Dust deposited on Colorado mountain snow cover: Effects on snow albedo and linkages to dust-source areas

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Photo by Chris Landry
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USGS science for a changing world
Why Care About Dust on Snow?

- Water resource management
- Rate, timing, and quantity of snow melt
- Leads to smaller late-season water supplies
Dust-on-Snow Sites

- Collect All Layers Merged samples from 12 High Elevation Sites in Colorado – 2,800 – 3,700 m (9,400 – 12,100 ft)
- Many potential dust source areas; Colorado Plateau + Wyoming Basin
- Dominant Wind Direction is from SW
How does dust affect on snow and snow melt?

Decreases albedo of snow surfaces

Which dust components affect albedo?
Characterizing Dust

Dust samples are analyzed to:

1) understand the properties of dust that affect snow albedo
2) Link DOS to dust-source areas

These properties are:

1) Reflectance as a function of the solar radiation spectrum
2) Mineral and chemical compositions and occurrences
3) Particle sizes
Dust Components

Varying capacity to absorb solar radiation

\[ R_{vis} = 0.15 \quad R_{vis} = 0.20 \quad R_{vis} = 0.13 \]

Goethite and Hematite identification from reflectance
OC as much as 7%

Quartz 21-47%
Feldspar 16-33%
Clay 11-36%
CO3 0-10%
Mica 2-26%

Median: 23 \( \mu \)m
80% less than 63 \( \mu \)m
PM2.5: 8%
PM10: 22%
Clay-coated Quartz with domains of iron oxides

Iron oxides scattered on illite

Coal particle

Absorption of solar energy from Reflectance

Fe oxide amount from magnetic measures

Organic matter from organic C % Black carbon?

correlation?

correlation?
Absorption of solar radiation by iron oxide minerals and organic carbon

When on surfaces of dust particles, iron oxide minerals (Ht + Gt; HIRM) diminish reflectance values.

Higher contents of organic matter (mostly soot + coal) correspond to lower reflectance.
Linking Dust to Dust-Source Areas

Can the effects of Dust-on-snow be minimized by mitigation efforts in source areas?

Remote sensing and particle-trajectory analyses

Dust can be transported from Four Corners area

(www.arl.noaa.gov/HYSPLIT_info.php)

Black - 100 MAGL
Red - 200 MAGL
Blue - 500 MAGL
Mineralogical and Chemical properties
Summary

• Visible wavelengths important part of solar spectrum that affects snow albedo
• Iron oxides and organic carbon are important dust components that affects snow albedo
• Dust deposited on snow cover can be linked to dust-source areas using remote sensing and particle-trajectory analyses, as well as mineralogy and chemistry

Next Steps

• Use isotope geochemistry to further distinguish among dust sources enabling stronger chemical linkages between deposited dust and potential dust sources
• Incorporate variability of dust-on-snow properties into dust radiative forcing snow models with collaborators at the Jet Propulsion Laboratory and UCLA