

Overview and further Development of the Global Ionospheric Flare Detection System – GIFDS

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Knowledge for Tomorrow



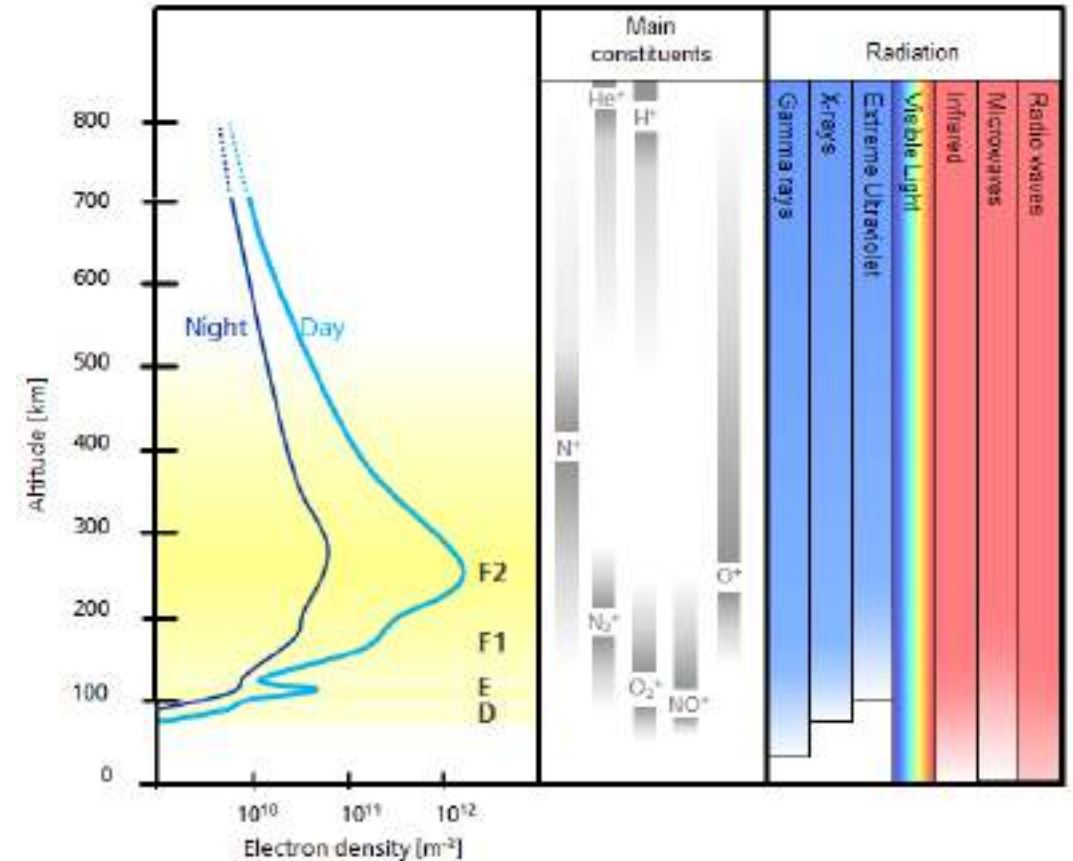
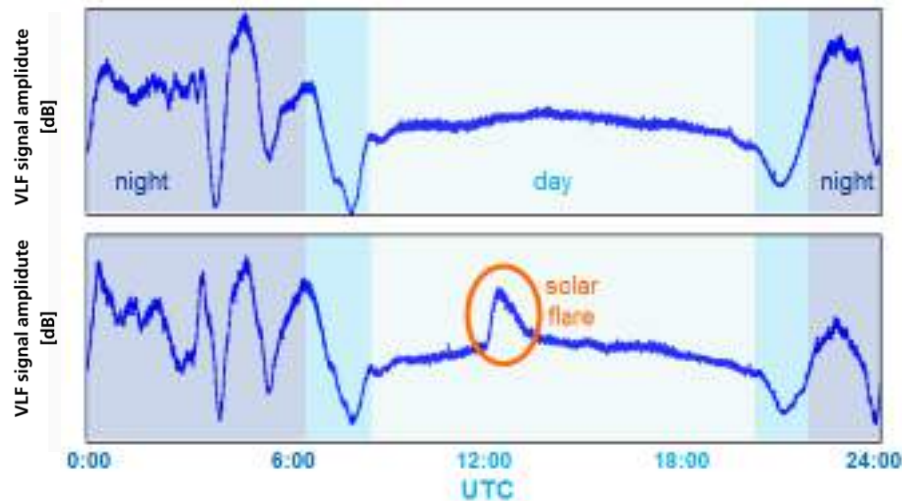
GIFDS Global Ionospheric Flare Detection System

Motivation

- VLF signals allow continuous observations of the lower ionosphere
- VLF signals contain information about space weather events

Objectives:

- Now cast detection of SIDs caused by solar flares using a ground-based VLF system
- Integration of real-time VLF data and flare alerts into IMPC with SO-WWE



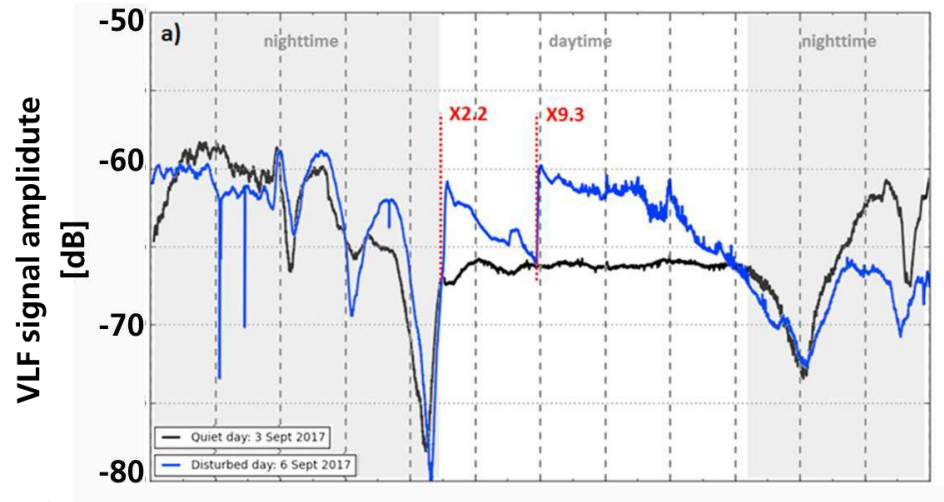
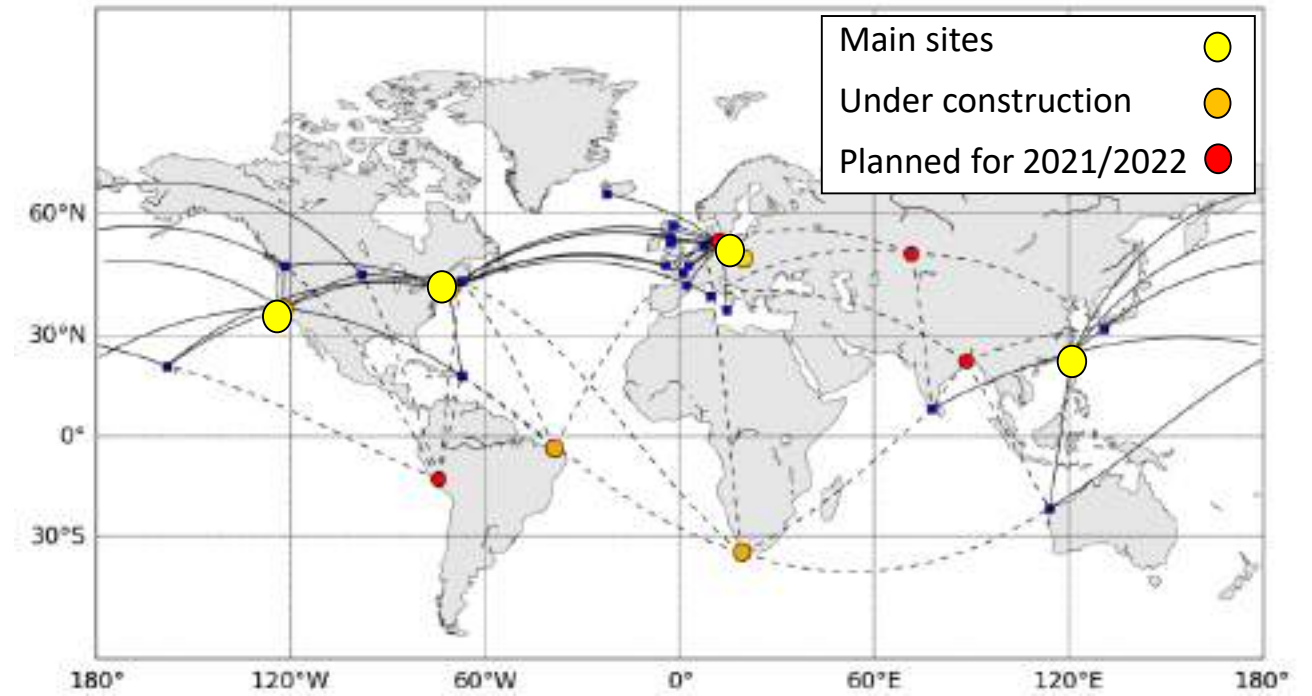
GIFDS Global Ionospheric Flare Detection System

Installation of a global VLF network

- Laptop → Industrial PC (Linux)
- Software Defined Radio (SDR)
- 10 MHz rubidium oscillator
- MiniWhip-antenna

Data

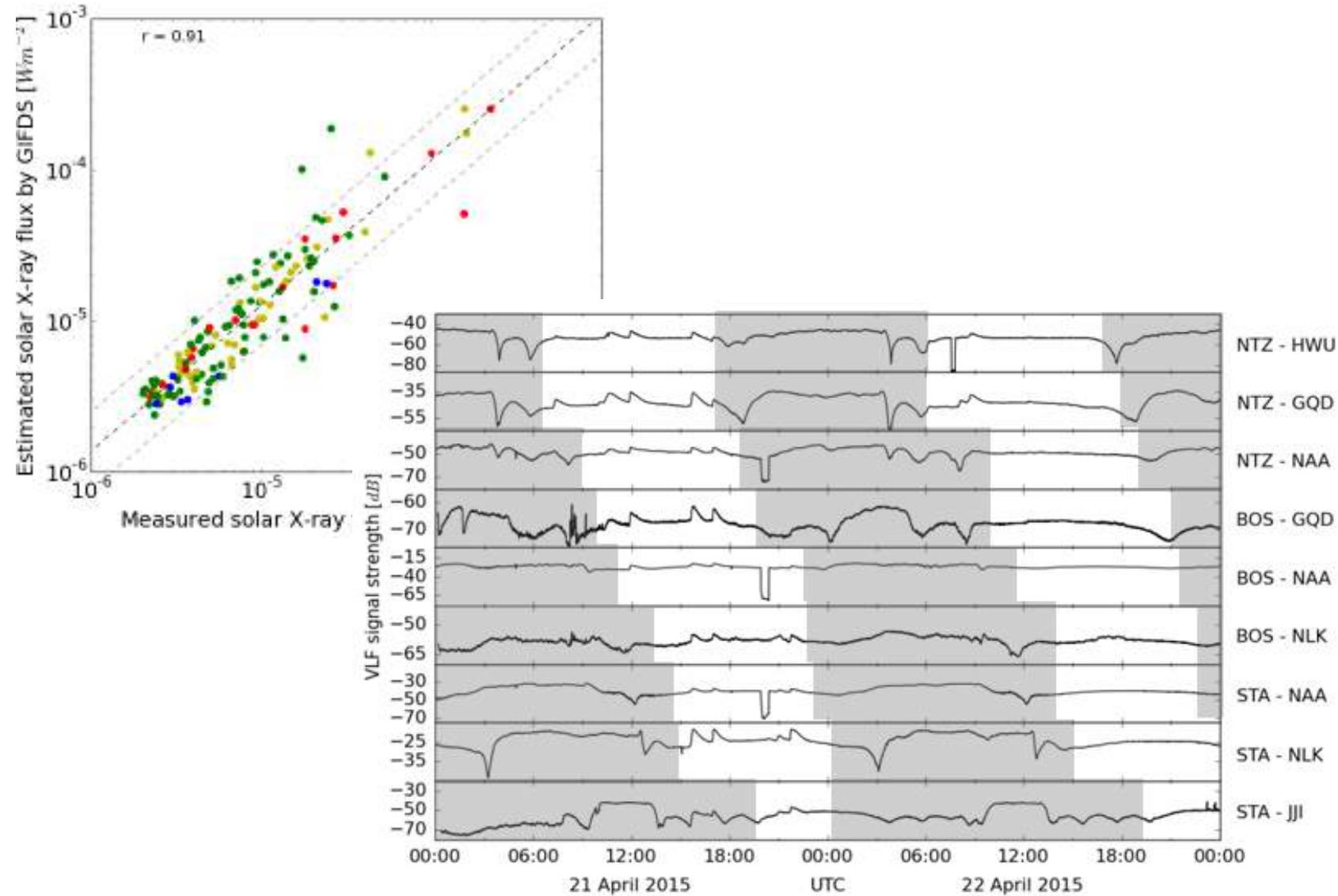
- 1Hz amplitude and phase measurements of various VLF transmitters (possible spectrum from 10 – 300 kHz)



GIFDS Flare Detection Algorithm

Comparative studies with GOES

- Strong correlation between peak solar X-ray flux and peak VLF amplitude of solar flares
- Aim for continuous information of lower dayside ionosphere via VLF
- Detrending of daytime VLF amplitude via polynomial fit of previous days
- Linear transformation by using historic flares
- Weighted arithmetic mean depending on solar zenith angle in order to combine all measurements to one compound information



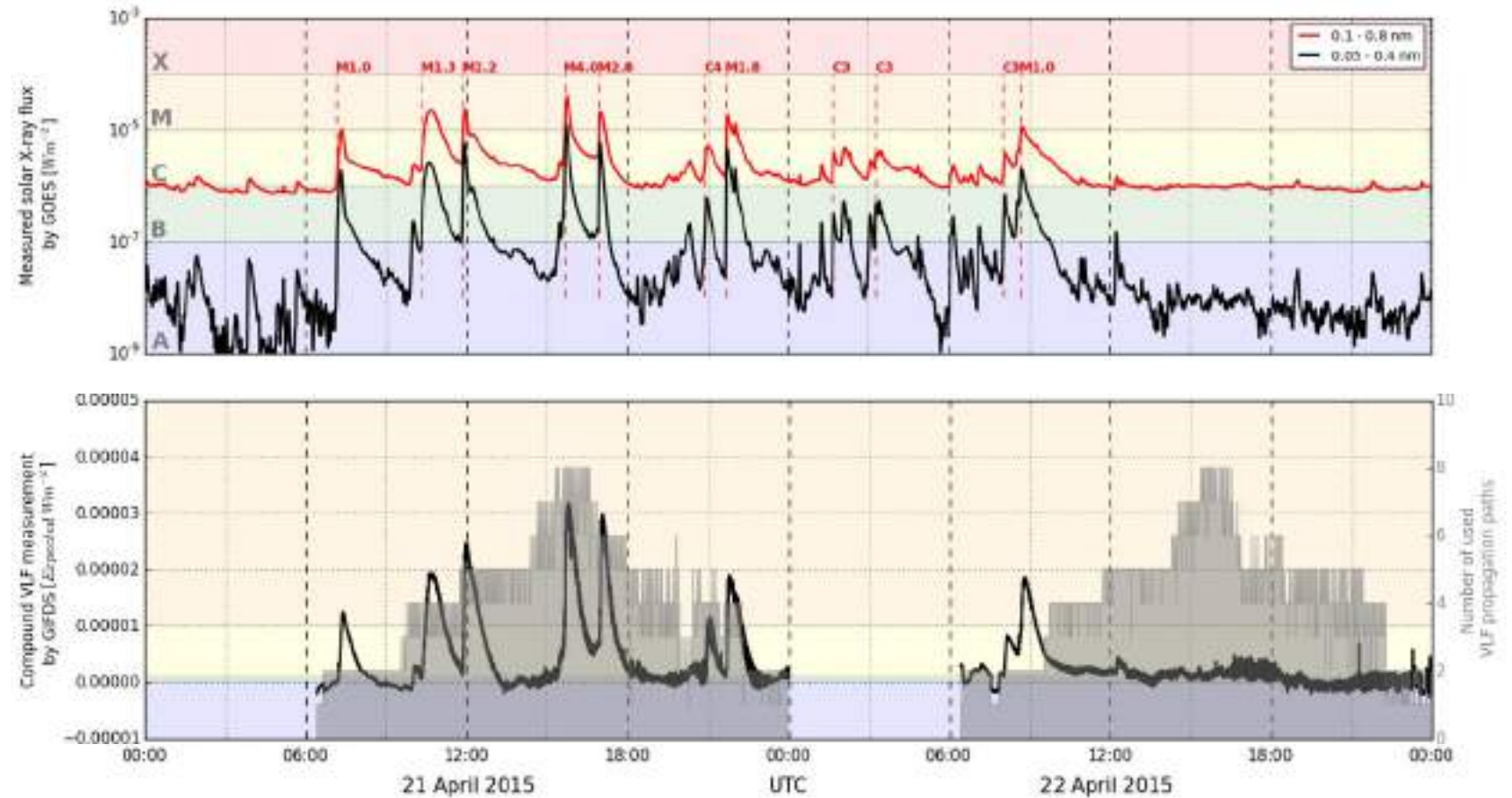
Wenzel et al., 2015, JASTP



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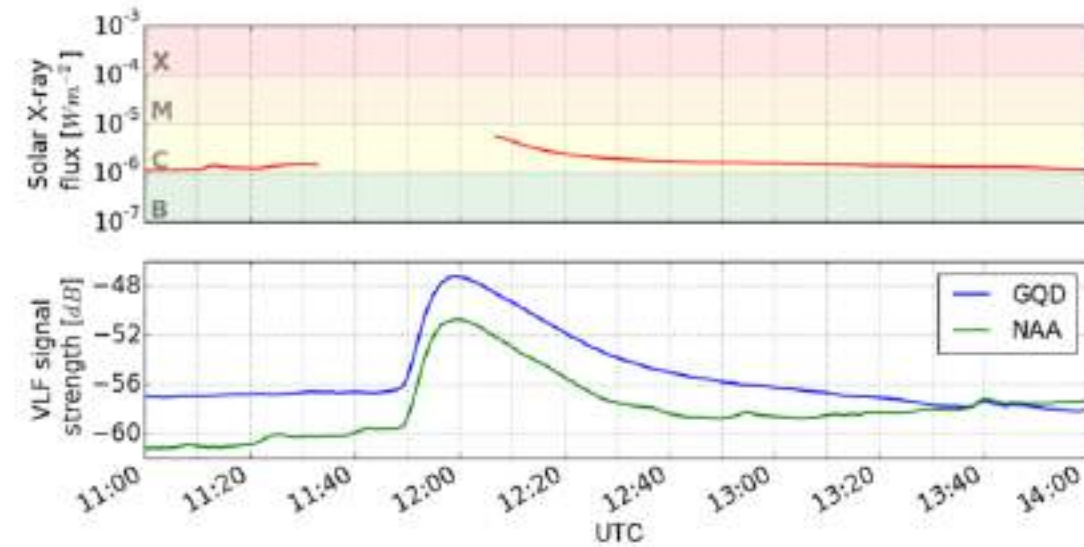
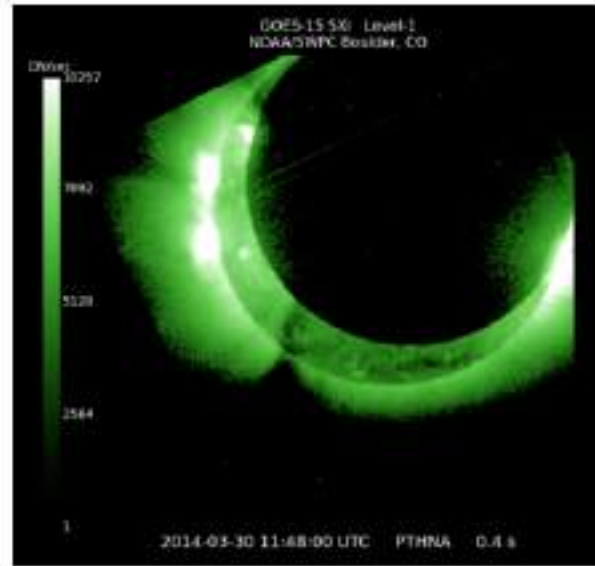
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GIFDS Applications

AMELIE

Analysis of the Mesosphere and Lower Ionosphere fall Effect

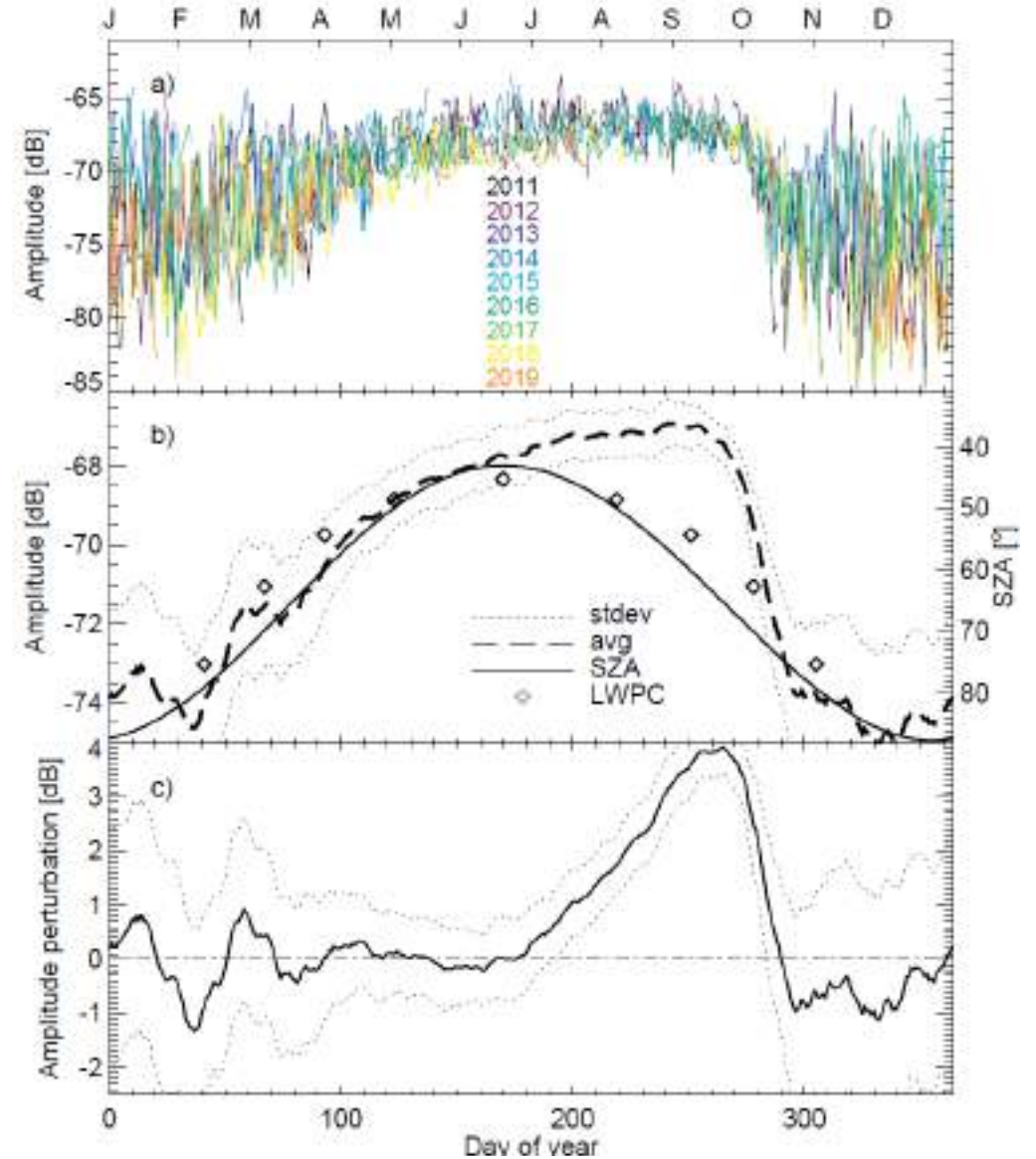
- Joint project with the University of Rostock / IAP Kühlungsborn
- Associates: Dr. Mark Clilverd (BAS)
Prof. Martin Friedrich (TU Graz)
Dr. Daniel Marsh (NCAR)
Dr. Nicholas Pedatella (NCAR)
Prof. Jean-Pierre Raulin (CRAAM)
- Seasonal variation of midday VLF amplitude exhibits an asymmetry (whereas the solar zenith angle variation is symmetric)
- Other Data: Radar, MLS, VLF, Ionosondes, GOES, SDO
- Used Models: WACCM-D, WACCM-X, LWPC, FIRI



Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center



Universität
Rostock



Macotella et al., 2021, GRL

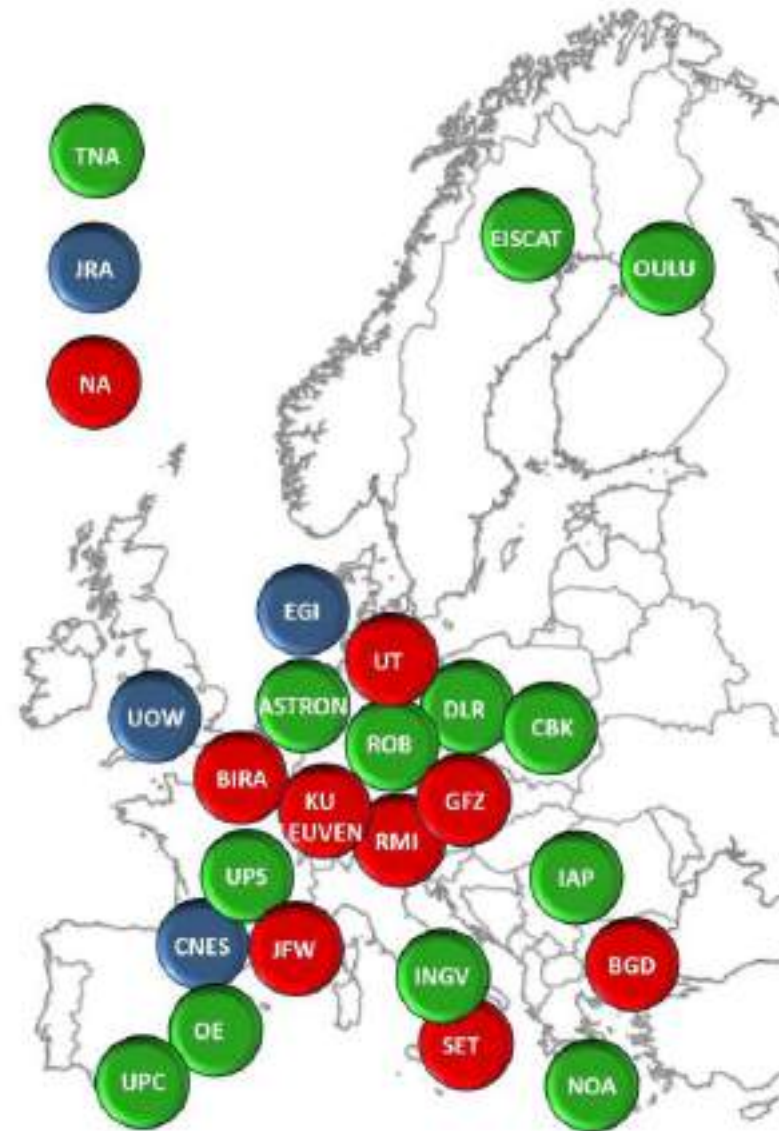


GIFDS Applications

PITHIA-NRF

Plasmasphere Ionosphere Thermosphere Integrated Research Environment and Access services:
a Network of Research Facilities

- Aims at building a European distributed network that integrates observing facilities, data processing tools and prediction models dedicated to ionosphere, thermosphere and plasmasphere research
- Integrates with key national and regional research infrastructures such as EISCAT, LOFAR, Ionosondes and Digisondes, GNSS receivers, Doppler sounding systems, riometers, and VLF receivers, ensuring optimal use and joint development
- Is designed to provide organized access to experimental facilities, FAIR data, standardized data products, training and innovation services.
- PITHIA-NRF consortium involves 22 administrative partners and one third party scientific enterprise
- DLR provides 1 out of 12 nodes for data access/distribution with the IMPC:
<https://impc.dlr.de/>



Horizon 2020
European Union funding
for Research & Innovation



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The screenshot displays a web interface for the PITHIA-NRF database. At the top, there is a map of the United States with several red dots indicating station locations. A callout box for station 'NAA 24k' shows its coordinates (44.8495, -67.2825). Below the map are search forms for 'Receiver' and 'Transmitter', each with fields for Name, Freq, and Location, and a Search button.

site	station *	position *	location *	service *	notes	!!!										
network	affiliate	orientation	bands	lat [°]	lon [°]	country	maintenance									
<input type="checkbox"/>	NME	25.2k	25200	VLF	0			46.385987	-98.355667	US	U.S. Navy	active	P	2T1297h	▶	edit
<input type="checkbox"/>	NPM	23.4k	23400	VLF		MSK		21.4202	-158.1511	US	U.S. Navy	active	P		▶	edit
<input type="checkbox"/>	NPM	21.4k	21400	VLF	200	MSK		21.4202	-158.1511	US	U.S. Navy	active	P		▶	edit
<input type="checkbox"/>	NLK	24.8k	24800	VLF	200		1200	48.281633	-121.916828	US	U.S. Navy	active	P		▶	edit
<input type="checkbox"/>	WWVB	60k	60000	LF		PWM PM(BPSK) AM		40.678058	-105.046944	US	NIST	active	P		▶	edit
<input type="checkbox"/>	NAA	24k	24000	VLF	200	MSK, FSK (E1B)	1800	44.6465	-67.2825	US	U.S. Navy	active	P		▶	edit

Search



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Receiver: Name: _____ Freq: _____ Location: Neuchâtel
 Search

Transmitter: Name: _____ Freq: _____ Location: US
 Search

site	station	position	location	service	notes	!!!						
network	affiliate	orientation	bands	lat [°]	lon [°]	country	monitor	status	contact	maintenance		
<input type="checkbox"/>	GIFDS	NTZ		LEVLF	53.33	13.07	DE	German Aerospace Center DLR	active	david.weizel@dlr.de		edit

identity	sender	position	location	operation	notes	!!!									
call sign	channel	frequency [Hz]	range	bandwidth	modulation	power [kW]	lat [°]	lon [°]	country	broadcaster	status	on air	maintenance		
<input checked="" type="checkbox"/>	NAA	24K	24000	VLF	200	MSK, FSK (F1B)	1800	44.6465	-87.2825	US	U.S. Navy	active	P		edit

Search

radio	position	properties	depot	notes	!!!							
call sign	affiliate	lat [°]	lon [°]	distance [km]	azimuth [°]	elevation [°]	wave order	run time [ms]	ground conductivity	label		
<input type="checkbox"/>	NAA	NTZ	58.325737	-31.322103	9625.15	-49.64	-19280	0.2	13.76348E-1	0	1	edit

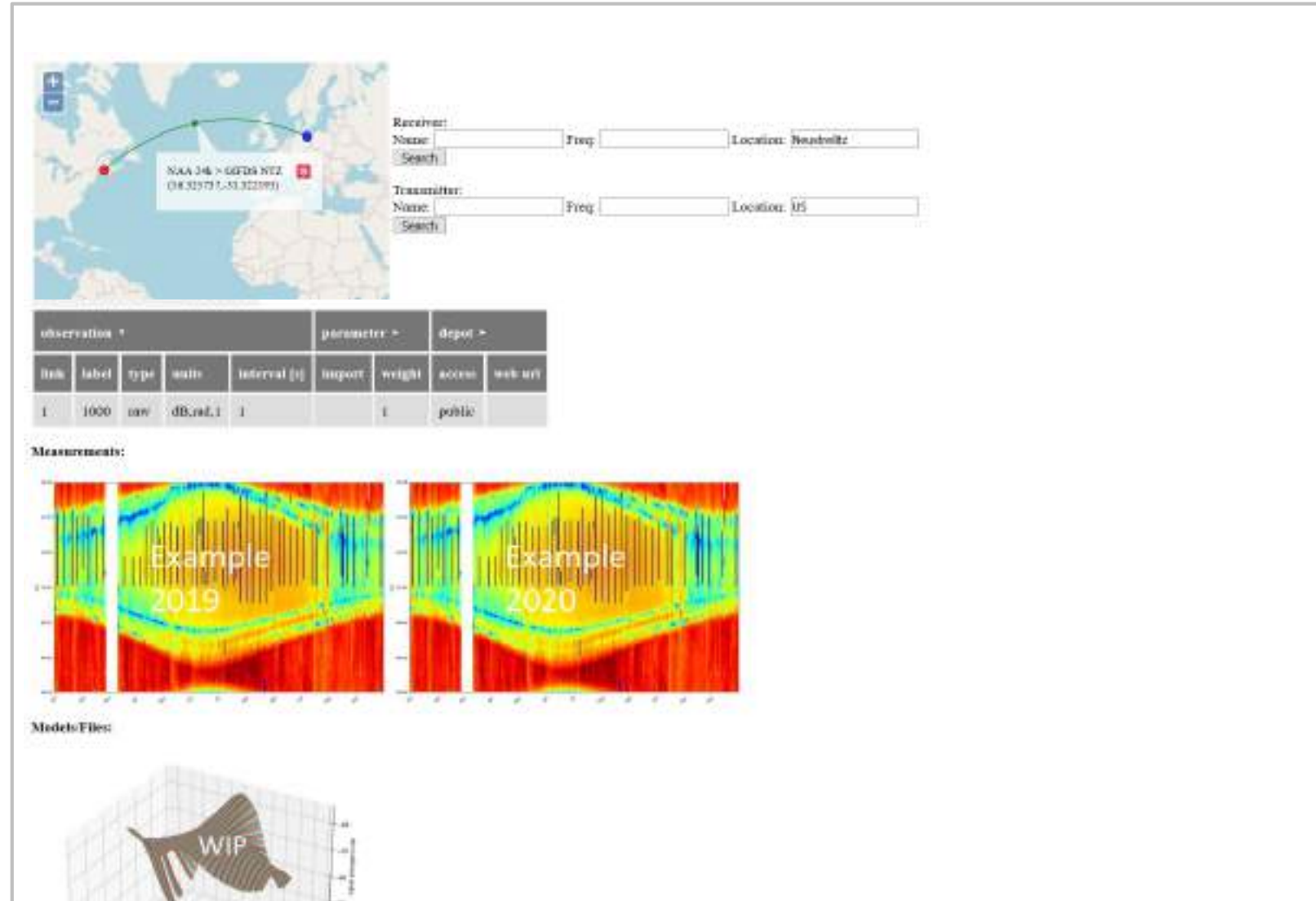


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The screenshot displays the GIFDS application interface. At the top left, a map shows a connection between two stations: NAA 346 (GIFDS NET) and Neustrelitz. To the right of the map are search forms for Receiver and Transmitter, each with fields for Name, Freq, and Location, and a Search button. Below the map is a table with columns for observation, parameter, and depot. The table contains one row of data.

observation	parameter	depot
1	1000	publ

Below the table, there are two measurement plots labeled "Example 2019" and "Example 2020", showing ionospheric data. At the bottom, there is a "Models/Files" section with a 3D visualization of a WIP (Wave Ionospheric Prediction) model.



Thank you!

