INFLUENCE OF MONSOON ASSOCIATED MESOSCALE SYSTEMS ON THE TROPICAL TROPOPAUSE AND STRATOSPHERE- TROPOSPHERE EXCHANGE

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SCIENCE OBJECTIVE

- The Observed extremely low tropopause temperature (191K) over a wide spatial extent over Indian tropics could contribute to dehydration of lower stratosphere and thus affect Ozone (O_3) in the UTLS region.
- The mesoscale convective activity is considered to be one of main causative mechanism for the same.
- In the present study an attempt is made to better understand (a) effects of convection on the tropical tropopause region and (b) close association in the occurrence of enhanced convection activity and observation of low

BACK GROUND

- The tropics, being the source region of the tropical convection and cyclone systems, act as a heat engine and thus influence the characteristics of the tropical tropopause region. The height and structure of the tropopause region plays an important role in the stratosphere troposphere exchange (STE). The tropics are therefore expected to play an important role in such exchange.
- Recent observations (Jain et al. 2006) over Indian tropics during monsoon and post monsoon seasons have shown the existence of regions of extremely cold tropopause with temperatures (191K) occurring over a wide area, which includes the Indian tropical region. This suggests that the Indian tropics, during monsoon seasons, could contribute significantly to the dehydration of the lower stratosphere and hence it is necessary to better understand the causative mechanism of the same.

Data Base and Method of analysis:

(a) Data Base

- Data from seven radiosonde stations viz. Bhubaneswar(BHU), Chennai(CHI), Port Blair(POR), Karaikal(KAL), Machilipatnam(MAC), Visakhapatnam(VIS), and Kolkata(KOL) and that collected onboard Sagar Kanya(SK) using GPS-Sondes during the BOBMEX period 20July-29August 1999.
- Satellite cloud pictures with cloud top temperature to identify high altitude clouds.
- Satellite observation maps of OLR.
- ECMRWF reanalysis of 100 hPa temperature, Specific humidity, Relative humidity fields and Zonal and meridional wind Fields.
- Synoptic analysis maps corresponding to 925 hPa and 1200 GMT.

(b) Methodology

All the above data (see Table 1) are examined together for the characteristics of the tropical tropopause region and to better understand the association between the occurrence s of enhanced convection and observation of the area of low tropopause temperature (LTT).

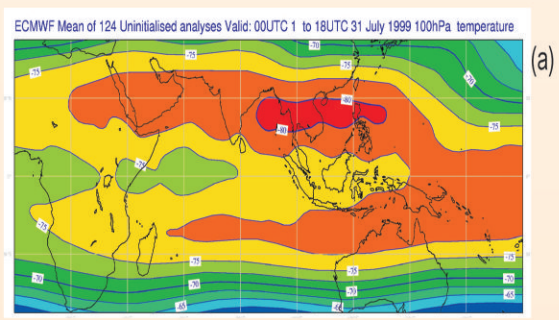
S No	Date	Stations	Coordinates of SK		Data Available		
			LAT N	LONG E	Synoptic Analysis	OLR	Cold Clouds
1	20 July 1999*	BHU, VIS, KOL	-	-	A	A	A
2	28 July 1999	CHI, POR, KAR, SK	17.60	89.20	A	A	A
3	29 July 1999	CHI, POR, VIS, SK	17.50	89.00	A	A	A
4	30 July 1999	SK	17.51	89.06	A	A	A
5	31 July 1999	SK	17.48	89.06	A	A	A
6	12 Aug. 1999	BHU, VIS, KAR, SK	19.50	87.30	A	A	A
7	13 Aug. 1999	SK	18.00	88.09	A	A	A
8	14 Aug. 1999	SK	17.56	88.99	A	A	A
9	20 Aug. 1999	SK	17.51	89.01	A	A	A
10	21 Aug. 1999	SK	17.49	88.95	A	A	A
11	22Aug. 1999	SK	17.49	89.01	A	A	A
12	23 Aug. 1999	SK	17.26	88.75	A	A	A
13	24 Aug. 1999	MAC, VIS, KOL, SK	18.00	88.00	A	A	A
14	25 Aug. 1999	CHI, BHU, VIS, KOL, SK	15.40	88.50	A	A	A
15	26 Aug. 1999	BHU, VIS, KOL, SK	13.20	87.30	A	A	A
16	27Aug. 1999	BHU, VIS, KOL, SK	13.10	86.10	A	A	A
17	28 Aug.1999	SK	13.07	85.51	A	A	A
18	29 Aug.1999	SK	13.12	83.72	A	A	A

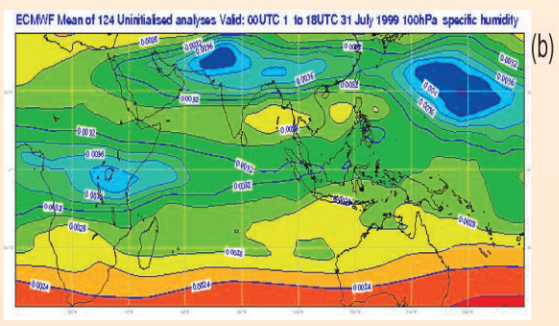
A: Available, NA: Not Available, BHU: Bhubaneswar, CHI: Chennai, KAR: Karaikal
KOL: Kolkata, MAC: Machilipatnam, POR: Port Blair, VIS: Visakhapatnam, SK: Sagar Kanya., * *Sagar Kanya* data is not available for this day.

Results

The main results of the present study are summarized below:

- It has been noted earlier that on the days of active convection the CPT temperature is cooler by ~2K compared to the days of weaker convection (Bhat, 2003). Recent results have shown that the days of low tropopause temperature, the temperature lapse rate just below the tropopause level is closer to the dry adiabatic lapse rate (Jain et al. 2006) suggesting relatively drier atmosphere at these heights.
- A comparison of 100mb monthly mean temperature, SH and RH field at 100mb level for the month of July 1999 shows that areas of low SH and high RH (80-100%) and low tropopause temperature (LTT) nearly overlaps. This suggests although SH is low, air is close to saturation due to low prevailing temperature, providing favorable condition for the formation of clouds at UTLS heights (Fig.1).
- This is confirmed by the observations of high altitude clouds with cloud top temperature of 193-213 K embedded in areas of low OLR that are associated to enhanced convection (Fig.2 and 3).
- Synoptic charts at 925 mb and areas of low tropopause temperature from RS and GPS-Sonde measurements show that pressure trough crosses through or touches the western edge of the area covered by the LTT. This indicates the possibility that enhanced convection due to trough passage and occurrences of LTT are associated (Fig.2 and 3).
- An examination of the OLR maps areas of observation of LTT shows that these two areas are spatially separated (Fig.2 and 3). The area of LTT is generally located south of area of low OLR with mean separation of ~3. Similarly in longitude, area of LTT lies west of low OLR area with mean separation of ~ 1.5.





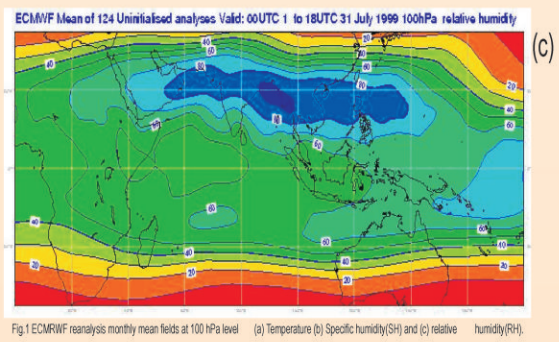
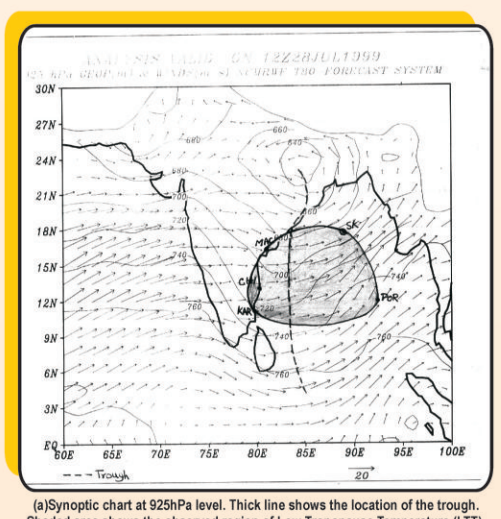
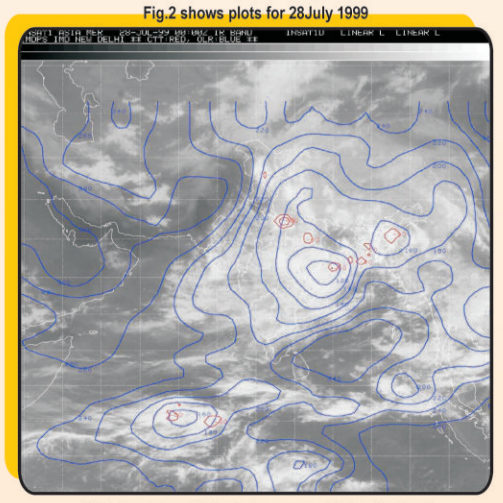


Fig.1 ECMRWF reanalysis monthly mean fields at 100 hPa level (a) Temperature (b) Specific humidity(SH) and (c) relative humidity(RH).



(a)Synoptic chart at 925hPa level. Thick line shows the location of the trough. Shaded area shows the observed region of Low Tropopause Temperature (LTT).

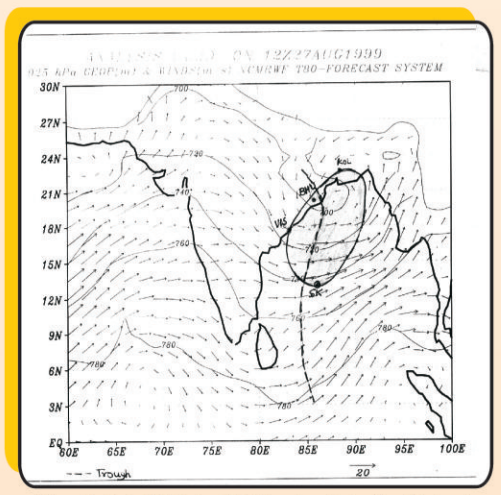
Fig.2 shows plots for 28July 1999



(b)Contour maps of Outgoing long wave radiation (OLR) and Cloud Top Temperature (CTT) with CTT 213K.

(c)Contour maps of OLR and shaded area is observed region of LTT. Low OLR ,with value 160 wm^{-2}, is marked by hatched lines.

Fig.3 shows plots for 27 August 1999.



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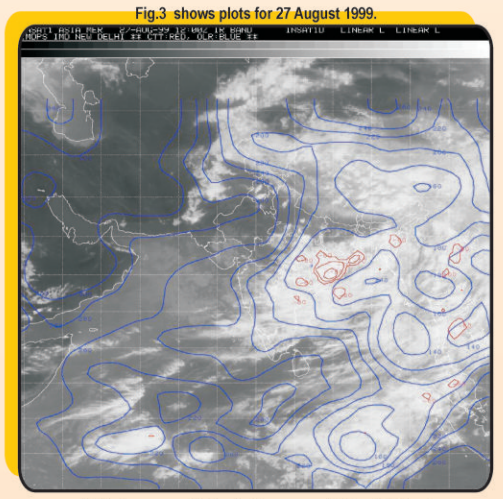

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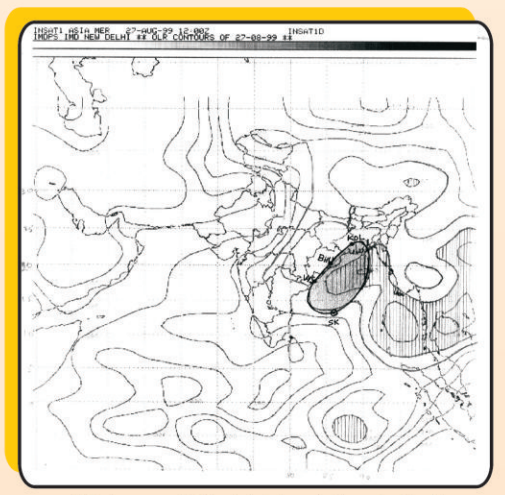

(c)Contour maps of OLR and shaded area is observed region of LTT. Low OLR ,with value 160 wm^{-2}, is marked by hatched lines.

CONCLUSIONS

Results of present analysis do bring out effects of monsoon associated TMCS on the structure of tropical UTLS region. It is noted that (a) area of low OLR, with enhanced convection, is embedded with high altitude clouds with cloud top temperature of 193-213 K and (b) areas of low OLR and of observed LTT are spatially separated, though these two areas partially overlaps on some days. The spatial separation in latitude (~3) appears to be too large to be explained, on a time scale of ~3-4 hr, on the basis of meridional winds which are in range of 0 to -12ms^{-1} with a mean value of -6 ms^{-1}.

References

Jain,A.R, Siddarth S. Das , Tuhin K.Mandal and A.P.Mitra.
Observations of extremely low tropopause temperature over the Indian tropical region during monsoon and postmonsoon months: Possible implications.
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