Bestimmung von Erdorientierungsparametern basierend auf VLBI-Daten mithilfe eines Kalman-Filters

Maria Karbon, Benedikt Soja, Tobias Nilsson, Robert Heinkelmann, James Anderson, Li Liu, Cuixian Lu, Julian A. Mora-Diaz, Virginia Raposo-Pulido, Minghui Xu, Santiago Belda und Harald Schuh

Geodätische Woche 2014
07.-09.10. 2014, Berlin
VLBI-ART: VLBI analysis in real time

- PI: Tobias Nilsson
- Since ~2 years at GFZ
- Funded by the Austrian Science Fund

Aims:
- Getting reliable results within “near real-time”
- Fully autonomous and automated

Why?
- Many applications need precise near real-time parameter, i.e. precise positioning and navigation, orbit determination, meteorological parameters, etc.
- VGOS: continues data stream, LSM no longer suitable

How?
- Implementation of a Kalman filter in the VLBI analysis software VieVS
Basics of the Kalman filter

\[ \hat{x}_{t+1} \quad \hat{P}_{t+1} \]
\[ \tilde{x}_{t+1} \quad \tilde{P}_{t+1} \]

\[ \sim \text{a priori} \]
\[ \wedge \text{a posteriori} \]

Backwards
Basics of the Kalman filter

$$\hat{x}_{t+1} \quad \hat{P}_{t+1}$$

Data

$$\tilde{x}_{t+1} \quad \tilde{P}_{t+1}$$

~..a priori

^..a posteriori

Smoothing
Demonstration data set

- **CONT08**
  - 12.-26.08.2008
  - 11 stations
  - 15 sessions á 24 hours
  - Combined to **ONE** big session

- **ERP from GPS**
  - Hourly
  - Used for validation
CONT08 gets filtered

“day breaks”  Look like clock breaks
CONT08 gets filtered
What to do??

process noise covariance matrix

$Q$
What to do?

$x_{t_0}$

$P_{t_0}$

$Q$

$Q$
CONT08 gets filtered

x Pole CONT08_raw

- GPS
- LSM
- KM

MJD · 10^4
CONT08 gets smoothed

Adjustments to x Pole

\[ x \times 10^{-4} \]

Break
LSM
KM

MJD \times 10^4
CONT08 gets smoothed

Adjustments to y Pole

$10^{-3}$

[as]

MJD $\cdot 10^4$

Break
LSM
KM
CONT08 gets smoothed

Adjustments to dUT1

$\times 10^{-5}$

Break
LSM
KM

MJD $\cdot 10^4$
CONT08 gets smoothed

X Nut

Y Nut

Break
LSM
KM
CONT08 gets smoothed

<table>
<thead>
<tr>
<th>std</th>
<th>GPS -Least squares</th>
<th>GPS-Kalman</th>
</tr>
</thead>
<tbody>
<tr>
<td>x Pole (*10^5)</td>
<td>1.753</td>
<td>1.471</td>
</tr>
<tr>
<td>y Pole (*10^4)</td>
<td>1.512</td>
<td>1.542</td>
</tr>
<tr>
<td>dUt1 (*10^4)</td>
<td>1.633</td>
<td>1.593</td>
</tr>
</tbody>
</table>

- Kalman filter results are comparable to the one from the least squares solution.
- Smoothing to strong, needs optimization
- EOP’s with higher resolution than 1h would be preferable for further testing.
Current status and outlook

- **VIE_Kalman**
  - First version finished, now in the debugging process
  - Fine tuning of process noise
  - Module implementation in VieVS software environment

- **ERP prediction:**
  - Atmospheric angular momentum
  - Investigation of the potential of incorporating additional data like ring-laser gyroscope observations and tropospheric delays from GNSS
  - Implementation in VieVS
Thank you for your attention!

This work was supported by the Austrian Science Fund (FWF), project P24187-N21 (VLBI-ART)