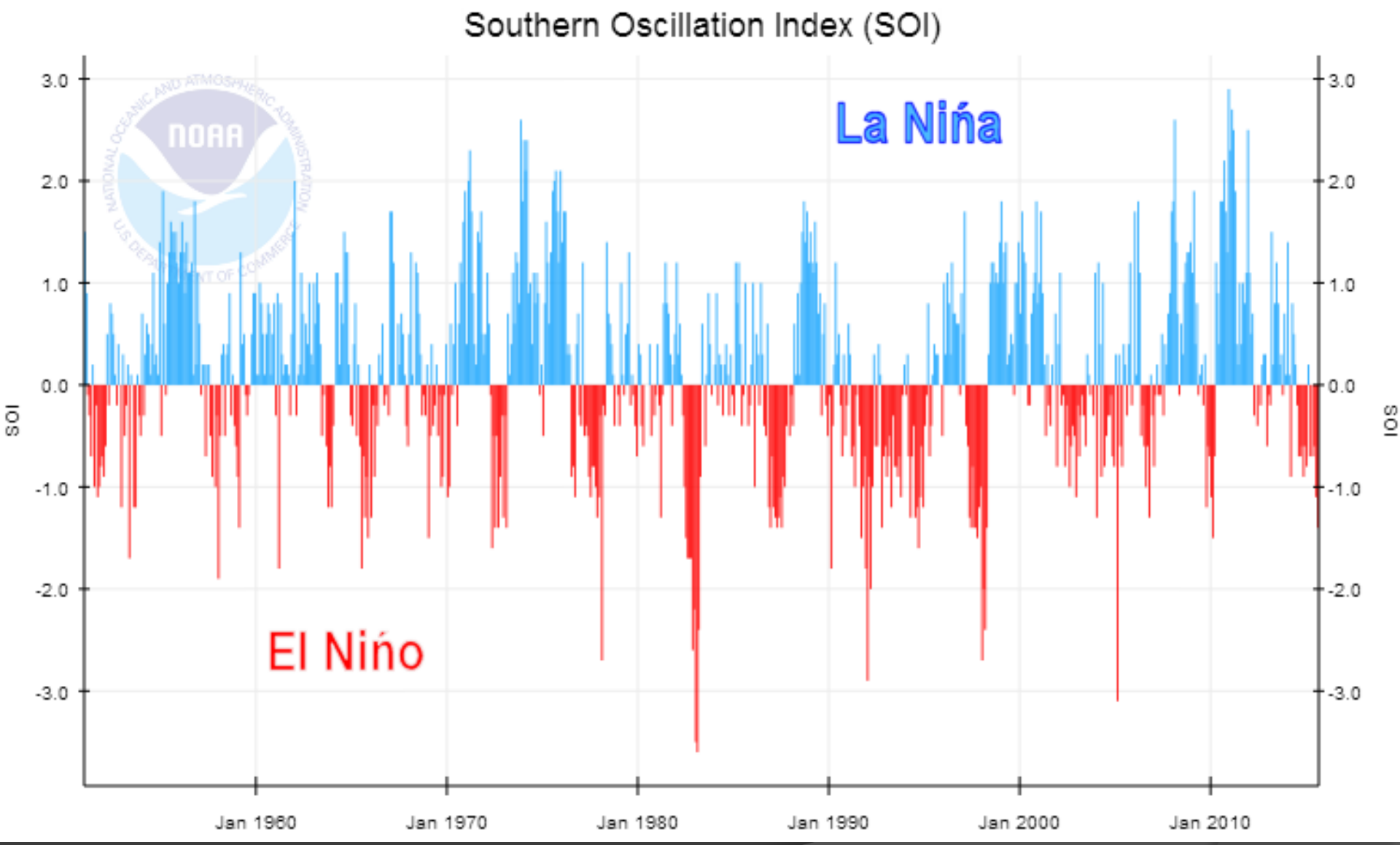
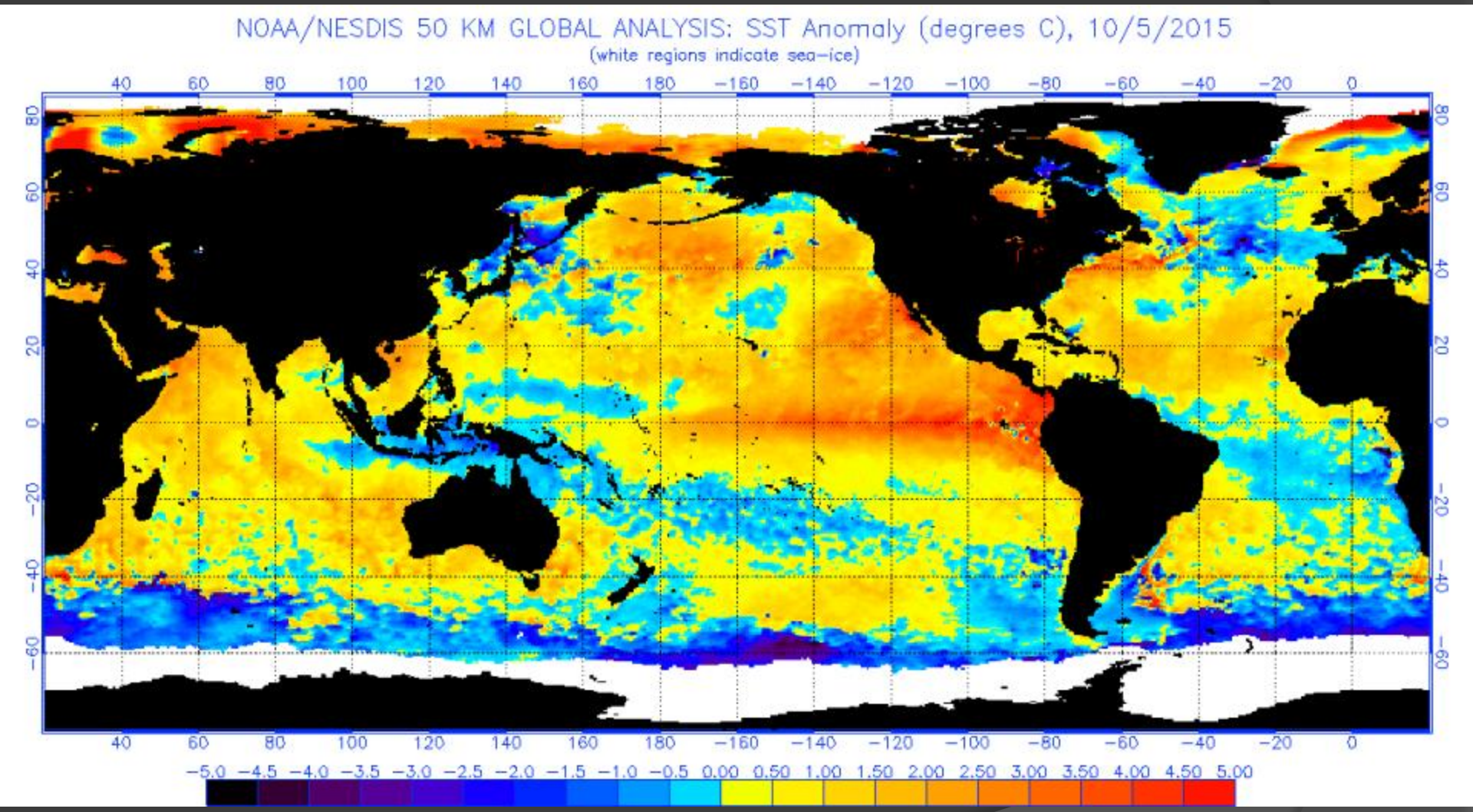
Zbigniew Zwoliński, Małgorzata Mazurek
Uniwersytet im. Adama Mickiewicza w Poznaniu
Piotr Wężyk
Uniwersytet Rolniczy w Krakowie

TECHNOLOGIE TELEDETEKCYJNE W MONITOROWANIU TELEKONEKSJI ZMIAN GLOBALNYCH ŚRODOWISKA

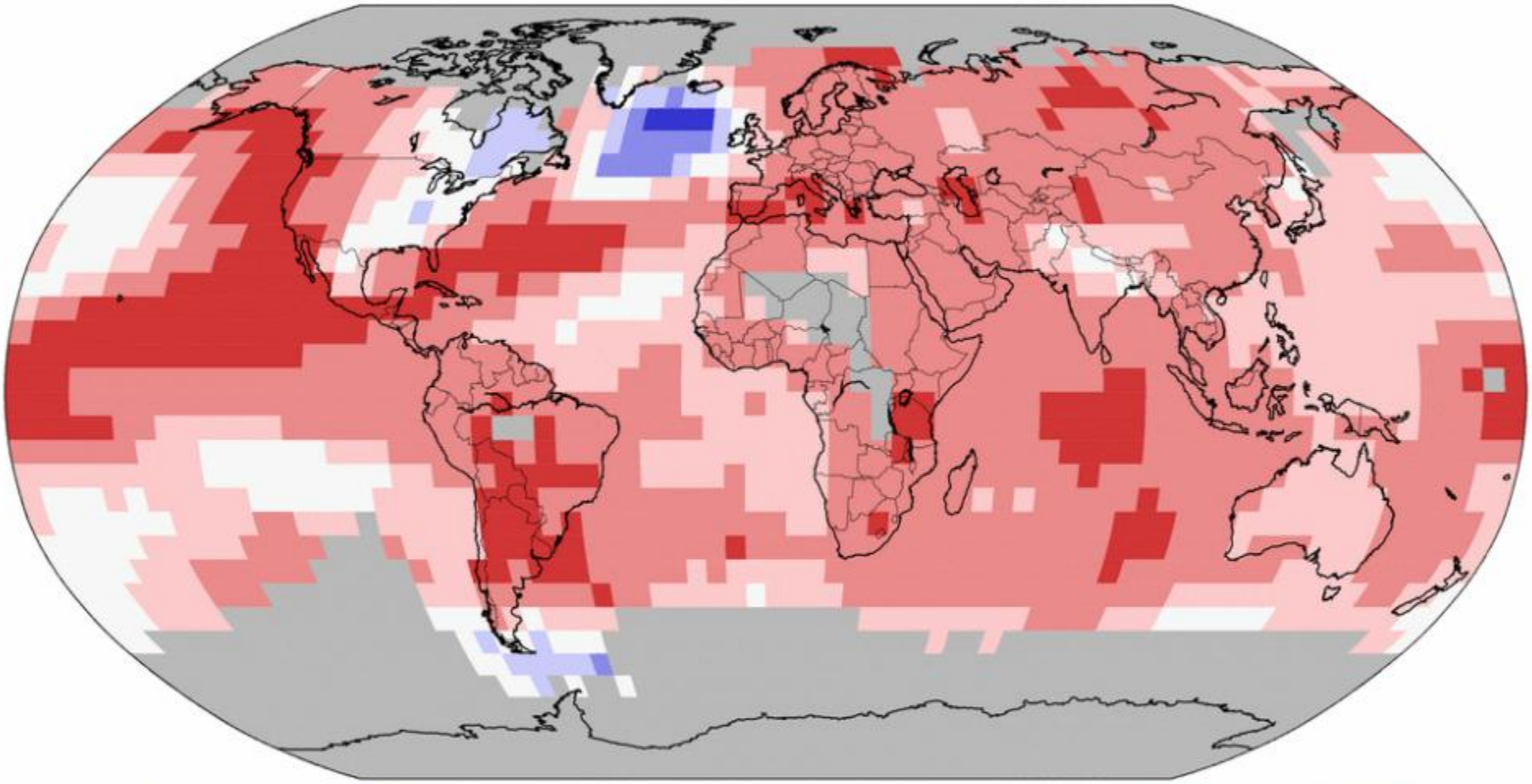

Southern Oscillation Index (SOI)
La Niña
El Niño
SOI
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
Jan 1960
Jan 1970
Jan 1980
Jan 1990
Jan 2000
Jan 2010


NOAA/NESDIS 50 KM GLOBAL ANALYSIS: SST Anomaly (degrees C), 10/5/2015
(white regions indicate sea-ice)
40 60 80 100 120 140 160 180 −160 −140 −120 −100 −80 −60 −40 −20 0
80 60 40 20 0 −20 −40 −60
−5.0 −4.5 −4.0 −3.5 −3.0 −2.5 −2.0 −1.5 −1.0 −0.5 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00

Land & Ocean Temperature Percentiles Jan–Aug 2015

NOAA's National Centers for Environmental Information

Data Source: GHCN–M version 3.3.0 & ERSST version 4.0.0



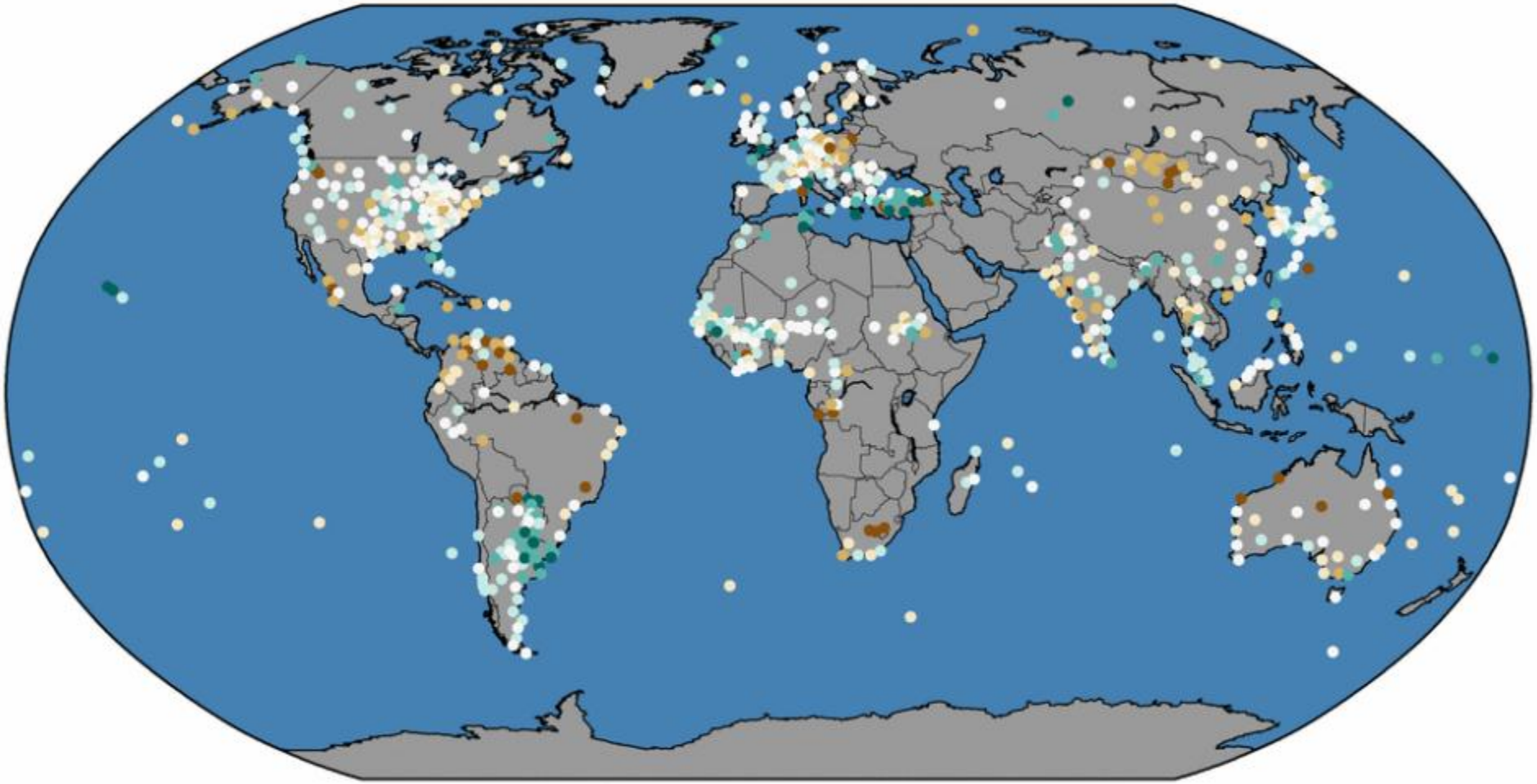
Record Coldest	Much Cooler than Average	Cooler than Average	Near Average	Warmer than Average	Much Warmer than Average	Record Warmest

Mon Sep 14 06:43:31 EDT 2015

Land–Only Precipitation Percentiles Aug 2015

NOAA's National Centers for Environmental Information

Data Source: GHCN–M version 2



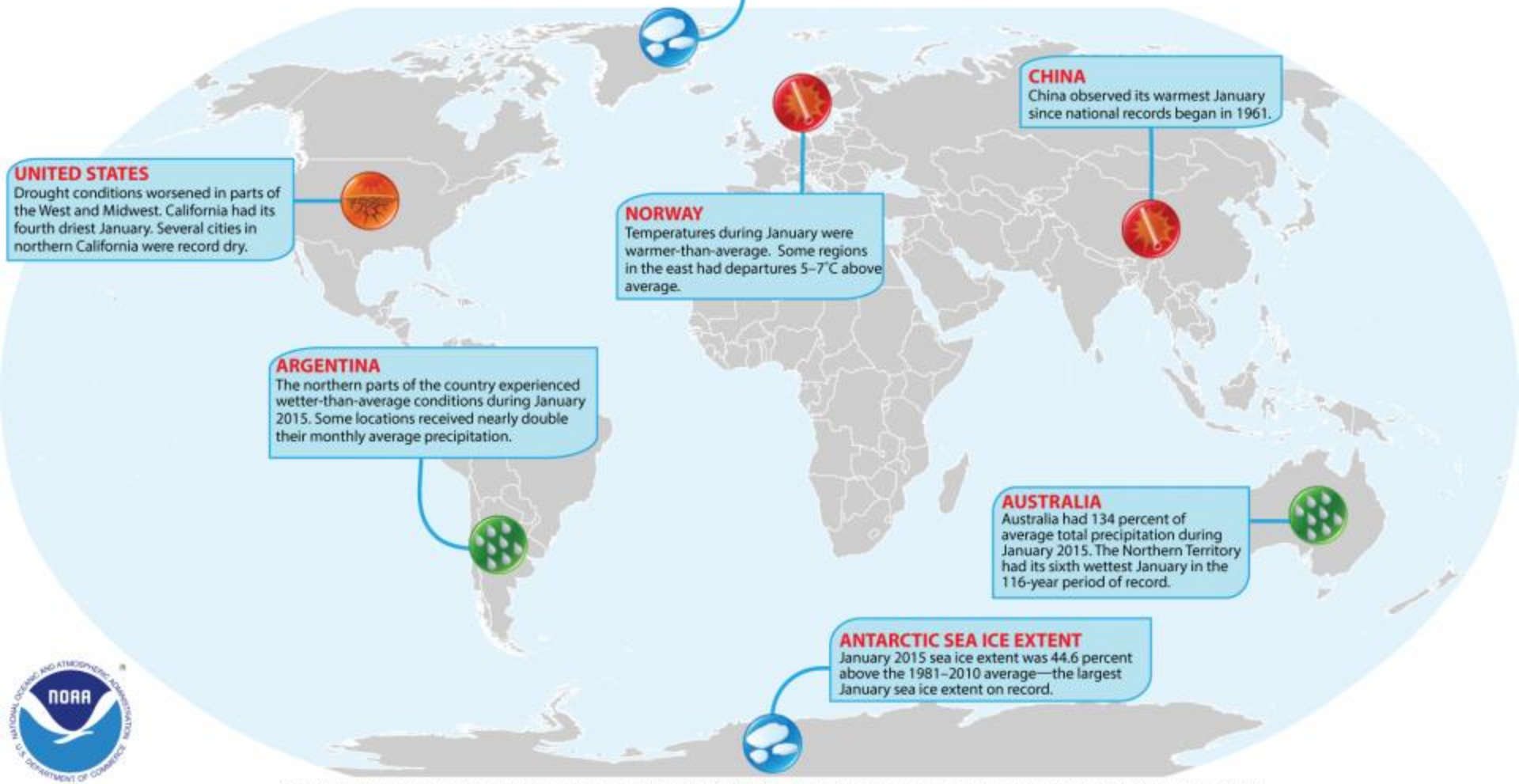
Record Driest | Much Drier than Average | Drier than Average | Near Average | Wetter than Average | Much Wetter than Average | Record Wettest

Wed Sep 16 09:58:09 EDT 2015

Selected Significant Climate Anomalies and Events January 2015

GLOBAL AVERAGE TEMPERATURE
January 2015 average global land and ocean temperature was the second warmest January since records began in 1880.

ARCTIC SEA ICE EXTENT
January 2015 sea ice extent was 6.3 percent below the 1981–2010 average—the third smallest January sea ice extent since satellite records began in 1979.



CHINA
China observed its warmest January since national records began in 1961.

UNITED STATES
Drought conditions worsened in parts of the West and Midwest. California had its fourth driest January. Several cities in northern California were record dry.

NORWAY
Temperatures during January were warmer-than-average. Some regions in the east had departures 5–7°C above average.

ARGENTINA
The northern parts of the country experienced wetter-than-average conditions during January 2015. Some locations received nearly double their monthly average precipitation.

AUSTRALIA
Australia had 134 percent of average total precipitation during January 2015. The Northern Territory had its sixth wettest January in the 116-year period of record.

ANTARCTIC SEA ICE EXTENT
January 2015 sea ice extent was 44.6 percent above the 1981–2010 average—the largest January sea ice extent on record.

Please Note: Material provided in this map was compiled from NOAA's NCDC State of the Climate Reports. For more information please visit: http://www.ncdc.noaa.gov/sotc

Selected Significant Climate Anomalies and Events August 2015

GLOBAL AVERAGE TEMPERATURE
August 2015 average global land and ocean temperature was the warmest August since records began in 1880.

ARCTIC SEA ICE EXTENT
August 2015 sea ice extent was 22.3 percent below the 1981–2010 average—the fourth smallest August sea ice extent since satellite records began in 1979.

Asia
Western Russia observed below normal temperatures during August, while parts of Eastern Russia and Mongolia experienced record warm temperatures.

CONTIGUOUS UNITED STATES
Ongoing drought and record summer heat plagued the US Pacific Northwest. Wildfires charred over one million acres in the Western US, including Alaska.

EUROPE
As a whole, Europe experienced an August average temperature 2.3°C (4.1°F) warmer than average. The United Kingdom was slightly cooler than average.

EAST PACIFIC BASIN
The East Pacific Hurricane basin was quite active. At the end of August, three storms — Kilo, Ignacio, and Jimena — represented the first simultaneous occurrence of three major hurricanes in the basin since records began in 1949.

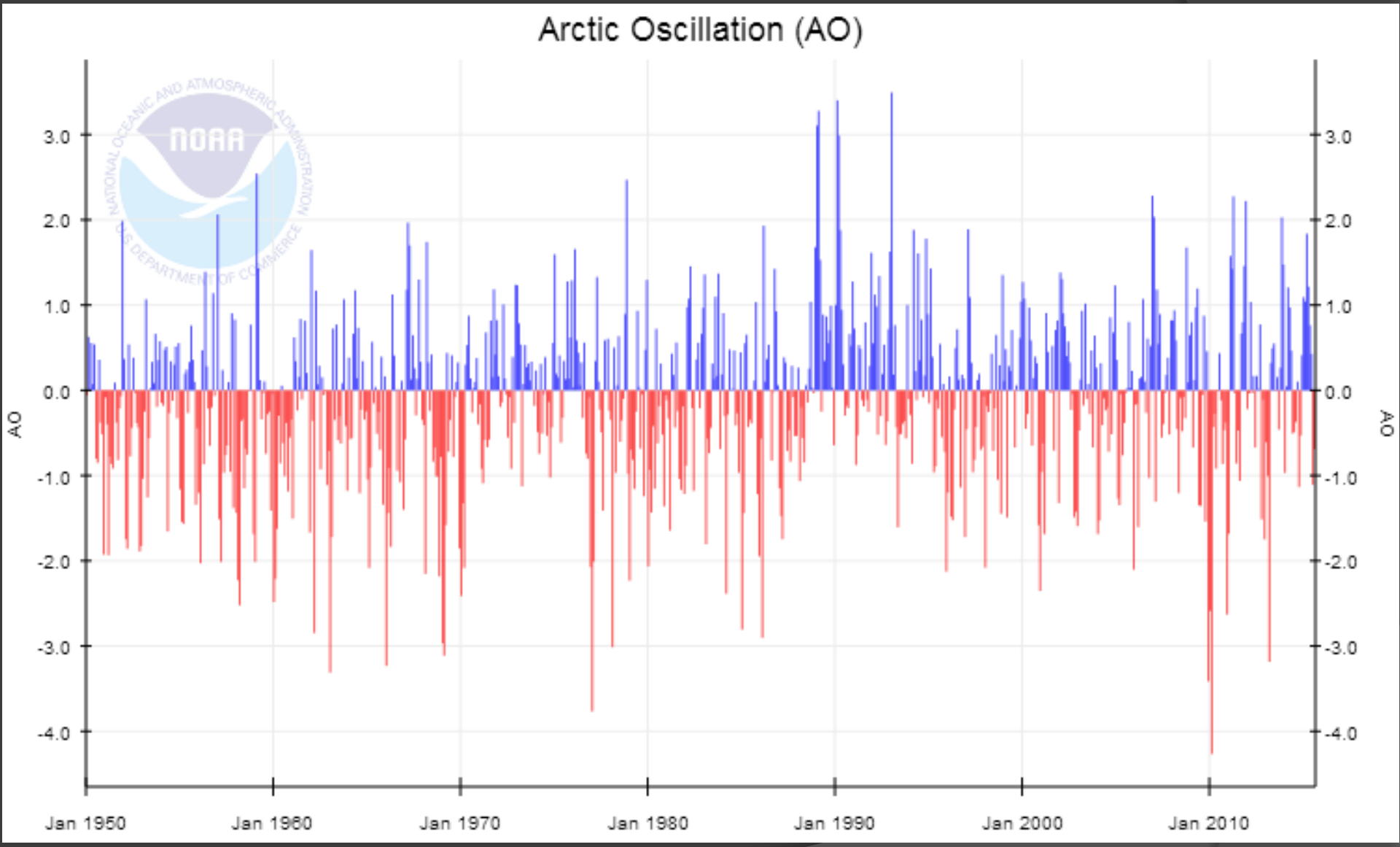
OCEANIA/AUSTRALIA
Oceania as a whole was 0.7°C (1.2°F) warmer than average. Australia was 0.6°C (1.1°F) warmer than its national average for August.

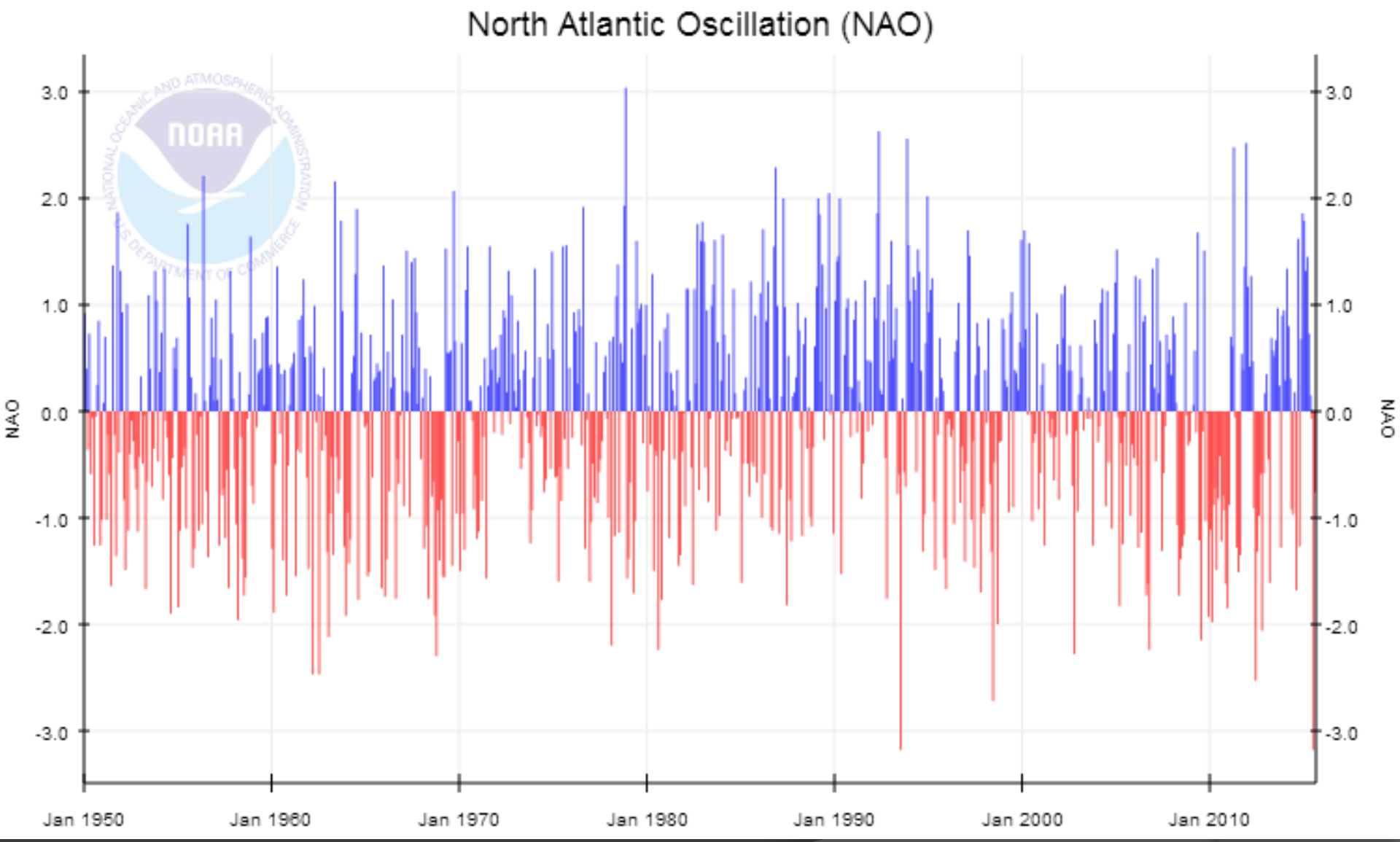
SOUTH AMERICA
The continental-averaged temperature for South America was the warmest since at least 1910. Argentina had its warmest winter on record, with some locations recording daily highs as warm as 40°C (104°F).

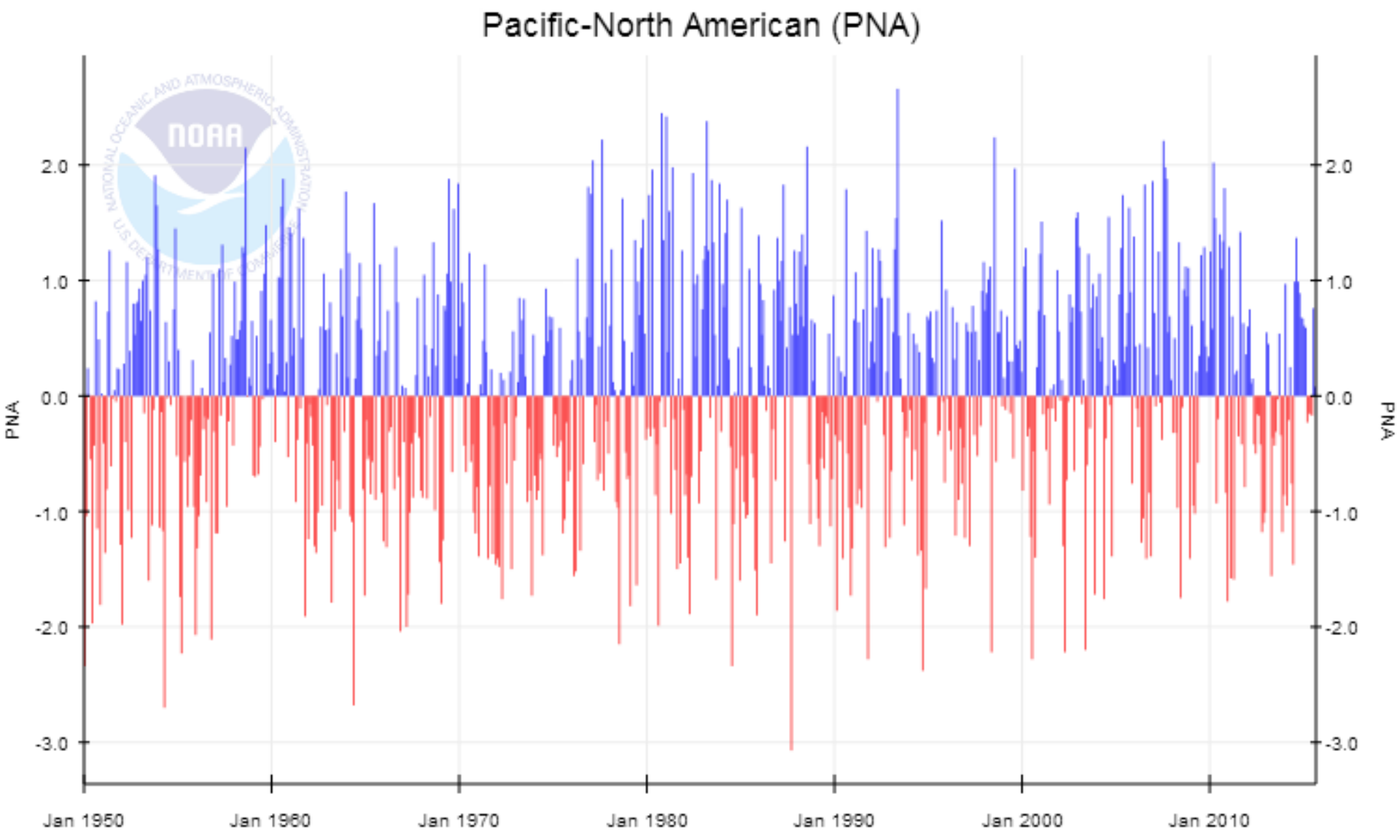
AFRICA
Temperatures averaged 1.4°C (2.5°F) above the long-term average for Africa, nominally the warmest August for the continent since at least 1910.

ANTARCTIC SEA ICE EXTENT
August 2015 sea ice extent was 0.5 percent below the 1981–2010 average—the ninth smallest August sea ice extent on record and the first below average month since November 2011.

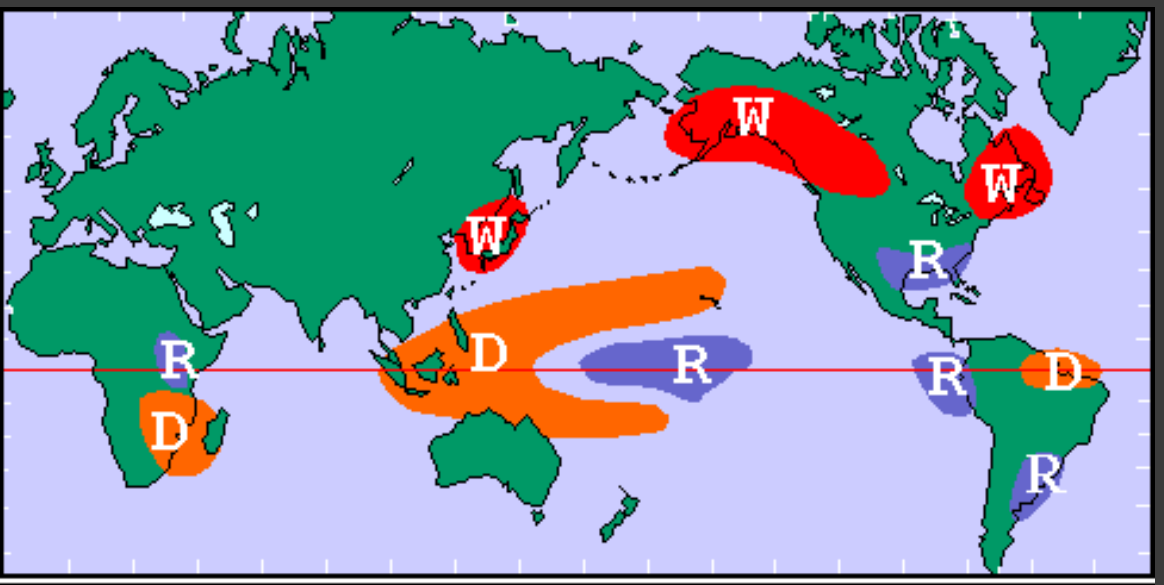
Please Note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: http://www.ncdc.noaa.gov/sotc


Arctic Oscillation (AO)
AO
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
Jan 1950
Jan 1960
Jan 1970
Jan 1980
Jan 1990
Jan 2000
Jan 2010

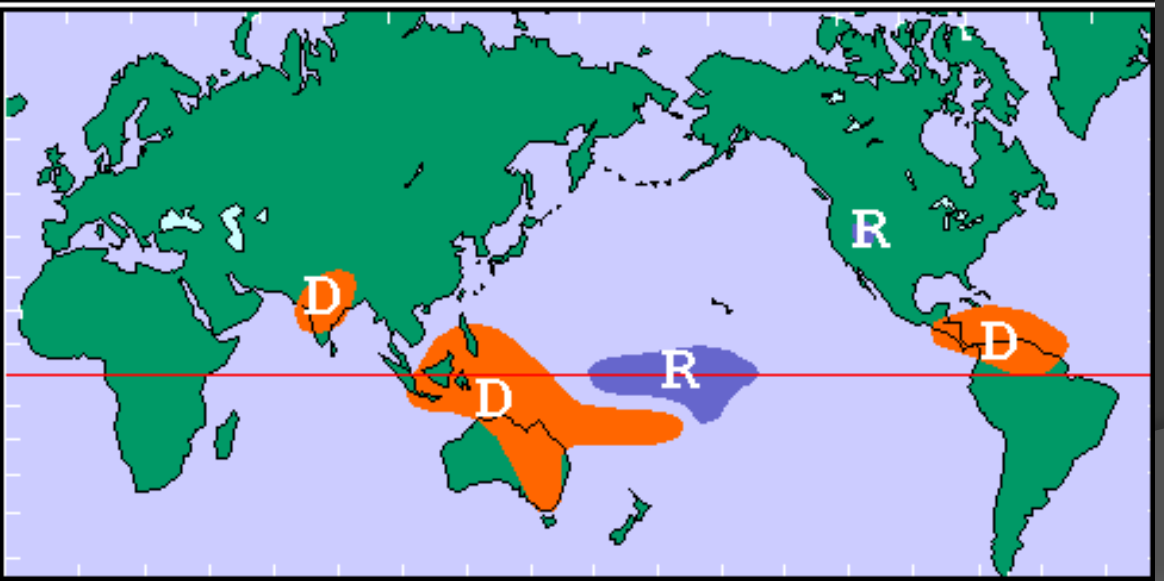

North Atlantic Oscillation (NAO)
NAO
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
Jan 1950
Jan 1960
Jan 1970
Jan 1980
Jan 1990
Jan 2000
Jan 2010


Pacific-North American (PNA)
PNA
2.0
1.0
0.0
-1.0
-2.0
-3.0
Jan 1950
Jan 1960
Jan 1970
Jan 1980
Jan 1990
Jan 2000
Jan 2010

Efekty El Nino



X - III

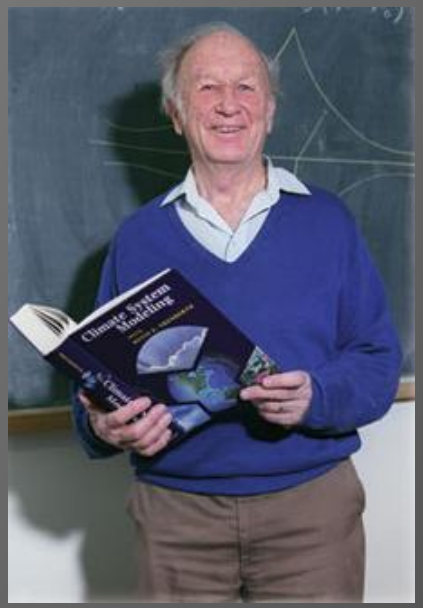


IV - IX

D – susza

R – ponadprzeciętne opady

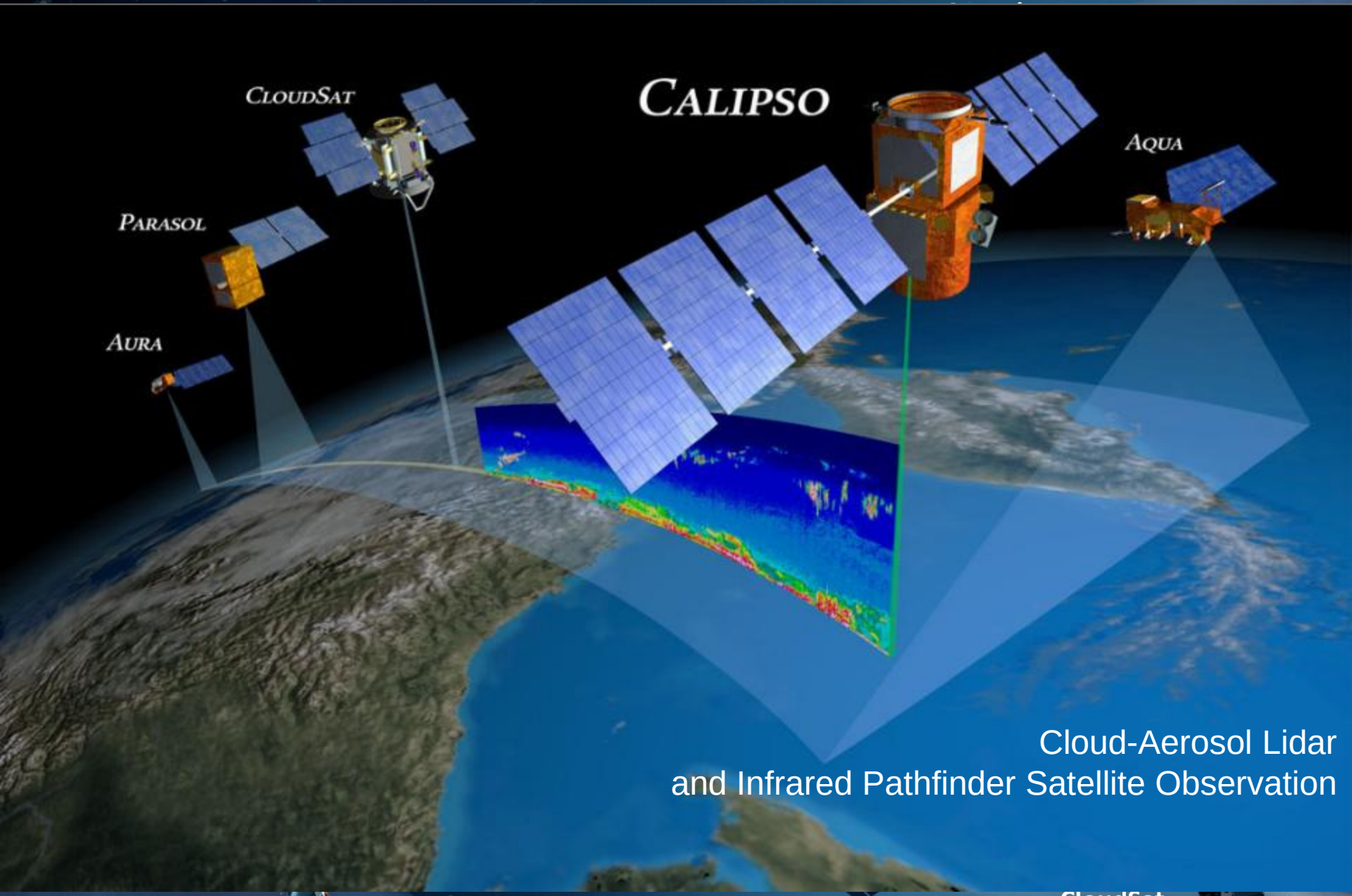
W – wysokie temperatury



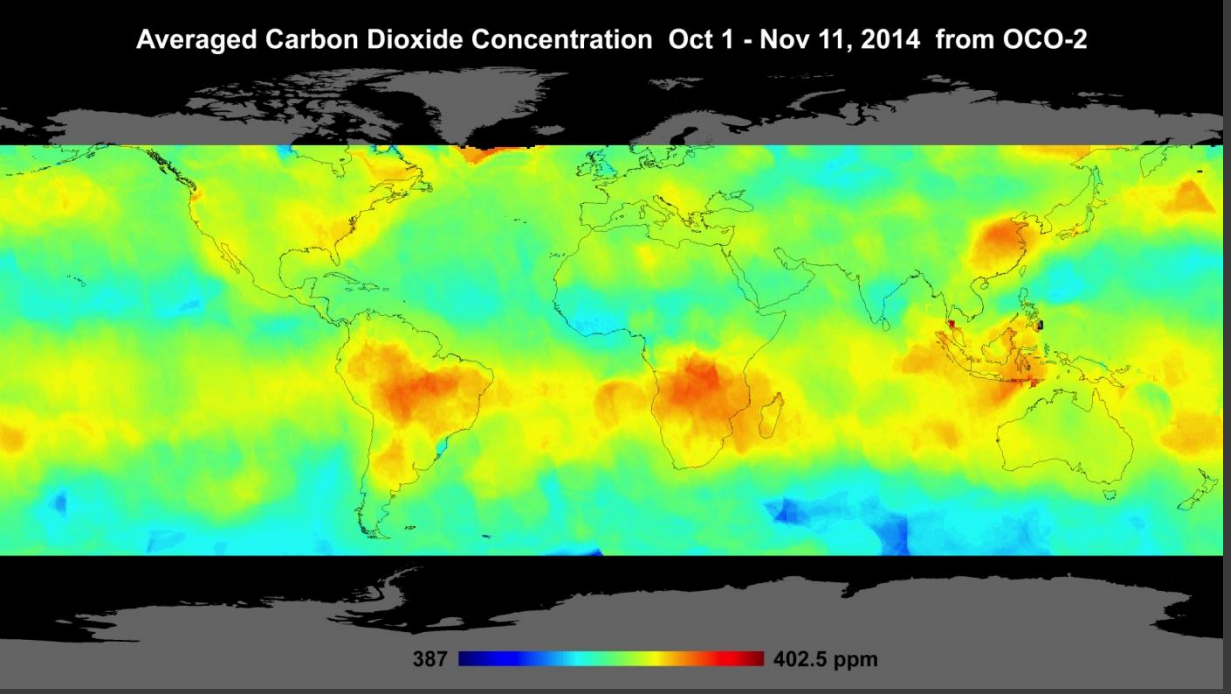
Edward Lorenz (1963)

Dowolny układ fizyczny, który zachowuje się nieokresowo, jest nieprzewidywalny .....

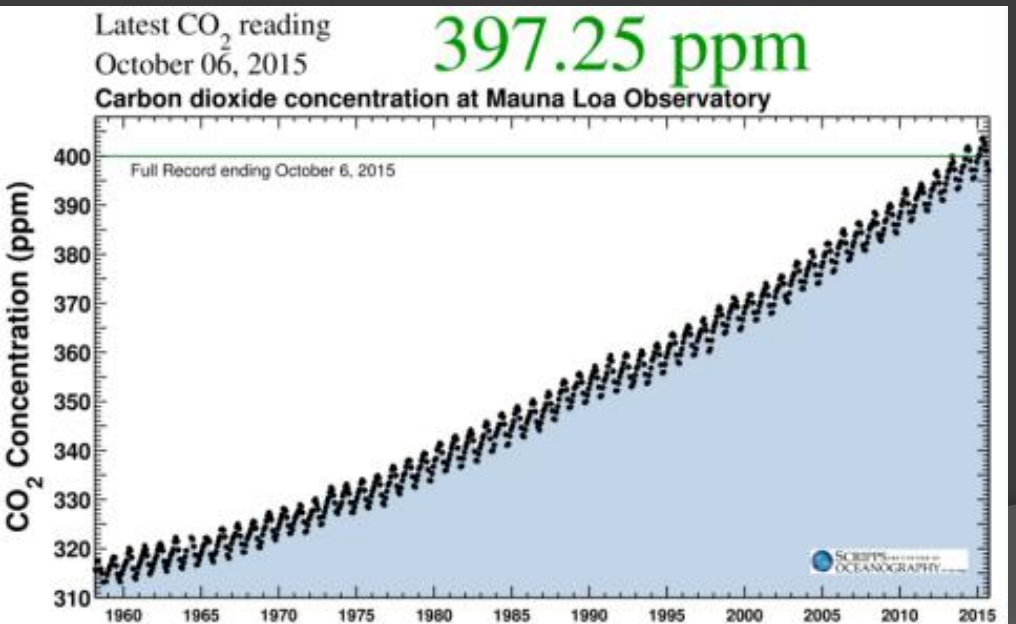
..... ale układy okresowe mogą być także nieprzewidywalne



Cloud-Aerosol Lidar
and Infrared Pathfinder Satellite Observation



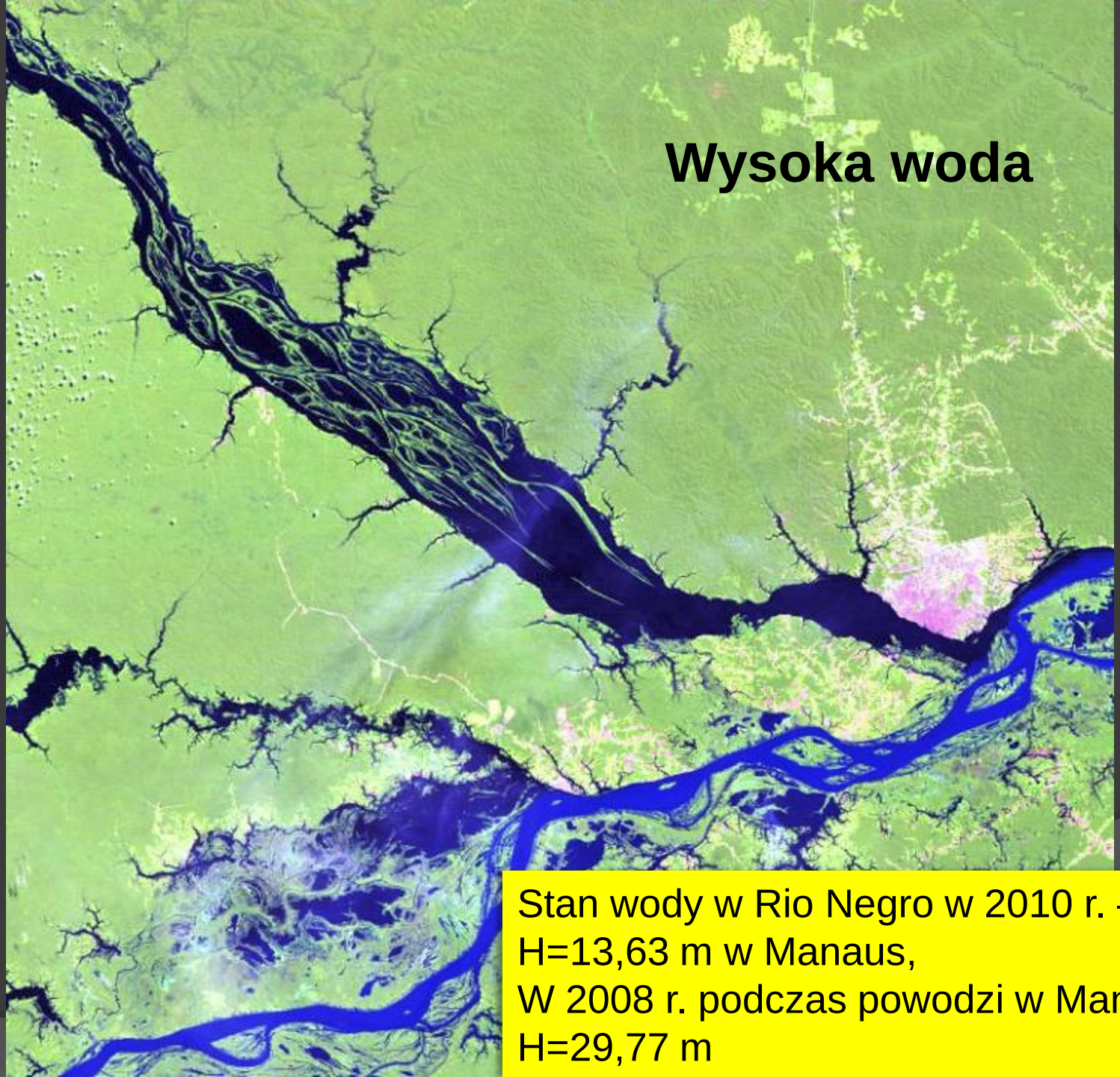
OCO-2
Pomiar dwutlenku węgla w atmosferze Ziemi



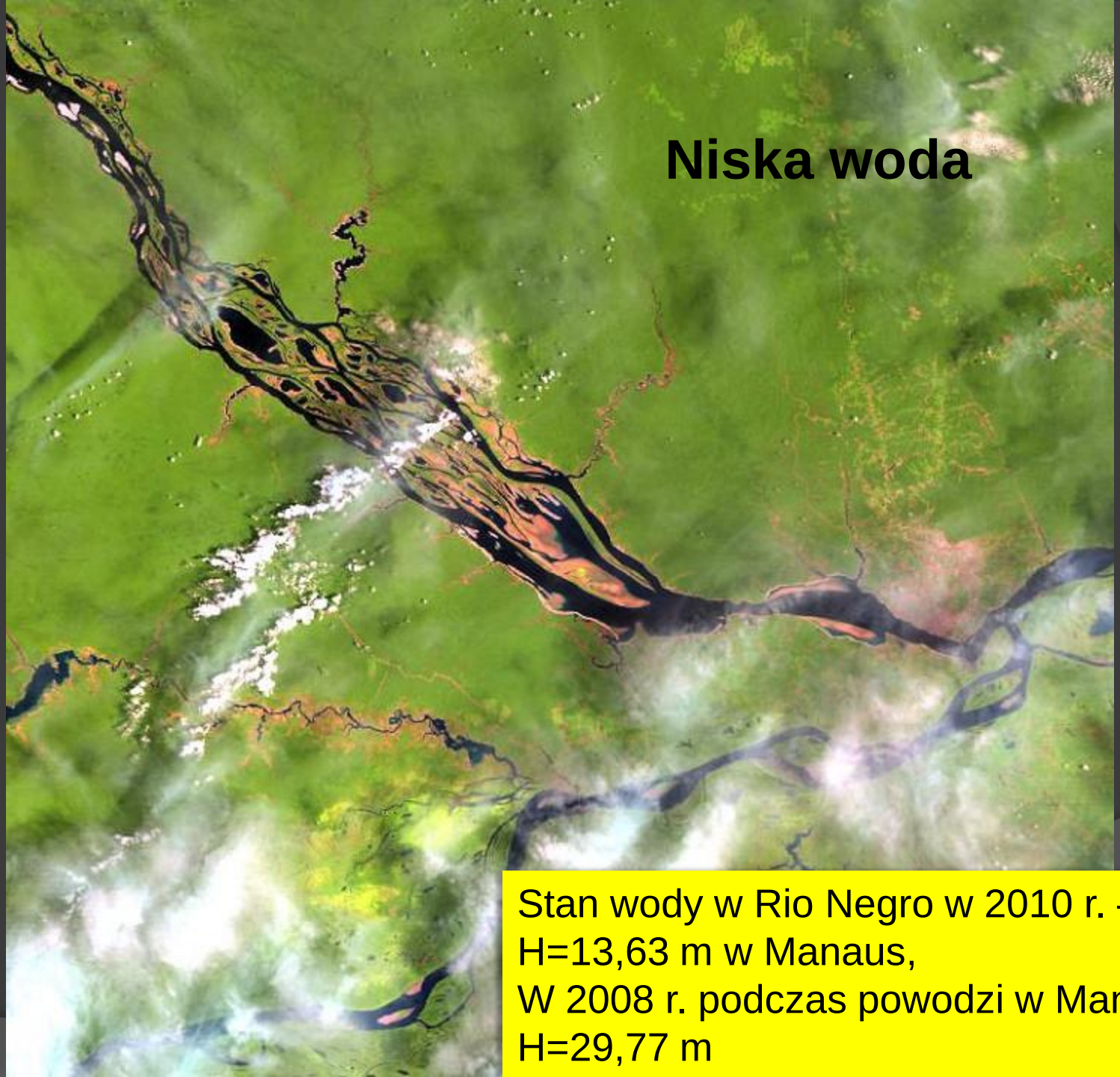
Manaus, Brazylia

Puszcza Amazońska

Rio Solimoes



Stan wody w Rio Negro w 2010 r. –
H=13,63 m w Manaus,
W 2008 r. podczas powodzi w Manaus
H=29,77 m



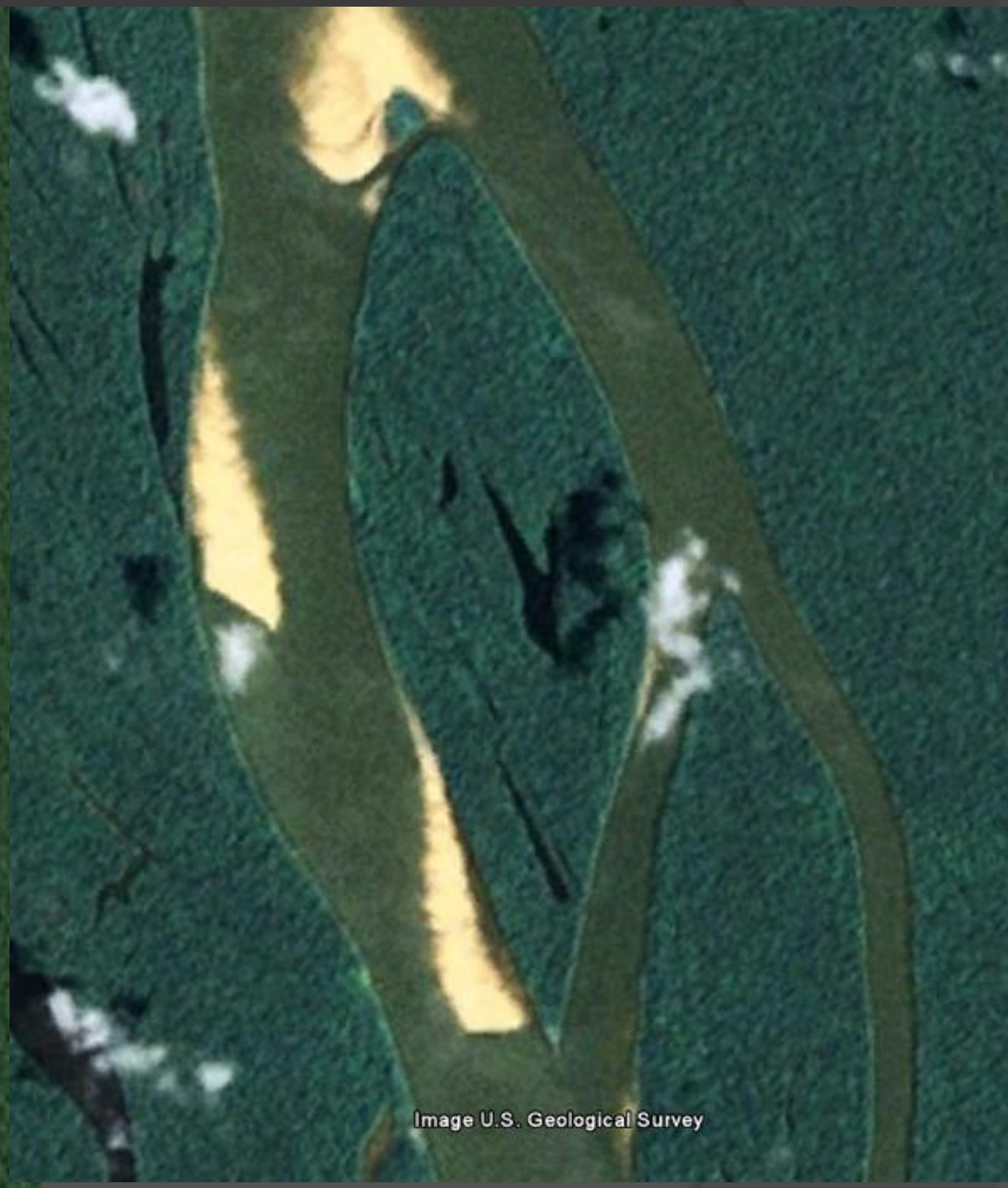
Stan wody w Rio Negro w 2010 r. –
H=13,63 m w Manaus,
W 2008 r. podczas powodzi w Manaus
H=29,77 m

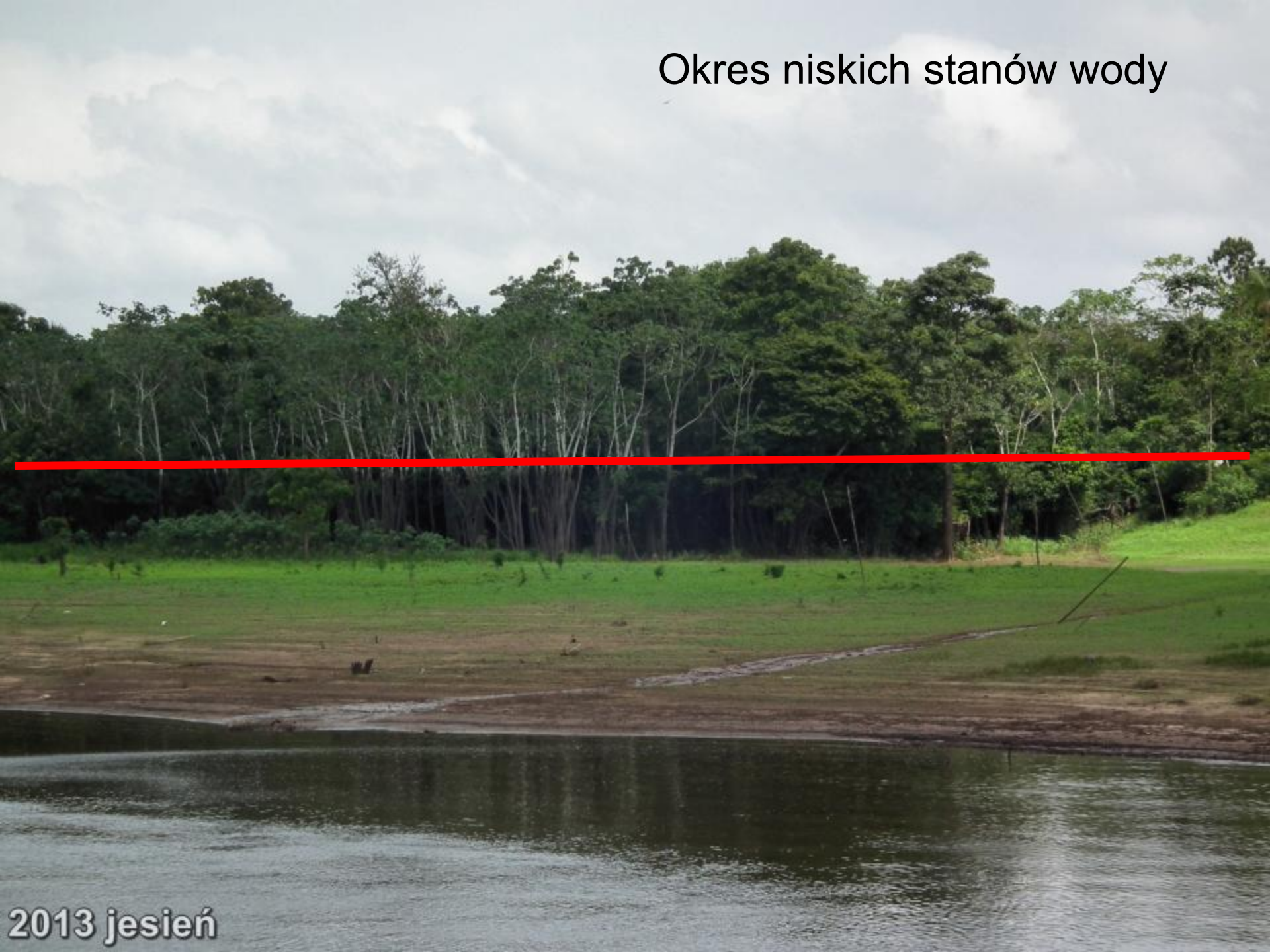
Rio Negro

Rio Negro

Wezbranie

Susza




Okres niskich stanów wody
2013 jesień

Wiosna 2012

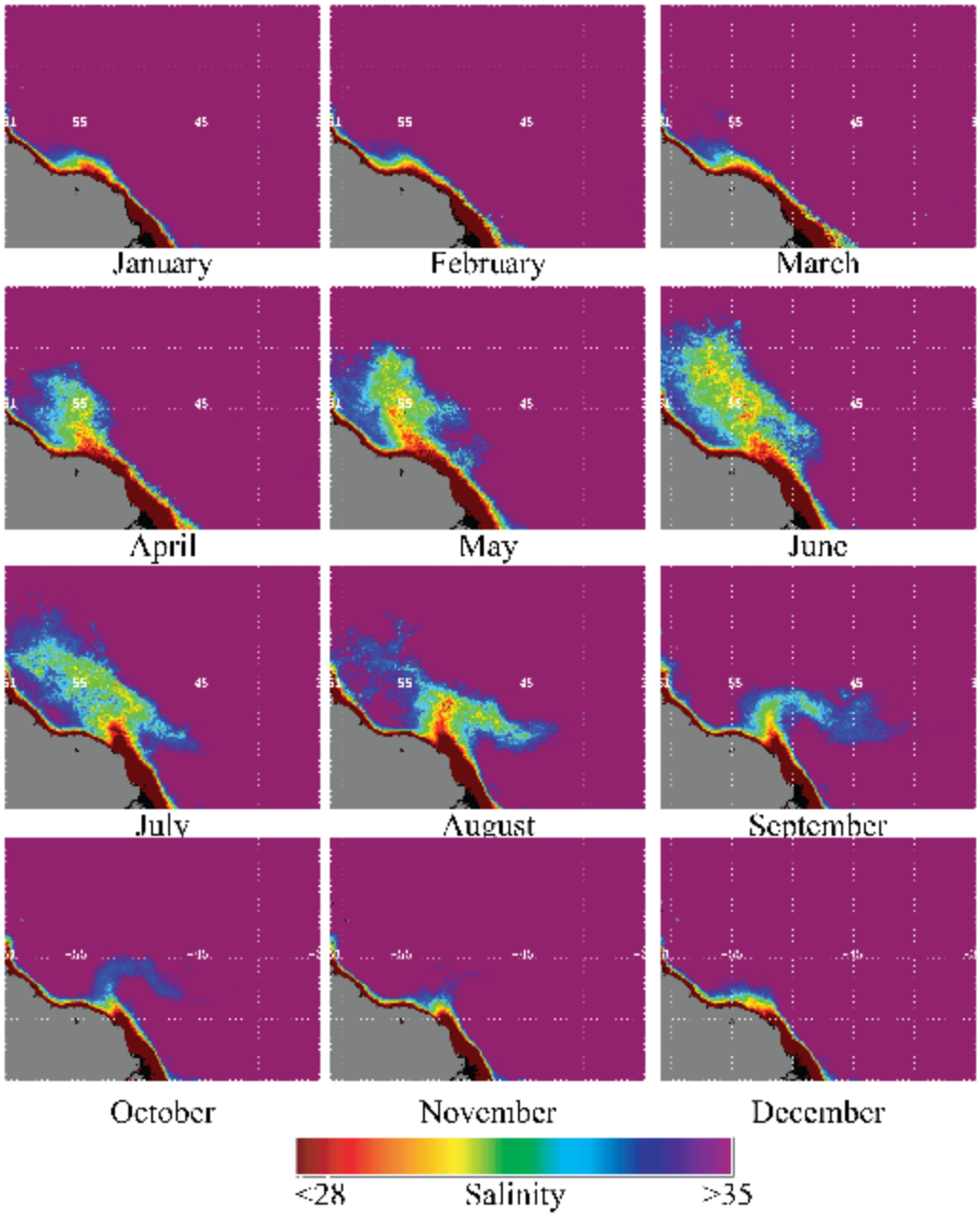
Jesień 2013

Ujście Amazonki

dostarcza 20 % słodkiej wody (odpływu rzecznego) do oceanów (5x Kongo), woda widoczna 400 km w głąb oceanu

zawiesina, kolor granatowy: substancje rozpuszczone organiczne, fitoplankton

MODIS, 30.08.2003

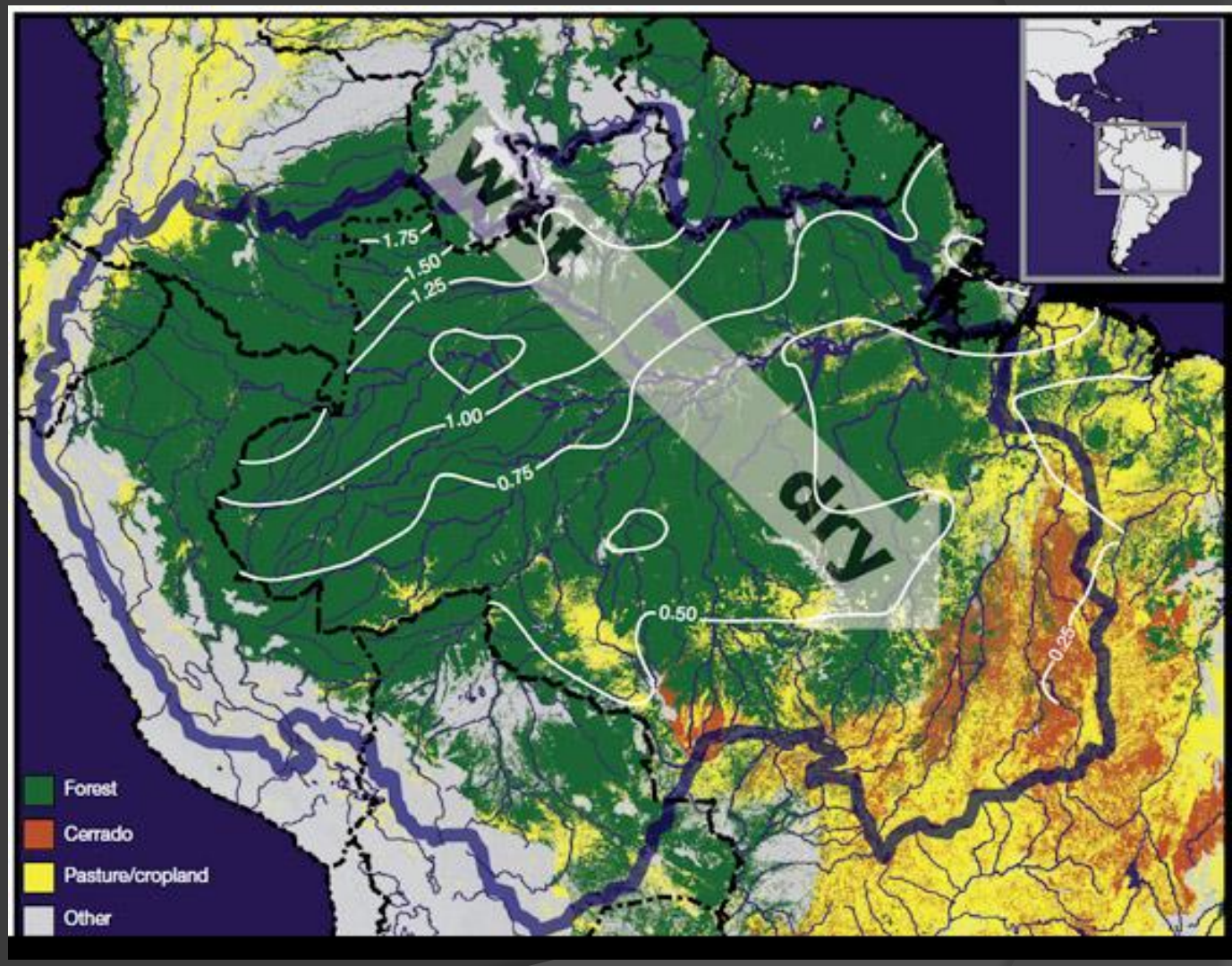


Location and Size of the Amazon River Plume Based on Monthly Climatologies of Satellite Derived K490

Ujście Amazonki
1200 mln t/rok

Susza w Amazonii

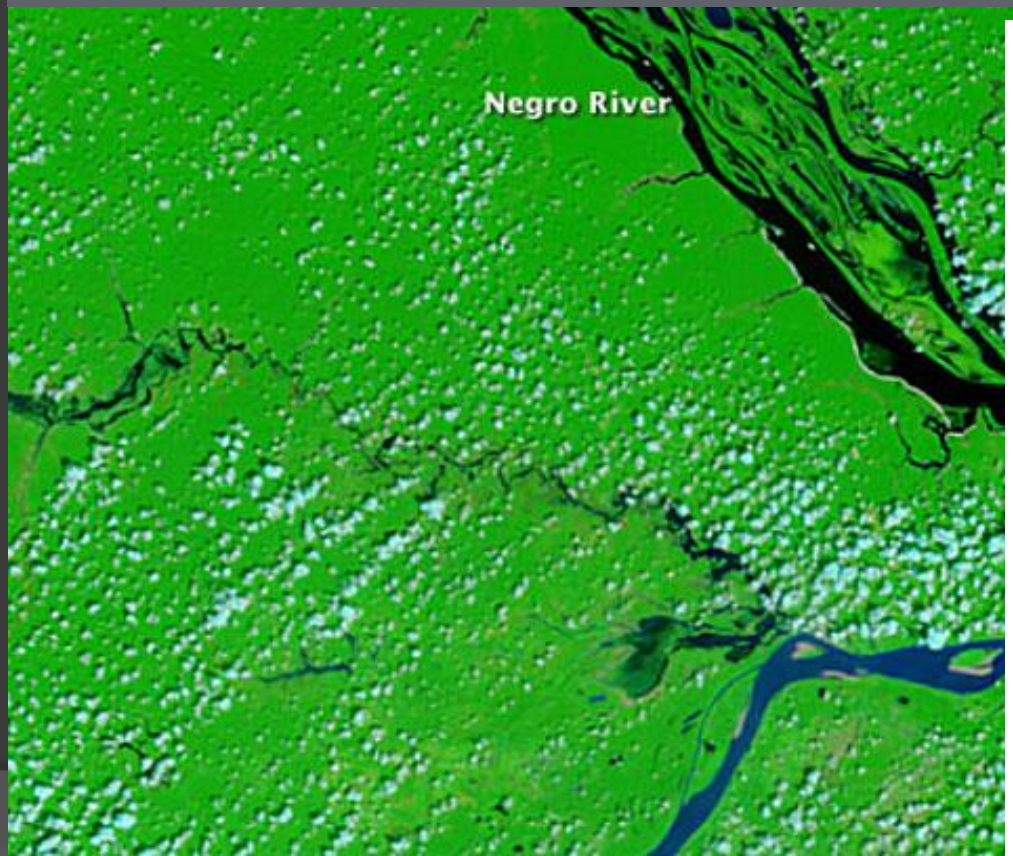
Jeśli ocieplenie wynosi 0,1°C w przeciągu dekady, to zniszczenie ekosystemów wynosi 5%.

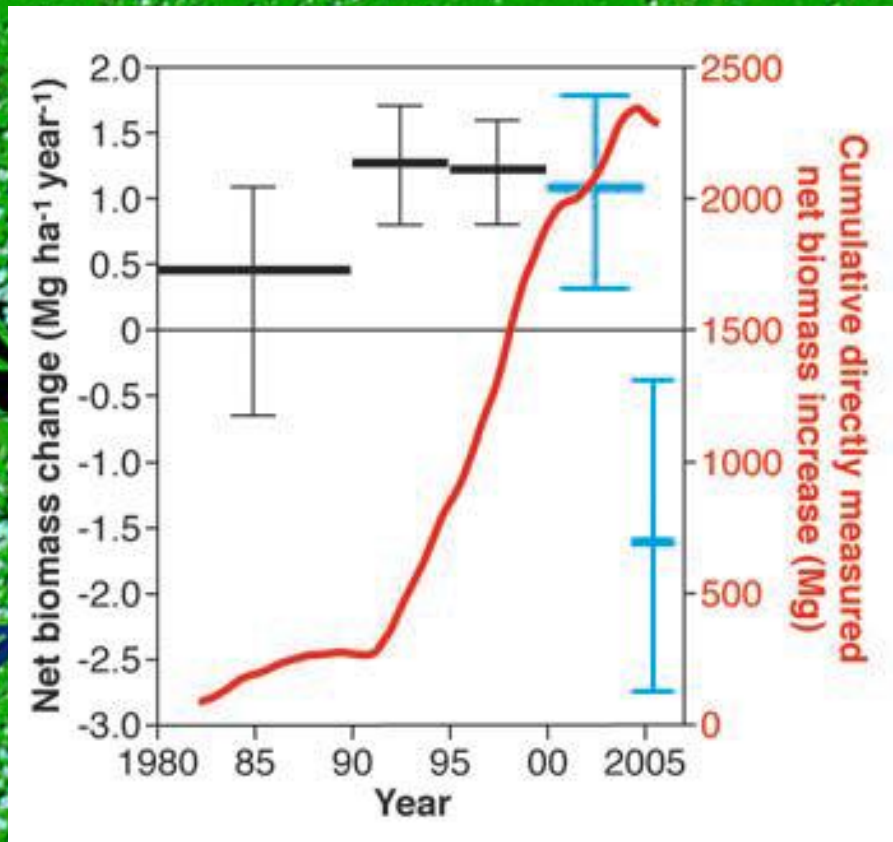


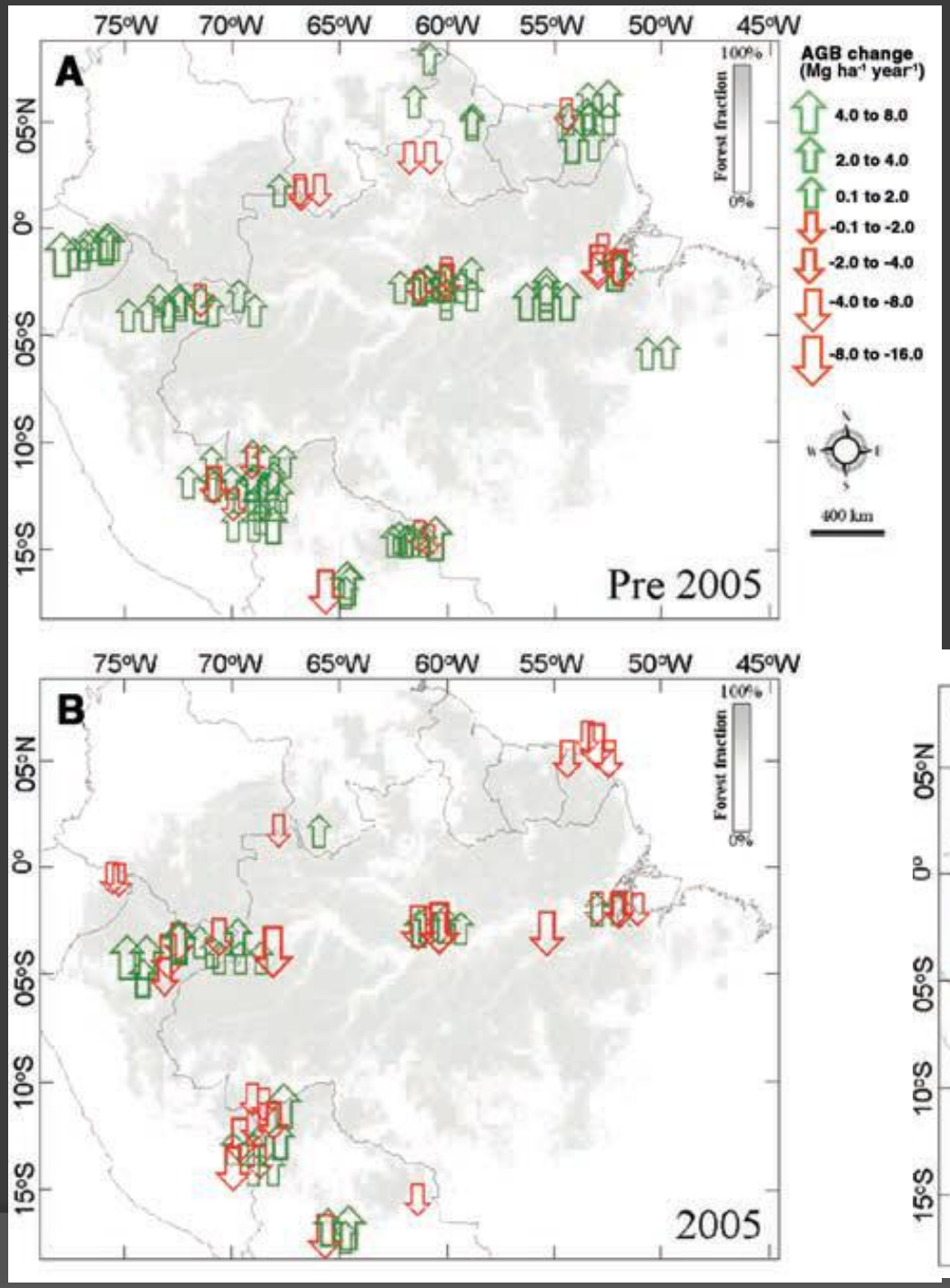
NATURE, Davidson at al. (2011)

Susza w Amazonii

Stary las w Amazonii gromadzi 120 petagramów (1.2×10^{17} g) węgla w swojej biomasie, przez fotosyntezę i oddychanie corocznie zawartość wzrasta zawartość węgla o 18 Pg. Spadek opadów o 100 mm powoduje uwalnianie 5,3 megagramów na ha węgla z biomasy.

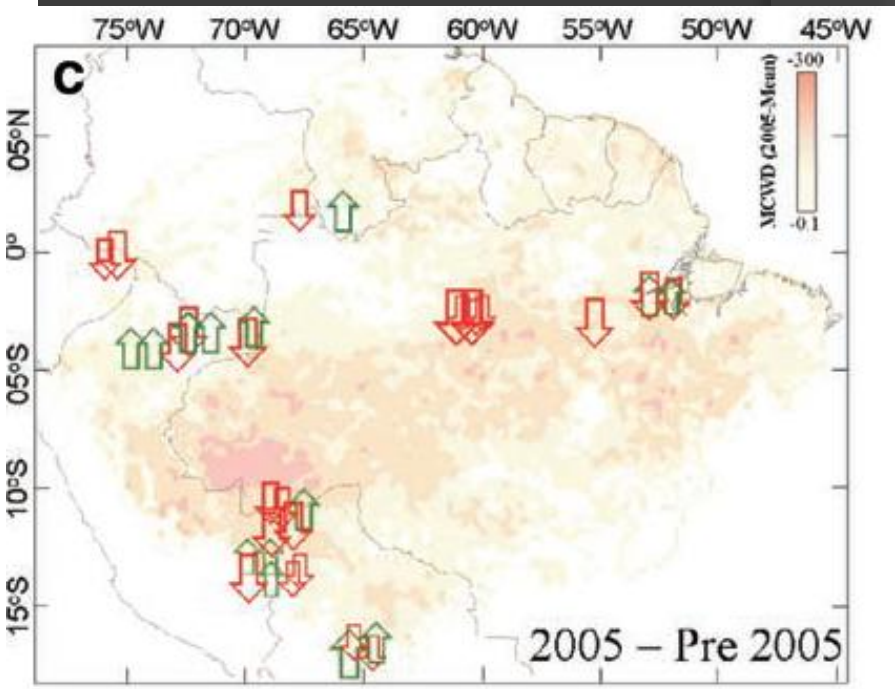




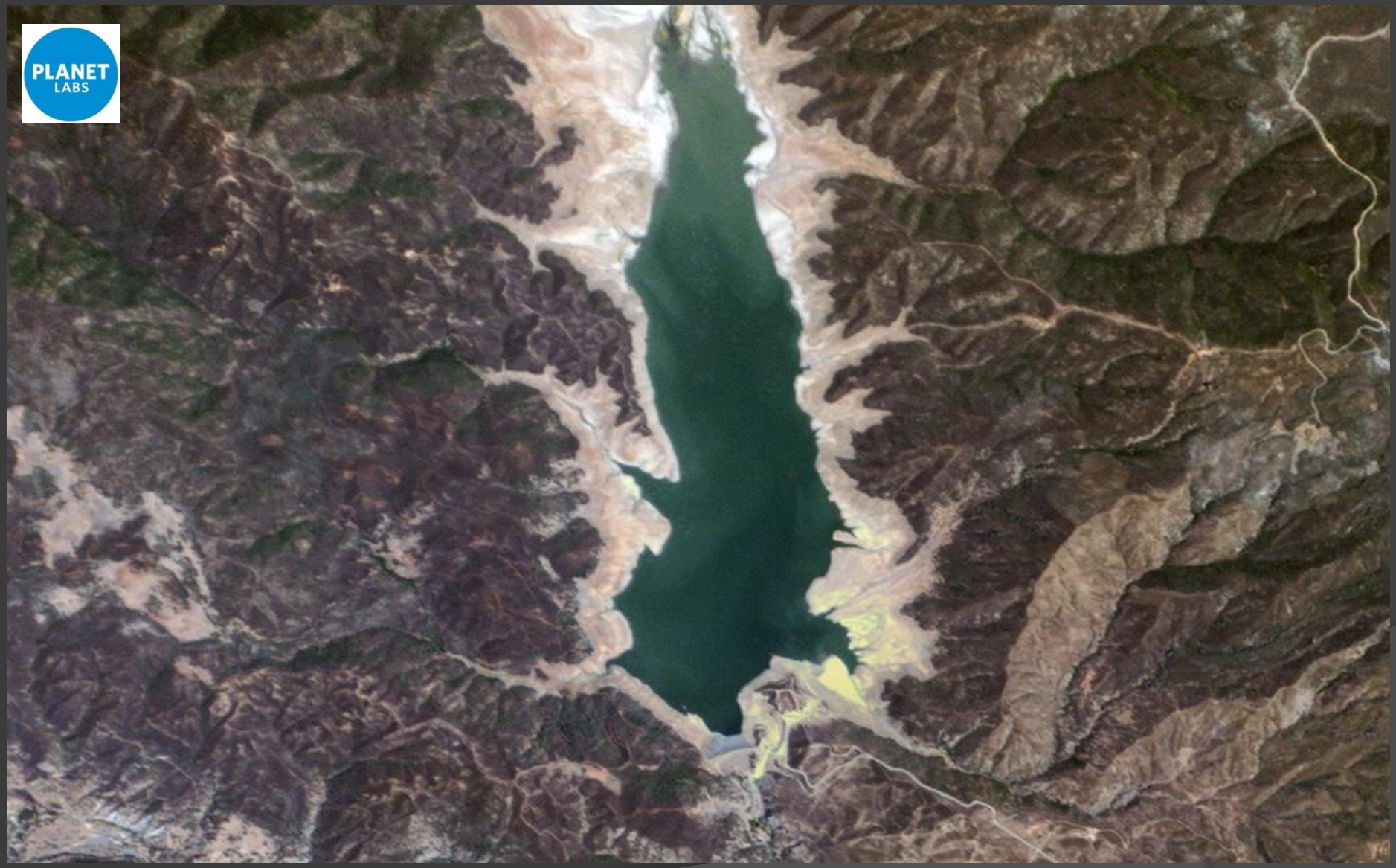


Amazonia
Zmiany w biomasie
A - przed 2005 r.
B - 2005 r.
C – 2005/1998-2005

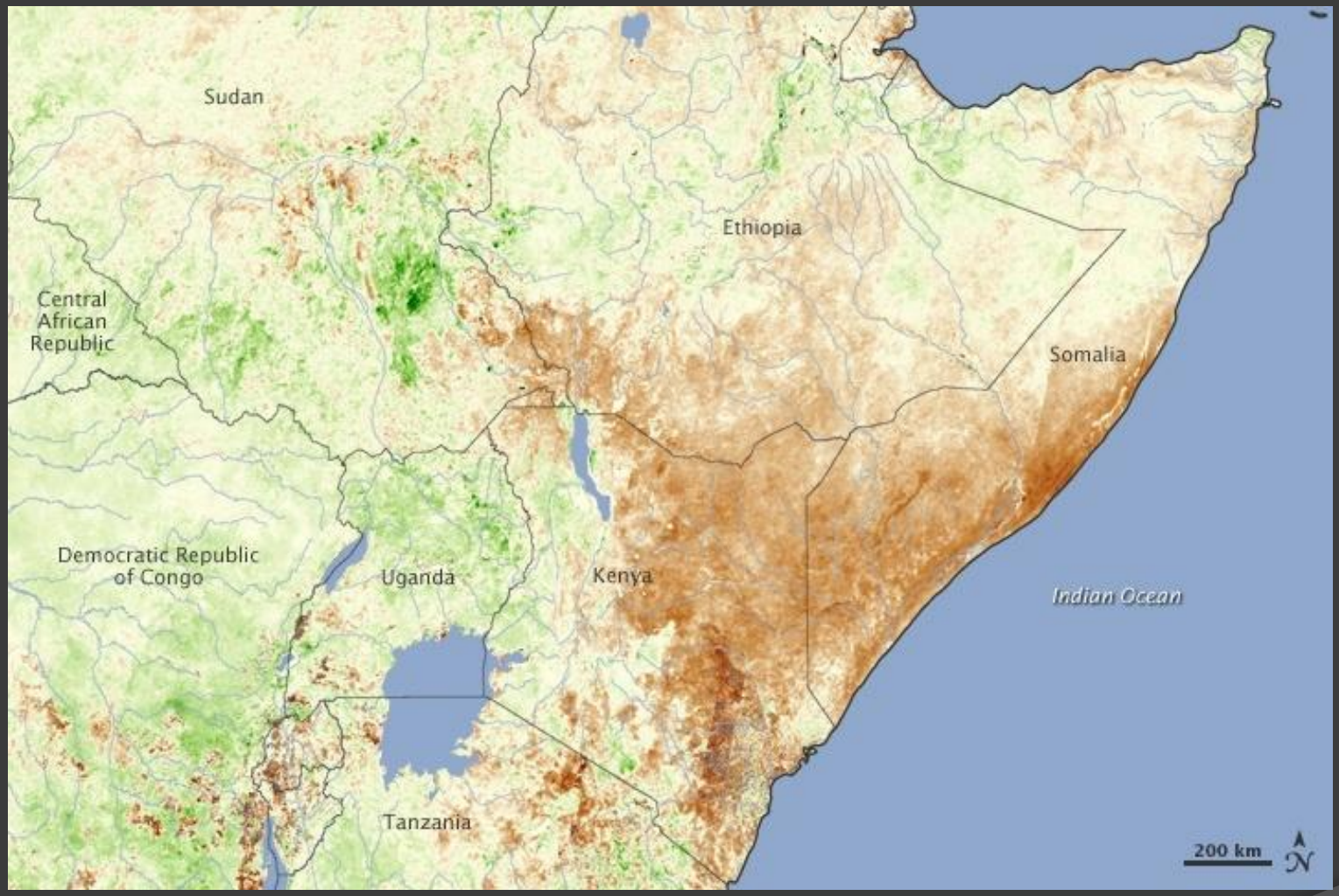
Science 232, 2009



Susze hydrologiczne

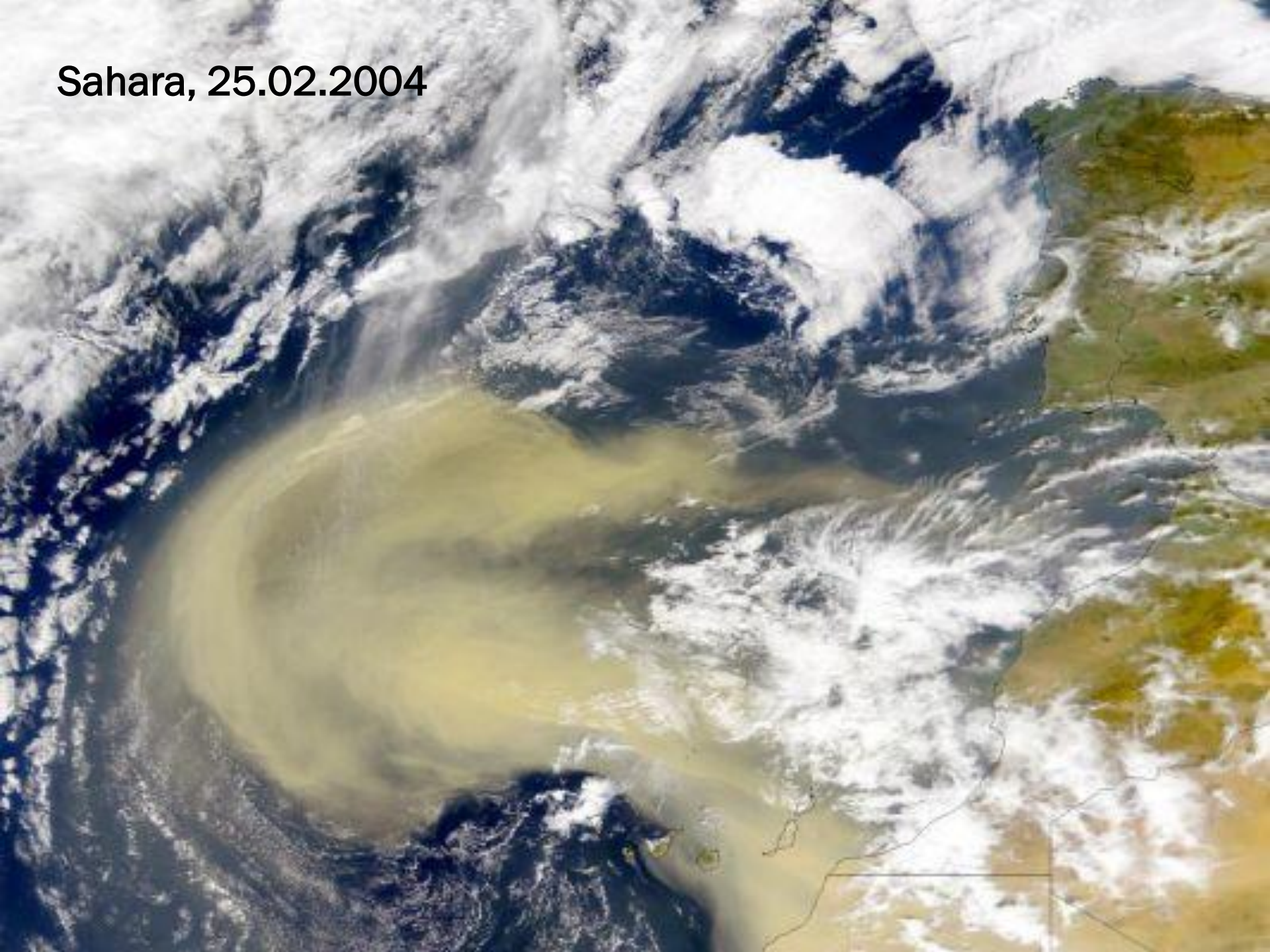


Susza we wschodniej Afryce - La Niña



SPOT

Anomalie w rozwoju roślinności – wzrost roślinności w styczniu 2011 w stosunku do średniego wzrostu w styczniu 1999-2009 = mały wzrost roślin, słabe ulistnienie


Sahara, 25.02.2004

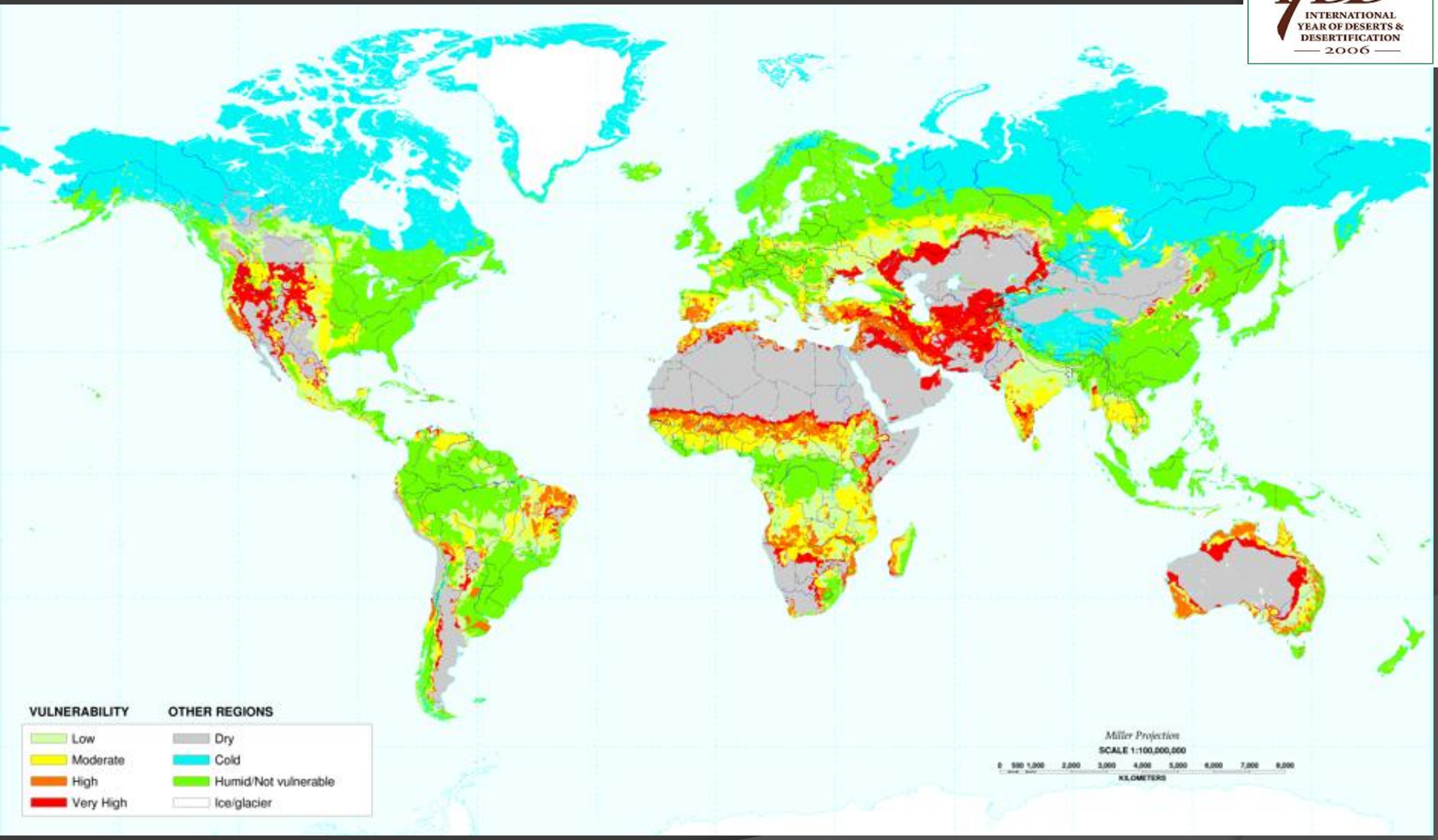
Gorące, suche wiatry powodujące burze pustynne na Saharze

Oaza Mhamid, Maroko, 2006

Pustynia Sechura, Peru

Atacama, Chile

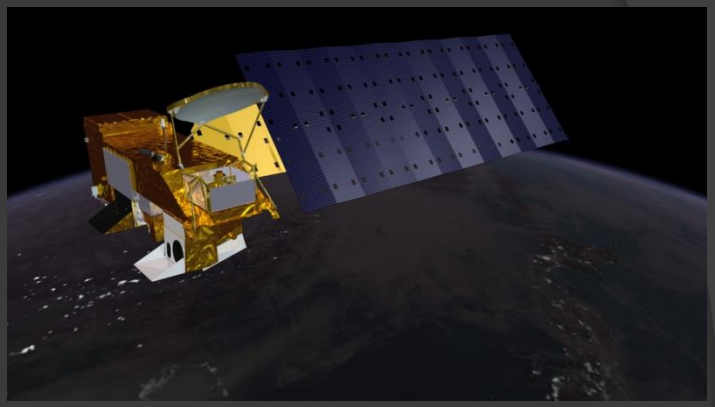
Obszary zagrożone pustynnieniem



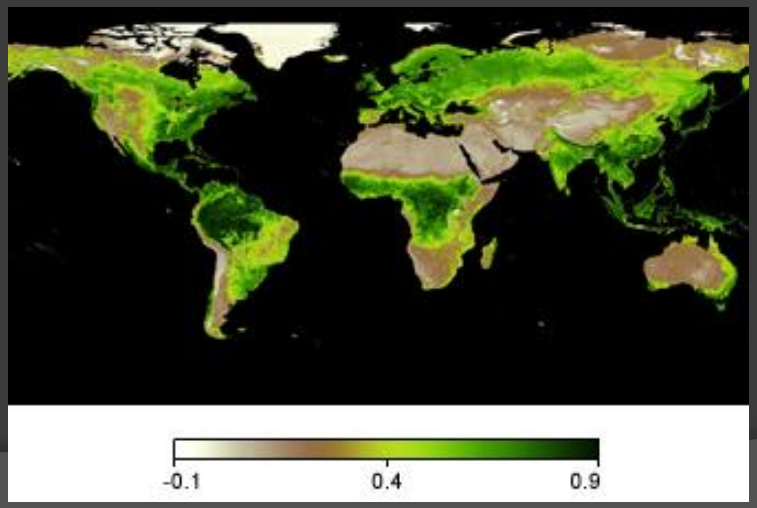
Pustynnienie co roku pochłania 47 tys. km^2

USDA, 2008

Moderate Resolution Imaging Spectroradiometer (MODIS) Aqua i Terra - 250/500/1000 m GSD; 36 spectral bands

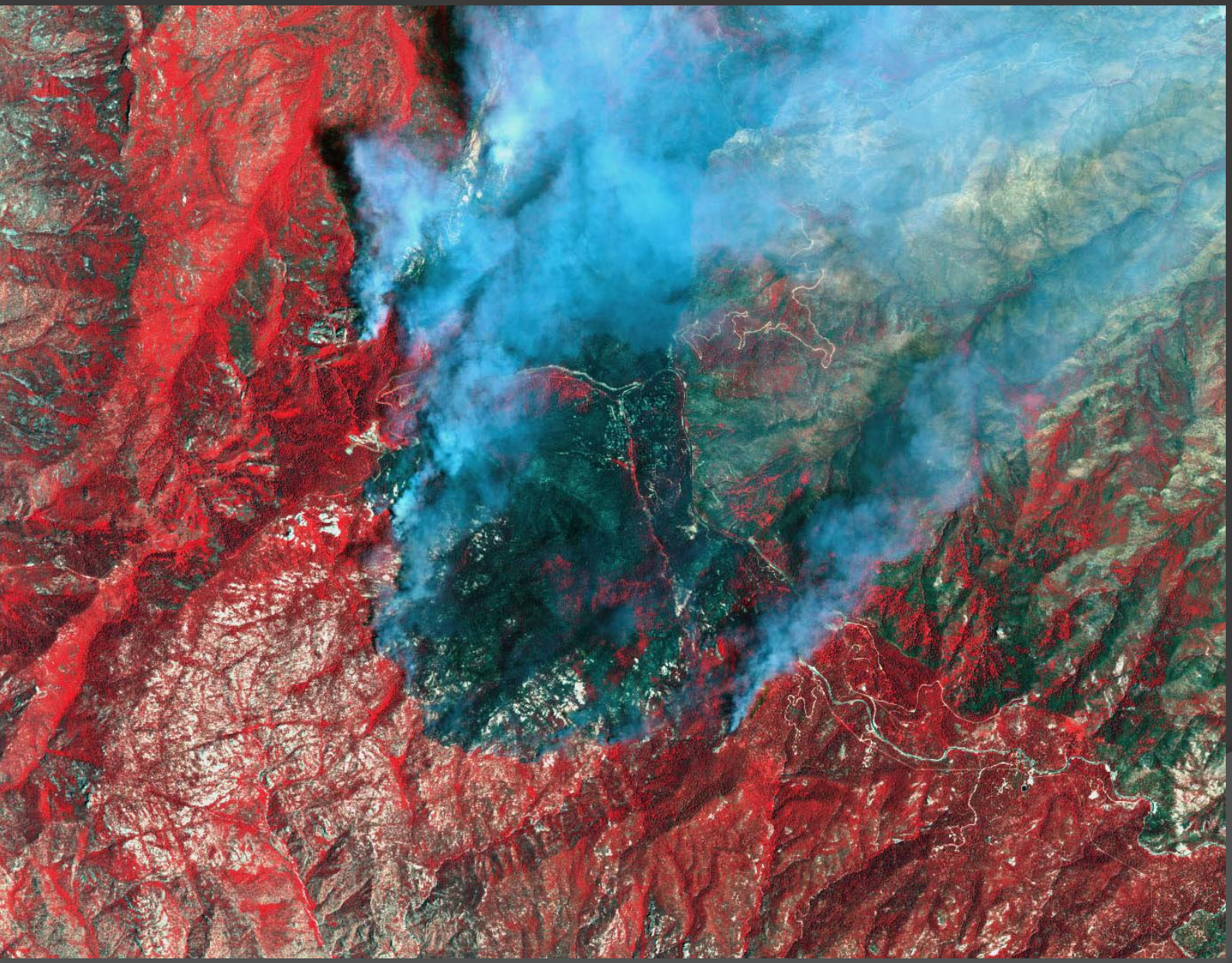


Pożary w Kalifornii (czerwone) 22.09.2015



Pożary na Borneo, 28.09.2015 r- wyjątkowo niskie opady na Borneo

IKONOS-2 (GeoEye) – Pożary lasów



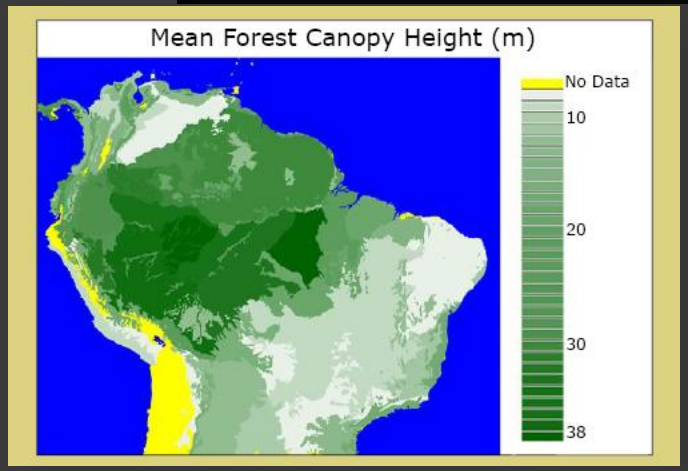
Pożar lasów California, USA

Pożary lasów

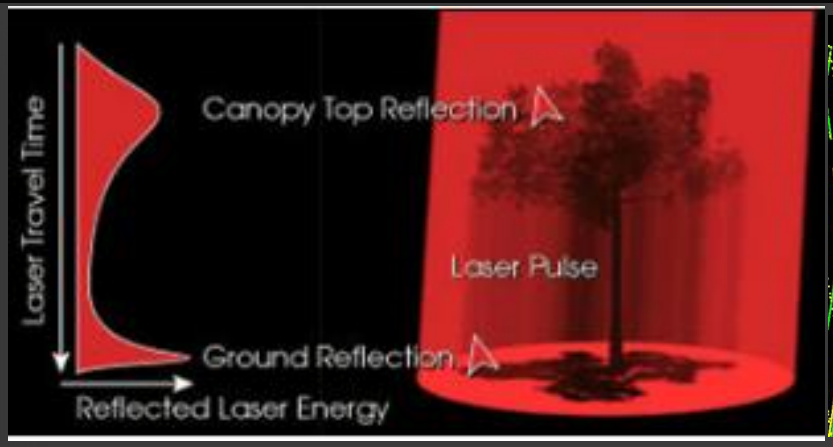
Pożary lasów

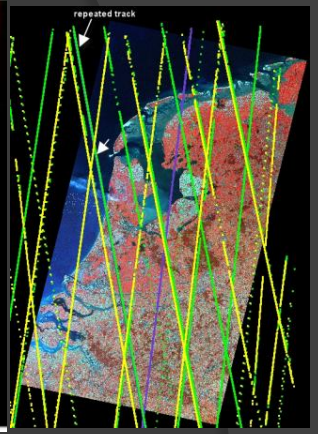
Indonezja 2005
© CRISP 2005

Satellite LiDAR
ICESat/ GLAS

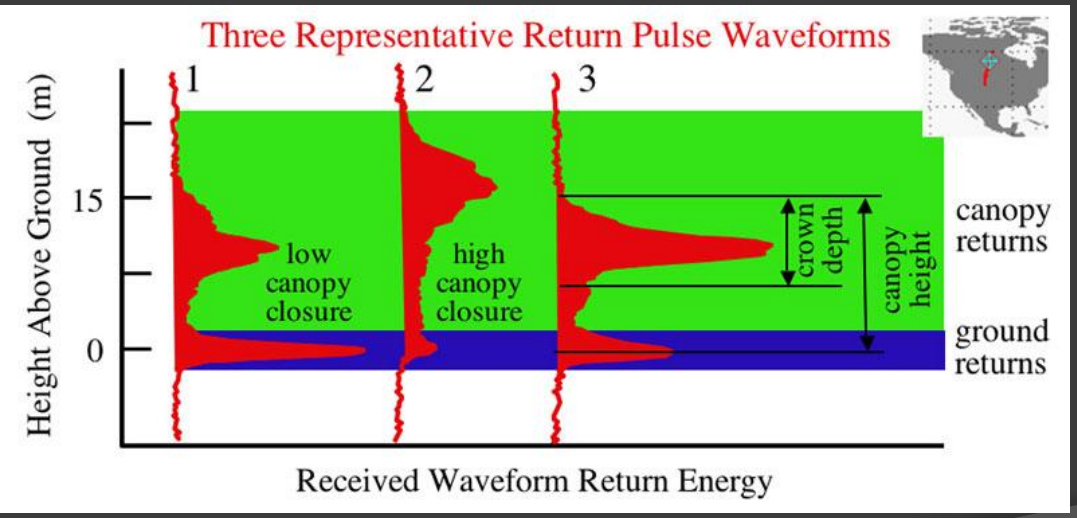


Forest cover monitoring in South America





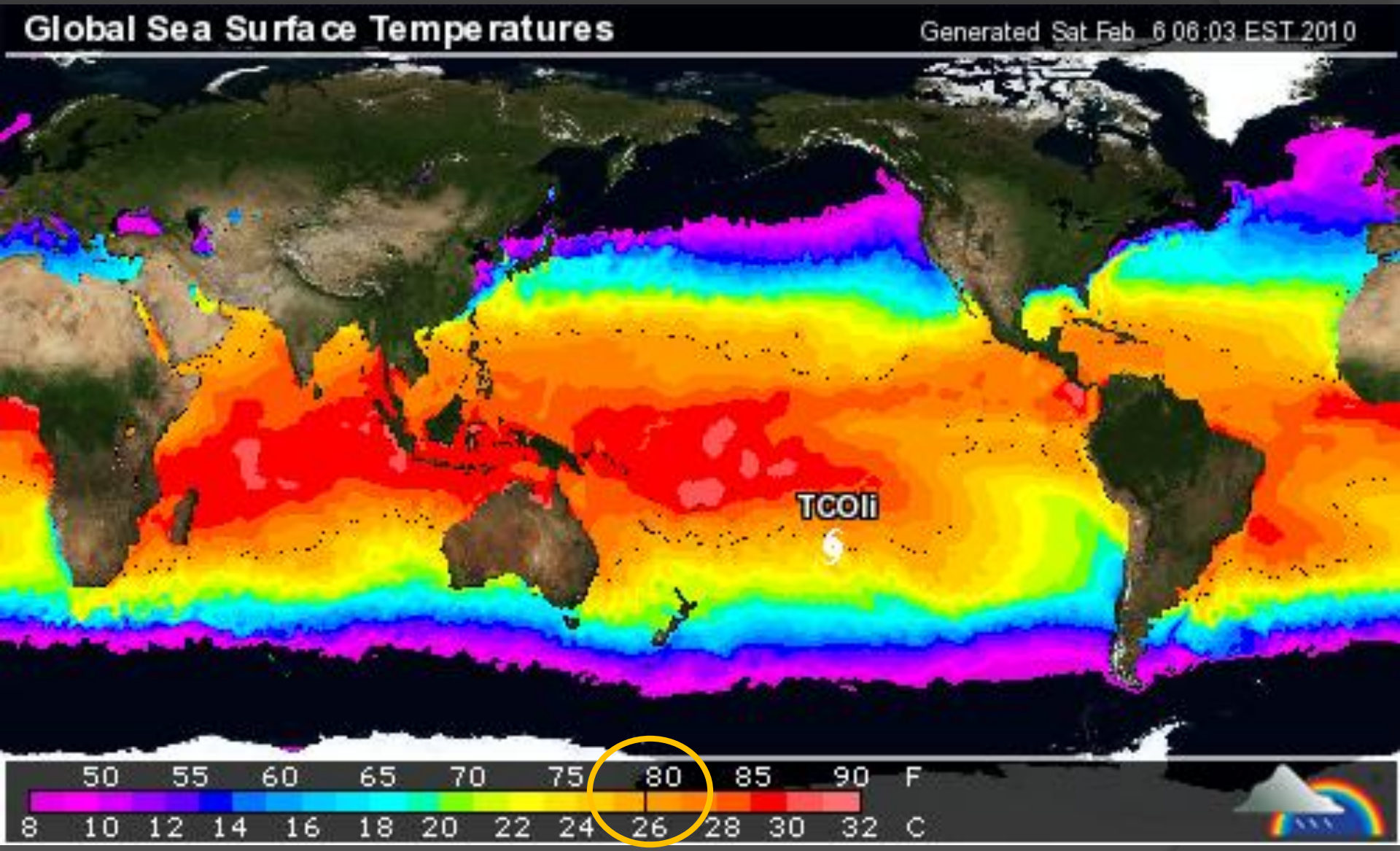
Beam size ϕ 70m, every 170m anlog the track



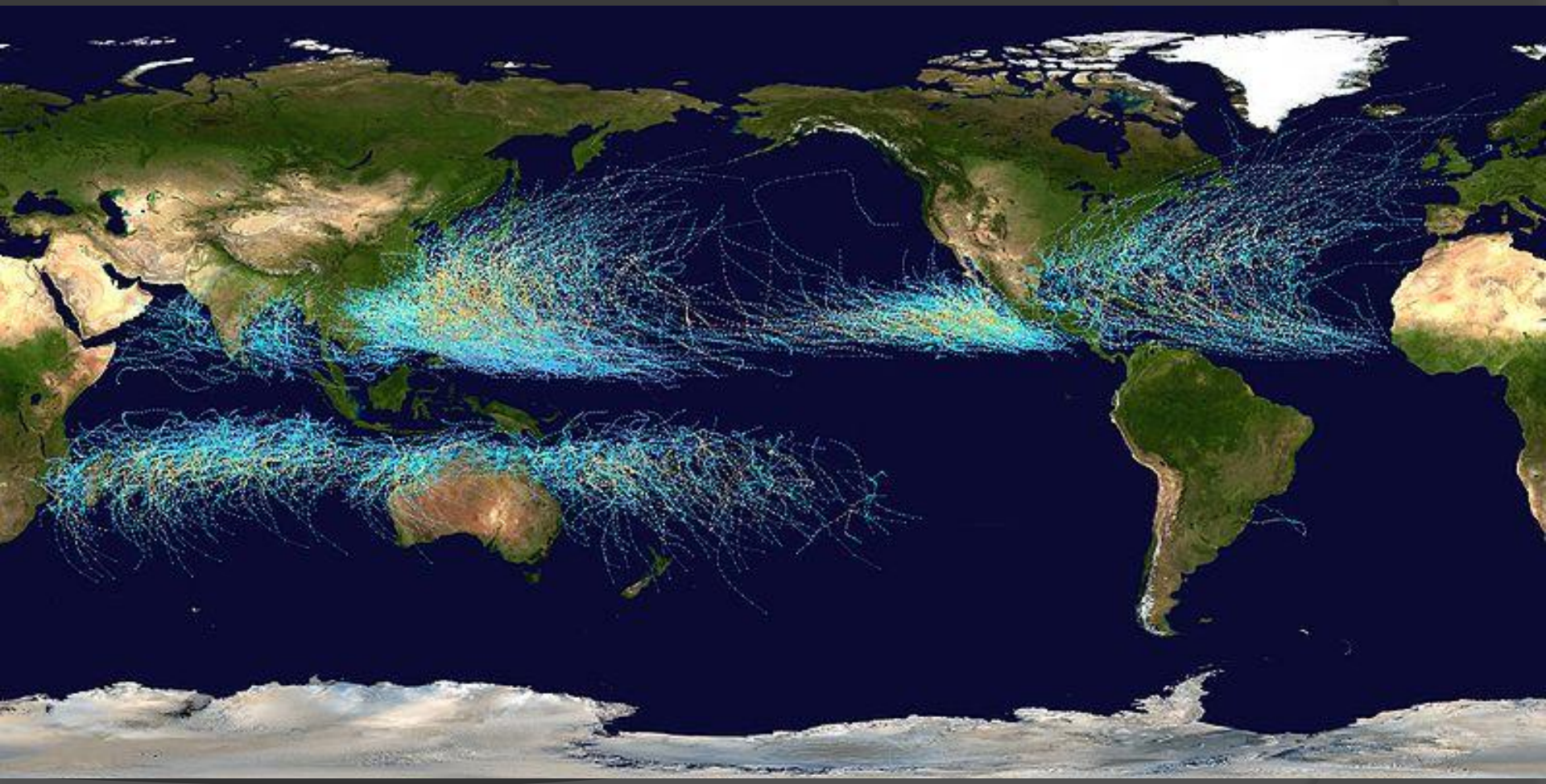
http://www.nasa.gov

P.Wężyk + Zb.Zwolinski, Rio Solimoes, 2013

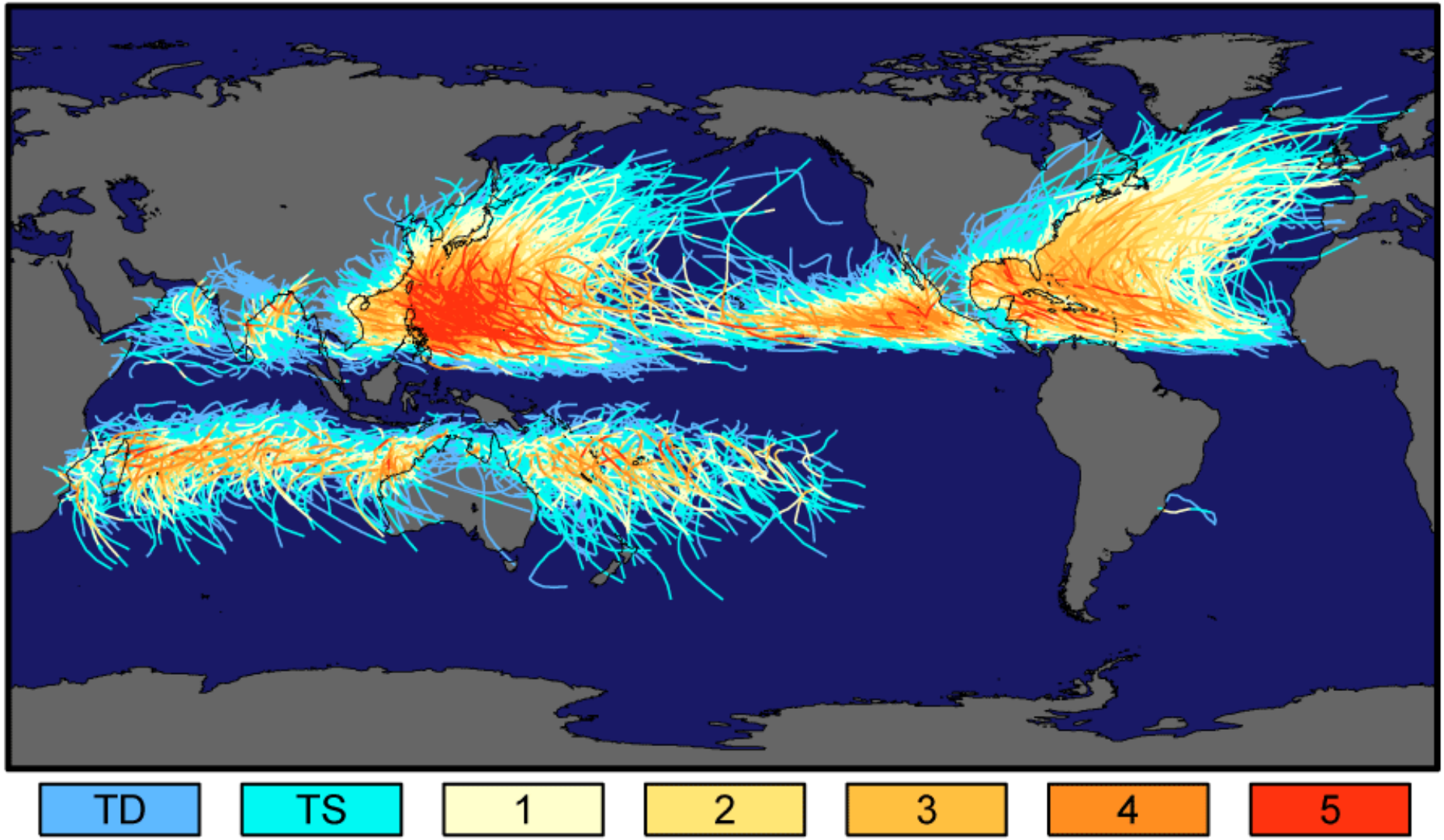
Cyklony tropikalne



Szlaki cyklonów tropikalnych w latach 1985-2005



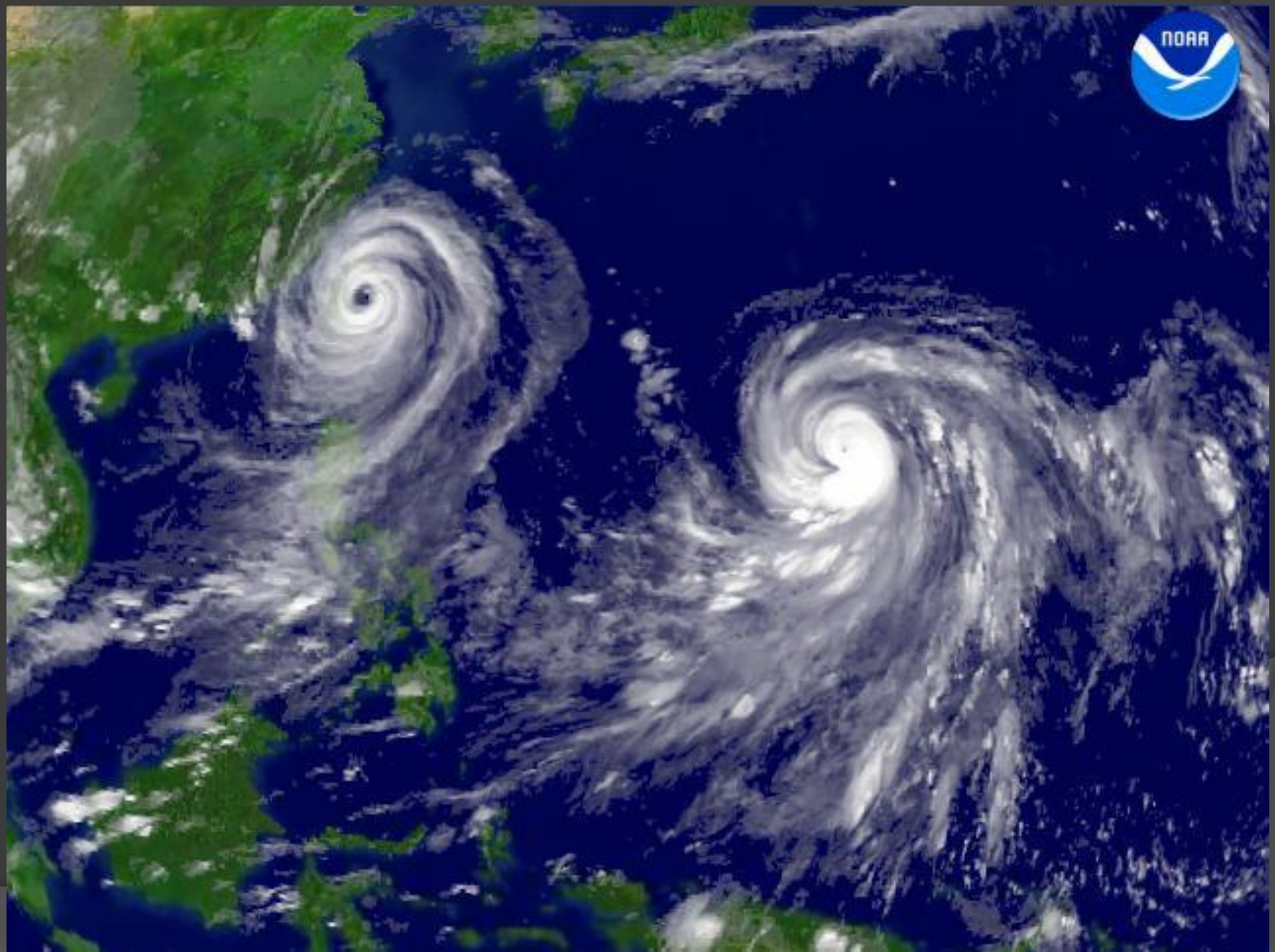
Tracks and Intensity of All Tropical Storms

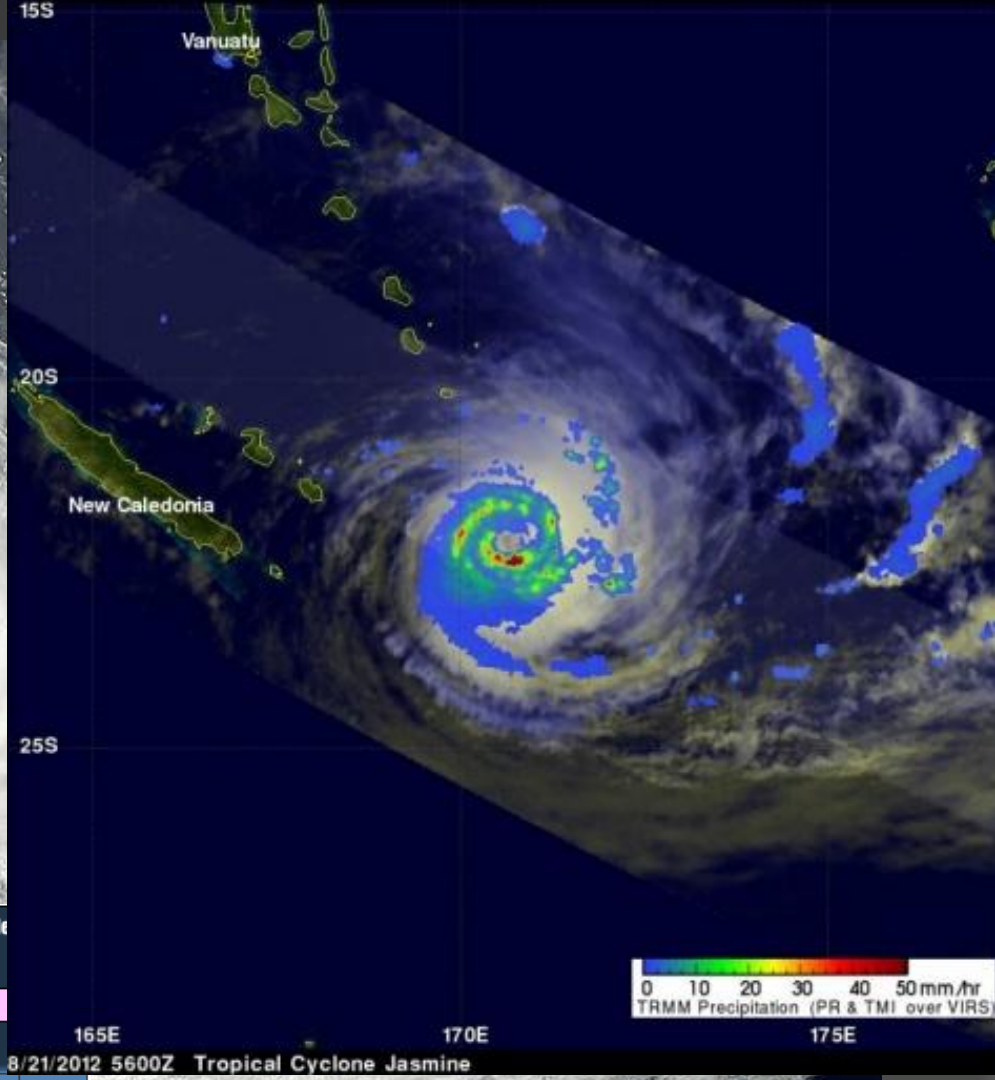


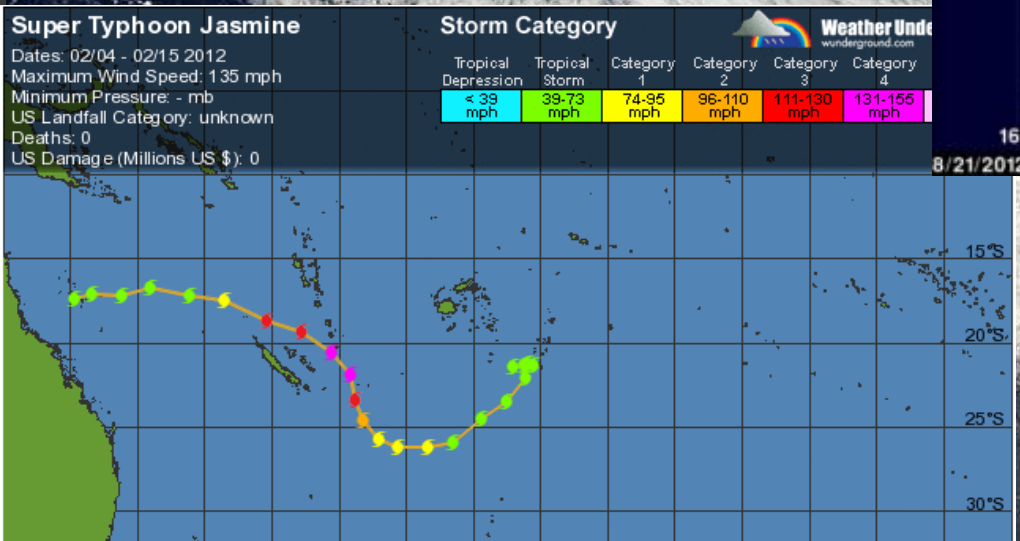
Saffir-Simpson Hurricane Intensity Scale

Apia, Samoa

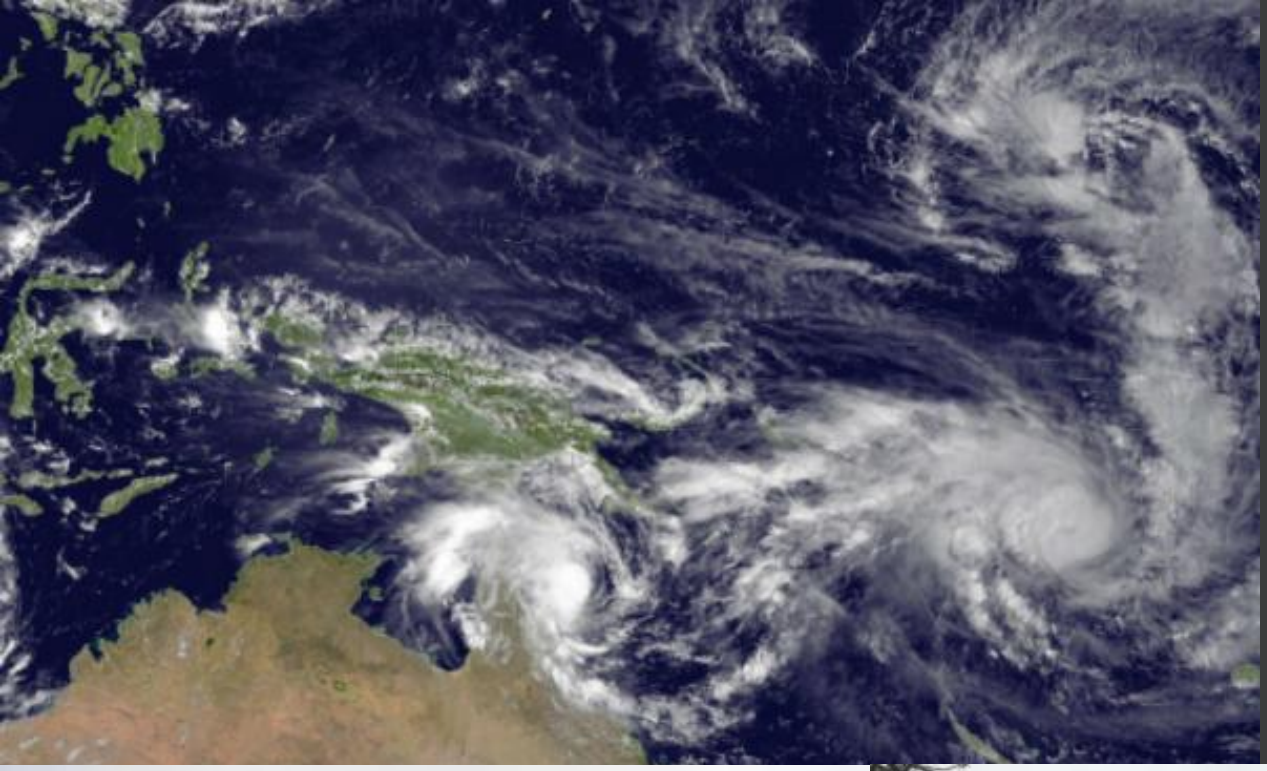
Okres tajfunów (huraganów) Atlantyk: Karaiby, Zat. Meksykańska



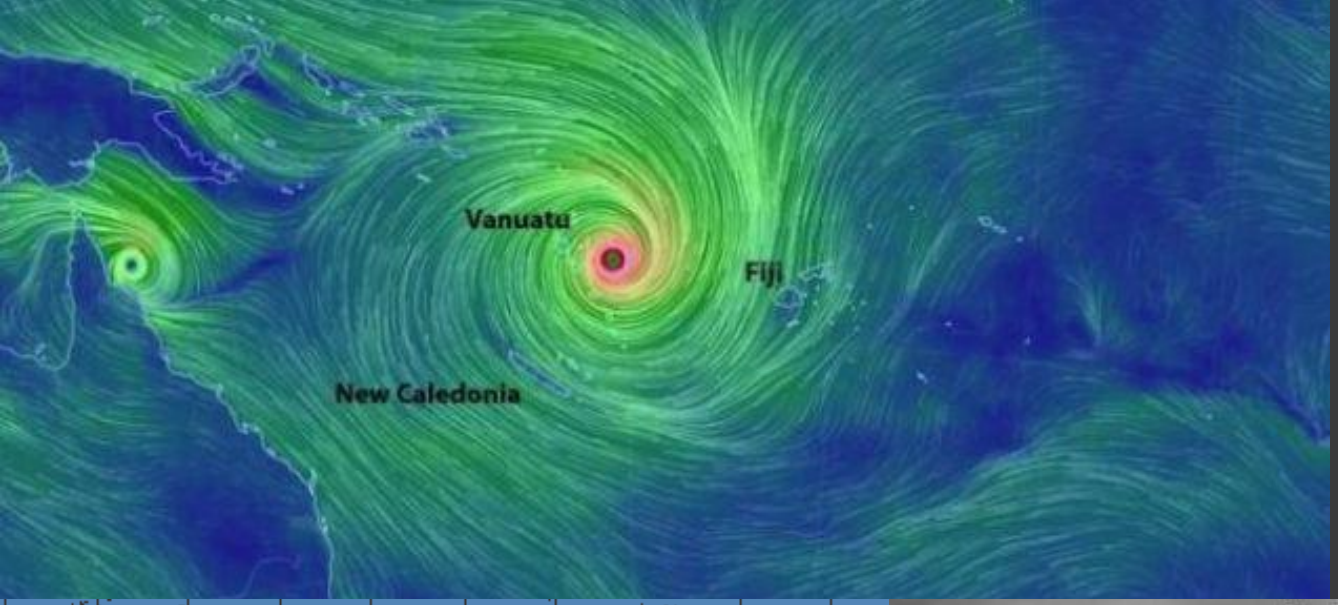




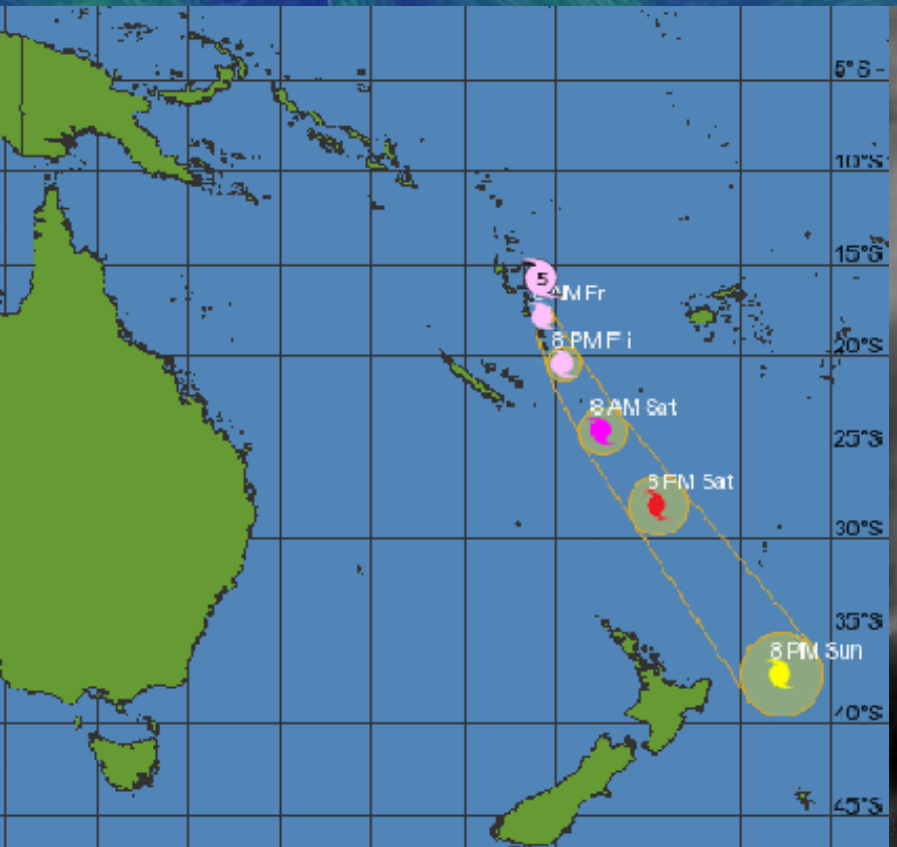
NASA Goddard MODIS Rapid Response Team

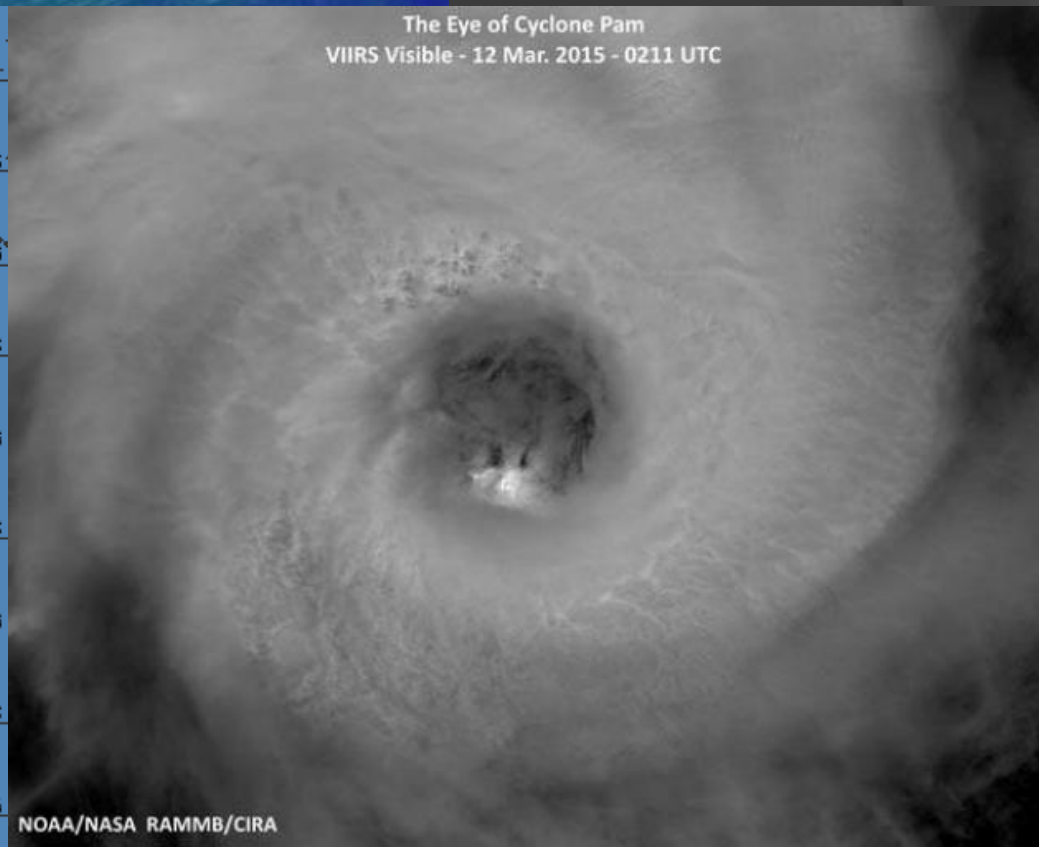


Vanuatu – cyklon Pam 12.03.2015



Vanuatu – cyklon Pam 12.03.2015



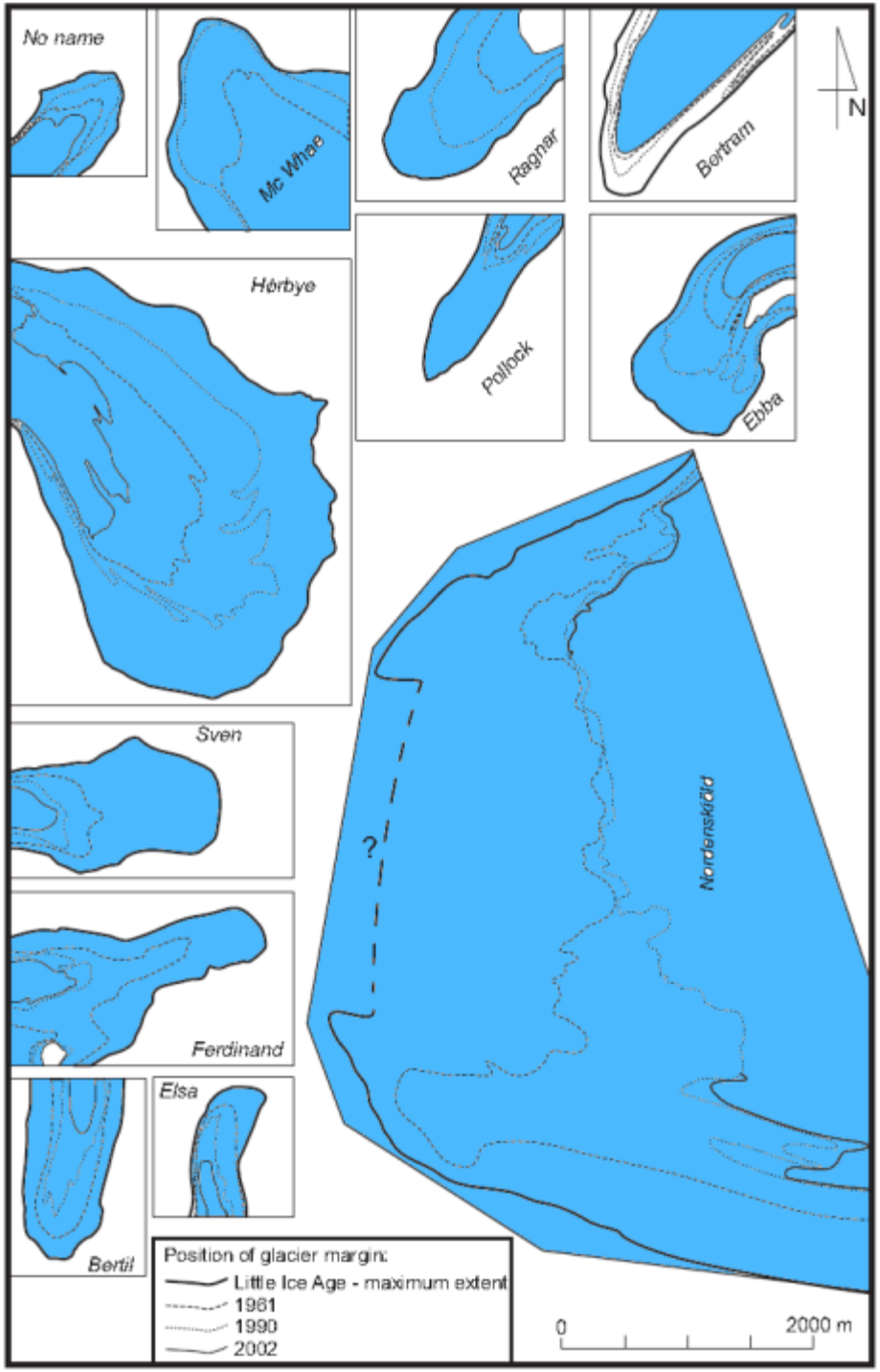


Zatoka Meksykańska, 2003

Zatoka Meksykańska, 2003

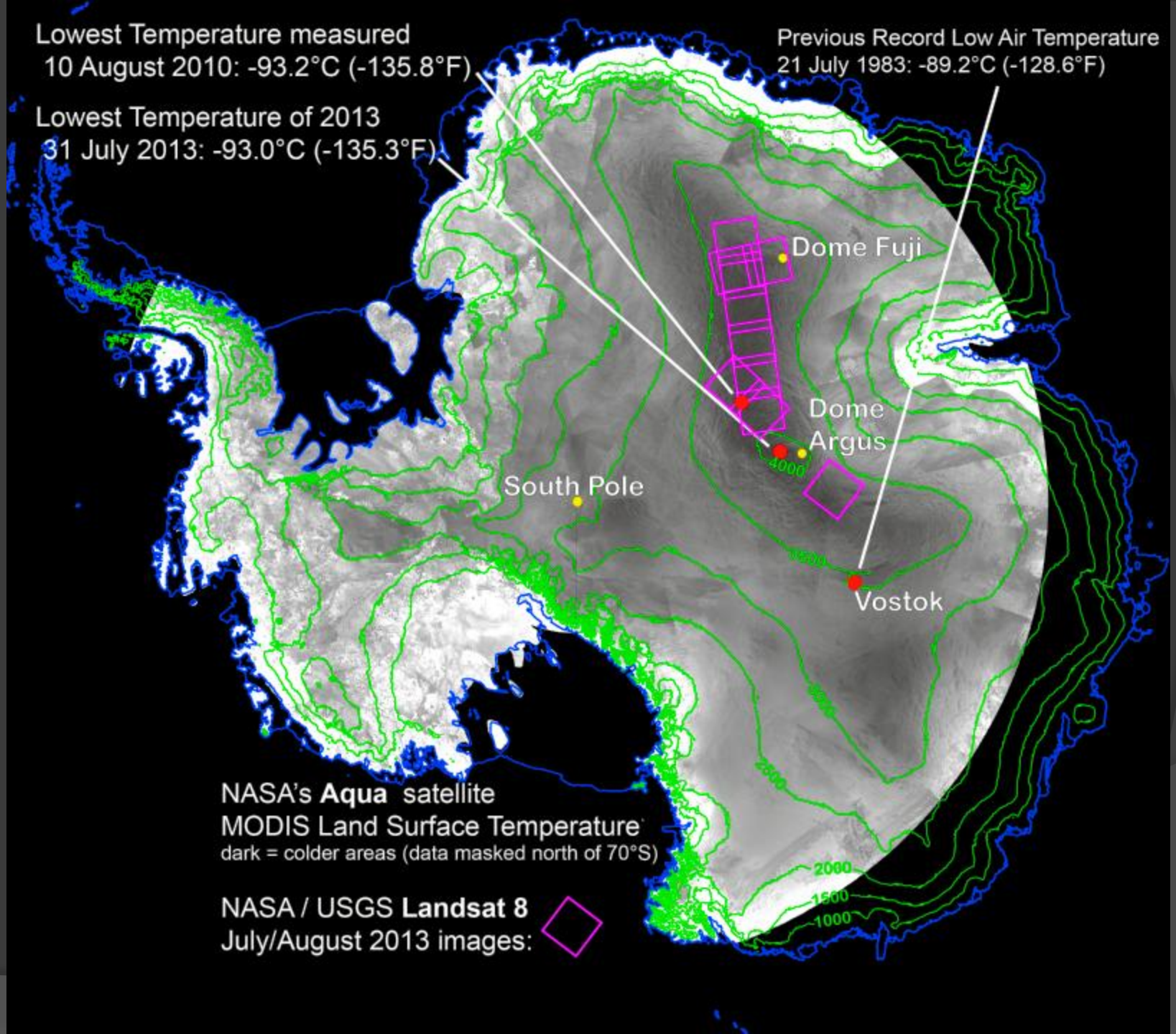
Fidżi, 2009

Arktyka



Petunibukta
Środkowy Spitsbergen
Stacja Bazowa Zintegrowanego Monitoringu Środowiska Przyrodniczego w ramach PMŚ

Lodowiec Scotta, Bellsund

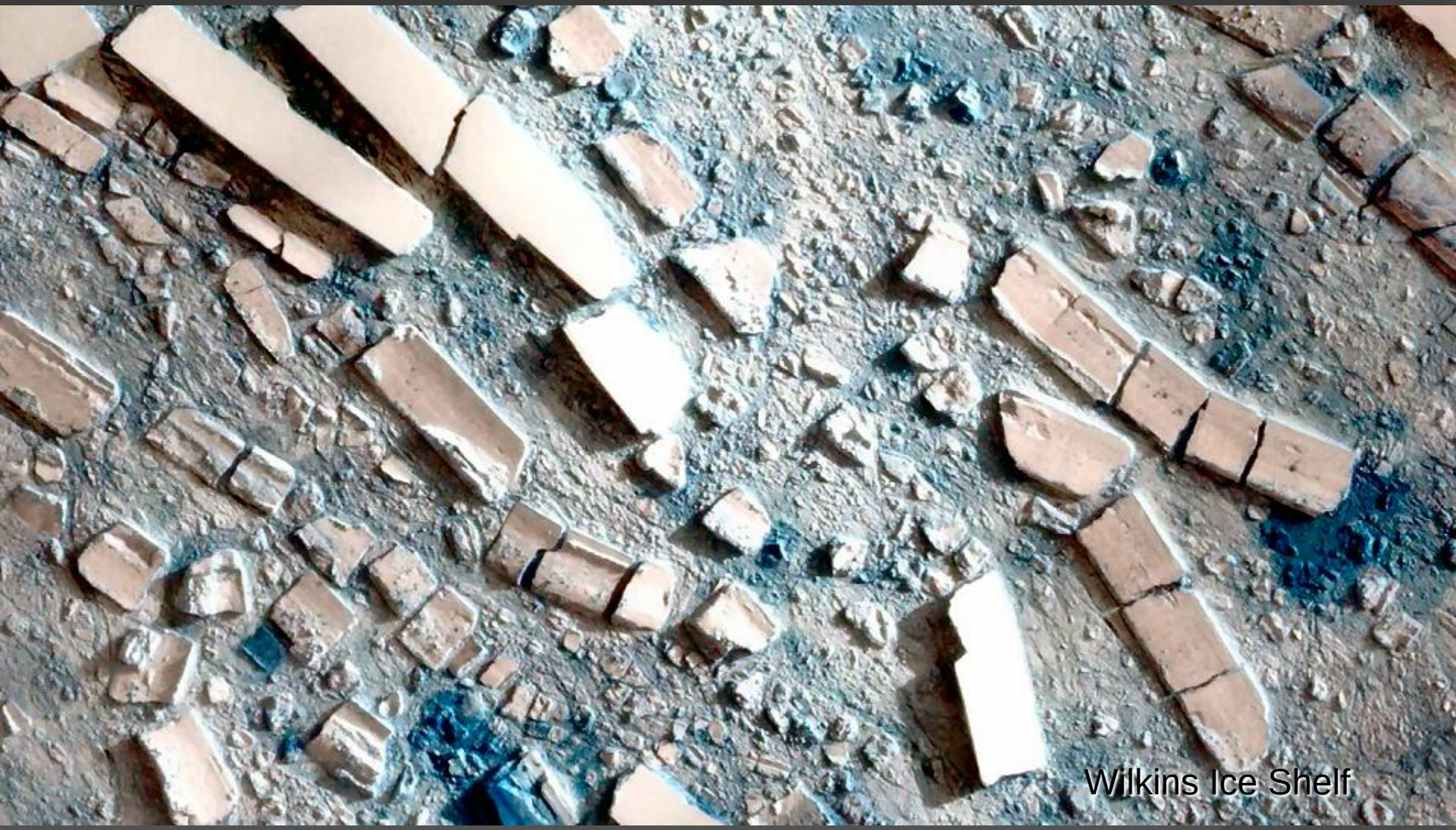

Lowest Temperature measured
10 August 2010: -93.2°C (-135.8°F)
Lowest Temperature of 2013
31 July 2013: -93.0°C (-135.3°F)
Previous Record Low Air Temperature
21 July 1983: -89.2°C (-128.6°F)
Dome Fuji
Dome Argus
South Pole
Vostok
4000
2000
1500
1000
NASA's Aqua satellite
MODIS Land Surface Temperature
dark = colder areas (data masked north of 70°S)
NASA / USGS Landsat 8
July/August 2013 images:

Zanik lodowców szelfowych

Global Greenhouse Warming (2008)

2009 German Aerospace Center

Zanik lodowców szelfowych



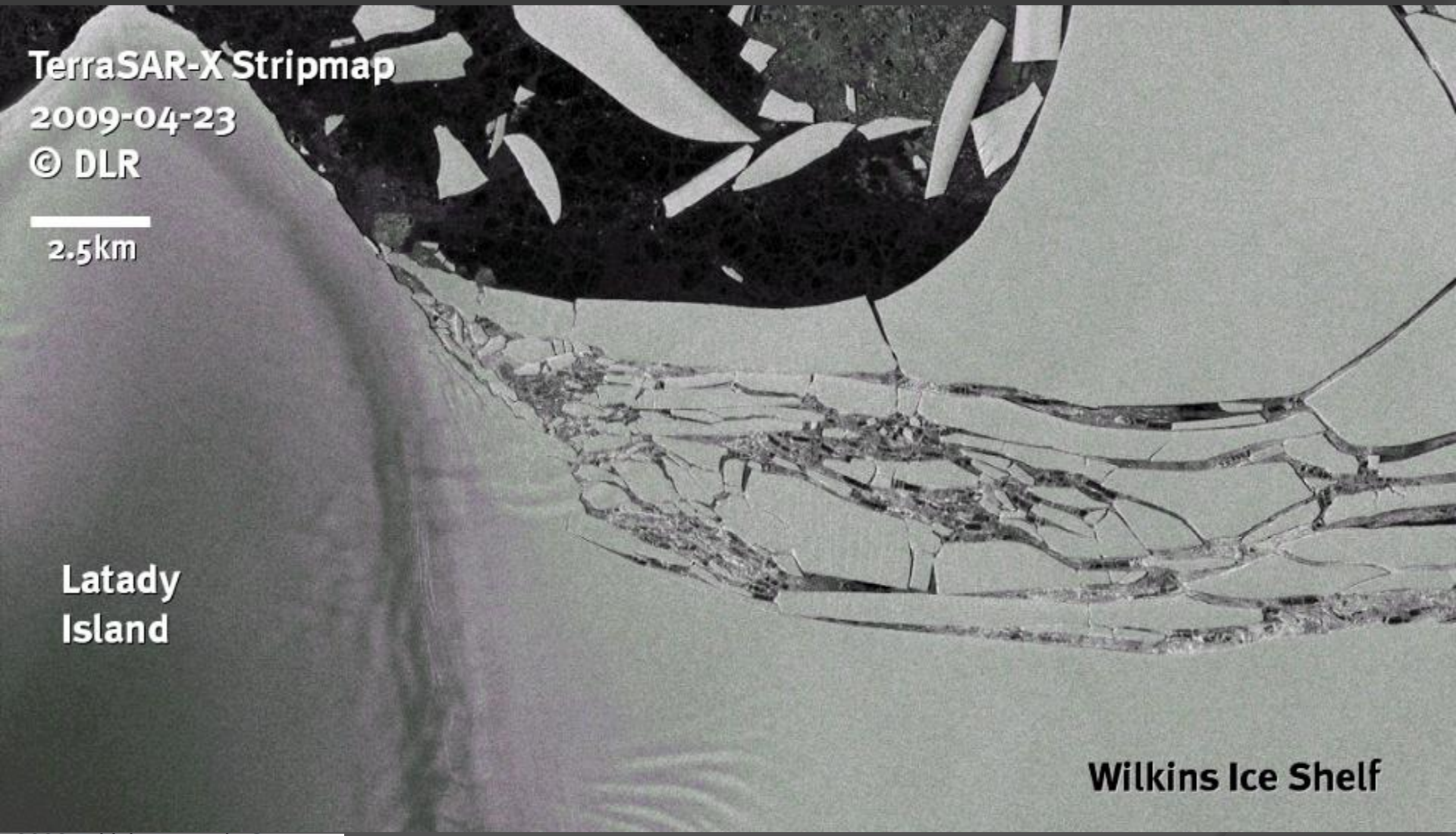
2009 German Aerospace Center

Zanik lodowców szelfowych

Wilkins Ice Shelf

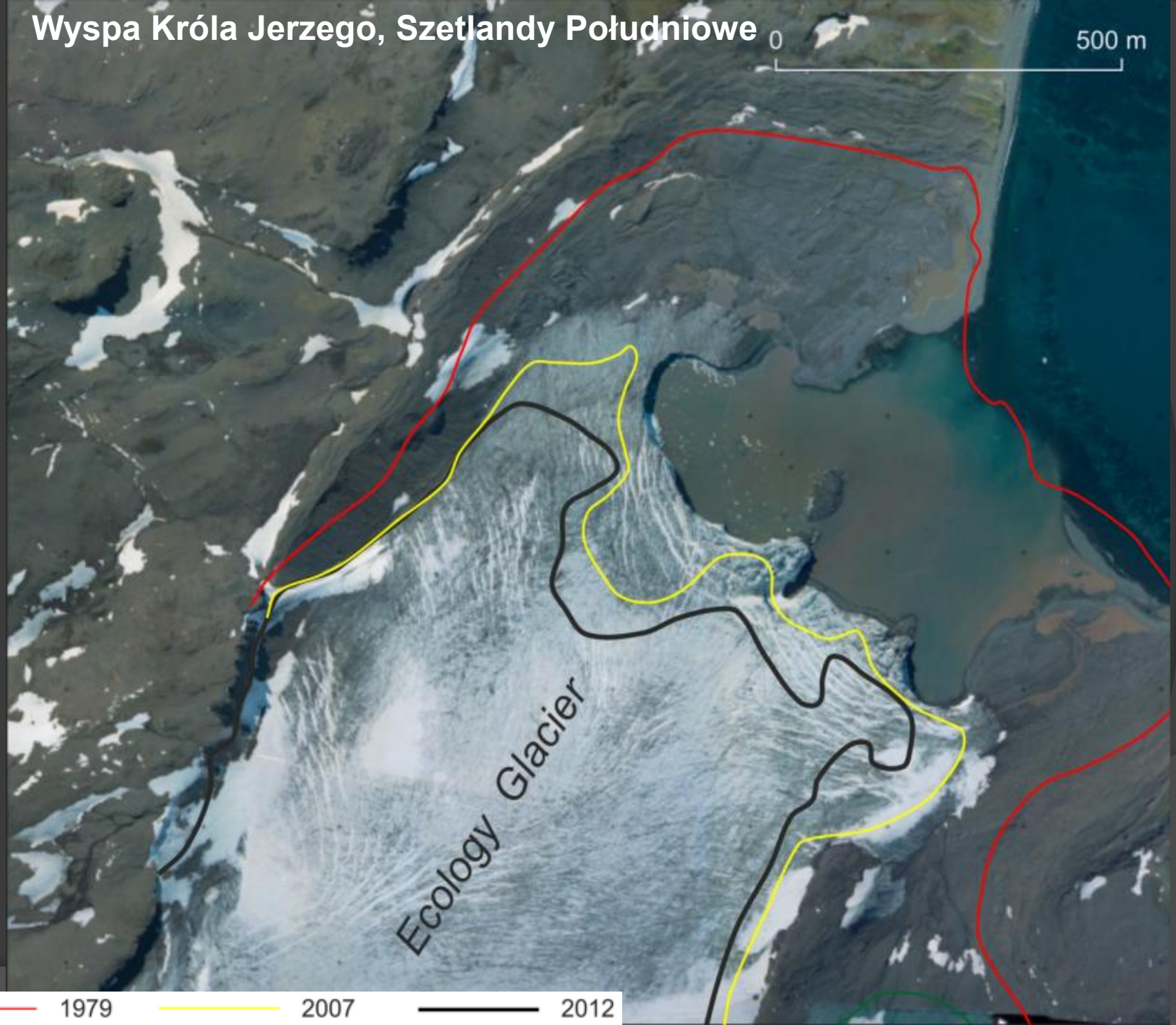
2009 German Aerospace Center

Zanik lodowców szelfowych

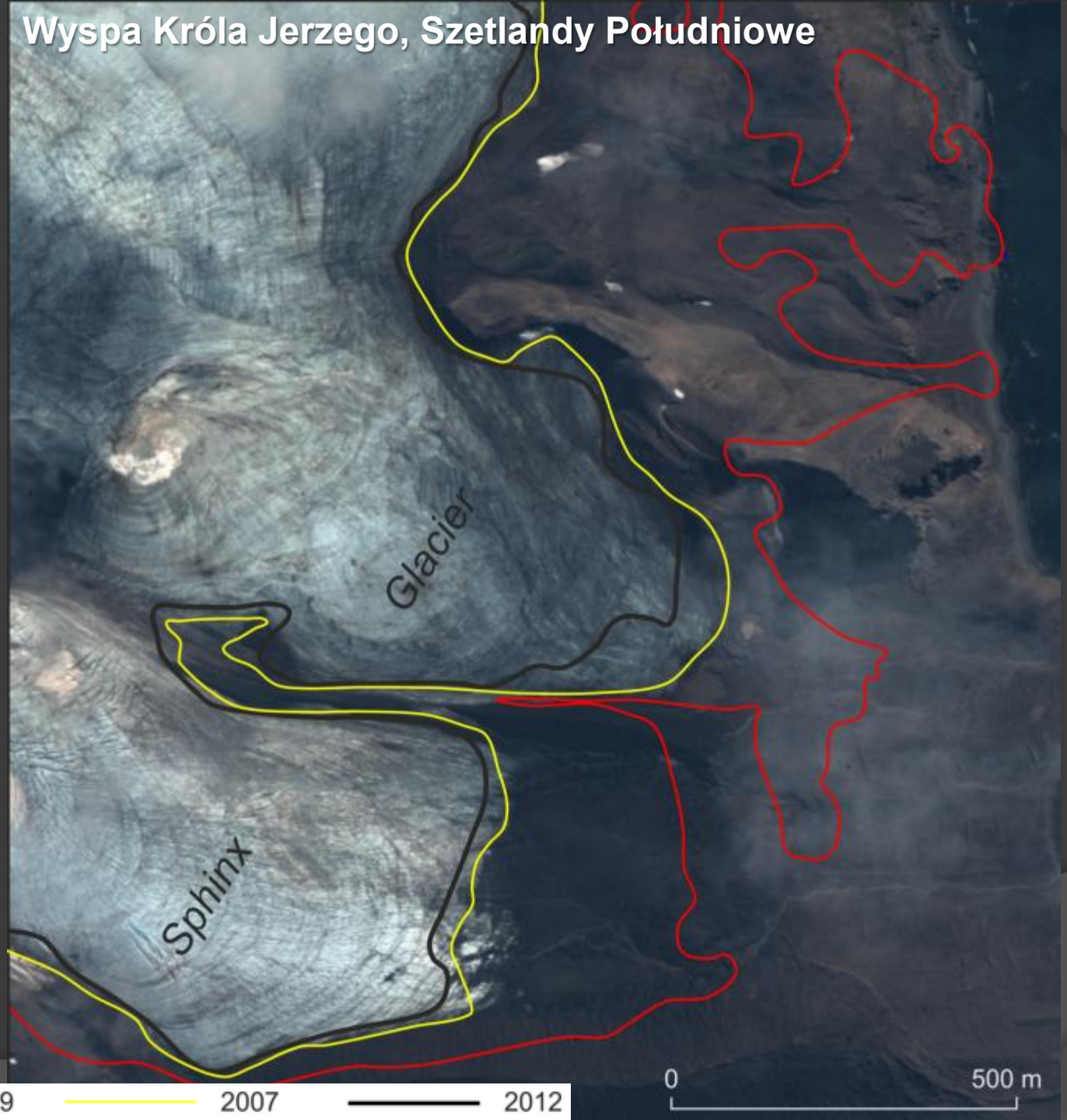


2009 German Aerospace Center

Wyspa Króla Jerzego, Szetlandy Południowe



Wyspa Króla Jerzego, Szetlandy Południowe



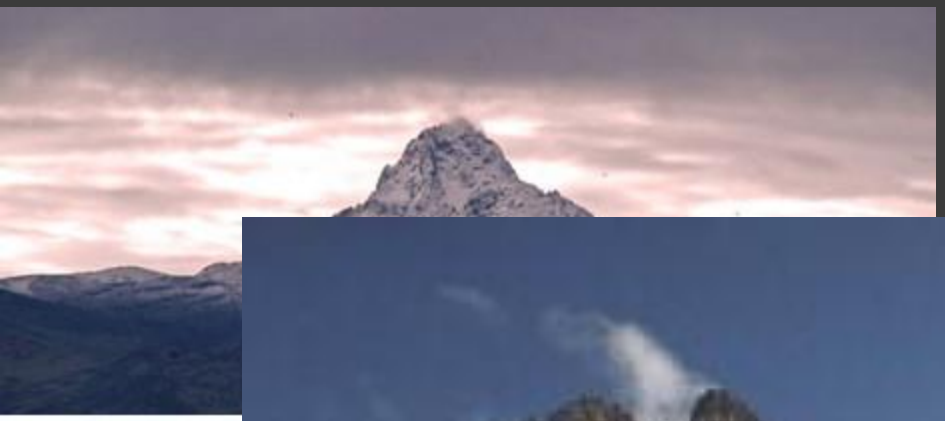
Lodowiec Furtwängler , Kilimandżaro
50% zmiana miąższości w latach 2000 – 2009
Tempo zaniku lodowców: 3.2% - 3.8% na rok

(Science, 2002).

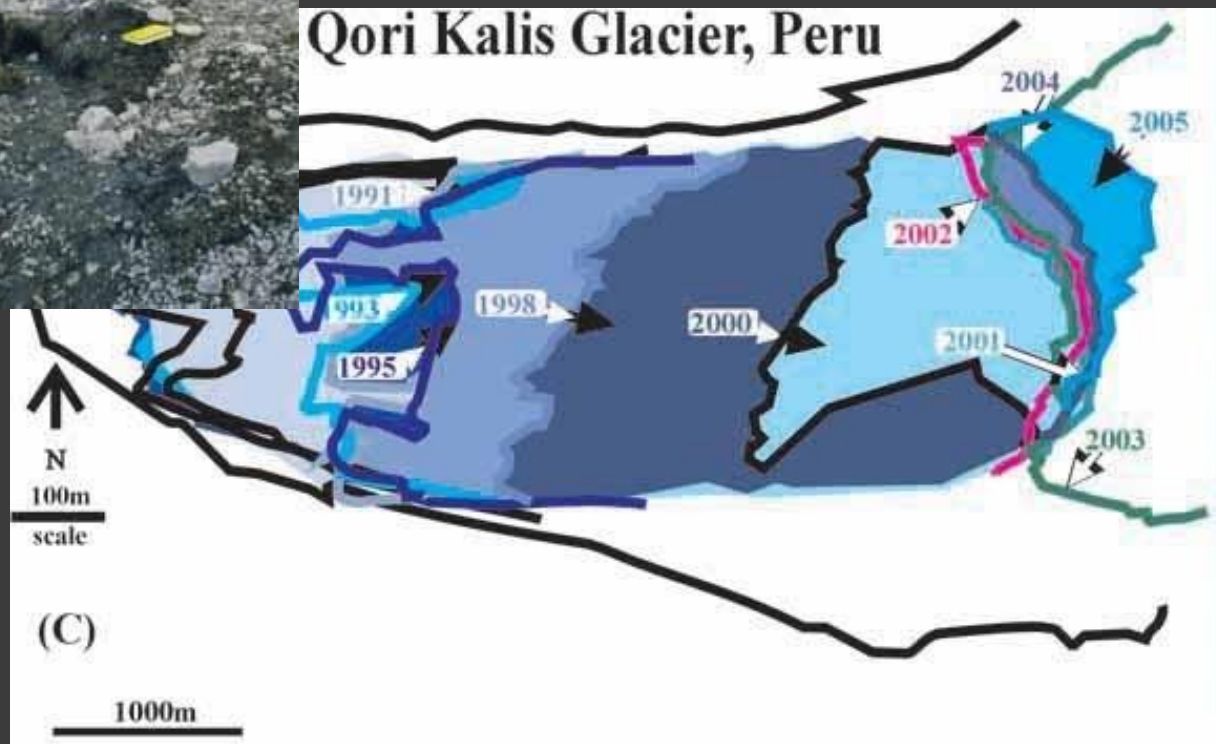
Northern Ice przetrwał od 11 700 BP w tym suszę
4 200 BP trwającą 300 lat.

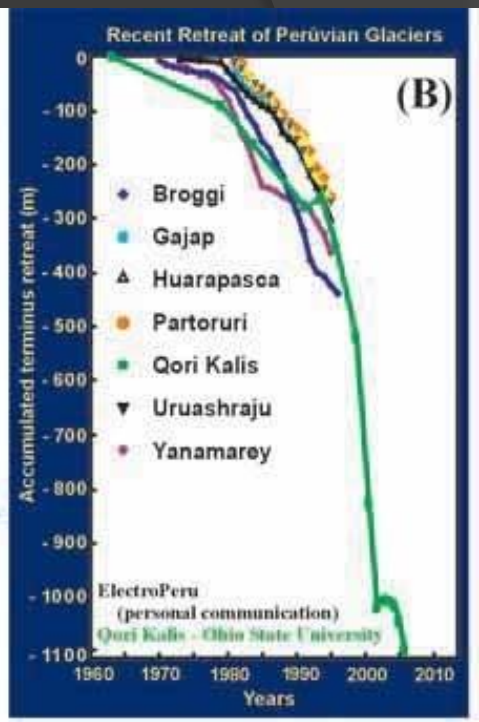
Masyw Kilimandżaro - Kibo

Kenia – 5 199 m n.p.m.
11 lodowców
lodowiec Lewis
(< 1km dł., pow. 0,3 km^2)



ok. 1963 r. tempo cofania 4,7 m/rok
Obecnie 205 m/rok





1978

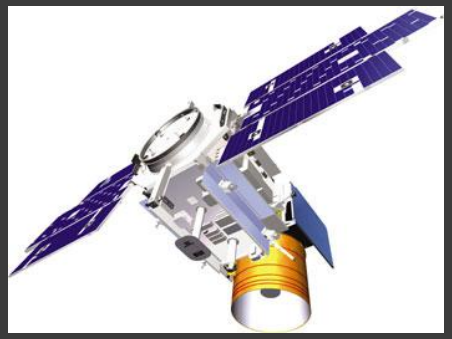
1991

1998

2000

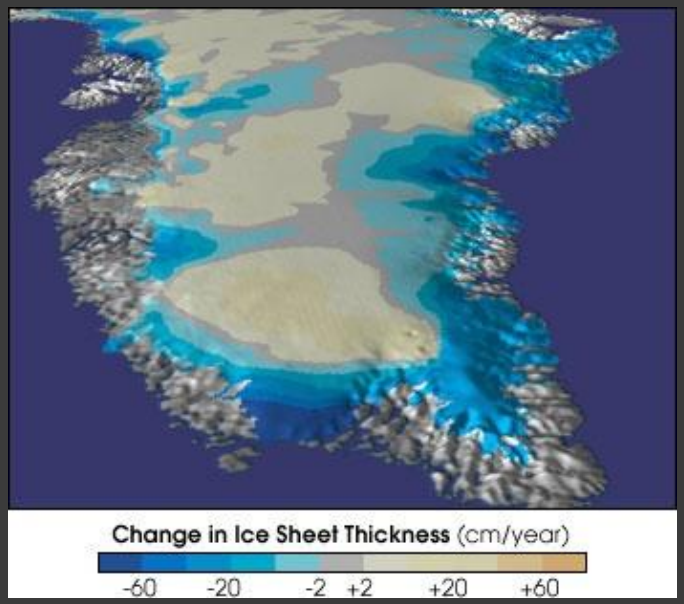
2005

Satellite LiDAR
ICESat/ GLAS

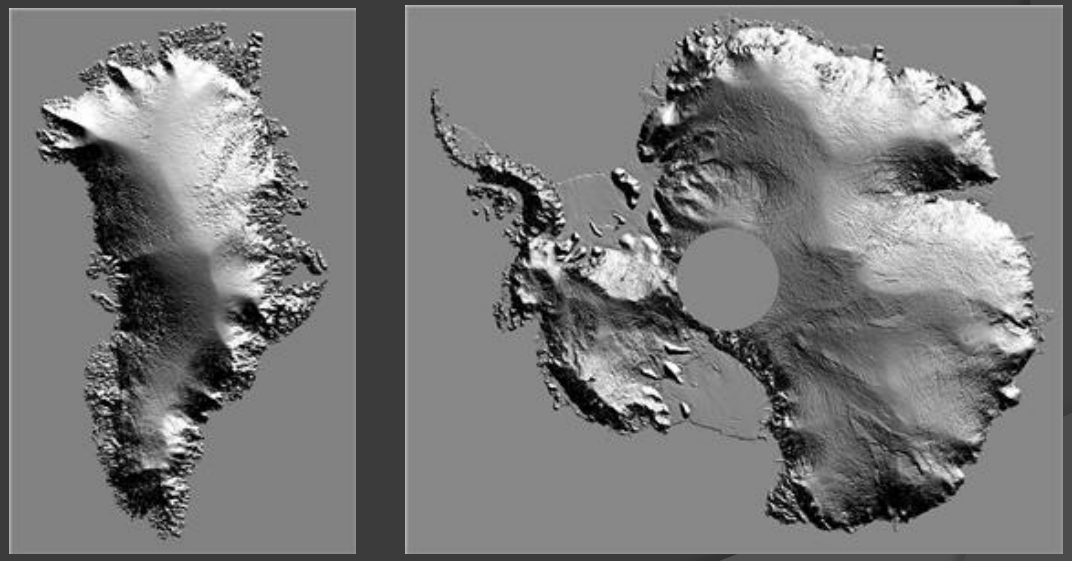


LiDAR altimeter **GLAS** (Geoscience Laser Altimeter System) zamontowany na satelicie NASA **ICESat** (Ice, Cloud and land Elevation). Full waveform scanner. The beam size on ground 70 m. Sampling every 170 m – 2 x in year.

Reference data for TanDEM-X !!!!!



Monitoring of ice Sheet Thickness

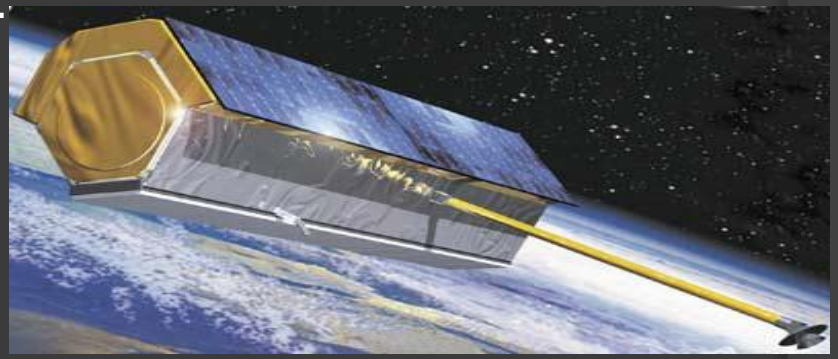


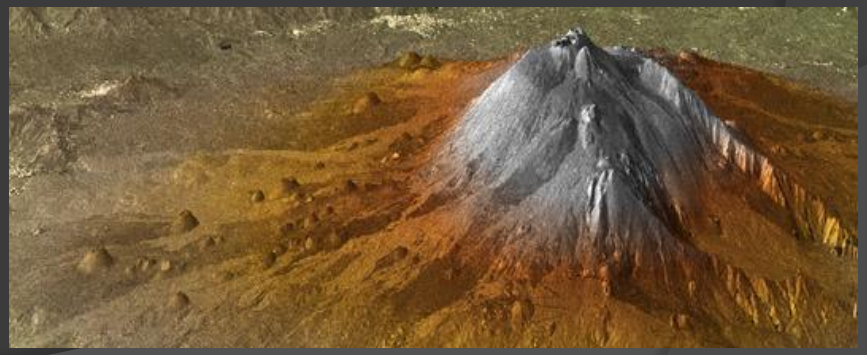
Greenland and Antarctica DEM Data Set (GSD 500m)

Cyfrowe Modele Wysokościowe

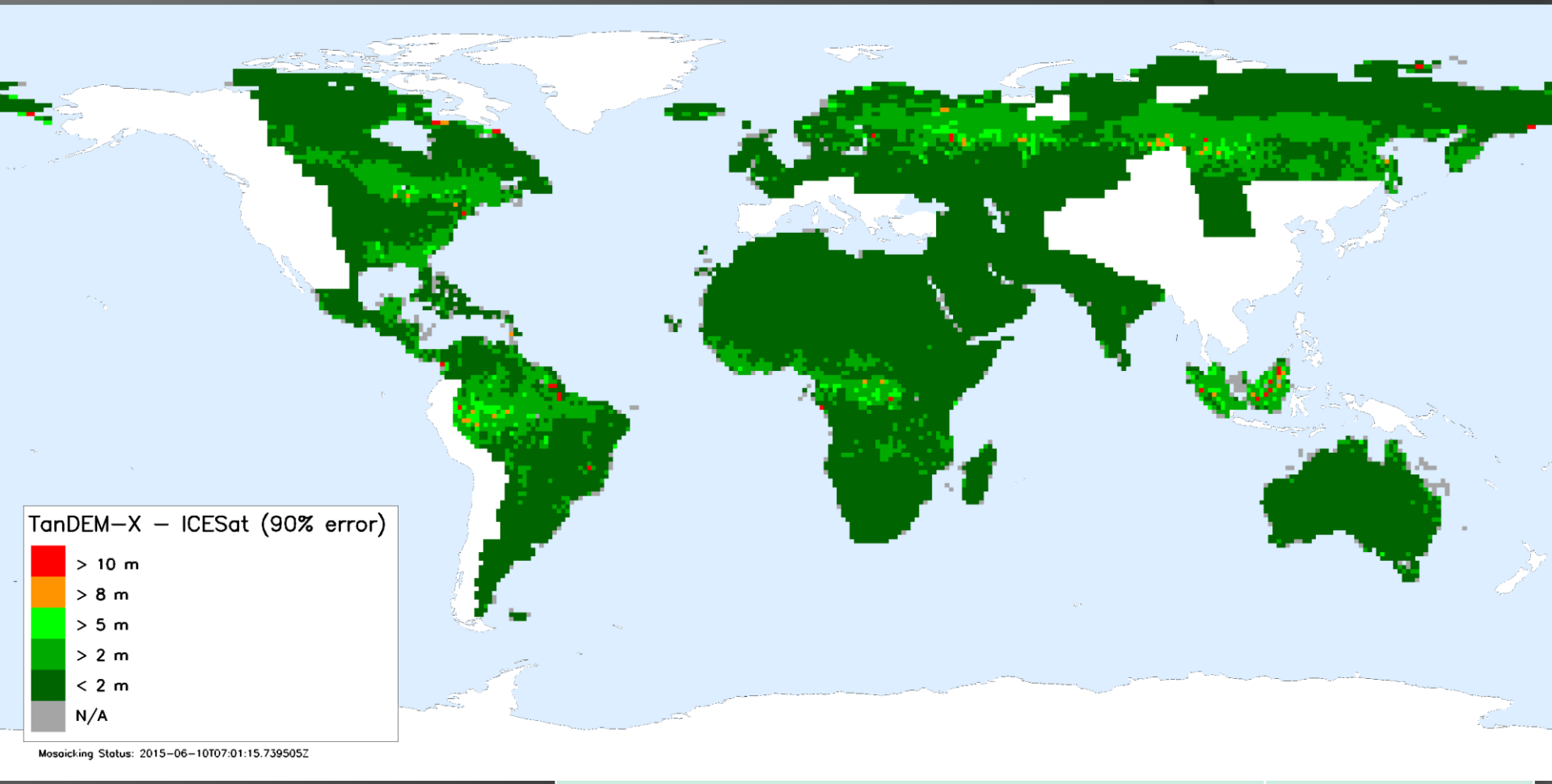
TanDEM-X + Terra SAR-X

TanDEM-X od czerwca 2010 na orbicie współpracuje z satelitą Terra SAR-X wystrzelonym w roku 2007. Obrazowanie ziemi 3D z pikselem do 1m. Wkrótce opracowany zostanie globalny model dla Ziemi.





Final DEM Production Status



Accumulated Absolute Height Accuracy (90% LE)	**1.1 m**

Dziękuję za uwagę