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

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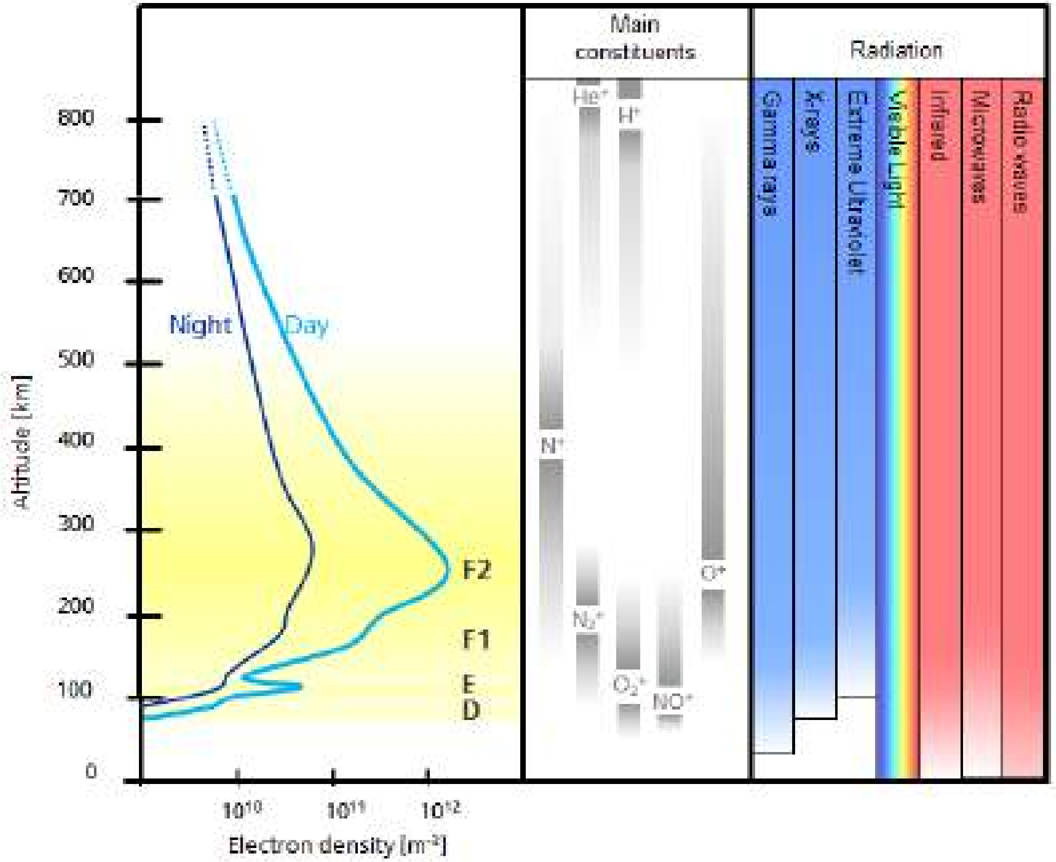
GIFDS Global Ionospheric Flare Detection System

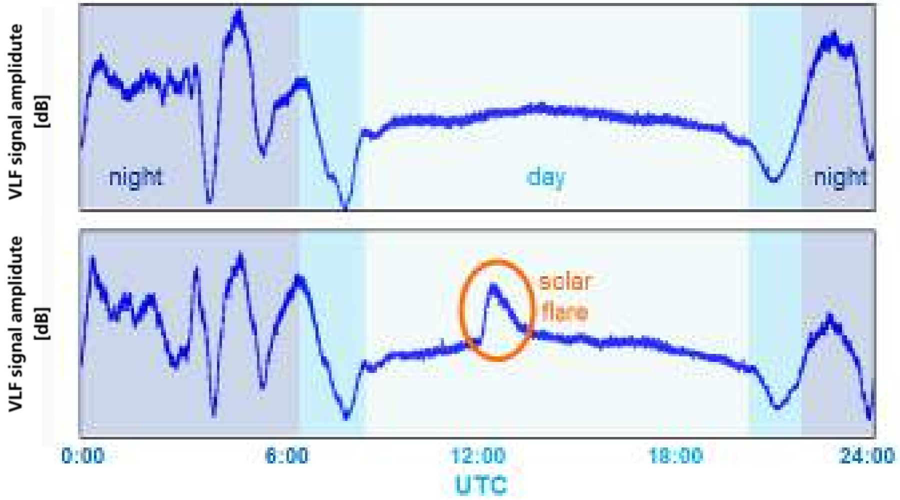
Motivation

- 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



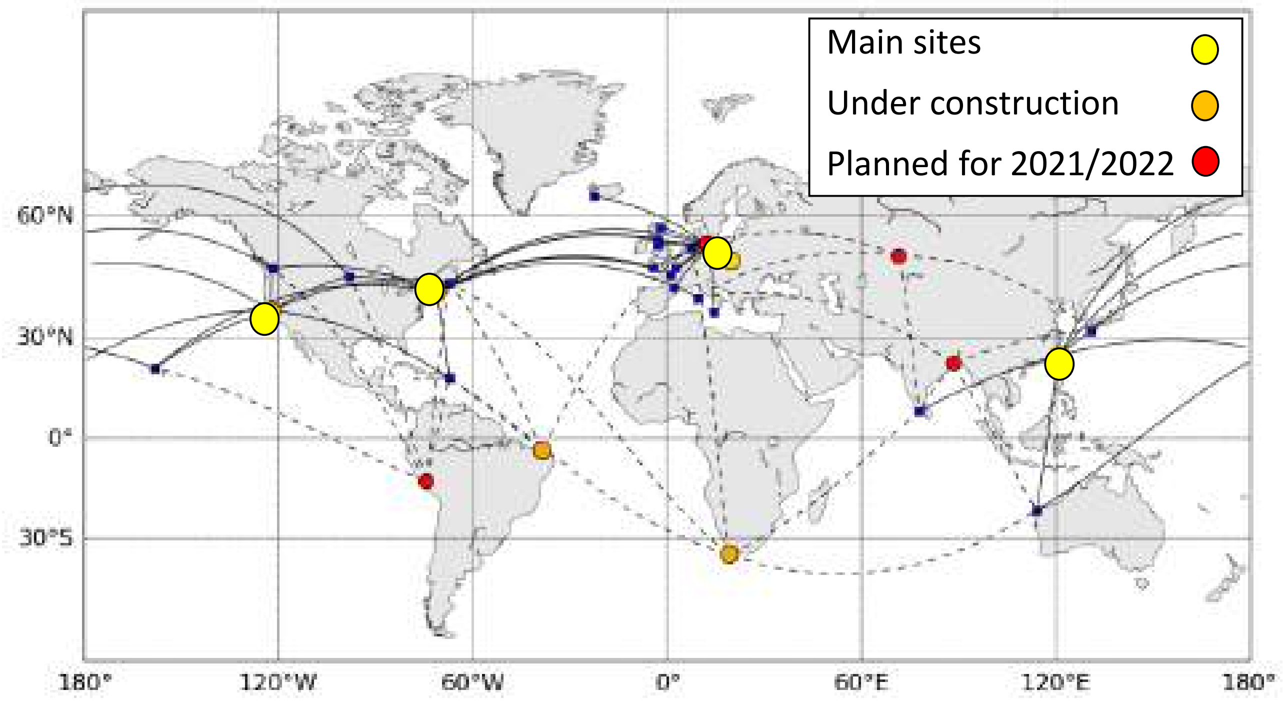
GIFDS Global Ionospheric Flare Detection System

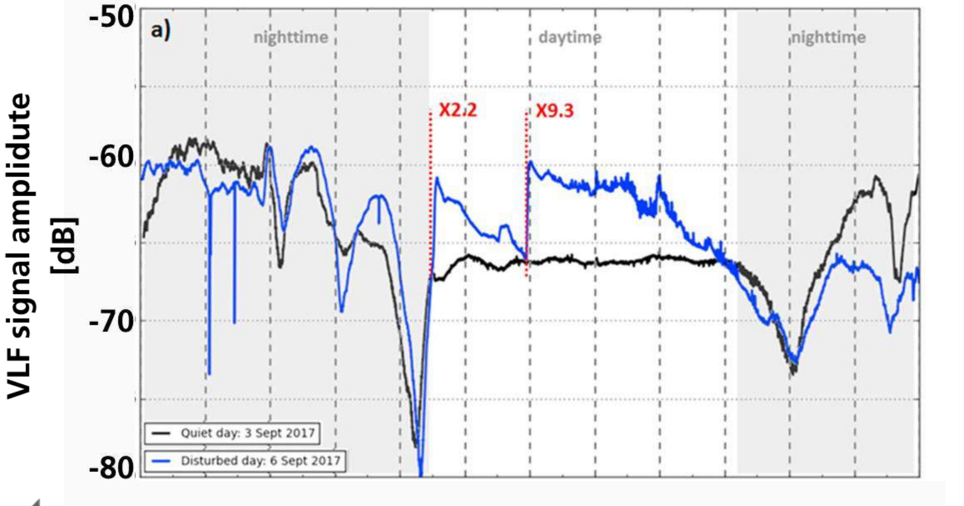
Installation of a global VLF network

- 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)





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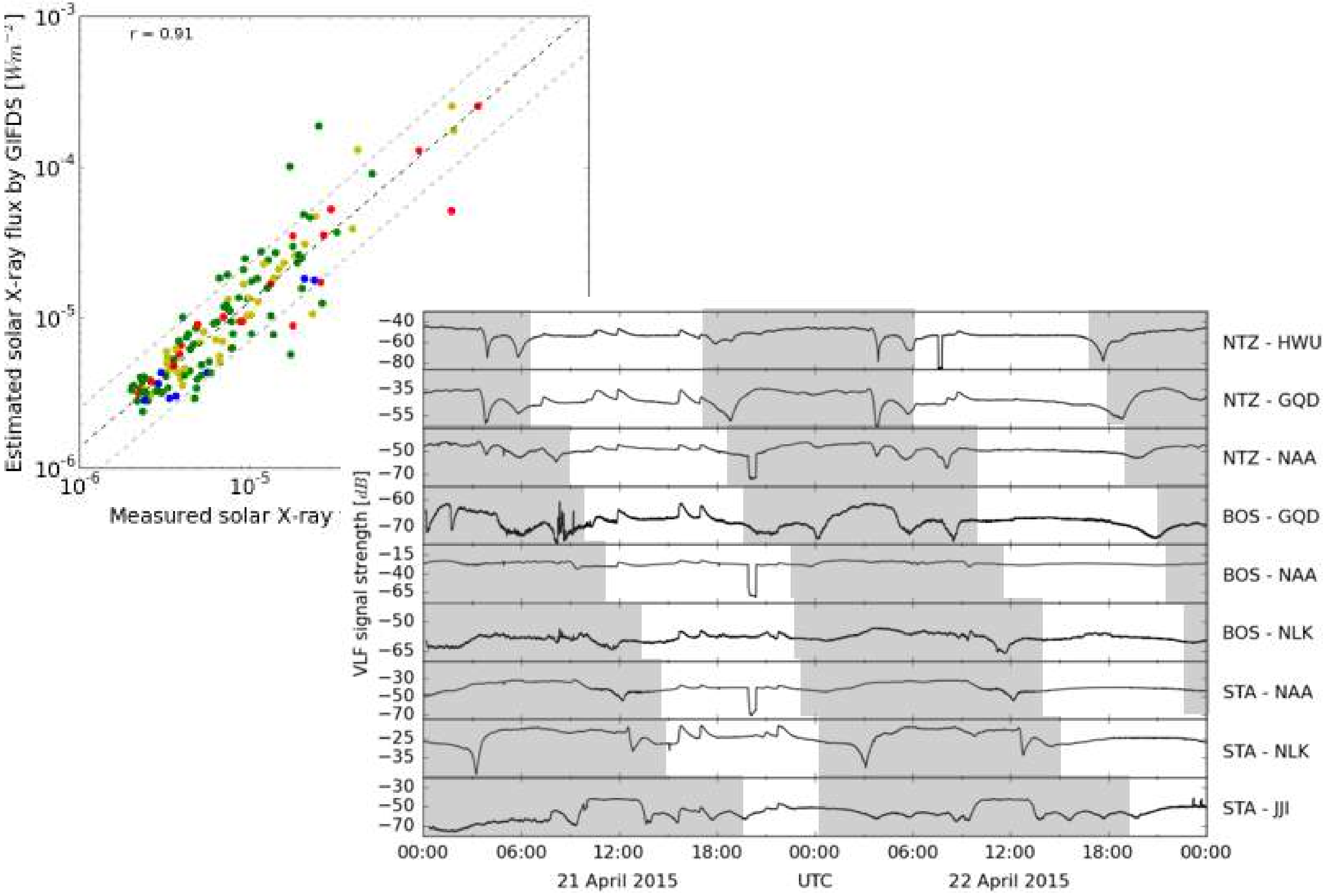
GIFDS Flare Detection Algorithm



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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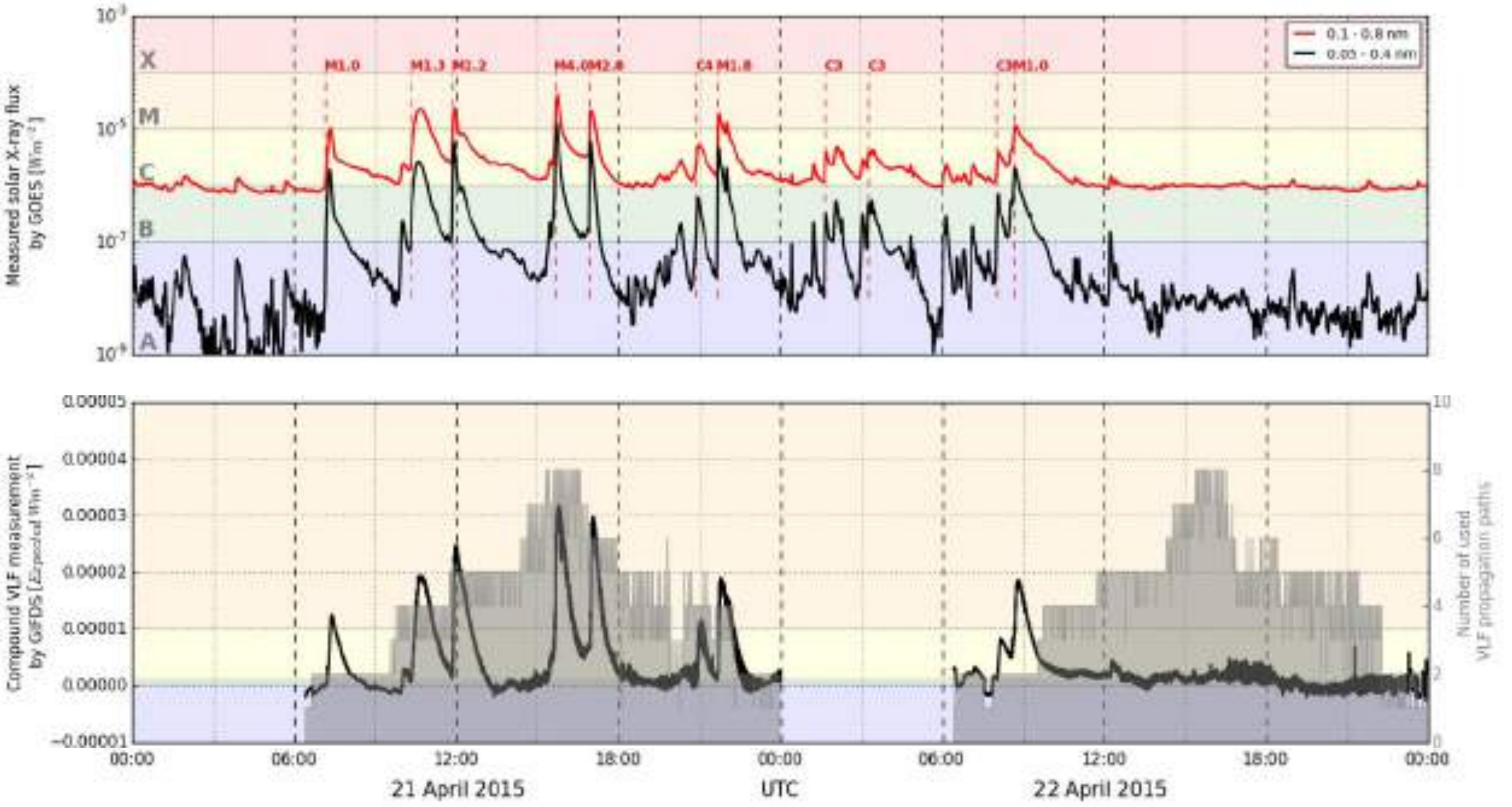

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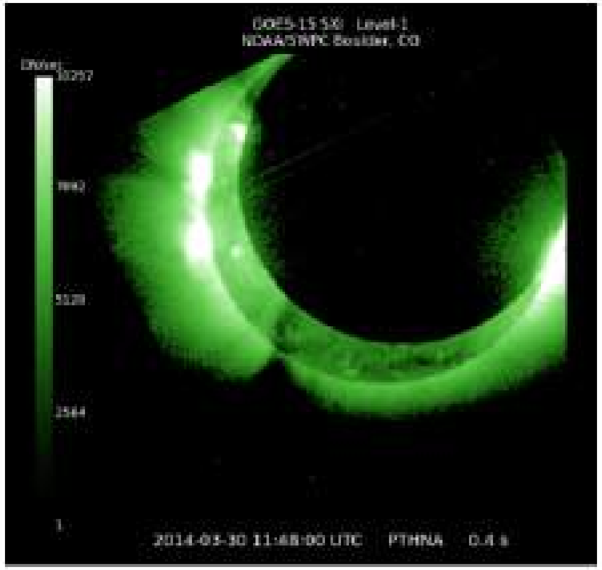

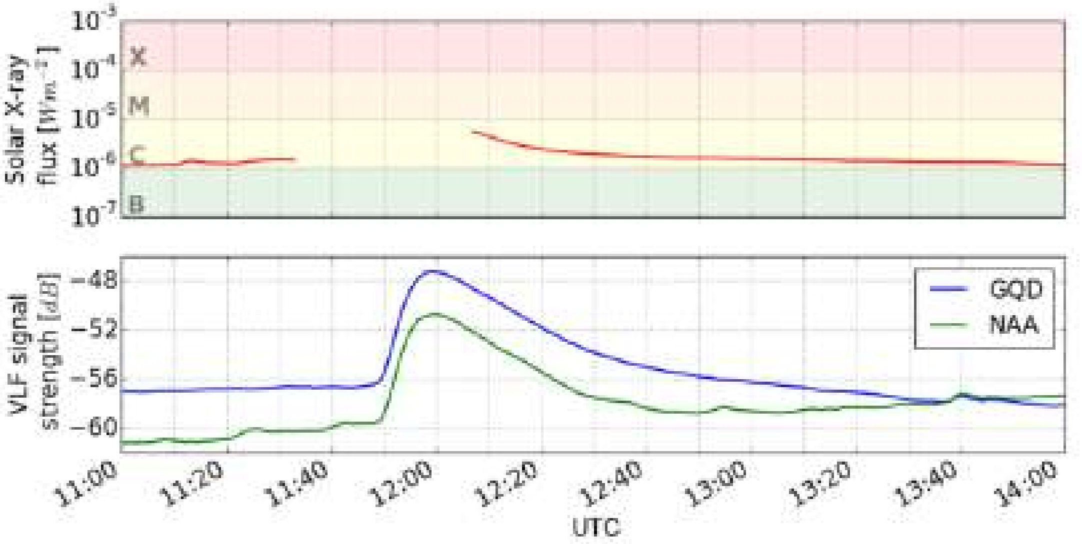

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GIFDS Applications

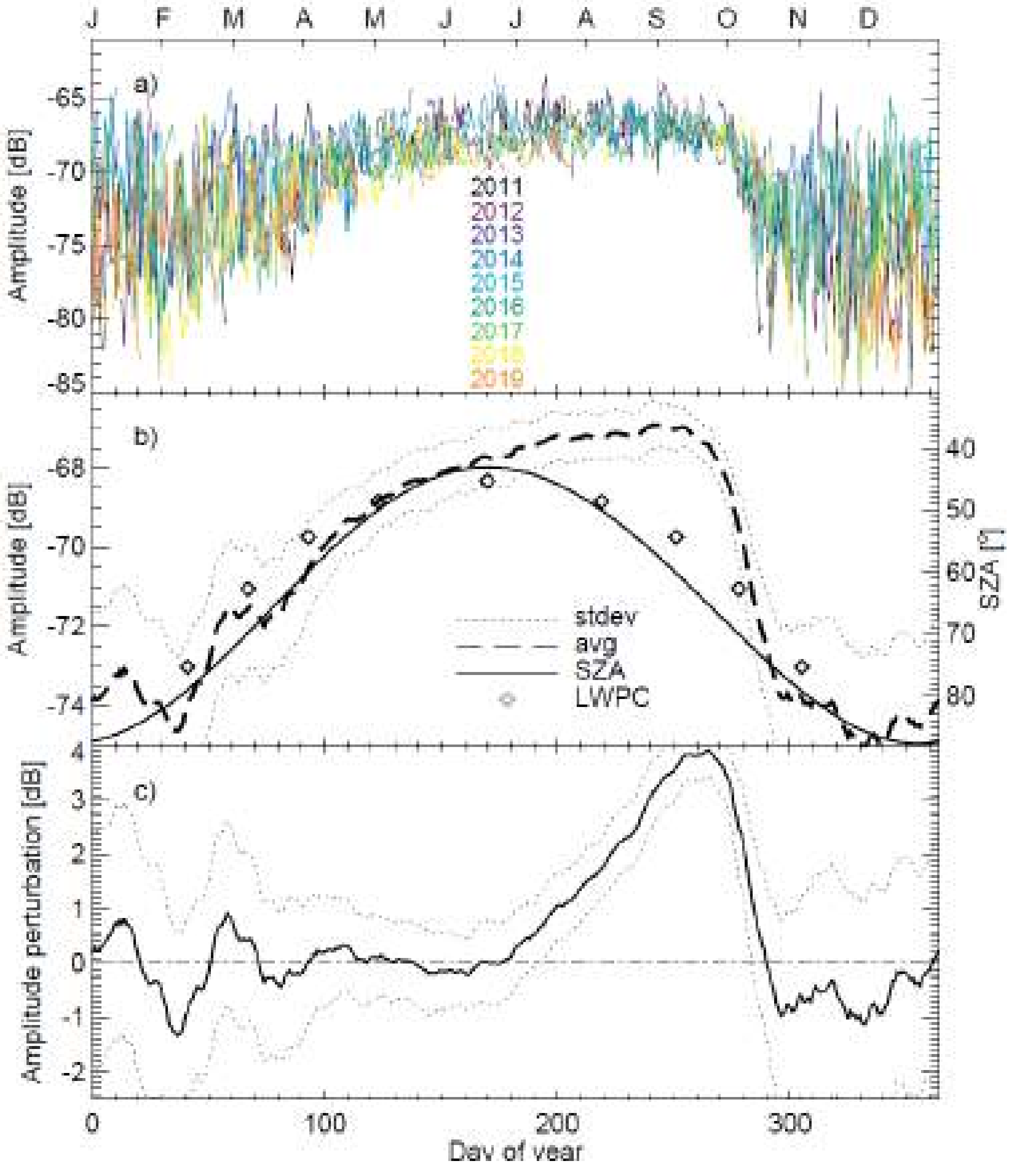
AMELIE
Analysis of the **Me**sosphere and **L**ower **I**onosphere fall **E**ffect

- 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

LEIBNIZ-INSTITUT FÜR ATMOSPHÄREN PHYSIK IAP

Universität Rostock

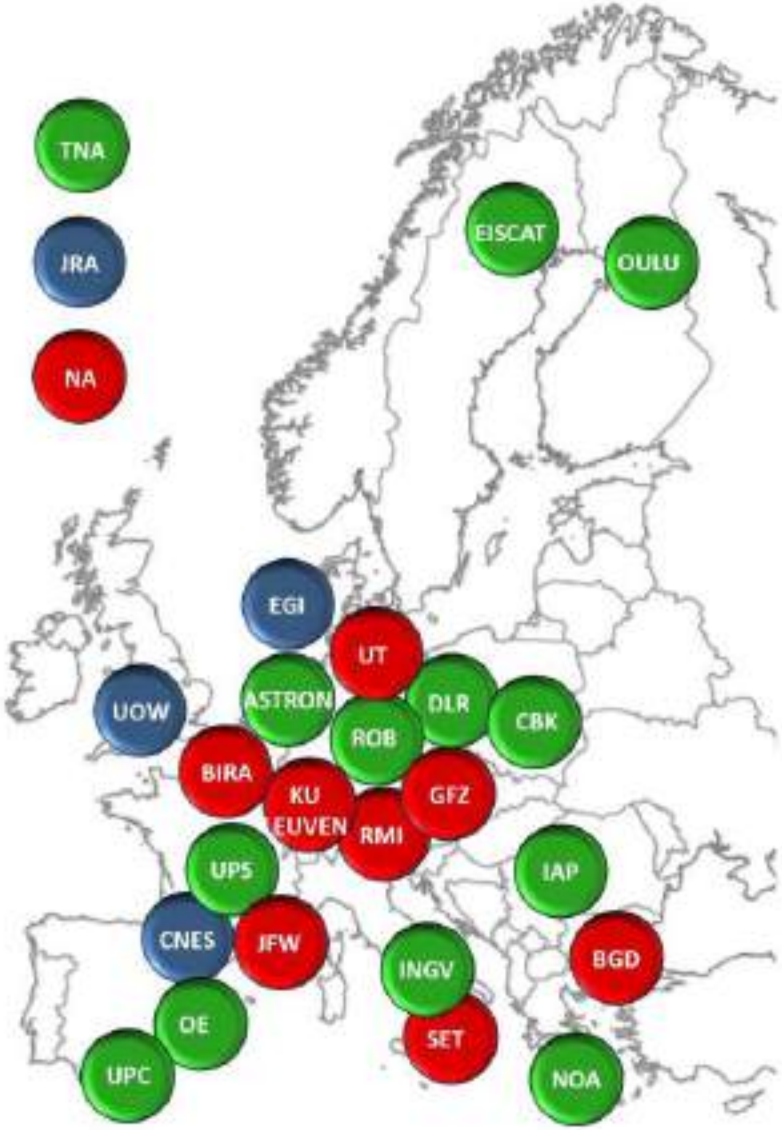


Macotela et al., 2021, GRL

GIFDS Applications

PITHIA-NRF
Plasmasphere **I**onosphere **Th**ermosphere **I**ntegrated Research Environment and **A**ccess services: a **N**etwork of **R**esearch **F**acilities

- 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/



European Commission
Horizon 2020
European Union funding for Research & Innovation

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Receiver:
Name: Freq: Location:
Search

Transmitter:
Name: Freq: Location: US
Search

☐	site		station ▾		position ▾		location ▾	service ▾	notes	!!!
	network	affiliate	orientation	bands	lat [°]	lon [°]	country	maintenance		

☐	identity ▾		sender ▾					position ▾		location ▾	operation ▾				notes	!!!
	call sign	channel	frequency [Hz]	range	bandwidth	modulation	power [kW]	lat [°]	lon [°]	country	broadcaster	status	on air	maintenance		
☐	NML	25.2k	25200	VLF	0		0	46.365987	-98.335667	US	U.S. Navy	active	P	2T12P7h	▸	edit
☐	NPM	23.4k	23400	VLF		MSK		21.4202	-158.1511	US	U.S. Navy	active	P		▸	edit
☐	NPM	21.4k	21400	VLF	200	MSK		21.4202	-158.1511	US	U.S. Navy	active	P		▸	edit
☐	NLK	24.8k	24800	VLF	200		1200	48.203633	-121.916828	US	U.S. Navy	active	P		▸	edit
☐	WWVB	60k	60000	LF		PWM/PM(BPSK)/AM		40.678056	-105.046944	US	NIST	active	P		▸	edit
☐	NAA	24k	24000	VLF	200	MSK, FSK (F1B)	1800	44.6465	-67.2825	US	U.S. Navy	active	P		▸	edit

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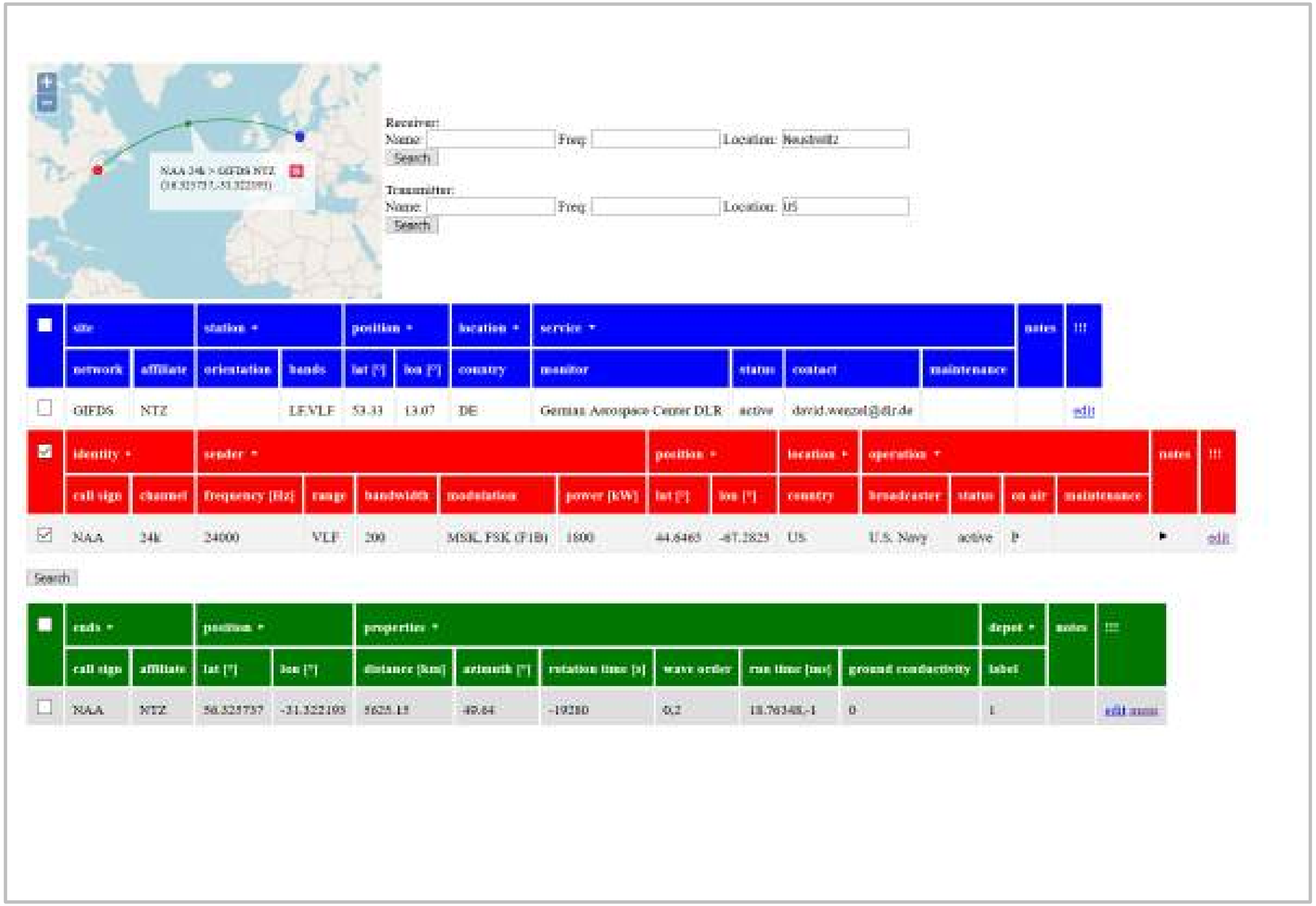

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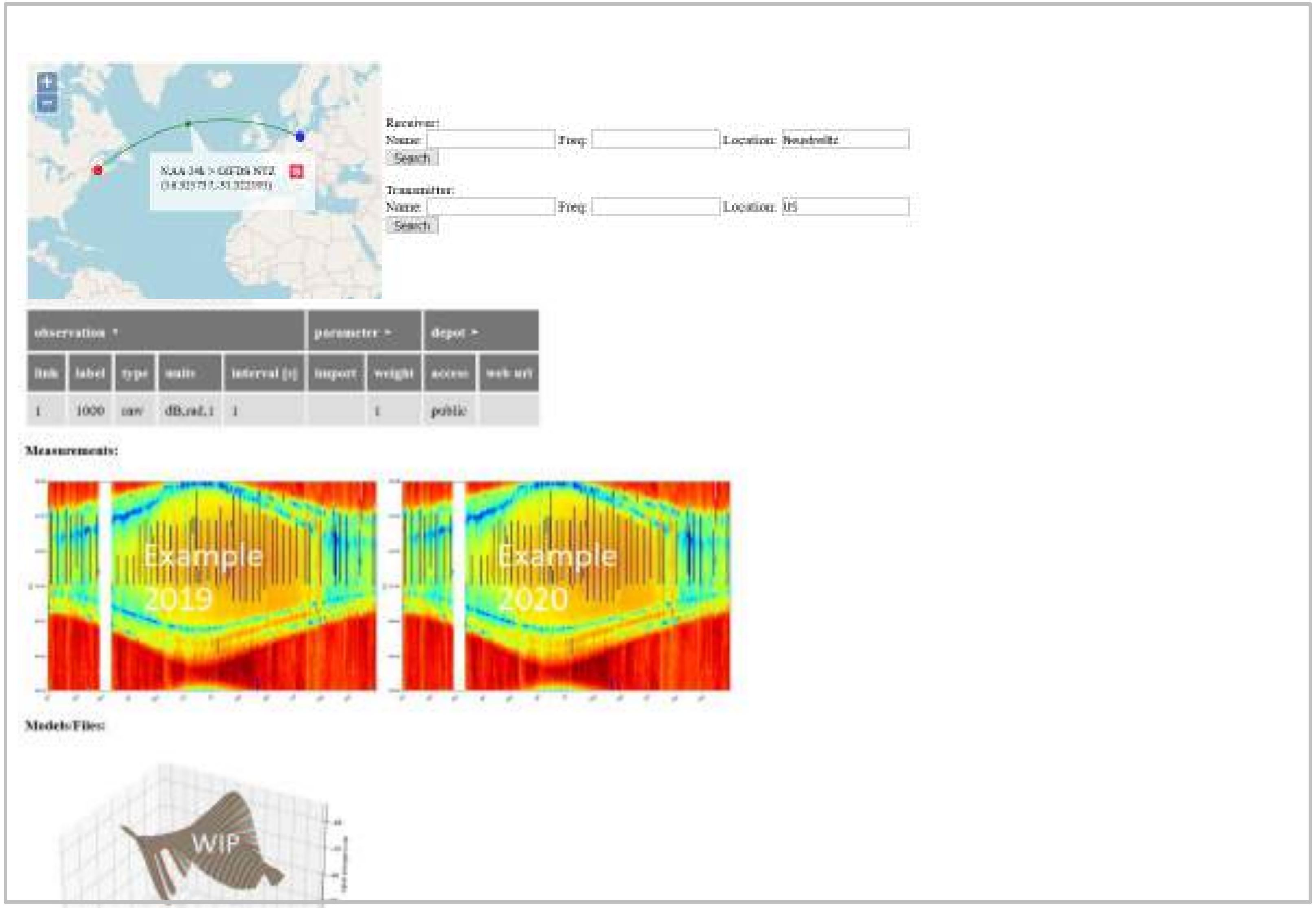

Thank you!