GGOS Bureau of Networks and Observations

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Carey Noll

Implementation of the GGRF in Latin America
Buenos Aires, Argentina

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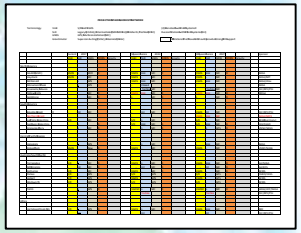
GGOS Bureau of Networks and Observations

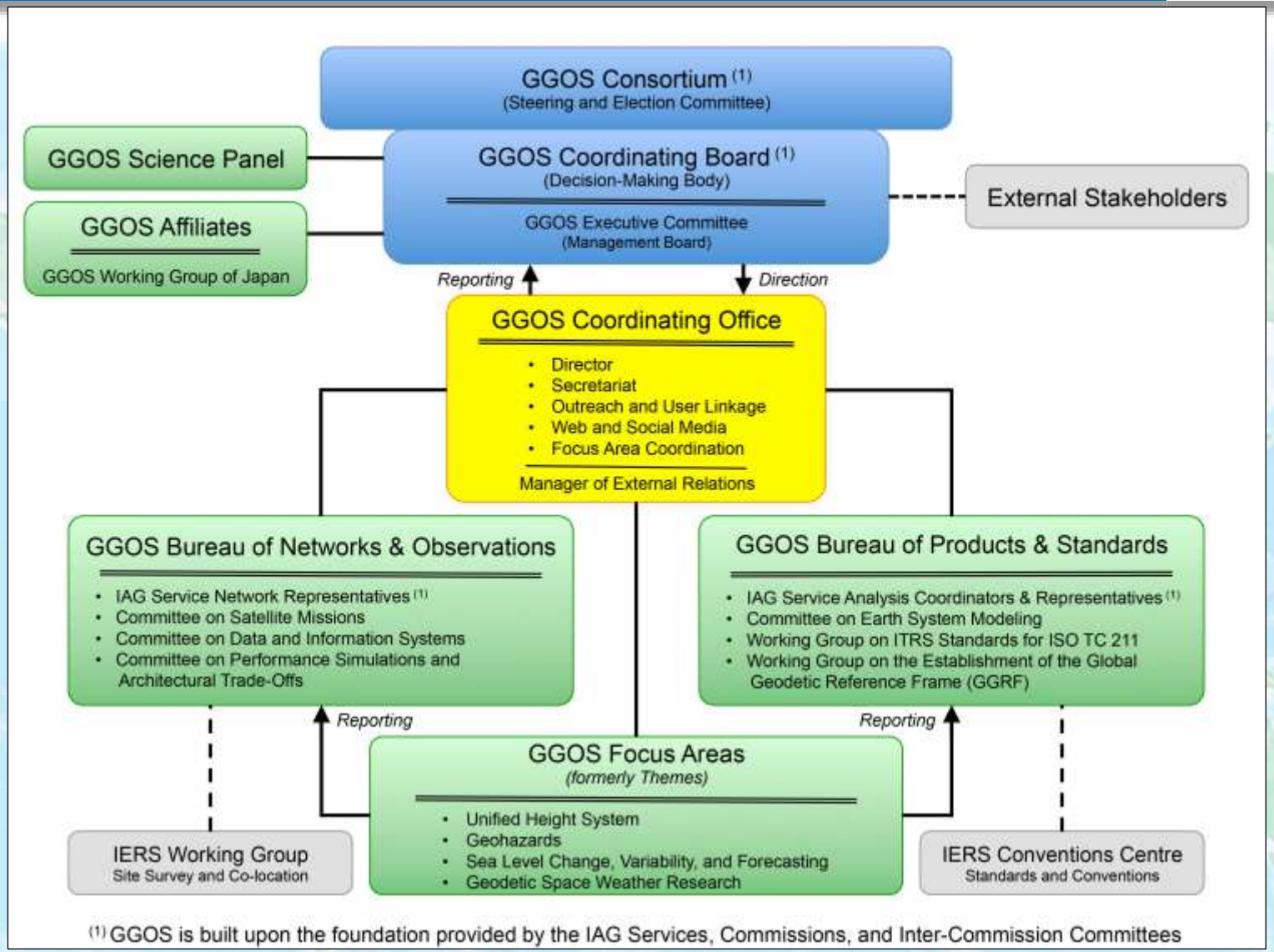
- Provide a forum for the Services to meet, update each other, discuss progress and issues;
- Advocate for the expansion and upgrade of the space geodesy network for the maintenance and improvement of the reference frame and other GGOS priorities;
- Encourage partnerships to build and upgrade ground stations;
- Scope the network for the Reference Frame;
- Maintain a Site Requirements Document;
- Monitor network status; projected network evolution based on input from current and expected future participants, estimate performance capability 5 and 10 years ahead;
- Simulation studies and analyses to assess impact on reference frame products of: network configuration, system performance, technique and technology mix, co-location conditions, site ties, and network trade of options (PLATO);
- Metadata System development for a wide range of users including GGOS; near term strategy for data products (Carey Noll at GSFC) and a more comprehensive longer-term plan for an all-inclusive system (Nick Brown at GA) (Committee on Data and Information);
- Provide the opportunity for representatives from the Services and the Standing Committees to meet and share progress and plans; discuss issues of common interest; meetings at EGU, AGU, GGOS Days, etc.;
- Talks and posters on the Bureau at EGU, AGU, JPGU-AGU, AOGS meetings, etc.;
- Letters/documentation to support stations, current/ new missions, and analysis centers;



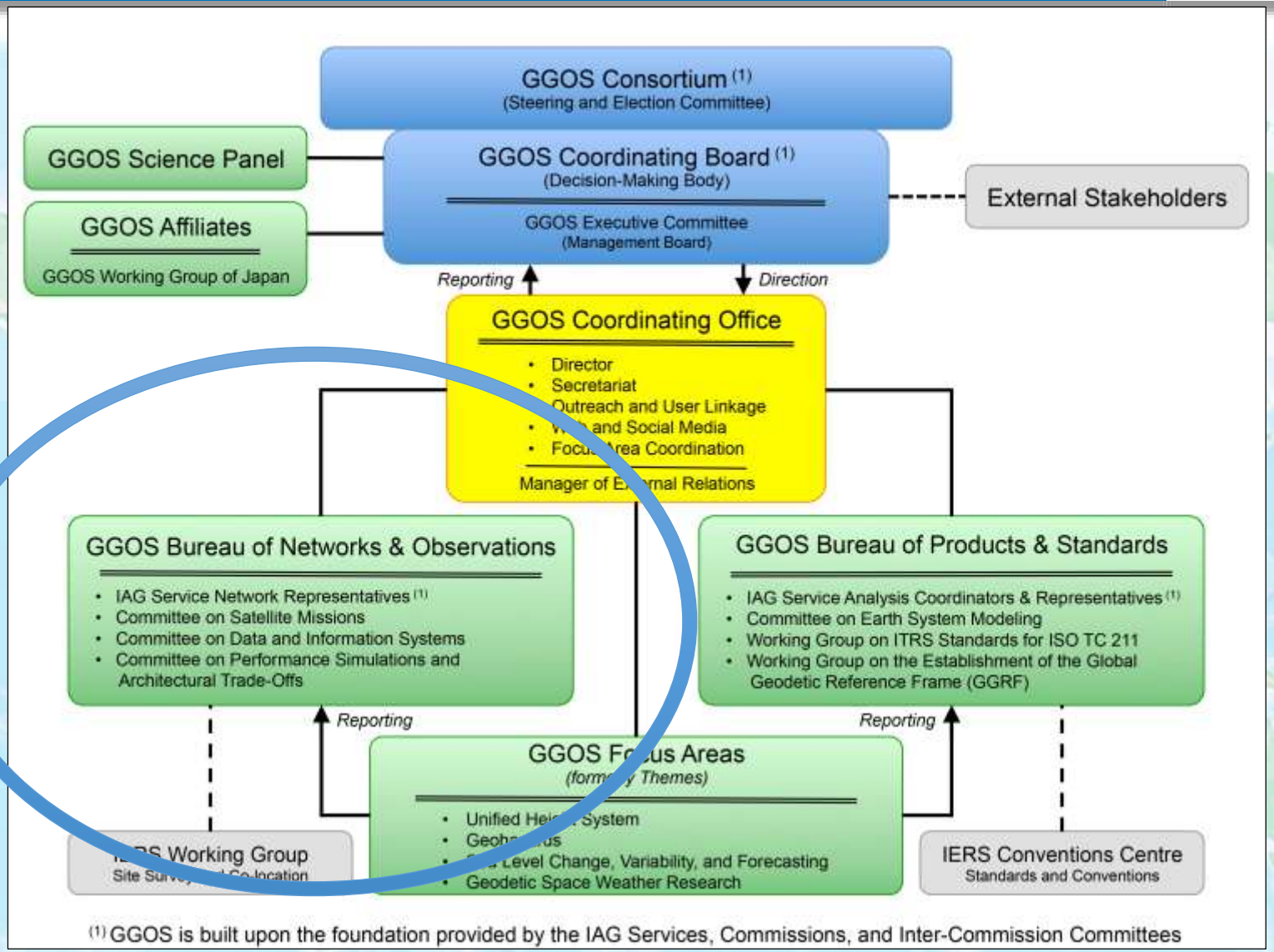





GGOS Organization



GGOS Organization



Space Geodesy Provides a Suite of Ground-based Metric Tools for Studying the Dynamics of the Earth System

VLBI

SLR

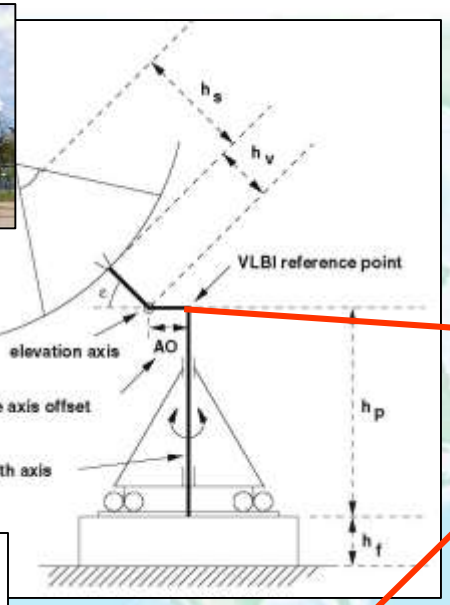
GNSS

DORIS

Tide Gauge/GNSS

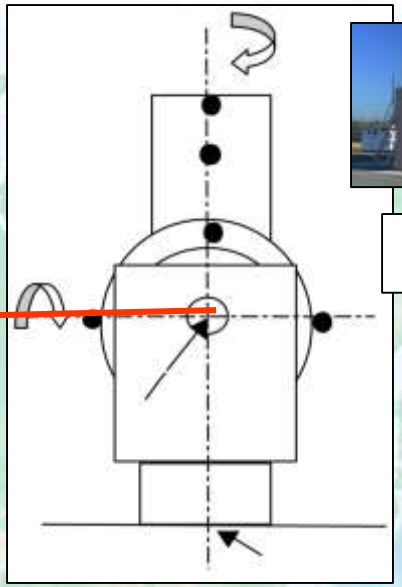
Gravimeters

Main Thrust is the Reference Frame



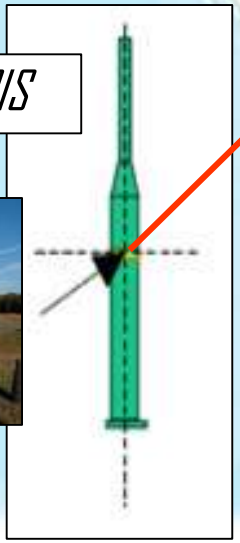
VLBI

Co-Location System

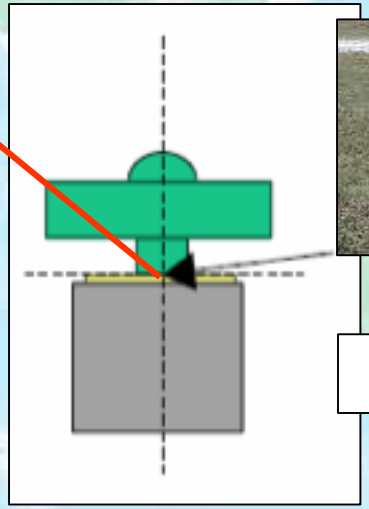


SLR

DORIS



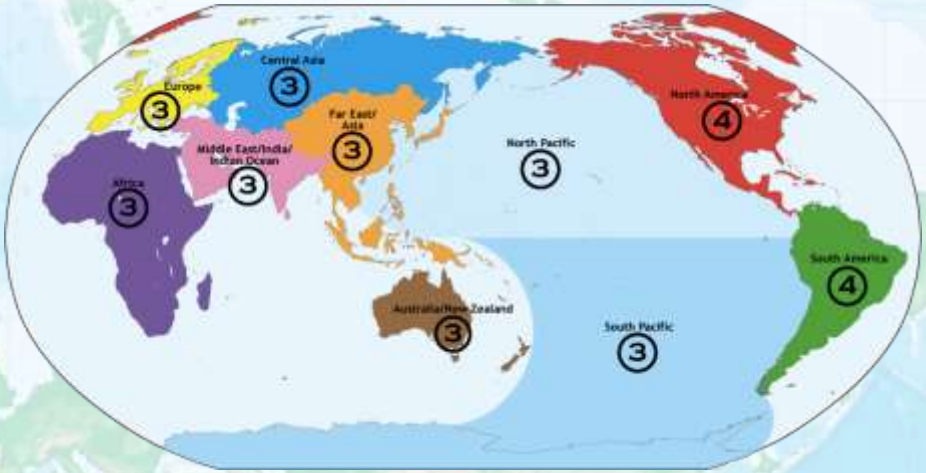
- Local survey is an essential part of co-location, but
- Great care must be taken to identify the system reference points

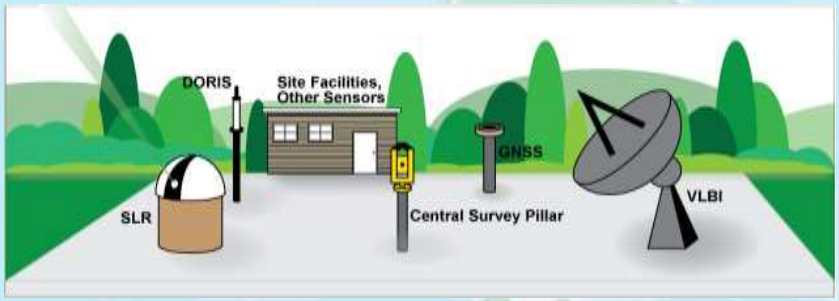


GPS

Early Simulation Studies to Scope the Network
(impact on the Reference Frame) (Erricos Pavlis)

- Early simulation studies showed the we needed:
  - ~32 globally distributed, well positioned, new technology, co-location sites will be required to define and maintain the reference frame;
  - ~16 of these co-location stations must track GNSS satellites with SLR to calibrate the GNSS orbits which are used to distribute the reference frame.



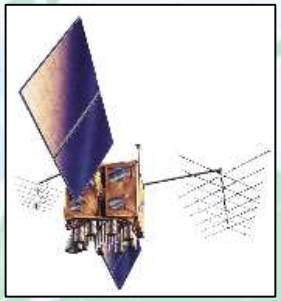


- **Design Initiative, a major challenge**
- **Will require time, significant resources, and strong international participation**
- **Not enough good sites**
- **Now we recognize that it will be a combination of core and co-location sites with global distribution.**

Co-location in Space

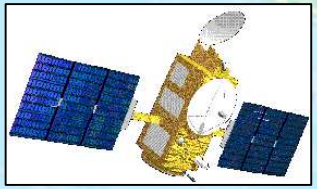
BeiDou
GNSS/SLR

GLONASS
GNSS/SLR



GPS
GNSS/SLR

Galileo
GNSS/SLR



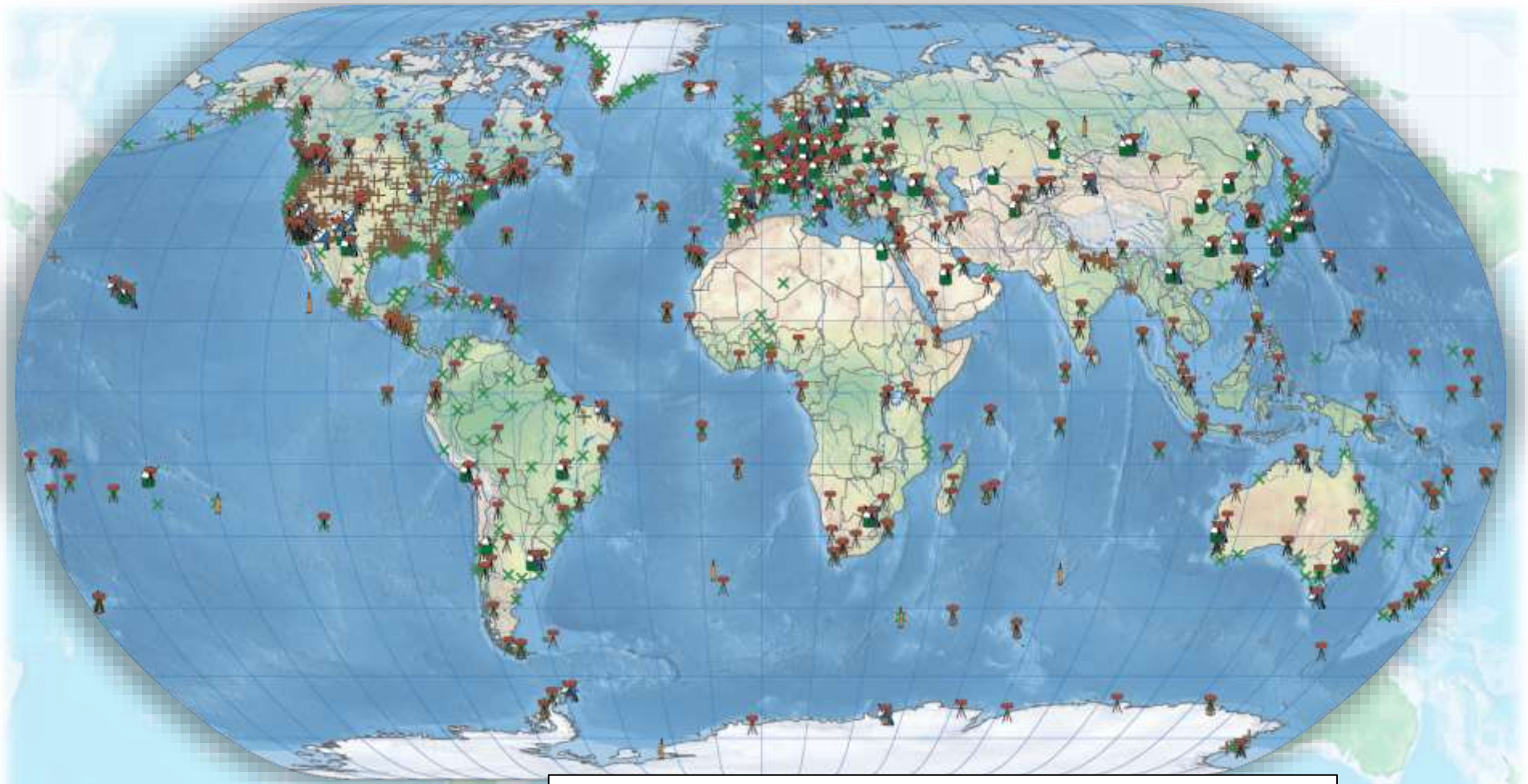
Jason
DORIS/GNSS/SLR

CHAMP
GNSS/SLR

Envisat
DORIS/SLR

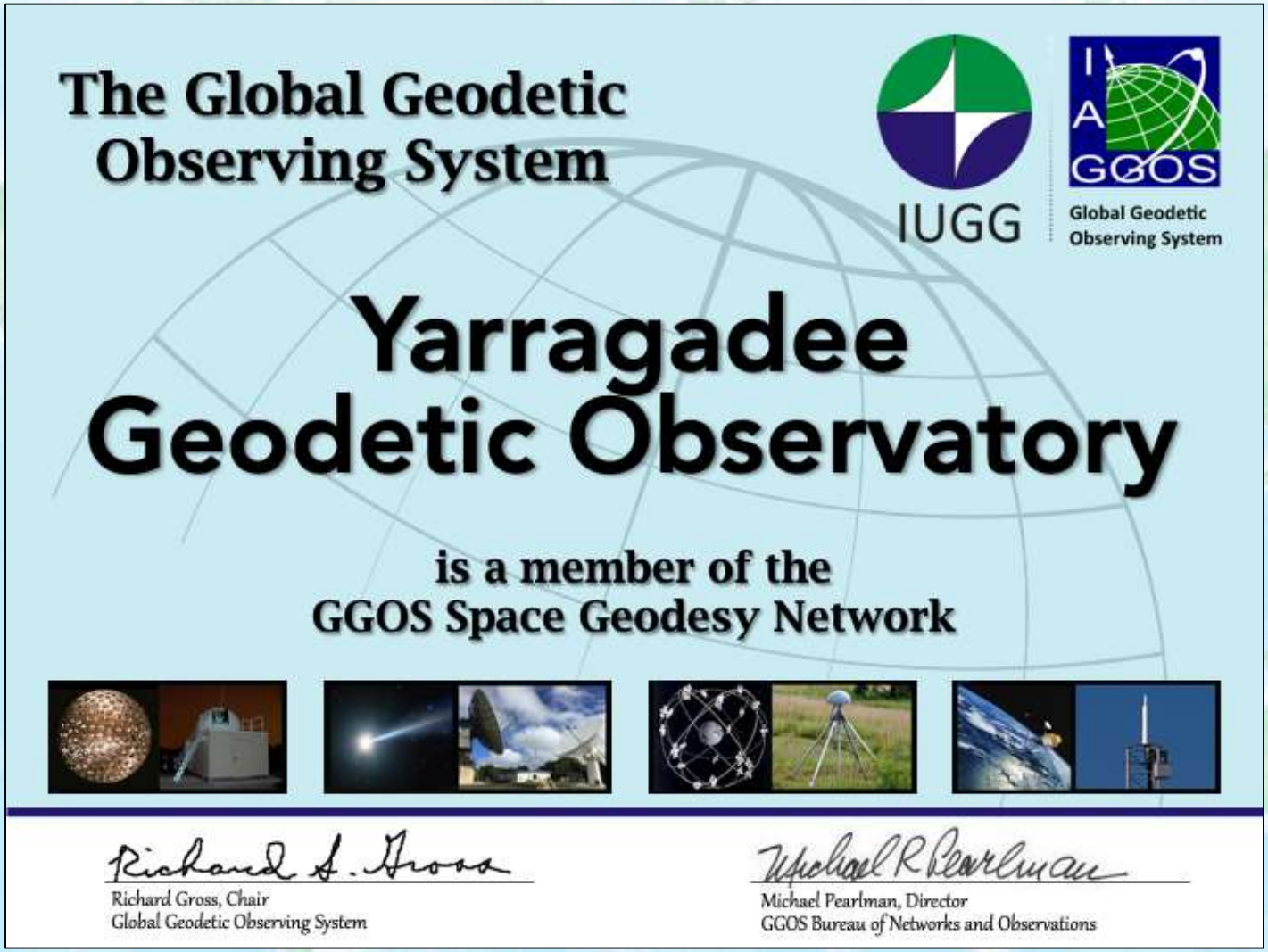
GRACE
GNSS/SLR

Global Network Supporting GGOS

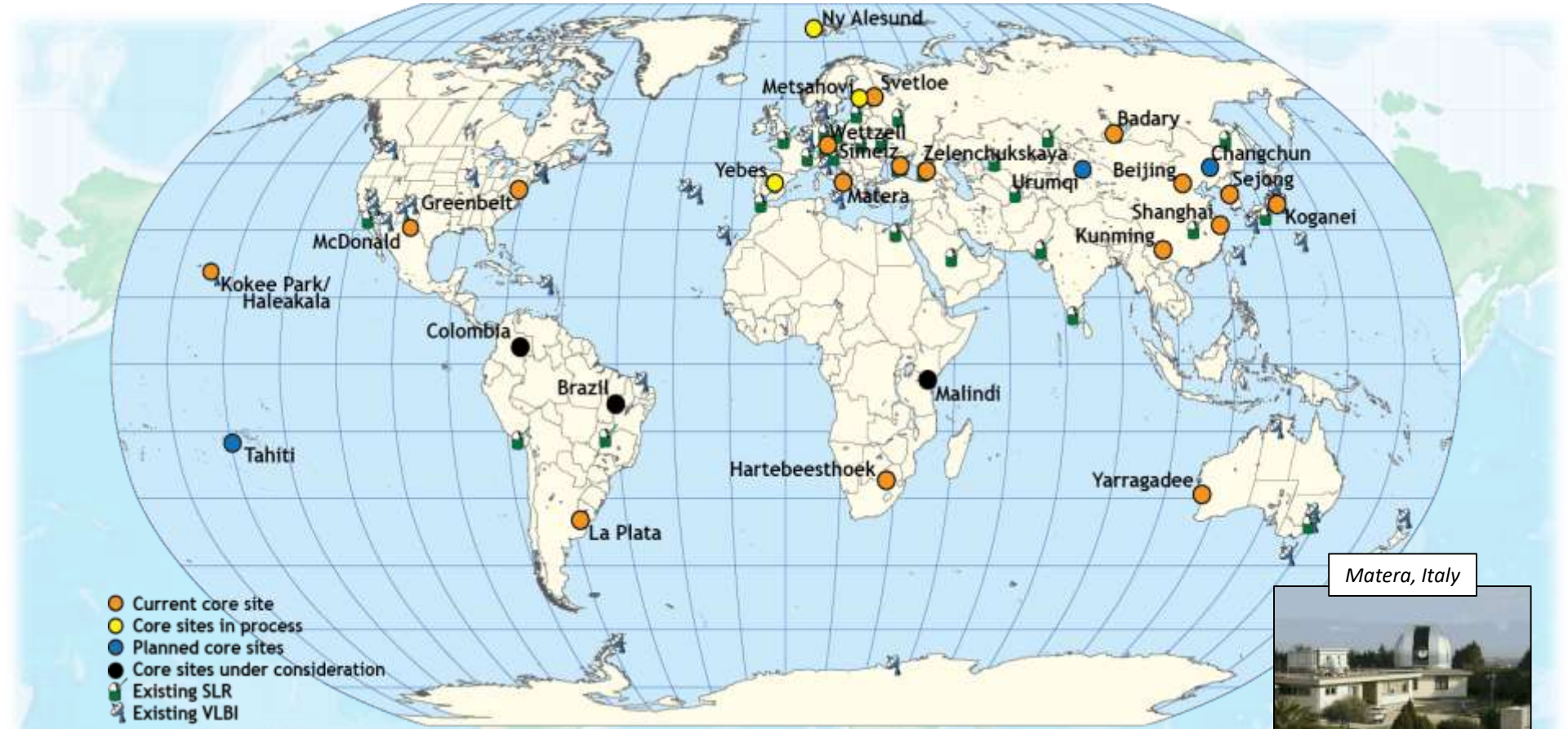


- *Three big initiatives: NASA, BKG, and ROSCOSMOS*
- *Number of stations still need to "join the club"*
- *Continue to recruit station through the CfP*

GGOS Network Certificate



Current and Projected Core Sites



Matera, Italy

Ny Ålesund, Norway

Greenbelt, MD USA

AGGO, Argentina

Metsähovi, Finland

Projected Space Geodesy Network

IUGG

IAG GGOS Global Geodetic Observing System

PROJECTED SPACE GEODESY NETWORK

Terminology			
	VLBI	S/X and VGOS	(2) denotes two VLBI Systems
	SLR	Legacy (<50Hz), Intermediate (50-500Hz), Kilohertz, Tochka (2 Int)	Russian Station with 2 SLR Systems (Int)
	GNSS	GPS, Multiconstellation (MC)	
	Gravitimeter	Superconducting (SCGr), Absolute (ABGr)	Stations that have or should provide strong RFI support

			Current	2017					5 years hence		2022				10 years hence		2027				Sponsor
			VLBI	SLR	GNSS	DORIS	Gravity		VLBI	SLR	GNSS	DORIS	Gravity		VLBI	SLR	GNSS	DORIS	Gravity		
North America																					
	GGAO (GSFC)		VGOS	L	MC	D			VGOS	kHz	MC	D			VGOS	kHz	MC	D			NASA
	Haystack		VGOS	-	MC	-			VGOS	-	MC	-			VGOS	-	MC	-			NASA/MIT
	McDonald		-	L	GPS	-			VGOS	kHz	MC	-			VGOS	kHz	MC	-			NASA/Utex
	Monument Peak		-	L	GPS	-			-	Closed					-						NASA
	Ensenada, Mexico								-	Tochka	MC	-			-	Tochka	MC	-			OJC/RPC/PSI
	Yellow Knife				MC	D			VGOS	kHz	MC	D			VGOS	kHz	MC	D			NRCan
	Goldstone		L		MC	D			L		MC	D			L		MC	D			
South America																					
	Brasilia, Brazil		-	Int	MC	-			-	Int	MC	-			VGOS	Int	MC	-			OJC/RPC/PSI
	Northern Brazil		-	-	-	-			-	-	-	-			VGOS	kHz	MC	-			NASA/IMPE
	La Plata, Argentina		S/X		MC	-			S/X	L	MC	-			S/X	L	MC	-			BKG (Germany)
	San Juan, Argentina		-	L		D			S/X	kHz	MC	D			S/X	kHz	MC	D			CAS/FAAO
	Arequipa, Peru		-	L	MC	D			-	L	MC	D			-	L	GPS	D			UNSA/NASA
Central Pacific Region																					
	Haleakala		-	L	GPS	-			-	L	MC	-			-	kHz	MC	-			NASA
	Kokee Park		VGOS	-	New	D			VGOS	-	MC	-			VGOS	-	MC	-			USNO/NASA
Australia/South Pacific																					
	Yarragadee		S/X	L	MC	D			VGOS	L	MC	D			VGOS	kHz	MC	D			GA/NASA
	Mt Stromlo		-	Int	MC	D			-	Int	MC	D			-	Int	MC	D			GA/EOS
	Katherine		S/X	-	MC	-			VGOS	-	MC	D			VGOS	-	MC	D			NCRIS
	Parkes		S/X	-	GPS	-			S/X	-	GPS	-			S/X	-	GPS	-			CSIRO/CASS
	Hobart		S/X	-	GPS	-			VGOS	-	GPS	-			VGOS	-	GPS	-			NCRIS
	Warkworth		S/X	-	GPS	-			S/X	-	GPS	-			S/X	-	GPS	-			NCRIS
	Tahiti		-	L	GPS	D			VGOS	L	MC	D			VGOS	L	MC	D			GRGS/UFP/NASA
										Tochka						Tochka					OJC/RPC/PSI
Africa																					
	Hartebeesthoek, SA		S/X	L	GPS	D			VGOS	L	MC	D			VGOS	kHz	MC	-			NRF
				Int						Int						Int					OJC/RPC/PSI

GGOS Site Requirements Document

Global Geodetic Observing System (GGOS)

GGOS Requirements for Core Sites
(Revision 2)

Contributors:

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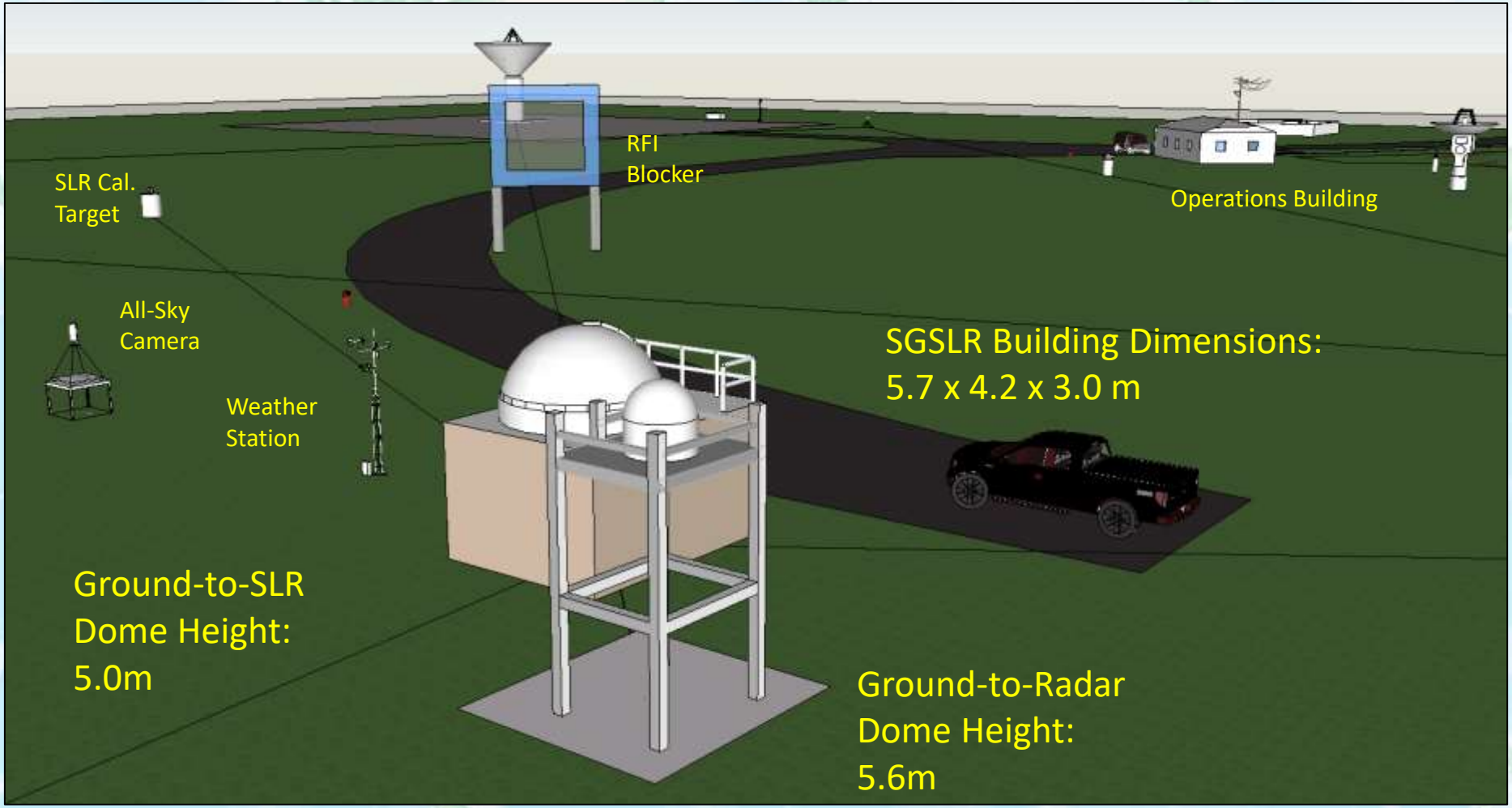
Michael Pearlman (Lead)	CfA
Jerome Saunier	IGN
David Stowers	JPL
Scott Wetzel	HTSI

GGOS Requirements for Core Sites Revision 2

- Introduction and Justification
  - What is a Fundamental Station?
  - Why do we need the Reference Frame?
  - Why do we need a global network?
  - What is the current situation?
  - What do we need?
- Site Conditions
  - Global consideration for the location
  - Geology
  - Site area
  - Weather and sky conditions
  - Radio frequency and optical Interference
  - Horizon conditions
  - Air traffic and aircraft Protection
  - Communications
  - Land ownership
  - Local ground geodetic networks
  - Site Accessibility
  - Local infrastructure and accmmodations
  - Electric power
  - Site security and safety
  - Local commitment

Site layout needs to recognize the issue of RF interference among the new technology systems



Approximate building dimensions shown

Standing Committee on Performance simuLations & Architectural TradeOffs (PLATO)/D. Thaller, B. Männel

- Examining trade-off options for station deployment and closure, technology upgrades, impact of site ties, etc. and project future network capability using projected network configuration in new system implementation;
- Conducting simulations to assess impact on reference frame products of: network configuration (e.g., new and additional sites), system performance (e.g., SLR station performance), technique and technology mix, co-location conditions, site ties;
- Conducting simulation studies to assess impact on reference frame products of: co-location in space, space ties, available satellites (e.g., tracking priorities for LAGEOS and Etalon);
- Developing improved analysis methods for reference frame products by including all existing data and available co-locations (e.g., consistent processing of LEO and ground-based observations);
- Conducting ongoing analysis campaign with exchanged simulated observations.

Standing Committee on Satellite Missions (CSM)/ J. Müller, R. Pail

- List of satellite contributions to fulfill the GGOS 2020 goals (1 mm / 0.1 mm/yr) has been prepared and will be regularly updated;
- Inventory of the GGOS satellite infrastructure has been prepared and will be regularly updated;
- Both lists are published at the CSM section of the GGOS website;
- ESA's Earth Explorer 10 call: CSM has contributed to proposal MOBILE (future gravity satellite mission) – not selected;
- Exchange with PLATO has been initiated by identifying joint interests and possible collaborations

Standing Committee on Data and Information System/ H. Titz, C. Noll

- Adopting and implementing a metadata system to provide access to GGOS relevant data products (Carey Noll);
- Work continues at CDDIS on collection-level metadata efforts (Carey Noll);
- Developing a full metadata system including site information and relevant tools and capability (Nick Brown/the Australian GL scheme)
  - Definition of the requirements;
  - Resolve issues and applicability of the Australian GL scheme and recommend schema;
  - Metadata implementation plan including definition of tasks, roles, and distribution of tasks, and plans for integration of components.

IERS Working Group on Site Survey and Co-location Tasks/ S. Bergstrand

- Geometric VLBI telescope deformation measurements have been shown to isolate apparent reference point movements that hitherto have been aliased into space geodetic processing at an order of several millimeters;
- High priority to have such measurements done at legacy VLBI telescopes before they are decommissioned to provide the best possible time series for future International Terrestrial Reference frames (ITRFs);
- Starting mid-2019, the GeoMetre Project (18SIB01) has been granted three years European Commission funding in the European Metrology Programme for Innovation and Research (EMPIR) to improve traceable long-distance measurements and local tie research.

Reality

Recognizing that:

- Many sites will not be at ideal locations nor have ideal conditions;
- Some new technology stations are being deployed, but not co-located;
- Core site deployment will occur over many years;
- We will have a mix of new and legacy technologies for many years;

As a result:

- Co-location sites (non-core sites) will continue to play a vital role in our data products;
- Quality of our output will be the product of network Core Sites, Co-location sites, mix of technologies, adherence to proper operational and engineering procedures, and making best use of the data once it leaves the field;

But:

- Many groups are taking the initiative to join, build and upgrade

Summary

- Challenging program with very important science and societal benefits
- Technologies are maturing
- Global distribution is essential
- Very large opportunity for participation in analysis, science, and technology areas – just show up and get involved
- Need to engage young scientists, engineers and students
- Success will depend on partnerships