Space-based Monitoring of Water Level Changes in the Entire Everglades Using Sentinel-1 InSAR Observations

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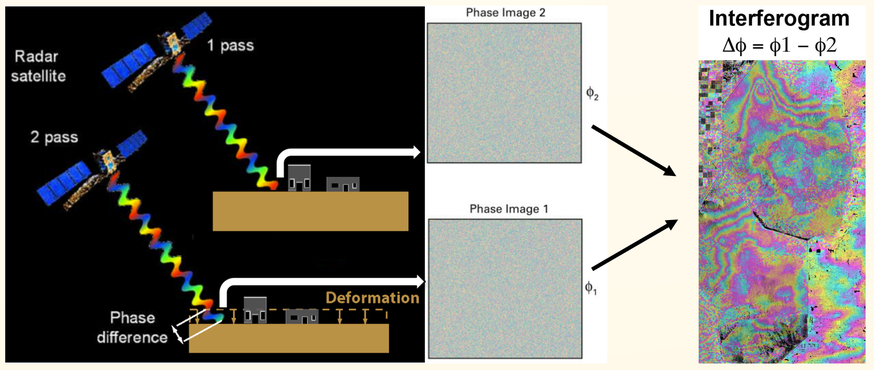
Objective

A key element in the Everglades conservation, management, and restoration involves monitoring its hydrologic system, as the entire ecosystem depends on its water supply. Hydrologic monitoring of the Everglades is mainly conducted by stage (water level) stations, which provide good temporal resolution, but suffer from poor spatial resolution, as stage stations are typically distributed several, or even tens of kilometers, from one another. Furthermore, due to logistical constraints many of the stage stations are located near hydrological structures and often do not represent water level conditions in interior sections. The space-based Interferometric Synthetic Aperture Radar (InSAR) technology provides the needed high spatial resolution hydrological observations.

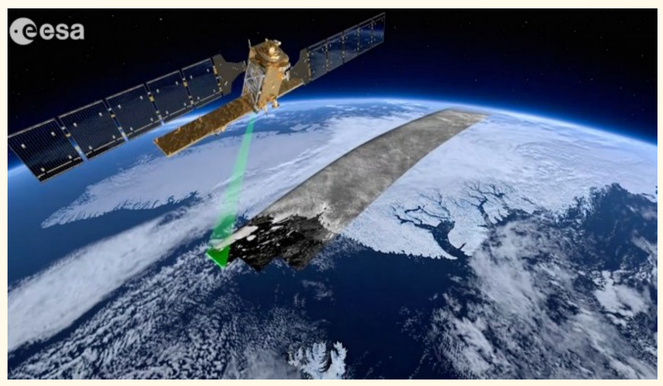
Method: Wetland InSAR

InSAR (Interferometric Synthetic Aperture Radar) is a remote sensing technique that uses phase information (0-2π) from two independent radar (SAR) images acquired roughly from the same location in space. Each phase image looks as a random distribution of phase values. Differencing between the two images reveals coherent phase patterns representing phase changes between the two acquisitions. Wetland InSAR displays phase changes in aquatic environment with emergent vegetation. Wetland interferograms (maps of phase changes) reflect mainly surface water level changes between the two acquisitions.



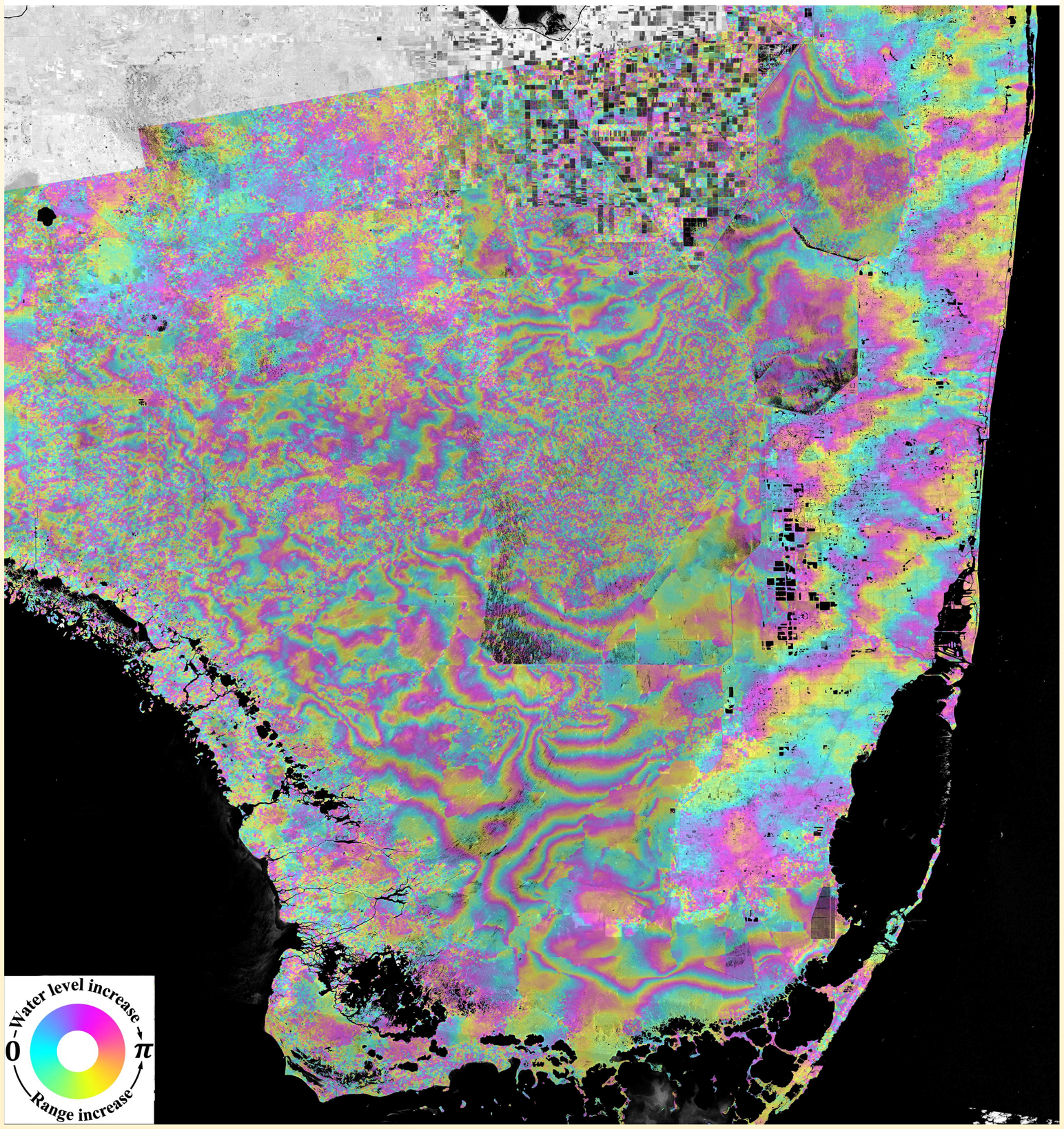
Data: Sentinel-1

The new Sentinel-1 satellite constellation, operated by the European Space Agency (ESA), provides high resolution (5x20 m^2 pixel size) wide coverage observations (250 km wide swath) with significantly higher temporal resolution of 6 day repeat orbit. Data are freely available from the ESA's archive.



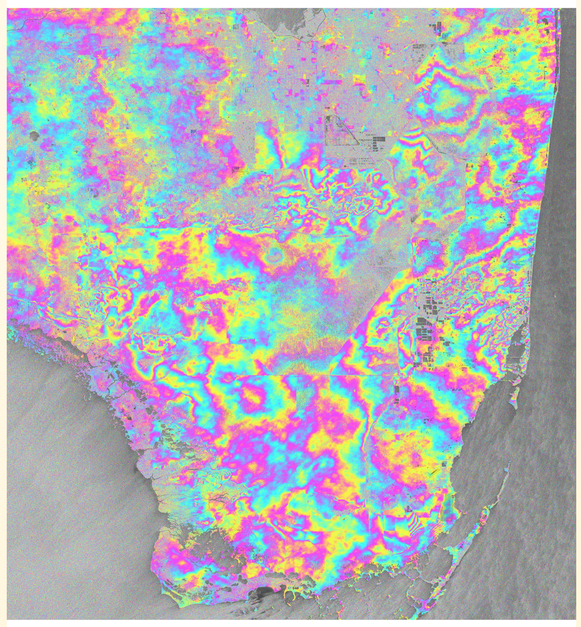
Interferograms

2015/09/21 - 2015/10/15



Interferograms: Detailed maps of phase changes occurring between the two acquisition dates. Each fringe cycle (blue-to-blue, yellow-to-yellow, etc.) represents 4 cm of water level changes.

2016/10/09-2016/10/15



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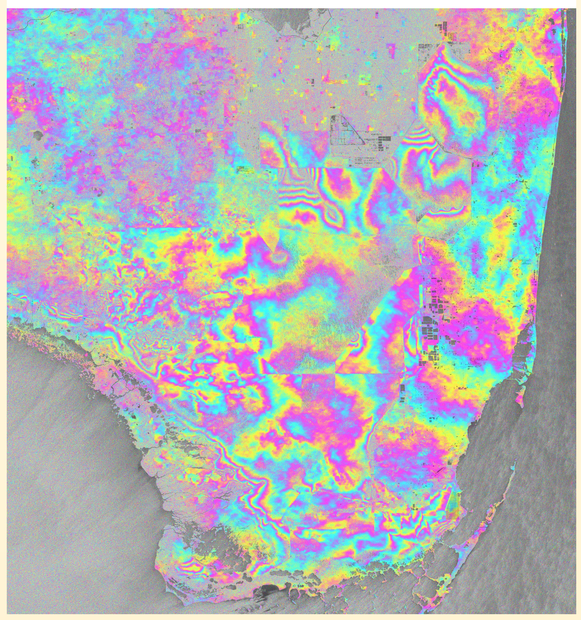

Results

- The interferograms reveal many interesting hydrological features, including:
  (1) flow discontinuities due to levies and roads,
  (2) patterns of tidal flow in the coastal Everglades,
  (3) water level changes due to hydrological structure operations
  (4) temporal changes in the fresh water flow characteristics.
- Phase changes in the urban area reflects atmospheric delay due to precitable water changes.
- The new Sentinel-1 observations have the potential for repeated high spatial resolution monitoring of surface flow changes in the entire Everglades wetlands.

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