

**Collection 6.1 MODIS Global Reservoir Product User's Guide
Version 1.2**

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August 2021

Document Change History Log

| Revision | Date | Prepared by | Description |
|-----------------|-------------|--------------------|----------------------------------|
| Draft (1.0) | 12/2020 | Huilin Gao | User Guide first draft for MxD28 |
| Draft (1.1) | 07/2021 | Huilin Gao | Revised known problems |
| Draft (1.2) | 08/2021 | Huilin Gao | Updated script in Appendix D |

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1. Introduction

This document provides the most current information about the NASA Moderate Resolution Imaging Spectroradiometer (MODIS) Collection 6 Global Water Reservoir product from both Terra (MOD28) and Aqua (MYD28) satellites. This product provides data for 164 reservoirs (Figure 1), which includes 151 man-made reservoirs (2,672 km³) and 13 regulated natural lakes (23,801 km³). The total storage capacity of the 151 man-made reservoirs represents 45.82% of the global capacity (in its category) according to the Global Reservoir and Dam (GRanD) database (Lehner et al., 2011). More details about these reservoirs and their attributes are provided in Appendix A.

For each reservoir, the results (from both Terra and Aqua) are presented at two temporal resolutions: 8-day and monthly (Table 1). The surface area, elevation, and storage values are available at both 8-day and monthly; while the evaporation rate and volumetric evaporation are only available at monthly intervals. This document is intended to provide the end user with practical information about how to use these products.

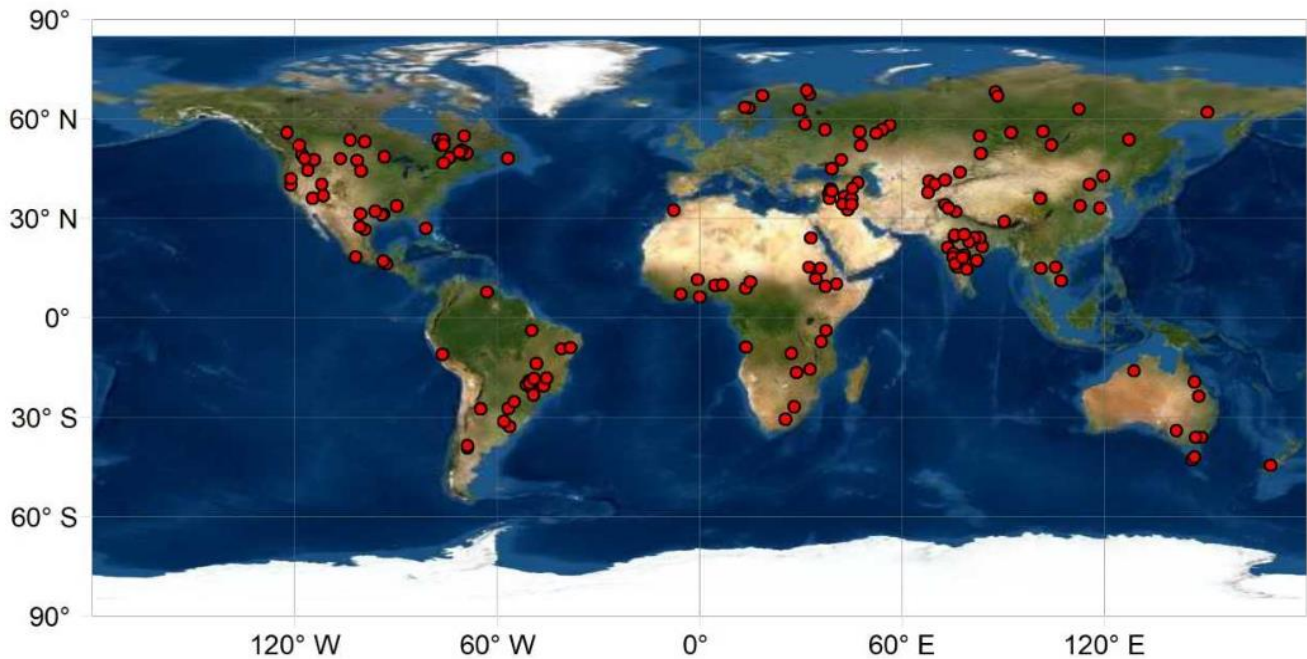


Figure 1. Locations of the 164 global reservoirs contained in this product.

Table 1. Summary of the MxD28 Global Water Reservoir product

| Terra/ Aqua Product ID | Temporal Resolution | Variables |
|------------------------|---------------------|--|
| MOD28C2/MYD28C2 | 8-day | Area, elevation, and storage |
| MOD28C3/MYD28C3 | Monthly | Area, elevation, storage, evaporation rate, volumetric evaporation |

2. MODIS Reservoir Product (MxD28) Algorithm Summary

2.1 MxD28C2 Algorithm

Figure 2 shows the algorithm for generating the MxD28C2 8-day product, which is described in more detail in Li et al. (in preparation). First, the 8-day reservoir area values are extracted from the 250-m Near Infrared (NIR) bands of MODIS Terra/Aqua surface reflectance (MOD/MYD09Q1) data. During the classification process, an area enhancement algorithm (after Zhang et al., 2014) is adopted to minimize the effects of various sources of contamination (e.g., cloud and snow/ice). Then, the area values are applied to the Area-Elevation (A-E) relationship—provided by the Global Reservoir Bathymetry Dataset (GRBD, Li et al., 2020)—to calculate the corresponding elevation value. Lastly, the reservoir storage can be estimated using Equation (1) (after Gao et al., 2012):

$$V_{MODIS} = V_c - (A_c + A_{MODIS})(h_c - h_{MODIS})/2 \quad (1)$$

where V_c , A_c , and h_c represent storage, area, and water elevation values at capacity; and V_{MODIS} , A_{MODIS} , and h_{MODIS} are the estimated storage, area, and water elevation from MODIS.

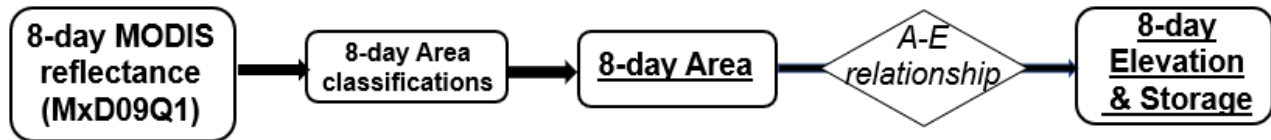


Figure 2. Flow chart of the algorithm for deriving the MxD28C2 product, which contains 8-day area, elevation, and storage results for the 164 reservoirs. The product components are underlined.

2.2 MxD28C3 Algorithm

Figure 3 shows the algorithm for generating the MxD28C3 monthly product, which is described in detail in Li et al. (2021). The monthly area values are first estimated based on the composite of the 8-day area classifications, and then converted to monthly elevation and storage results. In addition, monthly evaporation rates are calculated after the Lake Temperature and Evaporation Model (LTEM) (Zhao et al., 2020) using MODIS LST product (MOD21) and meteorological data from Global Land Data Assimilation System (GLDAS). Lastly, monthly evaporative volumetric losses were calculated as the product of evaporation rate and reservoir area values.

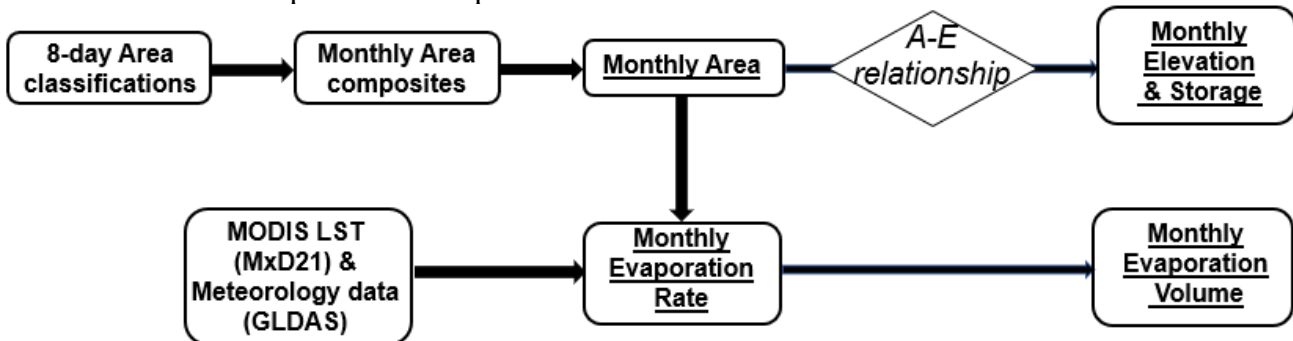


Figure 3. Flow chart of the algorithm for deriving the MxD28C3 product, which contains monthly area, elevation, storage, evaporation rate, and volumetric evaporation loss results for the 164 reservoirs. The product components are underlined.

3. MxD28 Global Water Reservoir Product Suite

3.1 Level 2 8-day Product (MxD28C2)

The MxD28C2 reservoir product contains the 8-day results of the reservoir area, elevation, and storage.

3.1.1 Naming Convention

The file naming convention is as follows:

MxD28C2.AYYYYDDD.061.YYYYDDDDHHMMSS.hdf

where,

MxD = either MOD or MYD. MOD stands for the Terra product, and MYD stands for the Aqua product.

YYYY= Year mapped

DDD = Start day of the year (Julian day) at the 8-day interval (see Table 2 for converting to calendar date)

061 = Collection 6.1

YYYYDDDDHHMMSS = Production time

Example: The product file MOD28C2.A2012161.061.2020323115311.hdf contains the Collection 6.1 reservoir results based on MODIS data (onboard of Terra) started on June 9, 2012 (with MODIS data collected during the 8-DAY period of June 9-16, 2012). The file was produced on November 18, 2020 at 11:53:11 UTC.

Table 2. Lookup table for converting the start date of the 8-day file from Julian Day to the calendar date

| DDD (8-day interval*) (Regular Years) | Corresponding Month and Day (Regular Years) | DDD (8-day interval) (Leap Years) | Corresponding Month and Day (Leap Years) |
|--|--|--|---|
| 001, 009, 017, 025 | Jan. 1, Jan. 9, Jan 17, Jan 25 | 001, 009, 017, 025 | Jan. 1, Jan. 9, Jan 17, Jan 25 |
| 033, 041, 049, 057 | Feb. 2, Feb. 10, Feb. 18, Feb. 26 | 033, 041, 049, 057 | Feb. 2, Feb. 10, Feb. 18, Feb. 26 |
| 065, 073, 081, 089 | Mar. 6, Mar. 14, Mar. 22, Mar. 30 | 065, 073, 081, 089 | Mar. 5, Mar. 13, Mar. 21, Mar. 29 |
| 097, 105, 113 | Apr. 7, Apr. 15, Apr. 23 | 097, 105, 113, 121 | Apr. 6, Apr. 14, Apr. 22, Apr. 30 |
| 121, 129, 137, 145 | May 1, May 9, May 17, May 25 | 129, 137, 145 | May 8, May 16, May 24 |
| 153, 161, 169, 177 | Jun. 2, Jun. 10, Jun. 18, Jun. 26 | 153, 161, 169, 177 | Jun. 1, Jun. 9, Jun. 17, Jun. 25 |
| 185, 193, 201, 209 | Jul. 4, Jul. 12, Jul. 20, Jul. 28 | 185, 193, 201, 209 | Jul. 3, Jul. 11, Jul. 19, Jul. 27 |
| 217, 225, 233, 241 | Aug. 5, Aug. 13, Aug. 21, Aug. 29 | 217, 225, 233, 241 | Aug. 4, Aug. 12, Aug. 20, Aug. 28 |

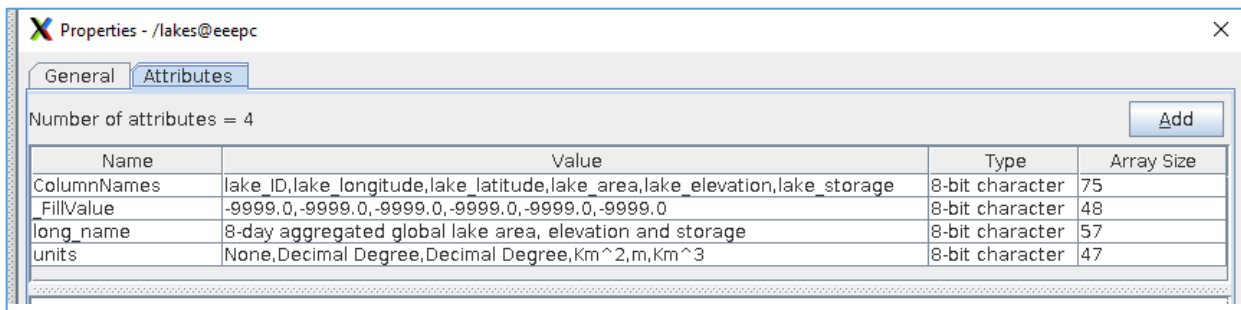
| | | | |
|---------------------------------|--|---------------------------------|--|
| 249, 257, 265, 273 | Sep. 6, Sep. 14, Sep. 22, Sep. 30 | 249, 257, 265, 273 | Sep. 5, Sep. 13, Sep. 21, Sep. 29 |
| 281, 289, 297 | Oct. 8, Oct. 16, Oct. 24 | 281, 289, 297, 305 | Oct. 7, Oct. 15, Oct. 23, Oct. 31 |
| 305, 313, 321, 329 | Nov. 1, Nov. 9, Nov. 17, Nov. 25 | 313, 321, 329 | Nov. 8, Nov. 16, Nov. 24 |
| 337, 345, 353, 361 ¹ | Dec. 3, Dec. 11, Dec. 19, Dec. 27 ¹ | 337, 345, 353, 361 ² | Dec. 2, Dec. 10, Dec. 18, Dec. 26 ² |

¹File with this start date is only based on the MODIS data from the last 5 days of a normal year;

²File with this start date is only based on the MODIS data from the last 6 days of a leap year.

3.1.2 Data Layers

The product contains one single layer named ‘lakes’. This layer contains information about the reservoir id, dam location (longitude and latitude), reservoir area, elevation, and storage. Figure 4 shows the general information about the ‘lakes’ layer displayed using HDFView.



| lake_ID | lake_longitude | lake_latitude | lake_area | lake_elevation | lake_storage |
|---------|----------------|---------------|-------------|-------------------|-----------------|
| 1 | 104.322 | 52.234 | 32014.30... | 455.7564412332... | 23579.316088... |
| 2 | 0.06 | 6.303 | 6405.844... | 78.99326540675... | 90.906088058... |
| 3 | 32.886 | 23.967 | 3691.646... | 170.1183753904... | 94.941647857... |
| 4 | 28.76 | -16.523 | 5358.309... | 484.9481635509... | 177.49038514... |
| 5 | 101.785 | 56.284 | 4601.315... | 398.1411787909... | 140.54076790... |
| 6 | 83.348 | 49.656 | 4271.331... | 390.0682519896... | 22.141223418... |
| 7 | -62.998 | 7.764 | 3941.133... | 273.9318833271... | 116.78024373... |
| 8 | -69.78 | 54.851 | 3374.917... | 530.1157822669... | 11.845852010... |
| 9 | -77.451 | 53.785 | 2751.172... | 174.5277677720... | 56.871232083... |
| 10 | -40.824 | -9.423 | 2781.815... | 391.1519877205... | 30.190956203... |
| 11 | -99.29 | 53.16 | 2624.255... | 256.1901215825... | 9.3899816340... |
| 12 | -75.963 | 53.729 | 3083.142... | 273.5257875084... | 104.40403541... |
| 13 | -49.647 | -3.833 | 2761.637... | 77.45435942828... | 51.020486337... |

Figure 4. General information about the ‘lakes’ layer displayed using HDFView. Top: sample file imported; Middle: metadata attributes; and Bottom: data information contained in the sample file. The Reservoir ID for the last row (not shown) is 164.

3.1.3 Metadata

Detailed description about the metadata can be found in Table 3.

Table 3. List of metadata for MxD28C2

| Column Name | lake_ID | lake_longitude | lake_latitude | lake_area | lake_elevation | lake_storage |
|-------------|-----------------------------------|----------------|----------------|-----------------|----------------|-----------------|
| Fill Value | -9999.0 | -9999.0 | -9999.0 | -9999.0 | -9999.0 | -9999.0 |
| Long name | 8-day aggregated global lake area | | | | | |
| Unit | None | Decimal Degree | Decimal Degree | km ² | m | km ³ |

3.1.4 Example Codes

Example codes (in Matlab and Python) for reading the MxD28C2 hdf files are provided in Appendix B.

3.2 Level 3 Monthly Reservoir Product (MxD28C3)

The MxD28C3 product contains the monthly results of the reservoir area, elevation, storage, evaporation rate, and evaporation volume.

3.2.1 Naming Convention

The file naming convention is as follows:

MxD28C3.AYYYYDDD.061.YYYYDDDDHHMMSS.hdf

where,

MxD = either MOD or MYD. MOD stands for the Terra product, and MYD stands for the Aqua product.

YYYY= Year mapped

DDD = Day-of-year (DOY) of the first day of each calendar month (please see Table 4 for more details)

061 = Collection 6.1

YYYYDDDDHHMMSS = Production time

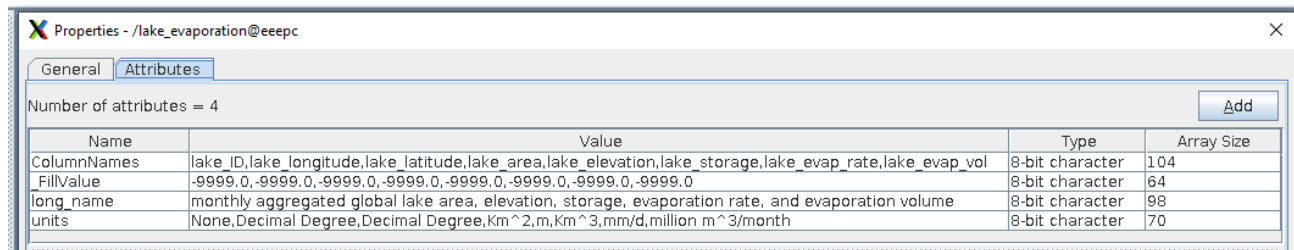
Example: The product file MOD28C3.A2012001.061.2020333100640.hdf contains the Collection 6.1 reservoir results based on MODIS data (onboard of Terra) in January 2012. The file was produced on November 28, 2020 at 10:06:40 UTC.

Table 4. Day-of-year (DOY) of the first day of each calendar month.

| Month | Non-Leap Year Start DOY | Leap Year Start DOY |
|-----------|-------------------------|---------------------|
| January | 1 | 1 |
| February | 32 | 32 |
| March | 60 | 61 |
| April | 91 | 92 |
| May | 121 | 122 |
| June | 152 | 153 |
| July | 182 | 183 |
| August | 213 | 214 |
| September | 244 | 245 |
| October | 274 | 275 |
| November | 305 | 306 |
| December | 335 | 336 |

3.2.2 Data Layers

The product contains one single layer named ‘lake_evaporation’. This layer contains information about the reservoir id, dam location (longitude and latitude), monthly reservoir area, elevation, storage, evaporation rate, and evaporation volume. Figure 5 shows the general information about the ‘lake_evaporation’ layer displayed using HDFView.



| lake_ID | lake_longitude | lake_latitude | lake_area | lake_elevation | lake_storage | lake_evap_rate | lake_evap_vol |
|---------|----------------|---------------|-----------|----------------|--------------|----------------|---------------|
| 1 | 104.322 | 52.234 | 32573.488 | 458.25394 | 23659.97 | 3.5605447 | 3479.3809 |
| 2 | 0.06 | 6.303 | 6398.7603 | 78.96738 | 90.740326 | 4.7594395 | 913.6354 |
| 3 | 32.886 | 23.967 | 3891.6008 | 171.05533 | 98.49423 | 8.277407 | 966.37085 |
| 4 | 28.76 | -16.523 | 5592.556 | 487.56955 | 191.84363 | 4.7328515 | 794.06213 |
| 5 | 101.785 | 56.284 | 6140.526 | 408.2501 | 194.83492 | 2.4113657 | 444.2116 |
| 6 | 83.348 | 49.656 | 4402.5957 | 390.67865 | 24.7885 | 4.9828753 | 658.12756 |
| 7 | -62.998 | 7.764 | 4198.67 | 277.64124 | 131.877 | 6.181749 | 778.6537 |
| 8 | -69.78 | 54.851 | 4471.5547 | 543.4764 | 64.26275 | 1.3763369 | 184.63097 |
| 9 | -77.451 | 53.785 | 3303.6506 | 180.6601 | 75.43632 | 1.3805424 | 136.82489 |
| 10 | -40.824 | -9.423 | 2815.4094 | 391.3438 | 30.727795 | 5.6935124 | 480.88705 |
| 11 | -99.29 | 53.16 | 2264.4343 | 255.40887 | 7.480362 | 4.389555 | 298.19577 |
| 12 | -75.963 | 53.729 | 2981.2869 | 270.94012 | 96.56375 | 1.3361756 | 119.50568 |
| 13 | -49.647 | -3.833 | 3138.4707 | 82.4347 | 65.71276 | 4.381322 | 412.5195 |
| 14 | 42.11 | 47.61 | 2357.0059 | 35.377224 | 13.590457 | 5.9836955 | 423.10815 |
| 15 | 127.307 | 53.771 | 2593.5598 | 319.98926 | 77.3835 | 2.8863337 | 224.57637 |
| 16 | 112.477 | 63.034 | 2684.0383 | 259.2802 | 71.47633 | 3.088728 | 248.70793 |

Figure 5. General information about the ‘lake_evaporation’ layer displayed using HDFView. Top: sample file imported and metadata attributes; and Bottom: data information contained in the sample file. The Reservoir ID for the last row (not shown) is 164.

3.2.3 Metadata

A detailed description of the metadata can be found in Table 5.

Table 5. List of metadata for MxD28C3

| Column Name | lake_ID | lake_longitude | lake_latitude | lake_area | lake_elevation | lake_storage | lake_evap_rate | lake_evap_vol |
|-------------|-------------------------------------|----------------|----------------|-----------------|----------------|-----------------|----------------|-------------------------------|
| Fill Value | -9999.0 | -9999.0 | -9999.0 | -9999.0 | -9999.0 | -9999.0 | -9999.0 | -9999.0 |
| Long name | monthly aggregated global lake area | | | | | | | |
| Unit | None | Decimal Degree | Decimal Degree | km ² | m | km ³ | mm/d | million m ³ /month |

3.2.4 Example codes

Example codes (in Matlab and Python) for reading the MxD28C3 hdf files are provided in Appendix C.

4. Known Problems

The reliability of the enhancement algorithm depends on the data quality of both water occurrence image and raw water classification. In high latitude regions, the water occurrence image generally shows small surface area dynamics (i.e., the distribution of occurrence values highly skewed to the left). Thus, the pixels with low occurrence values have relatively large uncertainties. In addition, the quality of raw water area classification can be affected by the lake ice coverage. Under such conditions, the enhancement algorithm might generate an incorrect threshold value, typically leading to overestimation of the surface area. This issue will be addressed in a future release of the enhancement algorithm. For the current version, to address this issue in time series analysis, an “outlier removal and gap-filling” script (Appendix D) is applied on the 8-day surface area time series. The outliers are identified using two criteria. The first uses the biases between the area values and their moving averages. If the bias of an area value falls more than 3 standard deviations from the average bias, that area value is considered an outlier. The second one is the area at capacity. If an area value is larger than the capacity value, it is removed as an outlier. When an area outlier is removed, its corresponding elevation and storage values are also removed. The area value data gaps are then filled in via interpolation. Afterwards, the missing elevation and storage data are calculated using the interpolated areas.

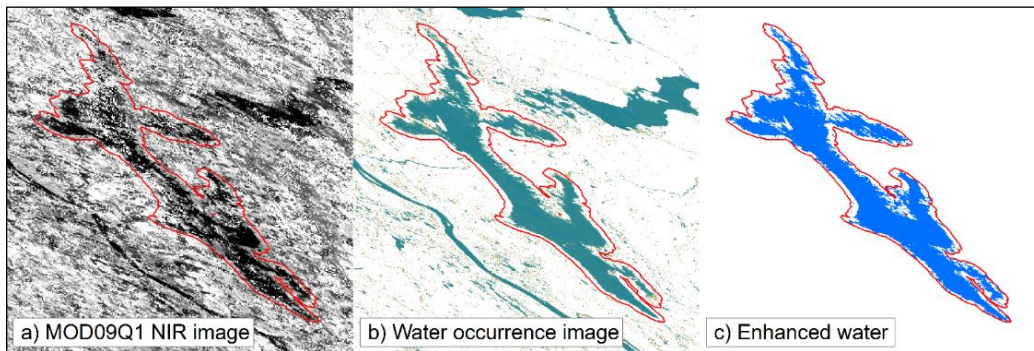


Figure 6. Water classification results for Aug 12, 2012 for Lake Khantayskoye (LAKE_ID: 17). The enhanced water area shows an overestimated water area.

Another problem is that the storage values are sometimes calculated to be negative—in which case they are reassigned to zero in the product. This is attributed to the following: First, some reservoir capacity values only include the live capacity (and not the dead storage capacity—i.e. the portion of the reservoir capacity that is not used for operational purposes). Therefore, the calculated storage value will be negative when the water surface level is below the dead storage level. The second reason is attributed to the uncertainty of the A-E relationship. If the estimated slope is steeper than the actual condition, negative values can happen when the water area values decrease beyond a certain threshold. It should be noted, however, that these zero values only occur occasionally (when the water level is very low) in a small number of specific reservoirs.

5. Relevant Web and FTP Sites

- MODIS Reservoir Product Overview: General information about the MODIS water reservoir products, with user guide and Algorithm Theoretical Basic Document (ATBD) is provided.
<https://modis-land.gsfc.nasa.gov/modgwr.html>
- MODIS Reservoir Product Downloading: Websites where MODIS Land products are distributed.
<https://lpdaac.usgs.gov/> and <https://ladsweb.modaps.eosdis.nasa.gov/>
- Software for visualizing MODIS Reservoir Product: HDFView can be used for viewing the product files and metadata.
<https://www.hdfgroup.org/downloads/hdfview/>
- Tools for post-processing MODIS Reservoir Product: Scripts from the science team to assist the users to further process the product (e.g., removing outliers from time series).
<https://dataverse.tdl.org/dataverse/HGao>
- MODIS Reservoir Product Validation:
(Note: link for publication will be provided later)
- MODIS LDOPE Tools: A collection of programs, written by members of the Land Data Operational Product Evaluation (LDOPE) group, to assist in the analysis and quality assessment of MODIS Land (MODLAND) products.
<https://ladsweb.modaps.eosdis.nasa.gov/tools-and-services/#ldope>

6. References

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Lehner, B., Liermann, C. R., Revenga, C., Vörösmarty, C., Fekete, B., Crouzet, P., ... & Nilsson, C. (2011). High-resolution mapping of the world's reservoirs and dams for sustainable river-flow management. *Frontiers in Ecology and the Environment*, 9(9), 494-502.

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Zhang, S., Gao, H., & Naz, B. S. (2014). Monitoring reservoir storage in South Asia from multisatellite remote sensing. *Water Resources Research*, 50(11), 8927-8943.

Zhao, G., Gao, H., & Cai, X. (2020). Estimating lake temperature profile and evaporation losses by leveraging MODIS LST data. *Remote Sensing of Environment*, 251, 112104.

Appendix A - List of the 164 Reservoirs and their Attributes

| Lake ID | GRanD_id ¹ | Reservoir Name | lon, lat (°) | Country | Continent | A-E Coefficients ² a, b | Storage capacity (km ³) | Area capacity (km ²) | Elevation capacity (m) | Capacity Source ³ |
|---------|-----------------------|---------------------------|---------------|------------|---------------|---------------------------------------|-------------------------------------|----------------------------------|------------------------|------------------------------|
| 1* | 5058 | Baikal | 104.32, 52.24 | Russia | Asia | 0.00447, 312.77026 | 23615.39 | 32265.61 | 456.88 | GRanD |
| 2 | 3667 | Volta | 0.06, 6.3 | Ghana | Africa | 0.00365, 55.58562 | 148 | 8502 | 86.65 | wikipedia |
| 3 | 4478 | Nasser | 32.89, 23.97 | Egypt | Africa | 0.00469, 152.81994 | 162 | 6500 | 183.28 | literature |
| 4 | 4056 | Kariba Reservoir | 28.76, -16.52 | Zambia | Africa | 0.01119, 424.98467 | 180 | 5400 | 485.41 | wikipedia |
| 5 | 5055 | Bratsk Reservoir | 101.78, 56.29 | Russia | Asia | 0.00657, 367.92163 | 169.27 | 5470 | 403.85 | wikipedia |
| 6 | 4787 | Zaysan | 83.35, 49.66 | Kazakhstan | Asia | 0.00465, 370.20585 | 49.8 | 5490 | 395.74 | GRanD |
| 7 | 2294 | Guri Reservoir | -63, 7.77 | Venezuela | South America | 0.0144, 217.16716 | 135 | 4250 | 278.38 | wikipedia |
| 8 | 1995 | Caniapiscou Reservoir | -69.78, 54.85 | Canada | North America | 0.01218, 488.99841 | 53.79 | 4275 | 541.08 | GRanD |
| 9 | 1394 | Robert Bourassa Reservoir | -77.45, 53.79 | Canada | North America | 0.0111, 143.99061 | 61.7 | 2905 | 176.24 | Hydro-Québec |
| 10 | 2516 | Sobradinho Reservoir | -40.82, -9.42 | Brazil | South America | 0.00571, 375.26816 | 34.1 | 3017.9 | 392.5 | GRanD |
| 11 | 712 | Cedar | -99.29, 53.16 | Canada | North America | 0.00217, 250.49224 | 9.64 | 2668.46 | 256.29 | GRanD |
| 12 | 1396 | La Grande 3 Reservoir | -75.96, 53.73 | Canada | North America | 0.02539, 195.25843 | 60 | 2451 | 257.48 | Hydro-Québec |
| 13 | 2365 | Tucuruí Reservoir | -49.65, -3.83 | Brazil | South America | 0.01322, 40.95573 | 45.5 | 2606 | 75.4 | GRanD |
| 14 | 4375 | Tsimlyanskoye Reservoir | 42.11, 47.61 | Russia | Euro | 0.01177, 7.63989 | 23.86 | 2702 | 39.44 | literature |
| 15 | 5834 | Zeyskoye Reservoir | 127.31, 53.77 | Russia | Asia | 0.02065, 266.43675 | 68.4 | 2420 | 316.41 | wikipedia |
| 16 | 5180 | Vilyuy Reservoir | 112.48, 63.03 | Russia | Asia | 0.02852, 182.74156 | 35.9 | 2170 | 244.62 | wikipedia |
| 17 | 4783 | Khantayskoye Reservoir | 87.81, 68.16 | Russia | Asia | 0.00445, 49.76375 | 23.5 | 2221.61 | 59.64 | GRanD |

| | | | | | | | | | | |
|----|------|-----------------------------|----------------|--------------------------|---------------|--------------------|-------|---------|--------|------------|
| 18 | 4505 | Cahora Bassa Reservoir | 32.7, -15.58 | Mozambique | Africa | 0.01542, 286.9568 | 55.8 | 2739 | 329.18 | wikipedia |
| 19 | 6 | Williston | -122.2, 56.02 | Canada | North America | 0.0529, 580.99344 | 39.47 | 1773 | 674.79 | literature |
| 20 | 4472 | Buhayrat ath Tharthar | 43.46, 33.69 | Iraq | Asia | 0.03955, -19.46261 | 85.59 | 2135.54 | 65 | literature |
| 21 | 5056 | Krasnoyarsk Reservoir | 92.29, 55.93 | Russia | Asia | 0.03863, 162.77316 | 73.3 | 2000 | 240.04 | wikipedia |
| 22 | 4623 | Kama Reservoir | 56.34, 58.12 | Russia | Euro | 0.00744, 96.07894 | 12.2 | 1915 | 110.32 | wikipedia |
| 23 | 1957 | Okeechobee | -81.1, 26.94 | United States of America | North America | 0.00617, -5.57499 | 5.2 | 1536.8 | 3.9 | wikipedia |
| 24 | 5295 | Hungtze | 118.73, 33.09 | China | Asia | 0.00749, 1.45816 | 13.5 | 2074.61 | 17 | literature |
| 25 | 4474 | Razazah | 43.89, 32.7 | Iraq | Asia | 0.01457, 11.06852 | 25.75 | 1621 | 34.69 | literature |
| 26 | 2023 | Gouin Reservoir | -74.1, 48.36 | Canada | North America | 0.00068, 402.90611 | 8.57 | 1570 | 403.98 | GReND |
| 27 | 4789 | Qapshaghay Bogeni Reservoir | 77.1, 43.92 | Kazakhstan | Asia | 0.00897, 467.10974 | 28.1 | 1850 | 483.71 | GReND |
| 28 | 753 | Fort Berthold Reservoir | -101.43, 47.51 | United States of America | North America | 0.02467, 528.64792 | 29.38 | 1477.4 | 565.1 | wikipedia |
| 29 | 2445 | Aperea Reservoir | -56.63, -27.39 | Paraguay | South America | 0.02242, 48.84199 | 21 | 1600 | 84.71 | literature |
| 30 | 870 | Oahe | -100.4, 44.46 | United States of America | North America | 0.02172, 462.72715 | 28.35 | 1429.57 | 493.78 | wikipedia |
| 31 | 2390 | Ilha Solteira Reservoir | -51.38, -20.37 | Brazil | South America | 0.03237, 290.94542 | 21.17 | 1200 | 329.78 | GReND |
| 32 | 4629 | Saratov Reservoir | 47.76, 52.05 | Russia | Euro | 0.02563, -0.27741 | 12.9 | 1117.7 | 28.36 | GReND |
| 33 | 4350 | Imandra | 32.55, 67.41 | Russia | Euro | 0.18726, -62.86735 | 10.8 | 1062.37 | 136.07 | GReND |
| 34 | 3640 | Kainji Reservoir | 4.61, 9.87 | Nigeria | Africa | 0.03997, 93.99579 | 15 | 1071.23 | 136.81 | wikipedia |
| 35 | 4785 | Novosibirskoye | 83, 54.84 | Russia | Asia | 0.01419, 98.78019 | 8.8 | 1070 | 113.97 | wikipedia |
| 36 | 4625 | Cheboksary | 47.46, 56.14 | Russia | Euro | 0.02447, 39.29789 | 13.85 | 1080.38 | 65.73 | literature |
| 37 | 4359 | Ilmen | 31.28, 58.46 | Russia | Euro | 0.0083, 9.98411 | 12 | 1120 | 19.28 | wikipedia |

| | | | | | | | | | | |
|----|------|-------------------------|--------------------|--------------------------|---------------|-----------------------|-------|---------|--------|------------|
| 38 | 4480 | Jebel Aulia Reservoir | 32.48, 15.24 | Sudan | Africa | 0.00624, 375.01032 | 3.5 | 861.19 | 380.39 | FAO |
| 39 | 1397 | Opinaca Reservoir | -76.58, 52.21 | Canada | North America | 0.02118, 194.07727 | 8.5 | 1040 | 216.1 | wikipedia |
| 40 | 2392 | Furnas | -46.31, -20.67 | Brazil | South America | 0.0437, 720.07262 | 22.59 | 1127.07 | 769.32 | wikipedia |
| 41 | 2368 | Serra da Mesa Reservoir | -48.3, -13.84 | Brazil | South America | 0.03356, 410.19963 | 54.4 | 1784 | 470.07 | wikipedia |
| 42 | 4624 | Votkinsk Reservoir | 54.08, 56.8 | Russia | Euro | 0.03892, 53.1356 | 9.4 | 850.82 | 86.25 | wikipedia |
| 43 | 6201 | Argyle Reservoir | 128.74, - 16.12 | Australia | Oceania | 0.02806, 66.43617 | 10.76 | 981.21 | 93.97 | wikipedia |
| 44 | 731 | Rainy | -93.36, 48.62 | Canada | North America | 0.00078, 336.08674 | 0.69 | 829.45 | 336.73 | GRanD |
| 45 | 307 | Fort Peck | -106.41, 48 | United States of America | North America | 0.04376, 643.31691 | 22.77 | 969.86 | 685.76 | wikipedia |
| 46 | 2375 | Tres Marias Reservoir | -45.27, -18.21 | Brazil | South America | 0.03553, 539.11233 | 21 | 1040 | 576.06 | wikipedia |
| 47 | 2012 | Pipmuacan Reservoir | -69.77, 49.36 | Canada | North America | 0.0498, 360.46403 | 13.9 | 978 | 409.16 | wikipedia |
| 48 | 4679 | Chardarinskoye | 67.96, 41.25 | Kazakhstan | Asia | 0.01786, 238.24413 | 5.7 | 800.66 | 252.54 | wikipedia |
| 49 | 4626 | Nizhnekamsk Reservoir | 52.28, 55.7 | Russia | Euro | 0.0138, 50.37324 | 13.8 | 1084 | 65.34 | wikipedia |
| 50 | 2456 | Negro Reservoir | -56.42, -32.83 | Uruguay | South America | 0.0194, 62.00777 | 8.8 | 1070 | 82.77 | wikipedia |
| 51 | 2343 | Chocon Reservoir | -68.76, -39.27 | Argentina | South America | 0.01519, 365.74893 | 22 | 820 | 378.2 | GRanD |
| 52 | 4442 | Ataturk Dam | 38.32, 37.49 | Turkey | Asia | 0.10643, 454.25042 | 48.7 | 817 | 541.2 | GRanD |
| 53 | 2513 | Itaparica Reservoir | -38.31, -9.14 | Brazil | South America | 0.03337, 279.33376 | 10.7 | 781.21 | 305.4 | wikipedia |
| 54 | 4464 | Assad | 38.55, 35.86 | Syria | Asia | 0.05942, 266.62629 | 11.7 | 610 | 302.87 | wikipedia |
| 55 | 3650 | Lagdo Reservoir | 13.69, 9.06 | Cameroon | Africa | 0.0374, 190.15542 | 7.7 | 691.12 | 216 | FAO |
| 56 | 1269 | Toledo Bend Reservoir | -93.57, 31.18 | United States of America | North America | 0.02039, 39.45546 | 5.52 | 636.18 | 52.43 | wikipedia |
| 57 | 6922 | Eastmain Reservoir | -75.89, 52.19 | Canada | North America | 0.06785, 245.91598 | 6.94 | 602.9 | 286.82 | literature |

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|----|------|-------------------------|----------------|--------------------------|---------------|---------------------|-------|--------|---------|--------------|
| 58 | 2009 | Outardes 4 Reservoir | -68.91, 49.71 | Canada | North America | 0.19049, 239.61011 | 24.5 | 640 | 361.53 | Hydro-Québec |
| 59 | 4349 | Kovdozero | 31.76, 68.6 | Russia | Euro | 0.00193, 78.17686 | 3.7 | 745 | 79.62 | GRanD |
| 60 | 2380 | Sao Simao Reservoir | -50.5, -19.02 | Brazil | South America | 0.0523, 369.16877 | 12.5 | 703 | 405.94 | wikipedia |
| 61 | 610 | Mead | -114.73, 36.02 | United States of America | North America | 0.13619, 288.76038 | 34.07 | 659.3 | 374.6 | USBR |
| 62 | 5087 | Yandrok | 90.38, 29.1 | China | Asia | 0.01275, 4435.35521 | 14.6 | 638 | 4443.49 | literature |
| 63 | 1391 | Angostura Reservoir | -92.78, 16.4 | Mexico | North America | 0.08079, 478.95889 | 18.2 | 640 | 530.67 | wikipedia |
| 64 | 4991 | Srisailam Reservoir | 78.9, 16.09 | India | Asia | 0.03079, 253.3044 | 8.29 | 534.05 | 269.75 | CWC |
| 65 | 2455 | Grande Reservoir | -57.94, -31.27 | Argentina | South America | 0.03068, 16.88963 | 5 | 592.83 | 35.08 | wikipedia |
| 66 | 4843 | Gandhisagar Reservoir | 75.55, 24.7 | India | Asia | 0.03366, 379.03449 | 6.83 | 619.89 | 399.9 | CWC |
| 67 | 2397 | Promissao Reservoir | -49.78, -21.3 | Brazil | South America | 0.08038, 342.73167 | 7.41 | 513.39 | 384 | GRanD |
| 68 | 282 | Arrow | -117.78, 49.34 | Canada | North America | 0.17477, 351.0668 | 10.3 | 504.82 | 439.3 | USACE |
| 69 | 2382 | Agua Vermelha Reservoir | -50.35, -19.87 | Brazil | South America | 0.05626, 351.61681 | 11.03 | 563.15 | 383.3 | wikipedia |
| 70 | 4898 | Hirakud Reservoir | 83.85, 21.52 | India | Asia | 0.02204, 177.26302 | 5.38 | 669.62 | 192.02 | CWC |
| 71 | 3041 | Kossour Reservoir | -5.47, 7.03 | Ivory Coast | Africa | 0.03423, 169.77945 | 27.68 | 1058.2 | 206 | GRanD |
| 72 | 4784 | Kureiskaya | 88.29, 66.95 | Russia | Asia | 0.04971, 67.89284 | 9.96 | 558 | 95.63 | literature |
| 73 | 3071 | Storsjon | 14.47, 63.3 | Sweden | Euro | 0.00422, 291.0872 | 8.02 | 484.6 | 293.13 | GRanD |
| 74 | 316 | Flathead Lake | -114.23, 47.68 | United States of America | North America | 0.13239, 816.09051 | 23.2 | 510 | 883.61 | wikipedia |
| 75 | 2004 | Kempt | -70.53, 50.66 | Canada | North America | 0.03312, 478.60112 | 2.22 | 470.44 | 494.18 | GRanD |
| 76 | 6700 | Kolyma dam | 150.23, 62.05 | Russia | Asia | 0.13658, 390.9085 | 15.08 | 454.6 | 453 | wikipedia |

| | | | | | | | | | | |
|----|------|-----------------------|----------------|-----------------------------|---------------|---------------------|-------|--------|---------|------------|
| 77 | 4501 | Mtera Reservoir | 35.98, -7.14 | United Republic of Tanzania | Africa | 0.02183, 688.04662 | 3.2 | 478.83 | 698.5 | literature |
| 78 | 4686 | Kayrakkumskoye | 69.82, 40.28 | Tajikistan | Asia | 0.02143, 335.23897 | 4.2 | 513 | 346.23 | wikipedia |
| 79 | 250 | Kinbasket | -118.57, 52.08 | Canada | North America | 0.31717, 622.76738 | 24.76 | 430 | 759.15 | wikipedia |
| 80 | 4634 | Mingechaurskoye | 47.03, 40.8 | Azerbaijan | Asia | 0.07215, 42.01887 | 15.73 | 567.97 | 83 | wikipedia |
| 81 | 2431 | Lago del Río Yguazú | -54.97, -25.37 | Paraguay | South America | 0.04517, 203.13232 | 8.47 | 620 | 231.14 | wikipedia |
| 82 | 4858 | Govind Ballabah Pant | 83, 24.2 | India | Asia | 0.06208, 241.75327 | 5.65 | 426.36 | 268.22 | CWC |
| 83 | 4422 | Keban Baraji | 38.76, 38.81 | Turkey | Asia | 0.11302, 772.50564 | 30.6 | 675 | 848.79 | wikipedia |
| 84 | 2340 | Los Barreales | -68.69, -38.58 | Argentina | South America | 0.30759, 290.07305 | 27.7 | 413 | 417.11 | literature |
| 85 | 4859 | Bansagar Lake | 81.29, 24.19 | India | Asia | 0.05088, 317.64432 | 5.17 | 471.6 | 341.64 | CWC |
| 86 | 1275 | Sam Rayburn Reservoir | -94.11, 31.07 | United States of America | North America | 0.0355, 35.65711 | 3.55 | 455.64 | 50.11 | TWDB |
| 87 | 2414 | Barra Bonita | -49.23, -23.21 | Brazil | South America | 0.00228, 565.24837 | 7.01 | 542 | 566.48 | GRanD |
| 88 | 4739 | Ukal | 73.6, 21.26 | India | Asia | 0.04229, 83.59772 | 6.62 | 509.85 | 105.16 | CWC |
| 89 | 479 | Utah Lake | -111.89, 40.36 | United States of America | North America | 0.02307, 1359.51211 | 1.07 | 380 | 1368.28 | wikipedia |
| 90 | 305 | Pend Oreille Lake | -117, 48.18 | United States of America | North America | 0.22845, 541.65792 | 54.2 | 381.47 | 628.8 | wikipedia |
| 91 | 4994 | Tungabhadra | 76.33, 15.27 | India | Asia | 0.04122, 483.33699 | 3.28 | 349.42 | 497.74 | CWC |
| 92 | 4461 | Mosul Dam Lake | 42.83, 36.63 | Iraq | Asia | 0.16032, 273.38375 | 11.1 | 353.16 | 330 | wikipedia |
| 93 | 4470 | Habbaniyah | 42.35, 34.21 | Iraq | Asia | 0.07125, 114.61642 | 8.2 | 418.4 | 144.43 | literature |
| 94 | 4946 | Sriramsagar Reservoir | 78.34, 18.97 | India | Asia | 0.04005, 319.94975 | 2.3 | 314.38 | 332.54 | CWC |
| 95 | 2376 | Lago das Brisas | -49.1, -18.41 | Brazil | South America | 0.08818, 471.03368 | 17 | 559.6 | 520.38 | wikipedia |

| | | | | | | | | | | |
|-----|------|--------------------|--------------------|--------------|---------------|------------------------|------|--------|---------|------------|
| 96 | 2356 | Meelpaeg | -56.78, 48.17 | Canada | North America | 0.0041, 269.35893 | 2.16 | 314.9 | 270.65 | GRanD |
| 97 | 4260 | Hendrik Verwoerd | 25.5, -30.62 | South Africa | Africa | 0.06907, 1236.10289 | 5.34 | 374 | 1261.93 | wikipedia |
| 98 | 1387 | Malpaso | -93.6, 17.18 | Mexico | North America | 0.30032, 89.06386 | 9.17 | 309.45 | 182 | literature |
| 99 | 1379 | Inhernillo | -101.89, 18.27 | Mexico | North America | 0.14118, 116.65544 | 12 | 400 | 173.13 | wikipedia |
| 100 | 4184 | Vaaldam | 28.12, -26.88 | South Africa | Africa | 0.0358, 1472.81742 | 2.61 | 320 | 1484.27 | wikipedia |
| 101 | 5062 | Longyangxia | 100.92, 36.12 | China | Asia | 0.18321, 2518.97907 | 24.7 | 383 | 2589.15 | wikipedia |
| 102 | 3727 | Hoytiainen | 29.48, 62.83 | Finland | Euro | 0.0064, 86.17122 | 2.39 | 293 | 88.05 | GRanD |
| 103 | 1423 | Baskatong | -75.98, 46.72 | Canada | North America | 0.05663, 207.28526 | 2.63 | 280 | 223.14 | GRanD |
| 104 | 5803 | Tri An Lake | 107.04, 11.11 | Vietnam | Asia | 0.07216, 39.48203 | 2.76 | 323 | 62.79 | wikipedia |
| 105 | 2007 | Peribonka | -71.25, 49.9 | Canada | North America | 0.10611, 411.5385 | 5.18 | 270.72 | 440.26 | GRanD |
| 106 | 4942 | Jayakwadi | 75.37, 19.49 | India | Asia | 0.03201, 451.67121 | 2.17 | 382.39 | 463.91 | CWC |
| 107 | 3638 | Shiroro | 6.84, 9.97 | Nigeria | Africa | 0.08602, 350.89662 | 7 | 312 | 377.73 | FAO |
| 108 | 4379 | Tshchikskoye | 39.12, 44.99 | Russia | Euro | 0.06161, 16.03972 | 3.05 | 286.28 | 33.68 | FAO |
| 109 | 710 | Tobin | -103.4, 53.66 | Canada | North America | 0.00897, 311.22766 | 2.2 | 263.86 | 313.59 | GRanD |
| 110 | 5796 | Noi | 105.43, 15.21 | Thailand | Asia | 0.05709, 129.50217 | 1.97 | 288 | 145.94 | wikipedia |
| 111 | 4483 | Roseires Reservoir | 34.39, 11.8 | Sudan | Africa | 0.02506, 475.84407 | 7.4 | 450 | 487.12 | wikipedia |
| 112 | 4675 | Toktogul'skoye | 72.65, 41.68 | Kyrgyzstan | Asia | 0.55471, 743.53409 | 19.5 | 284.3 | 901.24 | wikipedia |
| 113 | 6698 | Gordon | 145.98, - 42.73 | Australia | Oceania | 0.37007, 208.53588 | 12.4 | 278 | 311.42 | wikipedia |
| 114 | 4964 | Ujani | 75.12, 18.07 | India | Asia | 0.05453, 482.16622 | 1.52 | 268.91 | 496.83 | CWC |
| 115 | 2312 | Hondo | -64.89, -27.52 | Argentina | South America | 0.02922, 266.72004 | 1.74 | 330 | 276.36 | WLDB |

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|-----|------|--------------------------|--------------------|--|------------------|------------------------|-------|--------|---------|------------|
| 116 | 4362 | Ivankovo Reservoir | 37.12, 56.73 | Russia | Euro | 0.01794, 119.50914 | 1.17 | 220.57 | 123.47 | GRanD |
| 117 | 4702 | Tarbela | 72.69, 34.09 | Pakistan | Asia | 0.52839, 351.45663 | 13.69 | 250 | 483.55 | wikipedia |
| 118 | 4985 | Nagarjuna | 79.31, 16.57 | India | Asia | 0.29044, 100.77784 | 6.84 | 272.18 | 179.83 | wikipedia |
| 119 | 3070 | Kallsjon | 13.34, 63.43 | Sweden | Euro | 0.02782, 387.52135 | 6.14 | 189.74 | 392.8 | GRanD |
| 120 | 4431 | Karakaya | 39.14, 38.23 | Turkey | Asia | 0.22073, 631.76449 | 9.5 | 298 | 697.54 | wikipedia |
| 121 | 4792 | Beas | 75.95, 31.97 | India | Asia | 0.20473, 371.49329 | 6.16 | 254.85 | 423.67 | CWC |
| 122 | 4047 | Tshangalele | 27.24, -10.75 | Democratic Republic of the Congo | Africa | 0.03102, 1119.03312 | 1.06 | 225.65 | 1126.03 | GRanD |
| 123 | 4485 | Finchaa | 37.36, 9.56 | Ethiopia | Africa | 0.01891, 2216.55235 | 0.65 | 196.13 | 2220.26 | FAO |
| 124 | 4989 | Almatti | 75.89, 16.33 | India | Asia | 0.05275, 504.12335 | 3.11 | 293.42 | 519.6 | CWC |
| 125 | 4707 | Mangla | 73.64, 33.15 | Pakistan | Asia | 0.20109, 320.1312 | 9.12 | 251 | 370.6 | wikipedia |
| 126 | 4836 | Rana Pratap | 75.58, 24.92 | India | Asia | 0.1391, 324.74 | 1.44 | 197.66 | 352.81 | CWC |
| 127 | 3014 | Bagre | -0.55, 11.47 | Burkina Faso | Africa | 0.05719, 223.53693 | 1.7 | 255 | 238.12 | literature |
| 128 | 1991 | Junin | -76.19, -10.98 | Peru | South America | 0.02312, 4079.83703 | 1.08 | 206.71 | 4084.62 | WLDB |
| 129 | 4881 | Bargi Dam Reservoir | 79.93, 22.95 | India | Asia | 0.08518, 401.51078 | 3.18 | 236.24 | 422.76 | CWC |
| 130 | 6686 | Great Lake | 146.73, - 41.98 | Australia | Oceania | 0.40346, 969.53157 | 3.36 | 176 | 1040.54 | GRanD |
| 131 | 6800 | Hawea | 169.25, - 44.61 | New Zealand | Oceania | 0.14631, 323.54085 | 2.18 | 150 | 345.49 | GRanD |
| 132 | 3676 | Albufeira da Quiminha | 13.79, -8.96 | Angola | Africa | 0.13121, 34.99206 | 1.56 | 129.05 | 51.93 | GRanD |
| 133 | 6629 | Eucumbene | 148.62, - 36.13 | Australia | Oceania | 0.46484, 1097.64507 | 4.8 | 145.42 | 1165.24 | wikipedia |
| 134 | 1320 | Falcon Reservoir | -99.17, 26.56 | United States of America | North America | 0.06972, 71.73912 | 3.88 | 311.84 | 93.48 | TWDB |

| | | | | | | | | | | |
|-----|------|--------------------------|--------------------|-----------------------------------|------------------|------------------------|------|--------|---------|-----------------|
| 135 | 597 | Lake Powell | -111.49, 36.94 | United States of America | North America | 0.1406, 1047.2 | 30 | 609.38 | 1127.76 | wikipedia |
| 136 | 4463 | Dukan | 44.96, 35.96 | Iraq | Asia | 0.18893, 462.6788 | 6.97 | 270 | 513.69 | wikipedia |
| 137 | 1230 | Cedar Creek Reservoir | -96.07, 32.18 | United States of America | North America | 0.09423, 85.91971 | 0.8 | 133.03 | 98.15 | TWDB |
| 138 | 4041 | Lake Maga | 15.05, 10.83 | Cameroon | Africa | 0.01933, 309.62551 | 0.68 | 148.72 | 312.5 | literature |
| 139 | 5157 | Pasak Chonlasit | 101.08, 14.85 | Thailand | Asia | 0.05295, 33.58769 | 0.79 | 158.87 | 42 | literature |
| 140 | 6594 | Fairbairn | 148.06, - 23.65 | Australia | Oceania | 0.13, 186.48395 | 2.29 | 179.43 | 209.81 | wikipedia |
| 141 | 6628 | Hume | 147.03, - 36.11 | Australia | Oceania | 0.15399, 161.81633 | 3.04 | 201.9 | 192 | wikipedia |
| 142 | 4500 | Kikuletwa | 37.47, -3.82 | United Republic of Tanzania | Africa | 0.1, 677.01366 | 0.6 | 126.33 | 689.65 | wikipedia |
| 143 | 4958 | Nizam sagar | 77.93, 18.2 | India | Asia | 0.0893, 419.95709 | 0.5 | 92.75 | 428.24 | CWC |
| 144 | 6606 | Victoria | 141.28, - 34.04 | Australia | Oceania | 0.16558, 7.52685 | 0.68 | 122 | 27.73 | GRand |
| 145 | 1869 | Grenada Lake | -89.77, 33.82 | United States of America | North America | 0.12614, 49.34905 | 1.54 | 128.29 | 65.53 | Lakes Online |
| 146 | 138 | Canyon | -121.09, 40.18 | United States of America | North America | 0.68749, 1300.93547 | 1.61 | 108.39 | 1373.12 | wikipedia |
| 147 | 4638 | Aras Dam Lake | 45.4, 39.09 | Azerbaijan | Asia | 0.11845, 762.76554 | 1.35 | 145 | 779.94 | wikipedia |
| 148 | 4481 | Khashm el-Girba | 35.9, 14.93 | Sudan | Africa | 0.09342, 463.08227 | 1.3 | 125 | 474.76 | wikipedia |
| 149 | 370 | Lake Cascade | -116.05, 44.52 | United States of America | North America | 0.16232, 1455.02068 | 0.85 | 101.98 | 1471.57 | wikipedia |
| 150 | 3695 | Seitevare | 18.57, 66.97 | Sweden | Euro | 0.62918, 419.1852 | 1.68 | 81 | 470.15 | GRand |
| 151 | 4484 | Yardi | 40.54, 10.23 | Ethiopia | Africa | 0.33044, 533.59442 | 2.32 | 104.87 | 568.25 | GRand |
| 152 | 119 | Clear Lake Reservoir | -121.08, 41.93 | United States of America | North America | 0.19968, 1345.80215 | 0.65 | 100.36 | 1365.84 | wikipedia |
| 153 | 5196 | Guanting Shuiku | 115.6, 40.23 | China | Asia | 0.10764, 465.09336 | 4.16 | 130 | 479.09 | GRand |

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|-----|------|-------------------------|--------------------|--------------------------|---------------|-----------------------|------|--------|--------|------------|
| 154 | 2953 | Barrage Al Massira | -7.64, 32.47 | Morocco | Africa | 0.33916, 241.40761 | 2.76 | 80 | 268.54 | wikipedia |
| 155 | 1319 | Venustiano Carranza | -100.62, 27.51 | Mexico | North America | 0.09456, 252.29236 | 1.31 | 150.56 | 266.53 | literature |
| 156 | 4471 | Lake Hamrin | 44.97, 34.12 | Iraq | Asia | 0.11963, 80.22516 | 4.61 | 228 | 107.5 | literature |
| 157 | 4826 | Matatila | 78.37, 25.1 | India | Asia | 0.10028, 297.22136 | 0.71 | 112.07 | 308.46 | CWC |
| 158 | 1263 | Twin Buttes | -100.52, 31.37 | United States of America | North America | 0.49517, 576.78181 | 0.23 | 29.47 | 591.37 | TWDB |
| 159 | 4997 | Somasila | 79.3, 14.49 | India | Asia | 0.17144, 74.32045 | 1.99 | 153.17 | 100.58 | CWC |
| 160 | 5183 | Hongshan Reservoir | 119.7, 42.75 | China | Asia | 0.23268, 422.07692 | 2.56 | 66.9 | 437.64 | GRanD |
| 161 | 6583 | Lake Ross | 146.74, - 19.41 | Australia | Oceania | 0.11178, 32.60497 | 0.8 | 82 | 41.77 | wikipedia |
| 162 | 4978 | Yeleru Reservoir | 82.08, 17.3 | India | Asia | 0.58856, 57.51076 | 0.51 | 49.36 | 86.56 | CWC |
| 163 | 4696 | South Surkhan Reservoir | 67.63, 37.83 | Uzbekistan | Asia | 0.33795, 397.79868 | 0.8 | 40.26 | 411.41 | GRanD |
| 164 | 5287 | Zhaopingtai Reservoir | 112.77, 33.73 | China | Asia | 0.35804, 157.62551 | 0.71 | 46.5 | 174.27 | GRanD |

* The 164 reservoirs include 13 regulated natural lakes, whose IDs are 1, 6, 20, 23, 33, 37, 44, 62, 73, 102, 131, 150, and 151.

¹ GRanD: Global Reservoir and Dam Database (Lehner et al., 2011). All of the geographical location information is adopted from GRanD.

² a and b are the coefficients used in the A-E relationship equation: $h=a*A+b$, where h and A are elevation (m) and area (km²), respectively.

³ List of full names: FAO- Food and Agriculture Organization; USBR- United States Bureau of Reclamation; CWC- Central Water Commission of India; USACE- United States Army Corps of Engineers; TWDB- Texas Water Development Board; WLDB- World Lake Database.

Appendix B- Example codes (in MATLAB and Python) for reading MxD28C2 hdf files

1) MATLAB code for reading the MxD28C2 hdf file

```
%%% To get information about the file %%%  
  
a=hdfinfo('MYD28C2.A2012225.061.2020323120640.hdf');  
  
%%% Read the data %%%  
  
b=a.Vdata;  
  
x=hdfread(b,'Fields',{'lake_ID','lake_longitude','lake_latitude','lake_area','lake_elevation','lake_storage'});  
  
lake_id= x{1,1};  
longitude= x{2,1};  
latitude=x{3,1};  
area=x{4,1};  
elevation=x{5,1};  
storage=x{6,1};
```

2) Short version of the MATLAB code for reading the MxD28C2 hdf file

```
%%% Other way to read the data  
  
a=hdfinfo('MYD28C2.A2012225.061.2020323120640.hdf');  
  
%%% go to a.Vdata and find the name of the layer-> here it is 'lakes'  
  
%%% just use this layer name to read the data  
  
k=hdfread('C:\Users\User\Desktop\MYD28C2.A2012225.061.2020323120640.hdf','lakes');  
  
%%% The values in variable 'k' are in same order as a.Vdata.Field  
  
%%% Here it is lake_ID, lake_longitude, lake_latitude, lake_area, lake_elevation, lake_storage, respectively.
```

3) Python code for reading the MxD28C2 data from the hdf file

```
#####  
from pyhdf.HDF import HDF  
import pyhdf.VS  
  
##input the HDF filename and open it  
filename = "MOD28C2.A2012161.061.2020323115311.hdf"  
f=HDF(filename)  
  
##open the data table  
vs=f.vstart()  
vd=vs.attach('lakes')  
  
##get the filed names  
columns=vd._fields  
print (columns)  
  
##read the data table content  
for i in vd[:]:  
    print (i)  
  
##close the data table  
vd.detach()  
vs.end()  
f.close()  
#####
```


Appendix C- Example codes (in MATLAB and Python) for reading MxD28C3 hdf files

1) MATLAB code for reading the MxD28C3 hdf file

```
%%% To get information about the file %%%  
  
a=hdhinfo('MOD28C3.A2012001.hdf');  
  
%%% Read the data %%%  
  
b=a.Vdata;  
  
x=hdhread  
(b,Fields',{'lake_ID','lake_longitude','lake_latitude','lake_area','lake_elevation','lake_storage','lake_evap_rate','lake_evap_vol'});  
  
lake_id= x{1,1}';  
longitude= x{2,1}';  
latitude=x{3,1}';  
area=x{4,1}';  
elevation=x{5,1}';  
storage=x{6,1}';  
evaporation_rate=x{7,1}';  
evaporation_volume=x{8,1}';
```

2) Short version of the MATLAB code for reading the MxD28C3 hdf file

```
a=hdhinfo('MOD28C3.A2012001.hdf');  
  
%%% go to a.Vdata and find the name of the layer-> here it is 'lake_evaporation'  
  
%%% just use this layer name to read the data  
  
k=hdhread('MOD28C3.A2012001.hdf','lake_evaporation');  
  
%%% The values in variable 'k' are in same order as a.Vdata.Fields  
  
%%% Here it is Lake_ID, Lake_longitude, Lake_latitude, Lake_area, Lake_elevation, Lake_storage, Lake_evaporation_rate,  
and Lake_evaporation_volume, respectively.
```

3) Python code for reading the MxD28C3 data from the hdf file

```
from pyhdf.HDF import HDF
import pyhdf.VS

##input the HDF filename and open it
filename = "MOD28C3.A2012001.hdf"
f=HDF(filename)

## initialize the data table
vs=f.vstart()
##return data information
vdata_info=vs.vdatainfo()
##open the data table
vd=vs.attach('lake_evaporation')
##get the filed names
columns=vd._fields
print (columns)
##read the data table content
for i in vd[:]:
    print (i)

##close the data table
vd.detach()
vs.end()
f.close()
```

Appendix D – Outlier removal and gap filling script

To use this attached script, copy the code below to a file (e.g., process.py). Then run the script using python (with prerequisite packages installed) by typing: python process.py input.csv. The input.csv is a csv file contains the time series of lake_area values prepared by the user. The first column is date (year_doy, e.g., 2012009) and the second column is the lake_area value. Output file (input_new.csv) contains a new column with the lake_area_new values.

```
import numpy as np
import pandas as pd
import glob
from datetime import datetime

from pyhdf.HDF import *
from pyhdf.VS import *
# http://pysclint.sourceforge.net/pyhdf/pyhdf.VS.html

## 1. process hdf vector

output = []
for fname in glob.glob('0_dloaded/**/MOD*.hdf', recursive=True):

    #print(fname)
    f = HDF(fname)      # open 'inventory.hdf' in read mode
    vs = f.vstart()     # init vdata interface
    vd = vs.attach('lakes') # attach 'INVENTORY' in read mode

    colnames = vd._fields

    # Read all records at once, and loop over the sequence.
    for rec in vd[:]:
        output.append([fname.split('/')[-1]] + rec)

    vd.detach()        # "close" the vdata
    vs.end()           # terminate the vdata interface
    f.close()          # close the HDF file

date_start = datetime.strptime('1/1/2000', "%m/%d/%Y") ## any date before the start of MODIS is good

df = pd.DataFrame(output, columns=['fname'] + colnames)
df['date'] = df['fname'].apply(lambda x: datetime.strptime(x[9:16], '%Y%j'))
df['date_int'] = df['date'].apply(lambda x: (x-date_start).days)
df = df.sort_values(['lake_ID', 'date'])
```

```

## # 2. remove outliers and interpolate

def remove_bias(values, dates, wz):

    ## values: area or storage time series
    ## dates: corresponding dates (in integer)
    ## wz: windows size for calculating the moving average to determine the outliers

    weight = np.arange(1,wz,1)[int(wz/2):]
    weight = np.concatenate((weight, np.ones(len(values)-wz+1)*wz, np.flip(weight, 0)))/wz

    nol = 2
    limit = 50
    while nol > 0 and limit > 0:
        wt_ma = np.convolve(values, np.ones((wz,))/wz, mode='same')

        bias = values - wt_ma/weight
        b_avg = np.average(bias)
        b_sd = np.std(bias)

        outlier = [0 if (x >= b_avg+3*b_sd or x <= b_avg-3*b_sd) else 1 for x in bias]
        inreduce = nol - (len(outlier) - np.sum(outlier))
        nol = len(outlier) - np.sum(outlier)
        limit = limit - 1
        #print(nol)

        n_dates = [x for x,y in zip(dates, outlier) if y==1]
        n_enh = [x for x,y in zip(values, outlier) if y==1]
        if len(n_dates) >= 5:
            values = np.interp(dates, n_dates, n_enh)
        else:
            return dates, values

        if inreduce == 0 and nol <=2:
            break
    return n_dates, n_enh

lake_info_data = pd.read_csv('../input/modis_lake_info.6.1.2.txt', sep=' ')

wz = 7 # moving window

output_intp = []
for lake_id, group in df.groupby('lake_ID'):

    lake_info = lake_info_data[lake_info_data['LAKE_ID'] == lake_id].iloc[0]
    sto_cap_km3, area_cap_km2, elev_cap_m, a, b = lake_info[['sto_cap_km3','area_cap_km2', 'elev_cap_m', 'a', 'b']]

    group_valid = group[(group['lake_area'] > 0) & (group['lake_area'] <= area_cap_km2)]

```

```
if len(group_valid) > wz:
    areas = group_valid['lake_area'].values
    dates = group_valid['date_int'].values
    dates_new, areas_new = remove_bias(areas, dates, wz)

    areas_intp = np.interp(group['date_int'], dates_new, areas_new)
else:
    areas_new = group[(group['lake_area'] > 0)]['lake_area'].values
    dates_new = group[(group['lake_area'] > 0)]['date_int'].values
    areas_intp = np.interp(group['date_int'], dates_new, areas_new)

elevs_intp = [a*area+b for area in areas_intp]
stors_intp = [sto_cap_km3 - (area_cap_km2+area)*(elev_cap_m-elev)/2000.
              for area, elev in zip(areas_intp, elevs_intp)]

intp_flag = [0 if area==area_new else 1 for area, area_new in zip(group['lake_area'], areas_intp)]

group_new = pd.DataFrame({'date': group['date'], 'lake_area': areas_intp, 'lake_elevation': elevs_intp,
                          'lake_storage': stors_intp, 'intp_flag': intp_flag})
group_new['lake_ID'] = lake_id
output_intp.append(group_new)

df_intp = pd.concat(output_intp, axis=0).reset_index(drop=True)
df_intp.to_csv('modis_outlier_removed.csv', index=False)
```