PRESS CONFERENCE:
Wildfire-driven thunderstorms and their role in the climate system

Friday, 11 December
1:00 pm US Eastern Time

AGU FALL MEETING

U.S. NAVAL RESEARCH LABORATORY

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PANELISTS

- **Mike Fromm,** U.S. Naval Research Laboratory
- **David Peterson,** U.S. Naval Research Laboratory
- **Laura Thapa,** University of California Los Angeles

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INFORMATION FOR REPORTERS

- Slides from this presentation are available in the Fall Meeting Media Center: https://www.agu.org/Fall-Meeting/Pages/Attend/Media-Center

- A recording of this event will be posted to AGU's YouTube channel: https://www.youtube.com/c/AGUvideos
  - Playlist "Fall Meeting 2020 Press Conferences"

- An informal, 30-minute discussion room via Zoom will follow this event:
  - Link will be posted in this event's chat box
  - Meeting ID: 962 1469 2326
  - Passcode: agupress

- Questions: Email news@agu.org

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DAVID PETERSON, PH.D.

Meteorologist/U.S. Naval Research Laboratory

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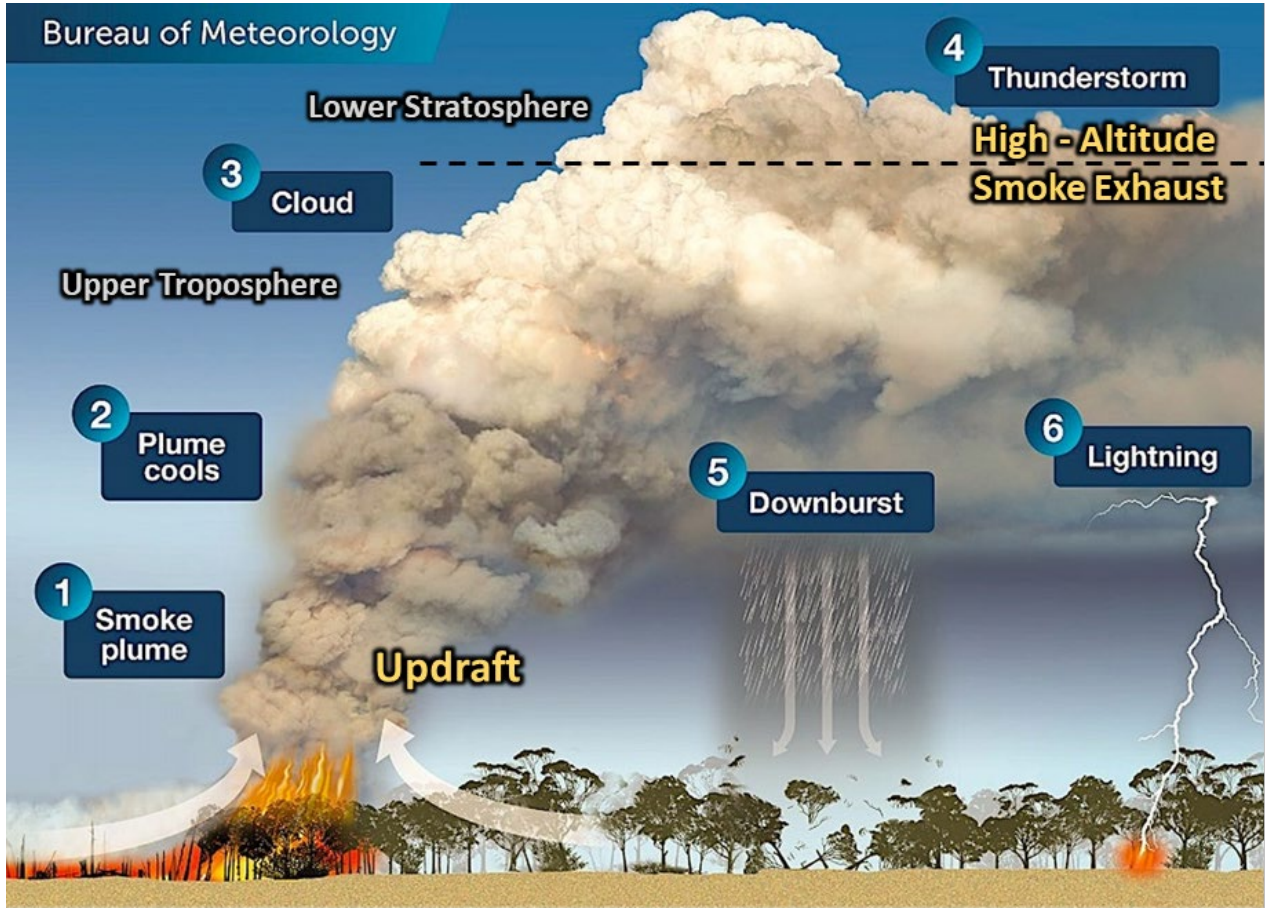
WILDFIRE-DRIVEN THUNDERSTORMS

PYROCUMULONIMBUS (PYROCB)



AUSTRALIAN NEW YEAR SUPER OUTBREAK (ANYSO)

UNPRECEDENTED FIRE AND PYROCB ACTIVITY

Algorithm developed by NRL

First Phase (29-31 December 2019)

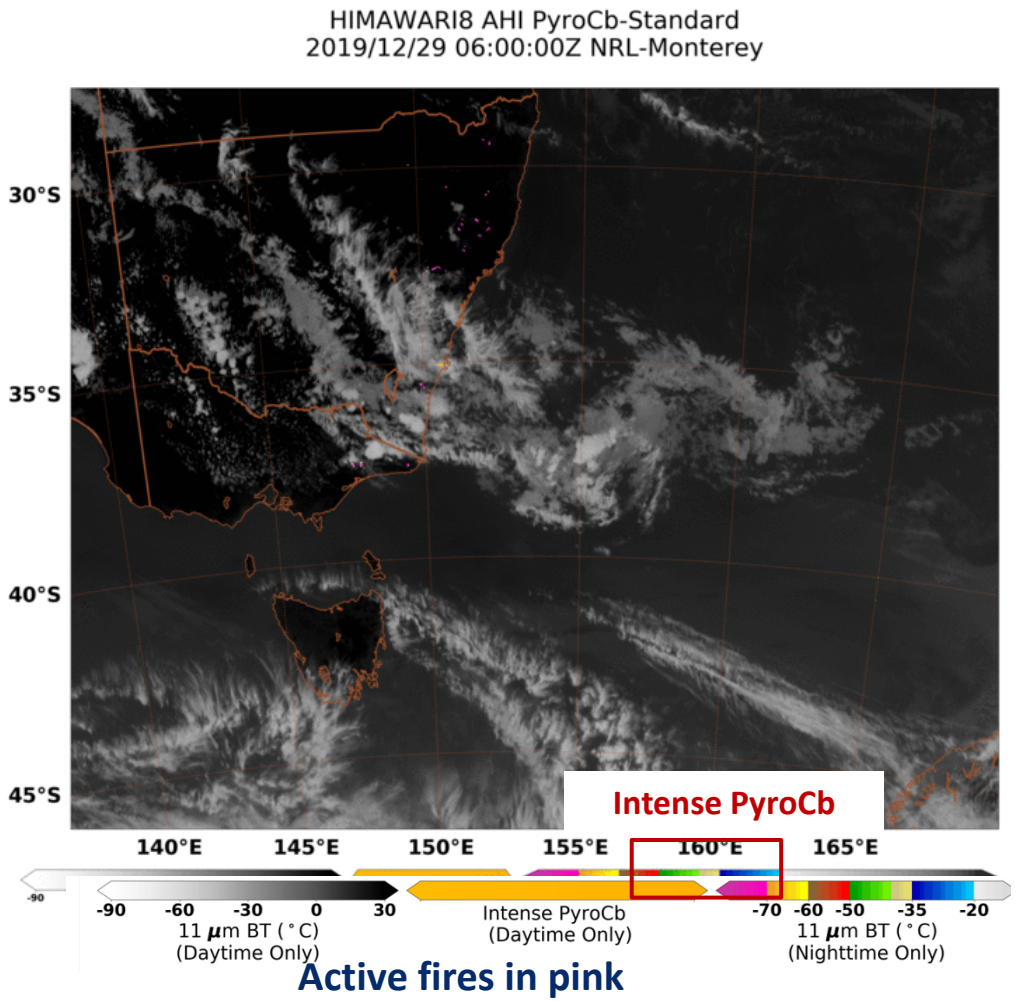
- **First known pyroCb "super outbreak"**
- 32 updrafts over ~45hrs (day and night)
- Previous events: less than 10 updrafts in less than 24hrs

Second Phase (4 January 2020)

- Similar to previous significant events
- Six updrafts over 6hrs (local evening)

Total Impact

- 38 updrafts transporting smoke to high altitudes
- **Two enormous smoke plumes in the stratosphere**



Active fires in pink

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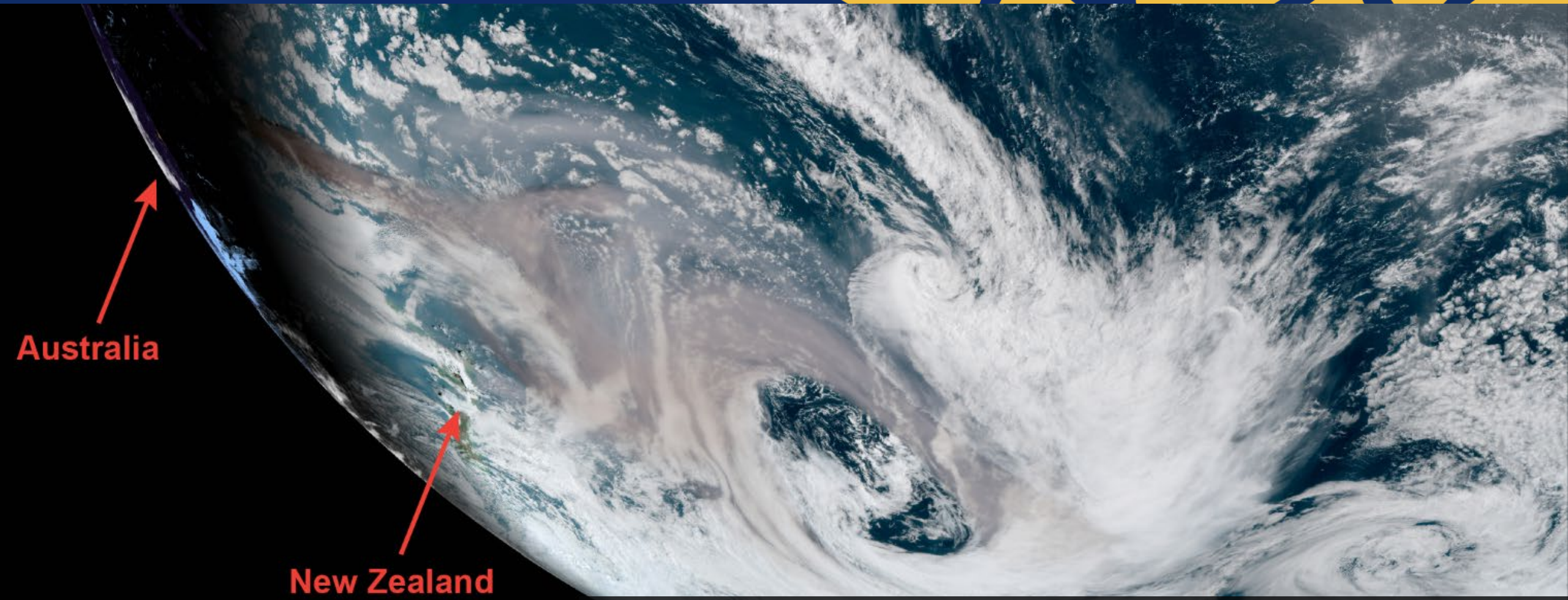

Imagery from CIRA
GOES-17, 1/02/2020, 18:40 UTC

ANYSO PHASE 1:
LARGEST KNOWN STRATOSPHERIC SMOKE INJECTION

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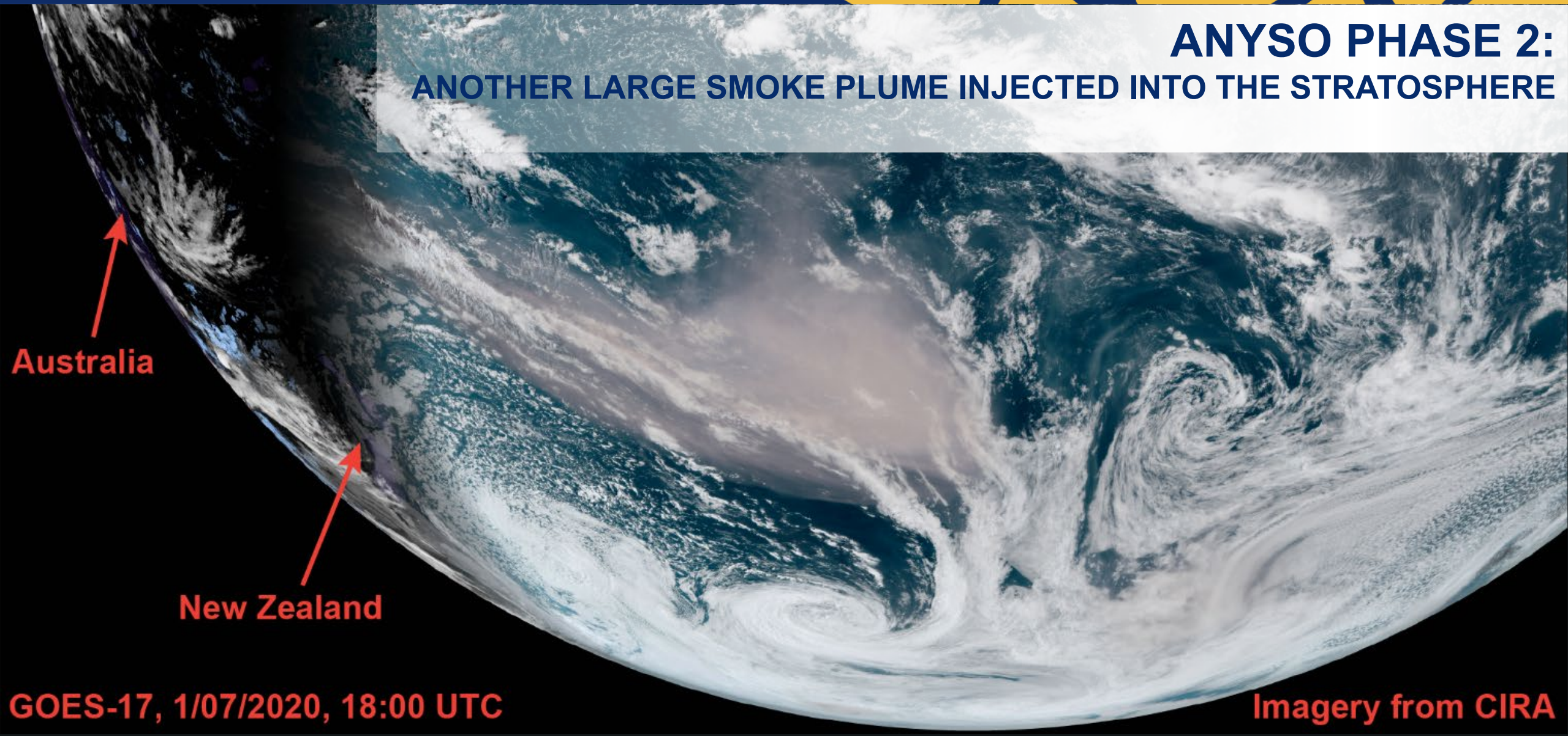
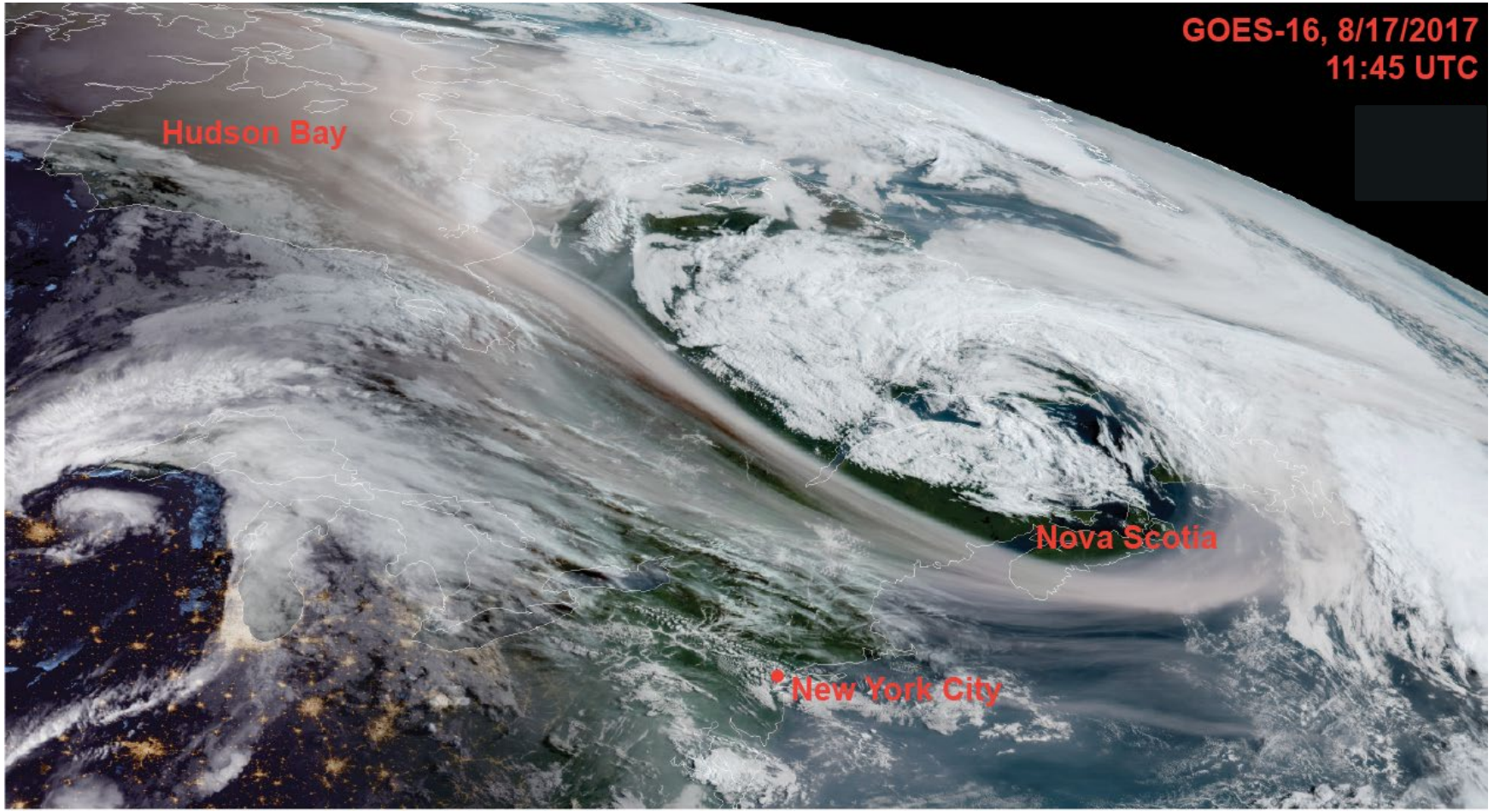
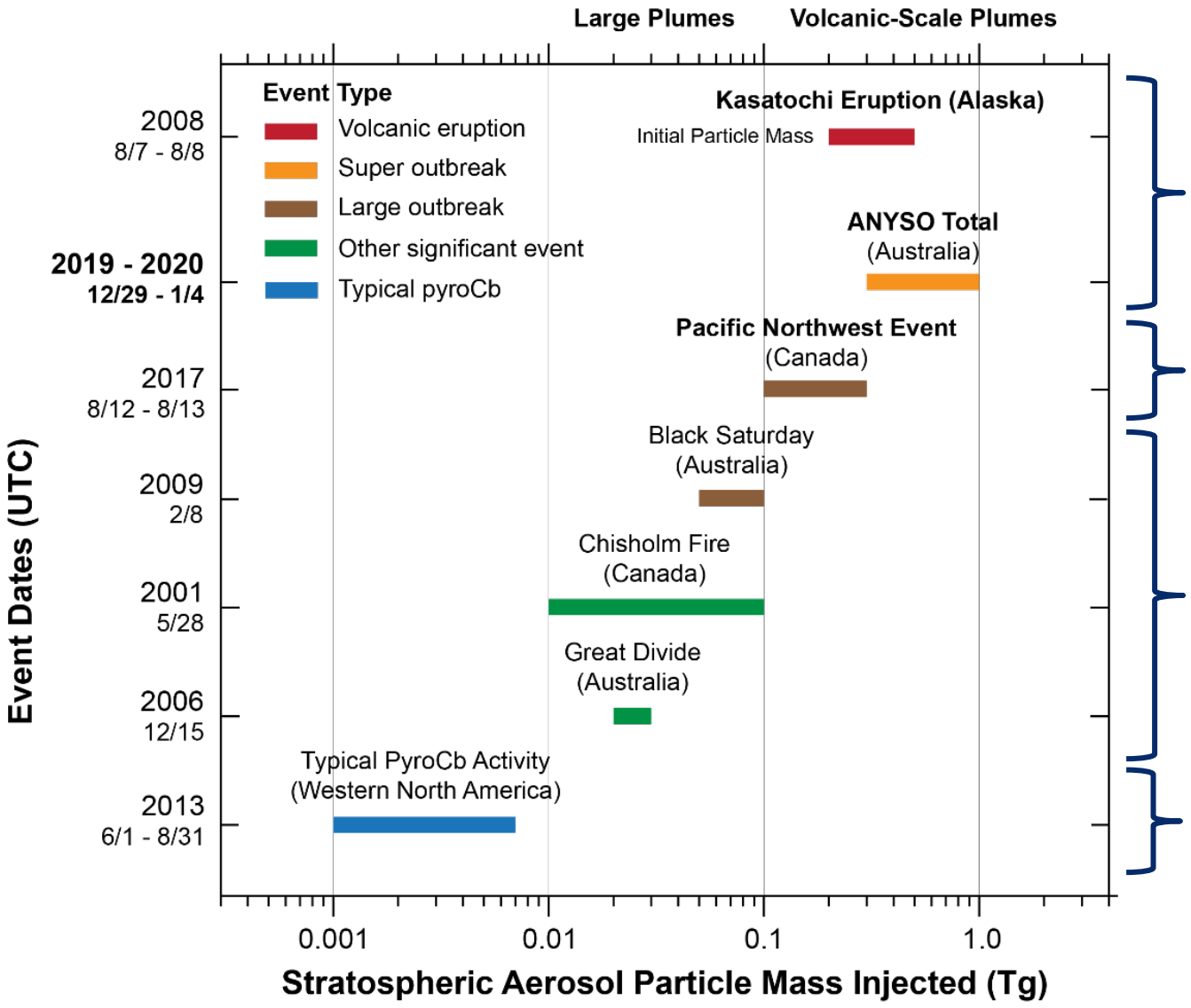
ANYSO PHASE 2:
ANOTHER LARGE SMOKE PLUME INJECTED INTO THE STRATOSPHERE



THE 2017 PACIFIC NORTHWEST EVENT:
PREVIOUS BENCHMARK FOR EXTREME PYROCB EVENT



How does pyroCb activity compare to volcanic eruptions?



A NEW CLASS OF VOLCANIC-SCALE SMOKE PLUMES?

- **Combined Australian pyroCb plume exceeds a moderate volcanic eruption**
- **At least three times larger than the 2017 Pacific NW event**

Previous benchmark for an extreme pyroCb event
Peterson et al. 2018

Significant pyroCb events in the early 2000s

Example of “typical” pyroCb events

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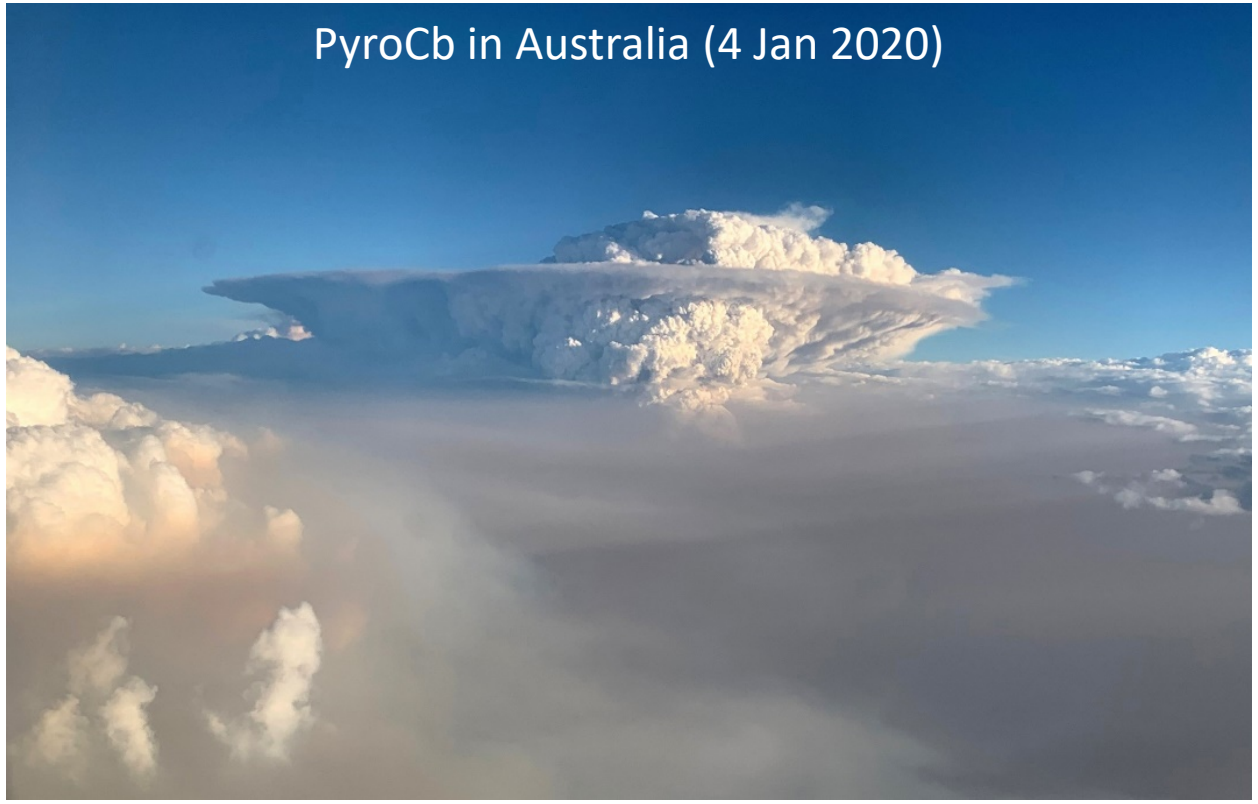
Peterson et al. In Prep (Nature PJ, Climate and Atmos. Science)

Contact: david.peterson@nrlmry.navy.mil Twitter: @DrDavePeterson

WHAT'S NEXT IN PYROCB RESEARCH?



https://www.nbcnews.com/science/environment/fire-clouds-after-australia-scientists-warn-erratic-weather-phenomenon-could-n1115686

It is now relevant to ask:

- Are recent events in Australia and Canada harbingers of even larger pyroCb outbreaks?
- Can we expect more pyroCb super outbreaks in a warming climate?
- What is the impact of large pyroCb smoke plumes on the atmosphere?

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MIKE FROMM, PH.D.

Meteorologist/U.S. Naval Research Laboratory

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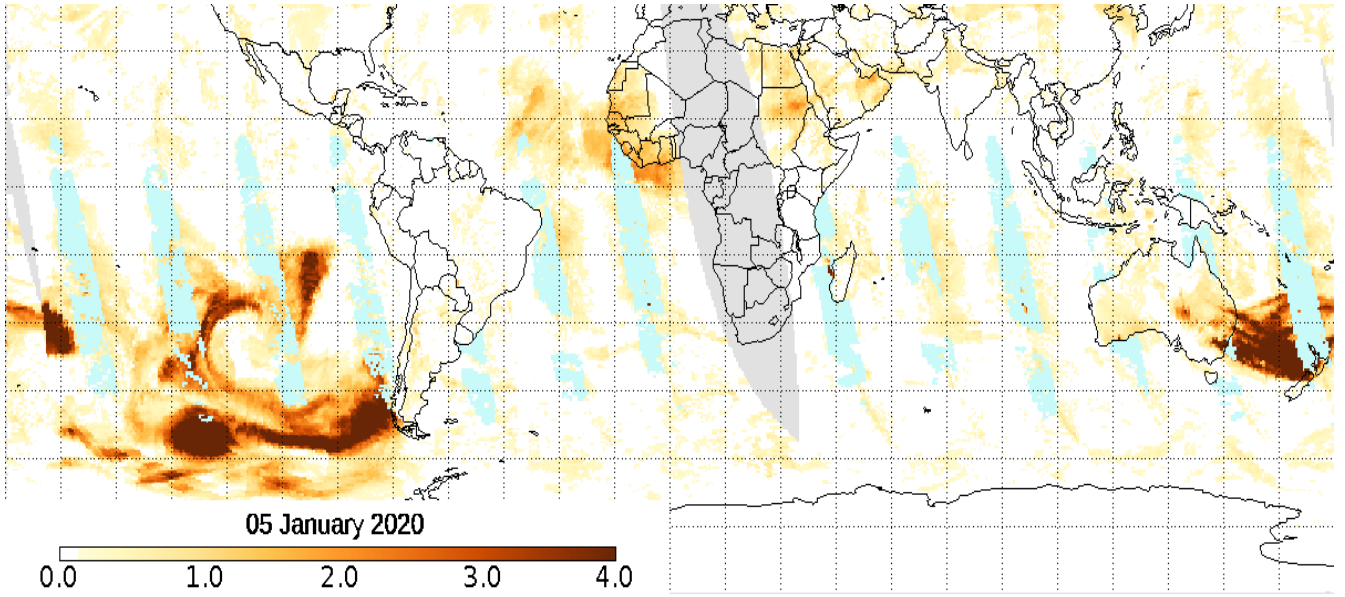
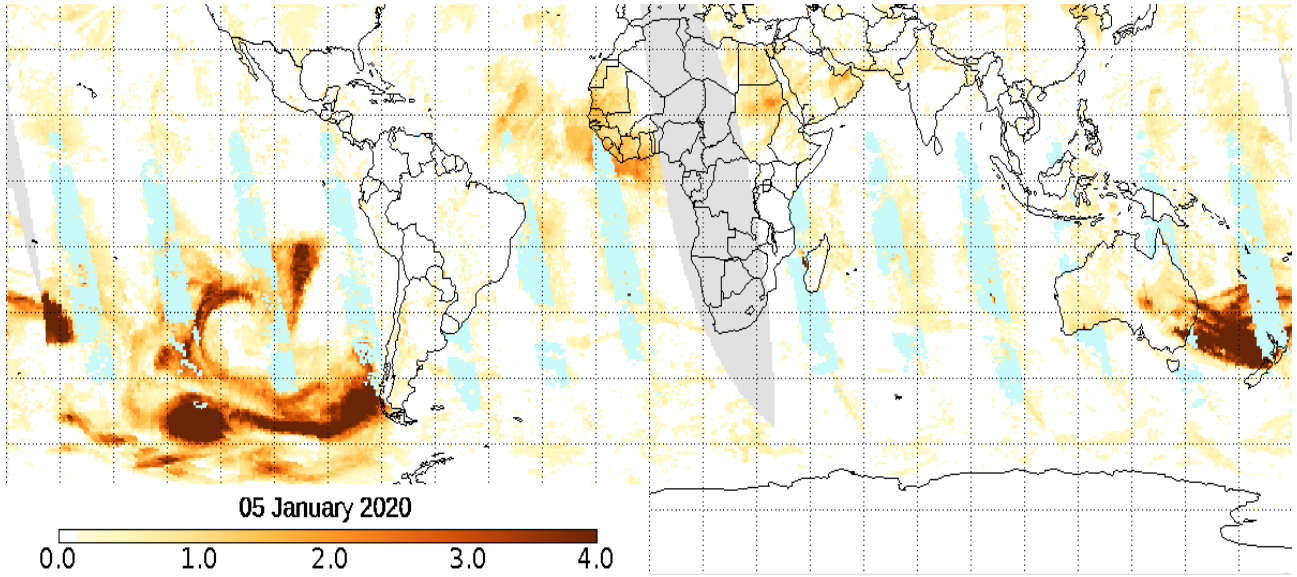
THE BIG PICTURE

One week after the Australia New Year pyroCb outbreak. Thick, high-altitude smoke from Australia to South America.



NASA Ozone Mapping & Profiler Suite UV Absorbing Aerosol Index, 5 Jan 2020.



AUSTRALIA PYROCB SMOKE IN THE STRATOSPHERE.

What's new? Surprising? Important?

- Smoke ascending into the middle stratosphere
- Smoke spinning as it ascends
- Smoke creates its own stratospheric circulation
- Smoke altitude rivals Mt. Pinatubo's 1991 volcanic cloud
- These "new" observations lead scientists to re-examine past plumes.
  - Hint: SWIRLs have happened before. We just didn't know 'til now.

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RECENT PUBLICATIONS

Geophysical Research Letters

RESEARCH LETTER
10.1029/2020GL088101

Australian PyroCb Smoke Generates Synoptic-Scale Stratospheric Anticyclones

G. P. Kablick III[1], D. R. Allen[1], M. D. Fromm[1], and G. E. Nedoluha[1]

[1]US Naval Research Laboratory, Washington, DC, USA

Key Points:

- Pyrocumulonimbus plumes diabatically heated the local stratosphere, driving rapid ascent

https://doi.org/10.1038/s43247-020-00022-5 OPEN

The 2019/20 Australian wildfires generated a persistent smoke-charged vortex rising up to 35 km altitude

Sergey Khaykin[1✉], Bernard Legras[2], Silvia Bucci[2], Pasquale Sellitto[3], Lars Isaksen[4], Florent Tencé[1], Slimane Bekki[1], Adam Bourassa[5], Landon Rieger[5], Daniel Zawada[5], Julien Jumelet[1] & Sophie Godin-Beekmann[1]

In press: J. Atmos. Science

Smoke with Induced Rotation and Lofting (SWIRL) in the Stratosphere

DOUGLAS R. ALLEN,[a] MICHAEL D. FROMM,[a] GEORGE P. KABLICK III,[a] AND GERALD E. NEDOLUHA[a]

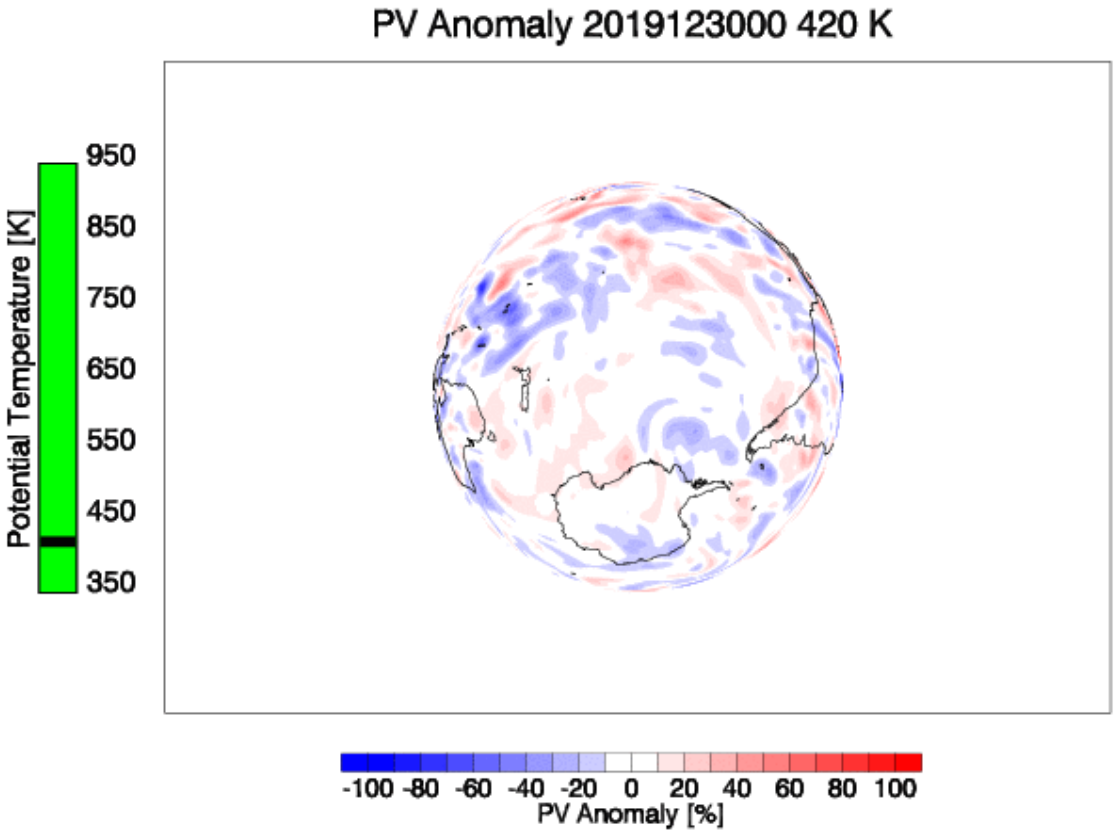
[a] *Remote Sensing Division, Naval Research Laboratory, Washington, D.C.*

(Manuscript received 5 May 2020, in final form 14 August 2020)

This animation follows the largest Australian SWIRL for two months. Follow the red blob. It starts in early January over the South Pacific. It moves east to South America, then reverses course. It then travels completely around the world by March 2020. The green scale on the left, with the rising back bar, shows the plume ascent during its travels. It started at ~15 km and more than doubled its altitude.

SWIRL

Q: Can we actually observe the smoke circulation?
A: Yes! See the next slide.



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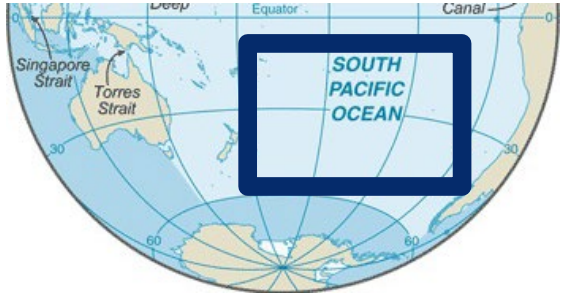
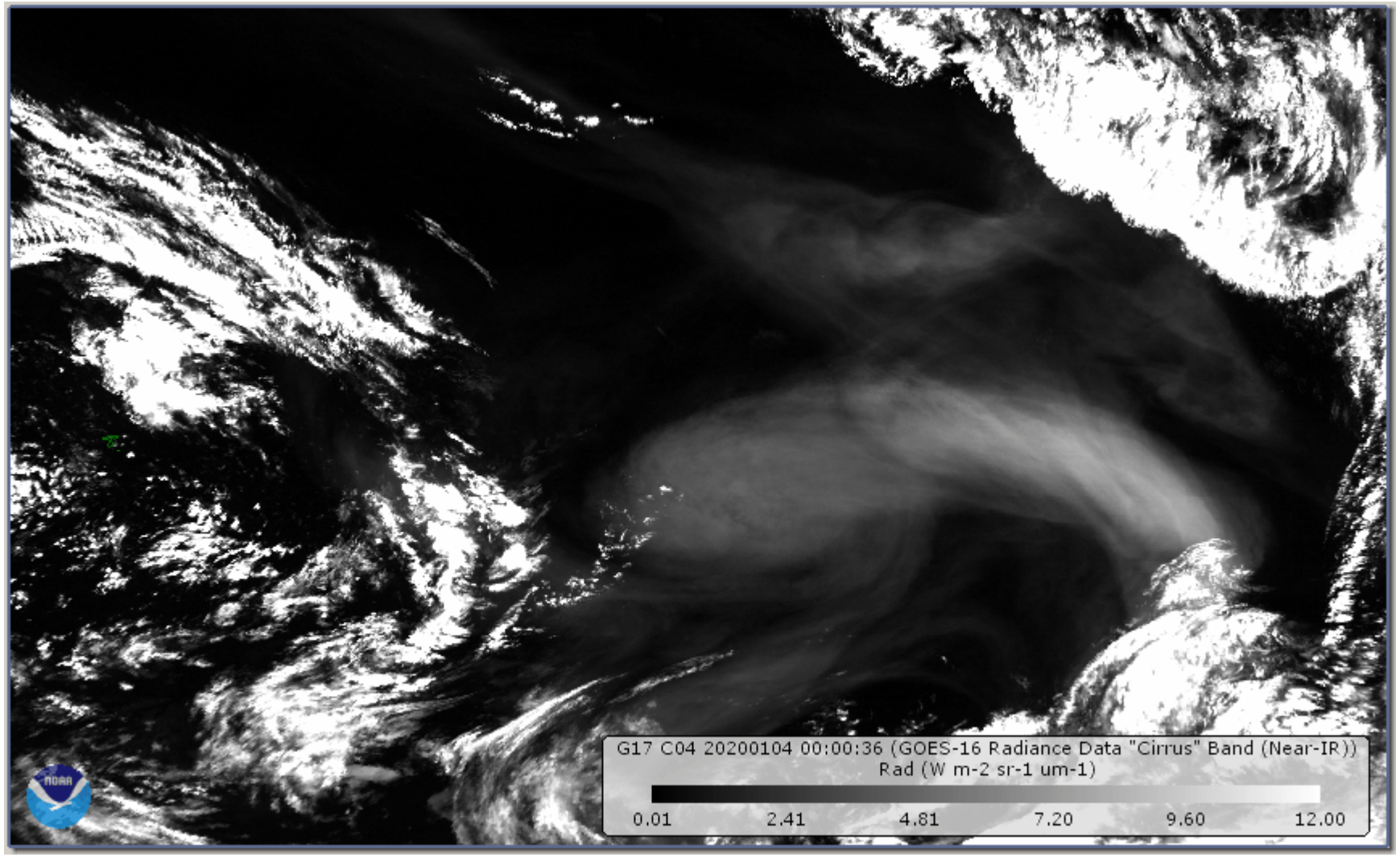
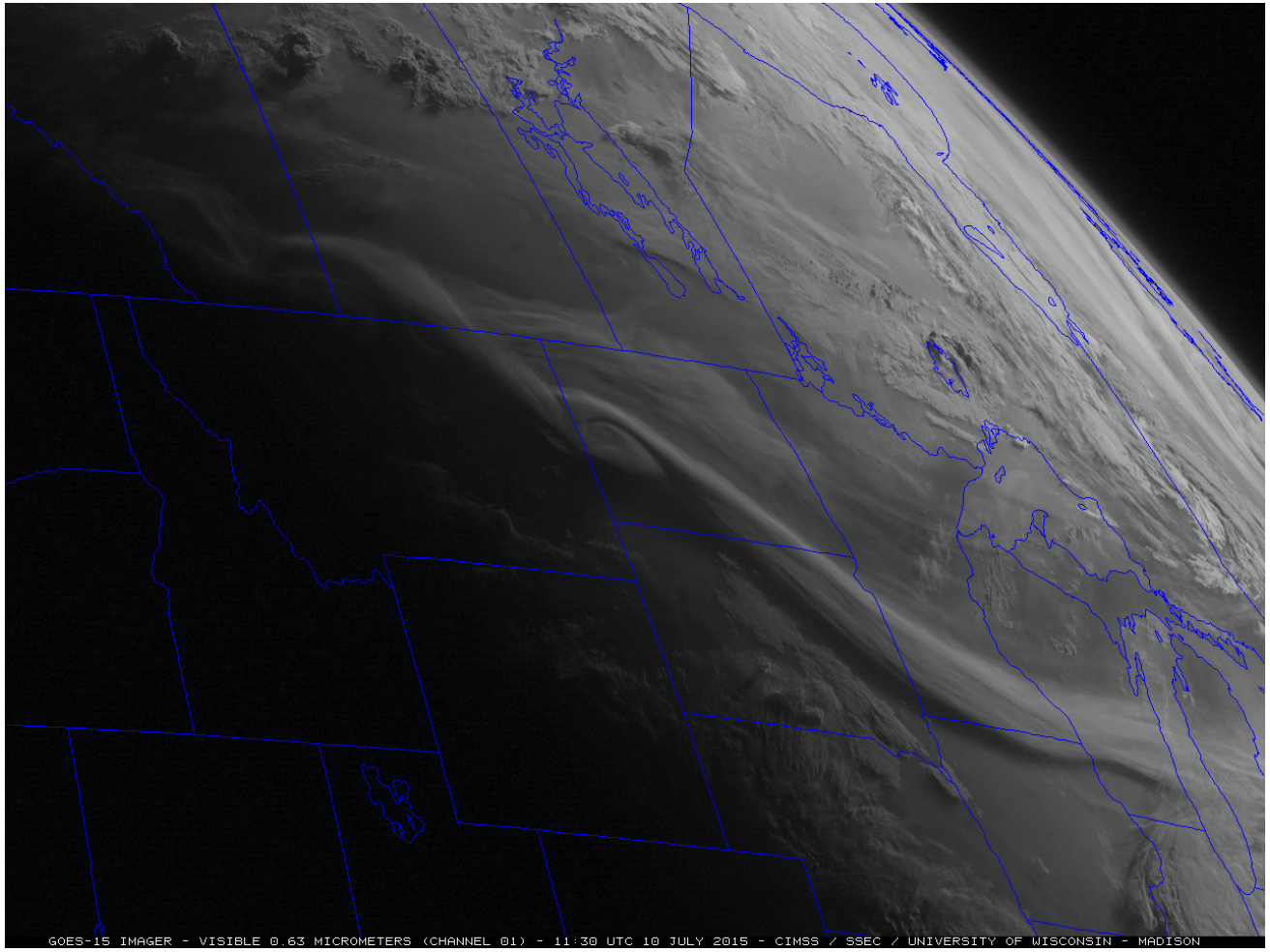
Clouds are white. Smoke is fuzzy gray. The stratospheric plume is spinning.



4 JANUARY
SOUTH PACIFIC



SPINNING SMOKE AT AIRLINER ALTITUDES. CANADA/USA. DID THE SMOKE ALTER THE JET STREAM?



NOAA GOES visible reflectance.

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AUSTRALIA PYROCB SMOKE SWIRLING IN THE STRATOSPHERE

What's next?

- We are in a golden age of satellite monitoring of Earth's atmosphere.
- Satellite data have shown us something "new," yet with a promise of unearthing missed discoveries.
- Weather and climate models now have brand new horizons to simulate. And existing model theories can be tested against these space-based observations.
- We can explore if Australia 2020 is truly unprecedented, or rather a recurring phenomenon.
- We can and should "get up and close" to pyroCbs, probing to understand just what causes these remarkable smoke plumes.

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LAURA THAPA

University of California, Los Angeles/ NREIP Intern, U.S. Naval Research Laboratory

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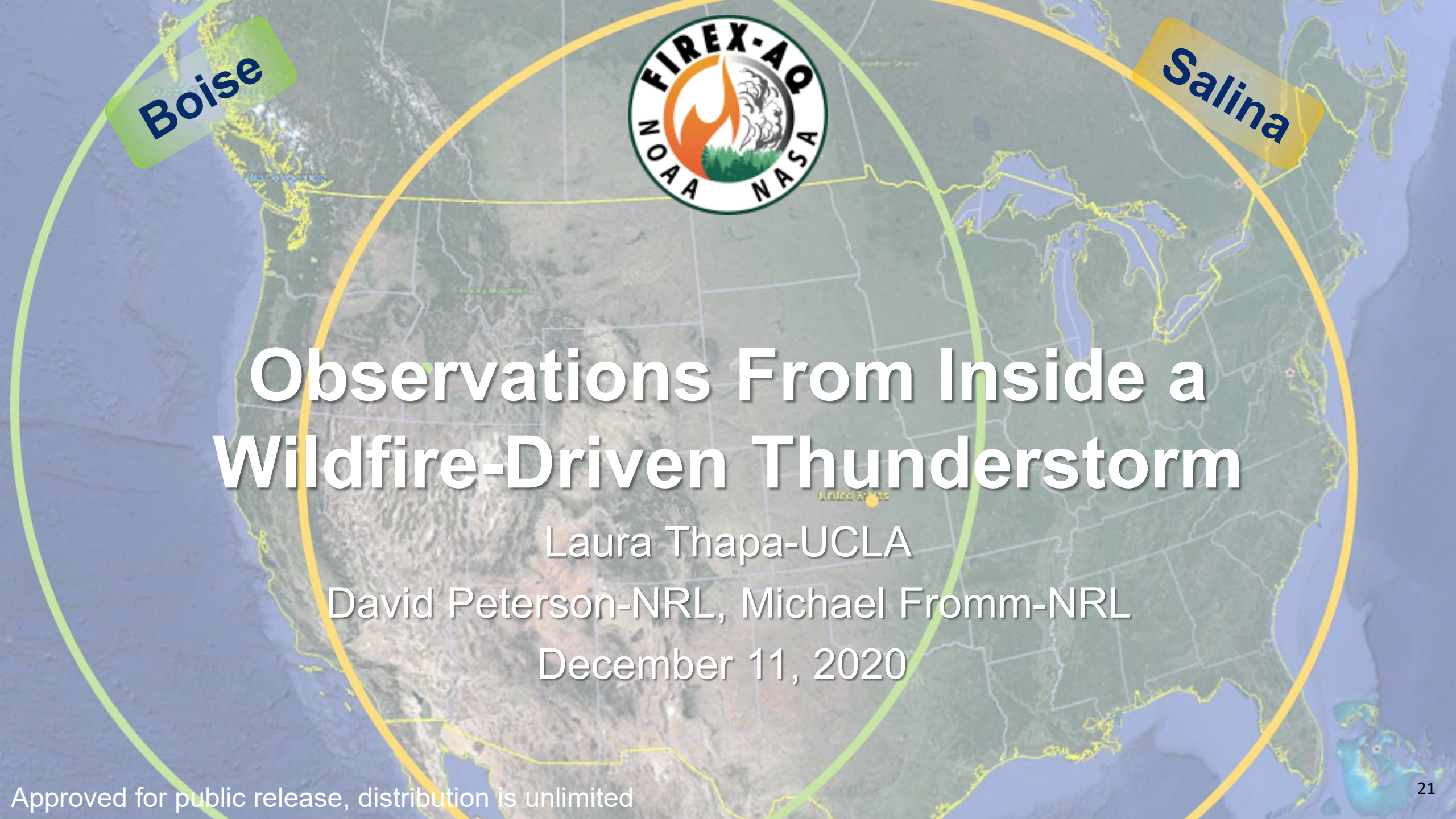

Observations From Inside a Wildfire-Driven Thunderstorm

Laura Thapa-UCLA

David Peterson-NRL, Michael Fromm-NRL

December 11, 2020

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FOR THE FIRST TIME EVER…

Scientists gathered detailed measurements from inside an active wildfire-driven thunderstorm in real time.

Using NASA's DC-8 airborne science laboratory!

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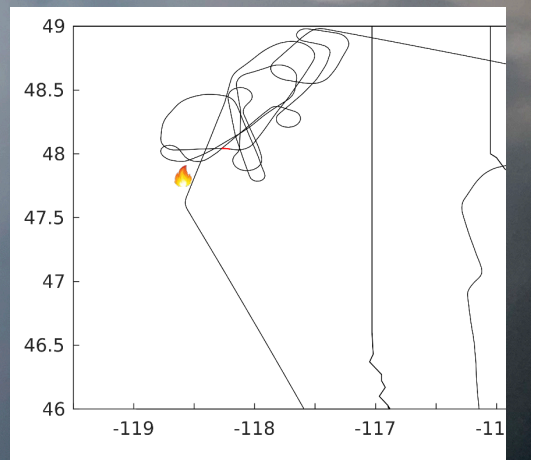
BRAND NEW SCIENCE QUESTIONS

1. What was sampled?



2. How does the *cloud* change the smoke?

3. How does the *smoke* change the cloud?

4. What kinds of ecosystems burned?

5. Downwind impacts?

Williams Flats Fire

- August 2019
- NE Washington State
- Case study: Aug 8 pyroCb event

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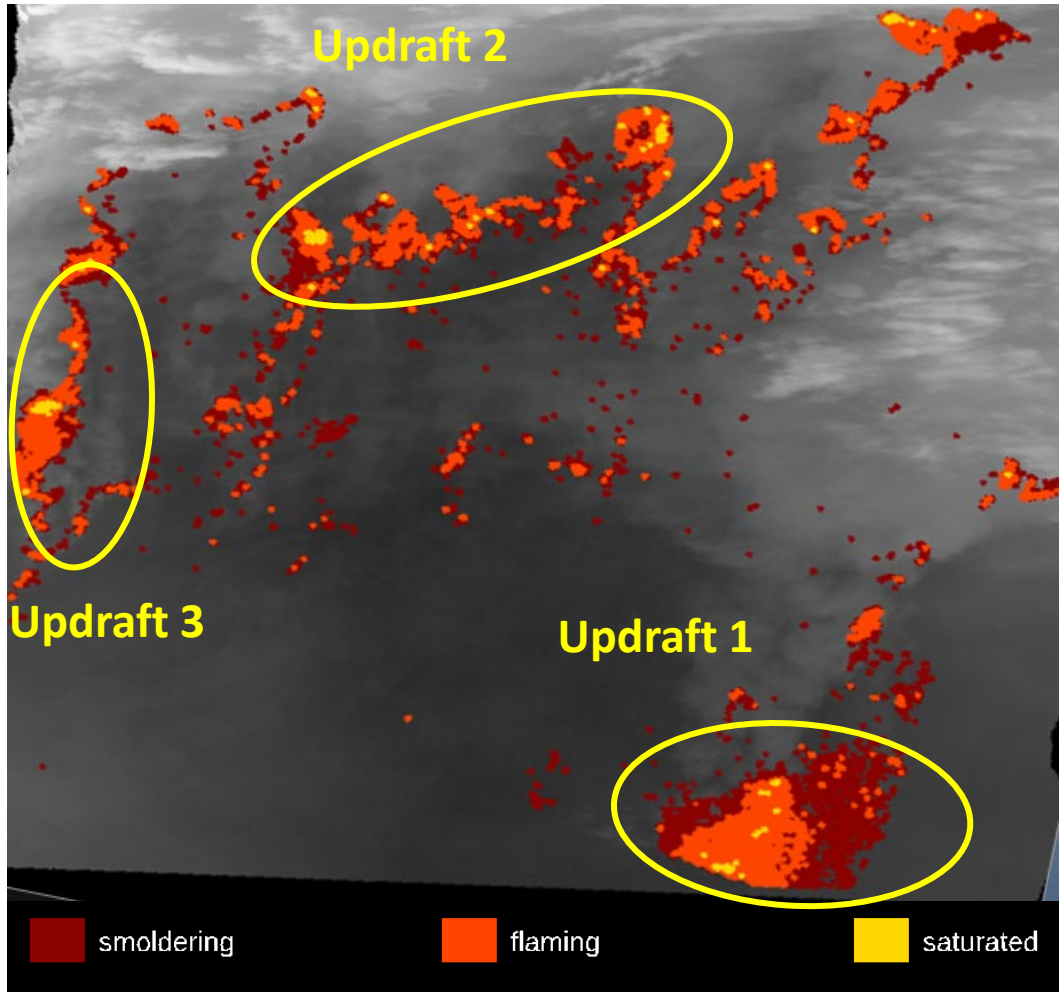
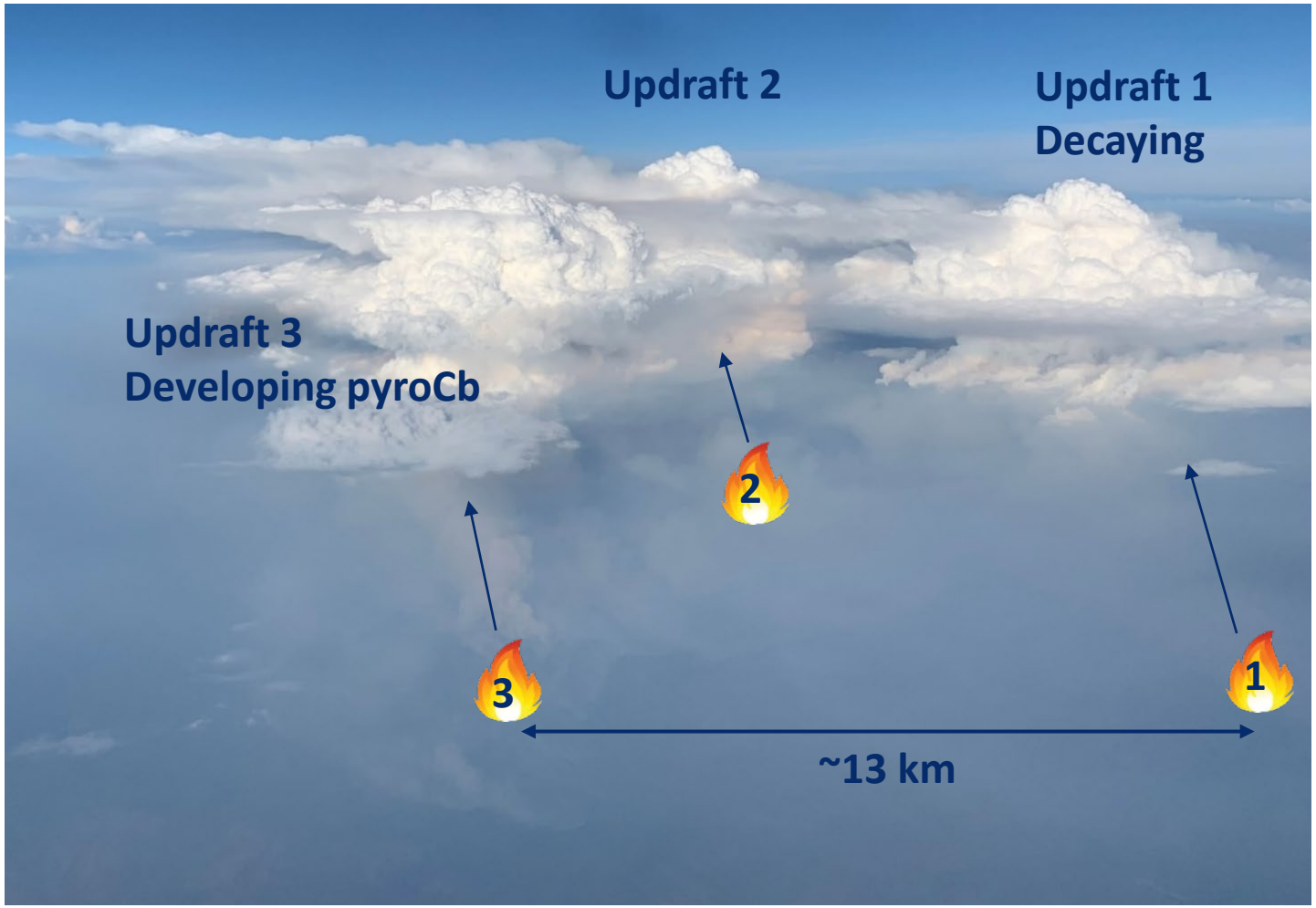
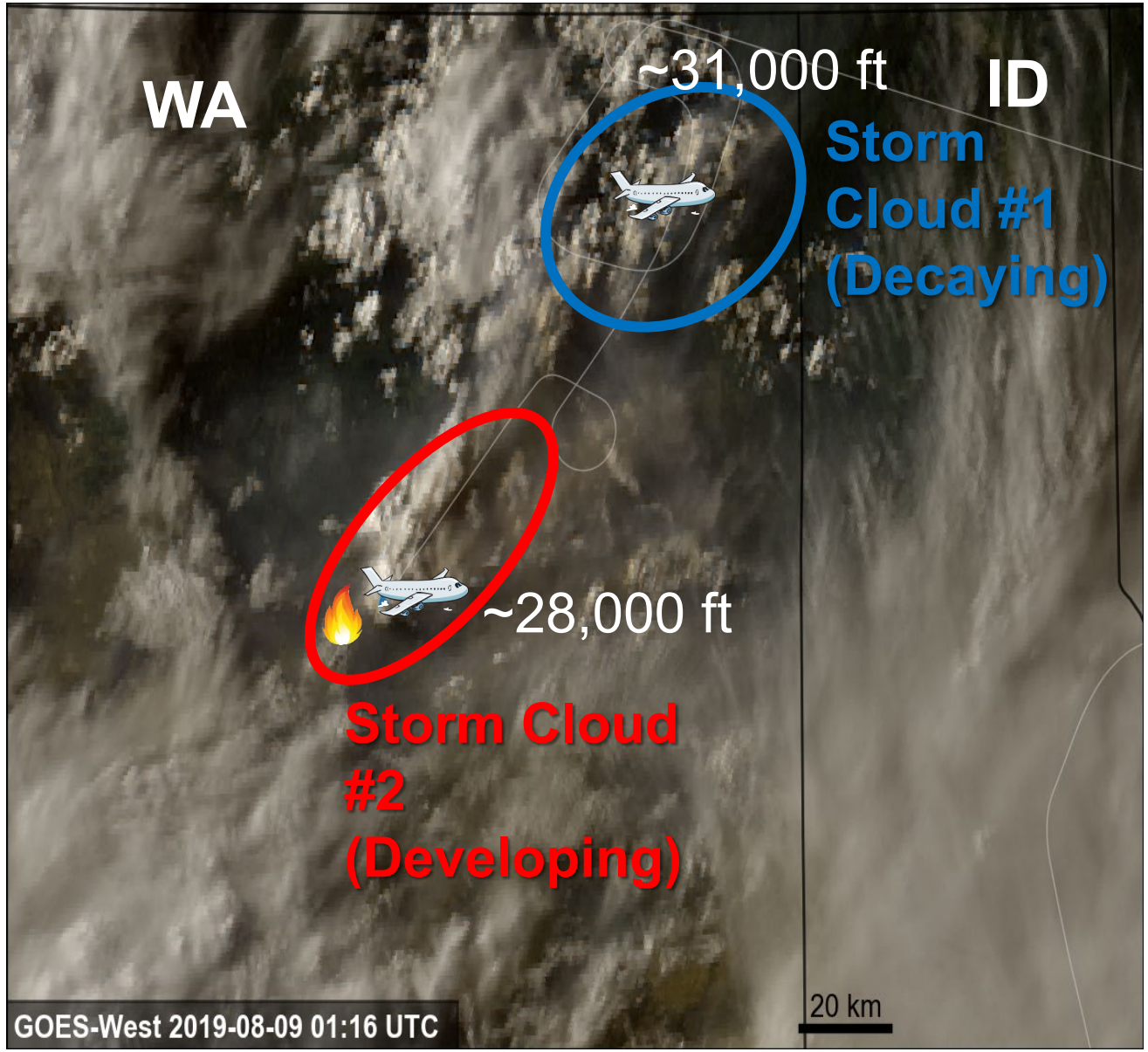
THREE FIRES IN ONE!





WHAT WE SAMPLED



Imagery courtesy of Chris Holmes and the FIREX-AQ Science Team

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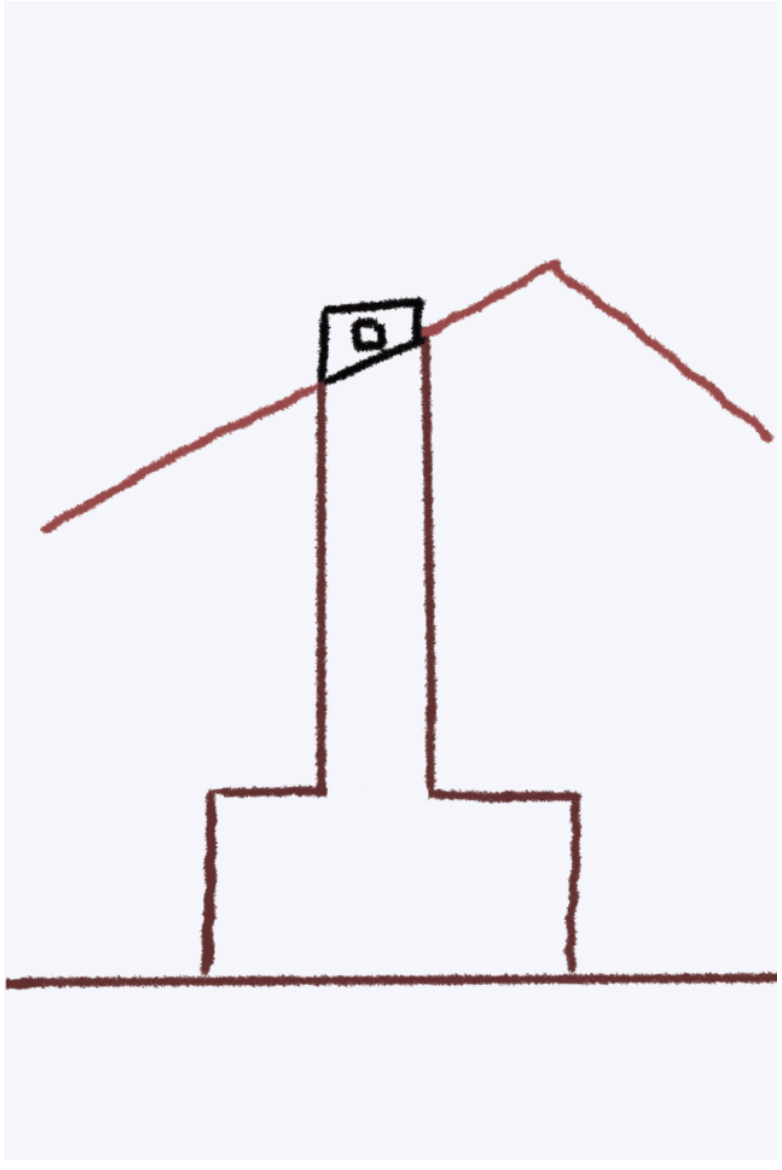
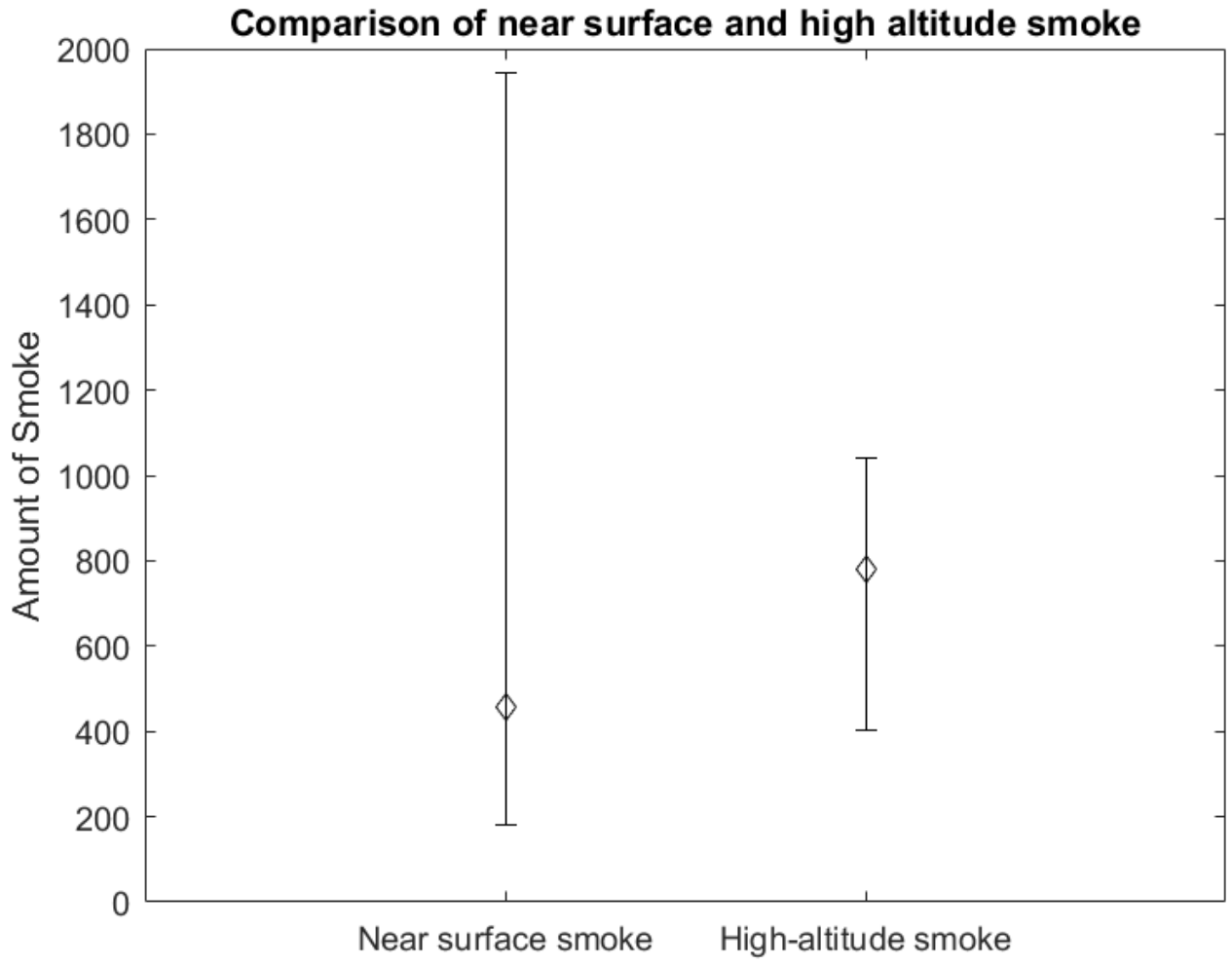
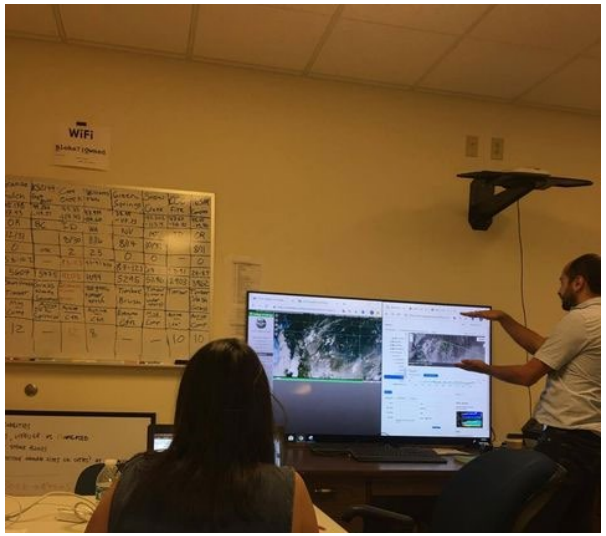
A CLOUDY CHIMNEY



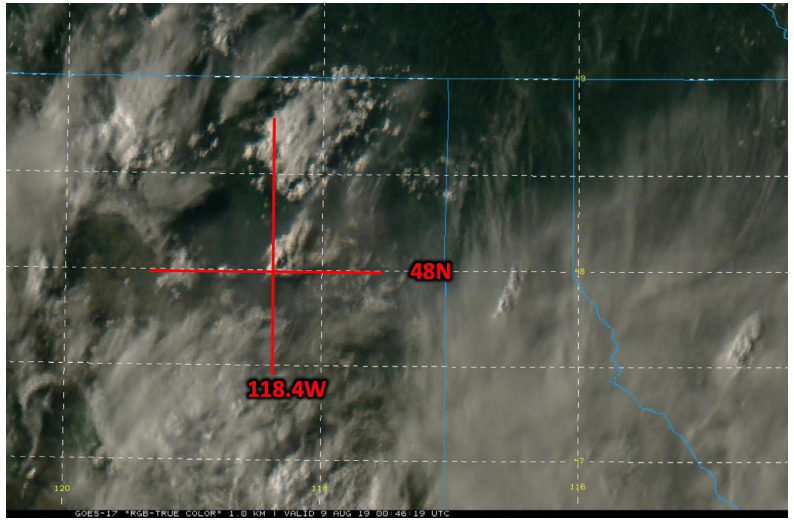


FROM THE GROUND TO THE AIR

In the forecasting room, we saw the storm beginning to form



We sent storm location to aircraft



The DC-8 Sampled the storm!

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THANK YOU!

(lthapa@ucla.edu, twitter: @wildfirebender)

THANK YOU

Contact us:
NRLPAO@NRL.NAVY.MIL

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QUESTIONS

Please write your questions in the Q&A box and AGU will ask it on your behalf.

Reminder: A 30-minute, informal discussion will commence in Zoom after this event ends.

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