Towards an improved understanding of the CO budget through different data assimilation frameworks



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BACKGROUND

Why are models underestimating CO?

$$\frac{d[CO]}{dt} = \frac{\delta[CO]}{\delta t} + \frac{\delta[CO]}{\delta t}$$

$$-k_{OH}[CO][OH] - k_{dep}[CO]$$

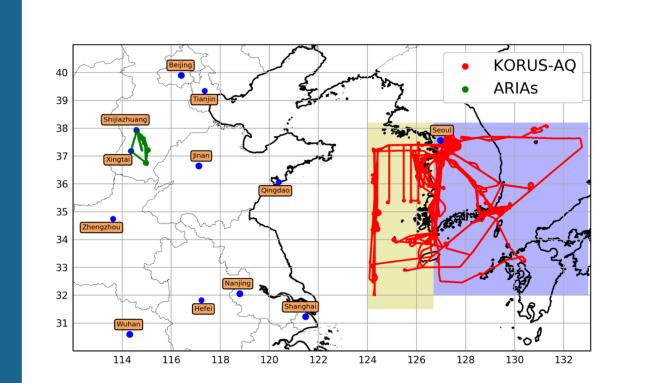
- ➤ CO is important for tropospheric chemistry, it is a major sink for OH, and can produces Ozone.
- >Common underestimation is not understood
 - Anthropogenic sources
 - Biogenic sources
 - OH sink
 - Deposition

METHODS

Number of vertical layers Chemical assimilation Mopital V8J Meteorological assimilation Online dynamic online chemistry online aerosols Methyl Chlorofom OH Interactive OH Anthropogenic BB Biogenic BB FINN 1.5 Biogenic DA algorithm State optimization New Mopital V8J Mopital V8J GGGRN data*, Mopital V8J FRA-Interim yes yes no (offline, driven by ERA-Interim yes yes for OH SINN 1.5 GFED41s MEGAN V2 + POET ADVar State optimization CO + some VOCs Anthropogenic emissions yes yes yes	Acronym	CAM-Chem/DART	TM5 4DVar
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No (but interactive		No (but interactive	
Chemical sink flux chem) no	Chemical sink flux	chem)	no

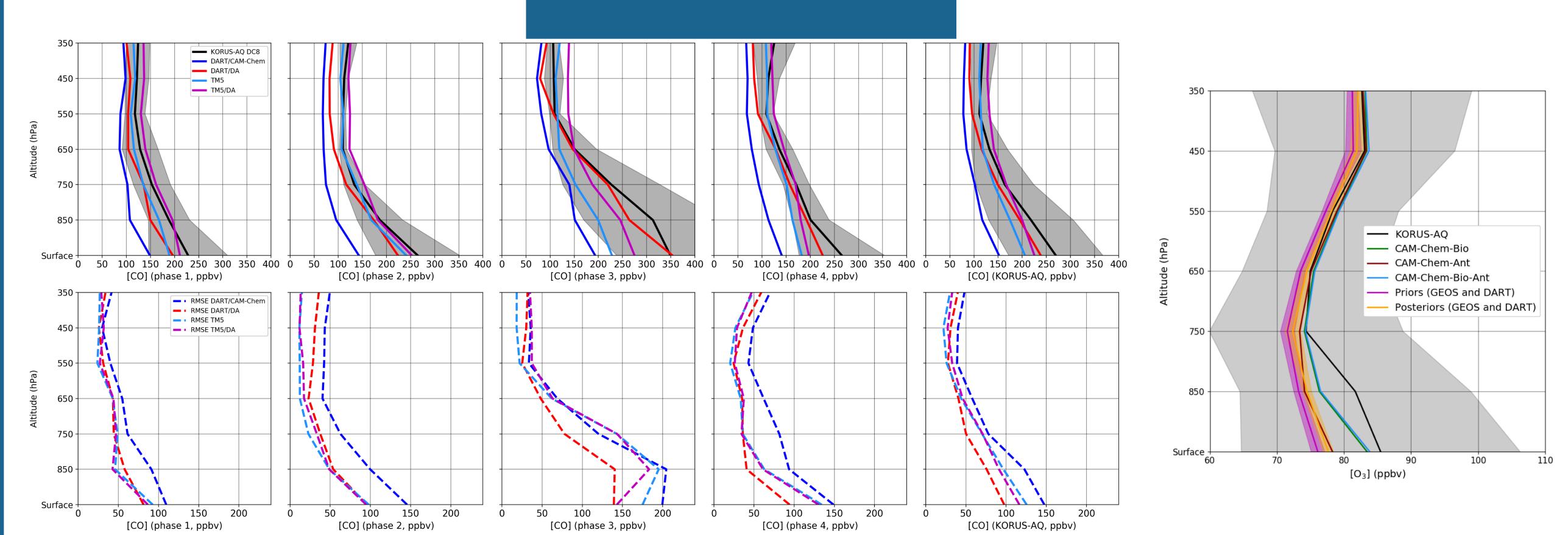
KORUS-AQ field campaign

- ➤ 20 research flights over South Korea in May-June 2016 with the NASA DC-8 aircraft.
- > Vertical profiles of CO, Ozone, Methane (CH4), Formaldehyde (CH2O).
- Extreme gradients of pollution, in space and time, over different weather regimes



Location of the KORUS-AQ DC8 and of the ARIAs Y-12.
Dots are from the 1-min merge.





- Phase 1, the synoptic weather system dynamically changed.
- Phase 2: Synoptic flow was weak, stagnant conditions led to strong enhancements of pollution over the Korean Peninsula.
- Phase 3: Strong westerlies existed, polluted air was rapidly transported from China to Korea, causing extreme pollution.
- ❖ Phase 4: a blocking pattern determined the large-scale ozone distribution over East Asia.

CONCLUSIONS

- > Inversion and forward runs suggests that most up to date emissions are underestimated.
- > Sensitivity experiments with CAM-Chem suggest that secondary CO is also underestimated, and is confirmed through comparison of measured VOCs.
- > The correction of the CO emission bias improve the Ozone profile and increasing biogenic emissions leads to a better Ozone.
- > CLIMCAPS CrIS is going to provide additional constraints, work in progress.
- > Will assess the role of OH, chemical sources and transport on retrieved emissions.

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