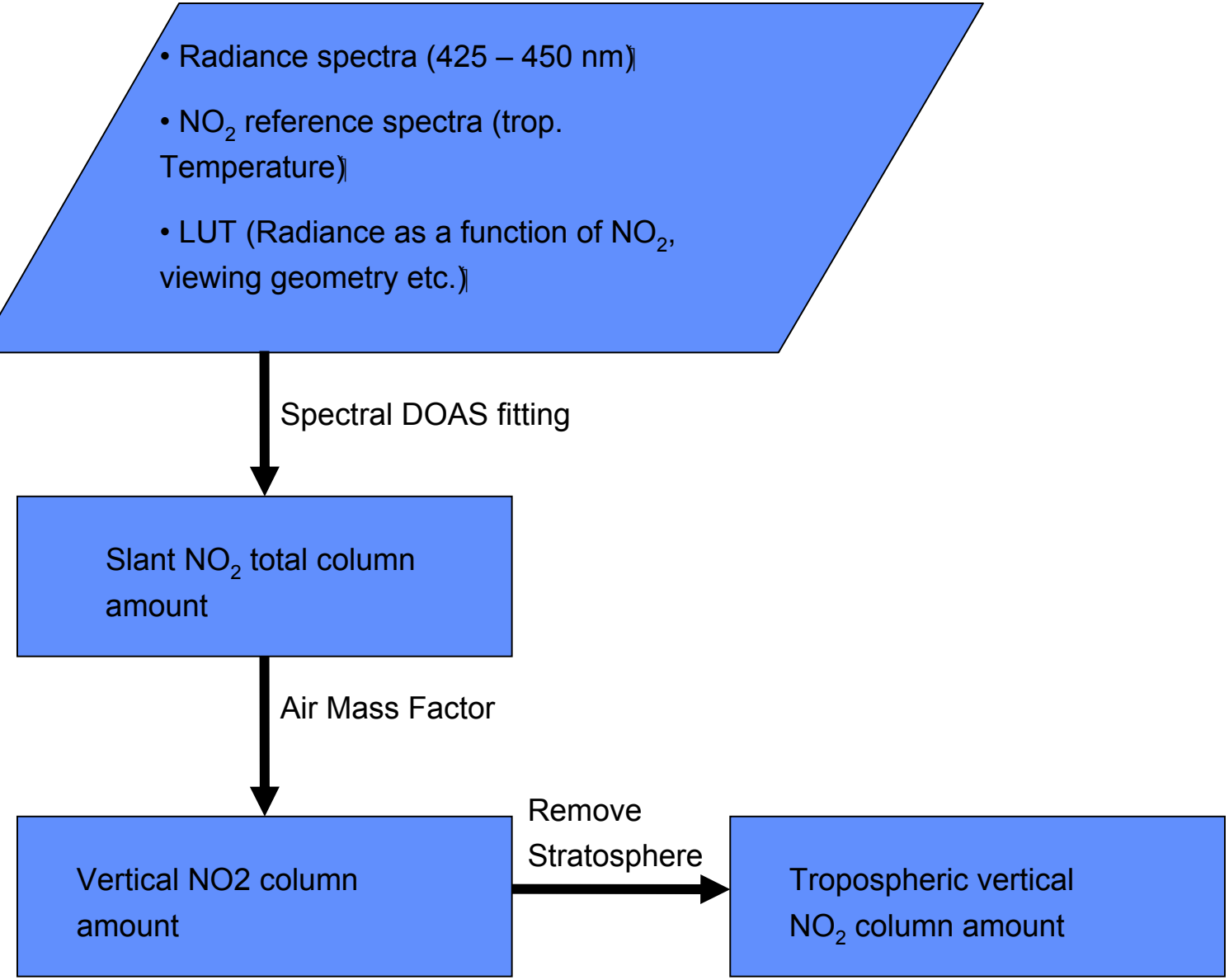
Tropospheric NO_2 Algorithm



Spectral Fitting

Measured radiance is fitted within the interval of 425nm to 450nm(Blue light).

Attenuation of the measured earthview signal contributed by optically active processes. We

e: *NO2, water vapor, raman scattering, o2-o2 dimer,*

ne(Chappuis band), Iodine Monoxide.

he fitting is a non-linear least squares parameter estimation routine. The *Elsunc* method ha

n implemented.

fitted parameters then give the slant column NO_2 within the mean photon path of the

ruments line of sight.

ther details on the spectroscopy and measurements are in the backup slides.

Air Mass Factor

e AMF converts the Slant column to the vertical column.

MF computation is inherently a Radiative Tranfer task.

$$AMF = N_{Slant} / N_{Vertical}$$

practice it is computed with RT assuming a vertical NO_2 profile(

lmer 2001). *m(z')* is the altitude resolved AMF, it is computed o

e with the *lidort* RT model and stored in a lookup table as a

nction of altitude, SZA, VZA, and Albedo.

$$M(z) = \frac{\int_z^\infty m(z')\ \alpha[T(z'), T_o]\ n(z')\ dz'}{\int_z^\infty n(z')\ dz'}$$

Air Mass Factor

Inputs to AMF calculation:

- Polluted Profile
- Unpolluted Profile
- Absorption cross section
- Monthly temperature profile climatology
- Radiative Transfer Lookup Tables.
- Cloud Fraction
- Cloud Top Height Pressure.

Cloud Information for AMF

- FAST Retrieval Scheme for Clouds from the Oxygen A band (FRESCO) developed by KNMI.
- Provides Cloud fraction, cloud top pressure, cloud top reflectiv
- FRESCO data is part of the L1B data stream. Provided in NR for each ground pixel.
- Uses 765nm to 775 nm spectral region(the Oxygen A-Band).
- Fallback to less accurate 360nm UV cloud fraction retrieval an cloud top pressure climatology.

MF for a partly cloudy pixel.

w is the cloud fraction. *Zc* is the cloud top height. *Z0* is the ground height.

$$M' = w\,M(z_c) + (1 - w)\,M(z$$

Computed AMF output Fields

AMFPolluted ----------

AMFPollutedClear ---------

AMFPollutedCloudy -------

AMFUnpolluted ------------

AMFUnpollutedClear -----

AMFUnpollutedCloudy ---

tropFractionUnpolluted ----

------AMFPollutedStd

------AMFPollutedClearStd

------AMFPollutedCloudyStd

------AMFUnpollutedClearStd

------AMFUnpollutedCloudyStd

------AMFUnpollutedStd

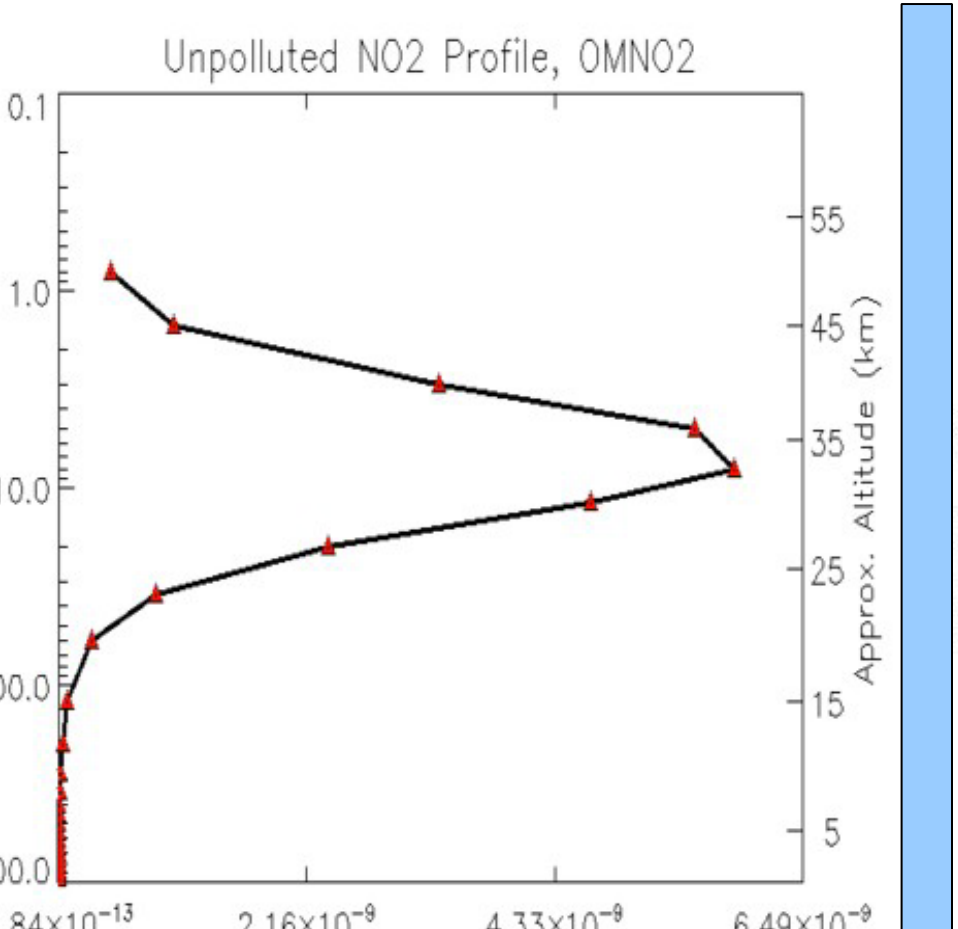
------tropFractionUnpollutedStd

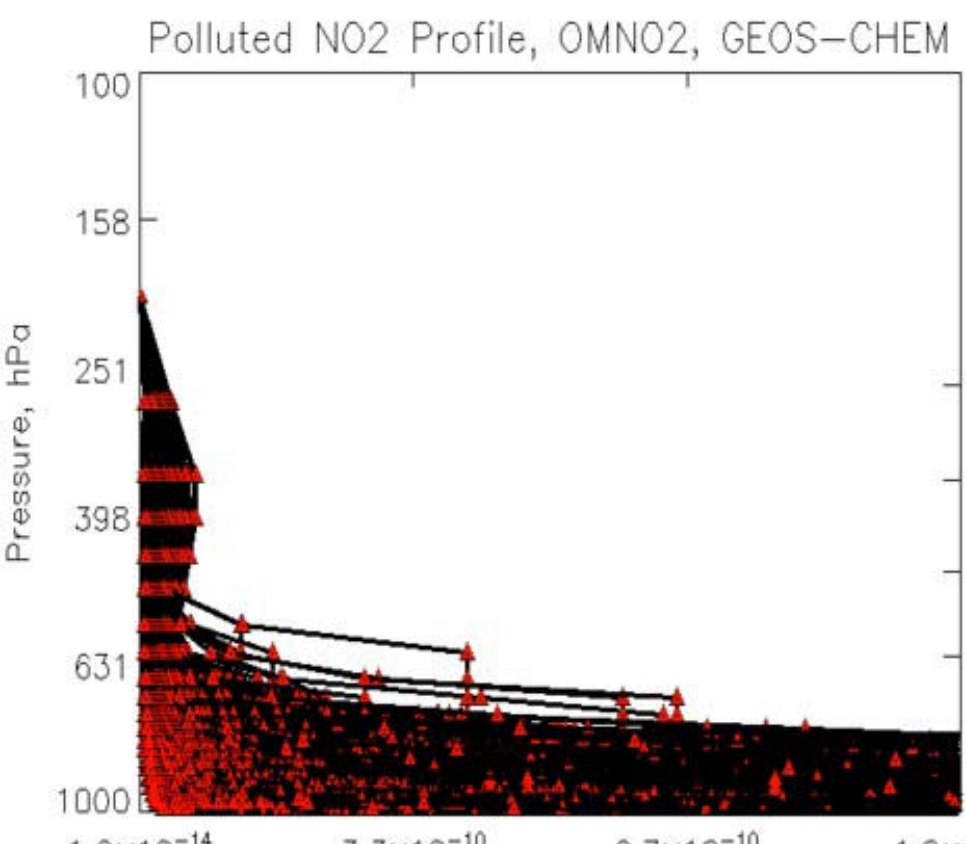
Where Std indicates Standard Deviation

MFQualityFlags

Unpolluted and Polluted Profiles

rofile shape is determined from climatology. For a polluted scene the assumed ofile shape is the sum of a stratospheric profile and a predetermined polluted ofile(derived from GEOS-CHEM).





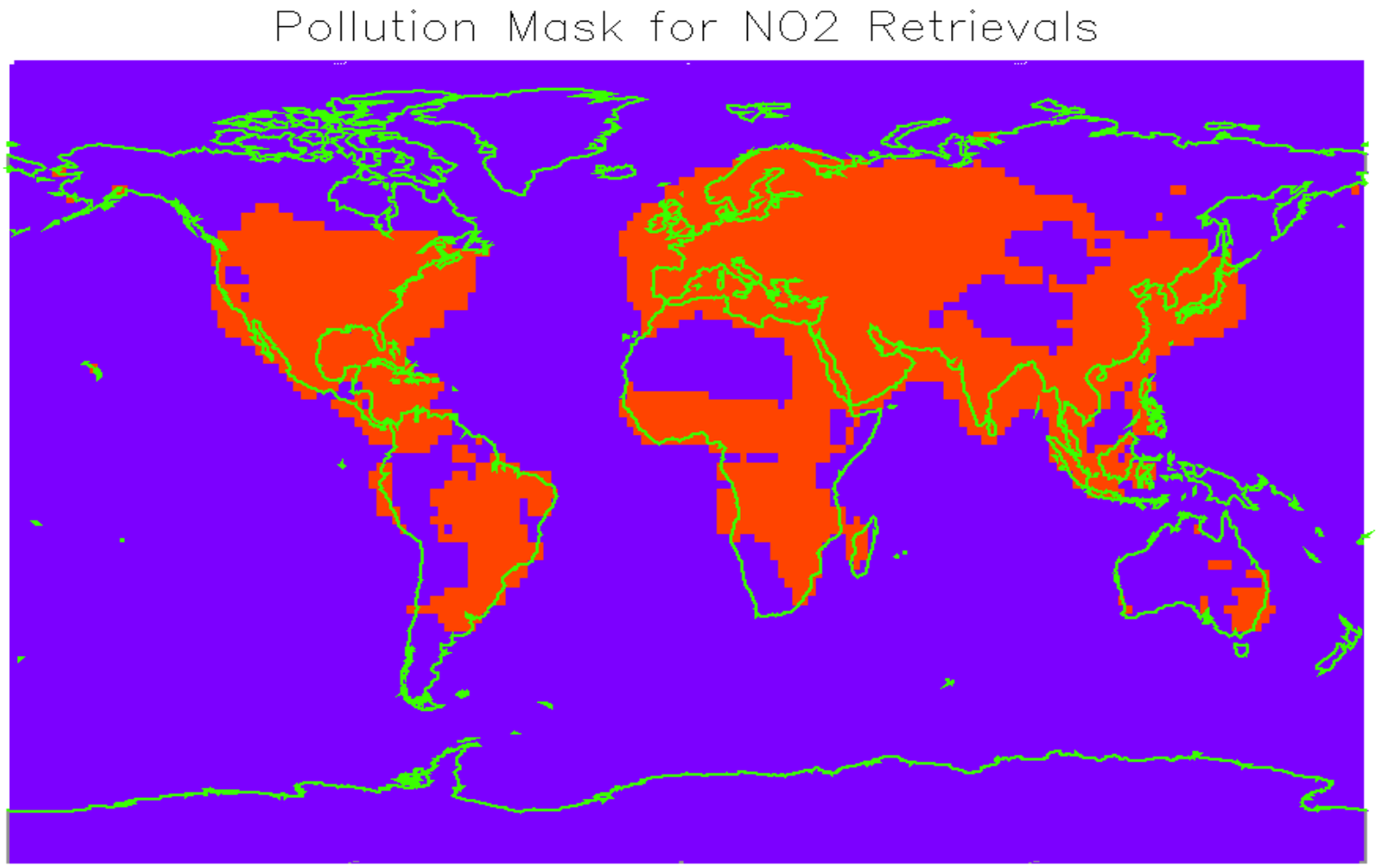
Tropospheric Computation

O2 Vertical Column Observations on 1˚x1˚grid.

Requires approximately one day of data.

Us

Po



Tropospheric Computation

Computes background unpolluted NO2 field.

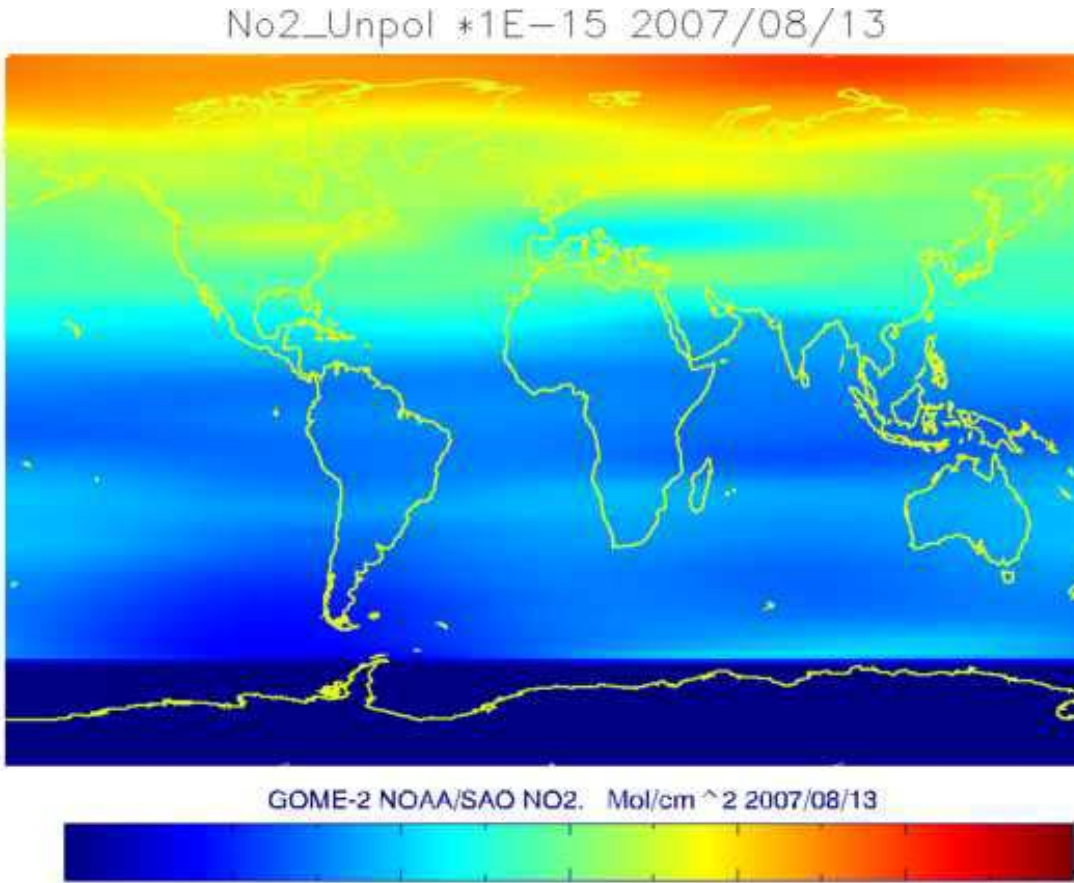
- Gridded total column no2 values are low pass filtered using fourier decomposition. Wave0, wave and wave2.
- Use LAPACK General Gauss-Markov Linear regression numerical routine: GGGLM( ).
- Fitting uses error estimates. Missing values ignor by setting large error estimate.

p to this point in the algorithm we have computed:

- Total Column NO2
- Stratospheric background(unpolluted) NO2
- AMF for total, polluted and unpolluted.

e then identify polluted and unpolluted regions by comparing to the standard deviation of the zonal mean NO_2.

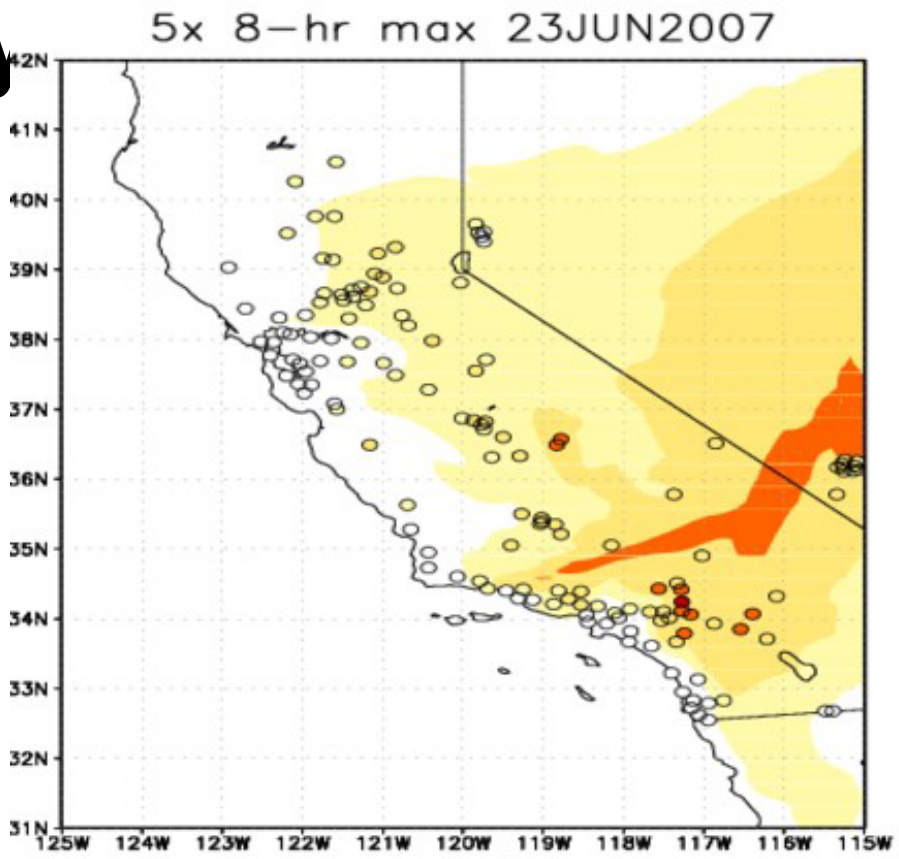
- Polluted pixels will use *AMFPolluted*.
- Unpolluted ground pixels will use *AMFUnpolluted.*



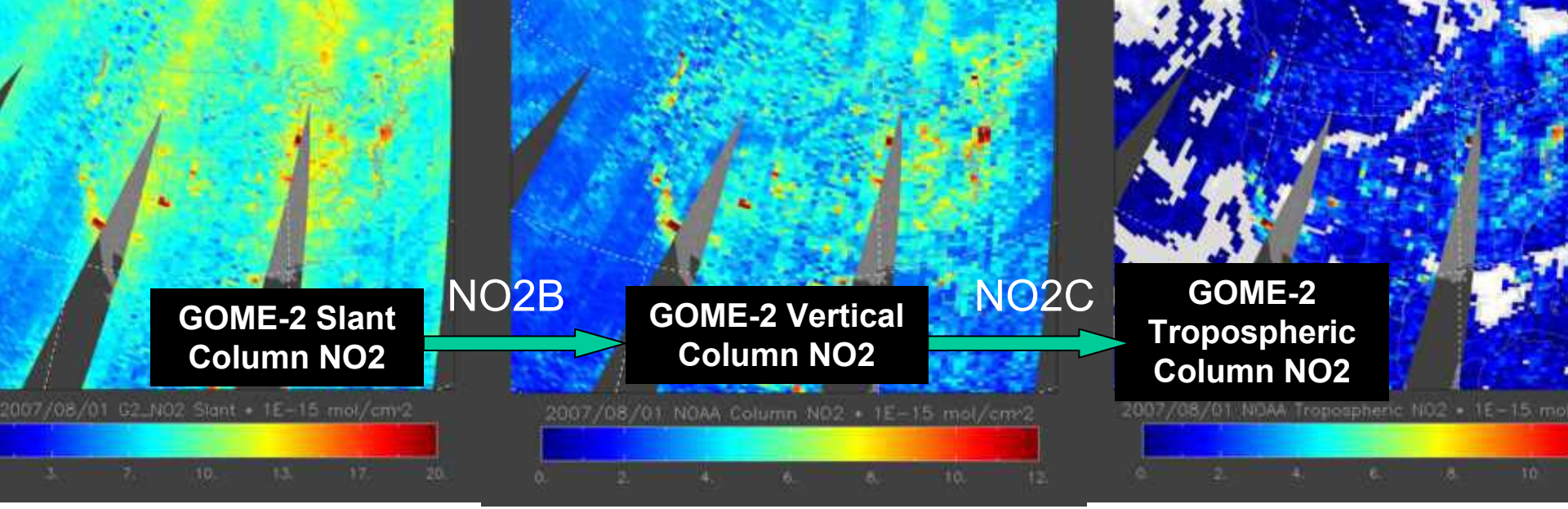
NCEP Air Quality Forecasting Sy

Evaluation of WRF-CMAQ NO2 predictions over CONUS

- **CMAQ urban area over-titration problem. Is there too much NOx in the model**



California Ozone Under-prediction problem



NOAA GOME-2/OMI NO2 Work

al: To process GOME-2 and OMI data with a common algorithm to study diurnal variations in tropospheric
2 over

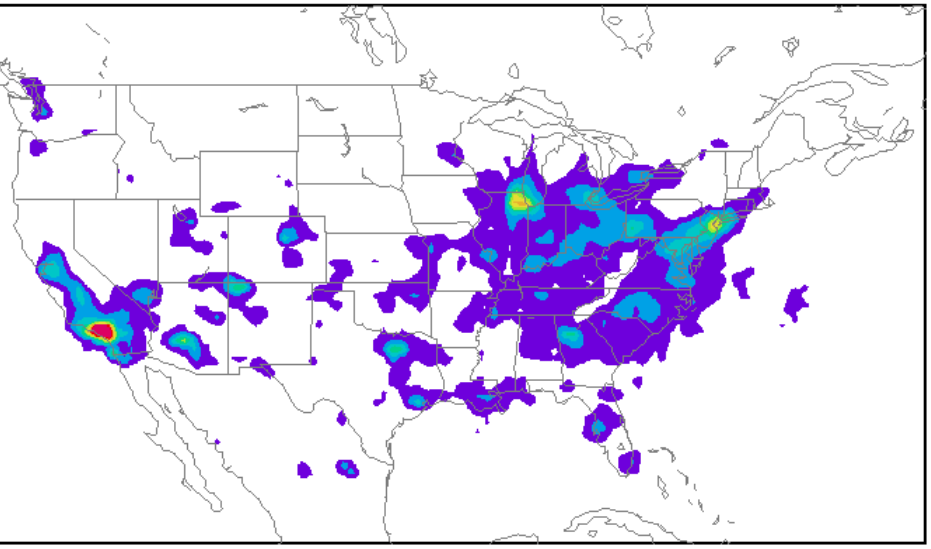
mmon Algorithm: Harvard SAO GOME slant column NO2 algorithm modified to run on both GOME-2 and
II. NASA GSFC OMI NO2B and NO2C algorithms to convert slant column NO2 to vertical column density and
noving stratospheric NO2 from total column to obtain tropospheric NO2 amount

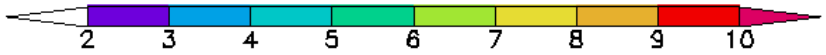
gress: (1) Test processing of the common algorithm on GOME-2 data for August 2007 complete, (2) Test
cessing of the common algorithm on OMI data for August 2007 underway

going and future work: (1) Optimize the algorithm (e.g., surface reflectivity database, NO2 cross sections, *a*
ori profiles), (2) conduct spatio-temporal analysis and verification of GOME-2 and OMI NO2 retrievals for
mmer 2007, (3) compare GOME-2 and OMI NO2 retrievals with NWS operational CMAQ NO2 predictions

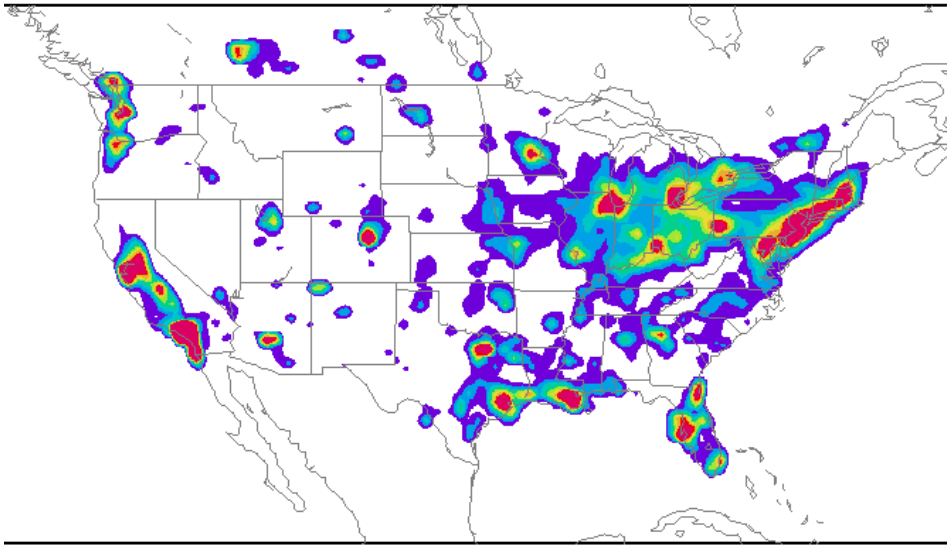
er applications: Work with state environmental agencies (e.g., NYDEC) in using OMI and GOME-2 NO2
ducts in SIP (State Implementation Planning) modeling

GOME2 NO2 Weekday 10**15 molec/cm**2

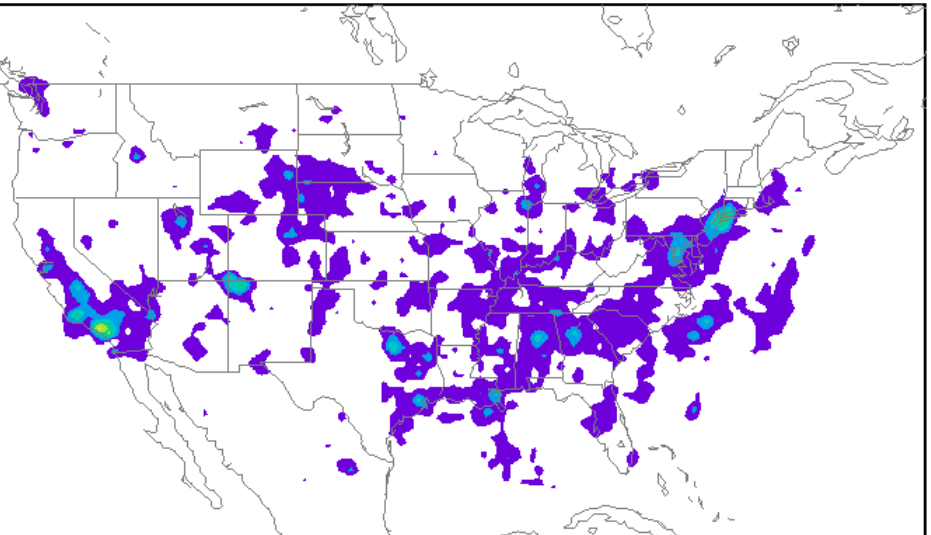




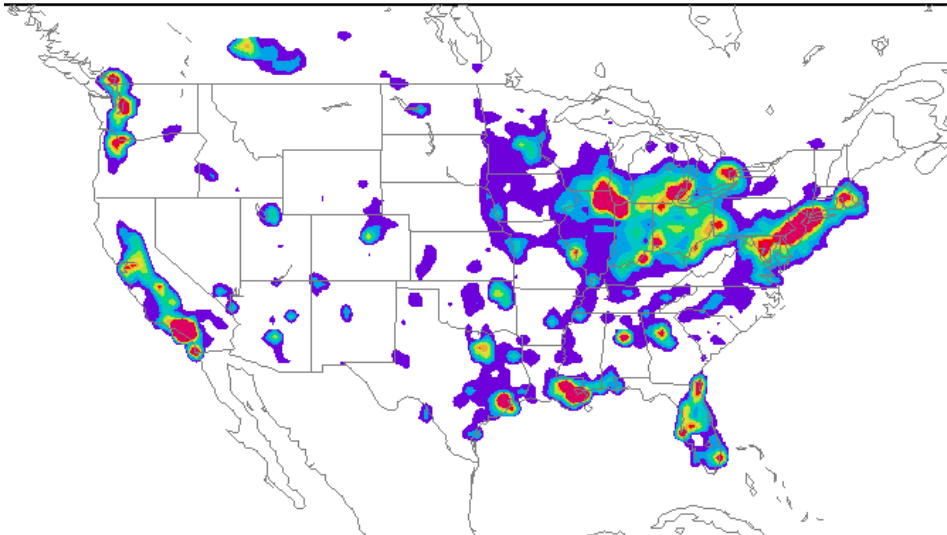
CMAQ NOx Weekday 10**15 molec/cm**2



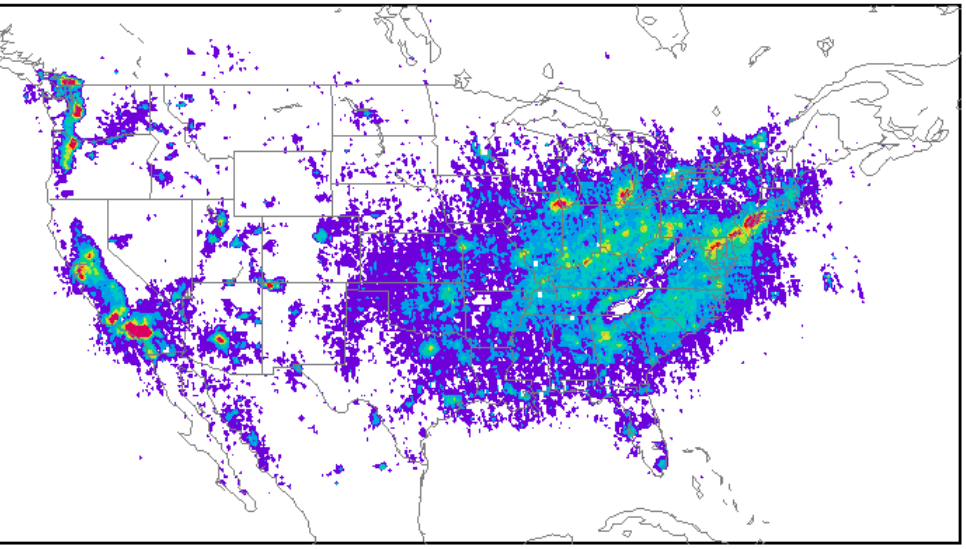
GOME2 NO2 Weekend 10**15 molec/cm**2



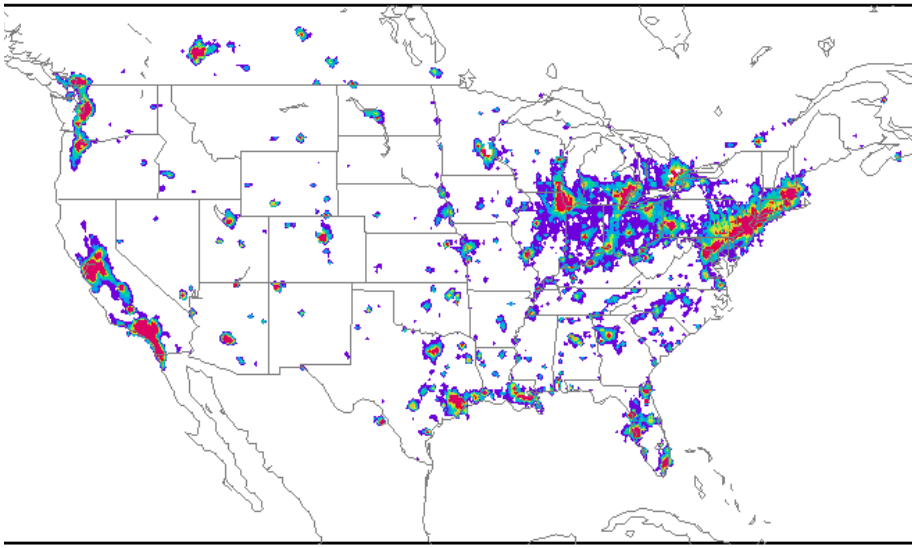
CMAQ NOx Weekend 10**15 molec/cm**2



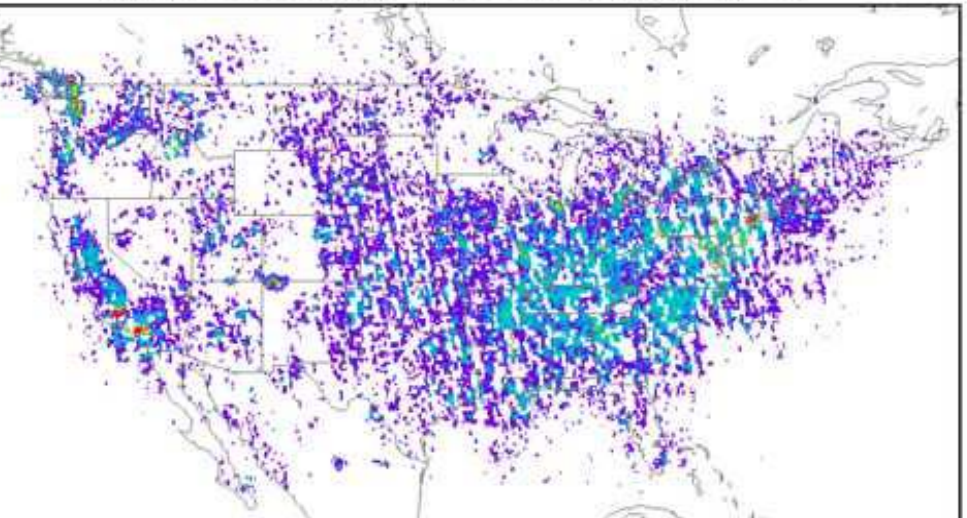
OMI NO2 Weekday 10**15 molec/cm**2



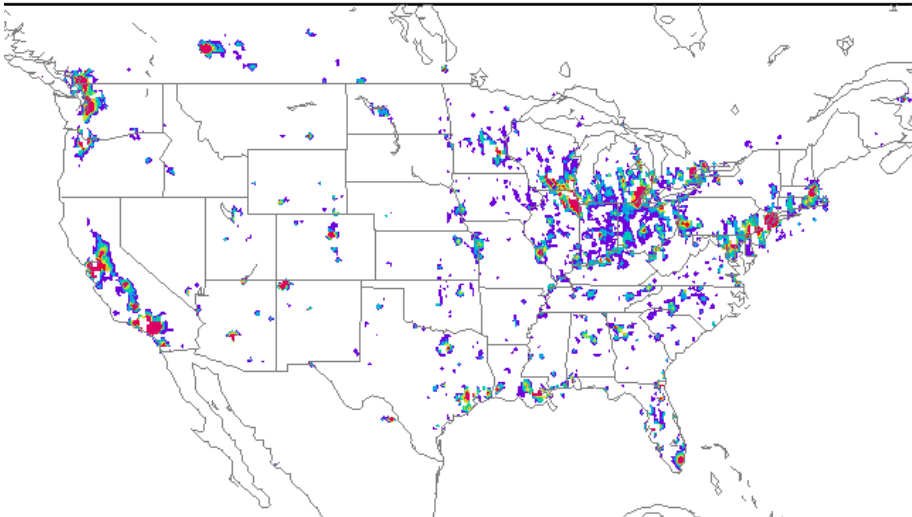
CMAQ NOx Weekday 10**15 molec/cm**2



OMI NO2 Weekend 10**15 molec/cm**2



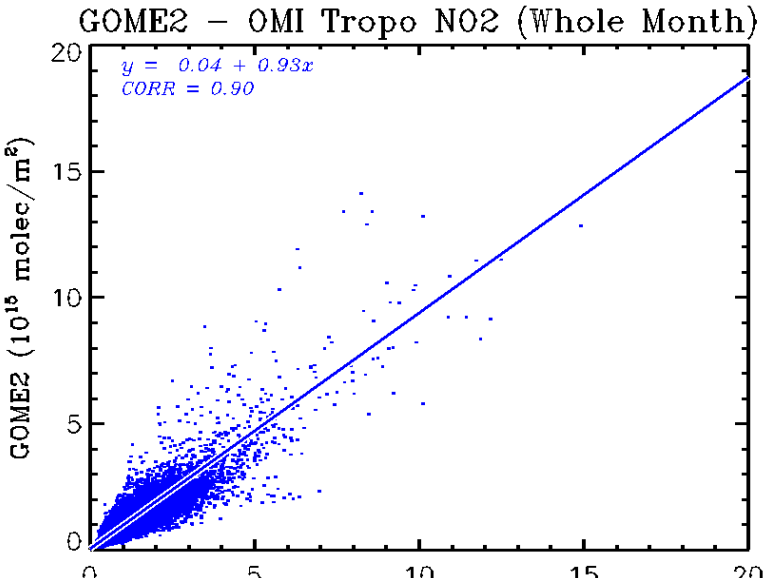
CMAQ NOx Weekend 10**15 molec/cm**2

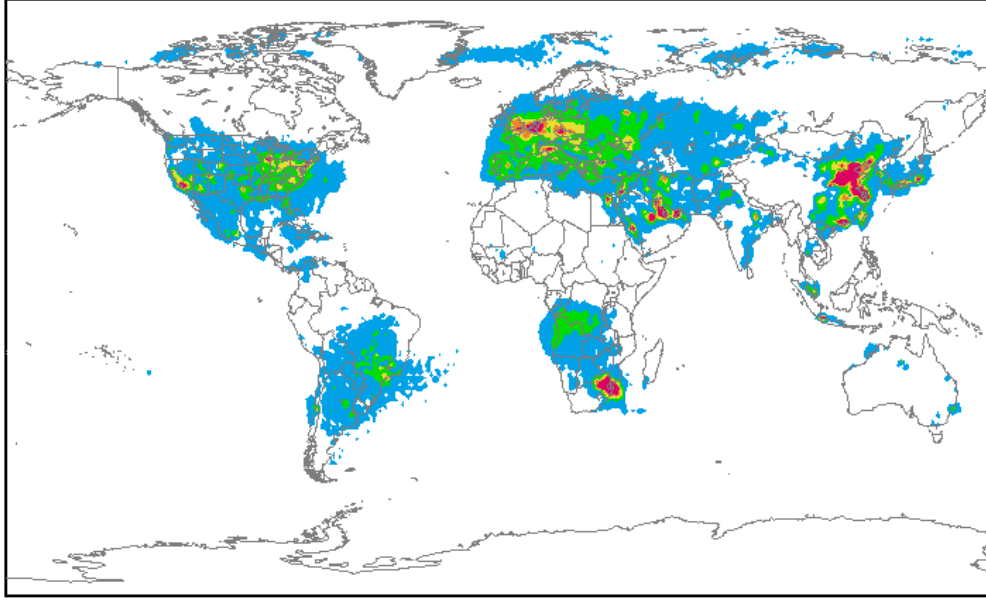


NO_2 Summary

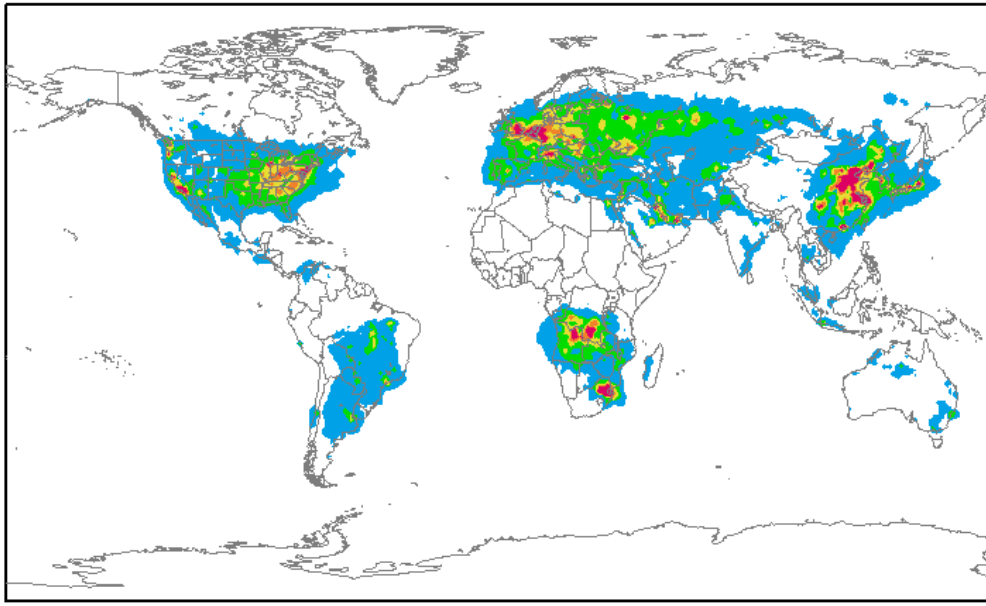
August 2007 monthly maps of GOME-2/OMI NO2, and NWS operational CMAQ tropospheric NOx show:

- OMI and GOME-2 show weekday vs weekend differences, whereas CMAQ differences are not that striking
- GOME-2 and OMI tropospheric NO2 amounts show similar features across the whole globe:





OMI NO2 Weekday 10**15 molec/cm**2



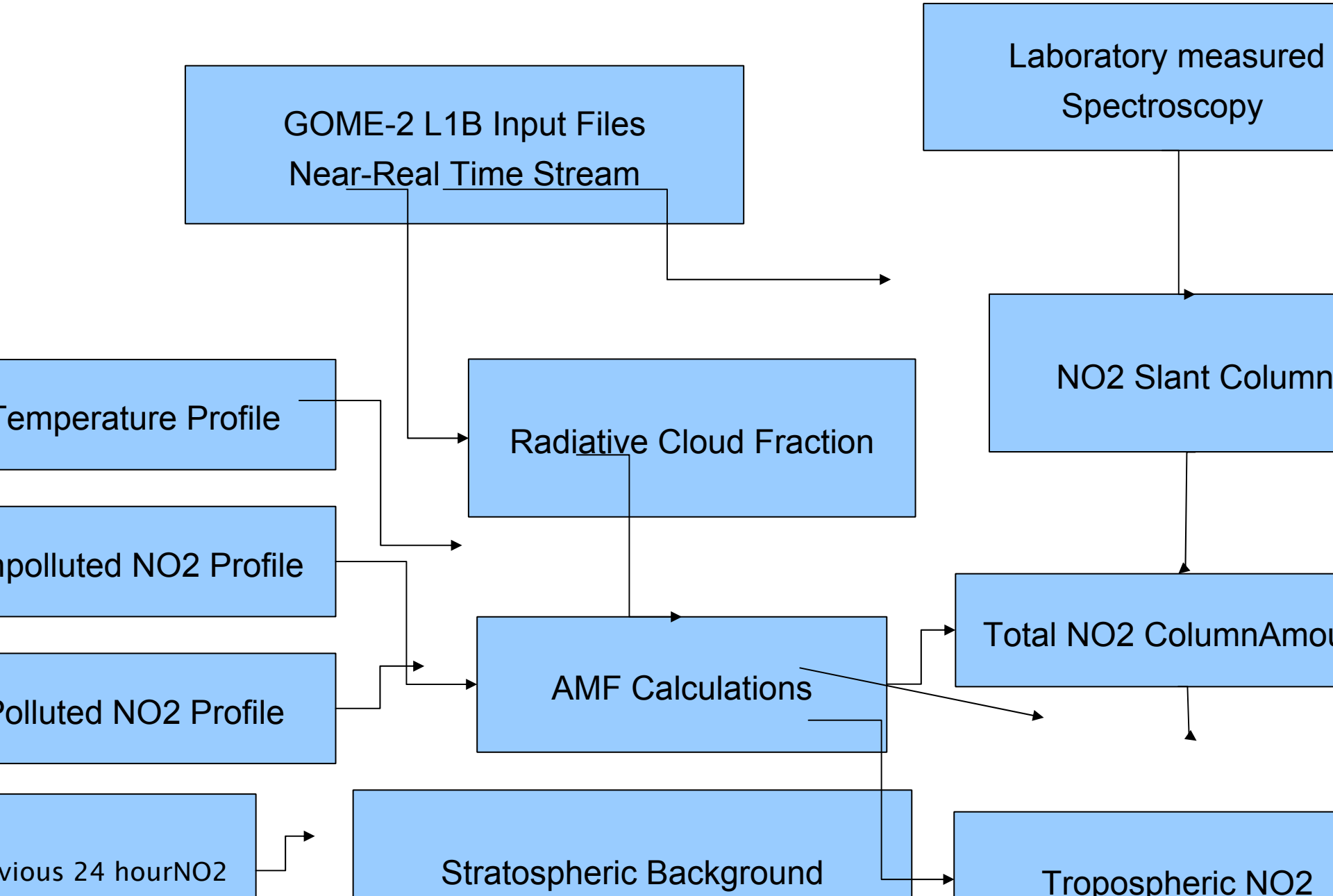
Tropospheric Computation

ith the status of the pixel being known as polluted or unpolluted the final applicatio
the appropriate AMF occurs and the data is written to the output file.

utput Fields for NO2 amount:

ColumnAmountNO2	ColumnAmountNO2Std
ColumnAmountNO2BelowCloud	ColumnAmountNO2BelowCloudStd
ColumnAmountNO2Polluted	ColumnAmountNO2PollutedStd
ColumnAmountNO2Trop	ColumnAmountNO2TropStd
ColumnAmountNO2Unpolluted	ColumnAmountNO2UnpollutedStd

Tropospheric NO2 Algorithm



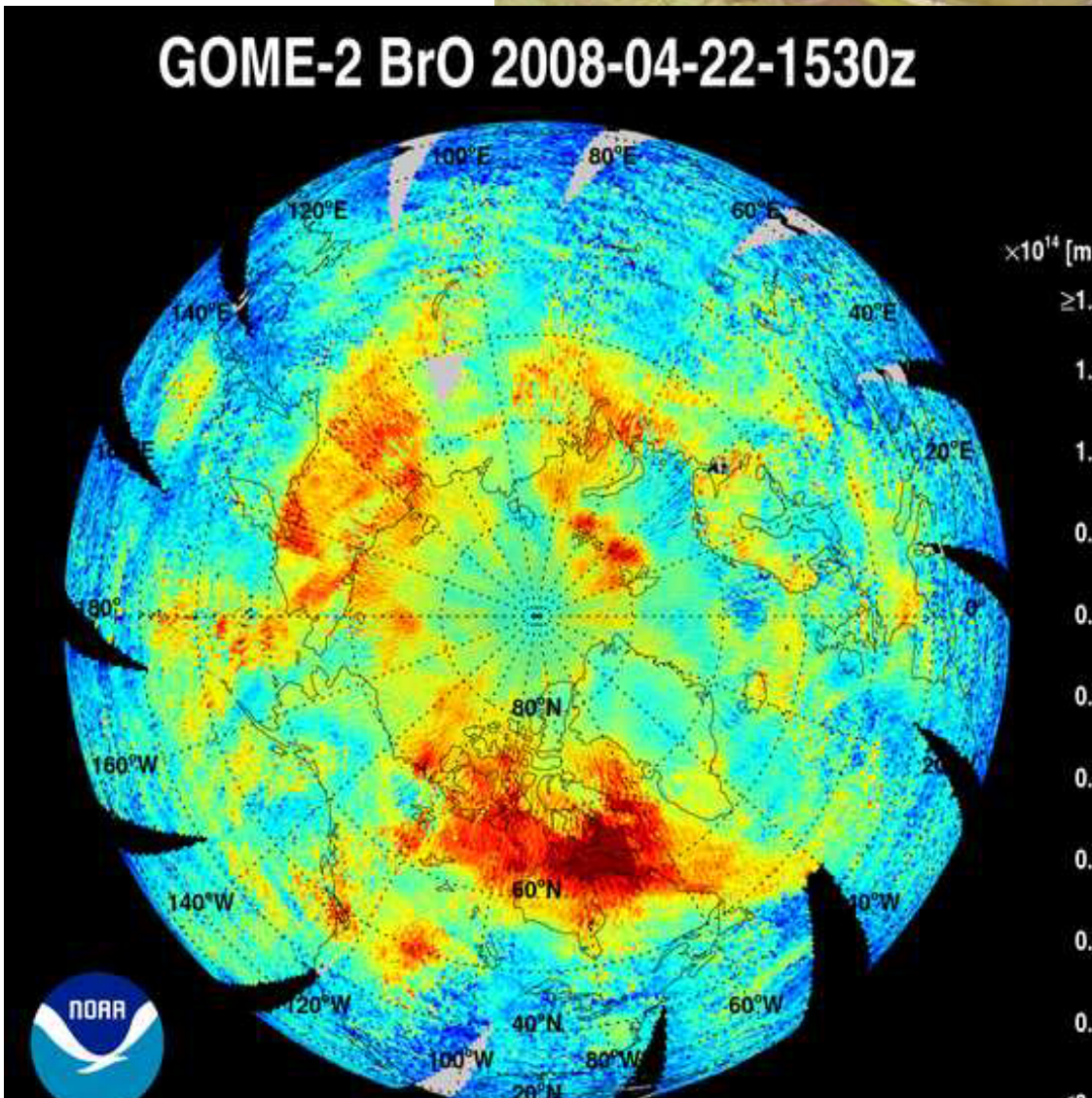
Future Plans

e have the opportunity to
retrievals from GOME-2
ta using the spectral fit
ethod for:

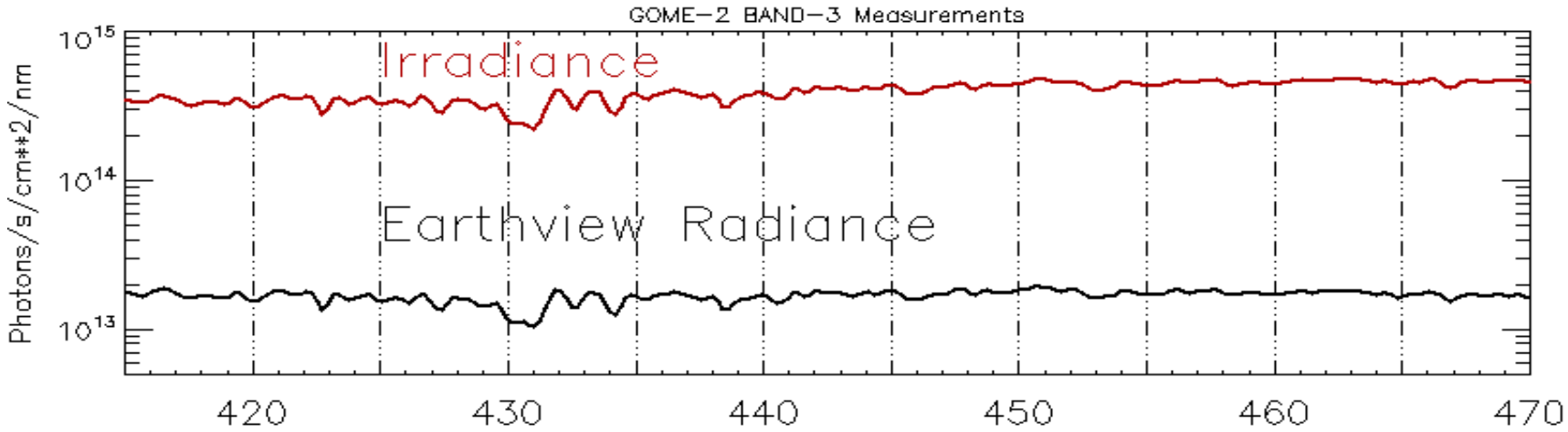
BrO Bromine Monoxide

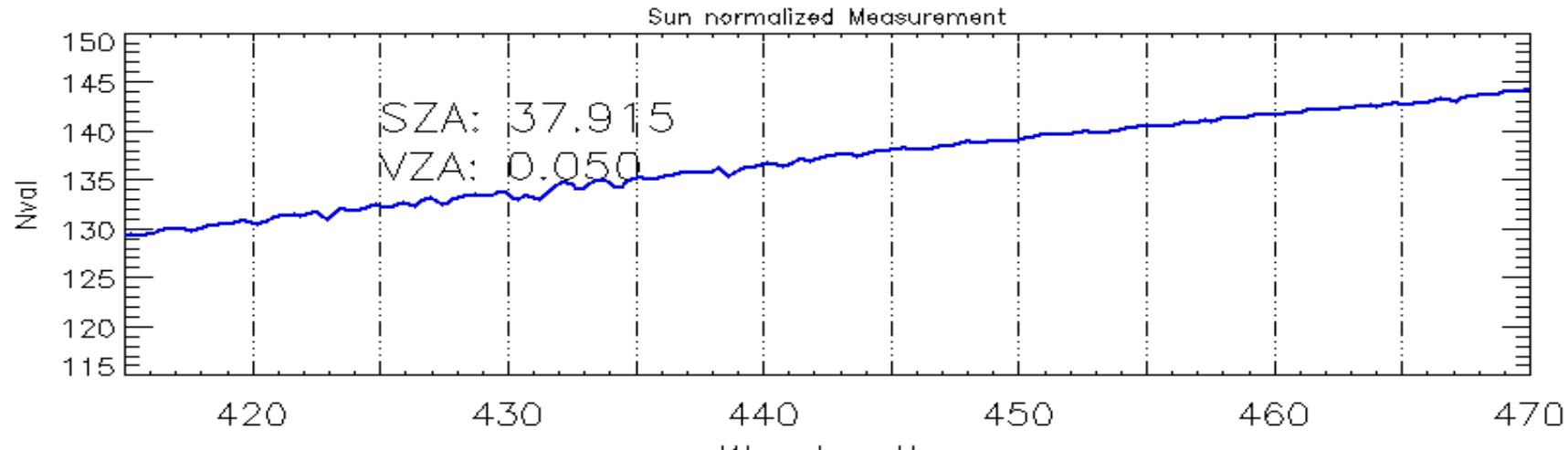
HCHO Formaldehyde

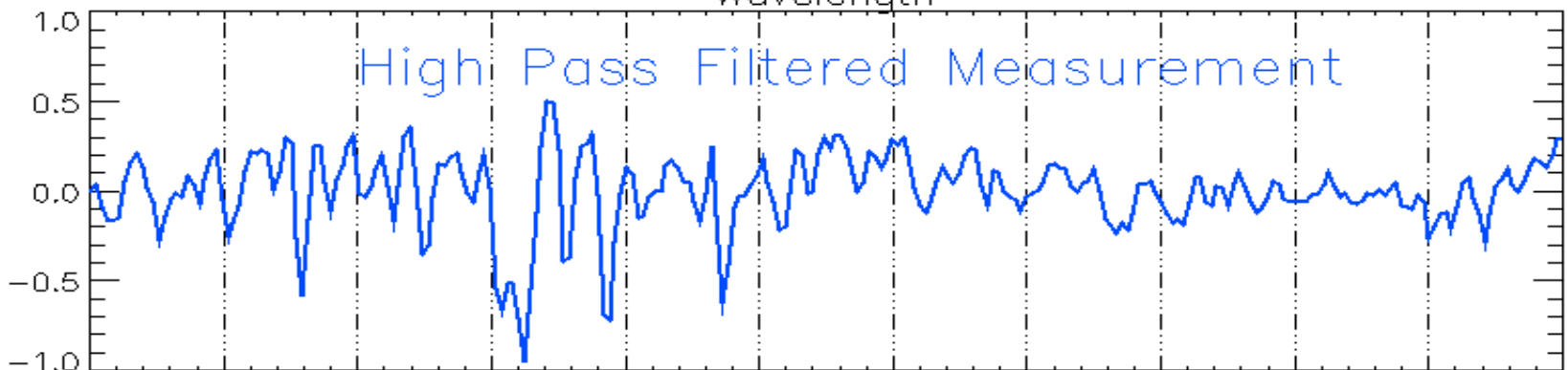
OClO Chlorine Dioxide



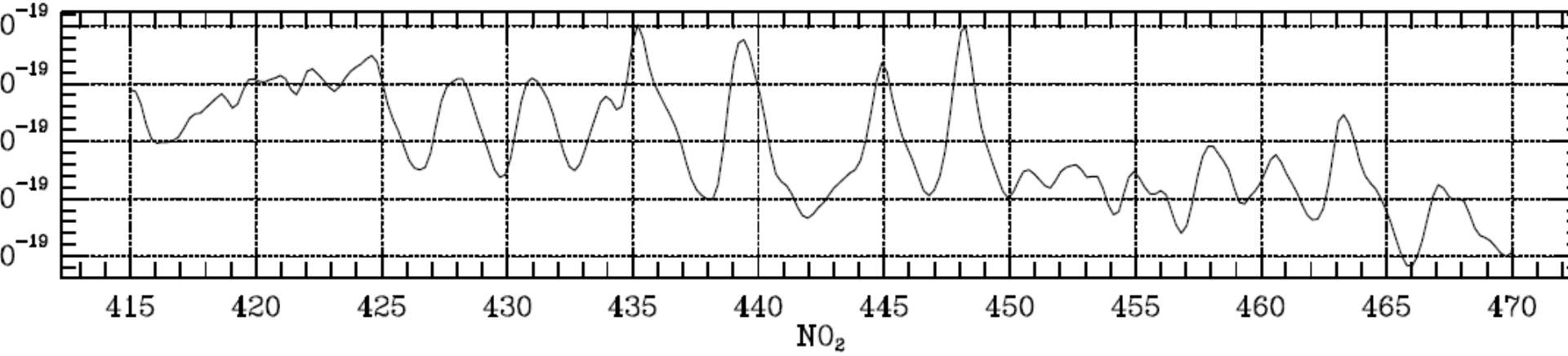
GOME-2 Example Measurement

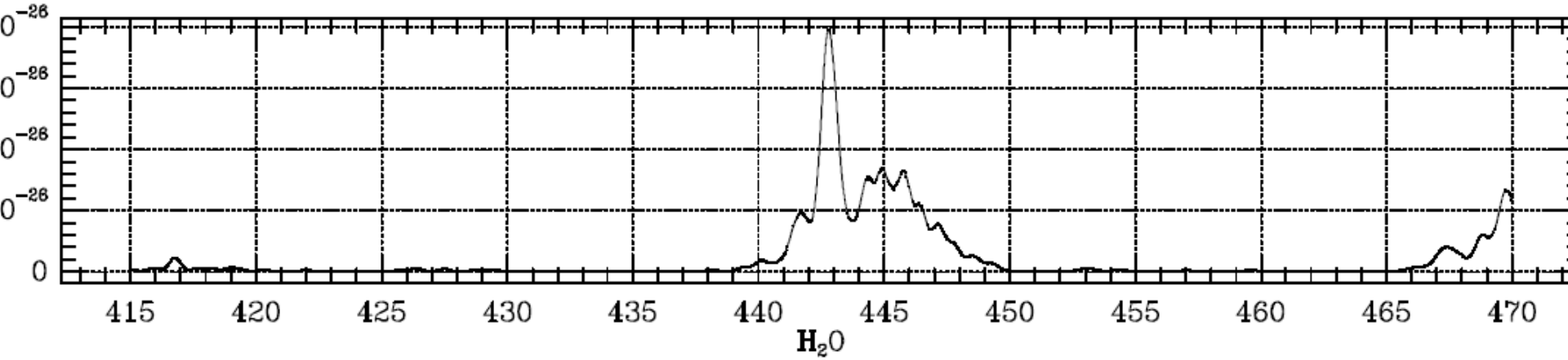


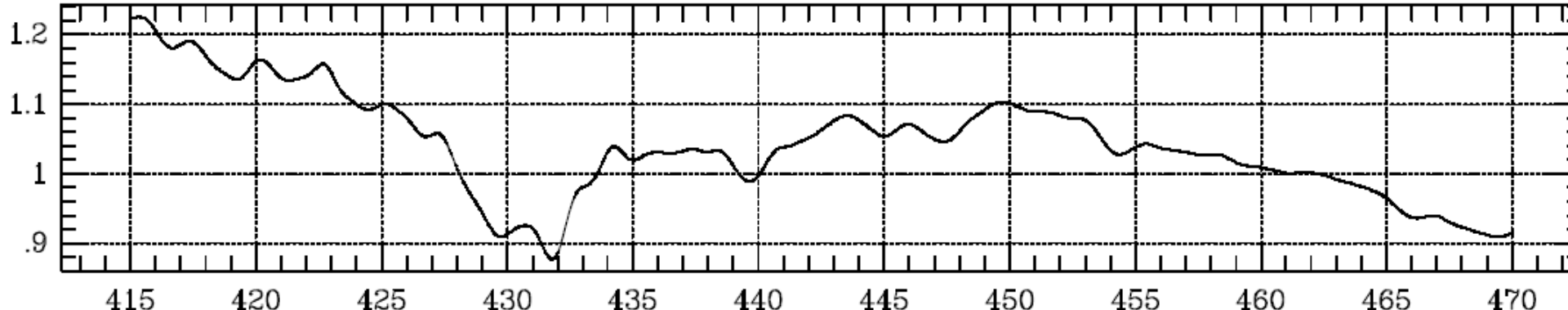




Spectral Fitting Basis Functions







Spectral Fitting Basis Functions