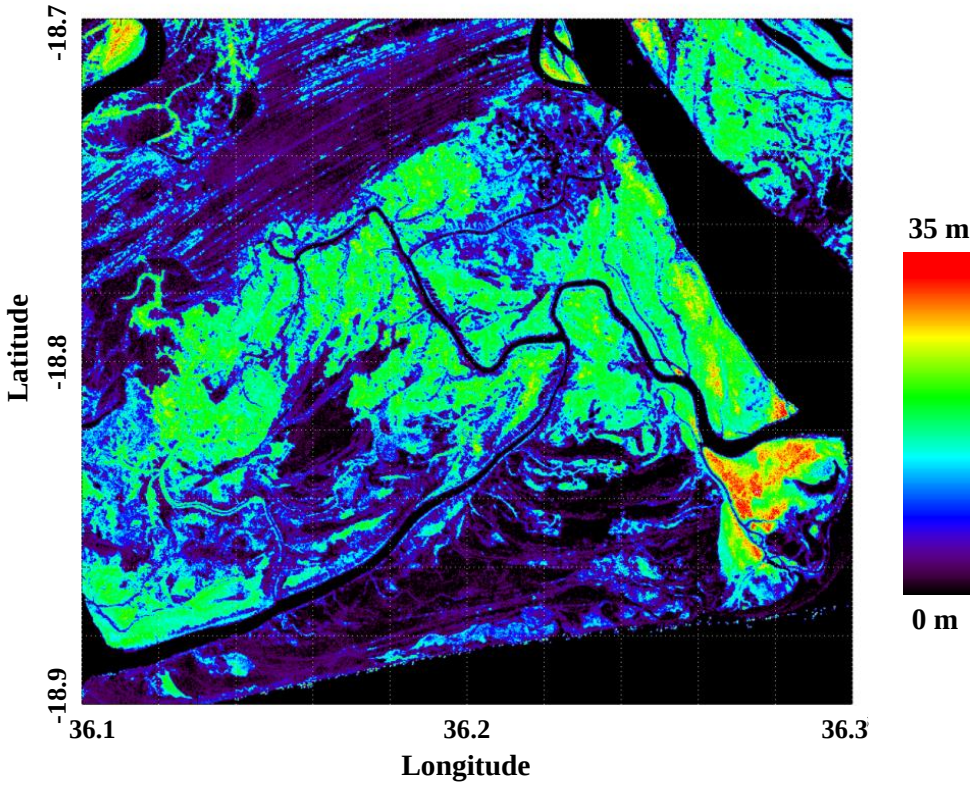
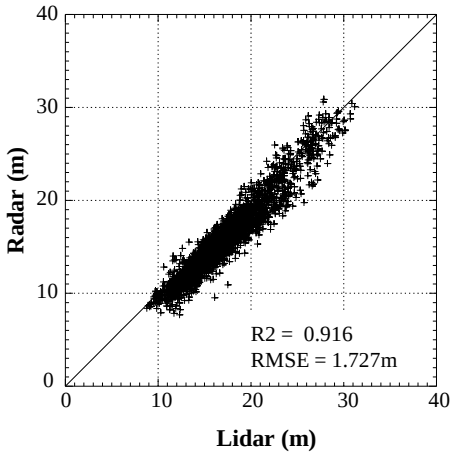
TanDEM-X Pol-InSAR Inversion for Mangroves over Zambezi Delta

SeungKuk Lee, Temilola Fatoyinbo, David Lagomasino Code 618, NASA/GSFC

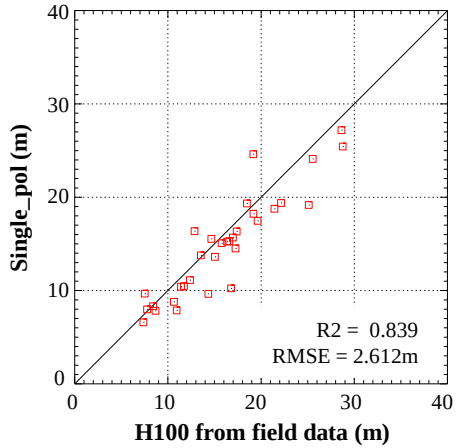
Mangrove Canopy Height from TanDEM-X



<Validation plot: Pol-InSAR vs. Lidar>



<Validation plot: Pol-InSAR vs. Field survey>

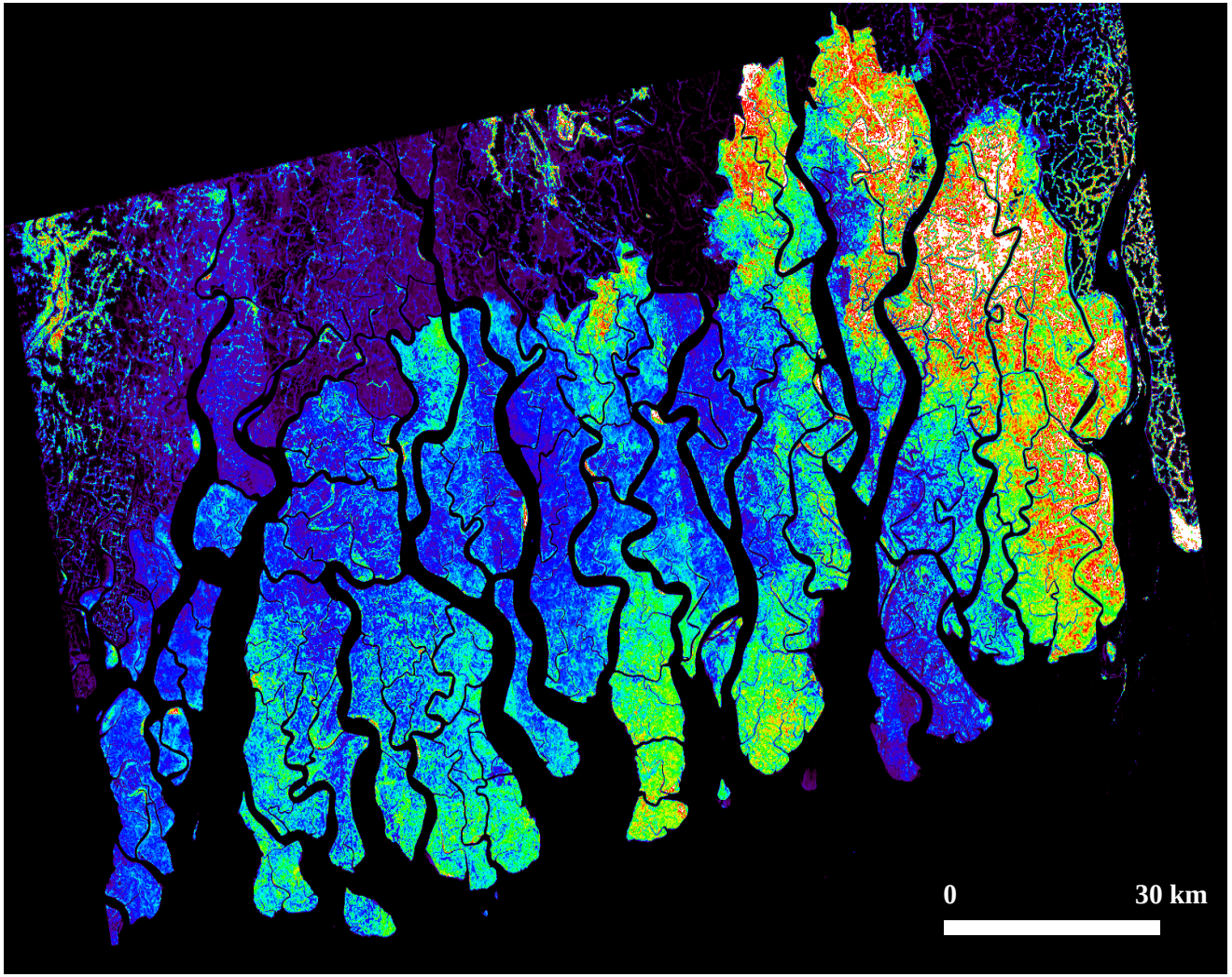


- Mangrove canopy height estimation using TanDEM-X data provided good results without an external DTM.
- The TDX results were validated against lidar H100 height (R^2: 0.916 / RMSE: 1.727 m) and Field measurement data (R^2: 0.839 / RMSE: 2.612 m).

SeungKuk Lee
NASA/GSFC

TanDEM-X Pol-InSAR Inversion for Bangladesh Mangroves

SeungKuk Lee, Temilola Fatoyinbo, David Lagomasino Code 618, NASA/GSFC



- Largest mangrove forest in the world
- 24 TanDEM-X data sets were used for Pol-InSAR inversion

SeungKuk Lee
NASA/GSFC

Name: SeungKuk Lee, NASA/GSFC, Code 618 and NASA Postdoctoral Program
E-mail: SeungKuk.Lee@nasa.gov
Phone: 301-614-7047

References: S.-K. Lee and T. E. Fatoyinbo, "TanDEM-X Pol-InSAR Inversion for Mangrove Canopy Height Estimation", *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.* (in review).

Data Sources: TanDEM-X and TerraSAR-X

Technical Description of Figures:
Graphic 1: TanDEM-X Polarimetric InSAR (Pol-InSAR) inversion results over a mangrove region in the Zambezi Delta, scaled from 0m to 35 m. The validation results against lidar and field measurements showed a very good correlation between both the lidar canopy heights and the Polarimetric InSAR data, and between the field measurements and the Polarimetric InSAR inversions of Canopy Height in the Zambezi Delta region in Mozambique. This map was produces as part of SK Lee's NASA Postdoctoral Project and an ongoing Carbon Monitoring System project entitled "Total Carbon Estimation in African Mangroves."
Graphic 2: Mosaic mangrove forest height map over the Sundarbans forest of India and Bangladesh estimated by the Pol-InSAR technique. To make this large-scale mangrove height map, 24 TanDEM-X data sets acquired from Jan 11 , 2011 to Jan 1, 2013 were selected and inverted using the new techniques developed in the above-mentioned paper. This map was produced as part of SK Lee's NPP and also as the NASA contribution to the SilvaCarbon Bangladesh project.

Scientific significance, societal relevance, and relationships to future missions:
One of the greatest challenges for the accurate estimation of forest carbon storage and emissions has been the accurate estimation of forest structure and biomass on large scales. Mangrove forests in particular are the most carbon rich ecosystem in the world and despite their limited distribution on coastal areas, their contribution to the Global Carbon Cycle is significant. This approach indicates a great possibility for generating global-scale mangrove height and biomass maps using polarimetric and Interferometric SAR data acquisitions. This is significant scientifically as it confirms that we can achieve canopy height estimates with accuracies comparable to airborne lidar with this new Pol-InSAR technique but with wall-to-wall coverage and regardless of cloud cover. It is of great societal significance as well as it can be implemented operationally into MRV (monitoring, reporting and verification) schemes being developed by International organizations such as the UN-REDD program (Reducing Emissions from Deforestation and Degradation) to adapt to and mitigate the effects of climate change on our Planet. Finally, this capability is also key to current and future missions, such as the EcoSAR airborne SAR and the recently selected Global Ecosystem Dynamics Investigation (GEDI), which will produce fused biomass data products using TanDEM-X and GEDI footprints.

Observations of rapid aerosol optical depth enhancements in the vicinity of polluted cumulus clouds

Thomas F. Eck (Code 618 NASA GSFC & USRA) and Brent N. Holben (Code 618 NASA GSFC)

Figure 1

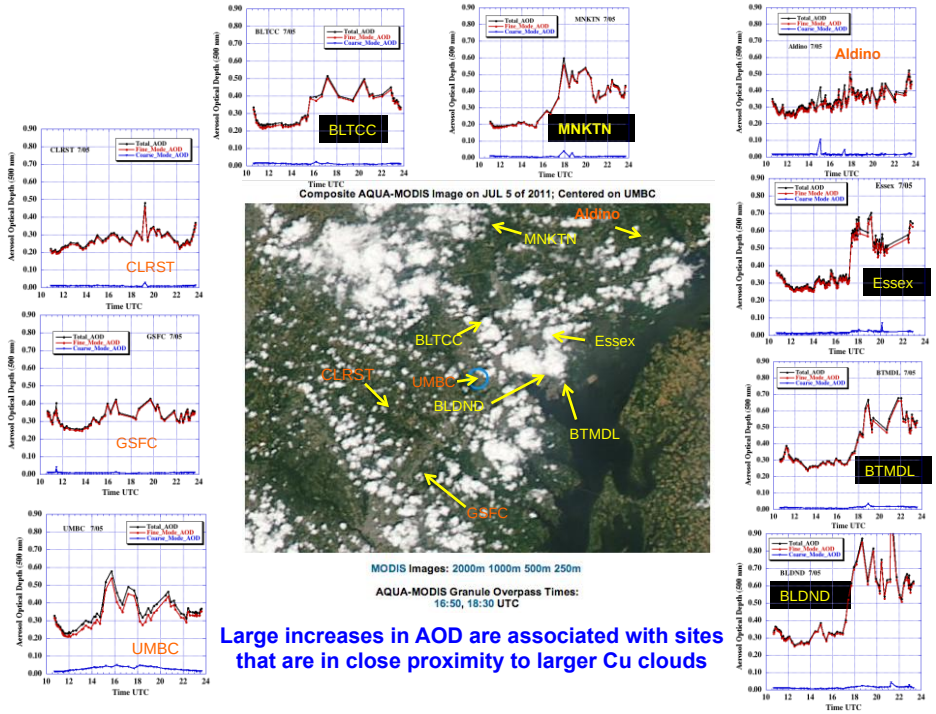
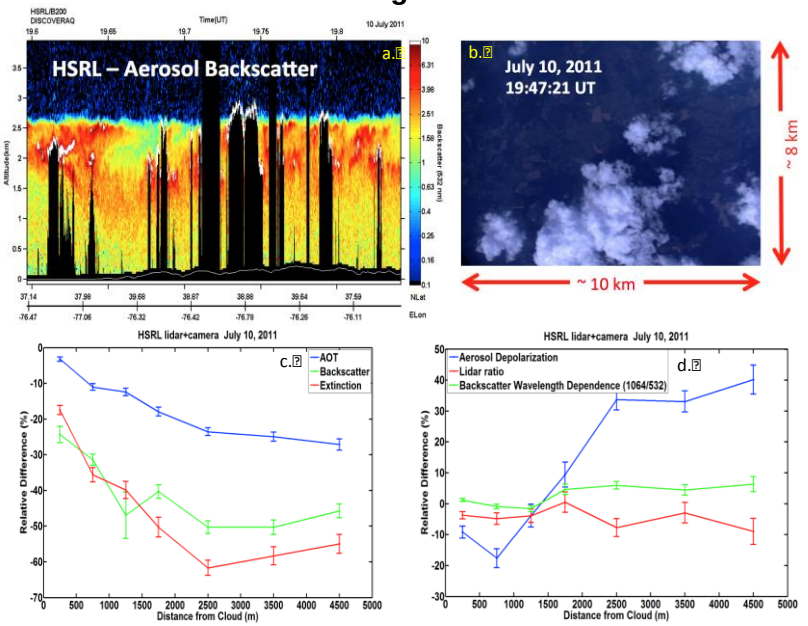


Figure 2



During the July 2011 DISCOVER-AQ field experiment in Maryland, significant enhancements in AERONET sun-sky radiometer measured Aerosol Optical Depth (AOD) were observed in the immediate vicinity of non-precipitating cumulus clouds on some days. Measures of aerosol size made before, during and after cumulus development often suggest little change in fine mode particle size, therefore implying possible new particle formation in addition to cloud processing and humidification of existing particles. In addition to radiometer measurements of large enhancements of fine mode AOD, lidar measurements made during the experiment also measured large increases in aerosol signal at altitudes associated with the presence of fair weather cumulus clouds. These data show modifications of the aerosol vertical profile as a result of the aerosol enhancements at and below cloud altitudes, and were used to estimate the spatial extent of these aerosol enhancements, finding increased AOD, backscatter and extinction out to 2.5 kilometer distance from the cloud edge.

Name: Tom Eck and Brent Holben Code 618 NASA/GSFC
E-mail: Thomas.F.Eck@nasa.gov
Phone: 301-614-6625

References:

Eck, T. F., Holben, B. N., Reid, J. S., Arola, A., Ferrare, R. A., Hostetler, C. A., Crumeyrolle, S. N., Berkoff, T. A., Welton, E. J., Lolli, S., Lyapustin, A., Wang, Y., Schafer, J. S., Giles, D. M., Anderson, B. E., Thornhill, K. L., Minnis, P., Pickering, K. E., Loughner, C. P., Smirnov, A., and Sinyuk, A.: **Observations of rapid aerosol optical depth enhancements in the vicinity of polluted cumulus clouds**, *Atmos. Chem. Phys.*, 14, 11633-11656, doi:10.5194/acp-14-11633-2014, 2014.

Holben B.N., T.F.Eck, I.Slutsker, D.Tanre, J.P.Buis, A.Setzer, E.Vermote, J.A.Reagan, Y.Kaufman, T.Nakajima, F.Lavenu, I.Jankowiak, and A.Smirnov, 1998: **AERONET - A federated instrument network and data archive for aerosol characterization**, *Rem. Sens. Environ.,* 66, 1-16.

Data Sources: Most of the measurements we have analyzed were made by sun-sky radiometers that are a part of NASA's AErosol RObotic NETwork (AERONET; Holben et al., 1998)), which is a federated global network of standardized radiometers calibrated to consistent reference sources and processed with state of the art algorithms. Over 400 sites located in diverse environments on all continents and oceanic islands are currently a part of AERONET. Most of the the AERONET sites analyzed in this study were from the Distributed Regional Aerosol Observation Network (DRAGON) of ~45 Cimels deployed in Maryland in July 2011 in support of the Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ) field experiment. Additionally airborne in situ aerosol measurements from the NASA Langley LARGE group were analyzed, plus both ground-based and airborne lidar data sets. Satellite data examined in this study were MODIS Terra and Aqua data as analyzed by the MAIAC algorithm, plus GOES East imagery.

Technical Description of Figures:

Figure 1: The Aqua MODIS satellite image centered on the UMBC site for July 5, 2011, showing the locations of selected AERONET sites. The time series of the fine and coarse mode AOD for each of these AERONET sites as determined by the Spectral Deconvolution Algorithm (SDA) are also shown. From this figure it is noted that sites in near proximity to the larger cumulus clouds showed significant afternoon increases in fine mode AOD (see BLDND and MNKTN sites for examples)), while sites that were in relatively cloudless regions or had mostly small cumulus cloud cells showed relatively stable AOD from morning through afternoon (see GSFC and CLRST sites for examples).

Figure 2: (a.) Downward viewing High Spectral Resolution Lidar (HSRL) measured backscattering coefficient (532 nm) from a 15-minute flight segment corresponding to a ~90 km transect on July 10, 2011 in the Maryland study region. (b.) An example digital camera image taken coincident with the HSRL data in order to determine the distance from cloud of each lidar scan pulse. (c.) Aerosol extensive parameters (backscatter, extinction, and AOD) inferred from HSRL data as a function of distance from the cloud edge. (d.) Aerosol intensive parameters (depolarization, lidar ratio, and backscatter wavelength dependence) inferred from the HSRL data as a function of distance from the cloud edge.

Scientific significance, societal relevance, and relationships to future missions: The interaction of aerosols and clouds and resultant effects on aerosol optical depth and size distribution currently contribute to significant uncertainties in radiative forcing of aerosols at the earth's surface and the top of the atmosphere. AERONET measurements of AOD and retrieval of aerosol optical and physical properties such as size distributions have and will continue to be utilized in climate forcing studies and in the validation of current and future satellite missions.