Implementation of Albedo from Melting Snow into WRF

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Cold Season 2-m Temperature Bias

- Significant Warm or Cold Model Bias in some regions at some time
- Why?
- How to reduce Bias?
- Source of Model Errors: Synoptic scale, Local scale (e.g., Surface Fluxes, Surface Albedo, Land Properties) etc.
- Unified Noah LSM
A Method for Warm Bias Reduction

- An option in Noah LSM: Zilitinkevich’s Thermal Roughness Length

\[ Z_{OT} = Z_{OM} \exp \left\{ - k \times C \times Re^{1/2} \right\} \]

\[ C = \text{Constant in present ARW} \]

\[ C = \text{Constant} \times \left\{ 1 + C_{max} \times \left( \frac{R_{ib}}{R_{ic}} \right)^2 \right\} \]

for stable regime in new NMM
A Method for Cold Bias Reduction

- To Parameterize the Albedo for Melting Snow
Observed spatial and temporal variability of albedo along a line of Instruments during the melt season (Arctic Field Experiment)
Noah LSM 2.7.1
1-D Model
Snow Depth (m)

Observation

max_albedo=0.47

max_albedo=0.7
Albedo (max_albedo=0.79; melting max_albedo=0.79*75%)
Snow Depth (m) (max_albedo=0.79 & melting max_albedo=0.79*75%)
Reduced max_albedo to 0.75% of Original Value during Melting Period

• Better agreement between the model output and ground observation of snow depth & time for complete melting
Implementation of Melting Snow Albedo to WRF for March 3, 2007 case
2-M TEMP NA12AQ 09H FCST VALID 21Z 03 MAR 2007

Control Run

Melting Snow Albedo Run
2-m Temperature Bias and RMS Error

Control Run

Melting Albedo Run

![Graph showing temperature bias and RMS error for control and melting albedo runs.](image-url)
Summary

- 2 preliminary schemes to reduce warm or cold bias of 2-m temperature during cold seasons
- Reduce warm bias by modifying Thermal Roughness Length calculation
- Reduce cold bias by considering Albedo of Melting Snow
- Just few lines of code changes are needed in the Unified Noah LSM
- Applicable to Global WRF, Climate Model & Data Assimilation