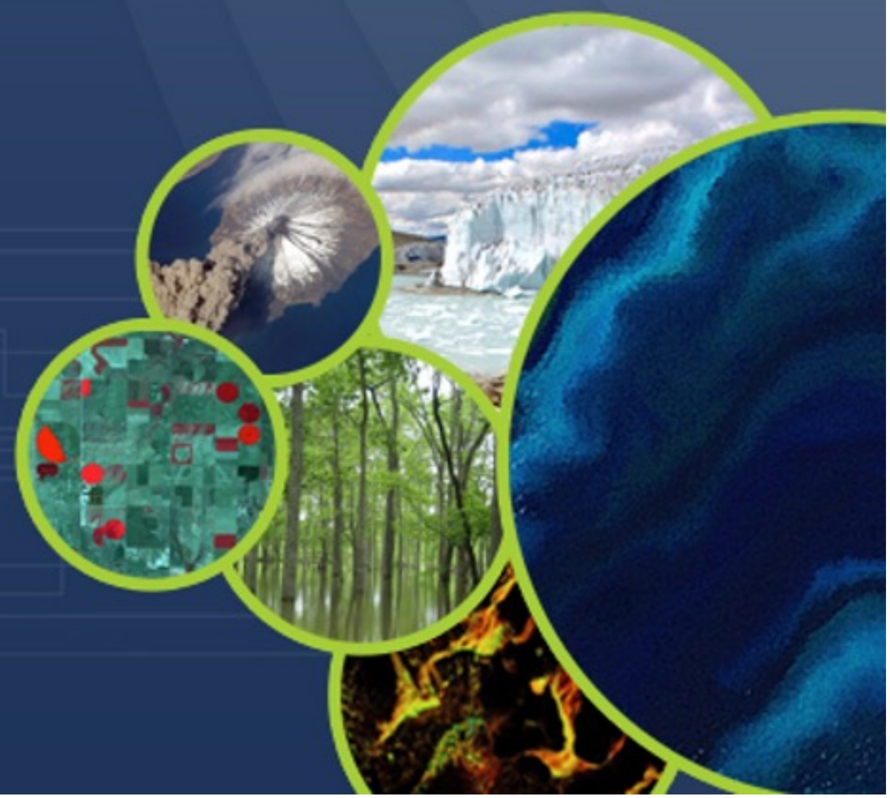
CEOS
Committee on Earth Observation Satellites

WildFire Pilot



Joshua Johnston, NRCan
Mark de Jong, NRCan
Denis Dufour, CSA
Peter Moore, UN FAO
Doug Morton, NASA
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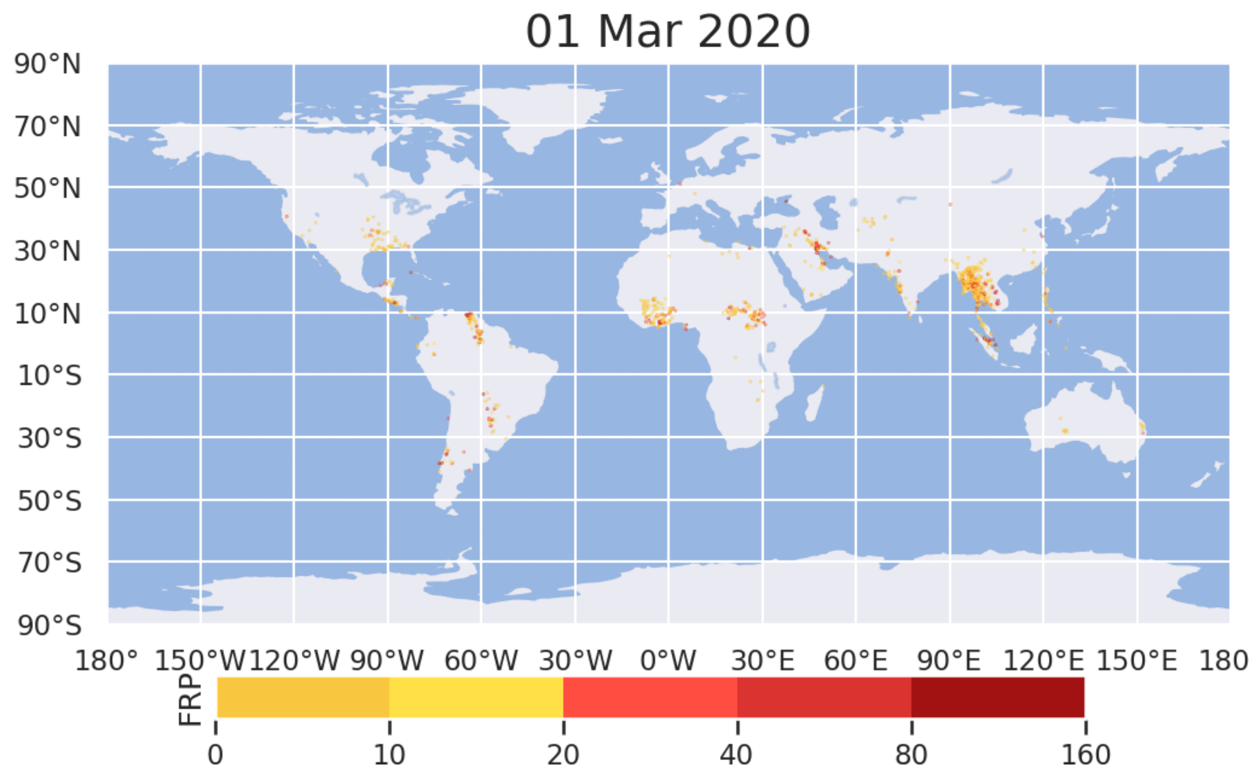
CEOS WG Disasters Meeting #18
October 4, 2022

Fire on Earth

Fire is an integral component of the Earth system with local to global scale impacts

Fire on Earth

- Globally, an area approximately the size of India burns each year (~348MHa; Giglio *et al.,* 2016)



Weekly Global fires and FRP from Sentinel-3A SLSTR (Mar 2020 – Feb 2021). Provided by Weidong Xu, King's College London

EO Remote Sensing for Fire

Remote sensing has applications before, during, and post fire

Pre-fire

Long term (months-years)

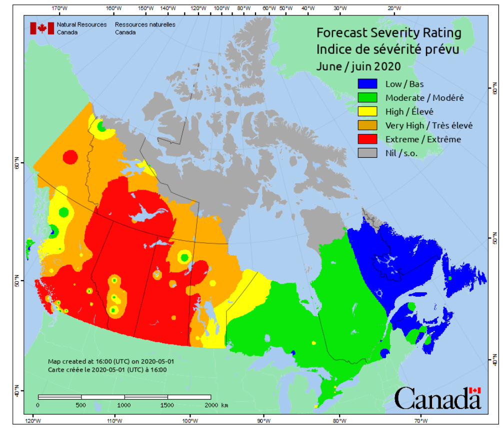
- Vegetation and soil/peat (fuel) mapping – optical (Wang et al., 2019), LiDAR (Lim *et al.,* 2003), radar (Poggio *et al.* 2019)
- SST data informs seasonal fire severity prediction e.g. Chen *et al.* (2016), CWFIS forecasts

Short term (~days)

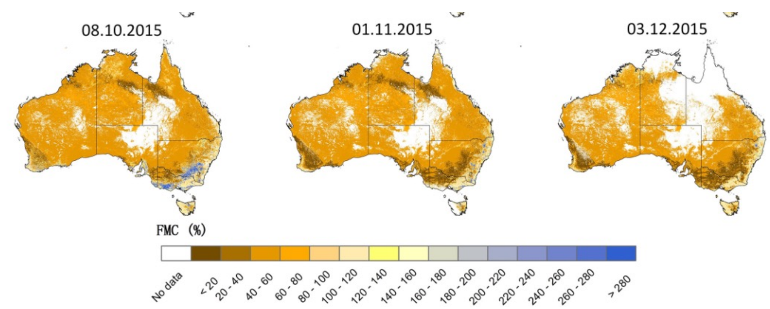
- Assessing fuel state e.g. optical methods for vegetation curing (Yebra *et al*., 2018), passive microwave estimates of ground fuel moisture (Varotsos *et al. 2020*)

Example applications:

Fire management policy, WUI development plans, fuel load reduction, fire agency resource allocation/staffing, fire bans



Monthly forecast fire severity rating for Canada in June 2020 https://cwfis.cfs.nrcan.gc.ca/



Live fuel moisture content changes in Australia, 2015 (Yebra et al 2018)

EO Remote Sensing for Fire

Remote sensing has applications before, during, and post fire

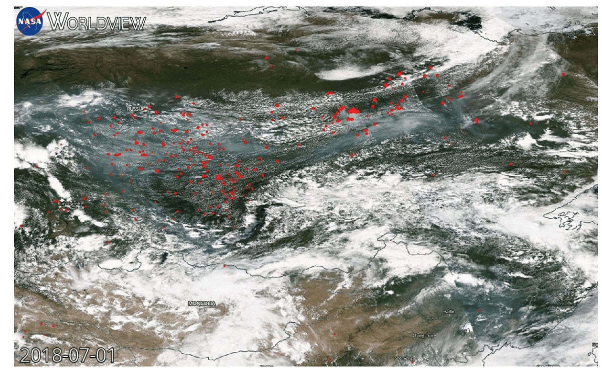
During fire (typically using MWIR & LWIR)

- Fire detection (‘hotspots’) , monitoring, and characterisation (e.g. energy release from Fire Radiative Power [FRP]) (Wooster *et al.,* 2021)

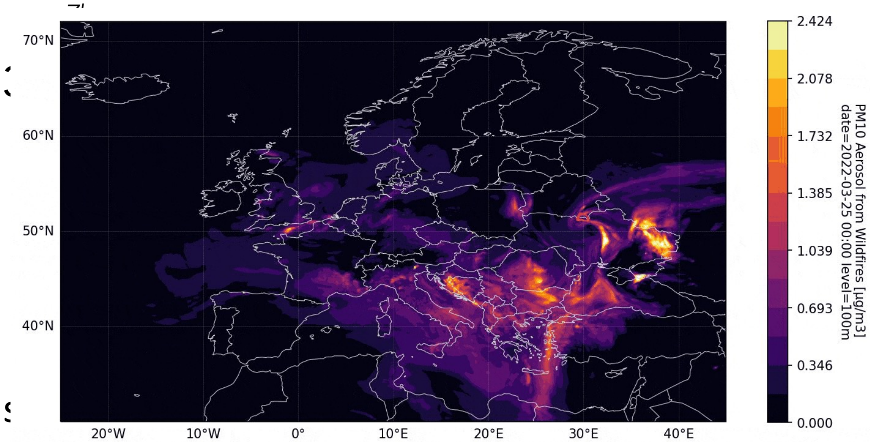
- Fire behaviour
  - Operational tracking fire fronts of individual fires
  - fire intensity and rate of spread(e.g. Paugam *et al.* 201 Johnston *et al.* 2017)

- NRT smoke and air quality forecasting using hotspots/FRP
  - USA/Canada (Larkin *et al.*, 2009; Chen *et al.*, 2019)
  - EU Copernicus CAMS-GFAS (GFAS; Kaiser *et al.* 2013)

Example Applications: strategic and tactical fire fighting decision emergency management response (e.g. community evacuations)



Siberia, 2018. MODIS active fires overlaying a true colour composite, with clearly visible smoke plumes. Provided by Tianran



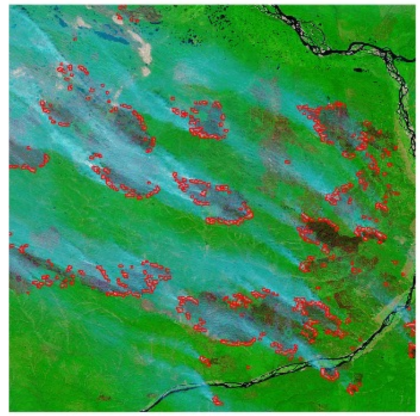
Atmospheric concentration of PM10 from wildfires, March 2022 (data from GFAS CAMS)

EO Remote Sensing for Fire

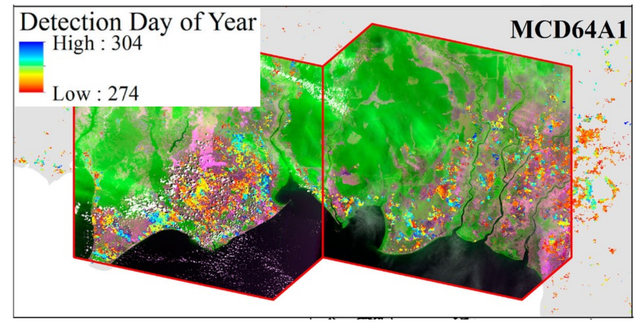
Remote sensing has applications before, during, and post fire

Post-fire

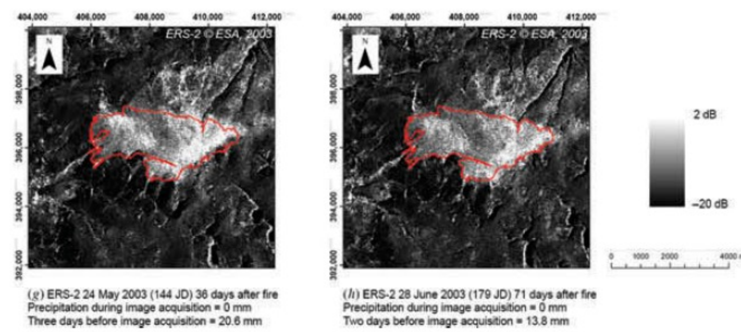
- VIS/NIR/SWIR mapping of fire burned areas (e.g. Coops *et al*., 2018; Giglio *et al.* 2013)
- Greenhouse Gas emissions reporting at national/global scale from e.g. GFED burned area maps (van der Werf *et al.*, 2017)
- Fire severity assessment and fuel consumption using SAR (Millin-Chalabi *et al.*, 2013), LiDAR & photogrammetry (Simpson *et al.*, 2016)



Fire burn scars (black) overlain with hotspot data (red) in MODIS imagery, Russia 2002 (Giglio et al 2006)



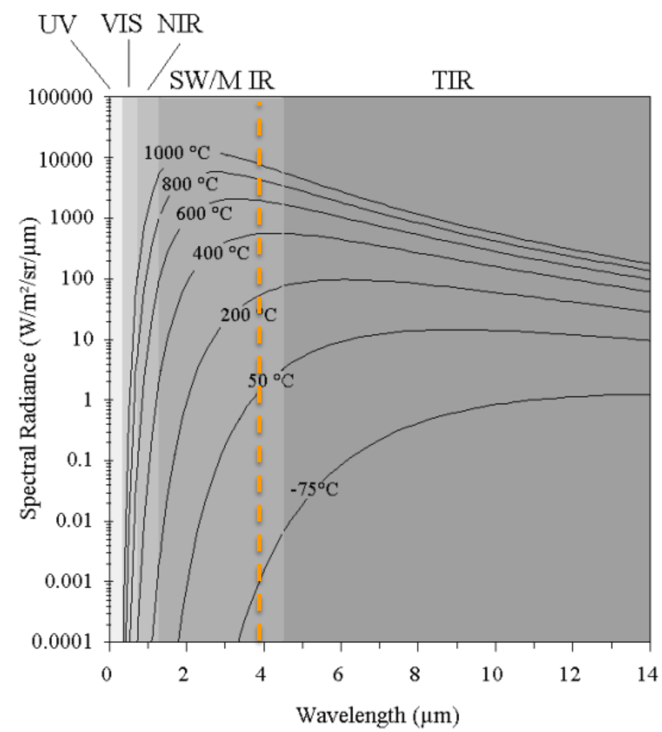
MODIS MCD64A1 burned area product with estimated day of burn, Indonesia, Nov 2006 (Humber et al 2019)



Mapping a burn scar with SAR intensity images, Bleaklow, UK, 18/04/2003 (Millin-Chalabi et al., 2013)

Active fire detection - basics

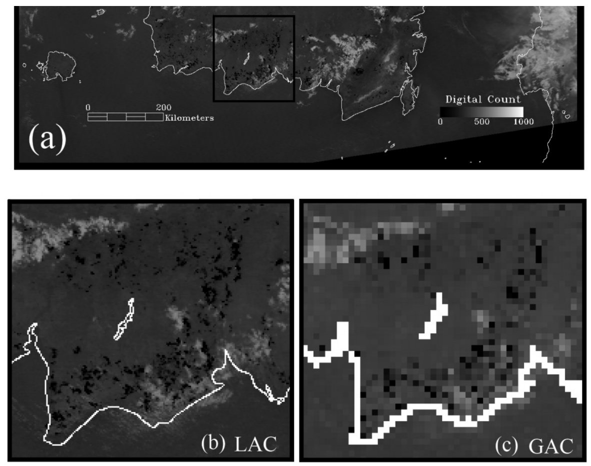
- Hot objects emit much more radiant energy than cooler objects in the MIR
- Fires (600-1000 K) are easily identifiable against ambient temperature background (300 K), so can detect extremely subpixel (< 0.1 % pixel area) fire events
- Detection and monitoring feasible with relatively coarse resolution instruments (e.g. AVHRR, MODIS, GOES 13-17)



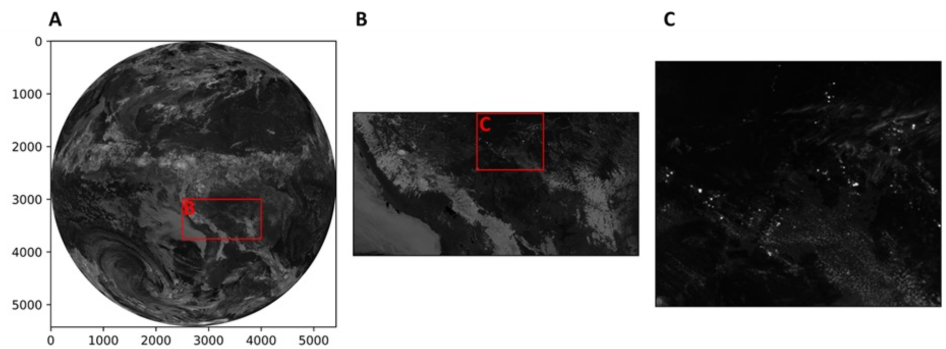
Planck spectral radiances for a range of temperatures (Wooster & Rothery, 2000)

Active fire detection - basics

- Long history of active fire EO (e.g. AVHRR, Flannigan & Vonder Harr, 1986)
- Active fire hotspot sensor requirements:
  - MWIR band ~3.9μm
  - LWIR band ~11-12μm
  - VNIR bands aid cloud screening
- FRP calculation:
  - wide dynamic range with high saturation points
- Operational active fire hotspot (and/or FRP) products from:
  - LEO: MODIS, VIIRS, SLSTR
  - GEO: SEVIRI, GOES, Himawari



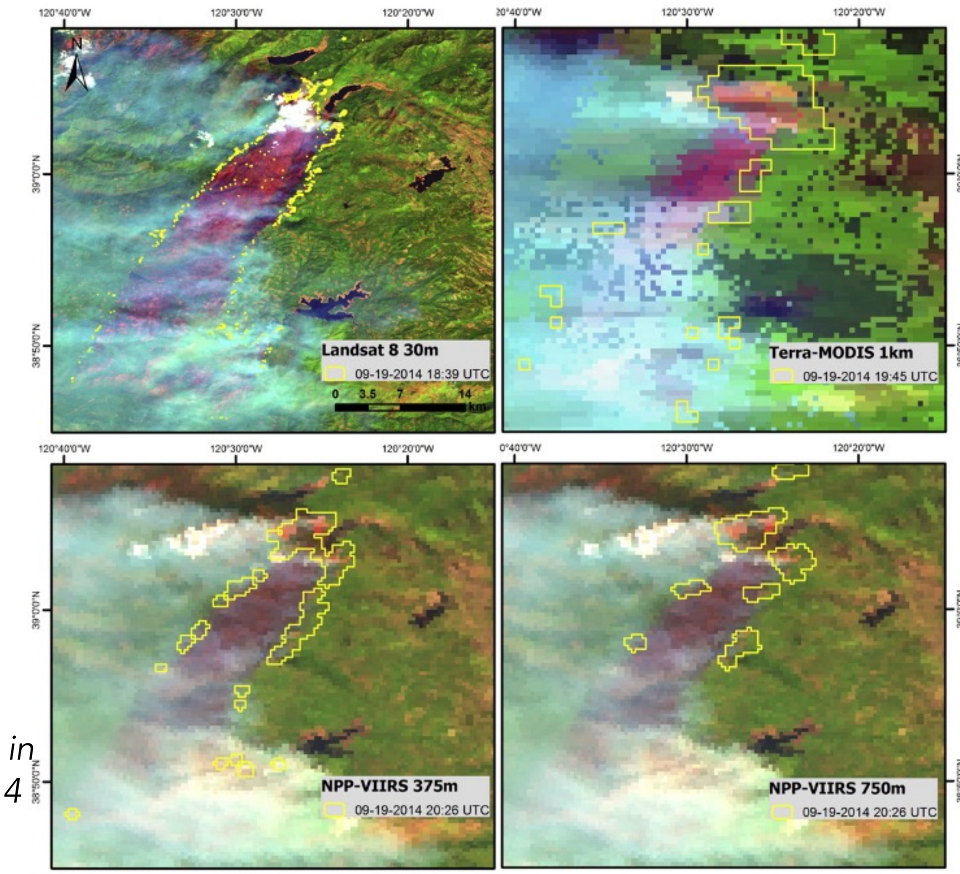
*AVHRR LAC **(A & B)** and GAC **(C)** imagery, Borneo, Oct 1997. Black pixels contain actively burning fires. (Wooster et al., 2012)*



*A GOES-16 ABI full disk image **(A)** and spatial subsets **(B and C)** at 17:20 UTC on 13 Aug 2019. Depicted is the difference between the middle wavelength infrared (MWIR) and long wavelength infrared (LWIR) brightness temperatures, where fire-affected pixels show a strong signal. In this example, locations hosting fires appear as bright white 'clusters' of pixels that are clearly visible in*

Active fire detection - basics

- VIS/NIR/SWIR can also be used to detect fire hotspots e.g. Landsat OLI (Schroeder *et al.*, 2016)
- But operational processing is less common

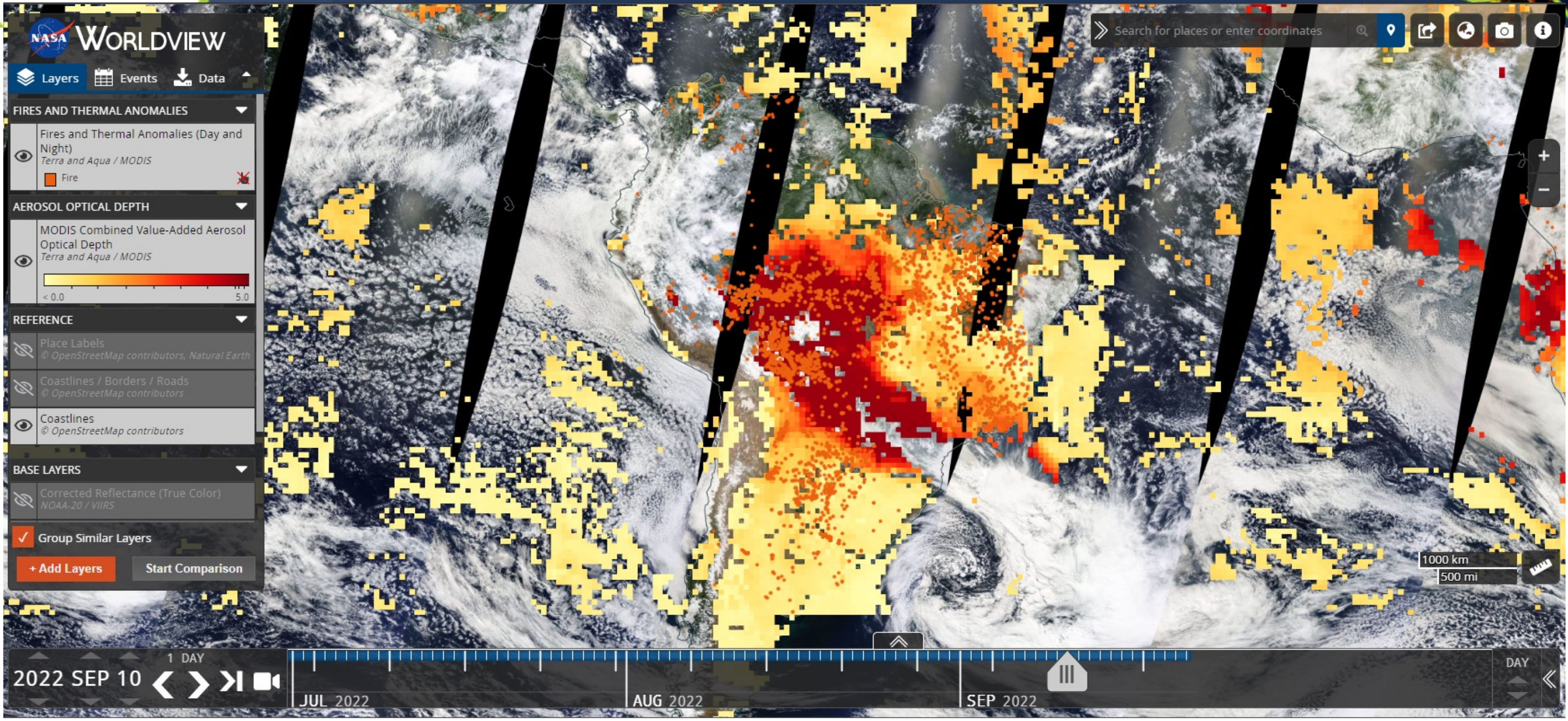


Multi-sensor imaging of the King fire in California/U.S. on 19 September 2014 (Schroeder et al. 2016)

Active fire data - FIRMS

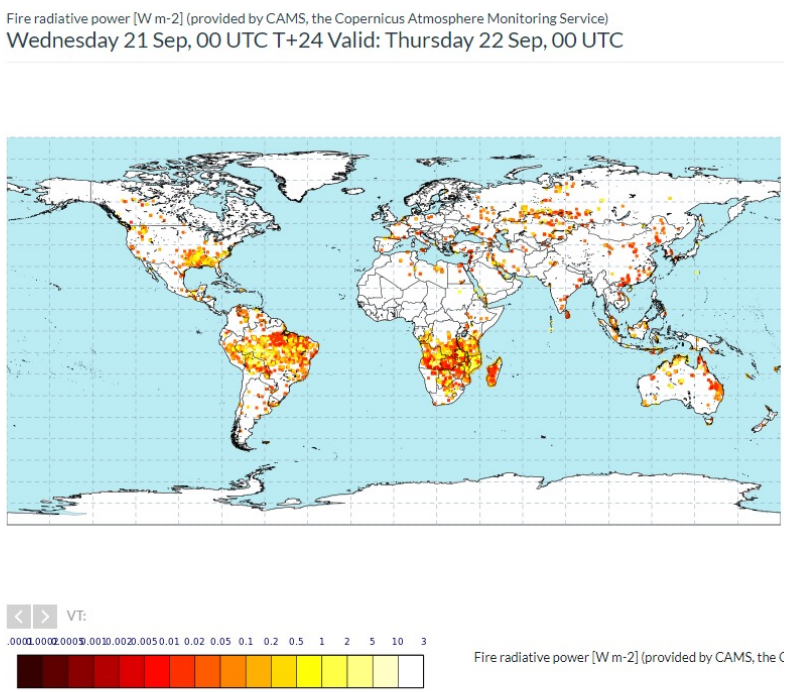
MODIS & VIIRS NRT (<24h) and historic 'Fire & Thermal Anomalies Data' generated by U. of Maryland, available from NASA FIRMS (also available direct)

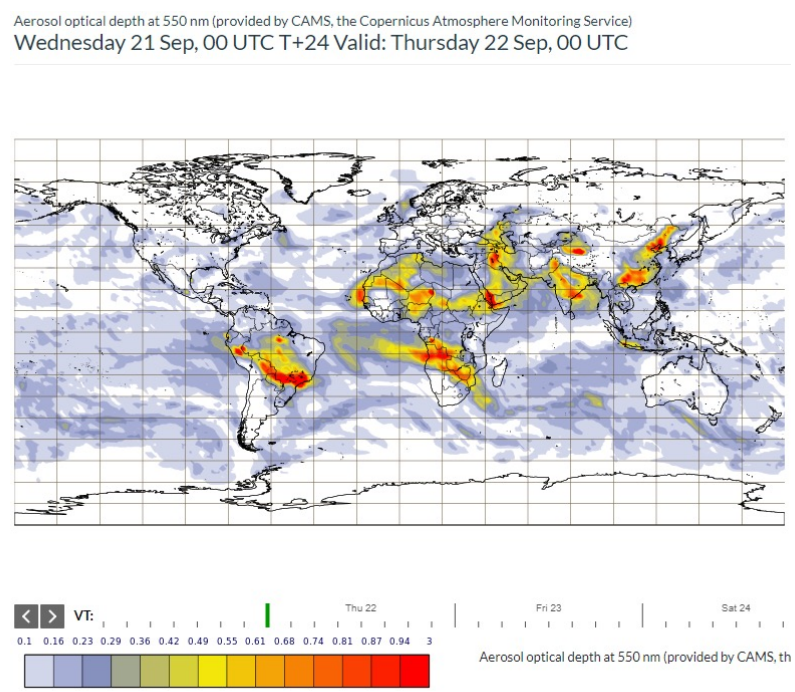
Active fire data - Worldview



NRT (<24h) and historic 'Fire & Thermal Anomalies Data' generated by U. of Maryland, available from NASA [Worldview](#) (also available [direct](#)). Background layer is MODIS Combined Value Added Aerosol Optical Depth.

Active fire data - CAMS





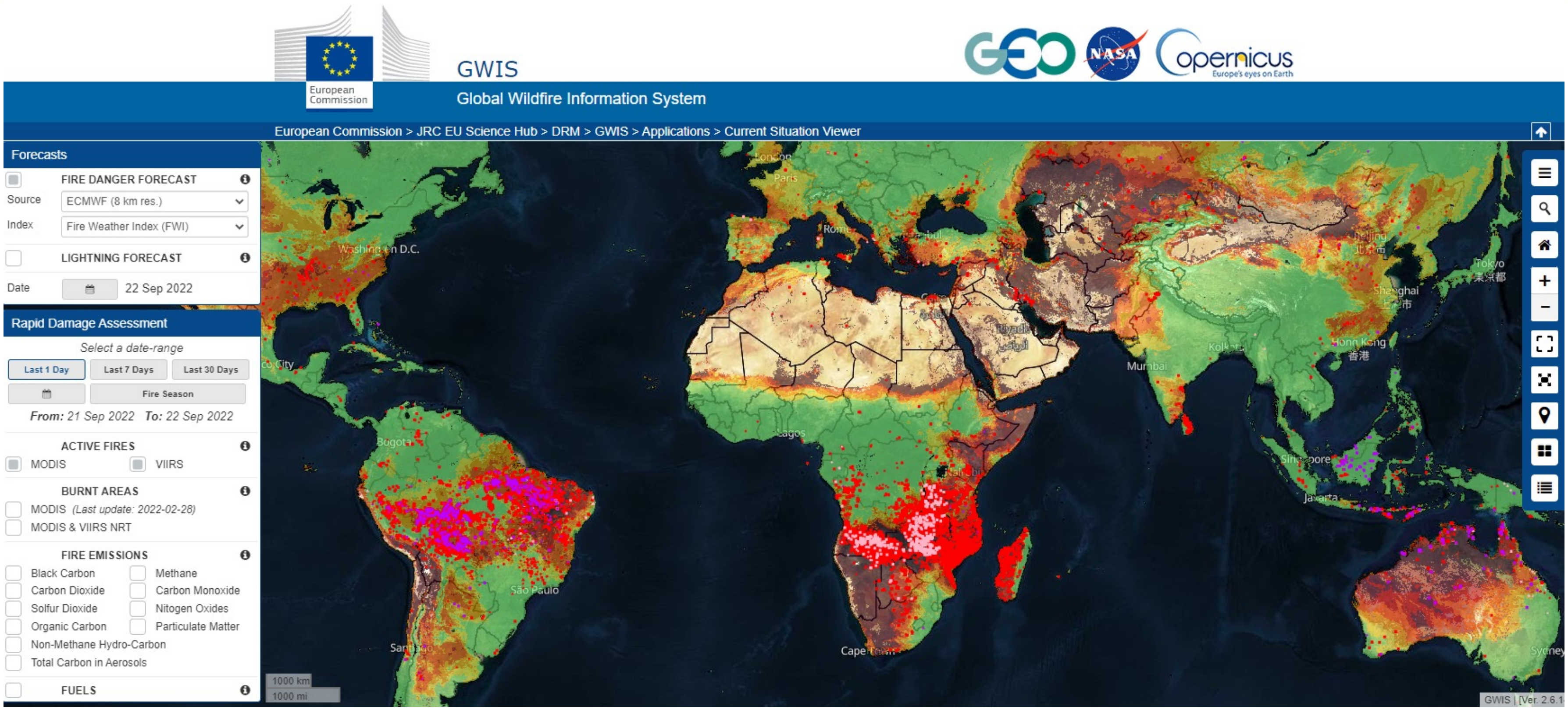
- Satellite FRP observations can be used to calculate emissions via fuel consumption
- Copernicus Atmospheric Monitoring Service (CAMS) incorporates FRP derived fire emissions into operational NRT regional and global air quality modelling through the Global Fire Assimilation Model (GFAS Kaiser *et al.*, 2013)

Active fire data - GWIS

- Global Wildfire Information System (GWIS) is a joint initiative of the GEO and the Copernicus Work Programs
- builds on the ongoing activities of the European Forest Fire Information System (EFFIS), the Global Terrestrial Observing System (GTOS) Global Observation of Forest Cover- Global Observation of Land Dynamics (GOFC-GOLD) Fire Implementation Team (GOFC Fire IT)

https://gwis.jrc.ec.europa.eu/

Active fire data - GWIS



- NRT hotspots (from FIRMS) & recently burned areas
- Fire danger forecasts, & fire emissions (from CAMS)

Active fire data - GWIS

Current Statistics Portal

Statistics are provided at national level and for regions of interest, such as the "Brazilian Legal Amazon" and the Arctic Monitoring and Assessment Program (AMAP).

The portal provides information on the evolution of the current fire season through the provision of:

1) Current statistics of burnt areas and number of fires, as compared to the average of the last 10 years. Statistics of the current year can be compared to a single year or a period in the past.
2) Seasonal cumulative trend in burnt areas and number of fires as compared to the average of the last 10 years.
3) Number of thermal anomalies detected by the VIIRS sensor as compared to the average of thermal anomalies for the last 10 years.
4) Number of thermal anomalies detected by the MODIS sensor as compared to the average of the thermal anomalies for the last 10 years.

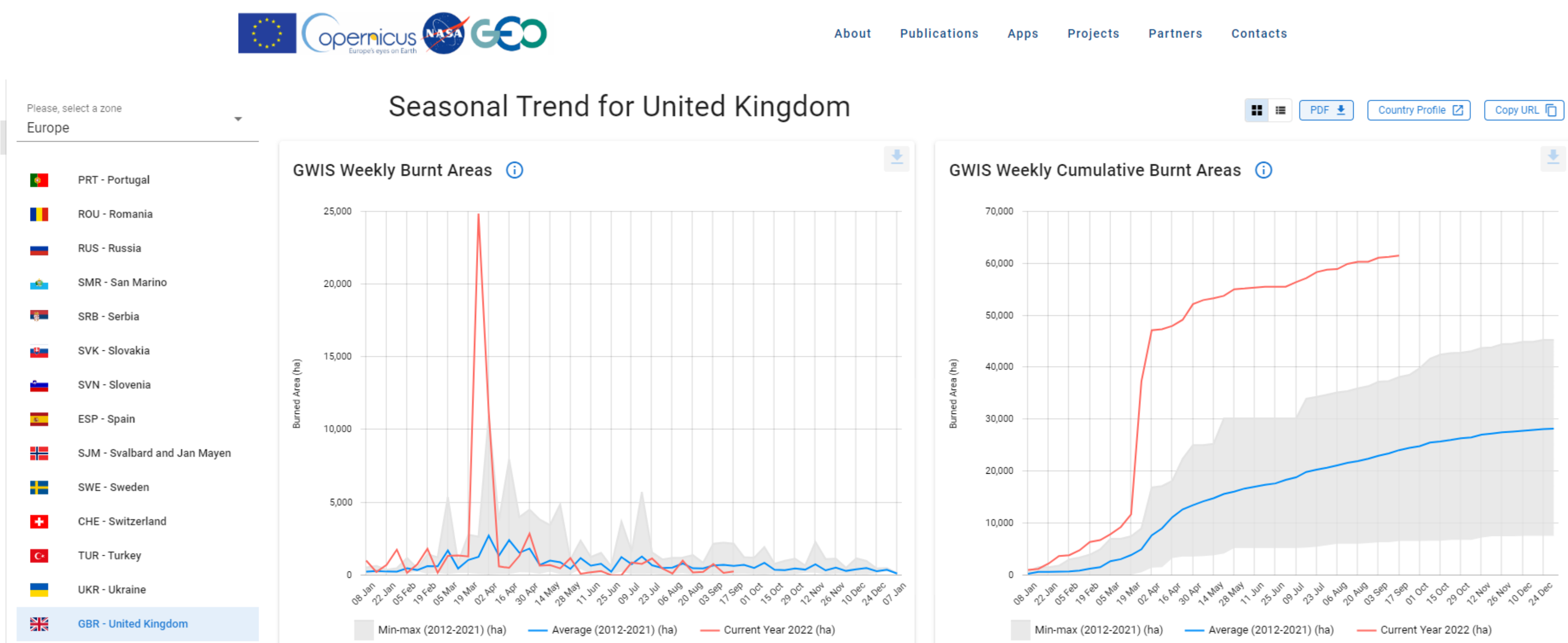
Country Profile

This application provides a historical overview of fire regimes at country and sub-country level for the period 2002-2019. It includes maps of yearly/monthly burnt areas, burnt area frequency and burnt area seasonality. Additionally, it provides multi-year and single-year charts of

1) Number of fires derived from GlobFire
2) Burnt areas derived from MODIS MCD64A1
3) Fire regimes (seasonality)
4) Monthly fire size distribution per year
5) Landcover damage and
6) Yearly/monthly wildfire emissions

Data are downloadable in the application.

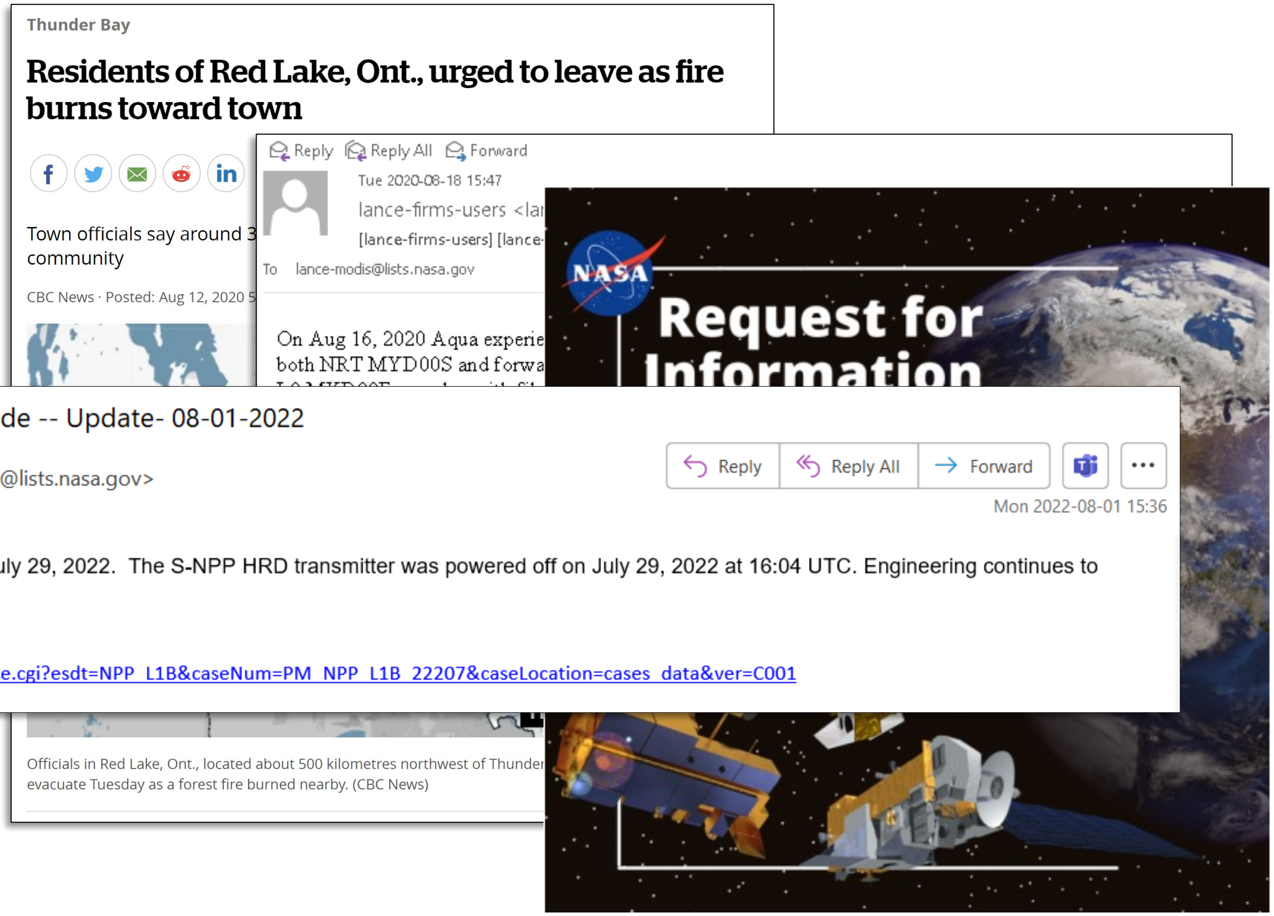
Active fire data - GWIS



Challenges…

Challenges…

- Wildfire monitoring is often secondary use case;
  - and not necessarily a priority;
- Long term continuity is not clear;
  - nor are the mechanisms for advocation;
- Co lo bu gr



[lance-firms-users] [lance-modis] SNPP in Safe Mode -- Update- 08-01-2022

lance-modis--- via lance-firms-users <lance-firms-users@lists.nasa.gov>
To lance-modis@lists.nasa.gov

Reply | Reply All | Forward

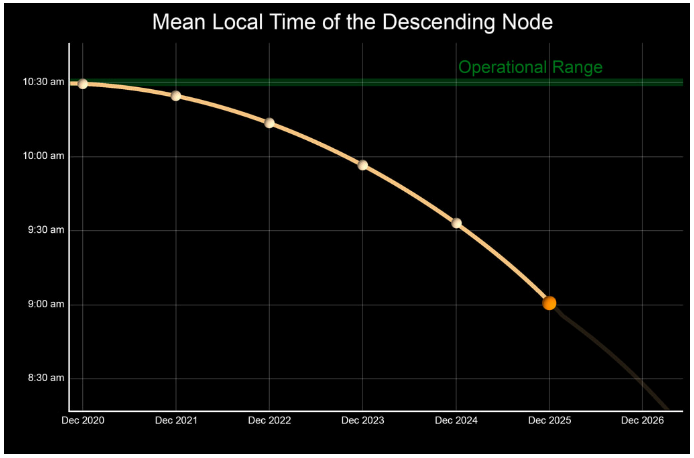
Mon 2022-08-01 15:36

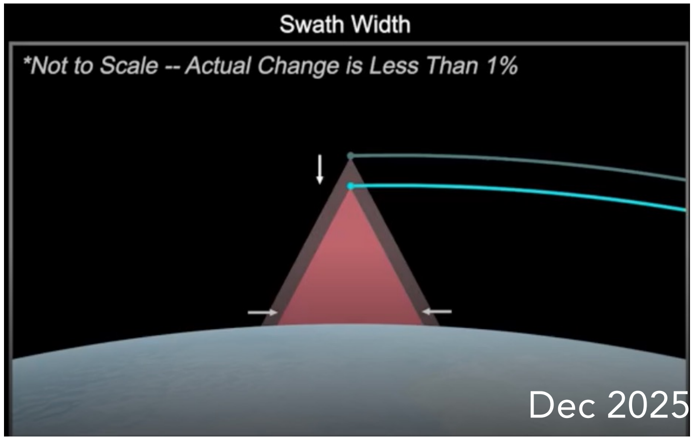
Update: S-NPP transitioned to Mission Point mode on Friday, July 29, 2022. The S-NPP HRD transmitter was powered off on July 29, 2022 at 16:04 UTC. Engineering continues to troubleshoot.

For more information visit:
https://landweb.modaps.eosdis.nasa.gov/cgi-bin/NPP_QA/displayCase.cgi?esdt=NPP_L1B&caseNum=PM_NPP_L1B_22207&caseLocation=cases_data&ver=C001

Terra/Aqua MODIS End of Life

- Current plan is to end instrument data collection in 2023
- RFI open for feedback before **October 11th** to NASA on:
  - **Novel Science:** Science objectives that can be achieved with Terra/Aqua/Aura data that are uniquely enabled by observations made during the period of orbital drift.
  - **Impact to Applications**: Benefits to and impact on current societal applications during the period of orbital drift.





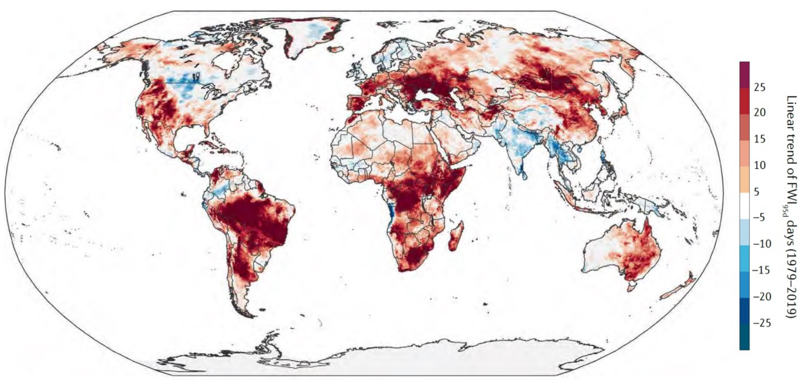
Uncertainties

When and where will our coverage end?

How will climate change impact our priorities?

Is anyone planning replacements?

Are we capable of supporting emergencies?



Are these plans complementary?

How do user needs compare globally?

(Bowman *et al.*, 2020)

Will the next generation of fire products meet the needs?

Will these needs change under climate change?

What's the plan?

WildFire Pilot Scope

Aim: to provide a fundamental basis for defining global priorities for active-fire monitoring satellite development and coordination.

Four specific Objectives:

1. Conduct a detailed inventory and gap analysis of existing and proposed EO systems suitable for global active-fire monitoring;
   - *Considering climate change driven fire regime changes and projected mission life spans*
2. Conduct a detailed analysis of global stakeholders and end-users of active-fire EO data;
3. Define targeted user requirements for active-fire remote sensing systems for the disaster mitigation applications;
4. Propose a way forward in coordinating global wildfire monitoring activities.

Key outcomes:

1. Existing and future gaps in wildfire EO capabilities will be explicitly identified;
2. The global community of wildfire stakeholders and end-users will be identified;
3. User requirements for active-fire remote sensing will be identified;
4. A way forward to closing existing and future gaps will be identified.

The pilot project is also expected to identify the need for conducting comparable projects for the other disciplines of wildfire EO (e.g. pre-fire and post-fire monitoring).

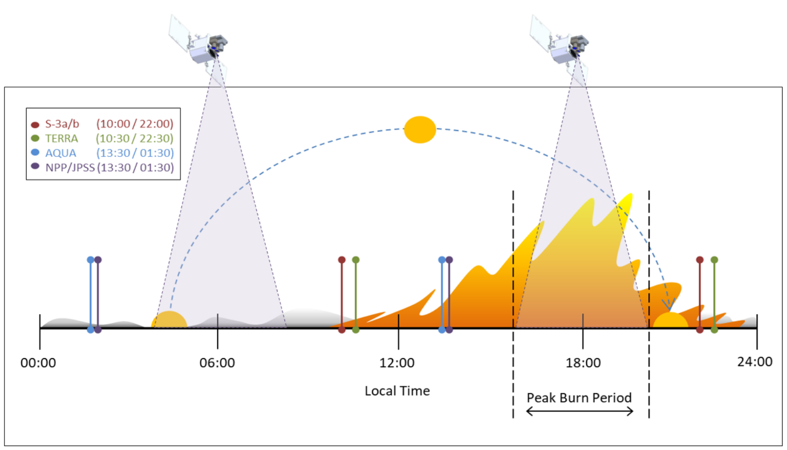
WildFireSat – Operational Mission

WildFireSat

La mission GardeFeu

WildFireSat – Operational Mission

- In April 2022, the Government of Canada awarded full funding for the WildFireSat Operational Mission;
  - The operational mission prioritizes fire management users;
  - Complete automated multi-tiered product suite;
- Launch tentatively set for winter 2027-28;
- Global data is possible via downlinking agreements:
- For more information contact:
  joshua.johnston@nrcan-rncan.gc.ca



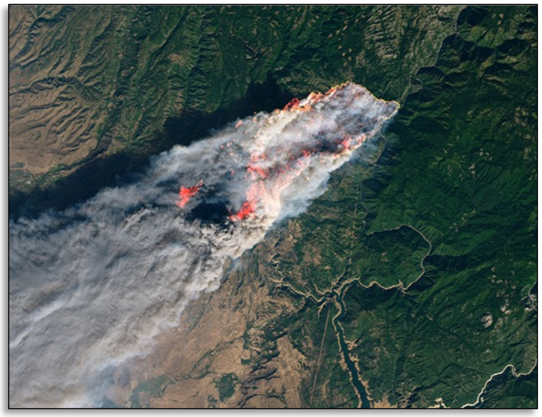
(Johnston *et al*, 2020)

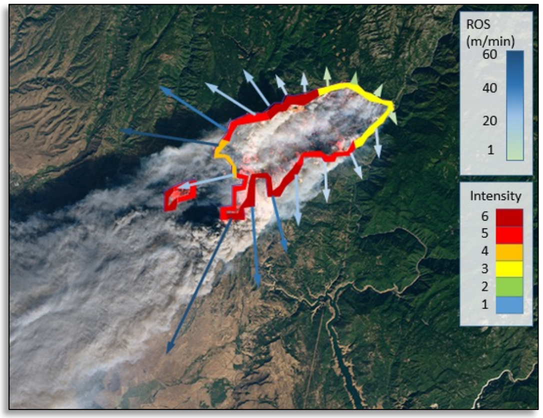
WildFireSat – Key Outcomes

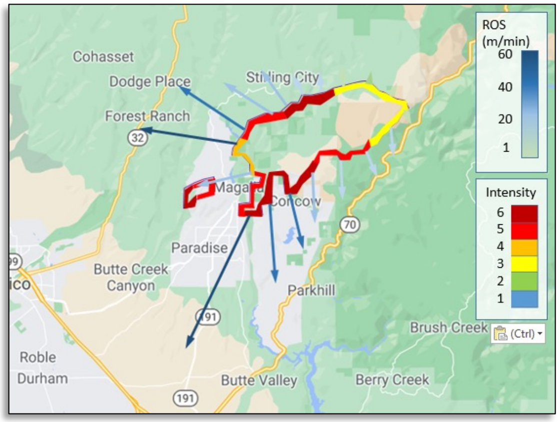
1. Canadian wildfire managers will be given unprecedented strategic intelligence on all active wildfires, daily, and in near-real-time (i.e. approximately 30 minutes);

2. Air quality, smoke, and carbon emissions from wildfires will be better forecasted and monitored in near-real-time; and,

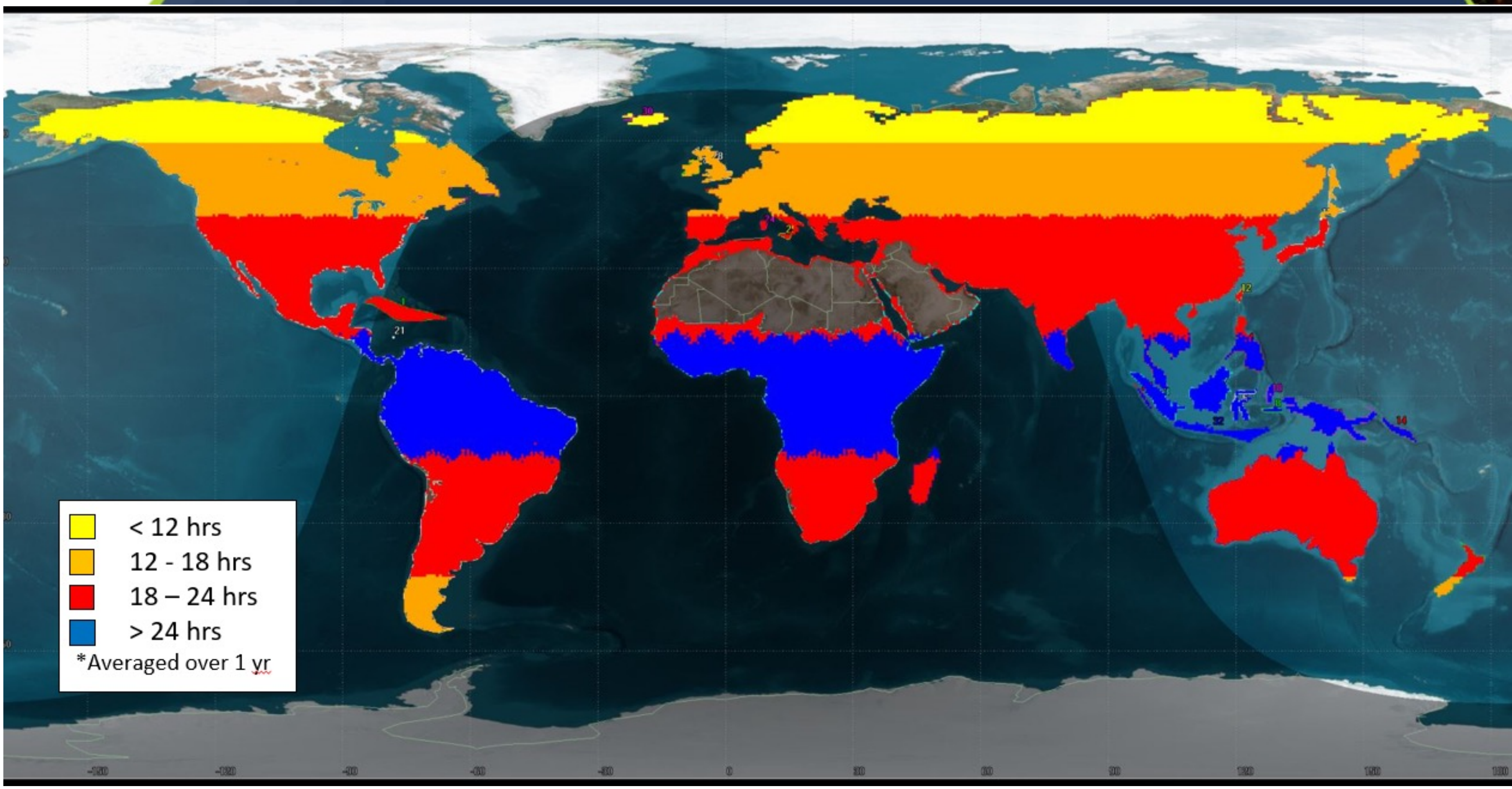
3. Through (1) and (2) there will be a significant reduction of the economic and societal risks and losses associated with the threat of wildfires.



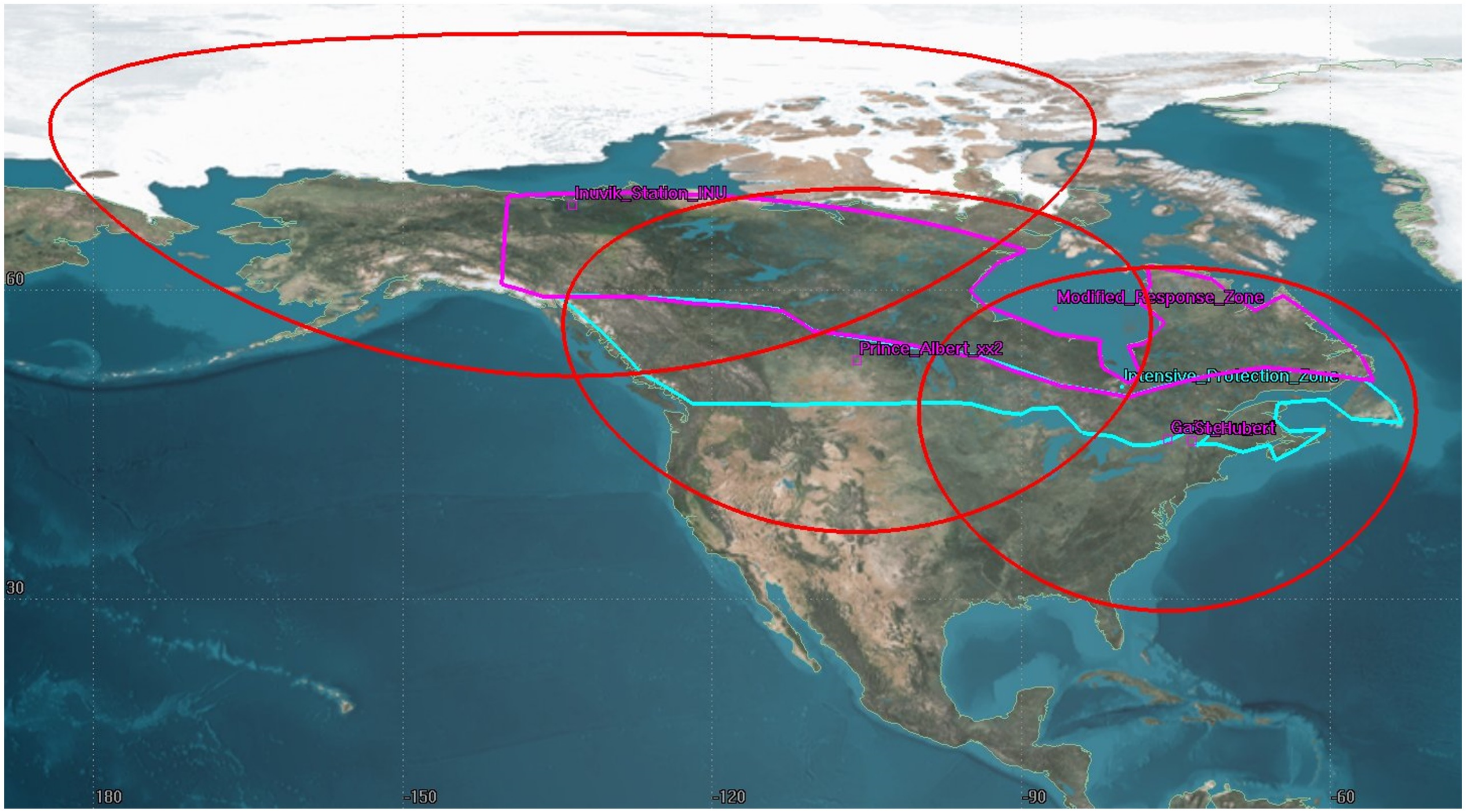




WildFireSat – Revisit Frequency



WildFireSat – Downlink Coverage




On Target?

Thanks!

Questions

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