RTCM-SSR Strategy of Bias Treatment

Gehard Wübbena
Geo++
Germany
www.geopp.de

Chair of
RTCM-SSR WG
www.rtcn.org
RTCM-SC104 SSR development

• Working group established in 2007
• 3 development stages:

  1. Development of messages for the transmission of **satellite orbit corrections**, **satellite clock corrections**, **satellite code biases** and **URA** values (currently GPS and GLONASS). Enables real-time dual frequency code based PPP. Completed in May 2011 and published in RTCM standard document: „**RTCM STANDARD 10403.1 with Amendments 1-5**“, July 1, 2011.

  2. Development of messages for the transmission of **phase biases** and **VTEC**. In preparation. Shall enable real-time phase based PPP including ambiguity resolution and real-time single frequency PPP.

  3. Development of messages for the transmission of **STEC** and **tropospheric parameters**. Shall enable PPP-RTK applications (centimeters in seconds)
General Requirements / Rules

- RTCM-SSR shall be a **self-contained** format as far as possible. I.e. all necessary information for consistent processing of an RTCM-SSR stream shall be contained in the stream or shall be specified as part of the standard document. The need for external information should be avoided.

- The definition of RTCM-SSR contents shall not limit/restrict the generation of such streams to certain generation models or approaches.

- International conventions for observation modeling and/or corrections shall be applied as far as necessary and as long as they are well defined and documented and freely usable.

- The standard shall allow **different update rates for different state parameters** in a flexible way.

- **Consistent processing** of SSR stream contents must be ensured.

- The RTCM-SSR standard shall allow global, continental, regional and/or local applications.
Major GNSS Error Sources / RTCM State Parameters

Satellite signal delay+bias
Satellite clock error
Satellite orbit error
Satellite antenna PCV
Ionosphere
Troposphere
Multipath
Antenna (PCV)
Rcvr clock error
Rcvr signal delay+bias
SSR to OSR transformation

- Transformation from State Space Representation (SSR) to Observation Space Representation (OSR)

  - Complete RTCM state vector can be transformed to OSR in form of PseudoRange and PhaseRange corrections, comparable to standard RTCM V2 corrections

  - PseudoRange and PhaseRange corrections (may) contain (average) receiver dependent effects ("average“ receiver = SSR$_{RX}$)

    - SSR$_{RX}$ residual receiver clock effects
    - SSR$_{RX}$ residual receiver signal biases

    - Most residual effects are common to all satellites

    - RTCM-SSR does not contain specifications defining characteristics (amount or time variations) of such SSR$_{RX}$ residual effects

  - SSR$_{RX}$ receiver/antenna type shall be transmitted using 1033 message
RTCM-SSR and Signal Biases

- RTCM-SSR messages for satellite and signal dependent Code and Carrier Biases are (will be) defined as
  - "absolute biases" (instead of differential biases)
    - No need to define reference signals or reference linear combinations
    - Flexible approach with respect to signal selection
    - SSR generating applications working with Differential Biases (DBs) shall chose absolute values in a way that the DBs a correctly represented and consistency is maintained
- RTCM-SSR biases may contain remaining/average/reference receiver biases
  - Biases common to all satellites
    - Easily eliminated through differencing or
    - Changing the estimates of corresponding rover parameters
  - In case of non-common biases (GLONASS FDMA)
    - a type 1033 message describing the type or instance of a reference receiver/antenna shall be sent with the RTCM-SSR stream