Research Capabilities of Giovanni: The Past and the Near-Future

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The Goddard Earth Sciences Data and Information Services Center (GES DISC) *Giovanni* system enables simplified visualization of many different Earth remote-sensing and model data sets, along with several basic analytical capabilities.

Giovanni operates almost exclusively on Level 3 (global gridded or regional gridded) data sets.

Giovanni has been developed primarily as a data exploration and visualization engine. However, the system's ease-of-use, speed, and analytical capabilities have made it useful for a variety of research interests.

The following presentation describes several research studies for which MODIS data in Giovanni was utilized.

Categories of MODIS data types in Giovanni commonly used for research

➢ Ocean color (biological and optical parameters)
➢ Sea surface temperature
➢ Aerosol optical depth
➢ Land surface temperature & water vapor
➢ Fire pixel count

A primary metric of Giovanni usage is citation in peer-reviewed research literature.   At this time, 860 research papers have cited the use of Giovanni. Approximately **60%** of these papers used MODIS data products, dominated by the categories listed above.

Giovanni has also been used in public and private reports, numerous meeting presentations, Masters theses Ph.D. dissertations, 'popular science' print and Web articles, and educational media.

Use of MODIS ocean color data in Giovanni for research

Giovanni was used to examine the phytoplankton bloom that occurred in response to the deposition of ash from the eruption of Kasatochi volcano in the Aleutian Islands.
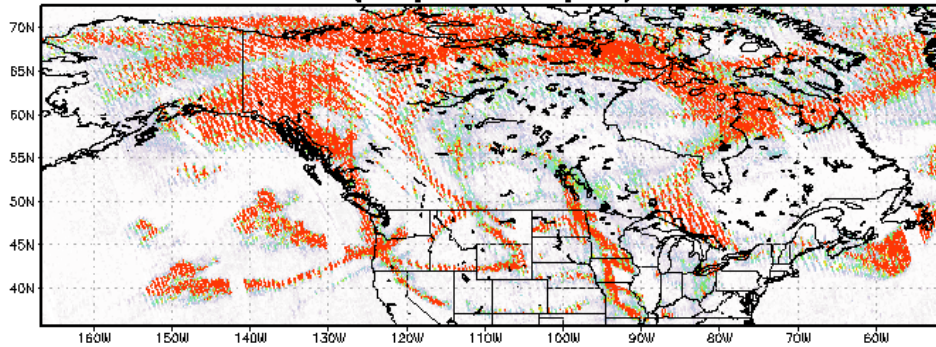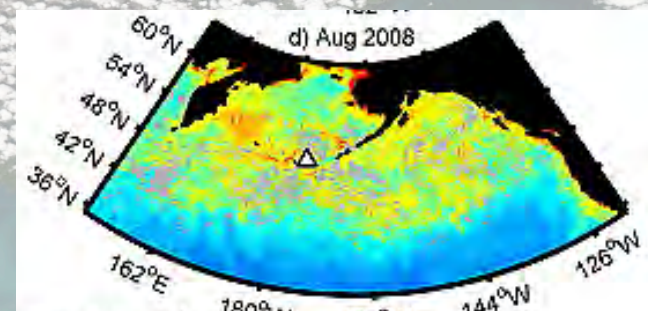

Kasatochi SO2 from OMI

The August 2008 bloom (MODIS Chl-a)

Ash deposition from the eruption


Giovanni time-series of Chl-a
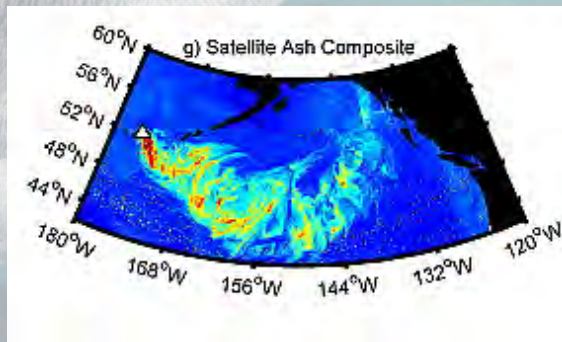
Use of MODIS ocean color data in Giovanni for research

Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia (Gill et al., Marine Ecology Progress Series)

MODIS *chl-a* data in Giovanni were used to characterize the blue whale habitat off of southern Australia. (Giovanni-4 will make "climatological" analyses like these directly.) SSC = "sea surface chlorophyll".
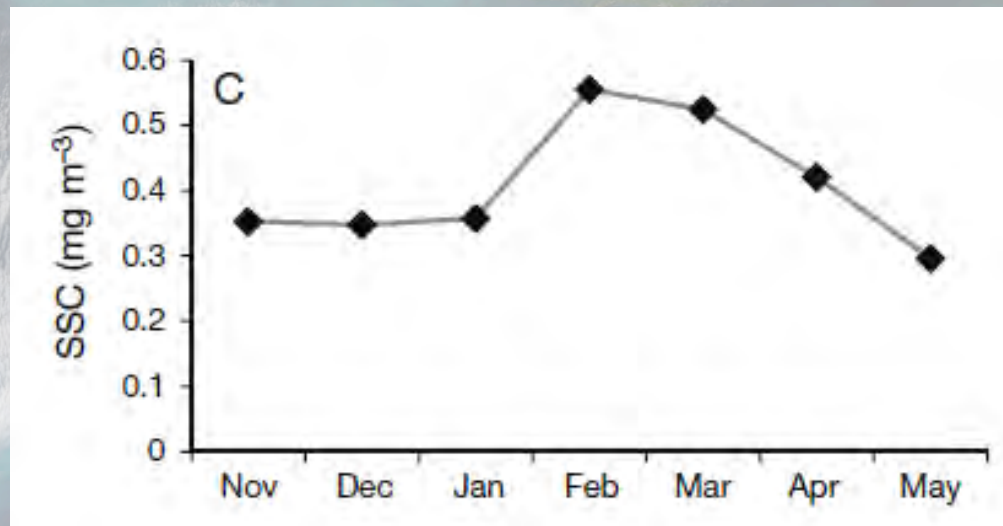
Use of MODIS sea surface temperature data in Giovanni for research

Due to the ease-of-use of the Giovanni system, MODIS SST is commonly obtained as an environmental variable used in a variety of studies.

Some examples:

-Long-standing environmental conditions, geographic isolation and host–symbiont specificity influence the relative ecological dominance and genetic diversification of coral endosymbionts in the genus *Symbiodinium*

- Physical oceanographic influences on Central Benguela fish catch

-Ecosystem modelling for ecosystem-based management of bivalve aquaculture sites in data-poor environments

Use of MODIS aerosol optical depth data in Giovanni for research

MODIS aerosol optical depth (AOD) data is used for examination of several different phenomena. Some of the main areas of interest are:

- Atmospheric dust and dust aerosols
- Smoke and soot from fires
- Anthropogenic atmospheric pollution

Development of Harbin, China smog event, October 15-19, 2013, shown with two-day rolling averages of MODIS AOD created with Giovanni
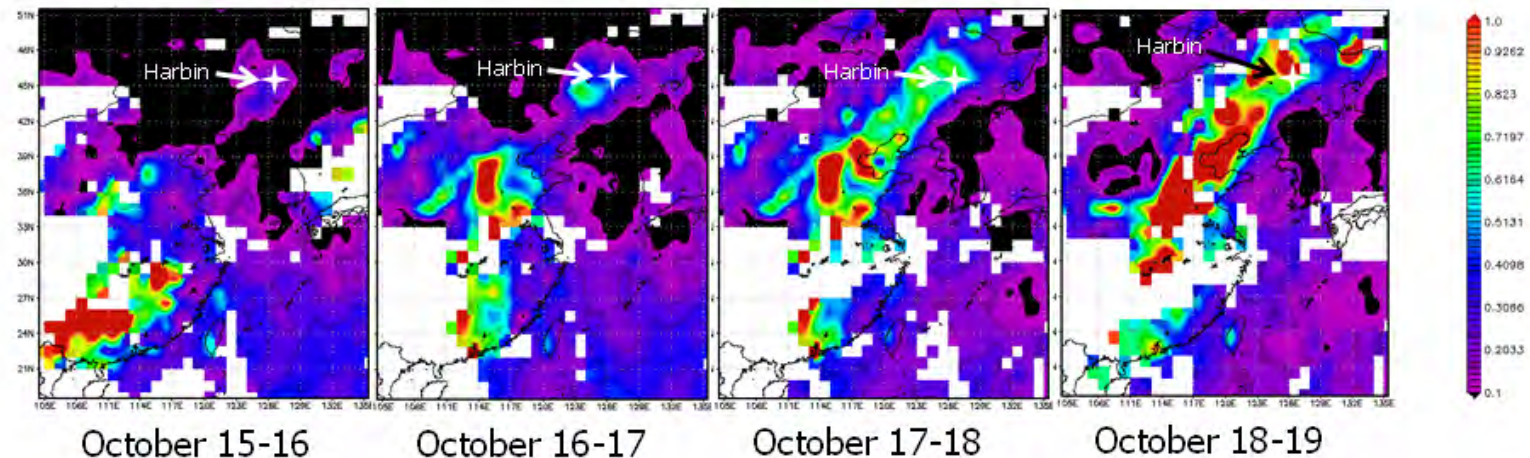
Use of MODIS aerosol optical depth data in Giovanni for research

Feedback between dust particles and atmospheric processes over West Africa during dust episodes in March 2006 and June 2007

Stanelle et al., *Atmospheric Chemistry and Physics*
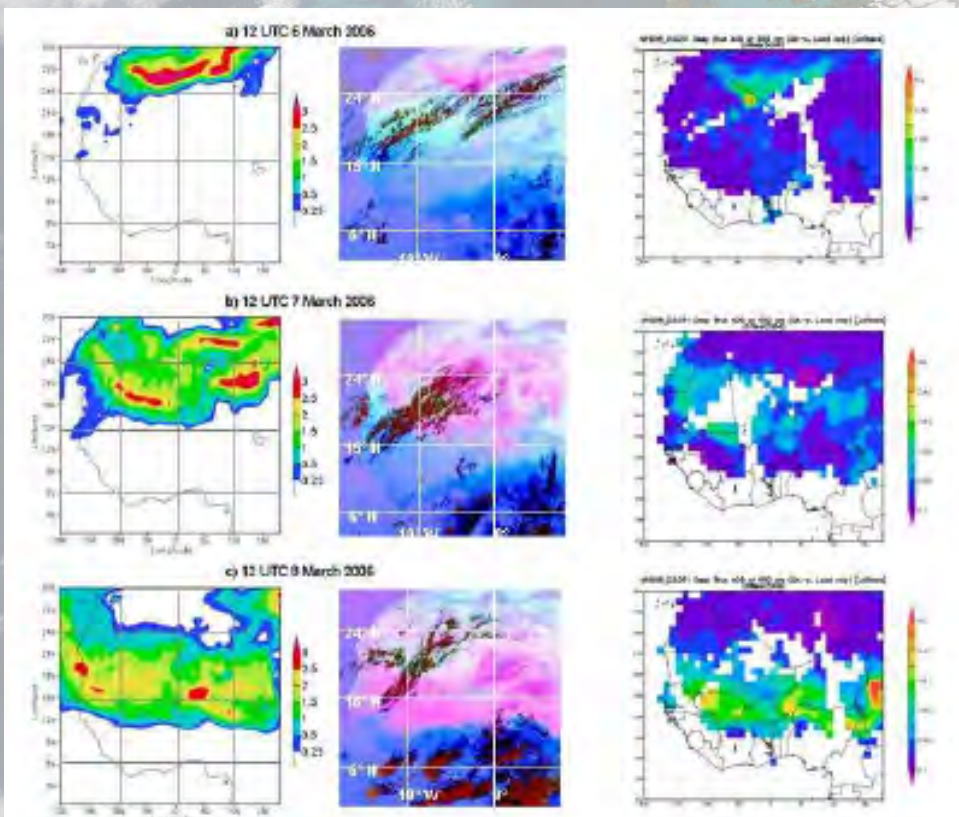
Simulated AOD at 450 nm of run F (left) and SEVIRI RGB dust product with dust shown in pink and cold high clouds in dark red (middle) and MODIS deep blue AOD retrievals at 550 nm.
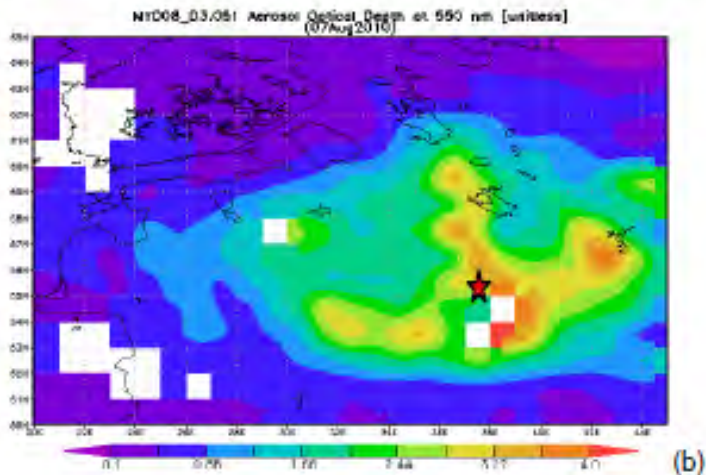
Use of MODIS aerosol optical depth data in Giovanni for research

Smoke aerosol and its radiative effects during extreme fire event over Central Russia in summer 2010

Chubarova et al., *Atmospheric Measurement Techniques*

Temporal variations of AOT500 in Moscow and Zvenigorod during 7 August 2010, when the highest aerosol loading was observed (a); MODIS AOT550 data over the Moscow region for the same day (b).

Use of MODIS aerosol optical depth data in Giovanni for research

Megacities as hot spots of air pollution in the East Mediterranean

## Kanakidou et al., *Atmospheric Environment*
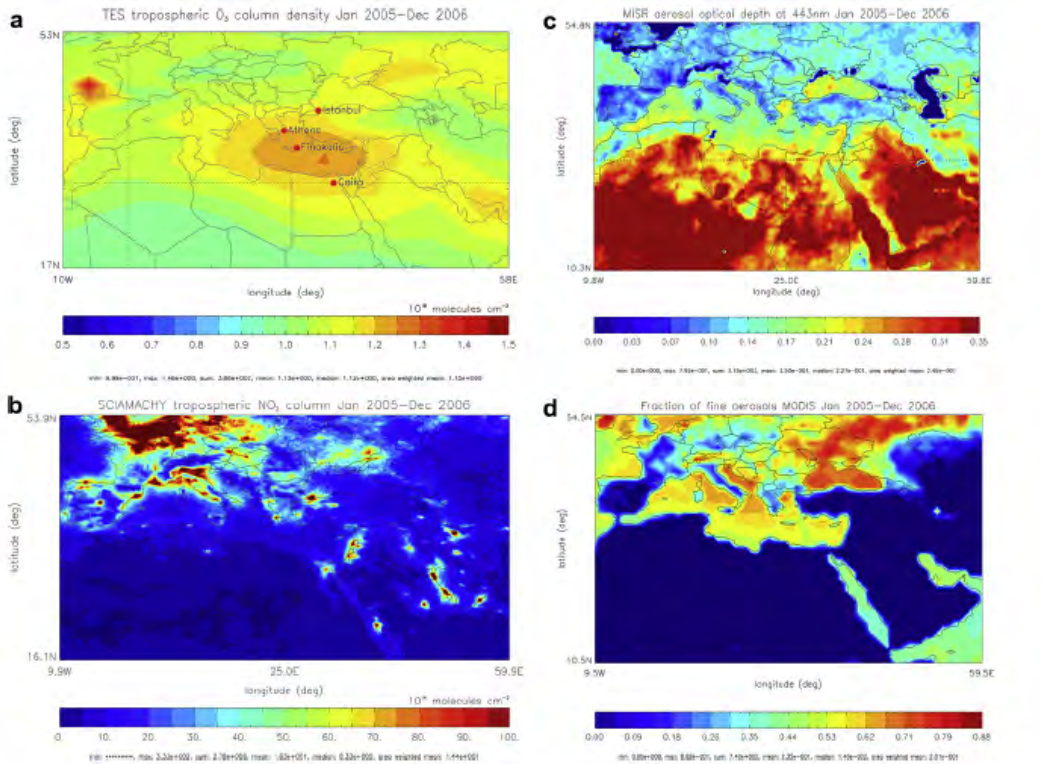
(a): Tropospheric O_3 column as deduced from TES (Tropospheric Emission Spectrometer) satellite sensor gridded in 2°x 4° lat x lon – The locations of Istanbul, Athens, Cairo and Finokalia are indicated; (b): Tropospheric NO_2 column from SCIAMACHY; (c) MISR aerosol optical thickness (AOT) at 443 nm in 0.5° x 0.5° and (d) MODIS aerosol small mode fraction in 1° x 1° resolution. Mean columns for the years 2005-2006 (a, c, d) have been derived from daily data using the Giovanni visualization tool of NASA.
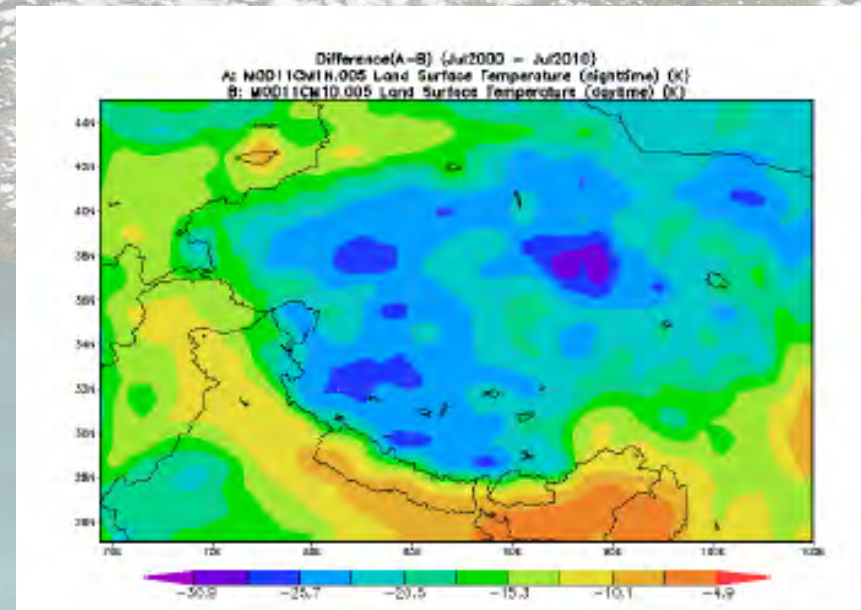
Use of MODIS land surface temperature data in Giovanni for research

Land–biosphere–atmosphere interactions over the Tibetan plateau from MODIS observations

Jin and Mullins, *Environmental Research Letters*
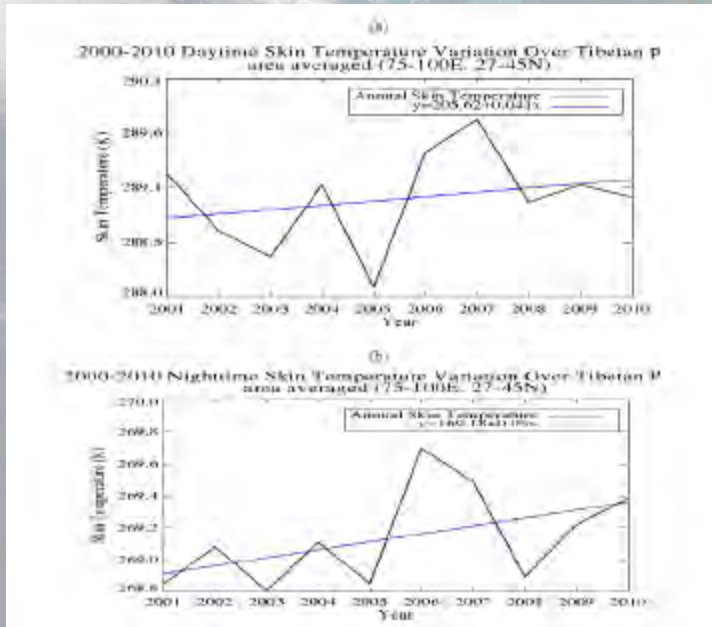
Trend of skin temperature over Tibetan Plateau (75–100E, 27–45N) for (a) annual daytime based on MODIS Terra (10:30 AM) and (b) annual nighttime based on Terra MODIS (10:30 PM).
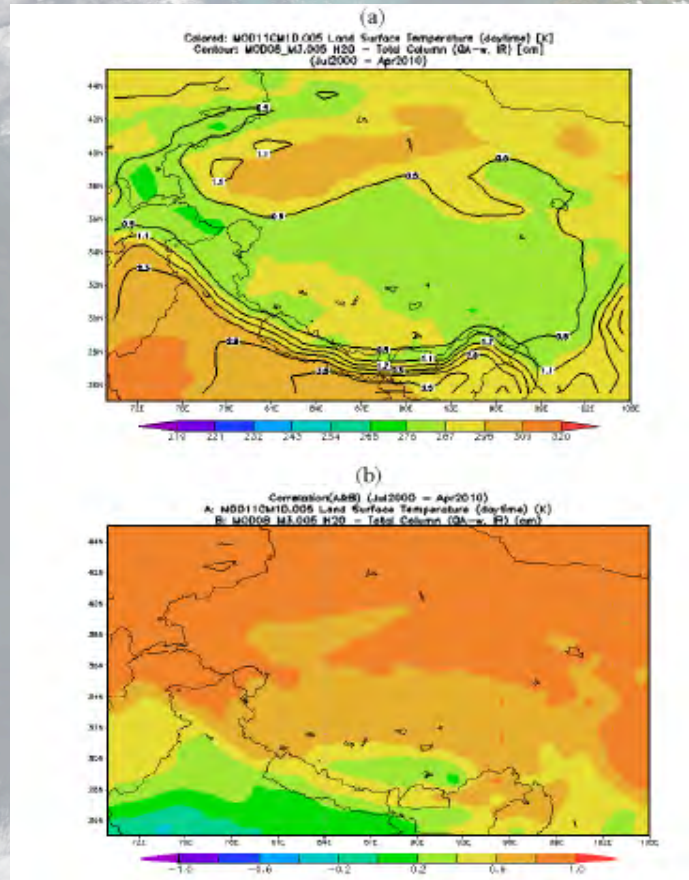
Diurnal range (nighttime minus daytime) of skin temperature averaged from July 2000 to July 2010. Data is from Terra MODIS.

Use of MODIS land surface temperature and water vapor data in Giovanni for research

Land–biosphere–atmosphere interactions over the Tibetan plateau from MODIS observations

Jin and Mullins, *Environmental Research Letters*

(a) 11 yr (July 2000–April 2010) annual averaged skin temperature and total column water vapor. Skin temperature is in color and water vapor is in contour. (b) Correlation map for 11 yr monthly mean skin temperature and water vapor, data is from July 2000 to April 2010, obtained by Terra MODIS at 10:30 AM. Data resolution is 1° x 1°. Water vapor data is only available until April 2010 when this work is conducted.

Use of MODIS fire pixel count data in Giovanni for research

Free tropospheric peroxyacetyl nitrate (PAN) and ozone at Mount Bachelor: causes of variability and timescale for trend detection

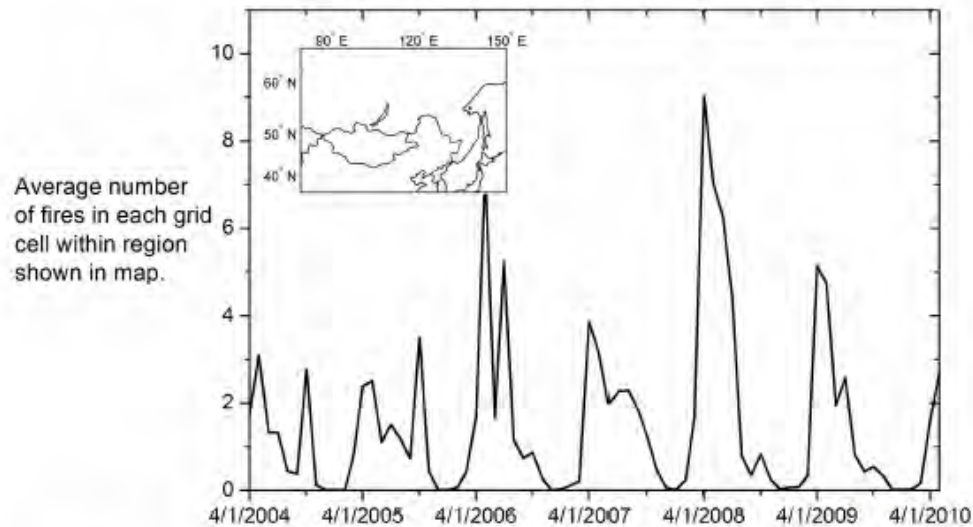Fischer et al., *Atmospheric Chemistry and Physics*

Fig. 3. Monthly average number of fires in each grid cell in region bounded by 35° N–65° N and 80° E–150° E (shown in inset map). Fires peak in this region in spring. There was an early and very strong fire source in this region in April and May 2008 due to early snow melt. Data used in this figure were retrieved from the Giovanni online data system, developed and maintained by the NASA GES DISC Northern Eurasia Earth Science Partnership Initiative (http://gdata1. sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=neespi) (Acker and Leptoukh, 2007).

From the conclusions:

"Springtime average PAN mixing ratios at MBO vary by 21% inter-annually. We explored the impact of temperature, trans-pacific transport efficiency, and *Siberian biomass burning* on the seasonally averaged PAN mixing ratios."

The near-future: *Giovanni-4*

Giovanni-4 is in development; Version 4.7 has been released.

http://giovanni.gsfc.nasa.gov/giovanni

Giovanni-4 features:

➤ markedly faster analysis speed;
➤ product-based search interface with ALL data products available;
➤ new analytical capabilities (seasonal + monthly average time-series!);
➤ interactive analyses;
➤ vector plots;
➤ save-able (bookmarkable) URLs, allowing exact replication of analyses (can be used to replicate and share both search criteria and data parameter selections);
➤ expanded color palette selections, potential for user-submitted palettes;
➤ and new output formats (PDF, TIFF, GeoTIFF).

The Giovanni-4 data interface

The near-future: *Federated Giovanni*

Based on Giovanni-4, the Federated Giovanni project will combine data from five data centers:

- Goddard Earth Sciences DISC, NASA GSFC;
- Physical Oceanography DAAC, Jet Propulsion Laboratory;
- MODAPS, NASA GSFC;
- Land Processes DAAC, USGS Eros Data Center;
- Ocean Biology Processing Group, NASA GSFC.

DAAC	Datasets
PO.DAAC	Sea Surface Temperature: Advanced Microwave Scanning Radiometer-EOS (AMSR-E), WindSat, Advanced Very High Resolution Radiometer (AVHRR), Moderate Resolution Imaging Spectroradiometer (MODIS), Multiscale Ultra-high Resolution (MUR), Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA), Aquarius Sea Surface Salinity, Ocean Surface Current Analyses-Realtime (OSCAR) currents, QuikSCAT and Advanced Scatterometer (ASCAT) ocean vector winds
OBPG	MODIS and SeaWiFS chlorophyll concentration, diffuse attenuation coefficient, CDOM index, particulate organic carbon, reflectance at various spectral bands
MODAPS	MODIS Aerosol Optical Depth (AOD) and MODIS Clouds
GES DISC	SeaWiFS AOD, Atmospheric Infrared Sounder (AIRS) Clouds, Tropical Rainfall Measuring Mission (TRMM) Precipitation
LP DAAC	Enhanced Vegetation Index

Federated Giovanni will: allow users to access satellite data from several collaborating DAACs and will facilitate better use of multi-satellite data sets.

The near-future:
Data-enhanced Investigations for Climate Change Education

✓ In the Giovanni-3 architecture, DICCE was constructed as a data portal with selected data parameters that were easy to understand and 'recognizable' to teachers and students.

✓ DICCE will be migrated to Giovanni-4 by creating global search URLs for specific data products of interest, based on the current DICCE set of parameters.

✓ The American Meteorological Society educational branch is teaming with DICCE on teacher training workshops, beginning this summer in California.

✓ DICCE uses MODIS chl-*a*, SST, AOD, Deep Blue AOD, euphotic depth, cloud fraction, mass concentration, land surface temperature, NDVI, and EVI.

Giovanni

The Bridge between Data and Science