

# Remote Sensing Observations of Tide Propagation through Coastal Wetlands

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- Coastal wetlands
- Remote sensing technique – InSAR
- InSAR observations
- Significance
- Summary & acknowledgements



# Coastal wetlands

Coastal wetlands are found in the 'transition zone' between land and sea, having both upland and aquatic characteristics.

- **Considered among the most productive ecosystems on earth.**
- **Important economic values**  
*(flood protection, filter nutrients, carbon sequester, recreation ...)*
- **Their existence is presently being threatened by climate change (sea-level rise) and human interference (e.g. development).**



*Vice-mayor DuBois' house before and after he illegally cut mangroves*



# Tidal flow through coastal wetlands

- These fragile ecosystems depend on a continuous water and nutrient replenishment by ocean tidal flow.

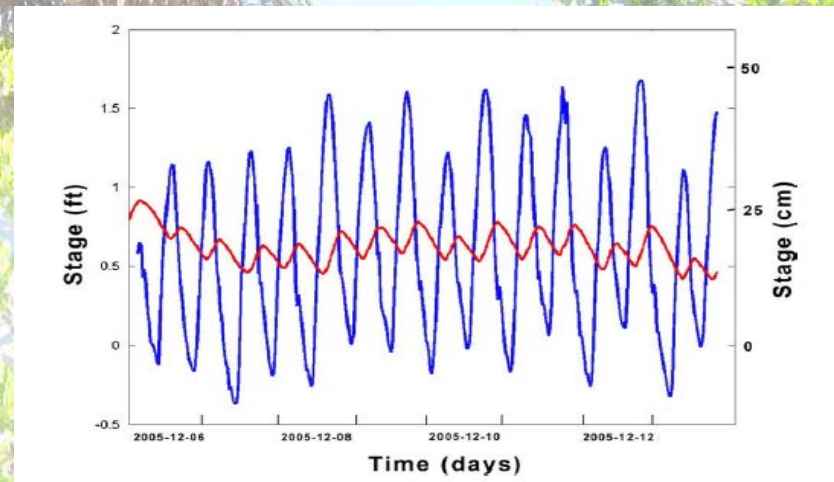


**Road construction in the Sian Ka'an wetlands (Yucatan) cut tidal flow circulation and destroyed a large mangrove forest.**



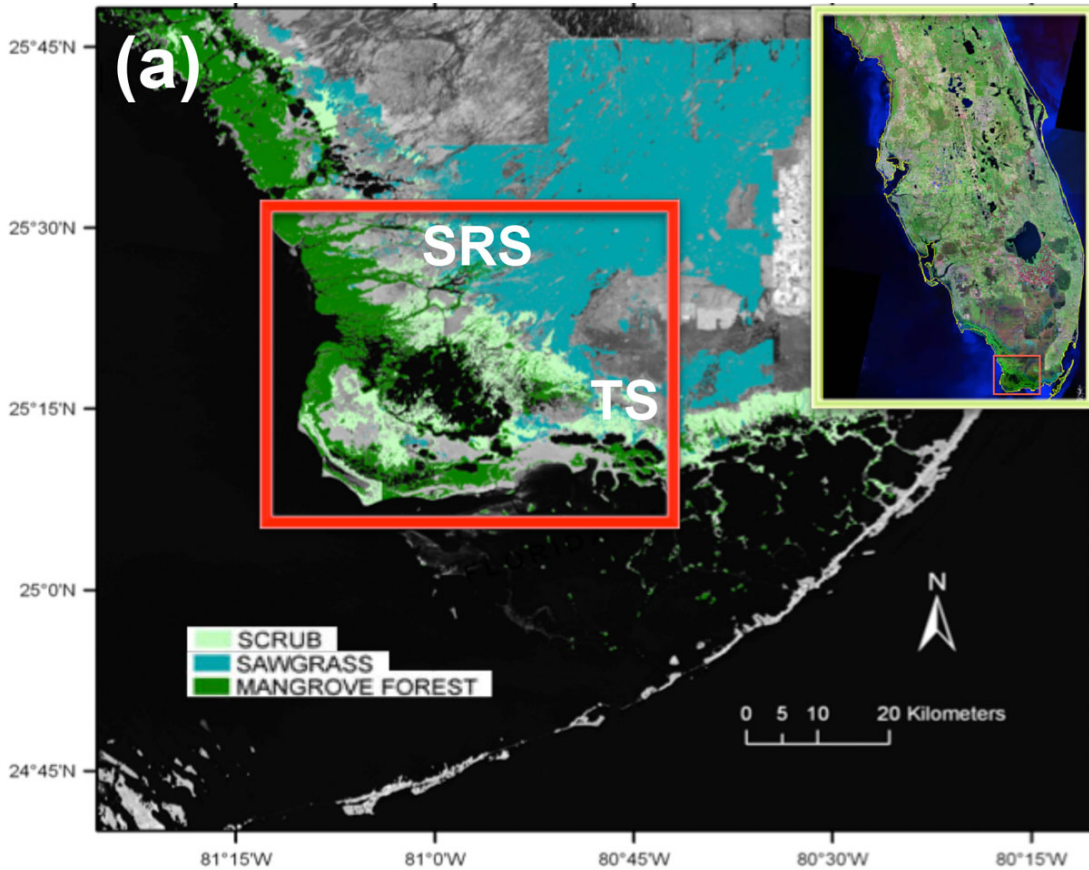
# Tidal flow through coastal wetlands

- While ocean tides are well known and forecasted, tidal flow movements through coastal wetlands are poorly known because vegetation resists and delay the tidal flow.
- The flow is monitored by stage (water level) stations
  - High temporal but low spatial resolution
  - Located in accessible areas, typically along tidal channels



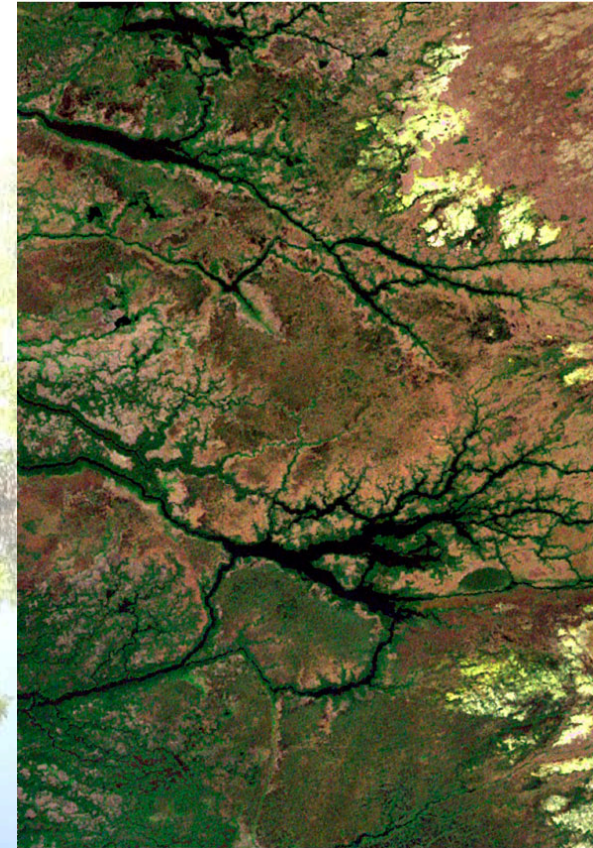


# Study area- Western Everglades





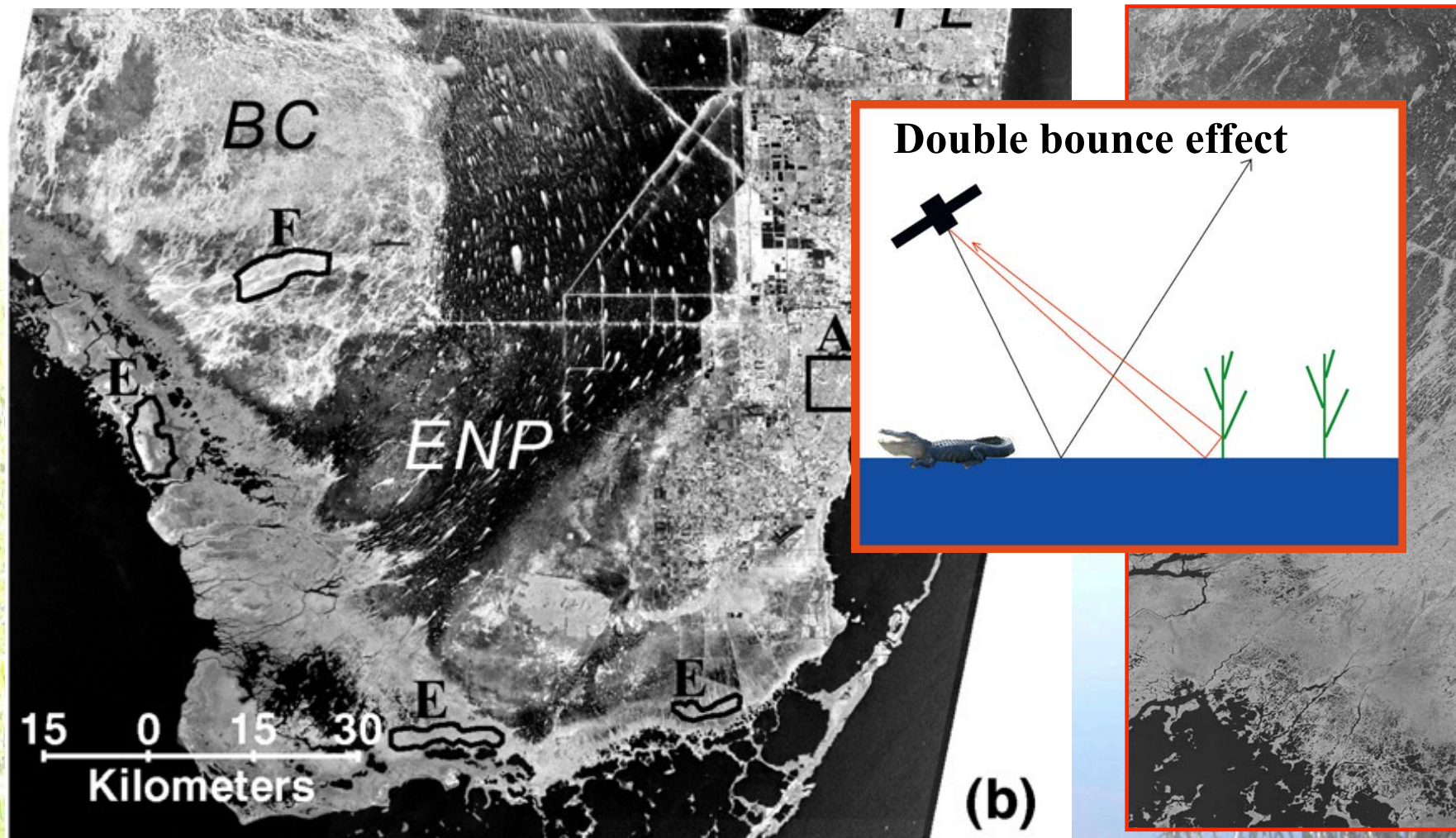
# Remote sensing of Coastal wetlands



**Optical data: sensitive to vegetation not to water flow**



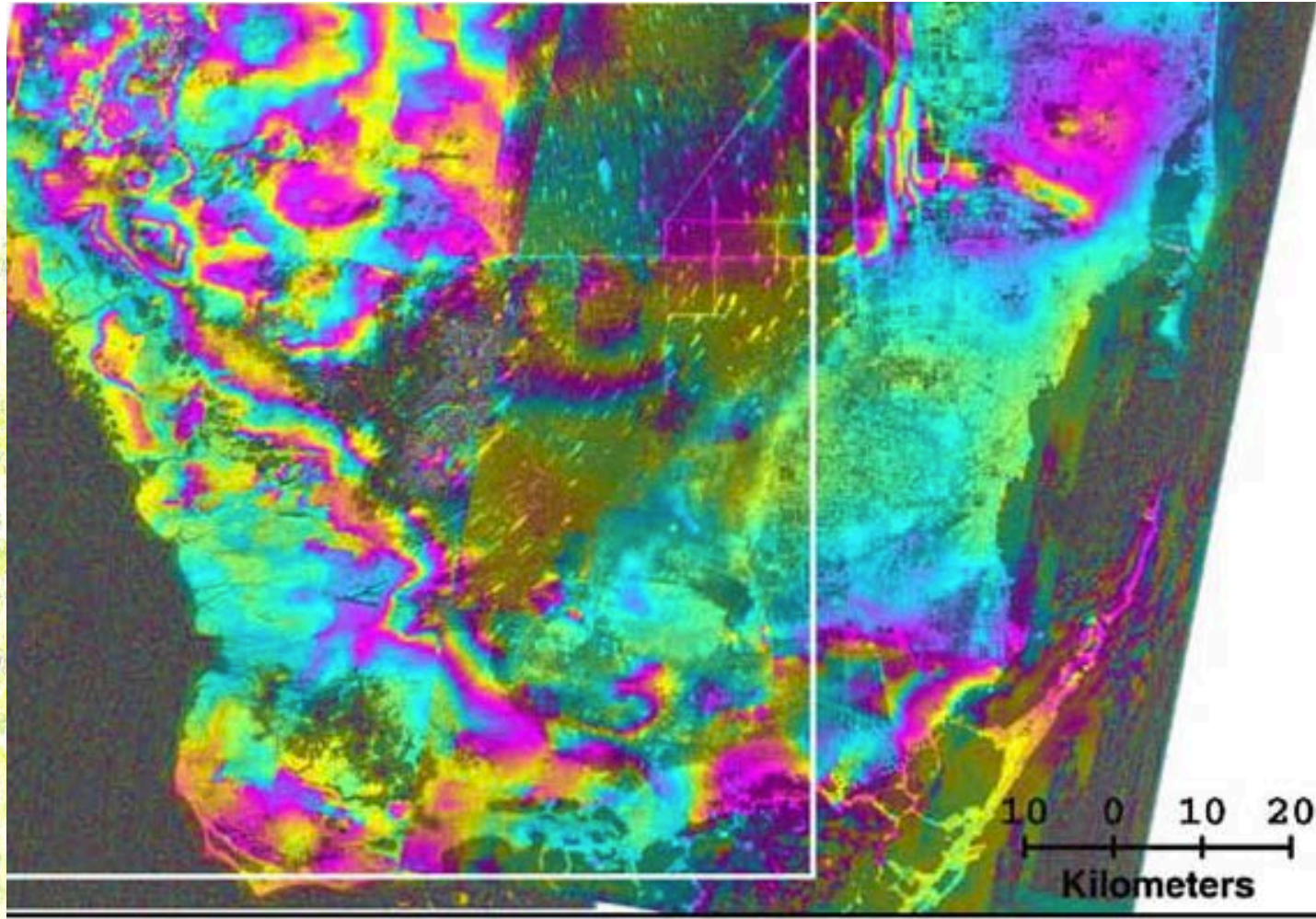
# Radar (SAR) remote sensing



**Radar amplitude data: also sensitive to vegetation**



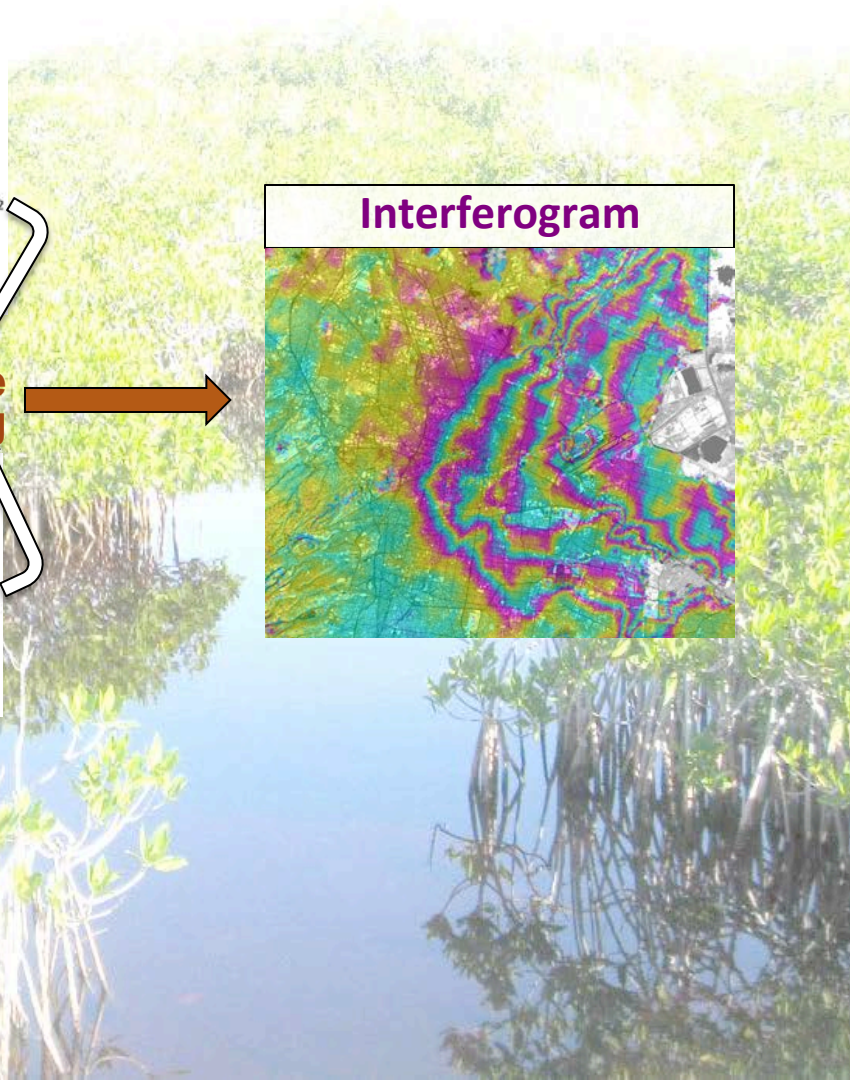
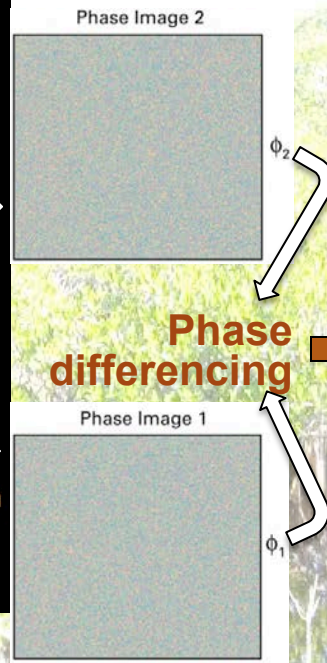
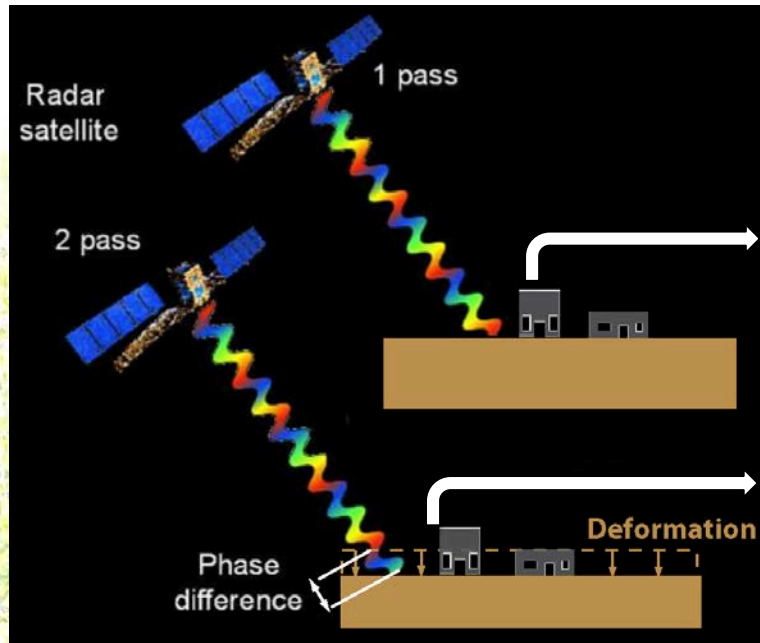
# SAR Interferometry (InSAR)



**Radar phase data: sensitive to water level changes**

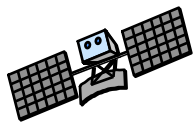


# What is InSAR?



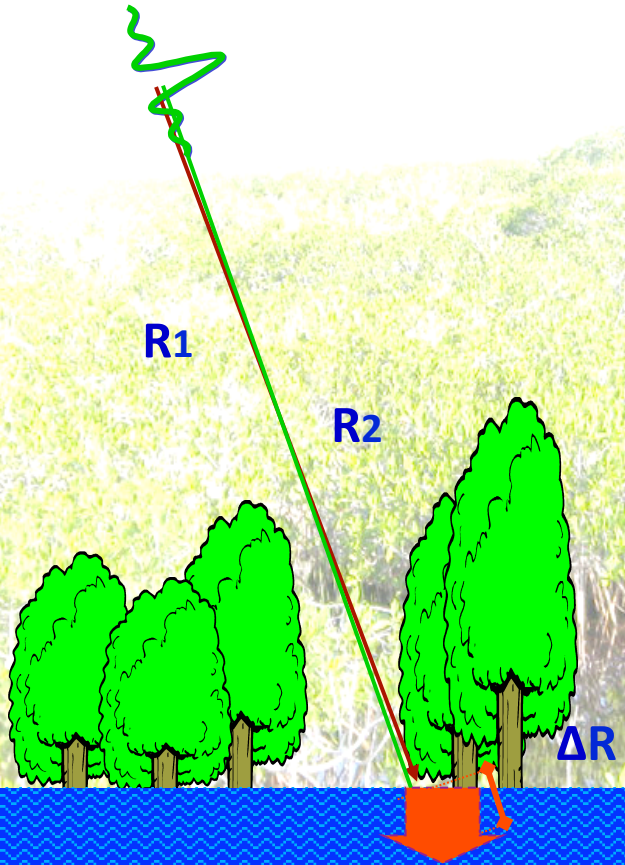


# Water level change measurements



1<sup>st</sup> acquisition  
2<sup>nd</sup> acquisition

$\Delta t = 24$  day  
(RADARSAT)

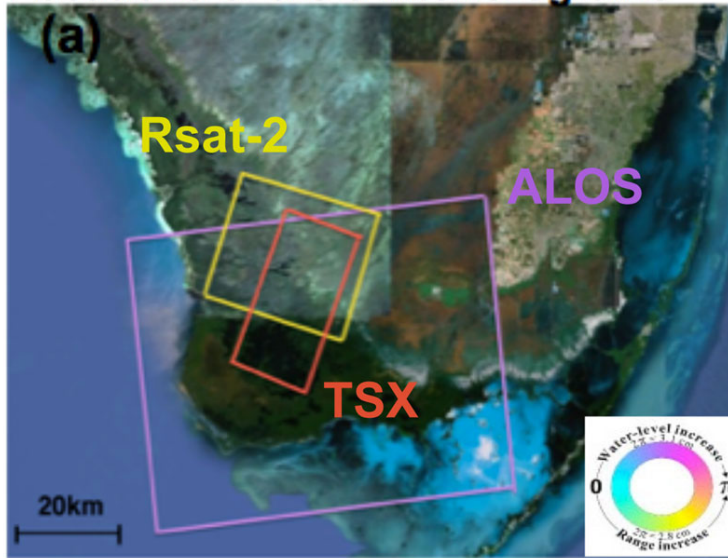


Water level change  
measurement (1st and 2nd acquisition)

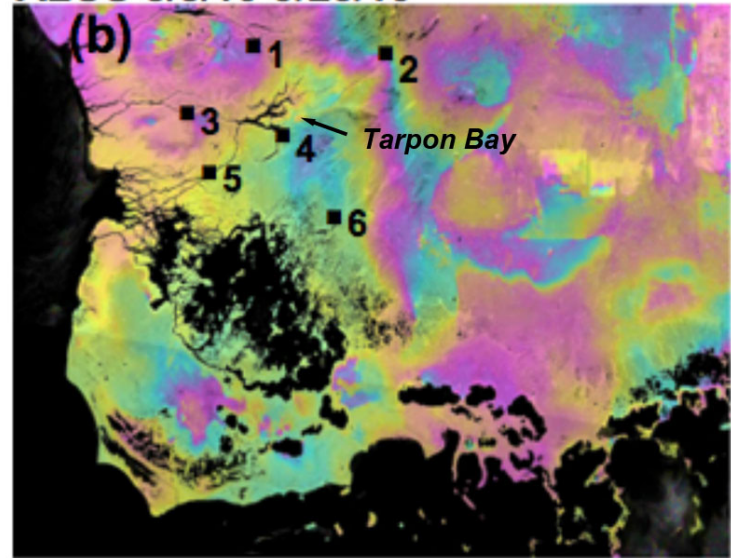


# Interferograms

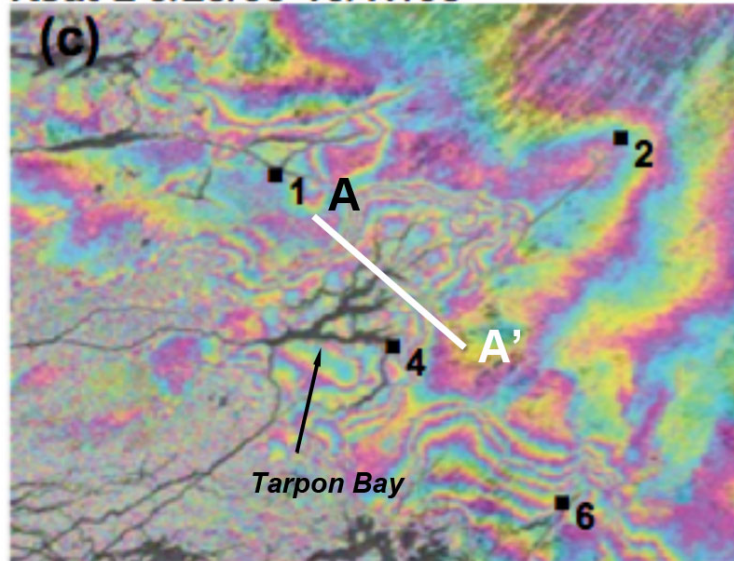
Locations of the 3 interferograms



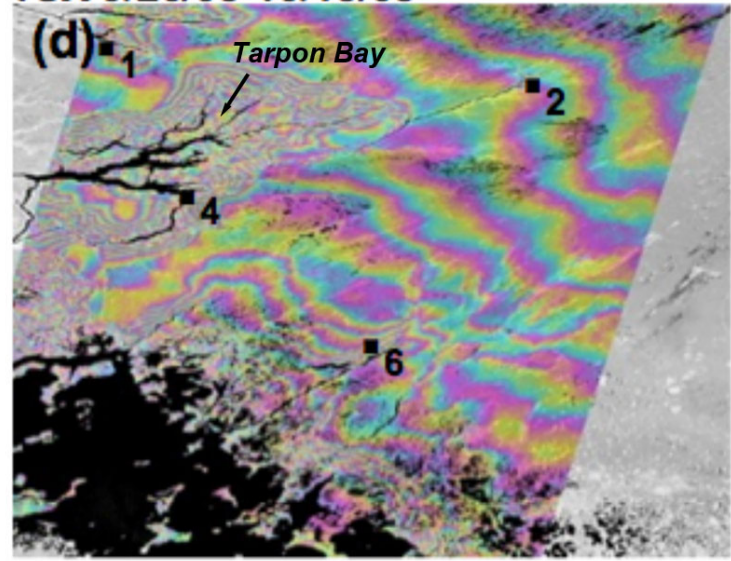
ALOS 8/8/10-9/23/10



Rsat-2 9/23/08-10/17/08



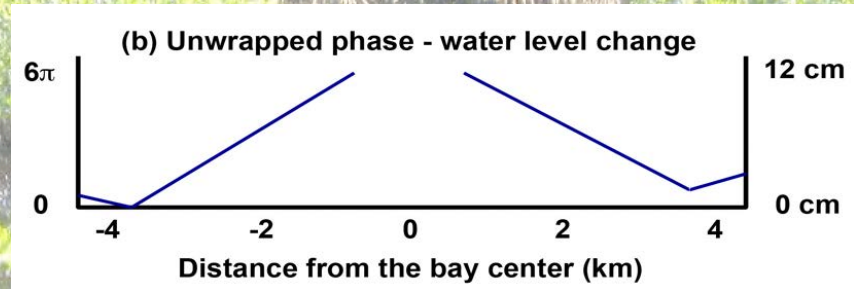
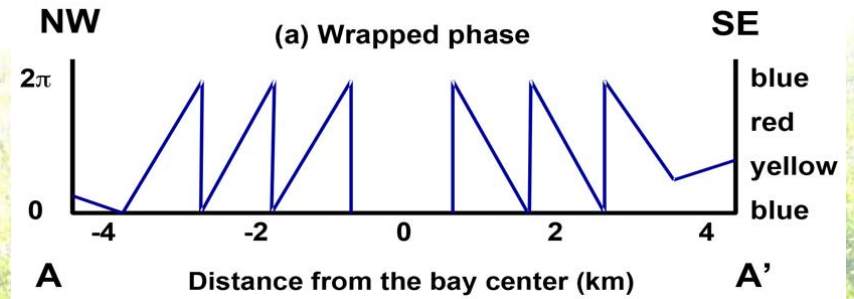
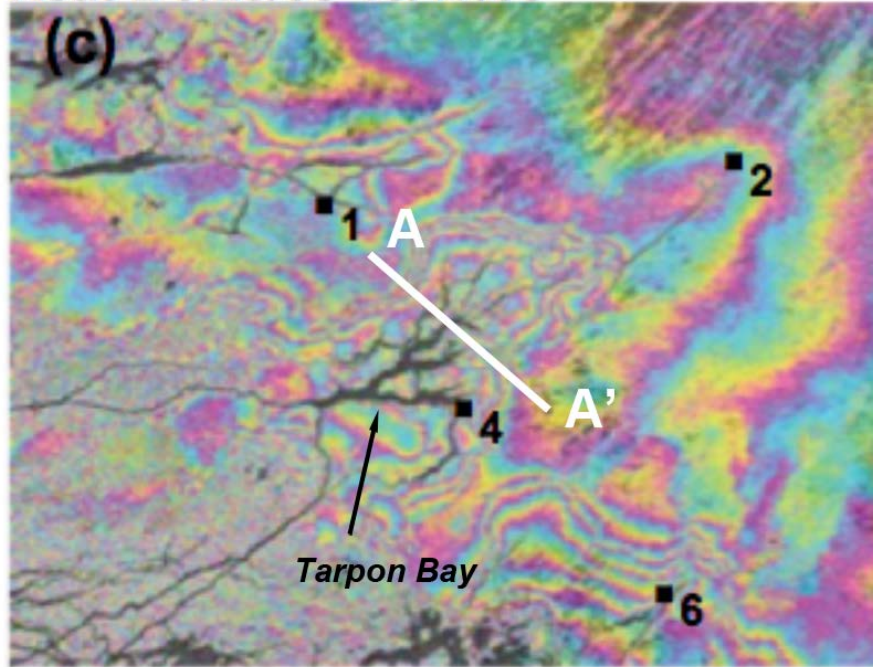
TSX 9/26/08-10/18/08





# From phase to water level change

Rsat-2 9/23/08-10/17/08

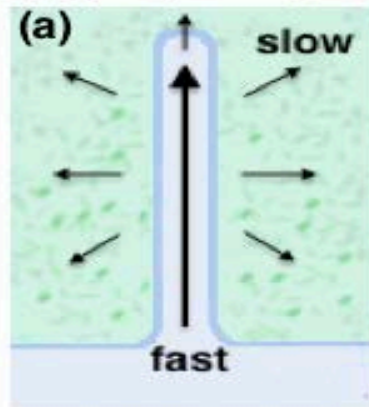




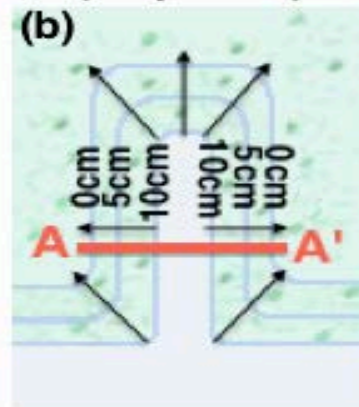
# Tidal-induced water level changes

Ascending  
Tidal  
Conditions

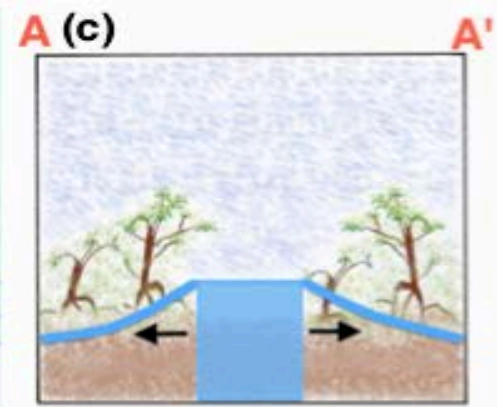
Tidal Channel  
Flow  
(map view)



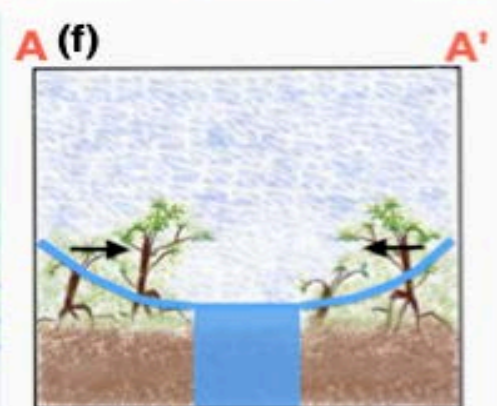
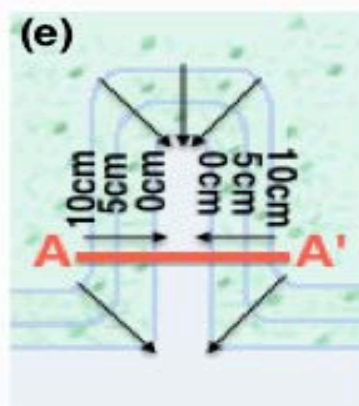
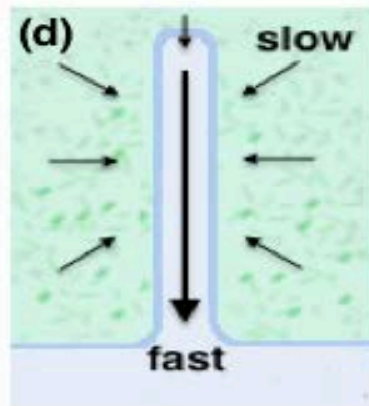
Water Level  
(map view)



Water Level  
(cross section)

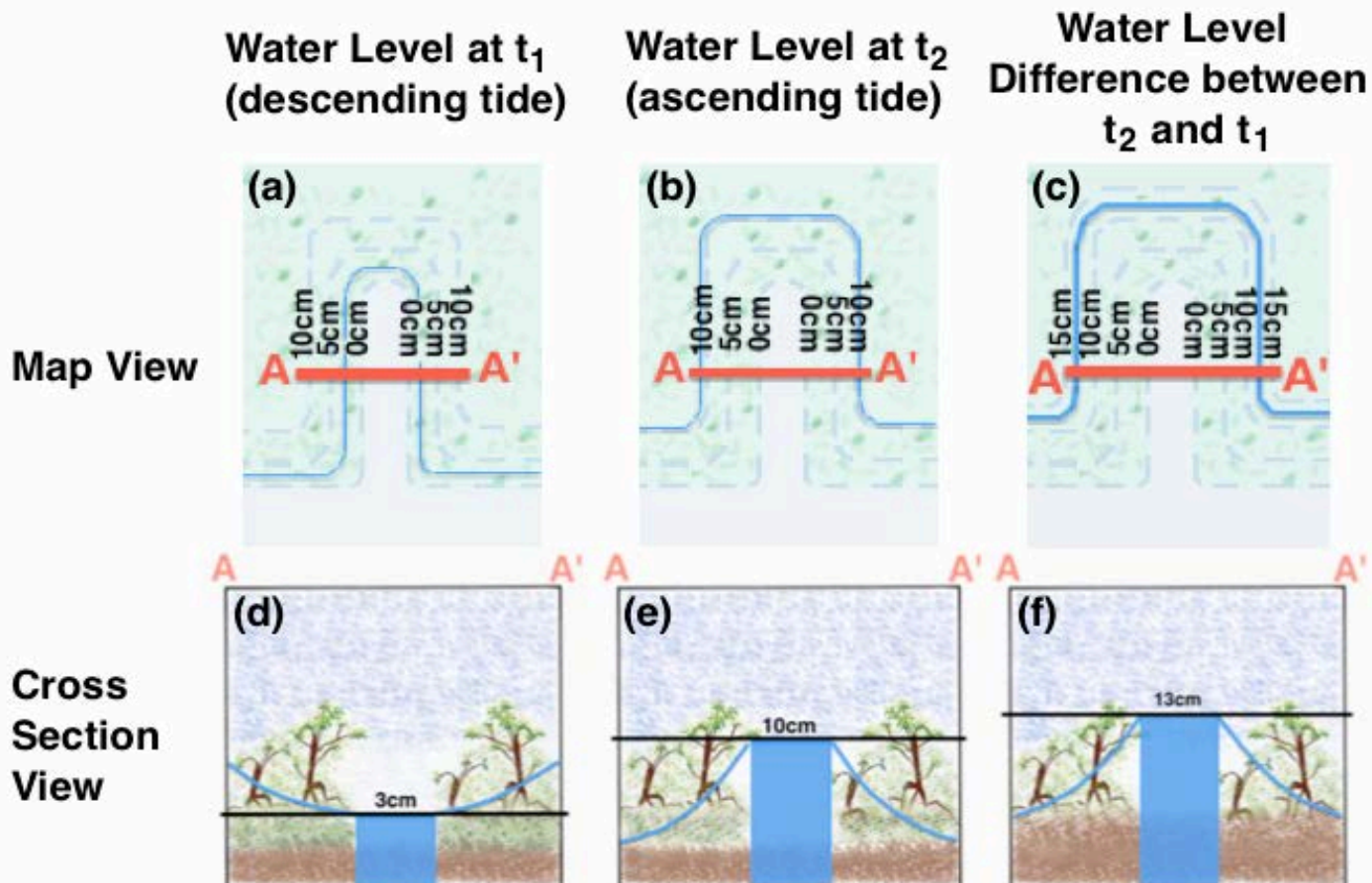


Descending  
Tidal  
Conditions





# Water level changes between two SAR acquisitions

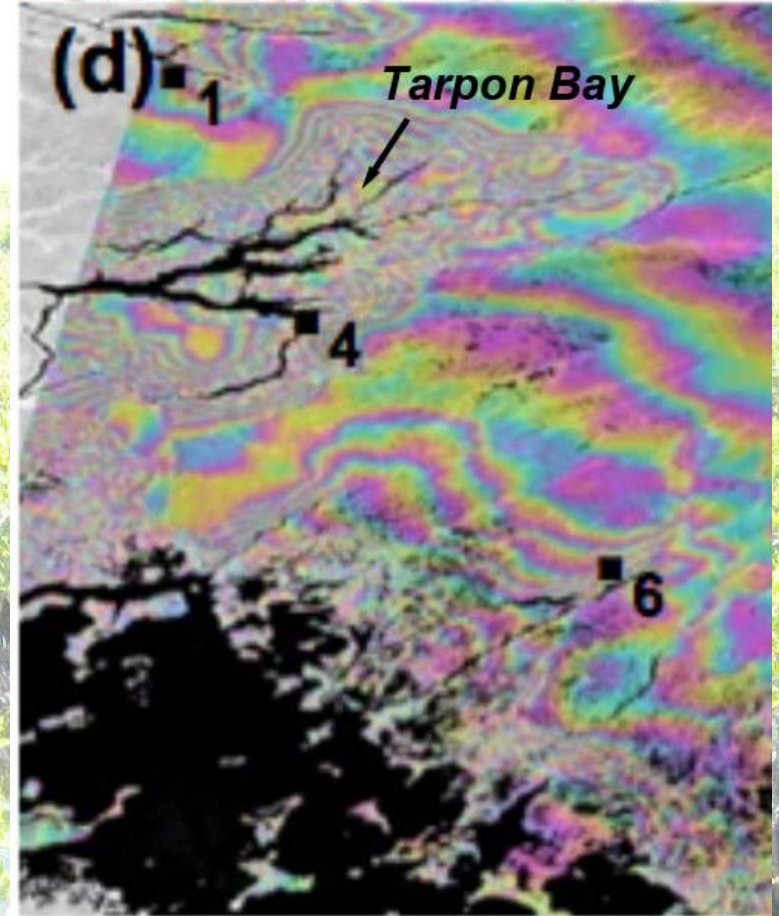




# Significance

- **Characterization of the tidal flushing zone**
  - **Width (2-3 km on each side of the channels)**
  - **Length – a few km beyond Channel's end.**
  - **Seasonal variations – need to be evaluated.**
- **Constraining quantitative flow models of tidal propagation through coastal wetlands.**

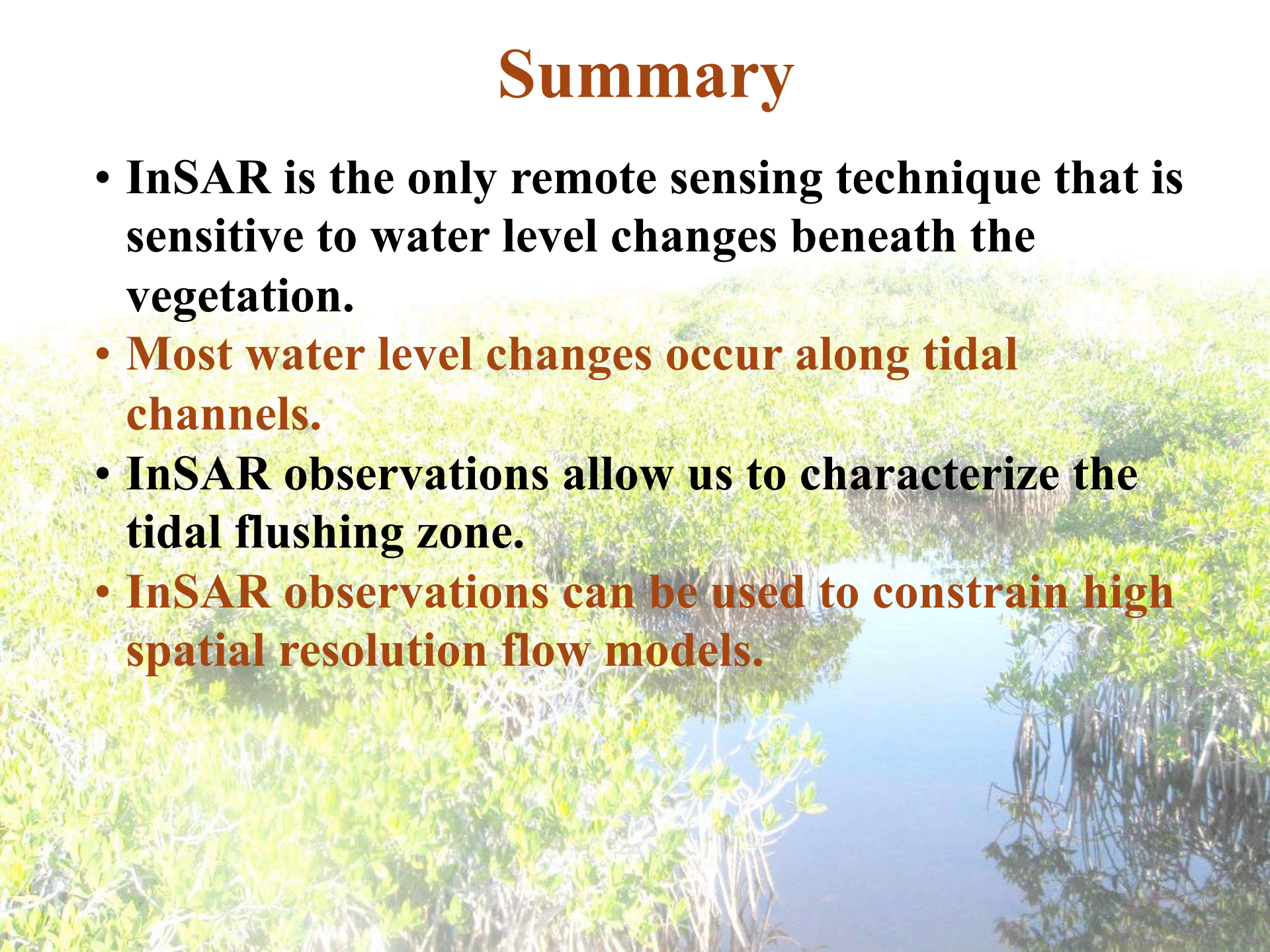
TSX 9/26/08-10/18/08





# Summary

- **InSAR is the only remote sensing technique that is sensitive to water level changes beneath the vegetation.**
- **Most water level changes occur along tidal channels.**
- **InSAR observations allow us to characterize the tidal flushing zone.**
- **InSAR observations can be used to constrain high spatial resolution flow models.**





# Acknowledgements

## SAR data

- JAXA – ALOS, L-band data
- CSA – RADARSAT-2, C-band data
- DLR – TerraSAR-X, X-band data
- ASI– Cosmo-SkyMed, X-band data

## Support

- National Institute for Water Research (USGS)
- NASA
- ONR
- SFWMD