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# ***International Earth Rotation and Reference System (IERS) Observations and Leap Seconds***

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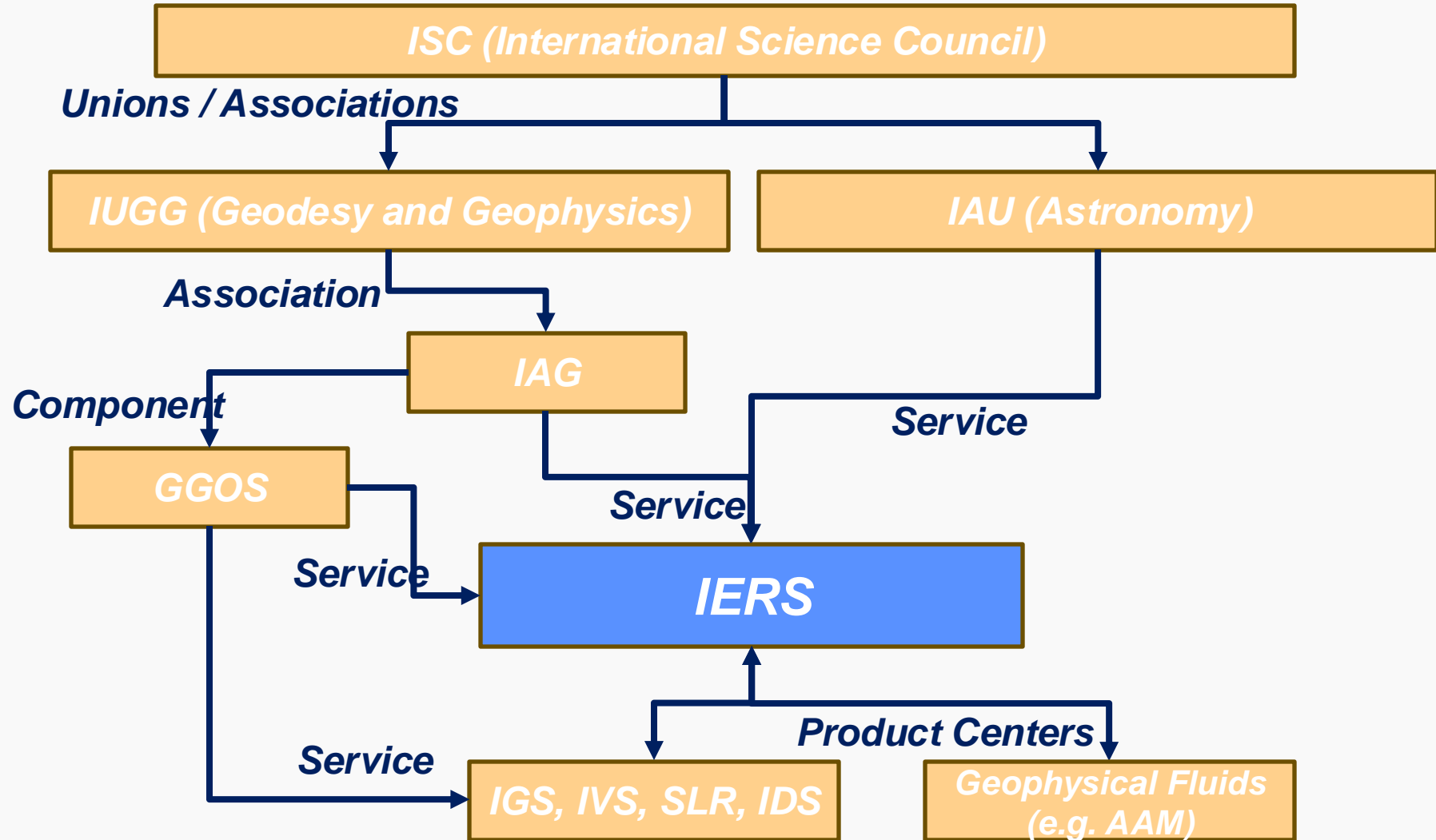
# U Outline



- ***Review of the IERS, Earth Orientation, and Leap Seconds***
- ***Past Observations of UT1-UTC***
- ***Risks of Attempting to Predict of Leap Seconds Beyond 6 months into the Future***
  - ***Example of a “Poor” Prediction***



# Organization<sup>U</sup> Chart Sketch (Geodetic Emphasis)





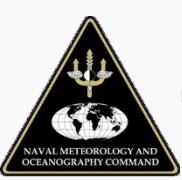
- ***IERS was established in 1987 by the IAU and the IUGG***
  - The primary objectives of the IERS are to serve the astronomical, geodetic and geophysical communities by providing data and standards related to Earth rotation and reference frames.
  - ***Service of the IAU, reports to the IAU A2 Regular Commission on the Rotation of the Earth.***  
([https://www.iau.org/science/scientific\\_bodies/commissions/](https://www.iau.org/science/scientific_bodies/commissions/))
  - ***Service under the IAG, which, in turn, is an Association of the IUGG.***  
( <https://iugg.org/about/structure/> and <https://iugg.org/> )
  - ***USNO is a co-founding member of the IERS and the EO Department is internationally known as the IERS Rapid Service / Prediction Center (IERS RS/PC)***



# Earth Orientation Parameters



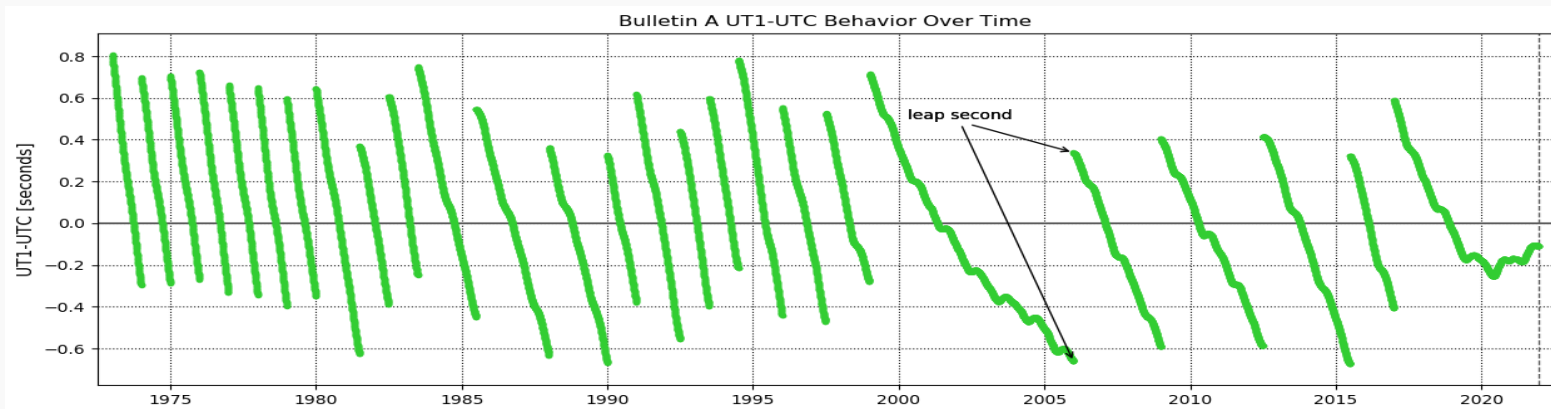
- ***EO Parameters needed to accurately model the terrestrial to celestial reference frame transformation.***
  - ***Systems with knowledge of location, attitude, and pointing directions in a celestial (inertial) frame can use EOPs to relate that information to a terrestrial (Earth-fixed) frame.***
- ***EOPs consist of 5 parameters updated daily.***
  - ***Observables and residuals to models from which the terrestrial reference frame orientation relative to the celestial frame can be determined.***
  - ***Direction cosine matrix calculations from terrestrial-to-celestial require EOP inputs. (Example is the USNO Earth Orientation matrix calculator.)***



# U Leap Seconds



- **Earth Rotation as measured by the angle UT1 varies compared to Atomic Time or Terrestrial Time.**
- **IERS Earth Orientation Center and IERS Rapid Service / Prediction Center (sub-bureaus of the IERS) maintain measurements of the variation of Earth Rotation versus Atomic Time (UTC).**
  - **UTC is not necessarily a continuous time scale. (Atomic Time) TAI and Terrestrial Time (TT) are continuous time scales.**
  - **To keep the cumulative difference in UT1-UTC less than 0.9 seconds, a leap second is added (or subtracted) in UTC to decrease the difference between UT1 and UTC**





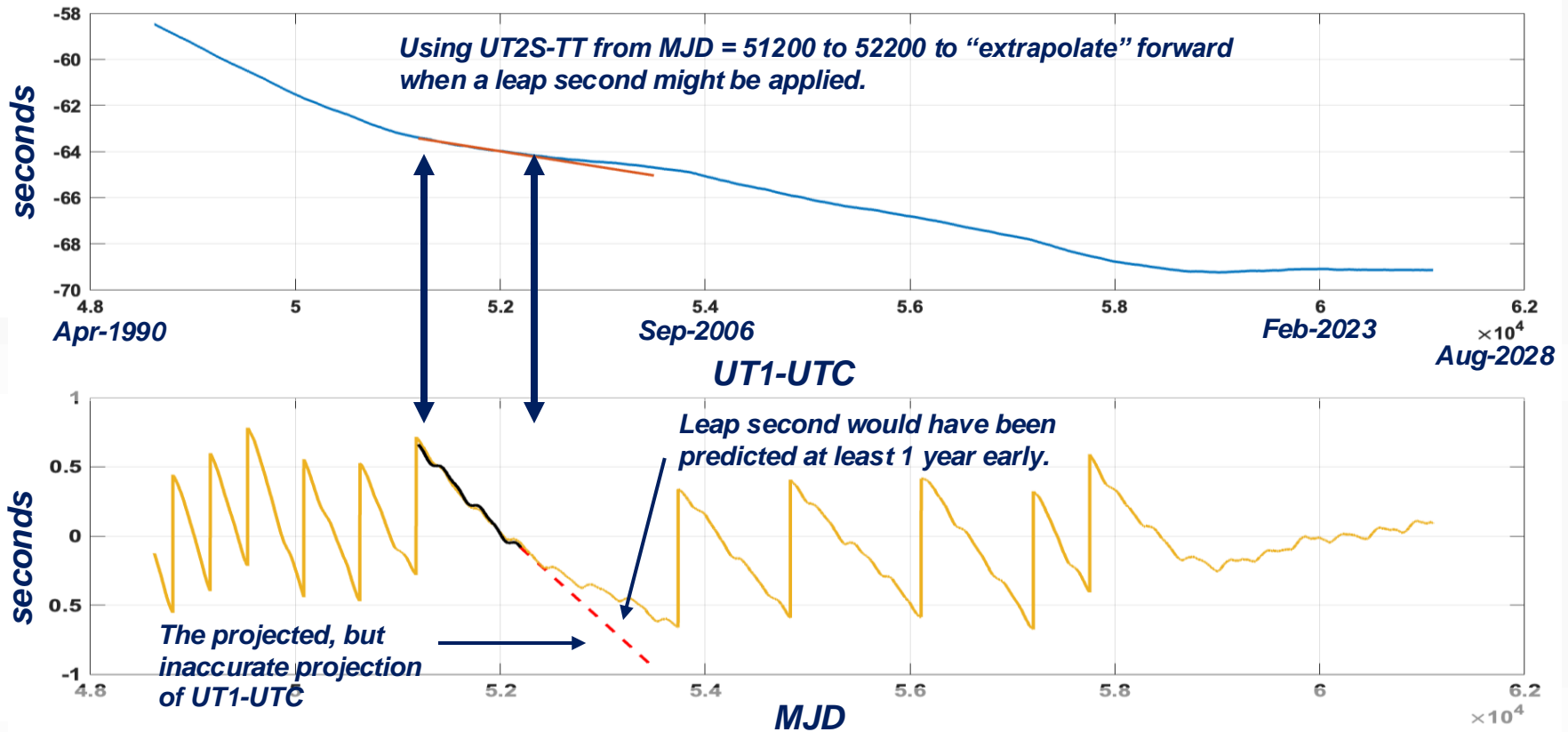
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# Inaccurate Leap Second Predictions

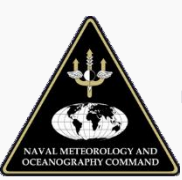


- Example of inaccurate prediction of a leap second change using past trends

**UT2S-TT converted from UT1-UTC (removed tides, seasonal, and leap seconds)**

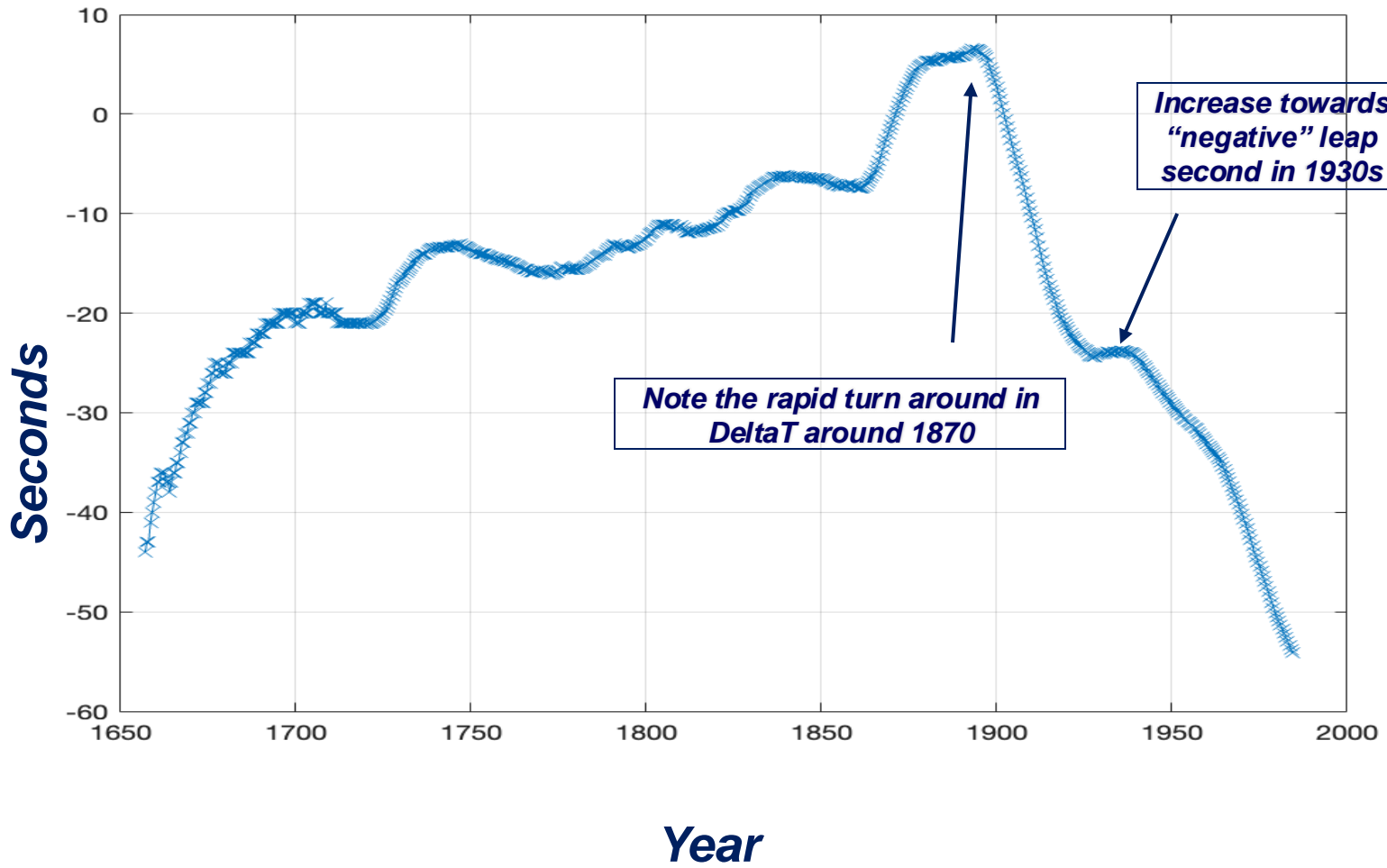


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# Historic DeltaT (UT1-TT)



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# U Summary



- ***Predictions of leap seconds using extrapolation from previous periods of time is not reliable.***



# Backup Slides





# IERS Technique Centers



- **The IGS, IVS, and ILRS are Technique Centres within the IERS**  
(<https://www.iers.org/IERS/EN/Organization/TechniqueCentres/TC.html>)
- The **IGS** provides GNSS orbits, tracking data, and other high-quality GNSS data (including some EOPs) and data products on-line in near real time. (“Functioning as a component of the Global Geodetic Observing System (GGOS) and member of the World Data System (WDS)” -- <https://igs.org/about/#at-glance>)
- **The IVS supports geodetic and astrometric work on reference systems, Earth science research and operational activities.** (“...is a Service of IAG, IAU and the WDS” -- <https://ivsc.gsfc.nasa.gov/>)
- **The ILRS supports geophysical research activities through Satellite Laser Ranging and Lunar Laser Ranging.** (“...is one of the space geodetic services of the International Association of Geodesy (IAG) and is a member of the IAG’s Global Geodetic Observing System (GGOS).” -- <https://ilrs.gsfc.nasa.gov/about/Overview.html>)