

Total Ozone: Harmonization of gridded satellite data sets

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Knowledge for Tomorrow

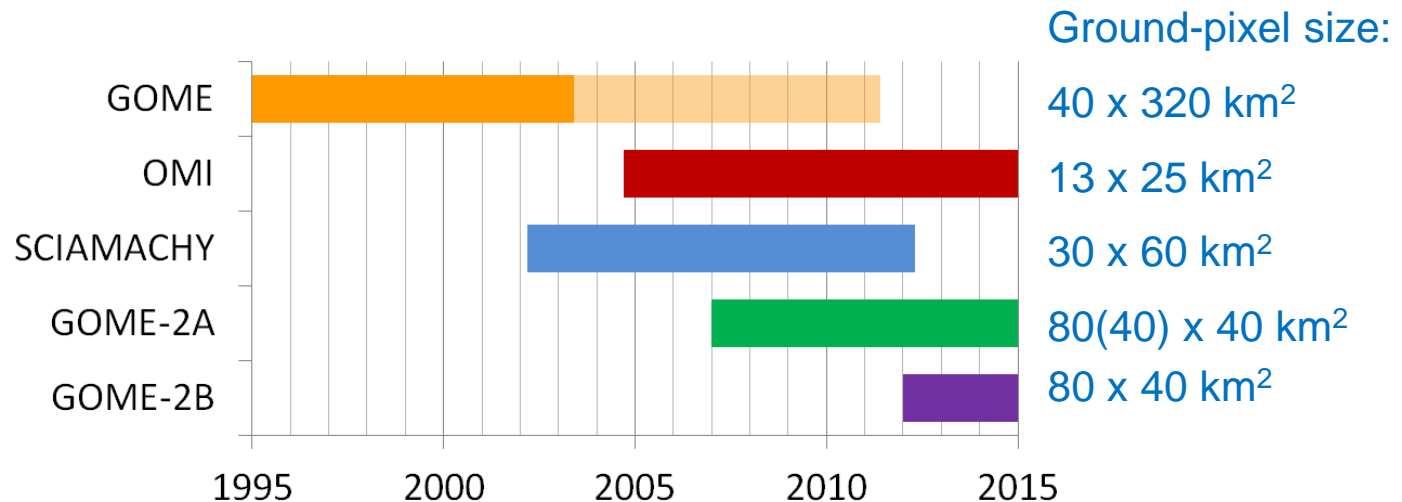
Outline

- GTO-ECV
 - Dataset
 - Merging & Validation
- MERRA-2
 - Dataset
 - Assimilation & Validation
- GTO-ECV and MERRA-2 comparison
 - Zonal Mean
 - Grid data
- Outlook



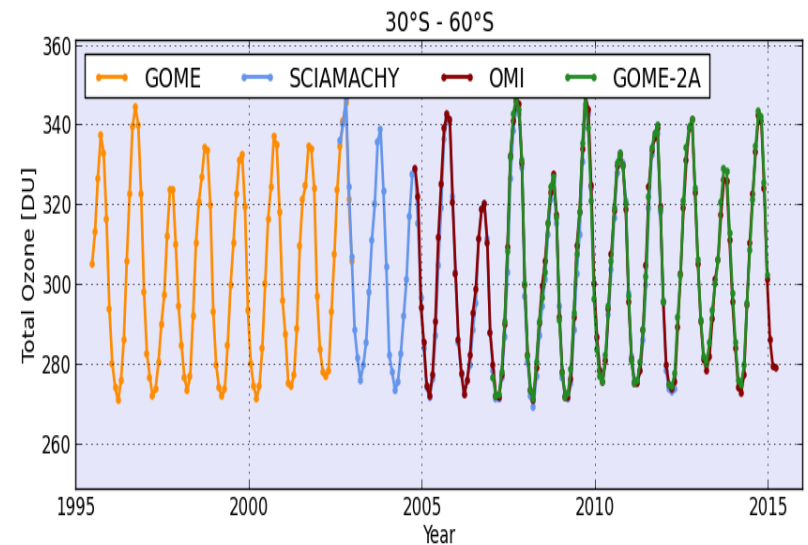
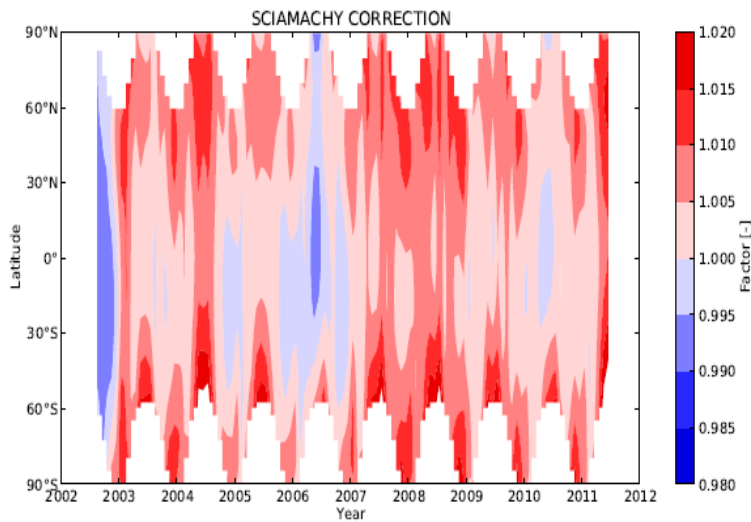
GTO-ECV Overview

- GOME-type Total Ozone Essential Climate Variable (GTO-ECV) is being developed as part of the ESA Climate Change Initiative project.
- Homogenization of total ozone from five European UV sensors: GOME/ERS-2, SCIAMACHY/ENVISAT, OMI/AURA, GOME-2/MetOp-A and MetOp-B

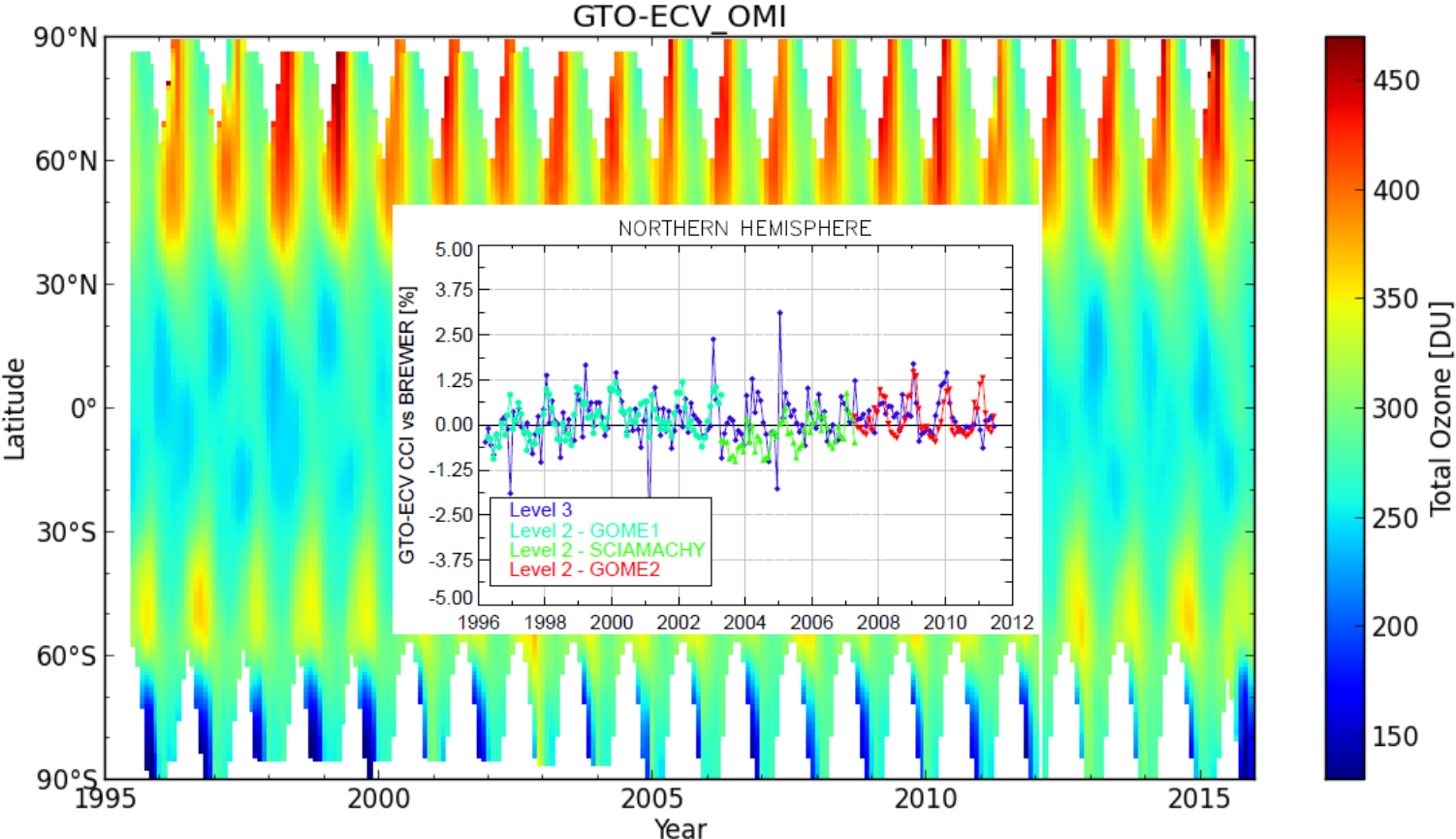


GTO-ECV Merging

- Level 2 based on GODFIT ozone retrieval version 3
 - Lerot et al., JGR, 2014 and Koukouli et al., JGR, 2015
- Level 3 merging is performed by using one instrument as reference and apply inter-sensor correction factors to the other sensors
 - Coldewey-Egbers et al., AMT 2015



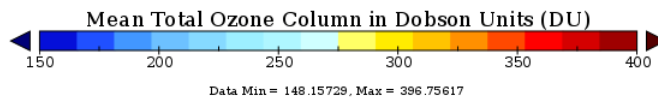
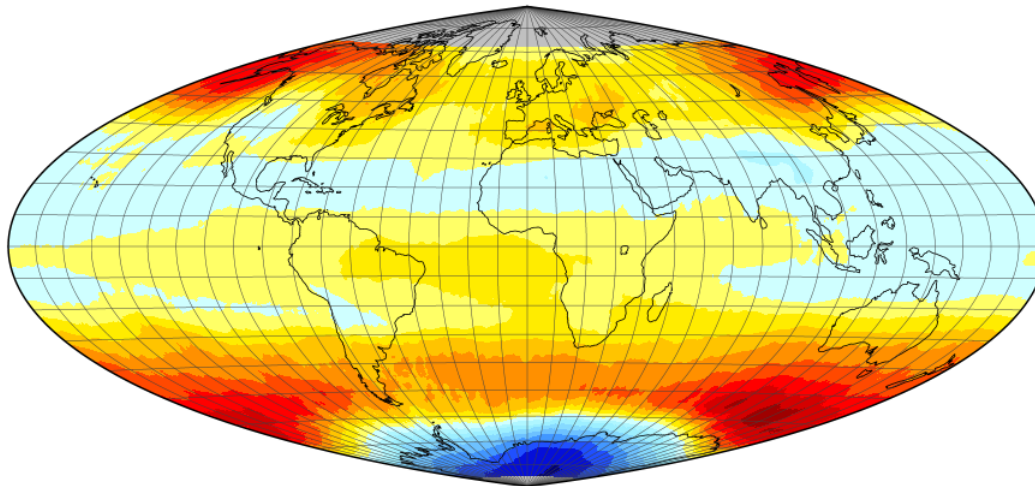
GTO-ECV Validation



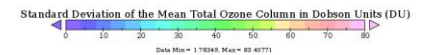
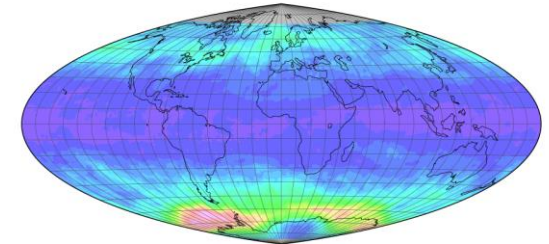
GTO-ECV Product Content

- Monthly mean grid 1°x1°grid data in netCDF CF
 - <http://www.esa-ozone-cci.org>
- Total ozone
- Standard deviation
- **Standard error** estimated using an OSSE

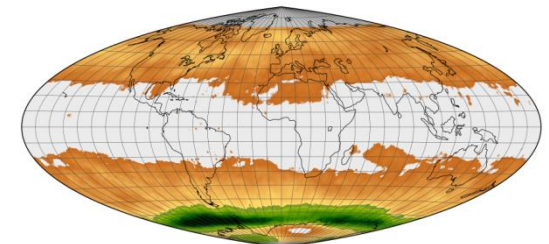
GTO-ECV October 2010
(GOME-2)



GTO-ECV October 2010
(GOME-2)



GTO-ECV October 2010
(GOME-2)



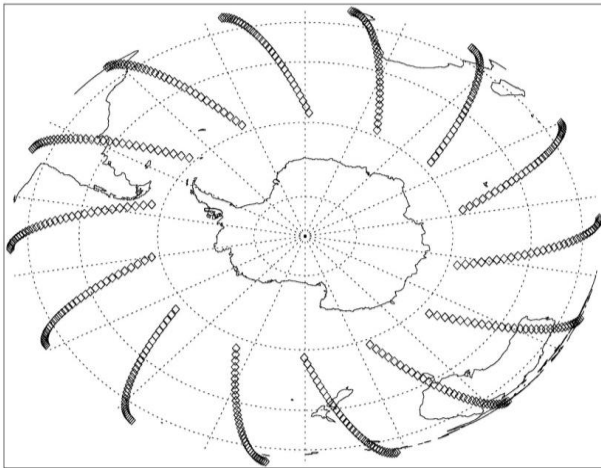
MERRA-2 Overview

- MODERN-ERA RETROSPECTIVE ANALYSIS FOR RESEARCH AND APPLICATIONS
 - Based on the GEOS-5 assimilation system
- Input:
 - Ozone profiles & total column (SBUV 1980-2004, MLS/OMI 2004-present), winds, temperature, pressure
- Ozone Output:
 - 72 vertical layers (about 1km in stratosphere)
 - 576 x 360 gridded data (0.625 x 0.5 degree)
 - Ozone profile (every 3 hours)
 - Total Ozone (every hour)
 - 1980 to present
 - Global daily maps (pole to pole)

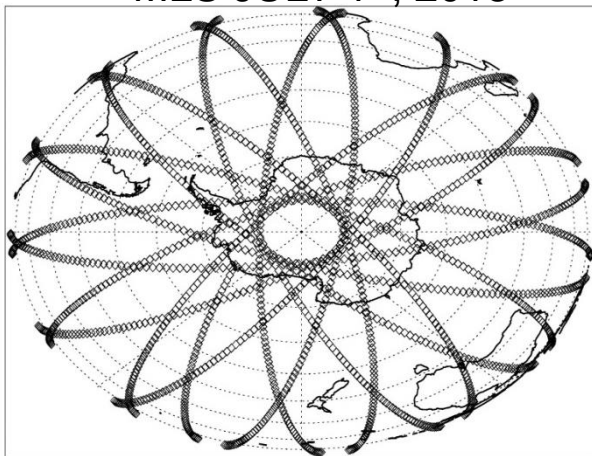


MERRA-2 Issues with the SBUV input

SBUV JULY 1st, 2003

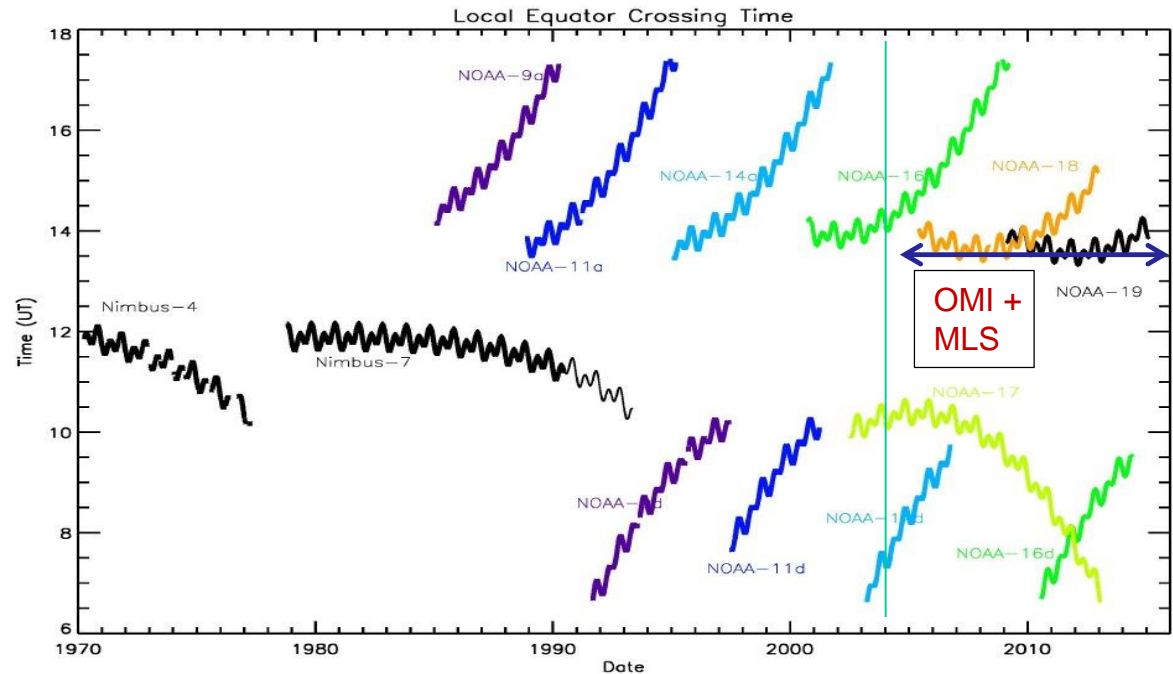


MLS JULY 1st, 2013



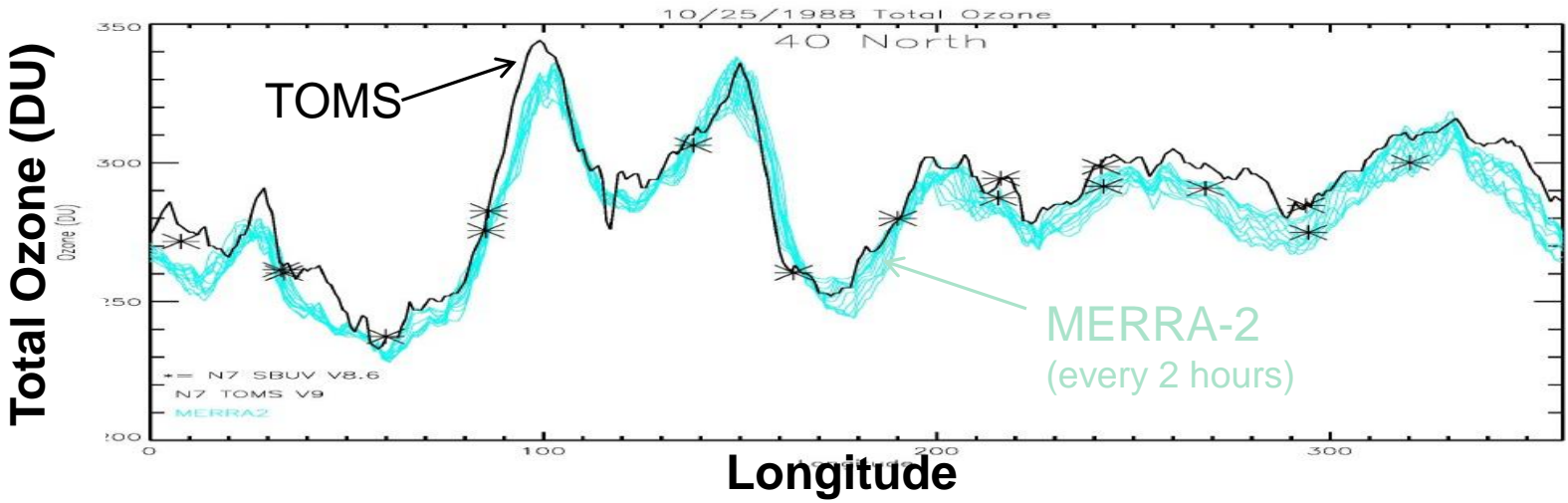
Nadir only (80N to 80S)
Drifting orbits
No data in Polar night

MLS resolves many of these issues

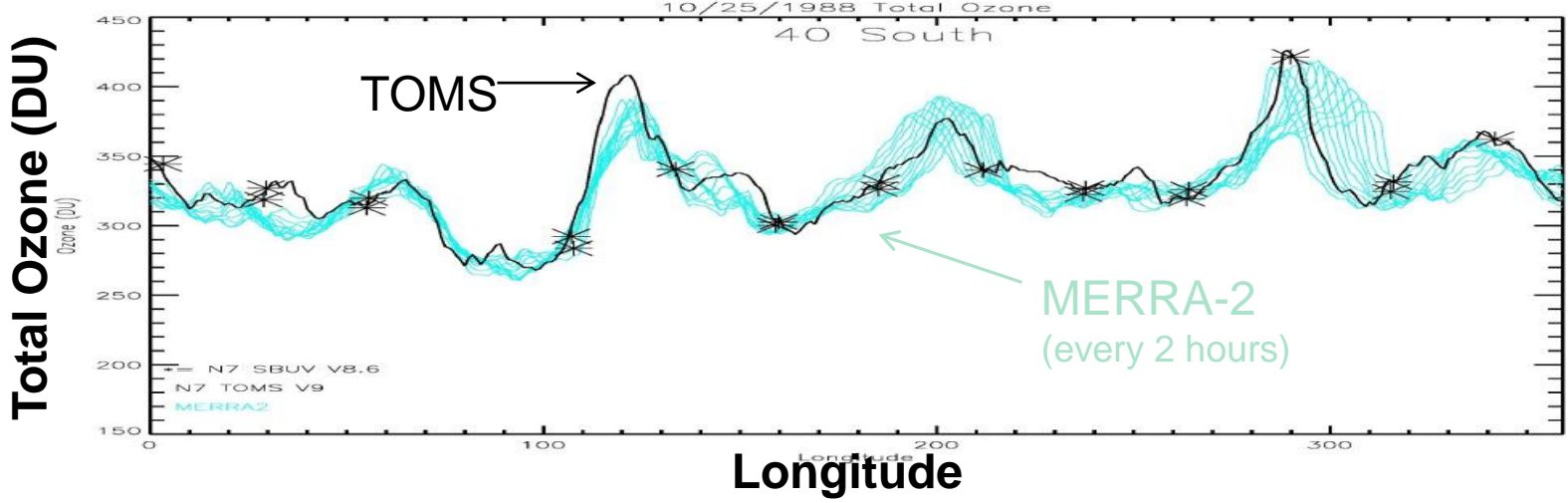


MERRA-2 comparison with TOMS

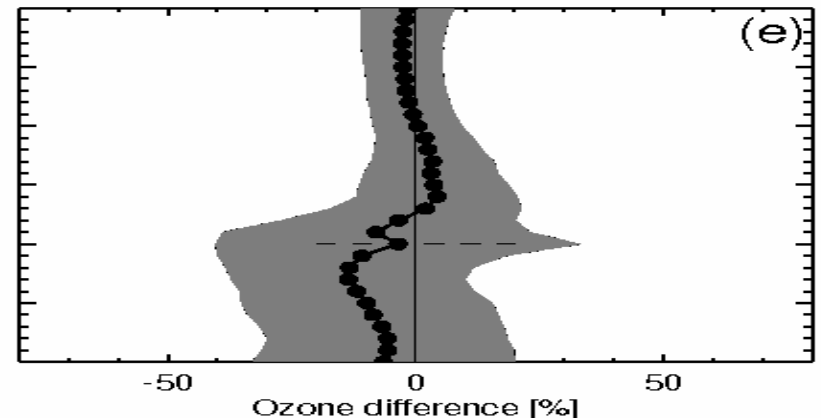
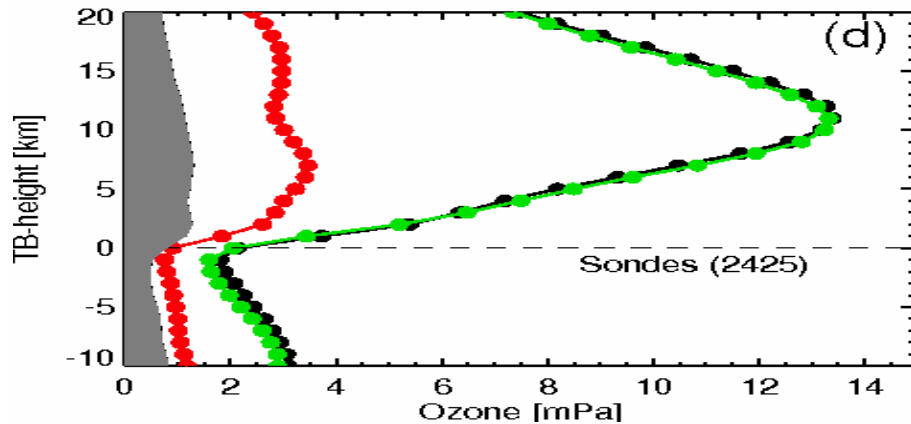
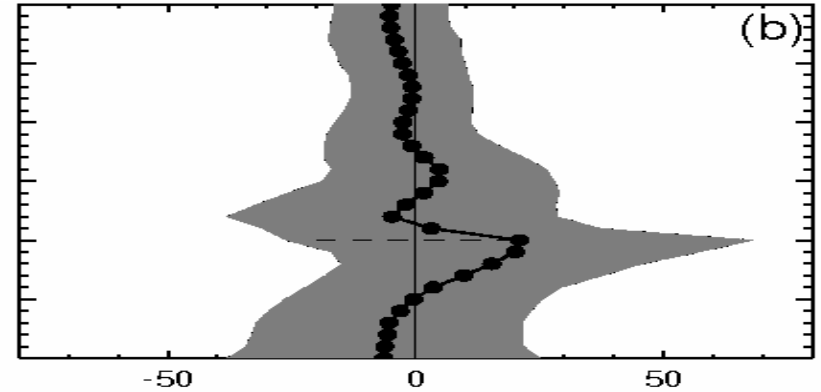
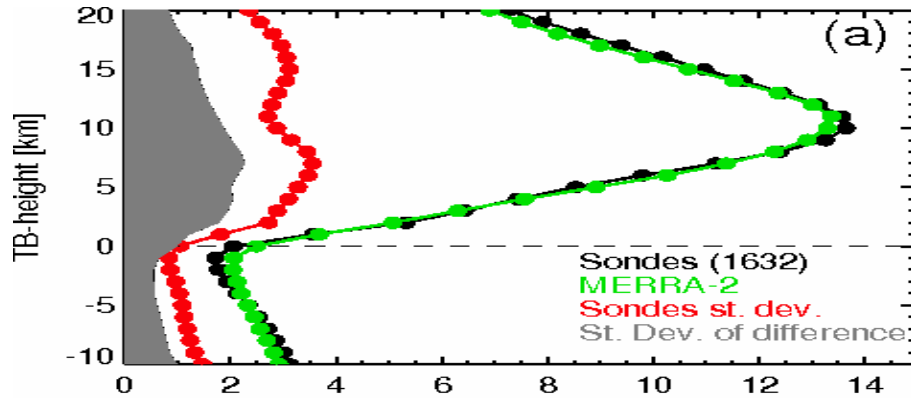
10/25/1988 Column Ozone at 40 North



10/25/1988 Column Ozone at 40 South



MERRA-2 comparison to ozonesondes



Statistical comparisons of MERRA-2 ozone against global ozonesondes available in 2003 (a-b) and 2005 (d-e). All data are interpolated to the tropopause-based vertical coordinate. Ozone sondes (black) and MERRA-2 (green). Standard deviation of ozonesonde (red).



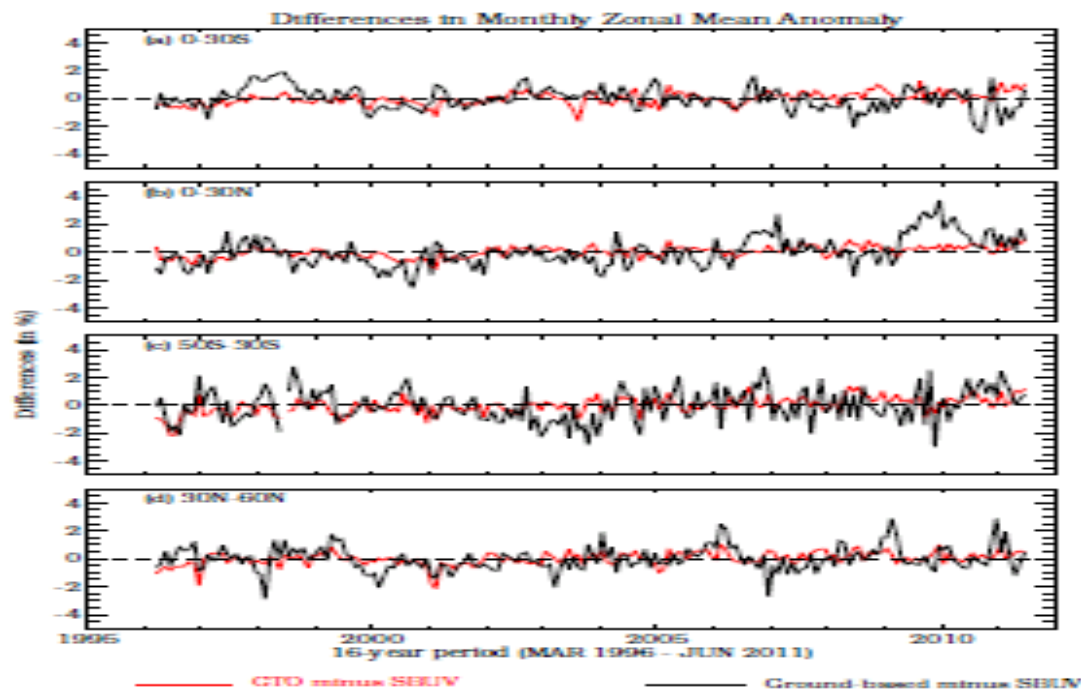
GTO-ECV and SBUV-MOD Comparison

Comparison of profile total ozone from SBUV (v8.6) with GOME-type and ground-based total ozone for a 16-year period (1996 to 2011)

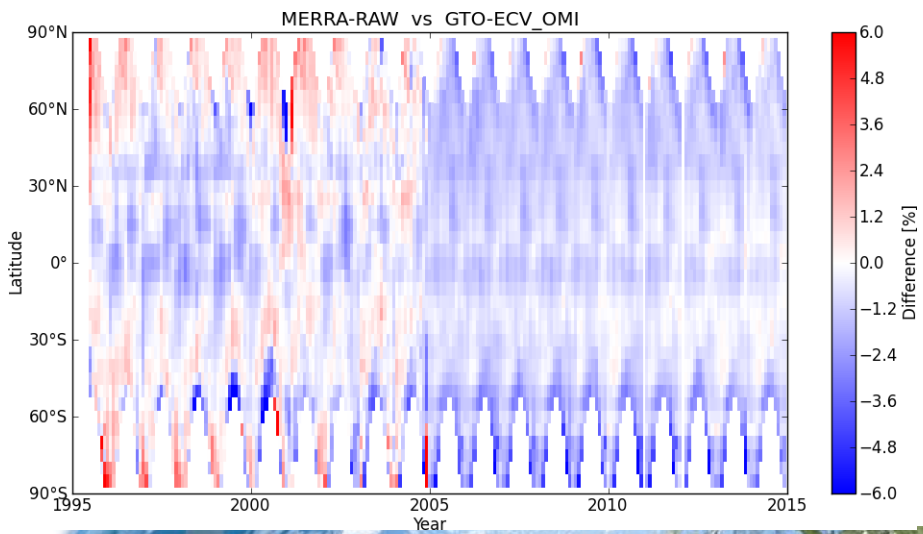
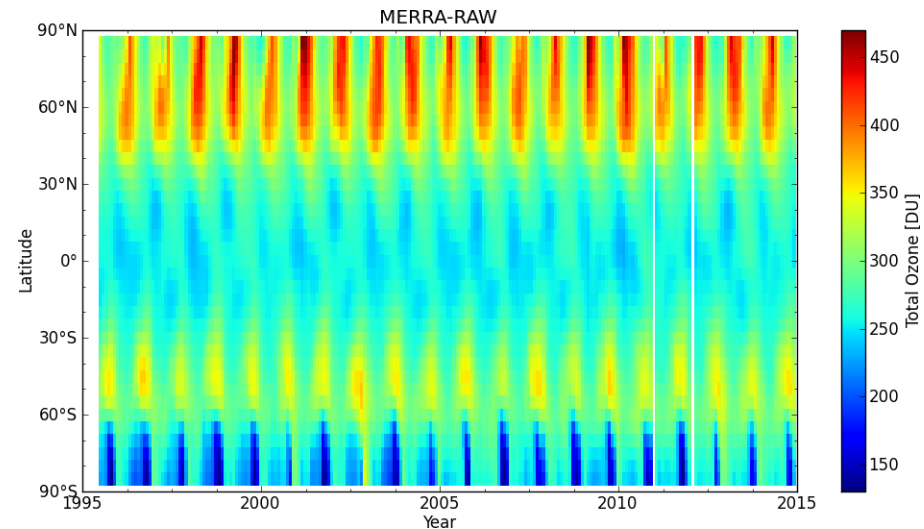
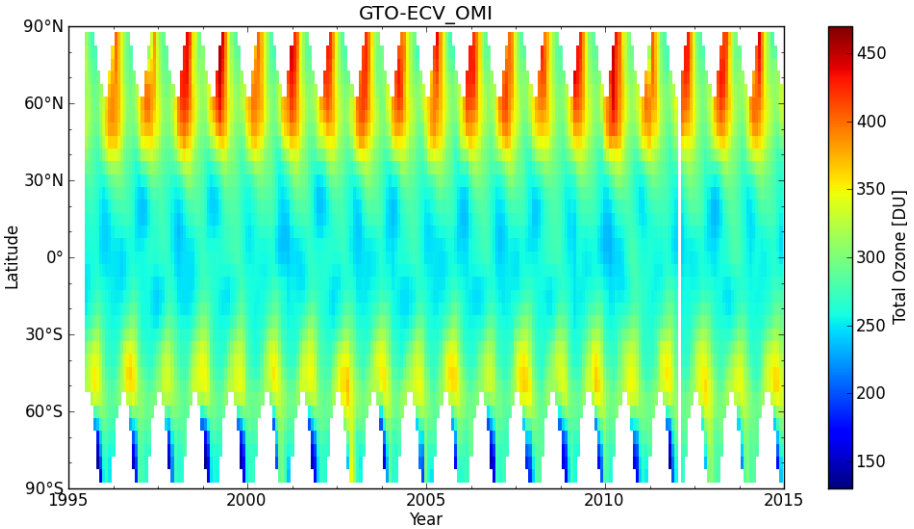
Atmospheric
Measurement
Techniques



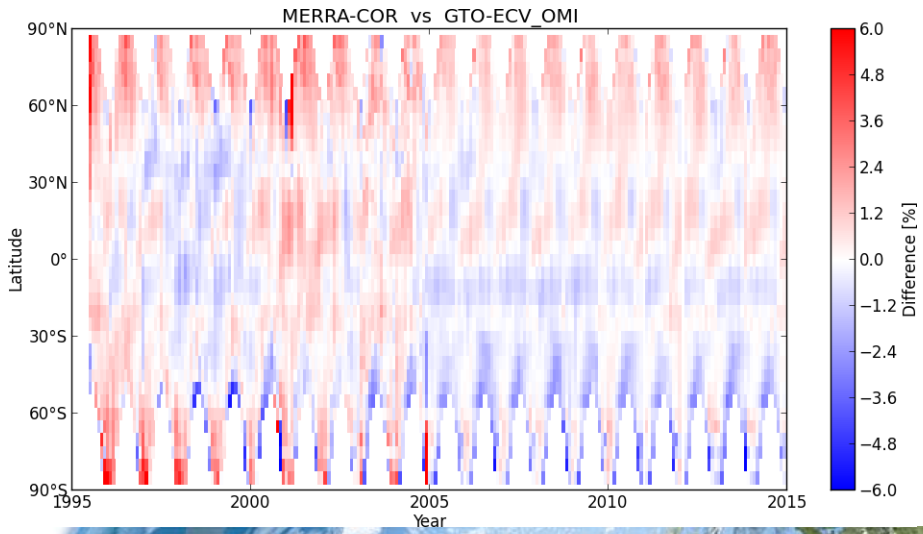
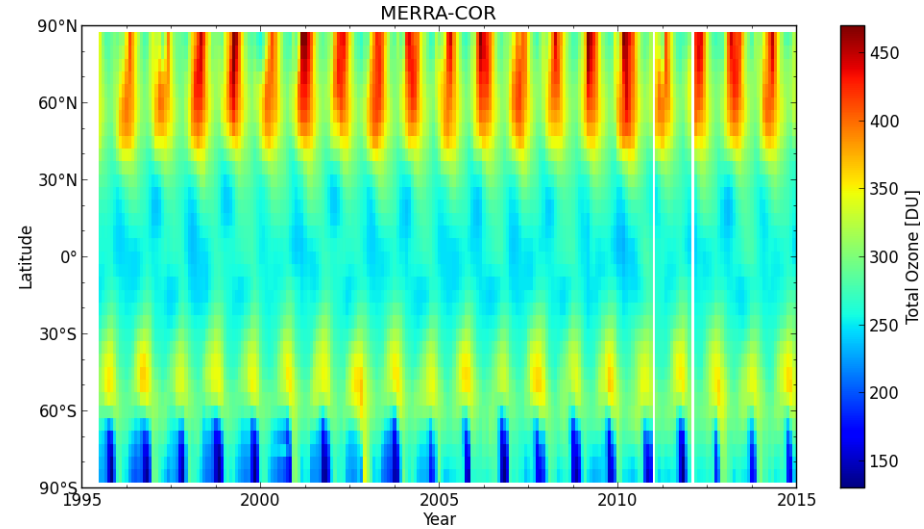
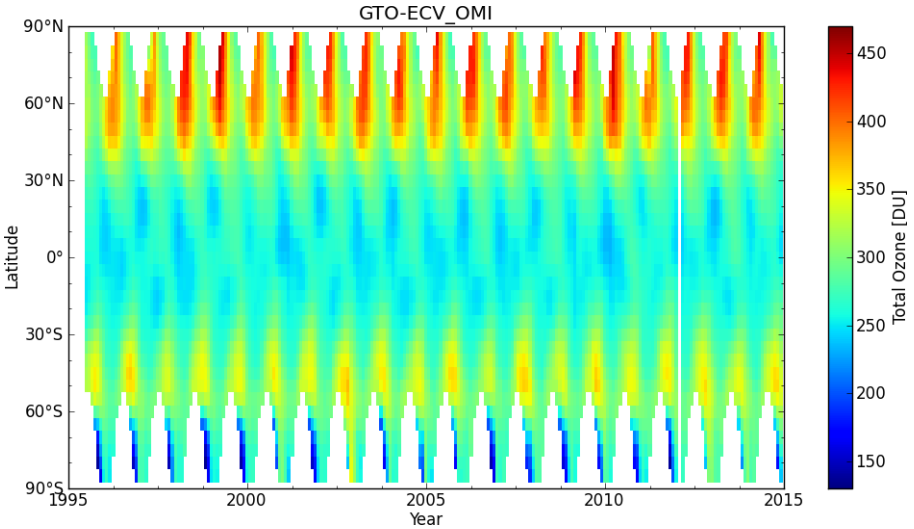
E. W. Chiou¹, P. K. Bhartia², R. D. McPeters², D. G. Loyola³, M. Coldewey-Egbers³, V. E. Fioletov⁴, M. Van Roozendael⁵, R. Spurr⁶, C. Lerot⁵, and S. M. Frith⁷



GTO-ECV and MERRA-2 Zonal Mean

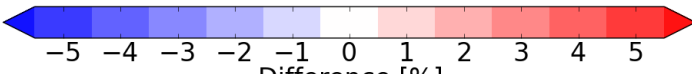
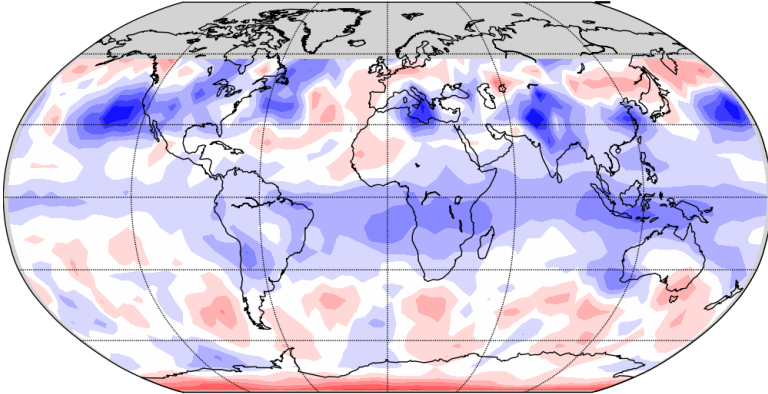


GTO-ECV and MERRA-2-CORR Zonal Mean

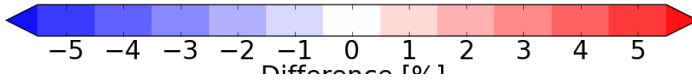
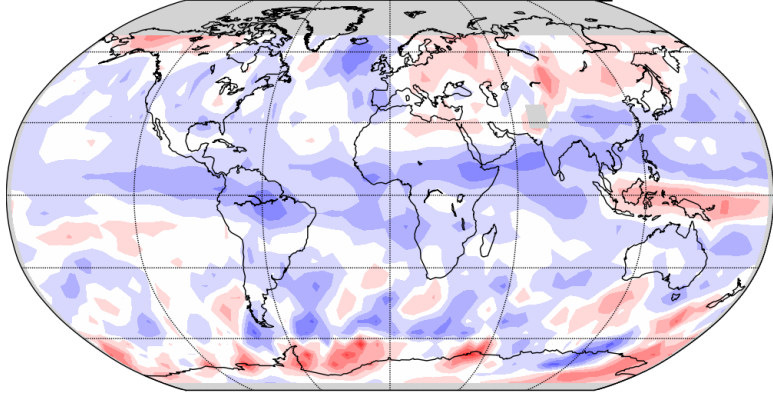


GTO-ECV and MERRA-2 Grid

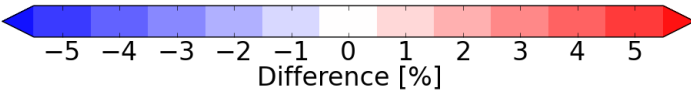
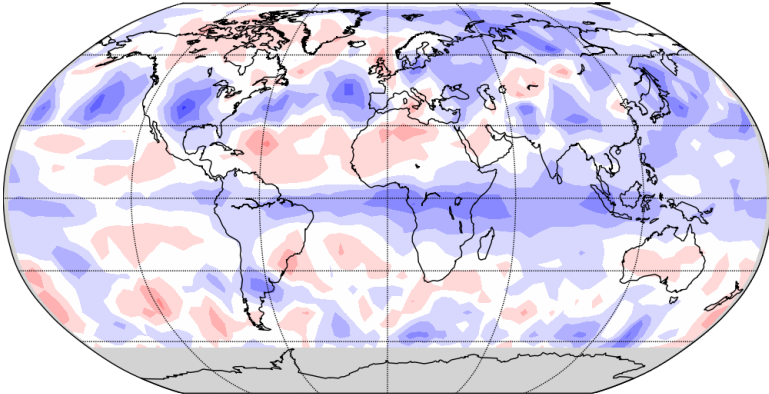
MERRA-RAW vs GTO-ECV 1997 01



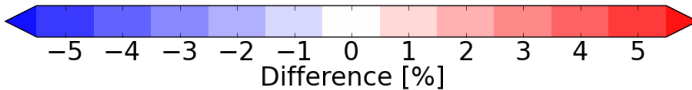
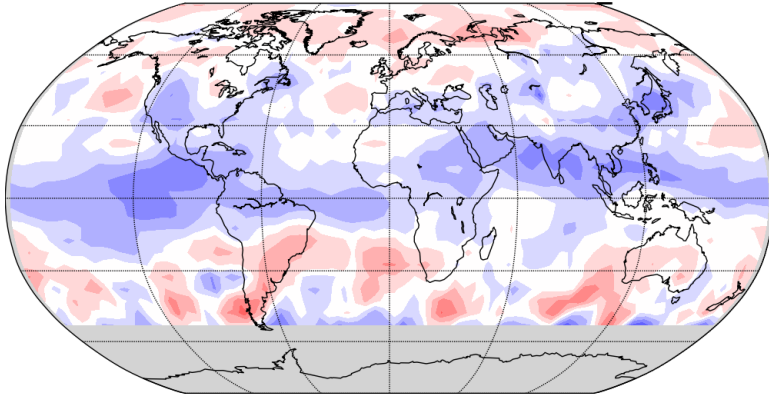
MERRA-RAW vs GTO-ECV 1997 10



MERRA-RAW vs GTO-ECV 1997 04

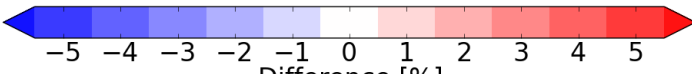
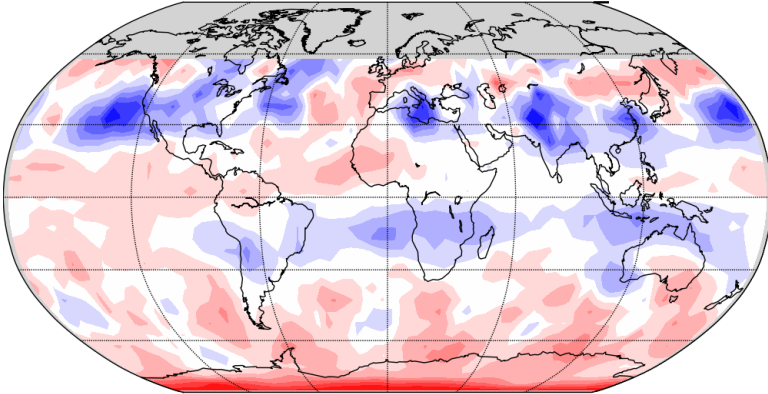


MERRA-RAW vs GTO-ECV 1997 07

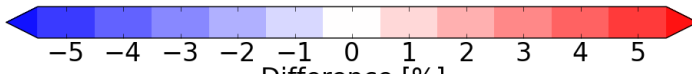
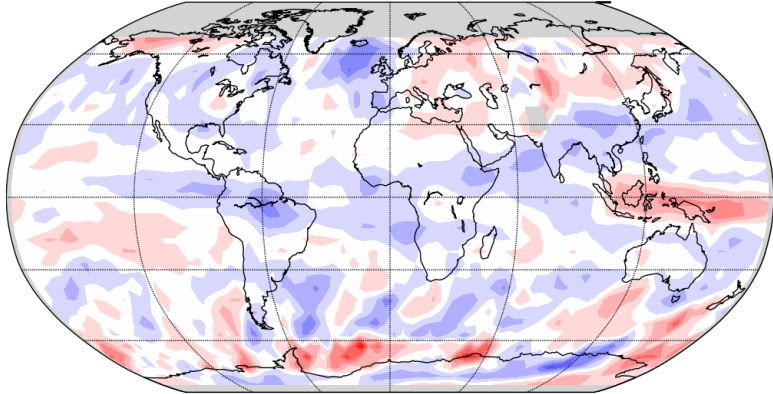


GTO-ECV and MERRA-2-CORR Grid

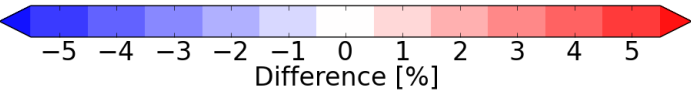
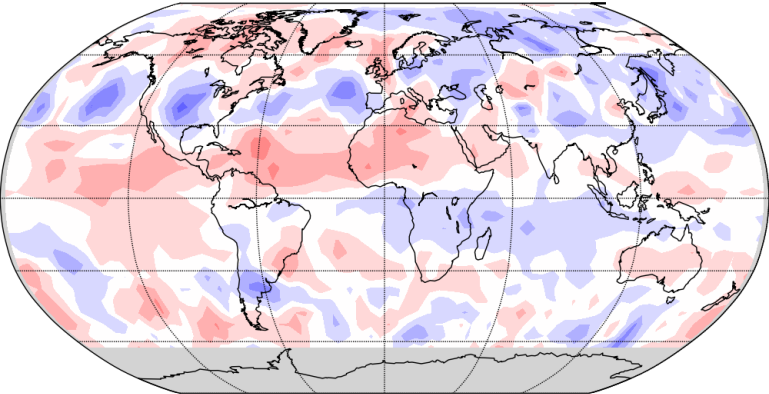
MERRA-COR vs GTO-ECV 1997 01



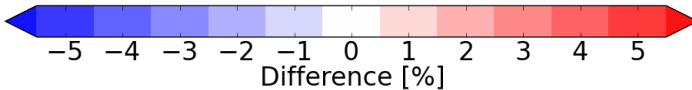
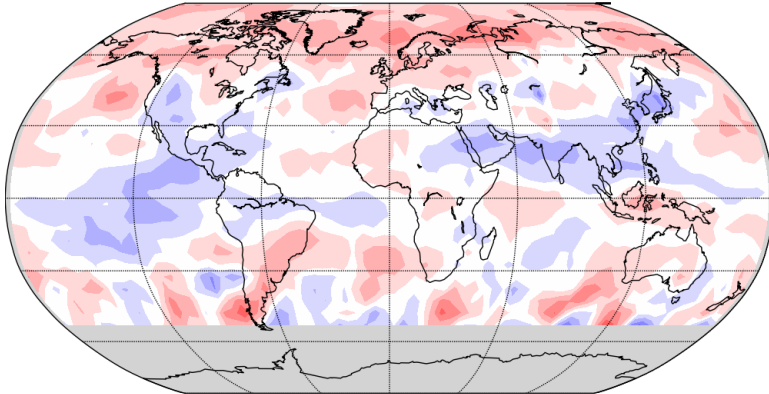
MERRA-COR vs GTO-ECV 1997 10



MERRA-COR vs GTO-ECV 1997 04

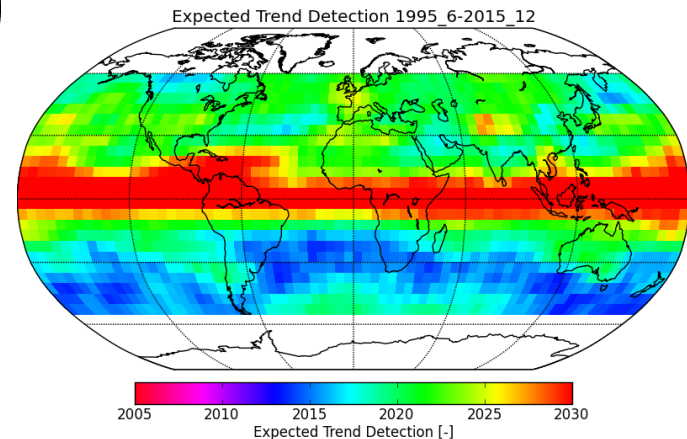
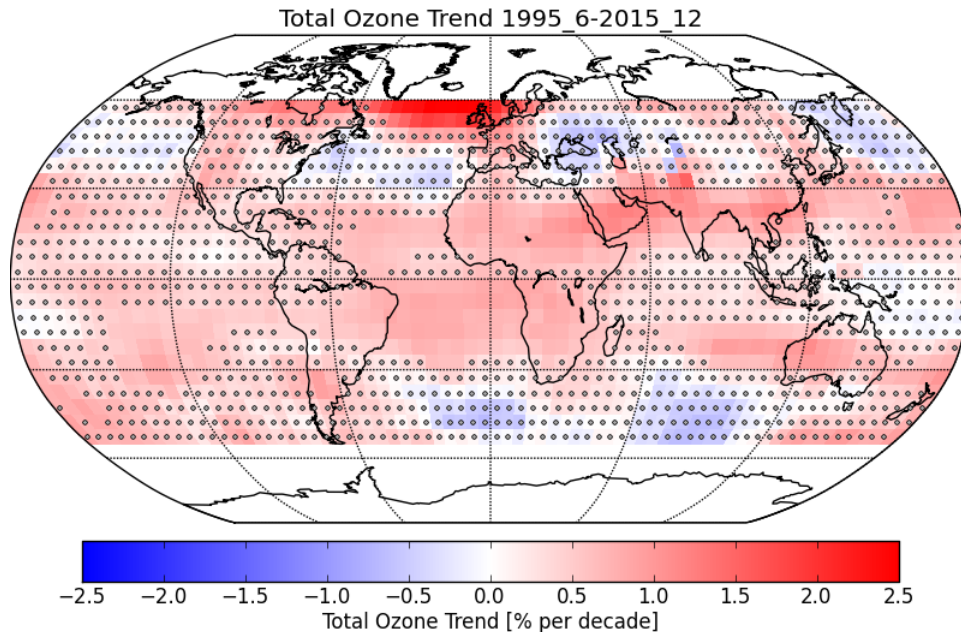


MERRA-COR vs GTO-ECV 1997 07



Outlook – Total Ozone in AC-VC 2017

- Finalize the comparison of GTO-ECV and MERRA-2 gridded data
- Extend GTO-ECV with TROPOMI/S5P and GOME-2/MetOp-C and update regional trends



Update of Coldewey-Egbers et al., GRL, 2014

