9th CCMC Community Workshop
College Park, Maryland
April 23 – April 27, 2018

# INTERNATIONAL SPACE WEATHER ACTION TEAM FOR THE COORDINATED ASSESSMENT AND IMPROVEMENT OF IONOSPHERE VARIABILITY PREDICTIONS

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# OVERVIEW OF COLLABORATION ACTIVITIES IN EUROPE

- Operation of observing networks : Ionosondes, Doppler Sounders, GNSS receivers
- Development of ionospheric prediction models
- Systematic collaboration with the European Space Agency for the provision of ionospheric prediction services that meet the needs of operations
- Implementation of European and international projects for achieving scientific advances driven by users requests



space situational awareness

esa

# IONOSPHERIC MONITORING NETWORKS

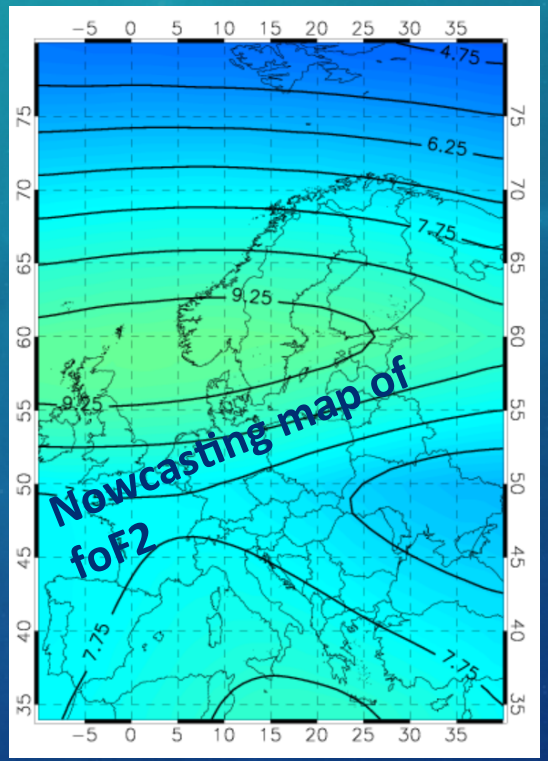

Mainly for large scale ionospheric disturbances
at mid & high latitudes

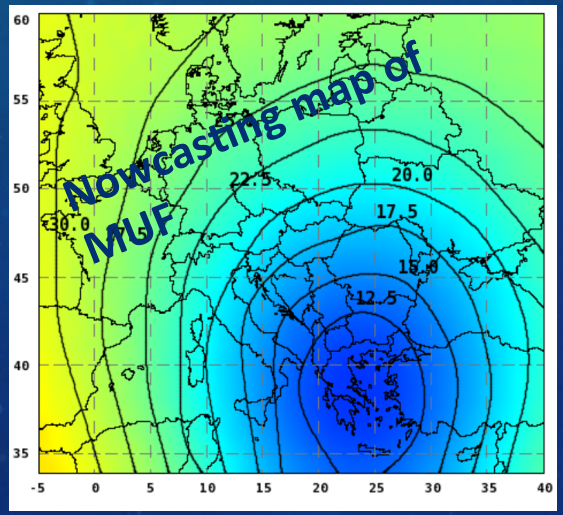
# THE EUROPEAN DIGITAL UPPER ATMOSPHERE SERVER

## REAL-TIME IONOSPHERIC VARIABILITY BASED ON THE COMBINED USE OF DIGISONDE DATA AND GNSS TEC

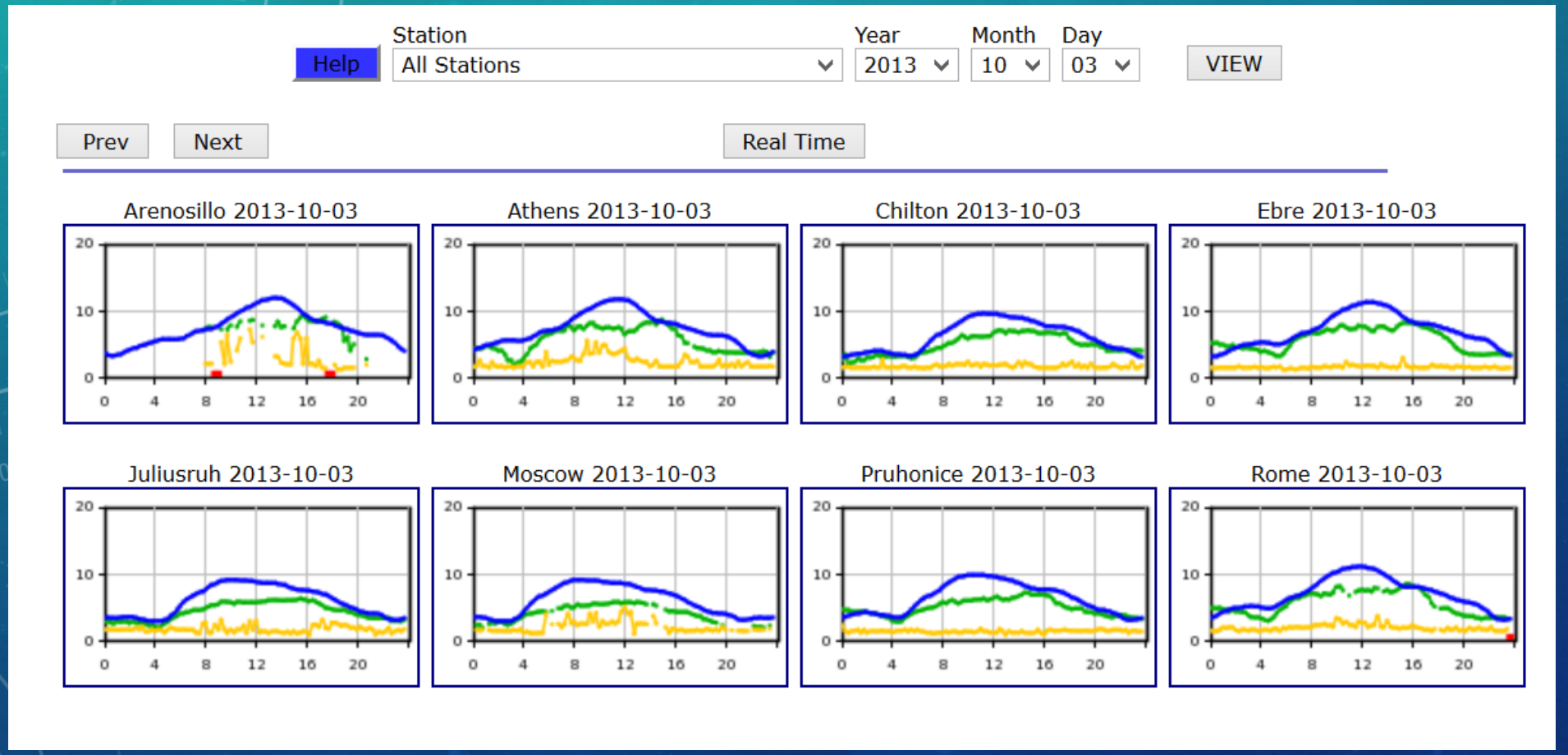
http://dias.space.noa.gr


- **Modeled areas: bottomside/topside ionosphere and plasmasphere**
- **Models implemented: SIRM, SIRMUP, SWIF, GCAM, TaD, IRI**

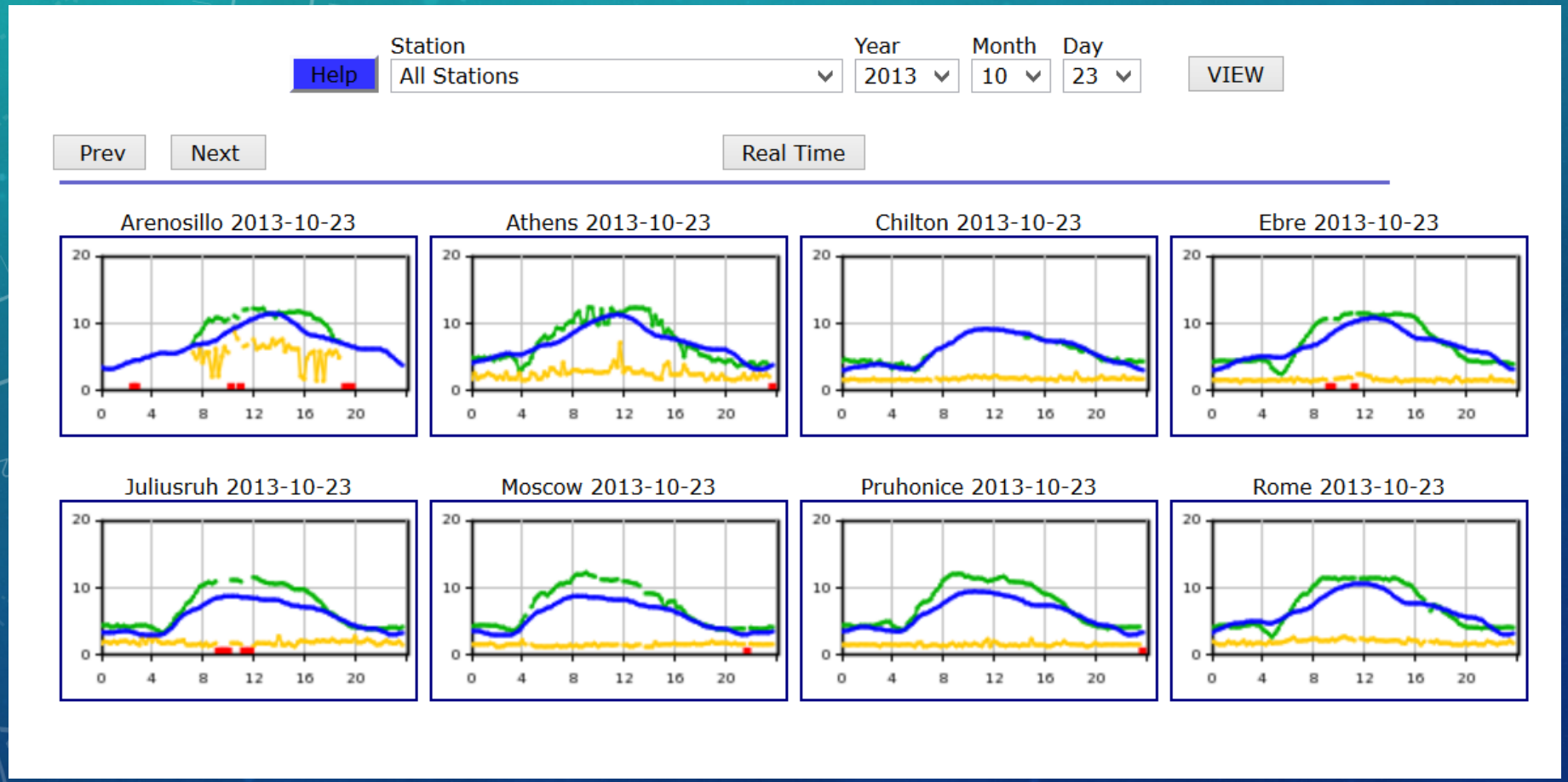


# Negative effect nowcasted by DIAS f-plots on 3.10.2013

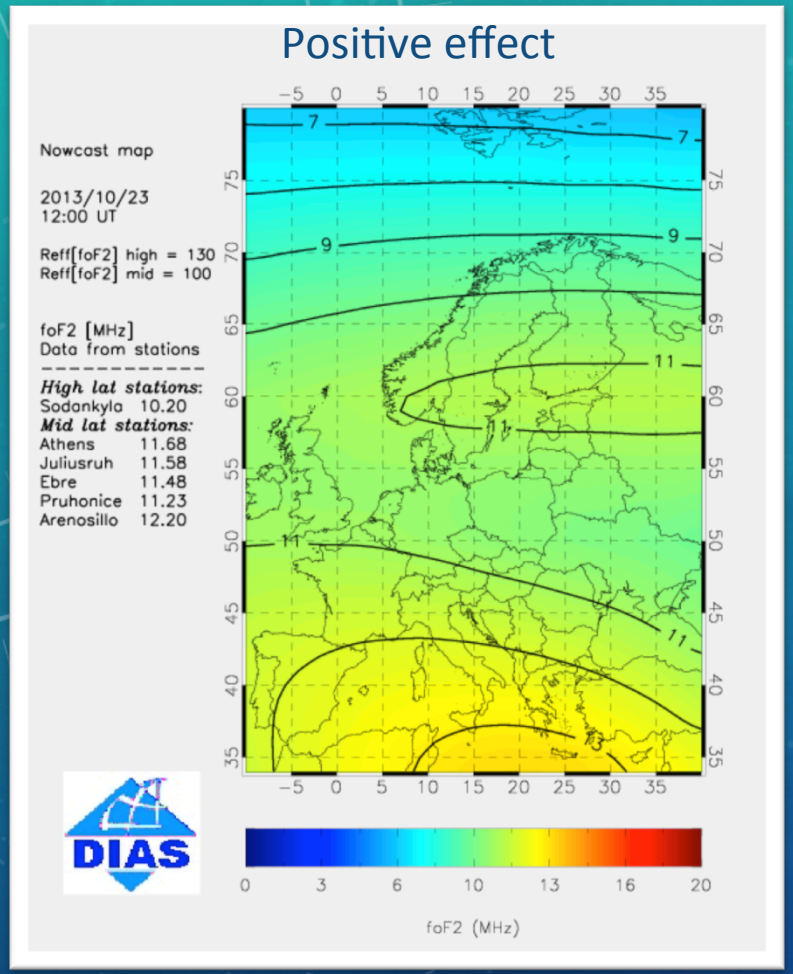


# Positive effect nowcasted by DIAS f-plots on 23.10.2013

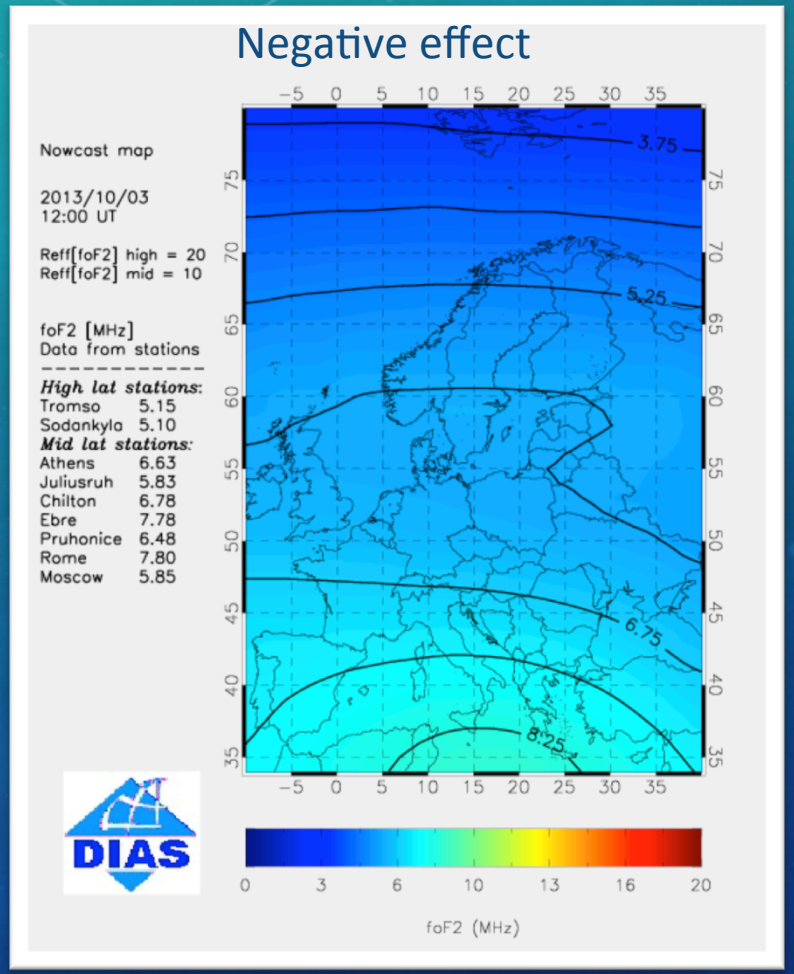


# NEW DIAS nowcasting maps of foF2

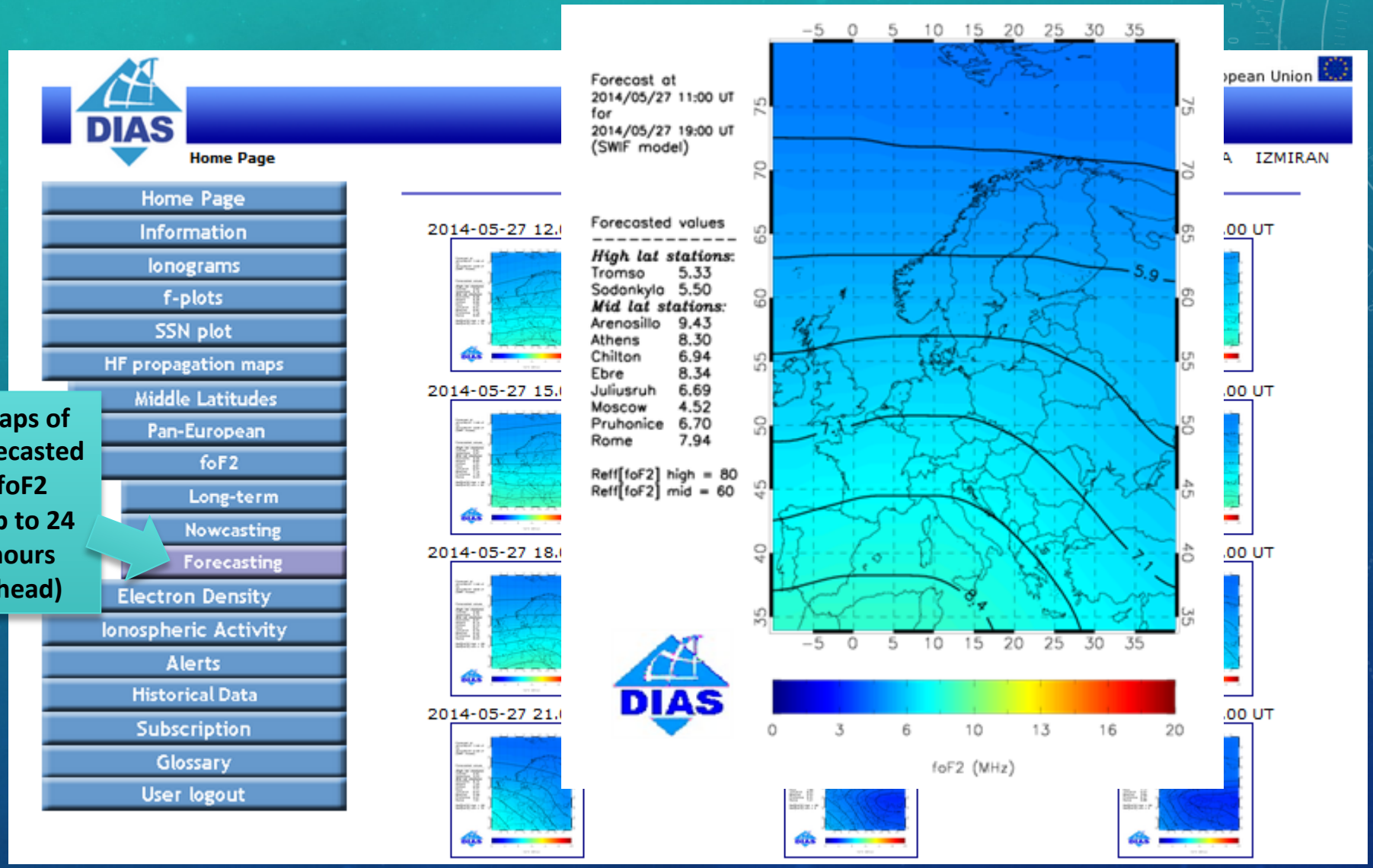
## Positive effect



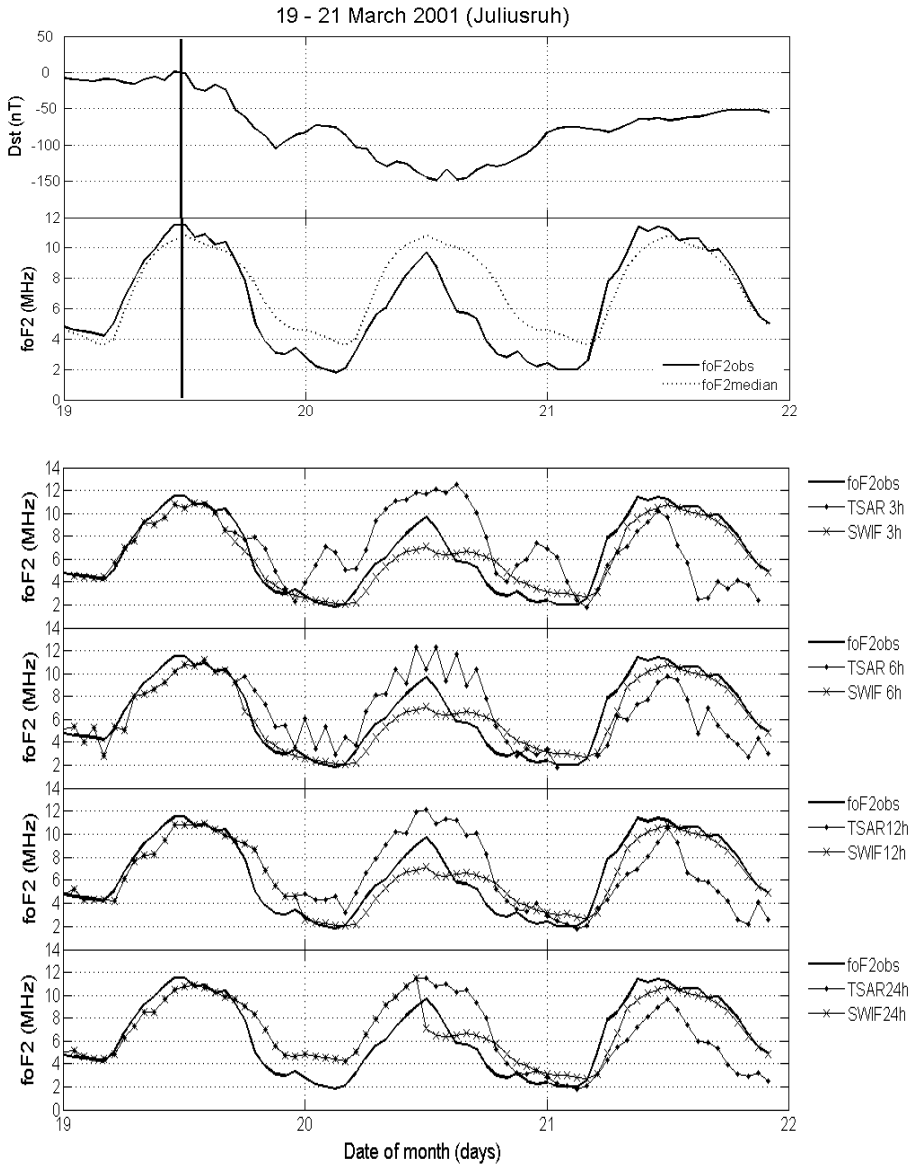

## Negative effect



# IONOSPHERIC FORECAST OF LARGE SCALE DISTURBANCES UP TO 24 HRS IN ADVANCE CAN BE ACHIEVED WITH EMPIRICAL MODELS DRIVEN BY SOLAR WIND DISTURBANCES OBSERVED AT L1



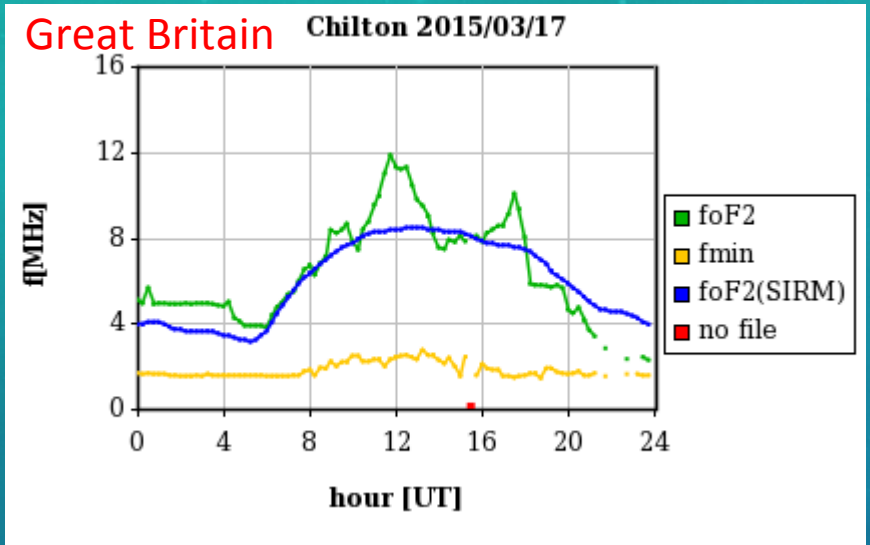
# SWIF
# The solar wind driven ionospheric forecast model



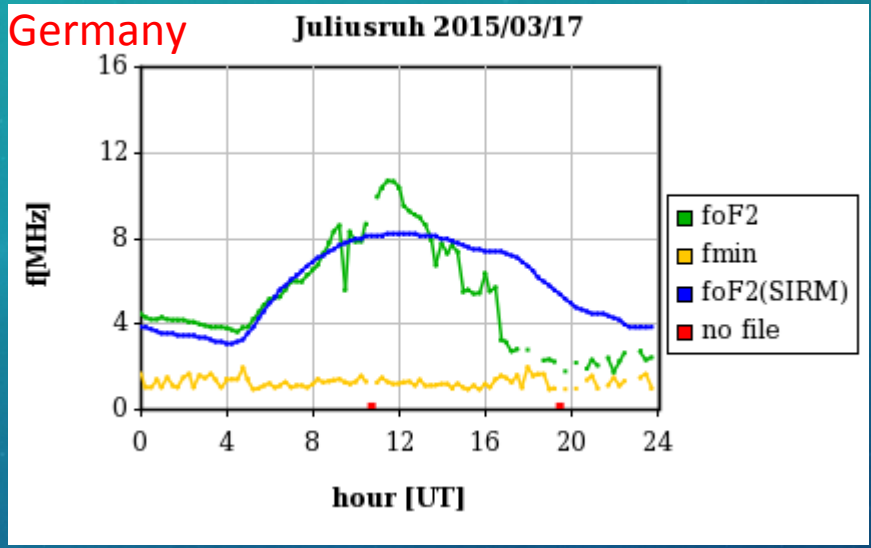

- The forecast up to 12 hrs ahead is much improved when the autoregression predictions are corrected with the empirical formulations of the Solar Wind Ionospheric Forecast model.
- Tsagouri, Koutroumbas and Belehaki (Radio Science, 2009)

# BUT HOW TO DETECT AND FORECAST TID?

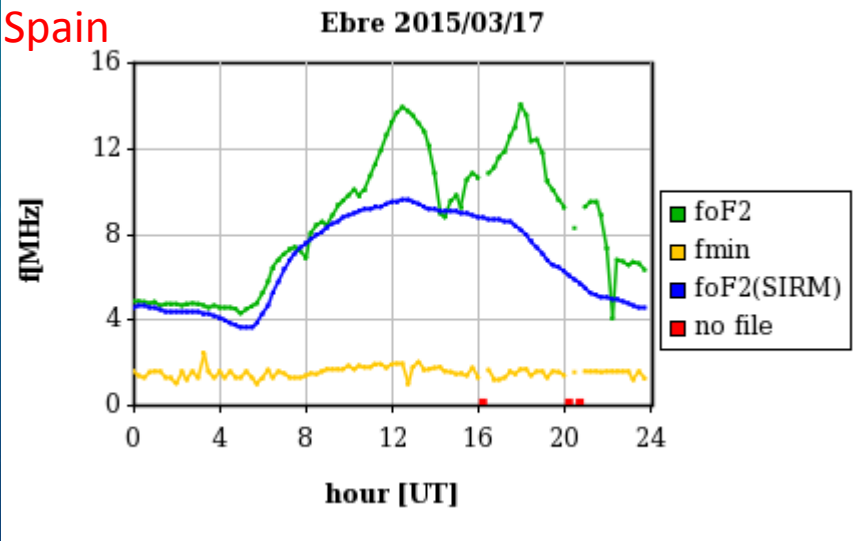
Great Britain



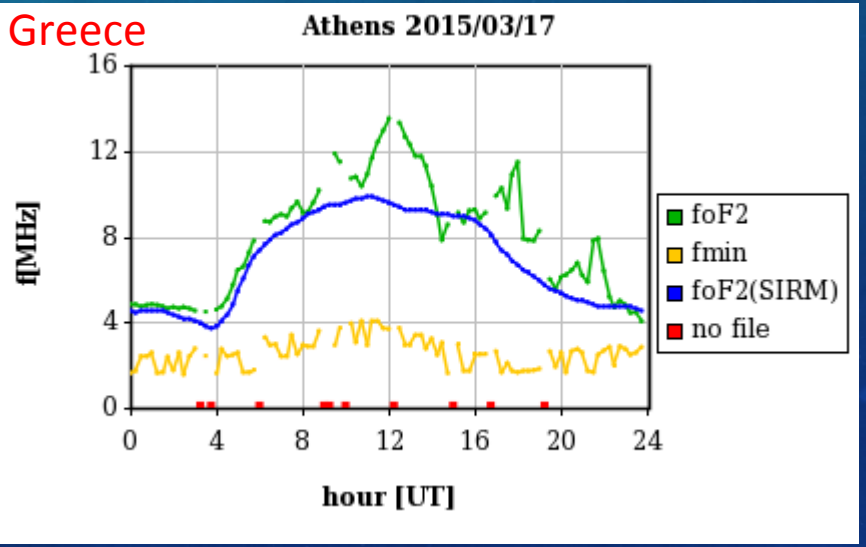

Germany



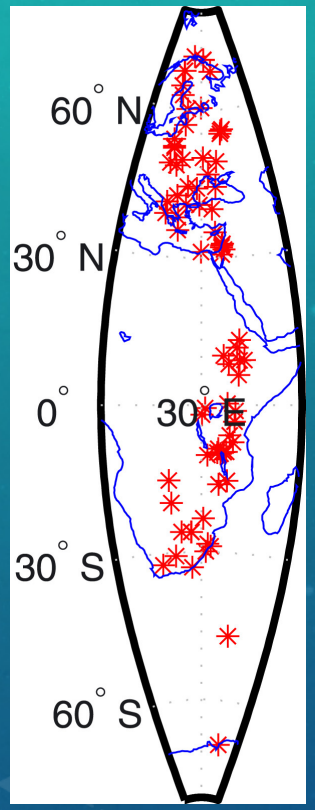

Spain

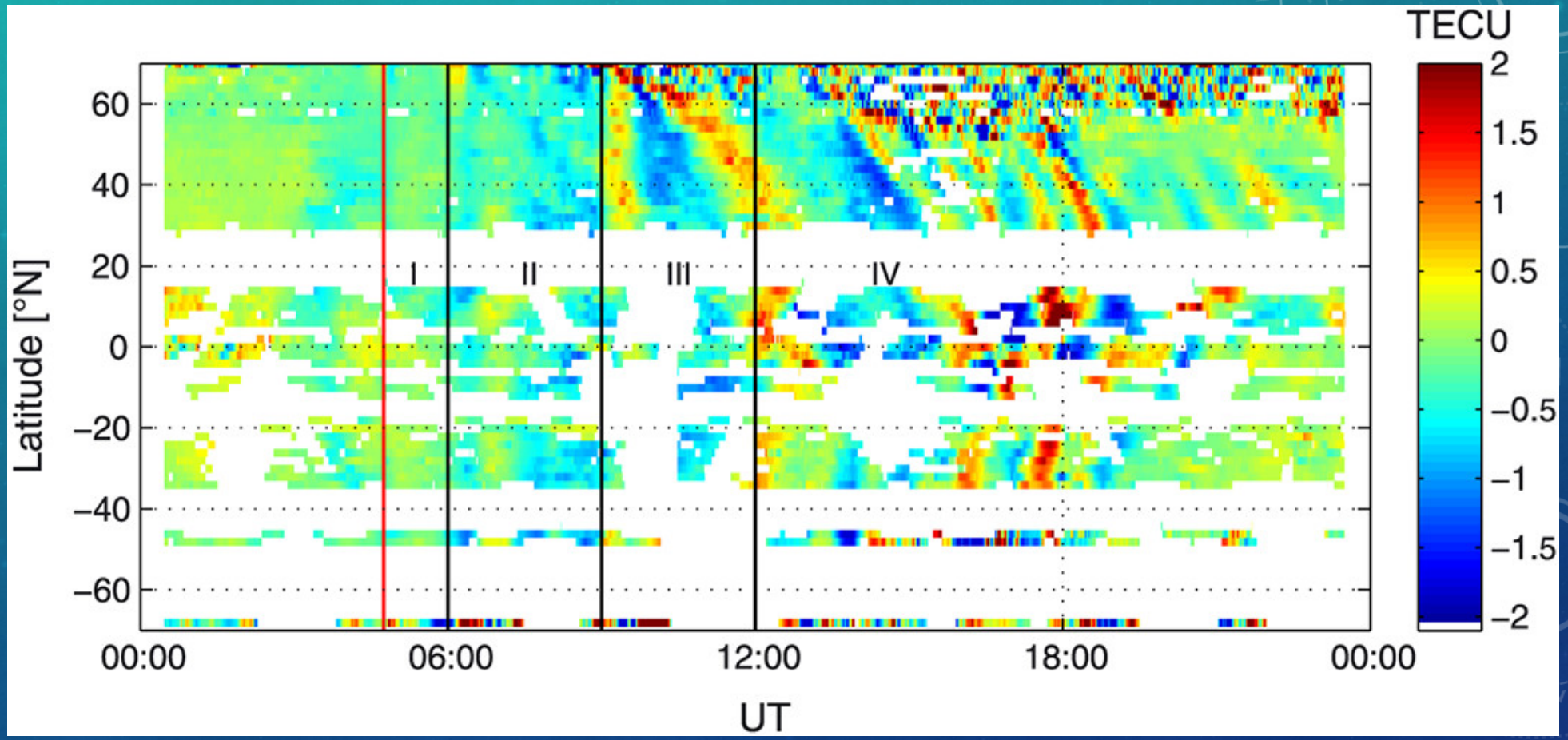



Greece



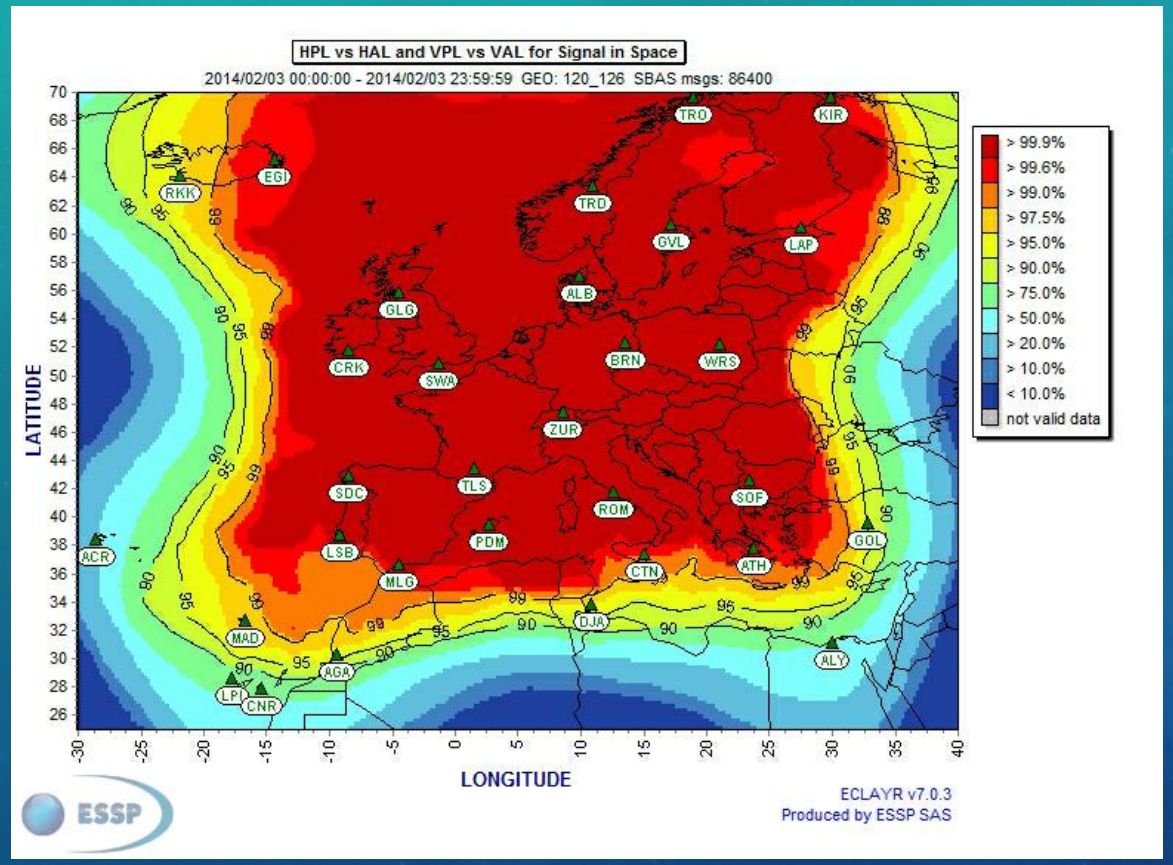
# LS TIDS IDENTIFIED WITH THE GRADIENT ANALYSIS OF TEC MAPS

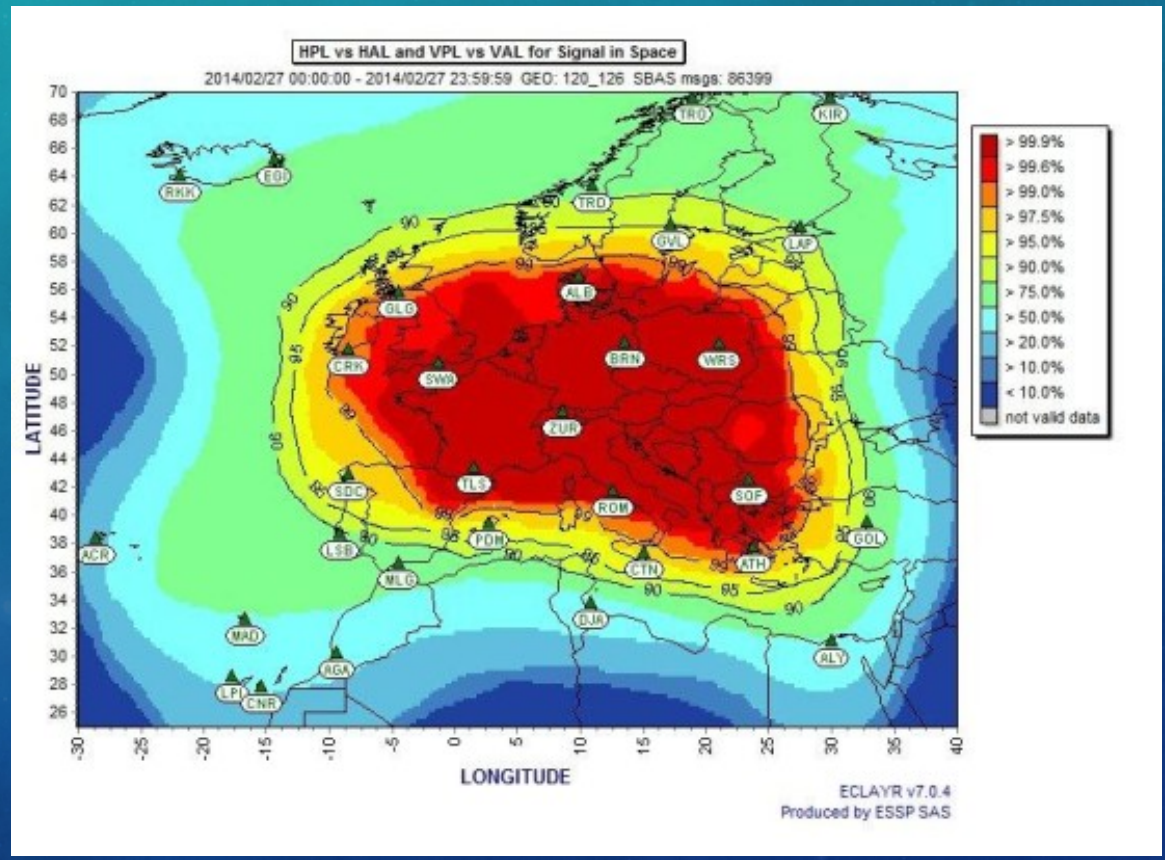


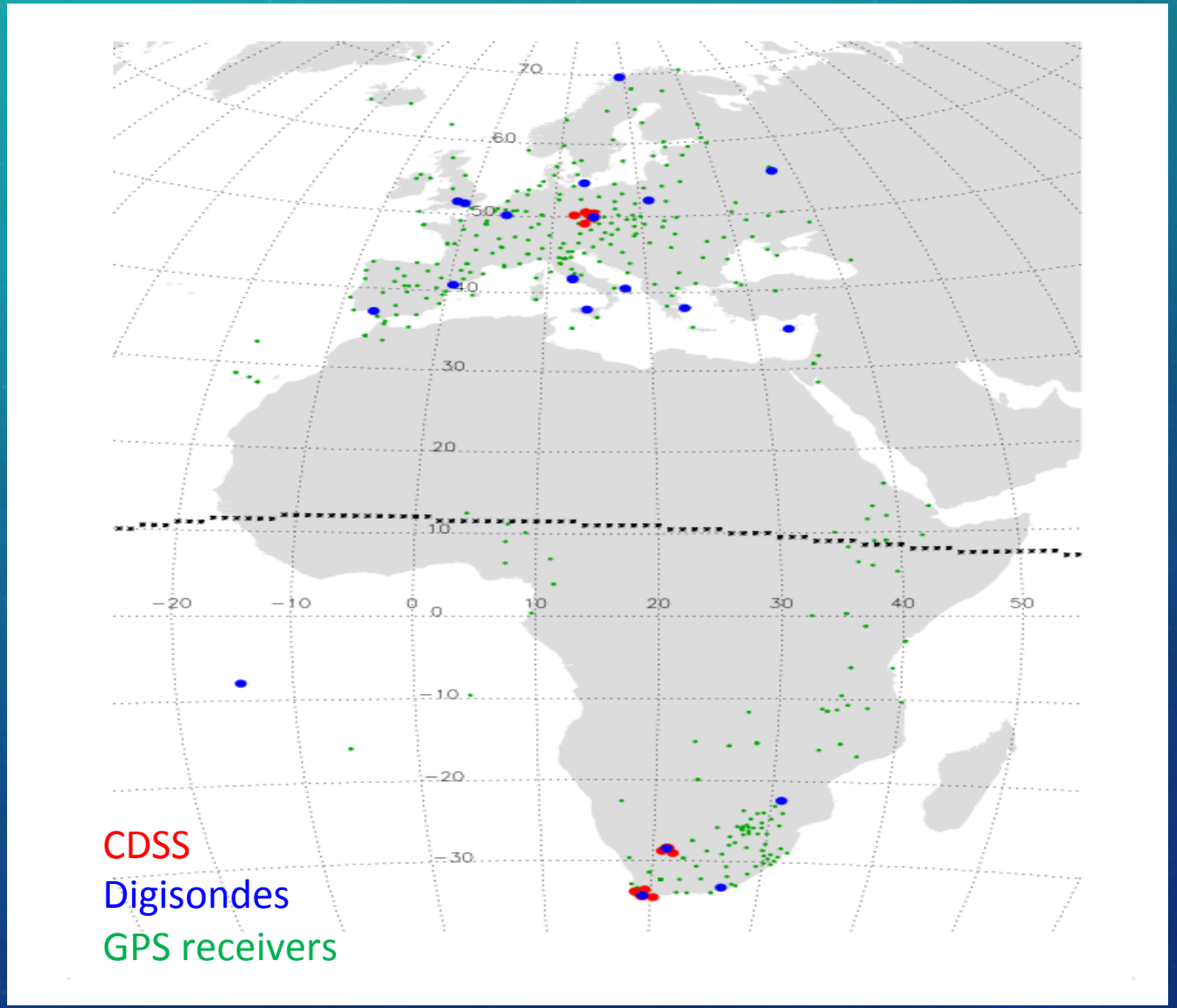

Borries et al., 2016

# HF GEOLOCATION AND SATELLITE – BASED AUGMENTATION SYSTEMS ARE MOSTLY AFFECTED BY TRAVELLING IONOSPHERIC DISTURBANCES



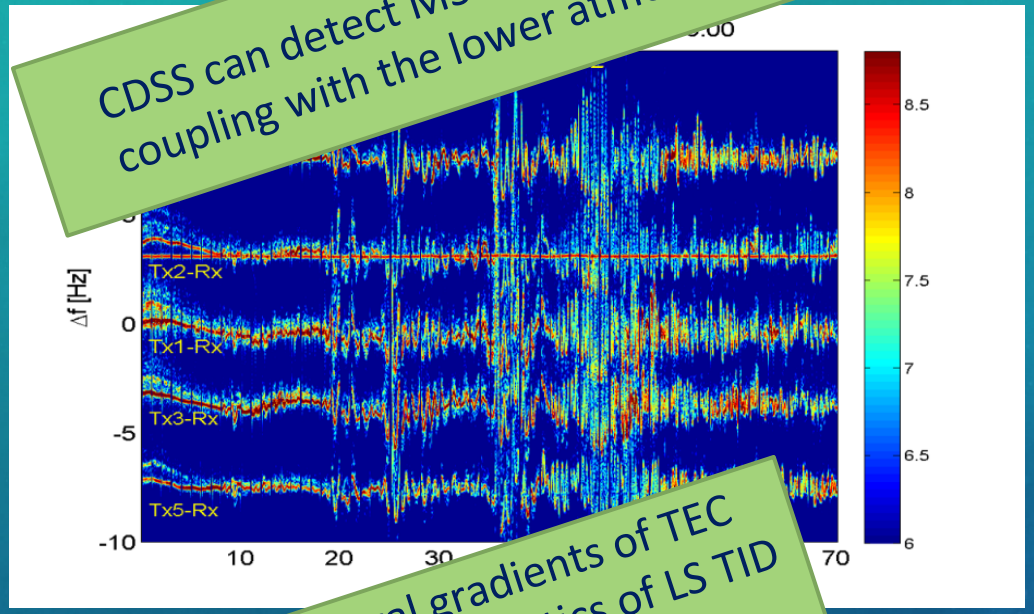



# HOW TO DETECT TIDS?
# 1. EXPLOIT ADDITIONAL NETWORKS IN NORTH AND SOUTH HEMISPHERES

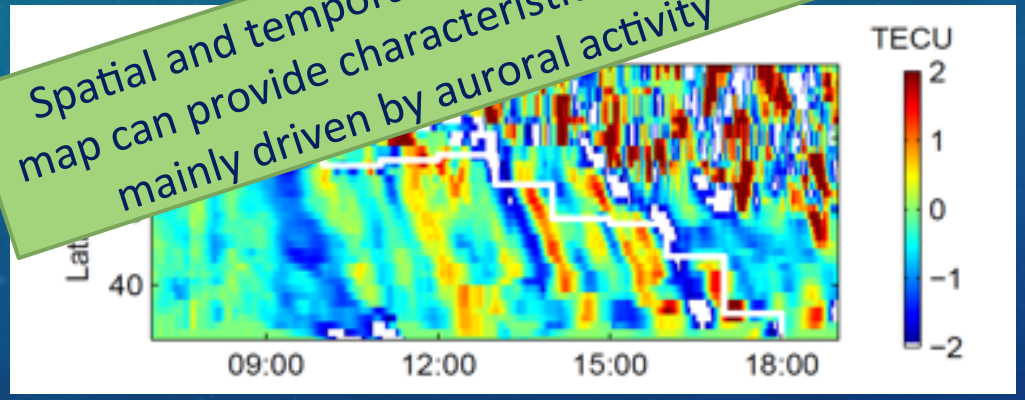


# HOW TO DETECT TIDS?
# 2. DEVELOP A METHODOLOGY BASED ON THE CAPABILITIES OF VARIOUS COMPLEMENTARY OBSERVING TECHNIQUES

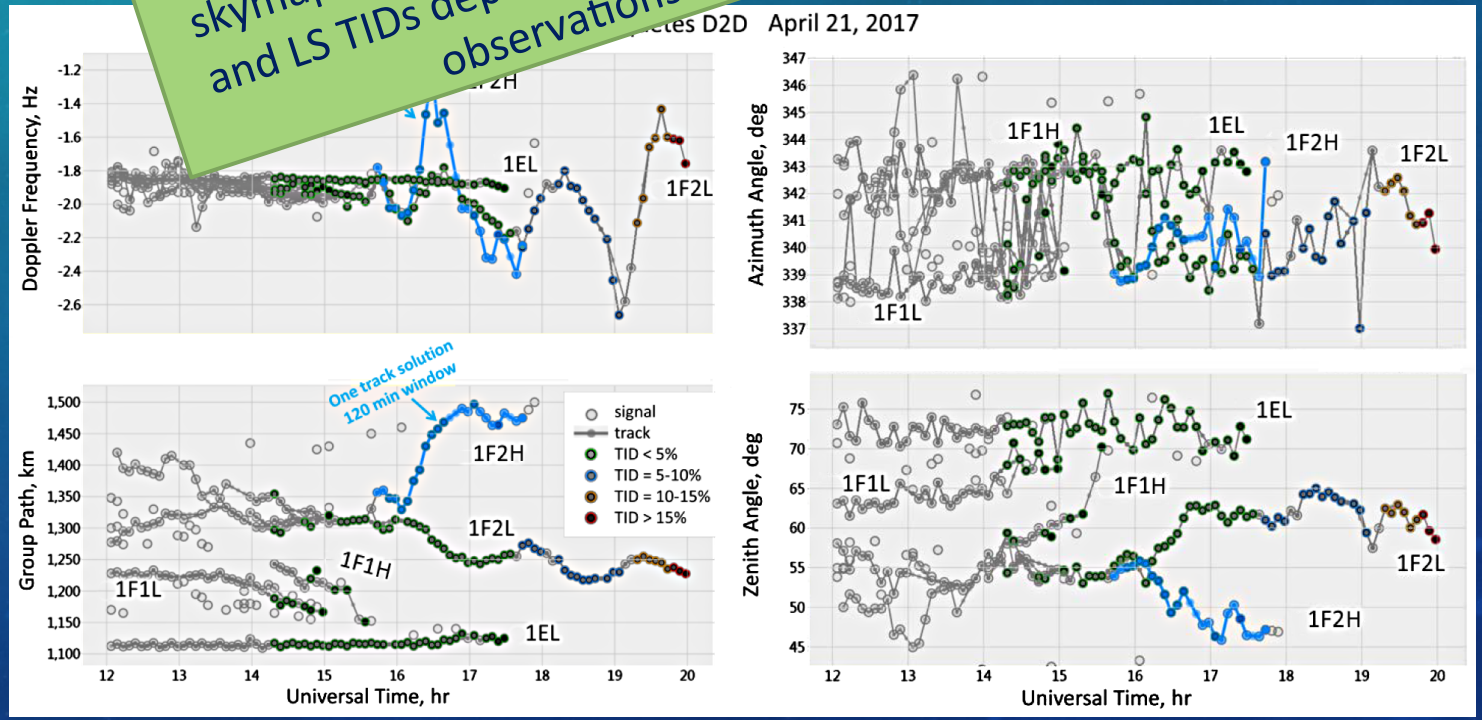
CDSS can detect MS TID mainly from coupling with the lower atmosphere




Spatial and temporal gradients of TEC map can provide characteristics of LS TID mainly driven by auroral activity

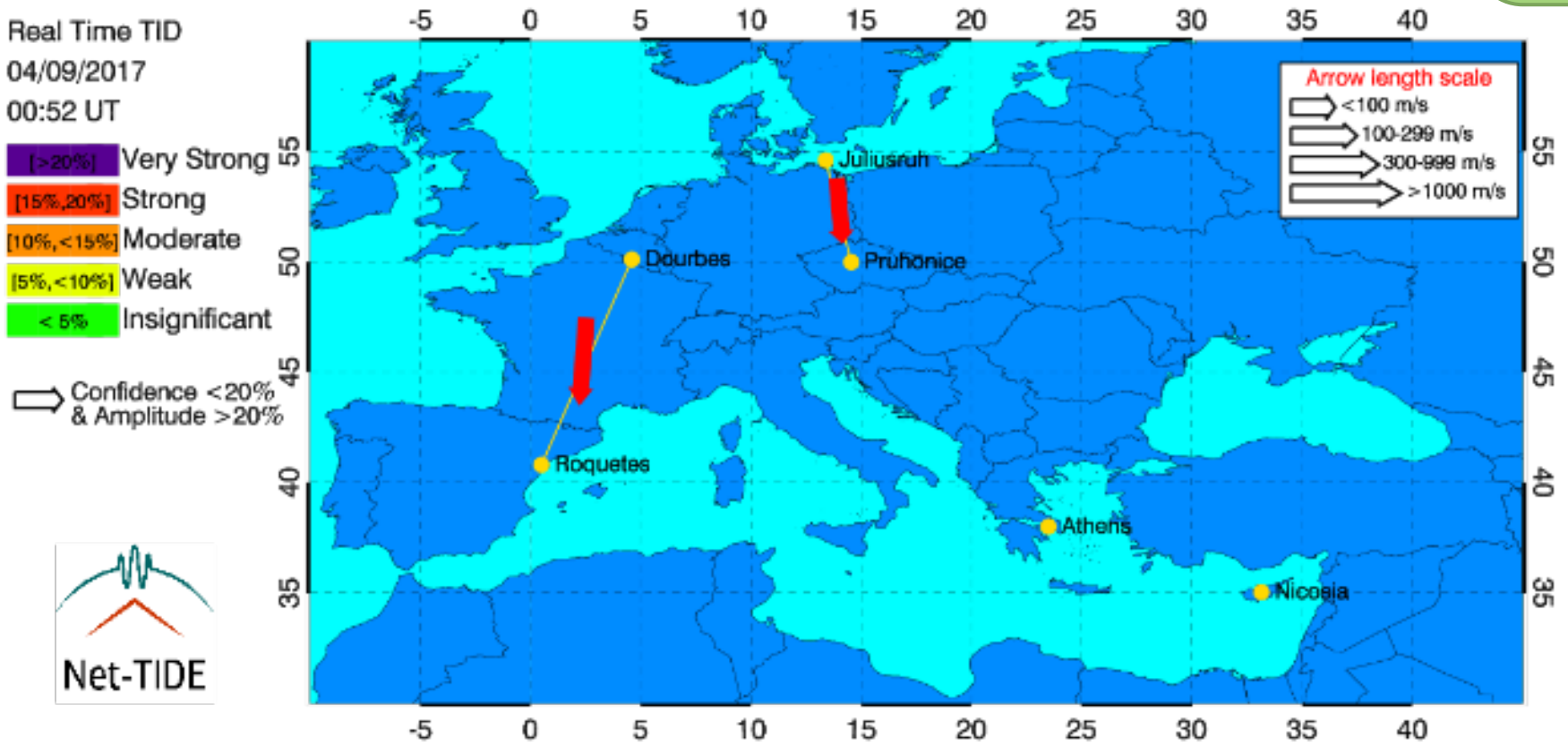



Digisonde – to – Digisonde (D2D) oblique skymaps can be used for the detection of MS and LS TIDs depending on the cadence of the observations cadence

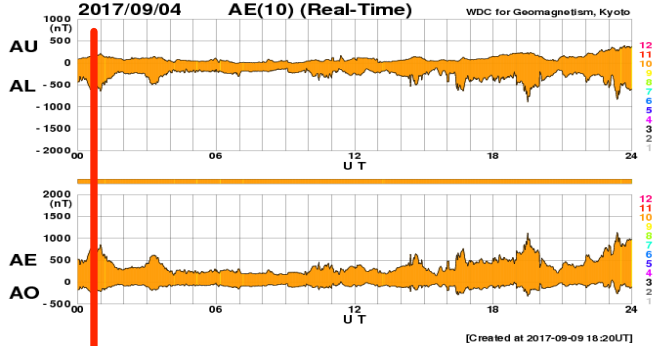


# HOW TO DETECT TIDS?
# 3. TRANSITION TO OPERATIONS

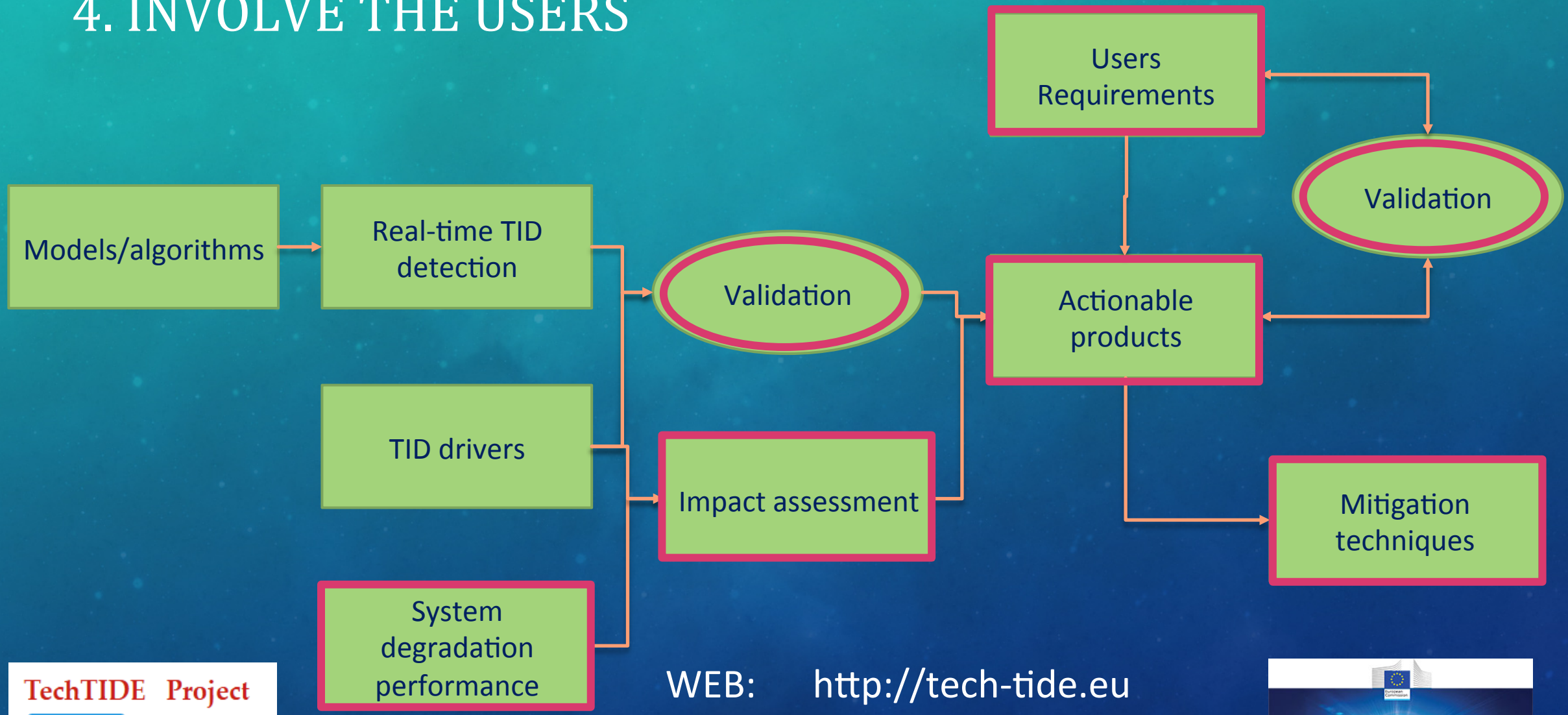
Net-TIDE is a collaborative project jointly implemented by 9 research institutes and universities in Europe, USA, Japan and Australia




Net-TIDE



# HOW TO DETECT TIDS?
# 4. INVOLVE THE USERS




TechTIDE Project
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WEB: http://tech-tide.eu
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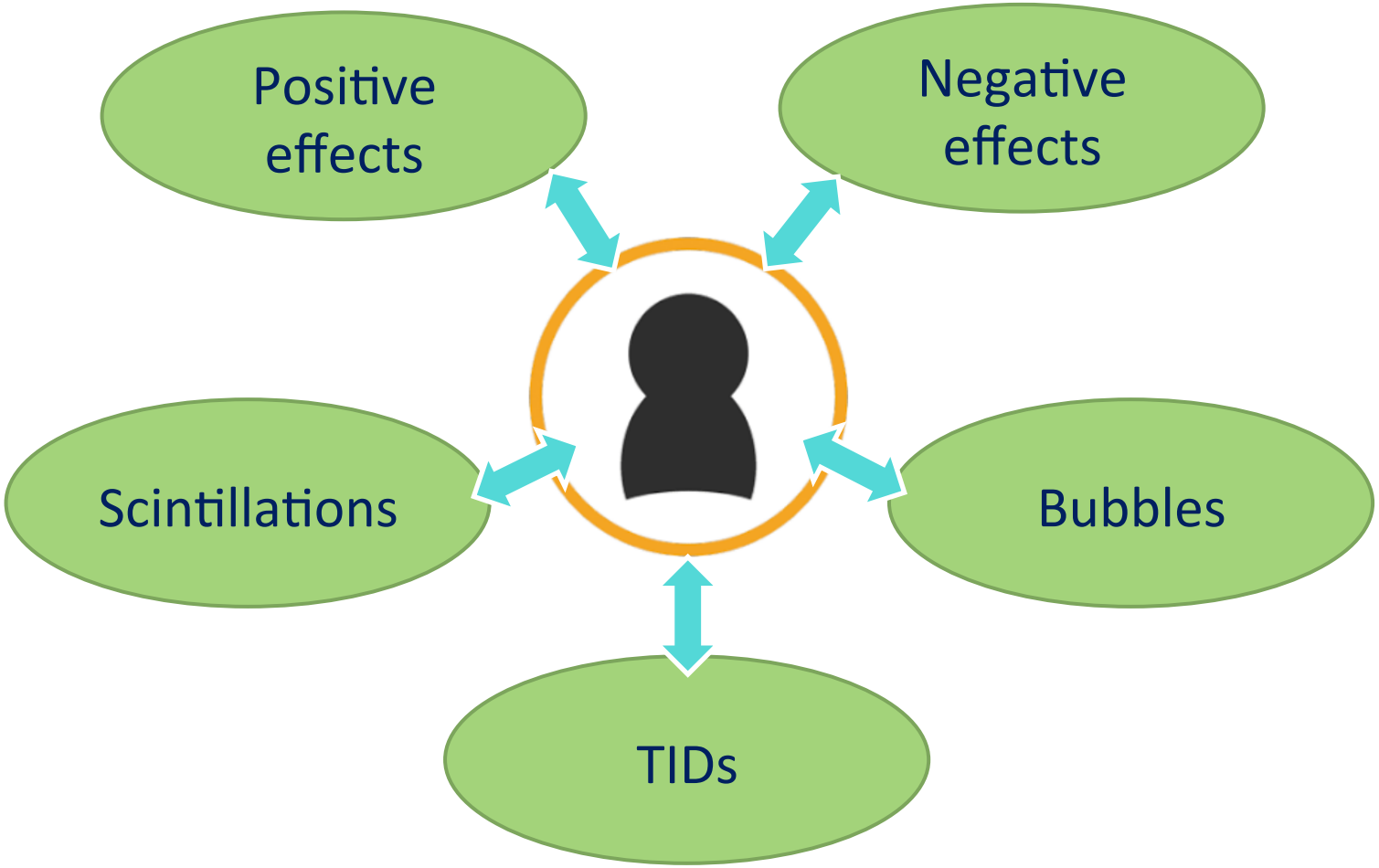
HORIZON 2020

# Adapt the TID detection methodology to monitor and forecast additional ionospheric perturbations that affect HF communications and satellite operations



# CHALLENGES TO BE CONSIDERED IN THE ISWAT FOR IMPROVING IONOSPHERIC VARIABILITY PREDICTIONS

- Improve the ionospheric forecasting window
  - Physical vs empirical models
  - Global vs regional models
  - Specify and forecast ionospheric drivers: solar, magnetospheric, lower atmosphere drivers
- Networking with users
  - work to improve users awareness ; collect/upgrade users needs
  - organize validation workshops for users ; support mitigation technologies
- Data availability/coverage
  - Ground based: oceans, polar regions, equator
  - Space missions: topside sounding system
- Data quality and standardization
  - Add quality flag to the ionospheric characteristics ; assess VTEC/STEC methodologies
  - Develop algorithms to fill in data gaps
  - Standardize metadata and data archiving