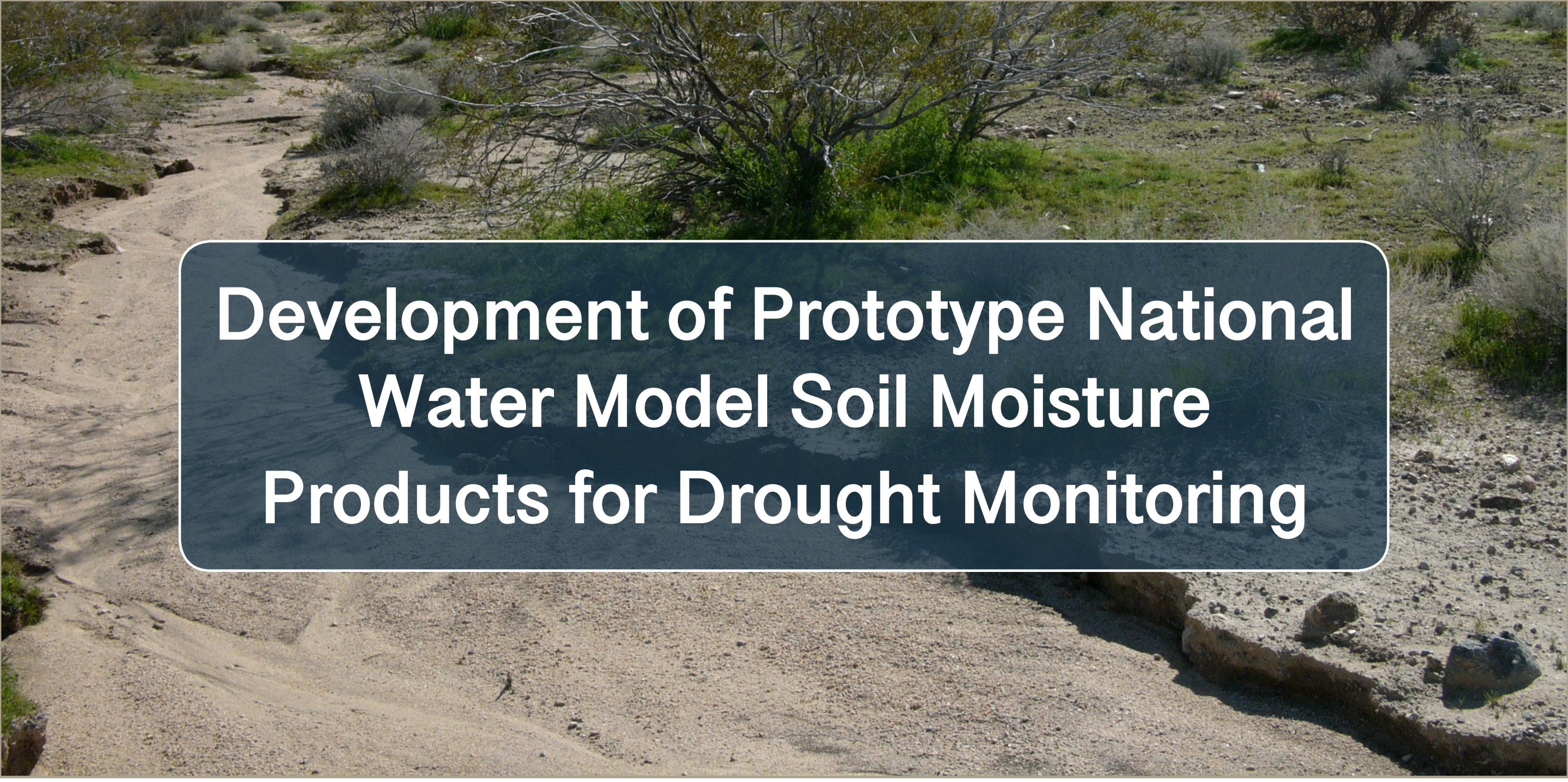

Development of Prototype National Water Model Soil Moisture Products for Drought Monitoring

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Drought affects every sector of the national economy, costing U.S. taxpayers billions of dollars in damages. Improved drought monitoring is needed to anticipate and understand impacts on urban and rural communities, the agriculture industry, water and electric utilities, public health, transportation, jobs, and natural resources.

Applying the National Water Model for Drought Monitoring

NOAA's National Water Model (NWM) predicts hydrologic information relevant to drought monitoring and forecasts at very high resolutions. Research is exploring how to use state-of-the-art NWM short-term forecasts of current hydrologic conditions as a proxy to monitor drought conditions. An experimental soil moisture drought monitoring capability is now being prototyped based on hourly, best available, quality-controlled NWM output. This experimental product is being evaluated as a resource to inform and enhance NOAA Climate Prediction Center (CPC) drought monitoring and outlooks in support of the National Integrated Drought Information System (NIDIS). NIDIS is authorized by Congress to coordinate and integrate drought research and monitoring with federal, tribal, state, private, and local partners in support of creating a national drought early warning information system.

Why the National Water Model?

The NWM forecasts streamflow, soil moisture, and other hydrologic conditions over the continental U.S. at 1 km to 250 m spatial resolutions with lead times ranging from hours to weeks. The prediction capability of the NWM depends on accurate atmospheric and land surface conditions, as well as representation of the physical processes responding to these conditions. Providing the best available information on atmospheric and land surface conditions as input to the NWM, and continuing to improve the NWM, remain high priorities for NOAA. A drought monitoring product based on NWM-calculated soil moisture is able to capitalize on these NOAA investments.

The advantages of the experimental NWM soil moisture drought monitoring product over existing drought monitoring tools include significantly higher resolution in time and space, decreased lag time, and a single integrated operational forecast system providing a physically consistent framework for objectively estimating drought for the continental U.S.

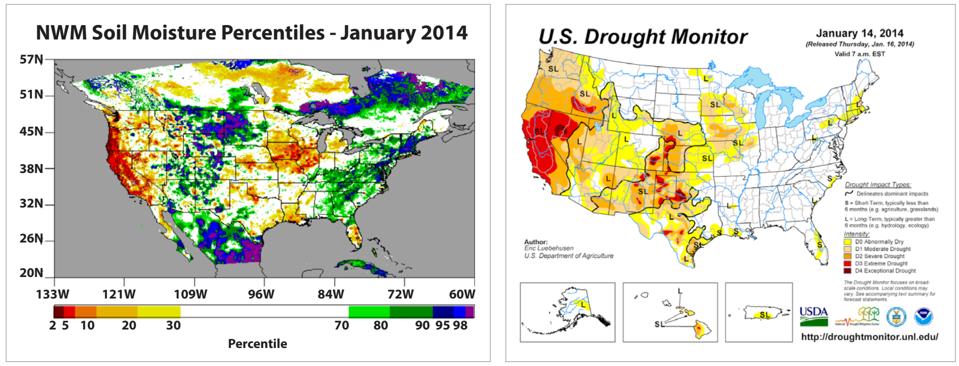

Figure 1. Comparison of the experimental National Water Model Soil Moisture Drought Monitoring Product (left) and operational U.S. Drought Monitor (right) for January 2014.

Methods

Since drought is commonly defined as a moisture deficit relative to the "normal conditions" for a given location, a quantitative soil moisture-based drought monitoring estimate needs to be calculated relative to a long-term record of local conditions. The experimental NWM soil moisture drought monitoring product is calculated as percentile values relative to a ten-year-long record of NWM-calculated soil moisture values. Using percentiles of NWM soil moisture values allows the experimental drought monitoring product to accurately represent moisture deficits relative to the broad range of local "normal conditions" that exist across the continental U.S.

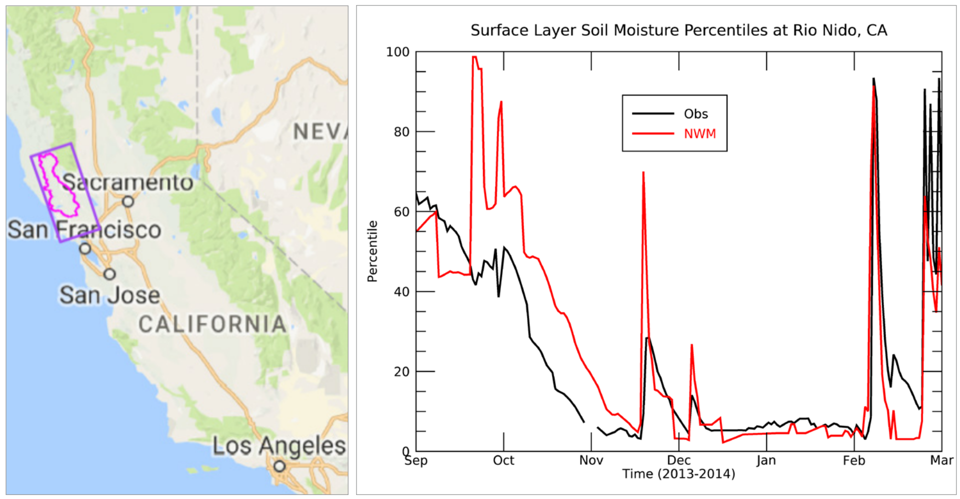

Figure 2. Map of California showing subdomain of the National Water Model and Russian River Watershed (left) and a Sept 2013 – Mar 2014 time series of measured and modeled soil moisture at Rio Nido, CA (right).

National Application of NWM Soil Moisture During Drought

Percentiles of soil moisture in the NWM show extreme dryness along the western states during January 2014 (Figure 1). During this period, California and much of the western U.S. were in severe to extreme drought, illustrated by the U.S. Drought Monitor (right panel) and revealed in the experimental NWM drought monitoring product (left panel).

Watershed Application of NWM Soil Moisture in CA's Russian River

NOAA's network of atmospheric and soil moisture observations in California's Russian River watershed, a NIDIS pilot basin, has been used to evaluate the role of key processes impacting the performance of the experimental NWM soil moisture drought monitoring product. The decline of soil moisture from near-average into drought-level values during the 2013/2014 winter (Figure 2) is illustrated in the time series of NWM calculated soil moisture (red line) and measured soil moisture from a field site in the southern part of the basin (black line). The individual time series of soil moisture conditions are similar to each other, initially higher values (near average at the beginning of the winter rainy season), decline to much drier-than-average values in January and February, and response due to rainfall events (sharp increases followed by gradual decreases) is consistent between the two datasets.

Next Steps

Additional watersheds will be selected in consultation with NIDIS and the U.S. Bureau of Reclamation to evaluate the fidelity of the experimental drought monitoring product. Targeted process-study evaluations will focus on watersheds with a dense network of sites with soil moisture and meteorological observations. These efforts will be used to assess the performance of the experimental NWM soil moisture drought monitoring product under a variety of weather conditions and climate regions.