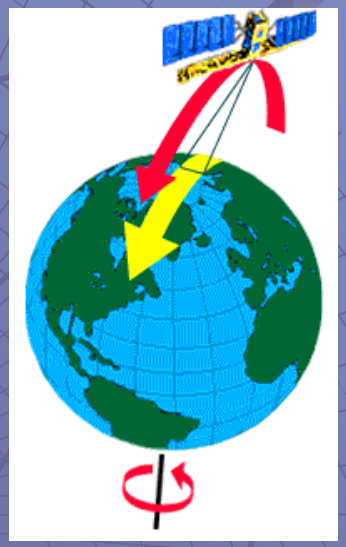
AVHRR – Satellites and Sensors



Training Center

U.S. Geological Survey
Center for Earth Resources
Observation and Science (EROS)
Sioux Falls, South Dakota, USA

Applications of Coarse to High Resolution Satellite Imagery for Land Productivity Assessment & Management

AVHRR – Satellites and Sensors

James Rowland – SAIC / USGS EROS

Bamako , Mali

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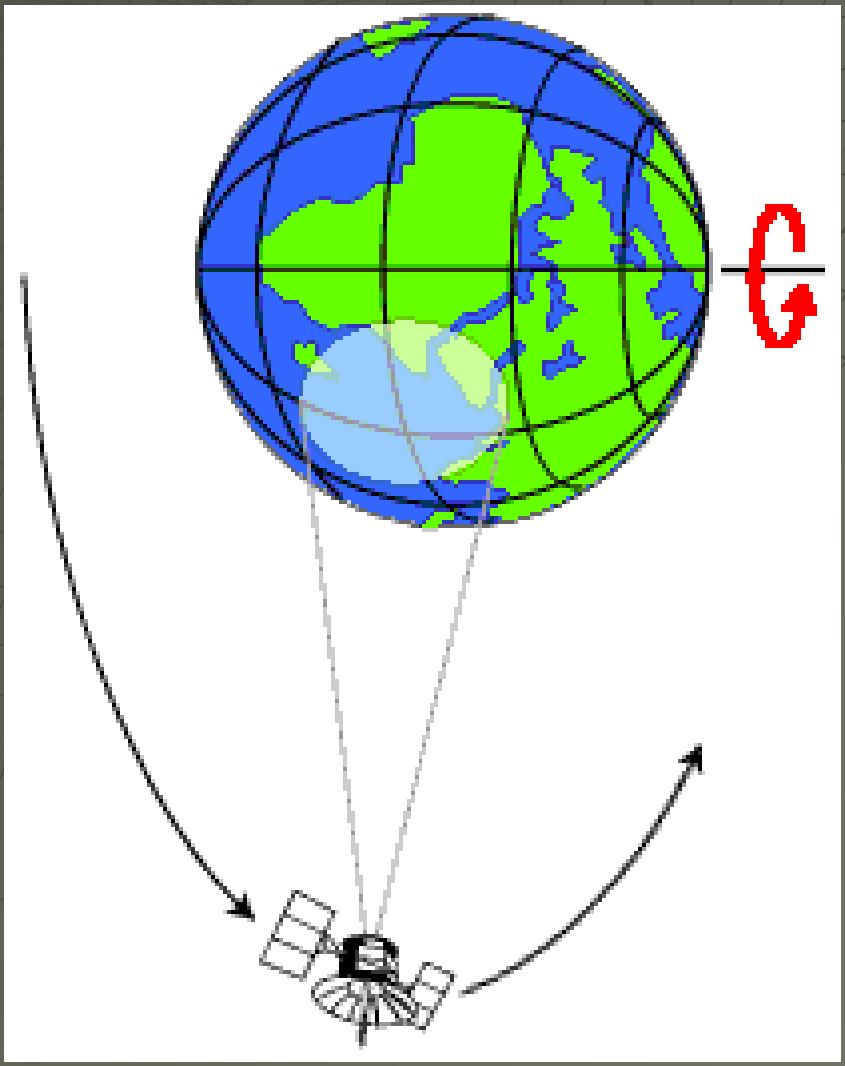
Geostationary Orbits

- Geostationary orbits have altitudes of approximately 36,000 km and revolve around the Earth at speeds that match the speed of the Earth's rotation.
- This synchronization relative to the Earth's surface allows the satellites to observe and collect information continuously over specific areas.

Geostationary Satellites

- Weather and communications satellites commonly have these types of orbits. Due to their high altitude, some geostationary weather satellites can monitor an entire hemisphere of the Earth.

Geostationary Satellites



Polar Orbits

- A near north-to-south orbit (pole-to-pole) which, in conjunction with the Earth's west-to-east rotation, allow a satellite and sensor to cover most of the Earth's surface over a certain period of time.
- In a *near-polar orbit*, the inclination of the orbit is relative to a line running between (not over) the North and South poles.

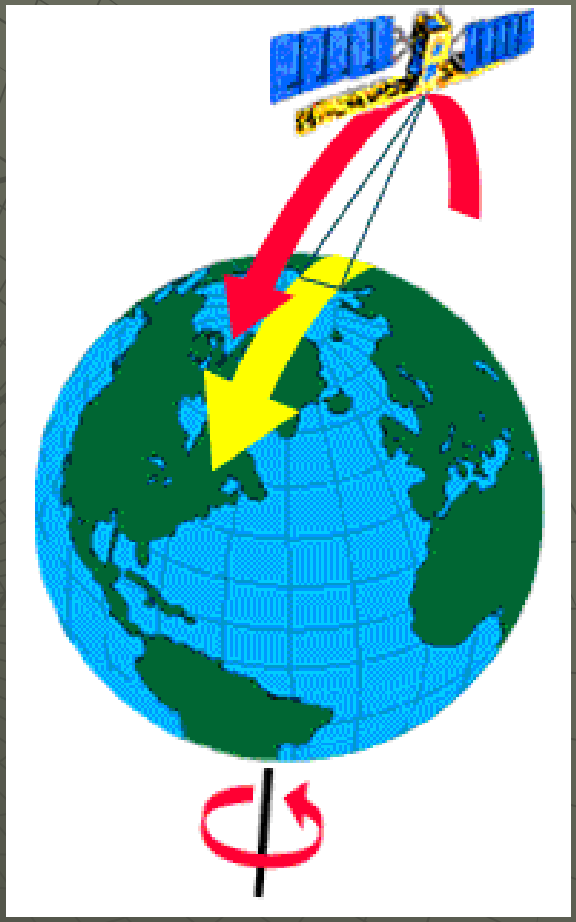
Sun-Synchronous Polar Orbits

- Polar orbits are *sun-synchronous* when they cover each area of the world at a constant local time of day (called *local sun time)*.
- At any given latitude, the position of the sun in the sky as the satellite passes overhead will be the same within the same season.

Sun-Synchronous Polar Orbits

- This type of orbit ensures consistent illumination conditions
  - When acquiring images in a specific season over successive years, or
  - Over a particular area over a series of days.
- This is an important advantage when analyzing images from year to year since the images do not have to be corrected for different illumination conditions.

Sun-Synchronous Polar Orbits



Ascending and Descending Orbit Passes

- In near-polar orbits, the satellite travels northwards (*ascending*) on one side of the Earth and then toward the southern pole (*descending*) on the second half of its orbit.
- Generally, for sun-synchronous orbits, the ascending pass is on the shadowed side of the Earth while the descending pass is on the sunlit side.

Orbital Swaths

- As a satellite revolves around the Earth, the sensor "sees" a certain portion of the Earth's surface. The area imaged on the surface, is referred to as the *swath*.
- Image swath widths for spaceborne sensors are instrument-specific, but generally vary between tens and hundreds of km wide.

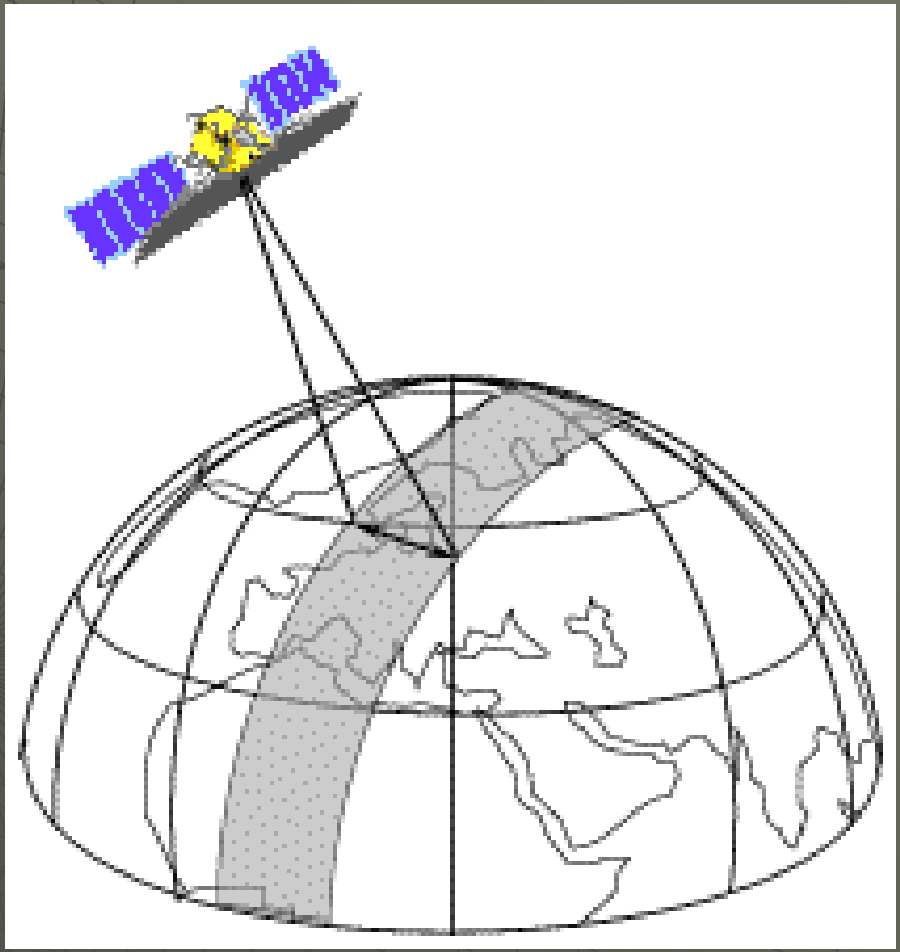
Orbital Swaths

- As the satellite orbits the Earth from pole to pole, its east-west position wouldn't change if the Earth didn't rotate.
- However, as seen from the Earth, it seems that the satellite is shifting westward because the Earth is rotating (from west to east) beneath it.

Orbital Coverage

- The Earth rotation allows the satellite swath to cover a new area with each consecutive pass.
- The satellite's orbit and the rotation of the Earth work together to allow complete coverage of the Earth's surface.

Orbital Coverage



Revisits

- Revisit period is an important consideration for monitoring applications, especially when frequent imaging is required (for example, to monitor the spread of an oil spill, or the extent of flooding).

Resolution Comparison

1 Kilometer Resolution

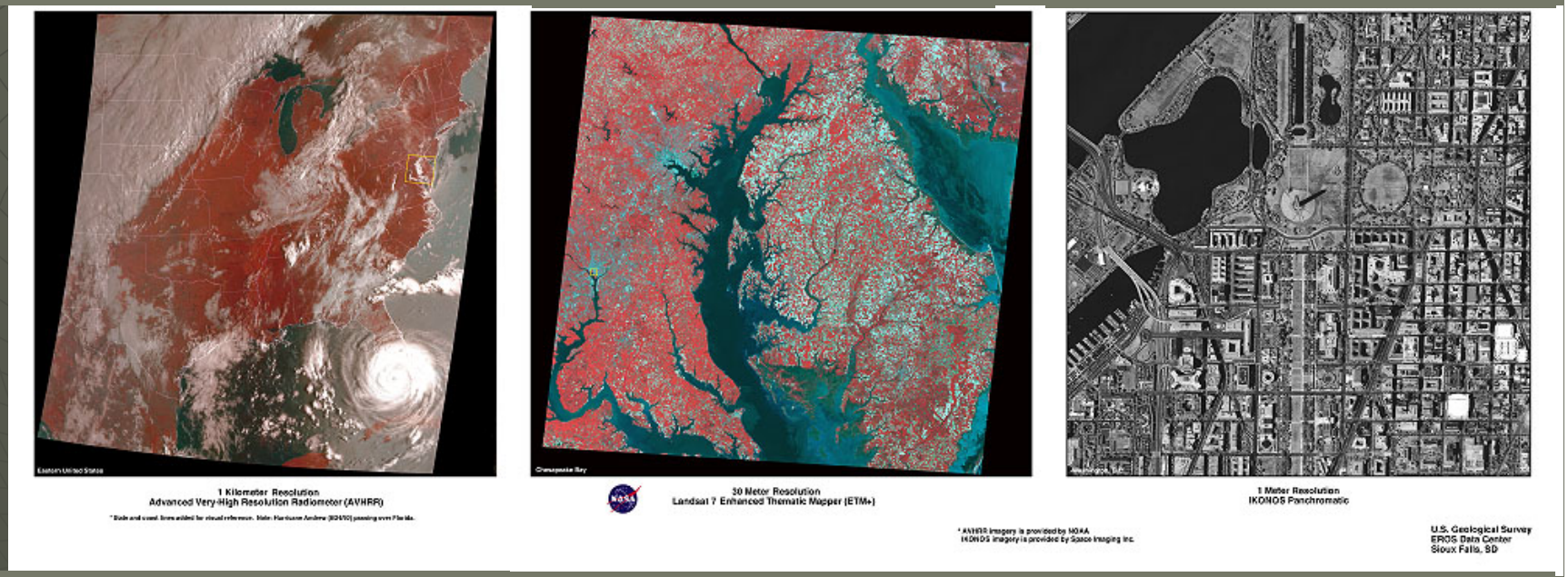
Advanced Very-High Resolution Radiometer

30 Meter Resolution

Landsat 7 Enhanced Thematic Mapper

1 Meter Resolution

IKONOS Panchromatic



State and coast lines added for visual reference. Note: Hurricane Andrew (8/24/92) passing over Florida.

NOAA Polar Orbiters

- Operational series of meteorological satellites designed to provide complementary information to the geostationary meteorological satellites (such as GOES).
- Sun-synchronous, near-polar orbits
- Altitudes ranging from 830-870 km above the Earth

NOAA Polar Orbiters

- Two satellites are always supposed to be functional:
  - One satellite crosses the equator in the early morning and evening.
  - The other other crosses in the afternoon and late-night.
- Together, they provide global coverage, and ensure that data for any region of the Earth is no more than six hours old.

NOAA Polar Orbiters

- Provide daily global coverage at up to 1.1 km resolution with a swath width of 2500 km.
- Primary sensor is Advanced Very High Resolution Radiometer (AVHRR)
- The primary objective of the AVHRR instrument is to provide cloud top and sea surface temperatures

NOAA Polar Orbiters

- AVHRR collects 5 bands of data
- AVHRR data are quantized at 10 bits (1024 levels)
- AVHRR instruments have been providing land remote sensing data since 1983 (cloud data since 1976).

AVHRR Spectral Bands

Band	Wavelength Region (µm)	Resolution (km)
1	0.58-0.68 (red)	1.1
2	0.725-1.10 (near-IR)	1.1
3	3.55-3.93 (high-temp TIR)	1.1
4	10.3-11.3 (TIR)	1.1
5	11.5-12.5 (TIR)	1.1

AVHRR Formats

Format	Spatial Resolution	Transmission and Processing
APT	*4 km*	*low-resolution*
(Automatic	*GAC*	*coverage from*
Picture Transmission)	*(Global Area Coverage)*	*recorded data*
HRPT	*1.1 km*	*selected full-resolution*
(High Resolution	*LAC*	*local area data from*
Picture Transmission)	*(Local Area Coverage)*	*recorded data & direct*
		transmission

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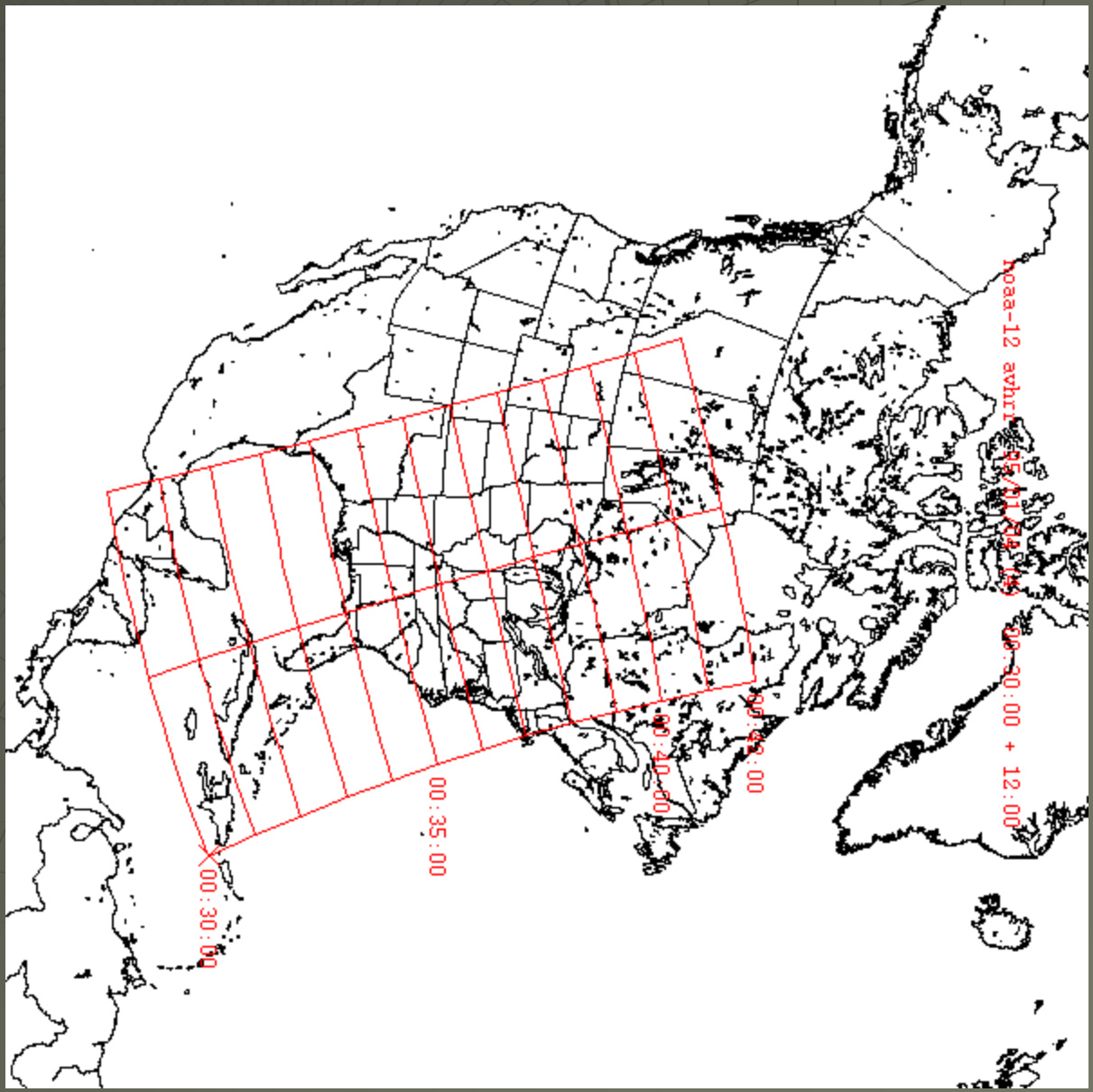

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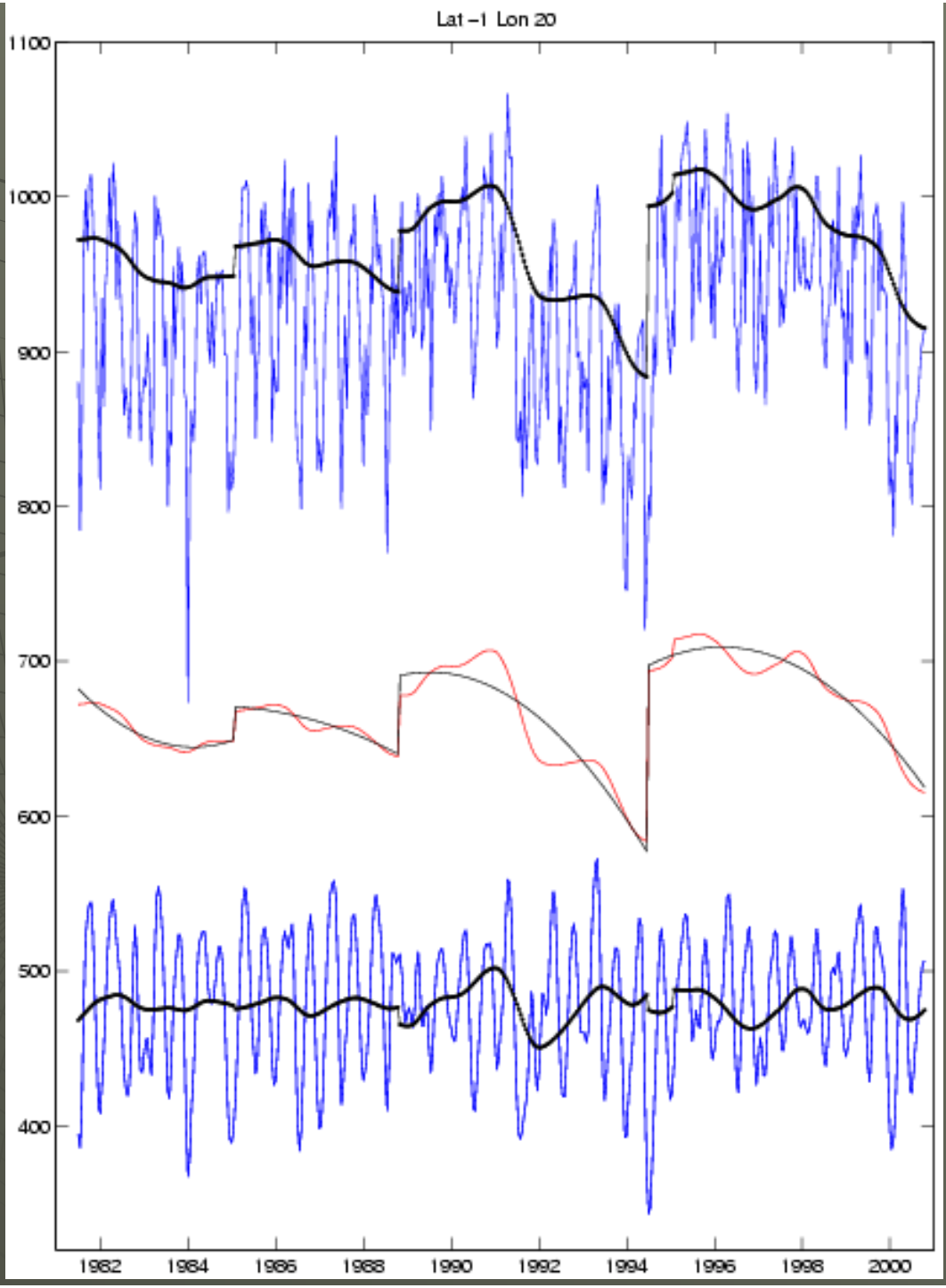

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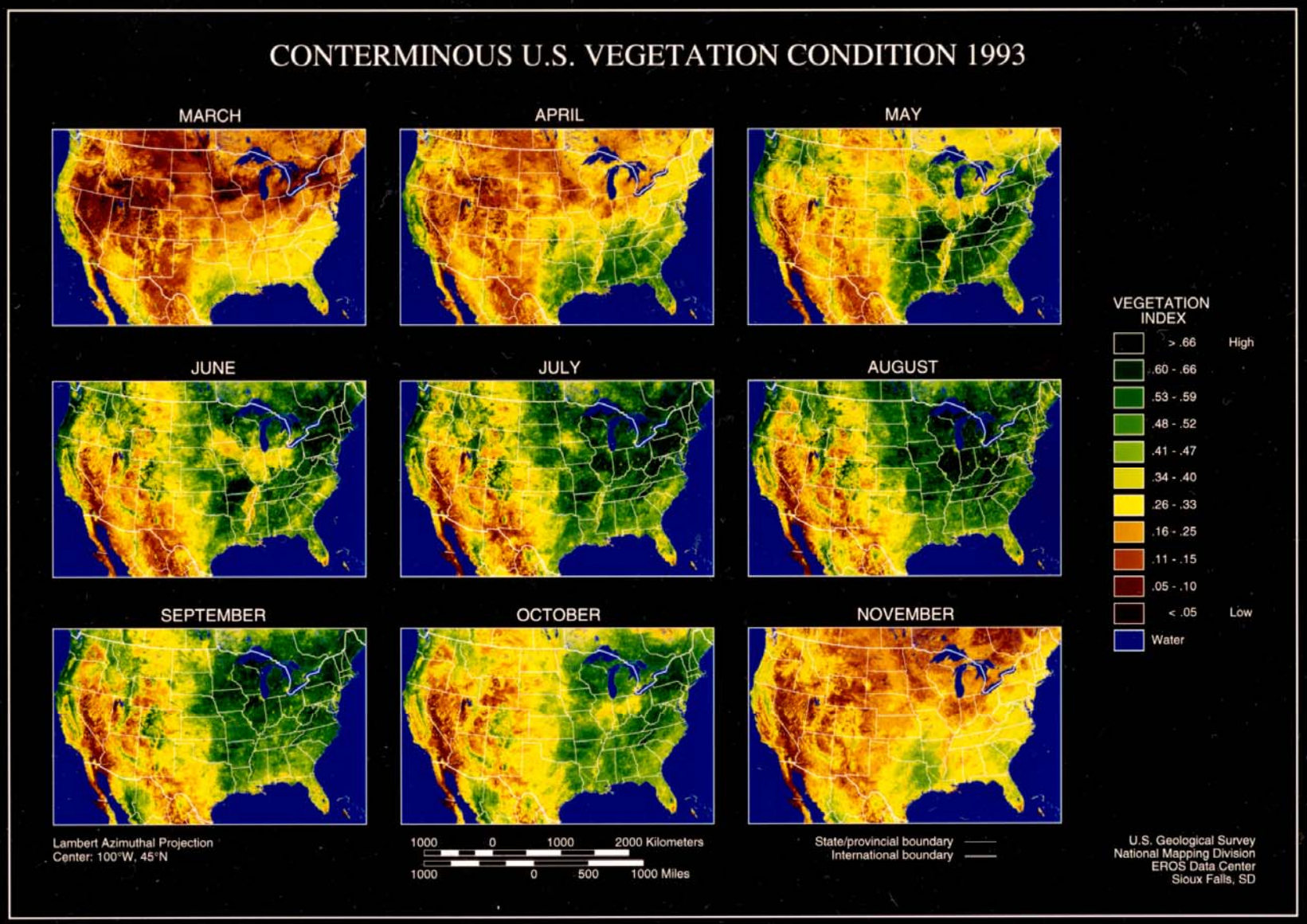
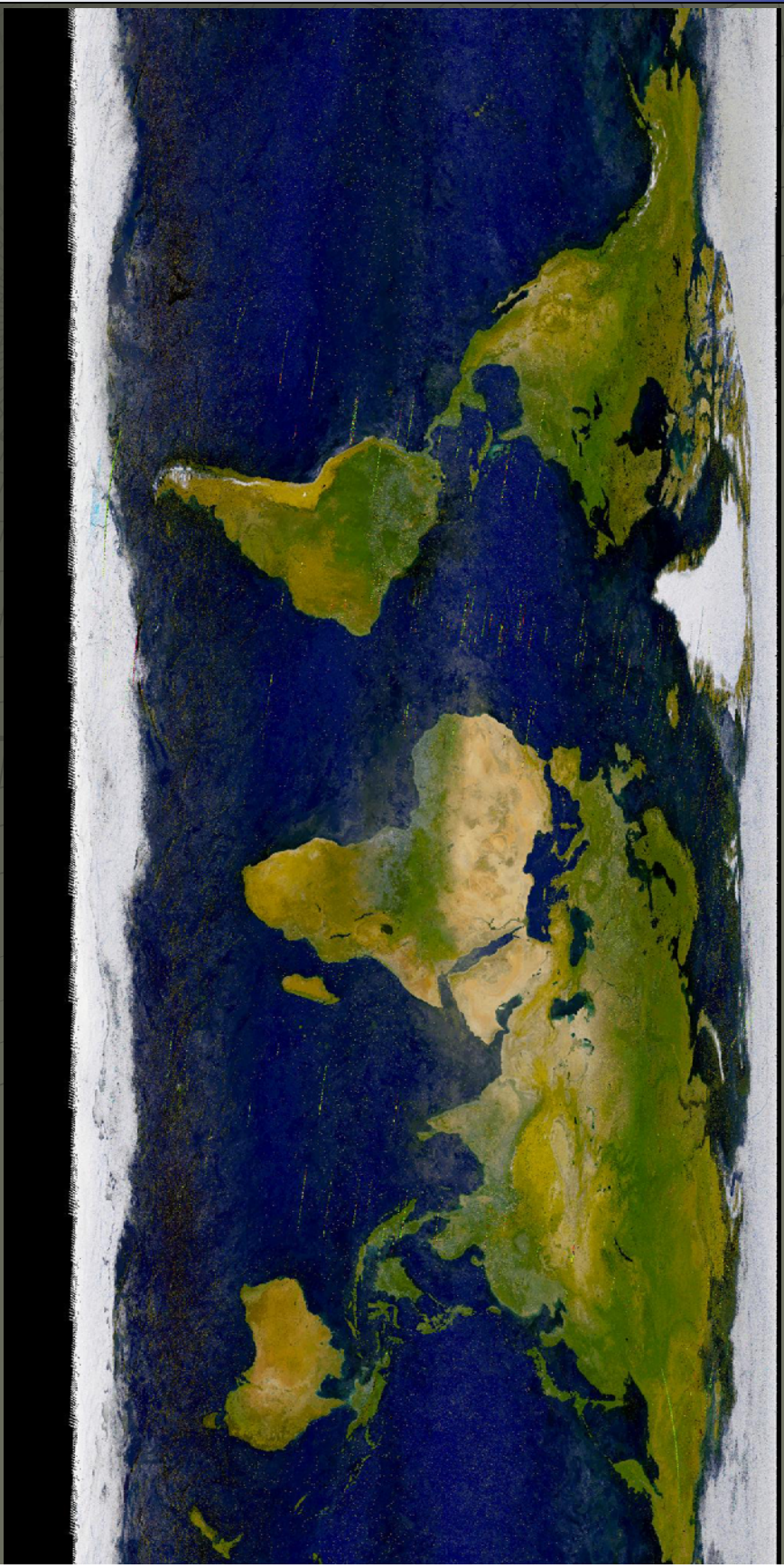
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