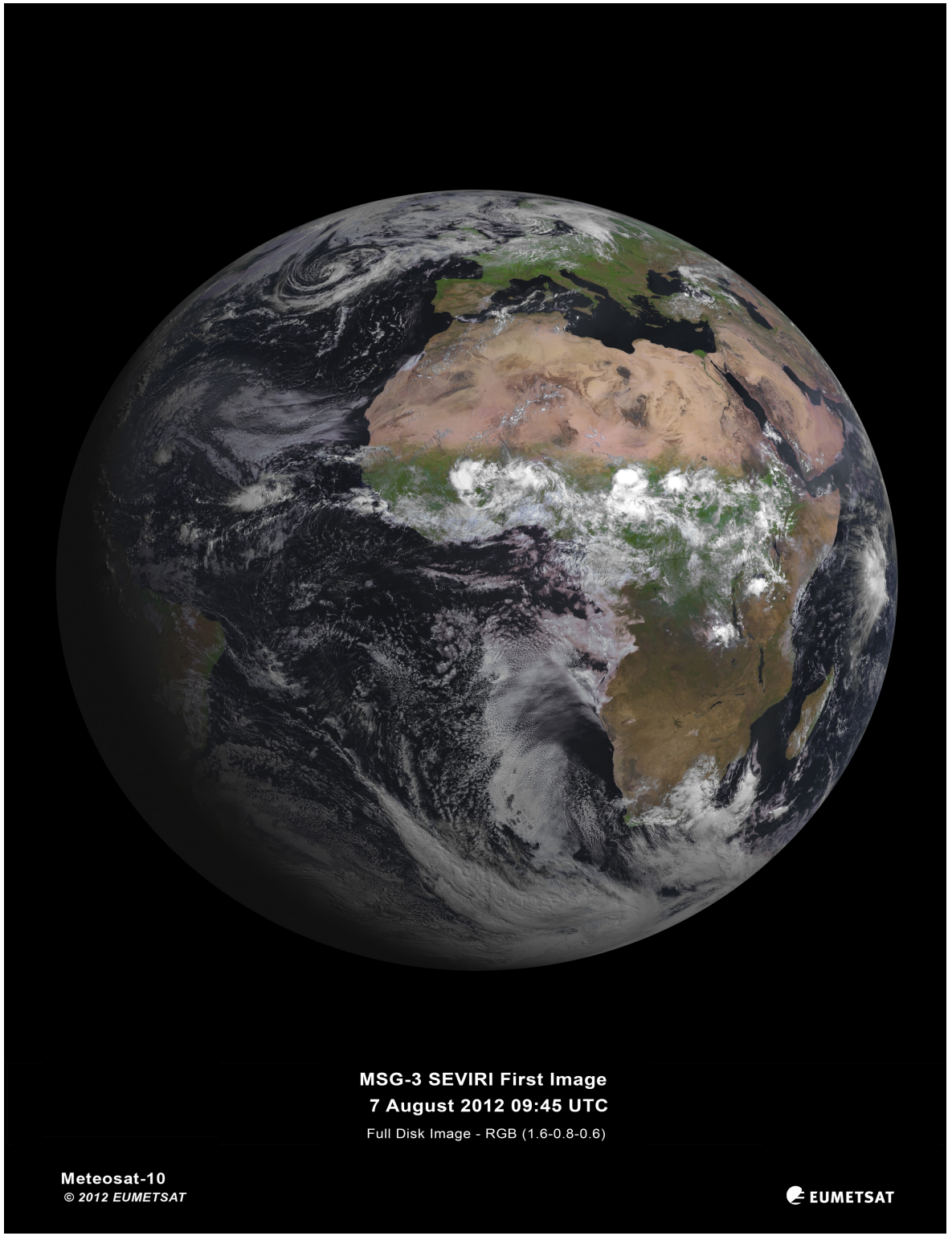
Africa and the Cosmos

Humanity's voyage from Africa to the solar system

Jonathan McDowell

Smithsonian Astrophysical Observatory



AFRICA AND THE COSMOS

How the stars came to Africa
How Africa is going to the stars

Jonathan McDowell

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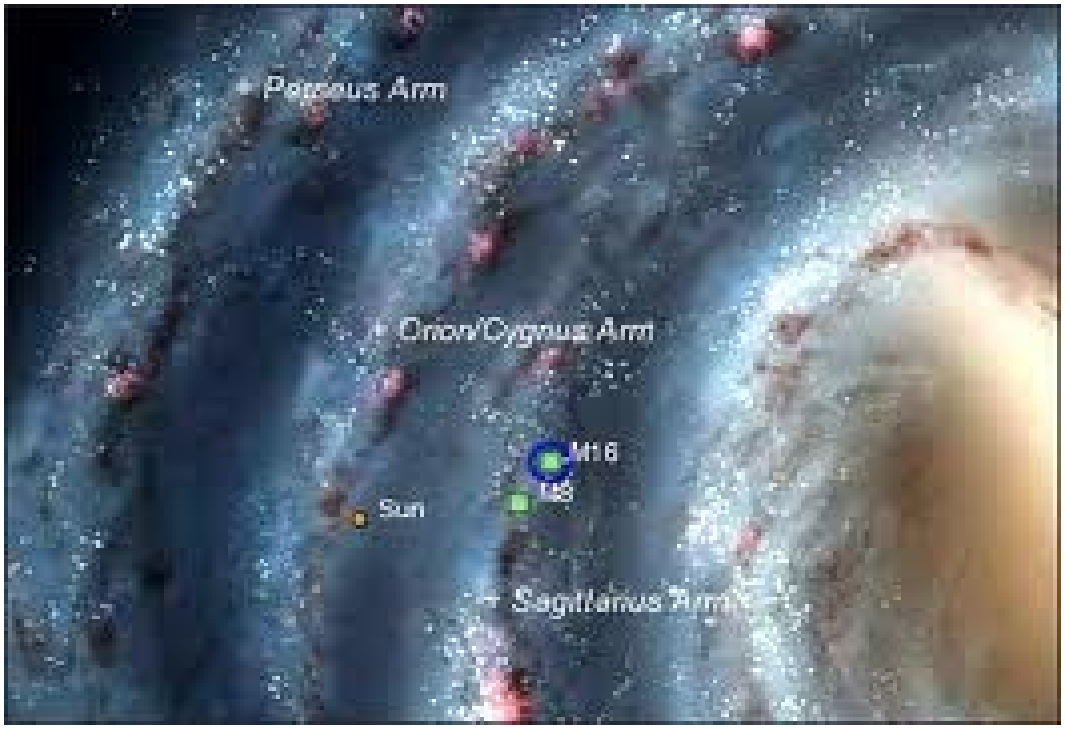
Part 1

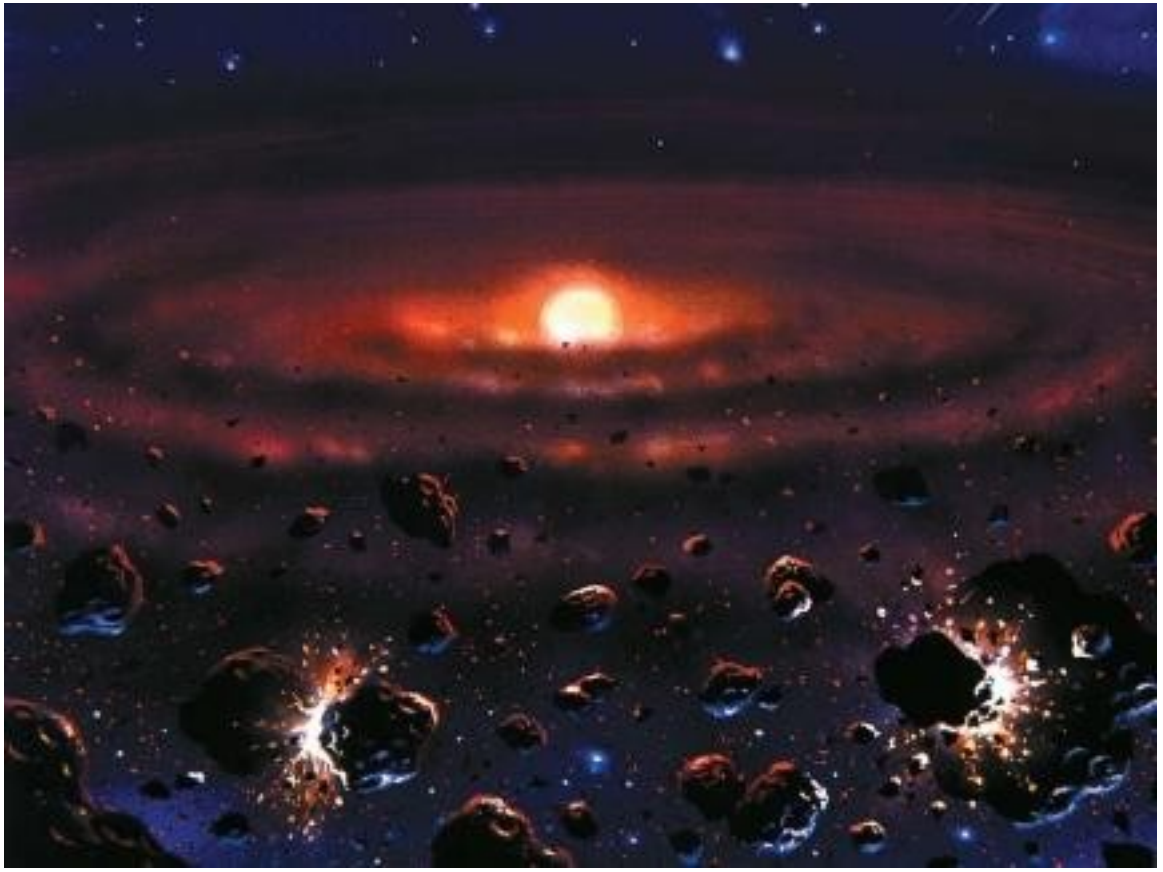
From the stars to Africa

Scene:
The Milky Way Galaxy

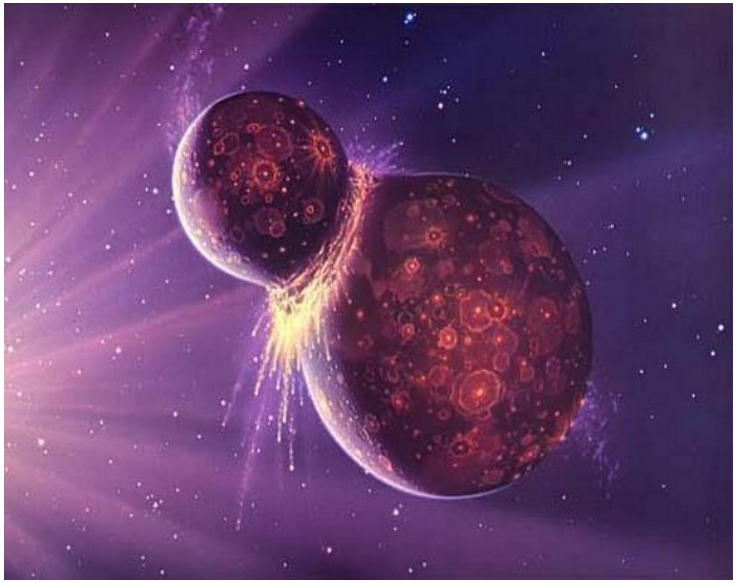
5 Billion Years Ago

In the star fields of what one day would become the Orion spiral arm, a new star system condenses out of the interstellar clouds....





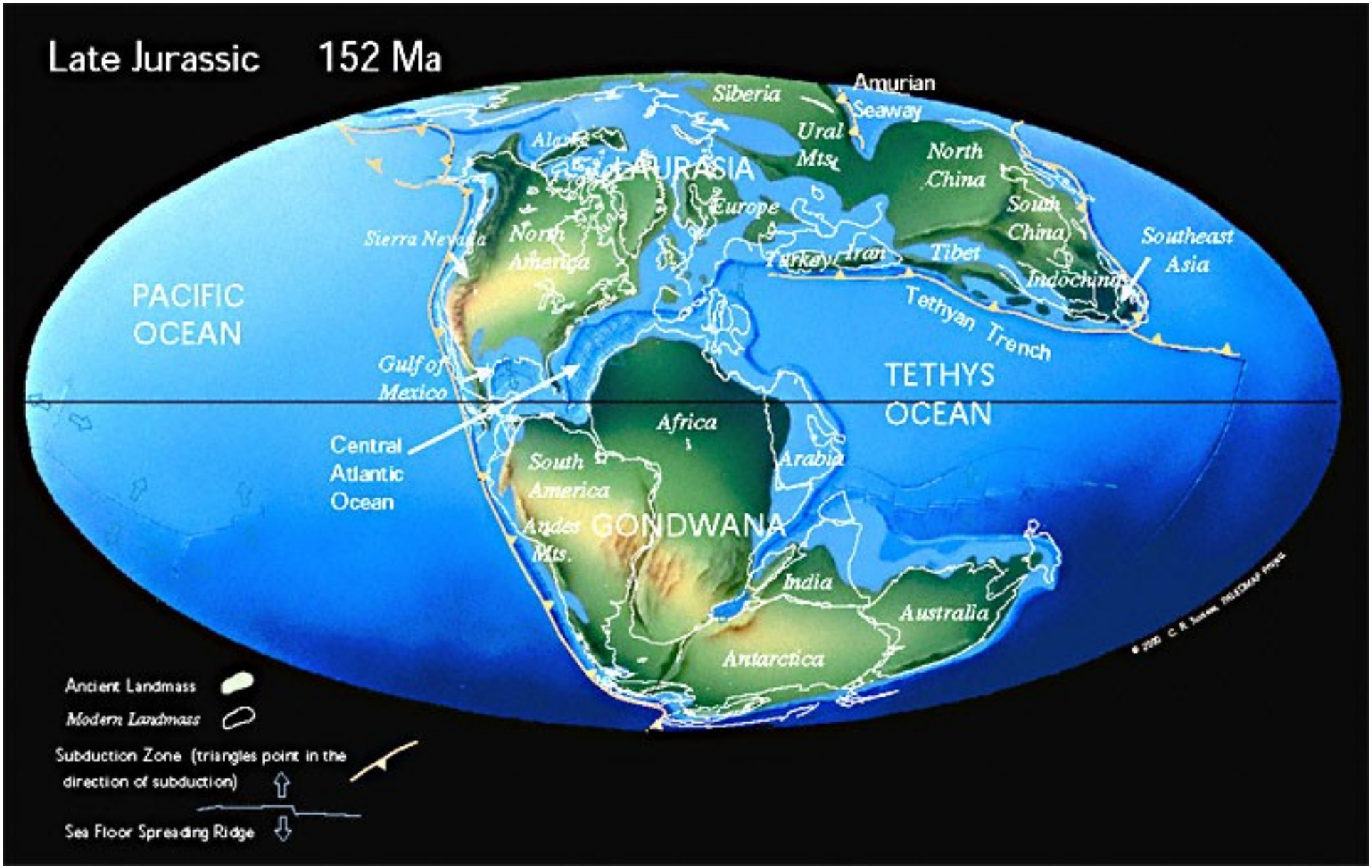
Around the infant Sun, small planetoids hit each other - and some of them stick, building up what will become the planets we know



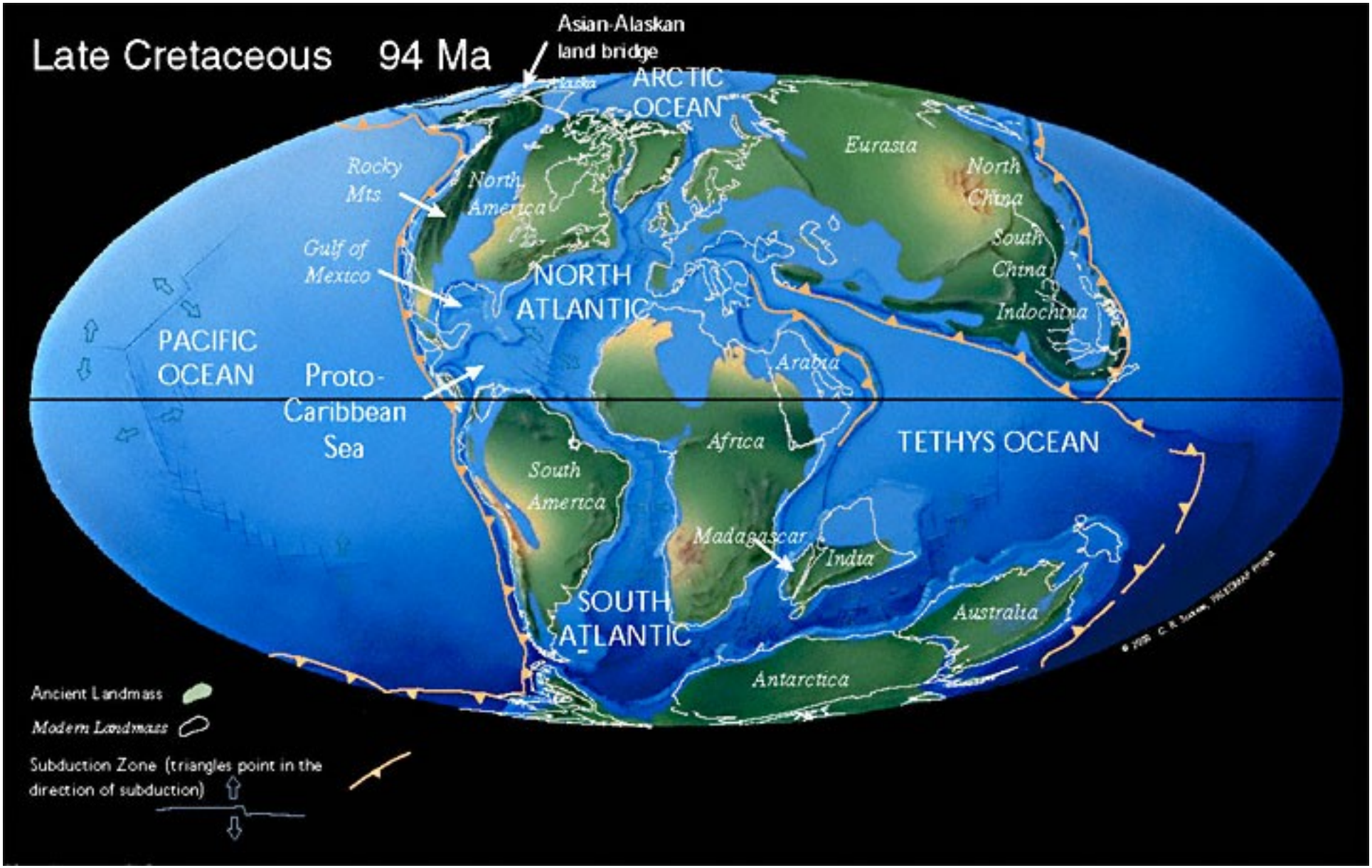
During the Hadean era, comets and asteroids bombard the Earth – the first few hundred million years are not a peaceful time

But “soon” - on cosmic timescales – the Earth cooled, the oceans formed, and simple living cells evolved.

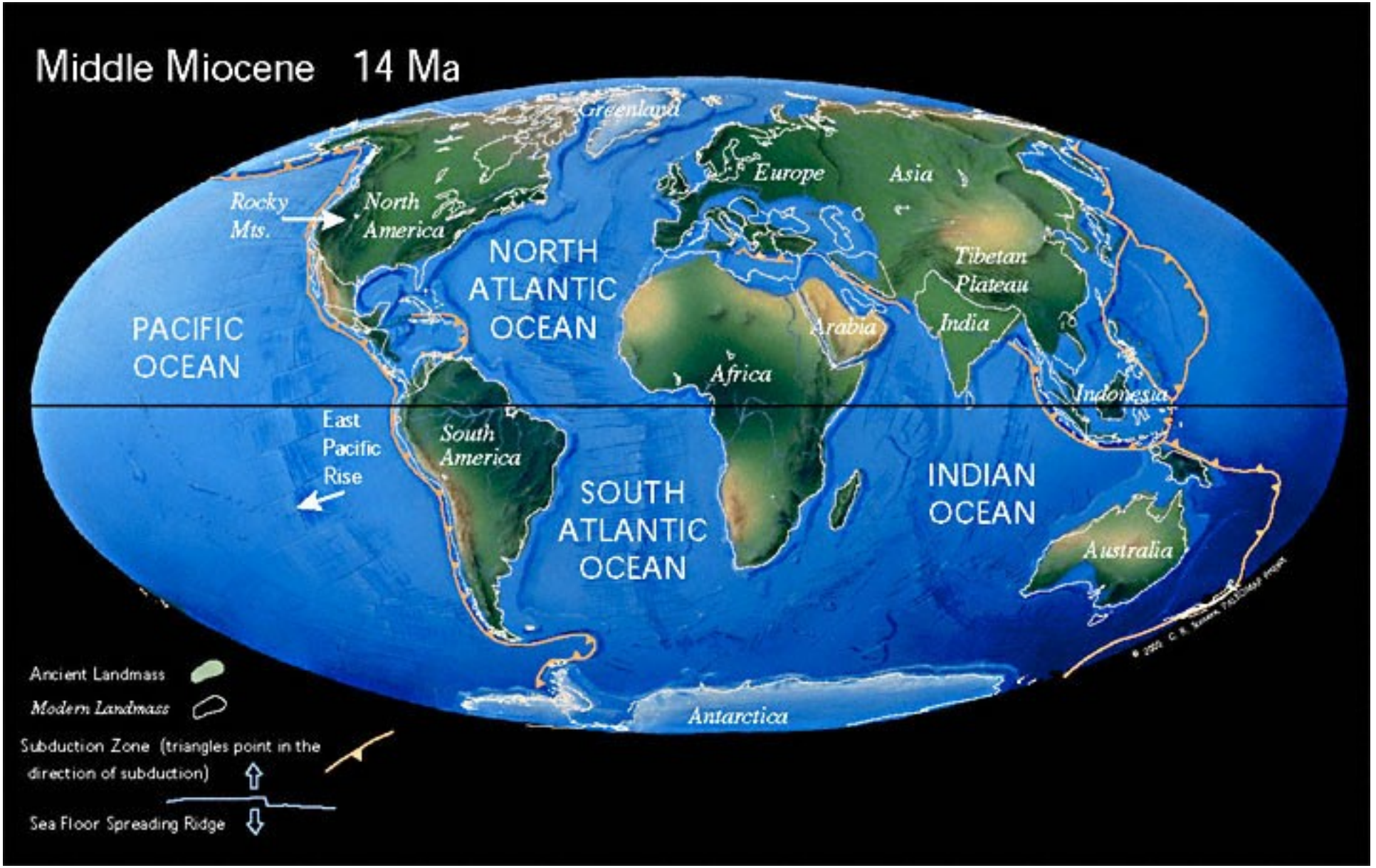
Four billion years later...



As dinosaurs rule the Earth, the land that would one day be Africa is part of the supercontinent Gondwanaland



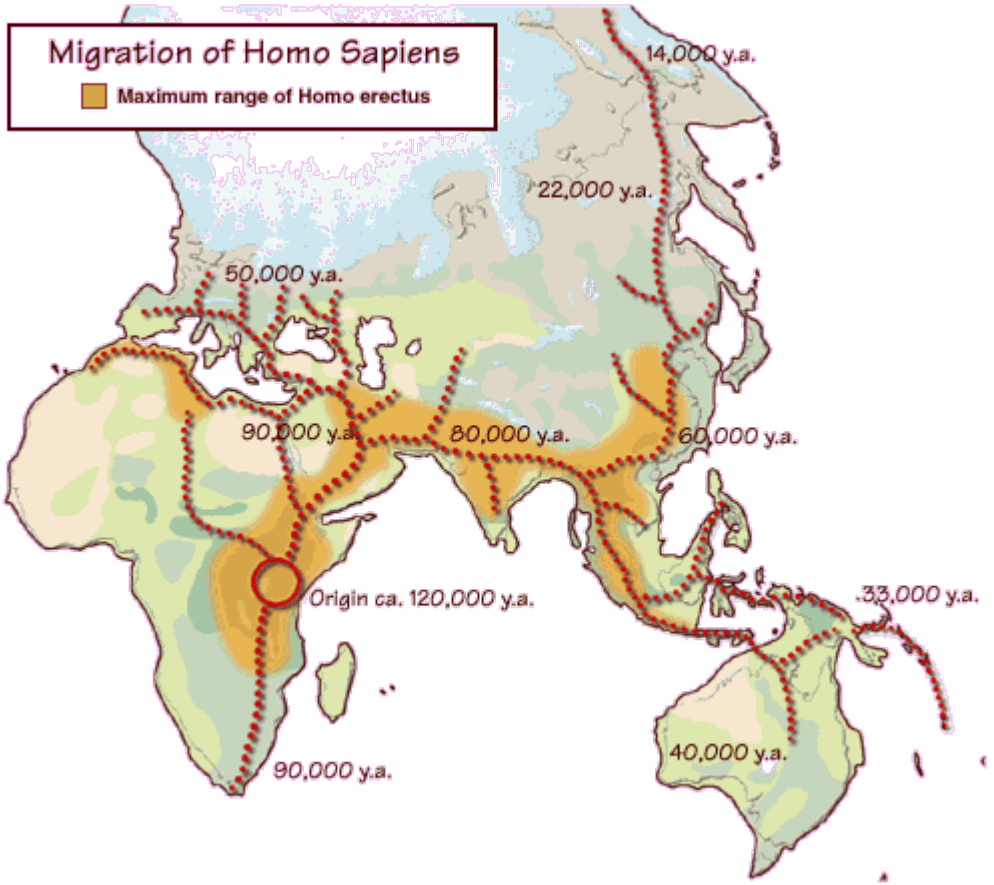
A hundred million years ago, Africa is born
Continental drift pulls it away from South America and Antarctica



By 15 million years ago, the continent of Africa is much like it is today. And by three million years ago (maybe?) an African ape looked up at the sun and the moon and began to wonder...

About 100,000 years ago:
an African tradition of exploration begins

African explorers and colonists discover the Middle East, Asia, Europe and Australia – the first steps on a path that will lead humans to the stars

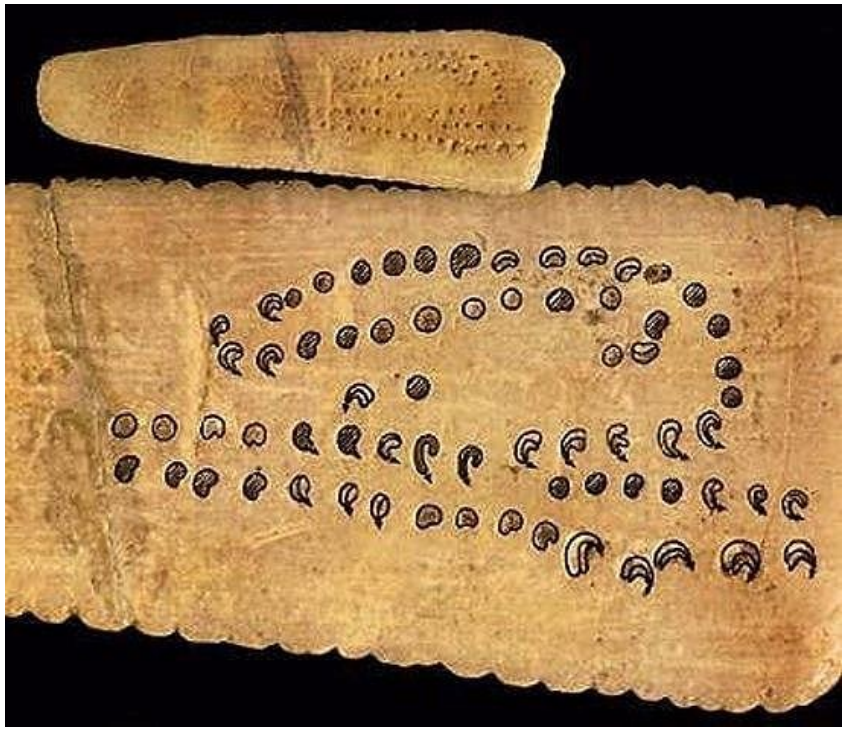


Toba supervolcano in Indonesia, 71000? BC
wipes out most humans?
creates genetic bottleneck?
A small group of survivors in Africa – our ancestors – started over, exploring, colonizing and populating the Earth

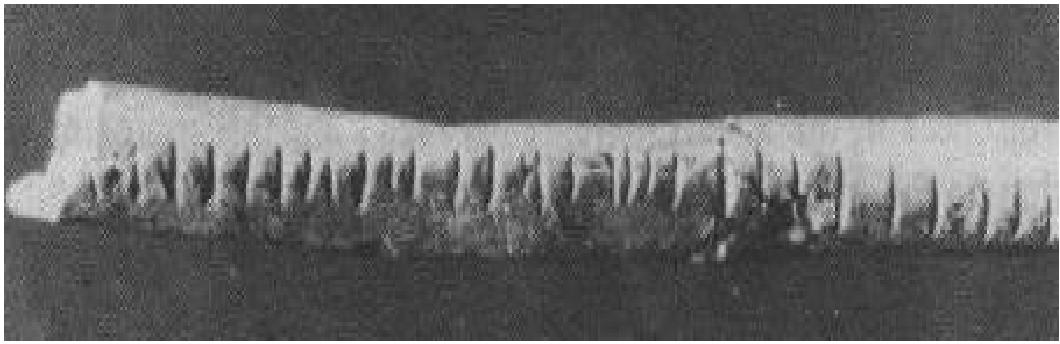
.

Africans studied the skies from the earliest times – the sky was a clock and a calendar for ancient cultures.

Early (pre-agricultural) societies are thought to have made use of lunar calendars - although the interpretation of the specific artifacts shown here is controversial (i.e. dubious)



Paleolithic lunar calendar from Europe



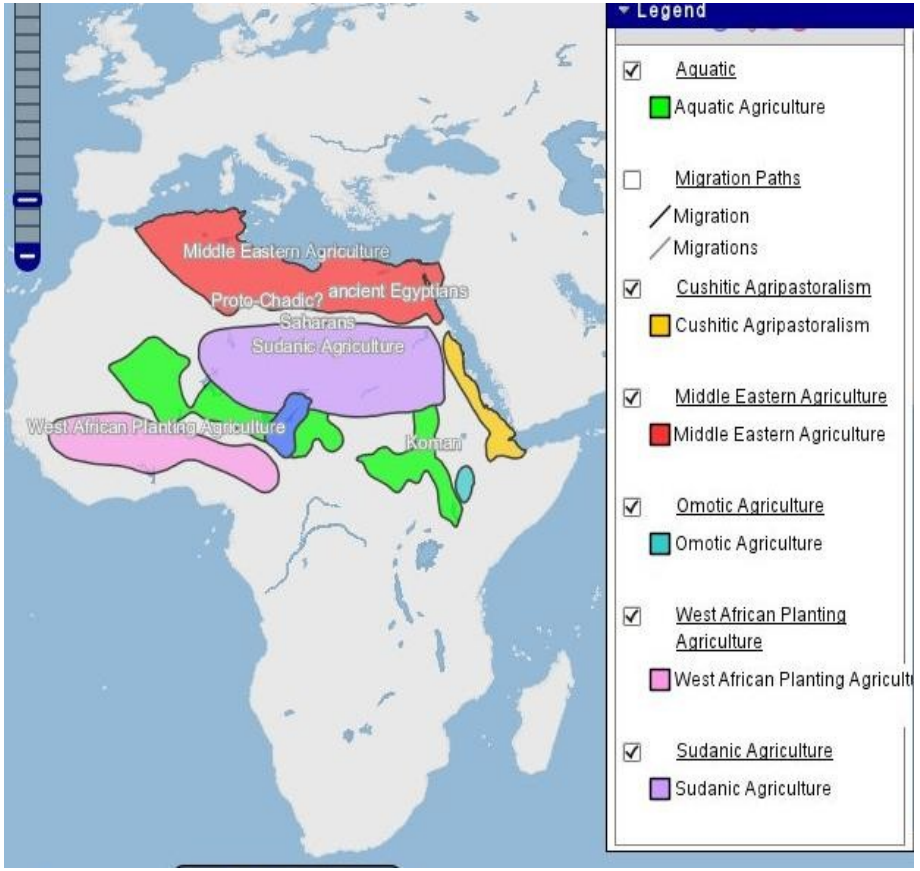
35000 BCE? notched bone claimed as a possible lunar calendar tally stick (Lebombo, Swaziland)

25000 BCE tally bone from Congo, possibly with moon phases

The invention of agriculture in the Middle East ca 9500BCE spread to East Africa some time later

Independent invention of farming with sorghum and millet in the Niger region of West Africa around 4000 BCE and led to the spread of Bantu-family speakers?

Among the many transformations that agriculture brings is a change of astronomical focus from the Moon to the Sun: the annual journey around the Sun determines when we must plant and harvest.



African agriculture 5500 BCE
(Ehret 2002)

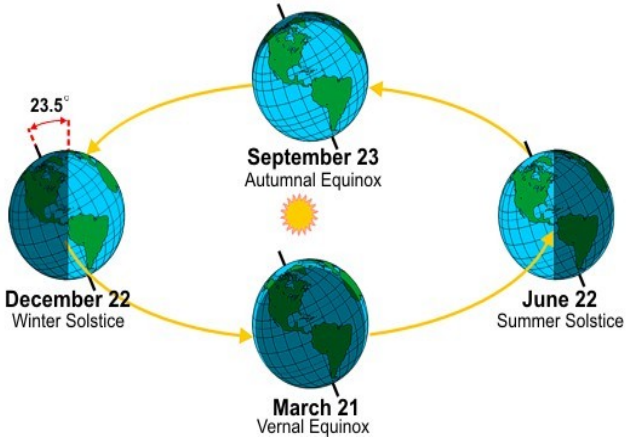
Many cultures today, including the European culture of the USA, retain a mixed lunisolar calendar where we keep track of both months (the Moon cycle) and years (the Sun cycle)

The solar calendar and the agricultural cycle also make us pay attention to the stars – in a particular location, the same constellation will rise over a landmark on the evening horizon at the same time of year. A classic example is the star Sirius, whose appearance in the dawn sky each year warned the ancient Egyptians of the Nile flooding season.

Constellations as seen fron Namibia
(P. Hanrahan, Mt Hood CC)

Sopdet (Sirius)
(Egypt, c 600 BCE)

Some central African cultures such as the Tabwa of Zaire used the orientation of the galactic plane (the Milky Way), which changes through the year, as a calendar.



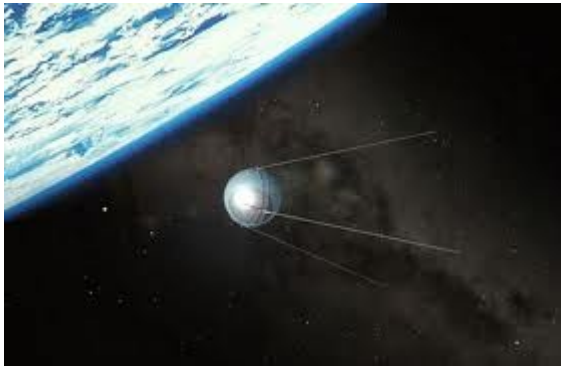
Unfortunately as far as I know we don't have reliable evidence for the calendars used in most of West and South Africa in ancient times, but it's a good bet that solar calendars were kept – a good opportunity perhaps for joint research by astronomers and African studies experts (a start was made by Anthony Aveni in his fascinating Smithsonian book 'Ancient Astronomers')

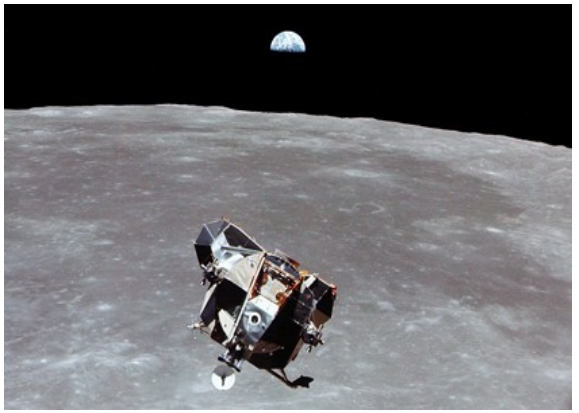
Part 2

From Africa to the stars

Africa from Apollo 17

December, 1972






Africa's role in the early years of the Space Age – 1950s to 1970s
was entangled with and limited by the legacy of colonialism, and with Cold War superpower rivalry

But now, in the 21st century, African nations are taking an independent role in the use of space technology – and the African legacy of exploration is poised to resume on the space frontier.

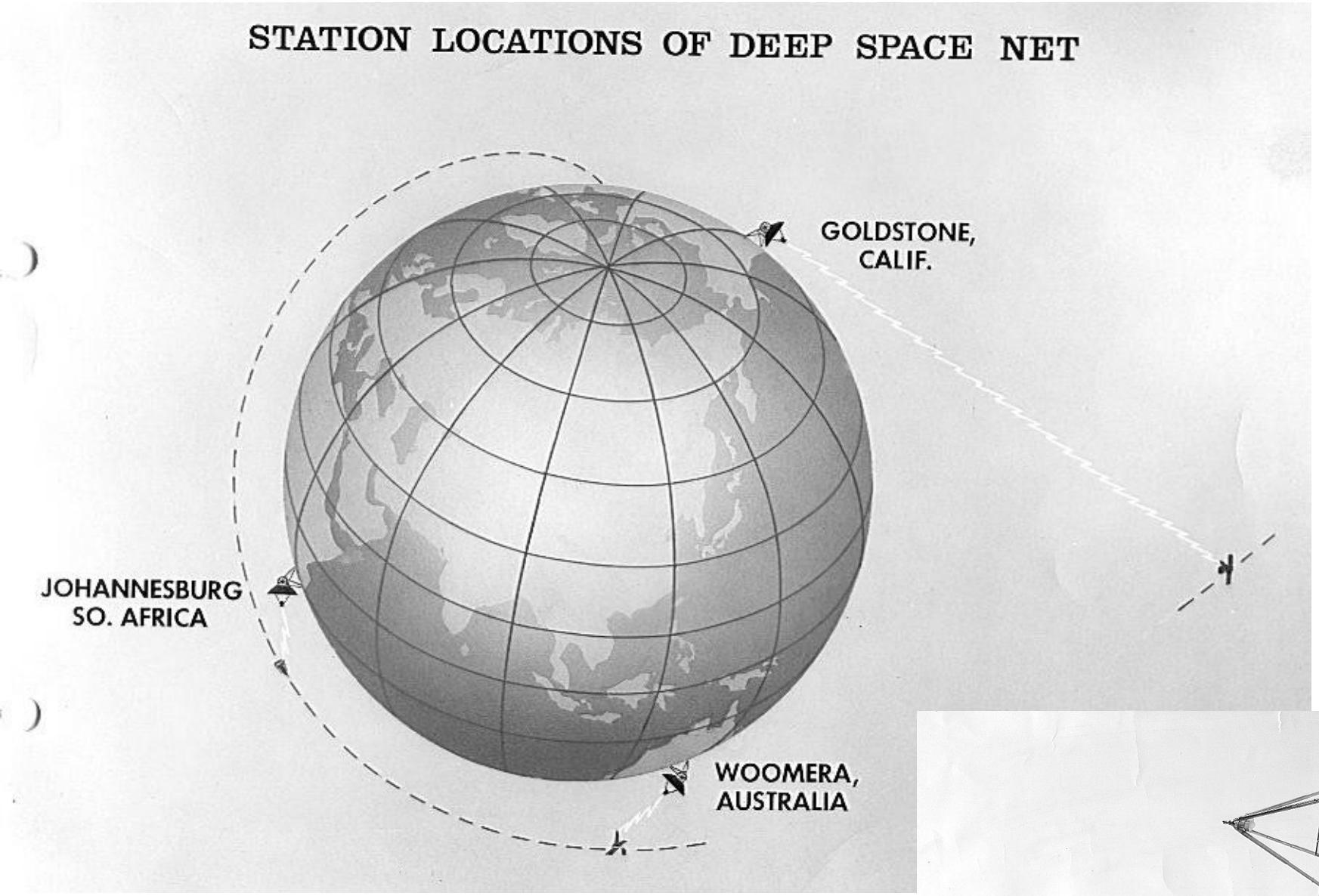
To understand where things stand today, we must review the era of colonial transition

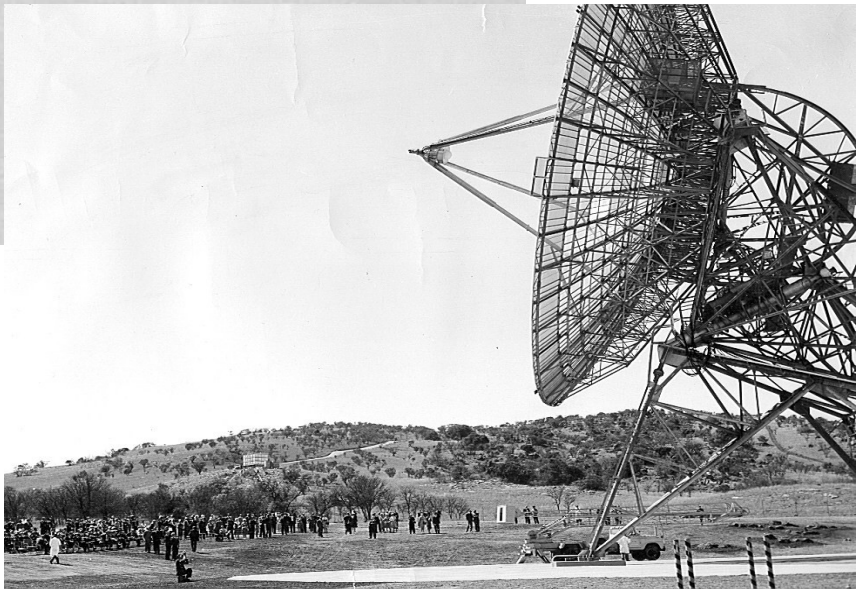
In the 1950s, American missiles launched from Cape Canaveral would land near Ascension Island. Eventually longer range missiles would overfly South Africa and hit the Indian Ocean

Once satellites orbited the Earth, the space agencies needed tracking stations dotted around the globe to talk to them

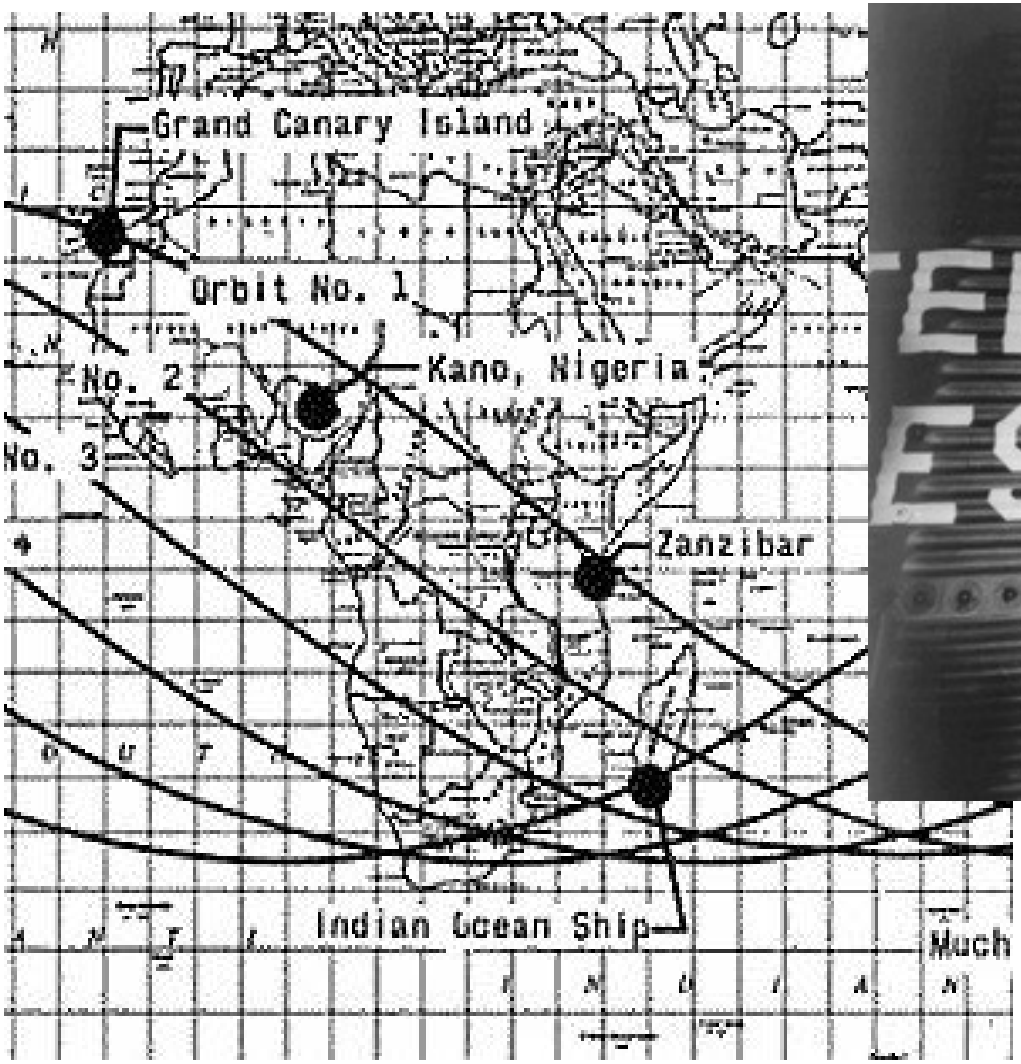
The Smithsonian Astrophysical Observatory built a network of Baker-Nunn satellite tracking cameras around the world to measure satellite orbits.

One of them was stationed near Johannesburg (Olifantsfontein)





Hartebeesthoek Radio Astronomy Observatory in South Africa was originally NASA's Deep Space Station 51, for communicating with Moon probes (1961)



The flight of Mercury spaceship “Friendship 7” in 1962 saw astronauts stationed in the Canary Islands, Nigeria and Zanzibar to talk to John Glenn aboard the orbiting capsule

Intelsat, the International Telecommunications Satellite Organization, linked African countries to the nascent global satellite telecom network. Intelsat was an IGO where the African nations were in principle equal participants, but in practice the technical aspects of the project were led from Washington

Intelsat's early 'Earth Stations' were large dishes costing millions of dollars, typically each country had only one.

First astronauts of the (more recent) African Diaspora

Arnaldo Tamayo Mendez
Cuba
Soyuz-38, Sep 1980

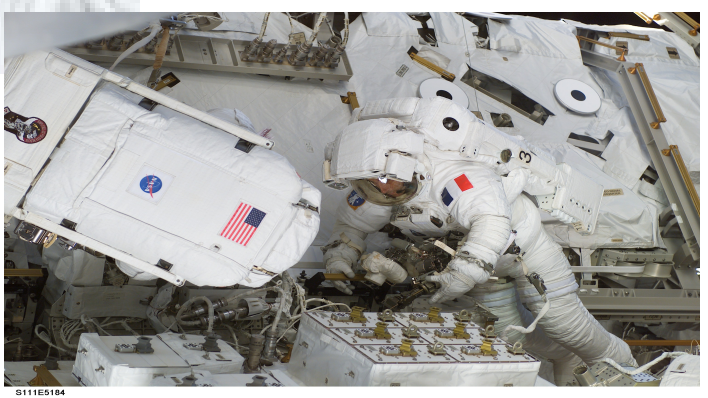
Guy Bluford
USA
STS-8, Aug 1983

Mae Jemison
STS-47, Sep 1992

2002 Shuttleworth

1985 Baudry

2004 Melvill

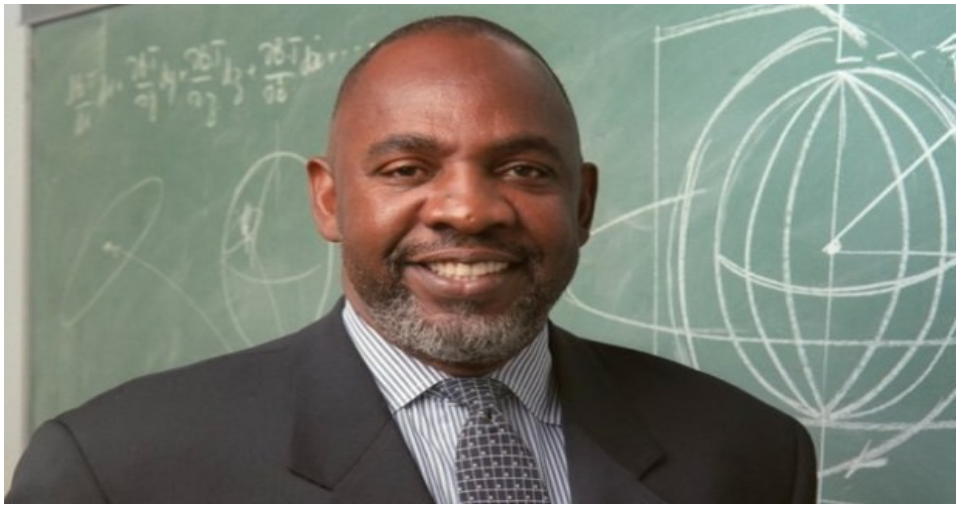


2002
Perrin

African-born astronauts of European ancestry – two French citizens, Patrick Baudry (Cameroun), STS-51G Phillipe Perrin (Morocco),; STS-111, and 2 S Africans - Mike Melvill (S Africa, with US dual citizenship), Spaceship One, Mark Shuttleworth (S Africa, with UK dual citizenship), Soyuz TM-34;

Expatriate Africans participated in the US space program:
Egyptian scientist Farouk el-Baz trained the Apollo astronauts in lunar geology

Malian aerospace engineer Cheick Mobido Diarra worked at the Jet Propulsion Laboratory, steering the Magellan spacecraft from Earth to Venus. In 2012 he served as Prime Minister of Mali

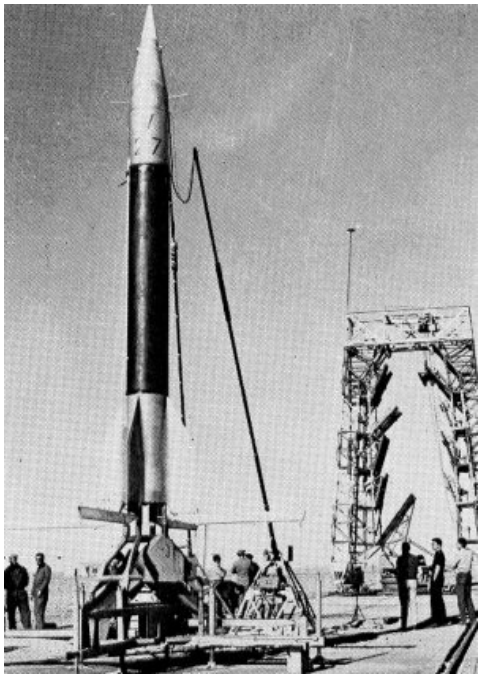


Kwatsi Alibaruho, US-born of Ugandan parents - Flight Director at NASA's Mission Control, Houston, was in charge of several Shuttle flights

Rockets from Africa

The first suborbital
space launch from the continent:
Feb 21, 1954 from Colomb-Bechar, Algeria
 - A French experiment to study the upper atmosphere using a Veronique rocket

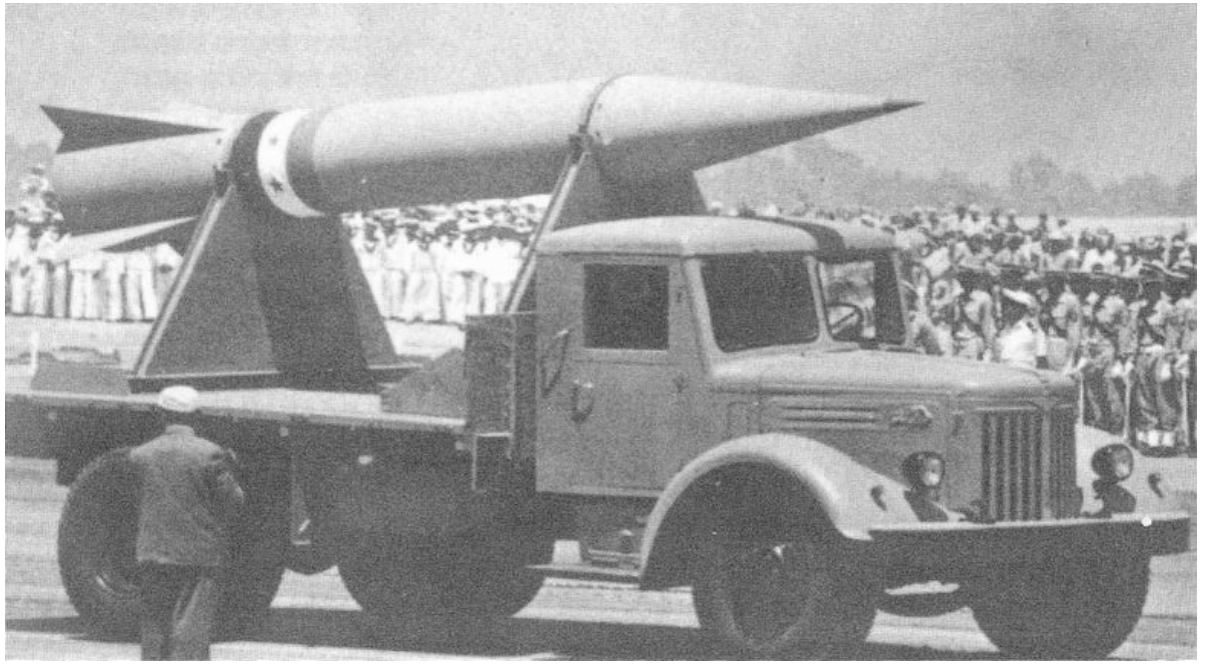
In 1955 operations moved to Hammaguir, further into the desert – it was here that France became the world's third country to put a satellite in orbit, in November 1965
Operations continued after Algerian independence in 1962.
In 1967 the French space team closed Hammaguir in agreement with the Evian accords.

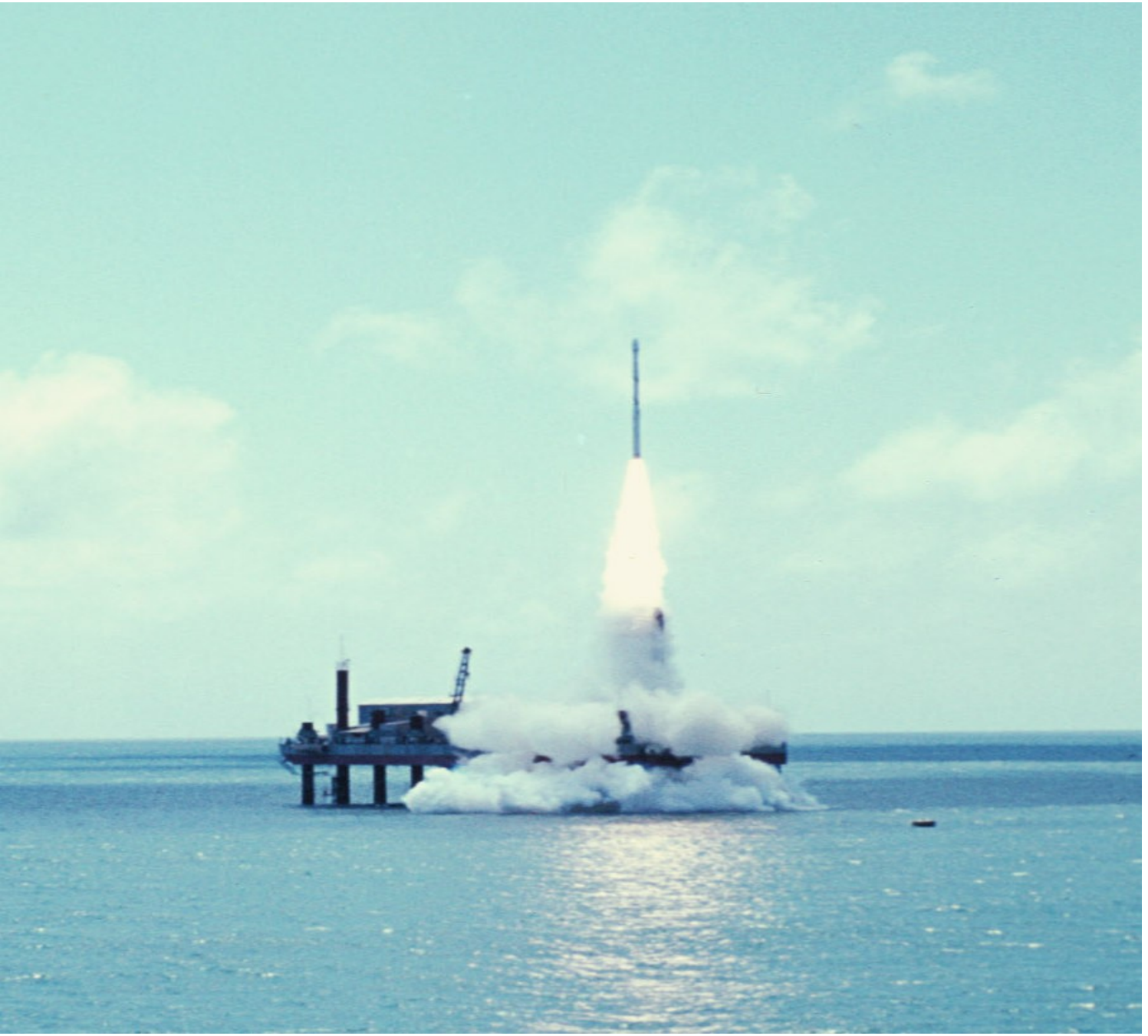


The first partly indigenous rocket program in Africa was Egypt's Al Kahir, first flown in 1962.

The rocket was developed in collaboration with German engineers as a military missile and continued by Egypt after the Germans pulled out.

It flew into the upper atmosphere, perhaps to 50 km, but not into space.

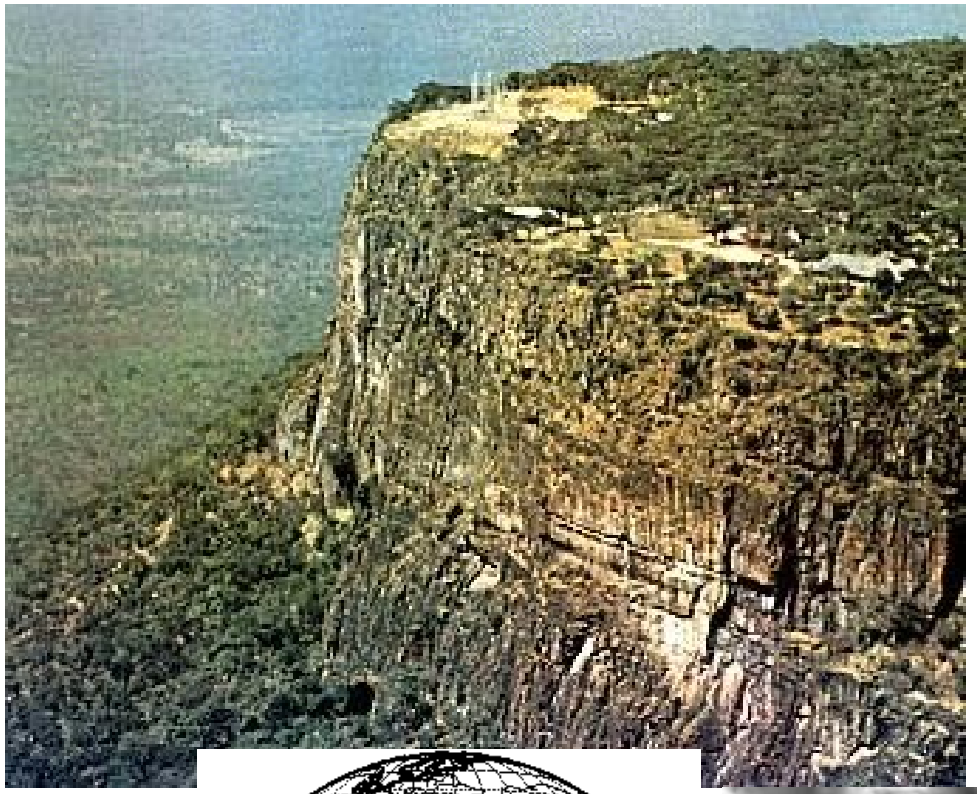


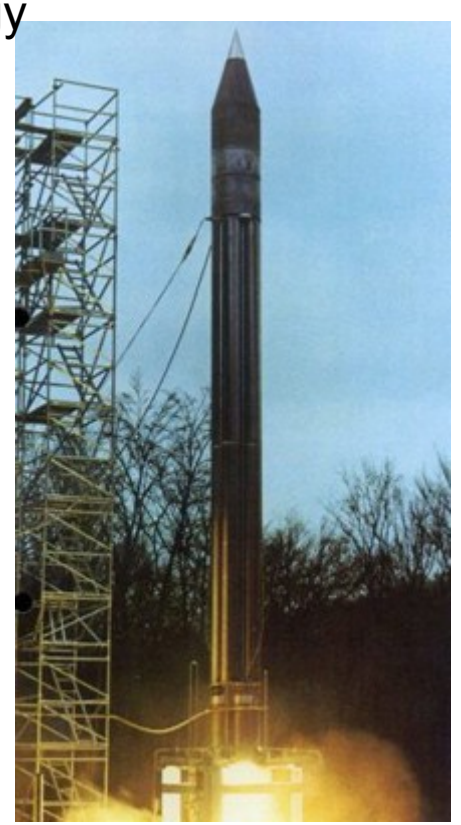


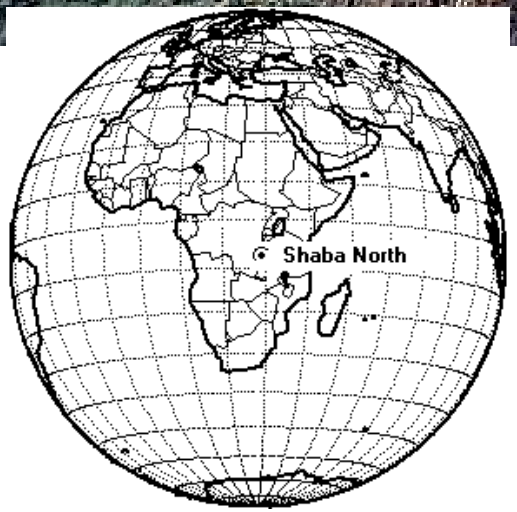
Italian complex
“San Marco”
off the Kenyan coast
near Malindi

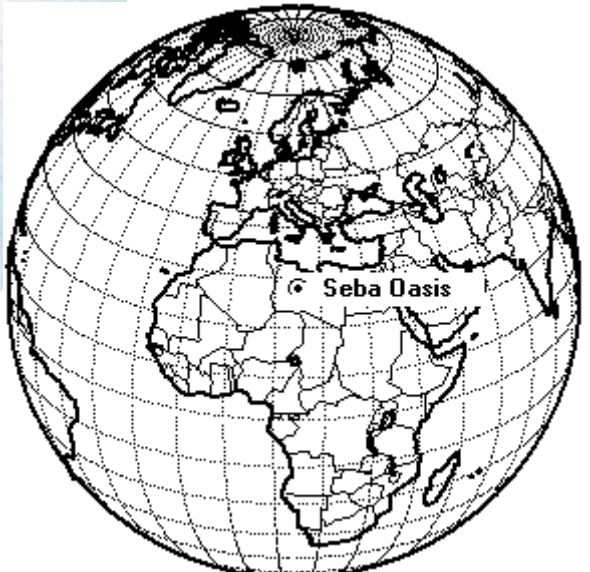
9 orbital launches
by NASA and Italy
using the Scout
rocket between
1967 and 1988

OTRAG: 1977-1982, Lutz Kayser's somewhat shady German rocket company trying to develop a cheap space rocket in Mobutu's Zaire and then in Gaddafi's Libya – concerns about missile technology transfer



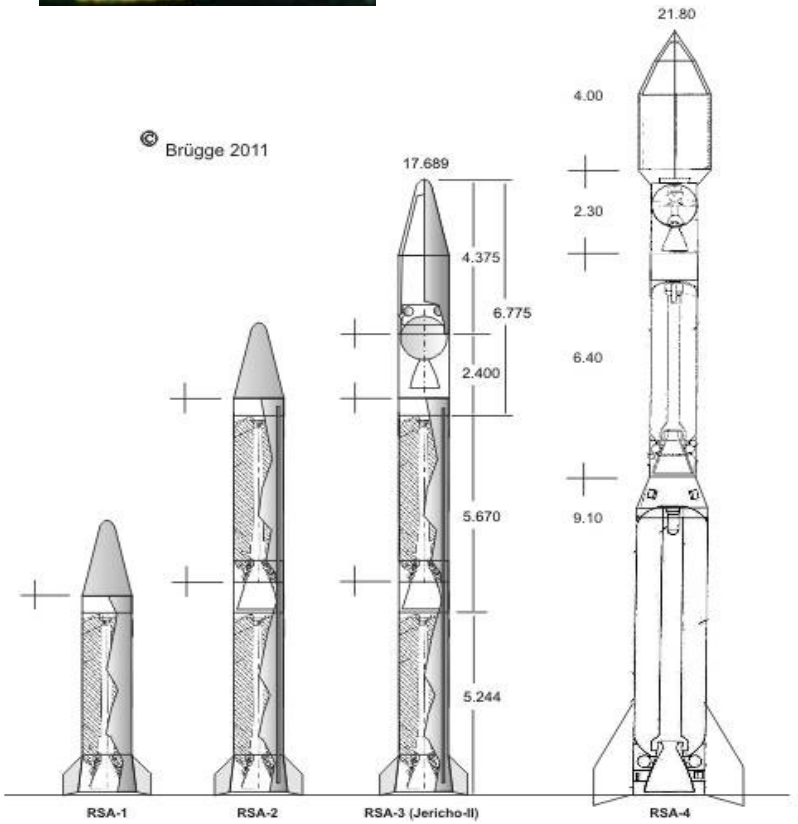






The most ambitious African rocket program was begun by the South African regime – both a missile and a satellite launch vehicle were being developed

Test launches were flown from the Overberg range.
The program was cancelled in 1994



More recenlty, a group of enthusiastic Congolese led by Jean-Patrice Keka has been building small endoatmospheric (low altitude, not space) rockets..

Mixed success so far... but could this be the beginning of a renaissance of African rocketry?

Africa comes into its own

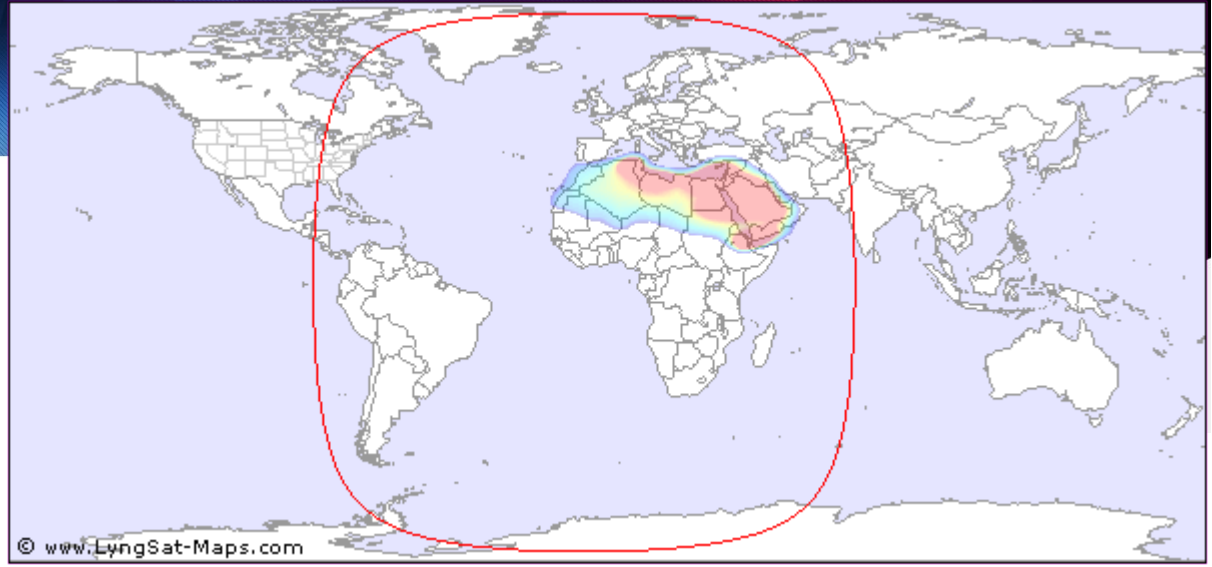
Afristar

Worldspace, founded by Ethiopian-born businessman Noah Samara, launched the Afristar satellite to empower local African radio stations to broadcast their content across the continent

Launched in Oct 1998, it was the **world's first satellite radio system** (2 years before Sirius and XM) together with its sibling Asiastar

Unfortunately the system ran into money troubles, but the 1-ton French-built satellites are still operating after their sale to Yazmi USA, another of Samara's companies

Nilesat



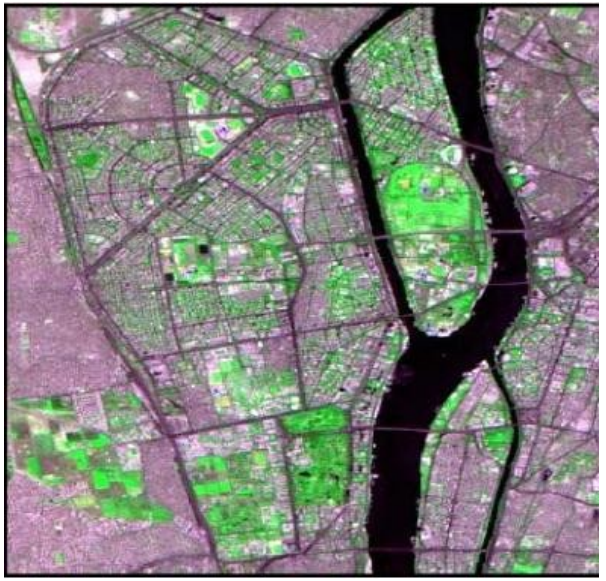
Nilesat 101 Launched Apr 1998, at 7.0W 0.8 m.tons
Nilesat 102 Launched Aug 2000, at 7.1W 0.8 m.tons
Nilesat 103 Leased from 2005 to 2006 from Eutelsat
Nilesat 201 Launched Aug 2010, at 7.1W 1.3 m.tons

Egypt's domestic communications satellite system
Television broadcasting
Uses French-built satellites with control centers near Cairo and Alexandria

MisrSat (Egyptsat) - Earth observing satellite, 100 kg
Egypt's National Authority for Remote Sensing and Space Science (NARSS)

Built by a Ukrainian company (Yuzhnoe)
Operated from 2007 to 2010

Control center at Aswan



Example image from MisrSat (Egyptsat-1)

RASCOM

The Regional African Satellite Communications Organization

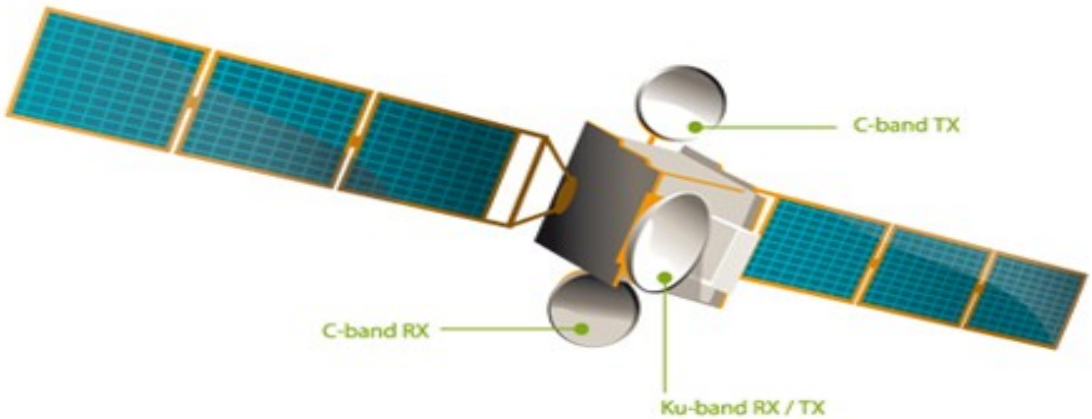
Established 1992 with HQ in Abidjan, Cote d'Ivoire

Operates communications satellites providing television broadcast, telephony and internet access to rural Africa

Two satellites, purchased from a French company; dry mass 1.4 tonnes
RASCOM-QAF1 launched 2007
RASCOM-QAF1R launched 2010

RASCOMStar-QAF, the satellite operator, is registered in Mauritius with mission control centers in Libya and Cameroon

Another satellite venture of note: Intelsat New Dawn, launched in 2011 – C-band payload for Africa failed and the S African partners pulled out.



Functional architecture

NIGCOMSAT
AFRICAN ROOTED GLOBALLY POSITIONED

Nigeria turned to China to build and launch its domestic satellite communication system

NIGCOMSAT-1 Launched May 2007 but failed in Nov 2008
NIGCOMSAT-1R Replacement launched Dec 2011

2.5 metric tons dry mass

The large satellites discussed above were built by European companies

In the 21st century African nations have begun developing their own small satellites, mostly for Earth observation.

A typical example is the Nigeriasat program – Nigerian engineers were sent to England to work as part of the Surrey Satellite Ltd. team building the first satellite, and learn the technology, and taking a successively larger role in later satellites.

Nigerian Earth imaging satellite control center

Morocco and Algeria are also following this path while South Africa is developing its own hardware

Centre Royal
de Télédétection Spatiale

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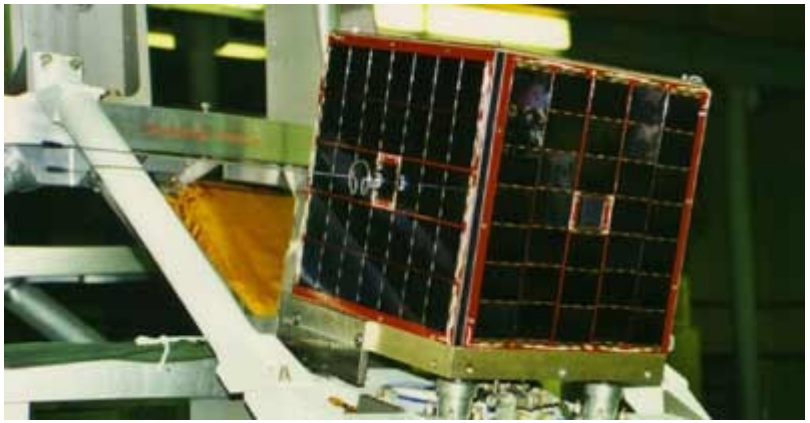
Calendrier 2012

Le Centre Royal de Télédétection Spatiale est l'Institution Nationale responsable de l'utilisation, de la promotion et du développement de la télédétection spatiale au Maroc.

Il est chargé de coordonner et de gérer les programmes nationaux de télédétection spatiale en partenariat avec les ministères, les universités et les opérateurs privés.

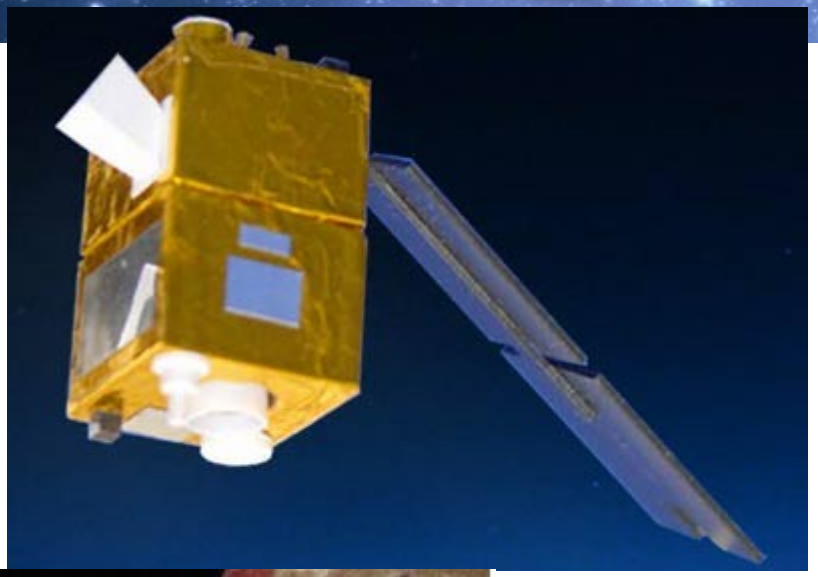


The “Zarkae al Yamama” satellite (MAROC-TUBSAT)

Instruments built by Moroccan researchers, satellite bus by TU Berlin
Launched from Russia in 2001
Worked until at least 2009

ASAL

AGENCE SPATIALE ALGERIENNE



Centre National de Techniques Spatiales (CNTS), Algeria

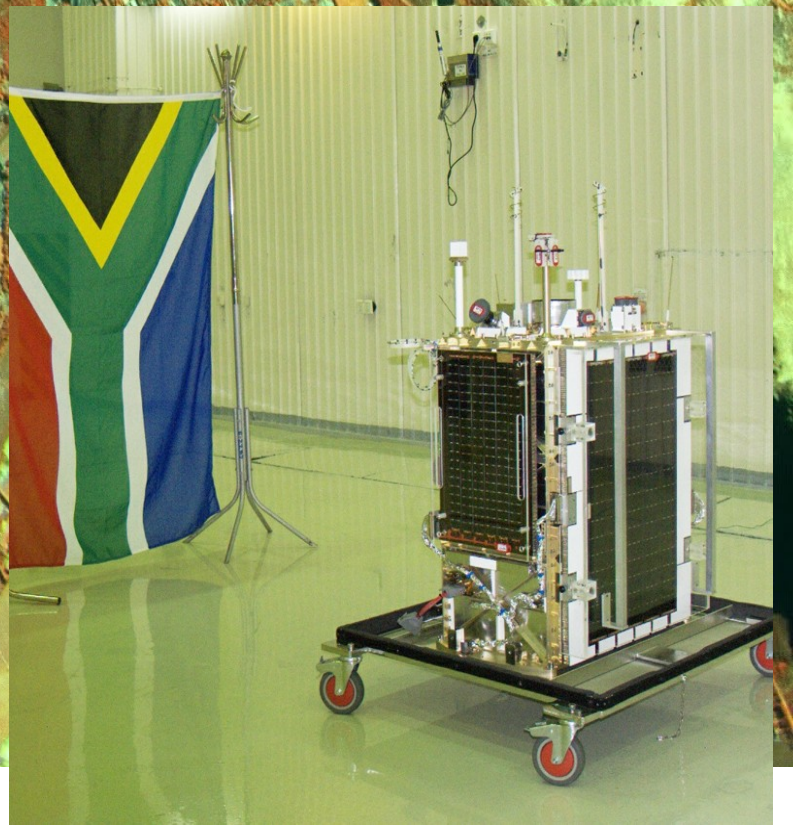
ALSAT-1	2002-2010	Built in UK
ALSAT-2A	2010-	Built in France

South African Satellites

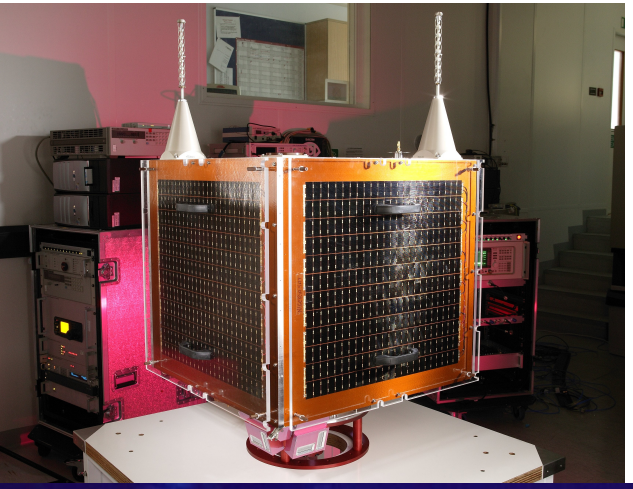
Under the apartheid regime, South Africa began a missile and space rocket program but it was later abandoned

In modern South Africa, engineers at Stellenbosch University and its spinoff company SunSpace have built two small imaging satellites

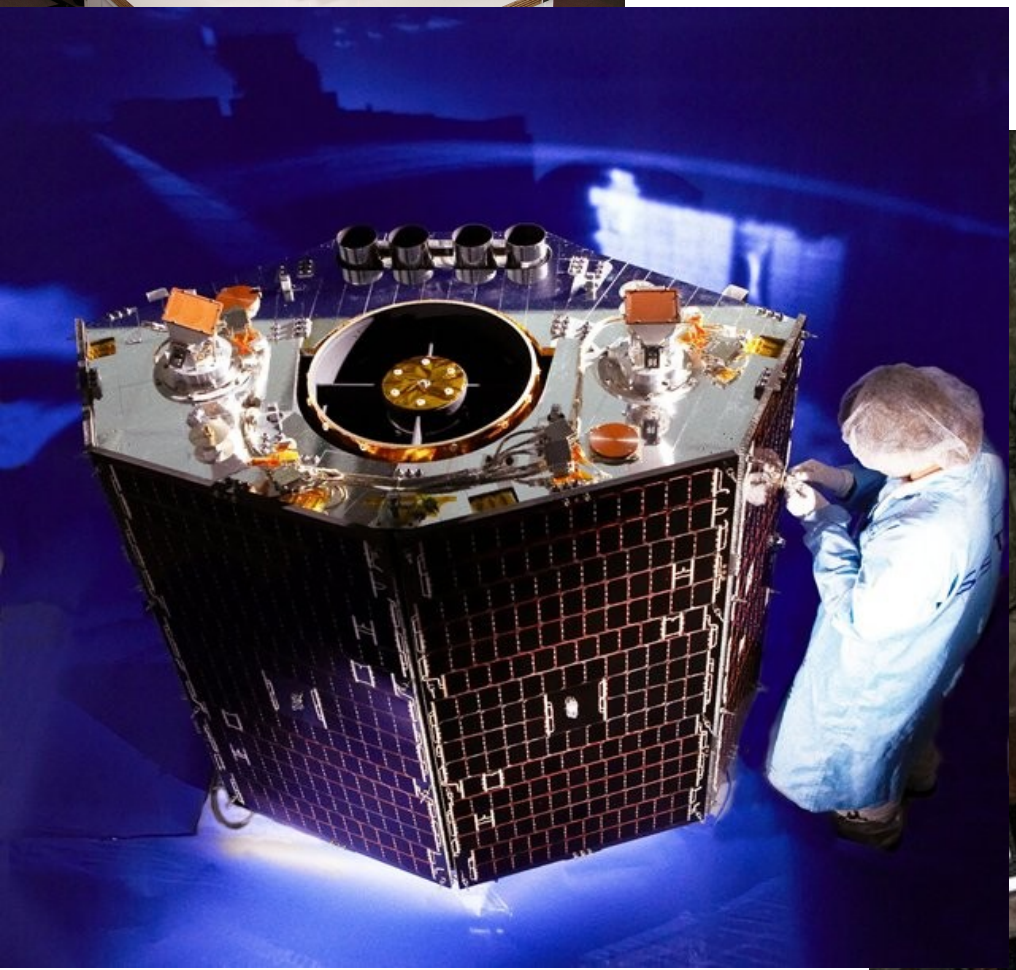
Sunsat, launched 1999 by NASA
Sumbandila, launched 2009 by Russia

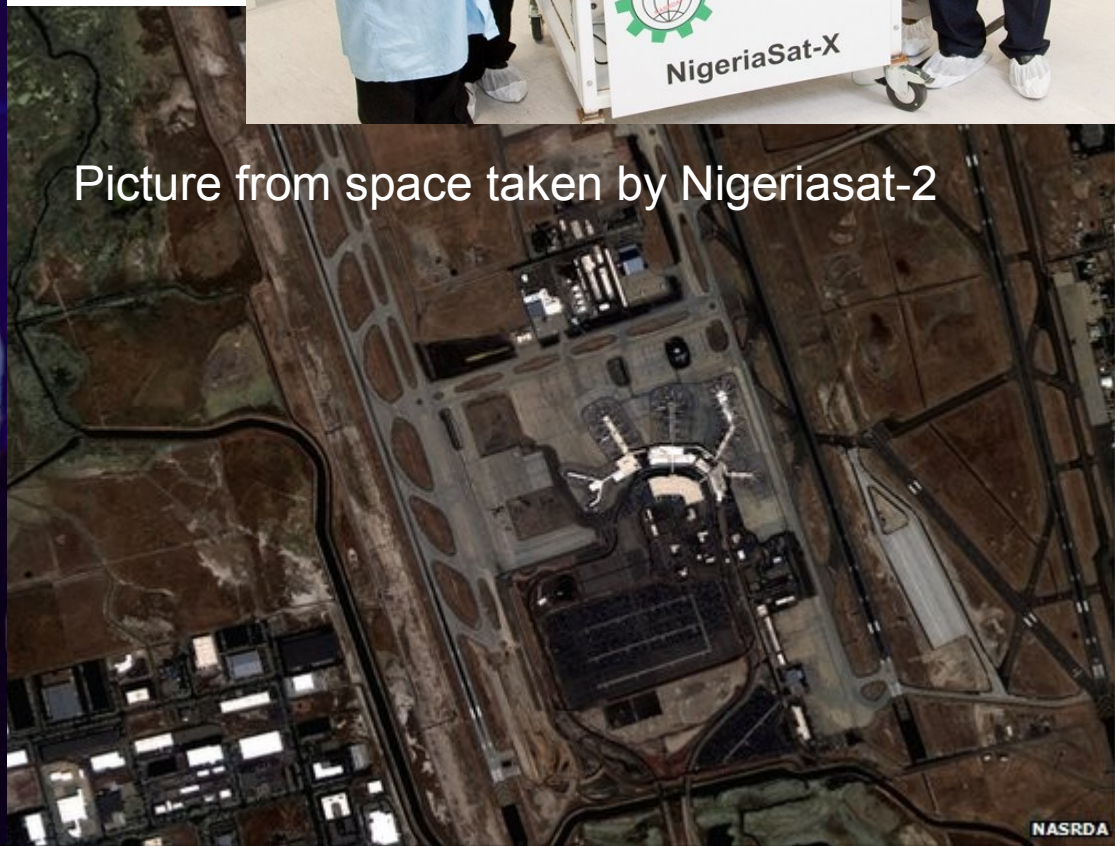


National Space Research Development Agency (NASRDA)
Abuja, Nigeria



Nigeriasat-1 Sep 2003 80 kg
Nigeriasat-2 Aug 2011 270 kg
Nigeriasat-X Aug 2011 86 kg





Picture from space taken by Nigeriasat-2

The next step for Africa could be participation in space-based scientific research

Astronomical research in Africa got a recent boost with the formation of the African Astronomical Society (AfAS) in Ouagadougou in 2010 – ground-based telescopes are the current focus (pun intended)

HESS gamma ray array in Namibia

Radio telescope dish in Ghana

SALT, the South African Large Telescope