Alicante IVS Analysis Center Report

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Abstract Over the past two years, we have contributed to the first update of the International Terrestrial Reference Frame (ITRF) 2020u through the reanalysis of Very Long Baseline Interferometry (VLBI) sessions. Further, since March 2023 we have regularly submitted R1/R4 sessions to the Combination Center in lieu of becoming a fully operational Analysis Center. Since September 2024, we have also submitted VO sessions. We have engaged in a variety of research activities such as precession/nutation model improvement, investigating the performance of VGOS sessions, investigating the consistency of VLBI products, and Earth orientation parameter (EOP) prediction.

1 General Information

The Alicante IVS Analysis Center (UAVAC) is framed in the research group "Space Geodesy and Dynamics" of the Department of Applied Mathematics and Aerospace Engineering at University of Alicante. It was funded in 2018 and started its operation in early 2022. Alongside other partners, notably Instituto Geografico Nacional (IGN) and the member stations themselves, the UAVAC is a key partner in RAEGE and takes the position of scientific advisor and partner data Analysis Center. Table 1 lists the current members of the UAVAC and the RAEGE Analysis Group.

Within this report we will focus solely on the UAVAC activities.

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Table 1 Team members.

UAVAC	
Santiago Belda	EOP modeling and prediction
Sonia Guessoum	EOP ML-prediction
Alberto Escapa	Theory
Jose Manuel Ferrandiz	Group leader, theory
Maria Karbon	Chief of operation and validation
Jose Antonio Martinez	IT and hardware
Lucia Del Nido	EOP and AAM prediction

RAEGE Analysis Group	
Esther Azcue	VLBI and GNSS analysis
Mariana Moreira	Operation and analysis at RAEGSM
Clara Pérez	VLBI analysis and modeling
Andrea Rosillo	VLBI performance
Jose Carlos Rodríguez	SLR

2 Activities During the Past Two Years

Within our activities of supporting ITRF realizations, we reanalyzed all sessions listed by the IVS for inclusion in ITRF2020 and its 2023 update. These sessions also form the basis for many of the research activities carried out. Here we want to highlight a few topics we worked on during the last two years.

2.1 Precession and Nutation Theory

One of our core activities focused on the improvement and update of the precession-nutation models. In a first step, corrections to the existing models IAU2000/2006a were proposed. We have followed different approaches, most recently: (I) a semi-empirical approach consisting of 14 periods (nine luni-solar, five

planetary terms) determined based on ivs24q1X, in 1984–2024, where corrections to precession and nutation components are available and (II) an analytical solution for the planetary origin nutation corrections consisting of the Oppolzer terms of a two-layer Earth model. Preliminary results show that the empirical solution is clearly superior to the analytical one and gives improvements between 15–20% in terms of the *wrms* of the CPO; also the ERP profits from the update, whereas, for the analytical solution, the improvements are significantly smaller, and the ERP are not affected in any way. A further complication is the fact that changing the nutation model also necessitates an update of the Free Core Nutation model, as it entirely depends on the residual signal. For this we updated our FCN estimation methodology.

2.2 EOP Prediction

Accurate Earth Orientation Parameter (EOP) predictions are needed for many applications; hence we investigate multiple methods, firstly, traditional statistical and empirical methods (Singular Spectrum Analysis + Copula) and more recently machine learning methods. One of the deep learning methods we use is the one-dimensional convolutional neural network (1D CNN), to model and predict the ERP using the IERS EOP 14 C04 and the atmospheric angular momentum (AAM). The comparison with respect to the first EOP PCC indicates that the 1D CNN can precisely predict the LOD parameters of ultra-short predictions (from one to seven days), providing comparable accuracy, and is even better than the Kalman filter and Copula + SSA methods developed within UAVAC together with BKG for the first and second day. The introduction of the AAM aids the predictions considerably.

2.3 Consistency Studies

Another focal point of our Analysis Center is the investigation of various products, methods, and components that are of the IVS and used within the IVS. For example, we examine the analysis results of modern geodetic VLBI sessions based on the center that correlated them, and we looked at key parameters to determine the differences and impact of the correlation of these key parameters.

After examining the *wrms* of the EOP, the performance of all CCs is comparable, hinting that any differences seen are less connected to the CCs and more to session-specific parameters. The overall performance of VGOS w.r.t. S/X emphasizes the lack of stations in the southern hemisphere, especially in South America, as they would contribute to the stability of Yp as well as the CPO. In terms of dUT1, VGOS shows an improvement, the weak network as well as the small number of sessions w.r.t. the legacy system notwithstanding. Looking at the station positions, a number of stations show periodic, almost yearly, signals identical in phase. The origin of these signals is still under investigation.

3 Current Status

We finalized our contribution to the ITRF2020 update for 2024 using VieVS@GFZ, and have internally prepared for the switch to the ITRF2020 update released December 2024. We currently work on the incorporation of JTRF2020 and its update to be able to compare and assess the different ITRS realizations in view of the IERS Technical Note focusing on their intercomparison.

4 Future Plans

UAVAC aims to integrate cutting-edge technology and innovative methodologies to enhance the analysis of VLBI data. Here we focus on improving the models employed as well as the methodologies themselves. We plan to enhance our capabilities in modeling and prediction and to streamline and automatize our operational analysis. We plan to expand our analysis capabilities to Level 3 within the upcoming years and to post correlation analysis as a long-term goal. Further, we plan on incorporating more of the RAEGE infrastructure into our research, i.e., the SLR station in Yebes as well as the SGs at Yebes and Santa Maria.

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