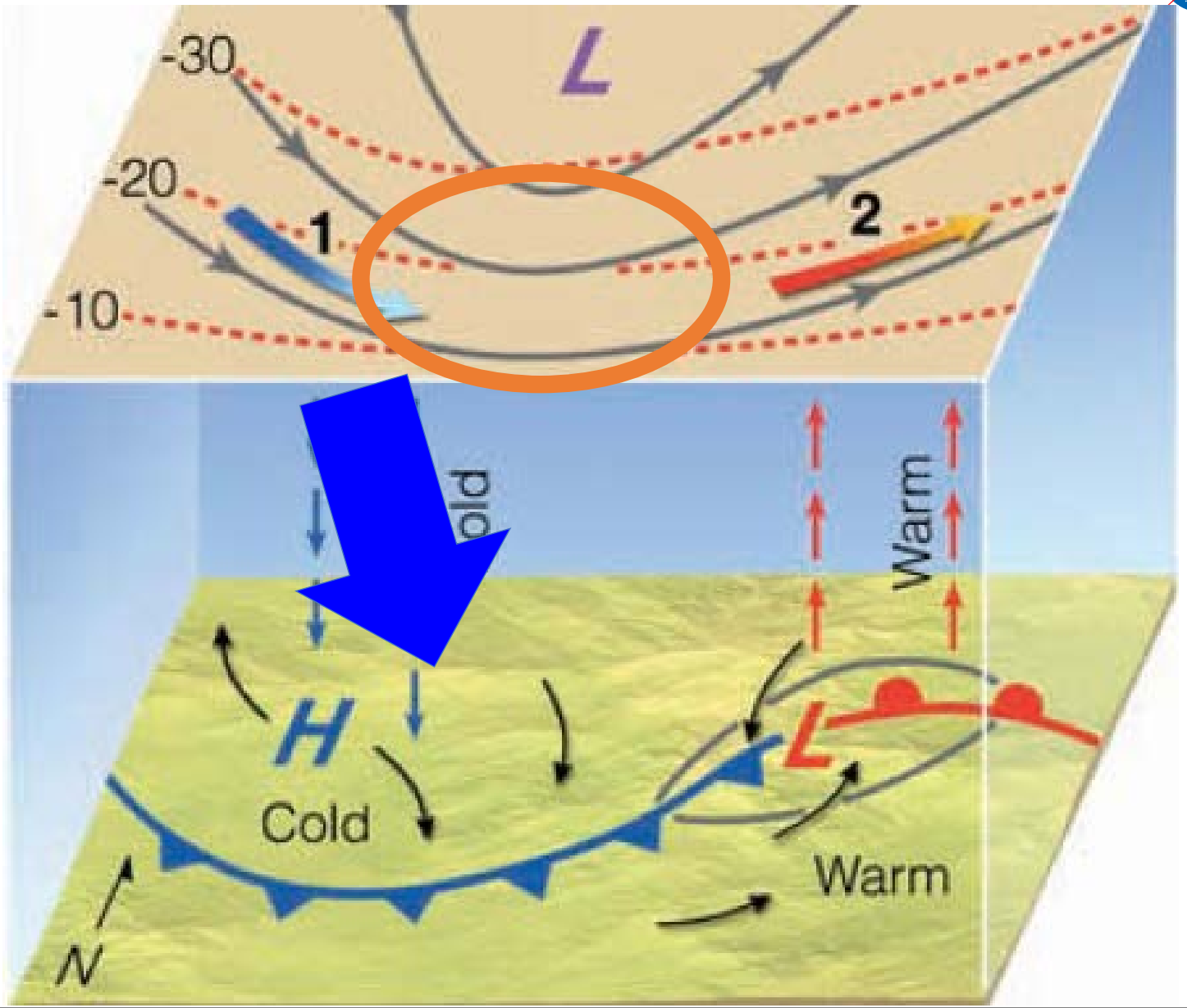
Using NASA's new composition forecast to investigate ozone exceedance events linked with stratospheric intrusions

K. Emma Knowland
(USRA/GESTAR, NASA GMAO)

In collaboration with
GMAO: Christoph Keller, Lesley Ott, Kris Wargan
Atmospheric Chemistry and Dynamics Laboratory: Bryan Duncan

- Converging air accumulates and subsides behind the cold front
- As air enters the trough, wind speeds increase

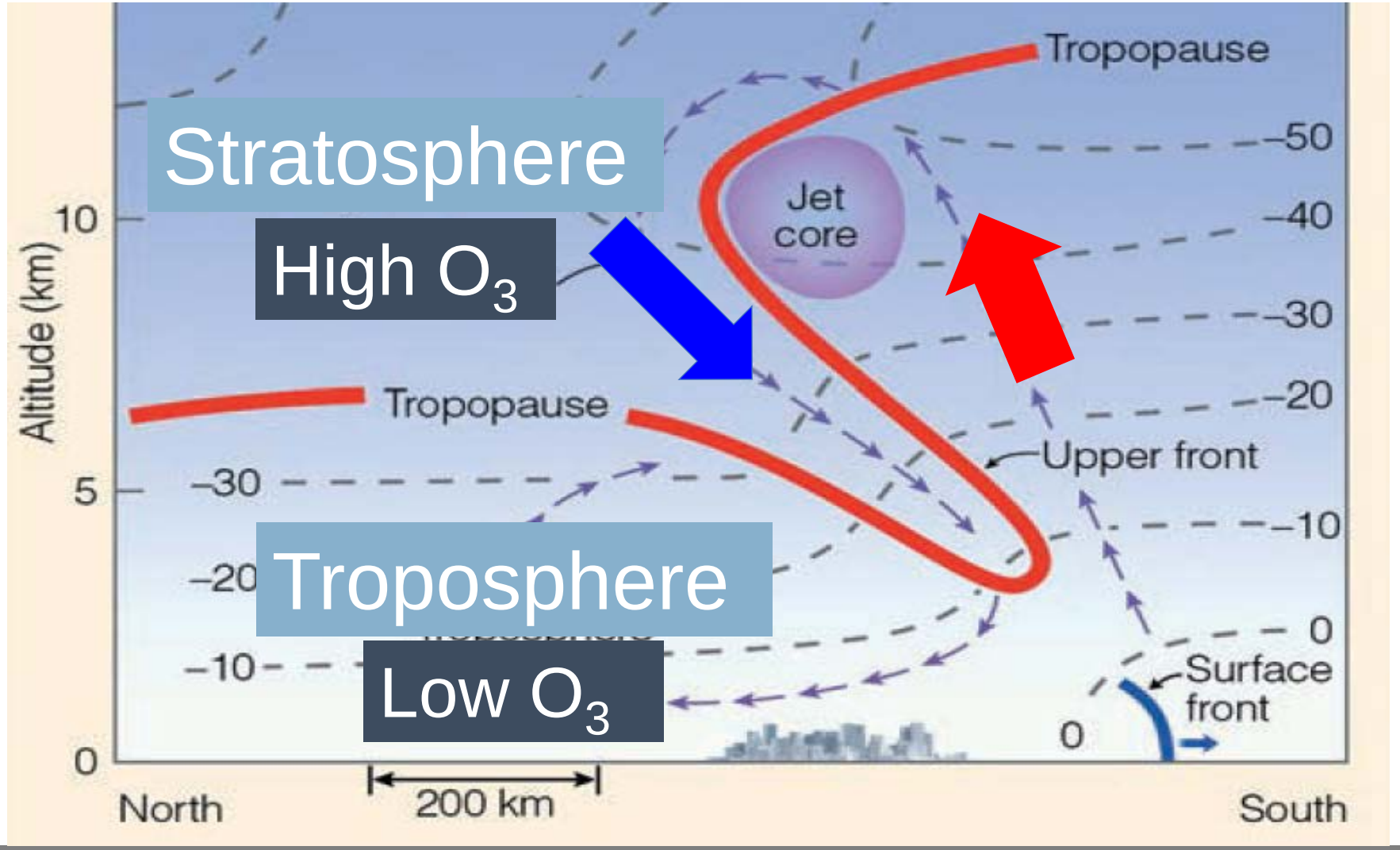


k.e.knowland@nasa.gov
christoph.keller@nasa.gov

Tropopause Fold (Stratospheric Intrusions: SI)

SIs are associated with:

- High O_3, PV
- Low CO, moisture (“dry intrusion”)



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christoph.keller@nasa.gov

Ozone is a regulated air pollutant

- SIs can lead to concentrations of ground-level O_3 exceeding the national ambient air quality standard (NAAQS) set by the EPA, especially at high elevations
- In October 2015, the EPA revised the U.S. NAAQS for daily maximum 8 h average (MDA8) O_3 from 75 parts per billion by volume (ppbv) to 70 ppbv

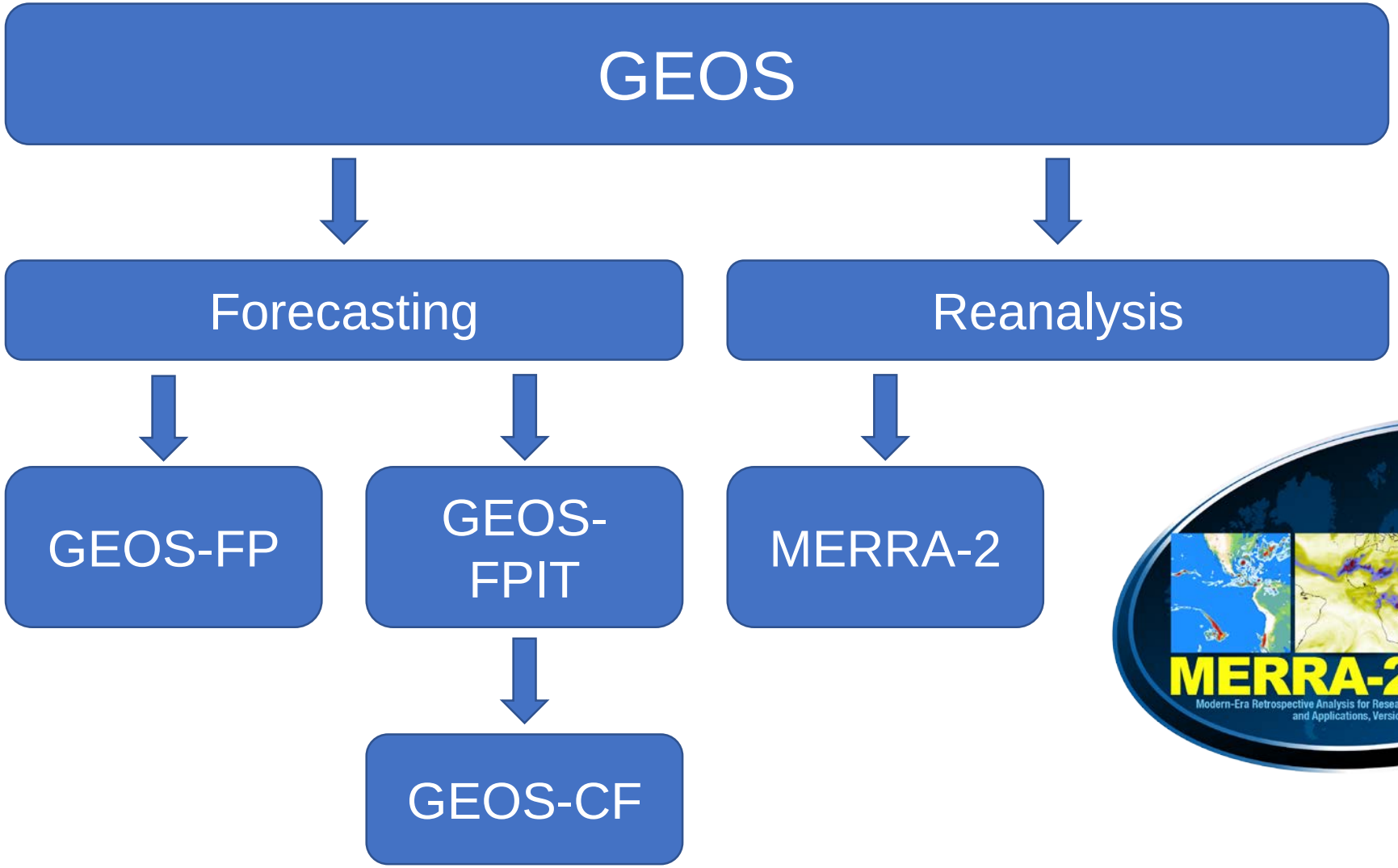
k.e.knowland@nasa.gov
christoph.keller@nasa.gov

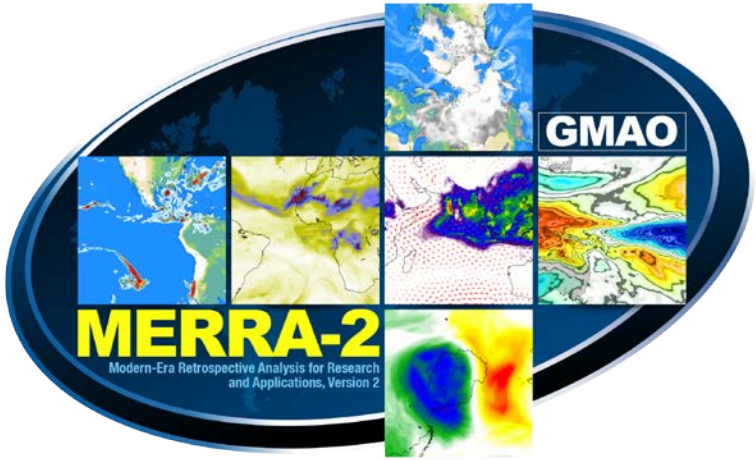
SIs misrepresented in models…until now!

- SIs are fine-scale features, resolution needs to be high enough to capture the filaments
- Simulating and predicting such events remains challenging
- Need horizontal resolution of 50 km or less

k.e.knowland@nasa.gov
christoph.keller@nasa.gov

NASA GMAO global meteorology and chemistry products





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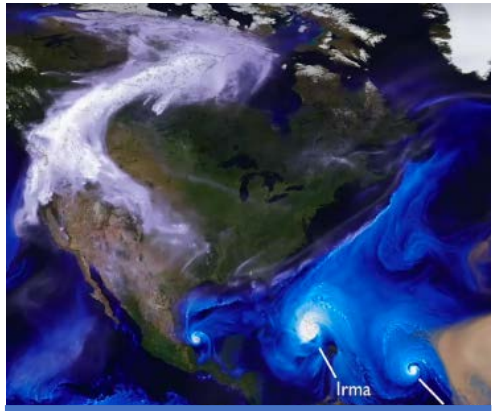
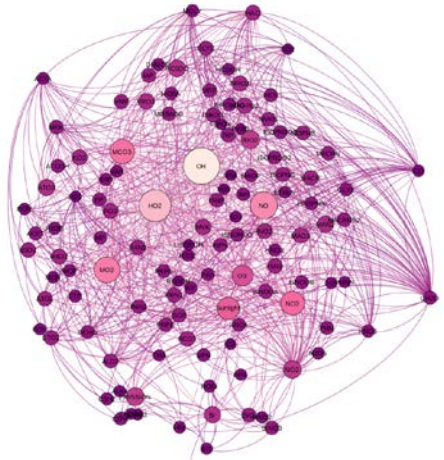
NASA's composition forecast, GEOS-CF

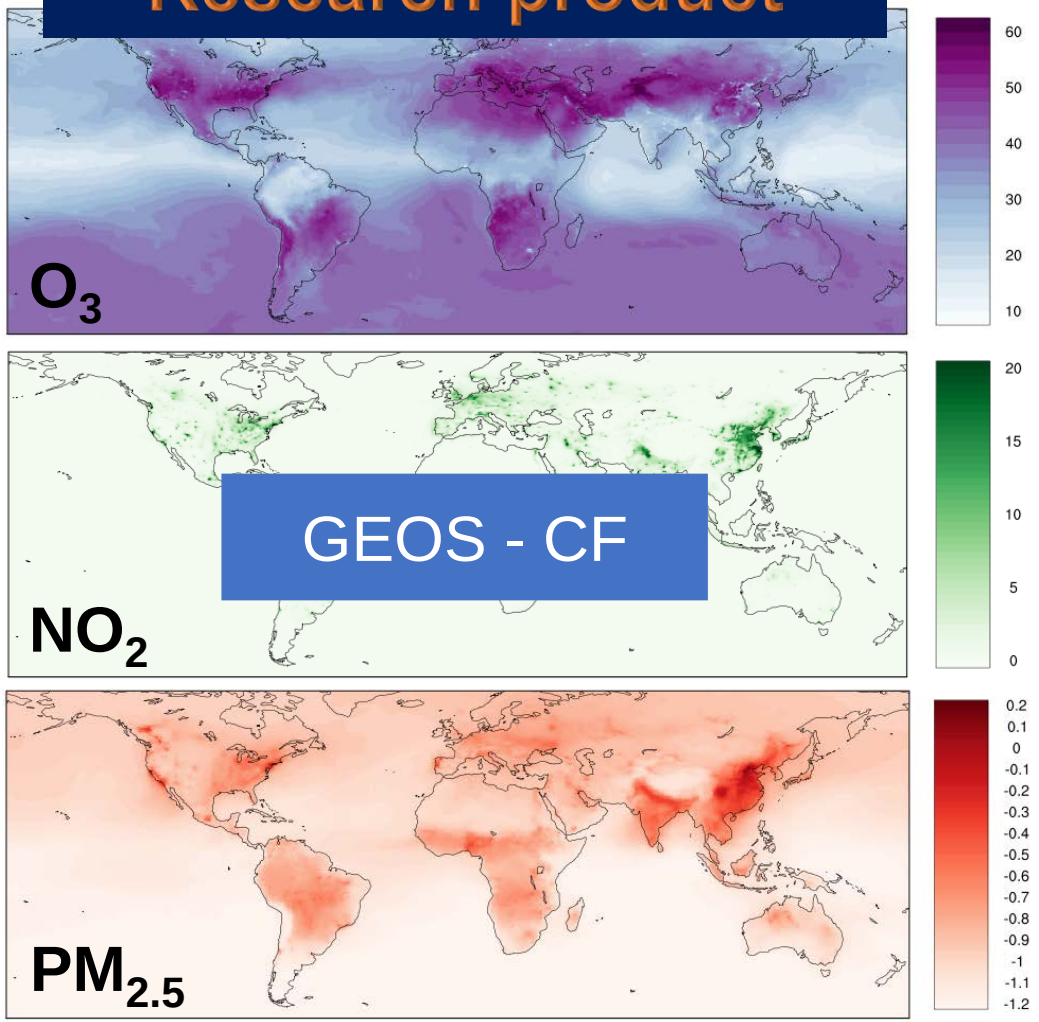


GEOS - FPIT



GEOS - Chem

Research product



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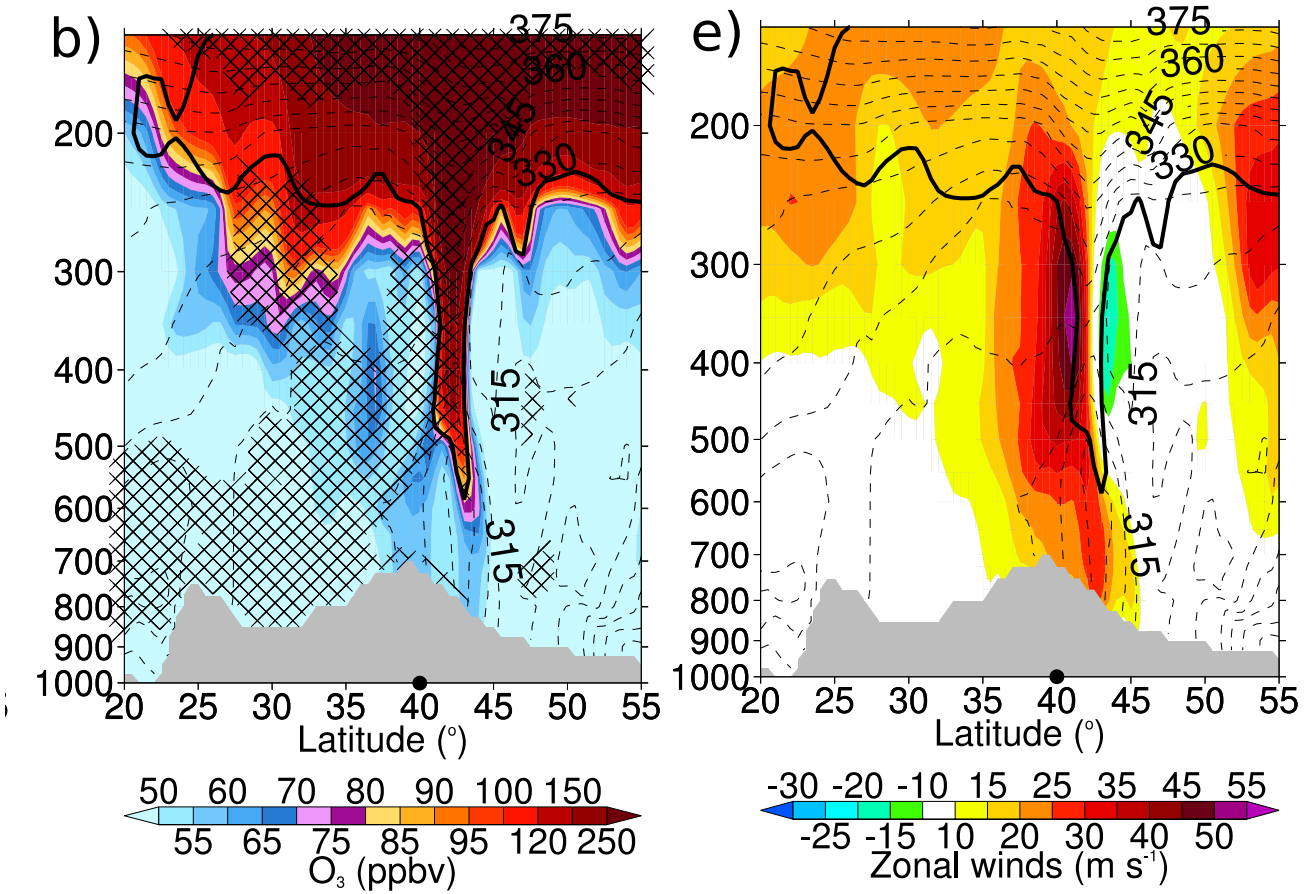
Question

How well does NASA's new GEOS-CF capture ozone exceedances known to have stratospheric origin?

MERRA-2

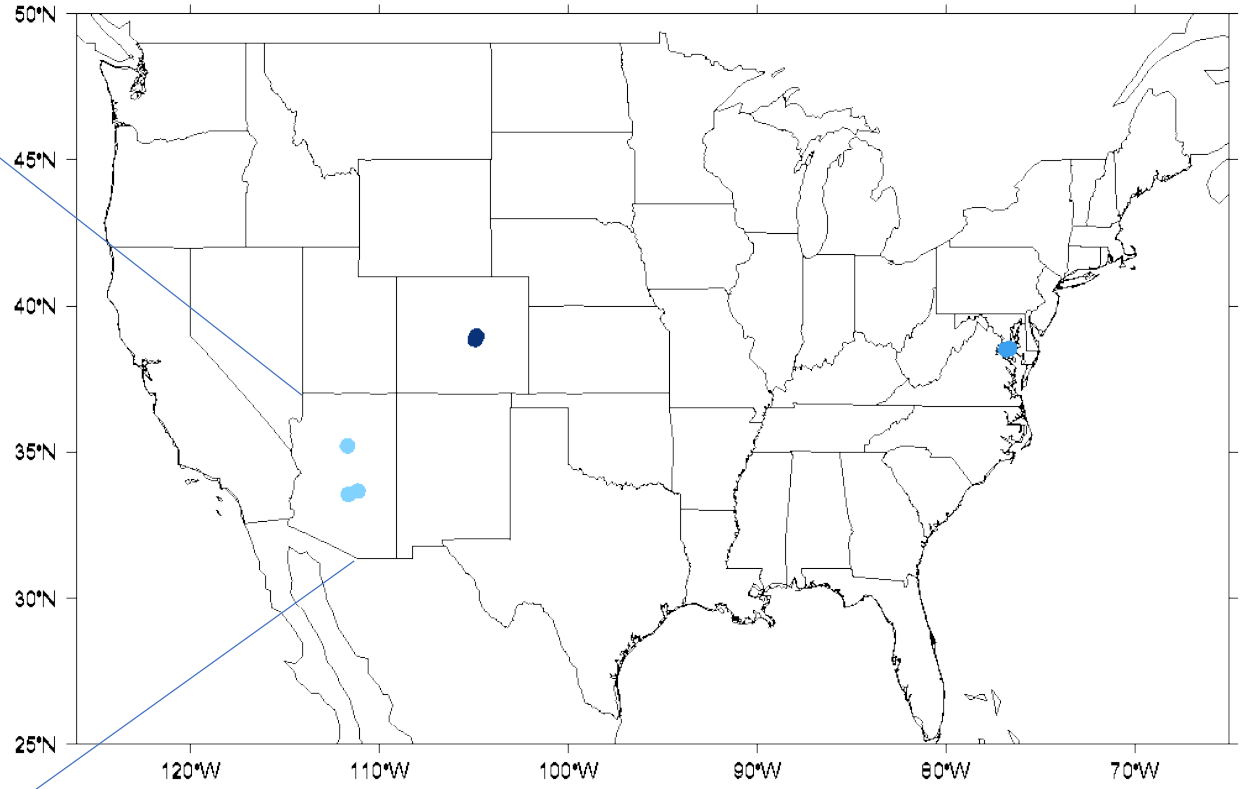


Knowland et al., 2017, GRL

k.e.knowland@nasa.gov
christoph.keller@nasa.gov

Case studies April 2018

SI impacting surface O_3 in
Maryland (April 16th)
Arizona & Colorado (April 17th-18th)



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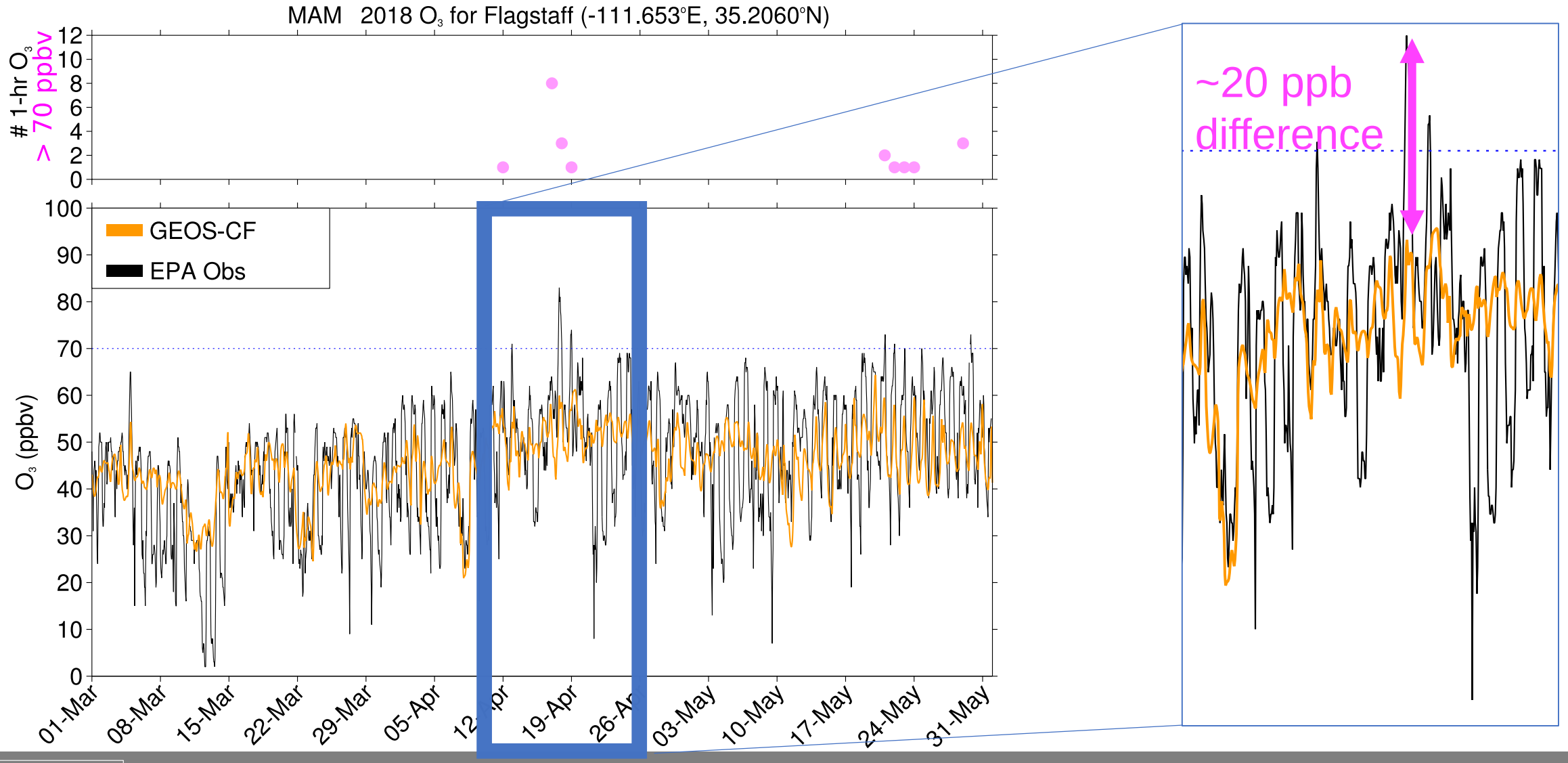
Flagstaff Hourly O_3 Observations vs GEOS-CF



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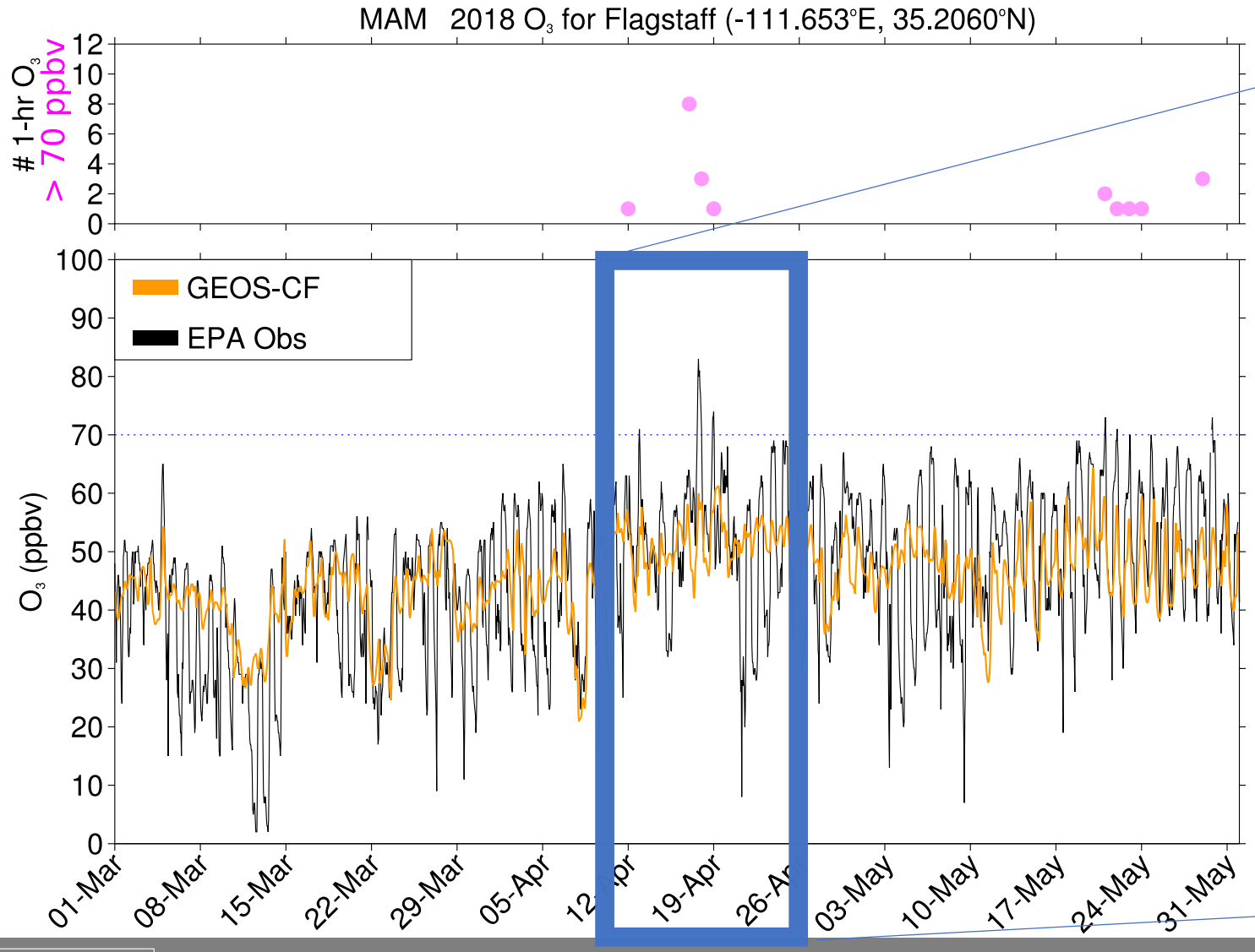
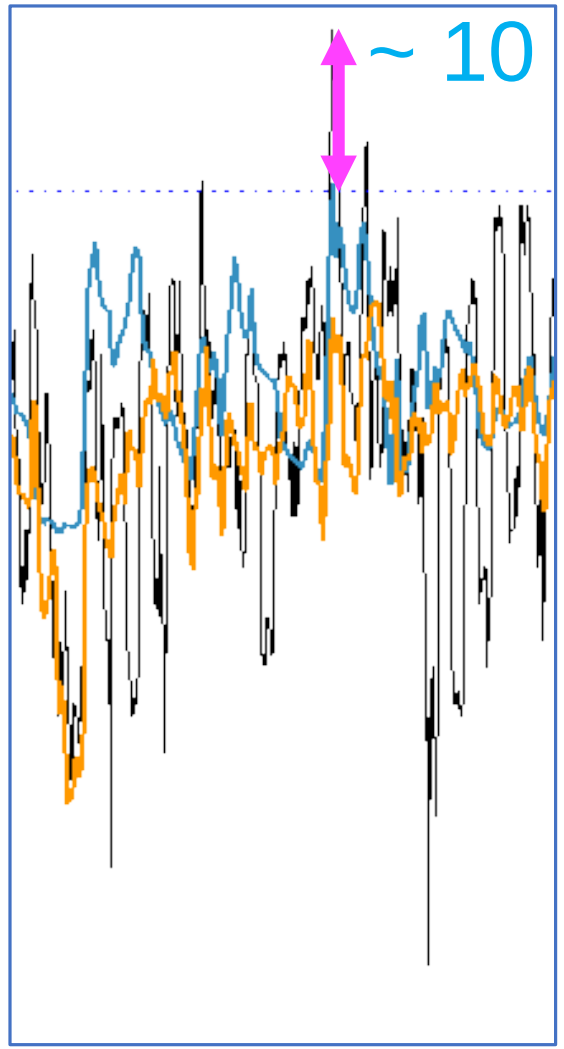


MERRA-2

~ 10 ppb



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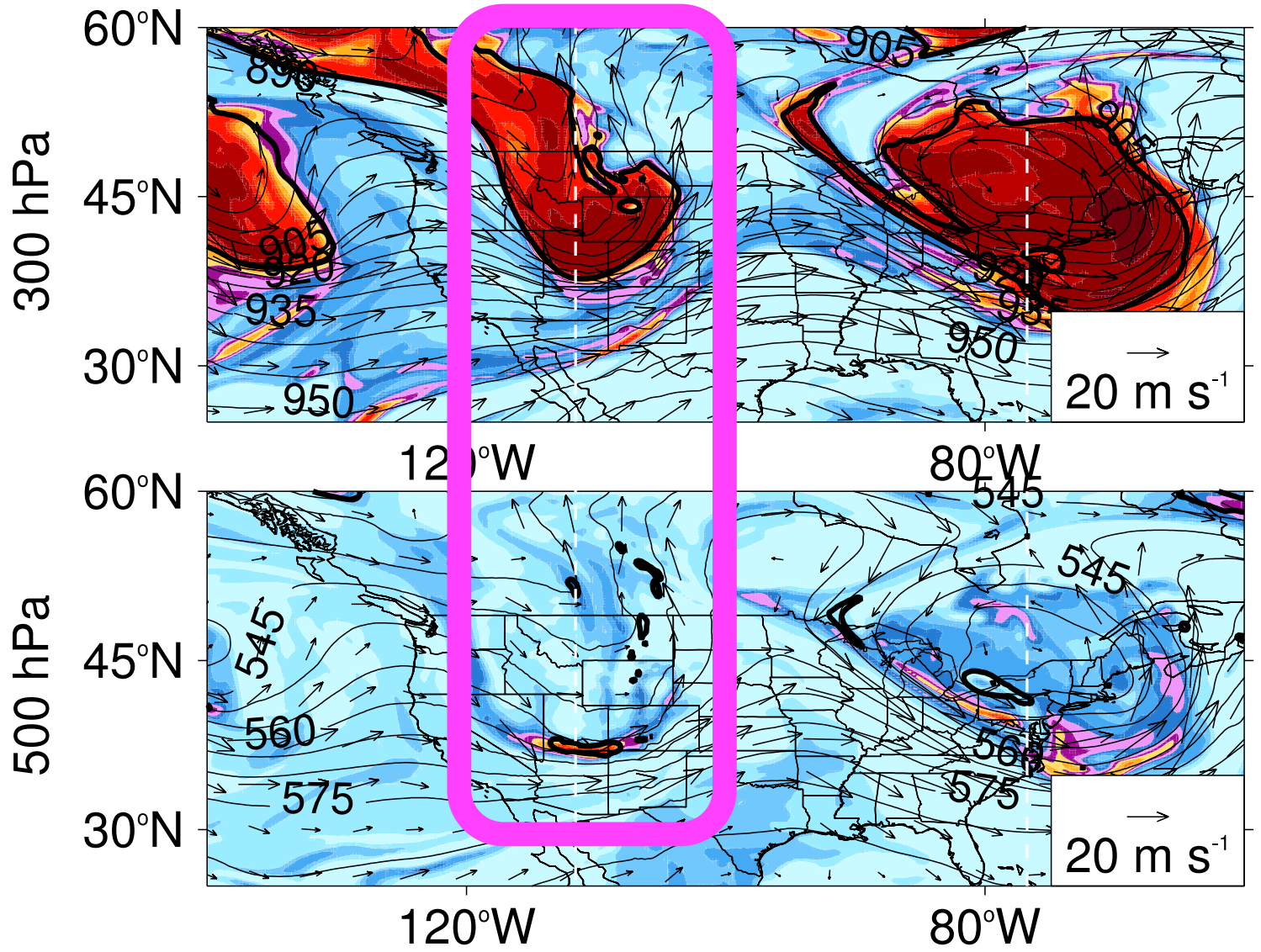
Upper-level flow pattern



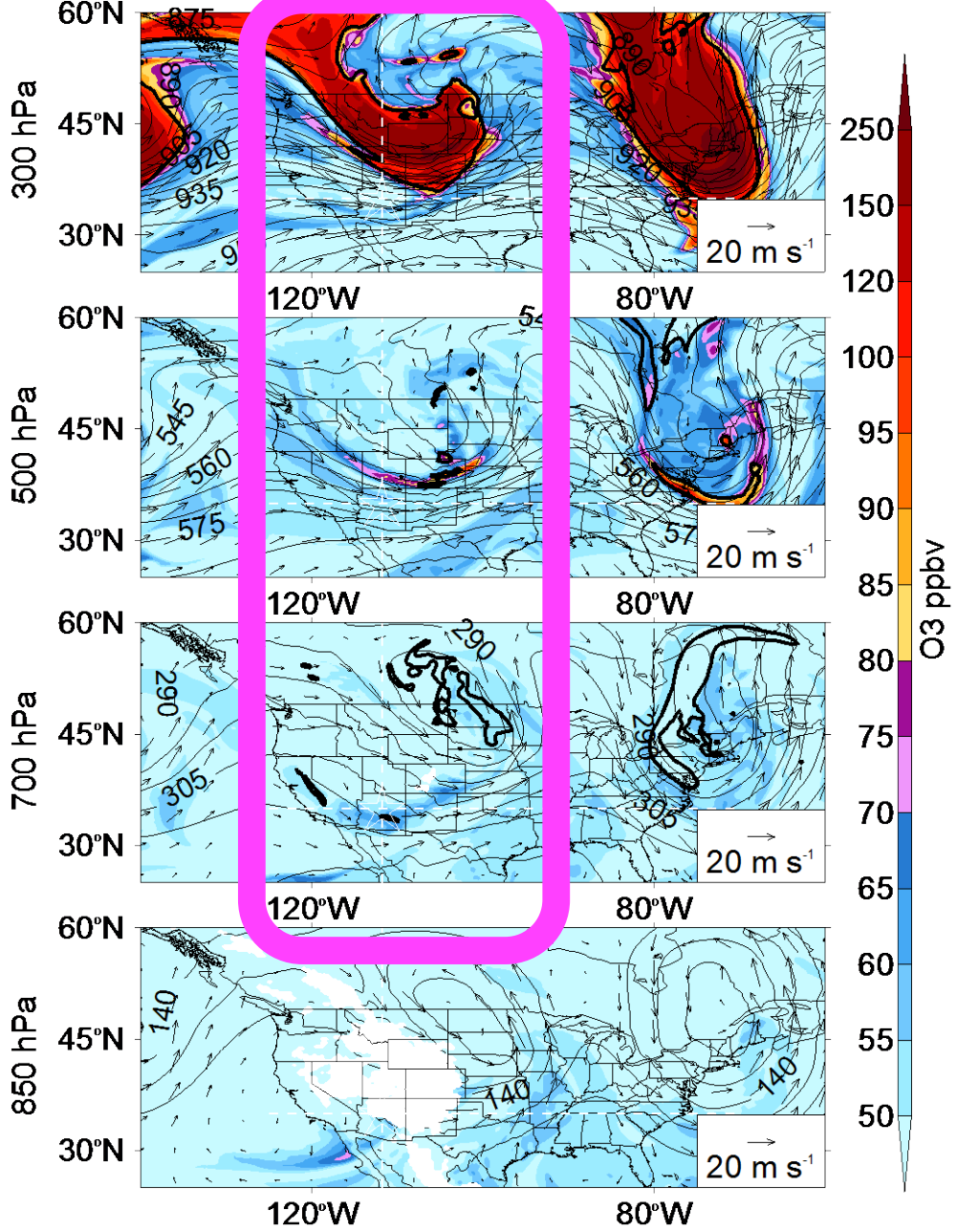
April 17, 2018

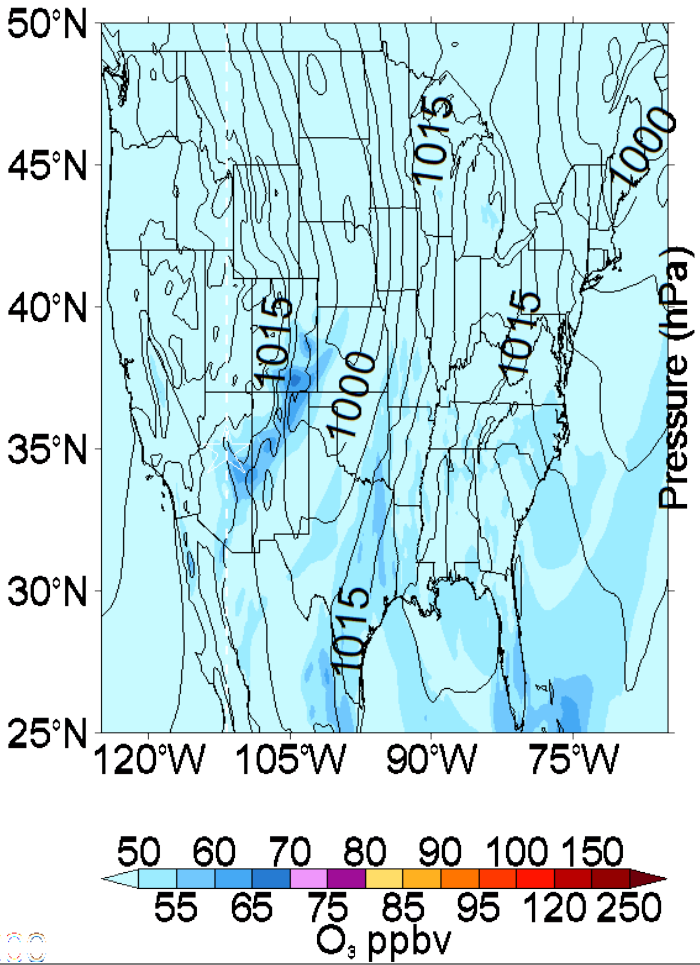
At time of maximum O_3 at Flagstaff, Arizona

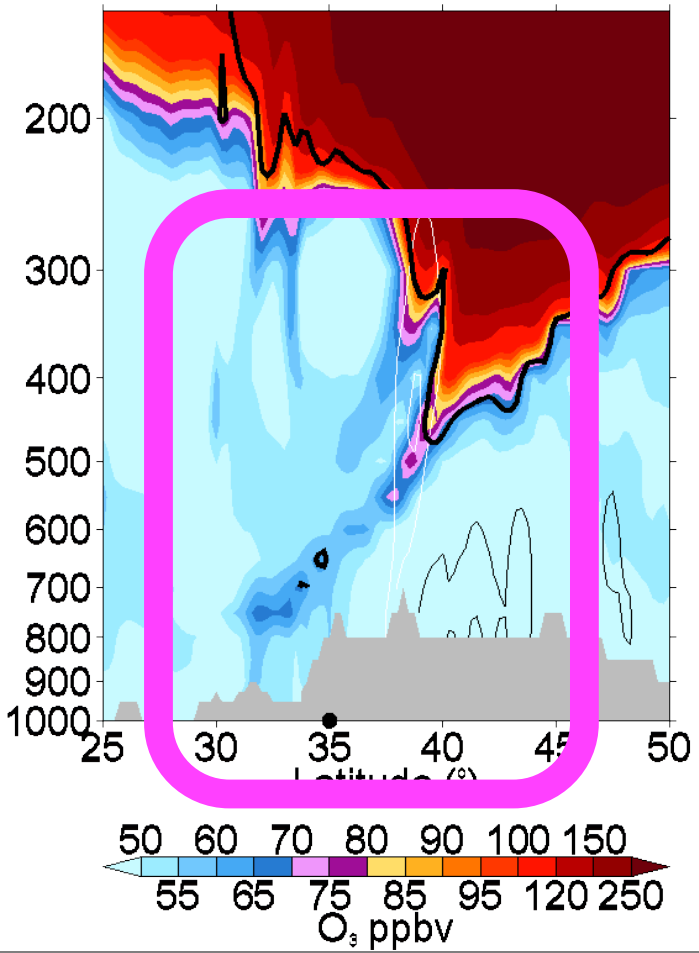
k.e.knowland@nasa.gov
christoph.keller@nasa.gov

Flagstaff, Arizona

SI is present in the 5-day forecast







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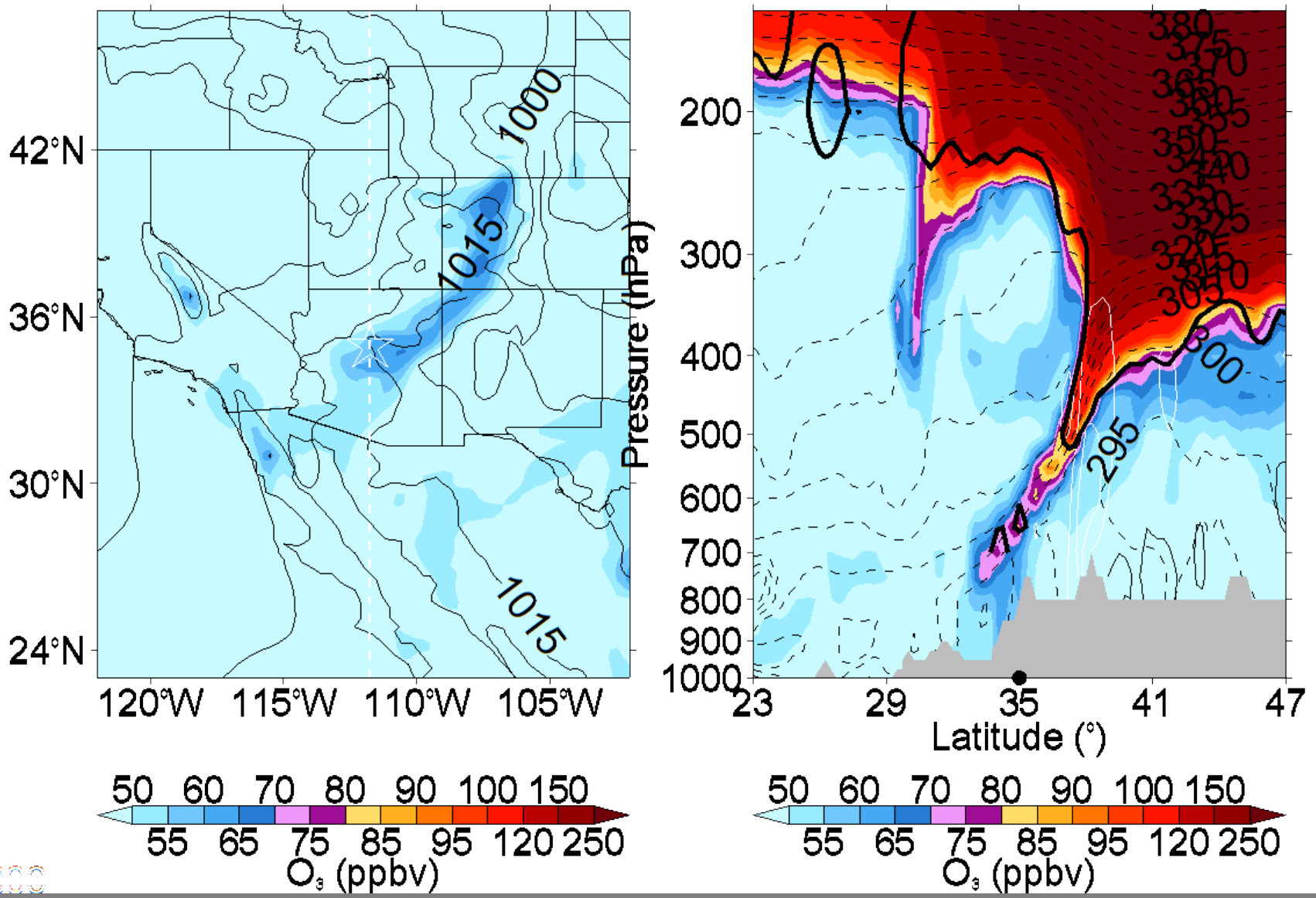
GEOS-CF at time of maximum observed O_3



- Higher O_3 at sfc
- Higher O_3 within the fold
- Dynamical tropopause reaches 500 hPa
  - With 2 PVU to 700 hPa

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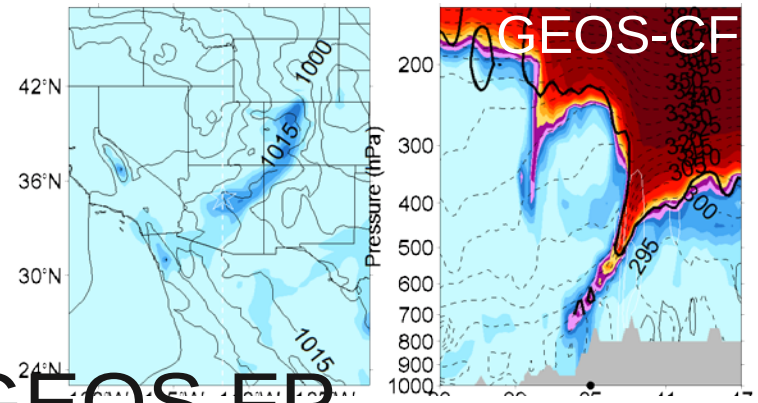
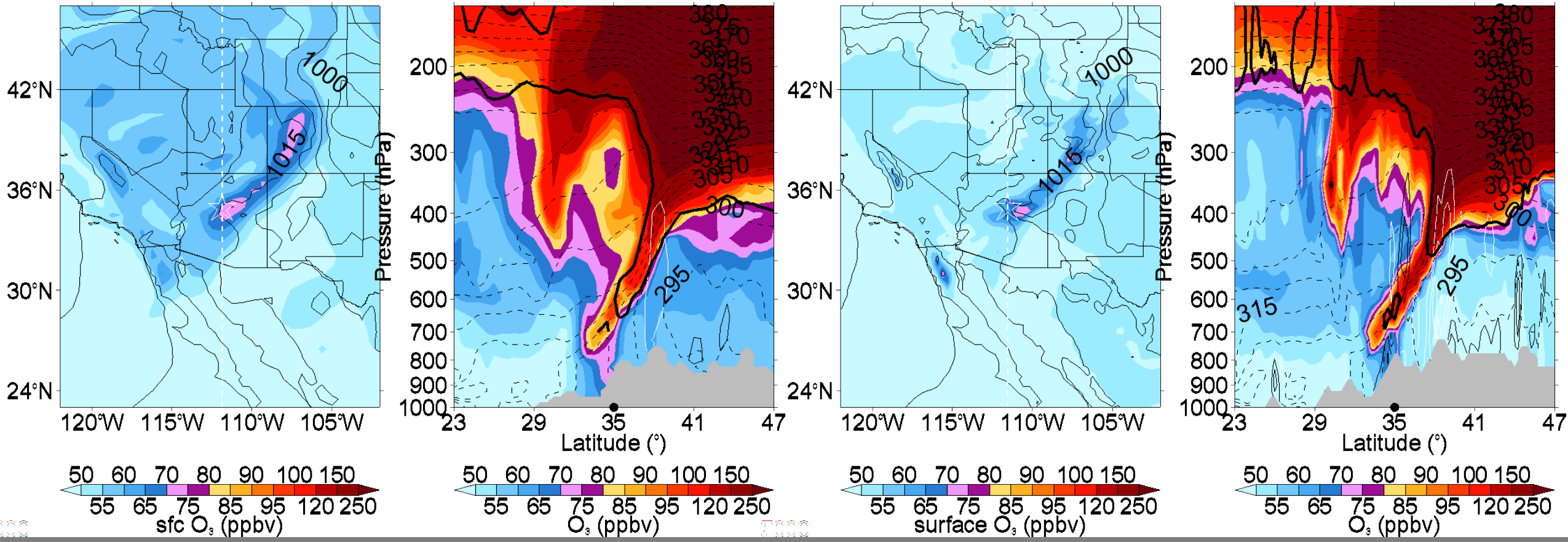
SI represented in MERRA-2 and GEOS-FP at time of maximum surface O_3



MERRA-2

GEOS FP



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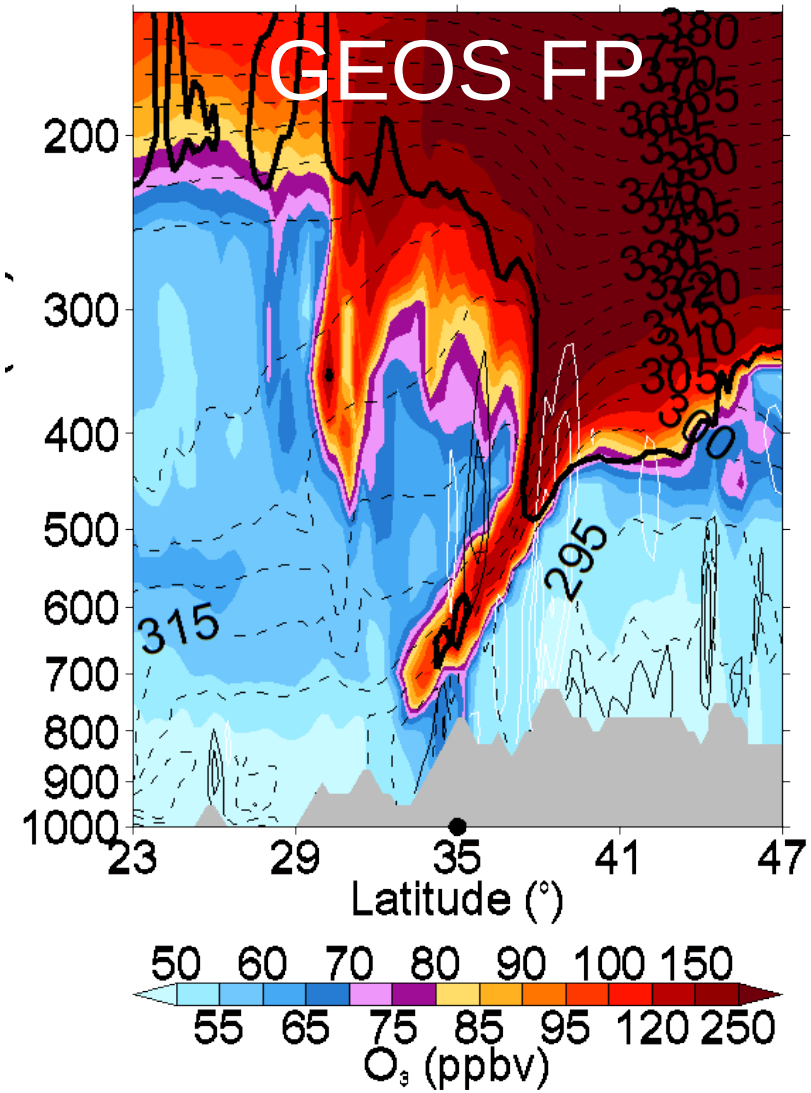
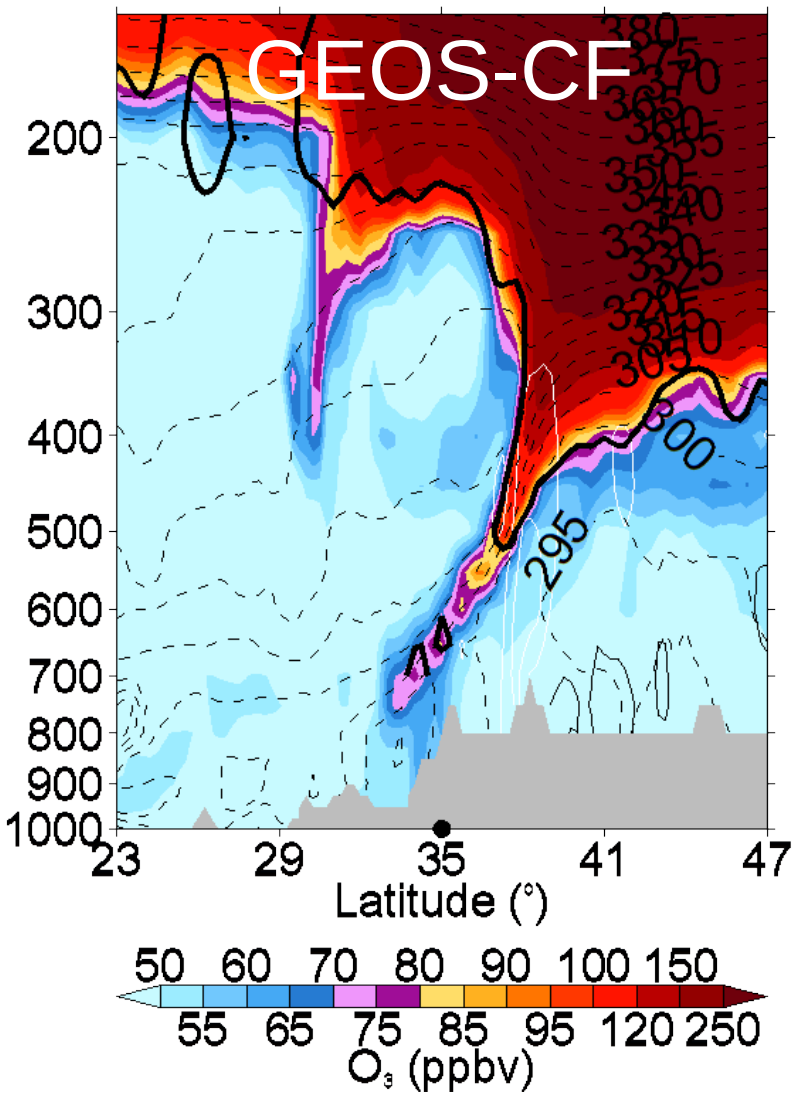
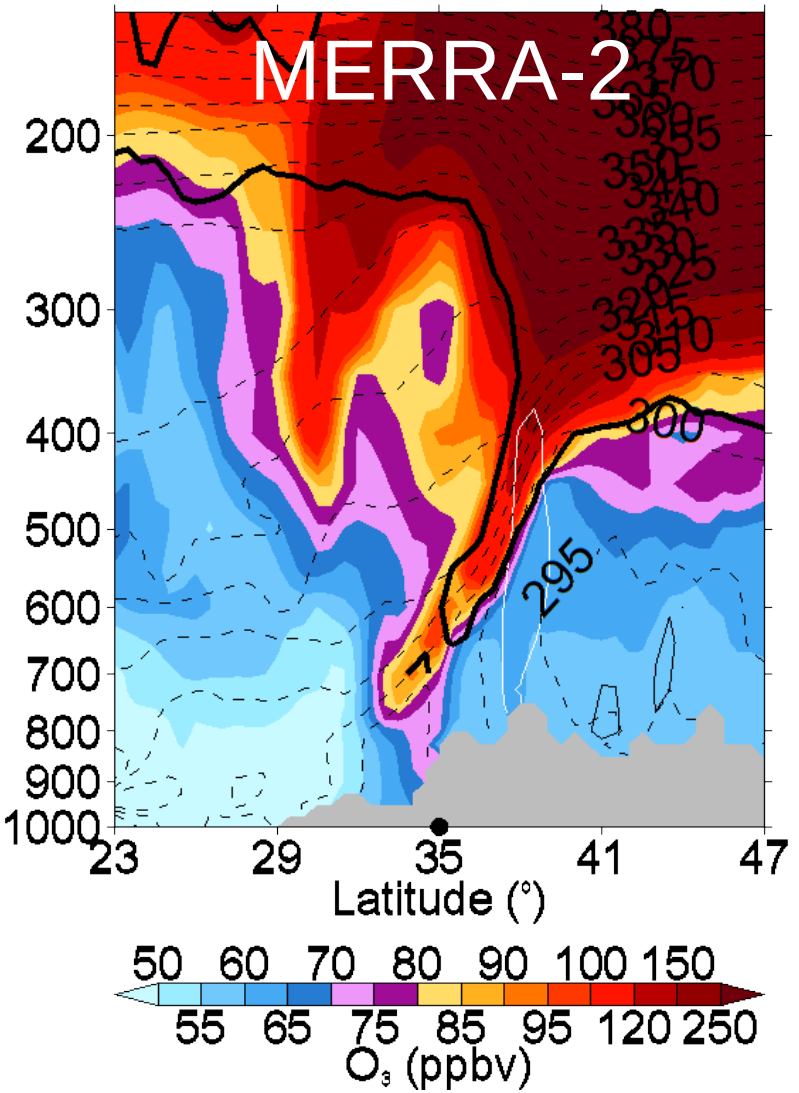
Comparison of the SI between 3 GEOS products







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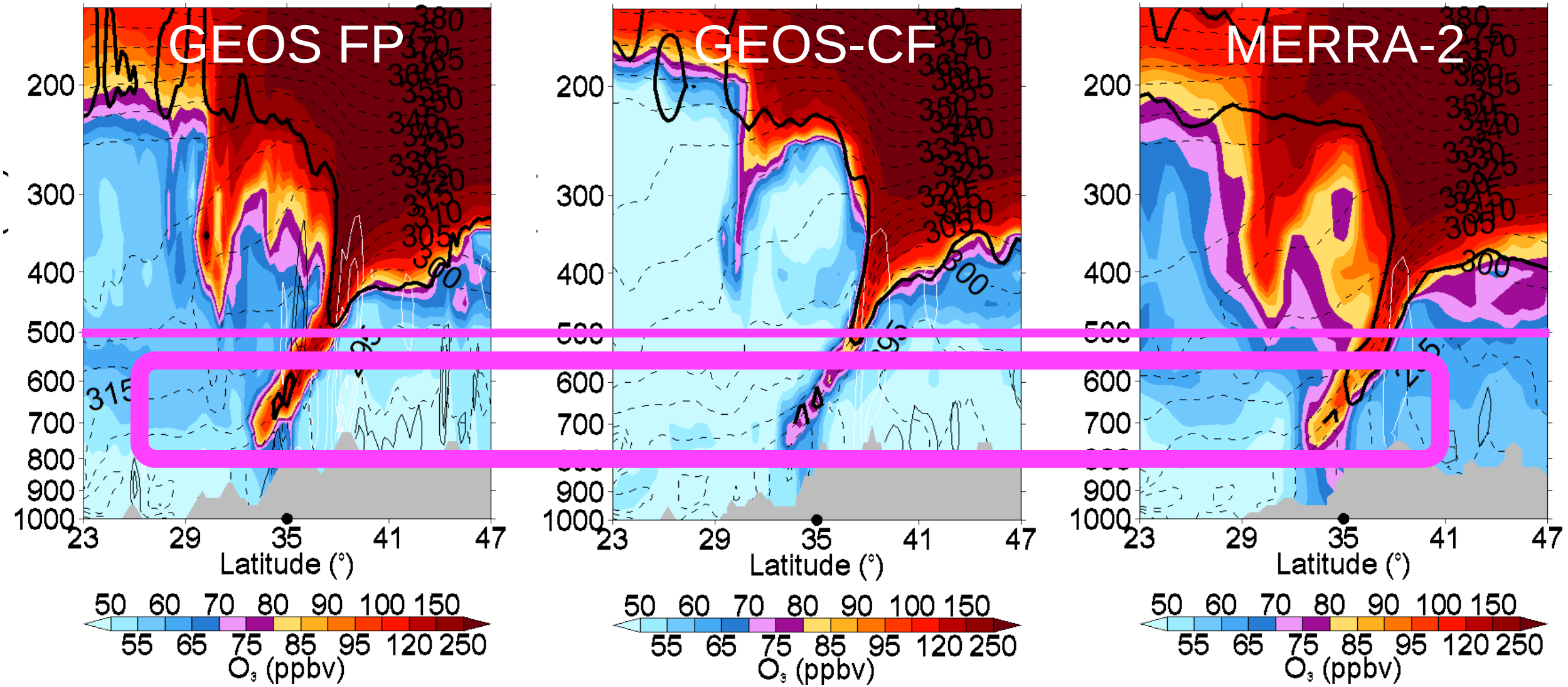
1. Tropopause is highest in GEOS FP and lowest in MERRA-2



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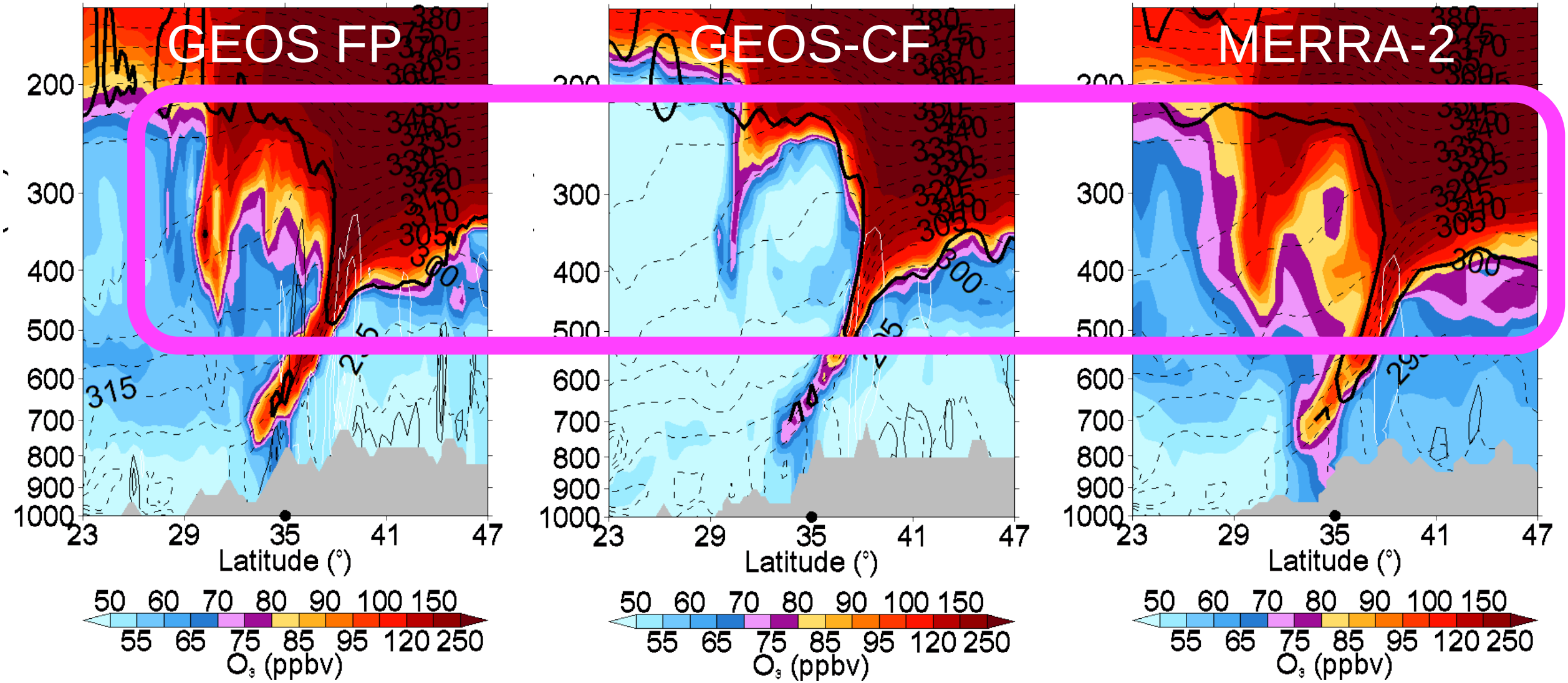
2. O_3 in UT is greater in the assimilated products (GEOS FP & MERRA-2)



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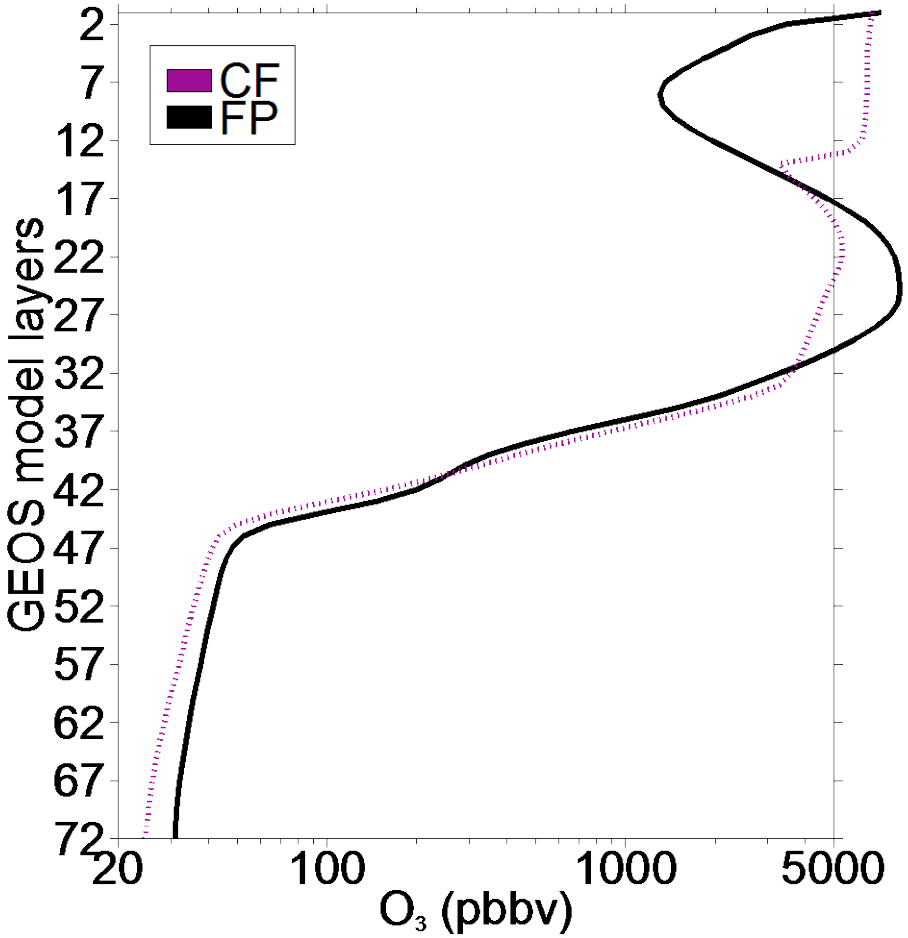
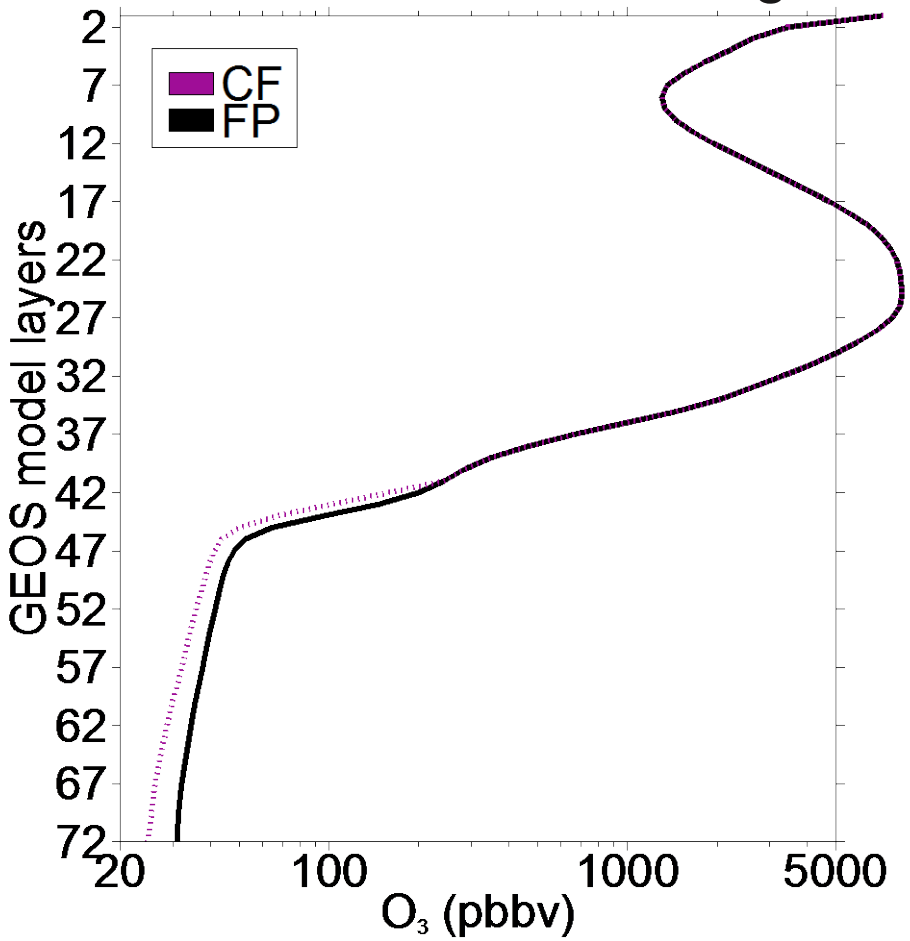
GEOS-CF taking advantage of O_3 assimilation

GEOS-CF



Relaxed to FP O_3



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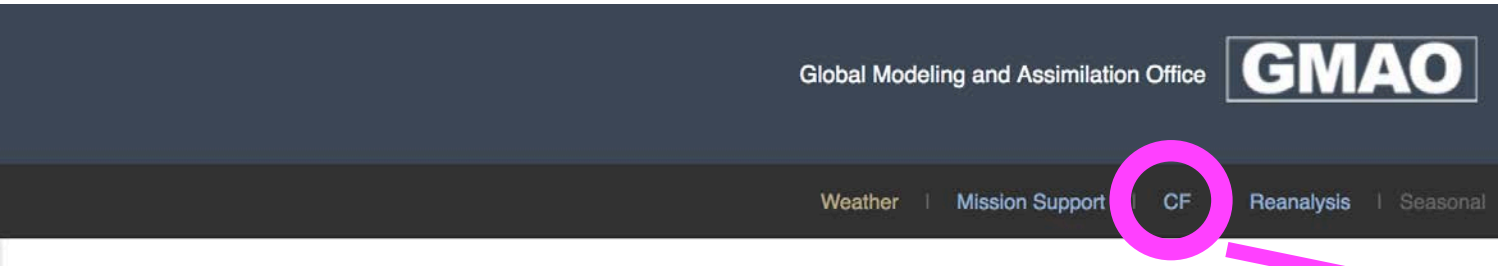
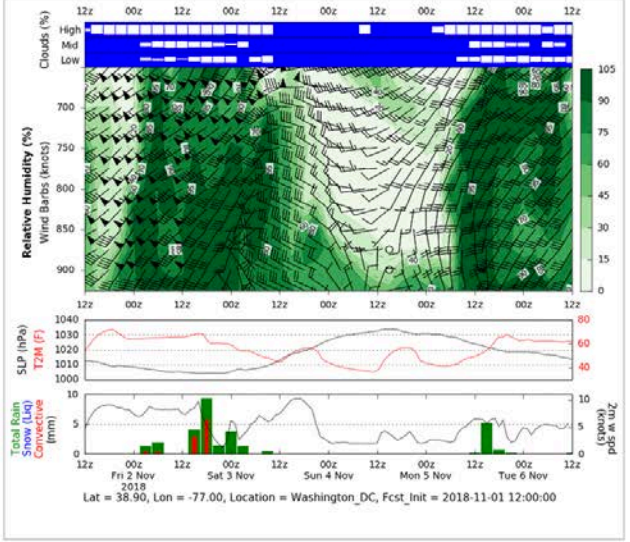
GEOS-CF is available to the public at fluid.nccs.nasa.gov

Data available for download and access through OPeNDAP coming soon!

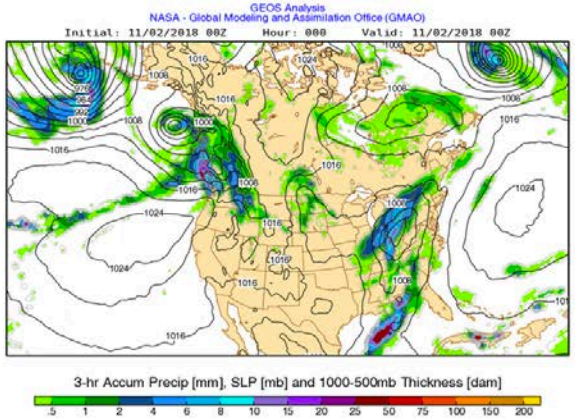


Weather Analyses and Forecasts

Datagrams

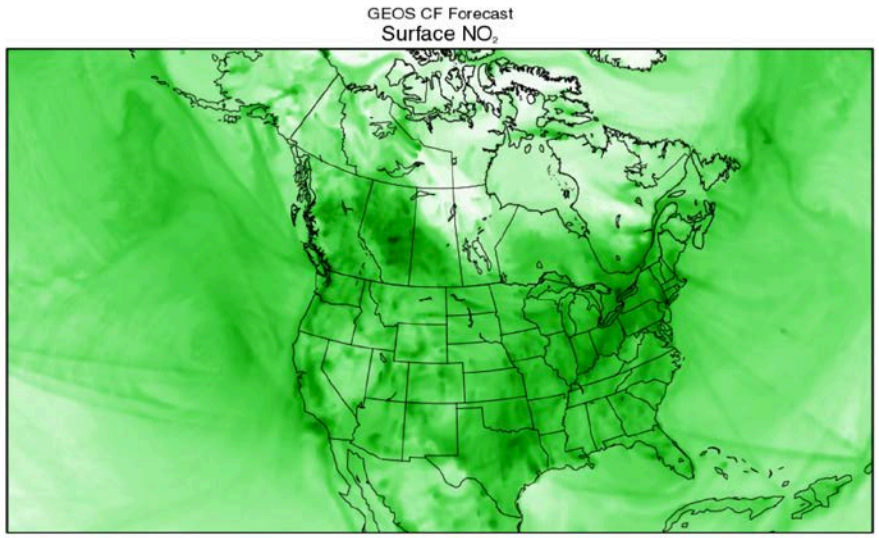


WxMaps



GMAO Composition Forecast Products

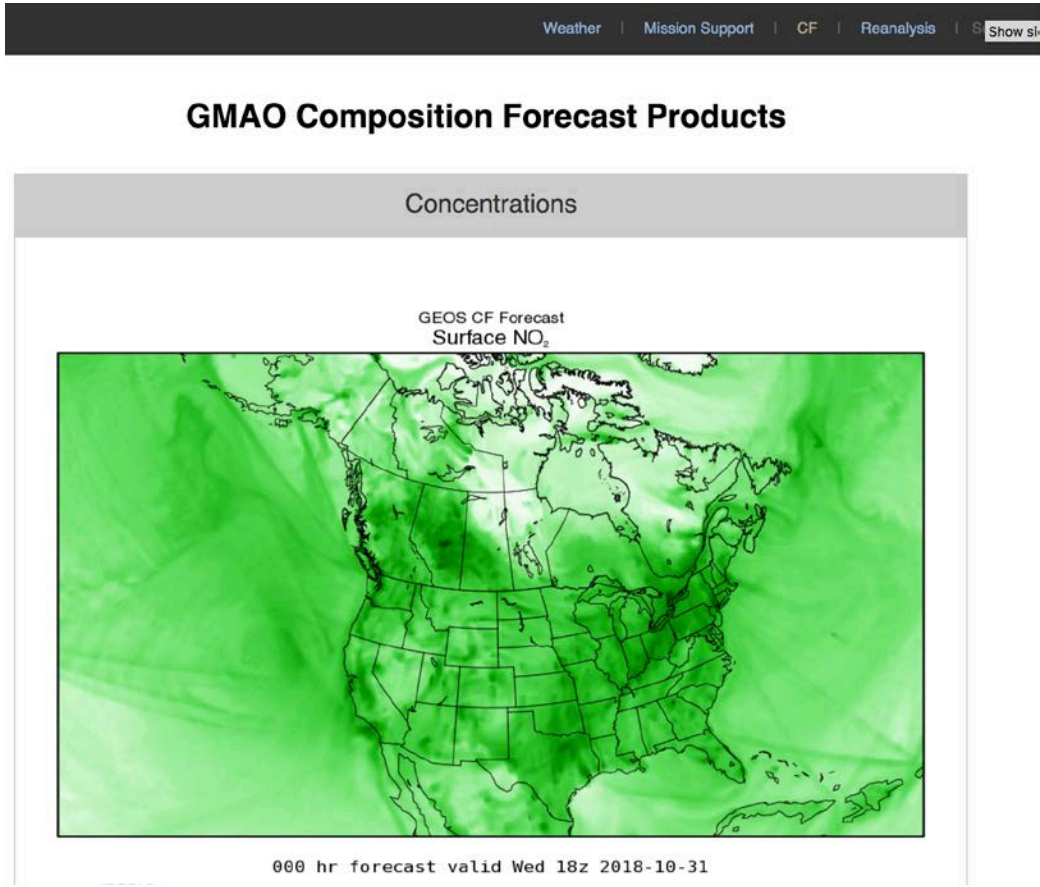
Concentrations



k.e.knowland@nasa.gov
christoph.keller@nasa.gov

Take home messages!

- GEOS-CF is able to represent the dynamical features of a stratospheric intrusion



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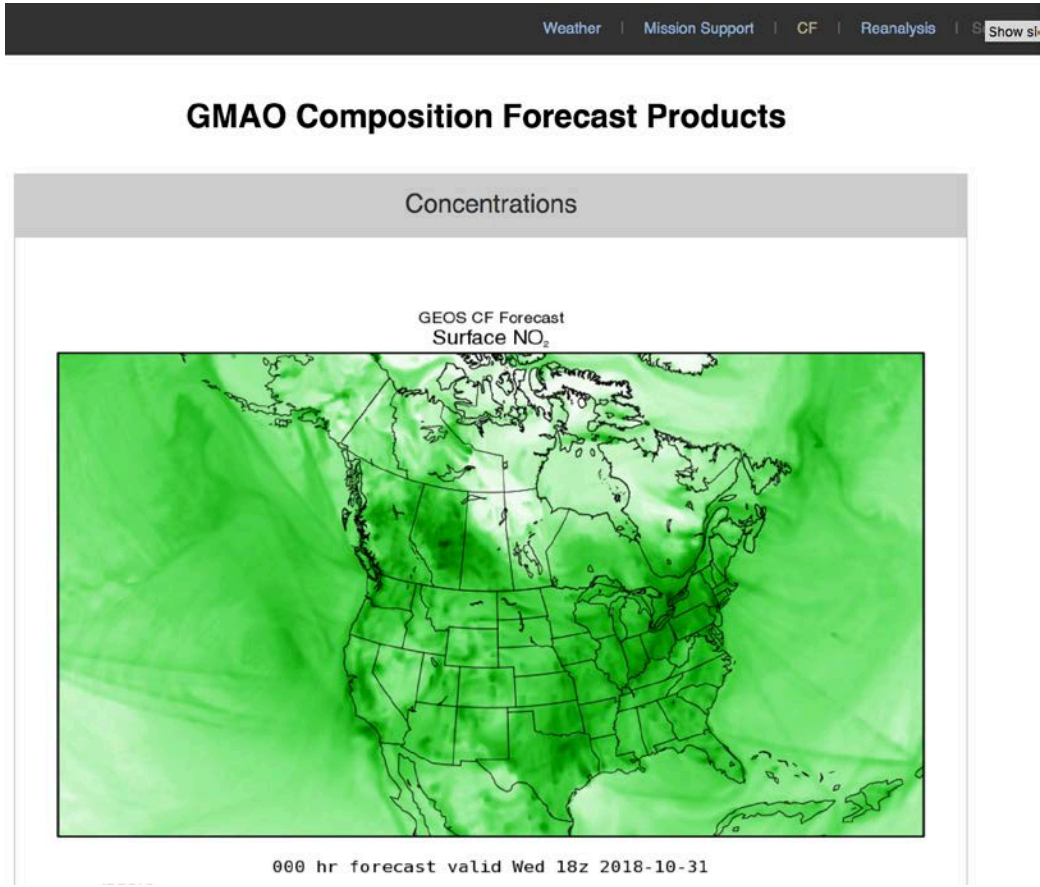
Take home messages!

- GEOS-CF is able to represent the dynamical features of a stratospheric intrusion
- We expect using the FP O_3 will improve the representation of O_3 within tropopause folds
  - Increase surface O_3 during SI events



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Thank you!

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