February 25, 2010

TO: Jeff Privette, NOAA NCDC Science Data Stewardship Project Office
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FROM: Lawrence E. Flynn, NOAA/NESDIS/STARSCMD/SPB
Co-Chair, Atmospheric Chemistry Product Oversight Panel

CC: E. Dunlea, F. Weng, M. Goldberg, S. Kondragunta, C. Long, D. McNamara

SUBJECT: Satellite Ozone Atmospheric Chemistry Project FY2009 Write-up

Enclosed is a report with the Progress and Plans for our FY2009 and FY2010 activities. The primary use of AC&CP funding was and will continue to be to support improvement, extension, and validation of the SBUV/2 total and profile ozone climate data records. Most of the funding was expended on a contract for an approximately 1/3-time programmer/analyst to conduct analysis, reprocessing and match up comparisons. This was augmented by an infusion of base funding to cover additional support for calibration and validation activities.

There are currently four operational SBUV/2 instruments (on NOAA-16, NOAA-17, NOAA-18, and NOAA-19 POES) making measurements used to generate ozone estimates with the Version 8 Algorithm. The last instrument in this series was launched on the NOAA-19 POES satellite in early 2009. We have implemented the Version 8 algorithm in operations to produce total ozone estimates from measurements made by the MetOP-A GOME-2 instrument as part of the Initial Joint Polar Satellite System (IJPSS). Production of daily total ozone, reflectivity and aerosol index maps from this instrument are available. See http://www.osdpd.noaa.gov/ml/air/gome.html .

We face two primary challenges in the coming years with regards to ozone climate records. The first is to maintain and extend the ozone record with data from the SBUV/2 instruments and the new GOME-2 instrument. While having data from two morning and two afternoon instruments allows checks and redundancy; the amount of analysis, reprocessing, and validation is increased as well. The hyperspectral measurements from the GOME-2 are a welcome source of new information, but must be characterized and validated. At some point in the future, we will want to use the GOME-2 record to extend the TOMS-SBUV/2-OMI total ozone records.

The second challenge is to prepare for the NPP and JPSS OMPS instruments and products. We are actively participating in the algorithm development and validation planning for the OMPS. After the NPP launch, there will be continuation of the SBUV/2 and TOMS products from the OMPS Nadir Profiler and Nadir Mapper, and new higher-vertical-resolution ozone profiles from the OMPS Limb Profiler. There is a plan to make the latter products in the NPOESS Data Exploitation system. We successfully submitted a proposal under the SDS program to set up and initiate a reprocessing and validation system for all three OMPS ozone products.

Support for the satellite ozone CDRs has been eroded over the last ten years by inflation and cuts. This seriously impacts our ability to extend and update the satellite ozone Climate Data Record. At the same time our satellite atmospheric chemistry program is growing with new products and users. We see substantial new atmospheric chemistry opportunities in exploiting the MetOP-A GOME-2 measurements. Such activities are beyond the scope of our existing ACCP support.

Stand-alone Highlights

L. Flynn of NOAA/NESDIS was lead author on a paper published in the International Journal of Remote Sensing: Flynn, L.E., McNamara, D., Beck, C. T., Petropavlovskikh, I., Beach, E., Pachepsky, Y., Li, Y. P., Deland, M., Huang, L. -K., Long, C. S., Tiruchirapalli, R., and Taylor, S. (2009) Measurements and products from the Solar Backscatter Ultraviolet (SBUV/2) and Ozone Mapping and Profiler Suite (OMPS) Instruments. International Journal of Remote Sensing, Volume 30 Issue 15, 4259.

The SBUV/2 products are once again featured in the NOAA report on the development and characterization of the Antarctic Ozone Hole (OH). September and October 2009 saw a medium size OH, consistent with the temperatures and stability of this year's Antarctic Polar Vortex and the continued high levels of effective equivalent stratospheric chlorine.

Results on trends from the SBUV/2 CDR time series will be included in Chapter 2 of the WMO Ozone assessment currently in preparation.

If you need additional information on our activities or plans, please let me know.

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Attachments: FY10 Proposed Budget, FY09/10 Report on Progress and Plans (Not Enclosed)

Progress and Plans: Atmospheric Chemistry Project

Lawrence E. Flynn, Shobha Kondragunta and C. Trevor Beck NESDIS/STAR

FY2009 Accomplishments and Activities

Reprocessing Activities for Version 8 SBUV/2 Record

We continued to acquire NOAA-16, -17, -18, and -19 SBUV/2 Version 6 and Version 8 products and perform the initial reprocessing of each new month's data in preparation for CDR creation.

Updates for the Version 6 and Version 8 calibration parameters and algorithms were implemented for all four operational NOAA satellites. The reprocessed versions are distinguished by three identifiers. The first is the algorithm Version number, either V6 or V8 for the Version 6 or Version 8 ozone profile retrieval algorithm; the second is a two digit revision number for algorithm improvements; and the third is a two digit recharacterization number for calibration adjustment iterations. For NOAA-18, we reprocessed the full record with a new calibration and a new stray light correction creating version V82014. For NOAA-17, we reprocessed the full record with a new calibration and a new stray light correction creating V81619. For NOAA-16, we reprocessed the full record with a new calibration creating version V81822. For NOAA-19, we reprocessed the record several times with updated calibration, day one value changes, and code fixes arriving at V60404 and V80406 for the latest versions.

Calibration/Validation

Validation results for the SBUV/2 Version 8 total ozone products (total column and ozone profile totals) are obtained from comparisons to ground-based Dobson network records acquired from the WOUDC. Comparisons are updated twice per year. New plots were created for NOAA-16, -17, -18 and -19 data records. See Figure 1 below for NOAA-17 and -18 SBUV/2 and GOME-2 total ozone validation. Profile results are compared among the four instruments. The newer calibration and characterizations have improved their consistency. The STAR web site "Integrated Satellite Instrument Calibration Validation System" has information on the current instruments performance at
http://www.star.nesdis.noaa.gov/smcd/spb/icvs/proSBUV2iinternal.php
http://www.star.nesdis.noaa.gov/smcd/spb/icvs/proSBUV2operation.php
http://www.star.nesdis.noaa.gov/smcd/spb/icvs/proSBUV2released.php
Figure 2 below is taken from the monitoring web site. It shows the differences between the monthly average ozone profile retrievals for the tropics with the average *a priori* profiles for the four instruments. The NOAA-16 SBUV/2 is a very early morning equator crossing time, and has poor viewing conditions. The NOAA-19 SBUV/2 has preliminary calibration without full characterization. The results for NOAA-18 SBUV/2 and NOAA-17 SBUV/2 agree well.

Additional validation results for SBUV/2 Version 8 ozone profile products are obtained from comparisons to Umkehr ozone profile retrievals. Our validation activities are also supported by a CREST researcher from Hampton University. He makes regular comparisons to OMI total ozone values and tracks trend differences among the four SBUV/2 instruments.

We continue to work with NASA in devising radiance adjustments for CDR improvements and extensions of the historical and current ozone data records in cooperation with their NASA Measures program efforts.

International Atmospheric Chemistry
We continue to work with CEOS. L. Flynn is the NOAA representative to the CEOS/WGCV Atmospheric Chemistry Sub-Group. He is also a co-author of Chapter 2 of the latest WMO Ozone Assessment under development.

Other Activities
NPP and JPSS OMPS: We continue to provide expert advice on a range of OMPS issues by participating in reviews and leading the O3OAT. We are working with the NPP Science Team and NDE to prepare for the OMPS LP on NPP. As part of our successful SDS proposal work, we are implementing the Version 8 total ozone and ozone profile algorithms to run on the OMPS SDRs measurements. We are also leading the Calibration and Validation activities for the IPO for ozone products from instruments (OMPS and CrIS) on the NPP mission.

China FY-3 SBUS and TOU: The Chinese Meteorological Agency (CMA) launched two ozone instruments on its FY-3 polar satellite this year. They make measurement similar to those from the SBUV and TOMS instruments. We have cooperative agreement to assist them in developing and validating products from these measurements. We have received and analyzed Level 1 and Level 2 data and provided feedback on anomalies and calibration. L. Flynn visited CMA for three weeks last year to assist in the implementation of the retrieval algorithms and collaborate on validation activities.

Ozone Hole Monitoring: The operational SBUV/2 products were once again featured in reports on the development and characterization of the Antarctic Ozone Hole (OH). September and October 2009 saw a medium size OH, consistent with the temperatures and stability of this year's Antarctic Polar Vortex and the continued high levels of effective equivalent stratospheric chlorine. Figure 3 shows a plot of the

FY2010 Plans

Version 8 Reprocessing
The major component of our work in the next year will be validation and intercomparison of the reprocessed NOAA-18 SBUV/2 data for 2005 to 2009 along with the newly reprocessed data from NOAA-16 and NOAA-17 SBUV/2 to provide another extension of the Version 8 total ozone column and vertical ozone profile CDR released in 2004 and extended in 2008. We expect to replace the full records of NOAA-16 and NOAA-17 SBUV/2 with this release. We will also track the NOAA-19 SBUV/2 instrument changes and make adjustments as necessary.

New Cross Sections
A key factor in the decision on making replacement releases will be progress on implementing improved ozone cross sections in the retrievals. We plan to switch all processing from the current measurement from Bass and Paur to those make by Brion, Daumont, and Malicet.
Brion, J., Chakir, A., Daumont, D. and Malicet, J.: High-resolution laboratory absorption cross section of O3. Temperature effect, Chem. Phys. Lett., 213 (5-6), 610-512, 1993.

Validation
We will continue our work to validate the NOAA ozone products from SBUV/2 and GOME-2 instruments and begin the initial transformation of operational products into CDRs. We will use total ozone comparisons among these and with ground-based (Dobson stations) and other satellite products (OMI, GOME-2 DOAS). We will use ozone profile comparisons among these and with ground-based (Umkehr and ozonesonde measurements) and other satellite products (OMI and MLS,).

Other Activities
We will continue to use the SBUV/2 and GOME-2 estimates to monitor the Ozone Hole. We will continue intercomparisons with the FY-3 SBUS and TOU instruments. We will expand preparations for

the launch of the OMPS on NPP in 2011, and we will continue to cooperate with international organizations on atmospheric chemistry and composition.

Papers, Reports, and Presentations.

NOAA Bulletin: Southern Hemisphere Winter Summary, 2009, Contributors: Angell, J.K., Flynn, L.E., Hofmann, D., Johnson, B.J., Long, C.S., Oltmans, S.J., Zhou, S., in preparation. http://www.cpc.ncep.noaa.gov/products/stratosphere/winter_bulletins/

Flynn, L.E., McNamara, D., Beck, C. T., Petropavlovskikh, I., Beach, E., Pachepsky, Y., Li, Y. P., Deland, M., Huang, L. -K., Long, C. S., Tiruchirapalli, R., and Taylor, S. (2009) Measurements and products from the Solar Backscatter Ultraviolet (SBUV/2) and Ozone Mapping and Profiler Suite (OMPS) Instruments. International Journal of Remote Sensing, Volume 30 Issue 15, 4259.

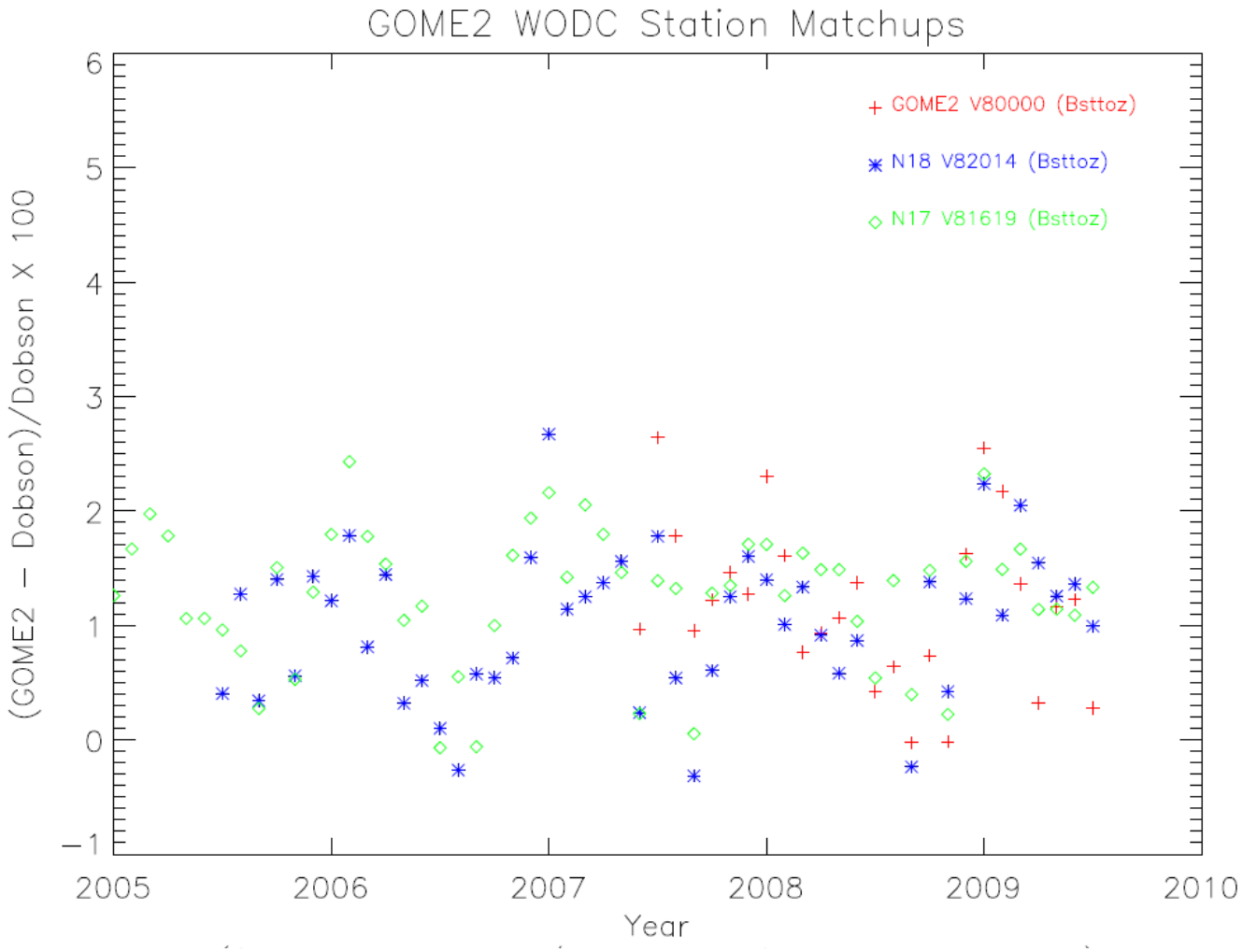

Figure 1. Time series of % differences for NOAA-17 and -18 SBUV/2 and MetOP-A GOME-2 total column ozone with Dobson data.

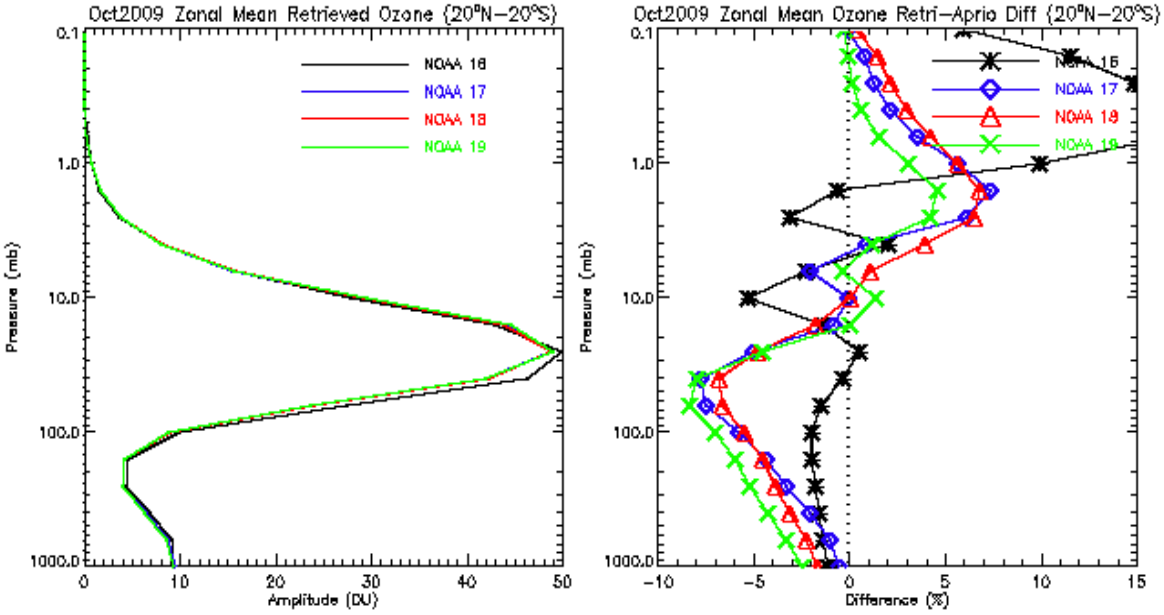

Figure 2. Comparison of NOAA-16, -17, -18, and -19 SBUV/2 ozone profiles for the tropics for October 2009. The three lines show the differences of the monthly zonal mean retrievals for each SBUV/2 with the algorithm's *a priori* ozone profiles.

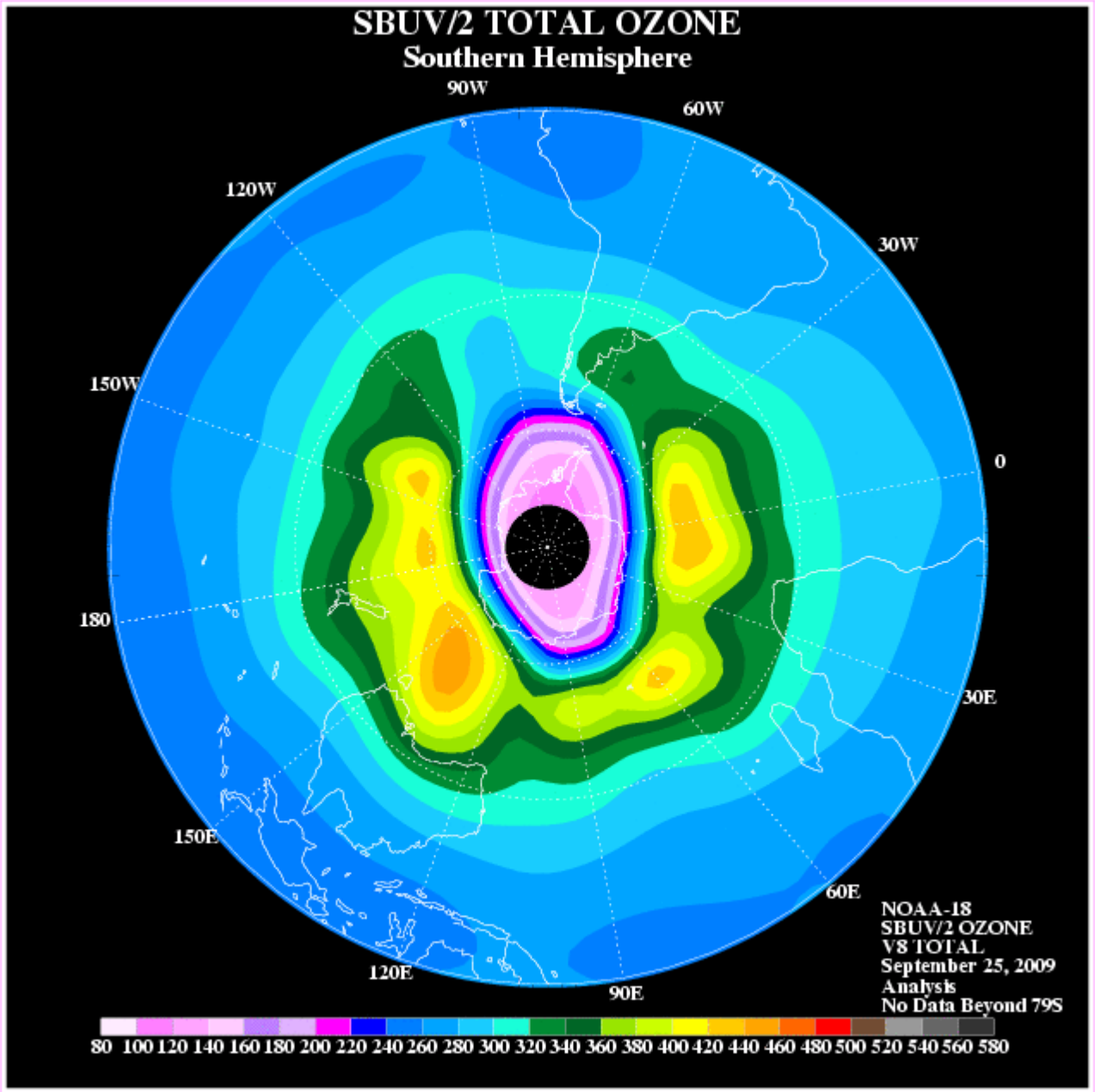

Figure 3. Assimilated NOAA-18 SBUV/2 total ozone for September 25, 2009. The pink and purple region show ozone levels below 220 DU, indicative of the depleted conditions called the ozone hole. The black are at the South Pole is caused by a lack of data from the SBUV/2 which require sunlight to make its measurements.