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Long Term Evaporative Losses Estimation and Water Budget Assessment of Lake Nasser, Nile River

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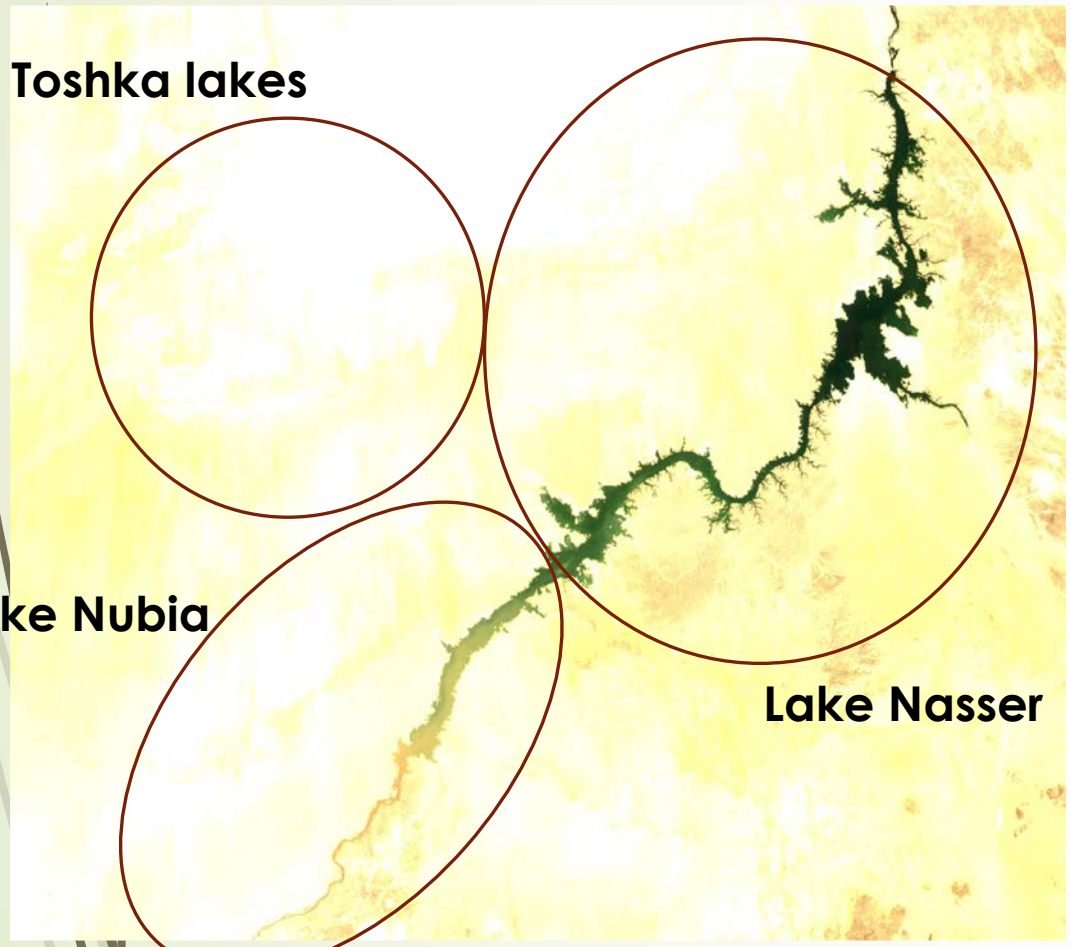
AHD Reservoir History (Lake Nasser & of Lake Nubia)



Lake Nasser Change (1984-2018)

Collection of Landsat 5,6,7,8 satellite images tracking the changes in Rasheed (North Nile Delta) and Lake Nasser

The construction steps can be historically summarized as follows:

1960: Start of construction.

1964: First dam construction stage is completed, reservoir started filling.

1970: The High Dam completed on 21th July.

1976: Reservoir reached full capacity

(Negm, Abdelazim M., and Sommer Abdel-Fattah. "Grand Ethiopian Renaissance Dam Versus Aswan High Dam." The handbook of environmental chemistry. Springer International Publishing (2017).)

AHD IMPACTS

Rasheed Change 1984-2018

Collection of Landsat 5,6,7,8 satellite images tracking the changes in Rasheed (North Nile Delta) and Lake Nasser

Among the main physical impacts of the dam were the following :

- **Changes in the level, velocity, and discharge of the flow in the Nile River both upstream and downstream of the dam.**
- **Increase in groundwater levels due to the introduction of year-long irrigation.**
- **Causing changes in soil salinity and water logging.**
- **Causing erosion of the river banks, beds, and delta.**
- **Causing sedimentation in the river and Lake Nasser.**
- **Possible earthquakes.**
- **Reclamation of the desert for human habitat and agriculture.**

Biswas AK, Tortajada C (2012) Impacts of the High Aswan Dam. A global assessment, water resources development and management. Springer, Berlin/Heidelberg

AHD IMPACTS

Nile Delta Change 1984-2018

Collection of Landsat 5,6,7,8 satellite images tracking the changes in Rasheed (North Nile Delta) and Lake Nasser

Among the economic impacts were :

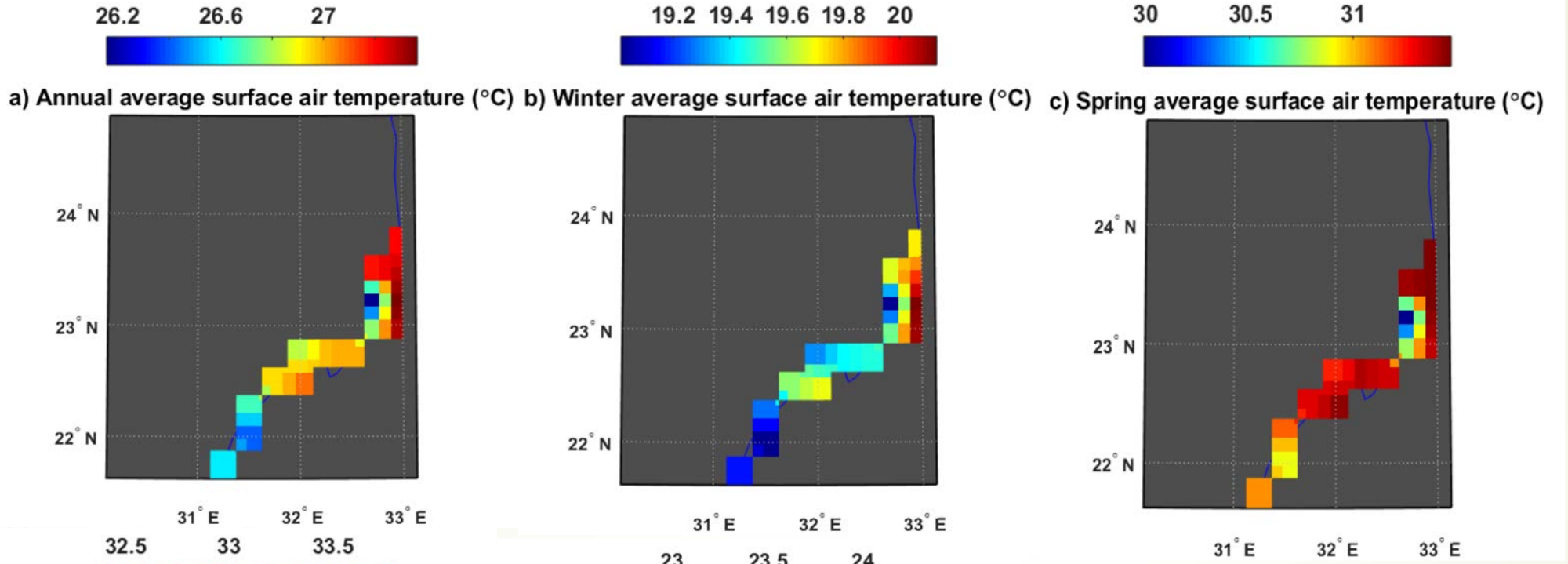
- **Generation of hydropower.**
- **Increase in industrial activities and industrial diversification, because of the availability of electricity.**
- **Increase in agricultural land, as well as crop intensification and diversification.**
- **Impacts on brick-making industry.**

There were several social impacts, which included :

- **Peace and stability of the country due to increased economic activities and a higher standard of living.**
- **Eliminating the ravages of floods and droughts downstream of the dam.**
- **Resettlement issues.**

Biswas AK, Tortajada C (2012) Impacts of the High Aswan Dam. A global assessment, water
resources development and management. Springer, Berlin/Heidelberg
Abu-Zeid MA, El-Shibini FZ (1997) Egypt's High Aswan Dam. Water Resour Dev 13 (2):209–217
El-Shabrawy GM (2009) Lake Nasser-Nubia. The Nile: origin, environments, limnology and
human use. Springer, Berlin, pp 125–155

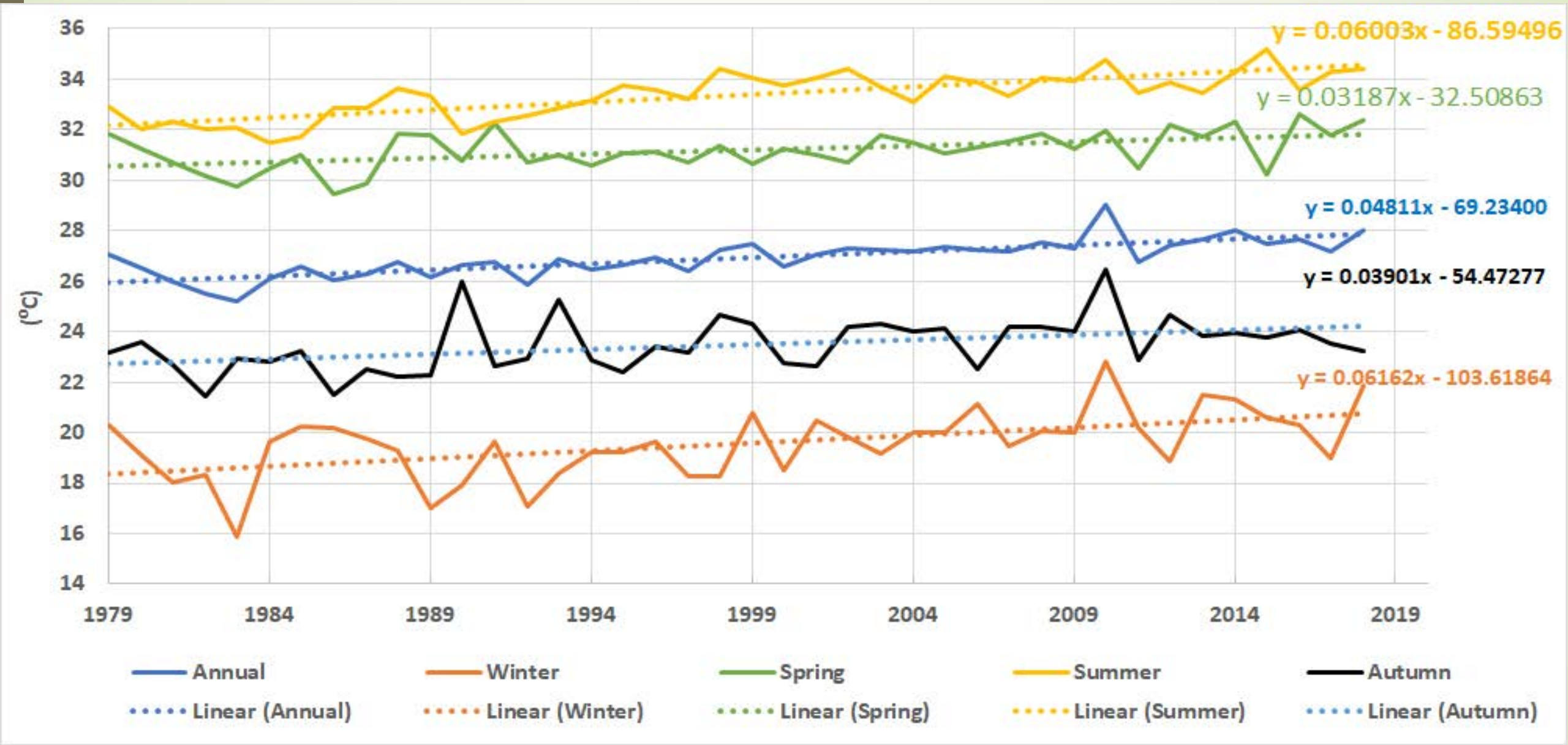
Spatial distribution of the mean annual/seasonal Lake Nasser t2m over the period from 1979 to 2018.



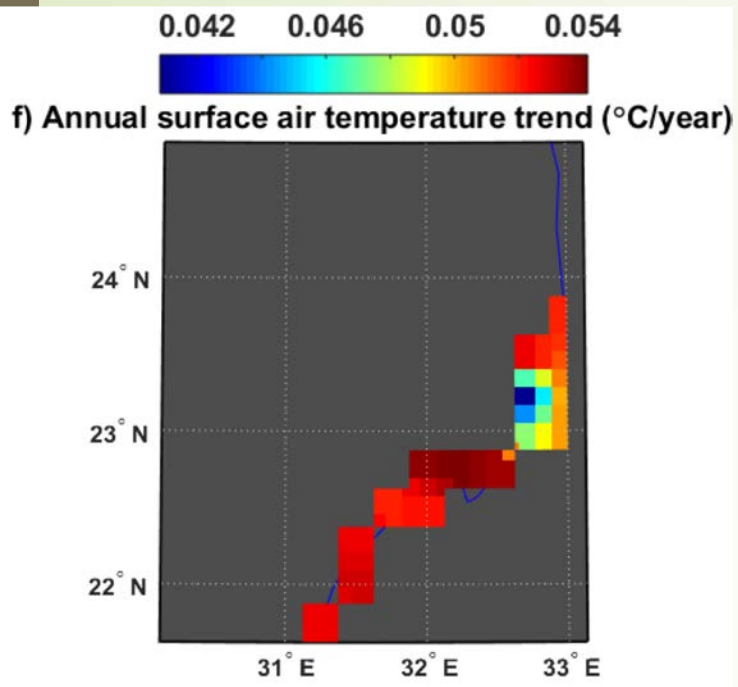
Era-interim full resolution database (http://apps.ecmwf.int/datasets/data/interim-full-daily/levtype=sfc/) with a 3-h temporal resolution and a spatial resolution of 0.125° × 0.125°;

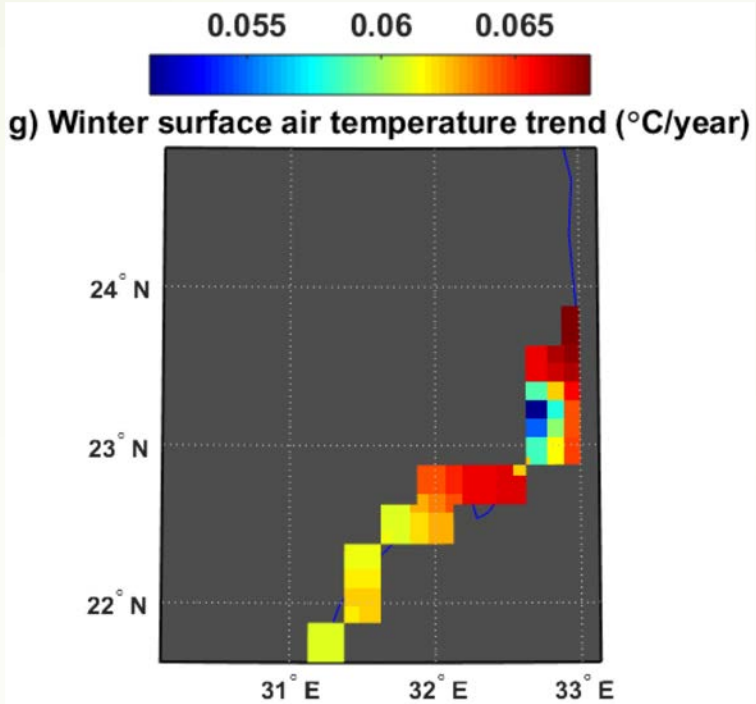
	Min	Max	Range	Average
Annual	26.2	27.4	1.2	26.9
Winter	19.0	20.1	1.1	19.5
Spring	30.0	31.5	1.5	31.2
Summer	32.4	33.8	1.4	33.4
Autumn	22.7	24.2	1.5	23.5

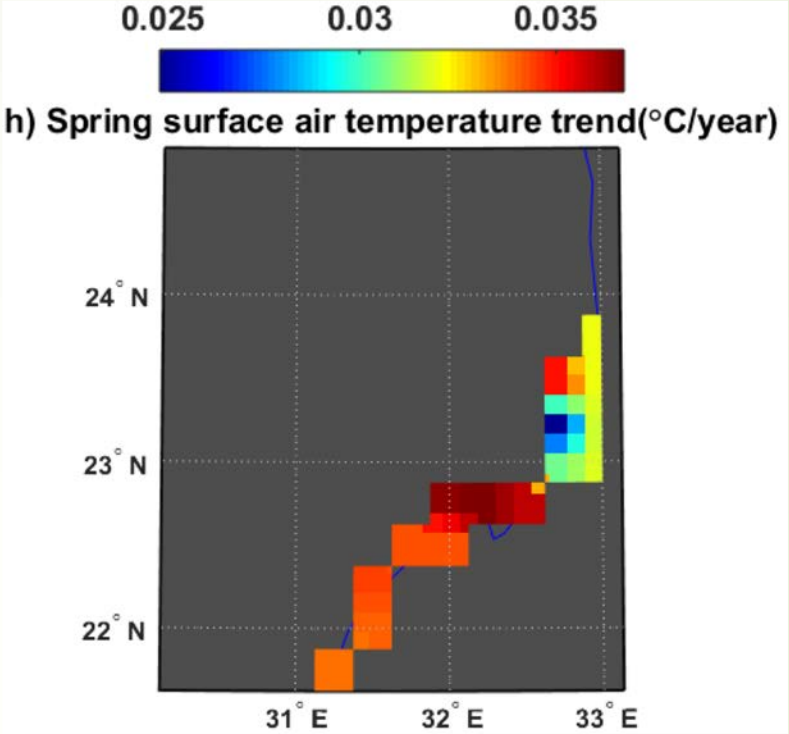
Annual / seasonal surface air temperature time series for Lake Nasser

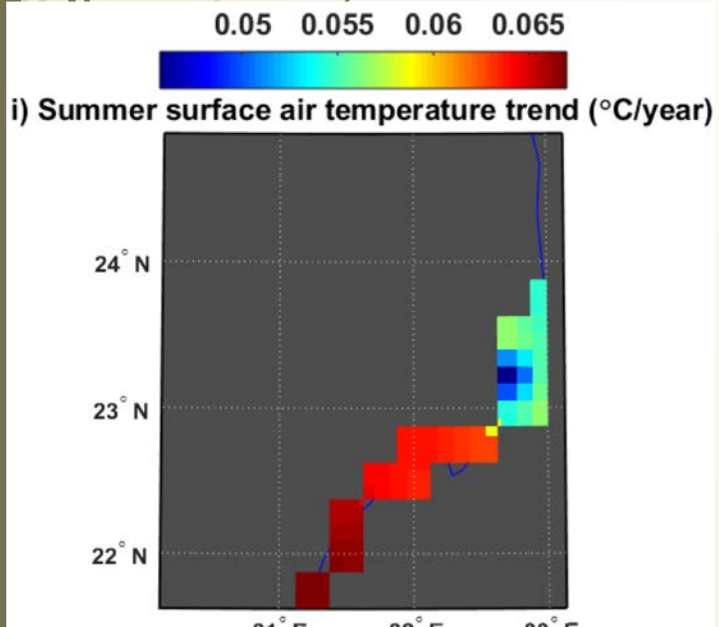


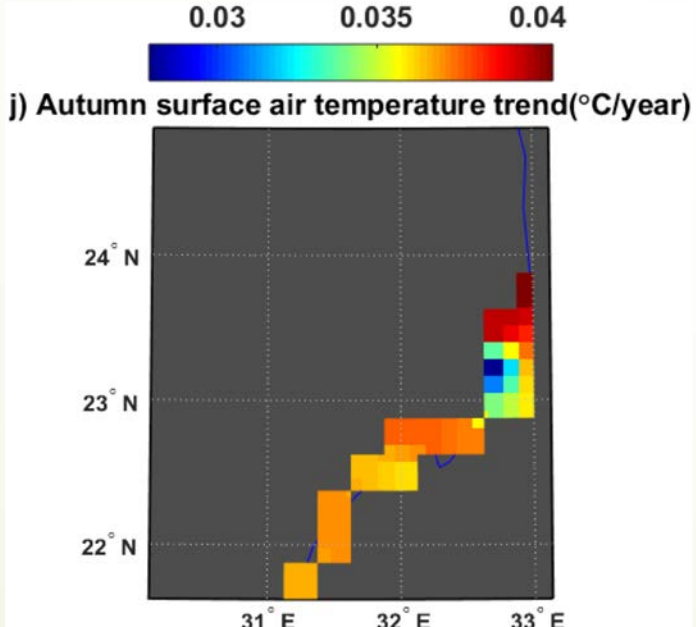
Spatial distribution of the annual/seasonal Lake Nasser t2m trends over the period from 1979 to 2018.





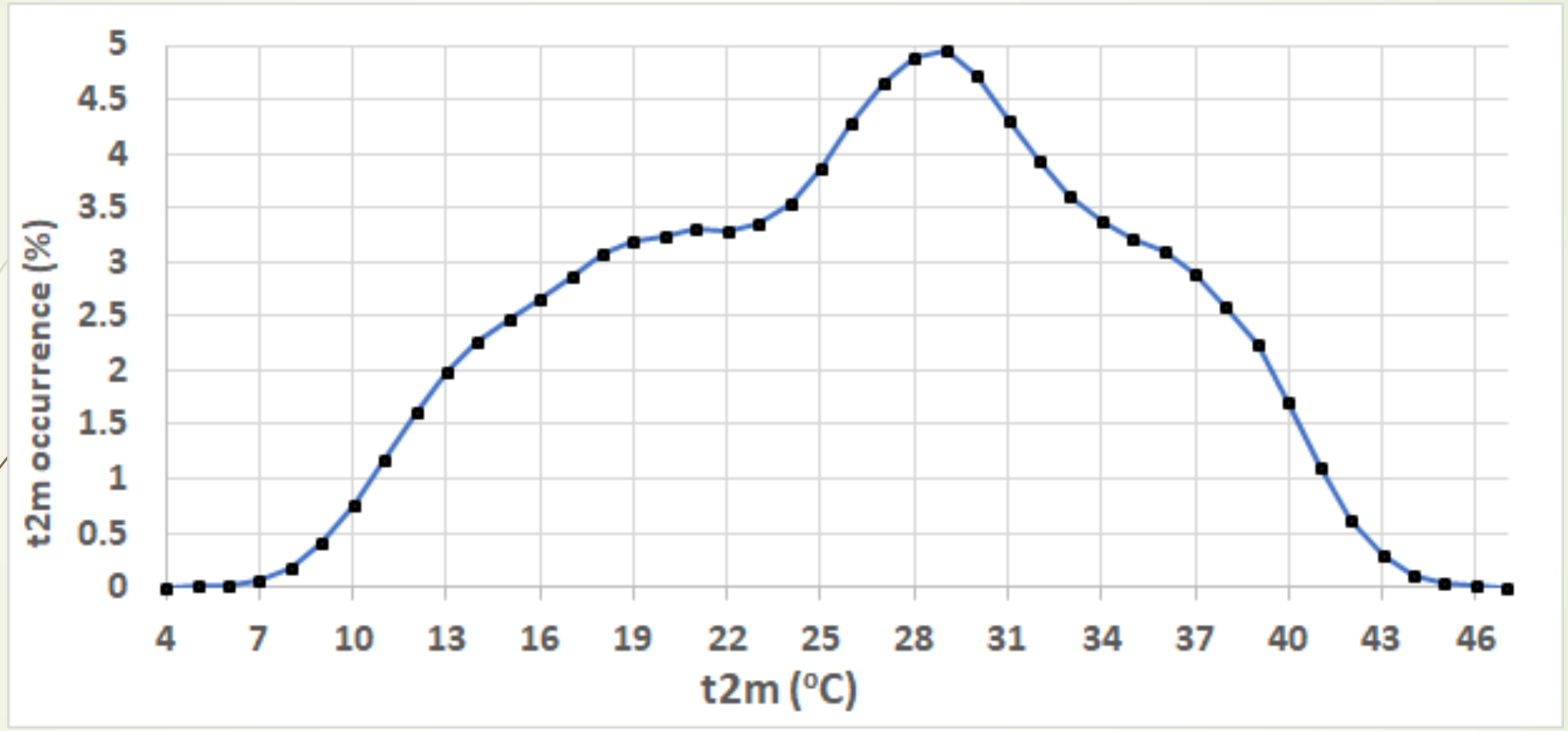




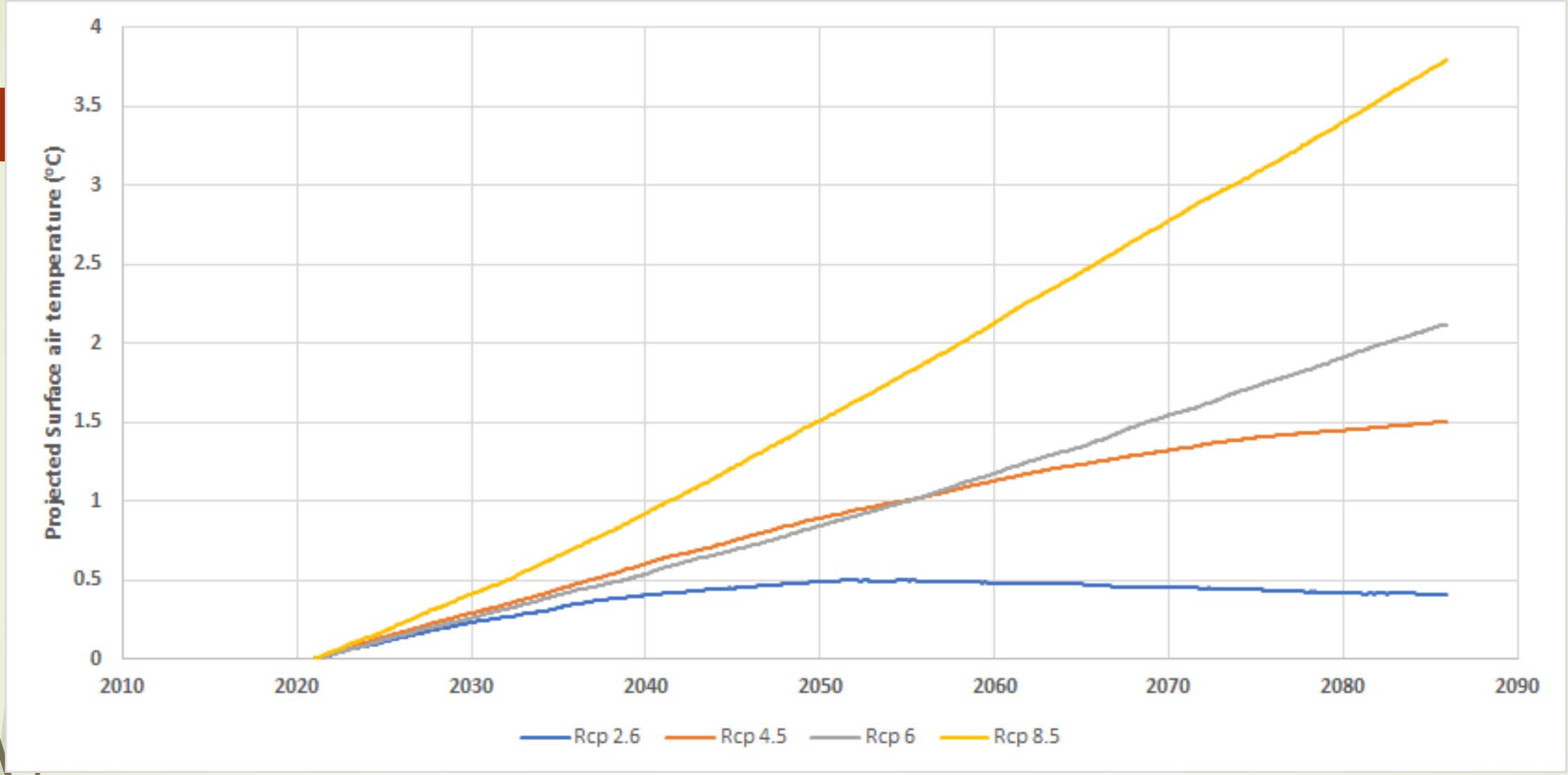


	Min	Max	Range	Average
Annual	0.041	0.054	0.013	0.051
Winter	0.051	0.068	0.016	0.063
Spring	0.025	0.037	0.012	0.033
Summer	0.046	0.067	0.021	0.060
Autumn	0.028	0.040	0.013	0.037

Occurrence percentage of the surface air temperature in Lake Nasser over the period from 1979 to 2018 based on daily average data.



Percentage (%)	Range
46.1 %	24 – 34 °C
91.9 %	13 - 39 °C



Thirty-year running annual means of projected sea surface temperatures (Tos) under the four representative concentration pathway scenarios studied (RCP2.6, RCP4.5, RCP6.0, and RCP8.5) relative to the 2006—2035 period for the Ensemble mean model simulation in Lake Nasser.

Bias Correction of Remote Sensing Data

Data:

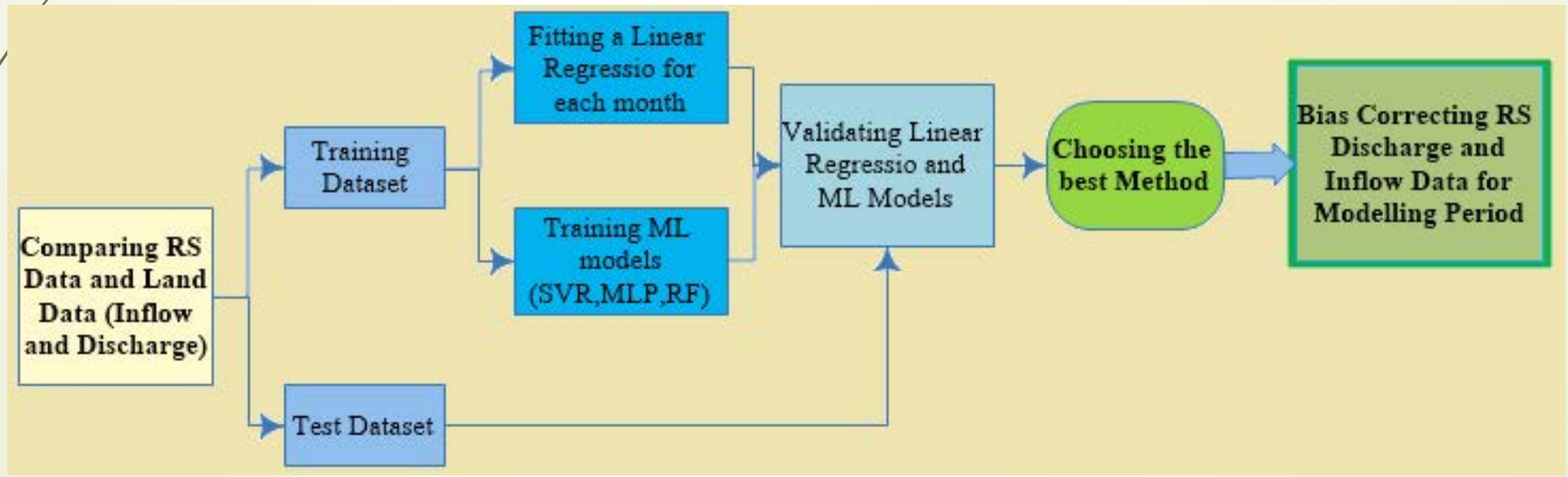
- Nile river discharge obtained from the Global Flood Awareness System (GloFAS) from 1979-01-01 up to near real-time. This dataset is freely downloaded from the Copernicus Emergency Management Service (CEMS) via https://cds.climate.copernicus.eu/cdsapp#!/dataset/cems-glofas-historical?tab=overview.

- This data simulated by forcing the hydrological river routing model with modelled gridded runoff data from global reanalysis. The land surface model that produced the runoff was HTESSEL, and the river routing model component was LISFLOOD, run with a 0.1° x 0.1° spatial resolution at a daily time step. Harrigan et al.(2020) showed that this data set provides a relevant tool to estimate how much water is flowing through rivers.

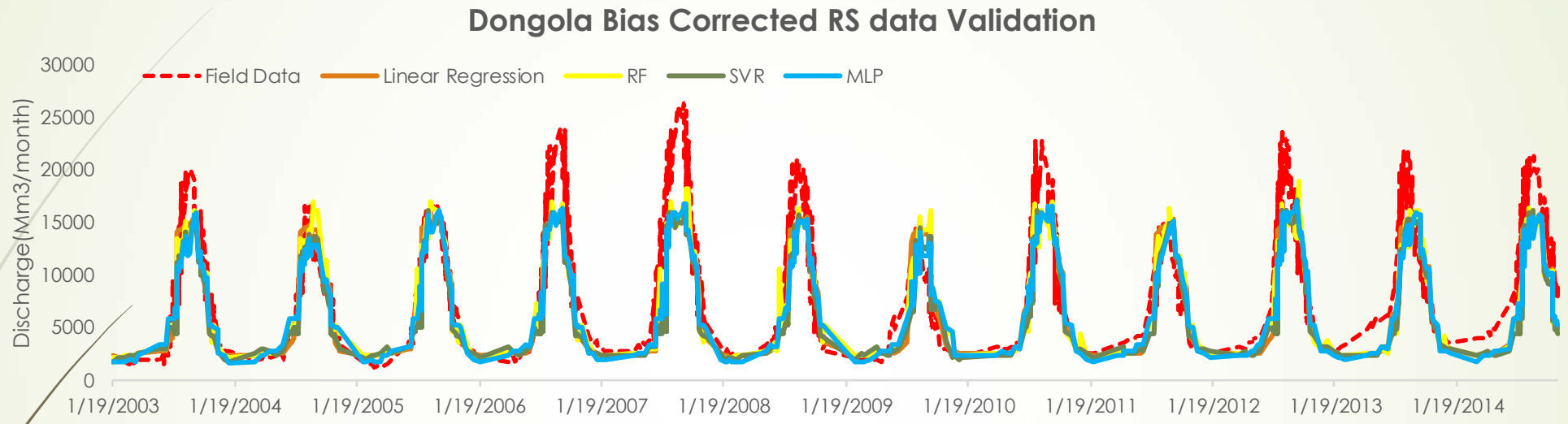
Harrigan, S., Zsoter, E., Alfieri, L., Prudhomme, C., Salamon, P., Wetterhall, F., Barnard, C., Cloke, H., Pappenberger, F. (2020): GloFAS-ERA5 operational global river discharge reanalysis 1979-present, Earth System Science Dat

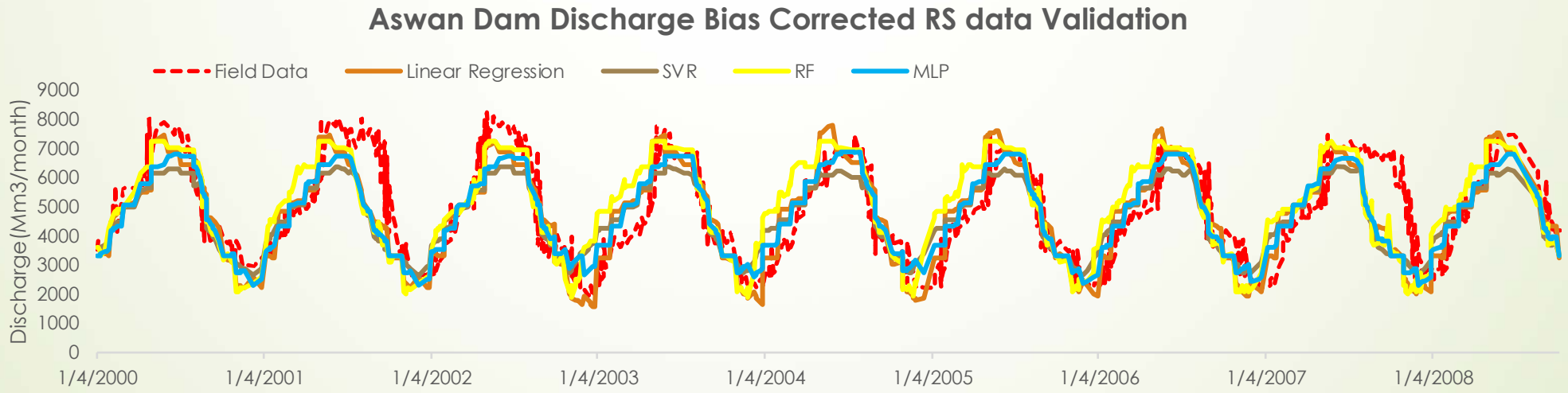
Bias Correction of Remote Sensing Data

- Methods:
  - Linear Regression
  - Machine Learning



Bias Corrected Data Validation Compared to Observation





Bias Correction Calibration and Validation Results

Dongola

	Linear Regression	Random Forest	SVR	MLP
NS Validation	0.594	0.649	0.635	0. 631
NS Calibration	0.637	0.799	0.698	0.691

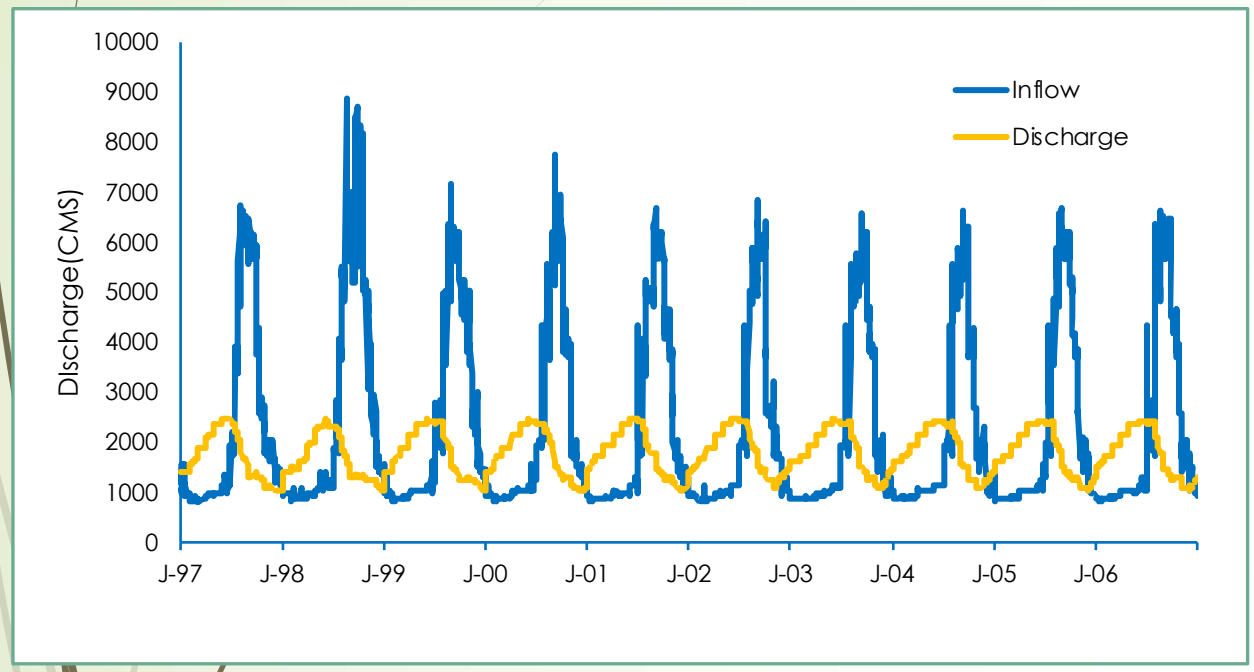
Lake Nasser Discharge

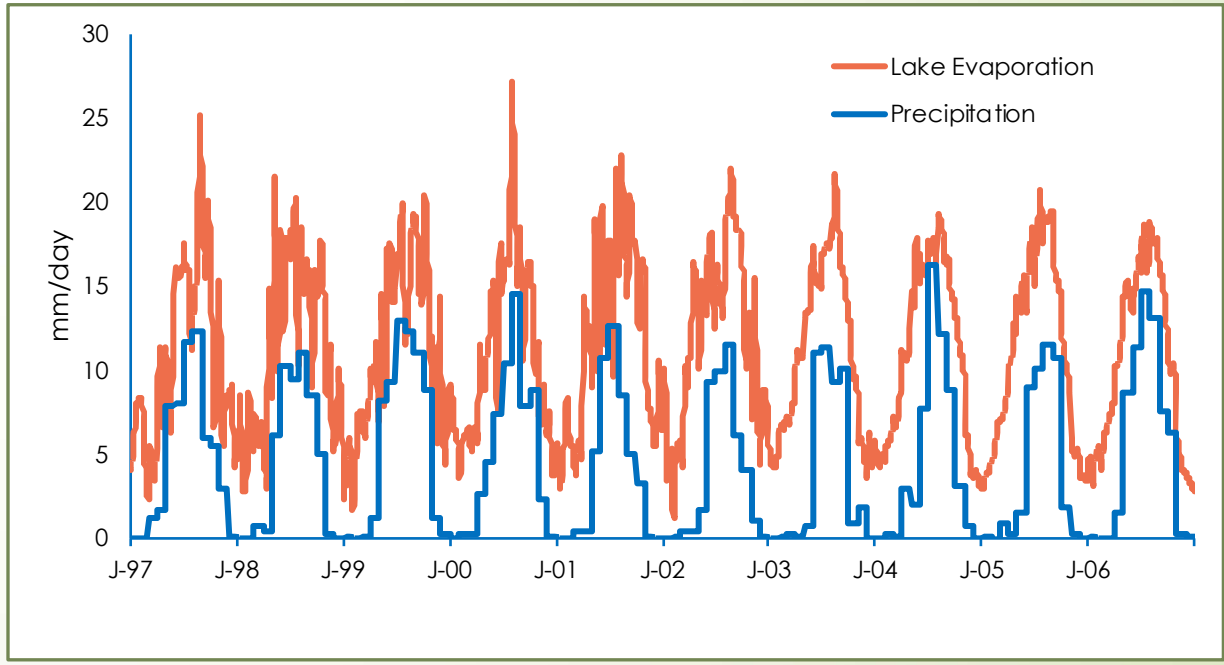
	Linear Regression	Random Forest	SVR	MLP
NS Validation	0.598	0.434	0.558	0.649
NS Calibration	0.780	0.885	0.724	0.724

Data

- Reservoir Inflow (Bias Corrected)
- Lake Nasser Discharge (Bias Corrected)
- Reservoir Evaporation (Bias Corrected)
- Rainfall Data
- Lake Nasser Level Global Reservoirs and Lakes Monitor (G-REALM)-TOPEX/Poseidon/Jason satellite series (at 10-day resolution
- Toshka Flow-Level Relation (Mostafa, 1998)
- Volume Elevation Area Relation of Lake Nasser (Shafik , 2016)
- Period of Data 1997-2007

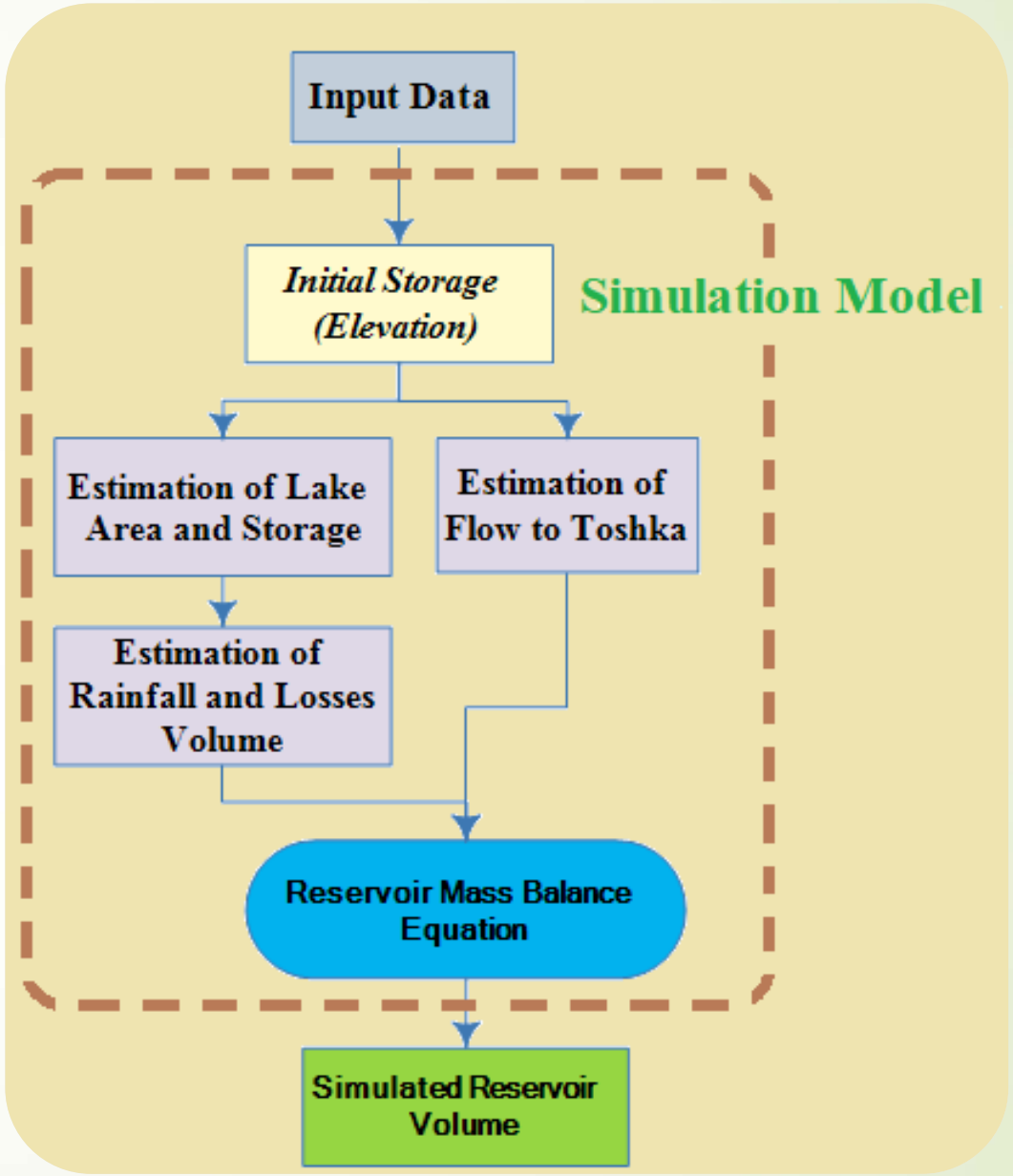
Data Time Series



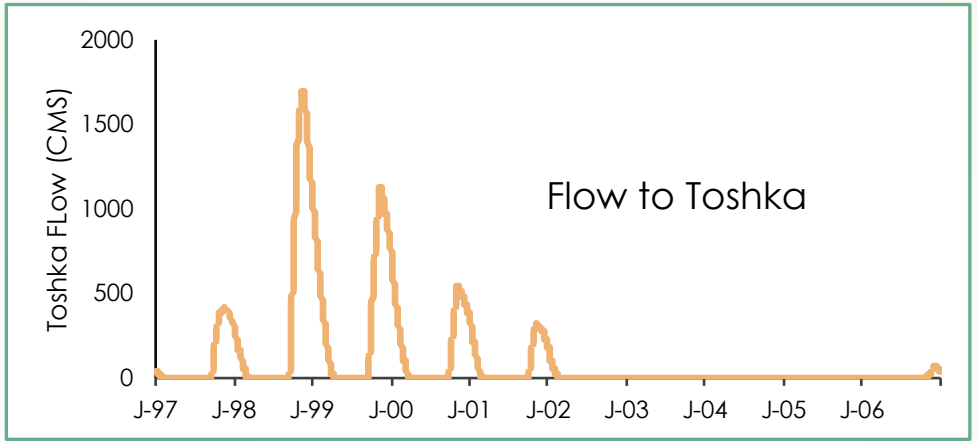


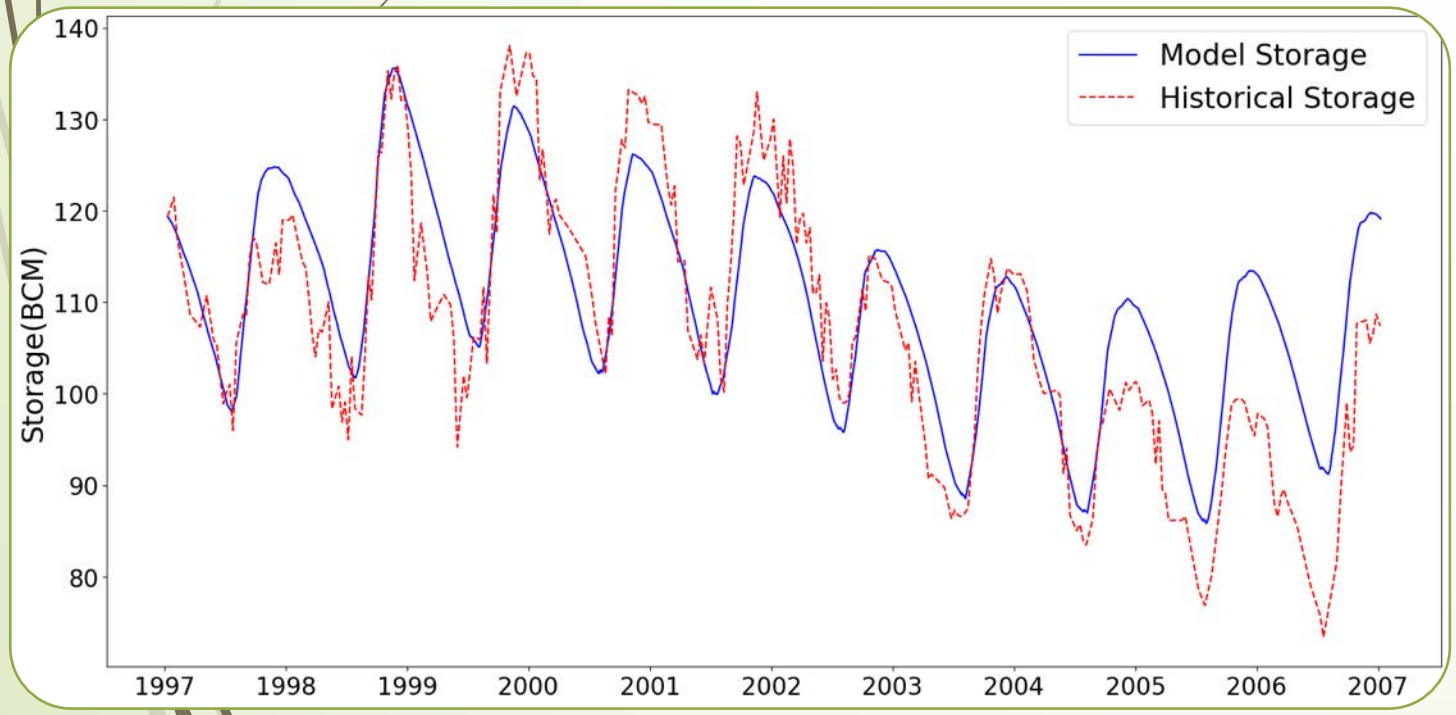
Simulation Model

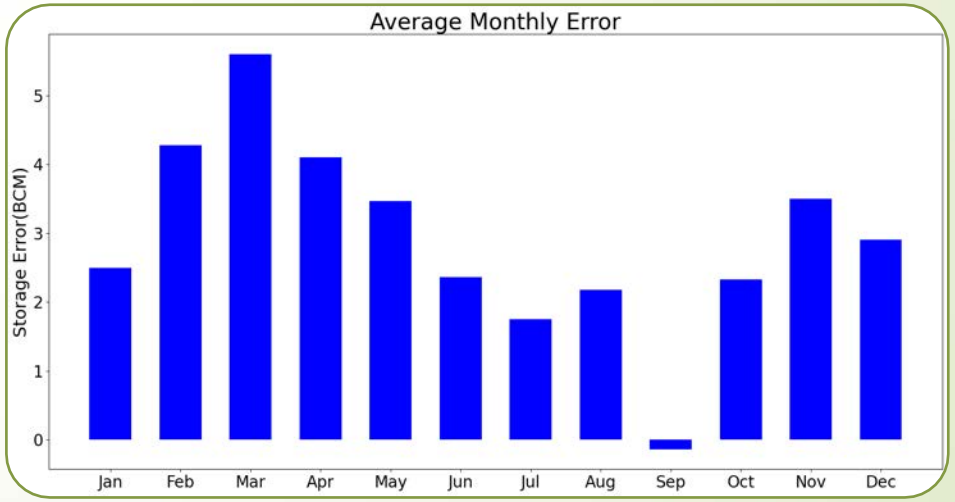
- **Mass Balance Reservoir Model**
- **Time Step (Daily)**
- **Developed in Python**



Model Results







Future Work…

- Compare the evaporation between Lake Nasser and GERD Lake under different climate change scenarios
- Study the evaporation in Lake Nasser khors
- Forecast short-term and long-term (using GCM projections) inflows to Lake Nasser
- Simulate the pumping to Toshka Lake
- Simulate the operation of Aswan dam and Multi-objective (e.g. decrease the losses/evaporation from the reservoir, supply water demand, and increase hydropower generation) analysis to optimize discharge from the dam

Thanks for your patience

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Ibraim Amer in his cucumber greenhouse / Claudia Gutierrez, USAID

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