

T-FORS

Travelling Ionospheric Disturbances Forecasting System

WP1 (Strategy and Capabilities)

Preliminary User Requirements

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Layout

- **Terminology**
- **Preliminary User Categories**
- **Preliminary T-FORS Design Requirements**

Background

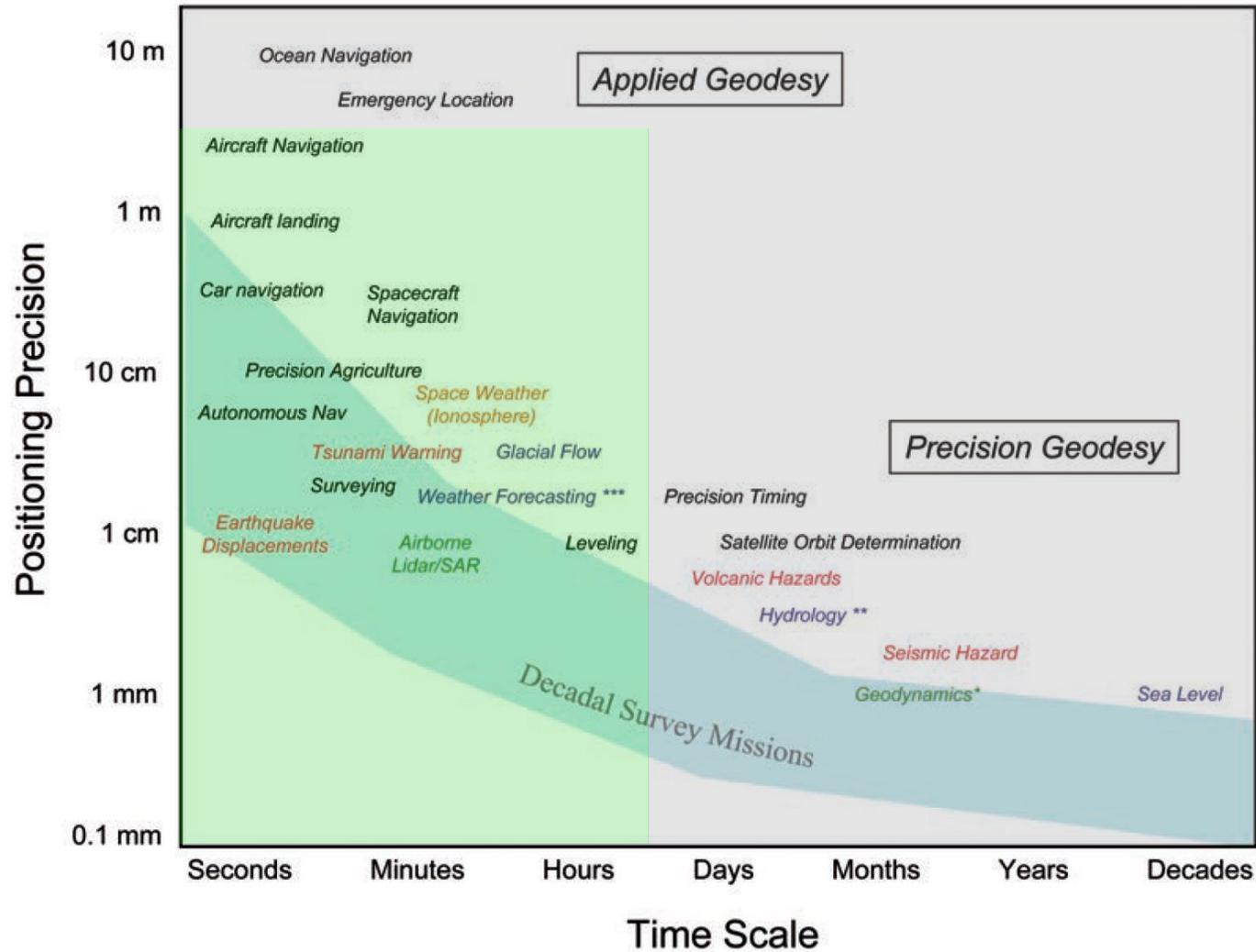
- Ionospheric Weather applications keep emerging
- New today: the unprecedented need for **high accuracy** of global Ionospheric Weather **Nowcast** and **Forecast** in near real-time.
 - TID is a **major operational nuisance** © AFRL
 - ❖ PPP (precise point positioning) applications of GNSS; also Real-Time Kinematic (RTK)
 - ✓ TID as a **“Silent Killer of PPP Accuracy”**
 - Precise-Nav systems cannot detect TID-inflicted errors by themselves
 - ✓ TID problem is more acute than GNSS scintillation/loss-of-lock
 - SSR (state spatial representation) correcting systems with reference stations
 - CLAS (Japan) centimeter-level augmentation system
 - 100% coverage is prohibitively expensive
 - ❖ HF Geolocation of Uncooperative Transmitters
 - ✓ **“Short-Range Catastrophe”**: a devastating TID impact on HF geolocation (10s km errors)
 - Academy is tasked to provide new understanding and accurate specification of the ionospheric dynamics
 - ❖ Space agencies and industry partners look for practical SSA solutions



Preliminary User Categories

- Top-Level Categorization
 - UHF (ultra-high frequency).. L-band satcom/nav
 - ❖ Ionosphere is a nuisance
 - HF (high frequency)
 - ❖ Ionosphere is the enabling technology, yet a nuisance
- UHF applications
 - Autonomous Precision Navigation:
 - ❖ Land: industrial, agricultural, civil vehicle positioning
 - ❖ Air: aviation landing and flight corridor allocation
 - ❖ Sea: shipping and mine drilling
- HF applications
 - Radars: geolocation, target registration, altimeters
 - Frequency management (MUF, optimal bands): radios and radars

Precision and Applied Geodesy



T-FORS Science Applications

- SAR for Earth Observations
- LOFAR and other VLBI
- Atmosphere-Ionosphere-Thermosphere-Ionosphere coupling
- Ray Tracing
- Space climate
- Space weather

Terms 1: Nowcast, Forecast, Prediction, Backcast

- **Nowcast:** system specification in the real-time
- **Forecast:** system specification in the future based on current system nowcast(s)
- **Prediction:** system specification in the future based on expected behavior in similar conditions
- **Backcast:** system specification in the past using updated sensor data measurements or re-analysis

Terms 2: Warning, Alert, Report

- **TID WARNING:** forecast/prediction of an upcoming disturbance with 2+ hour horizon
 - Could be based on current nowcast/forecast of TID drivers or statistical model predictions
- **TID ALERT:** forecast of an upcoming or ongoing disturbance with <2 hour horizon
 - Could be based on objective TID event sensor detections
 - Could be based on a short-term forecast of TID direction of travel
- **TID REPORT:** backcast of the observed disturbance
 - Re-analysis of the retrospective end-user data
 - Using updated ionospheric specification

Req ID	Requirement Statement	Priority	Users
1000 Series: General Scope of Services			
1010	T-FORS shall establish an operational system for issuing TID-in-progress alerts	M	All
1020	T-FORS shall establish an operational system for issuing upcoming TID possibility warnings	M	NRTK, EGNOS
1030	T-FORS shall establish an operational system for producing retrospective TID occurrence reports	M	All
1040	T-FORS shall accept geographic information to issue location-specific reports, alerts, and warnings	M	All
1050	T-FORS shall report timing information on elevated TID activity	M	All
1051	T-FORS shall report onset time of elevated TID activity	M	All
1052	T-FORS shall report stop time of elevated TID activity	M	All
1053	T-FORS shall report severity level of TID activity at the specified temporal resolution	M	All

M – mandatory
D -- desireable

Req ID	Requirement Statement	Priority	Users
1000 Series: General Scope of Services, cont.			
1060	T-FORS shall report spatial information of elevated TID activity	M	All
1062	T-FORS shall accept geographic location parameters to issue location-specific timelines of reports, alerts, and warnings	M	All
1063	T-FORS shall accept geographic area parameters to issue area-specific 2D maps of reports, alerts, and warnings	M	All
1070	T-FORS shall report percent certainty metrics of reported TID activity at the specified temporal and spatial resolution	M	All
1080	T-FORS shall use 4-level severity level: 0 (minor), 1 (elevated), 2 (strong), 3 (severe) at each define spatial and temporal resolution step	M	All
1100	T-FORS shall report LSTID and MSTID activity separately	M	All
1200	T-FORS shall issue geospace activity metrics in support of the TID alert and warning evaluations	M	All

M – mandatory
D -- desireable

Req ID	Requirement Statement	Priority	Users
2000 Series: Nowcast and Backcast Operation			
2010	T-FORS shall complete the operational nowcast computation within 15 minutes of the latest sensor measurement	M	All
2020	T-FORS shall complete computation of the updated backcast within 2 hours of the current time	D	GFP
2021	T-FORS shall complete computation of the updated backcast within 1 hour of the current time	M	ONERA
2030	T-FORS shall report the TID-in-progress Nowcast and Backcast with 5-min time resolution	M	All

M – mandatory
D -- desireable

Req ID	Requirement Statement	Priority	Users
3000 Series: LSTID Forecast			
3010	T-FORS shall issue a 3-day operational forecast of upcoming LSTID activity at a 1-hour cadence	D	NRTK, EGNOS
3011	T-FORS shall issue the 3-day forecasts with 1-hour resolution		
3020	T-FORS shall issue a 12-hour operational forecast of upcoming LSTID activity at a 30-min cadence	M	NRTK, EGNOS
3021	T-FORS shall issue the 12-hour forecasts with a 30-min resolution	M	All
3030	T-FORS shall issue a 2-hour operational forecast of upcoming LSTID activity at a 15-min cadence	M	NRTK, EGNOS
3031	T-FORS shall issue the 2-hour operational forecasts with a 15-min resolution	M	All
4000 Series: MSTID Forecast			
4010	T-FORS shall issue a 12-hour operational prediction of possible upcoming MS-TID activity	M	All
4041	T-FORS shall issue the 12-hour predictions with a 1-hour resolution	M	All



Horizon
Europe

Thank you for your attention!



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