Global Observation of Forest Cover (GOFC): Fire Implementation

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GOFC Fire: rationale

- Fires are an important resource management issue and an important aspect of global change research

- Fires are a hazard - a topic of the IGOS-P Disaster Management Support Group (DMSG) which is focusing on data requirements and in particular near real-time data provision for fire fighting

- Currently remote sensing of fire falls largely in the research domain – there is a need to transition tested methods and techniques into the operational domain and to develop robust procedures to provide improved information

- A significant improvement in the provision of operational satellite fire data is needed and feasible– and is largely a question of coordination and agency commitment

- Extreme fire events are raising public awareness –as to the significance of fire monitoring and management

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GOFC-Fire and Resource Management

- Fire management is increasingly important
- Fire management includes prevention, detection, pre-suppression and suppression, post fire assessment
- Good fire management requires an understanding of fire ecology (there is an overlap with the GC community interests)
- Remote sensing can provide input at different stages of fire management decision making:
  - Policy planning
  - Strategic planning
  - Management – occurrence and behavior prediction
  - Operations – response decision
- Remote sensing only satisfies part of the information needs
  - Field data are essential for fire management
  - Remote sensing is most useful when integrated with GIS
  - Remote sensing can also contribute to the development of fire behavior models
- DMSG – looking at required information requirements for fire suppression (15 minute response)

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Example Information Needs for Fire and Natural Resource Management

- **Underlying GIS (forest and land use maps, digital terrain data, roads etc)**
- **Fire history**
- **Fire susceptibility**
  - **Fuel load**
  - **Fuel condition (mesoscale weather)**
- **Active fire mapping**
  - **near real-time fire location, size, intensity**
  - **fire behavior models**
- **Burned area mapping/ estimation**
- **Fire fighting feature detection e.g. cut lines, water resources**
- **Smoke venting and dispersion**
- **End of season fire mapping – post fire assessment**

GOFC-Fire in GC Research

- Source of Trace Gas and Particulate Emissions
- Effects on Biogeochemical Cycling e.g. carbon and nitrogen cycles
- Indicator of Land Use Change e.g. tropical forest conversion
- Impact on Land Surface Radiation Budget
  - surface albedo / burn scars
  - aerosols and cloud formation and radiative properties
- Ecosystem Disturbance and Recovery – composition and structure
- Hydrological Cycling e.g. changes in evapotranspiration, run off
- Land / Atmosphere Feedbacks
- Interannual and decadal variability and changes in fire regimes – relationship of fires to ENSO and PDO
- IPCC National Emission Inventories – annual fire emissions

GOFC

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Information needs for Global Change Research *

– **Operational Data Needs**

- Satellite Products
    - Primary Fire Information (stable record over decades)
        » Location
        » Timing of fires (as an input to emissions)
        » *Burned area*
        » *Fire intensity / energy released*
        » *Return frequency*
    - Related Products (associated w. annual emission estimates)
        » Vegetation type and *parameters (e.g. % tree cover, biomass)*
        » *Vegetation moisture content*
        » Aerosol optical thickness / *Aerosol characteristics*
        » Distribution of traces gases e.g. CO, Tropospheric Ozone

* Not including fire hazard alert
Products in development phase

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- In-situ Data Needs
  - Satellite Instrument Vicarious Calibration
  - Satellite Product Validation Data
    - » Active fires
    - » Burned area
    - » Others

- *In-situ Data Needs Associated with Emissions Estimation*
  - Sampled Emission Factors – representative conditions
  - Sampled Fuel Loads –model validation
  - Sampled AOT – model validation
  - Ground Level Wind Speed – assimilated data ?

- *Model Output Needs Associated with Emissions Estimation*
  - Modeled annual primary production > fuel load
  - Modeled trace-gas and particulate emissions

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Associated Sensing System Requirements for Fire

- **Currently no one system meets all the global change user requirements**
- **Spectral Characteristics**
  - Mid-IR/Thermal (active fire)
  - Visible/Mid-IR/Microwave (burn scars)
- **Spatial Resolution**
  - Sub-pixel detection of active fires – (smoldering fires 10m by 10m ?)
  - Burn scar measurement - (100's m regional /10's m local ?)
- **Temporal Resolution**
  - Daily fire occurrence (sampling of the diurnal cycle – geostationary)
  - Annual area burned (some regions require time-series data through the year)
- **Coverage Requirements**
  - Global coverage (e.g. global estimates, transport studies)
  - Regional coverage (e.g. IPCC national reporting, process studies)
- **Calibration Requirements (consistent data record)**
  - Instrument stability
  - Geometric accuracy
- **Better definition and prioritization of requirements needed**

Fire Data System Requirements

- **Data Quality (operational and science QA)**
    - identify deviations from stated algorithm performance
    - identify impact of instrument degradation on product
    - provide users with information on data quality
- **Product Validation (higher resolution imagery or ground data)**
    - stated accuracy of the product over range of environmental conditions
    - validation data needs to be made available to users
- **Availability and Access (ease of access)**
    - Easily accessible data including data from long term archives
    - Metadata on what is available and how to get it
    - Automated internet access preferable – some demand for hard media
- **Cost (affordable to the user)**
    - Price by compiled data set (i.e. time series) affordable at the individual project level
    - When requesting an annual time series users cannot afford charges for individual orbits
- **Timeliness of Delivery (in time to be useful)**
    - 15 minutes for fire response /fighting
    - Availability 14 days after acquisition would satisfy most GC researchers needs
   - FTP pull within 24 hrs of availability, 7 days after ordering for media

Examples of Current and Planned Sensing Systems

- **Active Fire Detection**
  - **AVHRR, GOES, DMSP (operational systems)**
  - **TRMM, MODIS (AM), ATSR**
- **Burned Area Estimation**
  - **Coarse/moderate Resolution**
    - **AVHRR, SeaWiFS, ATSR, VEGETATION, MODIS**
  - **High Resolution**
    - **Landsat 7, SPOT**
    - **ERS/JERS (not current), Radarsat**
  - **Hyper Spatial Resolution – Ikonos**

- **Examples of Planned Systems (next 4 yrs)**
  - **MODIS (PM) – active fire (standard) / burned area (experimental)**
  - **MERIS – burned area**
  - **NPP VIIRS – active fire and burned area**
  - **ASTER – high resolution optical and thermal**
  - **VCL – vegetation structure**
  - **EO-1 – hyperspectral resolution**
  - **Others - Fuego, InSAR, MSG, GLI, BIRD**

Montana Fires 23 Aug. 2000
MODIS 1 km fire pixels on
band 1 (R), band 2 (G), band 3 (B)

~25 km

MODIS/MODLAND/Justice,Giglio
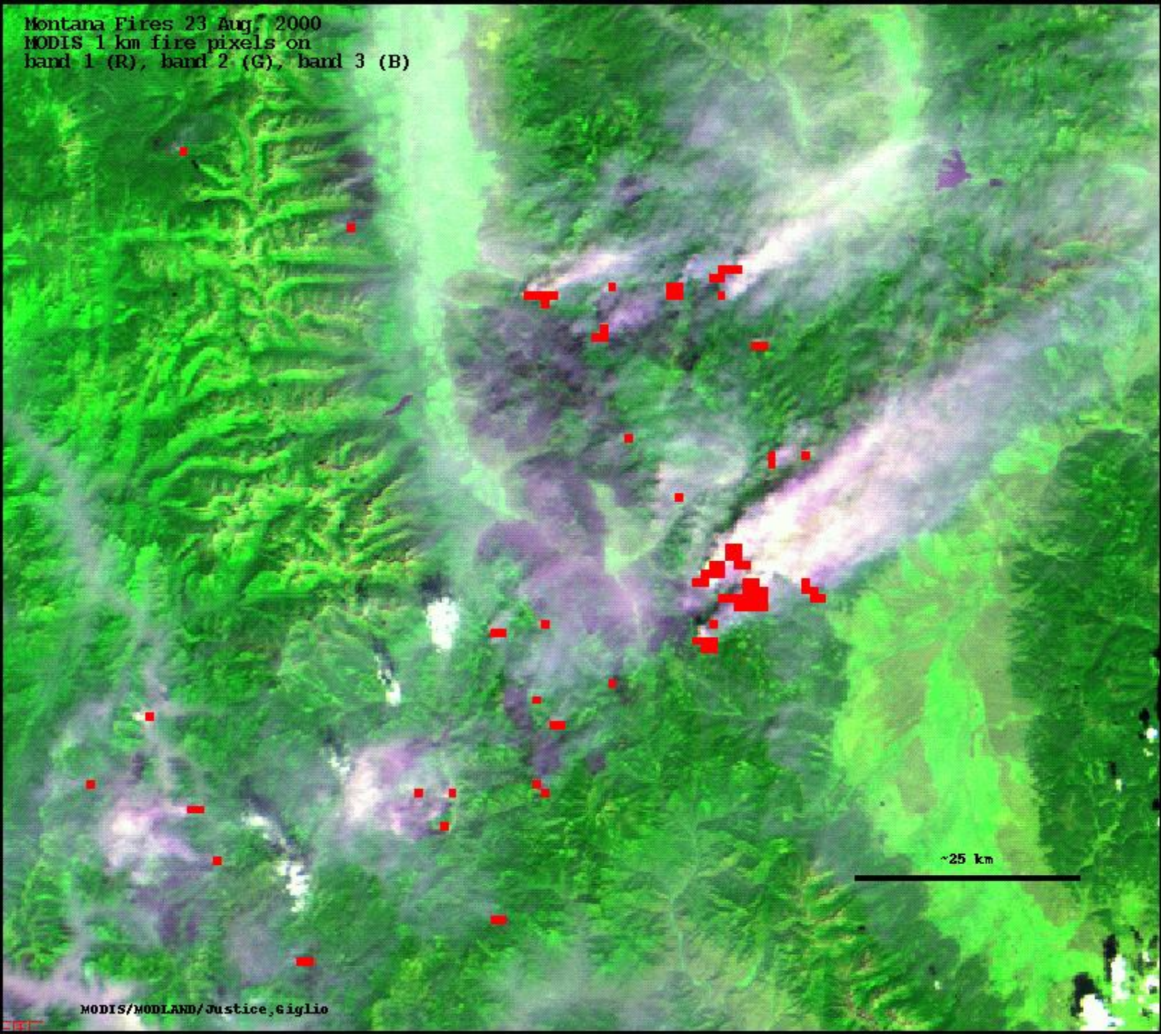
Areas for GOFC- Fire Activities:

- **Enhancing existing products and improving access to current satellite data** for fire monitoring – e.g. providing data to the users

- Helping to develop the user community – **strengthening regional networks of fire data users** – e.g. encouraging lateral transfer of appropriate technology, by providing consistent and reliable data

- Demonstrating current capabilities and new technologies for fire monitoring – **e.g. implementing operational pilot projects** – what case can be made from previous studies?

- **Articulating the current and future remote sensing needs** for fire monitoring and **securing the long-term operational provision of fire information** – e.g. recommendations to CEOS

- Research and Development priorities e.g. developing new techniques - **building a foundation for future operational systems** – identifying opportunities for technology infusion and mechanisms for the transfer of technology and methods from research to operational mode

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GOFC Fire Projects

- Three types of projects foreseen:

  – GOFC Fire 'community' projects – multiple data providers, users

  – Individual contributions aimed at demonstrating operational provision and use of data

  – Research and development projects, building a foundation for operational fire monitoring

- The projects should help to build a sustainable user community which will continue to use fire information once the GOFC project is completed – we recognize that the regional user networks will be the primary mechanism for strengthening the GOFC user community

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Summary of GOFC-Fire Implementation Goals

- **Geostationary global fire network** – providing operational standard fire products (active fire) in a timely fashion

- **Polar orbiters:**
  - providing operational moderate resolution long-term global fire products to meet user requirements and distributed ground stations providing regional products of known accuracy (active fire/burned area)
  - operational high resolution acquisition allowing post-fire assessments

- **Emissions product suites -** developed and implemented at the regional scale – input data and annual estimates being provided

- **Product accuracy -** fire validation sites and protocols established, providing accuracy assessment for operational products and test bed for new or enhanced products

- **Enhanced user products -** operational multi-source fire / GIS products - initial regional focus - Web based access

- **User Awareness** – increased understanding of the utility of satellite fire products for global change research, resource management and policy

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Emerging GOFC Fire Projects

- The expansion of the World Fire Web active fire monitoring network to global coverage with 24-hour turnaround time.

- The production of 1 km resolution regional and global area burned products, with moderate resolution sensors, such as AVHRR, ATSR , VGT and MODIS

- The development of 'community' demonstration projects, providing enhanced multi-source satellite data and GIS for selected regions of the world (e.g. WGISS Test Facility)

- Regional network fire product validation activities and test locations

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GOFC Observing System

Satellite observations - from both operational and experimental systems
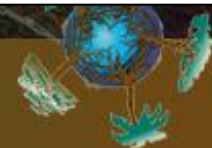
In-situ observations for validation and model parameterization

High Order Analysis and Information Services

Resource Management Users

Global Change Research Users

Policy Information Users

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Example "Community" Data System Deliverable

- Current products fall short of what is really needed –multiple sources/formats/information content

- Goal to make data available (within 48 hrs) for multiple current and future fire detection systems

  – Users need data produced by different algorithms and sensors on their PC in a form they can use

- Need to generate value-added products (visualization tools/synthesis of fire and other datasets) with innovative data access, to support GOFC e.g. custom on-demand fire products, fire information portals combining data from fire data providers and other GIS/remote sensing products

- One approach is to develop common interfaces for query and online data retrieval from differing sources (XML based) and publication of these interfaces within the GOFC group

GOFC Fire Working Group Example Deliverable —
WWW Multi-source Fire Detection System

ATSR

GMS

MODIS

Other

DMSP

AVHRR

Return Data

Query

WWW portal(s)
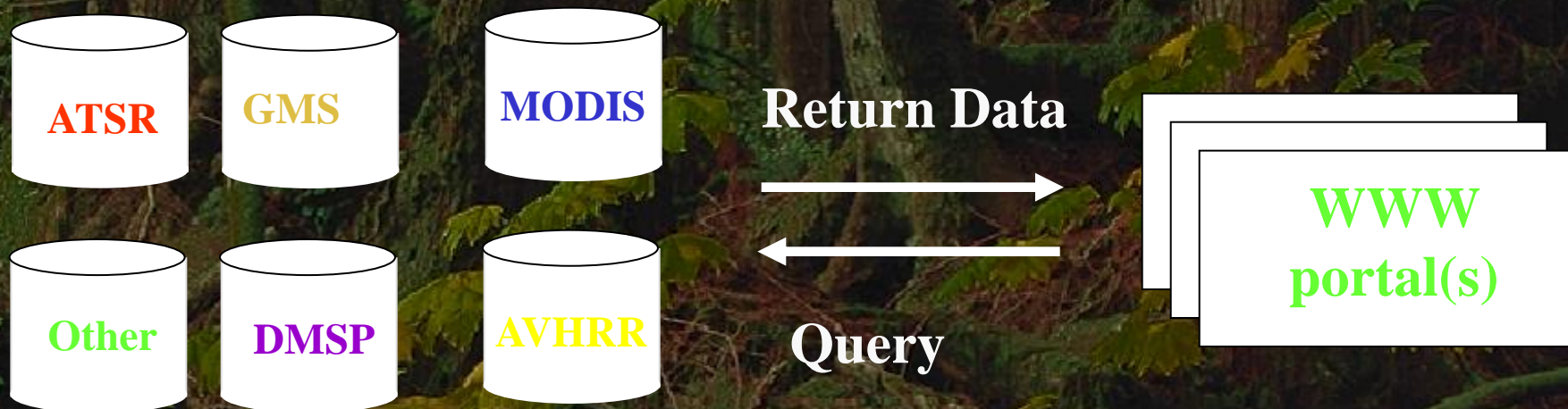
Data Source Providers with a common format product and interface

Combine fire and other data sources on the fly

Areas for GOFC-Fire Research and Development

- **GOFC Fire R and D activities should support**
  - the enhancement of primary fire products of interest to a broad range of users e.g active fire, burned area, pyrogenic emissions
  - the development of standards and protocols and sites for product accuracy assessment (validation methods)
  - the development of continuous long term fire data records using archival data and new sensing capabilities
  - the development of derived products tailored to meet the needs of specific user groups e.g. fuel type and amount, moisture content, fire intensity, trace gas and particulate emissions
  - the improvement of data management and delivery systems to provide enhanced access to and delivery of fire information – special attention will be given to
    - long term data archives
    - near real time data delivery
    - combination of satellite fire products and GIS data (Web GIS)

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GOFC Fire Policy Awareness

- **Need to 'make' national and regional policy bodies aware of what GOFC is attempting to do**
  - Strengthen operational fire monitoring, develop partnerships with the user community
  - Provide data to better understand global change and fire management issues
- **Identify 'key' individuals/organizations as early as possible and involve them in the GOFC process/network**
- **Develop targeted activities e.g. GOFC policy outreach package that could be used / modified by the regional networks, explaining policy relevance of GOFC-Fire and the use of satellite fire data**

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