Latitudinal & Longitudinal Gradients in GW/KW Signatures in the TTL Inferred from Ozonesondes

Anne M. Thompson, Sukyoung Lee, S. K. Miller, A. L. Loucks, Penn State Univ, USA;

G. A. Morris, Valparaiso Univ, USA; H. Vömel, GRUAN, DWD, Lindenberg Obs, Germany

Background & Goals

Wave activity in the tropics & subtropics (SBT) plays a vital role in temperature, ozone and water vapor variability throughout the free troposphere, TTL (tropical tropopause layer) and lower stratosphere (LS).

The SHADOZ (Southern Hemisphere Additional Ozonesonde) data set, 10 years long at a dozen tropical and SBT sites [Thompson et al., 2003] is used to evaluate GW/KW (Gravity/Kelvin wave) activity following the "Laminar Identification" method of Teitelbaum et al. [1994] as adapted by Grant et al. [1998] and Thompson et al. [2007; 2008].

Specific questions addressed are:

-- What is the laminar structure of an individual sounding?

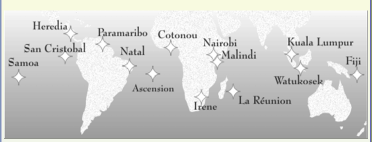
-- What is the climatological variation at a given location, ie laminar amplitude, frequency over seasons?

-- How do laminar parameters vary latitudinally and longitudinally?

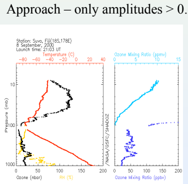
-- How do non-SHADOZ tropical and SBT sites compare in wave structure, eg INTEX-B/Milagro (2006), TC4 (2007) campaigns?

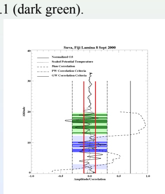
Data & Methods

Analyses here are based on (1) SHADOZ data, **Map below**, from 1998-2007; (2) soundings taken during INTEX-B/Milagro (Mar. 2006), by AMT and GAM in Mexico City (19N, 99W) & Houston (30N, 95W).



Data are from -
http://croc.gsfc.nasa.gov/shadoz - CD available!
Laminar method (raw profile, below left; laminae, GW/KW – refer to dashed line > 0.7, right). Conservative Approach – only amplitudes > 0.1 (dark green).





Results: Single-site Climatology

Illustrations are made for Fiji, first showing mixing ratio variability to 18 km over 1998-2007 (**Figure 1**) and seasonality (**Figure 2**).

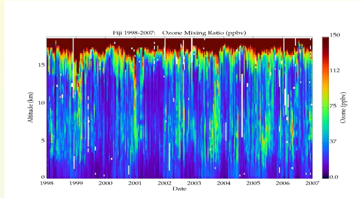


Figure 1

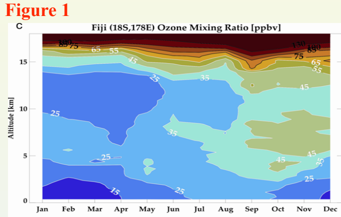


Figure 2

Laminar amplitude is 15-20% in the free troposphere, TTL and LS (**Figure 3**). Virtually all the laminae due to GW/KW activity (labeled as "Gravity wave" in figures). The GW frequency (**Figure 4**) indicates a layer with several maxima/year at 17-19 km (LS) and a possible separate pattern for the TTL (14-17 km, as in January-February).

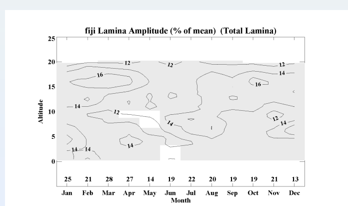


Figure 3

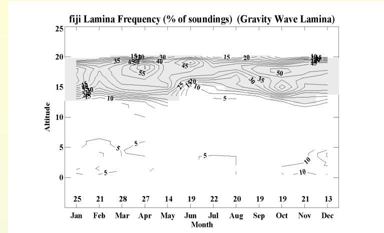


Figure 4

Results: Latitudinal & Longitudinal Variability

In general, sites with lower latitude and closer to Western Pacific and eastern Indian Oceans have greater laminar amplitude and GW/KW frequency. For example, Watukosek, which is 10 deg nearer the equator than Fiji, has an annual mean GW frequency 75% (of all sondes) vs 45% for Fiji (**Figure 5**). Sites with the greatest mid-latitude influence (Réunion, Irene, Both at > 20S) have the lowest frequency.

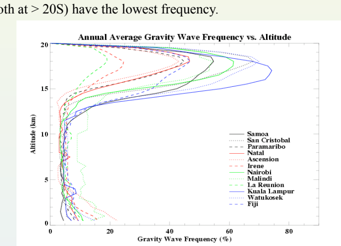


Figure 5

The overall longitudinal & seasonal variability of GW/KW, taken as the maximum frequency within the 15-20 km region, reflects the patterns described above: lower frequency over the Atlantic and greater frequencies normally in Sept – March.

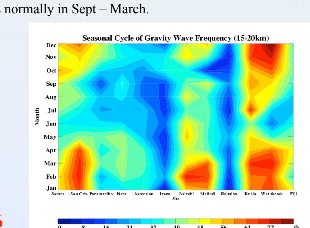


Figure 6

Results: Waves at Non-SHADOZ Sites

Laminar analysis was performed on soundings taken in tropical & SBT campaigns. In **Figure 7** both GW/KW and Rossby wave influences are detected at Mexico City (19N) and Houston (30N) in INTEX-B/Milagro, March 2006 (from Thompson et al., 2008). We have characterized GW/KW activity in TC4 soundings over Panama (8N, 80W) and Costa Rica (10N, 84W), the latter a SHADOZ site since 2006 (not shown). At those sites, frequencies are less than at nearby equatorial San Cristóbal (cf **Figure 5**).

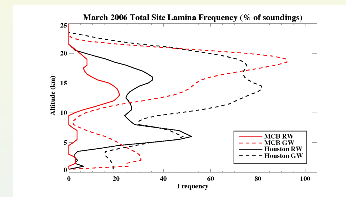


Figure 7

Summary & On-going Work

- Laminae are persistent throughout TTL & LS.
- GW/KW activity is strongest in the SH wet season & in western Pacific, eastern Indian Ocean; also stronger near equator.
- Campaigns in SBT & tropical no. hemisphere (March 2006; July 2007), SHADOZ site at Costa Rica also indicate GW/KW.
- NEXT: Use a GW "Index" to assess climate signal influences (eg ENSO, MJO).

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Acknowledgments

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