INSAR FOR WATER LEVEL MONITORING IN THE EVERGLADES WETLANDS, SOUTH FLORIDA

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The south Florida Everglades is a unique wetland environment consisting of a very wide, shallow, and slow sheet flow. The Everglades also includes a wide coastal wetland area (mangrove forests) located along the southwestern coast of Florida. Over the past century human activity have significantly affected the drainage pattern in the wetlands, destroyed a significant part of vegetation, and reduced wildlife habitat. The northern most Everglades, just south of Lake Okeechobee (L.O. – Figure 1) was drained and proclaimed as an agricultural area. The northern and central Everglades were compartmentalized into several Water Conservations Areas (WCAs), which serve as large water reservoirs for the increasing population in south Florida. Only the southern section of the Everglades, about 30% of the original wetland area, was designated as a national park and has kept its natural wetland sheet flow.

Hydrological monitoring of the Everglades is conducted by a dense network of stage (water level) stations, which provide high temporal water level observations in a finite number of locations. In order to improve the spatial resolution of the water level observations, we use space-borne Interferometric Synthetic Aperture Radar (InSAR) measurements, which provide cm-level accuracy of water level changes with 1-50 m spatial resolution depending on the sensor type. We analyzed InSAR data acquired by X-band (TerraSAR-X, Cosmo-SkyMed), C-band (ERS-1/2, Envisat, Radarsat-1/2), and L-band (JERS, ALOS) satellites. Our analysis shows that all data types can produce coherent interferograms, as long as the time span between the observations is short [1, 2]. The short wavelength, X- and C-band interferograms can maintain phase over periods of several weeks [3, 4, 5], whereas the longer wavelength L-band interferograms can maintain phase over months and even years [1, 2, 5].

The processed interferograms show different fringe patterns between freshwater wetland areas and the saltwater coastal wetland areas. The freshwater interferograms show an overall organized fringe pattern that follow boundaries of the WCAs, as well as discontinuous fringes across these boundaries, which reflect different water level changes across hydrological structures (Figure 1) [1, 2]. The saltwater interferograms show a more complex fringe pattern with high fringe gradient along tidal channels, reflecting high water level changes in the tidal flushing zone (Figure 2) [6].

The InSAR-based observations of water level changes are useful for detecting flow patterns, flow discontinuities, and for constraining high spatial resolution wetland flow models.

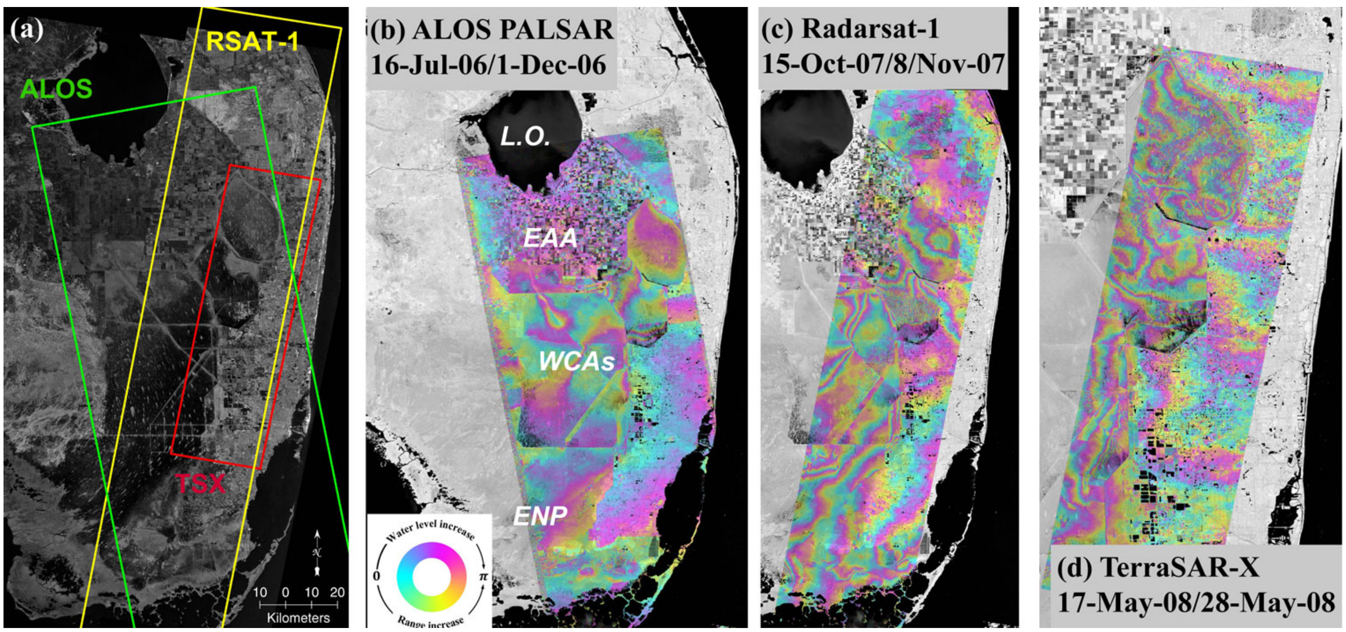

Figure 1. Interferograms showing phase changes, which were induced by water level changes in the Everglades wetlands, south Florida. (a) JERS-1 amplitude image of South Florida showing the location of the three interferograms. (b) L-band (24 cm wavelength) ALOS interferogram of 90 km wide ascending track. Each color cycle corresponds to 15 cm of water level change. (c) C-band (5.6 cm) Radarsat-1 interferogram of a 75 km wide descending swath. Each color cycle represents 4 cm of water level change. (d) X-band (3.1 cm) TSX interferogram of a 30 km wide descending swath. Some of the observed changes reflect changes in atmospheric moisture between the acquisitions. Each color cycle represents 2 cm of water level changes. L.O. – Lake Okeechobee; EAA – Everglades Agricultural Area; WCA – Water Conservation Area; ENP – Everglades National Park.

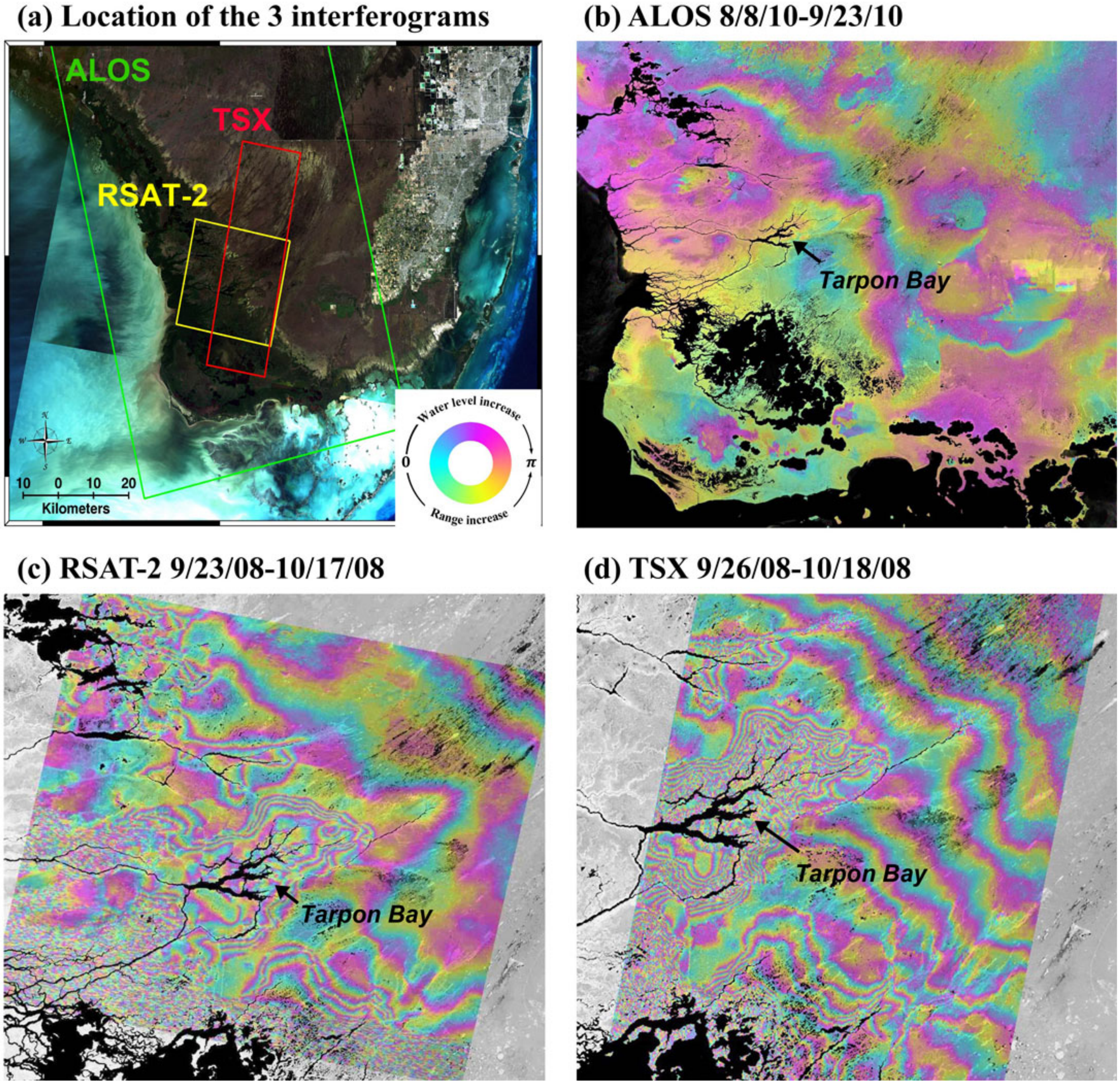

Figure 2. (a) Google earth's composite satellite image showing the location of the three interferograms used in coastal wetland area. (b) ALOS interferogram showing a coherent fringe along the transition between fresh- and salt-water vegetation and partial fringe along the tidal channels. (c) Radarsat-2 interferogram showing short wavelength fringes surrounding tidal channels in the mangrove forest area. (d) TerraSAR-X interferogram showing a similar fringe patterns around the tidal channels. The different number of fringes in each interferogram reflects the sensitivity of each sensor to detect surface changes. Each ALOS (L-band) fringe reflects 15 cm of water level change, Radarsat-2 (C-band) 4 cm, and TerraSAR-X (X-band) 2 cm. [After Wdowinski et al., 2013].

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