International journal of Engineering Research
&
Management Technology

ISSN:2348-4039
Volume-1,Issue-1
January 2014

Outgoing long wave radiation (OLR) a proxy of convection

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Abstract:

Outgoing long wave radiation (OLR) is a proxy indicator of convection. It is measured through satellite in watt /m2 and modulates climate and associated convective system. Its lower value indicates wet areas and higher values indicate dry area over the globe. Present work highlights the latest snowfall and rainfall over Himalayas and neighbored Delhi, Himachal Pradesh and Uttar-Pradesh on 11th and 13th March 2014. Satellite based proxy parameter helps in diagnosing the severity of the convective event.

Key words: OLR, INSAT, synoptic scale and convection

Introduction:

The outgoing longwave radiation (or the OLR) is the amount of energy emitted to space by Earth. INSAT satellite Infra red region (10.2 -12.2 um) is used to measure OLR and in new approach Water vapour channel also included as correction. The minimum in OLR, or the longwave emitted flux near the equator is due to the high cloud tops associated with the inter-tropical convergence zone (ITCZ), a region of persistent thunderstorms. This minimum migrates about the equator as seen in the monthly mean maps, and is also seen as a maximum in albedo. Precipitation is also depends on OLR and low values can be taken as an indicator of convention. Inter-annual Precipitation Extremes in Tropical Land Areas is studied by Chelliah and Arkin (1992), Gruber and Krueger (1984) and Holton et al (2003). Janowiak and Krueger (1985) made an atlas from National Oceanic Atmospheric Administration (NOAA) OLR data. Liebmann and Smith (1996) made interpolated OLR data sets for future studies. There are approaches which can be used to compute CAPE from radiosonde data as suggested and discussed by William and Renno (1993), Roy Bhowmik *et al* (2008) and show that OLR and Convective Available potential Energy (CAPE) has bi-model character.

Data and Methodology:

The data used in the present paper has been taken from the web site of India Meteorological Department (IMD). The processed data in graphical format is available on http://www.imd.gov.in/section/satmet/dynamic/insat.htm .The outgoing long wave radiation (OLR) is measured through Stephan Boltzmann radiation law.

OLD approach:

(a) $OLR = \sigma T_F^4$

$$T_F = T_b\left(a + bT_b\right)$$

T_b is the brightness temperature pertaining to radiance from narrow band and T_F is the flux temperature corresponding to broad band.

For zero zenith angle

$$a = 1.1889$$
$$b = -9.8906 \times 10^{-4}$$

Software determines the limb-corrected flux coefficients associated with the grid –box with specified zenith angle. This function currently uses a quadratic function which maps closely to the empirical data generated earlier for INSAT-1B satellite. Same is also using for Kalpana -1.

Zenith	A Emp	B Emp
0.00	1.1889	-9.8906e-4
21.48	1.1868	-9.79802-4
47.93	1.1737	-9.2700e-4
53.00	1.1648	-8.9555e-4
70.00	1.1333	-7.7057e-4
70.73	1.1357	-7.7666e-4

Outgoing long wave radiation (OLR): New approach

New technique developed by ISRO uses onboard on the geostationary operational Indian National Satellite (INSAT) Kalpana -1 uses radiances of $WIN(10.5-12.5\mu m)$ and $WV(5.7-7.1\mu m)$ channels. He transfer function used for the estimation in OLR is developed using the radiative transfer (Santa Barbara DISORT Atmospheric Radiative Transfer (SBDART) model. In mathematical form OLR can be represented as

$$OLR = F\left(\theta, N_i\left(\theta\right)\right),$$

where θ satellite zenith angle, N is the observed narrow-band radiance and i denotes the index for channel.

$$OLR = 13.94WIN - \frac{96.15}{WIN} + 114.11$$

$$OLR = 11.44WIN + 9.04WV + \frac{9.11WV}{WIN} - \frac{86.36}{WIN} - 0.14WV^2 + 111.12$$

$$OLR = 11.86WIN + 14.53WV - \frac{28.93}{WIN} + 94.92$$

$$OLR = 12.34WIN + 16.02WV + \frac{0.13WIN}{WV} + 82.59$$

$$OLR = 14.34WIN + 0.72WV + 0.10WINWV - \frac{72.27}{WIN} - \frac{14.34}{WV} + \frac{35.99}{WINWV} + \frac{130.06WV}{WIN} + 80.77$$

$$OLR = 12.94WIN + 16.50WV + \frac{10.09WV}{WIN} + \frac{12.94WV}{WIN + 0.39} + 77.47$$

$$OLR = 13.31WIN + 13.73WV + \frac{13.31WIN}{\frac{11.37}{WV + 0.289WIN} + WIN - 5.17} + 71.07$$

$$OLR = 13.74WIN + 8.37WV + \frac{11.01WV^2}{WIN} - \frac{14.60}{8.31WV + 1.71} + 94.49$$

Results and discussions:

Chief amount of rainfall in Uttar Pradesh , Himachal Pradesh ,Delhi and Haryana region and snow /rainfall over Himalayan regions on 11-12 March 2014. This is primarily was associated with the wesward moving system and induced effect generated by westerly tough. This event clearly captured in terms of measurement of low values of OLR (100-150 watt /m2) pink in color. This pink shade moved gradually and covered large area. As this minimum value of OLR progresses the clouds become more organized and sensitive to precipitation. Figures (a-d) shows the progressive approach of convection which was the indication of fairly wide spread rainfall /snowfall. Several houses were collapse due to heavy rain and snowfall in Jammu and Kashmir area. The Srinagar-Jammu highway remained closed continuous three days.

Concluding Remarks:

Outgoing long wave radiation is a proxy indicator of convection and is may lead to precipitation when goes smaller range (200 watt/m2 or less). He Changes in precipitation extremes are getting attention in the context of a warming climate to the global community. However, the lack of high-quality observations hinders the detection of variability in daily precipitation extremes over several regions, notably over the oceans. Hence, the outgoing longwave radiation (OLR) observed by satellites have long been used as a proxy to detect deep convection over the tropics. In recent past peoples allover the globe developed a heavy precipitation index based on daily OLR data over the global tropics. INSAT derived OLR is used in monitoring the convection as well as precipitation over the tropics. During winter most of the weather systems produce heavy to very heavy precipitation over J & K and neighbored. INSAT OLR is useful in monitoring and forecasting the weather events and avalanche related issue occurred in these areas.

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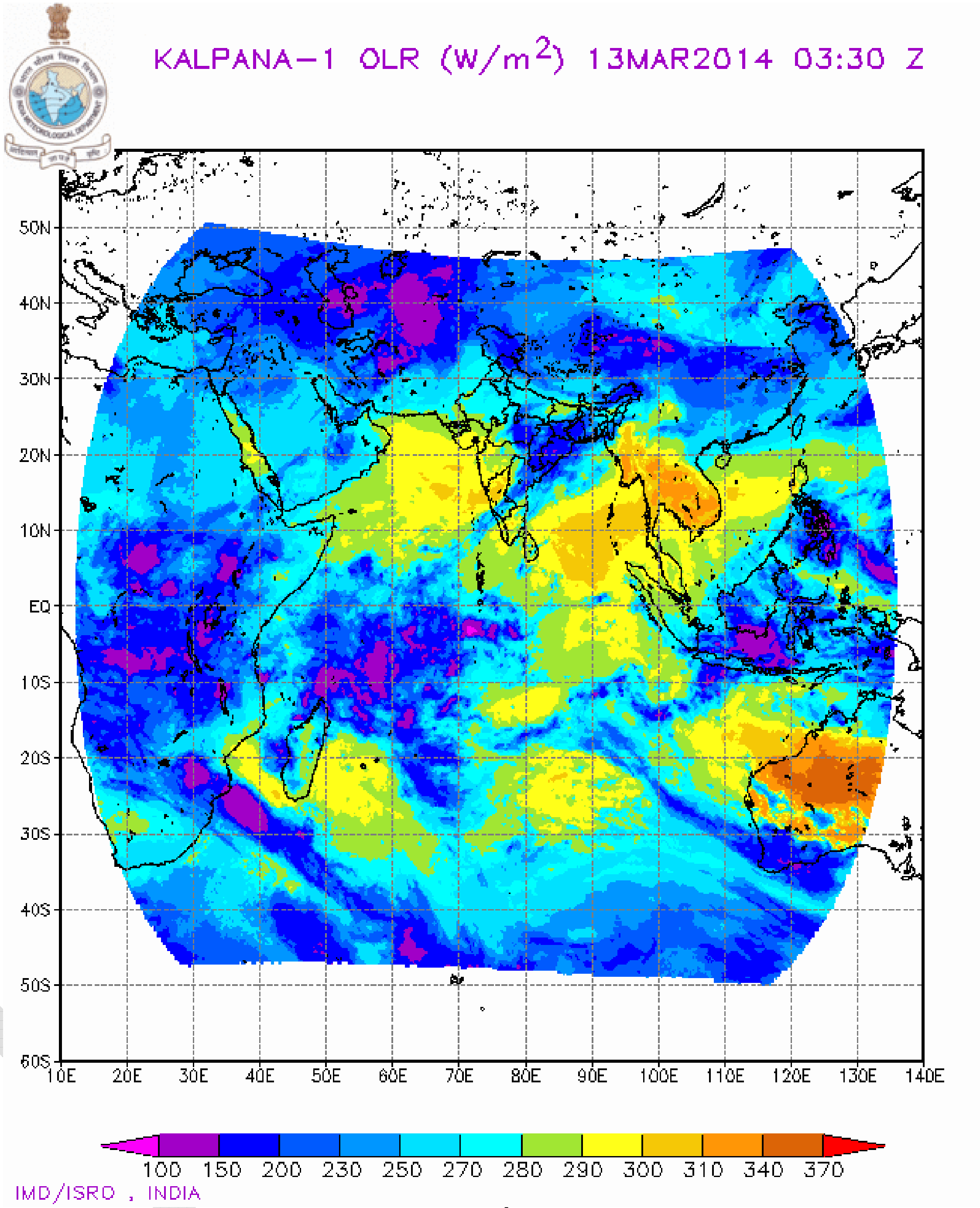

Fig (a) : INSAT OLR on 13th March 2014 (0330 UTC)
(Convection area approaches towards J & K,HP and neighbored)

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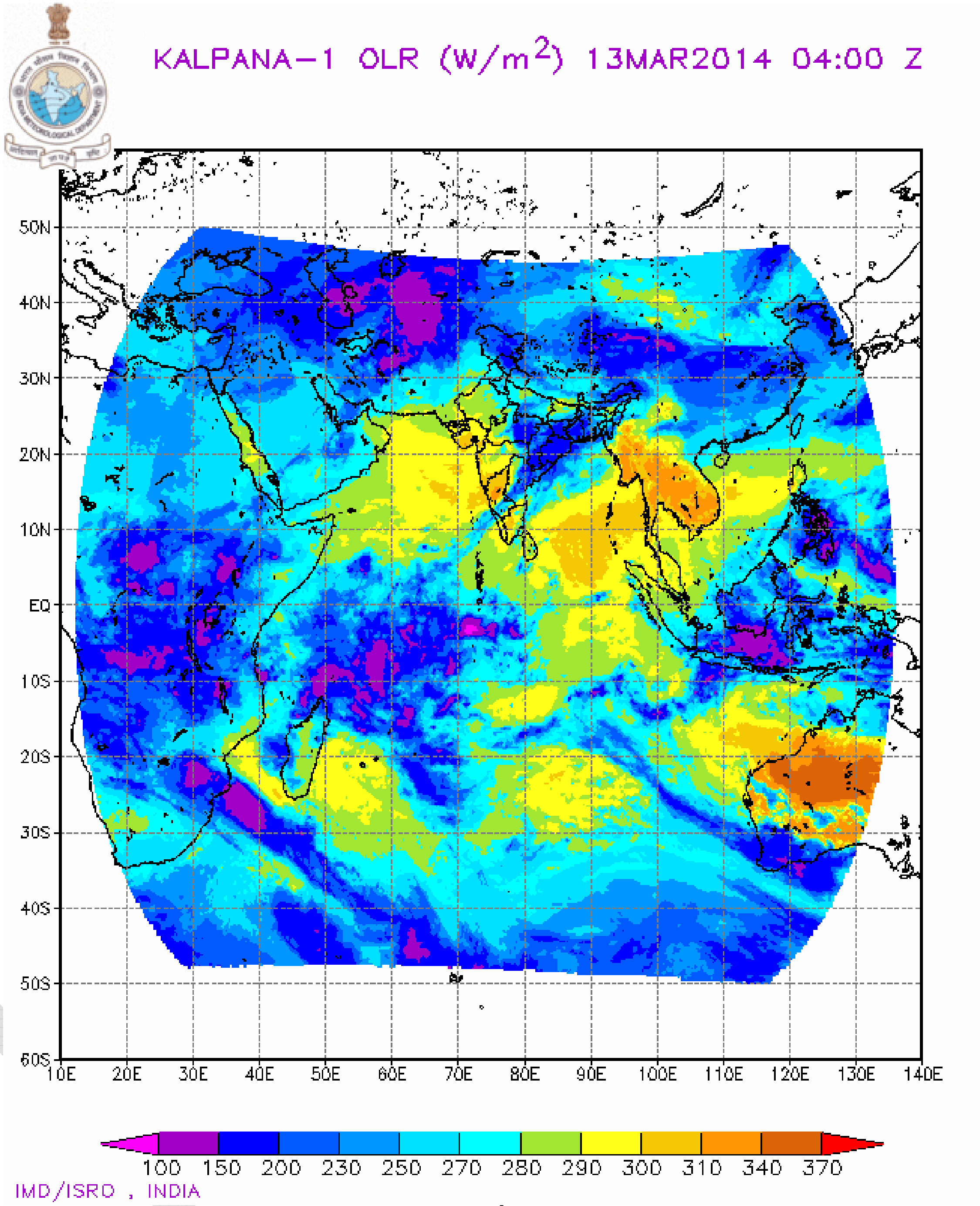

Fig (b) : INSAT OLR on 13th March 2014 (04:00 UTC)
(Convection area approaches towards J & K,HP and neighbored)

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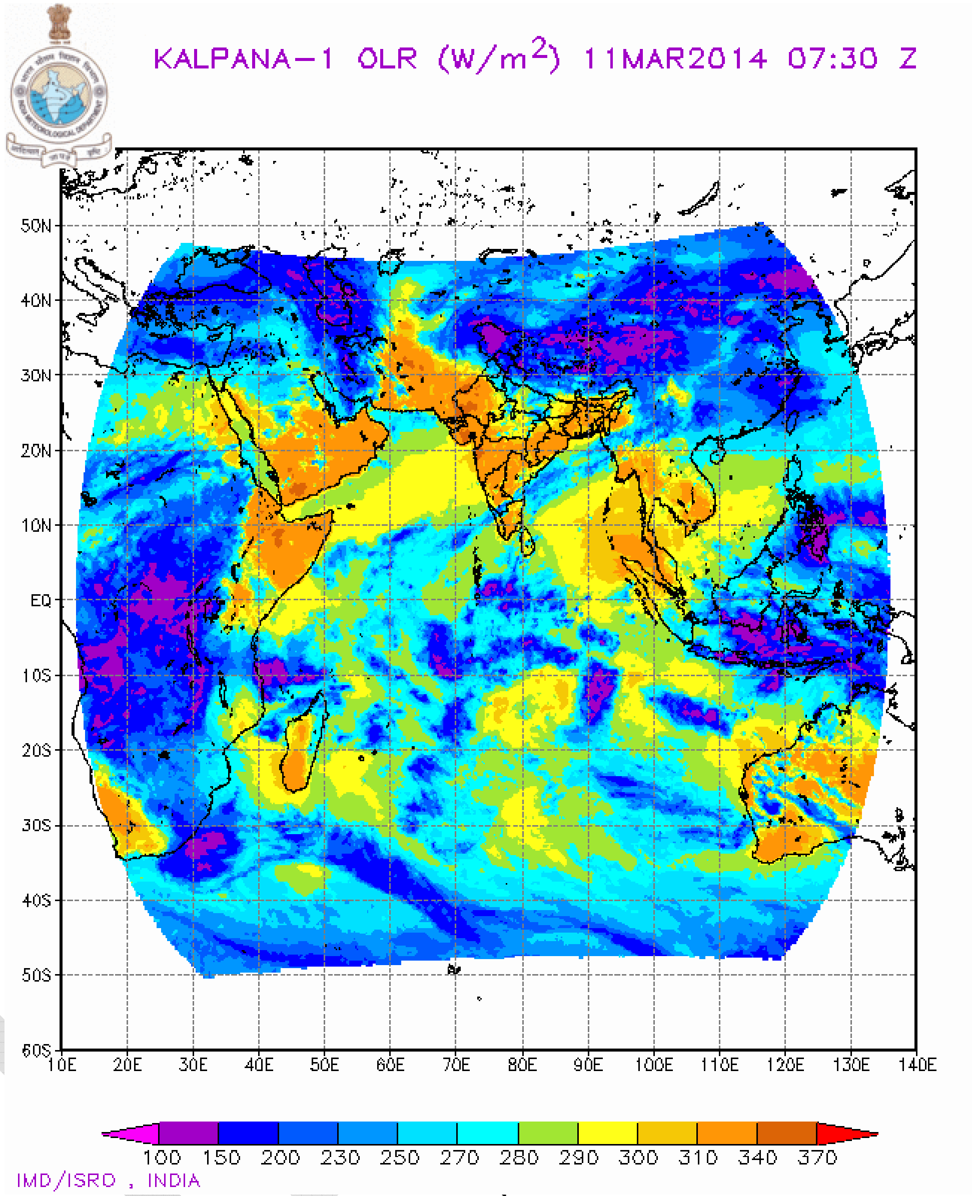

Fig (c) : INSAT OLR on 11th March 2014 (0730 UTC)
(Convection area lies over J & K region)

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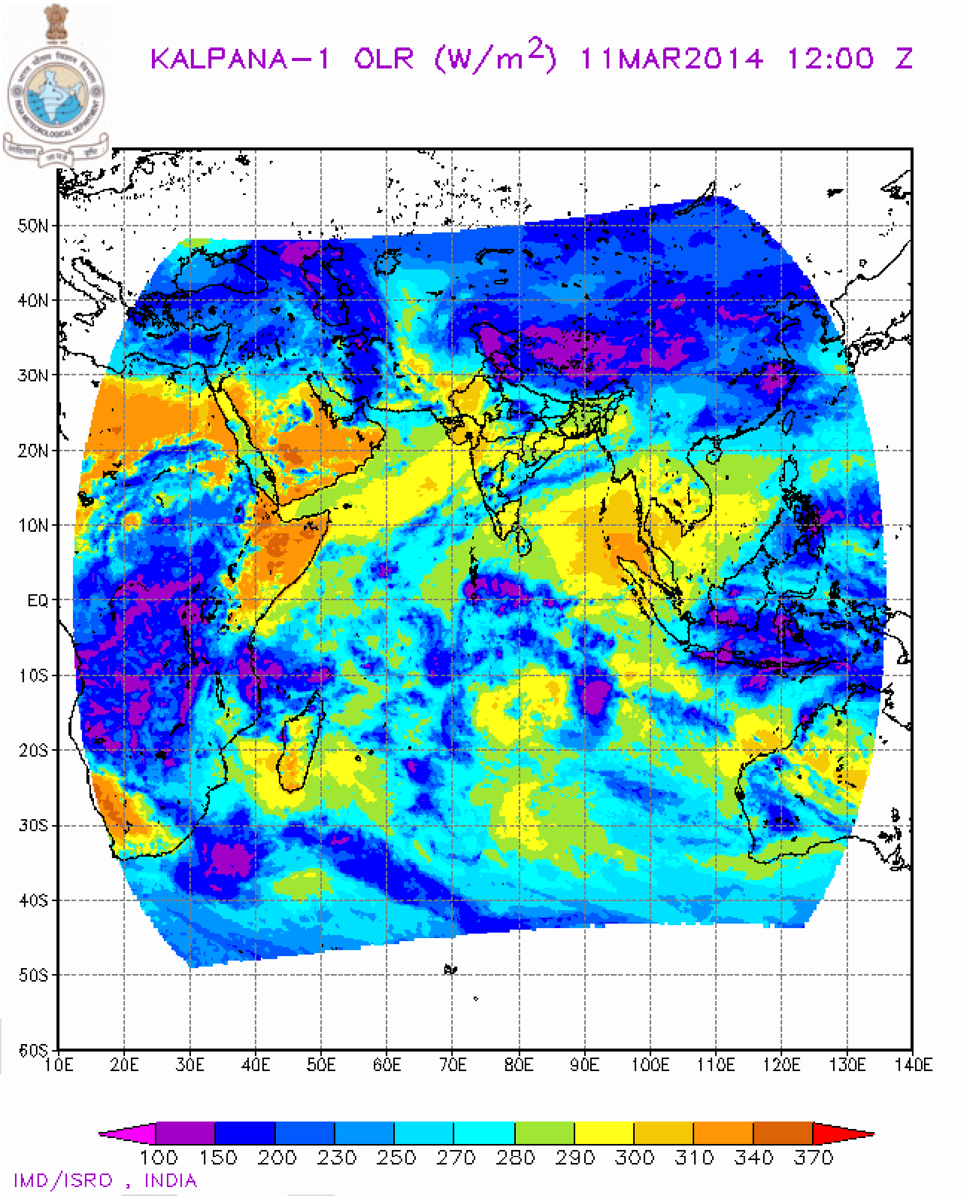

Fig (d) : INSAT OLR on 11th March 2014 (0730 UTC)
(Convection area lies over J & K,HP and neighbored)

Acknowledgements: The author is grateful for the valuable discussion with IMD.

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