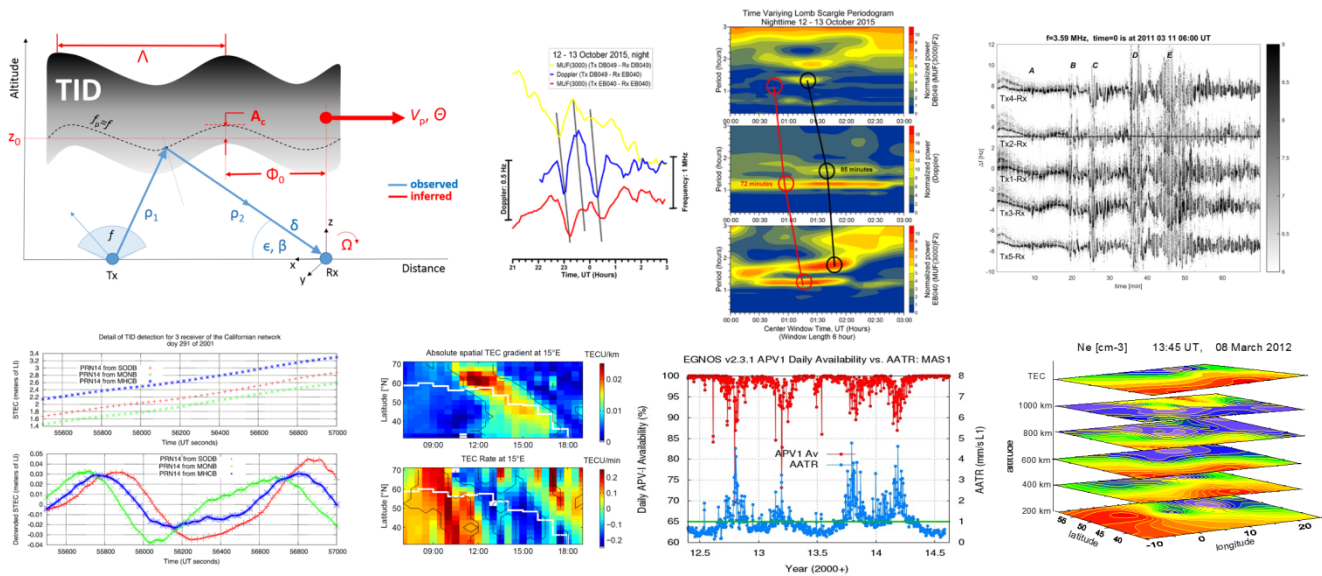


TechTIDE

Warning and Mitigation Technologies for TID effects



Travelling Ionospheric Disturbances Detection methods

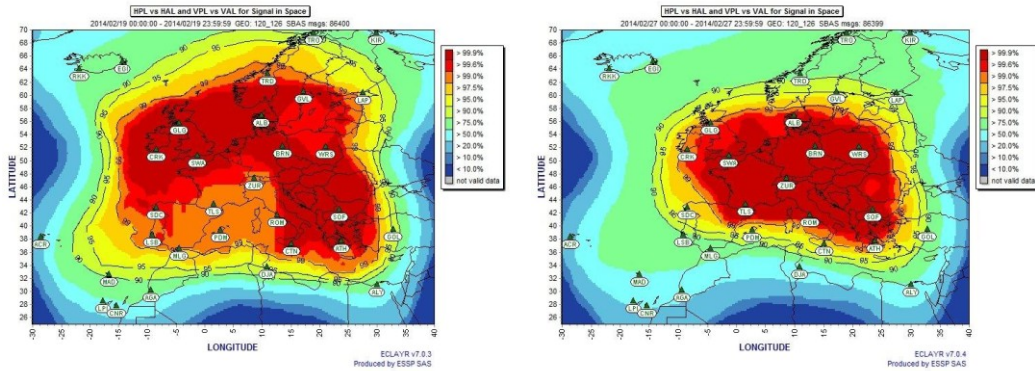
Proposal submitted to the EC H2020 COMPET 5 Call

The overarching objective of TechTIDE is to design and test **new viable TID impact mitigation strategies for the technologies affected**. In close collaboration with operators of these technologies, the project will demonstrate the added value of the proposed mitigation techniques which are based on TechTIDE products.

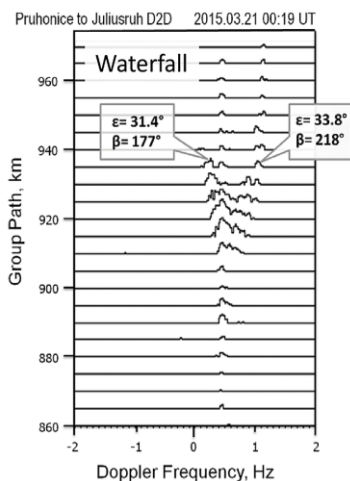
Contact: Anna Belehaki (belehaki@noa.gr) and Claudia Borries (claudia.borries@dlr.de)

TechTIDE rational

Travelling Ionospheric Disturbances (TIDs) are plasma density fluctuations that propagate as waves through the ionosphere at a wide range of velocities and frequencies. TIDs constitute a threat for operational systems using predictable ionospheric characteristics as they can impose disturbances with amplitudes of up to ~20% of the ambient electron density, and Doppler frequency shifts of the order of 0.5 Hz on HF signals. It is clearly demonstrated that TIDs can have multiple effects in the operation of aerospacial and ground-based infrastructures and especially in the European Geostationary Navigation Overlay Service (EGNOS) and Network Real-Time Kinematic (N-RTK) services, in High Frequency (HF) communications, in radio reconnaissance operations and in Very High Frequency – Ultra High Frequency (VHF-UHF) radiowave propagation.



EGNOS LPV PERFORMANCE RESULTS ON A NOMINAL DAY (TOP) AND ON A DISTURBED DAY (BOTTOM). THE DEGRADATION IS ATTRIBUTED TO LARGE SCALE TIDS



DOPPLER WATERFALL REPRESENTATION OF THE RECEIVING SIGNAL DURING DISTURBED CONDITIONS FROM PRUHONEICE TO JULIUSRUH DIGISONDES RESULTING IN MULTIMODE PROPAGATION.

TIDs constitute a specific type of space weather phenomenon that can be solar-driven and/or be driven by other processes acting below the ionosphere. Independent of their source, the effects imposed by TIDs at ionospheric altitudes are very important and for the user needs the source of TIDs is information of secondary importance. The main users' concern is to have direct and timely information of ionospheric perturbations due to TIDs and hence being able to mitigate the effects in their operations. It is for this reason that this need has been formulated as a clear customer requirement for the Space Weather segment of the Space Situational Programme (SSA) of the European Space Agency (ESA).

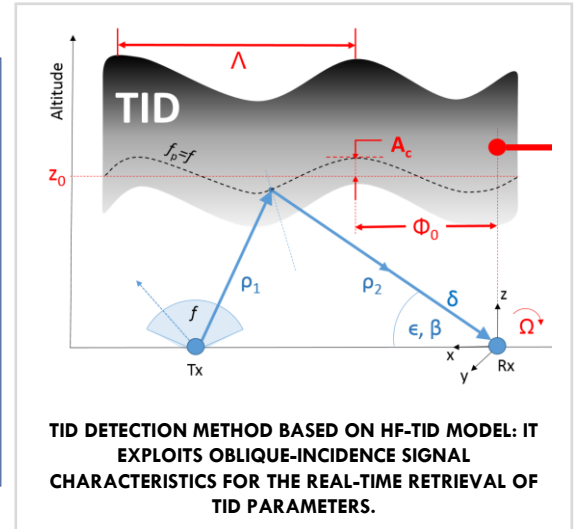
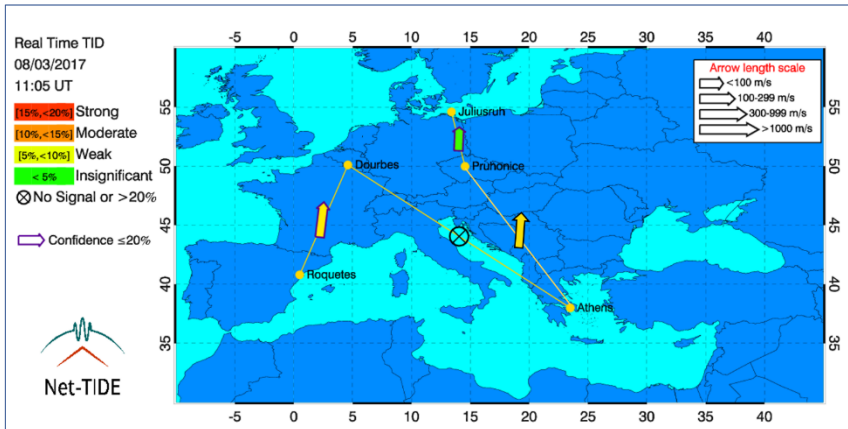
Because of the high occurrence frequency of TIDs (almost daily), and the variety of their

characteristics regarding their velocity, propagation direction and amplitude, their **identification and tracking is very complicated and has not been achieved in operational service mode.**

TechTIDE users communities: EGNOS services users, HF operators, space agencies, N-RTK services users, radio astronomers, radio amateurs, humanitarian aid organizations.

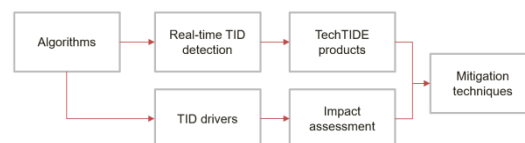
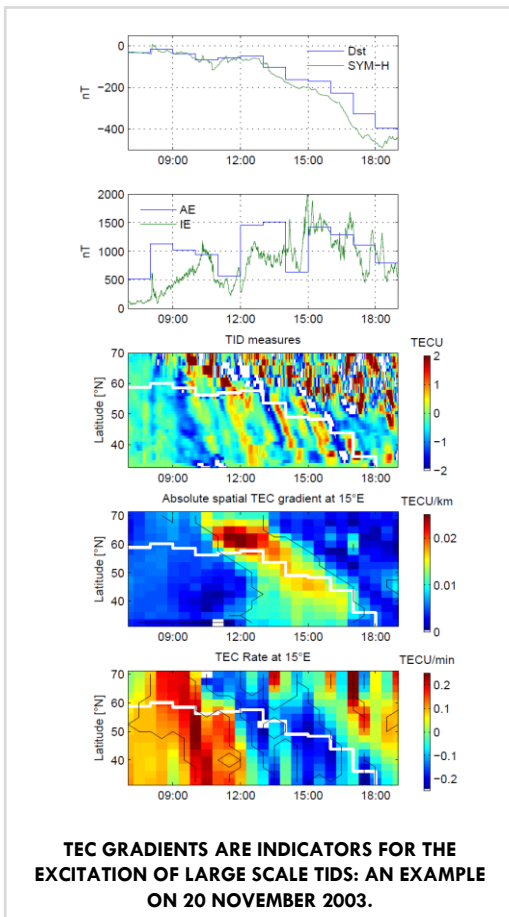
TechTIDE objectives

The overarching objective of TechTIDE is to design and test **new viable TID impact mitigation strategies for the technologies affected** and in close collaboration with operators of these technologies, to demonstrate the added value of the proposed mitigation techniques which are based on TechTIDE products.



To achieve this main goal, it is necessary to address the following specific objectives:

- Improve understanding regarding the physical processes resulting in the formation of TIDs, and consequently to identify the drivers in the interplanetary medium, the magnetosphere and the atmosphere;
- Identify the impact of the TIDs on the space based navigation systems (mainly EGNOS services and N-RTK) and on ground-based HF operations;
- Develop improved methodologies, suitable to support for the first time the direct, real-time identification and tracking of TIDs over wide world regions;
- Establish an operational system to issue warnings of the occurrence of TIDs over the region extending from Europe to South Africa, to estimate the parameters that specify the TID characteristics and the inferred perturbation, and provide all additional geophysical information to the users to help them assess the risks and to develop mitigation techniques, tailored to their applications;
- Work systematically with potential users to assess the functionality, reliability and efficiency of the TechTIDE services paving the way to its systematic exploitation from users and to its sustainable operation.



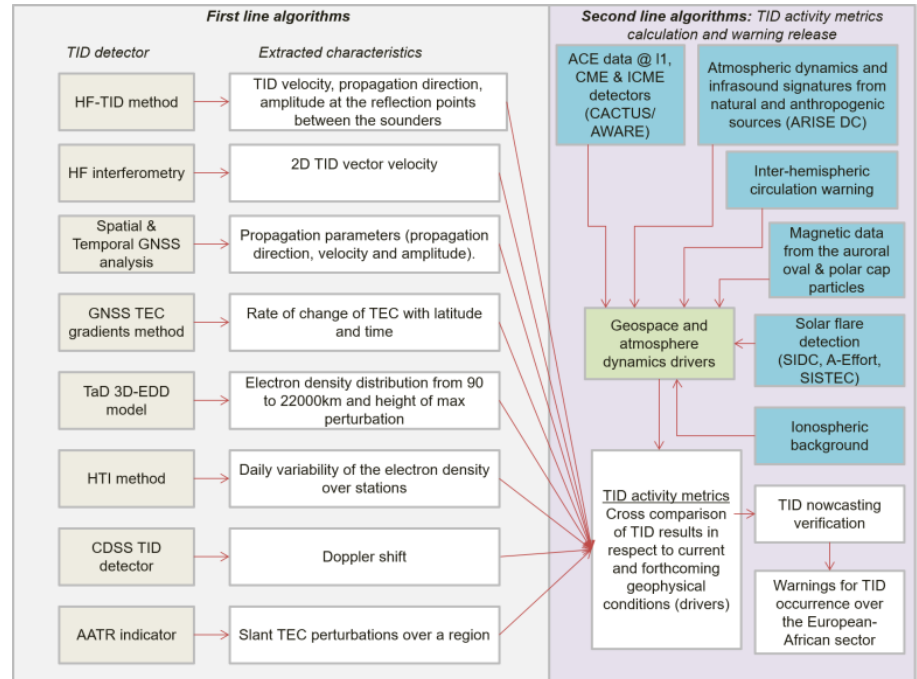
TechTIDE expected achievements

Achievement 1: TechTIDE will deliver a comprehensive system for TID identification, with an activity metrics report and recommended mitigation strategies for aerospace and ground-based operations.

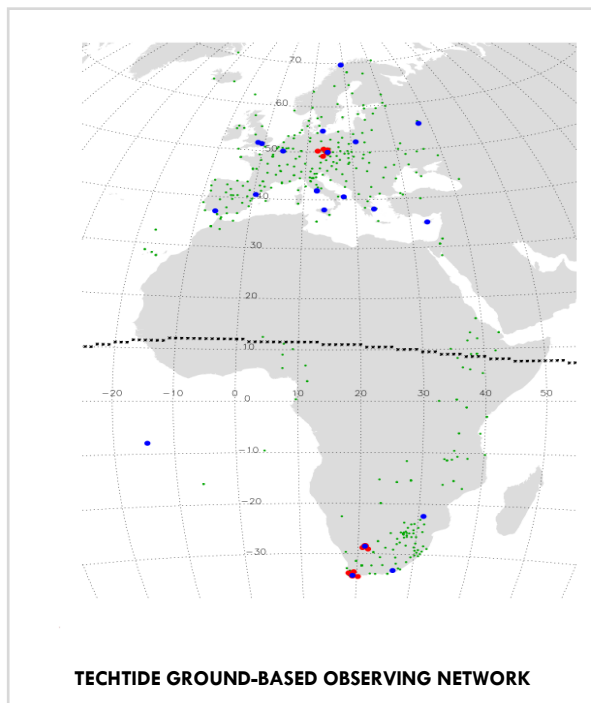
Achievement 2: TechTIDE will provide for the first time direct identification of TIDs in real-time based on 8 different and complementary detection techniques.

Achievement 3: Data from Digisondes, GNSS receivers and Doppler stations collected simultaneously from experiments operated in the European and South African regions will support novel studies on the TID triggering mechanisms including their intensification due to interhemispheric circulation.

Achievement 4: TechTIDE will fill in the gap in the current SSA ensemble of federated services, satisfying the requests of Trans-ionospheric domain for accurate ionospheric specification and especially for TIDs nowcasting.



Achievement 5: TechTIDE will be compliant to the ESA SSA technical specifications and will use as much as possible data from other SSA services. Consequently, TechTIDE can be easily integrated to the SSA services.



TechTIDE consortium

National Observatory of Athens (NOA), Greece
 Deutsches Zentrum für Luft- und Raumfahrt (DLR), Germany
 Ustav Fyziky Atmosfery AV CR (IAP), Czech Republic
 Institut Royal Meteorologique de Belgique (RMI), Belgium
 Observatorio del Ebro Fundacion (OE), Spain
 Borealis Global Designs Ltd. (BGD), Bulgaria
 Leibniz Institute of Atmospheric Physics, Rostock University (L-IAP), Germany
 Universitat Politecnica de Catalunya (UPC), Spain
 European Satellite Services Provider (ESSP), France
 South Africa National Space Agency (SANSA), South Africa
 Watermann Juergen Friedrich Wilhelm (JFWCONSULT), France
 Frederick University (FU), Cyprus
 German Federal Police (GFP), Germany
 University of Massachusetts Lowell (UML), USA
 Lowell Digisonde International (LDI), USA