

# Constructing high-resolution, absolute maps of atmospheric water vapor by combining InSAR and GNSS observations

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#### **Atmospheric water vapor**



#### Weather and Climate:

Most active greenhouse gas
Key element in the hydrological cycle



(In)SAR: (Interferometric) Synthetic Aperture Radar GNSS: Global Navigation Satellite Systems

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- Highly variable in time/space
- Available data are limited in temporal/spatial resolutions



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Noise

#### **Geodesy and Remote Sensing:**

- Source of error
- Methods for error mitigation
  - Empirical models
  - Calibration using external data
  - Time series analysis



(In)SAR: (Interferometric) Synthetic Aperture Radar GNSS: Global Navigation Satellite Systems

Signal

**Objectives** 

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# Study area and data sets



- (In)SAR (2003-2008)
- GNSS (since 2002)
- Meteorology

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MERIS (Reference)







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 $\phi_{i,j} = \phi_{topography} + \phi_{displacement} + \phi_{atmosphere} +$ 

 $\phi_{orbit} + \phi_{ref} + \phi_{noise}$ 

Poster "Constructing high-resolution maps of atmospheric water vapor using InSAR"

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Least squares inversion

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- Maps of partial wet delay  $\rightarrow$  water vapor
- Very good agreement with MERIS observations





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- + Maps of high spatial resolution
- Partial measurements  $\rightarrow$  no absolute values



- Least squares inversion
- Maps of partial wet delay  $\rightarrow$  water vapor
- Very good agreement with MERIS observations



How to reconstruct the total water vapor content? It is not only one offset  $\rightarrow$  A value has to be determined for each point

#### **Data combination**









P: Pressure T: Temperature RH: Relative Humidity





#### Data combination: Application to the data





C  [mm]	lpha [km <sup>-1</sup> ]	$\Delta L_{ m min}$ [mm]
8.0375	4.1342	25.0434

## Data combination: Application to the data





- Compute a value at each persistent scatterer
   digital elevation model is required
- Iterative solution







RH: Relative Humidity

#### **Data combination: Results**









MEAN [mm]	-0.43	
STD [mm]	0.84	
RMS [mm]	0.91	
Corr. Coeff.	0.92	

**18** F. Alshawaf, Institute of Photogrammetry and Remote Sensing

#### **Data combination: Results**





Day	CC [%]	RMS [mm]	MEAN [mm]	STD [mm]
June 27, 2005	75	1.00	0.07	1.00
September 5, 2005	87	0.88	0.15	0.86
July 17, 2006	80	0.76	-0.03	0.75
April 23, 2007	92	0.91	-0.43	0.84

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### **Conclusions and Outlook**





#### WRF: Weather Research and Forecasting

#### **Conclusions and Outlook**



Thank you very much for your attention