

# The IERS Rapid Service / Prediction Center UT1-UTC Combined Solution: Present and Future Contributions

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# Rapid Service / Prediction Center Products & Distribution Frequency

Product	Distribution Frequency	Description
Bulletin A (ser7.dat)	Weekly <sup>†</sup>	<ul style="list-style-type: none"> <li>• 7 day Combination</li> <li>• 1 year of Predictions</li> </ul>
finals.all	Weekly <sup>†</sup>	<ul style="list-style-type: none"> <li>• Begins in <b>1973</b></li> <li>• EOPs re-calculated 1 year in past</li> </ul>
finals.data	Weekly <sup>†</sup>	<ul style="list-style-type: none"> <li>• Begins in <b>1992</b></li> <li>• EOPs re-calculated 1 year in past</li> </ul>
finals.daily	Daily @ 17:30 UTC	<ul style="list-style-type: none"> <li>• 90 Combination</li> <li>• 90 Prediction Days</li> </ul>
finals2000A. [daily; data; all]	Same as above	<ul style="list-style-type: none"> <li>• CPOs in dX/dY</li> </ul>

<sup>†</sup> Weekly products produced on Thursdays by 19:00 UTC

- Calculated EOPs: PM-x, PM-y, UT1-UTC, LOD, dX, dY, d $\psi$ , d $\epsilon$
- Solutions are **monitored** and **verified 365 days/year**
- Non-operational solutions generated at 03:00, 09:00, 21:00 UTC (passively monitored, not verified)



# finals.daily UT1-UTC Solution Contributors

Contributor	Expected Latency	Mean Latency (2018)	Latency Goal Met (2018)	Data Used
GSFC INTs	22 hrs	<b>+ 1 day (46 hrs)<sup>†</sup></b>	<b>100%<sup>†</sup></b>	KkWz / IsWz baselines*
USNO INTs	22 hrs	<b>+ 1 day (46 hrs)<sup>†</sup></b>	<b>100%</b>	
GSI INTs	9 hrs	<b>+ 1 day (33 hrs)<sup>†</sup></b>	<b>91%</b>	IsWz baseline*
UTGPS	17 hrs	11 hrs	100%	12-hr solution
IGS Ultra Rapid LODs	17 hrs	17 hrs	100%	12-hr solution
GSFC 24hr VLBI	14 days	<b>+ 7 days (21 days)<sup>†</sup></b>	<b>90%</b>	R1 / R4
USNO 24hr VLBI	14 days	<b>+ 7 days (21 days)<sup>†</sup></b>	<b>83%</b>	
IVS Combination	21 days	<b>+ 7 days (28 days)<sup>†</sup></b>	<b>96%</b>	
IAA VLBI	28 days	<b>+ 7 days (35 days)<sup>†</sup></b>	<b>100%</b>	

<sup>†</sup> INT2's included in mean    \* Baseline substitutions occasionally made

<sup>††</sup> Latency goals not met some days, exceeded others

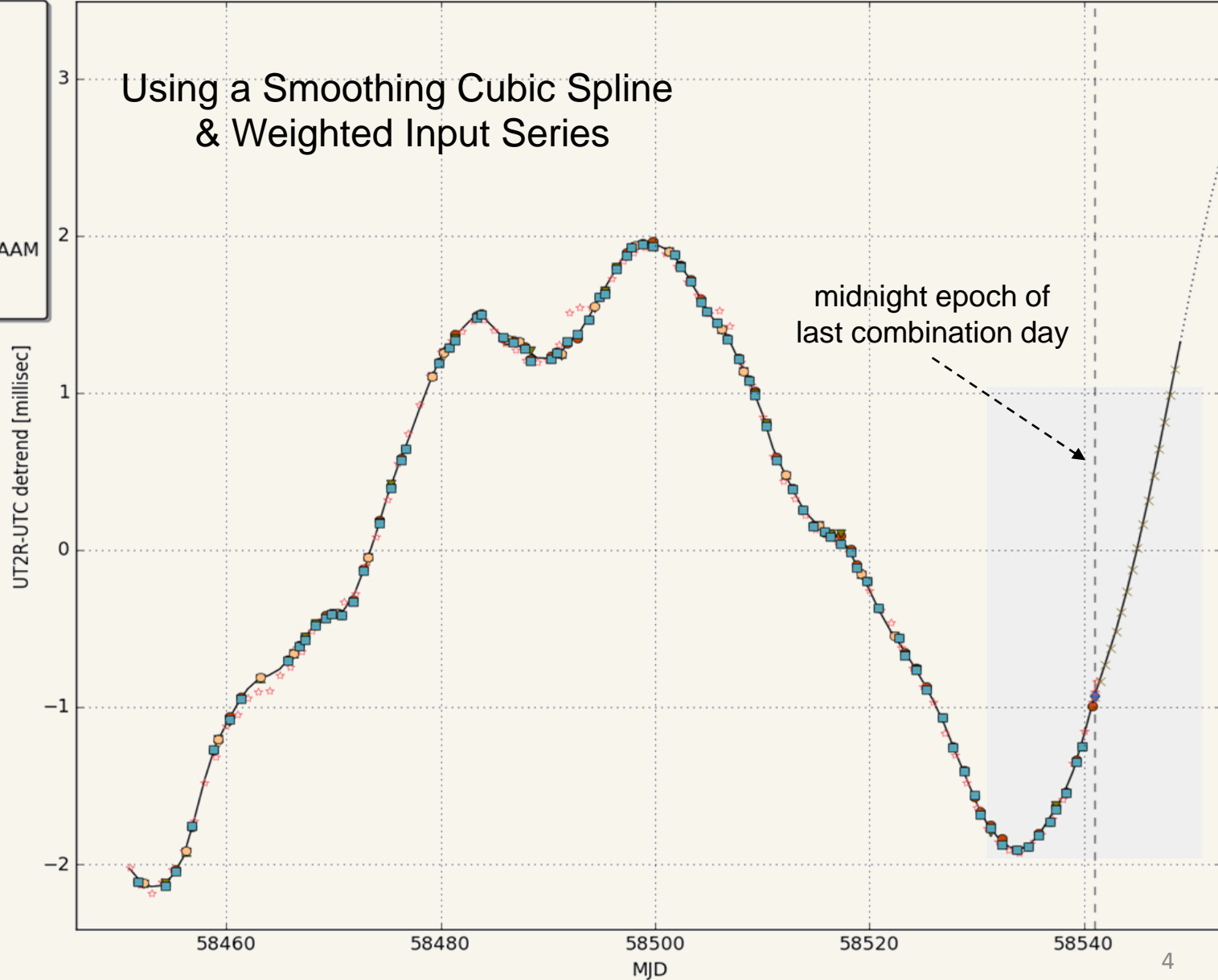
New Intensives are available **69% of all days** in 2018, and **82% of days** where an **intensive is scheduled**.

- AAM from NOAA and NAVGEM used for predictions



# Generating a Combined Solution for UT1-UTC

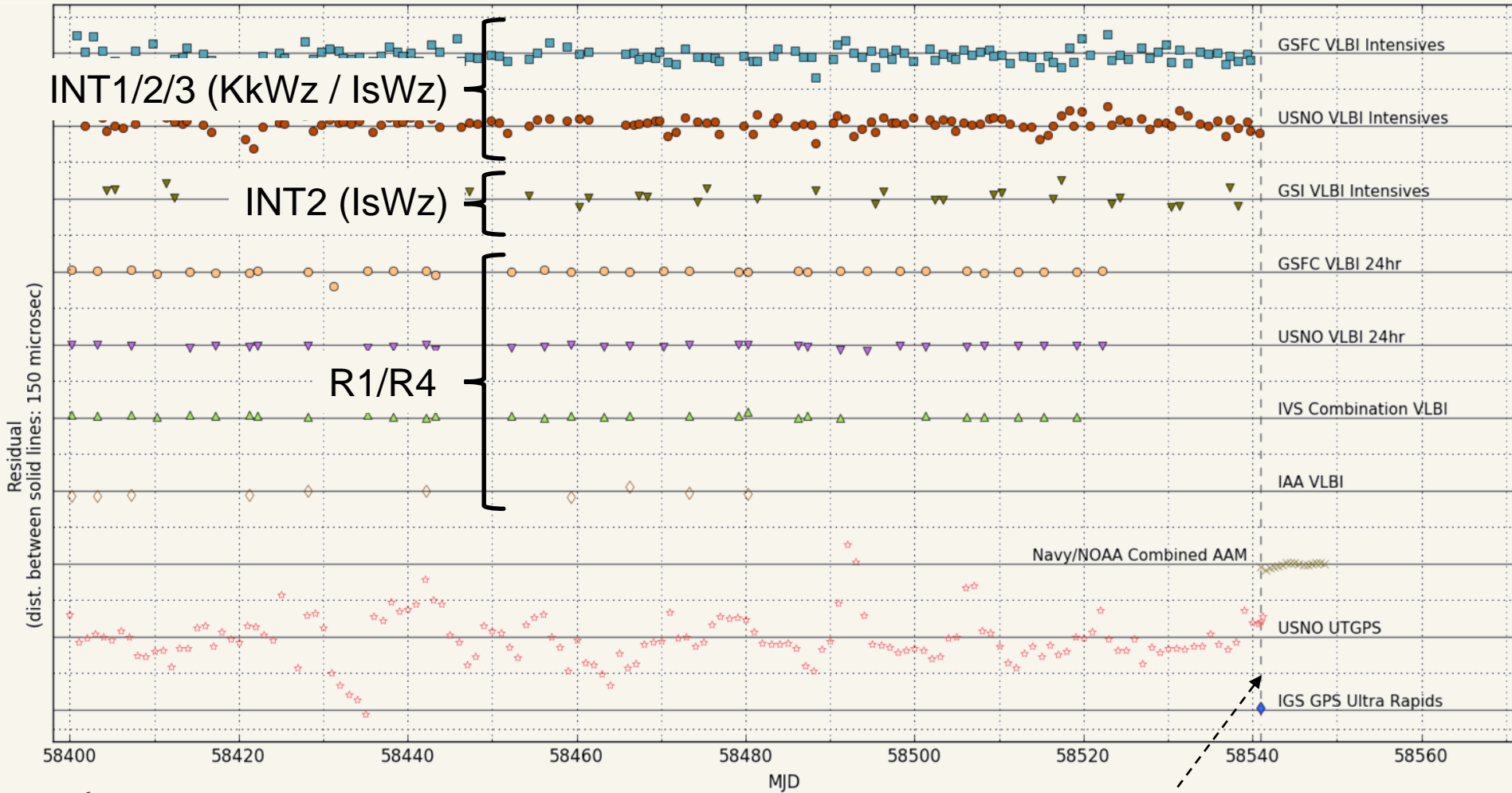
Using a Smoothing Cubic Spline  
& Weighted Input Series



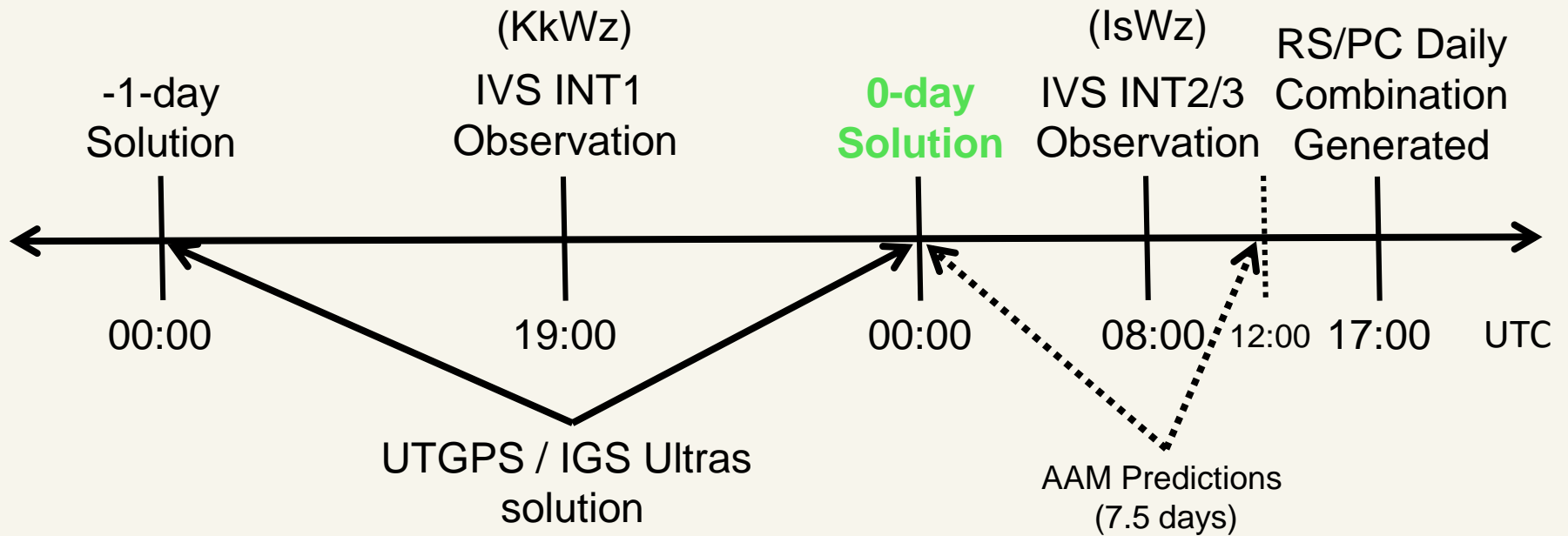
- ..... Predictions
- IERS RS
- USNO VLBI Intensives
- ▲ IVS Combination VLBI
- ▼ USNO VLBI 24hr
- ◆ IGS GPS Ultra Rapids
- ☆ USNO UTGPS
- ▼ GSI VLBI Intensives
- ◇ IAA VLBI
- × Navy/NOAA Combined AAM
- GSFC VLBI 24hr
- GSFC VLBI Intensives



# Input Series Used in UT1-UTC Combination



# Low-Latency Data is Critical for UT1-UTC Solution

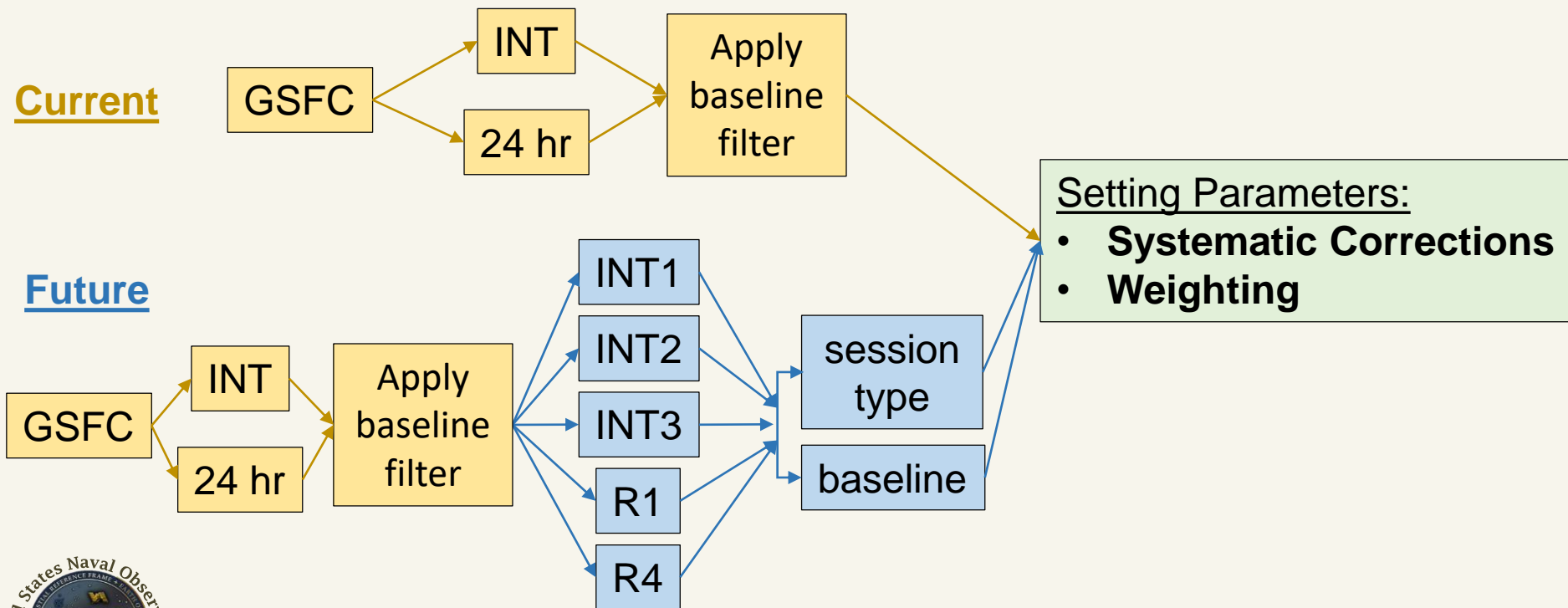


Present data determines UT1!



# Preprocessing UT1-UTC Contributions

- Data is whitelisted for a given data series (Analysis Center) by session-type, baseline, and MJD
- Variables are determined for expected baselines (e.g., KkWz and IsWz), but applied to whole Analysis Center's series



# Integrating a New Intensive Baseline Into Combination

- New baselines require a software change by RS/PC staff
- RS/PC must characterize a new baseline prior to whitelisting, to determine:
  - Systematic corrections ~~& if they vary from standard baselines~~  
(i.e. ~~KkWz / IsWz~~)
  - ~~If the new baseline is in-family with the standard baselines~~
  - RS/PC can characterize an Intensive baseline with 60 observations over a minimum 4 month period

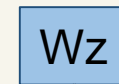




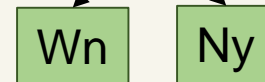
# Generating a More Robust UT1 Solution

- Characterize backup baselines for when Kokee, Wettzell, or Ishioka are unavailable
  - 60 observations over a minimum 4 month period are required to calculate systematic corrections, series weight, and formal error thresholds

Current Intensive Stations:

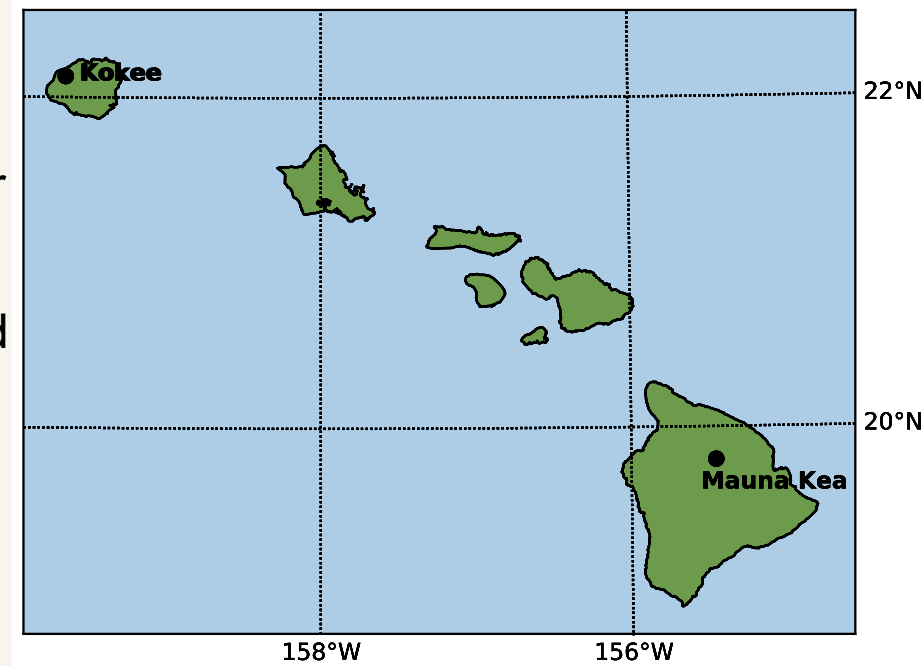


Investigating Substitutes:

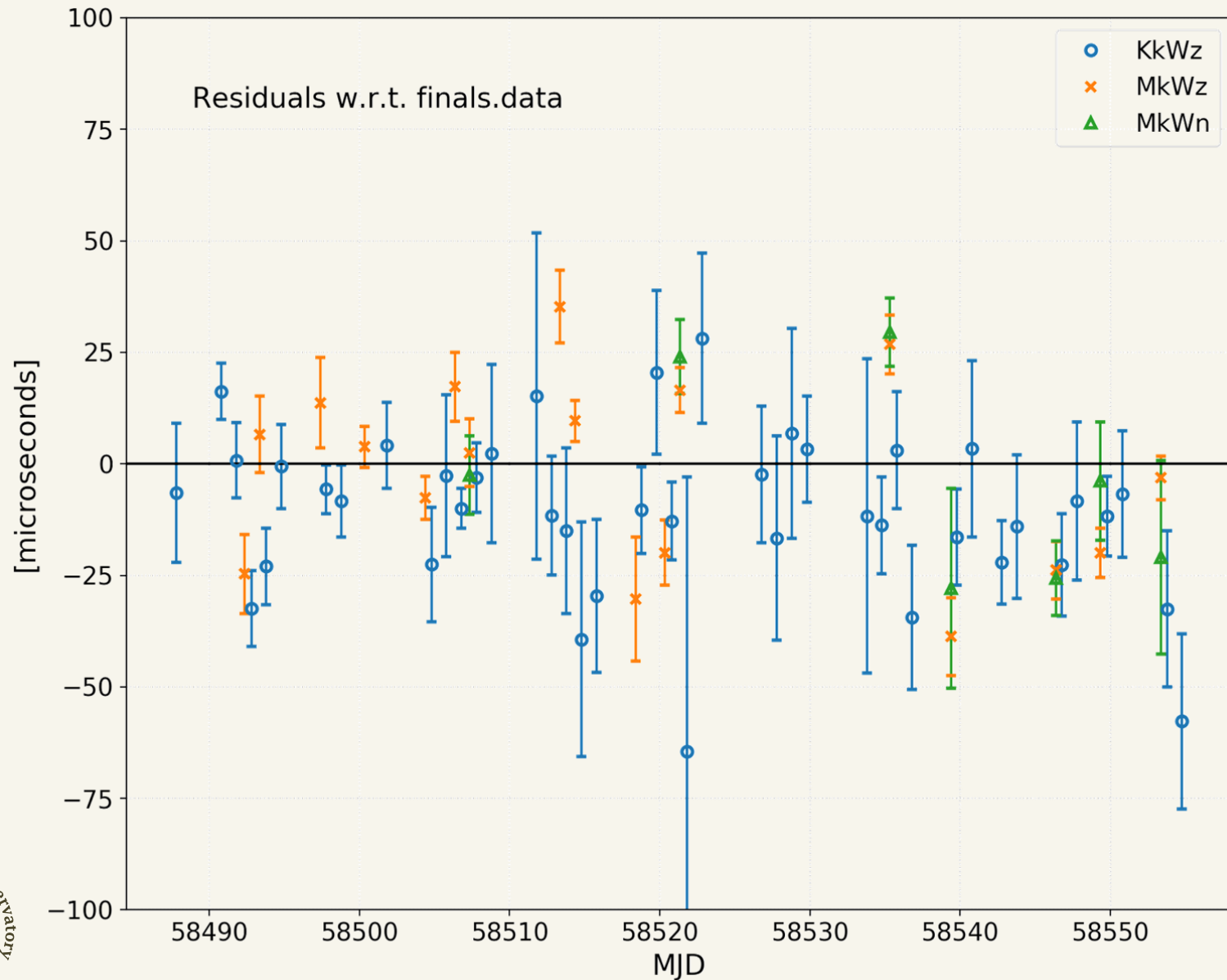


# Generating a More Robust UT1 Solution

- Currently running w-series 3 days/week, beginning in January, to characterize MkWz & MkWn baselines
  - We expect to achieve 60 observations with Wz by late-Summer
  - Interested in VLBA Mauna Kea antenna because of location on island and proximity to Kokee
  - Volcanic activity mid-2018 relocated station
  - See Chris Dieck's poster for more details on this series and Mauna Kea station position adjustments

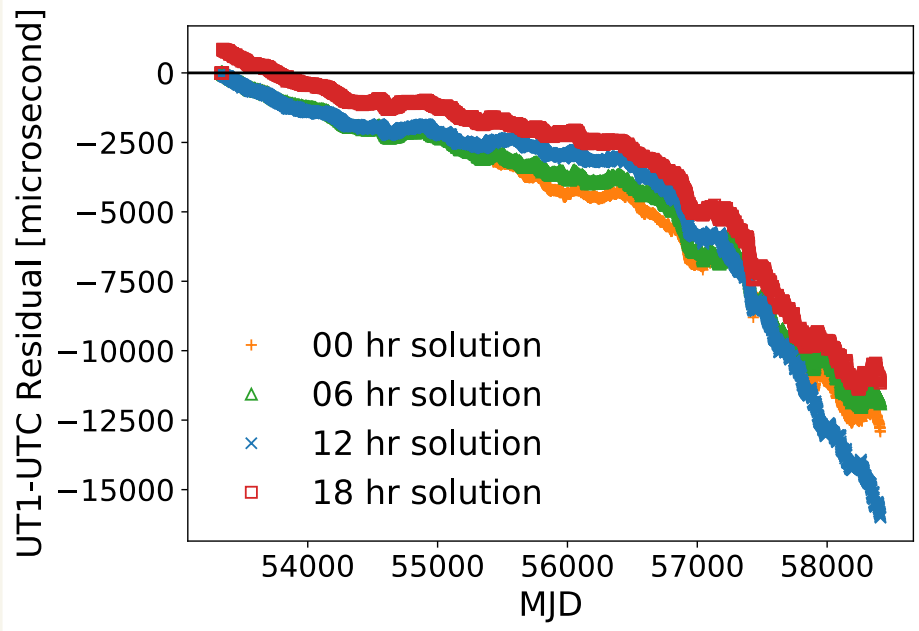


# W-series Performance Thus Far



# Generating a More Robust UT1 Solution

- Improving UTGPS UT1-UTC Contribution



- RS/PC pre-processing method
- Working with USNO GPS Analysis Division for model-level improvements
- Integrating more than 1 of 4 daily UTGPS solutions
  - currently only using 12-hr solution (produces midnight epoch)

- UTGPS provides best UT1 values for Combination when Intensives are not available



# Concluding Thoughts

- IVS Intensives are VERY important to the health of the RS/PC UT1 product
  - Characterized backup baselines for INT1s will help maintain low-latency Intensive integration into daily Combination
- When Intensives are delayed, the only other UT1-like data series are UTGPS<sup>1</sup> (currently noisy)
  - (Integrated LODs – AAM Predictions & IGS Ultras—are not UT1)
- Interesting future project: Southern Hemisphere Intensive (Tahiti-HARTRAO)?

<sup>1</sup> Kammeyer, P., 2000, "A UT1-Like Quantity from Analysis of GPS Orbit Planes," *Celest. Mech. Dyn. Astr.*, 77, pp. 241-272.



# Contact Information

(Also found at top of Bulletin A)

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IERS RS/PC Contact Page	<a href="https://www.iers.org/IERS/EN/Organization/ProductCentres/RapidServicePredictionCentre/rapid.html">https://www.iers.org/IERS/EN/Organization/ProductCentres/RapidServicePredictionCentre/rapid.html</a>

Primary Server	<a href="http://maia.usno.navy.mil/ser7">maia.usno.navy.mil/ser7</a>
Backup Server	<a href="http://toshi.nofs.navy.mil/ser7">toshi.nofs.navy.mil/ser7</a>
CDDIS	<a href="ftp://cddis.gsfc.nasa.gov/pub/products/iers">ftp://cddis.gsfc.nasa.gov/pub/products/iers</a>



# W-series Performance Thus Far

