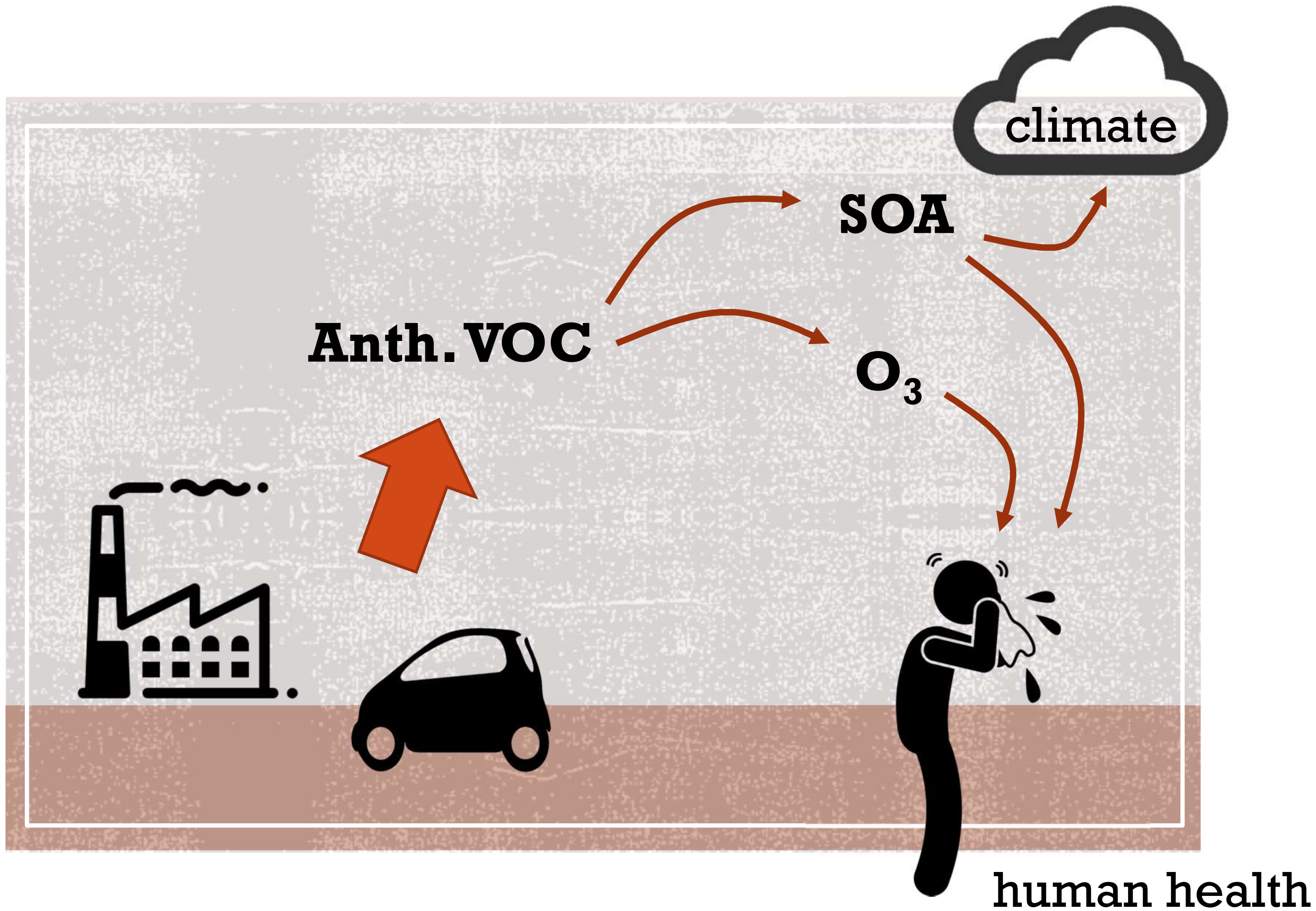
14 YEARS OF OMI HCHO OBSERVATIONS REVEAL VOC EMISSION TRENDS OVER LARGE CITIES WORLDWIDE

Maite Bauwens [1], Jenny Stavrakou [1], Jean-François Müller [1],
Isabelle De Smedt [1], Claire Granier [2,3], Nellie Elguindi [2]

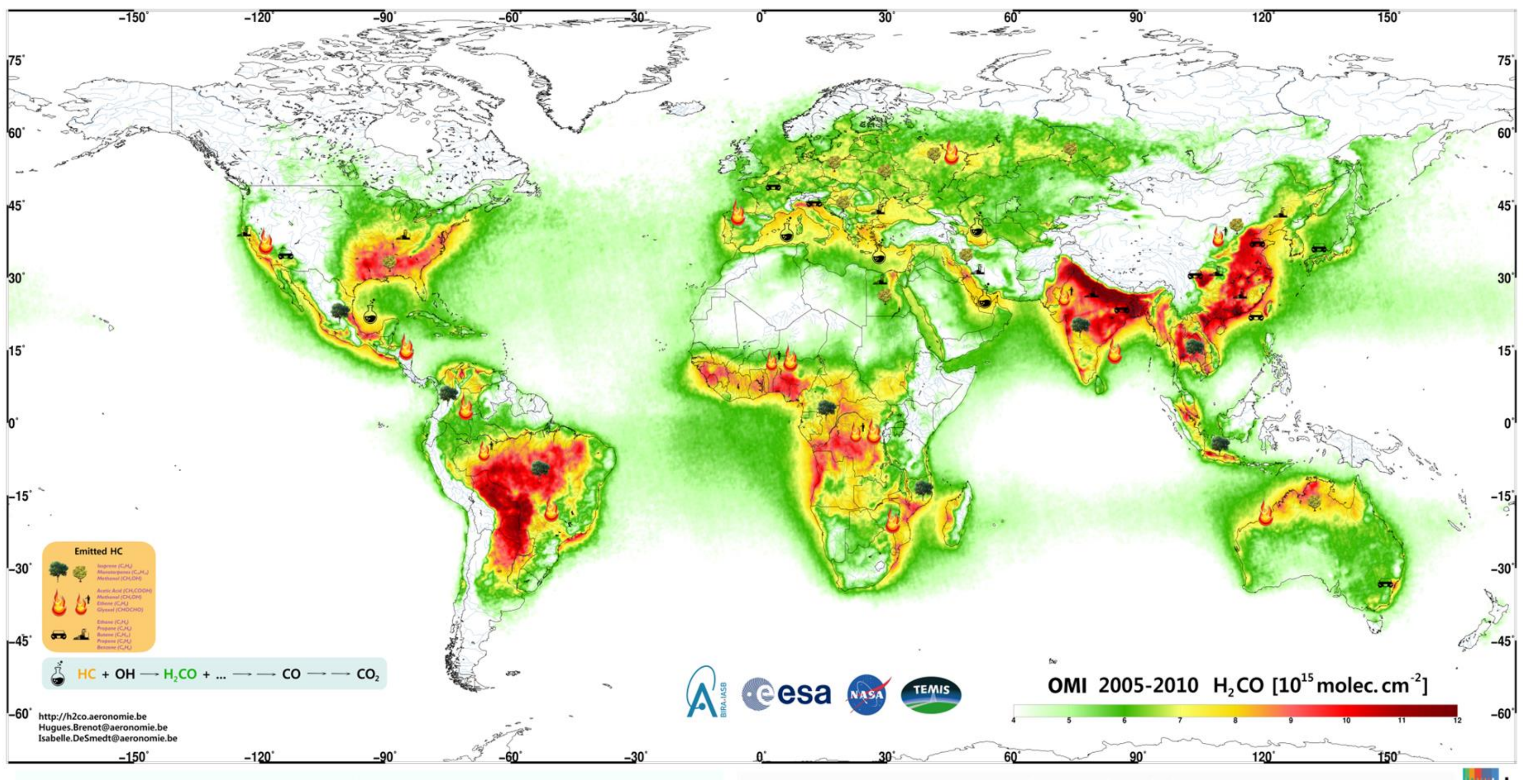
1. BIRA-IASB, Brussels, Belgium (contact: maiteb@oma.be)
2. Laboratoire d'Aérologie, Université de Toulouse, CNRS, UPS, France
3. NOAA/CSL and CIRES/University of Colorado, Boulder, USA

WHY DO WE NEED VOC EMISSION ESTIMATES?

- VOCs : precursors of O_3 and SOA ➔ indirect impact on climate and human health
- Megacities are emission hot spots
- Anthropogenic sources of VOCs :
  - Industry, transportation,…
- Uncertain bottom-up emissions:
  - Depend on activity data and emission factors that can vary temporally and locally
  - For 2020: ECLIPSE=87Tg, CAMS-ANT=180Tg
  - Year-to-year variations and trends are difficult to estimate



HCHO AS PROXY OF VOC EMISSIONS



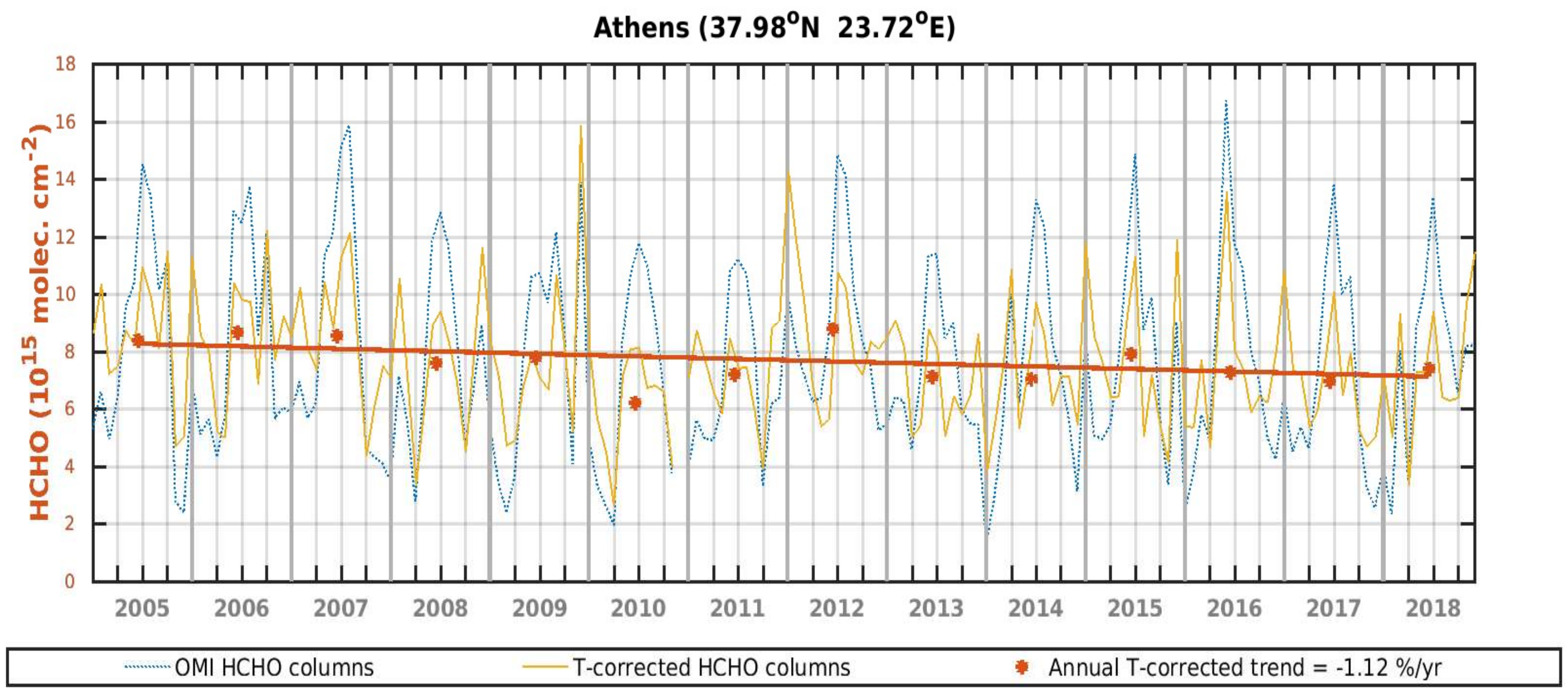
De Smedt et al. 2015

- HCHO is a high yield product of VOCs
- HCHO has been widely used to estimate biogenic VOC emissions (e.g. Palmer et al. 2003, Millet et al. 2008, Bauwens et al. 2016)
- Only 7% of the global HCHO column is of anthropogenic origin (Stavrakou et al. 2009) → <u>derivation of anthropogenic VOC emissions is very challenging</u>

- OMI HCHO trends over 2005-2016 were derived and linked to anthropogenic VOC emissions in China (Shen et al. 2019)

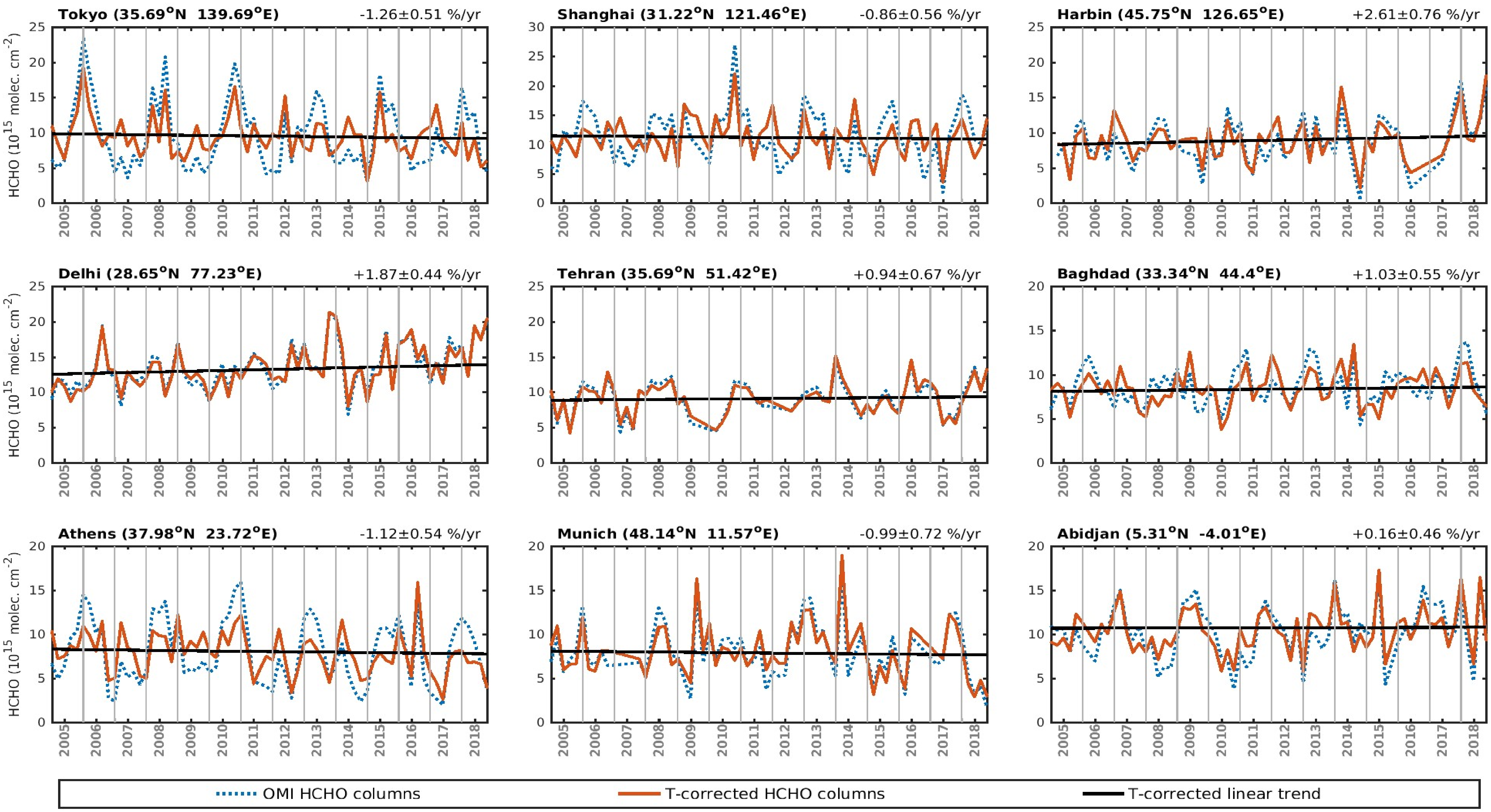
METHOD: Temperature-corrected HCHO columns

- We use monthly mean OMI QA4ECV HCHO observations over 2005-2018 (De Smedt et al., 2018), and collect column data lying within 30 km of large city centers (> 500,000 inhabitants, > 1,000,000 for China and India)
- Because the biogenic source has a large T-dependence, we remove this dependence in OMI HCHO columns by applying linear regression between monthly HCHO columns and noontime surface temperature from ERA-Interim data

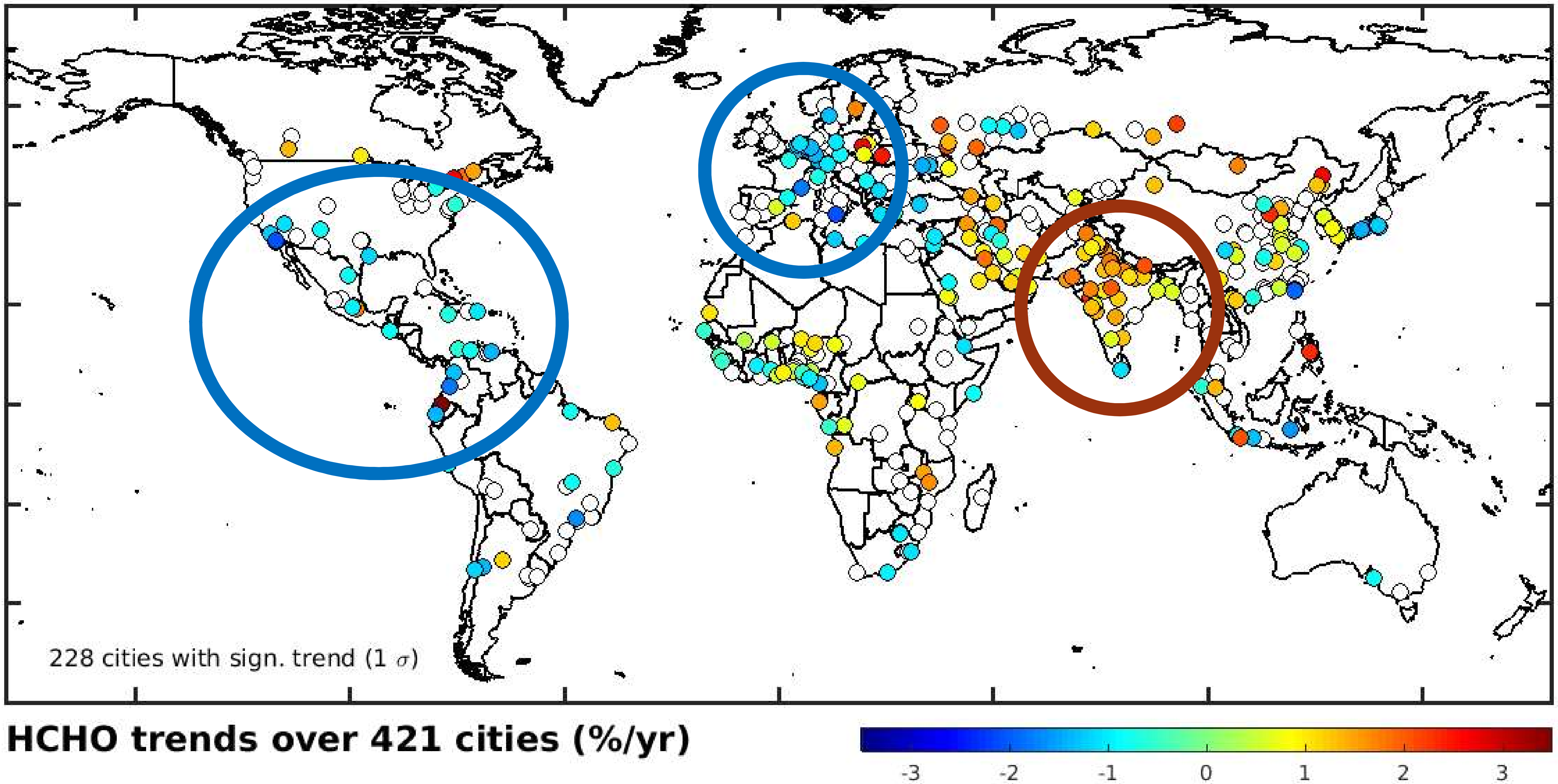


- Subtract the temperature dependence
- Calculate relative trend of the T-corrected HCHO column

RESULTS: time series for 9 cities



RESULTS: A global trend map

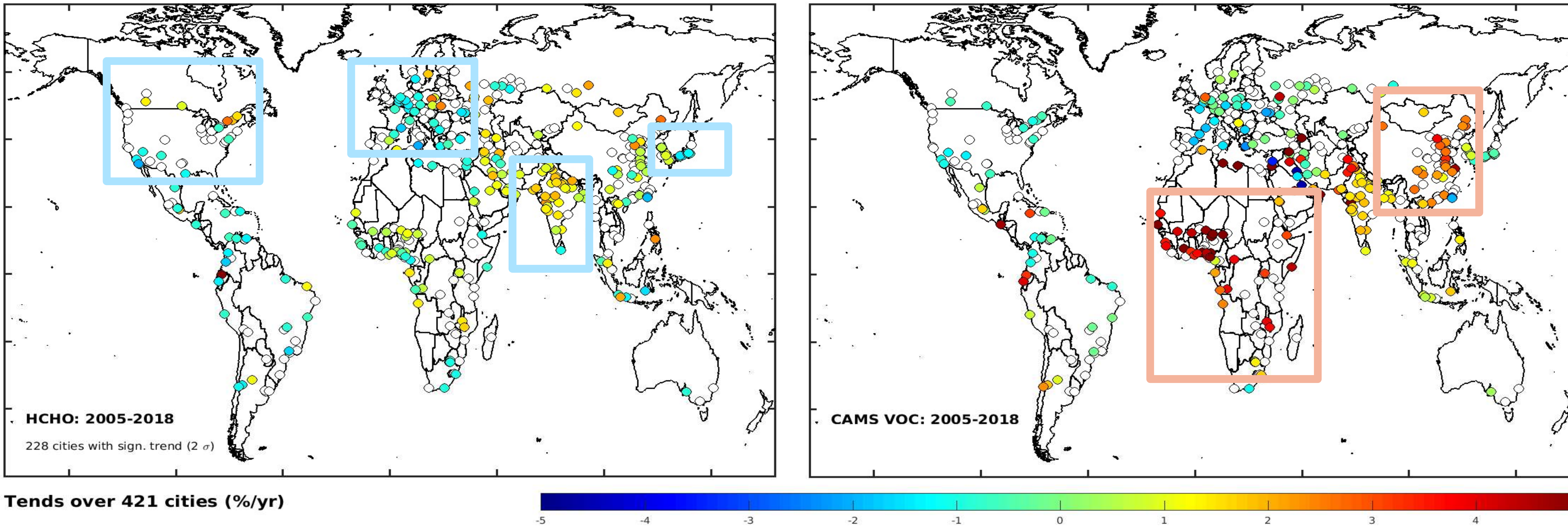


HCHO trends over 421 cities (%/yr)

- 228 cities show a significant trend
- Positive trends in India between 1 and 2.5%/yr
- Negative trends in Europe and US between -1 %/yr and -2%/yr
- Larger variability elsewhere

COMPARISON TO CAMS-GLOB-ANT-v4.1

- CAMS-GLOB-ANT (Granier et al. 2019) is based on EDGARv4.3.2 until 2012 (Crippa et al., 2018) and CEDS (Hoesly et al., 2018), uses 2011-2014 CEDS trends to extrapolate the EDGAR4.3 2012 emissions

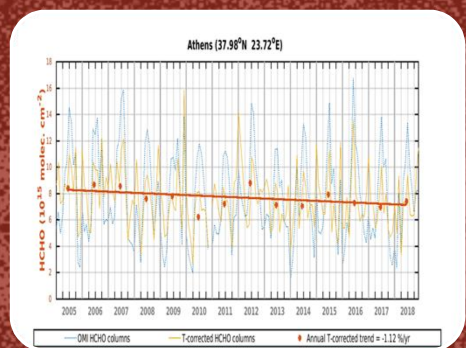


In EU, US, India and Japan, satellite trends are similar with CAMS emission trends

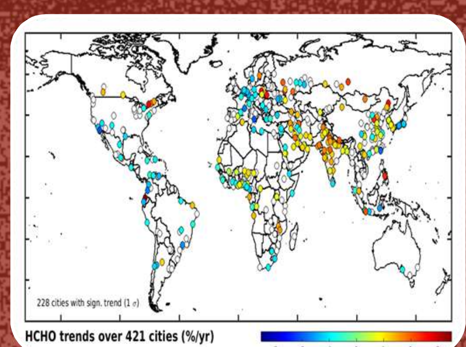
CAMS VOC trends are likely overestimated in China and possibly Africa

However, However, in Africa, strong biogenic and biomass burning contributions might make the anthropogenic component difficult to quantify

IN CONCLUSION

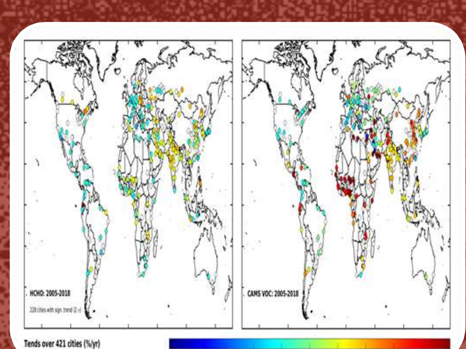


We used T-corrected satellite HCHO columns over 2005-2018 over large world cities to infer column trends and compare them to reported trends in anthropogenic VOC inventories



We found significant (1σ) anthropogenic column trends over 228 cities

- Positive trends in most Indian cities between +0.5 and +2.5%/yr
- Negative trends in Europe, US and Japan about -1%/yr on average
- Derived trends in China in agreement with Shen et al. (2019)
- Positive trends in Korean cities, about +1%/yr on average



In comparison to the CAMS-GLOB-ANT v4.1 inventory the derived trends are:

- in very good agreement over India, Japan and Korea
- in good agreement in Europe and North America
- CAMS-GLOB-ANT v4.1 trends are likely overestimated over China (recent activity data are needed!)
- CAMS-GLOB-ANT v4.1 shows much stronger trends over Africa → warrants further investigation