Intercomparison and geophysical analysis of harmonised satellite tropospheric ozone CDRs

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+ many data providers

VC-20-01
Tropospheric Ozone from Satellites

ROYAL BELGIAN INSTITUTE FOR SPACE AERONOMY

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Satellite tropospheric O3 : column-based data

+ others not discussed here (TOMS, GTTO-ECV v5sc, OMI/GTO-LIMB, S5P-BASCOE, OMPS-LNM)
Biases between satellite tropospheric O3

SAT minus OMI-MLS [%]

OMI-SUNLIT
LRT - 3 km

OMPS-MERRA2
dyn TP

EPIC-MERRA2
dyn TP

Pressure tropospheric top (hPa)
Satellite time series (20°S-20°N)
Objectives

• Can harmonisation improve agreement between satellite data sets?
  – Test several, complementary methods
  – Multi-annual mean, short-term variability, long-term changes
  – Global and regional scale

• Interaction with CEOS VC-20-01
  – Estimate bias due to different vertical level, smoothing, local time, ...
  – More complete understanding of uncertainty budget
  – Assist in product development (inclusion of metadata, XO3, ...)

• Interaction with TOAR II
  – Provide harmonised satellite data to multiple Working Groups
  – Assess (distribution) climatological mean, variability & long-term changes
Bias before/after harmonisation (60°S-60°N)

Method A: \[ \text{XO3} = \frac{\text{TrOC}}{\text{psfc} - \text{ptop}} \]

Method B: \[ \text{fill-in} = \text{TrOC} + \Delta \text{TrOCCAMSRA} \]

Comparison between:
- OMI-SUNLIT
- OMI-MLS
- OMPS-MERRA2
- EPIC-MERRA2
Bias before/after harmonisation (Europe)

No harmonisation

Method A : $XO3 = \frac{TrOC}{p_{SFC} - p_{TOP}}$

Method B : fill-in = $TrOC + \Delta TrOC_{CAMSRA}$
Bias before/after harmonisation (Asia)

OMI-SUNLIT
OMI-MLS
OMPS-MERRA2
EPIC-MERRA2

No harmonisation

Method A : \( \text{XO3} = \text{TrOC} / (p_{\text{SFC}} - p_{\text{TOP}}) \)

Method B : fill-in = \( \text{TrOC} + \Delta \text{TrOC}_{\text{CAMSRA}} \)
Bias before/after harmonisation (US)

**No harmonisation**

**Method A : XO3** = TrOC / (p_{sfc}-p_{top})

**Method B : fill-in** = TrOC + ΔTrOC_{CAMSRA}
Time series before/after harmonisation (20°S-20°N)

Method of Harmonisation: TrOC + ΔTrOC\text{CAMSRA}
Bias before/after harmonisation (20°S-20°N)

No harmonisation

Method A: \( \text{XO3} = \frac{\text{TrOC}}{(p_{slc}-p_{top})} \)

Method B: fill-in = \( \text{TrOC} + \Delta \text{TrOC}_{\text{CAMSRA}} \)
Harmonisation of OMI profile

Original OMI
Harmonised OMI: AP CDF1 TrOC
Transfer standard CAMSRA
Time series analysis: GTTO-ECV v5lc (before harm.)

preliminary
Conclusions & outlook

• **Comprehensive intercomparison** of nearly all satellite tropospheric O3 datasets (please send us updated / new data)

• **Preliminary findings**
  – Fill-in harmonisation is more successful than XO3 harmonisation for **column-based products** (though success depends on location)
  – Harmonisation method affects temporal structure of **profile-based products**

• **Next steps**
  – Add all profile-based satellite data (see talk by A. Keppens)
  – Finalise harmonisation scheme
  – Analyze distribution of multi-annual mean and long-term changes