Fire ECV
Requirements
NASA White paper
ESA Climate Change Initiative

Olivier Arino

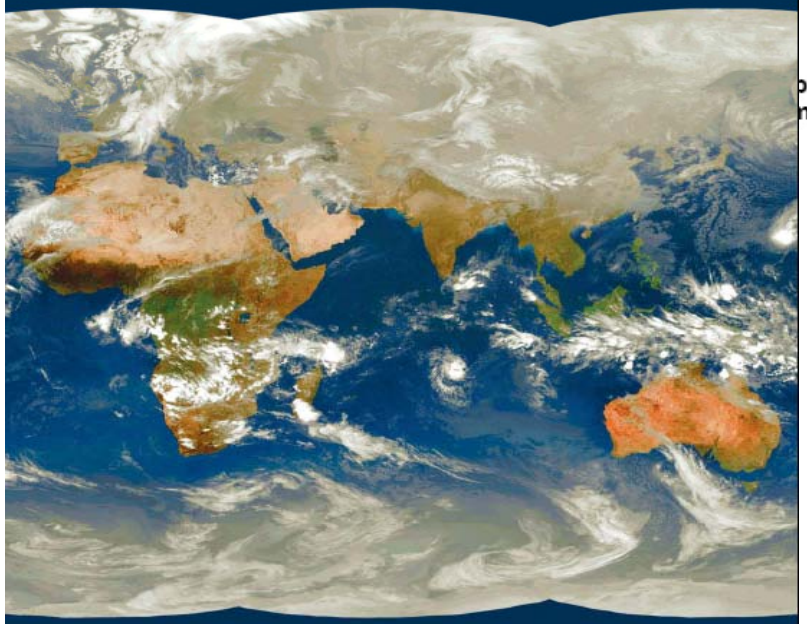
Frascati 26/03/2010

European Space Agency

GLOBAL
CLIMATE
OBSERVING

GEO 1000R
February 2005

Global Earth Observation System of Systems GEOSS



10-Year Implementation Plan Reference Document

Group on Earth Observations

ENVIRONMENT PROGRAMME

THE CEOS IMPLEMENTATION PLAN
FOR
SPACE-BASED OBSERVATIONS FOR GEOSS

Version 0.1.10
7th May 2007

CEOS
Committee on Earth Observation Satellites

GCOS 107 requirements

GCOS Objectives		Current Status
• Accuracy:	5% error in omission/commission	Unknown, high regional variation
• Spatial resolution:	250m	1 km
• Temporal resolution:	daily	monthly with Day of Detection
• Stability:	5%	Unknown, high regional variation

Classification accuracy: 95 %

Resolution: 250 meters

GTOS T13

Variable	Definition	Unit
Burned Area	Area affected by a human-made or natural fire	Square kilometer [km2]
Supplementary Variables	**Definition**	**Unit**
Active Fire	The area covered by vegetation that is currently being affected by a human-made or natural fire	Presence or absence of an active fire
Fire Radiated Power (FRP)	Rate of radiative energy emitted by an active fire, i.e. radiated power	Watts [W]; i.e. Joule per second [J/s]

Table 1 - Variables of the Fire Disturbance ECV

GTOS T13

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Table 1 - Variables of the Fire Disturbance ECV

GTOS T13

NAME	REFERENCE	SENSORS	COVERAGE		COVERAGE		DATA	STATUS
			spatial	temporal	spatial	temporal		
Burned Area Products								
Global Burnt Areas 2000-2007 (L3LRC)	www-tem.jrc.it/products_complete.htm	SPOT VGT	global	global	1 km	1 day	historical	finished
GBA 2000	www-tem.jrc.it/products_complete.htm	SPOT VGT	global	global	1 km	1 month	historical	finished
GLOBSCAR	http://dup.esrin.esa.int/ionia	ERS2-ATSR2	global	global	1 km	1 month	historical	finished
Modis Burned Area Product	http://modis-fire.umd.edu	Aqua/Terra –MODIS	global	global	500 m	1 day	historical	operational
Global Burnt Surface 1982-1999	www-tem.jrc.it/products_complete.htm	NOAA-AVHRR	global	global	8 km	1 week	historical	finished
GLOB CARBON	http://dup.esrin.esa.it/projects/summaryp43.asp	ATSR2, AATSR, SPOT-VGT	global	global	8 km	1 month	historical	operational

Table 3 - Major satellite-derived burned area products

GTOS T13

Active Fire Products								
MODIS active fire	http://modis-fire.umd.edu/MOD14.asp	Aqua/Terra –MODIS	global	2001-present	1 km	1 day	NRT +historical data	operational
World Fire Atlas (WFA-algo1/algo2)	http://dup.esrin.esa.int/ionia/wfa/	ERS2-ATSR2, Envistat-AATSR	global	1995-present	1 km	1 day	NRT	operational
EUMETSAT	www.eumetsat.int/Home/Main/Access_to_Data/Meteosat_Meteorological_Products/Product_List/index.htm#FIR	Meteosat-SEVIRI	Africa Europe		3km	15 min	NRT	operational
Active Fire Monitoring (FIR)	http://earthobservatory.nasa.gov/Observatory/Datasets/fires.trmm.html	TRMM-VIRS	40°N 40°S	1998-present	2 km	1 day	historical data	operational

NASA white paper

Active Fire Products: General Requirements

Global coverage
High temporal and spatial resolution
Long term data products
Short term data delivery after acquisition

Distinction between “science” and “applications” communities => requirements

Example: CEOS Disaster Management Support Group: 15 minutes after acquisition (only possible using GEO or airborne instruments)

NASA white paper

NASA Fire ESDR “science” uses

(i) as an indicator of daily, seasonal and inter-annual variability in fire activity regionally and globally, and trends associated with climate and climate change
(ii) as part of the validation process for fire affected (burned) area
(iii) as a way to determine more precisely the timing of burning for burned area products generated periodically during the burning season
(iv) as an integral part of some burned area mapping algorithms
(v) to estimate FRP, which has been shown to correlate with instantaneous rate of combustion and emission rates

NASA white paper

NASA Active Fire Requirements

- Middle infrared & thermal long wave sensors that will not saturate for the largest expected fires (assumed temperature at 1000K)
- geolocated to a fraction of a 1km pixel
- solar and viewing geometry
- optically thick cloud mask
- land/water mask
- 1 km global spatial resolution (GOFC 1999 requirement)
- 24 hour detection summary (the most stringent requirement is for active fire detection within 15 min for fire fighting applications)
- Products are needed at full resolution (1km) and summarized at 0.5 degrees
- Validation - simultaneous high spatial resolution sensing (20-30 m) is needed for active fire validation (e.g., ASTER).
- other parameters required
  - time of overpass
  - instantaneous and time integrated fire radiative power as a measure of fire emissions

NASA white paper

NASA Burned Area Requirements

- atmospherically corrected reflectance, visible to short wave infrared, thermal
- geolocated to a fraction of a 500m pixel
- solar and viewing geometry
- optically thick cloud mask
- 500 m globally (GOFC 1999 requirement)
- 30 m for regional and local mapping – (the most stringent requirement is for high resolution data within 2-3 days for rapid post-fire assessment)
- Monthly product as inputs to emission models recognizing the seasonality of fuel moisture, emission factors, and combustion completeness
- Products to be provided at full resolution and summarized at 0.5 degrees
- Validation – high resolution imagery (20-30 m) to be acquired one month apart

NASA white paper

NASA sources for the Active Fire ESDR

- AVHRR
- METOP
- ATSR
- OLS
- MODIS
- VIIRS

NASA sources for the Burned Area

- AVHRR
- SPOT-VEGETATION
- ATSR
- MODIS

NASA white paper

NASA Relationships to other products and programs

NOAA will be the provider of satellite data to the civilian applications user community in the NPOESS era.
Web Fire Mapper developed with NASA support to provide fire data to a wide range of users in a Web GIS format is currently being transitioned to the UN FAO supported by the NASA Applications program.

Inter-comparison will be needed between the Collection 5 MODIS burned area product and the ESA GLOBSCAR/GLOBCARBON products, following the procedures developed by Boschetti et al. (2004).

Fire data products are envisioned as part of the GEOSS and as inputs to the UN FCCC. The Fire ESDRs would meet the requirements of these organizations.

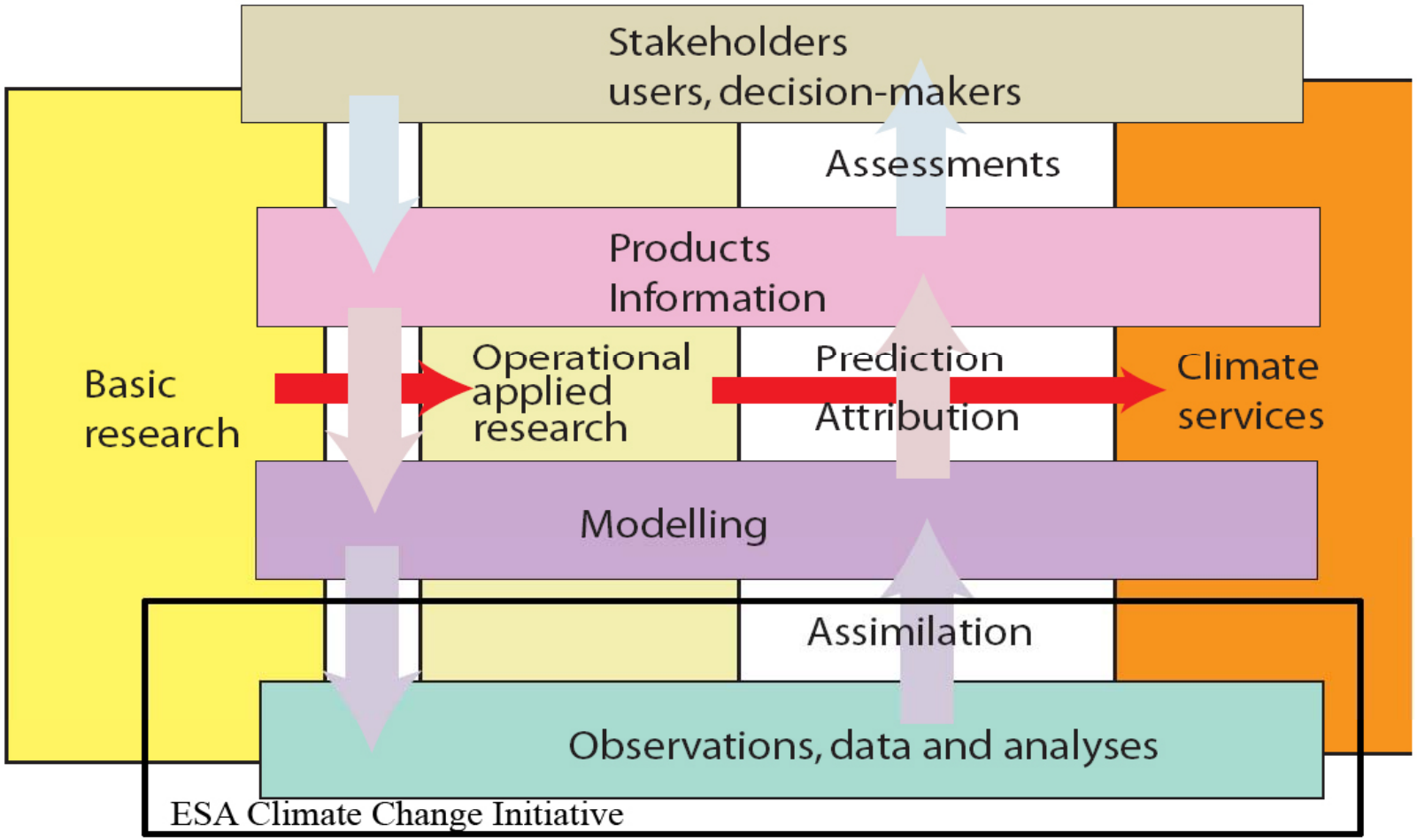
International coordination of fire monitoring associated with the ESDR should be conducted in the framework of GOFC/GOLD Fire

ESA Climate Change Initiative

The International Partners:

- **UNFCCC** which coordinates the interests and decisions of its Parties on Climate Policy,
- **GCOS** which represents the scientific and technical requirements of the Global Climate Observing System on behalf of UNFCCC,
- **International Research Programmes**, which represent the collective interests and priorities of the worldwide climate research community (e.g WCRP but also IGBP, IHDP, Diversitas…)
- **Committee on Earth Observation Systems (CEOS)**, which serves as a focal point for Earth Observation activities of Space Agencies
- **Individual Partner Space Agencies** with whom ESA cooperates bilaterally (e.g. Eumetsat, NOAA, NASA, JAXA, CNES…..)
- **EC and National Research Programmes** which establish research priorities and provide resources for climate research community within Europe (eg EC Framework Programme)

ESA Climate Change Initiative



The climate information system
(*from K. Trenberth: Observational needs for climate prediction and adaptation, WMO Bulletin 57(1), January 2008*) showing the locus of the ESA climate change initiative within it.

ESA Climate Change Initiative

Re-processing ex archive (e.g. calibration)

"Gather"

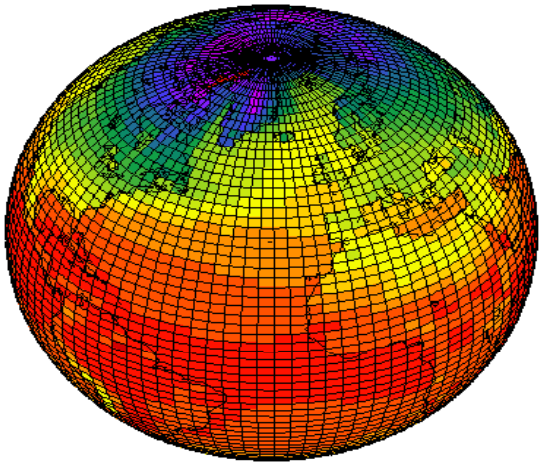
ECV generation (e.g. validation & bias)

"Deliver"

ECV assimilation & assessment

"Exploit"

FEEDBACK LOOP:



OUTPUT TO

International Climate Programmes
EC & MS R&D Programmes
IPCC Process, UNFCCC

Education & Awareness

"Show"

Advice from Climate Science Community (CSAB)

critical objectives, scientific challenges, major undertakings, key milestones of international climate research programmes

potential impact & relative importance for climate research & modelling programmes, of the satellite-based ECV data

mechanisms by which the feedback loops necessary to achieve GCOS objectives can be implemented & improved via CCI products & FCDRs

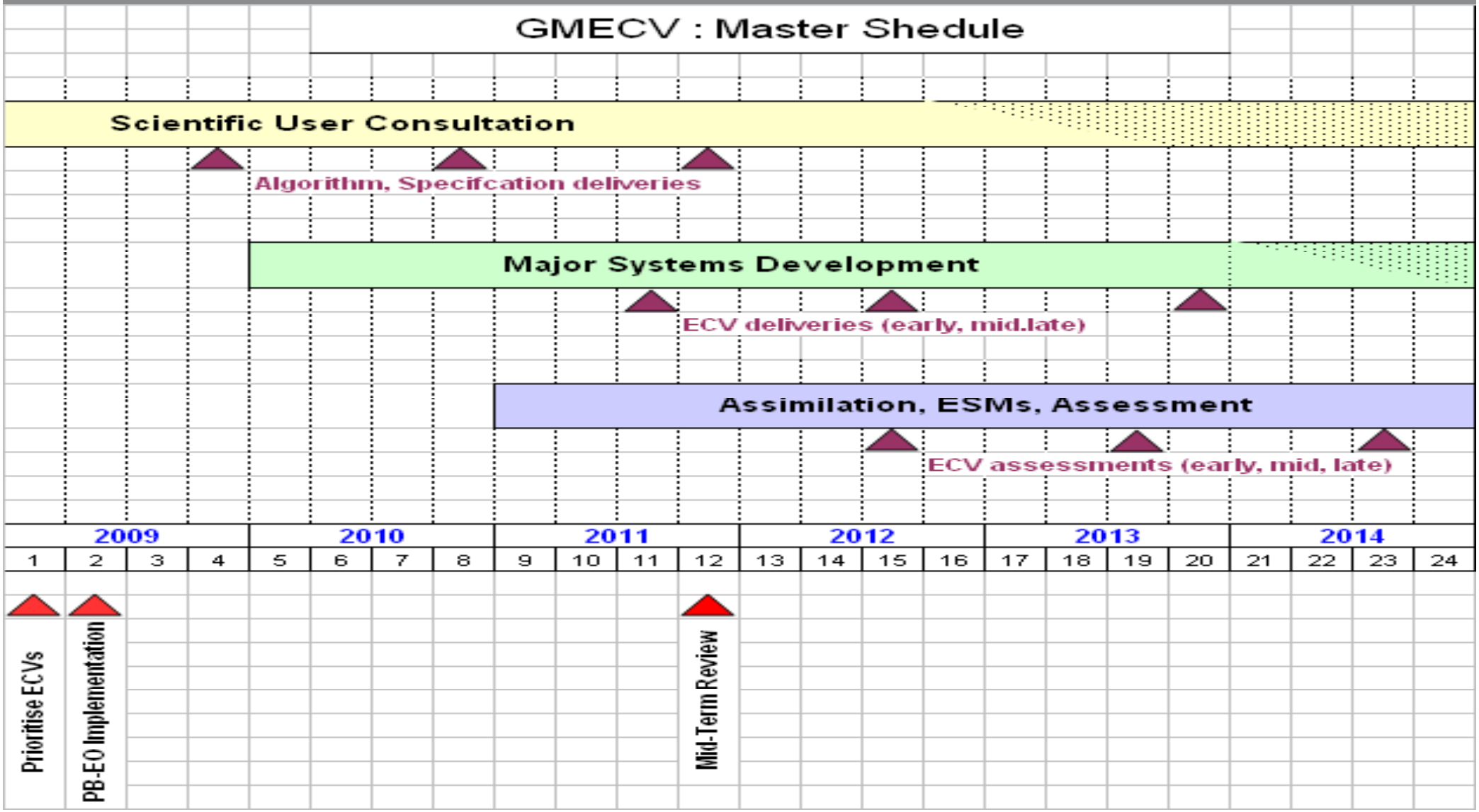
mechanisms by which this programme can further enhance interactions between EO data communities & climate research communities

how to facilitate use of the programme results within IPCC process

ensuring the scientific integrity of climate-related information for general public & decision makers

Overall Schedule

- Invitation To Tender closing 5 March 2010
- Project (3 years) KO planned May 2010

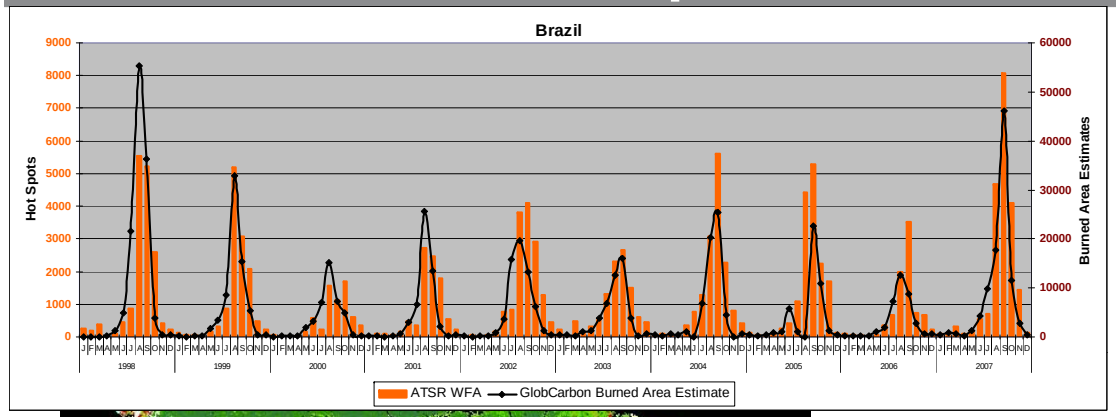


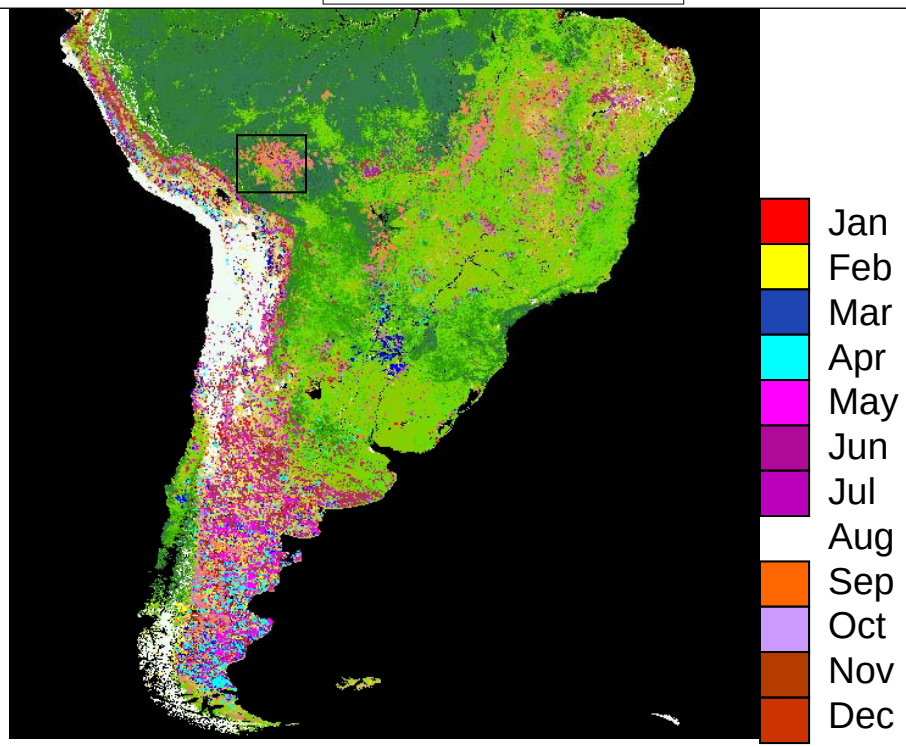
Climate Change Initiative

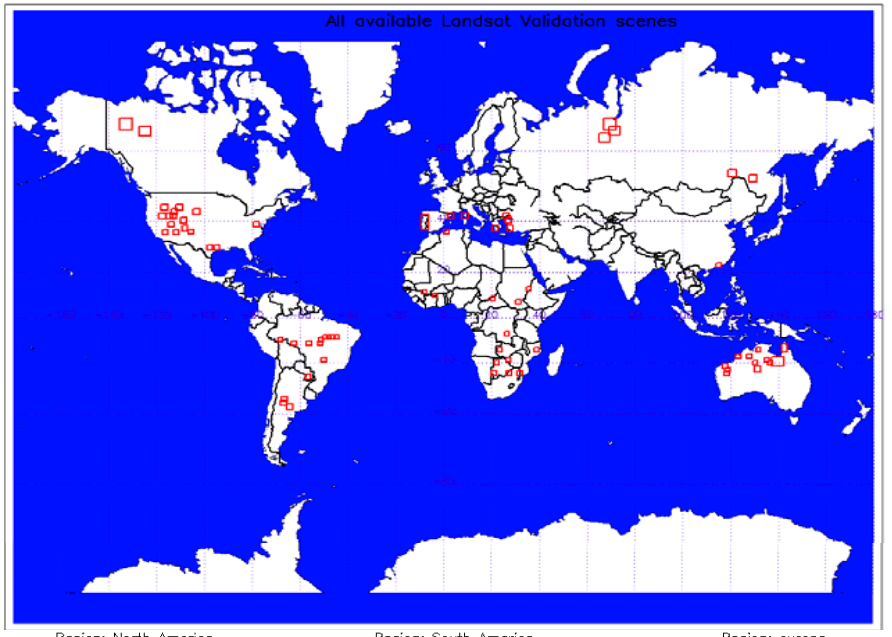
The Essential Climate Variables addressed in the CCI

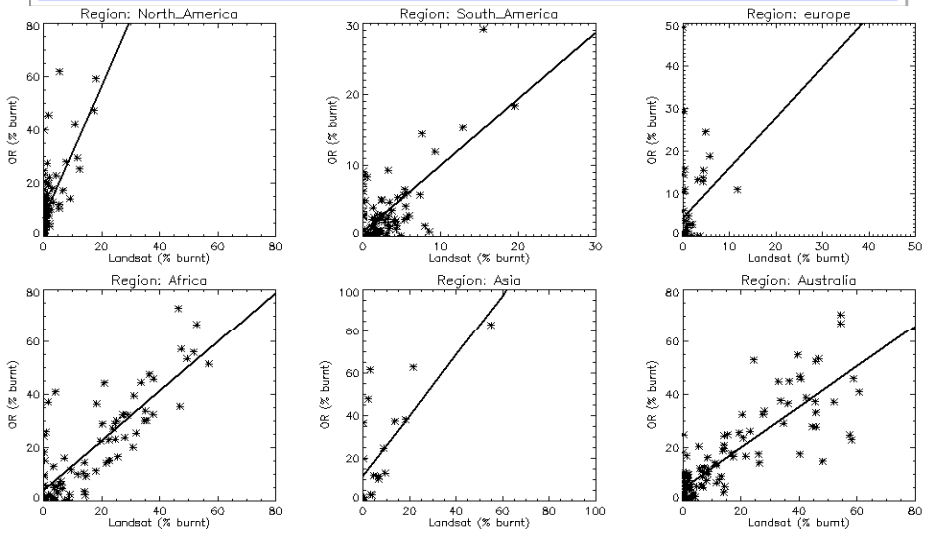
	ECV
Ocean	Sea Ice
	Sea Level
	Sea Surface Temperature
	Ocean Colour
Terrestrial	Glaciers
	Land Cover
	Fire Disturbance
Atmosphere	Cloud properties
	Ozone
	Aerosol
	Greenhouse Gases

GlobCarbon products & Validation 1998-2007 from VGT and ATSR, Plummer et al., 2006 Validation report on web, Tansey et al., 2008









GlobCarbon for VIP

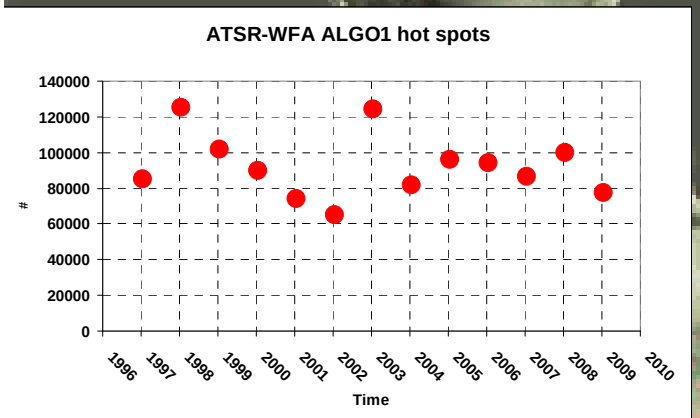
The GlobCarbon Burned Area Estimate (BAE) product has been processed to extract **monthly Burnt Pixel counts per country**.

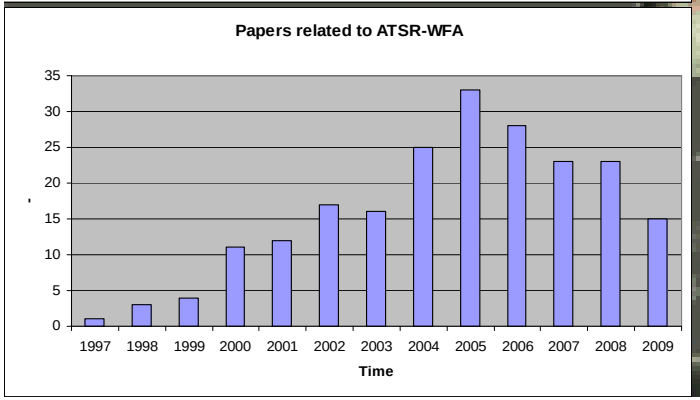
All the extracted results have been gathered in an Excel Table, which is freely available for download through Ionia GlobCarbon website:
http://www.esa.int/due/ionia/globcarbon

ATSR World Fire Atlas

07 - 1996

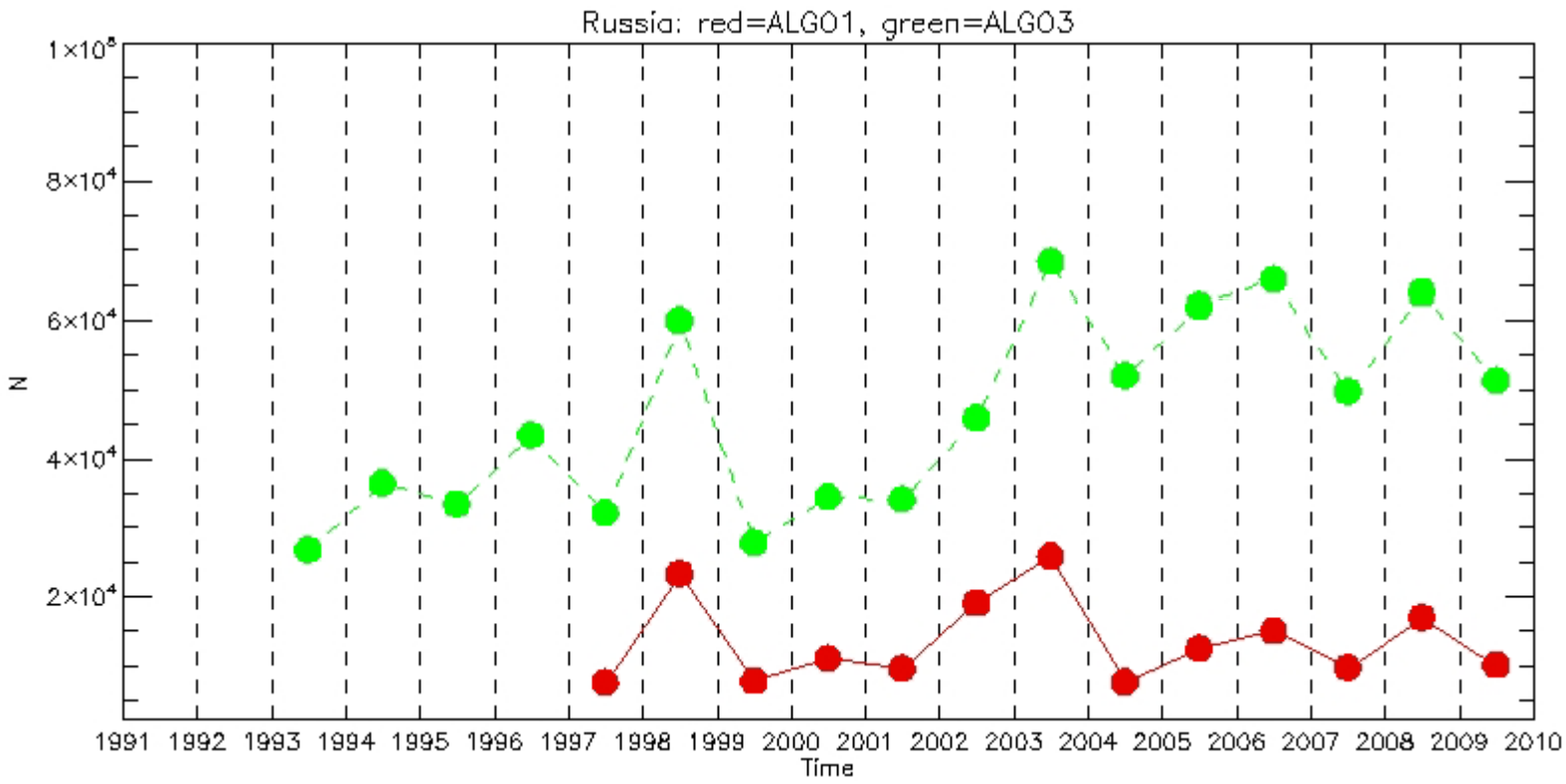
1991-Now
Arino and Casadio, 2009
Validation by IGBP,
Arino et al., 2001



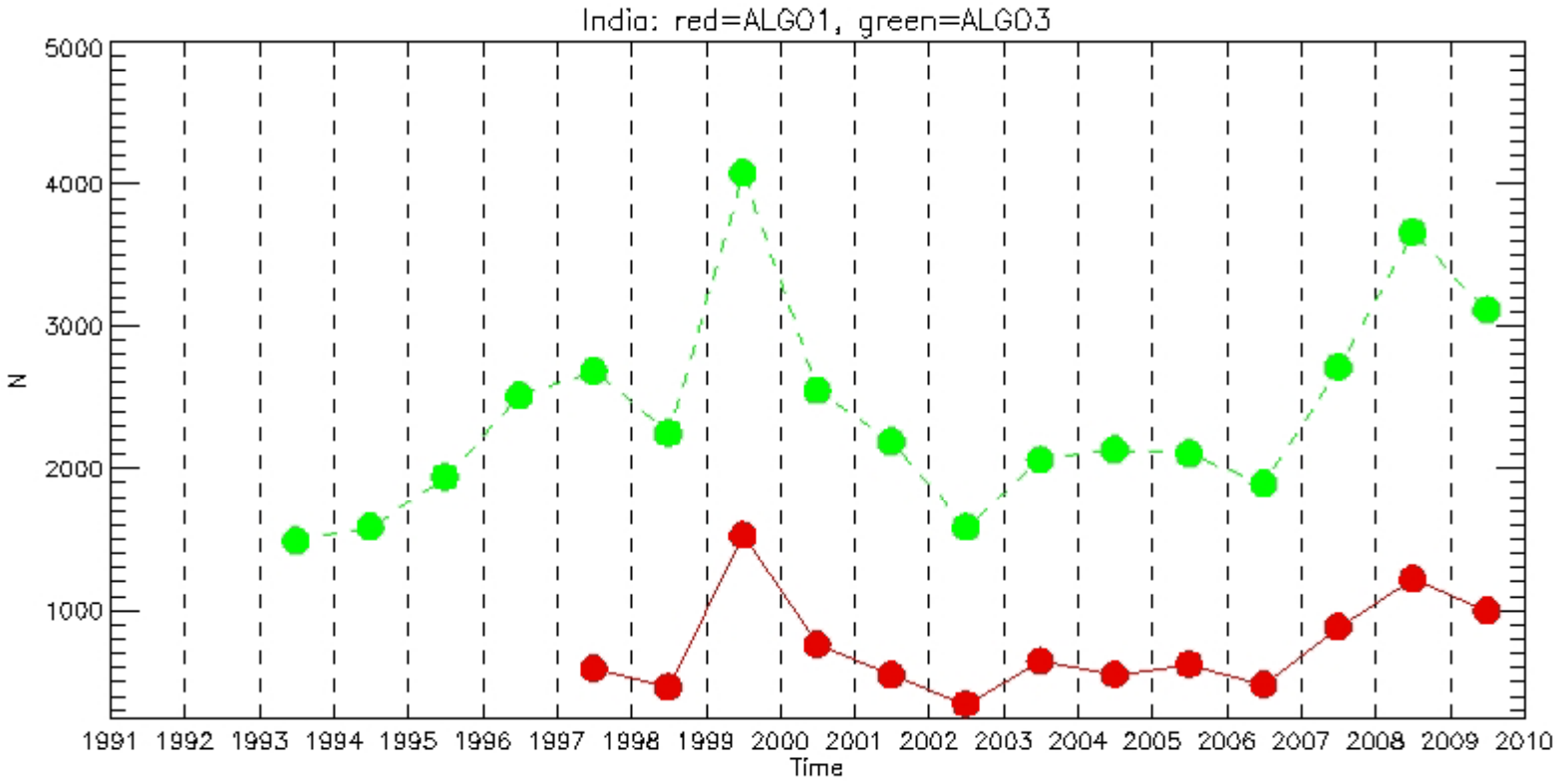


www.esa.int/due/ionia/wfa/

ATSR WFA RUSSIA Algo 1 and Algo3

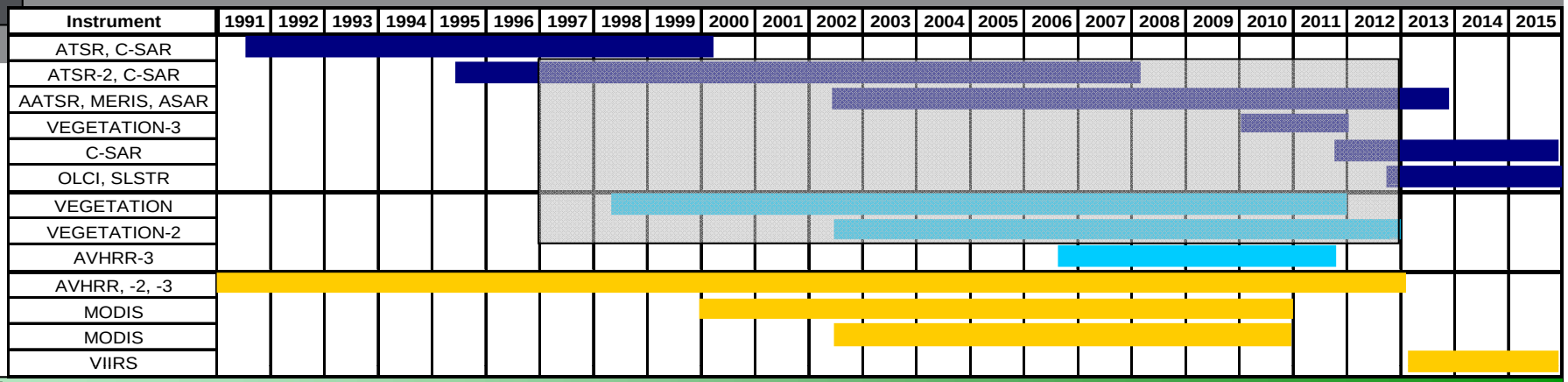


ATSR WFA India Algo 1 and Algo3

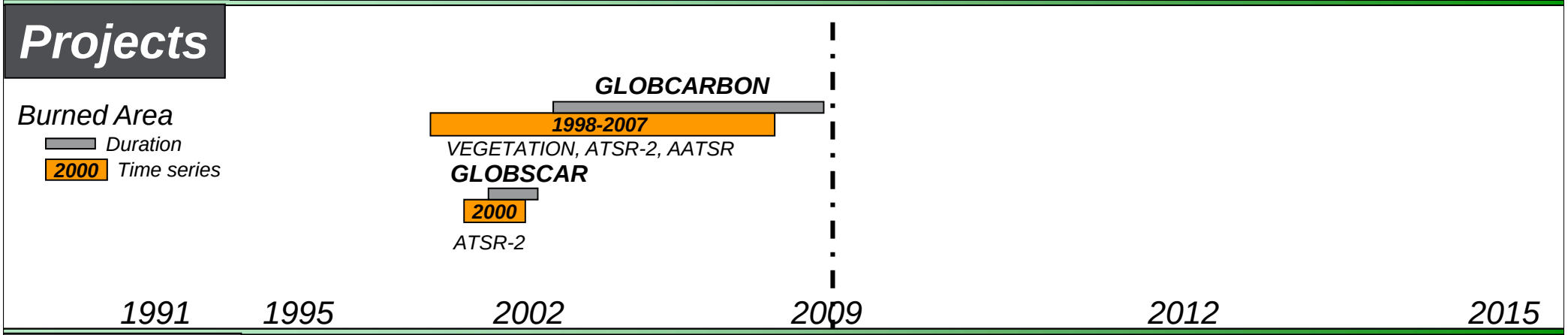


Fire Disturbance

Data



Projects



Users

Current Project Users

GLOBCARBON	Total Different Users: 130	MPI-Meteorology, LSCE, CTCD, PIK, GCP
WFA	Total Different Users: >4000	ECMWF, MPI, ATM Community

Key Partners

Fire Disturbance

GCOS Objectives		Current Status
• Accuracy:	5% error in omission/commission	Unknown, high regional variation
• Spatial resolution:	250m	1 km
• Temporal resolution:	daily	monthly with Day of Detection
• Stability:	5%	Unknown, high regional variation

- **Baseline data requirement**
  - Data processed to a universal level and in standard format
  - Consistency in calibration, sub-pixel geolocation, cloud, snow and cloud shadow screening and atmospheric correction
- **Linked projects / datasets**
  - L3JRC 'daily' burned area from VEGETATION
  - MODIS burned area
  - GlobCarbon burned area
  - JRC AVHRR GAC burned area
  - Regional databases e.g. Canada Large Fire Database, Brazilian Amazon Fire Database
- **Key Science Bodies**
  - GOFC-GOLD
  - GTOS
  - International Research Programmes (IGBP (AIMES), WCRP, ESSP esp Global Carbon Project)
- **Key Users**
  - Atmospheric Transport Modellers
  - Dynamic Global Vegetation Modellers

Fire Disturbance

Requirements

- **Determine the exact requirements for burned area** starting from GTOS T13 Report, for vegetation and atmospheric transport model community.

Baseline improvements

- **Consistency of geolocation** between MERIS, VGT, ATSR
- **Remove detection error sources**: snow disappearance, lake ice melt, cloud and topographic shadow.

Algorithms for Burned Area

- Develop new (**MERIS FR, RR**) and improved algorithms (**VGT, ATSR**) for the retrieval of **consistent global burned area estimates**.
- **Multiple detection and probability approaches for combining results. Include international collaborations** (e.g. MODIS MCD45A1, EC GLMCS) and use fully traceable **error characterisation**.

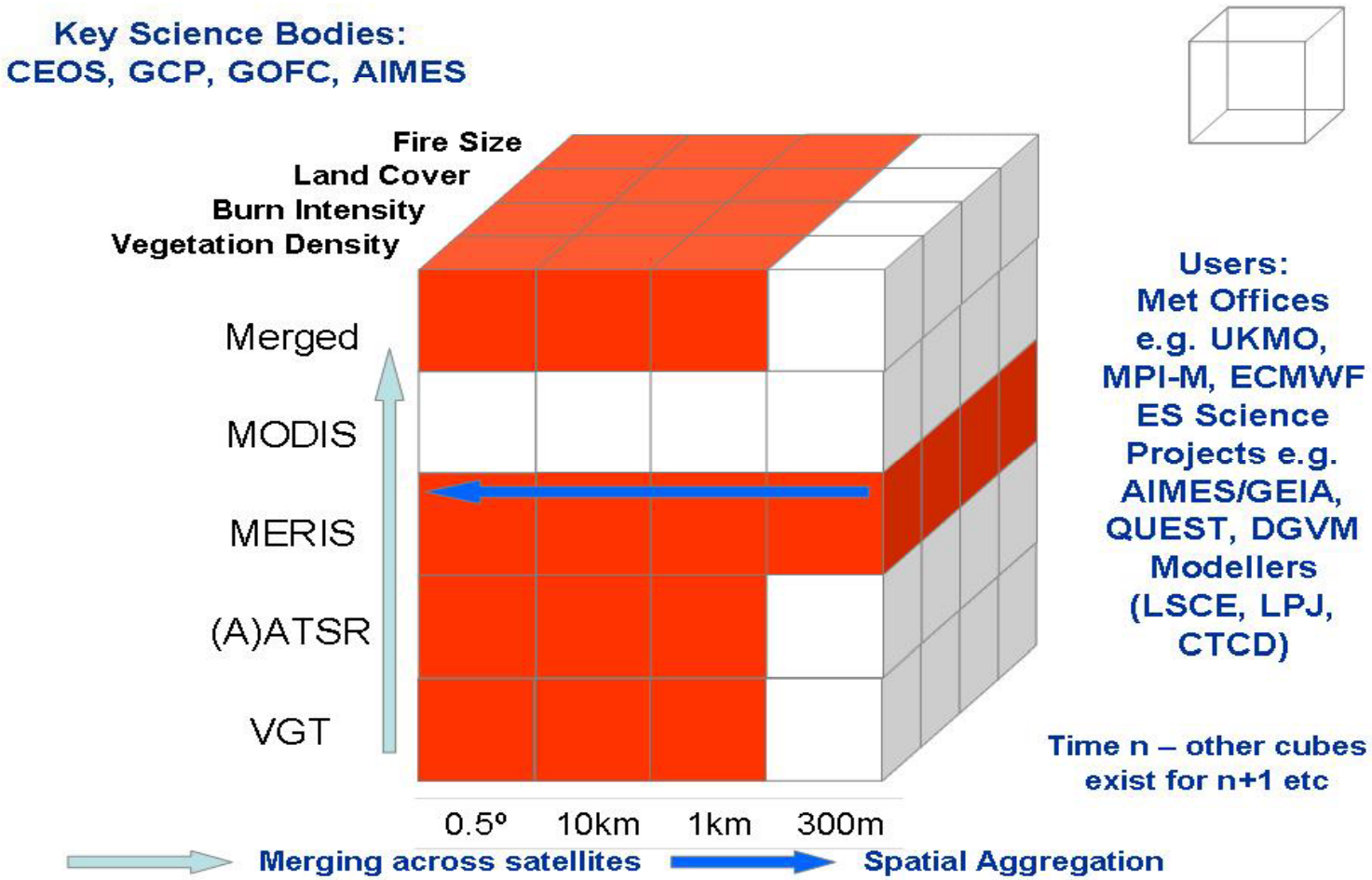
Validation

- Compare results against existing burned area products - **MODIS MCD45A1, L3JRC, GlonCarbon**.
- Improve validation database by consolidation of Landsat/SPOT HR burned area products following **CEOS WGCV BA Protocol**.

Modelling

- **Develop Vegetation and Atmospheric Transfer model components** capable of ingesting the products.

Fire Disturbance



Seed questions

- Who is entitle to specify the requirements?
- Are the today requirements feasible?
- How far can we extend the Fire ECV back in time and in future?
- How do you use the Fire ECV? (modellers, trendies, VIP)
- How do you validate the Fire ECV with available archive?
- How to bridge between 500m/1km (MODIS, VGT and ATSR) to 10m/30m (Landsat/Sentinel-2)?
- What about MERIS FR at 300m?
- What about use of active sensor (ASAR, PALSAR)?
- BAE by vegetation type?