Blending Approaches for SMOPS

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### SMOPS Project Team

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Outline

• Why SMOPS & Why Blending
• SMOPS Architecture and Blending Algorithms
  – CDF Matching to count satellite retrieval differences
  – Simple averaging for blending
  – TCEM-based weighting for blending
• Evaluation of the different blending method
• Summary and Path Forward
Why SMOPS & Blending

Evolution of Soil Moisture Mapping Sensors

1970s
- Limited global mapping (150 km)

1980s
- Ground and aircraft development and verification of theory (1 m)
- Exploration of spatial and temporal concepts (100 m)

1990s
- Limited global mapping, demonstrate feasibility (50 km)
- Large scale mapping and integrated hydrologic research (1 km)

2000
- Improved global mapping (50 km)

2010
- Limited global mapping, operational capability (50 km)
- Improved global mapping (10 km)
- Broad science, high spatial resolution, higher sensitivity (10 km)

Field Experiments

SMOS/Aquarius

AMSR/WindSat

ESTAR

PBMR

SMMR/SSM/I

SMAP

AMS2
Why SMOPS & Blending

NOAA SMOPS WindSat Soil Moisture: daily - 20120501

NOAA SMOPS SMOS Soil Moisture: daily - 20120501

NOAA SMOPS ASCAT Soil Moisture: daily - 20120501

NOAA SMOPS Blended Soil Moisture: daily - 20120501

Blended
CDF Matching

![CDF Matching graph](image-url)
Simple Average Blending

- Increased spatial coverage
- Multi retrieval variance could be used as error estimate
Weighted Average Blending

Triple Collocation Error Model (TCEM)

Individual SM:

\[ \psi_A = \Pi + \mu \]
\[ \psi_P = \Pi + \omega \]
\[ \psi_G = \Pi + \rho \]

Assuming their error are not correlated:

\[ \mu \rho = 0, \mu \omega = 0, \omega \rho = 0 \]

Then we get their relative RMSE as:

\[ \xi_A = (\psi_A - \psi_P)(\psi_A - \psi_G) = \mu^2 \]
\[ \xi_P = (\psi_P - \psi_A)(\psi_P - \psi_G) = \omega^2 \]
\[ \xi_G = (\psi_G - \psi_A)(\psi_G - \psi_P) = \rho^2 \]
Weighted Average Blending

Triple Collocation Error Model for Blending

Flow chart describing the TCEM weights-based SMOPS blended SM product.
Blending Method Comparison

GLDAS precip-based (left) and MODIS EVI-based (right) correlations over 1 April 2015-30 June 2018 period. EVI data lags SM data by 8 days.
Blending Method Comparison

Site (35.060°N, -86.590°E) ST: Cropland/Natural Vegetation Mosaics
Blending Method Comparison

Site (34.250°N, -92.030°E) ST: Mixed Forests

r=0.702  RMSE=0.087 m³/m³  ubRMSE=0.081 m³/m³

r=0.411  RMSE=0.089 m³/m³  ubRMSE=0.088 m³/m³
Blending Method Comparison

Site (33.090°N, -90.510°E) ST: Croplands

- SCAN
- TCW

r=0.719  RMSE=0.086m³/m³  ubRMSE=0.058m³/m³

r=0.433  RMSE=0.091m³/m³  ubRMSE=0.081m³/m³
Blending Method Comparison

Site (40.390° N, -109.350° E) ST: Grasslands

- **SCAN**: $r=0.657$, RMSE=0.059 m$^3$/m$^3$, ubRMSE=0.046 m$^3$/m$^3$
- **TCW**:

- **SCAN**: $r=0.460$, RMSE=0.058 m$^3$/m$^3$, ubRMSE=0.056 m$^3$/m$^3$
- **AVEW**:

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Blending Method Comparison

With Respect to the SCAN SM measurements for 10 cm soil layer, differences in (a) correlations ($r$), (b) RMSE, and (c) $ubRMSE$ between AVEW and the scaled TCW SMOPS blended SM data over 1 April 2015-June 30 2017 period. Site in blue color denotes improvement.
Blending Method Comparison

CONUS domain-averaged (a) correlations, (b) RMSE and (c) ubRMSE for each of the 6 individual satellite SM retrievals with respect to the 5 cm SCAN SM measurements and both SMOPS blended SM datasets against to the SCAN SM measurements over 1 April 2015-June 30 2017 period.
Soil Moisture Daily Maps

To display maps, please select a data type, region, year, month, and date, and then click 'Refresh'.

Use the '<' and '>' buttons to step ahead or backward through the images. Soil moisture is expressed in Volumetric Soil Moisture Content [m^3 water/m^3 soil] (see Documents for details).

Data Type: NOAA-AMSR-E, Region: Global, Year: 2004, Month: 7, Day: 1

Data Types:
- **NOAA-AMSR-E**: NOAA Soil Moisture from AMSR-E: Land surface soil moisture retrieved from AMSR-E X-band brightness temperature (TB10H) observations using the Single-Channel-Retrieval (SCR) algorithm.
- **NOAA-WindSat**: NOAA Soil Moisture from WindSat: Land surface soil moisture retrieved from Naval Research Lab's (NRL) WindSat X-band brightness temperature (TB10H) observations using the Single-Channel-Retrieval (SCR) algorithm.
- **NOAA-TMI**: NOAA Soil Moisture from TMI: Land surface soil moisture retrieved from the X-band brightness temperature.
Many satellite soil moisture data products have been available while NWS users requested a combined data layer for their application convenience.

Using CDF match algorithm, SMOPS unified individual satellite retrievals to a common global satellite data climatology before blending them together.

Current operational SMOPS uses simple average as the blended SM data layer.

A testing indicates that weighted averaging using the TCEM-based relative RMSE of individual sensor retrievals may generate better blended products.

Upgrading SMOPS using the weighted averaging is to be explored with further evaluation and resources assessment.
Thanks!

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