Monitoring Ozone Layer over Iraq by Space Tools

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Abstract

Ozone is one of important atmospheric components, which has significant impacts on human health and global environment and climate change. The present study is a qualitative research deals with monitoring the concentrations of total ozone over Iraq using global images obtained from (TOMS) on board Nimbus-7 (1978-1993), Meteor-3 (1991-1994), ADEOS (1996-1997), Earth Probe (1996-2005) missions and from OMI on board Aura (2004-2016). Monitoring of total ozone during (1978-2016) showed presence of ozone hole over Antarctica which started during 1980 and continued till this period in appearance especially during September and October. When monitoring of total ozone over Iraq in that period appeared remarkably low concentration in the total ozone extends from southern Iraq to the Arabian Peninsula, especially during 2005 on December. In 10th December 2005 noted a sharp decline in the total ozone reached a value to less than (220 Dobson Unit) over Iraq, and this value comparable to value of ozone hole. Deviation of total ozone level from normal (1978-1988 level) during day (10 December 2005) over the area of Iraq it was noted from total ozone images and estimated to be (-25%, -30%) for TOMS instrument, which was larger than that estimated for each of the other two (-20%, -25%) SCIAMACHY and (-15%, -20%) SBUV/2.

Key Words: Total Ozone, Monitoring, TOMS, Meteor-3, ADEOS and Earth Probe and OMI**.**

المراقبة الفضائية لطبقة الأوزون فوق العراق

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الخلاصة

يعد الأوزون من المركبات المهمة في الغلاف الجوي الأرضي لما له من تأثير على صحة الإنسان والبيئة العالمية وتغير المناخ . الدراسة الحالية اهتمت بمراقبة تراكيز عمود الاوزون الكلي فوق العراق من خلال صور عمود الأوزون الكلي المأخوذة من اجهزة TOMS المحمولة على الاقمار (1978–1993)Nimbus–7 (1994– Meteor–3 (1991, ، (1996–1997) ADEOS، (1996–2005) Earth Probe والمتحسس OMI (2004–2016) المحمول على القمر Aura. ولوحظ خلال الفترة (1979–2016) إن ثقب الأوزون فوق القطب الجنوبي ابتدأ عام 1980 واستمر في الظهور خلال أشهر الخريف وخاصة خلال شهري سبتمبر وأكتوبر وبقيم اقل من (200 DU). وعند مراقبة منطقتنا في تلك الفترة لوحظ انخفاض ملفت للنظر في تركيز عمود الأوزون الكلي يمتد من جنوب العراق إلى منطقة الجزيرة العربية خصوصاً خلال شهر ديسمبر عام 2005. وفي يوم 10 ديسمبر لوحظ هناك انخفاض حاد في تركيز عمود الأوزون الكلي وصل تقريبا إلى قيمة (220 DU) فوق منطقة العراق والتي تشبه قيم ثقب الأوزون. الانحراف السلبي لتركيز عمود الأوزون الكلي عن المستوى الاعتيادي (1978–1988level) خلال يوم 10 ديسمبر عام 2005 المحسوب من بيانات عمود الأوزون الكلي فوق منطقة العراق يقدر تقريباً بنسبة (25%– to 30%–) لجهاز TOMS والتي هي اكبر مما قدرت لكل من جهازي (20% –to 25%–) SCIAMACHY و(10%– to 20%–) SBUV/2.

الكلمات المفتاحية:- الاوزون الكلي ، مراقبة، مسبار قياس الاوزون الكلي (تومس)، متيور-3، اديوس،ارث – بروب و اومي

Introduction

Space organizations and scientific groups employs space tools, on board total ozone (TOZ) measuring instruments of Total Ozone mapping Spectrometer (TOMS), Solar Backscatter Ultra-Violet (SBUV/2), (Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY) and Ozone Monitoring Instrument (OMI) etc. for real time monitoring of the global ozone layer. The global monitoring of TOZ indicates some abnormal phenomena in the stratospheric ozone layer (Köhler, 1999). In recent years, there has been growing interest in the monitoring of terrestrial solar ultraviolet radiation due to the increasing evidence of global depletion of stratospheric ozone. Any reduction in the thickness of the ozone layer will result in an increase of the arriving of ultraviolet radiation intensity to the earth surface. The depletion of the ozone layer has become a global issue, which focused the attention of scientists in various countries of the world, because it entails the risk harming humans, plants and animals. The international community has developed a preventive measure by putting Vienna Convention for the Protection of the Ozone Layer in 1985, which included the exchange of information, research and monitoring results to protect human health and the environment from the adverse effects that may result from the depleting ozone layer and penetrating harmful UV radiation. In 1987 the Montreal Protocol has been developed and established a schedule to reduce the production and consumption of CFCs and halons, which stimulate the erosion of the ozone layer (UNEP, 2000), (Buchdahl, 1999). Iraq joined the Vienna Convention and Montreal Protocol for ozone layer protection in 25/6/2008, hereby Iraq be the 193th member of the list of countries that have acceded to the International Convention for the protection Ozone layer (UNEP, 2008). Iraq and bounded countries lacks to ground based measuring instruments to calibrate space data of TOZ. Our activity, in Aeronautics and Space technology Directorate, Ministry of science and technology is oriented for applying the real time available space image data for monitoring the ozone layer over Iraq as a first step. In this qualitative research we surveyed the existing long-term global images of TOZ column to monitor ozone hole over Antarctic and changes in the concentration of ozone layer over Iraq

Material and Methods

In this study the global maps of TOZ which is available as data product from different satellite sensors is used. TOMS instruments developed by National Aeronautics and Space Administration (NASA) / Goddard Space Flight Center offered valuable space images sets for the period (1978 -2005) (TOMS, 2009) , (EO/NASA, 2009) except for December 1994 and 1995 because no data available) (TOMS, 2009), (Sahoo *et al.*, 2005). Image from OMI sensor on board Aura satellite is also used. The current study is focused on monitoring the monthly appearance of ozone hole over the Antarctic from TOMS and OMI during (1978-2016). Ozone hole appears (total ozone < 220 DU) over Antarctica (OHW, 2009), (EC, 2005).These images are studied for monitoring the historical variation of the TOZ over Iraq. A special case (day 10 December 2005) is observed by using space images of TOMS, SBUV/2, and SCIAMACH. (WOMM, 2009). The available data of these instruments used in this study are presented in Table (1).

Table (1) Information of the Total Ozone Column Images Sets Which Used in this Study

Organization	Satellite	Instrument	Temporal coverage	Spatial coverage	Temporal resolution used in this research
NASA	Nimbus-7	TOMS	1978-1993	Global	Monthly Map
NASA	Meteor-3	TOMS	1991-1994	Global	Monthly Map
NASA	ADEOS	TOMS	1996-1997	Global	Monthly Map
NASA	Earth Probe	TOMS	1996-2005	Global	Daily & Monthly Map
NASA	Aqua	OMI	2004-Present	Global	Monthly Map
NOAA	NOAA 9	SBUV/2	1984-2007	Global	Daily Map
KNMI/ESA	ENVISAT	SCIAMACHY	2004-present	Global	Daily Map

Results and Discussions

The images of the monthly averages of global TOZ for the period (1979-2016) were prepared by NASA and ESA for instrument TOMS and OMI. They illustrate the existence of ozone hole in Antarctica. The ozone hole began in October 1980 and continued to expand, especially on winter months for each year during (1980-2016). Table (2) shows the months where ozone hole appears over Antarctica.

In our region this space historical images are reviewed to monitor the ozone concentration and there variation over the time and the geographical coverage. During (1979-2016) we noted a high decline in TOZ over southern Iraq and a minimum concentration occurred during winter 2005. Figure (1) shows the global images of monthly averages of TOZ for 2005, which was noted to be remarkably low in December, especially over the southern part of Iraq.

Accordingly, we focus our study to see the average value of the TOZ for the month of December for the period (1979-2016) as shown in Figures (2a, 2b and & 2c). In these figures the TOZ data during (1979-2016) are taken from TOMS and OMI instruments. A minimum value of TOZ is presented over the southern Iraq on December 2005. Because of this lowest value, day by day monitoring images were prepared on December 2005 to determine the days of these lowest ozone concentrations. It found through this monitoring that there is a high decrease of the total ozone over Iraq in days (9, 10 & 11) of the aboue mentioned month, so the daily space images of ozone concentration for three instruments (TOMS, SBUV/2, SCIAMACHY) were prepared to study this phenomena. A special case study of December 2005 day shows that the instruments response is same and the lowest day was 10th December 2005. Figure (3) illustrate the images of the total ozone column for the three instruments TOMS, SCIAMACHY and SBUV/2 for the 10th December 2005. It was observed that the concentration of TOZ column over the area of Iraq is lowest in TOMS instrument than in SCIAMACHY and SBUV/2.The estimated values of total ozone (200-225 DU) for TOMS, (225-250 DU) for SCIAMACHY, and (225-250 DU) for SBUV/2. The deviation values of concentration of TOZ column from normal level (1978-1988 level) on 10th December 2005 for these instruments are illustrated in Figure (4). We noted that the deviation of TOZ from normal (1978-1988 level) over the area of Iraq are -25% to -30% for TOMS and -20% to -25% for SCIAMACHY and -15 to -20 % for SBUV/2 sensors.

Table (2) Monthly Appearance of Ozone Hole (Blue) Over the Antarctic from (TOMS and OMI) During (1978-2016)

Year\month	1	2	3	4	5	6	7	8	9	10	11	12
1978												
1979												
1980												
1981												
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2010												
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2013												
2014												
2015												
2016												

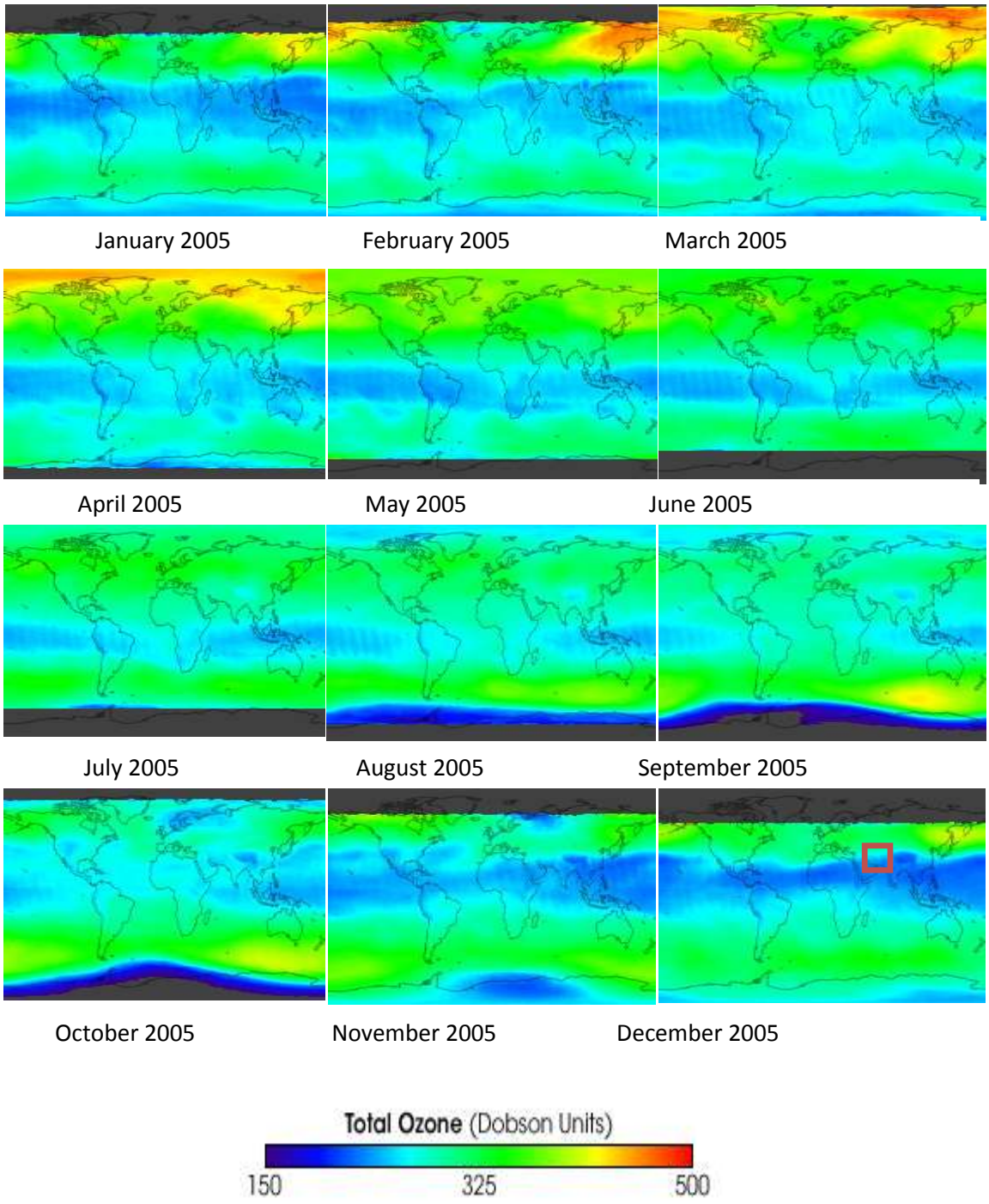


Figure (1) Monthly Images of Total Ozone Average for Year 2005 from Earth Probe (TOMS EP). ((EO) NASA)

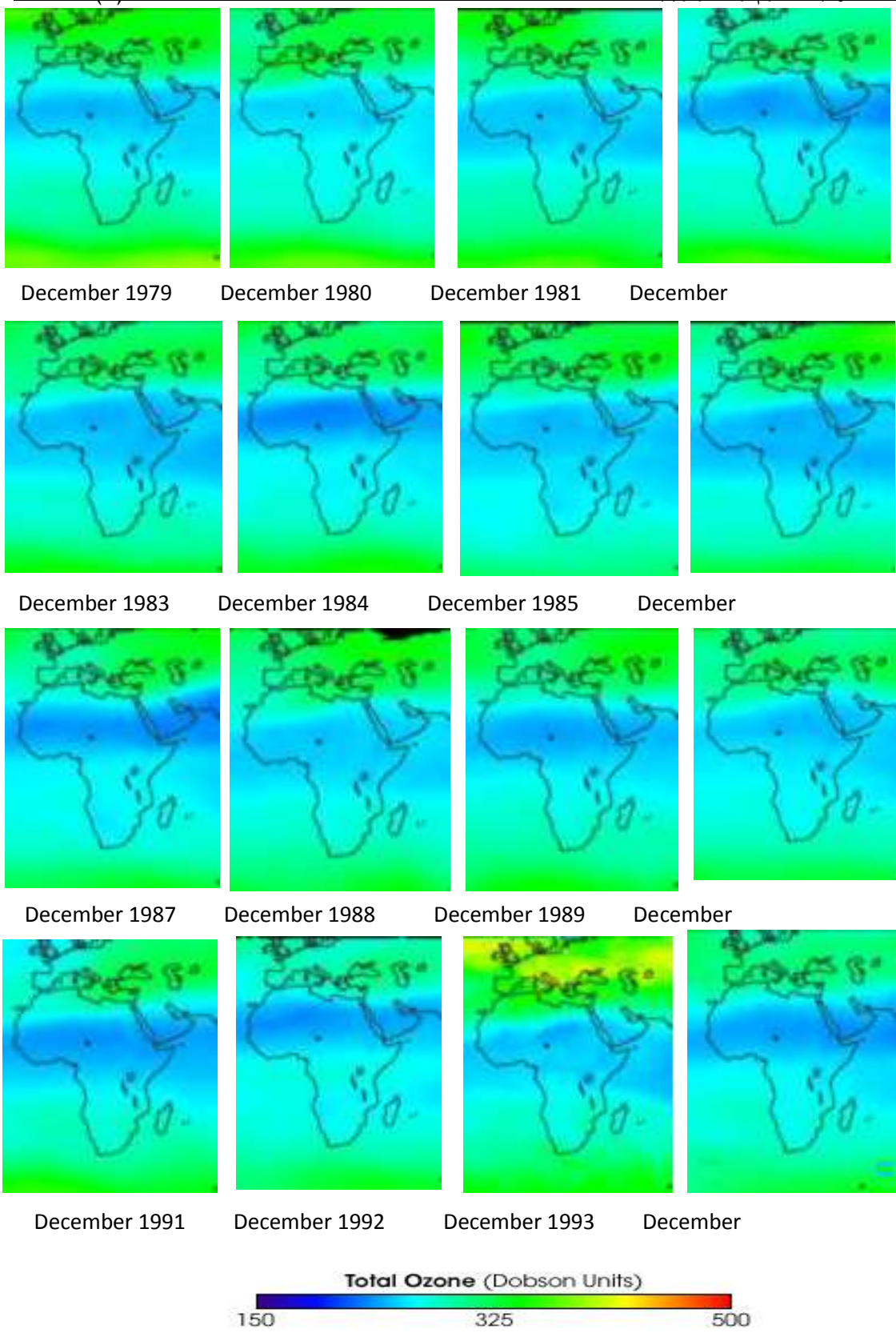


Figure (2a) December Mean of Total Ozone for Years (1979-1994) from TOMS (Except 1995 because no Data Available)

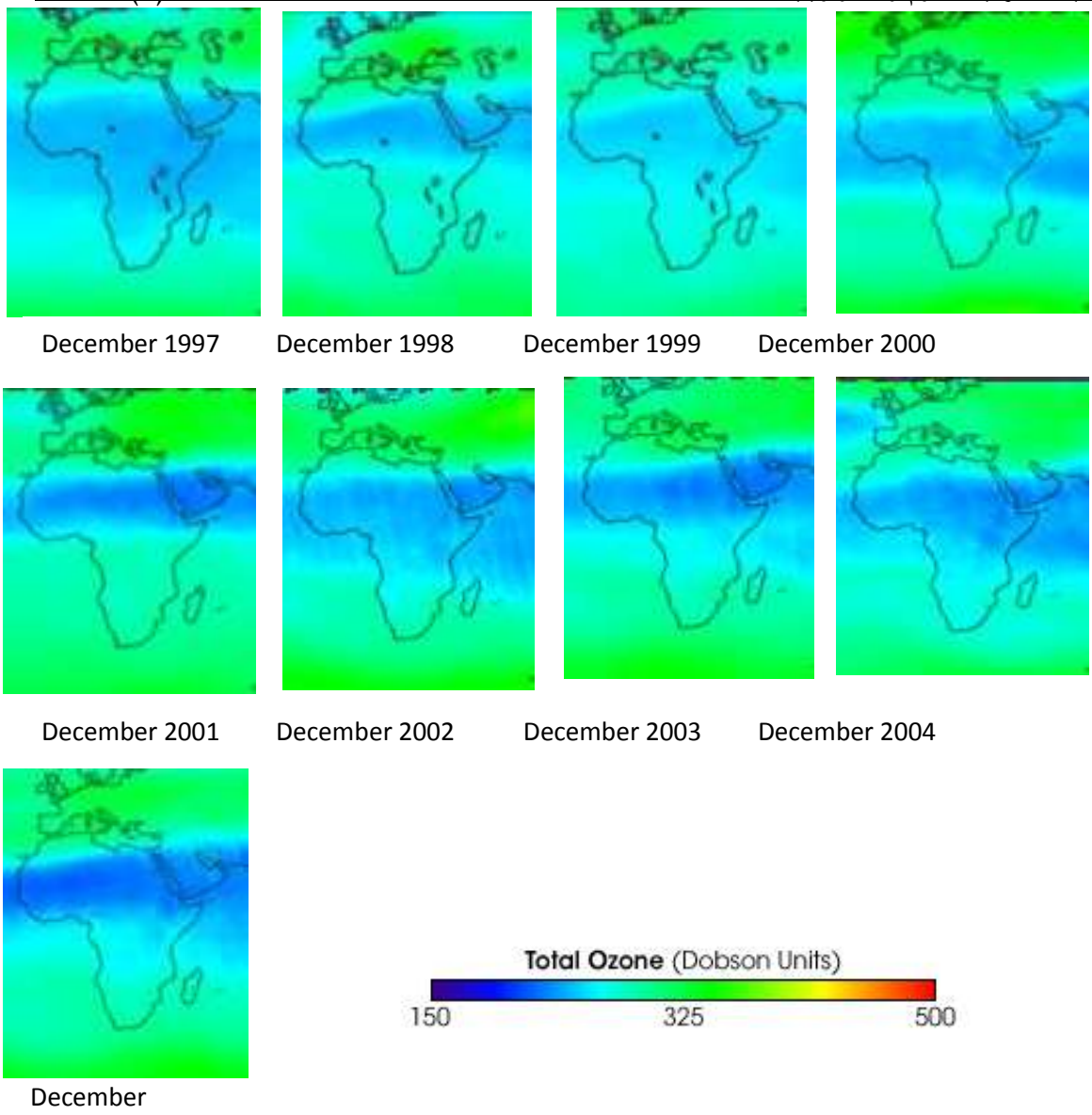


Figure (2b) December Mean of Total Ozone for Years (1996-2005) from TOMS

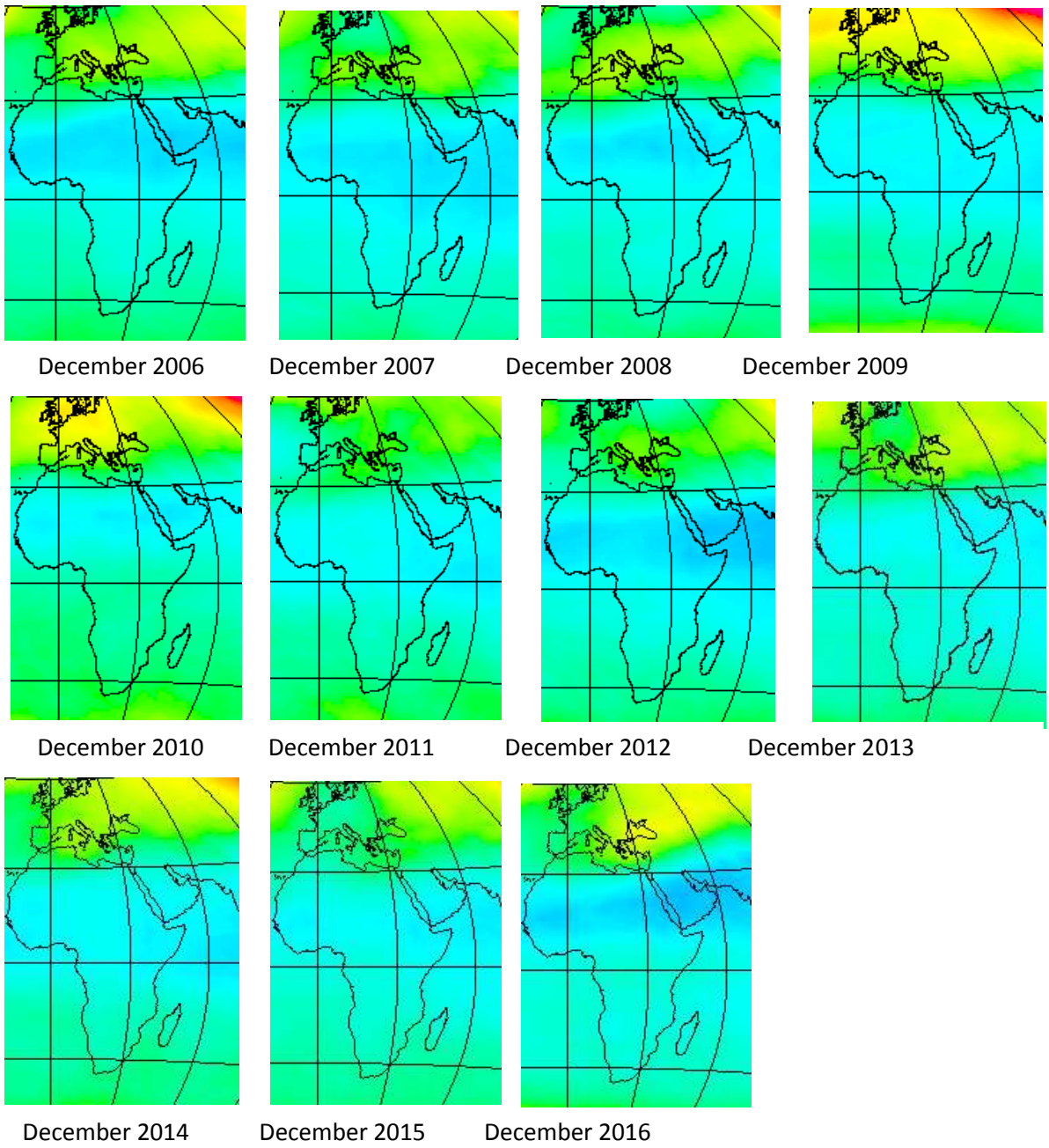
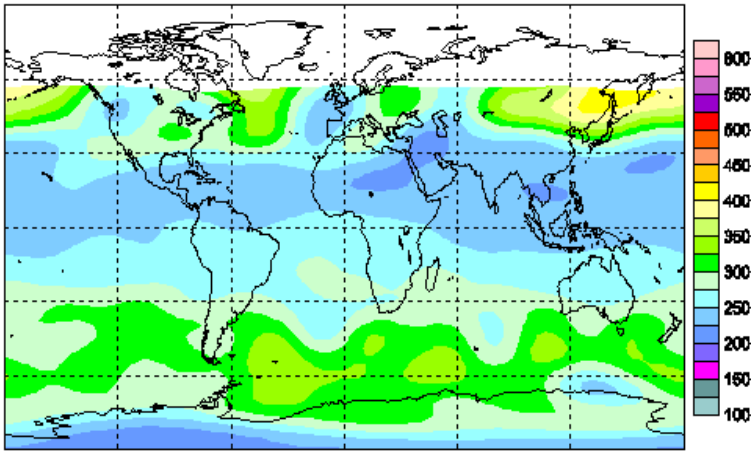
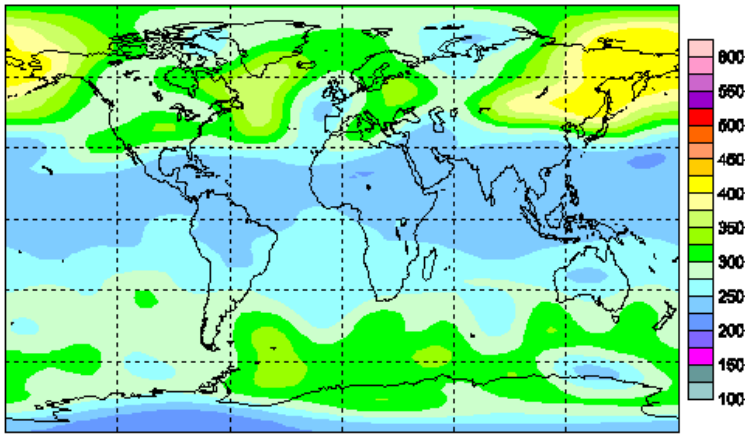


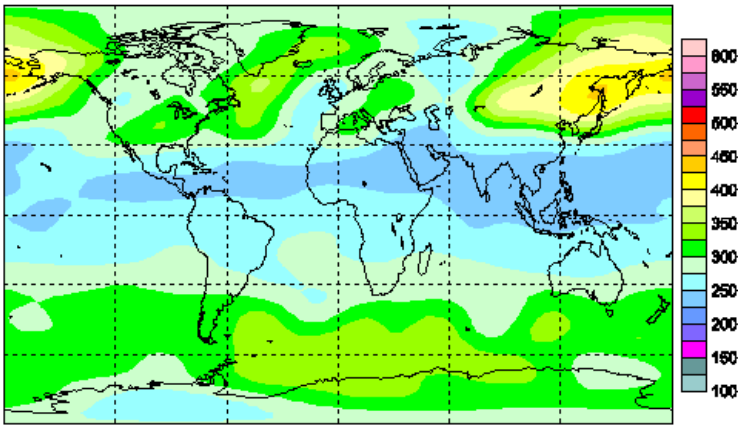
Figure (2c) December Mean of Total Ozone for Years (2006-2016) from OMI (http://www.temis.nl/protocols/O3global.html)



(a) TOMS Instrument /Earth Probe

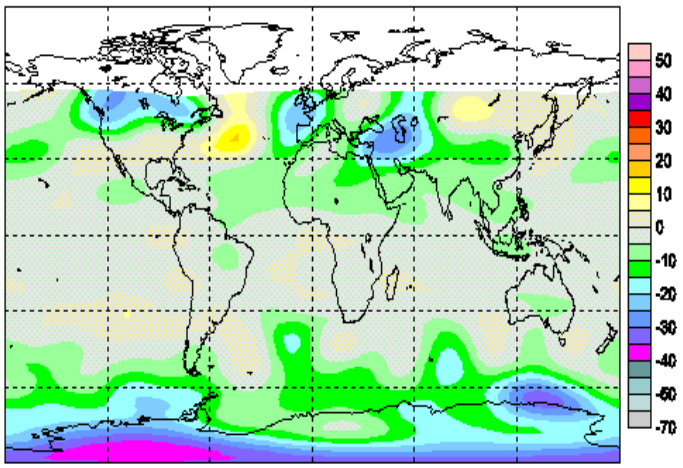


(b) SCIAMACHY Instrument / Envisat Satellite /KNMI

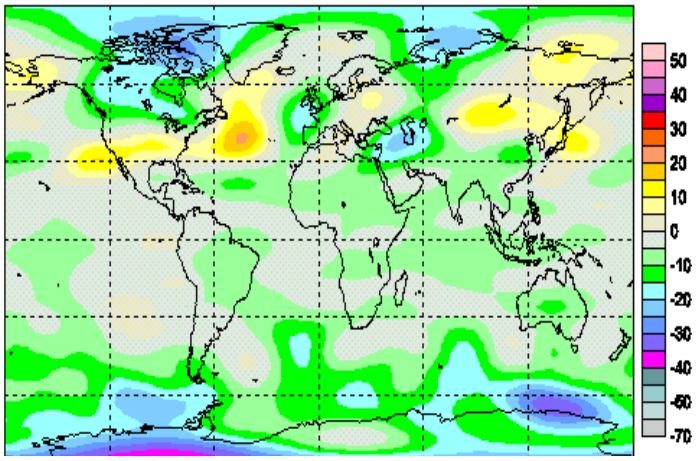


(c) SBUV/2 Instrument /NOAA Satellite /SMOBA

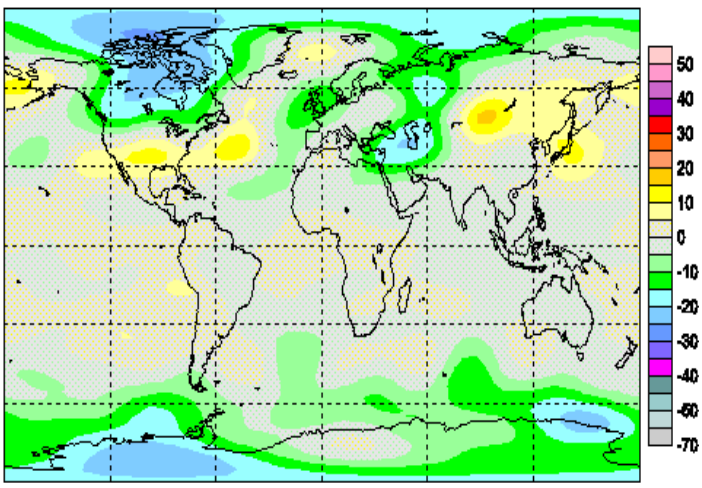
Figure (3) Total Ozone Column on 10 December 2005 from (a) TOMS, (b) SCIAMACHY and (c) SBUV/2 Instruments



(a) TOMS Instrument/Earth Probe Satellite/NASA



(b) SCIAMACHY Instrument /Envisat Satellite /KNMI



(c) SBUV/2 Instrument /NOAA Satellite/SMOBA

Figure (4) Total Ozone Deviations from Normal (1978-1988 Level) on 10 December 2005 Estimated by Using (a) TOMS, (b) SCIAMACHY, (c) SBUV/2),

Conclusions

It is concluded from monitoring total Ozone over Iraq the following points:

1- 2005 have Sharp decline in the monthly total ozone column in southern Iraq during December for the observed period (1978-2016) as measured by satellite instruments TOMS and OMI.
2- Sharp decline in the daily total ozone column reached the value around 220 Dobson units over Iraq on day 10 December 2005 by satellite instrument TOMS which is comparable to the value of ozone hole.
3- TOMS shows total Ozone column values and deviation to be higher than other satellite instruments (SCIAMACHY and SBUV/2).
4- Presence of ozone hole over Antarctica started during 1980 and continued till this period in appearance especially during September and October and starts to be decrease in last decade.

Recommendations

1- Further study is needed to uncover the reason for this abnormality in the observed total ozone using daily space images for incoming period.
2- Our region needs instrumental measurements of total ozone column to support the space images.

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