SWITNET

The Space Weather ITalian NETwork and Its Role in the European Scenario

Mauro Messerotti

INAF- Trieste Astronomical Observatory

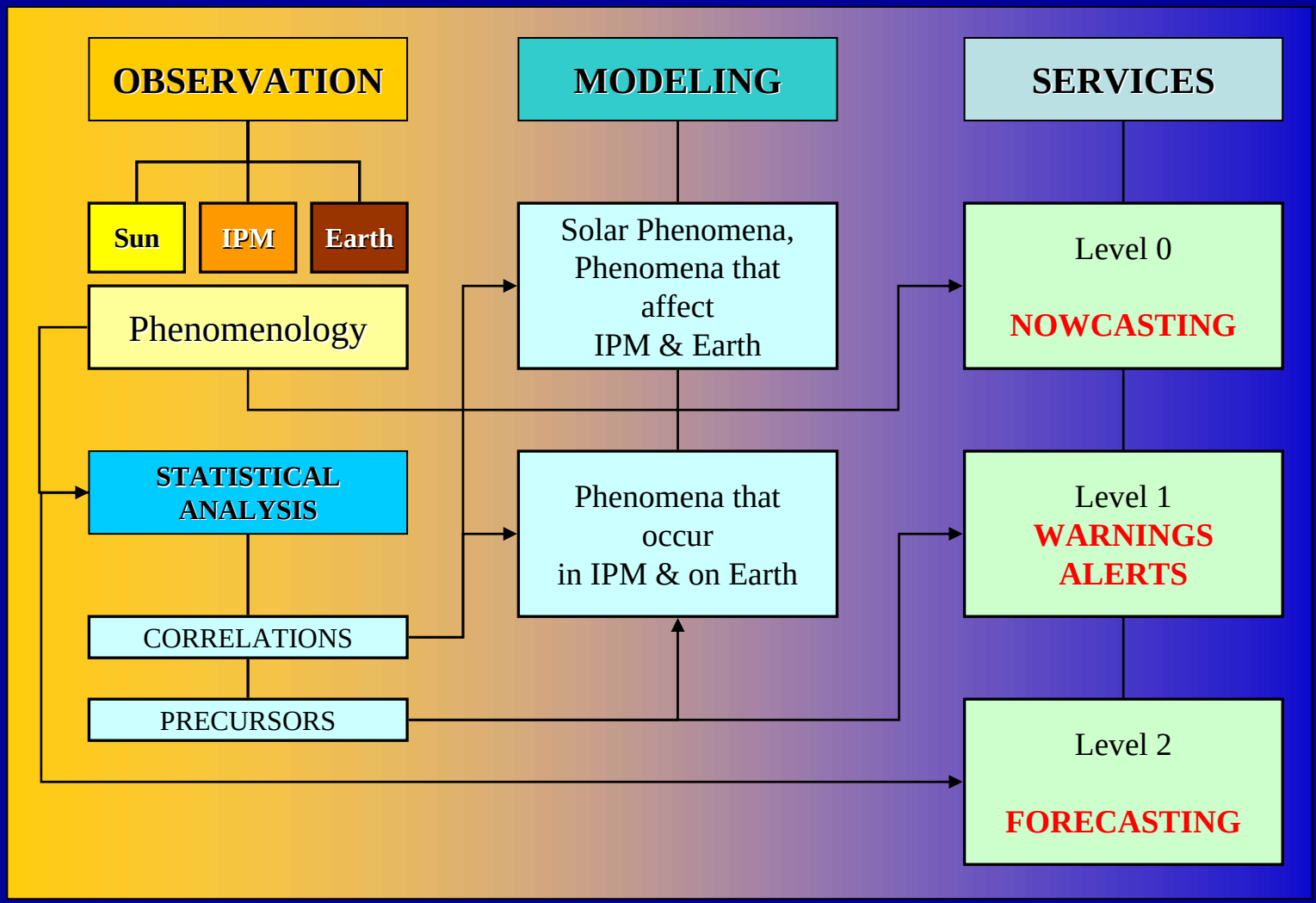
and

Department of Physics, University of Trieste

Outline of the Talk

- A Scheme for SpW Monitoring, Modelling and Forecasting
- SWITNET Space Weather ITalian NETwork
- The National, the European and the International Scenarios
- Conclusions

Space Weather Science & Service Scheme



SWITNET
The Space Weather Italian Network

What is SWITNET

SWITNET is not just a network of instruments that operate in coordinated mode, i.e., a service, but it is

- A network of instruments (SINERGIES)

AND

- A network of shared scientific expertise in S, S-T, T physics

AND (when completed)

- An advanced data handling system with processing and knowledge discovery capabilities (IVOSEC)

SWITNET at a Glance

ICTP

ARPL

Astrobiology

IFSI/INAF
ULYSSES

IFSI/INAF
Magnetosphere
Heliosphere

Turin

Trieste

SolarTerrestrial and Space Physics GROUP DIPARTIMENTO DI FISICA DELL'UNIVERSITÀ DELL'AQUILA

Florence

L'Aquila

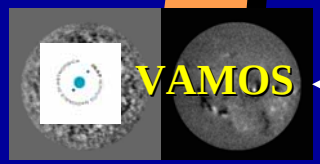
Rome

INGV
Geomagnetism
Ionosphere

Naples

Rome
Mt. Hermon (Israel)
IFSI/INAF
Los Cerrillos-Santiago
CR Monitors
LARC Antarctica
ROMA TRE

esa
CLUSTER II
IFSI/INAF
Cluster II

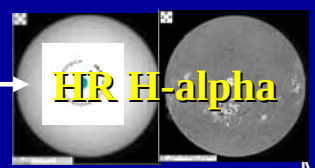


Rende

Palermo

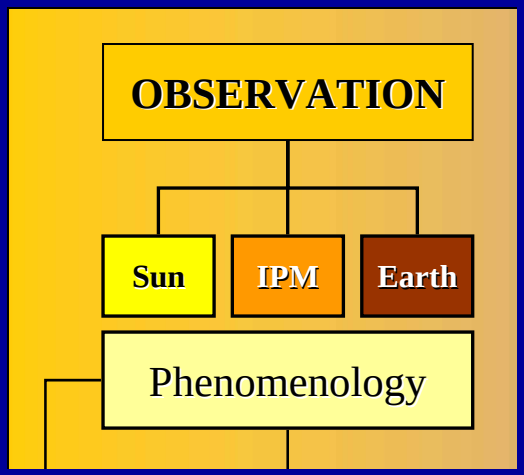
Catania

IFSI/INAF
Aurora Monitor



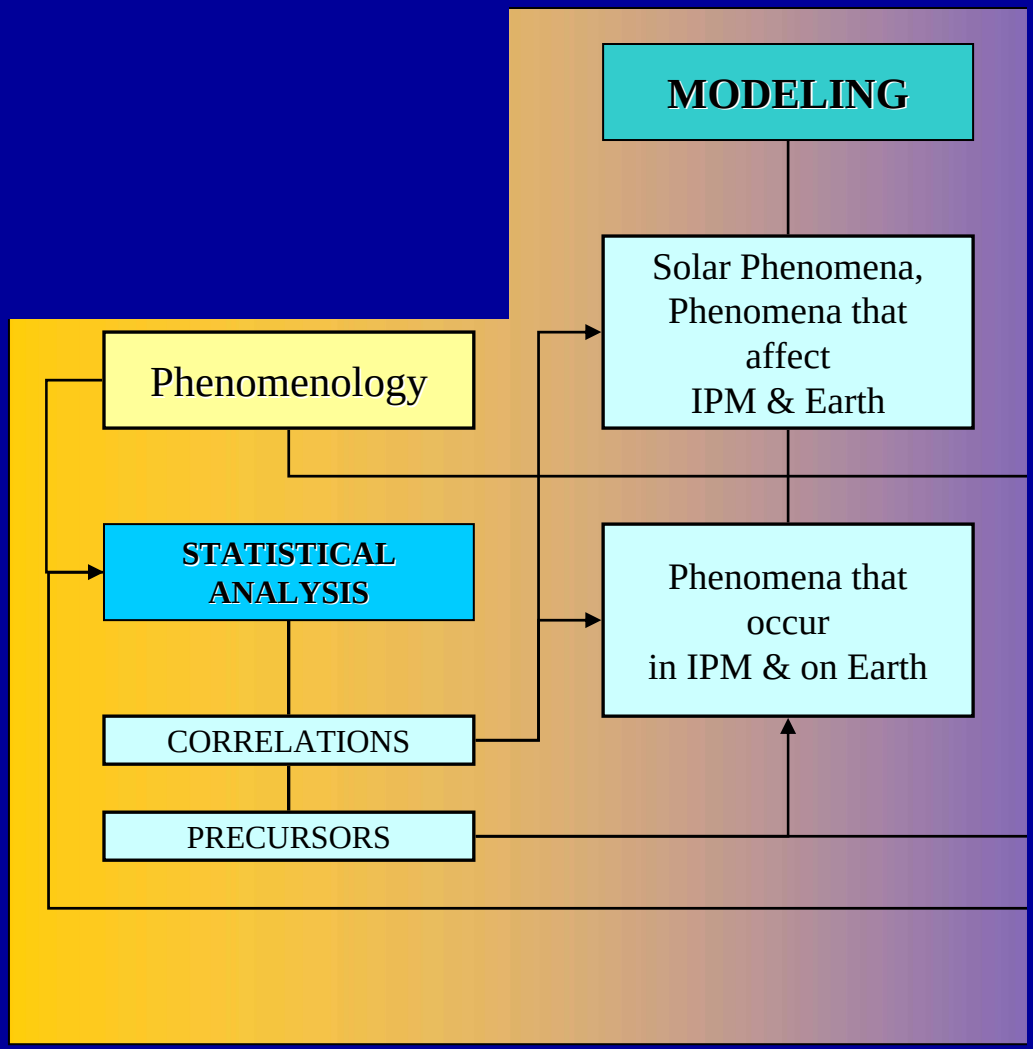
IFSI/INAF
Dome-C
SuperDARN
IPEV

SWITNET Observing Resources
SINERGIES



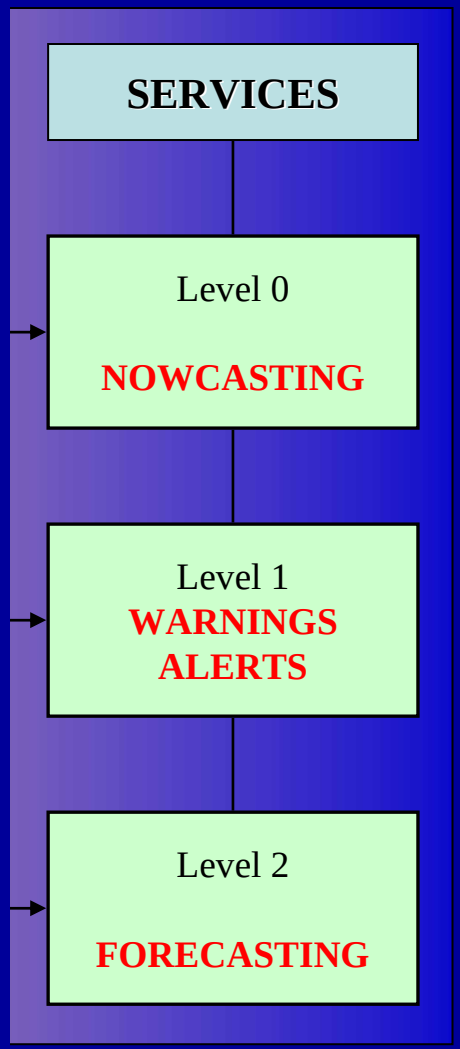
- **INAF-OATo** Solar & Heliospheric Space Observations
- **INAF-OATs** Trieste Solar Radio System
- **INAF-OAA** Next generation large aperture solar telescopes
- **UNI Fi** Solar & Heliospheric Space Observations
- **INAF-OAR** PSPT & CVS
- **UNI Roma 1** MOF
- **UNI Roma 2** Next generation large aperture solar telescopes
- **UNI Roma 3** Mini-Network of Neutron Monitors (see IFSI)
- **INAF-IFSI** - Solar & Heliospheric Space Observations
  - Magnetospheric & Ionospheric Observations
  - Mini-Network of Neutron Monitors
  - Antarctica Monitors
- **INGV** - Geomagnetic & Ionospheric Observations
  - Antarctica Monitors
- **UNI AQ** - Magnetospheric Observations (SEGMA magnetometer array & Antarctic stations)
- **INAF-OAC** - MOF (VAMOS)
  - Antarctica Observations
- **INAF-OACt** WL & H-alpha solar observations

SWITNET Modelling Resources



- All the previous institutes
- **ICTP** - Ionosphere Modelling
  - Astrobiology
- **UNI Na** - Flare physics
- **UNI Cal** - Turbulence
  - Flare precursors
- **UNI Ct** - AR formation
  - Flare precursors
  - Flare physics
- **INAF-OAPa** - Hydrodynamics of flux tubes
- **UNI Pa**

SWITNET Forecasting Resources



Flares
INAF-OACt

Radio Sun
INAF-OATs

Ionosphere
ICTP
INGV
IFSI

Geomagnetic Field
INGV
UNI AQ
IFSI

SWITNET
Advanced Data Handling and Integration

IVOSEC

The Italian Virtual Observatory for Sun-Earth Connections

IVOSEC Expected Features

- Based on SOLARNET as core architecture
- Can include S, S-T, T data bases
- Can handle real-time data ingestion and retrieval
- Is operable via an advanced web GUI for complex queries in user-trasparent mode
- Has capabilities for distributed processing for data visualization and analysis (V-Grid)
- Is compliant with VO standards

SOLARNET
Italian Solar Archives Federation
Hosted by INAF/Osservatorio Astronomico di Torino

Nodes
- SOLAR
- SOLRA
- PSPT
- DISCO/VAMOS
- CATANIA

EGSO Resources
- EGSO/SEC
- EGSO/DSO

Availability Check

Welcome to the SOLARNET Portal for browsing and retrieving Italian Solar Archives data.

The national project SOLARNET (SOLar ARchive NETwork) aimed to federating all the Italian solar archives as a distributed database, is the first step toward an Italian Virtual Solar Observatory, which interconnects the distributed resources and available solar data in a unified database by a web user interfaces. Different user interfaces allow searches of all participating data services using different input parameters. Currently there are 5 data providers in SOLARNET:
SOLAR , SOLRA , PSPT , DISCO/VAMOS and CATANIA archives, plus two services that the Italian solar comunity has developed for the EGSO project:
SEC (Solar Events Catalog) and DSO (Database for Solar Observatory).

Search by:

Date/Time Date/Time,Instrument

Italian Team

- **INA-OATo** National Coordinator
- **INAF-OATs** Technical Coordinator
- **INAF-OAA**
- **INAF-OAC**

The Role of SWITNET in the National Scenario

Participation in ASI Programs

- SWITNET is an Enabling Science integrated resource by providing
  - Ground-based support to operating and planned space missions for the exploration of the S-T environment
  - Availability of expertise in Theoretical and Numerical Modelling of the relevant plasma processes
  - Availability of expertise in Data Analysis and Interpretation
  - Advanced Data Handling capabilities to be interfaced with the ASI Science Data Center

The Role of SWITNET in the European Scenario

Participation in ESA SWENET

- Upon completion, SWITNET will be flawlessly interfaced with SWENET, the Space Weather European Network promoted by ESA through a Pilot Project.

- To date, the previsional resources:
  - GIFINT (Geomagnetic Indices Forecasting and Ionospheric Nowcasting Tools) operated by INAF-IFSI, INGV and UNI Aq
  - TSRS (Trieste Solar Radio System Radio Indices) operated by INAF-OATs

  are already integrated in SWENET.

The Role of SWITNET in the International Scenario

Collaboration with Int'l Organizations

Active collaborations (both scientific and organizational) exist with the following international organizations/projects

- COST Action 724 (Developing the Scientific Basis for Monitoring, Modeling and Predicting Space Weather)
- COST Action 296 (Mitigation of Ionospheric Effects on Radio Systems)
- CAWSES (Climate And Weather of the Sun-Earth System) by Scostep
- ILWS (International Living with a Star)
- E-Star
- ICESTAR by SCAR

Organization of Advanced Schools in 2006

- The Physics of the Sun: The Active Sun on Your Active Desktop (ISSS, L'Aquila, March 27-April 1, 2006)
- ICTP-COST-USNSWP-CAWSES-INAF-INFN International Advanced School on Space Weather (ICTP, Trieste, 2-19 May 2006)
- Advanced School in Space Environment ASSE 2006: Solar-Terrestrial Physics (ISSS, L'Aquila, 10-16 September 2006)

Involvement in International Initiatives

- IHY Int'l Heliophysical Year
- IGY Int'l Geophysical Year
- IPY Int'l Polar Year
- eGY Electronic Geophysical Year

Conclusions 1

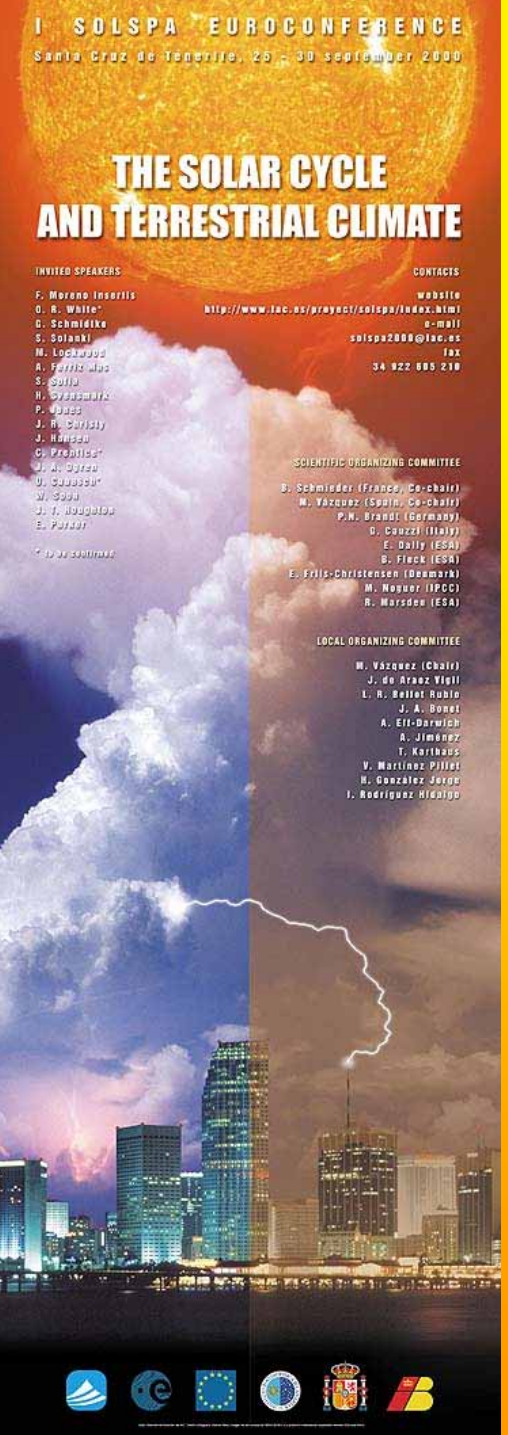
- SWITNET is a comprehensive geographic network of shared
  - ground-based instruments
  - modelling expertise
  - forecasting tools

  for monitoring, modelling and forecasting SpW

- SWITNET data handling will be managed soon by IVOSEC, the Italian Virtual Observatory for Sun-Earth Connections

Conclusions 2

- **Relevant Issues**
  - Growing interest in Europe and in the world for SpW
  - SWITNET
    - Completeness
    - International relevance
    - Test-bed for state-of-the-art data handling
    - Ground-based support to space missions
    - Enabling science resource
    - Resource for Education and Public Outreach
    - Italian expertise has been acquired for decades



IOSO Joint Organization for Solar Observations

Solar and Geophysical Databases

Solar and Geophysical Databases: The Tiles of a Planetary Meta-Archive

M. Messerotti

Trieste Astronomical Observatory

Data Organization

• Matter of Fact	Huge amount of space and g-b data
• Data Organization	Databases, Archives, Meta-Archives
• Data Indexing	Tables, Catalogs managed by RDBMS
• Data Access	FTP, TELNET, WWW via GUI
• Data Search	Local, Distributed over the net
• Data Analysis	Local

Scientific Requirements

- **Physical modelling** — MULTIWAVELENGTH DATA SEARCH
  MULTIWAVELENGTH DATA DISPLAY
  MULTIWAVELENGTH DATA ANALYSIS
  via a common unified, user-friendly interface
- **Space Weather** — SOLAR, SPACE, EARTH DATASETS
  MULTI-EVENT MODELLING
  LARGEST COVERAGE POSSIBLE
- **Event Prediction** — CROSS-SEARCH OVER ARCHIVES
  STATISTICAL ANALYSES
  REAL-TIME DATA AVAILABILITY

Scientific Motivations

- Some major Solar-Terrestrial Data Portals exist
- Mainly Resource Indexing is available
- Few resources partially allow complex, distributed data searching over limited subsets of databases
- Very few resources partially allow data analysis on inhomogeneous datasets

A PLANETARY META-ARCHIVE IS NEEDED TO EXPLOIT THE FULL SCIENTIFIC POTENTIALITIES OF MULTIWAVELENGTH MODELLING IN SOLAR-TERRESTRIAL PHYSICS

Solar-Terrestrial Physics Portals

CDS AstroWeb
http://cdsweb.u-strasbg.fr/astroweb.html

NASA Space Physics Data System (SPDS)
http://spds.nasa.gov/

NASA Space Physics Data Facility (SPDF)
http://nssdc.gsfc.nasa.gov/spdf/
Magnetospheric Yellow Pages
http://nssdc.gsfc.nasa.gov/spdf/yellow-pages/data-by-type.html

NASA National Space Science Data Center (NSSDC)
http://nssdc.gsfc.nasa.gov/

Canadian Astronomy Data Center
http://cadcwww.dao.nrc.ca/

CDS AstroWeb - Astronomy on the Internet

http://cdsweb.u-strasbg.fr/astroweb/solar.html (A)

ARTHEMIS	GDC	Hiraiso Solar Terrestrial Research Center/CRL	SEC
BAse Solaire Sol 2000 (BASS2000)	GDC	IPS Radio & Space Services	SEC
Big Bear Solar Observatory (BBSO)	GSO	Imager for Magnetopause-to-Aurora Global Exploration	ESE
Birmingham Solar Oscillations Network (BiSON)	GSN	Institut d'Astrophysique Spatiale (IAS)	SPI
Boulder, Colorado – Dept. Astrophys. and Planet. Sciences	SRI	Instituto de Astronomia y Fisica del Espacio (IAFE)	SPI
Catania Astrophysical Observatory (OAC)	SOO	International Solar-Terrestrial Physics (ISTP)	STN
Centre de Prevision de l'activite solaire et geomagnetique	SEC	Joint Organization for Solar Observations (JOSO)	ISO
Cluster II, ESA's spacefleet to the magnetosphere	SSE	Kharkov multi-wave station of solar monitoring (KHASSM)	SRO
Cracow - Solar radio emission in dm wavelength	SRO	Kiepenheuer-Institut für Sonnenphysik (KIS)	SRI
Departement d'Astronomie Solaire (DASOP, Observatoire de Paris)	SRI	Laboratory for Atmospheric and Space Physics (LASP)	SRI
ETH Institute of Astronomy (ETH Zurich)	SRI	LASCO/SOHO	SSE
Estación de Observación Solar / Solar Observational Station (EOS)	SOO	MEDOC (Multi-Experiment Data Operations Center for SOHO)	SDC
European Incoherent SCATtter	GIN	MSU Solar Physics Group (Montana)	SRI
GALLEX	GPE	Mees Solar Observatory (MSO, Hawaii)	SOO
Global Oscillation Network Group (GONG)	GSN	Metsahovi Radio Research Station	SRO
Haleakala Observatories (Hawaii)	SOO	Mount Wilson Observatory	SOO
High Altitude Observatory (HAO)	SOO	NRL Solar Physics Branch	SRI
High Energy Solar Spectroscopic Imager (HESSI)	SSE	National Astron. Obs. of Japan - Solar Phys. Division	SRI

CDS AstroWeb - Astronomy on the Internet

http://cdsweb.u-strasbg.fr/astroweb/solar.html (B)

National Solar Observatory (NSO)	SOO	Space Environment Center	SEC
NSO Sacramento Peak, Sunspot, NM (NSO/SP)	SOO	Stanford SOLAR Center	SEC
Naval Research Laboratory Space Science Division (NRL SSD)	SPI	Sternberg Astronomical Institute (Heliophys. and Seismology)	SRI
Observatoire Midi-Pyrenees (OMP)	SOO	THEMIS	SOI
Service d'Aeronomie	EDC	The INTER-SOL Sun Observation Programme (ISP)	GSN
Soft X-Ray Telescope onboard Yohkoh Satellite, ISAS, Japan	SSE	Transition Region And Coronal Explorer (TRACE)	SSE
Solar Data Analysis Center (SDAC)	SEC	Universitat de les Illes Balears - Solar Phys. at Dept. of Phys.	SRI
Solar Extreme-ultraviolet Rocket Telescope and Spectrograph	SSE	Wilcox Solar Observatory (WSO)	SOO
Solar Flare Theory (NASA/Goddard Space Flight Center)	SRI	Yohkoh Public Outreach Project (YPOP)	SSE
Solar Group of RATAN-600	SRO	Zurich Solar Radio Spectrometer	SRO
Solar Physics Division - American Astronomical Society	NSO		
Solar Physics at Stanford University	SRI		
Solar Terrestrial Activity Report	SEC		
Solar Terrestrial Dispatch (STD)	SEC		
Solar UV Atlas from HRTS (HRTS data)	SDC		
Solar and Heliospheric Observatory (SOHO)	SSE		
Solar, Auroral, Ionospheric, ... Information (Lethbridge, Canada)	SEC		
Solar-Terrestrial Physics Home Page (STP)	SEC		

64 Entries

Goals

- Index observational resources in ST Physics
- Index theoretical resources in ST Physics
- Allow
  - User-transparent data access to distributed datasets all over the world
  - Complex data searching, retrieval and analysis via a simplified common GUI

PRESENT DATA ARCHIVING TECHNOLOGIES ALLOW THE ACHIEVEMENT OF SUCH GOALS PROVIDED THAT A GLOBAL COORDINATION AND COLLABORATION IS ESTABLISHED AS WELL AS THE ALLOCATION OF PROPER FINANCIAL RESOURCES BY THE PARTICIPATING ORGANIZATIONS

Advances in Solar and Solar-Terrestrial Data Archiving and Retrieval Techniques

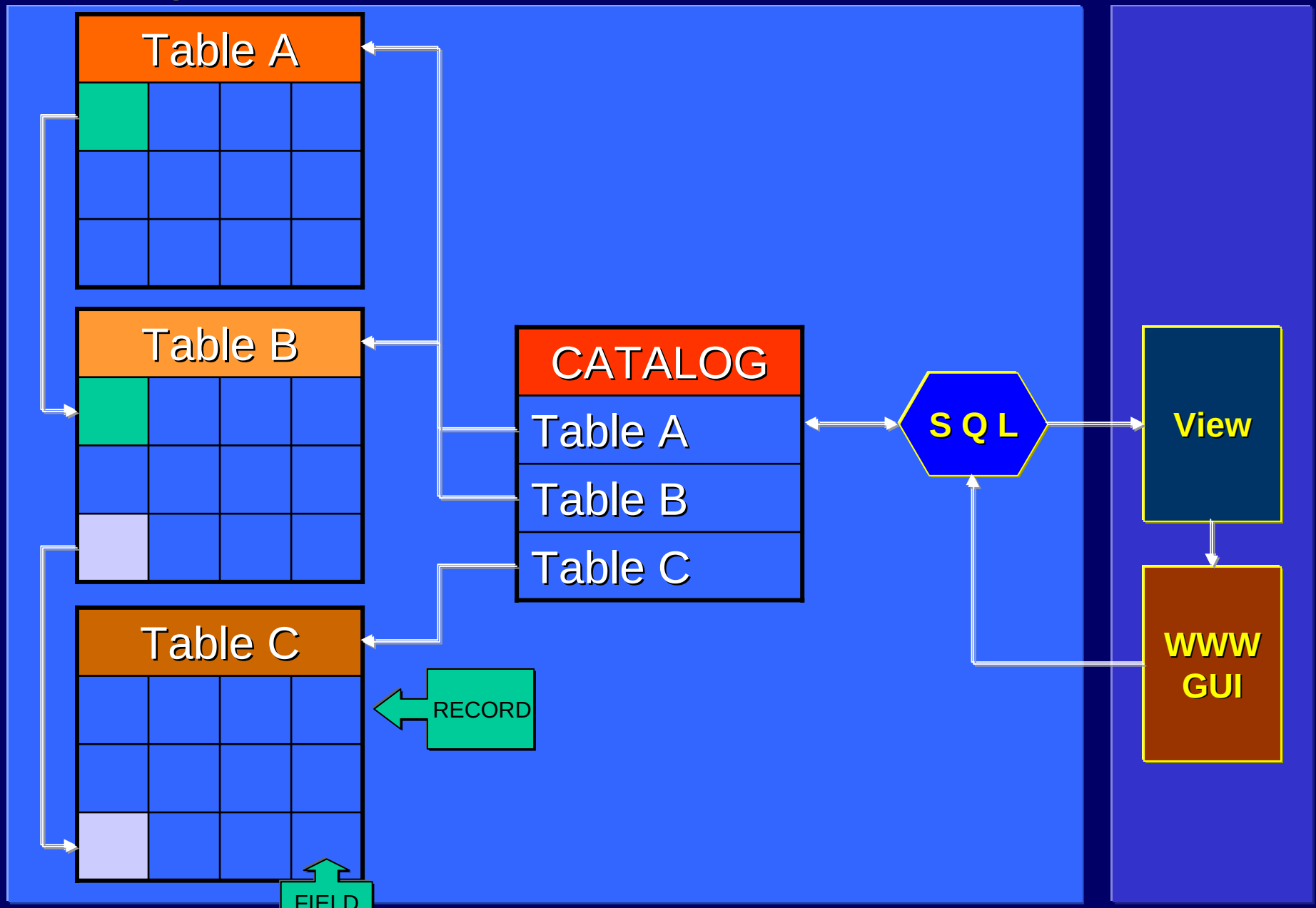
M. Messerotti

INAF-Trieste Astronomical Observatory

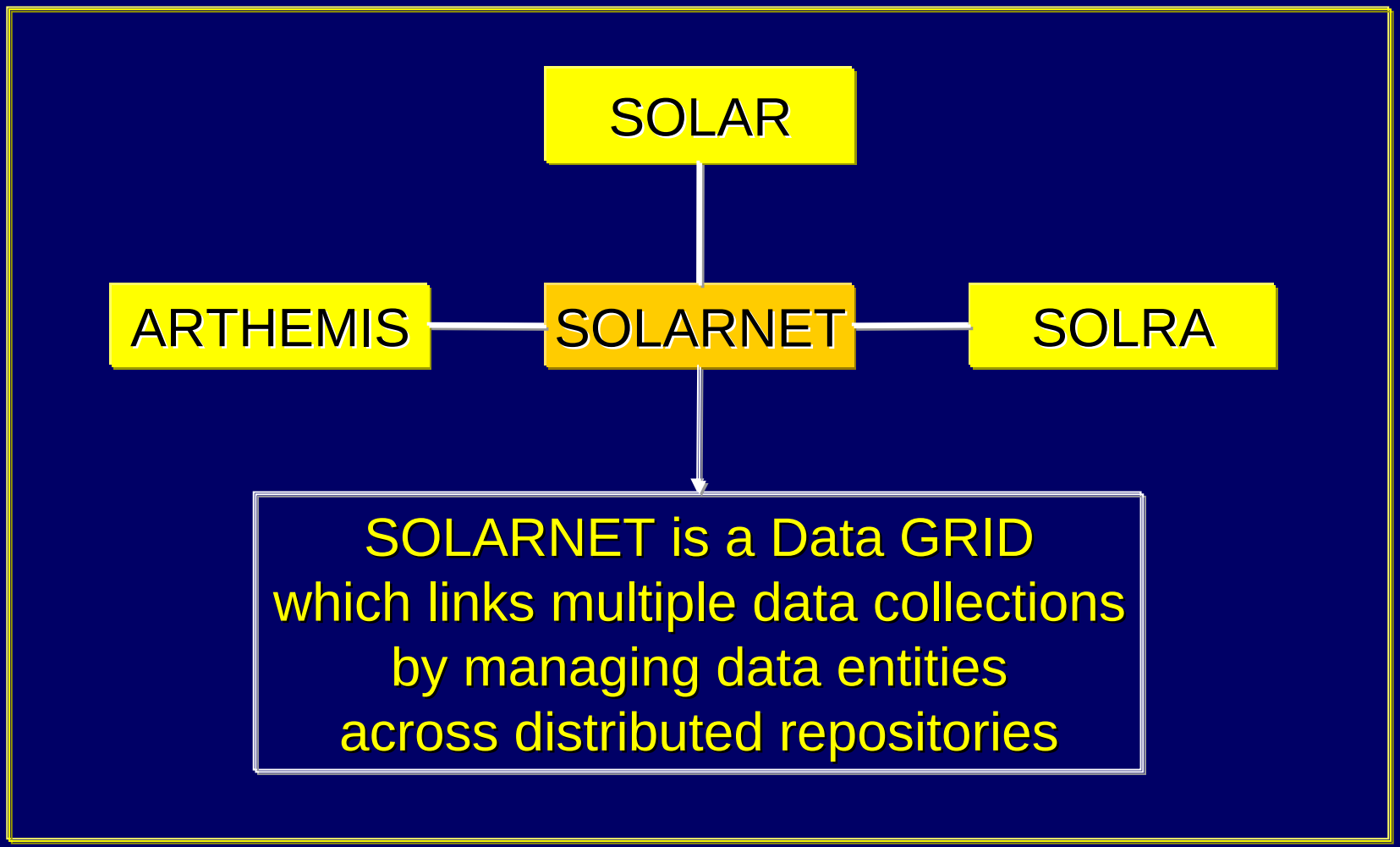
and

Physics Department, Trieste University

Simplified Architecture of an SQL-Based RDBMS



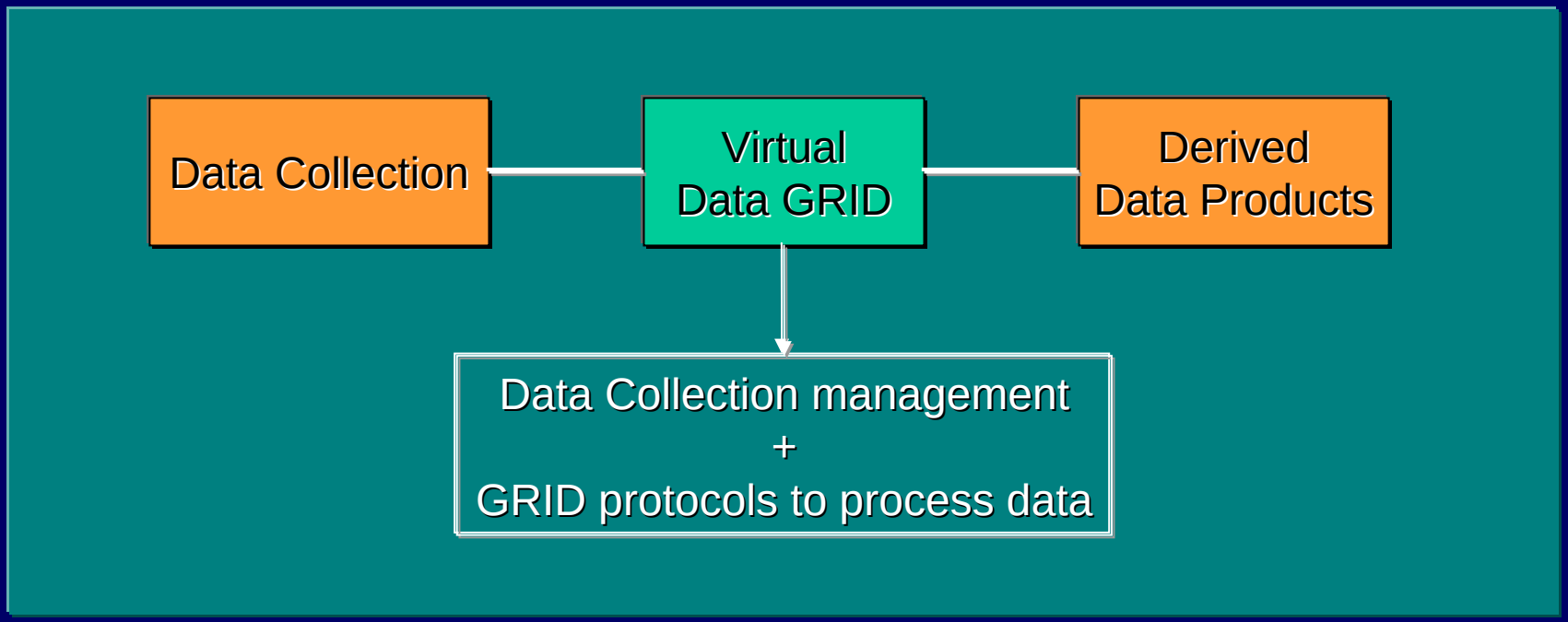
DATA GRID Architecture



VIRTUAL DATA GRID Architecture

A consistent modelling requires a multi-instrument multi-wavelength approach

DATA ANALYSIS must be provided in addition to **SEARCH and RETRIEVAL**

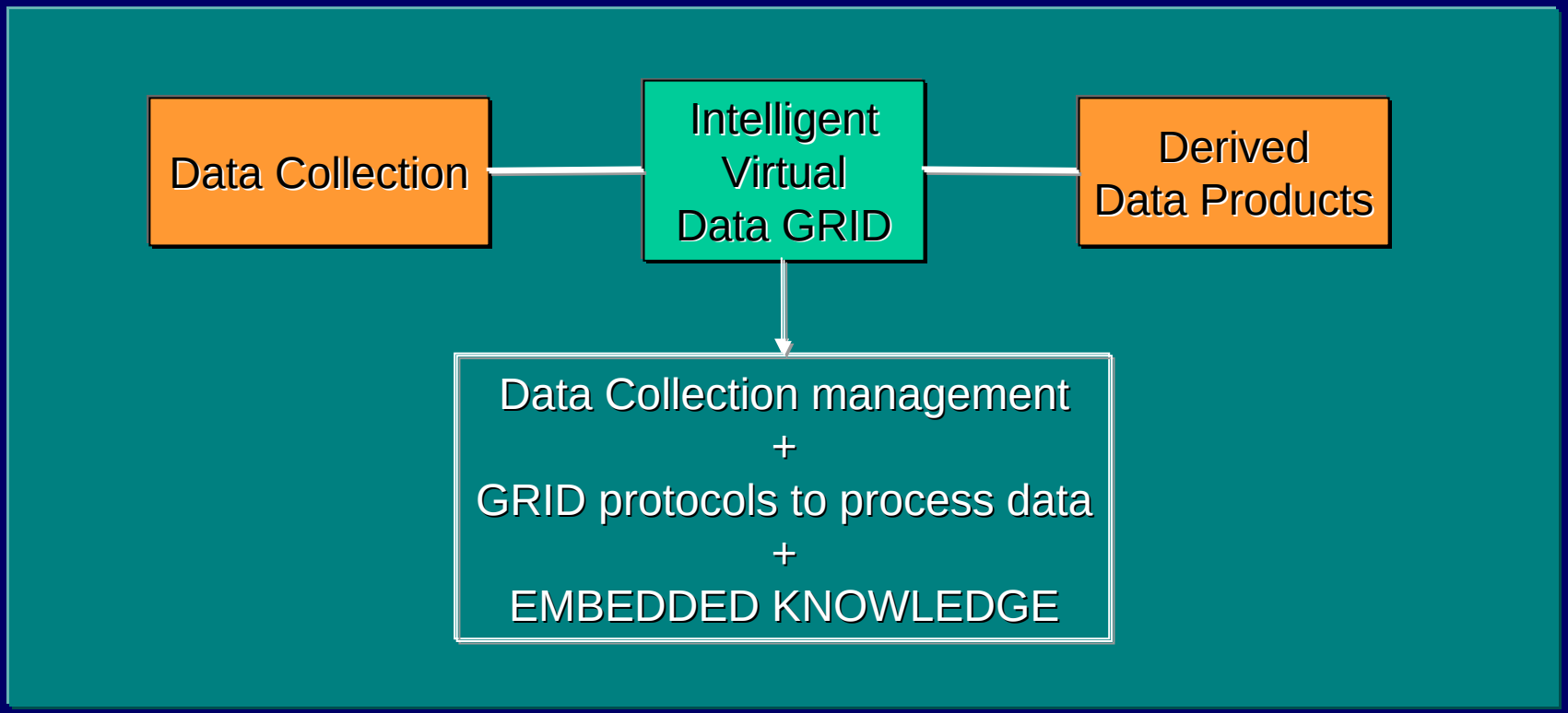


EGSO European Grid of Solar Observations

INTELLIGENT VIRTUAL DATA GRID Architecture

KNOWLEDGE DISCOVERY IN DATABASES (KDD)

DATA ASSOCIATION AND GUIDED PROCEDURES are EMBEDDED



ADVANCED GOAL

- **Pointing out the physical associations in multi-wavelength datasets is the basis of interpretative scientific research**
- **Concept association is the kernel of knowledge**
- **Automated storage and search of knowledge in databases is possible through advanced techniques and is called**

  Knowledge Discovery in Databases (KDD)

- **Advanced techniques are based on Artificial Intelligence (AI) and Expert Systems (ES) embedding**

THE EMBEDDING OF AI-ES TECHNIQUES IN THE GRID ARCHITECTURE REPRESENTS THE NEXT GENERATION IN DATA SEARCH, RETRIEVAL, PROCESSING AND ANALYZING

CONCLUSIONS

- S-T space and ground-based observatories operate
  - set of instruments which operate at different wavelenghts and produce inhomogeneous 1-, 2-, 3-, 4-D datasets
- Many S-T archives exist all over the world
- Modern archiving techniques allow
  - efficient data search and retrieval through
  - a Relational Data Base Management
  - onsite or in a distributed environment (GRID)
- Next generation archiving techniques will fully exploit the data information via KDD

An Advanced System for Data Handling in SPW

- Title of contribution — STEVM (Solar-Terrestrial Environment Virtual Monitor)
- Proposer — M. Messerotti (& al.)
- Relevant MoU objectives — Data standardization and accessibility
- Relevant parts of MoU sci. programme — Aims of WG4
- Deliverables — Resources survey & architecture (& ?)
- Timetable — 3-5 years according to final goals
- Required Manpower — To be defined according to final goals
- Resources availability — Existing Data Archives community
- Expected collaborations — With main VO projects (e.g. EGSO)
- Previous experience in the field — SOLAR, SOLRA, SOLARNET, EGSO

Space Weather as Driver of Data Homogeneization

- Inhomogeneous and fragmented character of available observations

CAUSES

Difficulties in carrying out a posteriori modelling of complex phenomena

- These limitations are intrinsic to data acquisition mode

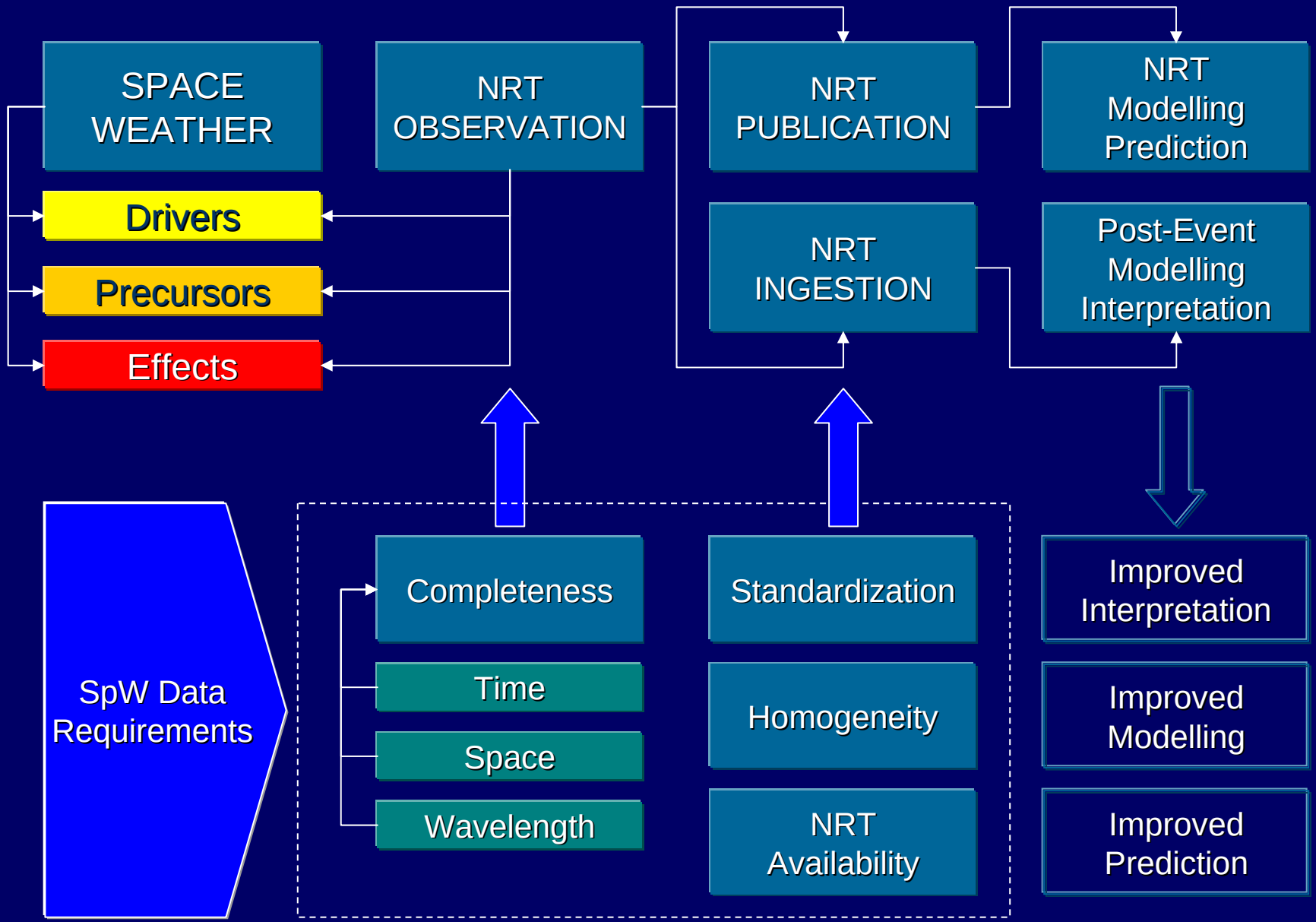
HENCE

Even advanced data search by Grid architectures cannot overcome

DRAWBACKS OF DATA INADEQUACY

- The outcomes are:
  - Inadequate modelling
  - Limited to a subset of phenomenological and physical aspects
  - Often neglects the complex interplays among different processes

Scheme of SpW Data Requirements



The Role of Observing Requirements for SpW

Observing requirements for SpW and SpW drivers observation in monitoring and nowcasting can play a primary role in providing:

1. homogeneization in observations
2. near real-time data ingestion in archives
3. unified data access via web through a user friendly GUI

capable to facilitate:

1. data availability in near real-time
2. full exploitation of the data information content by pointing out interrelationships in different datasets
3. self-consistent modelling

Introduction to the Electronic Geophysical Year, 2007-2008 (eGY)

www.egy.org

messerotti@oats.inaf.it

IGY+50

Four International Year (I*Y) programs are linked to the 50-year anniversary of IGY

International Polar Year

planetearth®
Earth Sciences for Society
2005 - 2007

International Heliophysical Year

Electronic Geophysical Year, 2007-2008

The Electronic Geophysical Year
2007-2008

eGY is an initiative of the International Union of Geodesy and Geophysics

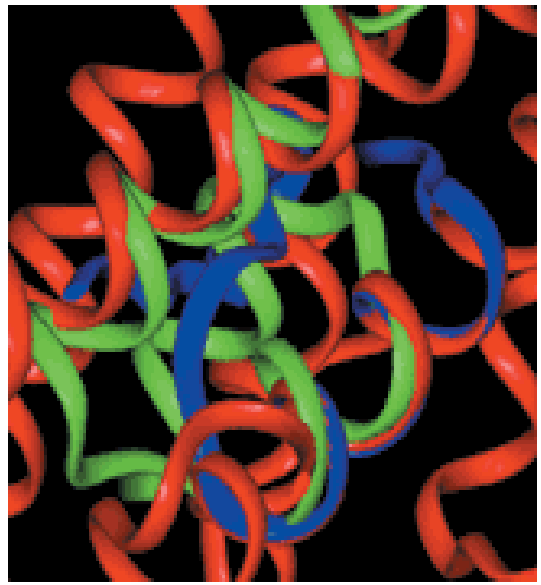
led by the International Association of Geomagnetism and Aeronomy

sponsored by: LASP, NASA, IUGG, IAGA

The information era - interoperability

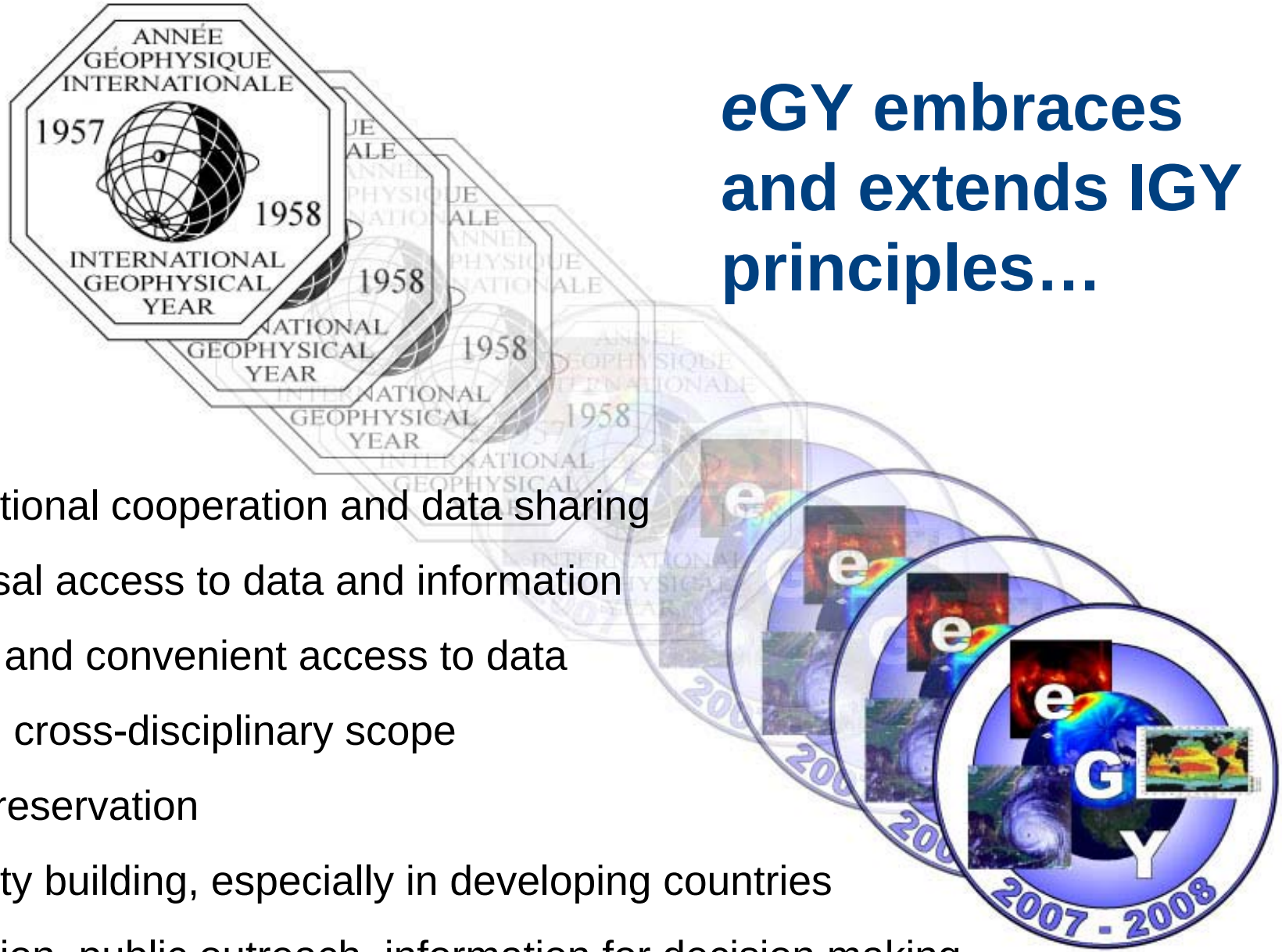
Modern information and communications technologies have creating an “interoperable” information era in which ready access to data and information can be truly universal. Open access to data and services enables us to meet the new challenges of understand the Earth and its space environment as a complex system:

- managing and accessing large data sets
- higher space/time resolution capabilities
- rapid response requirements
- data assimilation into models
- crossing disciplinary boundaries.



Vision

*e*GY will lead to a major step forward in geoscience capability, knowledge, and usage throughout the world by accelerating the adoption of modern and visionary practices for managing and sharing data and information.



*e*GY embraces and extends IGY principles…

International cooperation and data sharing

Universal access to data and information

Timely and convenient access to data

Global, cross-disciplinary scope

Data preservation

Capacity building, especially in developing countries

Education, public outreach, information for decision making

What is *e*GY?

*e*GY is a cooperative international effort to address the challenges of modern data stewardship, interoperability (e-Science), and integrative science:

- Ready and open access to distributed data, information and services
- Access to large, complex, and cross-disciplinary data sets
- Real-time access and assimilation of data into models
- Data integration and knowledge discovery
- Data discovery (who holds what, where, how? Metadata issues)
- Data release (secure access permission)
- Data preservation (preserve existing and future data)
- Data rescue (identify and rescue critical data sets at risk)
- Education and public outreach; informing decision makers
- Advancement of science in developing countries (reducing the digital divide)

Role

Facilitate, inform, stimulate, encourage, and promote:

- Modern data access and services ("e-Science for Geoscience")
- Responsible data stewardship
- Cooperation among bodies/initiatives to reduce duplication and proliferation of standards, and share expertise
- Establishment of **virtual observatories** throughout the geosciences
- Establishment of criteria to determine optimal and minimum funding for data activities supporting research

*e*GY also serves to provide a link between programs with related data and information requirements - IPY, IHY, Planet Earth, and initiatives such as GEOSS.

What value can *e*GY add?

Q. There's nothing original in the principles and objectives behind *e*GY, and lots of informatics (e-Science) initiatives are already taking place, so why bother with *e*GY?

A. We need awareness-raising and international cooperation to reduce duplication, reinvention, and proliferation of standards. IGY+50, together with the advent of GEOSS, provides a timely opportunity to help accomplish this. IGY+50 is also an opportunity to expand participation by geoscientists in informatics developments. *e*GY provides an international framework to help accomplish these goals.

Deliverables

- Networking, links to experts and peers
- Coordination for the I*Y and other programs
- A mandate via the *e*GY Declaration for a Geoscience Information Commons
- Codes of best practice
- Meetings, workshops, and symposia at conferences
- Presentations, articles, brochure, press releases
- Website: www.egy.org and *e*GY News
- Education and public outreach program
- Capacity building activities in developing countries (not yet implemented)

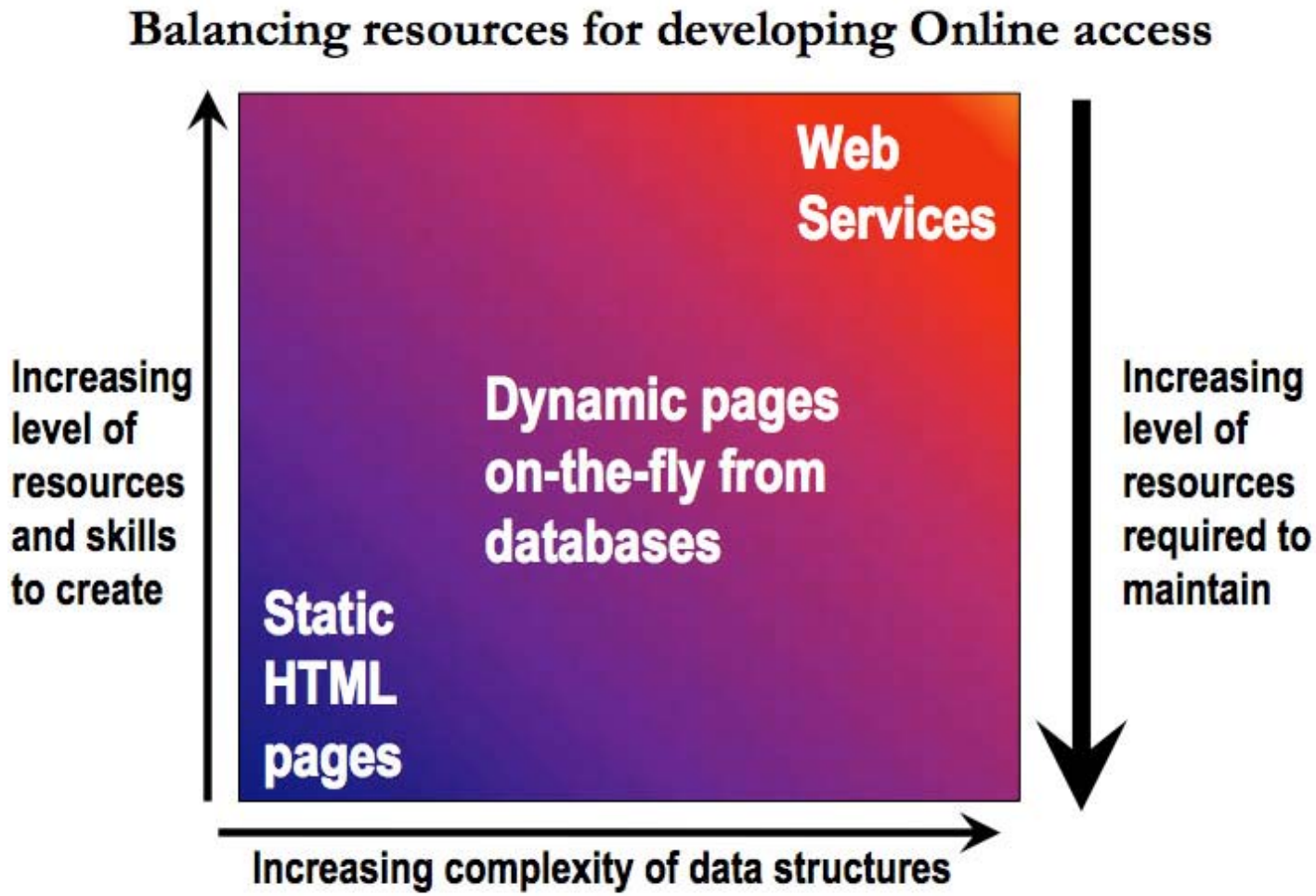
Declaration for a Geoscience Information Commons

"Knowledge is the common wealth of humanity"

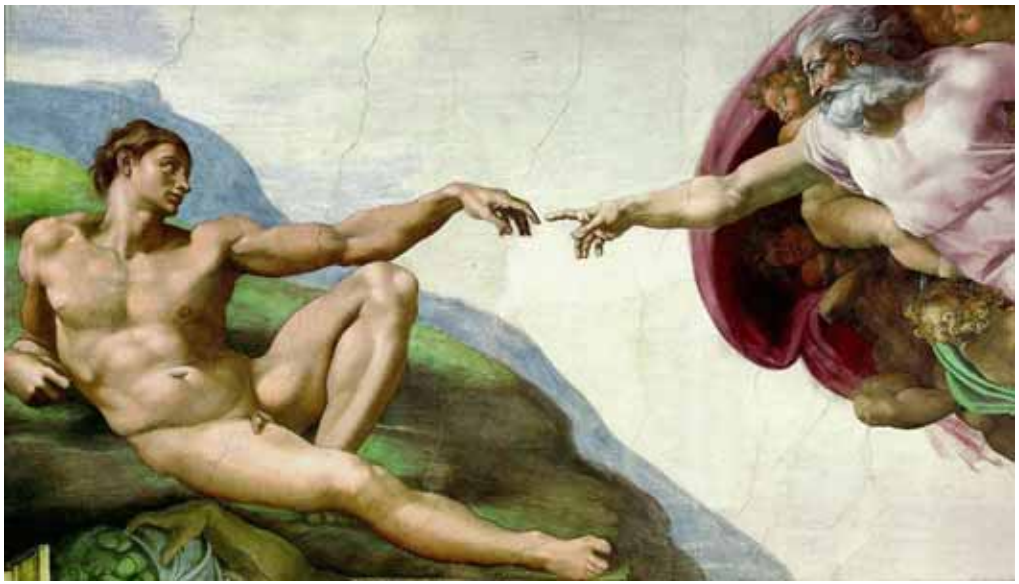
Adama Samassekou, Convener of the UN
World Summit on the Information Society

The underlying principles on which *e*GY is based have been articulated by ICSU, the World Summit on the Information Society, CODATA, and other bodies. The principles are encapsulated in the eGY *Declaration for a Geoscience Information Commons* - a statement of aspirations and principles of data stewardship.

Shifting the burden from the user to the provider



Challenging the “heroic” science funding paradigm



*e*GY draws attention to the need to reassessment our reward systems to recognise that the burden of making data and information easily accessible is shifting from the user to the provider.

Structure

Secretariat (at LASP, Univ. Colorado)

- Executive Director Dan Baker, LASP
- Secretary: Bill Peterson
- Communications: Marissa Rusinek
- Public Relations and E/PO: Emily CoBabe-Ammann

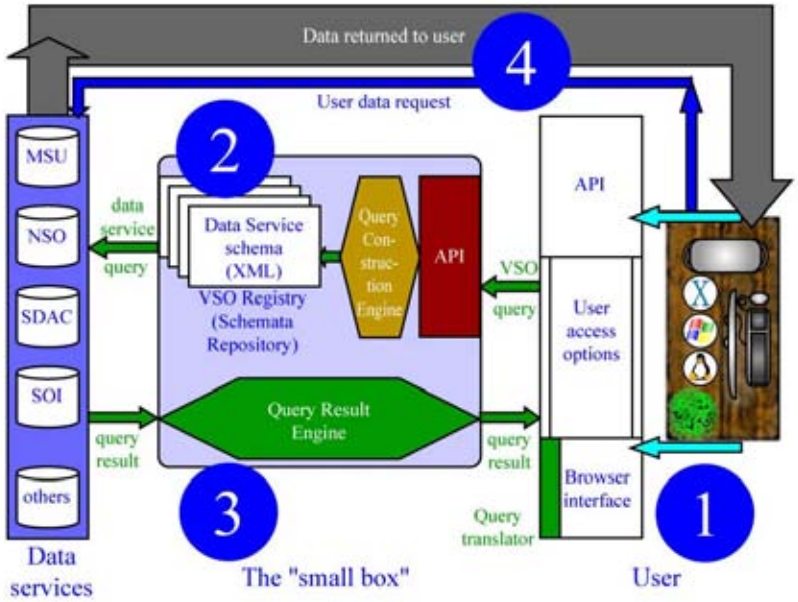
International Committee

- Chair: Charlie Barton
- Representatives from key participants and countries

Thematic Working Groups

- Virtual Observatories: Peter Fox
- Data Integration & Knowledge Discovery Paul Berkman
- Best Practice (joint with CODATA): Herb Kroehl, Jean Bonnin
- Data Rescue and Preservation: Jefff Love
- Education and Public Outreach: Emily CoBabe-Ammann

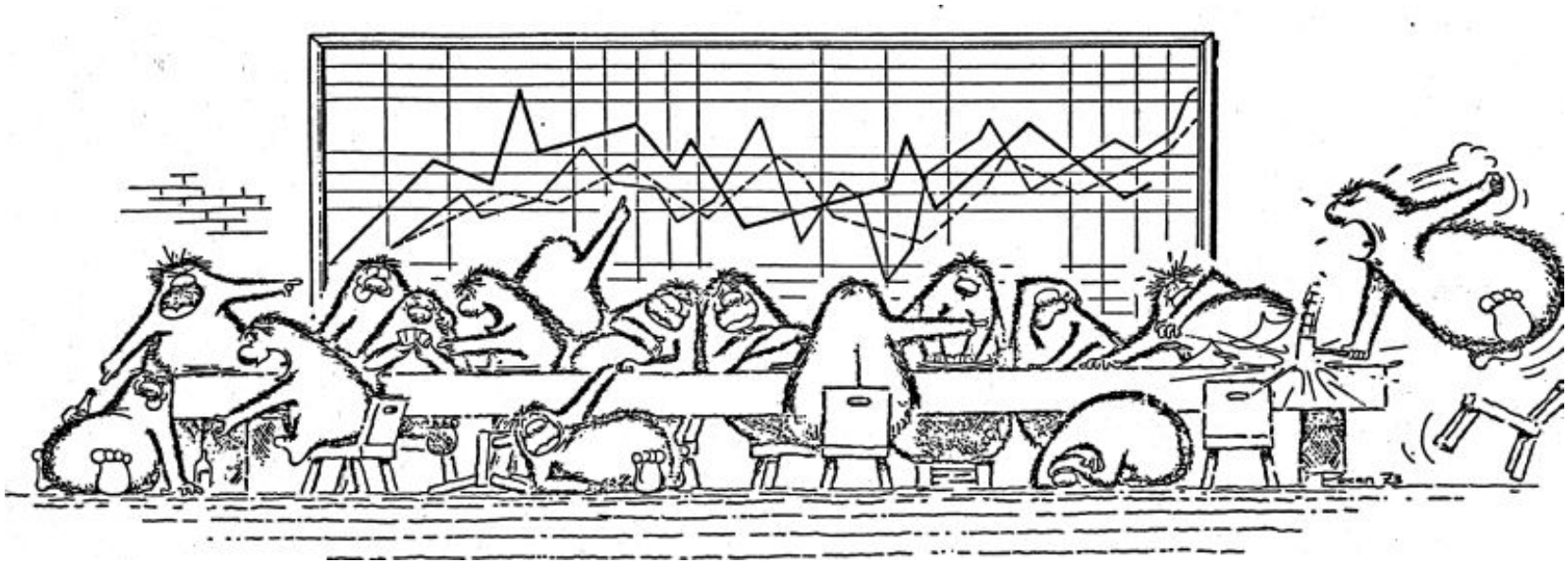
Working Group on Virtual Observatories



Virtual observatories complement in cyberspace the role of physical observatories by providing ready access to data from distributed sources. They also provide processing, analysis, visualisation, and simulation capabilities.

Promoting the development of Virtual Observatories in the Earth and space sciences is a central objective of eGY.

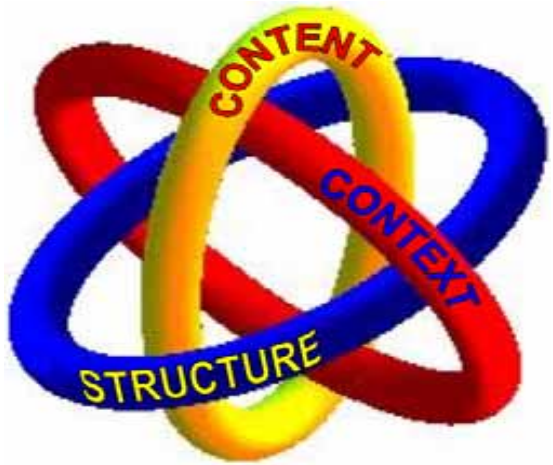
Working Group on Best Practice



Working Group on Data Integration and Knowledge Discovery

The Physics of Information

They way we think about data has changed



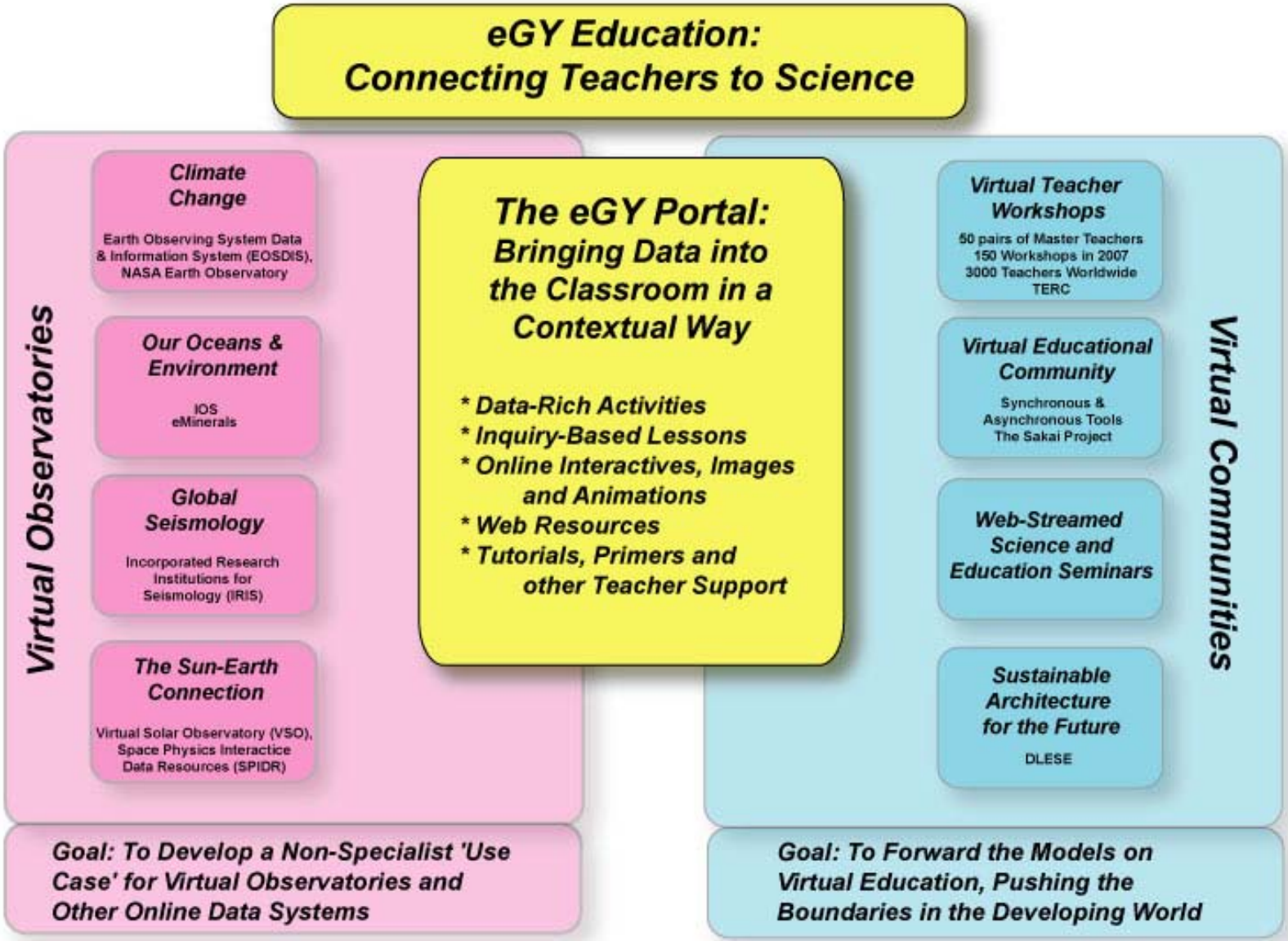
BORROMEAN RINGS

Three interlinked circles that represent inseparable parts of the whole. Remove any one ring and the other two fall apart. Borromean Rings have been used as a symbol of unity in many fields.

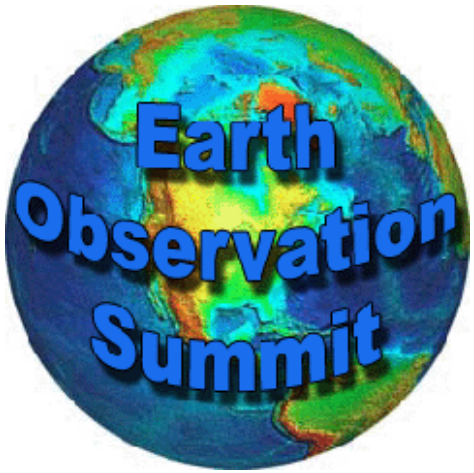
Information ingredients – ***content, context structure.***

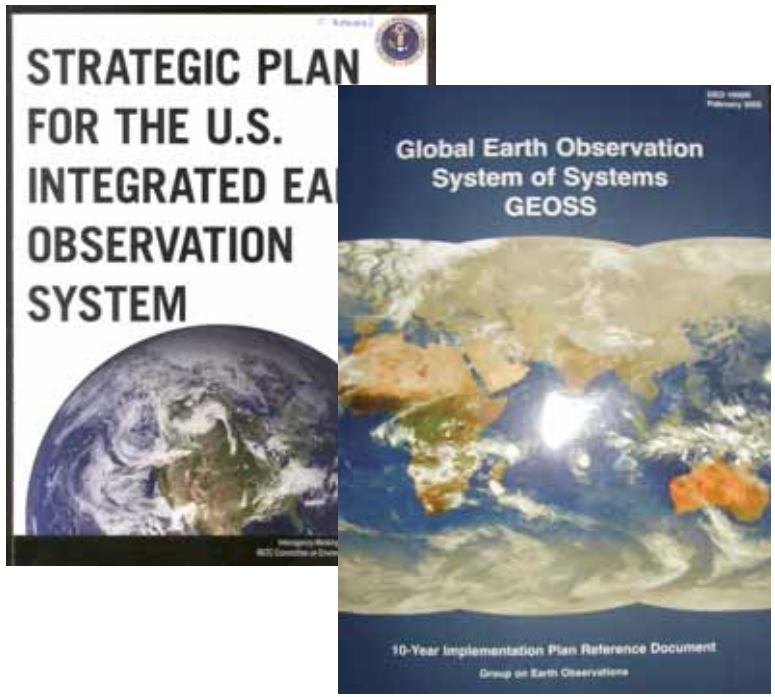
The ability to utilize automatically the inherent structure of information marks the threshold in information management from hardcopy to digital media.

WG: Education and Public Outreach



Discussions are underway with GEO to explore how to use *e*GY in the development of GEOSS





world summit
on the information society
Geneva 2003 - Tunis 2005

Interested in getting involved?

www.egy.org

eGY News

Email lists

Sign the “Declaration for a Geoscience Information Commons”

Bill.Peterson@lasp.colorado.edu

CODATA 2006

Scientific Data and Knowledge within the Information Society

22-25 October 2006, Beijing

CALL FOR PAPERS http://www.codataweb.org/06conf/call.html

DEADLINE FOR PAPER SUBMISSION: 30 June 2006

Virtual Observatories in the Geosciences

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