



Committee on Earth Observation Satellites

# CEOS WildFire Pilot

de Jong, M. (**Presenting**)

Johnston, J. (**Project PI**)

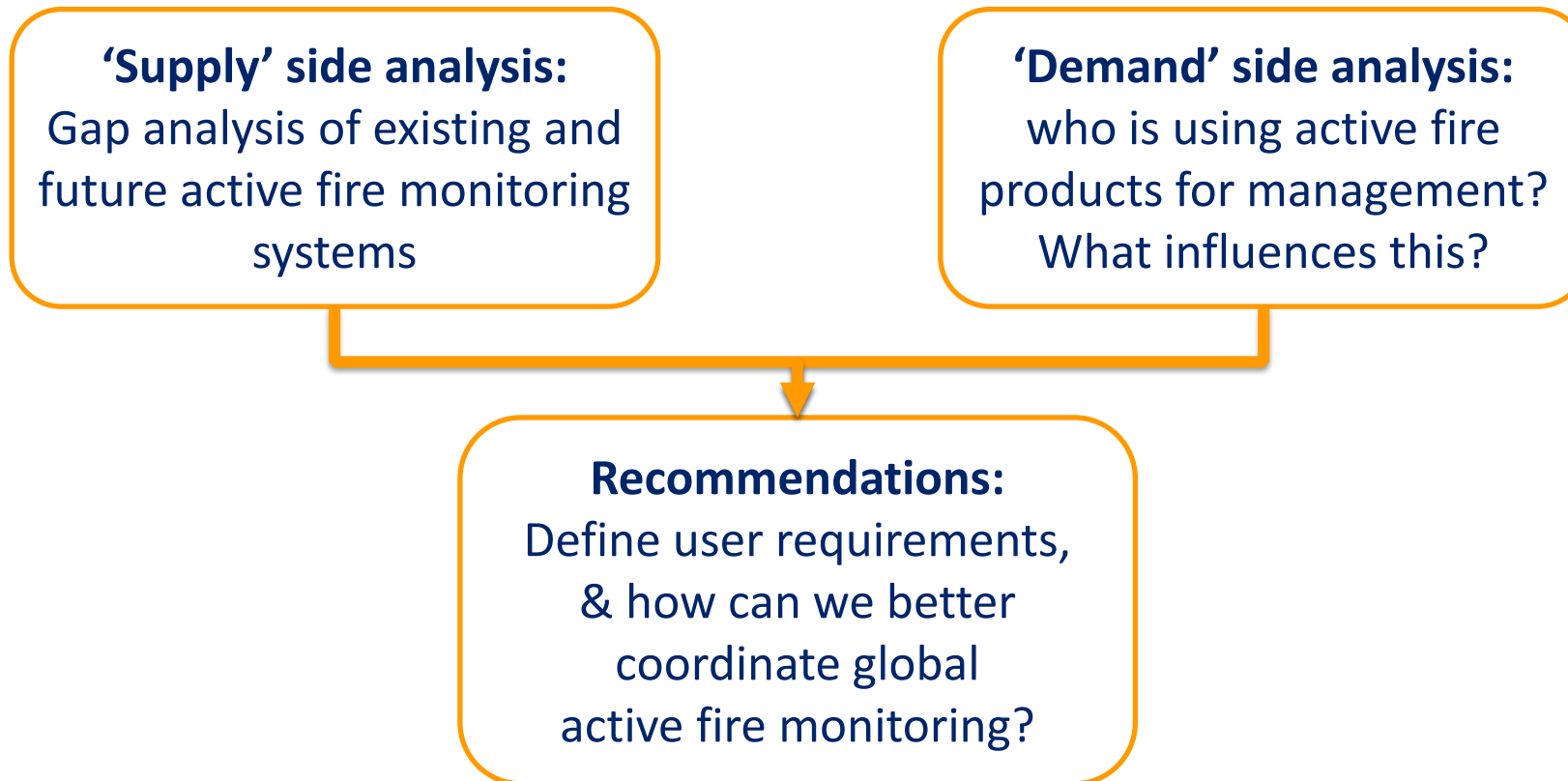
McFayden, C., Dufour, D., Moore, P., Morton, D., Crowley, M., Dobbin, J., Flannigan, M., Hope, E. Jain, P., Lynham, T., MacPherson, L., Patel, M., Turbelin, A., van Mierlo, H., Wang, X., Woolford, D., Yebra, M., Zhu, J.

GOFC-GOLD Fire-IT Meeting  
September 17-18<sup>th</sup>, 2024



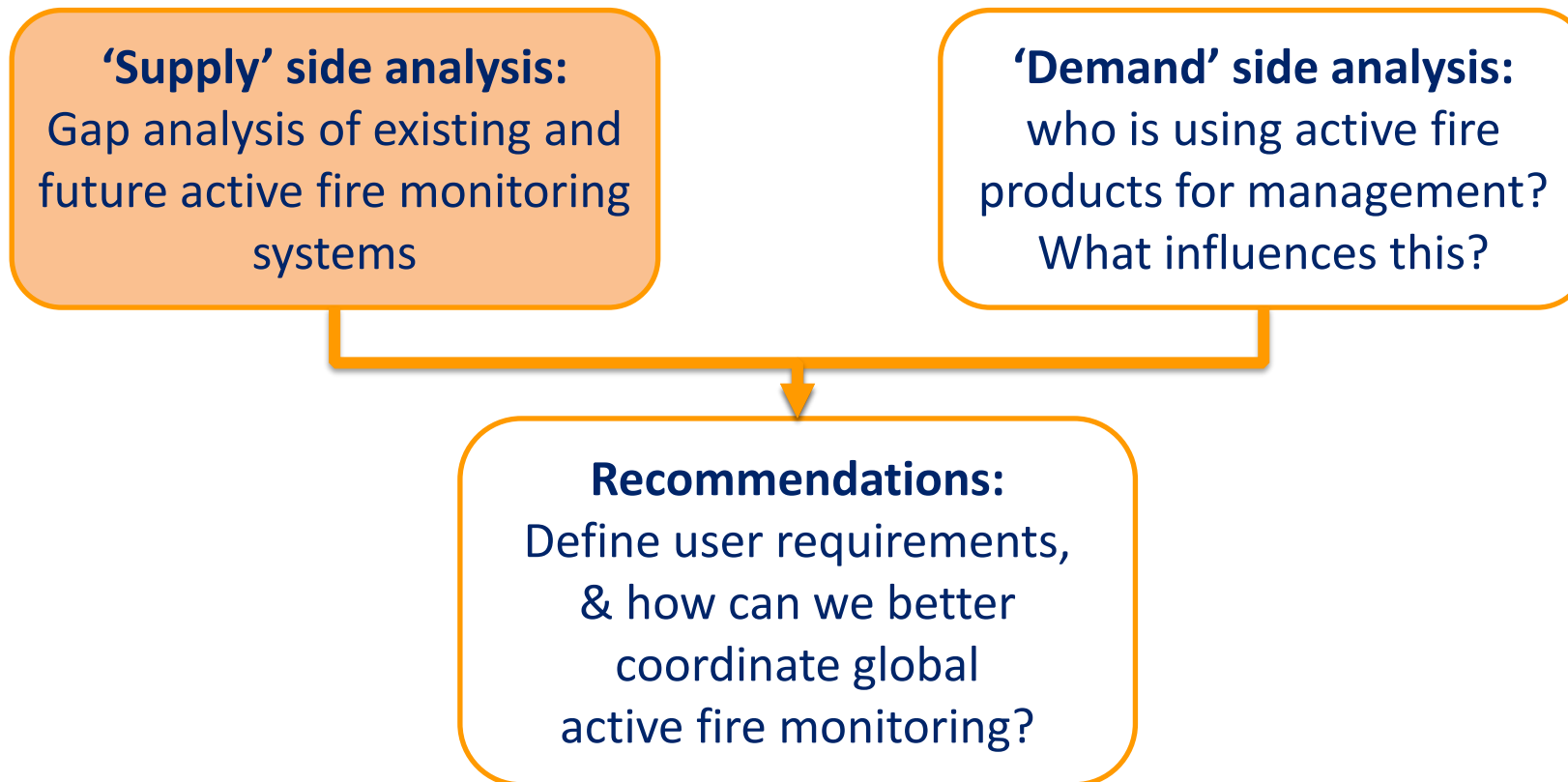


**Aim:** to provide a comprehensive gap analysis for active-fire earth observation





**Aim:** to provide a comprehensive gap analysis for active-fire earth observation



## CEOS Missions, Instruments, Measurements (MIM) Database

- all historic, current & planned missions for CEOS member space agencies, annual updates
  - 1970s-2040s period
  - >650 missions, ~950 instruments (~450 distinct)
- First pass, liberal** screening of all systems on orbit 2015-2045 that are **potentially useful** for fire detection or characterisation [ $N \sim 190$  unique systems]
  - Detection ('hotspot' mapping): **LWIR or MWIR or SWIR** [ $\geq 2.2\mu\text{m}$ ]
  - Characterisation (FRP, bispectral etc): **MWIR and LWIR**
- Second pass:** manual checking with e.g. space agency websites, EOPortal, WMO OSCAR
  - 119 unique systems (instrument/satellite combinations)
  - Types: SS-LEO=63, GEO=49, Other=7
- No private sector systems considered..
- Updated to reflect CEOS MIM Database in 2023

**CEOS** **esa** **THE CEOS DATABASE**  
Updated for 2022

Home Database Agencies EO Handbook Missions Activity Table Index Instruments Table Index Measurements Overview Timelines Datasets Activity ENHANCED BY Google

**MISSIONS, INSTRUMENTS, MEASUREMENTS and DATASETS**

Providing information on satellites based on an annual survey of CEOS member agencies.

Representing the only official consolidated statement of agency programmes and plans.

Providing a community focal point for the coordination of future planning, research and gap analyses, and providing an interface for the user community.

*More about the database...*

**Click here to read the CEOS Database Q1-2022 Activity Report**

**Agencies** Agency table with links to agency summary pages.

**Missions** **Activity** View recent satellite launch activity.  
**Table** Searchable mission table with links to mission and instrument summary pages.  
**Index** An alphabetical list with links to mission summary pages.

**Instruments** **Table** Searchable instrument table with links to instrument and mission summary pages.  
**Index** An alphabetical list with links to instrument summary pages.

**Measurements** **Overview** An overview of the measurement categories and detailed measurements indexed in the database.  
**Timelines** Customizable measurement timelines with links to mission summary pages.

**Datasets** **Activity** Checkout datasets and recent data releases and activity.

**Follow us @EOHandbook**

esa cryosat mission @esa\_cryosat

CRYO2ICE user update: #CryoSat-2 Predict Tracks product updated for newly released drift phase towards Antarctic alignment (impe June to 30th October 2022) @NASA\_ICE @earth\_wave

cs2eo.org/releases

**CRYO2ICE user update**

CryoSat-2 Predicted Ground Tracks product updated for newly released CRYO2ICE drift phase towards Antarctic alignment: visit cs2eo.org/releases

#CryoSat

ESA EarthObservation Retweeted ICEVE

Copyright 2022 CEOS | About | Site Search | Report an Issue Researched and written by Syr

CEOS MIM database:

<http://database.eohandbook.com/>



# Modelling Scenarios



- **Four scenarios** representing different combinations of:
  - (1) **Type** of fire information (*detection vs. characterisation*)
  - (2) fire product **data availability** – *open, transparent?*

Scenario	Satellite systems 'All' or 'characterization'?	Space agencies 'All' or 'FIRMS/GWIS' agencies?	Description
A – 'BaU'	All missions capable of hotspots	FIRMS/GWIS	<ul style="list-style-type: none"> <li>• Basic fire applications (detection/hotspots)</li> <li>• current international cooperation levels</li> </ul>
B	Only missions capable of characterization	FIRMS/GWIS	<ul style="list-style-type: none"> <li>• Advanced fire applications (FRP, size, etc)</li> <li>• current international cooperation levels</li> </ul>
C	Only missions capable of characterization	All	<ul style="list-style-type: none"> <li>• Advanced fire applications (FRP, size, etc)</li> <li>• broad international cooperation levels</li> </ul>
D	All missions capable of hotspots	All	<ul style="list-style-type: none"> <li>• Basic fire applications (detection/hotspots),</li> <li>• broad international cooperation levels</li> </ul>

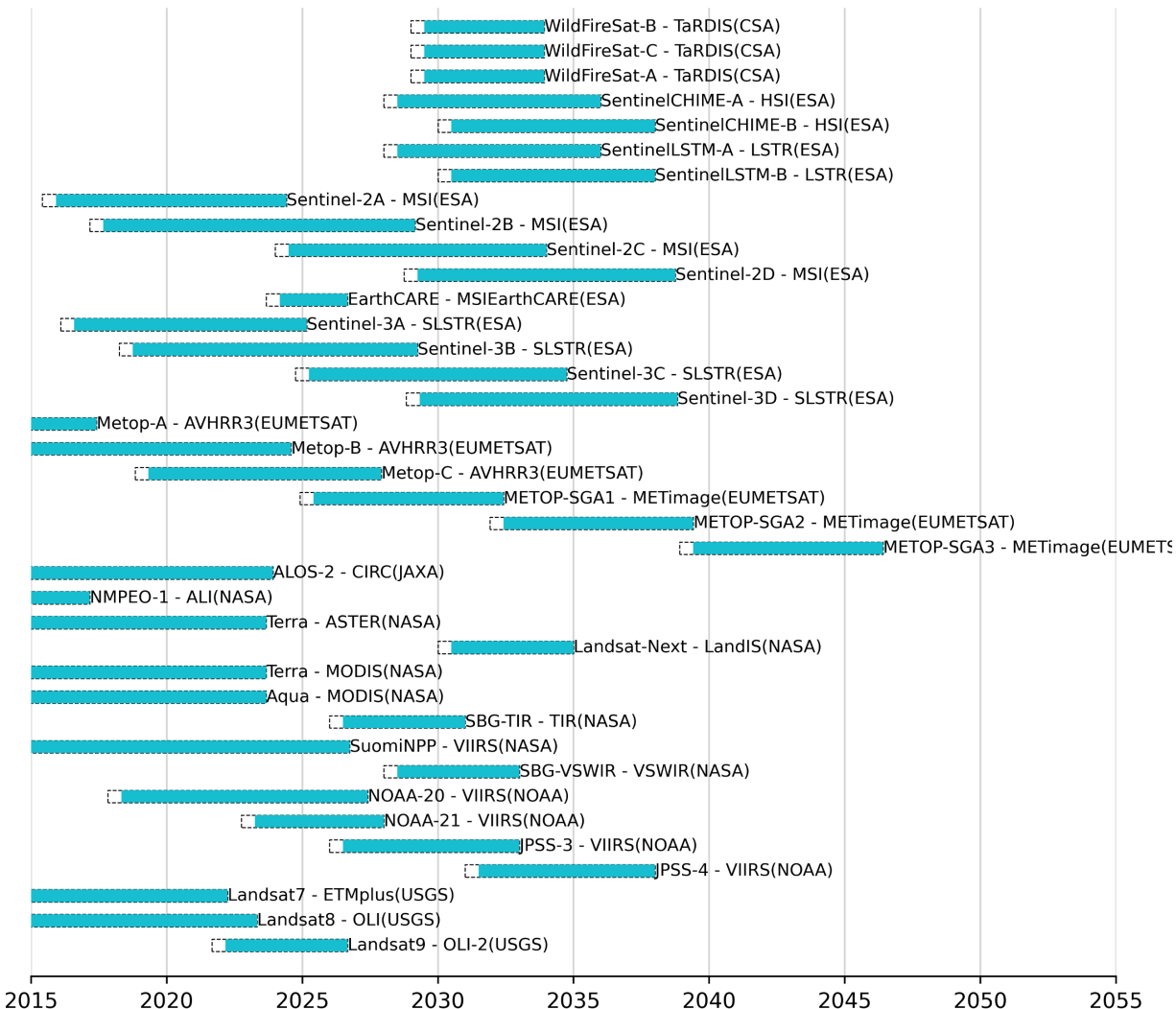
**Anticipated worst coverage**

**Anticipated best coverage**





Scenario A



- FIRM/GWIS affiliated agencies

### Scenario A

Fire hotspot detection

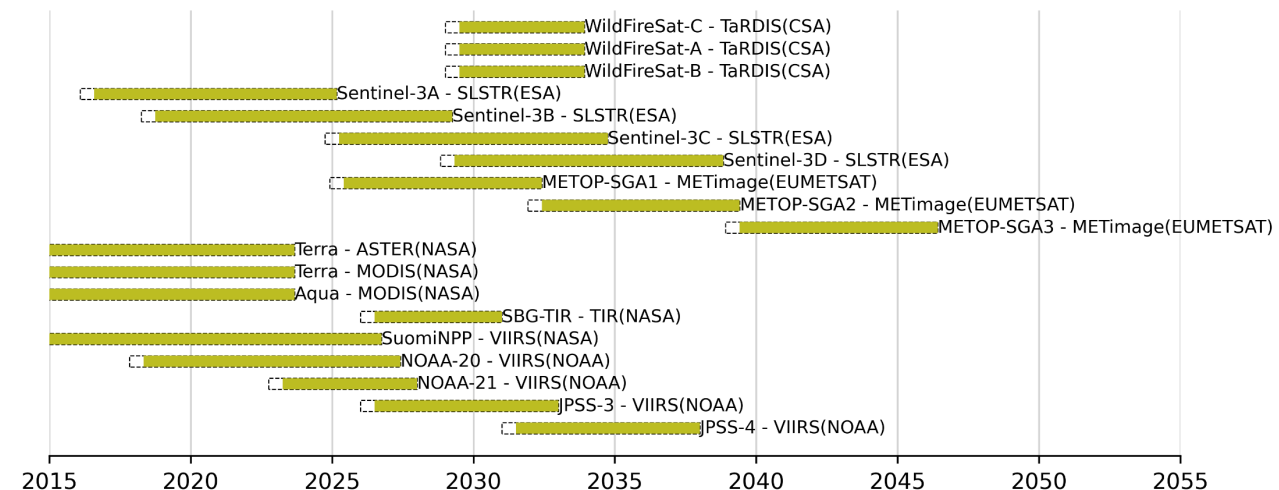
- I.e., SWIR [ $\geq 2.2\mu\text{m}$ ] or MWIR or LWIR

### Scenario B

Fire detection and characterization

- I.e., MWIR and LWIR

Scenario B





# LEO Scenarios C & D

- All agencies

## Scenario C

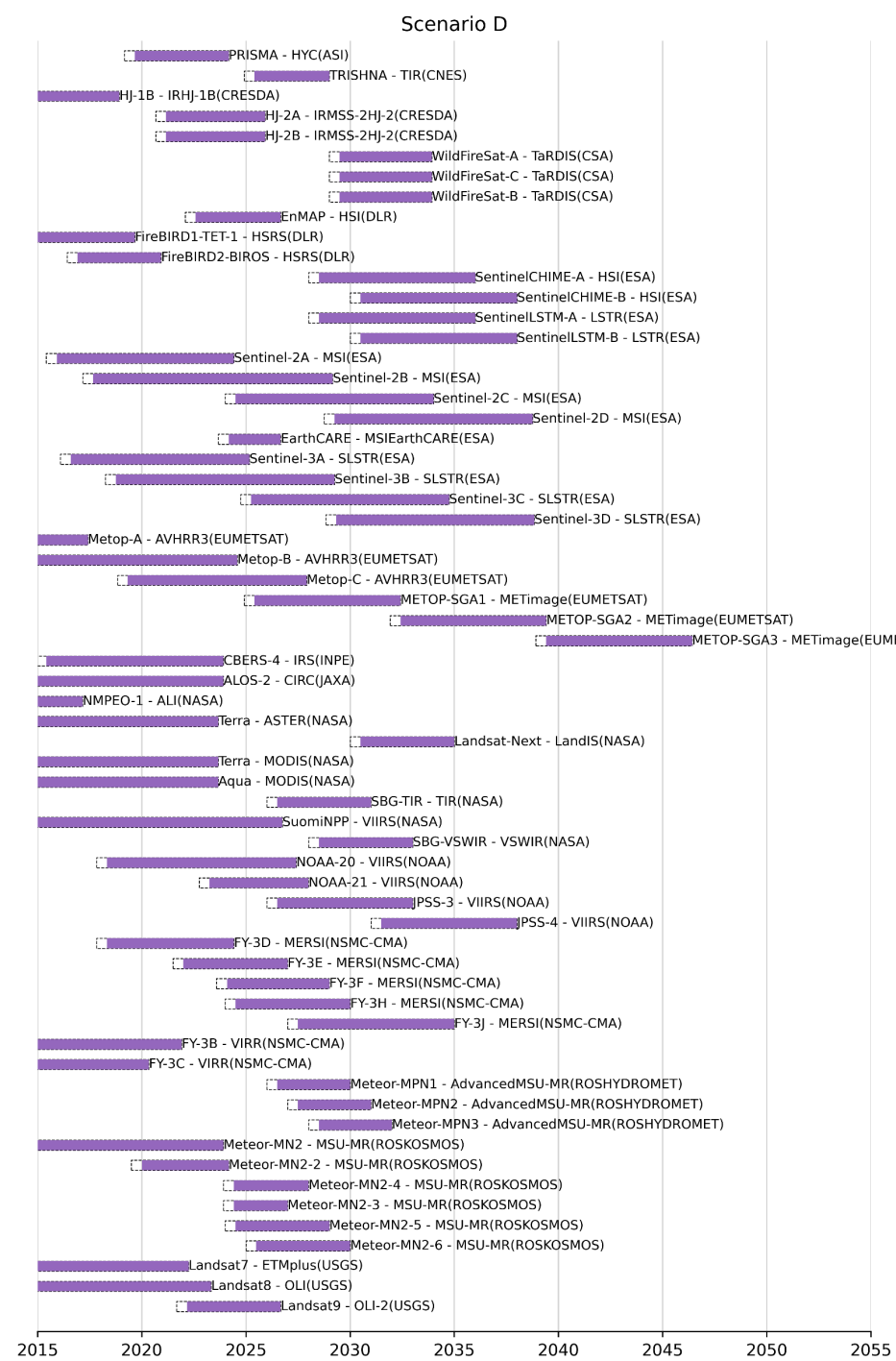
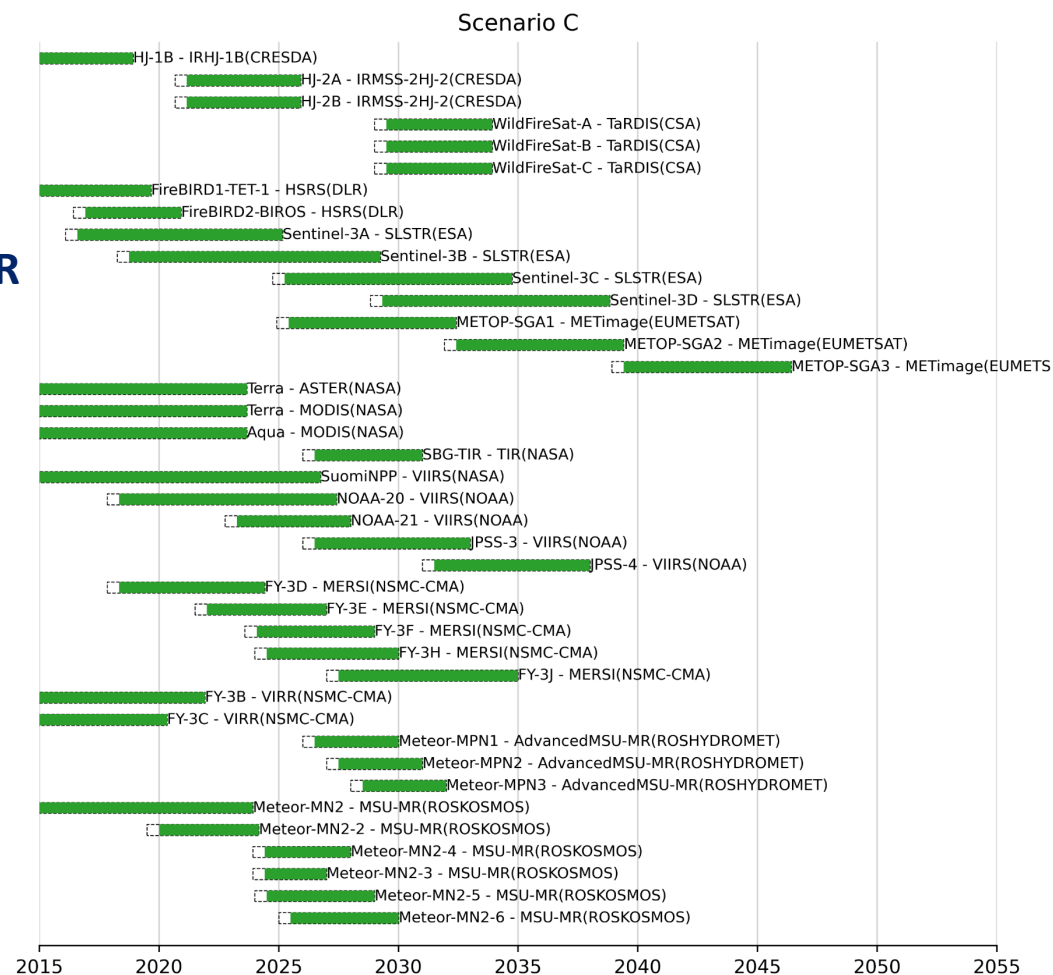
Fire detection and characterization

- I.e., MWIR *and* LWIR

## Scenario D

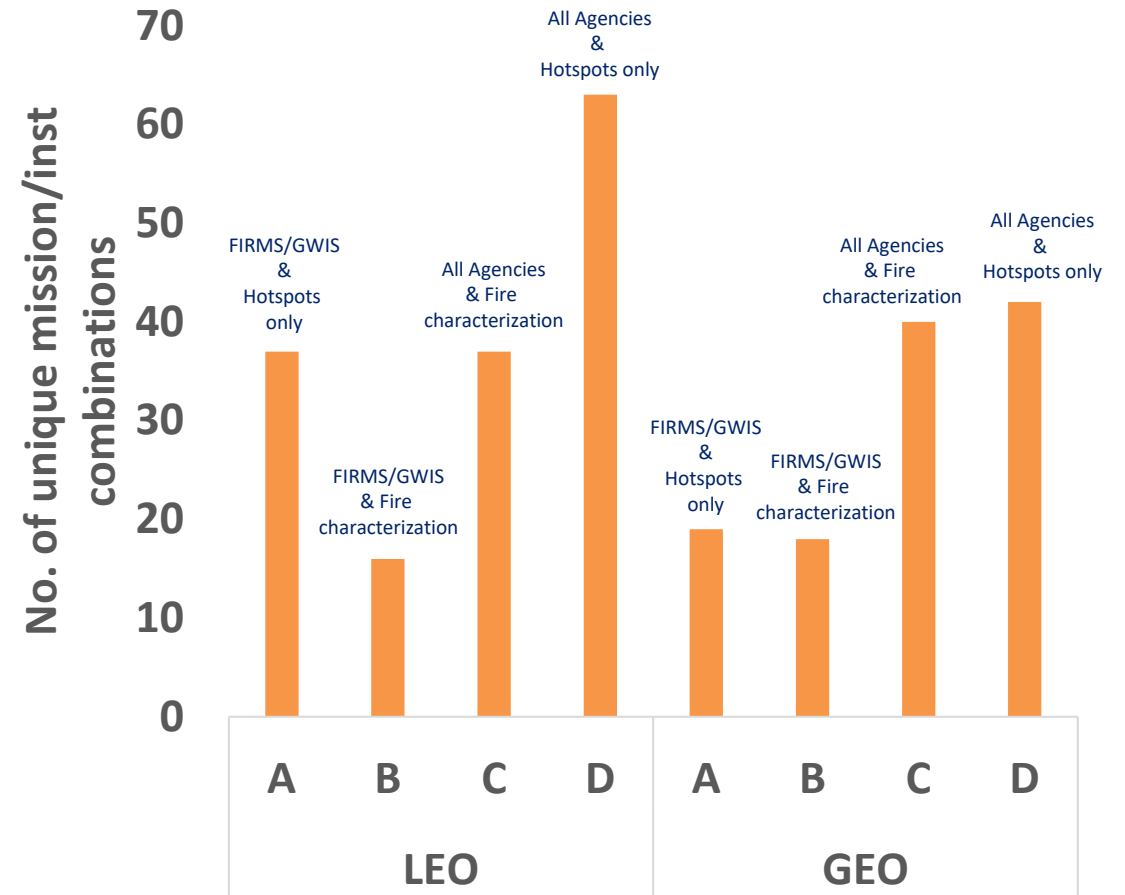
Fire hotspot detection

- I.e., SWIR  $\geq 2.2\mu\text{m}$   
or MWIR or LWIR



In terms of **raw numbers** of AF capable EO missions:

- FIRMS/GWIS capability **only represents approx. half of global capability**, both for LEO and GEO (*cf. Scenarios A and D*)
- For LEO, **few missions** are capable of **fire characterization**. Making **all agency missions easily available** would more than **double** this
  - (*cf. Scenarios LEO B and C*)
- **Conclusion: better global cooperation** would **vastly improve** active fire monitoring, **without committing to any new missions** beyond already on orbit/planned







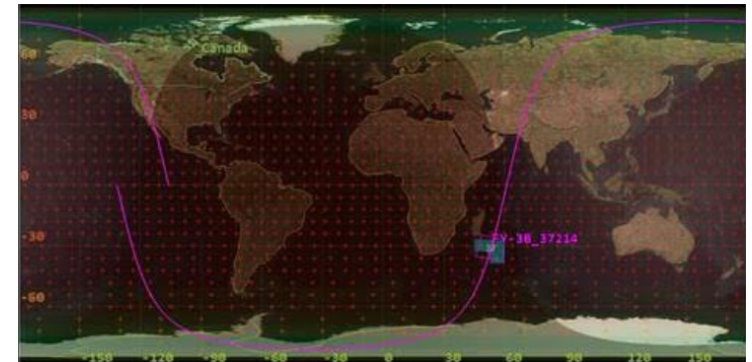
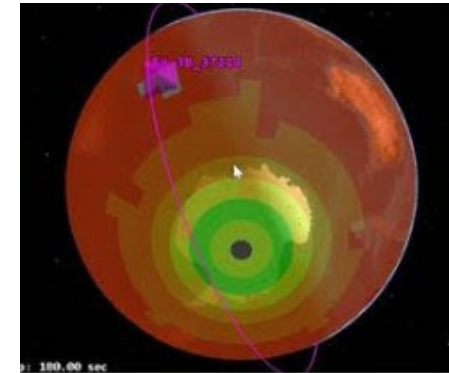
## Research Question 1: How does global future EO *active fire* monitoring *capacity change*?

### 1) Revisit time analysis

- **Aim:** what is the revisit time for satellites capable of fire monitoring in different locations? How does it change over time?
  - i.e. how long do fire managers have to wait for satellite observations, in average and worst-case scenarios?

### 2) Coverage density analysis

- **Aim:** How does the average daily number of observations (weighted by  $GSD^2$ ) change spatially, and over time?
  - sensors with higher spatial resolution (lower GSD) are weighted higher due to providing more observations per unit area
- **LEO STK modelling complete, data analysis nearly complete**
- **GEO modelling to do**



STK modelling of FY-3B overpasses



## Mean revisit time (2015 to >2035)

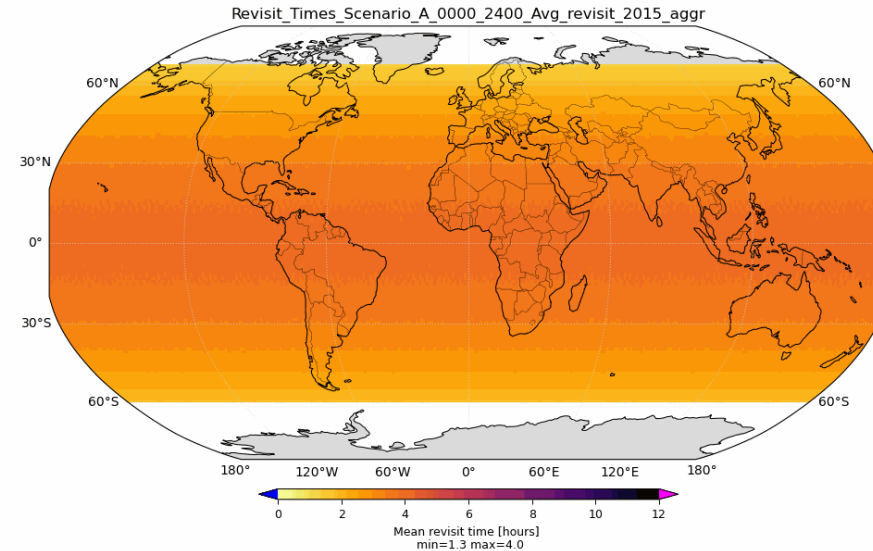
### Poorer coverage:

- for **characterization** vs. detection only
- in **(sub)tropics**
- in **later years** (fewer missions planned yet)

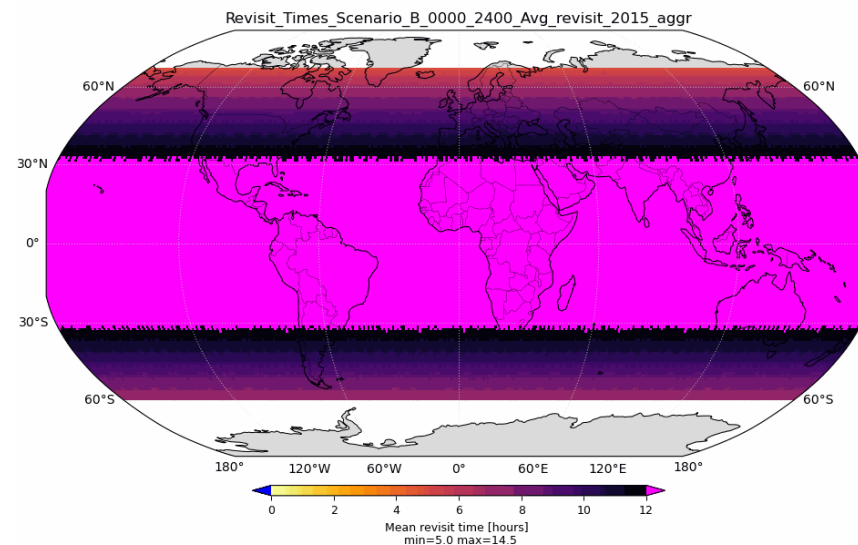
- Scen. A global range: 1-5h
- Scen. B global range: 2.4-20h

### Note:

*Coverage density analysis will likely show improving coverage over time*



**Scenario A:**  
FIRMS agencies,  
detection only



**Scenario B:**  
FIRMS agencies,  
detection & characterization



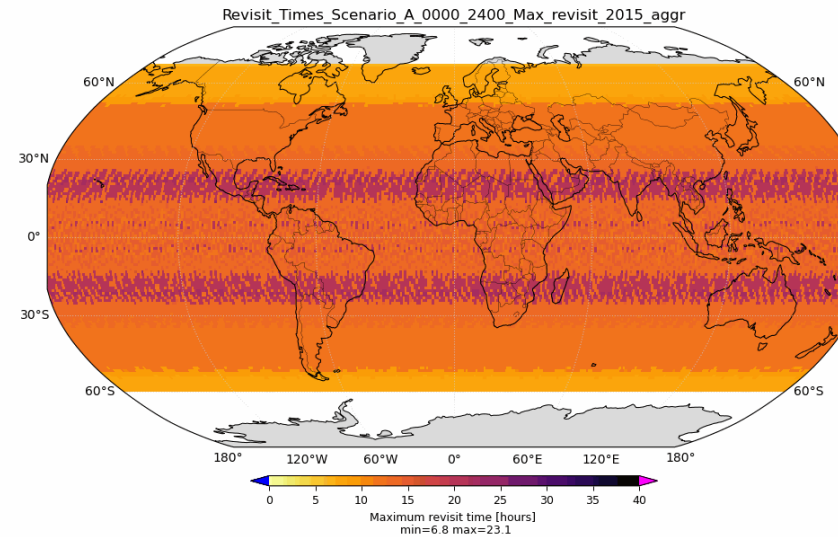
## Maximum revisit time (2015 to >2035)

### Poorer coverage:

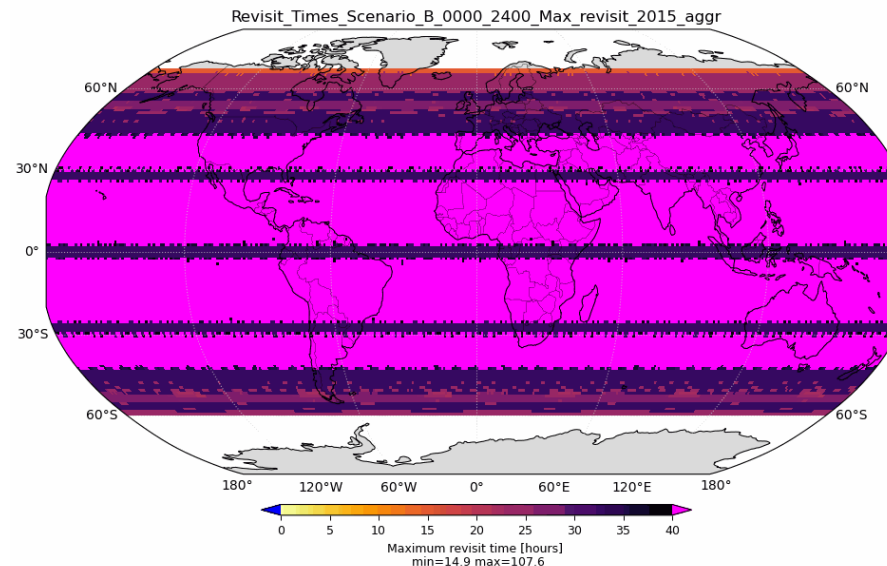
- for **characterization** vs. detection only
  - in **(sub)tropics**
  - in **later years** (fewer missions planned yet)
- 
- Scen. A global range: 3.7 - 48h
  - Scen. B global range: 6 - >100h

### Note:

*Coverage density analysis will likely show improving coverage over time*



**Scenario A:**  
FIRMS agencies,  
detection only



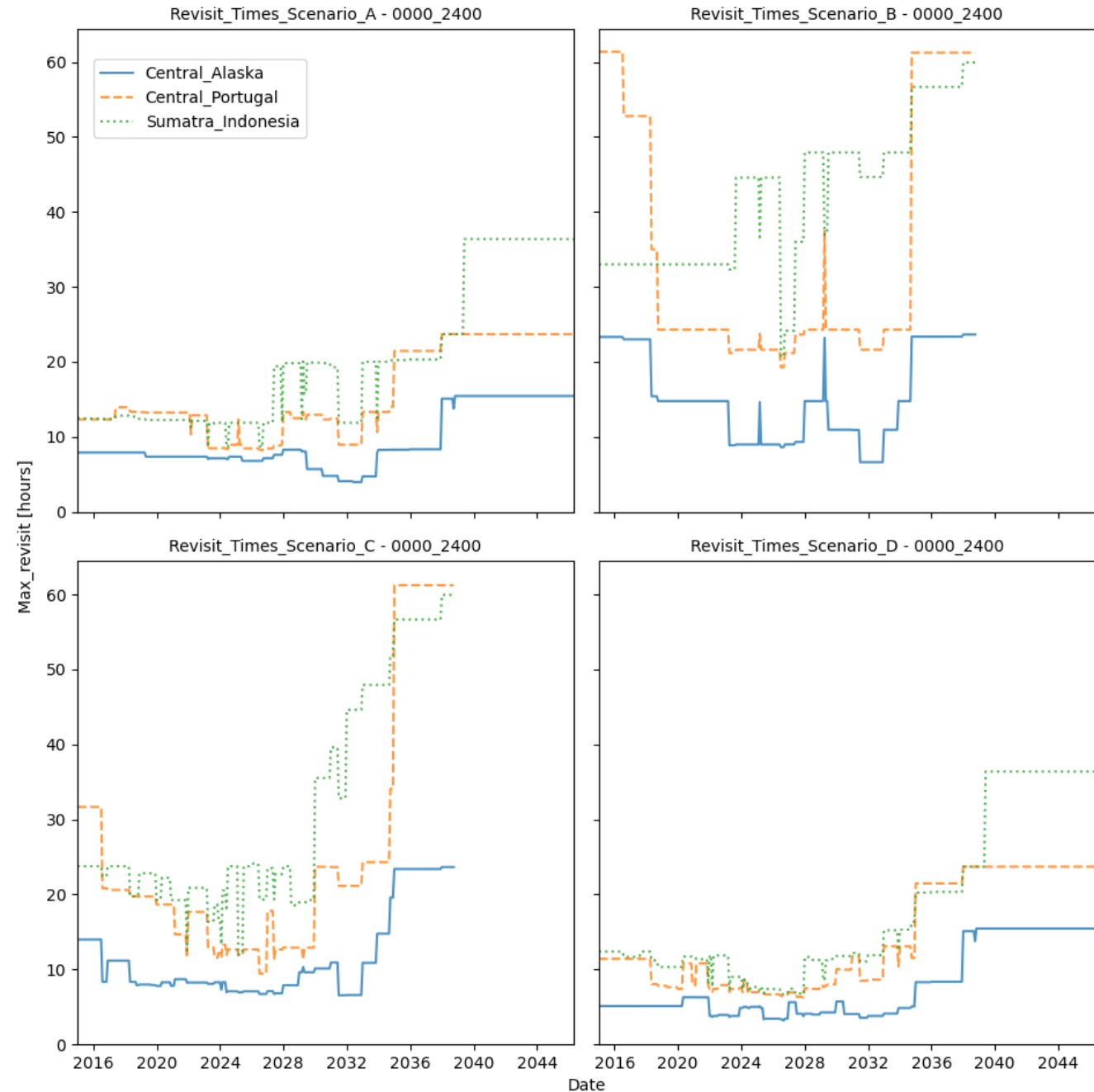
**Scenario B:**  
FIRMS agencies,  
detection & characterization



# LEO revisit time

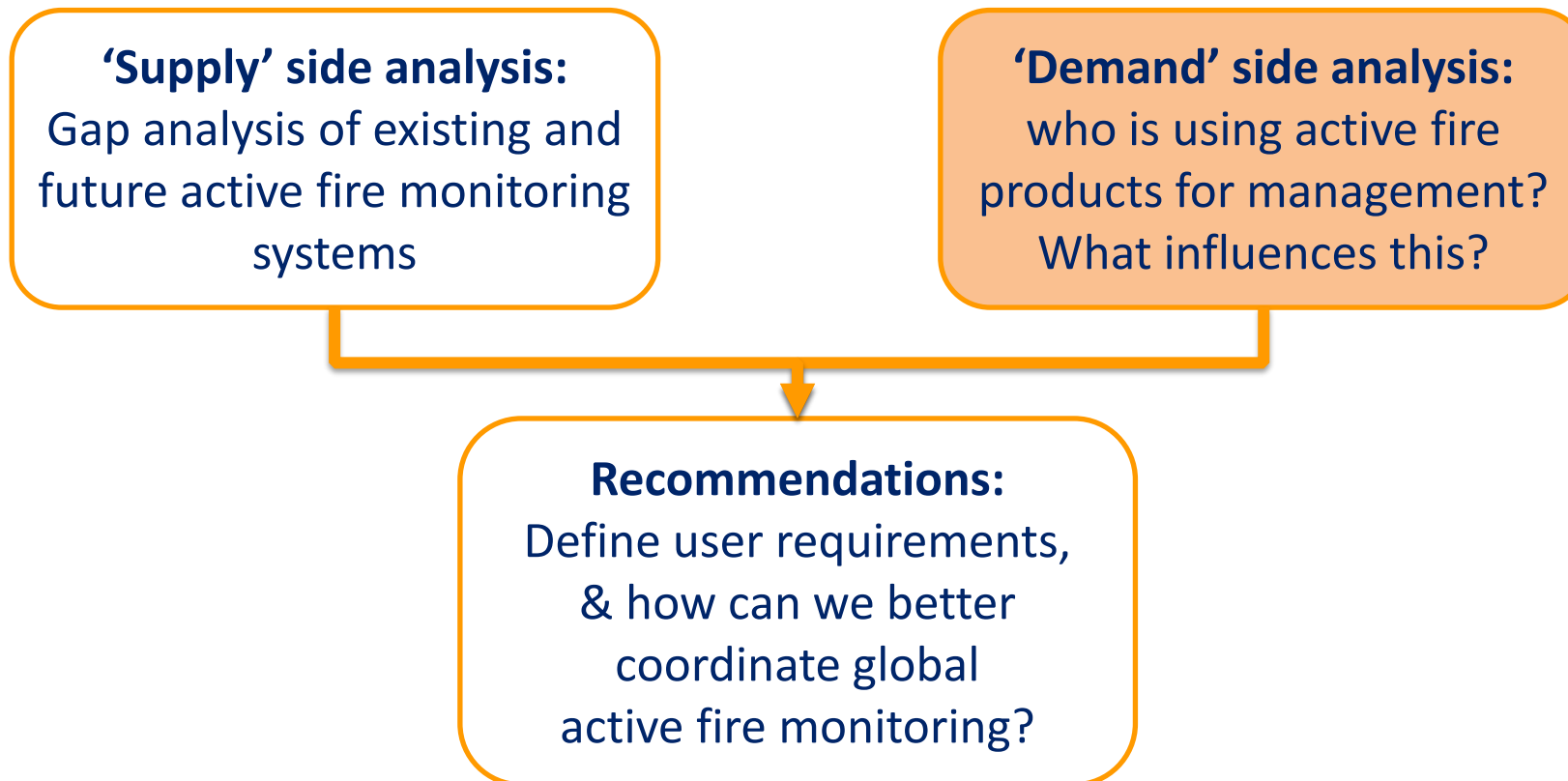
## Maximum revisit time

- Lower values = better
- **More variable** than mean revisit time
- **critical for fire management** – reflects the ‘**worst case scenario**’ for data availability
- Has **implications for operational users** relating to **reliability** and **trust**





**Aim:** to provide a comprehensive gap analysis for active-fire earth observation





# Approach overview: summary & goals

Investigating **capacity** of **end users** at country/regional levels through three complementary approaches:

## Measuring historic use of active fire products:

FIRMS/GWIS/EFFIS web traffic.

Who, where, when, how much use?

What drives use?

**(Hope et al., *in review*)**

## Global end user survey:

How is AF data used for by managers?

Barriers to use?

## Bibliometric analysis:

Where is research being done?

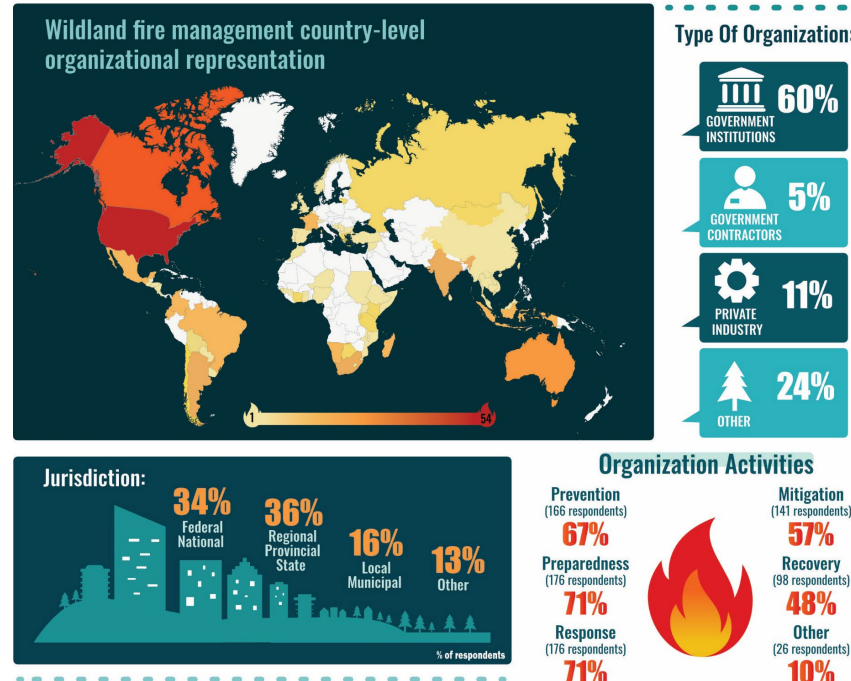
How involved are local stakeholders and operational users?

# Global end-user survey

- Surveyed 'fire managers' around the world (**247 respondents**)
  - GOFC-GOLD networks
  - FIRMS mailing list
  - Personal networks
- Widespread operational use (87%)**
- High trust (73 %)**
- Many (37 %) recent **new users (<1.5 years)**

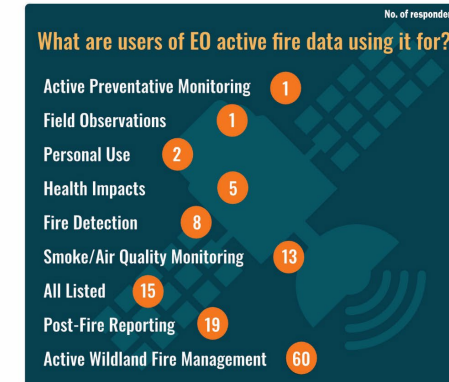
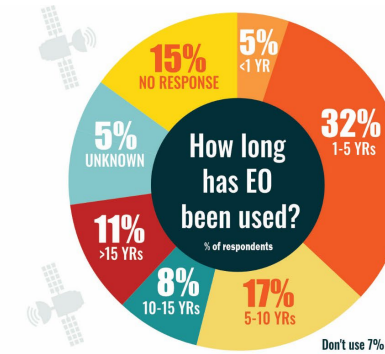
## ATTRIBUTES OF WILDLAND FIRE MANAGEMENT ORGANIZATIONS & END USERS

247 RESPONDENTS

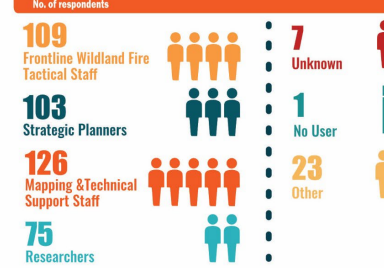


### HOW MANY RESPONDENTS USE SATELLITE OBSERVATION DATA?

**87%**  
216 RESPONDENTS



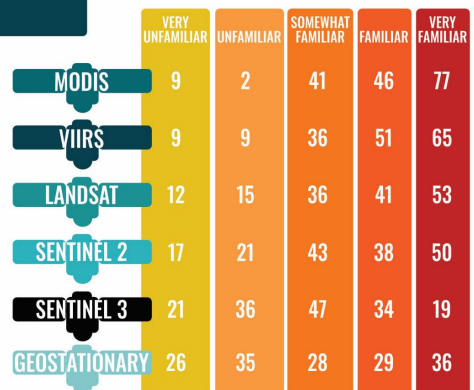
### Who are the users of EO active fire data?



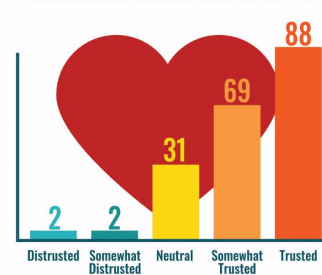
### TYPES OF EO DATA



### FAMILIARITY WITH EO PLATFORMS

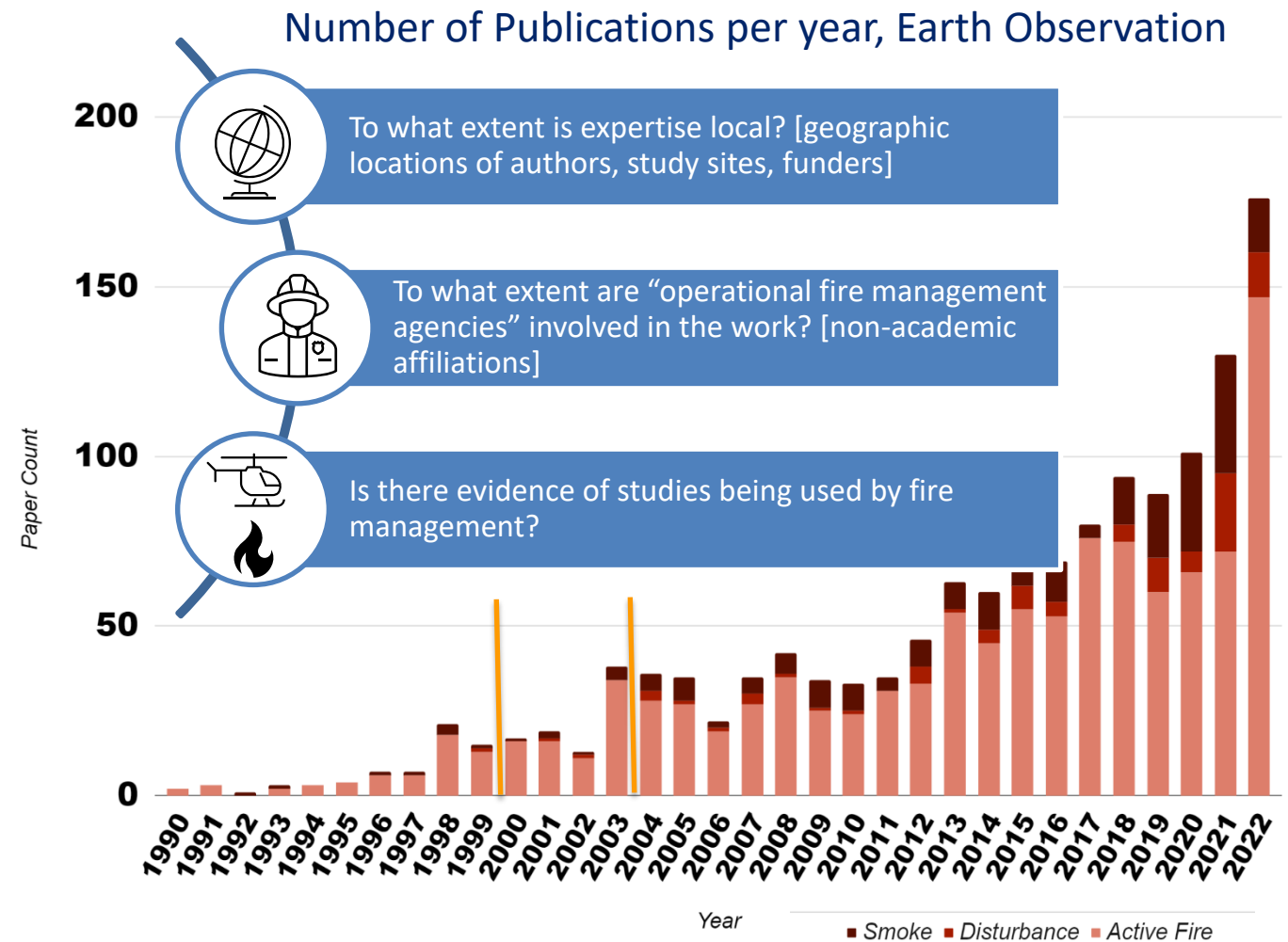


### ORGANIZATIONAL TRUST OF EO



# Knowledge production & availability

- **Bibliometric analysis** of academic studies to geographically assess levels of ‘scientific expertise’.
- **First pass:** >7,250 publications meet our filter criteria.
- **Second pass:** 1,425 publications using EO for “active fire”; focuses categorized as active fire; disturbance; or smoke
- **Third pass:** Classify/characterize papers
- **Next steps:** Normalizing results to country level to support further analyses





# Conclusions



- **High use** of EO active fire systems into operational fire management workflows around the world, with **rapidly increasing uptake**
- Improved (and even business as usual) globally coverage with **open, transparently produced, validated** data products is **not guaranteed** going forward
- Better **coordination** and **interoperability** of **existing and future missions** could help
- Working on recommendations to CEOS in the next year. Intent to propose an **active fire focussed group** (CEOS hosted?) to **bridge this gap** between space agencies, product developers, and fire managers.
- Next steps: Wildfire Pilot 2 on **prefire** conditions lead by **Marta Yebra**