DECSO emission versions

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The DECSO algorithm (Daily Emission estimation Constrained by Satellite Observations) has been applied successfully for NOx emission estimation in East Asia, Middle East, South Africa, and India. As the algorithm is further improved, emission estimations are updated accordingly. Below you can find an overview of the different algorithm versions. An extensive algorithm description can be found in Mijling and Van der A (2012), and the GlobEmission ATBD.

Version 1

- CHIMERE V2006
- No biogenic emissions
- INTEX-B emission inventory
- Landuse by GLCF database (1993)
- European diurnal cycle
- Boundary conditions LMDzINCA (gas), GOCART (aerosol)

Used in:

- Mijling and Van der A (2012)
- GlobEmission, phase 1 (East Asia)

Version 2

- Modelling CHIMERE with sector-dependent emission injection heights
- Fast back-trajectory calculations
- Adjusted retrieval error tropospheric NO2
- Update of NOx-correlated pollutants
- Noise and bias reduction in remote areas
- Full Kalman matrix inversion using LDL decomposition
- Initial emission inventories:
    - South Africa: EDGAR v4.2, 2008
    - India: EDGAR v4.2, 2008

Used in:

- Mijling et al. (2013)
- GlobEmission, phase 1 (India, South Africa)

Version v3a

- CHIMERE V2006.
- Initial emission inventories:
    - East Asia: MEIC 2008 (China) + INTEX-B (outside China)
    - South Africa: EDGAR v4.2, 2008
    - Middle East: EDGAR v4.2, 2008
- Diurnal cycle: flattened for China, European for other regions.
- Calculation speed: switching from g95 to ifort compiler, and calculating matrix inversions with LAPACK

Used in:

- GlobEmission, phase 2 (East Asia, Middle East, South Africa)

The emission estimates show unrealistic day-to-day (and possibly month-to-month) fluctuations of emissions. Emission noise in low-emitting areas (introduction of positive emission bias, and unrealistic seasonal cycle when assimilating OMI measurements).

Version v3b

- CHIMERE V2013: new transport schemes, secondary organic aerosol chemistry, updated chemical reaction rates.
- New land use data: GlobCover Land cover (2009).
- Biogenic emissions by MEGAN
- Initial emission inventories:
    - East Asia: MEIC 2010 (China) + INTEX-B (outside China), regridded.
    - Middle East: HTAP v2 (EDGAR v4.3)
- Reduction of day-to-day emission fluctuations by OmF criterium [-5,10].
- Diurnal cycle: flattened for Middle East, European for East Asia.

Used in:

- Ding et al. (2015)
- GlobEmission, phase 2 (East Asia, Middle East)

Version 4

- Reduction of day-to-day emission fluctuations by 3-sigma (emission error) criterion
- New parametrization of R matrix
- Diurnal cycle: flattened
- OmF criterion has been removed

Used in:

- GlobEmission, phase 2 (East Asia)

The emission noise is greatly reduced. The regional emission totals go down, but this is mainly related to the emission noise reduction (reduction of positive bias). Individual hot-spots, especially when undersampled, can disappear (e.g. Ulaanbaatar, and some power plants in North-East China). A slower convergence rate at changing emission signals. But 10% more observations have been used in this version compared with DECSO v3b.

Version 5

- Switch off biogenic emissions from MEGAN in CHIMERE, estimate total surface emissions instead of anthropogenic emissions
- Change the threshold of the sensitivity matrix from 0.05 h to 0.1 h.

Used in:

- GlobEmission, phase 2 (East Asia)
- Ding et al. (2017a, 2017b)

The total emissions are more realistic and we reduce the uncertainties in biogenic emissions from CHIMERE. The change of H threshold helps to reduce biases coming from the uncertainties occurring at the edge of a NO_2 plume.

This version is extensively validated for East China in Ding et al. (2017b)

Version 5.1

- Set maritime inject height of newly-found maritime at 40 m.
- Exclude the observations with a large pixel size by filtering out 8 pixels at each side of the swath
- Exclude the observations with a cloud fraction larger than 50%

Used in:

- Ding et al. (2018)

With the new settings, we get more clear shipping tracks near Chinese coast areas.

References

Ding, J. van der A, R. J., Mijling, B., Jalkanen, J.-P. Johansson, L., and Levelt, P. F.: Maritime NOx emissions over Chinese seas derived from satellite observations, Geophysical Research Letters, accepted, 2018.

Ding, J., van der A, R. J., Mijling, B., and Levelt, P. F.: Space-based NOx emission estimates over remote regions improved in DECSO, Atmos. Meas. Tech., 10, 925-938, https://doi.org/10.5194/amt-10-925-2017, 2017a.

Ding, J., Miyazaki, K., van der A, R.J., Mijling, B., Kurokawa, J., Cho, S., Janssens-Maenhout, G., Zhang, Q., Liu, F., and Levelt, P.F., Intercomparison of NOx emission inventories over East Asia, Atm. Chem. Phys.,, 17, 10125-10141, doi:doi.org/10.5194/acp-17-10125-2017, 2017b.

Ding, J., van der A, R. J., Mijling, B., Levelt, P. F., and Hao, N.: NOx emission estimates during the 2014 Youth Olympic Games in Nanjing, Atmos. Chem. Phys., 15, 9399-9412, doi:10.5194/acp-15-9399-2015, 2015.

Mijling, B. and R. van der A, Using daily satellite observations to estimate emissions of short-lived air pollutants on a mesoscopic scale. J. Geophys. Res. 117, D17, doi:10.1029/2012JD017817, 2012.

Mijling, B., R.J. van der A, R. J., and Q. Zhang, Regional nitrogen oxides emission trends in East Asia observed from space, Atmos. Chem. Phys. 13, 12003-12012, doi:10.5194/acp-13-12003-2013, 2013.