



Space4Climate HydroGNSS and GNSS Reflectometry



Martin Unwin 17th Sept 2025

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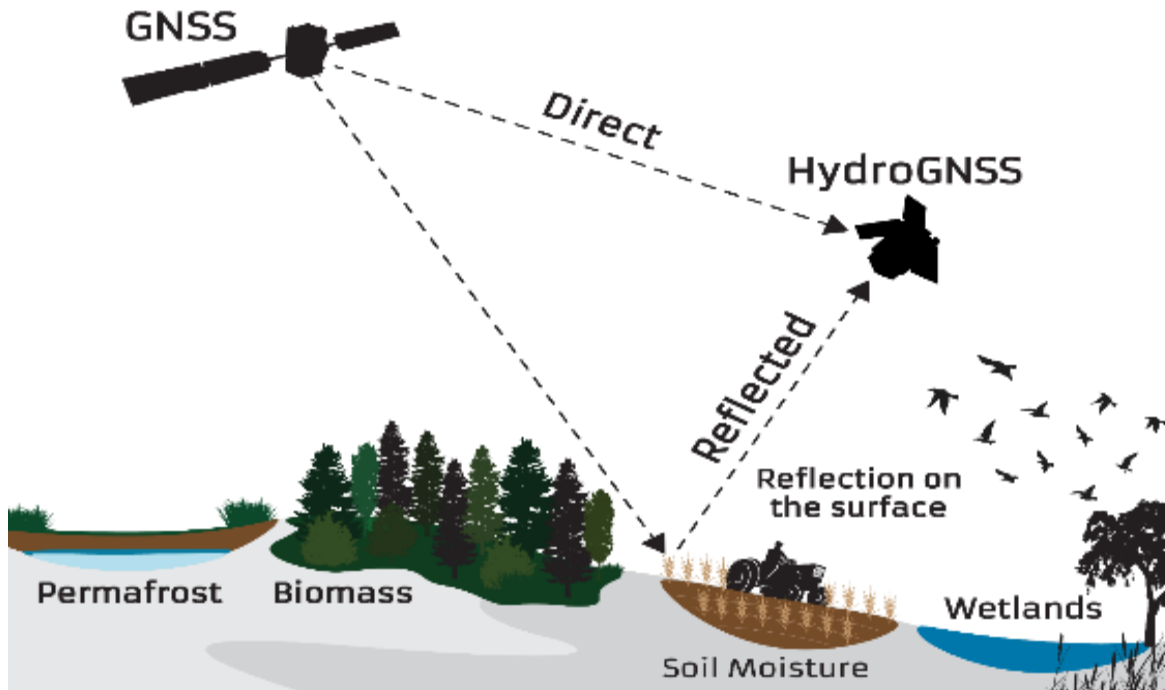
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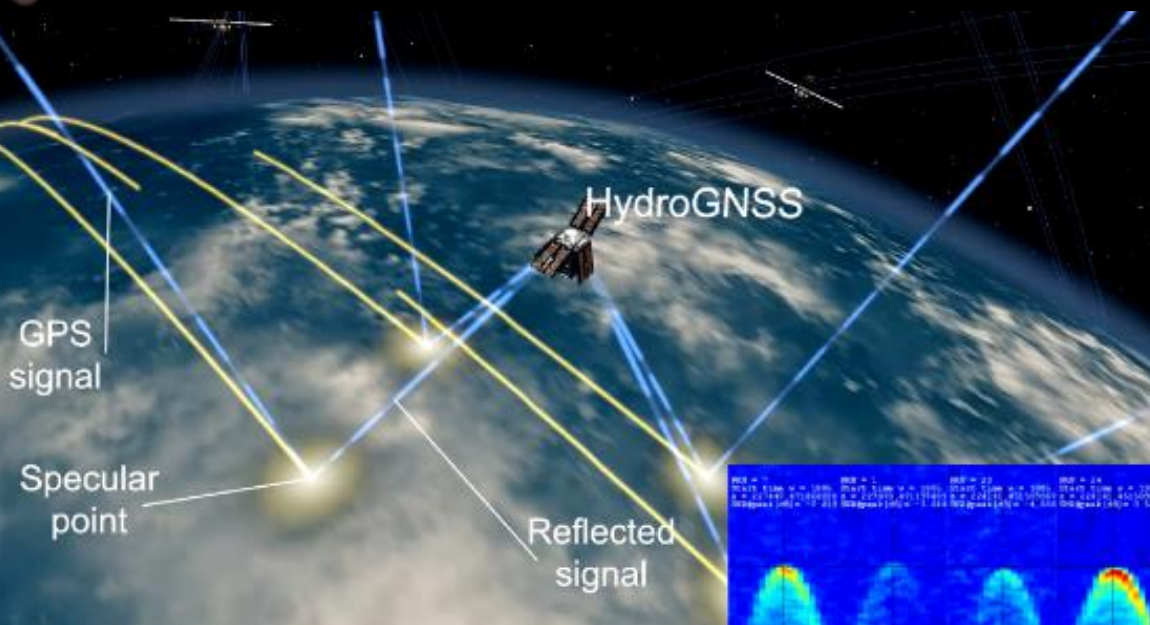
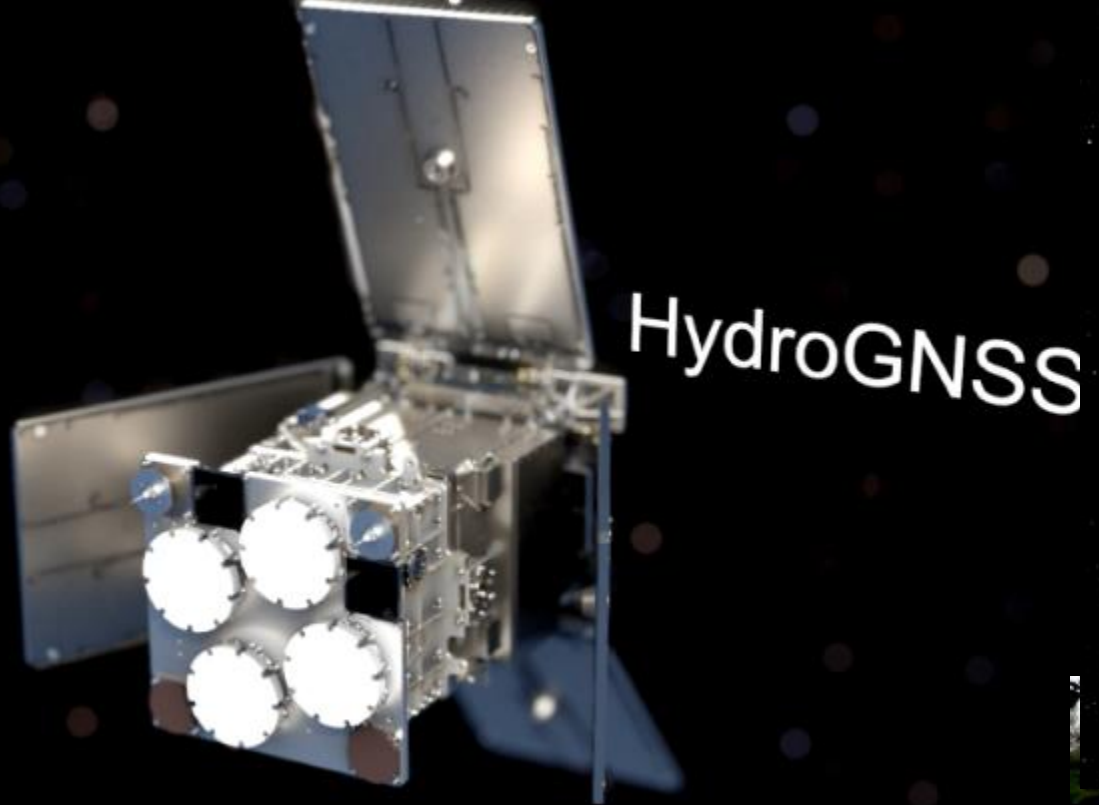
GNSS-R on HydroGNSS Mission



- SSTL early pioneer of GNSS Reflectometry (UK-DMC, TDS-1, CYGNSS)
 - Instrumentation sponsored by CEOI / UKSA, and ESA
- **ESA Scout** – scientific EO missions, small satellite platforms – mini-Earth Explorer
- **HydroGNSS** - two small satellites targeting land parameters linked to GCOS Essential Climate Variables (ECVs) using GNSS-R



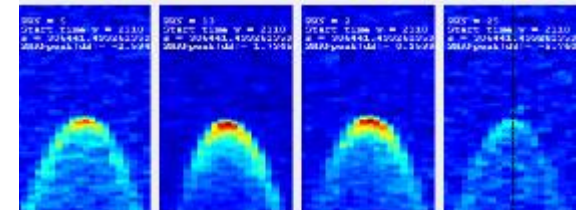
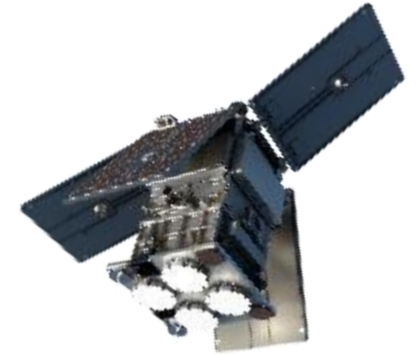
- **Soil Moisture, Biomass** and **Permafrost** are ECVs.
- **Wetlands** a primary source of greenhouse gases
- **GNSS-Reflectometry for EO**
 - Radar satellite using GNSS signals - no need for transmitter
 - Novel, complementary, and unique remote sensing technique
 - Addresses shortage in L-band EO measurements



HydroGNSS Mission & Science Objectives



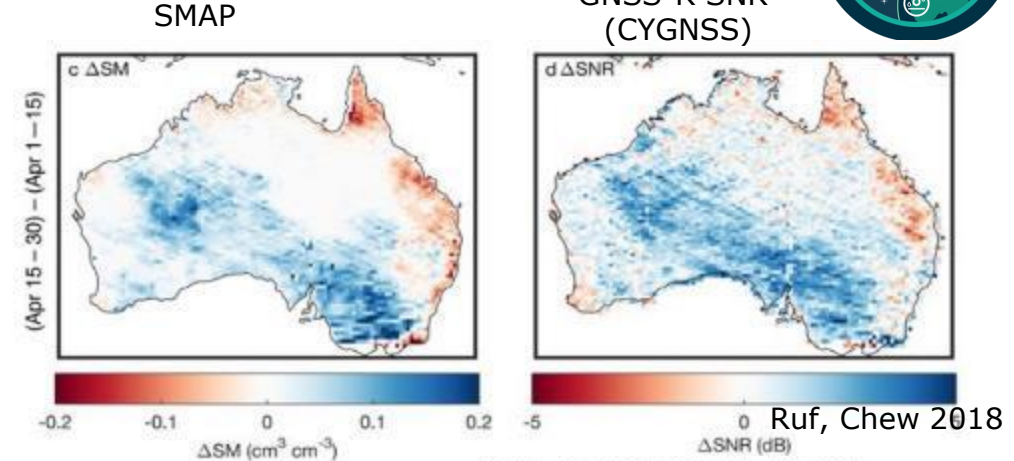
- Exploit L-band satellite navigation signals to monitor Earth's water systems to a finer resolution and derive measurements linked to ECVs defined by the Global Climate Observing System (Internationally agreed framework for common climate monitoring goals)
- **Soil Moisture**
 - Requirement $0.08 \text{ m}^3/\text{m}^3$, Goal $0.04 \text{ m}^3/\text{m}^3$
- **Inundation**, also wetlands
 - Requirement 90% classification
- **Soil Freeze/Thaw state**, incl. permafrost regions,
 - Requirement 90% classification
- **Forest Biomass**
 - Requirement 30%, goal 20%
- **Resolution requirement 25 km, goal 1 km**
 - Achievable resolution expected strong dependency on signal coherency
- Secondary objectives - **Ocean wind speed and ice extent** 2 m/s, 90%
- Level 2 and Level 1 (**Delay Doppler Maps**) made freely available
- Timeliness - 31 days standard and <7 days goal for faster service, view towards <24 hours
- Coverage - >80% of globe in 15 days (more satellites will reduce repeat time)
- Objectives captured in Mission Requirements Document (MRD)



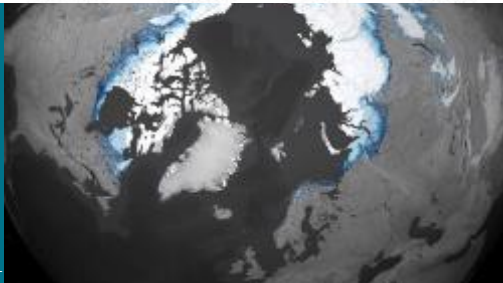
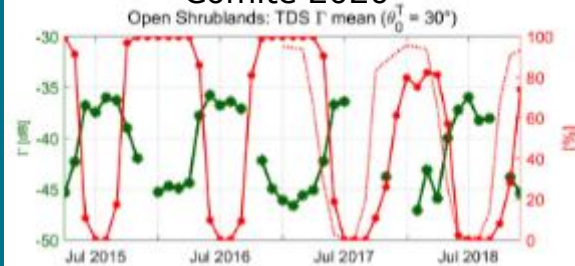
HydroGNSS Science Products from GNSS-R



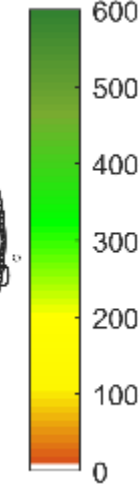
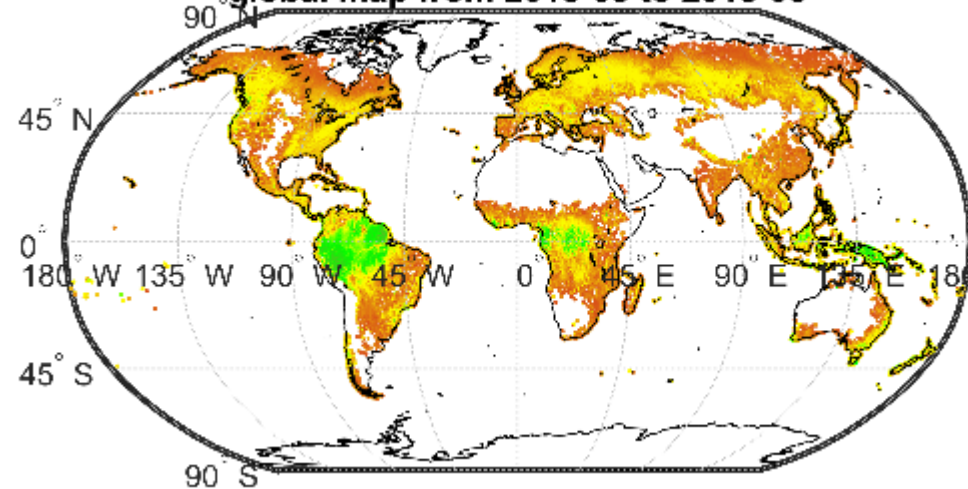
- Main HydroGNSS products are for hydrology established and innovative GNSS-R methods
 - **Soil Moisture** - compare CYGNSS vs SMAP
 - **Freeze / Thaw** - compare TDS-1 vs SMAP
 - **Inundation** - compare CYGNSS vs SMAP
 - **Biomass** - compare CYGNSS vs Pantropical
- Also **Ocean wind speed, sea ice extent** as secondary products
 - Science Partners from Italy, Spain, Finland, UK, Austria



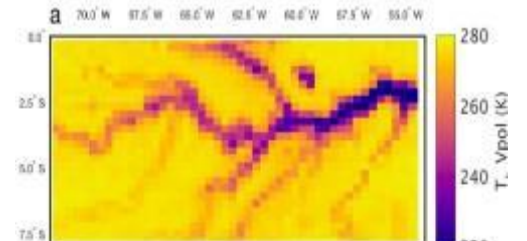
Freeze/Thaw from GNSS-R (TDS-1)
Comite 2020



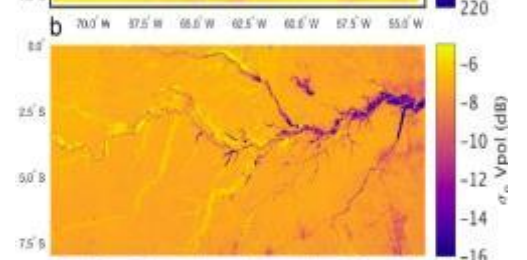
Biomass from GNSS-R (TDS-1) – Santi25
global map from 2018-03 to 2018-08



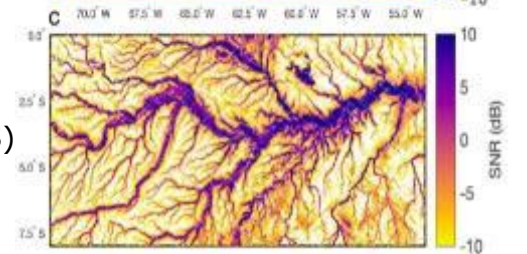
SMAP
Passive



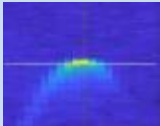
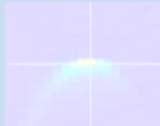
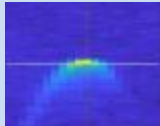
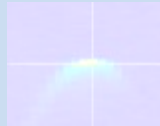
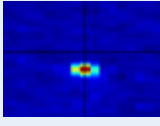
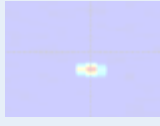
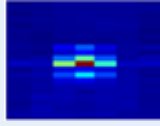
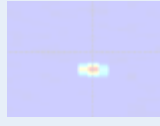
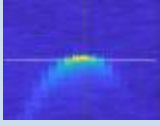
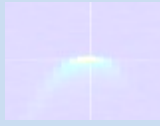
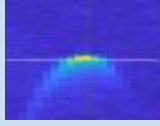
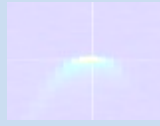
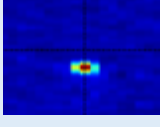
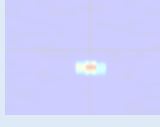
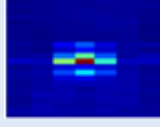
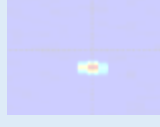
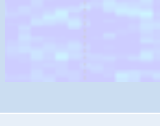
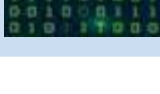
SMAP
Active



GNSS-R
SNR
(CYGNSS)



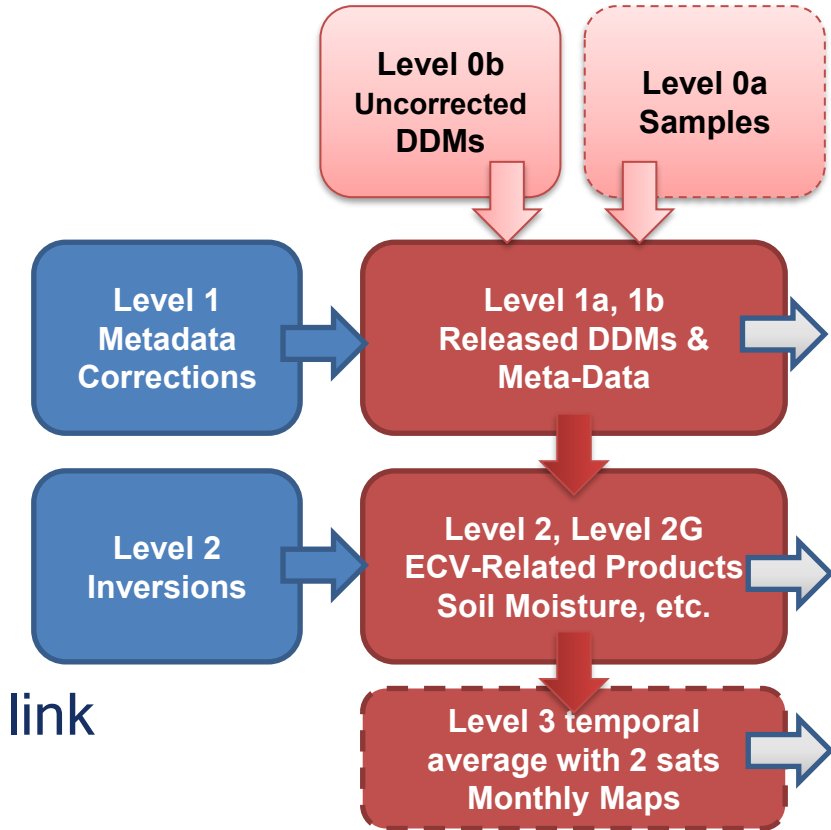
Level 0 / 1a – Old & New Products

Level 0b, near continuous	GPS - LHCP	GPS - RHCP	Galileo - LHCP	Galileo - RHCP
L1 Band Non-coherent DDMs 4 satellites every 1 sec	 *	 *	 *	 *
Coherent Channel 4 complex ch., 250 Hz	 *	 *	 *	 *
L5 Band Non-coherent DDMs 4 satellites every 1 sec	 *	 *	 *	 *
Coherent Channel 4 complex ch., 250 Hz	 *	 *	 *	 *
Black Body, L1 and L5 Bands x 1, each LNA	 *	 *	(Same)	(Same)
MetaData	Incl. Settings of Instrument, temperatures, zenith measurements GNSS position, velocity and time – Used for Level 1 corrections			
Level 0a (Typ. 60 seconds)	LHCP (All GNSS)	RHCP (All GNSS)	Previous / New Products	
L1 Band Sampled data	 *	 *	* Previously available on TDS-1 * Indicates new to HydroGNSS	
L5 Band Sampled data	 *	 *		

Ground Segment and Data Access

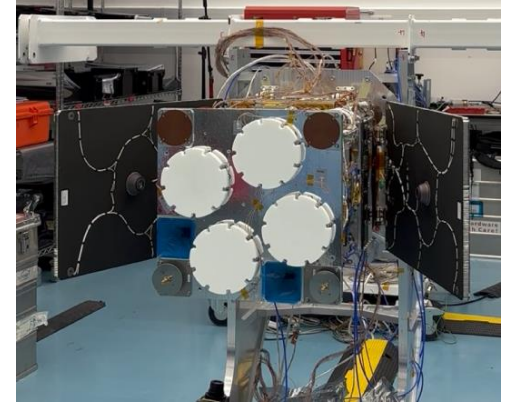


- Spacecraft MOC and PDGS located in Guildford, UK
 - Comms via Svalbard (S & X-band), Guildford back-up
- Payload Data Ground Segment takes data from Level 0 to Level 1, and Level 2, and some at Level 3
 - Processors provided by Science Team
- Calibrated products at Level 1B
 - **Reflectivity and Normalised BRCS**
- Six months anticipated for commissioning
 - Check-out, testing, data logs, preliminary validation
- HydroGNSS website point of contact - registration, data link
- Data provided on free and open basis for registrants
 - Data owned by ESA, disseminated by SSTL
 - Documentation and sample scripts available to help
- Timeliness - once operating, data delivery goal within 7 days



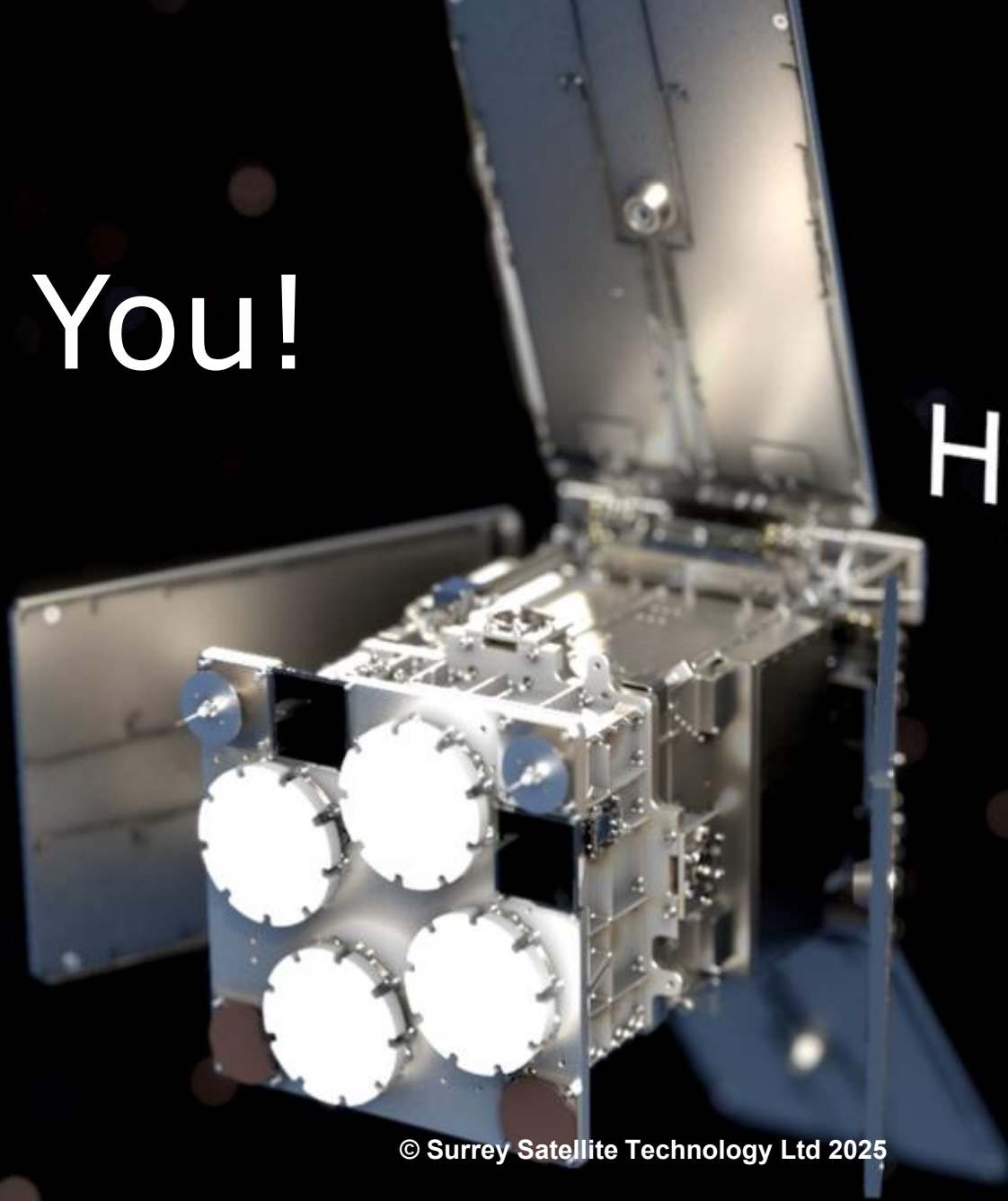
Two Satellites Packed and Shipped for Launch

- Satellites now en route to SpaceX in California
- Launch date likely to be mid-to-late November 2025
- First data expected to be released in **June 2026**



Thank You!

HydroGNSS



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