The 6-7.5 GHz range – importance for Earth observations and potential RFI issues

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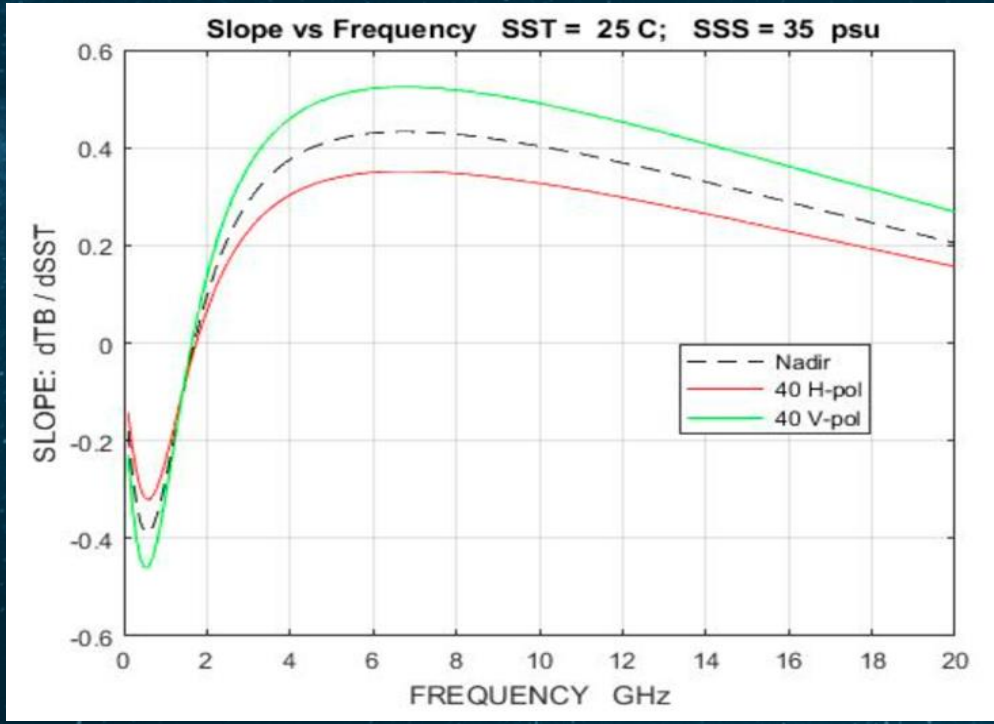
Outline

- Importance of the 6-7.5 GHz range for Earth Observation (EO)
- Regulatory status of EO sensors
- Current RFI
- Potential new RFI
  - Ultra wide band devices
  - Wi-Fi 6E
  - 5G
- Conclusions

Uniqueness of the 6-7.5 GHz range for EO

- EO sensors need to operate at **frequencies that are determined by physical properties**.
- The peak sensitivity to Sea Surface Temperature (SST) is, for most ocean conditions, in the 6-7.5 GHz range.

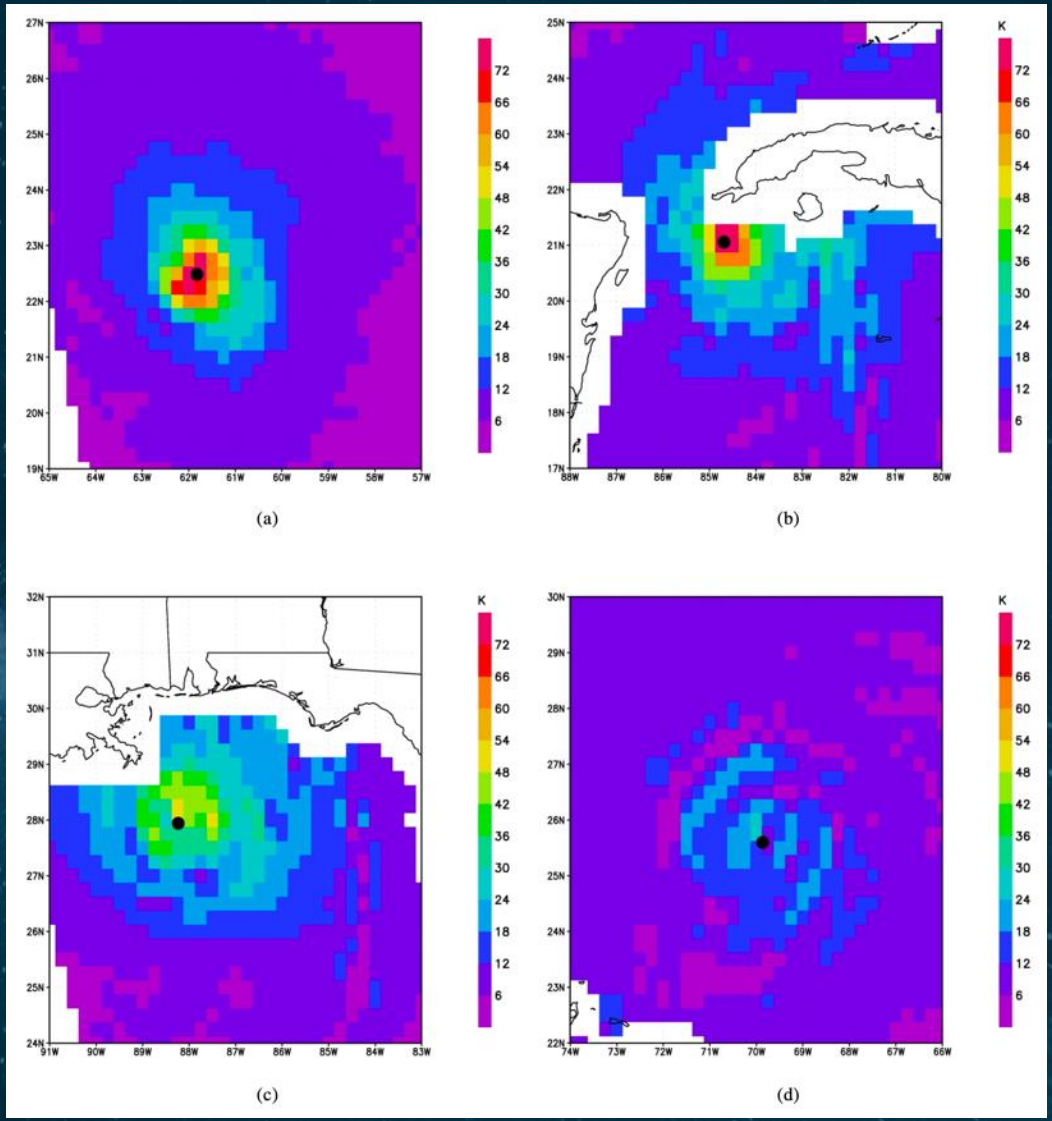


Le Vine and Dinnat, 2020

Uniqueness of the 6-7.5 GHz range for EO

The 6-7.5 GHz range is also useful for retrievals of many other parameters, such as:

- Wind speed over the ocean
- Sea ice concentration
- Sea ice thickness
- Soil moisture
- Precipitation

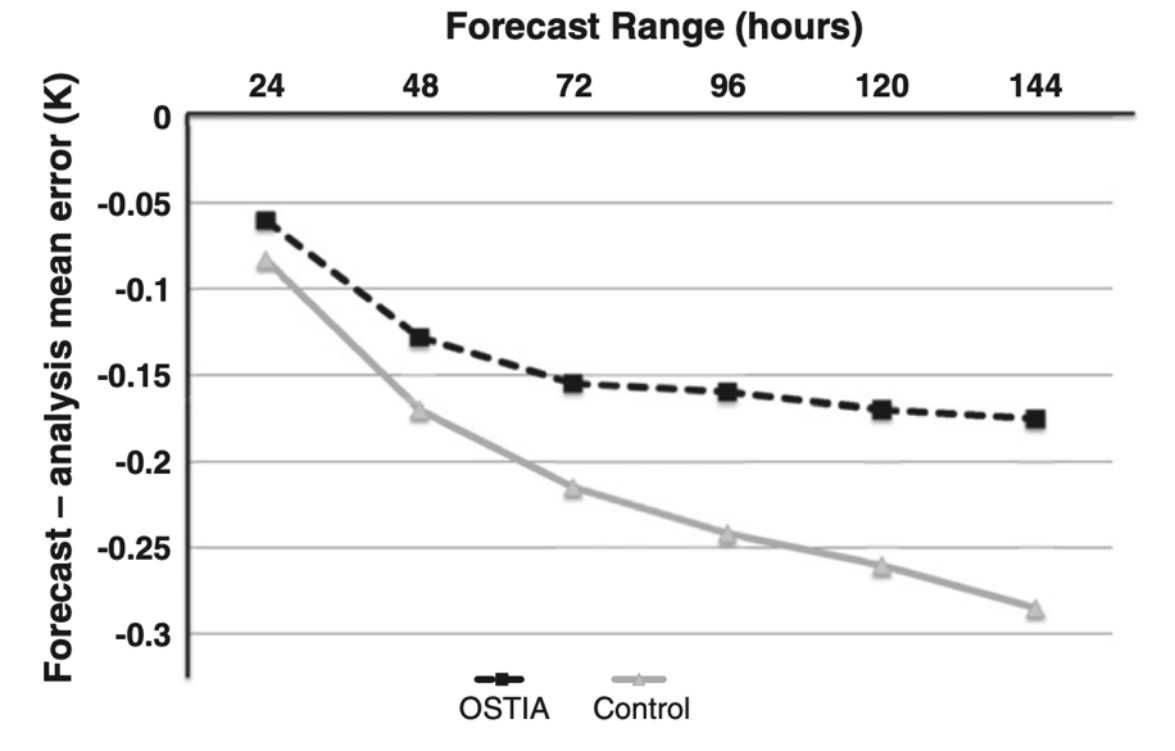


Shibata, 2006

Applications enabled by the 6-7.5 GHz range

Retrievals made using the 6-7.5 GHz range enable, for example:

- Estimation of **fishery resources**;
- Improved predictions of **tropical cyclones**, especially in difficult weather conditions;
- **Climate** monitoring;
- Improved Numerical Weather Prediction (**NWP**) models



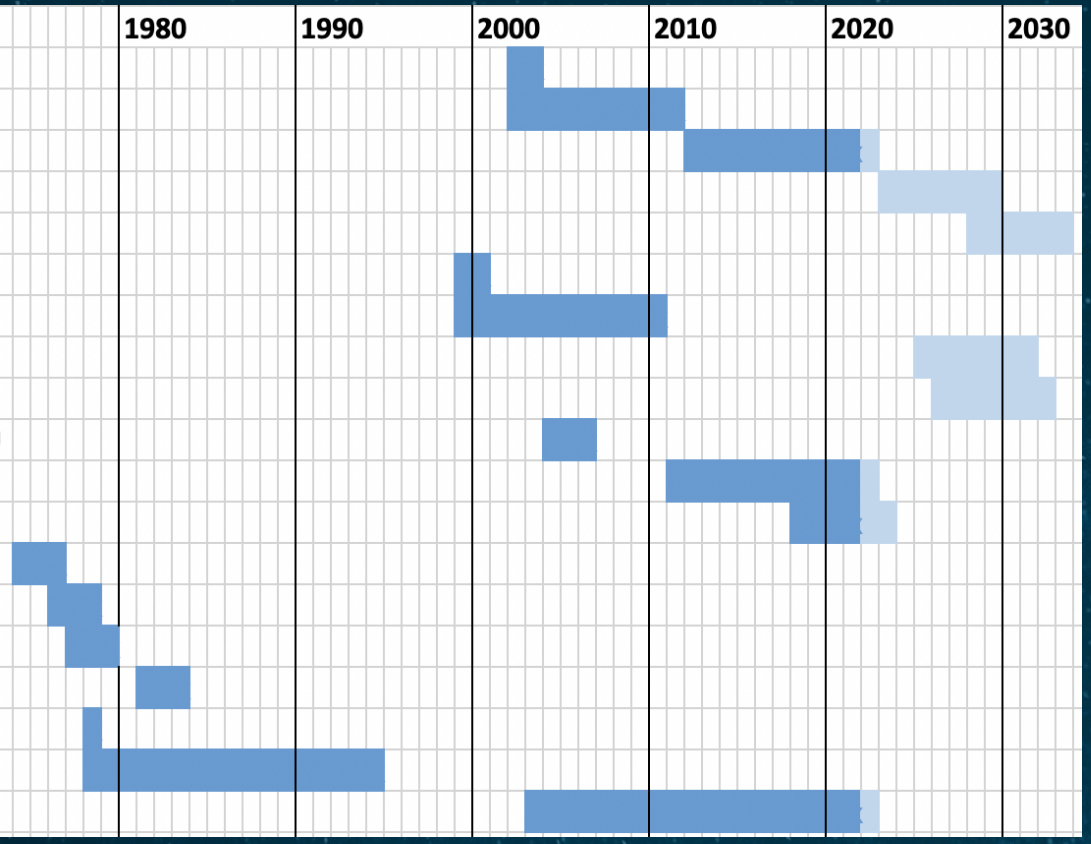
Donlon et al., 2012

Past and future use of the 6-7.5 GHz range

This band has a very rich history. This allows to produce **long time series** and to **build on decades of work**.

Several future missions also plan to operate here.

Instrument	Satellite	Agency
AMSR	ADEOS-2	JAXA
AMSR-E	Aqua	NASA, JAXA
AMSR-2	GCOM-W	JAXA
AMSR-3	GOSAT-GW	JAXA
CIMR	CIMR	ESA
Delta-2D	Okean-O-1	Roscosmos
MSMR	OceanSat-1 (IRS-P4)	ISRO
MTVZA-GY-MP	Meteor-MP N1	RosHydroMet
MTVZA-GY-MP	Meteor-MP N2	RosHydroMet
MTVZA-OK (MW)	SICH-1M	Roscosmos, NSAU
MWRI (HY-2)	HY-2A	NSOAS
MWRI (HY-2)	HY-2B	NSOAS
SHF	Meteor-P1	Roscosmos
SHF	Meteor-P2	Roscosmos
SHF	Meteor-P3	Roscosmos
SHF	Meteor-P6	Roscosmos
SMMR	SeaSat	NASA
SMMR	Nimbus-7	NASA
WindSat	Coriolis	NASA, DoD



Regulatory status of EO sensors

In most cases, users of the spectrum operate within allocations as set out in the Radio Regulations (RR).

However, **there is no allocations for EO in the 6-7.5 GHz range**.

Use of this range by EO sensors is simply acknowledged in footnote 5.458 of the RR:

5.458 *In the band 6 425-7 075 MHz, passive microwave sensor measurements are carried out over the oceans. In the band 7 075-7 250 MHz, passive microwave sensor measurements are carried out. Administrations* ***should bear in mind*** *the needs of the Earth exploration-satellite (passive) and space research (passive) services in their future planning of the bands 6 425-7 075 MHz and 7 075-7 250 MHz.*

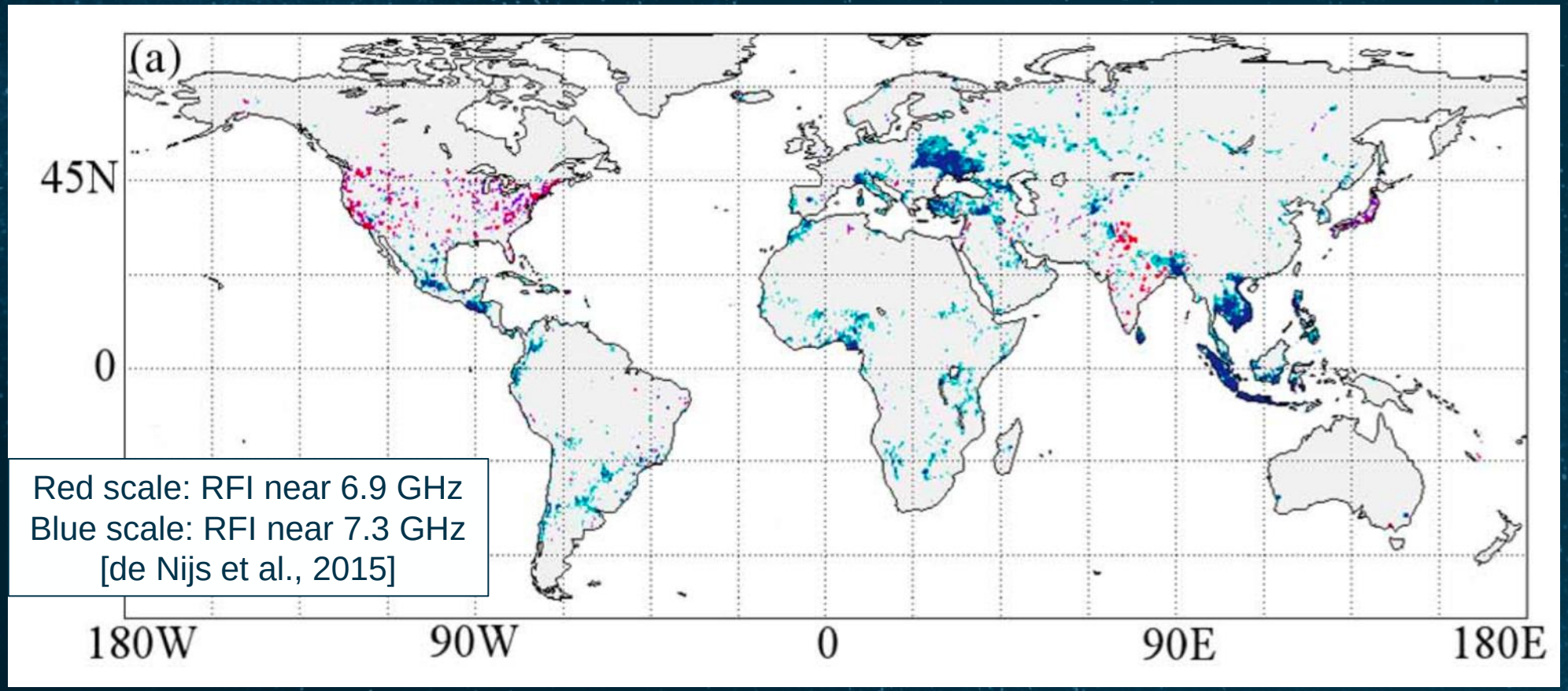
Because EO sensors in these frequencies operate outside allocations, it is **difficult to argue for their protection** in frequency management fora.

Current RFI

The 6-7.5 GHz band is known to have many RFI sources.

But EO sensors have no regulatory status → they **cannot claim protection** from the RFI they experience.

The RFI reporting process adopted by SMOS and SMAP cannot be followed.

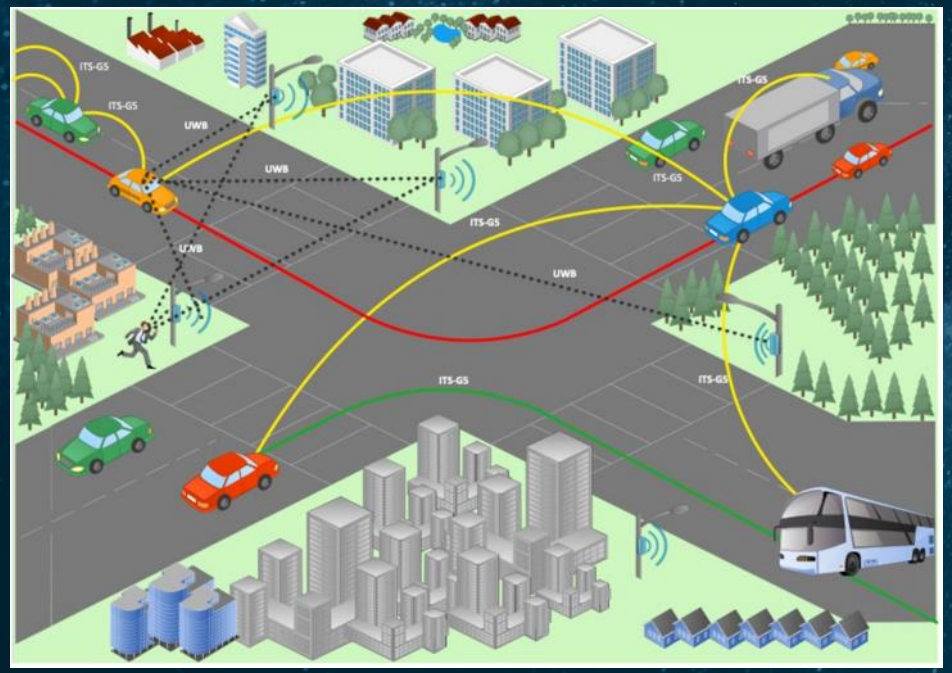


Red scale: RFI near 6.9 GHz
Blue scale: RFI near 7.3 GHz
[de Nijs et al., 2015]

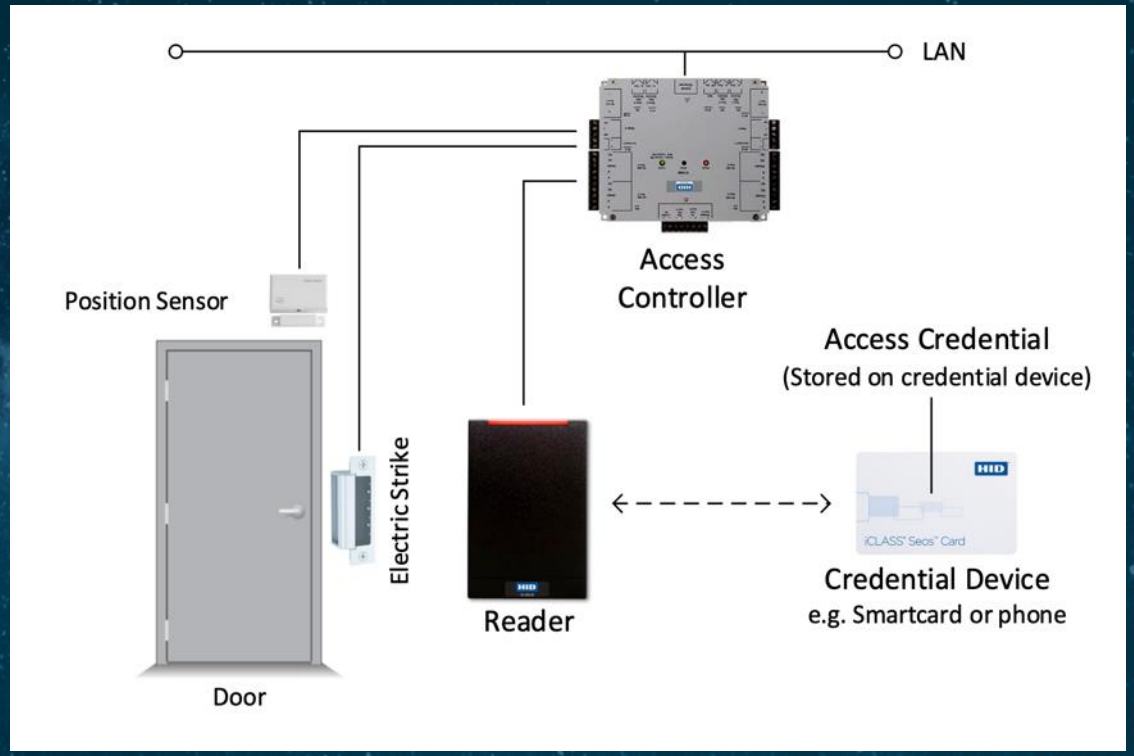
Potential new RFI: UWB in Europe

New Ultra Wide Band (UWB) applications are being planned in Europe (CEPT) in the 6-8.5 GHz range.

UWB devices are already authorized in this band, so the risk is that these new applications will lead to more devices and therefore to **more interference to EO sensors**.



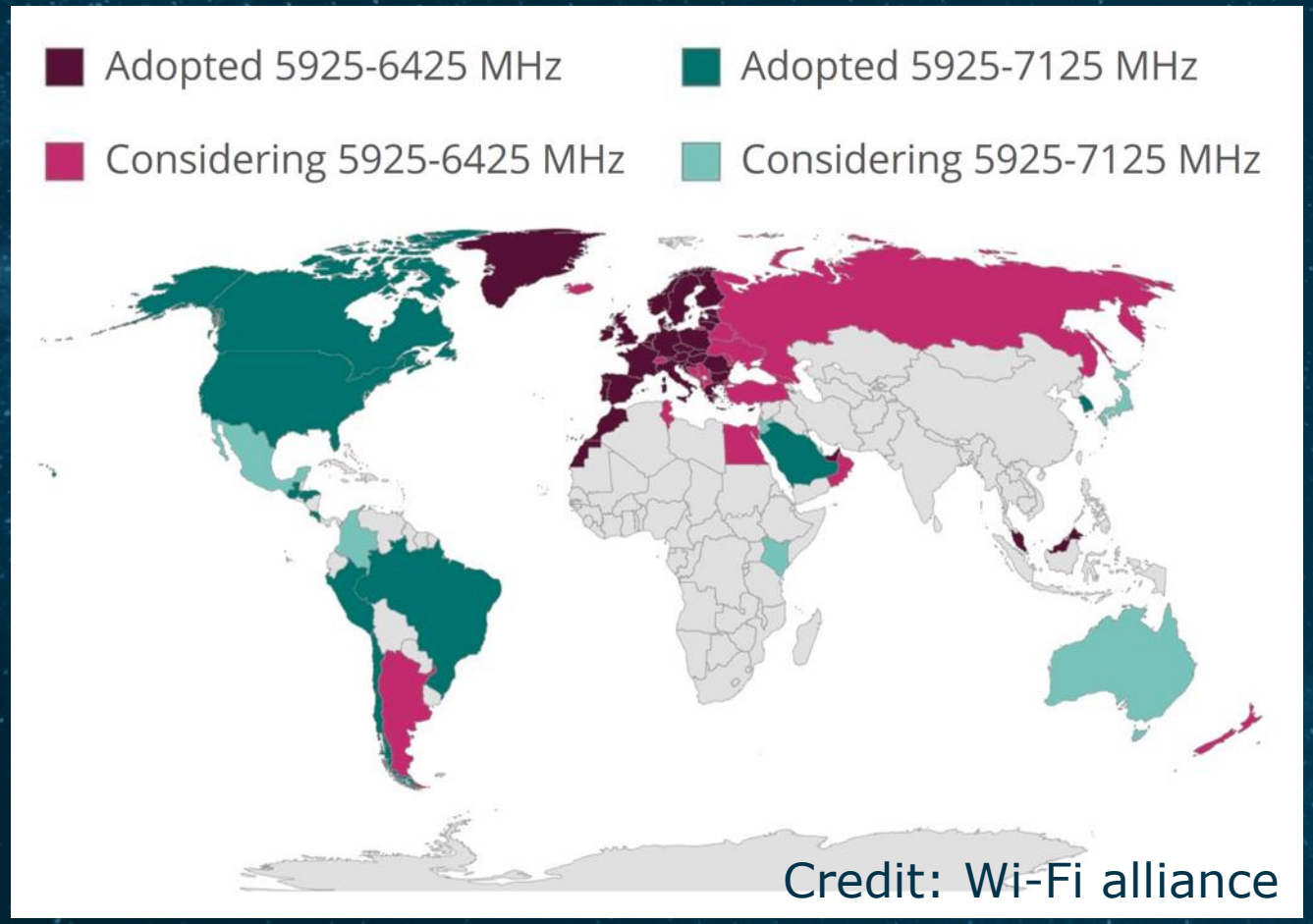
Positioning devices on cars



Physical access control systems

Potential new RFI: Wi-Fi 6E

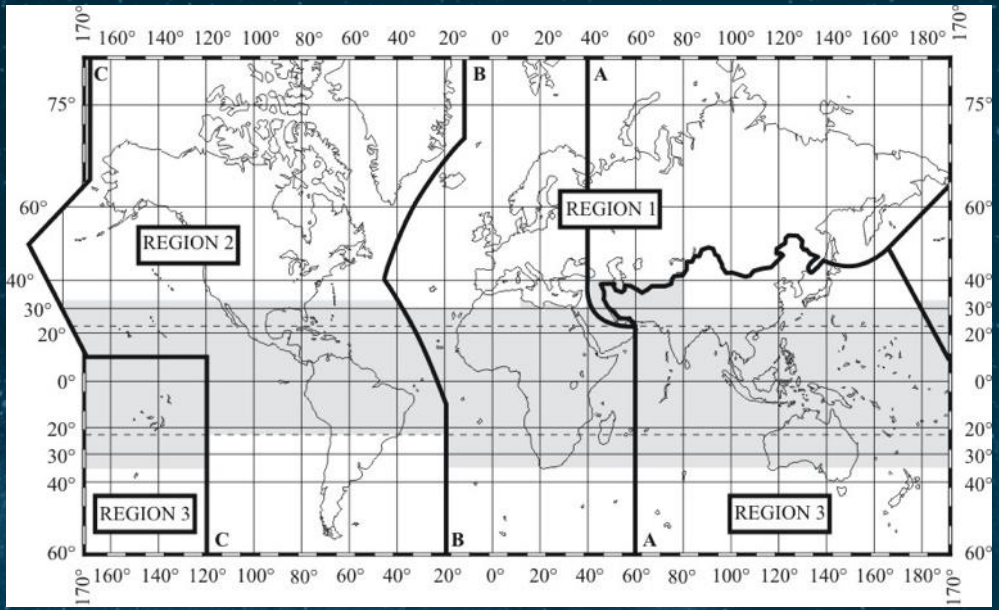
Use of the 5.925 - 7.125 GHz band for Wi-Fi is also being authorized by countries around the world.



Potential new RFI: C-band 5G

5G is looking for additional spectrum under **WRC-23 agenda item 1.2**. The bands under consideration are:

- 3 300-3 400 MHz (Region 1 and 2);
- 3 600-3 800 MHz (Region 2);
- **6 425-7 025 MHz (Region 1);**
- **7 025-7 125 MHz (globally);**
- 10 000-10 500 MHz (Region 2).

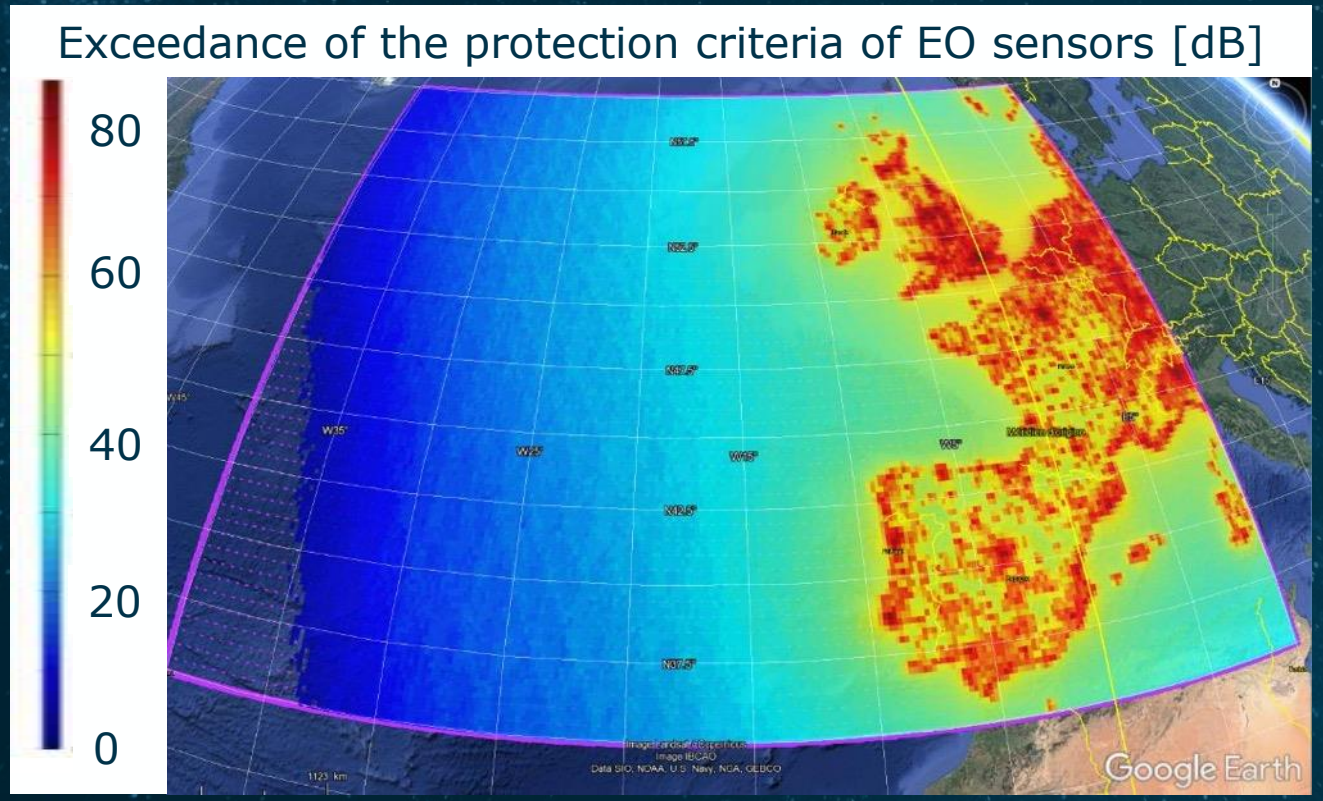


EO sensors have no regulatory status in this band → studies involving EO are considered out of the scope of the work to be done under this agenda item.

Potential new RFI: C-band 5G

A preliminary study has been prepared by France on the estimted impact of 5G on EO sensors.

The figure below shows the impact on CIMR. Color indicates the received power above the protection criteria. **The protection criteria is met ~2000 km away from landmasses!**



Credit: ANFR - French contribution to ITU - 5D/976 and 7C/306

Potential new RFI: C-band 5G

The band considered for 5G is already allocated to the Fixed service and the Fixed-Satellite Service (FSS) (downlinks and uplinks), so IMT would have to coexist with those services.

- Ground receivers (Fixed and Fixed-satellite services): 5G networks may need to respect a certain separation distance from these receivers
- Spaceborne receivers (Fixed-satellite service): some studies show that interference from 5G would exceed the protection criteria of satellite receivers; others show that the protection criteria is met.

Regarding EO missions, a **new ITU Report is being developed** to document the importance of this band and to capture the impact of other services on EO missions.

Annex 17 to Working Party 7C Chairman's Report

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R RS.[EESS(PASSIVE)6-7 GHz]

EESS (passive) in the 6 425-7 250 MHz range

Potential new RFI: C-band 5G

- **Some administrations have shown interest for 5G** in this band
- Coexistence with allocated services may be possible
- If 5G is fully deployed in this band, **"clean" observations may be possible only in polar regions and in open ocean** (i.e. ~2000 km away from landmasses)
- In that case, what steps could we take?
  - Need for good RFI detection strategies;
  - Design future sensors with **larger channel bandwidths** and/or **use multiple nearby channels?**
  - What about an **additional allocation in the 6-10 GHz range?**
  - Working Party 7C of the ITU-R might look into these topics. Views/contributions are welcome!

Conclusions & way forward

- The 6-7.5 GHz range is unique and it includes the **peak sensitivity to sea surface temperature**
- Measurements enable **multiple applications**: modelling of tropical cyclones; climate monitoring; …)
- There is already RFI in this band, and it cannot be reported to the ITU
- **RFI is expected to increase,** also due to:
  - UWB devices in Europe;
  - Wi-Fi 6E;
  - 5G (work ongoing)
- In particular, **5G would have a significant impact on EO missions**
- Difficult to protect EO sensors in this band; need to think about long-term solutions
- <u>What you can do:</u>
  - <u>Publish: e.g. about RFI; about the link between frequency bands and science goals;</u>
  - <u>Get involved in the frequency regulatory process (e.g. via FARS, your institution or administration)</u>

Thank you for your attention!

Questions?

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