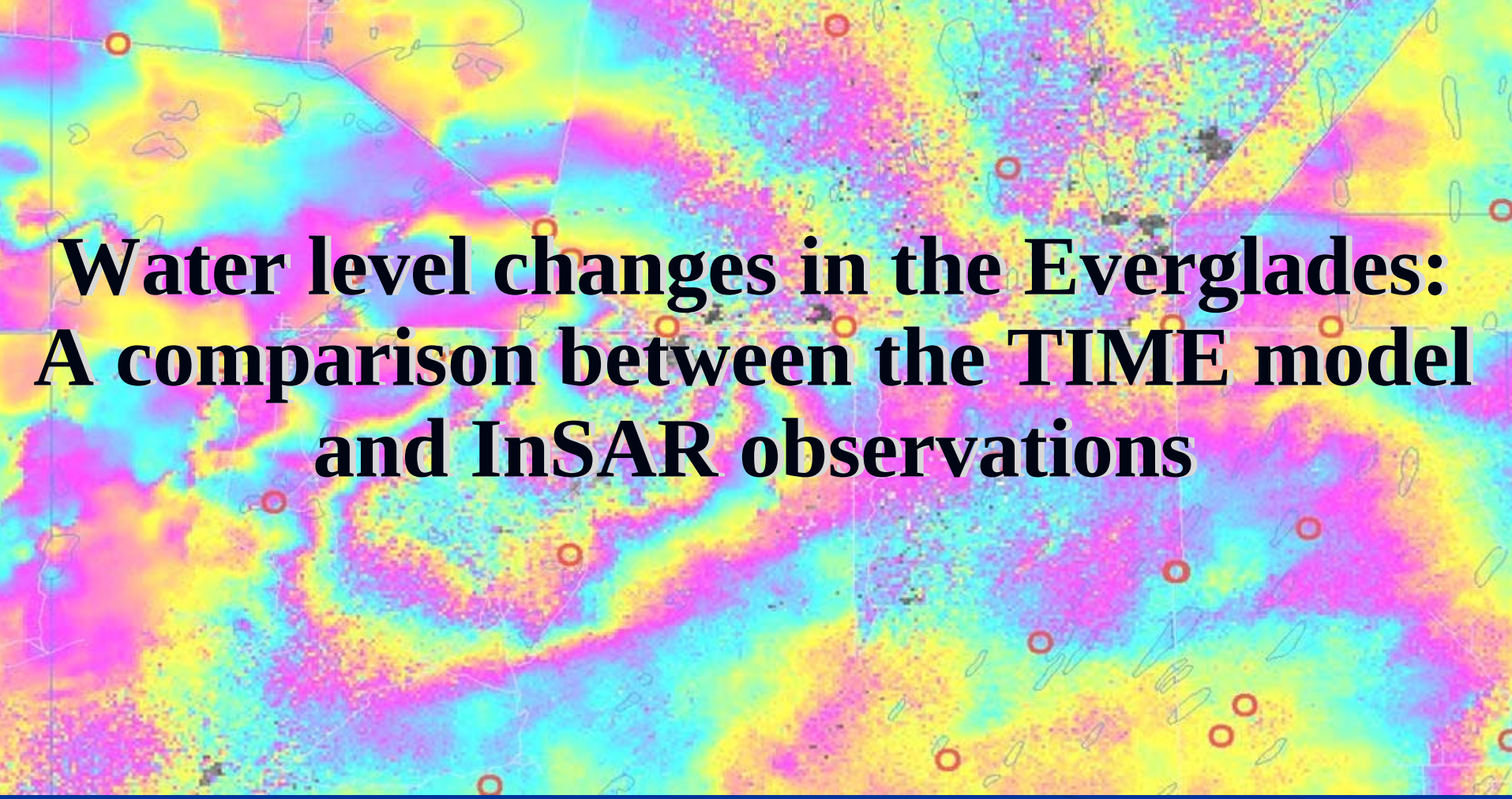

Water level changes in the Everglades: A comparison between the TIME model and InSAR observations

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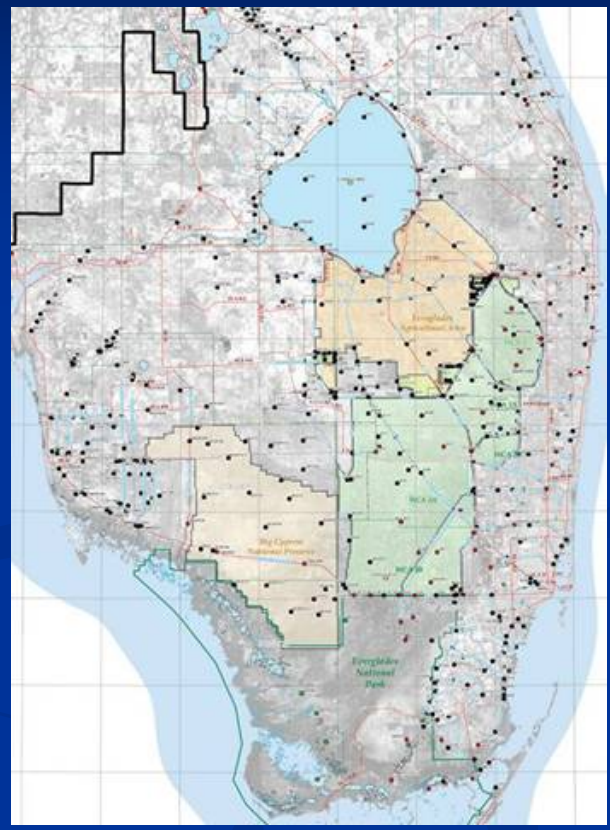
Water levels in the Everglades

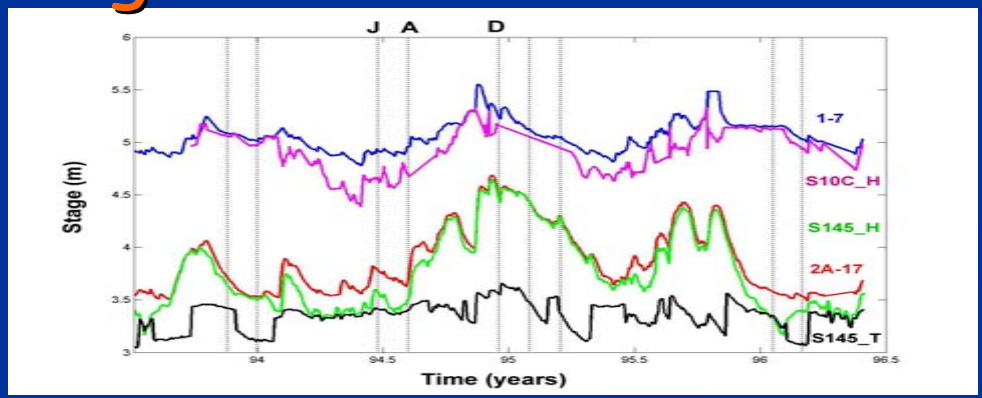
- Why is it important?
  - The Everglades is currently a managed wetland. The amount and timing of water supply determine water level conditions and the characteristic of the eco-system.
- How water levels are monitored?
  - Stage stations
  - Space-based observations (InSAR)

Terrestrial monitoring (stage)

Stage station

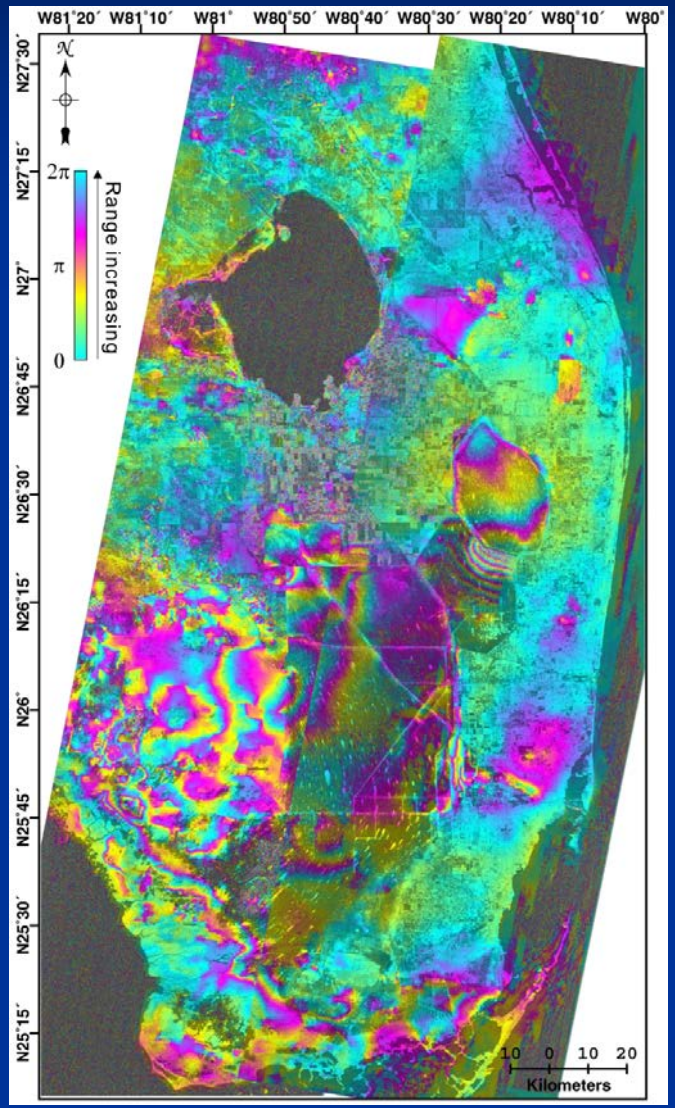


Stage time series



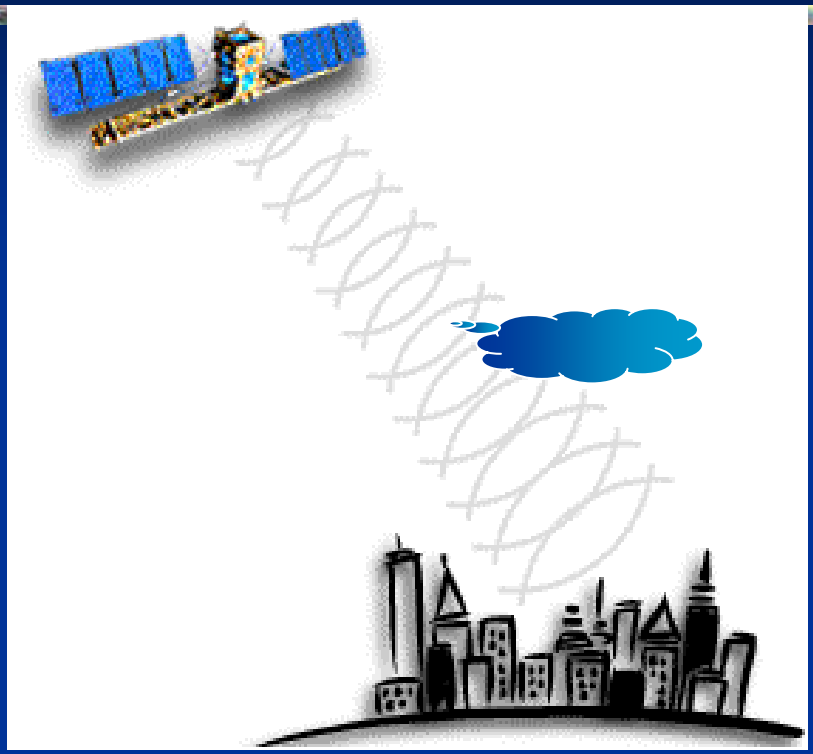
Dense network (~200 stations)

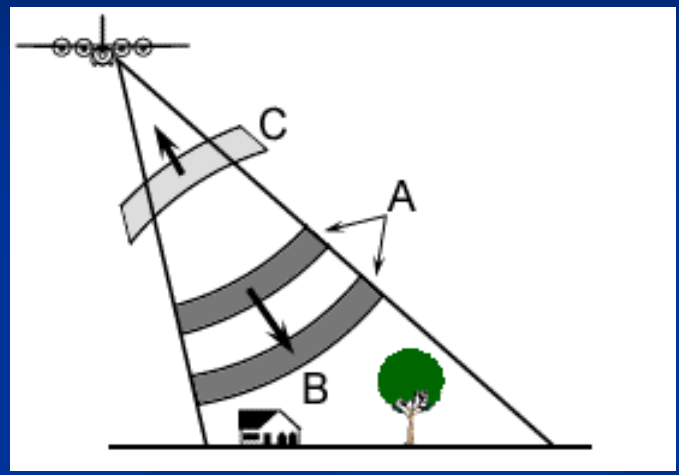
Space-based observations (InSAR)



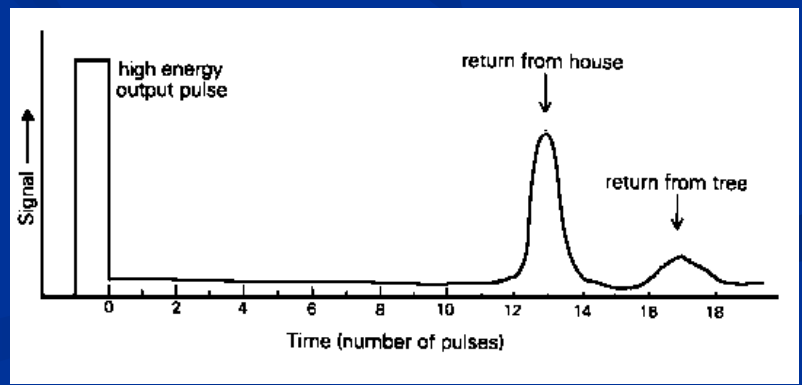
- High spatial resolution maps (7-50 m pixel resolution)
- Measure water level changes between two acquisitions.
- Low temporal resolution (24-44 days between acquisitions).

Synthetic Aperture Radar (SAR)

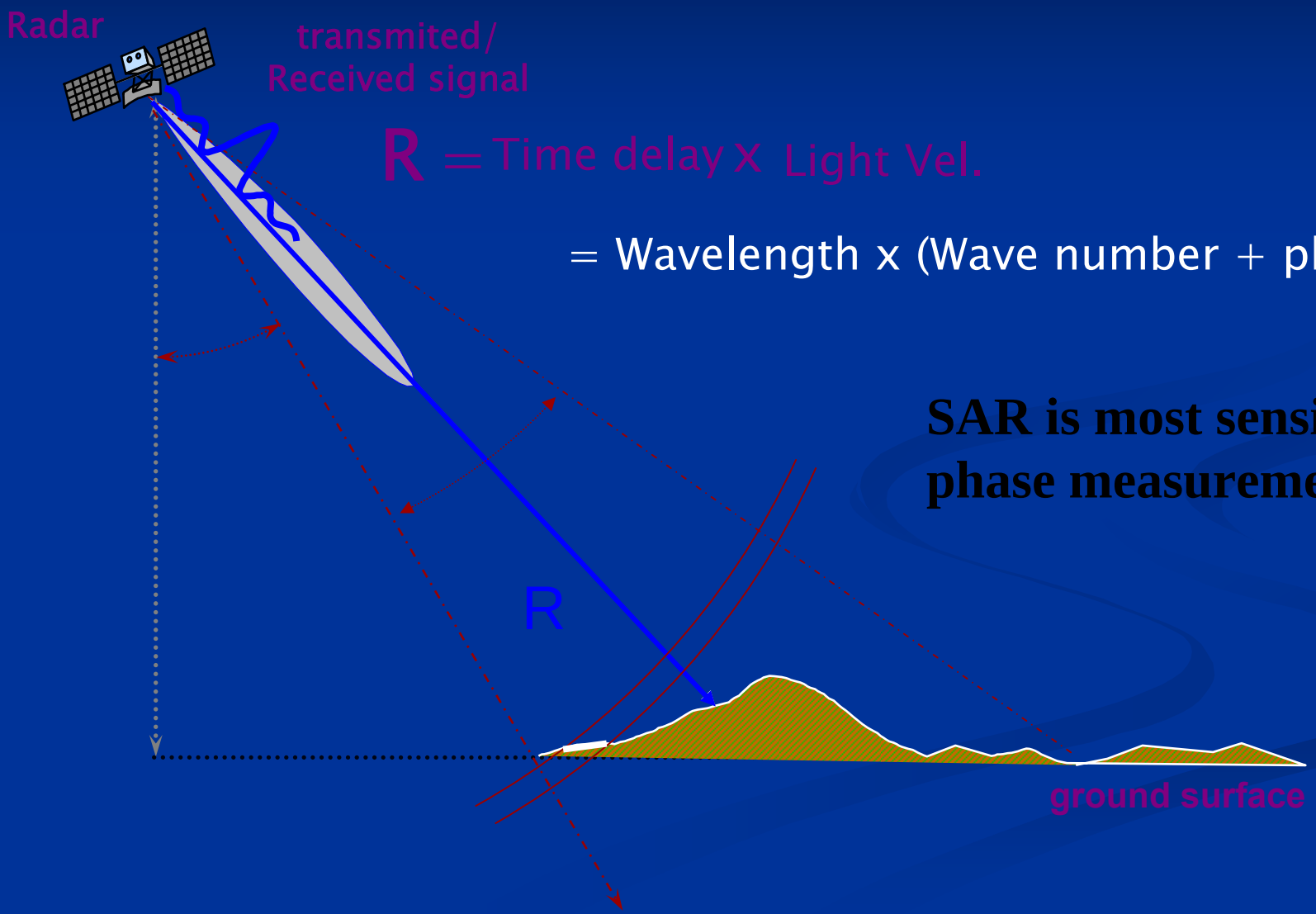




RADAR remote sensing is an `active` imaging technique that utilises the microwave region (~1-100 cm) of the EM spectrum

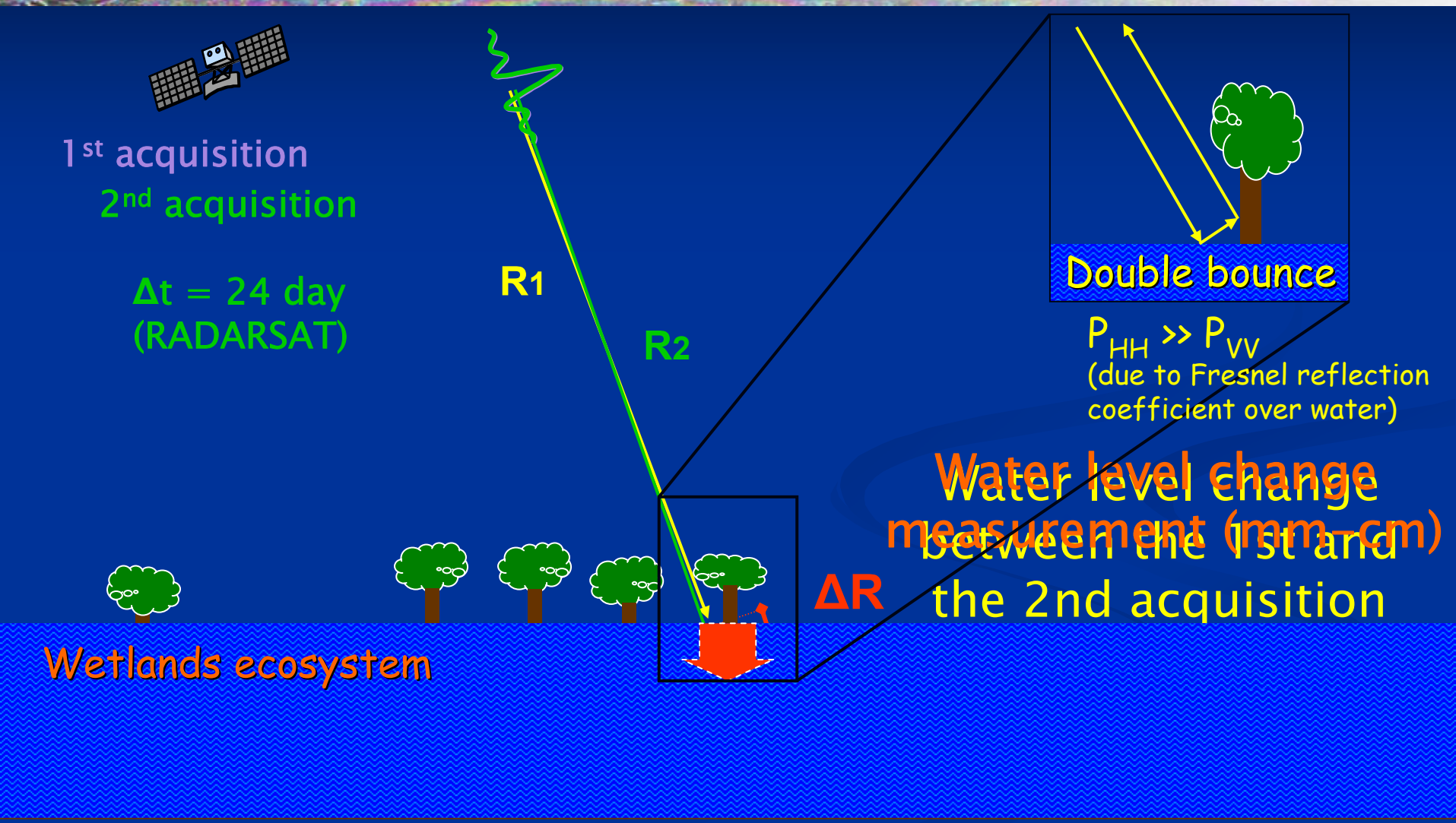


SAR – phase observable

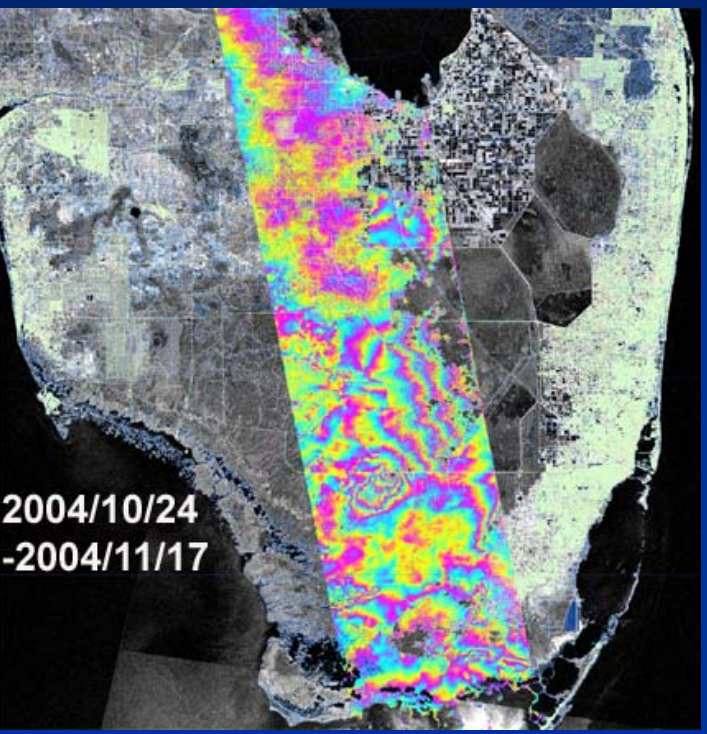


SAR is most sensitive to phase measurements

Water level change measurement by InSAR



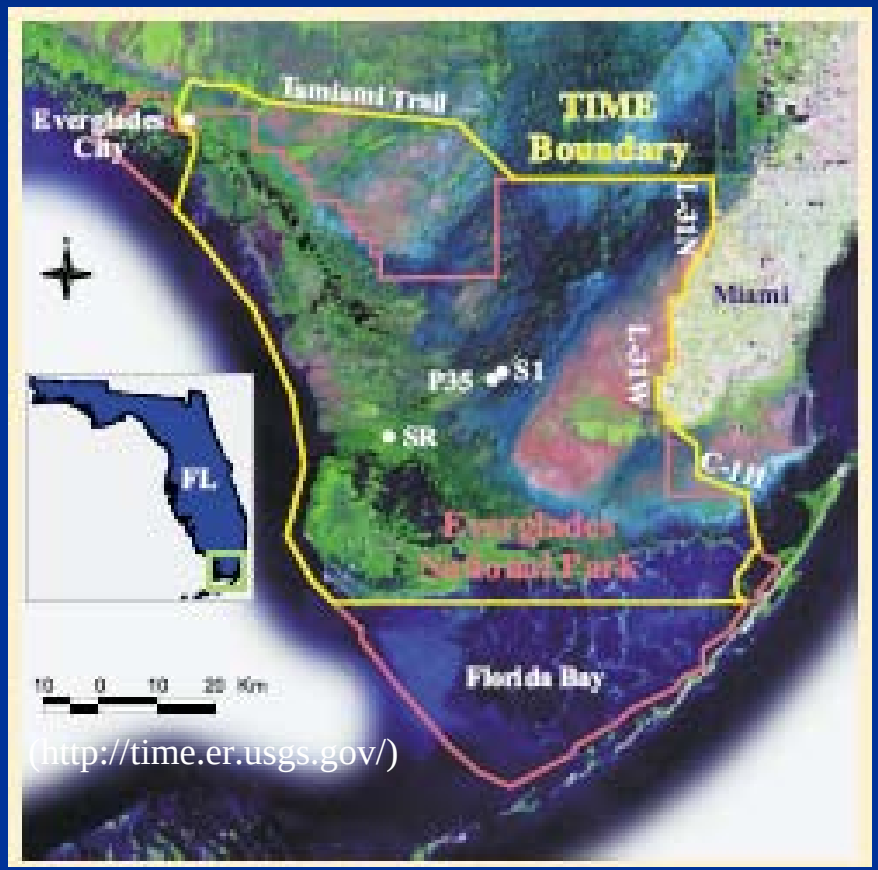
Applications of the InSAR observations



- Integration with stage data to obtain "absolute" levels
- Detection of flow discontinuities
- Constraining flow models (e.g., the TIME model)
- Development of high resolution flow models
- Real-time monitoring

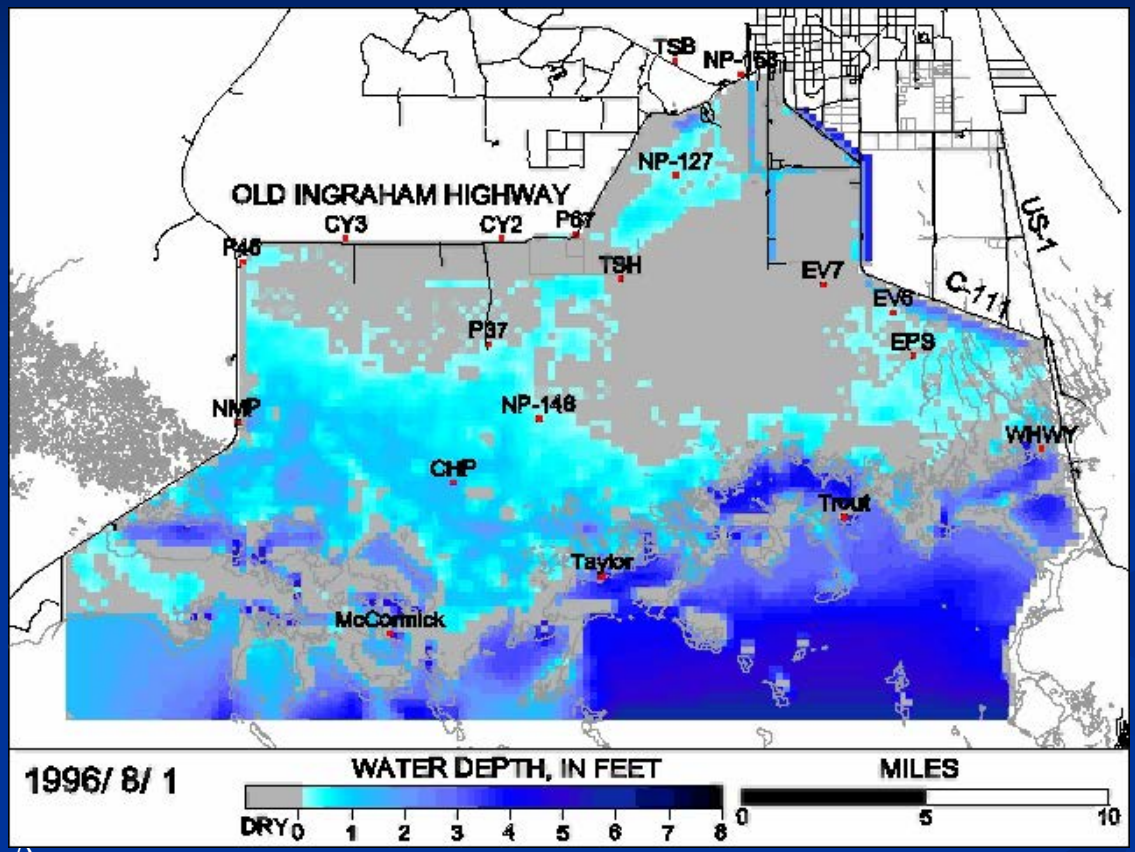
TIME Model

(The Tides and Inflows in the Mangroves of the Everglades).



- TIME model investigates the interacting effects of freshwater inflows and coastal driving forces in and along the mangrove ecotone of the Everglades National Park.
- The TIME model domain encompasses the entire - interface zone along the southwest Gulf coast and Florida Bay boundaries of Everglades National Park (ENP).

TIME Model



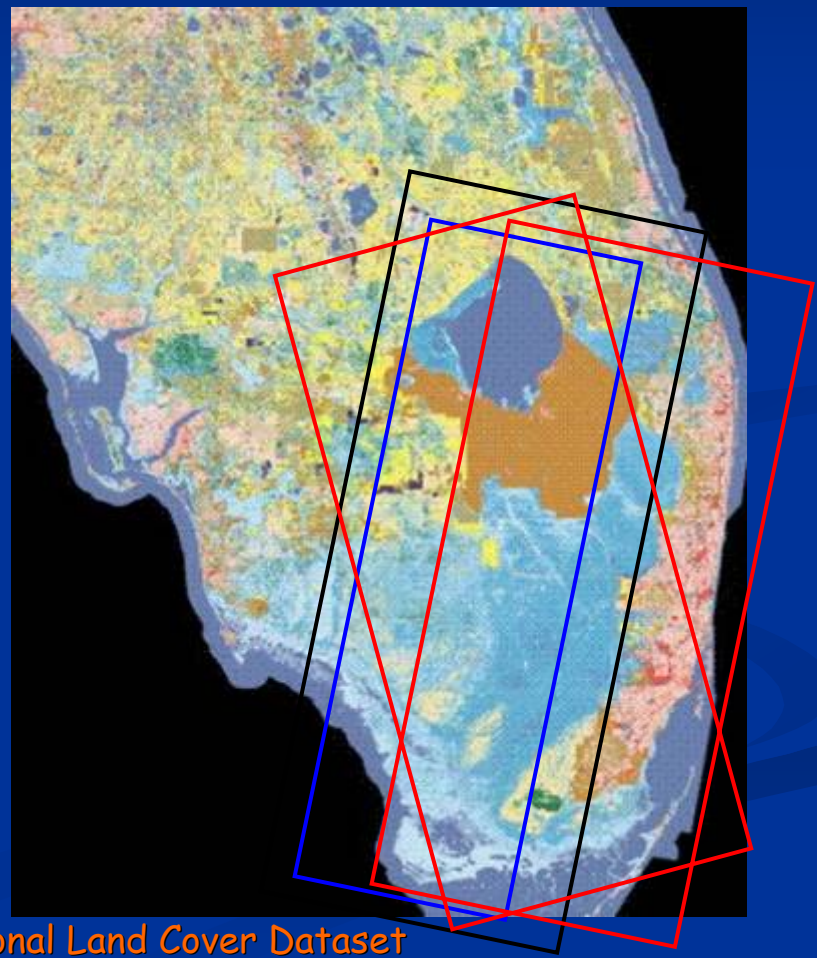
(http://time.er.usgs.gov/)

- The model has been calibrated for the 1996-2002 time period, using stage data.
- One of output is water depth levels (500 m resolution).

SAR Dataset

SAR data acquired during 1996-2002 are used for the study

- 2 JERS-1 (1996)
- 18 ERS-1/2 (1996-1998)
- 20 RADARSAT-1 S1 mode descending and ascending (1997-1998)

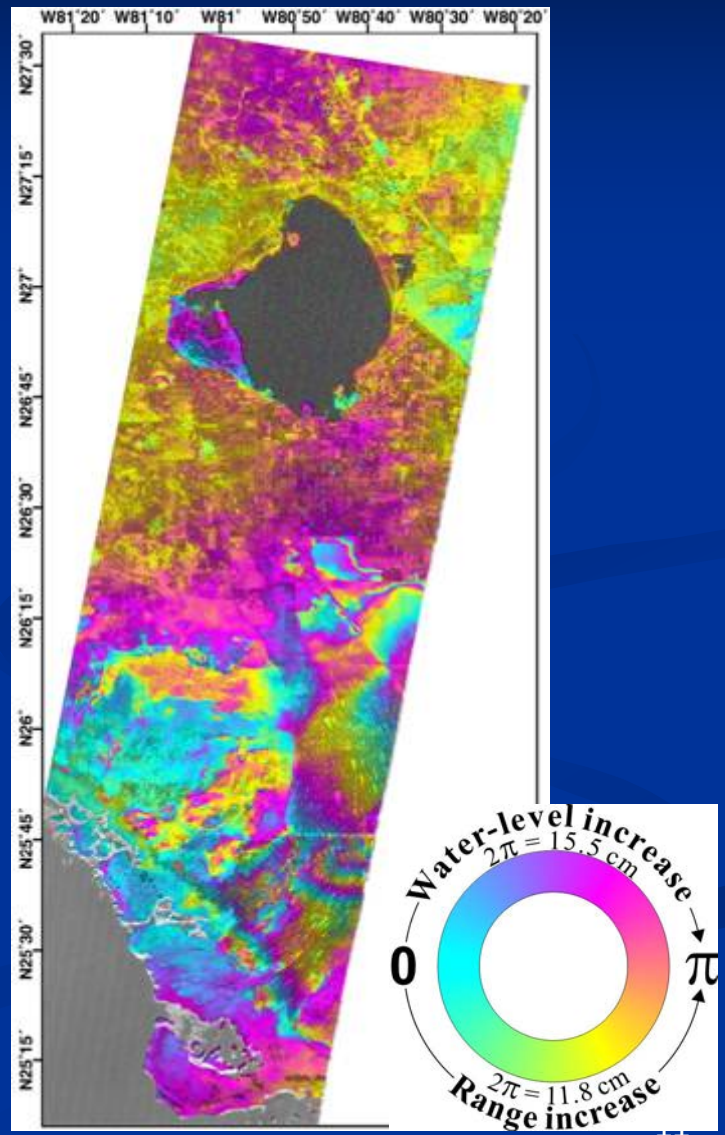


National Land Cover Dataset
(http://seamless.usgs.gov)

JERS-1 InSAR Measurements

- JERS-1 (1992-1998)
  - L-band (23.5 cm wavelength)
  - HH polarization
  - look-angle of 35°
  - 75 km swath width
  - 18 m pixel resolution
  - 44 days repeat orbits

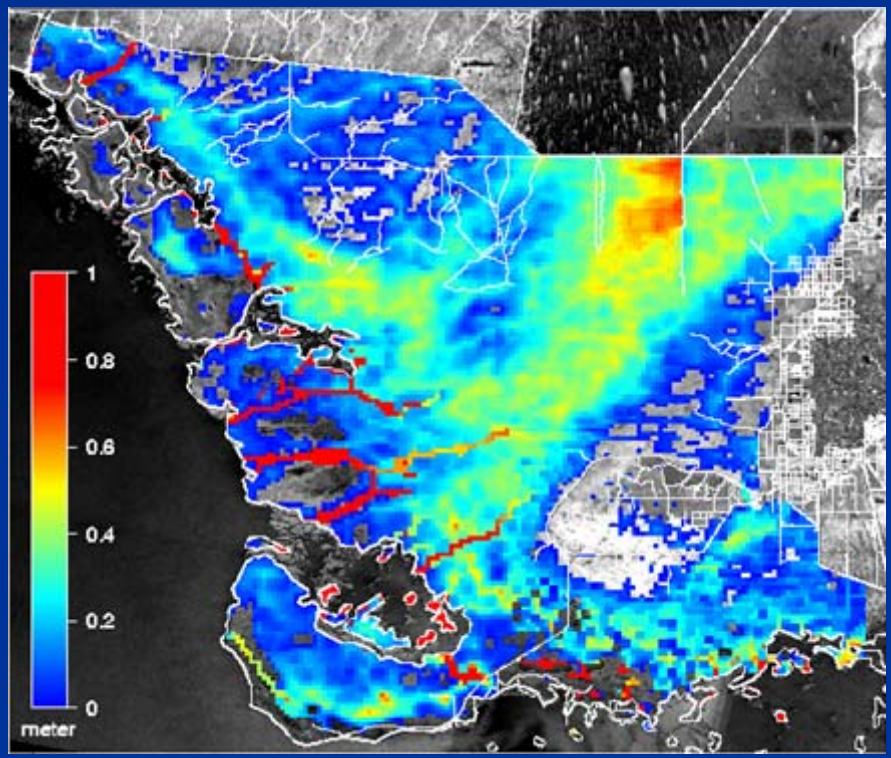
One color cycle (2π)
= 15.5 cm water level change



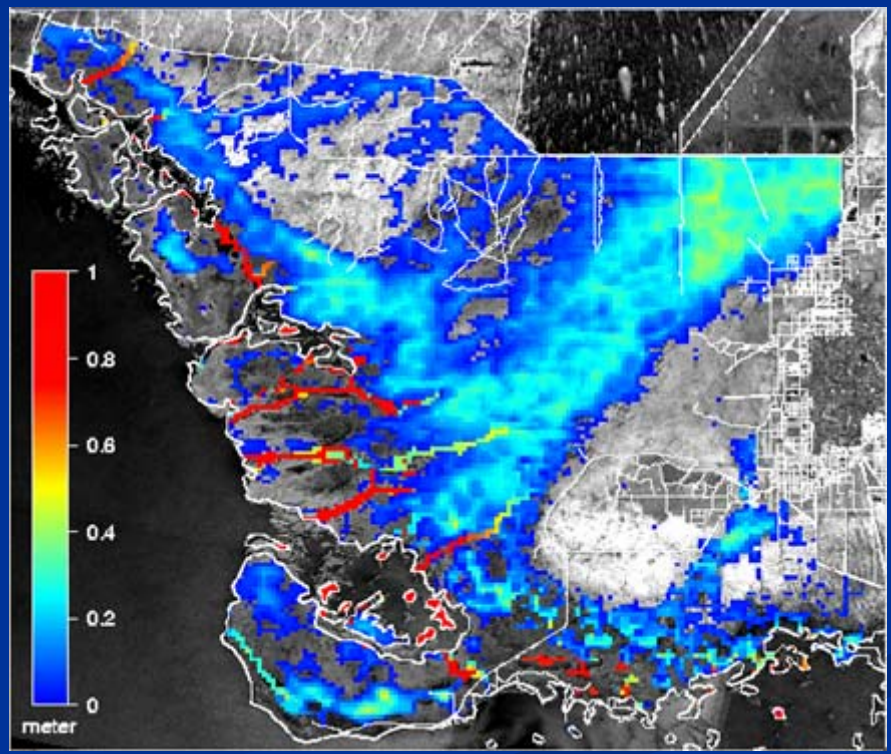
Master SAR image: 1996/01/20
Slave SAR image: 1996/03/04

TIME Model (Surface water depth)

1996/01/20

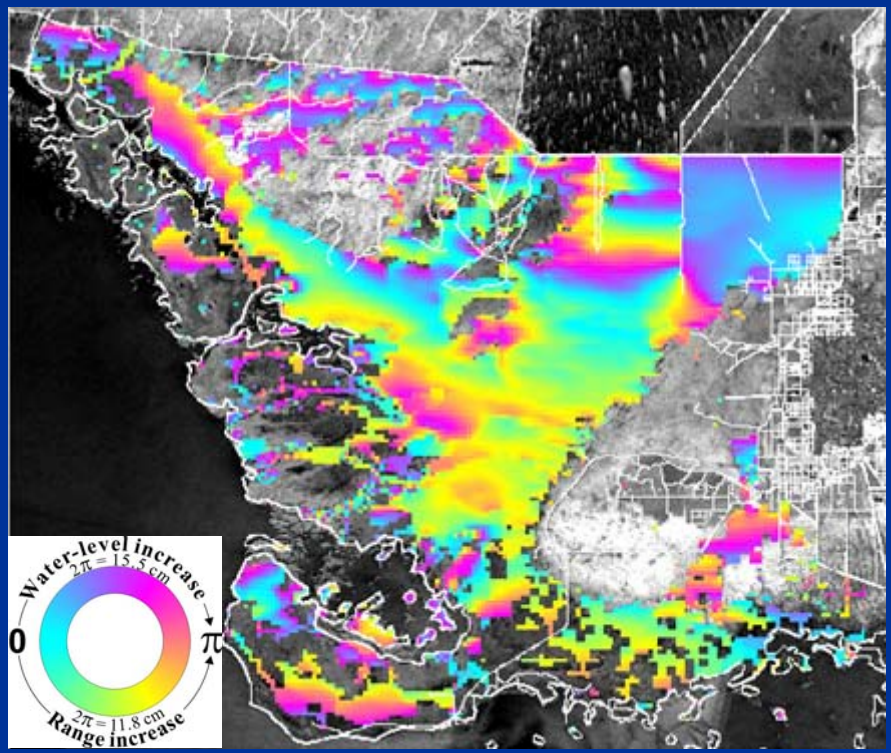


1996/03/04

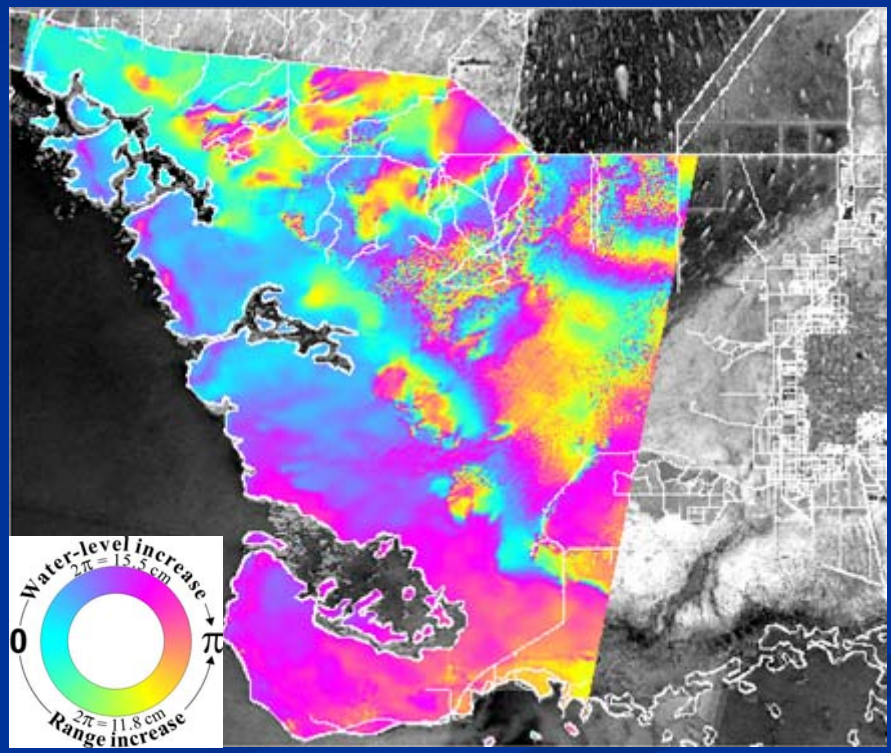


Water Level Change Map

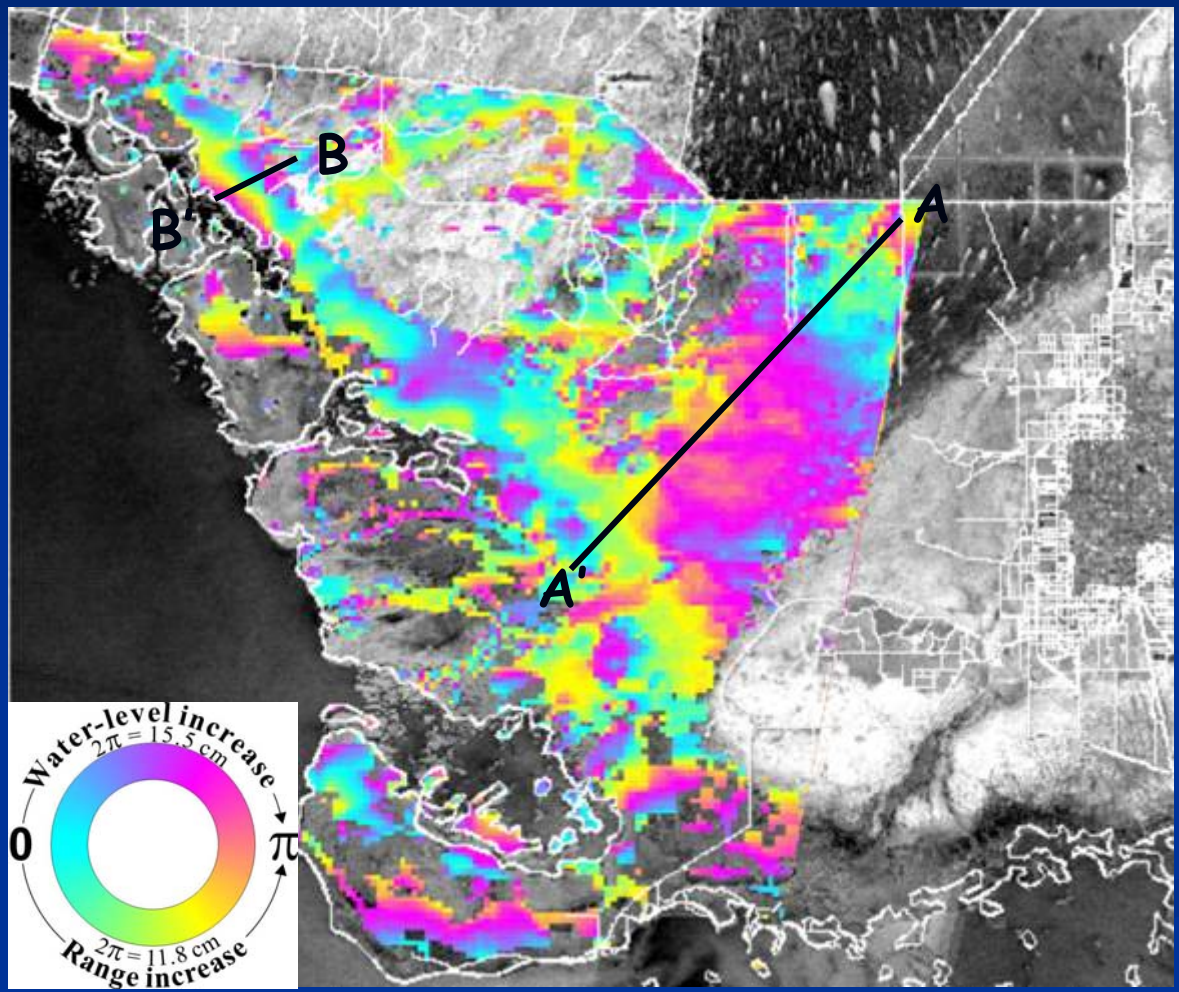
TIME model
1996/01/20-1996/03/04



InSAR measurement
1996/01/20-1996/03/04



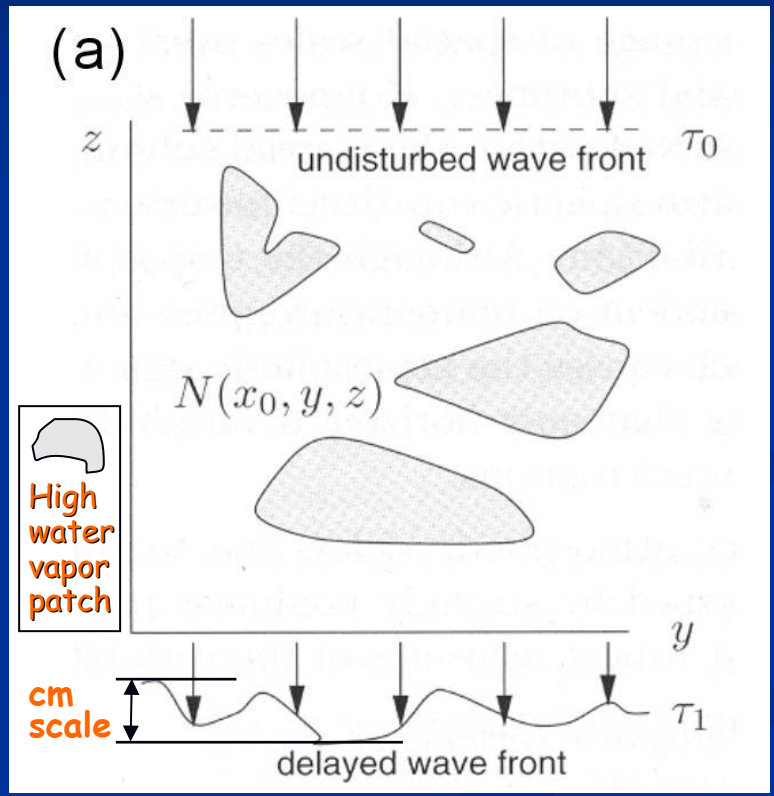
TIME model – InSAR



A–A': 20 cm

B-B': -30 cm

Atmospheric effect in InSAR

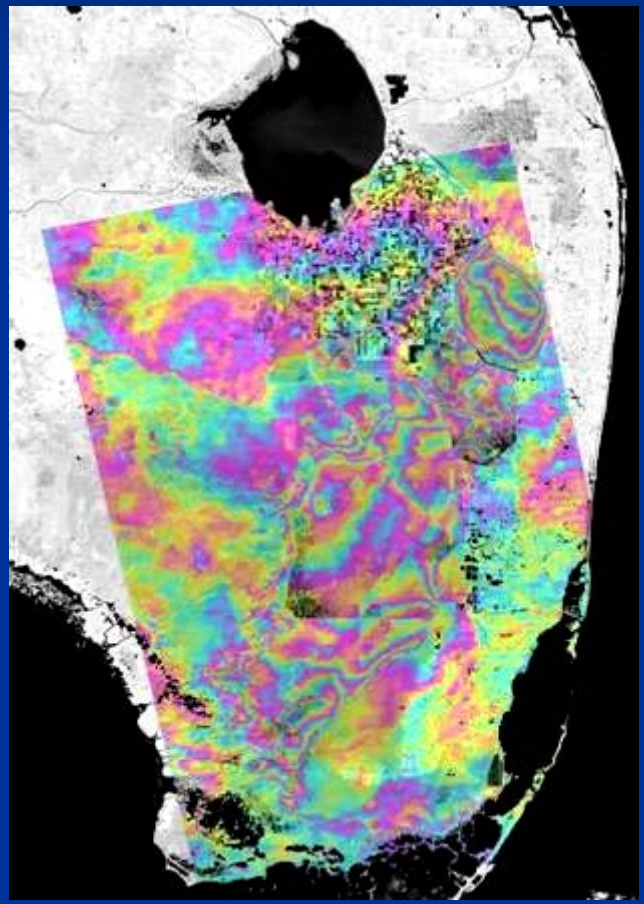


RADAR remote sensing is an `active` imaging technique that utilises the microwave region (~1-100 cm) that can penetrates the clouds.

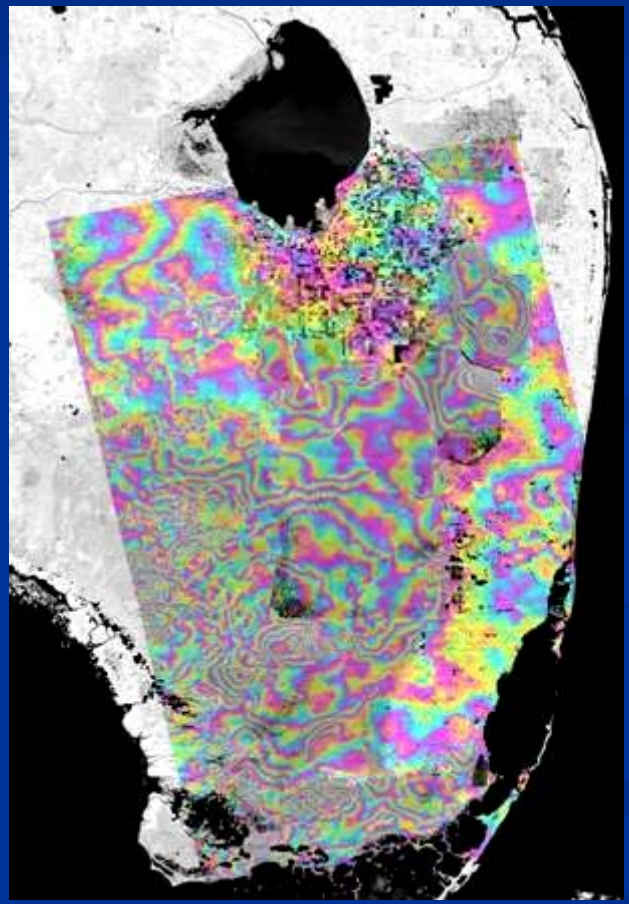
RADARSAT-1 InSAR Measurements

(1997-1998)

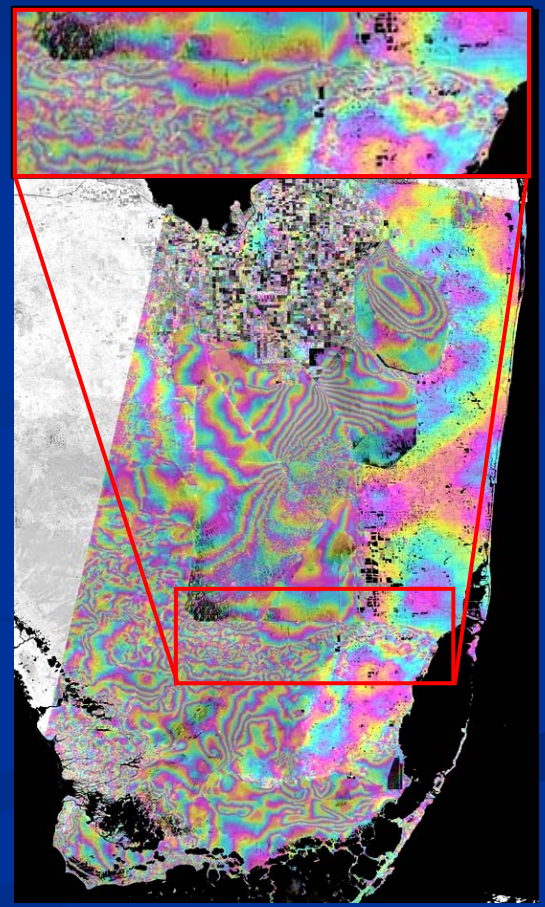
(1997/02/19-1997/03/15)



(1997/07/13-1997/08/06)

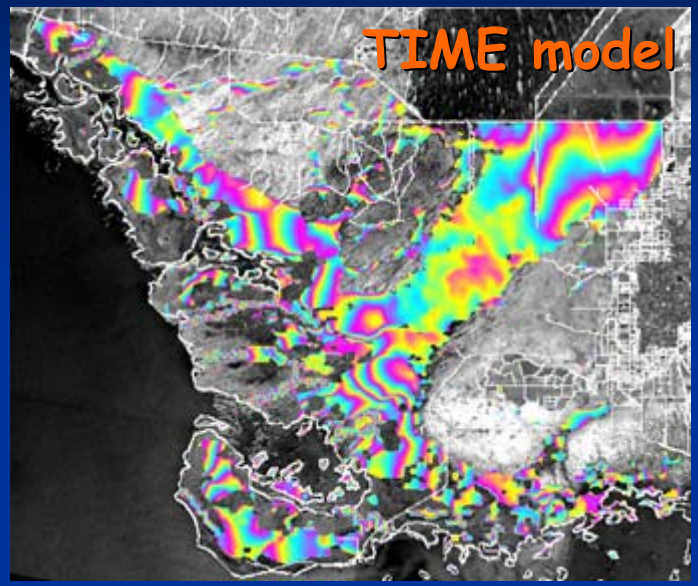


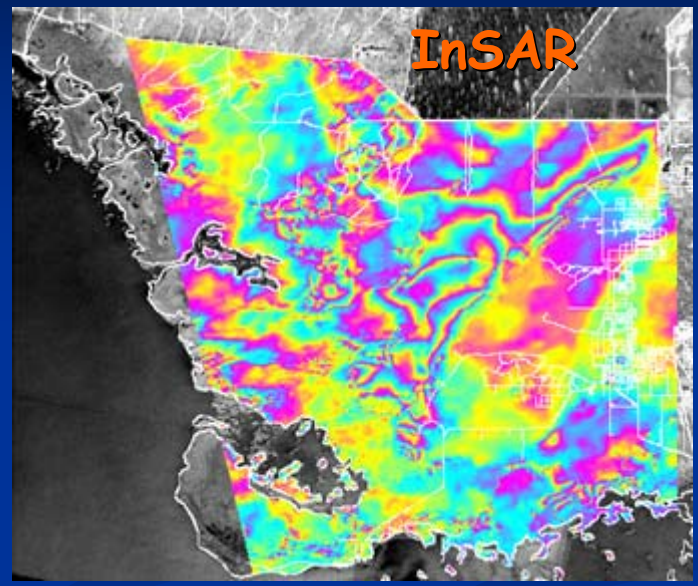
(1998/09/16-1998/10/10)

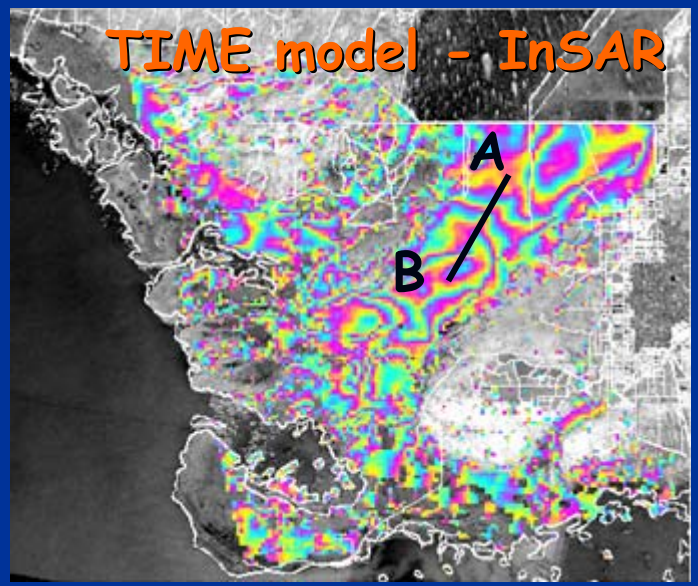


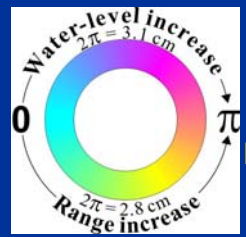
RADARSAT-1 InSAR Measurements

(1997/02/19-1997/03/15)









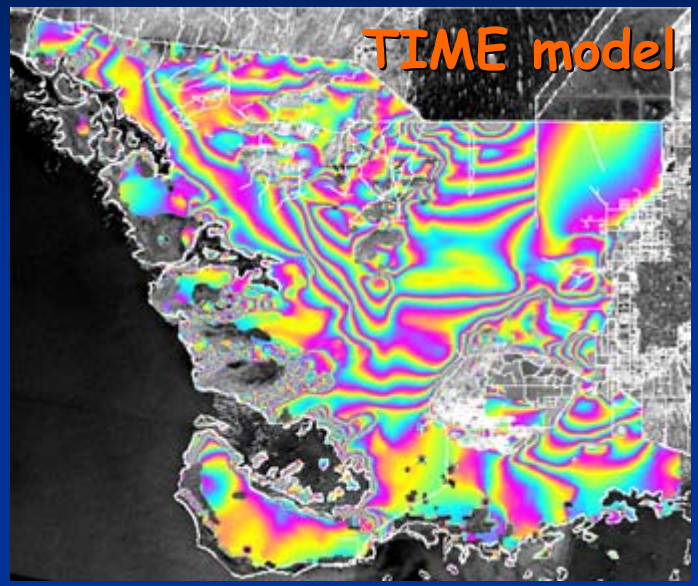
A–B:
-12 cm

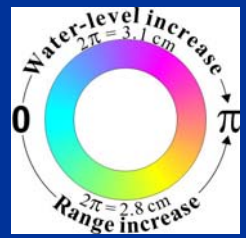
- RADARSAT-1
  - C-band (5.6 cm wavelength)
  - HH polarization
  - look-angle of 23.5° (S1)
  - 100 km swath width
  - 20 m pixel resolution
  - 24 days repeat orbits

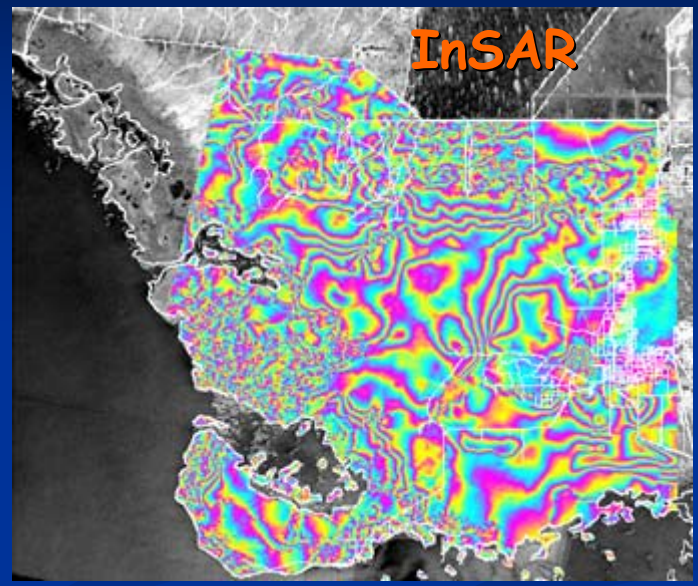
2π = 3.1 cm water level change

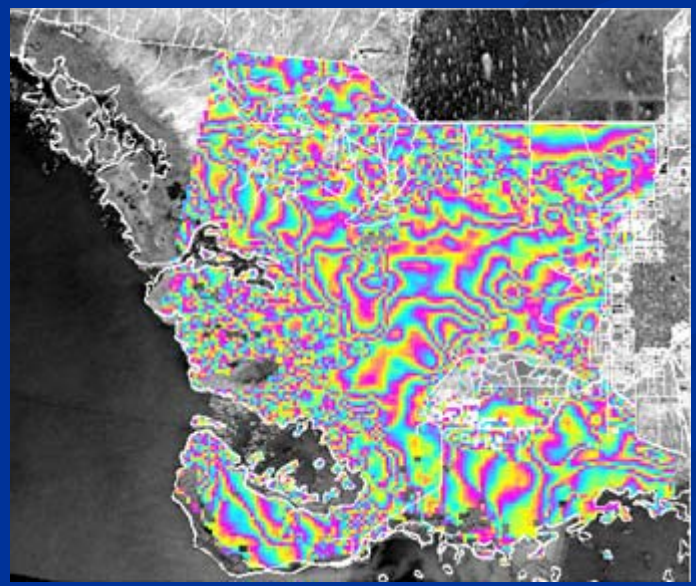
RADARSAT-1 InSAR Measurements

(1997/07/13-1997/08/06)







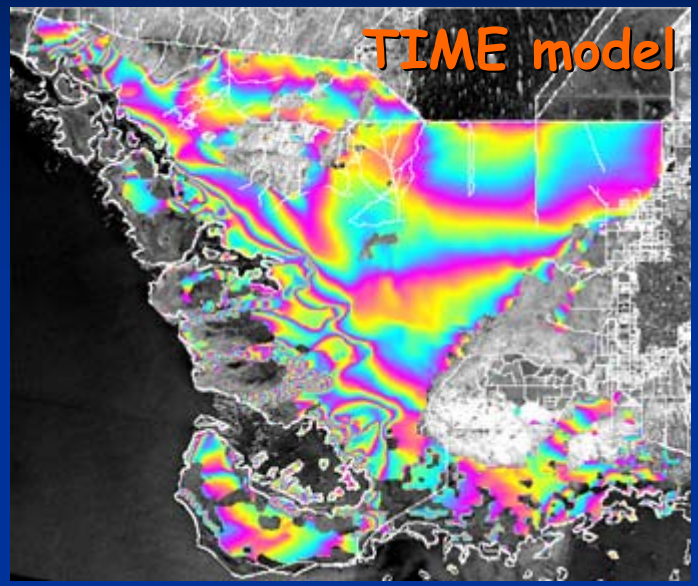


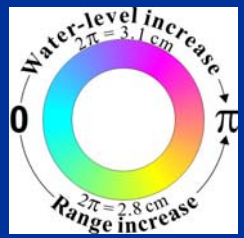
A lot of atmospheric effects

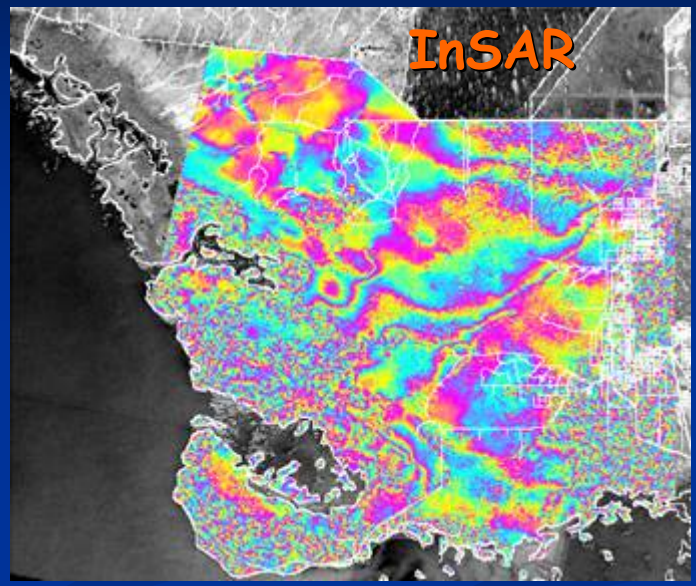
TIME model - InSAR

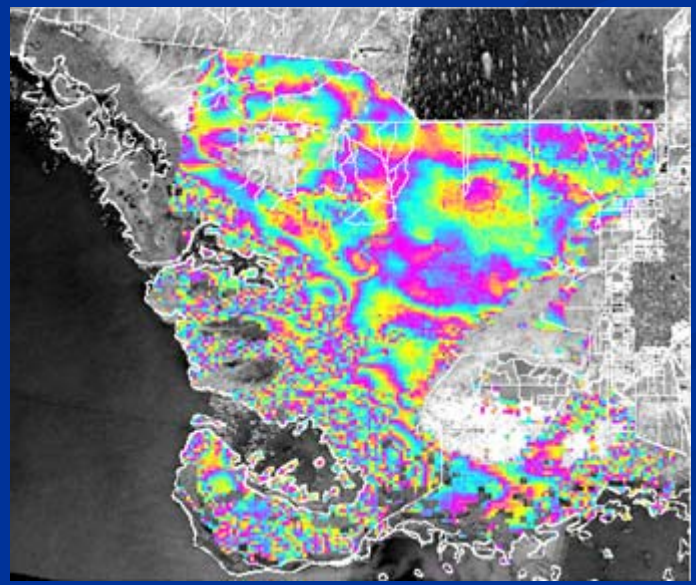
RADARSAT-1 InSAR Measurements

(1998/09/16-1998/10/10)





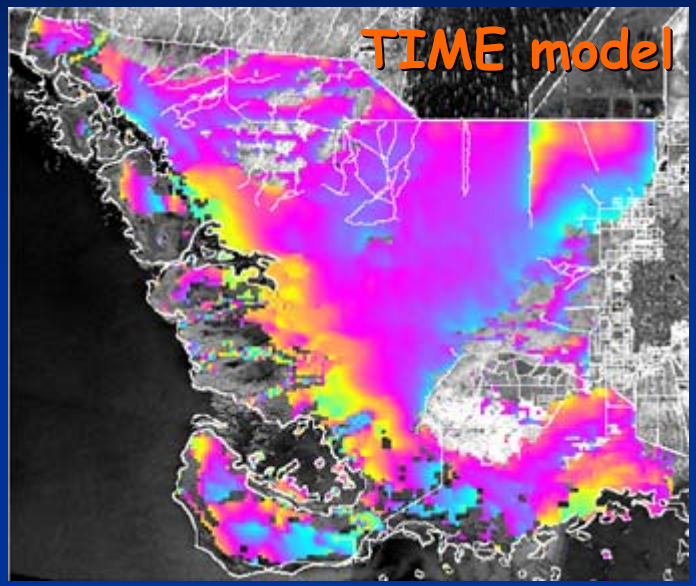


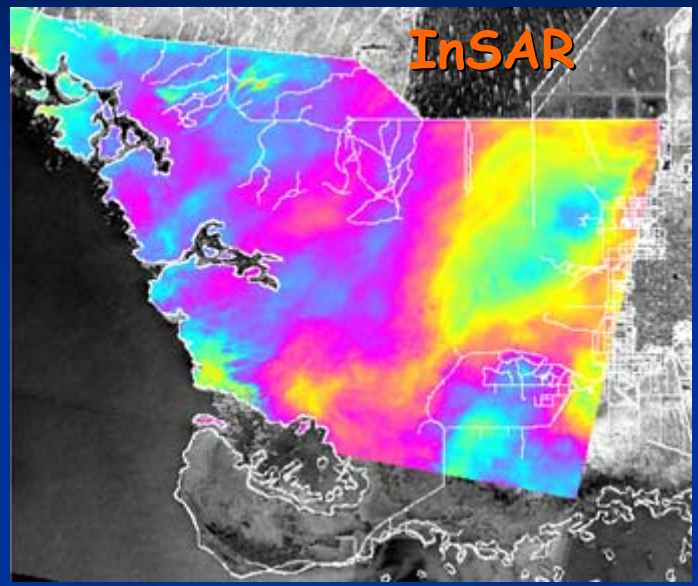


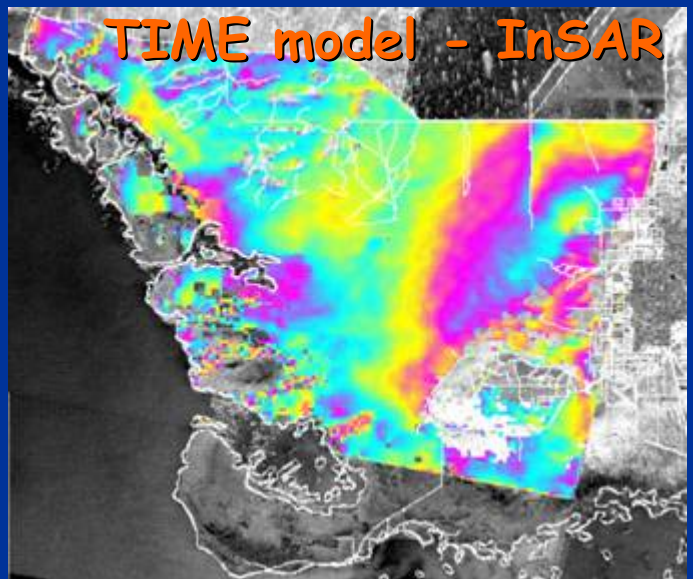
TIME model - InSAR

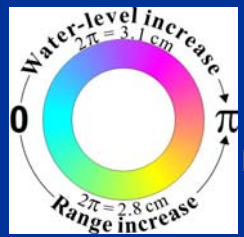
ERS-1/2 InSAR Measurements

(1996/01/15-1996/01/16)







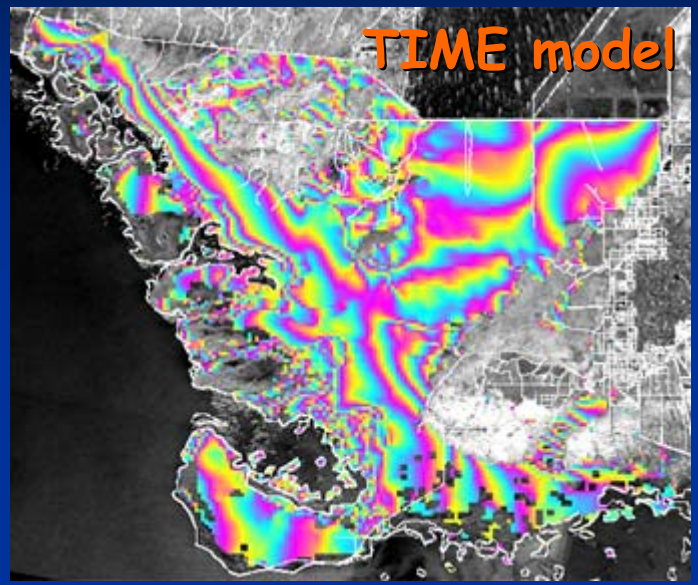


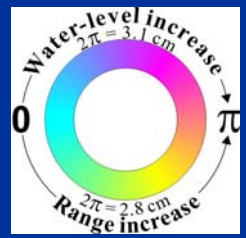
- ERS-1/2
  - C-band (5.6 cm wavelength)
  - VV polarization
  - look-angle of 23°
  - 100 km swath width
  - 25 m pixel resolution
  - 35 days repeat orbits

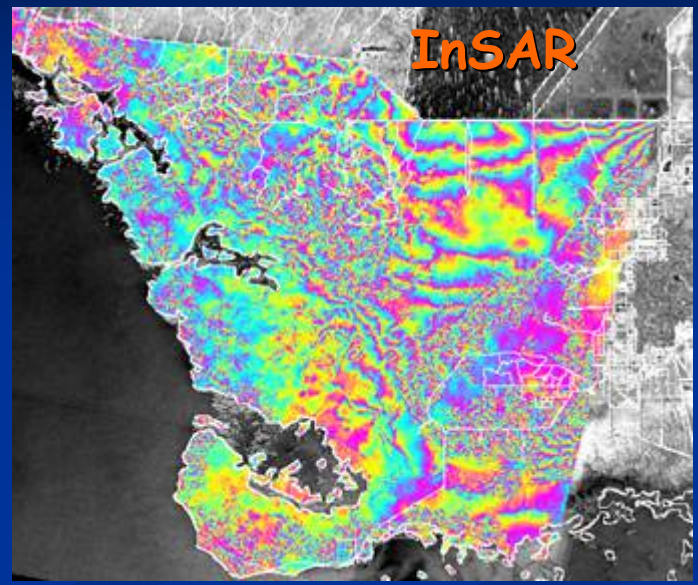
2π = 3.1 cm water level change

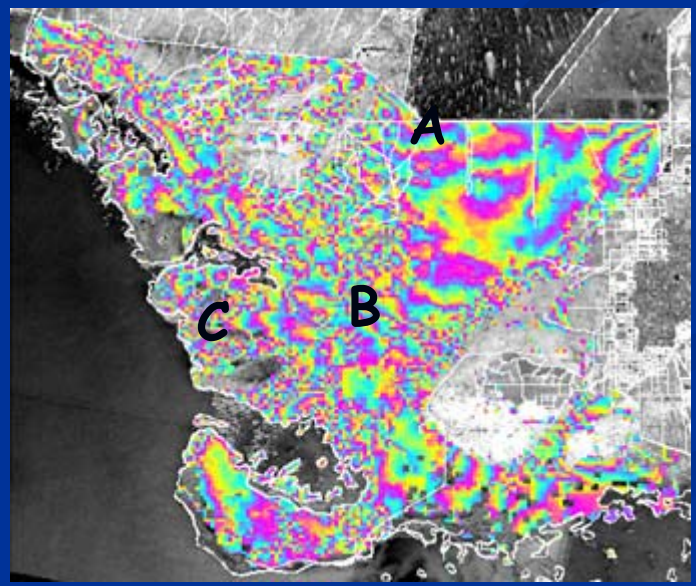
ERS-1/2 InSAR Measurements

(1996/10/22-1996/11/26)







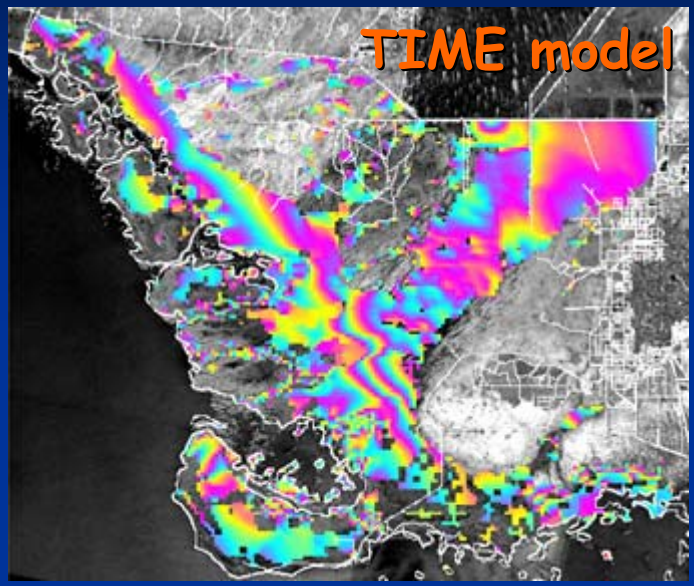


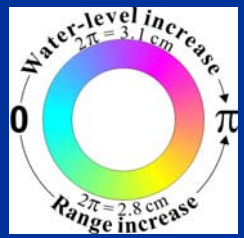
A-B: -18 cm
B-C: 12 cm
A-C: -6 cm

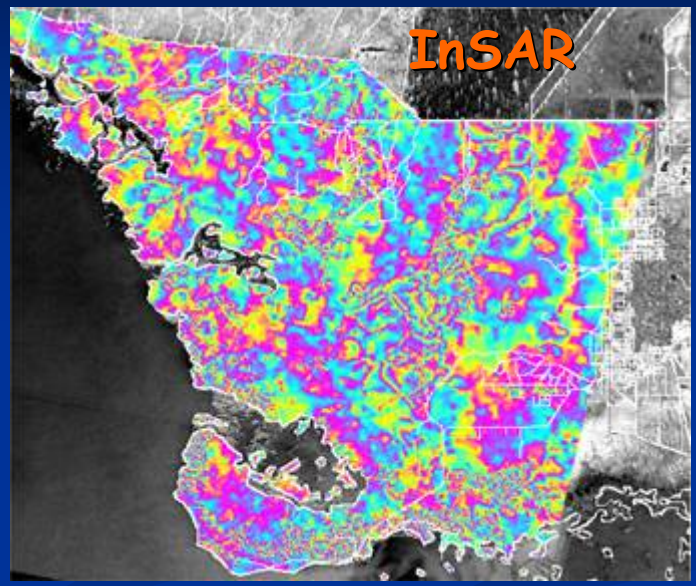
TIME model - InSAR

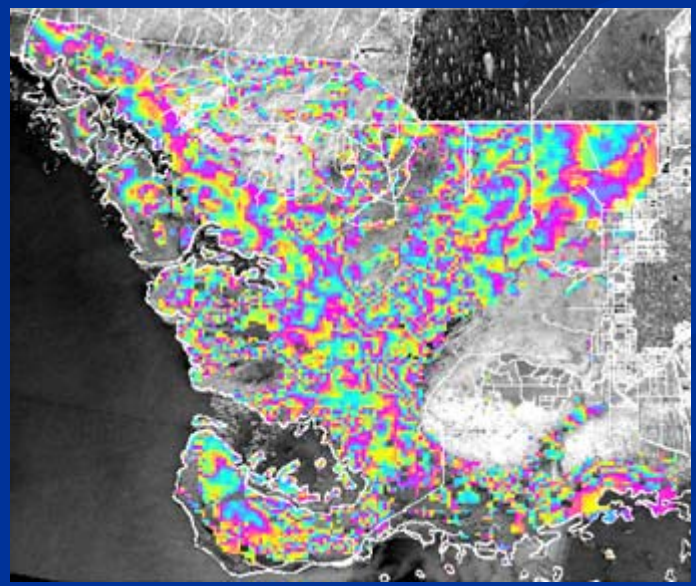
ERS-1/2 InSAR Measurements

(1997/04/15-1997/05/20)









TIME model - InSAR

Summary and future works

- About twenty InSAR-measured water level change maps are produced using JERS-1, RADARSAT-1 and ERS-1/2 and SAR images during 1996-1998.
- 2-D water level maps at the satellite acquisition times are derived from the TIME model simulation and used to synthesize water level change maps comparable to those obtained from InSAR observations.
- Our initial findings show that there are differences of about 10-20 cm in water level change map and also differences in pattern, especially in interface zone along the southwest Gulf coast.
- These preliminary results show the great possibility of InSAR in wetlands Hydrology study.

- Future works
  - Comparing with the gage station data as well as the model data.
  - Generation of more possible InSAR pairs without atmospheric effect.
  - Comparison of the recent InSAR measurements (2005) with EDEN (Everglades Depth Estimation network) model.