

Exploring Features for Improving Orographic Snowfall Retrieval Shangyong Shi Mentor: Yongzhen Fan

Introduction

Orographic Effect on Precipitation

- Increase of precipitation with altitude
- Modified snowfall distribution upslope Key factors:
- Low-level wind (magnitude, orientation)
- Terrain slope orientation, steepness
- Moisture flux convergence...

Most past studies focused on rainfall. Scheme incorporating orographic variables reduces bias in rainfall retrievals. (Shige et al., 2013)

Such schemes haven't been applied for snowfall. Our work would focus on improving orographic snowfall retrievals.

Objectives

- Find the proper method to identify orographic snowfall.
- Analyze NOAA operational SFR product and compare statistics of the orographic and non-orographic snowfall
- Identify the elevation-related features to improve the performance of the SFR algorithm for orographic snowfall.



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Data

Time: 2018.1.1-2022.12.31 Satellite: N20 Surface: GFS (0.5*0.5) Ground Truth: StageIV Elevation: SRTM (1km, 1/120*1/120)

Methods

Orographic upward motion $w = \vec{V} \cdot \nabla h$ **Orographic Precipitation Index** $OPI = TPW \cdot w$ an index that shows the amount of

moisture advected over the sloping terrain.

h: elevation (m) , \vec{V} : the surface horizontal wind. TPW: total precipitable water ($kg m^{-2}$)



115°W

105°W

125°W

Case Study: 12/31/2022

3000 2500

- 500

- 0.03

- 0.02

0.01

-0.01

-0.02

-0.03

dh/db 0.00

Lo









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Results

- Identified major mountain ranges with higher percentages of orographic snowfall (>30%)
- The classification performance for the non-orographic category is slightly better than the orographic category.
- The larger OPI, the larger bias with reference to Stage IV precipitation rate.
- RMSE increased considerably for SFR data with OPI>1.0.



Snowfall Detection	POD	FAR	TSS	HSS
Orographic (OPI>0.25)	0.90	0.015	0.885	0.868
Non-Orographic (OPI<0.25)	0.93	0.029	0.905	0.893

OPI values show strong correlation (i.e. 0.45) with SFR bias for orographic snowfall (OPI>0.25) and could be used as a feature to improve the machine learning SFR bias correction algorithm.