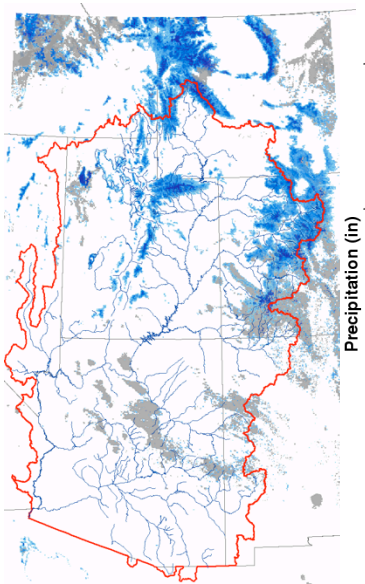
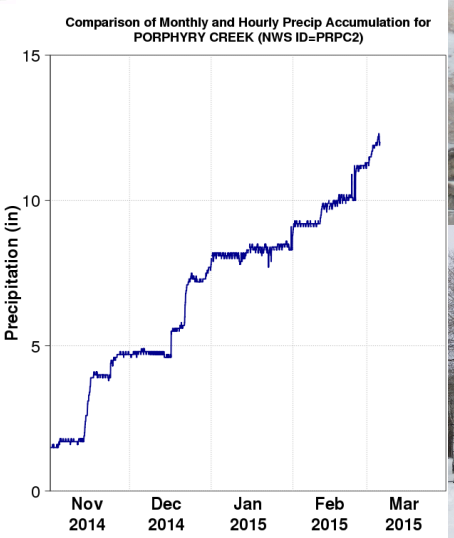
Snow Model Adjustment Methods at NOAA/CBRFC

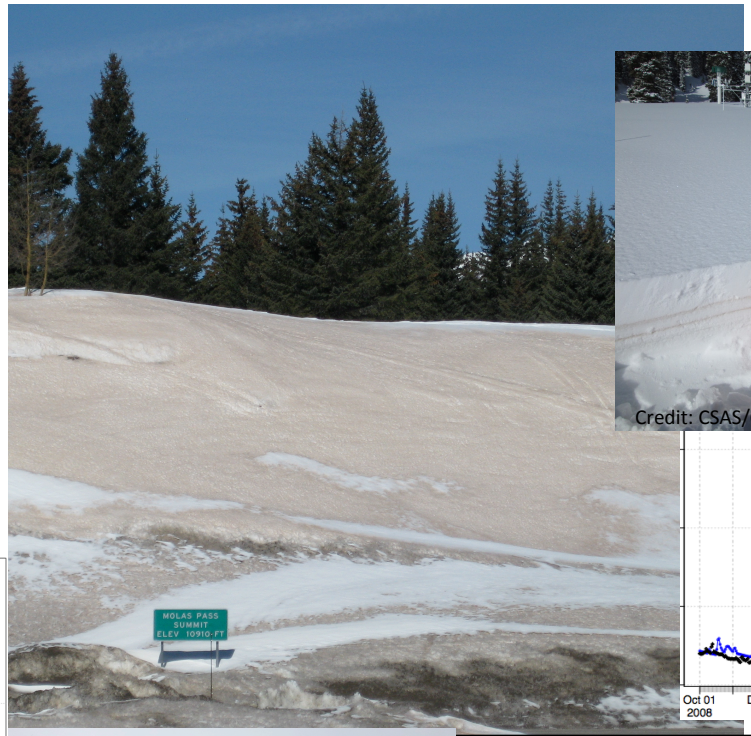
CBRFC Stakeholder Forum

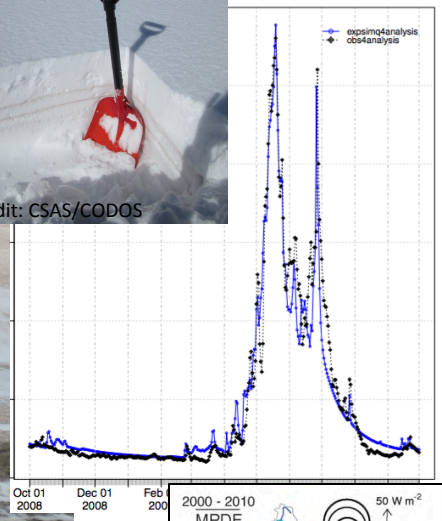
Salt Lake City

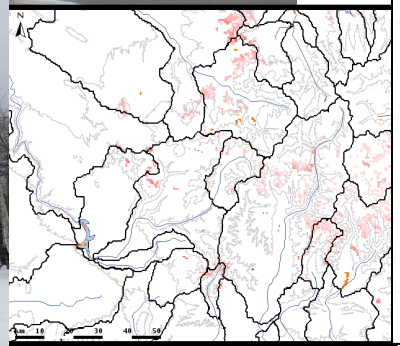
October 18, 2016

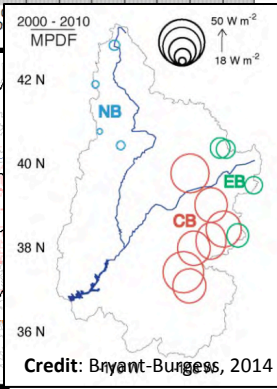








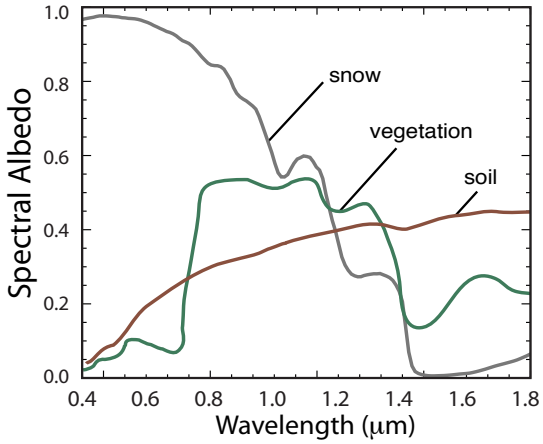




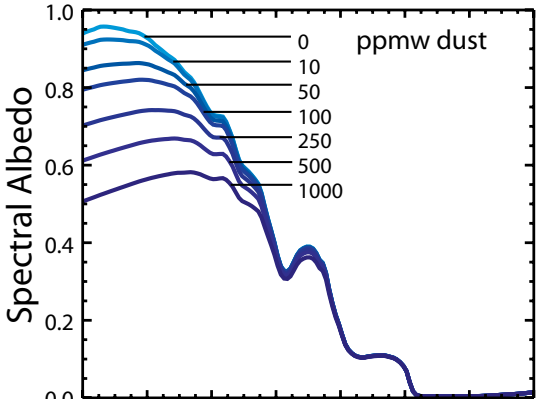
Credit: Bryant-Burgess, 2014

Tools: RS Snow Datasets

- **Exploit differences in spectral characteristics of snow in the VIS and NIR to derive snow cover and dust information**
  - SCAG (MODSCAG, VSCAG) algorithms provide per-pixel fractional snow cover (%)
  - DRFS (MODDRFS) provides per-pixel radiative forcing by dust at snowpack surface (W m^{-2})



- **Data Availability:**
  - MODIS-based (MOD) data available for period of record (2000 to present) and in near real time
  - VIIRS-based (V) data currently being processed by NASA/JPL - fully available sometime next year



REFERENCES:

Painter, T. H., K. Rittger, C. McKenzie, R. E. Davis, and J. Dozier, Retrieval of subpixel snow-covered area and grain size from MODIS reflectance data, *Remote Sensing of Environment,* 113, 868-879, doi: 10.1016/j.rse.2009.01.001.

Painter, T. H., A. C. Bryant, and S. M. Skiles, Radiative forcing of dust in mountain snow from MODIS surface reflectance data, *Geophysical Research Letters,* doi: 10.1029/2012GL052457.

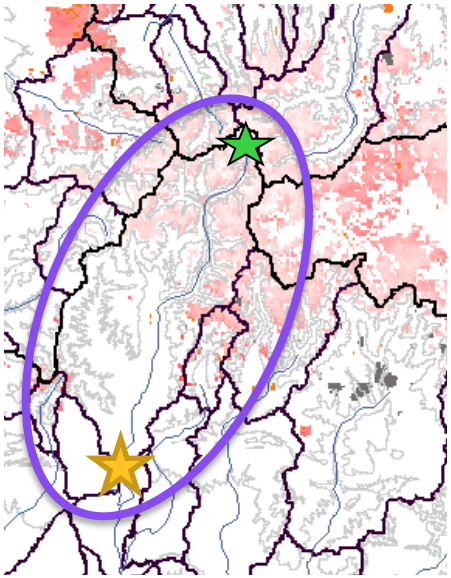
Experimental Melt Rate Adjustment Method: MODDRFS (satellite-based) "dust on snow" data

MODDRFS = MODIS Dust Radiative Forcing in Snow

- Satellite-based remote sensing dataset from NASA/Jet Propulsion Laboratory

Jet Propulsion Laboratory
California Institute of Technology

MODDRFS on April 10, 2014 (W m^{-2})



Durango, CO

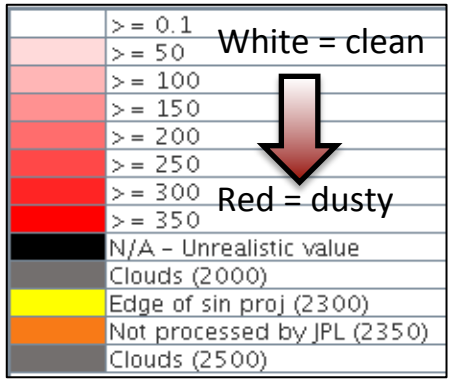


Photo: Dust layer D4 emerging on April 10, 2014, in the upper Animas watershed (along Hwy 550 south of Red Mountain Pass). Courtesy Center for Snow and Avalanche Studies, Colorado Dust-on-Snow Program, Silverton, CO

Experimental Melt Rate Adjustment Method: MODDRFS (satellite-based) "dust on snow" data

MODDRFS-informed manual (pre-WY16) adjustments to snowmelt rate by CBRFC forecasters are helpful but time-consuming and subjective.

- Need a more efficient, objective method of incorporating MODDRFS "dust-on-snow" data into CBRFC modeling and forecasting for WY 16 and beyond

- MODDRFS "dust on snow" data
  - use it to tweak input temperatures for snow model (SNOW17, which is a temperature-index snow model)

Experimental Melt Rate Adjustment Method: MODDRFS (satellite-based) "dust on snow" data

Methodology, in a nutshell:**

Original, unadjusted input temperatures	+	DRFS values (remote sensing of dust-on-snow)	x	Land Cover Info (coniferous veg.)	=	adjusted temperatures that can be input to SNOW17

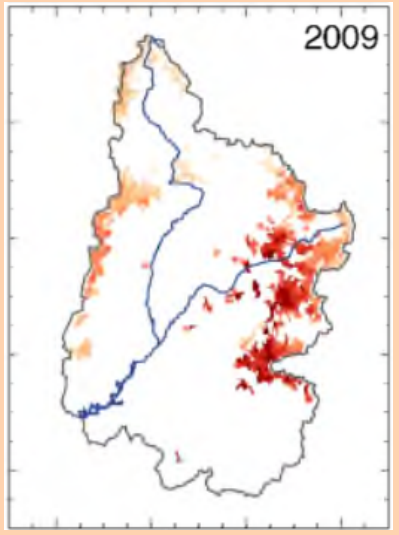
Preliminary Results for Uncompahgre R. in SW CO – NWS id = UCRC2:

- Minimal (+/- 3%) impacts on water year and seasonal runoff **volumes** (Apr-Jul)
- **Timing** of melt (and snowmelt-driven streamflow) *within the April-July runoff period* is altered by incorporation of MODDRFS ("dust on snow") data into SNOW17

Example case for SW CO in WY2009 (heavy dust):

2009 Dust:
→ Heavier, more than normal

2009 AMJJ runoff:
→ 118% average

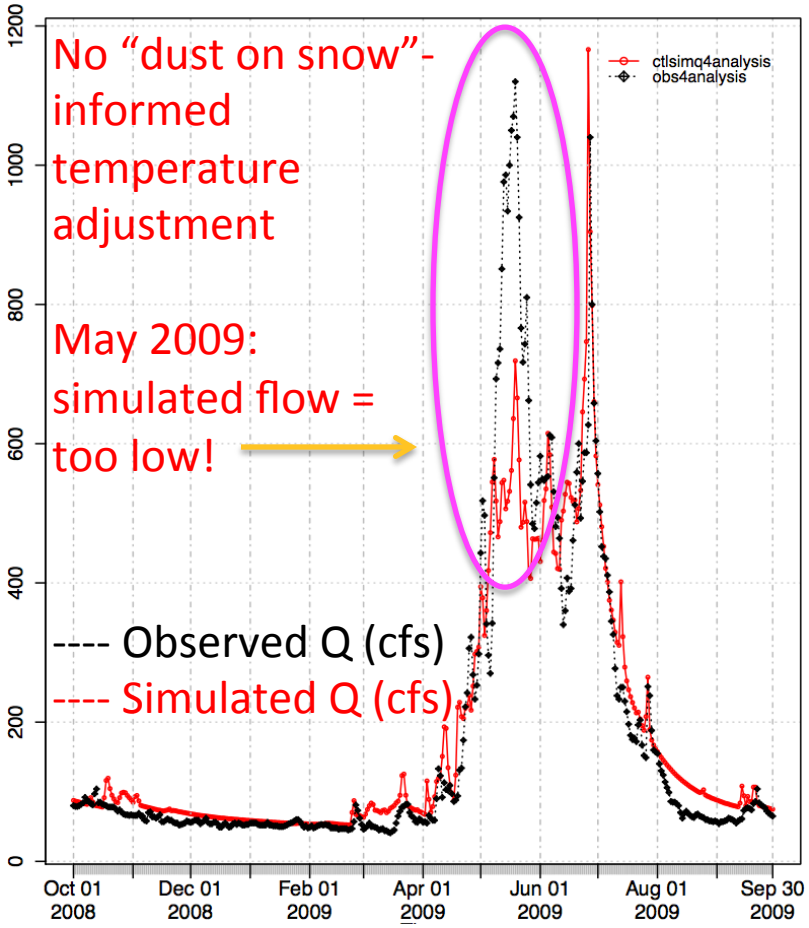


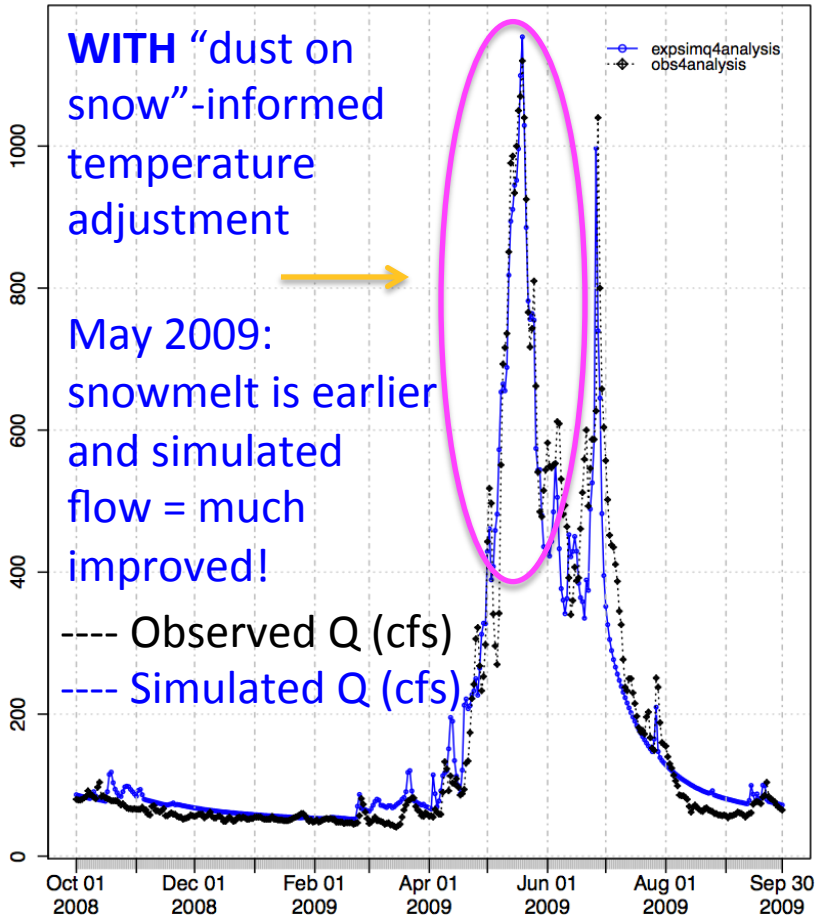
Map credit: Bryant-Burgess, 2014

Experimental Melt Rate Adjustment Method: MODDRFS (satellite-based) "dust on snow" data

Let's look at the hydrographs for WY2009 (more dust than normal in WY09):

- Uncompahgre River in southwestern CO (NWS ID = UCRC2)
- WY2009 – "heavy dust" year





Experimental Melt Rate Adjustment Method: MODDRFS (satellite-based) "dust on snow" data

- Primarily affects timing. However, volumes may be affected if a SWE adjustment is used instead of the correct temperature adjustment

- Problems that have occurred:
  - Clouds – does not work under cloudy conditions
  - Data reliability
  - Future Snow – may temporarily reduce the adjustment until the top layer is melted
  - Effect – generally minor except under very dusty conditions

Experimental Melt Rate Adjustment Method: MODDRFS (satellite-based) “dust on snow” data