

A large, stylized graphic for the SWARM 10 Year Anniversary Science Conference. It features the word "SWARM" in a bold, teal, sans-serif font. Below it, the number "10" is rendered in a large, teal, outlined font. To the right of the "0" is a small globe with a teal arrow pointing towards it. Below the "10" are the words "YEAR ANNIVERSARY" and "SCIENCE CONFERENCE" in a smaller, teal, sans-serif font. The entire graphic is set against a background of teal and blue wavy lines and a satellite in orbit.

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A detailed illustration of a satellite in orbit above the Earth. The satellite is red and white, with a large solar panel array. It is connected to a white service module. The Earth's horizon is visible below, with a green aurora-like glow. Other smaller satellite components are visible in the distance.

Swarm 10 Year Anniversary & Science Conference 2024

A model to estimate the L-band amplitude scintillation index from Swarm faceplate electron density measurements

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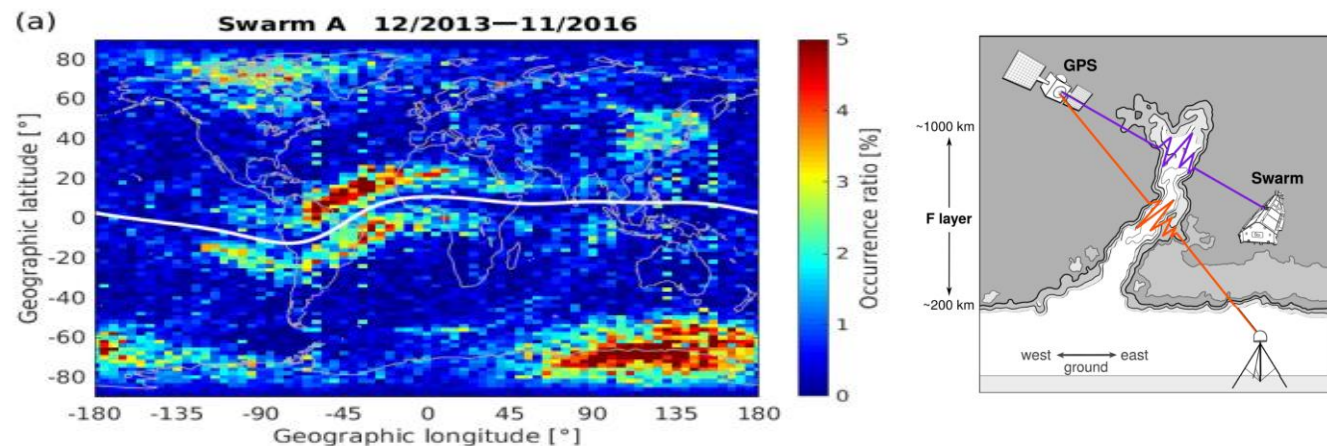


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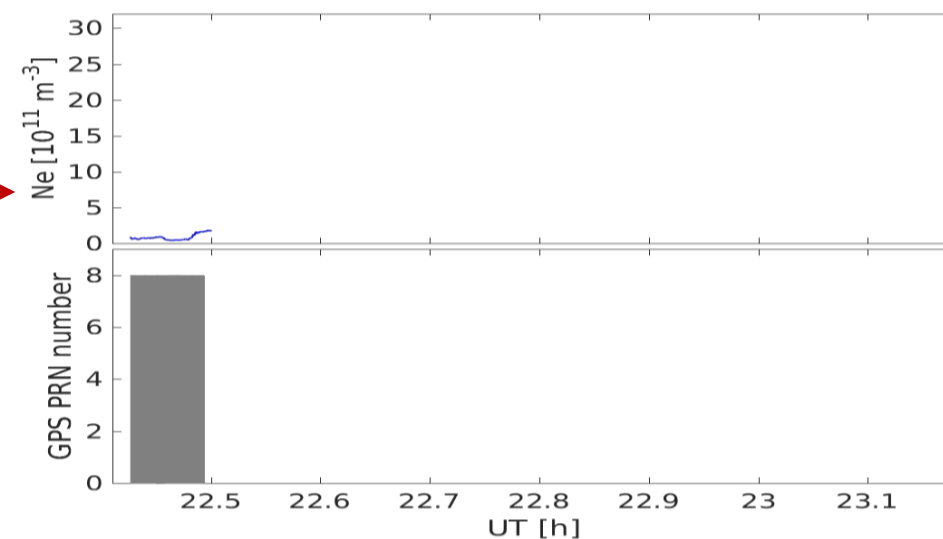
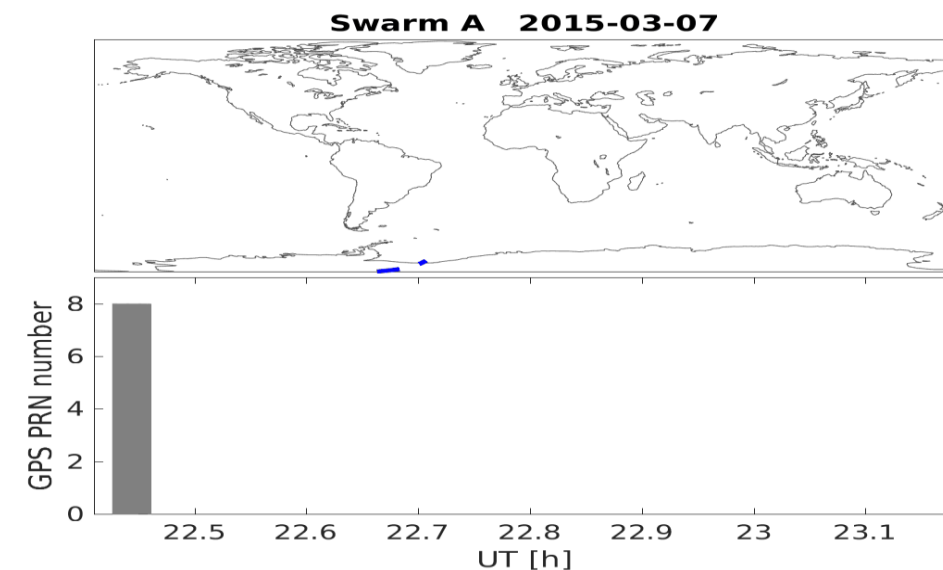


GNSS SCINTILLATION AND SWARM

- There has been a growing interest in using Swarm data as a proxy for the GNSS scintillation activity.
- This in view also to exploit present and future LEO missions to model the effect of small-scale irregularities on L-band signals in the critical areas

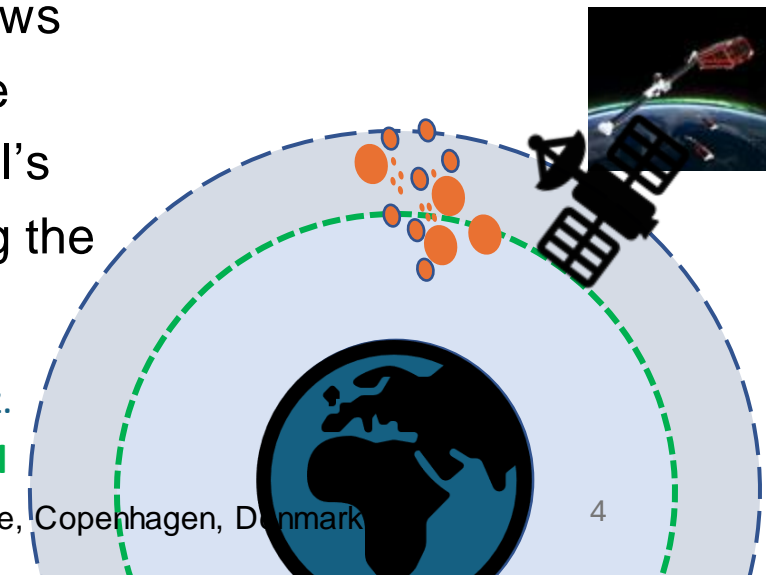


Scintillation caused GPS signal interruption of Swarm
 [Xiong et al., 2016; 2018]



THE BIG PICTURE OF SCINTILLATION MODELLING

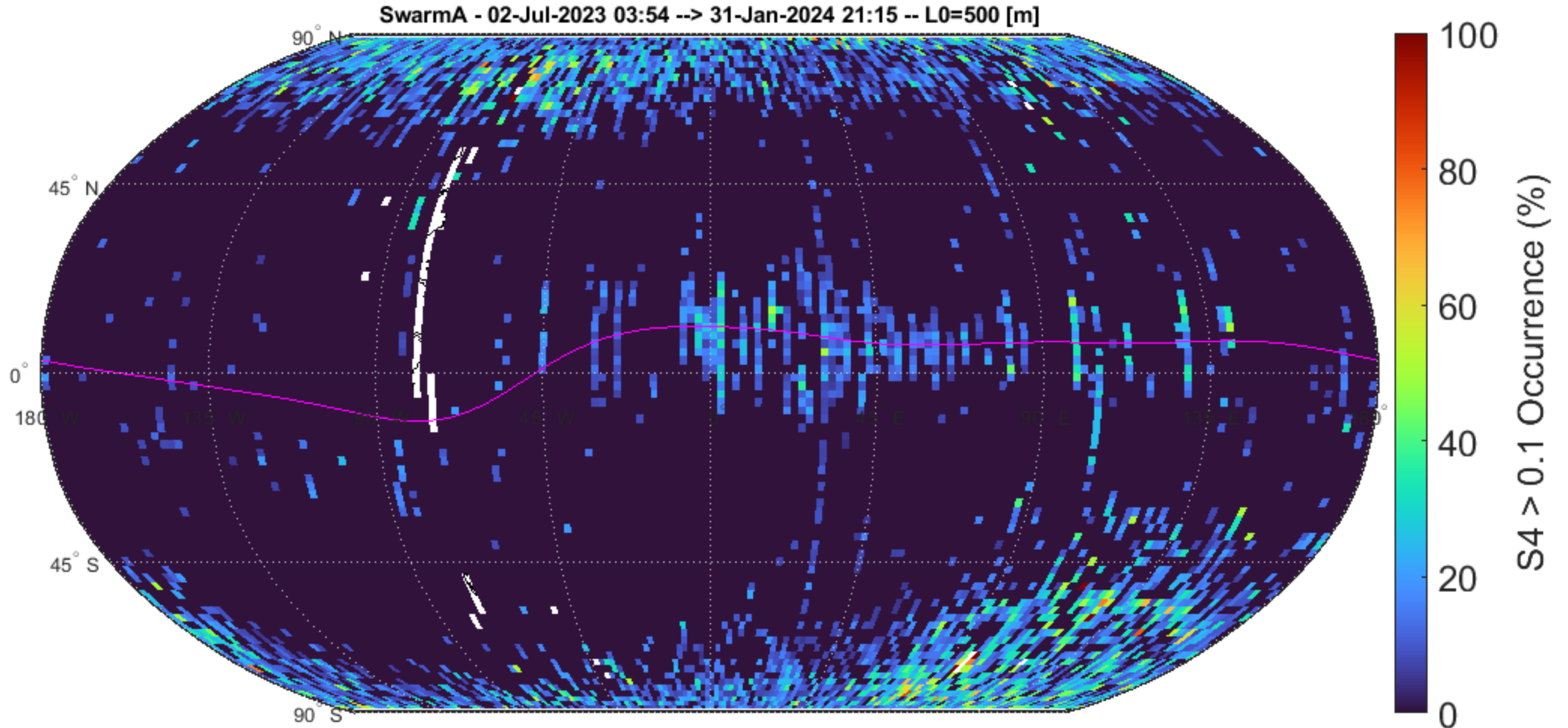
- Inspired by WAM, we have the capability to **model the S4 index based on Swarm FP**
 - Significantly longer dataset w.r.t. DE2 (sol max conditions only)
 - Swarm carries other instruments which assist the interpretation and validation
 - More ground-based observations are now available for model validation
- The 16 Hz sampling rate, combined with the Swarm orbital features, allows modelling the effect of spatial scales with scale size of ~ 500 m along the Swarm flight direction (roughly N-S), which are slightly above the Fresnel's scale relevant for L-band scintillations (few hundreds of metres) affecting the propagation of GNSS signals.



Swarm: **in situ** Electron Density at 16Hz.

WAM: Phase screen **model**

MODEL OUTPUT – SWARM A – 01.07.2023-31.01.2024

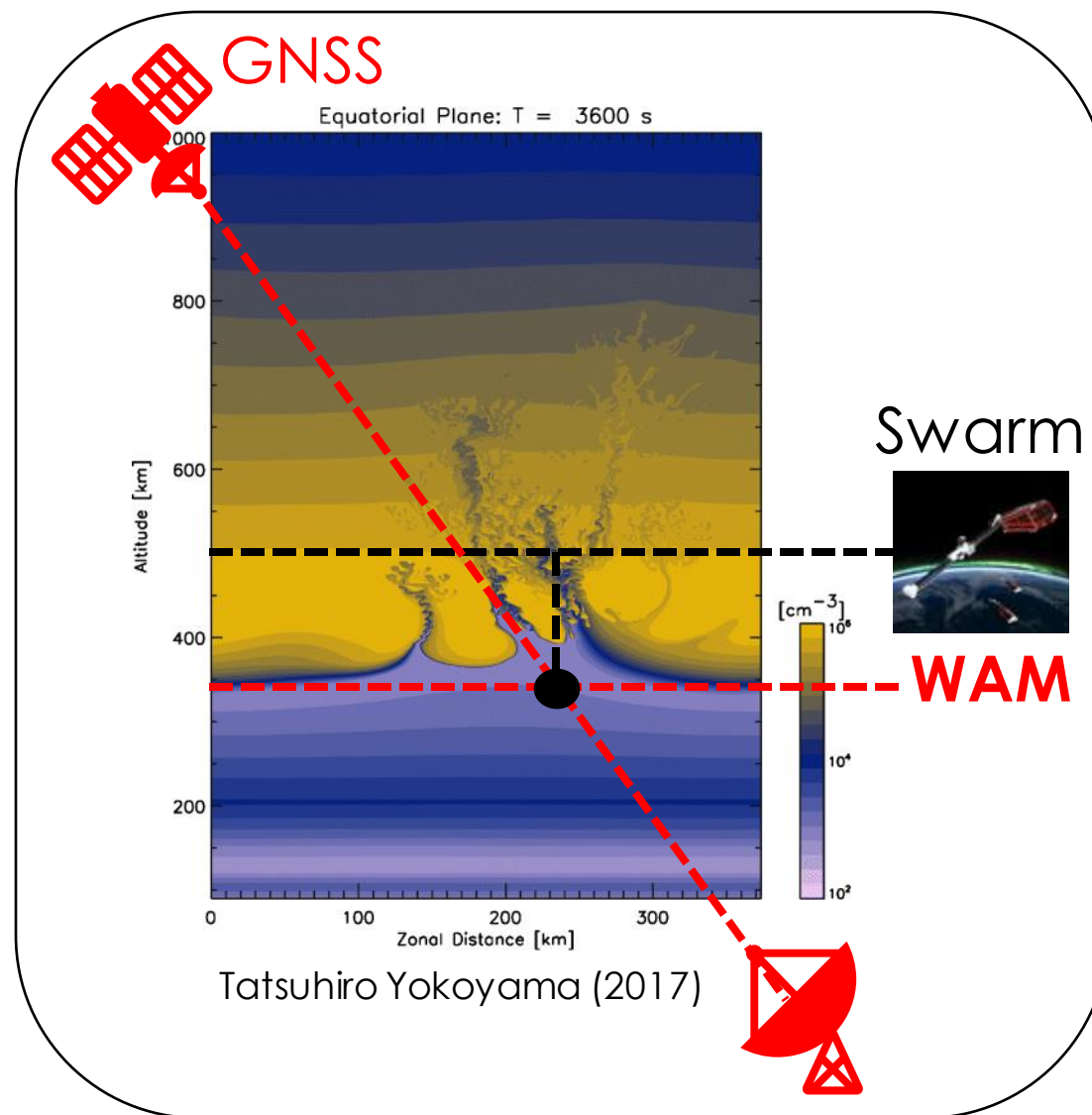




MODEL OUTPUT VALIDATION

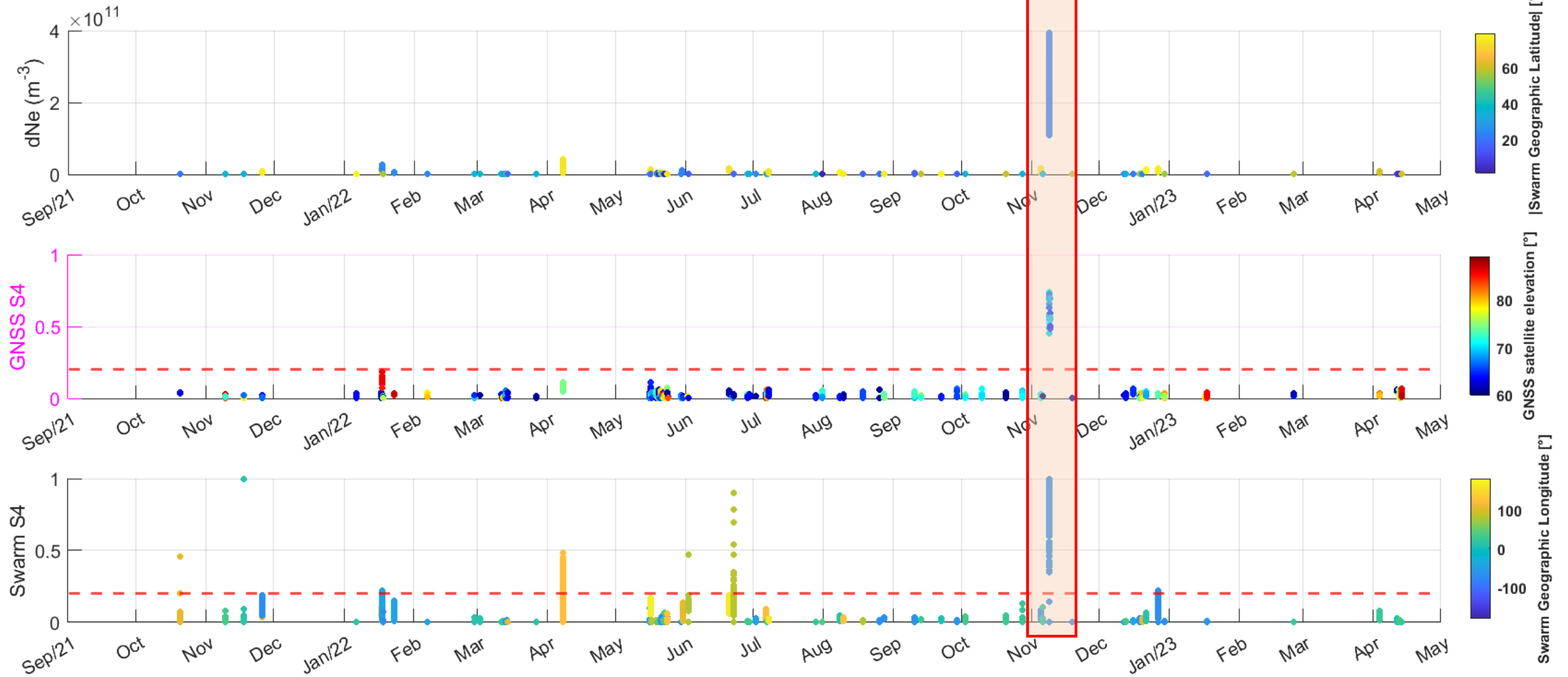
- S4 from Swarm is validated against S4 from GNSS receivers.

→ **eSWua GNSS scintillation network (7+ low latitude stations) Sep 2021 – Apr 2023**



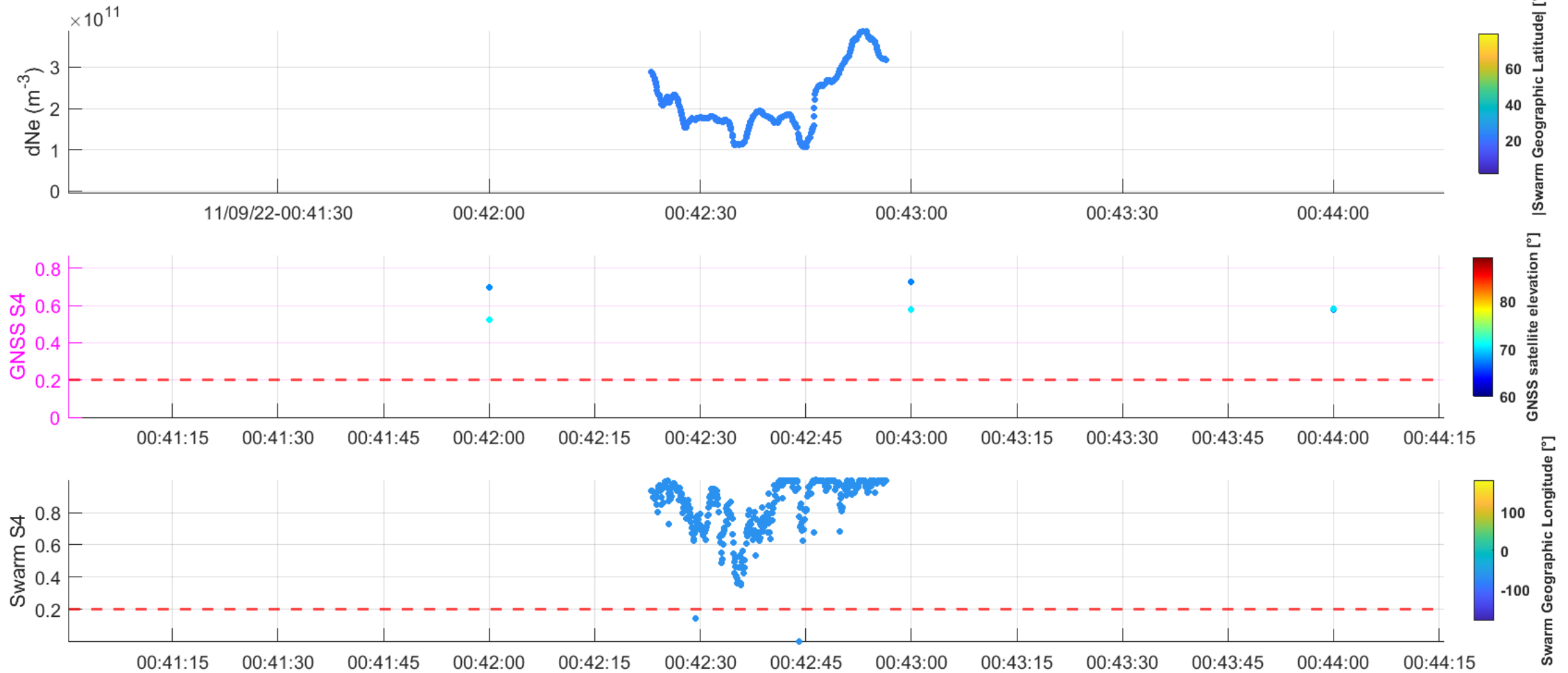
SWARM A – ESWUA GNSS CONJUNCTIONS 09.2021-04.2023

SwarmA - 20-Oct-2021 11:50 --> 13-Apr-2023 17:02 -- L0=500 [m]



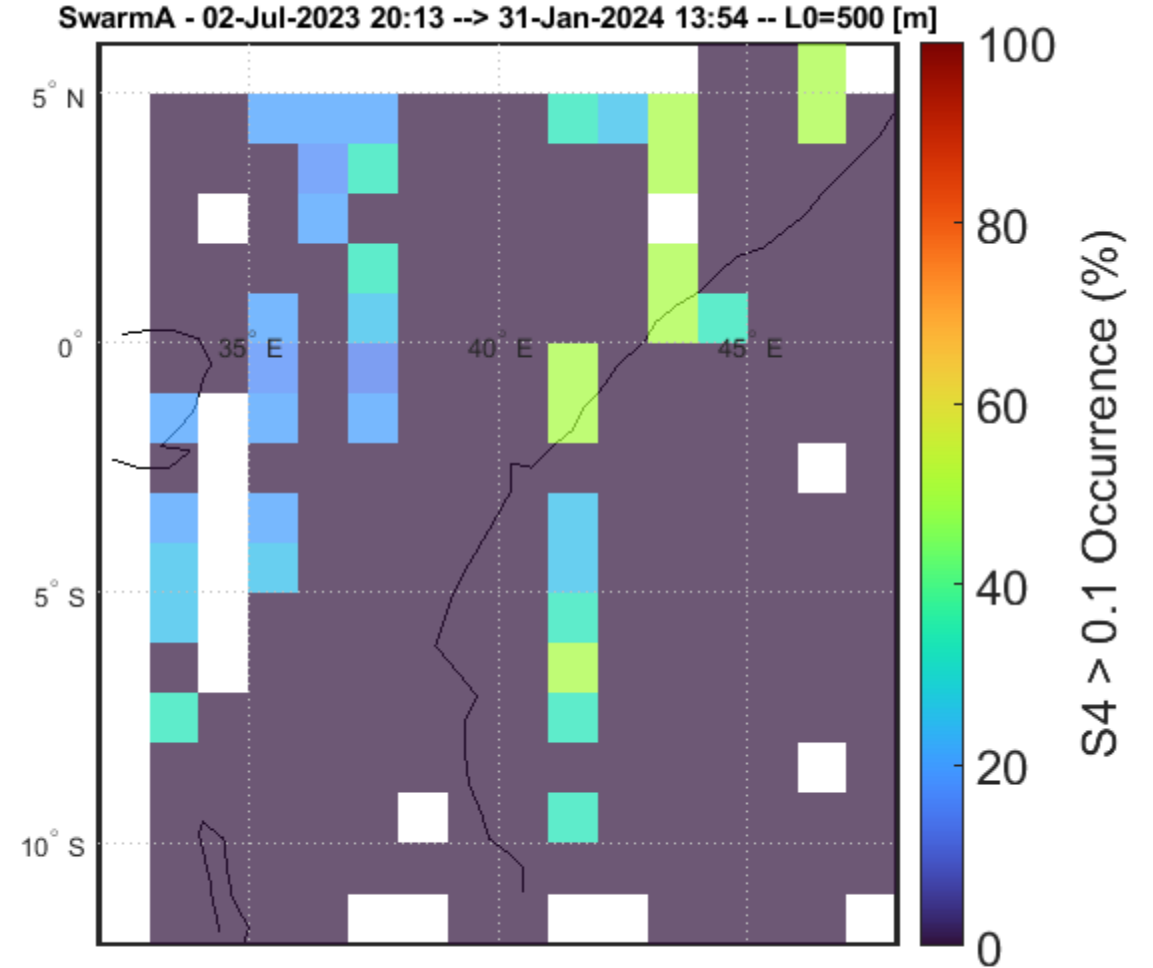
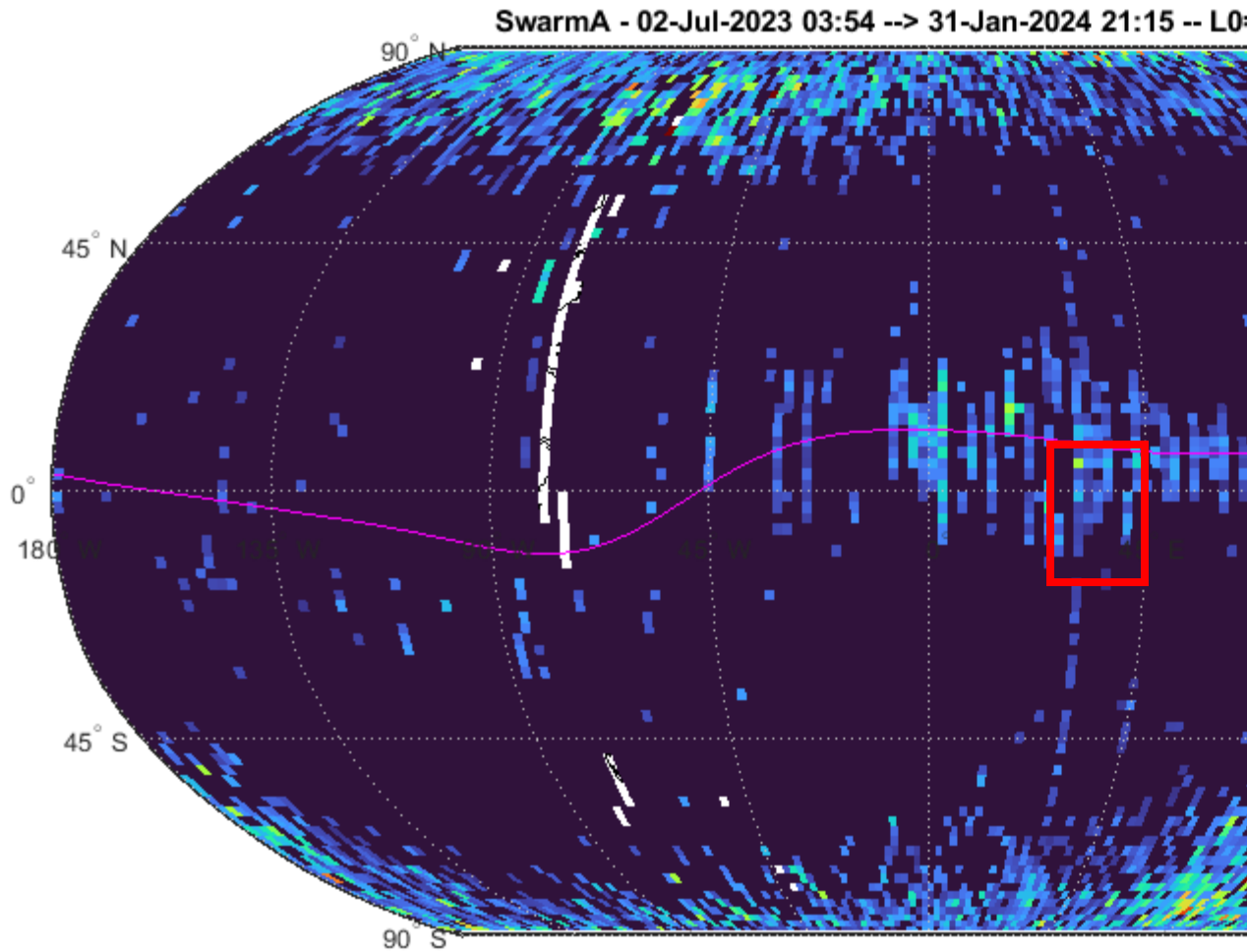
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SWARM A-MALINDI (KENYA) CONJUNCTIONS

01.07.2023-31.01.2024



REMARKS



- We developed a **Swarm amplitude scintillation index** (S4) for measuring irregularities that affect L-band Global Navigation Satellite Systems (GNSS) signals.
- Such an index from Swarm measurements is important for **filling** ground-based GNSS scintillation **measurement gaps**.
- We **validate** the model inputs and outputs using Swarm's conjunctions with GNSS and ionosondes.
- This S4 data product has the potential to be used **for space weather applications** and for near real-time specification of the ionosphere.

Thank you for your attention!



湖北珞珈实验室
HUBEI LUOJIA LABORATORY

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