IGS

SESSION 10:

WORKING GROUP REPORTS

International GLONASS Service – Pilot Project Status
March 31, 2002

James A. Slater, Chair
IGLOS Pilot Project Committee

1. GLONASS CONSTELLATION STATUS

Between January 1 and March 31, 2002, there were 6-7 healthy, operational GLONASS satellites. They are all in planes 1 and 3 of the constellation. The first new GLONASS-M satellite, GLONASS No. 711 in Plane 1/Slot 5, has not yet been designated as operational. It is not clear what if any problems may have been encountered after launch.

2. TRACKING NETWORK STATUS

A. GLONASS Receivers

The number of "permanent" tracking stations has grown slightly since December 2001. There are now 50 stations in the network, continuously tracking the GLONASS satellites and transmitting their data to the IGS Data Centers. Forty-five or more of these stations have been sending data to the data centers each week. Most of the receivers are Ashtech Z18 or JPS Legacy models. New stations that came on-line during the last three months include:

- Frankfurt, Germany (FFMJ)
- Kourou, French Guyana (KOU1)
- Zimmerwald, Switzerland (ZIMZ)

An updated map of participating stations is included at the end of this report.

B. SLR Tracking

The ILRS has agreed to continue to track three GLONASS satellites as part of their standard tracking protocol. In January 2002, the IGLOS Project Committee requested the ILRS to track two of the satellites in orbit plane 1 and one satellite in plane 3. Unfortunately, the new GLONASS-M satellite in Plane 1/Slot 5 has been set healthy since it was launched, although this does not prevent SLR stations from tracking it.

SLR Observations of GLONASS Satellites
(Jan. 1– Mar. 31, 2002)

Plane-Slot	GLONASS No. (SLR/Russia)	No. of Passes	No. of Normal Pts.	No. of Tracking Sites
1 - 7	80 (786)	417	2,056	22
1 - 6	86 (790)	71	387	14
1 - 3	87 (789)	204	950	20
1 - 5	88 (711)	9	69	3
3 - 24	84 (788)*			

*Although being tracked, the actual no. of passes, normal points and tracking sites for GLONASS 84 as of March 31, 2002 was not clearly defined when this table was produced.

3. ORBIT PROCESSING

BKG, ESA and the Russian Mission Control Center (MCC) continue to compute and make available GLONASS orbits on a routine basis. The MCC orbits are based on SLR data. A combination orbit is produced by Robert Weber, the Analysis Center Coordinator, from the orbits of these three centers.

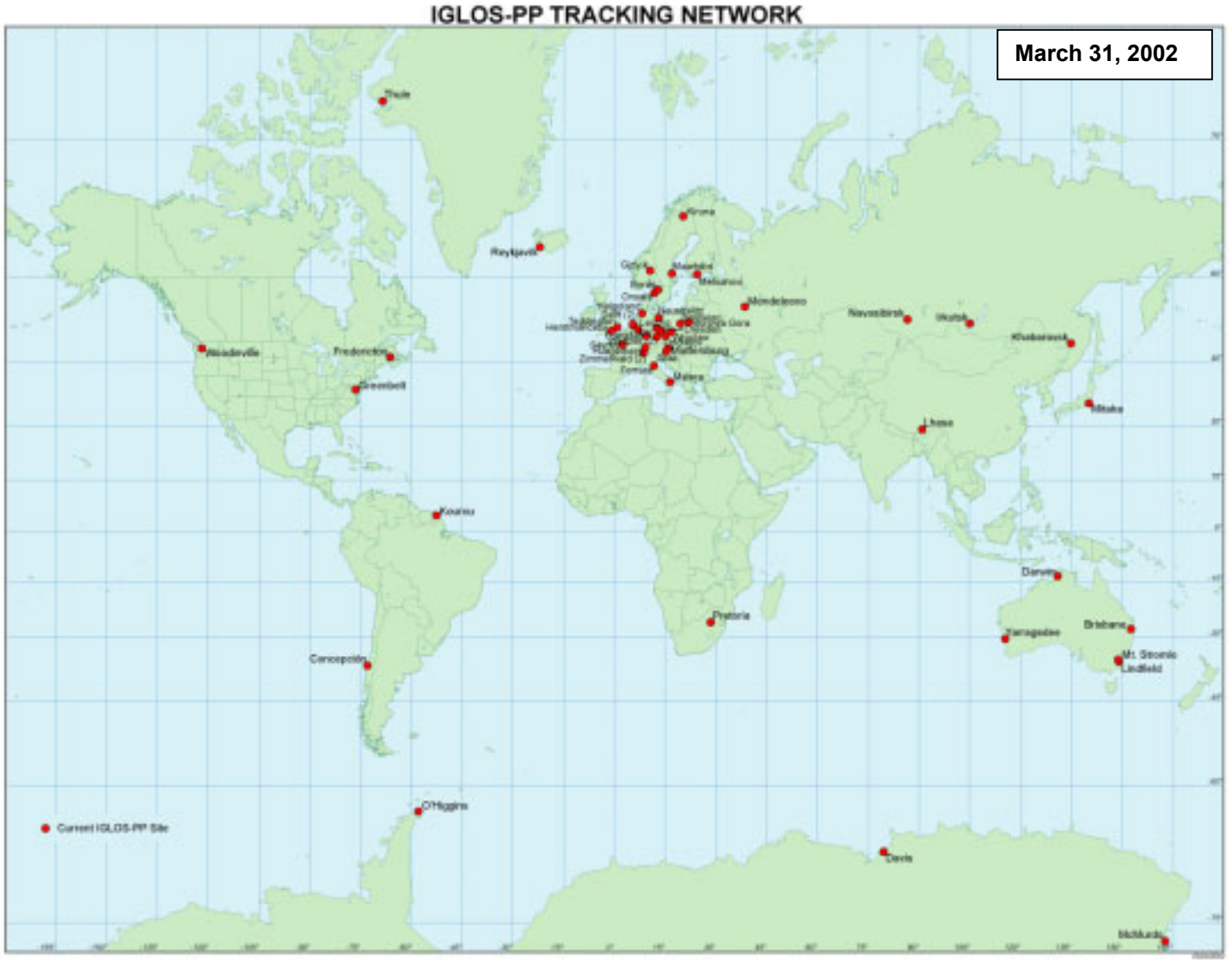
4. USER INFORMATION

In order to identify any users of the IGLOS data products, both Ashtech and Topcon were contacted. According to Ashtech, they are selling few if any Ashtech Z18 receivers and not promoting the receiver any more. The number of receivers sold was so small that they thought it wasn't worth pursuing the owners, as many of them are already IGLOS participants. Attempts to contact Topcon have so far elicited no response, but we will continue to try to get Topcon's help in identifying a user community.

5. INTEGRATION OF IGLOS INTO IGS STANDARD OPERATIONS

In February, the IGS sent letters to all IGLOS participants officially inviting them to become part of the IGS. Procedural instructions were provided so that the IGLOS tracking stations could comply with IGS documentation requirements.

Incorporation of the IGLOS stations requires revised station log forms, some modifications to the Analysis Center processing software, and some adjustments at the global data centers to accommodate GLONASS data mixed in with GPS data. It appears that all is essentially ready to start combined GLONASS-GPS operations.


IGLOS-PP TRACKING NETWORK
March 31, 2002
Thule
Reykjavik
Kiruna
Matera
Novosibirsk
Irkutsk
Khabarovsk
Mizusawa
Lhasa
Fredericton
Greenbelt
Kourou
Concepcion
Pretoria
Darwin
Yaragadee
Brisbane
Mt. Stromlo
Lindfield
O'Higgins
Davis
McMurdo
Current IGLOS-PP Site

IGS Reference Frame Working Group Report

Remi Ferland

02/04/10

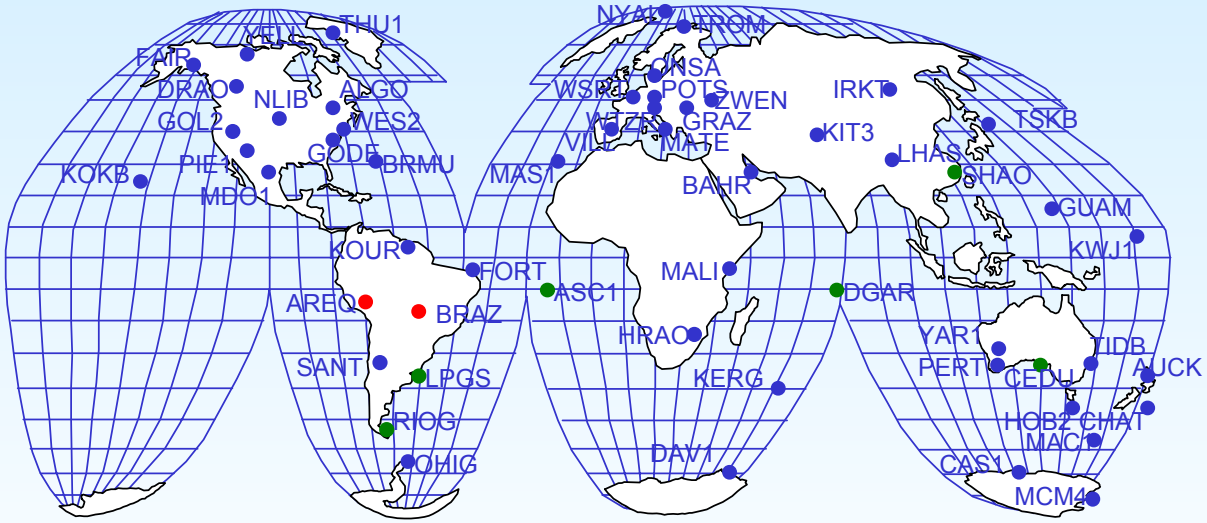
Natural Resources Canada Ressources naturelles Canada

Canada

Summary

- Realisation of ITRF2000
  - Stations / Transformations (IGS97-IGS00)
- SINEX Combination
  - Stations / ERP's / Geocenter
- Contribution to IERS Analysis Campaign
- SINEX V 2.0

IGS Realization of ITRS

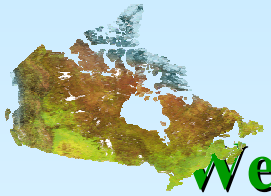


- Tracking Sites used for IGS97 but Removed for IGS00 (2)
- Tracking Sites Added to IGS00 (5)
- Tracking Sites used for IGS97 and IGS00 (49)

IGS00 highlights

- Stations (51 - 2 + 5 = 54)
- Implemented Wk 1143 (01/12/02)
- Transformation IGS00 to IGS97 (1998.0):

Parameter	Units	Estimate	Sigma	Estimate	Sigma
				(-/y)	(-/y)
R X	(mas)	0.04	0.05	0.00	0.04
R Y	(mas)	0.00	0.06	0.00	0.04
R Z	(mas)	0.04	0.04	0.03	0.03
T X	(m)	0.0060	0.0025	-0.0004	0.0017
T Y	(m)	0.0056	0.0033	-0.0008	0.0019
T Z	(m)	-0.0201	0.0051	-0.0015	0.0028
SCL	(ppb)	1.40	0.12	0.01	0.12



Weekly Combination (Wk1157)

ESA - 59/38

GFZ - 86/38

JPL - 73/29

EMR - 41/26

igs - 166/52

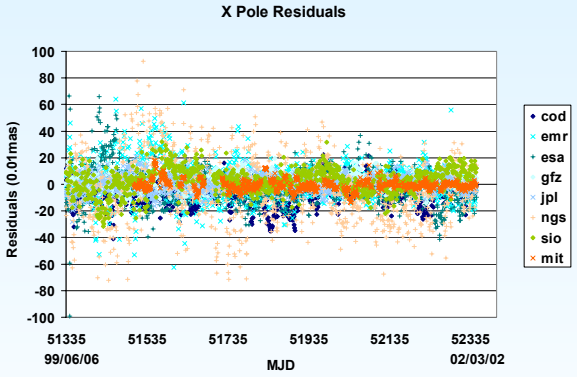
NGS - 74/50

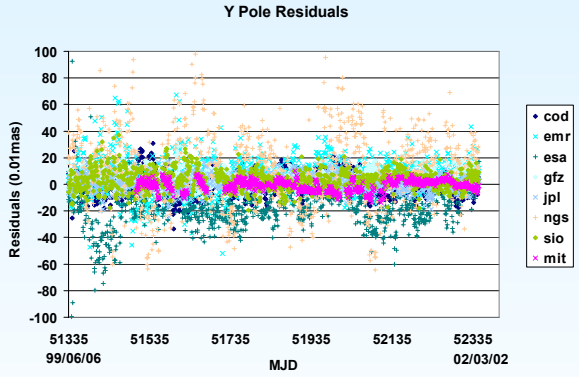
COD - 131/48

IGS - 308/54

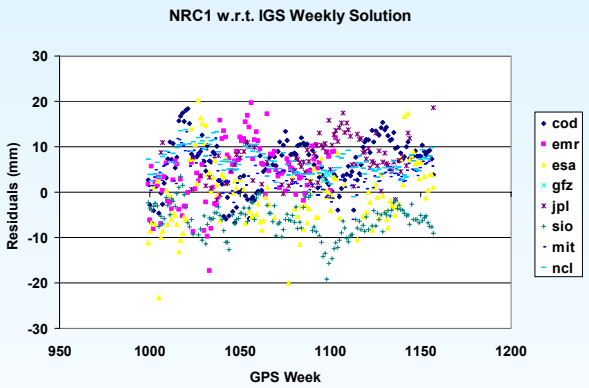
SIO - 131/46

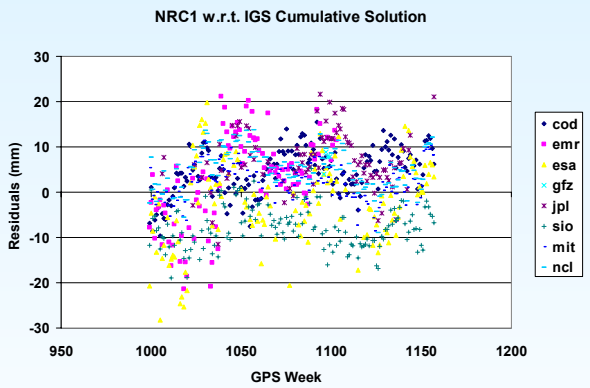
Daily AC & GNAAC
X&Y Pole Residuals w.r.t. igs00P02





AC & GNAAC Height Residuals at NRC1 w.r.t. IGS Weekly & Cumulative



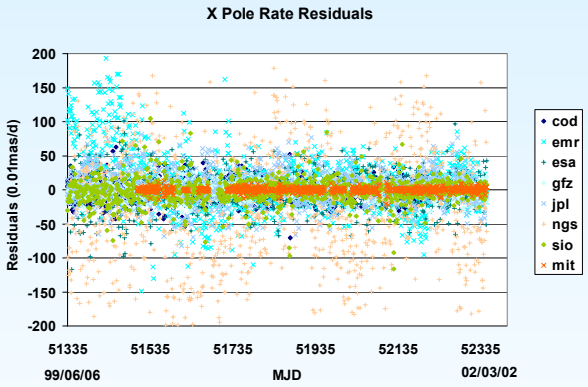


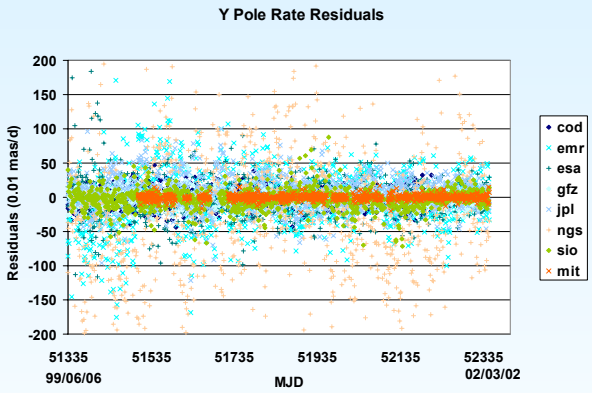
Tabular form of the time series residuals is available at:

ftp macs.geod.nrcan.gc.ca

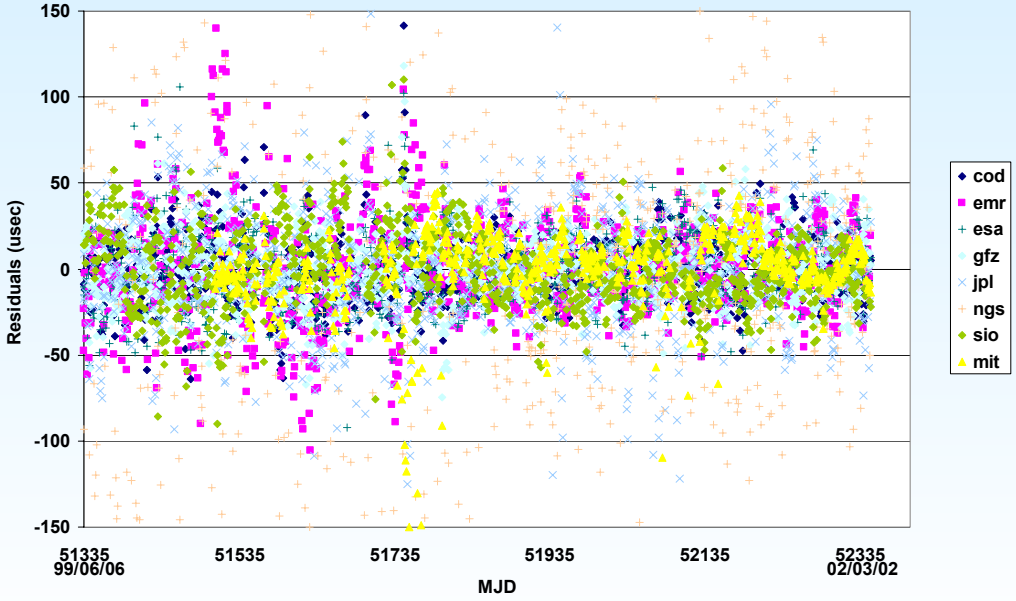
cd /pub/requests/sinex/res

Daily AC & GNAAC
X&Y Pole Rate Residuals w.r.t. igs00P02

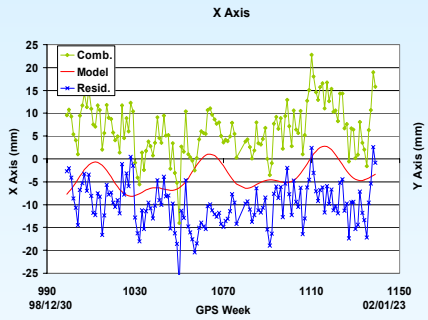


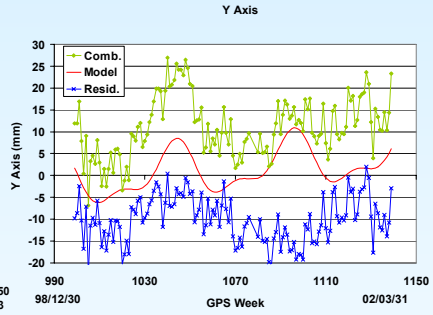


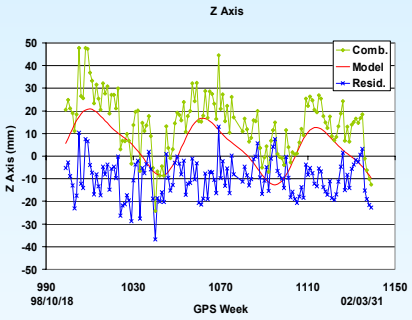
Daily AC & GNAAC LOD Residuals w.r.t. igs00P02



Apparent Geocenter (ITRF2000)







Comb shifted up 10mm
Resid shifted down 10mm

Linear:

Bias(99/02/28) -6.2mm

Drift 1.7mm/y

Periods:

Annual 3.3mm

Semi-A 1.9mm

Linear:

Bias(99/02/28) -1.6mm

Drift 2.4mm/y

Periods:

Annual 5.5mm

Semi-A 2.6mm

Linear:

Bias(99/02/28) 8.8mm

Drift -4.1mm/y

Periods:

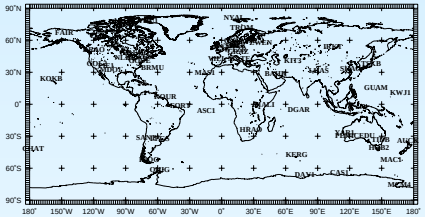
Annual 12.0mm

Semi-A 3.3mm

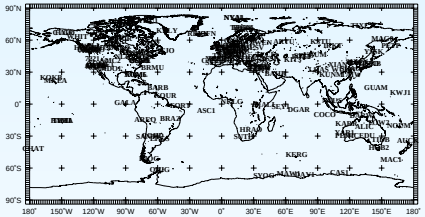
Contribution to IERS

- Objectives:
  - Understand/Resolve systematic bias
  - EOP Accuracy Objective (0.1mas)
- Phase 1-Generate EOP's series with:
  - Different network geometry
  - Different weighting:
    - Minimal
    - Formal
    - Heavy (Formal * 0.01)

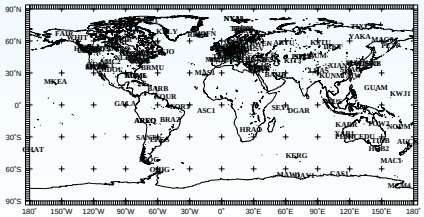
Contribution to IERS



54 Stations ITRF2000
54 Stations IGS00

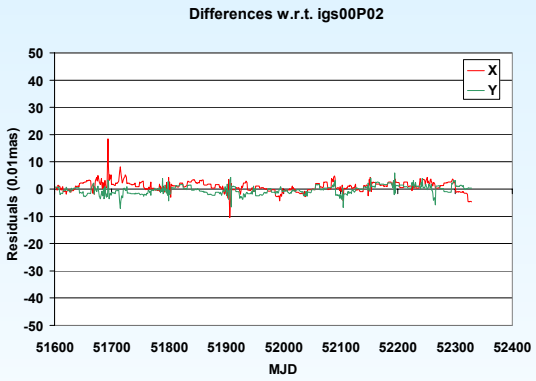


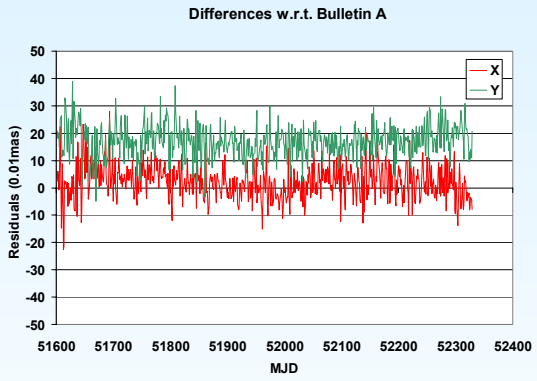
154 stations ITRF2000



132 stations IGS00

Typical X & Y Pole Differences w.r.t. igs00P02 & Bulletin A

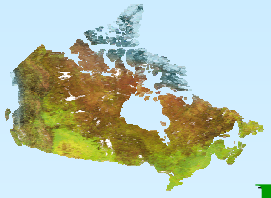




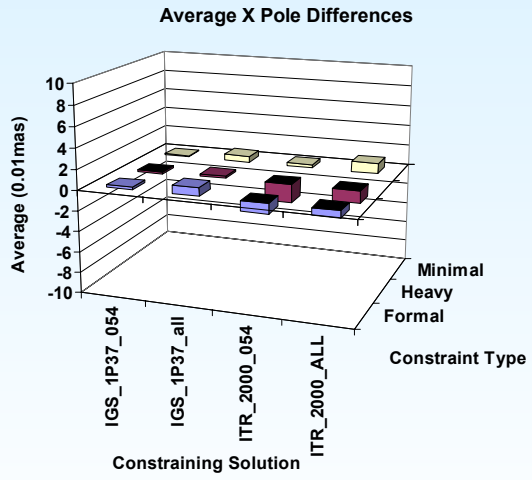
Constraining Solution : ITRF2000

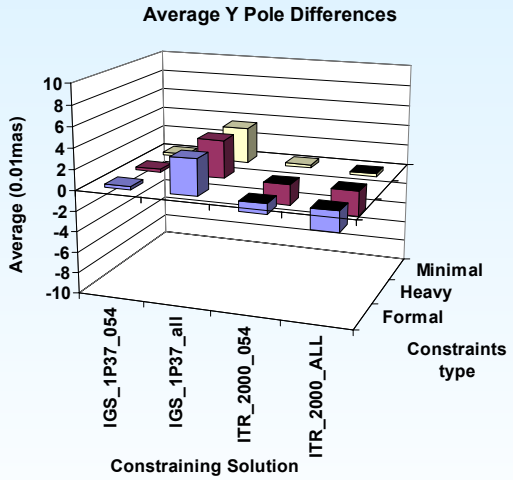
Number of Stations: 154

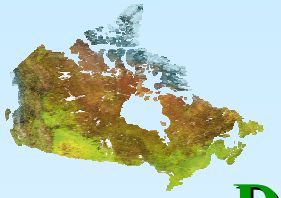
Constraints type: Minimal



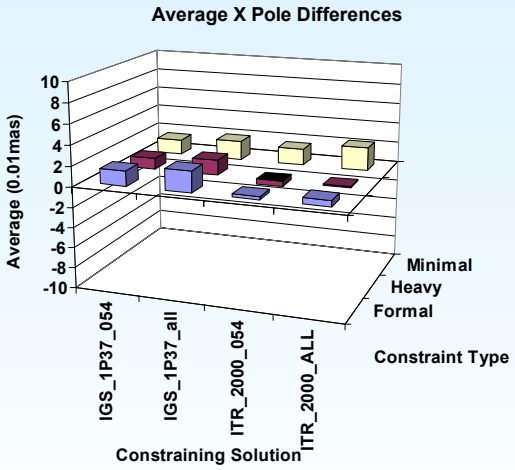
Average X&Y Pole Differences w.r.t. igs00p02

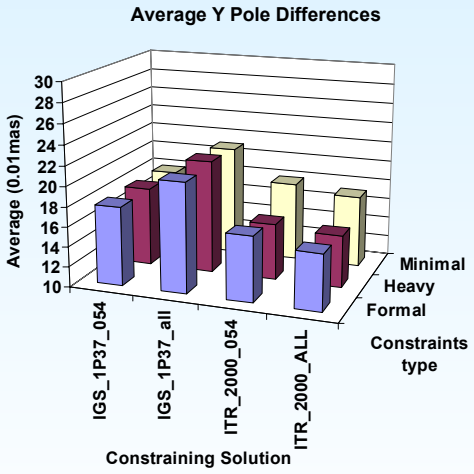






Average X&Y Pole Differences w.r.t. Bulletin A





SINEX V 2.00

- Extensions proposed by IERS to Accommodate Multi-techniques
- New Parameters
- New Blocks (Normal eq. , Documentation)
- Solution Blocks Consistency
- Backward Compatibility

Summary

- Realization of ITRF2000
  - 54 Stations
- Combination
  - Stations(Weekly 160+ , Cumulative 200+)
  - ERP's (0.05-0.15mas, 0.15-0.50mas/d)
  - Geocenter (Annual & semi-annual periods)

Summary (Cont.)

- Contribution to IERS Analysis Campaign
  - Stability (+- 0.03 mas)
- SINEX V2.0
  - Backward Compatibility
- Some Constraints issues to resolve

Status of IGS/BIPM Time Transfer Project

J. Ray

- **Tracking Network**

  - nearly 300 stations in IGS network (March 2002)
  - stable clocks: ~40 H-masers, ~25 Cs, ~15 Rb
  - ~18 IGS stations located at timing labs
  - number of timing labs in IGS net growing steadily
  - Ashtech Z-12T receiver popular due to ability to calibrate
  - environmental stability issues remain important
  - multipath mitigation also important but poorly understood

- **Analysis Issues**

  - IGS combined clocks implemented officially on 5 Nov 2000
  - time scale stability limited by GPS time
  - internal IGS time scale developed by K. Senior
  - **how/when to implement new time scale officially ?** <<<
  - **how to ensure future time scale reliability ?** <<<
  - **future direct links to UTC ? (via BIPM & labs)** <<<

  - time transfer accuracy agrees approximately with formal error estimates (~115 ps), in the best cases
  - performance varies greatly among stations, apparently due to site-specific causes
  - limiting stability is ~1.3 x 10^{-15} at 1 d

  - **ACs: need to “densify” clock solutions ! (using PPP)** <<<
  - to include all stable clocks & timing labs

  - **maintenance of P1/C1 bias table ?** <<<
  - **eliminate cross-correlator receivers from IGS net ?** <<<

- **Calibration of Instrumental Timing Delays**

  - G. Petit *et al.* have developed absolute & differential calibration methods for Ashtech Z-12T
  - calibrated BIPM receiver now visiting timing labs
  - RINEX -> CGGTTS utility by P. Defraigne very useful for differential calibrations against common-view receivers

- **Intercomparisons with Other Techniques**

  - should now move from research to byproduct of BIPM's UTC/TAI combination/comparisons
  - will probably reveal longer-term instabilities in system calibrations & other similar effects

- **Future of Pilot Project**

  - pilot phase should end on 31 Dec 2002
  - **needs to transition to operational phase for IGS** <<<

  - will not be used operationally by BIPM yet
  - products need closer evaluation in quasi-operational mode & comparison with common-view/two-way satellite methods

  - **propose permanent liaison between IGS & BIPM** <<< **starting in 2003** <<<

IGS/BIPM Pilot Project: GPS Carrier Phase for Time/Frequency Transfer and Time Scale Formation

J. Ray and K. Senior

Abstract. The development within the International GPS Service (IGS) of a suite of clock products, for both satellites and tracking stations, offers some experiences which mirror the operations of the Bureau International des Poids et Mesures (BIPM) in its formation of TAI/UTC but some aspects differ markedly. The IGS relies exclusively on the carrier phase-based geodetic technique whereas BIPM time/frequency transfers use only common-view and two-way satellite (TWSTFT) methods. The carrier phase approach has the potential of very high precision but suitable instrumental calibration procedures are only in the initial phases of deployment; the current BIPM techniques are more mature and widely used among timing labs, but are either less precise (common-view) or much more expensive (TWSTFT). In serving its geodetic users, the essential requirement for IGS clock products is that they be fully self-consistent in relative terms and also fully consistent with all other IGS products, especially the satellite orbits, in order to permit an isolated user to apply them with few-cm accuracy. While there is no other strong requirement for the IGS time scale except to be reasonably close to broadcast GPS time, it is nonetheless very desirable for the IGS clock products to possess additional properties, such as being highly stable and being accurately relatable to UTC. These qualities enhance the value of IGS clock products for applications other than pure geodesy, especially for timing operations. The jointly sponsored "IGS/BIPM Pilot Project to Study Accurate Time and Frequency Comparisons using GPS Phase and Code Measurements" is developing operational strategies to exploit geodetic GPS methods for improved global time/frequency comparisons to the mutual benefit of both organizations. While helping the IGS to refine its clock products and link them to UTC, this collaboration will also provide new time transfer results for the BIPM that may eventually improve the formation of TAI and allow meaningful comparisons of new cold atom clocks. Thus far, geodetic receivers have been installed at many timing labs, a new internally realized IGS time scale has been produced using a weighted ensemble algorithm, and instrumental calibration procedures developed. Formulating a robust frequency ensemble from a globally distributed network of clocks presents unique challenges compared with intra-laboratory time scales. We have used these products to make a detailed study of the observed time transfer performance for about 30 IGS stations equipped with H-maser frequency standards. The results reveal a large dispersion in quality which can often be related to differences in local station factors. The main elements of the Project's original plan are now largely completed or in progress. In major ways, the experiences of this joint effort can serve as a useful model for future distributed timing systems, for example Galileo and other GNSS operations.