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

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## BACKGROUND

### Why are models underestimating CO?

$$\frac{d[CO]}{dt} = \frac{\delta[CO]}{\delta t}_{transport} + \frac{\delta[CO]}{\delta t}_{emissions} + \frac{\delta[CO]}{\delta t}_{chemical\ sources} - k_{OH}[CO][OH] - k_{dep}[CO]$$

➢CO is important for tropospheric chemistry, it is a major sink for OH, and can produces Ozone.

➢Common underestimation is not understood

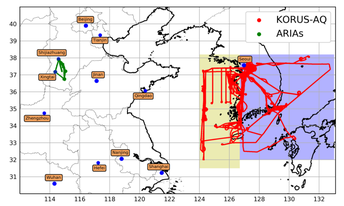
- ❖ Anthropogenic sources
- ❖ Biogenic sources
- ❖ OH sink
- ❖ Deposition

## METHODS

| Acronym | CAM-Chem/DART | TM5 4DVar |
|---|---|---|
| horizontal resolution | 0.9° x 1.25° | 3°x2° global, 1°x1° zoom |
| Number of vertical layers | 32 | 25 |
| Chemical assimilation | MOPITT V8J | GGGRN data*, MOPITT V8J |
| Meteorological assimilation | yes | no (offline, driven by ERA-Interim) |
| Online dynamic | yes | no (offline, driven by ERA-Interim) |
| online chemistry | yes | yes (OH sink) |
| online aerosols | yes | no |
| Methyl Chlorofom OH | no | yes |
| Interactive OH | yes | no (fixed OH) |
| Anthropogenic | CMIP6 + CREATE | MACCity |
| BB | FINN 1.5 | GFED41s |
| Biogenic | MEGAN 2.1 (CLM) | MEGAN v2 + POET |
| DA algorithm | EAKF | 4DVar |
| State optimization | CO + some VOCs | CO |
| Anthropogenic emissions | yes | no |
| BB emissions | yes | yes |
| Chemical source flux | No (but interactive chem) | yes (IMAGES total column) |
| Chemical sink flux | No (but interactive chem) | no |

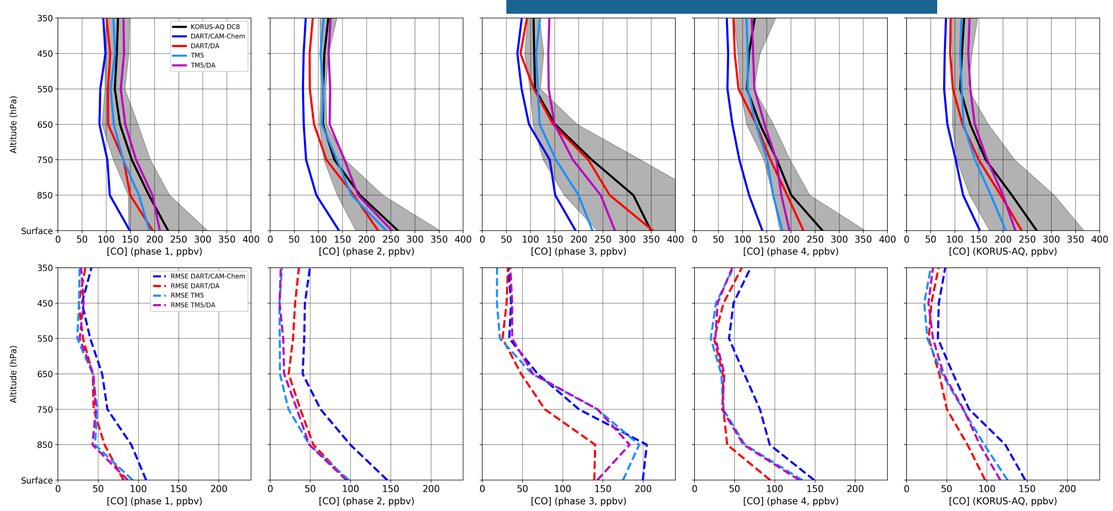
## KORUS-AQ field campaign

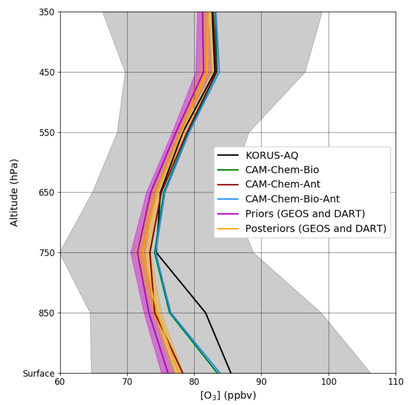
- ➢ 20 research flights over South Korea in May-June 2016 with the NASA DC-8 aircraft.
- ➢ Vertical profiles of CO, Ozone, Methane (CH4), Formaldehyde (CH2O).
- ➢ Extreme gradients of pollution, in space and time, over different weather regimes




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

## RESULTS




- ❖ 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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