https://ntrs.nasa.gov/search.jsp?R=20200001922 2020-05-24T04:16:00+00:00Z

NASA's High-Resolution GEOS Forecasting and Reanalysis Products: Support for TOLNet

K. Emma Knowland

USRA/GESTAR

NASA Global Modeling and Assimilation Office (GMAO)

In collaboration with:

NASA GMAO: Christoph Keller, Lesley Ott, Steven Pawson, Brent Smith, Callum Wayman

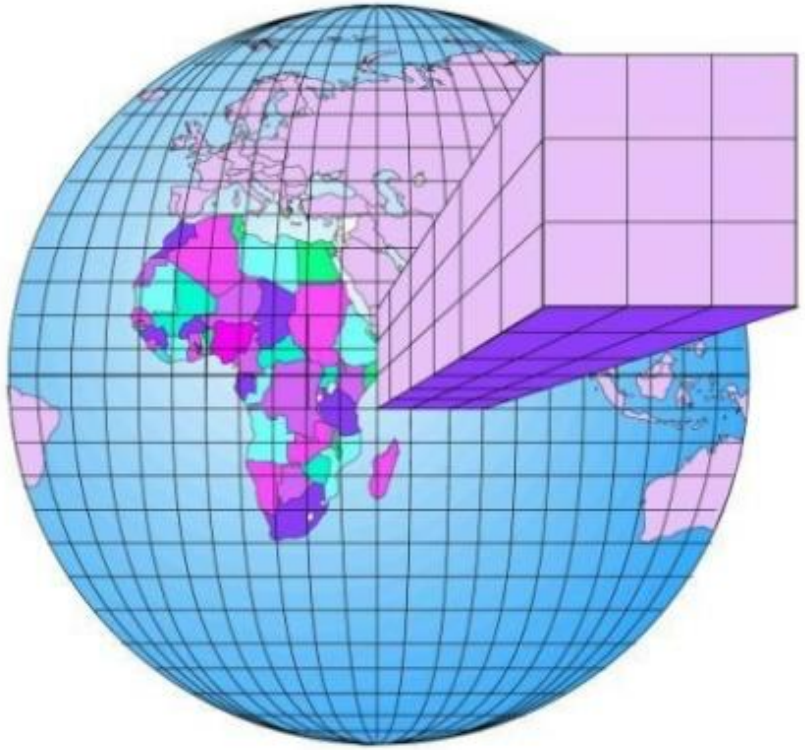
NASA Atmospheric Chemistry and Dynamics Lab: Bryan Duncan, John Sullivan

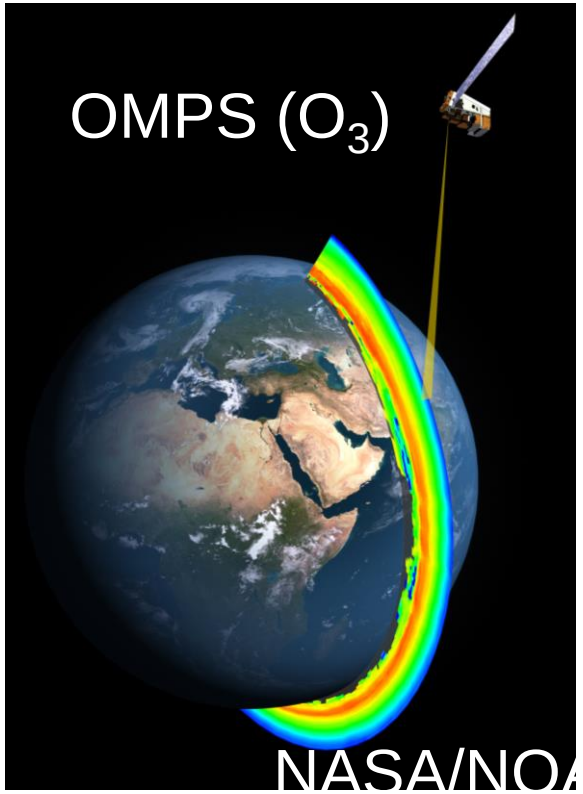
NASA LaRC: Tim Berkoff, Guillaume Gronoff

12 March 2020

NASA GMAO global meteorology and chemistry products

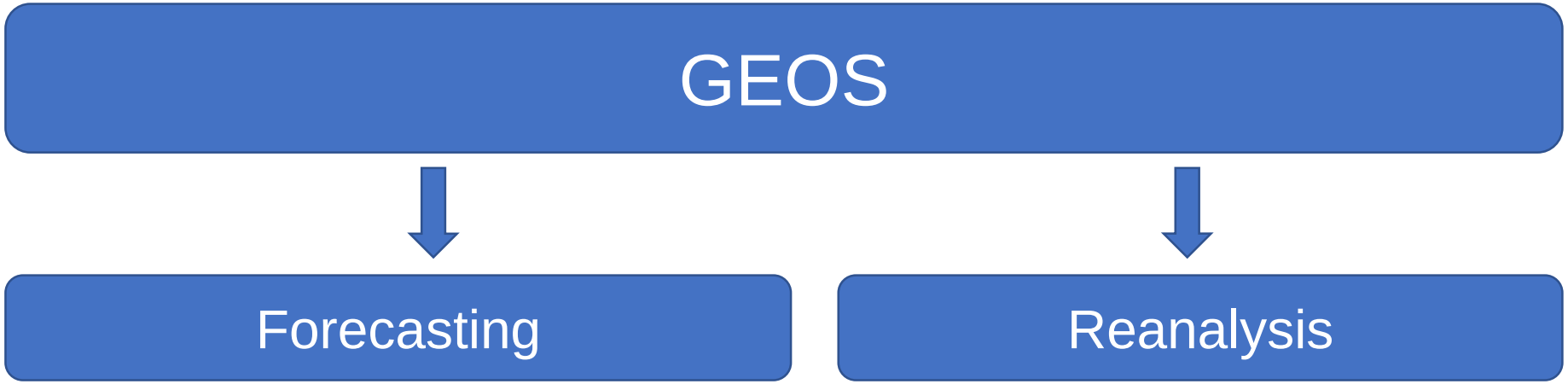
GEOS





www.nasa.gov

NASA GMAO global meteorology and chemistry products



NASA GMAO global meteorology and chemistry products

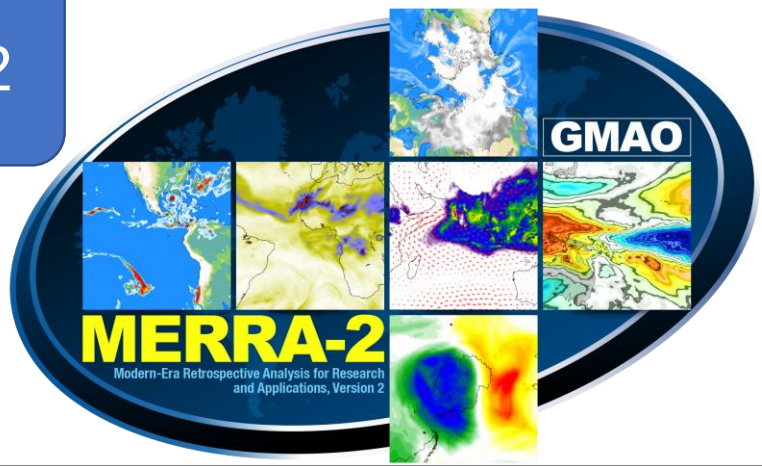
GEOS

Forecasting

Reanalysis

GEOS FP

MERRA-2



NASA GMAO global meteorology and chemistry products

GEOS

Forecasting

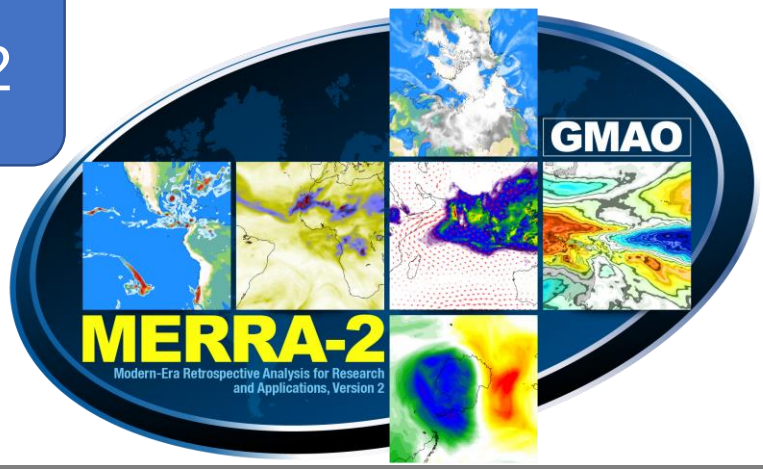
Reanalysis

GEOS FP

MERRA-2

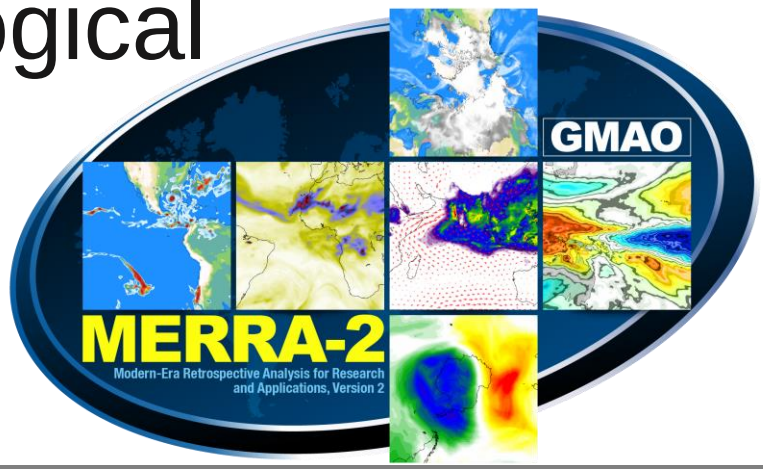
GEOS 5.17	11/01/2017 - 7/11/2018
5.21	7/11/2018 - 3/13/2019
5.22	3/13/2019 - 1/30/2020
5.25	1/30/2020 - on-going

GEOS 5.12.4



NASA's MERRA-2 Reanalysis

- High resolution global data set
  - ➢ 50 km horizontal
    0.5º latitude x 0.625º longitude
  - ➢ 72 levels up to 0.01 hPa
- Product of GEOS data assimilation system
  - Assimilates conventional meteorological observations, aerosols and ozone
- Available since 1980 to a few weeks behind present



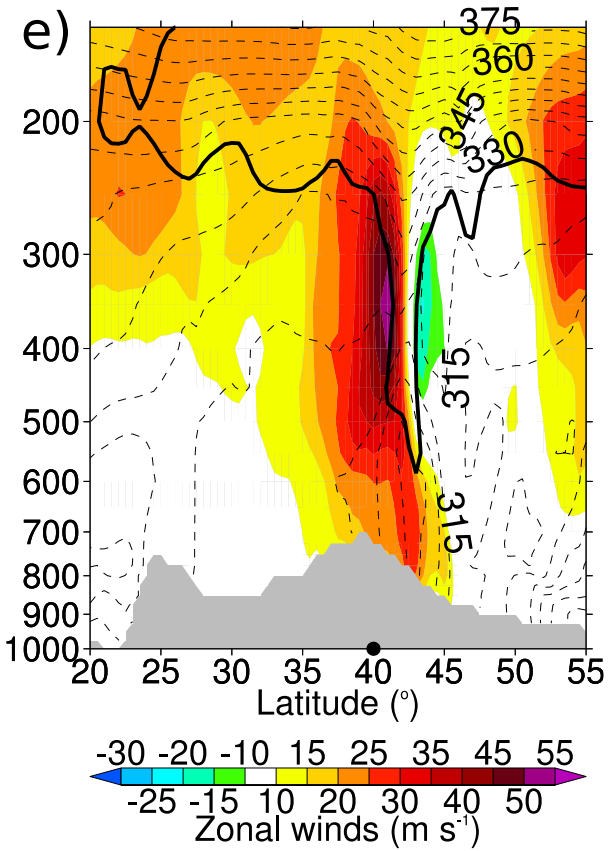
Question 1

Can MERRA-2 capture the dynamical features of a stratospheric intrusion?

March 27, 2012 0UTC

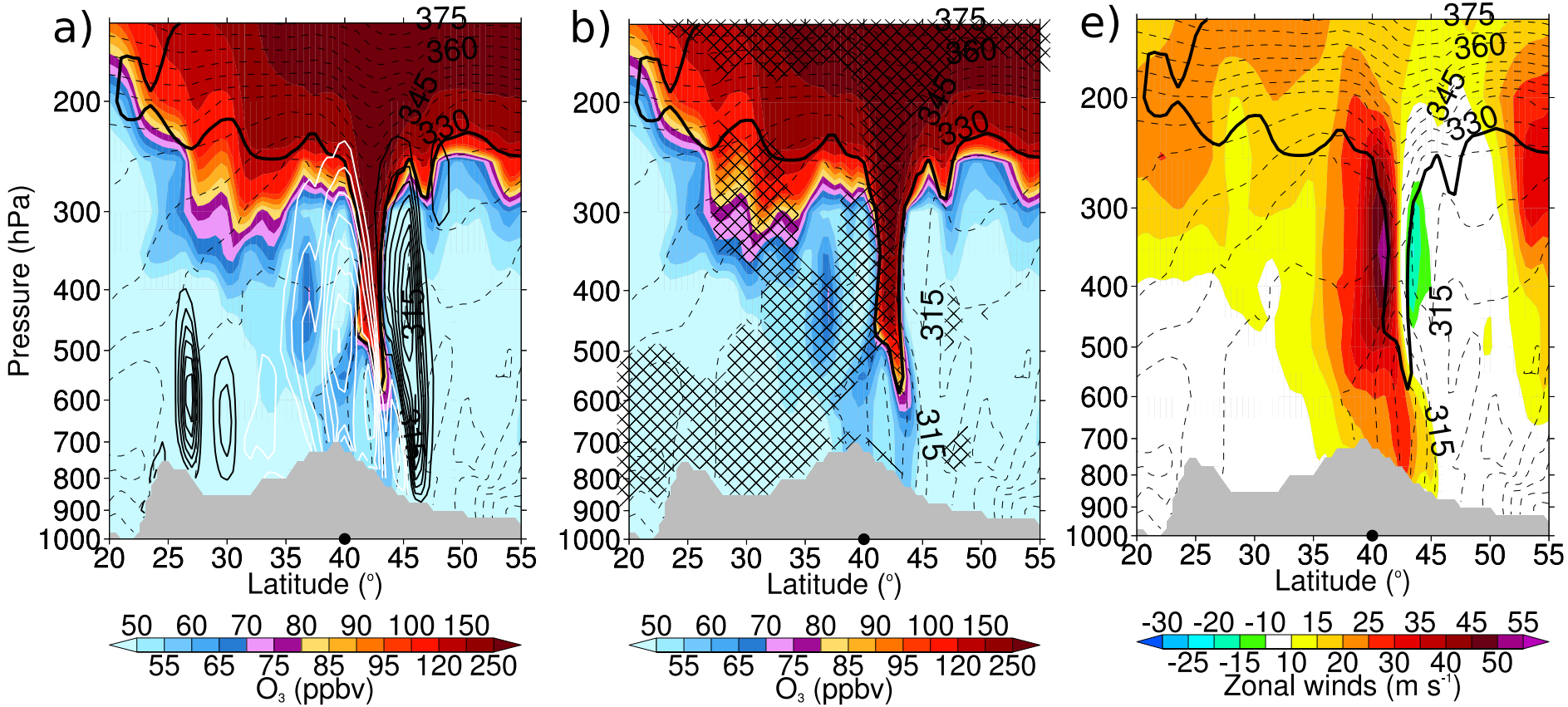
Atmospheric dynamics

- ✓ Tropopause descends to ~600 hPa
- ✓ Wrapped around jet core



Knowland et al., 2017, GRL

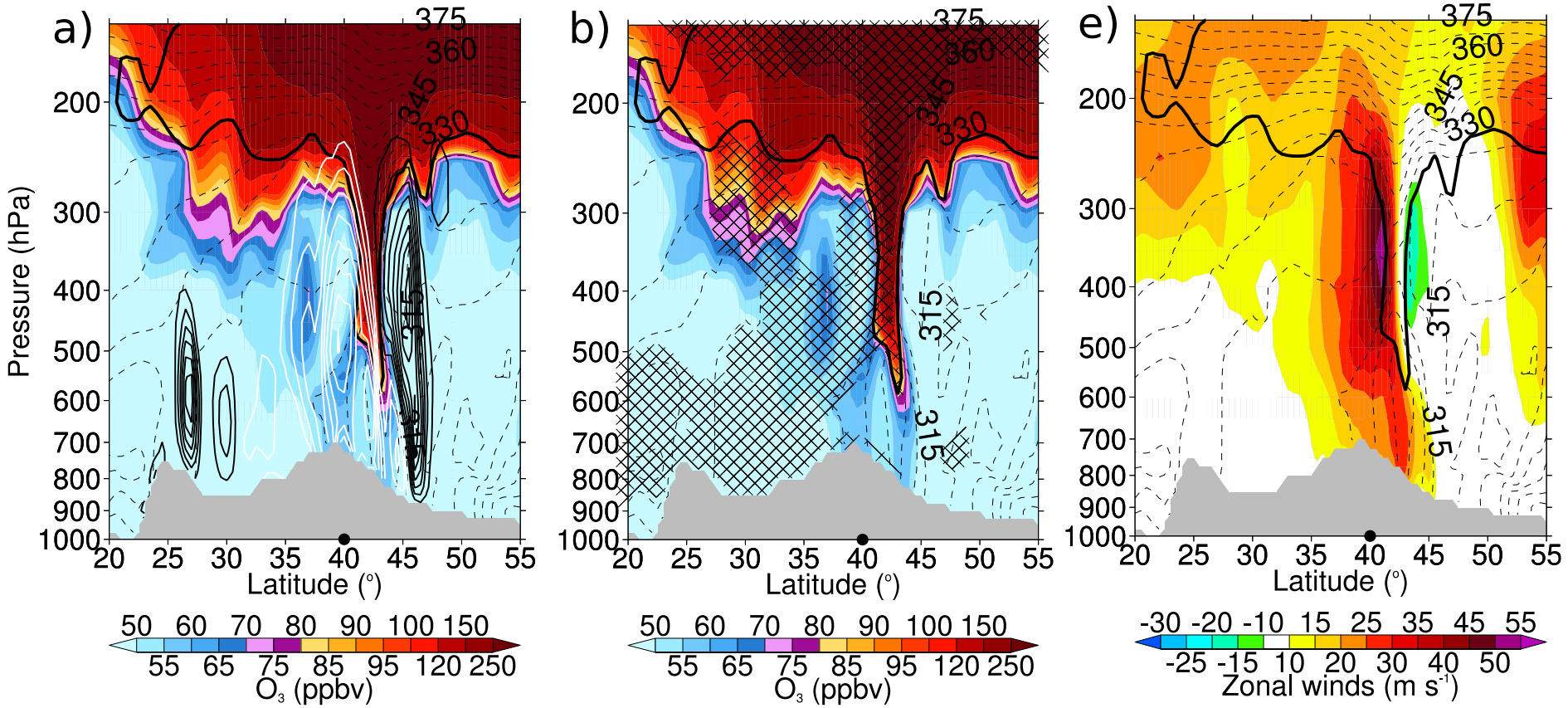
March 27, 2012 0UTC



- Tropopause folds are associated with:
  - High O_3, PV (2PVU thick line)
  - Low RH (hatching), CO (not shown)

Knowland et al., 2017, GRL

March 27, 2012 0UTC



- Since assimilated O_3 is mainly stratospheric, MERRA-2 O_3 is realistic within the SIs, however biased elsewhere in the troposphere.

Knowland et al., 2017, GRL

Question 2

Can we forecast SI events in GEOS forecasting products?

NASA GMAO global meteorology and chemistry products

GEOS

Forecasting

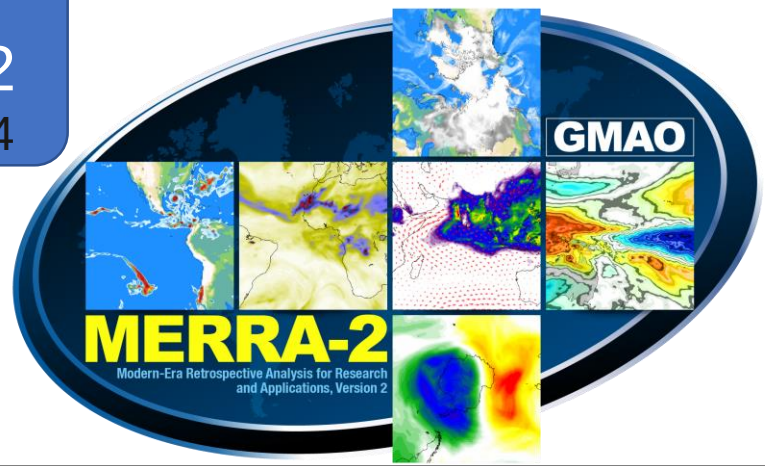
Reanalysis

GEOS FP

GEOS FP-IT
GEOS 5.12.4

MERRA-2
GEOS 5.12.4

GEOS-CF



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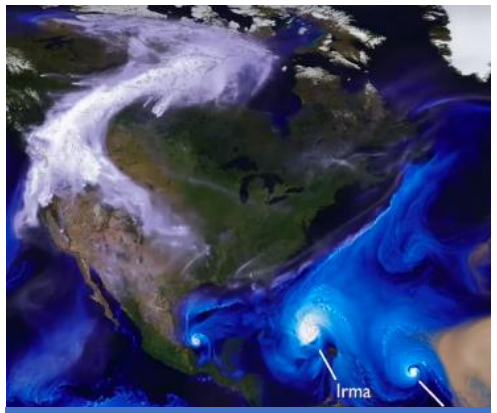
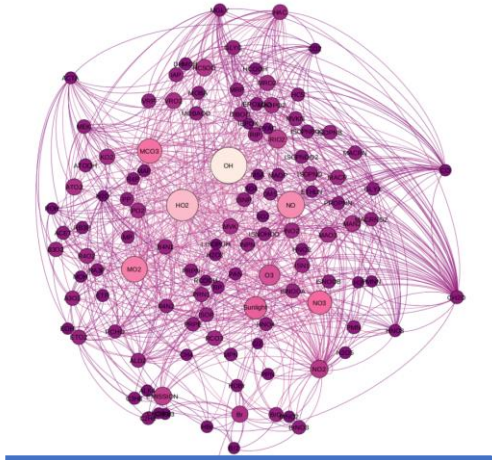
NASA's composition forecast (GEOS-CF)



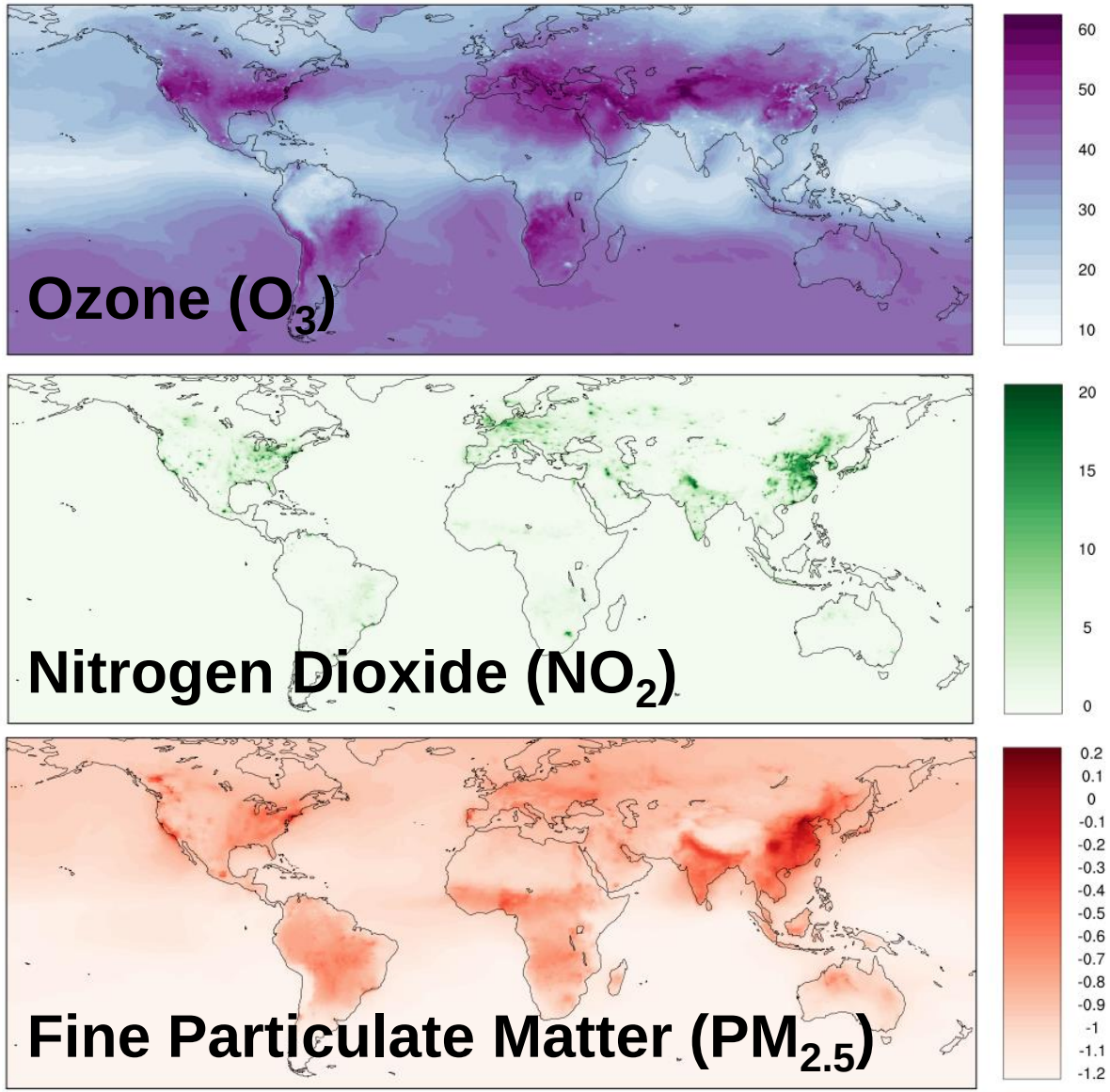
GEOS FP-IT



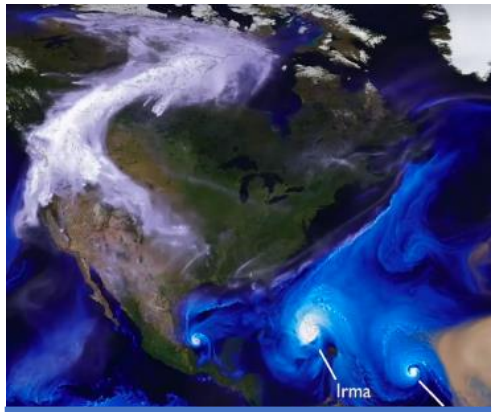
GEOS - Chem

- 250 Chemical Species
- 725 Chemical Reactions

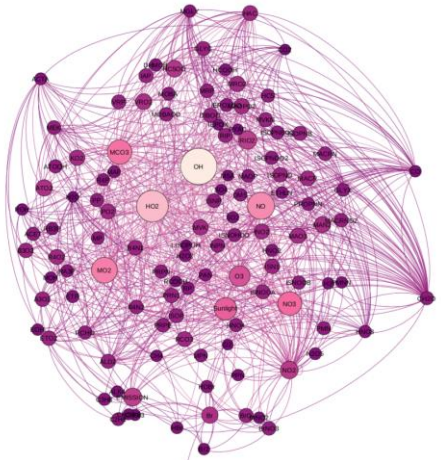
GEOS-Chem



Incorporation of satellite observations



GEOS NWP



GEOS - Chem

GEOS - CF

- Currently no direct data assimilation of constituents
- Real-time fire emissions from QFED
- Anthropogenic emissions scaled using satellite data (previous year)
- Stratospheric O_3 nudged to GEOS assimilated O_3

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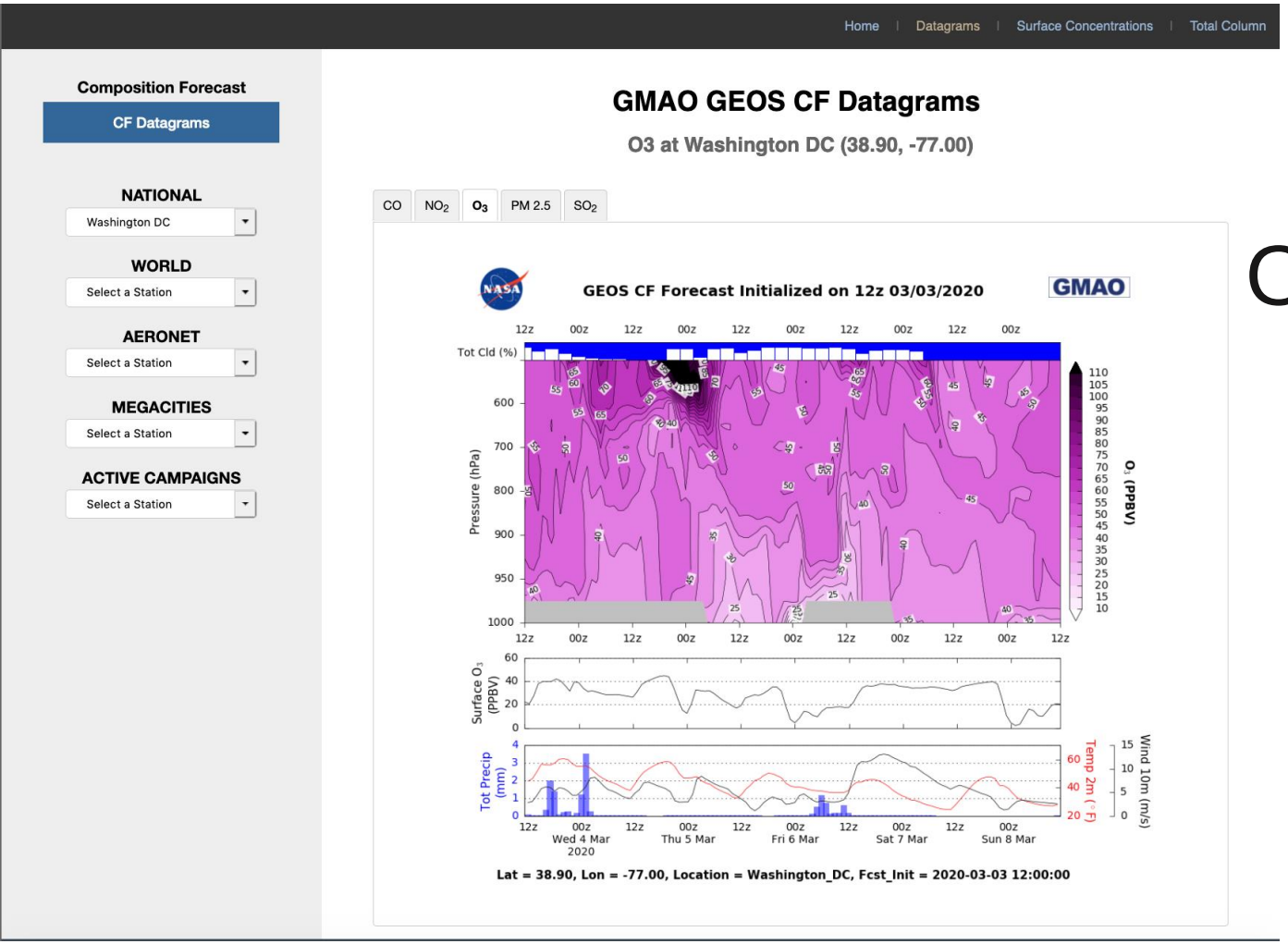
Forecasting and validating SI events



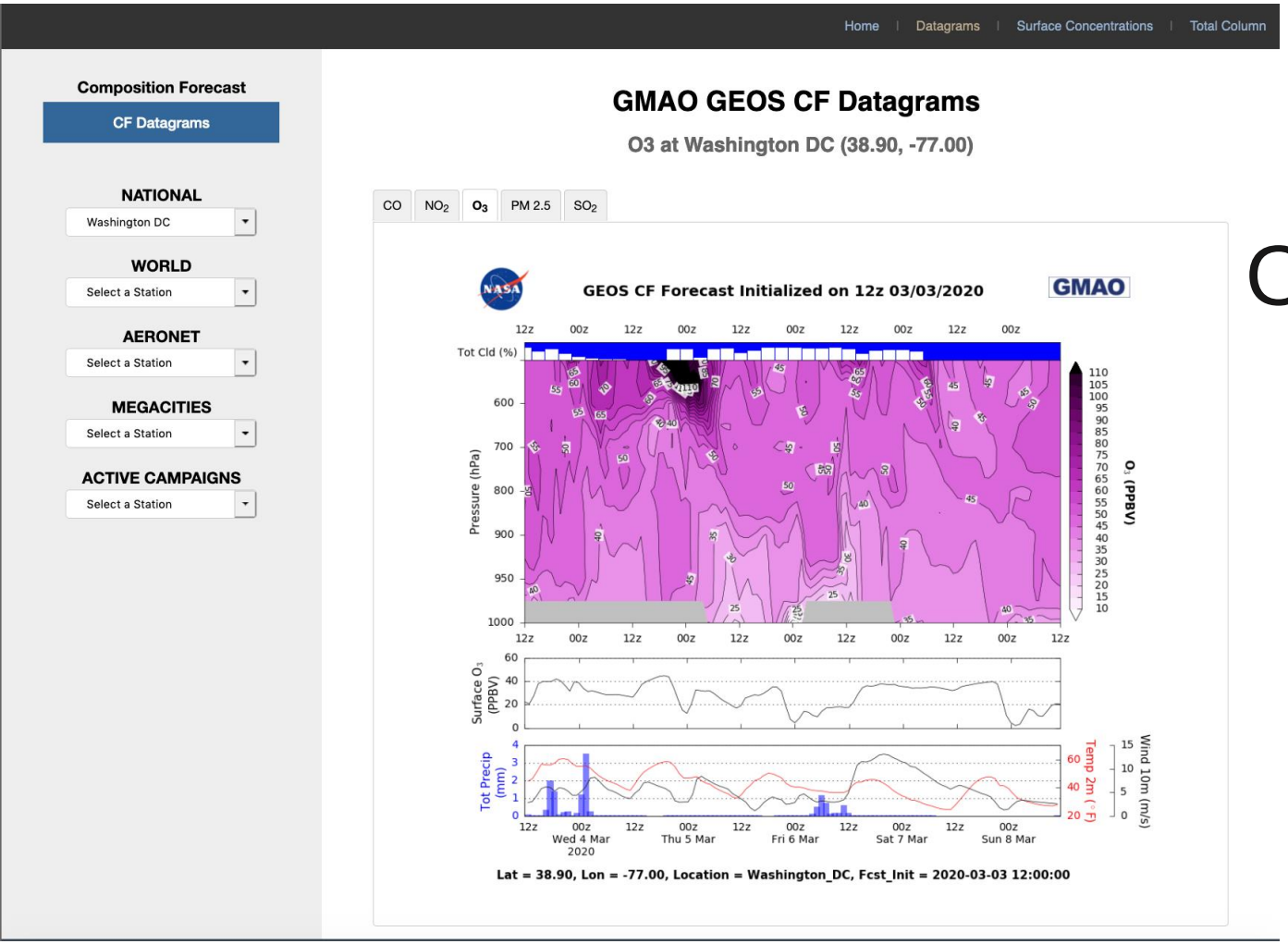
GEOS - CF

One **5-day forecast** per day

- 1-day replay
- 5-day forecast
- c360 (0.25°, **~25x25** km^2)
- Chemistry and Meteorology fields

www.fluid.nccs.nasa.gov/cf

Forecasting and validating SI events



GEOS - CF

One **5-day forecast** per day

- 1-day replay
- 5-day forecast
- c360 (0.25°, ~25x25 km^2)
- **15-minute** 2D fields
- **1-hour** 2D and 3D fields
- Available since **Jan 2018**

www.fluid.nccs.nasa.gov/cf

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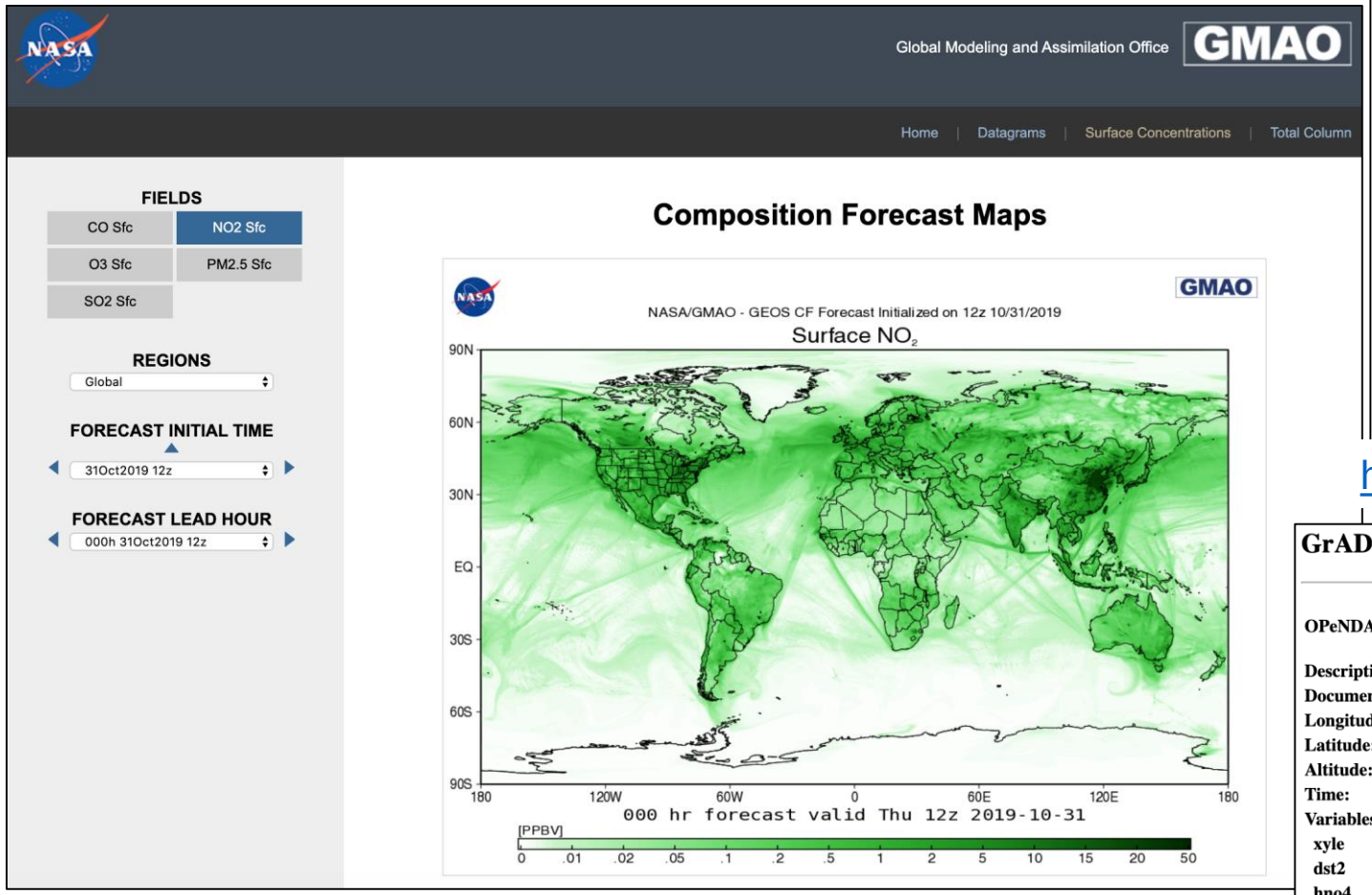
GEOS-CF model output available to the public in near real-time



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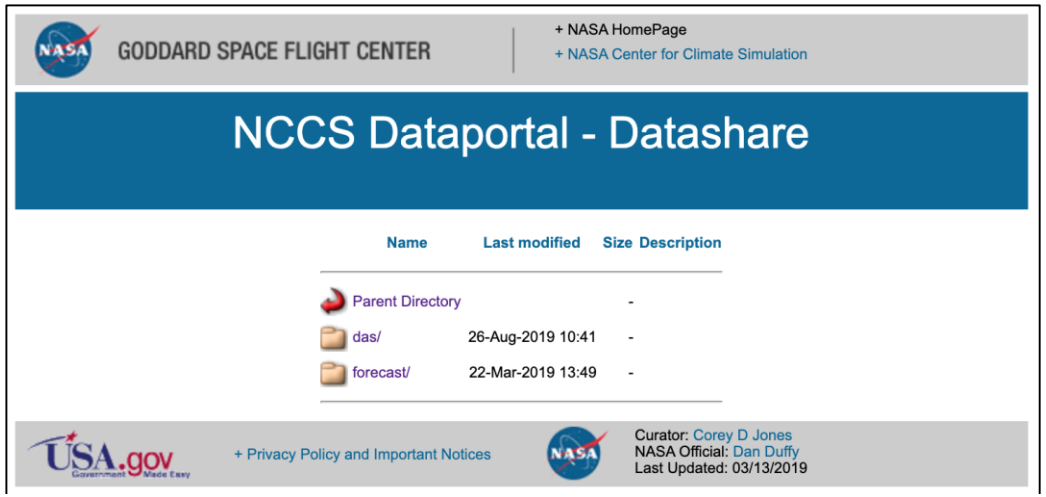
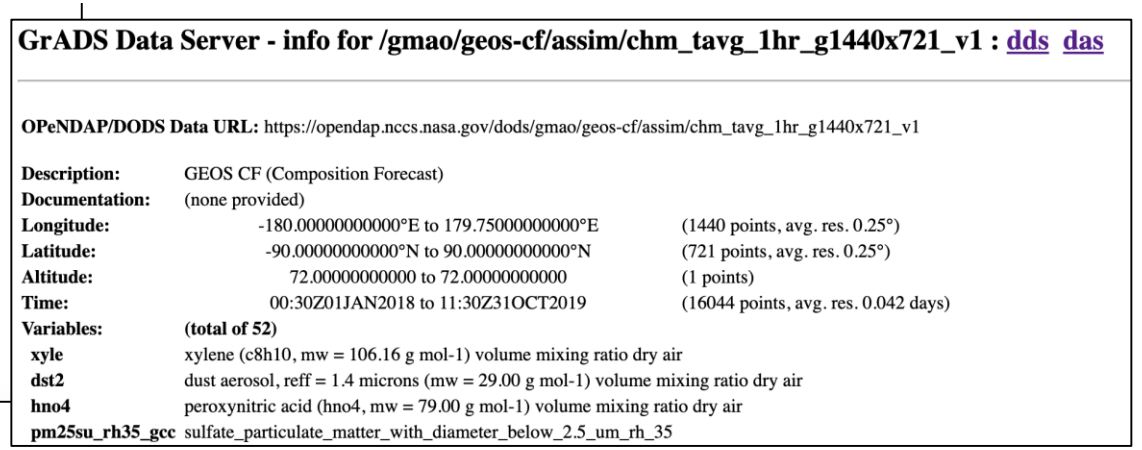


https://portal.nccs.nasa.gov/datashare/gmao/geos-cf/v1/



https://opendap.nccs.nasa.gov/dods/gmao/geos-cf/

Global Modeling and Assimilation Office GMAO

Home | Datagrams | Surface Concentrations | Total Column

Composition Forecast

CF Datagrams

NATIONAL

Select a Station

WORLD

Select a Station

AERONET

NORTH AMERICA

LMOL

MEGACITIES

Select a Station

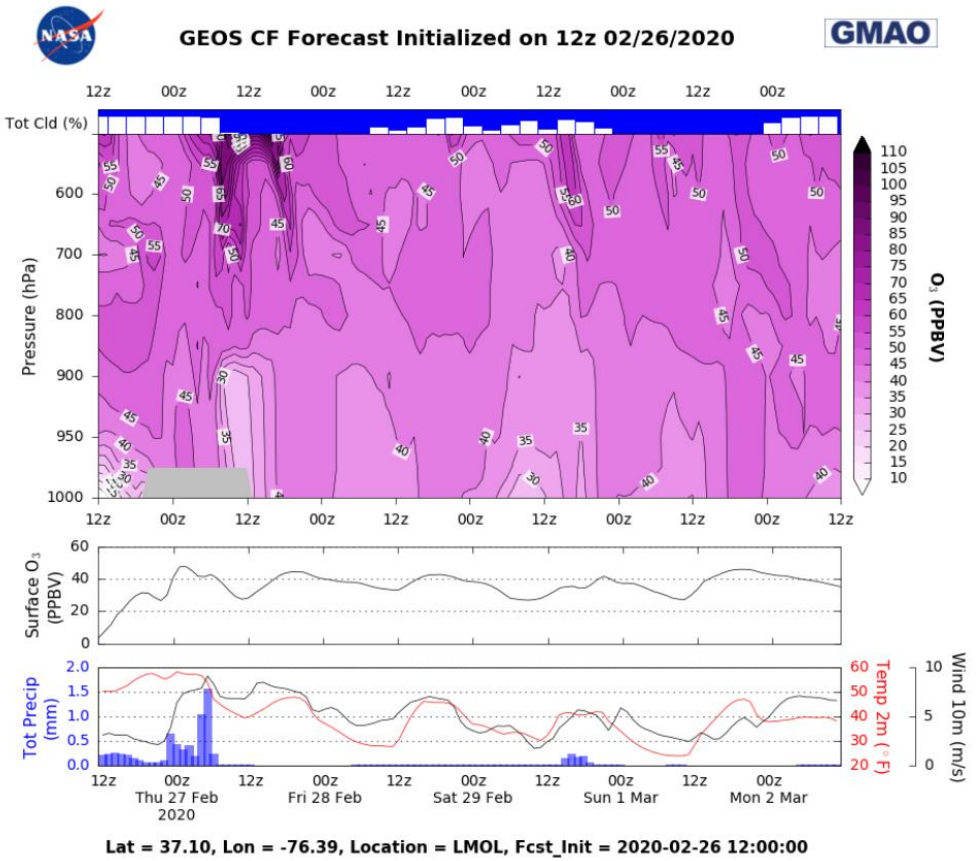
ACTIVE CAMPAIGNS

Select a Station

GMAO GEOS CF Datagrams

O3 at LMOL (37.10, -76.39)

CO | NO_2 | **O_3** | PM 2.5 | SO_2



www.fluid.nccs.nasa.gov/cf

Next step:

Can we provide a flag or alert to indicate to end-users that a stratospheric intrusion is likely in their area?

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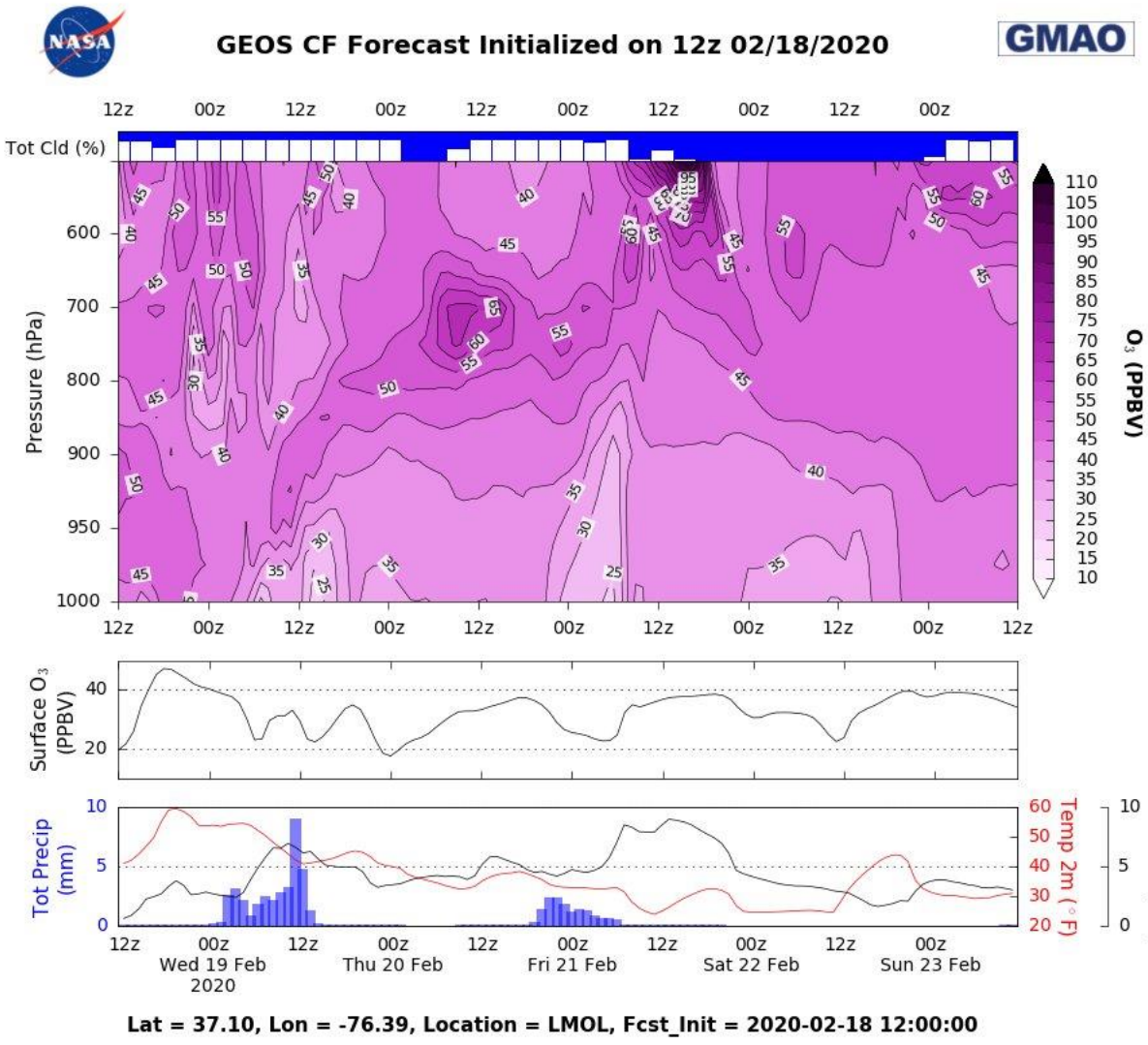
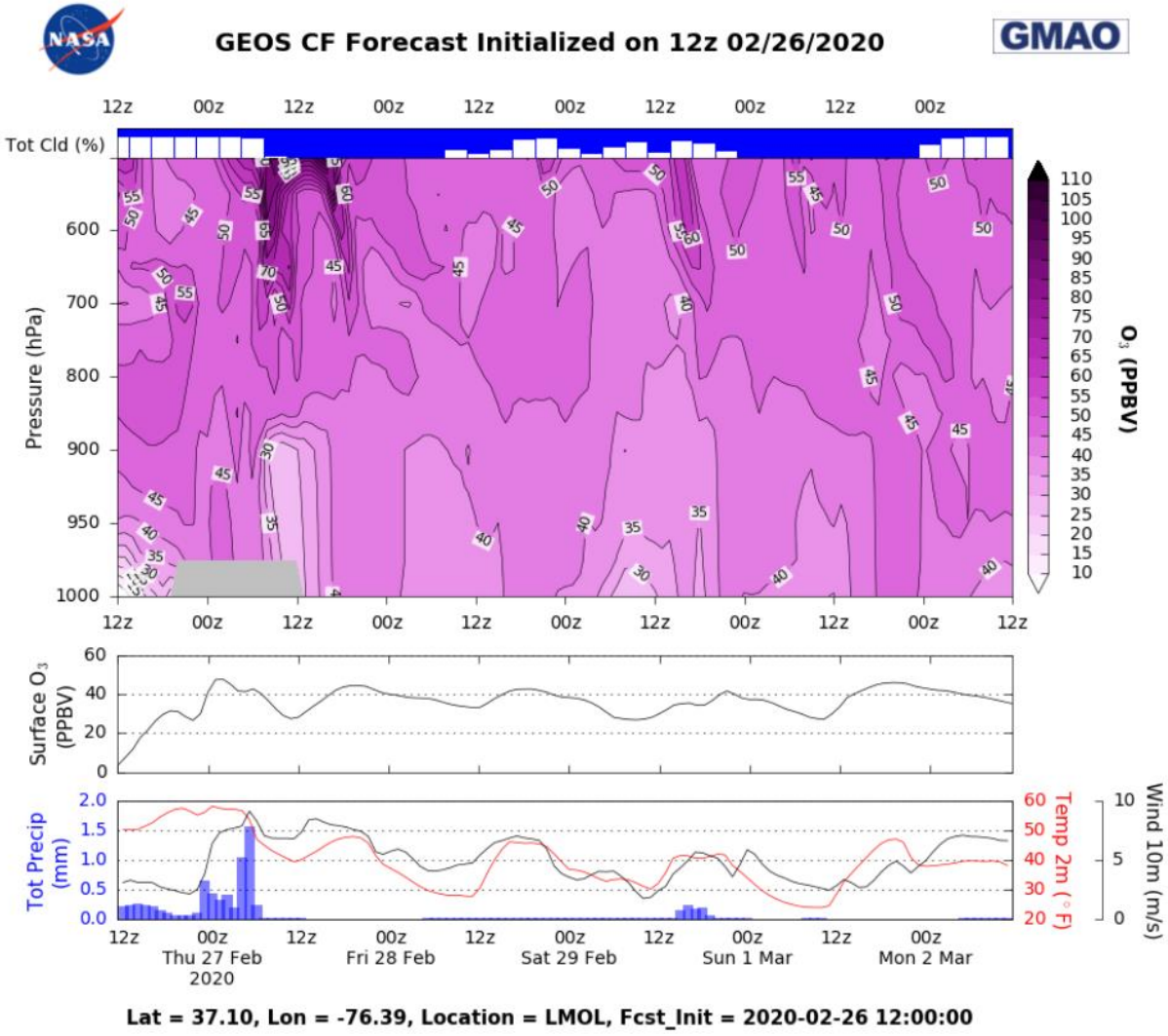
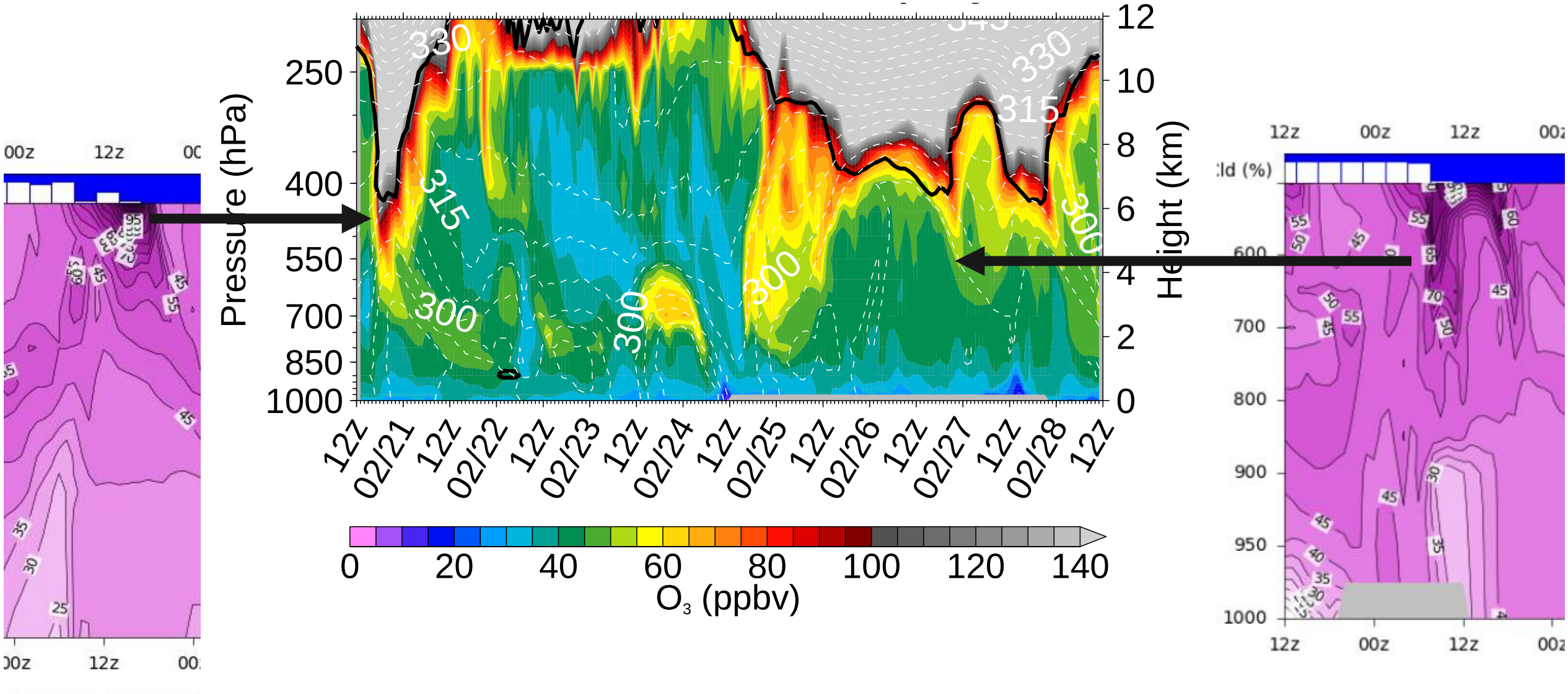
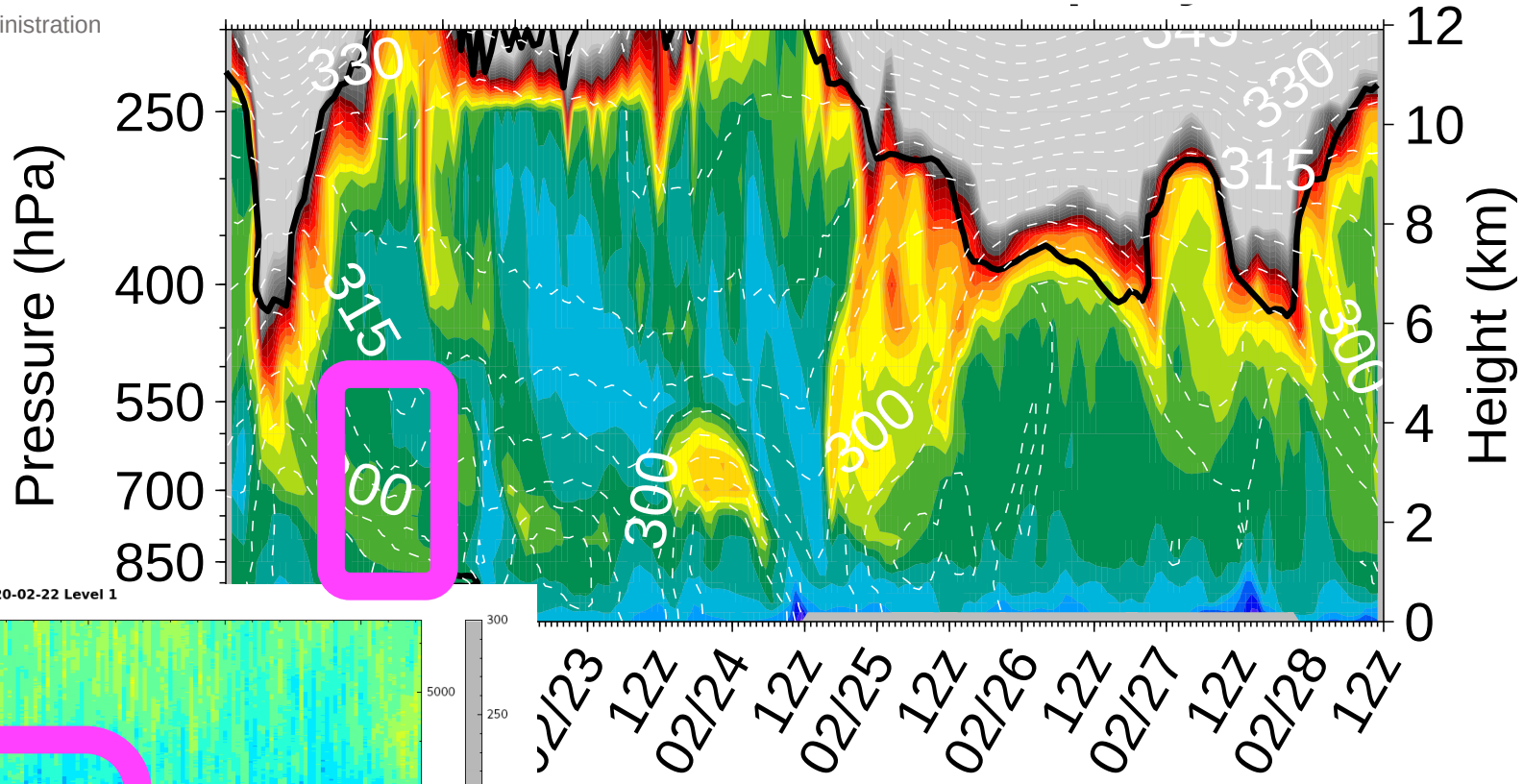
GEOS-CF Forecasts for NASA Langley: "LMOL"

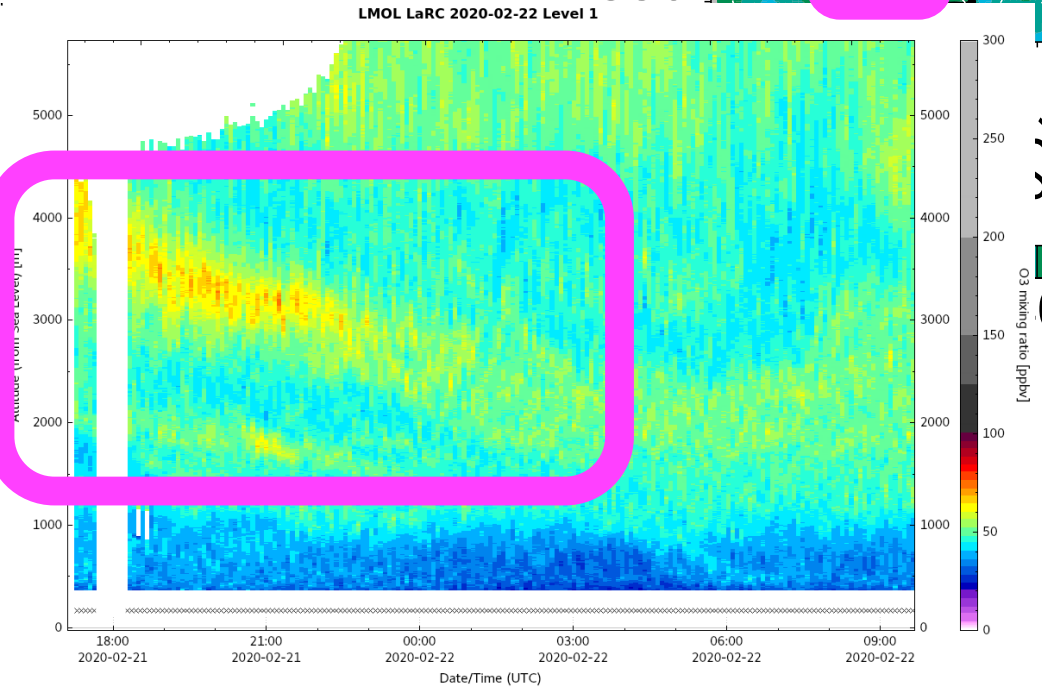




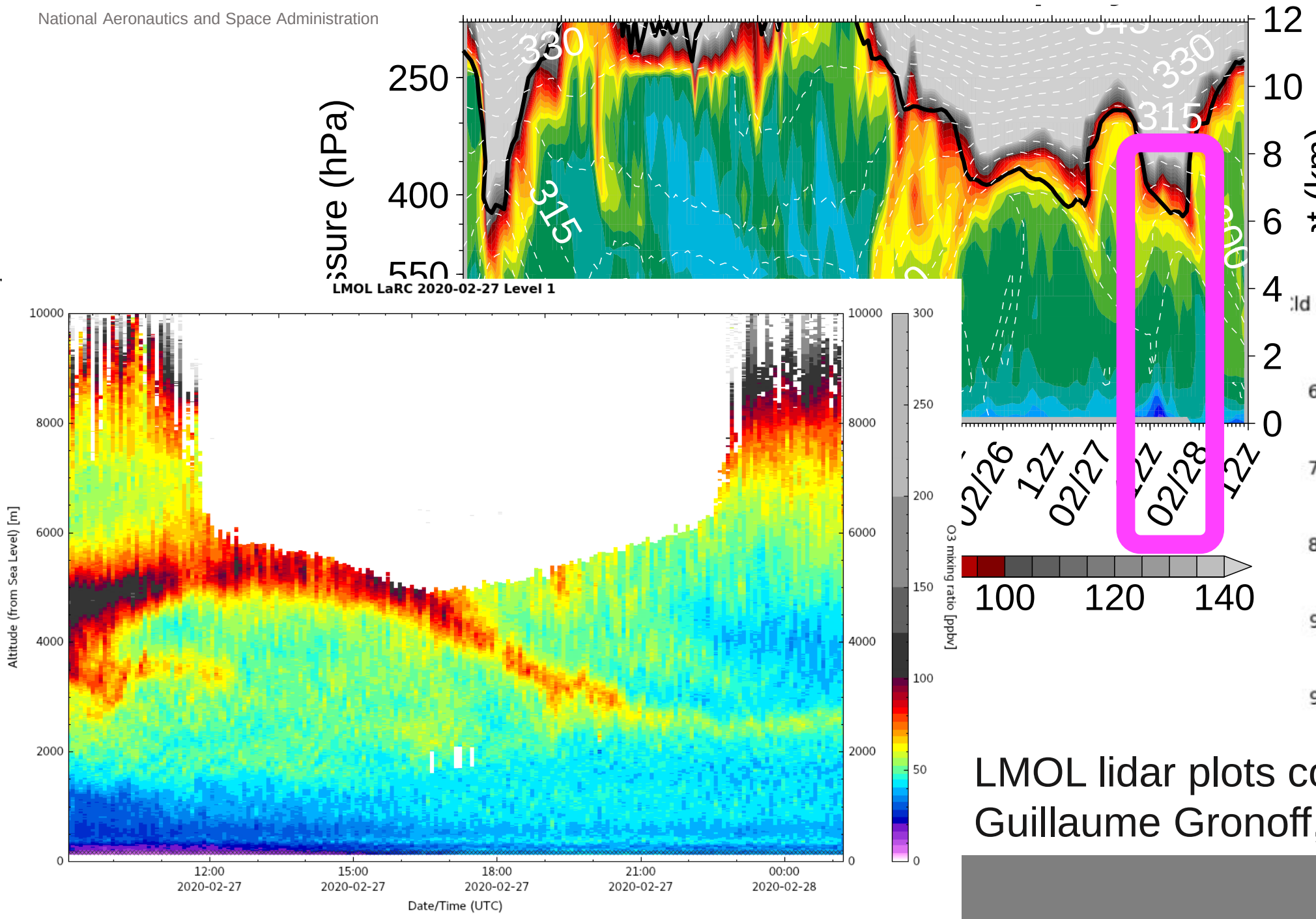
GEOS-CF ‘analysis’ at Langley (12z Feb 20 – 12z Feb 28, 2020)

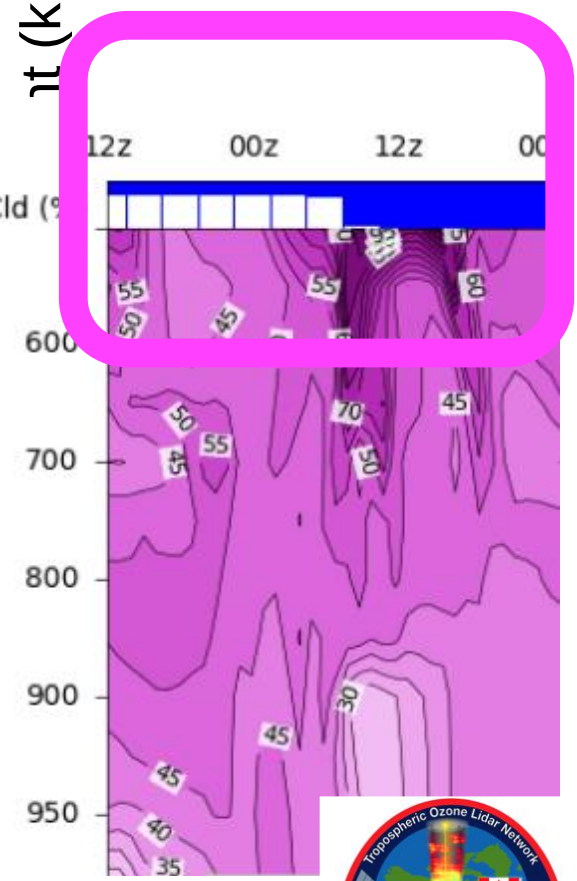






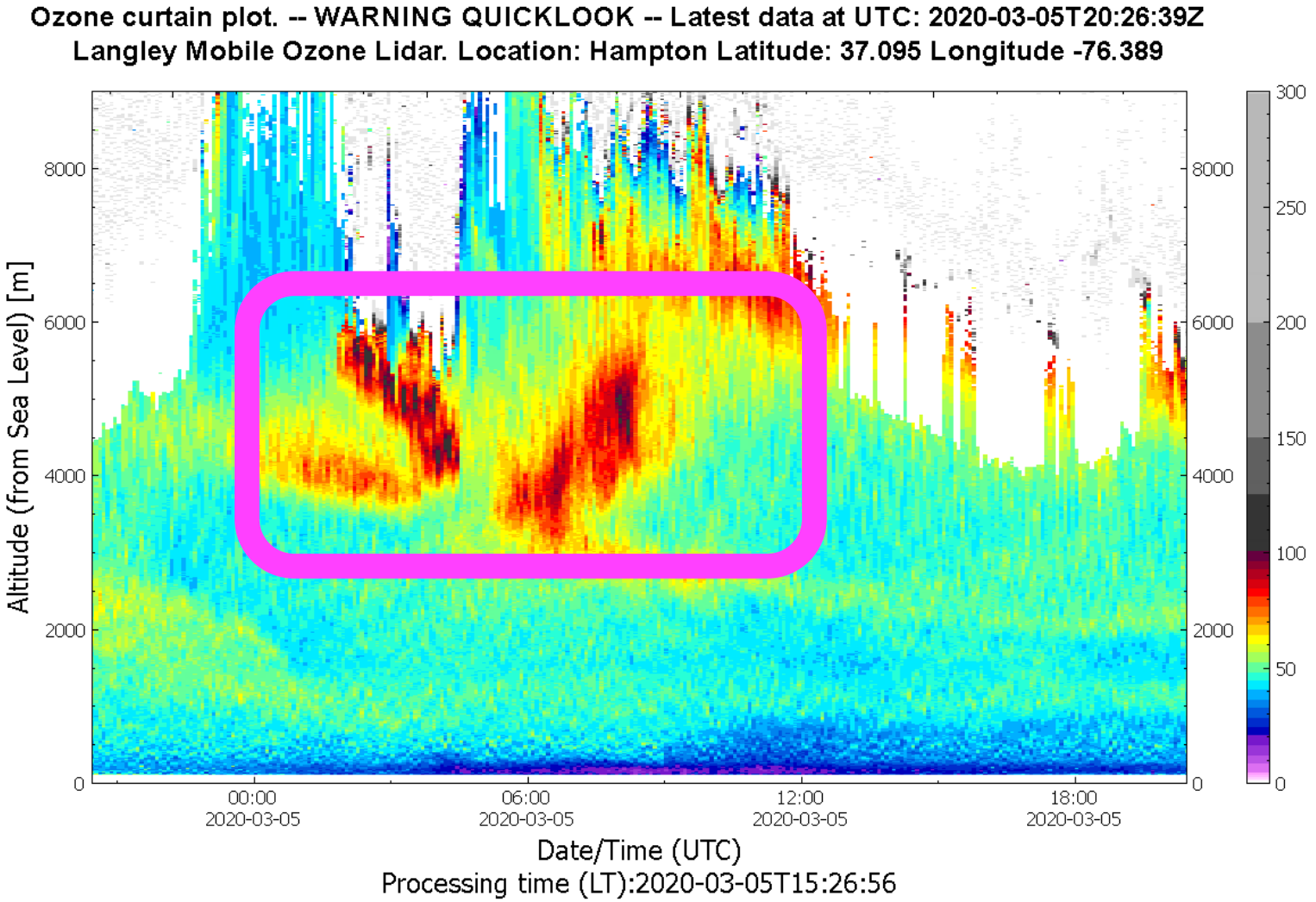
LMOL lidar plots courtesy of Guillaume Gronoff, LaRC

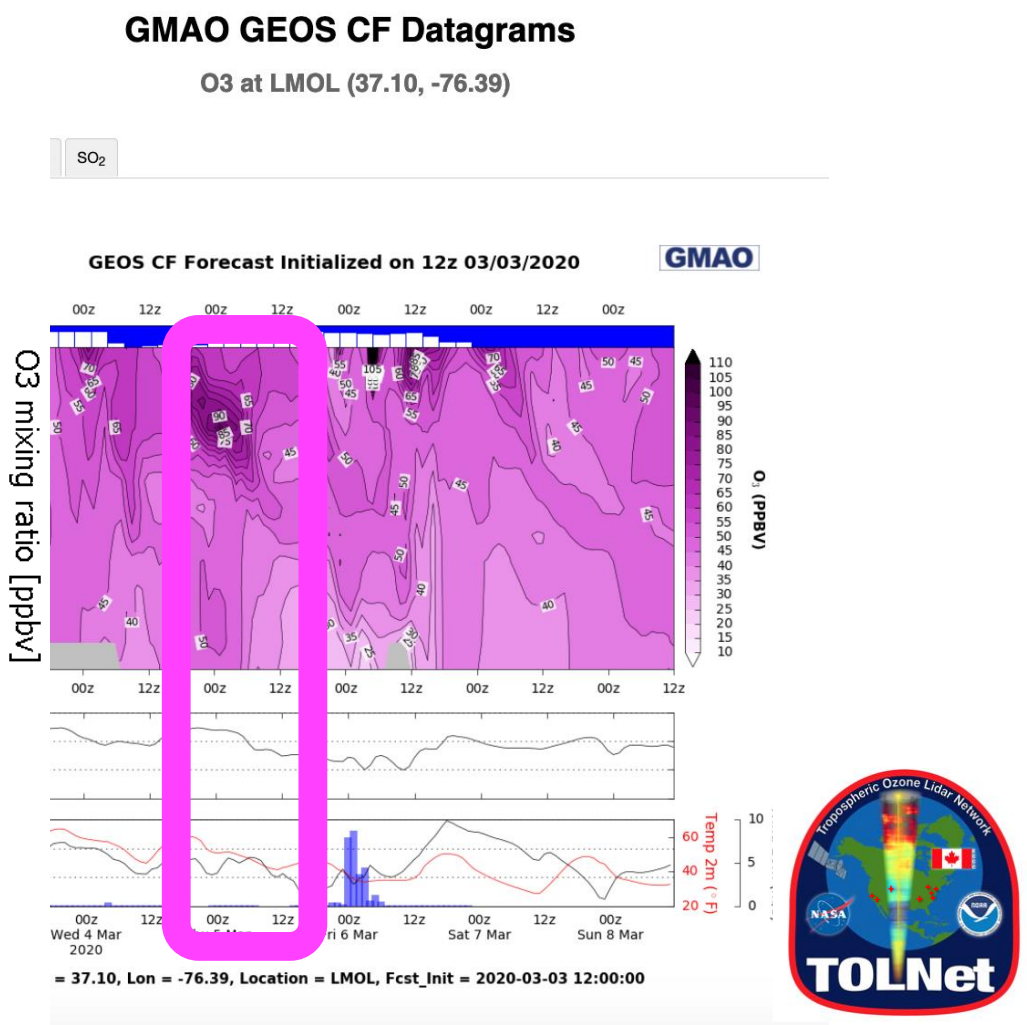




LMOL lidar plots courtesy of Guillaume Gronoff, LaRC

John Sullivan (GSFC) and Guillaume Gronoff (LaRC) captured last week's event ☺





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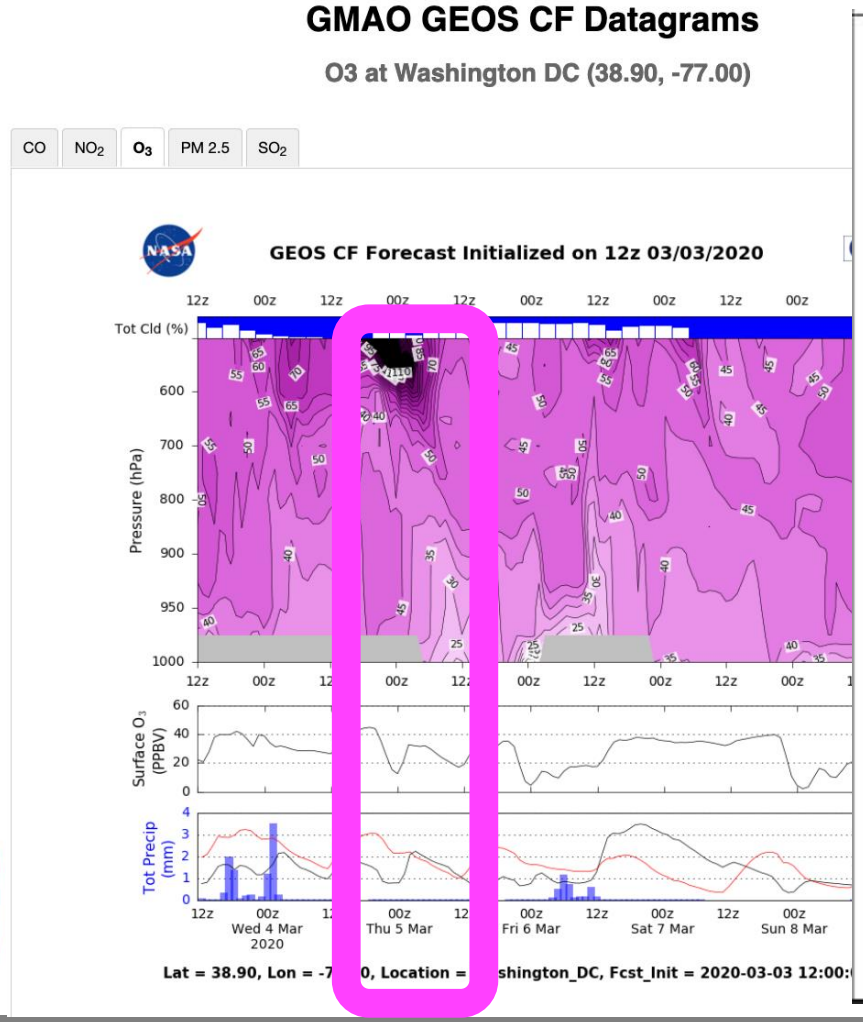
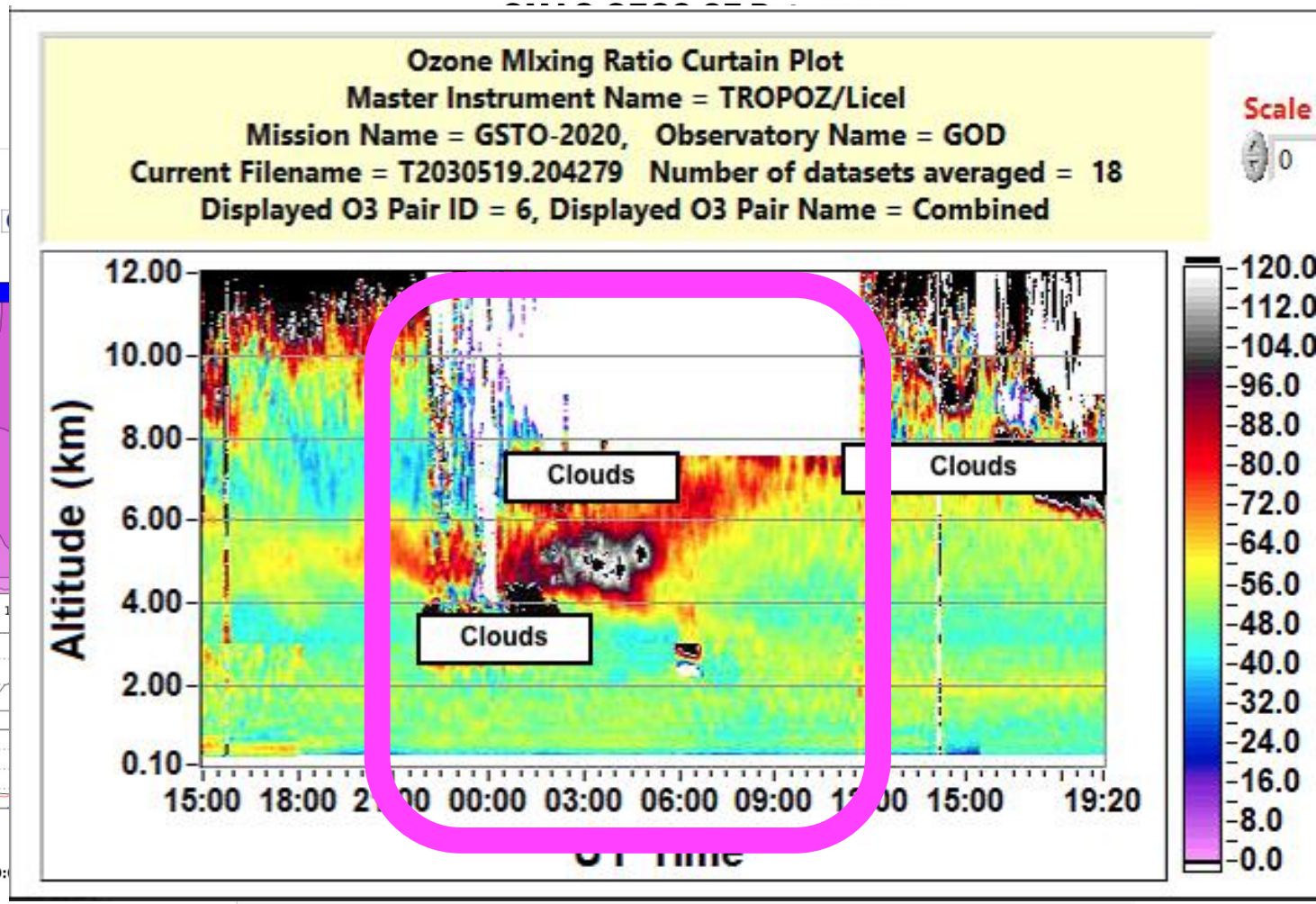
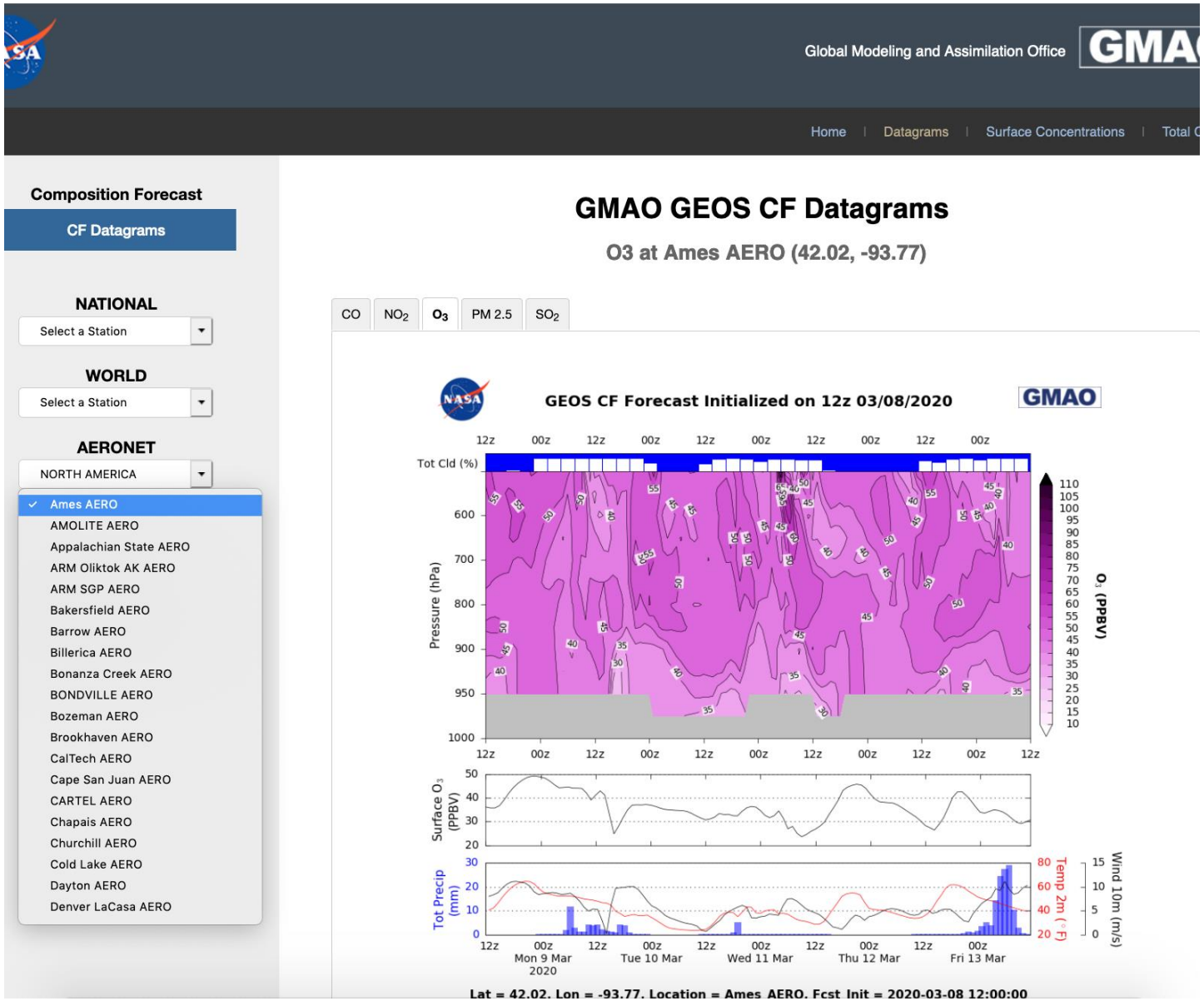






Do we have all the TOLNet locations?

Fluid has 200 preset Datagram locations:

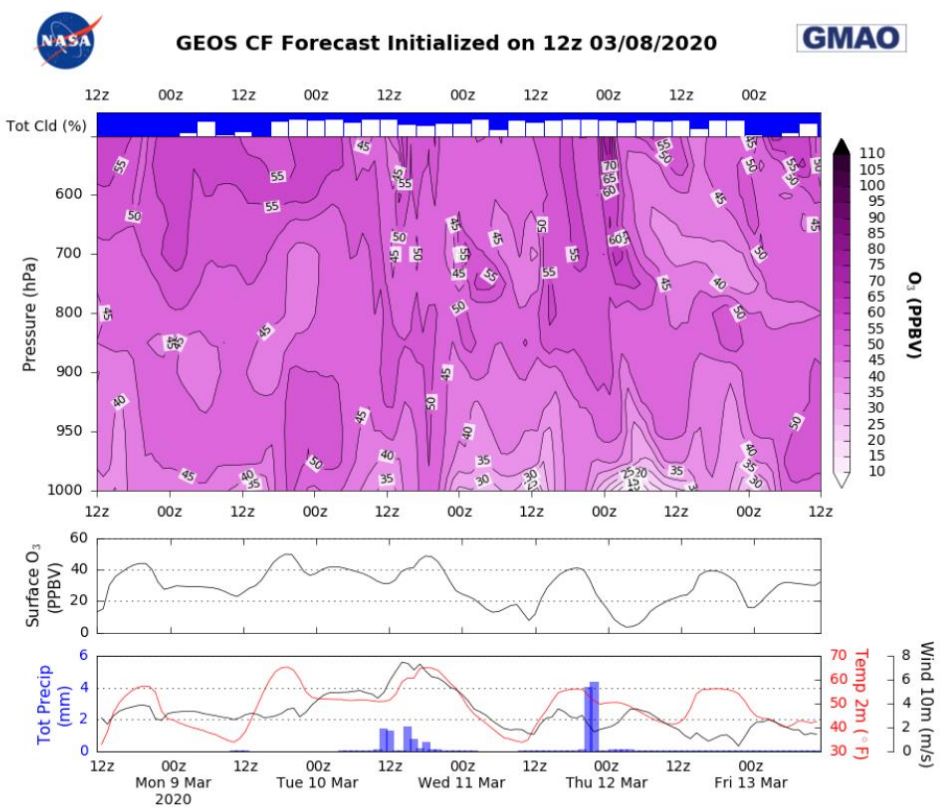
1. National locations
2. World
3. **Aeronet (by continent)**
4. Megacities
5. NASA Campaigns

GSFC and LaRC

GMAO GEOS CF Datagrams

O3 at TROPOZ (38.99, -76.84)

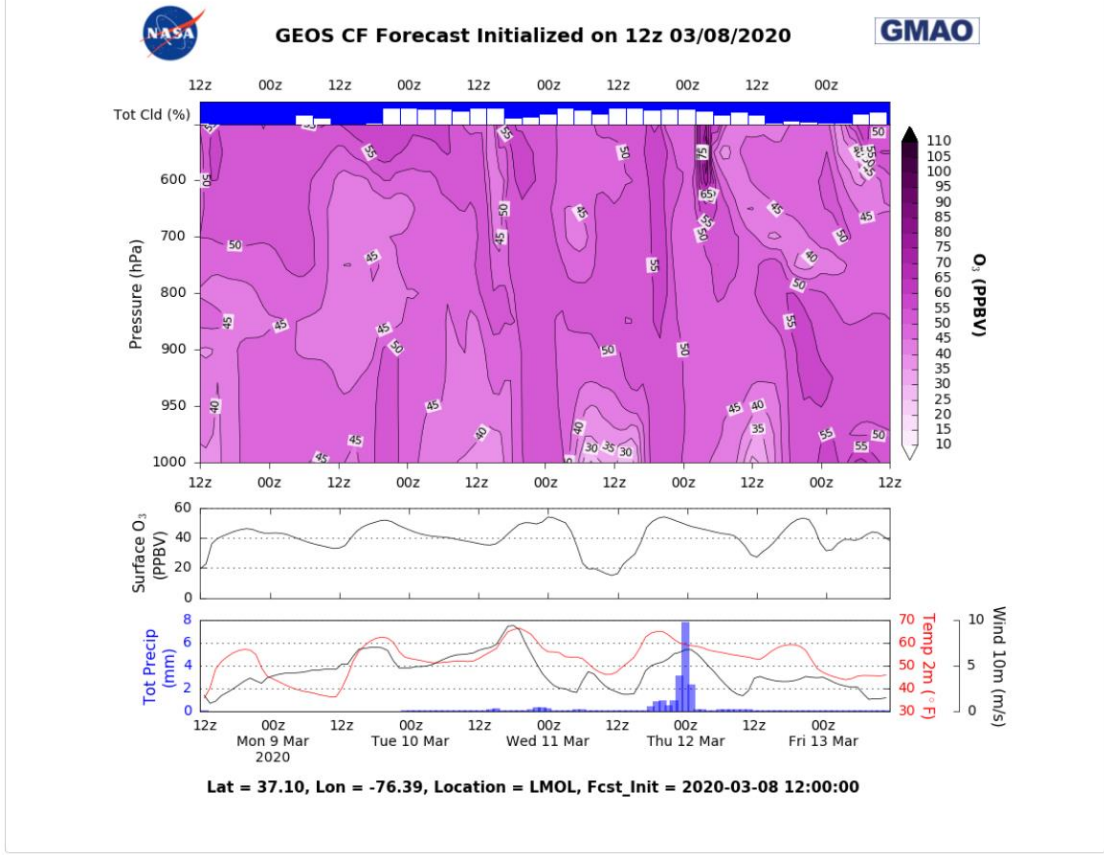
CO | NO_2 | **O_3** | PM 2.5 | SO_2



GMAO GEOS CF Datagrams

O3 at LMOL (37.10, -76.39)

CO | NO_2 | **O_3** | PM 2.5 | SO_2

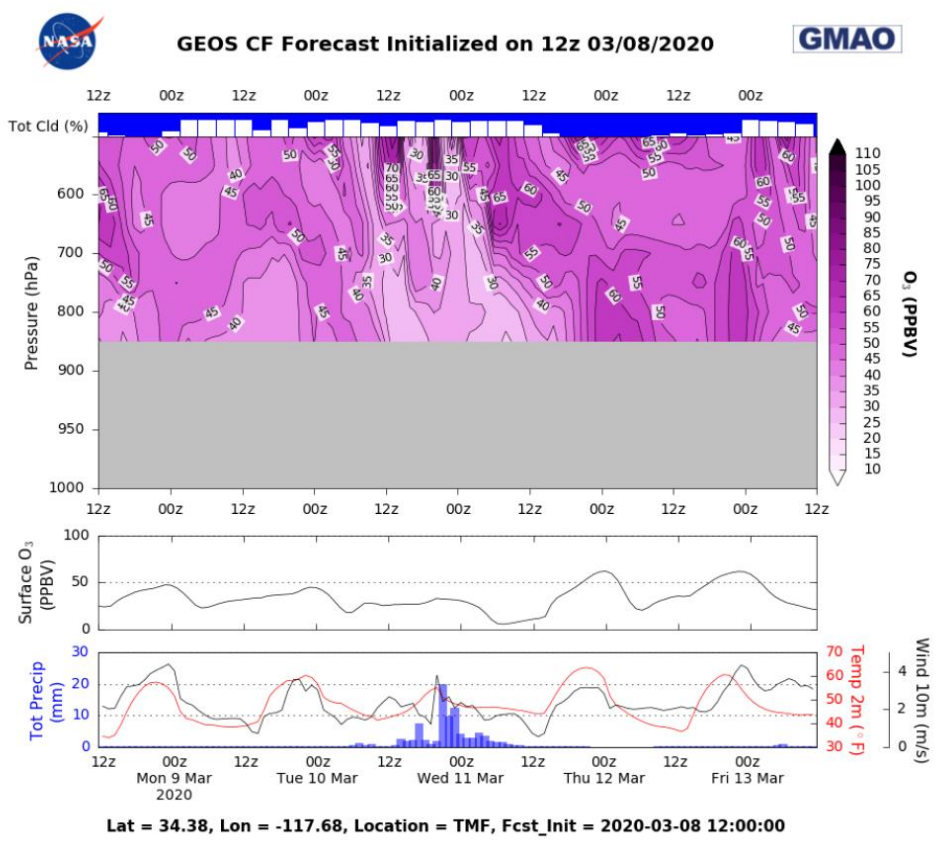


TMF and Mauna Loa

GMAO GEOS CF Datagrams

O3 at TMF (34.38, -117.68)

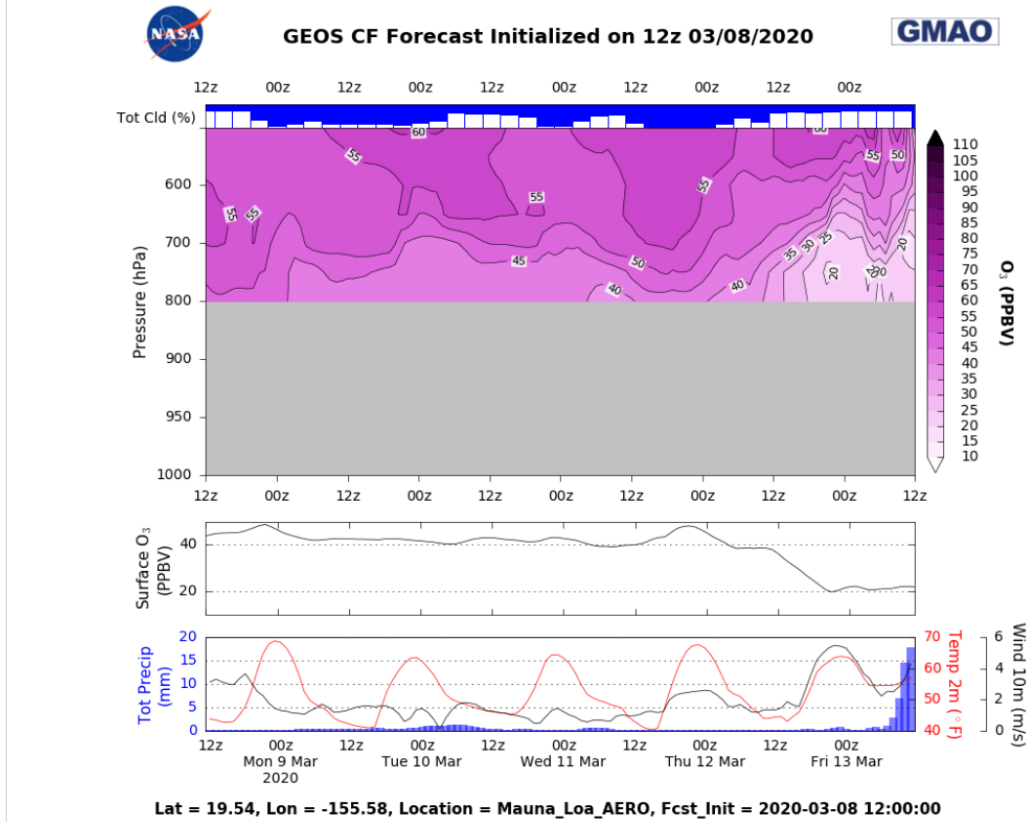
CO | NO_2 | **O_3** | PM 2.5 | SO_2



GMAO GEOS CF Datagrams

O3 at Mauna Loa AERO (19.54, -155.58)

CO | NO_2 | **O_3** | PM 2.5 | SO_2

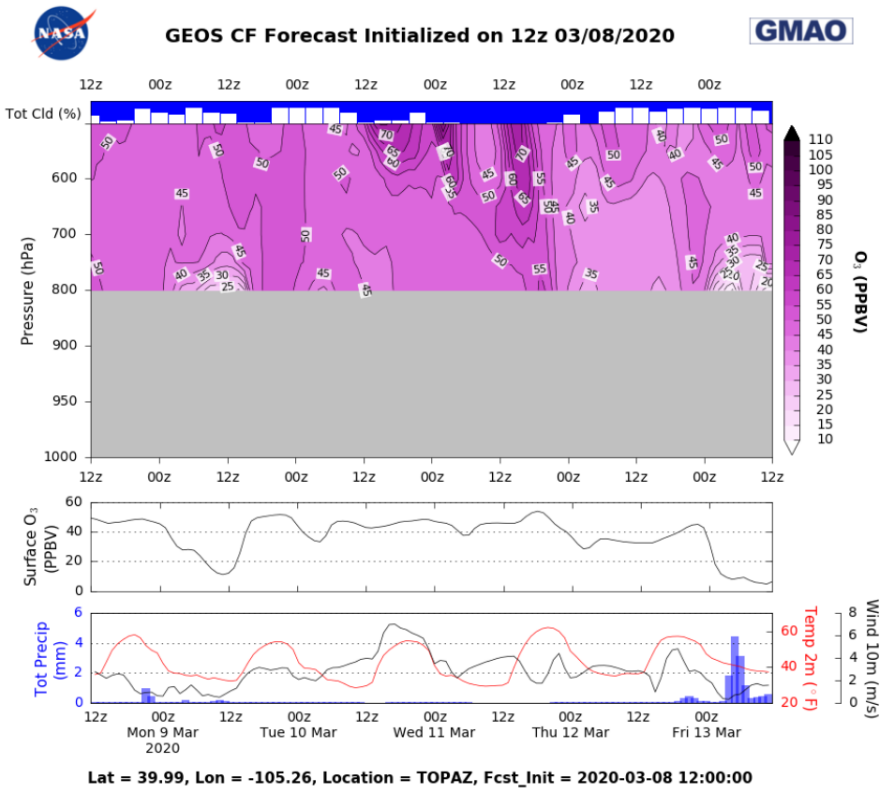


NOAA Boulder and NASA Huntsville

GMAO GEOS CF Datagrams

O3 at TOPAZ (39.99, -105.26)

CO | NO_2 | **O_3** | PM 2.5 | SO_2



GMAO GEOS CF Datagrams

O3 at RO3QET (34.73, -86.64)

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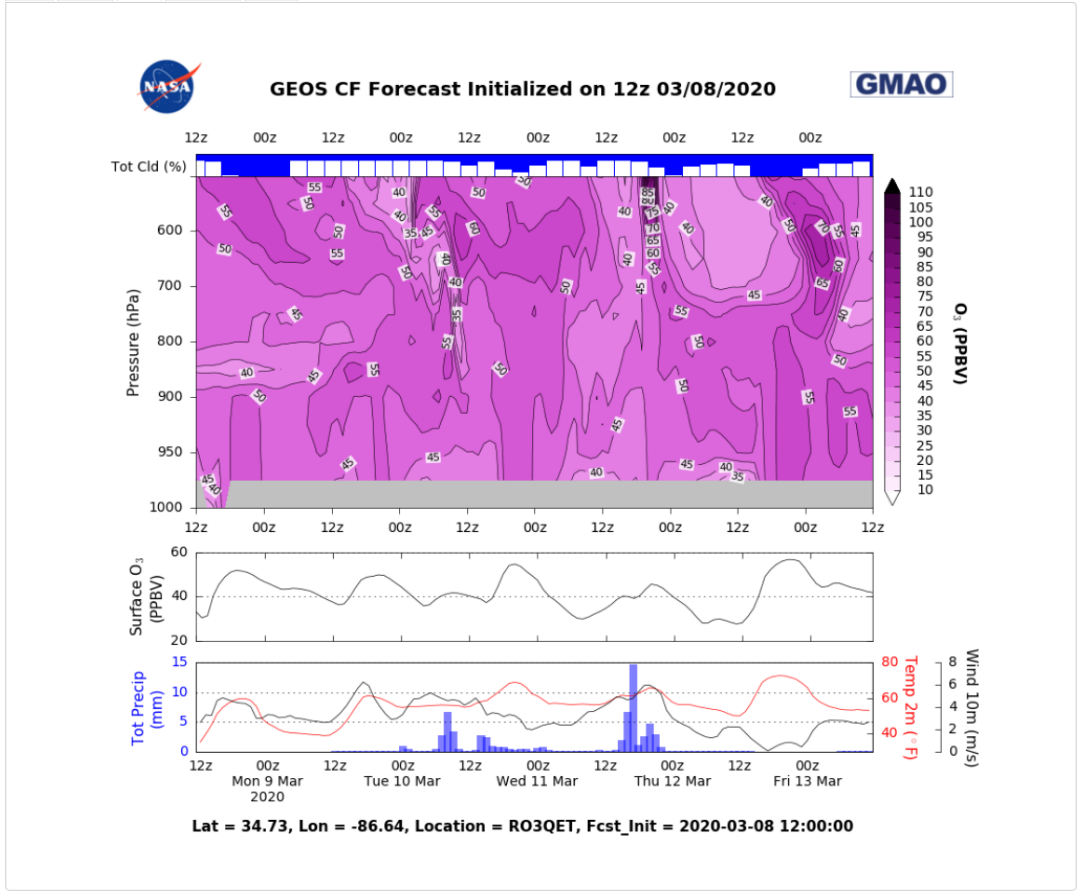
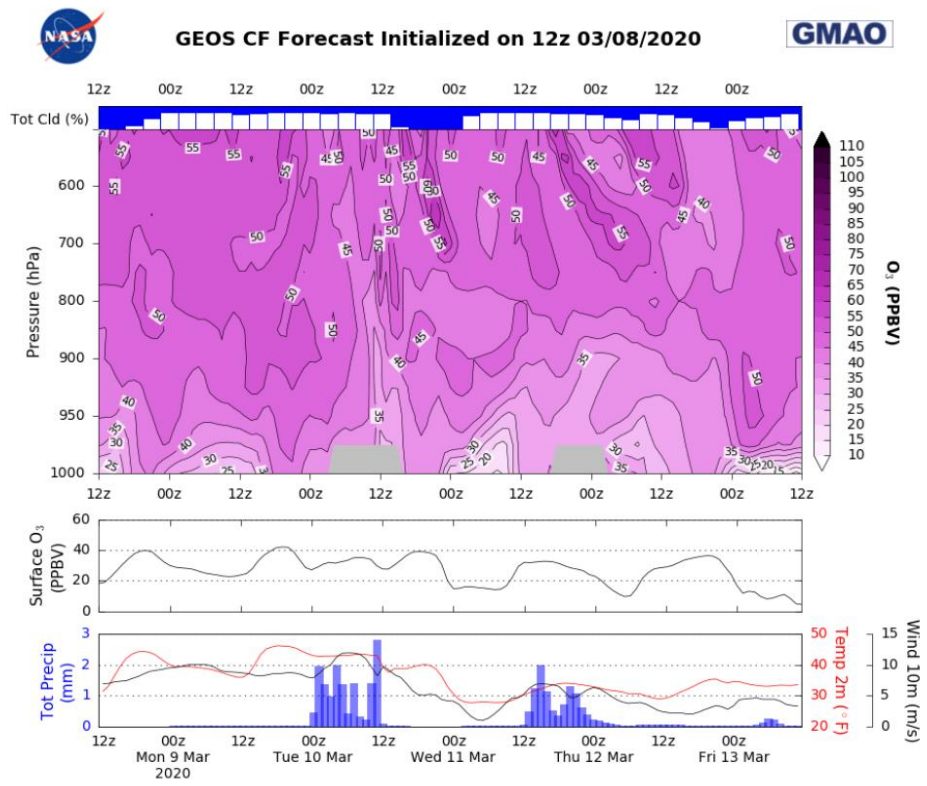


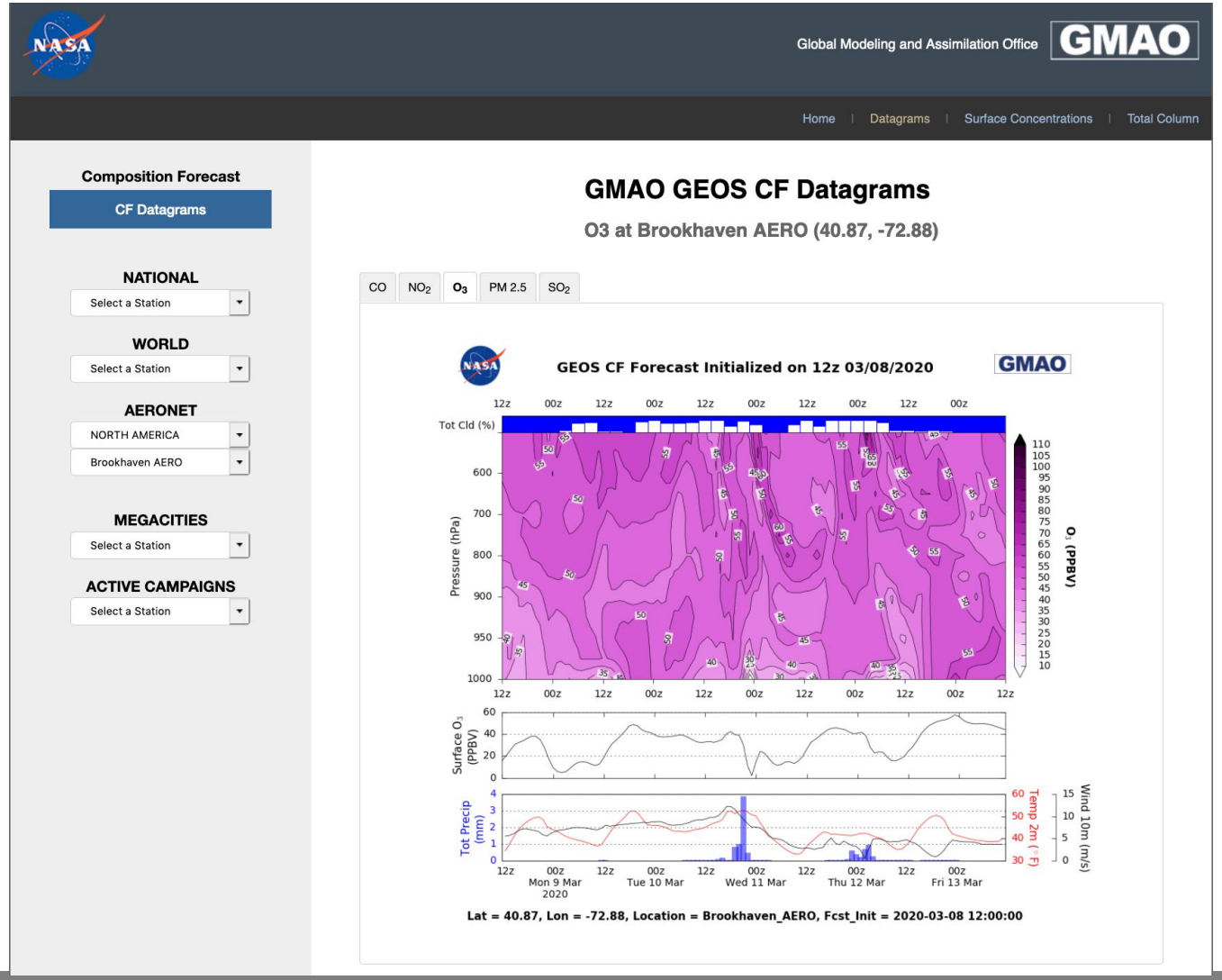
ECCC and CCNY
(approximate locations, the AMOLITE location is in Alberta)

GMAO GEOS CF Datagrams

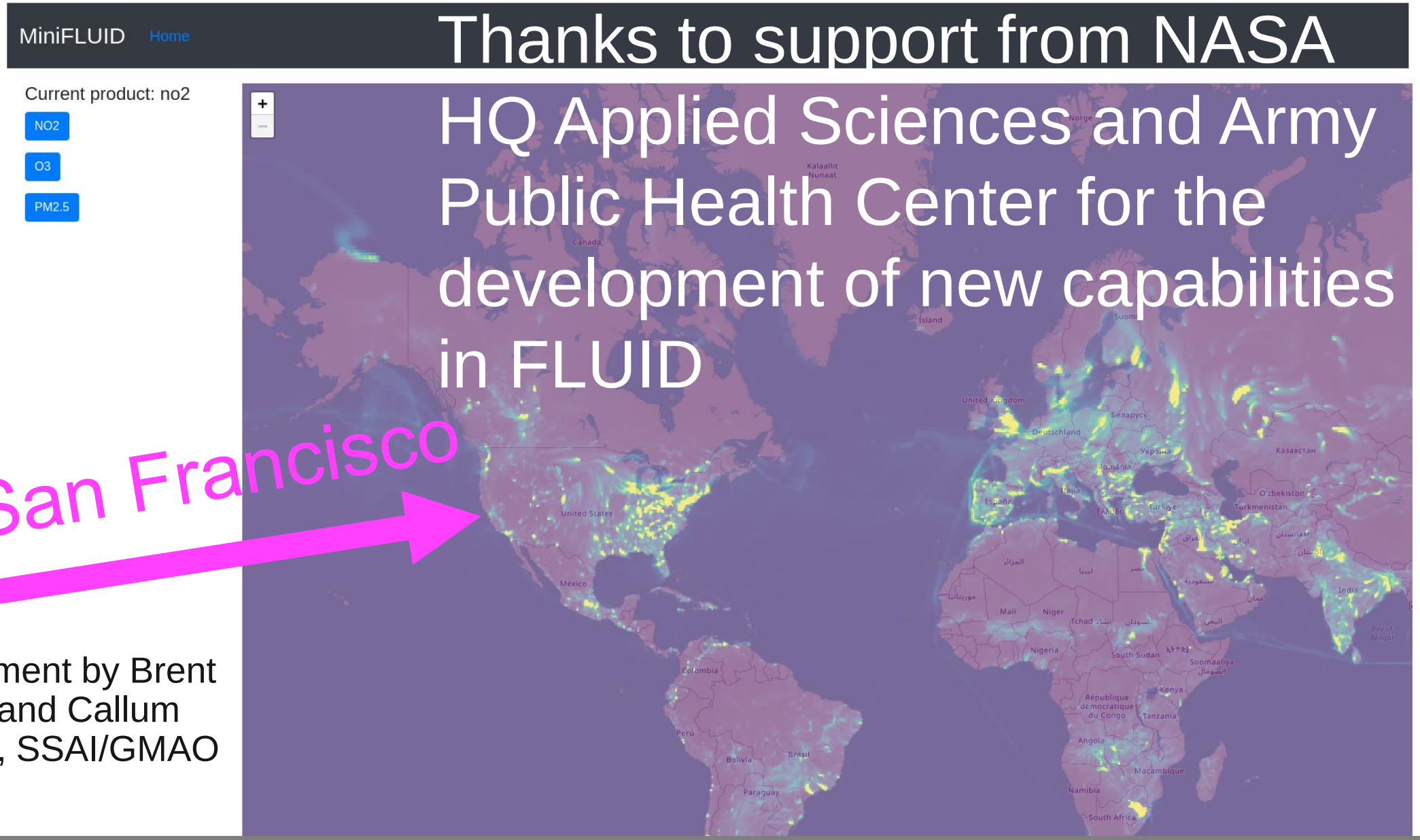
O3 at Toronto, Canada (43.60, -79.40)

CO | NO_2 | O_3 | PM 2.5 | SO_2



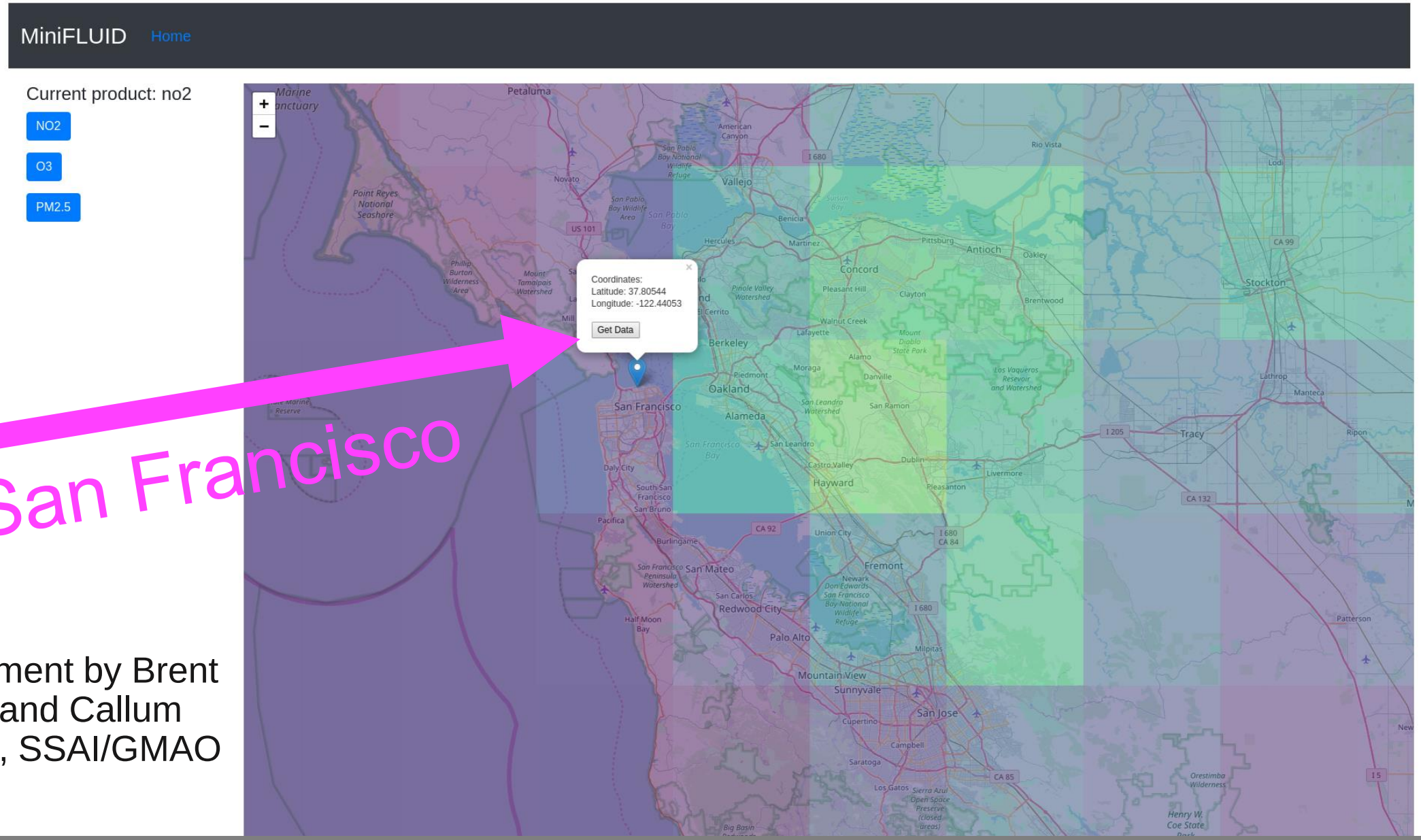


Added features to FLUID *in Development* ☺



Development by Brent Smith and Callum Wayman, SSAI/GMAO

Added features to FLUID *in Development* ☺



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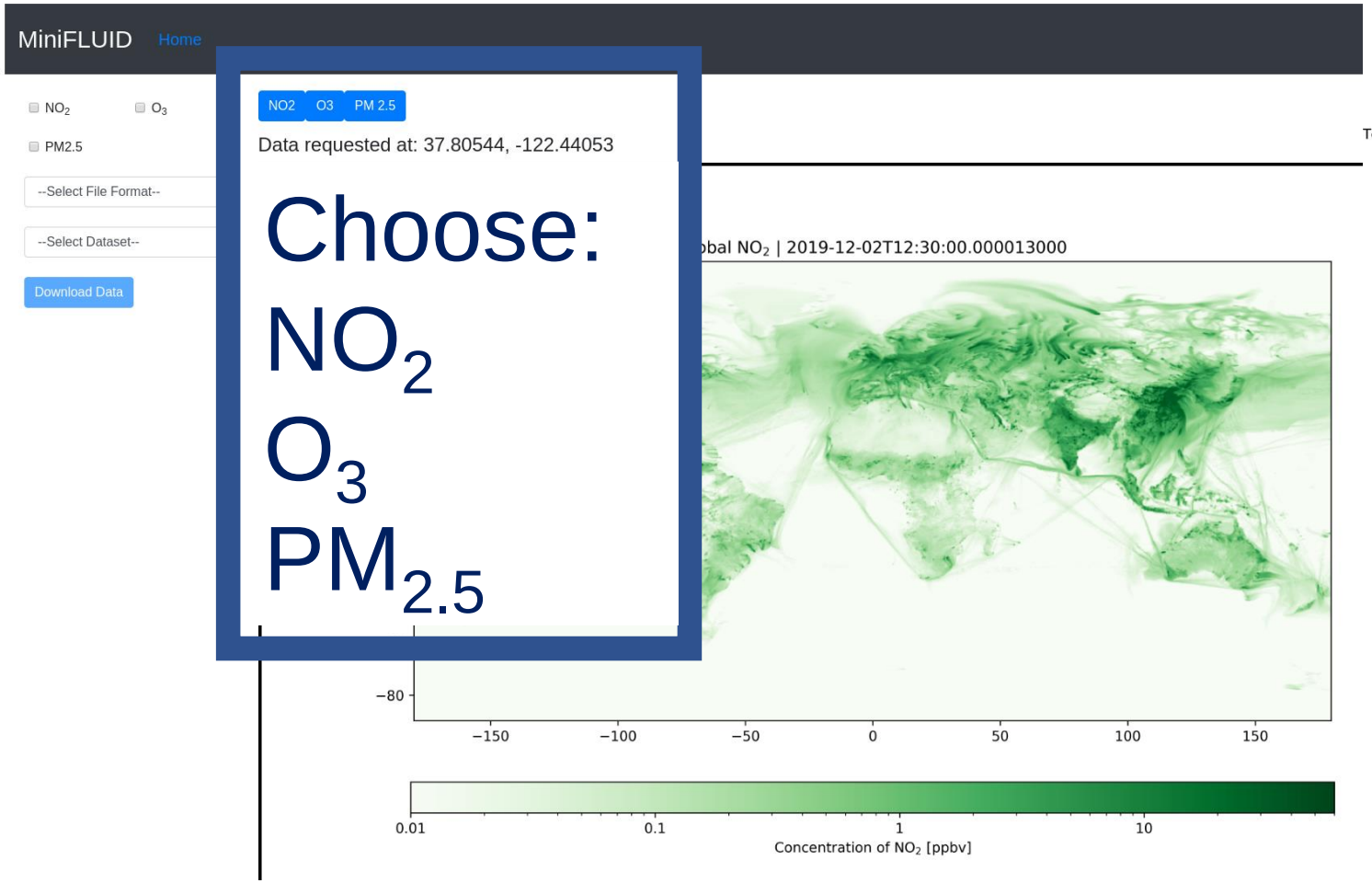

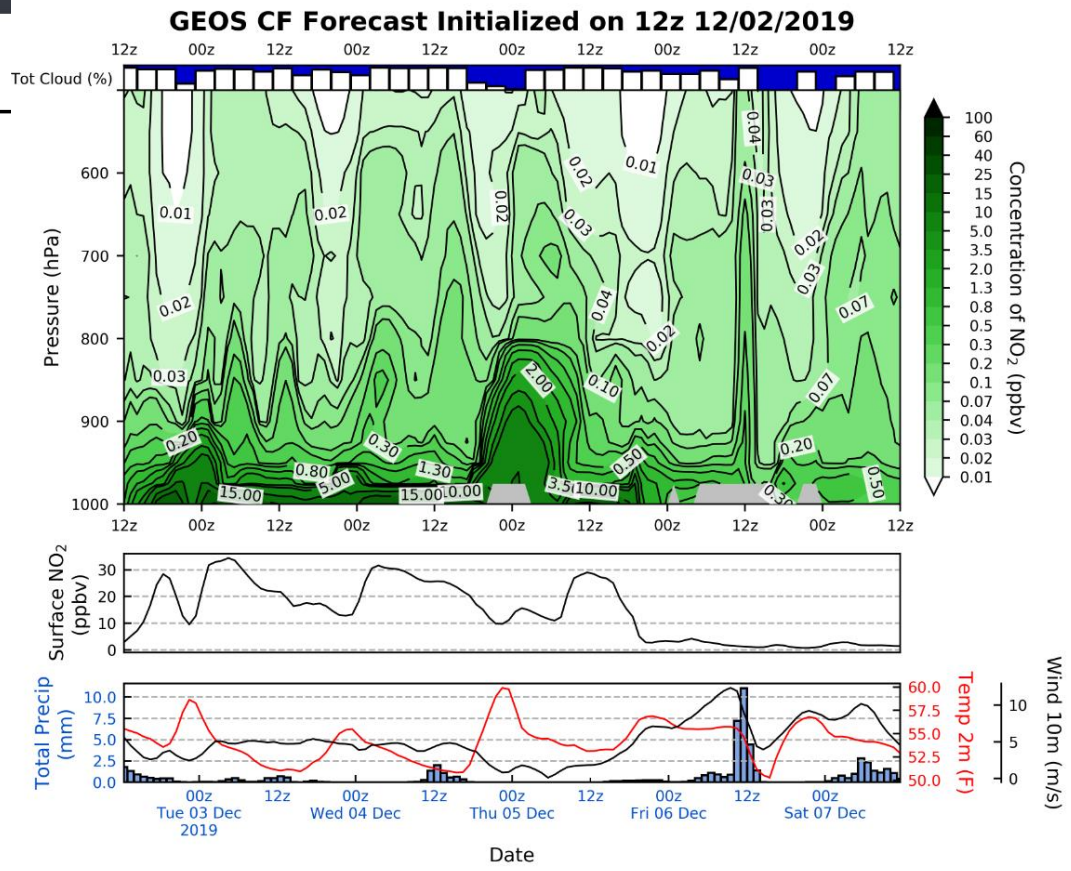

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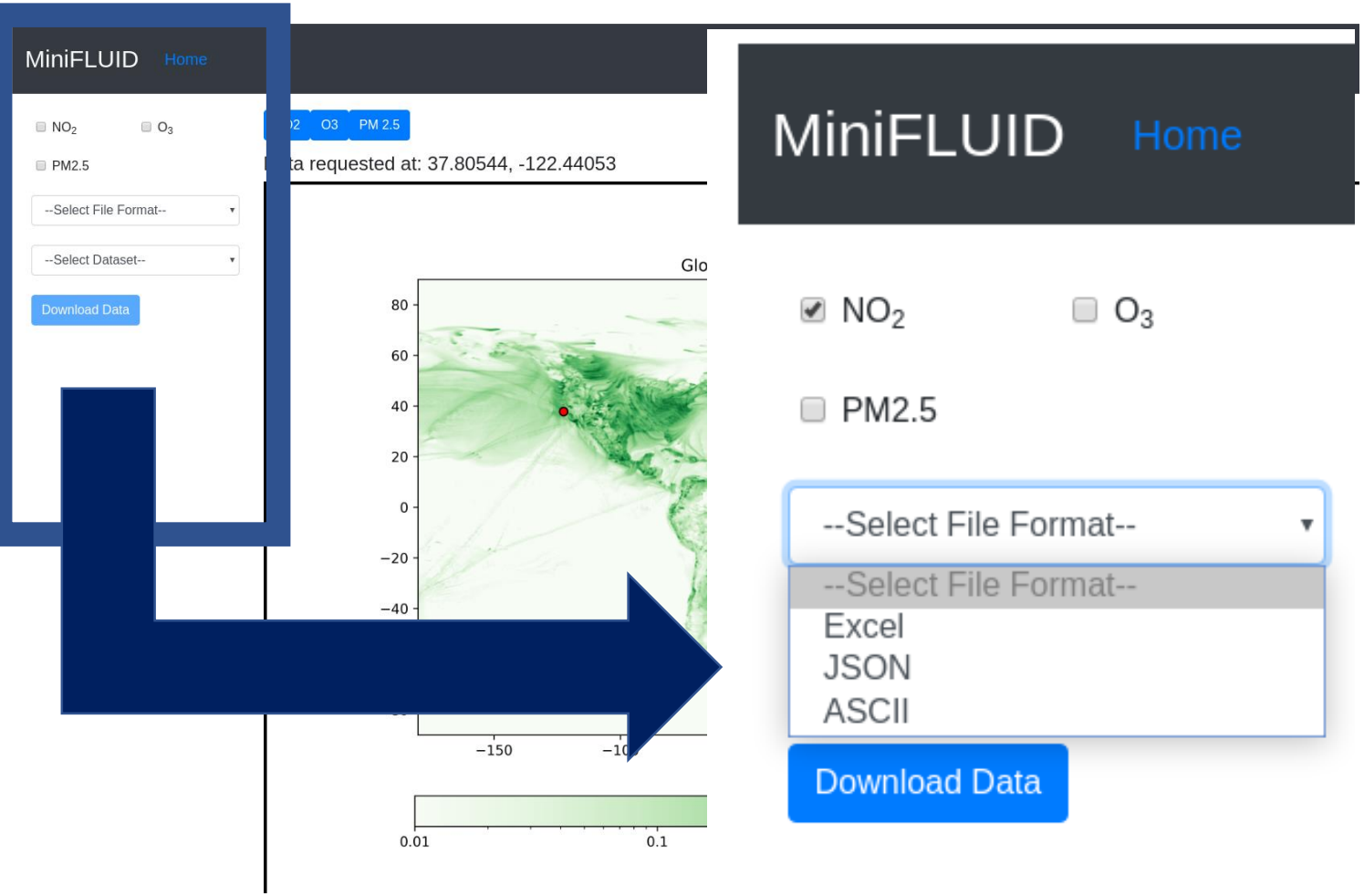

Download Data in 3 user-friendly formats

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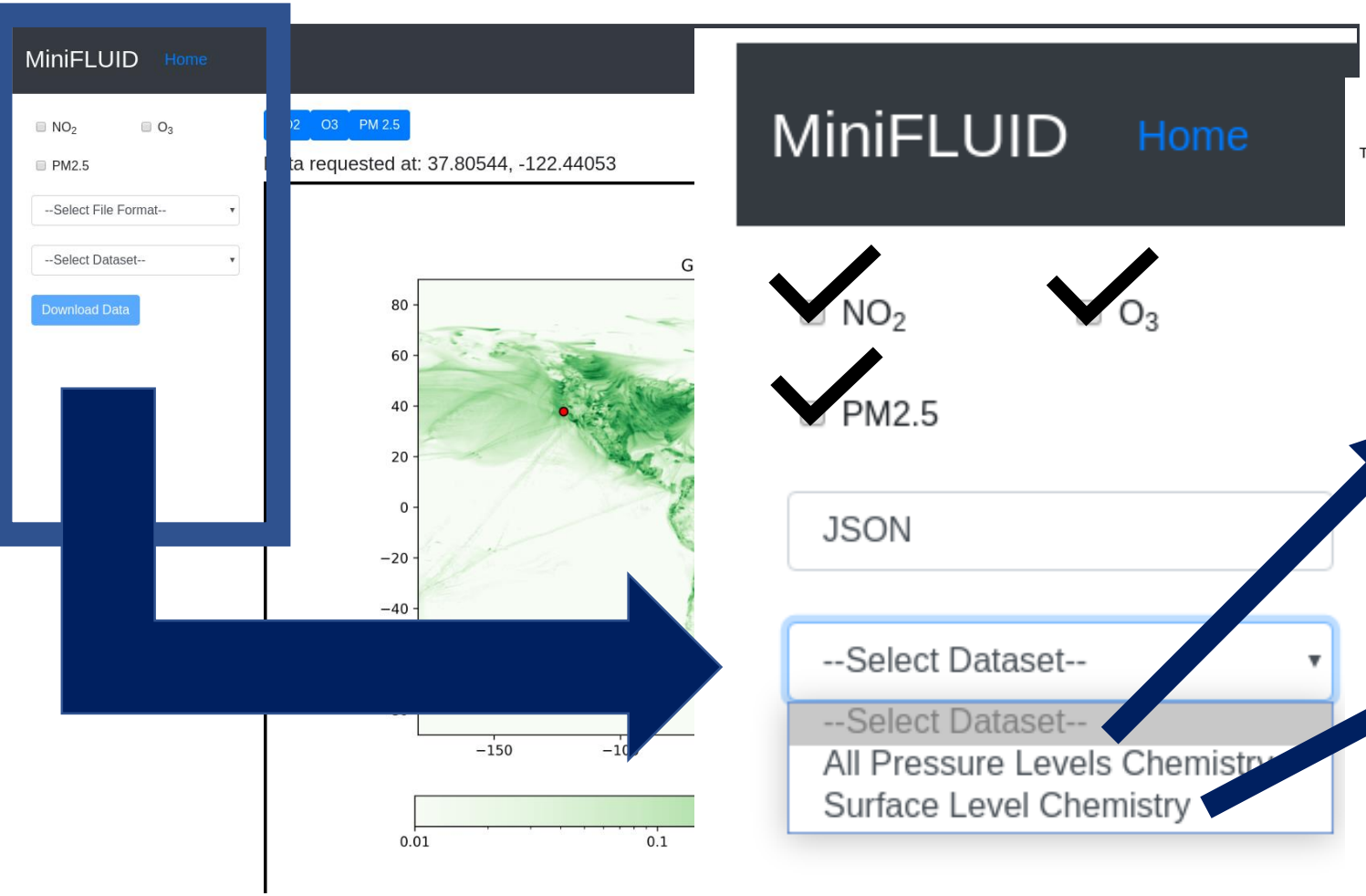

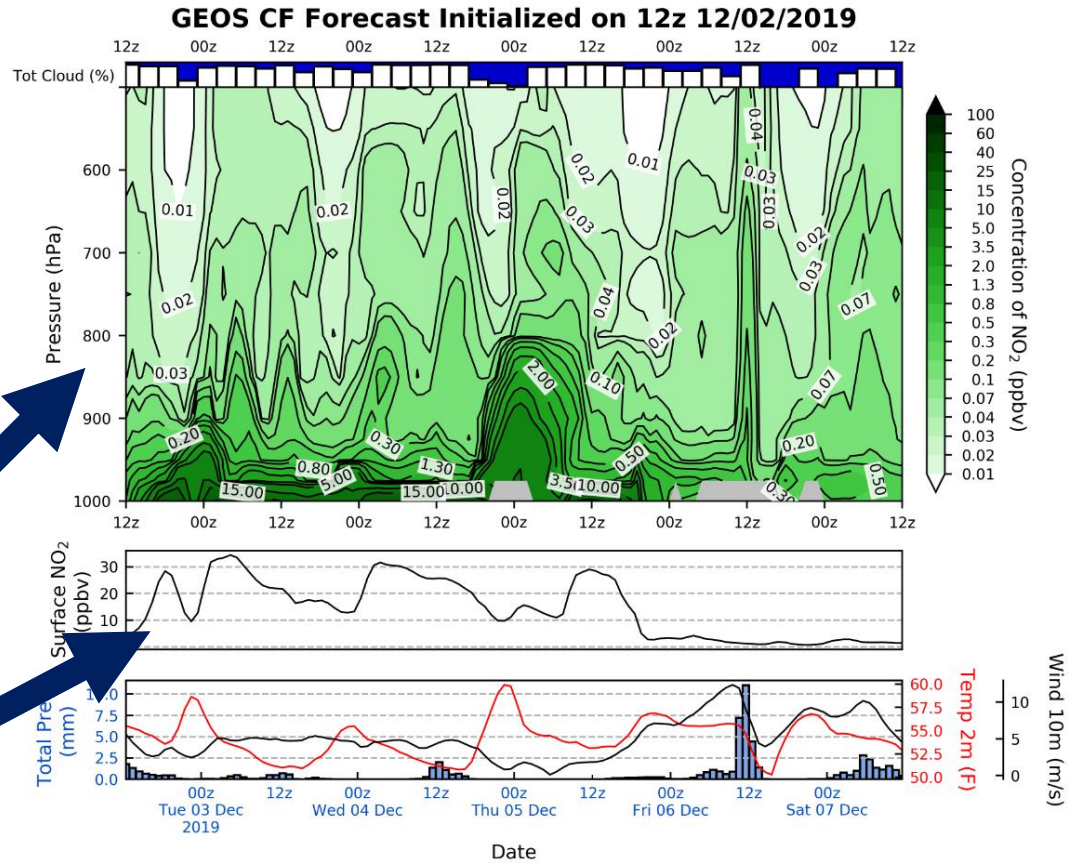

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What type of model output would be useful?

- Pressure or Height z-axis coordinate system
- Meteorological output: U, V, OMEGA, T, Q, Theta, Theta_e ??
- Chemistry output: Ozone, NO2, aerosols?

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Summary

- ✓ MERRA-2 is a high-resolution global reanalysis which can be used in scientific studies to identify SIs by both atmospheric dynamics and O_3
- ✓ GEOS-CF is suitable tool to support instrument teams measuring tropospheric and lower stratosphere composition
- ➢ Working on best approach to communicate SI potential to interested end-user groups.

Knowland, et al (2017). Stratospheric intrusion-influenced ozone air quality exceedances investigated in the NASA MERRA-2 reanalysis. GRL https://doi.org/10.1002/2017GL074532

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