

Colorado Cattlemens Association
November 19, 2009

The “Martian Winter” of 2008/2009

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Center for Snow and Avalanche Studies
Silverton, CO

in collaboration with
Tom Painter - Univ. of Utah Snow Optics Laboratory
Andrew Barrett - National Snow & Ice Data Center



April 3, 2009



April 5, 2009

Near Red Mountain Pass



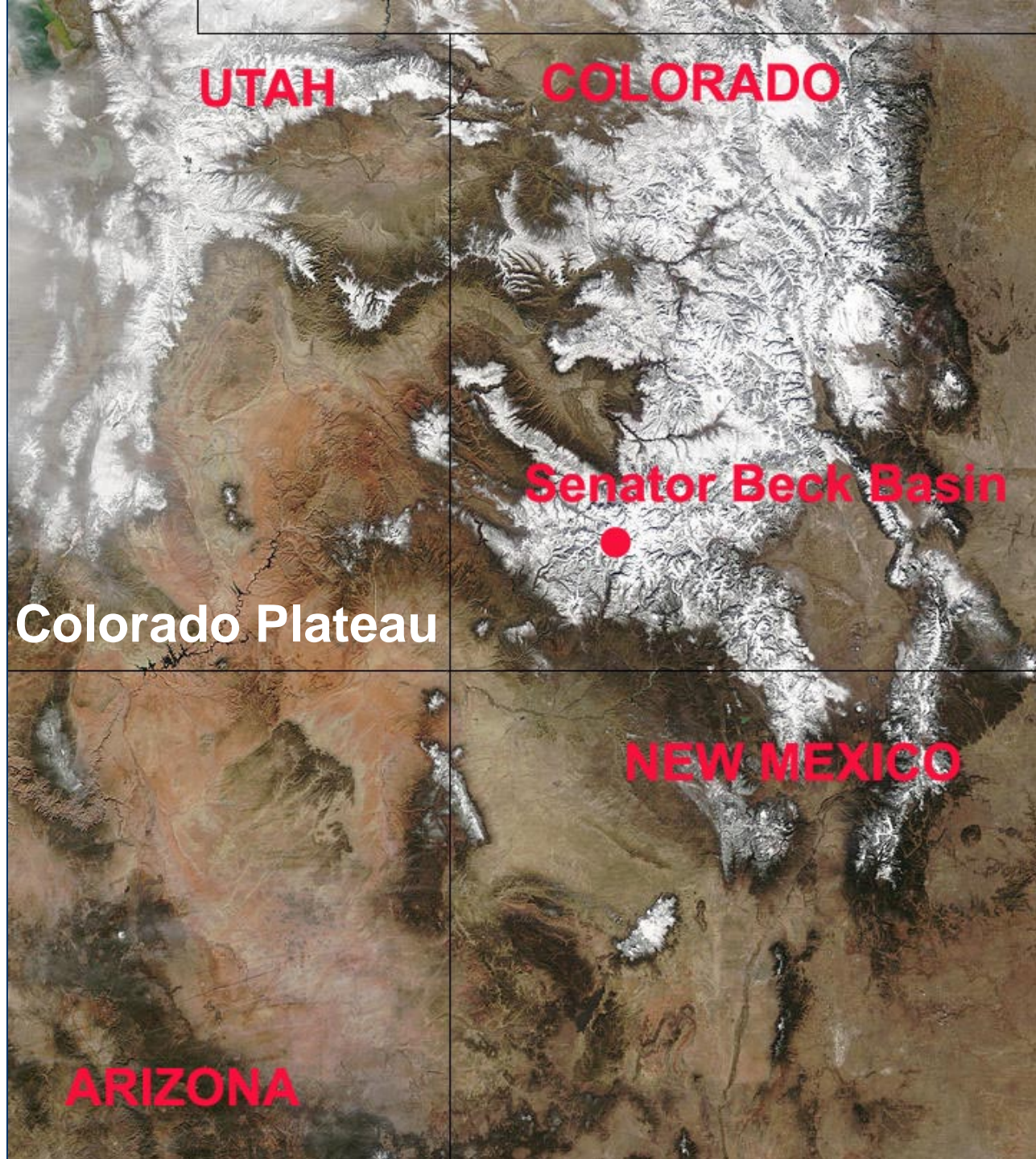
April 24, 2009



May 18, 2009

*Desert/Mountain
Interactions*

influencing Colorado snowmelt



Findings ...

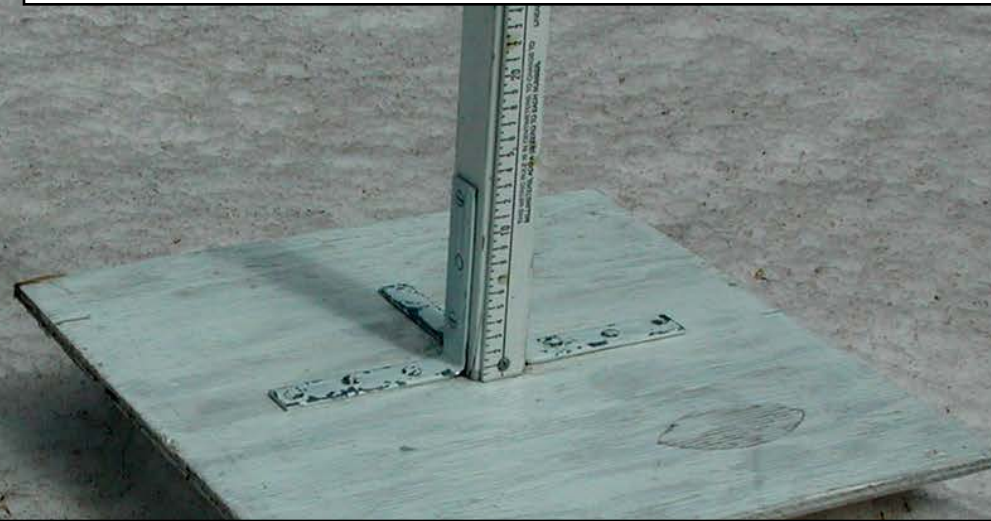
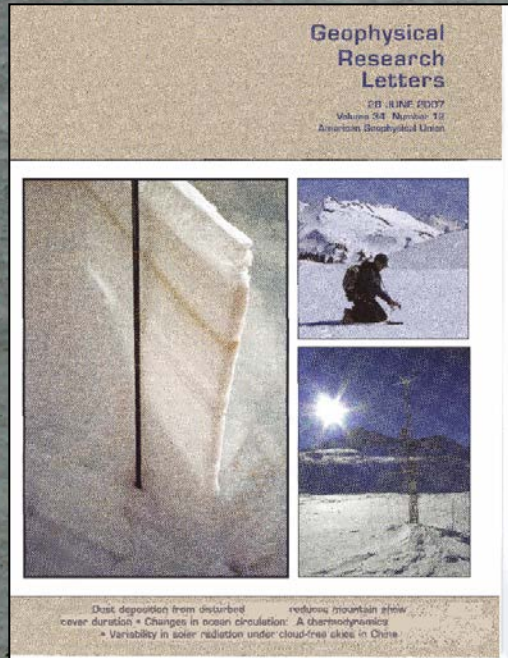
Collaborative Research funded by:

National

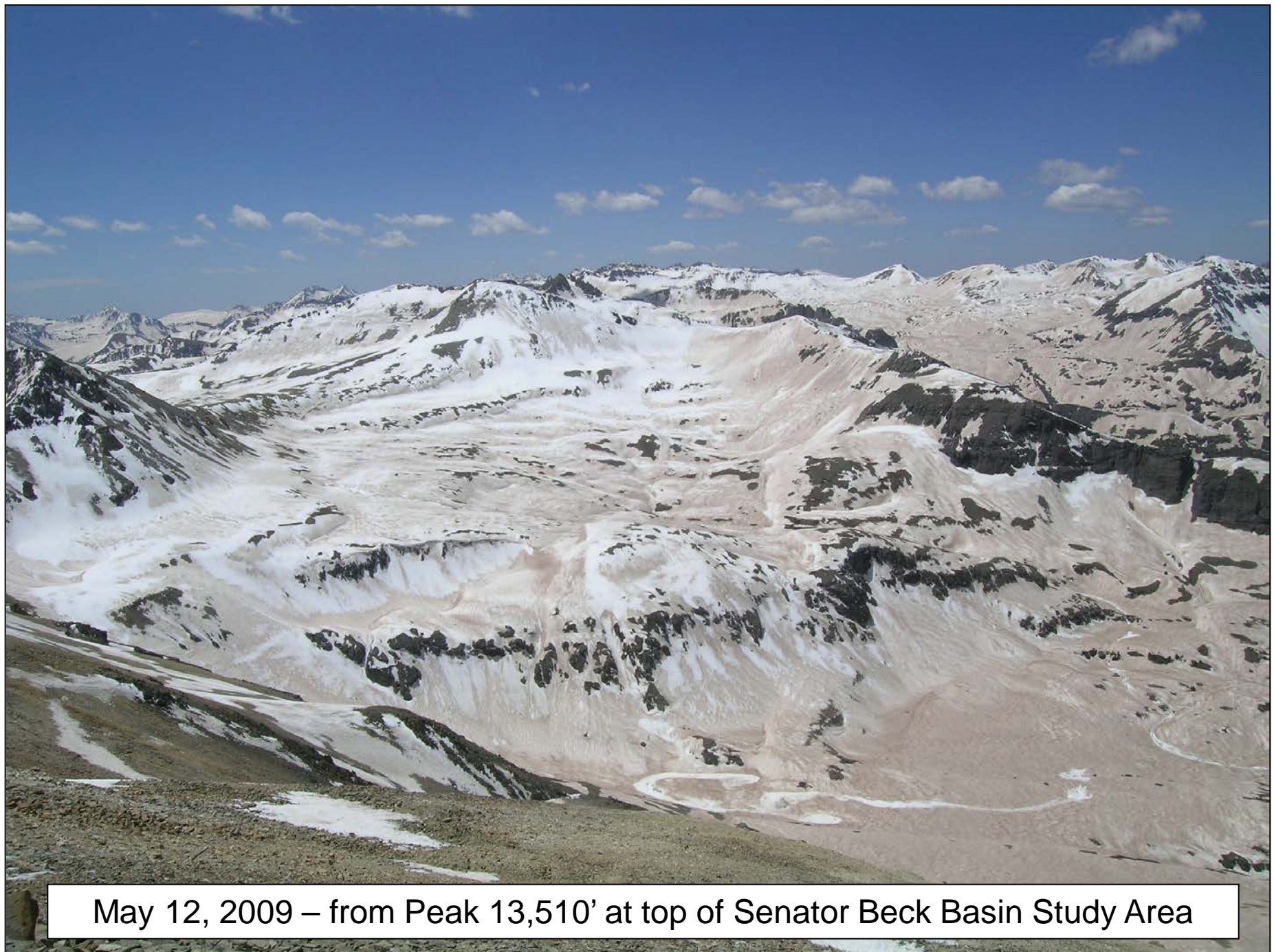
Science Foundation Atmospheric Sciences,

Geography, and Hydrologic Sciences

Grants ATM-0432327 and ATM-0431955



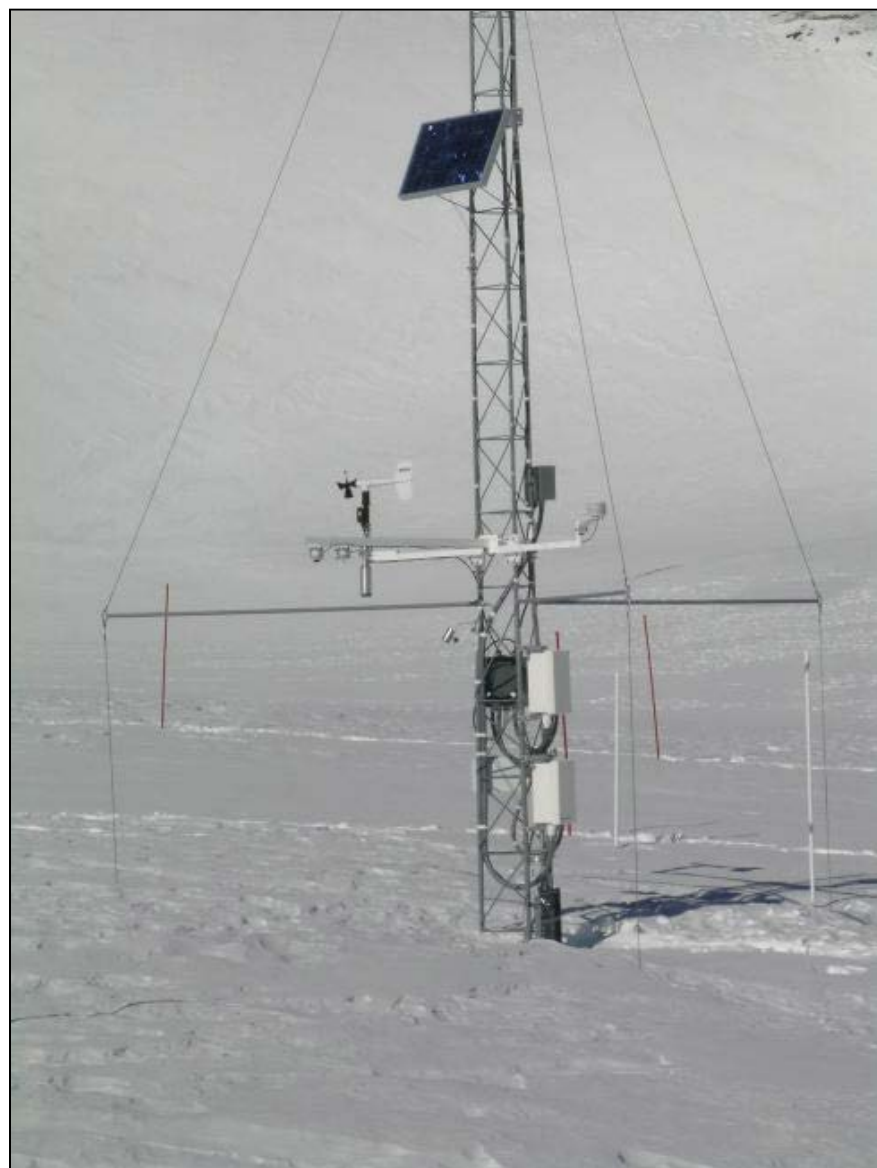
- Exposing layers of dust-in-snow decreases snow albedo and increases radiative forcing on a *regional scale*, accelerating SWE ablation
- Observed reductions in snow albedo have advanced snowmelt by up to *one month* and resulted in a *higher amplitude* and *shorter duration* hydrograph



May 12, 2009 – from Peak 13,510' at top of Senator Beck Basin Study Area

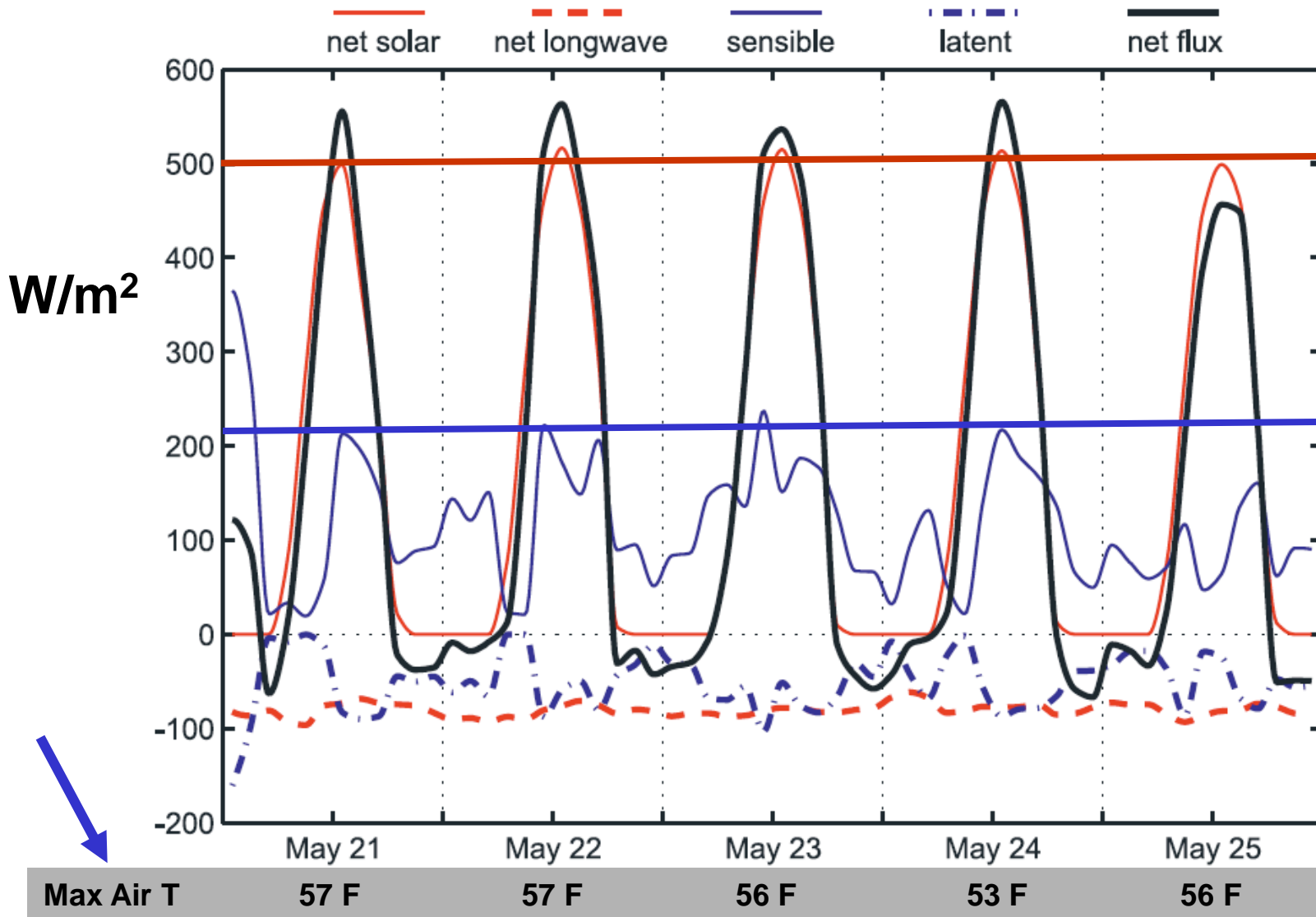
Snow Albedo Measurement

Senator Beck Study Plot 12,200'



Snowmelt Energy Budget

Dusty Snow Surface, Clear Skies – Senator Beck Study Plot, May 2005



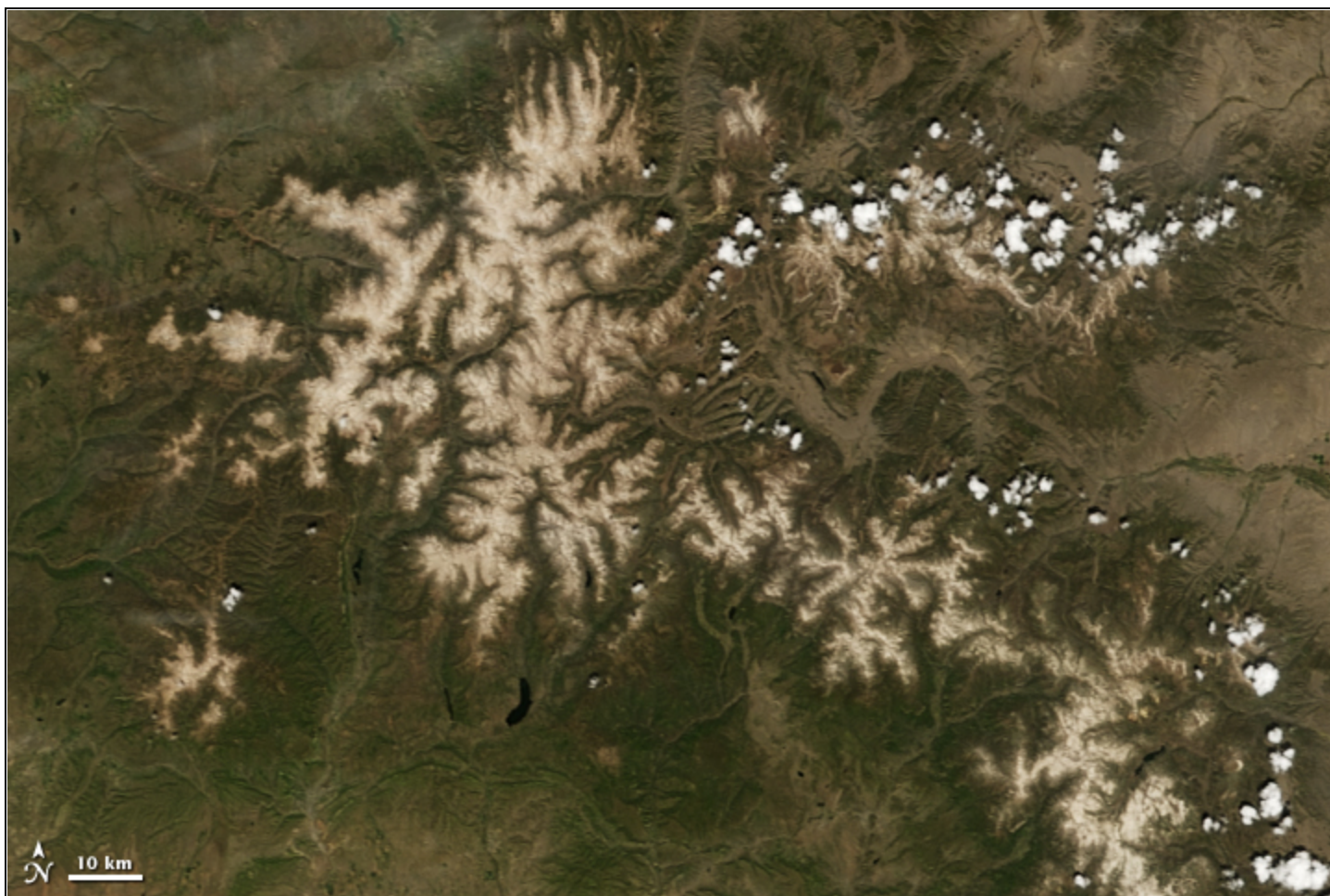
Dust at Top of Snowpack (all
or most layers merged):

Spring 2008 = 12 gm/m²

Spring 2009 = 55 gm/m²



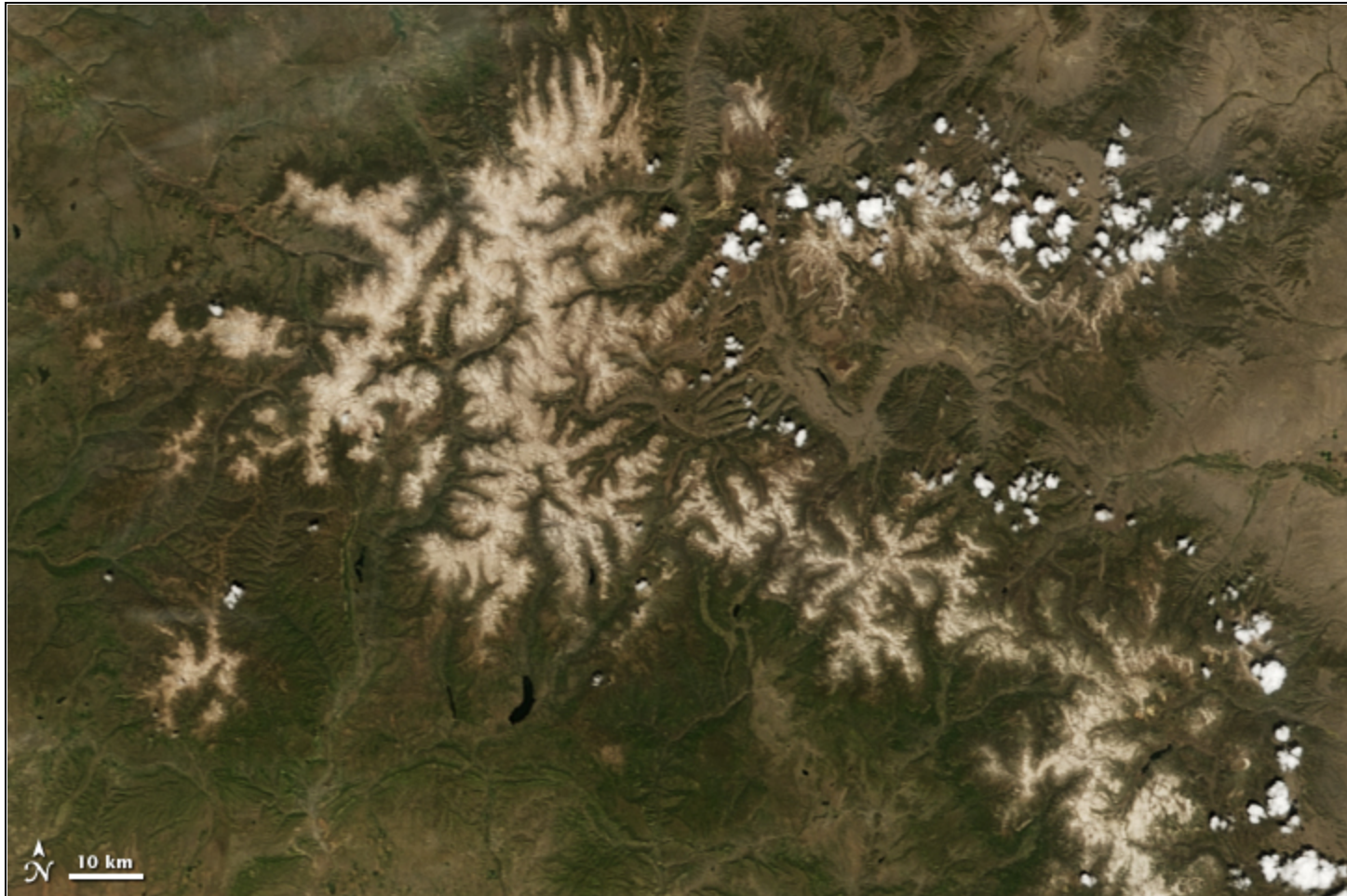
May 13, 2009 – Swamp Angel Study Plot



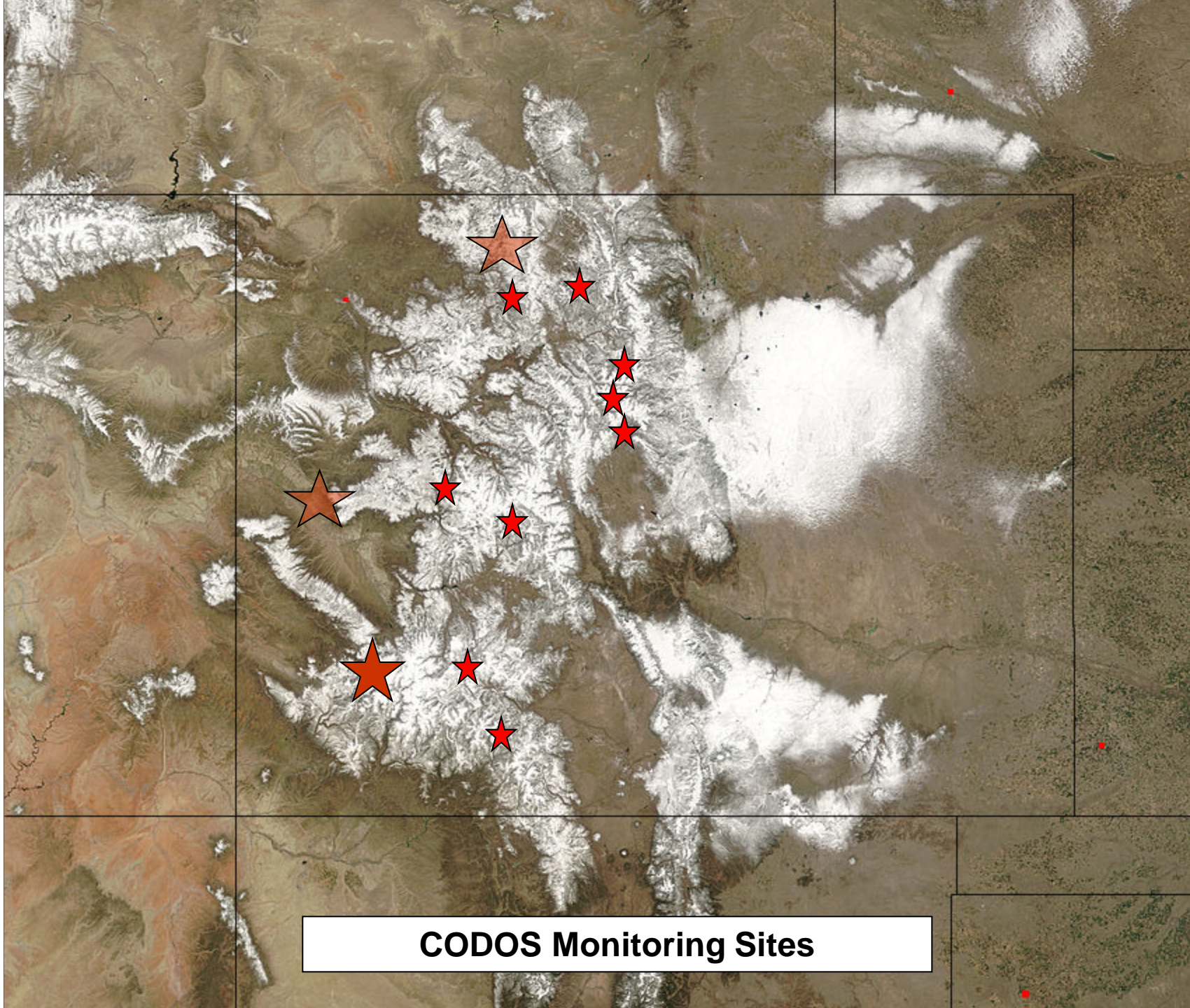
**May 18, 2009 – San Juan Mountains
NASA MODIS Image**



**May 31, 2008 – San Juan Mountains
NASA MODIS Image**



**May 18, 2009 – San Juan Mountains
NASA MODIS Image**



CODOS Monitoring Sites

Senator Beck Basin: March 22, March 29, April 3, April 8, April 15 layers



Below Treeline – April 22



Above Treeline – April 24



April 16, 2009 – Wolf Creek Pass



April 17, 2009 – Berthoud Pass

Dust Updates



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Colorado Dust-on-Snow Alert #8, June 1, 2008

Following the expected brief pause in snowmelt discussed in Alert #7 of May 24th, all Snotel sites that we've been monitoring this spring have shown a second steep decline in SWE during the past week. All sites showed losses in SWE of equal or greater magnitude than the drop seen earlier, in mid-May, and some sites have reached "Snow All Gone (SAG)". The substantial dust layer (composed of multiple, "merged" layers) that was temporarily covered by clean new snow over the weekend of May 24th and 25th has extensively re-emerged at the snowpack surface, first at lower elevations on all aspects, and more recently at the highest elevations on even northerly aspects. Lingered patches of the May 23/24 storm snow stand in stark, bright white contrast to the surrounding dirty snow, as seen in the May 31st photo below, looking westward at the Senator Beck Basin Study Area (far right) and nearby terrain at Red Mountain Pass, here in the San Juan Mountains.

The direct absorption of solar energy by this dust layer, in tandem with two periods of sunny weather and warm air temperatures, has produced two periods of much-greater-than-average rates of snowmelt, as compared to the 30-year average rate of decline in SWE. This is clearly evident in Snotel 2007/2008 Water Year graphs around the State. Thus, even though all the Snotel sites we monitor reported substantially greater-than-average SWE values this season, most sites are also currently on a snowmelt trajectory that will result in earlier-than-average dates of SAG (Snow All Gone), some perhaps several weeks earlier than average. Some lower elevation sites that have recently reached SAG on/about their average date have done so beginning with a much above-average season maximum SWE, under very high snowmelt rates.



6/1/2008



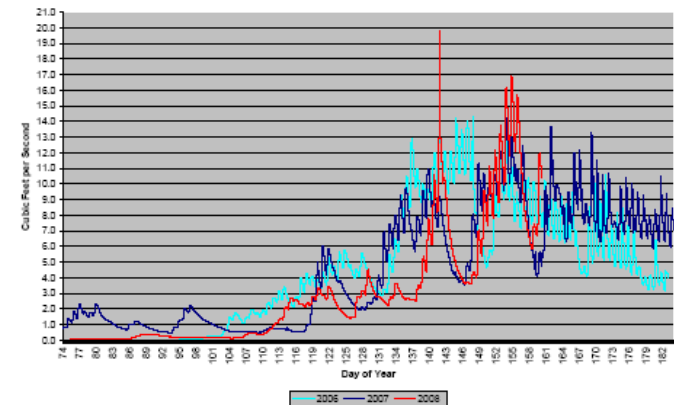
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Colorado Dust-on-Snow Alert #9, June 8, 2008

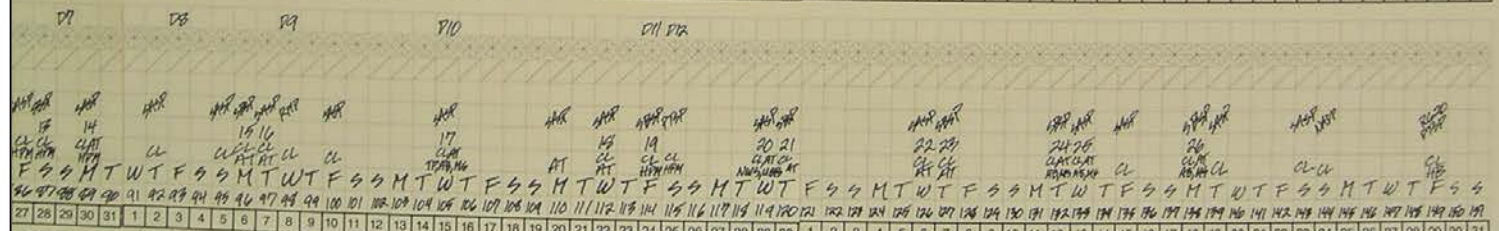
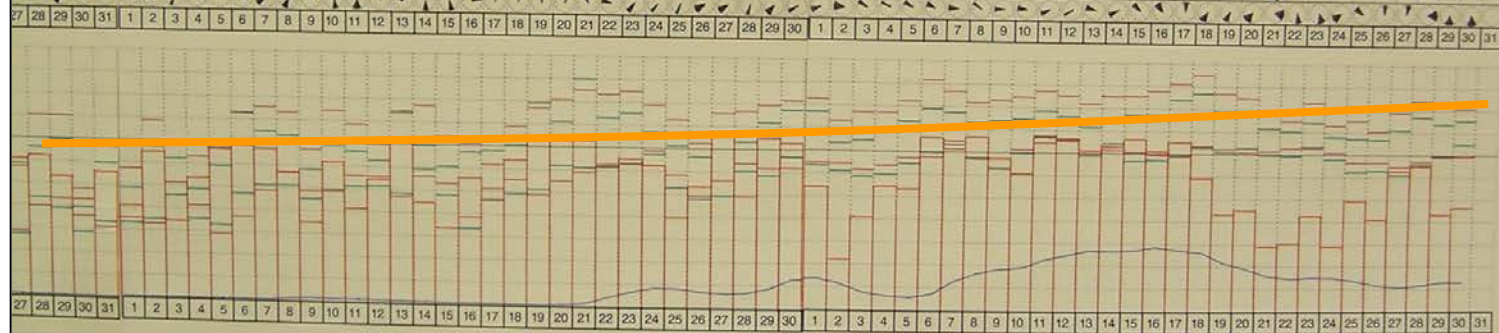
As anticipated by NWS – Grand Junction, fresh snow and cool air "reset" the snowmelt clock on Wednesday and Thursday of last week; we received 16 mm of SWE in the Senator Beck Basin Study Area, as 4-8" of new snow, varying by elevation. We did not detect any fresh dust with this storm here in our study area, and have received no reports of fresh dust elsewhere. That fresh snow layer resulted in a temporary return to a high albedo that, combined with cooler temperatures, dropped our Basin discharge from near 17 cfs on June 3 to 6 cfs by June 6, as seen below, ending our second major surge of snowmelt and stretching the date of snow-all-gone (SAG) a few days further into the future. Following that low point in streamflow on June 6, however, the new clean new snow quickly succumbed to sunny skies and the absorption of direct solar radiation by the underlying dust, revealing the underlying dirty snow surface once again. Our third surge in flows this season has now begun, as of this writing, despite somewhat cooler air temperatures here in the San Juans over the past weekend.

Senator Beck Basin Hourly Discharge - 2008, 2007, 2006



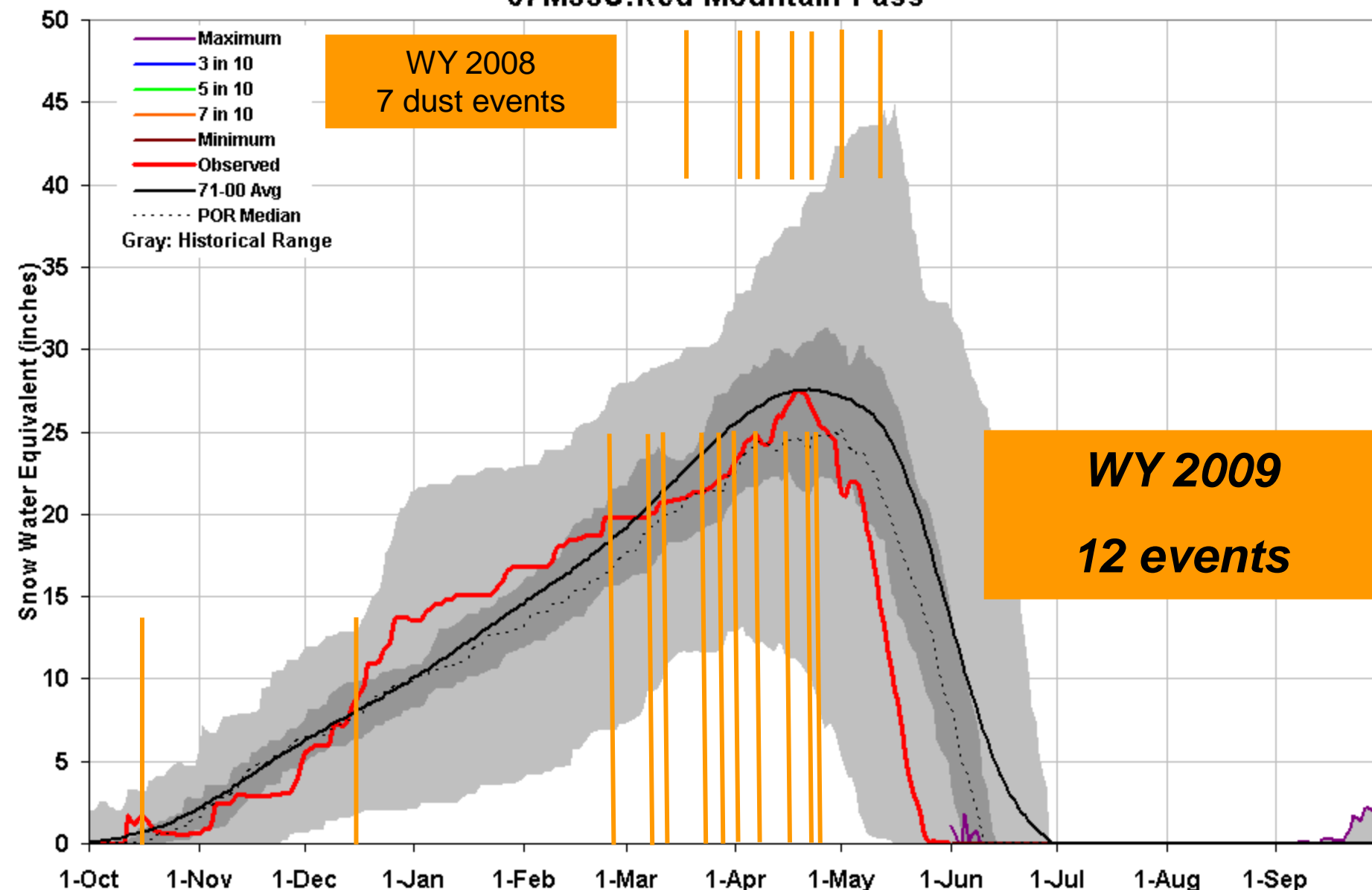
Based on our first-hand observation of extensive dust layers in mid-May, it is our assumption that a similar return to high albedo (caused by new snow) occurred throughout most of the remaining Colorado mountain snowpack last Wednesday and Thursday, followed by a similar, subsequent ablation of the clean new snow and re-emergence of the underlying dirty snow surface. Some Central and Northern mountain areas may have received additional snow showers on Saturday or Sunday, but not in amounts that will cause a prolonged return to high snowcover albedo values. Therefore, given that the current NWS – Grand Jct. 7-day forecast calls for generally sunny skies through Sunday, June 15th, except for a brief disturbance on Wednesday the 11th, and temperatures at 10,000' in the 60's (except Wednesday and Thursday), another surge of dust-enhanced snowmelt is expected.

6/8/2008



YTD → April '09: 152 mm H₂O 834 mm H₂O YTD → May '09:

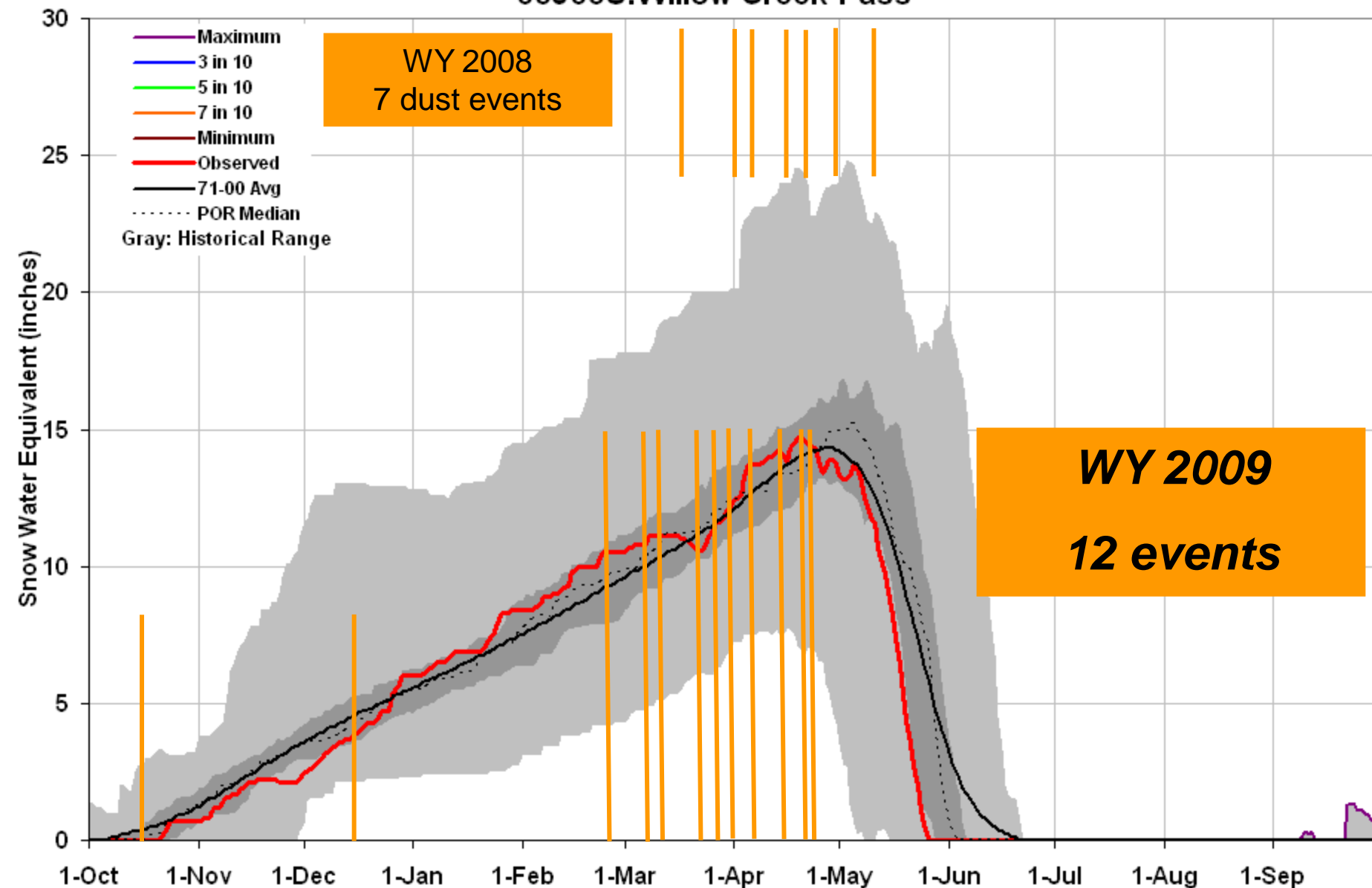
07M33S:Red Mountain Pass



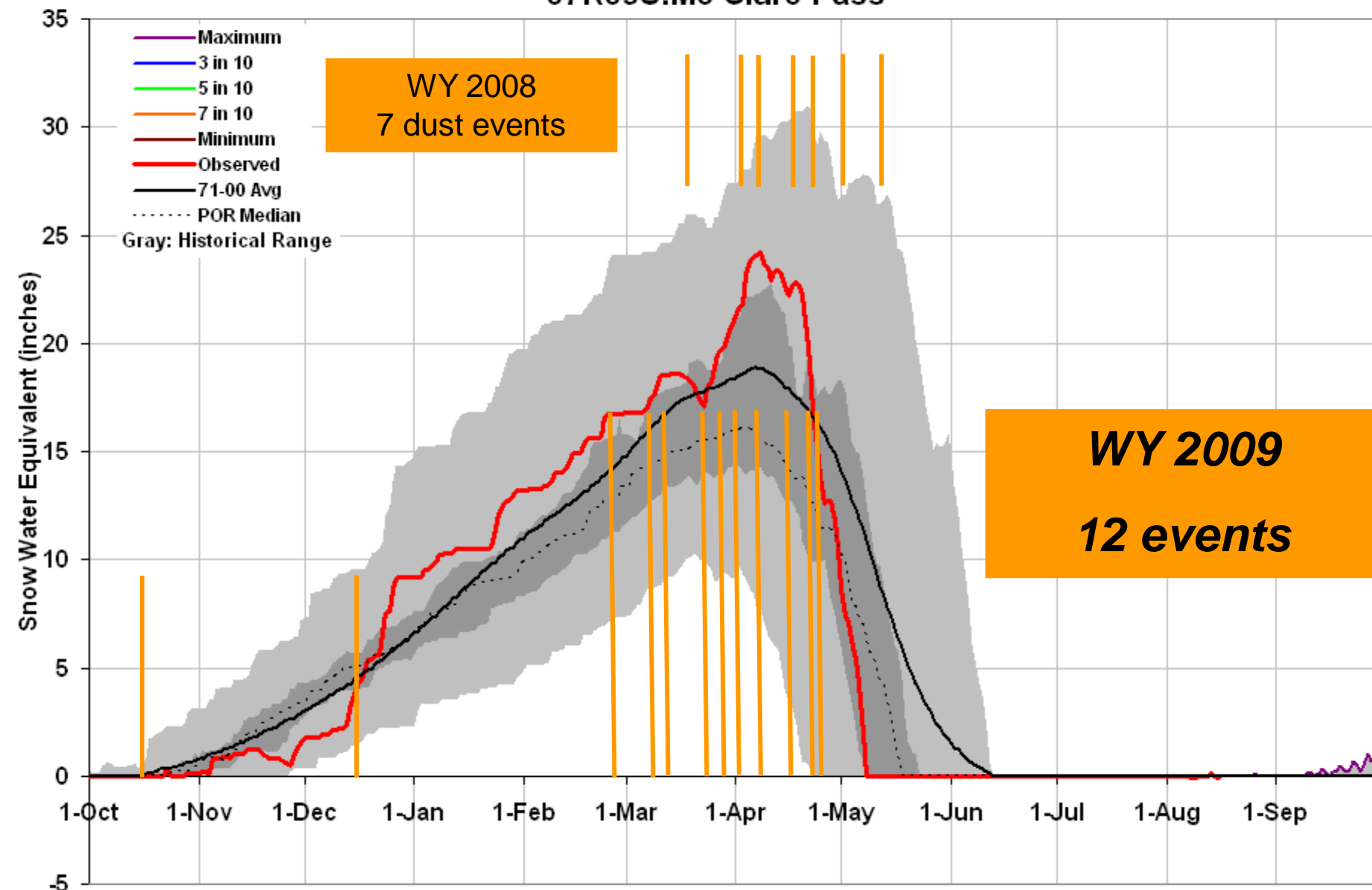
This is an automated product based on SNOTEL data, provisional data are subject to change.

This product combines the historical period of record data (gray background) with the recent daily data (heavy red, left) to project into the future (colored lines, right). This product does not consider climate information such as El Nino or short range weather forecasts and therefore should only be used as a seasonal planning tool. Contact Tom.Pagano@por.usda.gov 503 414 3010

06J05S:Willow Creek Pass



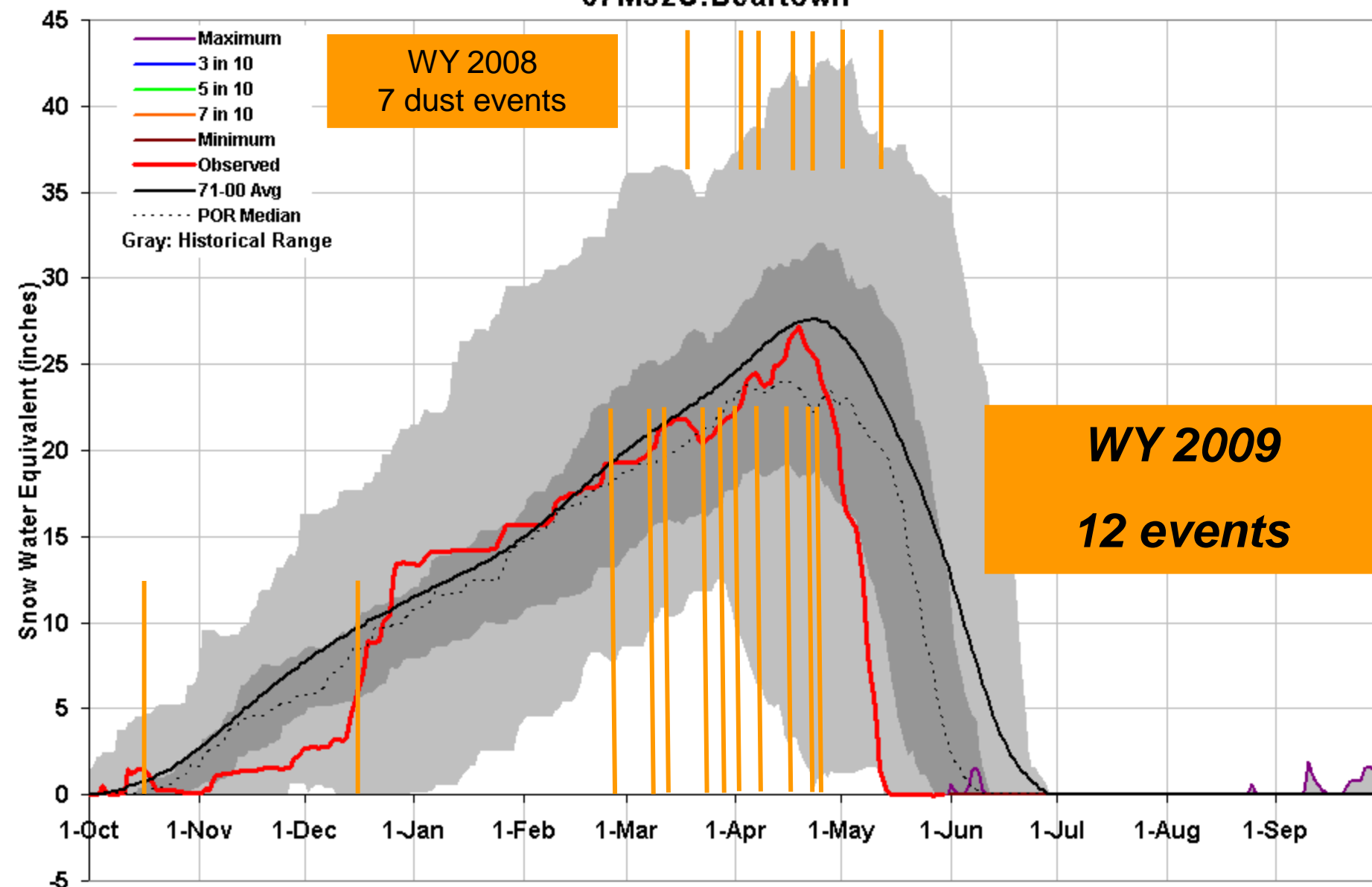
07K09S:Mc Clure Pass



This is an automated product based on SNOTEL data, provisional data are subject to change.

This product combines the historical period of record data (gray background) with the recent daily data (heavy red, left) to project into the future (colored lines, right). This product does not consider climate information such as El Nino or short range weather forecasts and therefore should only be used as a seasonal planning tool. Contact Tom.Pagano@por.usda.gov 503 414 3010

07M32S:Beartown



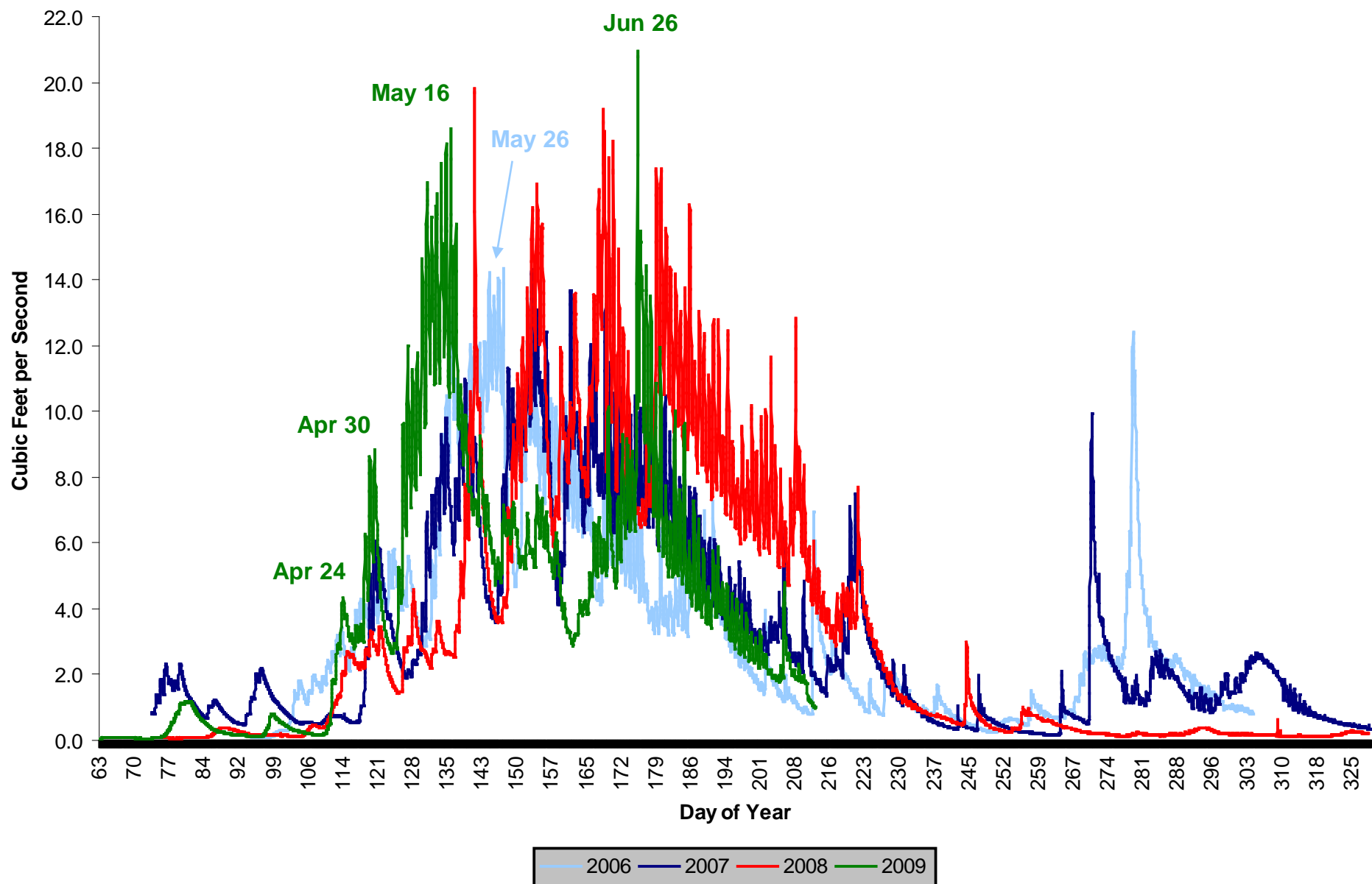
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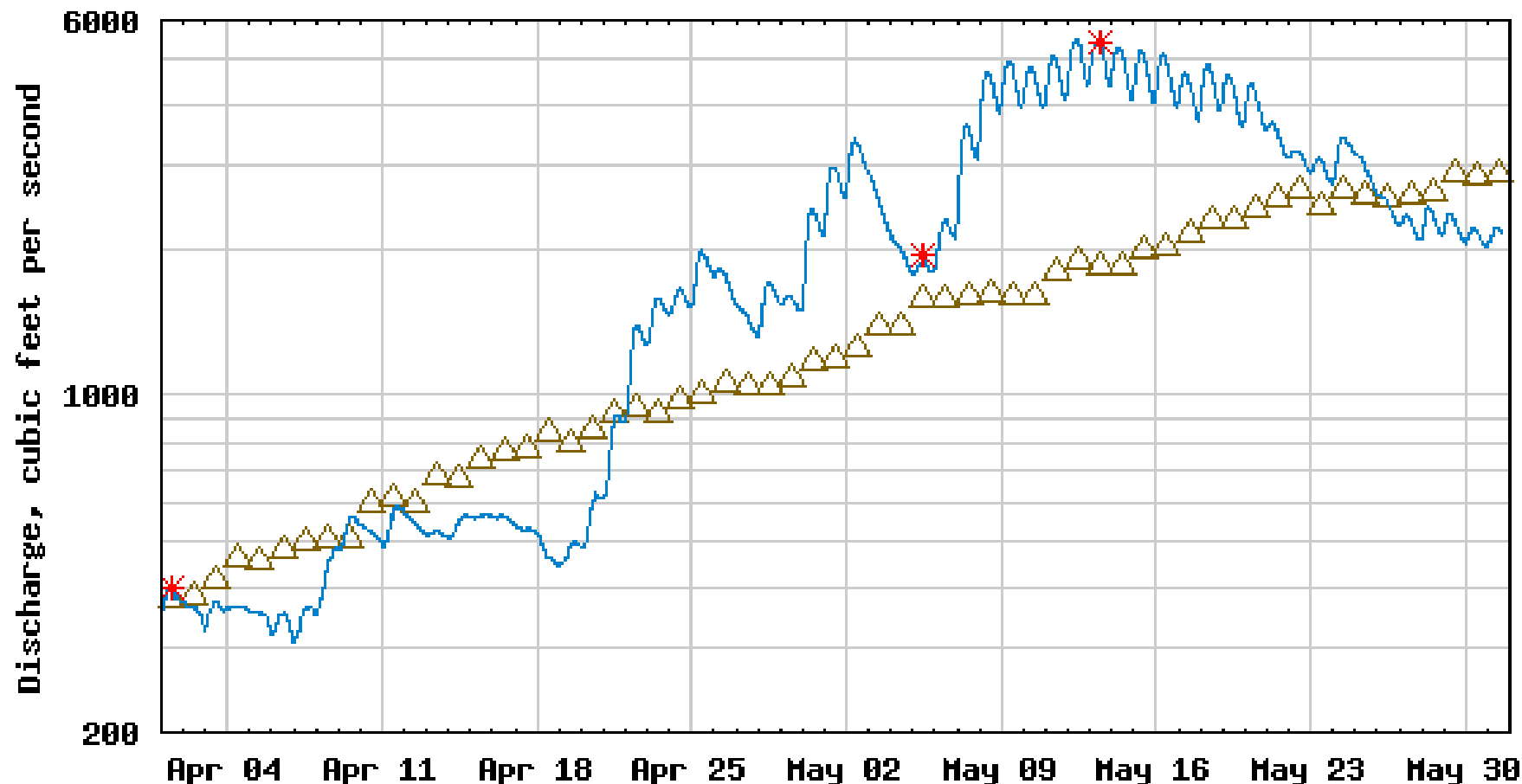


May 13, 2009 –Senator Beck Stream Gauge at 16 cfs

Senator Beck Basin Discharge – WY 2006, 2007, 2008 & 2009



USGS 09361500 ANIMAS RIVER AT DURANGO, CO



---- Provisional Data Subject to Revision ----

- △ Median daily statistic (97 years)
- ★ Measured discharge
- Discharge

Colorado Dust-on-Snow (CODOS) Program Participants:

Colorado River, Southwestern, and Rio Grande Water Conservation Districts

Upper Gunnison River, Tri-County, Animas-La Plata, and Northern Water Conservancy Districts

Colorado Water Conservation Board

Bureau of Reclamation – Western Colorado, Denver Water, Western Water Assessment

Center for Snow &



Avalanche Studies

