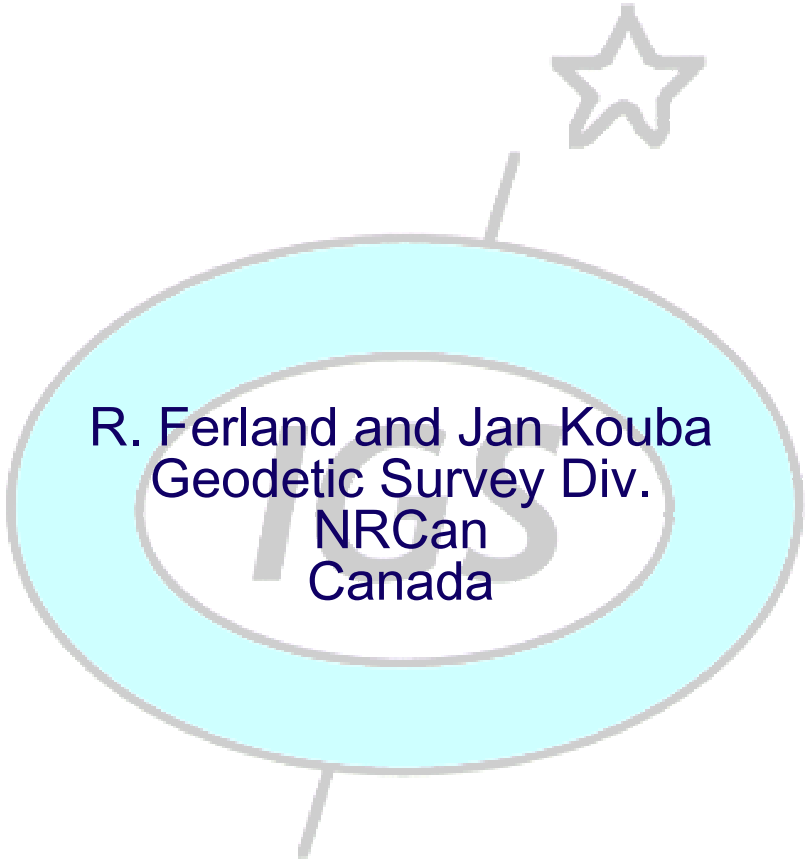
IGS ITRF Realization and Transformations



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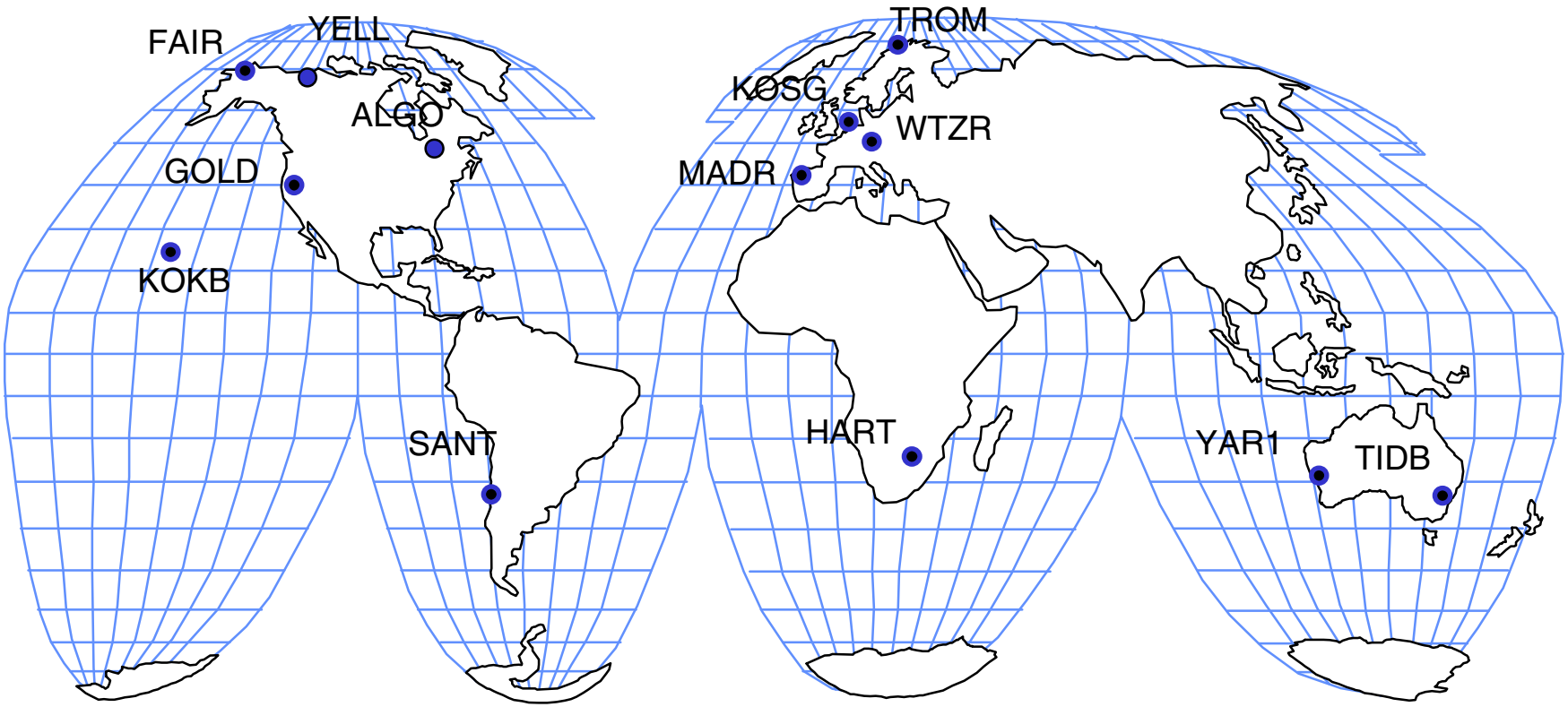
Content

- Realizations
  - IGS-ITRF92, IGS-ITRF93, IGS-ITRF94 (13 stations)
  - IGS-ITRF96 (47 stations)
  - IGS-ITRF97 (51 stations)
- IGS ITRF Transformations
  - ITRF Transformations
  - ITRF-Geodetic Datum Transformation
- IGS SINEX Combined Products
  - Quality control
- Future developments

IGS ITRF Realization

Station set (13) used for the IGS Realization of ITRF92-93-94



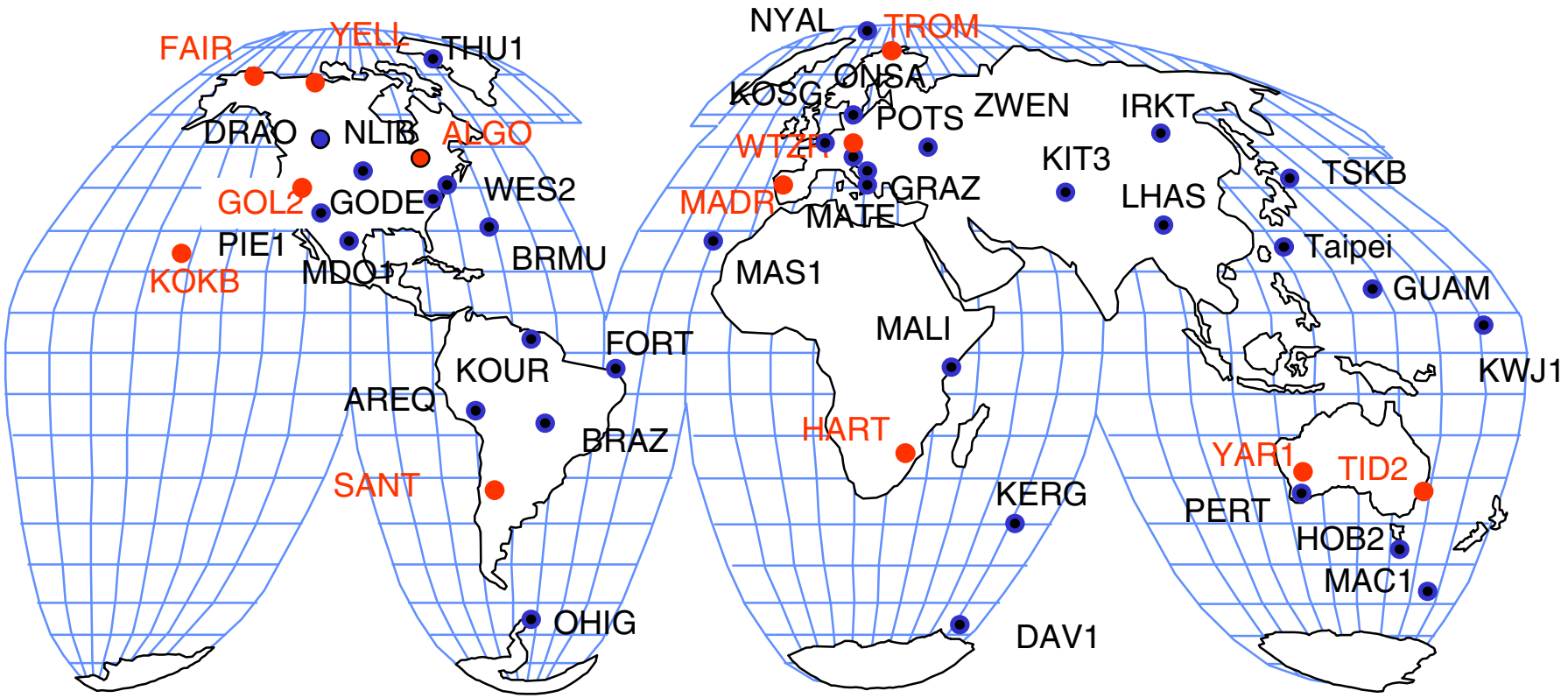
- **IGS Global Tracking Sites**

13 Stations Network Limitations

- Used for the IGS Realizations of ITRF92-93-94
- Limited number of stations
  - VLBI and/or SLR collocations
  - Good ITRF coordinate solutions
  - Good GPS data quality, latency and long observation history
- Missing stations were occasionally having significant impact on the IGS ITRF realization stability.
  - At times only 8 stations were available
- Sub-optimal stations distribution.
- Small discontinuities between IGS realizations of ITRF.

IGS ITRF Realization

Station set (47) used for the IGS Realization of ITRF96



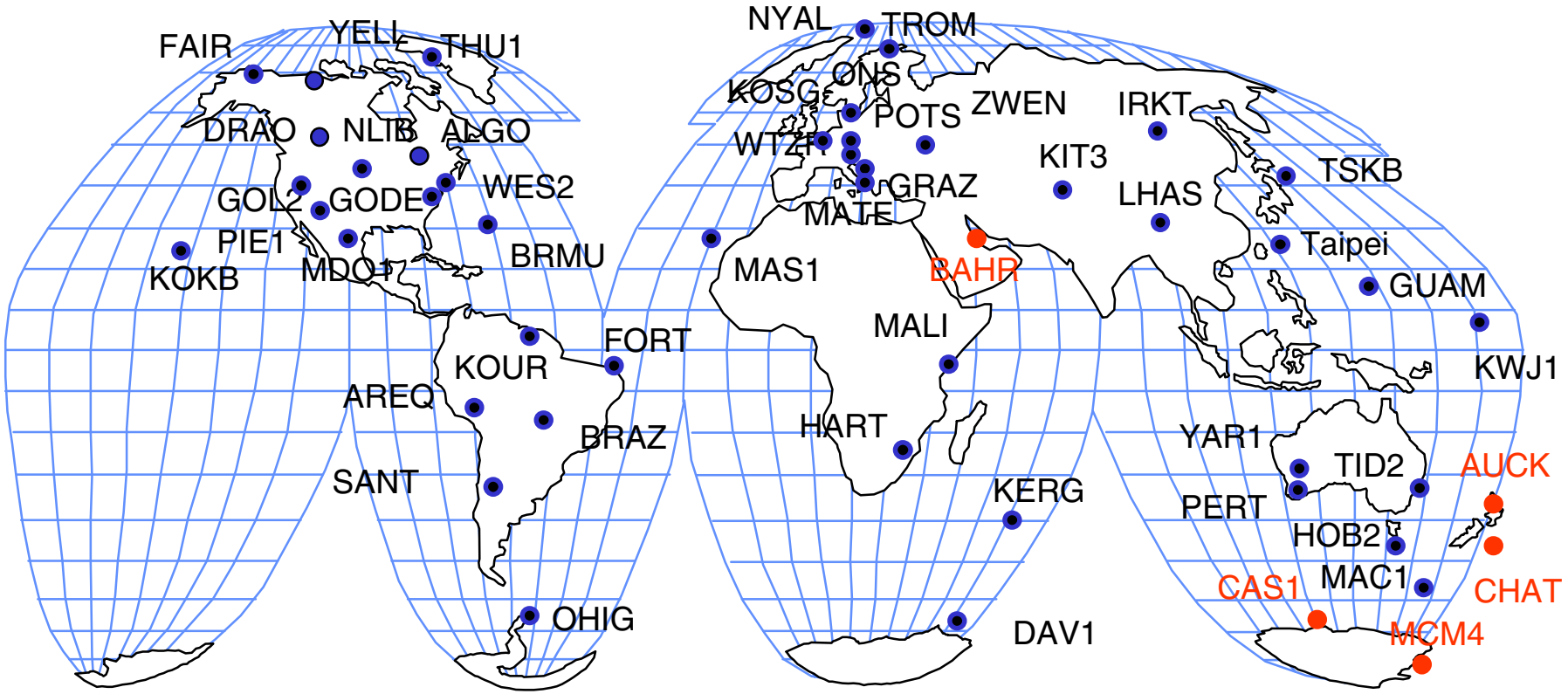
- **IGS Global Tracking Sites**
- **IGS "Original 13" Global Tracking Sites**

ITRF Stations Selection Criteria

- Reliable position/velocity ITRF/AC/IGS solutions
- Stable monumentation
- Quality and reliable station hardware (minimum hardware changes)
- Data quality (e.g. low multipath)
- Data latency (low and reliable communication)
- Long observation history (>2 years)
- Collocated with other techniques (VLBI, SLR, DORIS)
- Geographical location (world wide balanced geometry)
- Supportive and responsive station staff

IGS ITRF Current Realization

Station set (51) used for the IGS Realization of ITRF97



- **IGS Global Tracking Sites**
- **IGS "new" Global Tracking Sites**

IGS ITRF Dates

ITRF	FROM Calendar	FROM GPS	TO Calendar	TO GPS	# sta
92	94/01/02	0730	94/12/31	0781	13
93	95/01/01	0782	96/06/29	0859	13
94	96/06/30	0860	98/02/28	0946	13
96	98/03/01	0947	99/07/31	1020	47
97	99/08/01	1021	Now		51

IGS ITRF Realizations

New ITRF97 realization

- Based on IGS SINEX Combined Solution
  - Cumulative combined SINEX solution over four years for the 51 ITRF97 stations (a subset of the *IGS00P04.snx* product)
  - Available from:

    ftp://macs.geod.emr.ca/pub/requests/sinex/rfwg/ IGS00P04_RS51.snx
- Used for IGS Final Orbits/ERP/clocks from Feb 27, 2000 (from GPS Wk 1051; MJD 51601)
  - IGS Final Orbits/ERP/Clock production delay increased from 10 to 12 days
  - Improved IGS ITRF97 realization/precision for the IGS Final orbits/ERP/clocks
- No noticeable changes to the IGS users (no transformation necessary, no noticeable steps!)
- See IGS Mail #2750 and #2751 for more details

IGS ITRF Transformation

From ITRF	To ITRF	Epoch	T1 (mm) (mm/y)	T2 (mm) (mm/y)	T3 (mm) (mm/y)	D (ppb) (ppb/y)	R1 (mas) (mas/y)	R2 (mas) (mas/y)	R3 (mas) (mas/y)
93	92	1995.00	20. 2.3	8 0.4	3 -0.8	-0.1 0.11	1.66 0.12	0.68 0.15	0.55 -0.04
94	93	1996.50	-21 -2.7	-1 0	1 2.0	-0.2 -0.09	-1.27 -0.13	-0.87 -0.20	-0.54 0.04
96	94	1998.16	0 0.2	-1 -0.9	1 0.2	-0.4 -0.07	-0.21 -0.02	-0.01 0.01	-0.22 0.01
97	96	1999.58	-0.3 0.7	-0.5 -0.1	14.7 1.9	-1.430 -0.043	-0.159 -0.013	0.263 0.015	0.060 -0.003

Transformation Program

SP3 Orbit/Station/EOP/Clock Transformation program (trnfsp3n)

- A simple ftn77 program, description, examples and all the necessary transformation files are available from:

  ftp://macs.geod.emr.ca/pub/requests/itrf96_97

- Example:

  trnfsp3n SP3in SP3out trans [EOPin EOPout]

  - where *SP3in*, *SP3out* are input & output orbit files;
  - trans is the transformation file provided
  - *EOPin*, *EOPout* are optional EOP input & output
- see the appendix/hand out for more details and the program source

IGS ITRF Product List

- igsyyPwwww.snx
- IGSyyPww.snx
- igsyyPwwww.erp
- igsyyPwwww.sum
- igsyyPwwww.itr
- igsyyPwwww.res
- IGSyyPww.res

- Combined Weekly solution
- Cumulative Combined Solution
- Daily Earth Rotation Parameters (SINEX)
- Weekly Summary Report
- Residuals between the AC&GNAAC and the ITRF97 (51 stations)
- Residuals between the AC&GNAAC and Weekly igsyyPwwww.snx
- Residuals between the AC&GNAAC and Cumulative IGSyyPww.snx

- yy=last 2 digits of the year
- ww=week of the year
- wwww=GPS week #

SINEX Products Precision

	Availability	Interval	Precision
IGS weekly combined station Position (igsyyPwwww.snx)	2-4 weeks	1 week	5-10mm
IGS Cumulative combined station positions and velocities (IGSyyPww.snx)	2-4 weeks	----	1-5 mm,1-3mm/y
Polar Motion (PM)	2-4 weeks	1 day	0.1mas,0.2mas/d
LOD	2-4 weeks	1 day	0.05ms
Geocenter (apparent)	2-4 weeks	1 week	5-10mm

Geodetic Datum

- If a recent (after 1997) WGS84 transformation available
  - likely also applicable for ITRFyy transformations (within 10 cm)
- If cm precision transformation (ITRF to geodetic Datum) required:
  - Observe and compute GPS positions (cm precision) of several points, fixing IGS Final or Rapid products, either using single station precise point positioning or relative positioning (wrt IGS or ITRF stations)
  - compute x,y and z coordinates from the national geodetic datum ϕ :latitudes, λ:longitudes and h :heights (sea level+ geoid heights) at the GPS points
    - Warning- use the proper ellipsoid and geoid!
  - For small area (<10 km) simple average of the GPS-geodetic xyz differences at all points used (the differences should be the same within a few cm)
    - use 3 (translation) parameter the transformation only (ITRF to geodetic and vice versa)
  - For larger areas, use a minimum of 3 well distributed points; solve for and use all the 7 transformation parameters (3 translations, 3 rotations and scale)
    - The 3 rotation parameters are time dependent (rates required) when the geodetic ϕ, λ *and* h are not to change with time (I.e. fixed to a crustal plate)
    - Warning: For non- global station distributions, only the 3 rotation parameters are physically meaningful !

SINEX Product Characteristics

- A normal matrix (addition) stacking of seven AC SINEX station/ERP solutions
- The SINEX Cumulative (station positions/velocities) solution based on:
  - Three GNAAC (Global Network AAC) combined SINEX solutions between GPS weeks 0837 - 0977
  - Seven AC SINEX solutions from weeks 0978 till now (GNAAC used for quality control)
- Using the IGS log files as summarized in:
  - *ftp://igscb.jpl.nasa.gov/igscb/station/general/igs.snx*
- Aligned to ITRF97; 7/14 inner (minimum) constraints are applied to the weekly and cumulative solutions, rep. constraints derived from all the available (51) RF stations:
  - *ftp://igscb.jpl.nasa.gov/igscb/station/coord/ITRF97_IGS_RS51.SNX*
- The SINEX products are also consistent with the other IGS CORE products (orbits/ERP/clocks)

IGS ITRF Quality Control

- Independent GNAAC SINEX combinations
- Regular comparisons of cumulative solution velocity field with plate motion models (NUVEL1).
- Ongoing improvements of the procedures/programs.
- Independent quality check of the SINEX combined solutions before each submission.

Future Developments

- The IGS SINEX station/ERP combined solutions have become official since February 20, 2000
- Reprocessing of GPS weeks 0837 - 0977 (underway);
  Possible addition of older weekly solutions
- Plate motion monitoring (not included in the IGS sum report yet)
- IGS Station Polyhedron Combination (back substitution of regional solutions) for up to 200-250 stations

QUESTIONS?

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