Full slides

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How different are the Sierra Nevada SWE estimates from four land surface models with three forcing datasets?

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SnowEx 2020 virtual meeting

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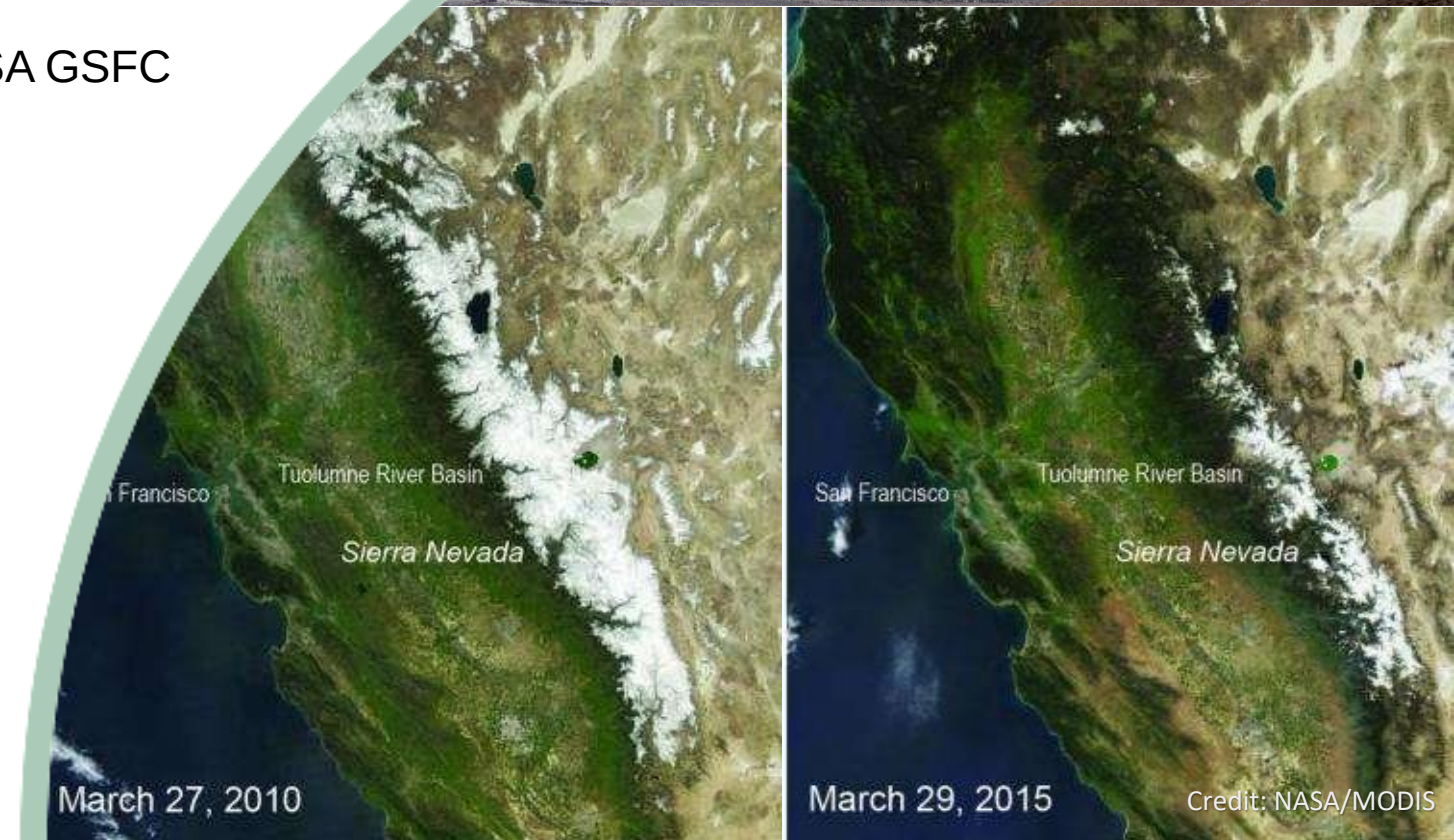

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Motivation

Despite the popularity of the snowpack products from multiple land surface models (LSMs) with different forcing data for hydrologic and climate researches, quantifying differences in the SWE estimates and identifying dominant sources of errors (LSM physics vs. Forcing) are elusive, especially in mountainous regions.

Research Questions

1. How different are total snowpack estimates from four land surface models (LSM) and three forcing datasets over the Sierra Nevada?

2. Does the LSM physics or forcing data generate the larger errors in SWE estimates?

3. Do the errors depend on dry vs. wet years?

SWE Datasets

Snow Ensemble Uncertainty Project (SEUP) SWE products (12 combinations; 5 X 5 km^2)

Four LSMs

(1) Noah version 2.7.1 (Noah 2.7.1)
(2) Noah-Multi-Parameterization, version 3.6 (Noah-MP)
(3) Catchment version 2.5 (CLSM 2.5)
(4) Joint UK Land Environment Simulator (JULES)

Three Meteorological Forcings

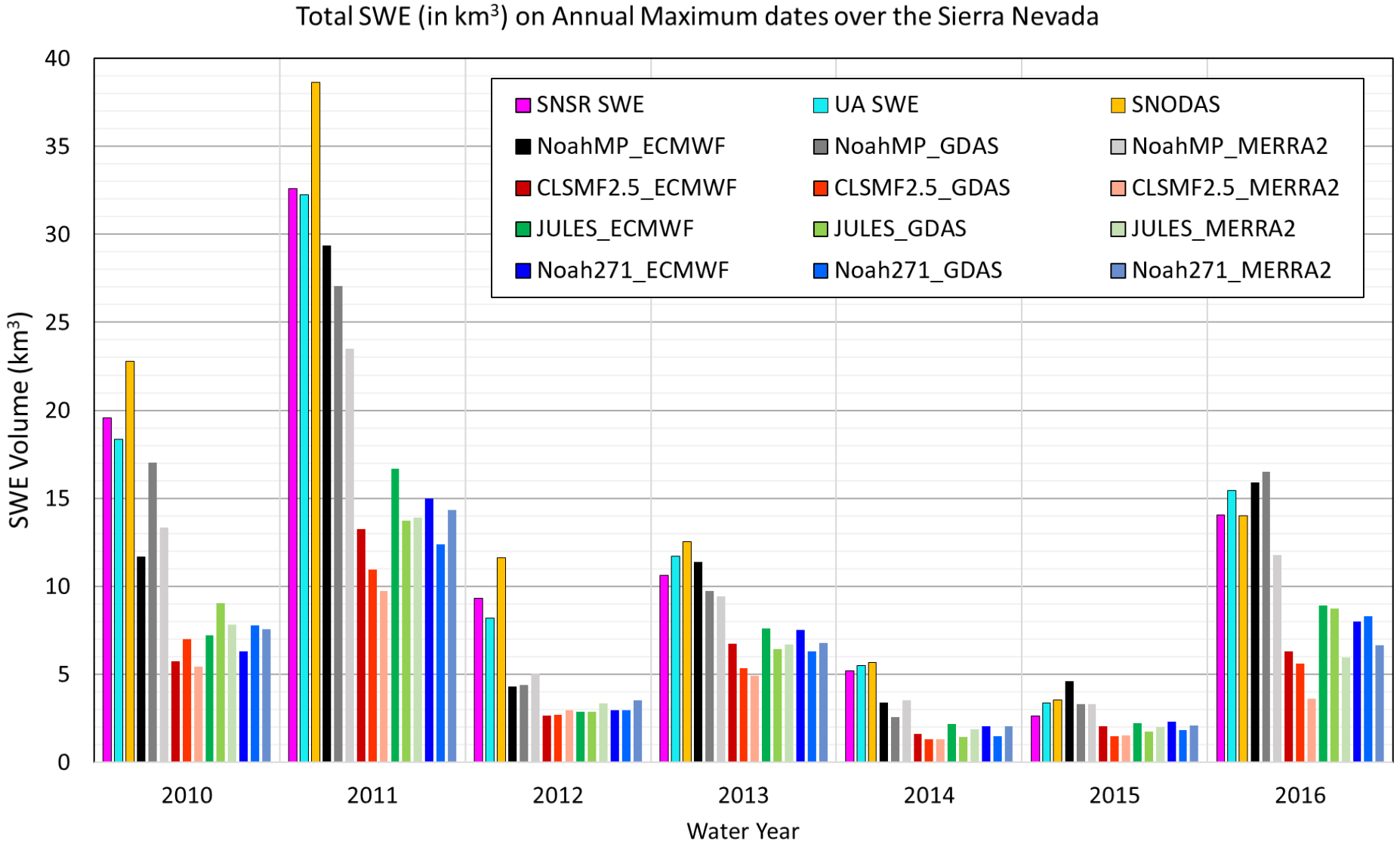
(1) Modern-Era Retrospective Analysis for Research and Applications, version 2 (MERRA2)
(2) Global Data Assimilation System (GDAS)
(3) European Centre for Medium-Range Weather Forecasts (ECMWF)

Three reference SWE data

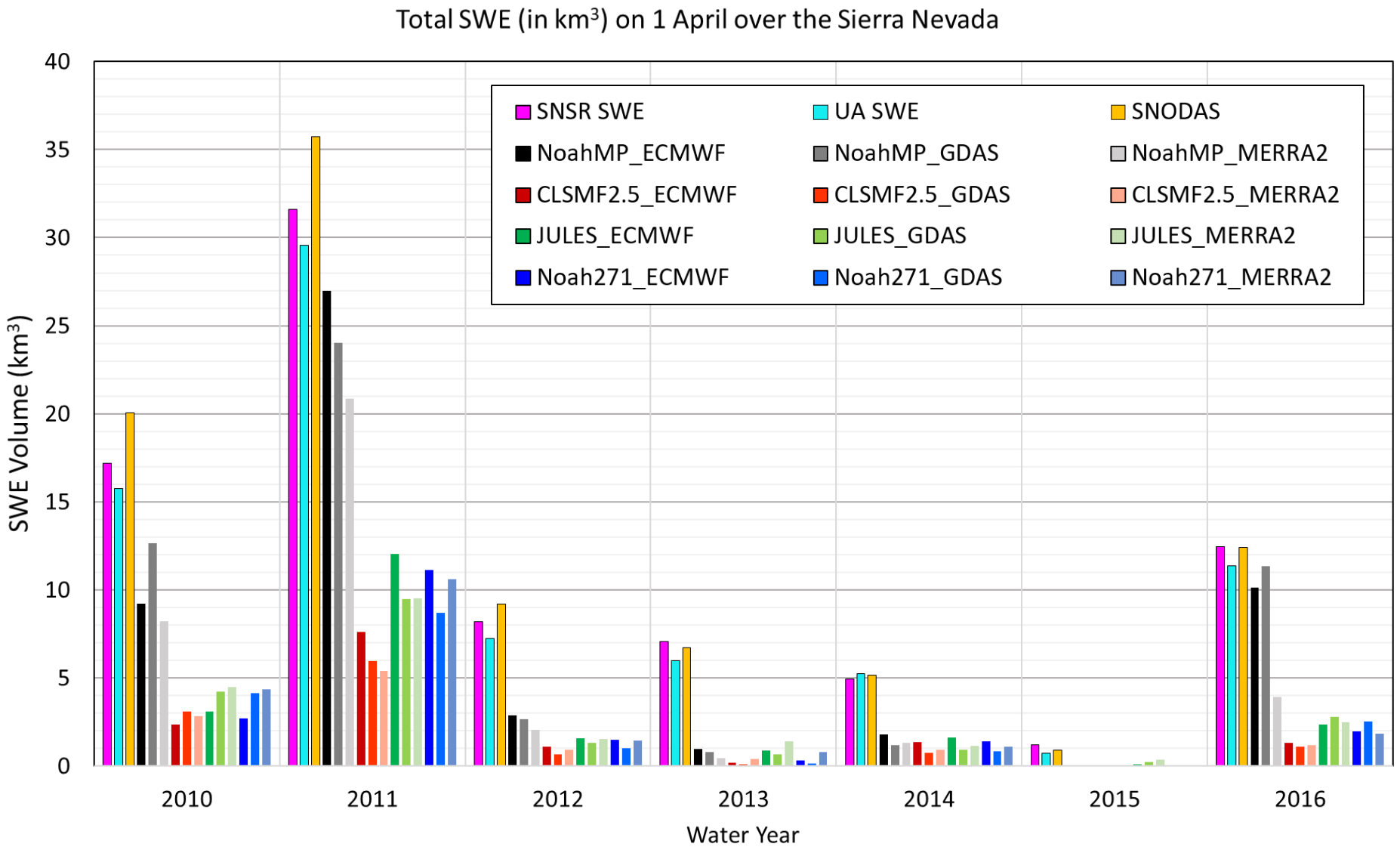
(1) Sierra Nevada Reanalysis (**SNSR**) SWE (90 X 90 m^2)
(2) University of Arizona (**UA**) SWE (4 X 4 km^2)
(3) **SNODAS** SWE (1 X 1 km^2)

- Temporal period: 2010 to 2017 (7 years; Spin-up: 2000-2009)
- Spatial extent: California's Sierra Nevada

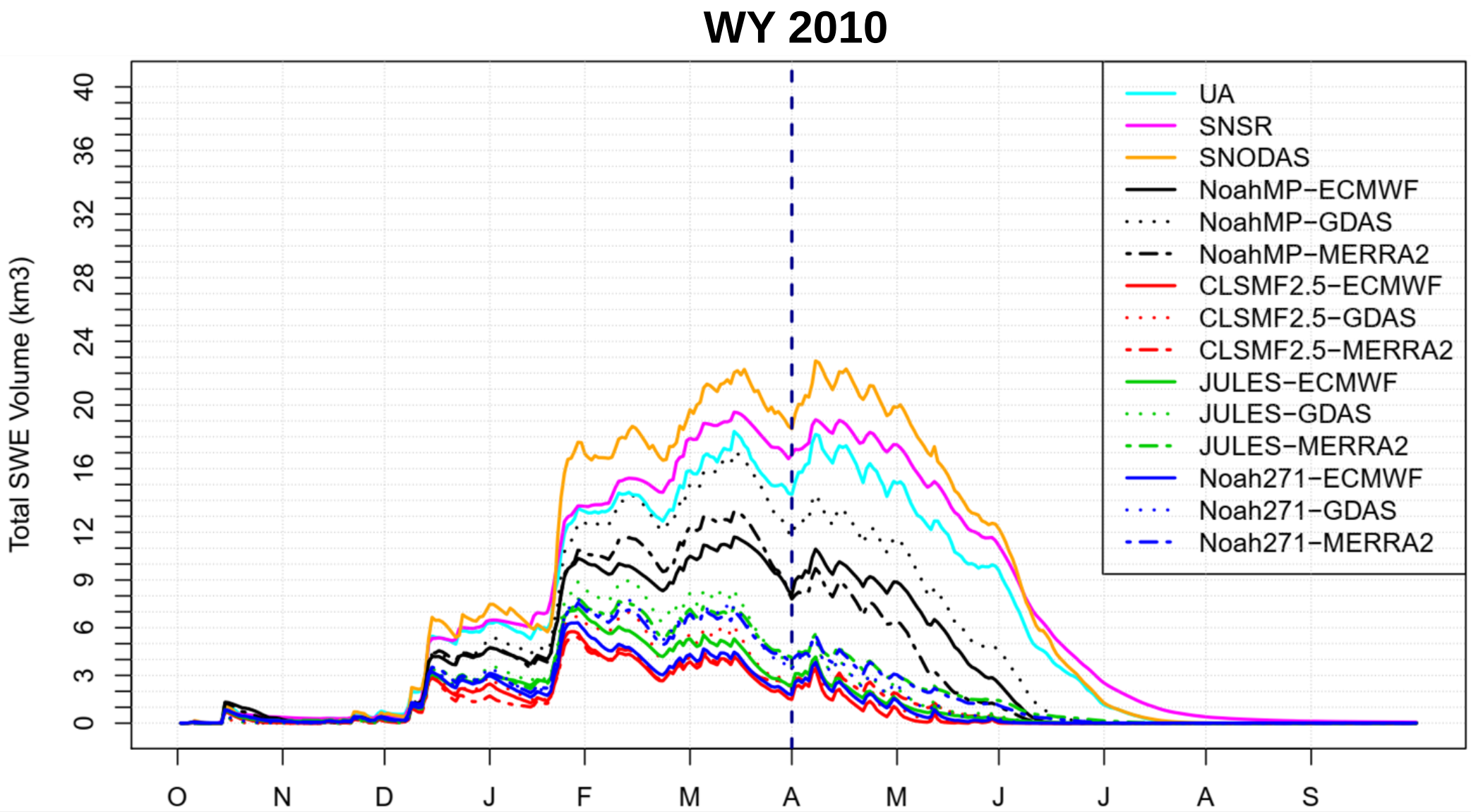
Result 1. Total Annual Maximum SWE



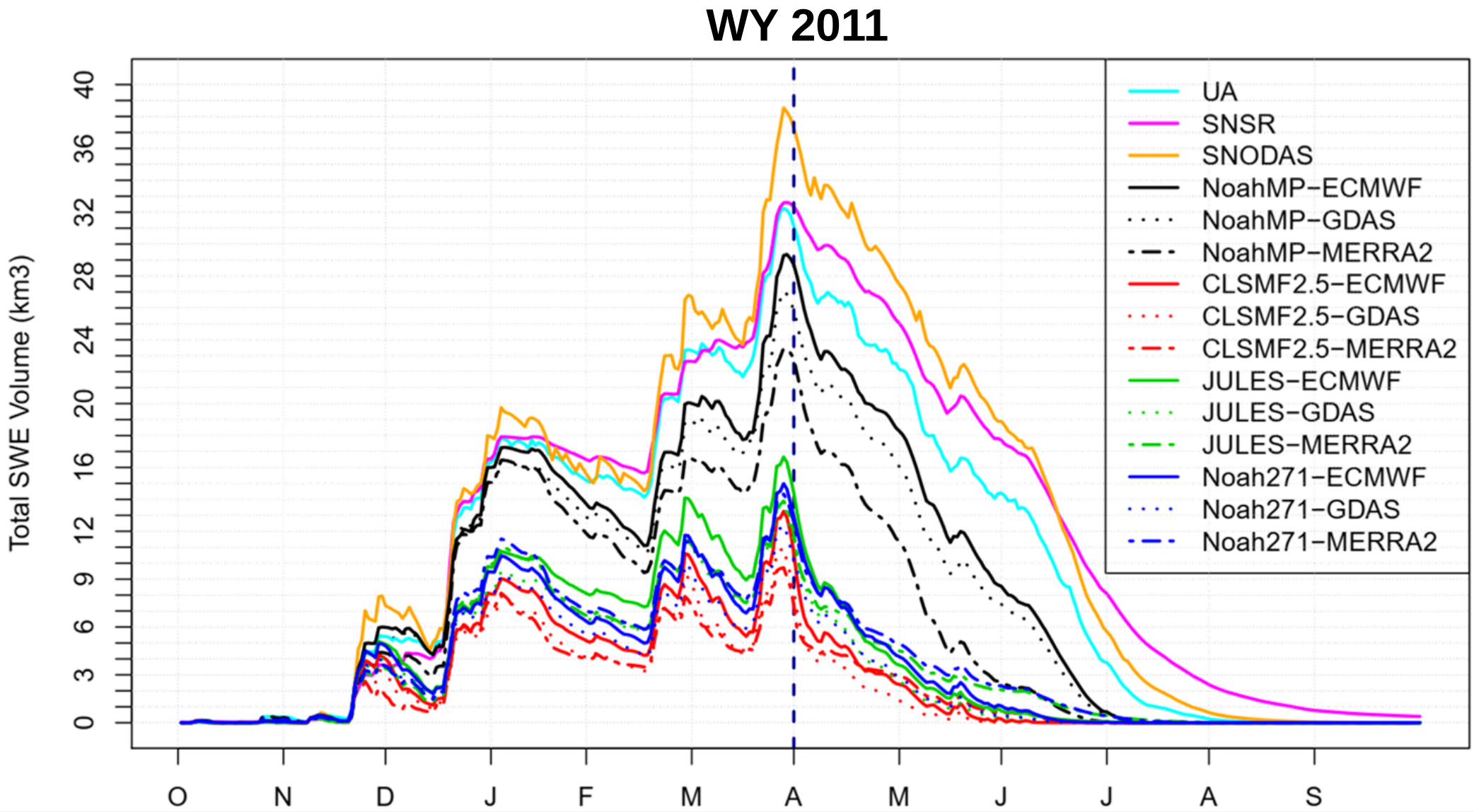
Result 1. Total April 1st SWE



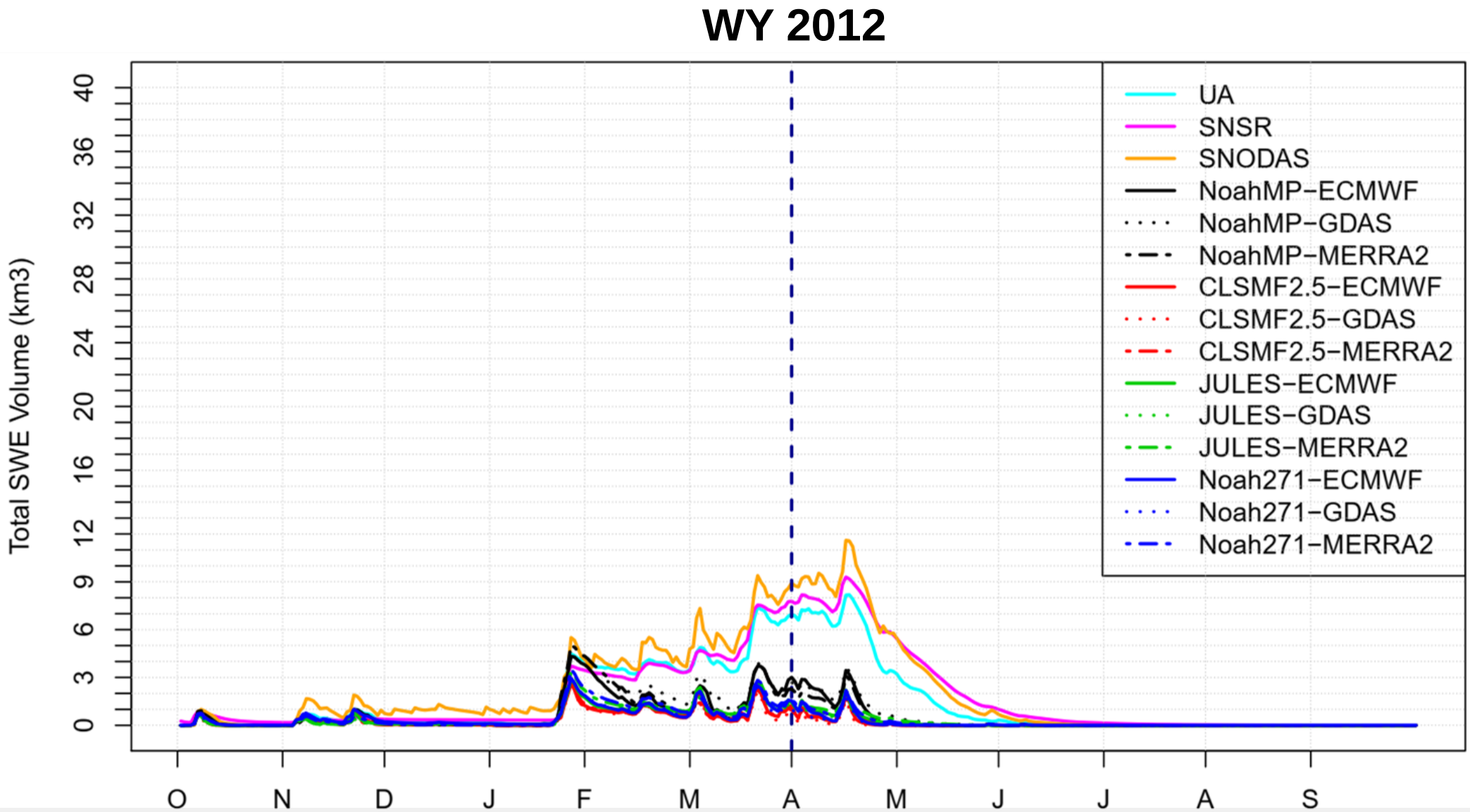
Result 2. Time series of Total SWE Volume (**Moderate year**)



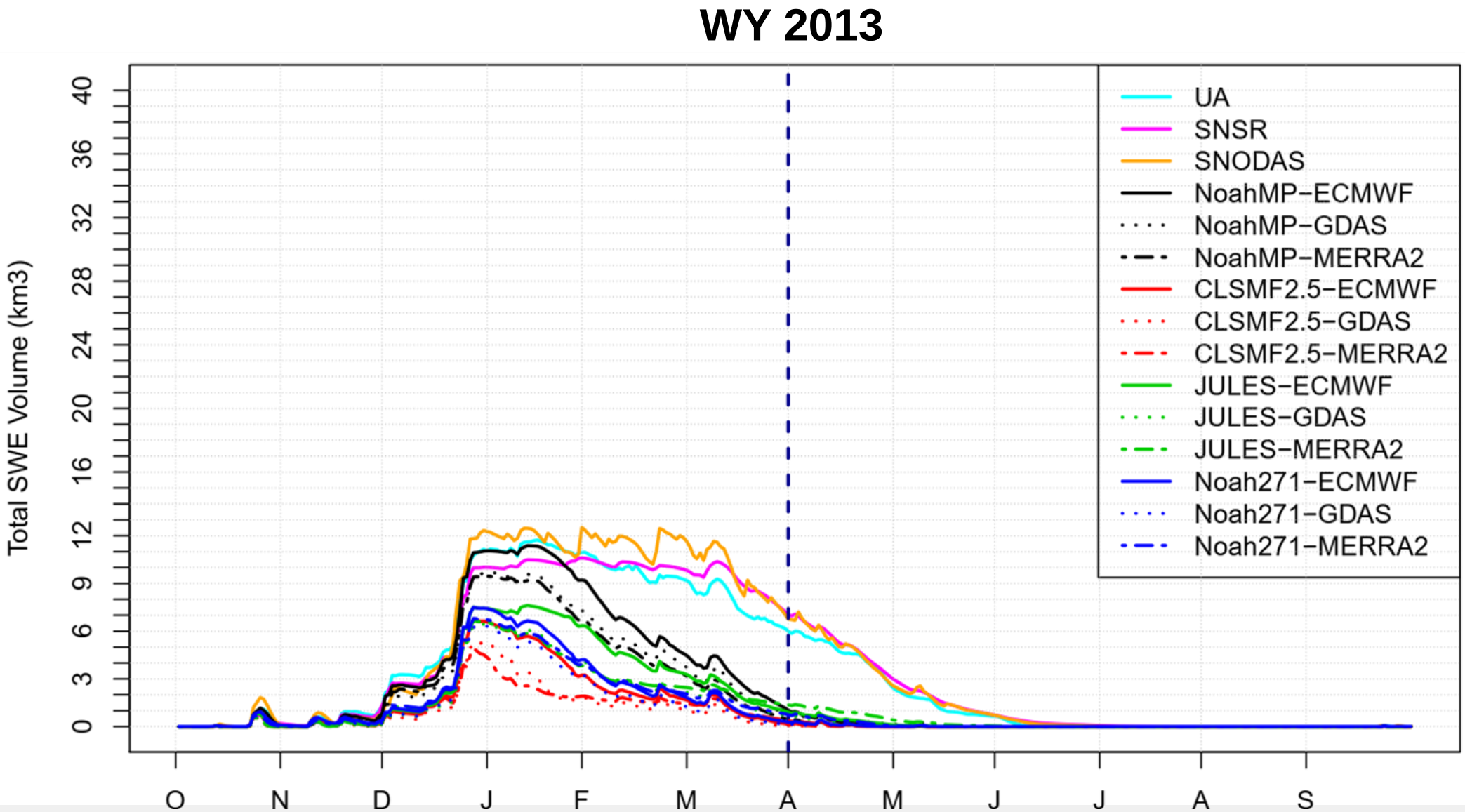
Result 2. Time series of Total SWE Volume (**Wet year**)



Result 2. Time series of Total SWE Volume (**Dry year**)



Result 2. Time series of Total SWE Volume (**Dry year**)



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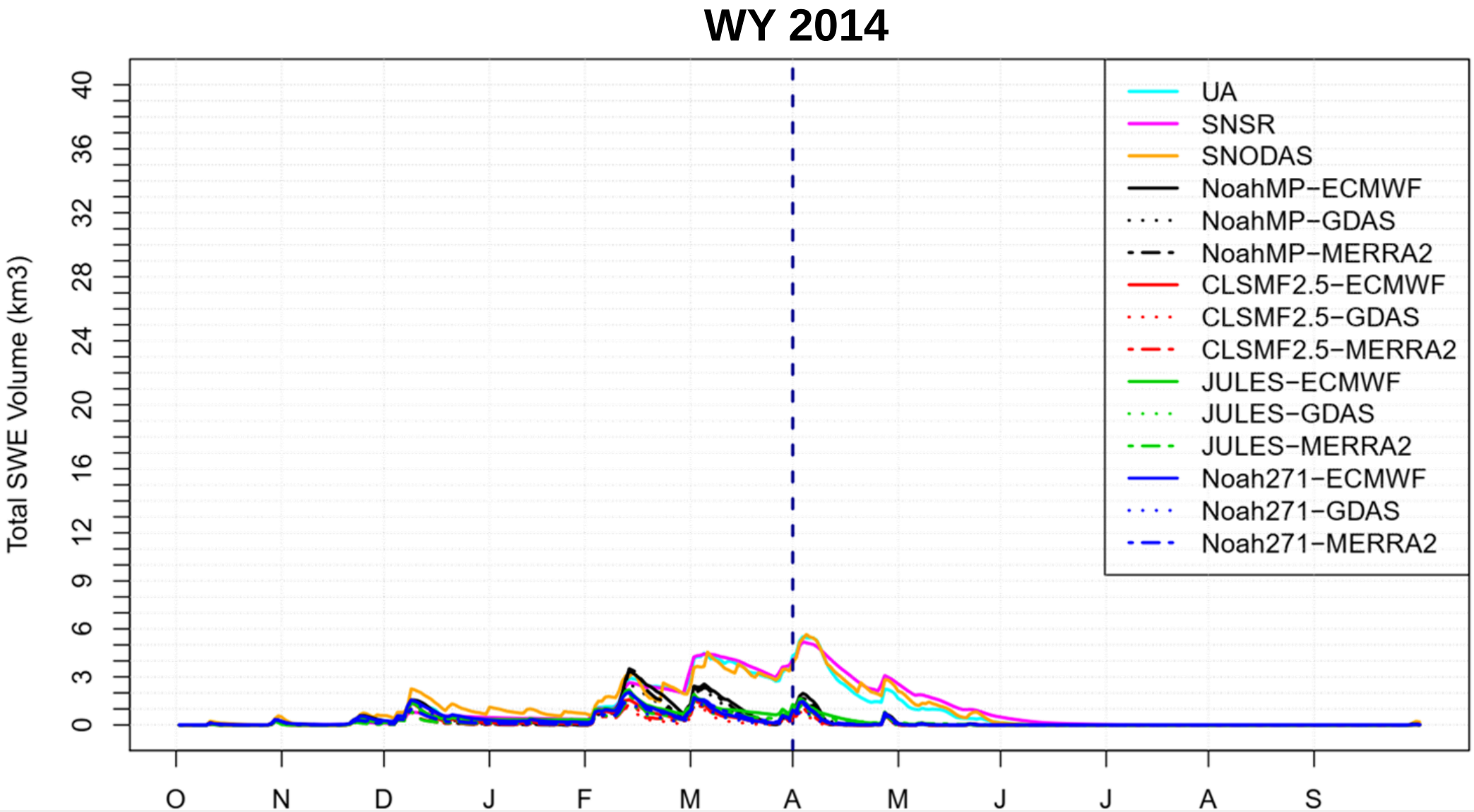

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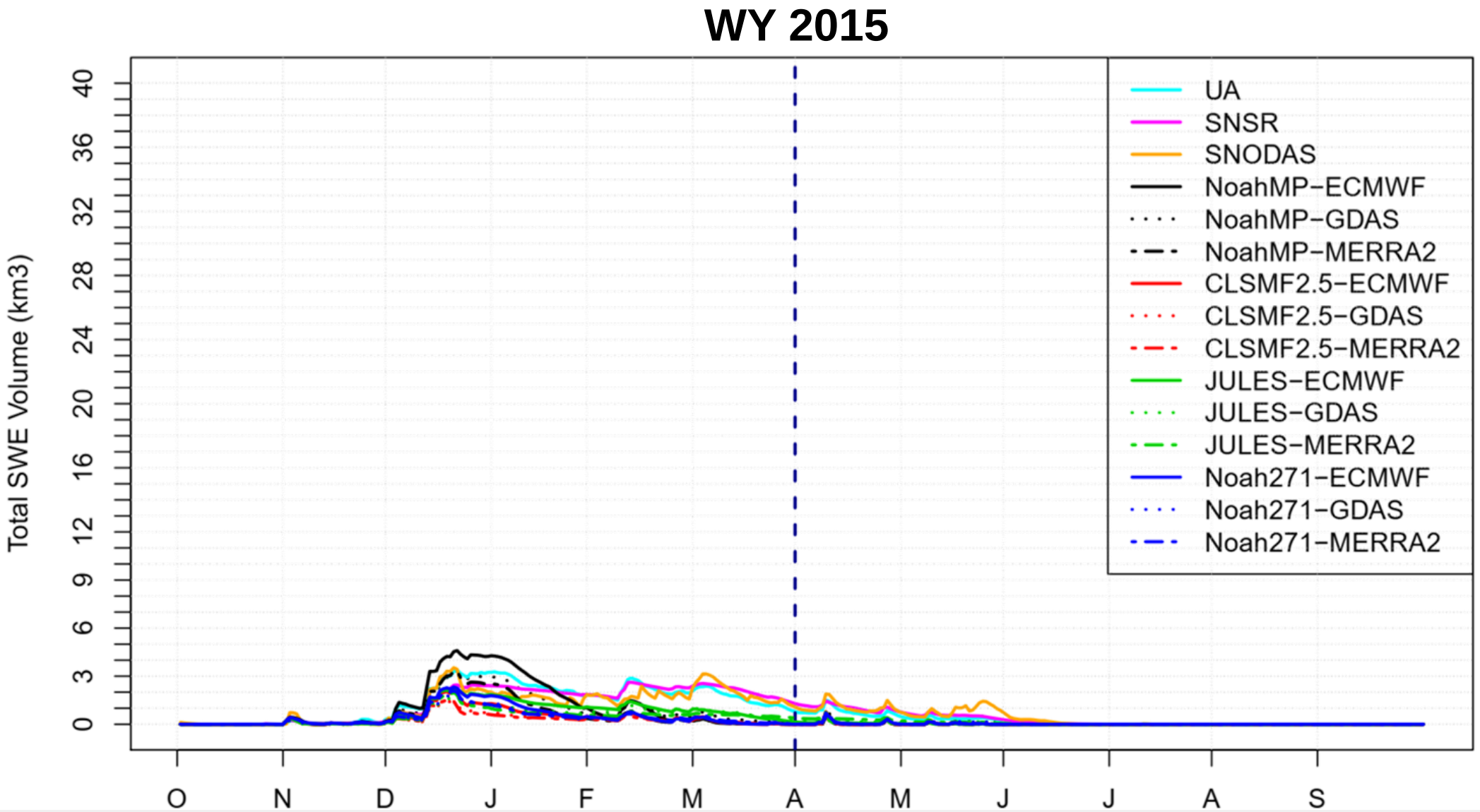
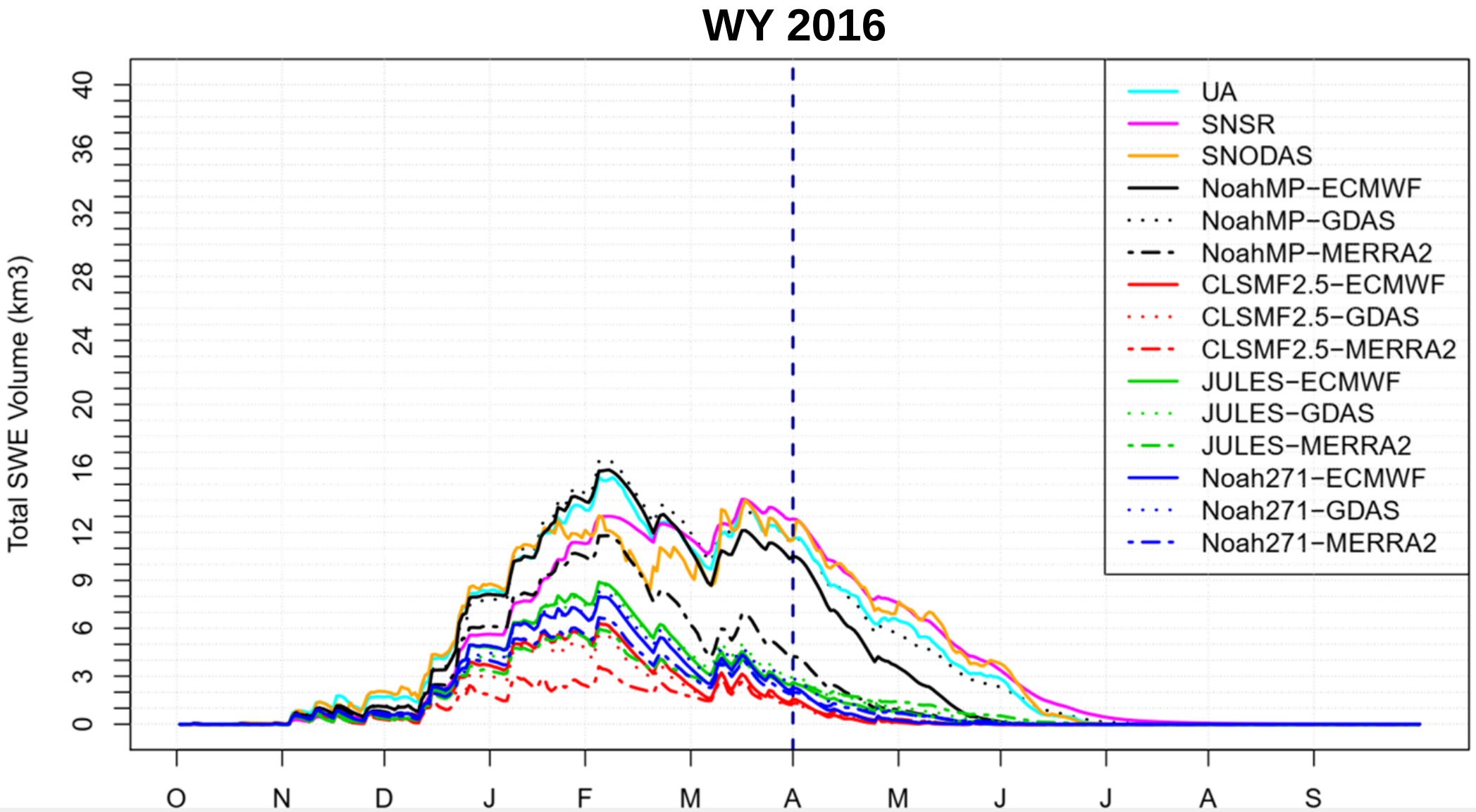
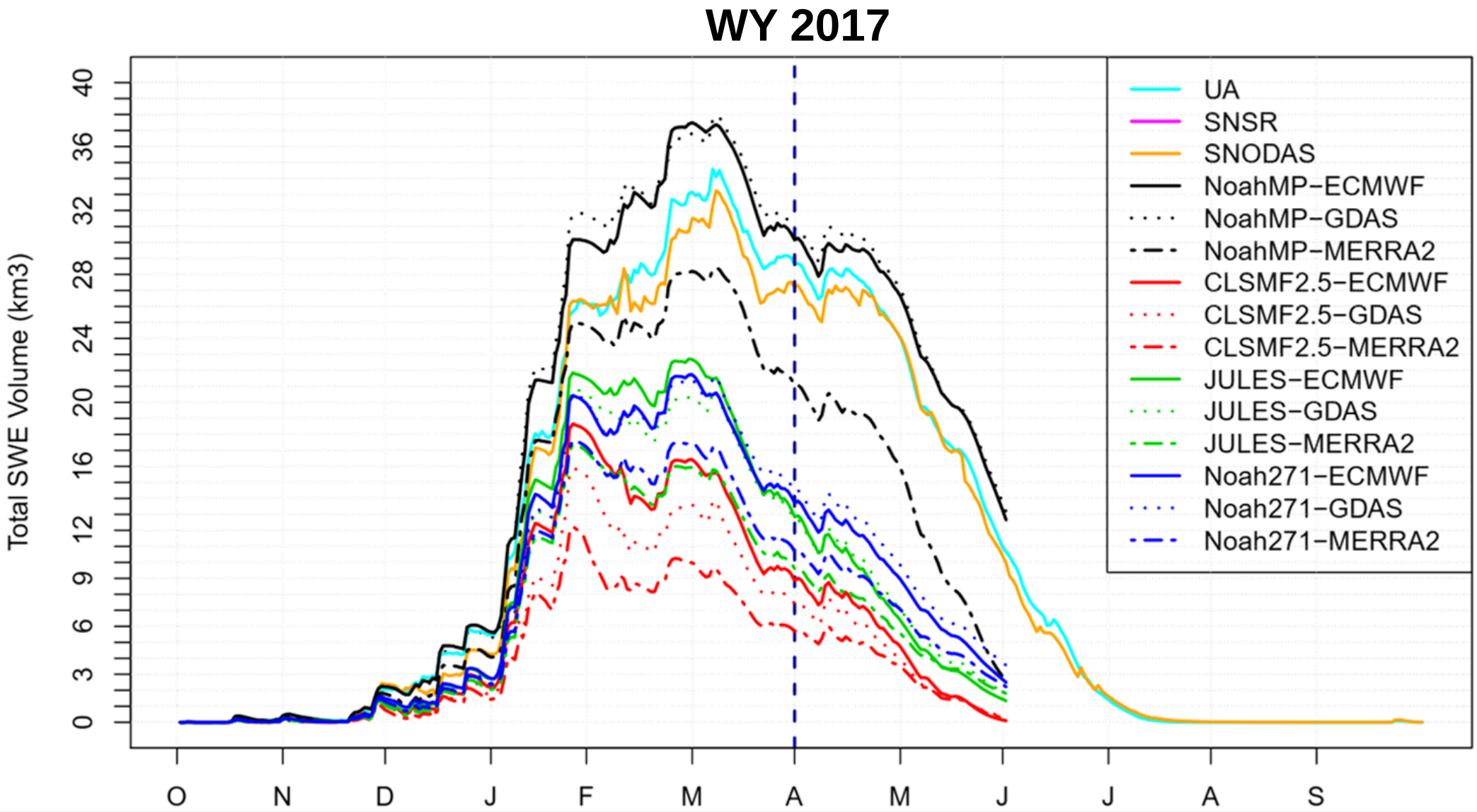


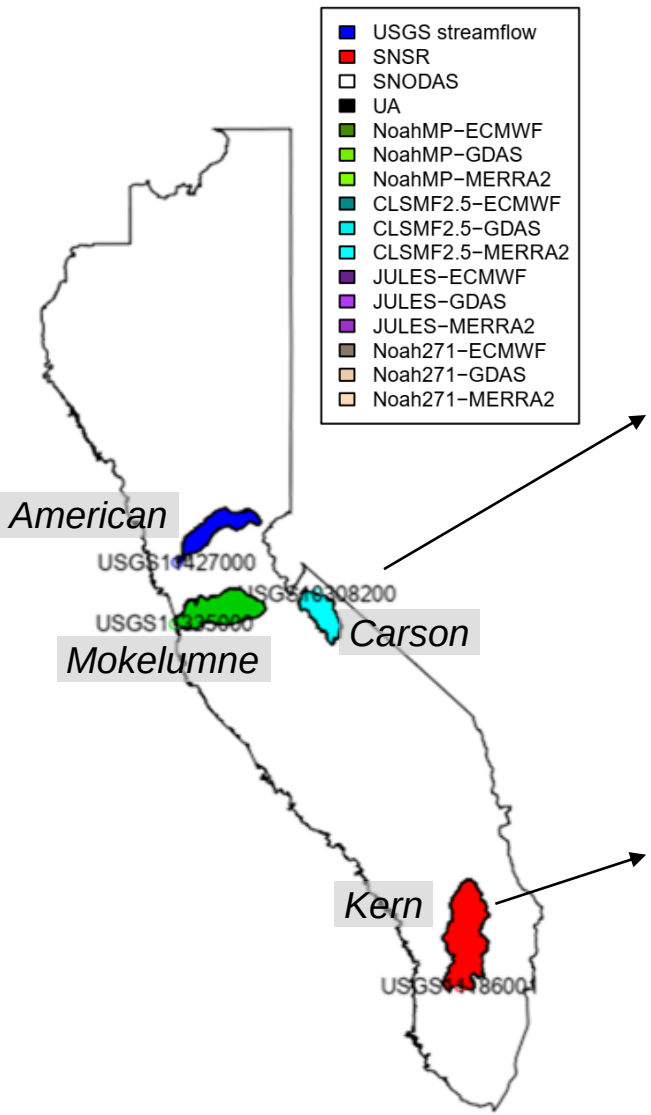
Result 2. Time series of Total SWE Volume (**Moderate year**)



Result 2. Time series of Total SWE Volume (**Wet year**)



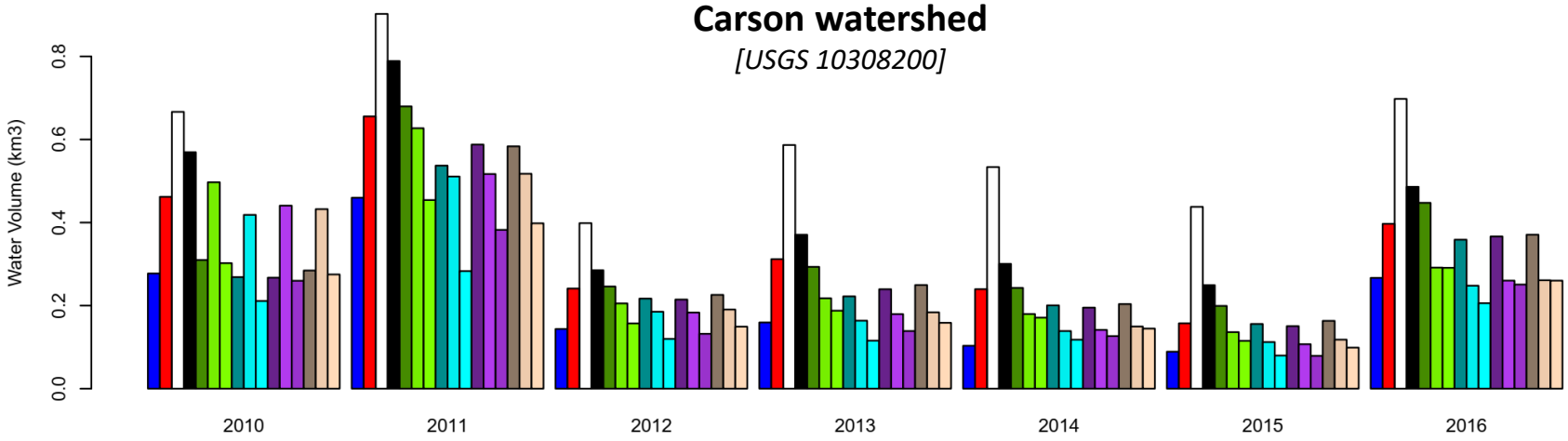
Result 3. Streamflow vs. Total SWE depletion (daily steps)

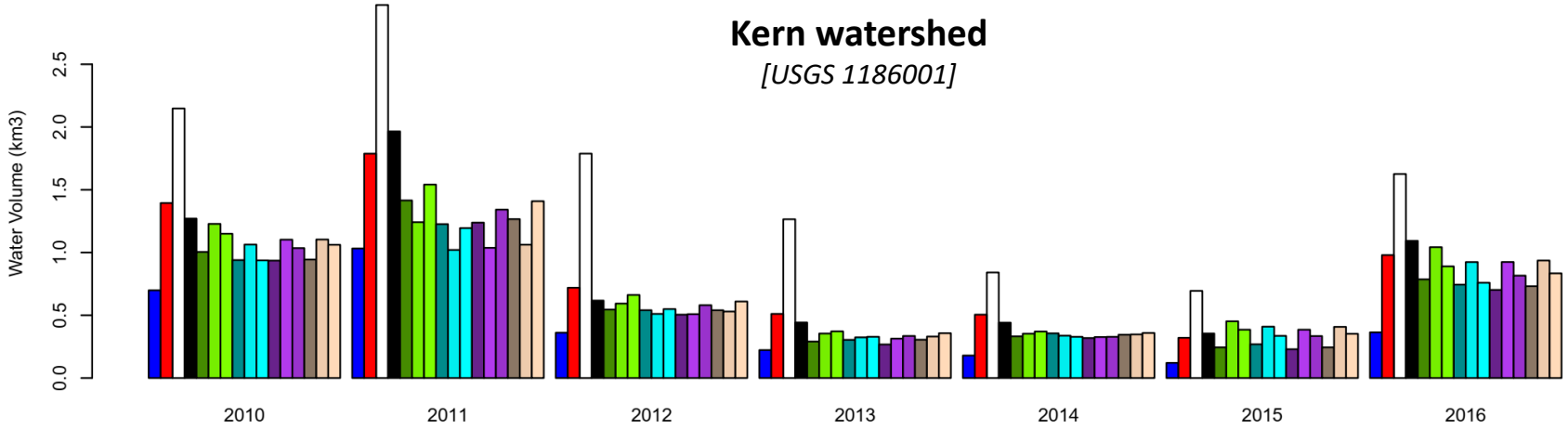


USGS Streamflow from Oct-1 to Jun-30

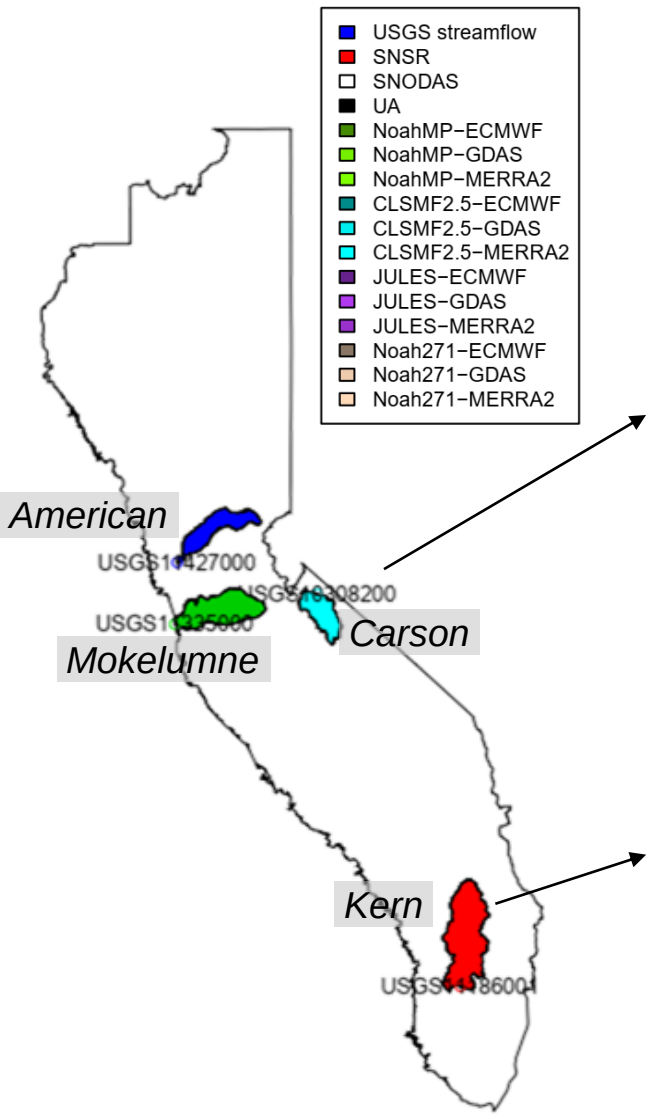
Total ΔSWE from Oct-1 to May-31

$\Delta SWE_i = SWE_i - SWE_{i+1}$, when $SWE_i - SWE_{i+1} > 0$ (i = date)



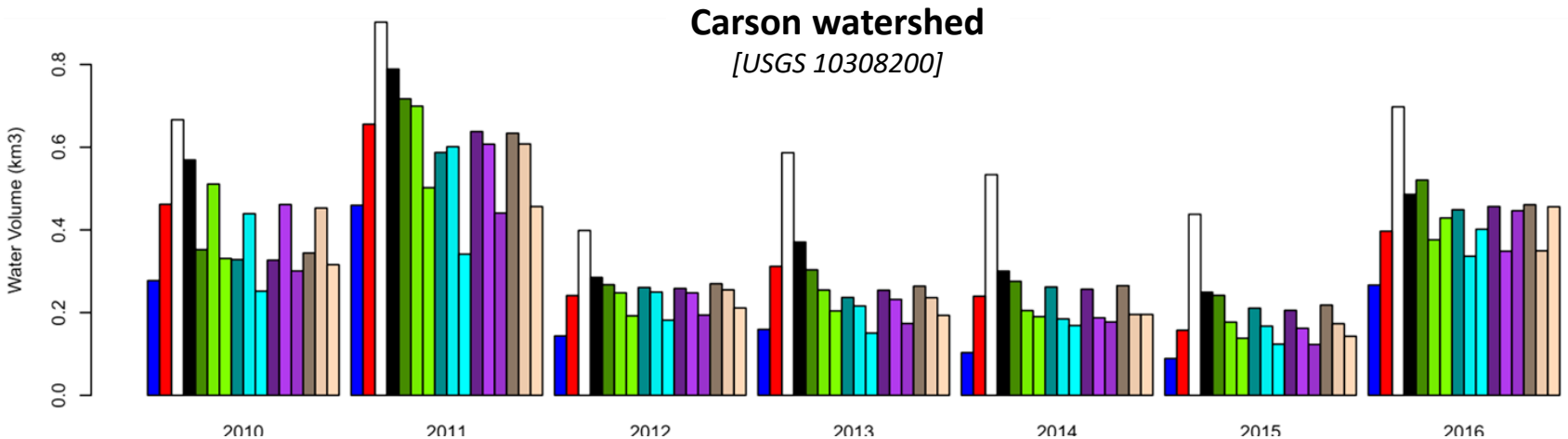


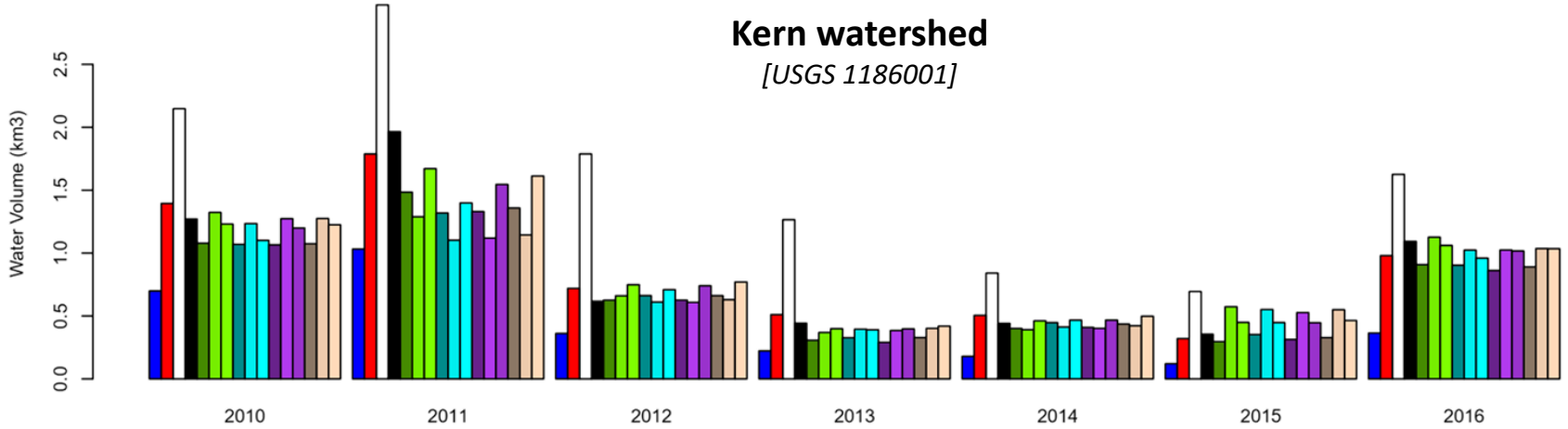
Result 3. Streamflow vs. Total SWE depletion **+ Liquid precip.**



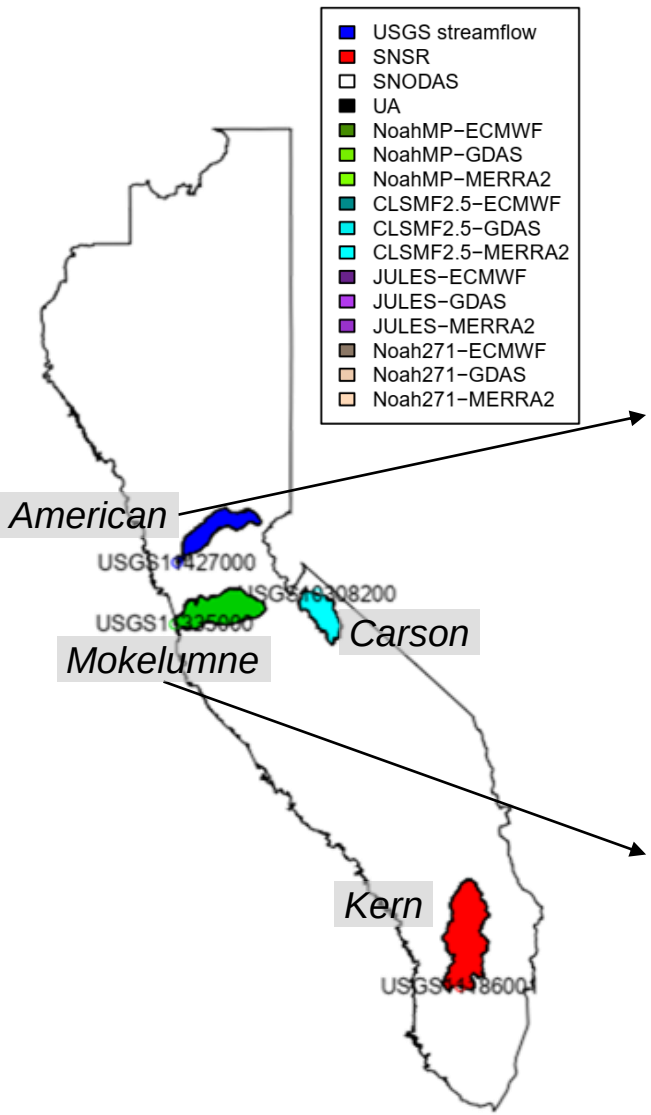
USGS Streamflow from Oct-1 to Jun-30

Total ΔSWE + Liquid P from Oct-1 to May-31





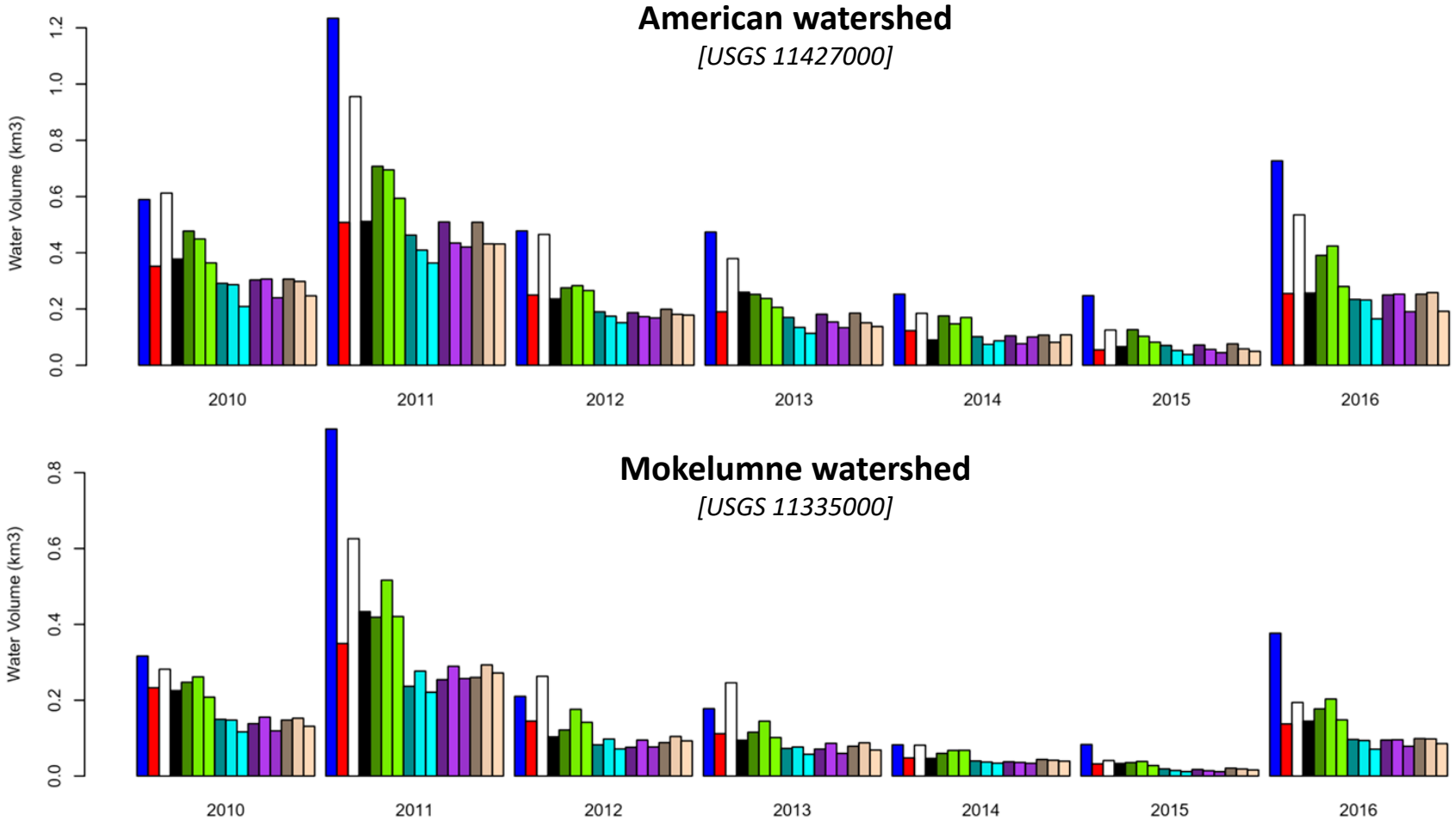
Result 3. Streamflow vs. Total SWE depletion (daily steps)



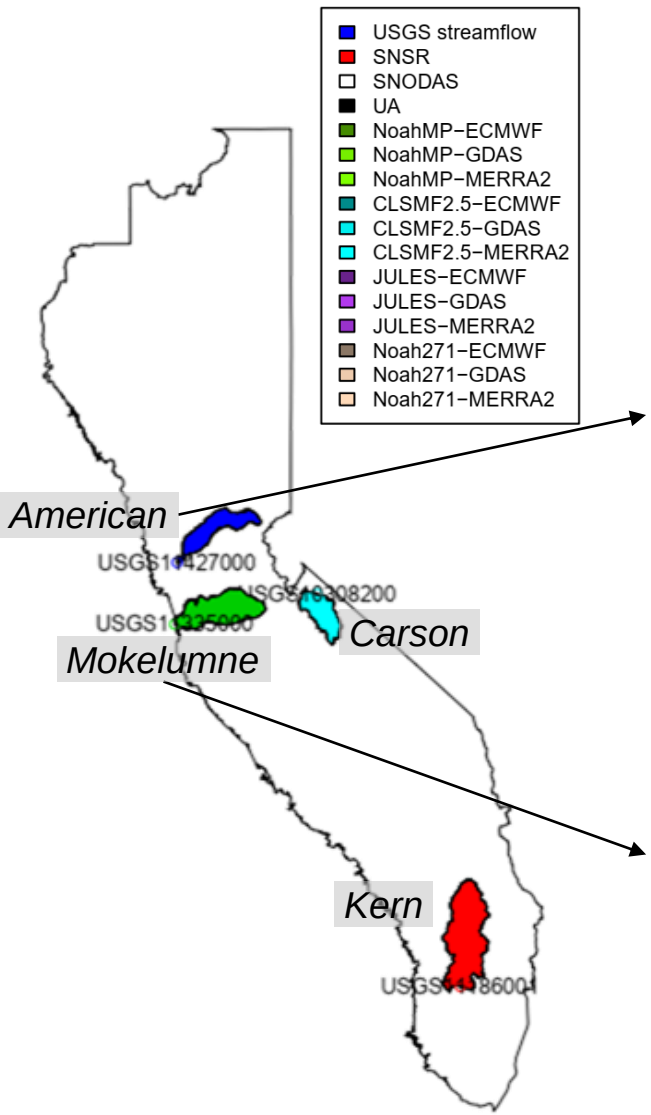
USGS Streamflow from Oct-1 to Jun-30

Total ΔSWE from Oct-1 to May-31

$\Delta SWE_i = SWE_i - SWE_{i+1}$, when $SWE_i - SWE_{i+1} > 0$ (i = date)

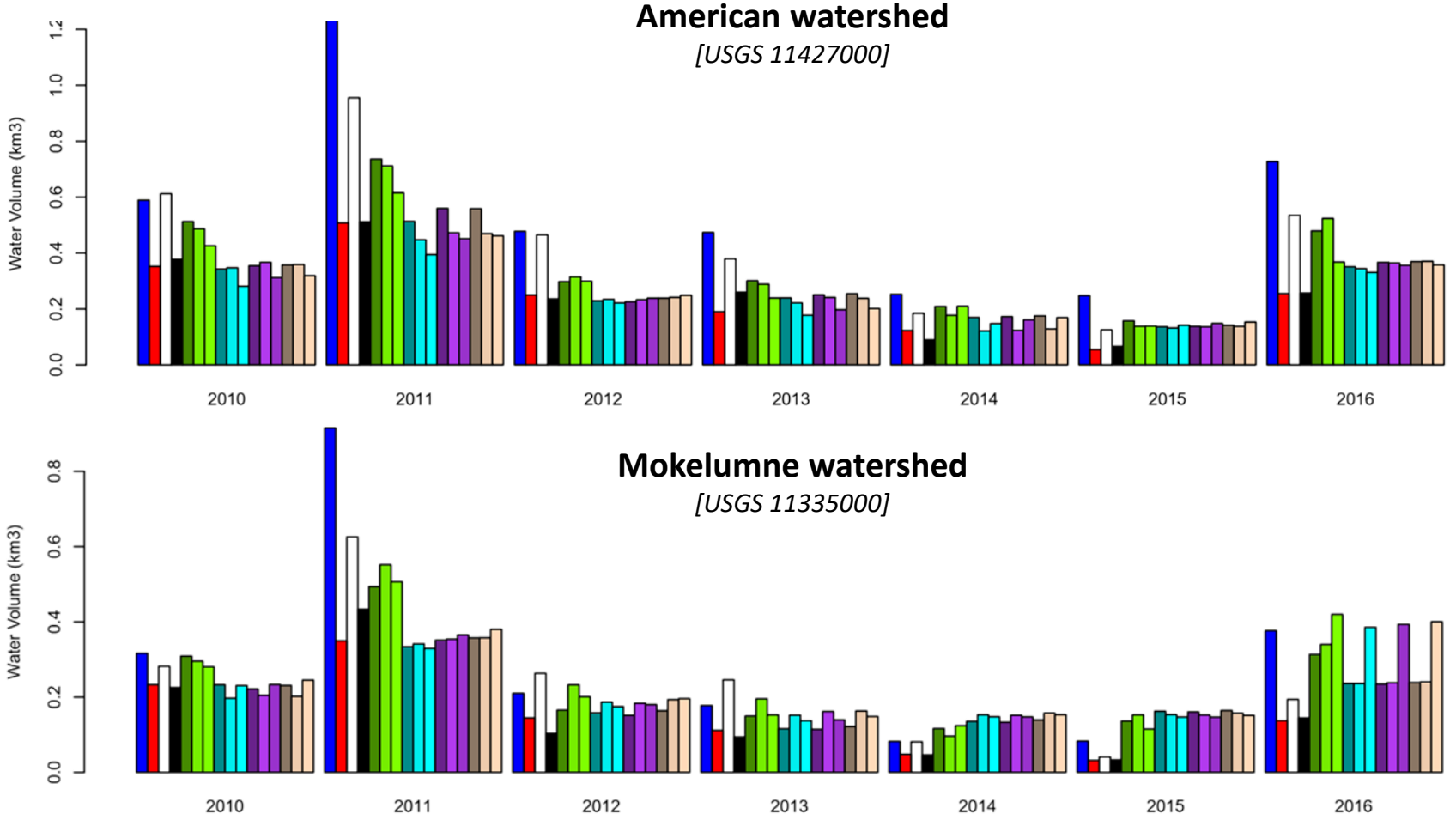


Result 3. Streamflow vs. Total SWE depletion **+ Liquid precip.**



USGS Streamflow from Oct-1 to Jun-30

Total ΔSWE + **Liquid P** from Oct-1 to May-31



Conclusion

Q. How different are total snowpack estimates from four land surface models (LSM) and three forcing datasets over the Sierra Nevada?

A. Noah-MP runs have a snowpack that is closest to the three reference SWE.

Q. Does the LSM physics or forcing data generate the larger variations in SWE estimates?

A. LSM's differences generate larger SWE uncertainties than forcing difference.

Q. Do the errors depend on dry vs. wet years?

A. Yes, there are even differences in SWE estimates between similar wet years (e.g. 2011 vs. 2017).

✓ The effectiveness of the method using the total streamflow for evaluating total snowpack products may depend on watershed's water balance.

Thank you.

If you have any questions or comments, please email me!

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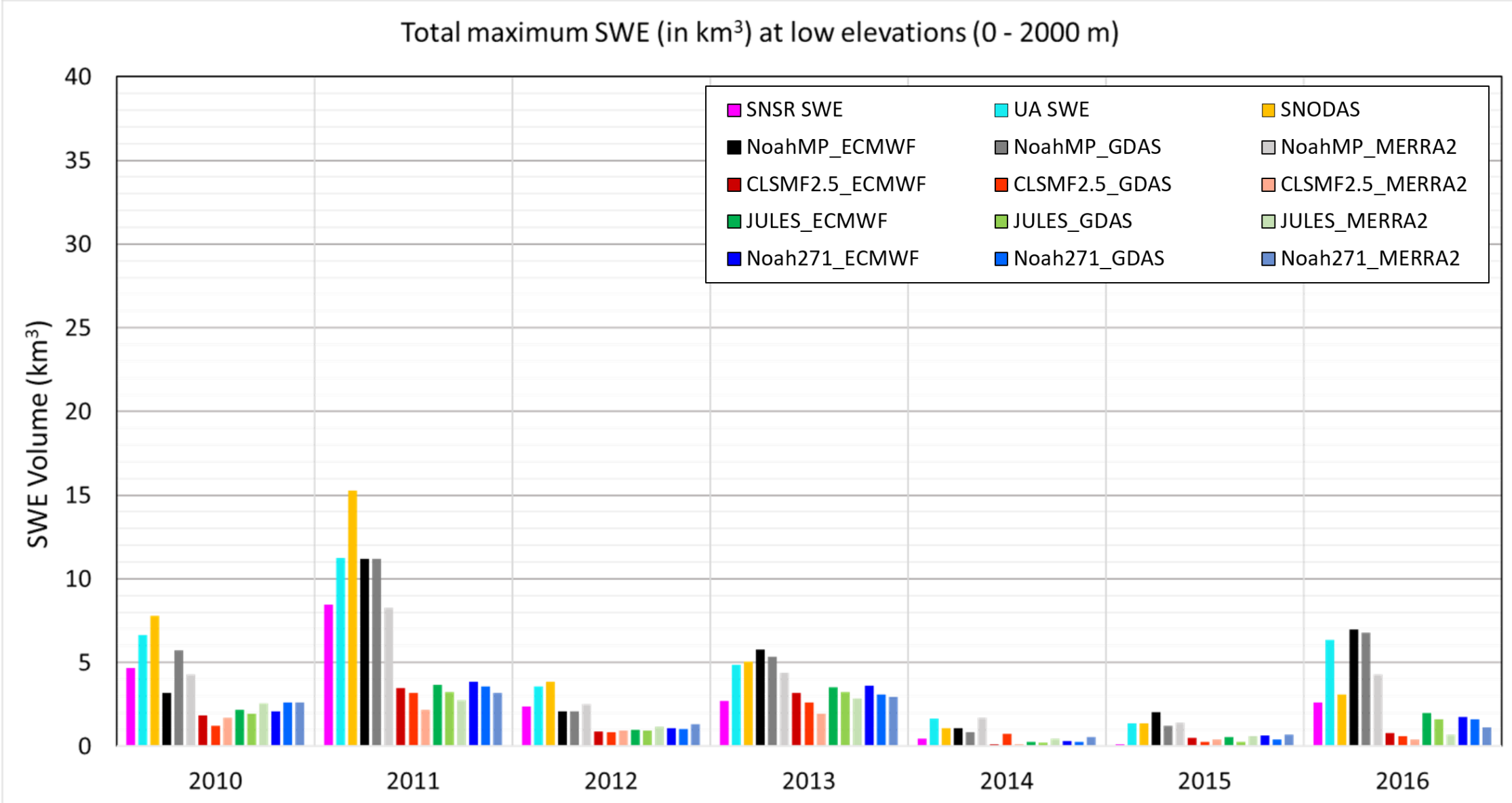
Supplementary information: low/moderate/high elevations



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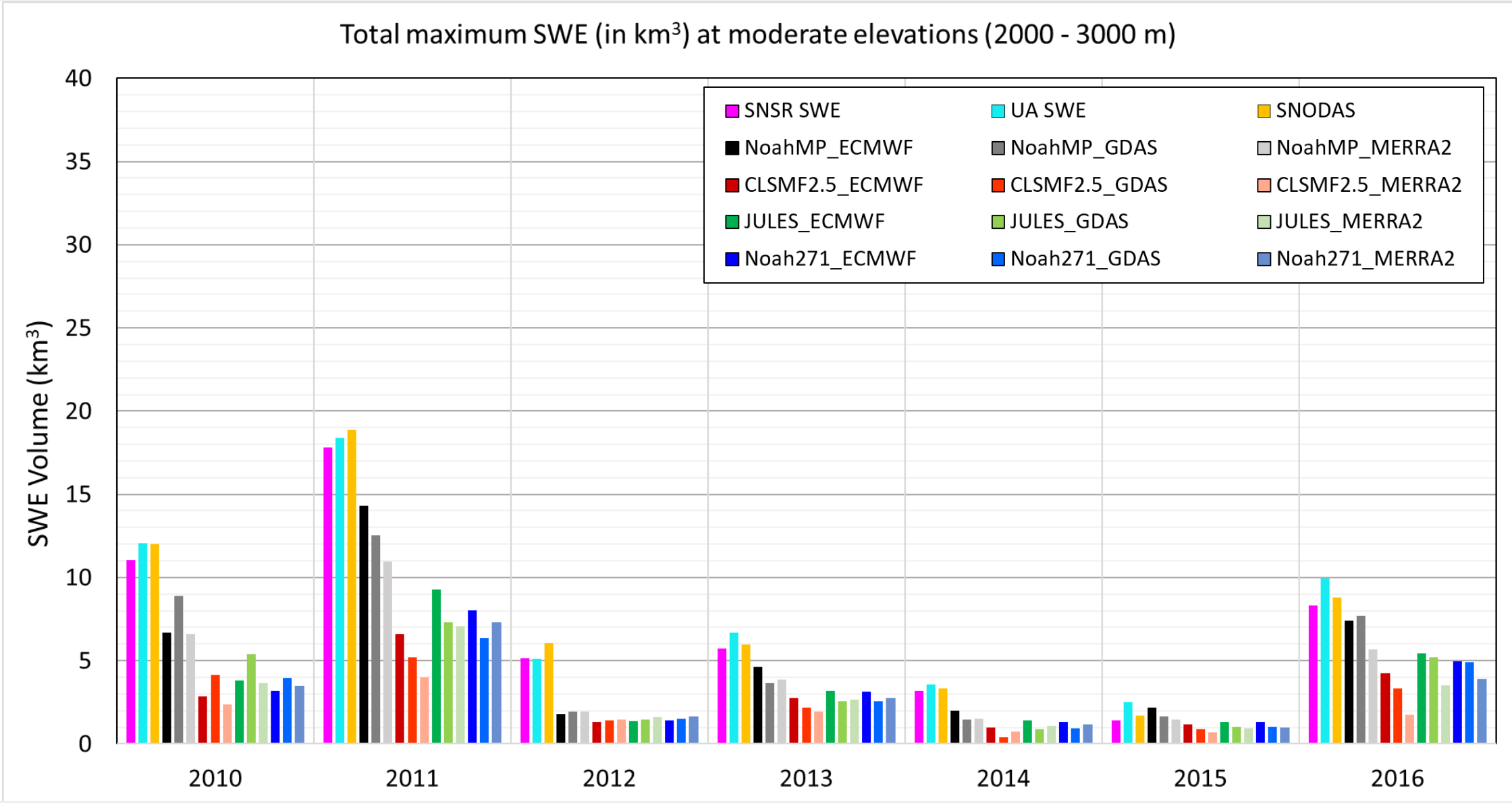

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