First results of X/S and X/Ka-band catalog combinations with full covariance information

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Motivation

Features of the ICRF2

- 3414 sources
  - 2197 single session sources
  - 295 defining sources
- NNR to ICRF1
- consistency with VTRF2008
- only S/X band observations
- only one single monolithic solution
Motivation

ICRF2 (Defining-Sources)

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Goals for the ICRF3

- Improved frequency coverage
- Combined product of multiple VLBI solutions
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X/Ka catalog (8.4 / 32 GHz)

X/S catalog analysis center 1

X/S catalog analysis center 2

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Combination of datum-free normal equation systems \((X/S)\) with solutions including full covariance information \((X/Ka)\)

- **X/S catalog analysis center 1**
- **X/S catalog analysis center 2**
- **X/Ka catalog**
  - \(8.4 / 32\) GHz
1. **Step**: Generating a X/S catalog based on daily datum-free GSFC SINEX files (Combination of datum-free normal equation systems)

**X/S datum-free single session NEQs**

- session selection
- arc / global parameters
- parameterization

**X/S datum-free monolithic NEQ**

- datum definition
- parameter reduction
- parameter estimation

Station positions (ST), EOPs (E), Source positions (SO)

About 4000 SINEX files

**X/S GSFC CRF**
1. Step: Generating the X/S catalog based on daily datum-free GSFC SINEX files

- 1682 estimated global source positions (at least 3 good observations in each session necessary)
- including all 295 defining sources
2. **Step:** Import of the X/Ka catalog with full covariance information (Data provided by Christopher Jacobs et al. (JPL))

**X/Ka solution information**

- Solution vector
- Full covariance matrix

**Features of the provided X/Ka catalog**
- Solution vector with 631 X/Ka sources (1262 parameters)
- Including 208 of 295 defining sources
- NNR constraint uses these 208 defining sources
- No station positions or EOPs available
2. Step: Import of the X/Ka catalog with full covariance information
GREEN: X/Ka and X/S catalog (443 sources including 208 defining sources)
RED: only X/Ka catalog (188 sources)
BLUE: only X/S (1227 sources)
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Southern Celestial Hemisphere

GREEN: X/Ka and X/S catalog
RED: only X/Ka catalog
BLUE: only X/S

123 of 188 only X/Ka sources are in the southern celestial hemisphere
Residuals between X/S and X/Ka catalog after transformation (3 rotations)

Estimation of 3 rotation angles between the X/S and X/Ka catalog (Transformation based on the 208 defining sources)

<table>
<thead>
<tr>
<th>Catalog Pair</th>
<th>Rotation angles ((x, y, z) ) [mas]</th>
</tr>
</thead>
<tbody>
<tr>
<td>X/S vs. X/Ka</td>
<td>(-0.03, 0.02, 0.002)</td>
</tr>
</tbody>
</table>
Reconstruction of datum-free X/Ka NEQ

Information about used constraints
- NNR constraint
- 208 of 295 defining sources
- three rotations constrained to 20 μas

Generating constraints matrix
\[ C = B^T \ast W \ast B \]

X/Ka catalog
solution vector \( x \)
and
full covariance matrix \( Q_{xx} \)

X/Ka datum-free NEQ
\[ N_{\text{free}} = Q_{xx}^{-1} - C \]

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X/S and X/Ka Combination Approach

X/S datum-free monolithic NEQ

- ST
- X/S sources
- EOPs

X/Ka datum-free monolithic NEQ

- X/Ka sources

Combination on the level of datum-free normal equations

X/S & X/Ka combined datum-free NEQ

- ST
- X/S & X/Ka sources
- EOPs

X/S & X/Ka combined CRF

- datum definition
- parameter reduction
- parameter estimation
Residuals Combined Catalog minus Original X/Ka Catalog

To be investigated

- Non ITRF telescope positions
- Frequency dependence
- Core shift
- „Source Tie“