

Use of Satellite Data/Imagery for Air Quality Forecasting in Colorado

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Colorado Air Quality Forecasting

Colorado Department of Public Health and Environment (CDPHE)

Air Pollution Control Division

Technical Services Program

Meteorology and Prescribed Fire Unit

3 Meteorologists on staff

Daily forecasts 2x/day, 365 days/year

All NAAQS Pollutants

Air Quality Action Days (within the Front Range) as necessary

~40/year

Air Quality Health Advisories (outside the Front Range) as necessary

O₃, Wildfire Smoke, PM_{2.5/10}

Exceptional Event Documentation/Demonstrations

Year	# of Action Days (O ₃)	# of Action Days Total
2011	30	30
2012	42	52
2013	38	44
2014	18	18
2015	30	35
2016	36	36
2017	45	45
2018	52	52
Average	36	39

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
<i>When the AQI is in this range:</i>	<i>...air quality conditions are:</i>	<i>...as symbolized by this color:</i>
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Overview of Colorado Air Quality- Emphasis Areas

Known AQ issues statewide

Wildfires (mainly summer, but can be year-round)

Primarily in the Rocky Mountain West, but do happen throughout the entire state

PM₁₀/PM_{2.5} (winter)

Indoor burning restrictions in the 7-County Denver/Boulder Metro Area, below 7000 ft.

Exemptions: Certified devices; Above 7,000 feet.

Indoor burning is the primary source of heat

Lamar, CO (PM₁₀, late spring/early summer)

Ozone (summer)

O₃ Non-Attainment Area (NAA), Northern Colorado Front Range

Other areas with occasional O₃ issues-

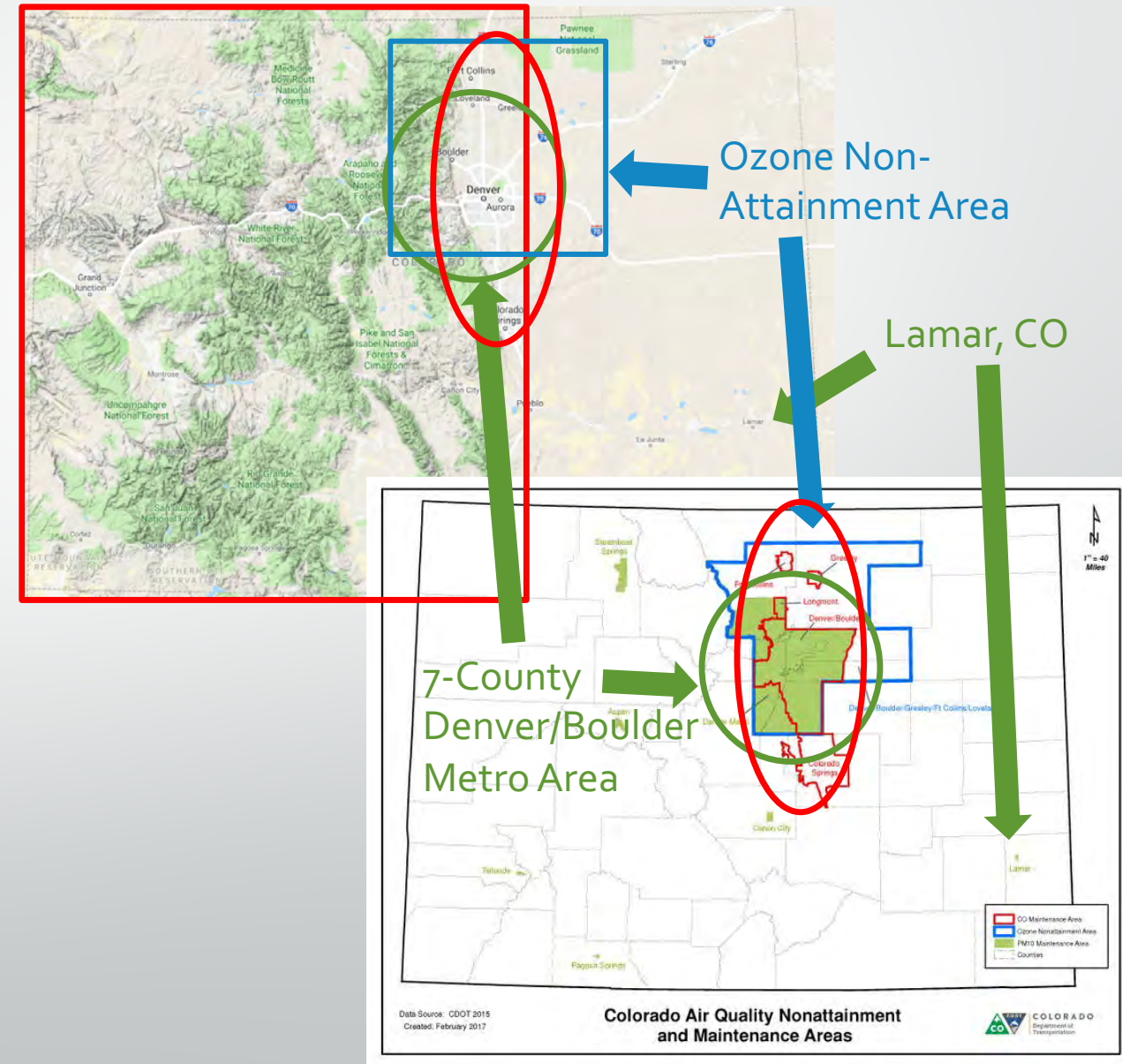
4 Corners/Southern Ute Indian Tribe

High elevation Sites (Gothic, Mesa Verde, RMNP)

Uintah Basin -> Rangely

AQ Focus (often): The Front Range Urban Corridor

Occasional NO₂, SO₂



Use of Satellite Data/Imagery for Air Quality Forecasting—Before GOES 16/17

The 'Dark' Ages... Ok, just grayscale

Prior to the improvements gained with geostationary imagery with a wealth of bands/channels and the multispectral imagery that they combine to make, we worked in the 'dark'!

Verification was often left to webcams and surface observations to confirm what we were looking at, and to determine the severity and extent of impacts.

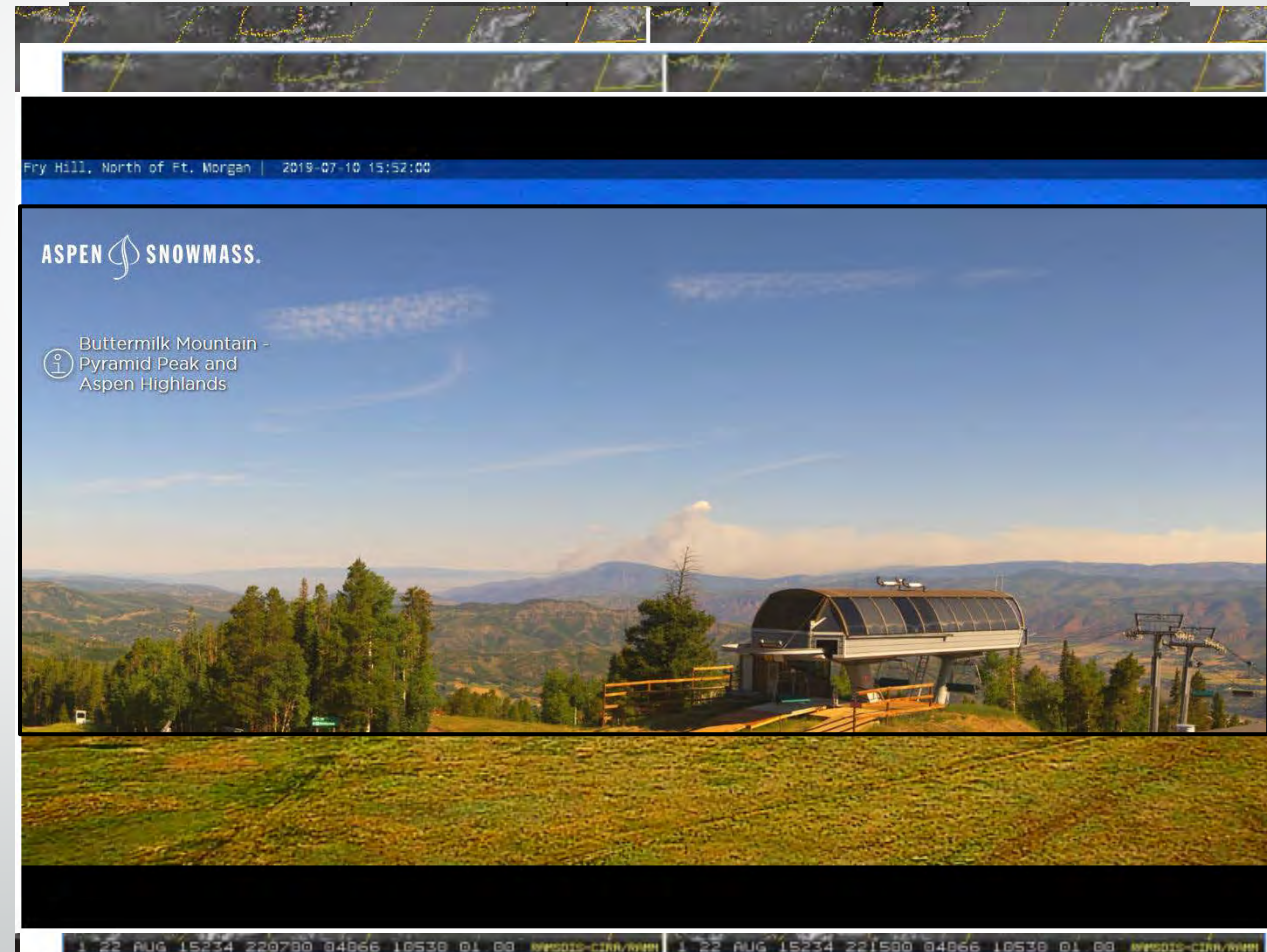


Figure 9: GOES East satellite images at (a) 2:55 PM, (b) 3:00 PM, (c) 3:07 PM, and (d) 3:15 PM MST (2155Z, 2200Z, 2207Z, and 2215Z, respectively) August 22, 2015.
(Source: <http://rammb.cira.colostate.edu/ramsd/online/goes-west/goes-east.asp>)

1KM VIS 20130619/1845 UTC

Introducing GOES 16 and 17...

Now in TRUE COLOR!!



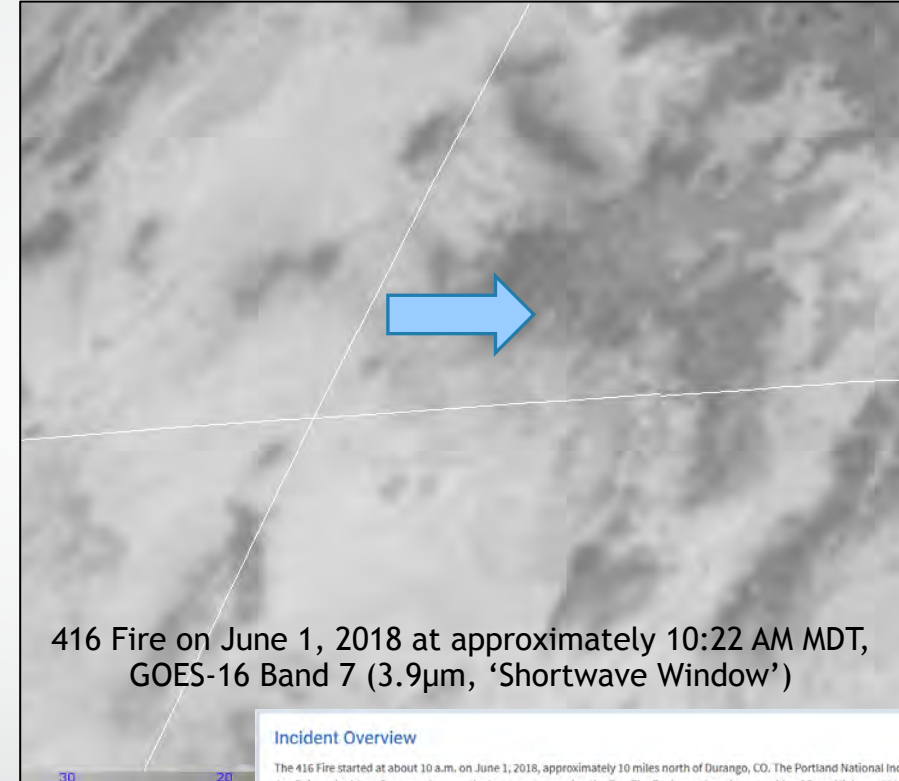
Use of Satellite Data/Imagery for Air Quality Forecasting-Wildfires

Wildfire Detection

Increased spatial and temporal resolution

16 Channels give WAY better ability to identify hot spots and monitor fire intensity and growth

First detections have improved drastically



Incident Overview

The 416 Fire started at about 10 a.m. on June 1, 2018, approximately 10 miles north of Durango, CO. The Portland National Incident Management Organization (NIMO) team, Joe Reinartz Incident Commander, was the last team managing the fire. The fire burned on the west side of State Highway 550 on some private land and on the San Juan National Forest in grass, brush, and timber. The fire has been less active for about a week and has received significant rain. The NIMO Team passed the fire back to the San Juan National Forest at noon July 10th.

The 416 fire was called out on 11/29/18.

Incident Information

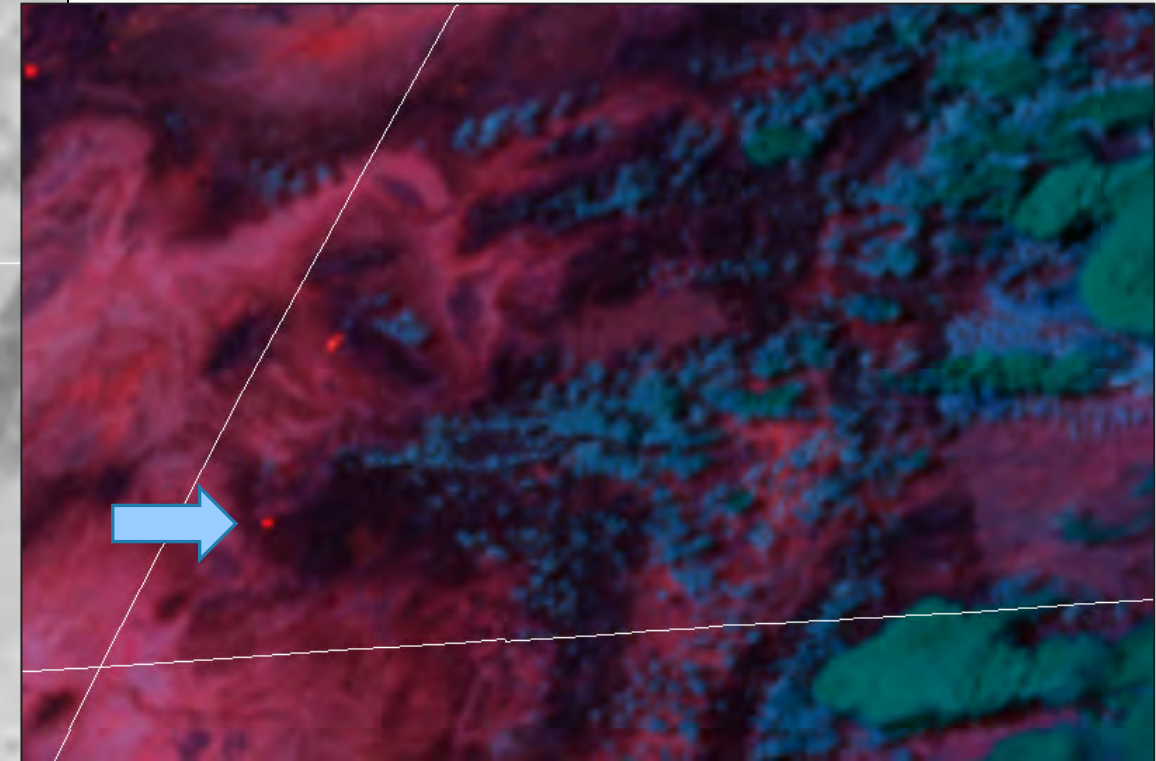
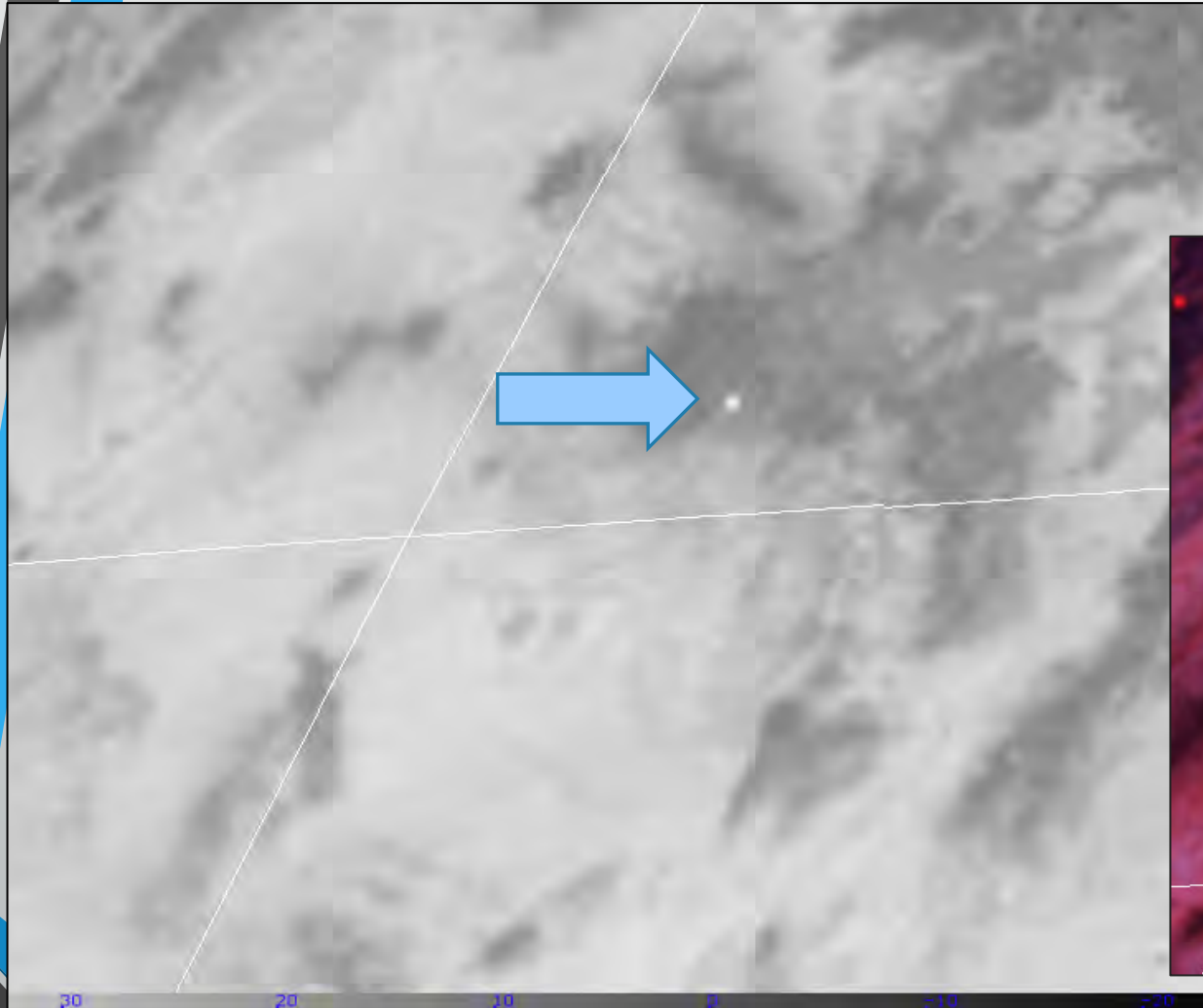
Basic Information

Current as of	5/12/2019, 2:55:44 PM
Incident Type	Wildfire
Cause	Unknown
Date of Origin	Friday June 01st, 2018 approx. 10:02 AM
Location	13 miles north of Durango, CO
Incident Commander	Jason Hutchinson ICT3 Chris Tipton ICT3(T)
Incident Description	Wildfire
Coordinates	37.461 latitude, -107.808 longitude

Current Situation

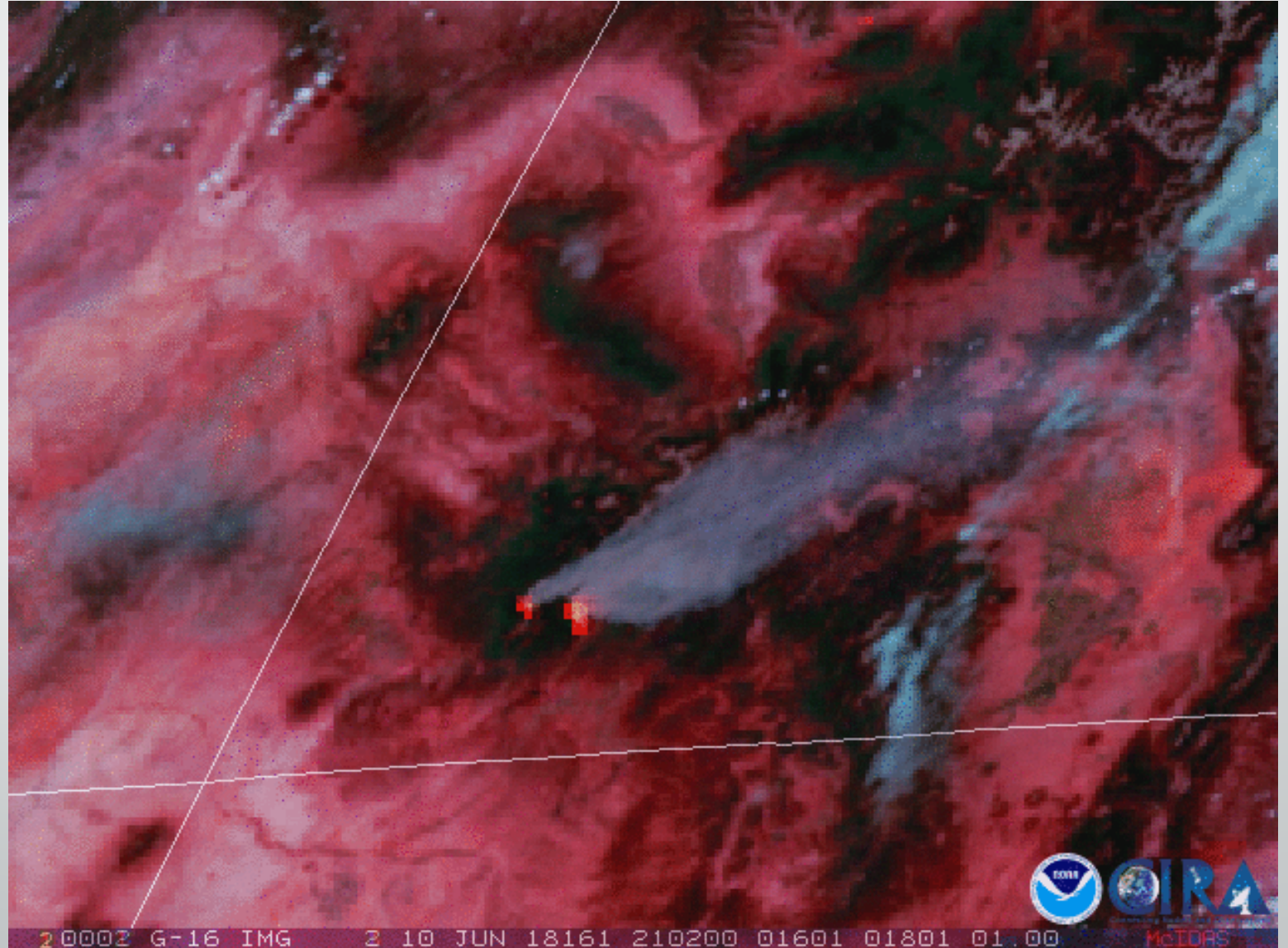
Total Personnel	21
Size	54,129 Acres
Percent of Perimeter Contained	100%
Estimated Containment Date	Tuesday July 31st, 2018 approx. 12:00 AM
Fuels Involved	Timber (Grass & Understory) Brush (2 feet) Timber (litter and understory)

416 Fire



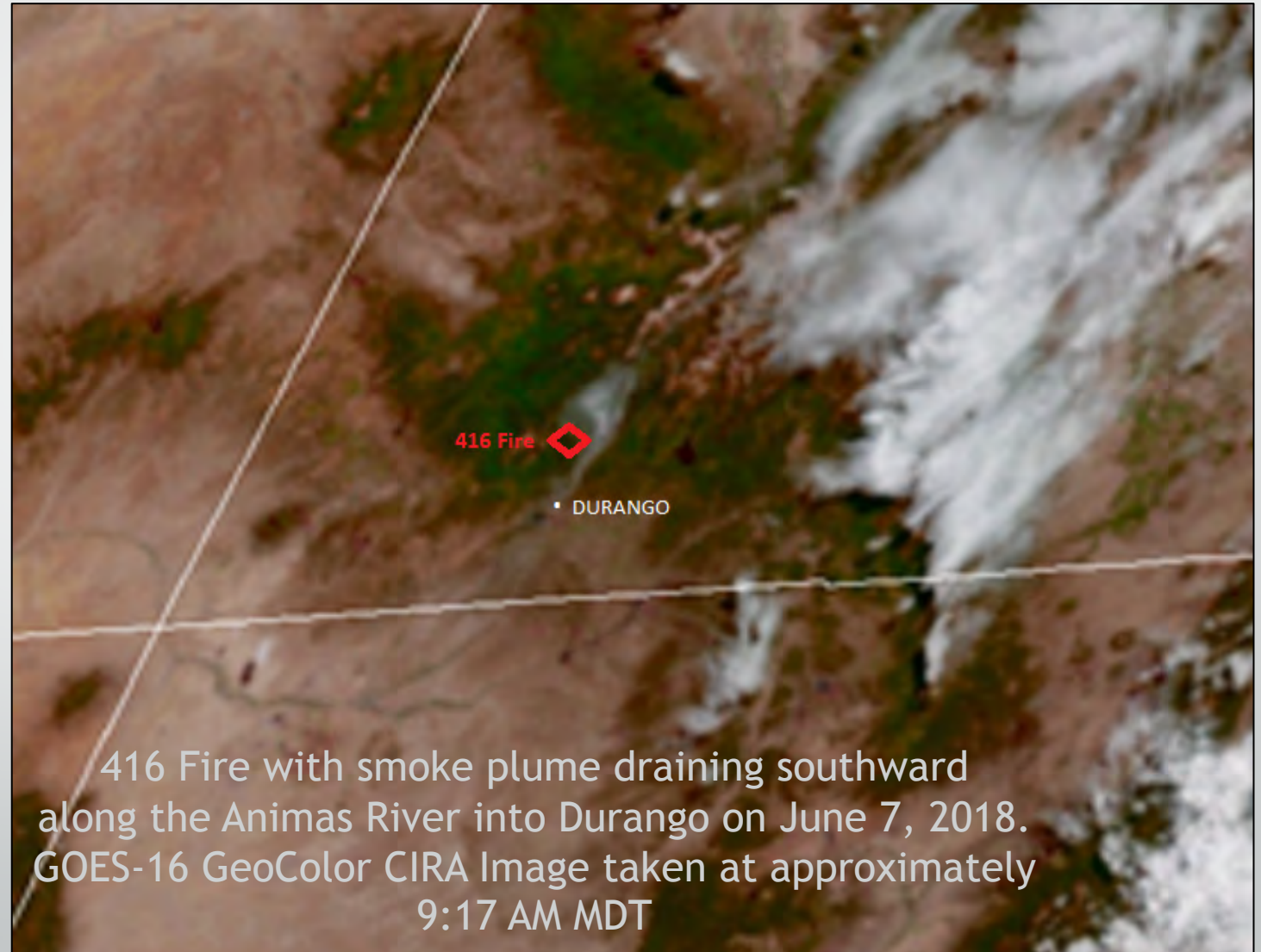
416 Fire on June 1, 2018 at approximately 10:32 AM MDT, GOES-16 Band 7 (left), Fire Temperature RGB Composite (CIRA, right)

416 Fire/Burro Fire- Fire Temperature Product Overlaid with GeoColor Product



Wildfire Smoke- 416 Fire

Increased resolution allows us to better fully assess the extent of terrain effects and smoke impacts



416 Fire with smoke plume draining southward along the Animas River into Durango on June 7, 2018. GOES-16 GeoColor CIRA Image taken at approximately 9:17 AM MDT



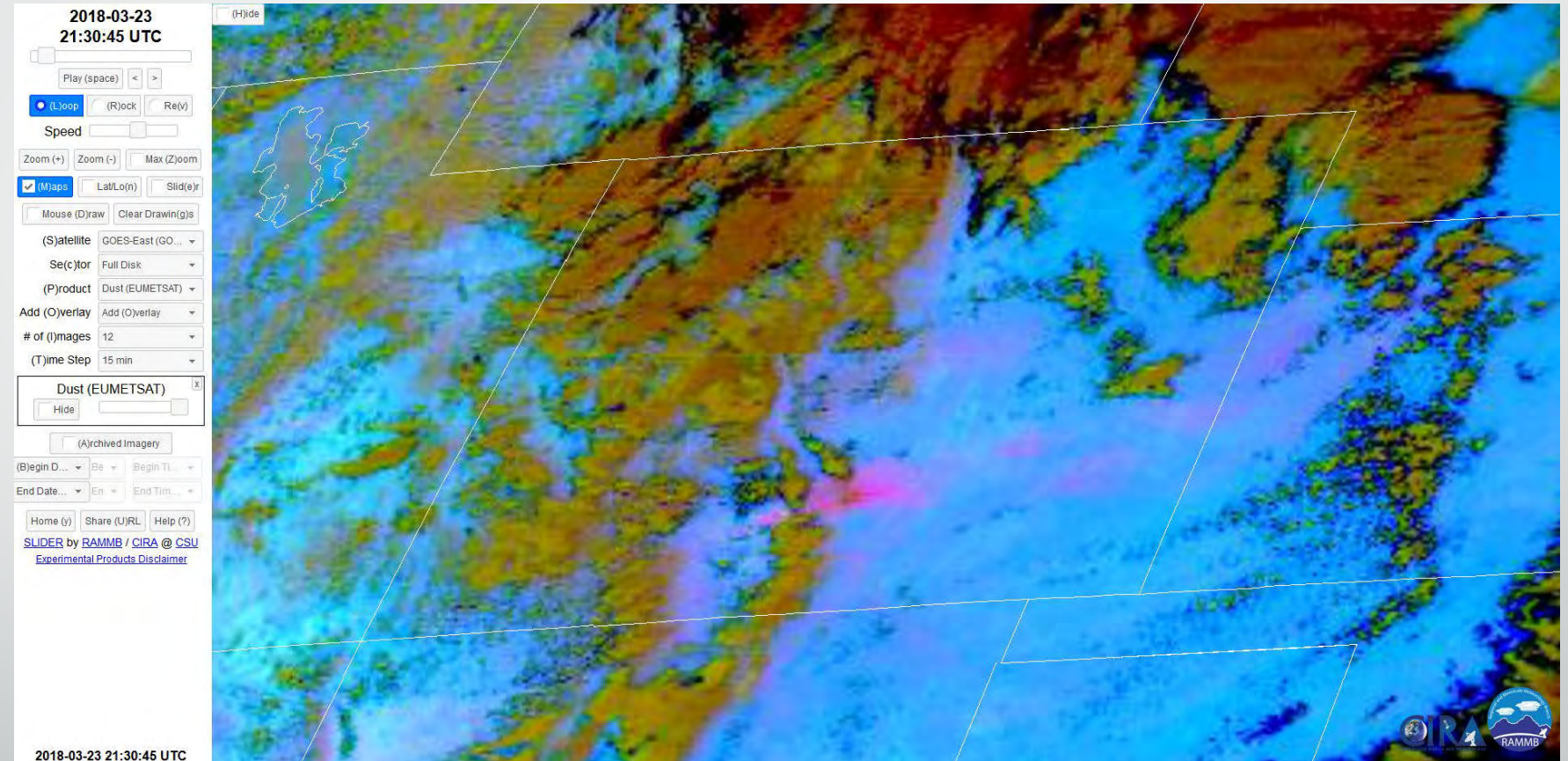
View of Durango from Smelter Mountain (looking east-northeast)
on June 7, 2018 at approximately 9:19 AM MDT

Use of Satellite Data/Imagery for Air Quality Forecasting-Blowing Dust

PM₁₀- Blowing Dust
(EUMETSAT
Product)

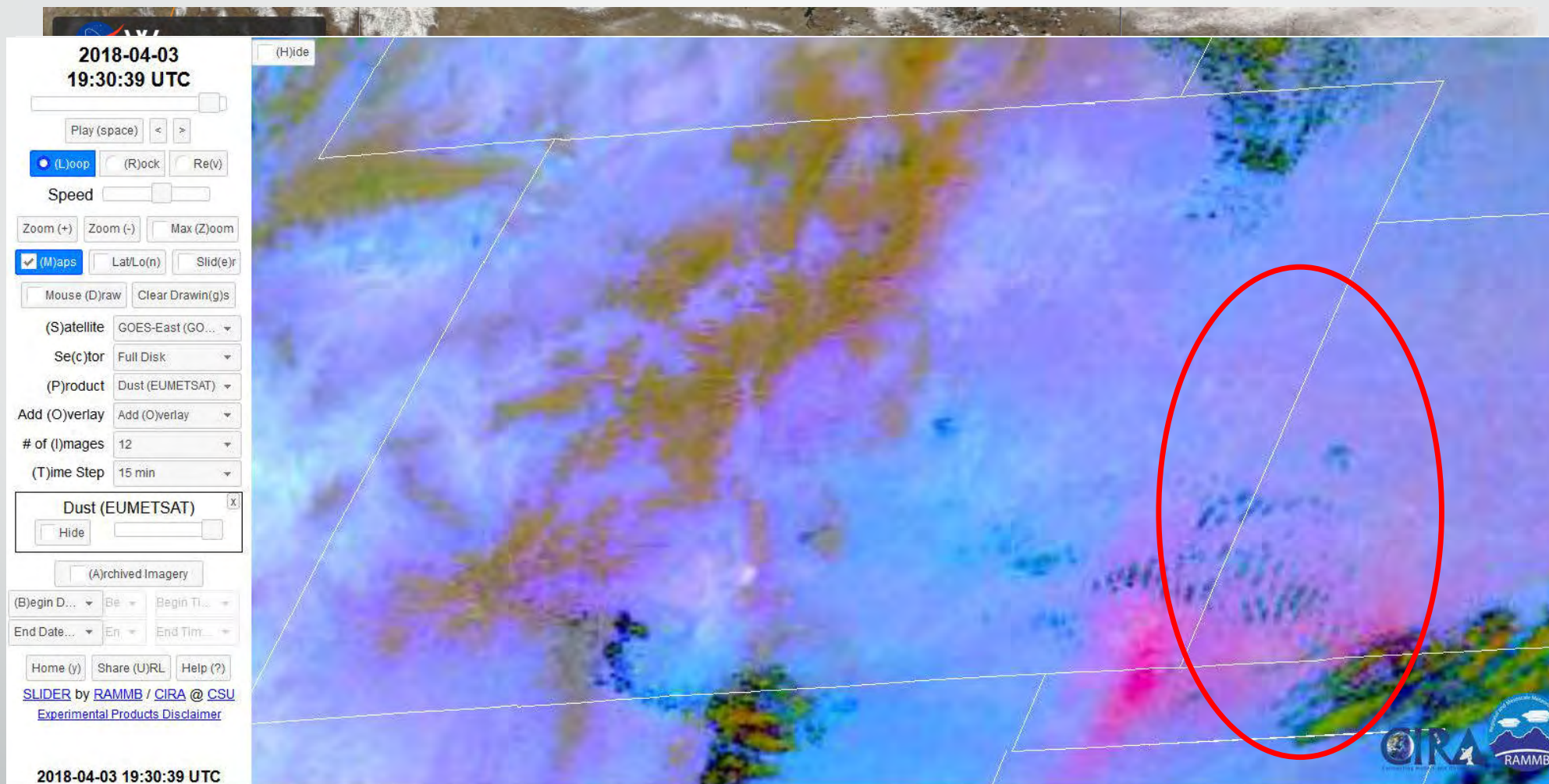
The identification of
dust storms in
multispectral
products allow for:

- Better detection early on
- Better ability to identify the areas with highest concentrations
- Assess full extent of impacts

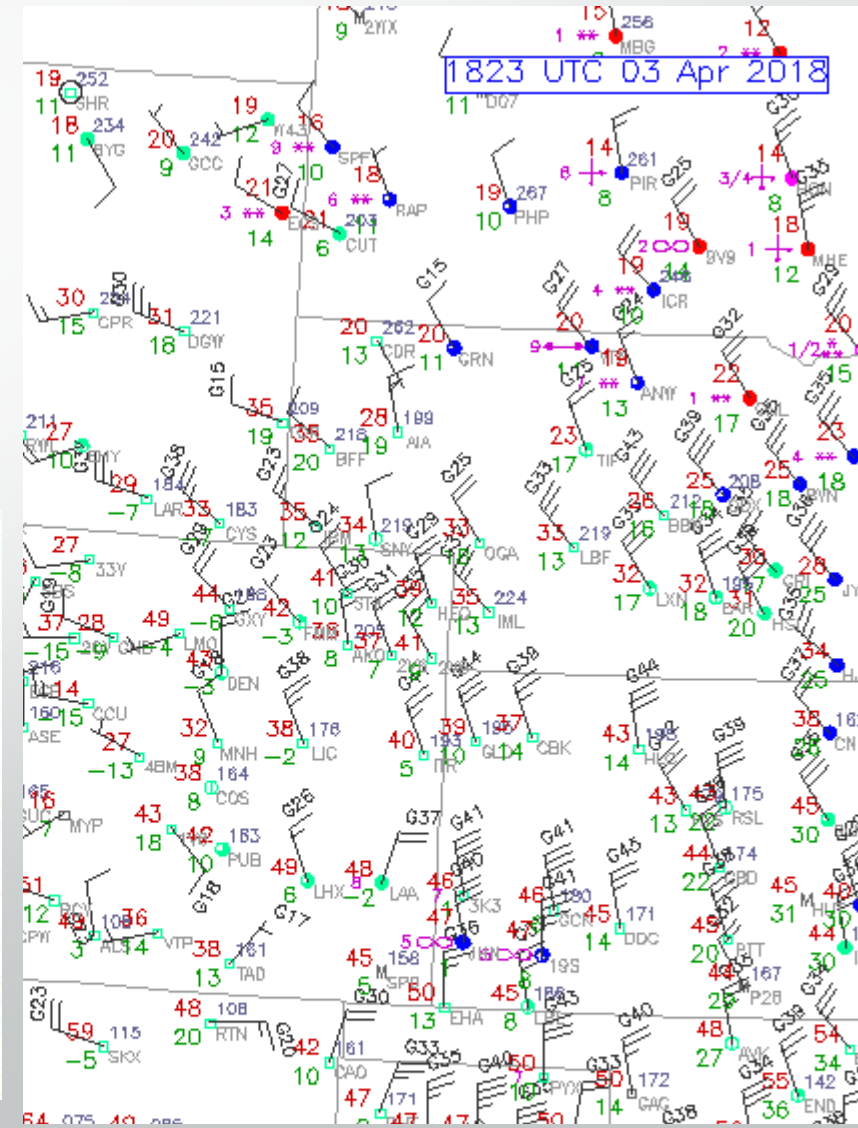


Blowing Dust, Another Example

Sometimes
specialized
products still
help to color
the event
better



Sure enough, observations and webcams caught the dust too



Use of Satellite Data/Imagery for Air Quality Forecasting

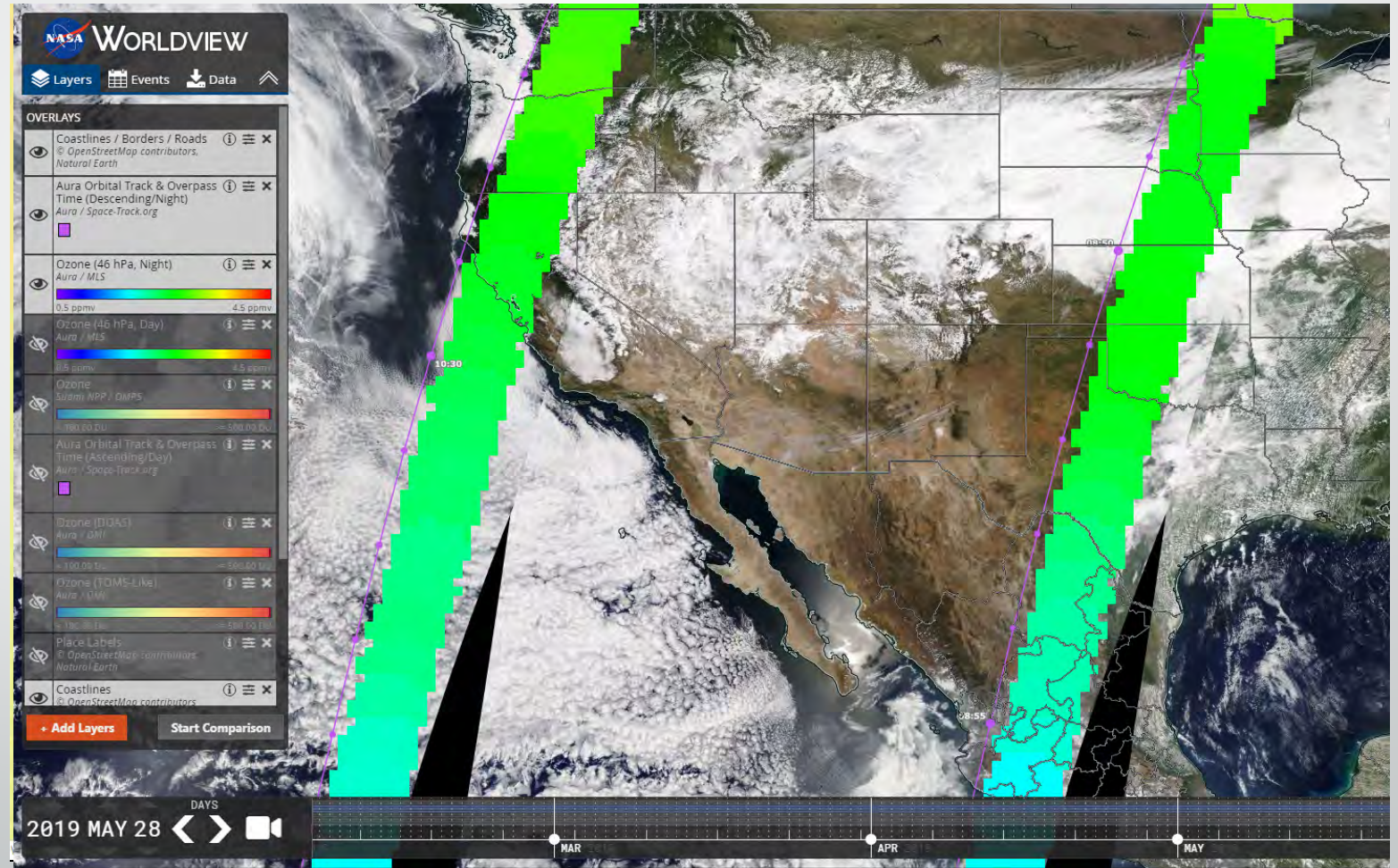
Ozone

Ground-level ozone concentrations are difficult to discern from satellite measurements alone

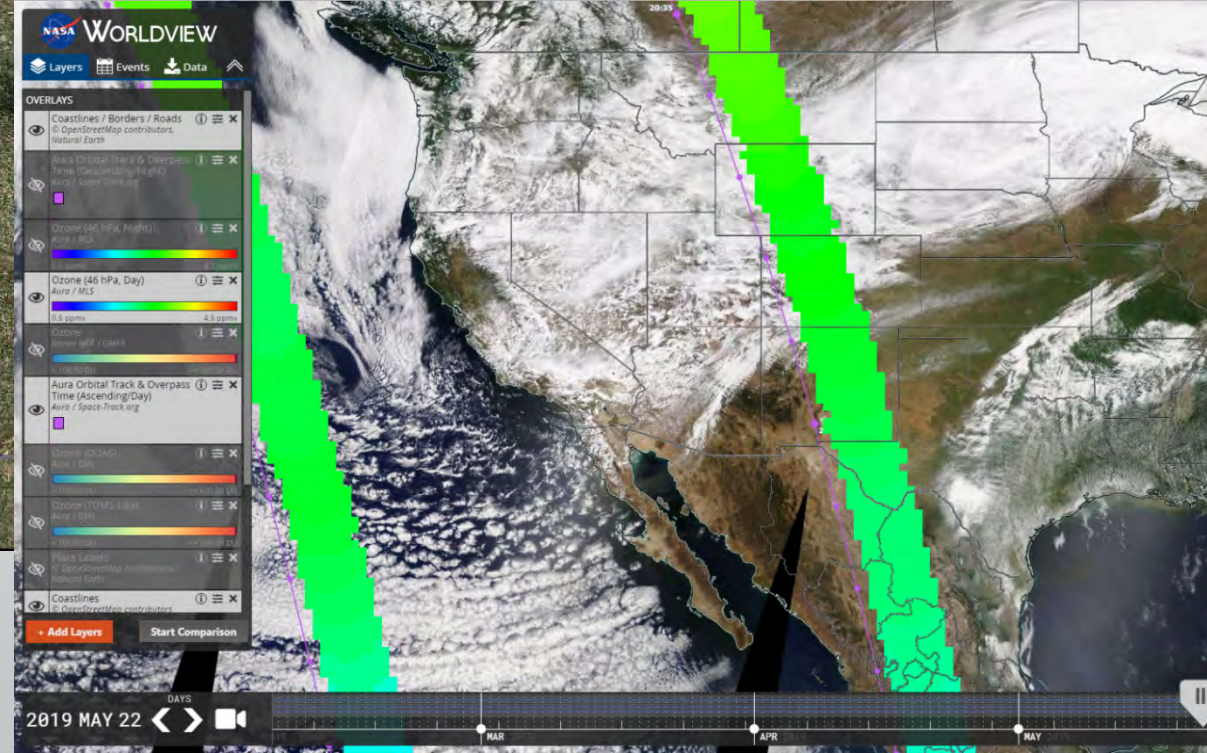
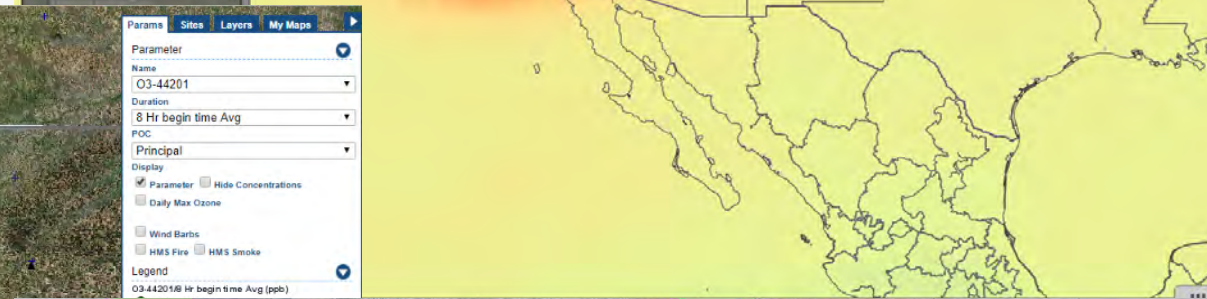
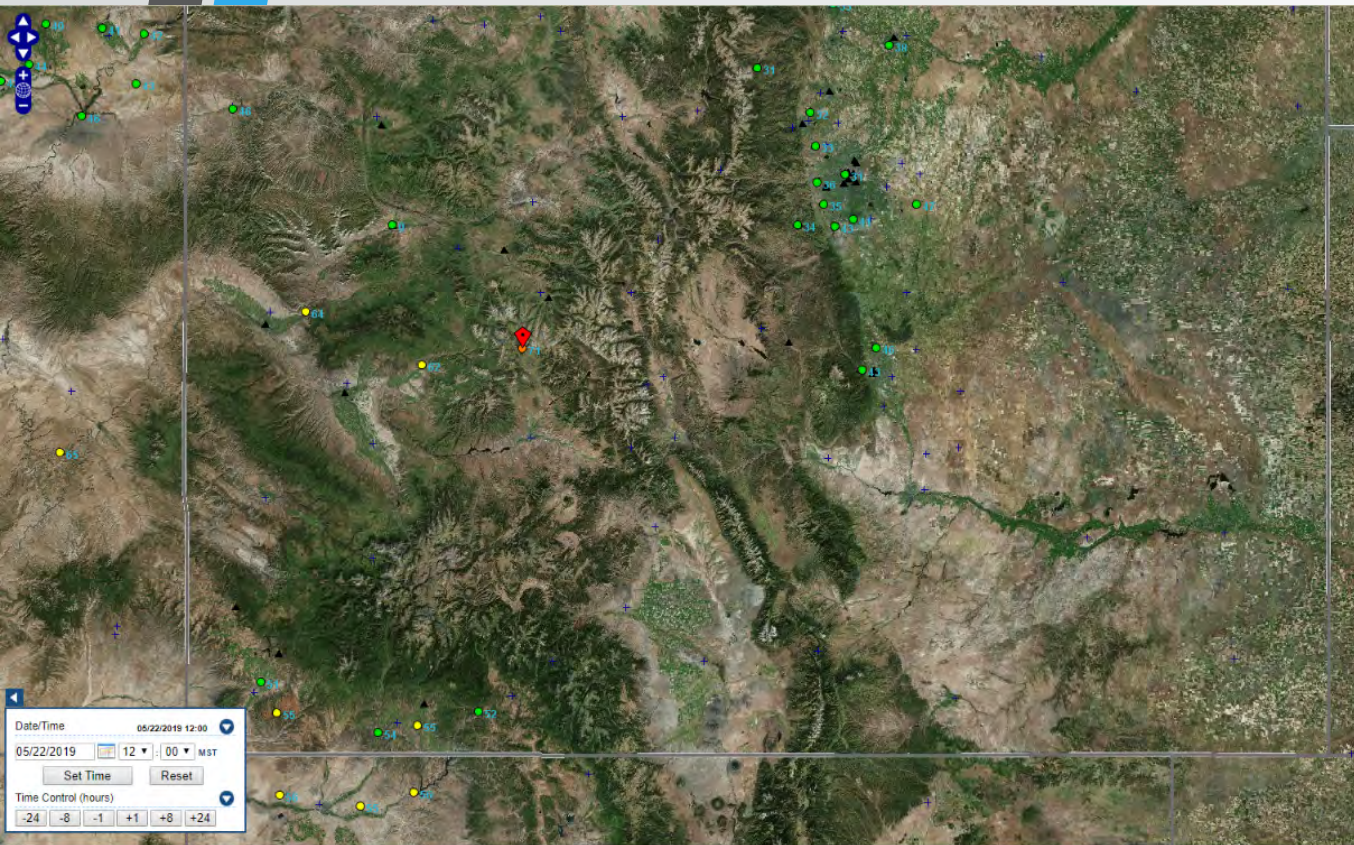
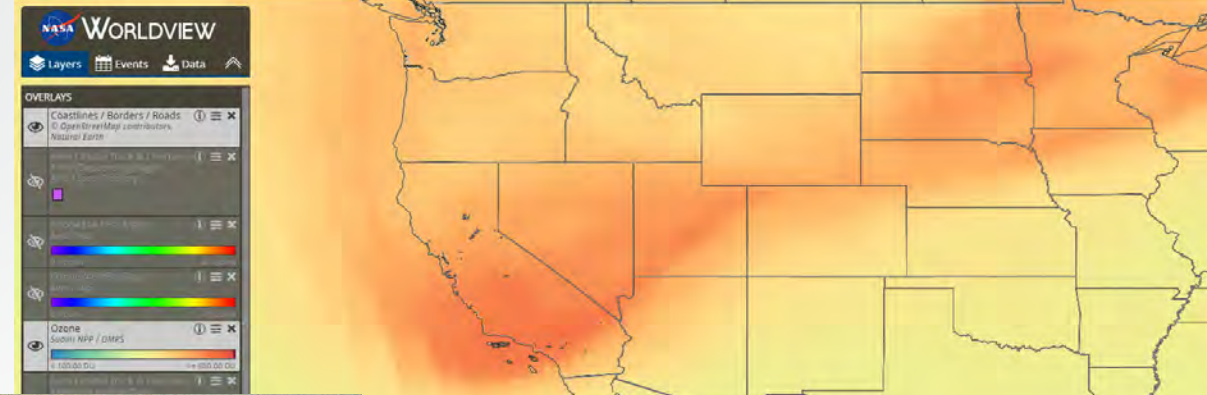
Total-column and upper-air measurements help to identify areas where higher concentrations exist throughout the atmosphere, but will they have a surface influence?

High elevation only or will it make it to the Front Range?

Most O_3 measurements are from polar orbiters, so time of day is often not optimal for daily forecasting use, orbital over-pass coverage can be poor, and when these things align retrievals are still often of limited use



Use of Remote Sensing for Ozone Forecasting, 'Source' Identification



Areas of Interest for Improvement

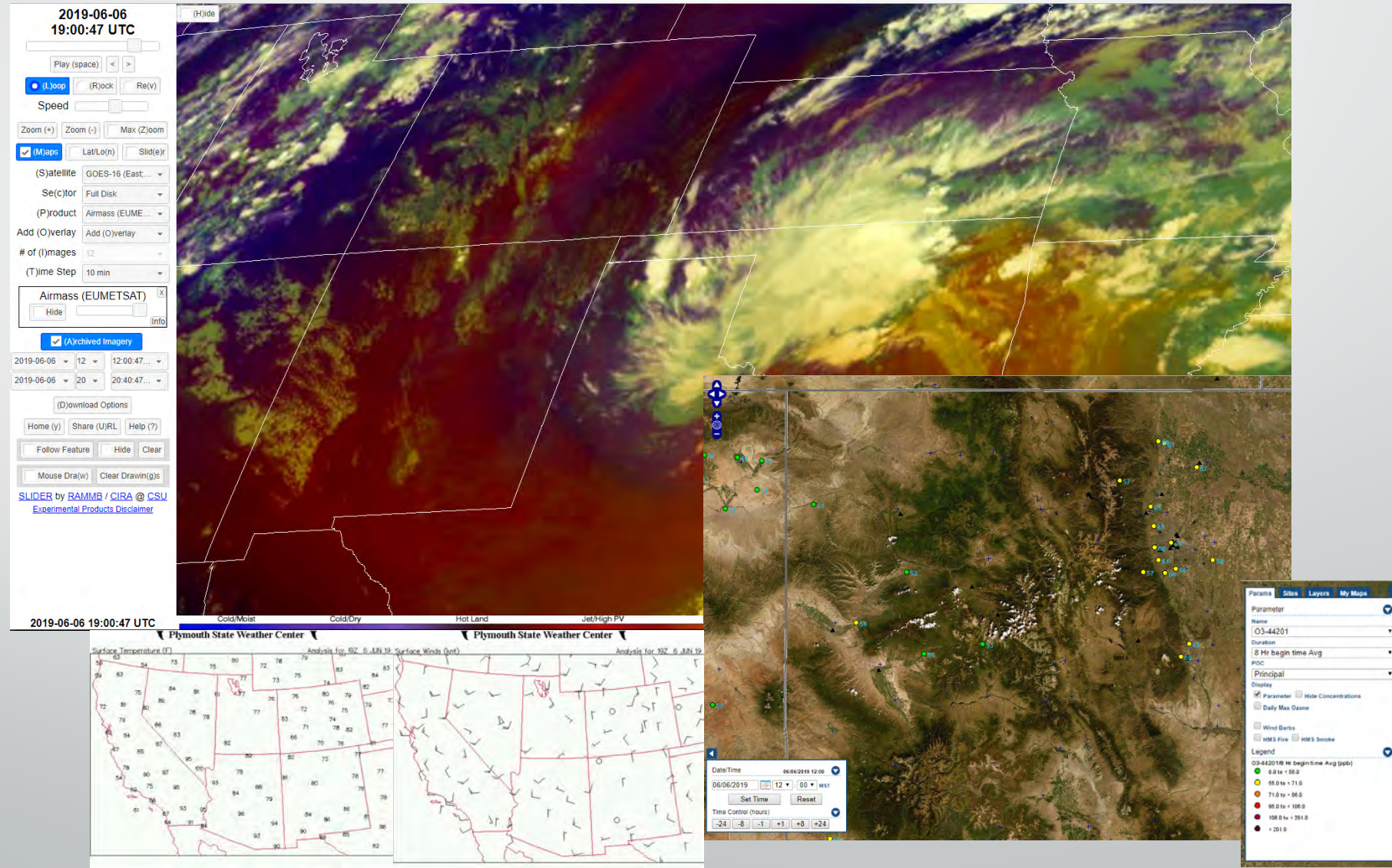
Goals/Hopes for the Future

RGB Airmass
Imagery may be
helpful, still working
on a better
understanding

Geostationary O₃
measurements are
what we are really
after...

Better connection of
satellite retrievals
(and modeling) with
surface
measurements,
verification

TEMPO!





Thanks!

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Additional Slides

Multispectral Products, Bonus

Even small fires are easier to detect with specific bands and multispectral imagery!

