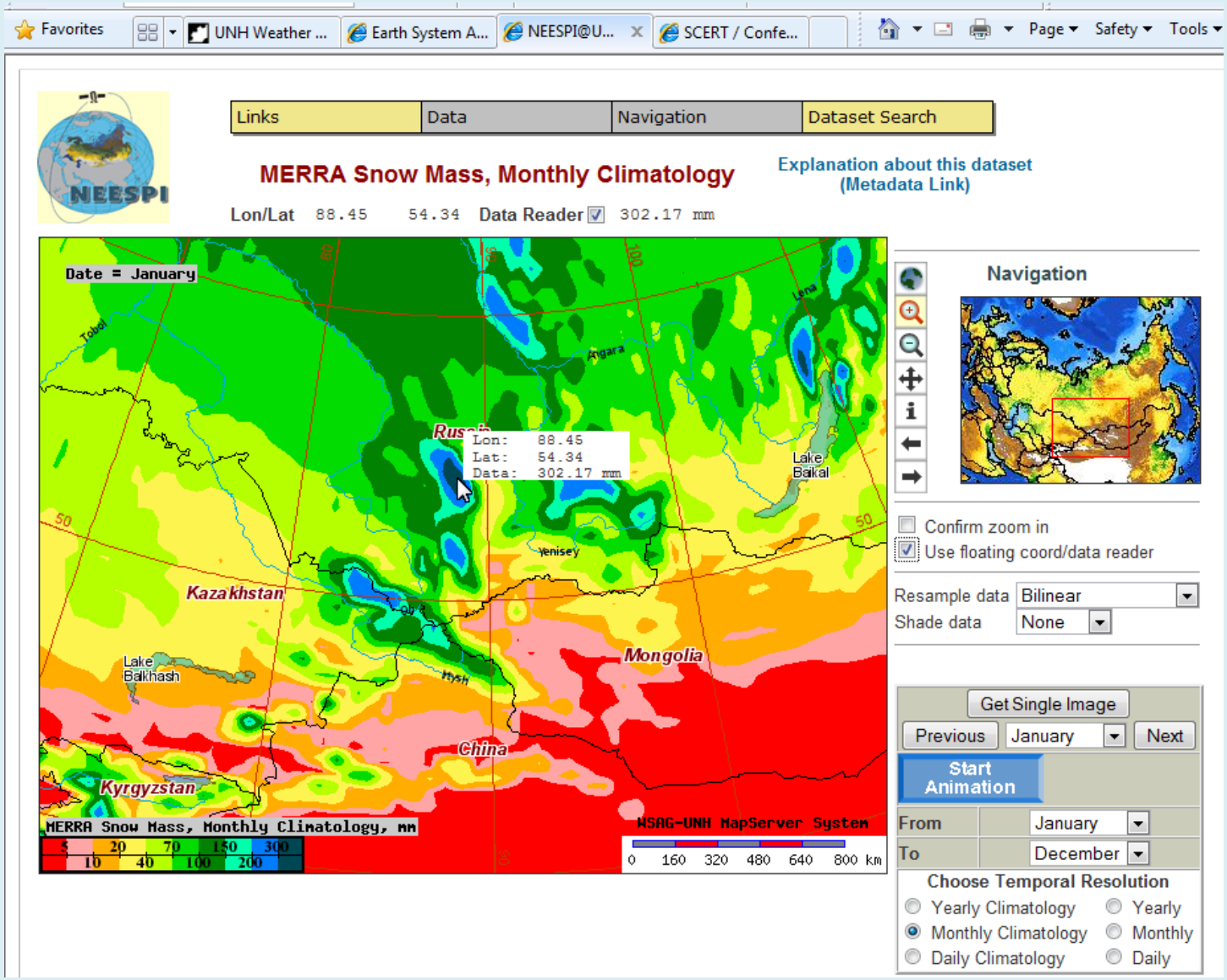
Example:
Temperature difference between the warmest and coldest month of the year is calculated for the NEESPI project.

The equation is entered in the "Pixel Equation" input form and the results are displayed as a map and frequency histogram at the bottom of the Web page.

Summary for the RIMS (Regional Integrated Mapping and Analysis System) system design and applications

1) The system is primarily used for data management, mining, aggregation, manipulation, automated or batch model runs.
2) Web visualization (maps, graphs, GIS calculator) is a secondary, but important side of the RIMS system. Web client API is scalable and customizable for a specific projects.
3) RIMS is designed for use in science applications. For example, NEESPI RIMS is a set of Web based and online research and data analysis tools that can be used for rapid analysis of various natural phenomena and events.
4) System is build on Open Source system libraries (e.g. GDAL, Proj4, UNM MapServer, GD) interfaced with Perl, Perl PDL, Python APIs.
5) RIMS can be ported or can be used for hosting data.
6) The system can be customized for education and other applications.

Demo # 1:
Reading map data values, class names on mouse over



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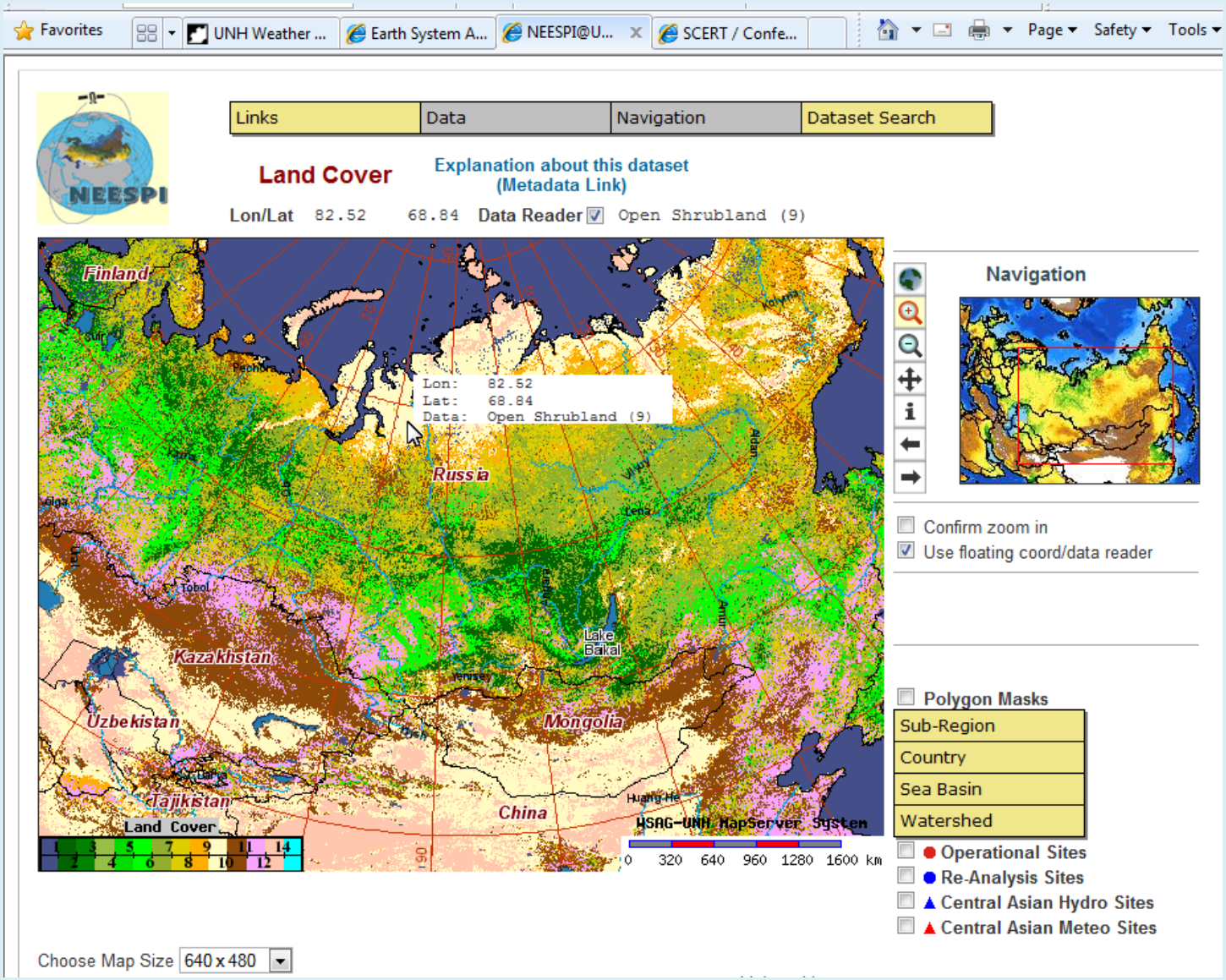
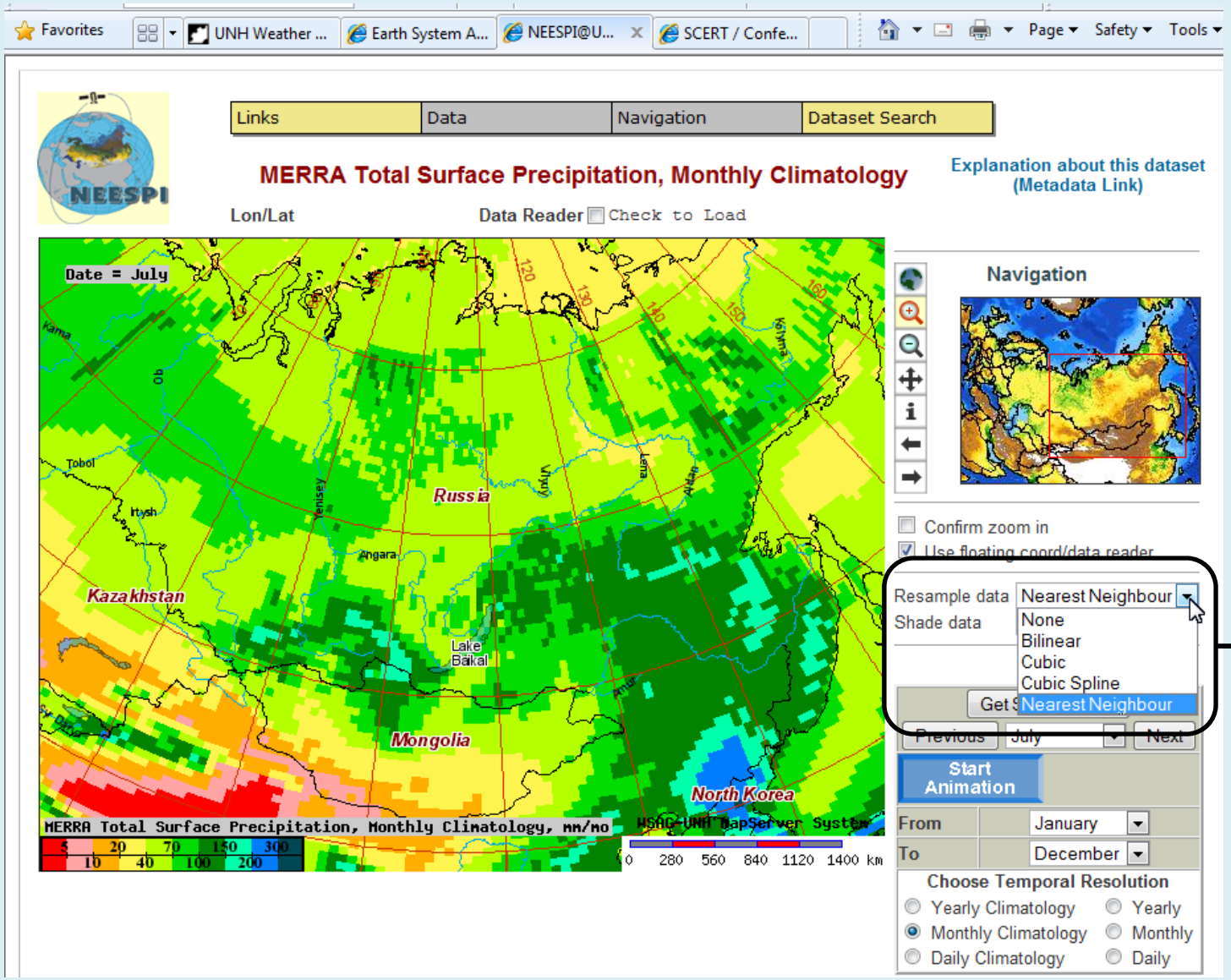


Demo # 2:
Controls of interpolation method



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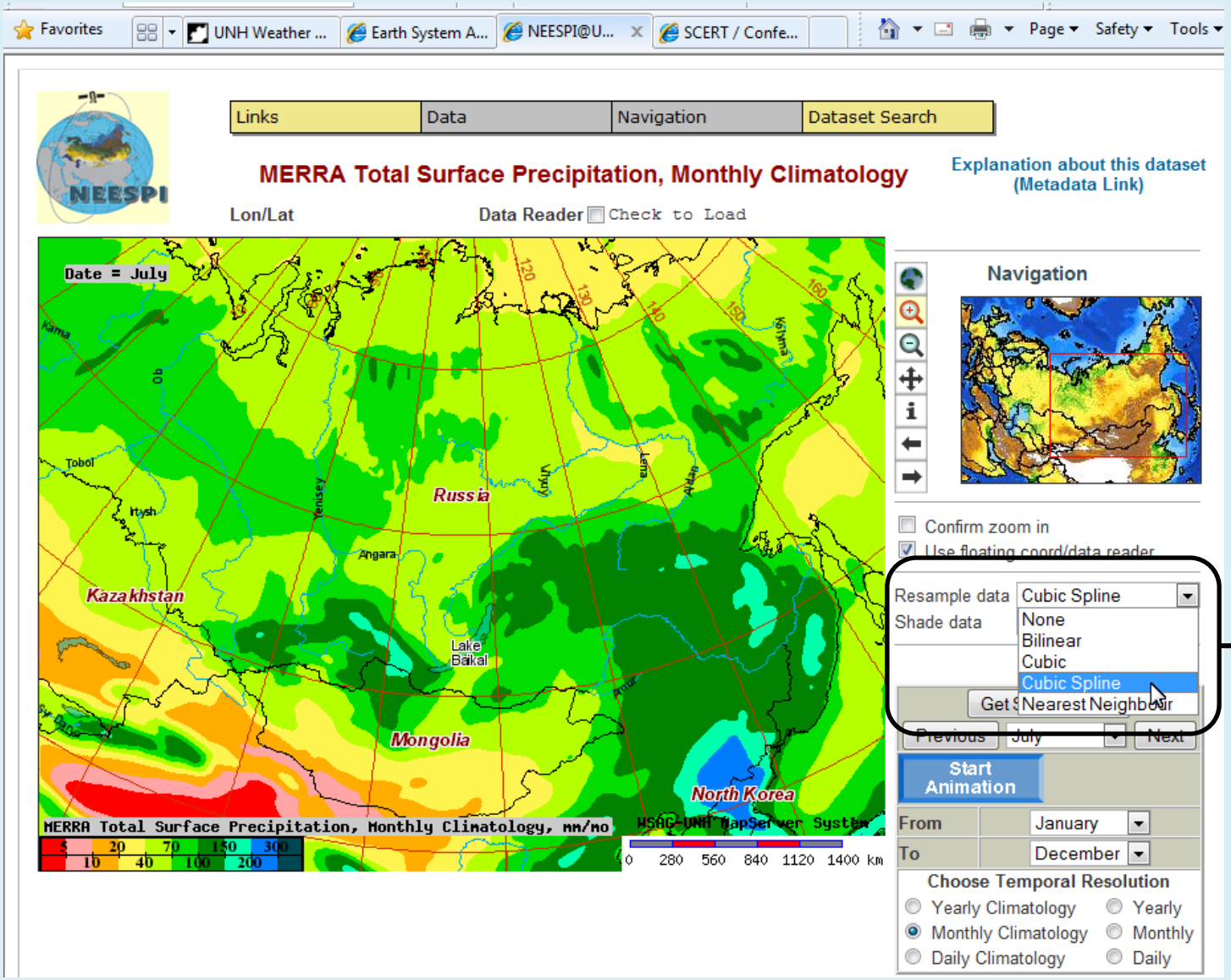

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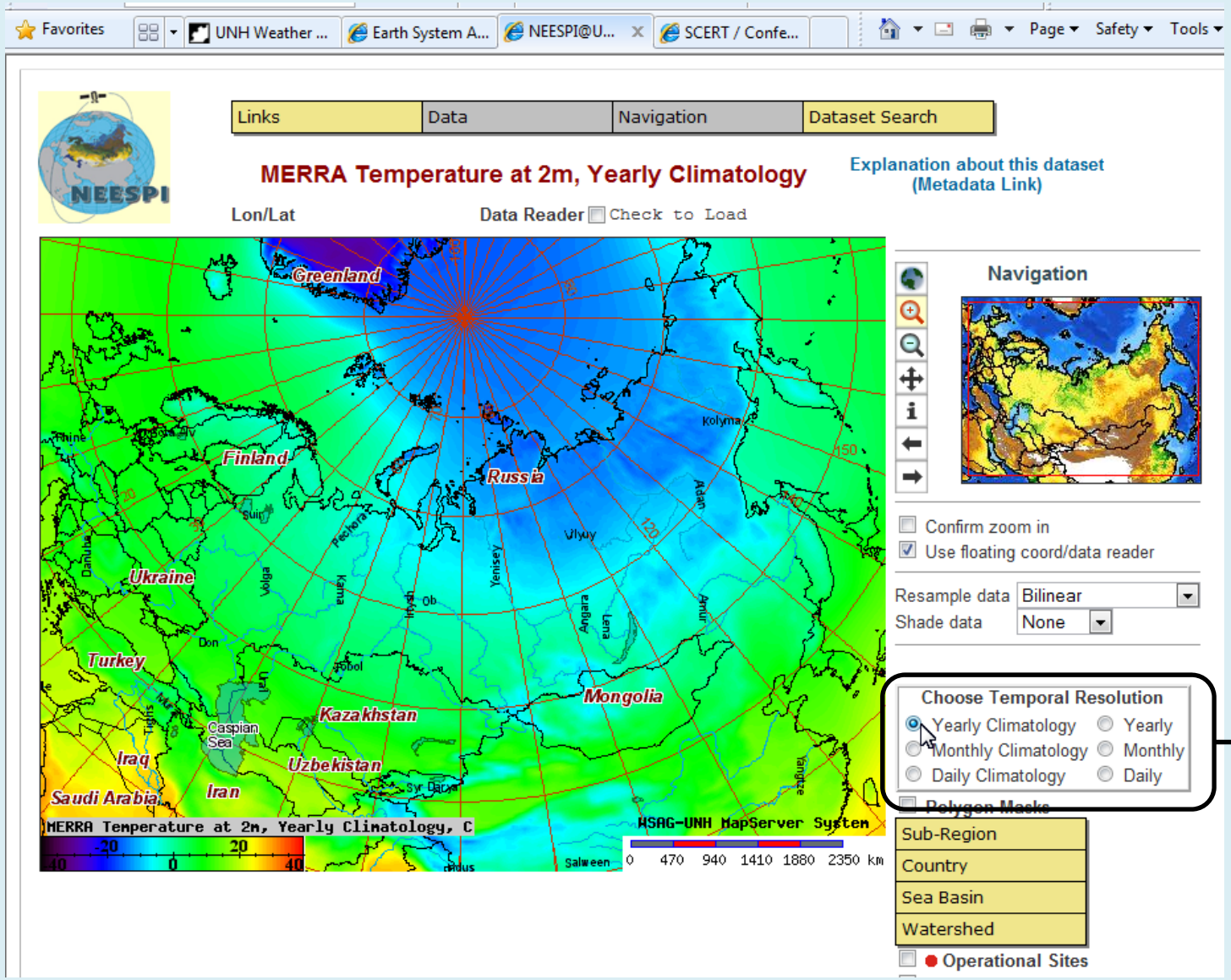
Demo # 3:
Controls of temporal resolutions



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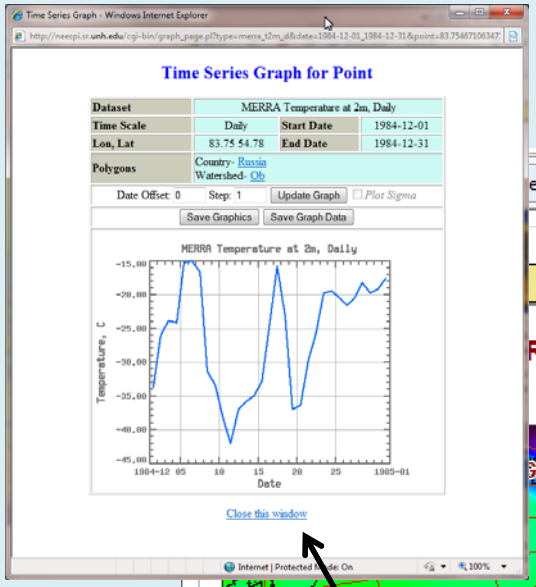

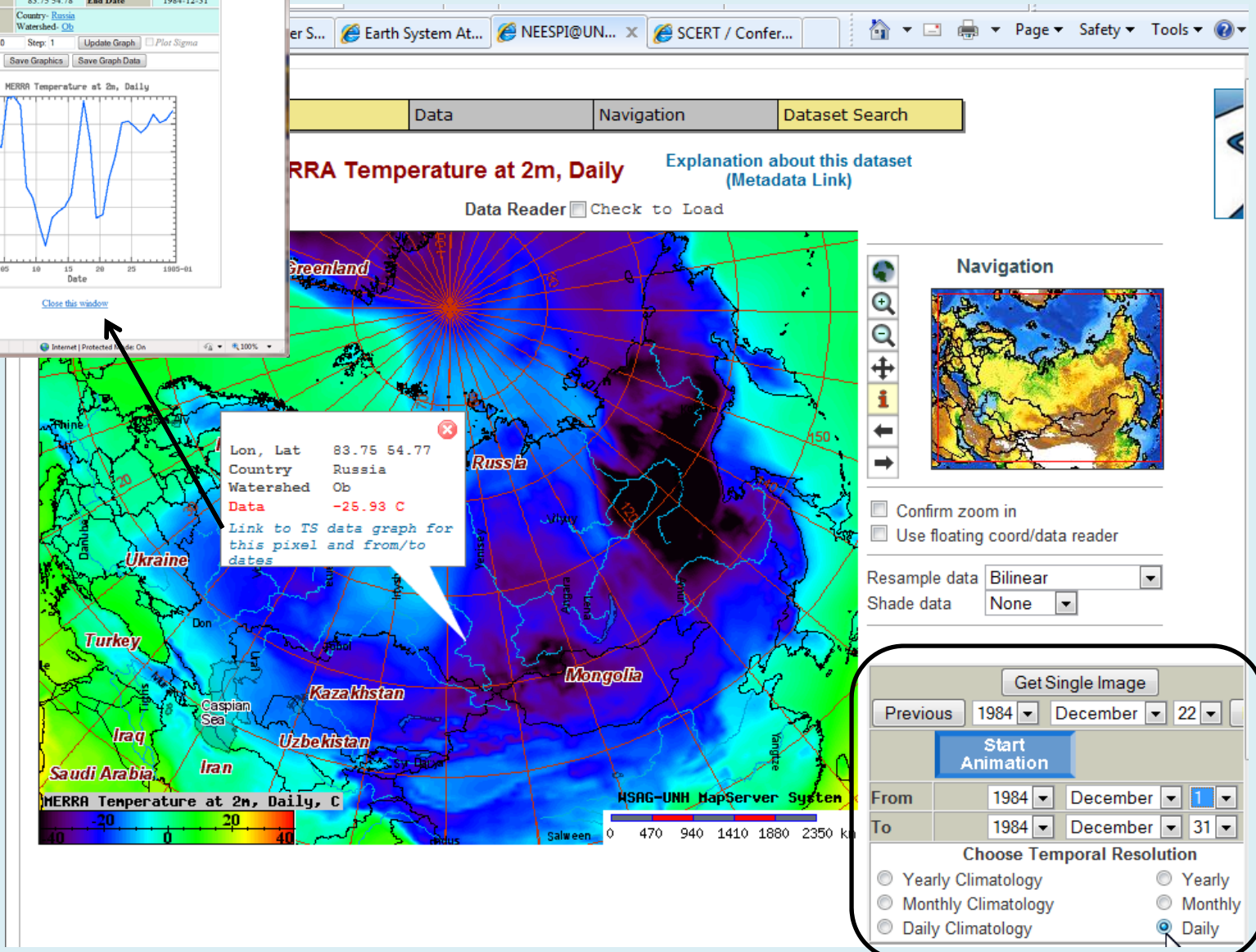

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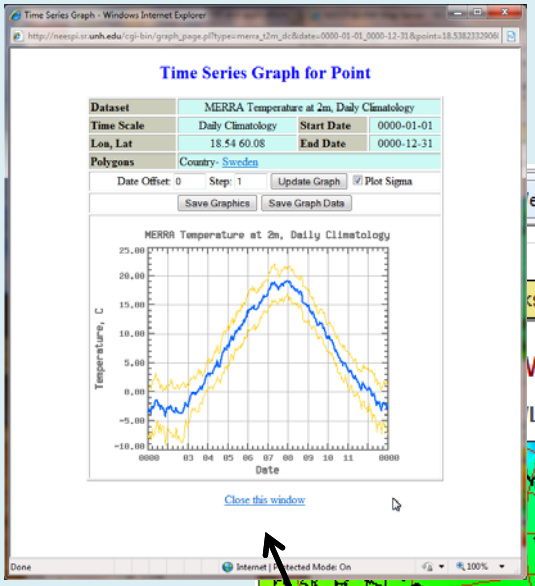
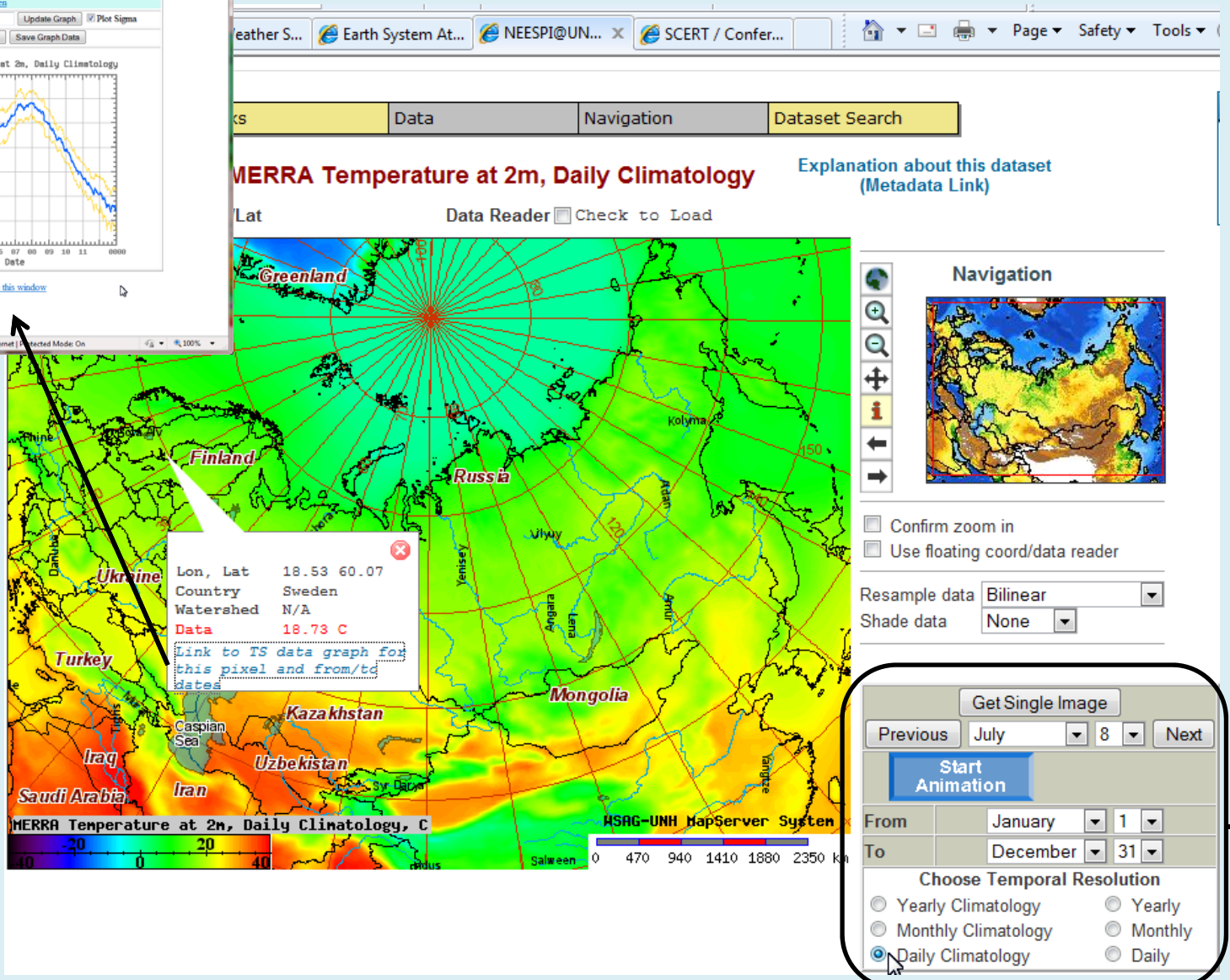
Controls of temporal resolutions





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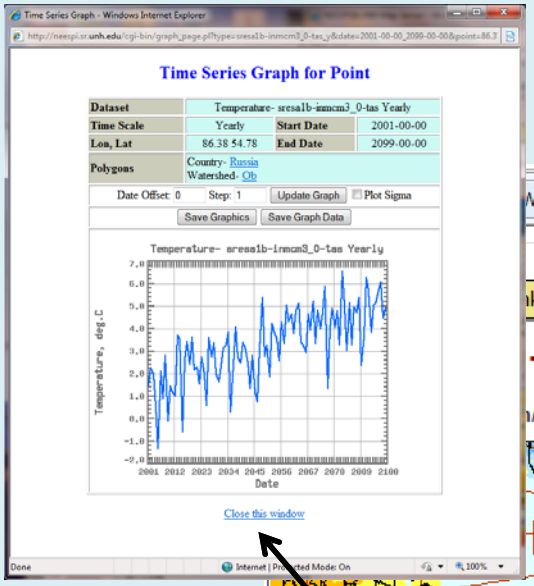

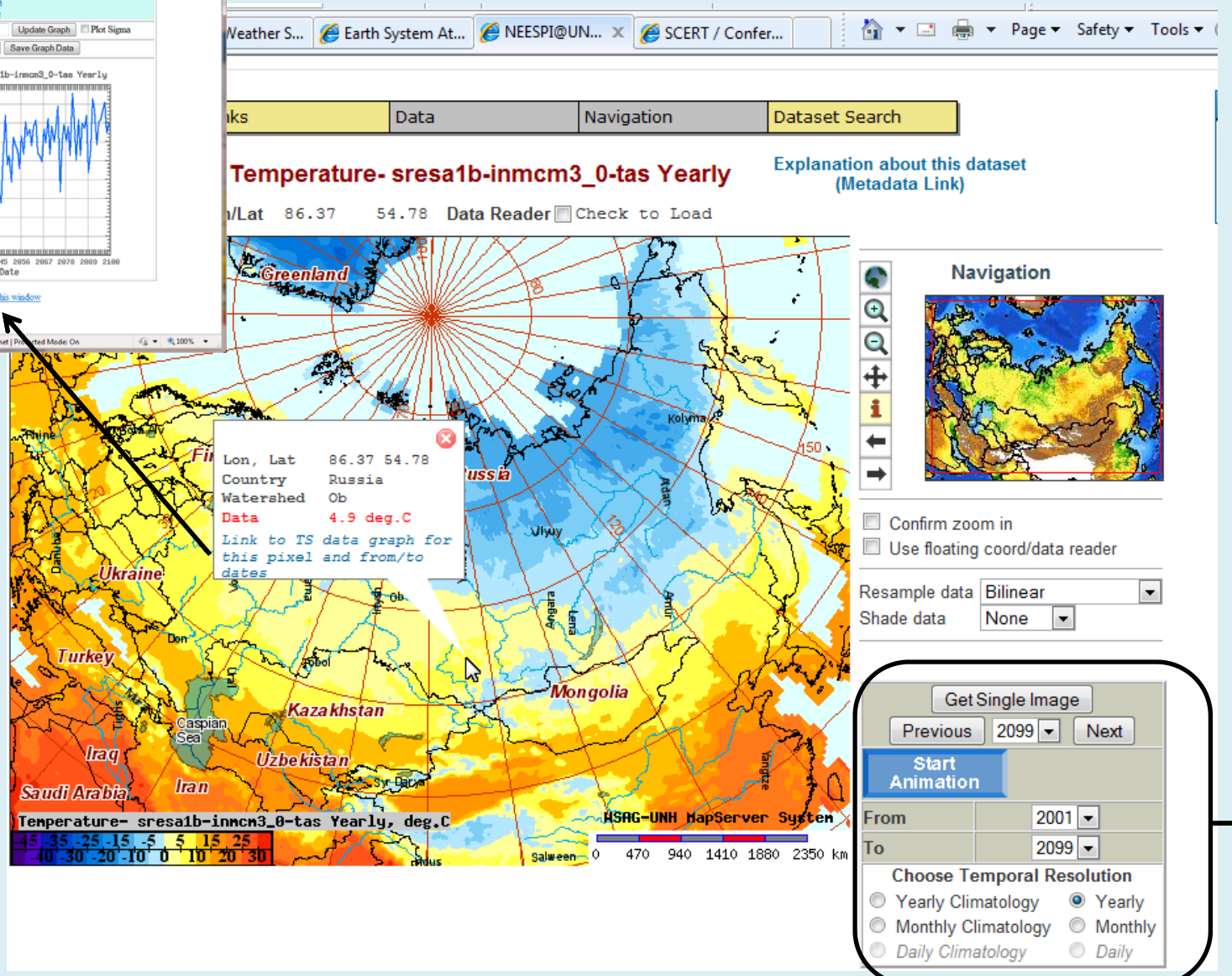

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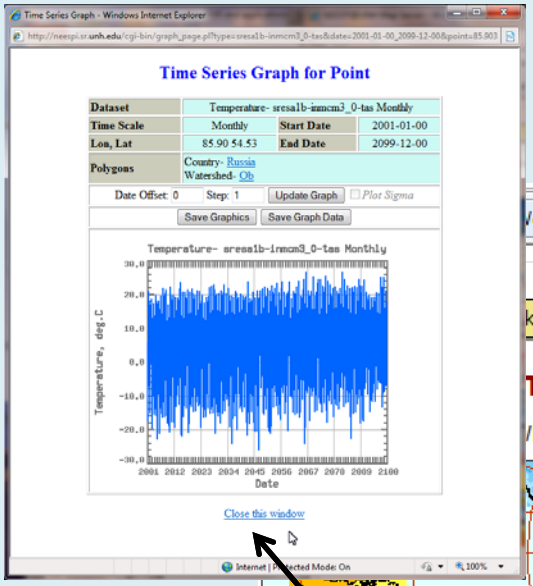

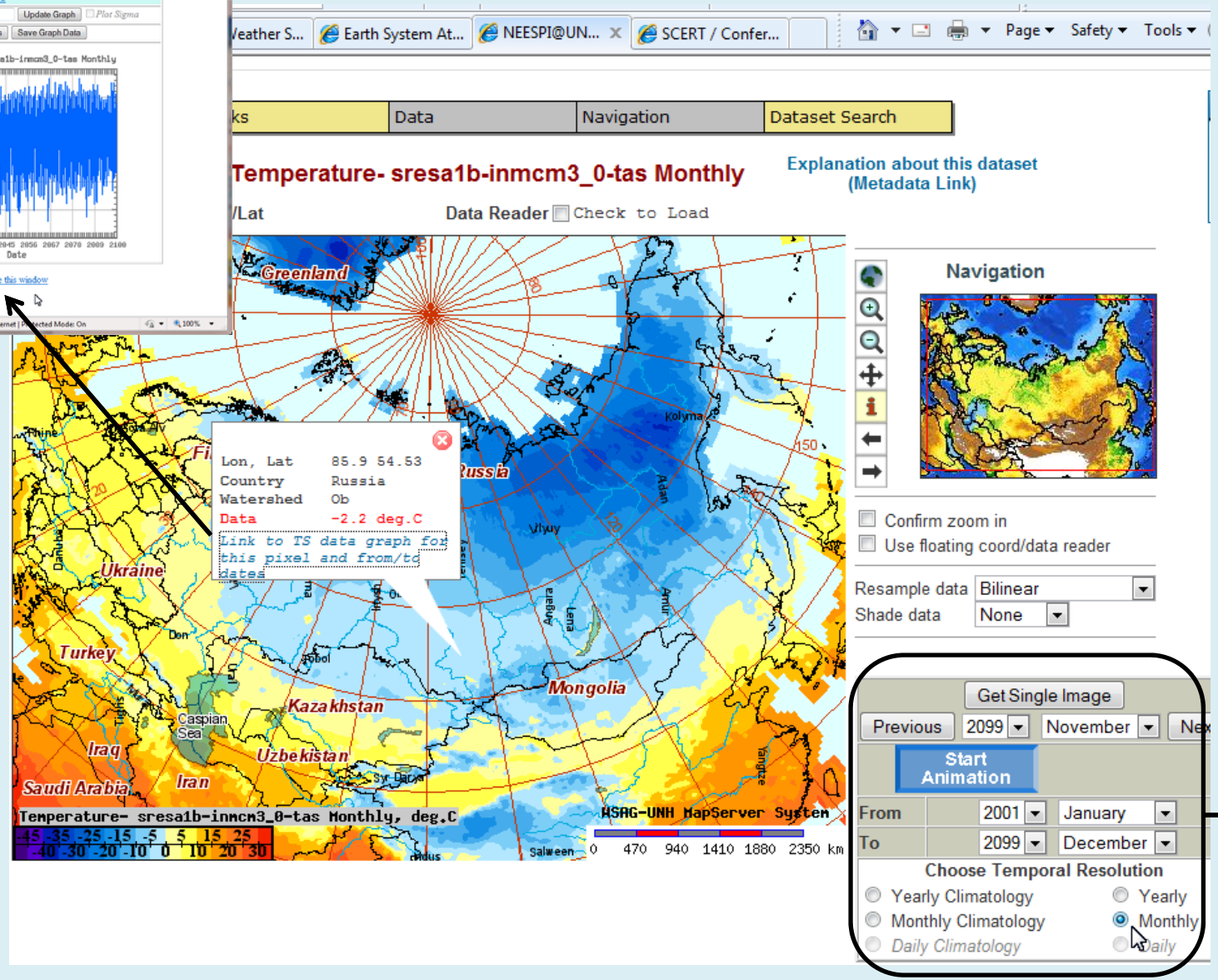

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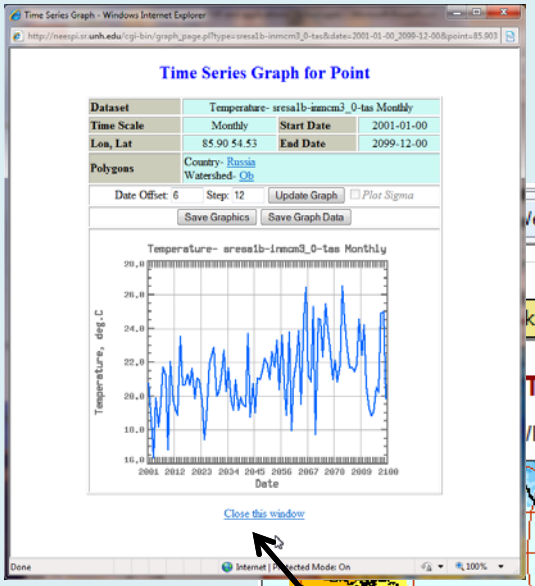

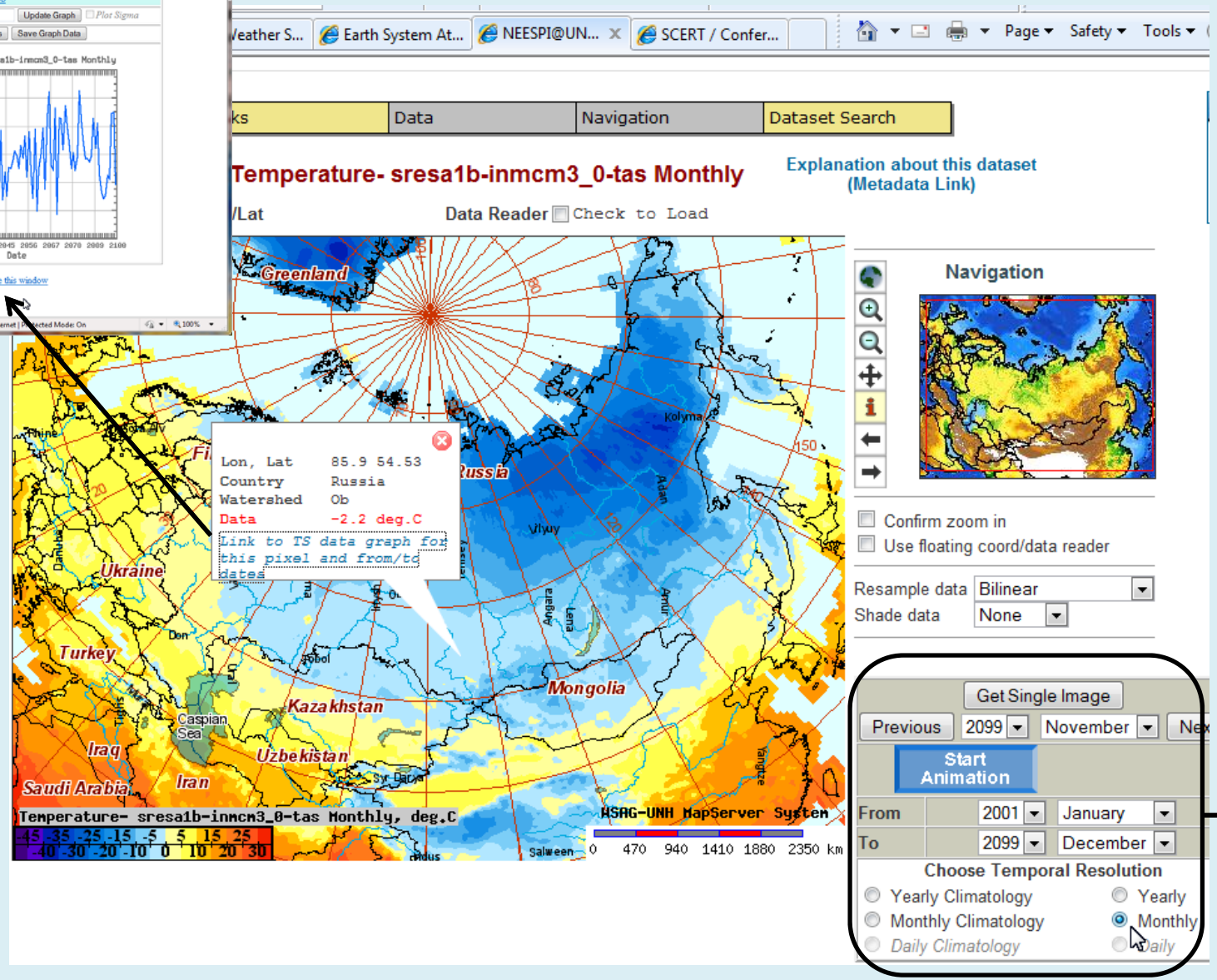

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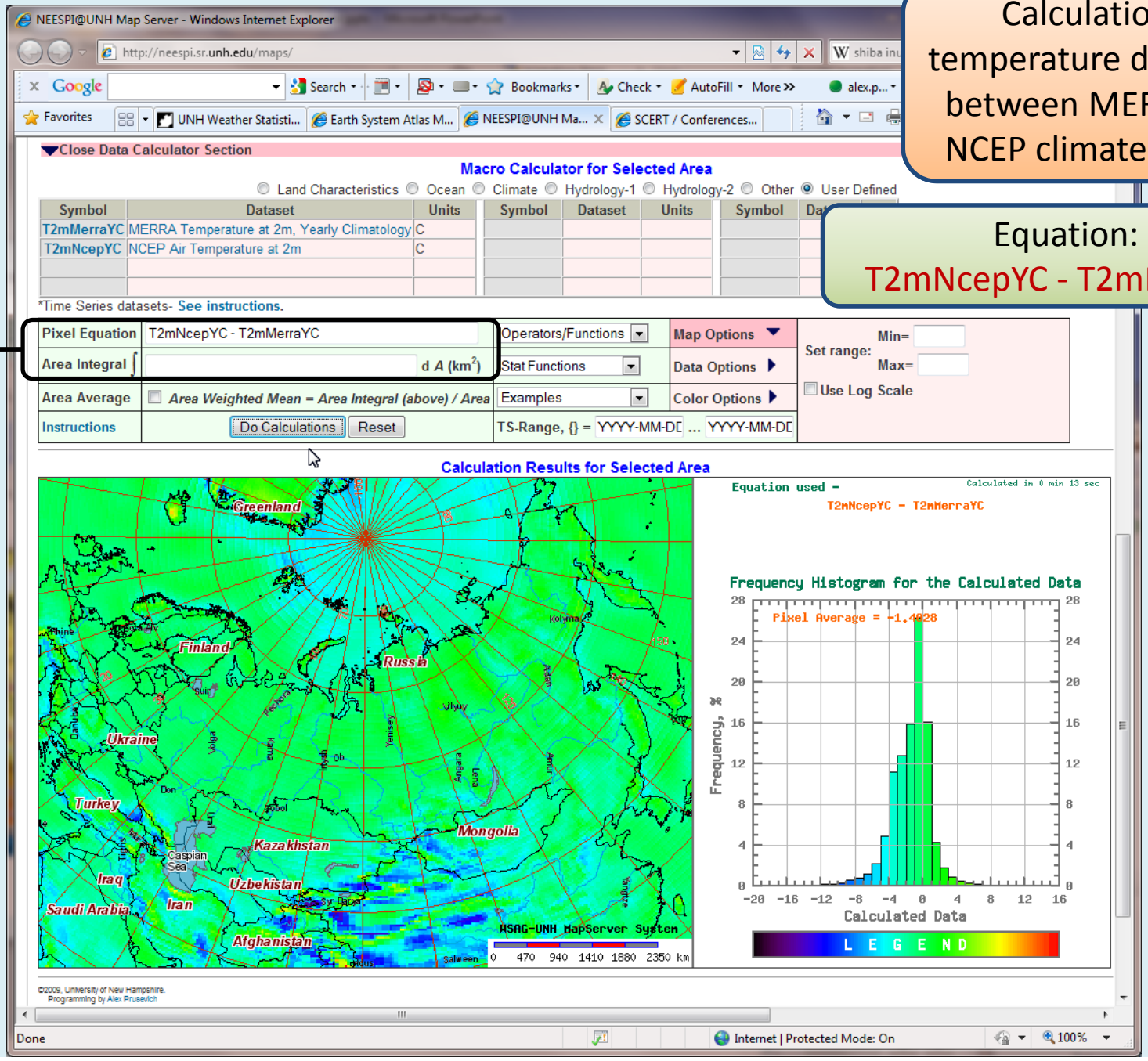
Demo # 4: The Data Calculator

Calculation of temperature difference between MERRA and NCEP climate models

Equation:
T2mNcepYC - T2mMerraYC

NB

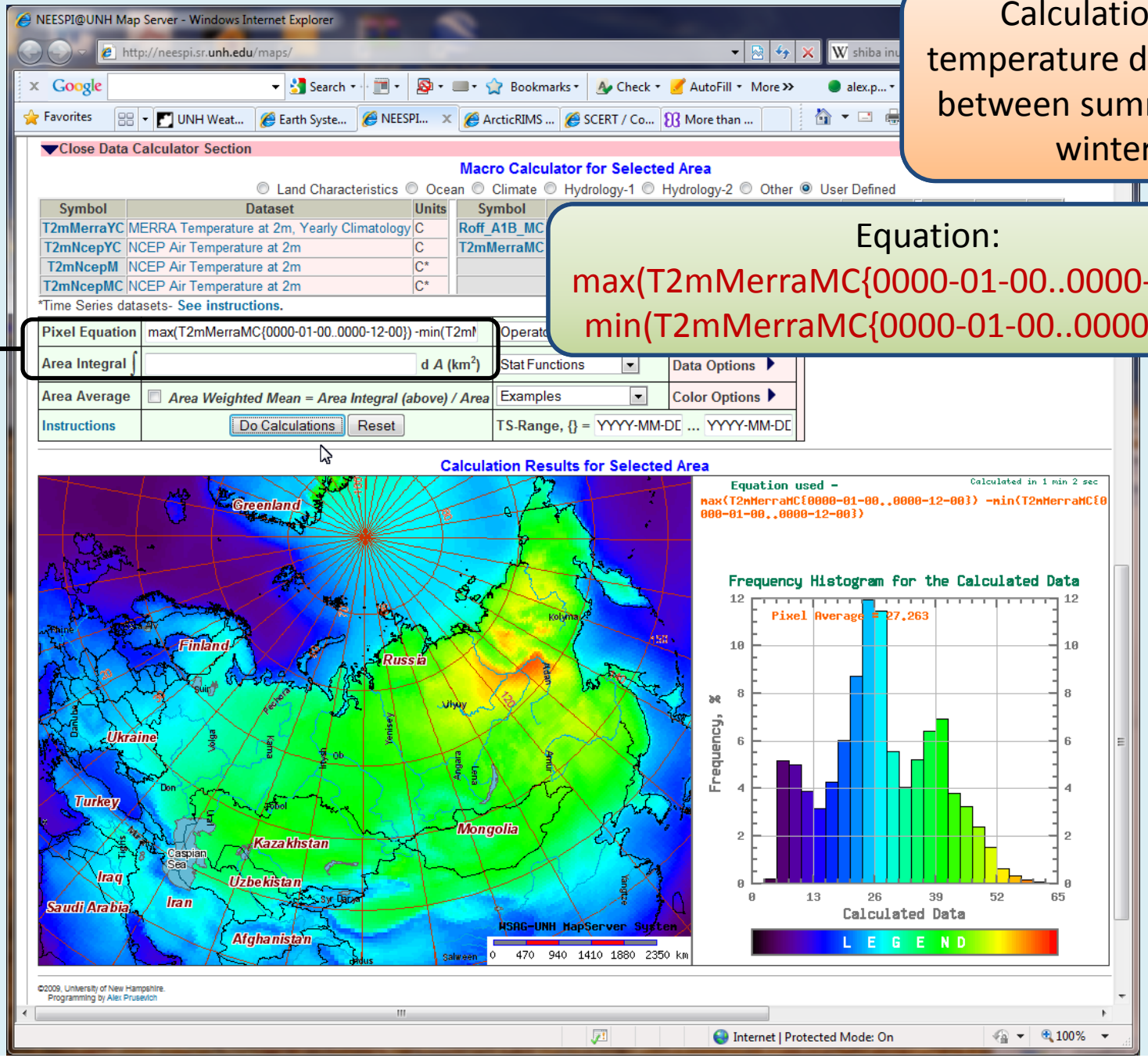


Demo # 4: The Data Calculator

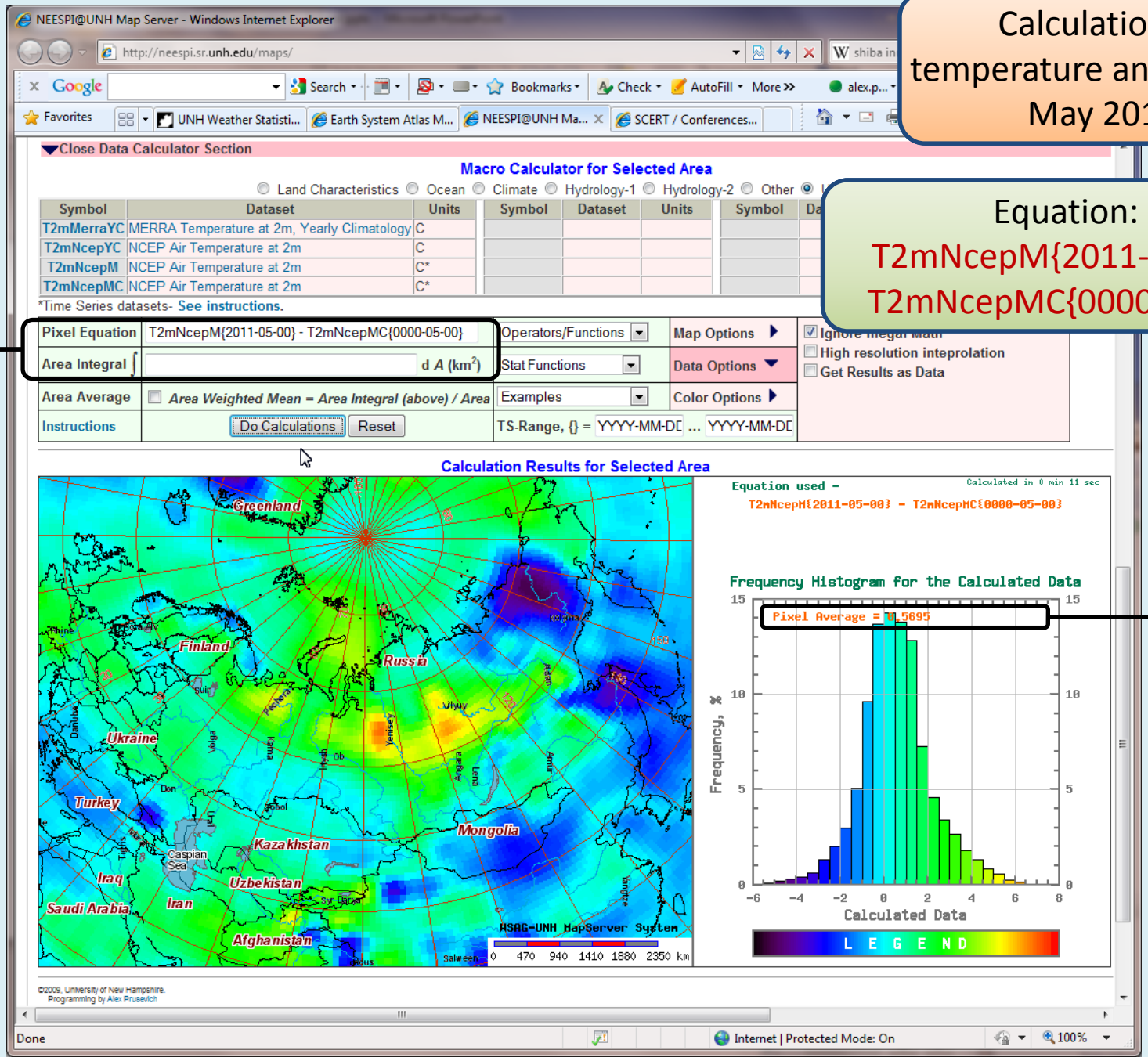
Calculation of temperature difference between summer and winter

Equation:
max(T2mMerraMC{0000-01-00..0000-12-00}) - min(T2mMerraMC{0000-01-00..0000-12-00})

NB



Demo # 4: The Data Calculator



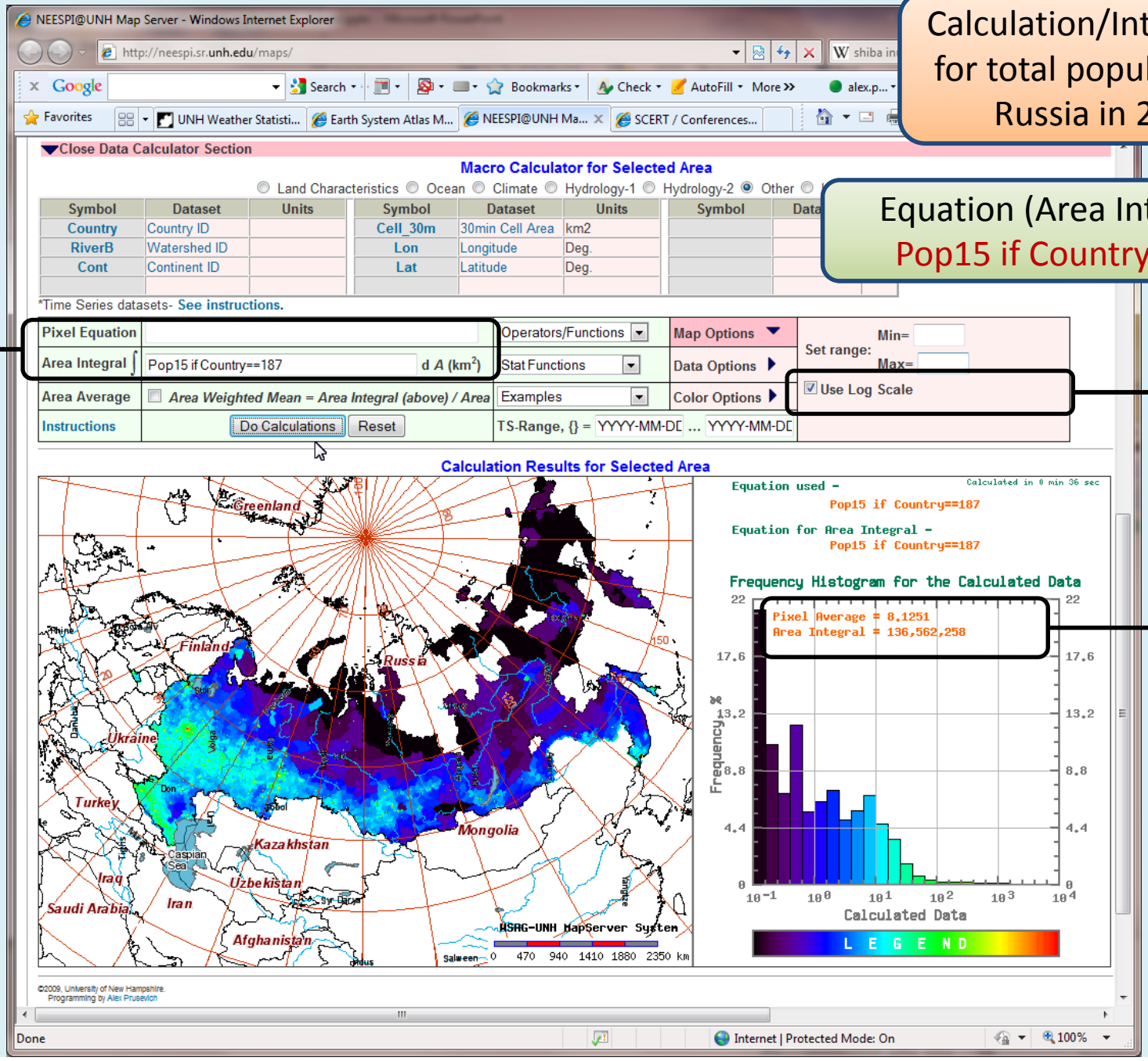
Calculation of temperature anomaly for May 2011

Equation:
T2mNcepM{2011-05-00} - T2mNcepMC{0000-05-00}

NB

NB

Demo # 4: The Data Calculator



Calculation/Integration for total population of Russia in 2015

Equation (Area Integral): Pop15 if Country==187

NB

NB

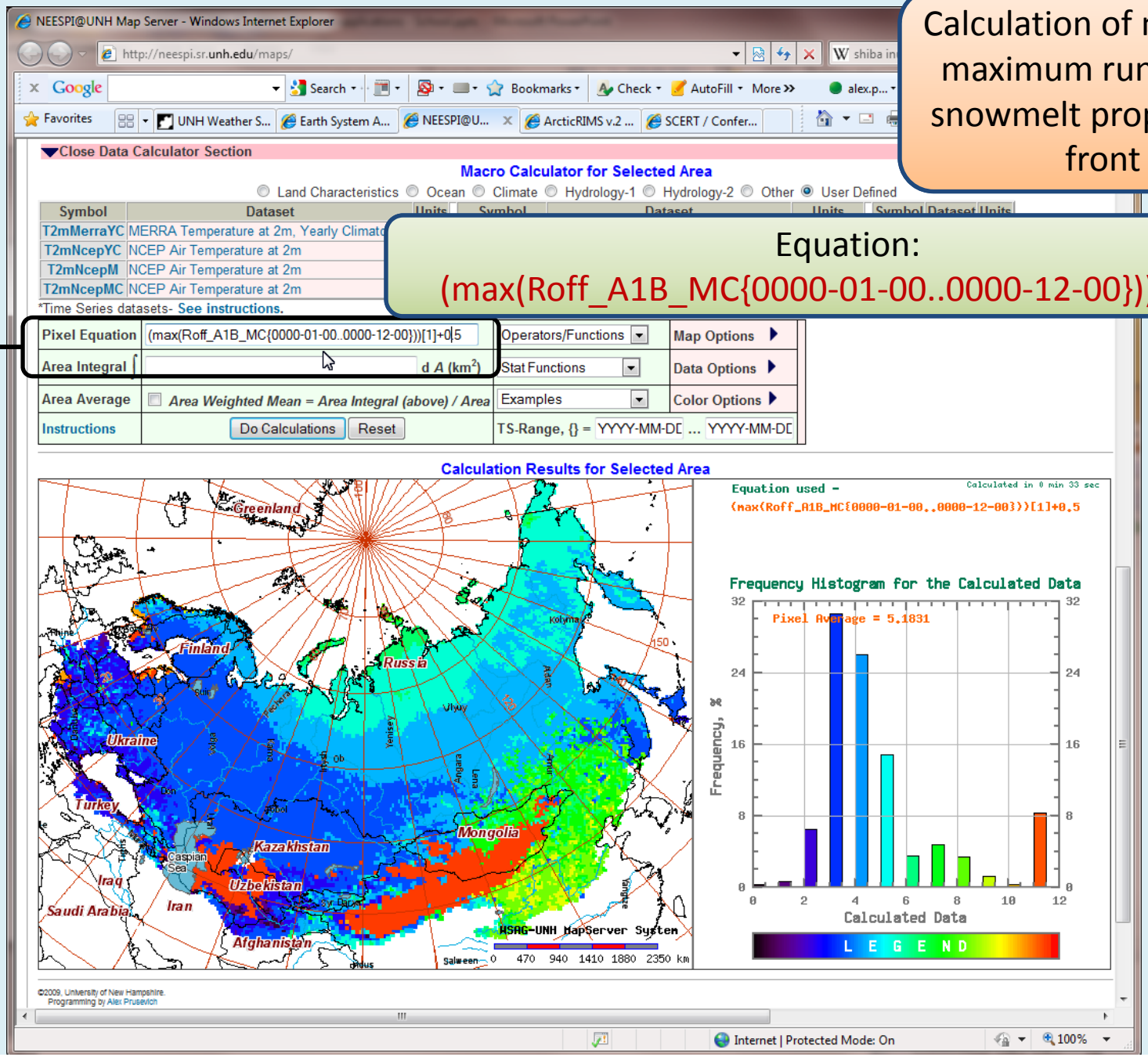
NB

Demo # 4: The Data Calculator

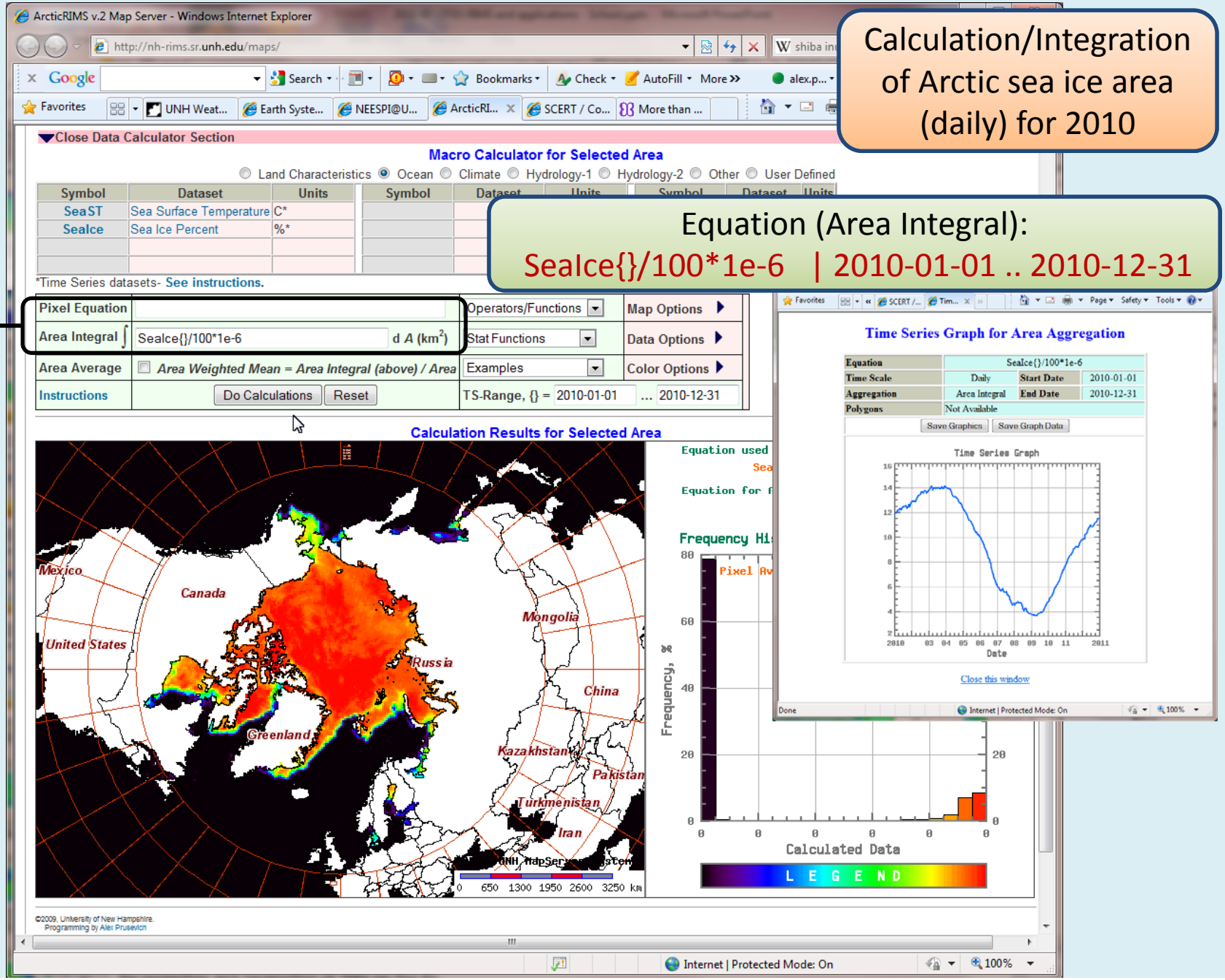
Calculation of month of maximum runoff as a snowmelt propagation front

Equation:
(max(Roff_A1B_MC{0000-01-00..0000-12-00}))[1]+0.5

NB



Demo # 4: The Data Calculator

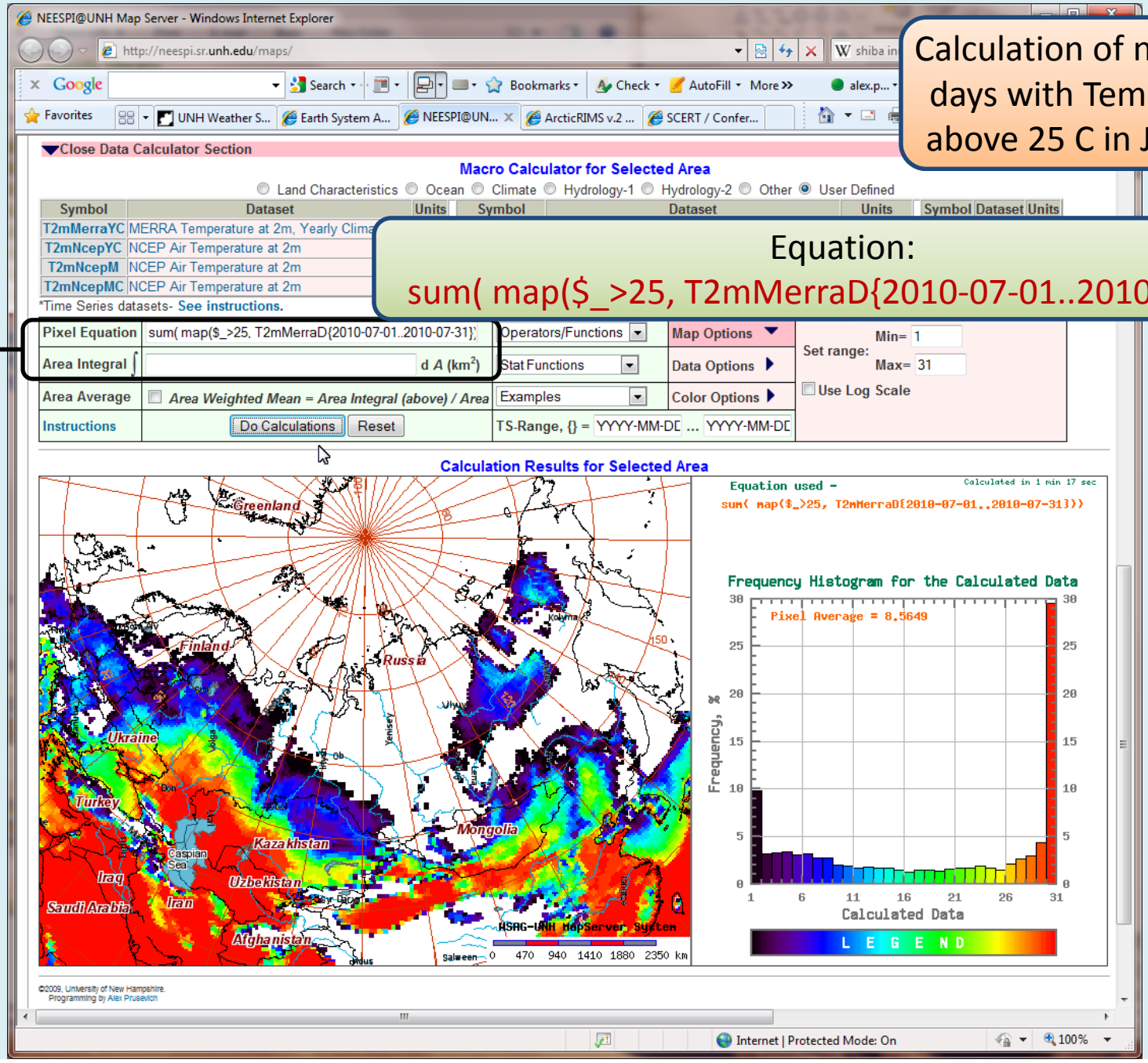


Calculation/Integration of Arctic sea ice area (daily) for 2010

Equation (Area Integral):
SeaIce{}/100*1e-6 | 2010-01-01 .. 2010-12-31

NB ←

Demo # 4: The Data Calculator



Calculation of number of days with Temperature above 25 C in July 2010

Equation:
sum(map($_>25, T2mMerraD{2010-07-01..2010-07-31}))

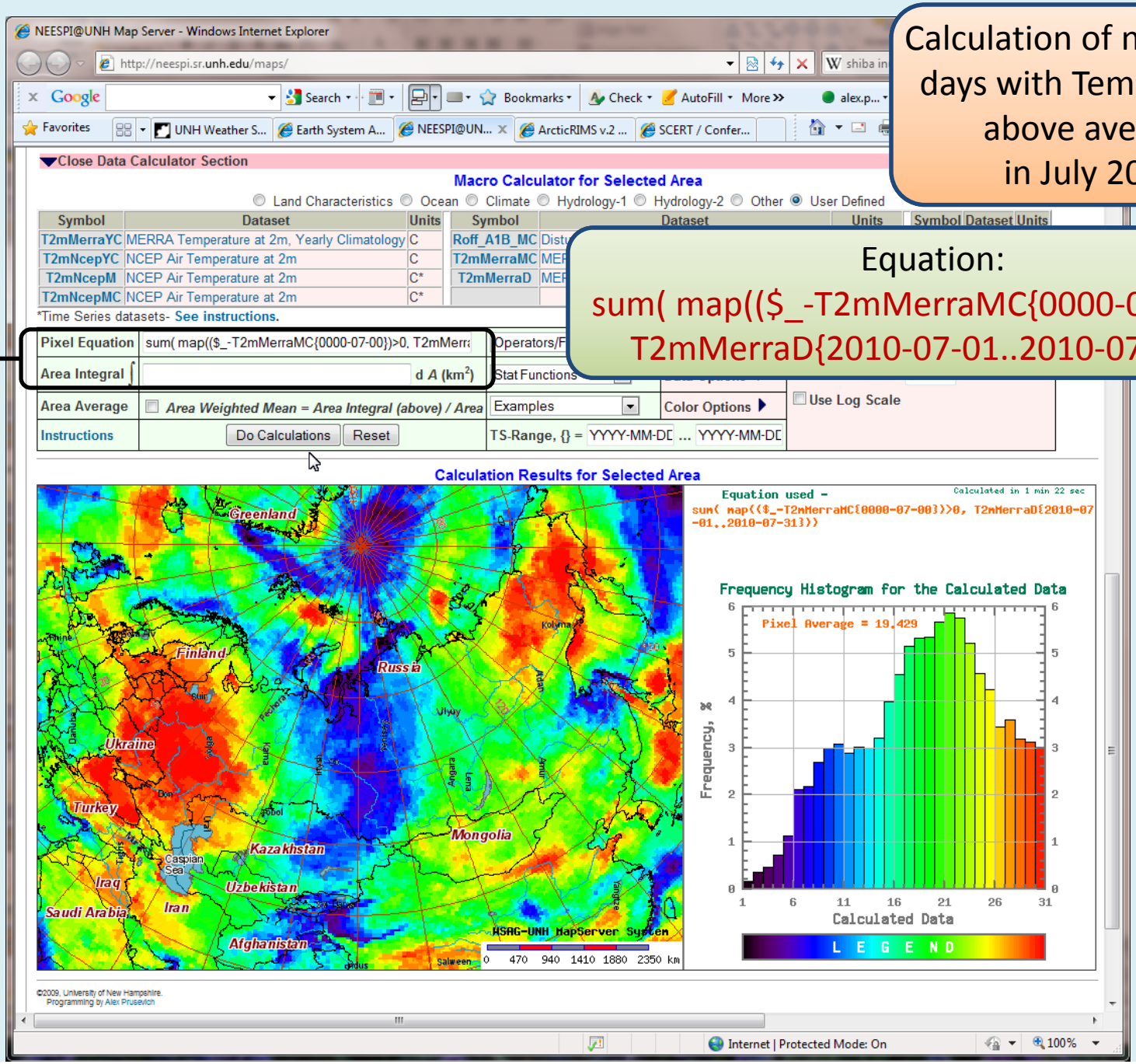
NB ←

Demo # 4: The Data Calculator

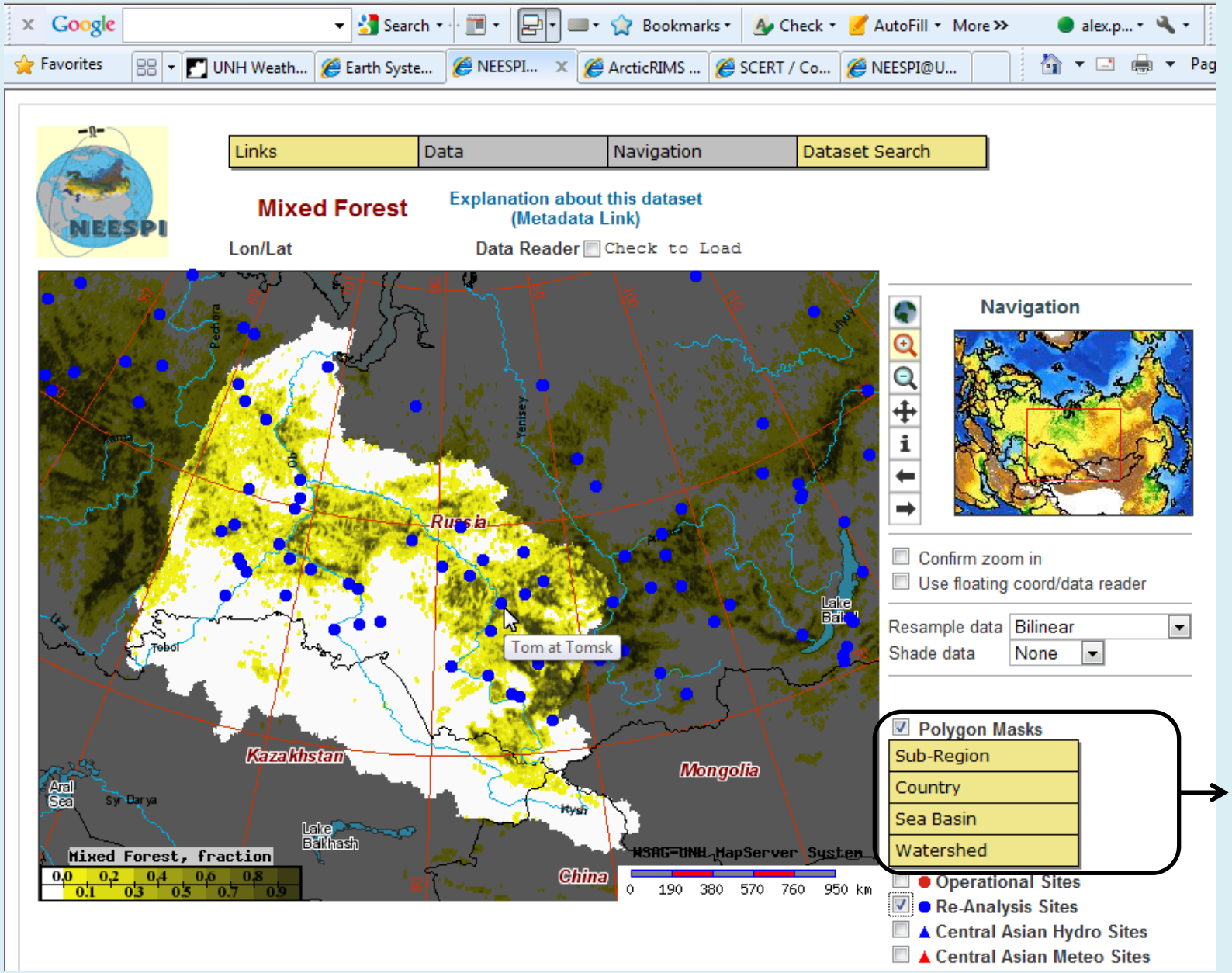
Calculation of number of days with Temperature above average in July 2010

Equation:
sum(map(($_-T2mMerraMC{0000-07-00})>0, T2mMerraD{2010-07-01..2010-07-31}))

NB



Demo # 5: The Data Masking by a Polygon



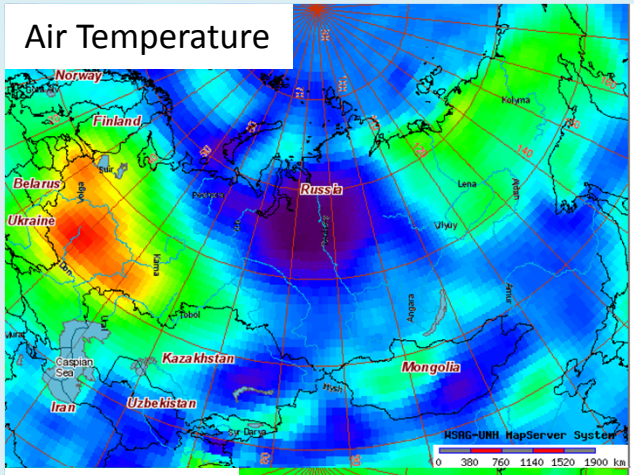
Thank You!

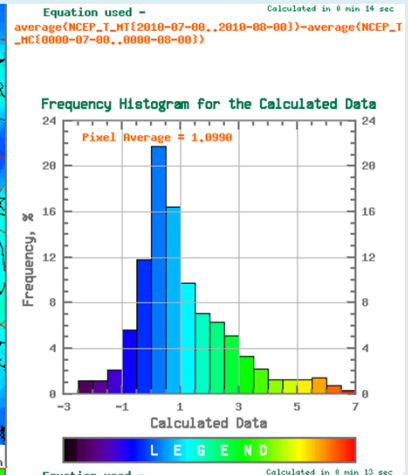
Acknowledgements-
This ongoing project has been indirectly supported by a number of NSF, NASA, NH-IRC, etc.

Analysis of 2010 extreme summer in Russia

Example of RIMS Application to a Regional Research

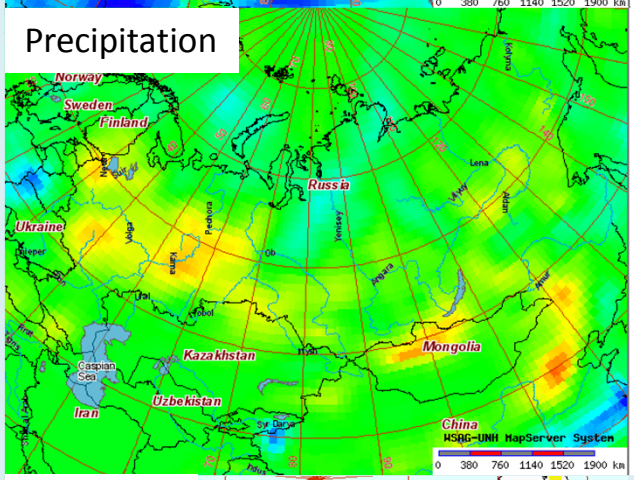
Air Temperature

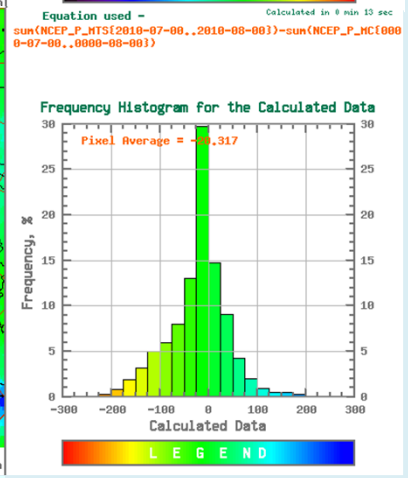




Deviation of mean July-August air temperature in 2010 from LTM over 1948-2010 (NCEP data)

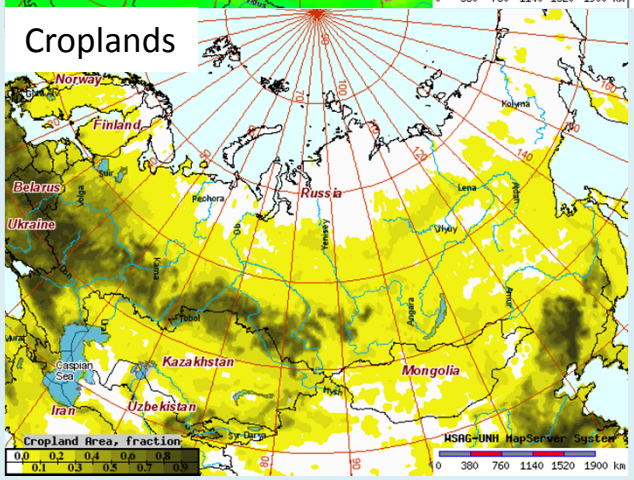
Precipitation





Deviation of sum of precipitation over July-August 2010 from LTM over 1948-2010 (NCEP data)

Croplands

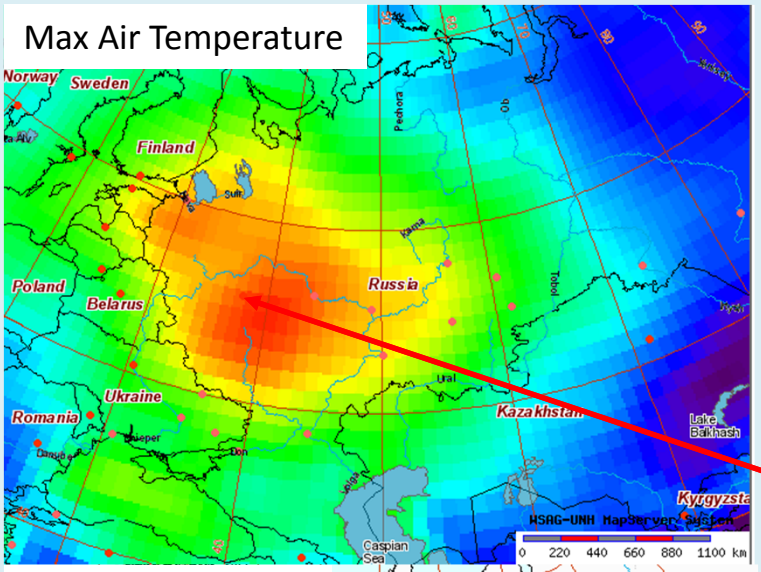


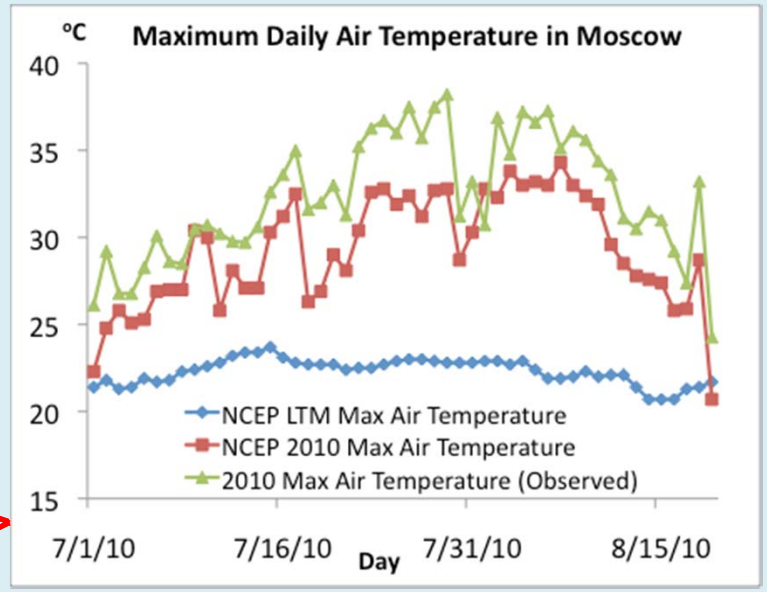
Distribution of cropland area

Analysis of air temperature and population in summer 2010

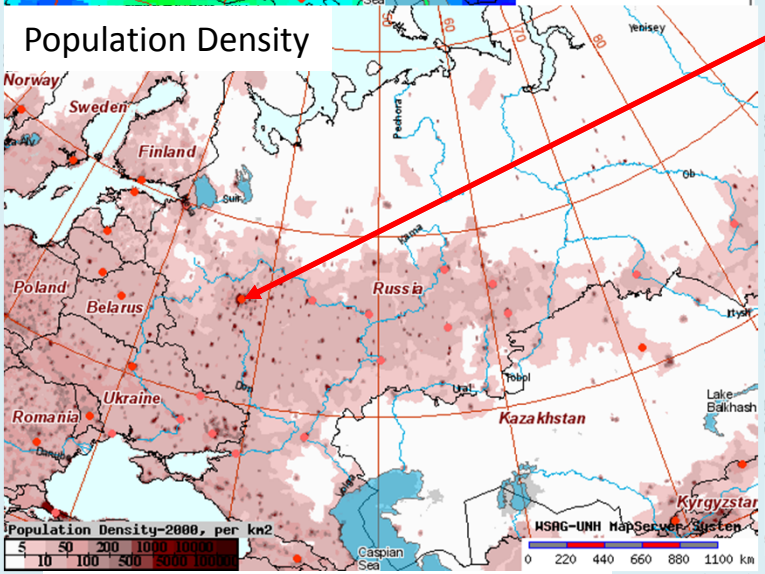
Deviation of daily max air temperature over July2-Aug18, 2010 from LTM

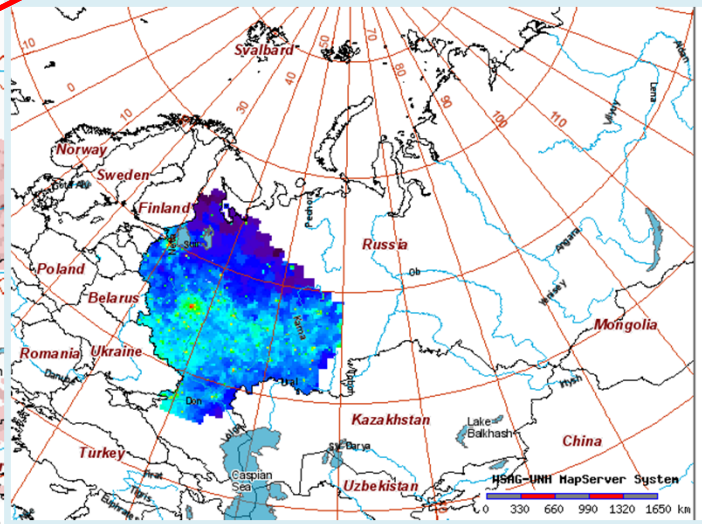
Max Air Temperature

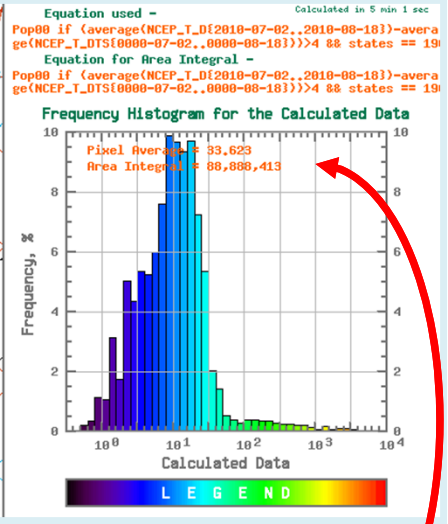




Population Density







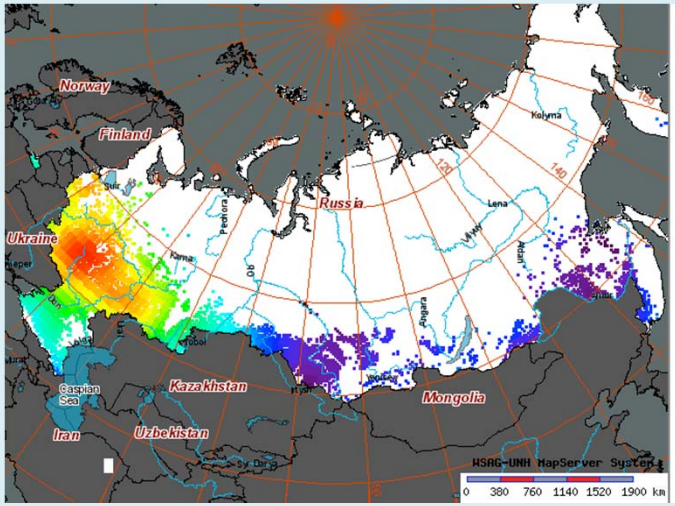
Distribution of population density

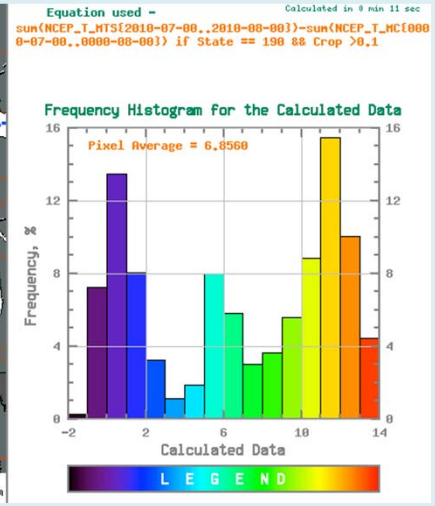
Calculation of area and population in Russia where mean daily air temperature over the period 07-02-2010 to 08-18-2010 was 4^0C higher then LTM. This heat effected about 90 million people or ~ 60% of total Russian population

Anomalies of air temperature and precipitations in summer 2010 from long-term mean over 1985-2010 for Russian cropland area (cropland >10% per grid cell)

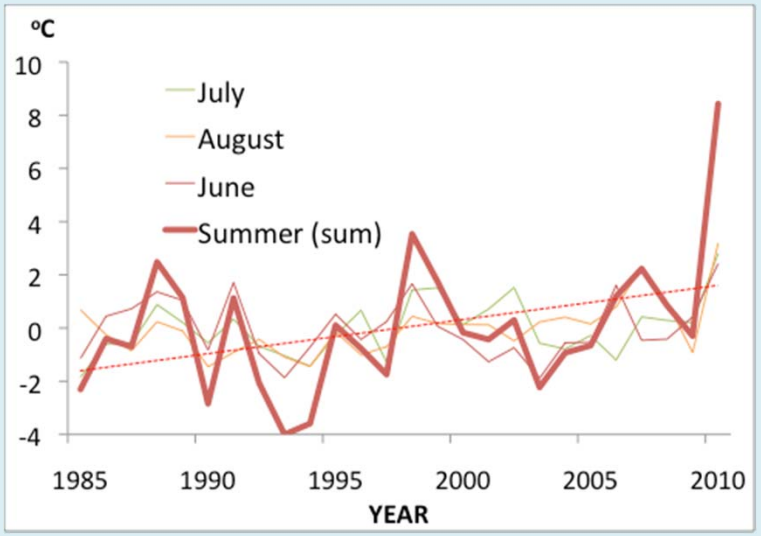
Air Temperature

Anomalies of summer 2010 from LTM



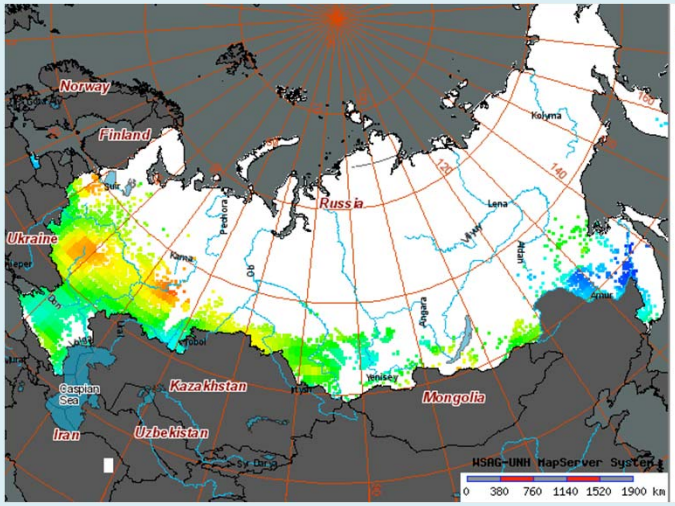


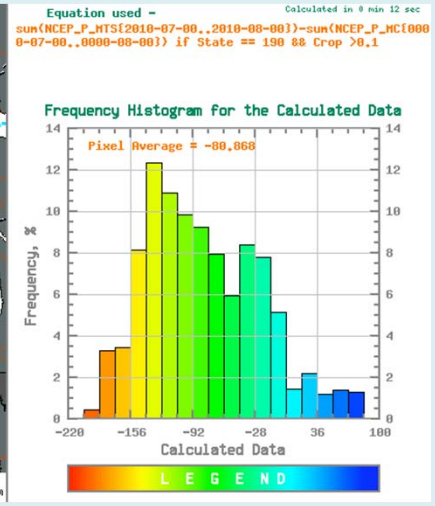
Anomalies of over 1985-2010

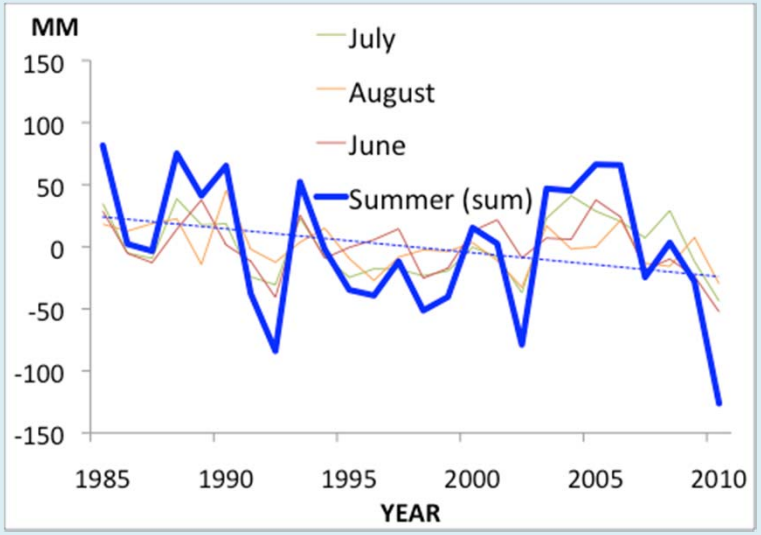


Precipitation

Anomalies of summer 2010 from LTM

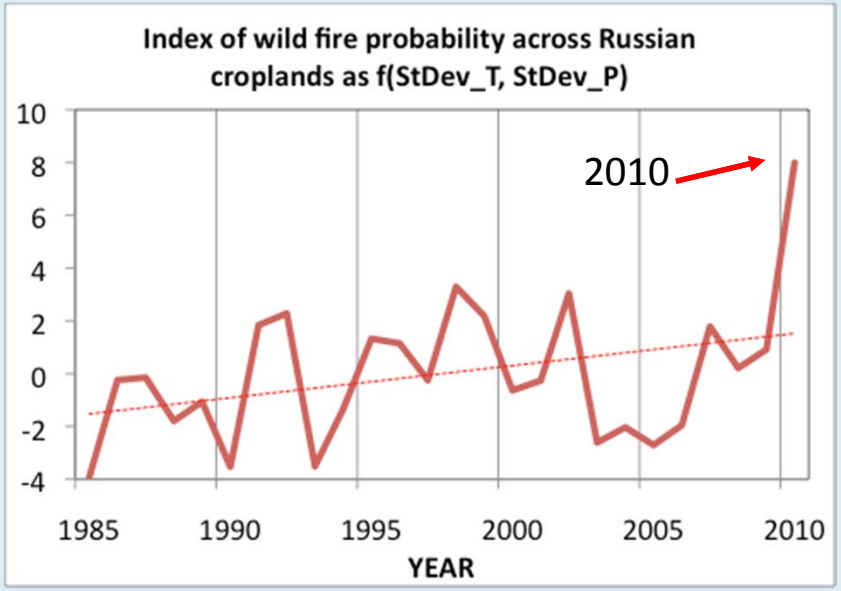


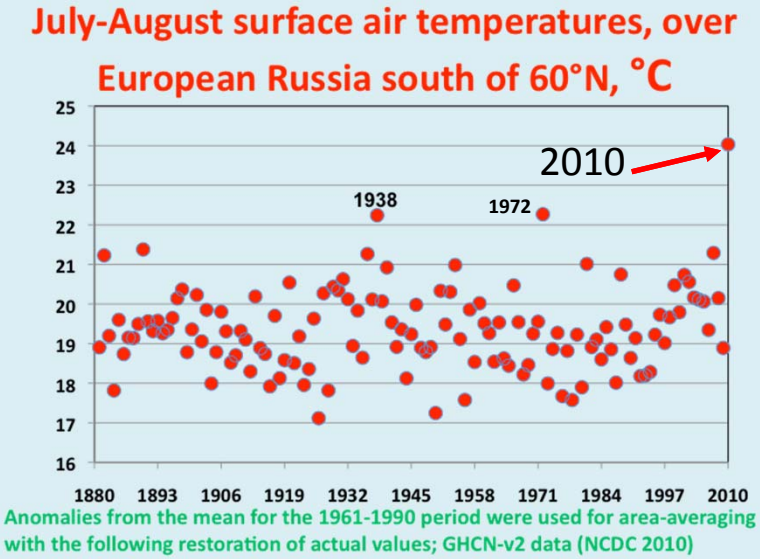


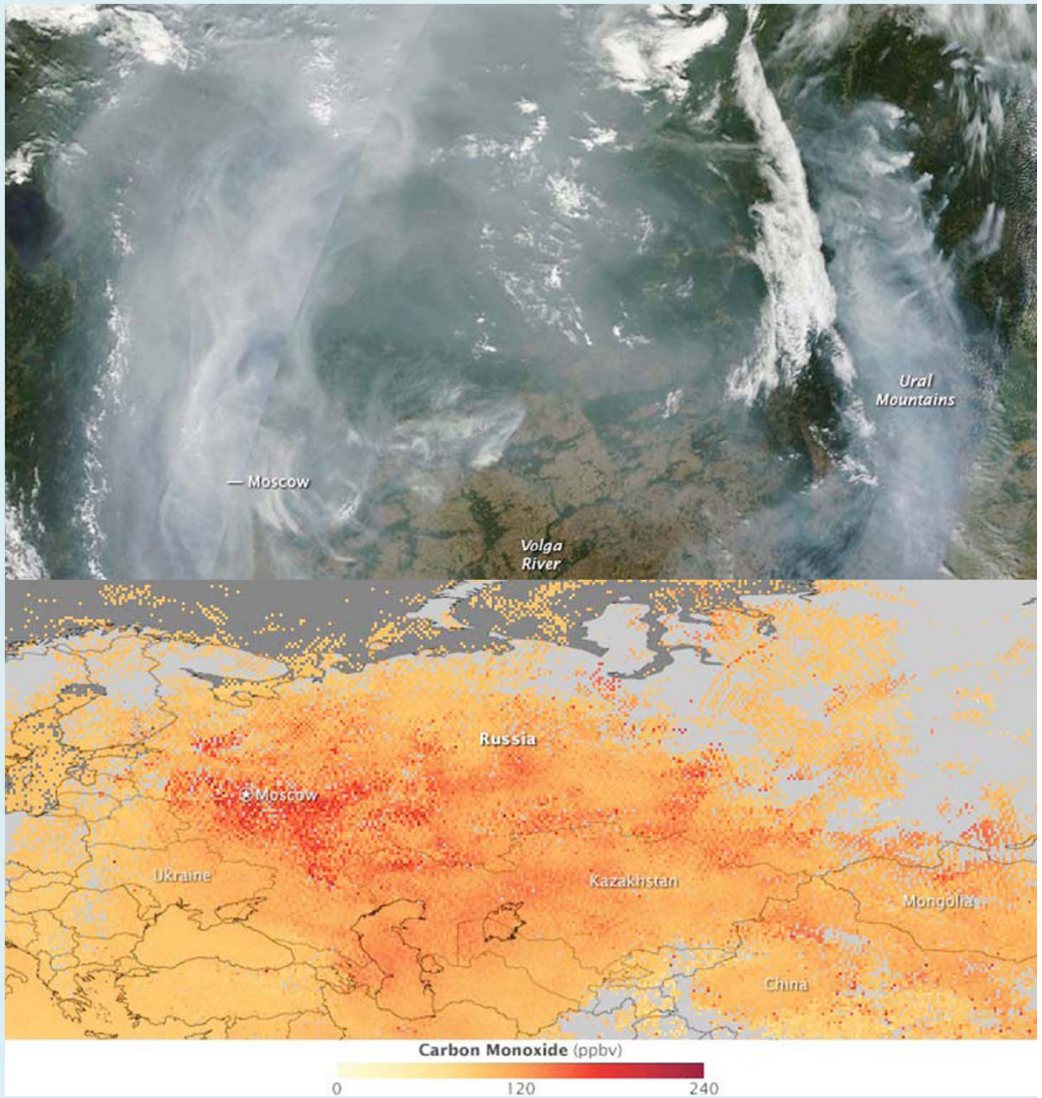


2010 wheat yield in Russia was ~40% less than in 2008, 2009

Using air temperature and precipitation data in NEESPI RIMS we evaluated index of wild fire probability for summer months from 1985 to 2010







Carbon monoxide concentrations in the atmosphere between 2 and 8 km above Russia as recorded from 1 to 8 August 2010 by NASA (MOPITT). Ground concentrations of this dangerous gas are reported to be much higher, causing people to report headaches, dizziness, and other more serious conditions.