Extratropical-Tropical meridional teleconnection: the role of eddies and its time scale

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A Abstract

It was shown earlier by several studies that a spectral analysis technique can be used to study the large-scale eddy characteristics especially focusing on transient eddies. The conventional space-time decomposition method (*Peixto & Oort, 1984*) confirms the eddy estimation by spectral methods. Physical parameter ***A*** (***u*** or ***T***) and meridional wind component ***v*** and its positive (negative) cospectra $C_f(A,v)$ gives a measure of the poleward (equatorward) transport of the quantity ***A*** due to particular eddy frequency by ***f*** (*Nitta, 1970*).

This study uses a co-spectral analysis to study the horizontal and vertical structures of eddy heat and momentum transport during monsoon season over the Indian region. Over subtropical Indian region, there is an equatorward flux transport at upper tropospheric level. Over equatorial Indian region, the entire troposphere witness poleward eddy transport. The northward and southward transport of eddy momentum and heat flux in the sub-seasonal range shows spatial variability. The study reveals that the transport of eddies in horizontal direction could act as an eddy forcing on circulation over the Indian Territory.

The eddy transport associated with fluctuations in the subtropical westerly Jetstream. Hence, such fluctuations and its significant teleconnection potentially indicate a distinct control mechanism of the subseasonal variability of monsoon. It is well known that such variations can potentially impact the monsoonal low-frequency variability from extratropical circulation activities (*Ramaswamy, 1962, Ramamurthy K, 1969, Krishnan et al., 2009, Goswami et al., 2006 and R. Chattopadhyay et al., 2015, Fadnavis & Chattopadhyay, 2017*). Although, several studies indicate that the extratropical to tropical (E2T) teleconnection plays a significant role in the monsoon circulation, a general systematic description of monsoon intraseasonal oscillation life-cycle and the E2T teleconnection is unclear. Large-scale extratropical features affecting the rainfall statistics over Indian region need to be studied. The proposed finding will be adhering to some of the following objectives.

- New techniques to eddy analysis.
- Comparison between conventional and spectral eddy analysis.
- Eddy flux transport
- Eddy life cycle.
- E2T teleconnection over the Indian region: a case study.

B Introduction

Eddies can term as an “additional forcing” in the zonal momentum or temperature equation. Thus they influence the heat and momentum transfer. The study reveals the transport of eddies in the horizontal direction could act as an eddy forcing. Formally eddies are defined as departures from products of two average fields (Peixto & Oort, 1984). In spectral analysis, it is a real part of cross-spectrum; it determines the relationship between two time series as a function of frequency. In given covariance of the two time series, a cospectrum calculates in-phase oscillation in the frequency domain, i.e. it explains the particular frequency from one-time series is equals in amplitude to other time series at the same frequency

C Datasets & Results

In this study the analysis for wind circulation, eddy transport (by heat and momentum flux) we used daily average data sets from the National Centers for Environmental Prediction/National Centers for Environmental Information (NCEP/NCAR) reanalysis (Kalnay & The, 1996). The data sets based on 2.5° x 2.5° with 17 Pressure levels (mb). Wind components (u, v) and temperature have been used for the period 1950 to 2016 (April, May, June, July, August and September (AMJJ & JJAS)). High resolution gridded (0.25° x 0.25°) daily rainfall data set from the year 1950-2016 (JJAS) have used (India Meteorological Department (IMD), Pai et al., 2015).

D New Techniques

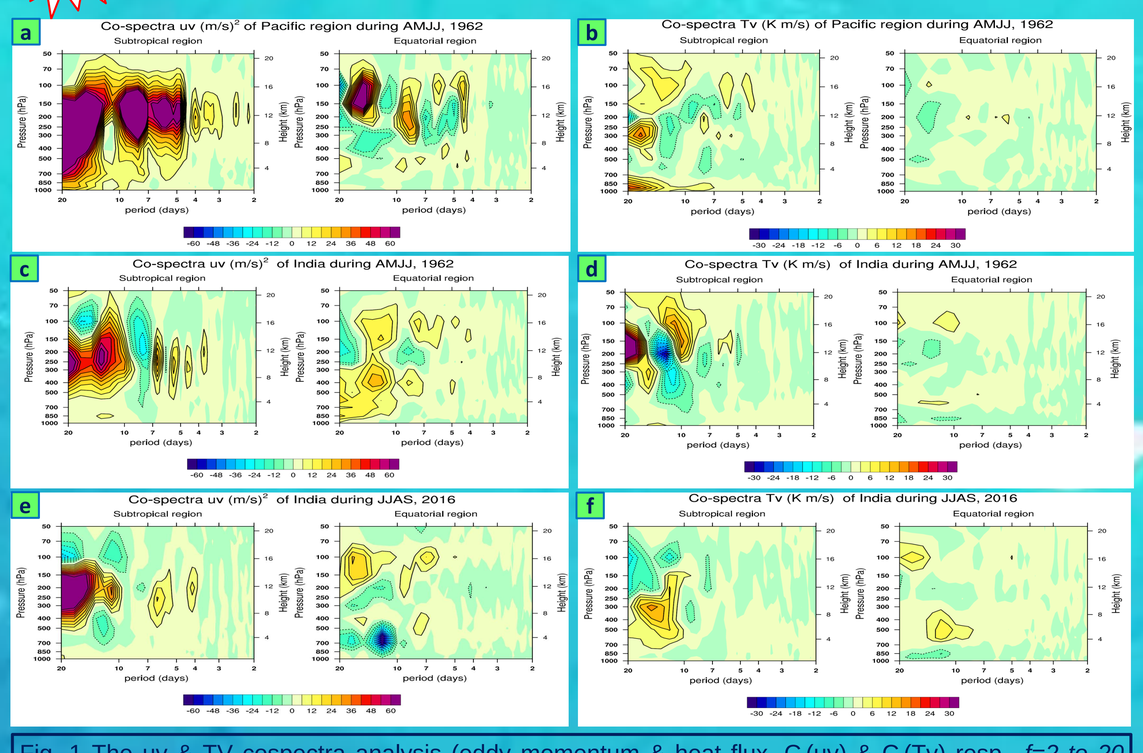

Fig. 1 The uv & TV cospectra analysis (eddy momentum & heat flux, $C_f(uv)$ & $C_f(Tv)$ resp., *f=2 to 20 days*). Fig. a & b represents subtropical & tropical Pacific region (Nitta, 1970) during AMJJ of 1962 year. Fig. c & d represents analysis over 20°N-40°N/65°E-100°E and 0-20°N/65°E-100°E during AMJJ of 1962 year. Fig. e & f represents similar analysis as per fig. c & d during JJAS of 2016 year. Positive (negative) cospectra represents Northward (Equatorward) eddy flux transport.

E Comparison

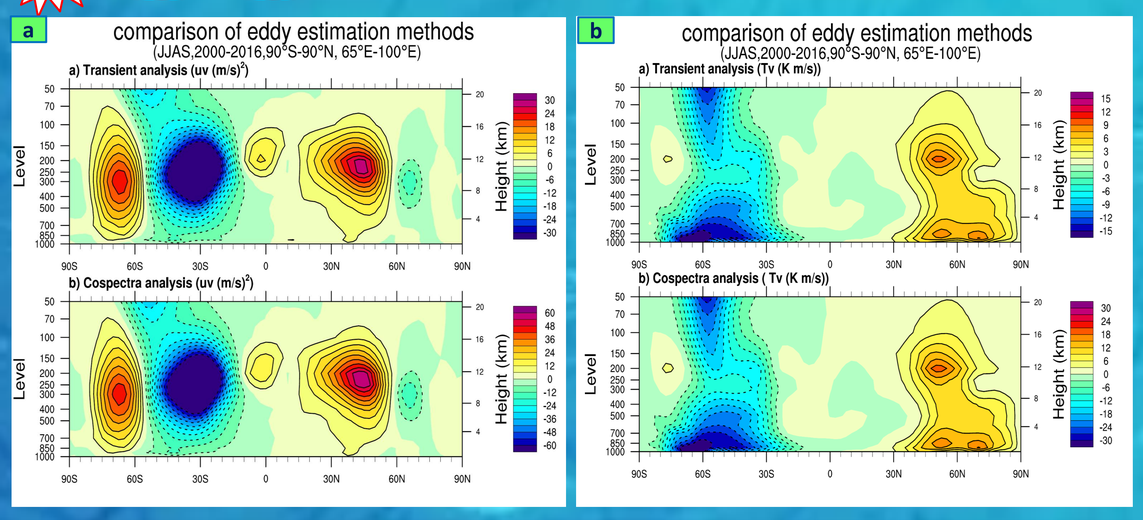

Fig. 2 Comparison conventional meridional transient eddy transport of momentum & heat flux with $C_f(uv)$ & $C_f(Tv)$ resp., *f=2 to 60 days periods.*

F Transport & cycle

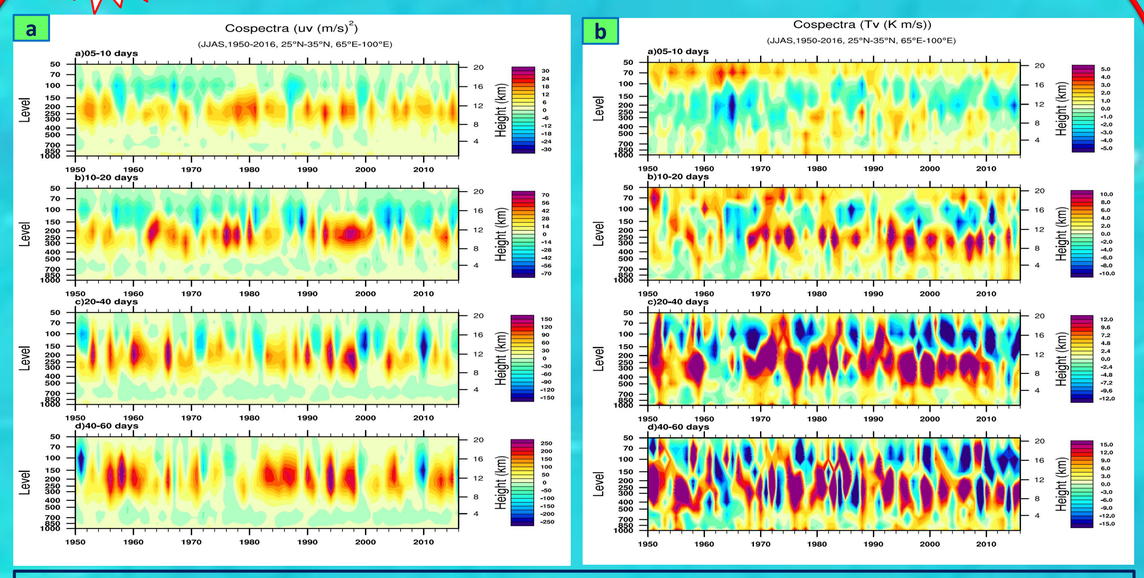

Fig. 3 The interannual variations of the $C_f(uv)$ & $C_f(Tv)$ are shown in fig. a & b respectively. By using advantages of cospectra techniques the different periodicity of eddies are categorized into four arbitrary bands (5-10 days, 10-20 days, 20-40 days and 40-60 days) during JJAS season.

G Interactions

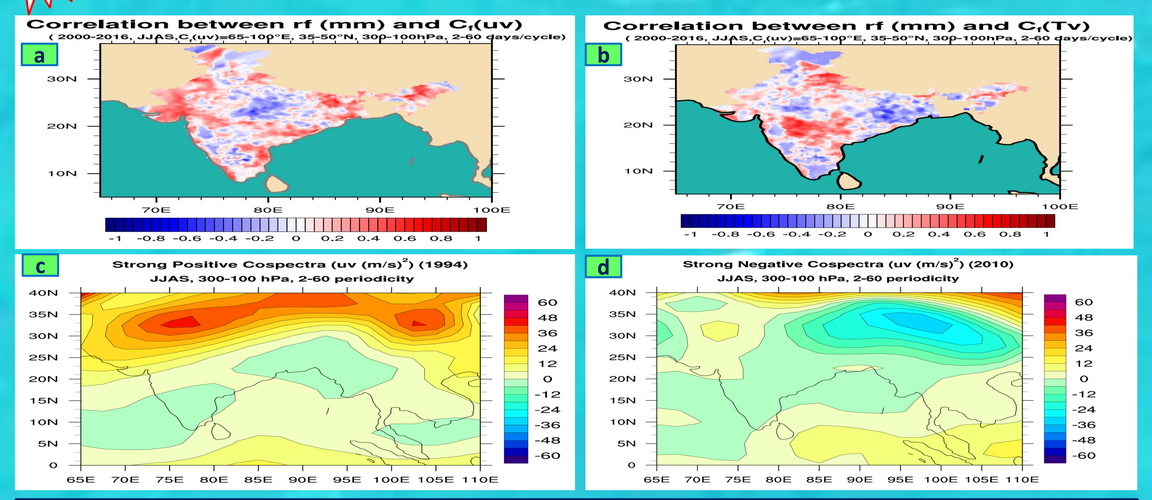

Fig. 4 Correlation between all India summer time rainfall anomalies with extratropical $C_f(uv)$ & $C_f(Tv)$ (*f=2 to 60 days, averaged over 300 to 100hPa) are shown in fig. a & b respectively. Fig. c & d represents a spatial distribution of strong and weak transport of* $C_f(uv)$ during 1994 and 2010 year respectively.

H Conclusion

1. First ever attempts to spatiotemporal structure of cospectra eddy analysis over Indian region.
2. Reasonable comparison between conventional and cospectral eddy analysis.
3. Interannual seasonal and subseasonal variation of eddy flux transport are present.
4. Even few years are associated with strong directional change in eddy transport.
5. Eddy manifesting by large scale extratropical features are affecting the ISM rainfall distribution.

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J References

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