GEOS-Chem and the GMAO: Reaction, Replay and Reanalysis

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Objective: to highlight the role of GEOS-Chem chemistry in the GMAO's GEOS Earth System Model, with progress from "research" to "production" capability

Progress of Two Applications of GEOS, Beginning in ~2004

Online implementation of tagged tropospheric tracers to support Intex-NA (Jacob-Pawson; Eric Nielsen)

Emergence of the first version of the GEOS CCM (Chemistry-Climate Model) (Stolarski-Pawson; Eric Nielsen)

Set a precedent of GEOS generating custom products for NASA's field missions

Set a precedent of GEOS applications to multi-decadal ozone change studies

Scrutiny of transport in analyses and forecasts – features; emissions

Scrutiny of transport in multi-decadal simulations

Presently transporting about 10 idealized tracers and 29 aerosols (with assimilation) in GEOS FP system

Presently transporting stratospheric and tropospheric constituents in GEOS CCM system

Newest analysis and forecasting system, GEOS CF, is based on GEOS-Chem

GEOS CCM is considering a future that will be based on GEOS-Chem

Realism of Total Column Ozone in the GEOS CCM

- Successive changes in GEOS CCM have led to very realistic representation of total global ozone evolution
- Only sparse investment in development of the GMI strat-trop chemistry mechanism
- GEOS-Chem mechanism is under continual development by a huge team!
- The bar is already set quite high when it comes to the total column ozone

Figure by Luke Oman and Qing Liang

GEOS-4 -> GEOS-5 (improved circulation)

Very short-lived bromine compounds;
Volcanic aerosols;
Quasi Biennial Oscillation (QBO)

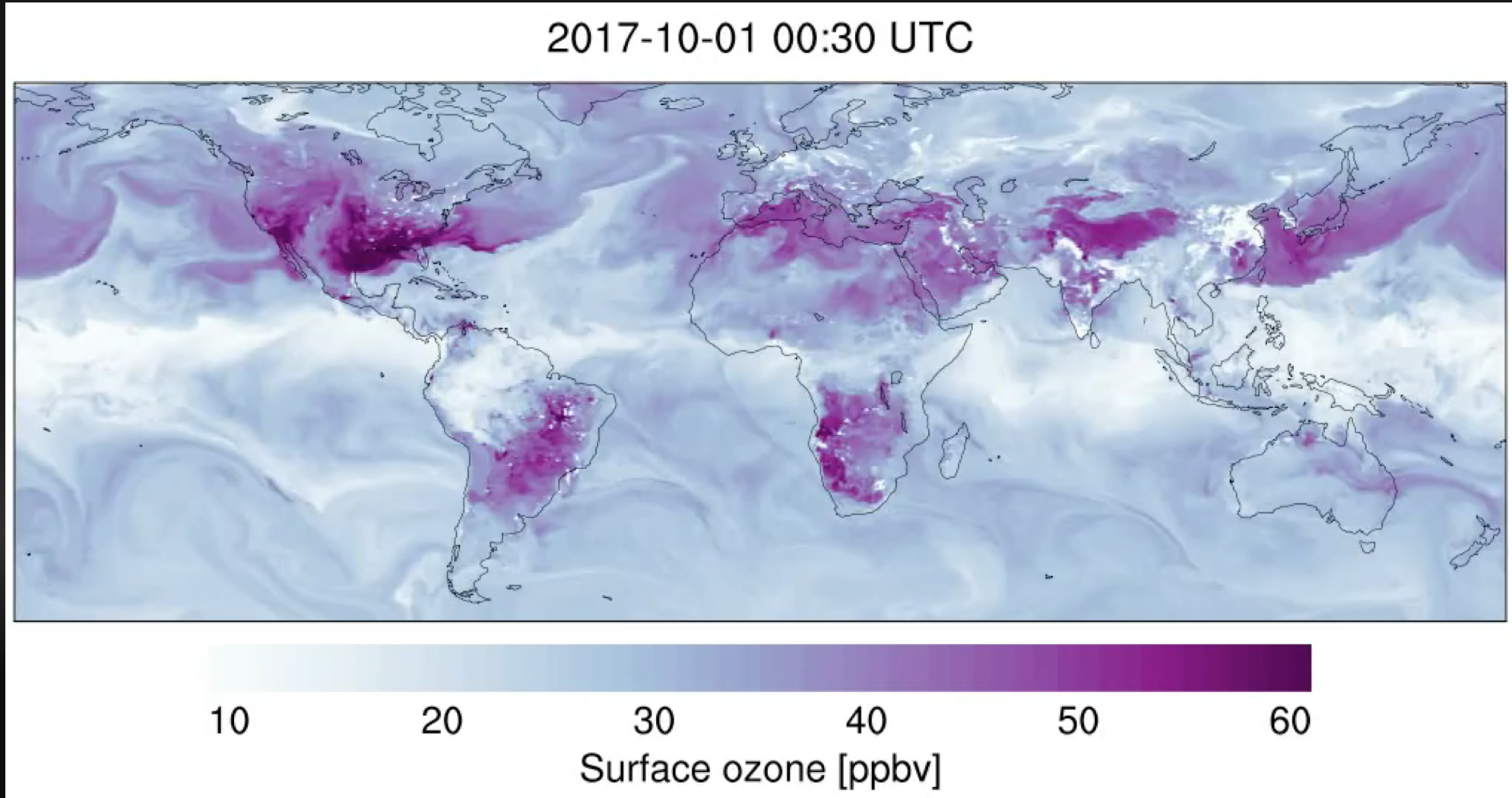Tropospheric chemistry;
11-yr Solar cycle
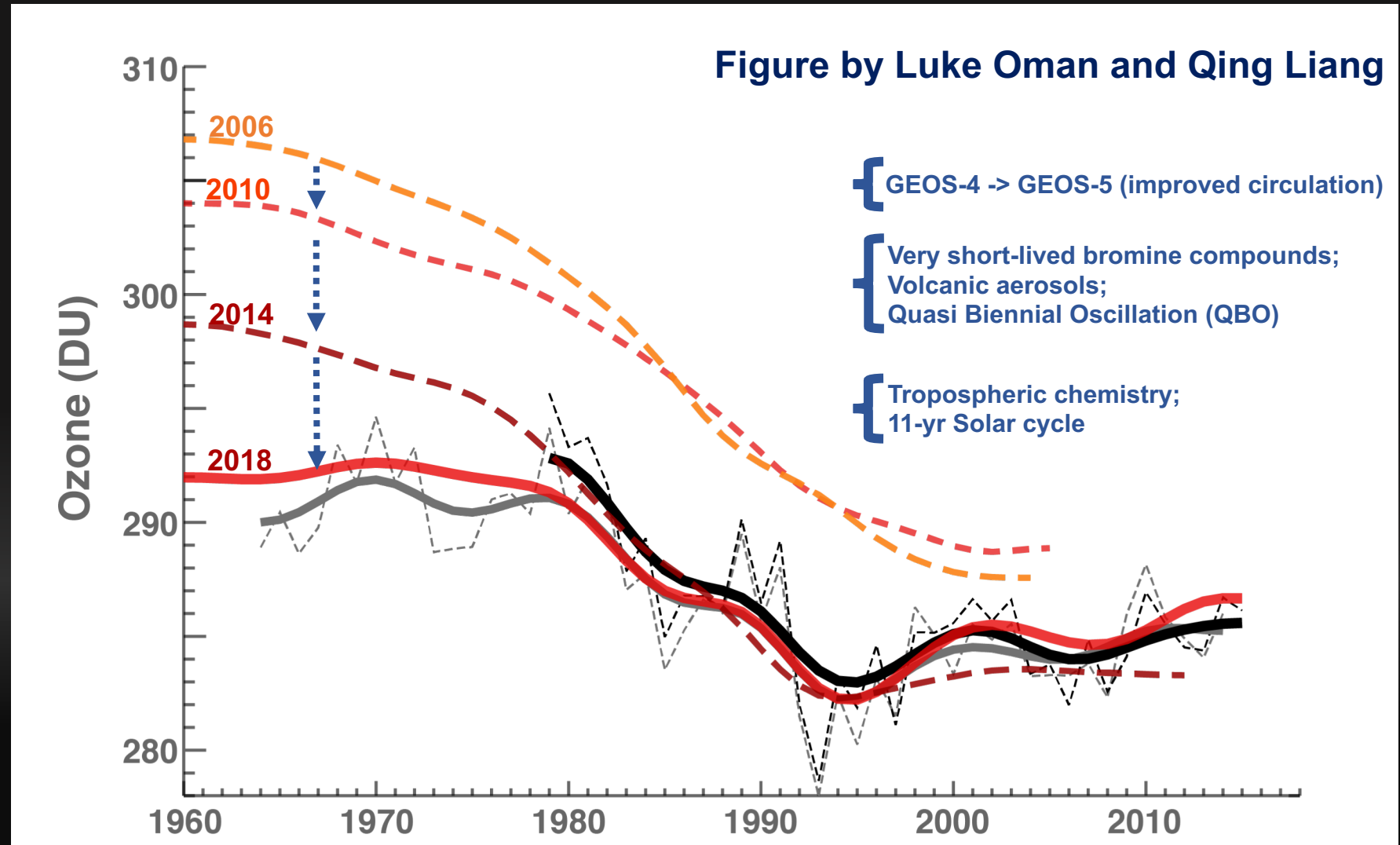
GEOS CF (Composition Forecasting) System

Real-time analysis and forecasting system for atmospheric composition:

- Based on GEOS meteorological analyses, using REPLAY technique

- Emissions and reactive chemistry based on GEOS-Chem

- No assimilation of constituents (at least for now)

- Resolution: c360L72, or ~25km globally

- One five-day forecast each day

Zurich, Switzerland, 2017-10-26 00:00 UTC
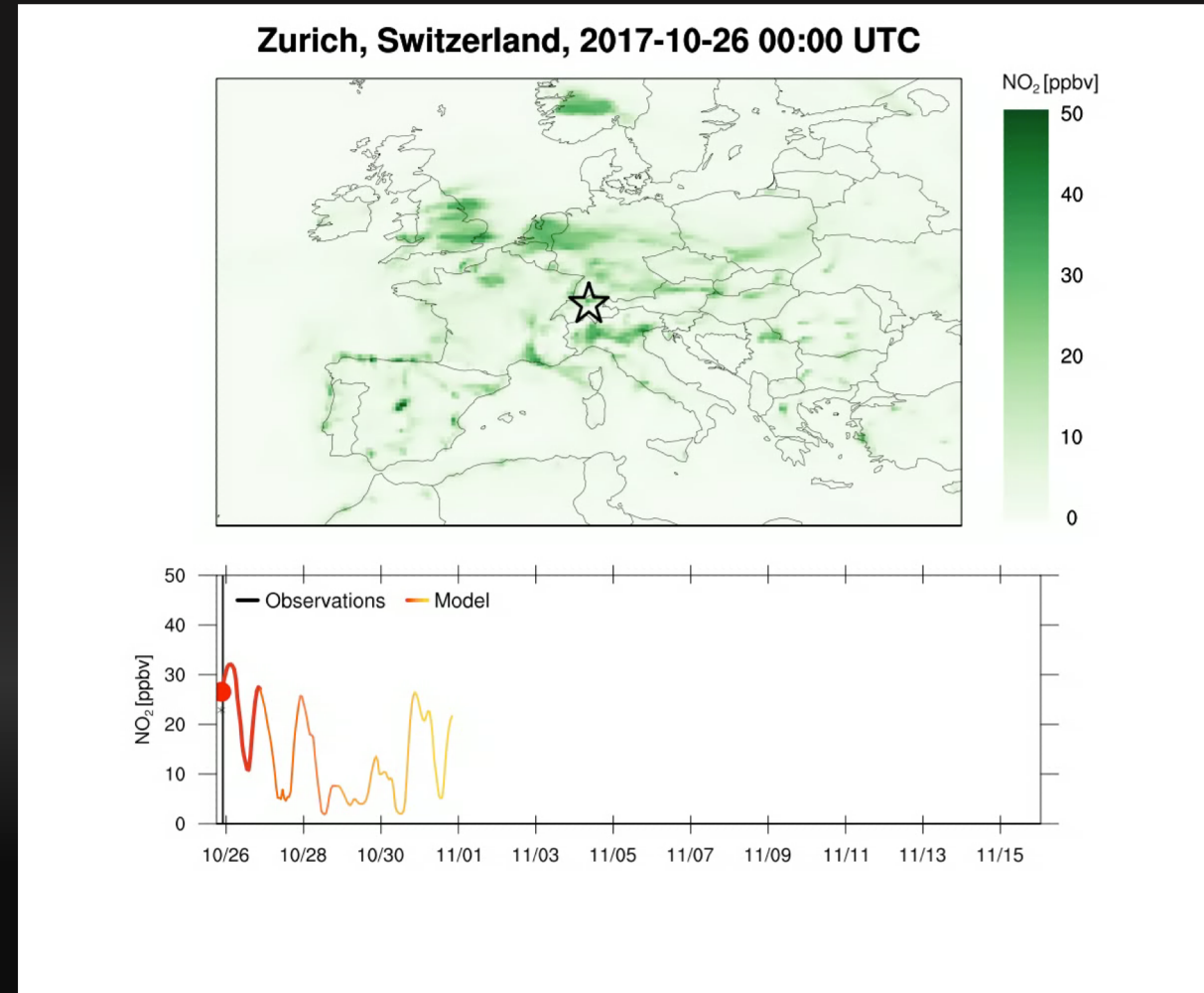
Example output: GEOS-CF surface ozone "analysis"

2017-10-01 00:30 UTC

Surface ozone [ppbv]

Keller, Knowland, et al.

Summary

GEOS-Chem provides a pathway to sustainable modeling of atmospheric composition in GMAO's GEOS systems:

➤ GEOS CF already exploits this capability

➤ Central repository allows for easy code sharing

➤ Pathway from "research" to "production" systems (and beyond?)

Hope to use a GEOS CF system for a 20-year REANALYSIS of atmospheric composition, using EOS observations and more

Examining the possibility of using GEOS-Chem in the GEOS CCM – stringent demands on the stratosphere

Reactions (not very chemical)

➢ Any questions?