GSICS UV Sub-Group Activities

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with contributions from NOAA, NASA and GRWG UV Subgroup Participants, in particular L. Flynn

GRWG-UV Subgroup Baseline Projects

Based on a user survey designed to assess the most appropriate focus for the GSICS sub-group activities.

Reference Solar Spectrum

Aim: to evaluate the available reference solar spectra and make a recommendation for a reference solar spectrum for community use. Lead – Larry Flynn (NOAA)

White Paper on Ground-based Characterisation of UV/Vis/NIR/SWIR spectrometers

Aim: to prepare a white paper documenting best-practise for the on-ground calibration of UV/Vis/NIR/SWIR spectrometers based on in-orbit experience from relevant missions.
Lead – Rüdiger Lang (EUMETSAT)

Match-ups and Target Sites

Aim: to produce over-pass comparisons of UV sensors for specific target sites in use by the community. As a first step summaries of methods and results for target sites currently in use will be collected. Lead – TBC.

Cross-calibration below 300nm

Aim: To devise new methods for comparison of wavelength pairs for different viewing geometries taking into account contribution function equivalence to allow radiometric performance comparisons for ozone profile wavelengths from 240 – 300 nm. Lead Larry Flynn (NOAA).

GRWG-UV & CEOS WGCV-ACSG Co-operation

Joint GSICS Research Working Group UV Sub-Group (GRWG-UVSG) and CEOS Working Group on Calibration and Validation - Atmospheric Composition Sub-Group (CEOS WGCV-ACSG) meeting NOAA/NCWCP, College Park, MD, on the 8th and 9th October 2015

Calibration of radiance and irradiance data will remain a focus.

Pre-launch characterization and calibration identified as one of the most needed topics for future discussion.

Solar reference spectrum definition of common interest (also to other groups e.g. CEOS Infrared and Visible Optical Sensors (IVOS) Subgroup)

Reference Solar Spectrum

Compare solar measurements from BUV (Backscatter Ultraviolet) instruments.

Main Steps:

- Catalog high spectral resolution solar reference spectra and agree on a common spectrum to use for the project (SOLSTICE, SIM, Kitt Peak).

Participants provide for each instrument:

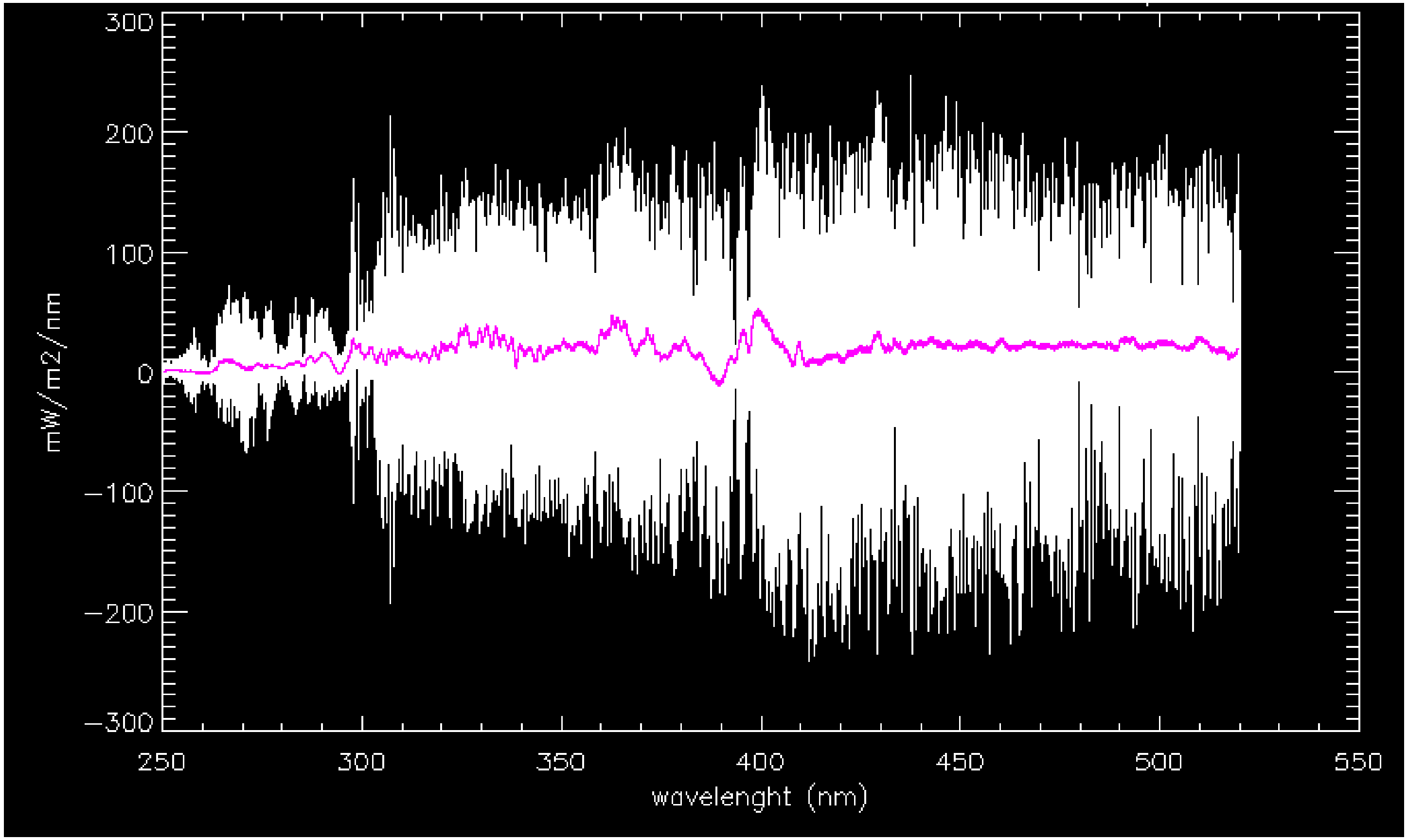
- Solar measurement for some date (wavelength scale, irradiance)
- Wavelength scale and bandpass (Δλ, # of points, bandpass centers, normalized bandpass weights)
- A synthetic spectrum from common reference (wavelength scale, irradiance)
- A synthetic spectrum for wavelength scale perturbations (±0.01 nm) from common reference (wavelength scale, irradiance)
- A synthetic spectrum from an alternative reference spectra (wavelength scale, irradiance)
- The solar activity pattern (wavelength, relative change)
- Mg II index (if 280 nm is covered) Mg II 279.6 Mg I 285.2 (date, index)
- Ca H/K index (if 391 nm to 399 nm is covered) Ca II 393.4 and 396.8.

Goals:

Agreement at 1% on solar spectra relative to bandpass-convolved high resolution spectra as a transfer after identifying wavelength shifts and accounting for solar activity.
Long-term solar spectra drift and instrument degradation can also be analysed.

Comparison by NOAA of Reference Solar Spectra NASA (C. Seftor) EUMETSAT (R. Lang)

Slide provided courtesy of L. Flynn, NOAA



Aim is to get the measurements, models and band passes for the different instruments and start on the comparisons in January.

Analysis of Time Series of Solar Spectra

OMI, GOME-2 and OMPS teams have generated models of time series of their solar measurements considering:

Solar activity

- With proxies (e.g., Mg II Indices)
- Directly estimating pattern over solar rotations

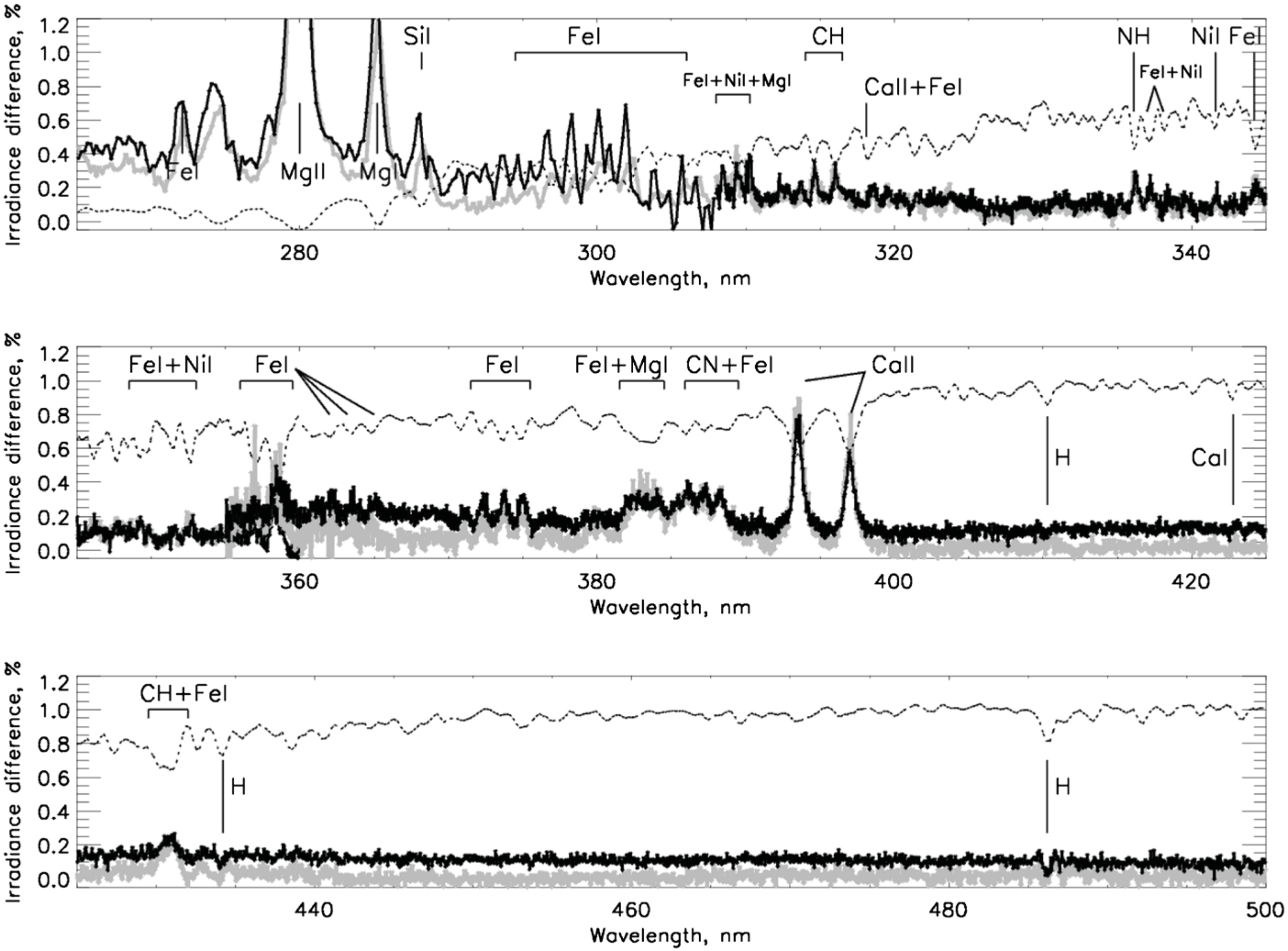
Wavelength shifts

- With proxies (e.g., optical bench temperatures)
- Directly from fits of solar features
- Spectral Line Source lamp measurements

Diffuser and instrument degradation

- With proxies (e.g., diffuser exposure times)
- From working and reference diffuser measurements
- From residual changes after identifying activity and wavelength changes
- Considering albedo changes over targets or compared to other sensors
- Modeling of long-term instrument changes

OMI Time-averaged irradiance differences: (mid-2012+2013) vs. (mid-2007+2008+mid-2009)



S. V. Marchenko and M. T. DeLand, "Solar Spectral Irradiance Changes During Cycle 24", The Astrophysical Journal, 789:117 (17pp), 2014 July 10

Spectral dependence of solar variations as observed by OMI.

Black line shows the normalized long-term difference spectrum (2012–2013 vs. 2007–2009), average 27 day variability spectrum
(gray line).

For reference, the scaled solar spectrum is shown as a dotted line.

Reference Solar Spectrum:
OMPS Nadir Profiler Solar Diffuser

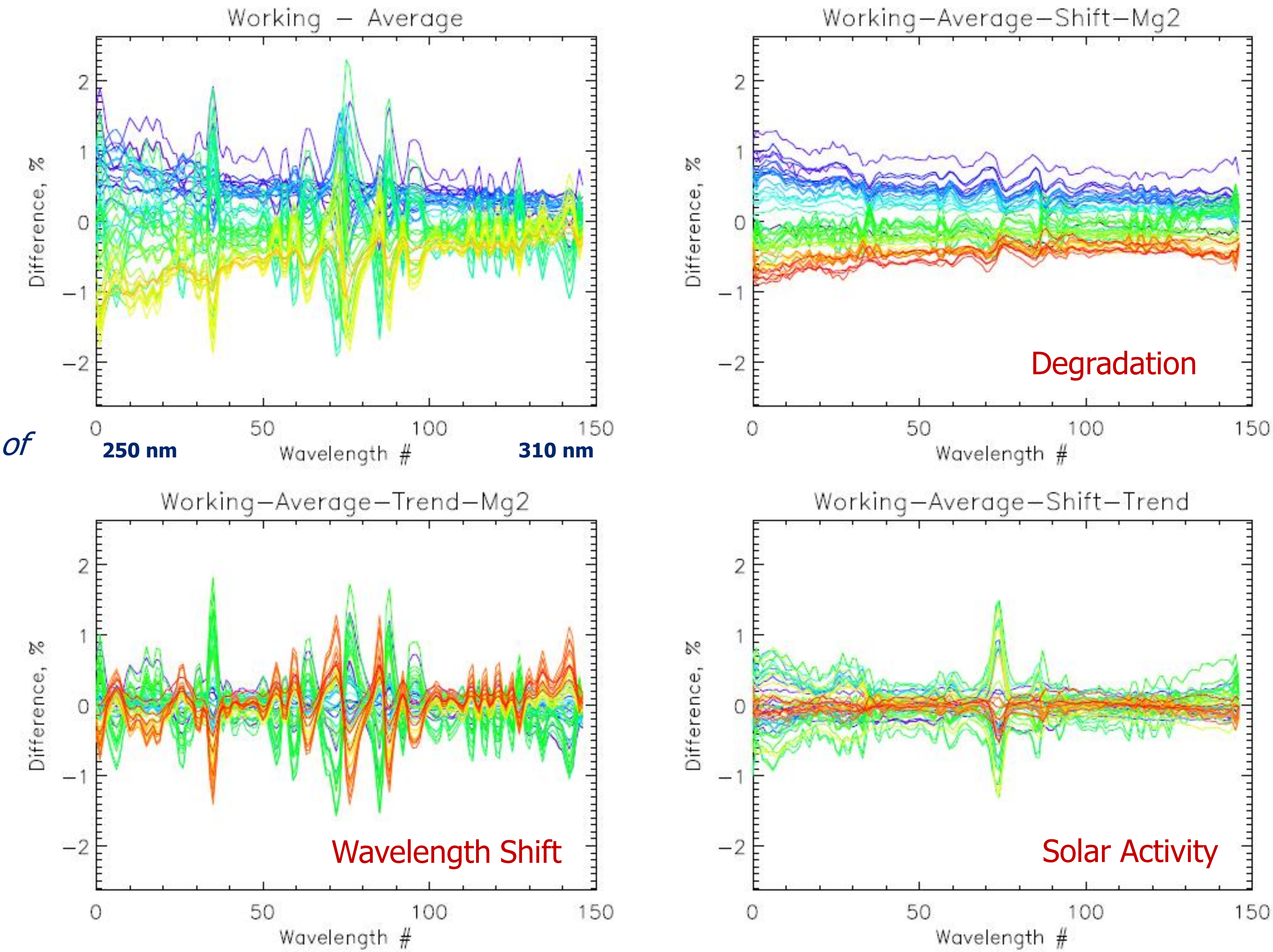
- Comparison of OMPS Nadir Profiler Working Diffuser Solar spectra to their average (L. Flynn and colleagues)

- Fit the differences with a model using three patterns of the form

a1(t)*WavelengthShift(λ) + a2(t)*SolarActivity(λ) + t*Degradation(λ)

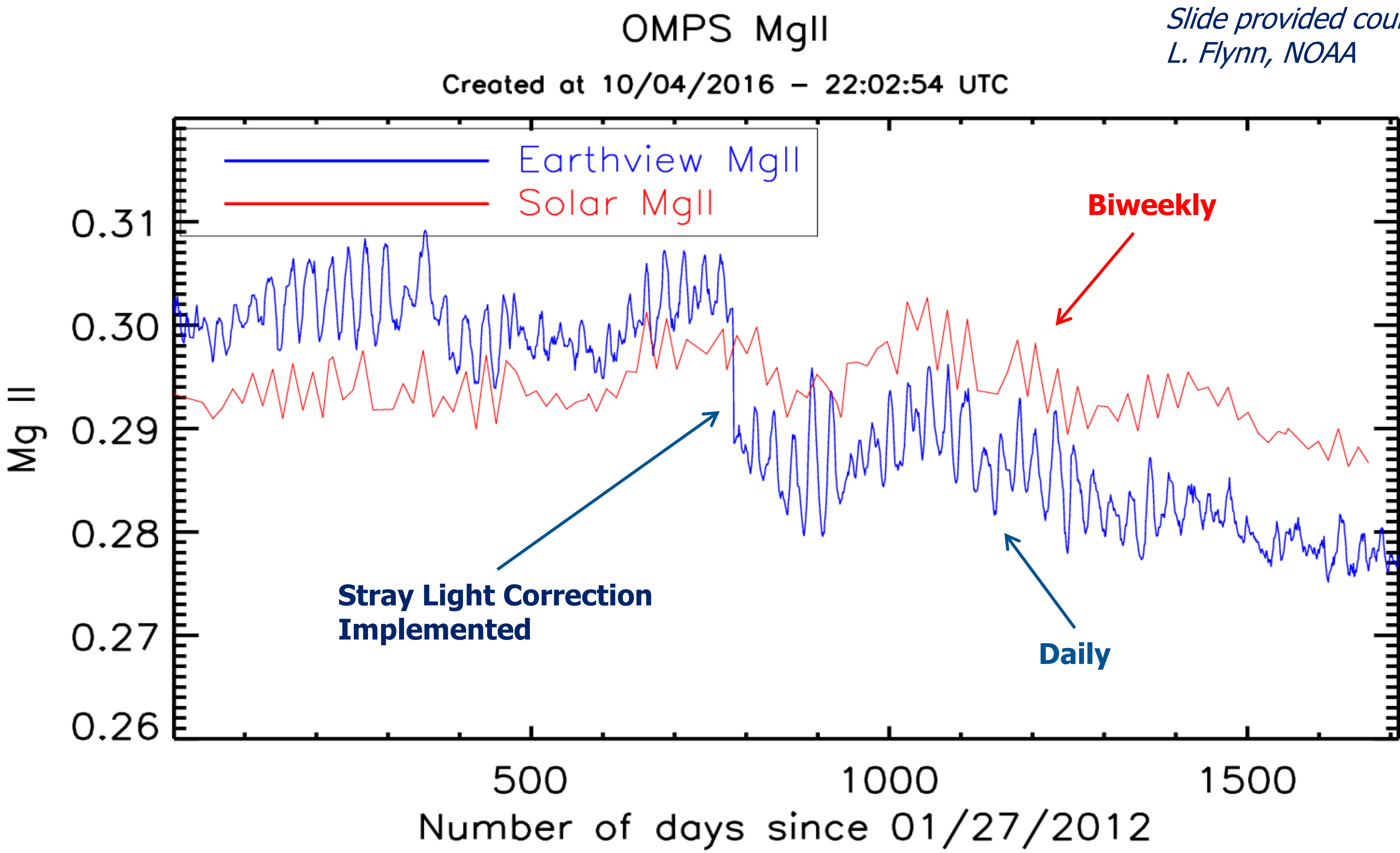
Reference Solar Spectrum:
OMPS Nadir Profiler Solar Diffuser

Slide provided courtesy of L. Flynn, NOAA



Daily OMPS Mg II Index from Earth-View Spectra

Slide provided courtesy of L. Flynn, NOAA



White Paper on Ground-based Characterisation

White Paper in initial drafting stage, scope outline etc.

- GSICS has a survey that is still open at:

https://docs.google.com/a/noaa.gov/forms/d/1sXbhrq85aPa5Yh-gycNleX47CKkdjDZgb2lMY97-6sY/viewform

Your participation is welcome.

Target Sites – Effective Reflectivity Project

Produce over-pass comparisons of UV/Vis sensors for specific target sites in use by the community.

Main Steps:

Collect summaries of methods and results for target sites currently in use.

Compare measurements of reflectance for channels from 330 nm to 500 nm.

- Ice, desert and open ocean targets.
- Absolute Radiance/Irradiance check; Track variations over time.
- Reflectance range/distribution, 1-percentile, Deep Convective Clouds (DCC)
- Wavelength Dependence – Aerosol Indices, Clean atmospheres
- Viewing and Solar angle considerations

Compare global monthly surface reflectance data bases

Complications:

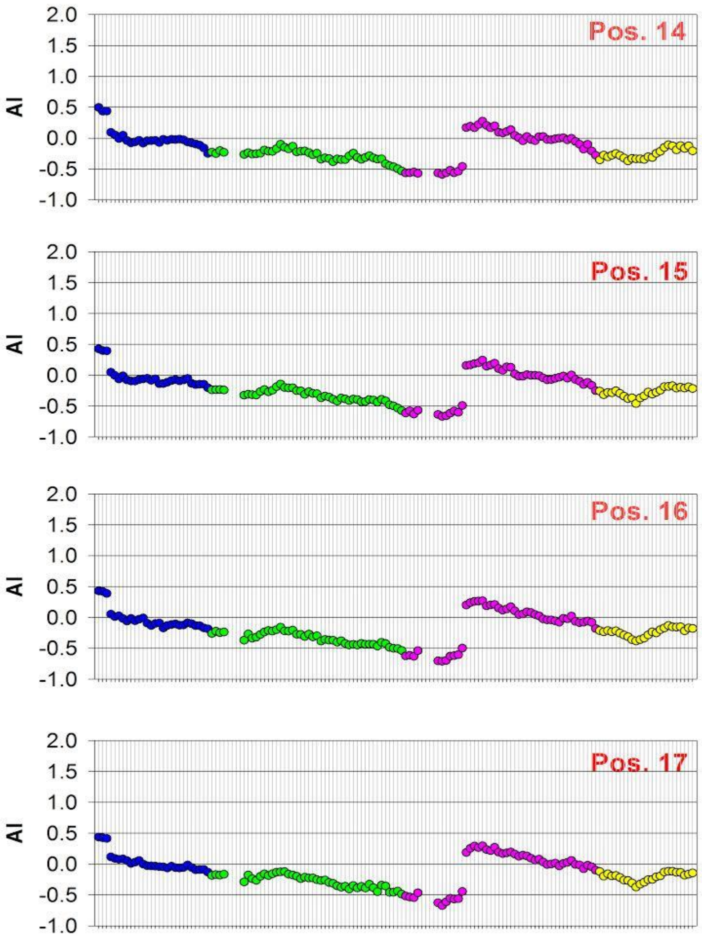
- Sun glint; surface pressure; partially cloudy scenes; polarisation; inelastic scattering, turbidity, chlorophyll.

Goals:

- Agreement at 1% on cloud free scene reflectance for 340 nm. Desert, Equatorial Pacific, Polar Ice.
- Agreement at 1% on aerosol index – wavelength dependence of reflectance.
- Long-term stability of 0.5% in reflectance

Reflectivity and Aerosol Index for an Equatorial Pacific Region

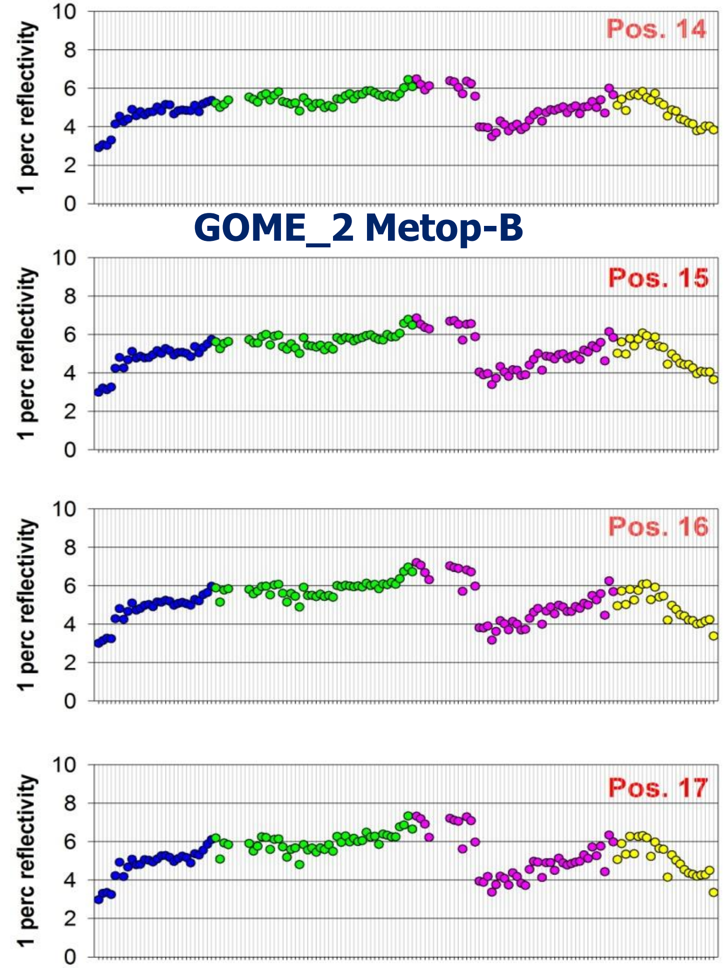
NOAA are examining the V8 TOMS algorithm reflectivity and Aerosol Index Values for an Equatorial Pacific Region for OMPS, OMI and GOME-2



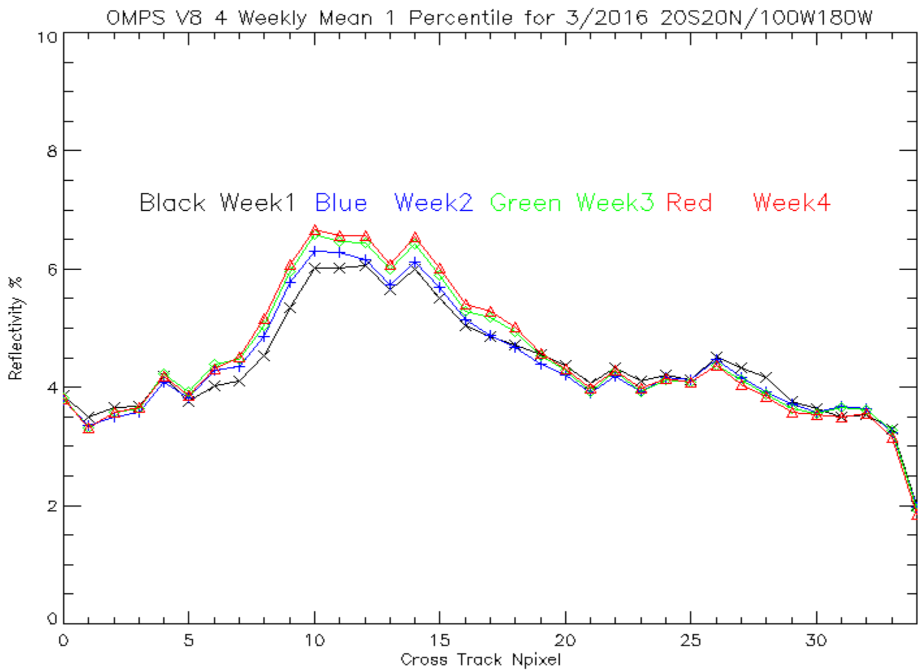
←Time Series of GOME-2 Aerosol Index (360 nm vs 331 nm) Equatorial Pacific

Time Series of → GOME-2 1-percentile Reflectivity Equatorial Pacific

Jumps are from NOAA-applied soft calibration adjustments to the operational products.

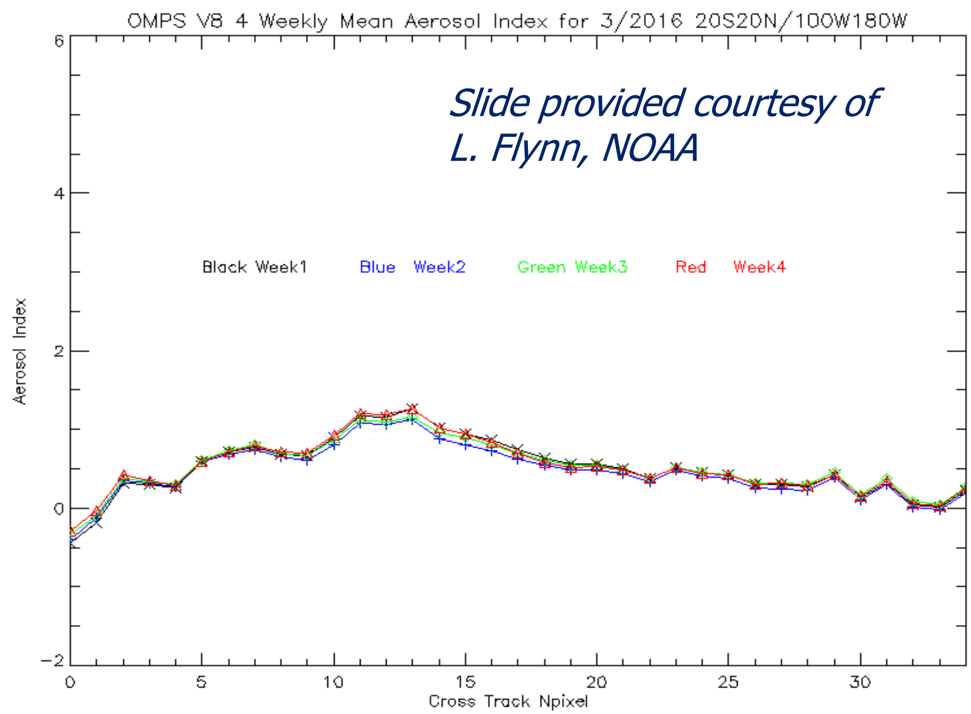


Cross-Track Internal Consistency for OMPS



← **Weekly Effective Reflectivity values for the V8 algorithm for March 2016 for all data in a latitude/ longitude box in the Equatorial Pacific versus cross-track view position, 17 is nadir. We expect the values to be approximately 5% for this region of the globe. The cross-track variations for positions 8 to 15 are related to sun glint effects.**

Weekly Aerosol Index values for the V8 algorithm for March 2016 for all the data in a latitude/ longitude box in the Equatorial Pacific versus cross-track view position, 17 is nadir. We expect the aerosol index values to be approximately zero N-values for this region of the globe. The cross-track variations for positions 8 to 15 are related to sun glint effects. →



Match-ups

Aim to expand the use of satellite matchup comparisons for UV instruments – current approaches include ….

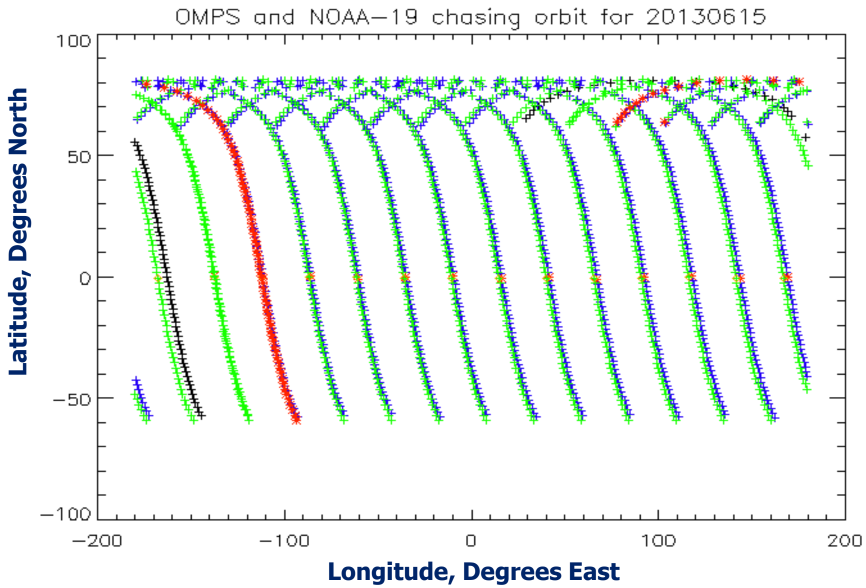
- LEO vs LEO Simultaneous Nadir Overpass
  (and its non-simultaneous No-Local-Time-Difference zonal means)

- Chasing Orbits (Opportunistic Formation Flying)
  - S-NPP and EOS-Aura have 16-day repeat cycles but one makes 227 orbits and the other 233 so every 64 hours they are flying with orbital tracks within (360/14)*110*3/(14*8*2) ~ 40 km of each other, 15 minutes apart.
  - For NOAA-19 and S-NPP, the matchups are every 12 days – (360/14)*110/(14*12*2) ~ 9 km.

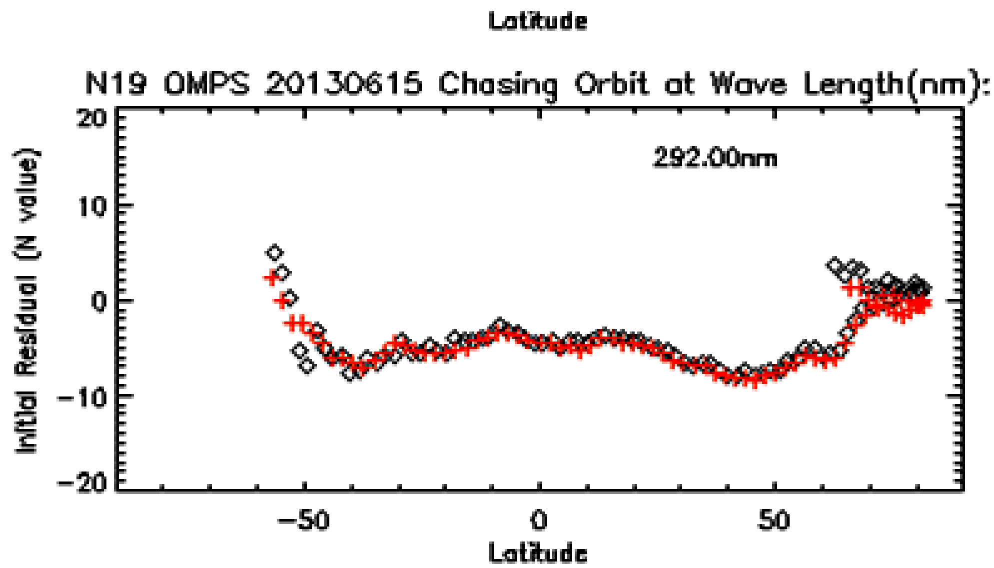
- LEO under flights of GEO and L-1 instruments – Coincident Line-of-Sight Observations. (GOME-2 vs. SEVIRI, OMPS vs. TEMPO)

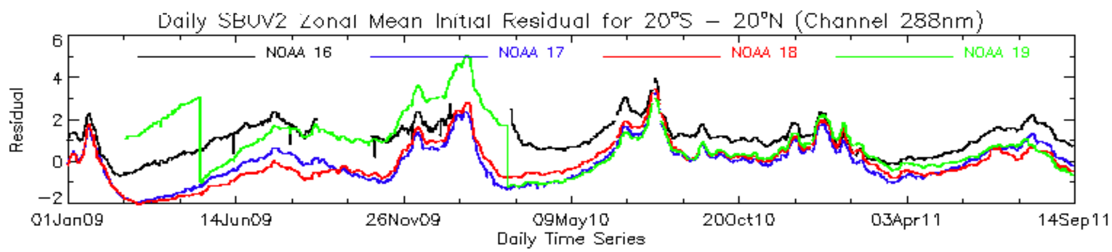
Match-ups and Target Sites – Examples

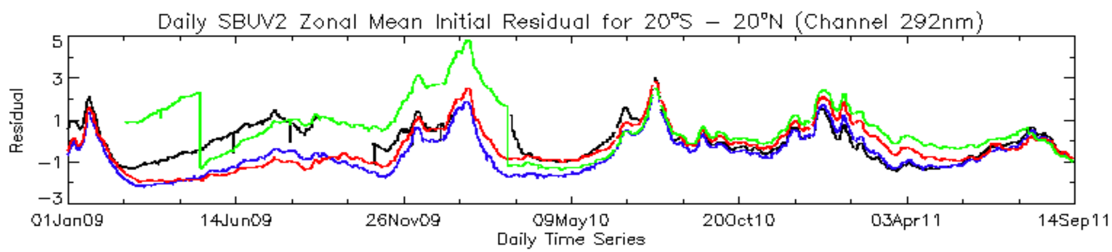
Well-matched orbits for 6/15/2013



Comparison of Initial V6 Measurement Residuals for S-NPP OMPS NP and NOAA-19 SBUV/2





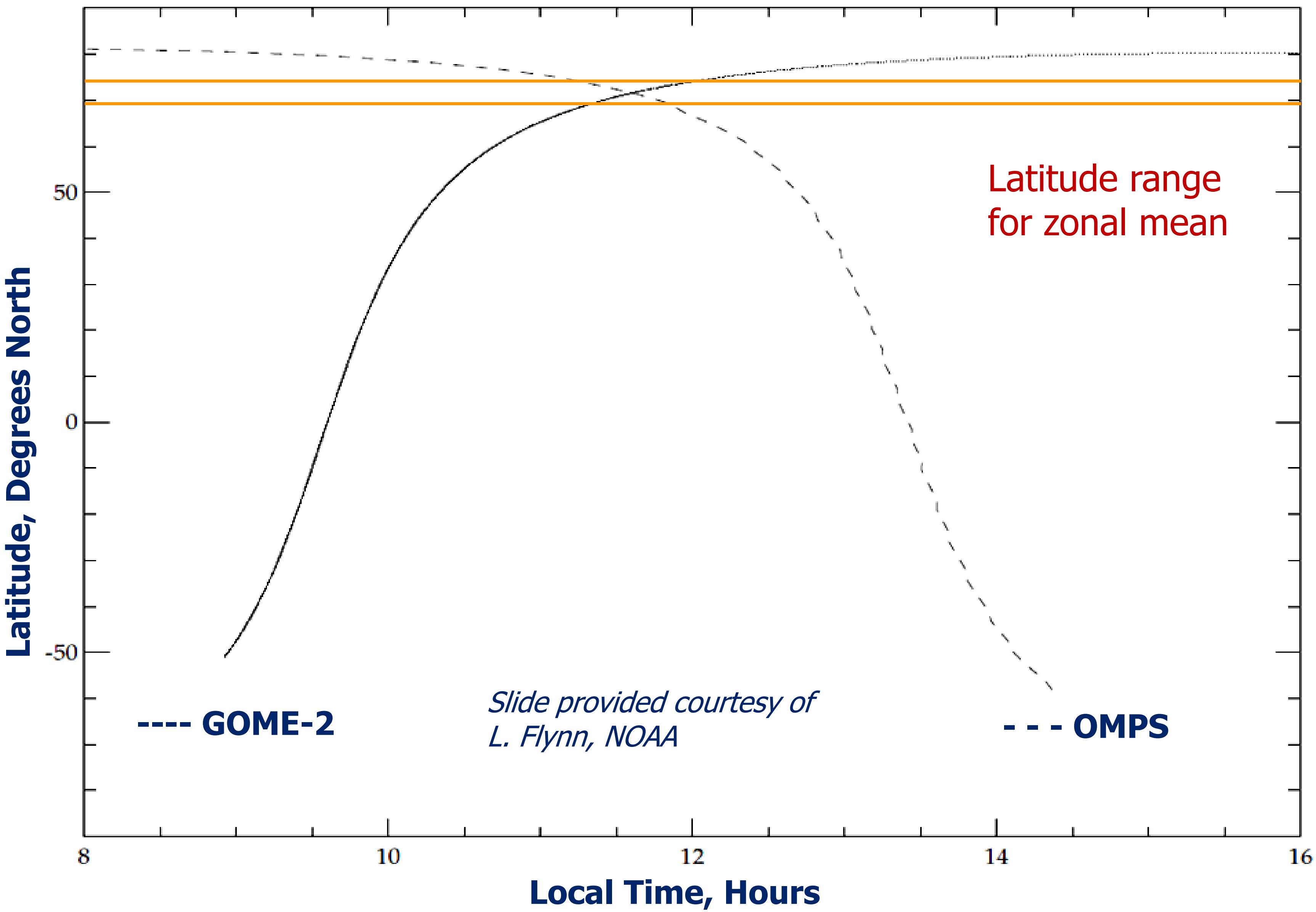


Operational Monitoring
Daily Means
Equatorial Pacific Box

20S – 20N Latitude
100W – 180W Longitude

Slide provided courtesy of L. Flynn, NOAA

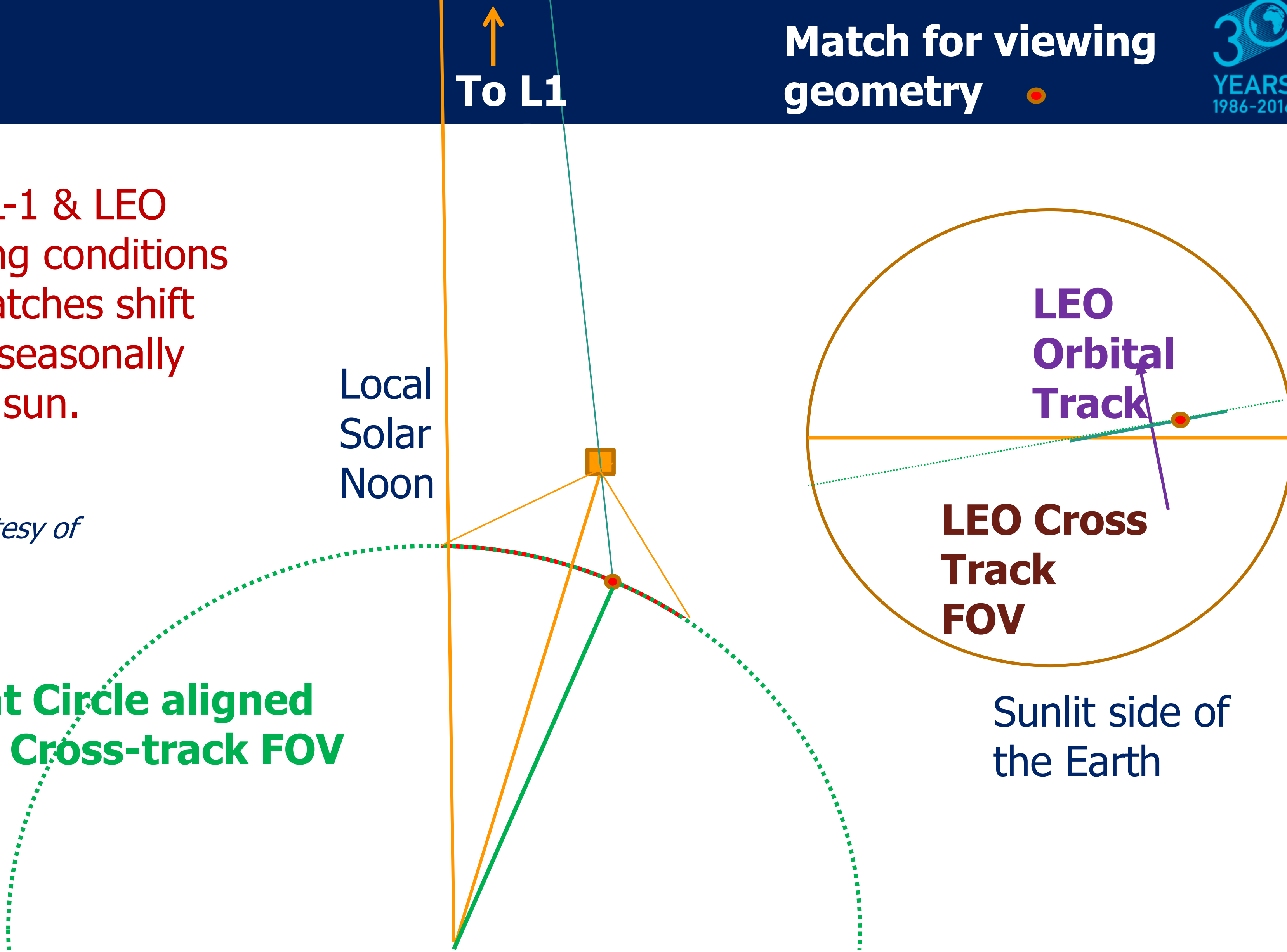
Simultaneous Nadir Overpass and No Local Time Difference Comparisons



L1 & LEO

Schematic for L-1 & LEO matched viewing conditions at Equinox. Matches shift north or south seasonally "following" the sun.

Slide provided courtesy of L. Flynn, NOAA



Simultaneous View Path (SVP) match up between DSCOVR EPIC at **0º offset with the Earth/Sun line** and S-NPP OMPS. **Matches will be present for any BUV instrument on a GEO platform with one in a LEO orbit as the LEO orbital tracks pass near the GEO sub-satellite point.**

Cross-Calibration below 300nm –
Initial Measurement Residual Project (NOAA)

Purpose of this project – to use initial measurement residuals from the Version 8 ozone profile retrieval algorithm to compare channels from 240 nm to 290 nm. *(Note, this will require modification of the first guess creation to use consistent total ozone starting values as inputs.)*

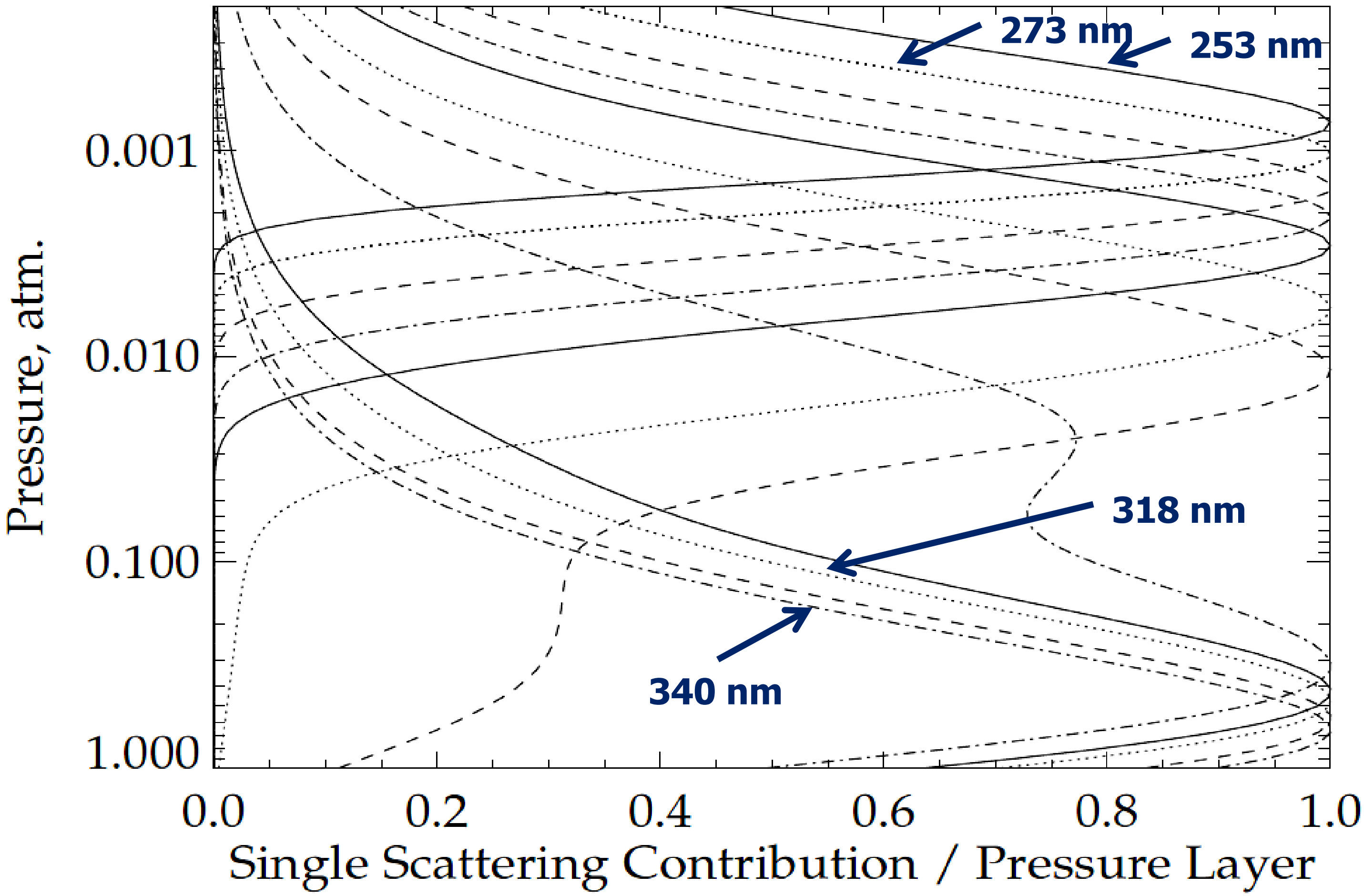
- Ascending/descending equivalent channel concept will be used with hyper-spectral measurements i.e compare residuals for λ1 and λ2 where S1*α1 = S2* α2. Here S values give the path lengths and α values give the ozone absorption cross sections.
- Zonal mean and other matchup criteria will be used both to establish offsets and track relative drifts.
- Expand SBUV(/2) results to other sensors (OMPS, SBUV, OMI, GOME-2)
- Monitor time dependence for multiple instruments.

http://www.star.nesdis.noaa.gov/smcd/spb/OMPSDemo/proSBUV2released-2.php
http://www.star.nesdis.noaa.gov/smcd/spb/OMPSDemo/proOMPSbeta.O3PRO_V8.php

Goals

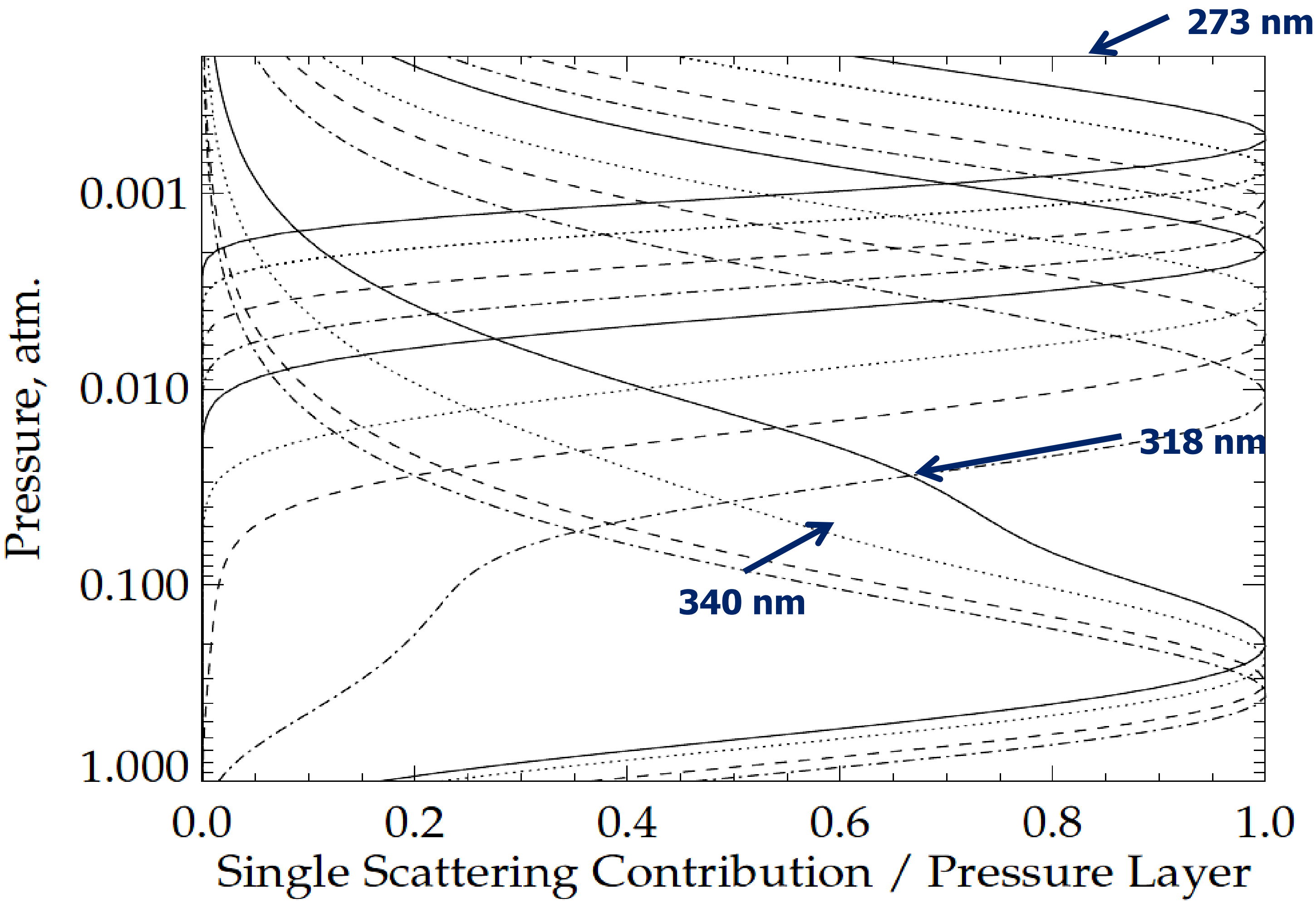
Agreement at 2% for Profile channels by using the Version 8 *A Priori* Profiles with TOMRad Tables and single scattering.

Normalized Single Scattering Contribution Functions – SZA 30º



Normalized Single Scattering Contribution Functions for 12 wavelengths at [253, 273, 283, 288, 292, 297, 302, 306, 313, 318, 331, 340] nm for a 325 DU total column ozone profile for Solar Zenith Angle $\theta_0 = 30°$.

Normalized Single Scattering Contribution Functions – SZA 70º



Normalized Single Scattering Contribution Functions for 12 wavelengths at [253, 273, 283, 288, 292, 297, 302, 306, 313, 318, 331, 340] nm for a 325 DU total column ozone profile for Solar Zenith Angle θ_0 = 70°.

Pseudo-channels in the UV from 250 nm to 300 nm

- As the SZA or SVA increases, the contribution functions shift up. One can find combinations of longer channels that can represent (capture the response to ozone changes) a measurement at a shorter channel at SZA=0 and SVA=0.
- We can compare instruments measuring at different viewing geometries or times of day.
- This can help to determine both internal and external biases.
- Diurnal ozone variations will present an involved complication.

Summary

- Additional ideas and participants for projects welcome
- Volunteers to lead work on Match-ups and Target Sites also welcome
- Please contact rosemary.munro@eumetsat.int if you would like to be included on the distribution list.

Thank you for your attention!