Time Bias Service Latest Implementation and Status

S. Bauer[1], J. Steinborn[2]

[1] GFZ Potsdam, Brandenburg, Germany.

[2] DiGOS Potsdam, Brandenburg, Germany.

Content

- Introduction
- Latest implementation: Web
- Latest implementation: JSON API
- Service application examples
  - Comparison of predictions
  - Monitoring of predictions
  - Prediction of time bias values
  - Communication with providers and missions
- What could stations want?

Introduction

- Prediction quality affects station performance: if satellites can only be acquired late or at all
- First time bias service in 11/17, allows to evaluate prediction quality
- Estimation of time bias values from recorded passes and prediction to current point in time, for various satellites, providers and predictions, this can be used
  - During acquisition (choose the best available prediction and get a real time a priori time bias value)
  - For analysis by comparison (for predictions from different providers for the same targets)
  - For monitoring of quality over time (modeling issues, unmodeled maneuvers, outages, etc.)
- Benefit is
  - Support for quicker or acquisition at all, thus more data or quicker target switching
  - Notification of providers AND stations upon issues (modeling, maneuvers or outages)
  - Support for effective as well as autonomous operation and avoiding unnecessary acquisition attempts
  - Support of mission initial phases
- JOG paper in Special Issue on SLR accepted and online
  - Bauer, S. & Steinborn, J. J Geod (2019). https://doi.org/10.1007/s00190-019-01304-3

Latest implementation: Web

- First time bias service interface via website
- Targets: LEOs, Geodetic, Space Debris and GNSS
- Predictions: for different targets, providers & over time
- List of
  - Predicted time bias value at current point in time
  - Residuals of passes w.r.t. used fit
  - Number of passes used for prediction
- Modeling upgrades improved accuracy
  - Correction for atmospheric delay
  - Effect of solid tides on station position
  - Fit order adjusted to number of data points
  - Eccentricity vector if existent with a station

Watch List | LEO Targets | Geodetic Targets | Debris Targets | GNSS Targets

DiGOS

CPF time bias prediction

Contact:
jens.steinborn@digos.eu
sven.bauer@gfz-potsdam.de

GFZ Helmholtz Centre Potsdam

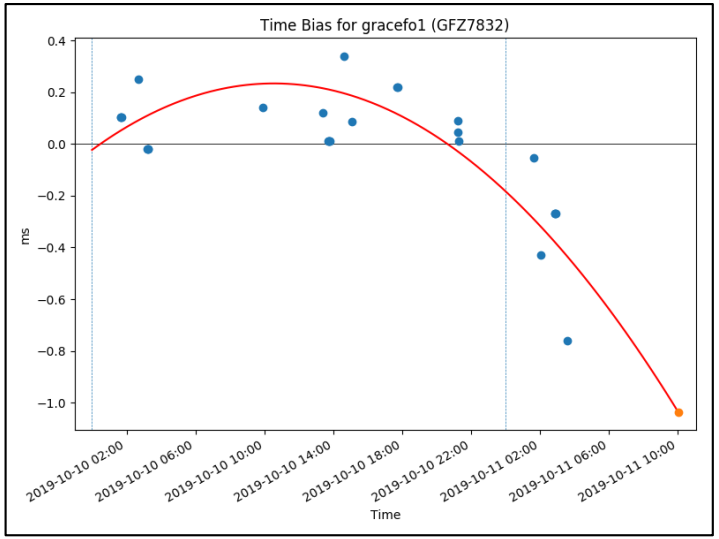
Watch List
Predictions for: 2019-10-11 09:59:13 UTC

Target	Provider	CPFs			
beaconc 6503201 / 317	HTS	HTS7831 -5.1ms (0.7 / #24)	HTS7821 -14.8ms (1.2 / #39)	HTS7811 -27.5ms (1.1 / #48)	HTS7801 -17.9ms (0.9 / #43)
beaconc 6503201 / 317	SGF	SGF7841 -1.8ms (0.2 / #24)	SGF7831 -4.6ms (0.2 / #39)	SGF7821 -12.5ms (0.3 / #48)	SGF7811 -24.6ms (0.5 / #43)
geoik2 1603401 / 5561	SPN	SPN7831 0.4ms (0.5 / #19)	SPN7821 0.8ms (0.7 / #36)	SPN7811 12.2ms (1.0 / #57)	SPN7801 13.6ms (1.2 / #62)
gracefo1 1804701 / 123	GFZ	GFZ7841 -1.4ms (0.1 / #4)	GFZ7832 -1.0ms (0.1 / #16)	GFZ7831 5.0ms (0.1 / #16)	GFZ7822 -6.1ms (0.1 / #26)
gracefo2 1804702 / 124	GFZ	GFZ7841 0.1ms (Last / #3)	GFZ7832 1.0ms (0.1 / #15)	GFZ7831 -0.1ms (0.1 / #15)	GFZ7822 -8.4ms (0.3 / #23)
hy2a 1104301 / 2201	SHA	SHA7841 -3.6ms (Last / #2)	SHA7831 -11.7ms (0.2 / #14)	SHA7821 -13.9ms (0.2 / #26)	
hy2b 1808101 / 2208	SHA	SHA7841 -0.3ms (0.0 / #4)	SHA7831 -0.5ms (0.7 / #20)	SHA7821 0.3ms (0.6 / #30)	SHA7811 1.7ms (0.5 / #48)
icesat2 1807001 / 6873	GSF	GSF7831 -74.6ms (5.7 / #6)	GSF7821 69.3ms (11.1 / #10)	GSF7811 150.8ms (17.9 / #14)	GSF7801 475.0ms (22.8 / #15)
kompsat5 1304201 / 3803	KGS	KGS7841 -4.7ms (Last / #1)	KGS7831 -4.4ms (0.2 / #10)	KGS7821 -37.2ms (0.5 / #19)	
lightsail2 1903629 / 4202	NXT	NXT7806 No Data			
paz 1802001 / 2501	HDS	HDS7831 0.8ms (0.1 / #10)	HDS7821 4.9ms (0.2 / #20)	HDS7811 20.6ms (4.6 / #30)	HDS7801 14.9ms (4.8 / #31)
snet1 1801410 / 6204	AAS	AAS7831 -3.5ms (0.1 / #5)	AAS7821 -3.5ms (0.1 / #5)	AAS7821 6.0ms (0.5 / #8)	AAS7821 6.0ms (0.5 / #8)
snet1 1801410 / 6204	DLR	DLR7841 -3.2ms (Last / #1)	DLR7831 5.7ms (0.5 / #5)	DLR7821 39.5ms (0.3 / #8)	DLR7811 50.9ms (0.6 / #10)
snet3 1801408 / 6206	AAS	AAS7831 No Data	AAS7821 No Data	AAS7811 No Data	AAS7801 No Data
snet4 1801409 / 6207	AAS	AAS7831 1.6ms (0.2 / #5)	AAS7821 21.8ms (0.4 / #7)	AAS7811 26.2ms (0.6 / #11)	
snet4	DLR	DLR7841	DLR7831	DLR7821	DLR7811

Snapshot of the time bias service website http://slr.gfz-potsdam.de:5000/tb/v1.

Latest implementation: Web

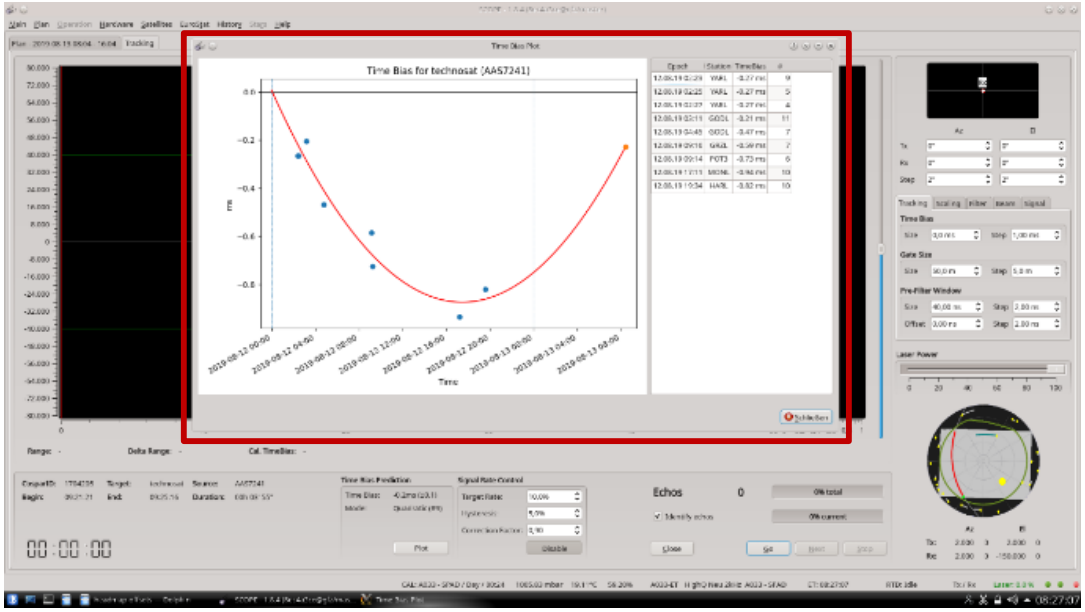
- First time bias service interface via website
- Targets: LEOs, Geodetic, Space Debris and GNSS
- Predictions: for different targets, providers & over time
- List of
  - Predicted time bias value at current point in time
  - Residuals of passes w.r.t. used fit
  - Number of passes used for prediction
- Modeling upgrades improved accuracy
  - Correction for atmospheric delay
  - Effect of solid tides on station position
  - Fit order adjusted to number of data points
  - Eccentricity vector if existent with a station
- Improved graphical representation



Graphical representation of time bias values (blue: recorded passes, orange: predicted) as well as the applied fit (red) from the time bias service website.

Latest implementation: JSON

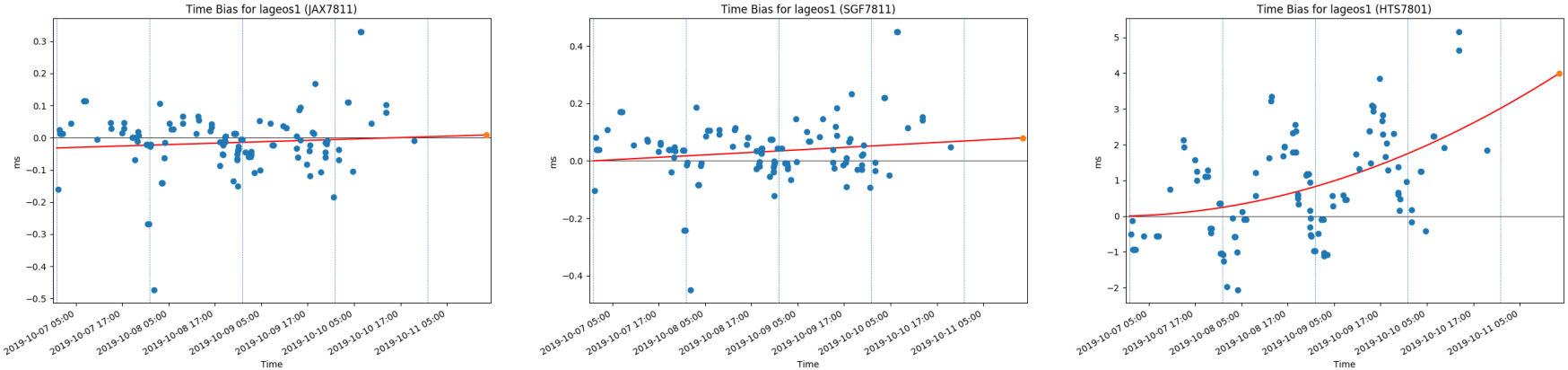
- Request for target & prediction: http://slr.gfz-potsdam.de/tb/v1/cpf/<target>/<provider+seq>
- Returns data in JSON format
  - Time bias values of recorded passes
  - Predicted time bias value
  - Applied fit
  - Link to graphical representation
- Allows for convenient integration into software
- Instead of crawling the website
- Example: SCOPE software integration



Example for JSON API implementation in SCOPE software. The data retrieved via the JSON API is displayed in the box highlighted in red.

Analysis by comparison

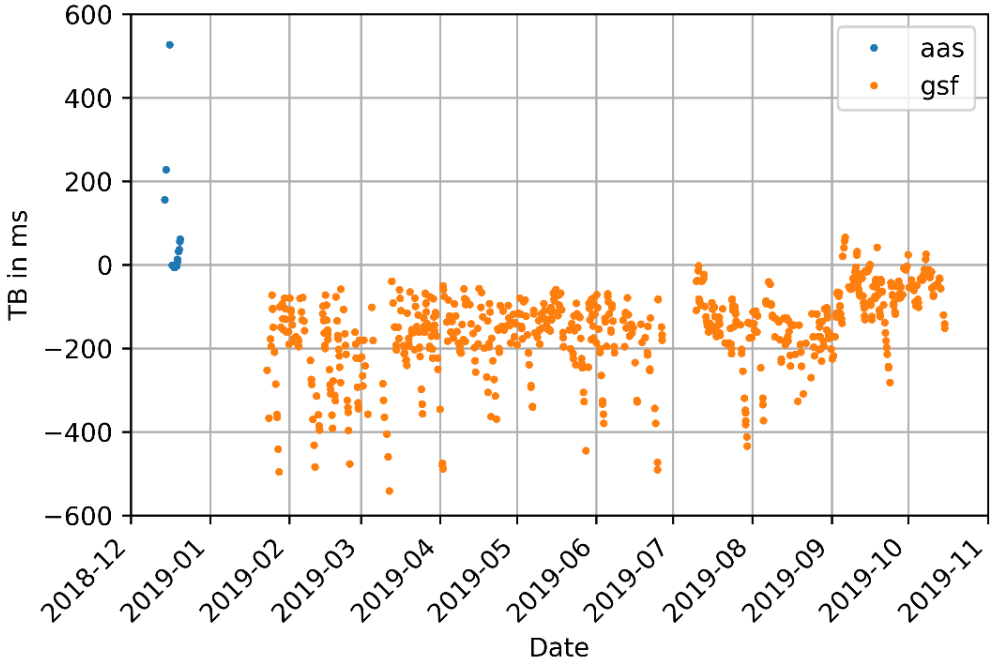
- Lageos 1 predictions
  - Good quality for all providers over first day (so totally fine!), afterwards trends visible
  - Gives an idea about the applied modeling – here trends and oscillations
  - In case of outage you know what you can expect from an older or a backup prediction



Lageos time bias values for passes recorded with predictions from different providers.
Note the different ranges on the Y-Axis.

Monitoring over time

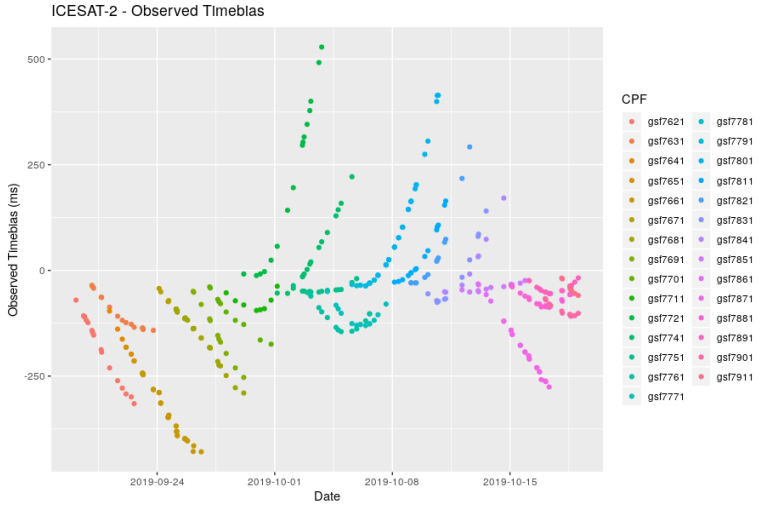
- Icesat2 predictions,
  - Quality analysis from monitoring over time
  - Large negative offsets and trends
  - Modeling issues?
  - No change for a long time
- But lately, improvement visible
- However, time bias service helps to track Icesat2 quite routinely



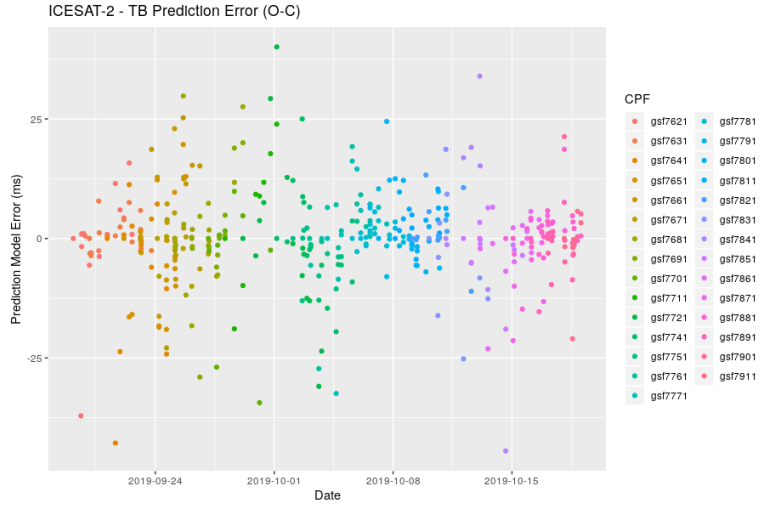
Icesat2 time bias values for passes recorded with predictions from different providers. Note the continuously existing negative trends and general offset towards negative values.

Time bias value prediction

- Icesat2
  - Relative prediction error is approx. 10% on average over full Icesat2 mission (up to now)
  - Predicted time bias values supports routine tracking even with large values



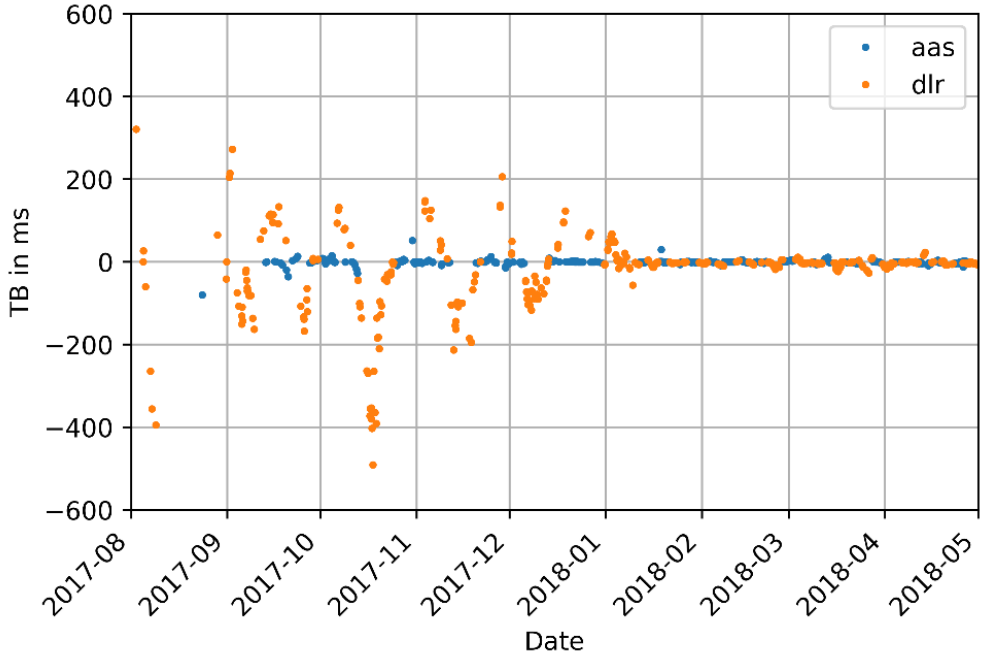
Time bias value of Icesat2 passes over a selected period of time with the respective color coded predictions.



Absolute prediction error (predicted – observed) over the selected timeframe with the respective color coded predictions.

Communication with providers & missions

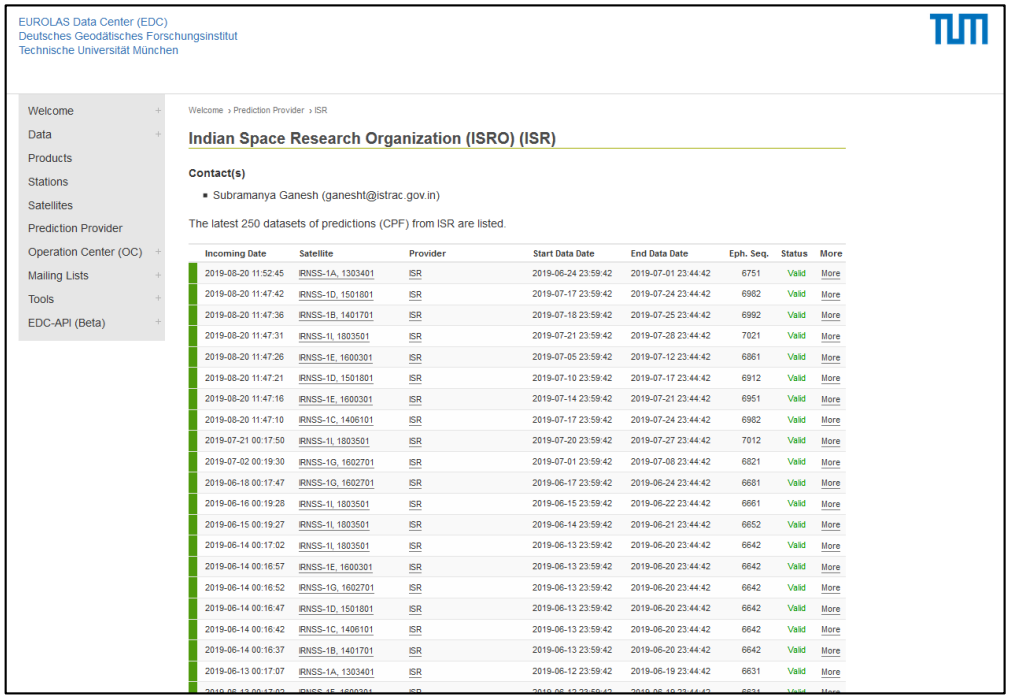
- Technosat
  - improvement of DLR predictions upon notification
- Analysis by comparison of predictions from different providers
- Monitoring over time
- Communication with provider
  - Notifcation end of 12/17
  - Improvement from mid 01/18 on



Technosat time bias values for passes recorded with predictions from different providers.

Communication with providers & missions

- IRNSS
  - Prediction outage without further notice or communication
  - No more SLR data required? Outage?
- Case for other missions too
  - Compass sometimes
- But also more good examples
  - Jason 2, notification upon all kinds of issues
  - Sentinel, notification upon maneuvers and others



Snapshot of the last available IRNSS predictions on the EDC website (requested on Oct 7th 2019).

What could stations want?

- … with respect to predictions or „**if you want your satellites actually to be tracked …**"
- Coverage and quality
  - Continuous and good predictions – good = sufficient for tracking, rather easy acquisition
- Communication
  - Modeling improvement upon notification if tracking is not feasible
  - Notifications for providers, stations and missions if something is wrong (modeling issues, maneuvers, outages or SLR data is not required for the mission anymore, etc.)
- Why or what would be the results?
  - Only try to acquire targets or missions that need SLR data
  - Save time on useless attempts (bad predictions and no information)
  - More effective operation, relevant with more targets and autonomous operation
- Continuing time bias service
  - Supporting the prediction quality evaluation, providing a basis for discussion and support during satellite tracking and for missions

Thanks