Constraining CH$_4$ lifetime using multi-constituent chemical DA

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OH estimation methods
1. Methylchloroform (Turner et al. 2017; Patra et al. 2021)
2. CH$_4$ profiles (Zhang et al., 2018)
3. Chemical data assimilation (Miyazaki et al. 2020)

Sources
- O$^1$(D)+H$_2$O 33%
- NO+HO$_2$ 30%
- O$_3$+HO$_2$ 14%
- H$_2$O$_2$+hv 10%
- OVOCs, ROOH+hv 13%

Sinks
- OH+HO$_1$ 18%
- OH+NO$_2$ 2%
- OH+CH$_4$ 12%
- OH+CO 39%
- OH+other C$_1$VOC$^3$ 15%
- OH+C$_2$+VOC$^4$ 14%
(Lelieveld et al., 2016)

Annual means: NH/SH

<table>
<thead>
<tr>
<th>Model</th>
<th>Assimilation</th>
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<tbody>
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<td>1.31</td>
<td>1.19</td>
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2020 COVID anomaly
- 18-25% NOx → - 6Tg O3 → - 4% OH (global mean)
Increased the methane lifetime by 4 months, which could explain the observed high CH$_4$ anomaly in 2020

Miyazaki et al. (in press, Science Advances)