Wetland InSAR: Observations and Implications

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Abstract

Wetlands are transition zones where the flow of water, the nutrient cycling, and the sun energy meet to produce a unique and very productive ecosystem. They provide critical habitat for a wide variety of plant and animal species, including the larval stages of many ocean fish. Wetlands also have a valuable economical importance, as they filter nutrients and pollutants from fresh water used by human and provide aquatic habitats for outdoor recreation, tourism, and fishing. Globally, many such regions are under severe environmental stress, mainly from urban development, pollution, and rising sea level. However, there is increasing recognition of the importance of these habitats, and mitigation and restoration activities have begun in a few regions. A key element in wetlands conservation, management, and restoration involves monitoring its hydrologic system, as the entire ecosystem depends on its water supply. Heretofore, hydrologic monitoring of wetlands are conducted by stage (water level) stations, which provide good temporal resolution, but suffer from poor spatial resolution, as stage station are typically distributed several, or even tens of kilometers, from one another.

Wetland application of InSAR provides the needed high spatial resolution hydrological observations, complementing the high temporal resolution terrestrial observations. Although conventional wisdom suggests that interferometry does not work in vegetated areas, several studies have shown that both L− and C−band interferograms with short acquisition intervals (1−105 days) can maintain excellent coherence over wetlands. In this study we explore the usage of InSAR for detecting water level changes in various wetland environments around the world, including the Everglades (south Florida), Louisiana Coast (southern US), Chesapeake Bay (eastern US), Pantanal (Brazil), Okavango Delta (Botswana), and Lena Delta (Siberia). Our main study area is the Everglades wetland (south Florida), which is covered by probably the densest stage network in the world (more than 200 stations), located 5−10 km from one another. The stage data is very important in evaluating the uncertainty of the InSAR observations. Stage data also allow us to tie the relative InSAR observations (water level changes) to absolute reference frame and to produce high spatial−resolution (10−100 m resolution) maps of absolute water levels. High resolution wetland interferograms also provide direct observations of flow patterns and flow discontinuities and serve as excellent constraints for high resolution flow models.