Status of ESA's independent Earth Orientation Parameter product

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Outline

- Introduction
- ESA’s contributions to International Services
- Motivation for an ESA’s independent EOP product
- ESA Study on Independent generation of Earth Orientation Parameters
- Combination approach
- Preliminary results (from study)
- Way forward for ESA’s independent EOP product
- Takeaways

Introduction

- The availability of highly accurate, up-to-date Earth Orientation Parameters (EOP) is of major importance for all positioning and navigation applications on Earth, Sea, Air and also in Space.
- Today, the EOP predictions are generated by a single non-European actor, provided on a non-European server.
- Over the past years, ESA repeatedly experienced problems with outdated or missing predictions of the Earth Orientation Parameters (Bulletin A).
- Considering the importance of up-to-date Earth orientation parameters, the dependence on a single source outside Europe is considered as a risk for European industry, for ESA missions and EU programmes.

ESA's contributions to International Services

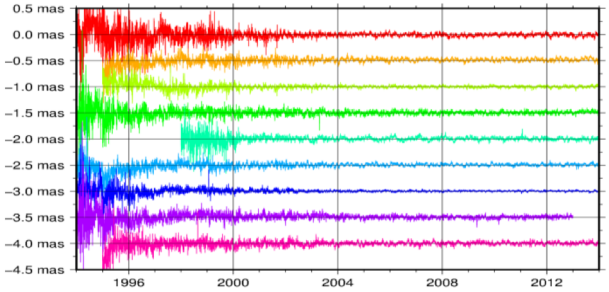
provided by ESOC

- Contribution to **International GNSS Service (IGS)** as Analysis Centre
- Contribution to **International Laser Ranging Service (ILRS)** as Analysis Centre
- Contribution to **International DORIS Service (IDS)** as Analysis Centre
- Contribution to **International VLBI Service (IVS)** as Analysis Centre planned
- Contribution to **Coordinated Universal Time (UTC)**

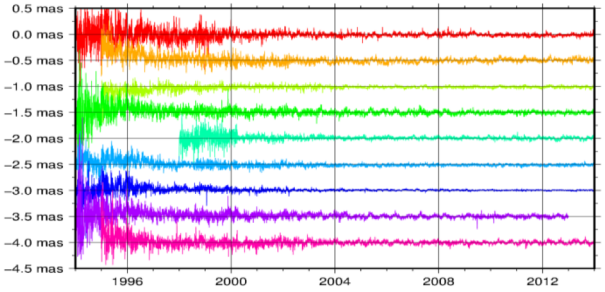
ESA's IGS contribution/EOP's (REPRO2)

provided by ESOC

AC / ig2 X-pole differences



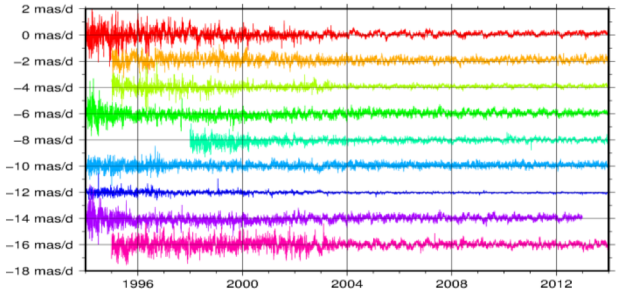
AC / ig2 Y-pole differences



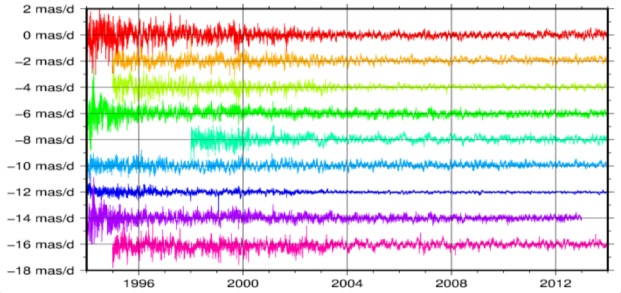
WRMS of EOP residual time series

AC	XPO µas	YPO µas	XPOR µas/d	YPOR µas/d	LOD µs/d
cod	34.7	33.5	175.3	184.1	17.1
emr	40.0	44.4	218.1	182.9	35.2
esa	25.6	25.8	138.6	143.5	15.8
jpl	31.0	28.0	169.2	172.4	27.0
mit	16.9	16.4	62.7	70.1	15.5

AC / ig2 X-pole rate differences



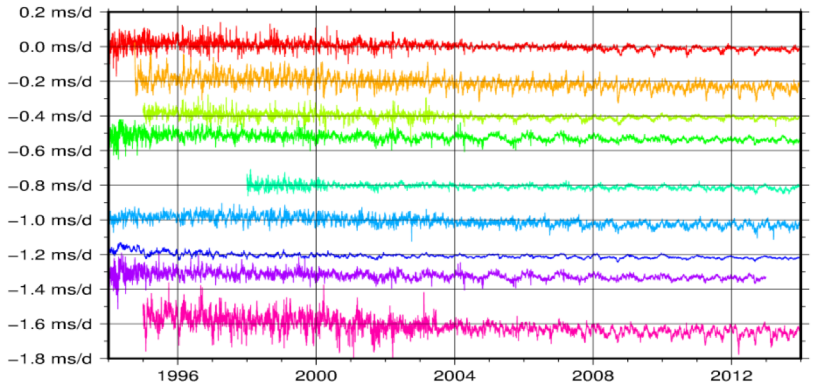
AC / ig2 Y-pole rate differences



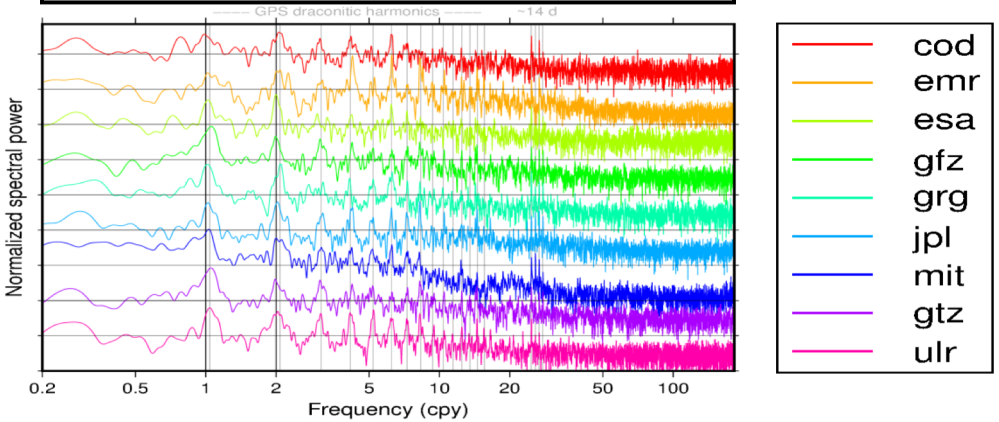
ESA's IGS contribution/length of day (REPRO2)

provided by ESOC

AC / ig2 LOD differences



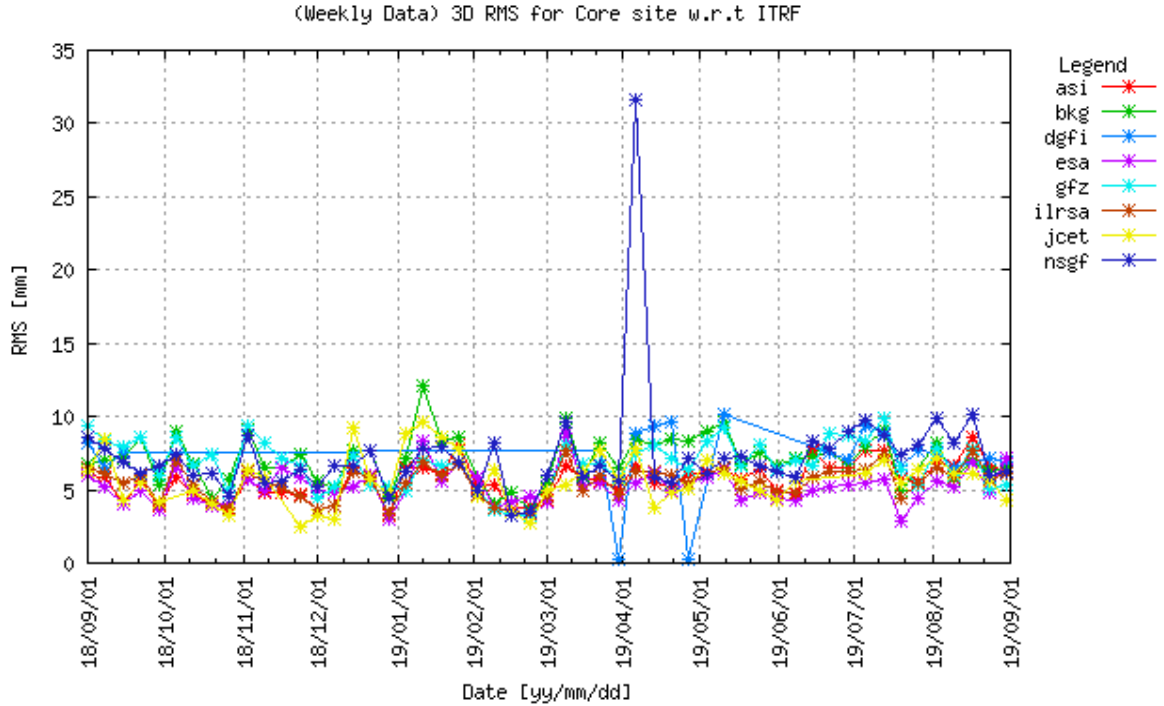
Normalized periodograms



ESA EOP/LOD Quality amongst the best in the IGS

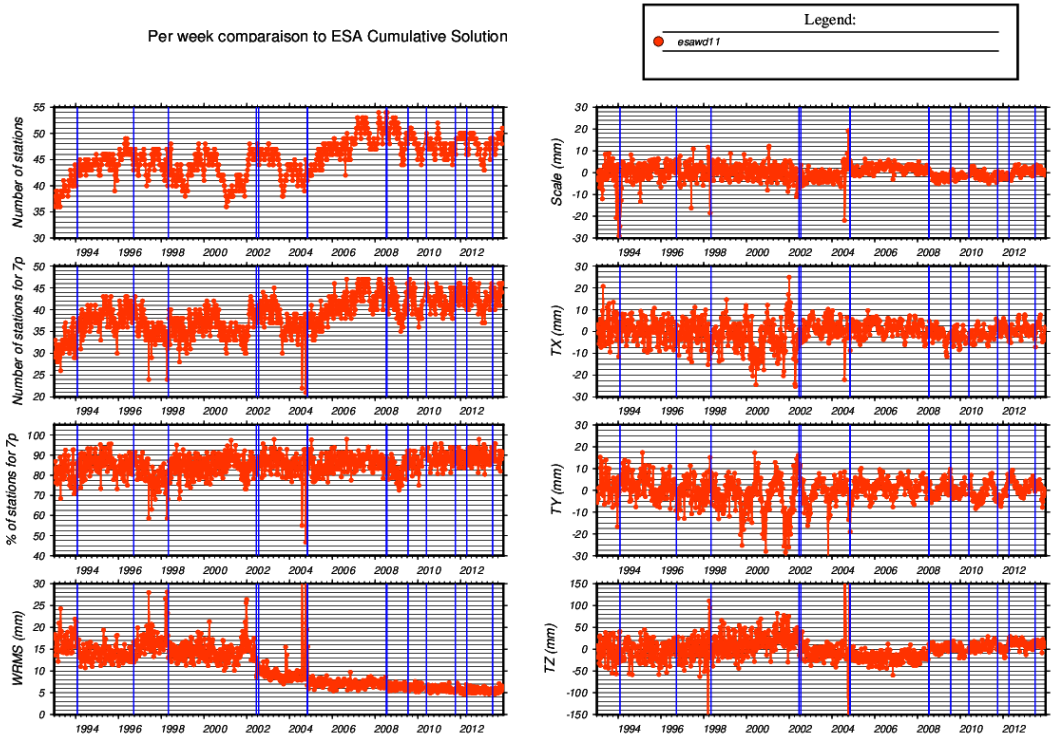
ESA's ILRS contribution

provided by ESOC



ESA's ILRS solution amongst the best

ESA's IDS contribution
provided by ESOC



On the left are shown the Helmert parameters from the first ESA ITRF2020 test solution over the ITRF2014 period (comparison to the IDS ITRF2014 cumulative solution). First combination of this solution with the other ACs show that the ESA solution is the closest to the new combination solution.

The ESA solution is still evolving and several improvements are planned before the final submission planned for early 2021.

ESA's internal VLBI solution

provided by ESOC

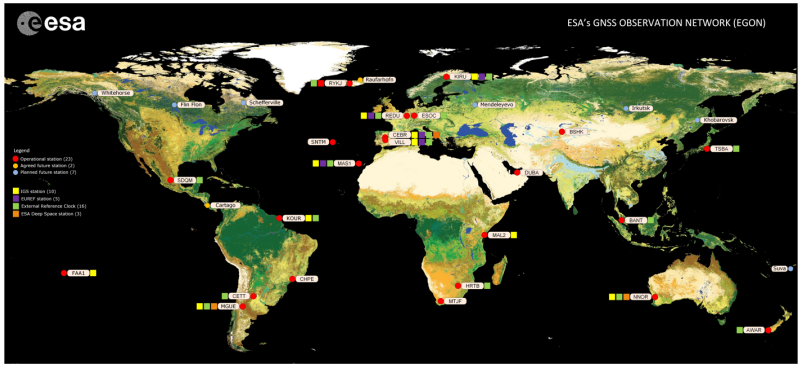
The plots compare two VLBI realizations of the EOP time series with the IERS C04 solution. ESA estimates are plotted in colour, while the grey dots represent the results provided by an official IVS AC (artificial offsets applied). The scatter of the two datasets is comparable and there are no significant spurious signals affecting the long-term behaviour.

Motivation for an ESA's independent EOP product

ESA's Navigation Support Office is responsible for providing the Geodetic reference for ESA missions, and acts as Coordinator of the Galileo Reference Service Provider (GRSP) to provide the Geodetic reference and corresponding EOP's to Galileo.

ESA operates Ground Infrastructure

- *ESA'S GNSS Observation Network (EGON)*
- ESA/Europe is building up SLR stations
- European Space Tracking network (ESTRACK)
  Note: Stations and correlator are not yet ready for VLBI



ESA operates Data Centres

- *Gnss Science Support Centre (GSSC)*

ESA generates all input products needed for the generation of EOPs.
ESA's contributions are always among the best in the world.

European Independence

Although all required input products are generated by ESA, ESA and its customers are still relying on a single, non-EU entity to provide EOPs.

ESA/ESOC study
Independent generation of Earth Orientation Parameters

Objective:

Prototype development of an independent ESA Earth Orientation Parameter product, providing the best possible accuracy and precision for real-time and post-processing applications.

Consortium:

DGFI

Bundesamt für Kartographie und Geodäsie

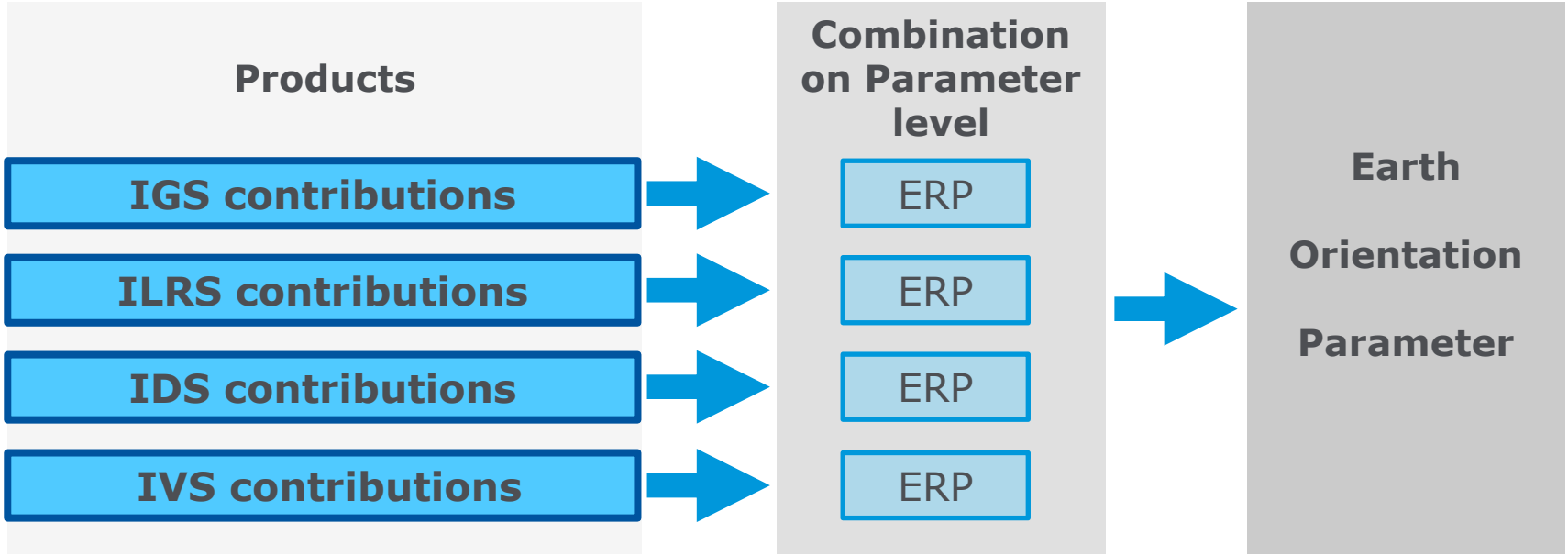
TU WIEN

Technische Universität München

GFZ Helmholtz Centre Potsdam

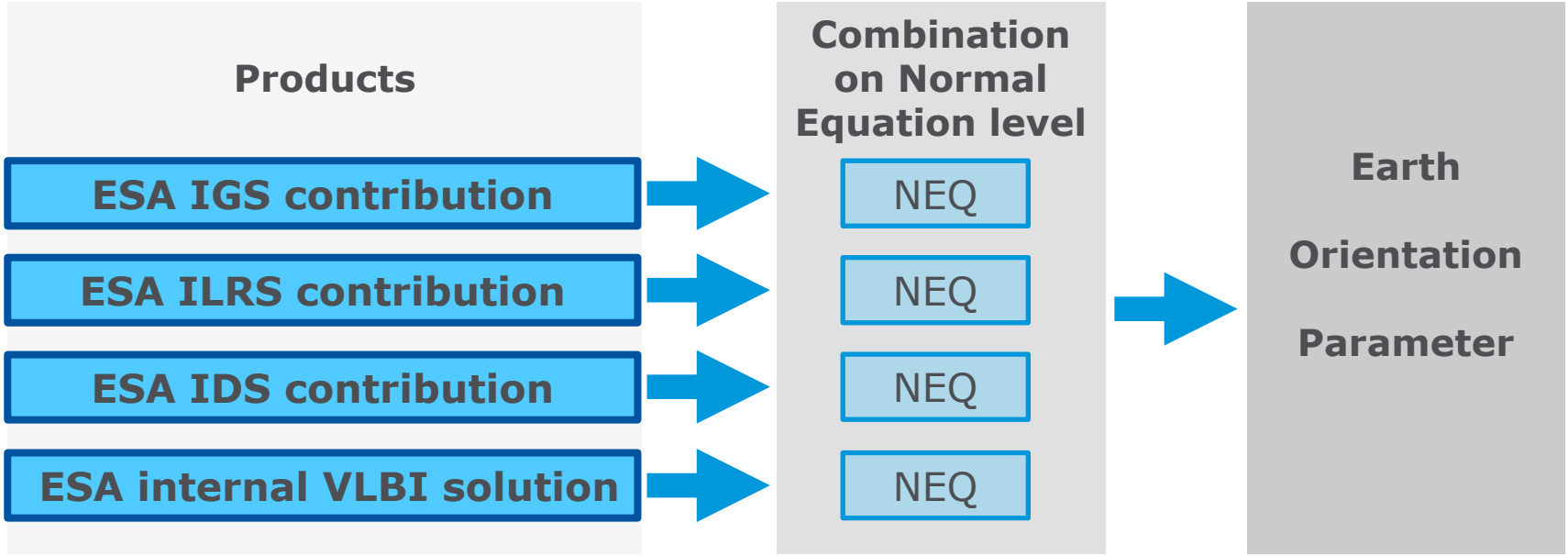
Completion: Mid-2020

IERS state of the art combination approach



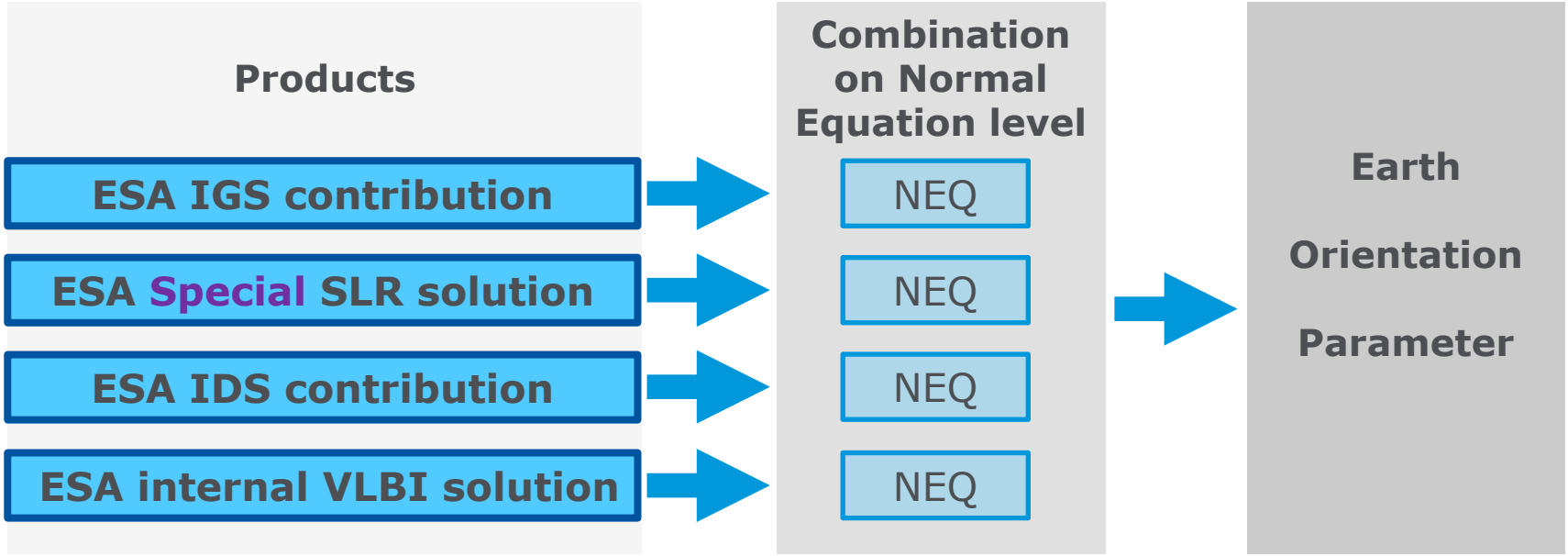
Limitations: Model inconsistencies, Correlations not considered!

ESA approach



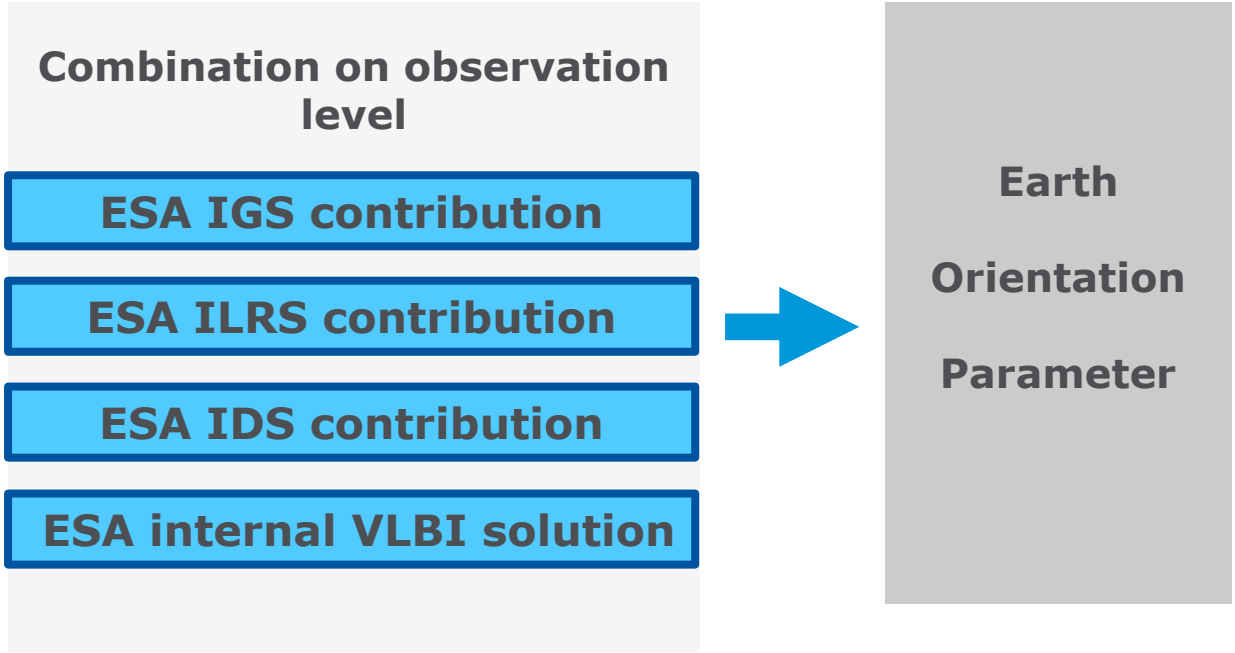
Same software and models. Correlations considered.

ESA approach



ESA ILRS solution replaced by optimised SLR solution e.g. adding Larets, Stella, Starlette, and Ajisai

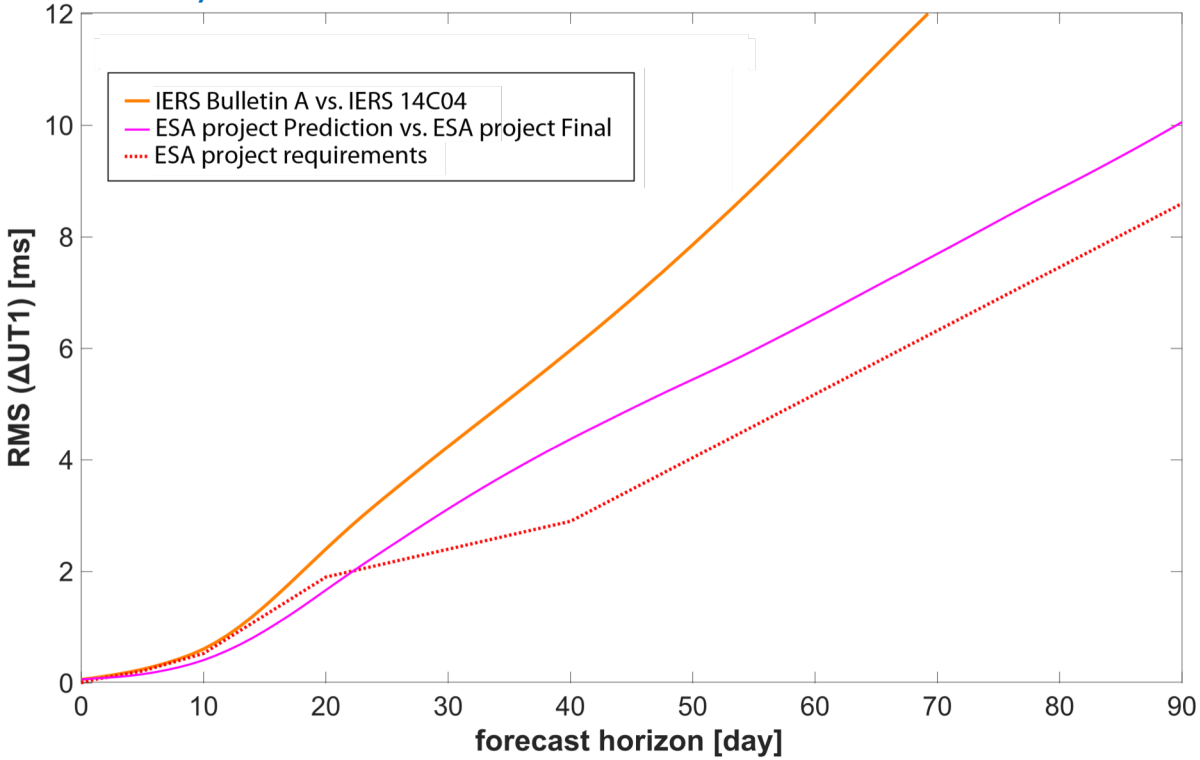
ESA target approach



Rigorous combination on observation level.

Preliminary results from ESA-EOP study

ΔUT1 predictions accuracy



Preliminary results from the ESA study "Independent generation of Earth Orientation Parameters" showed that the predictions already outperformed the up-to-date Bulletin A

Way forward for ESA's independent EOP product

Available for all ESA space missions, Europe's Space program and European industry

End of 2020

ESA internal VLBI solution

End of 2020

Operational provision of ESA's independent EOP Solution

End 2021 (to be agreed)

ESA contribution to IVS

Takeaways

- Earth Orientation Parameters are critical for all Space Missions, positioning and navigation solutions.
- Up-to-date Europe is relying on a single non-European actor.
- ESA’s Navigation Support Office is one of the main contributors to the International Services, generating the ITRF and the EOP’s.
- ESA’s Navigation Support Office will start providing an independent European Earth Orientation Parameter Prediction product by the end of 2020.

Europe’s independent Geodetic and EOP Reference

Navigation Support Office
ESA’s Navigation Supporter

Provider of ESA’s geodetic and timing reference
GRSP Coordinator (GTRF provider)
Contributor to IERS (ITRF, EOP)
Contributor to UTC

http://navigation-office.esa.int

GNSS Science Support Centre
ESA’s Galileo Navigation Science Office

IGS Global Data Centre
ILRS Data Provider
GNSS Science Exploitation Platform
GNSS Big Data Station

https://gssc.esa.int/

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