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AMPLIFYING EFFECT OF SEASONAL OZONE FLUCTUATIONS ON TEMPERATURE VARIABILITY IN THE NEAR TROPICAL TROPOPAUSE AT SELECTED STATIONS

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1.0. INTRODUCTION

- The tropical tropopause is a dynamically and climatically important feature of the atmospheric circulation.
- O_3 helps in maintaining the stratospheric temperature distribution.
- O_3 absorbs short-wave and long-wave radiation
- O_3 controls the Ultra-violet (UV)-radiation flux

2.0. OBJECTIVES

- To investigate the relationship between seasonal ozone fluctuations and mean monthly temperature variability in the near tropical tropopause region by;

1. determining the extent of O_3 fluctuations in the TTL and UTLS regions.
2. assessing the temporal variability of O_3 and temperature in the near tropical tropopause.

3.0. LITERATURE REVIEW

- The magnitude of the direct radiative mechanism responsible for O_3 –Temp. coupling has been estimated as a 10% O_3 loss near the TTL results in a cooling of 0.5K *[Randel et al., 2006]*.
- The seasonal cycle in O_3 tends to reduce the radiative heating during NH winter. This would tend to reduce the upward mass flux into the tropical stratosphere, if not offset by an additional cooling *[Folkins, 2005]*.
- In the tropics, very high clouds with cloud top temperatures less than 200K are observed more frequently during NH winter than summer [Folkins et al., 2006]
- The seasonal cycle of O_3 at 17km is mainly driven by seasonal changes in dynamics [Folkins et al., 2006]
- A reduction and/ or redistribution of O_3 with altitude could alter the distribution of temp. and other weather elements. This is due to UV solar radiation which is very strongly absorbed by ozone. The temp. of the stratosphere is largely maintained by balance between absorption of solar radiation by ozone and emission of atmospheric infra-red radiation by ozone, carbon dioxide and water vapour. *[Muthama, 1989]*

4.0. DATA

- Simultaneous observations of O_3 and temp. profiles from SHADOZ in Nairobi, Kenya (1°S, 37°E), Java-Watukosek, Indonesia (7°S, 1130E), and Kuala Lumpur, Malaysia (3°N, 102°E) were used
- Radiosonde temp. profiles from Nairobi were used.
- The soundings from SHADOZ were about 190 for Nairobi (from 1999-2006), about 90 for Java (from 2000-2004), and about 190 for Kuala Lumpur (from 1999-2006).

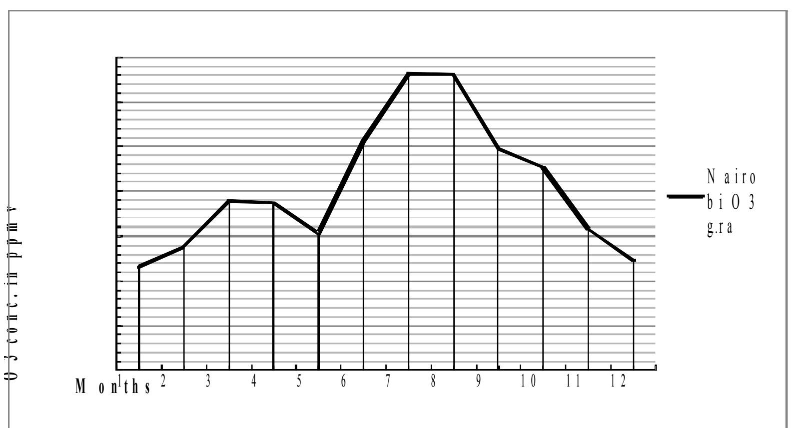
5.0. METHODOLOGY

- Missing data has been estimated using the arithmetic averaging method
- Quality of the entire dataset was examined using Residual Mass Curve
- The characteristics of time series investigated in this study are; Trend and Seasonal Variations for both Temp. & O_3
- Monthly O_3 gradient in the UTLS was calculated & correlation analysis done between Temp. & O_3

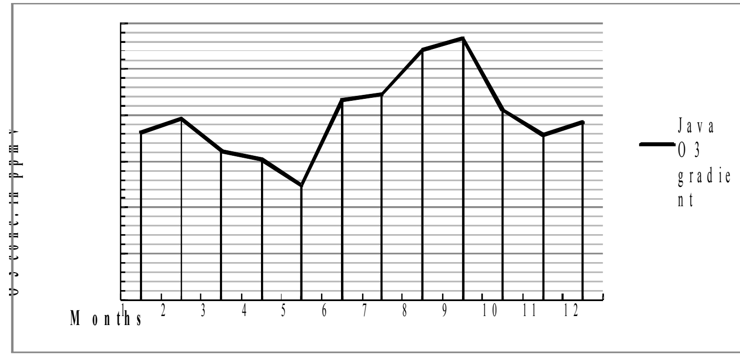
6.0 RESULTS:

6.1. O_3 Vertical Gradients

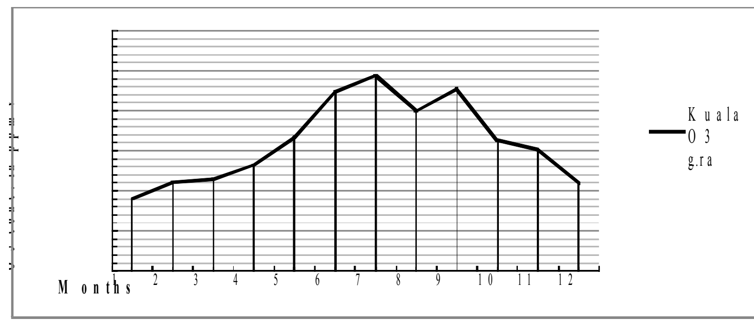
A. Nairobi



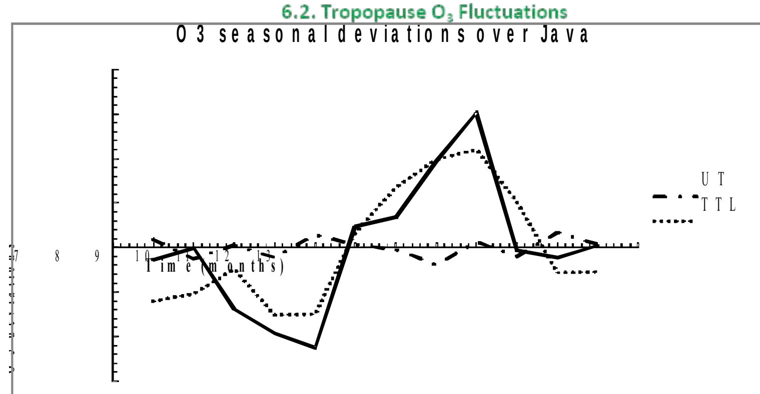
B. Java Watukosek



C. Kuala Lumpur



6.2. Tropopause O_3 Fluctuations



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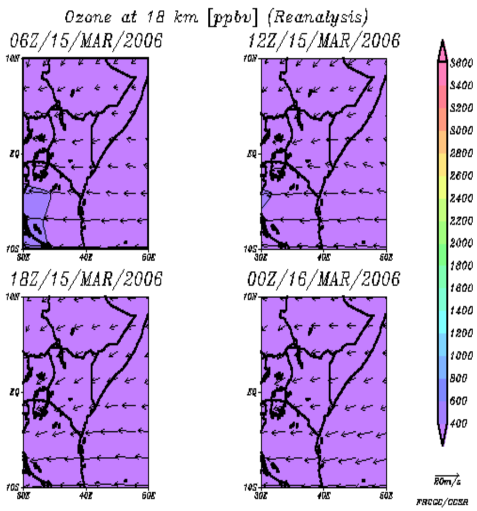
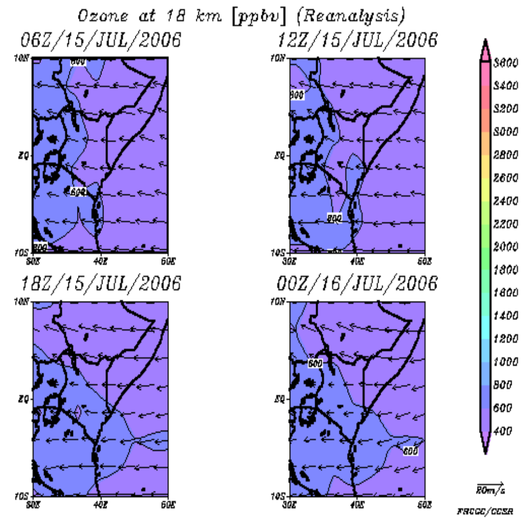
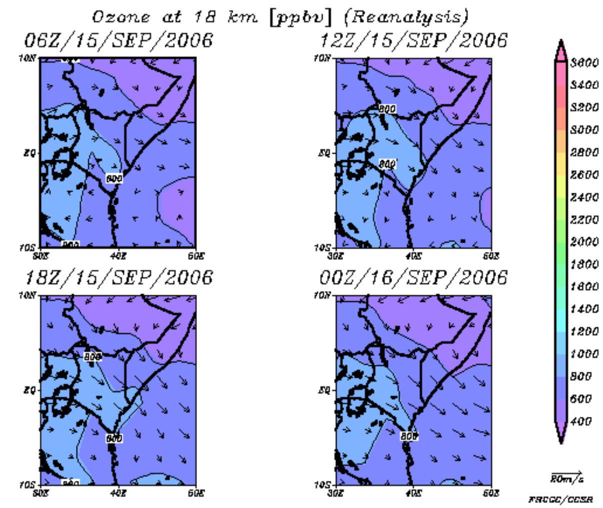
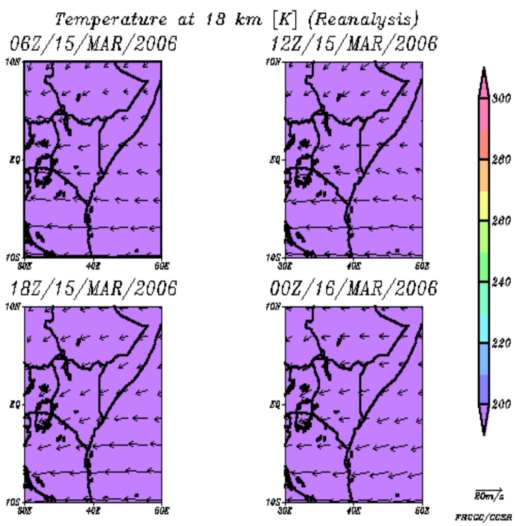
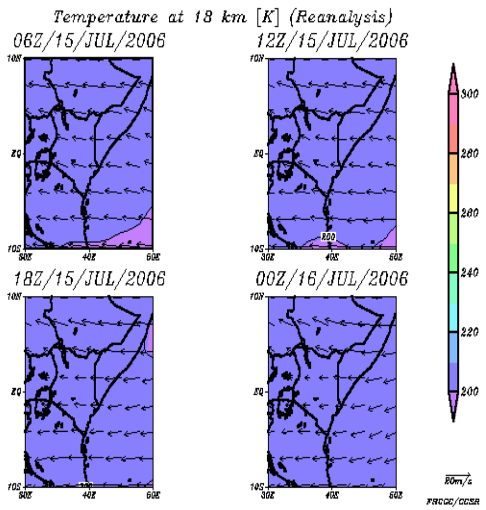
JAMSTEC MODEL REANALYSIS RESULTS FOR OZONE AND TEMPERATURE CHANGES OVER SELECTED TROPICAL REGION

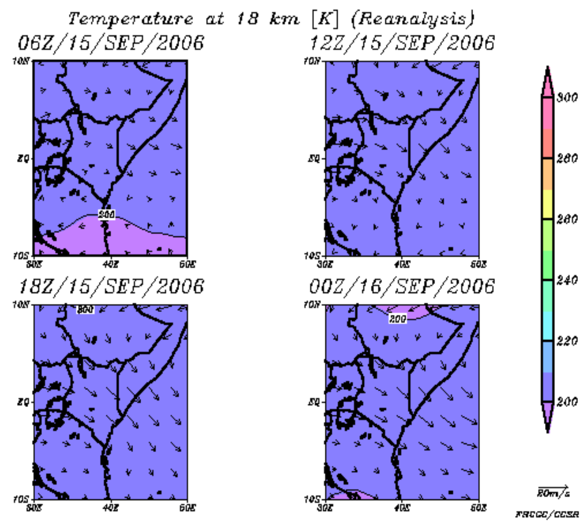


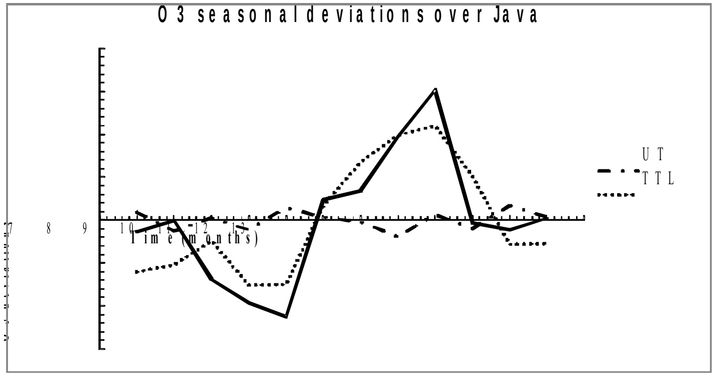


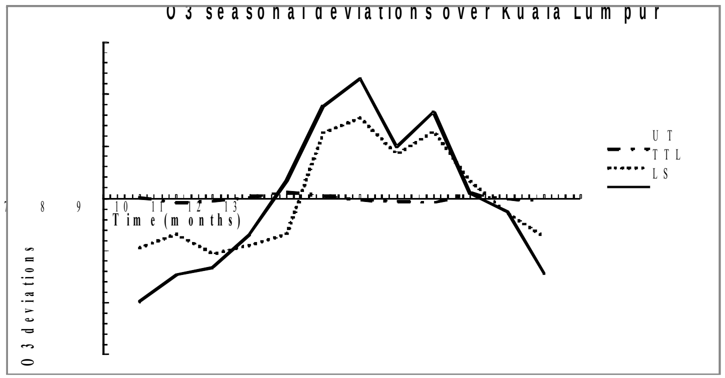












6.3. Correlation Coefficients between Ozone and Temperature

A. Nairobi

	UT	TTL	LS
Year	r	r	r
1999	0.28	0.98*	0.94*
2000	-0.30	0.94*	0.84*
2001	0.11	0.59	-0.55
2002	-0.25	0.95*	0.76*
2003	0.24	0.97*	0.96*
2004	0.07	0.99*	0.94*
2005	-0.58	0.89*	0.46
2006	0.60	0.96*	0.98*

B. Java Watukosek

	UT	TTL	LS
Year	r	r	r
2000	-0.20	0.78*	0.10
2001	-0.55	0.74*	0.37
2003	-0.45	0.83*	0.50
2004	0.68*	0.94*	0.88*

C. Kuala Lumpur

	UT	TTL	LS
Year	r	r	r
1999	-0.11	0.88*	0.88*
2000	0.41	0.95*	0.95*
2001	0.58*	0.74*	0.43
2002	0.47	0.94*	0.88*
2003	0.12	0.91*	0.91*
2004	0.53	0.97*	0.96*
2005	0.48	0.95*	0.79*
2006	0.42	0.99*	0.94*

Key: * significant

7.0 CONCLUSIONS

- O_3 seasonal gradients between the Lower Stratosphere-LS and Upper Tropopshere-UT regions fluctuate with higher values between July and Sept. and relatively lower values in Dec. and Jan.
- Seasonal analyses indicates relatively lower O_3 quantities from Jan. to May and higher quantities in July to Sept. in all the three regions
- O_3 concentrations reduce again from October till December in these regions
- There is a significant positive statistical correlation coefficient between O_3 and Temp. in the near Tropical Tropopause
- In all the stations the extent of O_3 fluctuations increases in going from the Upper Troposphere-UT, through the Tropical Tropopause Layer-TTL and to the Lower Stratosphere-LS

8.0. ACKNOWLEDGEMENT

- SHADOZ team of National Aeronautics and Space Administration – NASA
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9.0. SELECTED REFERENCES

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