

ESA/ESOC's EOP Estimation and Prediction Activities

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- Introduction
- Motivation for ESA/ESOC's EOP estimation and prediction activities
- ESA/ESOC's contributions to International Association of Geodesy (IAG)
- ESA/ESOC's EOP generation + prediction approach
- ESA/ESOC's EOP prediction accuracy (study results)
- Way forward for ESA/ESOC's Earth Orientation Parameter products
- Takeaways

- The Navigation Support Office at ESA/ESOC is responsible for the generation of the geodetic reference frame for all ESA missions.
- In line with this responsibility, ESA's Navigation Support Office contributes to the realisation of the International Terrestrial Reference Frame (ITRF) and the combined EOP series in the framework of the International Earth Rotation and Reference Systems Service (IERS).
- Highly accurate up-to-date Earth Orientation Parameters - the independency for ESA's Space Missions, European Industry Space Missions and the support to the EC Space Activities is of major importance.

Motivation for an ESA's independent EOP product



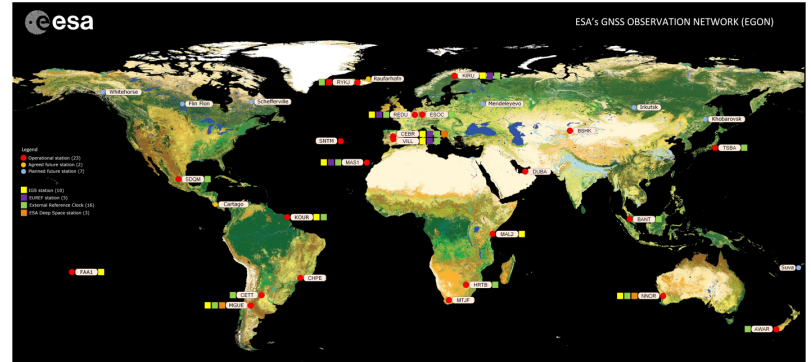
ESA's Navigation Support Office is responsible for providing the Geodetic reference for ESA missions, and are the Coordinator of the Galileo Reference Service Provider (GRSP) to provide the Geodetic reference and corresponding EOP's to Galileo.

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.

**Although all required input products are generated by ESA,
ESA and its customers are still relying on a single none European source.**



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
- Work in progress to become an **International VLBI Service (IVS)** Analysis Centre
- Contribution to **Coordinated Universal Time (UTC)**



ESA's EOP generation + prediction approach



ESA's Earth Orientation Parameter generation and prediction approach has been developed in the frame of a study by:



Technische Universität München

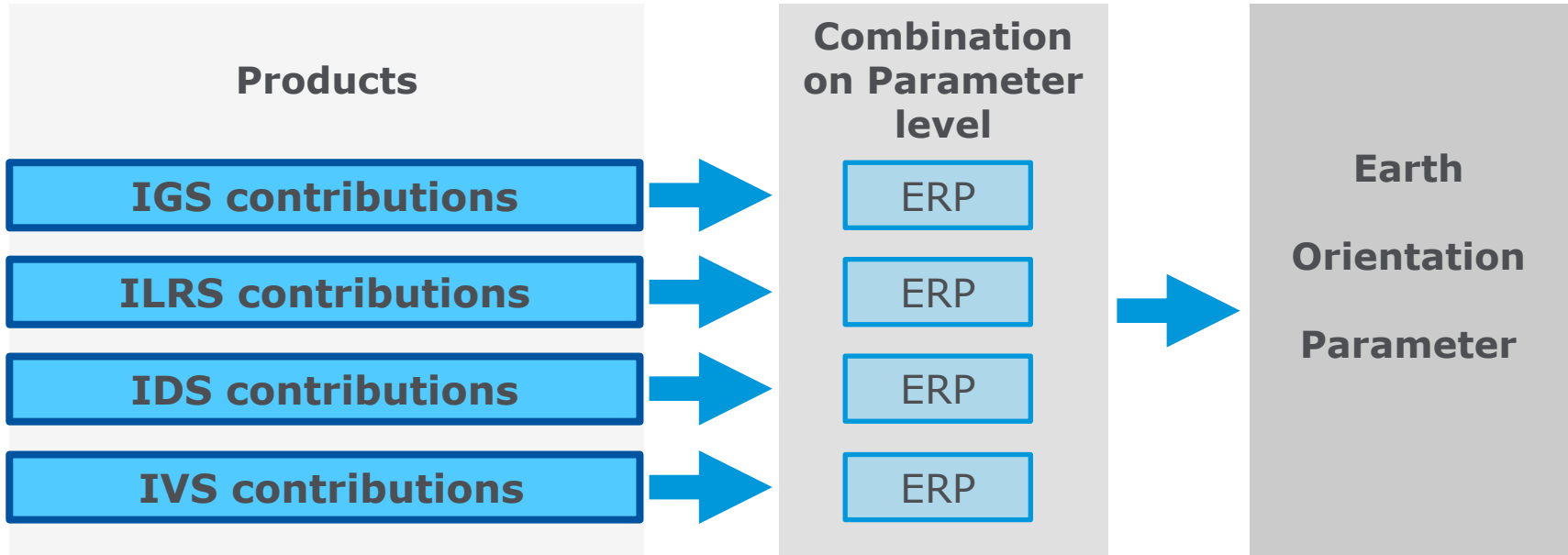


Helmholtz Centre
POTSDAM

Successfully concluded in October 2020.

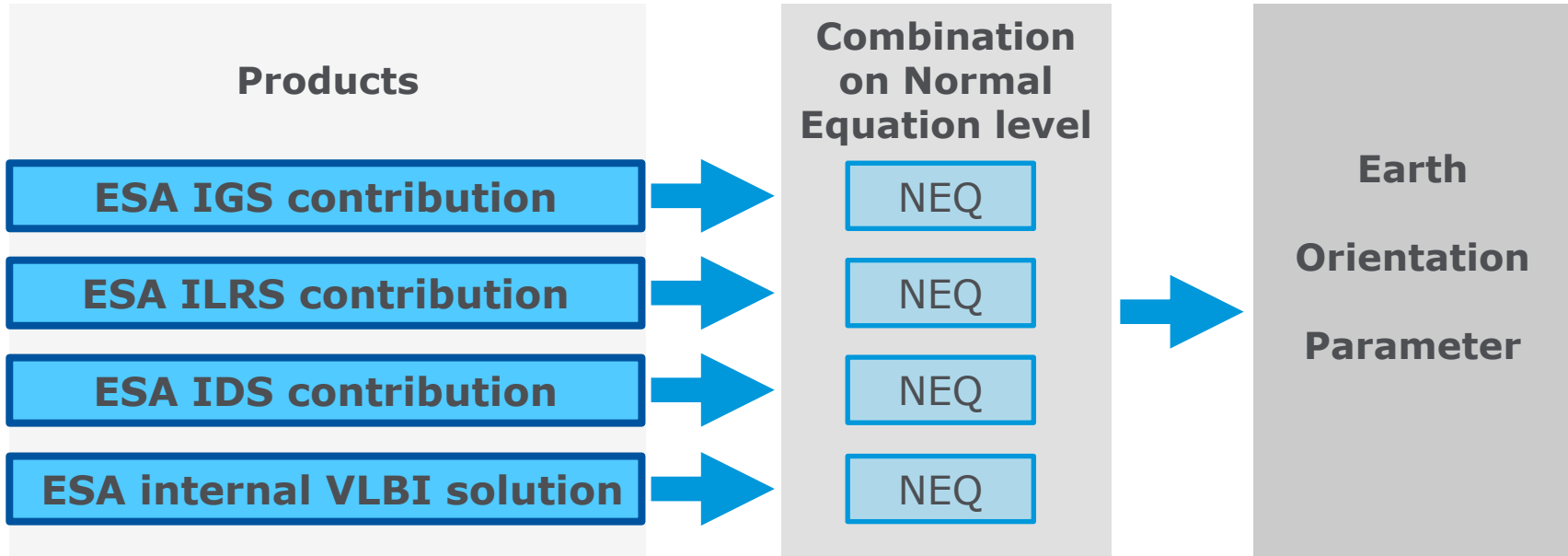


IERS state of the art combination approach



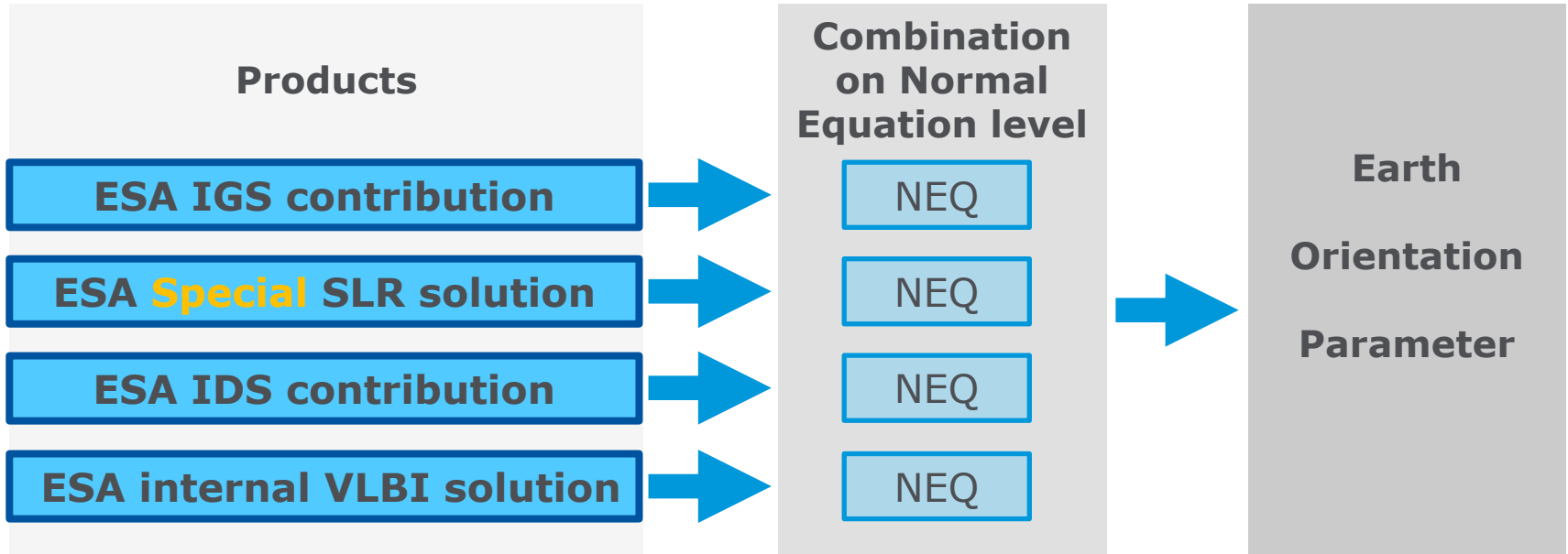
Limitations: Model inconsistencies, Correlations not considered!

ESA approach



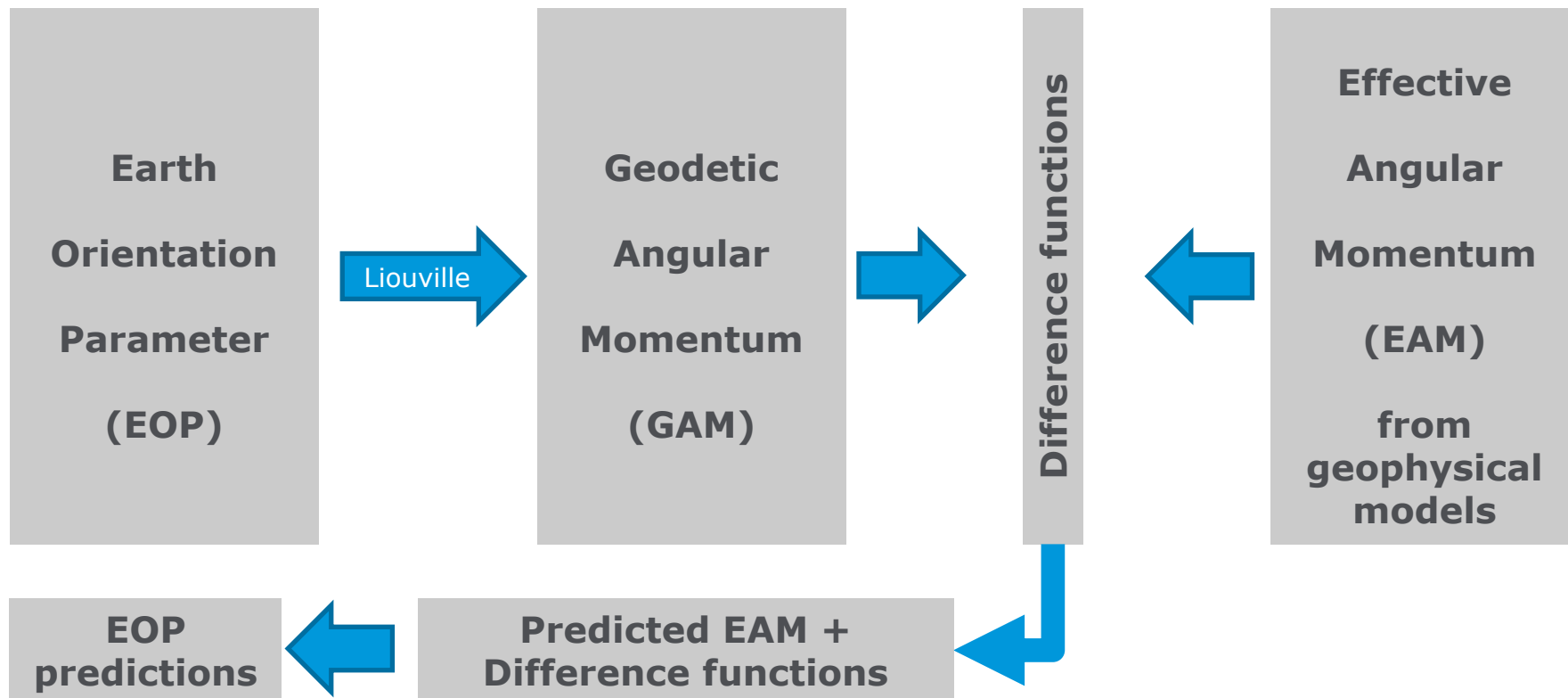
Same ESA software and models. Correlations considered.

ESA approach



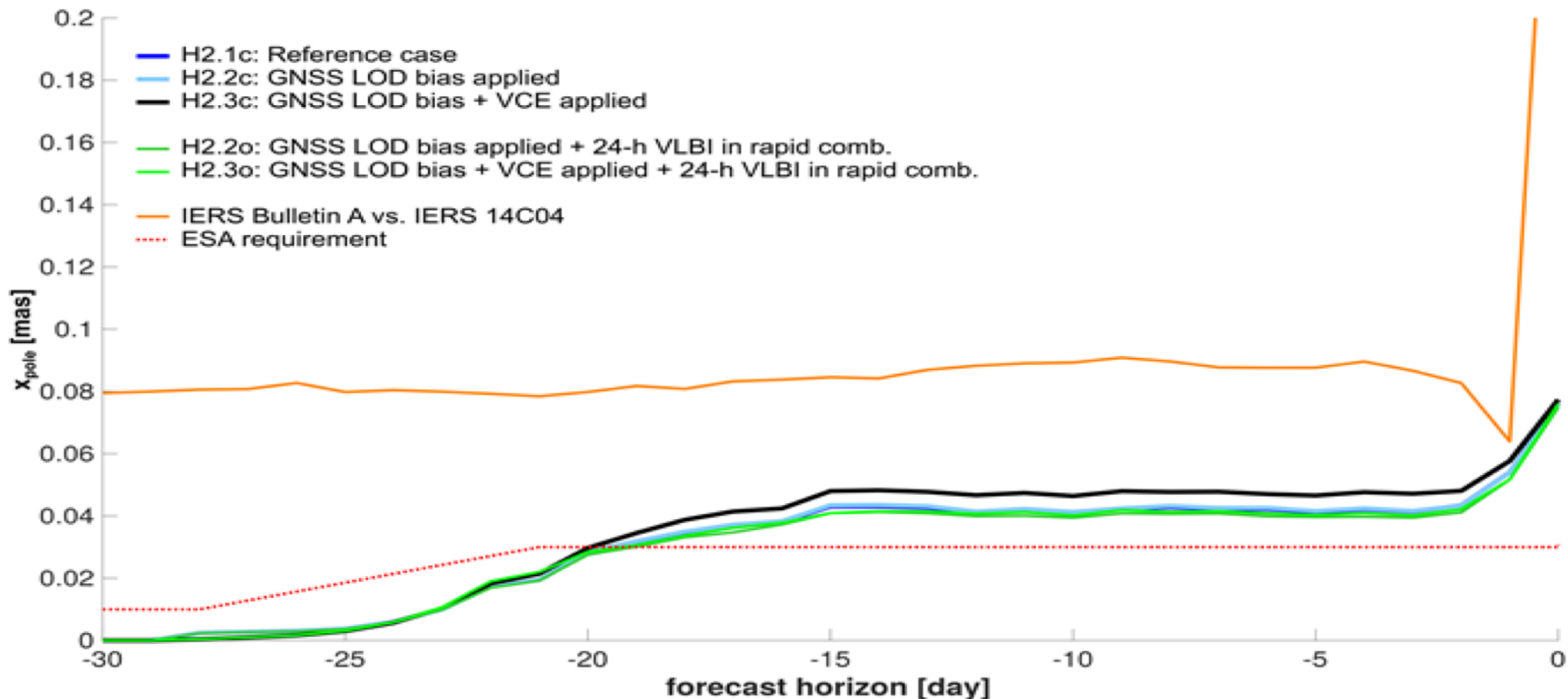
ESA ILRS solution replaced by optimised SLR solution e.g. adding Larets, Stella, Starlette, and Ajisai

ESA approach (EOP predictions)



Study results

x_{pole} hindcast experiments, rapid [-30, 0] days

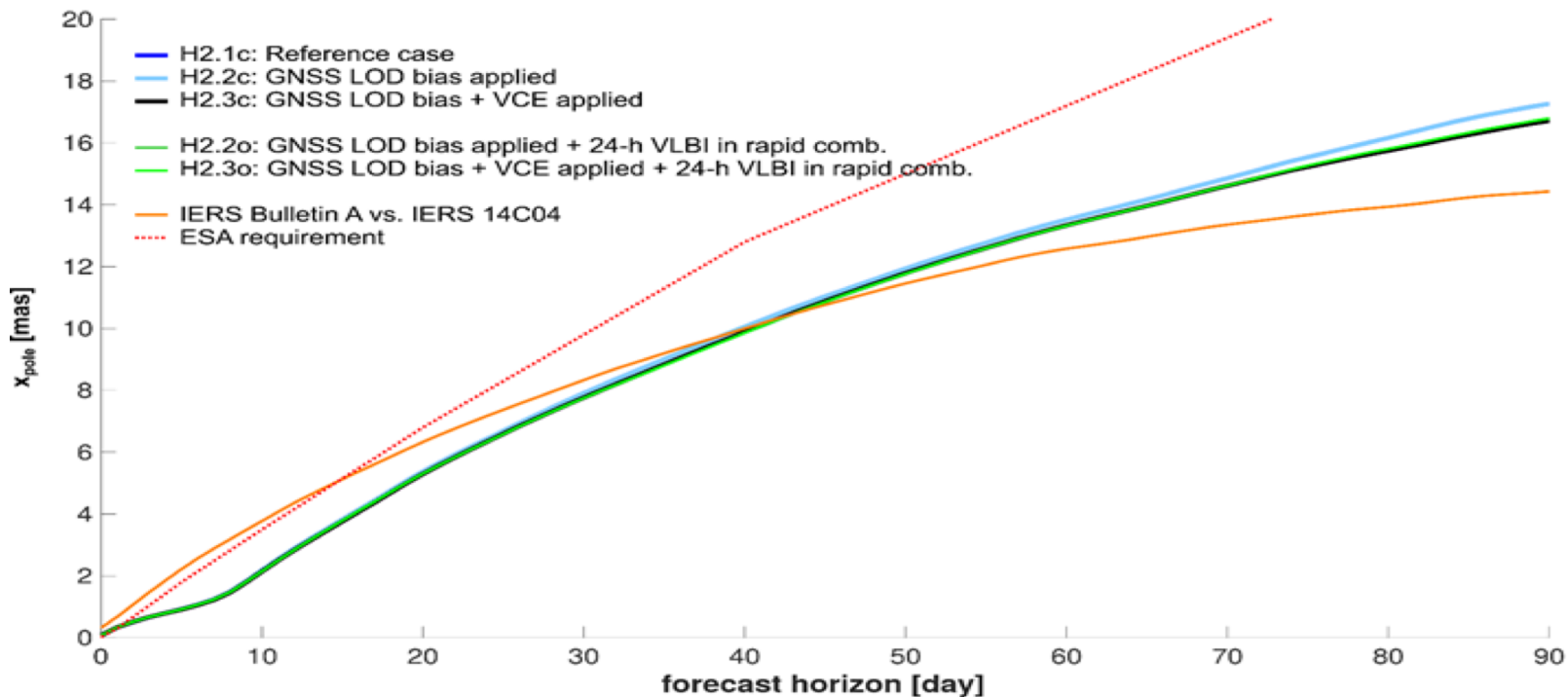


Results from the ESA study "Independent generation of Earth Orientation Parameters"
 x_{pole} hindcast experiments, rapid [-30, 0] days.



x_{pole}

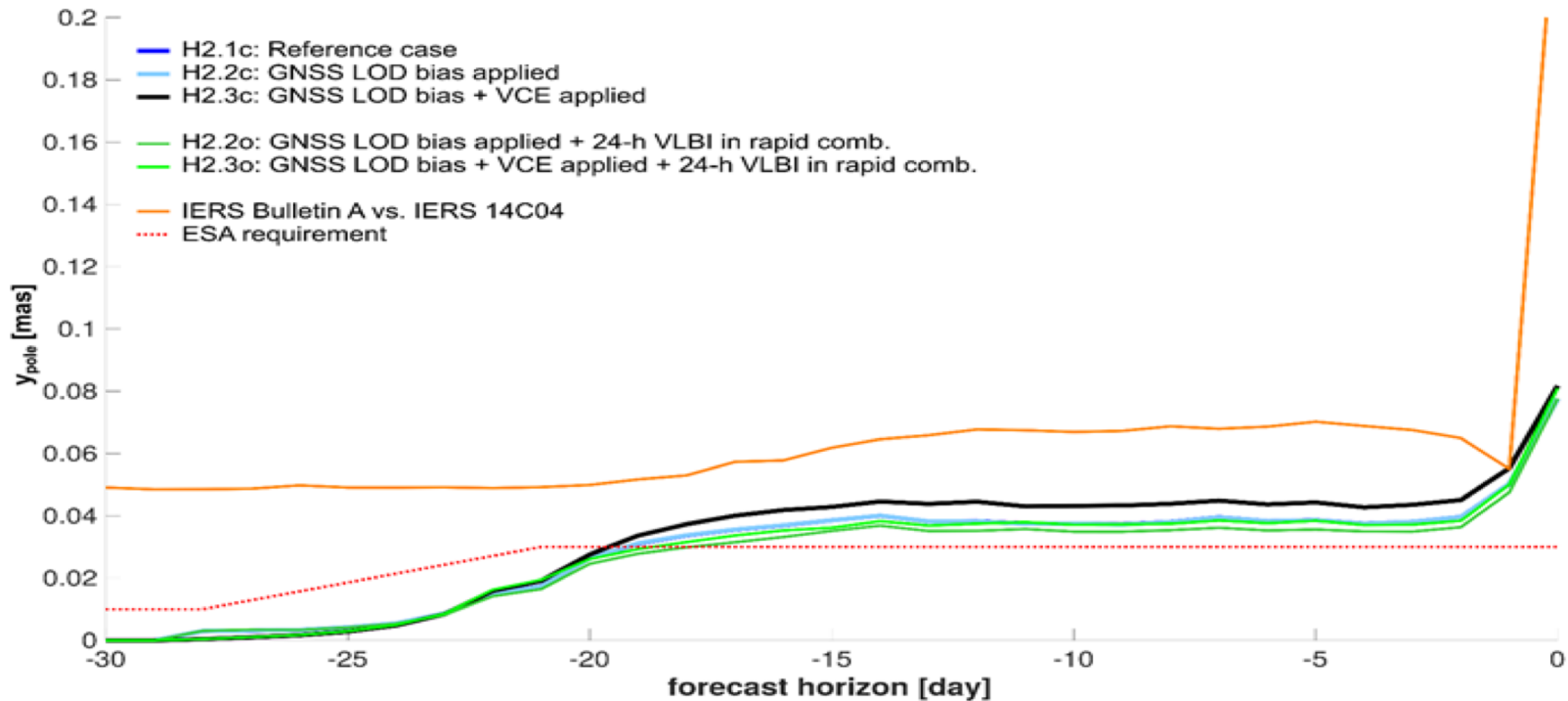
hindcast experiments, prediction [0, 90] days



Results from the ESA study "Independent generation of Earth Orientation Parameters"
 x_{pole} hindcast experiments, prediction [0, 90] days.



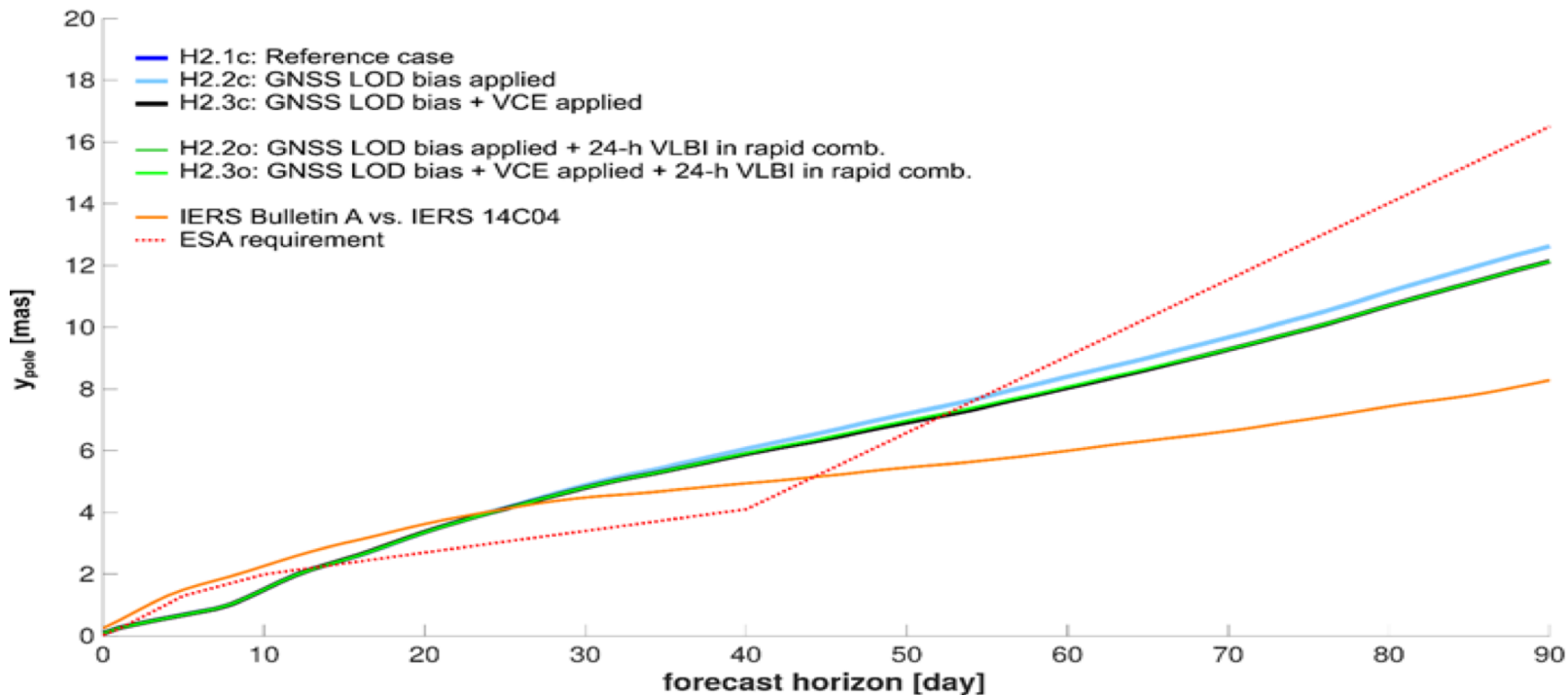
y_{pole} hindcast experiments, rapid [-30, 0] days



Results from the ESA study "Independent generation of Earth Orientation Parameters"
 y_{pole} hindcast experiments, rapid [-30, 0] days.



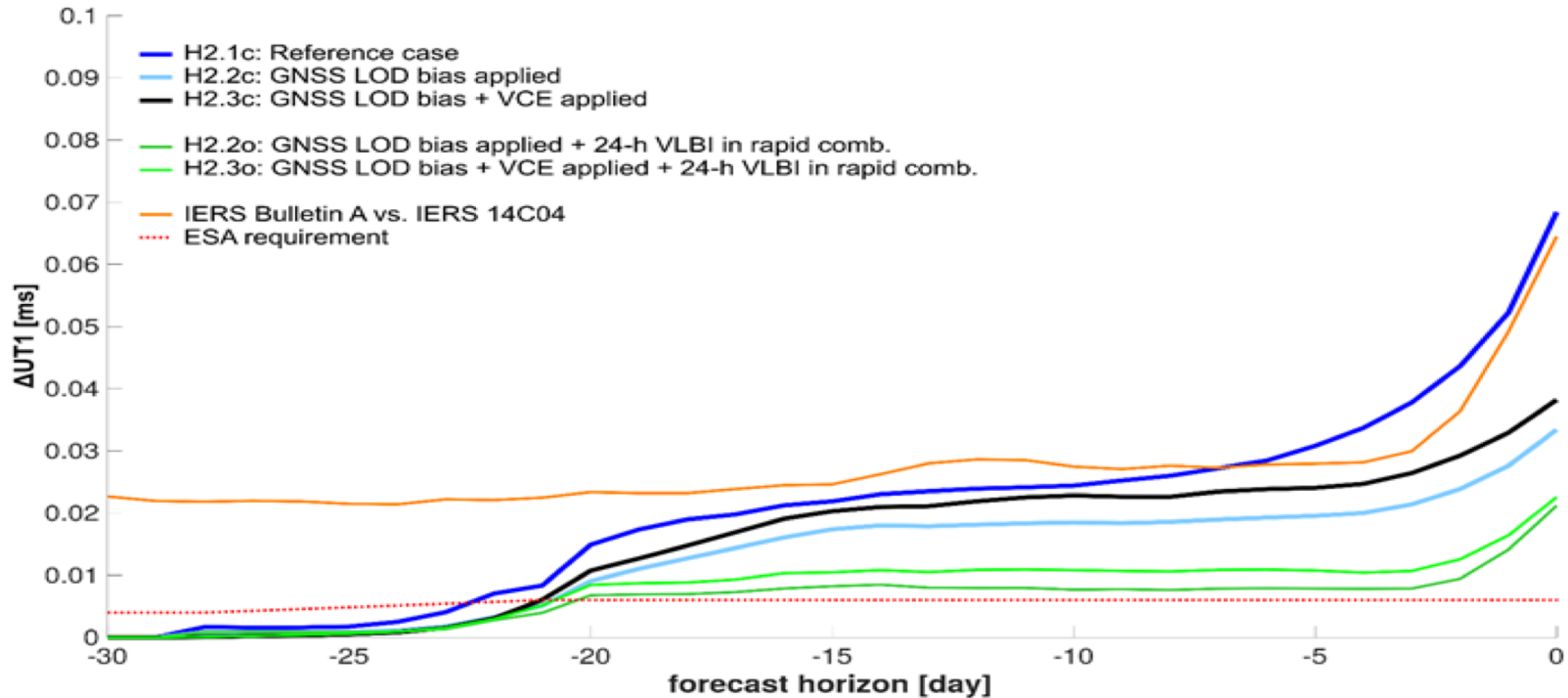
y_{pole} hindcast experiments, prediction [0, 90] days



Results from the ESA study "Independent generation of Earth Orientation Parameters"
 y_{pole} hindcast experiments, prediction [0, 90] days.

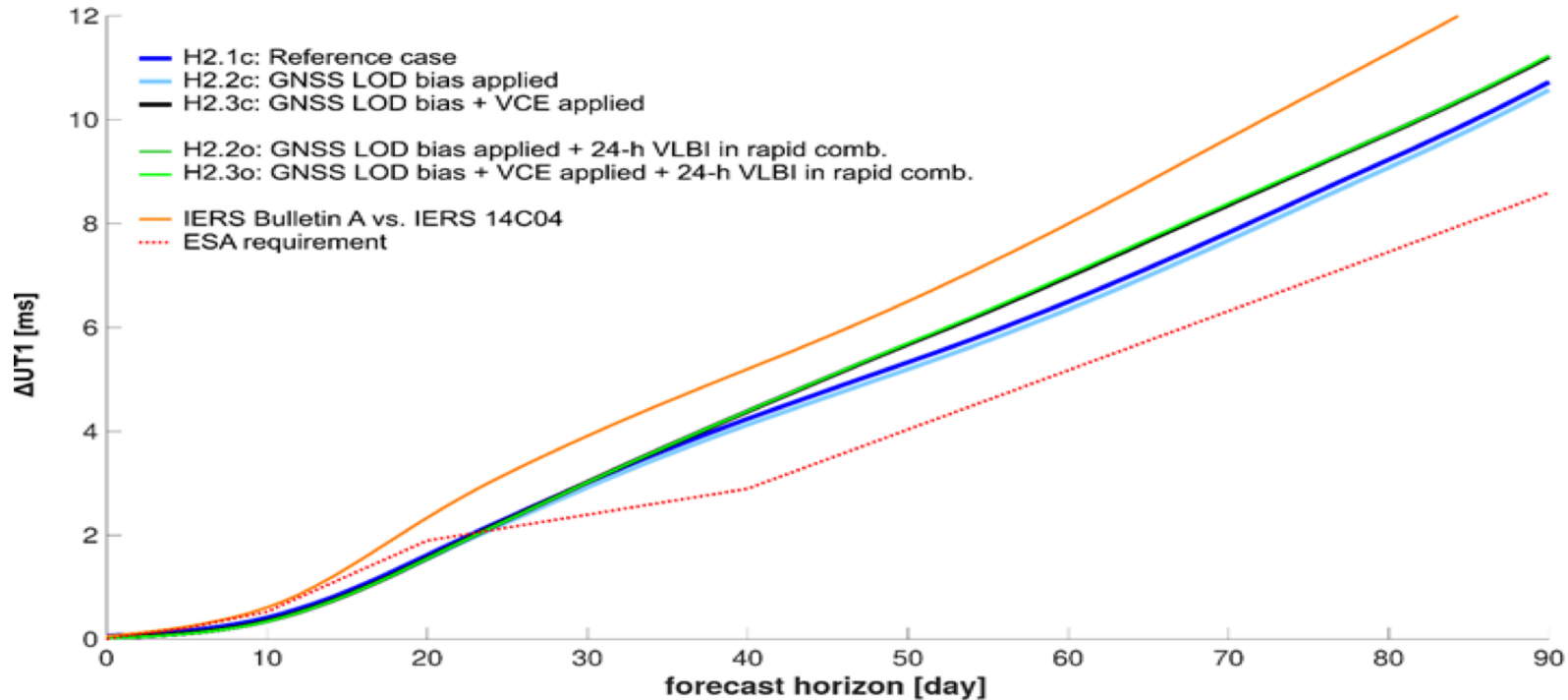


$\Delta UT1$ hindcast experiments, rapid $[-30, 0]$ days



Results from the ESA study "Independent generation of Earth Orientation Parameters"
 $\Delta UT1$ hindcast experiments, rapid $[-30, 0]$ days.

$\Delta UT1$ hindcast experiments, prediction [0,90] days



Results from the ESA study "Independent generation of Earth Orientation Parameters"
 $\Delta UT1$ hindcast experiments, prediction [0, 90] days.

Way forward for ESA/ESOC's independent EOPs



Ongoing

- Integration in ESA software. Operational setup and testing at ESA

Q4 2020

- Start of ESA internal pre-operational service

Q1 2021

- ESA internal VLBI solution

Q2 2021

- Operational provision of ESA's independent EOP Solution

End 2021 (to be agreed)

- ESA contribution to IVS



Takeaways



ESA's Navigation Support Office at ESOC is responsible for the generation of ESA's geodetic reference.

In near future it is closing the gap by providing an ESA own Earth Orientation Parameter product, removing any dependency on an external provider, mitigating the risk for ESA missions, for European industry and EU programmes.

ESA/ESOC's EOP estimation and prediction approach has been developed by a consortium within an ESA study.

ESA/ESOC's Earth Orientation Parameter products are currently under validation and shall become operational in Q2 2021.

The prediction approach selected for ESA/ESOC's Earth Orientation Parameter Product, making use of EAM predictions, provides excellent results. It is even outperforming the up-to-date available EOP predictions from IERS.



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/>

