

# IGS Network Issues 2002-2004

Update Since Ottawa Workshop

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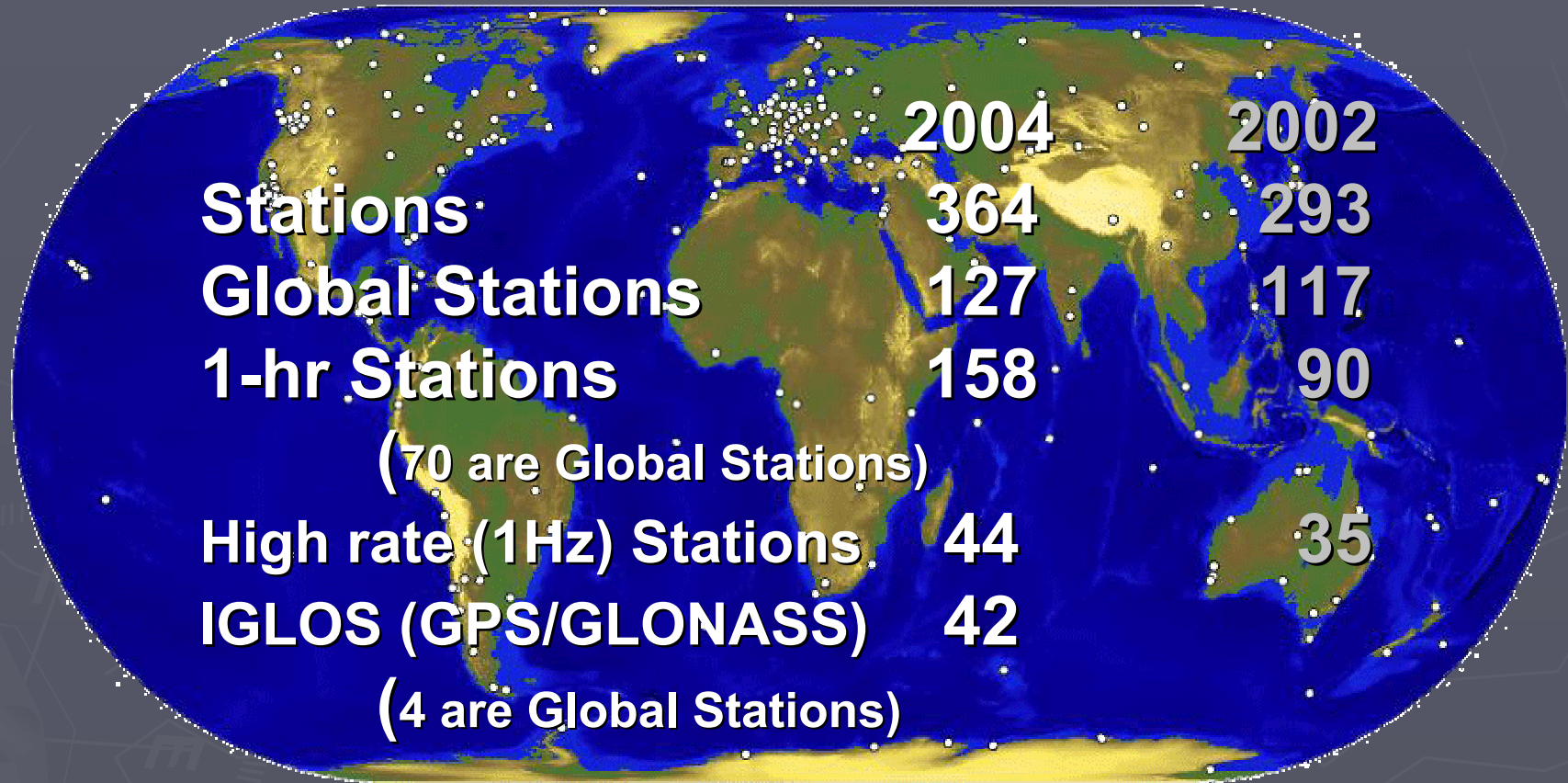
Bern, March 2004

# IGS Network: Progress 2002-2004

- ▶ Network Status 2004
- ▶ Five Principal Recommendations from Ottawa:
  - GPS / GNSS Modernization
  - Associate Regional Networks
  - Instrumentation / Site Changes
  - Data Exchange Format and Industrial Relations
  - Station Metrics
- ▶ Summary



# IGS Network 2004



## *Global Station:*

- IGS Stations which are analyzed by at least three IGS Analysis Centers for the purpose of orbit generation*
- At least one of the Analysis Centers lies on a different continent than the station considered*



# IGS Network: New Sites 2002-2004

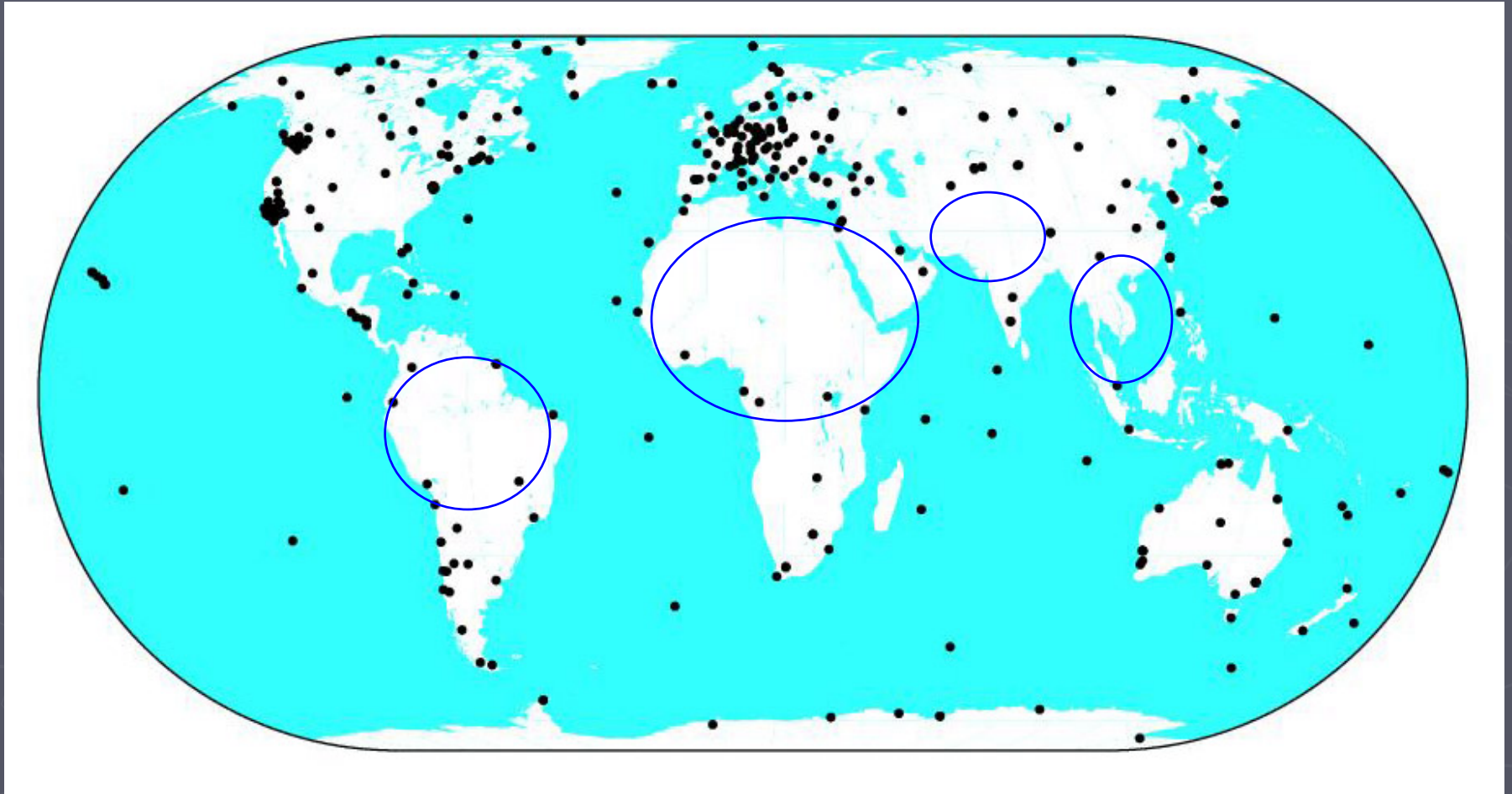


- GPS
- IGLOS



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# IGS Network 2004



# Ottawa: GPS / GNSS Modernization (1)

- ▶ The IGS must assess the implications of GPS modernization and new GNSS technologies on the delivery of IGS products;
- ▶ Based on this, the IGS must consider the optimal means for ensuring a seamless transition to the modernized system(s).
- ▶ 2002:
  - first Block IIR-M launch date as 2003
  - first Block IIF launch date as 2005
  - By 2011 the GPS constellation will have 28 satellites with full L2C capability of which 18 satellites will have L5

.../2



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# GPS / GNSS Modernization (2)

## ▶ 2004:

- First Block IIR-M (L2C) launch date as 2004-2005 (?)
  - 'Spaceflight Now' reports December 2004
- First Block IIF (L2C + L5) launch date as 2009, 2010, ??
- Full L2C / L5 Capability ??
- Galileo first launch 2006(?) – operational 2008 (??)
- Full GLONASS ??
- More on Wednesday

## ▶ Implications for IGS?

- What are the implications for the IGS Network in terms of the new GNSS satellite signal(s)?
- Should the IGS set targets for the upgrade of current IGS stations to handle new signals wrt:
  - Timeframe;
  - Coverage (IGS 'Global Stations', 1 hour sites, real time sites);
- Seamless Transition to new Signals

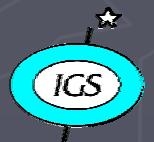
## ▶ International GNSS Service (?)

## ▶ IGS GNSS Working Group (Thursday Morning)



# Ottawa: Associate Regional Networks (1)

- ▶ The IGS should consider the concept of Associate Regional Networks (ARN) for those areas where
  - agencies operate stations that meet the IGS criteria
  - station density is greater than that required by the IGS
- ▶ Data from ARN stations that are required globally would continue to be submitted to IGS data centres
- ▶ Issues leading to this:
  - Is the current distribution of IGS stations (GPS and GLONASS) sufficient to meet requirements for reference frame, final, rapid and ultra-rapid products, etc.?
  - What is the optimal distribution of IGS stations required to meet IGS Product Stream?
    - ▶ How many of these have to be IGS 'Global Stations'?





## Associate Regional Networks (2)

- ▶ IGS has to determine the requirements for station distribution world-wide to meet the requirements to produce the IGS products and data streams
  - Address the issue of stations which are part of regional networks and / or are redundant to primary IGS objectives
  - Adequate coverage in many (but not all) areas of the world
  - Certain amount of redundancy is desirable / necessary to ensure a robust network and thus products
  - Adding new stations in areas of the world with dense station coverage may be confusing and redundant
- ▶ The IGS must somehow balance the conflicting goals of inclusivity and providing a globally relevant and high quality data / product set
  - IGS values its inclusive and voluntary nature
  - Up to now, has accepted any proposed station meeting the technical requirements. (Mutual benefits to both host agencies and IGS)
  - ARN seen as a way to continue inclusive nature of IGS at a Network vs. a station level
- ▶ See Berne Network Issues PP for more discussion and other proposals
- ▶ Strongly recommend that the issue of station density / coverage be resolved



# Ottawa: Instrumentation / Site Changes (1)

- ▶ In order to minimize jumps at Reference Frame Stations, a set of best practices is encouraged including clear guidelines for equipment and site changes
- ▶ Any change in site coordinates whether due to instrument changes, seismic activity or other factors should be carefully noted and published
- ▶ New Guidelines
  - New set of station Guidelines (Sept. 2003) are available at: <http://igscb.jpl.nasa.gov/network/.guidelines/guidelines.html>
  - Spearheaded by NC, reviewed by experts within the IGS
  - Approved by Governing Board
  - Living Document (see also Bern Networks PP)
  - NB New version to be published on www pending updates after Bern meeting (draft on line since fall 2003)



# Instrumentation / Site Changes (2)

<http://igscb.jpl.nasa.gov/network/guidelines/guidelines.html>

## New Guidelines (cont.)

- Introduction and how to use this document
- 2. For all IGS sites
- 3. Future site planning, and additional physical characteristics of the highest geodetic quality sites
- 4. IGS Reference Frame Sites
- 5. IGS sites submitting hourly data
- 6. IGS sites submitting LEO Pilot Project (LEO-PP) (15min/1Hz) data
- 7. IGS sites with GPS/GLONASS receivers
- 8. IGS sites submitting meteorological data
- 9. IGS sites participating in the Tide Gauge Benchmark Monitoring Project (TIGA-PP)



# Instrumentation / Site Changes (3)

- ▶ New Log File Format
  - Implemented
- ▶ On-Line monumentation info
  - <http://igscb.jpl.nasa.gov/network/monumentation.html>
- ▶ Change in site coordinates due to instrument changes, seismic activity or other factors should be carefully noted and published
  - Change in coordinates is analysis dependent so publication of an “absolute value” may be difficult
  - AC’s encouraged to develop a system of feedback to site operators
  - Discontinuities as determined by IGS AC could be published on IGS web site in collaboration with site operator and NC
    - ▶ To be Resolved (see proposals in Reference Frame PP)



# Communicating Change in Site Coordinates

► Ch

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AC res

Wk

1230

1231

1232

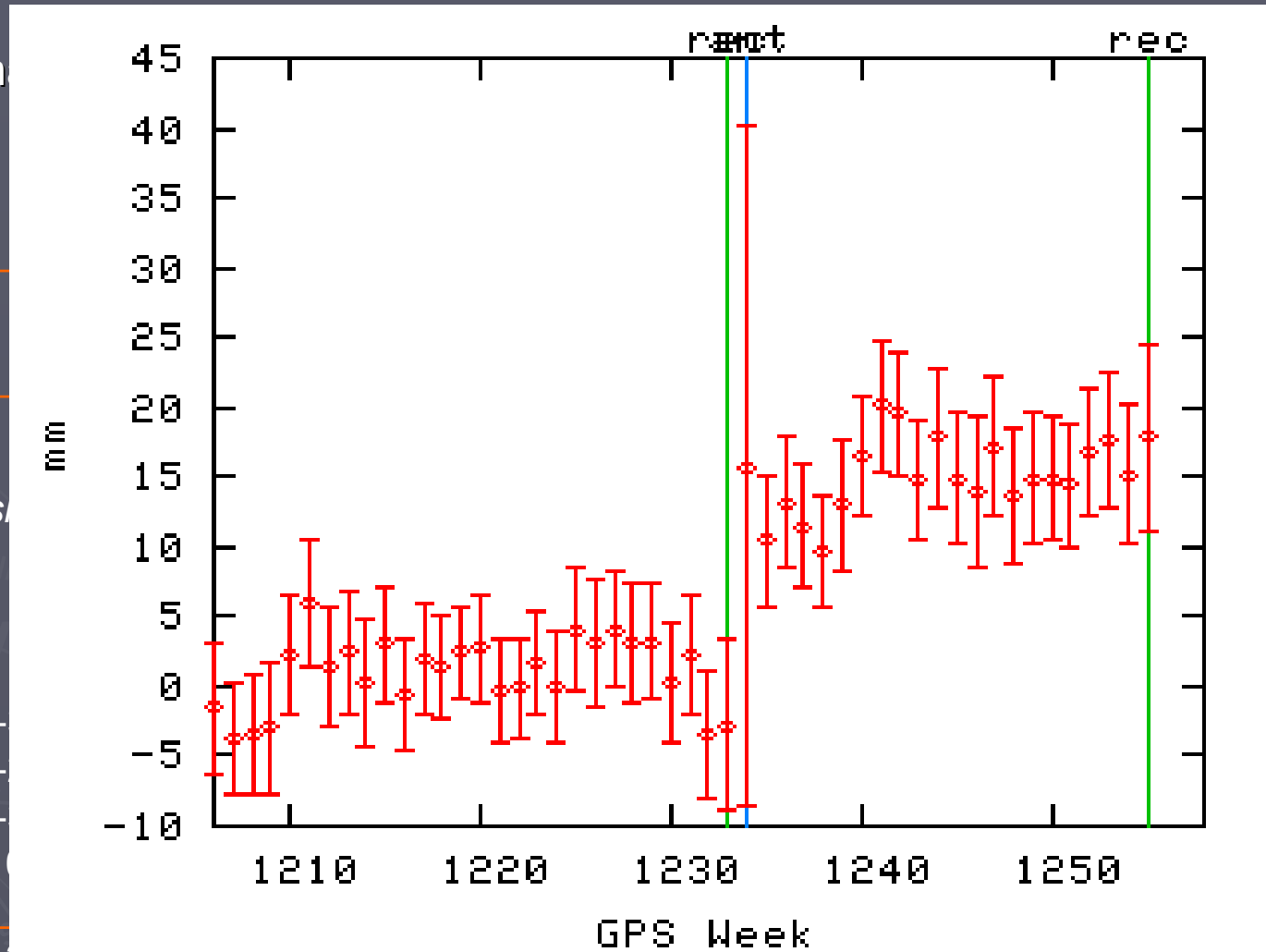
1233

1234

1235

1236

1237



1233-2

1233-4

1234-3

1234-5

1235-1

1235-3

230-1237

: Clear  
Discontinuity

Wk 1234;  
+'ve trend

No apparent  
change;  
-'ve trend

	5.0	9.2	-1.4	17.7	1.7	7.7	10.4	15.5	-4.2	5.5
1235	5.0	9.2	-1.4	17.7	1.7	7.7	10.4	15.5	-4.2	5.5
1236	4.9	8.6	-11.1	24.7	3.4	8.1	7.5	15.7	-5.1	5.3
1237	6.2	8.3	-6.5	12.7	1.3	8.2	-3.2	15.3		



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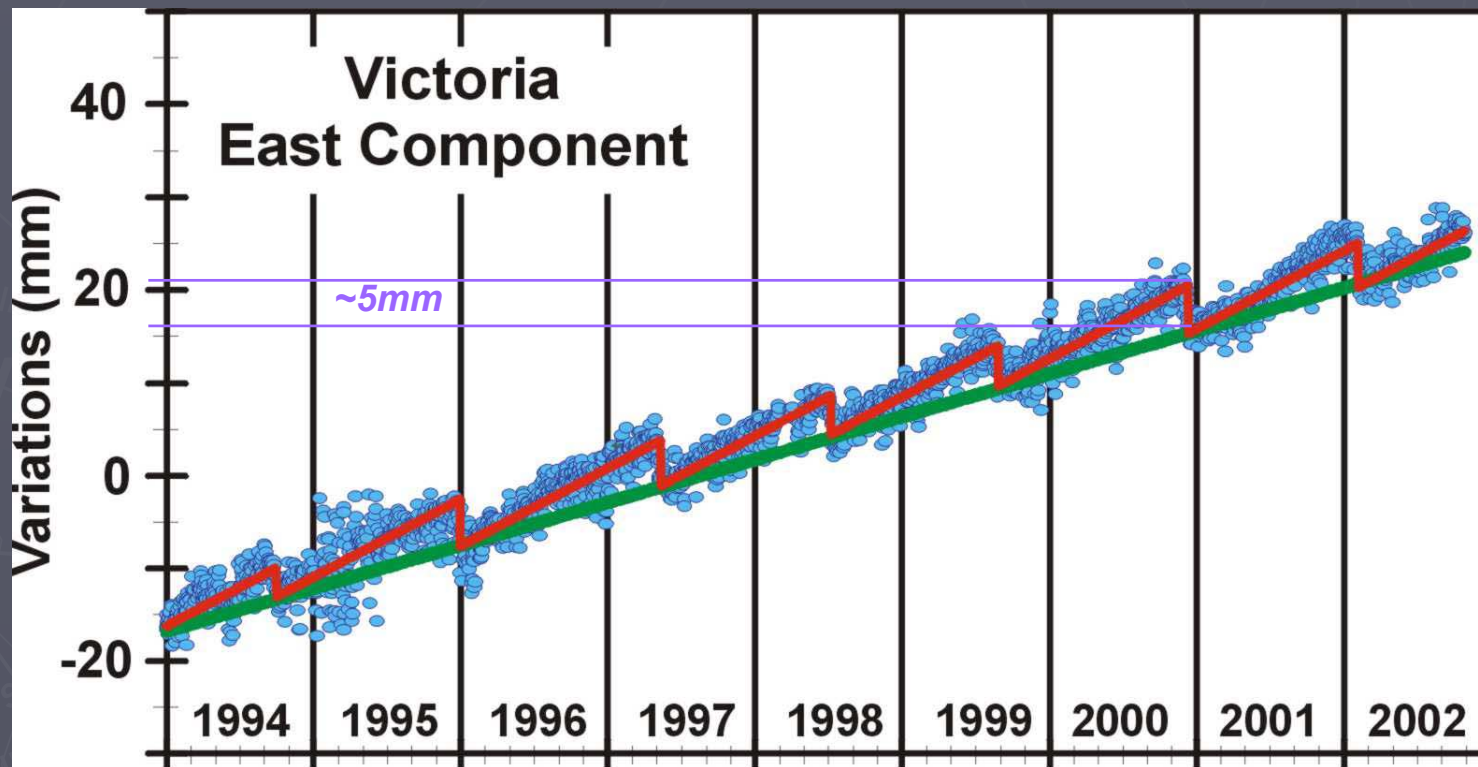
How do we derive an offset value to be communicated?

# Temporal Changes

## Example: Episodic Slip and Tremor (EST)

Long-term linear trend  
(gradual eastward motion)

Segment trend with steps  
(accelerated eastward motion  
followed by brief reversal)



(Dragert et al, 2003)

Periodicity ~14mths Duration: up to ~14days



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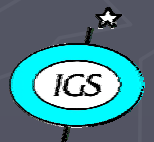
# Ottawa: Data Exchange Format and Industrial Relations

- ▶ The IGS should establish a joint Task Force with GPS manufacturers to:
  - coordinate the evolution and international acceptance of the RINEX format
  - encourage standardization of meta-data nomenclature
  - coordinate any future data exchange formats
- ▶ Started – to be completed



# Ottawa: Station Metrics

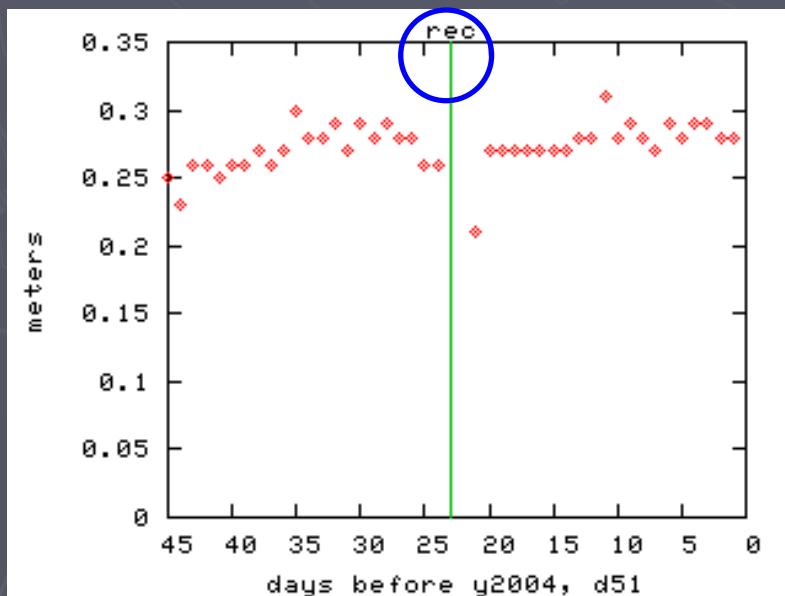
- ▶ The IGS should examine the current station performance metrics and determine required changes;
- ▶ Consider efficient methods of compiling and communicating station events or periods which may challenge present and future users' analysis;
  - Unresolved (analysis dependence is also an issue here)
  - see Reference Frame PP
- ▶ Determine ways to improve any deficiencies in communicating station quality issues between AC's, the Coordinators (ACC, Ref. Fm. Coordinator, and NC), station operators, and outside users.
  - Unresolved



# Station Metrics (2)

## Station Quality Plots

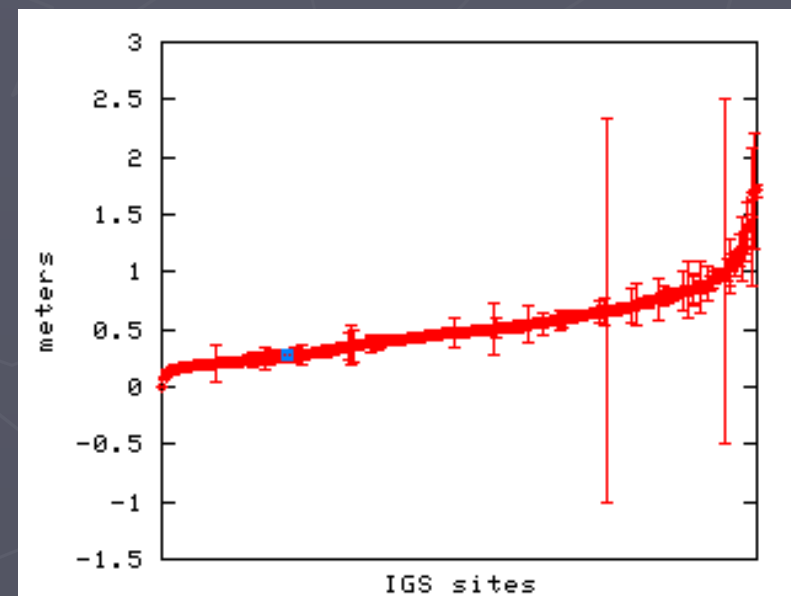
Recent daily number of observations  
Recent cycle slips X1000/observations  
Recent RMS MP1 (L1 Multipath)  
Recent RMS MP2 (L2 Multipath)



from TEQC

## IGS 45 Day Network Averages

Daily number of observations  
Cycle slips X1000/observations  
RMS MP1 (L1 Multipath)  
RMS MP2 (L2 Multipath)



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# Station Metrics (3)

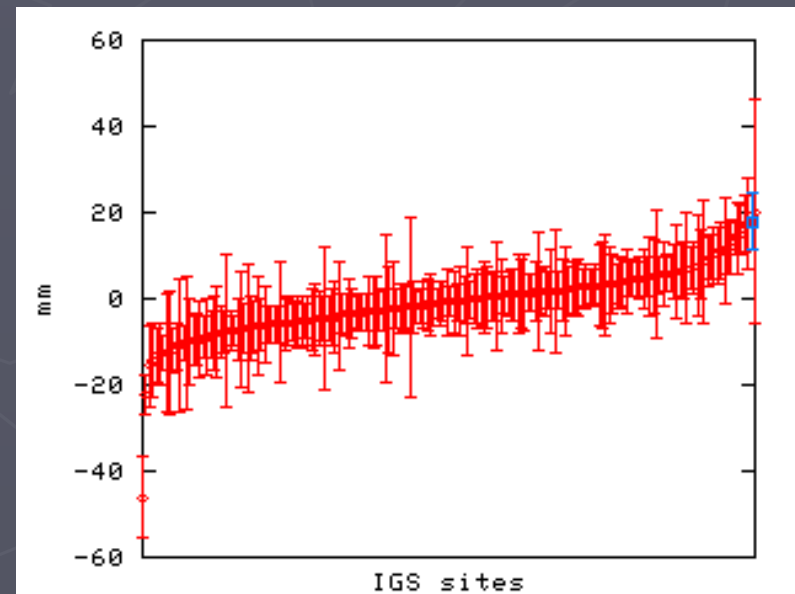
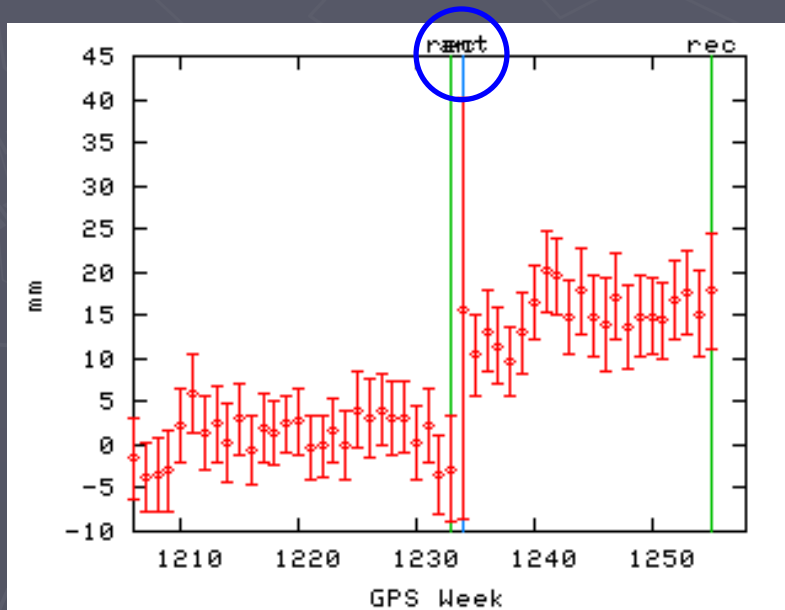
Position Residuals (Cumulative Minus Weekly) for the Past Year

Most Recent Week SITE in Blue all Other IGS Sites in Red

North Residuals  
East Residuals  
Height Residuals

North Residuals  
East Residuals  
Height Residuals

*Wk 1234: Receiver, Antenna, Dome, RF Screen changed*



from SINEX Combination



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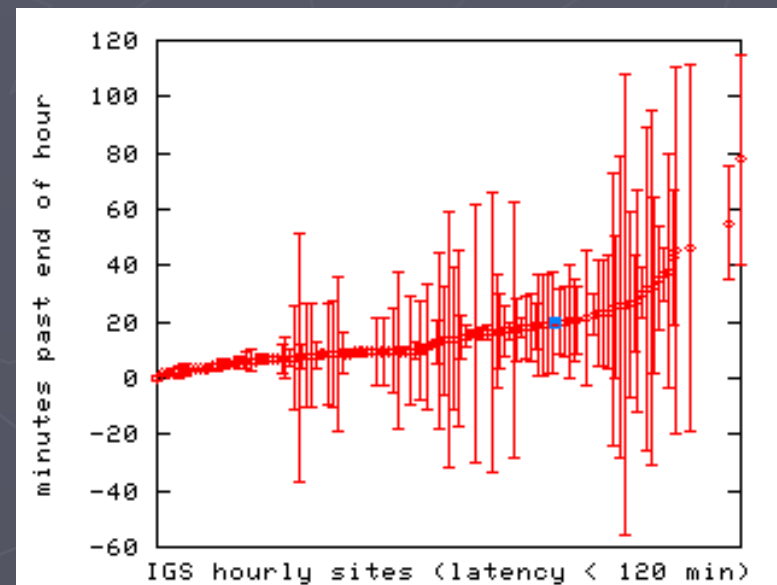
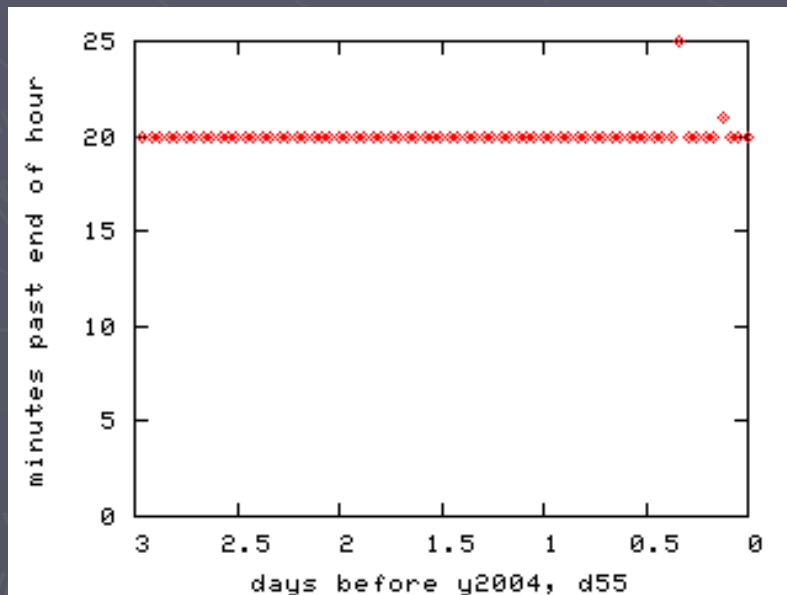
# Station Metrics (3)

File submission Latency: SITE

Latency IGS SITE in Blue all Other IGS Sites in Red

24 hr File Latency  
1 hr File Latency

24 hr File Latency IGS  
1 hr File Latency IGS



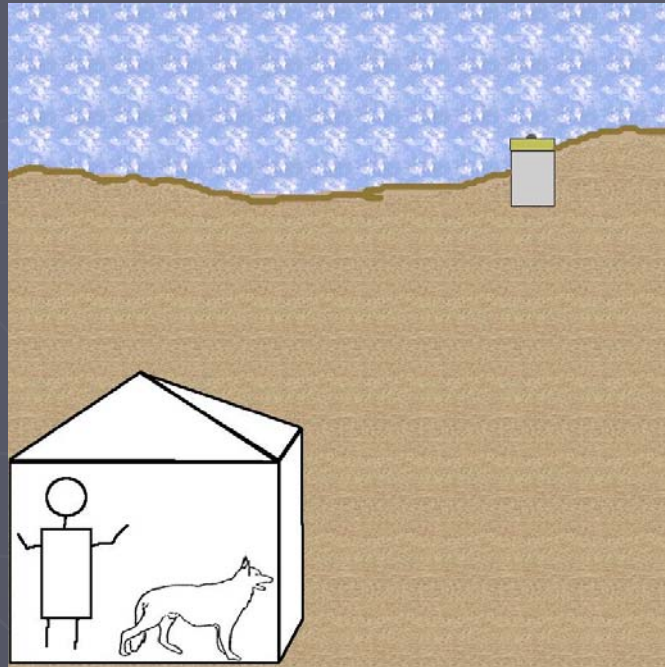
# Summary

- ▶ Number of IGS stations has increased
  - Necessary to resolve required station density / coverage and thus “core sites” in order to produce reliable high quality data / products
- ▶ Station Metrics vastly improved
- ▶ IGS Guidelines approved / implemented (living document)
- ▶ New Station Log format
- ▶ Monumentation Info on-line
- ▶ Still some issues to address (see Berne PP)
- ▶ Overall: Good Progress





The IGS Reference Frame site of the future:  
The equipment's job is to collect the data.  
The person's job is to feed the dog.  
The dog's job is to bite the person if he tries to touch the equipment.

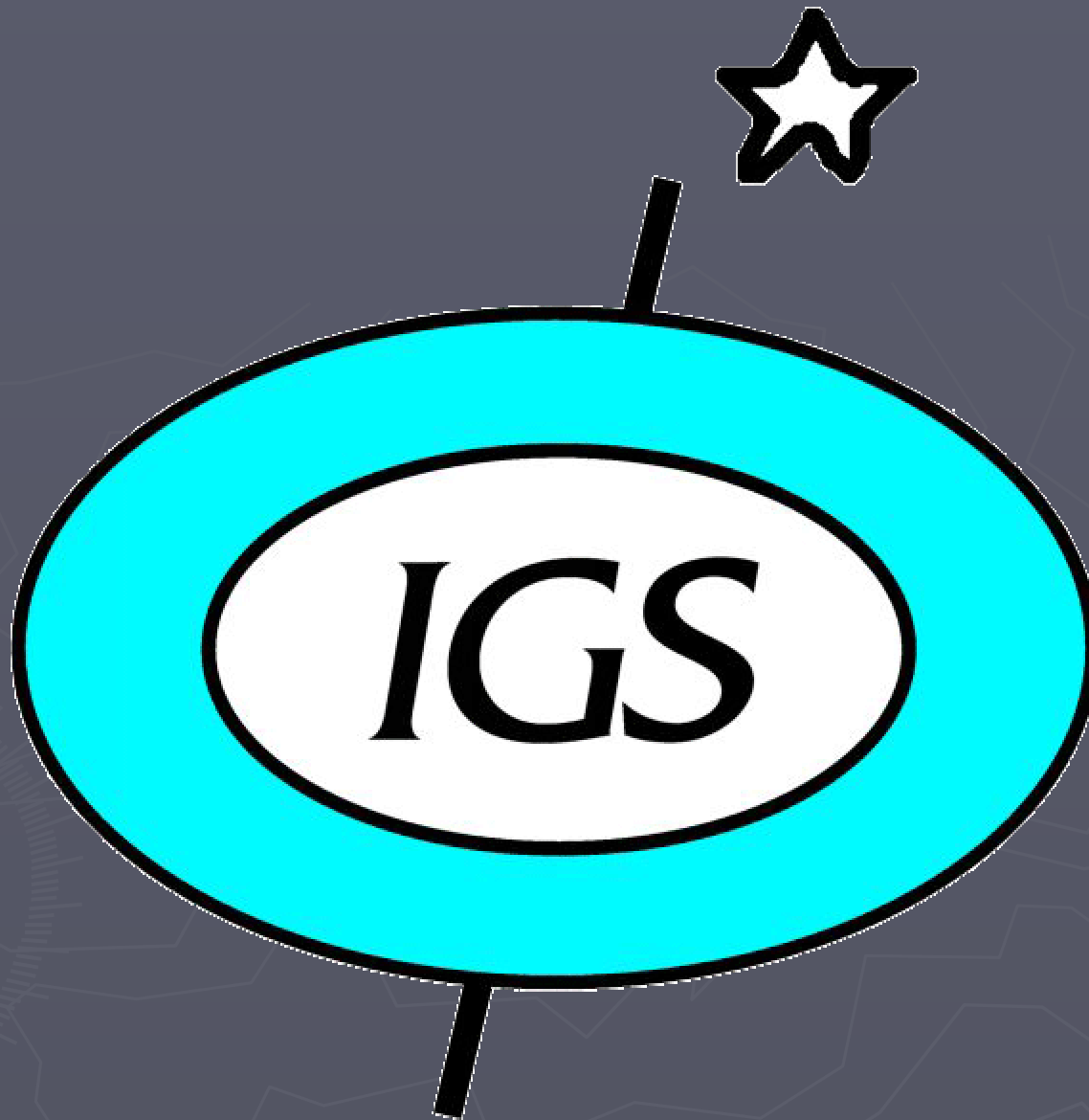


Inspector Clouseau "Does your dog bite?"  
Hotel Clerk "No."  
Dog "Grrr, snarl, snap."  
Clouseau "I thought you said your dog does not bite."  
Clerk "That is not my dog"

*from Peter Sellers' : The Pink Panther Strikes Again*



1994



2004

# Slides not used



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# Communicating Station Quality Issues - summary

- ▶ compiling and communicating station events or periods which may challenge present and future users' analysis;
  - Unresolved:
    - ▶ determine robust method to detect and log apparent changes at sites
    - ▶ determine which IGS sites will be scrutinized to this level (presumably the IGS does not have the means to check all sites)
    - ▶ short term: the AC's should put a watch on any site with an announced change (instrumentation, seismic event, other)
- ▶ improve any deficiencies in communicating station quality issues between AC's, the Coordinators (ACC, Ref. Fm. Coordinator, and NC), station operators, and outside users.
  - Unresolved:
    - ▶ important to consult with station operators in order that
      - the apparent discontinuity is confirmed and the correct information is logged;
      - feedback loop is established to improve overall network operations (mutually beneficial to operators and network)



# Communicating Station Quality Issues (1)

## ► Changes at ALBH Wk 1233-1235:

- 2003-08-26: Receiver changed 1233-2
- 2003-08-28: Receiver disconnected from Maser; on internal clock; 1233-4
- 2003-09-03: RG-214 cable replaced by Andrews FSJ-2-50 cable; 1234-3
- 2003-09-05: Antenna replaced; dome replaced, RF screen removed; 1234-5
- 2003-09-08: New RF screen added; 1235-1
- 2003-09-10: Receiver connected to Maser; 1235-3

1) Do the AC's look for offsets at time of equipment changes?

*Apparently there is no routine check*

2) In the case of an offset is an advisory warranted and if so:

- *when, i.e. how soon after the change? (this information may not be available until several days after the change)*
- *what should the advisory indicate:*

*(a) amount of offset - which is dependent on analysis method,*

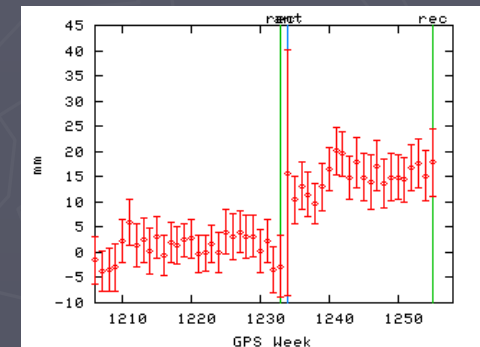
*No. of AC's processing site, Reference Frame issues, etc.*

► *therefore not a "calibrated" offset*

*(b) flag the existence of an offset?*

- *how are short / temporal offsets (e.g. due to snow / ice, EST, etc.) handled?*

*etc.*



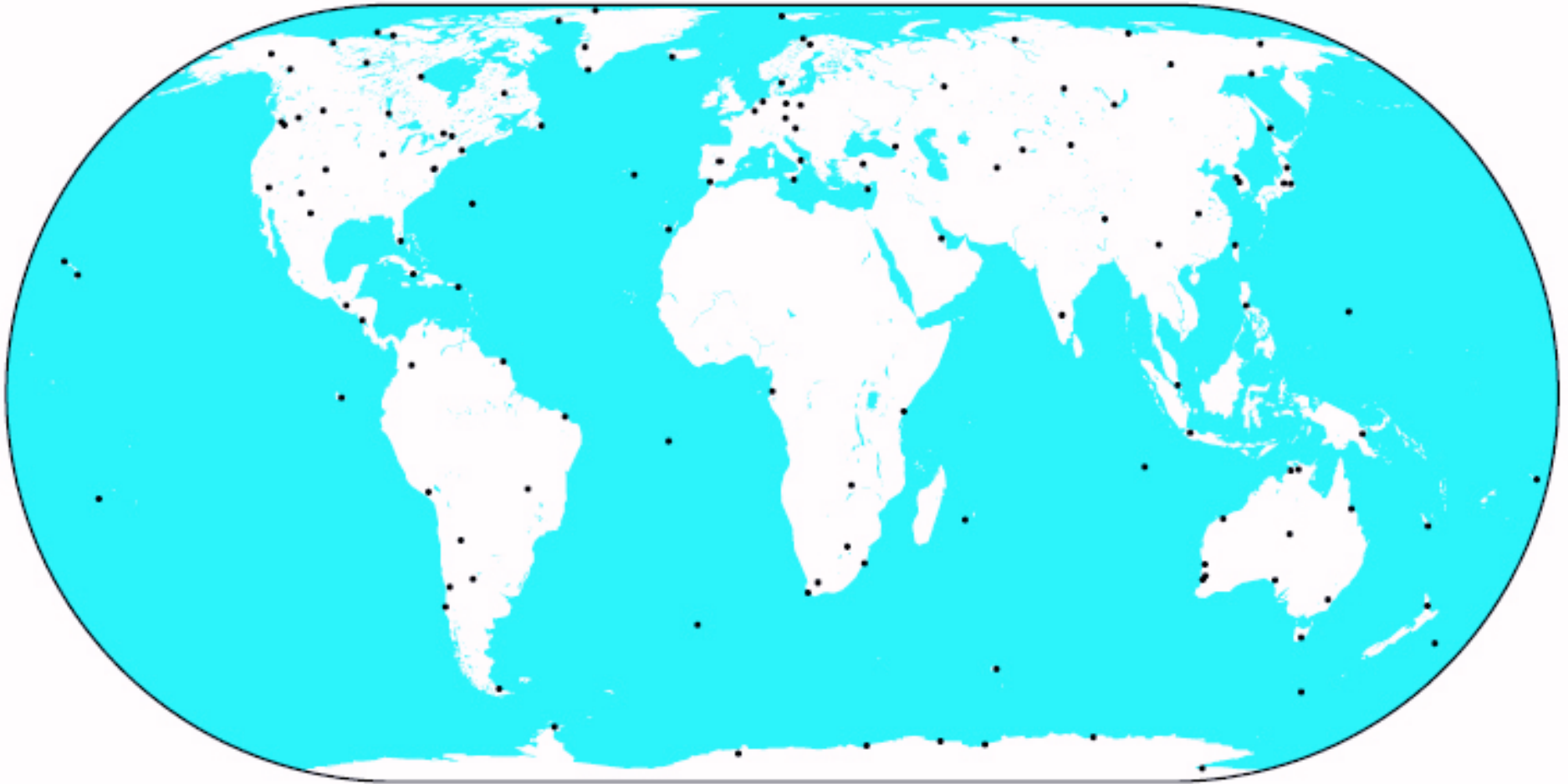
# Global Sites 2002



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# Global Sites 2004



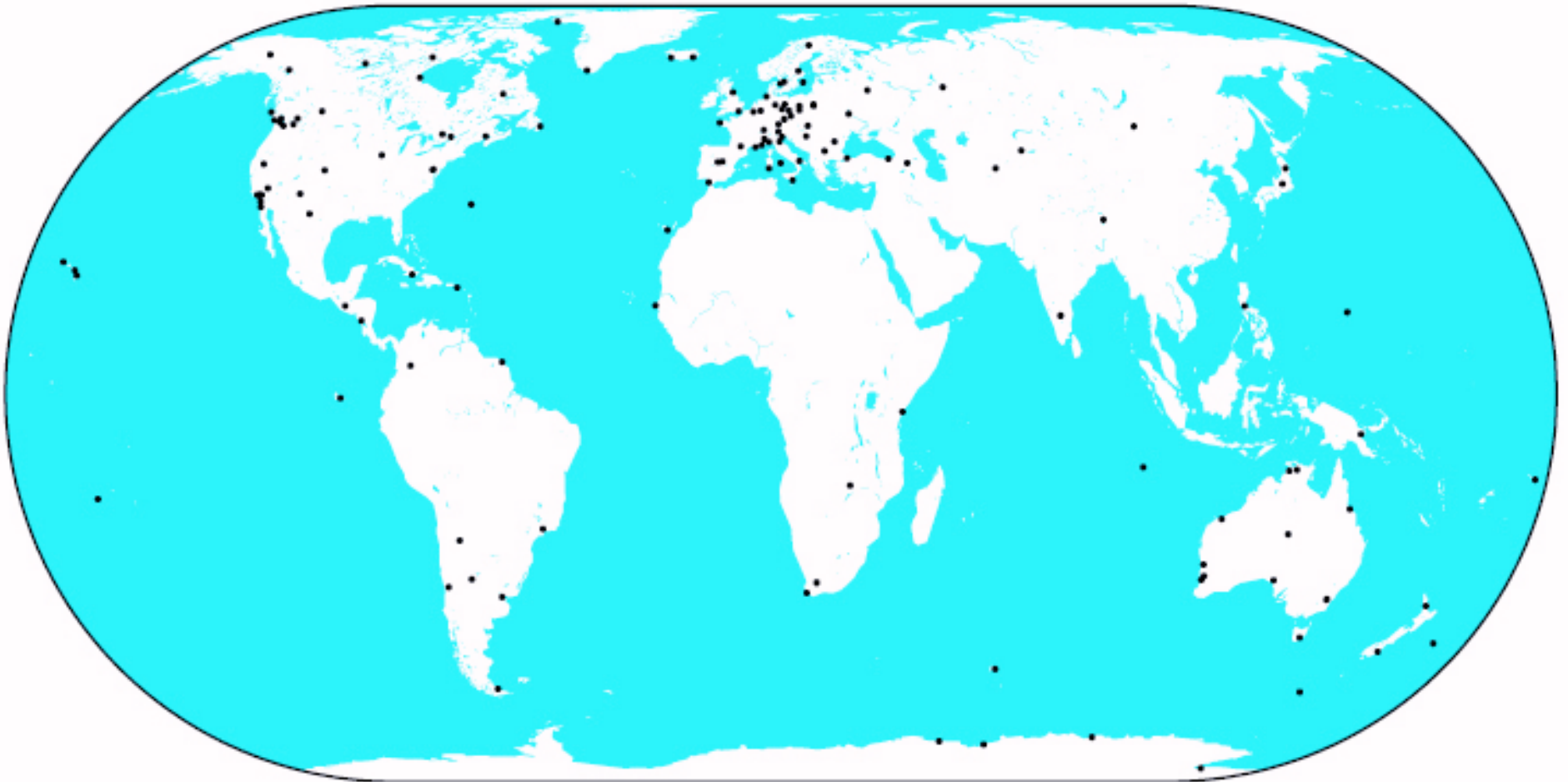
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# 1 Hour Sites 2004



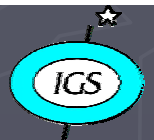
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# 1 Hour Sites 2004



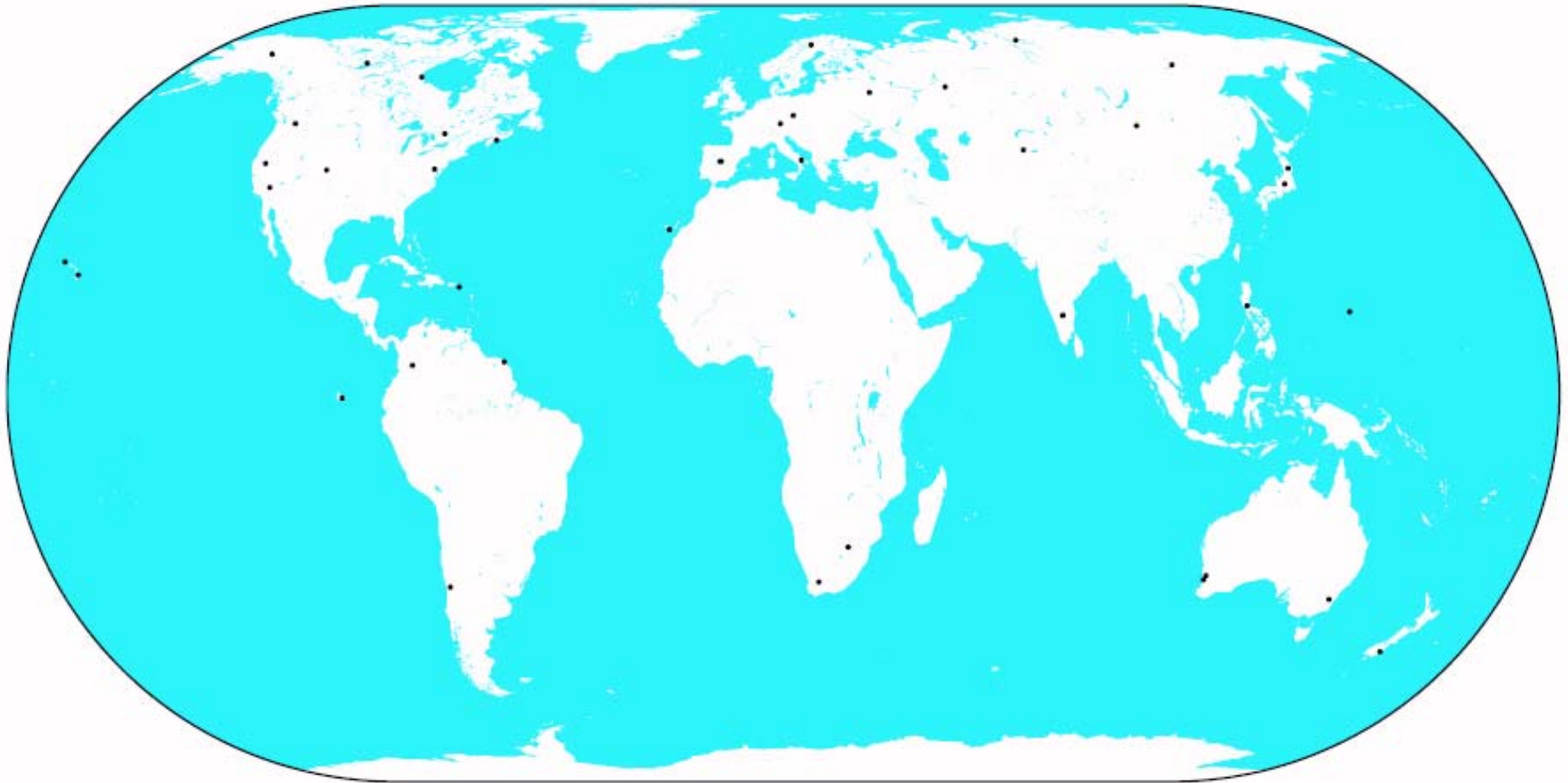
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# 1Hz 15 min Sites 2002



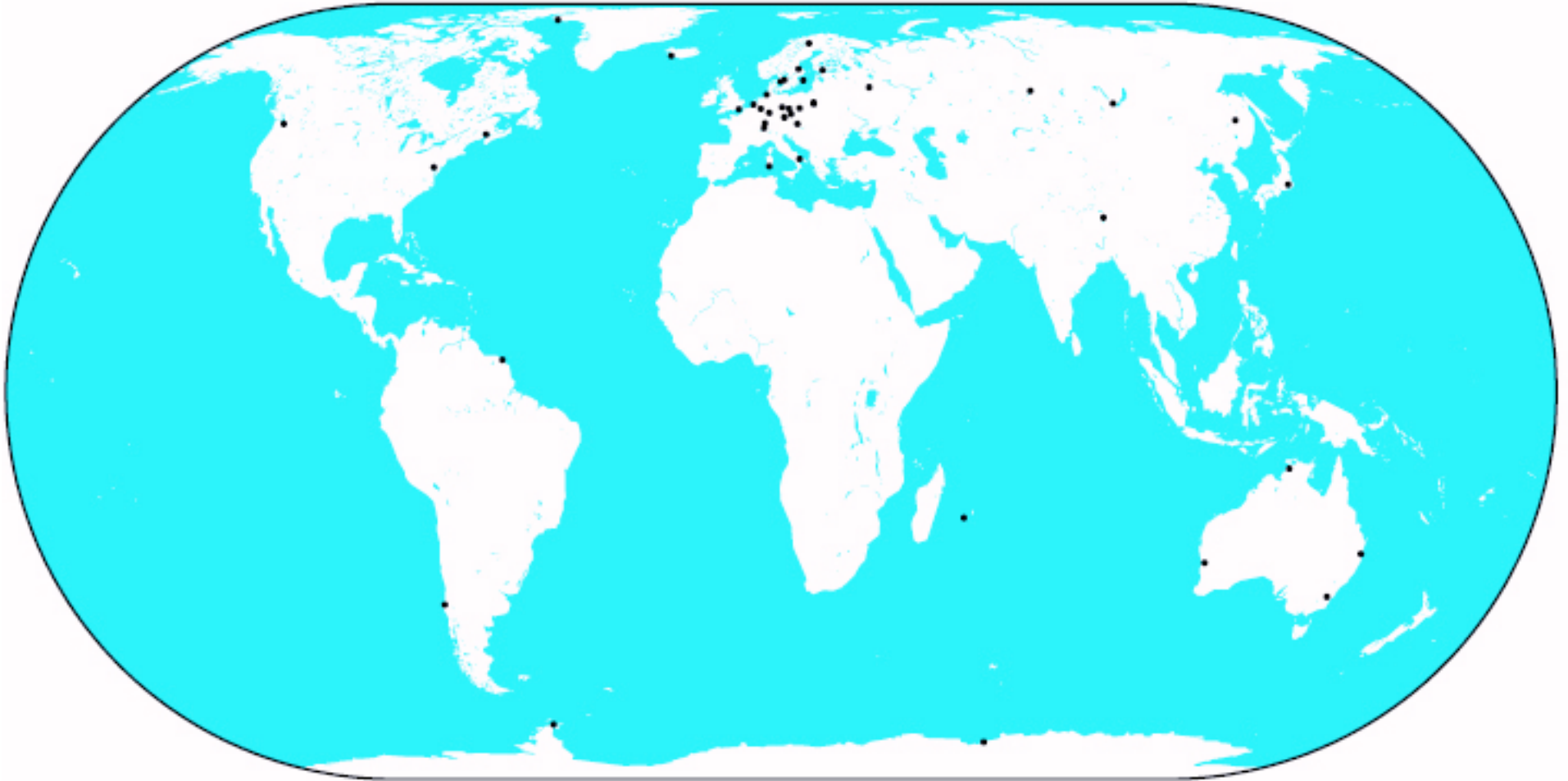
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# 1Hz 15 min Sites 2004



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# IGLOS Sites 2004



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