Hydro-JULES

Winter school – 19th January 2023

Monitoring Soil Moisture from Space

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UK Centre for Ecology & Hydrology

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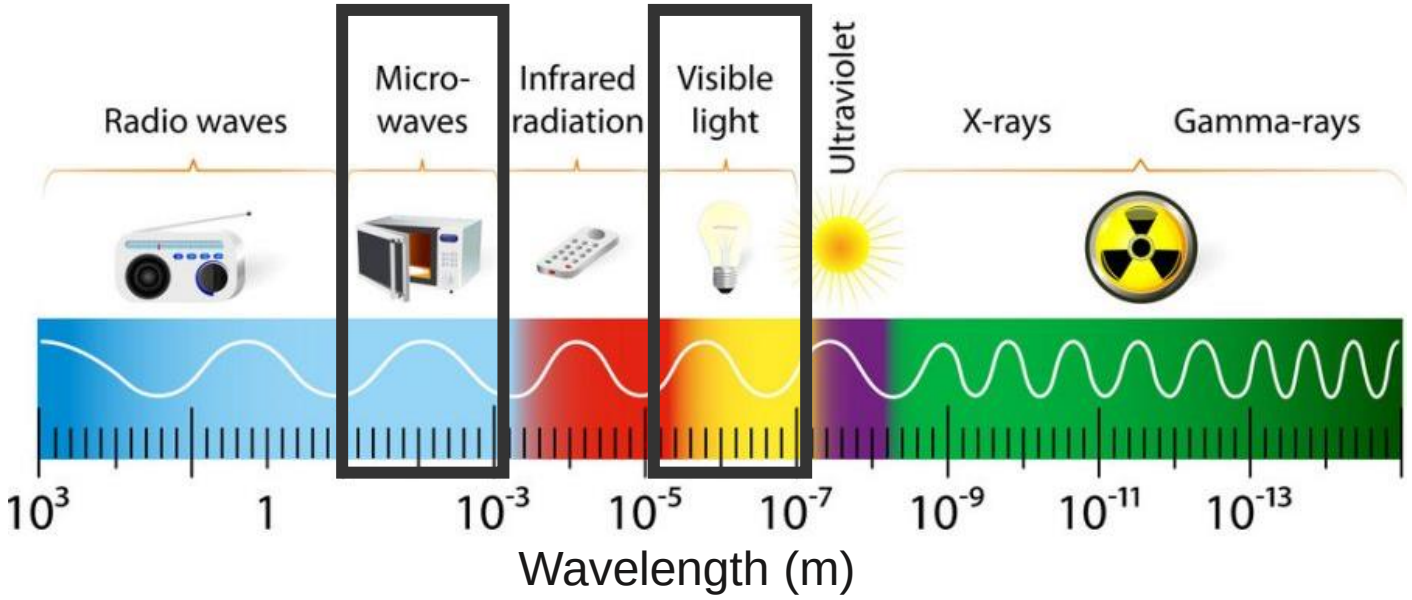
Approaches to measure SM from space

Remote sensing: technique to observe the earth surface or the atmosphere from satellites or aircrafts.
It uses the **electromagnetic spectrum.** It records the electromagnetic energy reflected or emitted by the earth's surface.



Microwave (MW) signal: → can go through clouds, dust, rain
→ penetrates a few cm below surface

Image source: VectorStock.com/1571487

Active MW vs. Passive MW

Active microwave: a microwave pulse is sent and received. The power of the received signal is compared to that which was sent to determine the backscattering coefficient of the surface.

Passive microwave: natural thermal emission of land surface (or brightness temperature) is measured at microwave wavelengths, using a radiometer.

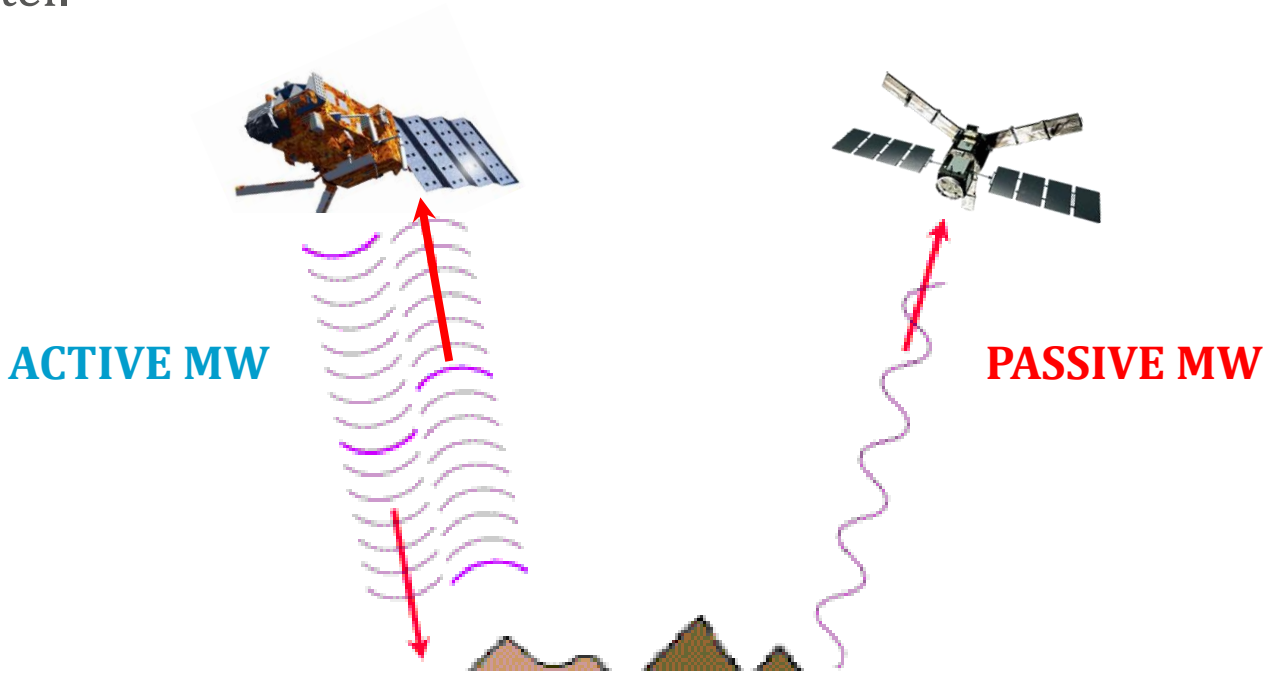


Image source: http://www.geol-amu.org/notes/mw4-2-2.htm;
http://www.russianspaceweb.com/metop.html;
http://www.cse.dmu.ac.uk/EAPRS/projects_smos.html

Active MW

Surface reflectivity ~ dielectric constant

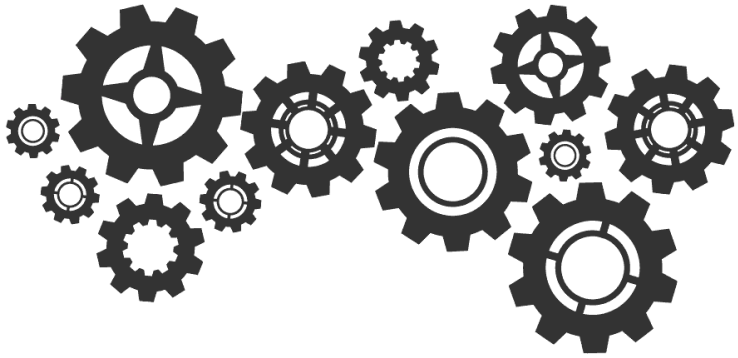
Passive MW

ALGORITHMS

Physical

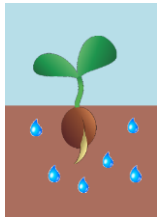
Semi-empirical

Empirical



- Higher spatial resolution.
- Low temporal resolution

Soil Moisture



ACCURACY affected by:

Vegetation

MW wavelength

Surface roughness

View angle

- More accurate.
- Higher temporal resolution
- Lower spatial resolution

Image source: https://www.nassimsoleimanpour.com/education and http://www.gardenergranny.de/

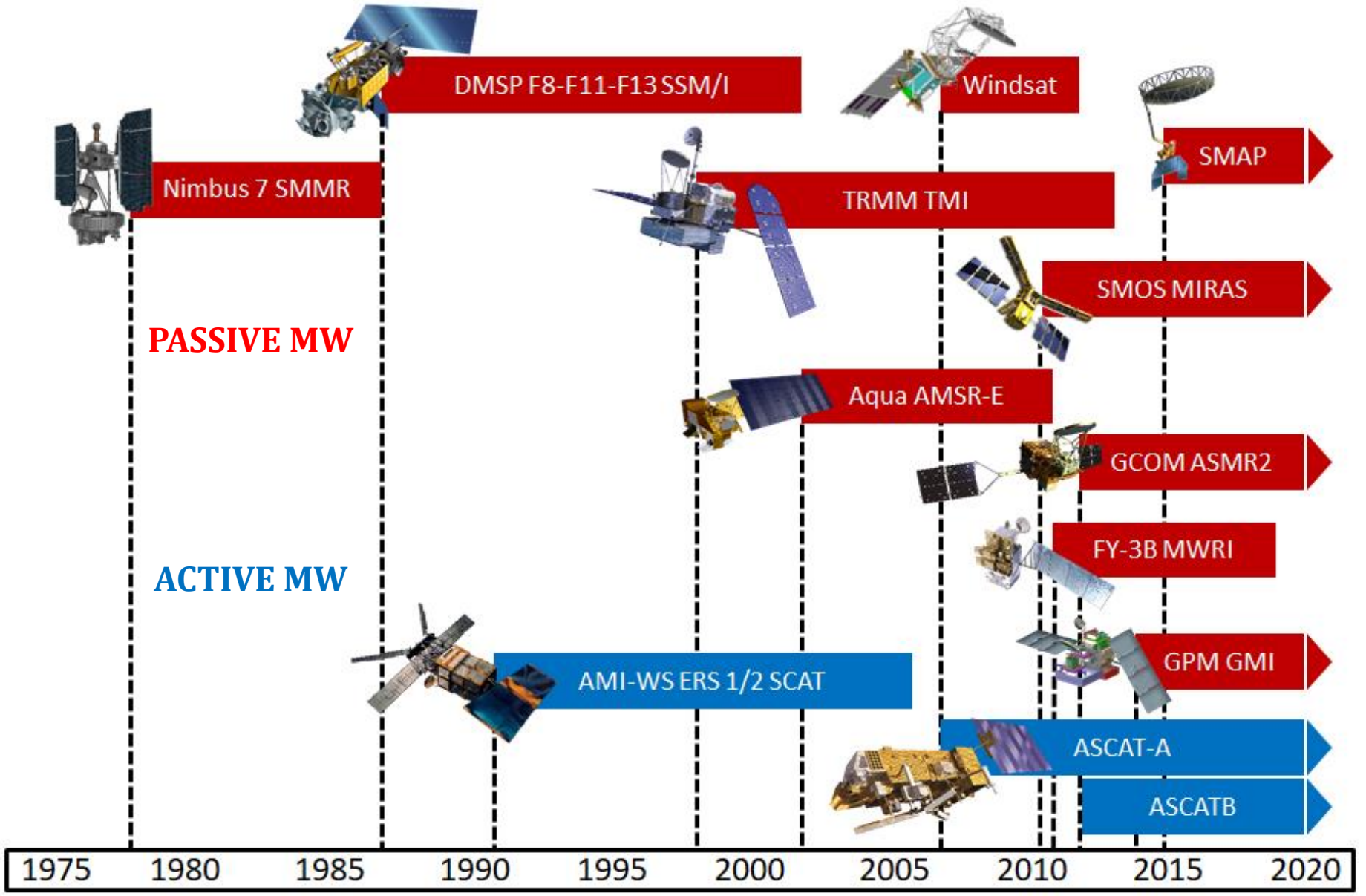


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Image source: https://esa-soilmoisture-cci.org/

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2) **The challenge**
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What is the challenge?

Field equipment

Reliable
Continuous

Expensive
Only point/field scale

Remote sensing

Regional maps
Freely available

Variable accuracy
Missing data
Coarse resolution

Models

High resolution
Continuous

They are not observations

Soil Moisture product

Continuous
High res.
Reliable

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Image source: VectorStock.com/37144787, Alwin Aulia and Template from Noun project

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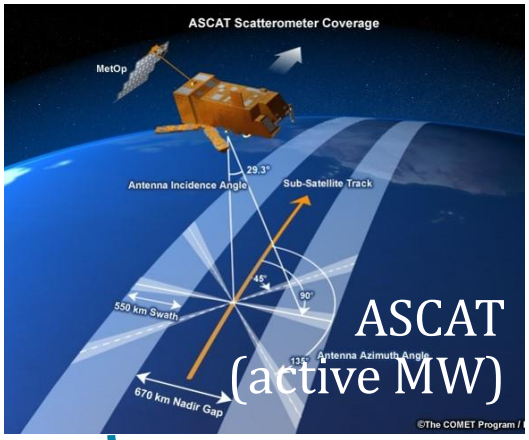
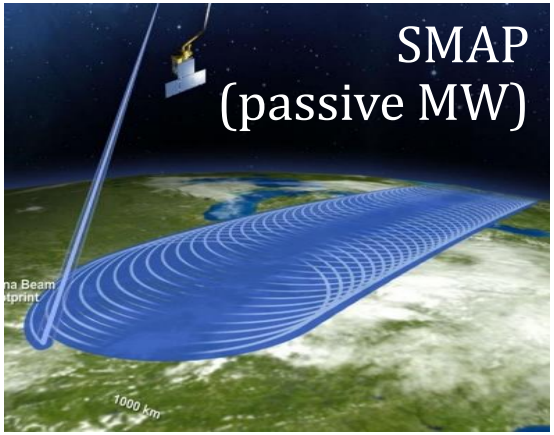
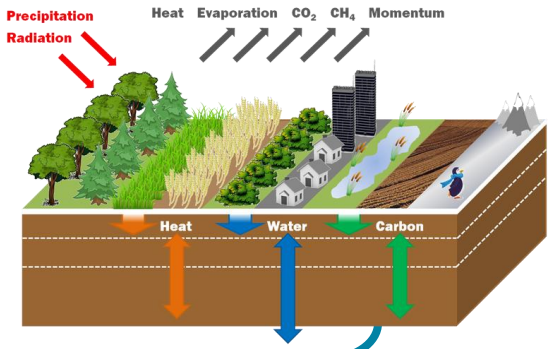
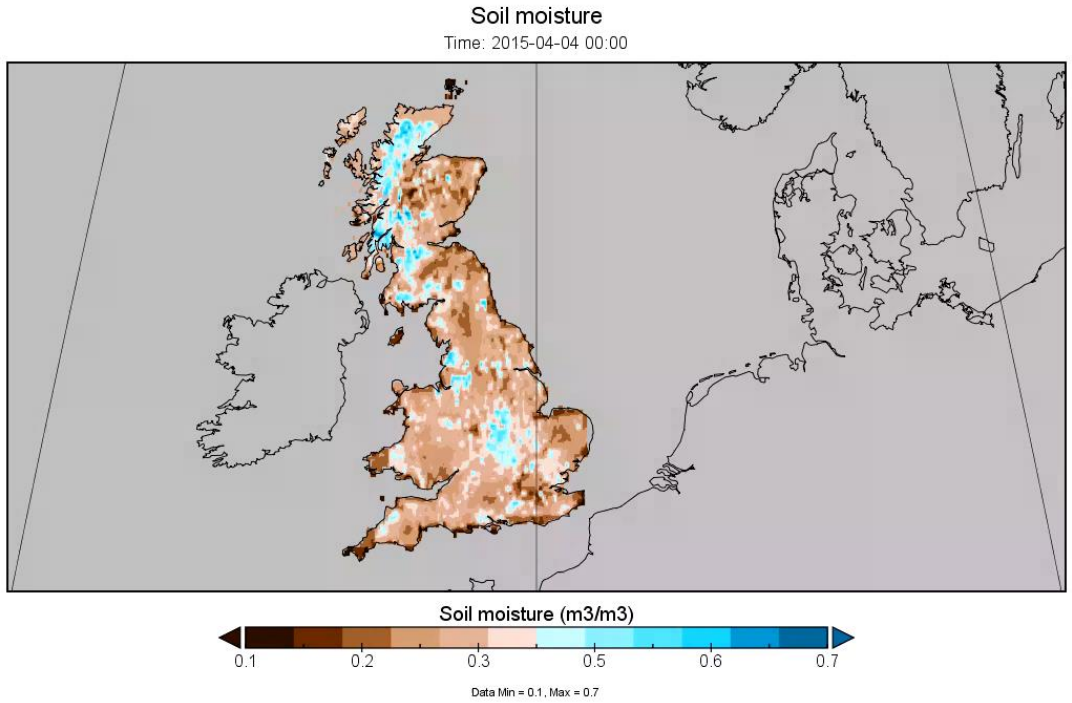




JULES-CHESS (model)



Triple collocation merging



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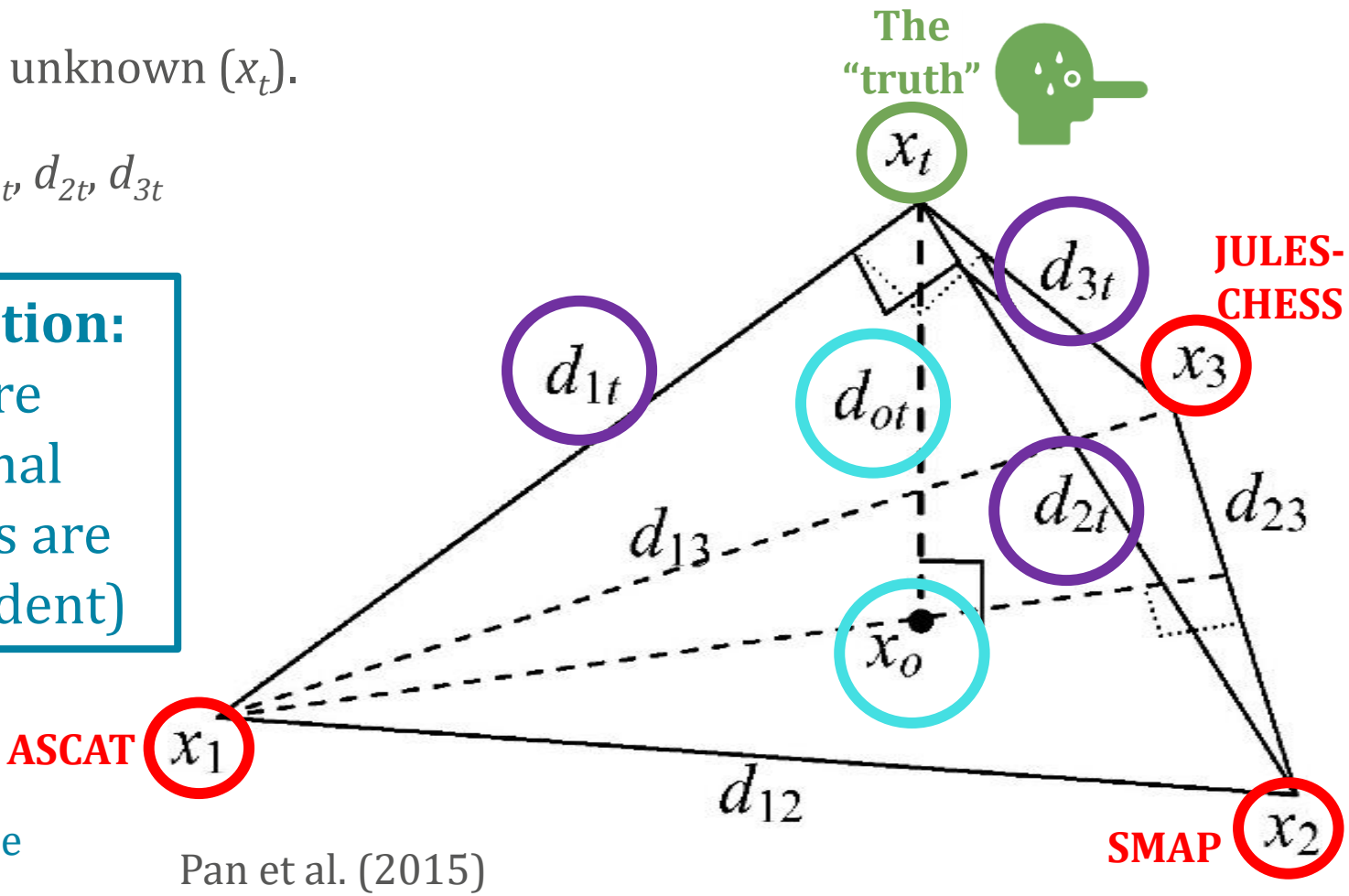
Triple Collocation (TC) method

Method for error assessment from three source estimates (x_1, x_2, x_3).

"Truth" is unknown (x_t).

Errors: d_{1t}, d_{2t}, d_{3t}

Assumption: Errors are orthogonal (datasets are independent)



Hilbert Space

Pan et al. (2015)
https://doi.org/10.1016/j.rse.2015.10.028

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Image source: HeadOfBirds from Noun project

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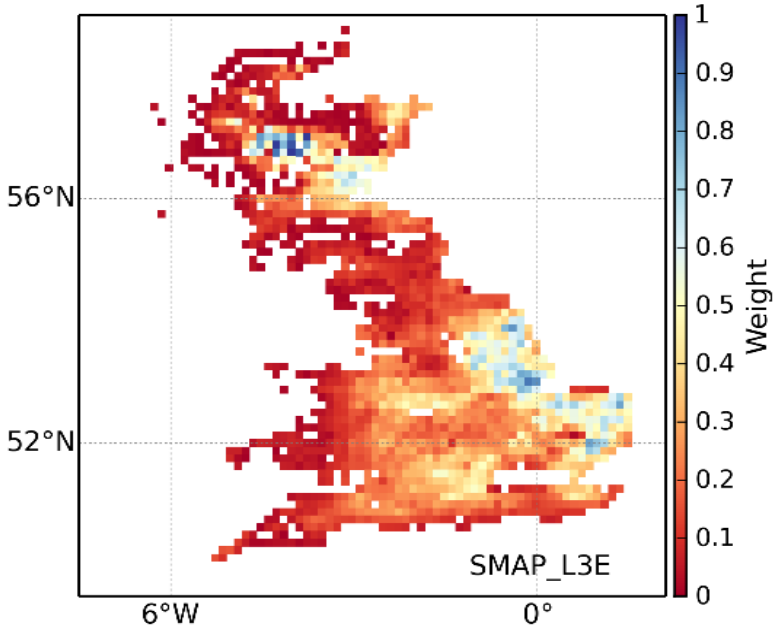
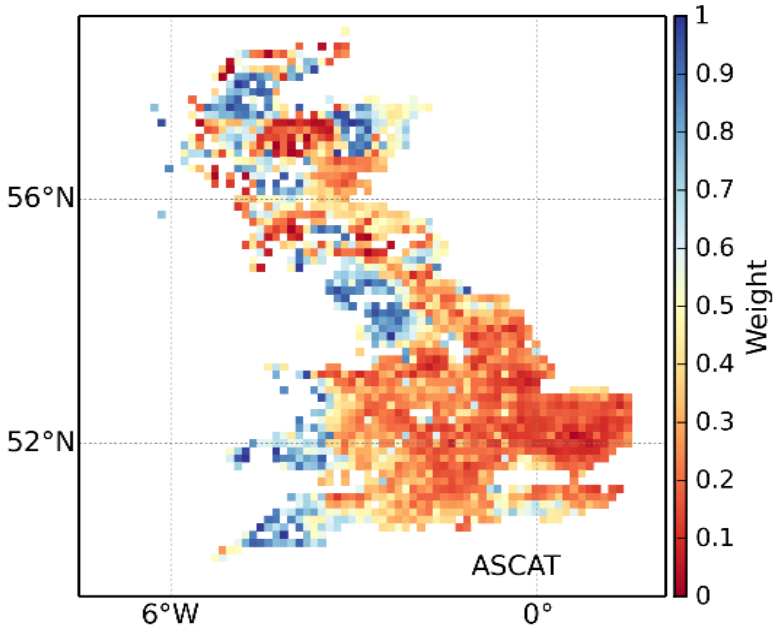
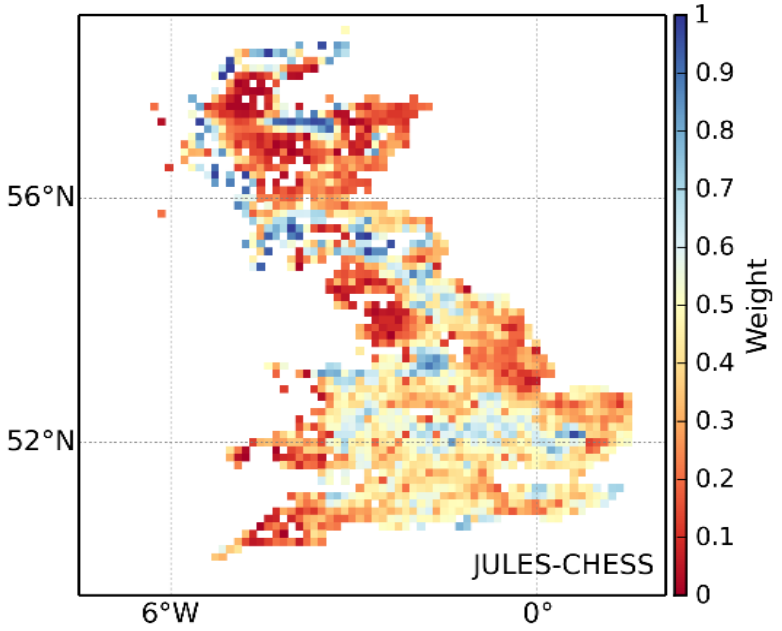
Weights







Peng et al. (2021), RSE,
https://doi.org/10.1016/j.rse.2021.112610

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Image source: Yo! Baba from Noun project

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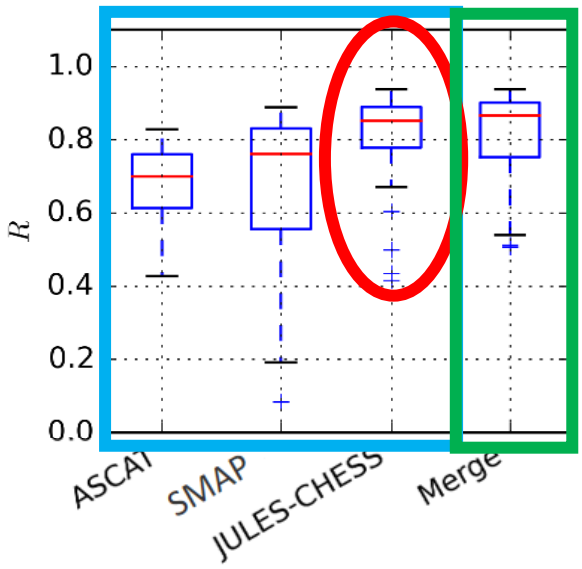
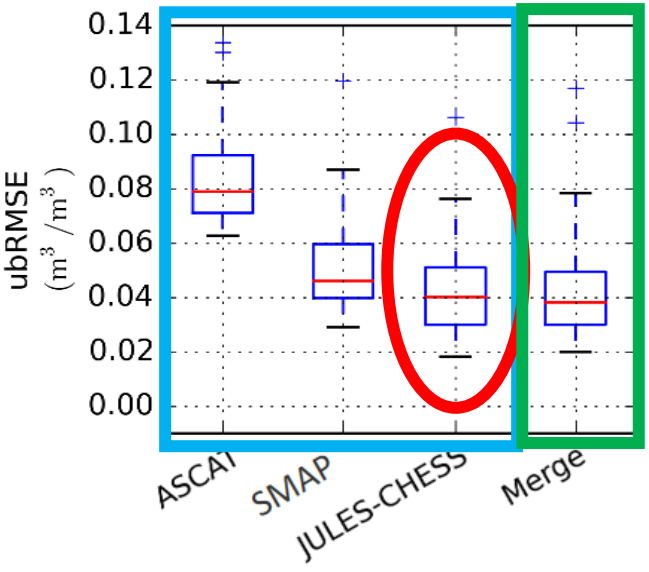
Results

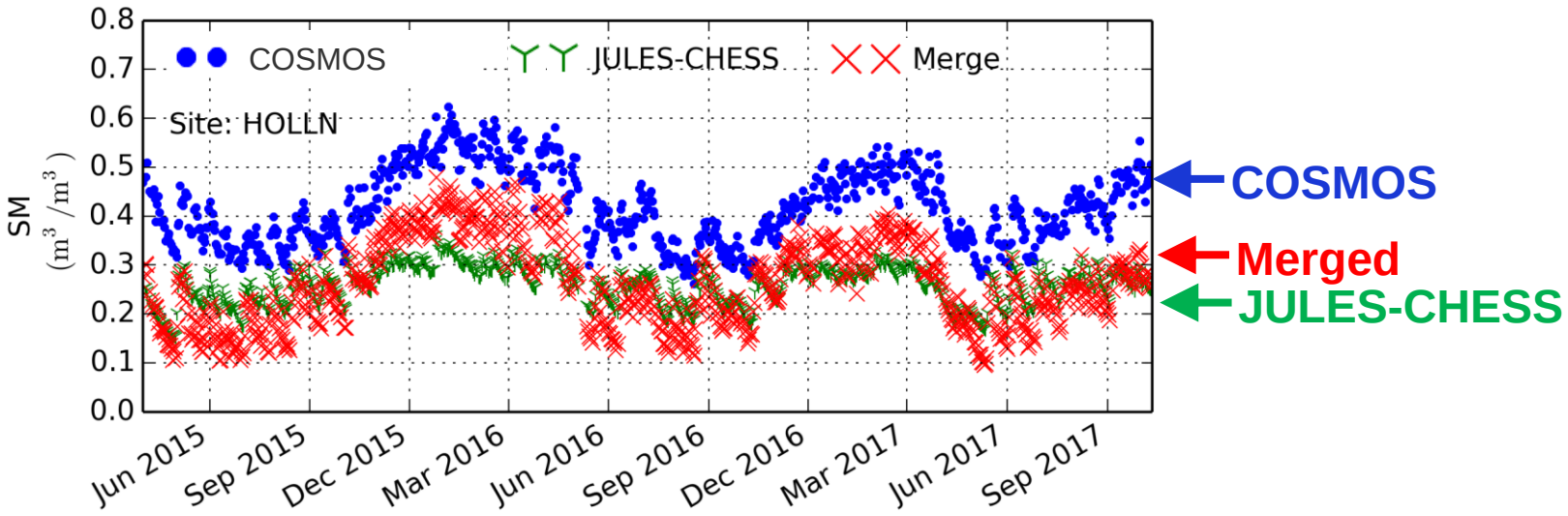
Comparison with COSMOS soil moisture:

Pearson correlation coefficient (R)





Unbiased root mean square error (ubRMSE)



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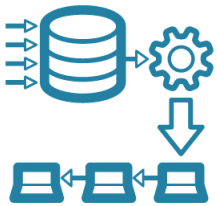
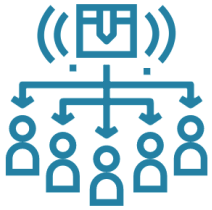
Future work



Pathways to operationali-sation

Comparison with other SM products



Dissemina-tion

Apply elsewhere

Thank you

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