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Global soil water estimates as landslide predictors: the effectiveness of …

… observations, simulations and data assimilation

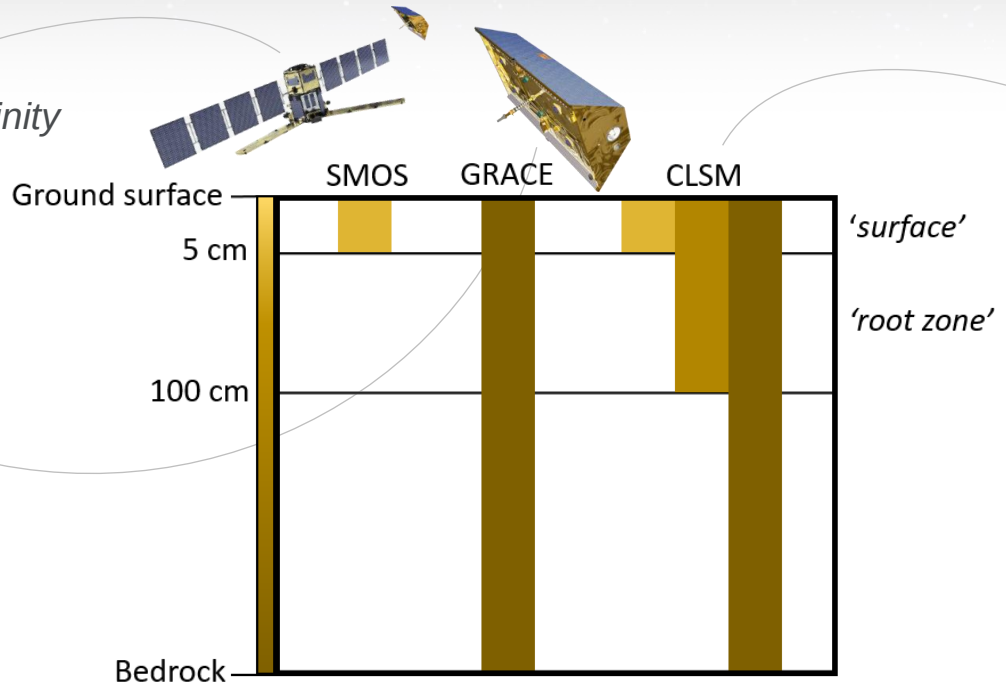
= satellite *= model* *= model + satellite*

Soil Moisture Ocean Salinity (SMOS)

revisit time every 2-3 days,
~40 km spatial resolution

Gravity Recovery And Climate Experiment (GRACE)

monthly temporal resolution,
~300 km spatial resolution

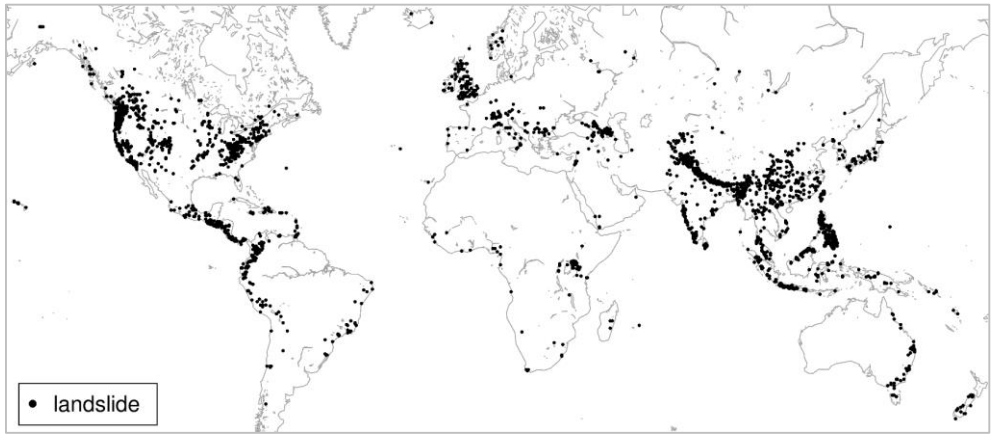


Catchment Land Surface Model (CLSM)

Koster et al. (2000), Journal of Geophysical Research: Atmospheres 105, 24809–24822

up to hourly temporal resolution, here: daily,
up to 1 km spatial resolution, here: ~36 km

3951 landslide events during study period (January 2011 – July 2016)



Global Landslide Catalog: Kirschbaum et al. (2010), Nat Hazards 52, 561–575, Federal State Budgetary Institution "Hydrospetsgeology", R. F. Archive of Quarter Annual Reports of Exogenous Geological Processes on Territories of the Russian Federation, 2018. http://geomonitoring.ru/arxiv.html.

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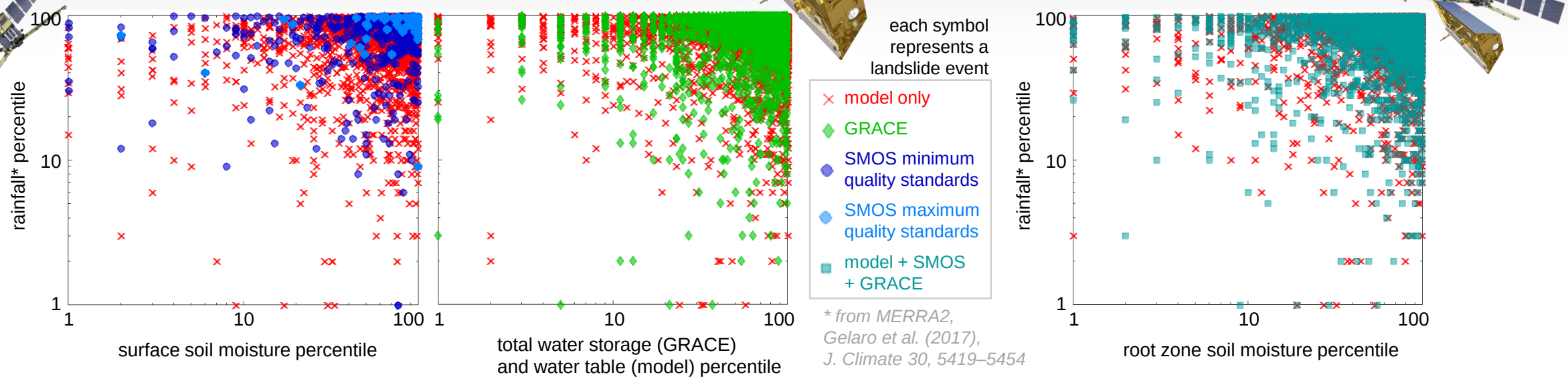
= *SMOS*, *GRACE* = *model* = *model + SMOS + GRACE*



* from MERRA2, Gelaro et al. (2017), J. Climate 30, 5419–5454

SMOS is available for ~1-14 % of landslide events (depending on quality standards). A lot of the missed events are situated in strongly mountainous terrains, e.g. Himalayas.

GRACE is available for ~75 %, the *model* for 100 % of landslide events.

General tendency towards higher soil water content at landslide event visible in all data products.

Assimilating *SMOS* and *GRACE* observations does not change this tendency.

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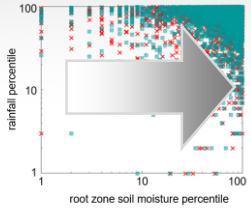
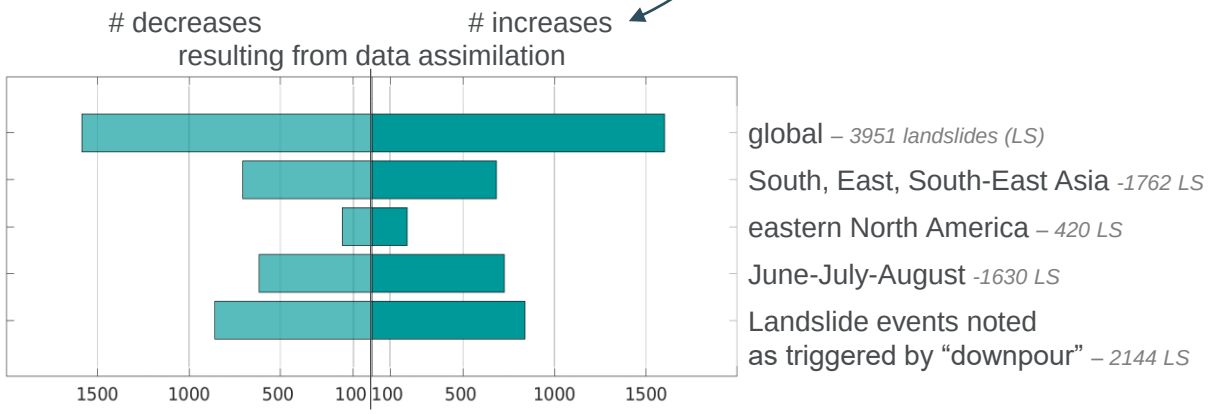
… data assimilation

= model + SMOS + GRACE



Assumed higher probability of landslide with increased root zone soil moisture.



Which global soil water estimates to use for landslide modeling?

data assimilation estimates,
combining advantages of observations (actual soil conditions) and models (estimation of intermediate soil moisture, temporal and spatial resolution increasable, no gaps)

While the assimilation of *SMOS* and *GRACE* is only somewhat beneficial for landslide probability prediction (certain regions and seasons), soil moisture and water table estimates from data assimilation are generally more reliable (De Lannoy and Reichle 2016, Girotto et al. 2019)

De Lannoy and Reichle (2016), Hydrology and Earth System Sciences 20, 4895–4911
Girotto et al. (2019), Remote Sensing of Environment 227, 12–27

This assimilation of *SMOS* and *GRACE* does not primarily increase soil moisture at known landslide events.

Possible reasons: coarse scale (~36 km), satellite data quality, meteorological forcing possibly rather overestimating rainfall (i.e. satellite corrections decrease soil moisture).

SMAP data assimilation product (Soil Moisture Active Passive, L4) has more of a tendency to increase soil moisture at known landslide events. (not shown)

Possible reasons: finer spatial resolution (~9 km), better quality of satellite data, corrected meteorological forcing.

Reichle et al. (2018),
doi: https://doi.org/10.5067/KPJNN2GI1DQR. [01-2020]

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