The Impacts of Wildland Fires and Lower Troposphere Ozone in relation to Air Quality during CABOTS 2016

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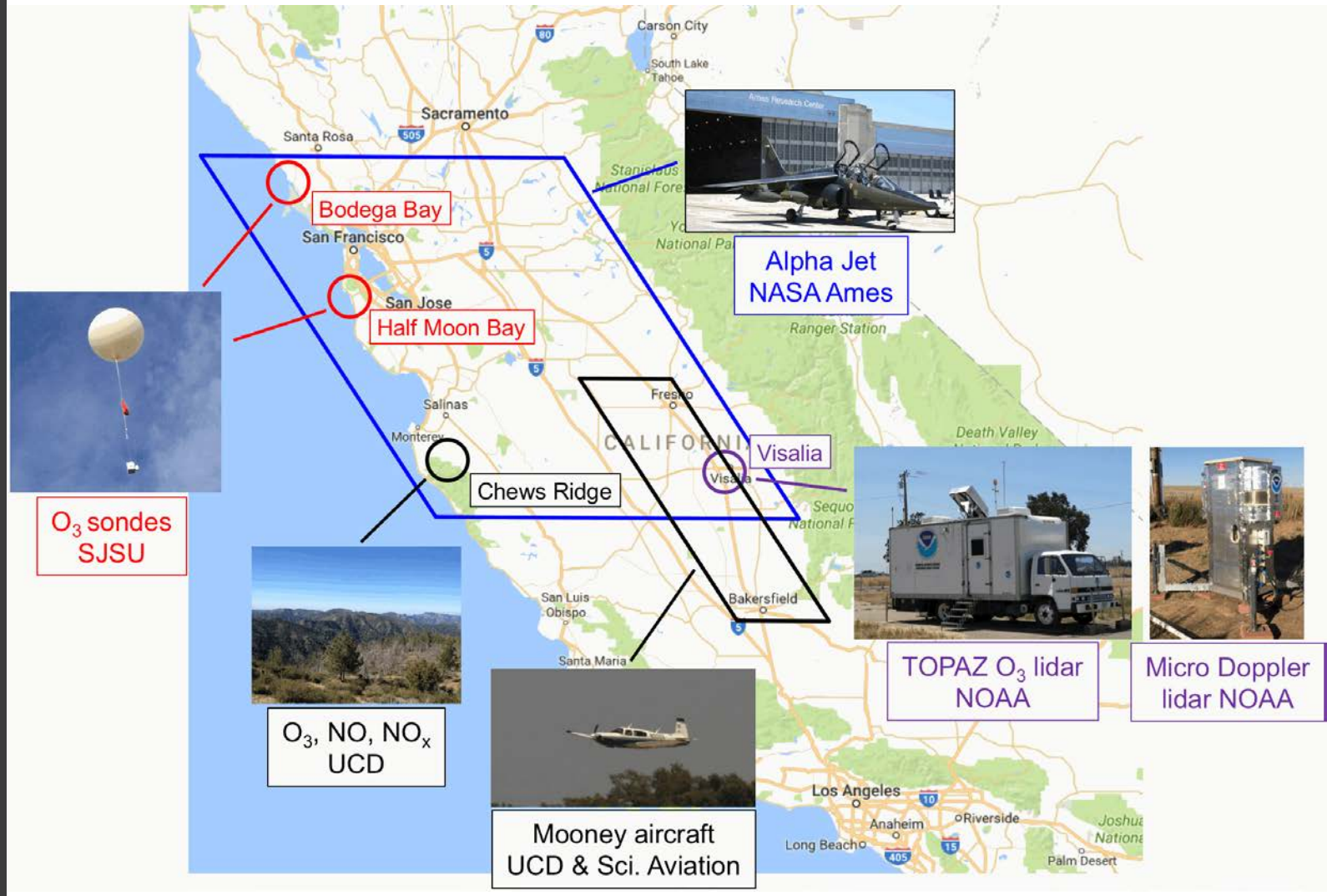
Introduction
What is CABOTS?

The CABOTS air quality study was conducted from May – August 2016.

Sought to quantify California's starting point for complying with the federal O3 standard, by making precise O3 measurements aloft.

Included two intensive observational periods.

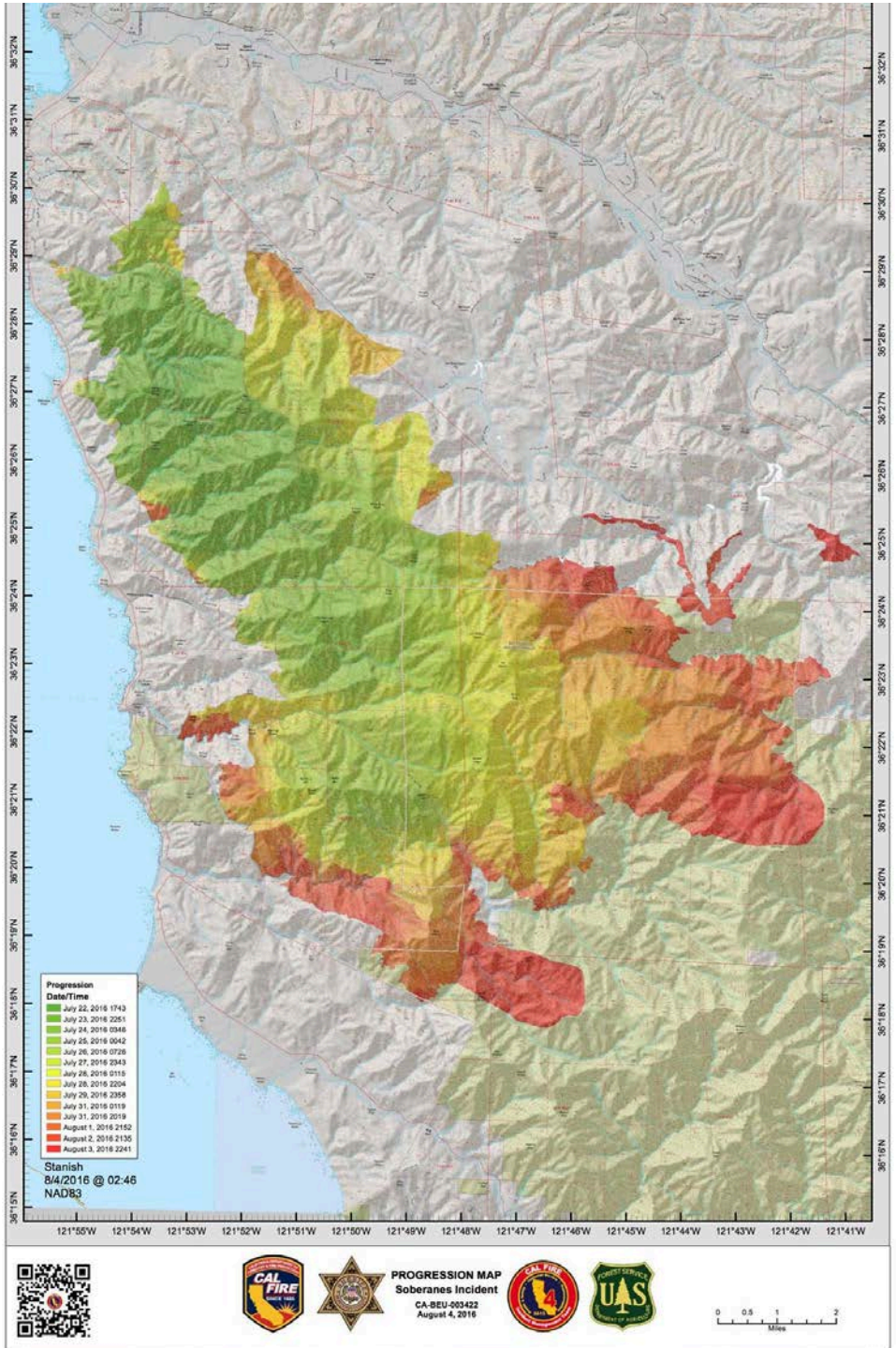
1. during the spring "transport" season, from late May to mid-June (IOP1).
2. during the summer "ozone" season when locally produced ozone is high, from mid-July to early August (IOP2).



https://www.esrl.noaa.gov/csd/projects/cabots/scienceintro.html

Why is this study important?

- Despite dramatic improvements in California's air quality, some areas still do not meet the 2008 set NAAQS for MDA8 of 75 ppbv.
- Understanding the variations in O3 entering California has become of greater importance as the state strives to meet the stricter 2015 O3 set NAAQS of 70 ppbv.
- This study shows links between low-level stratospheric intrusions from the north and wildfire outbreaks during IOP2, both which contribute to the non-attainment of the region.
- While high Potential Vorticity (PV) in the upper atmosphere is a known tracer of stratospheric air, in the lower levels it can be an indication of convention.
- Yet high PV values in the lowest layers of the atmosphere corresponding with minimal moisture would be an indication of stratospheric air near the surface, bringing along high O3 concentrations which could lead to harmful exceedances of the NAAQS.



The Soberanes Fire Monterey County

- Ignited July 22nd, 2016 @ 8:48 am (1448 UTC)
- Active through October 13, 2016
- July 26 – State of Emergency declared for Monterey County
- Grew by ~4000 acres the night of August 3rd

https://fire.ca.gov/incident

The Cold Fire Yolo County

- Ignited August 2nd, 2016 @ 4:36 pm (2336 UTC)
- Active through August 12, 2016
- Exploded night of 2nd and into the 3rd when burning 4600 acres of its 5731 acre total

https://fire.ca.gov/incident

Data

MERRA-2 PV and Specific Humidity (SH)

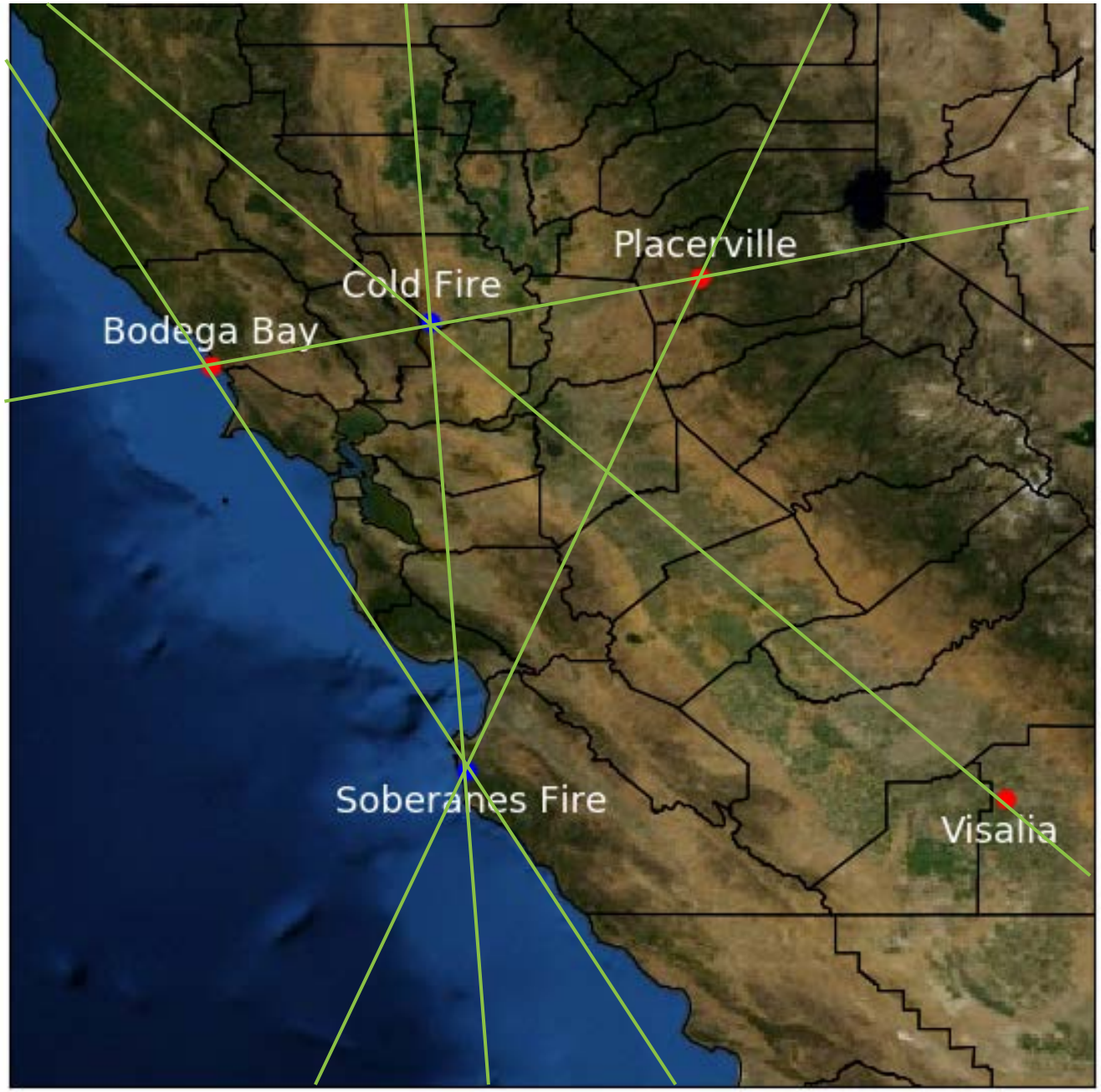
Analysis Methods

Vertical Cross-sections – Show intrusion into Fire and Ozone locales

Differences between the regional averages and local averages a.k.a. the anomalies – confirm the timing and strength of the stratospheric influence into the local area.

Vertical Cross-Sections

- Defines the regional area for averaging
- Multiple PV and SH cross-secs were performed through Fire and Ozone observation sites
- Analyzed for July 15 – Aug 14, 2016 to show the arrival of a stratospheric intrusion into Fire and Ozone locales on dates of interest

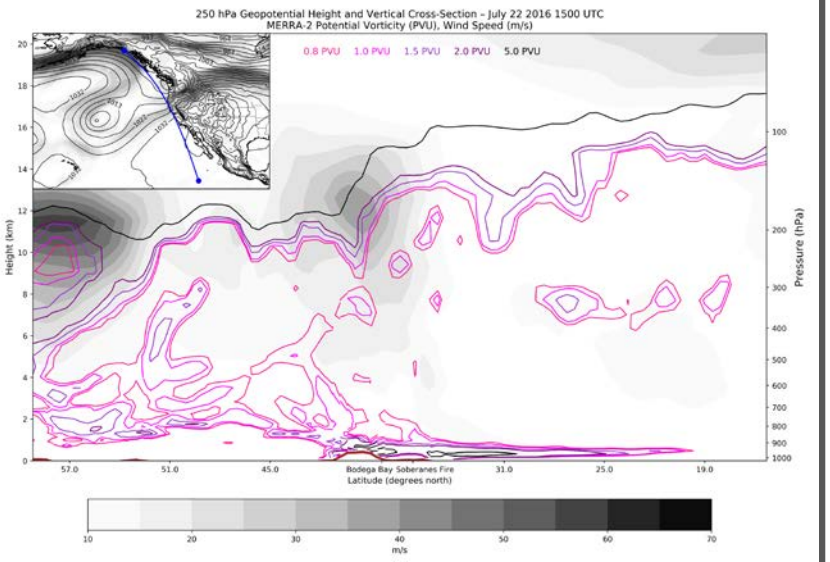


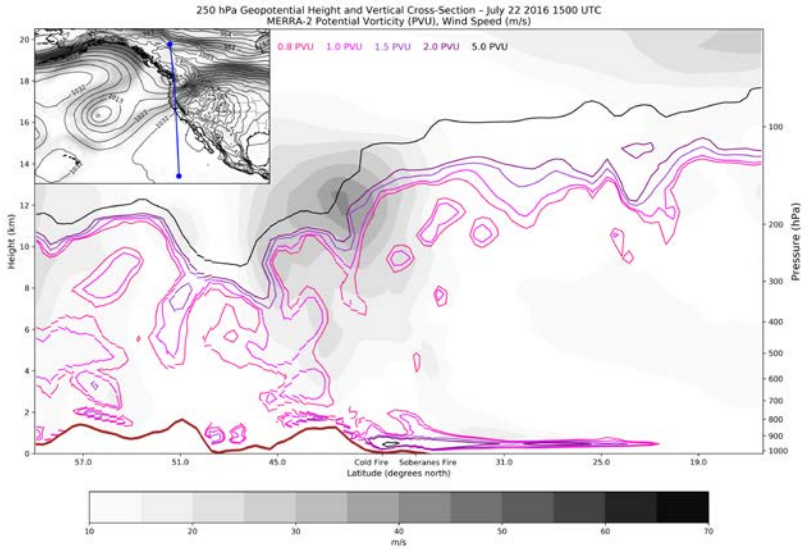
Calculated Differences between Regional averages and local averages

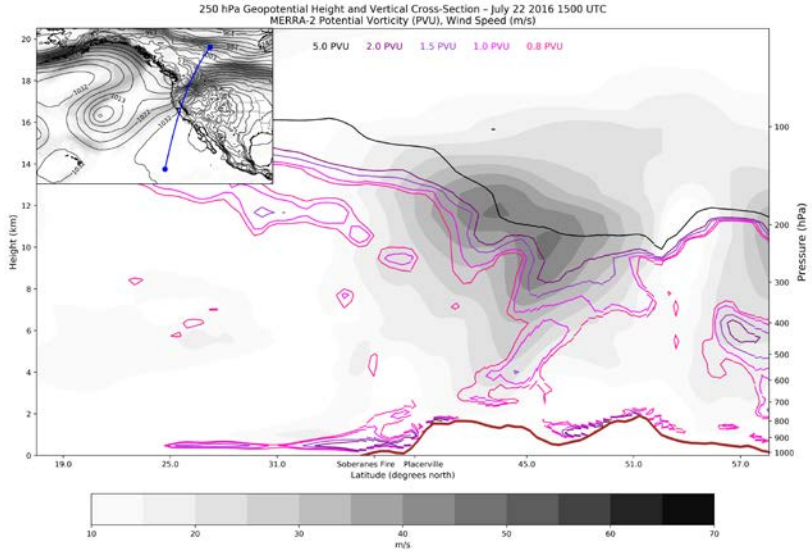
- The Northern California regional averages display the main synoptic features that will influence the large region.
- To gain a greater understanding to the spatial and temporal variations of these synoptic features and their impacts, the deviation of the variables in the vertical column elevated was analyzed for the 5 regions of interest.
  - Coastal site : Bodega Bay
  - Fire Sites : Cold and Soberanes
  - Inland Sites : Placerville and Visalia
- Anomalies in PV and SH are used to investigate temporal and spatial influence of the low-level stratospheric intrusion filaments.

Results

PV vertical cross-sections and local PV anomalies show that the anomalies could be used to forecast the arrival of stratospheric air into the lower atmosphere and therefore bring prime meteorological conditions for fire outbreak, development and growth.

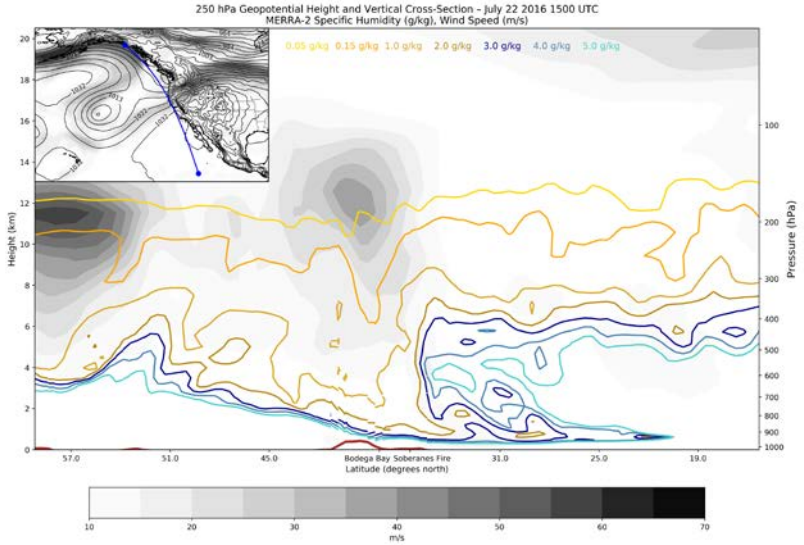


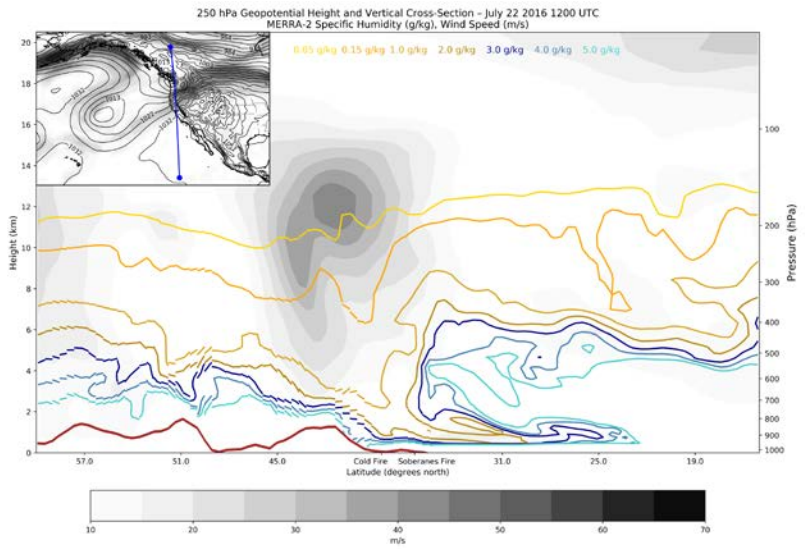


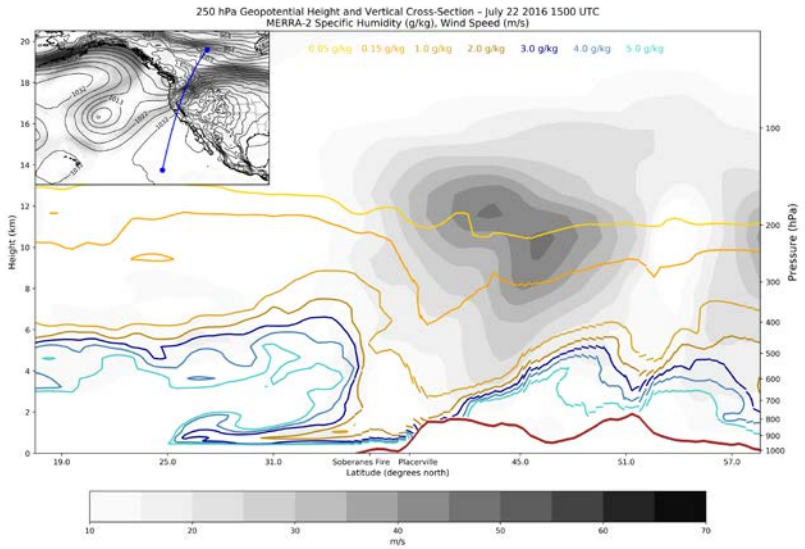


PV Soberanes Fire Case

July 22, 1500 UTC

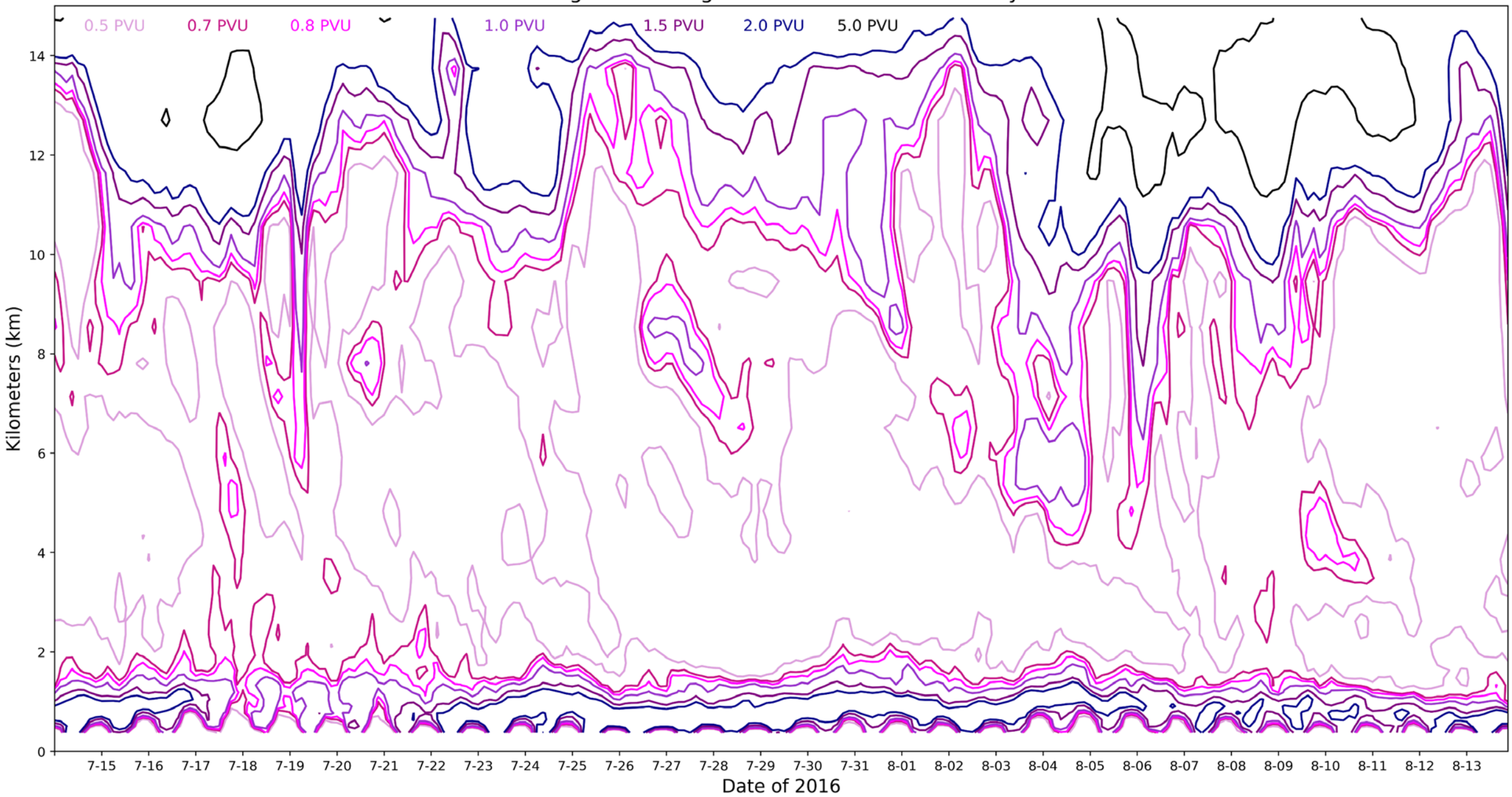


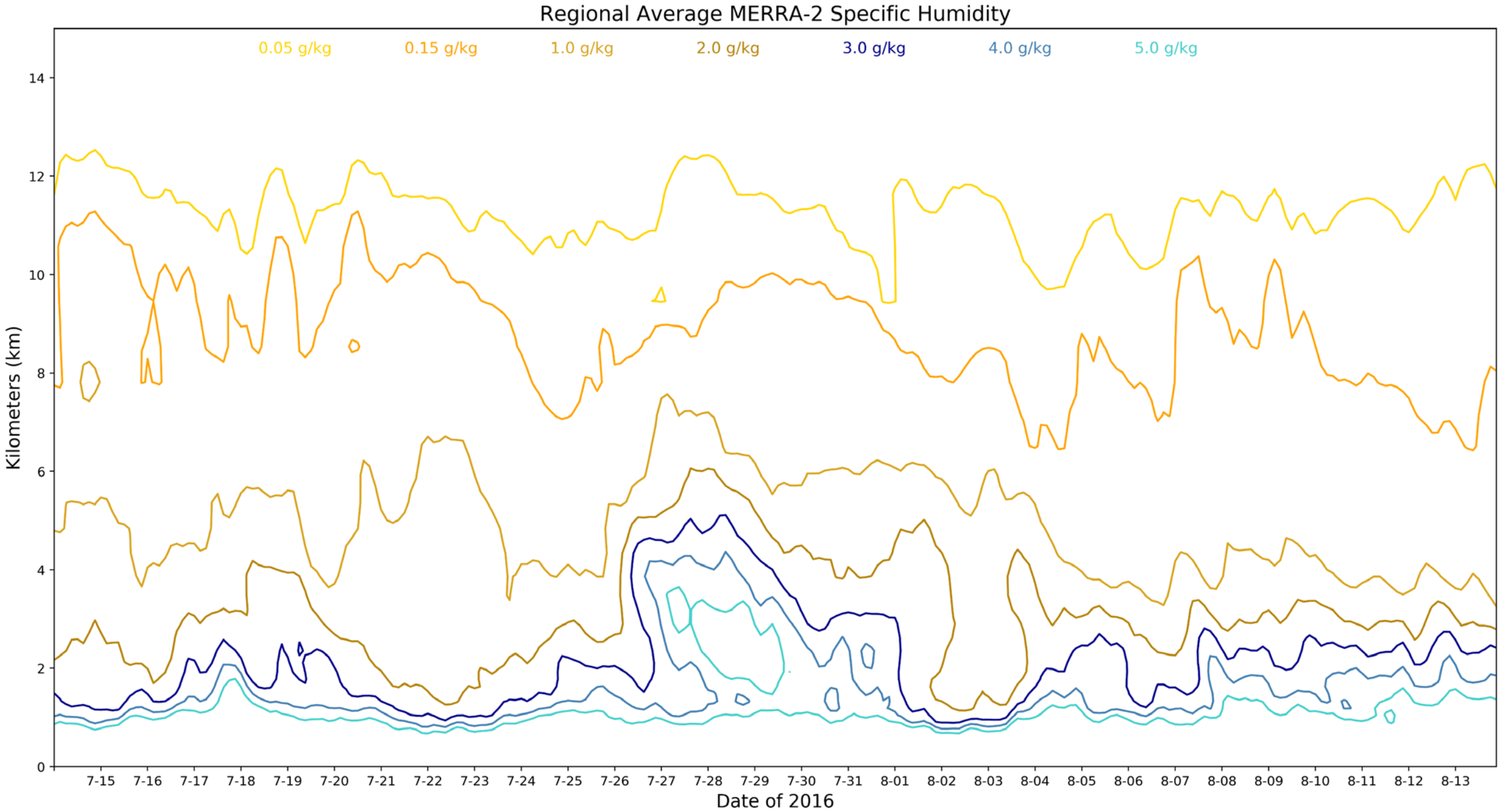




SH Soberanes Fire Case

July 22, 1500 UTC


Regional Average MERRA-2 Potential Vorticity
0.5 PVU
0.7 PVU
0.8 PVU
1.0 PVU
1.5 PVU
2.0 PVU
5.0 PVU
Kilometers (km)
0
2
4
6
8
10
12
14
7-15
7-16
7-17
7-18
7-19
7-20
7-21
7-22
7-23
7-24
7-25
7-26
7-27
7-28
7-29
7-30
7-31
8-01
8-02
8-03
8-04
8-05
8-06
8-07
8-08
8-09
8-10
8-11
8-12
8-13
Date of 2016


Regional Average MERRA-2 Specific Humidity
0.05 g/kg
0.15 g/kg
1.0 g/kg
2.0 g/kg
3.0 g/kg
4.0 g/kg
5.0 g/kg
Kilometers (km)
0
2
4
6
8
10
12
14
7-15
7-16
7-17
7-18
7-19
7-20
7-21
7-22
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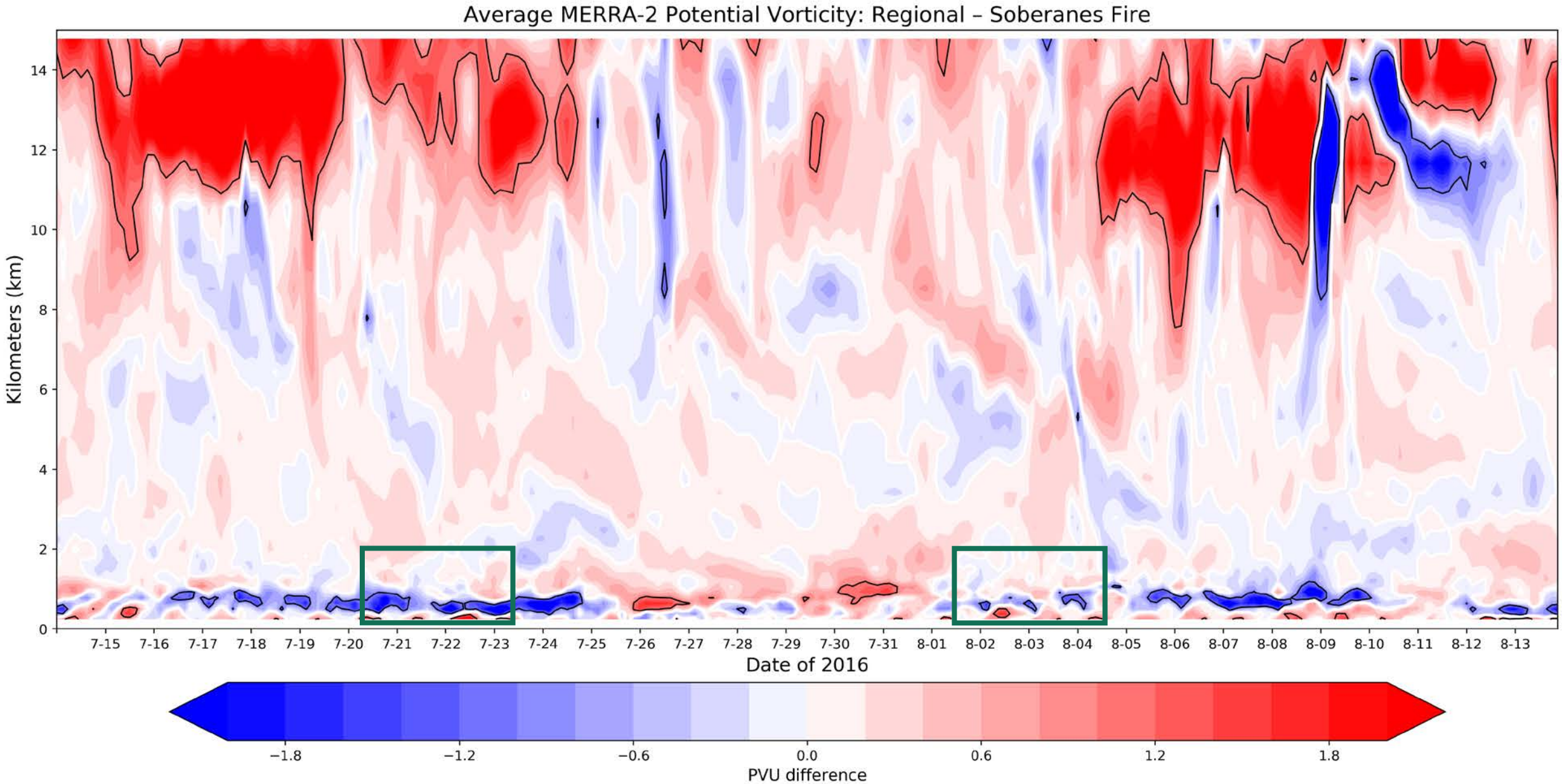
Date of 2016


Average MERRA-2 Potential Vorticity: Regional – Soberanes Fire
Kilometers (km)
0
2
4
6
8
10
12
14
7-15
7-16
7-17
7-18
7-19
7-20
7-21
7-22
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8-03
8-04
8-05
8-06
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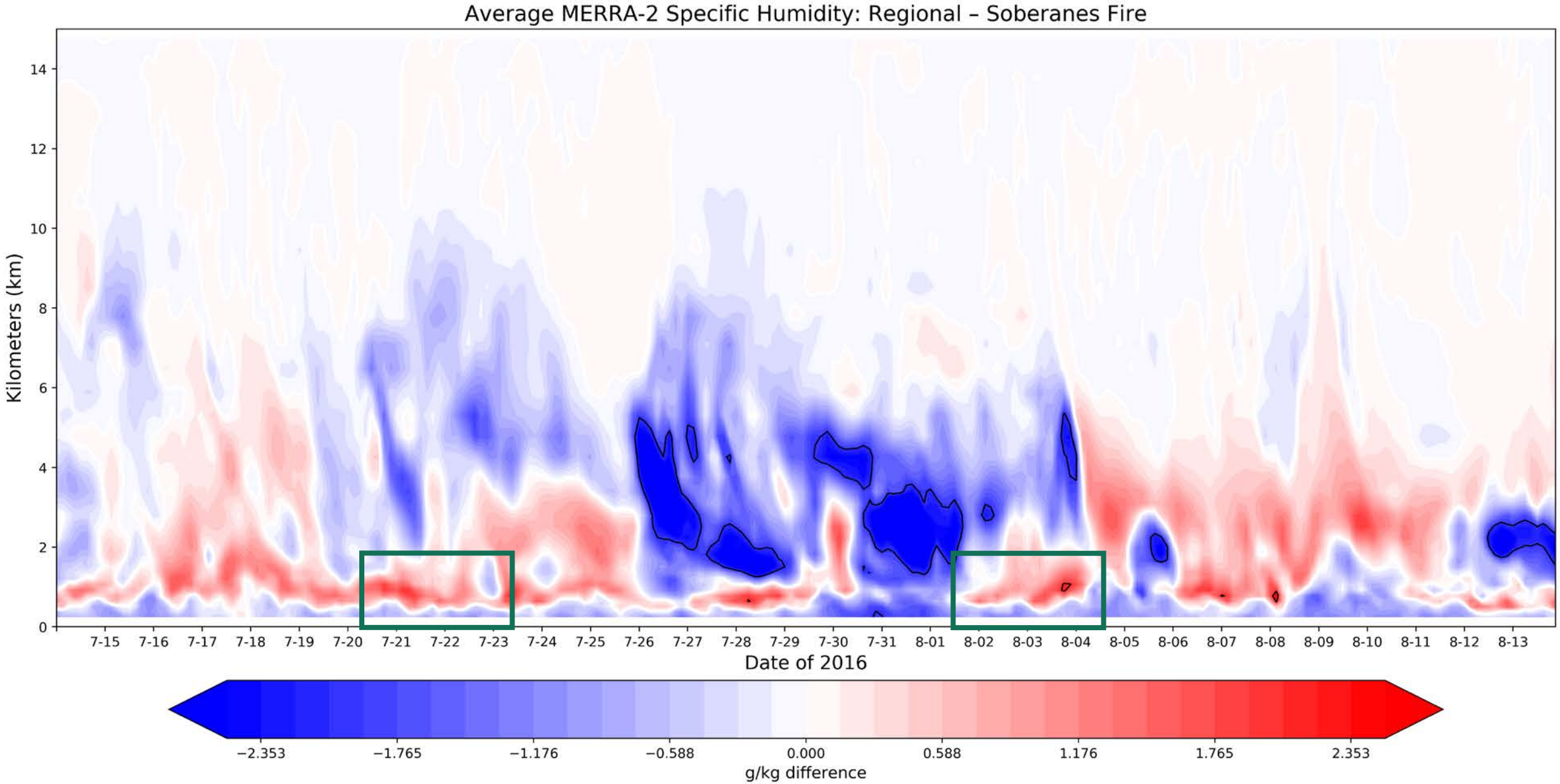
8-09
8-10
8-11
8-12
8-13
Date of 2016
−1.8
−1.2
−0.6
0.0
0.6
1.2
1.8
PVU difference


Average MERRA-2 Specific Humidity: Regional – Soberanes Fire
Kilometers (km)
0
2
4
6
8
10
12
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7-15
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8-06
8-07
8-08
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8-12
8-13
Date of 2016
−2.353
−1.765
−1.176
−0.588
0.000
0.588
1.176
1.765
2.353
g/kg difference

Conclusion

- The latitudinal vertical cross-sections indicate that as an upper-level closed low to the north approaches from the west, moves onshore directly to the north, and passes through to the east, the extended tongue of the SI event transports stratospheric air into to lower levels of the atmosphere elevated above California and offshore.
- Values of 0.8 PVU and 2.0 g/kg SH together give a good indication of stratospheric air influence into the middle and lower troposphere.
- Low-level PV and SH anomalies can indicate the arrival of stratospheric air into the local surface area where PV values tend to be high (> 2.0 PVU).
- The arrival of this air is shown to be associated with fire outbreaks and growth.
- Without cross-section analysis, anomalies are a helpful tool to recognize conditions that could influence surface O3 concentrations above the set NAAQS.

Future Work

To analyze the Visalia PV and SH anomalies and the arrival of the wildfire plumes in association with the TOPAZ Lidar O3 data collected during IOP2 and use Bodega Bay ozonesonde data as a baseline to lead to quantifying background O3 influence.