NOAA Soil Moisture Operational Product System (SMOPS): Version 2

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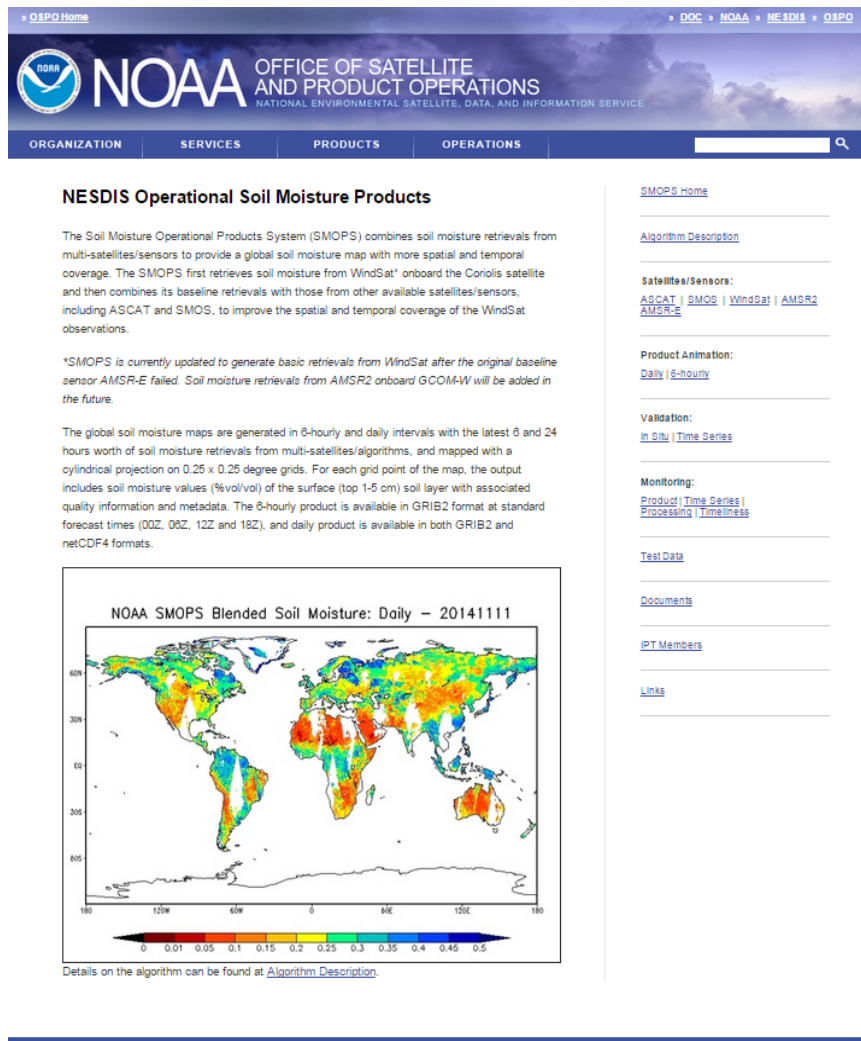[4] **Environmental Modeling Center, NOAA/NCEP, College Park, MD 20740, USA.**
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Outline

- **What's SMOPS**

- **Why**

- **How**

- **When**

- **Who cares**

- **What else**

What's SMOPS

http://www.ospo.noaa.gov/Products/land/smops/index.html

The Soil Moisture Operational Products System (SMOPS) combines soil moisture retrievals from multi-satellites/sensors to provide a global soil moisture map with more spatial and temporal coverage. The SMOPS first retrieves soil moisture from WindSat onboard the Coriolis satellite and then combines its baseline retrievals with those from other available satellites/sensors, including ASCAT and SMOS, to improve the spatial and temporal coverage of the WindSat observations.

What's SMOPS

- **Developed by NOAA/NESDIS/STAR**

- **Operationally running at NOAA/NESDIS/OSPO**

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Why SMOPS

- **Global soil moisture is one of the critical land surface initial conditions for numerical weather, climate, and hydrological predictions.**

- **Land surface soil moisture remote sensing provides a practical tool.**

- **A number of soil moisture products have been produced from different satellite sensors (AMSR-E, SMOS, ASCAT, WindSat, AMSR2, etc).**

- **Different data formats, projection and insufficient spatial and temporal coverage of soil moisture products from individual sensors.**

- **SMOPS is to:**
  1. **Provide a one-stop for most of the available operational soil moisture products.**
  2. **Provide a blended soil moisture layer that is merged form soil moisture retrievals from all available products.**

How SMOPS Works
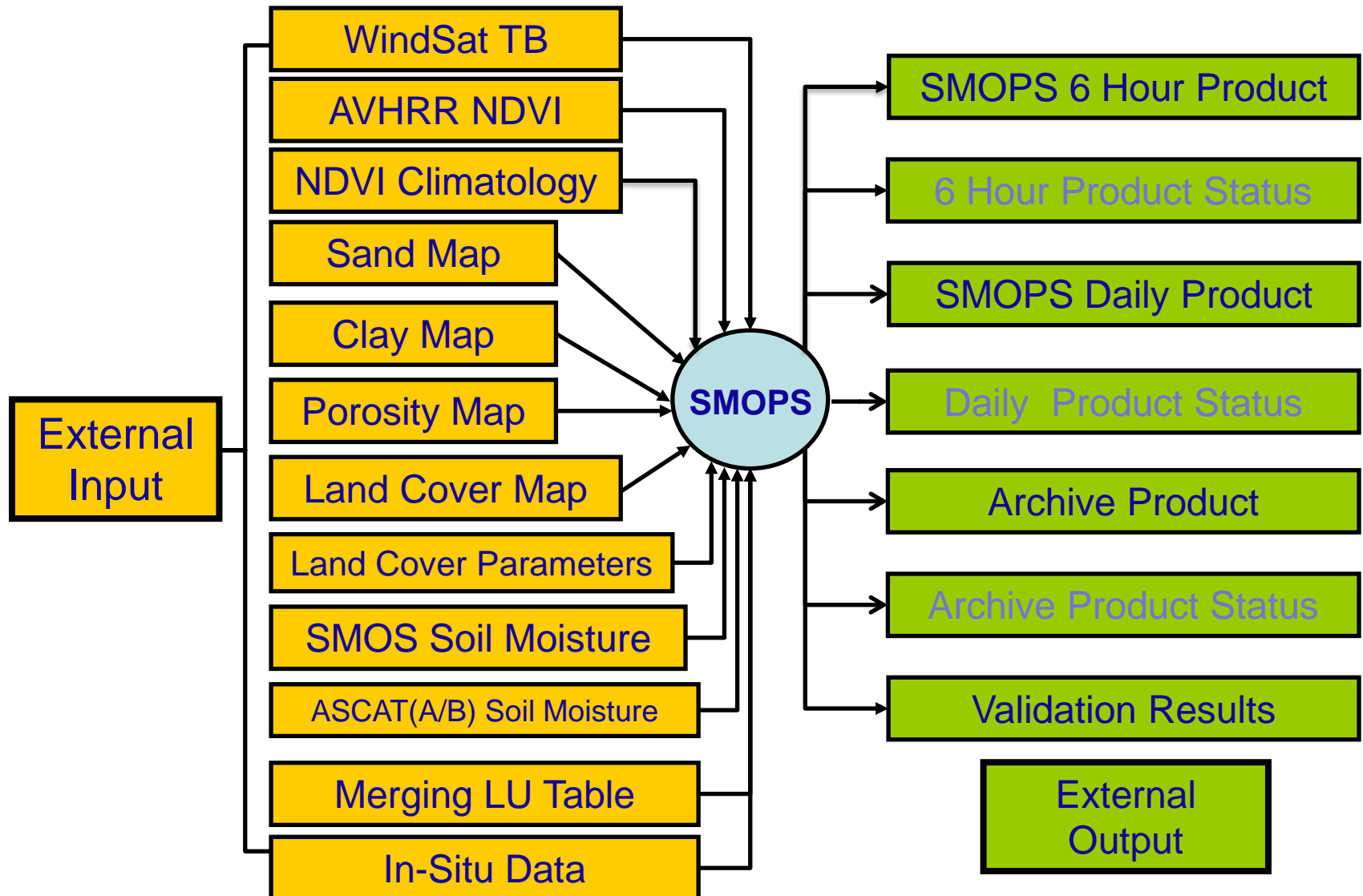
SMOPS Process Flow

- **Branch 1 is the Pre-Processing function**

- **Branch 2 is the Retrieval function**

- **Branch 3 is the Merging function**

- **Branch 4 is a reprocessing step for the Archive Product**
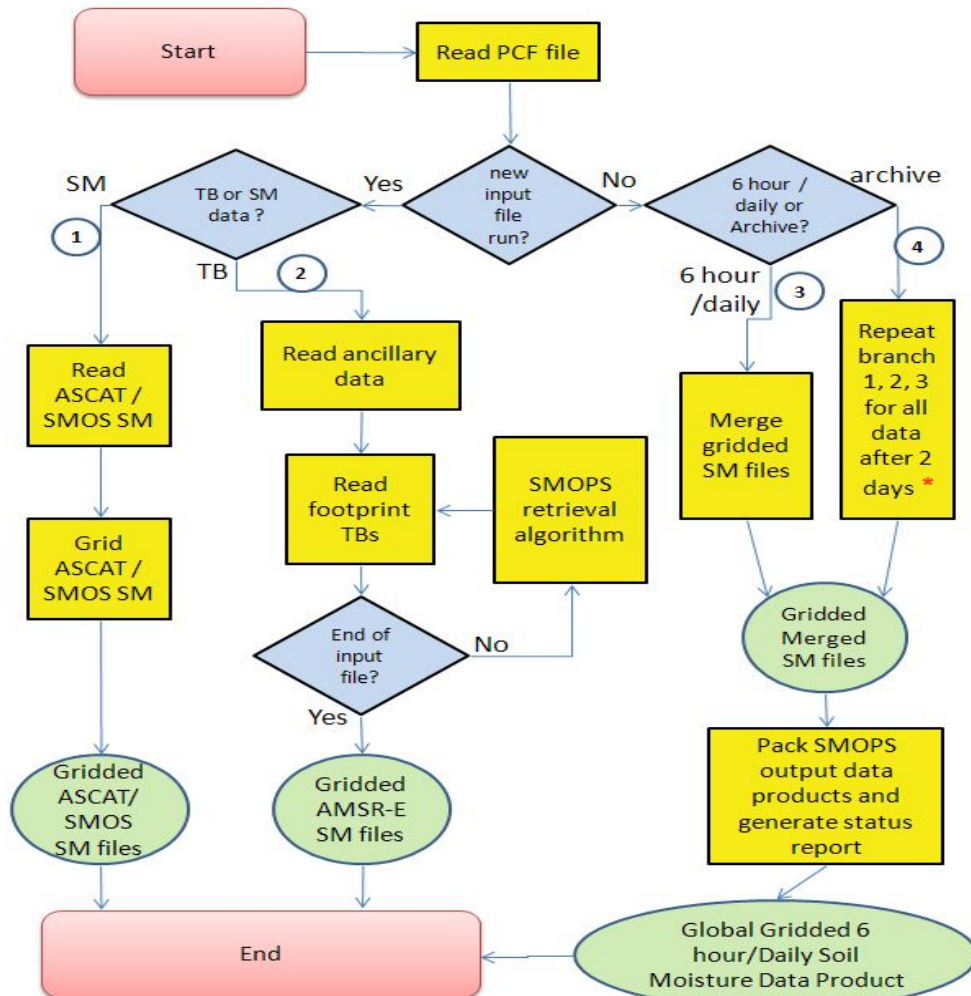
*All data acquired within the 6 hour or whole day time period arrived in the past 48 hours

How SMOPS Works

Major SMOPS External Output Description

Item	Description	Format	Projection	Spatial Coverage	Spatial Resolution	Main Purpose
SMOPS 6 Hour Product	SMOPS 6 hour Gridded Soil Moisture	GRIB2	Lat/Long	Global	0.25 degree (720x1440)	For NCEP
SMOPS Daily Product	SMOPS Daily Gridded Soil Moisture	GRIB2	Lat/Long	Global	0.25 degree (720x1440)	For NCEP
SMOPS Archive Product	SMOPS Daily Gridded Soil Moisture	netCDF4	Lat/Long	Global	0.25 degree (720x1440)	For CLASS

How SMOPS Works

SMOPS Product Data Layers

Layer #	Data Description	Data Type	Fill Value	Valid Range	Scale Factor
1	Blended Soil Moisture	2-byte signed integer	-999	0 – 1000	1000
2	AMSR-E/2 Soil Moisture	2-byte signed integer	-999	0 – 1000	1000
3	SMOS Soil Moisture	2-byte signed integer	-999	0 – 1000	1000
4	ASCAT-A Soil Moisture	2-byte signed integer	-999	0 – 1000	1000
5	ASCAT-B Soil Moisture	2-byte signed integer	-999	0 – 1000	1000
6	WindSat Soil Moisture	2-byte signed integer	-999	0 – 1000	1000
7	NOAA SMOS Soil Moisture	2-byte signed integer	-999	0 – 1000	1000
8-21	Observation Time Layers	1-byte signed integer	-99	0 – 23 0 – 59	1
22-28	Bit-packed Quality Assessments	2-byte signed integer	-999	N/A	N/A

How SMOPS Works

WindSat   **SMOS**   **ASCAT**
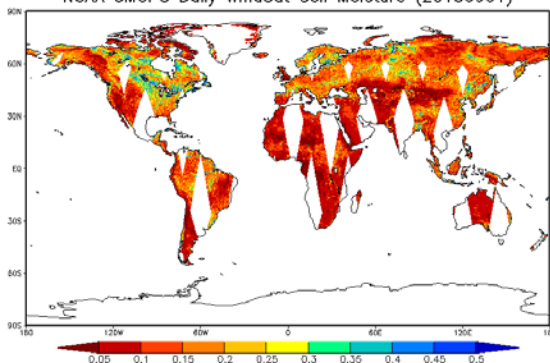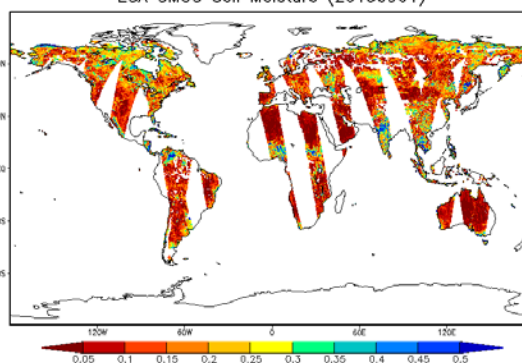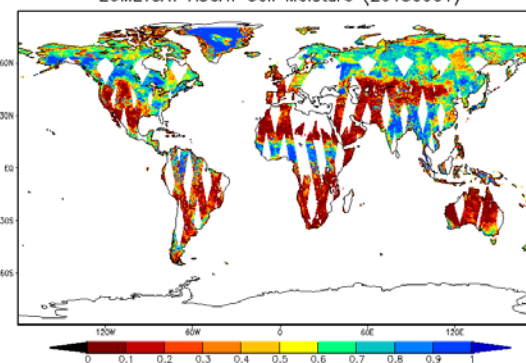
Blended
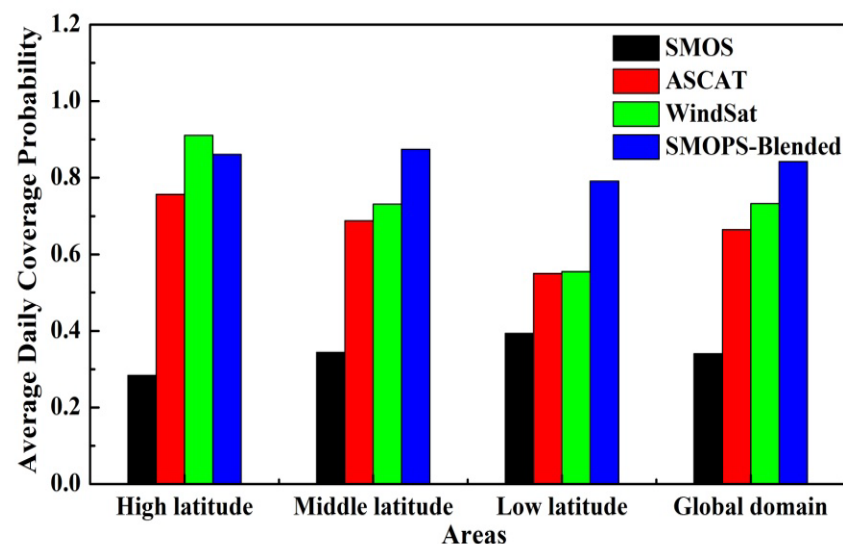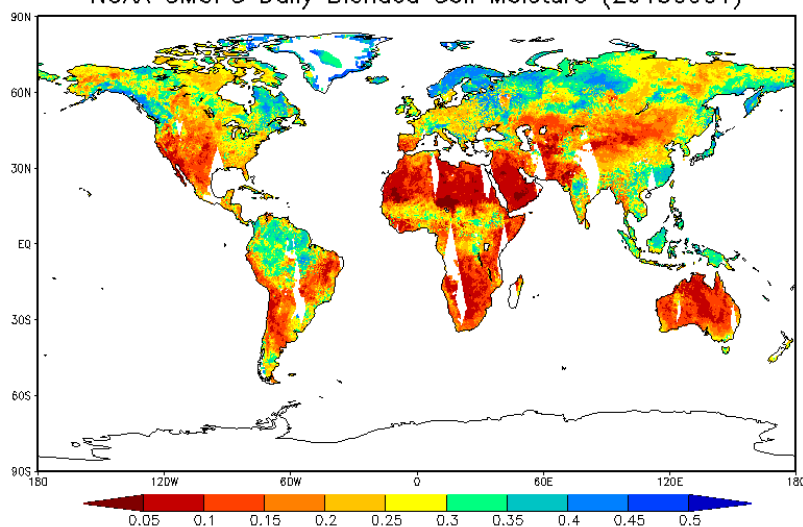
SMOPS Project Milestones

- **Gate 3 Review – Dec 14, 2009**

- **Preliminary Design Review – May 26, 2010**

- **Critical Design Review – Oct 28, 2010**

- **System Readiness Review – Sep 13, 2011**

- **Delivery to Operations – Oct 7, 2011**

- **Version 2 Update – Early 2015**

Does Global Forecast System (GFS) Care?

Experiment:

Control Run: GFS run without SM assimilation

EnKF run: GFS run with SMOPS Blended SM assimilated using Ensemble Kalman Filter.

CICS-MD Science Meeting

SMOPS Blended SM

GFS_CTL
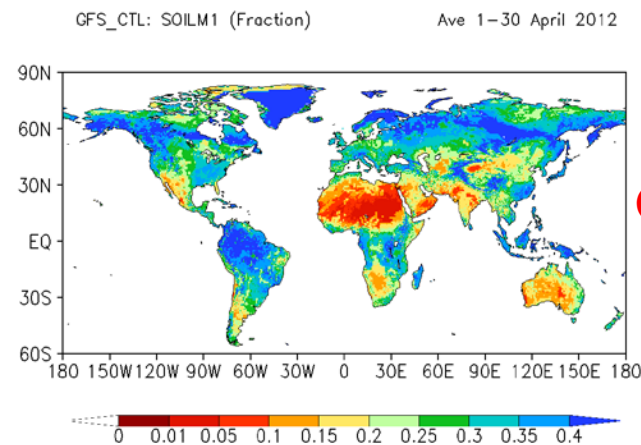
GFS_EnKF
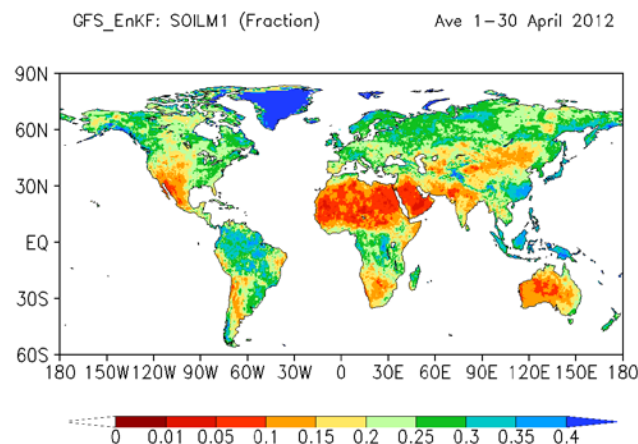
EnKF-CTL
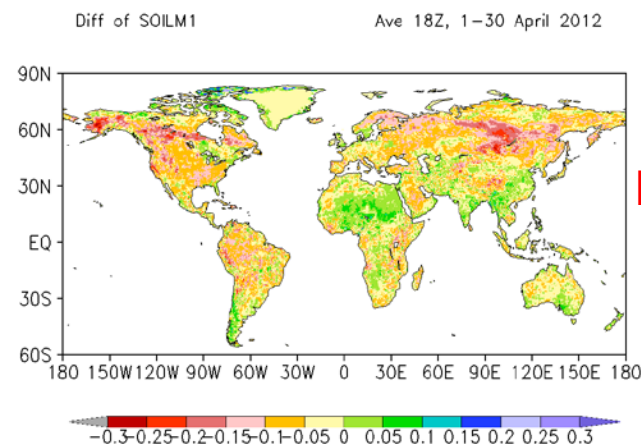
GFS Cares:

("Assimilation of Blended Soil Moisture Products from SMOPS in the NCEP GFS", W. Zheng *et al.*, *JCSDA Quarterly*, Dec. 2013)

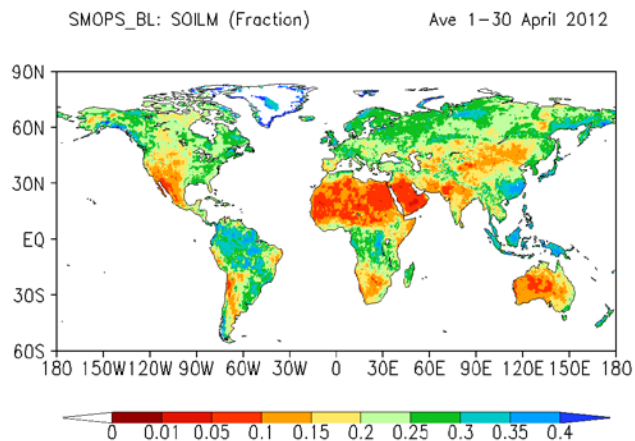*"The satellite soil moisture blended products from SMOPS were assimilated in NCEP GFS and the result shows 1) Improved GFS deeper layer soil moisture estimates comparing with in situ measurements; 2) Improved GFS forecast scores and reduced its bias and root-mean-square errors; and, 3) Showed some positive impact on precipitation on CONUS but not for heavy precipitation."*
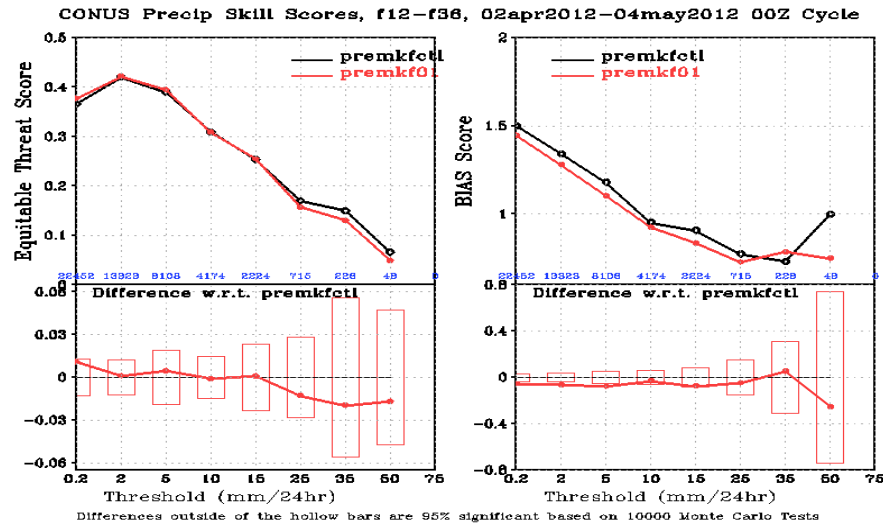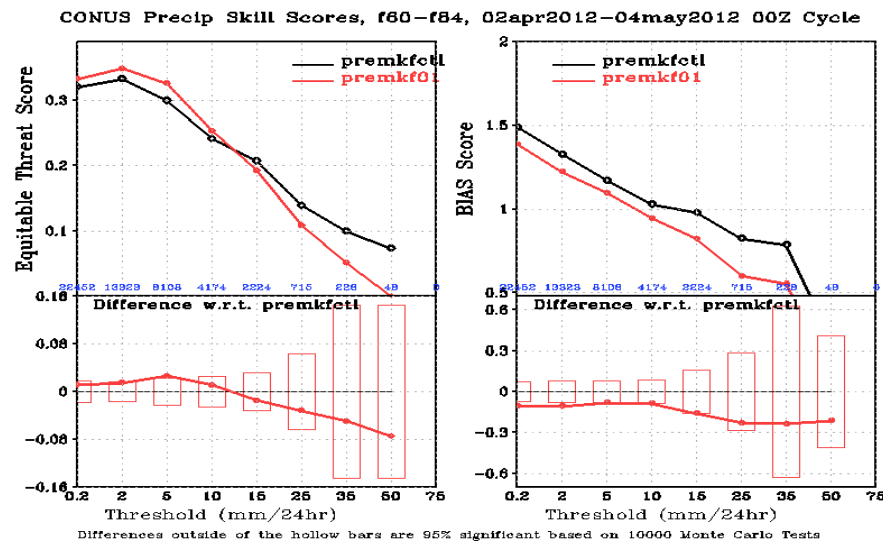
GFS Cares: (W. Zheng *et al*.: JCSDA Quarterly, Dec. 2013)

Validation using USDA-SCAN ground observations.

	East CONUS (26 sites)			West CONUS (25 sites)			Whole CONUS		
	RMSE	*Bias*	*Corr-Coef*	*RMSE*	*Bias*	*Corr-Coef*	*RMSE*	*Bias*	*Corr-Coef*
CTL	0.135	0.046	0.565	0.124	0.033	0.448	0.129	0.040	0.508
EnKF	0.130	-0.031	0.613	0.114	-0.021	0.549	0.123	-0.031	0.587

❖ Improved GFS SM product quality with SMOPS SM assimilated.

GFS Cares:

("Enhancing Model Skill by Assimilating SMOPS-Blended Soil Moisture Product into Noah Land Surface Model", J. Yin *et al.*, *Journal of Hydrometeorology*, 2014)

"The improvements of assimilating SMOPS-Blended data on model soil moisture and soil temperature can be seen not only in low and middle GVF areas, but also in high GVF areas, and the best performance is shown in middle GVF areas. Temporal correlations between *in-situ* observations and SWnet/LWnet are stronger with assimilating SMOPS-Blended product than without the benefit of data assimilation."

RMSD-DA Minus RMSD-OLP for Top Layer SM
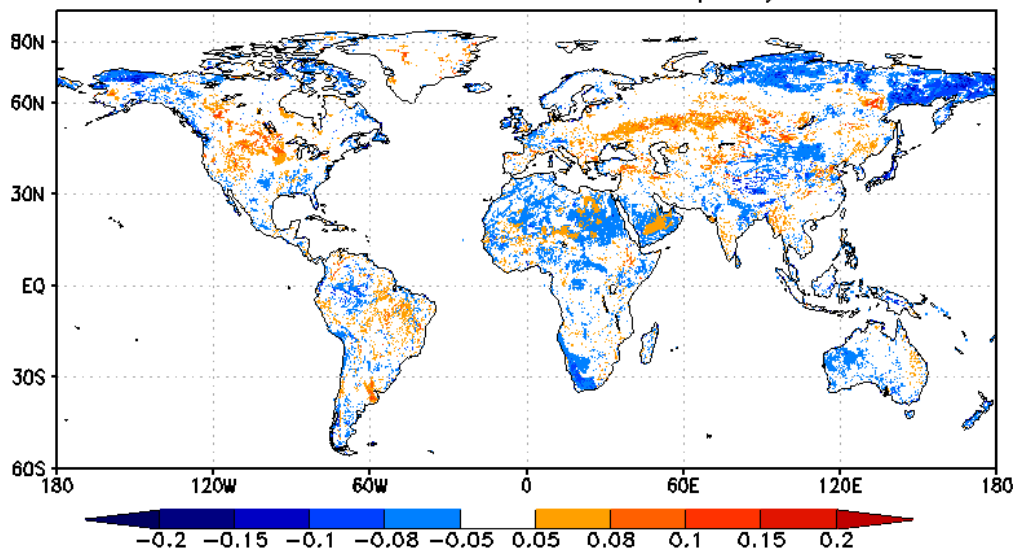
Negative (Blue): Increased model performance.

What else we need to do about SMOPS?

Soil Moisture Product	SMOPS Version 1	SMOPS Version 2
SMOPS Blended	√	√
NOAA AMSR-E	√	✗
ESA SMOS	√	√
EUMETSAT ASCAT-A	√	√
EUMETSAT ASCAT-B	✗	√
NOAA WindSat	√	√
NOAA AMSR2	✗	√
NOAA SMOS	✗	√
SMAP	✗	✗
Other Products		

What else we need to do about SMOPS?

- ➢ **To include more soil moisture products**

- ➢ **To update CDFs for blended product regularly**

- ➢ **To improve retrieval algorithm**

- ➢ **To do more DA experiments**

Go SMOPS!

Thank you!