A global daily soil moisture dataset derived from Chinese FengYun-3 Microwave Radiation Imager (MWRI)

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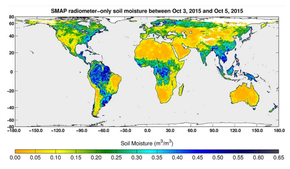
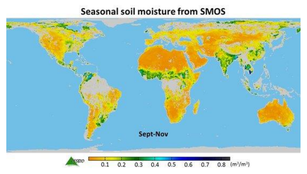
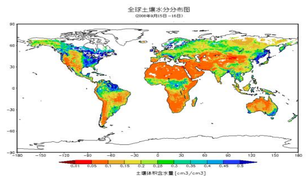
Motivation

- Surface soil moisture is an important variable in drought monitoring, floods predicting, weather forecasting, etc. For monitoring of soil moisture, microwave remote sensing, especially the L-band radiometers, SMOS and SMAP , provides unique observation ability with global coverage and high accuracy.





L band soil moisture from SMOS and SMAP



X band soil moisture from MWRI/FY-3

- X band and higher bands radiometers MWRI from Chinese FengYun-3 series satellites, although has a lower sensitivity to soil moisture than L band, provide sustainable and daily multiple-observation since 2008.

? Can we transfer the high accuracy of L band to X band and higher frequencies?

Data

- **TBs from MWRI on Chinese FengYun-3 series satellites**

Satellite	Equatorial crossing times	Time coverage
FY-3B（ceased）	13:40-14:00A	2010-2019
FY3C	10:00-10:20D	2013-present
FY-3D	13:40-14:00A	2017-present

Frequency/GHz	Polarization	Resolution/km
10.65	V,H	51×85
18.7	V,H	30×50
23.8	V,H	27×45
36.5	V,H	18×30
89	V,H	9×15

- **Soil moisture from SMAP**

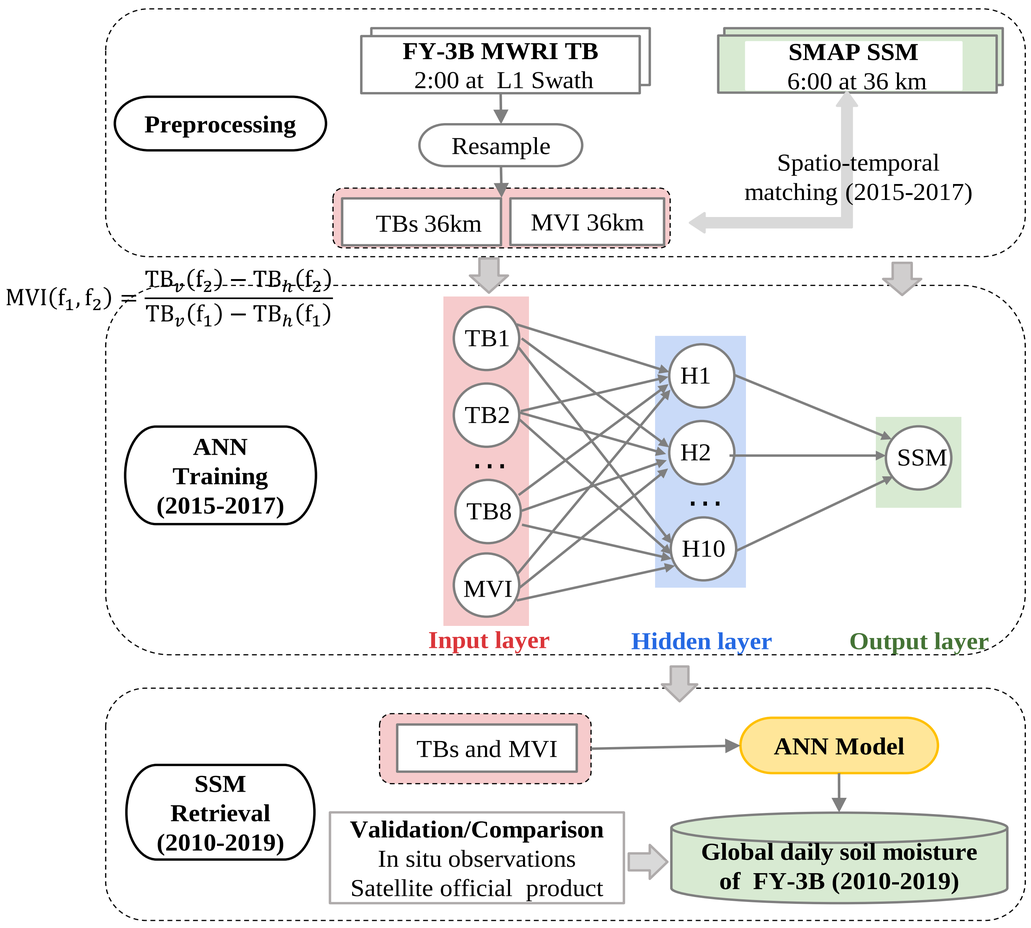
Data	Source	Time Period	Spatio-temporal resolution
FY-3B MWRI L1 TB	provided by NSMC	2010-2019	Swath
SMAP L3 soil moisture	https://nsidc.org/data/smap	2015-2017	36 km, Daily

- **In situ Soil moisture**
  - **14 Dense validation networks**

    (a) 7 USDA watershed networks, (b) 2 Tibetan Plateau networks, (c) 2 OZNet networks, (d) the REMEDHUS network, and (e) 2 AMMA networks.
  - **5 flux datasets(258 sites)**

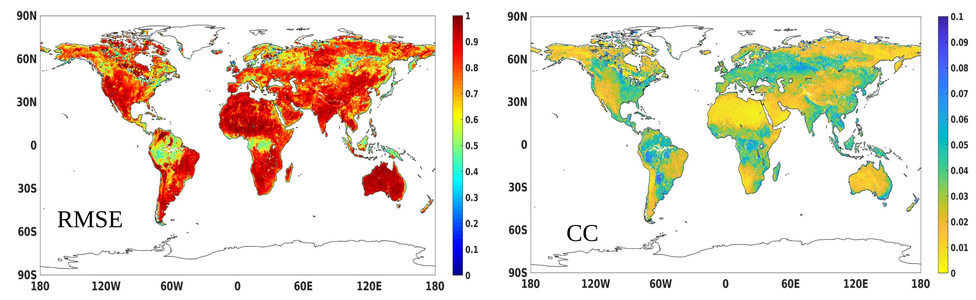
    (a) FLUXNET2015, (b) ICOS2020, (c) ICOSETC2022, (d)AmeriFlux Network (e) TERN

Methods



- Only FY-3 TBs and SMAP products(3 years) are used, Not use vegetation indices from VIS/IR RS data, and LST from numerical models
- Using Machine learning technology and L band soil moisture as target

Result: training results



- high CC (>0.8) with the target SMAPL3sm globally, except for regions of equatorial rainforest and forest at high latitude such as part of Russia. Statistically, 57 percent of RMSE over global land are below 0.03 m^3/m^3, and 29 percent of RMSE is between 0.03 m^3/m^3 and 0.05 m^3/m^3.

Result: Validation and Comparison

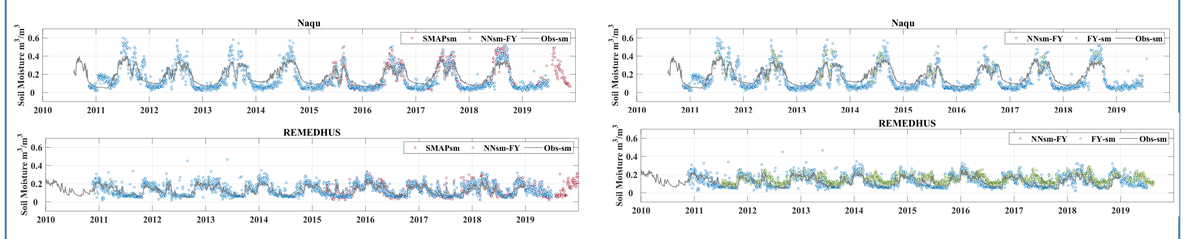


Fig Time series comparison of the SMAPsm (red dots), NNsm-FY (blue dots) , FY-sm (green dots) and in situ soil moisture observations (obs-sm in gray lines)

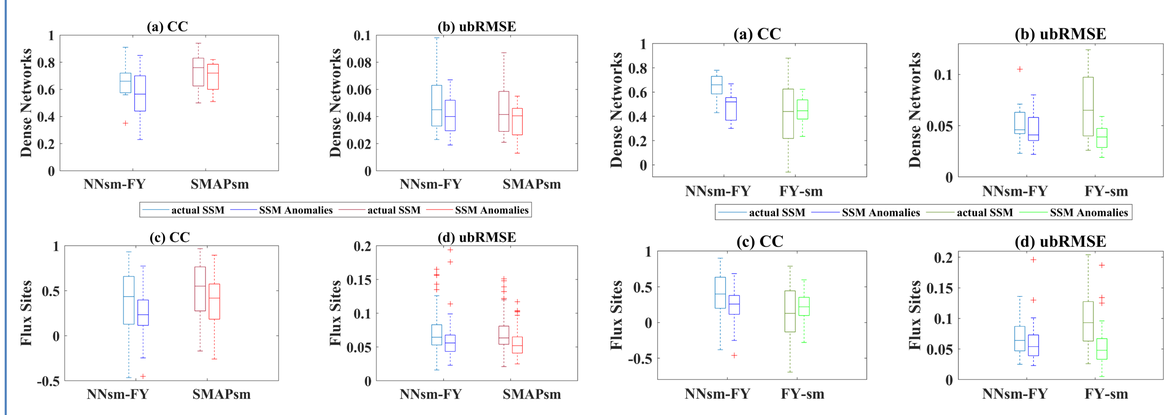


Fig Box plots of statistics of NNsm-FY and SMAPsm FY-sm against in situ soil moisture at an independent validation period (2018-2019), for both actual SSM and SSM anomalies: (a) CC, (b)ubRMSE(m^3/m^3) at dense networks, (c) CC and (d) ubRMSE(m^3/m^3) at flux sites.

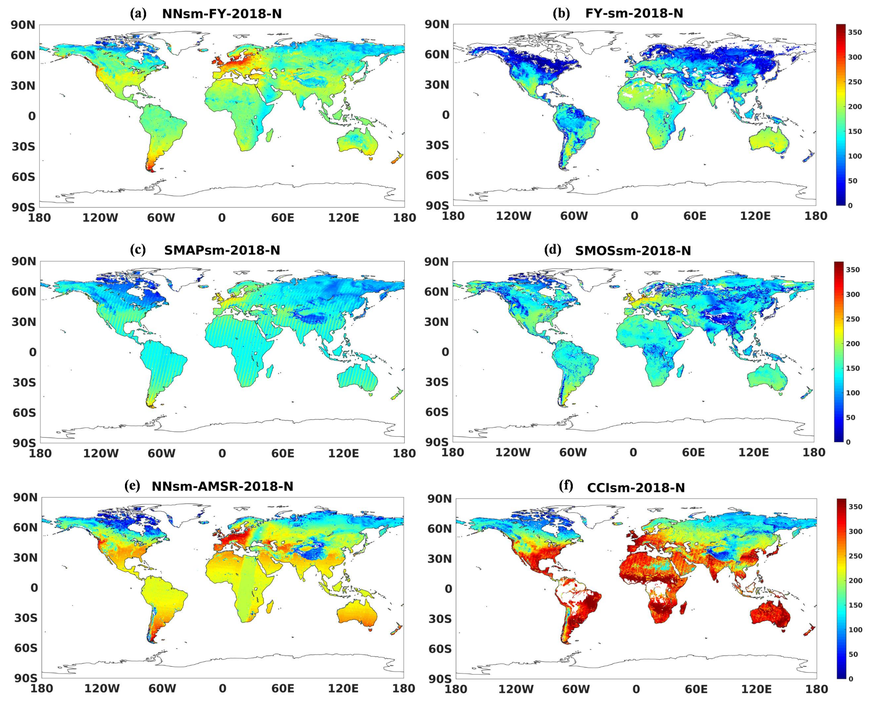


Fig Amount of soil moisture retrievals at each grid cell within 2018 for the following products

Conclusion

- **A new soil moisture dataset derived from Chinese FengYun-3 series satellite(NNsm-FY), using Machine learning technology and SMAP L band soil moisture.**
- **The NNsm-FY shows good agreement with in-situ observations and SMAP product and has a higher accuracy than that of official FY-3B product.**
- **Chinese FY-3 satellites may play a larger role and provide opportunities of sustainable and longer-term soil moisture data record for hydrological study.**