U.S. Global Change Research Program

US GEWEX
Soil Moisture Mini-Workshop #2
Agenda

July 23, 2021
12PM-3PM
Virtual Workshop

12:00 PM **Welcome** (Drew Story – USGCRP)

12:05 PM **Opening Remarks** (Geoff Plumlee – USGS)

12:10 PM **Introduction to US GEWEX** (Jared Entin – NASA; Jennifer Arrigo – DOE)

12:18 PM **Soil Moisture Activities: Modeling and Satellite Data**

(Moderated by Renu Joseph – DOE) *10-minute presentations followed by 2 minutes for clarifying questions*

12:20 PM **Xiwu "Jerry" Zhan**: NOAA NESDIS Soil Moisture Operational Product System (SMOPS)
12:32 PM **Fred Ogden**: Soil Moisture Predictions in the Current Operational and Next Generation National Water Model
12:44 PM **Randy Koster**: The SMAP Level-4 Soil Moisture Product
12:56 PM **David Mocko**: Soil moisture products within Land Data Assimilation Systems at the Hydrological Sciences Laboratory at NASA/GSFC
1:08 PM **Clara Draper**: Land Data Assimilation at NOAA
1:20 PM **Dave Lawrence**: Soil moisture data in CMIP6 and a Representation of subgrid-scale soil moisture in the Community Land Model (CLM)
1:32 PM **Elena Shevliakova**: Global soil moisture in the GFDL climate and Earth system models

1:45 PM **Panel Discussion and Q&A** (Moderated by Jennifer Arrigo & Jared Entin)

- What is the primary motivation for producing the soil moisture data/products? (e.g. science research, model improvement, weather forecasting, climate projections, managing water resources)
- Does your group have any near term plans to make a significant process level improvement/change and re-generate SM data sets?
- Do you have ongoing collaborations with observational groups to enable evaluation of your data/model/etc. or science research? Are you specifically looking to create such collaborations?
- Are your efforts connected or contributing to any larger activities (i.e. GEWEX/WCRP projects or sub-groups, National Climate Assessment, WMO/Thorpex, etc.)

2:30 PM **Next Steps for US GEWEX**

- What do you think would be most useful in terms of future engagements with USGCRP / US GEWEX going forward?

3:00 PM **Conclusion**

Presentation Titles and Abstracts

Xiwu "Jerry" Zhan
Title: NOAA NESDIS Soil Moisture Operational Product System (SMOPS)
Abstract: In this presentation we'll introduce the time periods, satellite sensors, algorithms and validation results of the soil moisture and soil moisture proxy data products from SMOPS and GET-D. Results of assimilating SMOPS blended product into Noah-MP model will be compared with the assimilation of other GLDAS and ESA CCI soil moisture products.

Fred Ogden
Title: Soil Moisture Predictions in the Current Operational and Next Generation National Water Model
Abstract:The current operational National Water Model (NWM) uses the Noah-MP LSM to calculate the evolution of soil moisture on a 1 km grid, assuming a 2 m thick homogeneous (non-layered) soil over the modeled domain, which includes CONUS and contributing areas of Canada and Mexico, Hawaii, Puerto Rico, and portions of Alaska. Noah-MP as employed in the current operational NWM solves the water-content form of the Richardson/Richards equation, which is strictly valid only for homogeneous soils under non-saturated conditions, using four discretizations of 10, 30, 60, and 100 cm from the land surface down to the bottom of the soil, respectively. Coarse discretizations are commonly applied in LSMs to make the soil moisture code fast and reliable, and to avoid the occurrence of saturation from above. The homogeneity assumption prevents accurate simulation of the influence of ubiquitous soil layering. For these reasons, we urge careful interpretation of soil moisture outputs from the current operational National Water Model, while we work to improve the representation of soil physics in the Next Generation National Water Model.

Randy Koster
Title: The SMAP Level-4 Soil Moisture Product
Abstract: The NASA satellite-based Soil Moisture Active Passive (SMAP) mission, launched in 2015, produces global estimates of soil moisture based on passive L-band radiometer measurements. Although the SMAP instrument “sees” soil moisture in only (nominally) the top 5 cm of soil, the SMAP project includes a Level 4 product that combines the radiometer measurements with meteorological data in a data assimilation setting, thereby providing soil moisture estimates (globally, at 9-km spatial resolution) down to a depth of 1 meter. In this presentation, we describe the SMAP Level 4 data product and its extensive evaluation against surface measurements.

David Mocko
Title: Soil moisture products within Land Data Assimilation Systems at the Hydrological Sciences Laboratory at NASA/GSFC
Abstract: Land Data Assimilation Systems (LDAS) aim to produce high-quality fields of land-surface states (including soil moisture) and fluxes by integrating satellite- and ground-based observational data products, using advanced land-surface modeling and data assimilation techniques. The Hydrological Sciences Laboratory at NASA’s Goddard Space Flight Center has been developing multiple LDASs and distributing LDAS output for more than two decades. Products include the Global (GLDAS), North American (NLDAS, in collaboration with and run operationally at NOAA), National Climate Assessment (NCA-LDAS), Famine Early Warning Systems Network (FEWS NET) (FLDAS), and Western (WLDAS). Details, evaluations, applications, and future directions of these products will be presented.

Clara Draper
Title: Land Data Assimilation at NOAA
Abstract: This presentation will review the current and planned use of land data assimilation at NOAA, focussing on applications relevant to constraining the soil moisture in NOAA's global Numerical Weather Prediction (NWP) models. Currently, NOAA does not use data assimilation to constrain the soil moisture in our global NWP models, although our model soil moisture is retrospectively corrected for errors in recent precipitation forecasts. A land data assimilation system

is currently under development, and will initially assimilate 2m temperature and specific humidity to update the model soil moisture and soil temperature, using an Ensemble Kalman Filter. It is hoped that this will quickly be expanded to also assimilate satellite soil moisture observations.

Dave Lawrence
Title: Soil moisture data in CMIP6 and a Representation of subgrid-scale soil moisture in the Community Land Model (CLM)
Abstract: The CMIP6 archive hosts a large number of soil moisture and related variables datasets from > 12 Earth System Models. Simulations that are available include coupled and land-only historical simulations as well as coupled projection period simulations for multiple SSPs. Additionally, single forcing experiments (e.g., land use and land cover change including separation of various aspects of land management, aerosols, volcanic emissions, etc) that enable researchers to isolate what aspects of forced and unforced variability affect soil moisture variations and trends. For land-only simulations, forcing uncertainty can be evaluated via simulations with four different historical climate/weather reconstructions. The Community Land Model (CLM5) is one of the models available in CMIP6. The next generation version of CLM will include the capacity to computationally efficiently represent sub-grid soil moisture heterogeneity through a representative hillslope formulation. Within this formulation, the impacts of lateral subsurface flow, slope, aspect, and meteorological forcing downscaling drive more realistic variations in soil moisture across a large-scale gridcell without the computational cost of ultra high-resolution simulations.

Elena Shevliakova
Title: Global soil moisture in the GFDL climate and Earth system models
Abstract: All GFDL climate and Earth system models include a land component. The GFDL land components (e.g. LM3 and LM4). represent ecological, biogeochemical, and hydrological processes, including dynamics of liquid and frozen water in vertical soil columns. GFDL land models capture sub-grid heterogeneity in soil moisture due to land use and natural disturbances (e.g. fire and forest gap formation). GFDL has contributed dozens of experimental simulations to the Coupled Model Intercomparison Project (CMIP6) with a new coupled climate model CM4 and the new Earth system model ESM4.1. These experiments include multidecadal simulations of the preindustrial (constant 1850 radiative forcing), historical (1850-2014), and future (2015-2100) simulations as well as dozens of specialized climate experiments to explore effects of land use, specific radiative forcings, and land-climate coupling. Soil moisture data from these experiments is available from the public archives (e.g. https://esgf-node.llnl.gov/projects/cmip6/)

Participants

US GEWEX Members
Jared Entin (Co-Chair) – NASA
Renu Joseph (Co-Chair) – DOE
Jin Huang – NOAA
Jennifer Arrigo – DOE
Chungu Lu – NSF
Sally McFarlane – DOE
Tanya Spero – EPA
Margaret Hurwitz – NOAA/NWS
Gabriel Senay – USGS
Maoyi Huang – NOAA

Invited Guests
Members of USGCRP Observations Interagency Working Group (ObsIWG)
Members of USGCRP Interagency Group on Integrative Modeling (IGIM)
Laura Lautz – NSF
Tom Graziano – NOAA/NWS
Ed Clark – NOAA/NWS
Thomas Cuff – NOAA/NWS
Mark Brusberg – USDA
Teferi Tsegaye – USDA
Peter Vadas – USDA
John Bolten – NASA
John Eylander USACE
Jenni Kyrouac – Argonne National Lab
Ryan Sullivan – Argonne National Lab
Roland Roberts – NSF/NEON
Ed Ayres – NEON
Paula Mabee – NEON
Chris McKay – NEON
Kirsten Ruiz – NEON
Jerad Bales – CUAHSI
Sebastien Biraud – AmeriFlux
Margaret Torn – AmeriFlux
Russ Scott – AmeriFlux
Marcy Litvak – AmeriFlux
Veva Deheza – NIDIS
Marina Skumanich – NCSMMN
Mike Cosh – FSMWG
Jiafu Mao – RUBISCO
Trevor Keenan – RUBISCO
Forrest Hoffman – RUBISCO
V Ramaswamy – NOAA/GFDL
Peter van Oevelen – International GEWEX Project Office