What Do We Know About Dying and Dead Seas?

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Keyword: “Dying Sea”

2003	**609,000 references**
21 July 2014	**37,400,000 references**

Critical Lakes

The Aral Sea
The Caspian Sea
The Kara Bogaz-Gol Bay (Turkmenistan)
The Sarykamysh Lake (Turkmenistan)
The Balkhash Lake (Kazakhstan)
The Issyk-Kul Lake (Kirgizstan)
The Dead Sea (Israel)
The Akrotiri Lake (Cyprus)
The Mesopotamia (Iraq)
The Great Salt Lake (Utah, USA)
The Mono Lake (California, USA)
The Salton Sea Lake (California, USA)
The Pyramid Lake (Nevada, USA)
Great Lakes (USA/Canada)
The Lobnor Lake (China)
The Qinghai Hu Lake (China)
Lake Ebinur (China)

The Chad Lake (Africa)
The Victoria Lake (Africa)
The Kyoga Lake (Uganda)
Lake Elmenteita (Kenya)
The Turkana Lake (Kenya)
The Tanganyika Lake (Africa)
The Nyasa Lake (Malawi)
The Rukwa Lake (Tanzania)
Lake Corangamite (Australia)
Lake Eyre (Australia)
The Lake Biwa (Japan)

NATO ARW "Critical Scientific Issues of the Aral Sea Basin: State of Knowledge and Future Research Needs", Tashkent, Uzbekistan, May 2-5, 1994

W.D. Williams (1996):

The Issyk-Kul Lake - 10 m since 1876
The Dead Sea - 8 m since 1980,
200 to 340 g/l since 1910
The Mono Lake - 15 m since 1920,
48 to 90 g/l since 1941
The Pyramid Lake - 21 m since 1910,
3.8 to 5.5 g/l between 1933 and 1980
The Lobnor Lake (China) ,
completely dried up in 1972
The Qinghai Hu Lake - 10 m since 1908,
5.6 to 12 g/l since 1950
Lake Elmenteita - 0.7 m since 1978
Lake Corangamite - 3 m since 1960,
35 to 50 g/l since 1960

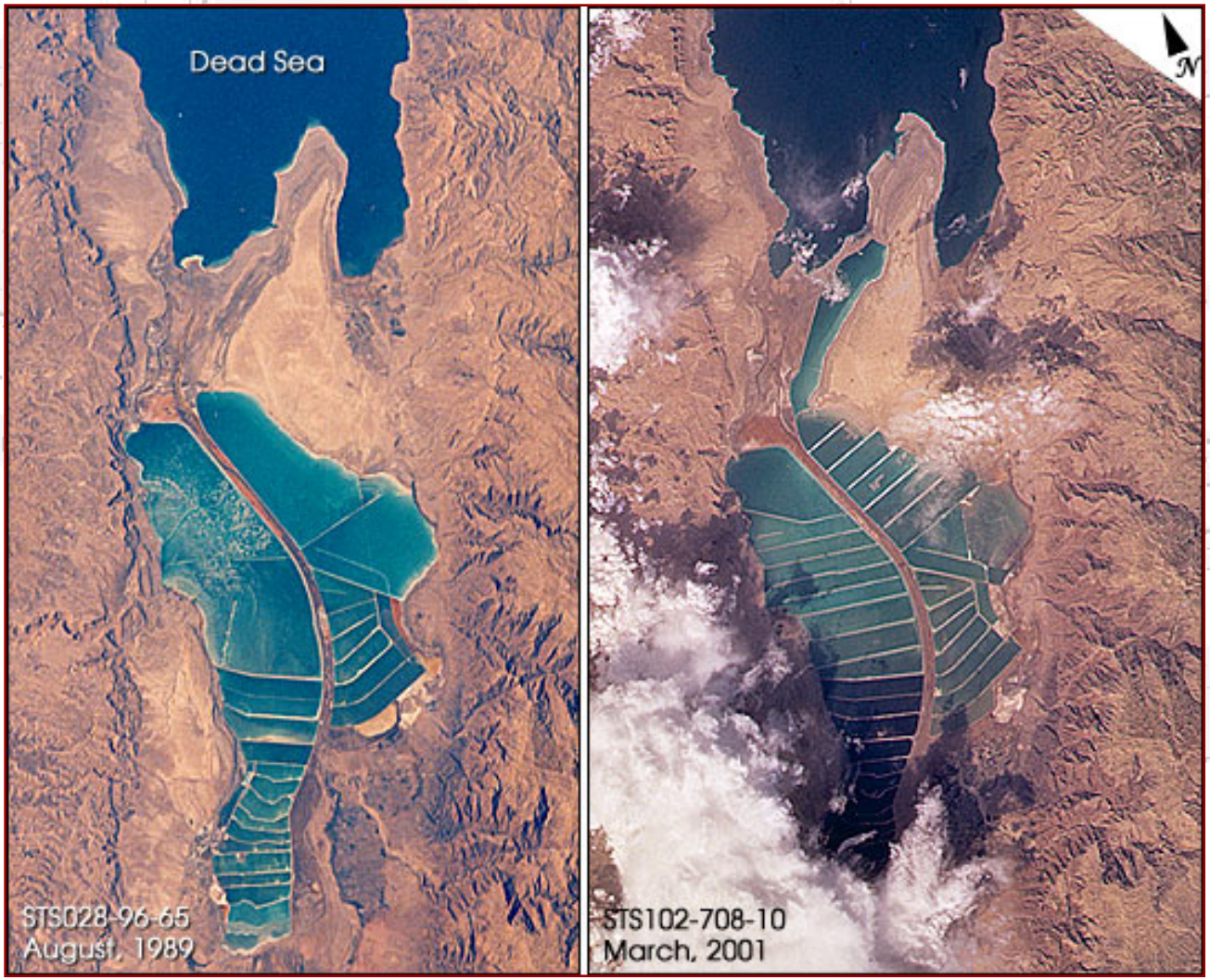
Lake Lobnor

Lobnor was a fresh water lake during the Holocene era. It became a saltwater lake about 750 years ago. North and northwest China, where the average annual precipitation has decreased by one third between the 1950s and the 1980s, has been experiencing a desiccation process. For example, lake Lobnor vanished in 1972, and lake Kukunor, since the beginning of Holocene period, has dwindled in area by one third and in depth by 100 m. The depth of lake Ohlin, at the head of the Yellow River, has been dropping by over 2 cm annually (Wang Hongchang, 1993).

Dead Sea

The MODIS image on 10 September 2000

Dead Sea

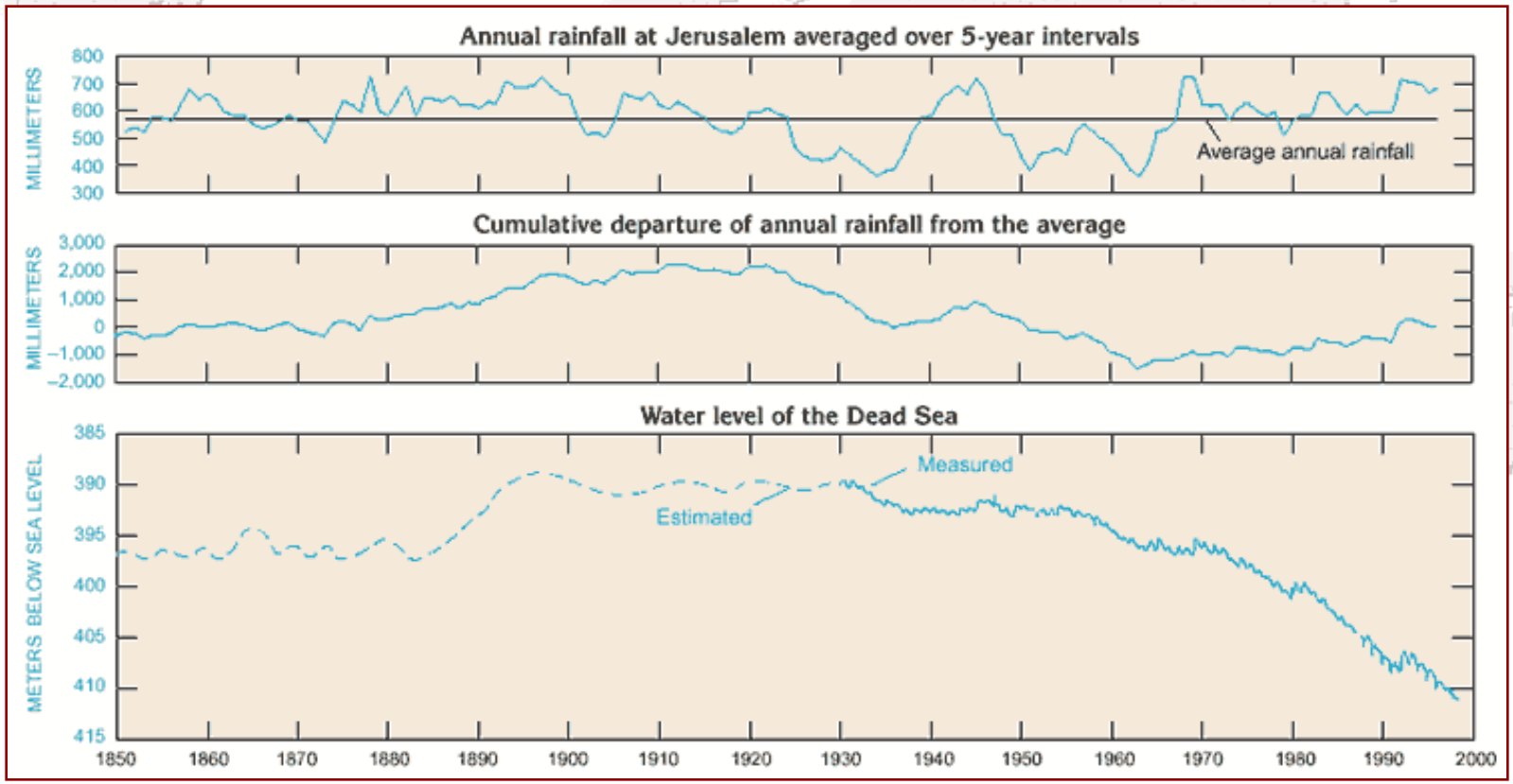


Salt Evaporation Ponds, Dead Sea (Space Shuttle)

Dead Sea

Since 1978 the length of the Dead Sea decreased from 80 km to 50 km, max depth has diminished to 316 m, surface - 815 km sq., volume - 146 km cub., sea level has reached -414 m (14 m drop with an average rate of 0.6-1.0 m/year), salinity - 280 ‰ (usual salinity).

Reason: evaporation exceeds rain and runoff into the sea (Gertman, Hecht, 2002)

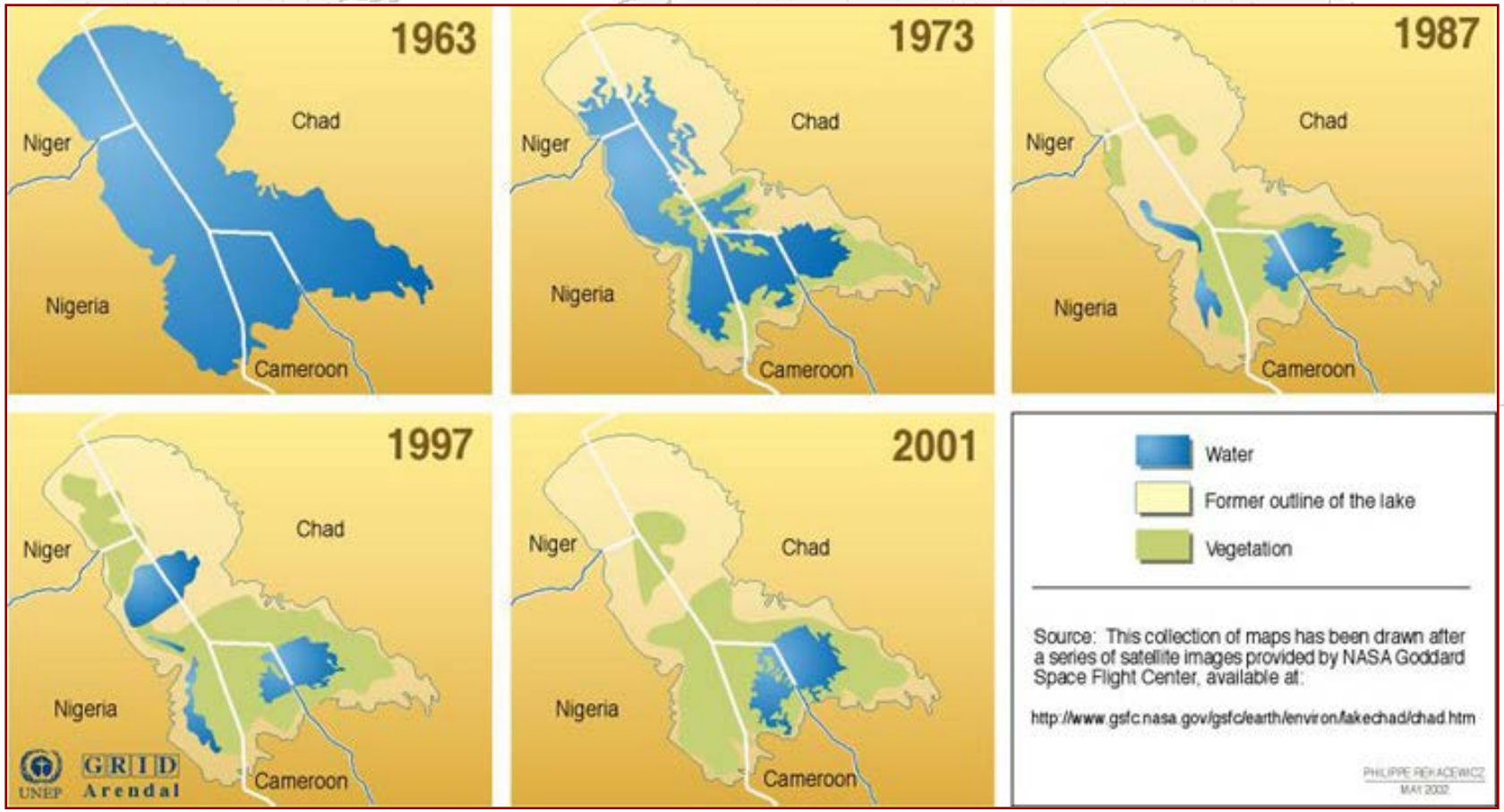


Lake Chad

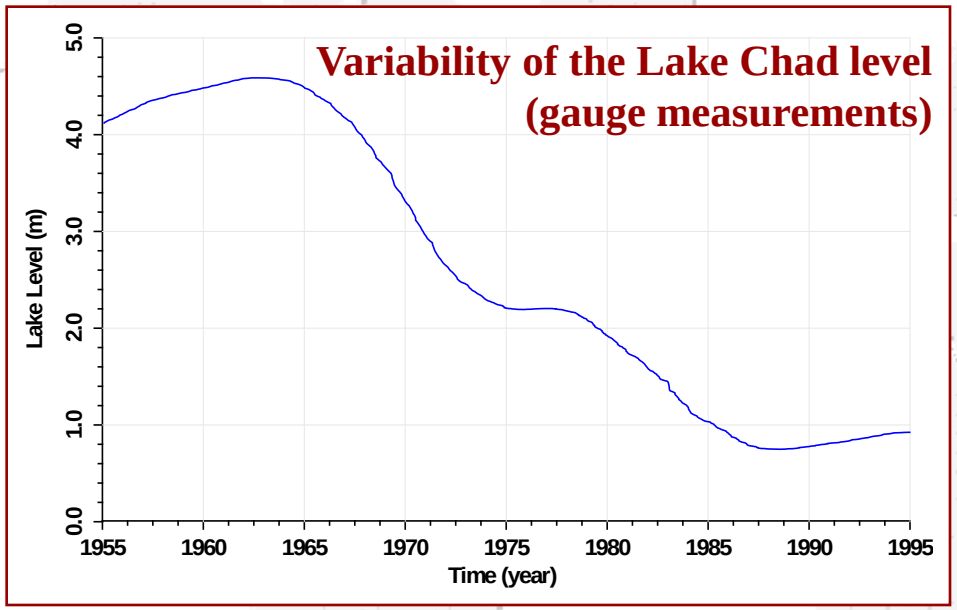
Lake Chad, once one of the largest on the Earth has been dramatically decreasing since the sixties. Today, it only covers about one-tenth of its maximum surface.

Lake Chad

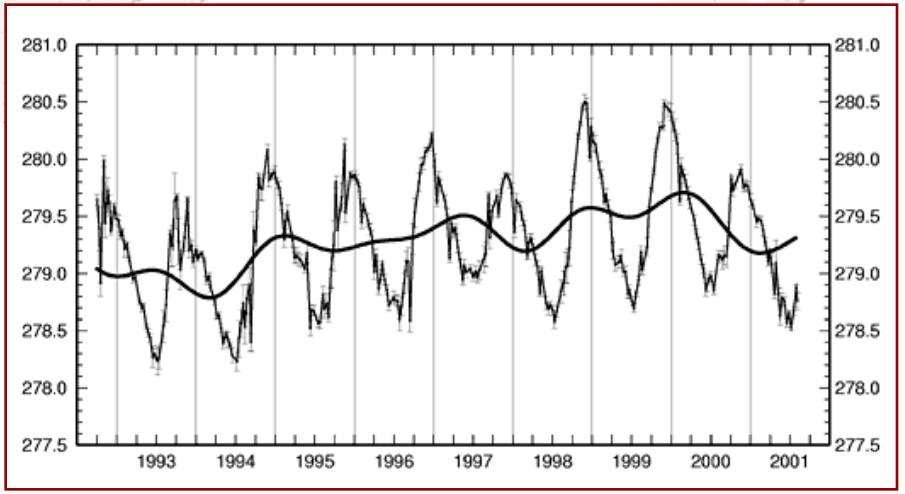
Disappearance of Lake Chad



Lake Chad



The lake level decrease was correlated to drought and to pumping and irrigation. The monitoring of this level by Topex/Poseidon shows that this dramatic decrease has stopped and a rise of the water level of about 1 meter since 1993 is observed. This rise is welcomed to solve water resources and ecological problems (AVISO).

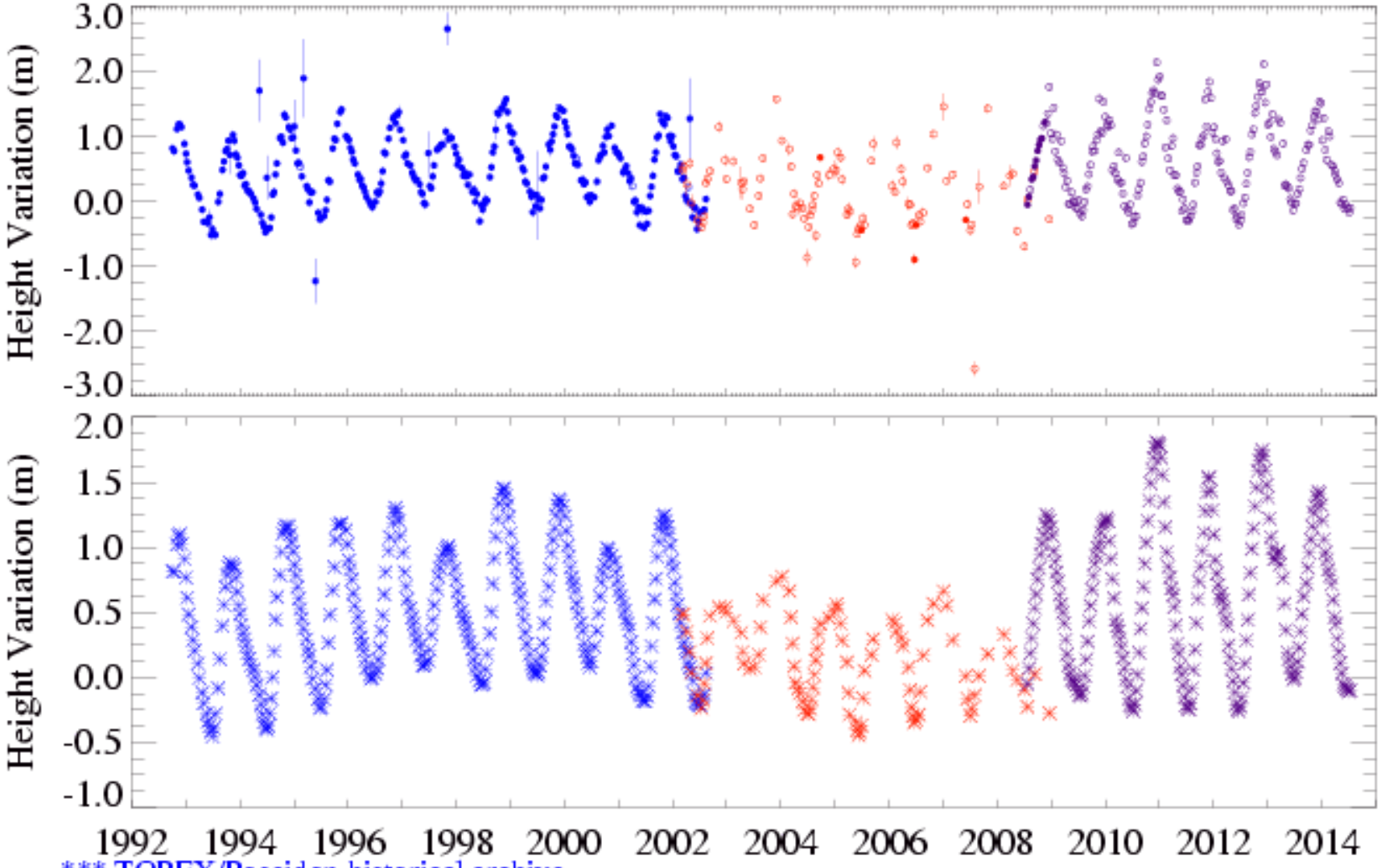


Time variation of the Lake Chad level by TOPEX/POSEIDON satellite altimetry (AVISO)

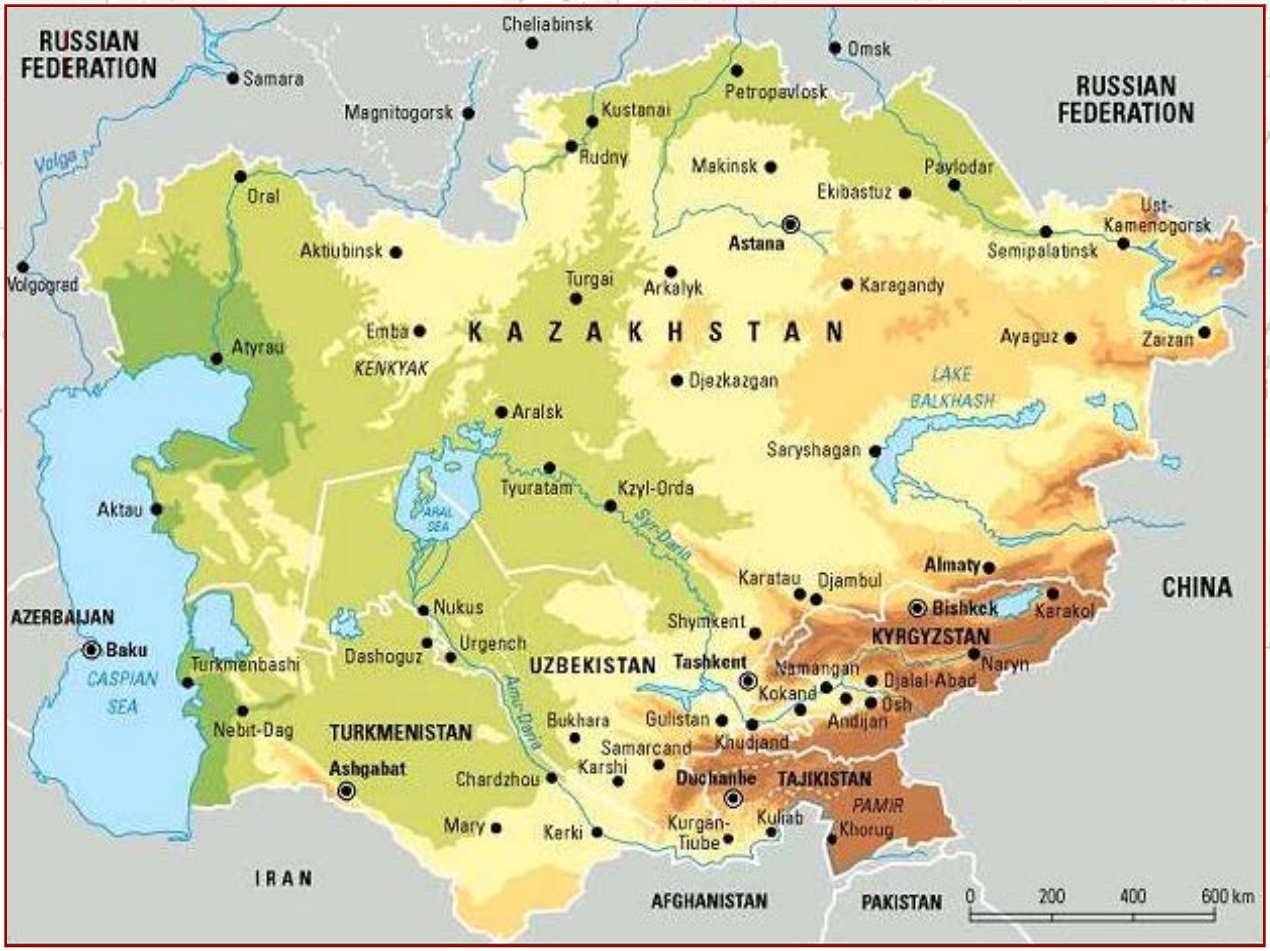
USDA, 2014

Lake Chad Height Variations

Jason-2 Geo-referenced 20Hz Along Track Reference Pass 248 Cycle 75



Seas and Lakes of Central Asia



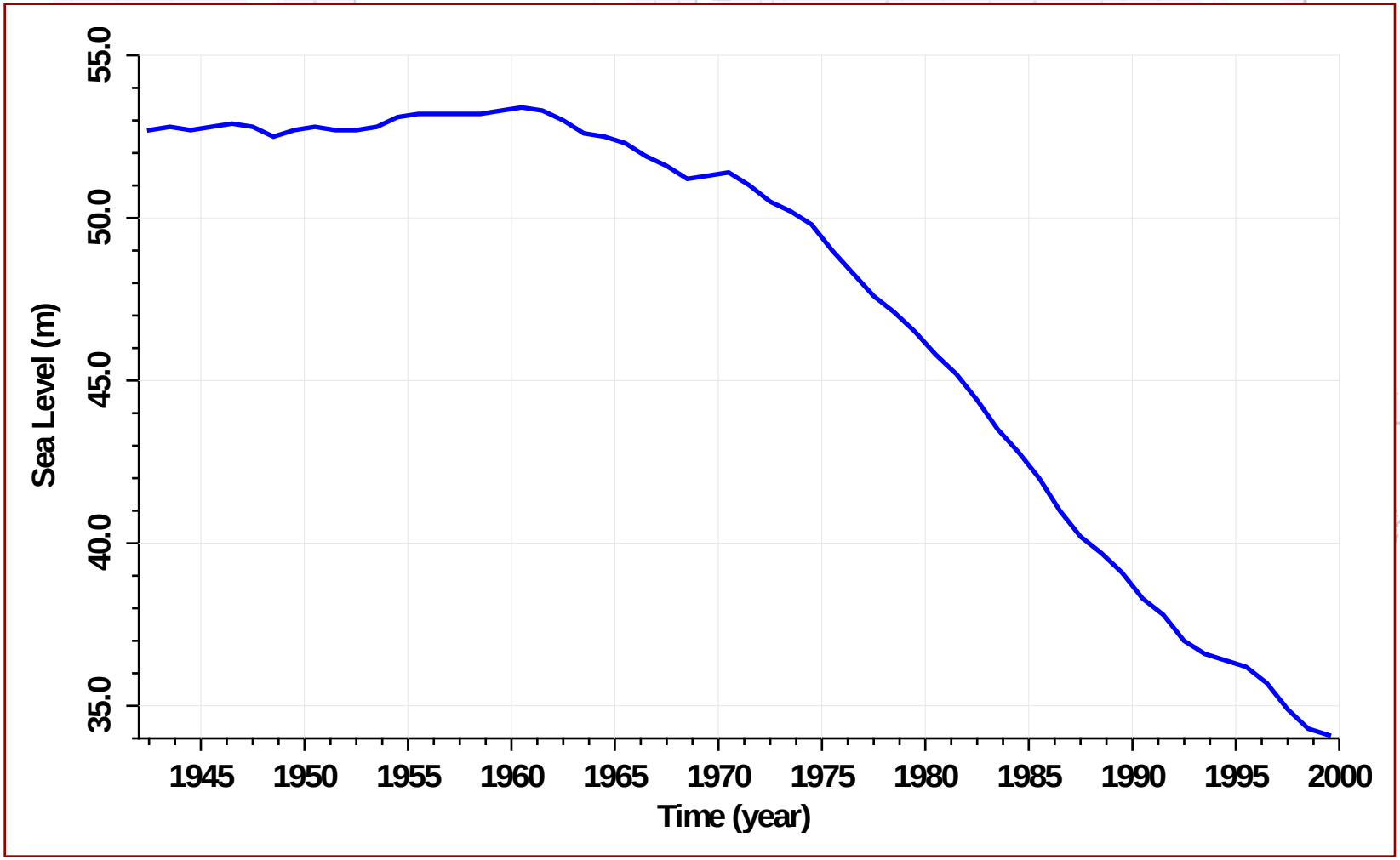
Aral Sea

Survey of the Sea of Aral by Commander A. Butakoff, Imperial Russian Navy, in 1848-1849

The MODIS image on 18 May 2002

Aral Sea

The Aral Sea level (1940-2000)



The Aral Sea:
Selected Bibliography

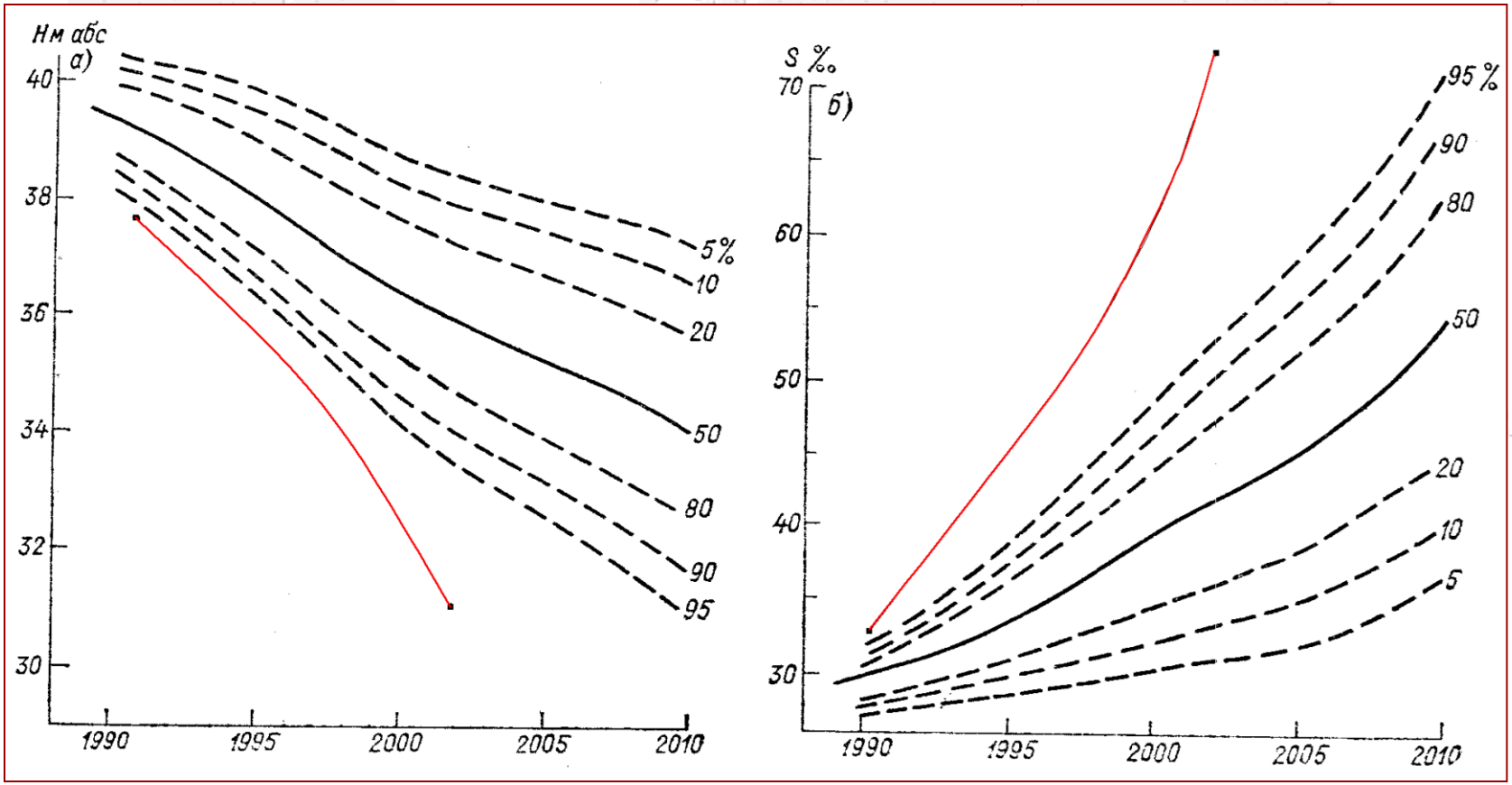
NOOSPHERE
Moscow, 2002

Editors:
J.C.J. Nihoul
A.N. Kosarev
A.G. Kostianoy
I.S. Zonn

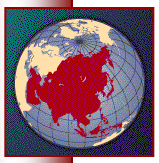
1829 – 2000
1540 publications
1172 authors

Aral Sea

Prediction of the Aral Sea absolute level and salinity



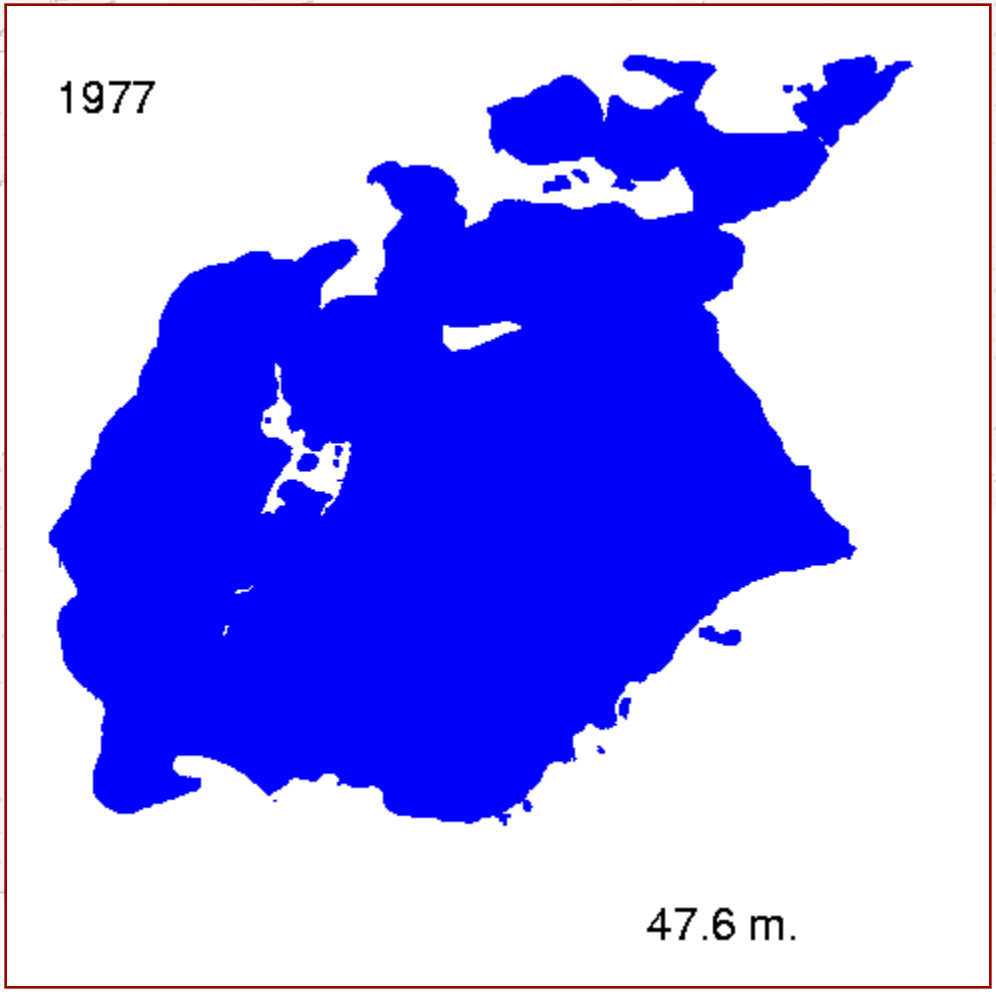
Bortnik and Chistyaeva (1989)



Aral Sea

Year	Area (km^2)	Volume (km^3)	Sea Level (m)	Salinity (g/l)	Data Source
1960	~68,000	~1,040	53	~10	*WDB II*
1985	45,713	468	41.5	~23	*NOAA-AVHRR*
1986	43,630	380	40.5		*NOAA-AVHRR*
1987	42,650	354	40		*NOAA-AVHRR*
1988	41,134	339	39.5		*NOAA-AVHRR*
1989	40,680	320	39	~30	*NOAA-AVHRR*
1990	38,817	282	38.5		*NOAA-AVHRR*
1991	37,159	248	38		*NOAA-AVHRR*
1992	36,087	231	37.5		*NOAA-AVHRR*
1993	35,654	248	37		*NOAA-AVHRR*
1994	35,215	248	37		*NOAA-AVHRR*
1995	35,374	248	37		*RESURS-01*
1996	31,516	212	36		*RESURS-01*
1997	29,632	190	35		*RESURS-01*
1998	28,687	181	34.8	~45	*NOAA-AVHRR*
November 2002	~15,000	~100	30.47	82-94	*Hydrography*
2010	21,058	~124	32.4	~70	*Bathymetry*

Aral Sea

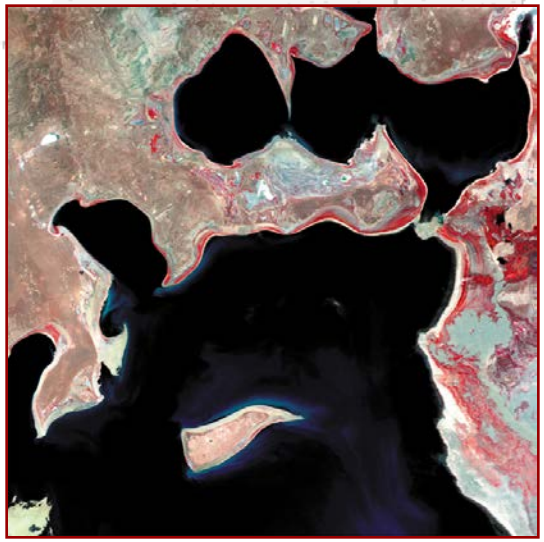


Desiccation of the Aral Sea (1977-2050)

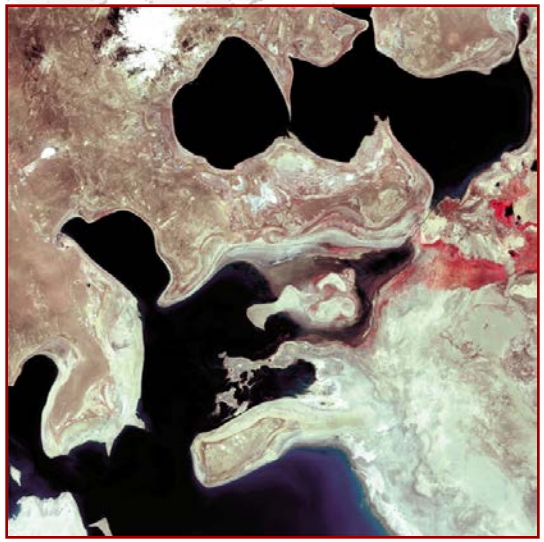
Aral Sea

The sequence of satellite images acquired by Landsat shows dramatic changes of the northern Aral Sea between 1973 and 2000.

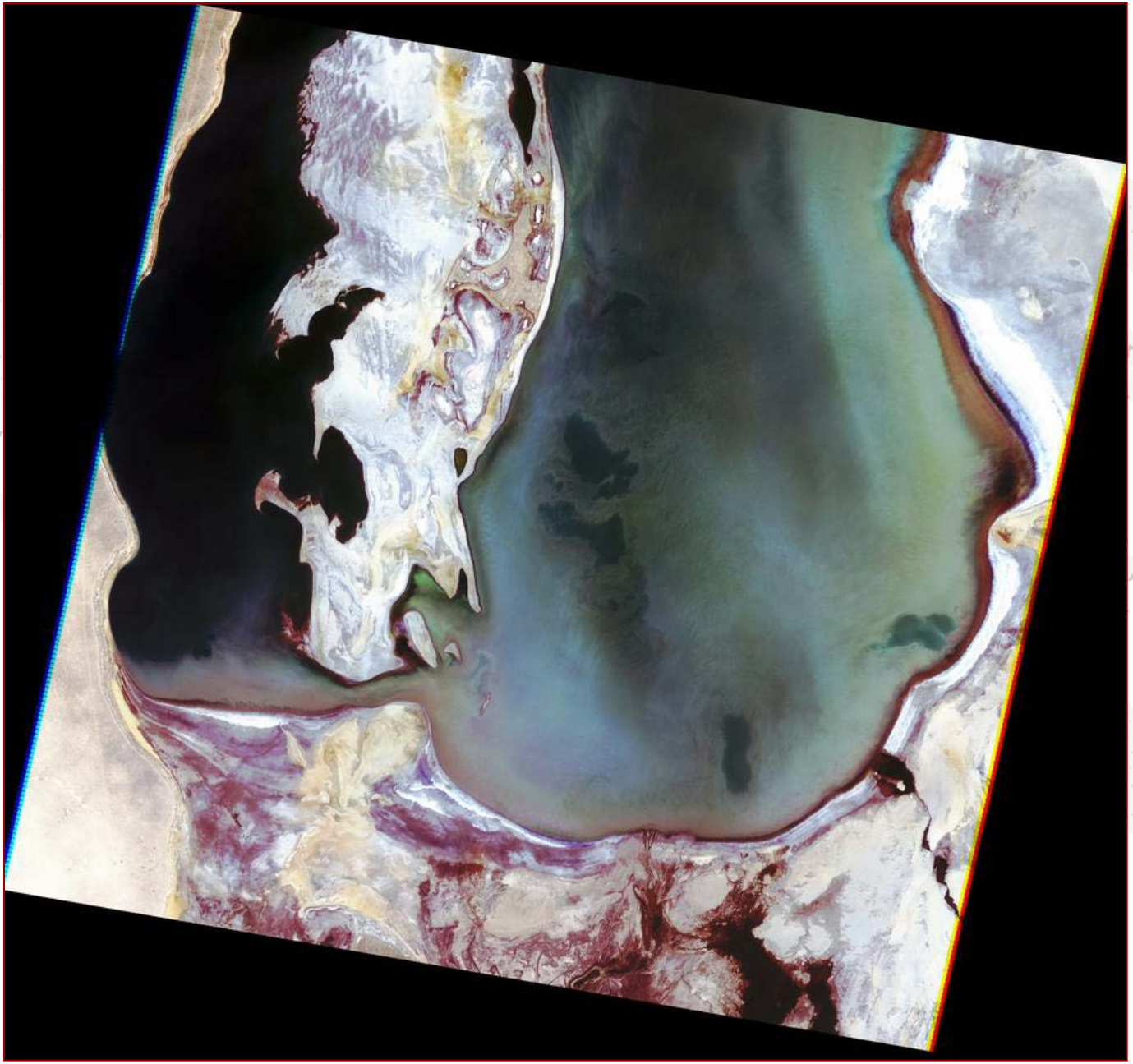
29 May 1973



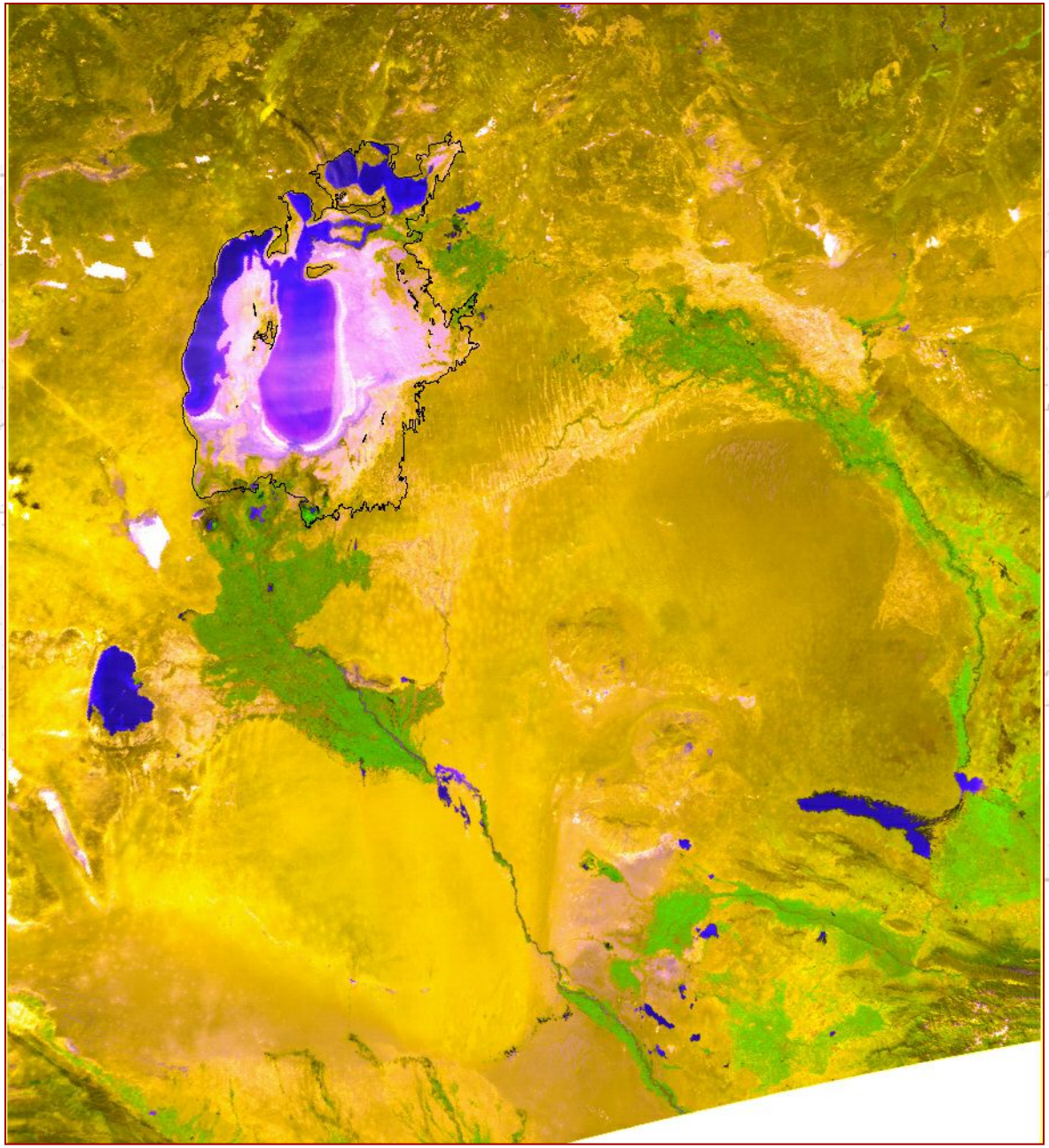
19 August 1987



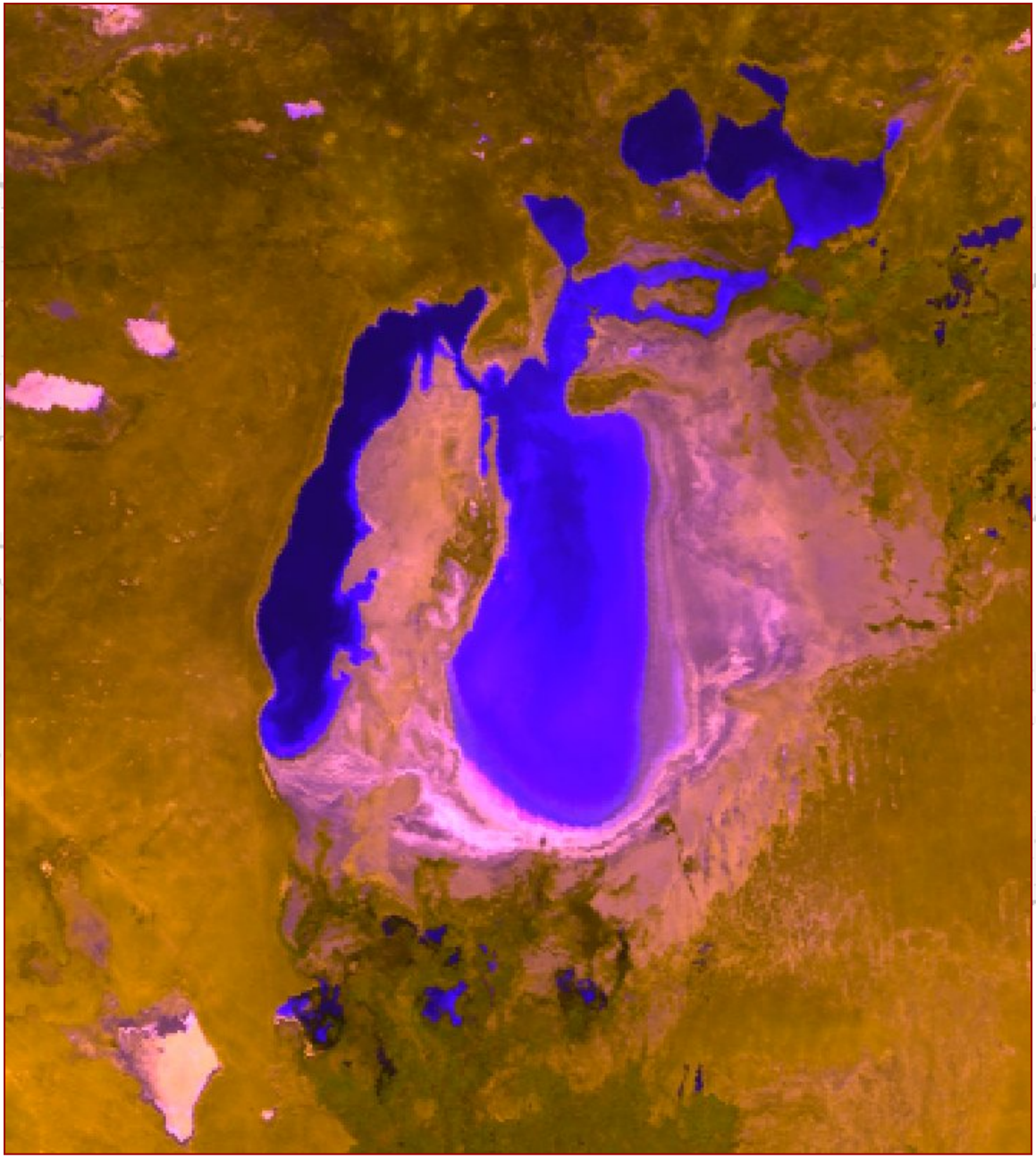
29 July 2000



12 August 1999



8 September 2002



9 November 2002

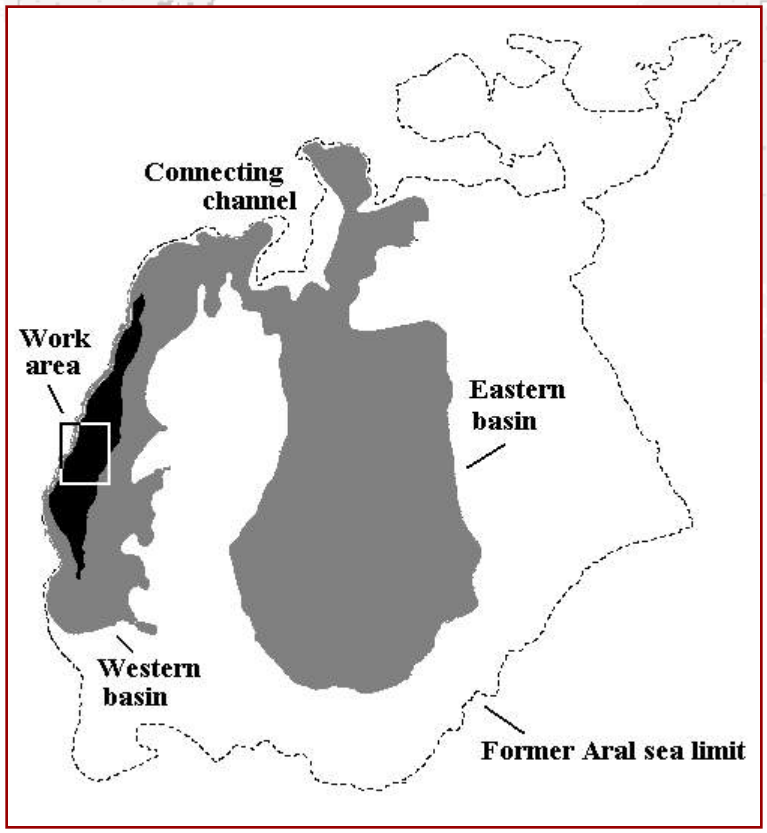
Dried bottom of the western Aral Sea

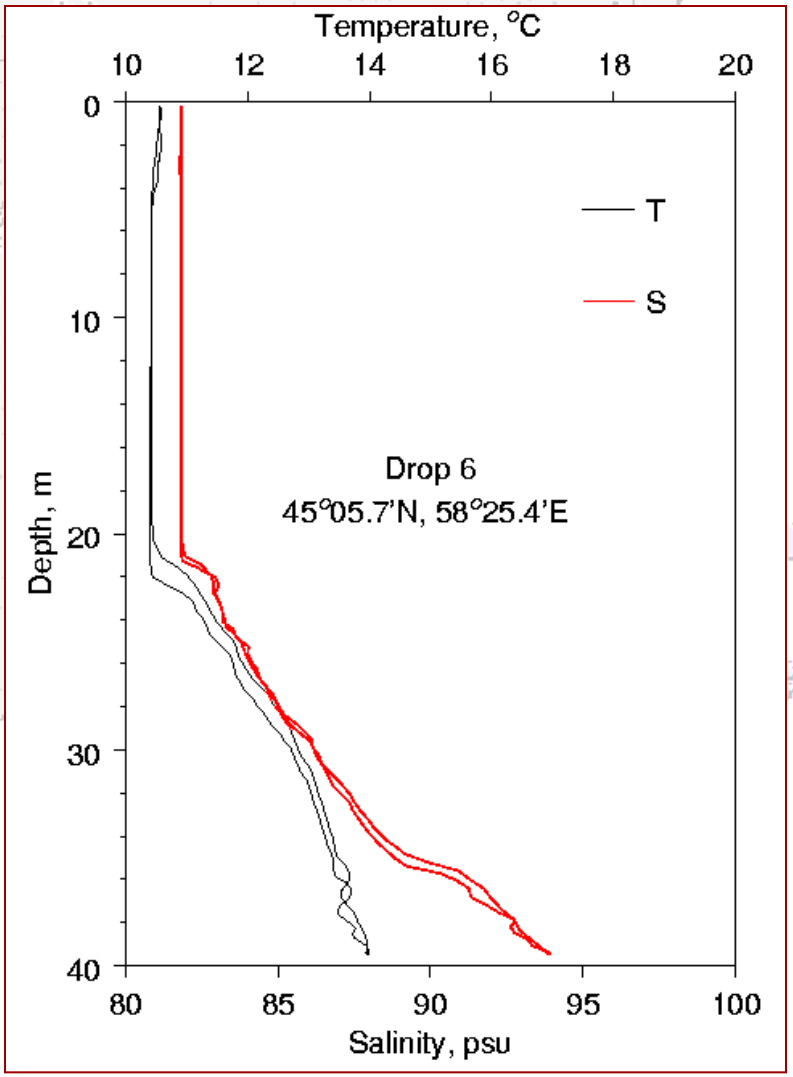
The Aral Sea shoreline

Aral Sea

November 2002

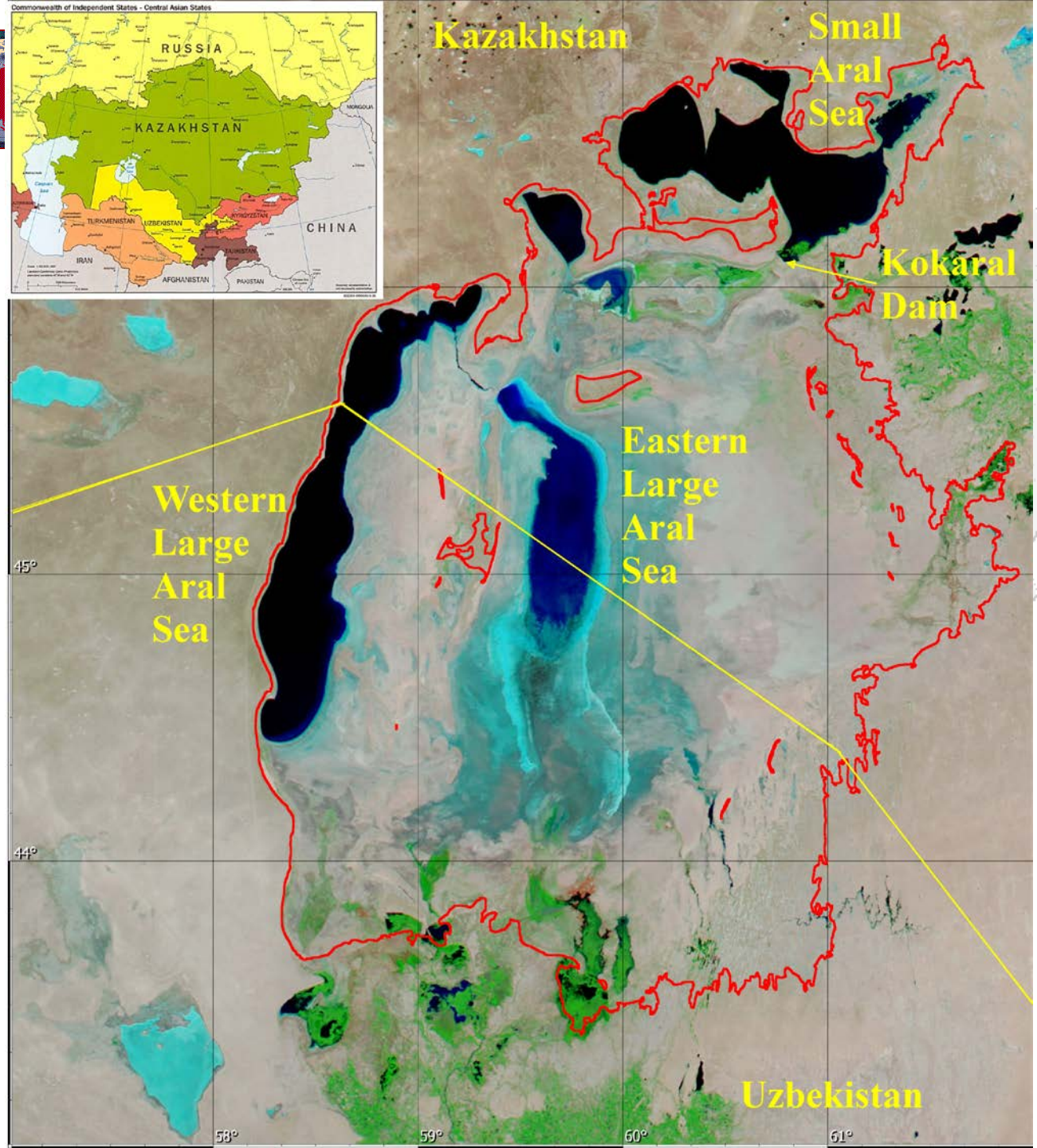
Sea level – 30 m 47 cm





Aral Sea problems

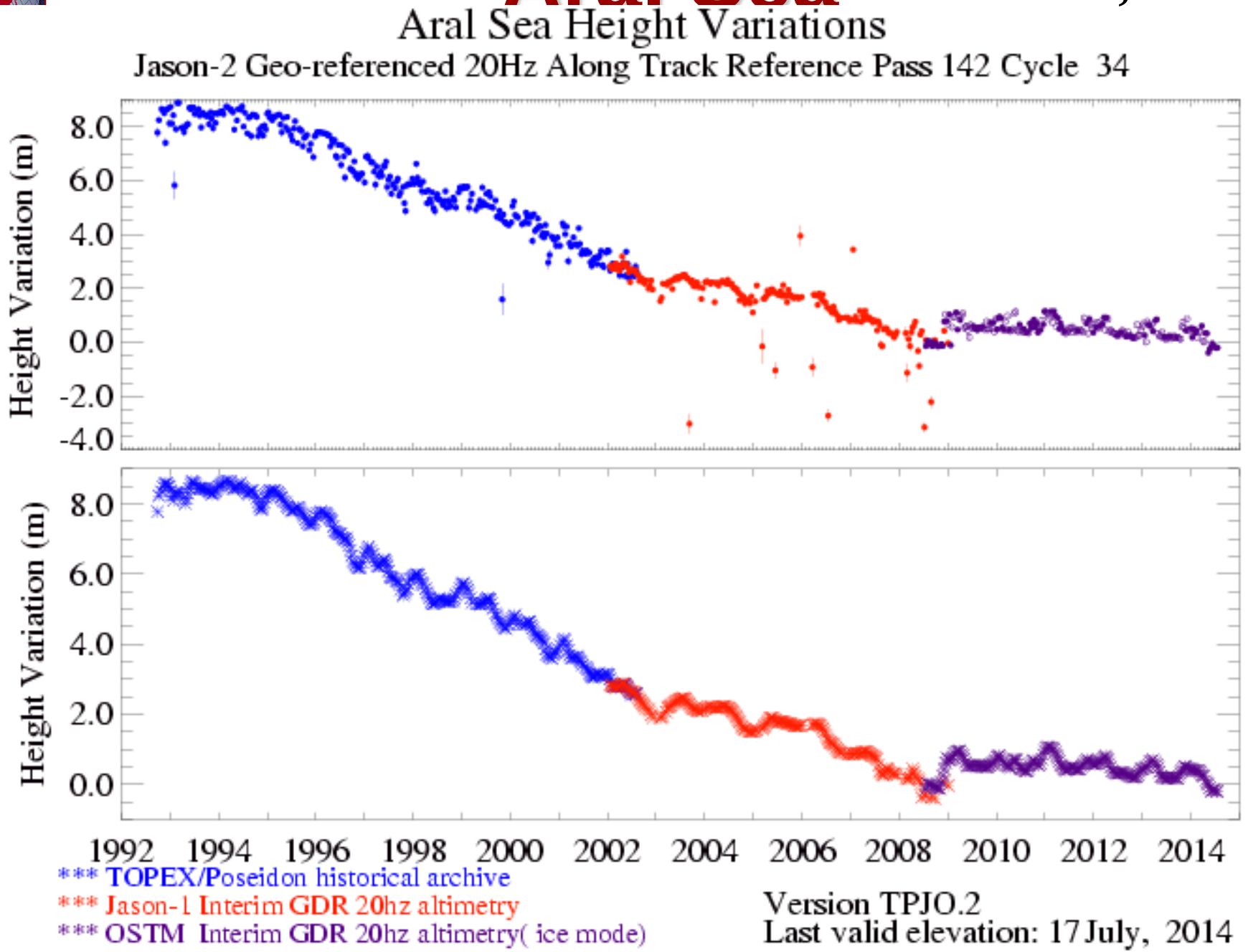
Climatic	Ecological	Economic	Health
Increase of continentality	Desiccation of the Aral Sea and desertification of the Aral Sea region	Total collapse of the fishing industry (originally 44,000 t/a)	Increase of serious diseases (e.g. cholera, typhus, hepatitis, gastritis, blood cancer)
Shift of seasons	Destruction of the Aral Sea and terrestrial ecosystems	Decrease of productivity of agricultural fields	Increase of respiratory system diseases (asthma, bronchitis)
Increase of SST	Degradation of the Amu Darya and Syr Darya delta ecosystems	Unemployment	Birth defects and high infant mortality
Shortening of the vegetation period	Increase of salt and dust storms		



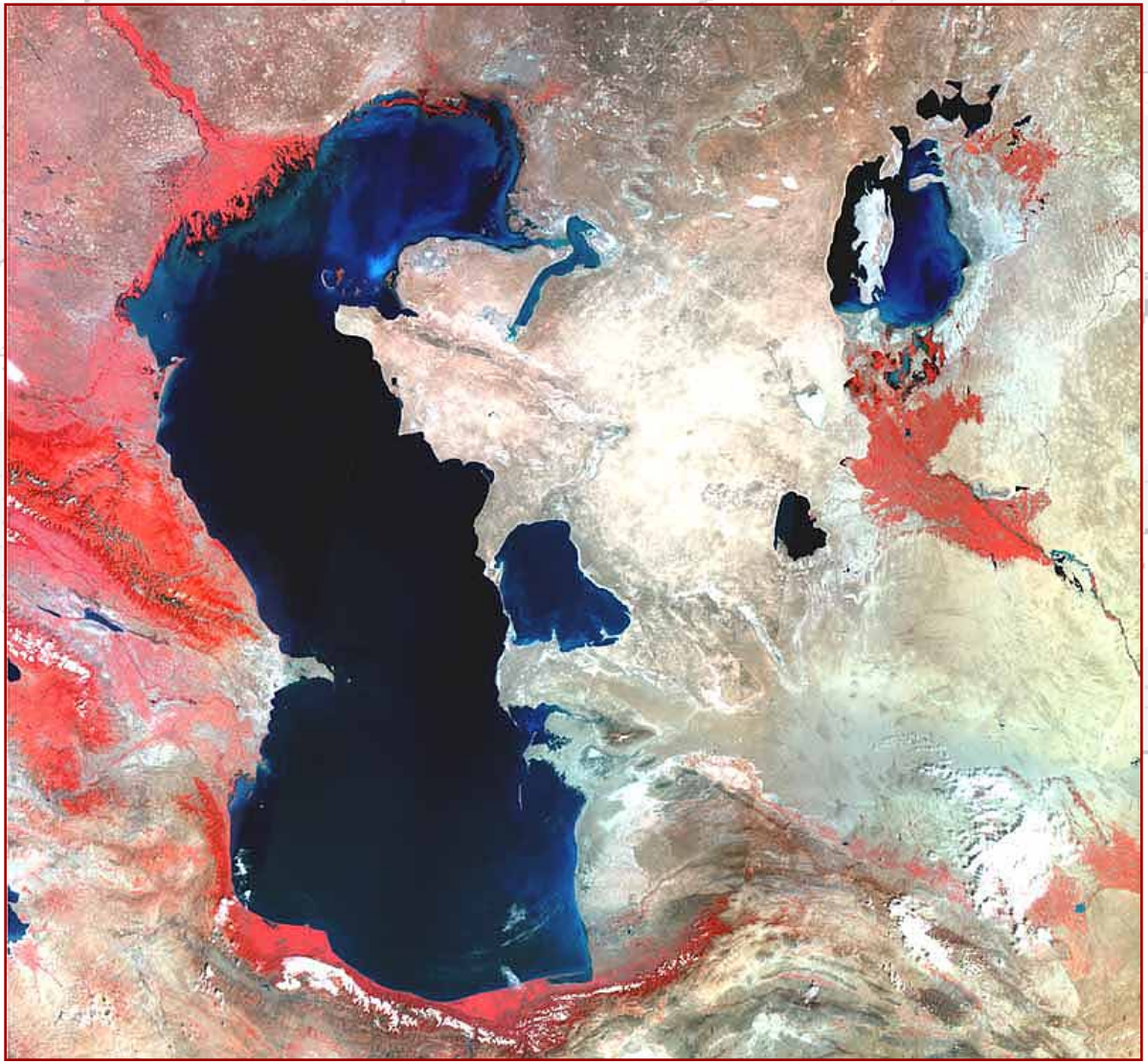
Aral Sea
7 September 2012

Aral Sea

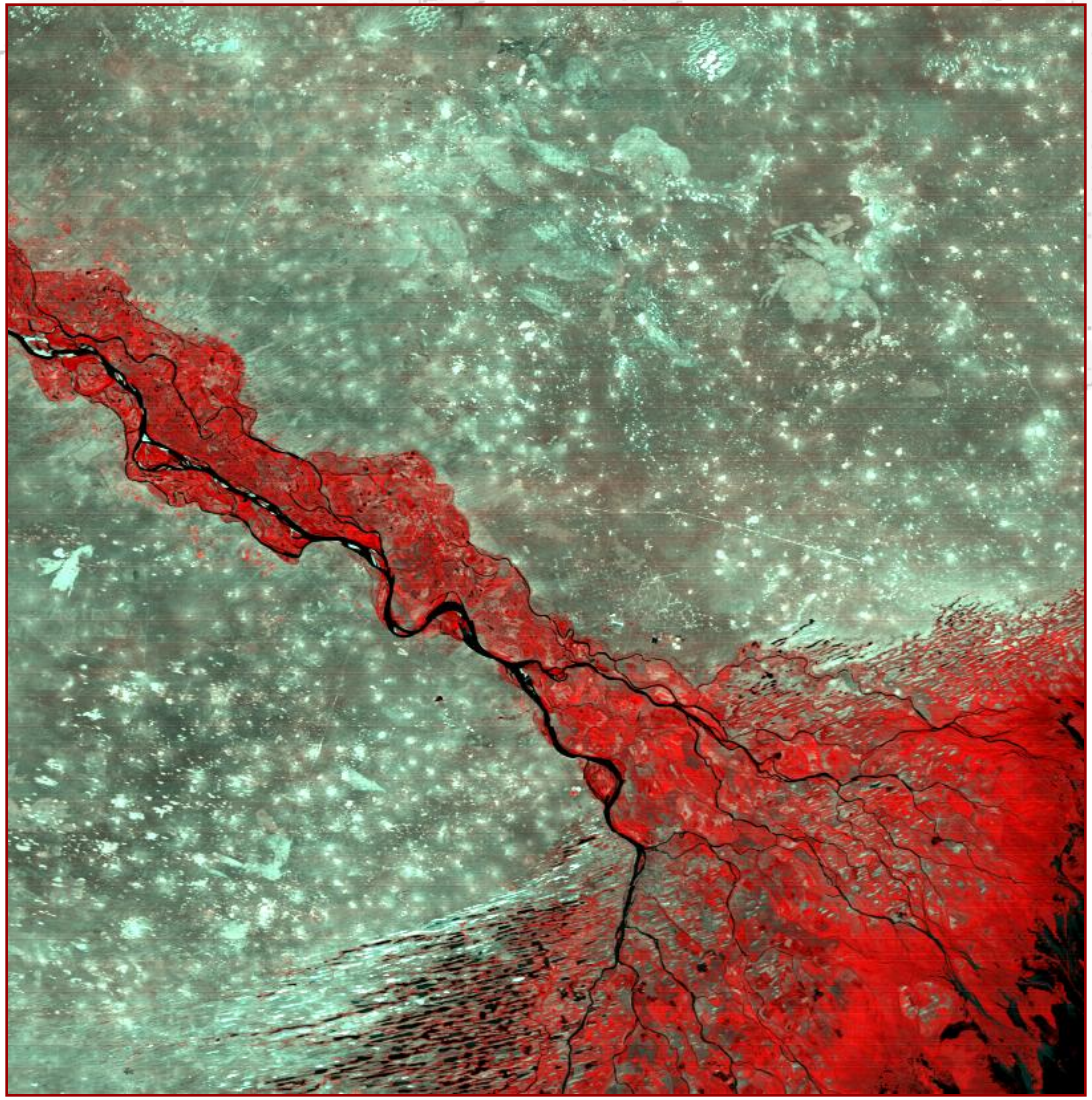
USDA, 2014



Caspian Sea

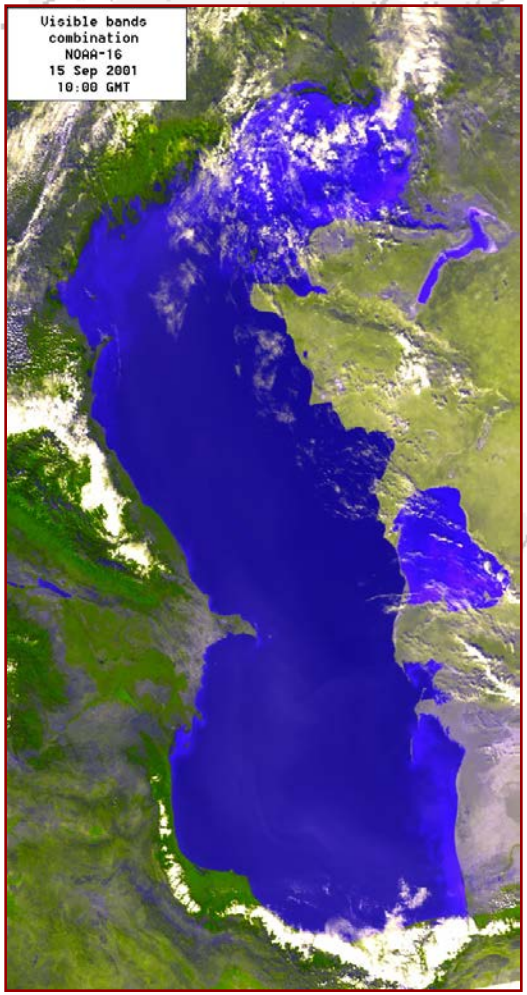


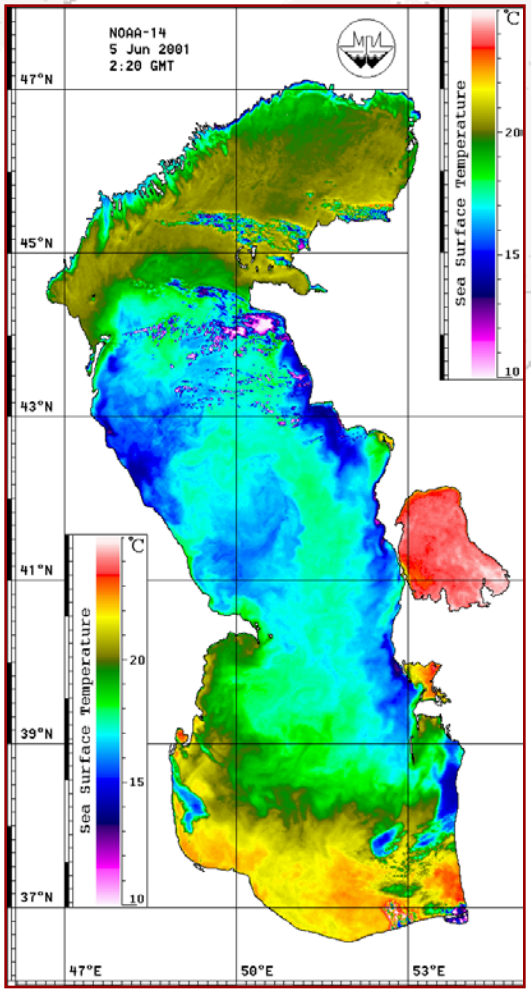
Caspian Sea

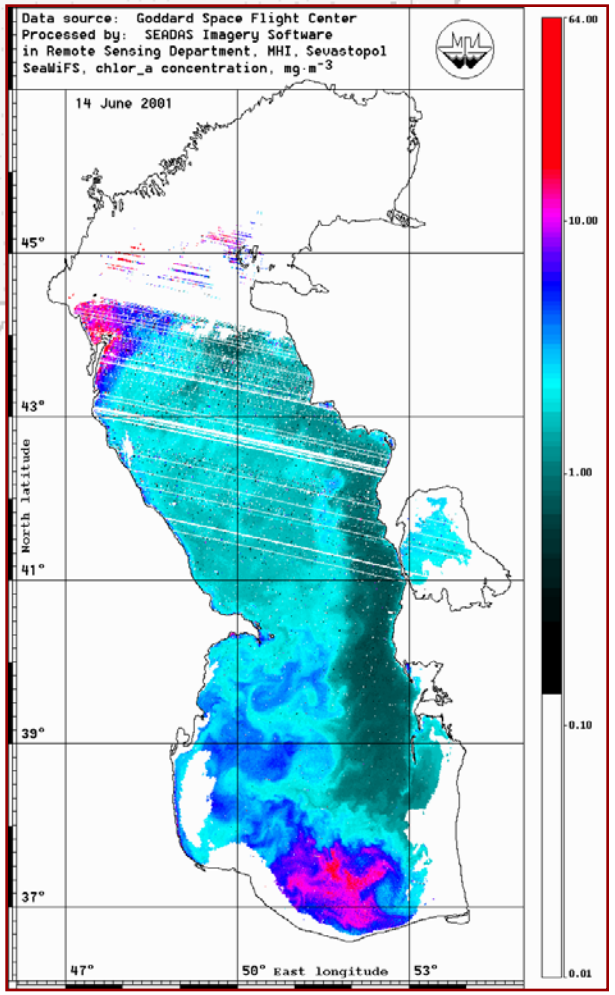


The Volga delta 80% of the river run-off to the Caspian Sea

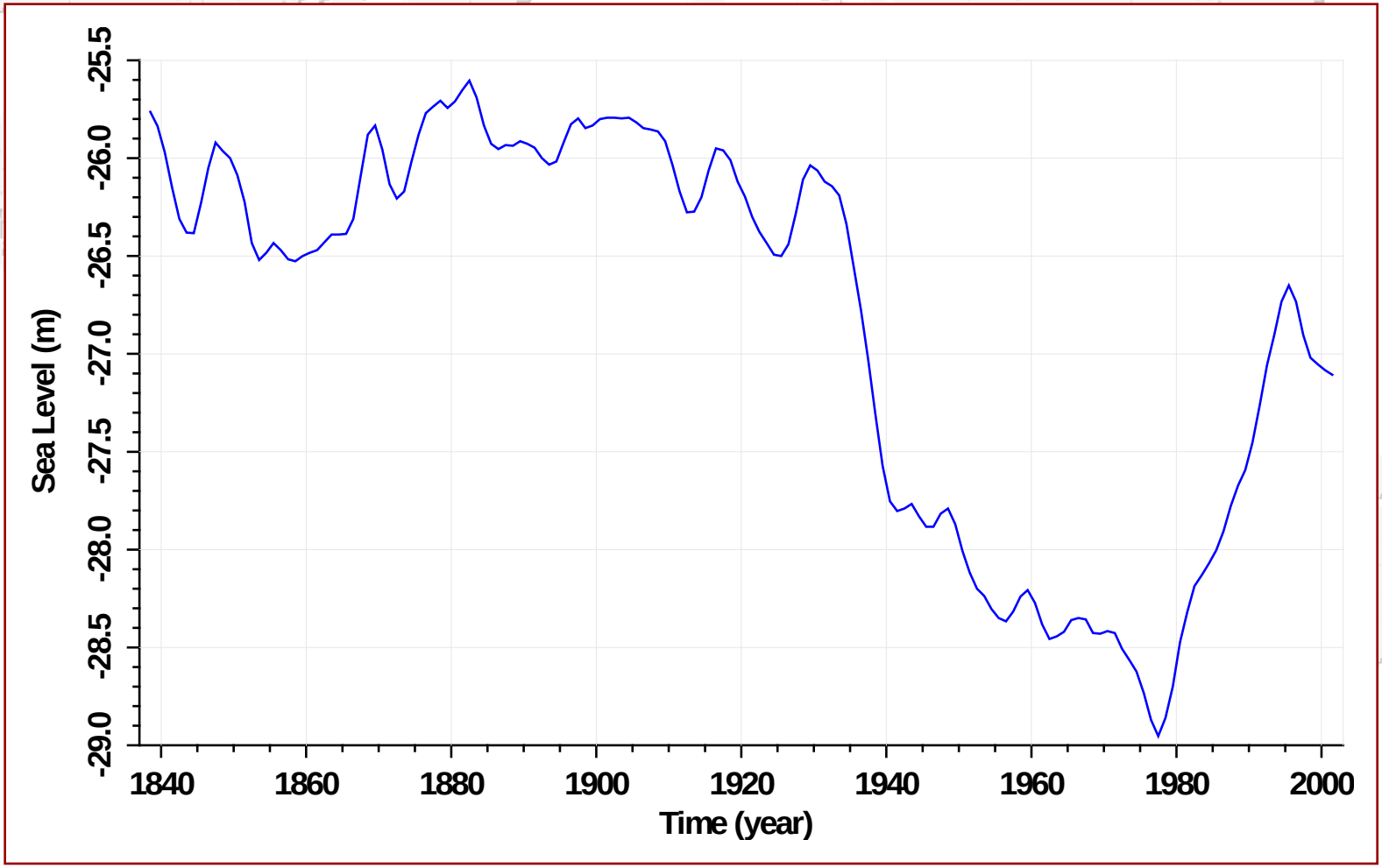
Caspian Sea







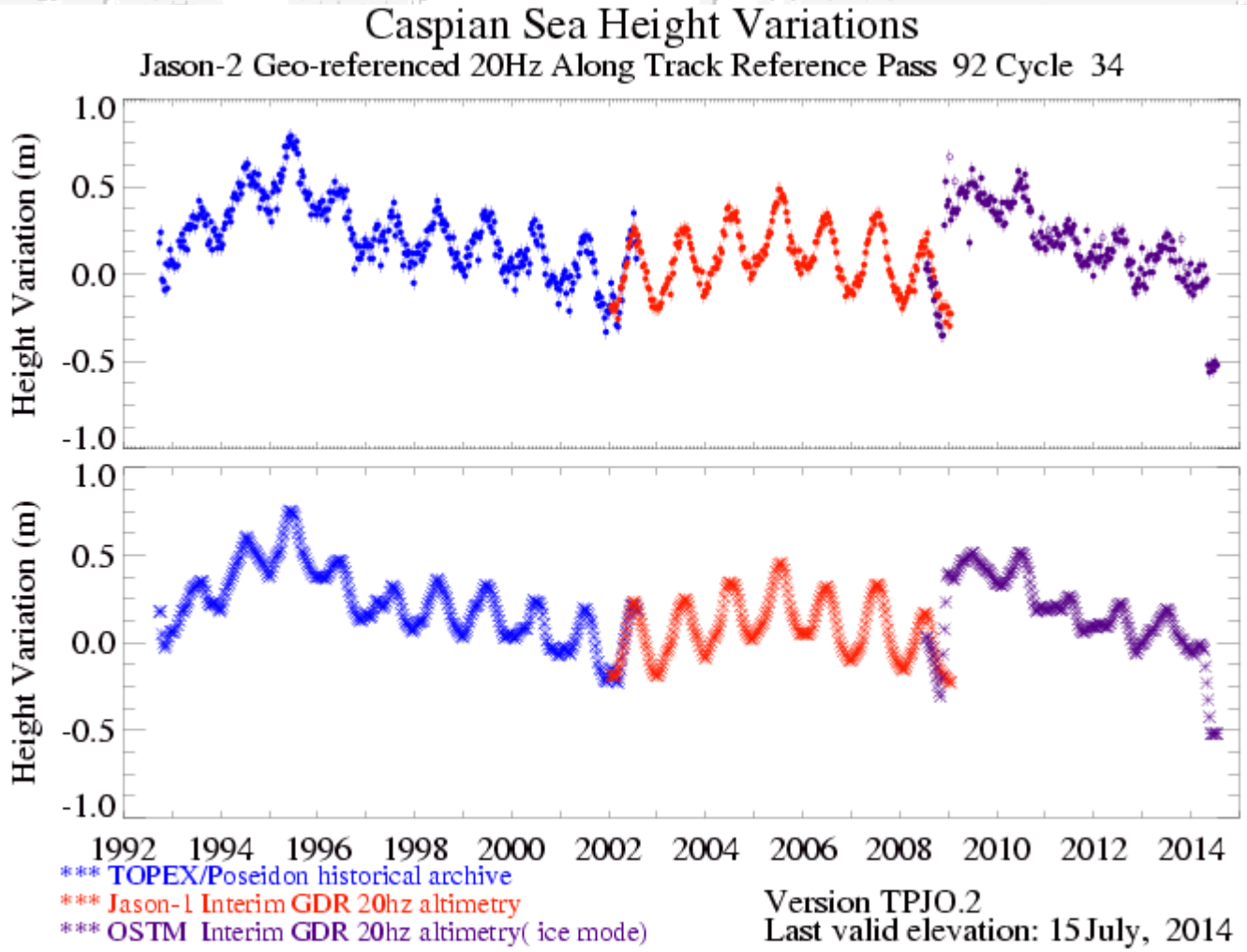
Caspian Sea



Caspian Sea level by instrumental measurements (1837-2003)

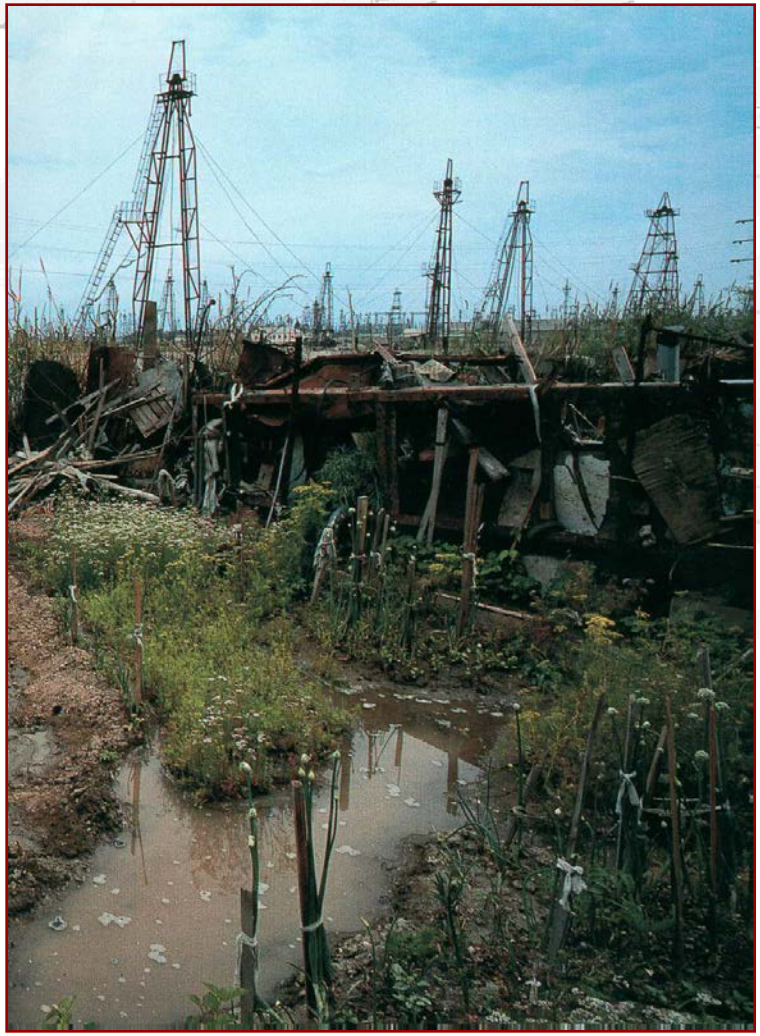
Caspian Sea

USDA, 2014



Caspian Sea level by satellite altimetry measurements (1992-2014)

Caspian Sea



Oil production and transport

Mnemiopsis leidyi **has invaded the Caspian Sea in 1999. It was introduced into the Caspian with ballast waters. This led to a catastrophic drop of industrial fisheries.**

Kara Bogaz Gol

The Kara-Bogaz-Gol (KBG) is a large, shallow lagoon of the Caspian Sea, normally about 7,000 square miles and just a few meters deep.

KBG is 2-3 m lower than the Caspian Sea, so water flows from the Caspian through a narrow strait into the KBG, where it evaporates. The KBG is one of the saltiest bodies of water in the World; at one time its salt concentration was about 350 promiles.

The salt in this natural evaporation basin has been used commercially since at least the 1920s.

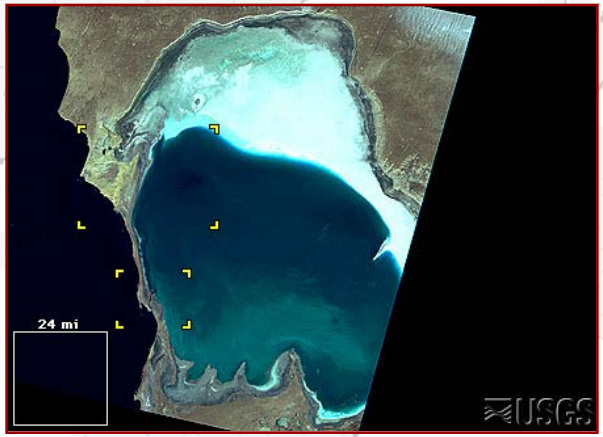
In March 1980 the Caspian-KBG strait was dammed.

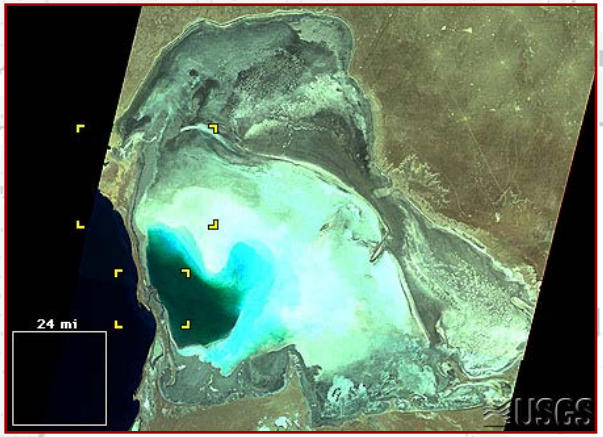
By November 1983 the KBG had already dried up entirely.

In 1992 the dam was exploded.

Kara Bogaz Gol

The Landsat-5 MSS images



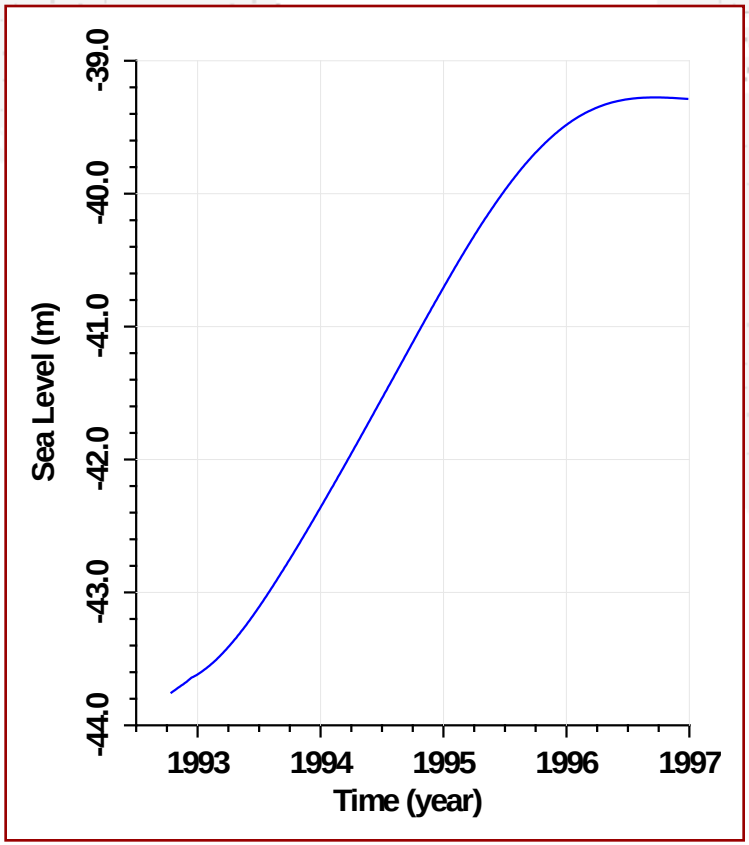


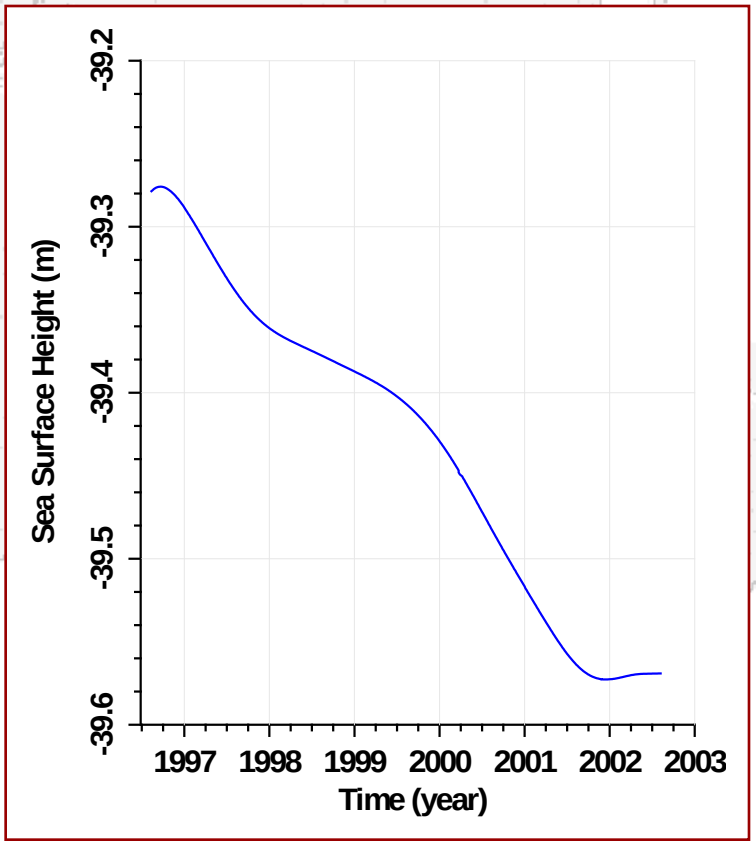
4 December 1972

29 September 1987

Kara Bogaz Gol

Time variation of the Kara Bogaz Gol Bay level by TOPEX/POSEIDON satellite altimetry data

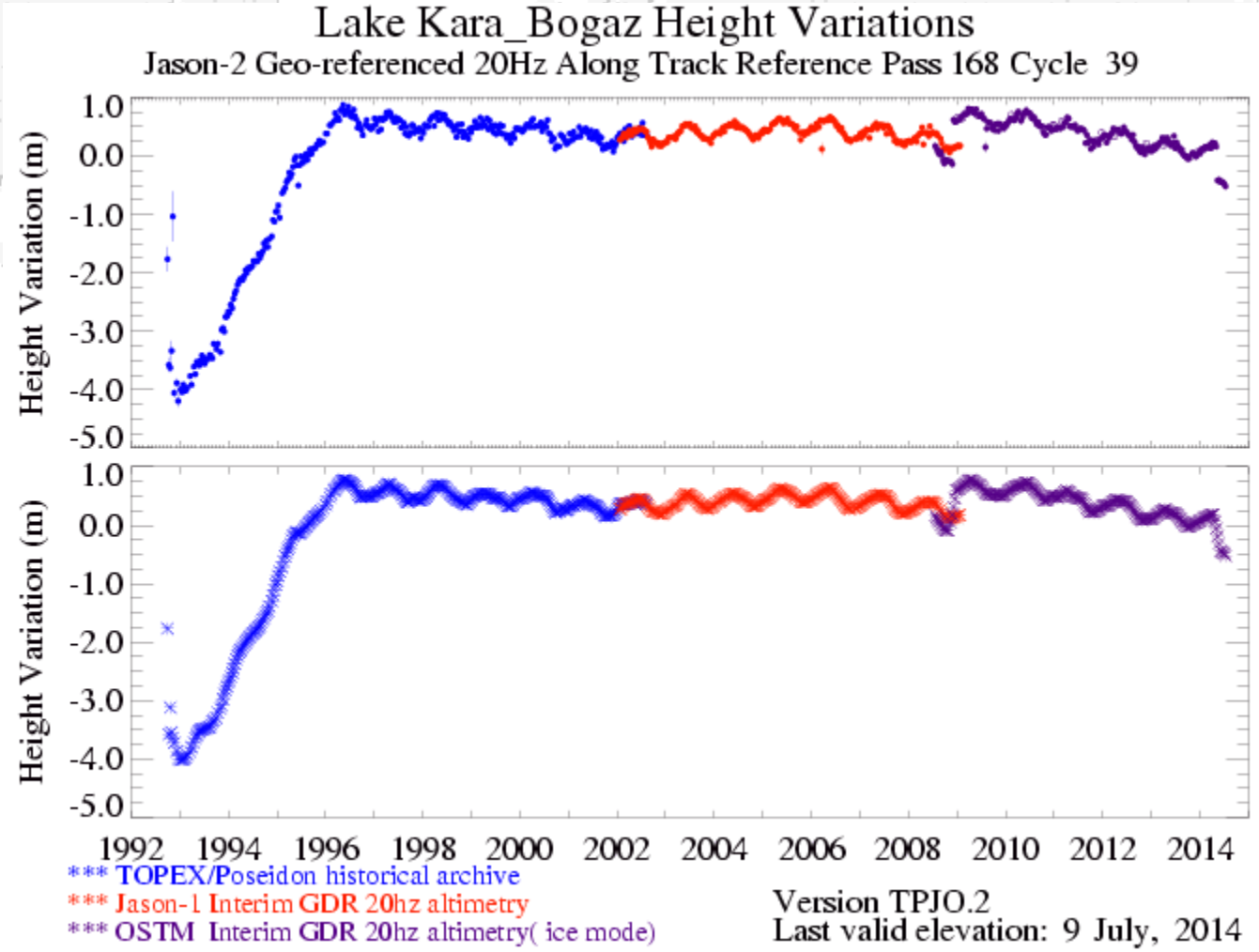




USDA, 2014

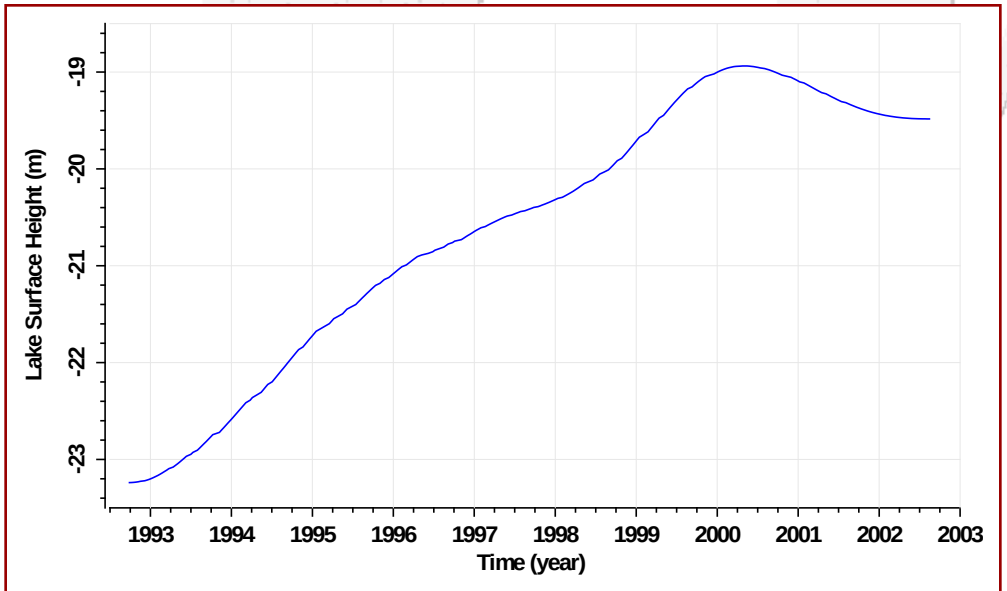
Kara Bogaz Gol

Time variation of the Kara Bogaz Gol Bay level by satellite altimetry data 1992-2014



Sarykamysh Lake

Time variation level of the Lake Sarykamysh by TOPEX/POSEIDON satellite altimetry

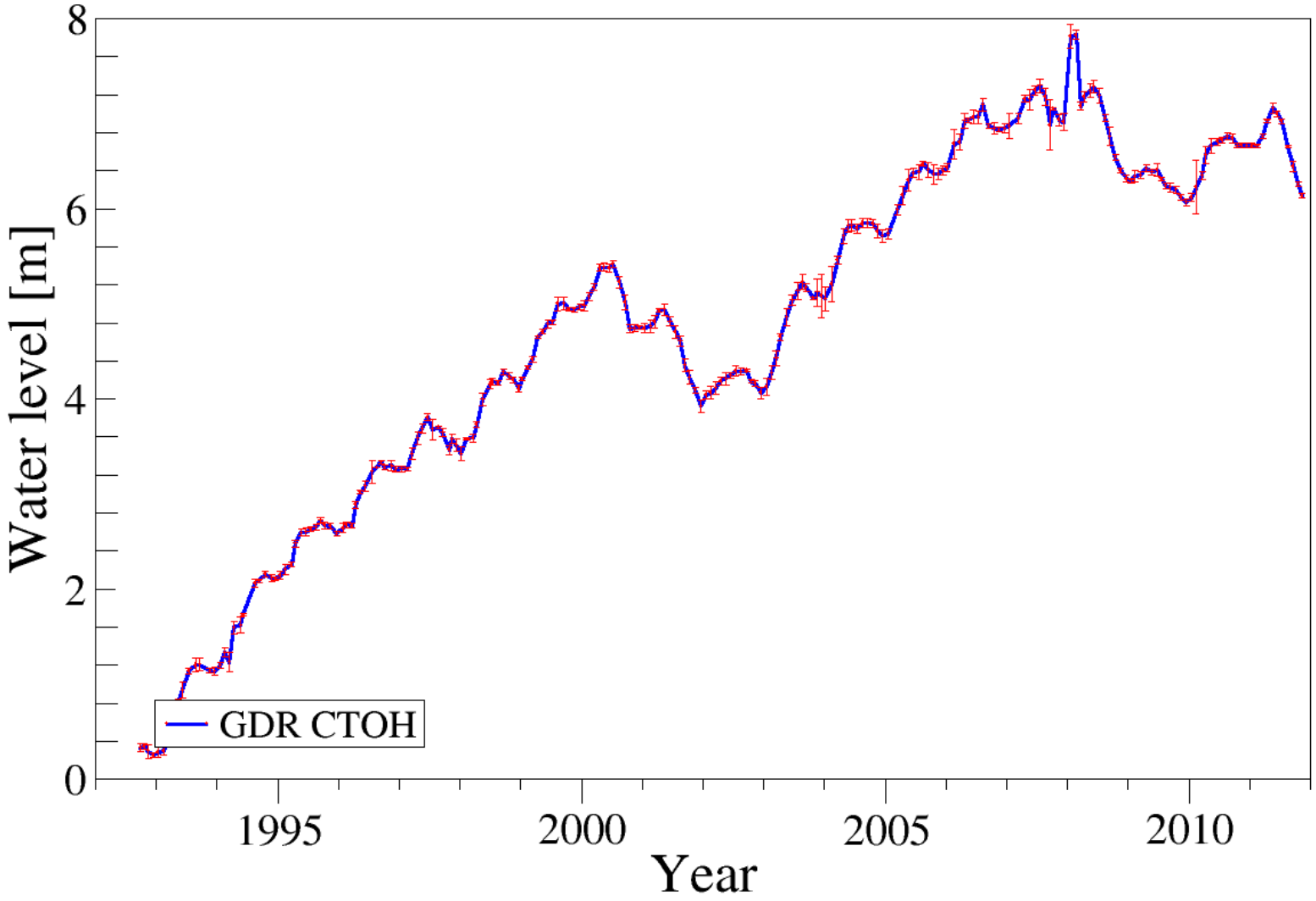


The MODIS image 7 November 2002

HYDROWEB

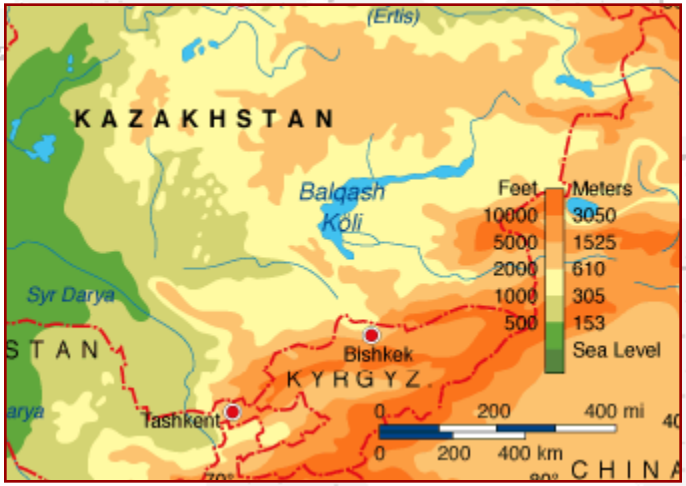
http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/index.html

Lake Sarykamish lat=42.00 lon=57.70

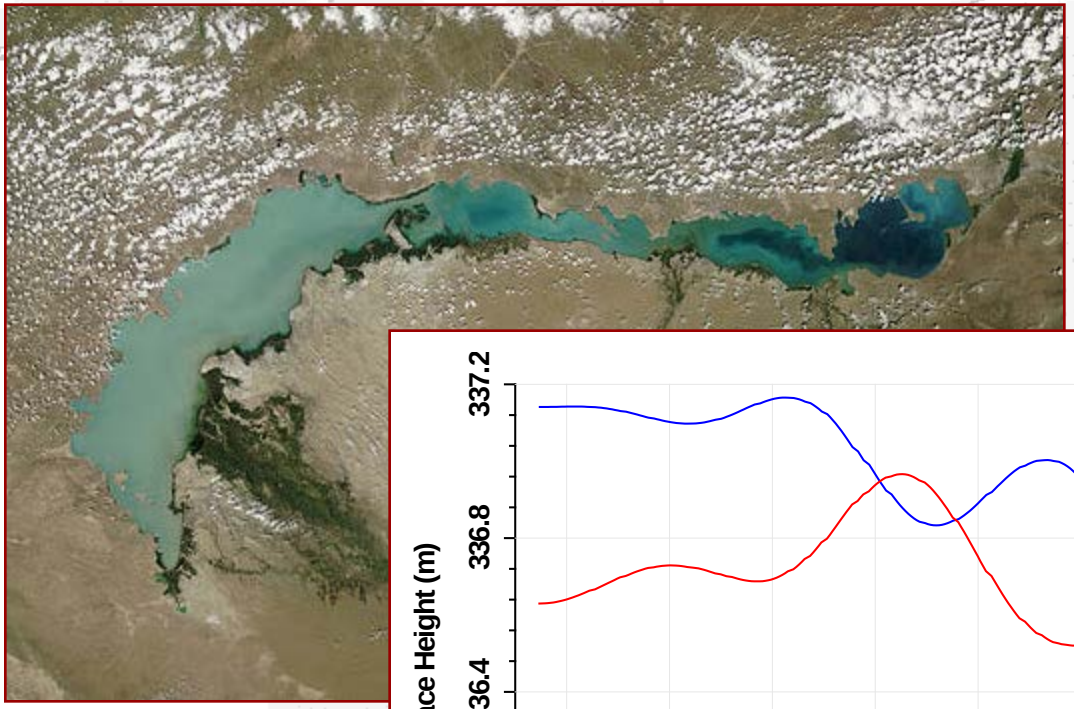


Appropriate citation is : Surface monitoring by satellite altimetry
Corresponding Author : jean-francois.cretaux@legos.obs-mip.fr

Balkhash Lake

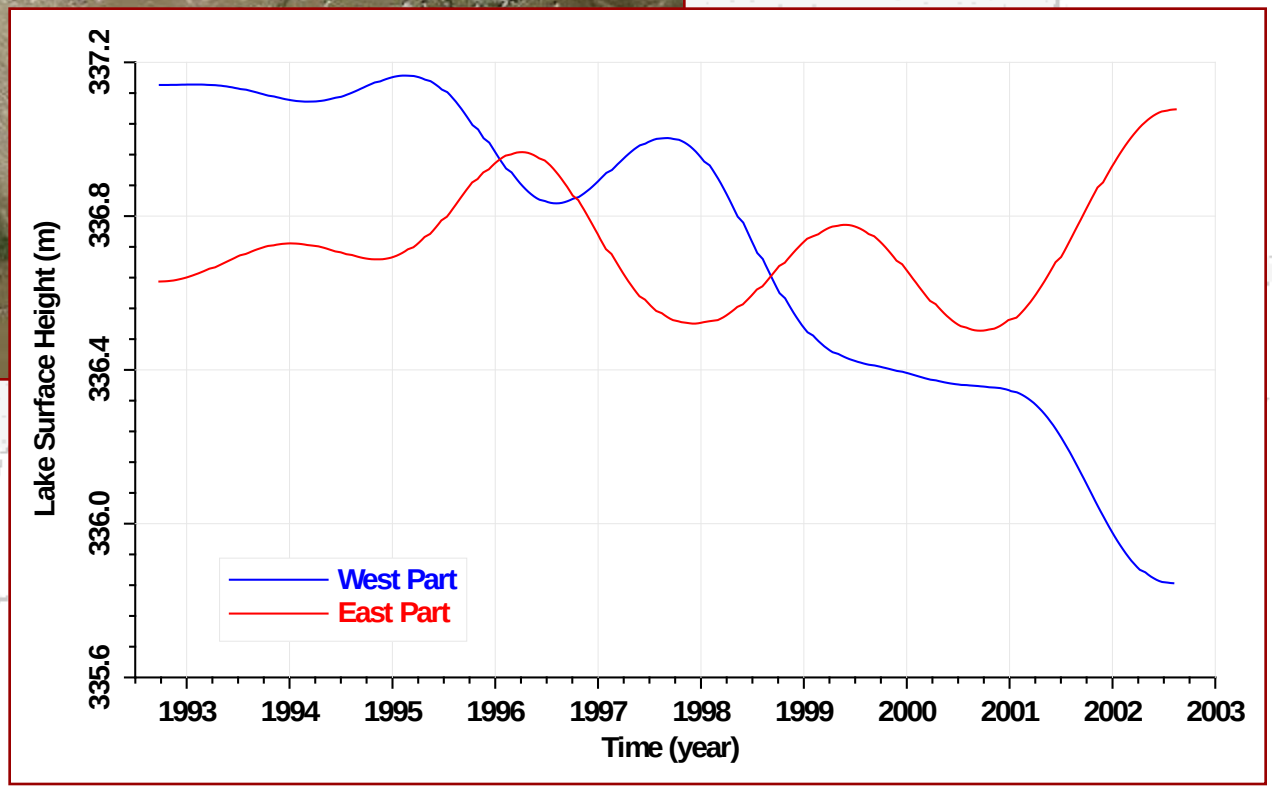


Balkhash Lake



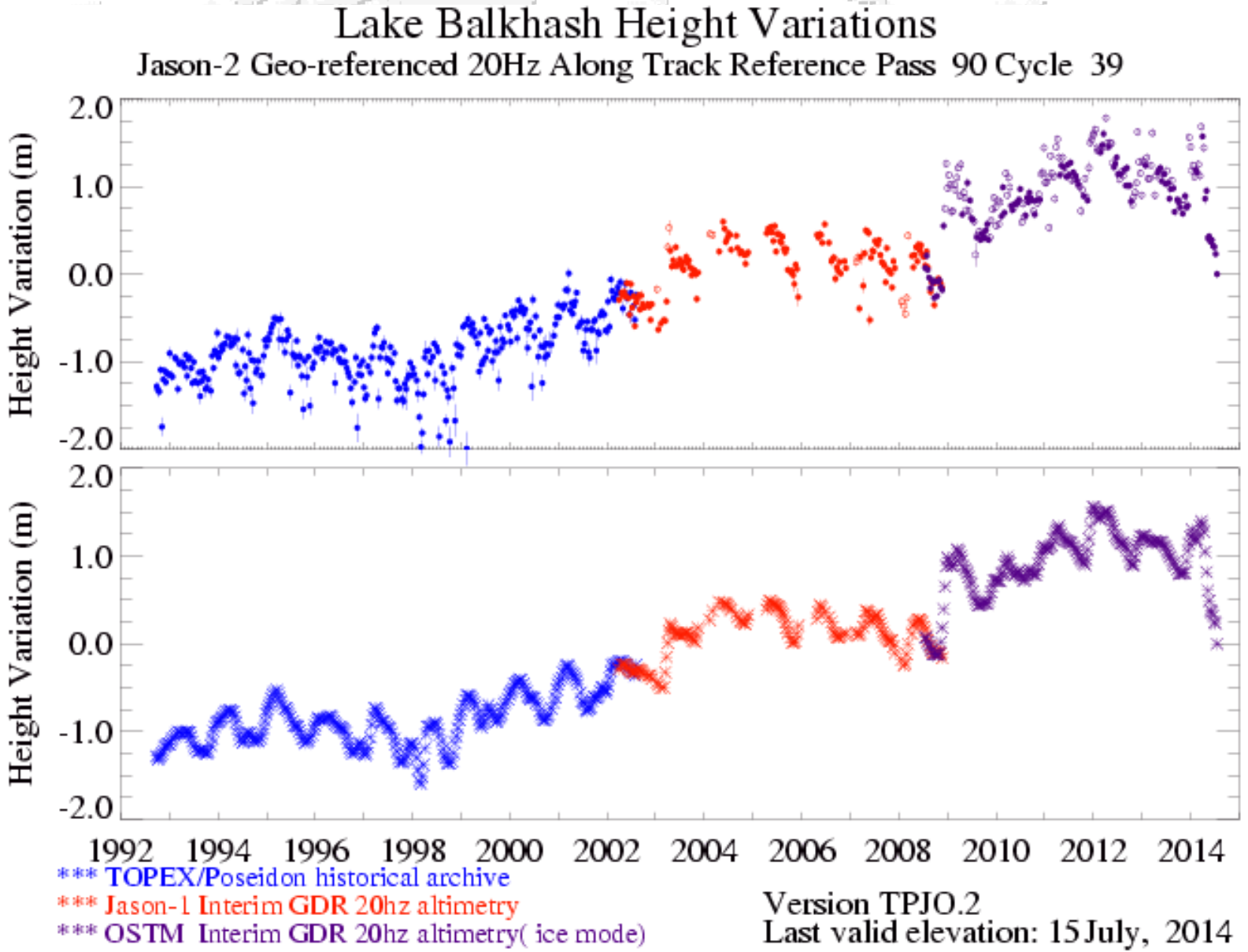
The MODIS images 13 June 2002

Time variation level of the Lake Balkhash by TOPEX/POSEIDON satellite altimetry

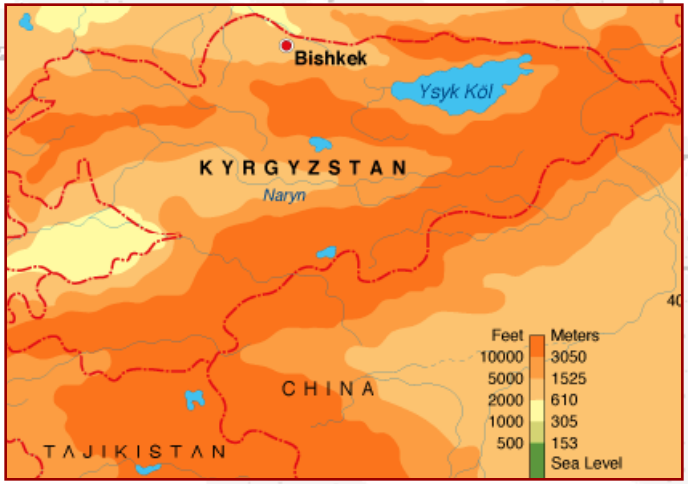


Balkhash Lake

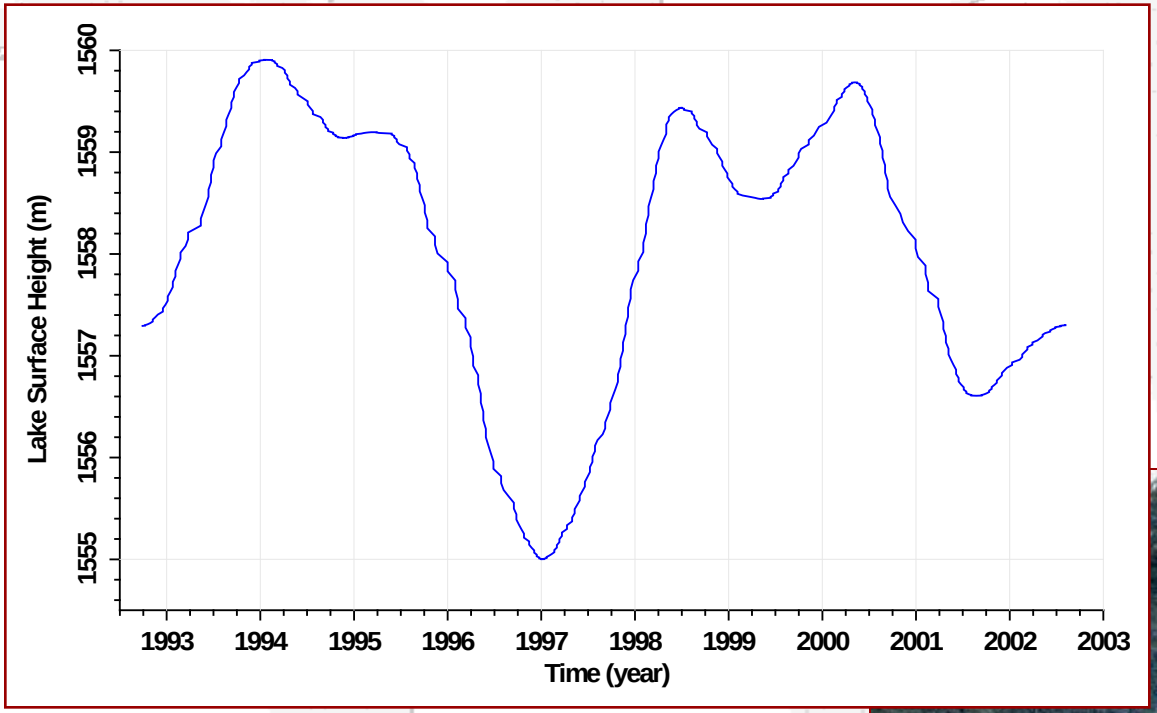
USDA, 2014



Lake Issyk-Kul

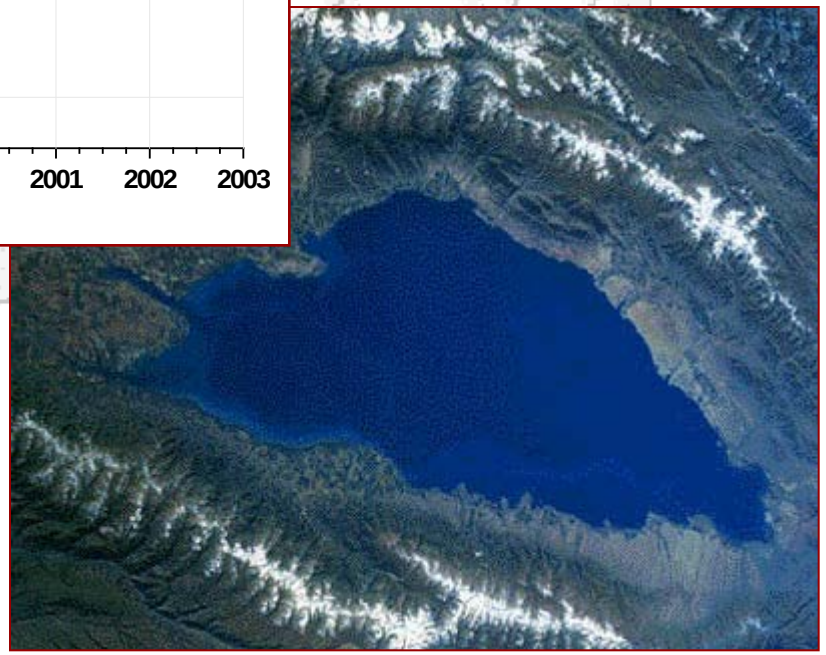


Lake Issyk-Kul



Time variation level of the Lake Issyk-Kul by TOPEX/POSEIDON satellite altimetry

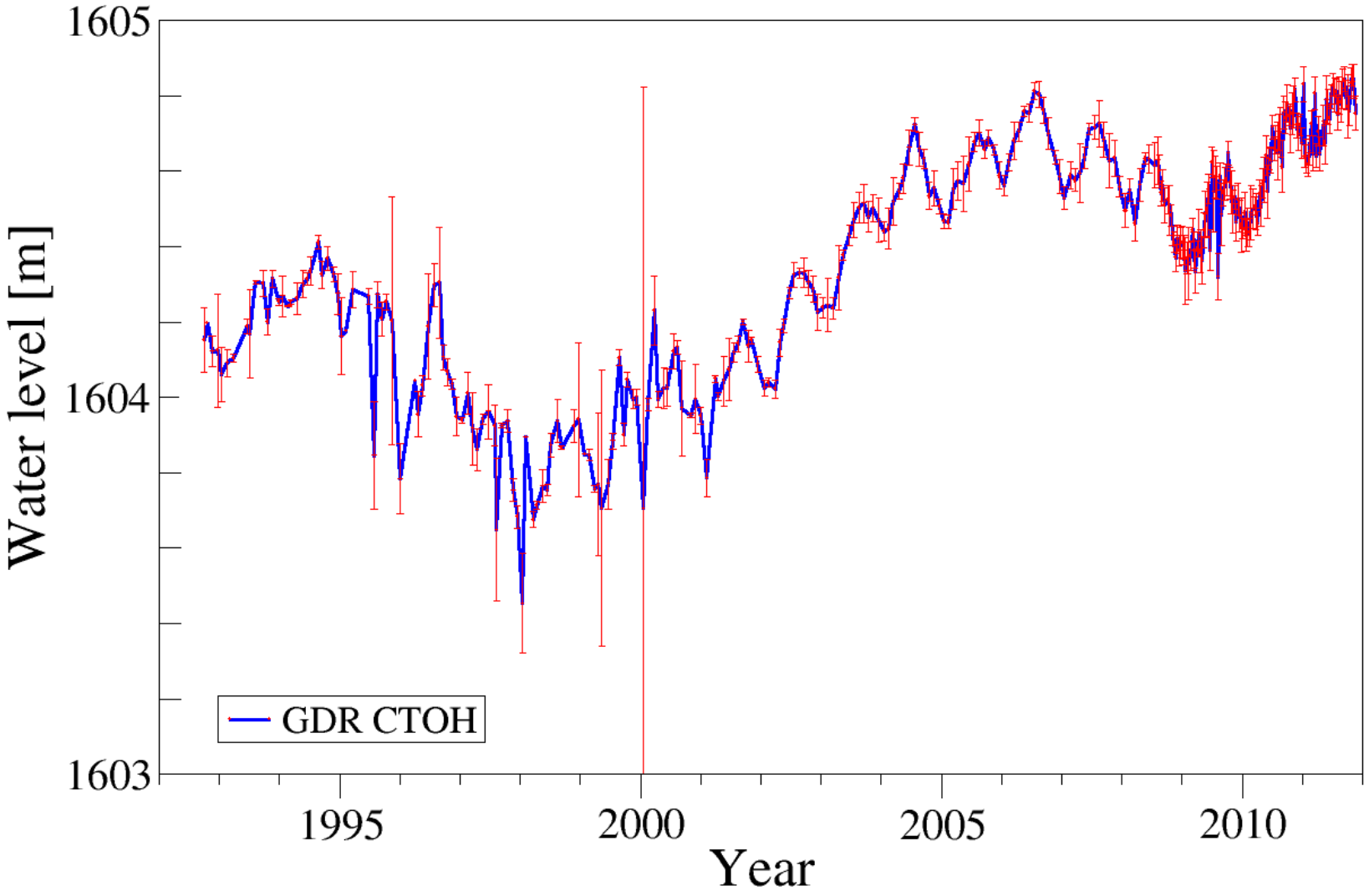
The MODIS images 13 June 2002



H Y D R O W E B

http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/index.html

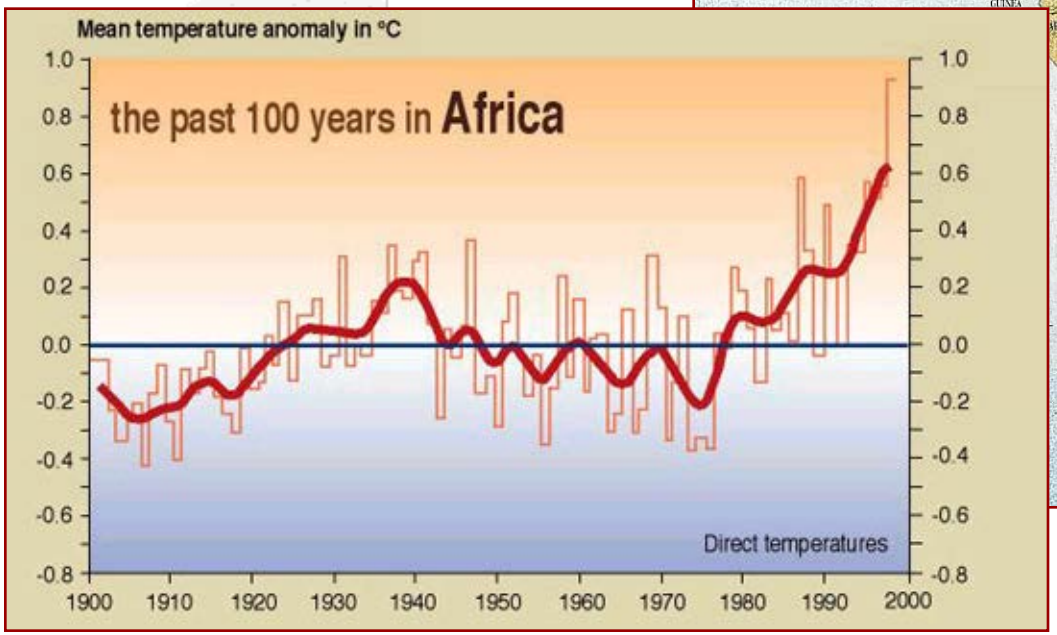
Lake Issykkul lat=42.50 lon=77.10

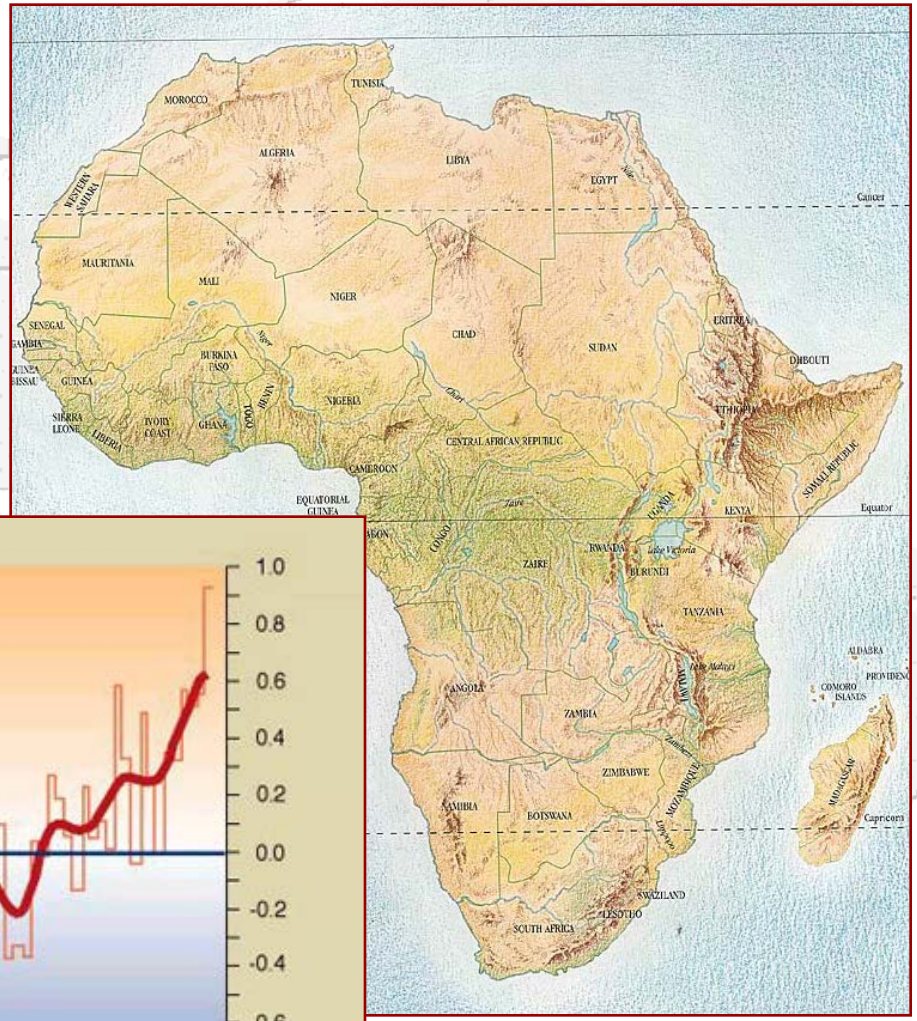


Appropriate citation is : Surface monitoring by satellite altimetry
Corresponding Author : jean-francois.cretaux@legos.obs-mip.fr

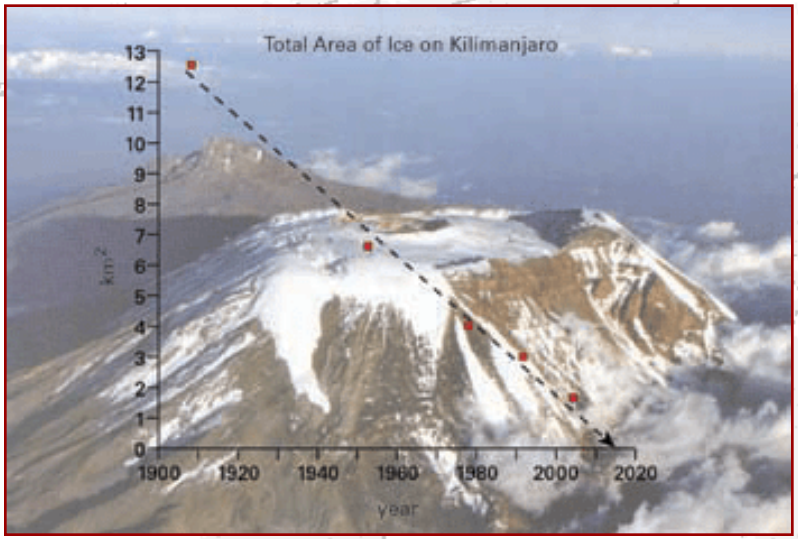
Lakes in Africa

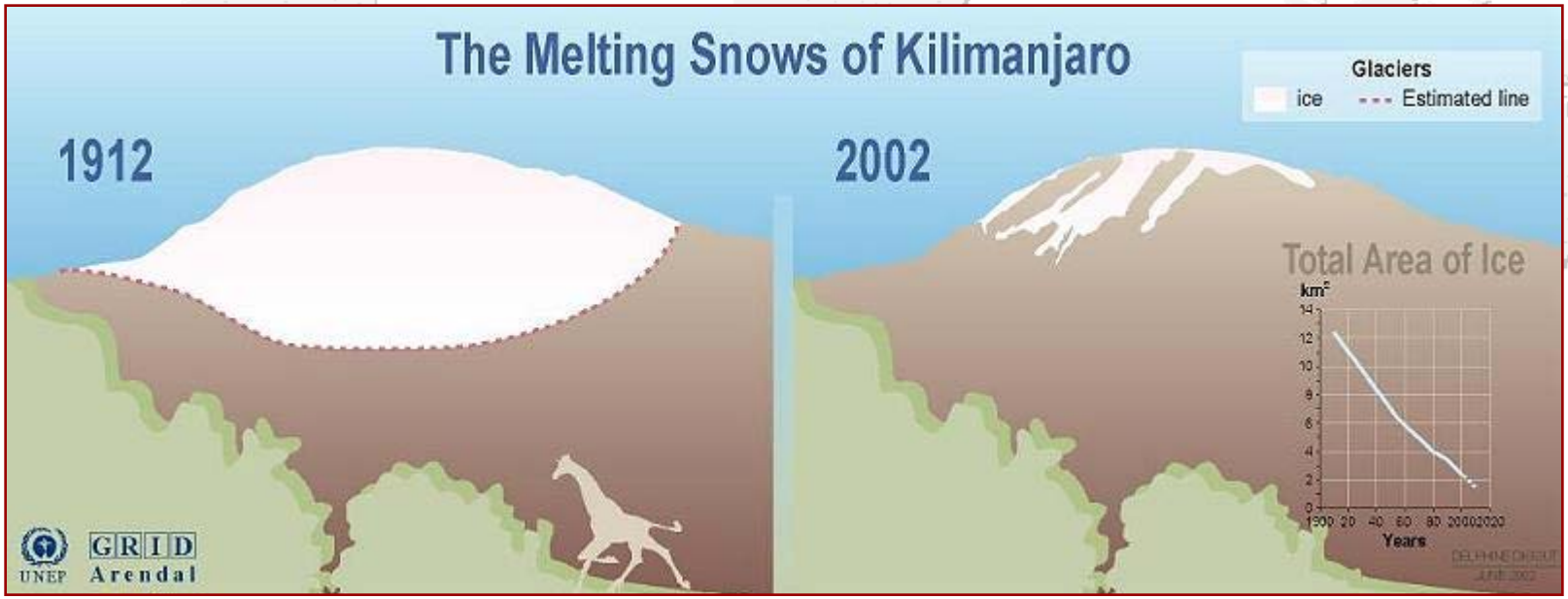
Variation of the surface temperature



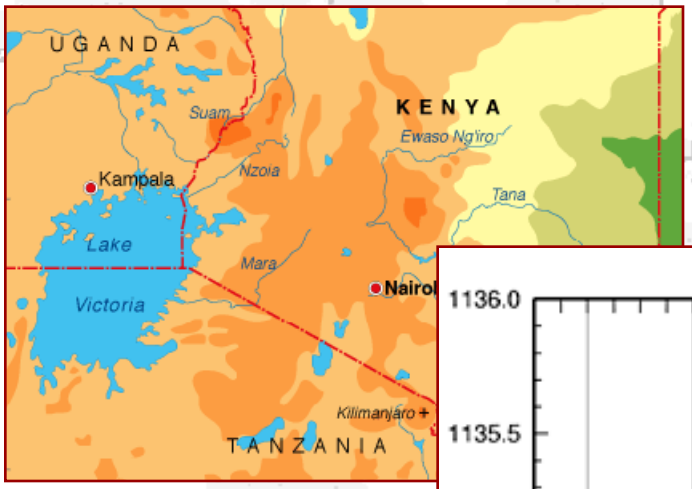


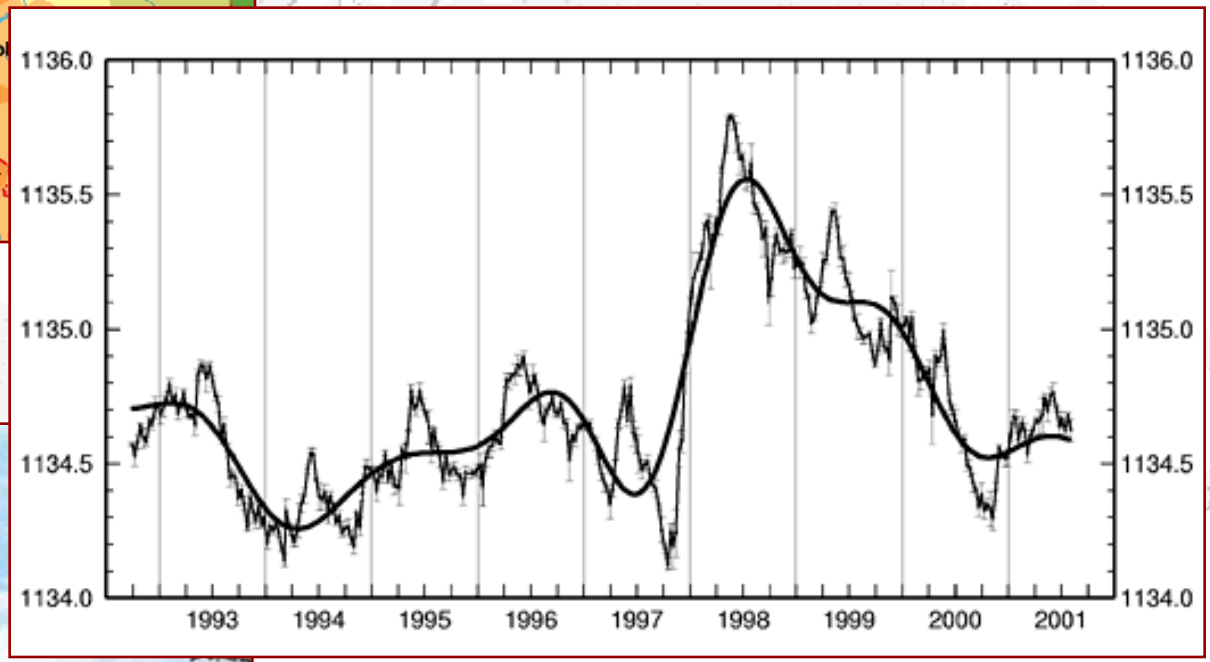
Kilimanjaro snows

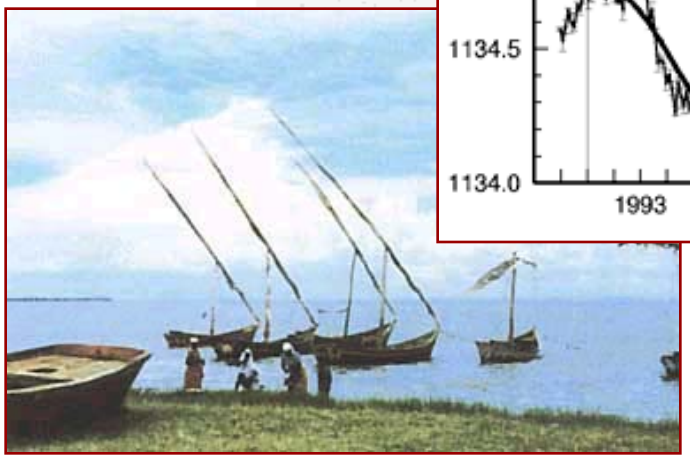




Lake Victoria

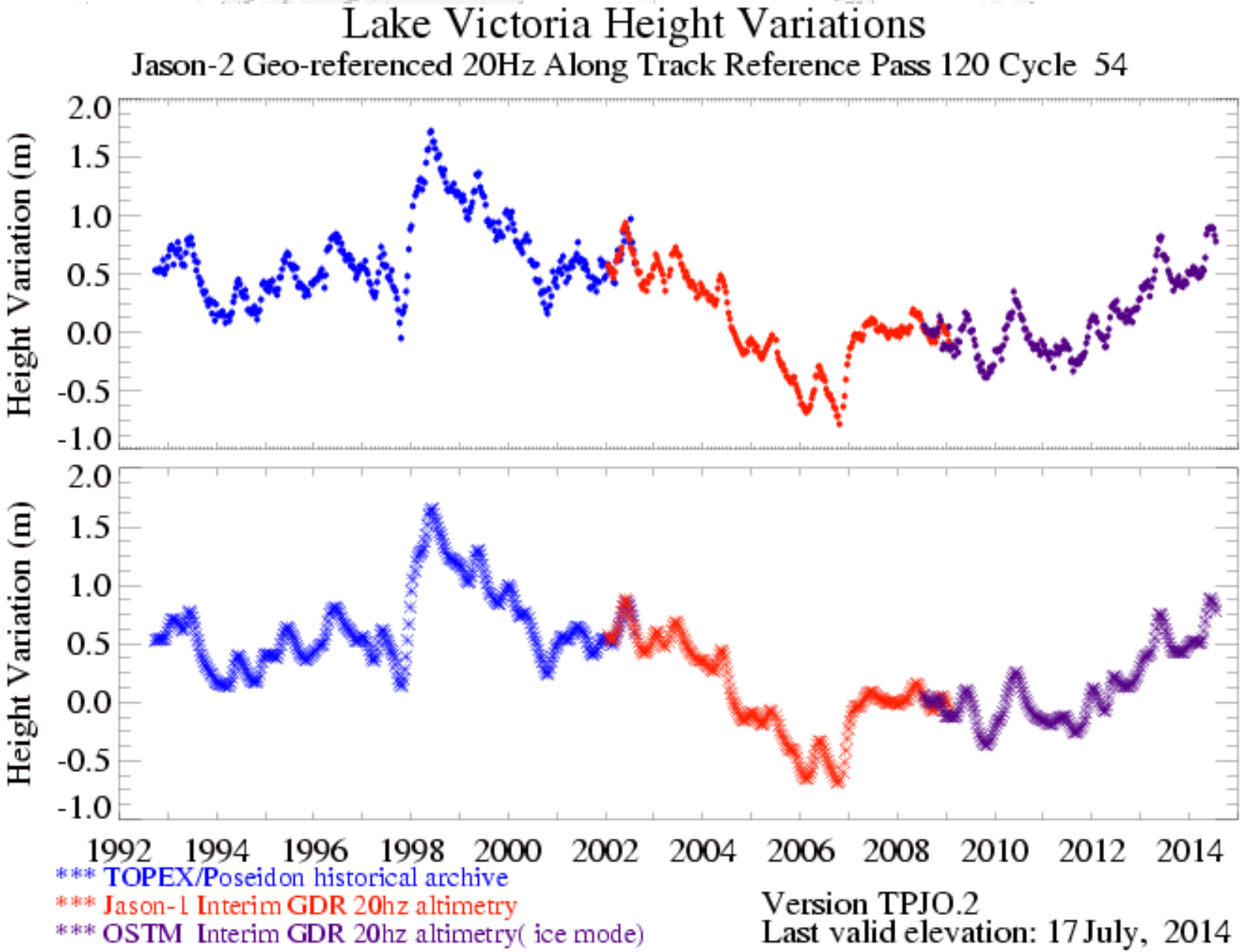




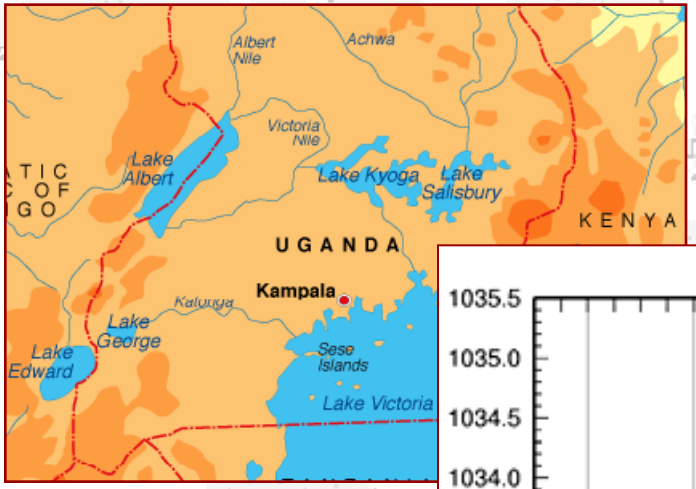


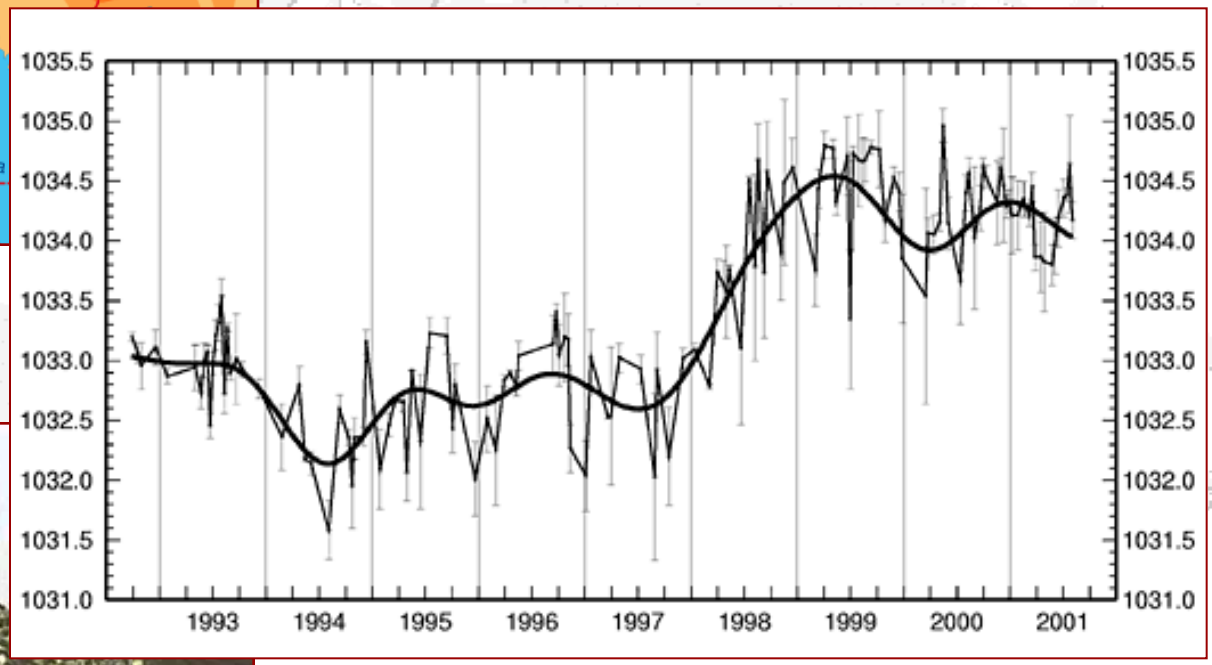
Time variation level of the Lake Victoria by TOPEX/POSEIDON satellite altimetry (AVISO)

Lake Victoria



Lake Kyoga



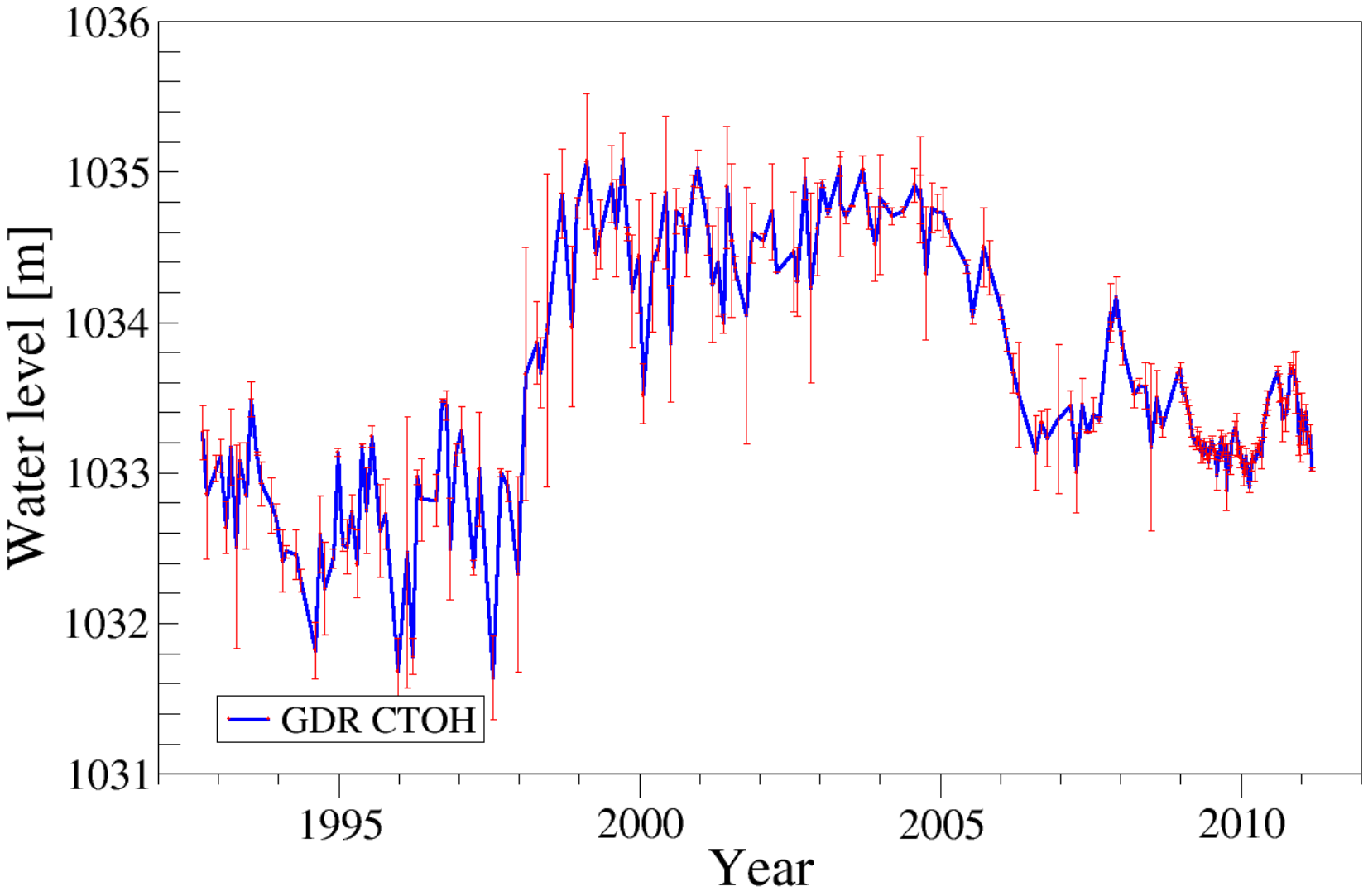


Time variation level of the Lake Kyoga by TOPEX/POSEIDON satellite altimetry (AVISO)

HYDROWEB

http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/index.html

Lake Kyoga lat=1.40 lon=33.10



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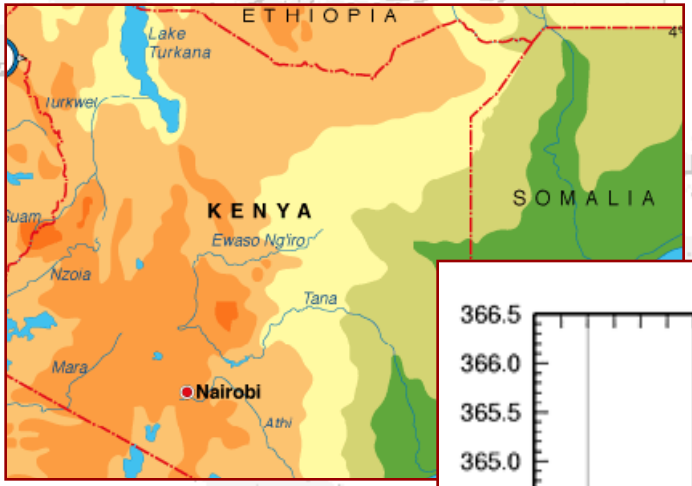
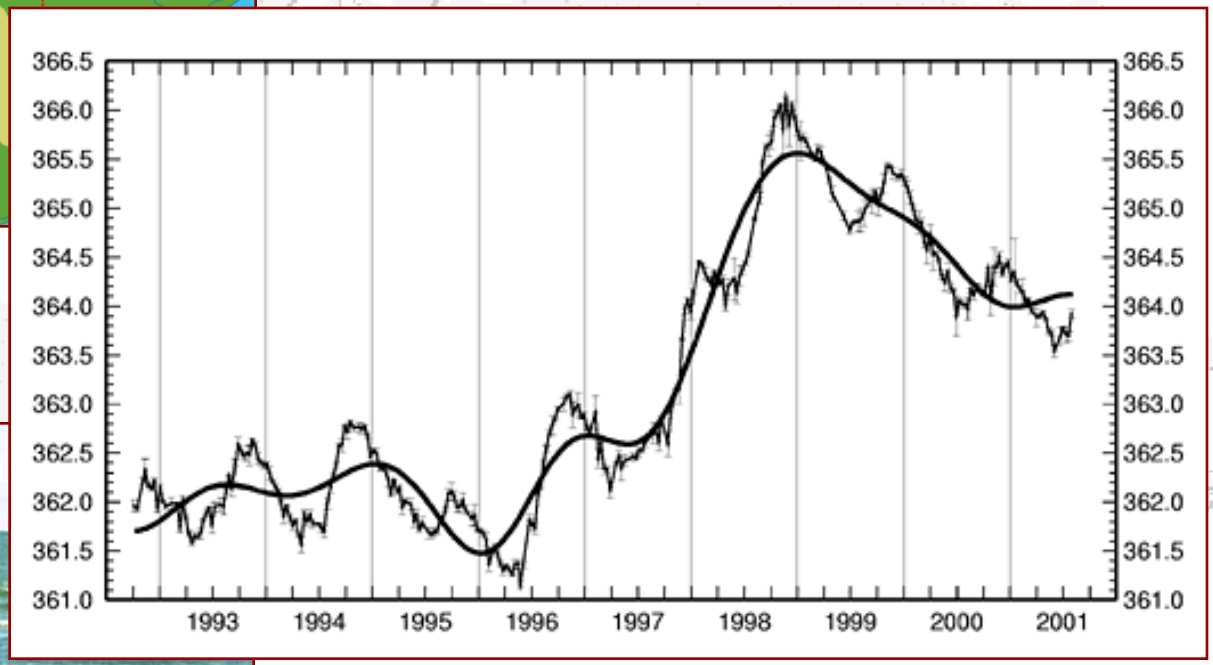
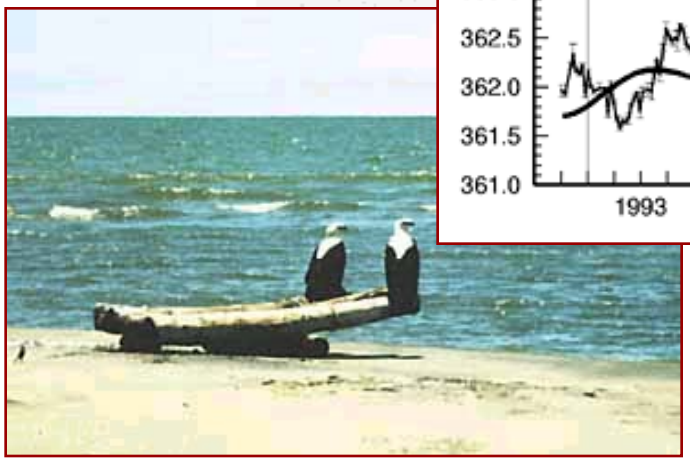
Corresponding Author : jean-francois.cretaux@legos.obs-mip.fr

Lake Turkana

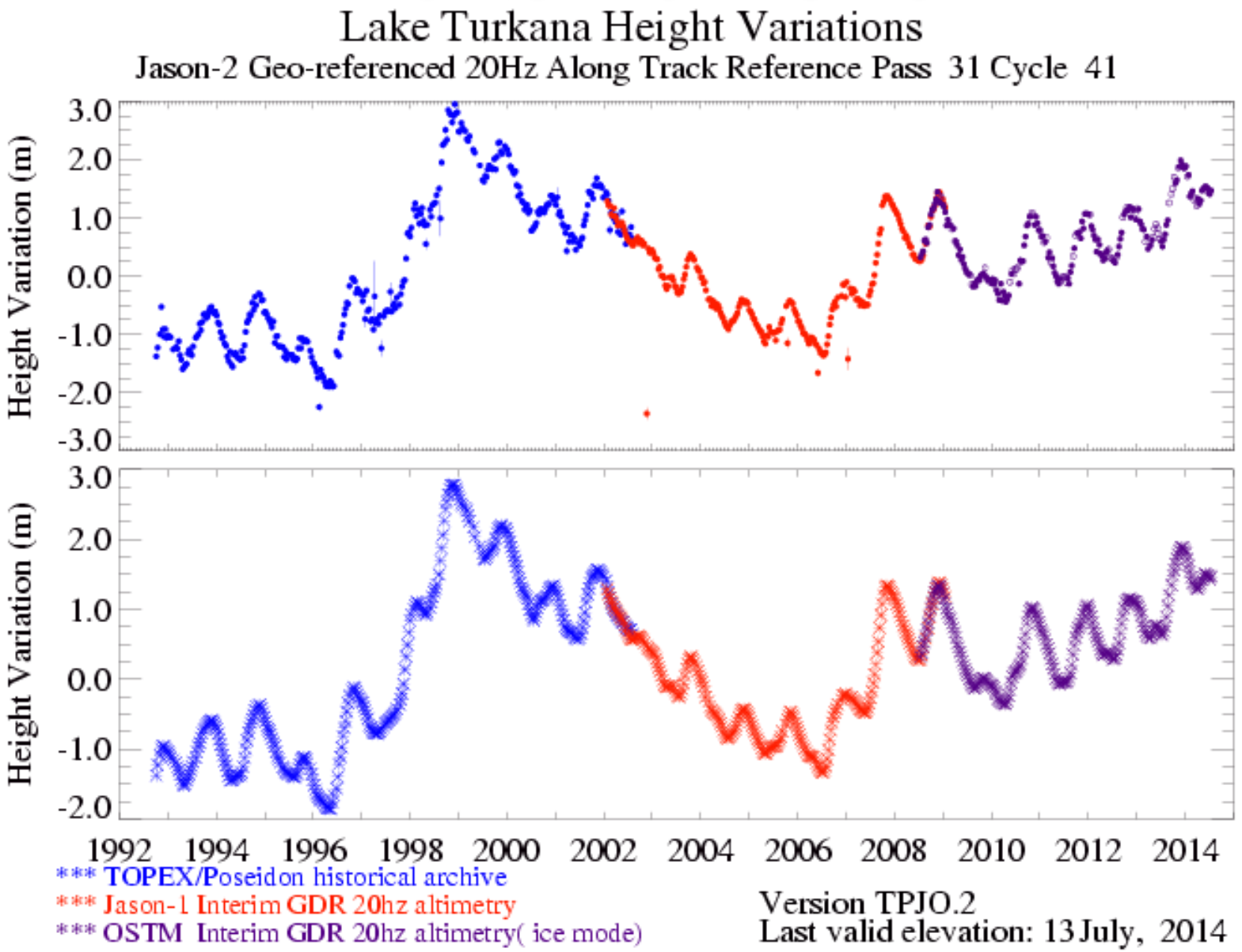




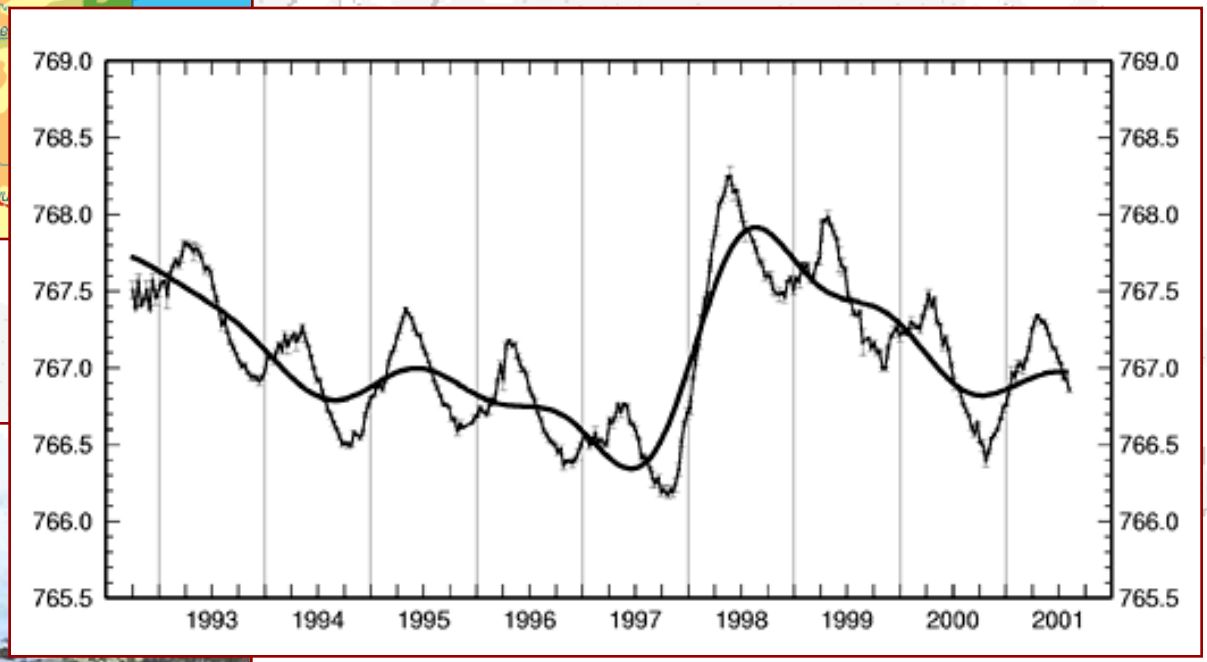


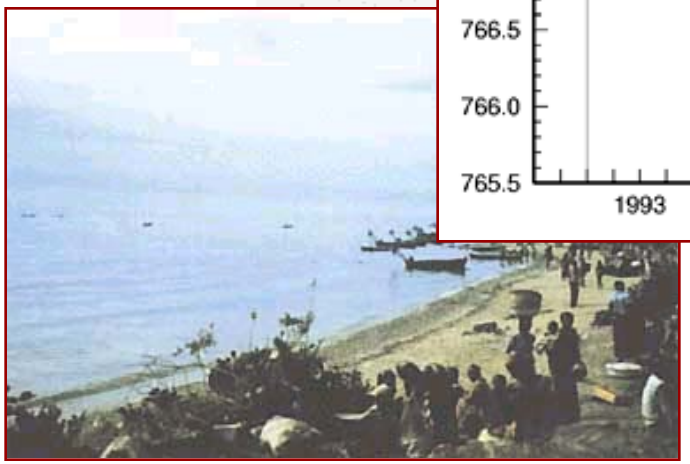
Time variation level of the Lake Turkana by TOPEX/POSEIDON satellite altimetry (AVISO)

Lake Turkana



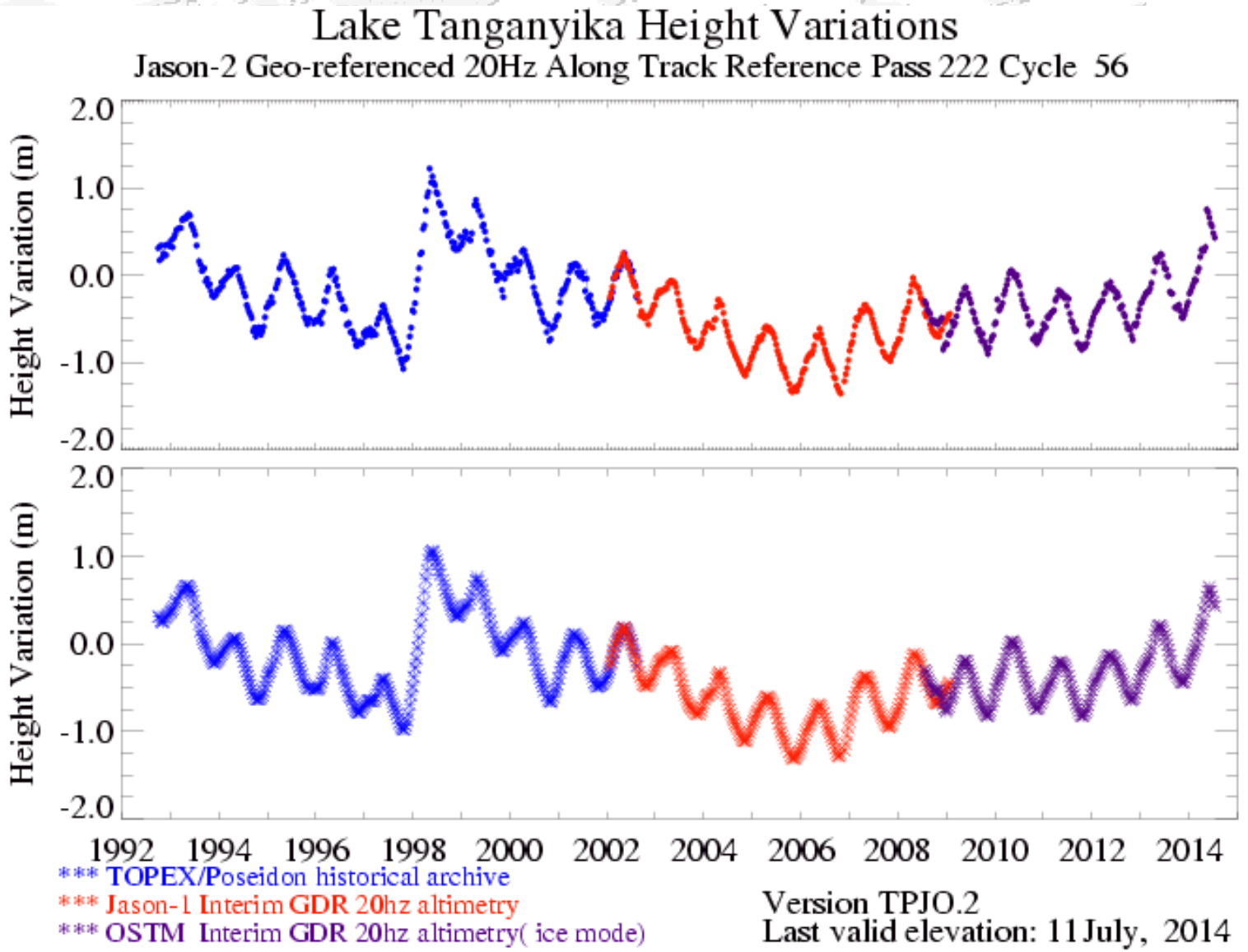
Lake Tanganyika



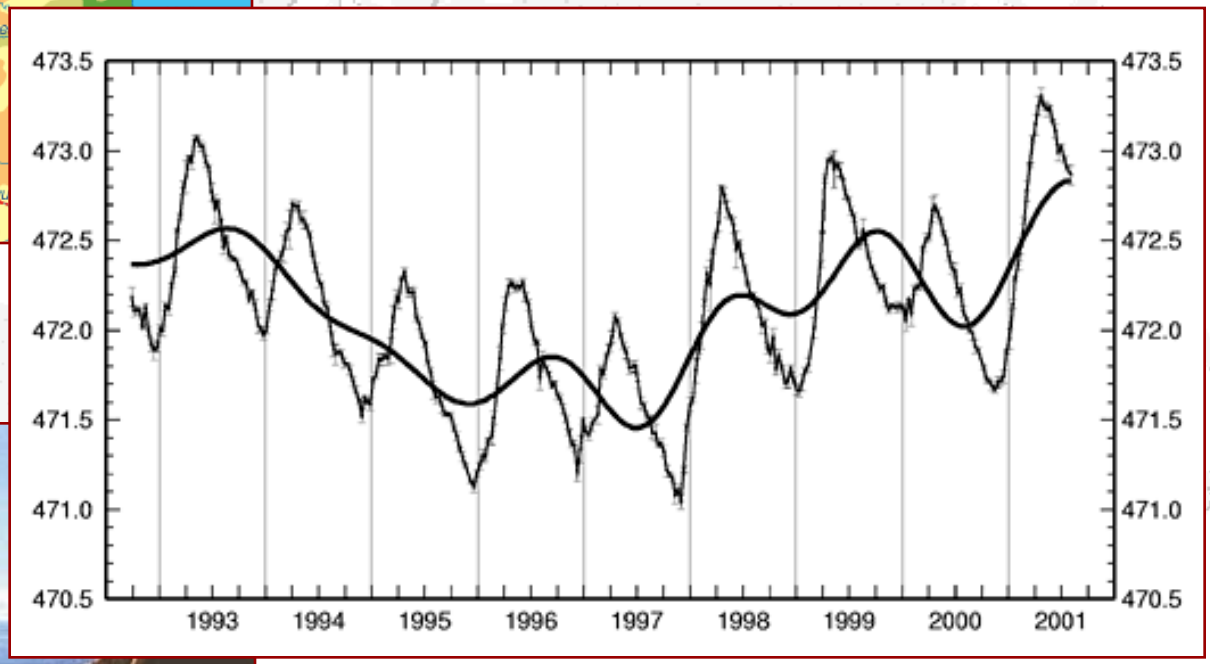


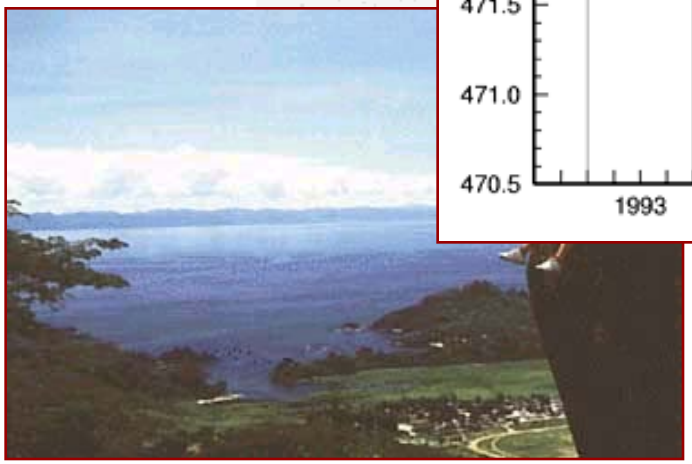
Time variation level of the Lake Tanganyika by TOPEX/POSEIDON satellite altimetry (AVISO)

Lake Tanganyika



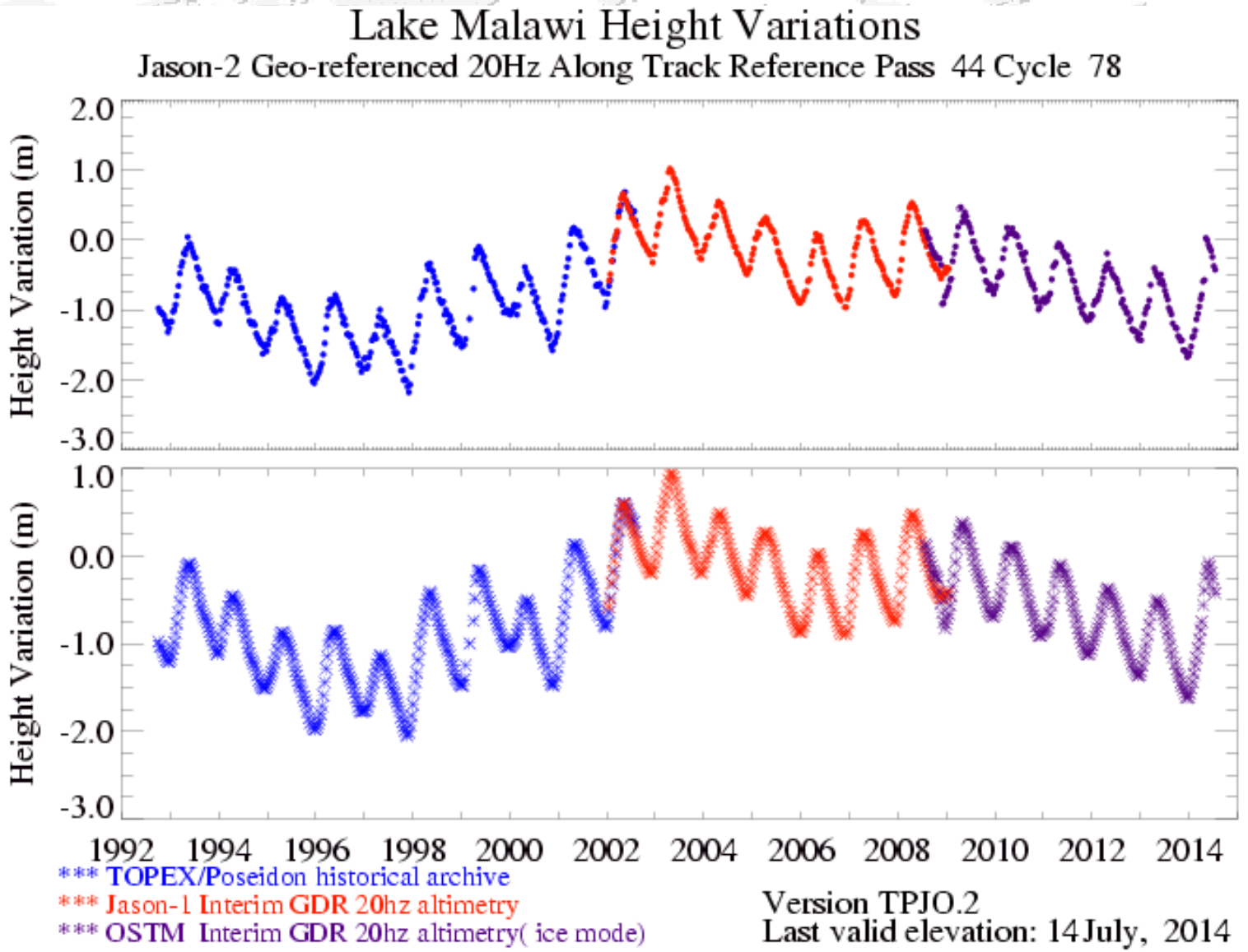
Lake Nyasa (Malawi)



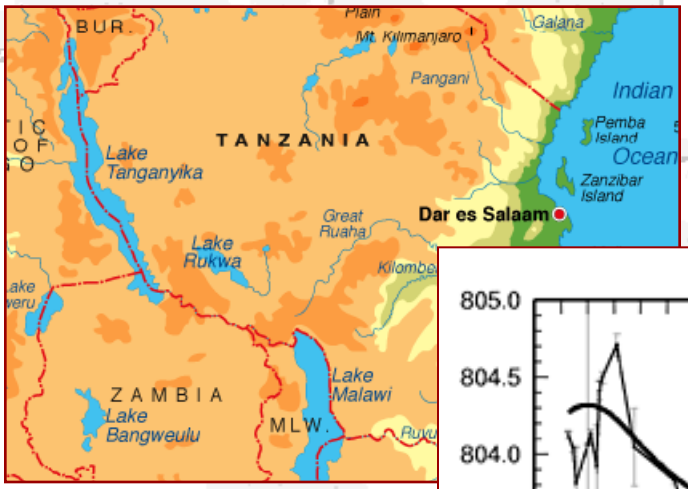


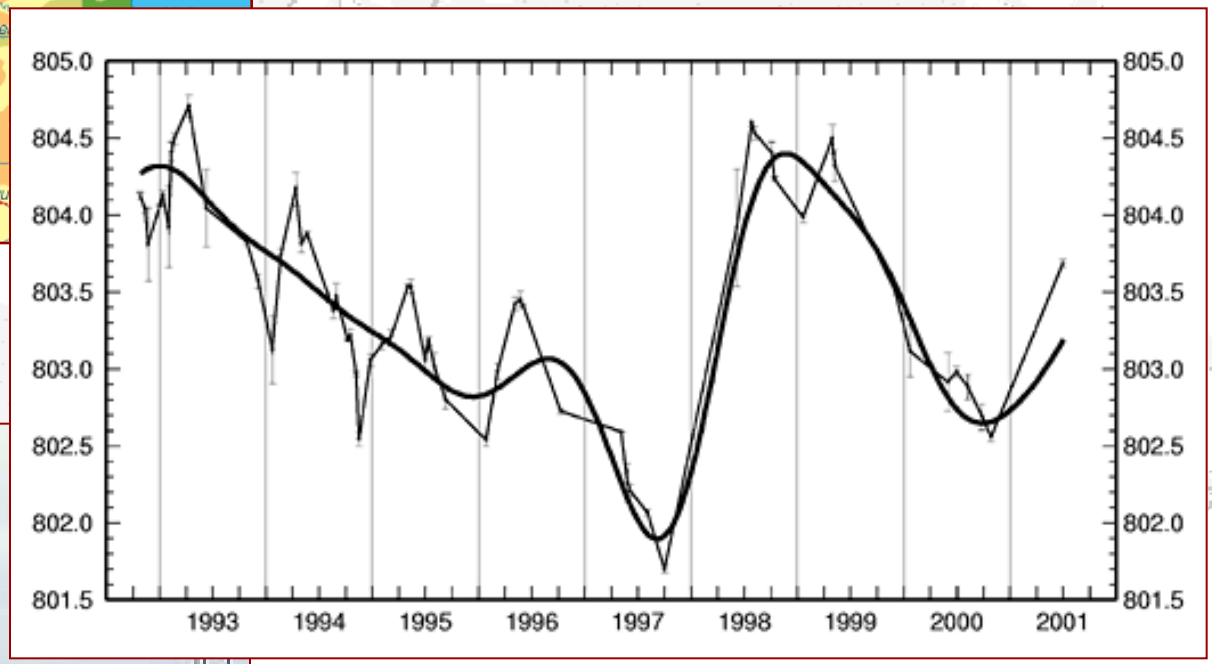
Time variation level of the Lake Nyasa (Malawi) by TOPEX/POSEIDON satellite altimetry (AVISO)

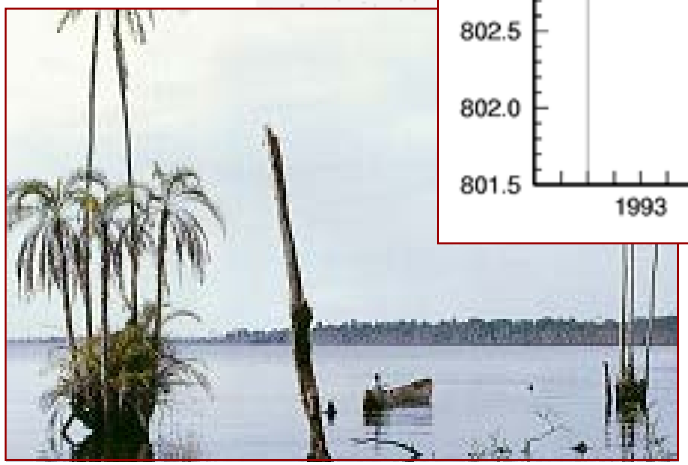
Lake Nyasa (Malawi)



Lake Rukwa

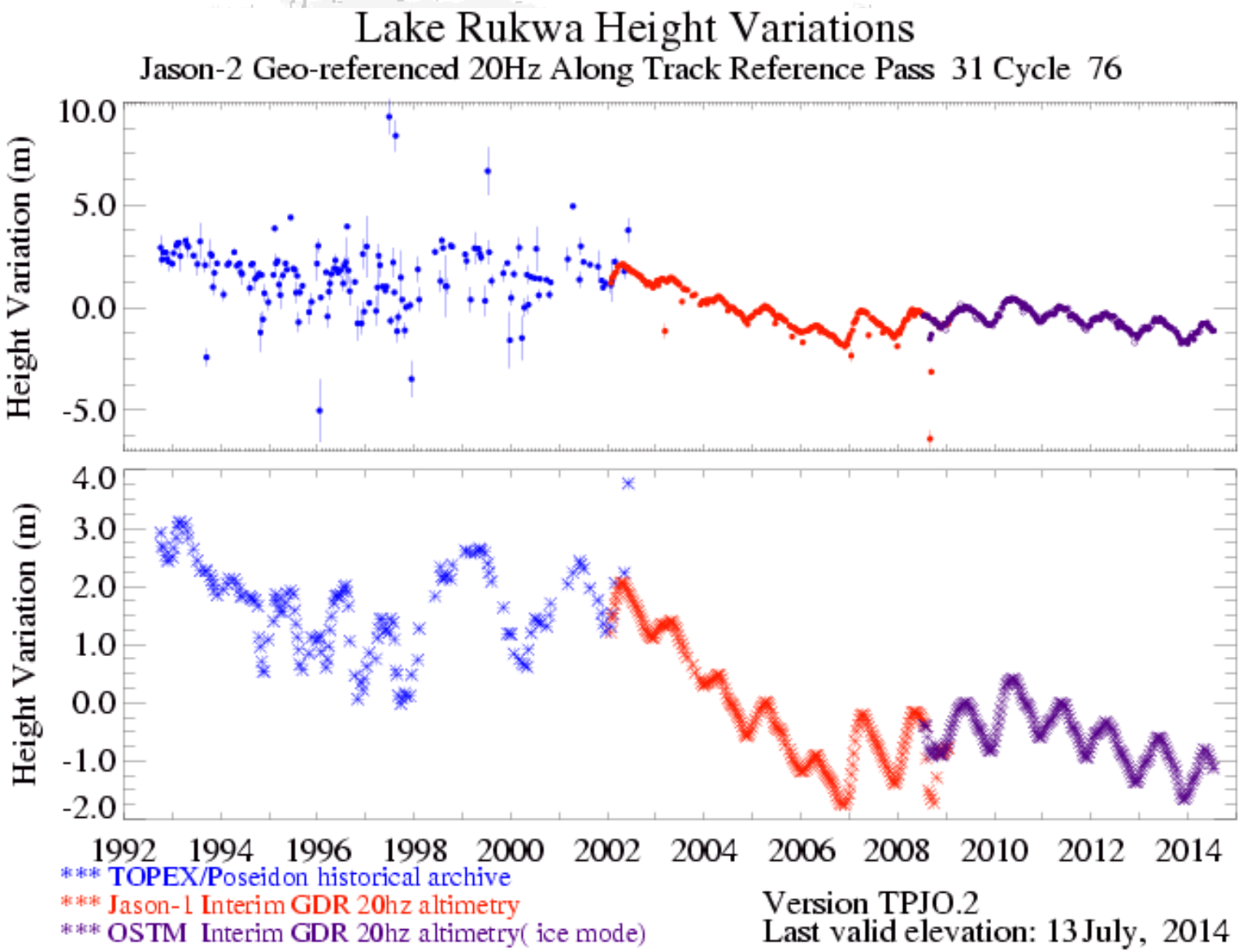






Time variation level of the Lake Rukwa by TOPEX/POSEIDON satellite altimetry (AVISO)

Lake Rukwa



Lake Elmenteita

Elmenteita is a small (18 sq km) soda lake, nestled in the eastern sweep of the Great Rift Valley. Maximum depth 1.2 m. Mean depth 0.9 m.

The lake attracts many visiting flamingo, and it shores are grazed by zebra, gazelle, eland and families of warthog.

Great Salt Lake

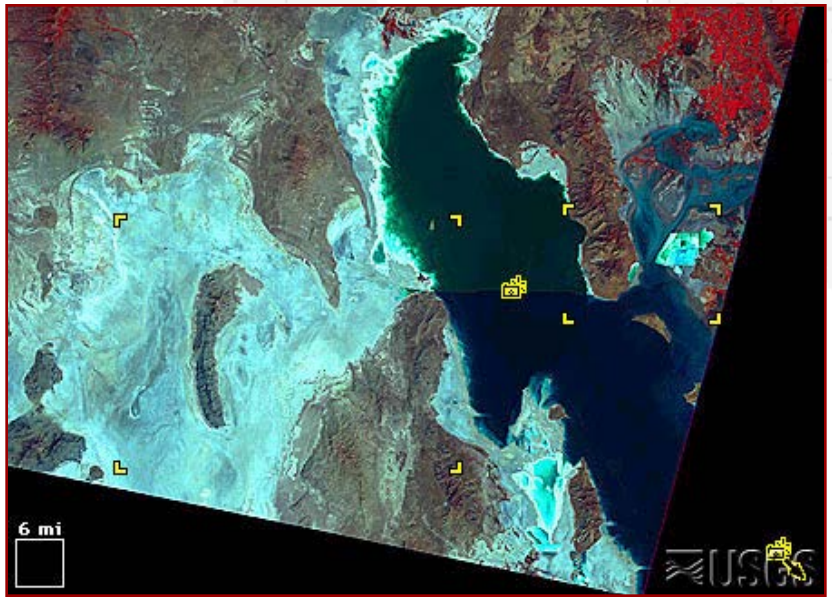
Lack of precipitation and a hot summer have caused the Great Salt Lake level to recede sharply. It is now at 4,198 feet above sea level, the lowest since 1980.
Salinity level of the Great Salt Lake is 280 ppt

Great Salt Lake

These images show the dramatic effects of the Great Salt Lake's high water levels in the 1980s.

Since water leaves the lake only through evaporation, it leaves behind its dissolved minerals, making the lake up to 8 times as salty as sea water.

Rainy weather beginning in 1982 brought the highest levels in recorded history, peaking in June 1986 and March-April 1987.



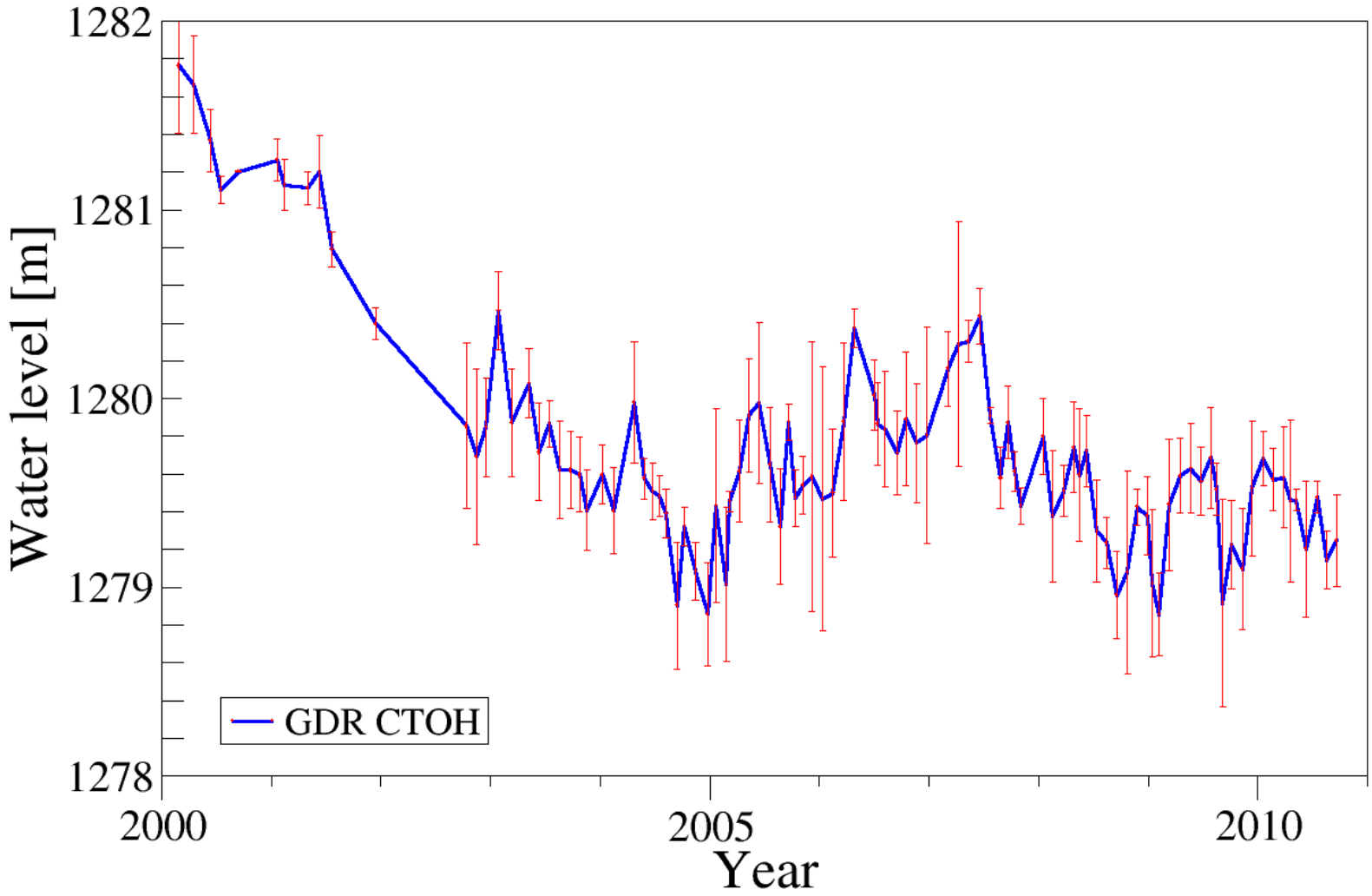
Landsat 1 image 13 September 1972

Landsat 5 image 18 December 1987

HYDROWEB

http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/index.html

Lake Greatsalt lat=41.00 lon=-112.50



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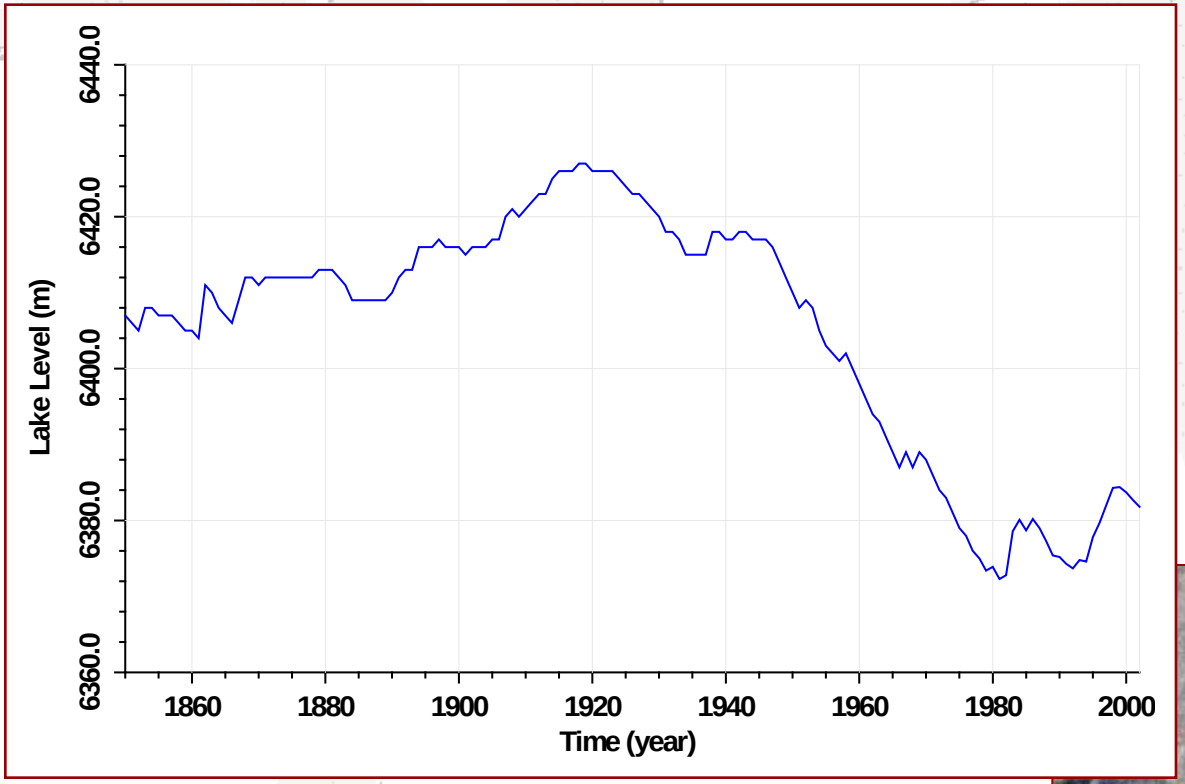
Pyramid Lake

Pyramid Lake's elevation declined 26 m between 1905 and 1967 and its salinity increased from about 3.7 g/l to its present level 5 g/l

Mono Lake

Currently, the salinity level of the Mono Lake is 87 ppt

Mono Lake



The MODIS image,
15 September 2002

The Mono Lake level since 1850 to present time.
50 m level drop between 1920 and 1980.

Salton Sea Lake

The Salton Sea is the largest lake in California (360 square miles). The ecological problems facing the Salton Sea, mainly the deposition of agricultural chemicals and rising salinity levels, are due to the fact that it is a closed basin. Water only leaves the lake by evaporation, leaving the salt and chemicals behind.

Rising salinity level is presently an extensive problem at the Salton Sea. Average salinity is currently 43 to 45 ppt. Increasing salinity has caused the collapse of fisheries based on introduced freshwater species, such as rainbow trout, that could not survive the increase in salinity.

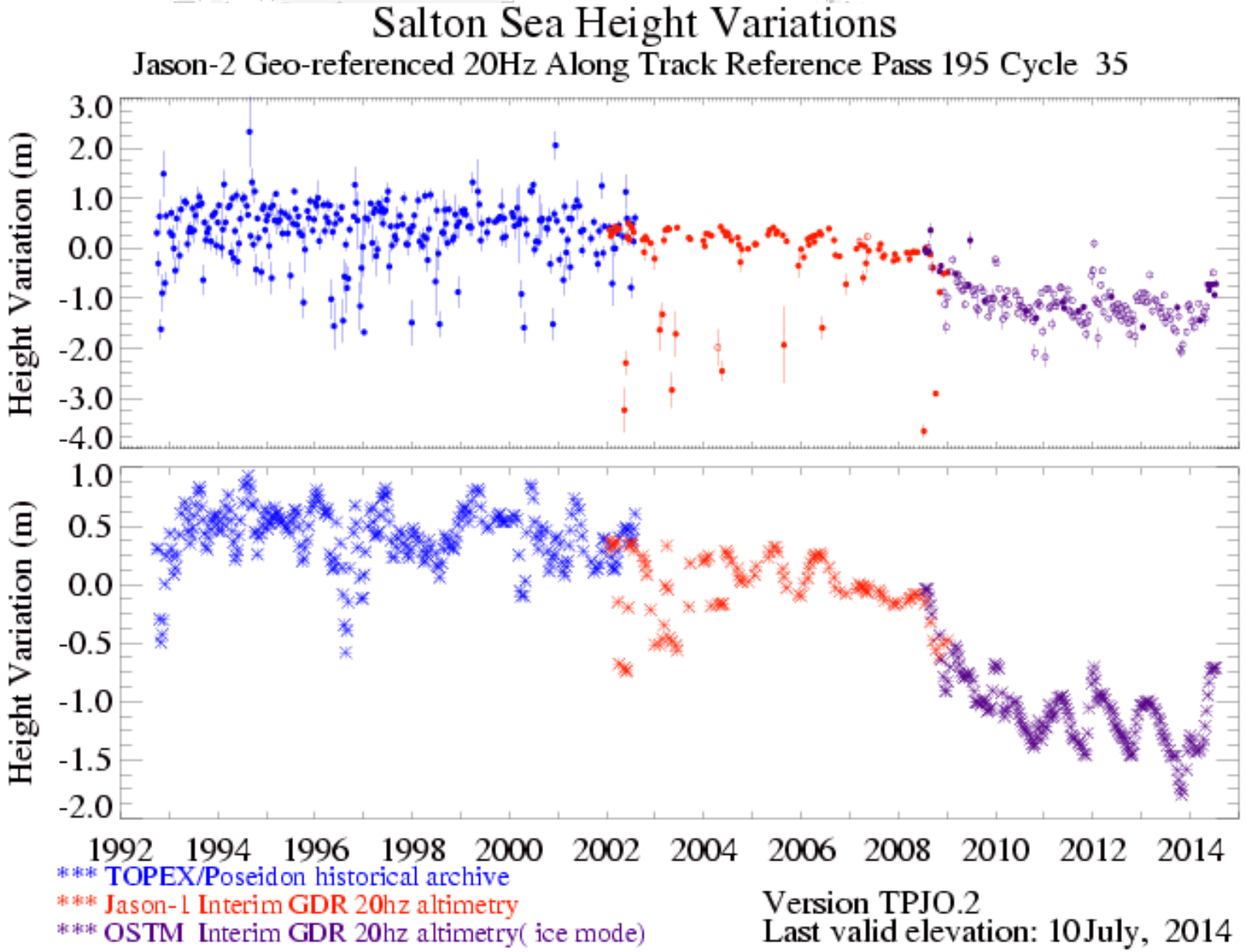
Salton Sea Lake

The MODIS image on

9 October 2002

In modern times, the Salton Trough, a desert basin whose center is 278 feet below sea level, became a lake in 1891, but dried up within a year. It began to form again in 1893. In 1905, the Colorado River flooded and was accidentally diverted into the Salton Trough, thus creating the Salton Sea. The Salton Sea was originally a fresh water lake. Because it is a closed system, with no outlet, water is lost only through evaporation. The salts from the surrounding environment have been concentrated in the sea for many years, and now it is more saline than the ocean. The sun evaporates 18% of the sea's volume every year, but the salt is left behind. Evaporation also concentrates pesticides and other pollutants.

Salton Sea Lake



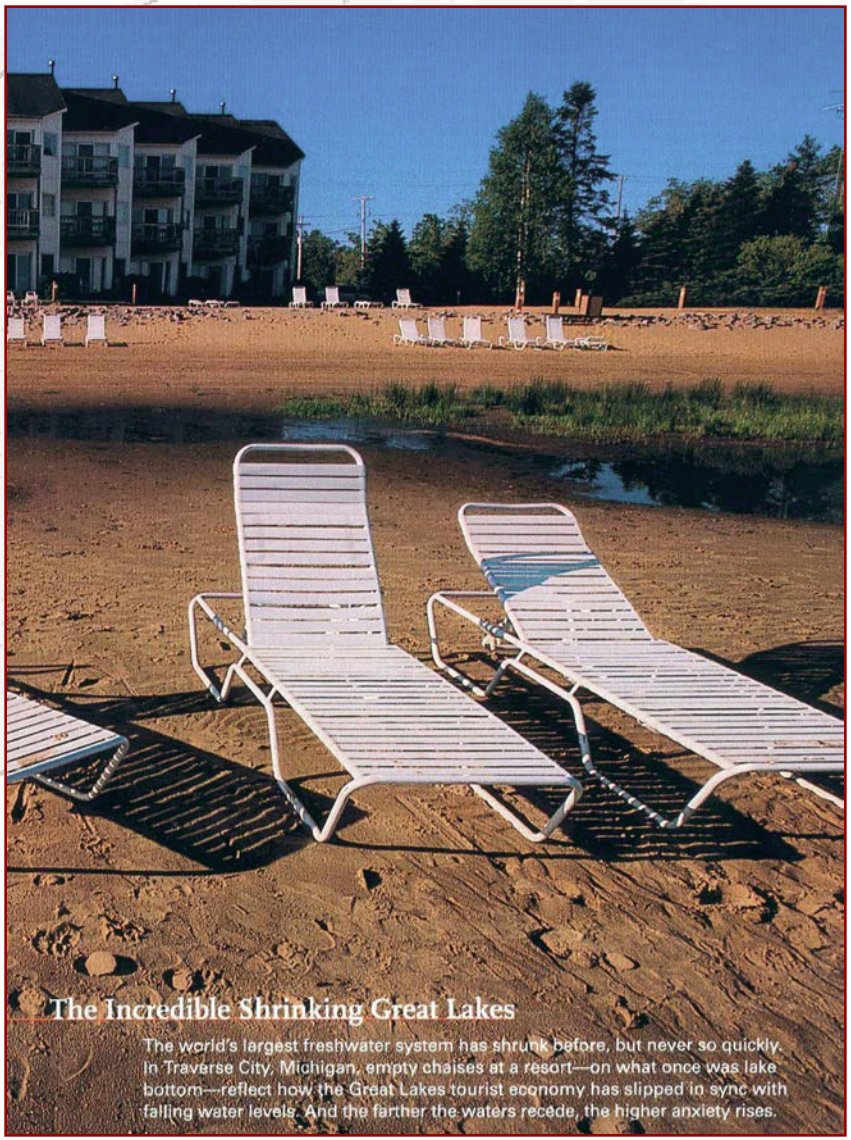
Great Lakes

How the Lakes Shrink?

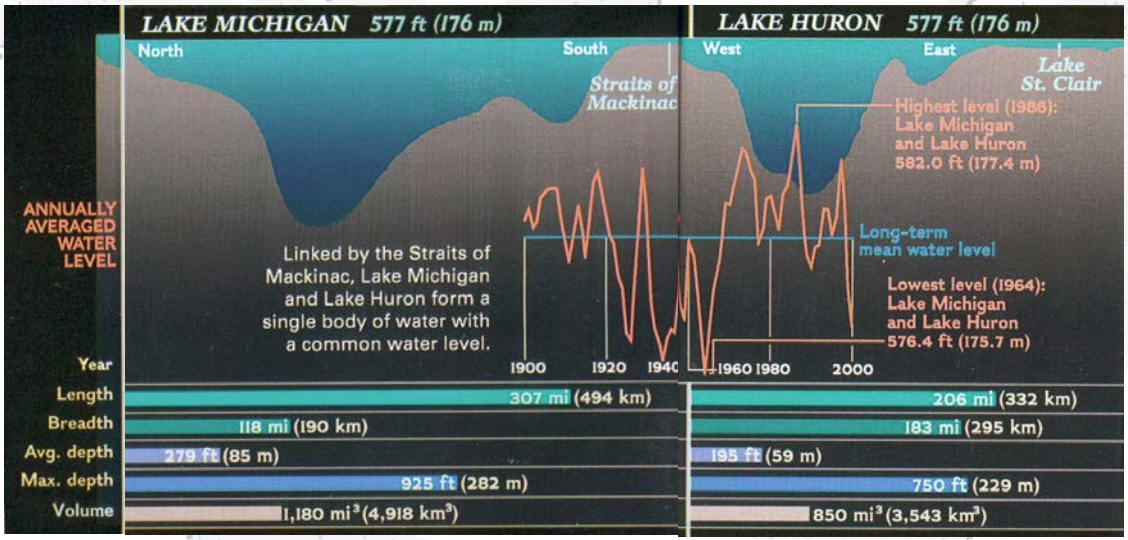
Drop of precipitation and less winter snow.

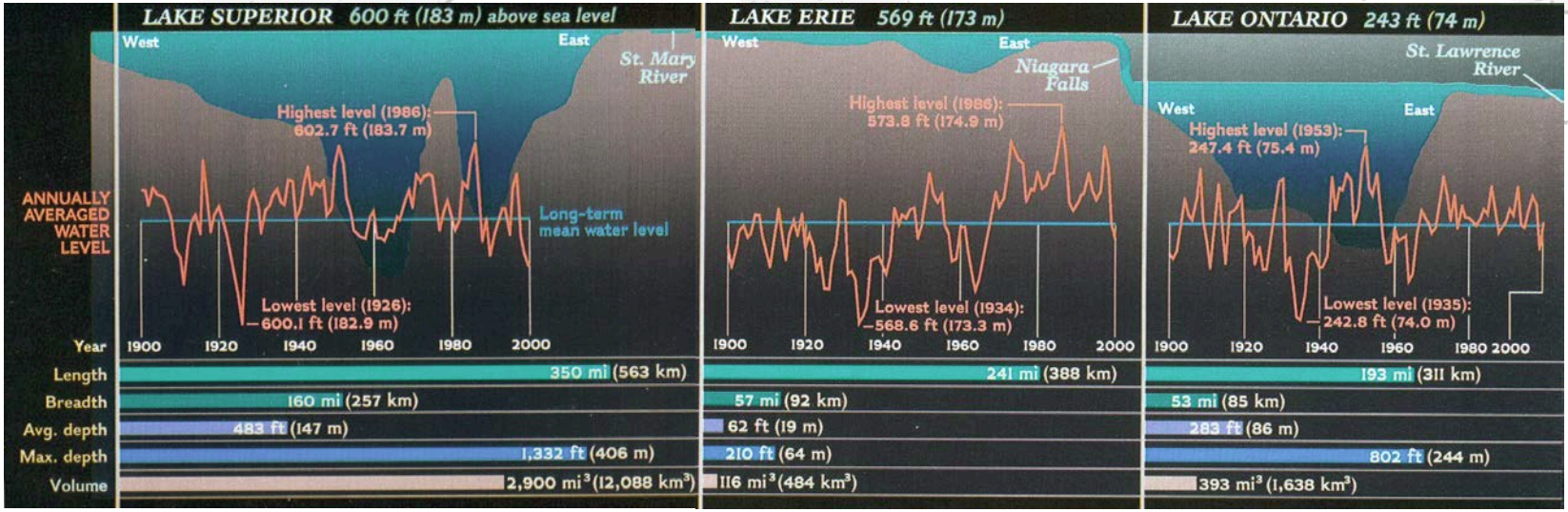
Warmer temperatures have increased the rate of evaporation and transpiration from trees. Reduced ice cover increases evaporation.

Consumption. Chicago sends its 2.4-billion-gallon-a-day draw on to the Mississippi after treatment.

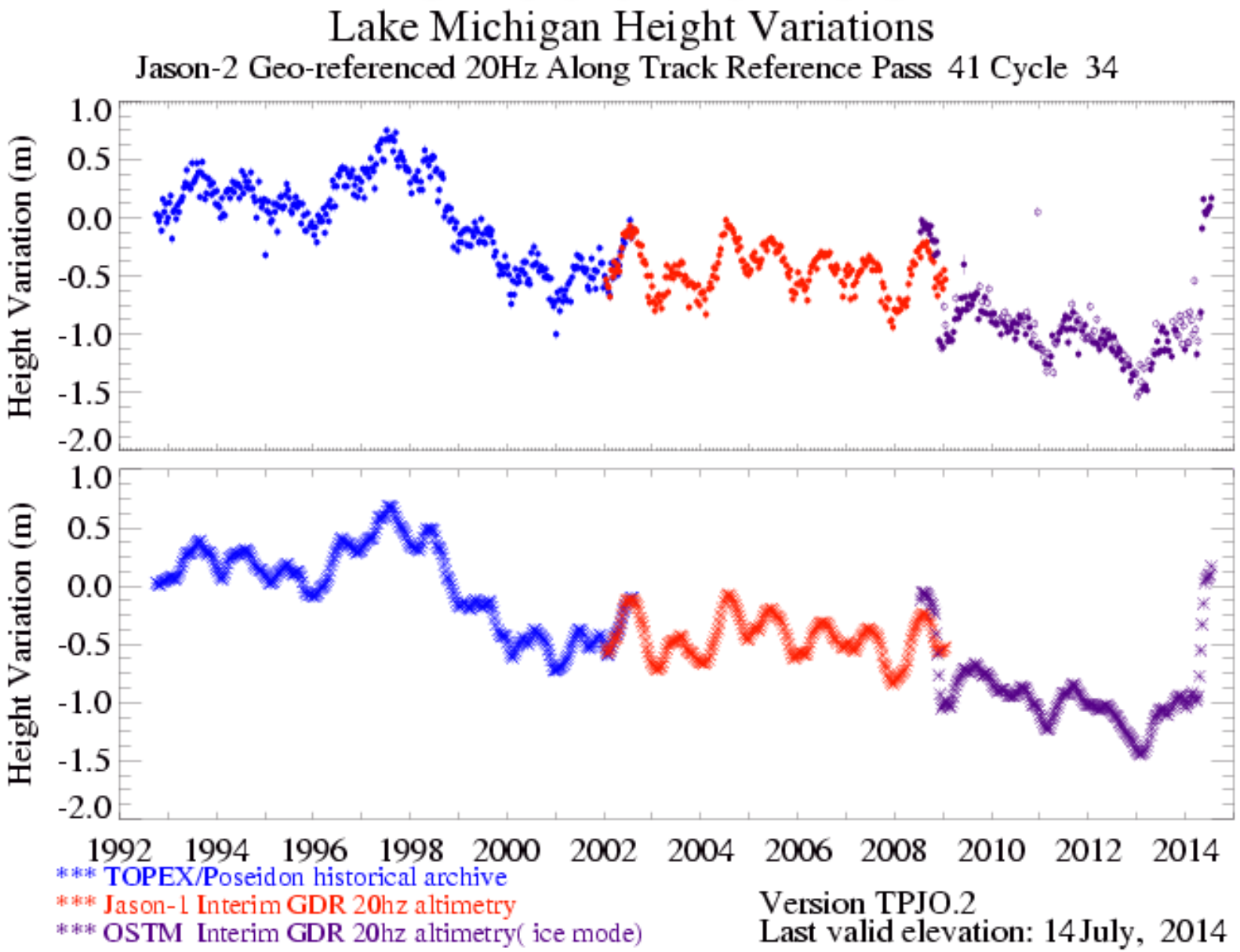


Great Lakes





Great Lakes



Lake Corangamite

An important example of a salt lake damaged by water diversion is Lake Corangamite, Victoria. This lake is the largest natural, permanent body of water on continental Australia. It is rapidly decreasing in size and increasing in salinity because its major inflow, the Woady Yaloak Creek has been diverted into the Barwon River.

From 1959 to 1990 the level of the lake has dropped ~2 m and the salinity has risen from ~35 to ~60 g/L.

Lake Eyre

Lake Eyre is Australia's largest salt lake, situated in the driest region in the country, within a major internal river drainage system of the interior lowlands. When dry, which is its usual state, the lake bed is a glistening sheet of white salt. The lake was named after Edward Eyre who was the first European to sight it in 1840.

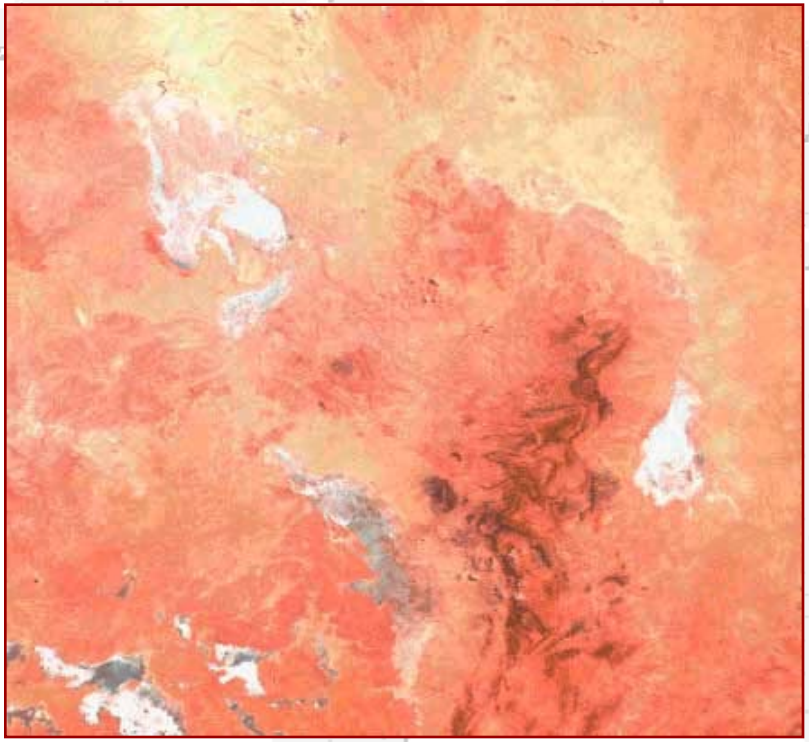
Lake Eyre

It actually comprises two lakes - North Lake Eyre and South Lake Eyre - evident in the image, and connected by a narrow channel. The lake appears partially full at the time of this imagery.

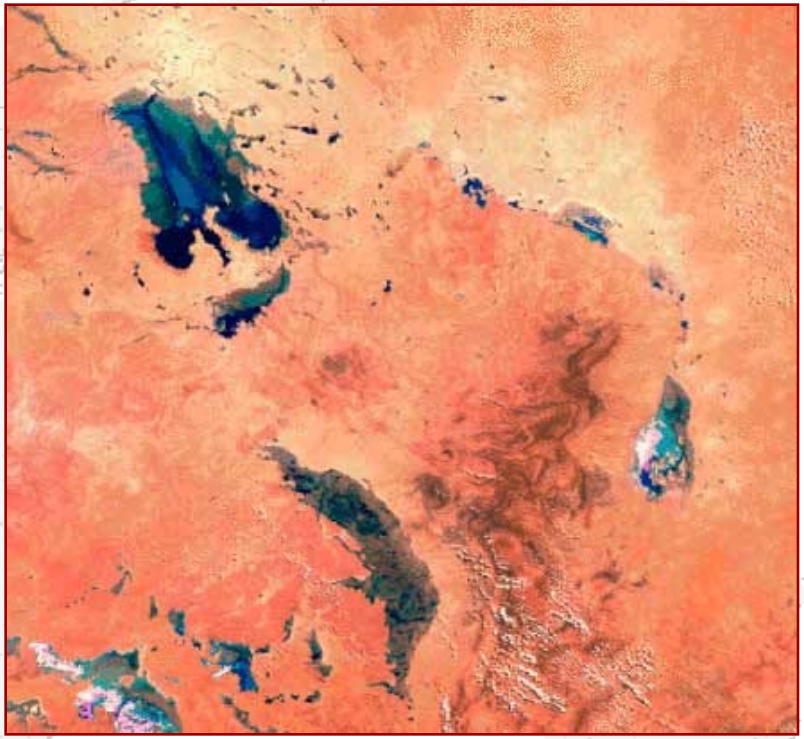
When the lake does fill, it becomes temporarily Australia's largest lake as it spreads out to 9500 sq km; and at its deepest, reaches to almost 6 m. This has occurred only three times last century, the latest being in 1989. The bed of Lake Eyre is also the lowest area in Australia, at 17 m below sea level.

Satellite image of Lake Eyre partially filled - 22 Feb 1984

Lake Eyre



19 Jan 2000
The whole system is dry



23 Feb 2000
Lake Eyre partially filled (both North and South)

Lake Qinghai Hu

Overuse of the lake water for agricultural purposes.

According to the lake's water resources protection bureau, the water level dropped an average 10 cm a year between 1959 and 1982.

Emergency measures then led to the lake rising an average 10 cm a year from 1983 to 1989. But for the last decade, the lake's water level has again dropped off.

Lake Qinghai Hu

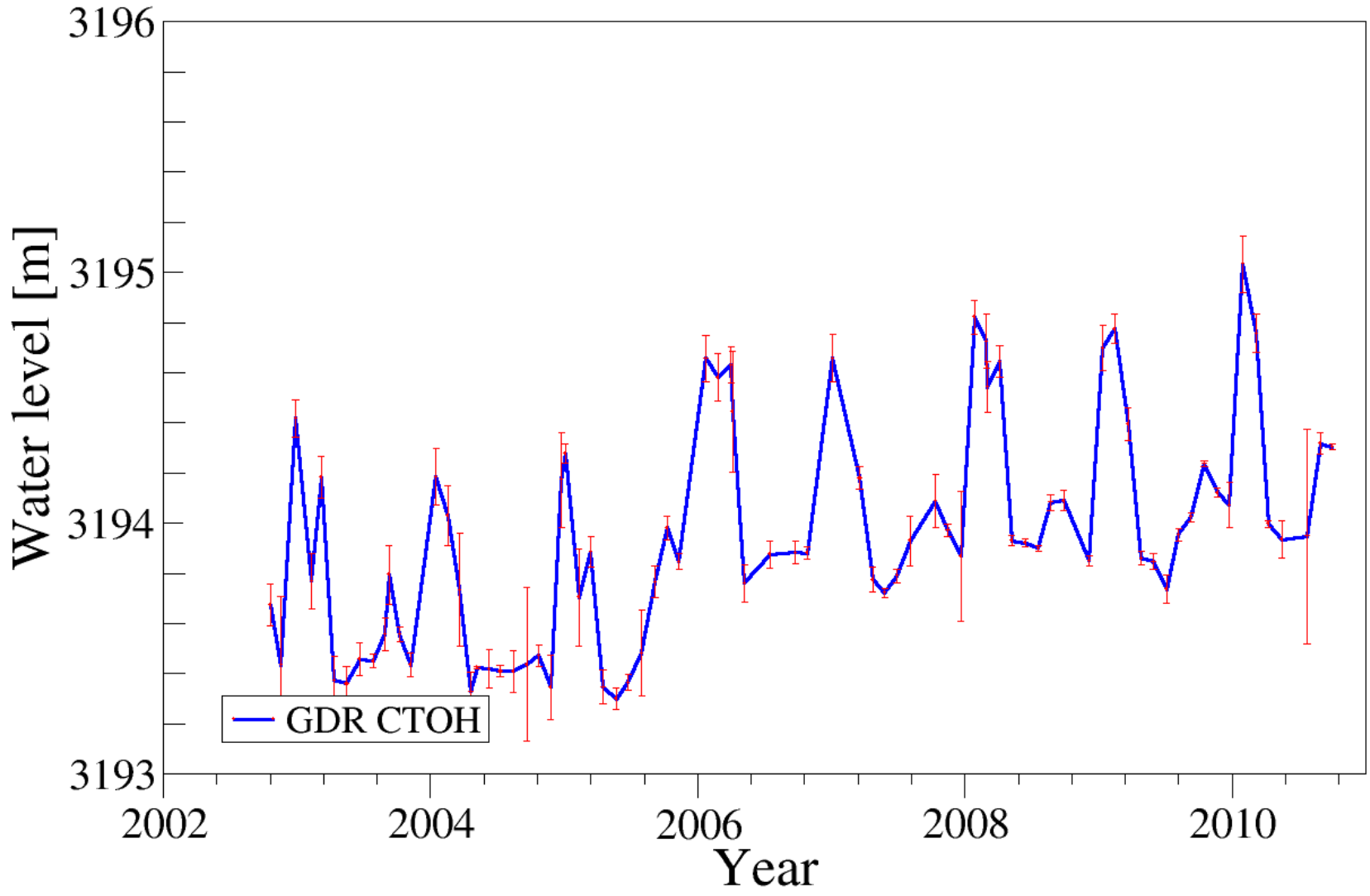
A decrease in both rainfall and underground water supply has resulted in a drop of 11.7 meters in the lake's water level within a century. Salt level has increased accordingly.

The MODIS image on 7 November 2002

H Y D R O W E B

http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/index.html

Lake Qinghai lat=37.00 lon=100.00



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Lake Ebinur

Owing to sandstorms and rapid population growth, the surface of Ebinur Lake, the largest salt lake in northwest China's Xinjiang Uygur Autonomous Region, has shrunk to 530 square km in the past five decades.

Formed in the Quaterary Period, Ebinur Lake has gradually been turned from a fresh water lake into a salt one.

Its water surface was 1,200 square km in the early 1950s, only one third of its original size. As a result, the number of 117 rare plants and animals living in and around the lake have reduced considerably. Antelope, red deer, swan and other rare species have become extinct in the region.

Statistics show that the wind blows an estimated 4.8 million tons of dust and sand away from the region annually. The No. 312 national highway, which is adjacent to Ebinur Lake, has to alter the route as part of the original road has been buried by sand. The Euro-Asia Continental Railway Bridge suspended operation on several occasions for the same reason.

To prevent the lake from shrinking slowly, the regional government has taken a series of measures including planting trees and grass around the lake and setting up a nature preserve in the region.

CONCLUSIONS

WILL BE GIVEN ON SATURDAY, MAY 10, 2003
BY

D. SIRJACOBS and J.C.J. NIHOUL

WHAT DON'T WE KNOW ABOUT DYING AND DEAD SEAS?