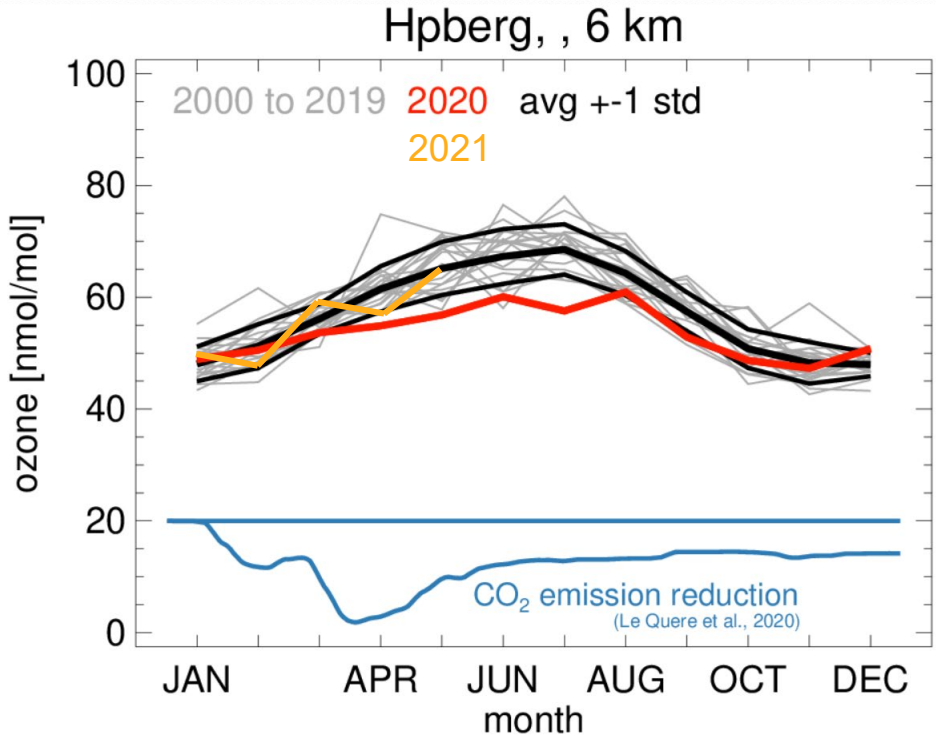
COVID-19 crisis reduces free tropospheric ozone across the Northern Hemisphere

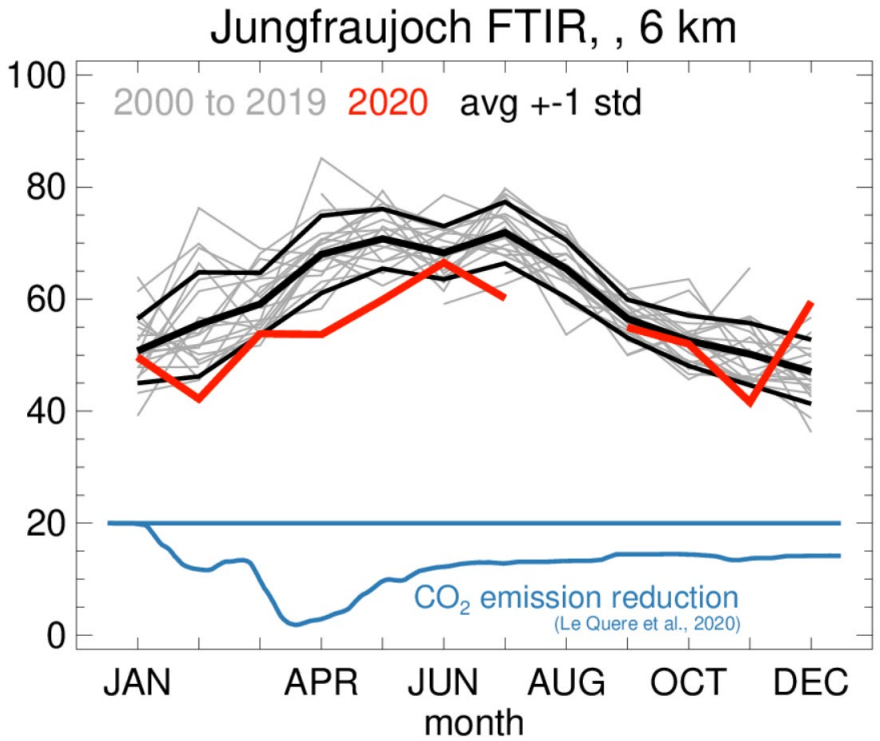
Observations: W. Steinbrecht, D. Kubistin, C. Plass-Dülmer, J. Davies, D.W. Tarasick, P. von der Gathen, H. Deckelmann, N. Jepsen, R. Kivi, N. Lyall, M. Palm, J. Notholt, B. Kois, P. Oelsner, M. Allaart, A. Piters, M. Gill, R. Van Malderen, A.W. Delcloo, R. Sussmann, E. Mahieu, C. Servais, G. Romanens, R. Stübi, G. Ancellet, S. Godin-Beekmann, S. Yamanouchi, K. Strong, B. Johnson, P. Cullis, I. Petropavlovskikh, J. Hannigan, J.-L. Hernandez, A. Diaz Rodriguez, T. Nakano, F. Chouza, T. Leblanc, C. Torres, O. Garcia, A. Röhling, M. Schneider, T. Blumenstock, M. Tully, C. Paton-Walsh, N. Jones, R. Querel, S. Strahan, R.M. Stauffer, A.M. Thompson, A. Inness, R. Engelen, K.-L. Chang, O.R. Cooper, GRL paper: https://doi.org/10.1029/2020GL091987

NCAR / MPI Modelling: G. Brasseur, I. Bouarar, B. Gaubert, …

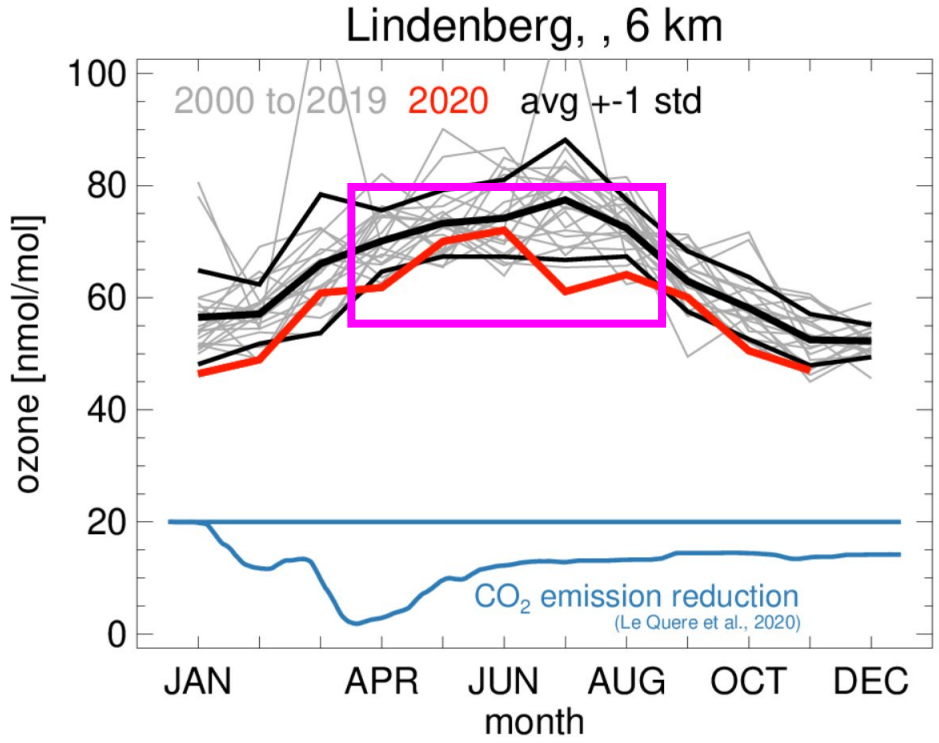
free troposphere: NO_x limited
less NO_x = less Ozone

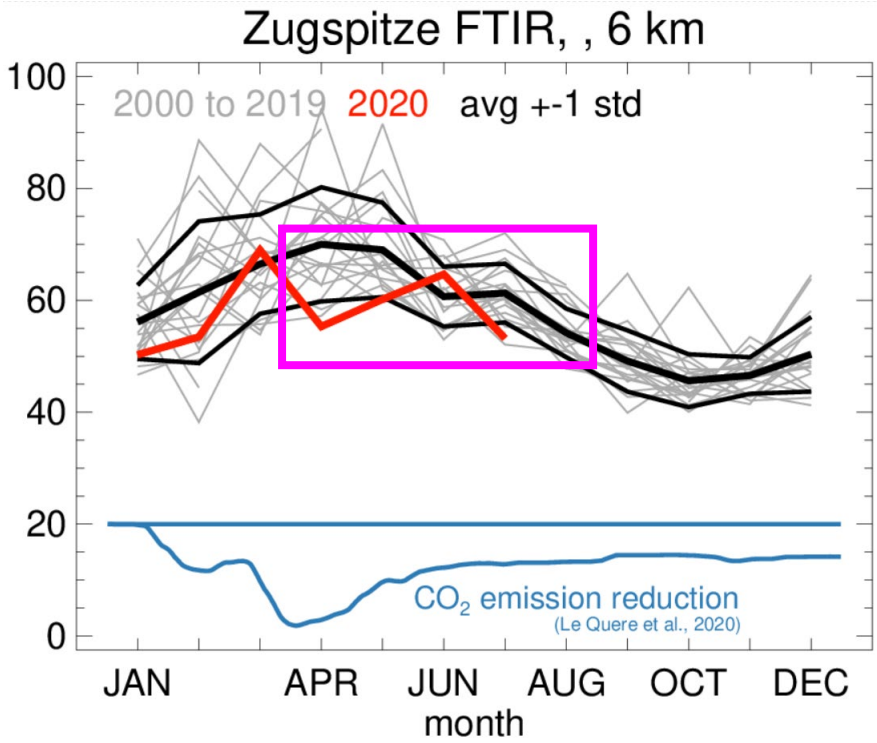
Ozone annual cycles @ Hpberg





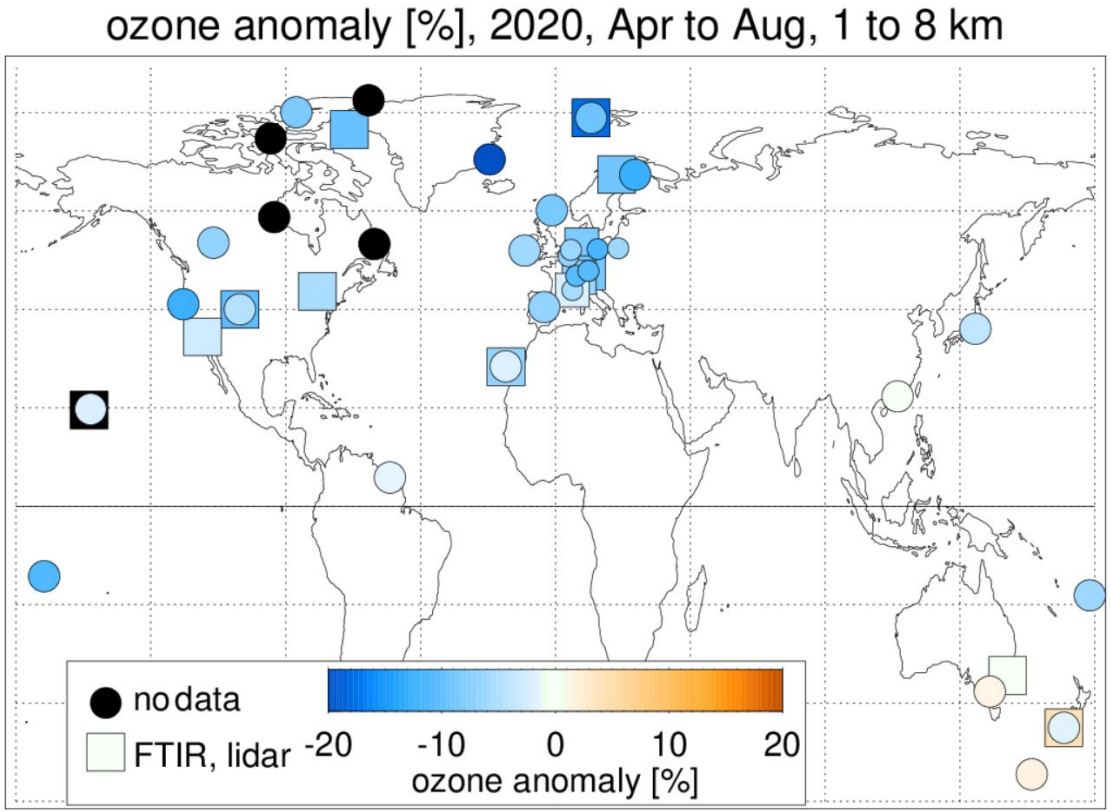
Ozone annual cycles





free troposphere ozone anomaly 2020

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



- ~45 stations / instruments
- Sondes
- 11 FTIRs
- 2 lidars
- reasonably fast data delivery (NILU, WOUDC, NDACC)

WMO

GAW

World Ozone and Ultraviolet Radiation Data Centre

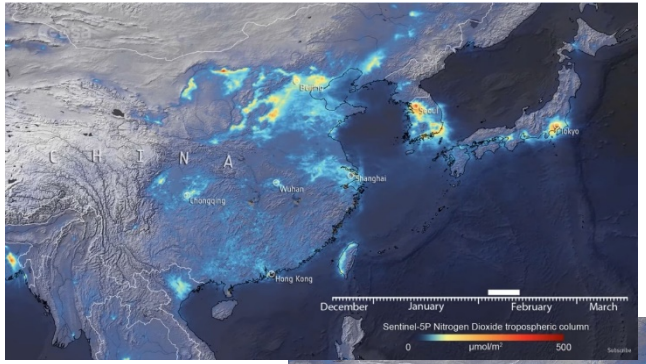
NDACC

Different in 2020

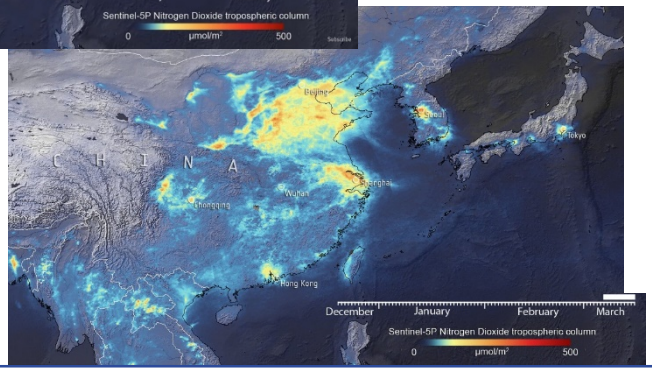
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

1.) reduced emission due to COVID-19

NO_2 over China, Feb. 2020 (lockdown)



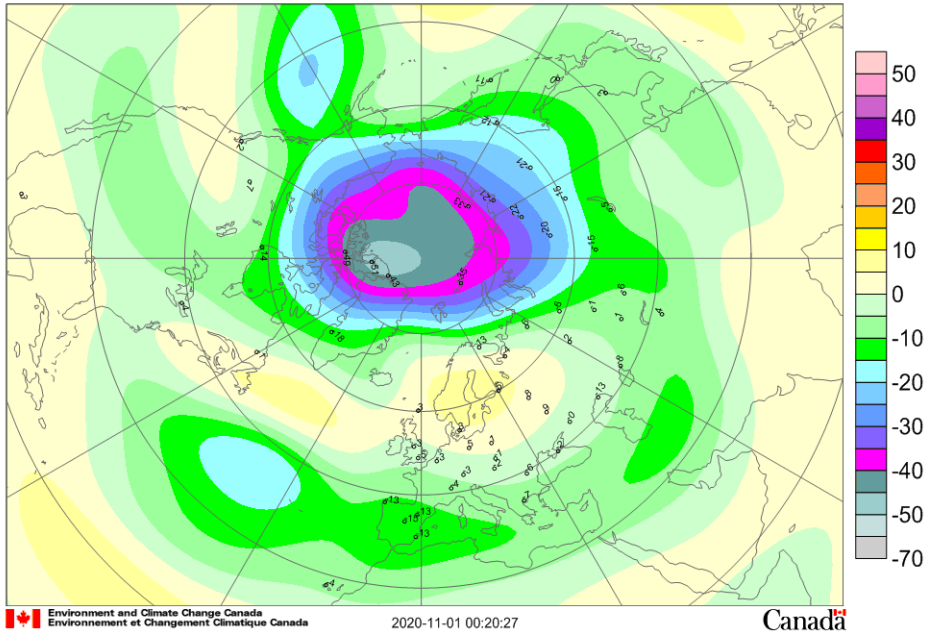
March 2020



www.copernicus.eu
www.esa.int

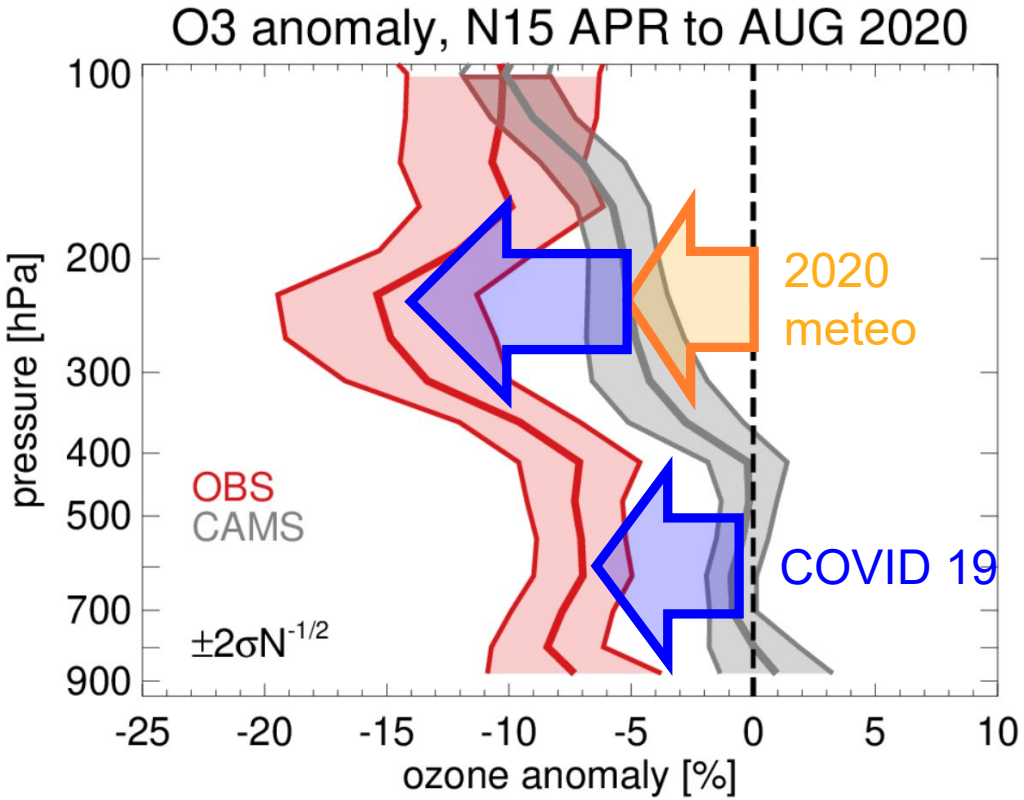
2.) 2020 Arctic “ozone hole”

Mean deviation (%), 2020/03/01-2020/03/31



www.woudc.org

2020 anomalies, vertical profile

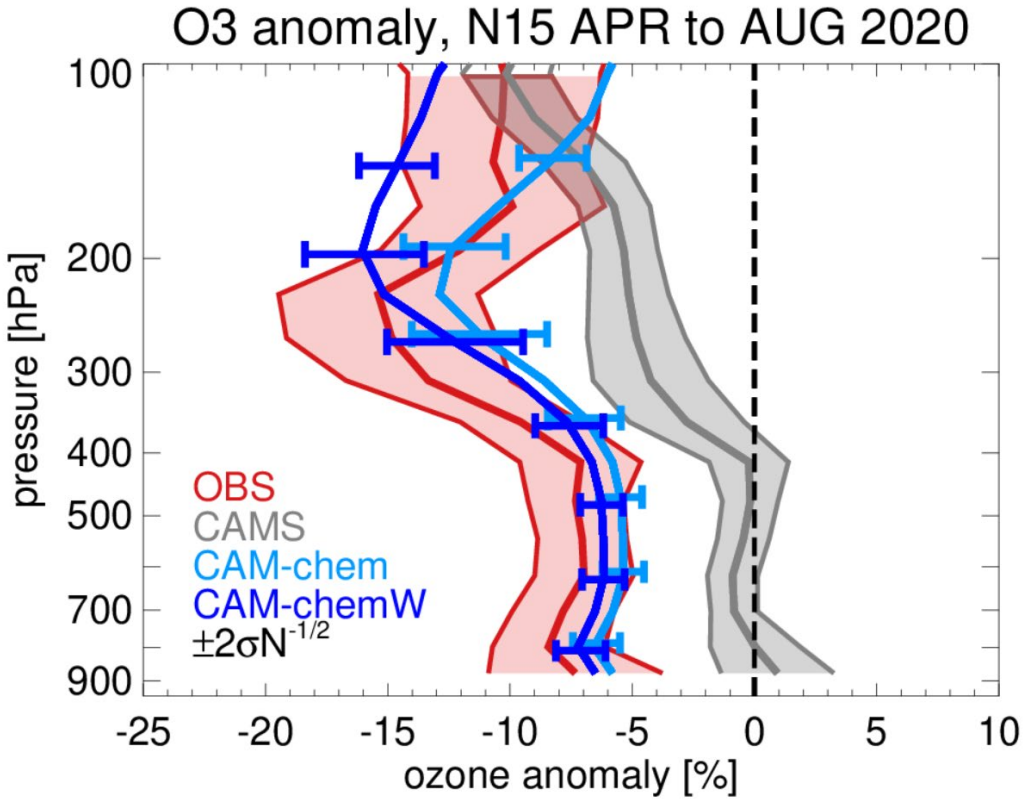


➔ 2020 ozone hole + meteo conditions above 400hPa

➔ COVID-19 emission reductions below 200 hPa

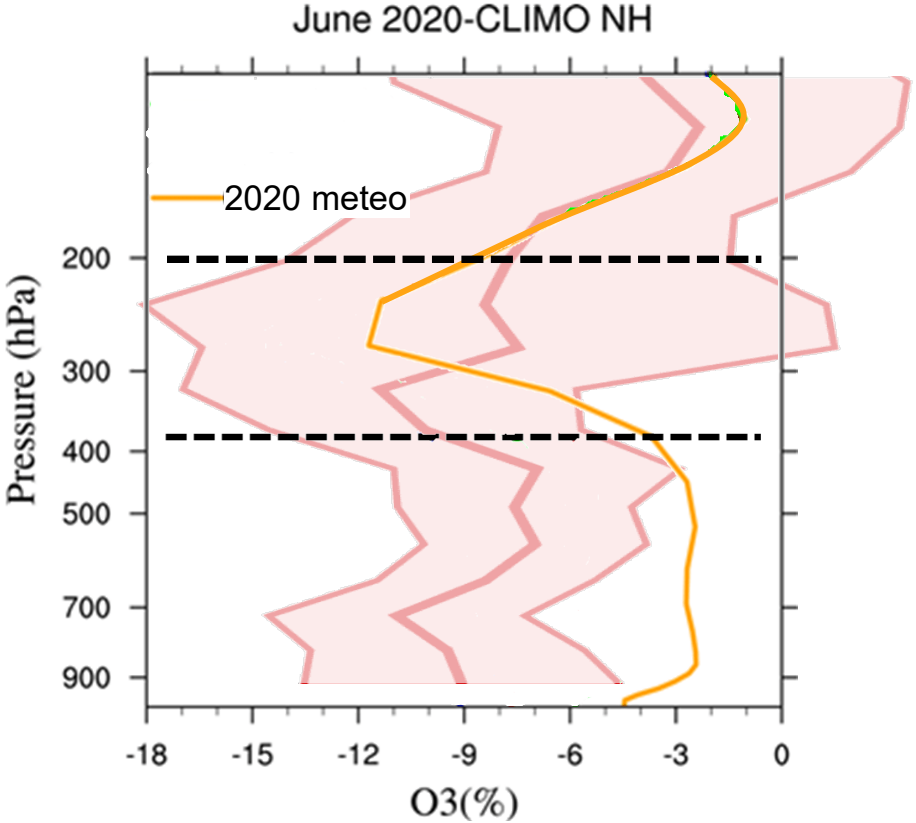
CAMS = Copernicus Atmosphere Monitoring Service = ECMWF chemical weather forecast
2020 meteorology, incl. O_3 hole
"normal" emissions

Vertical Profile, also NCAR simulations

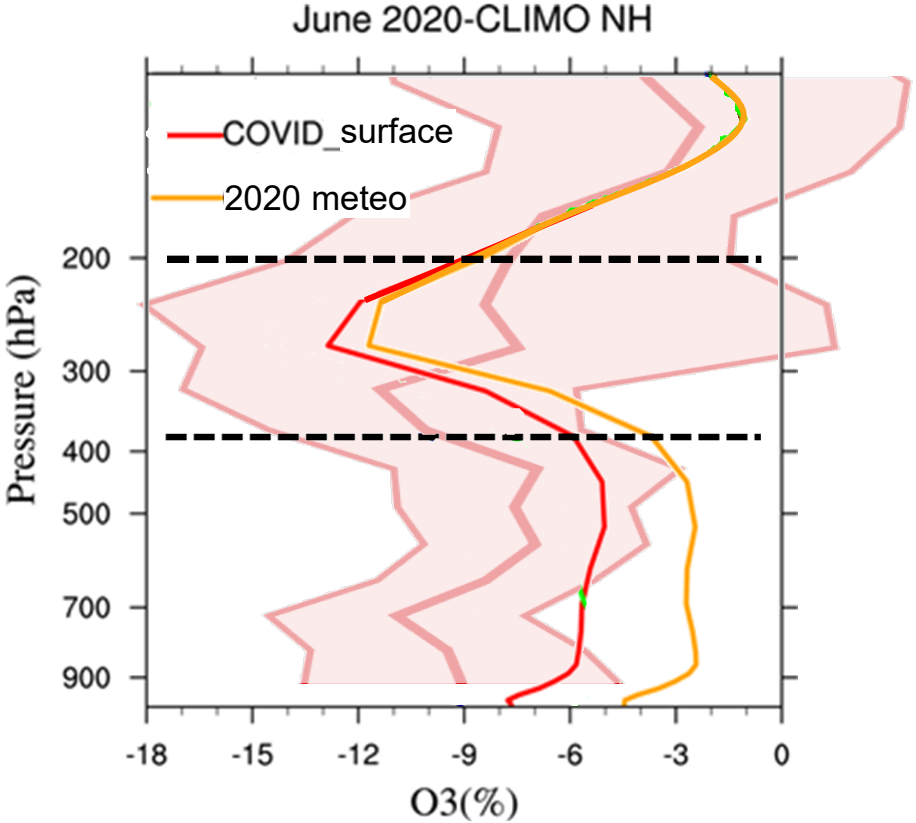


- ➔ 2020 ozone hole + meteo conditions above 400hPa
- ➔ COVID-19 emission reductions below 200 hPa
- ➔ CAM-chem consistent with OBS
- ➔ CAM-chemW better ozone hole: -1% trop O3

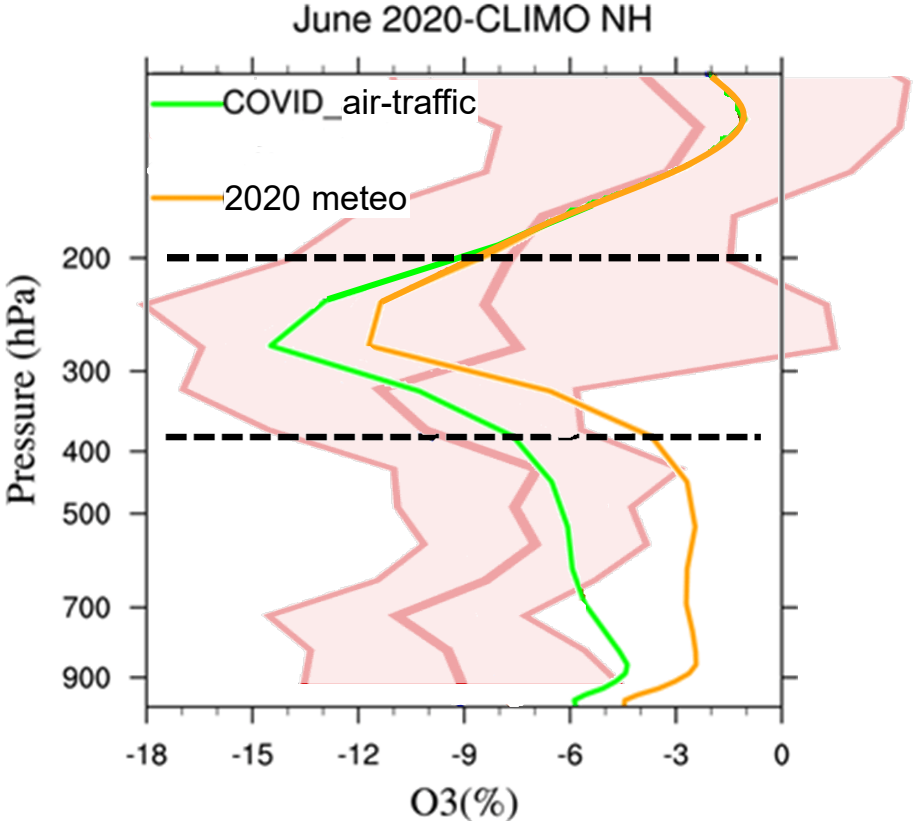
NCAR simulations (June, entire NH)



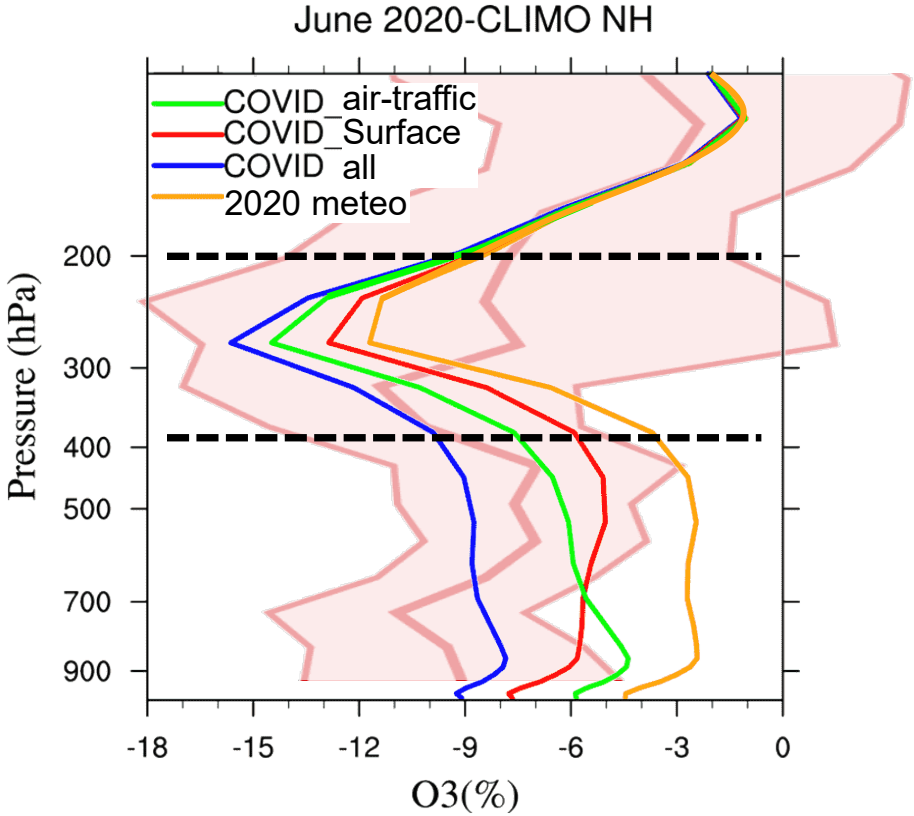
NCAR simulations (June, entire NH)



NCAR simulations (June, entire NH)



NCAR simulations (June, entire NH)



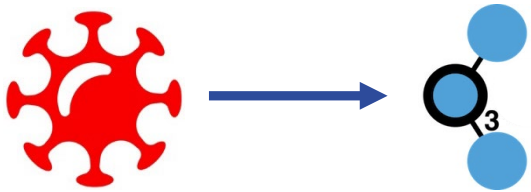
- above 200hPa:
- 2020 meteo conditions, including ozone hole
- below 400 hPa:
- 1/3 meteo conditions
- 1/3 surface emission reduction
- 1/3 air-traffic reduction
- 2/3 COVID-19 reductions

summary

- 7% ozone reduction in NH free troposphere, April to August 2020, 1 to 8 km
- below 8 km: 2/3 due to COVID-19 emission reductions (NO_x ,…)
- (1/3 surface emissions, 1/3 air-traffic reduction)
- 1/3 from 2020 meteorology (incl. Arctic stratospheric ozone hole)

- in SH: (smaller) COVID-19 effect washed out by 2020 natural conditions

- accidental “global experiment”, much to be learned
- importance of “monitoring” + data availability



- GRL: obs: paper, simulations: submitted

WMO GAW

Government of Canada / Gouvernement du Canada
World Ozone and Ultraviolet Radiation Data Centre

NDACC


ECMWF
Met Office
MET éireann
The Irish Meteorological Service
Atmosphere Monitoring Service
atmosphere.copernicus.eu
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG
FMI
Thank You !
Environment Canada
UNIVERSITY OF TORONTO
METEO IMGW-PIB
meteo.imgw.pl
NCAR UCAR
National Center for Atmospheric Research
Japan Meteorological Agency
気象庁
MeteoSwiss
Max-Planck-Institut für Meteorologie
NDACC
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
NASA
LIÈGE université
WMO
GAW
Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu
JPL
Jet Propulsion Laboratory
California Institute of Technology
KIT
Karlsruher Institut für Technologie
Australian Government
Bureau of Meteorology
Institut Pierre Simon Laplace
UNIVERSITÉ DE VERSAILLES ST-QUENTIN-EN-YVELINES
OVSQ
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RMI
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NIWA
Taihoro Nukurangi
AEMet
Agencia Estatal de Meteorología