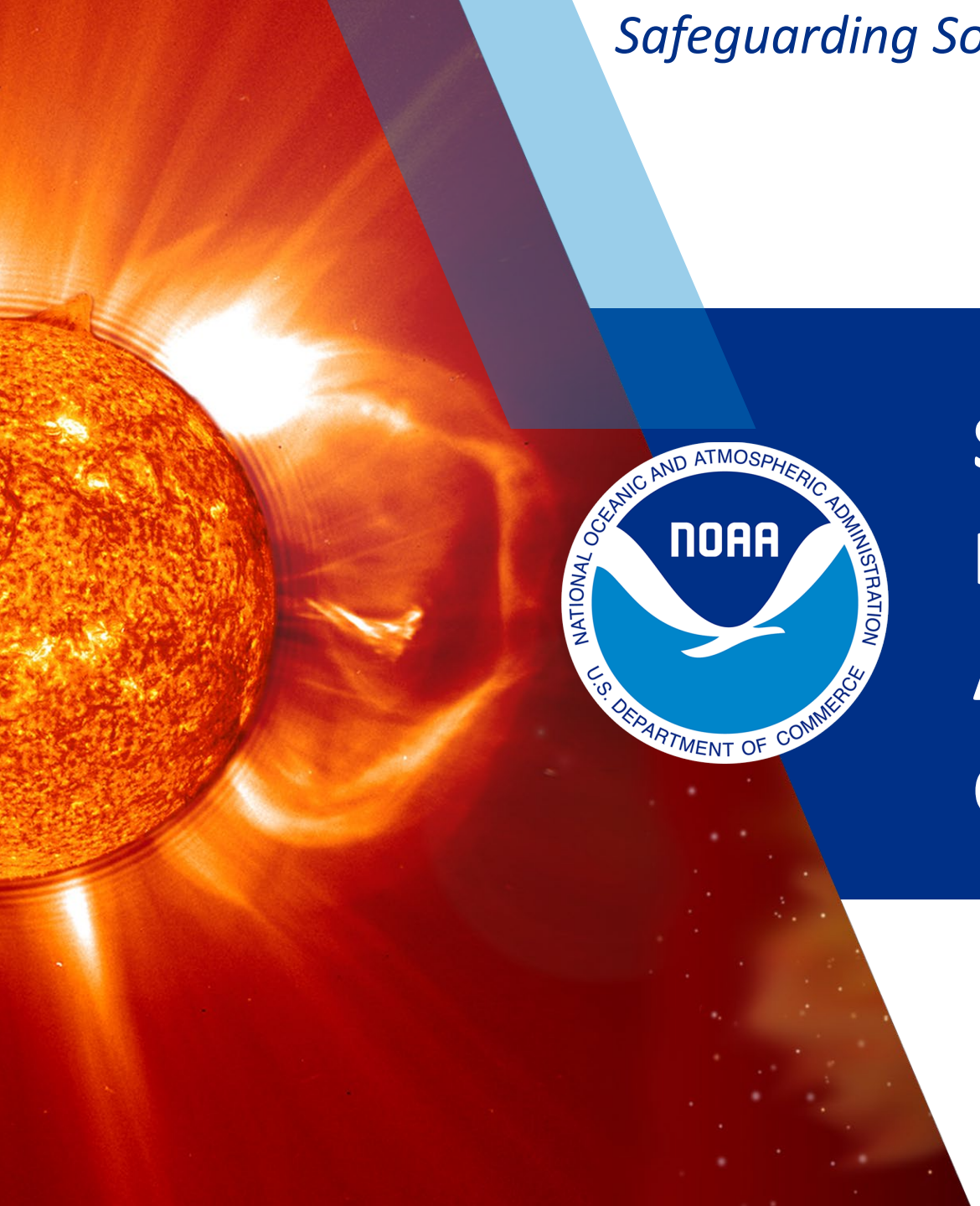
Safeguarding Society with Actionable Space Weather Information



SWPC's Product Development: In collaboration with Academia, Agencies, Users, and Commercial Groups

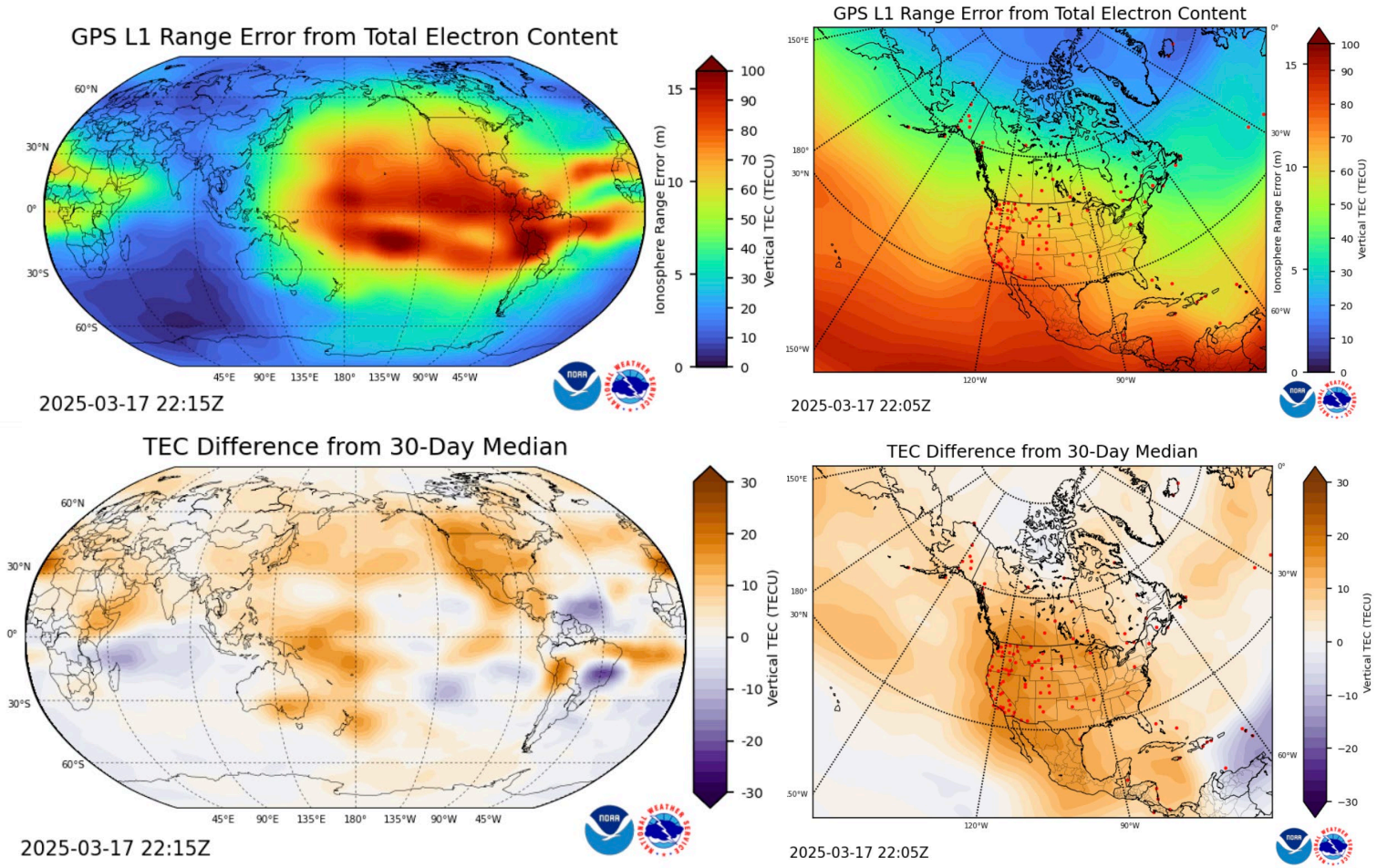
Tzu-Wei Fang

NOAA Space Weather Prediction Center

Example 1

GloTEC - Nowcast

- Global 3D electron density data assimilation, in operation on Feb 2025
- Provide global TEC map is provided on a 2.5° lat and 5° long grid every 10 minutes
- IRI-16 background model
- Data source
  - Real-time ground-based GNSS observations
  - Real-time Space-based GNSS observations (COSMIC-2 RO and commercial RO)
  - Future source: POD, Google data



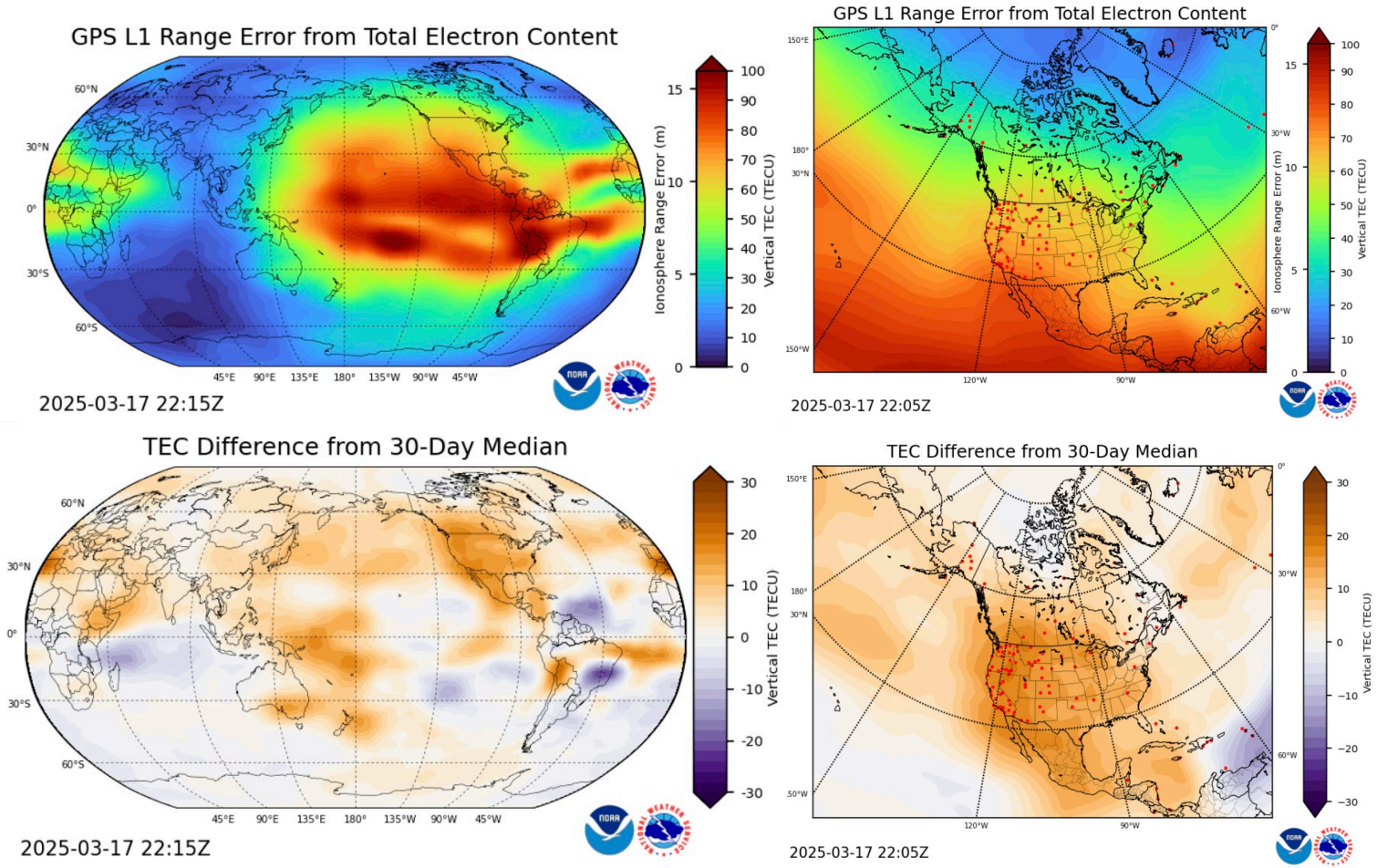
https://www.swpc.noaa.gov/products/glotec

NOAA

- SWPC real-time DA system
- NOAA/USSF COSMIC-2
- Commercial RO data purchased by NESDIS Commercial Data Program

User Engagement in May 2025

- USSF through UDL
- GNSS receiver manufactures
- Cell phone application
- Space-based PNT
- Space industry
- Precision agriculture
- Aviation Users
- Drone community
- Timing Applications



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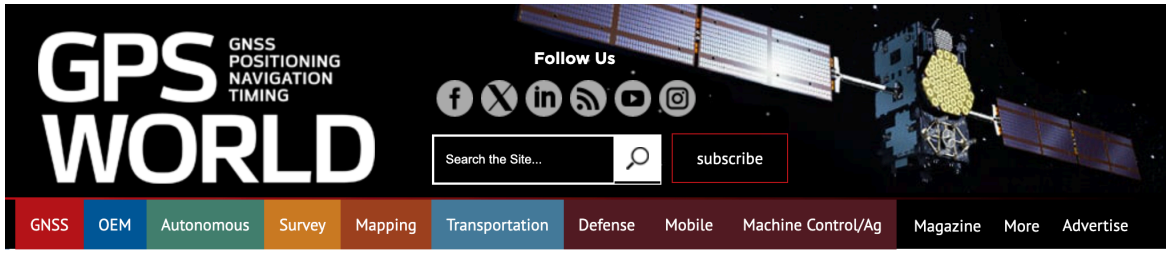
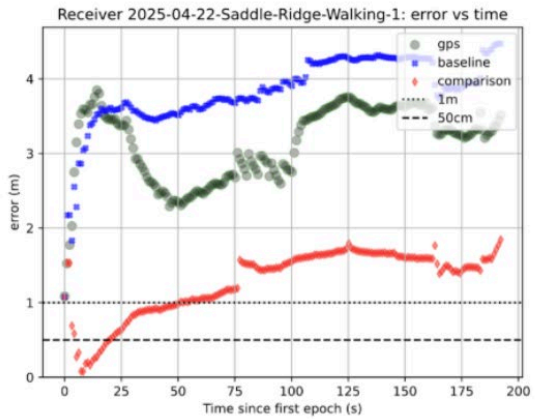
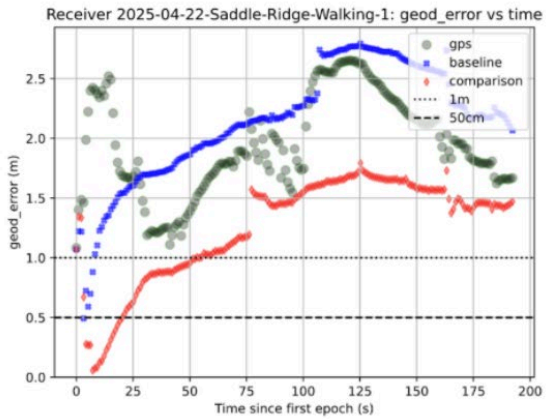


Nowcasting the ionosphere: Evaluating GloTEC for real-time GNSS corrections

July 14, 2025 - By Sean Gorman

Est. reading time: 4:30

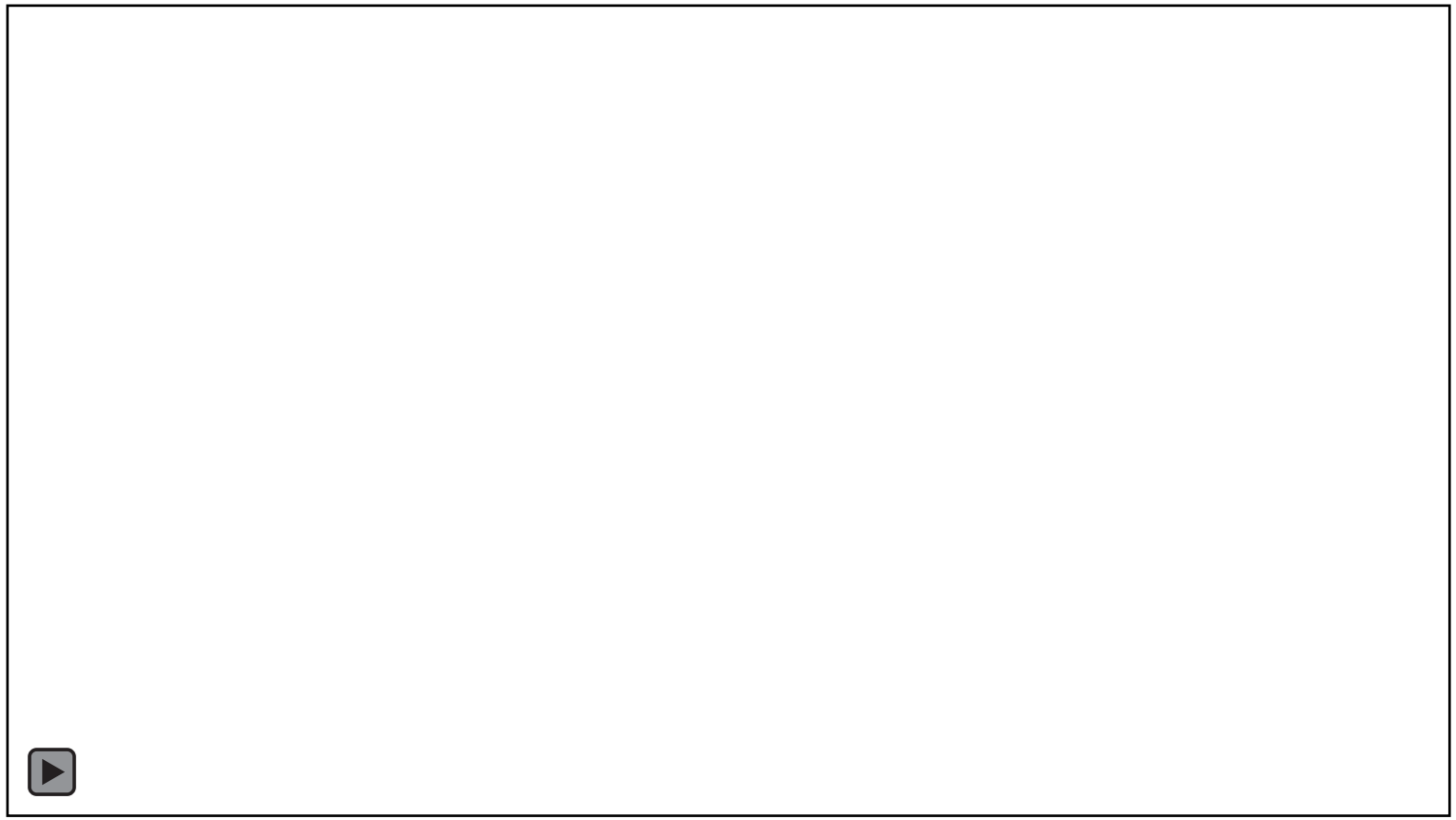




	3D error (m)	2D error (m)
zephr + GLOTEC	1.27	1.25
zephr + predicted CODETEC	3.83	2.13
smartphone GPS	3.14	1.94

Example 2: WAM-IPE (Whole Atmosphere and Ionosphere Plasmasphere Electrodynamics Model) – Nowcast and Forecast

- Physics-based model include lower atmosphere weather and processes
- WAM provides the 3D fields for neutral winds, temperature, density for drag. The plasma component, IPE, provides plasma densities and velocities, and temperatures in the ionosphere and plasmasphere for communications and navigation impacts
- In operation since July 2021 with the latest upgrade in Aug 2023. Two operational CONOPS provide T-I nowcast as well as forecast two days in advance



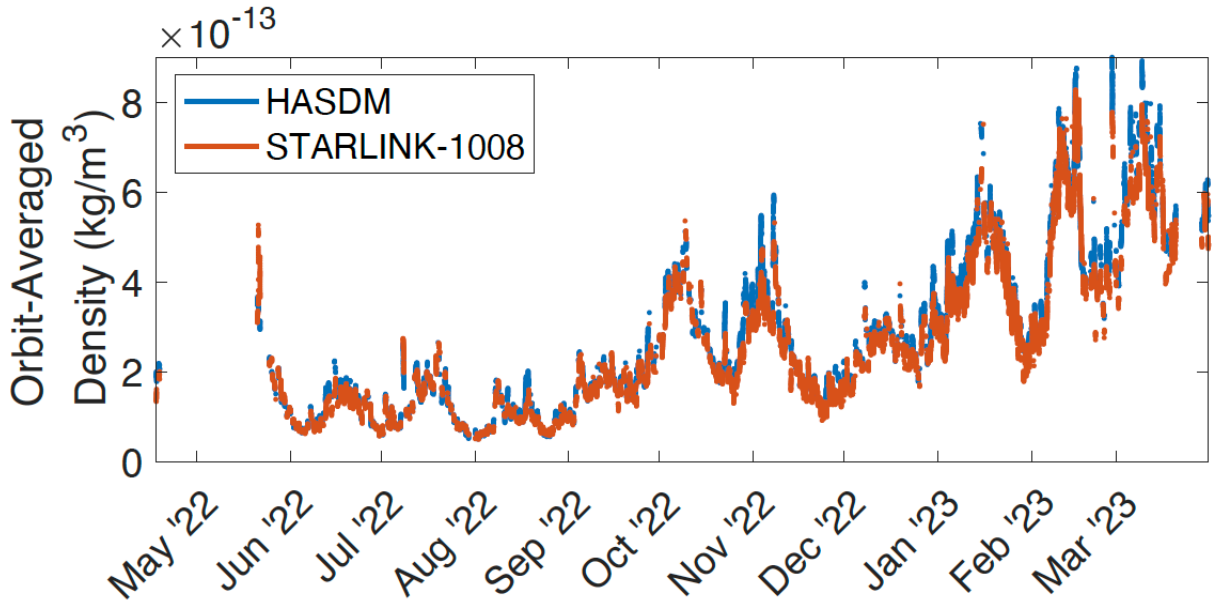
https://www.swpc.noaa.gov/products/wam-ipe

Neutral Density Estimation (NOAA JV Project)

Densities from 1 Starlink Satellite

v1.0 densities:

- Very low bias/std with respect to HASDM
- E.g., STARLINK-1008:
  - Mean Bias (data/model): **–6.5%**
  - StD (data/model): **11.6%**



Eric Sutton (CU SWxTREC)

WAM-IDEA Neutral Density Data Assimilation (Nowcast)

NOAA

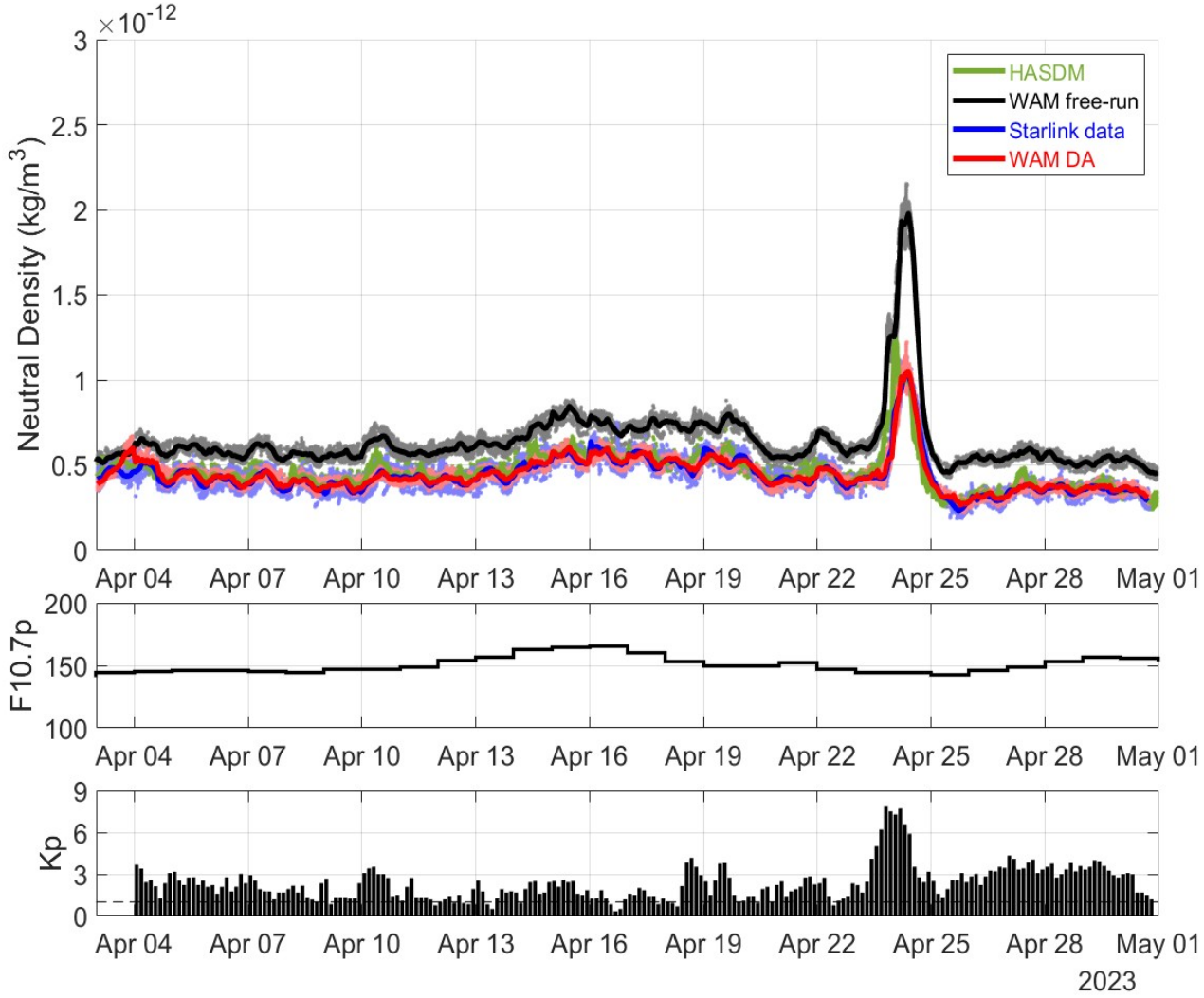
- NWS/SWPC modeling system and real-time workflow (model development funded by NASA, NSF, ONR, NOAA over many years)
- Research project funded by Joint Venture program in NESDIS

Academic (CU-Boulder)

- Algorithm development for neutral density extraction
- DA system development and testing

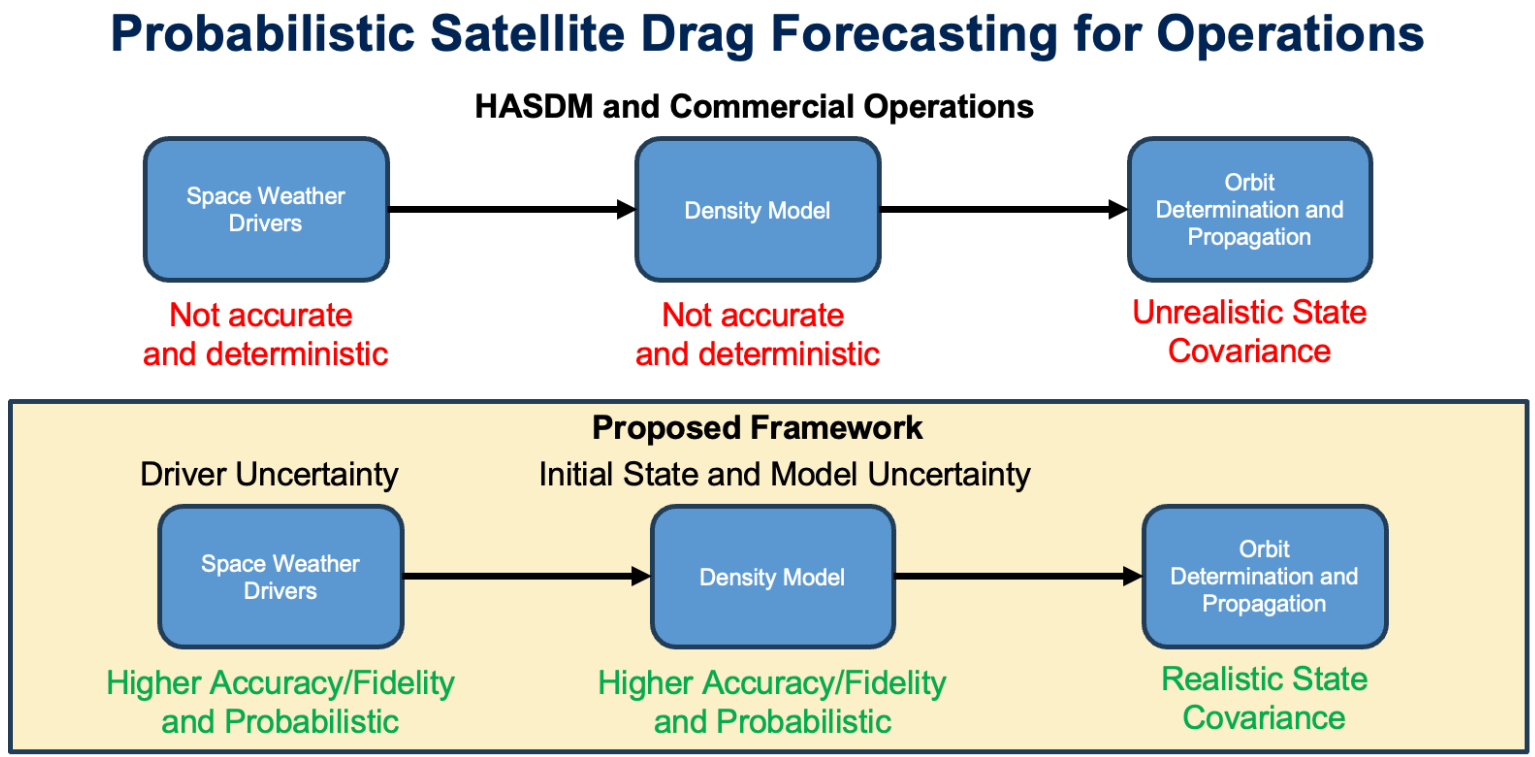
Commercial (SpaceX Starlink)

- Providing test dataset and support



Example 3: Next-Generation Probabilistic Drag Modeling Framework
(Funded by the Office of Space Commerce)

- **Satellite drag in LEO and impacts/influences**
  - Mission design and planning; e.g. lifetime, orbits, etc.
  - Object tracking and identification, data/track association and custody
  - Orbit determination/prediction, conjunction assessment and collision avoidance
  - Informing debris generation and mitigation; e.g. forensic analysis
  - Policy and guidelines



Piyush Mehta (WVU)

NOAA

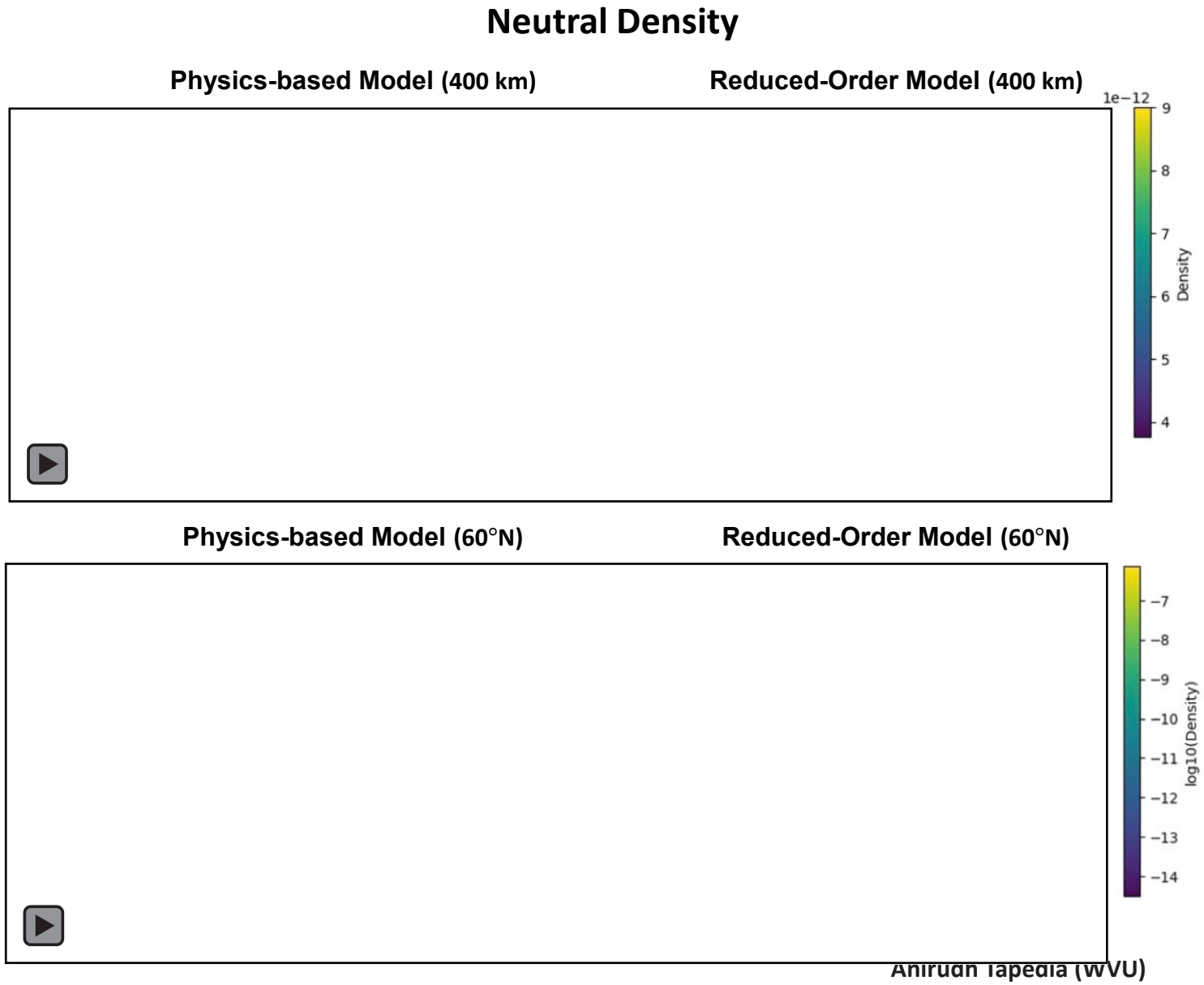
- NWS/SWPC provides a long-term run of the physics-based model
- Research project funded by the Office of Space Commerce

Academic (West Virginia University)

- AI/ML neutral density model development
- Develop a probabilistic drag modeling framework
- DA system integration and testing

Advisory Team (SpaceX Starlink, Amazon Leo, LeoLabs, and NASA CARA)

- Testing delivered software package
- Provide feedback and operational requirements



Anirudh Tapedia (WVU)