# HIRDLS Gravity Wave Validation and Monsoon Studies

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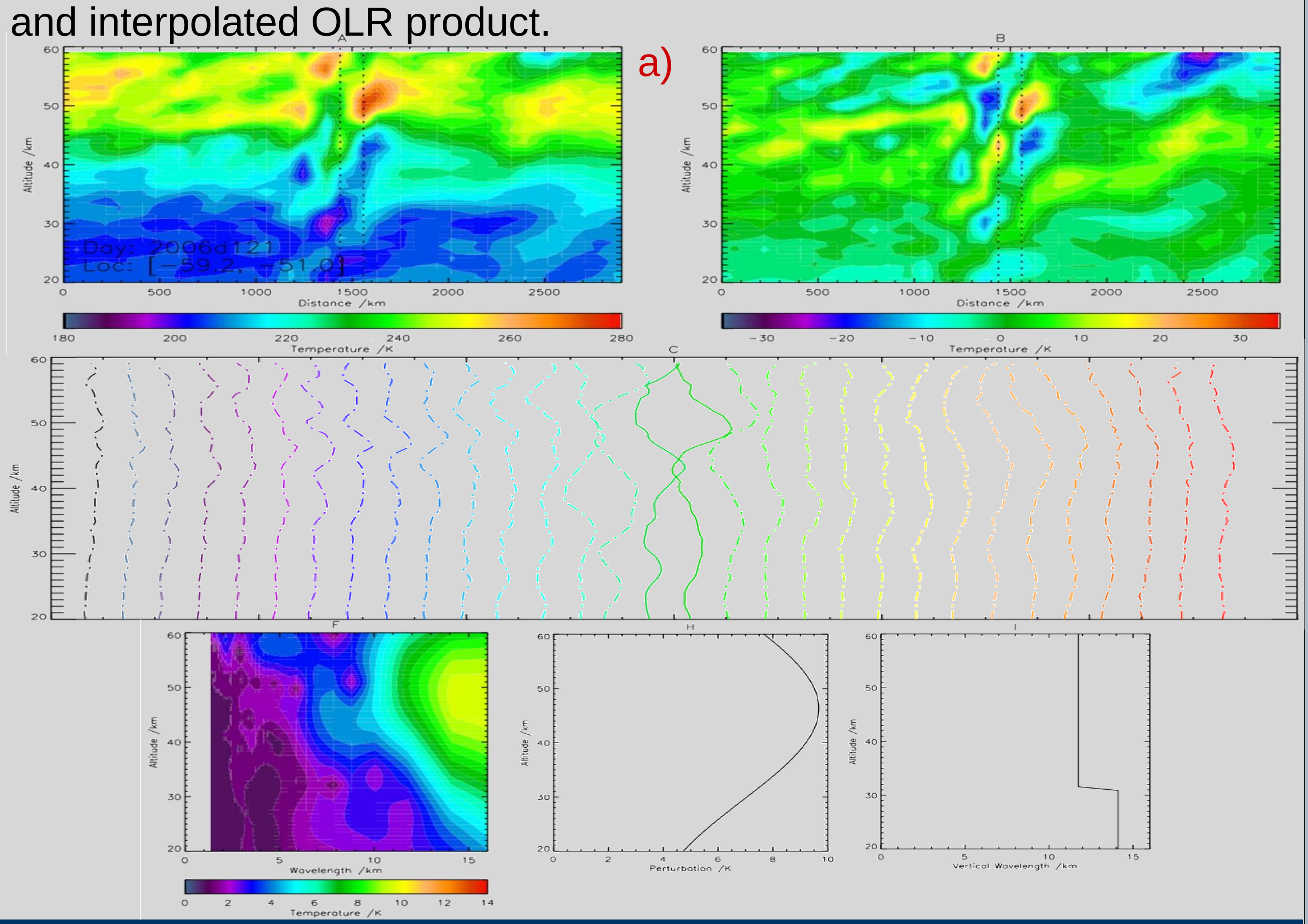
## Abstract

The HIRDLS instrument on NASA's Aura satellite provides temperature soundings across the globe, with a high vertical resolution and narrow along-track profile spacing which greatly facilitates the detection of gravity wave signals in the stratosphere. In this poster, we show comparisons of the gravity wave detection capabilities of HIRDLS, SABER and COSMIC, and a case study analysing HIRDLS-detected gravity wave momentum flux (MF) produced by monsoons across the globe.

## Gravity Wave Detection & Data Sources

HIRDLS GW MF is calculated by the method of *Alexander et al [2008]*. Using HIRDLS data, we first calculate the daily mean and zonal wavenumbers 1-3, and remove them from the temperature profiles. The S-Transform (*Stockwell et al, 1996*), is then applied to the residuals, returning the vertical wavelengths present in the data at each height. For each pair of adjacent profiles a cospectrum is then computed, and the maximum located, giving the dominant vertical wavelength as a function of height. For this wavelength, we extract a covarying amplitude of the wave *T'*, horizontal wavelength $k_h$, and derive the momentum flux MF. Figure a) shows this process.

Precipitation is sourced from the 3-hourly product of the Tropical Rainfall Monitoring Mission (TRMM), and OLR from NOAA's gridded and interpolated OLR product.

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All results based on HIRDLS V5
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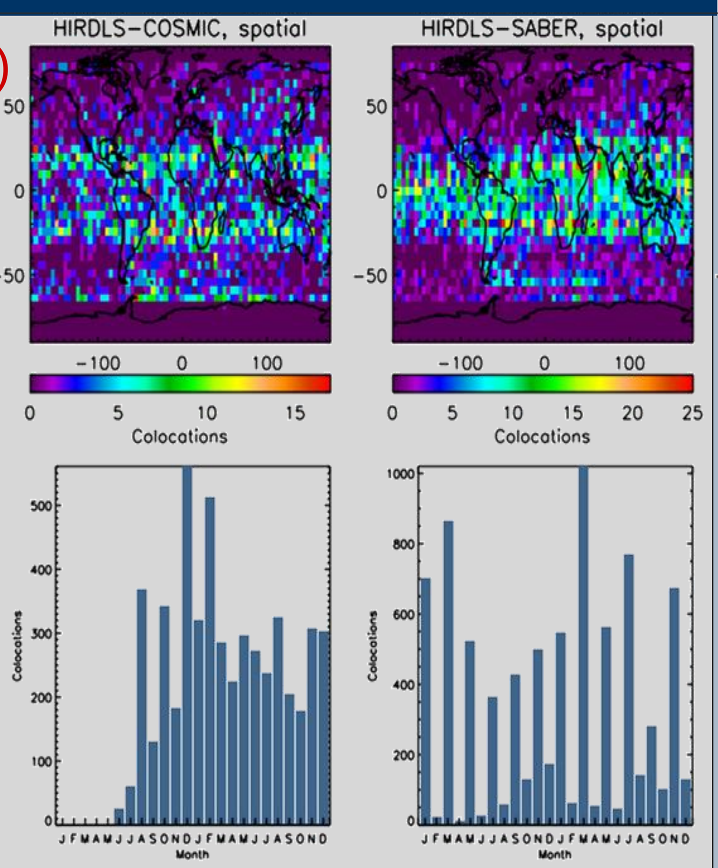
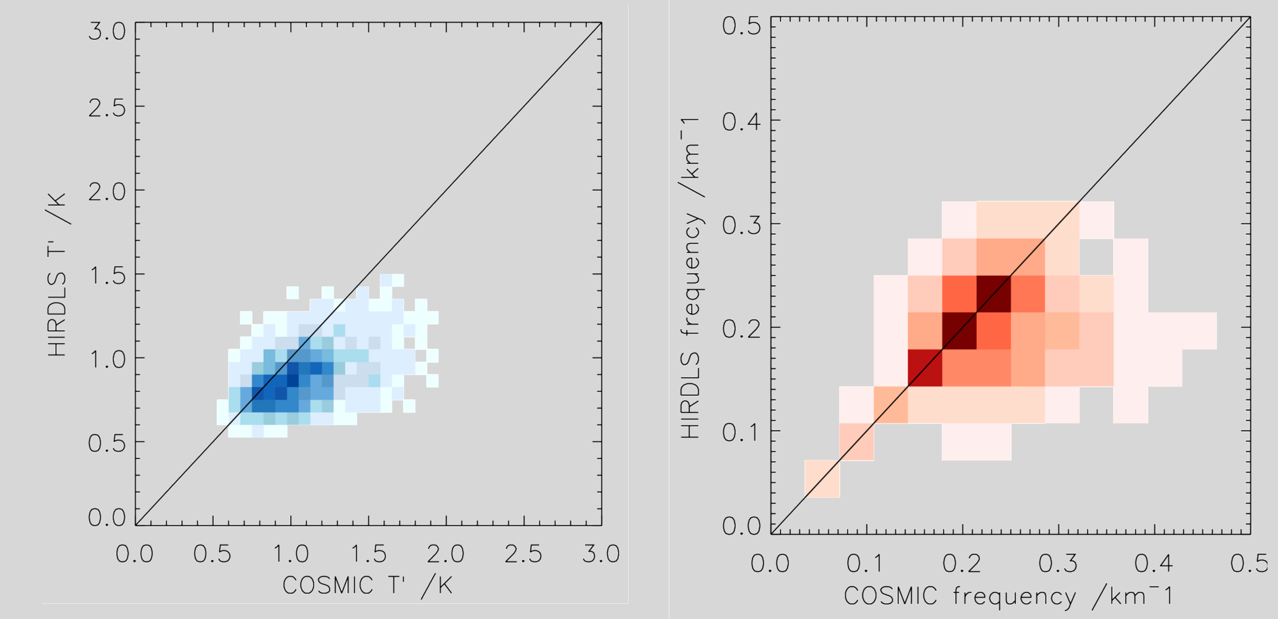
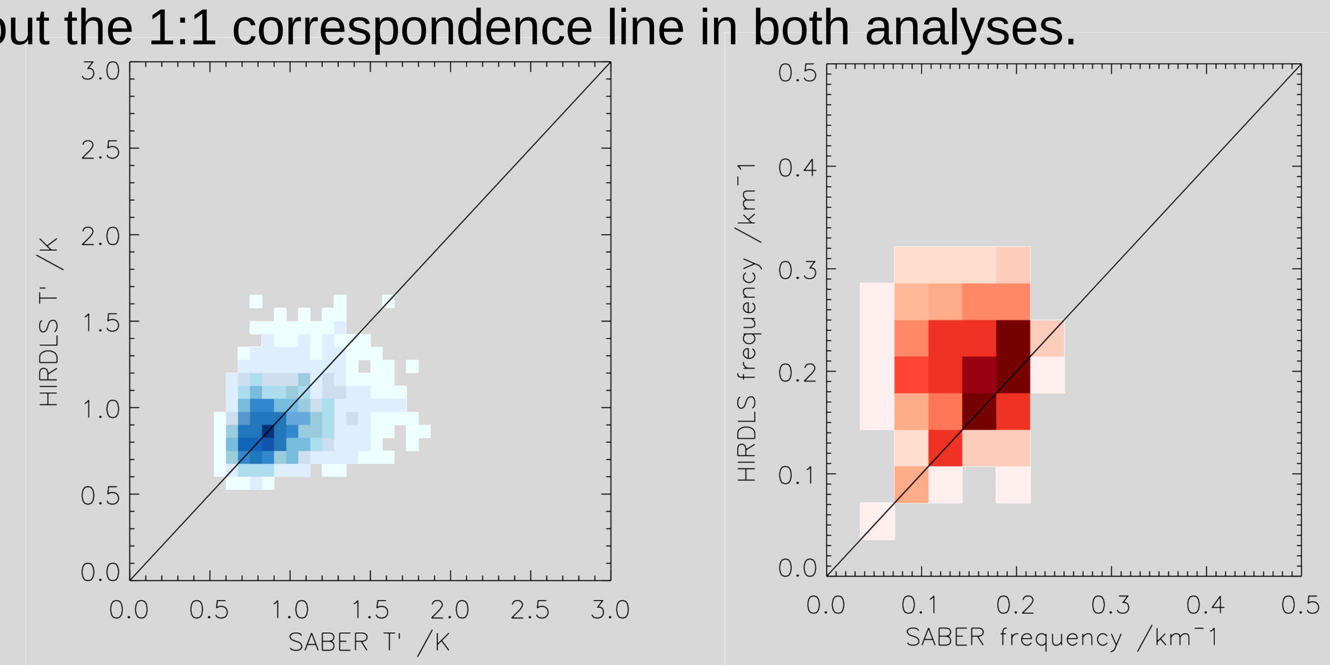
## Comparisons to SABER and COSMIC GW Detection

To validate our HIRDLS gravity wave results, the same methodology was applied to colocated (180km, 900s) profiles from SABER and COSMIC which exhibited significant vertical variability (high standard deviations for both profiles). Figure b) shows the spatial and temporal distributions of these pairs over 2005-2007. COSMIC pairings increase as the constellation entered formation, whilst SABER pairings alternate with the satellite's yaw cycle. The profiles were then individually S-Transformed (singly, not as pairs), and the peak temperature perturbations and vertical frequencies extracted and compared over the range 100hPa-8hPa.

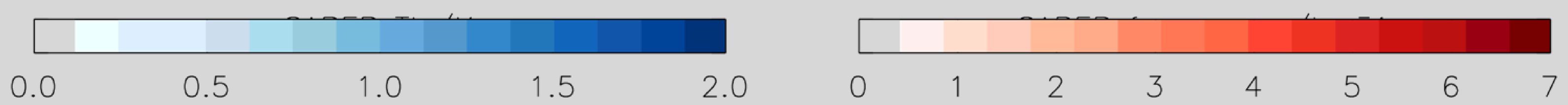



Figures c) and d) show HIRDLS-COSMIC comparisons for temperature perturbations and vertical frequency respectively. The two instruments reproduce each other well, with a slight high-frequency and higher-T' bias observed in COSMIC indicative of a potentially slightly higher resolution available to COSMIC. Results are peaked about the 1:1 correspondence line in both analyses.



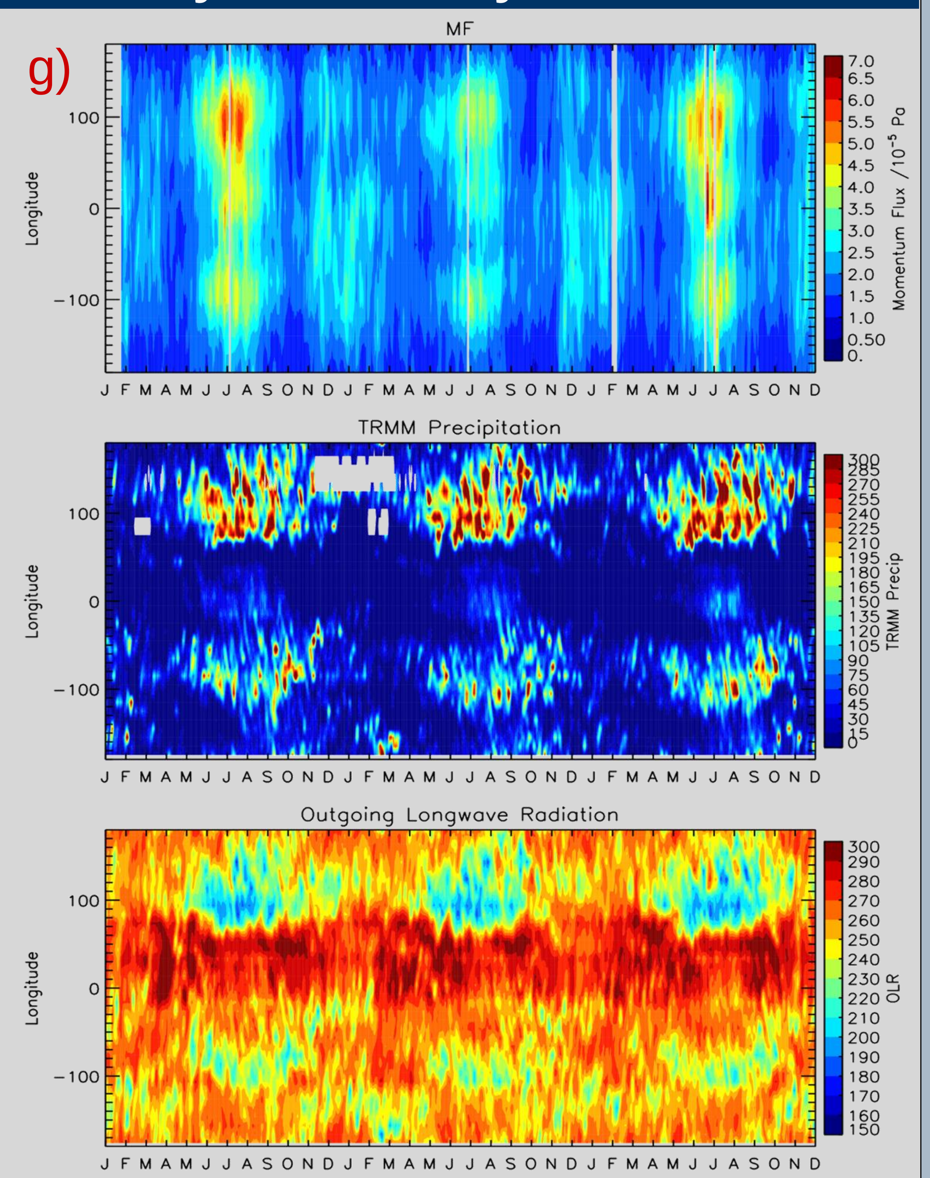

Figures e) and f) show HIRDLS-SABER comparisons. SABER has a much lower vertical resolution (2km vs 1km) and the results are accordingly biased towards higher frequencies in the HIRDLS results. Results nevertheless still peak strongly on the 1:1 correspondence line between the two instuments.

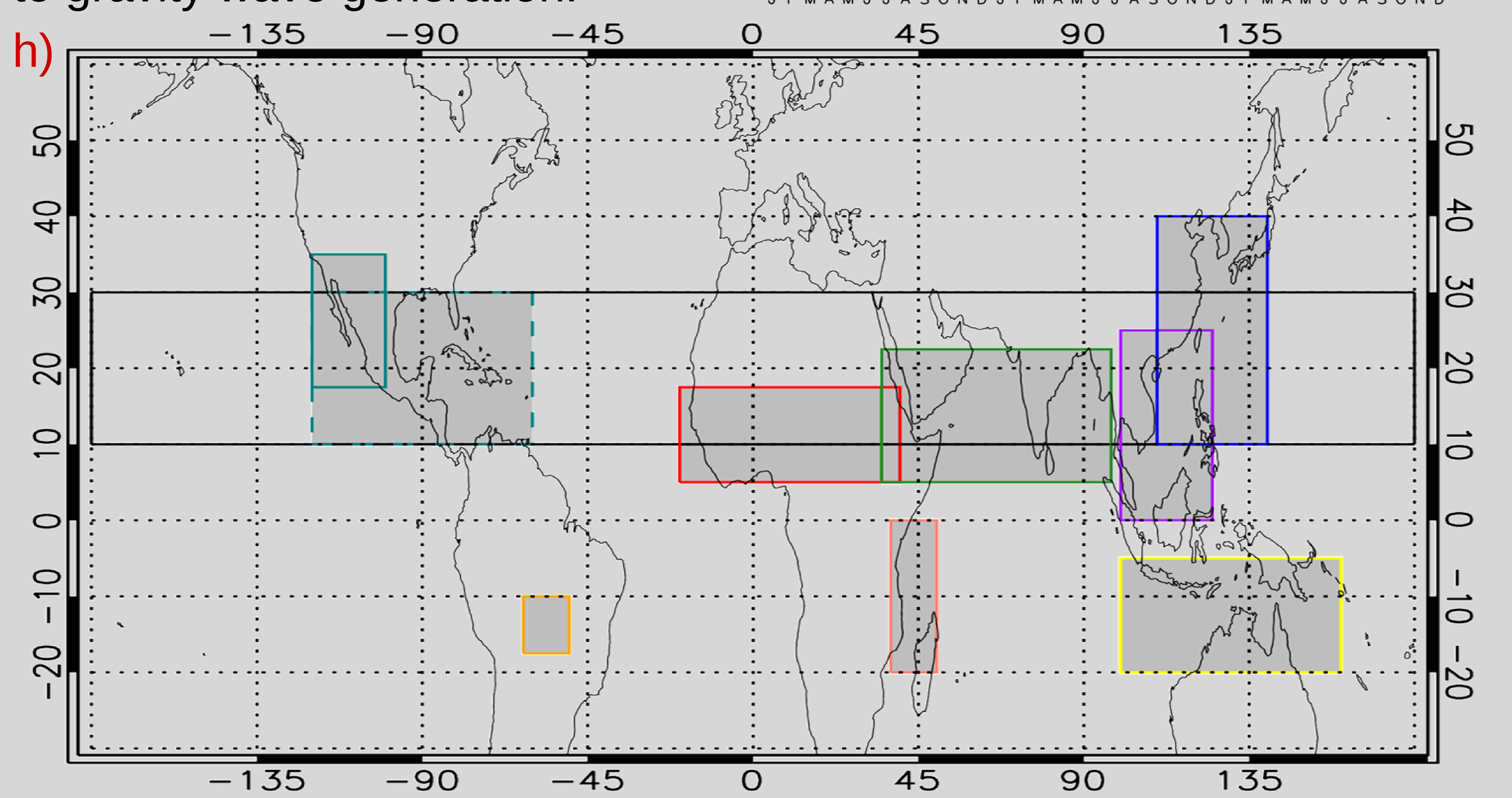



Wright et al (2011), Atmos. Meas. Tech. Discuss. 4, 737-764

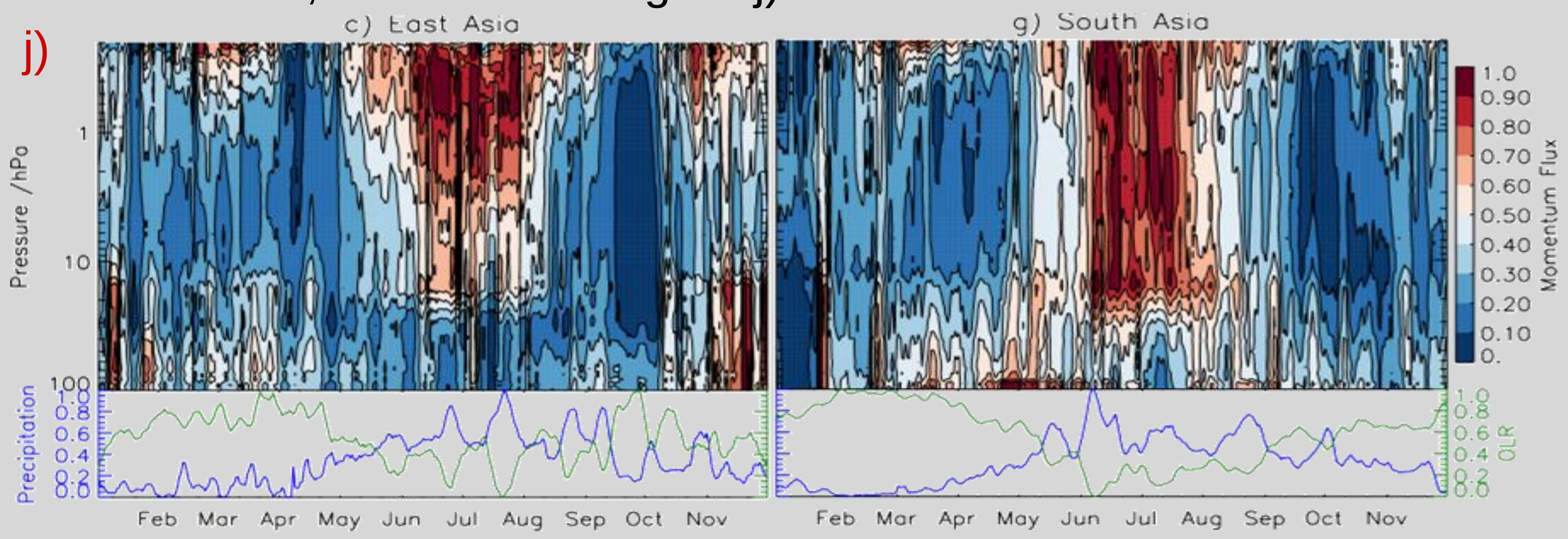
## HIRDLS Monsoon Gravity Wave Analyses

HIRDLS observations over the latitude band 10N-30N show strong peaks of momentum flux during boreal summer at African, Indian, SE Asian and American longitudes. These are clearly apparent in the top panel of figure g), which shows MF averaged over this latitude band for the three years 2005-2007. These peaks correlate strongly both temporally and spatially with monsoon-related peaks in precipitation (middle panel) and troughs in OLR (bottom panel), two proxies for deep convective processes in the tropics which should lead to gravity wave generation.




Eight individual monsoon regions, as defined by *Li and Zeng [2002]*, were then annualised, normalised, and examined (figure h). Seven of these regions showed good (~0.6-0.7) Pearson linear correlations between upper stratospheric MF and the OLR/TRMM traces, the exception being the North American monsoon region, most probably due to a strong secondary peak in momentum flux in winter which does not correspond to rainfall or low OLR. Two sample regions, South Asia and East Asia, are shown in figure j).




Wright and Gille (2011), J. Geophys. Res., submitted