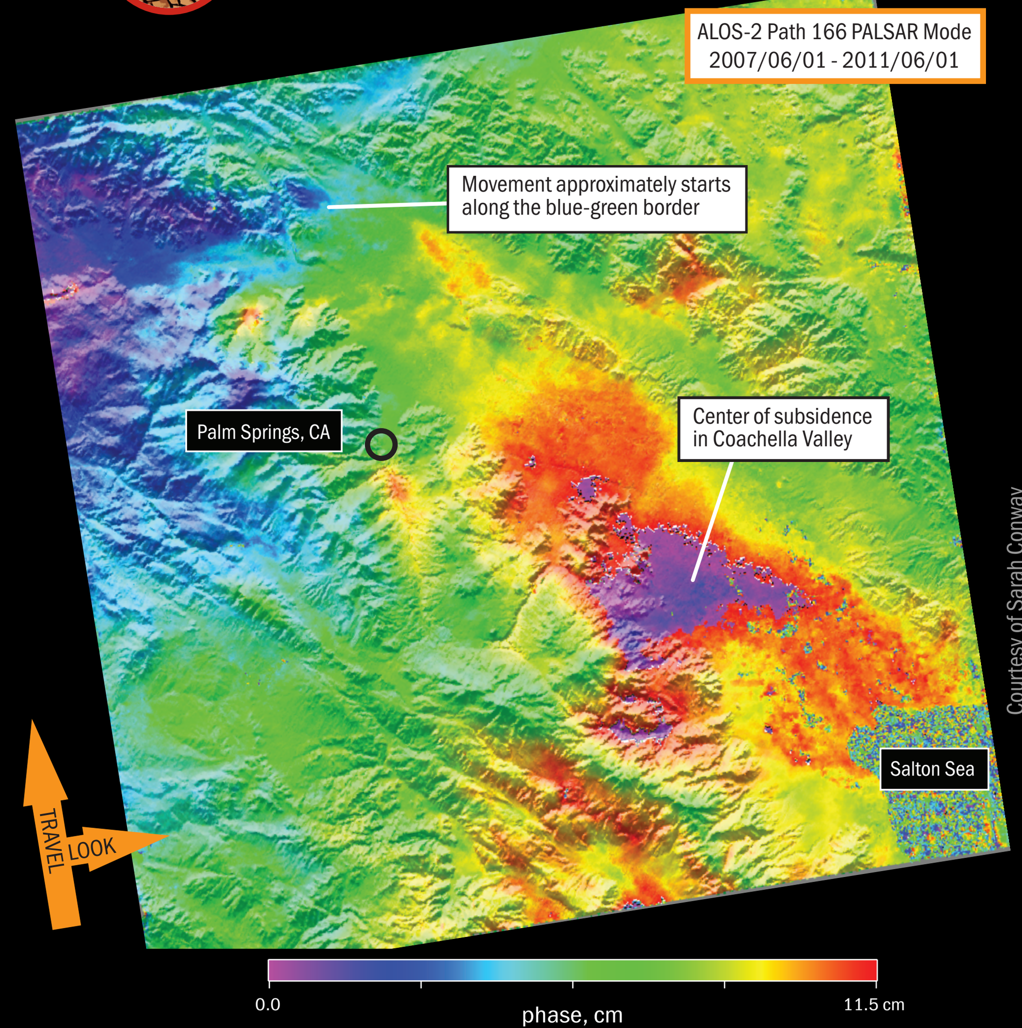
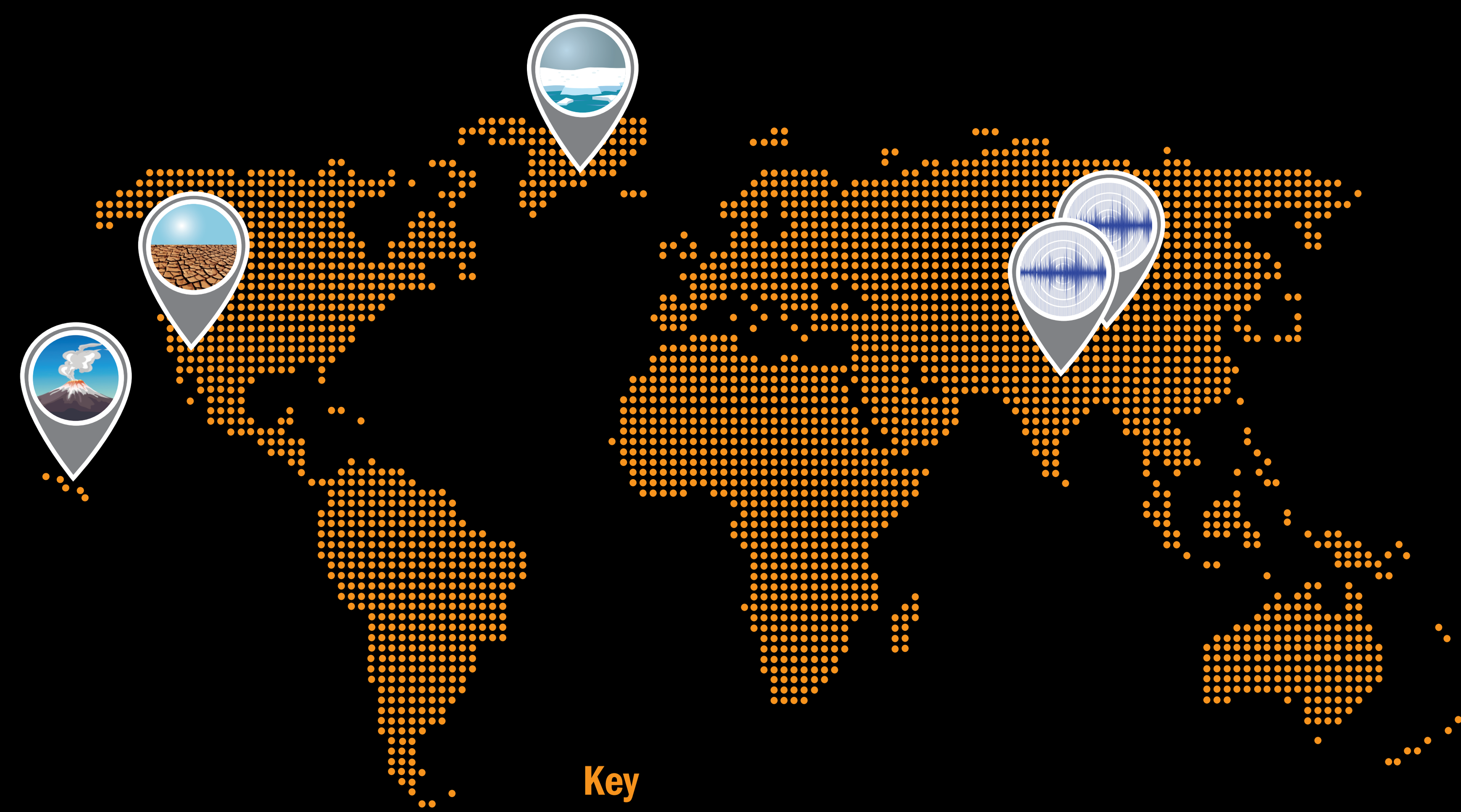
How we use InSAR to study our Earth

Subsidence
Palm Springs, California, 2007 to 2011



The Palm Springs, California region has subsided approximately 7 - 10 cm over a four year period (2007 to 2011) due to groundwater pumping in the Coachella Valley.



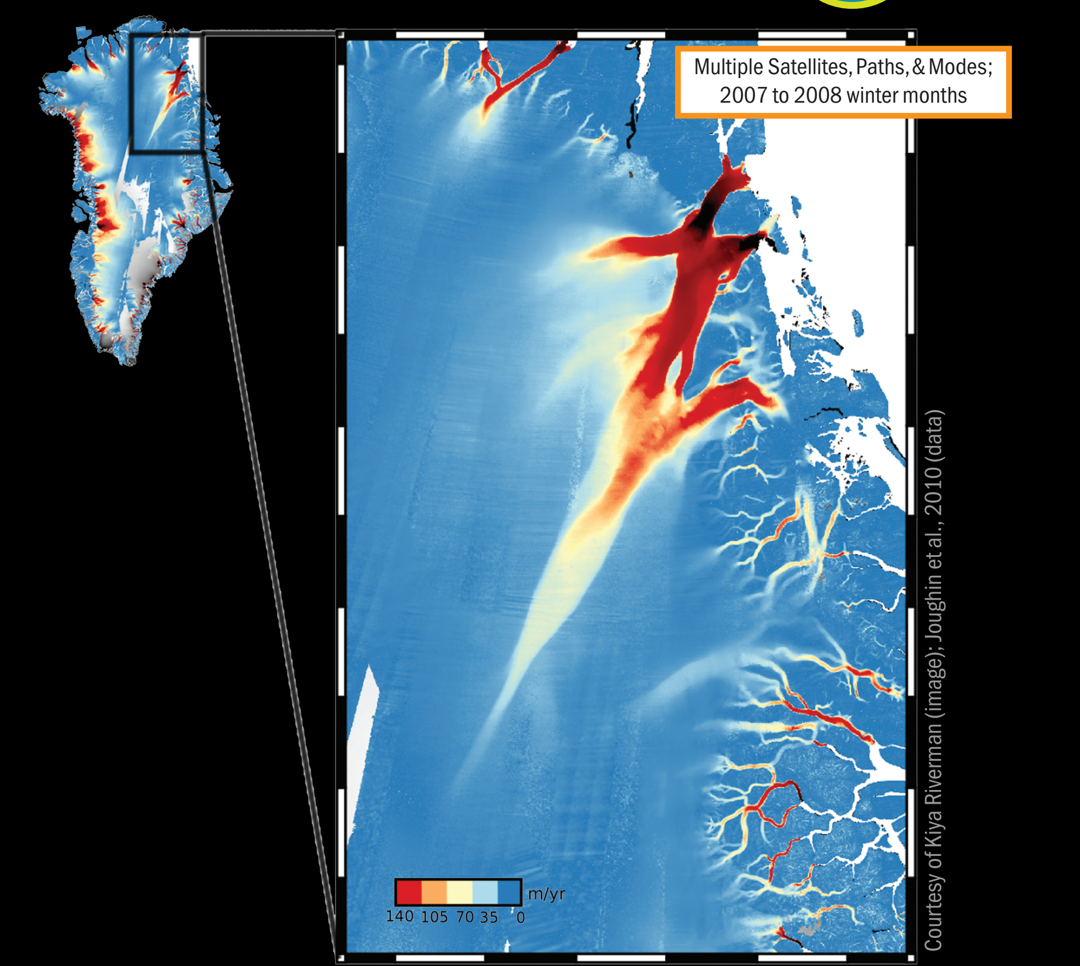
Key

Toward satellite

Away from satellite

Use this key to practice reading these interferograms from around the world.

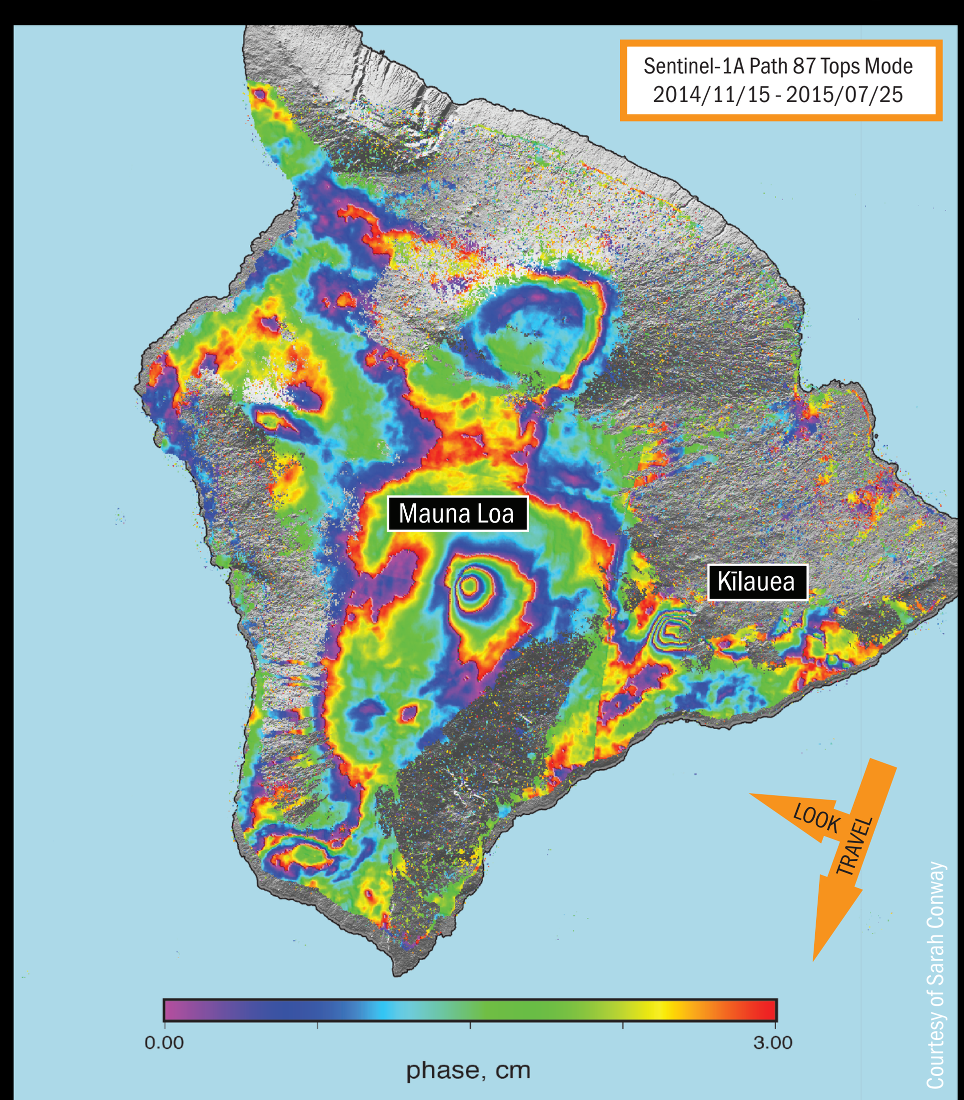
Ice Velocity
Greenland, 2007 to 2008



Hundreds of satellite images were combined to create this image depicting rapid horizontal ice velocities in northeast Greenland over the 2007 to 2008 winter months. This is an unwrapped interferogram.

Unwrapped Interferograms Color fringes in interferograms can be converted to more useful units like distance or velocity. This is known as "unwrapping the interferogram." While there are times when unwrapping interferograms is useful, the unwrapping process is computationally intensive, yields a non-unique solution, and can introduce error into the measurement, which is why scientists often leave interferograms wrapped.

Volcano Inflation
Big Island, Hawaii, November 15, 2014 to July 25, 2015

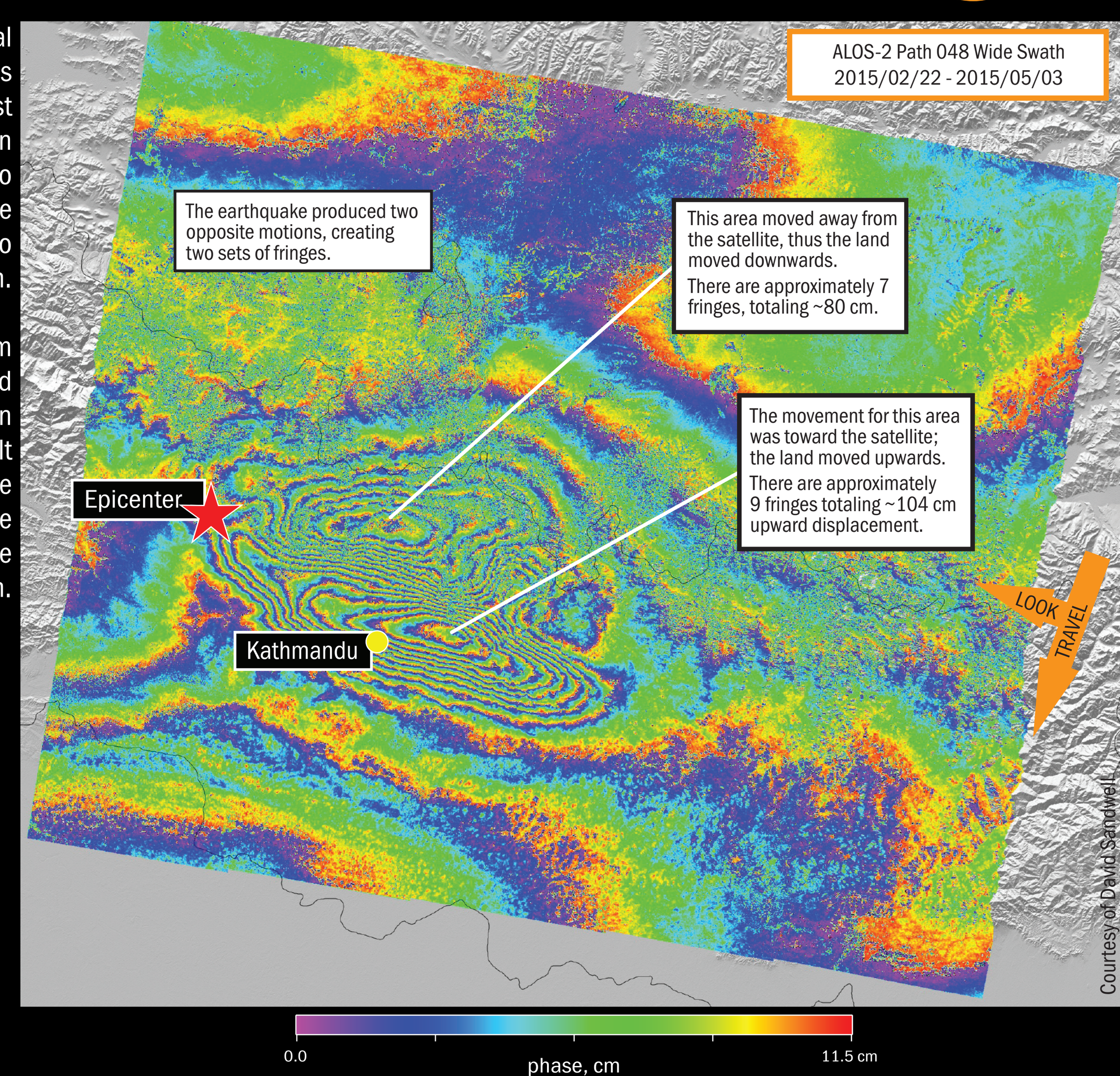


Within a period of 8 months, ground around both Mauna Loa and Kilauea moved towards the satellite, indicating inflation. The centers of Mauna Loa and Kilauea both rose by about 12 cm.

Earthquake
Mw = 7.8, Nepal, April 25, 2015

The 2015 Nepal earthquake was the result of thrust faulting between the Indian plate to the south and the Eurasian plate to its north.

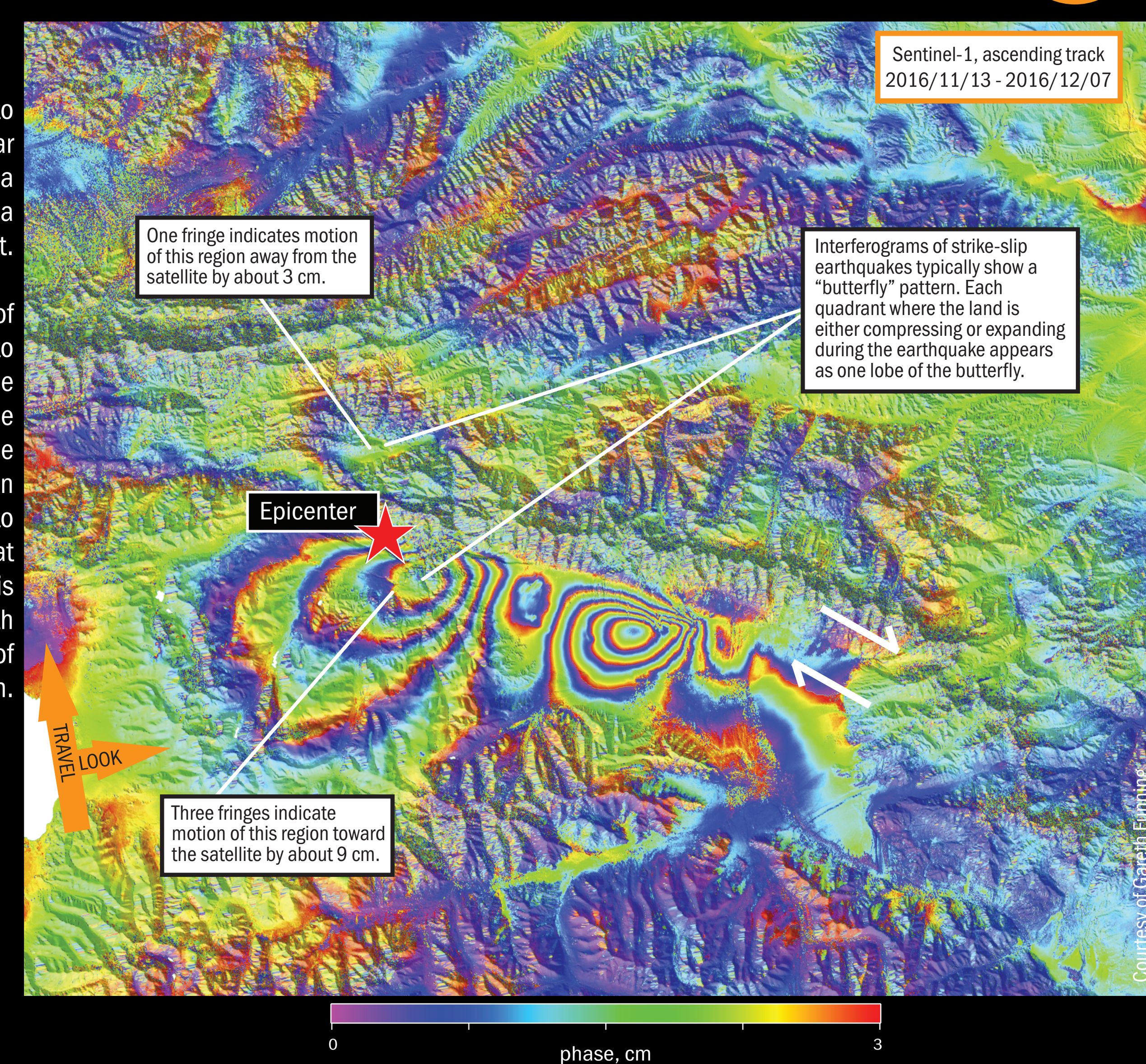
The interferogram incicates the land on the southern side of the fault moved up and the land on the northern side moved down.



Earthquake
Ms = 6.7, China, November 11, 2016

The 2016 Akto earthquake near Xinjiang, China occurred along a strike-slip fault.

The land south of the fault moved to the west, while the land north of the fault moved to the east. Total motion amounted to about 12 cm at the surface of this blind fault, with about 1 meter of slip at depth.

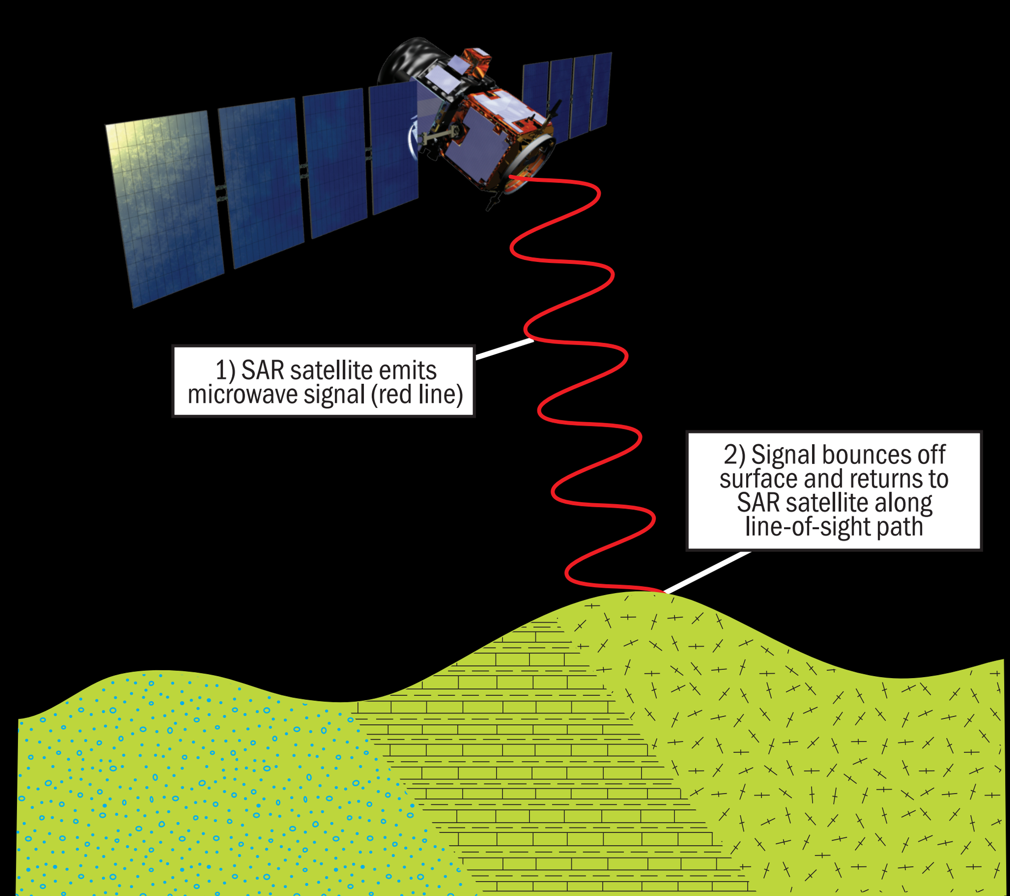


How does InSAR detect changes in the landscape?

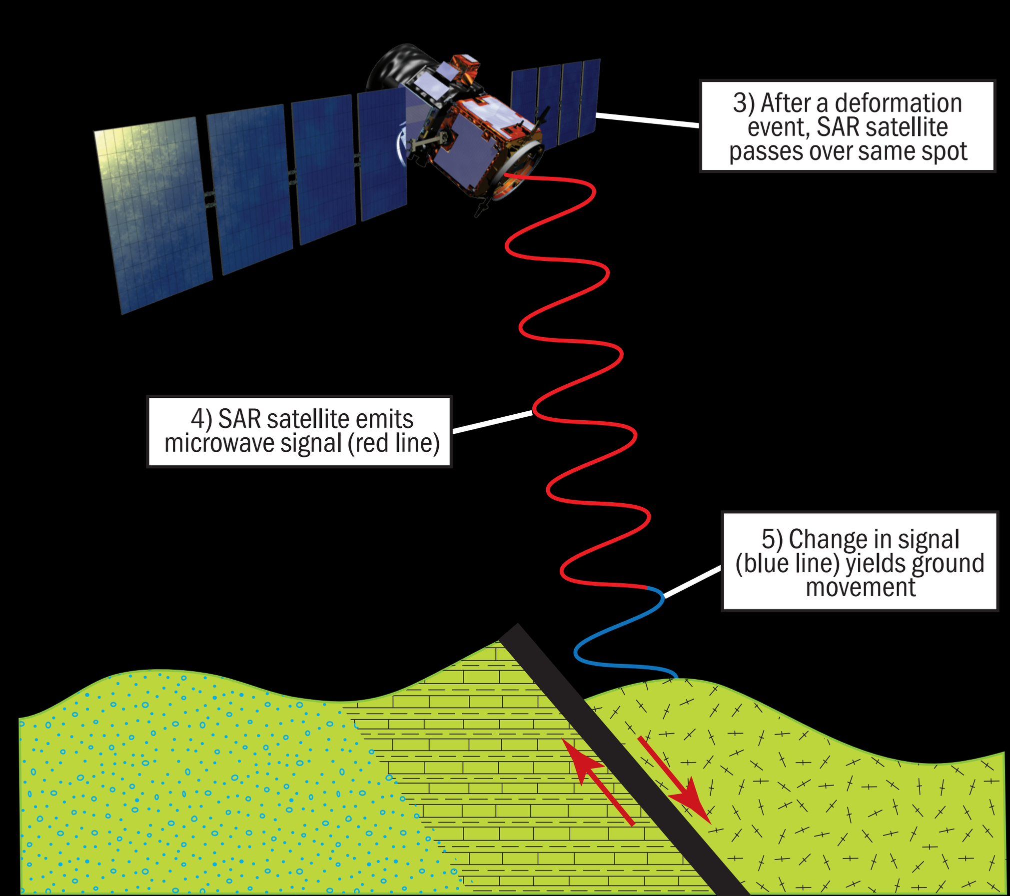
Multiple satellite passes are needed to measure changes.

Example of InSAR detecting change
(Earthquake)

Satellite Pass #1 — Pre-deformation



Satellite Pass #2 — Post-deformation

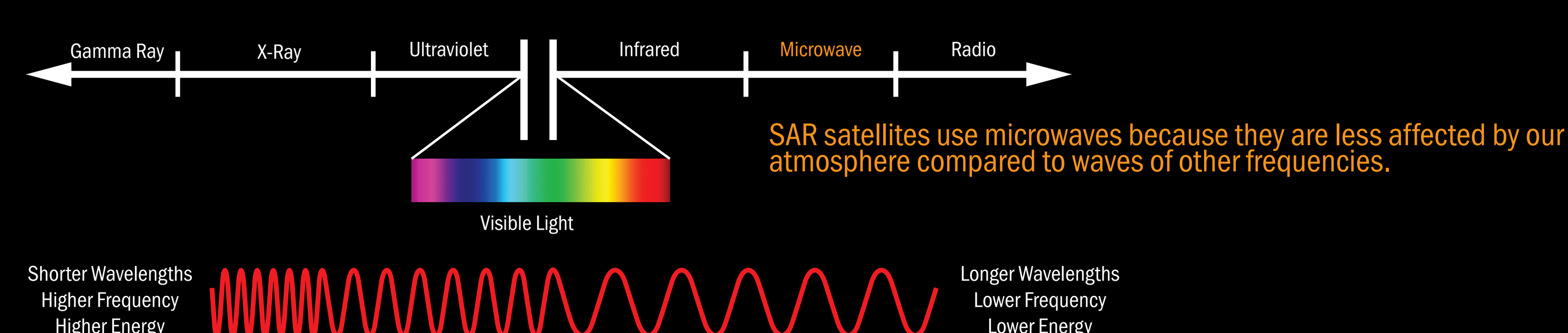


What Do We Already Know?
- Location of satellite during both passes
- Speed of light

What Do We Need to Know?
- Phase of the return signal for both satellite passes.
- Local topography and atmospheric conditions at time of measurement.

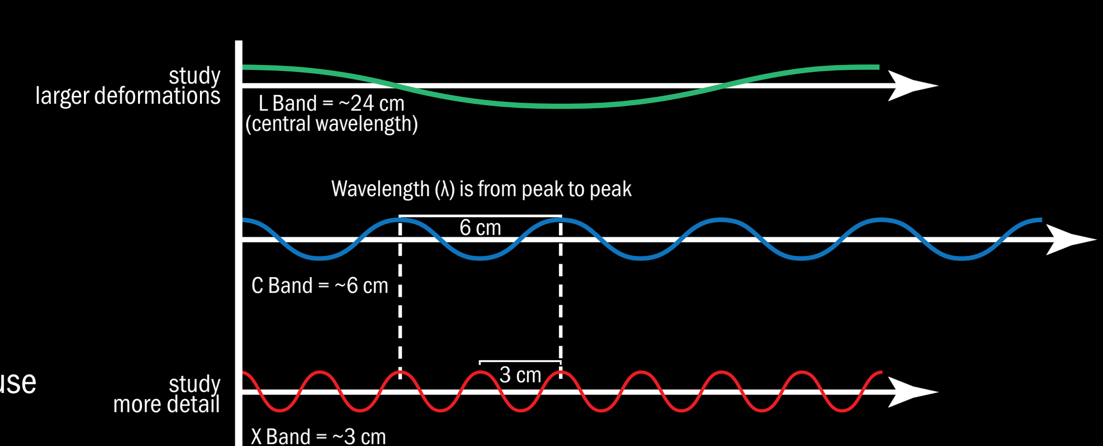
So, Now What?
- After measuring the phase for both satellite passes, and applying any corrections, subtract the difference in phase to create an interferogram.

Different SAR satellites emit different microwave wavelengths, providing different levels of detail.



SAR satellites use microwaves because they are less affected by our atmosphere compared to waves of other frequencies.

- All SAR satellites operate in the microwave band, but different satellites use different wavelengths: ~24 cm (e.g., ALOS-2),~6 cm (e.g., Sentinel-1B), and ~3 cm (e.g., TerraSAR-X)
- Shorter wavelengths reveal more detail
- Longer wavelengths allow measurement of larger surface deformations
- Vegetation and geology will affect what wavelength you use to study the feature of interest



NSF NASA USGS GAGE SAGE Operated by EarthScope Consortium

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