A Long-Range Science Plan for Seismology (LRSPS)

Requested by NSF - required by Cooperative agreement between IRIS and NSF - request renewed by Associate Director of NSF

Working Title:

From Crust to Core and Earthquakes to Climate: Challenges for Seismology in Understanding Earth's Dynamic Systems and Hazards

IRIS Workshop, Skamania, WA 2008

Why now?

- Opportunities for initiatives with new administration
- Increasing concern within NSF that O&M costs for major facilities be justified by a science plan
- Help ensure future of seismology during planned NSF budget increase
- Recent advances in science and data facilitate exciting new research directions

LRSPS Audiences

- High level NSF and interagency (e.g., USGS, DOE, DOD, and NOAA)
- GEO/EAR-OCE within NSF
- Broad research community
- Numerous other potential audiences (e.g., university administration, science staffers, …)

LRSPS Products

- Concise (~10 page) and accessible overview for broad audience summarizing key questions and challenges.
- One page Executive Summary
- A separate, more extensive exploration and documents consisting of key questions and challenges to encourage an exchange of ideas and help stimulate long-term strategic planning within the university community and in the GEO directorate at NSF
- Supporting web materials

Timeline for LRSPS Development

2007 - IRIS Board appoints Rick Aster, Don Forsyth, Barbara Romanowicz to chair development of LRSPS

January 2008 - NSF representatives emphasize interest in development of LRSPS

June 2008 - Discussion of plan at IRIS Workshop

June 2008 - Application process opens following IRIS Workshop

July - August 2008 - Specific plans for workshop organization and writing teams developed. Strawman drafts of key questions and document components will be encouraged.

September 18-19 **- LRSPS Workshop at Qwest Center, Lakewood, CO (full 2-days).**

October - December - Writing, community feedback and document preparation

Fall AGU 2008 Report distributed

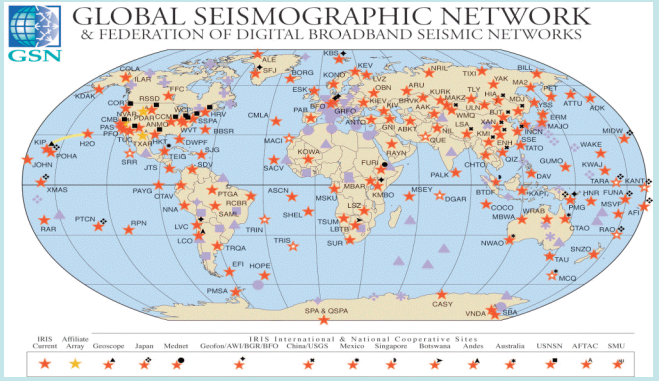
September 18-19 LRSPS Workshop Goals

- Identify ~ 8-10 examples of key challenges/questions that will drive the science for the next decade
- Produce concise summaries of these challenges and their significance
- Briefly summarize/point out recent exciting developments
- Identify Technological and Programmatic Challenges qnd plan for future infrastructure and coupled science

  examples:
  - Sustain and improve current seismic infrastructure
  - Strengthen support for research and data analysis
  - Instrument the oceans to improve global and regional coverage
  - Cultivate interdisciplinary/interagency/interdivision opportunities
- Provide written summaries of breakout group and plenary discussions

Recent theoretical, computational, and data advances facilitate exciting new research directions, e.g.:

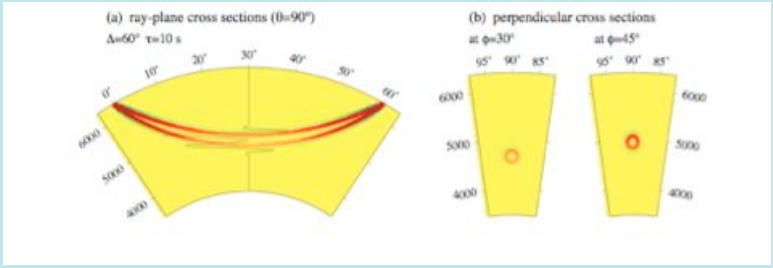
- Unprecedented density of global and regional networks of high-quality seismic stations reporting continuous data in real time with open and easy access.



- Advances in computing resources and codes that facilitate numerical modeling of seismic wave propagation in 3-D, heterogeneous, anisotropic attenuating media.

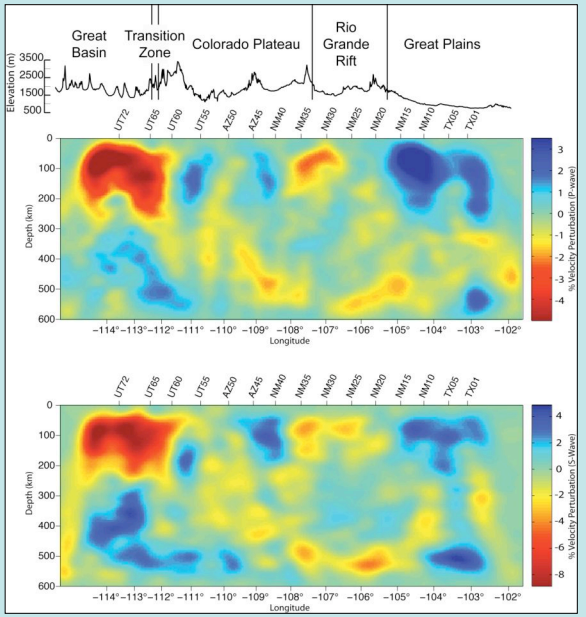
Recent theoretical, computational, and data advances facilitate exciting new research directions, e.g.:

- Theoretical advances in understanding finite-frequency sensitivity of propagating seismic waves to Earth structure.



Hung et al., 2000

- Unprecedented resolution of crust and upper mantle structure on a continental scale driven by data from EarthScope, PASSCAL, and other facilities.

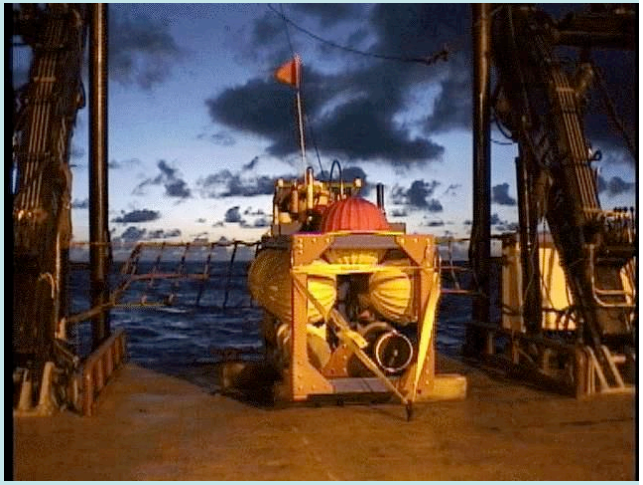


Sine et al., 2008

•The capability to deploy 2-D arrays of broadband land-based seismometers anywhere in the world, including polar regions

SOUTHBERG

•A community pool of ocean-bottom seismometers



WHOI

•A new ship, the *Marcus Langseth*, equipped for high resolution 3-D imaging of ocean crust

•An expanding global scientific culture of increased data sharing and multi-disciplinary integration in seismological and broader Earth science.

AGU

IASPEI

Istituto Nazionale di Geofisica e Vulcanologia

IAVCEI

NSF

International Federation of Digital Seismograph Networks
a global organization

IRIS

USGS
science for a changing world

JAMSTEC

Some Broad Thematic Areas:

- Multi-scale investigations of structures and dynamic processes from surface to core

- Understanding earthquakes, volcanoes, glaciers and other seismic sources and their effects

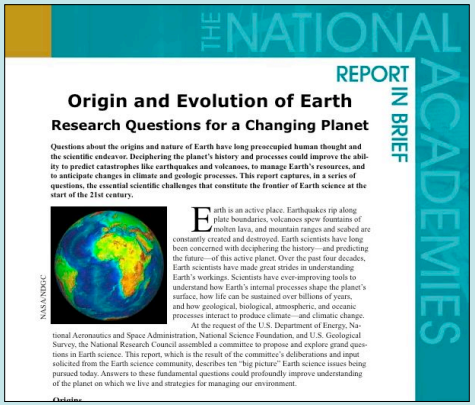
- Atmosphere/ocean/solid earth dynamic coupling manifested in the seismic wavefield

Possible Examples of Key Questions

- *What is the relationship between silent slip events, fault-zone tremor and major earthquakes?*
- *What is the form of convection in the mantle beneath the plates?*
- *What are the key roles of water in Earth's mantle?*

Links with other supporting studies will be important, e.g.:

Origin and Evolution of Earth: Research Questions for a Changing Planet

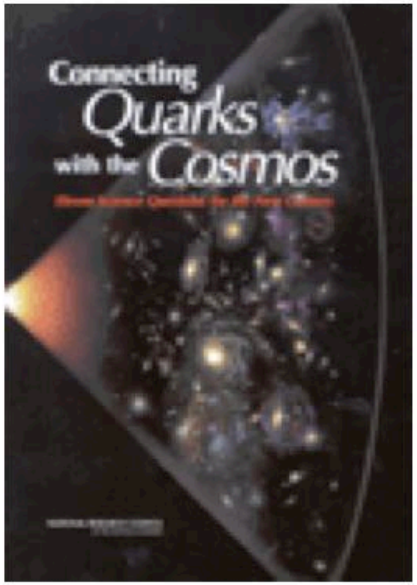


NRC Committee on Grand Research Questions in the Solid-Earth Sciences (DePaulo et al., 2008).

- How did Earth and other planets form?
- How does Earth's interior work, and how does it affect the surface?
- Why does Earth have plate tectonics and continents?
- How are Earth processes controlled by material properties?
- Can earthquakes, volcanic eruptions, and their consequences be predicted?
- How do fluid flow and transport affect the human environment?

An example analogue from the physics community

- Concise summary document
- Coupled report
- Active web site

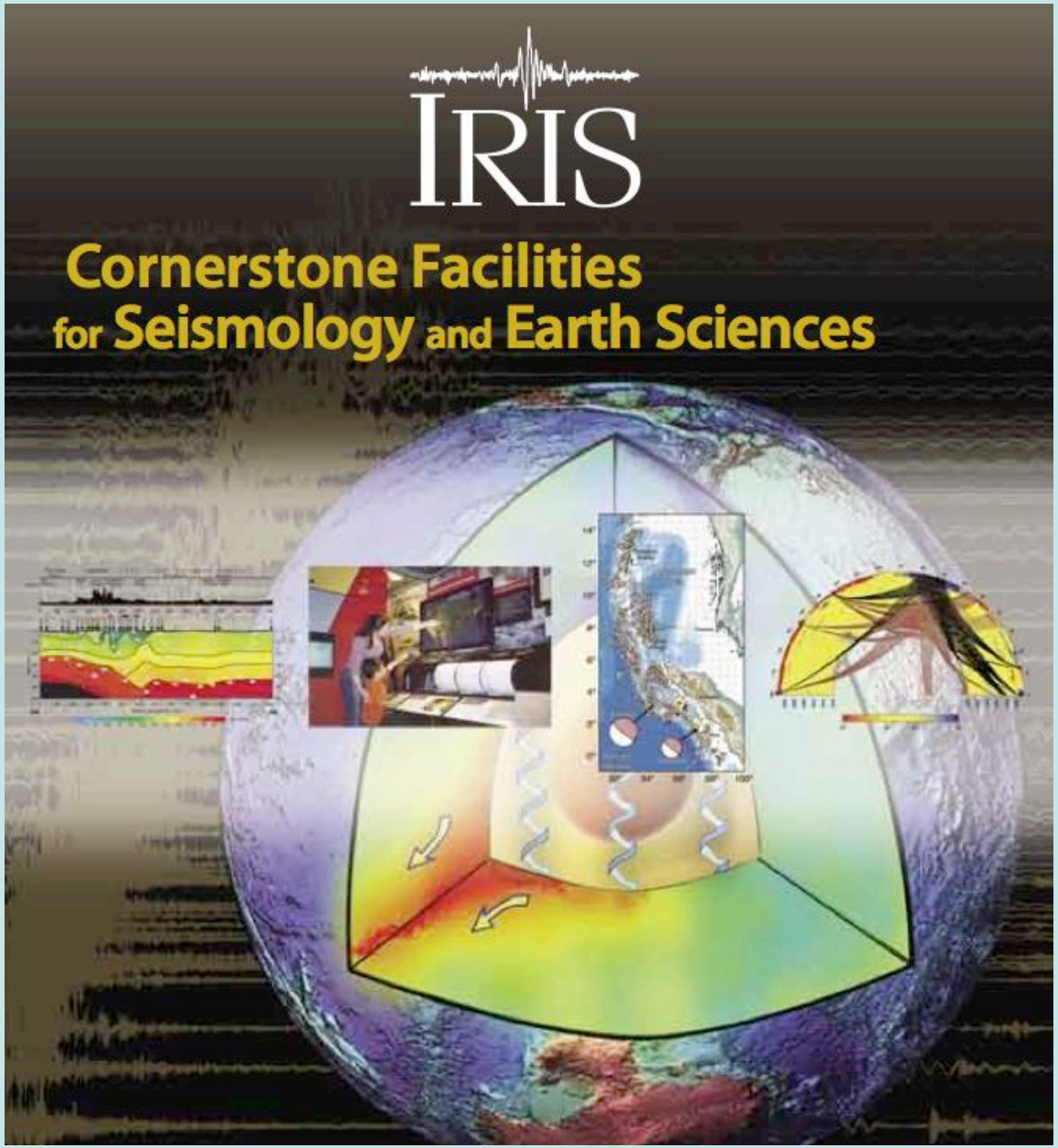


Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century

Committee on the Physics of the Universe, National Research Council

ISBN: 978-0-309-07406-3, 222 pages, 7 x 10, paperback (2003)

http://www.quarkstothecosmos.org/



A General announcement for the September 18-19 LRSPS workshop will go out early next week (via IRIS bulkmail, website, etc.).

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Scientific Evaluation Study of the International Monitoring System

B. Romanowicz, UC Berkeley

Scientific Evaluation Study of the CTBT verification system: CTBT-ISS

- ISS initiative launched by PTS in Spring 2008
  - 10 years since IMS/IDC was established in Vienna (1997)
  - Reaching out to the scientific community
- *For CTBT community*: Provide improved basis for political assessment of Treaty verification
- *For scientific community*: First step towards reopening the discussion on IMS broader data accessibility
- Culminates in Scientific Symposium to be held in June 2009 in Vienna.

- *Goals are to demonstrate that:*
  - IMS data are useful for CTBT verification
  - IMS data are useful for basic research
  - Progress in basic science in last 10 years can help improve the performance of the IMS
  - broader access to IMS data does not threaten the integrity of the CTBT verification system
  - CTBT could benefit from more routine use of auxiliary and open station data
  - There are scientific opportunities at the interface between the 4 CTBT disciplines

- *Our participation in this assessment is important for the future of our science*:
  - Huge asset for seismology ($1 Billion capital investment - $100M/year operating costs)
  - This initiative relates directly to the justification for continued political and technical support of the IMS system
  - Need to weaken the arguments that have led to restricted access to the IMS data
  - Capabilities of IMS for basic research are currently under-exploited

Scientific Evaluation Study of the CTBT verification system: CTBT-ISS

- For information, go to :
  - http://www.ctbto.org
    - → reference
    - -> information material
  - ISS Brochure
- Interested in participating:
  - Write to iss@ctbto.org
  - Contact me or any other member of the Evaluation Coordinating Group
  - We're working on obtaining some seed funding..

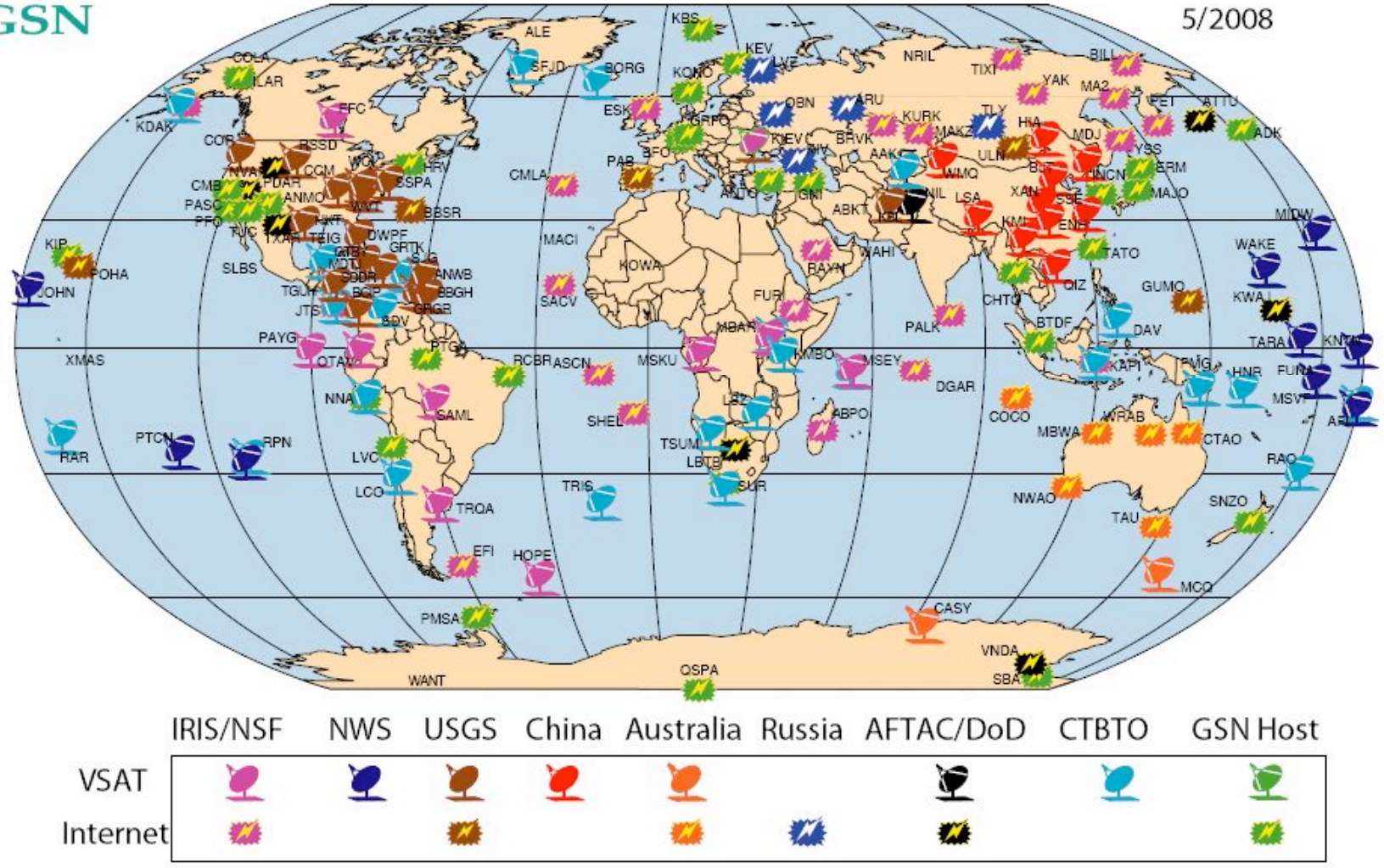
ISS – Seismology Evaluation Coordinating Committee

- Members:
  - S. Barrientos (Chile)
  - H. Bungum (Norway)
  - A. Dziewonski (US)
  - R. Engdahl (US)
  - D. Giardini (Switzerland)
  - A. Michelini (Italy)
  - P. Richards(US)
  - B. Romanowicz (US, Co-chair)
  - D. Storchak (UK, ISC)
  - S. Tsuboi (Japan)
  - Wu Zhongliang (China, Co-chair)
  - J. Zucca (US)

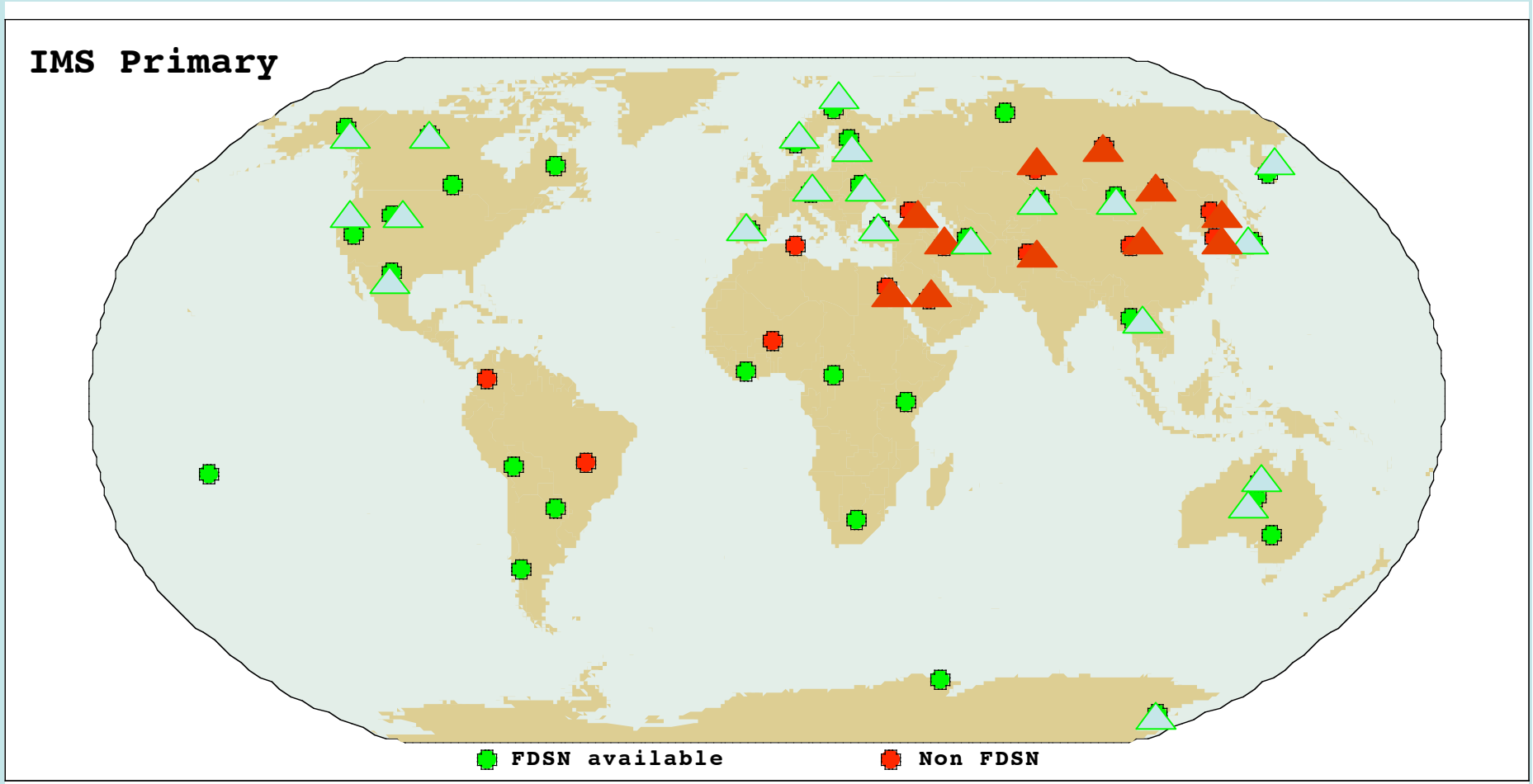
Questions and Comments?

- Future Facilities
- Earthquake Dynamics/Sources
- Slow Slip to Silent
- Glacial Movements/Polar Studies
- Fault Zone Studies
- High Resolution Continental Crust
- Continental Lithosphere
- Upper Mantle/Transition Zone
- Lower Mantle
- Core
- Ocean Environment
- Global Models
- Earthquake Triggering
- Volcanic and Magmatic Processes
- Ocean-Atmosphere-Solid Earth Interaction
- Other interdisciplinary Studies

GSN TELEMETRY

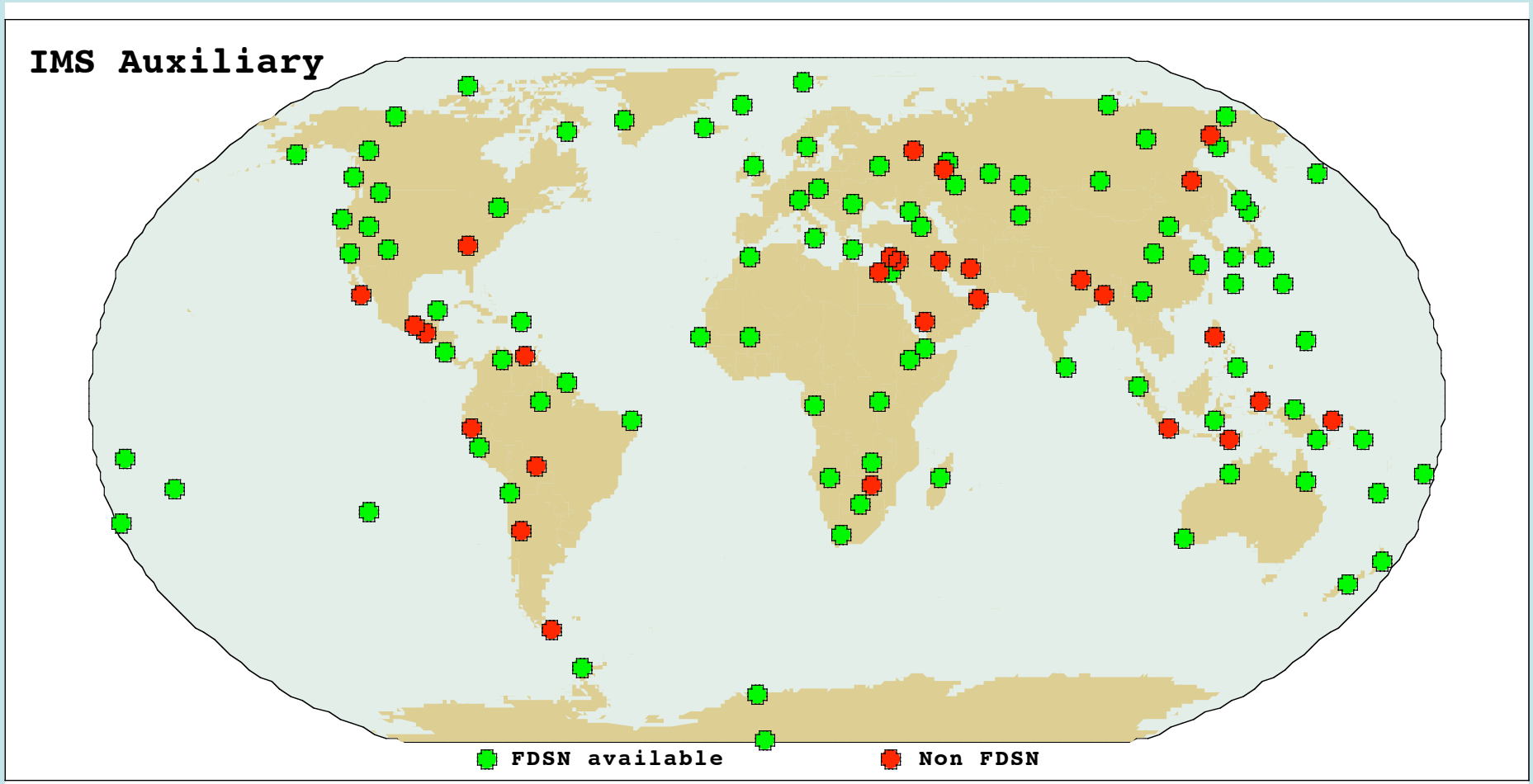


IMS FDSN Seismic Stations



3-Component (circles)
9 or 16 element circular arrays with 3-C at center (triangles)
vault or borehole (50 – 100 m)

IMS FDSN Seismic Stations



International Monitoring System

50 Primary stations

30 array stations
19 three component stations
1 to be determined (place and type)
37 certified

120 Auxiliary stations

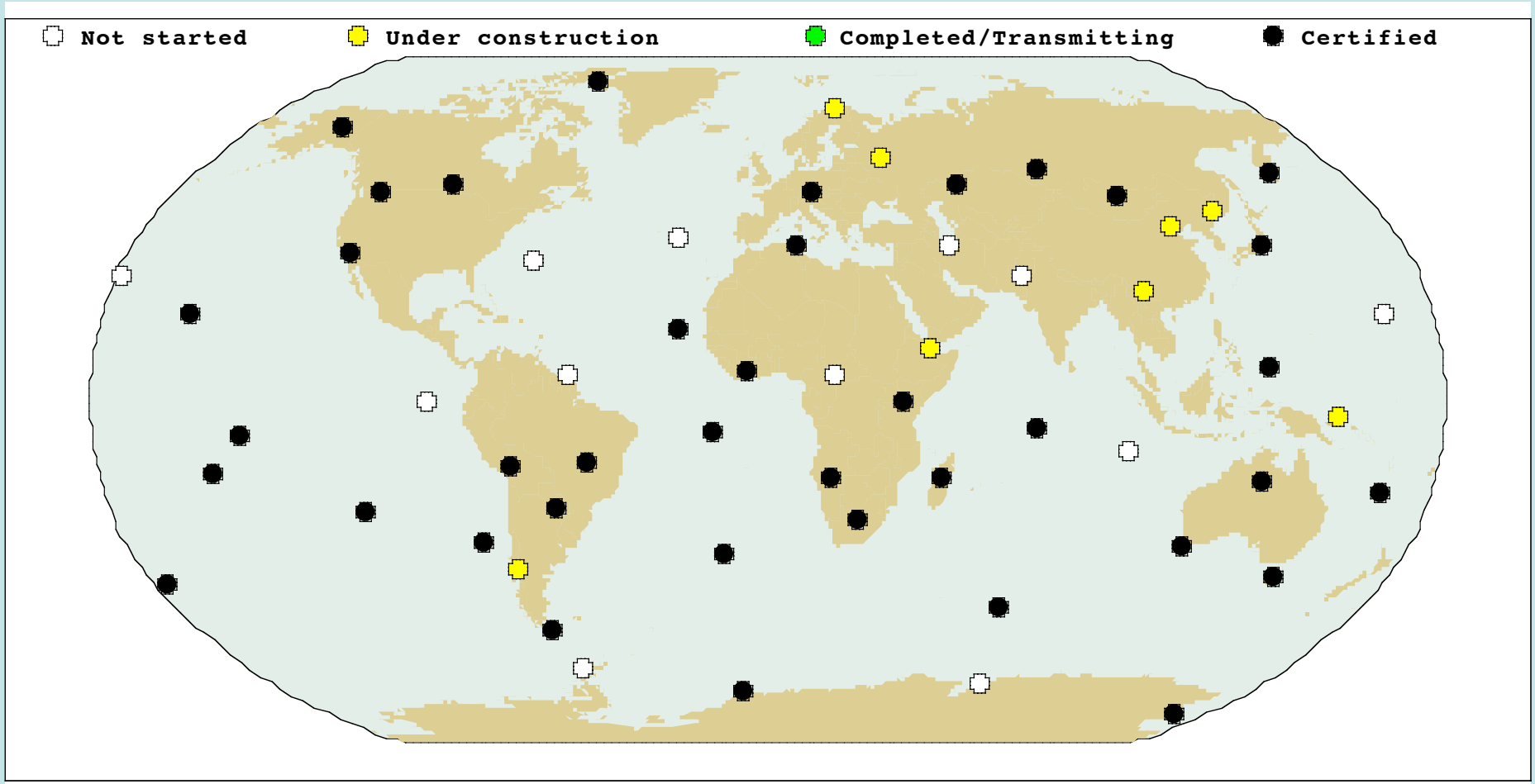
7 array stations
112 three component stations
1 to be determined (location and type)
82 certified

29 IRIS-USGS/ASL stations shared with IMS
14 IRIS-IDA
28 certified

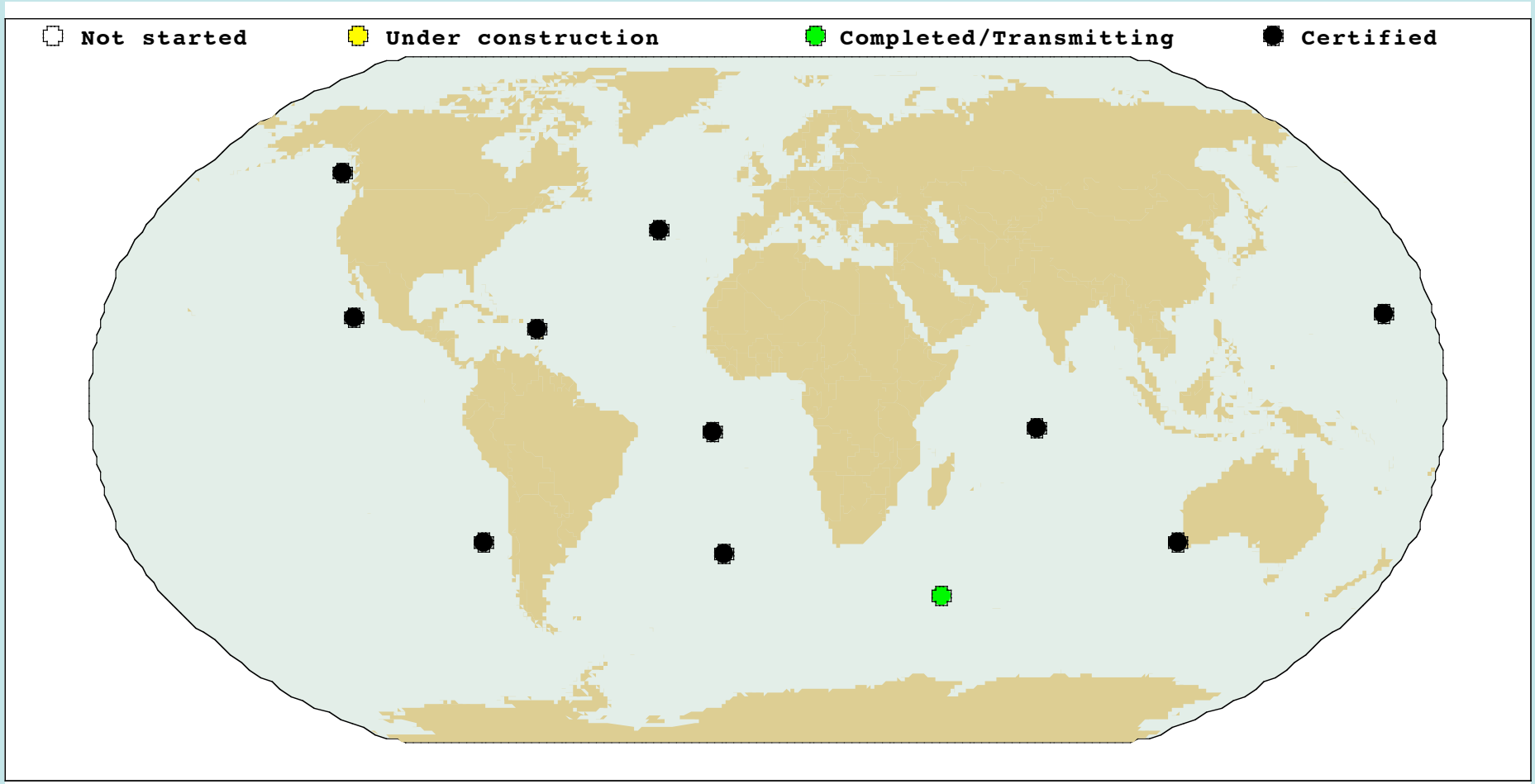
IMS (non FDSN) Equipment

Seismometers		Digitizers	Station Computer	Communication
Guralp CMG-3TB	40 sps Flat vel or accel 50 Hz – 100 sec 2000-20000 V/m/s	Nanometrics Europa T	Solaris/Linux system	VSAT (Psi Sys Corp)
CMG-3T	40 sps Flat vel or accel 50 Hz – 120 sec 1500-20000 V/m/s	Nanometrics HRD	Continuous: CD1 or CD1.1 data format Segmented: Autodrm CM6 or CSF	VPN
Streckeisen STS-2	40 sps Flat vel 50 Hz – 100 sec 2000-20000 V/m/s			

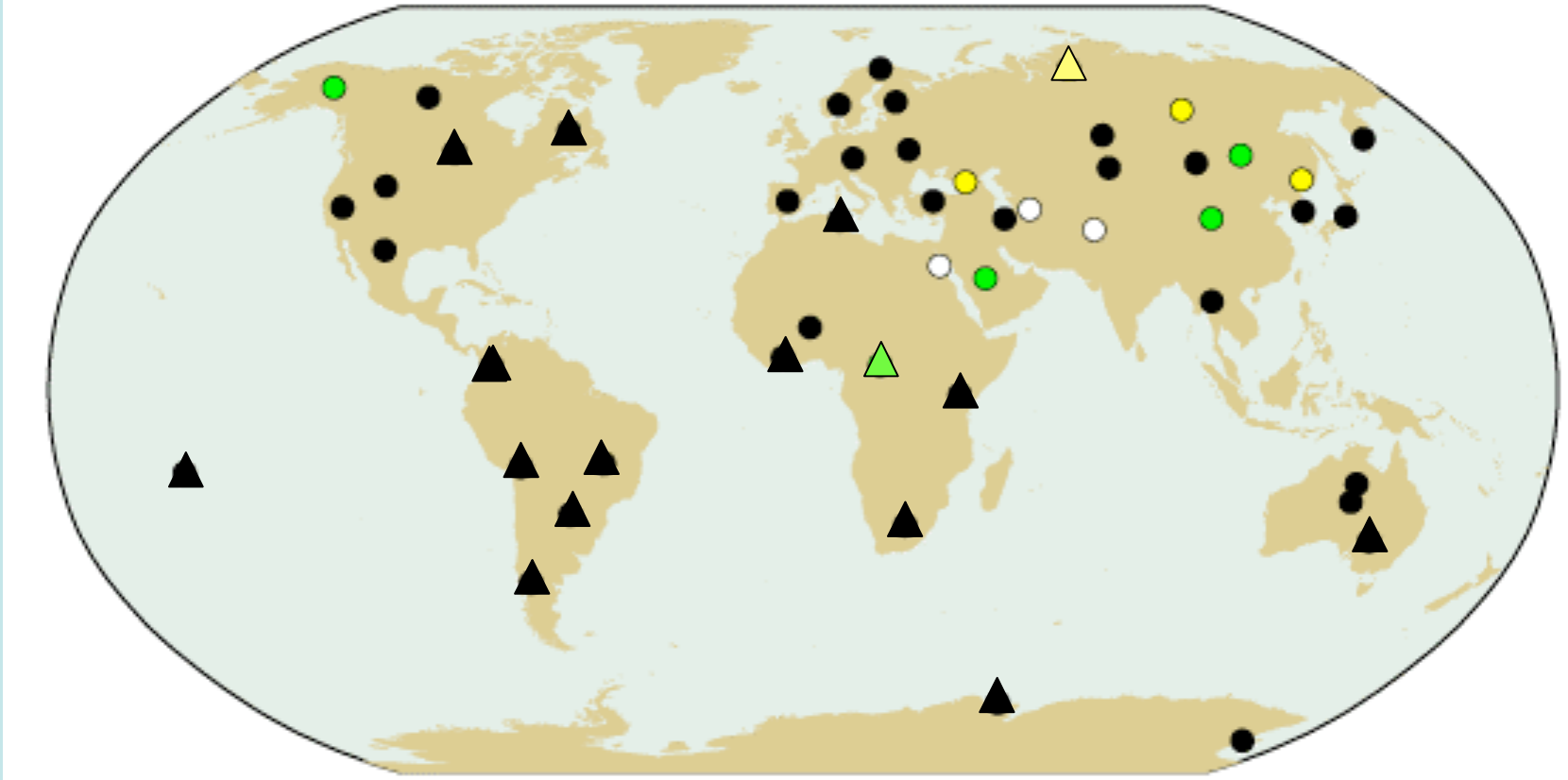
Infrasound Stations



Hydroacoustic Stations



Primary Seismic Network
(50 Stations)



○ Not started (4) ● Under construction (4) ● Completed/Transmitting (5) ● Certified (37)

Circles = Arrays Triangles = 3C station