



مباحث ویژه (پردازش سیگنال های راداری)

نیم سال دوم ۰۳-۰۴

معرفی درس و مقدمه

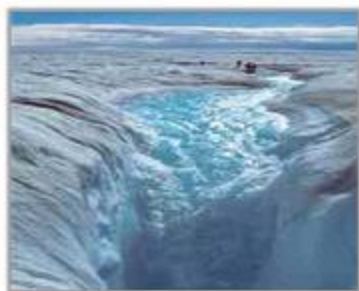
- موضوع درس: آشنایی با الگوریتم های پردازش سیگنال رادار و سونارهای تصویربردار از داده خام تا تصویر نهایی
- تعداد واحد: ۳
- کلاس: روزهای شنبه و دوشنبه ساعت ۱۳:۳۰ تا ۱۵، کلاس شماره ۲۰۶ و ۱۰۸
- نحوه ارزشیابی:
- کار مستمر (تمرین و آزمون ها): ۵ نمره
- پروژه پایانی: ۷ نمره
- آزمون پایانی: ۸ نمره
- تماس: داخلی ۳۳۲۴، رایانامه s.r.hashemi@gmail.com

- مقدمه
- مروری بر سامانه و سیگنال های راداری
- معرفی رادار روزنه مصنوعی
- روش های تشکیل تصویر
- جبران سازی حرکت و خودمیزانی
- چالش ها و کاربردها

- Cumming, Ian G., and Frank H. Wong. "Digital processing of synthetic aperture radar data." *Artech house*, 2005.
- Carrara, Walter G, et al. "Spotlight synthetic aperture radar signal processing algorithms." *Artech House*, 1995.
- Soumekh, Mehrdad. "Synthetic aperture radar signal processing." New York: Wiley, 1999.
- ...

Remote Sensing: Motivation

- Provides unique information to solve societal challenges of global dimension



Climate Change



Environment



Resources



Sustainable Development



Megacities



Mobility



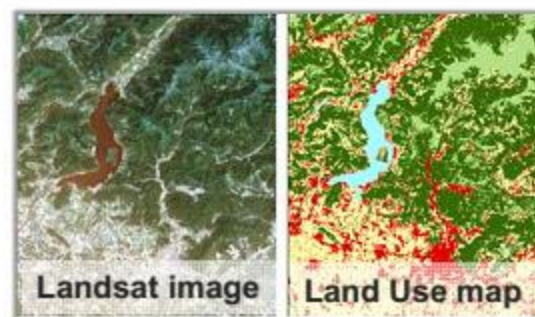
Hazards



Disaster

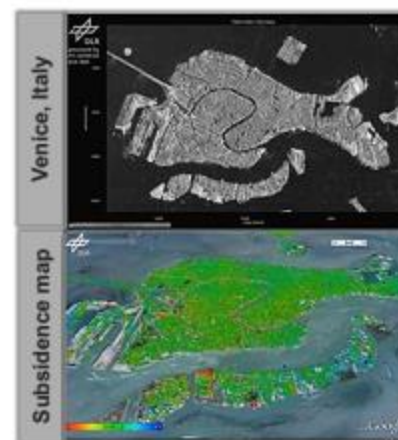
Remote Sensing

- Measuring objects properties from distance with dedicated instruments
- Acquired information
 - spatial (geometric resolution)
 - spectral (frequency resolution)
 - intensity (radiometric resolution)
 - temporal (revisit time)
- Different types of remote sensing sensors:
 - Optical and infrared sensors
 - passive:
 - High-resolution
 - Multispectral, hyperspectral
 - active: Lidar

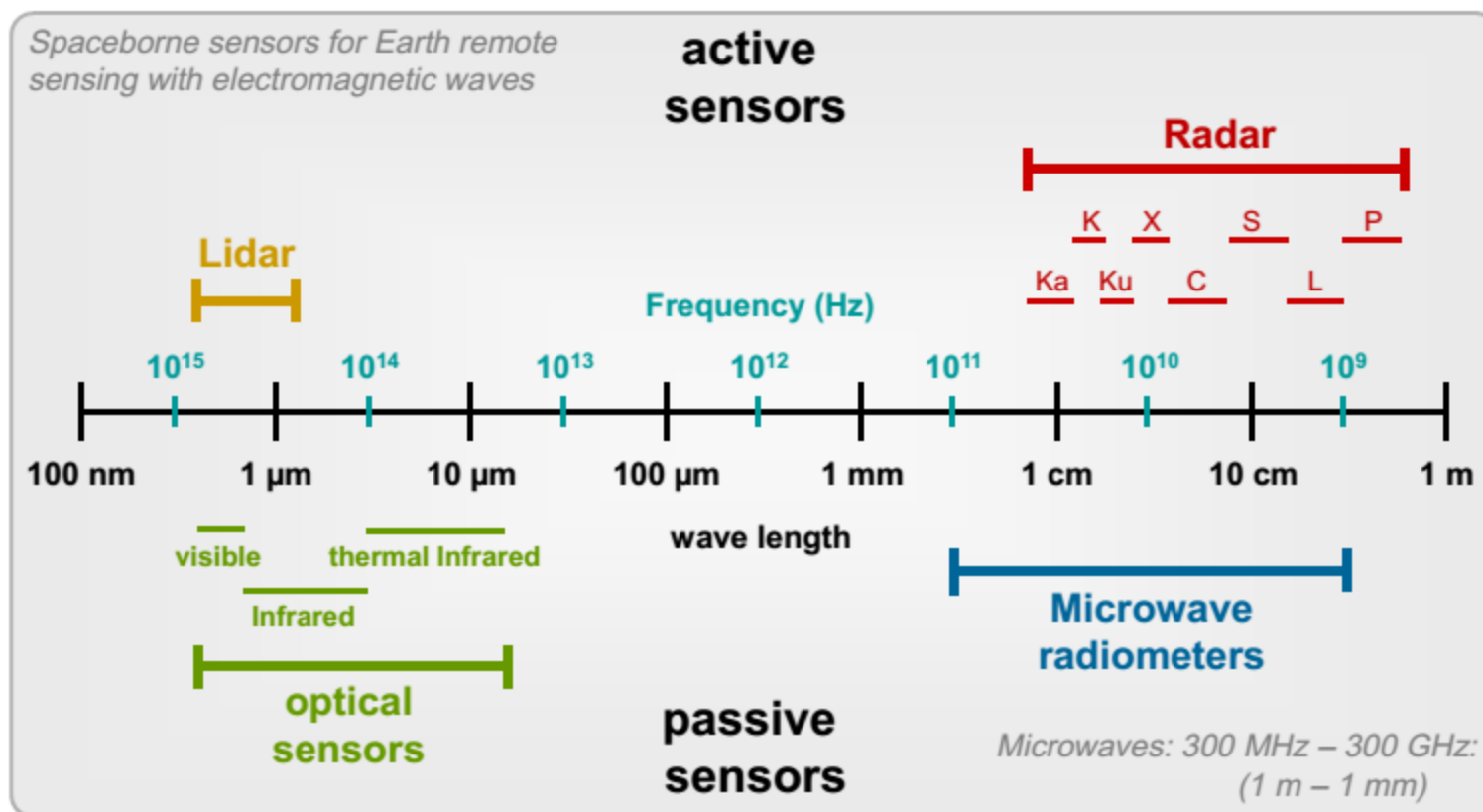


Remote Sensing

- Measuring objects properties from distance with dedicated instruments
- Acquired information
 - spatial (geometric resolution)
 - spectral (frequency resolution)
 - intensity (radiometric resolution)
 - temporal (revisit time)
- Different types of remote sensing sensors:
 - Microwave sensors
 - passive (radiometers)
 - active (radars)
 - Scatterometer, Altimeter
 - Synthetic Aperture Radar - SAR



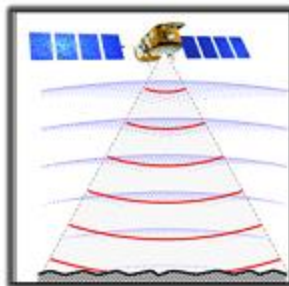
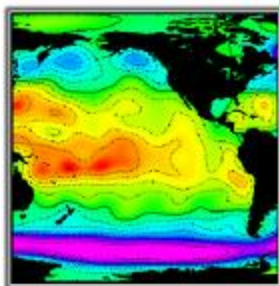
Types of Remote Sensing Sensors



Spaceborne Radar Remote Sensing

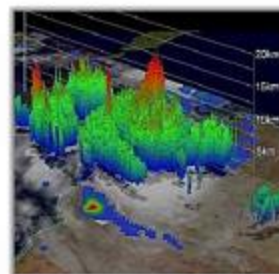
Radar Altimeter

Measures surface topography (surface height)



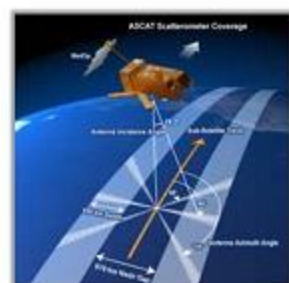
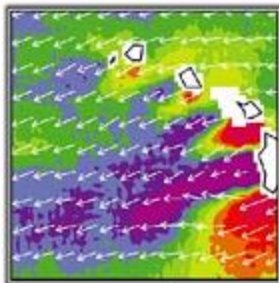
Weather Radar

Measures three-dimensional rainfall distribution



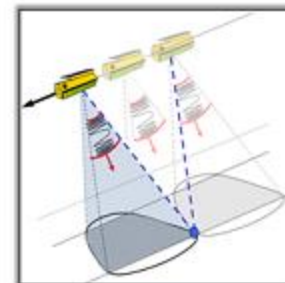
Radar Scatterometer

Measures surface backscattering (sea winds)



Synthetic Aperture Radar (SAR)

Measures 2D surface backscattering



رادار روزنه مصنوعی

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X-band, High Resolution Airborne SAR, F-SAR, Kaufbeuren, Germany

رادار روزنه مصنوعی

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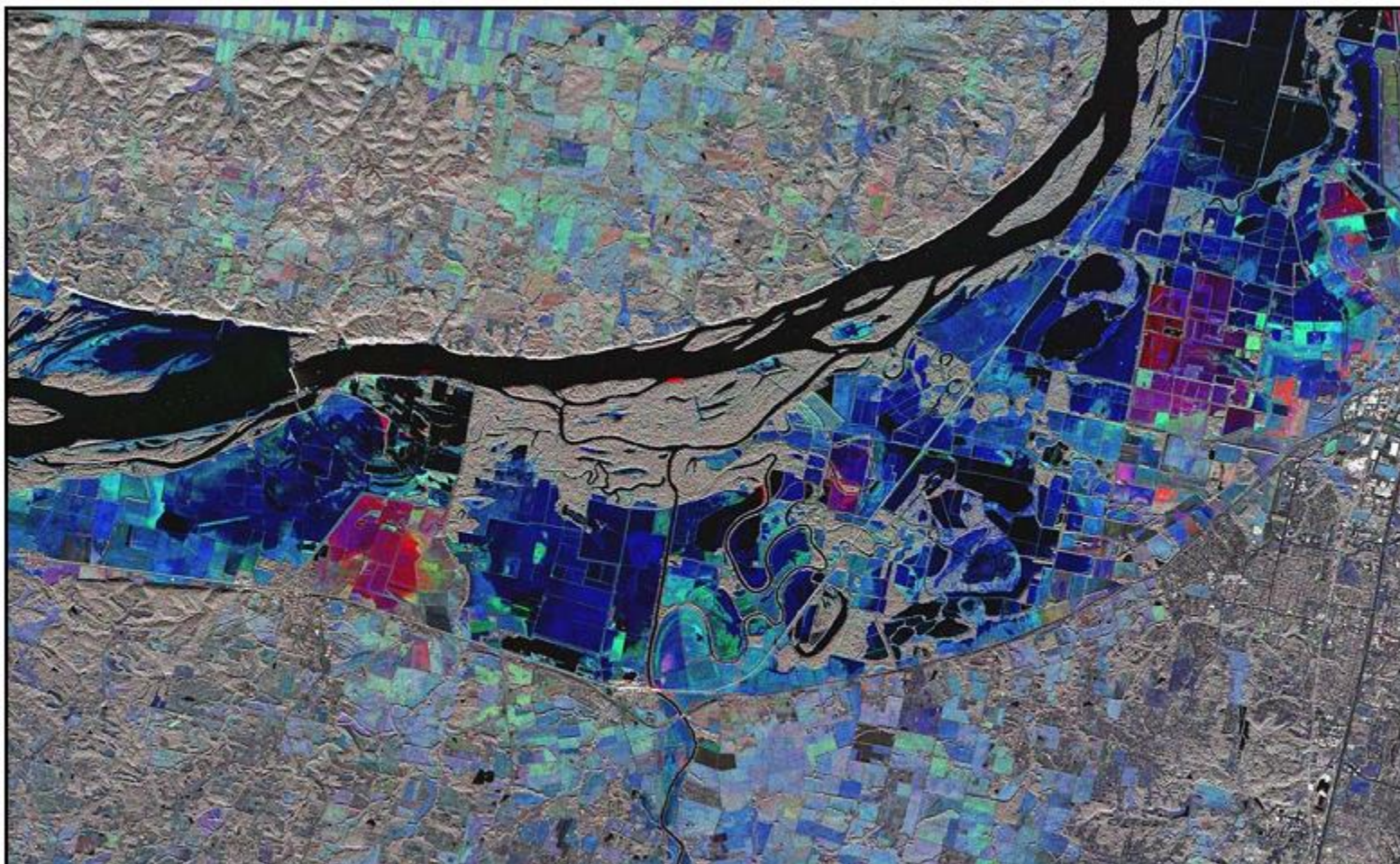
X-band, Airborne SAR, F-SAR, Full Polarimetric

رادار روزنه مصنوعی

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C-band, Airborne SAR, F-SAR, Full Polarimetric



TerraSAR-X, Mississippi, USA - Flooding

رادار روزنه مصنوعی

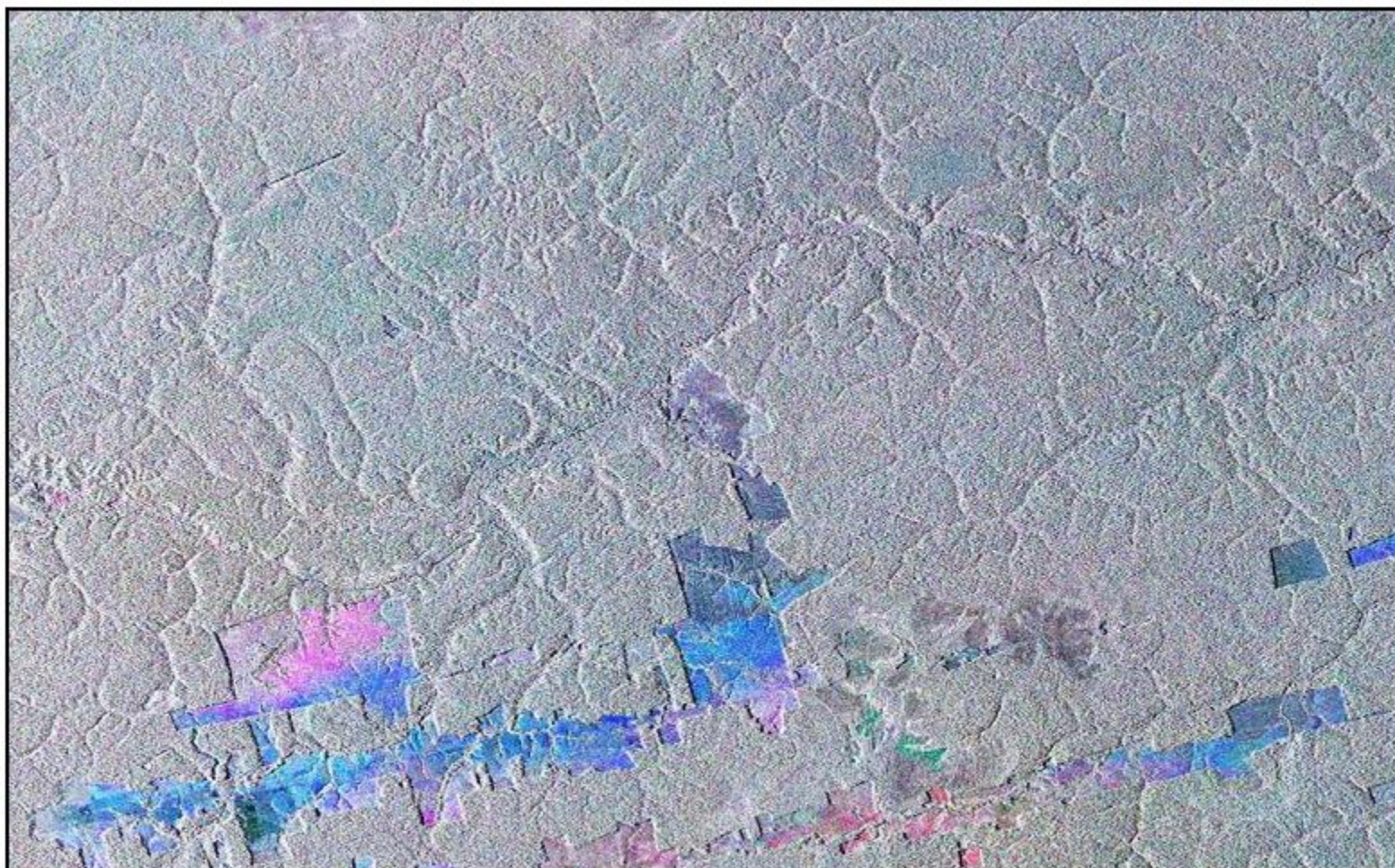
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TerraSAR-X, Las Vegas, USA (time series of 20 images)

رادار روزنه مصنوعی

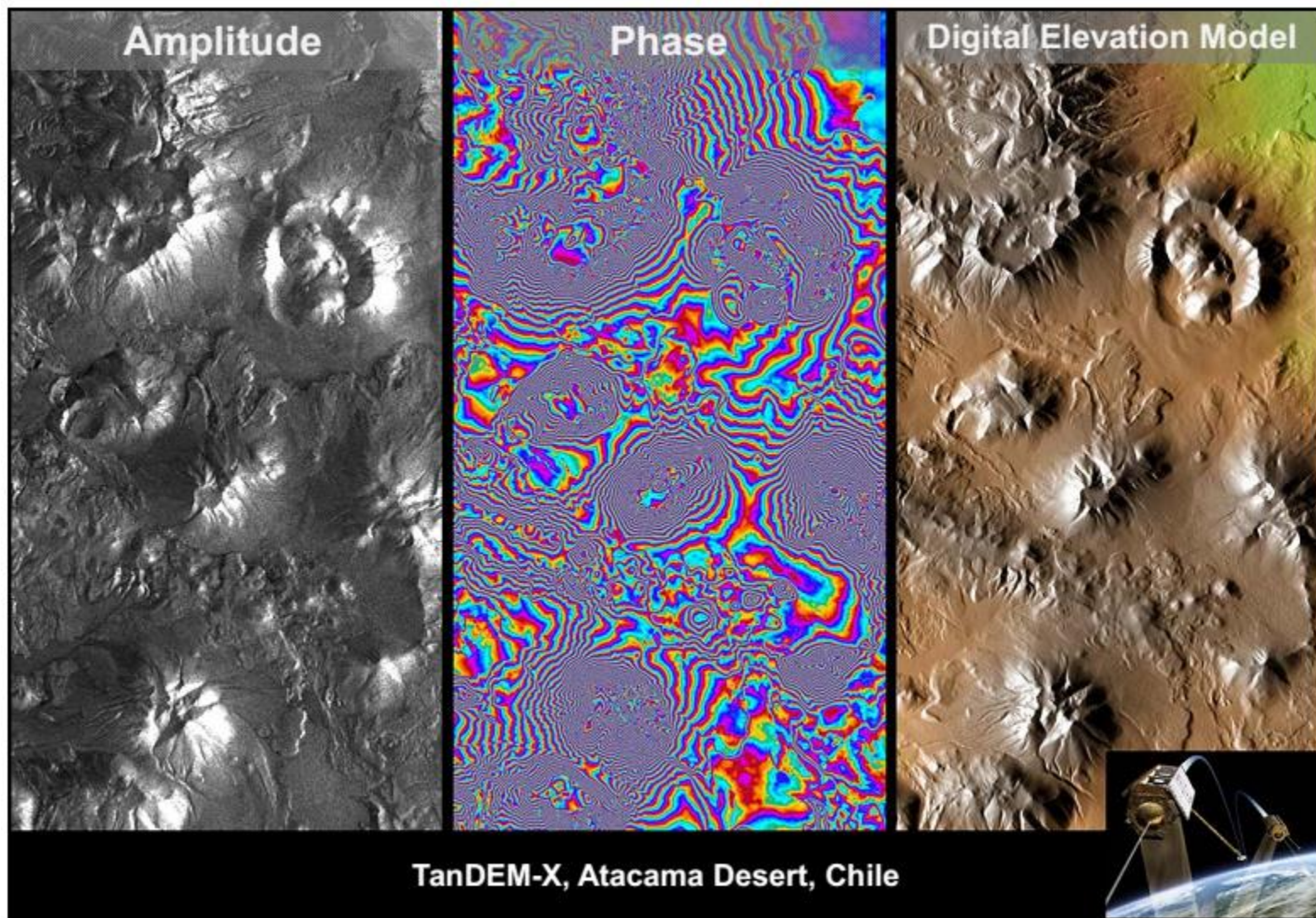
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Mato Grosso, Brazil - Deforestation

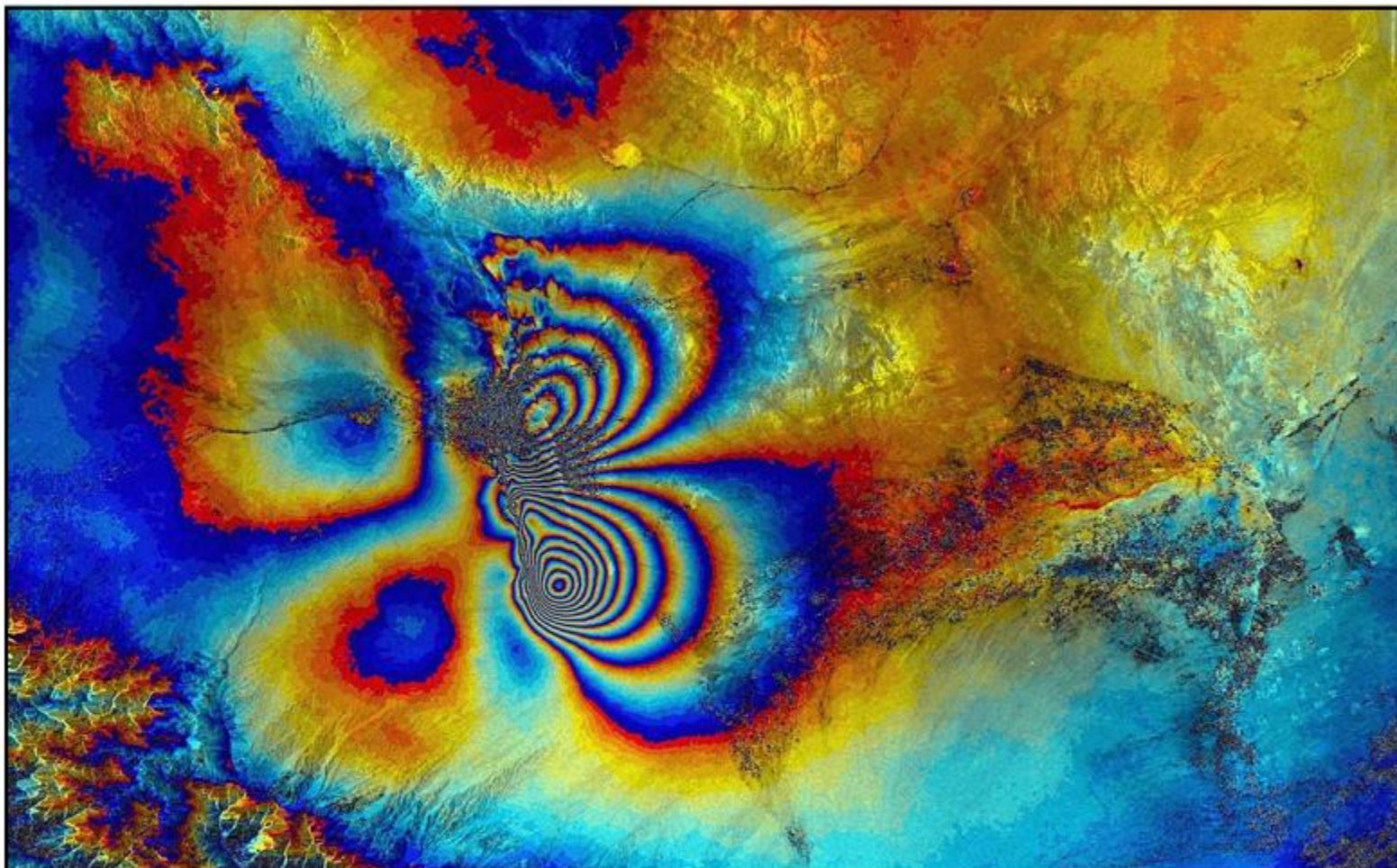
رادار روزنه مصنوعی

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رادار روزنه مصنوعی

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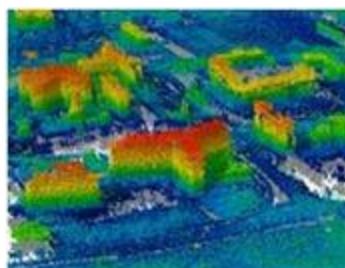
ENVISAT/ASAR, Bam Earthquake, 2003 (© ESA)

Motivation for Spaceborne SAR

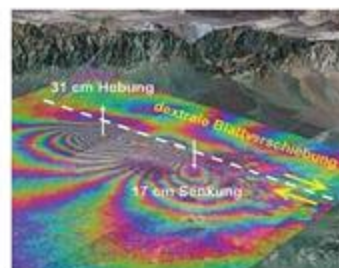
- Complementary information to optical systems
- Penetration of radar waves
- Weather independent
- Day-and-night imaging capability
- Geometric resolution independent of the distance
- New image products by coherent combination of radar images
(i.e. using phase information in the radar images)



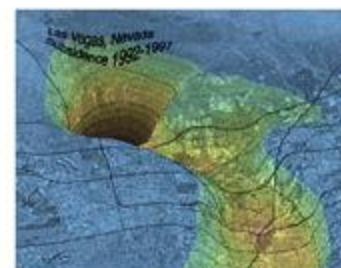
3D Mapping
(Digital Elevation Model)



Tomography
(Urban Mapping)



Differential Interferometry
(Earthquake deformation)



Differential Interferometry
(Subsidence)

SAR Main Properties and Applications

- high resolution capability (independent of flight altitude)
- weather independence by selecting proper frequency range
- day/night imaging capability due to own illumination
- complementary to optical systems
- polarization signature can be exploited (physical structure, dielectric constant)
- innumerous applications areas:

- Topography (DEM generation with interferometry)
- Oceanography (wave spectra, wind speed, ocean currents)
- Glaciology (snow wetness, snow water equivalent, glacier monitoring)
- Agriculture (crop classification and monitoring, soil moisture)
- Geology (terrain discrimination, subsurface imaging)
- Forestry (forest height, biomass, deforestation)
- Moving Target Indication (MTI)
- Volcano and earthquake monitoring (differential interferometry)
- Environment monitoring (oil spills, flooding, urban growth, global change)
- Military surveillance and reconnaissance (strategic policy, tactical assessment)