Assimilation of VIIRS AOT EDR for Air Quality Analyses and Forecasts: A Comparison with the Assimilation of MODIS AOT

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WRF/Chem and GSI Aerosol Data Assimilation
- WRF/Chem is an online-coupled meteorology-chemistry model
- allow aerosol/chemistry feedback to meteorological fields.
- 3D mass concentrations of 15 aerosol variables from the GOCART aerosol module within the WRF/Chem model are analysis variables in GSI
  - Hydrophobic and hydrophilic organic carbon (OC1, OC2)
  - Sulfate, Dust in 5 particle-size bins, Sea salt in 4 particle-size bins
  - P25: unspeciated aerosols contributing to PM_{2.5}
- Aerosol background error covariance statistics
  - "NMC" method, univariate correlation, no cross-correlation b.w. variables
  - Allow the assimilation of MODIS/VIIRS AOT/Radiance and surface PM_{2.5}PM_{10}
- Observation operator: CRTM for MODIS/VIIRS AOT and visible-band radiances
- Multiple data assimilation methods can be used: 3DVAR, EnKF and Hybrid
- Also allow simultaneous assimilation of aerosol and meteorological observations

Experiment design
- Domain: East Asia
- Resolution: horizontal 20km; vertical 57L
- Grid points: 240x200
- Study Period: 2013-11-06 ~ 2013-12-06; 06 UTC analyses with 24h cycle
- Spin up: 10 days from 2013-11-01
- Background error: (48hfc-24hfc) from control experiment
- WRF/Chem Emission: Global EDGAR + Streets (monthly variation)
- Meteor. initial conditions are the same for 3 cycling experiments:
  (1) Control: No AOT DA, continued aerosol forecasts
  (2) VIIRS AOT DA: assimilate VIIRS Ch 4 AOT @555nm
  (3) Aqua MODIS AOT DA: assimilate MODIS Ch 4 AOT @555nm
- 3 cycling experiments:
  a. Control: No AOT DA, continued aerosol forecasts
  b. VIIRS AOT DA: assimilate VIIRS Ch 4 AOT @555nm
  c. Aqua MODIS AOT DA: assimilate MODIS Ch 4 AOT @555nm

Verification using surface PM2.5
- VIIRS AOT generally has better coverage than MODIS AOT from Aqua over East Asia for the data marked as the best quality
- Assimilating MODIS (Aqua only) or VIIRS AOT improved aerosol analysis and subsequent forecasts
- Assimilating VIIRS AOT resulted in slightly better results than assimilating Aqua MODIS AOT.

Future Plan
- Assimilate MODIS and VIIRS AOT together
- Assimilate multiple channels VIIRS AOT
- Improve quality control and observation error specification
- Direct assimilation of VIS/NIR radiances
- Extend from regional to global applications