A Downscaled Atmospheric Forcing Dataset for Land Surface Modeling

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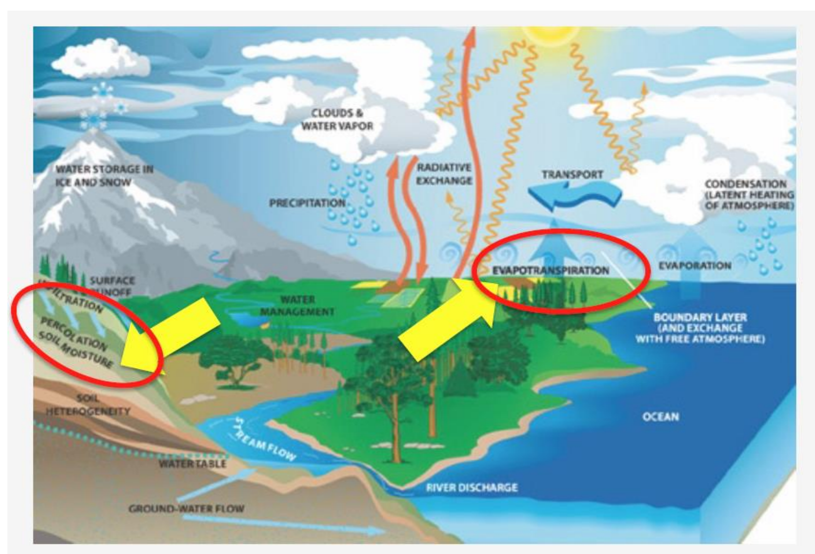
Motivation

Why soil moisture?

- Soil water content has influence on cloud coverage, precipitation, runoff and evapotranspiration
- A realistic soil moisture improves weather and climate prediction, hazard mitigation (floods and droughts), agricultural planning and water resources management



How much water is there?

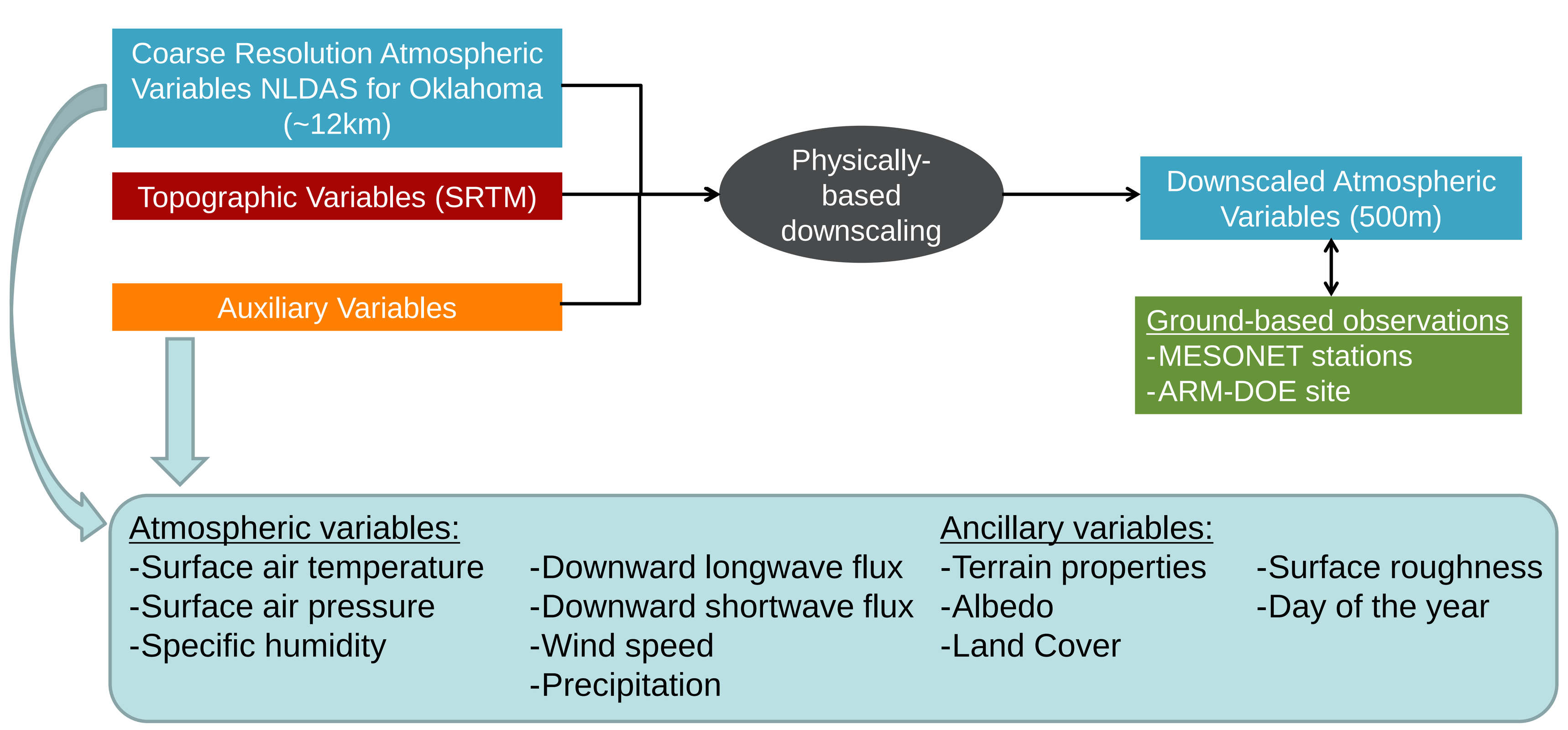
Component	USGS	UNESCO (1990)
Oceans	97.09%	93.93%
Glaciers	1.99%	1.65%
Groundwater	0.62%	4.12%
Atmosphere	0.29%	0.001%
Lakes	0.012%	0.016%
Soil moisture	0.004%	0.005%
Rivers	0.0001%	0.0001%
Total	100%	99.72%

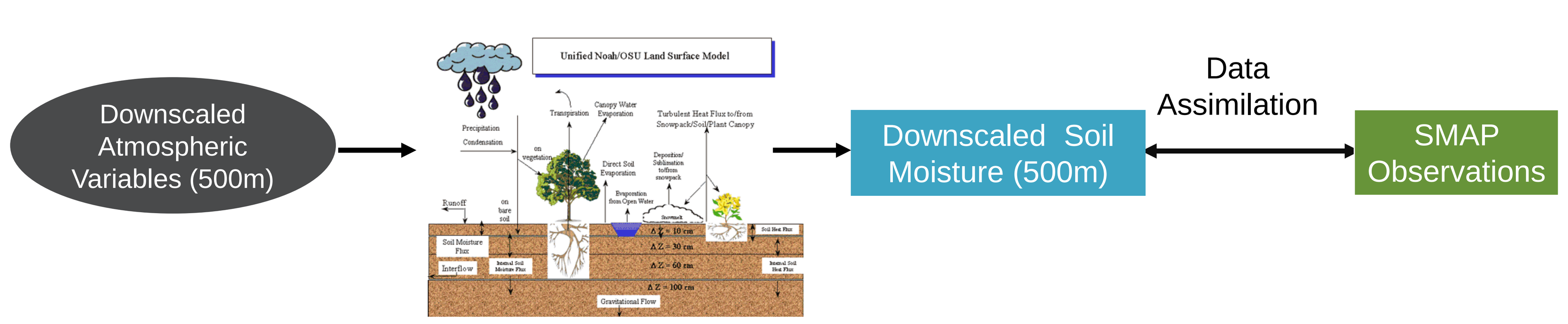
Source: Applied Remote Sensing Training Program

- Availability of in-situ soil moisture measurements is scarce
- NASA Soil Moisture Active Passive (SMAP) mission provides information on surface soil moisture (top 5 cm of the soil column)
- SMAP soil moisture is limited by course resolution (36 km)

Methodology

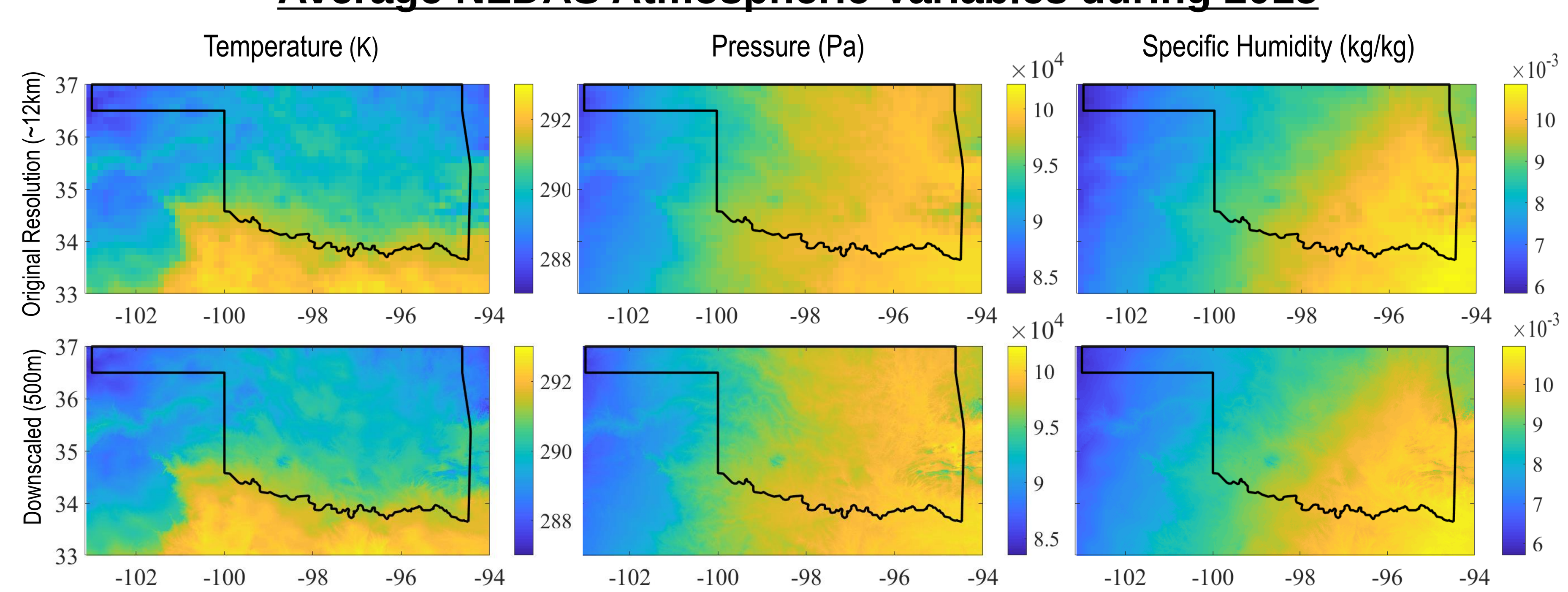
Physically-based surface meteorology downscaling are developed to study surface flux, storage, and water balance changes and investigate the causality of these changes at the regional to local scale.



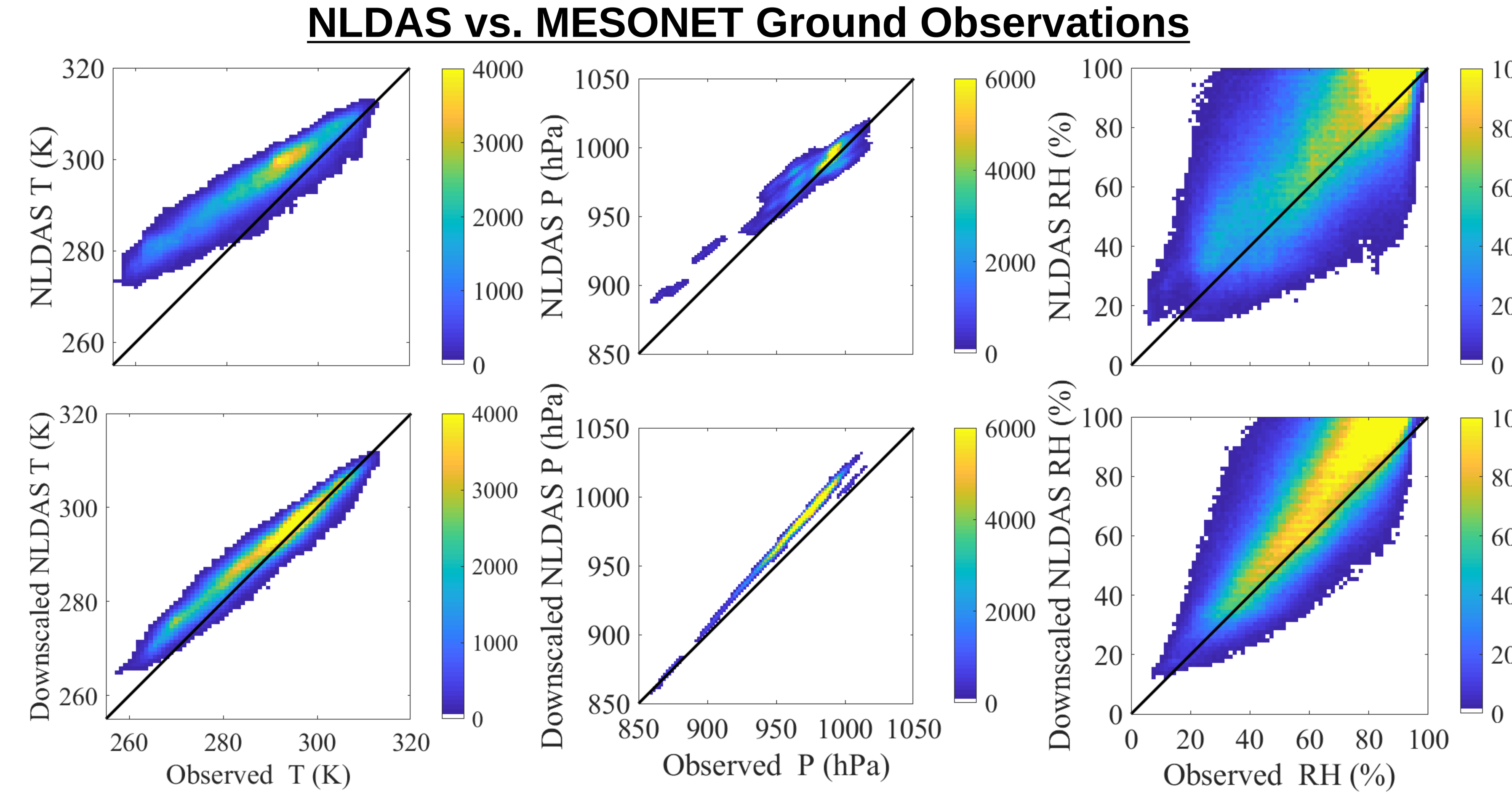


Validation

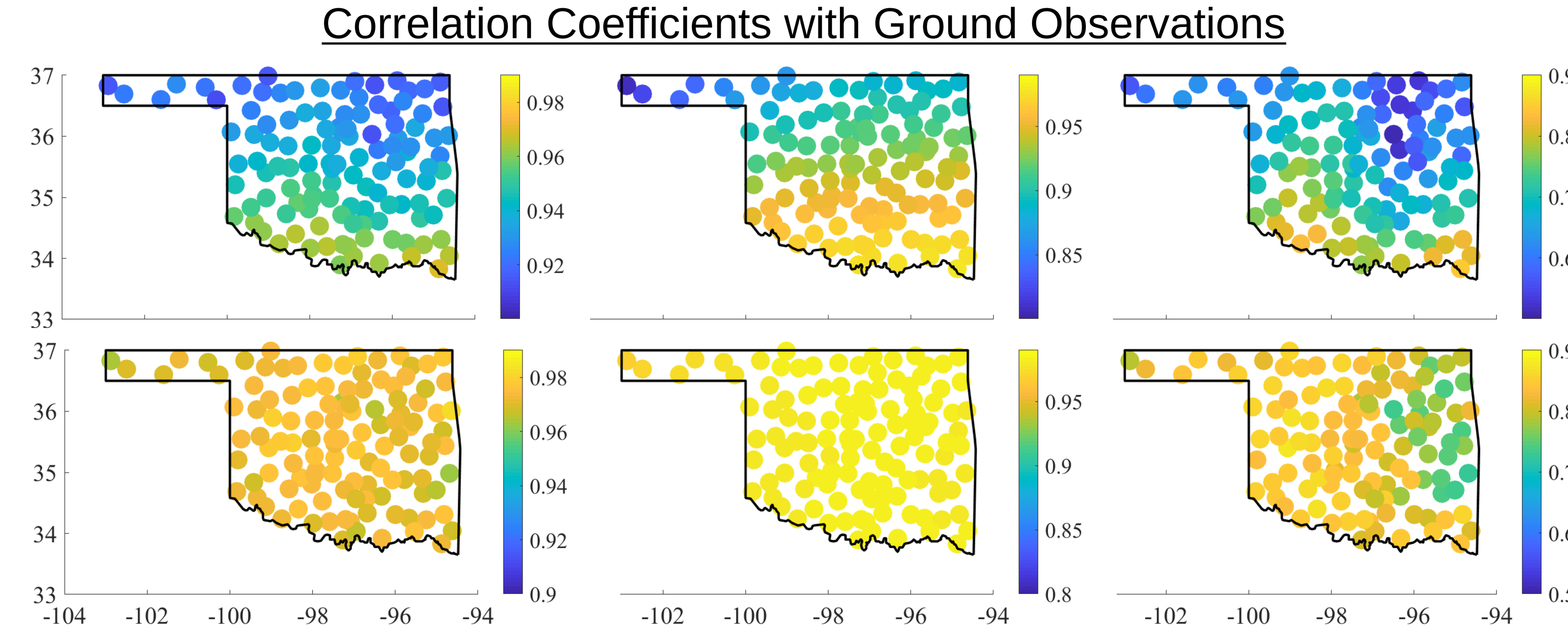
Average NLDAS Atmospheric Variables during 2015



NLDAS vs. MESONET Ground Observations



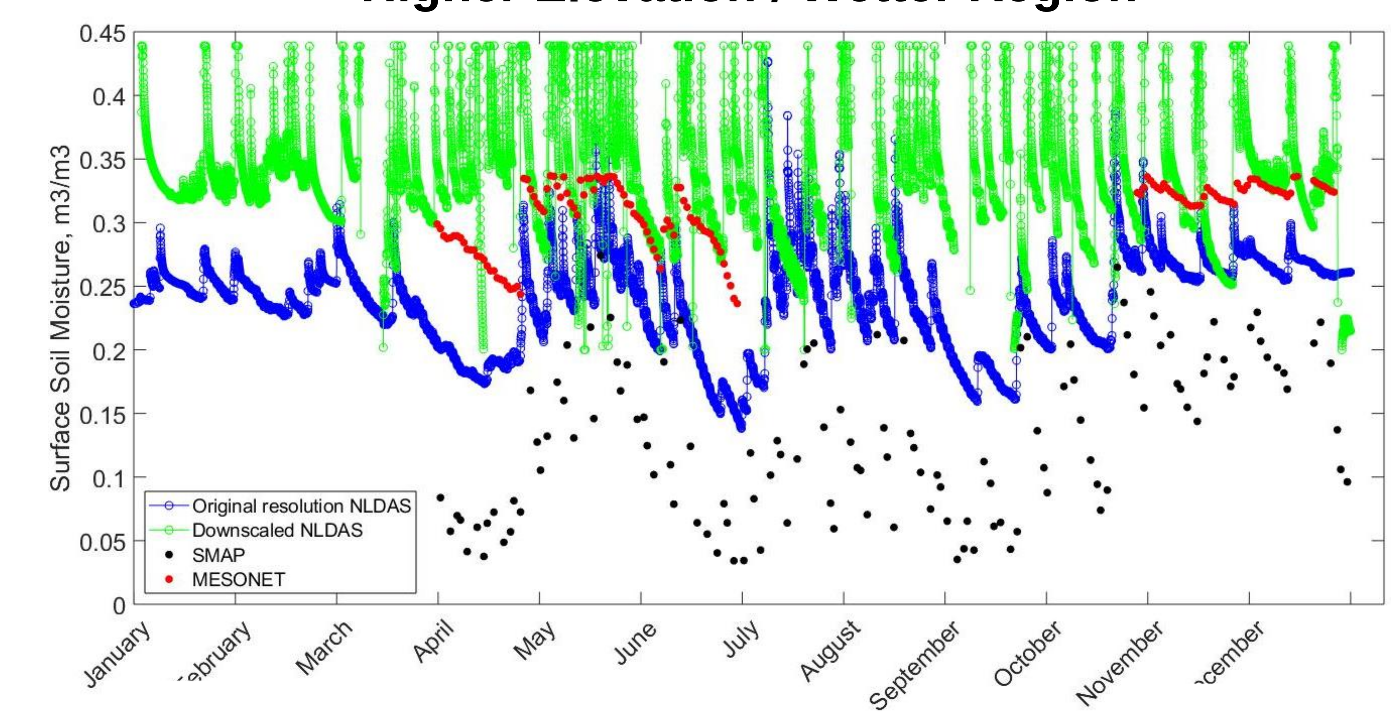
Correlation Coefficients with Ground Observations



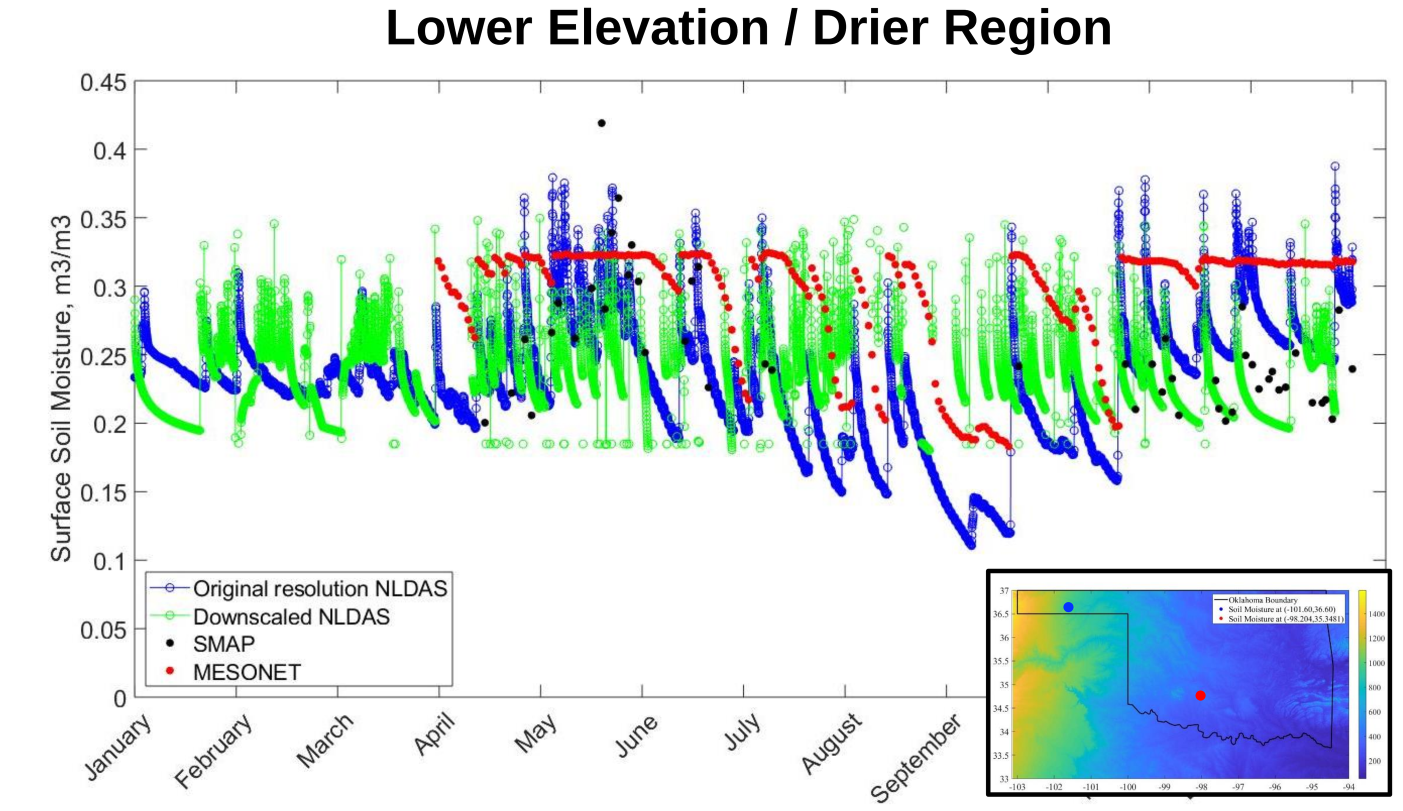
	Original/Downscaled		
	Correlation	RMSE	MRE
Temperature (K)	0.94/0.97	5.09/2.69	0.01/0.00
Pressure (hPa)	0.94/1.00	13.8/2.75	0.12/0.00
Relative Humidity (kg/kg)	0.69/0.92	17.1/12.6	0.21/0.16
Longwave Radiation (W/m^2)	0.73/0.82	49.4/36.9	0.12/0.09
Shortwave Radiation (W/m^2)	0.91/0.86	119/158	-1.3/0.47
Wind Speed (m/s)	0.70/0.70	2.22/2.21	-1.5/1.9

LSM Simulations

Higher Elevation / Wetter Region



Lower Elevation / Drier Region



Conclusions

- Surface meteorological downscaling techniques were developed and validated in Oklahoma.
- Validation show good downscaling performance:
  - Correlation coefficients (biases) between the downscaled dataset and observations are consistently higher (lower) than the native resolution and the reference.
  - The downscaled forcing dataset has a positive impact on LSM soil moisture simulations.
- Next steps:
  - Investigate SMAP soil moisture data assimilation in downscaled hyper-resolution land surface modeling
  - Perform bias adjustment before assimilating SMAP observations
  - Validate the hyper-resolution surface and root zone soil moisture products against the MESONET ground-based observations

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