The Evolution of the IGS Flow of Data (and Products and Information) and Steps Ahead

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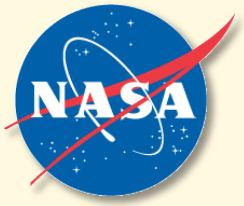

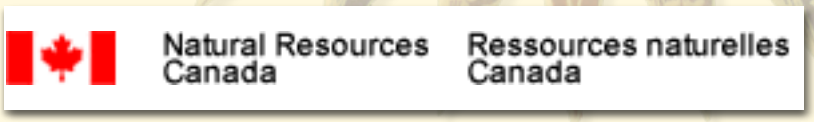

Evolution of the IGS Flow of Data and Steps Ahead

- Background
  - Past DC-Related Recommendations
  - Statistics on Data Availability
  - Statistics on Data Latency
- Issues
- Way forward
  - Data flow
  - RINEX construction
  - Compression

Past DC-Related Recommendations

- For DCs:
  - Provide statistics covering data availability, data latency, completeness of data files and the consistency of the records in the RINEX header and the site logs
  - Determine need for better harmonization of the IGS data center structure and contents
  - Investigate accumulation of data streams as a possible replacement for ftp file transfer of selected IGS data sets (i.e., high-rate 15-minute 1Hz files) with the provision that IGS data centers archive files of identical content
- For ACs:
  - Define requirements for data latency
  - Define requirements for data QC and validation at IGS data centers
- For others:
  - Update TEQC to accommodate new RINEX formats and future satellite systems

Statistics on Data Availability

- Daily status files available at CDDIS recently enhanced per IC request
- ftp://cddis.gsfc.nasa.gov/pub/gps/data/daily/*YYYY*/*ddd*/*YYddd*.status
- Software available to other DCs

IGS Tracking Network Status for 10-May-10 100510 10130 GPS Week 1583 Day 2 As of date: May 17 2010 10:27:21

Site	Dly (H)	No. Exp.	No. Obs.	Pts. Del.	%	Avg. MP1	Avg. MP2	Pos. Diff	No. Slps	V	Receiver Type	Antenna Type	Ant. Height	Marker Name	Marker Number	Type	RINEX Version	Dly (M)
abmf	10	25780	25640	136	99	0.41	0.51	0.04	23	1	TRIMBLE NETR5	TRM55971.00 NONE	0.0000	ABMF	97103M001	M	2.11	630
abpo	1	26268	25800	0	98	0.35	0.37	0.09	23	1	ASHTECH UZ-12	ASH701945G_M SCIT	0.0083	ABPO	33302M001	G	2.11	14
ade1	20	25447	25133	0	98	0.43	0.41	0.04	4	1	ASHTECH Z-XII3	ASH700936B_M SNOW	0.0000	ade1	50109S001	G	2.11	1253
ade2	20	25447	25071	1	98	0.42	0.41	0.04	5	1	ASHTECH Z-XII3	ASH700936B_M SNOW	0.0000	ade2	50109S001	G	2.11	1253
adis	24	28500	22796	672	79	0.53	0.58	0.03	22	1	JPS LEGACY	TRM29659.00 NONE	0.0010	ADIS	31502M001	M	2	1490
aira	1	24806	22489	608	90	0.35	0.48	0.03	30	1	TRIMBLE 5700	TRM29659.00 DOME	0.0000	AIRA	21742S001	G	2.11	111
ajac	8	23674	23644	0	99	0.19	0.16	0.04	2	1	LEICA GRX1200GGPRO	LEIAT504GG NONE	0.0000	AJAC	10077M005	M	2	511
albh	1	25563	25235	0	98	0.22	0.26	0.03	3	1	AOA BENCHMARK ACT	AOAD/M_T SCIS	0.1000	albh WCDA-ACP 927	40129M003	G	2.11	8
algo	1	24839	24730	0	99	0.22	0.23	0.07	1	1	AOA BENCHMARK ACT	AOAD/M_T NONE	0.1000	ALGO CACS-ACP 8831	40104M002	G	2.11	11
alic	3	25127	25120	0	99	0.28	0.32	0.04	12	1	LEICA GRX1200GGPRO	AOAD/M_T NONE	0.0070	ALIC	50137M001	M	2.11	231
alrt	1	29982	28999	12	96	0.11	0.13	0.06	8	1	ASHTECH UZ-12	ASH701945C_M NONE	0.1000	ALRT	40162M001	G	2.11	112
amc2	1	24442	23963	0	98	0.33	0.34	0.06	7	1	ASHTECH Z-XII3T	AOAD/M_T NONE	0.0000	AMC2	40472S004	G	2.11	10
amu2	8	58175	58045	4	99	0.32	0.36	0.16	2	1	TRIMBLE NETRS	ASH700936D_M SCIS	0.0000	AMU2	66040M002	G	2.11	493
ankr	9	24955	24856	0	99	0.37	0.45	0.06	0	1	TPS E_GGD	TPSCR3_GGD CONE	0.0700	ANKR	20805M002	M	2.11	570
antc																		
areq	1	25340	25179	0	99	0.17	0.19	0.05	17	1	ASHTECH UZ-12	AOAD/M_T JPLA	0.0610	AREQ	42202M005	G	2.11	11
arev																		
artu	1	25479	24966	0	97	0.40	0.41	0.03	3	1	ASHTECH Z-XII3	ASH700936D_M DOME	0.0796	ARTU	12362M001	G	2.10	10
aspa	1	25738	24918	790	96	0.59	0.43	0.03	14	1	TRIMBLE NETR5	TRM55971.00 NONE	0.0000	ASPA	50503S006	M	2.11	84
auck	6	24755	24754	1	99	0.28	0.32	0.07	0	1	TRIMBLE NETRS	TRM41249.00 NONE	0.0550	AUCK	50209M001	G	2.11	373
aukt	6	24748	23920	342	96	0.35	0.41	0.04	20	1	TRIMBLE NETRS	TRM55971.00 NONE	0.0030	AUKT	50216M001	G	2.11	373

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Statistics on Data Latency

- Monthly and yearly files summarize latency of hourly data at CDDIS
- Could be expanded to summarize daily and sub-hourly high-rate latency
- ftp://cddis.gsfc.nasa.gov/pub/gps/data/hourly/*YYYY*/
- Software available to other DCs

Hourly GNSS Archive Statistics -- 2010/04/01 to 2010/04/30

Mon.	00-04m	05-09m	19-29m	30-59m	01-24h	01-3d	3d-mis
abmf	----	----	89.31%	7.08%	3.61%	----	----
abpo	----	83.41%	3.20%	0.76%	5.02%	7.61%	7.61%
adis	----	----	83.63%	3.56%	12.81%	----	----
aira	20.72%	1.39%	----	76.77%	1.11%	----	----
albh	----	83.17%	1.13%	0.28%	7.50%	6.51%	6.51%
algo	86.46%	10.39%	0.63%	0.63%	1.89%	----	----
alic	----	----	7.39%	6.14%	78.24%	7.53%	7.53%
amc2	----	98.06%	0.83%	0.28%	0.83%	----	----
ankr	----	----	90.39%	5.15%	4.46%	----	----
areq	----	91.69%	3.66%	1.13%	3.52%	----	----
arev	----	86.83%	5.65%	2.96%	4.57%	----	----
artu	----	----	97.91%	0.14%	1.95%	----	----
aspa	67.23%	26.44%	1.27%	3.38%	1.69%	----	----
auck	----	----	0.70%	97.91%	1.39%	----	----
aukt	----	----	9.17%	31.67%	59.17%	----	----
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zeck	----	----	89.93%	5.87%	4.20%	----	----
zim2	98.88%	----	----	----	1.12%	----	----
zimj	0.85%	0.14%	98.45%	0.14%	0.42%	----	----
zimm	98.88%	----	----	----	1.12%	----	----
zwe2	----	----	85.79%	4.60%	8.77%	0.84%	0.84%
Avg.	20.23%	23.55%	39.57%	6.87%	9.00%	0.59%	0.59%
Mon.	00-04m	05-09m	19-29m	30-59m	01-24h	01-3d	3d-mis

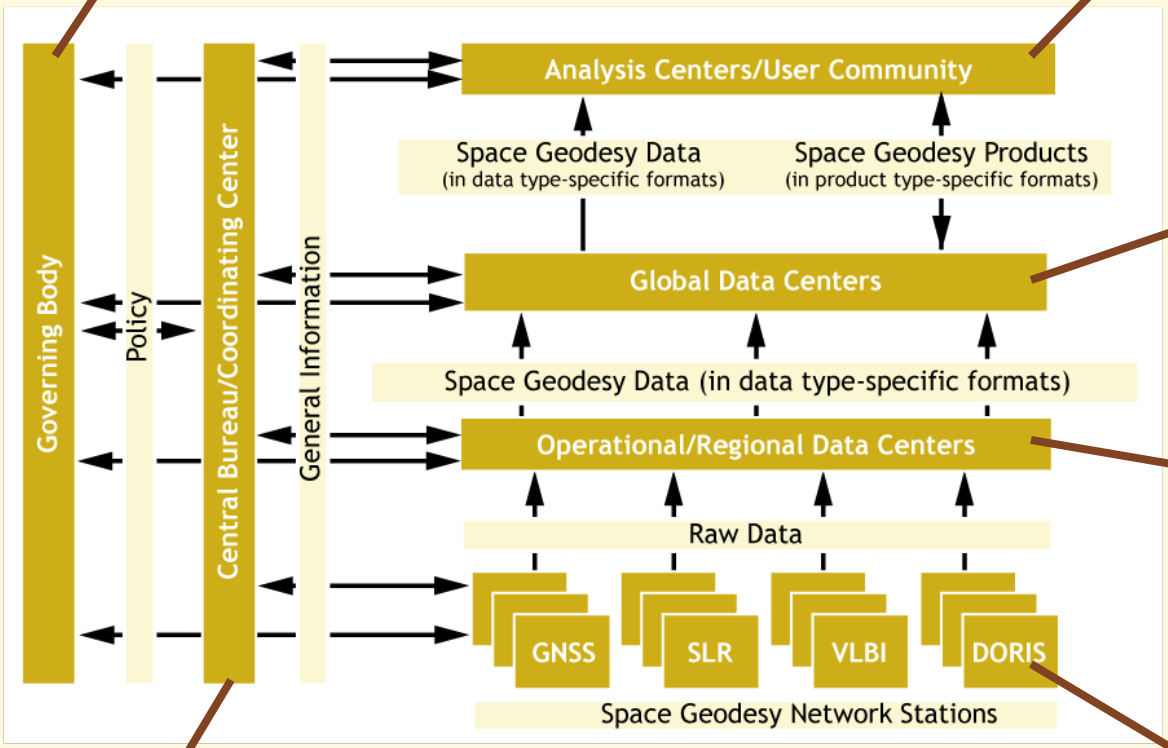
Steps Ahead

- Data flow
- Construction of RINEX files
- Compression
- Other?

Flow of Files within IGS

(Information, Data, Products)

- Governing Body
  - General oversight of service
  - Future direction



- Central Bureau
  - Management of service
  - Facilitate communications
  - Coordinate activities

- Analysis Centers and Coordinators
  - Provide products to users (e.g., station coordinates, precise satellite orbits, Earth orientation parameters, atmospheric products, etc.)

- Global Data Centers
  - Global data / product distribution
  - Both within and beyond the IGS

- Operational / Regional Data Centers
  - Interface to network stations
  - Perform QC and data conversion activities
  - Archive data for access to analysis centers and users

- Space Geodesy Network Stations
  - Continuously operational
  - Timely flow of data

Data Flow - Current Status

- Site guidelines: Data from IGS sites submitted to at a minimum of two DCs of which one is a GDC
  - DCs identified in site logs
- Current (actual) situation:
  - ODCs provide data to:
    - Either one or more RDC (usually one)

      and/or
    - One or more GDC
  - RDCs forward IGS sites to (one or more) GDC as required
  - RDCs/GDCs currently equalize selected data from selected sites
    - i.e., there is some equalization of data but there is no rigorous mirroring of primary data submissions or subsequent re-submissions
  - Result: inhomogeneous data set in DCs

Data Flow – Identified Problems & Goals

- Identified problems from GDC/AC perspective:
  - GDCs provide access to different sets of IGS sites
    - Users must “shop” multiple GDCs to retrieve required data
  - GDCs not synchronized and therefore not necessarily holding most current data
    - I.e., data holdings are not mirrored across GDCs
    - Inhomogeneous data set in GDCs and RDC’s (especially wrt replacement data sets)

- Goal: ensuring robust (24/7) AC/User access to data:
  - Primary data submissions must reach intended GDCs (and RDC’s)
  - Data resubmissions must reach intended GDCs (and RDC’s)
  - Continued data flow when designated GDC is unavailable (and by extension RDCs as well)

Data Flow - Recommendations

- GDC archive content
  - All GDCs archive data from **ALL** IGS stations as identified on the IGS network website
  - Advantages:
    - Ensures that data are consistent among GDCs and replacement data are distributed to all GDCs
    - Ensures users can easily get data from any GDC for any IGS site
    - Provides redundant data availability (also for resubmission)
- Data flow:
  - ODCs push primary data submission from their stations to ALL GDCs
  - ODCs push any/all subsequent resubmissions to ALL GDCs
  - ODCs issues advisory for ALL resubmissions
  - Advantages:
    - Implies simplified data flow
    - Ensures responsibility for data remains with ODC
    - Allows for publishing information about replacement data

Data Flow - Implementation

- How do we get there:
  - Prepare GDCs for new data flow paths (and additional storage required)
  - Prepare ODCs for data push to:
    - All GDCs
    - Appropriate RDCs
    - Others (as required on individual basis)
  - Implement ODC to GDC (and RDC) direct push

RINEX Construction Issues (1/2)

- Several methods are used to form daily RINEX file of 30-second sampled observations
  - Generated at station (receiver)
  - Created from concatenated hourly files
  - Created from accumulated either binary or RTCM high-rate RT data streams and filtered/decimated to 30-second sampling rate
- Different methods cause different results
  - Concatenated files are not necessarily equivalent to “true” 24 hr data files
  - RINEX files from RT data stream:
    - Number of epochs reduced due to loss of data in data stream
    - Increase in data gaps and/or cycle slips
  - RINEX files from RT RTCM:
    - Observation types in RINEX file: at most 4 observables transferred through RTCM, analysis-specific s/w formatting
    - Data field resolution: code observable from RTCM 3.0 less accurate than RINEX V2; HP-RTCM should address this
    - New RTCM format (HP-RTCM) should address accuracy concerns
  - Receiver features yield different # obs in epoch or different cycle slips

RINEX Construction Issues (2/2)

- Currently the IGS site guidelines state that daily/hourly files should NOT be created from streams
- However, for future consideration, creating daily/hourly RINEX files from streams:
  - Advantages:
    - Stream established directly from receiver to DC
    - Files available immediately following end of epoch (hour or day)
  - Disadvantages
    - Stream interruptions mean incomplete files
    - Inconsistent files at DCs if multiple DCs receive streams and generate RINEX
- Further research needed to address differences (see RINEX Construction Recommendations)

File Generation Differences

- At this time files created from streams are not equivalent to files created at stations and transferred by ftp
  - Adequate for real-time and near real-time applications?
  - Not adequate for long term archive and future analysis
- Different numbers of epochs (loss of data in data stream)
- Different RINEX observation types
  - Currently, 4 observables at most transferred through RTCM (HP-RTCM will resolve this)
  - Analysis software-specific formatted files (e.g., Bernese software 5.0 ignores C2 observable)
- Features of receivers may cause different numbers of observations within an epoch and different cycle slips
- Data field resolution (code observable from RTCM 3.0 less accurate than RINEX 2)

RINEX Construction - Recommendations

- Develop tool for comparison of RINEX files from various construction approaches, e.g., zero-baseline processing
  - Run the tool at the site and at the data center to recover receiver-specific and transport-specific issues
- Define minimum requirements for acceptance of an accumulated data stream of observations as a RINEX file in IGS data archives (work with IC)
  - Minimum number of epochs
  - Maximum tolerated epoch differences per satellite
  - Maximum tolerated numerical difference for each individual observation (after appropriate harmonization of compared RINEX files)
  - Data field resolution for each observation type
- Specification of observation types that are mandatory and others that are optional
- Agree on procedures to fill the gaps in the case data streams have been interrupted

Compression

- Currently used data compression (Unix compress) is inefficient and out of date
- Recommendation:
  - Change compression used in IGS infrastructure from UNIX compress (Z) to:
    - bzip2 or
    - gzip
- Discussion:
  - Both are widely distributed across multiple O/S
  - Better compression factor
  - Speed:
    - gzip faster than ‘Z’
    - Bzip2 slower than ‘Z’
  - Current leaning is toward bzip2 but need to complete testing/consultation
- Implementation scenarios:
  - Change compression throughout IGS infrastructure
  - Allow DCs to utilize more efficient compression on historic archives
- **Any changes must be coordinated with DCs, ACs, manufacturers, users, …**

Remaining Issues

- Long-term access to high-rate data
  - Can hourly files be created and archived from sub-hourly files?
  - Can files be “packaged” on a site/day basis
  - How long retained online?
- Data usage statistics
  - GDCs provide information (who, how much) on data downloads by ODC/station
- Continue to work with the IC and ACs to resolve these and other issues!

Data Center WG Meeting

- Tuesday, June 29, 16:30-17:30
- Topics:
  - Viability/Requirement for WG
  - Membership
  - Top Issues
    - Compression
    - High-rate data archive
    - RINEX formulation

Backup Slides

Data Center Updates

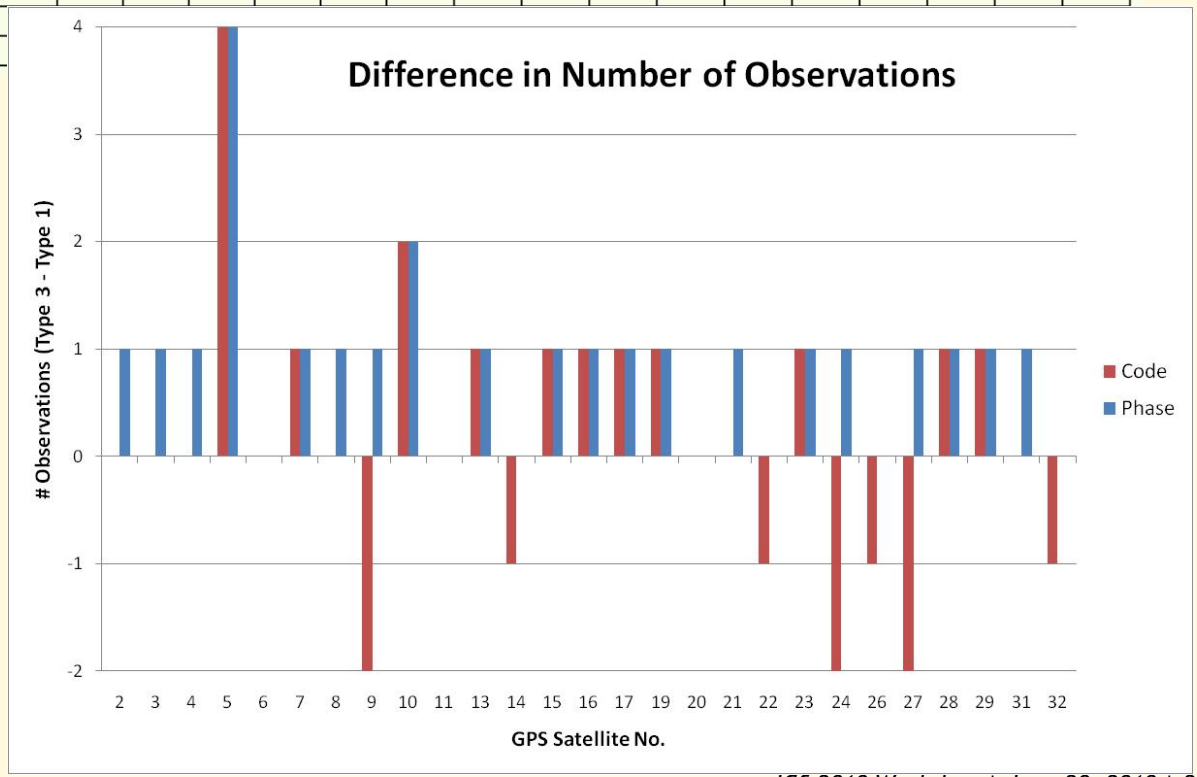
- CDDIS
  - Operational on new server system, same access for users, new access procedure for data and product upload
  - Working on revision to metadata and new data discovery capability
  - Archiving test data sets (software receiver, RINEX V3, L5)
- IGN
  - Developing new websites for the GDC and RF coordination
- KASI
  - GDC system upgraded for better reliability and backup capabilities
  - Three cluster servers for high availability of GDC system
  - Mirroring to backup server
- BKG
  - Archiving RINEX V3 data
  - Preparing to archive Galileo data

File Generation Differences (1/2)

- Single epochs are missing in from files created in data streams (statistics available at EUREF)

	174/2010 (23-06-2010)																						
	0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
ACOR	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	96%	88.5%	88.6%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
ALAC	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	96.1%	88.6%	88.7%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
ALBA	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	96.1%	84.9%	88.6%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
ALME	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	96.1%	88.5%	88.7%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
AUT1	100%	100%	100%	100%	100%	95.5%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	95.6%
BELF	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BELL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99.9%	100%	100%	100%	100%	100%	100%	100%
BOR1	100%	100%	100%	100%	100%	100%	100%																	
BORJ	100%	100%	99.1%	100%	100%	100%	100%																	

- Tests show that there are different numbers of observations/epoch in stream files than station files for some satellites



Compression (2/2)

- Implementation (proposed):
  - Sept 30, 2010: last date for post workshop comments to be received by IGS DCWG
  - Oct 30, 2010: complete synthesis of input and final recommendation by DCWG
    - Circulate to IC, DC's, AC, manufacturer's for last comment
  - Nov 30, 2010: complete feedback for final discussion and report completion at DCWG meeting at Fall AGU
  - Distribute recommendation (IGS, Manufacturers, etc.)
  - January 2011: commence implementation
  - NOTE: period of overlap (6mths – 1 yr) required to accommodate the necessary changes to multiple post processing software which retrieve data from IGS-DC's