

Earth observation contribution to UN Sustainable Development Goals

European Scientists on Spectrum for Earth Observations (ESSEO)

Catherine Prigent (CNRS, Observatoire de Paris), Yan Soldo (ESA), Stephen English (ECMWF), Giulia Panegrossi (CNR), Jesse Andries (ROB), Alessandro Battaglia (PoliTo), Philippe Chambon (Météo-France), Karsten Fennig (DWD), Chawn Harlow (MetOffice), Kenneth Holmlund, Yann Kerr (CNES/CESBIO), Andrea Monti Guarnieri (PoliMi), Catherine Prigent (CNRS), Melody Sandells (Northumbria U.), Markus Dreis (EUMETSAT), Bruno Espinosa (ESA), Juliette Challot (ESA) and Josep Roselló (ESA)

European Scientists on Spectrum for Earth Observations (ESSEO)

Why ESSEO

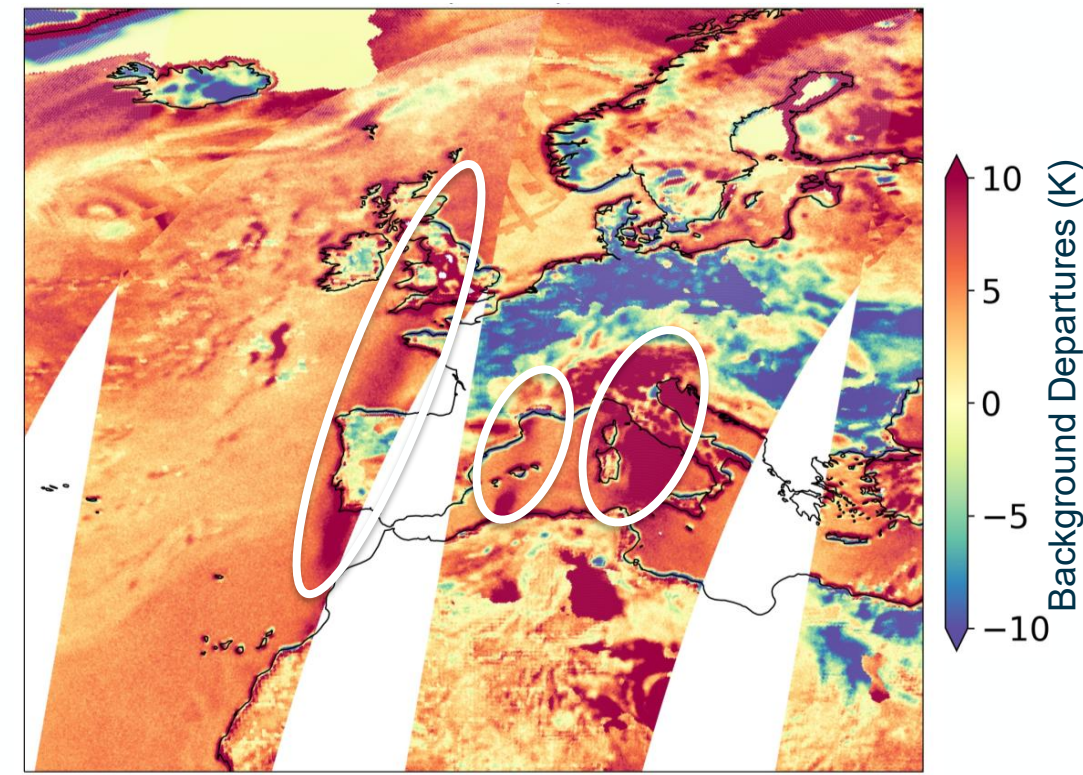
Who is ESSEO

Earth observation contribution to UN SDGs

Reports produced by ESSEO for WRC-27 preparation

Examples

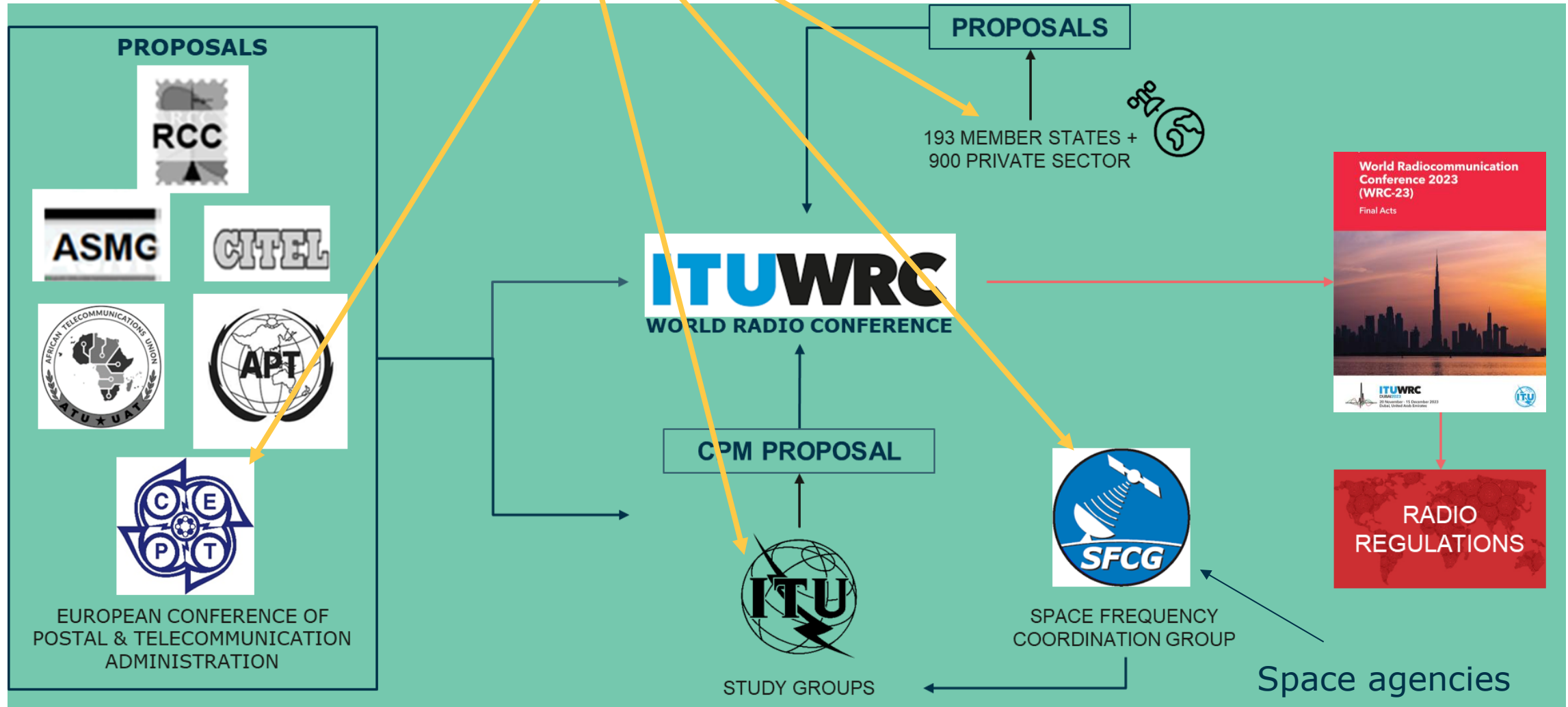
AMSR2 10.65 GHz V pol.



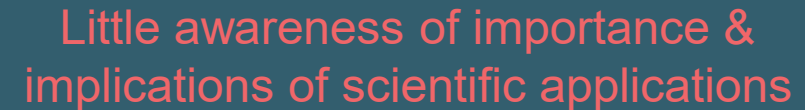
Scanlon et al., 2026₂

ESSEO – Why?

ESSEO (via ESA/EUMETSAT)



The **World Radiocommunication Conference (WRC)** updates the Radio Regulations every 4 years.



Breaks down scientific implications of frequency regulatory activities, and bridges the gap between solid scientific basis (e.g. peer-reviewed articles) and non-technical high-level summaries.

Science community

Knowledgeable on science needs & importance of scientific applications
Little awareness of regulatory discussions & their impact on scientific satellites

Frequency managers

Knowledgeable on regulatory discussions & their impact on science services
Little awareness of importance & implications of scientific applications

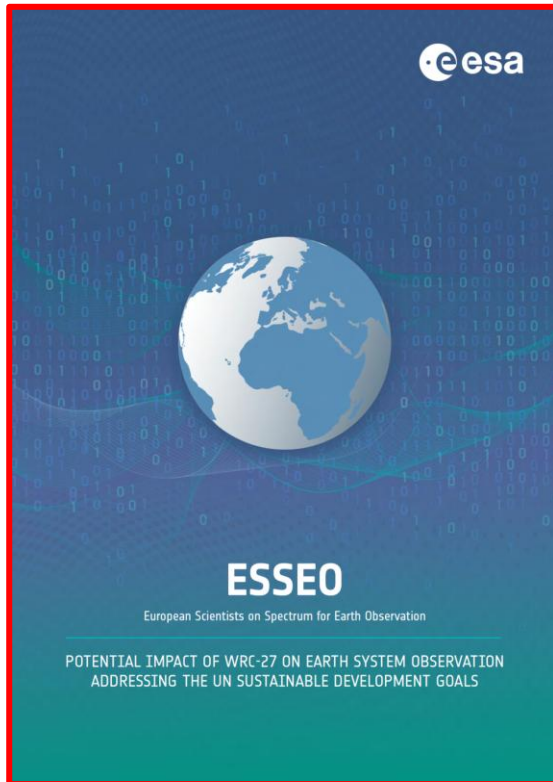
ESSEO's goals are to:

- **Narrow the gap between scientists and frequency management activities (focus on WRC-27)**
- Provide a more solid **scientific basis for ESA-EUMETSAT positions**
- Indirectly **contribute to frequency regulatory activities** with science-based considerations
- Informed view on **impact of RFI**
- Assessment of the **value of bands** in operations and research
- Link spectrum in wider contexts, e.g. to the **UN SDGs**



www.tinyurl.com/ESSEO-WRC

Report on WRC-27



Scientific background for the WRC Report



Select Preliminary WRC-31 AI

AI	Topic
1.1	GSO and NGSO ESIM in the 47.2-51.4 GHz band
1.2	Small FSS antennas in the 13.75-14 GHz band
1.3	NGSO FSS E-s in the 51.4-52.4 GHz band
1.4	BSS and FSS in the 17.3-17.8 GHz band
1.7	IMT in the 4.4-4.8, 7.125-8.4 and 14.8-15.35 GHz bands
1.8	Radiolocation above 230 GHz
1.12	Low-data rate MSS in the 1427-2025 MHz band
1.13	IMT from satellite in the 694-2700 MHz band
1.17	Space weather in the 27.5-614 MHz range
1.18	Protection of RR No. 5.340 bands above 86 GHz under resolves 1
1.19	Long-term solution for SST
2.1	New allocations in the 275-325 GHz range
2.6	IMT in some bands between 102 and 275 GHz

Contents

1	INTRODUCTION	5	Frequency regulatory context; document structure; summary of links with the UN SDGs
1.1	Short description of regulatory elements mentioned in this document	6	
1.2	Linkage with the UN Sustainable Development Goals	10	
2	WRC-27 AGENDA ITEMS	11	Addresses WRC-27 agenda items individually
2.1	AI 1.1 (GSO and NGSO ESIM in the 47.2-51.4 GHz band)	11	
2.1.1	Regulatory background	11	
2.1.2	Interest for the EO community	12	
2.1.3	Relevance for the SDGs	12	
2.1.4	Summary	13	
2.2	AI 1.2 (Small FSS antennas in the 13.75-14 GHz band)	14	
2.2.1	Regulatory background	14	
2.2.2	Interest for the EO community	14	
2.2.3	Relevance for the SDGs	15	
2.2.4	Summary	15	

Selected preliminary agenda items for WRC-31

2 WRC-27 AGENDA ITEMS

2.1 AI 1.1 (GSO and NGSO ESIM in the 47.2-51.4 GHz band)

2.1.1 Regulatory background

2.1.2 Interest for the EO community

2.1.3 Relevance for the SDGs

2.1.4 Summary

Provides context for the AI, particularly aimed at scientists or non-regulatory people

Describes use of the bands by EO missions, and the applications enabled by measurements in each band

Links with the UN SDGs, supported by peer-reviewed literature

Summary aimed at non-scientific people

The Sustainable Development Goals relevant to Earth Observations



End poverty in all its forms everywhere



End hunger, achieve food security and improved nutrition and promote sustainable agriculture



Ensure healthy lives and promote well-being for all at all ages



Ensure availability and sustainable management of water and sanitation for all



Ensure access to affordable, reliable, sustainable and modern energy for all



Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all



Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation



Make cities and human settlements inclusive, safe, resilient and sustainable



Ensure sustainable consumption and production patterns



Take urgent action to combat climate change and its impacts



Conserve and sustainably use the oceans, seas and marine resources for sustainable development



Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

2 WRC-27 AGENDA ITEMS

2.1 AI 1.1 (GSO and NGS0 ESIM in the 47.2-51.4 GHz band)

2.1.1	Regulatory background
2.1.2	Interest for the EO community
2.1.3	Relevance for the SDGs
2.1.4	Summary

2.1.3 Relevance for the SDGs

Passive EO measurements in the 50.2-50.4 GHz band support MW temperature sounding over the whole 50-58 GHz band which is one of the most important inputs to NWP models. NWP model forecasts support several UN SDGs:

- increasing the agricultural productivity and incomes of small-scale food producers (**SDG Target 2.3**) [81];
- ensuring sustainable food production systems. [102] discusses the importance of weather forecasting to crop yield prediction. Thus, MW temperature sounding can improve crop yield prediction capabilities (**SDG Target 2.4**) [81];
- monitoring the availability of safe and affordable drinking water. There is a definite link to NWP modelling and forecasting water availability with hydrologic models. Water quality issues are more serious in areas of low water availability (**SDG Target 6.1**) [81];
- assessing and monitoring risks that could affect infrastructure (e.g. risk of floods). Hydrologic models driven by NWP forecast fields or coupled land-surface/atmospheric models can be used to predict soil moisture and rainfall as well as streamflow. Extreme streamflow events lead to floods (**SDG Target 9.1**) [52] [96] [82];
- predicting and assessing the risk of water-related disasters (**SDG Target 11.5**) [52] [96] [82];
- increasing resilience to climate-related hazards and natural disasters. NWP models can be used to predict extreme temperature and precipitation conditions leading to blizzards, floods, drought, coastal flooding, etc. (**SDG Target 13.1**) [52] [96] [82].

Some elements from the ESSEO Report may be particularly useful for regulators:

1) High-level summary of the scientific implication for each AI

2 WRC-27 AGENDA ITEMS

2.1 AI 1.1 (GSO and NGS0 ESIM in the 47.2-51.4 GHz band)

- 2.1.1 Regulatory background
- 2.1.2 Interest for the EO community
- 2.1.3 Relevance for the SDGs
- 2.1.4 Summary

2.1.4 Summary

The 50.2-50.4 GHz band is extensively used for surface characterisation, in particular in support of lower tropospheric air temperature sounding and precipitation. The measurements in this band are used by hydrological and meteorological prediction systems to predict air temperature, wind speed, cloudiness, and rainfall. Thus, these measurements help the prediction of severe events such as wind storms, floods and blizzards. Measurements in this band have been recorded since the late 1970's and they have helped understand the evolution of the Earth's climate in the satellite era.

ESSEO Report – Elements for Regulators

Some elements from the ESSEO Report may be particularly useful for regulators:

- 1) High-level summary of the scientific implication for each AI
- 2) Mapping between AIs and EESS bands

From AIs to EESS bands

AI	Section	Topic	Main EO bands
1.1	2.1	GSO and NGSO ESIM in 47.2-51.4 GHz	Passive: 50.2-50.4 GHz
1.2	2.2	Small FSS antennas in 13.75-14 GHz	Active: 13.25-13.75 GHz
1.3	2.3	NGSO FSS Earth-to-space in 51.4-52.4 GHz	Passive: 52.6-59.3 GHz
1.4	2.4	BSS and FSS in 17.3-17.8 GHz	Active: 17.2-17.3 GHz
1.7	2.5	IMT in 4.4-4.8, 7.125-8.4 and 14.8-15.35 GHz	Passive: 4.2-4.4 GHz 6.425-7.250 GHz* 8.4-8.5 GHz** Communications: 7.19-7.25 GHz (uplinks) 7.45-7.55 GHz (downlinks) 7.75-7.9 GHz (downlinks) 8.025-8.4 GHz (downlinks)

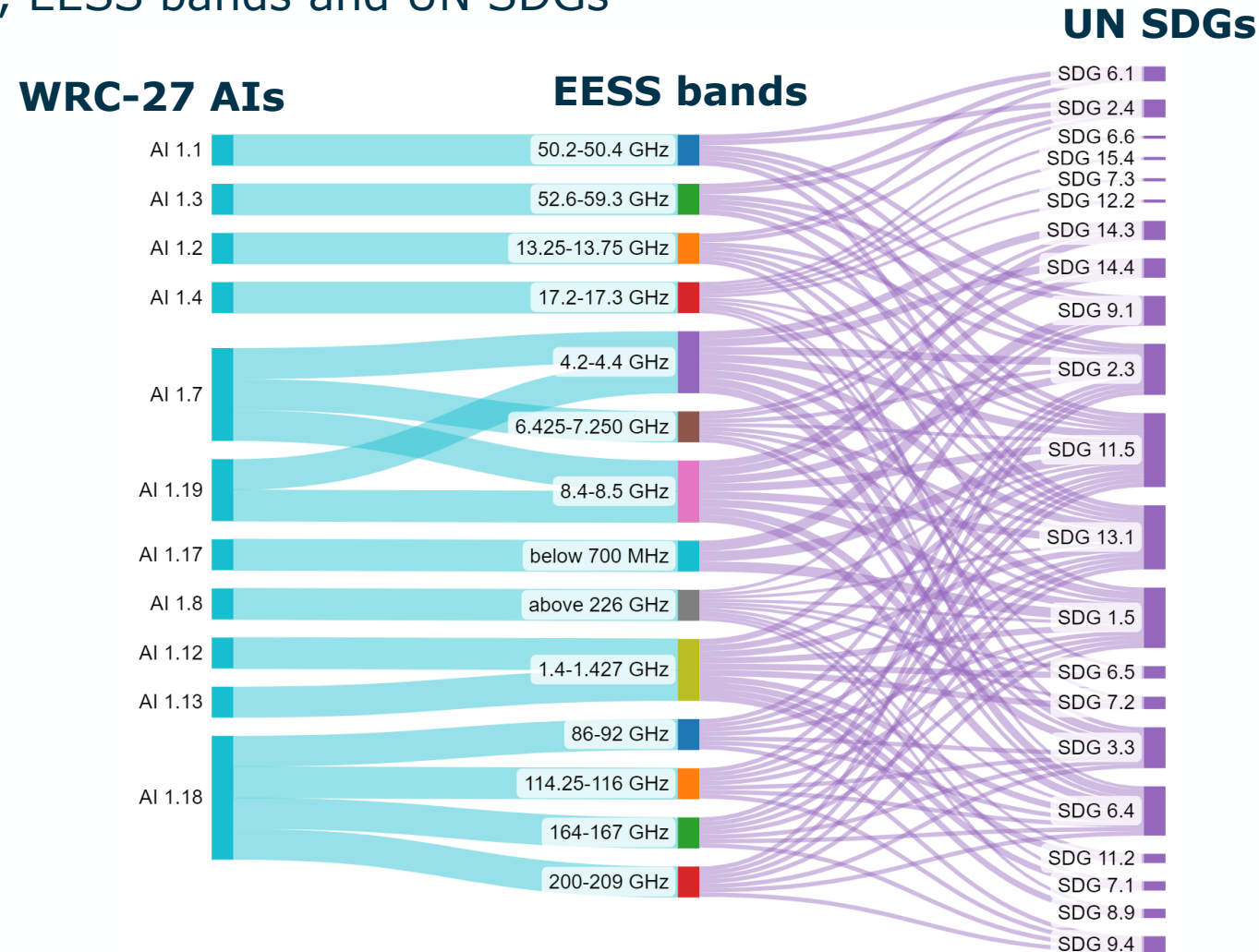
From EESS bands to AIs

E0 bands for sensors	Active/Passive	AIs
27.5-614 MHz (space weather)	Passive	1.17
1.4-1.427 GHz	Passive	1.12, 1.13
4.2-4.4 GHz	Passive	1.7, 1.19
6.425-7.25 GHz	Passive	1.7
8.4-8.5 GHz	Passive	1.7, 1.19
13.25-13.75 GHz	Active	1.2
17.2-17.3 GHz	Active	1.4
50.2-50.4 GHz	Passive	1.1, 1.3
52.6-59.3 GHz	Passive	1.3
86-92 GHz	Passive	1.18
100-102 GHz	Passive	2.6
109.5-111.8 GHz	Passive	2.6
114.25-116 GHz	Passive	1.18
148.5-151.5 GHz	Passive	2.6
164-167 GHz	Passive	1.18, 2.6
174.8-191.8 GHz	Passive	2.6
200-209 GHz	Passive	1.18, 2.6
226-231.5 GHz	Passive	1.8, 2.6
Various bands between 235 and 247.2 GHz	Active and Passive	1.8
250-252 GHz	Passive	1.8, 2.6
Various bands between 275 and 325 GHz	Active and Passive	1.8, 2.1
Various bands between 325 and 700 GHz	Passive	1.8

ESSEO Report – Elements for Regulators

Some elements from the ESSEO Report may be particularly useful for regulators:

- 1) High-level summary of the scientific implication for each AI
- 2) Mapping between AIs and EESS bands
- 3) Links between AI, EESS bands and UN SDGs



Science background document

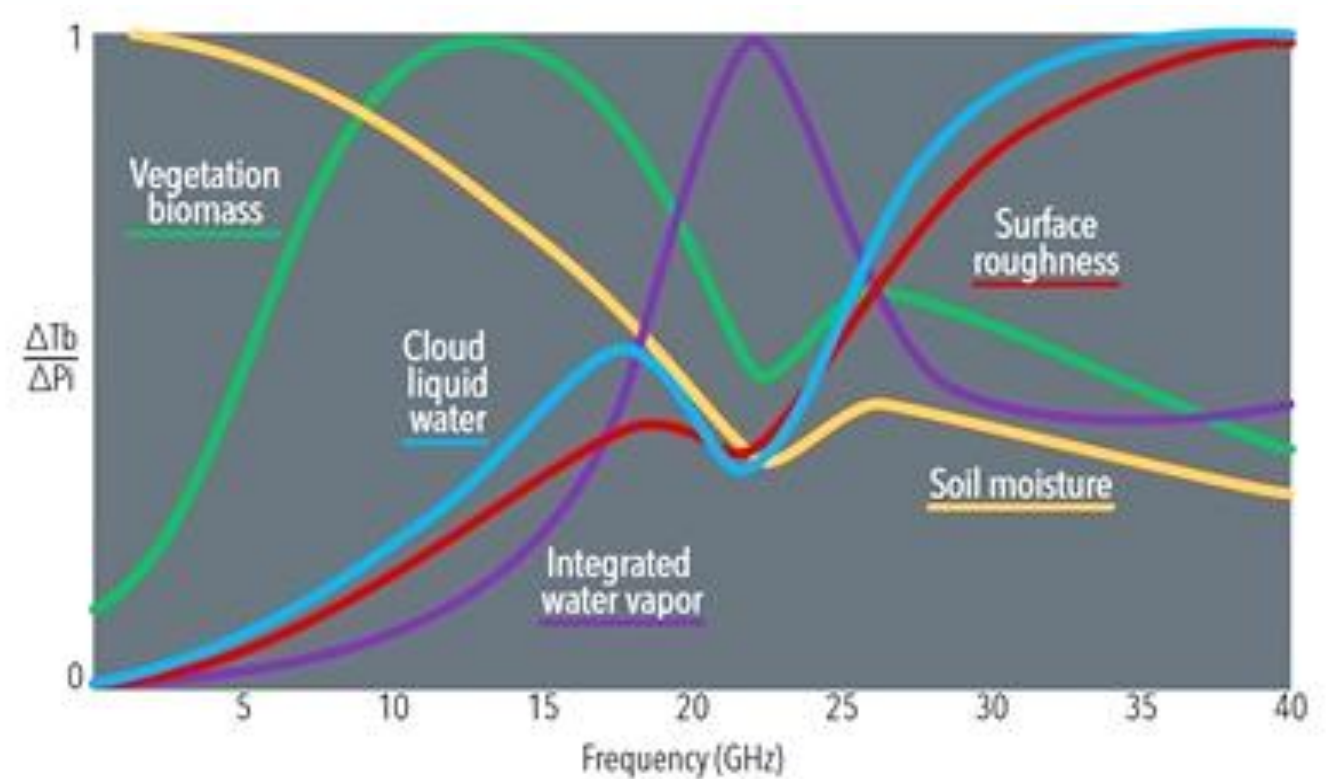


1	Introduction	7
2	Atmosphere (including clouds & precipitation)	11
2.1	Environmental monitoring	15
2.2	Environmental prediction	25
2.3	Environmental long-term change monitoring	32
2.4	Linkage to WRC-27	38
3	Ocean and sea ice	41
3.1	Environmental monitoring	42
3.2	Environmental Prediction	47
3.3	Environmental long-term change monitoring	48
3.4	Linkage to WRC-27	51
4	Land, snow pack and land ice and hydrology	53
4.1	Environmental monitoring	54
4.2	Environmental prediction	65
4.3	Environmental long-term change monitoring	70
4.4	Linkage to WRC-27	72
5	Space weather	75
5.1	Linkage to WRC-27	78
6	Current evidence for and potential strategies for handling RFI in EO bands	79

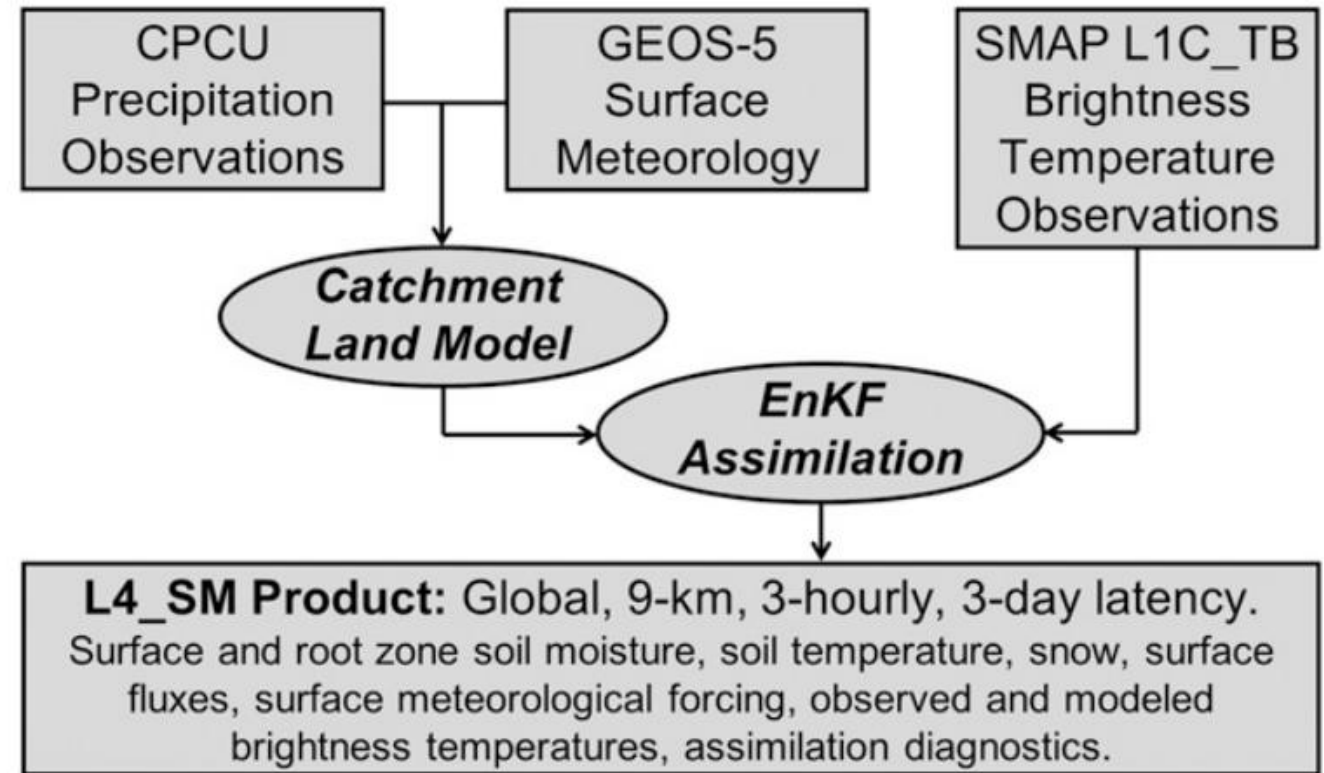
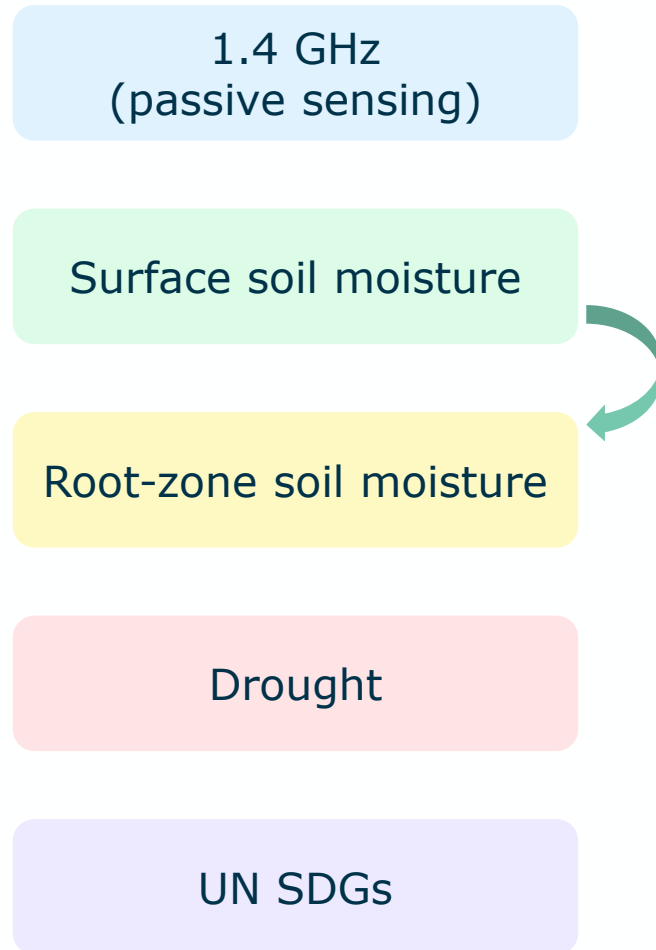


WRC -27 AI	Frequency bands (GHz)	Use in current environmental state	Use in current environmental prediction	Use in climate monitoring
1.1	47.2-51.4 GHz	50.2-50.4 GHz band is extensively used for surface characterisation, in particular in support of lower tropospheric air temperature sounding and precipitation	50.2-50.4 GHz are not normally assimilated but it is essential to characterize surface emission in the 50-59 GHz temperature sounding band.	50.2-50.4 GHz bands available since 1970s so a mature CDR
1.2	13.75-14 GHz	13.25-13.75 GHz band used for winds and precipitation monitoring using active sensors (scatterometers, radars)	13.25-13.75 GHz band assimilation improves wind and precipitation predictions (scatterometers, radars)	Scatterometers and precipitation radars available since late 1990's so a mature CDR

UN SDGs



From Frequencies to SDGs – An Example



Reichle et al., 2017

From Frequencies to SDGs – An Example

1.4 GHz
(passive sensing)

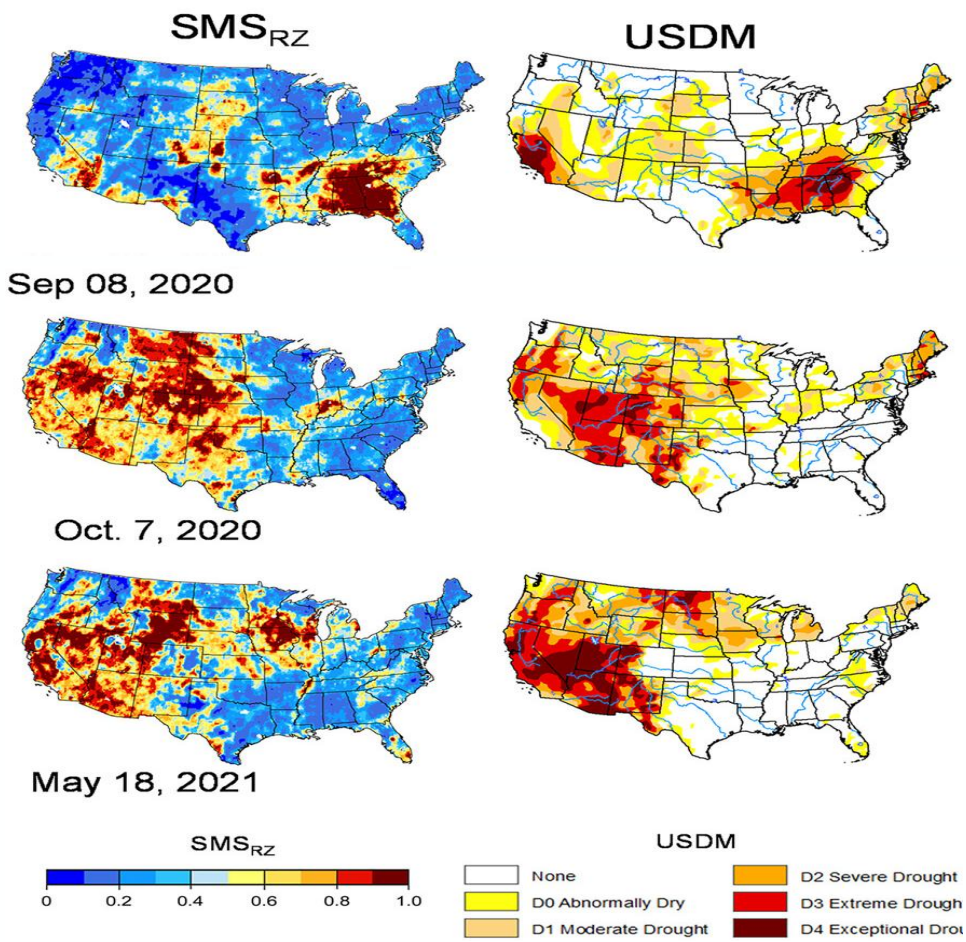
Surface soil moisture

Root-zone soil moisture

Drought

UN SDGs

a) WEC-based SMS_{RZ} v/s USDM Outlook for CONUS



Sehgal et al., 2024

From Frequencies to SDGs – An Example



1.4 GHz
(passive sensing)

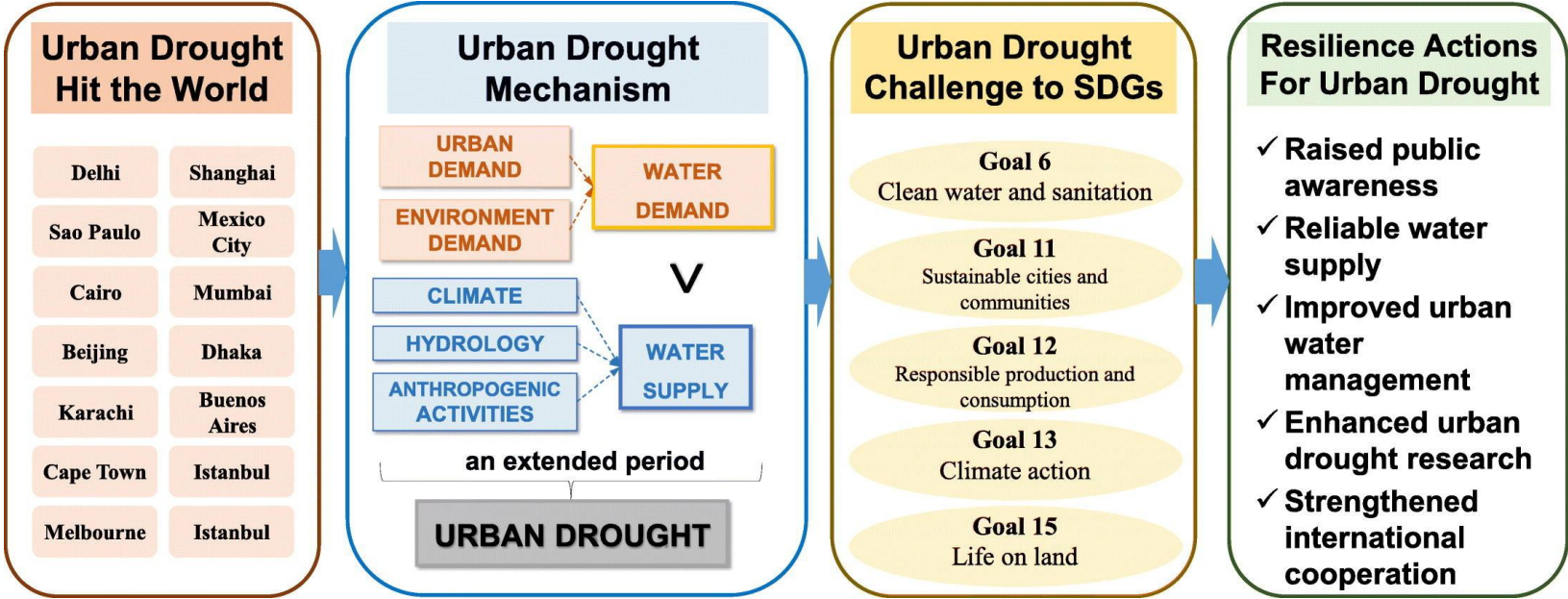
Surface soil moisture

Root-zone soil moisture

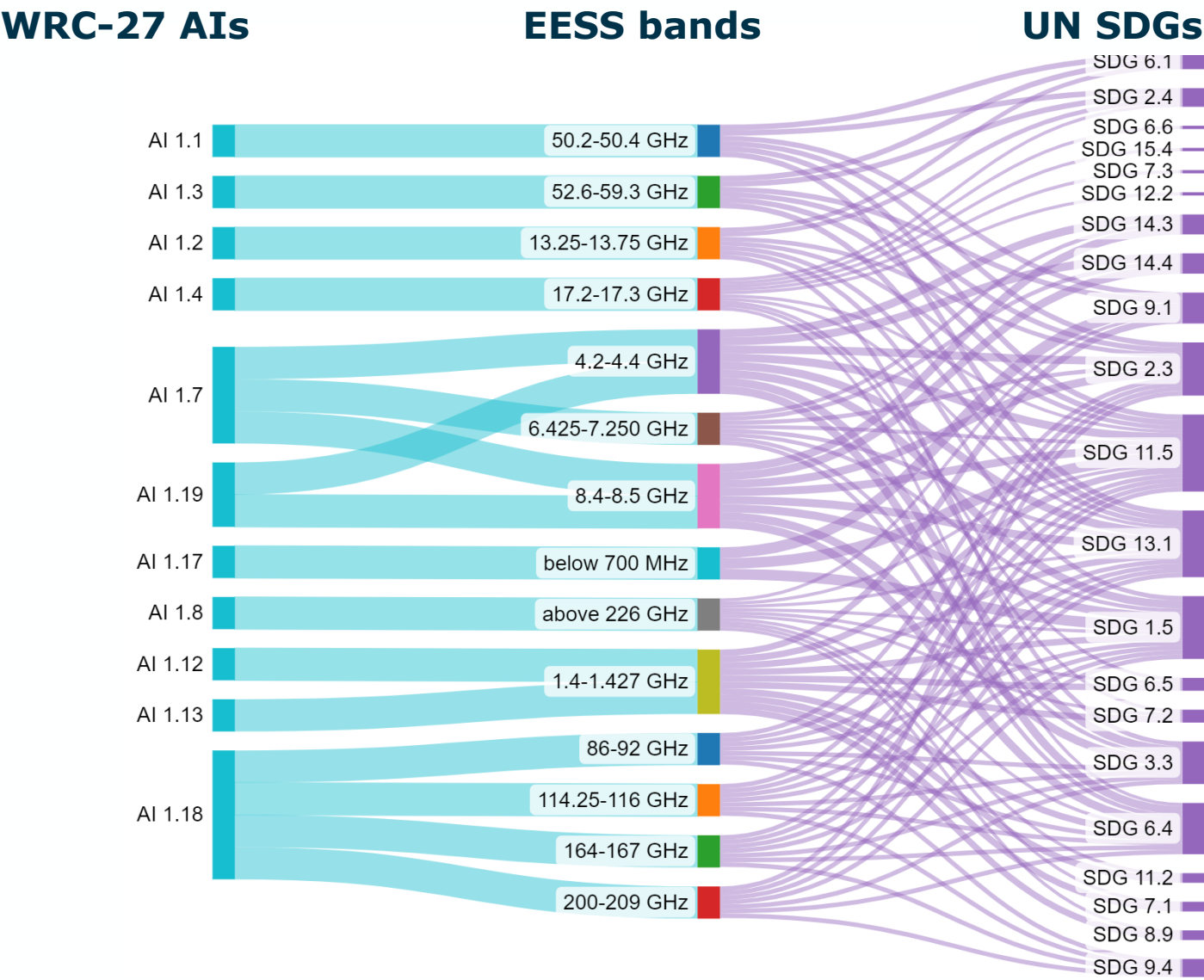
Drought

UN SDGs

Zhang et al., 2019



ESSEO Report – Linkage between WRC and UN SDGs



Questions?

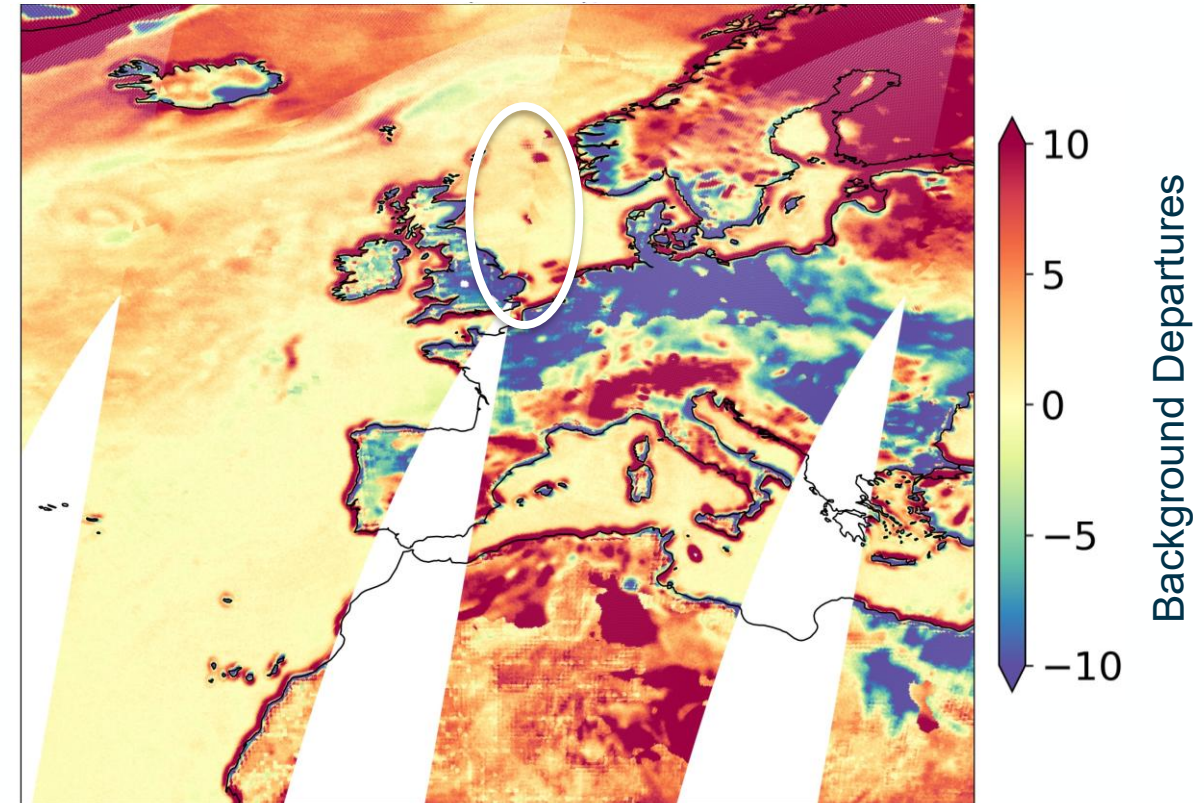
More on ESSEO:



European Scientists on Spectrum for Earth Observations

- Why ESSEO
- Who is ESSEO
- Work done
 - WRC-27 Report
 - Elements for Regulators
 - Science background
 - Example link between frequency and SDGs

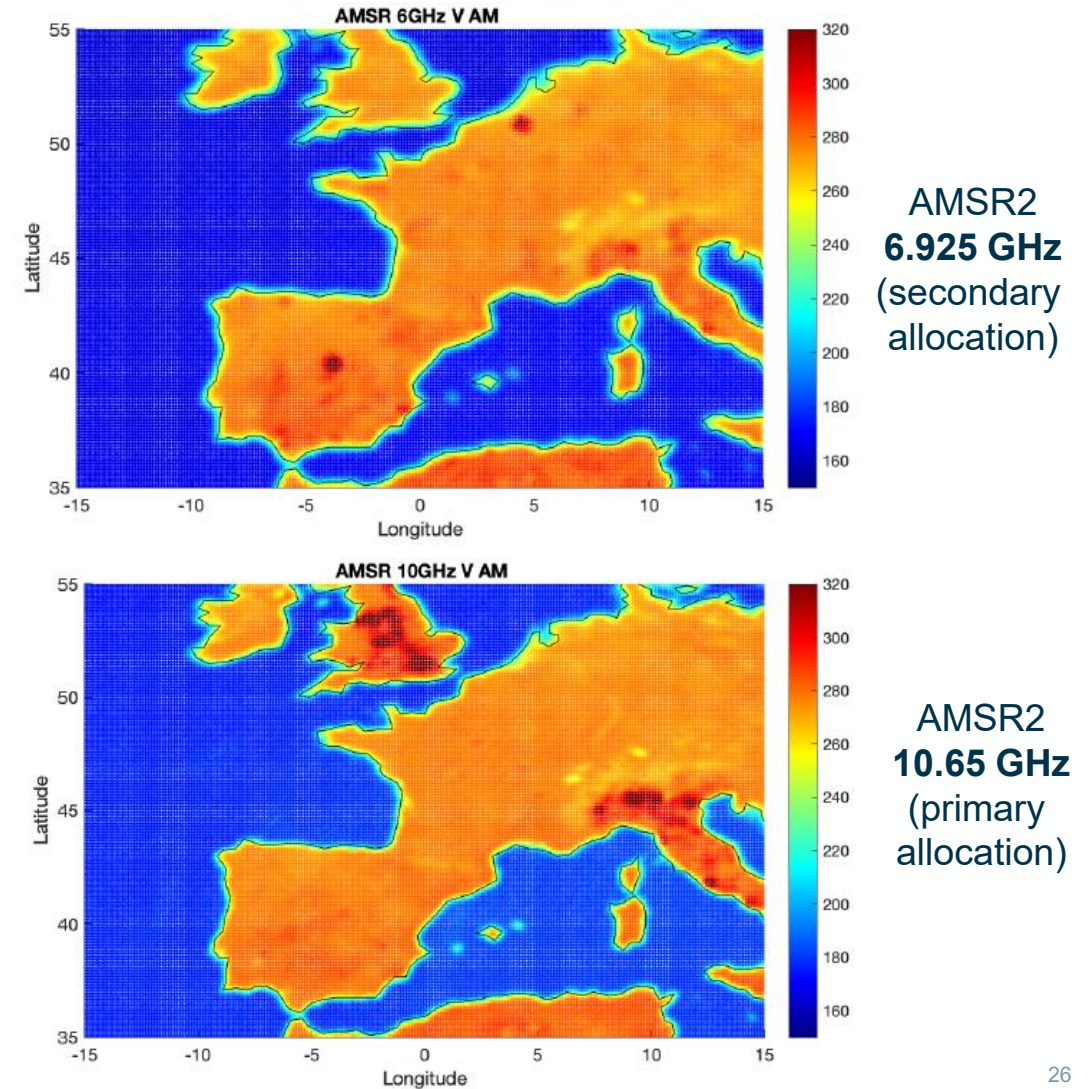
AMSR2 6.925 GHz V pol.



Scanlon et al., 2026

European Scientists on Spectrum for Earth Observations

- Why ESSEO
- Who is ESSEO
- Work done
 - WRC-27 Report
 - Elements for Regulators
 - Science background
 - Example link between frequency and SDGs



2 WRC-27 AGENDA ITEMS

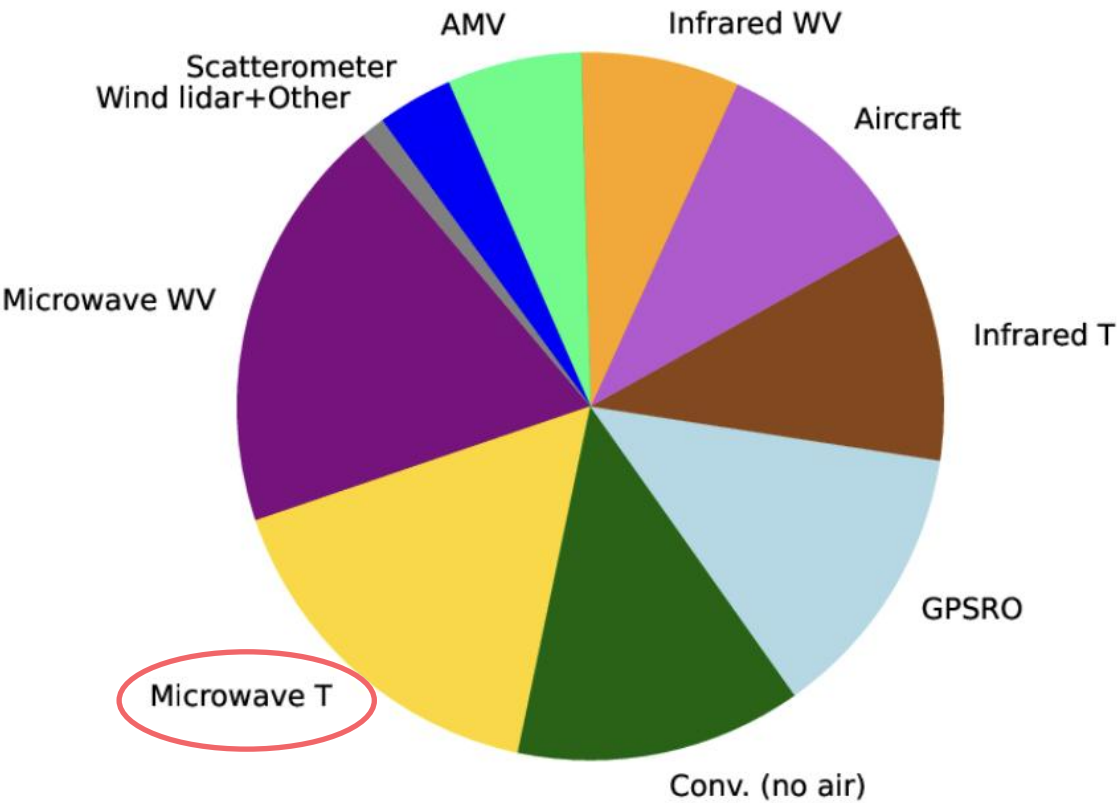
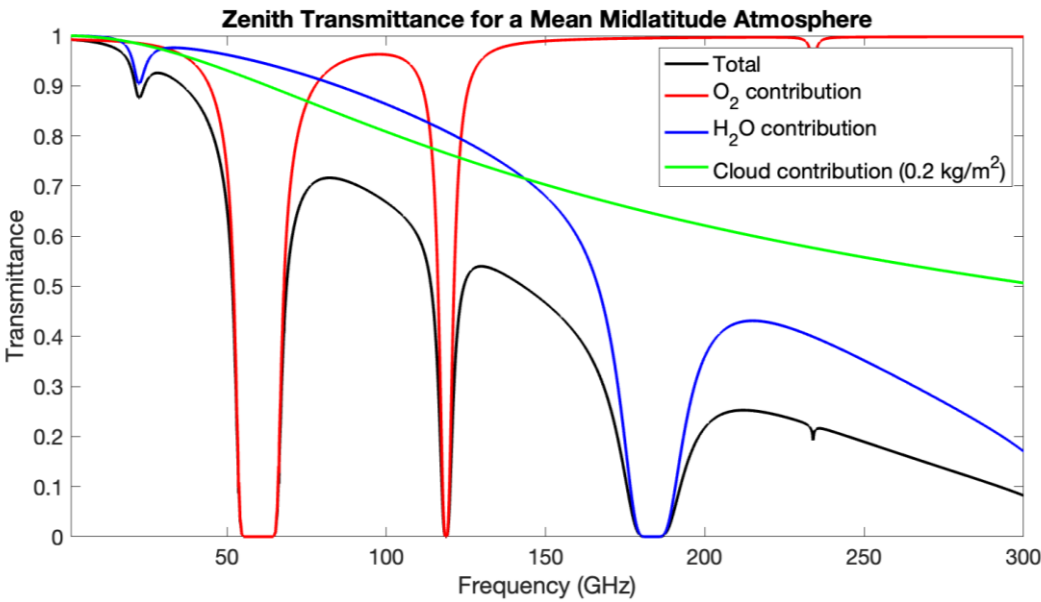
2.1 AI 1.1 (GSO and NGS0 ESIM in the 47.2-51.4 GHz band)

2.1.1 Regulatory background

2.1.2 Interest for the EO community

2.1.3 Relevance for the SDGs

2.1.4 Summary

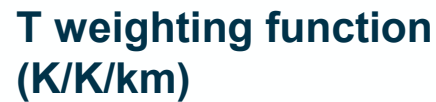


Contributions of different observation types at ECMWF to the skill of short-range weather forecasts

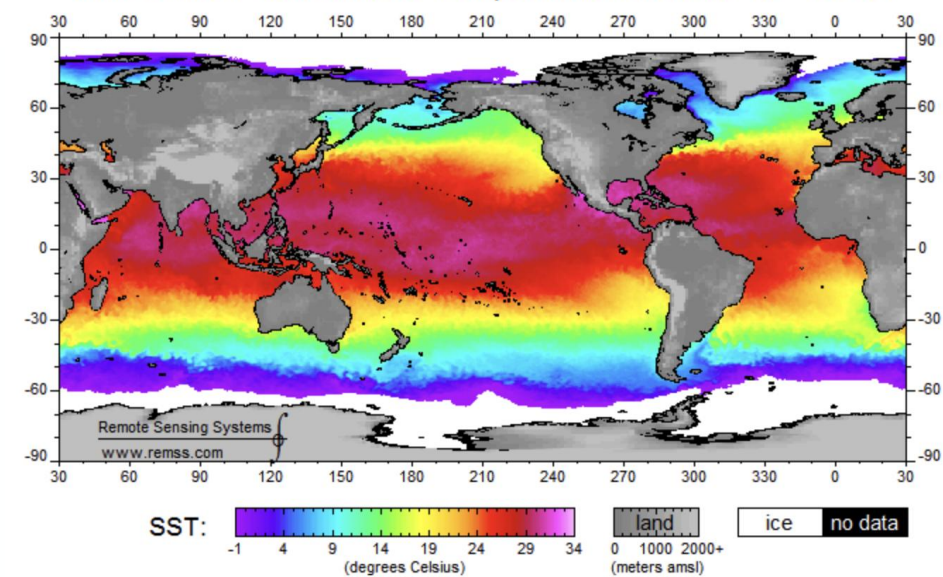
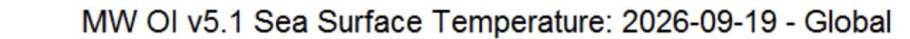
English et al., 2024 ²⁷

2.1 AI 1.1 (GSO and NGS0 ESIM in the 47.2-51.4 GHz band)

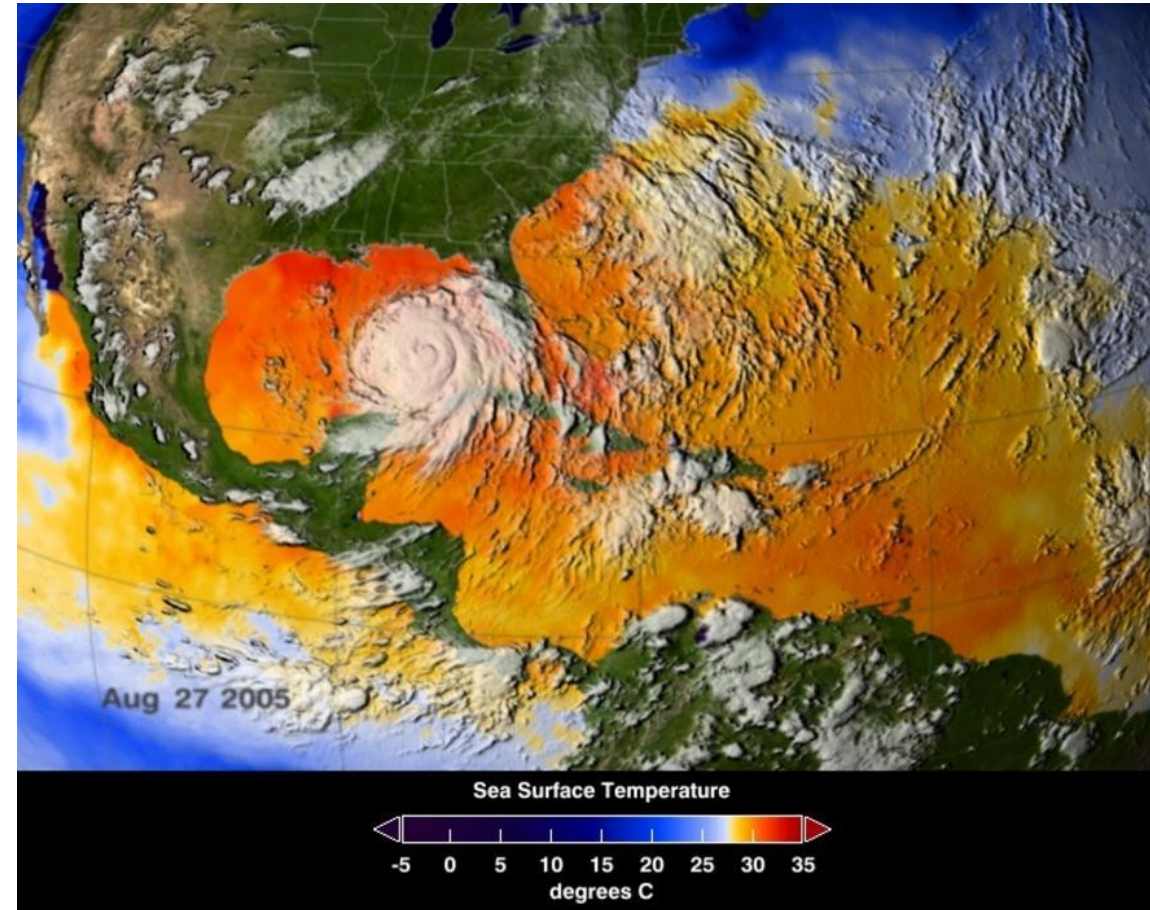
- ### 2.1.2 Interest for the EO community

English et al., 2024²⁸

Sea Surface Temperature



Tropical cyclone Prediction



From Frequencies to SDGs – An Example

6 GHz
(passive sensing)

Sea Surface
Temperature

Tropical cyclone
Prediction

UN SDGs



- to strengthen resilience to climate related hazards in vulnerable communities (SDG Target 1.5)
- to predict and assess risks related to disasters (SDG Targets 11.5 and 13.1)