Snow Model Adjustment Methods at NOAA/CBRFC

CBRFC Stakeholder Forum
Salt Lake City
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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:

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

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

| >= 0.1 | White = clean |
| >= 50  |              |
| >= 100 |              |
| >= 150 |              |
| >= 200 |              |
| >= 250 |              |
| >= 300 |              |
| >= 350 |              |
| N/A - Unrealistic value |
| Clouds (2000)          |
| Edge of sin proj (2300) |
| Not processed by JPL (2350) |
| Clouds (2500) |

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
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**:

<table>
<thead>
<tr>
<th>Original, unadjusted input temperatures</th>
<th>DRFS values (remote sensing of dust-on-snow)</th>
<th>Land Cover Info (coniferous veg.)</th>
<th>Adjusted temperatures that can be input to SNOW17</th>
</tr>
</thead>
</table>

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
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

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

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**WITH “dust on snow”-informed temperature adjustment**

May 2009: snowmelt is earlier and simulated flow = much improved!

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**No “dust on snow”-informed temperature adjustment**

May 2009: simulated flow = too low!
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