SWAMPS

Surface WAter Microwave Product Series

Version 2.0

This dataset is accessible through the Inundated Wetlands Earth System Data Record Project URL: http://wetlands.jpl.nasa.gov

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R Schroeder, K C McDonald, M Azarderakhsh, T J Bohn, B Chapman, K Jensen, J S Kimball, E Podest, N Steiner, Z Tessler, R Zimmermann and M Küppers (2014) "Development and Evaluation of a Multi-year Inundated Land Surface Data Set Derived from Active/Passive Microwave Remote Sensing Data: Assembly of a Global-scale Inundated Wetlands Earth System Data Record." In preparation

Dataset Description

This dataset provides an initial release of the global time series inundated area fraction dataset component of the NASA Inundated Wetlands Earth System Data Record (ESDR)

(http://wetlands.jpl.nasa.gov). Passive microwave data from the Special Sensor Microwave Imager (SSM/I, v1) and the Special Sensor Microwave Imager/Sounder (SSMIS, v2) (Armstrong et al. 1994), and microwave radar backscatter from ESA's European Remote Sensing (ERS), NASA's SeaWinds-on-QuikSCAT (QSCAT) and ESA's Advanced Scatterometer (ASCAT) provide the basis for the construction of this global time series inundated area fraction dataset (Fig 1). The Boston University MOD12Q1 V004 (BU-MODIS) Land Cover Product (Knowles 2004) provides ancillary land cover information to support determination of the potential global domain of open water impacted land, and land cover-specific parameterization supporting implementation of a dynamic mixture model. The version 2.0 dynamic mixture models accounts for atmospheric variability through the use of Modern-Era Retrospective Analysis for Research and Application (MERRA) reanalysis of Rienecker et al. (2011) providing hourly estimates of total water vapor, total cloud liquid water and 2 m wind speed. A complete description of the algorithm supporting derivation of this dataset is provided by Schroeder *et al.* (2014 in prep).

This version 2.0 of the FW dataset extends from January 1, 1992 to March 31, 2013 (Fig 2). The dataset is global in extent, provided for land area for periods with non-frozen surface conditions, no snow cover, and during times with no precipitation (Fig 3). The dataset is suitable for hydrologic assessment, global change-related investigation, and a variety of other research applications that utilize information on surface water dynamics. The FW dataset is considered research data. Although extensive quality checks have been carried out on this dataset, uncertainty analyses are ongoing and users are advised to verify that data quality is suitable for their purposes.

Comments and feedback should be directed to the Principal Investigator of the Inundated Wetlands ESDR project, Kyle McDonald: kmcdonald2@ccny.cuny.edu

Technical questions concerning use of these data may be directed to Ronny Schroeder: rschroeder@ccny.cuny.edu

Data and Map Projection Formats

The fractional water (FW) dataset is provided on a 25 km global cylindrical (ml) and northern hemisphere azimuthal (nl) Equal Area Scalable Earth grid (EASE-grid) (see http://nsidc.org/data/ease/ for a detailed description of the original EASE-grid ml and nl map projections).

Each individual, daily data file of this time series is a one-band (flat), floating point-type, binary file. Pixel resolution for the global (northern hemisphere) data is 1383 (721) columns/samples by 586 (721) rows/lines. Byte order is little endian (Intel).

Valid (FW) Data Range: 0.-1. (Dynamic)
Invalid Data/ Outside of Domain: -9999. (Dynamic/Static)
Snow Cover/Frozen Ground: -999. (Dynamic)
Precipitation: -99. (Dynamic)

Geolocating EASE-Grids in ENVI

The following web link describes how to geolocate the global (ml)/northern hemisphere (nl) EASE-grids using the ENVI software:

http://nsidc.org/data/ease/geolocate/index.html

File Naming Convention

{*YEAR*}{*MONTH*}{*DAY*}_SSMI_{*VERSION*}_{*RADAR*}_FW.DAT

The *YEAR* string contains four digits (**1992**-**2013**). *MONTH* string contains two digits (**01**-**12**). *DAY* string contains two digits (**01**-**31**). The passive microwave brightness temperature SSM/I *VERSION* string contains 2 characters (**V1** or **V2**) (refer to http://nsidc.org/data/nsidc-0032 for more details concerning the interpolation scheme in use for SSM/I V1 and V2 data versions, Fig 2). The *RADAR* string contains multiple characters (**ERS**, **QSCAT** or **ASCAT**) which correspond to the concurrent active microwave radar backscatter time series in use.

Product Naming Convention

FW_{*WINDOW SIZE*}_SWE

Large amounts of liquid water within melting snow packs can lead to the erroneous retrieval of high surface water fractions (FW). As a result, we derived for all grid cells identified as frozen snow, the daily snow water equivalent (SWE). Daily estimates of SWE were then temporally smoothed via 28-, 14-, 06-, 02- or 00-day long sliding mean time domain filter to allow for gap filling of previously unidentified grid cells of wet snow packs common during periods of temporary snow melt and winter warm periods.

The *WINDOW SIZE* string contains two digits (**00, 02, 06, 14,** or **28**) which corresponds to the length of the time domain filter [in days, centered on current day] over which daily SWE was smoothed. 00-day FW product removes pixels identified as frozen snow only. Research shows that the 14-day FW product may be optimal for the study of surface water dynamics in landscapes with characteristically large snow packs and relatively brief summer snow-free periods.

FW Domain (/ancil folder contents)

The domain of this dataset is the global land surface limited to regions with less the 100% permanent open water (i.e. large lake bodies and ocean), permanent snow and ice cover (i.e. glaciers and ice sheets) and urban/built-up area (i.e. densely populated metropolitan areas). To define the domain of this dataset, we used the Boston University high-resolution 1 km MOD12Q1 V004 (BU-MODIS) Land Cover Product (Knowles 2004). The file in the ancil folder (/ancil) provides a binary mask file corresponding to the FW dataset domain.

'**FW_ML_DOMAIN.DAT**' ('**FW_NL_DOMAIN.DAT**') is a one-band (flat), byte-type, binary mask file with 1383 (721) columns and 586 (721) rows. Byte order is little endian (Intel).

Valid data range: 0 or 1 with zero (0) being outside of the FW domain (static)
Invalid data: not defined

Accuracy and Quality Check

The open water fraction dataset has been extensively compared to open water and inundated area products from BU-MODIS, MOD44W, JERS-1 and ALOS-PALSAR and show general spatial agreement. Open water fraction can be greater than that provided by MODIS/MOD44W because of seasonally varying flooding and saturated soils. The mixture model employed in derivation of the FW dataset has limitations when applied to barren (desert) regions with associated retrieval errors being common in these regions. Also, dense vegetation canopies attenuate microwave radiation significantly and may hinder identification of surface water, such as in regions along tributaries of the Amazon River, leading to an underestimation of surface water fraction. A quality control (QC) map was developed to provide a probabilistic indicator of estimated retrieval quality relative to daily sensor coverage, land cover composition, topographic variability and the likelihood of correctly identified seasonal wet and dry periods (Fig 4).

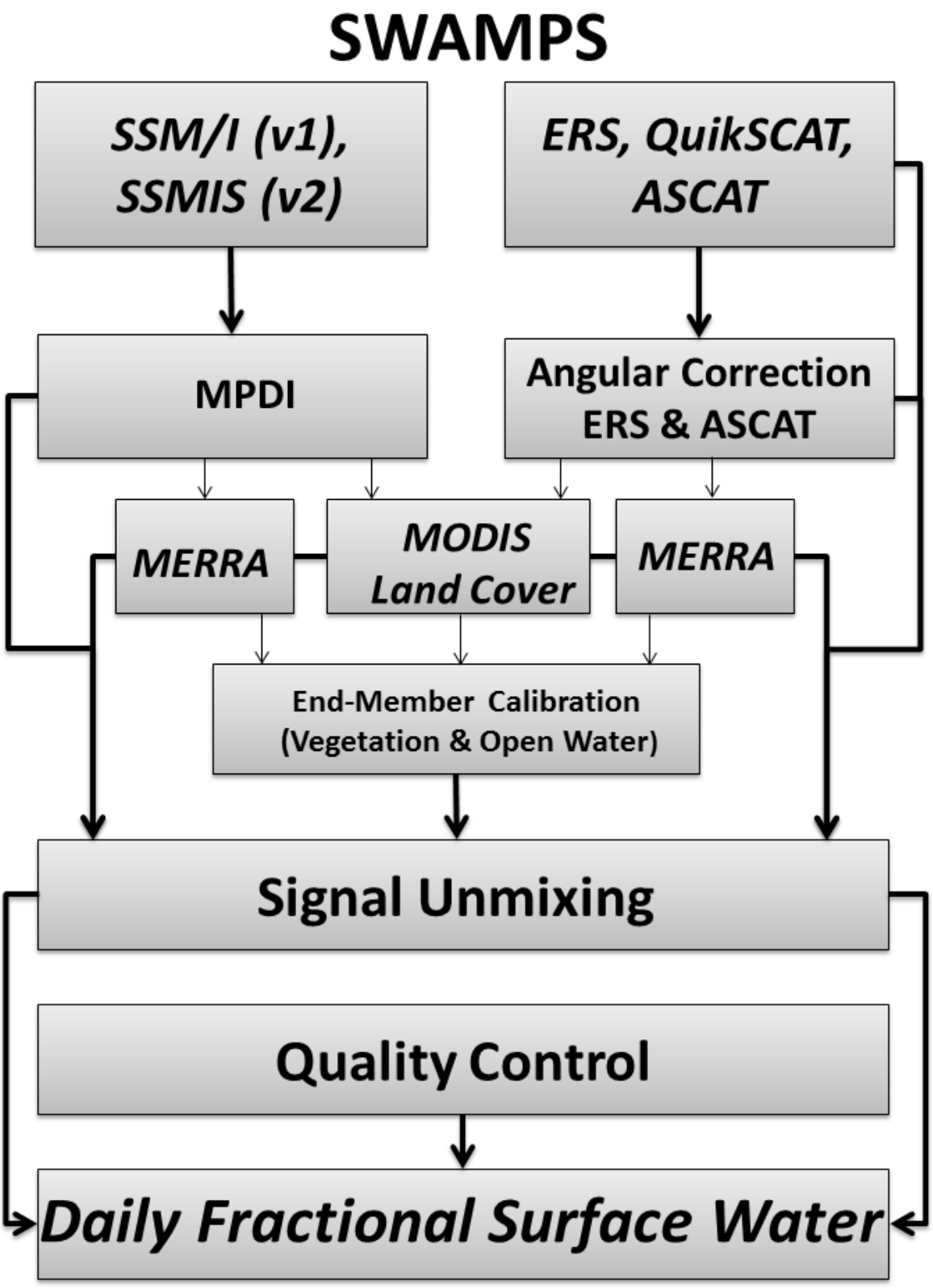


Figure 1 Flow chart of the SWAMPS surface water fraction retrieval scheme including the calibration of vegetation and open water end-members and post-product quality control (QC).

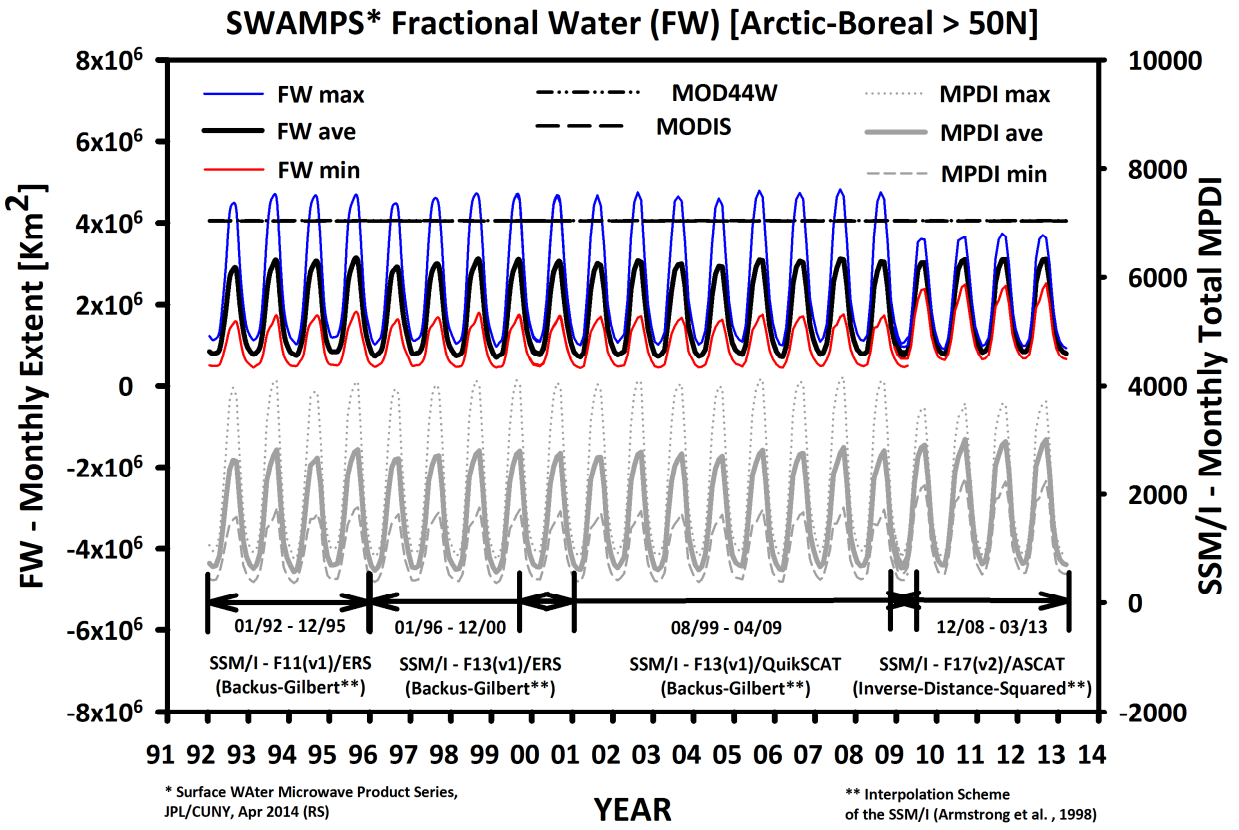
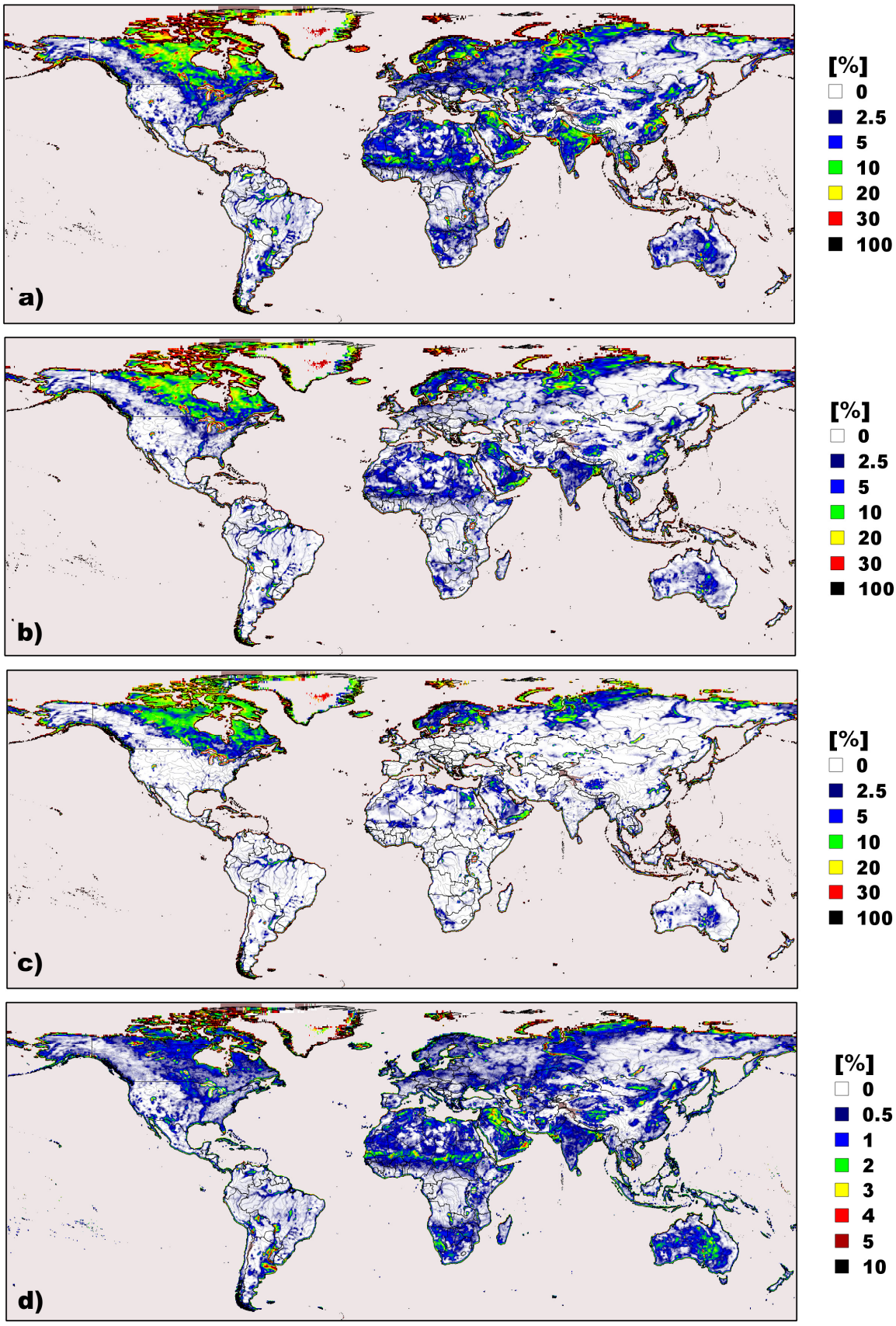


Figure 2 Seasonal progression of monthly FW extents (km^2) from SWAMPS and the total MPDI in the Arctic-Boreal domain (> 50°N) as generated from monthly maximum (FW_{max}, $MPDI_{max}$) average (FW_{ave}, $MPDI_{ave}$) and minimum (FW_{min}, $MPDI_{min}$) records for the study period (1992-2013). The Arctic-Boreal FW extent from static measures of FW from the MOD44W and MODIS including Wetlands products are shown for comparison. Note that the v2-ASCAT FW_{max} (FW_{min}) FW extent is notably lower (higher) than from corresponding FW records of v1-ERS and v1-QSCAT. This discrepancy coincides with lower (higher) total monthly $MPDI_{max}$ ($MPDI_{min}$) v2-SSM/I MPDI and associated change in the interpolation scheme of the SSM/I. FW_{max}, FW_{ave}, FW_{min} and $MPDI_{max}$, $MPDI_{ave}$, $MPDI_{min}$ has been plotted from all record periods including simultaneous measurements taken during period overlap from July 1999 through December 2000 (v1-ERS and v1-QSCAT; 18 months) and from November 2008 through April 2009 (v1-QSCAT and v2-ASCAT; 6 months).


a)
[%]
0
2.5
5
10
20
30
100
b)
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2.5
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20
30
100
c)
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0
2.5
5
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20
30
100
d)
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0
0.5
1
2
3
4
5
10

Figure 3 Maps of the average annual maximum (a), mean (b), minimum (c) fractional water extent and associated standard deviation of the annual means (d) over the global domain as determined from combined, v1-ERS (1992-1999) and v1-QSCAT (2000-2008) monthly means. Areas in light grey are outside of the domain, while areas in dark grey represent snow-covered regions.

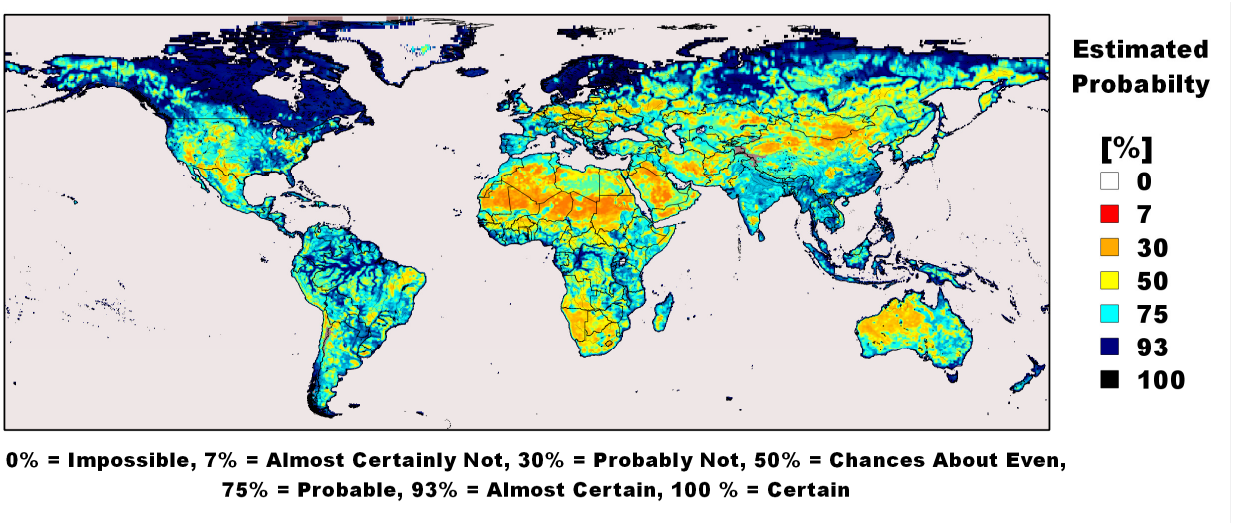

Figure 2 A quality control map was developed to provide a probabilistic indicator of estimated FW retrieval quality relative to daily sensor coverage, land cover composition, topographic variability and the likelihood of correctly identified seasonal wet and dry periods. Areas in light grey are outside of the domain, while areas in dark grey represent snow-covered regions.

Acknowledgements

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