CALIOP Stratospheric Aerosol Typing Performance from the 2019-2020 Australian Bushfire Event

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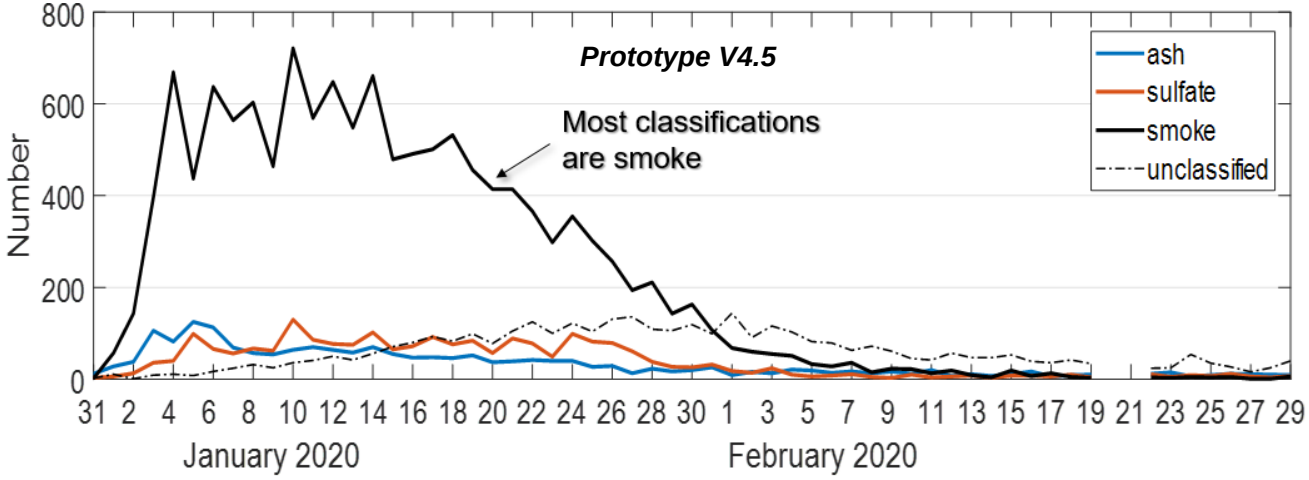
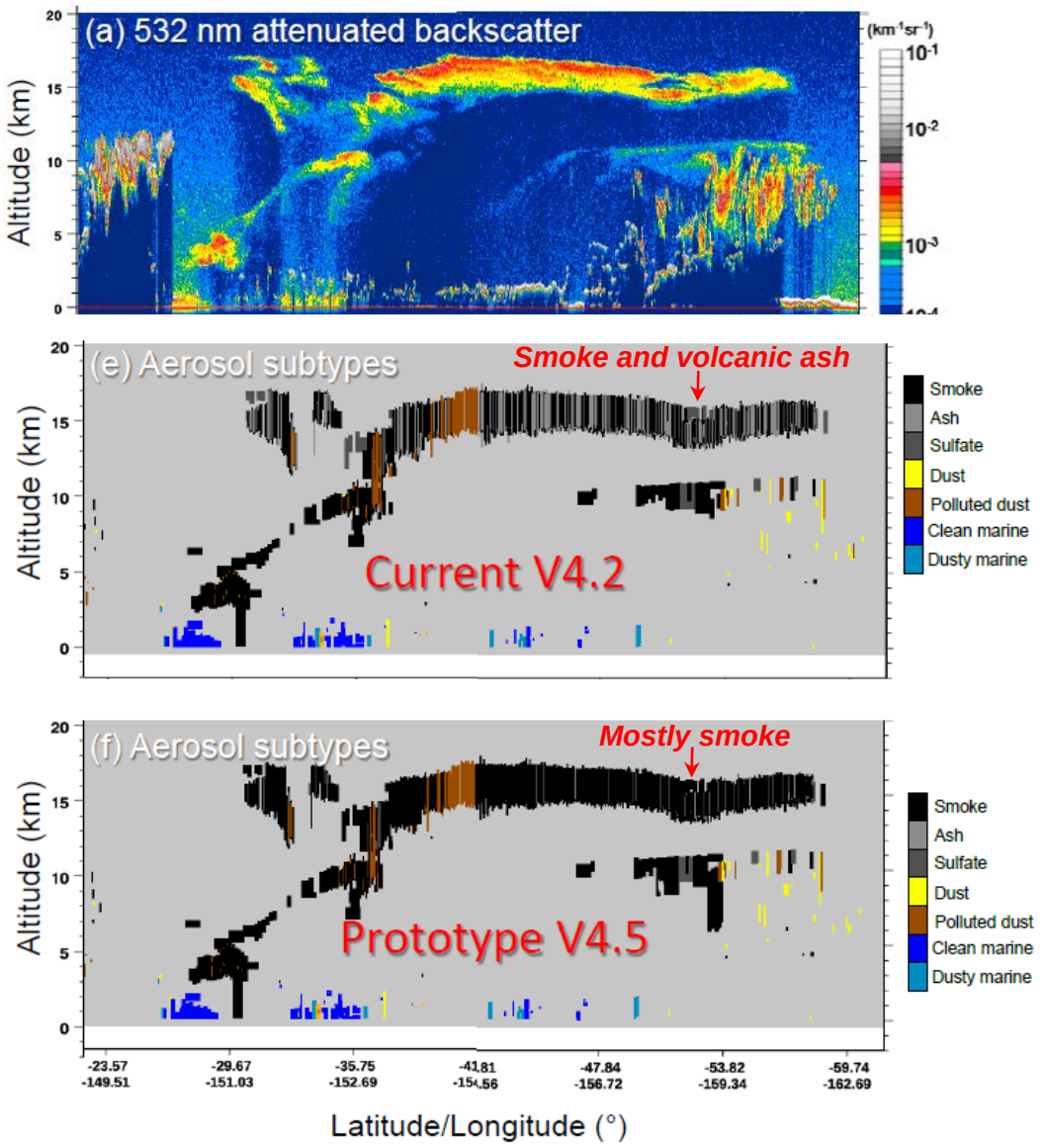
- CALIOP level 2 products discriminate between smoke, volcanic ash, and volcanic sulfate above the tropopause
- Upcoming revisions to the stratospheric aerosol typing algorithm in V4.5 will improve discrimination between depolarizing smoke and volcanic ash
- The pyroCb events in Australia injected a large amount of depolarizing smoke into the stratosphere.
- The current CALIOP products misclassifies 70% of these smoke layers as ash or sulfate.
- The prototype V4.5 algorithm classification is predominantly smoke (61%).

Daily CALIOP stratospheric aerosol classification below 20°S



Example CALIOP Observation on 2020-Jan-03



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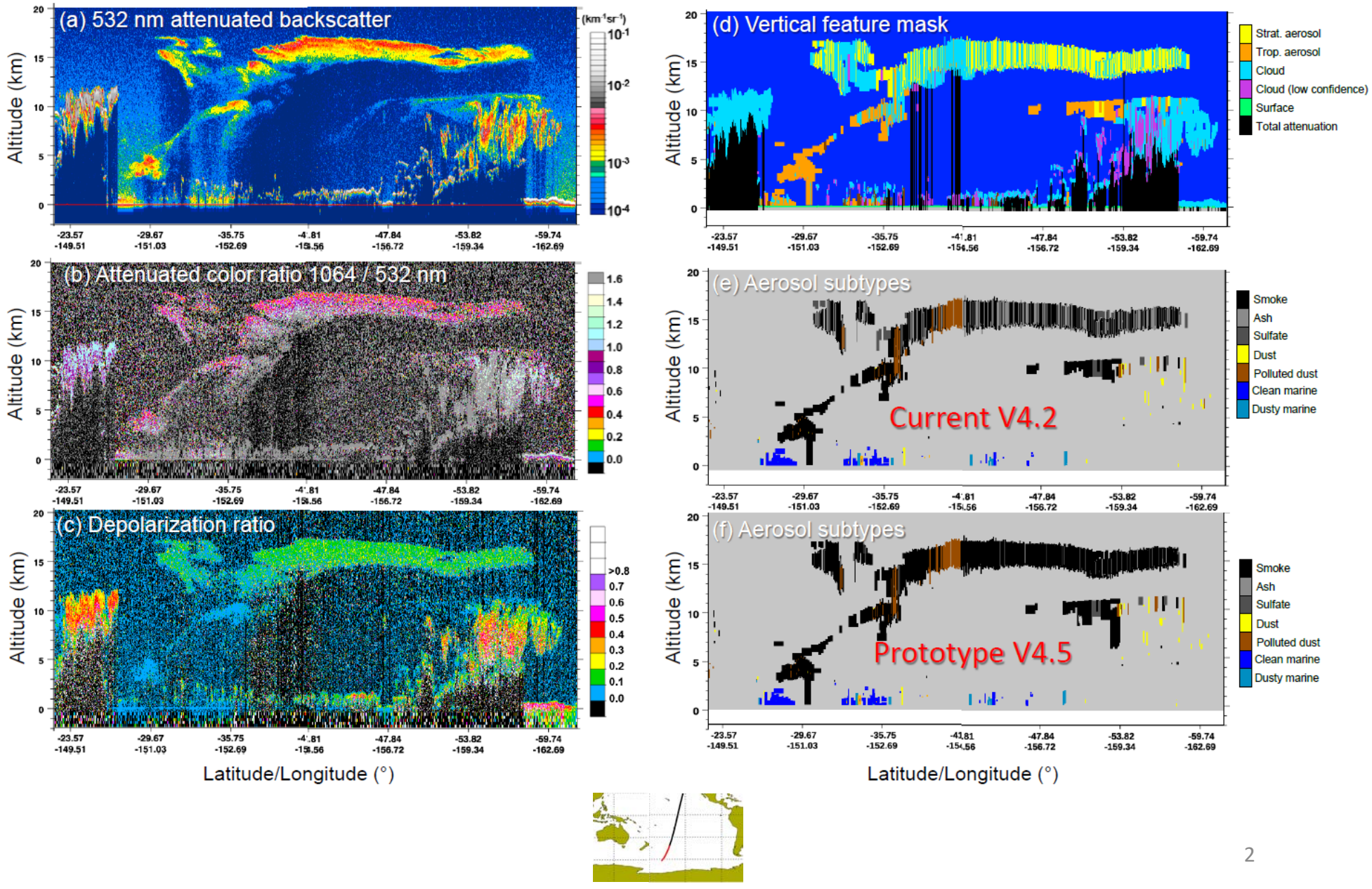
Example CALIOP Observation on 2020-Jan-03

A series of pyroCb events occurring in southeast Australia in late December 2019 and early January 2020 injected a large amount of smoke into the stratosphere. This CALIOP observation captured the smoke plume east of Australia on January 3rd at 11 UTC. The stratospheric smoke is measurably different as compared to smoke at lower altitudes. Namely, the depolarization ratio measured by CALIOP was higher.

The CALIOP cloud-aerosol discrimination algorithm classified some of this plume as stratospheric aerosol and others as ice cloud. The latter is due to the elevated color ratio and depolarization which are characteristics of ice clouds. The aerosol subtypes determined by the CALIOP level 2 algorithms are shown. Whereas the current V4.2 release classifies this plume as a mixture of smoke and volcanic ash (a misclassification), the prototype V4.5 release classifies the bulk of the plume in this example as smoke.

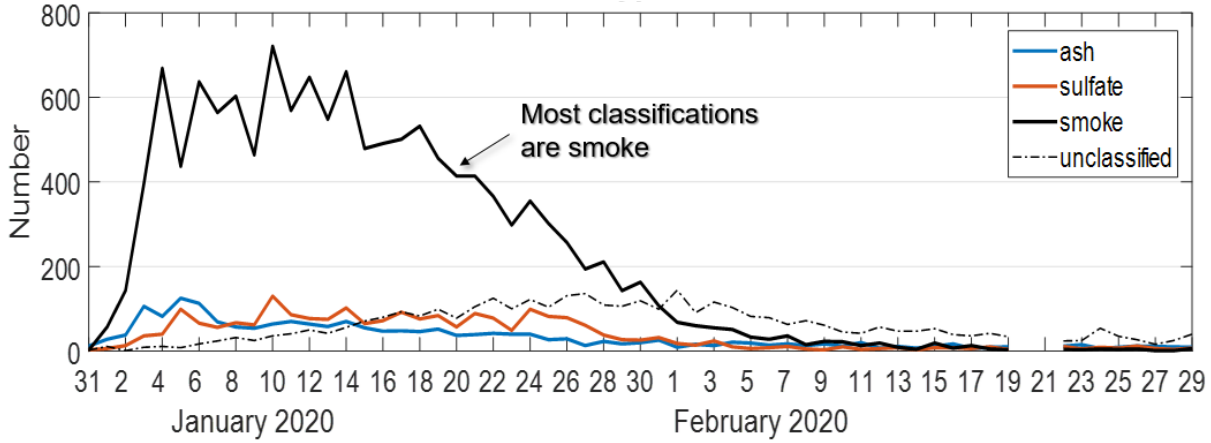


Aerosol Type Classification

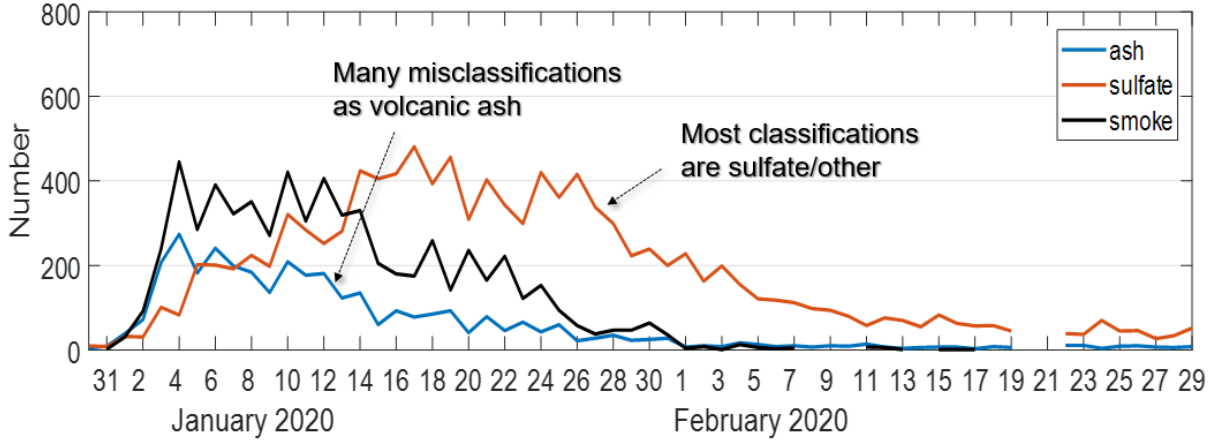
The time series below show the rise in number of stratospheric aerosol layers detected by CALIOP in the southern hemisphere due to the Australian bushfires.The type classification is predominantly smoke (61%) for V4.5. Around 20% of the layers are misclassified as ash or sulfate. This is an improvement relative to the current V4.2 release which misclassifies 70% of these layers as ash or sulfate.

Daily CALIOP stratospheric aerosol classification below 20°S

Prototype V4.5



Current V4.2



Upcoming Revisions to the Stratospheric Aerosol Typing Algorithm in V4.5

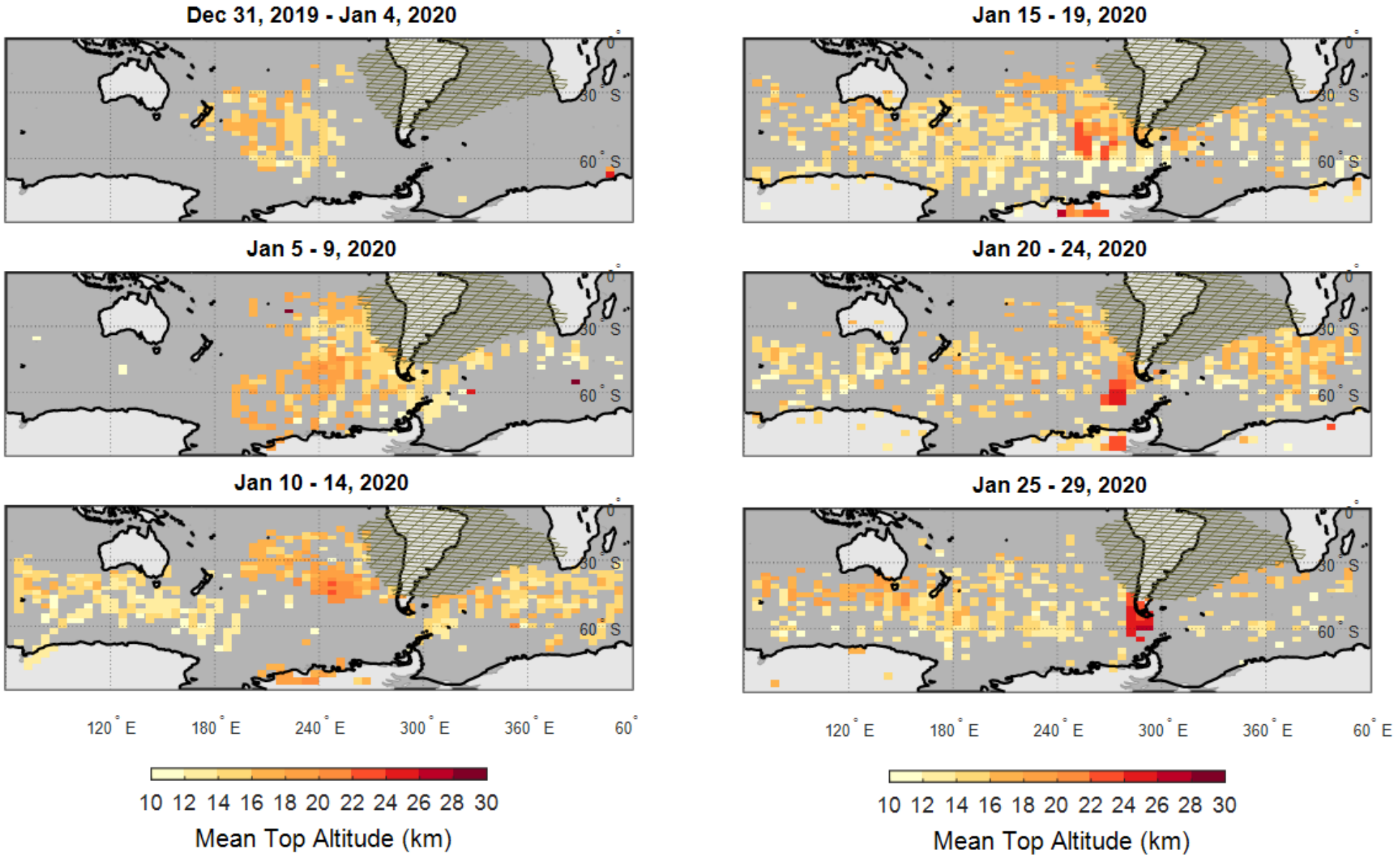
- Improved discrimination between depolarizing smoke and volcanic ash
- Improved discrimination between sulfate and weakly scattering stratospheric aerosol
- Increased opportunities for identifying ash, sulfate, and smoke among weakly scattering aerosol features

Distribution of Subtype Classification for All Stratospheric Aerosol Below 20°S; Dec 31, 2019 – Feb 29, 2020

	Upcoming V4.5	Current V4.2
Smoke	61.7 %	30.1 %
Ash	10.5 %	17.8 %
Sulfate	10.7 %	52.8 %
Unclassified	17.1 %	N/A

Mean Altitude of Stratospheric Smoke Layers

The maps show the mean top altitude of stratospheric layers identified as smoke by the prototype V4.5 aerosol typing algorithm following the pyroCb injections during December 2019/January 2020. A portion of the plume rose to very high altitudes (in red), reaching over 30 km in February. *Hatched areas are excluded to avoid low laser energy shots in the South Atlantic Anomaly region.*



Measured Lidar Optical Properties of Smoke Comparison

The smoke plume reaching the stratosphere contained particles that were smaller and more aspherical compared to tropospheric smoke events. The 2D histograms below show the layer integrated attenuated color ratio (1064/532 nm attenuated backscatter) versus particulate depolarization ratio for tropospheric smoke events over North America and South Africa compared to stratospheric smoke from the Australian bushfire event. Color ratio increases with particle size and, for smoke, increases with layer optical depth. Particulate depolarization ratio is a proxy for asphericity.