OMPS Products (S-NPP), JPSS-1, JPSS-2

- Operational Near-Real-Time Products (Reprocessing will produce Climate Data Record extensions)
  - Total Column Ozone, UV Absorbing Aerosol Index, Total Column SO\textsubscript{2}
    - (50x50) 17x17 km\textsuperscript{2} resolution at Nadir
    - Full coverage of the sunlit Earth once per day.
  - Nadir Ozone Profile
    - Nadir orbital track at (250x250) 50x250 km\textsuperscript{2} resolution
    - Vertical resolution from 7 to 10 km in the middle and upper stratosphere
  - Limb Ozone Profile (Only on S-NPP and JPSS-2)
    - Nadir orbital track with 150 km reporting
    - Vertical resolution of 3 km in the stratosphere

- Daily Global and Regional Products
  - Daily global maps for Total Column Ozone, UV Absorbing Aerosol Index & Effective UV reflectivity
  - OMPS Total Column SO\textsubscript{2} will be used in the hazards warning system in place of OMI
  - Ozone products are used to create UV Index Forecasts
    - https://www.epa.gov/sunsafety/uv-index-1
  - Limb Ozone products are used to create orbital profile curtain plots

- Research products
  - OMPS Nadir Mapper total column and tropospheric NO\textsubscript{2}
  - OMPS Nadir Profiler daily Mg II Index
  - OMPS Limb Profiler stratospheric aerosol profile
Sample Plots
More Sample Plots

Dust from the Russian Chelyabinsk Meteor

From a talk by Nick Gorkavyi
OMPS UV Absorbing Aerosol Index in high resolution mode.
Other BUV Instruments

- NOAA has access to the MetOP GOME-2 measurements and products
  - https://atmos.eoc.dlr.de/gome/product.html
- NOAA will have access to the TEMPO products (US GEO)
- NOAA will have access to the TROPOMI products.

**HCHO**
Formaldehyde total column

<table>
<thead>
<tr>
<th>Acquisition Time</th>
<th>Sensor</th>
<th>Plot Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 NOV 2016 23:02:55</td>
<td>GOME-2</td>
<td>0.0 : 321.5</td>
</tr>
<tr>
<td>17 NOV 2016 20:05:56</td>
<td>MetOp-AB</td>
<td>11.2 ± 10.6</td>
</tr>
</tbody>
</table>

**NO₂ TROPO**
Nitrogen Dioxide tropospheric

<table>
<thead>
<tr>
<th>Acquisition Time</th>
<th>Sensor</th>
<th>Plot Range</th>
<th>Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 NOV 2016 23:02:55</td>
<td>GOME-2</td>
<td>0.0 : 63.5</td>
<td>GDP 4.8</td>
</tr>
<tr>
<td>17 NOV 2016 20:05:56</td>
<td>MetOp-AB</td>
<td>1.1 ± 1.8</td>
<td>UPAS 1.3.9</td>
</tr>
</tbody>
</table>
Table D.2-3 TEMPO STM\(^1\) clearly links science questions with instrument and investigation requirements.

<table>
<thead>
<tr>
<th>Science Questions</th>
<th>Science Objective</th>
<th>Science Measurement Requirement</th>
<th>Instrument Function Requirements</th>
<th>Investigation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. What are the temporal and spatial variations of emissions of gases and aerosols important for AQ and climate?</td>
<td>- High temporal resolution measurements to capture changes in pollutant gas distributions. - High spatial resolution measurements that sense urban scale pollutant gases across GNA and surrounding areas. - Measurement of major elements in tropospheric O(_2) chemistry cycle, including multispectral measurements to improve sensing of lower-tropospheric O(_2), with precision to clearly distinguish pollutants from background levels.</td>
<td>Spatially imaged &amp; spectrally resolved, solar backscattered earth radiance, spanning spectral windows suitable for retrievals of O(_3), NO(_2), H(_2)O, SO(_2), and NO(_2) at spatial scales comparable to regional atmospheric chemistry models.</td>
<td>Relevant absorption bands for trace gases &amp; windows for aerosols</td>
<td>1-year mission lifetime (minimum)</td>
</tr>
<tr>
<td>Q2. How do physical, chemical, and dynamical processes determine tropospheric composition and AQ over scales ranging from urban to continental, diurnally to seasonally?</td>
<td>Multispectral in suitable O(_2) absorption bands to provide vertical distribution information.</td>
<td>Spectral radiance measurements with suitable quality (SNR) to provide multiple measurements over daylight hours for solar zenith angle &lt; 70(^\circ).</td>
<td>Baseline Trace gas column densities (10(^{-6}) cm(^{-2})), unless noted, hourly @ 8&lt;4.5 km(^2).</td>
<td></td>
</tr>
<tr>
<td>Q3. How do episodic events affect atmospheric composition and AQ?</td>
<td>- Observe aerosol optical properties with high temporal and spatial resolution for quantifying and tracking evolution of aerosol loading.</td>
<td>Spatially imaged, wavelength dependence of atmospheric reflectance spectrum for solar zenith angles &lt;70(^\circ).</td>
<td>Baseline Aerosol/Cloud properties hourly @ 8&lt;4.5 km(^2).</td>
<td></td>
</tr>
<tr>
<td>Q4. How does AQ drive climate forcing and climate change affect AQ on a continental scale?</td>
<td>- Determine the instantaneous radiative forcings associated with O(_2) and aerosols on the continental scale.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q5. How can observations from space improve AQ forecasts and assessments for societal benefit?</td>
<td>- Integrate observations from TEMPO and other platforms into models to improve representation of processes in the models and construct an enhanced observing system.</td>
<td>No additional observable requirements</td>
<td>No additional physical requirements</td>
<td>Albedo Calibration</td>
</tr>
<tr>
<td>Q6. How does intercontinental transport affect AQ?</td>
<td>- Quantify the flow of pollutants across continental boundaries; Join a global observing system.</td>
<td>No additional observable requirements</td>
<td>No additional physical requirements</td>
<td>AOD(^a) Precision: 0.05 354, 388 nm 1000 1596 AOD(^a) Precision: 0.03 346,354 nm 600 1008 Albedo Calibration</td>
</tr>
</tbody>
</table>

\(^{1}\) FT=Free Troposphere (2km-tropopause), SOC=Stratospheric Ozone Column, AOD=Aerosol optical depth, AAOD=Aerosol absorption optical depth, AI=Aerosol index, CF=Cloud Fraction & CTP=Cloud Top Pressure, Albedo=Radiance/Irradiance, FOR=Field Of Regard, IFOV=Instantaneous Field of View, GSD=Ground Sample Distance. * Projected to 36.5°N,100°W from GEO 100°W. # Threshold Products at 8<9km\(^2\) and 80-minute intervals instead of hourly.
### S5P TROPOMI Level-2 Products (operational)

<table>
<thead>
<tr>
<th>Species</th>
<th>Characteristics</th>
<th>expected accuracies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone -O3</td>
<td>vertical profile</td>
<td>10-30 % (6 km res.)</td>
</tr>
<tr>
<td></td>
<td>total column</td>
<td>3.5 –5 %</td>
</tr>
<tr>
<td></td>
<td>tropospheric column</td>
<td>25%</td>
</tr>
<tr>
<td>Nitrogen dioxide -NO2</td>
<td>total column</td>
<td>&lt;10%</td>
</tr>
<tr>
<td></td>
<td>tropospheric column</td>
<td>25-50%</td>
</tr>
<tr>
<td>Sulphur dioxide-SO2</td>
<td>SO2enhanced</td>
<td>30 %</td>
</tr>
<tr>
<td></td>
<td>total column</td>
<td>30 –50 %</td>
</tr>
<tr>
<td>Formaldehyde-HCHO</td>
<td>total column</td>
<td>40 –80 %</td>
</tr>
<tr>
<td>Methane-CH4</td>
<td>total column</td>
<td>1.5 %</td>
</tr>
<tr>
<td>Carbon monoxide -CO</td>
<td>total column</td>
<td>&lt;15%</td>
</tr>
<tr>
<td>Cloud</td>
<td>optical depth, fraction, height</td>
<td>&lt;20 % (all parameters)</td>
</tr>
<tr>
<td>Aerosol</td>
<td>UV absorption index~1 AAI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>layer height</td>
<td>&lt; 100 hPa</td>
</tr>
<tr>
<td>Surface UV</td>
<td>spectral irradiance, UV index</td>
<td>TBD</td>
</tr>
</tbody>
</table>
JPSS and GOES-R Atmospheric Chemistry/Composition Product Capabilities

Prepared by Shobha Kondragunta and Lawrence E. Flynn
NESDIS/Center for Satellite Applications and Research

NESDIS-AC4 Meeting
October 19, 2016
NESDIS Satellite Products Relevant to Atmospheric Chemistry and Climate

**SNPP and JPSS**
- Aerosol Optical Depth
- Aerosol Detection
  - Dust, smoke, volcanic ash
- Ozone, SO2, (NO2)
- SO2, N2O, CH4, CO, CO2, Nitric Acid
- Fire hot spots
- Fire emissions
- Fire burned area

**GOES-R**
- Aerosol Optical Depth
- Aerosol Detection
  - Dust, smoke, volcanic ash
- Ozone at 10% accuracy
  - *probably not very useful*
- Fire hot spots
- Fire emissions
- Fire burned area
OMPS Products

- **Nadir Mapper Daily Global Products**
  - Climate-quality Total Column Ozone (climate, monitoring, assimilation, UV Index)
  - UV-absorbing Aerosol Index (Smoke, Dust, Volcanic Ash)
  - Column SO2 for Hazards and Air Quality (inventory, forecasts, campaigns)

- **Nadir Ozone Profile Products**
  - Ozone vertical profiles for middle and upper stratosphere (Climate monitoring, assimilation)
  - Solar Mg II index and spectral variations (Solar UV spectra)

- **Limb Ozone Profile Products**
  - High vertical resolution stratospheric Ozone profiles (Ozone hole, monitoring)

- **Research Products**
  - Nadir Mapper Column NO2
  - Limb Profiler High vertical resolution stratospheric Aerosol profiles
High-Spatial-Resolution Capabilities
The image on the left shows a false color map of the OMPS effective reflectivity (from a single Ultraviolet channel at 380 nm) over the Arabian Peninsula region for January 30, 2012 when the instrument was making a set of high-spatial-resolution measurements with $5 \times 10^{14}$ km$^2$ FOVs at nadir. The color scale intervals range from 0 to 2 % in dark blue to 18 to 20 % in yellow. The image on the right is an Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) Red-Green-Blue image for the same day.

The OMPS Nadir Mapper instrument is very stable, extremely flexible, and has excellent SNRs.
Near-Real-Time OMPS SO$_2$ Product

NPP/OMPS Orbits 10253 & 10252 -- 10/19/2013 - 10/20/2013

Eruption of Kliuchevskoi Volcano (Kamchatka, Eastern Russia)
10/19/2013

Orbit: 10253 Low-res

Orbit: 10252 Hi-res

SO$_2$ column 5 km [DU]
Limb Aerosol Extinction Retrievals

Dust from the Russian Chelyabinsk Meteor

March 4 2013

March 31, 2013

From talk by Nick Gorkavyi
OMPS-NM measurements can be used to make state-of-the-art SO$_2$, NO$_2$ and Aerosol retrievals for air quality and hazard applications. Examples below are for Asia for 10/20/2013 (top) & 10/23/2013 (bottom)