

Summary of and Selected Highlights from the Surface Atmosphere Integrated Field Laboratory (SAIL) Field Campaign

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Abstract

For SAIL, the ARM Program successfully deployed the AMF-2 across the East River Watershed near Crested Butte, Colorado. SAIL collected data from Sept. 1, 2021 to June 15, 2023. By collecting 100+ datastreams and leveraging strong federal, state, and local partnerships, SAIL has advanced understanding of the precipitation, snowpack, aerosol, and radiative processes that impact surface water and energy budgets in the Upper Colorado River. A small sample of ongoing research highlights are shown.

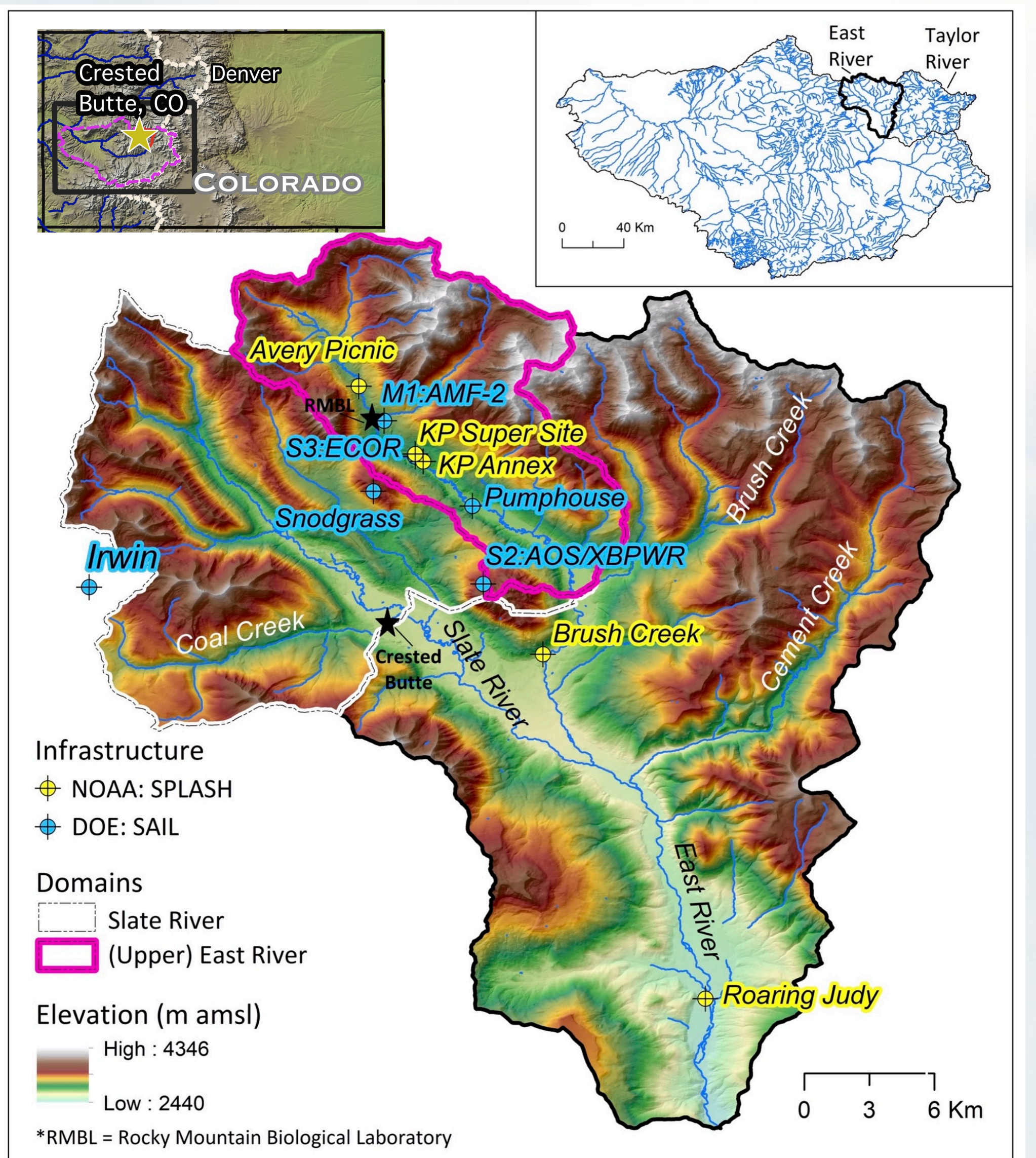


Fig 1: Location of SAIL in Upper Colorado River Basin and SAIL specific locations (in blue) and partner SPLASH locations (in yellow) from [1]

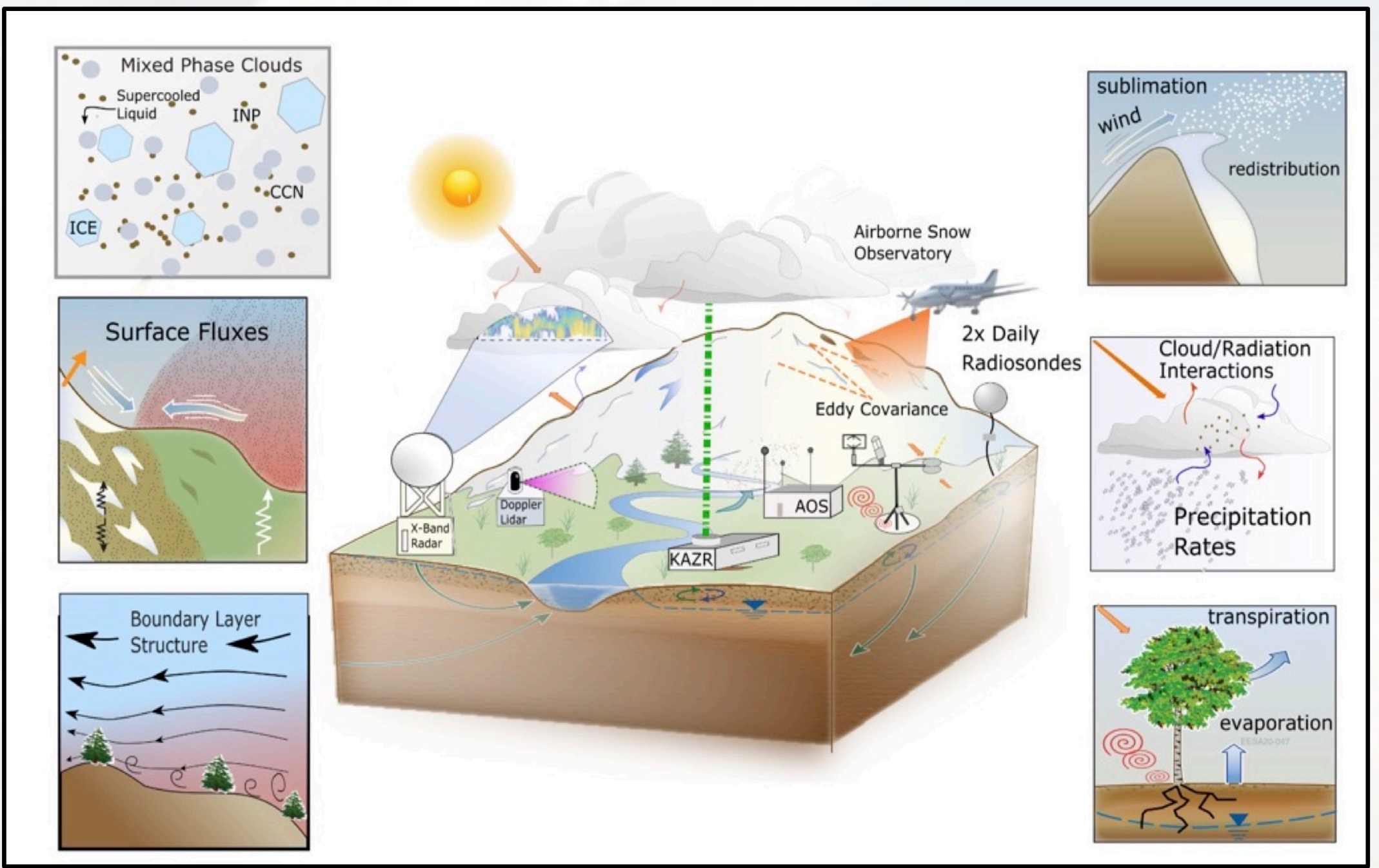


Fig 2: Cartoon showing the density of observations across the East River Watershed that captures the dominant atmospheric and surface processes that impact mountainous hydrology. From [1].

Learn more about SAIL and get a copy of this poster here:



Measurements across the East:

SAIL measured across the 300 km² East River Watershed and included 3 valley sites, and one mountain site.



A Whole Lot of SAIL Data:

The dozens of instruments deployed at SAIL collected over 100 datastreams, with more products planned by end of 2023, including guest instrument datasets.

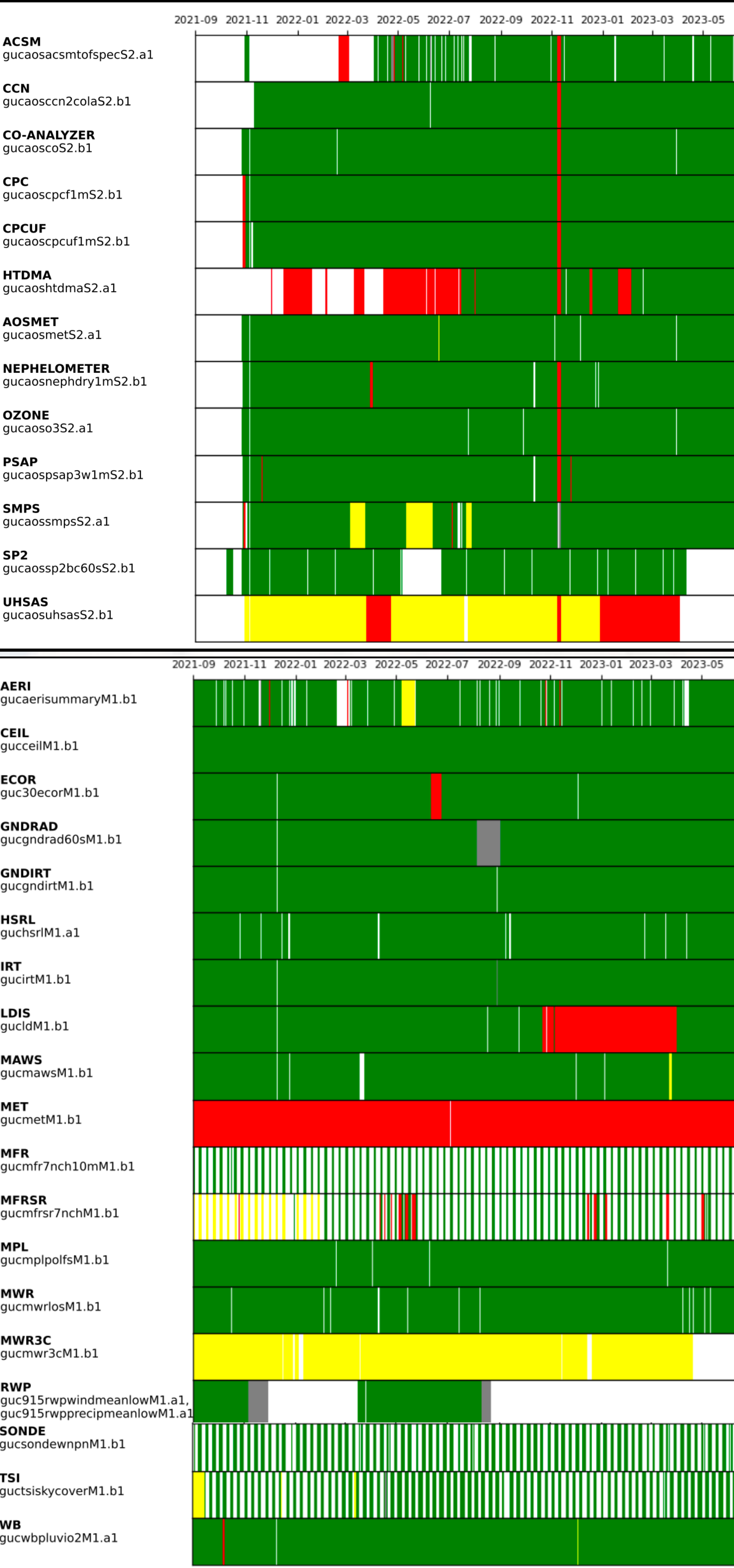


Fig 3: SAIL data-stream availability on ARM Data Discovery (green) and gaps (white, red, and yellow) over the Campaign's duration.

Highlight: Insights into T2m Biases

Dozens of publications have all found that the two-meter surface air temperature (T2M) field that Earth System Models and atmospheric process models report is too cold in mountains in the winter. There are many potential causes for these biases. SAIL data provide unique insights into when, where, and possibly why these biases arise: They show that models need to couple the surface and atmosphere more tightly in winter.

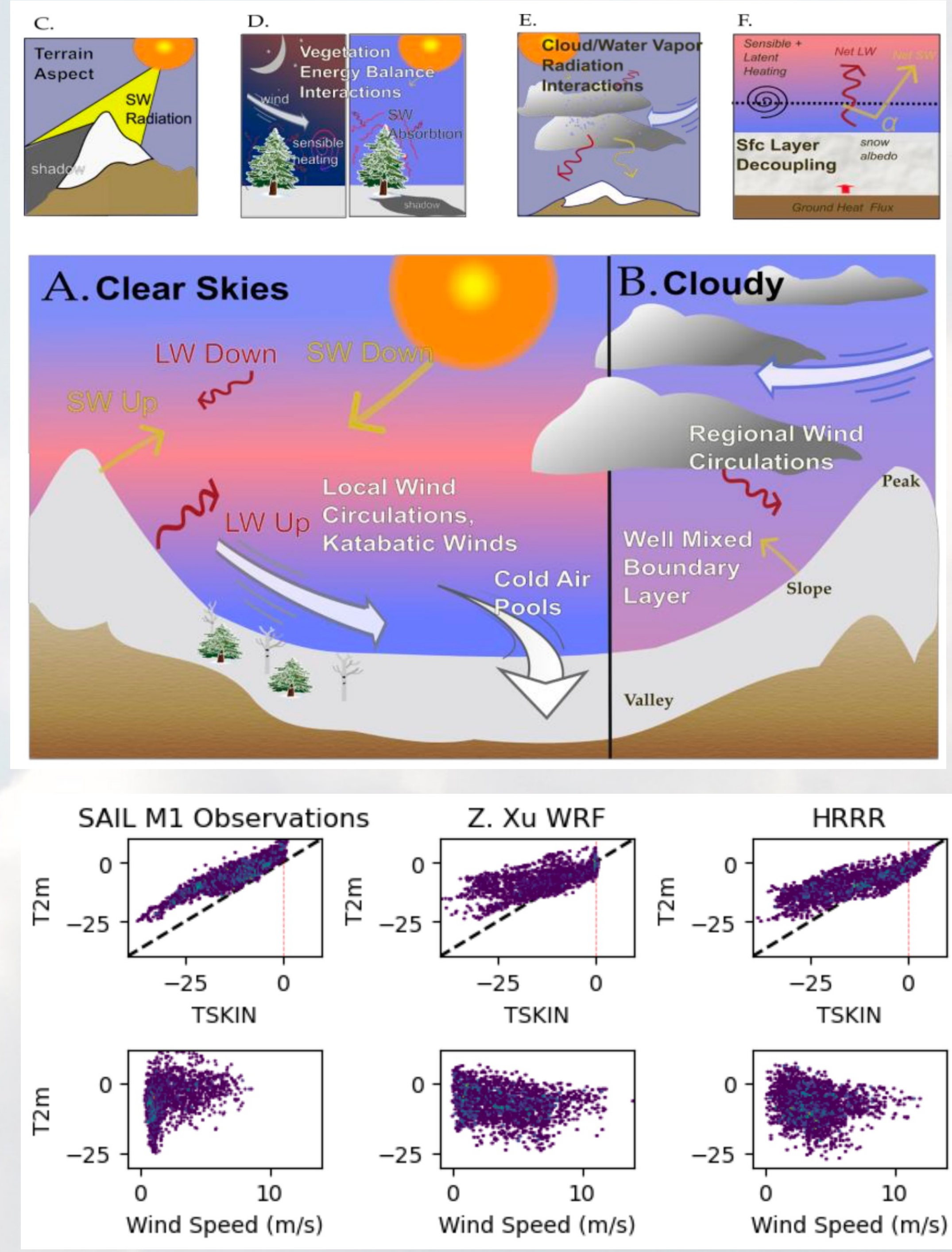


Fig 4: (Above) Depiction of processes that impact T2m in complex terrain. (Below) Comparison of T2m vs skin temperature at SAIL vs modeled values from WRF and HRRR. From [2].

Highlight: Resilient snowpack estimation

SAIL show how radar data can address a known problem with snowpack estimation: snow patterns are expected to change, but the network of snow monitoring stations cannot move easily. From [3].

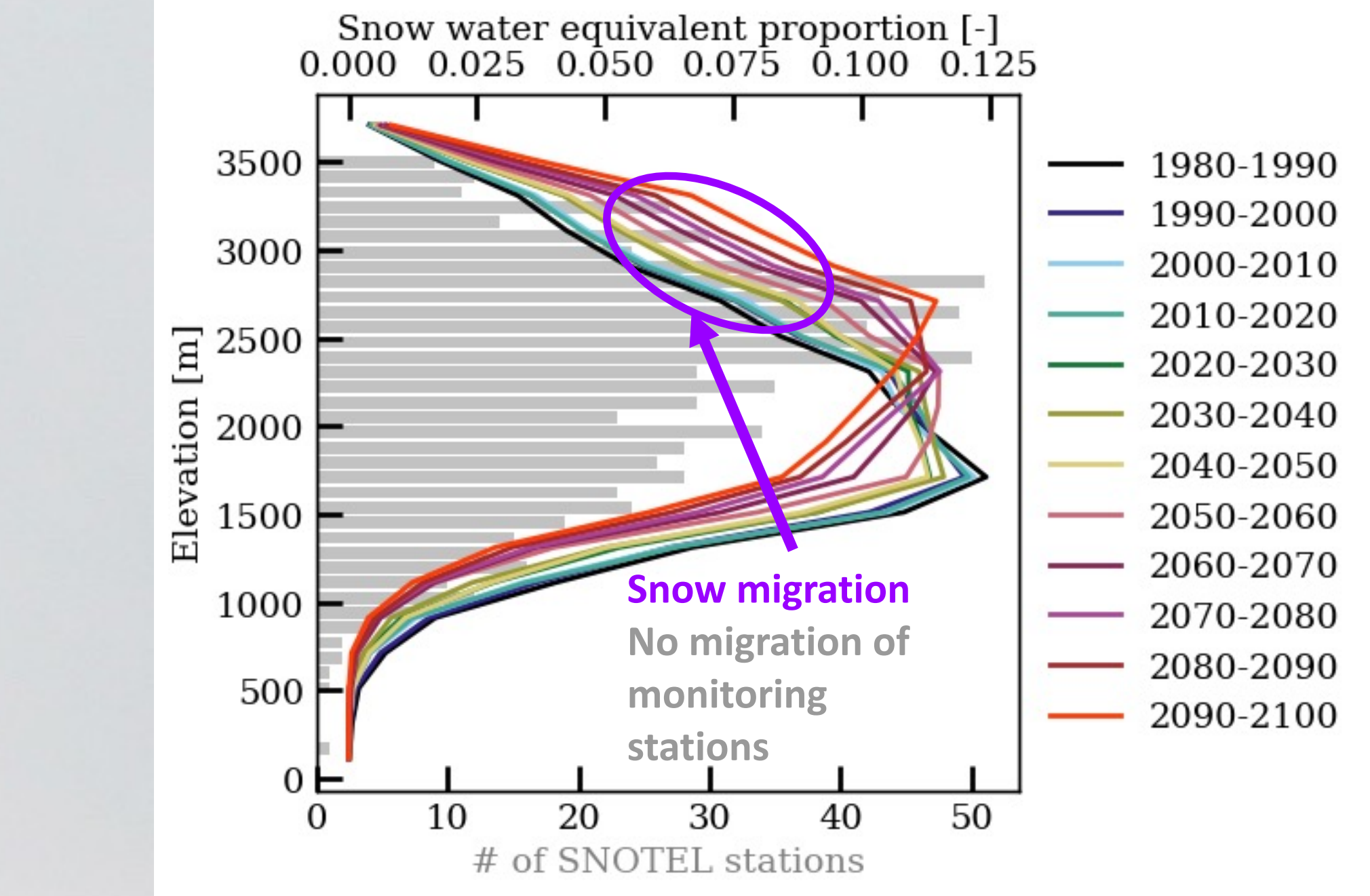


Fig 5: Estimated of snowfall measured by SNOTEL stations in the 21st Century. From [3].

Highlight: End of Hoar Frost?

Surface hoar-frost formation is the result of thermodynamic deposition of water. Warmer temperatures can create unfavorable conditions for hoar-frost formation. SAIL observations probe the limitations of this formation. From [4]

Fig 6: Image of large hoar frost formation in Palisades, California (from AlpenGlow Expeditions)

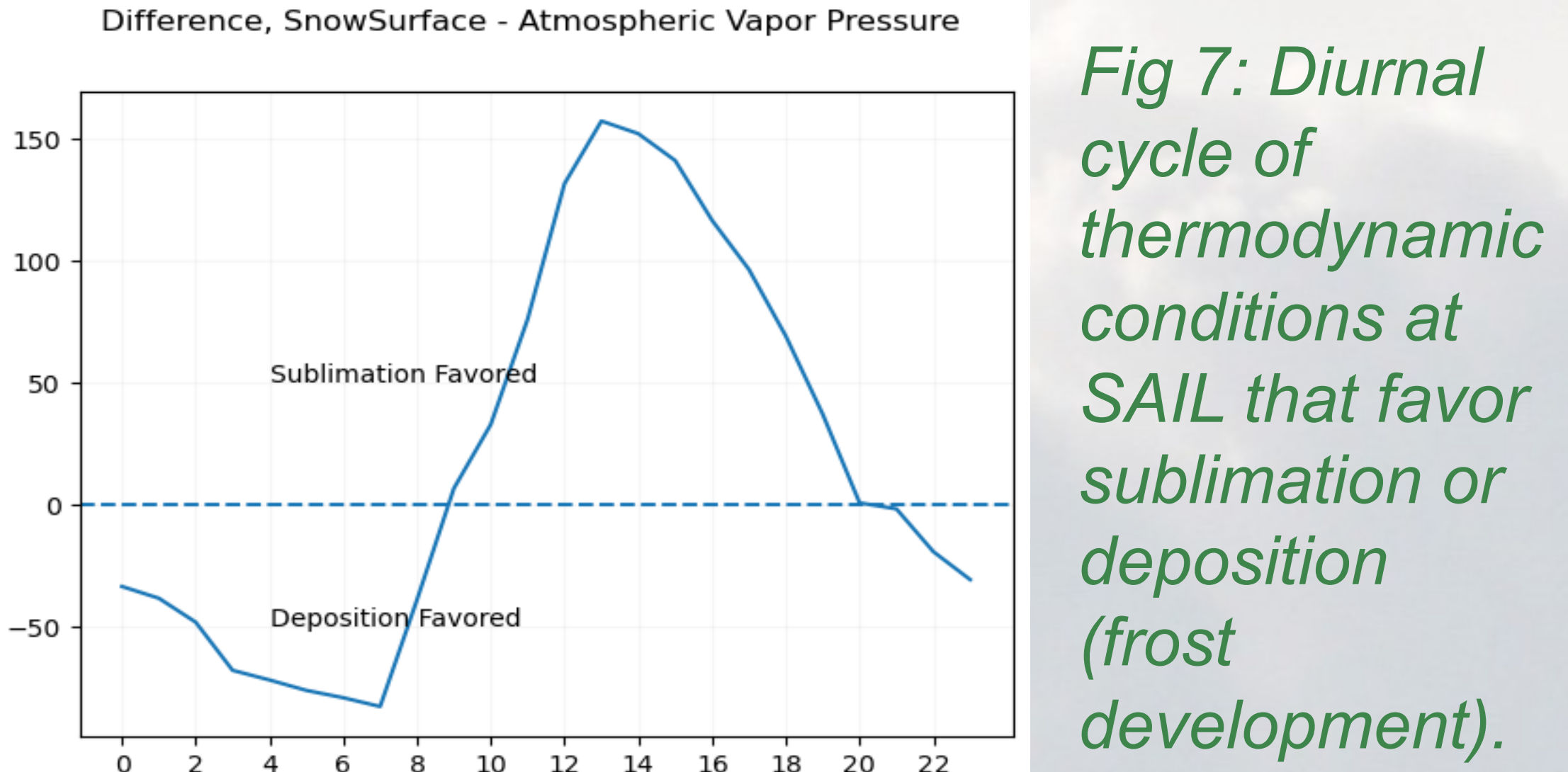


Fig 7: Diurnal cycle of thermodynamic conditions at SAIL that favor sublimation or deposition (frost development).

Highlight: Santa Slammer Case Study

SAIL + SPLASH data capture the atmospheric dynamics, thermodynamics, and microphysics that produced ~1/3 of total snowfall in 2021/2022 from 23-Dec-2021 to 1-Jan-2022, enabling connections between precipitation, thermodynamics, and microphysics.

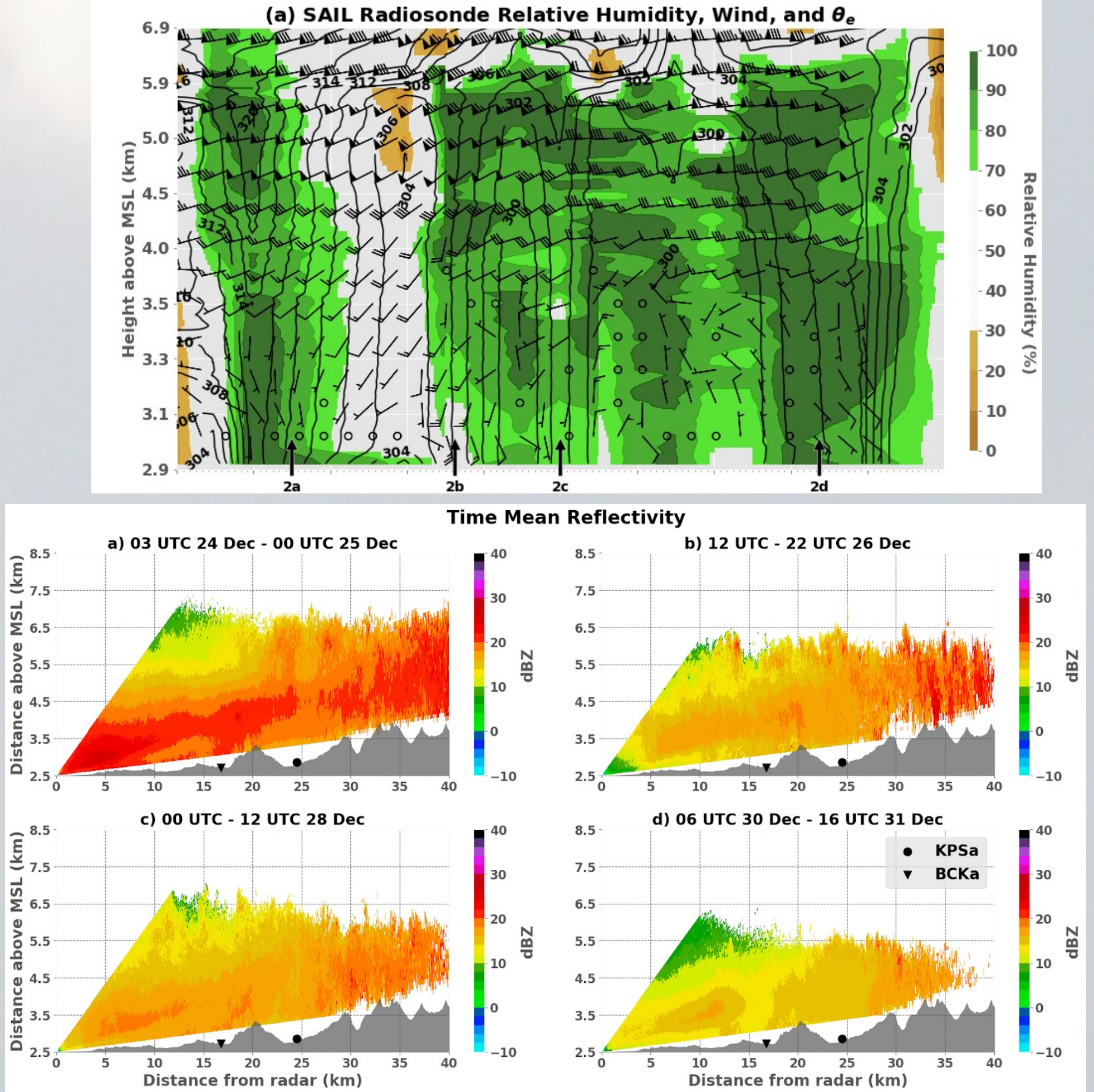


Fig 8: SAIL radiosondes and SPLASH radar time-mean reflectivity fields from RHI scans. From [5]

Acknowledgments

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References

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