Exploring extreme heat: Satellite imagery and spatial analysis in R

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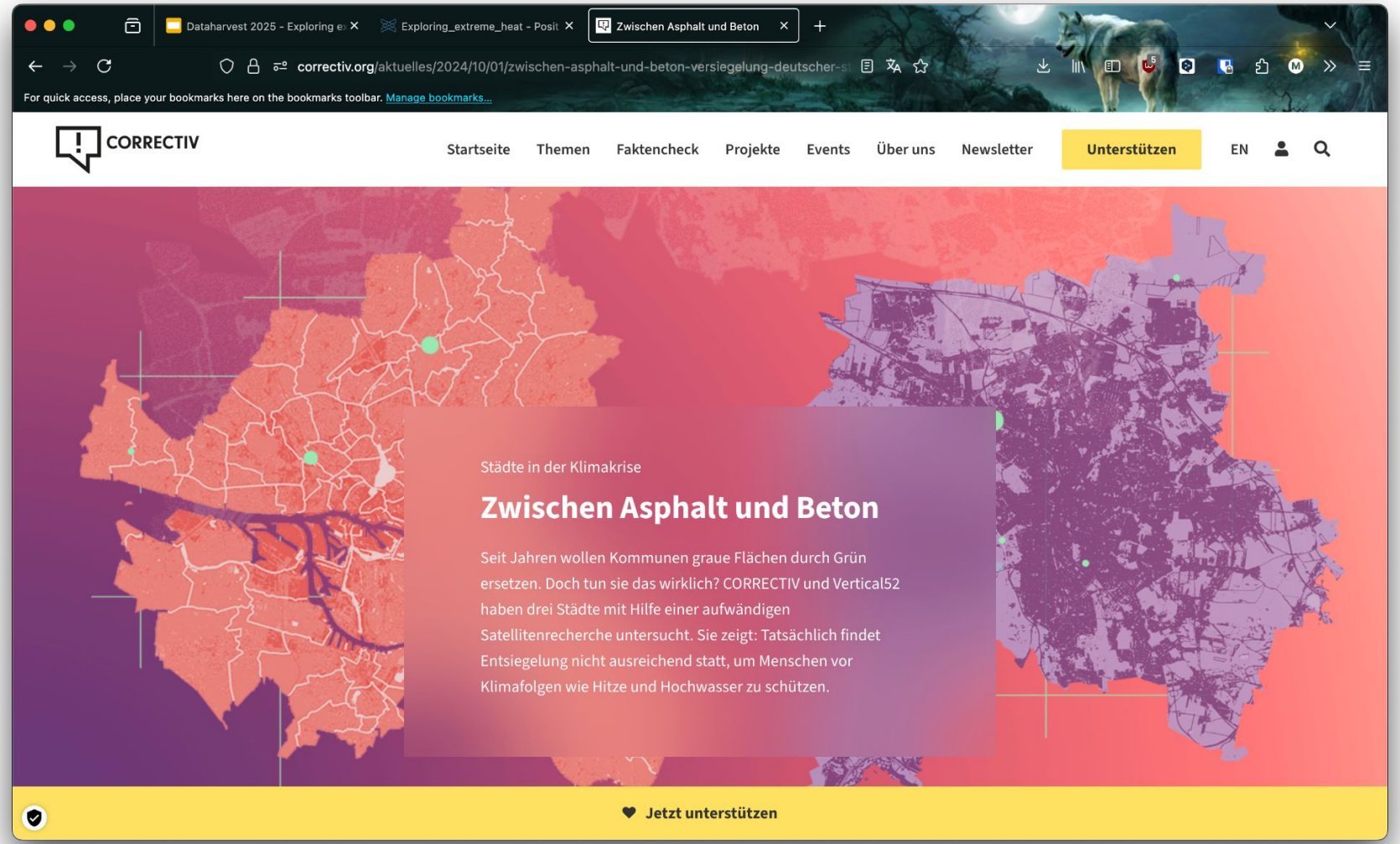
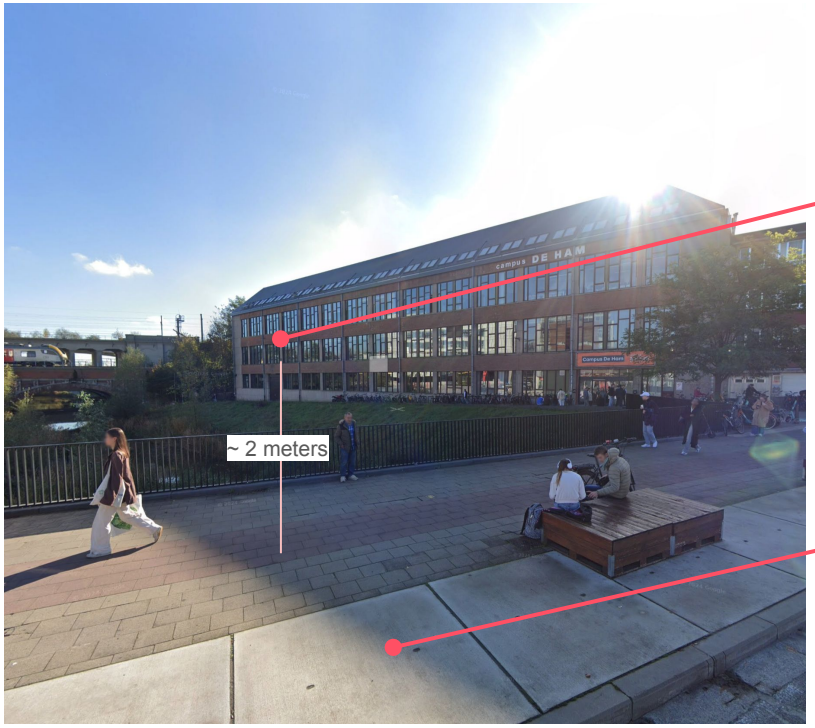
Unsealing German cities



Source: CORRECTIV

Beyond the weather report

Measuring temperature



Source: Google Street View

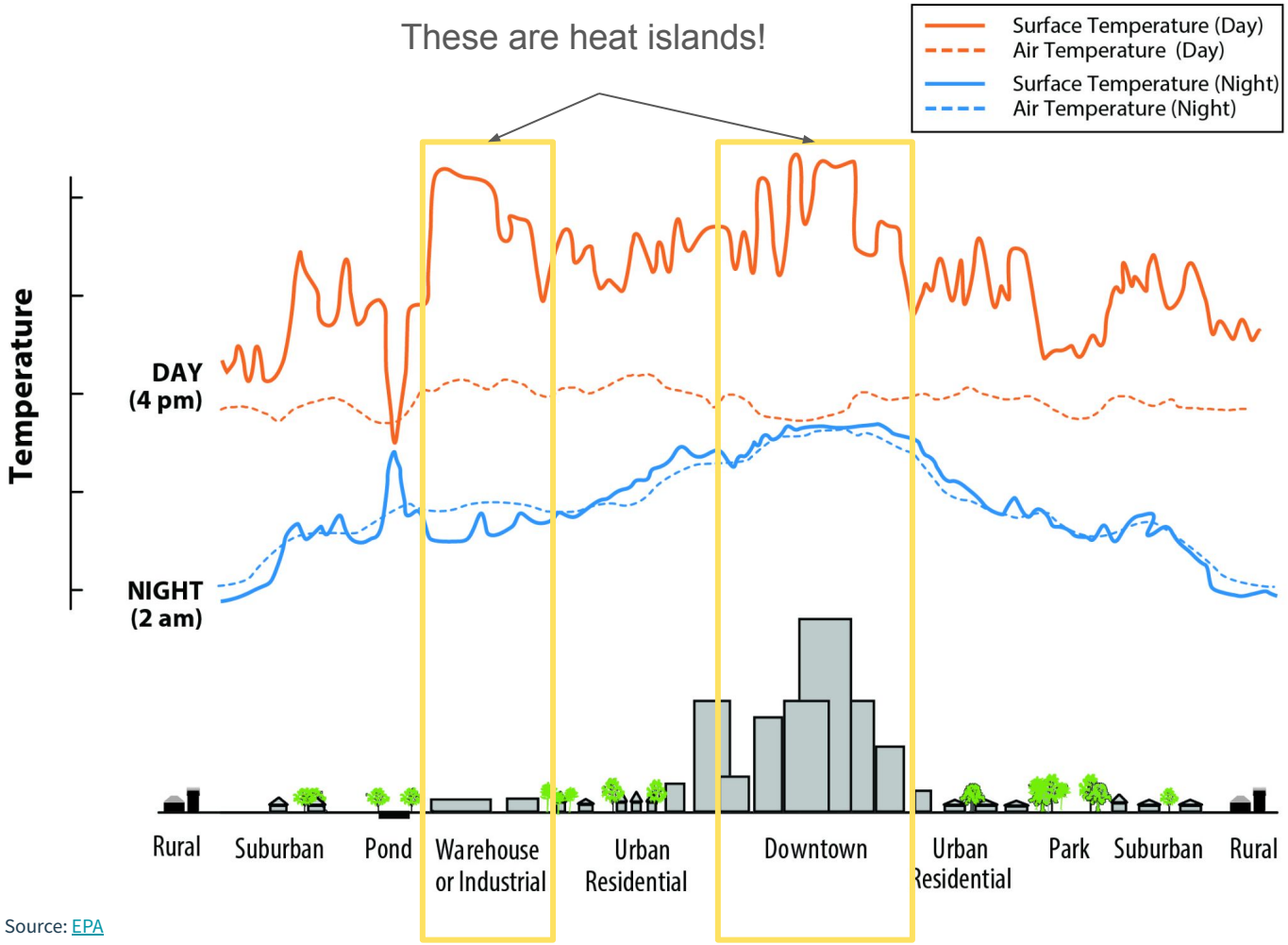
Surface Air Temperature

- ca. 2m off the ground
- Standard in weather reports
- Closer to what you feel

Land Surface Temperature (LST)

- Can be several degrees warmer or cooler than air temperature
- Temperature is strongly influenced by material, i.e. concrete will absorb more heat than grassy land

Measuring temperature



Source: EPA

Which metric is better to use?

Air Temperature

✅ Reflects more closely what we experience

✅ Directly measured via weather stations, sensors, and other instruments

✅ Measurements are continuous throughout the day, independent of weather conditions

❌ Limited coverage that may not be representative of an entire geographic area (i.e. sensors only at specific crossings)

❌ Need to proof for consistency (i.e. sensors at the same height, facing same direction, etc.)

Land Surface Temperature (LST)

✅ Better geographic coverage

✅ Show the impact of sealing and specific materials in urban areas

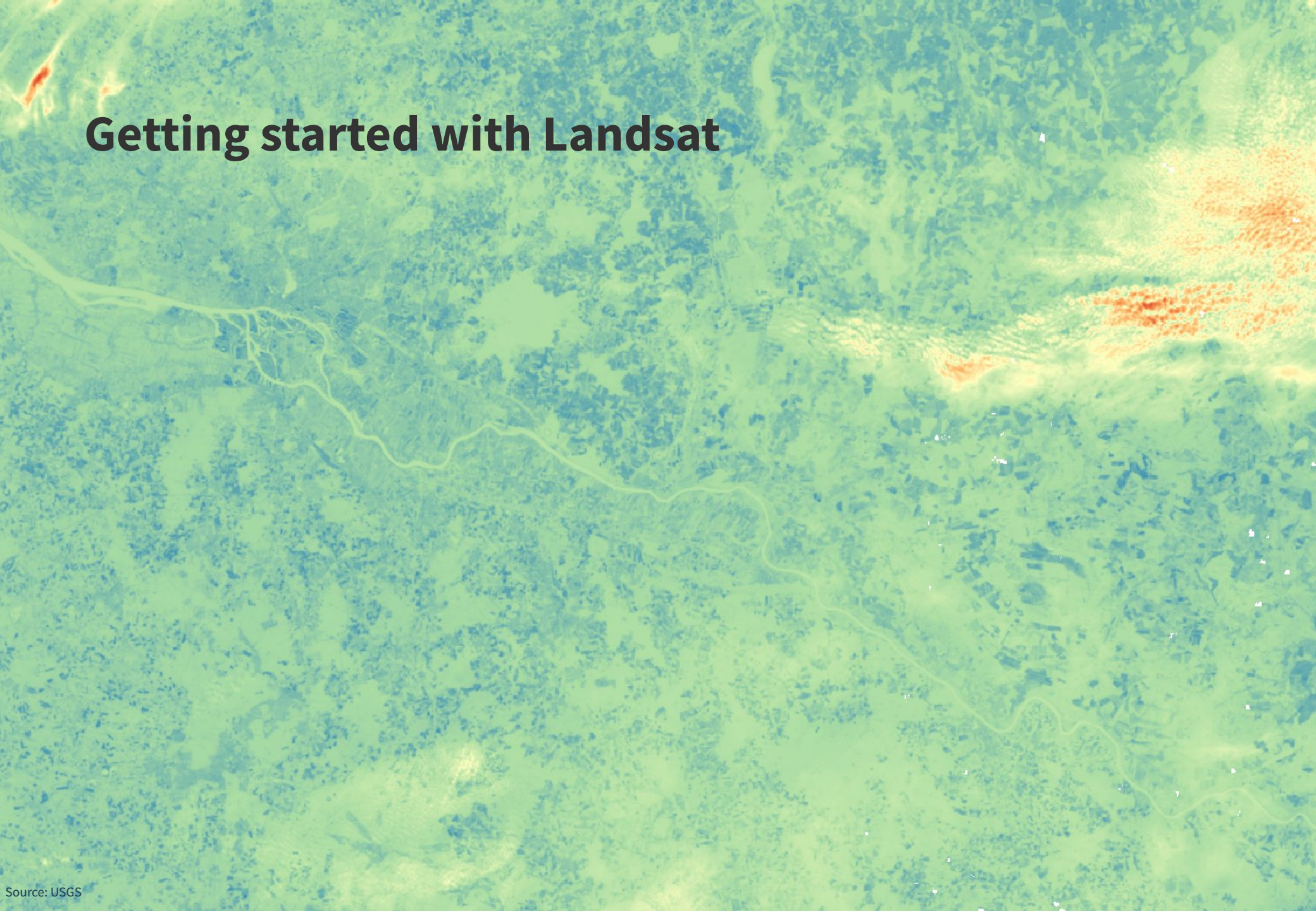
✅ Can be measured via satellites, aircrafts or ground-based thermal sensing

❌ Clouds, trees and tall buildings can block accurate readings of surface temperatures

❌ Temporal resolution is dependent on external factors (i.e. satellite orbit)

❌ Spatial resolution is dependent on measurement methods, higher quality data can be costly

Getting started with Landsat



Source: USGS

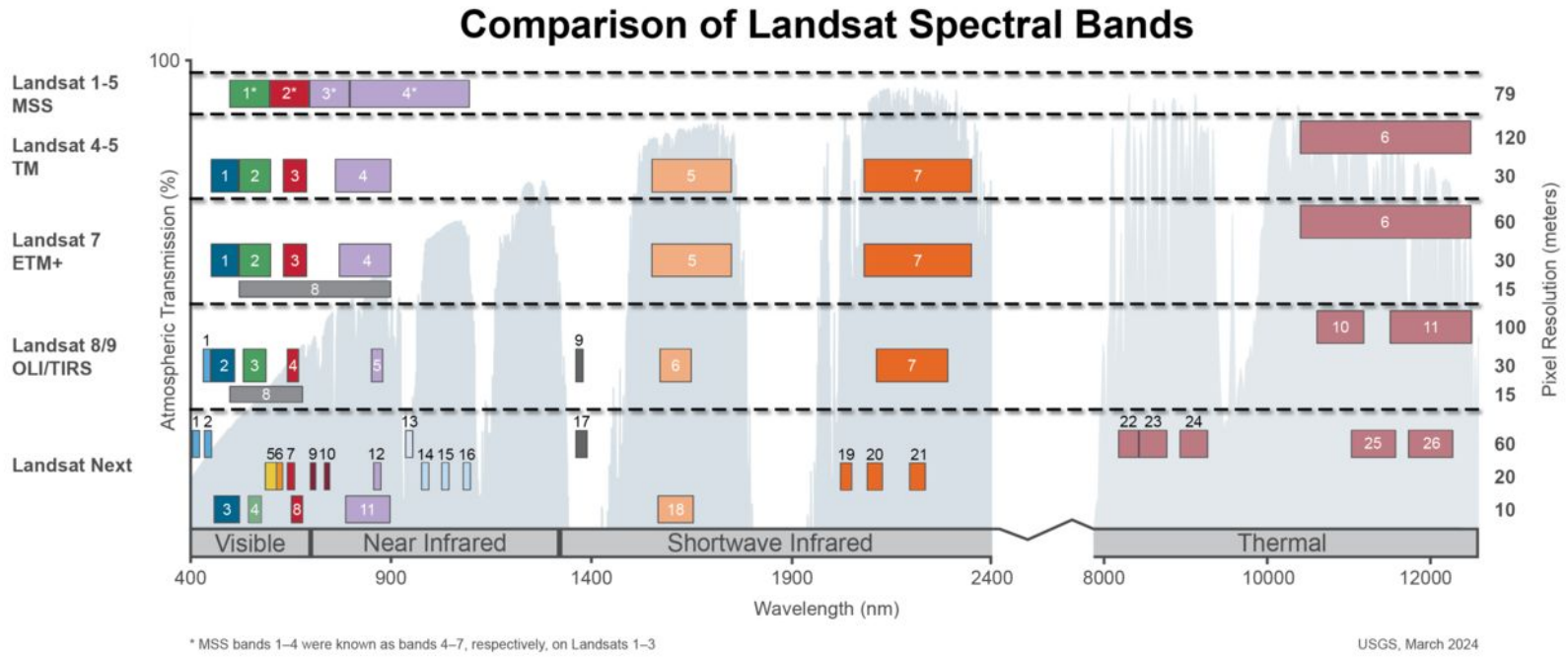
Landsat Missions

Since 1972, Landsat satellites have continuously acquired images of the Earth's land surface, providing uninterrupted data to help land managers and policymakers make informed decisions about natural resources and the environment. Data acquired by Landsat satellites are distributed from the USGS Earth Resources Observation and Science (EROS) Center in Sioux Falls, South Dakota. (Source: US Geological Service)

… it's also **free!**

How do satellites measure surface temperature?

Unlike cameras which only capture visible waves in the electromagnetic spectrum, satellites can record other wavelengths.

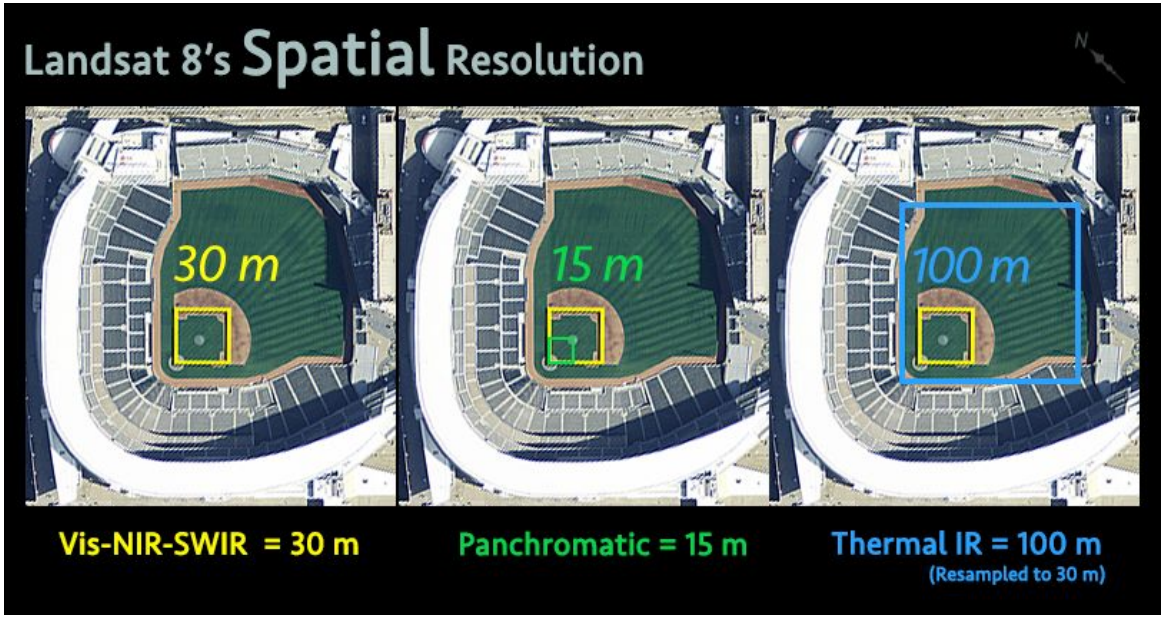


Landsat Specs

Spatial resolution: 15 - 100 meters

(LST is 30 meters with resampling)

Temporal resolution: 16 days



Source: USGS

Landsat Data Structure

- **Collection 2** is basically a reprocessed, improved version of **Collection 1**
- **Collection 2 Level-1** consists of **multispectral image data**
  - ✅ High coverage
  - ❌ Complex calculations required to estimate LST
- **Collection 2 Level-2** consists of “analysis-ready” data, enhanced by additional datasets
  - ✅ Higher quality LST data that only needs to be scaled
  - ❌ More limited coverage

More helpful links

- Landsat Collection 2 Surface Temperature
- Which measurement is more accurate: taking Earth's surface temperature from the ground or from space?
- How we measure temperature and why it matters
- Measuring Heat Islands
- Mapping Urban Heat Islands Leads NYC Council Data Team to Landsat
- Zwischen Asphalt und Beton (CORRECTIV publication)