Data Assimilation of Remotely Sensed Soil Moisture in Hydrological Modeling to Improve Flood Forecasting

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Background of the problem

- Data assimilation of soil moisture in hydrological models can improve flood forecasting in situations where rainfall is the primary driver of river flows instead of snowmelt

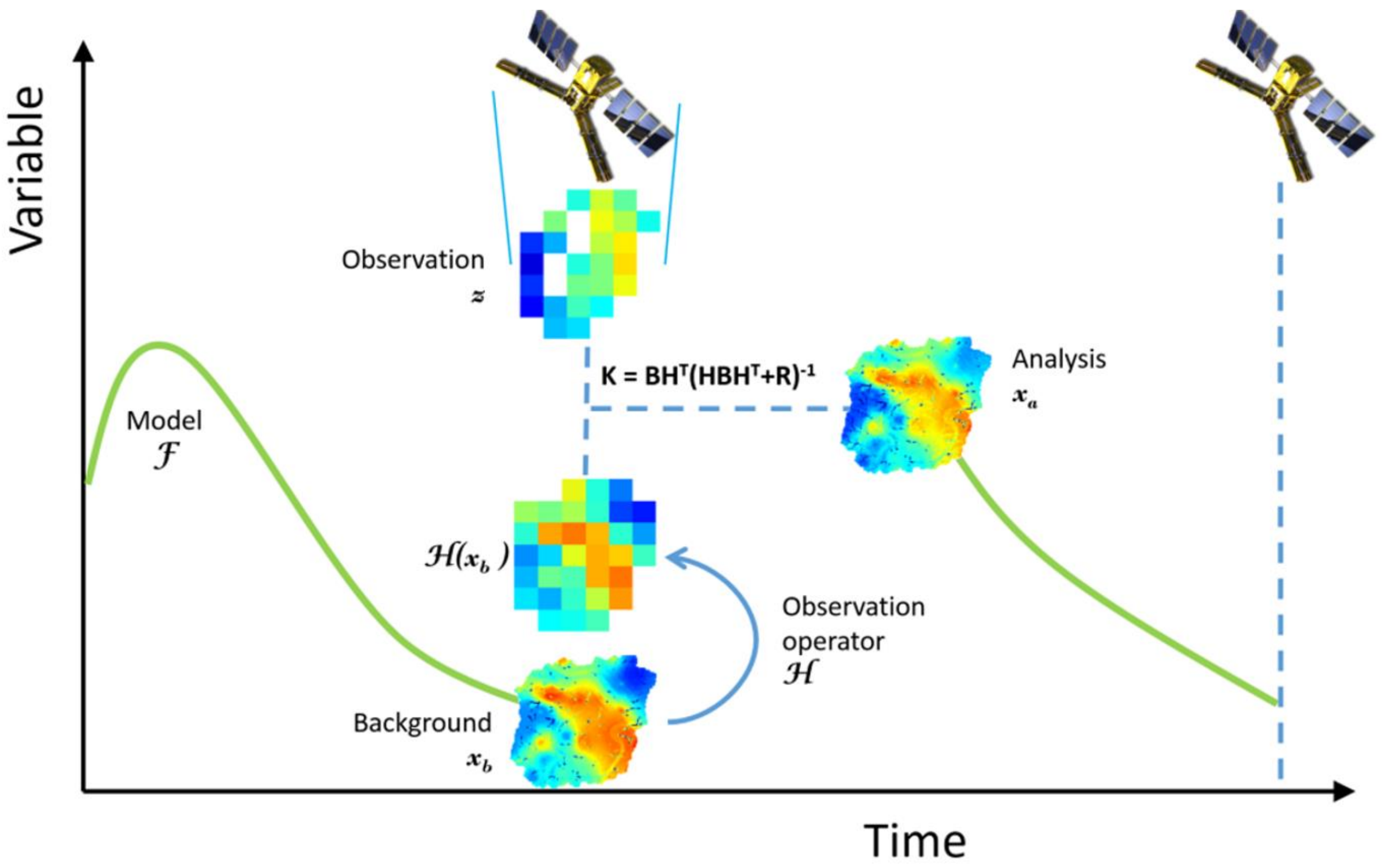


Figure: Visual summary of data assimilation procedure (Leroux & Pellarin, 2016)

- Yet some of the challenges commonly plaguing data assimilating of remotely sensed soil moisture in hydrological modeling are:
  - ➢ Vertical extrapolation of satellite soil moisture

    Satellite derived soil moisture can only measure the top few centimeters of soil, while moisture in the subsurface root-zone has a more important role to play in streamflow simulation. A possible solution is to first estimate subsurface soil moisture from surface information and then assimilate the estimated subsurface information in hydrological models
  - ➢ Spatial interpolation/extrapolation of satellite soil moisture

    Spatial discontinuity of data may occur if the study watershed is larger than what the satellite footprint can cover during one pass or there is dense vegetation within the satellite covered regions making soil moisture estimates over those regions too biased to be useful. A possible solution is to first interpolate/extrapolate satellite derived soil moisture then assimilate the estimated information in hydrological models

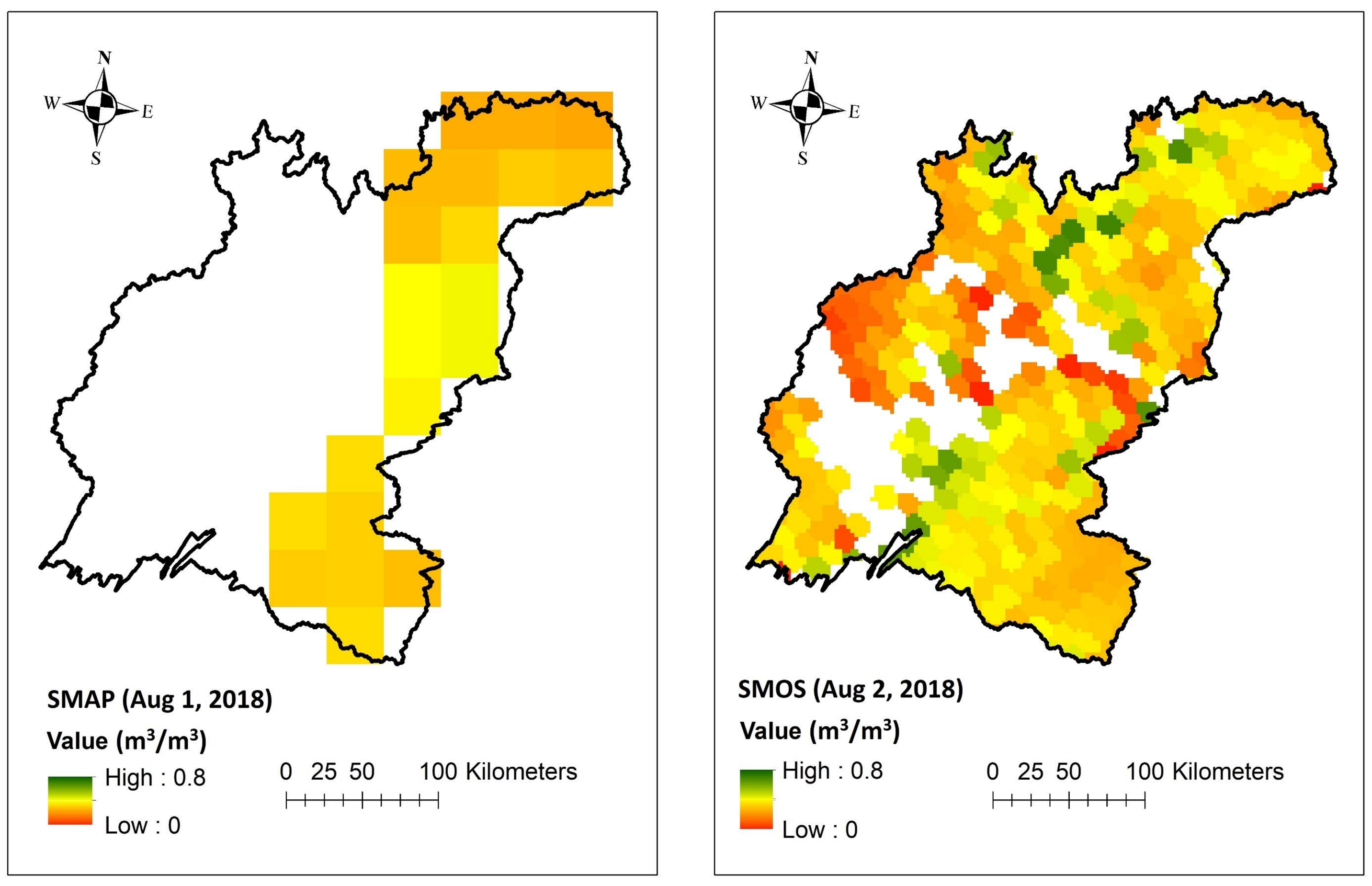
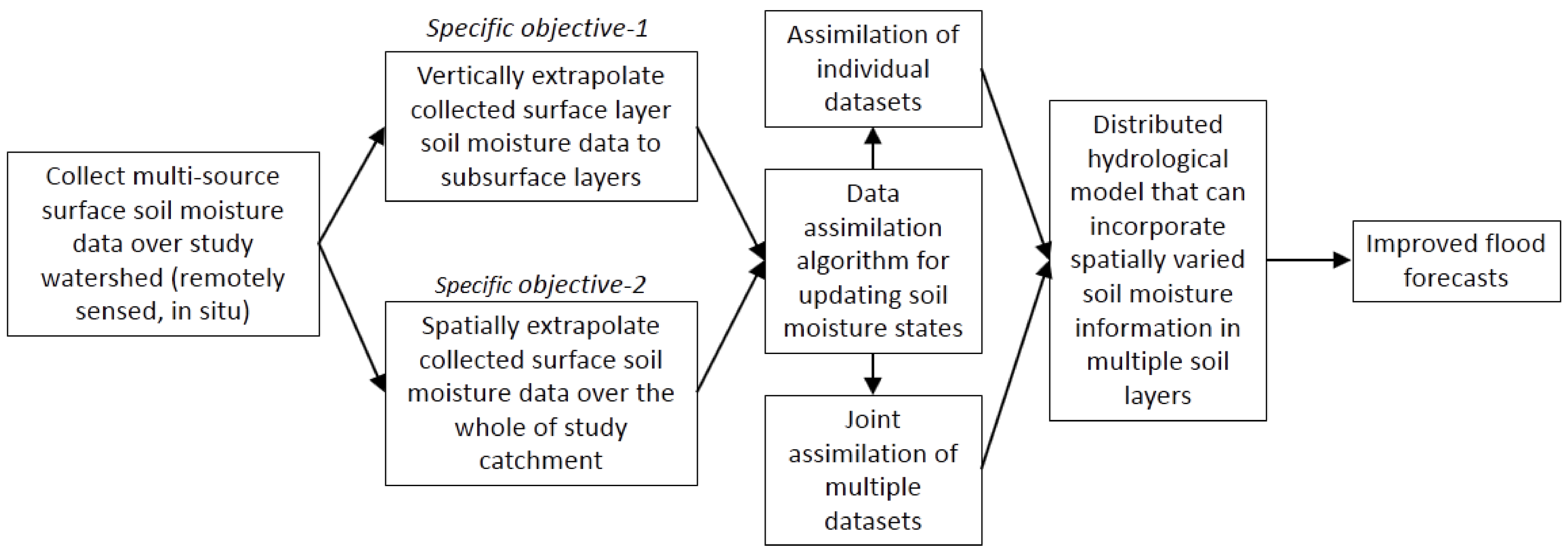


Figure: Example of spatial limitations of satellite soil moisture data (Susquehanna basin)

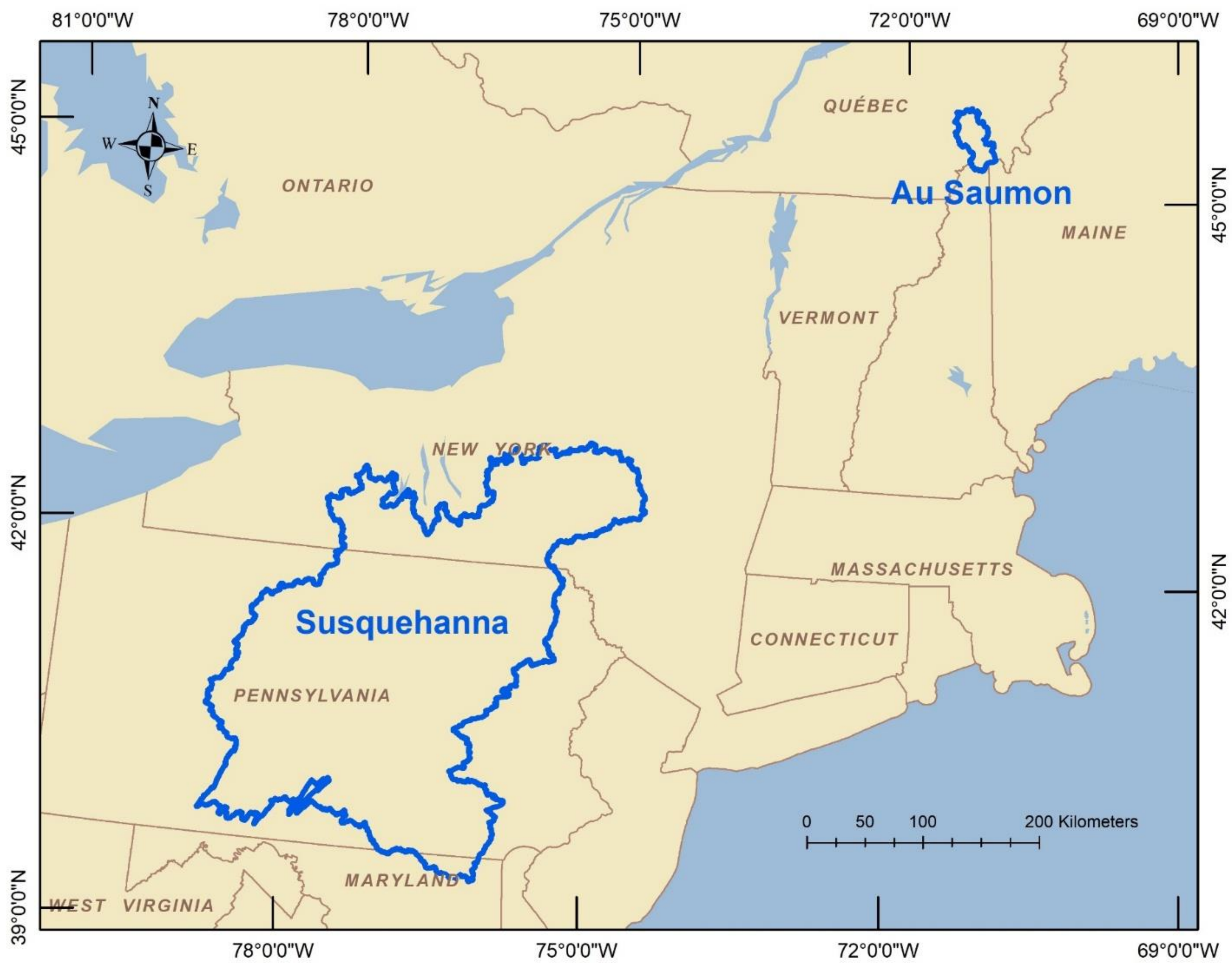
Proposed objectives

- To compare the performances between empirical, physically based and AI based methods for estimating subsurface soil moisture from surface soil moisture information, and to evaluate the performance of these estimated data through data assimilation for improving flood forecasts.
- To compare the performances of geostatistical, non-geostatistical and AI based methods for spatially interpolating/extrapolating remotely sensed soil moisture data, and to use these interpolated/extrapolated data to evaluate their comparative performance through data assimilation for improving flood forecasts.

Proposed methodology

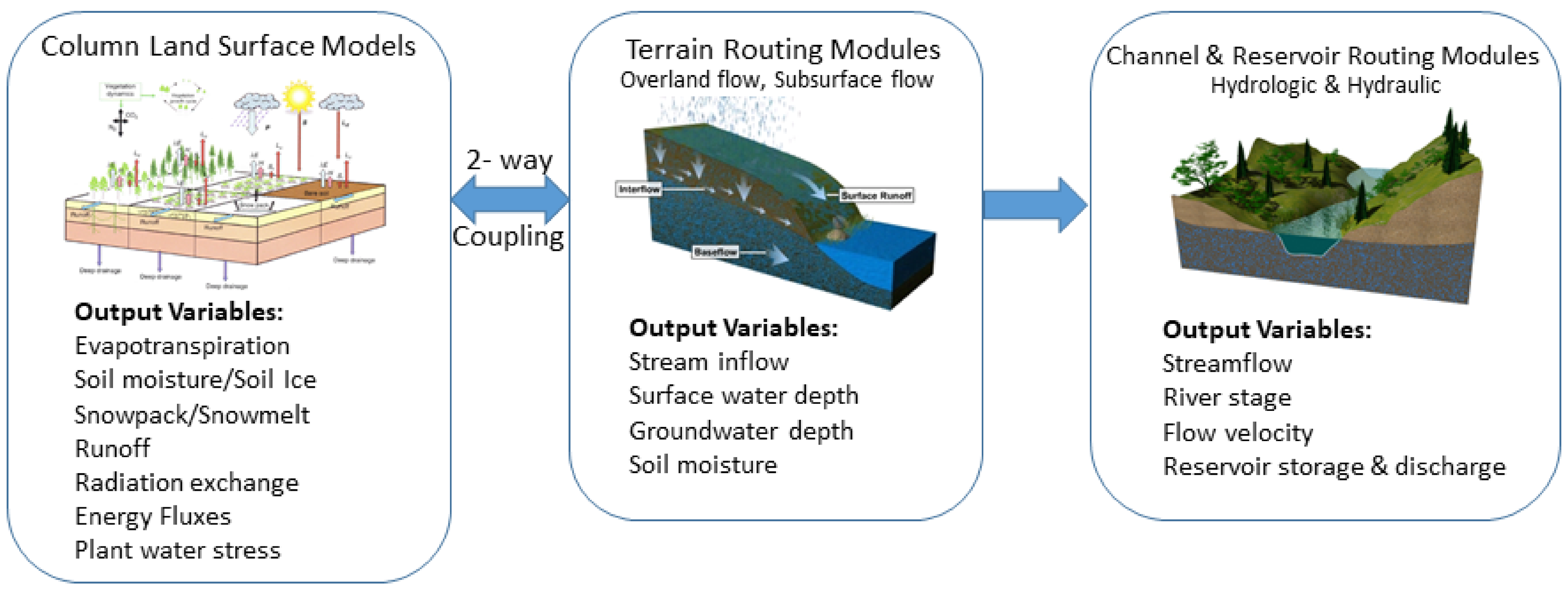


Study area



Watershed	Area (km²)	Lakes (%)	Forest (%)	Agriculture (%)
Susquehanna	71,225	2.89	58.83	31.63
Au Saumon	1,022	0.99	88.79	8.69

Hydrological model (WRF-Hydro)



Satellite soil moisture data

Property	AMSR-2	SMOS	SMAP (passive)	Sentinel-1	RADARSAT-2	RCM
Frequency	6.9-89 GHz	1.4 GHz	1.41 GHz	5.4 GHz	5.4 GHz	5.4 GHz
Spatial resolution	25-50 km	35-60 km	40 km	5-20 m	3-10 m	3-10 m
Temporal resolution	1 day	1-3 days	1-3 days	3-12 days	24 days	4 days
Swath	1445 km	1000 km	1000 km	20-400 km	50-500 km	20-500 km
Altitude	700 km	758 km	685 km	700 km	798 km	586-615 km
Data availability	2012-present	2010-present	2015-present	2014-present	2007-present	2019-present

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