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Remote Sensing Group

National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

Ozone Profiling from Satellite UV nadir Sounders
Recent RAL Developments

RAL Remote-Sensing Group

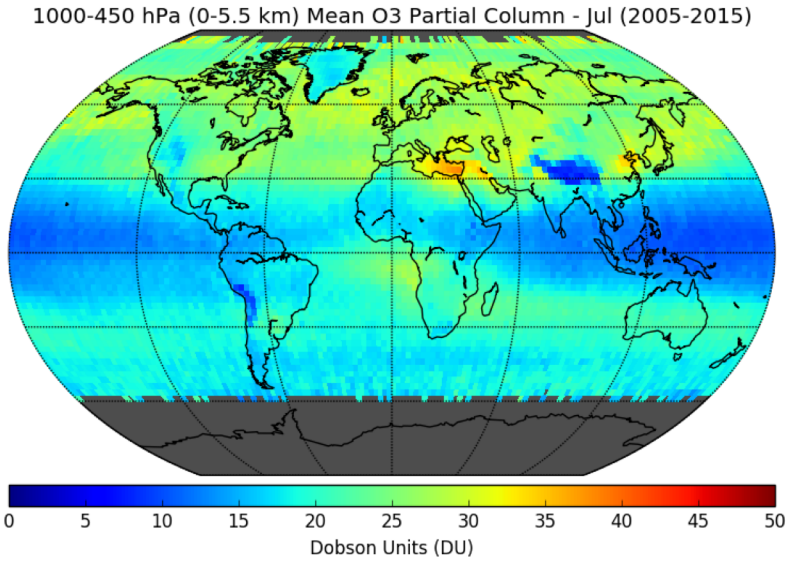
B. Kerridge, R. Siddans and B. Latter

Science & Technology Facilities Council

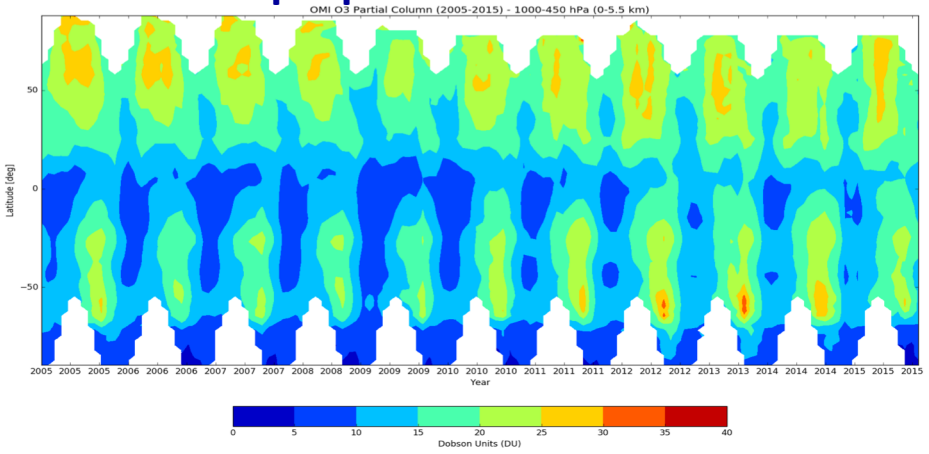
esa

ECMWF Copernicus Europe's eyes on Earth European Commission

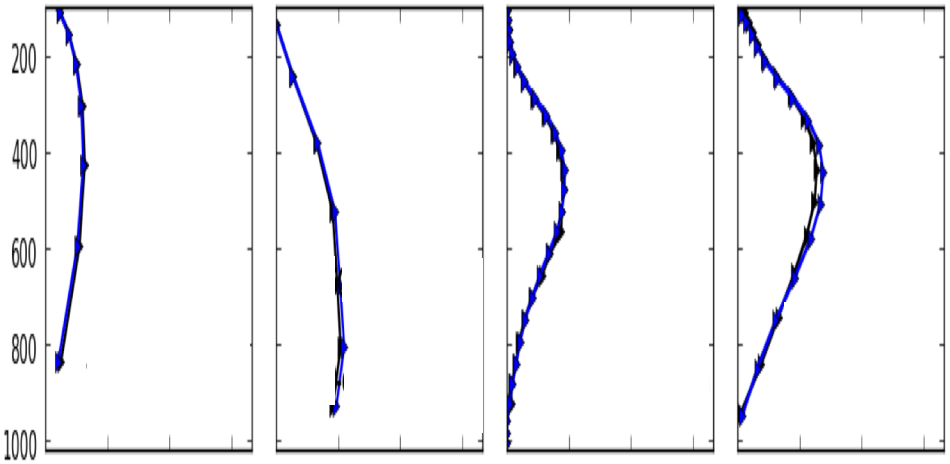
RAL OMI Tropospheric Ozone / TOAR



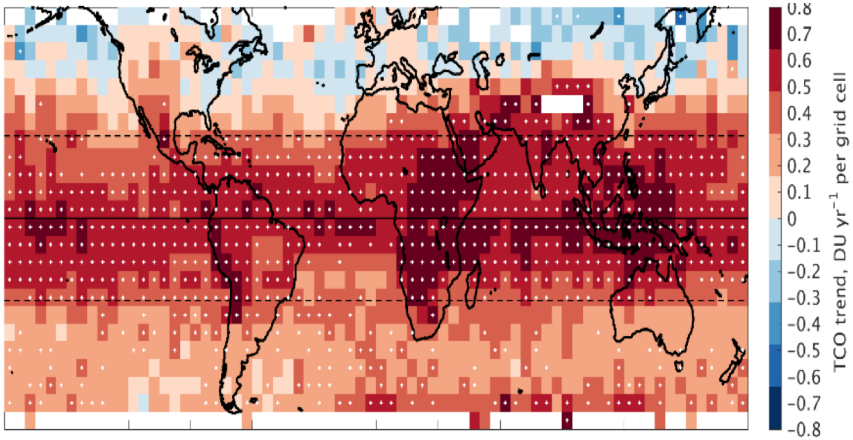
OMI tropospheric ozone 2005-15



OMI-Harvard | OMI- RAL | IASI-SOFRID | IASI-FORLI



RAL OMI tropospheric ozone trend 2005-15



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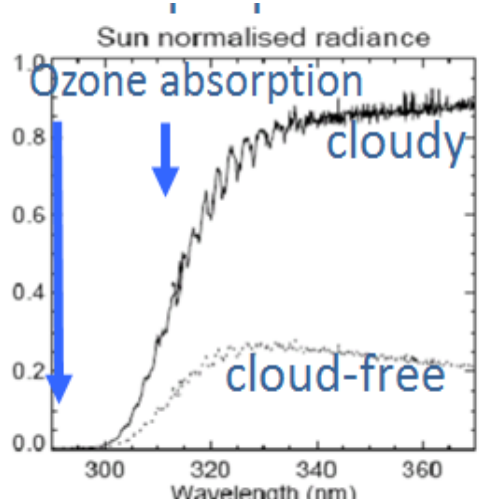
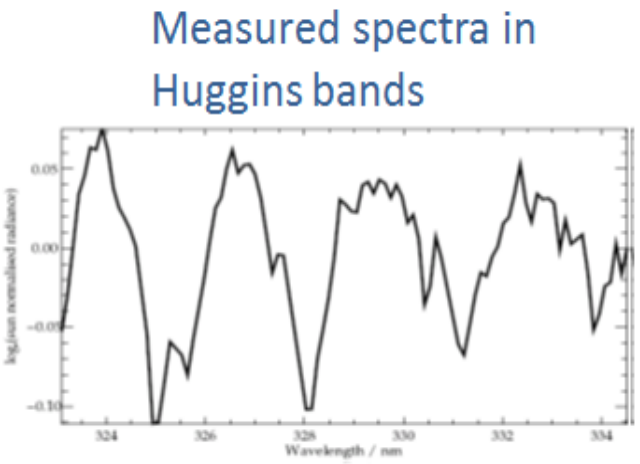
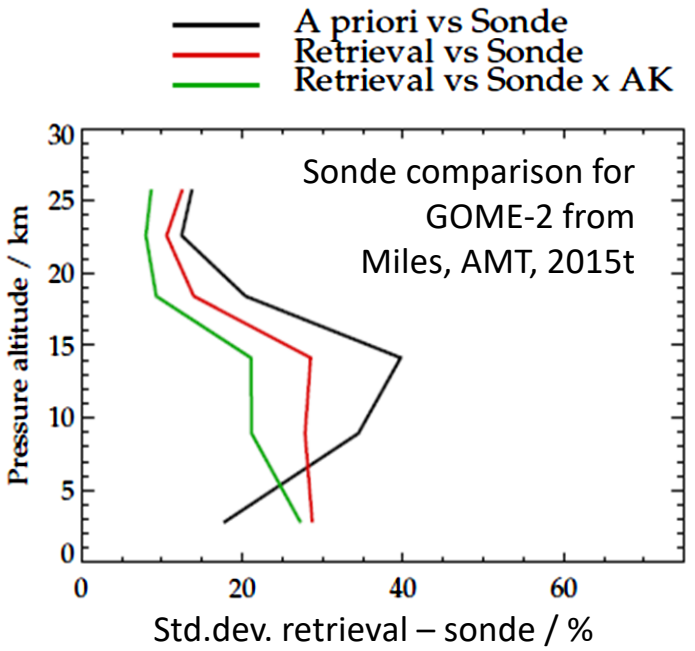
RAL UV Nadir Ozone Scheme Overview

- 3-step retrieval: band 1a, surface albedo, band 2b.
- Uses absolute sun-normalised radiance in Hartley and “DOAS” spectra in Huggins
- Hartley band, has information on stratospheric profile. Relies on very good absolute calibration. *Need empirical correction for absolute calibration errors / degradation.*
- Huggins band T-dependence has information on tropospheric ozone, requires precision of fit better than 0.1% : *Requires detailed modelling of instrumental changes (esp spectral response) as well as accurate radiative transfer modelling*

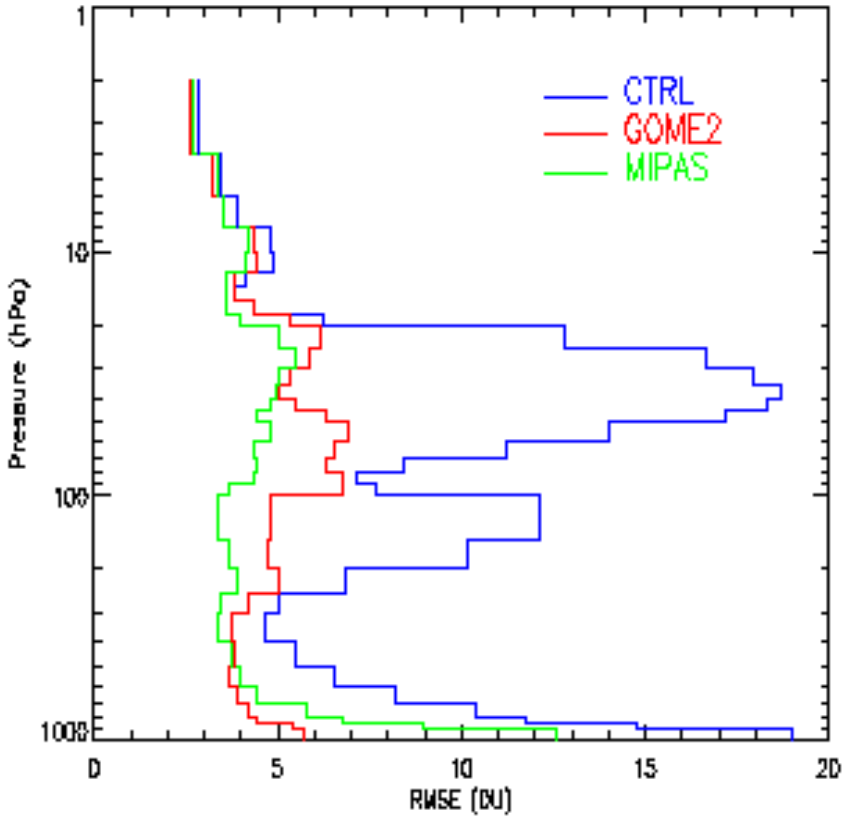






ECMWF Assessment of GOME-1 and GOME-2

Analysis – Sonde RMS difference
30-60N Aug-Oct'08



CTRL - assimilates O_3 column & SBUV 6 partial columns

RAL's GOME-1 & -2A data sets selected by ECMWF for ERA-5

R.Dragani, CCI Climate Modelling User Group Report, July 2015

OMI Retrieval Scheme

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- Spectral range: 270-307 nm from UV1; 321-338nm from UV2
- Joint fit of NO2, BrO, Formaldehyde, albedo, Ring scale factor, wavelength mis-registration, radiometric gain/offset parameters; cloud from operational L2.
- Modelling of Ring effect updated to better model effect on ozone absorption
- Uses Serdyuchenko cross-sections – after applying an optimised wavelength shift in Huggins range – these then lead to (slightly) better fit and bias in tropospheric ozone cf BMD
- So far we process at coarse spatial sampling due mainly to computational resource limits (but also to reduce noise)
  - UV2 pixels averaged 2x4 across-along track to approx 50x50km resolution.
  - UV1 averaged to match this
- Uses fixed solar referenced spectrum (median Nov 2004)
- Spectral response from fitting super-Gaussian to solar reference spectrum (varies x-track, constant with time)

New GOME-1 & GOME-2 Processing

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- Developments for RAL OMI height-resolved ozone now applied to full processing of GOME-1 and GOME-2 Metop A.
- To mitigate effect of variations in spectral response function (esp. of GOME-2), GOME-1 and GOME-2 measurements convolved to spectral resolution similar to OMI (0.45nm) – same spectral fit window as OMI used.
  - Slit function retrieved from direct-sun spectra
  - Spectral response function width scale factor retrieved in orbit (relative to solar fit)
- Radiometric offset with spectral dependence fitted in B2 (like OMI)
- Degradation correction improved in B1
- New degradation correction developed in B2 to ensure stable surface albedo retrieval during mission.
- Latest options to treat solar diffuser BRDF at L1 implemented (both instruments)
- Averaging kernels improved
- Flagging of reduced information content in South Atlantic Anomaly improved.
- More stable time-series than previous versions of GOME-1 & GOME-2 processing, *without* need for joint fitting of systematic residuals to account for previously unexplained FM errors (cf fit of several patterns for GOME-2 previously)

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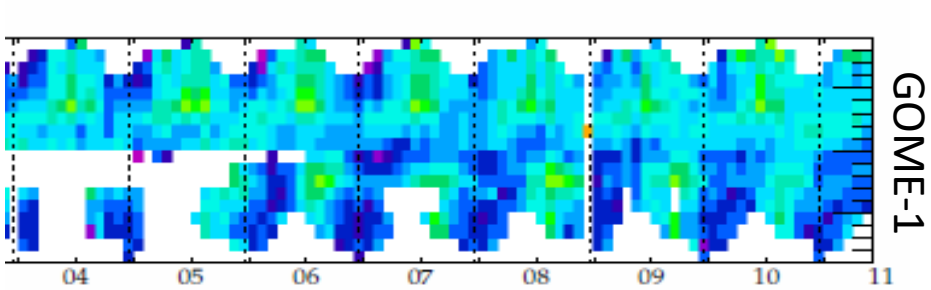
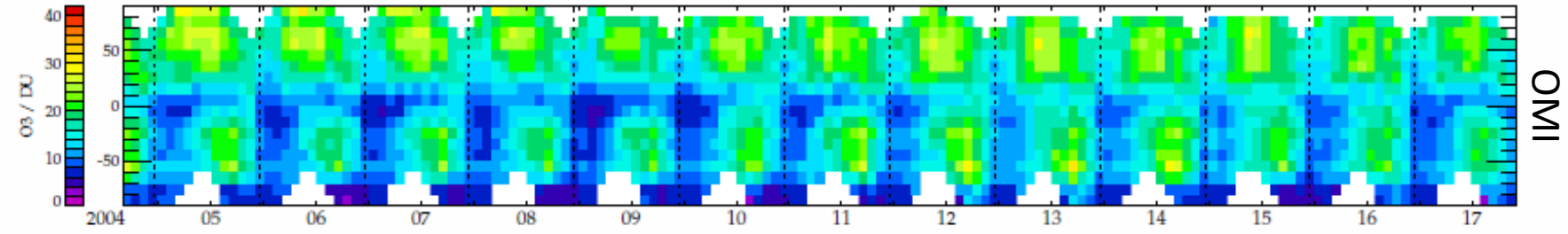
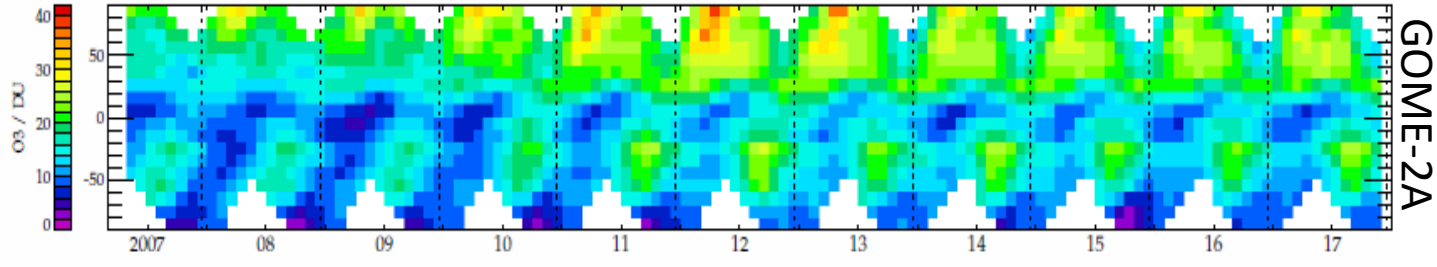
CCI O3

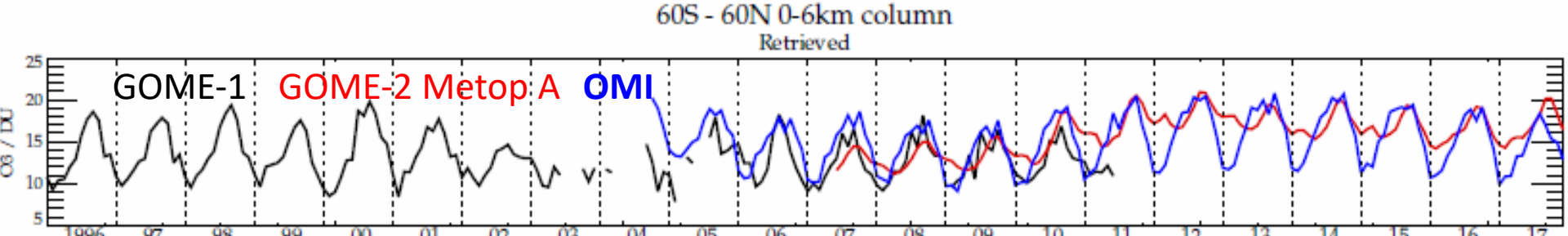
GOME-1, GOME-2 & OMI time-series produced by RAL for EU Copernicus Climate Change Service (C3S)



GOME-1 & -2A time-series more stable than earlier versions







Summary

- RAL's GOME-1 & -2A data sets selected by ECMWF for ERA-5
- New GOME-1 and GOME-2A and extended OMI multi-year global height-resolved data sets produced by RAL with consistent scheme:
  - UV degradation correction (GOME-1 & 2A)
  - Measurement-vector (spectral range & sampling)
  - State-vector (geophysical & instrumental variables)
  - Ozone absorption cross-section (Surdyuchenko)
  - Spectral response function & use of direct sun spectrum
- Delivered to Copernicus Climate Change Service in April
- Work underway to assess and reconcile data sets on 1000-450Pa layer
  - E.g. adjustment for bias in annual cycle against ozone sonde ensemble
- SCIAMACHY and GOME-2B to be reprocessed with improved scheme