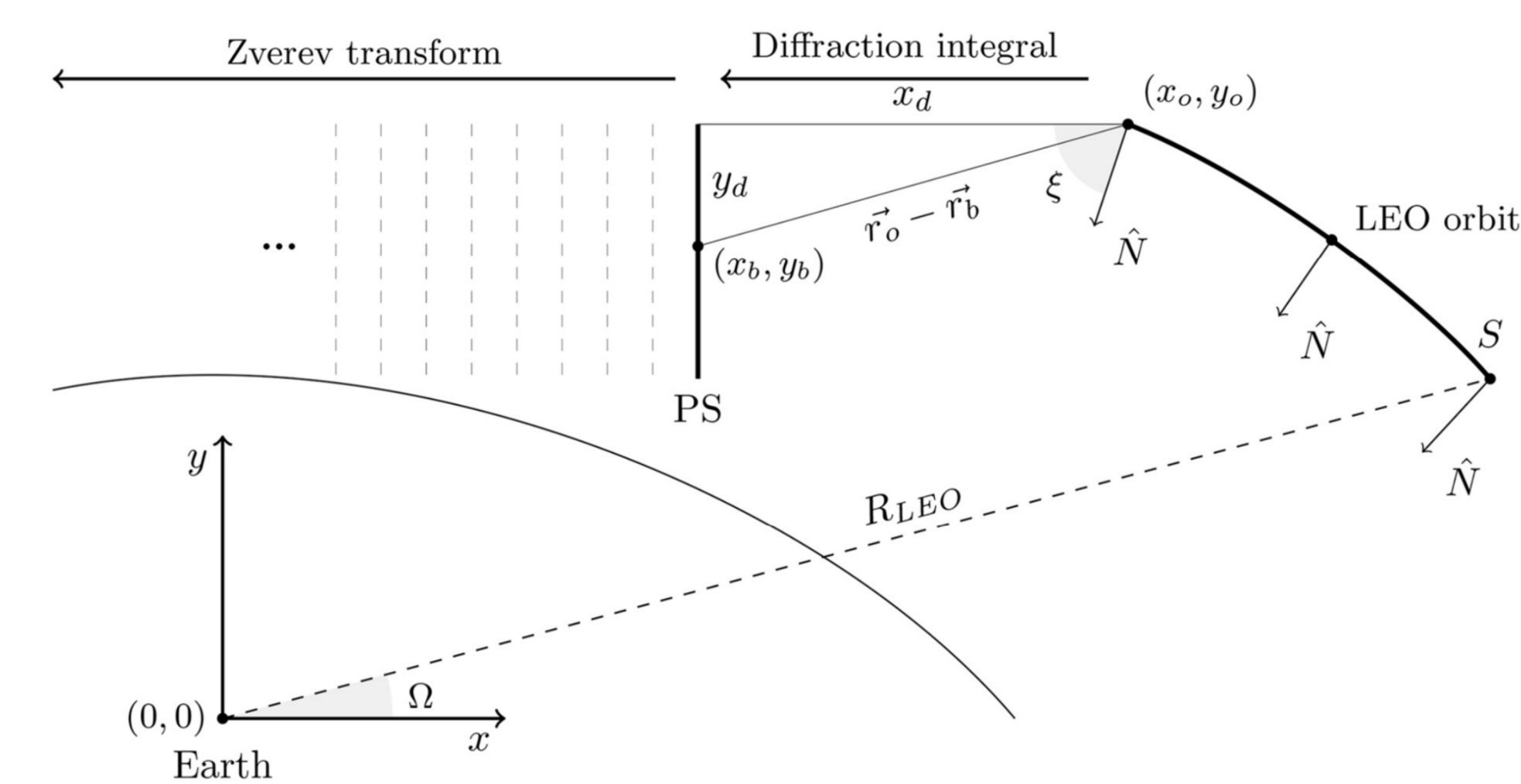
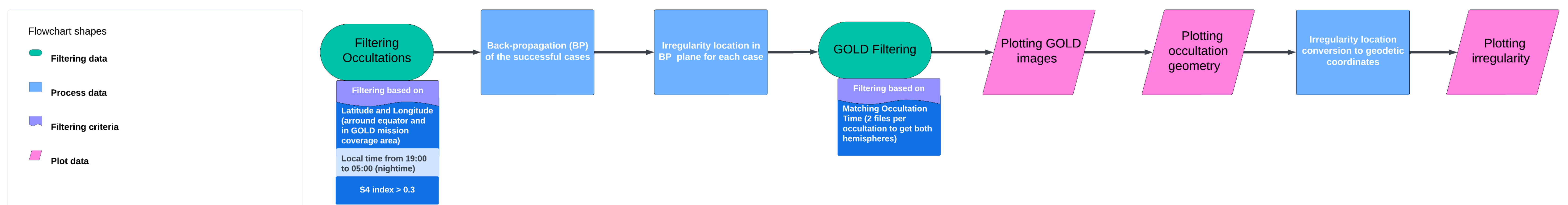


# Estimation of position and extension of ionospheric irregularities using the back propagation method

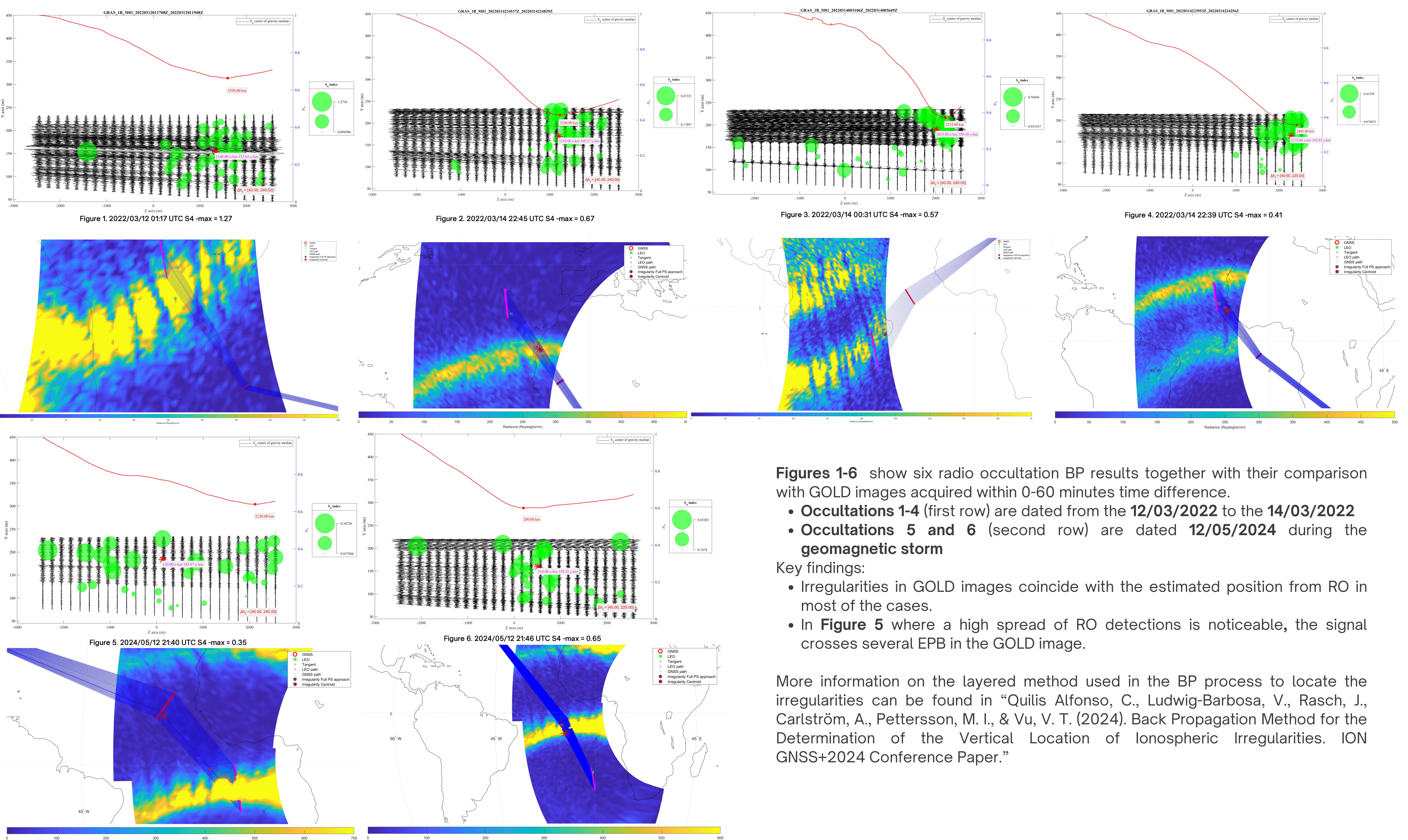
This poster presents validation results of a new layered GNSS-Radio Occultation Back Propagation (BP) technique used to estimate the vertical location and magnitudes of ionospheric irregularities, specifically Equatorial Plasma Bubbles (EPB). The occultation geometry and the geodetic location of the irregularity are shown using EUMETSAT radio-occultation data. The results from the method are validated against NASA's GOLD mission data, providing insights into the ionosphere's behaviour and helping to understand the effect of EPBs in the BP process and also in the overall GNSS-RO technique.



## 1 Methodology



## 2 Results



**Figures 1-6** show six radio occultation BP results together with their comparison with GOLD images acquired within 0-60 minutes time difference.  
 • **Occultations 1-4** (first row) are dated from the **12/03/2022** to the **14/03/2022**  
 • **Occultations 5 and 6** (second row) are dated **12/05/2024** during the **geomagnetic storm**  
**Key findings:**  
 • Irregularities in GOLD images coincide with the estimated position from RO in most of the cases.  
 • In **Figure 5** where a high spread of RO detections is noticeable, the signal crosses several EPB in the GOLD image.

More information on the layered method used in the BP process to locate the irregularities can be found in "Quilis Alfonso, C., Ludwig-Barbosa, V., Rasch, J., Carlström, A., Pettersson, M. I., & Vu, V. T. (2024). Back Propagation Method for the Determination of the Vertical Location of Ionospheric Irregularities. ION GNSS+2024 Conference Paper."

## 3 Conclusion

- The poster shows the comparison of a new method to locate ionospheric irregularities in the beam path from GNSS satellites to LEO-RO receivers, with the information provided by GOLD mission N11 135.6 images
- Further studies are being processed to show the new method's performance locating different irregularities under several scenarios and to improve the algorithm capabilities.

### Related literature

V. Ludwig-Barbosa et al., 'Detection and localization of F-layer ionospheric irregularities with the back-propagation method along the radio occultation ray path', *Atmospheric Meas. Tech.*, vol. 16, no. 7, pp. 1849-1864, Apr. 2023, doi: 10.5194/amt-16-1849-2023.

R. Notarpietro et al., 'RADIO OCCULTATION IONOSPHERIC PRODUCTS FROM GRAS ON BOARD METOP EPS SATELLITES: OVERVIEW AND VALIDATION'. Global-scale Observations of the Limb and Disk (GOLD) Data Products. "Courtesy of NASA/GOLD and the mission science team."