Talking Points

AACP
20 February 2020

Title Slide: Chauncey Shultz is the SOO at Bismarck ND, and he has viewed AACPs with severe weather during the warm season there. Kris Bedka is one of the World Leaders in research into AACPs and their relationship to severe weather

2. Expanded view of Title slide, showing both the visible image, with a plume of an AACP extending downwind from the region of the Overshooting Top, and in infrared image showing that the plume is warm – it is in the stratosphere – relative to the cold top of the anvil cirrus that is near the tropopauses.

3. Investigation of AACPs has been used a multi-instrument approach. Radar imagery tracks the storms and is combined with multispectral ABI data, radar imagery of storm rotation, updraft and microphysical data, ENTLN total lightning, Severe Weather reports and NWS watches/warnings (where appropriate) to identify severe storms and to analyze the AACP signature. The observations are taken at very high temporal resolution

4. AACPs correlate well with very strong updrafts, and wave breaking in and ice injection into the stratosphere. Plumes are a warm anomaly if the atmospheric thermal structure is well-behaved, that is, if there is a well-defined tropopause with warmer stratosphere above. You can find examples with cold AACPs however – be aware of that.

5. Plume is easy to find in visible imagery – especially in low light, when the Sun is low in the sky. The cirrus plume is thin, and infrared imagery can penetrate through from below, diluting the warm signal. The warm signal should originate from near the overshooting top. It's a very strong updraft that punches through the tropopause, causing wave-breaking.

6. Here is an example that shows what a plume looks like in Visible imagery, in the sandwich product, and in two different IR enhancements. Don't be afraid to tweak the enhancement to view the plume if you think it is present because its presence should make you more bullish on warning issuance.

7. This shows the same storm complex, but a little later. The plume is more fully developed.

8. back to the example from the Title Slide. There are multiple plumes here. Consider tweaking the IR enhancement to bring out the information, to make the plumes more apparent.

9. This shows CALIOP measurements across a plume. Note that the plume is between the two arms of the Enhanced V, and downwind of the OT that is the vertex of the Enhanced V. The region between the two very red arms of the Enhanced V is a cloud that is much higher that adjacent regions! This is the AACP.

10. AACPs are relatively easier to find in visible imagery. If you have just a single IR image, it can be tough to view the AACP – animations make it somewhat easier.

11. An excellent example of multiple severe storms and multiple plumes over the high plains. Warning polygons are under the storms with plumes, and observed severe weather also occurred near plumes.

Remember: Plumes can be warmer than the enhanced Vs, key on that when you examine the IR imagery.

12. Scientific study on plumes and their relationship with severe weather required plume identification. This slide describes the methodology, and how the identified plumes correlated with observed severe weather.

13. How are plumes identified. Some examples are listed on this slide. Some of this information you've heard already. Plumes are typically warm, but unusual tropopause structures can lead to cold AACPs.

14. Why is plume identification important? Look at the black lines in these slides, showing the path of storm tracks with plumes (compared to white: storm tracks with no plumes). The overlay of severe weather events: winds, hail, tornado occur far far more frequently on top of black lines (plumed storms) than white. Severe reports cluster along the black lines (showing where the plumed storms are moving!)

15. Indeed, Plume storms produced 14x as many severe events as non-plumed storms. ¾ of all supercells generated plumes. 59% of the plumed storms were severe! 73% of the storms producing large hail, strong gusts, or tornadoes had plumes. They really do indicate the likelihood of severe weather! Use the Presence of a plume to increase your confidence in issuing a severe warning! This is especially true if you're in a region of poor radar coverage!

15. IR and VIS imagery of plume-producing severe weather over North Dakota. The presence of the plume should boost your confidence in issuing warnings, and maybe also for tagging the warning with higher gusts, or hail sizes, than you might otherwise consider given radar alone.

16. An MCS can also generate plumes, and the relationship between plume and observed severe weather remains.

17. This series of slides shows Box/Whisker plots. 40-dbZ relationship to the tropopause height, and whether or not a plume is present. A plume storm is more likely to have 40 dbZ near the tropopause: Strong updraft! There is a similar relationship with NEXRAD divergence. Both of these mean that large ice particles will rise higher into storms with plumes (relative to non-plumed storms). But both plumed and non-plumed storms can be very electrically active, and both can have very cold cloud tops. Do not rely on lightning and cold cloud tops alone to gauge severity.

18. The next animations will show 4 radar fields, and the storm in question is the easternmost radar cell in the MRMS MESH Fields. Does it look imposing?

19. Here's the radar for the storm up to warning issuance. Keep in mind where the radar might be slicing through the storm. The end of the animation shows the MRMS MESH field at the time of issuance. How confident are you that this will verify? It should help that the storm producing this cell has a well-developed plume! That's shown too.

20. Here's the satellite imagery up until warning issuance. Again: Plume is obvious.

21. Radar imagery from 0124 to 0138 UTC. What's happening with the MRMS MESH fields?

22. The Hail tag is upped to 1.5". From 0138 UTC to 0148 UTC. At 0148 UTC, 3.5" Hail is observed.

23. Satellite imagery from Warning issuance to just beyond Hail observation time. Note: Pronounced Plume (and also warning of the coldest cloud top).

24. Radar animation from large hail to the end (about 15 minutes)

25. Read all about it in a Weather and Forecasting paper.

26. Summary thoughts. AACPs are well-linked to severe weather, and their presence in warning operations should help build confidence in warning issuance.