ON THE VALUE OF HIGH-RESOLUTION WEATHER MODELS FOR ATMOSPHERIC MITIGATION IN SAR INTERFEROMETRY

Shizhuo Liu[1], Agnes Mika[2], Ramon Hanssen[1]
[1]Delft Institute of Earth Observation and Space Systems (DEOS), Delft University of Technology, the Netherlands
{s.liu}{r.f.hanssen}@tudelft.nl
[2]BMT ARGOSS, the Netherlands
agnes.mika@bmtargoss.com

SAR acquisitions (green square) over Mexico city (source: Google-earth)

1. Introduction:

The Earth's atmosphere manifests itself as a slant range delay in repeat-pass SAR Interferometry (*InSAR*). Mitigation of the delay is crucial for accurate deformation monitoring using *InSAR*. In this study, we use the *WRF* (Weather Research and Forecasting) weather model [1] to hindcast atmospheric delays at SAR acquisition times. The value of the model for atmosphere mitigation is evaluated by comparing its predicted delay difference to *atmosphere only* interferograms (i.e. B_t <= 4 months).

The areas chosen in our case studies are *Mexico City* where strong surface topography is present and *the Netherlands* which has almost flat terrain.

SAR acquisitions over the Netherlands

2.1 Case study of Mexico City

Best case

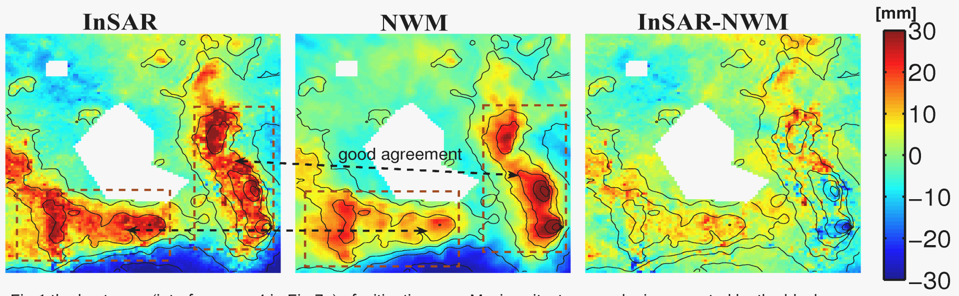

Fig.1 the best case (interferogram 4 in Fig.7a) of mitigation over Mexico city; topography is presented by the black contour lines; subsiding area due to excessive ground water pumping is masked out.

Worst case

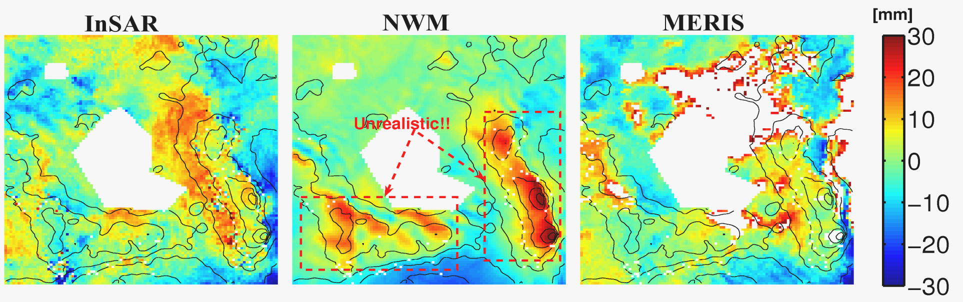

Fig.2 the worst case (interferogram 5 in Fig.7a) of mitigation over Mexico city; MERIS reduced resolution water vapor product is used here for validation, cloud pixels of MERIS are masked out.

Vertical stratification & turbulent mixing (the best case of Mexico city)

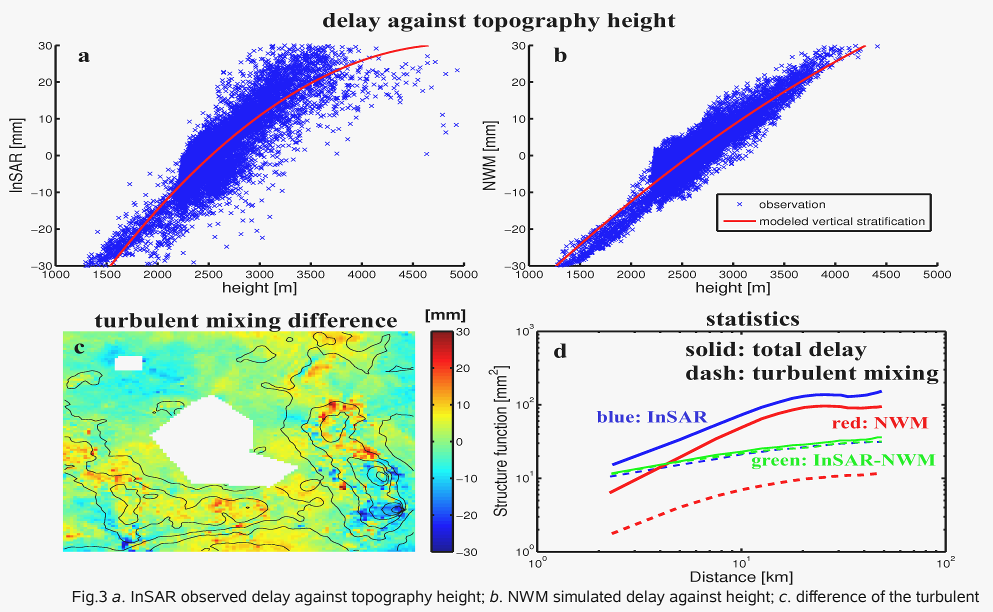

Fig.3 *a.* InSAR observed delay against topography height; *b.* NWM simulated delay against height; *c.* difference of the turbulent mixing part of the delay between InSAR and NWM, the turbulent mixing is the difference between the total delay and the modeled vertical stratification (red curves in *a* and *b*); *d.* structure functions of the total delay and the turbulent mixing

2.2 Case study of the Netherlands

Best case

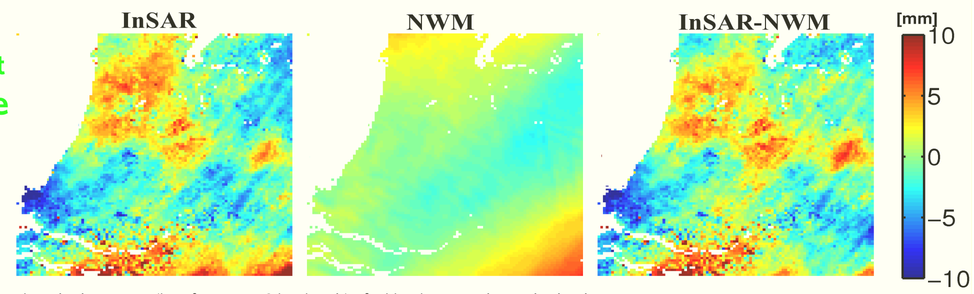

Fig.4 the best case (interferogram 8 in Fig.7 b) of mitigation over the Netherlands

Worst case

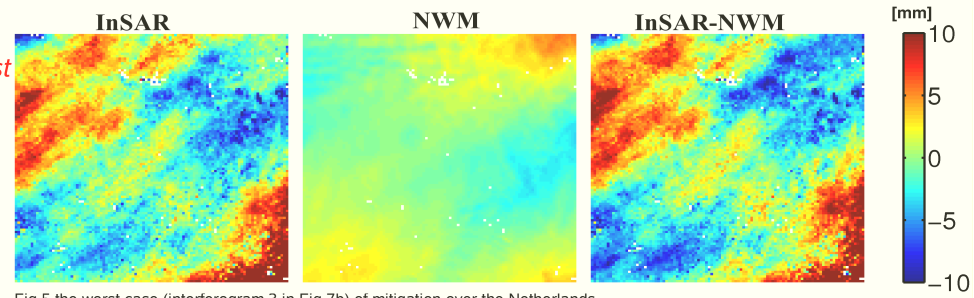

Fig.5 the worst case (interferogram 3 in Fig.7b) of mitigation over the Netherlands

Turbulent mixing statistics (the best and worst case of the Netherlands)

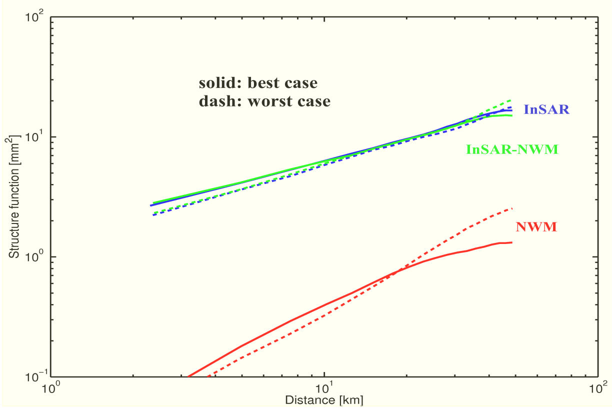

Fig.6 structure functions of InSAR, NWM and their difference for both the best and worst case; solid line: structure functions of the best case (blue: Insar, red: NWM, green: InSAR-NWM); dash lines: structure functions of the worst case.

2.3 Overall results

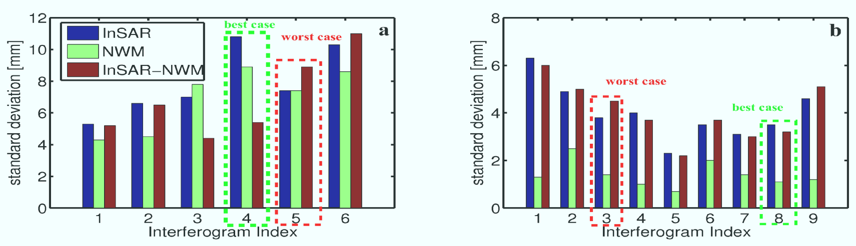

Fig.7 mitigation resulst overview of Mexico City (*a*) and the Netherlands (*b*); x-axis: interferogram number; y-axis: standard deviation of delay in [mm]

3. Conclusion:

The results of our case studies show that NWM may effectively estimate vertical stratification of the delay in mountainous but not always. For flat terrains, NWM not only fails to correctly estimate atmospheric delay in magnitude and location but also largely underestimates the spatial variability of the delay. This is the result of poor estimation of the turbulent mixing (i.e. convectivity) part of the delay. Although our evaluation is based on the WRF model only, this model is expected to outperform older generation NWMs such as e.g. NH3D and MM5[2][3]. Therefore, we can conclude that atmospheric mitigation using NWM is currently not applicable.

References:

[1] " Weather Research and Forecasting (WRF) model," http://www.wrf-model/org, Last accessed: 4 Jan.2009

[2] J. Foster, B. Brooks, T. Cherubini, C. Shacat, S. Businger, and C.L.Werner, " Mitigating atmospheric noise for InSAR using a high resolution weather model," Geophysical Research Letters, vol. 33, no. L16304, p.doi:10.1029/2006GL026781,2006

[3] G. Wadge, P.W. Webley, I.N. James, R. Bingley, A. Dodson, S. Waugh, T. Veneboer, G. Puglisi, M. Mattia, D. Baker, S.C. Edwards, S.J. Edwards, and P.J. Clarke, "Atmospheric models, gps and insar measurements of the tropospheric water vapour field over mount etna," Geophysical Research Letters, vol. 29, pp. 11/1-4, Oct.2002

TU Delft

Delft University of Technology