TOAR tropospheric ozone assessment report

List of Exposure and Dose Metrics

First approved by the TOAR Steering Committee on July 31, 2015, and revised on June 27, 2016 to add two additional metrics.

Following is the list of exposure and dose metrics to be calculated and made publicly available in fulfillment of the goals of the Tropospheric Ozone Assessment Report. The TOAR Steering Committee approved the original list on July 31, 2015. This revision adds two exposure metrics:

- Number of exceedances of daily maximum 8-h values greater than 70 ppb per year.
- Annual and summertime mean of the daily maximum 8-h values

Model-measurement comparison metrics

Surface O_3 metrics at individual sites:

a) Monthly means of 24-h average concentrations and maximum daily 8-h average (MDA8) concentrations, and their standard deviation, median, 5^{th}, 25^{th}, 75^{th}, and 95^{th} percentiles.
b) Monthly mean diurnal cycle (monthly average of all 0100h, 0200h, 0300h, etc. values).
c) Monthly average of daily minimum and maximum of hourly average concentrations.

Free Tropospheric metrics:

d) Monthly, seasonal, annual and decadal means from ozonesonde, aircraft, and lidar measurements at high vertical resolution (e.g., at intervals of 25hPa pressure surfaces). Standard deviations, median and 5^{th}, 25^{th}, 75^{th}, and 95^{th} percentiles where sampling is sufficient.
e) Monthly mean diurnal cycle with high frequency aircraft data (e.g., MOZAIC).
f) Monthly mean tropospheric column ozone (TCO) from a variety of satellite instruments (OMI/MLS, TES, IASI, GOME...) harmonized to a common horizontal (e.g., 1degx1.25deg as for OMI/MLS) and vertical (if possible) grid.
g) Monthly mean TCO from ozonesondes.
h) Estimate of annual variation averaged over a decade in TCO and on 25hPa pressure surfaces.

Special metrics to be calculated by a single TOAR investigator and posted to the TOAR portal:

i) Polynomial fits (i.e., power series expansions) at selected baseline sites: polynomial "shape factors" that describe long-term trends will be calculated for selected baseline sites and made available in table form, as described by Parrish et al. (2014). The polynomials will be computed by David Parrish, and he will submit his results to Jülich and the files will be posted to the TOAR portal. The results will not be in the TOAR database and will not be accessible through the TOAR JOIN interface. The results will be listed on a Jülich TOAR web page. David Parrish will also compute the same metrics from the model results.

j) Fourier series expansion of seasonal cycles at selected baseline sites: a very few harmonic terms adequately describe seasonal cycles. These will be calculated for select baseline sites by David Parrish and will be provided in table form that will be submitted to Jülich. The files will be posted to the TOAR portal. The results will not be in the TOAR database and will not be accessible through the TOAR JOIN interface. The results will be listed on a Jülich TOAR web page. David Parrish will also compute the same metrics from the model results.

Data to be included in TOAR dataset:

k) Gridded (1degx1deg) hourly surface O_3 concentrations from US and Europe networks (Schnell et al. 2014).
l) Trajectory mapped ozone - gridded product that uses global wind fiends to distribute ozonesonde observations several days upwind and downwind (Liu et al., 2013).

Liu, G., Liu, J., Tarasick, D.W. et al., 2013. A global tropospheric ozone climatology from trajectory-mapped ozone soundings, Atmos. Chem. Phys., 13, 10659-10675, doi:10.5194/acp-13-10659-2013, 2013.

Parrish et al., 2014. Long-term changes in lower tropospheric baseline ozone concentrations: Comparing chemistry-climate models and observations at northern mid-latitudes. J. Geophys. Res. Atmos., 119, 5719–5736, doi:10.1002/2013JD021435.

Schnell, J. L., Holmes, C. D., Jangam, A., Prather, M. J., 2014. Skill in forecasting extreme ozone pollution episodes with a global atmospheric chemistry model, Atmos. Chem. Phys., 14, 7721-7739, doi:10.5194/acp-14-7721-2014, 2014.

Human health metrics

a) 4th Highest 8-h Average Concentration for Each Year. Twenty-four running 8-h averages are used to identify the daily maximum 8-h value. The 8-h running mean for a particular hour is calculated on the concentration for that hour plus the following 7 hours.
b) 4th Highest 8-h Average Concentration for Each Year. Twenty-four running 8-h averages are used to identify the daily maximum 8-h value. Using the procedures specified in the EU Airbase, the 8-h running mean is determined based on the concentration for that hour and the previous 7 hours.
c) 4th Highest 8-h Average Concentration for Each Year. For each day a daily maximum 8-h value is determined, the running 8-h values are calculated between 0700 and 2300 h as per the recommendation of the U.S. EPA’s November 25, 2014 Proposed Ozone Standard. The last 8-h period of the day begins at 2300 h and ends at 0700 h the next day. (U.S. EPA Proposed Revision to the 8-h standard). The 8-h running mean for a particular hour is calculated on the concentration for that hour plus the following 7 hours.
d) Maximum daily 8-h average over the entire year.
e) Maximum daily 1-h average over the entire year.
f) SOMO35(i.e., the annual sum of the positive differences between the daily maximum 8-h ozone concentration and the cutoff concentration set at 35 ppb (70 $\mu g/m^3$) calculated for all days in a year). The 8-h average concentrations are determined as per Item (b) above.

g) SOMO10 (i.e., the annual sum of the positive differences between the daily maximum 8-h ozone concentration and the cutoff concentration set at 10 ppb (20 $\mu g/m^3$) calculated for all days in a year). The 8-h average concentrations are determined as per Item (b) above.
h) 4^{th} highest W90 5-h cumulative exposure index as described in *Lefohn et al*. (2010).
i) Annual and seasonal percentiles (median, 5^{th}, 25^{th}, 75^{th} and 95^{th}) of hourly average concentrations over 24-h period.
j) Number of exceedances of daily maximum 8-h values greater than 50, 60, 70 and 80 ppb per year.
k) Number of exceedances of daily maximum 1-h values greater than 90, 100, and 120 ppb.
l) Running mean of the 3-month average of the daily 1-h maxima, and the date of the annual maximum of this metric. The date of the mid-point of the maximum value of the 3-month running mean will be available in the database.
m) Annual and summertime (Apr-Sep in N. Hemisphere and Oct-Mar in S. Hemisphere) mean of the daily maximum 8-h values

Lefohn, A.S., Hazucha, M.J., Shadwick, D., Adams, W.C., 2010. An alternative form and level of the human health ozone standard, Inhalation Toxicology, 22, 999-1011.

Vegetation metrics

a) W126 (3-month, 24-h (monthly periods specified in accompanying documentation).
b) W126 (6-month, 24-h (monthly periods specified in accompanying documentation).
c) W126 (7-month, 24-h (monthly periods specified in accompanying documentation).
d) W126 (12-month, 24-h (for tropical or subtropical moist climate zones).
e) W126 (3-month, 12-h (0800-1959h) (monthly periods specified in accompanying documentation).
f) W126 (6-month, 12-h (0800-1959h) (monthly periods specified in accompanying documentation).
g) W126 (7-month, 12-h (0800-1959h) (monthly periods specified in accompanying documentation).
h) W126 (12-month, 12-h (for tropical or subtropical moist climate zones) (0800-1959h).
i) AOT40 (3-month, 0800-1959h) (monthly periods specified in accompanying documentation).
j) AOT40 (6-month, 0800-1959h) (monthly periods specified in accompanying documentation).
k) AOT40 (7-month, 0800-1959h) (monthly periods specified in accompanying documentation).
l) AOT40 (12-month, 0800-1959h) (for tropical or subtropical moist climate zones).
m) AOT40 (3-month, daylight over the period when clear sky radiation > 50 W/m^2) (monthly periods specified in accompanying documentation).
n) AOT40 (6-month, daylight over the period when clear sky radiation > 50 W/m^2) (monthly periods specified in accompanying documentation).
o) AOT40 (7-month, daylight over the period when clear sky radiation > 50 W/m^2) (monthly periods specified in accompanying documentation).
p) AOT40 (3-month, nighttime over the period when clear sky radiation <5 W/m^2) (monthly periods specified in accompanying documentation).
q) AOT40 (6-month, nighttime over the period when clear sky radiation < 5 W/m^2) (monthly periods specified in accompanying documentation).
r) AOT40 (7-month, nighttime over the period when clear sky radiation < 5 W/m^2) (monthly periods specified in accompanying documentation).

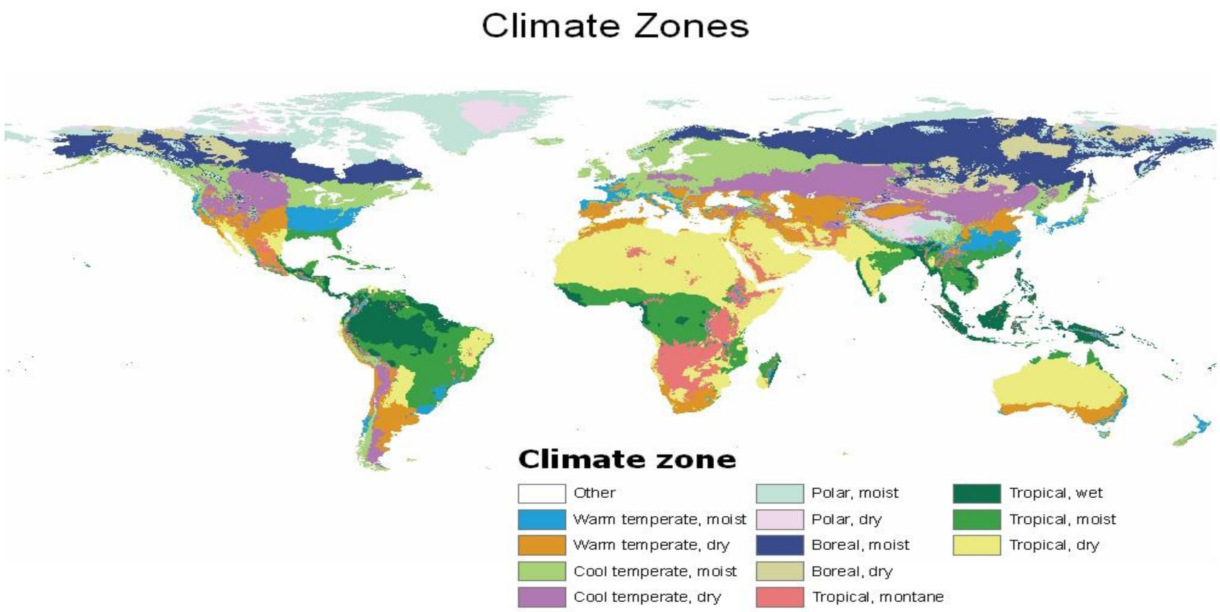
s) Daily 12-h average averaged over 3 months, (0800-1959h) (monthly periods specified in accompanying documentation).
t) Daily 12-h average averaged over 6 months, (0800-1959h) (monthly periods specified in accompanying documentation).
u) Daily 12-h average averaged over 7 months, (0800-1959h) (monthly periods specified in accompanying documentation).
v) Daily 12-h average averaged over 12 months, (0800-1959h).
w) Flux-Based Indices will be externally generated for a selected number of sites and provided to the TOAR database for entry for the time periods specified in accompanying documentation.
x) Seasonal percentiles of hourly average concentrations (March-May, June-August, September-November, December-February) (median, 5^{th}, 25^{th}, 75^{th} and 95^{th}, 98^{th}, and 99^{th}) of hourly average.

Data to be included in TOAR dataset:

W126 24-h monthly values.
W126 12-h (0800-1959h) monthly values.
AOT40 12-h (0800-1959h) monthly values.
AOT40 daytime
AOT40 nighttime
Daily 12-h average (0800-1959h) averaged over one month with associated number of monthly hours reported.

Table 1. Time windows for 3-, 6-, and 7-month metrics.

zone	Simplified Climate Zone	Climate zones represented	Hemi-sphere	3 month metrics, wheat	3 month metrics, rice	6 month metrics, fixed per hemisphere	7 month metrics, fixed per hemisphere
1	Polar	Polar	NH	n.a.	n.a.	n.a.	n.a.
2	Boreal, moist/dry	Boreal, moist and Boreal, dry	NH	June, July, Aug	n.a.	Apr to Sep	Mar to Sep
3	Cool Temperate	Cool Temperate moist and Cool Temperate, dry	NH	Apr, May, June	May, June, July	Apr to Sep	Mar to Sep
4	Warm Temperate	Warm Temperate, moist and Warm Temperate, dry	NH	Mar, Apr, May	Jun, July, Aug	Apr to Sep	Mar to Sep
5	Tropical, wet/moist/ montain	Tropical, montain; Tropical, wet and Tropical, moist	NH	Jan, Feb, Mar	July, Aug, Sep	Apr to Sep	Mar to Sep
6	Tropical, dry	Tropical, dry	NH	Jan, Feb, Mar	Aug to Oct	Apr to Sep	Mar to Sep
3	Cool, Temperate, 0 - 30 degrees south	Cool Temperate, moist and Cool Temperate, dry	SH	Feb, Mar, Apr	Dec to Feb	Oct to Mar	Sep to Mar
3	Cool, Temperate, > 30 degrees south	Cool Temperate, moist and Cool Temperate, dry	SH	Nov, Dec, Jan	Dec to Feb	Oct to Mar	Sep to Mar
4	Warm Temperate, dry	Warm Temperate, dry	SH	Aug - Oct	Jan to March	Oct to Mar	Sep to Mar
4	Warm Temperate, moist	Warm Temperate, moist	SH	Mid-Aug, to mid Nov	Nov, Dec, Jan	Oct to Mar	Sep to Mar
5	Tropical, wet/moist/ montain	Tropical, montain; Tropical, wet and Tropical, moist	SH	July, Aug, Sep	Dec to Feb	Oct to Mar	Sep to Mar
6	Tropical, dry	Tropical, dry	SH	Aug, Sep, Oct	n.a.	Oct to Mar	Sep to Mar



Source: http://eusoils.jrc.ec.europa.eu/projects/RenewableEnergy/