



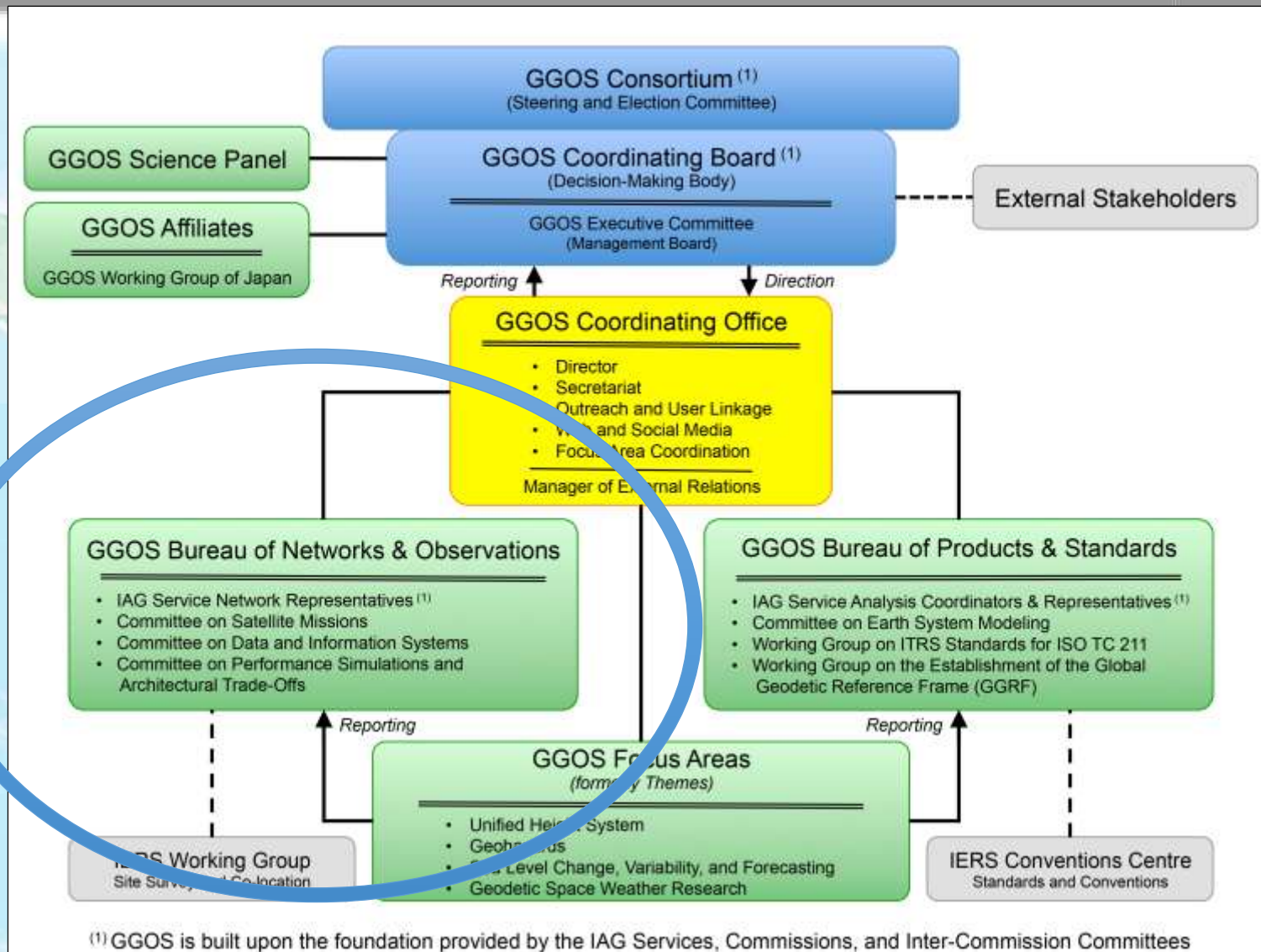
GGOS Bureau of Networks and Observations

Mike Pearlman
Carey Noll

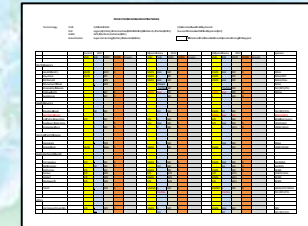
SIRGAS Meeting
November 11 – 14, 2019
Rio de Janeiro, Brazil

November 12 - 14, 2019

GGOS Organization



- 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;
- Organize a GGOS Affiliated Network through a CfP;
- 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.;
- 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;
- 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;
- Develop MOU with ROSCOSMOS



Station ID	Station Name	Latitude	Longitude	Altitude	Status	Notes
1
2
3
4
5
6
7
8
9
10



- Standing Committee on Performance Simulations and Architectural Trade-offs/PLATO

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-off options

Good presentations on projected benefits from network enhancements

- Standing Committee on Data and Information

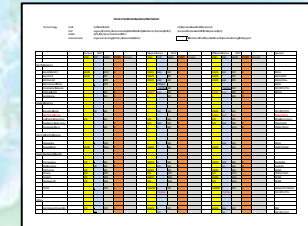
Metadata System development for a wide range of geodesy users including GGOS; near term strategy for data products (Carey Noll at GSFC) and a more comprehensive longer-term plan for an all-inclusive system (Nick Brown at GA)

- Standing Committee on Missions

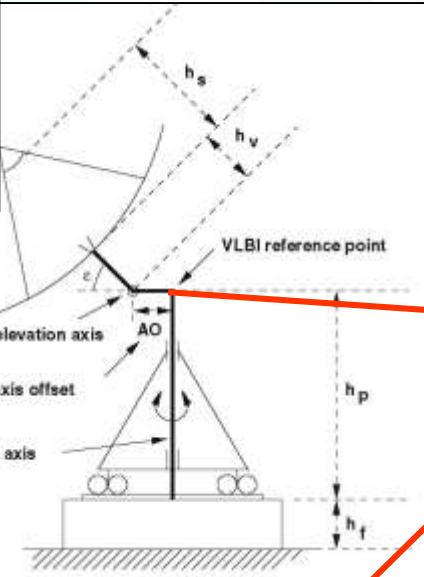
Maintain lists of current and proposed satellites that contribute to GGOS Goals; advocate for new missions and project the benefit to GGOS

- IERS Working Group on Site Survey and Co-location

Ground survey and co-location issues including critical co-locations for the reference frame and gravity deformation of VLBI antennas

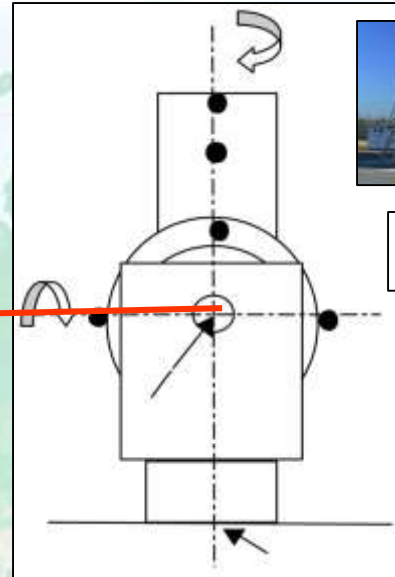


Main Thrust is the Reference Frame

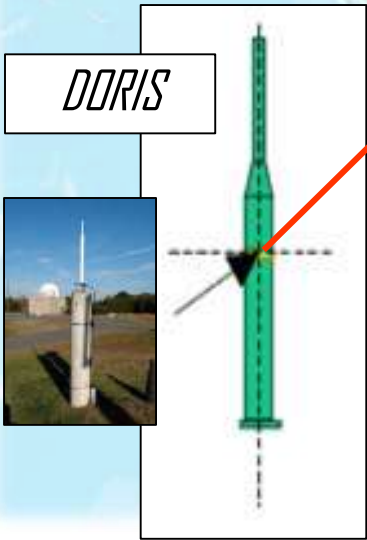


VLBI

Co-Location System



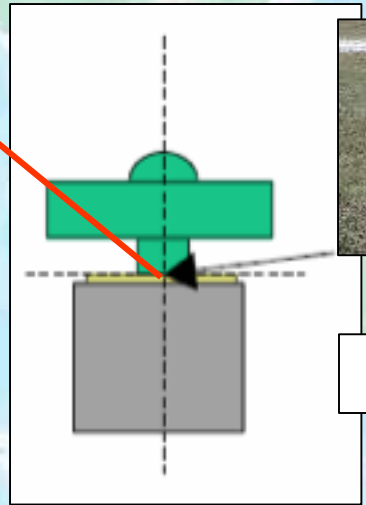
SLR



DORIS



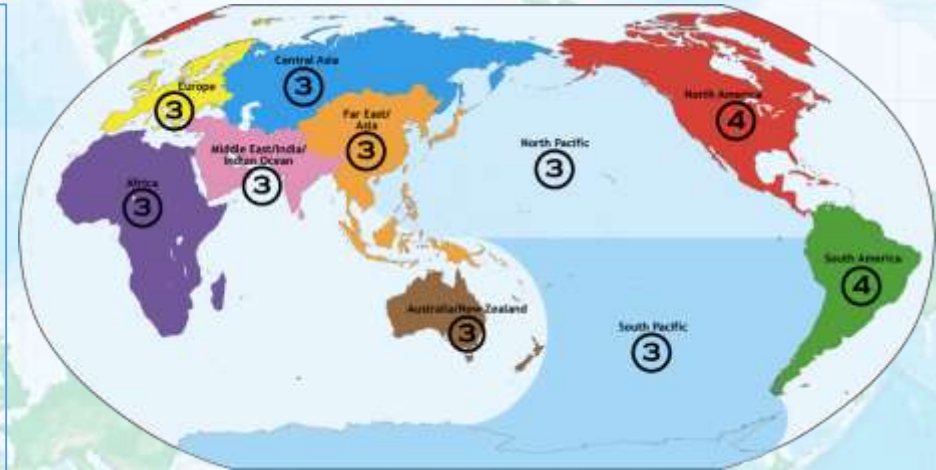
- Local survey is an essential part of co-location, but
- Great care must be taken to identify the system reference points
- Need to integrate gravimeters and tide gauges



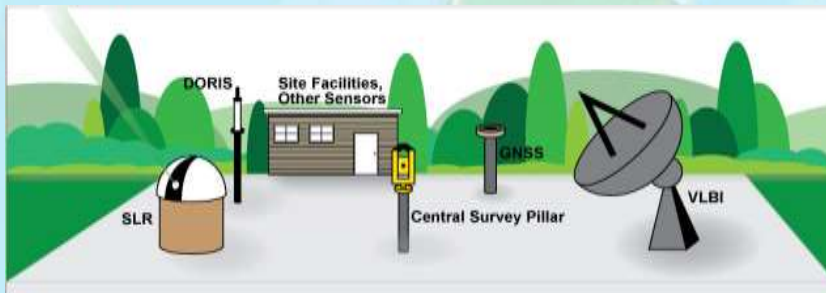
GPS

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.



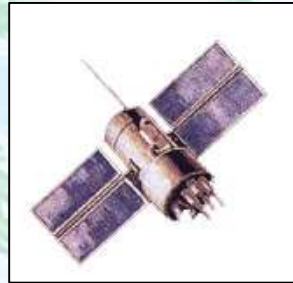
- **Design Initiative, a major challenge**
- **Will require time, significant resources, and strong international participation**
- **Not enough good sites**
- **Now we recognize that it will be a combination of core and co-location sites with global distribution.**



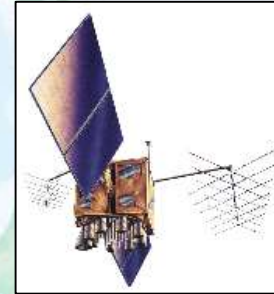
Co-location in Space



BeiDou
GNSS/SLR



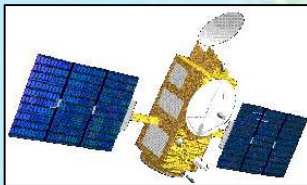
GLONASS
GNSS/SLR



GPS
GNSS/SLR



Galileo
GNSS/SLR



Jason
DORIS/GNSS/SLR



CHAMP
GNSS/SLR

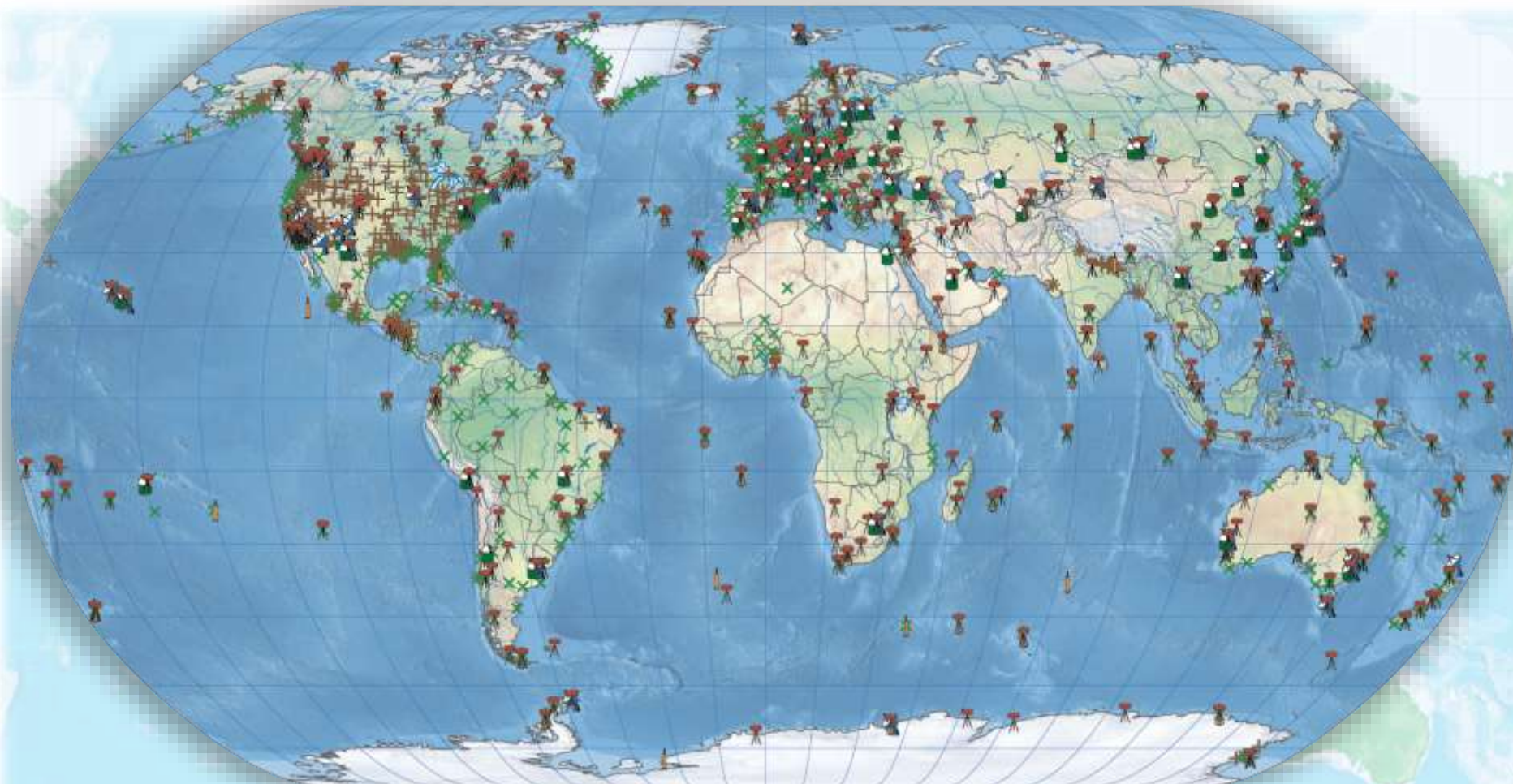


Envisat
DORIS/SLR



GRACE
GNSS/SLR

GGOS Affiliated Network (CfP)



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

Space geodesy in South America

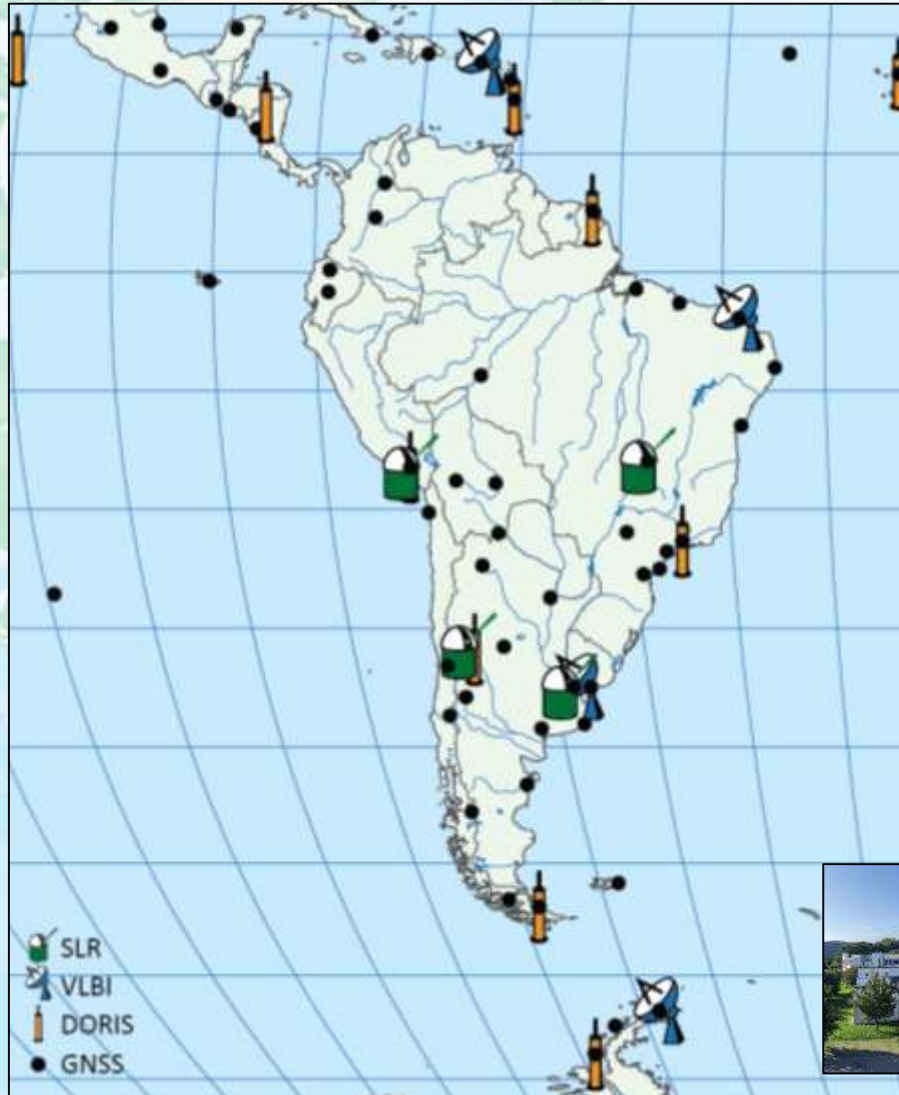
*Arequipa,
Peru*



*San Juan,
Argentina*



*O'Higgins,
Antarctica*



*Sazhen-TM,
Brasilia, Brazil*



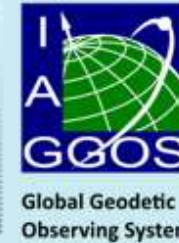
*Fortaleza,
Brazil*



AGGO, Argentina



**The Global Geodetic
Observing System**



Yarragadee Geodetic Observatory

is a member of the
GGOS Space Geodesy Network



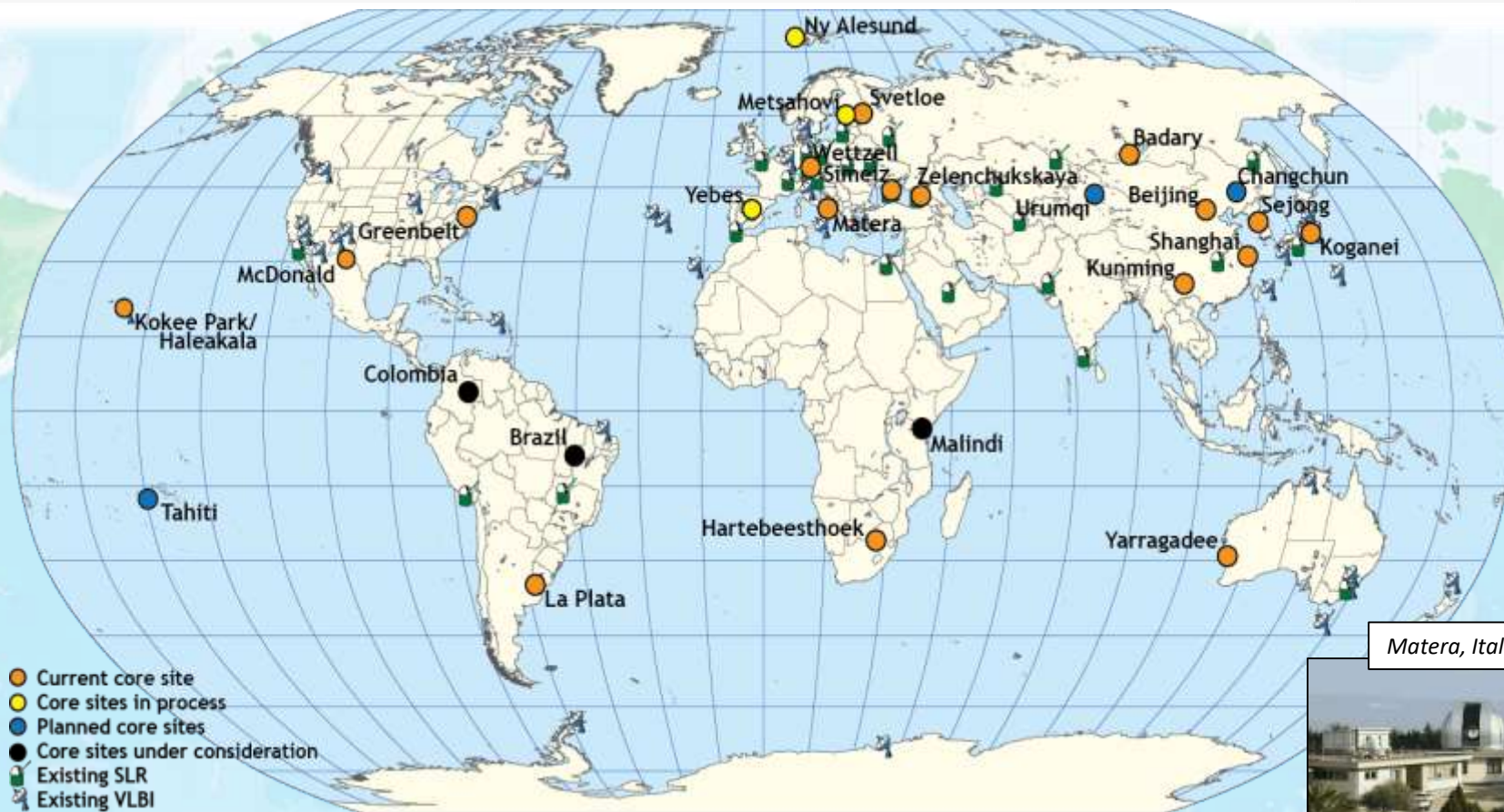
Richard A. Gross

Richard Gross, Chair
Global Geodetic Observing System

Michael R. Pearlman

Michael Pearlman, Director
GGOS Bureau of Networks and Observations

Current and Projected Core Sites



Matera, Italy



Ny Ålesund, Norway



Greenbelt, MD USA



AGGO, Argentina



Metsähovi, Finland



Projected Space Geodesy Network

PROJECTED SPACE GEODESY NETWORK

Terminology: VLBI (S/X and VGOS), SLR (Legacy (<50Hz), Intermediate (50-500Hz), Kilohertz, Tochka (Int)), GNSS (GPS, Multiconstellation (MC)), Gravimeter (Superconducting (SCGr), Absolute (ABGr)). (2) denotes two VLBI systems. Russian stations with 2 SLR systems (Int). Stations that have or should provide strong RF 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	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		VGOS	kHz	MC	D		VGOS	kHz	MC	D		NASA	
Haystack	VGOS	-	MC	-		VGOS	-	MC	-		VGOS	-	MC	-		VGOS	-	MC	-		VGOS	-	MC	-		NASA/MIT	
McDonald	VGOS	L	GPS	-		VGOS	kHz	MC	-		VGOS	kHz	MC	-		VGOS	kHz	MC	-		VGOS	kHz	MC	-		NASA/Utex	
Monument Peak	-	L	GPS	-		-	Closed				-					-					-					NASA	
Ensenada, Mexico	-					-	Tochka	MC	-		-	Tochka	MC	-		-	Tochka	MC	-		-	Tochka	MC	-		OJC/RPC/PSI	
Yellowknife	-		MC	D		VGOS	kHz	MC	D		VGOS	kHz	MC	D		VGOS	kHz	MC	D		VGOS	kHz	MC	D		NRCAN	
Goldstone	L		MC	D		L		MC	D		L		MC	D		L		MC	D		L		MC	D			
South America																											
Brasilia, Brazil	-	Int	MC	-		-	Int	MC	-		VGOS	Int	MC	-		VGOS	Int	MC	-		VGOS	Int	MC	-		OJC/RPC/PSI	
Northern Brazil	-	-	-	-		-	-	-	-		VGOS	kHz	MC	-		VGOS	kHz	MC	-		VGOS	kHz	MC	-		NASA/IMPE	
La Plata, Argentina	S/X		MC	-		S/X	L	MC	-		S/X	L	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		S/X	kHz	MC	D		S/X	kHz	MC	D		CAS/FAAO	
Arequipa, Peru	-	L	MC	D		-	L	MC	D		-	L	GPS	D		-	L	GPS	D		-	L	GPS	D		UNSA/NASA	
Central Pacific Region																											
Haleakala	-	L	GPS	-		-	L	MC	-		-	kHz	MC	-		-	kHz	MC	-		-	kHz	MC	-		NASA	
Koee Park	VGOS	-	New	D		VGOS	-	MC	-		VGOS	-	MC	-		VGOS	-	MC	-		VGOS	-	MC	-		USNO/NASA	
Australia/South Pacific																											
Yarragadee	S/X	L	MC	D		VGOS	L	MC	D		VGOS	kHz	MC	D		VGOS	kHz	MC	D		VGOS	kHz	MC	D		GA/NASA	
Mt Stromlo	-	Int	MC	D		-	Int	MC	D		-	Int	MC	D		-	Int	MC	D		-	Int	MC	D		GA/EOS	
Katherine	S/X	-	MC	-		VGOS	-	MC	D		VGOS	-	MC	D		VGOS	-	MC	D		VGOS	-	MC	D		NCRIS	
Parkes	S/X	-	GPS	-		S/X	-	GPS	-		S/X	-	GPS	-		S/X	-	GPS	-		S/X	-	GPS	-		CSIRO/CASS	
Hobart	S/X	-	GPS	-		VGOS	-	GPS	-		VGOS	-	GPS	-		VGOS	-	GPS	-		VGOS	-	GPS	-		NCRIS	
Warkworth	S/X	-	GPS	-		S/X	-	GPS	-		S/X	-	GPS	-		S/X	-	GPS	-		S/X	-	GPS	-		NCRIS	
Tahiti	-	L	GPS	D		VGOS	L	MC	D		VGOS	L	MC	D		VGOS	L	MC	D		VGOS	L	MC	D		GRGS/UFP/NASA	
							Tochka					Tochka					Tochka					Tochka				OJC/RPC/PSI	
Africa																											
Hartebeesthoek, SA	S/X	L	GPS	D		VGOS	L	MC	D		VGOS	kHz	MC	-		VGOS	kHz	MC	-		VGOS	kHz	MC	-		NRF	
		Int					Int					Int					Int					Int				OJC/RPC/PSI	

Global Geodetic Observing System (GGOS)

GGOS Requirements for Core Sites (Revision 2)



Contributors:

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GGOS Requirements for Core Sites Revision 2

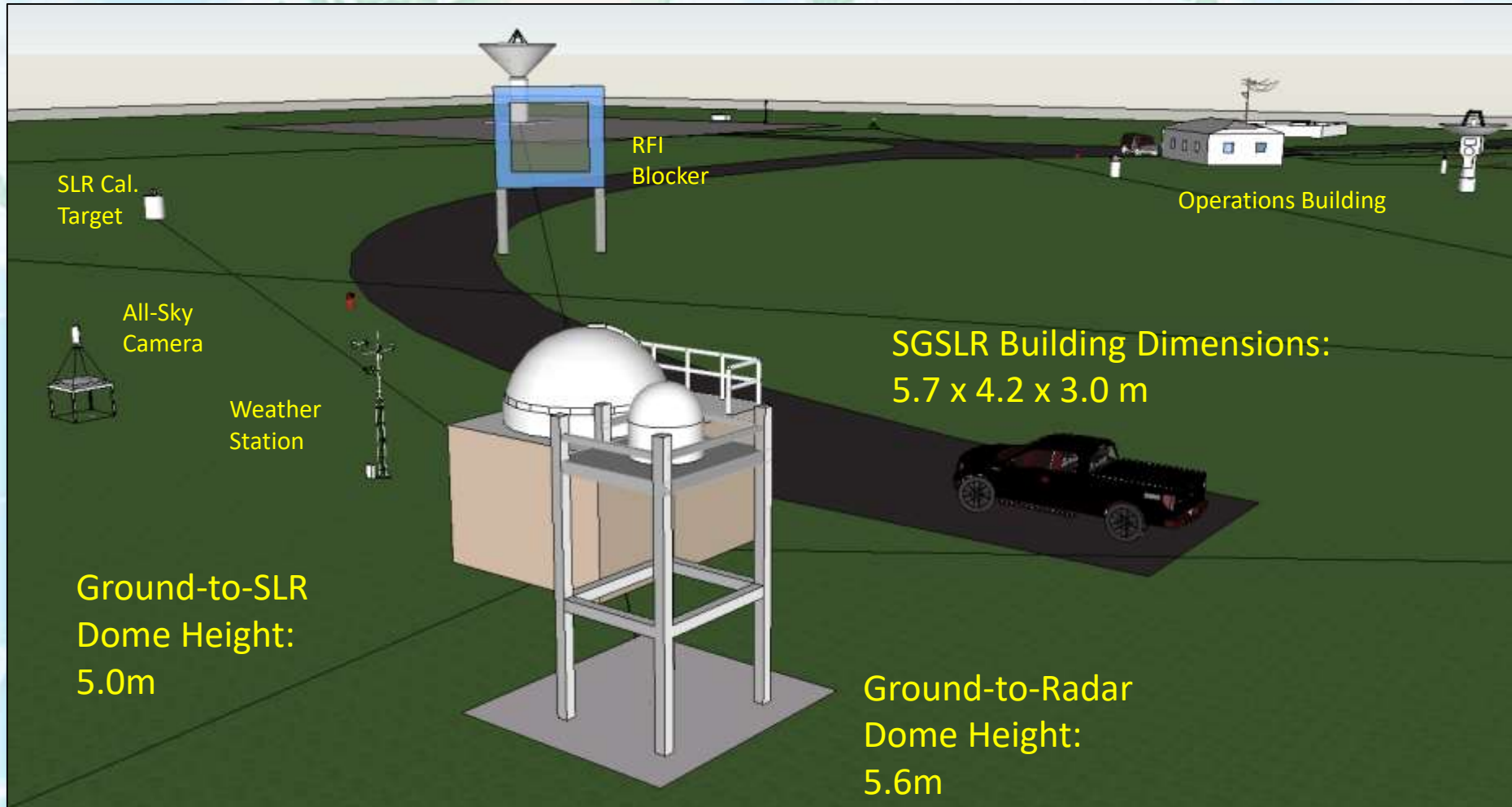
• Introduction and Justification

- 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 accommodations
- 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

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

- Challenging program with very important science and societal benefits
- Technologies are maturing
- Global distribution is essential
- Very large opportunity for participation in analysis and scientific research
- Need to engage young scientists and students
- Success will depend on partnerships