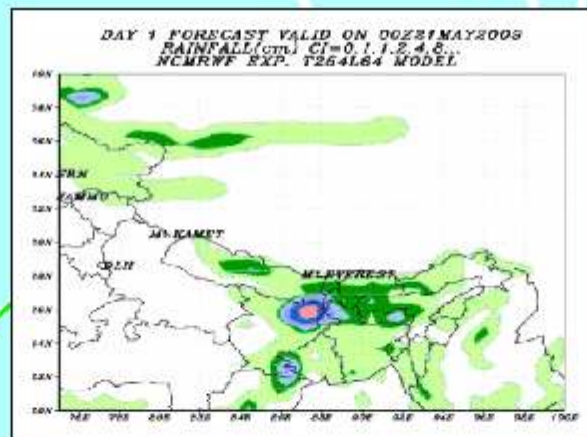
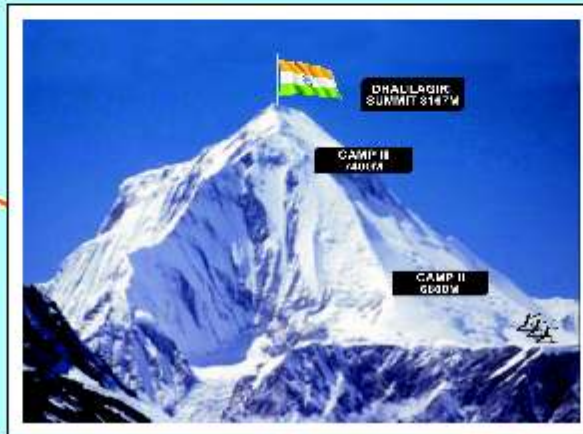


Customized Weather Forecast For Mountaineering Expeditions In India



Jagvir Singh, Akhilesh Gupta, G.R. Iyengar,
Ashok Kumar, Ranjeet Singh, E.N. Rajagopal
L. Harenduprakash and L.S. Rathore



Government of India
Ministry of Earth Sciences
National Centre For Medium Range Weather Forecasting
Noida-201 309

Note :

1. Front cover:

Front cover contains pictures of Mt. Dhaulagiri and global model T254L64 predicted precipitation valid for 00UTC of 21st May 2009.

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3. Report is also available on following website of Ministry of Earth Sciences and National Center For Medium Range Weather Forecasting (NCMRWF);

www.moes.gov.in and

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Customized Weather Forecast For Mountaineering Expeditions In India

Earth System Science Organisation
National Centre For Medium Range Weather Forecasting

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9	Originating Unit	National Centre For Medium Range Weather Forecasting (NCMRWF), Ministry of Earth Sciences (MoES), Government of India, A-50, Sector-62, Noida-201309
10	Abstract (100 words)	Weather forecast plays a crucial role in the successful and safe completion of Mountaineering expeditions. NCMRWF has been providing numerical weather prediction models based customized weather forecast support interactively (by mobile / email / phone / website) to the Armed forces for their mountaineering expeditions since 2001. A total of thirty eight safe and successful mountaineering expeditions have been supported by NCMRWF during 2001-2009. Method of preparation of customized forecast at NCMRWF, details of mountaineering expeditions and feed back analysis of the products as evaluated by the expeditions teams are documented and presented in this report.
11	Security classification	Unrestricted
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Jagvir Singh, Akhilesh Gupta*, G.R. Iyengar, Ashok Kumar
Ranjeet Singh, E.N. Rajagopal, L.Harenduprakash and L.S. Rathore

National Centre for Medium Range Weather Forecasting (NCMRWF),
Ministry of Earth Sciences, A-50 Institutional Area,
Sector-62, Noida-201 309

* Department of Science and Technology, Technology Bhavan,
New Mehrauli Road, New Delhi-110 016

Abstract

Mountaineering expeditions are the important peace time activities of Indian defence and paramilitary forces. Weather plays a crucial role in the successful and safe completion of adventure expeditions in the tough, uninhabited and almost inaccessible places like high mountains. There has been a good improvement in the accuracy of the weather forecasts during past two decades or so mainly due to the voluminous increase in observations both from conventional and non-conventional platforms such as satellites, radars, etc. NCMRWF has been catering to demands from various sectors like agriculture, power, transport, tourism industry, defence, etc. since its inception. During the past decade, the Centre has been regularly providing its customized products to mountaineering expeditions through its web site and also through personal interactions with the participating teams. There has been a very high success rate of these expeditions which is to a great extent attributed to high accuracy of products supplied by NCMRWF. This technical report is about such thirty eight safe and successful mountaineering expeditions during 2001 to 2009. The fact that there has been a gradual increase in the demand of such products over the time, suggests popularity and usefulness of these products.

Key words:

NWP - Numerical weather prediction models;

AAW - Army Adventure Wing;

Forecast - NWP based customized weather forecasts for mountaineering;

NCMRWF - National Centre For Medium Range Weather Forecasting;

IMD - India Meteorological Department;

BSF - Border Security Force;

ITBP - Indo-Tibet Border Police.

1. Introduction:

The Government of India established the National Centre for Medium Range Weather Forecasting (NCMRWF) with a primary responsibility of generating and providing medium range weather forecast (3-10 days in advance) for catering to farming sector. The then Prime Minister of India late Shri Rajiv Gandhi inaugurated NCMRWF under the Ministry of Science and Technology and dedicated the first super computer Cray-XMP/14 to the nation in April 1988, for this purpose. NCMRWF began providing its first operational medium range weather forecast products to India Meteorological Department (IMD), the national weather service agency from 1st June 1994. In addition to the research and development work carried out by the Centre (NCMRWF) with the aim of improving the weather forecasting in the country, the Centre had the main responsibility of rendering medium range weather forecast based Agro-Advisory Service (AAS) from Agro-meteorological Field Units located at 127 agro-climatic zones in the country. The AAS service was established and nurtured by the NCMRWF for over 15 years before it was transferred to IMD in 2007.

With the development of NWP at NCMRWF, demand for customized weather products had gradually increased from different agencies like the Ministry of Agriculture, Ministry of Water Resources, Power Sector, Armed Forces, etc. NCMRWF developed NWP products based customized weather forecasts to cater to such requirements. This activity of meeting the specific demands for weather forecasting products began in 1998 and continued till date. There has been a gradual improvement in the accuracy and range of such forecasts as well as their real time dissemination. The centre has been providing weather forecast support to the following agencies:

- a. Crop Weather Watch Group (CWWG) meetings of the Department of Agriculture and Cooperation, Ministry of Agriculture since 1998 until 2008.
- b. Indian Army for strategic and adventure purposes beginning from 1999 during Kargil's conflict and subsequently for a number of mountaineering, hot air ballooning and paragliding expeditions.
- c. Ministry of Home Affairs (MHA) for mountaineering expeditions organised by BSF, ITBP, IB.
- d. Nehru Institute of Mountaineering Uttarkashi (NIM), S.G. Mountaineering Institute Gangtok(SGMI), Himalayan Mountaineering Institute Darjeeling (HMI) for their mountaineering expeditions.
- e. The Power Grid Corporation of India Ltd. (PGCIL) from time to time for power distribution and management.
- f. Indian Oil Corporation Ltd. for their off shore single point moored project work (2008)
- g. A large number of media groups both print and electronic media

This report however is confined to the supply of NWP products based customized weather forecast support for the mountaineering expeditions.

2. Brief Account of the Expeditions

The following paragraphs give a brief account of customized forecast products generated and supplied by NCMRWF to defence and paramilitary forces for mountaineering expeditions. A brief introduction of background of customized forecasting at NCMRWF is also given here.

2.1 Beginning of Customized Forecasting at NCMRWF

NCMRWF received its first request of customised weather forecast from the Indian Army in the context of a strategic application during the Kargil conflict with Pakistan in 1999. It was the first occasion when NCMRWF prepared customized forecasts based on its NWP model for the region and provided the same to the office of Director General of Military Operation (DGMO). Forecasts of snowfall and rainfall over Western Himalayan region and the Kargil area (Figure 1) were issued 4-5 days in advance using the T80 global model products. These products were found to be accurate and useful on several occasions in the day to day military operations conducted by the Indian Army and Indian Air Force. This provided encouragement and inspiration for customization of NWP products and had greatly helped NCMRWF to take up new areas of application of NWP products.



Figure 1

2.2 First customized forecast for Mountaineering Expedition to the Mount Everest

In late 2000, the Army Adventure Wing (AAW) at the Army HQ., New Delhi was planning a major mountaineering expedition to Mount Everest during 2001 summer. The Indian Army had a few set backs in the past as they had to abandon some of their expeditions to Mount Everest due to bad weather situations. They needed weather forecast which is quantitative, accurate and having validity beyond two days. India Meteorological Department had been issuing qualitative weather forecast valid for 48 hours for the Everest area and disseminating the same through All India Radio. Although such a forecast was useful for having a general idea of weather conditions, but the mountaineers needed more quantitative and camp-wise forecast for at least next four days. Mountaineers climb from Base camp to Summit in four intermediate stages and have to pass through four camps. These are - Camp-I, Camp-II, Camp-III and Camp-IV. The entire climbing from Base Camp to Summit normally takes 4 to 5 days.

AAW approached NCMRWF to provide at least 4 days advance forecast for their expedition to the Mount Everest during April-May, 2001. NCMRWF had no past experience of forecasting for the Everest region. It was a daunting task especially for the fact that Mount Everest area was a data void region. Moreover the forecasts were to be prepared using a coarse resolution model (T80L18 Model) having about 150 km horizontal resolution. However, considering the fact that user like Indian Army has approached with great expectations, the Centre decided to take up this challenge. Scientists of Application group were entrusted with the responsibility of preparation and dissemination of these forecasts.

The Expedition team led by Col. K.Kumar left New Delhi in the mid March, 2001 and reached Base Camp in early April, 2001. The team began its initial acclimatization and started working for the establishment of various camps and rope fixing. They set up a Control Room in the Base Camp with dedicated communication facility. They carried with them some basic weather observing equipments duly certified and calibrated by IMD. These included thermometers (dry bulb, wet bulb, maximum and minimum), barometer, wind wane and anemometer. Some of the members had some experience of visual cloud cover and visibility estimates. The team began disseminating all real-time meteorological observations to NCMRWF over satellite phone twice a day. These were of great help to NCMRWF's team of forecasters to calibrate the forecast issued on daily basis to the team. The NCMRWF team started issuing the customized forecast and had several mock exercises with the help of observations from the Expedition team.

Despite failures during the experimental phase of forecast in the month of April, 2001, the forecast products turned out to be reasonably accurate during the crucial phases of the Mt. Everest expedition in 2001. A team comprising of seven Army men and three Sherpas successfully scaled Mount Everest in two groups on 22nd May 2001. Col. Rajender Singh, Director AAW conveyed his appreciation to the NCMRWF in its first ever endeavor to predict the weather conditions over the Mount Everest.

2.3 Forecast for subsequent Expeditions to Mount Everest and Other Peaks in the Himalayan region

Encouraged by the success of 2001, Indian Army Mountaineering Expedition to Mt. Everest, the demand for such forecast products from Indian Army started pouring for other expeditions such as those for Mountaineering Expeditions to Mt Annapurna-I (in 2002), Mt. Lhotse and Mt Everest (in 2003) and several more. NCMRWF has attempted providing weather forecast products for all such expedition. Incidentally, all these expeditions were successfully completed without any single causality. Subsequently the Border Security Force, Indo-Tibetan Border Police, Special Frontier Force of the Ministry of Home Affairs and several Mountaineering Institutes were also provided specialized weather forecast support for their expeditions.

Beginning from 2001 until 2009, NCMRWF provided meteorological forecast support to thirty eight mountaineering expeditions. All these expeditions have been completed successfully without any loss of human life. Interestingly, a number of foreign teams also used NCMRWF's forecasts through Indian expedition teams and found these products very useful.

Figure 2 depicts the number of expeditions for which forecast were provided during 2001 to 2009.

Figure 3 shows a few select landmarking successful expeditions for which NCMRWF provided forecast. It is worth mentioning that although there had been some loss of lives due to avalanche, illness, cardiac and respiratory problems, but there has been no single casualty due to bad weather in any of the expedition for which NCMRWF provided support since 2001.

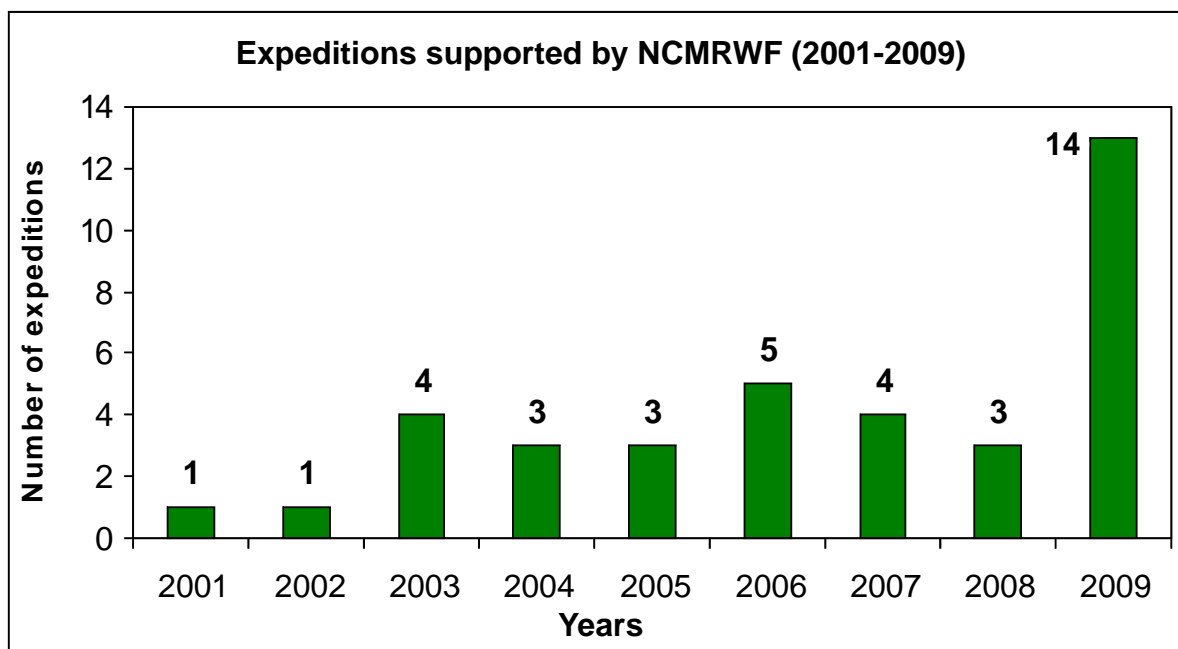


Figure 2

NCMRWF's Success Stories of providing Tailored Forecast for Mount Everest Expeditions

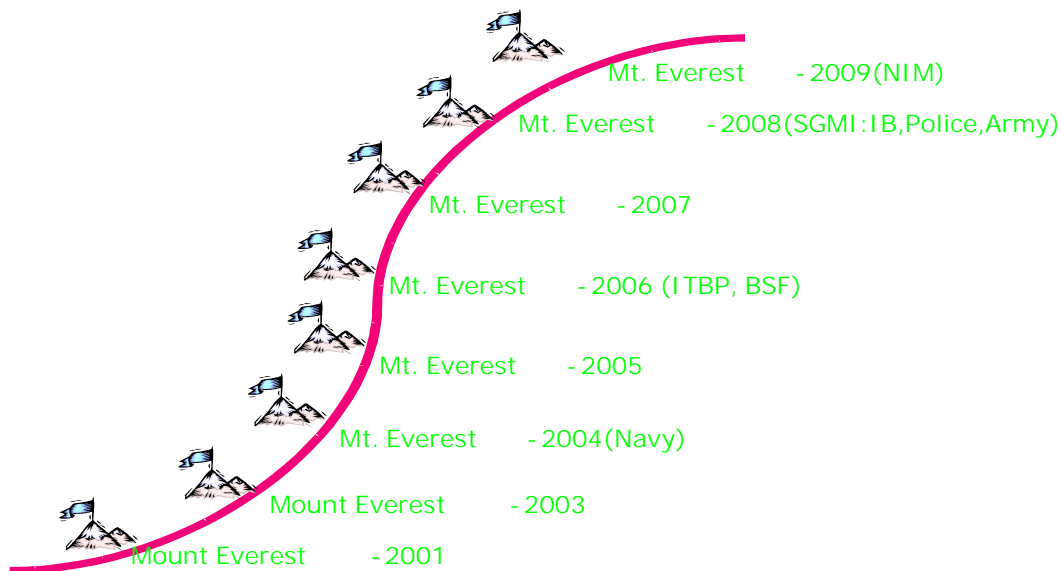


Figure 3

The expeditions to which NCMRWF provided specialized customized weather forecasts include; Mt. Everest expedition of Army during 5 April-1 June 2001; Mt. Annapurna-I during 20 April-25 May 2002; Mt. Everest 4 April-13 May 2003; Mt. Lhotse 4 April-27 May 2003; Mt. Gangotri-II 10-22 September 2003; Mt. Everest 15 April-15 May 2004; Mt. Saser Kangri 1-18 May 2004; Mt. Kamet September 2004; Mt. Kanchenjunga, October 2004; Mt. Everest May-June 2005; Mt. Shisha Pangma, May 2005; Mt. Gangotri-I May, 2005; Mt. Cho Oyu, 2006; Mt Everest (from south), 2006; Mt. Everest (from north), April-June 2006; Mt. Satopath and Mt. Everest, April-June 2007; Mt. Satopath, Mt. Kanchenjunga and SGMI's (Police, IB, Army) Mt. Everest expedition of April-June 2008. Fourteen successful mountaineering expeditions were provided forecasts by NCMRWF in the year 2009. These include; NIM's Mt. Everest, HMI's Mt. Makalu, Joint Indo-Kazakh Army's Peak of Marble Wall (Kazakhstan), ITBP's Mt. Kamet, Mt. Abigamin, Army's Mt. Dhaulagiri, Mt. Saser Kangri, Mt. Satopath, Mt. Mana, Mt. Vasukital, Mt. Gangchua and Mt. Shivling. However, the ITBP expedition to Mt Everest during 2009 was called off by them based on NCMRWF's forecast of continuous bad weather (snowfall) in first fortnight of October, 2009. The team returned safely from mid-route to Mt. Everest. Thus forecast support was provided to the fourteen mountaineering expeditions, largest number within same year i.e. 2009. Different sections of the armed forces had requested for forecasts for their different adventurous activities and expeditions. NCMRWF thus played an important role in the safe and successful summits by armed forces (viz. Army, Navy, BSF, ITBP, SFF, IB and Police Department of MHA). There have been ten safe and successful Mt. Everest expeditions viz. by Indian Army in 2001,2003,2004,2005,2007,2008; by ITBP in 2006, by BSF in 2006, Navy in 2006, MHA(SGMI,IB, Police) in May 2008 and NIM in May 2009. Similarly, other difficult mountaineering expeditions like Mt. Kanchenjunga (2004, 2008), Mt. Annapura (2002),

Mt.Lhotse(2003), Saser Kangri(2004,2009), Mt. Satopath(2007,2008,2009), Mt. Gangotri-II(2003), Gangotri-I(2005), Mt. Cho Oyu(2006); Mt Makalu, Mt. Kamet, Mt. Abigamin, Mt. Dhaulagiri, Mt. Shivling Mt. Mana Mt. Vasukital and Mt. Gangchua (2009) had demonstrated the importance of weather service for planning for safe summiting. Table 1 contains the list of major expeditions along with their summit month and year.

Table 1: Mountaineering expeditions with month and year of their summit

S.No.	Mountain/Peak	Time of Summit	Summiteers/Depts./Institute
1.	Mt. Everest (Sagarmatha)	May-2001	Army
2.	Mt. Annapuran-I	April-May 2002	Army
3.	Mt. Everest	April-May 2003	Joint Army Team
4.	Mt. Lhotse	2003	Joint Army Team
5.	Mt. Gangotri-II	10-22 Sep 2003	NCC
6.	Mt. Everest	15 Apr-15 May 2004	Navy
7.	Mt. Saser Kangri	1-18 May 2004	Army
8.	Mt. Kamet	September 2004	Armed Forces
9.	Mt. Kanchenjunga	October 2004	Armed Forces
10.	Mt. Everest	May-June 2005	Army
11.	Mt. Shisha Pangma	May 2005	Army
12.	Mt. Gangotri-I	May 2005	Army
13.	Mt. Everest	April-May 2006	BSF
14.	Mt. Everest (from north)	April-June 2006	ITBP
15.	Mt. Cho Oyu	2006	Army
16.	Mt. Annapurna-I	April-June 2006	Army
17.	Mt. Lhotse	April-June 2006	Army
18.	Mt. Everest	April-June 2007	Army
19.	Mt. Everest	April-June 2008	SGMI (IB, Police, SFF, Army)
20.	Mt. Satopath	September 2008	NIM Uttarkashi
21.	Mt. Kanchanjunga	1 - 26 May 2008	BSF
22.	Mt. Everest	14 April-22 May 2009	NIM
23.	Mt. Makalu	April-May 2009	HMI Darjeeling
24.	Marble wall peak (Kazakhstan)	29 Aug-4Sep 2009	Joint Indo-Kazakh Army
25.	Mt. Kamet	2009	ITBP
26.	Mt. Abigamin	April-June 2009	ITBP
27.	Mt. Dhaulagiri 8167m	April-May 2009	Army
28.	Mt. Saser Kangri	April-May 2009	Army
29.	Mt. Satopath	May-June 2009	Army
30.	Mt. Mana	2009	Army
31.	Mt. Gangachua	2009	Army
32.	Mt. Shivling	2009	Army
33.	Mt. Vasukital	2009	Army
34.	Mt. Chaukhamba-I	Aug-Sept 2009	Army
35.	Mt. Everest	Sept-Oct 2009	ITBP

Forecasts of winds and weather were also provided to the Indian Army for their hot air Trans-India Ballooning expeditions in March 2003 (Pune – Hyderabad) and November-December 2003 (Devas to Jamshedpur) ; Day-night ballooning from Jaipur to Shivpuri in February-March 2006 and the paragliding expeditions of 2004 and 2009. Maj. Kumar Bhaskar of Indian Army broke previous Indian record and set a new record of traveling continuously 17 and half hour in one go from Pune to Hyderabad on a hot-air balloon during March 2003. It was a difficult task because the only control available with the balloon pilot is height adjustment through increase or decrease of volume of gas in the balloon. The balloon is otherwise completely driven by the prevailing wind direction and speed at that particular level. To reach at the destination point, very high accuracy of wind direction and speed was required. Maj. Kumar Bhaskar was in constant touch with the NCMRWF Scientists for advisory on the trajectory of the balloon during entire period of balloon flight.

A description of the forecasts for various expeditions along with feedback and verification by the expedition teams is given in Table 2.

Table 2: Details of mountaineering and other adventure expeditions for which forecast support was provided by NCMRWF

Year	Expeditions Mountaineering/ Ballooning	NCMRWF's Customized forecast	Observation/Realization/ Feedback
2001	Mt. Everest Expedition (5 th April-5 th June 2001)	<ol style="list-style-type: none"> 1) Forecast of clear weather on 8th May 2001 2) Forecast of bad weather during 15th-16th May 2001 against forecast of good weather by other agencies. 3) Forecasted on 19th May, for clear weather for safe summit during 21st-23rd May 2001 	<ol style="list-style-type: none"> 1) Team faced strong winds in south col (Wrong Forecast). 2) Indian Army team along with other 18 foreign teams attempted, but all failed due to bad weather which was predicted. 3) Indian and 18 other teams successfully scaled the Sagarmatha (i.e. Mt. Everest) as per forecasts
2002	Mt. Annapurna-I 20 th April-25 th May 2002	<ol style="list-style-type: none"> 1) Initial forecasts 2) Corrections were made to and forecasted for favorable weather window 	<ol style="list-style-type: none"> 1) Forecasts were found wrong due to lack of knowledge of team's route from north 2) First-ever Indian team made it a success after their two previous expeditions which failed due to bad weather
2003	Mt. Lhotse (8511 m) 13 th May, Morning	<ol style="list-style-type: none"> 1) Forecast was erroneous due to not knowing features of "GALLI" in particular 2) Forecasted a narrow clear weather window of less than 24Hrs. viz. 12th May(F/N)-13th May 2003 Morning 	<ol style="list-style-type: none"> 1) Corrections were applied after consultation of features with team leader Col. Abbey 2) Indian Army scaled the peak on 13th May 2003, 6AM. Soon after the team landed in Camp-IV, winds strengthened considerably.
	Mt. Everest 22 nd May, Morning	<ol style="list-style-type: none"> 1) Forecasted clear weather during 21st May 22nd May 2003 	<ol style="list-style-type: none"> 1) Army team completed summit successfully on 22nd May (morning) as per forecasts.
	Gangotri-II	<ol style="list-style-type: none"> 1) Forecasted clear weather during 20th Sept. 21st September 2003 	<ol style="list-style-type: none"> 1) Team performed summit in early morning of 22nd September 2) Team appreciated forecast, as 6 mountaineers from other countries died on 18th September on same route.

	<p><i>Trans India hot air ballooning, Ahemdabad to Kolkata, 1-22 March</i></p> <p><i>Hot air ballooning 27Nov-27Dec.2003 Pune-Hyderabad</i></p>	<p>1) <i>Prediction of winds at different heights, rains were provided during 1-22March</i></p> <p>1) <i>Prediction of winds at different heights, rains were provided</i></p>	<p>1) <i>Indian army team first-ever performed such expedition. Forecasts were applauded.</i></p> <p>1) <i>Team performed successfully Team reported back the usefulness of forecasts.</i></p>
2004	Mt. Saser Kangri April-May 2004	1) Forecasted weather to be favorable on 21 st May 2004	1) Army team scaled the peak on 21 st May. Team leader applauded forecast. Special mention of accurate forecasts in flag in ceremony in July 2004.
	Mt. Everest, May 2004	1) Forecasted weather to be favorable on 22 nd May 2004	1) Navy team scaled the peak successfully on 22 nd May
	<i>Paragliding over western Himalayan region, June 2004</i>	1) <i>Provided forecasts of winds direction and speed mainly</i>	1) <i>Army team performed the expedition successfully. Special mention of accuracy of forecasts during Flag in ceremony in August 2004.</i>
	Mt. Kanchenjunga September- October 2004	1) Forecasts were issued to Army team	1) Forecasts were found very useful by team in success. Advisories were appreciated.
2005	Mt. Everest May-June 2005	1) Forecasts & advisories were provided through out May-June and final forecast of favorable weather during 1 st -2 nd June 2005	1) Army's team with first ever largest number of women(8) successfully made summit on 2 nd June. Special mention in flag in ceremony and in presence of Honb'le President Dr. Kalam on 27 th June at Rashtrapati Bahvan
	Mt. Gangotri-I May 2005	1) Issued forecast on 26 th May2005 for favorable weather on 28 th -29 th May to summit	1) Special Frontier Force performed summit successfully on 29 th May as per forecasts. Maj. General/Head SFF visited NCMRWF in appreciation of forecasts.

2006	Mt. Everest (From north side)	1) Forecast in expedition period and favorable weather 15 th -19 th May 2006	1) ITBP successfully summit the peak on 15 th and 19 th May 06. Forecasts were greatly appreciated. [ITBP had failed to summit in past due to bad weather.]
	Mt. Everest	1) Forecasts of favorable weather during 20 th -24 th May 2006	1) BSF successfully summit the peak.
	Mt. Cho Oyu	1) Forecasted favorable weather for safe summit	1) Army's team safely summit the peak on 24 th May 2006.
	Mt. Satopath	1) Forecasted weather conditions to team of Indian Air Force, 24 th May-6 th June 2006	1) Air Force team successfully made summit according to NCMRWF forecasts and advisory of their Met. Wing.
	Day-night hot air ballooning, Jaipur-Shivpuri	1) <i>Issued forecast during Feb-March. Forecasted winds to be favorable on 2nd March 2006.</i>	1) <i>AAW team performed the expedition successfully and safely on 2nd March. Team and AAW appreciated forecasts.</i>
2007	Mt. Everest	1) Forecasts and advisories issued for expedition. Forecast of favorable weather during 14 th -16 th May 2007 *Forecasts were communicated through emails also	1) Maratha Infantry of Army successfully summit the peak as per forecasts. Forecasts and coordination were greatly appreciated.
2008	Mt. Everest	1) Forecasts of weather to SGMI mountaineering team (comprising of IB, Police, SFF and Army) during April-May 2008 and clear weather during 20 th -22 nd May 2008	1) Teams successfully completed the expedition on 22 nd May, morning. Forecasts were found accurate and appreciated by teams.
	Mt. Kanchenjunga	1) Forecasts issued to BSF in May 2008. Favorable weather predicted for 25 th May.	Team was fed up with continuous bad weather. But team had patience and completed the summit according to forecasts. Team and DG appreciated the forecasts.

	Mt. Satpath	1) Forecasts were issued to NIM's team during September-October 2008	1) Nehru Institute of Mountaineering (NIM) team scaled the pre-Everest expedition of Mt. Satopath
2009	Mt. Everest	1) Forecasted on 16 th May 2009 for clear weather for subsequent 4-5 days, i.e. up to 21 st May 2009.	1) NIM Uttarakashi team successfully summit the PEAK on 21 st May 2009. Col. M.Masur team leader and Principal NIM applauded forecasts in presence of Honbl'e MoS Defence and Army Chief in flag in ceremony.
	Mt. Makalu	1) Forecasted on 16 th May clear weather during 19-21 May 2009 2) Team leader Col. Rana requested for forecast, telephonically from route	1) HMI Darjiling team scaled the peak and Col Rana also made a record of paragliding. Col. Rana, team leader appreciated forecasts.
	Wall of Marble Peak (Kazakhstan)	1) Forecasted 36 Hr clear weather, cautioning for not clear weather for continuous 48 Hrs on 29 th August to 3 rd September 2009	1) Team completed the summit successfully with calculated risk. Leader informed that they got trapped in westerly storm for few hours as forecasted.
	Mt. Dhaulagiri 8167m	1) Forecasted light snowfall and no stormy weather during 7 th –11 th May 2009 2) Forecast of light snowfall during 10-11 went wrong	1) Team scaled the peak safely on 8 th May 2009 F/N. Team appreciated forecasts to be superior than forecasts by other agencies.
	Mt. Abigamin	1) Forecasted 3 days in advance for clear weather 4 th –7 th June 2009	1) ITBP Team accordingly scaled the peaks of successfully and safely
	Mt. Kamet	1) As above, June 2009	1) ITBP Team scaled the peaks of successfully and safely
	Mt. Saser Kangri	1) Provided forecasts June-September 2009	1) Army team successfully scaled the peak
	Mt. Satopath	1) Forecasts were issued June-September 2009	1) Team found forecasts of great use in their success

	Mt. Mana	1) Forecasted 3-4 days in advance for clear weather during 14 th –16 th June2009	1) Team required 2 days clear weather window to summit. They did it successfully on 16 th June 2009
	Mt. Gangachua	1) Forecasts were provided and team had to be in base camps due to usual bad weather in September2009.	Team made very good use of forecasts. They completed summit safely, as per NCMRWF's clear weather forecasts
	Mt. Shivling	1) It was bad weather frequently, NCMRWF Forecasted for bad and clear weather windows, September2009	1) Team successfully summit the peak as per forecasts of clear weather
	Mt. Vasukital	1) It was bad weather frequently, Forecasted for bad and clear weather windows, September2009	1) Team successfully summit the peak as per forecasts of clear weather
	Mt. Chaukhamba-I	August-September2009	-do-
	Mt. Everest Expedition, September-October 2009	1) It was cautioned that weather becomes severe over eastern regions, whenever monsoon is poor. 2) Forecasts were provided regularly on mobile.	Team could not find sufficient clear weather windows for completion of camps, stocking and finally had to call off in first week of October 2009. Team could return safely.

3. Methodology and Procedure of Preparation of Forecasts

Non-availability of observed weather data and lack of knowledge of terrain have been the major bottle-necks in the prediction of weather over the high altitude Himalayan region. Whatever information that are available are usually of a gross climatological nature on the seasonal scale. As far as day to day weather data is concerned there is hardly any data available for the region except for satellite imageries and other remotely sensed products. During the initial discussion that took place in 2001, a major point that came up was how the expedition teams were to provide real time observations from their route positions. Army and MHA's armed forces do not have their own meteorological wing. Therefore, NCMRWF scientists have been delivering the essential and required lectures and training on observation of weather and atmospheric parameters to the expedition teams, since 2001. Expedition teams are provided with a list or proforma of atmospheric parameters which they are to measure and report every day to the team of NCMRWF, scientists whose mobile numbers, phone numbers and emails are given to the teams. However, these observations that are made from time to time by the expedition teams, lack continuity and a lot more needs to be done in gathering systematic and continuous meteorological information from those locations. Satellite products have increased and diversified the information that are available. These information serve the purpose of knowing the actual atmospheric and weather conditions in the expedition area that are never available otherwise.

NWP systems have fairly large errors not only in the forecasts but occasionally in the analyses (analysis represents the observed state of the atmosphere) too. It is mainly due to poor or coarse representation of features of the region. There is lack of weather information over the Himalayas and neighborhood and the observational network. This problem was acute in 2001 while preparing model based forecasts to the Army expedition team. One failed forecast and the feed back on it received from the team helped NCMRWF to correct the subsequent forecast advisories to the team. The modified forecasts were issued to the Army expedition team and turned out to be accurate and of great help in summiting Mt. Everest safely in 2001. With the experience accumulated, new procedures and methods were developed in 2003 while by the group of NCMRWF Scientists, who were preparing the forecasts for Army's Trans-India hot air ballooning expedition, for these kinds of specific requirements (Jagvir Singh et al. 2008). The protocol is based on the use of details from model forecast products, conventional observations by teams, satellite imageries and products. Doppler weather radar (DWR) products were also used in 2009 for the Mt. Everest and Mt. Makalu expeditions. Detailed discussion on DWR products of Kolkata region with Dr. D. Pradhan(IMD) was useful. It is crucial to have observations at various altitudes of different locations along the course of any expedition. With observations of wind speed, wind direction, temperatures, visibility, clouds, precipitation and plumes on mountain peaks, etc. provided by the team members, model products for corresponding locations of nearly same altitudes are modified. This way, the team of scientists incorporated the bias and errors in model forecasts as compared to the observed situation in a particular location. Every effort is made to reduce the errors in the forecasts with the help of all kind of observations so as to make the forecasts as accurate as possible for the users. Subsequently, the procedure has been meticulously adhered to while preparing forecasts for expeditions. The schematic diagram of the procedure is given in Figure 4.

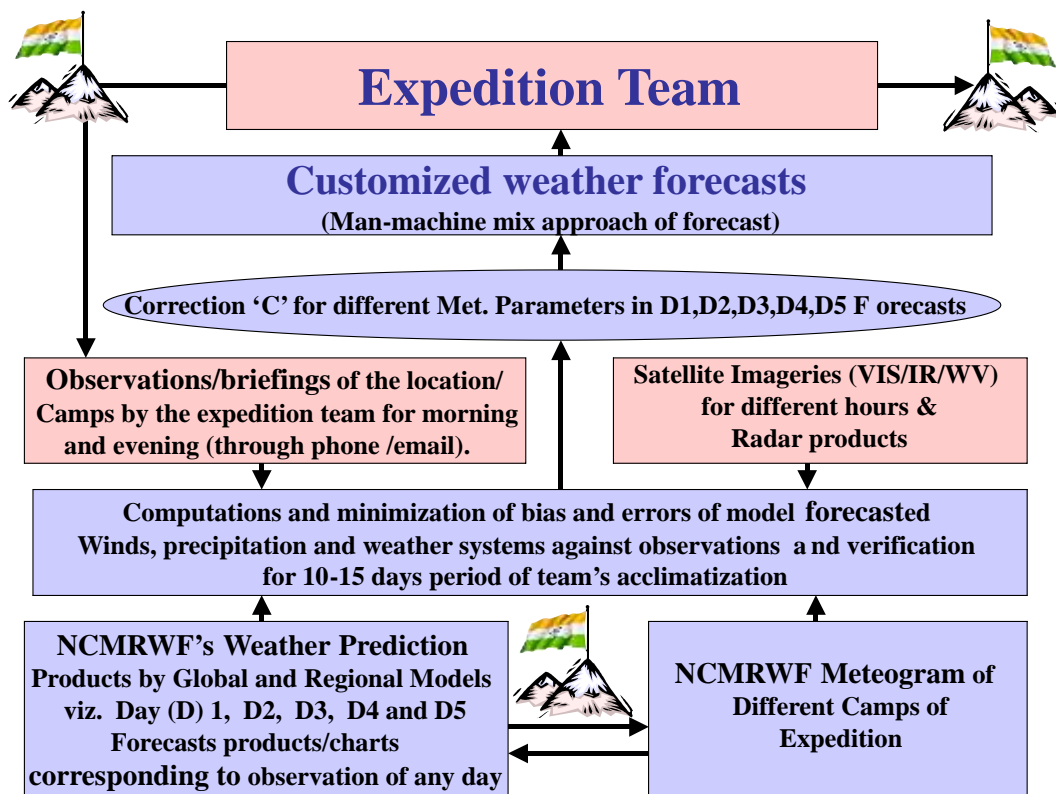


Figure 4

3.1 Meteograms For Route Locations

The Models (T80/L18 till 2008 and T254/L64, T382/L64 thereafter) generate forecasts at gaussian grid points over the globe for different heights and pressure levels in the atmosphere and not at any arbitrary location. The simplest way to get forecast at a specific location is to use the interpolated value from the four grid points surrounding it. But if the location is very near to a grid point, then the forecast at that grid point can also be taken as the forecast for the location. In order to decide as to which forecast among the two should be given more weightage for a location, it is necessary to know the distance of the location from the four grid points surrounding it. If the distance of the location from the nearest grid is less than one-fourth of the diagonal distance between any two grid points, then more importance is given to the nearest grid forecast values; otherwise the interpolated value is considered as shown in the following figure 5 (Kumar et.al.,1999).

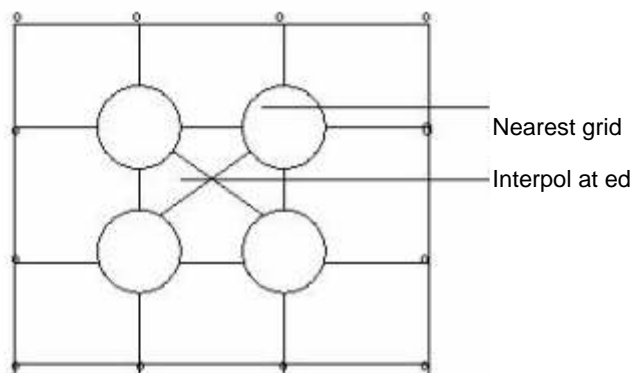


Figure 5: Area considered around a grid point for deciding the relative importance of nearest grid and the interpolated Direct Model Output (DMO) forecast values for a particular location.

The forecast values are obtained at every time step (that is 7.5 minutes for the T254L64 model) for surface pressure, maximum and minimum temperature. Six hour average forecast values are taken for rainfall and wind speed and wind direction from the operational run of T-254 Model (Rajagopal *et. al.* 2007), for plotting the meteograms.

Thus, meteograms depicting the forecast of the weather parameters viz. rain or snowfall, surface pressure, maximum and minimum temperature, wind speed and wind direction for the next seven days were prepared for the base camp and also for all the other camps along the path of the expedition and also for the final peak of the summit. This provides weather information in a well neat graphical form to the forecaster and the expedition team. Meteograms have been prepared for the locations of camps and the peaks of mountains for mountaineering expeditions since 2007. NWP products need to be customized with the help of actual observations and satellite imageries along with synoptic assessment of the situations by a forecaster. Much more needs to be done towards making the NWP products more reliable.

4. Weather Forecast Support to Armed Forces for Adventurous Expeditions

The following is a brief description of NCMRWF's support to the armed forces for some of their mountaineering expeditions during 2001 to 2009. Forecasts using model products, satellite imageries and way of coordination with mountaineering teams in the field are given for expeditions during 2007 to 2009.

4.1 Expedition 2001

Mt. Everest expedition

Forecasts were issued to the Army team led by Col. Kumar during April-May 2001. Initially the confidence was low, but at same time good confidence of model's capability in representing the middle tropospheric westerly bound weather systems over Himalayan region which was demonstrated during the Kargil conflict of 1998. Given below are major day to day forecasts during the course of Army's successful expedition 2001.

13th May, 2001

Feedback from Team: The team informed that they propose to start from Camp-III in the morning of 14th to reach South Col around noon from where they would start for summit in the night and complete their journey between 10 pm of 14th May and 9 am of 15th May. It was informed that there were total eighteen teams comprising of Americans, British, Russian, Korean, etc., and all the teams were also preparing to make summit on 15th and 16th May 2001. They also informed that these teams had got clearance from their respective weather bureaus.

NCMRWF's advice: After detailed analysis of our products and after careful analysis of their proposed plans for making summit, it was advised **NOT TO MOVE FORWARD** as there was clear indication of (a) Considerable increase in wind speed (Camp-IV upwards) from 15th May onwards which was to cross the threshold limit of 50-60 kmph to become 80-90 kmph on 16th May and 100 kmph on 17th May and (b) Possibility of snowfall activity on 15th May onwards. These conditions might prove hazardous to the team while they return from Summit on 15th May.

15th May, 2001

Feedback from Team: Major Saurabh Shekhawat informed that as per NCMRWF's prediction, the weather had started becoming very bad on that day with snowfall activity at Base Camp (BC) and Camp-II. They also noticed strengthening of winds at higher levels. It was informed that all other teams which had earlier got clearance from their respective weather bureau, had also decided to return to BC. All these teams were now at BC and were very eager to know about NCMRWF's forecast as our forecast came absolutely correct and accurate.

19th May, 2001

NCMRWF's forecast and advice: Clear indication of reduction in wind speed and snowfall activity from 21st May onwards. Winds are likely to remain within threshold limits on 22nd and 23rd May also. The team was asked to move forward for making summit.

21st May, 2001

Feedback from Team: The weather over South Col and Summit is sunny with 50 kmph westerly winds (considerable reduction in winds is noticed since the previous day). The Team has reached Camp-III in the evening of 20th and has now started for South Col in the morning. It was informed that all other foreign teams were making bee-line behind the Indian team.

23rd May, 2001

Feedback from Team: The Team had successfully scaled the Summit. Seven members of the team and 3 Sherpas started out from South Col at 10 pm on 22nd May as advised and reached summit in two groups at 7.30 am and 8.55 am of 23rd May. They encountered winds of the order of 50-55 kmph with light cirrus and cirri-cumulus clouds. The weather realized at Everest was as per NCMRWF's forecasts.

Failure, 8th May 2001: Forecast issued by NCMRWF to go ahead on 8th May. We called them back after observations receive showed strong winds at South Col.

4.2 Expedition 2002

Mt. Annapurna-I

Annapurna-I is considered as technically the most difficult peak in the world to scale. This was the first ever successful expedition by any Indian to Annapurna-I. The previous two expeditions failed due to BAD WEATHER.

Some initial difficulties were encountered in forecasting and making the advisories because of lack of understanding of the terrain. But these were corrected soon after the team briefed us that they were climbing from the north side. Subsequently, NCMRWF forecasts were found accurate and the Indian Army team, without much exertion, summited in the first attempt itself, safely.

4.3 Expeditions 2003

(a) Indo-Nepal Army's Joint Mt. Lhotse and Mt. Everest Expeditions

i) Mt. Lhotse 2003

Indo-Nepal Army jointly planned these mountaineering expeditions. This was a great experience and challenge for NCMRWF to provide clearance on weather front for both Lhotse and Everest which were to be scaled almost simultaneously. Both the mountains required two different favourable weather scenarios for summit. Mt. Lhotse is the fourth highest peak in the world (8511 m) and technically one of the most difficult ones to scale.

Forecasting task for this expedition became much more difficult as there was hardly any major change in the wind pattern almost throughout May, 2003. This was due to persistent western disturbance activities over the Himalayan region.

NCMRWF had provided a very narrow window of less than 24 hours (Forenoon of 12th to morning of 13th) for making Summit and predicted that by forenoon of 13th May, winds will strengthen beyond the threshold limit (>50 kmph).

Indian Army scaled 'Lhotse' at 6 am on 13th May, 2003. This was the first time in the history of Indian mountaineering Expeditions that an Indian Team had submitted the Lhotse Peak. The Team leader confirmed that NCMRWF's prediction was so accurate that as soon as they landed in Camp-IV around 8 am, winds strengthened considerably.

Failure - There was some mis-understanding about the Terrain (particularly the 'Galli') and threshold winds in the beginning. Col Abbay, Team leader had to be consulted for corrections.

ii) Mt. Everest 2003

There was a Trough in the Middle and Upper Tropospheric Westerlies along 75° E (Pakistan and Northwest India) which remained stationary almost throughout May, 2003. Under its influence, the Jet Stream was passing through Everest Region almost throughout May, 2003. Winds over Everest Region remained West South Westerly to South Westerly (SW) and unfavourable for climbing from the South Side. Almost all the models suggested no change in the situation. The Team's license for completing the Expedition was to expire on 31st May, 2003.

22nd May, 2003

A six member team of Joint Indo-Nepal Army scaled Mount Everest Peak that morning, two members at 0650 hours and other four around 0755 hours. This was done under extremely adverse weather conditions. The winds over Everest were blowing much above threshold value (> 50 kmph) for the past 10 days and there was no clear window in sight for making summit. We had predicted that the winds might come down below threshold limit in the late evenings of 20th and 21st May but strengthen again by next day forenoon. Therefore it was advised that the team may attempt summit in such a way as to complete the job by the early morning hours of 22nd May, 2003. The team went strictly by our advice and completed the job successfully. We monitored the team movement throughout the night and was getting messages almost every hour. The team was in constant touch with NCMRWF Forecast Team via INMARSAT satellite phone. Our advice was based on NCMRWF's and several other models and also by our own subjective interpretation. Reports received around 9 am on 22nd May suggested that while returning to South Col the team was facing very strong winds. The team leader conveyed their appreciation for yet another accurate forecast issued by NCMRWF. It is noteworthy that there were other international teams such as US, Irish, German and Russian, who preferred to stay at Base Camp in view of adverse weather situation predicted by their agencies and were still waiting for favourable situation.

Before the summit, the sequence of forecasts and various incidents occurred as follows:

1st - 16th May, 2003

Winds at higher levels remained in the range 50-80 kmph. Attempt to summit not feasible

16th May, 2003

Forecast based on this day's analysis suggested possibility of decrease in wind speed beginning from 20th but increasing once again on 23rd May, 2003.

18th May, 2003

NCMRWF gave clearance to the team to move to Camp-III by 20th May to attempt summit in the late night of 21st May and early morning of 22nd May, 2008. Following the advisory, team reached Camp-III on 20th May. The team reported that four teams (US, UK, French and Russian) who had gone by US forecast and attempted summit on 20th May night failed due to strong winds beyond South Col. At NCMRWF, various models products were again analyzed and forecasted clear weather and gave clearance to go ahead for attempting Summit on 21st May (With some tips and strategies). The Indian team successfully scaled the peak followed by Japanese and Korean teams whereas all other international teams were waiting for clearance from their forecasters.

A case study of the accuracy of the NCMRWF forecasts was presented for the International Conference at Kathmandu (Akhilesh Gupta et al., 2004).

Failure - We had given clearance to team to go ahead on 9th May. We recalled the team after they reported very strong winds beyond Col region

4.3 (b) Gangotri-II, 2003

Compared to the other expeditions, scaling of Gangotri-II appeared easier. But a major accident had occurred on 18th September in which Seven mountaineers died while attempting the peak due to landslides in the same area. NCMRWF gave clearance of weather to the Indian Army Team on 20th September to move ahead and scale by 21st September late night. The team successfully scaled the Gangotri-II Peak in the late night of 21st September - early morning of 22nd September, 2003. The team verified the accuracy of forecast and appreciated NCMRWF for its courage in providing clearance to the team.

4.4 Expeditions 2004

Indian Navy's Mt. Everest Expedition, May, 2004

Initially the model products, viz. winds, temperatures at different heights up to 10 km were provided as requested by the Navy, as its meteorological wing did not have these. But finally customized weather forecasts were provided to the coordination cell of Indian Navy for expedition to the Mount Everest during April-May 2004. The team followed advice of NCMRWF's clear weather window for safe and successful expedition. Indian Navy scaled the Everest summit successfully and safely.

4.5 Expeditions 2005

(a) Indian Army Women Expedition to Mount Everest-2005

2nd June, 2005

The issue of special forecasts for Indian Army Women Expedition to Everest was a difficult task considering that it was the first and largest women expedition team comprising of nine women and Eighteen men officers. The mountaineering team was provided forecasts of winds, precipitation and temperature for several camps and also the summit. These forecasts were given to them twice a day over satellite phone throughout the period of the expedition including holidays including Saturdays and Sundays. Four women and five men of the team successfully scaled Mt. Everest in the early morning of 2nd June in a narrow window of clear weather that occurred within a period of continuous unfavourable weather conditions. The accuracy of forecast got wide appreciation.

Special mention of the accuracy and usefulness of NCMRWF's forecast was made in the presence of His Excellency the President of India on 27th June at Rashtrapati Bhawan, New Delhi.

4.5 (b) Special Frontier Force (SFF) Mt. Gangotri-I Expedition

29th May, 2005

Special Frontier Force (SFF) requested for forecasts for their Mt. Gangotri-I expedition. They were very cautious in this expedition in view of an unfortunate accident in which all nine member of ITBP mountaineers team lost their live due to avalanche, while returning after scaling Mt. Panchachuli Utrakhand in September 2005. Maj. General and Inspector General of SFF himself visited NCMRWF on 26th May for forecast based final advisory and instructions for the team which was to scale the peak. A detailed discussion took place as snowfall was going on over the region and IG SFF wanted to avoid the risk of avalanche. Favourable conditions of weather were predicted for 26th May during detailed discussion with the Major General and Head of the SFF. It was forecast that snowfall would occur over the region during 26th -27th May, and then reduce significantly and become clear on 28th May night and 29th May morning.

So it was decided that the team was to attempt soon after the snowfall reduces significantly as the westerly weather system was bound to move away towards the east. The logic of this decision was that, if more sunny days and hours passed while waiting for the clear window, then it could lead to increased probability of avalanche. According to the forecast based advisories, the team scaled the peak safely and successfully on 29th May 2005. Maj. General and IG SFF Mr. Dalvir Singh visited NCMRWF Noida campus and appreciated the forecasts.

4.6 Expeditions 2006

4.6 (a) ITBP's Mt. Everest Expedition (North side route), 2006

15th – 18th May, 2006

Indo-Tibetan Border Police(ITBP) requested NCMRWF for customized special weather

forecast and also advice on clear weather period in advance to its team for scaling of Mt. Everest during April-May 2006. During the discussions, it was told that ITBP's earlier attempt for Everest had failed to summit due to bad weather. The team decided this time for summit from the north route. The north approach to Mt. Everest entirely lies in Tibet whereas approach for South Summit lies partly in Nepal and partly in Tibet.

North side is technically less difficult terrain-wise but more difficult weather wise. About three times more mountaineers summit the Sagarmatha (Mt. Everest) from south side.

The mountaineering teams were provided forecasts of winds, precipitation and temperature for several camps and the summit located at different altitudes and locations. These forecasts were conveyed to them twice-a-day over satellite phone throughout the duration of expedition including holidays. The ITBP team successfully scaled the Mt. Everest on 15th and 18th May from the north side.

4.6 (b) BSF's Mt. Everest Expedition 2006

20th–24th May

Border Security Force (BSF), Ministry of Home Affairs requested NCMRWF for special weather forecasts of clear weather period in advance to its team for expedition to Mt. Everest. Weather conditions and impact of weather are different on the north route of Mt. Everest than those from the south side. Forecasts were issued every day. NCMRWF predicted clear weather for the window of 19th–20th May 2006. BSF team successfully scaled the Mt. Everest on 20th and 24th May 2006 with achieving a world record of summit for the eldest officer of high rank (DIG Mr. Negi). BSF appreciated the forecasting support of NCMRWF for its safe and successful summit.

4.6 (c) Indian Army's Mt. Cho Oyu Expedition, 2006

24th–25th May, 2006

Forecasts were provided to the team through mobile phones and land phones whenever the team contacted concerned Scientists of NCMRWF. Clear weather window was forecasted with sufficient lead time and the AAW team scaled the CHO OYU peak in the morning of 24th–25th May. The team leader talked from height of the Mt. Cho Oyu and shared the joy of success and appreciated the forecasts.

4.6 (d) Indian Air Force's Mt. Satopath Expedition, 2006

May, 2006

Forecast was provided to the team through mobile phones and land phones through the coordinating office and also whenever the team called and asked for it. The team safely scaled the peak making good use of forecasts.

[The accuracy of forecasts and support during expeditions in 2006, were appreciated by the teams and Honbl'e Defence Minister of India and also the Honbl'e Home Minister of India.]

4.7 Expeditions in 2007

(a) Army's Mt. Everest Expedition 2007

The Maratha Infantry of Army planned for Mt. Everest expedition in the pre-monsoon period during March-May 2007. AAW and the team leader Col. I.S. Thapa contacted MoES for forecasts. As per the MoES instructions, NCMRWF forecasts were prepared for the expedition. Initially a lecture was delivered to the team when they visited NCMRWF. They were told about taking atmospheric observations and NCMRWF's method of forecasts for requirements of mountaineering.

Forecasts and observations through internet and email:

The team narrated about the facilities available with them during expedition like the strength of tents, ropes, clothes, food, weather tracker (handy), communication/INMARSAT mobile and computer with internet connectivity at base camp. As computer with internet facility was available with the team, it was decided to provide forecasts through emails in addition to the service through mobile phones. It was the first-ever planned to provide forecasts through emails. NCMRWF entrusted a team of its experienced Scientists for preparing and providing the forecast to the expedition team. Expedition team leader Col. Thapa and deputy leaders Captain Dr. Haldar and Captain N.C. Chandel were asked to make arrangement for providing observations and also give feed back on forecasts to the coordinating scientists of NCMRWF through emails on a regular basis.

6th April, 2007

First email from mountaineering expedition team was received at NCMRWF from Medical Officer Captain Haldar in the afternoon of 6th April. It was from New Tingri at the foot hills of Everest. A beautiful picture of sacred Goddess was send as enclosure (Annexure-II 1.a).

We were in receipt of satellite (Kalpana) imageries twice a day in 2007 on IMD's web site. These were not sufficient. NCMRWF Scientist processed the water vapour imageries of Meteosat-7 and made available the six hourly imageries in a loop for the purpose (Figure 6). These imageries were of great use in detecting the diurnal changes in cloudy conditions over the area. An increase in water vapor towards evening can be seen in these imageries. Team also started sending observations through emails (Annexure-II, 1.e).

Team was in regular contact with NCMRWF Scientists on their mobile. Concerned scientist also sent the forecasts almost everyday, in the course of acclimatization, fixing ropes, stocking and establishment of camps by the team during April-May 2007.

9th–10th May, 2007

Leader and deputy leaders of the team asked about clear weather for planning to summit on 10th May. Team was given forecast of clear weather during 14th May to 16th May, with the 14th and 15th May to be better during the given period.

11th–12th May, 2007

Day-4 and day-5 model forecasts products(Figure 7) of precipitation; winds and temperature (500hPa, 400hPa, 300hPa levels) based on 10th and 11th May 2007 initial conditions, clearly indicated for suitable weather window for summit during 14th-15th May 2007. Whenever team contacted, forecast was updated with a clear weather window during 13th May night to 16th May early morning. Also the team was asked details of plan to worship/summit the great SAGARMATHA.

13th May, 2007

On the day, we received an email message of Captain N. Chandel stating plan of the team for summit on 15th and 16th May as per NCMRWF forecasts advisory. He also stated that twelve other teams were also following the Indian team. (Annexure-II, 1.c).

15th May, 2007

Six members and six sherpas, total twelve persons could perform summit in the night of 14th May and 15th May 2007 morning. Received the message of success from their base camp. The team applauded forecasts support. (Annexure-II, 1.c and 1.d)

4.8 Expeditions 2008

(a) SGMIs Mt. Everest Expedition 2008

April–May, 2008

Sonam Gyasto Mountaineering Institute (SGMI)'s Mt. Everest expedition team requested the Secretary, MoES for weather forecast support. The team consisted of mountaineers from SGMI, Intelligence Bureau, Police Departments, Special Frontier Force (SFF) and the Indian Army. The Secretary, MoES desired that NCMRWF should provide weather forecast for these expeditions. Training and one lecture was given to the team on weather observations and the method of forecasts. Customized forecasts were prepared based on (i) global T254, T80 models; (ii) ETA, WRF and MM5 regional models; (iii) snowfall forecast by Everest weather site and (iv) observations by expedition team along with the satellite products. Charts of winds, temperatures for different heights of 500hPa, 400hPa, 300hPa, 250hPa and 200 hPa and precipitation of the region of expedition were generated. Meteograms were also prepared for the Base Camp, Advanced Base Camp, Camp-I, Camp-II, Camp-III and Camp-IV that were at different altitudes on route to summit. Meteogram based on 19th May and 21st May valid for 22nd May for Camp-III, Camp-IV(Figure 8); day-1, day-3 and day-5 forecasts of precipitation; winds and temperature at 300hPa level valid for 22nd May 2008 (early morning) are shown in Figure 9.

The final forecasts were communicated to the teams through emails in addition to forecasts through mobile phones and land phones. Same forecasts were also provided to the controlling offices of the concerned teams (Annexure-II, 2.a).

There were frequent western disturbances, that moved one after another across the Himalayan region causing precipitation and change in winds during April-May 2008 in the region of the expeditions. A cyclone also formed in the Bay of Bengal which re-curved across North Bay. The window available for scaling of Mt. Everest further narrowed because a clear weather phase in the 2nd week of May was solely reserved and utilized for taking the Olympic torch to the Mt. Everest and none of other teams was permitted to summit before the torch. Thus the team for Mt. Everest was to perform the summit within a tightly limited time frame.

21st-22nd May, 2008, a record making day

The teams were provided the weather forecasts during the entire duration of their expeditions. The available clear weather window for summiting Mt. Everest were determined to be 21st May night to 22nd May 2008 (Figure 8 and Figure 9). The day for which NCMRWF had predicted for clear weather, a historic record number of mountaineers including our Indian team completed their summit of Mt. Everest in the early morning of 22nd May 2008. Members of teams were thrilled and they reported their success and appreciated NCMRWF's weather forecasts from the heights of Mt. Everest. The Indian teams of MHA (SGMI, IB, Police), Army and SFF greatly appreciated the accuracy of weather predictions and the efficient coordination by concerned scientists at NCMRWF with the team and their controlling offices. (Annexure-II, 2.b and 2.c)

Atul Karwal & Anita Karwal mentioned the appreciation to forecasts support of NCMRWF in their book titled "Think Everest, Scaling Mountains With the Mind".

4.8 (b) BSF's Mt. Kanchenjunga Expedition 2008

The Border Security Force (BSF), MHA requested MoES for weather forecasts for their Mt. Kanchenjunga expedition during April-May 2008. NCMRWF provided forecasts regularly to the team directly and also to the BSF HQ. Soon after the team completed establishment of camps, as well as stocking and roping, the weather became frequently bad over the area due to western disturbances. They were advised in advance to stay in safe camps and not to venture out because of expected bad weather on three occasions. The team reported that these predictions in fact were realized.

25th May, 2008

The team was discouraged at a point in time because of continuous bad weather. Intermittent bad weather was not expected to give enough scope to scale the peak. There were continuous telephonic discussions with Cdt. Mr. N. Satish Chander, the team's leader. They were advised on 19th May, 2008 to wait for a week and it was predicted that insignificant snow fall with less speed of winds would occur during 24th-25th May 2008. The team made good use of the forecast and scaled the summit on 25th May 2008. NCMRWF forecasts were greatly appreciated by the team. The Director General of BSF, felicitated NCMRWF for its support, accurate forecasts, and coordination for their expedition to Mt. Kanchenjunga in 2008 and to Mt. Everest in 2006, in a function at BSF HQ, New Delhi.

4.8 (c) NIM's Mt. Satopath Expedition 2008

Nehru Institute of mountaineering (NIM) Uttarkashi planned an expedition to Mt. Satopath (7075 meters) and requested NCMRWF for weather forecast support during August-September 2008. NCMRWF provided customized weather forecasts to the team leading to a safe and successful expedition. NIM found the forecast accurate and very useful. NCMRWF forecast was appreciated by NIM, vide Letter No. NIM/Everest/2008-1643, dated 24th October.

[The Secretary MoES appreciated the efforts and valuable service, the DG BSF felicitated NCMRWF for providing accurate forecasts and all the teams appreciated forecasts]

4.9 Expeditions in 2009

NCMRWF received requests for forecasts for a total of fourteen mountaineering expeditions by teams of AAW, ITBP, NIM and HMI. This is the maximum number of mountaineering expeditions which were provided the value added forecasts in a single year. ITBP attempted three expeditions viz. Mt. Kamet, Mt. Abegmain and Mt. Everest out of the fourteen expeditions. The rest were by the Army and the institutes HIM and NIM. Details of weather prediction for certain expeditions are given below.

4.9 (a) NIM Uttarkashi's Mt. Everest Expedition, 2009

Deputy team leader with the team members visited NCMRWF in April 2009. A lecture on weather observations with description of the Beaufort scale was delivered to them. They already had the experience of NCMRWF's forecasts for their successful expedition of Mt. Satopath in the previous year 2008. The team was provided forecasts on regular basis. The team made good use of forecasts in establishing camps, stocking, roping and in formulating the strategy for a safe expedition. Some of the day to day forecasts were as given below;

12th May 2009

Col. Masur, the team leader telephoned for detailed forecasts for final summit. The team was suggested to wait for two days for better and clear weather.

16th May, 2009

Col. Masur held discussions in the afternoon. Meteogram, generated at NCMRWF were showing significant reduction in snowfall and winds as well during 20th May(A/N) to 21st May. Metegrams based on 16th May and 19th May initial conditions are shown in Figure 18(a). For best possible forecasts other products were also sought. Dr. Tim Palmer was requested for EPS meteogram of Mt. Everest. Subsequently, an EPS meteogram based on 13th May initial condition was received (Figure 18b). Six days forecasts available on web site, www.snow-forecast.com were also considered (Figure 19). It was forecasted that no heavy snowfall was expected during the next 4-5 days and the wind speeds were expected to be not more than 20 kmph during 18th- 20th May. It was conveyed to the team that good period from the weather point of view was expected after 17th May, for summitting of Sagarmatha (Mt. Everest). In the late

evening the same message was also emailed to the team, after reassessing the products (Annexure-II, 3.a).

17th May, 2009 (morning)

Forecasts were communicated to NIM Uttarkashi and AAW HQ, as the MTNL (the telephone service provider) had called for a 2 days long strike. It was a handicap as regular communication between NCMRWF scientists and the expedition team was disrupted. A message could be send in the evening when the communication became functional for some time (Annexure-II, 3.b).

17th–19th May, 2009

Communication (Land Phone, Mobile Phone and Internet) failed for the period 17-19 May due to the strike by MTNL.

19th May, 2009

It was a day full of panic due to the disrupted communication service. It was not possible to communicate one caution message that arose with respect to a cyclonic circulation which formed over Haryana and adjoining regions on the evening of 19th May 2009. It caused Andhi (Dust Storm) and isolated to scattered rain and hail over the National Capital Region (Delhi) and was moving eastward. This storm was expected to reach West Bengal and adjoining areas. But, it had a low possibility of affecting eastern Himalayan region. This cyclonic circulation (CYCIR) that formed in situ could not be predicted by models. However, after its formation, models indicated its movement in the eastward direction.

Both the models viz. global and regional, predicted wind speed to be 5 to 25 kmph. The team was told about the moderate winds and of the suitable weather conditions for summit that were predicted to occur during 20th May (night) to 22nd May (morning).

20th May, 2009

Satellite imageries of cloud top temperature (CTT) were evaluated critically. The CYCIR was expected to affect Gangetic West Bengal (GWB) on 20th May evening after moving across Uttarakhand, U.P. and Jharkhand. But there was remote and poor possibility of the CYCIR to affect the adjoining eastern Himalayas. The advice cautioning about the light snowfall was passed to Col I.S. Thapa, Principal of NIM, Uttarkashi. Satellite imageries, products from the Doppler Weather Radar, Kolkata; the discussions with Scientist of Dept. of Science & Technology (earlier had been at NCMRWF), Dr. D. Pradhan IMD Kolkata and B.P. Yadav IMD were all utilized in preparing the advisory. DWR Kolkata products of 11UTC, 20May (Figure 10), satellite cloud top temperature imageries 'CTT' (Figure 11), Quantitative Precipitation Estimates 'QPE' (Figure 12), Outgoing Longwave Radiation 'OLR' (Figure 13) of period 19-21May show clear weather as observed on 20-21 May 2009. Global model's day-1 to day-4 forecasts of precipitation/snowfall for 20th May and day-1 to day-5 forecasts of precipitation for 21st May 2009 are given in Figures 14b and 15b respectively. Day-1 to day-5 forecasts of winds,

temperatures at 500hPa, 400hPa, 300hPa and 200hPa levels valid for 20th May and at 300hPa, 200hPa levels valid for 21st May 2009 are shown in Figures 14a and 15a respectively. Winds at 300hPa and 200hPa are very important to know the position of Jet stream. If, Jet is seen over the area of expedition then its simply to avoid the summit. Meso-scale model forecasts for 20th and 21st May (Figure 16 and Figure 17 respectively) reconfirmed that the CYCIR was bound to move to Gangetic West Bengal around Kolkata. Day-1 to day-3 forecasts of winds at 500hPa level by WRF model; 500hPa, 400hPa and 300hPa by MM5 model and 400hPa, 300hPa and 250hPa level by ETA models are shown in Figures 16a, 16b and 16c respectively. Day-1 to day-3 forecasts of precipitation/snowfall by regional models WRF, ETA and MM5 are shown in Figure 17.

Meanwhile the team contacted NCMRWF by phone call as they wanted to push for final summit from Camp-IV. They were told to go ahead as per plan and not to worry about weather as it was neither expected to be moderate/heavy snowfall nor the stormy winds.

21st May, 2009

At 7.30 AM in the morning a phone call was received from the Principal, NIM and at 10.45 AM from the expedition leader Col. Masur informing the safe and successful summit. It was told that 31 other international teams also had better faith in the NCMRWF's and appreciated the forecasts. Eighty mountaineers scaled the summit on 20th May.

Col. Masur applauded NCMRWF's forecasts and efficient coordination of weather forecast support in the flag in ceremony in the presence of Honb'le Minister of State for Defence Shri. Pallam Raju. Col. Masur narrated his experience of the snowfall during the final stage of summit, causing panic in the team. However it stopped within a short period of time as was predicted by NCMRWF. The Honb'le minister also expressed appreciation. Emails and the

Table 3: Observations en-route to Mt. Everest and models predictions on 21st May 2009, morning

A) T254 00Z	Day-1 FC	Day-2 FC	Day-3 FC	Day-4 FC	Day-5 FC	Observations 8 th May 2009, 3Z, 4758m
Average Wind > (Unit)	14 (5-22)	7 (3-10)	7 (3-10)	7 (5-10)	2 (Up to 5)	4
Snow mm				5-10	5	0
Cloud	0	0	0	0	0	0
B) WRF 00Z						
Wind Km/Hr	5 (1-9)	5 (1-9)	6 (1-11)			
Snow mm	10	5	5			

4.9 (b) HMI's joint Indo-Bangladesh expedition of Mt. Makalu with paragliding, 2009

11th May, 2009

This was the first Indian expedition to Mt. Makalu with paragliding there. Himlayan mountaineering Institute (Darjeeling) was leading the joint Indo-Bangladesh team. The leader of the joint team Col. N. Rana telephoned from 7600 meter high location en-route on 11th May (F/N) and requested for NCMRWF's forecasts on mobile. Formally the team was in receipt of briefing from IMD. Col. Rana was asked of the location of the planned summit. Mt. Makalu is in the close proximity of Mt. Everest with its location about 70KM east of Mt. Everest. So the only factor to be incorporated while customizing the forecast was the difference in location. Therefore the forecast products were generated in the same way as for Mt. Everest expeditions but taking into account the change in location.

The team wanted to scale the summit and perform paragliding during the next 3 days viz. 11th–14th May 2009. The satellite imageries and model products were analysed thoroughly. In the evening, Col. Rana contacted by telephone and asked for forecast and advisory. In the telephonic discussion the team was advised to remain in safer camps for 2-3 days in view of the expected moderate to high snowfall and blizzard. The team later informed NCMRWF that there really was no other option than to be confined to the camps because of the heavy snowfall and windy conditions. Unfortunately one of the mountaineers died due to some injury and illness.

15th May, 2009

NCMRWF forecasted significant improvement in the ongoing snowfall and winds during 16-21 May (Annexure-I, 4.9a). The team successfully completed the summit with a world record of paragliding from the height of Mt. Makalu by Col. Rana of HMI Darjiling. The timely forecasts through mobile phones as well as the accuracy of forecasts and also the coordination were appreciated by the team leader.

4.9 (c) AAW's Mt. Dhaulagiri Expedition 2009

AAW sent a request to MoES for forecasts support to its Indo-Australia Joint Army Expedition of Mt. Dhaulagiri. Subsequently, Lt. Col. Chauhan the team leader and Maj. Dharmjot Singh asked for a lecture on practical aspects of weather observations and also how to be in line with forecasters. A lecture was delivered to the team at Army Office Lodi Road. Col. Chauhan provided detailed route maps of the Mt. Dhaulagiri expedition (Figure 20a). It was told that it was the first attempt by the Army to summit Mt. Dhaulagiri.

18th April, 2009

The team leader sent NCMRWF weather observations from their base camp. Plumes were observed at heights with high speed winds on 17th April. The team was sent forecast indicating better conditions during 20th -22nd April.

1st May, 2009

NCMRWF predicted (a) light to moderate snowfall during 3rd May evening to 4th May and decrease thereafter (b) wind speeds are likely to increase significantly (to exceed 35 kmph) on 3rd May (c) after 4th May weather is likely to be clearer. The message was sent by email too. The team replied that they would strictly follow the forecast and advices. This area experiences sudden change over to harsh weather conditions. One foreign team performed summit but same time got trapped in a blizzard and the leader was blown away by stormy winds. Two more mountaineers of other teams lost their lives as they got trapped in bad weather in the course of attempting Mt. Dhaulagiri summit this year. So the Army team was very careful and followed the NCMRWF forecasts meticulously. The team was advised not be in a hurry and wait patiently for clear weather window giving importance to the safety.

5th May, 2009

It was told to the team that more than 40kmph winds were expected till 7th May morning. Very light snowfall was expected on 10th May forenoon which may increase towards the night of 10th May 2009.

The clear weather window was predicted to occur for scaling the Mt. Dhaulagiri peak during afternoon of 7th May to early morning of 10th May. The messages were sent through emails, in addition to the discussions on phone(Annexure-II, 4.a, 4.b). The forecasts of clear weather window proved to be correct as can be seen from the CTT satellite imageries (Figure 20 b).

8th May, 2009

We got phone call from Lt. Col. Chauhan in the after noon. He told that the team had made safe and successful summit. The team applauded the forecasts by email too.(Annexure-II 4.c).

Table 4: Observations by expedition team over Mt. Dhaulagiri and model predictions for 8 May, 2009

A) T254 00Z	Day-1 FC	Day-2 FC	Day-3 FC	Day-4 FC	Day-5 FC	Observations 8May2009, 3Z, 4758m	Customize forecasts
Average Wind > (Unit)	20	15	15	20	25	4	Less than 20Km/Hr
Snow mm	3	0	0	0	0	0	0
Cloud	0	0	0	0	0	0	PC
B) WRF 00Z							
Wind Km/Hr	15	15	15				
Snow mm	0	5	0				

4.9 (d) Indo-Kazakhstan Joint Army expedition to the Marble Wall Peak in the Tien Shan Mountains of Kazakhstan, 2009

29th August, 2009

NCMRWF received a telephone call from Col. S. Shekhawat and subsequently phone and email from Maj. Harish Sharma of AAW for forecast support to the Indo-Kazakhstan Joint Army expedition to the Peak of Marble Wall in Kazakhstan. The geographical location and altitudes of the base camp and summit point were asked for and Maj. Sharma provided the information immediately. The peak located at 42^o N latitude and 81^o E longitude at the altitude of 6500m. The team planned to summit during 30th-31st August. Maj. Sharma was told in the evening that there was going to be moderate to heavy snowfall due to a trough in the westerlies. The westerly trough and associated clouds could be seen moving towards the area of concern in the satellite imageries and NWP products.

On 30th August (Sunday), predictions were provided to Mr. Sharma as well as to Col. Shekhawat the team leader who spoke from en-route of the expedition to Marble Wall Peak. Snowfall and strong winds over the area were forecasted to occur during the planned days, viz. 30th-31st August 2009 (Annexure-II, 5.a, 5.b).

31st August, 2009

Six hourly NWP products and charts with details of winds, precipitation, humidity and cloud cover for the region were generated. Six hourly forecast of precipitation over the region of “Peak of marble wall, Kazakhstan” are shown in Figure 21. Observations of places around the area like the capital of Kazakhstan and the nearest airport were obtained from internet so that we could prepare the best advisory.

Col. Shekhawat was provided with forecasts of snowfall and storm and he was advised to obtain information (radar) from the nearest airport through the Kazakhstan team for the best assessment of the situation and to form the strategy for safe summit, using all the information.

2nd September, 2009

Col. Shekhawat telephoned and told that there was heavy snowfall and also stormy winds on 31st August. It was emailed to one of the NCMRWF scientists who was at that time in France (MFI) asking him for some more relevant products for the expedition (Annexure-II, 5.b). In the telephonic discussion, Col. Shekhawat told that 48 hours period of clear weather is required for summit. He also provided the positions of different camps.

3rd September, 2009

NCMRWF predicted that westerly weather systems will move one after another, across marble wall peak. No clear weather window of 48 hrs was available in the period under consideration. However a clear weather window of 36-40hrs was available. This was communicated to the team leader when he contacted NCMRWF through telephone. The team leader wanted to know specifically the time period during which bad weather was to clear from the area. It was conveyed to them that bad weather is expected on 6th September, 2009.

6th September, 2009

The team took a calculated risk keeping the clear weather window of only about 40 hrs and scaled the peak. The team leader telephoned and narrated the success. He told that the team got trapped in bad weather, it was totally white out making everyone blind on the way back to the base camp after successful summit. It was told that all the members hold each other and lay down. They were just praying and hoping the bad weather to move away. It lasted for about two-three hours. All the team members could finally return safe. The forecasts were appreciated (Annexure-II, 5.c).

4.9 (e) ITBP's Mt. Abigamin and Mt. Kamet Expeditions with skiing, 2009

Indo-Tibetan Border Police requested NCMRWF forecast support for these two expeditions. A lecture was delivered to the team and also to the officials at ITBP HQ New Delhi. Their weather tracker instrument was calibrated and they were told how wind strength and direction could be observed over mountainous region using the Beaufort scale concept when instruments fail. The

team leader Mr. Harbhajan Singh DIG and Dr. Jaivir Singh commandant ITBP used to discuss with the NCMRWF scientists for the forecasts everyday through telephone during the specified period.

31st May and 1st June, 2009

It was forecasted the weather to be clear during 3rd-4th June. The team scaled the peaks safely and successfully during 3rd-4th June 2009 and they also performed skiing on their return from height of the peaks .

4.9 (f) ITBP's Mt. Everest Expedition in September-October 2009

The team planned for the expedition and asked for forecasts. It was told to the ITBP officials that whenever poor rains prevail over India in June-August, enhanced activity is observed, in general, over the eastern Himalayas and the eastern and north-eastern states particularly during September-October.

Expedition's Call Off Due to Bad Weather Conditions, October 2009:

It was frequent moderate to heavy snowfall over the Base Camp and surrounding region. The team could somehow establish camps during narrow windows of clear weather. By the time they completed roping the weather deteriorated further. The predictions did not show any clear weather window of 2 days duration and in addition fresh snow loaded over the hills. The team discussed the situation and called off the expedition in the first week of October 2009 before it could cause any loss of life. Cloud top temperatures and imageries were also depicting harsh weather(thick and tall clouds) during last week of September to first week October 2009.

4.9 (g) Army's mountaineering expeditions over Uttarakhand during monsoon 2009

Teams were provided forecasts for their Mt. Shivling, Mt. Mana, Mt. Vasukital, Mt. Gangchua and Mt. Chaukhamba-I expeditions over Uttarakhand region. Teams were also given forecast support for expedition to Mt Saser Kangri and Mt. Satopath. Teams were advised to remain in safer camps for about four days during a period of bad weather resulting from interaction between a westerly trough and monsoonal easterlies. They followed forecasts and remained safe in camps as suggested. Subsequently, teams completed expeditions with successful summits of the peaks.

5. NWP models, computer and network resources at NCMRWF

Almost all the adventurous places do not have any observational systems to record systematic information of atmospheric parameters and precipitation. But, now the satellites are powerful observing tools in such areas. They provide very useful satellite products viz. imageries (visible, infra-red and water vapour), cloud top temperatures ($^{\circ}\text{C}$), outgoing long wave radiations (OLR: $\text{W/m}^2\text{m}$) and quantitative precipitation estimation(QPE: mm). Earlier these were available twice

a day or four times (six hourly) a day. Nowadays these are available at an hourly interval with a lag of about one hour on the web site of India Meteorological Department (www.imd.gov.in).

Teams generally have with them weather tracker (wrist watch kind) which can measure atmospheric pressure(hPa), temperatures and humidity. However instrument always needs to be calibrated and some of the team members need to know conventions of winds (direction and speed), kind of clouds and plumes etc. The data received from the teams are crucial information over the locations/camps of expeditions.

There is no means other than NWP models for knowing the atmospheric conditions/weather 3-5 days in advance. At present a Global Forecast System (GFS) based on T254L64 model (about 50km horizontal resolution and 64 layers in vertical) is operational at NCMRWF. The GFS has capabilities to assimilate various conventional as well as satellite observations including radiances from different polar orbiting and geostationary satellites. Seven day forecasts are generated everyday with the initial conditions of 00UTC. High computing resources are required to run NWP models in an operational mode.

To meet the requirement of operational run of the models, NCMRWF is equipped with supercomputing machine, front end systems and network as given below;

IBM P575 HPC

It has a peak speed of 24.4 Teraflop with 5376 GB memory. This system has the storage of 300TB Archival, 200 Tb near online and 100 TB online.

CRAY- X1E:

It has 64 processors, 8 node @32 GB RAM(total 256 GB RAM), 1.1 Teraflops speed It is mainly for operational run of T254 model.

Dec-alpha parallel processing system:

Total 8 servers, server alpha-4100 with 600MHz, 1.0GB, alpha-workstation are with 600MHz, 512MB connected by Gega-switch. This is mainly used for data processing, quality control and assimilation.

CRAY SGI:

This is 'Silicon Graphics India' workstation with IRIX 6.5 operating system (OS), originally stand by for CRAY XMP-216 and gateway to supercomputing machine CRAY SV1 during years 2006 to March 2011. These are two Origin-200 SGI workstations with 270 MHz speed, 4 MB cache, 1GB/512 MB memory, 5 disks with 9.1 GB each, One of these five disks is gateway to the CRAY SV1 machine.

Three O-200 computers: These are with single CPU of 270MHz clock speed, 256MB cache, 512 MB memory, RAID 5 is configured on 5 disks of 9.1 GB each running on IRIX 6.5 OS Two O2 workstation with 200MHz clock speed, 128 MB RAM, 1MB cache. Disk Vault of 6 x 18.6GB ie. 100 GB and RAID 5 is configured on 5 disks of 9.1 GB. This low cost, entry-level workgroup server supports one to four MIPS® processors and PCI Inputs/Outputs.

Param Padma:

64 processors, IBM P5, 0.5 Teraflops speed. Mainly for Assimilation for T254 model and post processing as well.

Networking:

NCMRWF has 8 MBPS dedicated fiber leased line. There is centralized ftp data server for reception of satellite data and continuous GTS data as well. The data server is connected to Dec-alpha and PARAM computer systems through a router. The Modem is directly connected to the watch guard (firewall) which is a hardware firewall and acting as a security man between the internet and the internal LAN.

Website:

Particulars of global and regional models and their standard products (analyses and forecasts) are placed on the website of NCMRWF. Other related information e.g. daily data monitoring for every week, latest technical reports, models based forecast bulletin with numerical forecast of temperatures and rains/cloudy every days are also placed on the web site. In addition, forecasts of temperatures, winds for 500hPa, 400hPa, 300hPa, 250hPa and 200hPa levels corresponding to approximately heights of 5 KM, 7KM, 8KM, 9.5KM, 11KM and precipitation are uploaded for Himalayan region separately. Forecasts for Africa, Kenya and Quatar are also prepared and placed every day on the website. NCMRWF also prepares special forecasts of Indian Ocean Wave and uploads every day. Many of the above products along with kind of variety of analyses and forecast products are also placed on ftp server of NCMRWF for convenience of users. The website is solely maintained by NCMRWF scientists in addition to the R&D and operational run of models. Addresses of NCMRWF's website and ftp server are www.ncmrwf.gov.in and [ftp.ncmrwf.gov.in/pub/outgoing](ftp://ncmrwf.gov.in/pub/outgoing).

6. Limitations of Forecasting

The weather systems that affect the Himalayas, in general are connected with the westerly flow over the mountains. Though weather is also influenced to a large extent by easterly winds during the Southwest Monsoon (June-September). Heavy precipitation takes place out of interaction between low level monsoonal easterlies and mid-tropospheric and mid-latitude westerlies during the monsoon season. There is poor representation of complex orographic features of Himalayas in any type of global or regional NWP model. The weather is highly inhomogeneous in the horizontal directions and change rapidly. These conditions make very stringent demands on predicting the location and time of weather conditions and events. In addition, observations of the atmosphere are not available over the said parts of Himalayas except for some discrete data samples or data sets pertaining to the period of certain expeditions.

7. Concluding remarks

NCMRWF has been providing customized weather forecasts to mountaineering expeditions since 2001. In the year 2010, NCMRWF supported ten mountaineering expeditions. With these ten expeditions, the total number of expeditions supported during the period 2001-2010 become forty eight. In all these expeditions no casualty occurred that could be attributed to faulty weather forecast. On the other hand, except in two or three cases that were called off due to persistent bad weather, all the expeditions were successful. As could be seen from the facts presented in this report, the NCMRWF forecasts were critical to the successful and safe completion of most of these expeditions.

Scaling of tall peaks of a height of 8000m and more is always a test of human endurance and tenacity. Even in good weather conditions it remains a dangerous and risky activity with little scope for rescue if something goes wrong. The security and defence forces of our country are required to be capable of occupying and controlling any location within our territorial borders. This also includes the tall mountains in the Himalayas. To maintain such a capability it is necessary for the forces to train themselves to undertake these dangerous and arduous duties. It is a matter of great satisfaction that NCMRWF could contribute to the safety and successes of the efforts of our forces, totally relying on our own resources and resourcefulness. This was made possible because of the freedom and support that were given to NCMRWF by the Ministry (while it was part of the Department of Science and Technology and a part of the Ministry of Earth Sciences now) to deal in a more flexible manner with respect to the emerging needs in weather forecasting. As could be seen from this report, in the case of such a demanding and critical requirement of weather forecast information, NCMRWF achieved success. The proof of it is the sustained confidence that the users i.e., the mountaineering teams, are placing on the forecast provided by NCMRWF. This successful example gives NCMRWF the confidence and inspiration to face the emerging challenges in the field of medium range weather forecasting and its applications by developing advanced and novel forecast methods and technologies.

8. Acknowledgements

We sincerely acknowledge motivation and opportunities of challenging tasks provided by the Secretary Ministry of Earth Sciences and also the Secretary Department of Science & Technology. We also acknowledge India Met Dept. for various satellite products made available on their website. All scientists of NCMRWF have assisted in preparation of forecasts for different kind applications from time to time whenever required. Acknowledgement is due to them all. Dr. Tim Palmer Scientist, European Centre For Medium Range Weather Forecasting (ECMWF) who provided the EPS meteogram of Mt. Everest on a occasion when requested towards conformity of forecast of clear weather window to the expedition team in May 2009, is to be appreciated for a prompt response. Our brave friends of armed forces provided observations of remote places (under expedition). These observations were crucial in having instant knowledge of the places and preparation of customized weather forecasts, even superior than the forecasts by other agencies worldwide on many of the occasions. Their cooperation is heartily acknowledged. Our special thanks are due to the present and former Heads of NCMRWF for providing guidance, all possible facilities and motivation to the concerned Scientists in undertaking this task.

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ANNEXURE-I

Figure 6: METEOSAT-7 water vapour channel pictures of 10th April 2007 (T1:00UTC, T2:06, T3:12 & T4:18UTC)

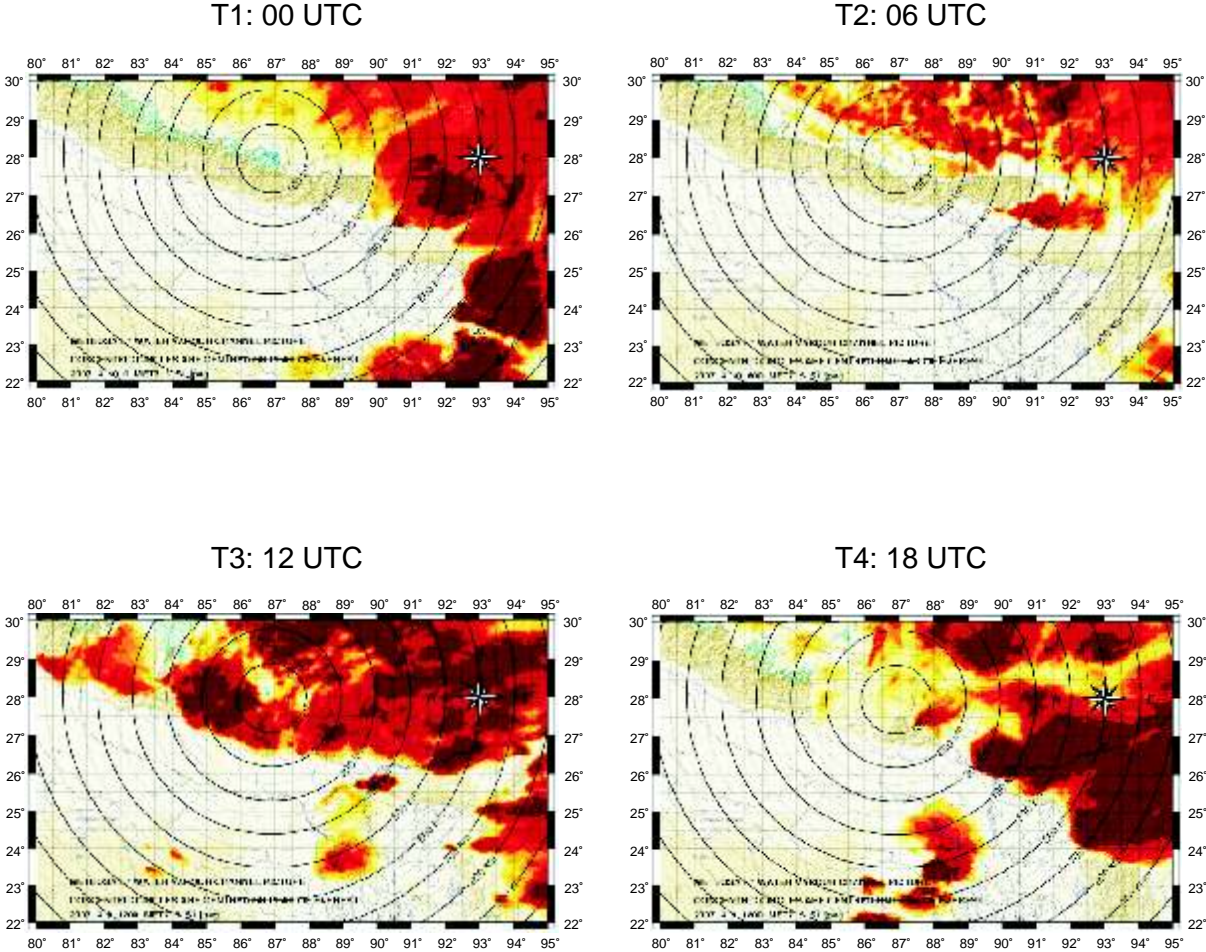


Figure 7: Day-4 and Day-5 Forecasts of winds/temperatures at heights of 500hPa, 400hPa, 300hPa and precipitation for 14-15 May 2007 (T80 model)

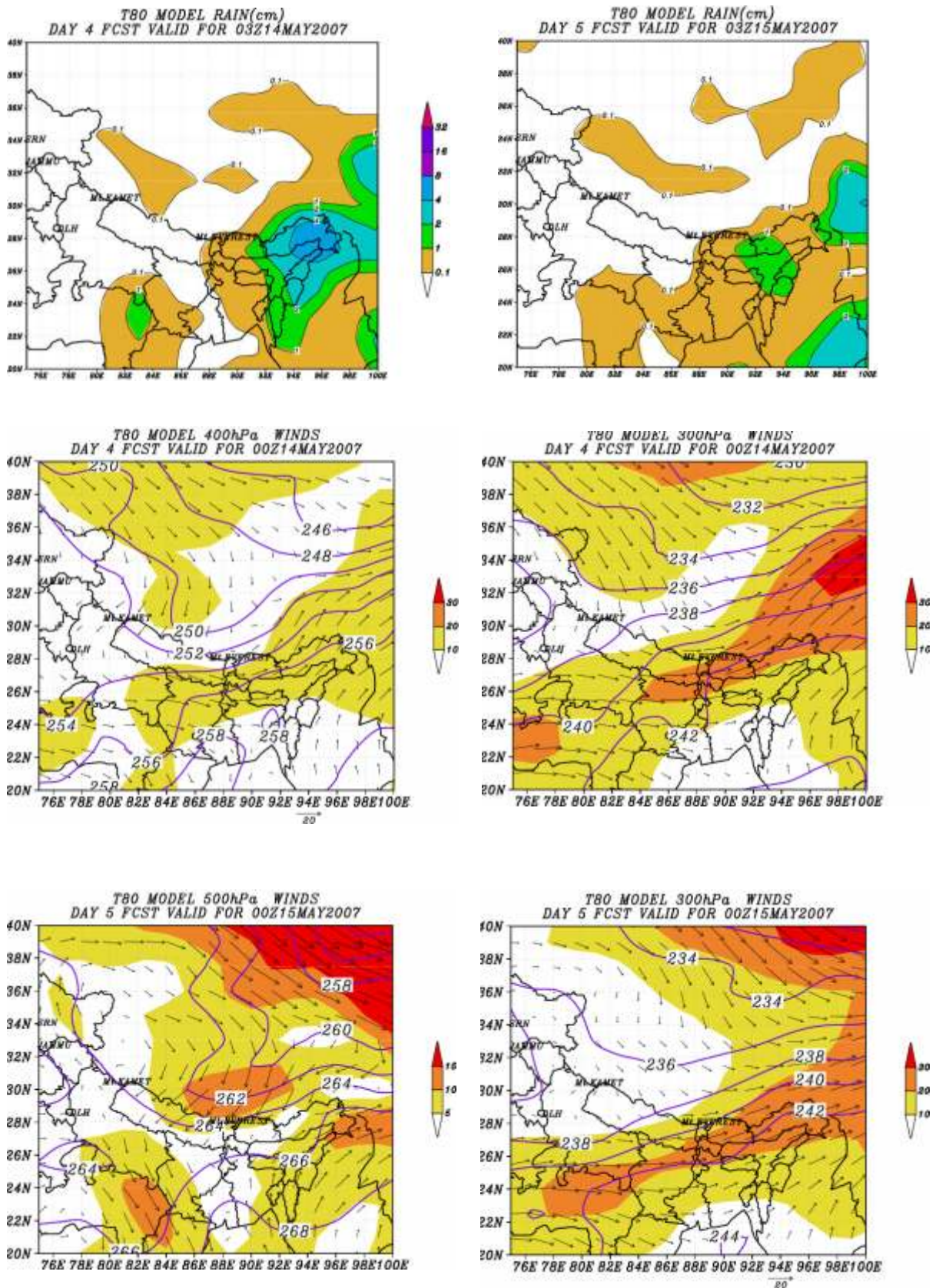


Figure 8: Meteogram for different Camps(camp-III and Camp-IV) of SAGARMATHA expedition for 22nd May 2008 (Morning),

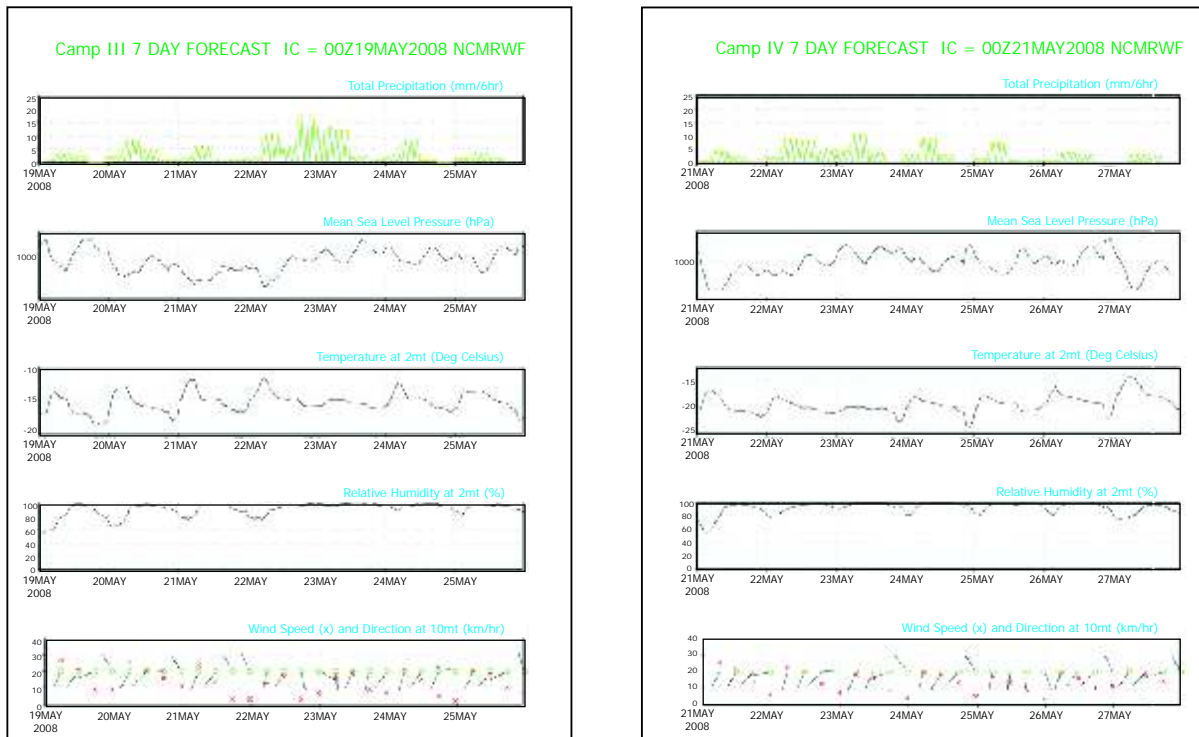


Figure 9: Forecast of winds, temperature at 300hPa and precipitation for 22nd May 2008.

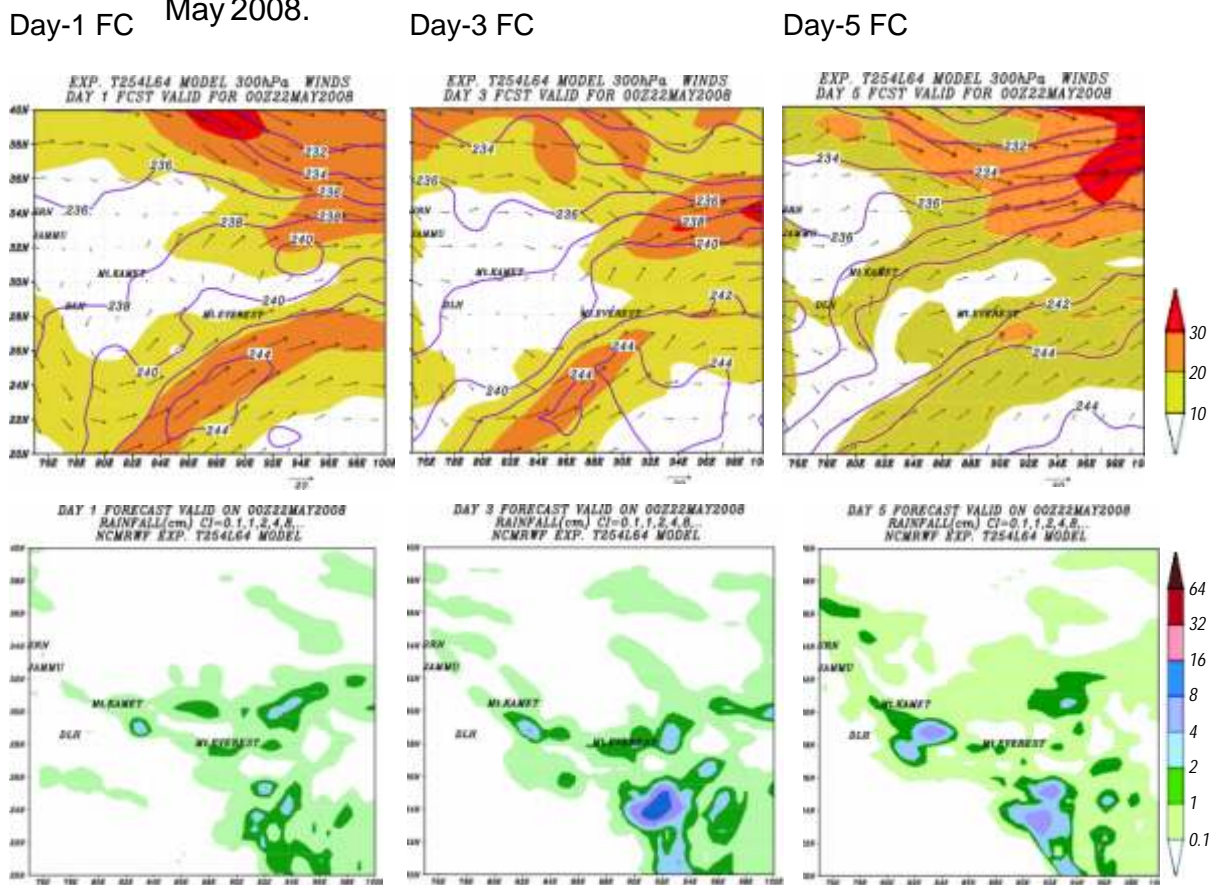
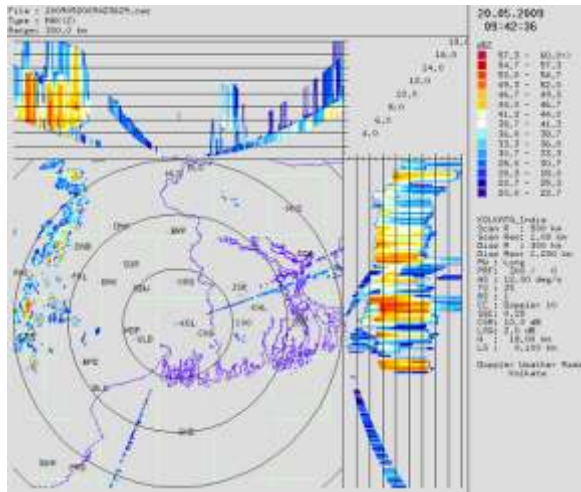
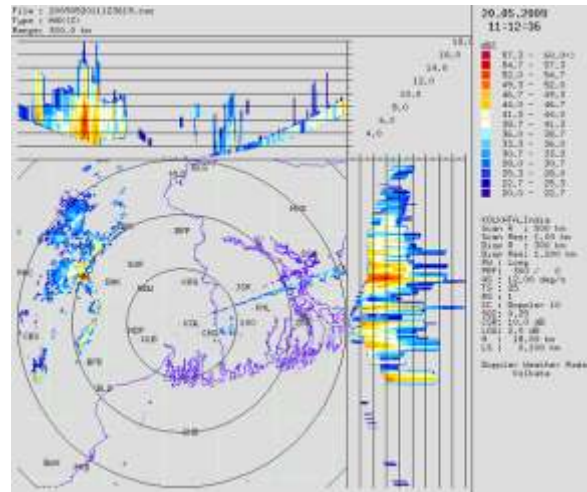


Figure 10: Doppler weather radar(Kolkata) products on 20th May 2009, 11UTC.

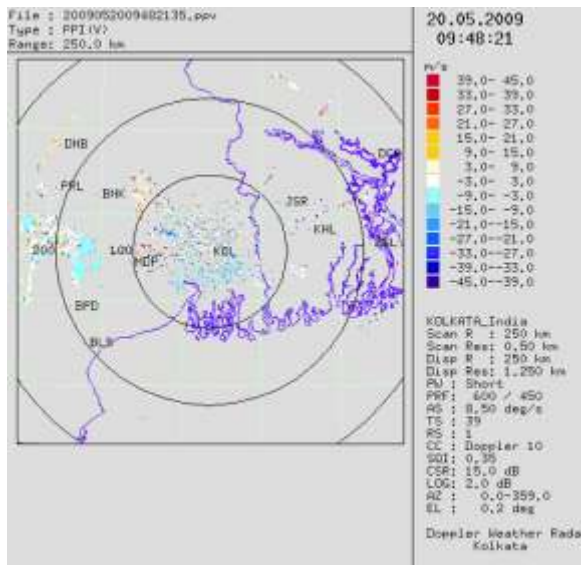
MAX(Z)



MAX(Z)



PPI(V)



PPI(V)

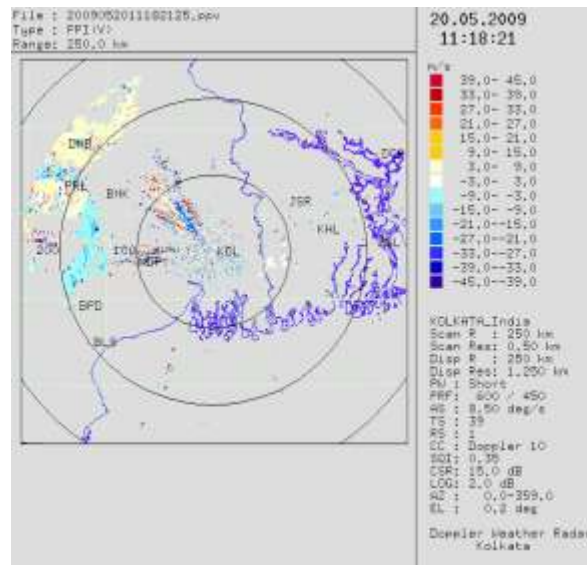
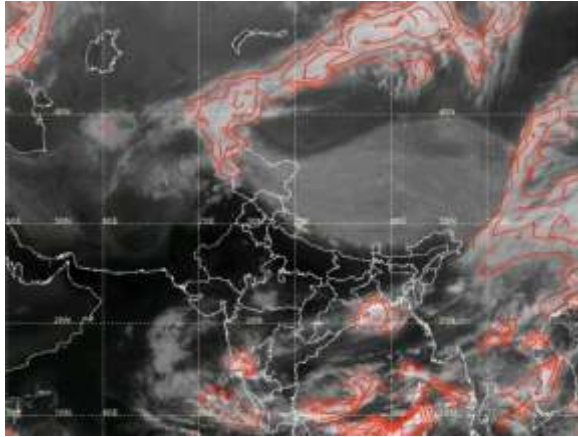
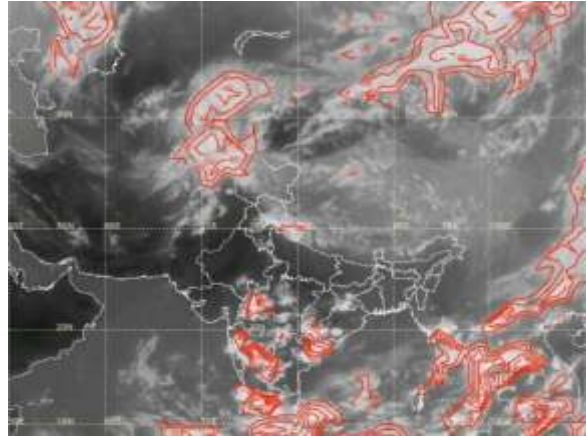


Figure 11 : Cloud Top Temperature (CTT) & imageries from Satellite (Kalpana-1) during 19-21 May 2009

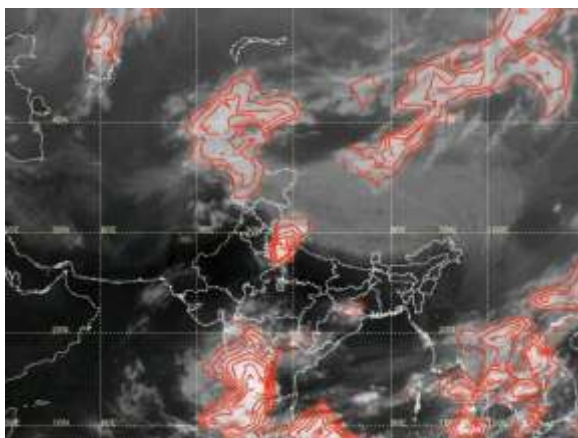
19 May, 00 UTC



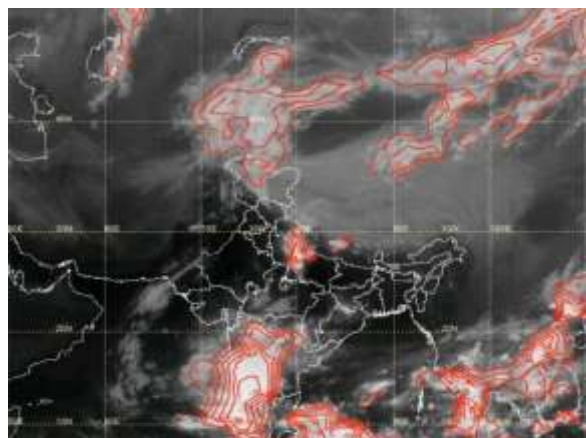
19 May, 12 UTC



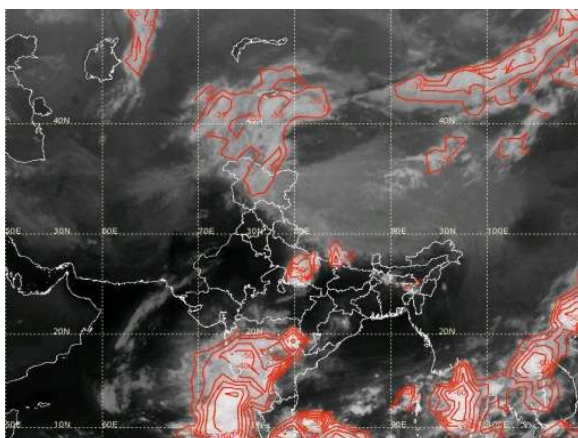
19 May, 18 UTC



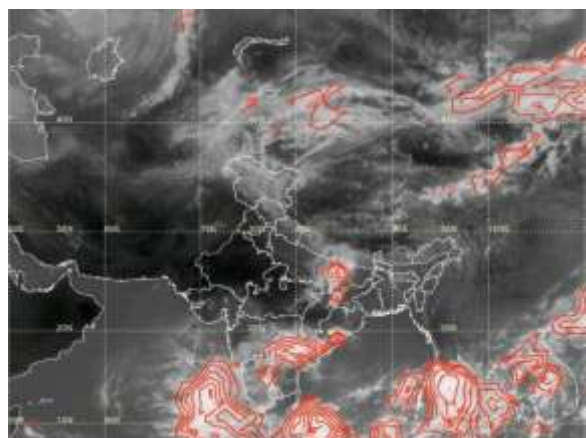
19 May, 21 UTC



20 May, 00 UTC



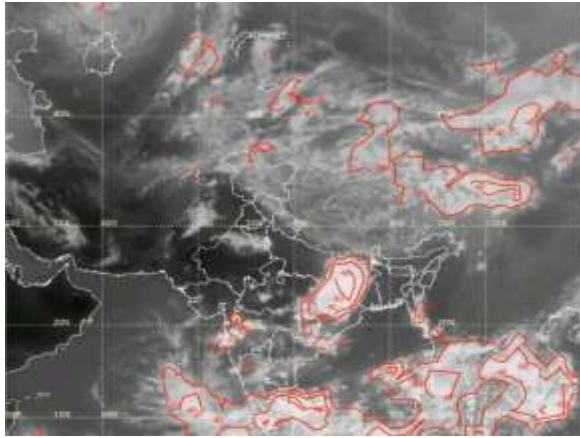
20 May, 06 UTC



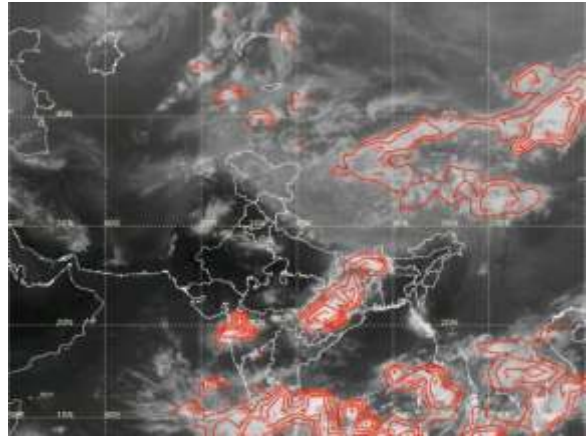
Continue...

Figure 11 : Continue from previous page

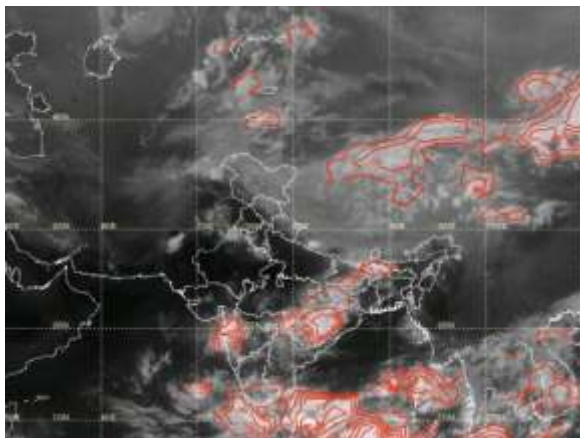
19 May, 00 UTC



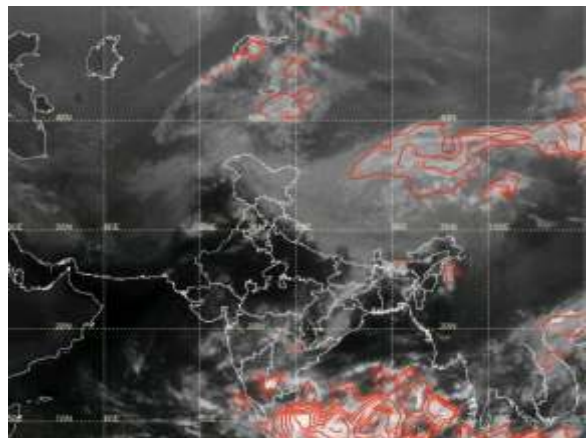
19 May, 12 UTC



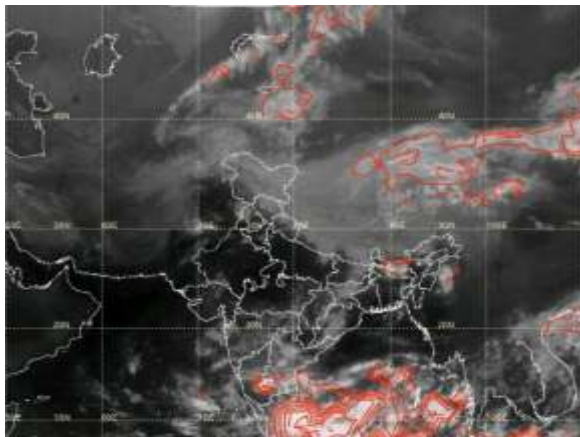
19 May, 18 UTC



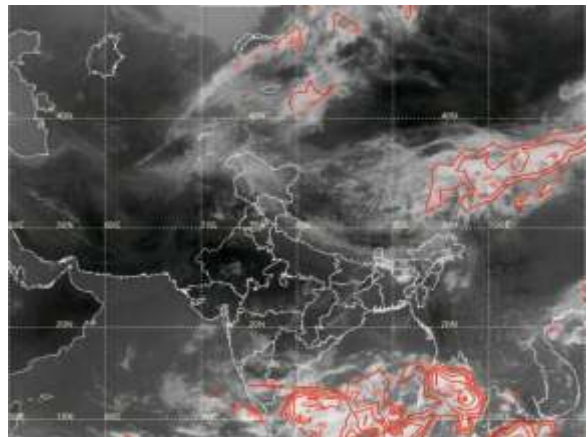
19 May, 21 UTC



20 May, 00 UTC



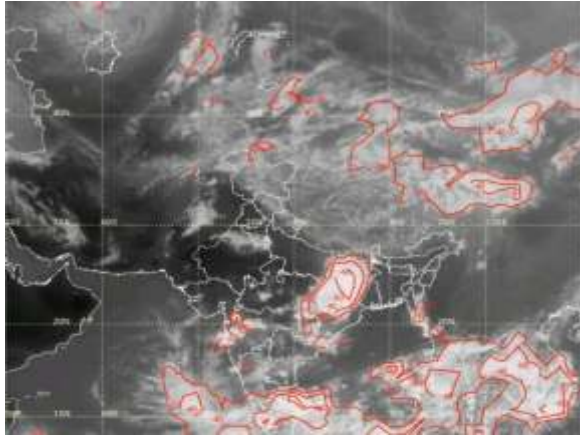
20 May, 06 UTC



Continue...

Figure 11 : Continue from previous page

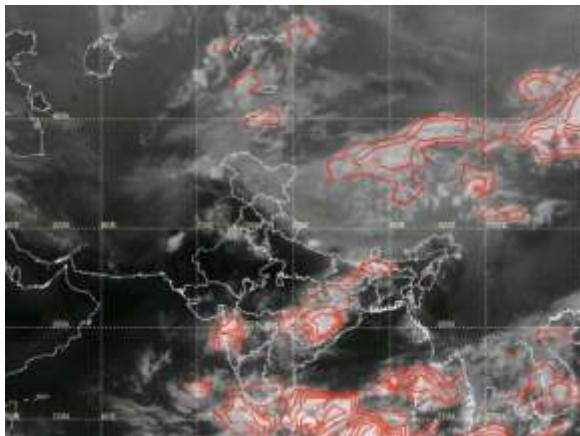
20May, 12UTC



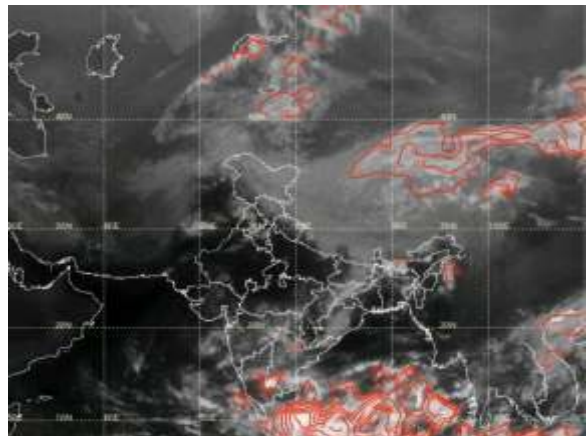
20May, 15UTC



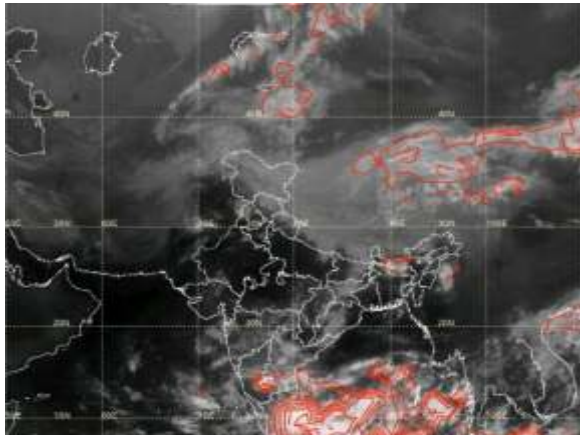
20May, 18UTC



20May, 23UTC



21May, 00UTC



21May, 05UTC

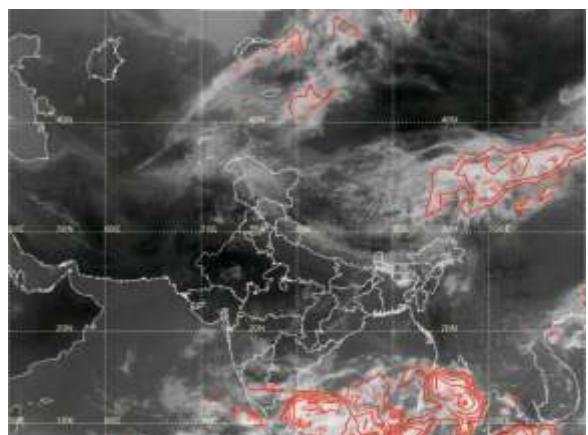
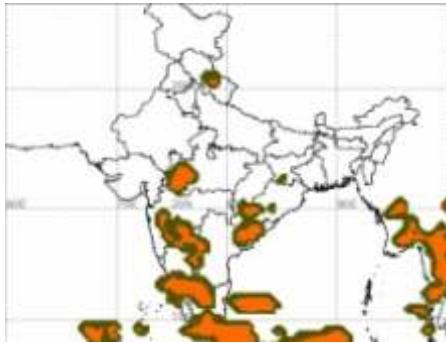
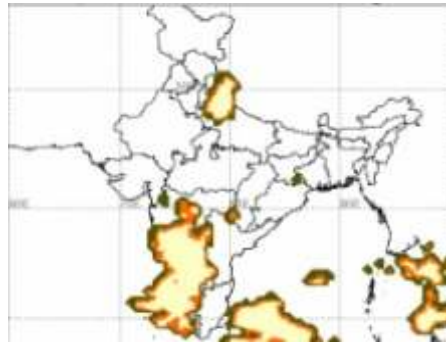


Figure 12 : Quantitative Precipitation Estimation (QPE in mm) from Satellite (Kalpana-I) during 19-21 May 2009

19 May, 12 UTC



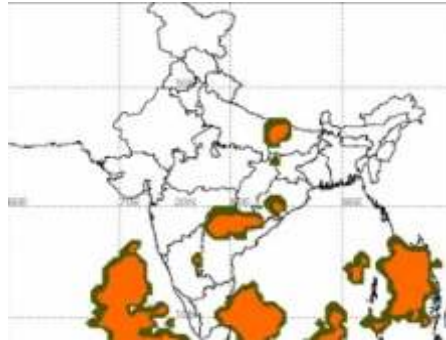
19 May, 18 UTC



20 May, 00 UTC



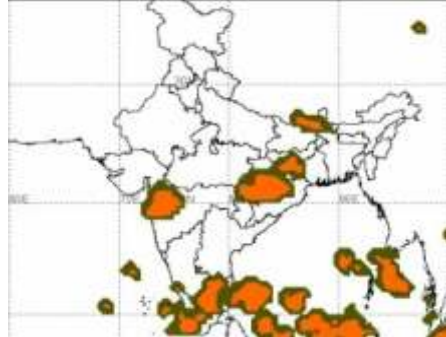
20 May, 06 UTC



20 May, 12 UTC



20 May, 15 UTC



21 May, 00 UTC

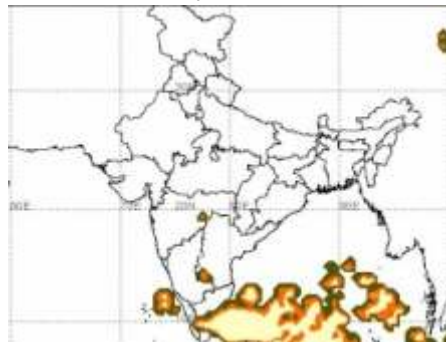
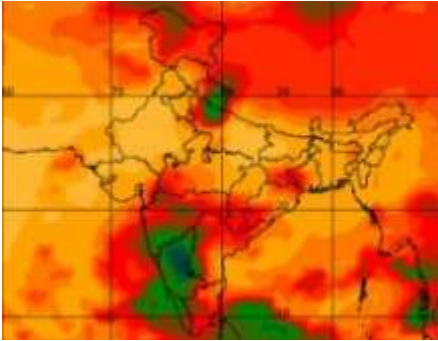
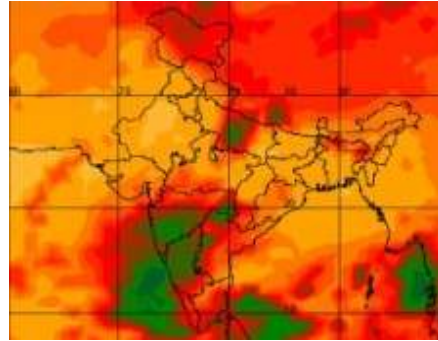


Figure 13: Outgoing Long Wave Radiation (OLR: Watts/Sq.M) from Satellite (Kalpana-1) during 19-21 May 2009

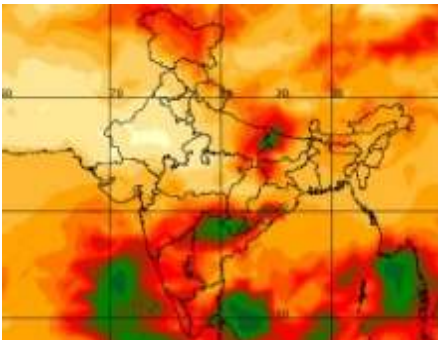
19 May, 18 UTC



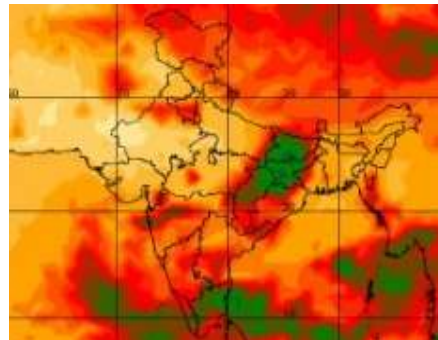
20 May, 00 UTC



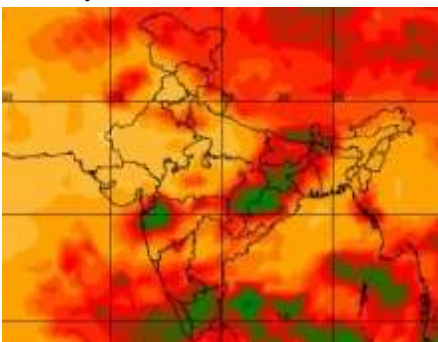
20 May, 06 UTC



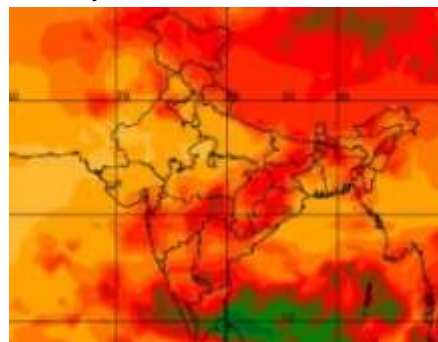
20 May, 12 UTC



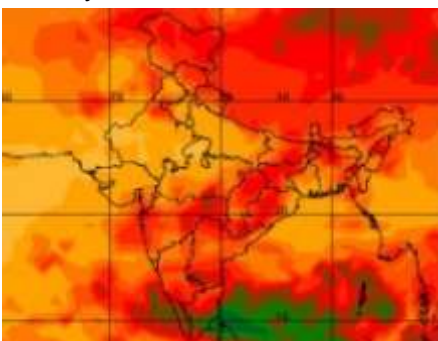
20 May, 15 UTC



20 May, 21 UTC



21 May, 00 UTC



21 May, 03 UTC

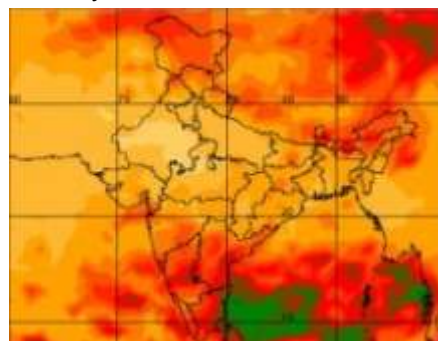
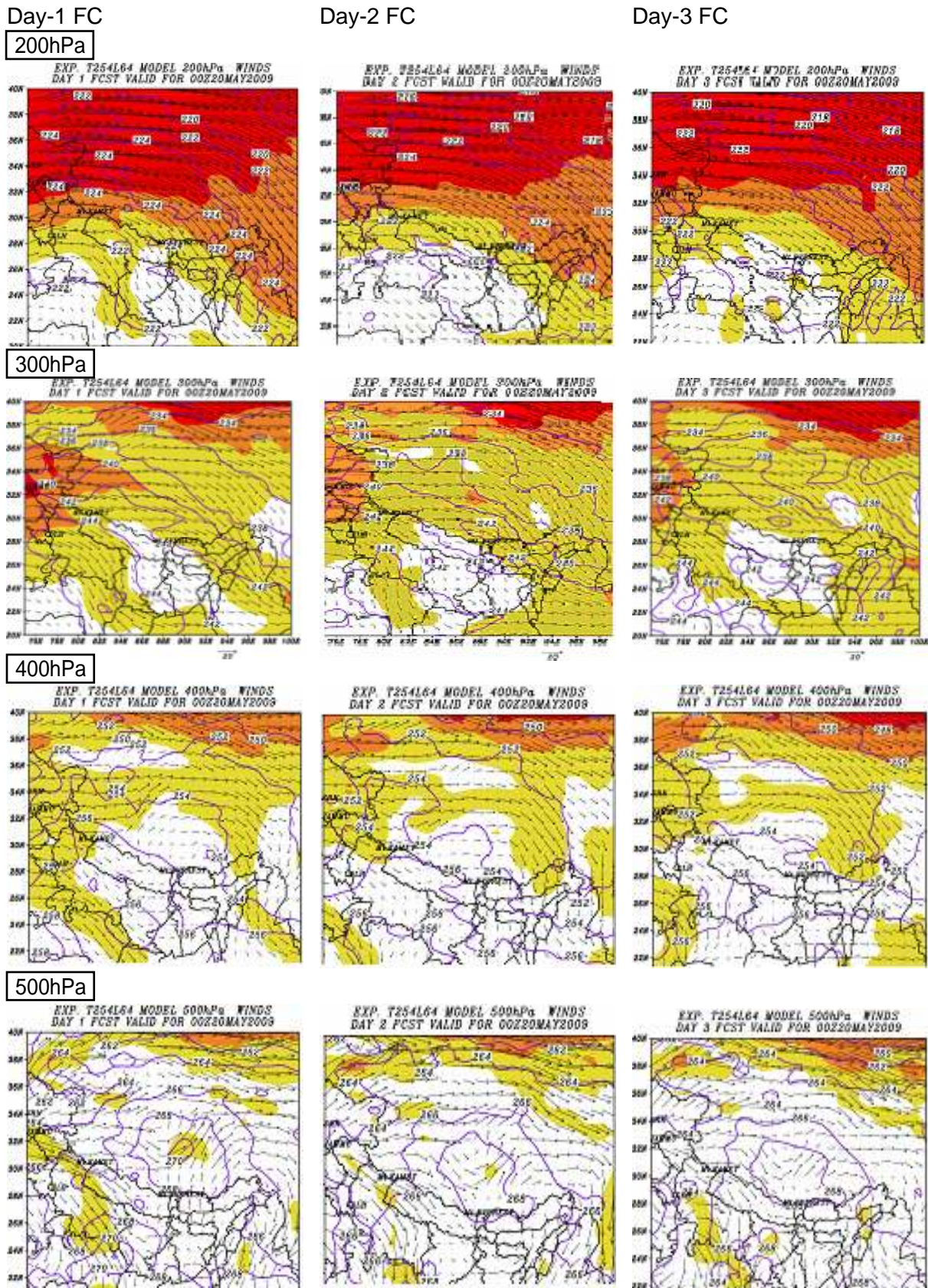


Figure 14: (a) Forecasts of winds and temperatures at 500hPa, 400hPa, 300hPa and 200hPa levels; (b) precipitation for 20th May 2009 (T254 model)



Continue...

Figure 14(a): Continue from previous page

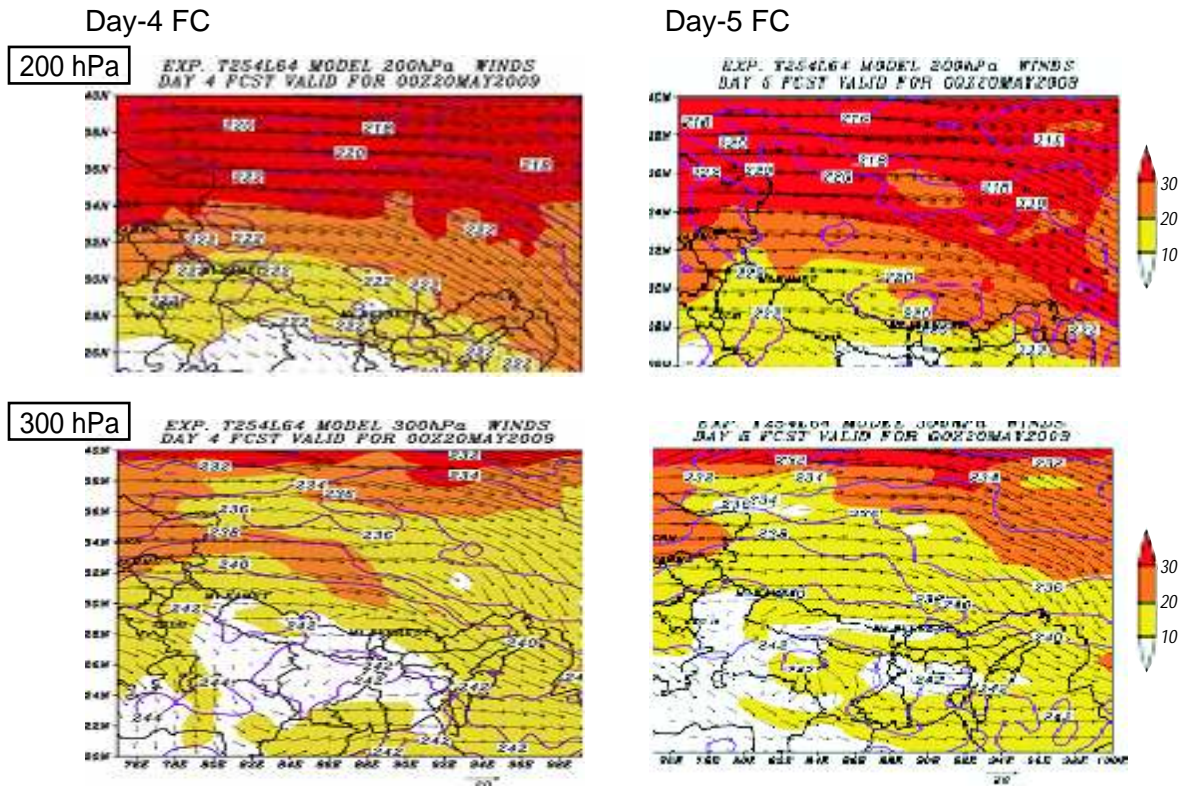


Figure 14(b): Precipitation :

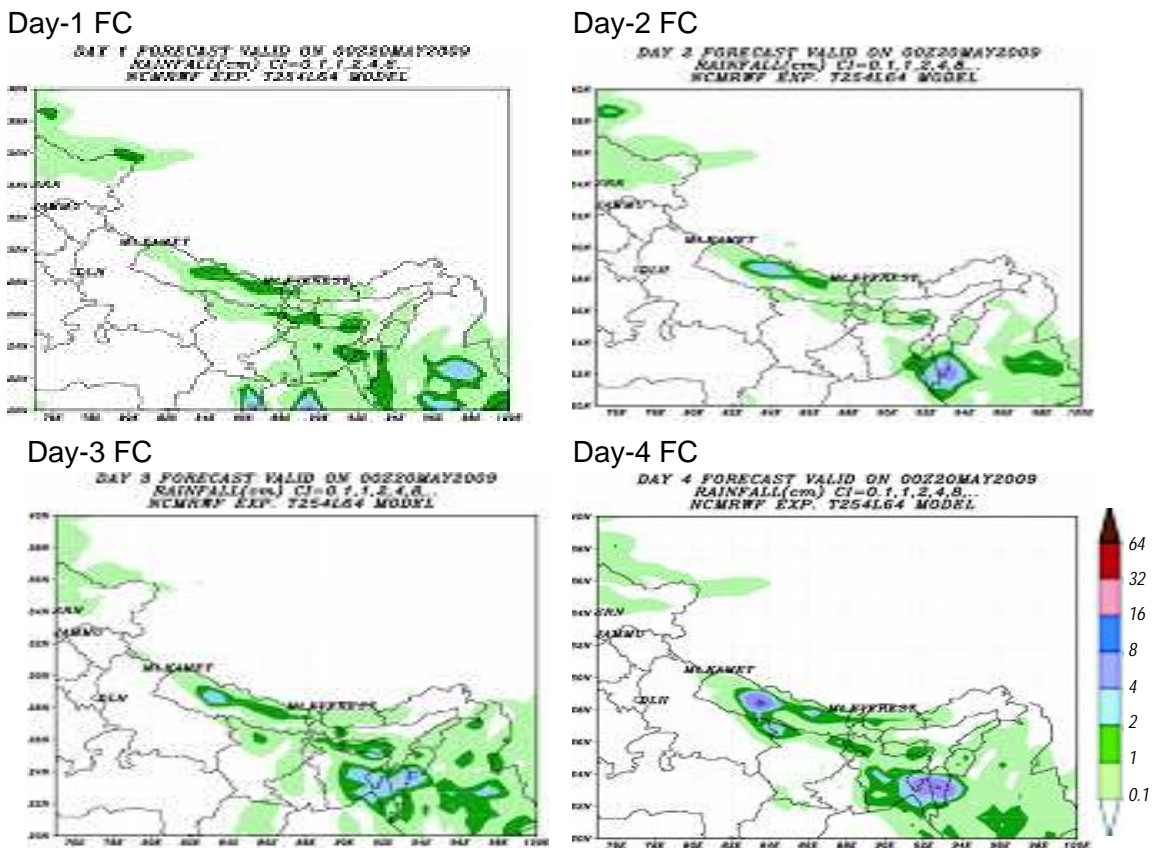


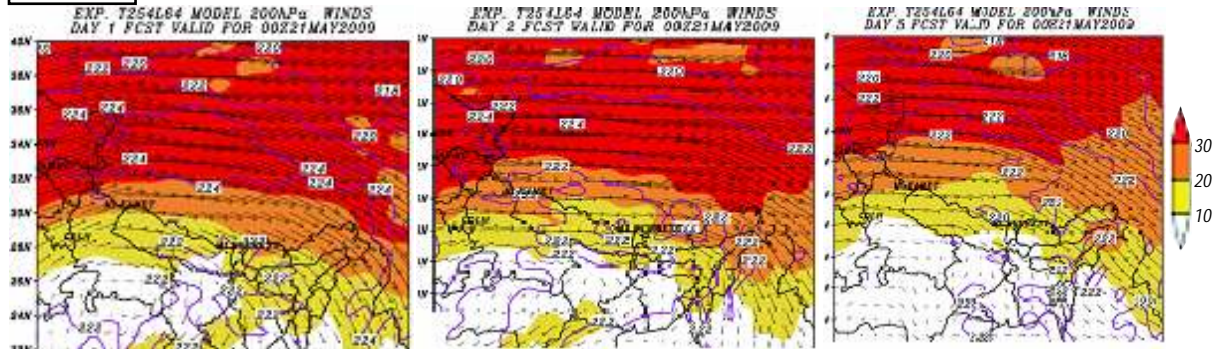
Figure 15(a): Wind and temperature forecasts at 300hPa, 200hPa levels valid for 21st May 2009

Day-1 FC

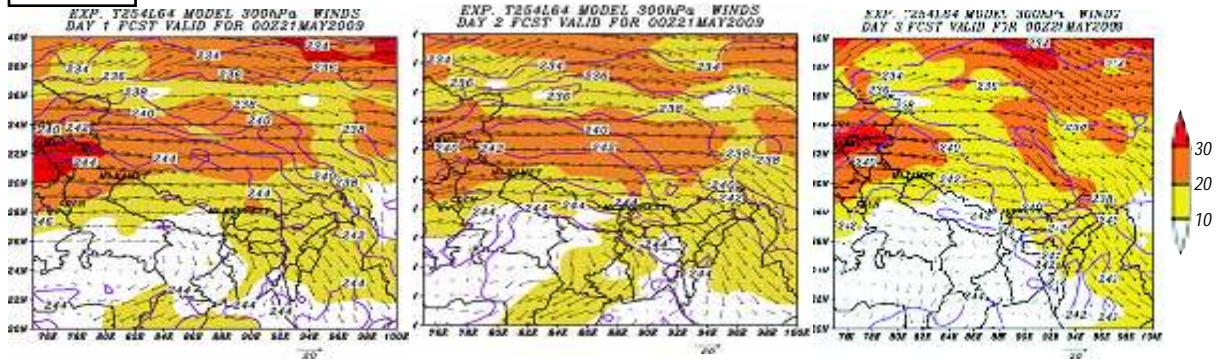
Day-2 FC

Day-3 FC

200hPa :



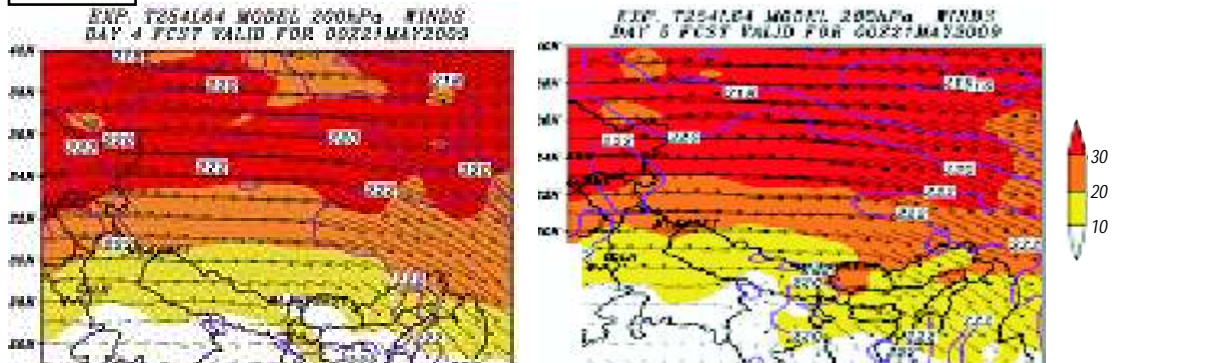
300hPa :



Day-4 FC

Day-5 FC

200hPa :



300hPa :

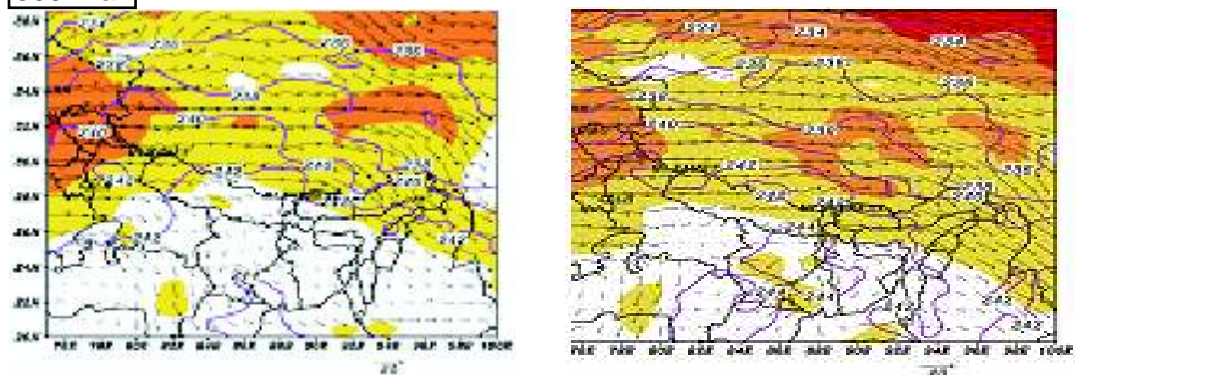
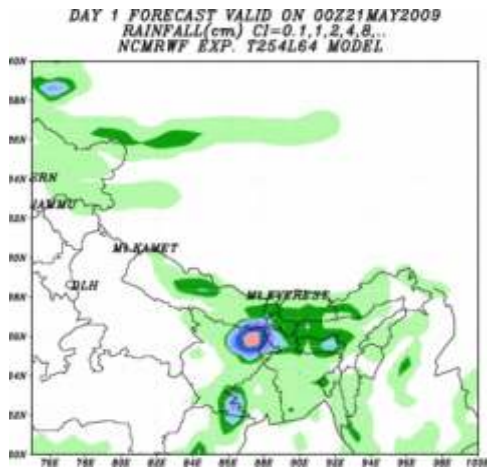
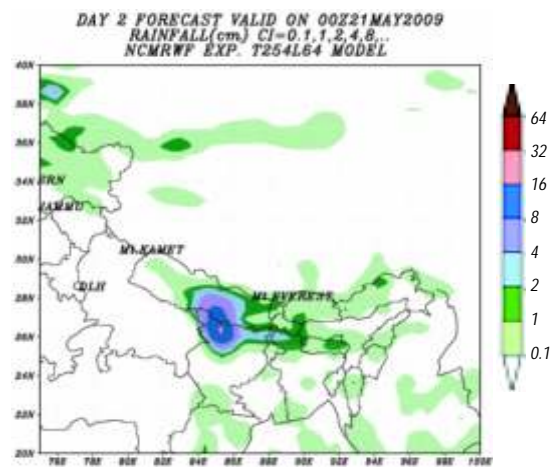


Figure 15(b): Precipitation forecasts valid for 21st May 2009 (T254 model)

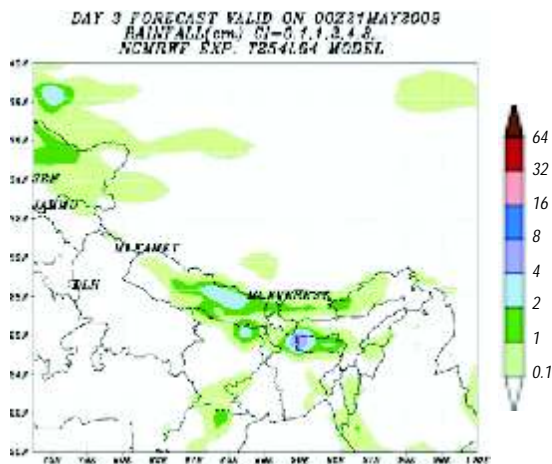
Day-1 FC



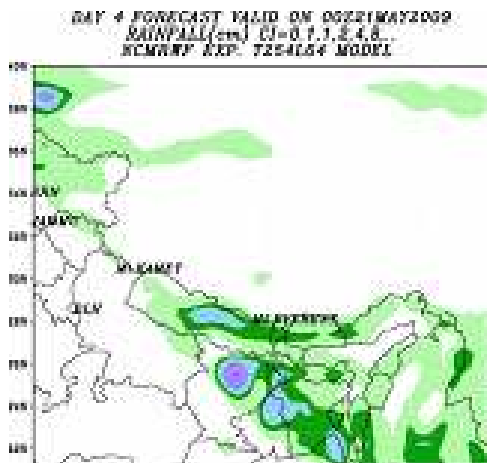
Day-2 FC



Day-3 FC



Day-4 FC



Day-5 FC

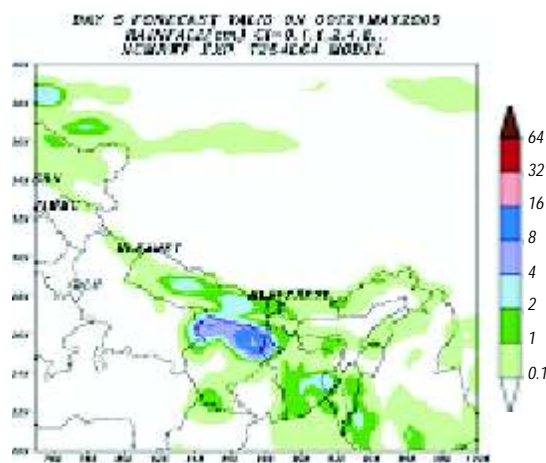
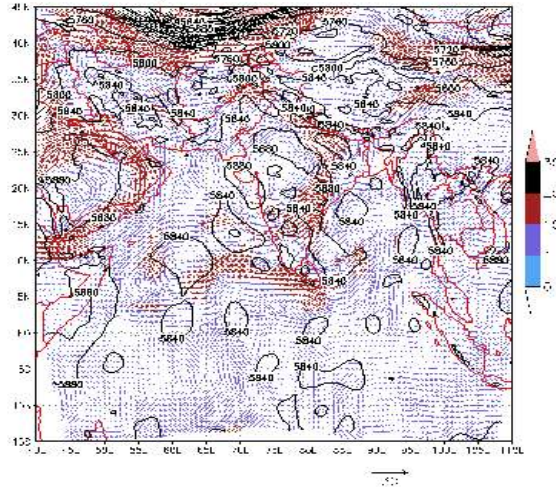


Figure 16(a): Wind and temperature forecasts at 500hPa level by 'Regional WRF 2.2 Model' for 00UTC of 21st May 2009

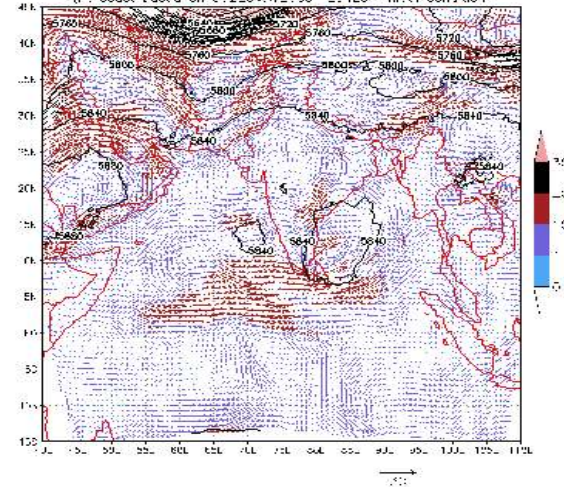
Analysis-21 May 09

WRF2.2 MODEL 500hPa GEOP. HT & WINDS [Experimental Runs]
Analysis VALID FOR 00Z21MAY2009



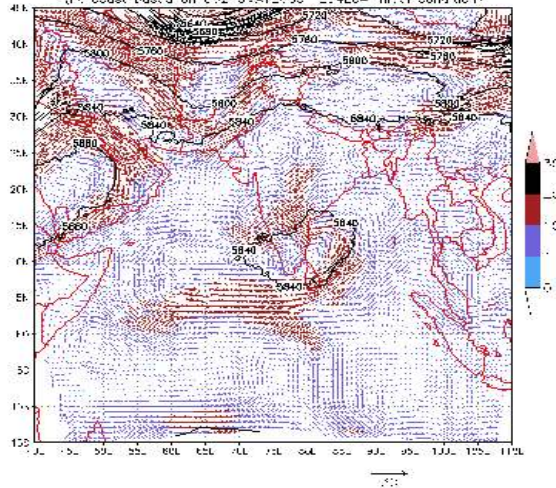
Day 1F/C-21 May 09

WRF2.2 MODEL 500hPa GEOP. HT & WINDS [Experimental Runs]
DAY 1 FCST VALID FOR 00Z21MAY2009



Day 2F/C-21 May 09

WRF2.2 MODEL 500hPa GEOP. HT & WINDS [Experimental Runs]
DAY 2 FCST VALID FOR 00Z21MAY2009



Day 3F/C-21 May 09

WRF2.2 MODEL 500hPa GEOP. HT & WINDS [Experimental Runs]
DAY 3 FCST VALID FOR 00Z21MAY2009

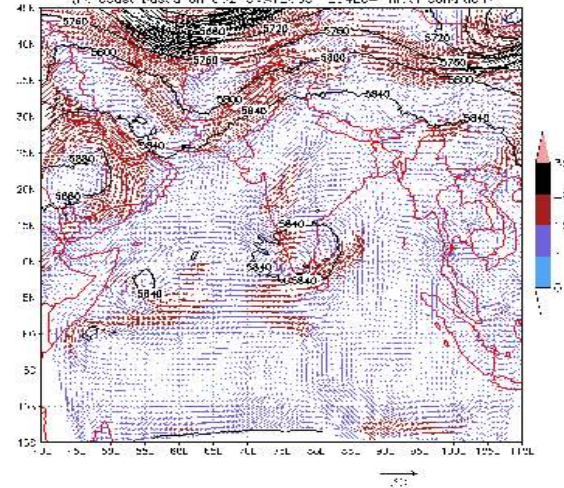


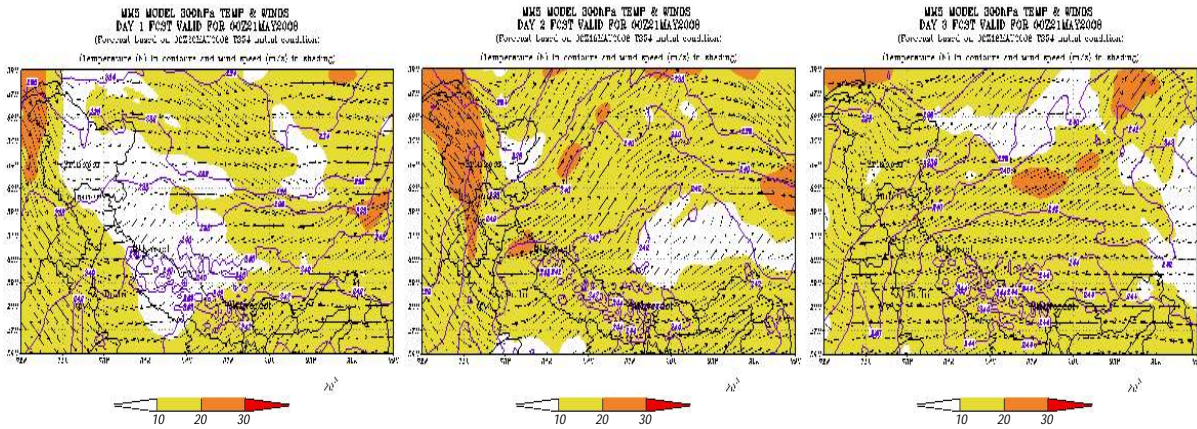
Figure 16(b): Forecasts of wind & temperature at 500hPa, 400hPa, 300hPa levels by MM 5 model for 21st May 2009.

Day 1F/C-21 May 09

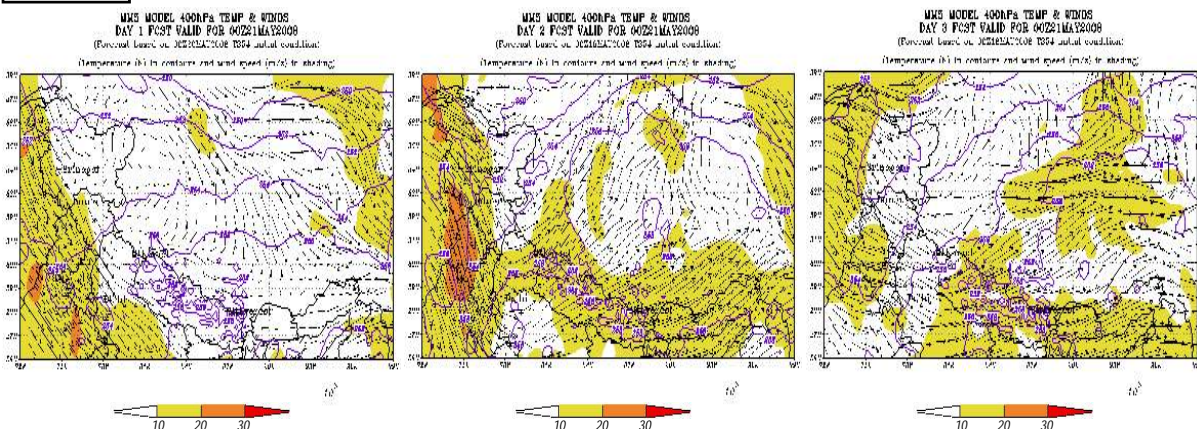
Day 2F/C-21 May 09

Day 3F/C-21 May 09

300hPa



400hPa



500hPa

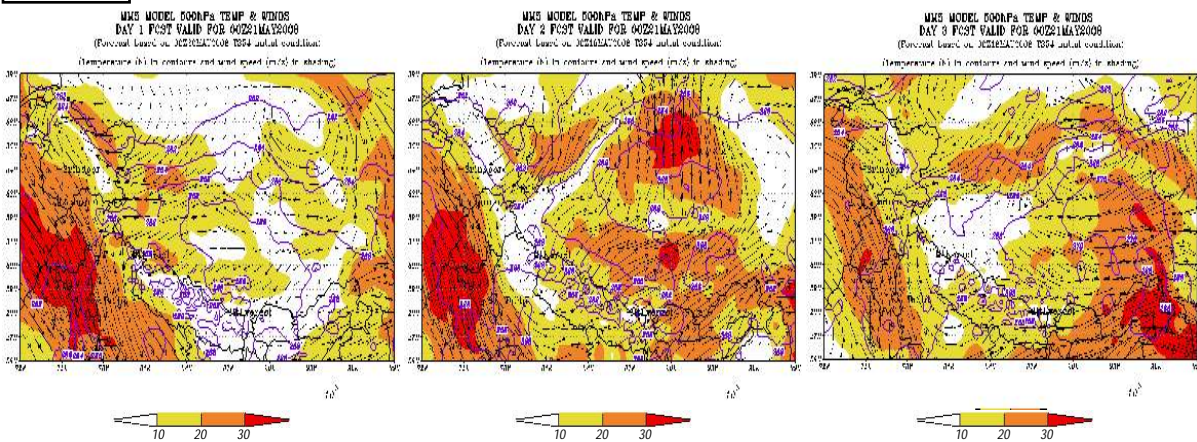


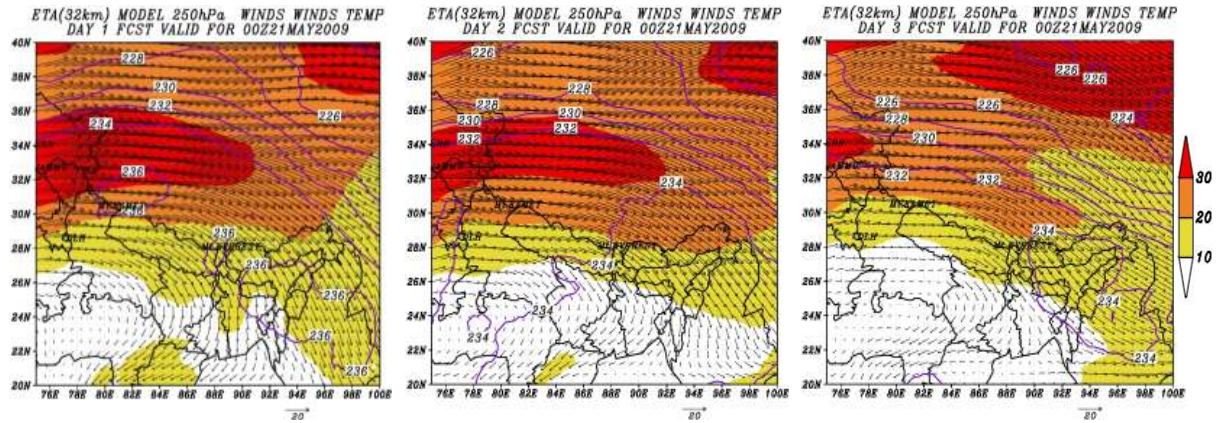
Figure 16(c): Wind and temperature forecasts at 400hPa, 300hPa, 250hPa of 21st May 2009 by ETA model.

Day-1F/C-21 May

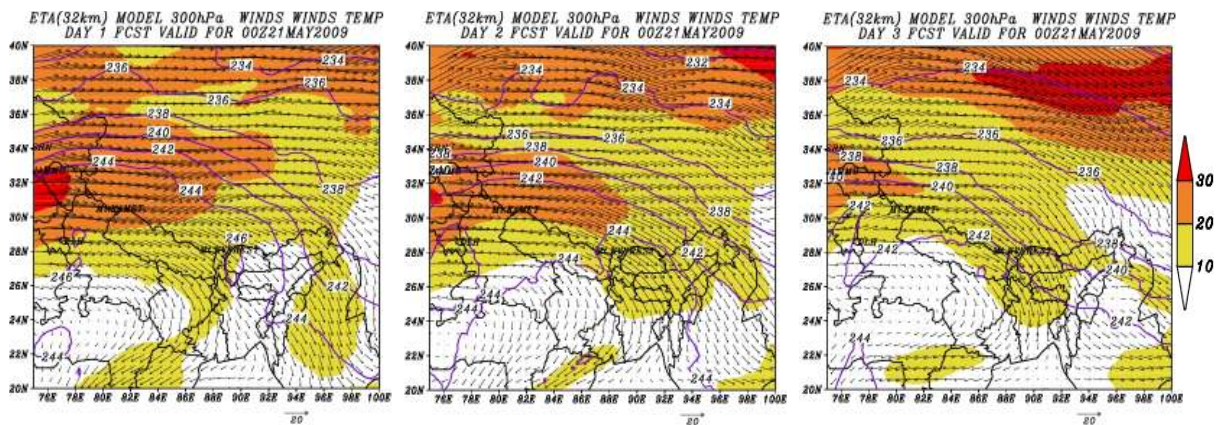
Day-2F/C-21 May

Day-3F/C-21 May

250hPa



300hPa



400hPa

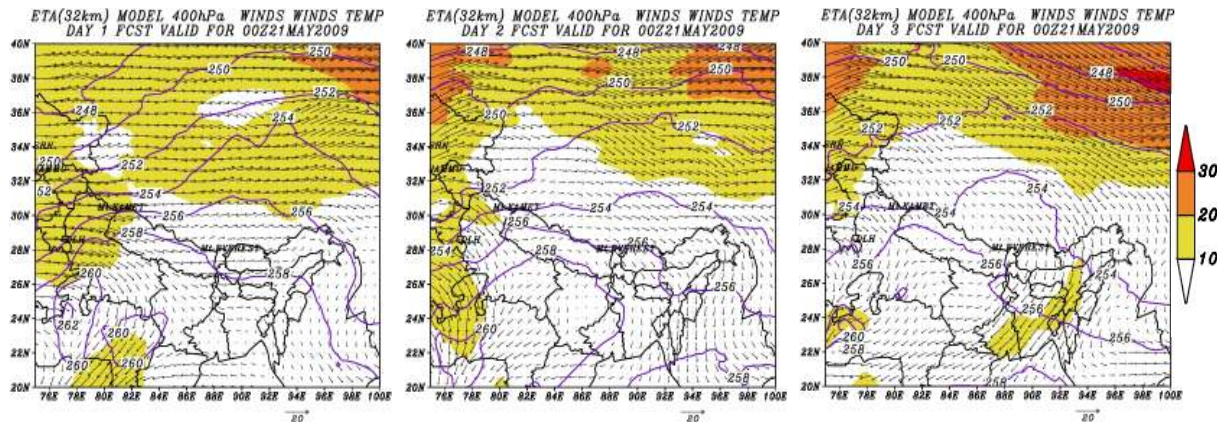


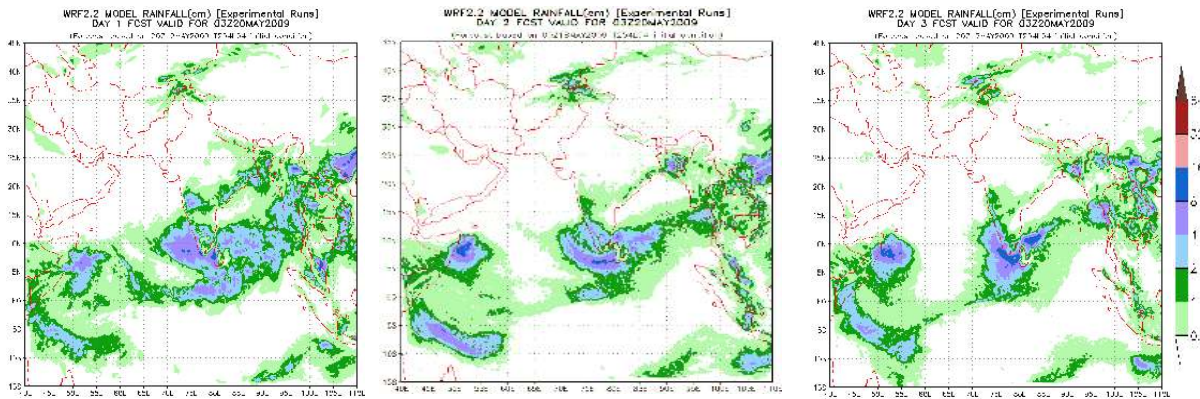
Figure 17: Precipitation forecasts by regional models for 20th May, 2009

Day-1F/C-20 May 09

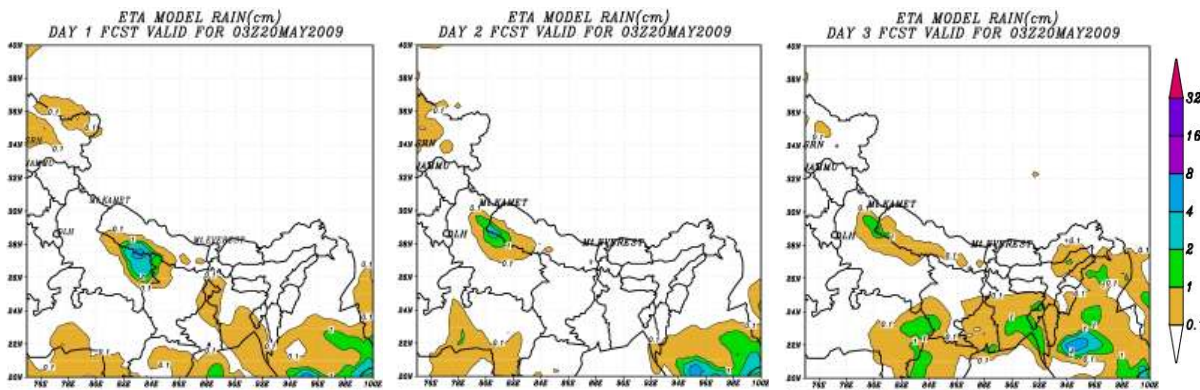
Day-2F/C-20 May 09

Day-3F/C-20 May 09

WRF 2.2



ETA



MM5

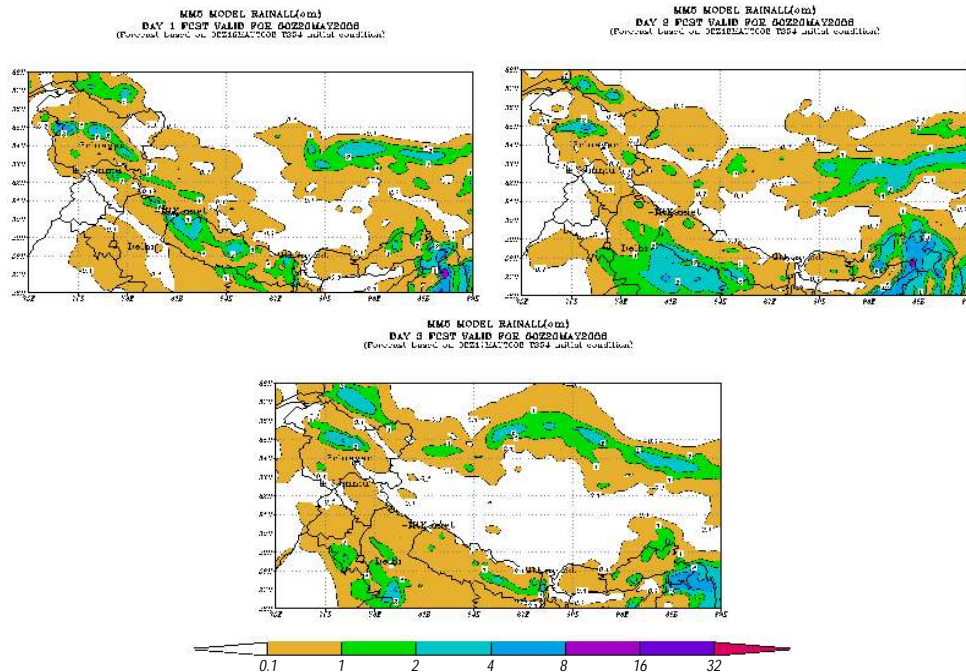


Figure 18: (a) Meteograms (NCMRWF T254) and (b) EPS meteogram (ECMWF) of winds, temperatures, cloud and precipitation for 20-21 May 2009.

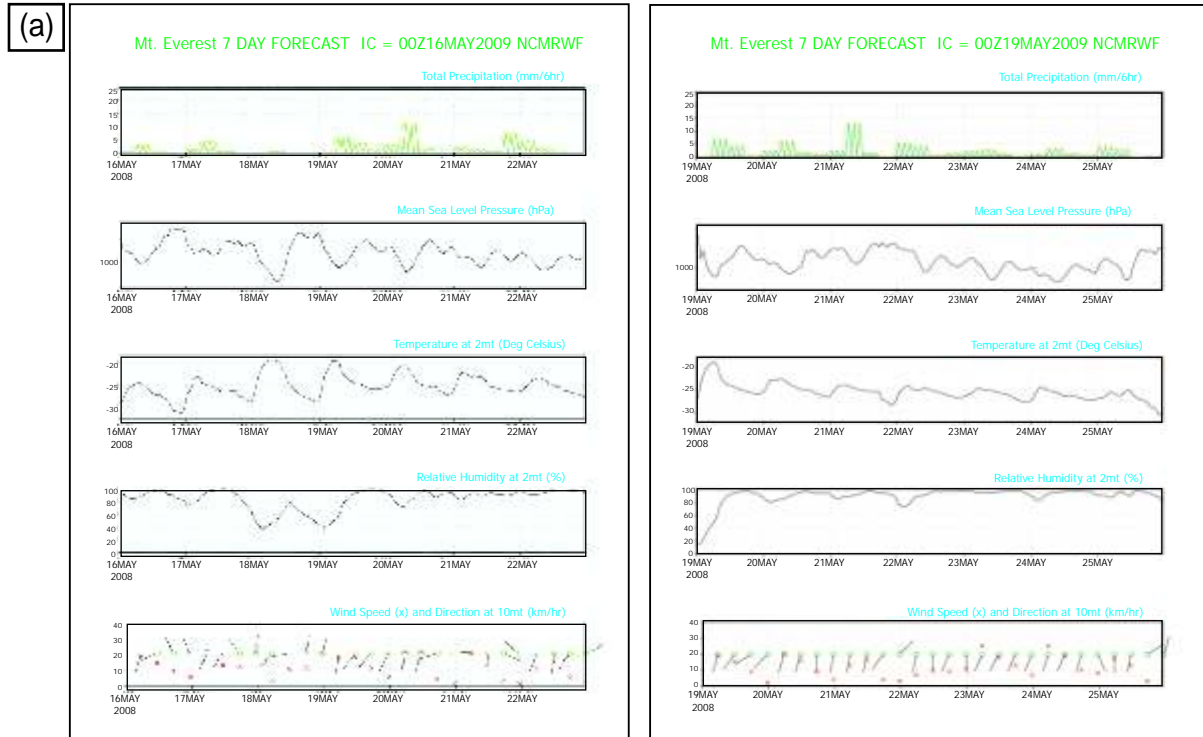


Figure 19: Forecasts from <http://www.snow-forecast.com/resorts/Everest/6day/mid> for Mt. Everest

6 Day Weather Forecast for Mount Everest at 6564 m altitude,

issued (local time): 05 am 15 May 2009

Days 0-3 Mount Everest Weather Summary:

A heavy fall of snow, heaviest during Fri afternoon. Temperatures will be well below freezing (max -10°C on Sun morning, min -17°C on Sat night). Wind will be generally light.

Days 4-6 Mount Everest Weather Summary:

A heavy fall of snow, heaviest during Tue afternoon. Temperatures will be well below freezing (max -9°C on Mon morning, min -14°C on Tue night). Wind will be generally light.

?? Metric <input checked="" type="checkbox"/>	Fri	Fri	Fri	Sat	Sat	Sat	Sun	Sun	Sun	Mon	Mon	Mon	Tue	Tue	Tue	Wed	Wed	Wed
?? Imper. <input type="checkbox"/>	15	15	15	16	16	16	17	17	17	18	18	18	19	19	19	20	20	20
	morn-	after-	night	morn-	after-	night	morn-	after-	night	morn-	after-	night	morn-	after-	night	morn-	after-	night
Wind (km/h)	10	10	10	15	20	20	15	15	15	5	5	0	10	10	5	10	10	5
Summary	clear	heavy snow	snow shwrs	snow shwrs	light snow	snow shwrs	clear	snow shwrs	snow shwrs	clear	snow shwrs	snow shwrs	snow shwrs	heavy snow	snow shwrs	snow shwrs	heavy snow	snow shwrs
Snow cm	-	13	6	2	3	-	-	1	-	-	3	3	4	13	-	1	14	5
Rain mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

6 Day Weather Forecast for Mount Everest at 6564 m altitude,

issued (local time): 05 am 19 May 2009

Days 0-3 Mount Everest Weather Summary:

A moderate fall of snow, heaviest on Wed afternoon. Temperatures will be well below freezing (max -7°C on Wed morning, min -13°C on Tue night). Wind will be generally light.

Days 4-6 Mount Everest Weather Summary:

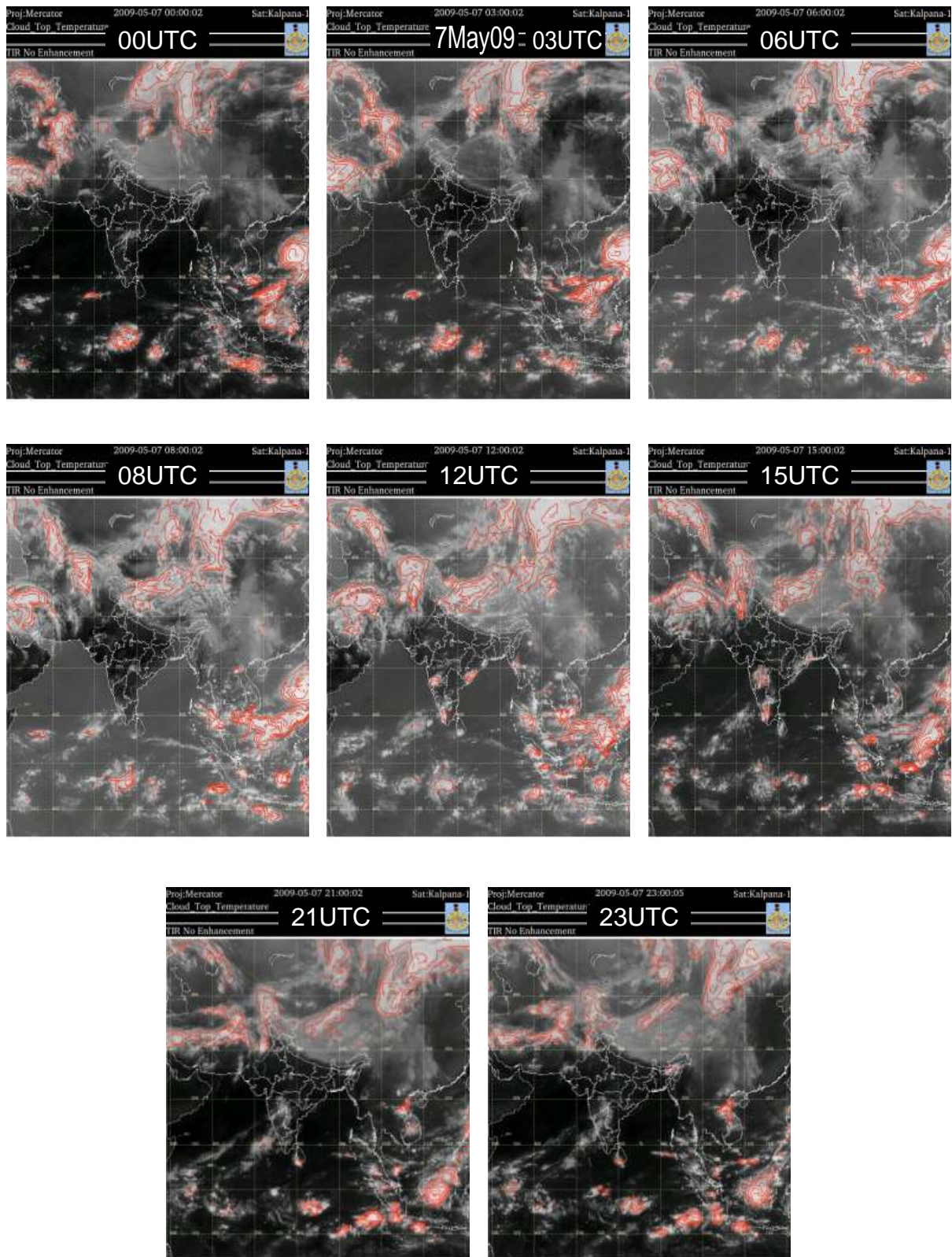
A moderate fall of snow, heaviest on Fri afternoon. Temperatures will be well below freezing (max -9°C on Sun morning, min -14°C on Sun night). Wind will be generally light.

?? Metric <input checked="" type="checkbox"/>	Tue	Tue	Tue	Wed	Wed	Wed	Thu	Thu	Thu	Fri	Fri	Fri	Sat	Sat	Sat	Sun	Sun	Sun
?? Imper. <input type="checkbox"/>	19	19	19	20	20	20	21	21	21	22	22	22	23	23	23	24	24	24
	morn-	after-	night	morn-	after-	night	morn-	after-	night	morn-	after-	night	morn-	after-	night	morn-	after-	night
Wind (km/h)	15	10	0	10	10	5	5	10	5	10	15	5	15	20	15	20	20	20
Summary	clear	snow shwrs	snow shwrs	snow shwrs	mod. snow	snow shwrs	snow shwrs	light snow	snow shwrs	snow shwrs	light snow	snow shwrs	snow shwrs	light snow	snow shwrs	snow shwrs	light snow	snow shwrs
Snow cm	-	-	-	1	6	2	2	3	1	2	4	1	-	-	2	2	1	1

Figure 20 (a): Route map of Mt. Dhaulagiri and view of the Peak



Figure 20 (b): Cloud and cloud top temperatures by satellite (Kalpana-I) during Mt. Dhaulagiri summit period 7-8 May 2009



Continue...

Figure 20 (b): Continued from previous page

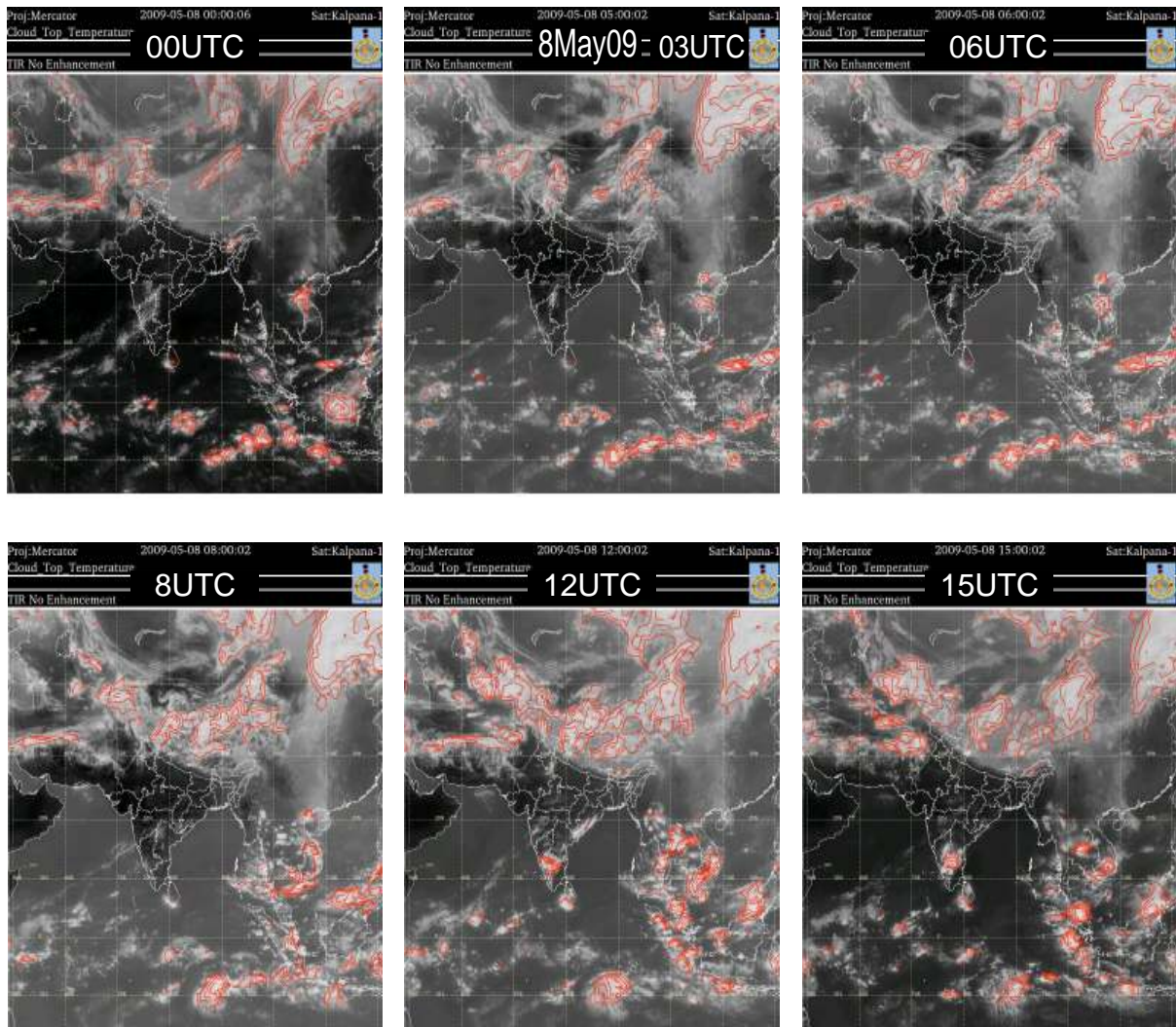
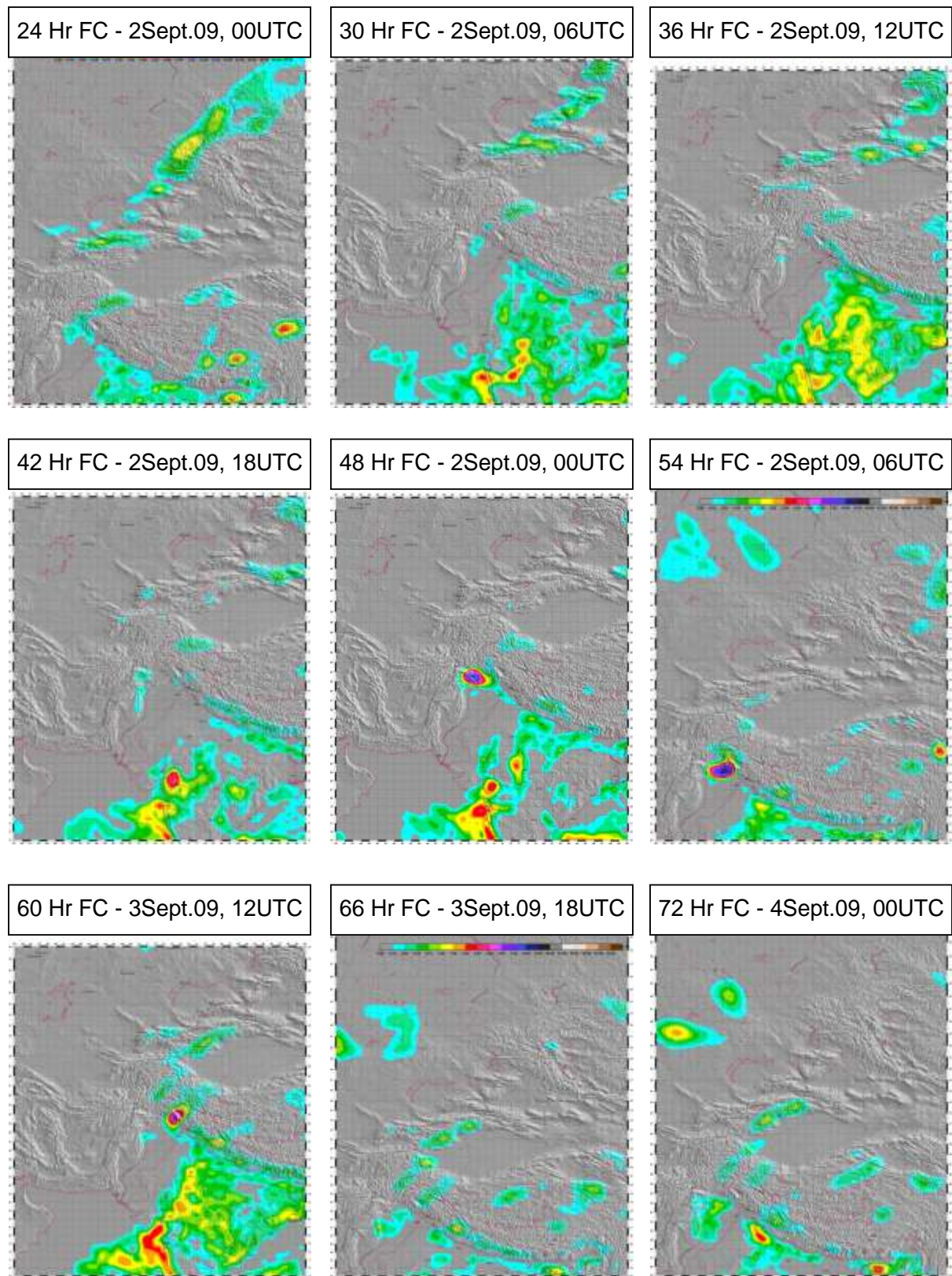


Figure 21: Six hourly forecast of precipitation over 'Peak of marble wall' Kazakhstan area during 2-4 September 2009



ANNEXURE - II

Annexure -II

1. a)

Date: Fri, 6 Apr 2007 13:12:38 +0530
From: "chanchalkumar haldar <chanchalkumar.haldar@gmail.com>
To: jvsingh@ncmrwf.gov.in
Subject: Hallo sir

Hallo sir,

This is Dr Haldar from new tingri foothill of mt everest . tomorrow we are moving to Everest base camp . till now everything is going well . hope all well in Delhi. By Dr c k Haldar MO Attachment 2: DSC00794.JPG (1.9MB



Date: Fri, 6 Apr 2007 15:54:11 +0630
From: "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
To: "chanchalkumar haldar" <chanchalkumar.haldar@gmail.com>
CC: akbohra@ncmrwf.gov.in; Israthore@ncmrwf.gov.in; harendu@ncmrwf.gov.in; rajagopal@ncmrwf.gov.in
Subject: Re: Hallo sir All headers

Hallo Dr. Sahab ! Namaskar !

Nice to hear from you that you have started to base camp. NCMRWF wishes all the success for you all the team members. Convey our best wishes to all friends.

Many thanks for sending holy picture to us.

You may contact any time apart from formal timings of observation and briefing of weather forecast and advisory from us.

With warm wishes & regards,
(Jagvir Singh)

Scientist

National Centre For Medium Range Weather Forecasting,

Phone: 011-26266576 (R), 9911255010 (M),

0120-2403900 to 07 Extn. 235, 248 (Office)

Office direct numbers will be intimated to you, soon.

Alternate email: jvsingh21@gmail.com

1. b)

Date: Thu, 19 Apr 2007 18:37:14 +0630
From : "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
To: "narendra chandel" <chandelgeorgy@gmail.com>
Subject: Re: General happiness All headers

Dear Captain Chandela !

Some points to be taken care during next 3-4 days are;

- 1) Wind speed are likley to remain unchange till tommorrow(20/4) forenoon thereafter speed are likely to increse and become nearly 1.5 times to double compare to present wind speed, during 21 to 23 April.
- 2) Snowfall is likely during 21April-22April

Wish you Good luck

(Jagvir Singh)

Scientist

Phone: 0120-2403913

1. c)

Date: Sun, 13 May 2007 15:05:21 +0530
From: "narendra chandel" <chandelgeorgy@gmail.com>
To: jvsingh@ncmrwf.gov.in
Subject: Hello

Hello Sir

Thanks for your concern

As per your advise team has moved to camp II and will be attempting summit on 15 and 16may I am proud to be an Indian and having hard working offrs like you in our weather dept You bwill also be happy to know that 12 teams are following us as per your prediction

Sdo lets hope for the best

See you all soon in delhi

Bye

1. d)

Date: Tue, 15 May 2007 09:05:41 +0530
From: "narendra chandel" <chandelgeorgy@gmail.com>
To: "yoginder sejwal" <yogindersejwal@gmail.com>, wow_wowweather@wowweather.co
Subject: Hello

Hi

This is a great news for all of us who are concerned with the Indian Army Mt Everest Expedition07

The first team comprising of 06 Members and 06 Sherpas unflurred Indian and Indian Army flag on Mt Everest at 0600 Hrs

The next move of the team is that second team comprising of 06 Members and 06 Sherpas will repeat the success tomorrow almost the same time

Will keep upodating you all

Bye

1. e)

Date: Wed, 11 Apr 2007 14:46:51 +0530
From: "chanchalkumar haldar" <chanchalkumar.haldar@gmail.com>
To: jvsingh@ncmrwf.gov.in
Subject: All Well All headers

All attachments

Dear sir,

All well here. I will send as per requirement.

INDIAN EXPEDITION TO MOUNT EVEREST -2007
SIT REPAS ON 11APR 07

Loc: Everest Base Camp Alt 17160Ft

TempMax 7.1° C Min -15° C

Str : Member No -20 , Sherpa 12, Kitchen Staff 5,

Activity: Acclimatization Walk .

Weather Data: - Normal , Mix Cloudy/ Sun.

10Apr 2007 0600h 1400h Everest base camp

-do-

(5200M/17160Ft)

-d0- 540mb Nil

Nil -

nil

- -8°C

7.1°C - 15°C

-2°C 20mm

Nil Low Cloud And Higher ridge not Visible

Cloudy and Plums W to E Cloud in Aprox 20000ft toward west side and Dense cloud north Everest

Health Report:- All members and sherpas are fit and fine. Load preparation for higher camps is in progress. Plan for 12 Apr 07, Second stage accn continues Load preparation for higher camps continues.

2. a)

Date: Sat, 17 May 2008 12:43:45 +0530
From: "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
To: rahul.mahajan24@yahoo.com
CC: akbohra@ncmrwf.gov.in; ashok@ncmrwf.gov.in; gopal@ncmrwf.gov.in;
jvsingh@ncmrwf.gov.in
Subject: Army: NCMRWF Forecast dated 17May08 Dear Captain Rahul

As discussed 3 days back, it is to further inform you that the weather predictions suggest for partly cloudy with poor chance of light snowfall during next 3-4 days. Subsequently, in the night of 20May and 21st May Morning there are chance of light to moderate snowfall but again clear weather

2) Winds direction are expected to change from West south westerly to north-westerly during next 4-5 days.

3) A better period for planning to complete the activity.

With best of wishes to all of you

Yours truly

(J.V.Singh), Scientist E, NCMRWF, MoES, Ph: 9868105010 M

2. b)

Date: Wed, 21 May 2008 03:54:19 -0700 (PDT)
From: Rahul Mahajan <rahul.mahajan24@yahoo.com>
To: "MR.JVSINGH" <jvsingh@ncmrwf.gov.in>
CC: "MR.JVSINGH" <jvsingh21@gmail.com>, "DR.AKHILESH" <akhilesh.g
Subject: weather observations

Good afternoon Sir,

Thank you for your cooperation so far. Right now the team is at south col and they are planning to try for summit tomorrow morning for the task they will leave the south col tonight..

With warm regards.

Rahul

2. c)

Date: Fri, 23 May 2008 09:34:26 -0700 (PDT)
From: Rahul Mahajan <rahul.mahajan24@yahoo.com>
To: jvsingh <jvsingh@ncmrwf.gov.in>
Subject: Re: Congratulations

GOOD EVENING SIR,
THANK YOU SIR. THE SUCCESS IS ALL DUE TO UR HELP AND BLESSINGS OF SAGARMATHA.. TOTAL 09 OUT OF 12 CLIMBERS SCALED THE TOP OF THE WORLD.. REST THREE RETURNED BACK FROM CAMP III DUE TO HEALTH PROBLEM.

THE TEAM CAME BACK TO BASE CAMP TODAY REACHED BY 04:00 HRS.. ALL ARE HAPPY . ALL MY TEAM MEMBERS AND ESPECIALLY MY TEAM LEADER WANT TO THANK YOU AND ALL NCMRWF TEAM INCLUDING THE HEAD DR AK BOHRA FOR UR GREAT COOPERATION AND GUIDANCE.. THE TEAM WILL BE BACK TO DELHI BY 06TH JUNE..
THANK YOU . WITH REGARDS.
CAPT RAHUL

----- Original Message -----

From: jvsingh <jvsingh@ncmrwf.gov.in>
To: Rahul Mahajan <rahul.mahajan24@yahoo.com>
Cc: akbohra@ncmrwf.gov.in
Sent: Thursday, May 22, 2008 3:48:00 AM
Subject: Congratulations

Dear Captain Rahul and all team members.

It has been very nice to talk the team members when they telephoned from Camp-II after successful expedition. I shall be happy if could get information about entire team telephonically or by email. Is Col Abbe at South Col right now or in Camp-II ? Total how many members have scaled ?

Dr. Bohra Head NCMRWF and all NCMRWF Scientists wish you all brave friends Heartily Congratulation for successful worship/expedition of SAGARMATHA. Waiting to see you all after your arrival here/HQ.

Wishing Col. Abbe and the brave team members many more glorious successes in future

With Warm Regards

(J.V.Singh)

Scientist E, Min. of Earth Sciences, National Centre For Medium Range Weather Forecasting (NCMRWF)

A-50, Sec.-62, NOIDA-201307; Ph: 0120-2403913 (O), 9868105010 (M)

3. a)

Date: Sat, 16 May 2009 22:25:30 +0630
From: "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
To: mmmarmee@yahoo.com
CC: akbohra@ncmrwf.gov.in; ashok@ncmrwf.gov.in; jvsingh@ncmrwf.gov.in;
jvsingh21@gmail.com
Subject: sagarmatha ncmrwf 16may09

Very good evening Col. Masur

In continuation with telephonic discussion today afternoon, following is forecast update;

- 1) No heavy snowfall is expected during next 4-5 days. However intermitent light snowfall may occur during 19-20May.
- 2) Winds speed are likely to be less than 20 Km/Hr during 18May-20 May morning. during next 48 Hrs., it is likely to be less than 30 Km/Hr.
- 3) After tomorrow it is expected to be good period from the weather point of view for worship/expedition of Sagarmatha.
- 4) Please find meteogram also

With best wishes to all of you

Warm regards

(Jagvir Singh)

Scientist E

MoES, NCMRWF Ph:9868105010 M, 011-26266576 R, 24528010 R

3. b)

Date: Sun, 17 May 2009 19:47:53 +0630
From: "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
To: mmmarmee@yahoo.com
CC: akbohra@ncmrwf.gov.in; ashok@ncmrwf.gov.in; gakhilesh2002@yahoo.co.in
BCC: jvsingh@ncmrwf.gov.in; jvsingh21@gmail.com
Subject: NCMRWF SAGARMATHA 17May09

Good evening Col. Masur !

As told in the morning and yesterday's forecast;

- 1) Next 4 days i.e. till 21May, no heavy snowfall is expected. However intermitent light snowfall is expected on 19 and 20 May.
- 2) Winds are likely to be less than 25 Km/Hrs in general.
- 3) Out of 4 days, next 2 days till 20May are supposed be best weather wise
- 4) Shall update tomorrow in evening, but feel free to discuss your plan irrespective of day/night hours.

We all scientists here wish the team all the best,

WISH YOU ALL GOOD LUCK

(J.V.Singh)

Scientist E

MoES, NCMRWF

4. a)

Date: Tue, 5 May 2009 17:30:00 +0630
From: "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
To: dhaulagiri2009@gmail.com
CC: akbohra@ncmrwf.gov.in; ashok@ncmrwf.gov.in; ranjeet@ncmrwf.gov.in;
jvsingh@ncmrwf.gov.in
Subject: Mt. Dhaulagiri -NCMRWF dated 5May09

Dear Col Chauhan !

Following is forecast for next 6 days

- 1) Chances of more than 40 Km/Hrs winds are expected till 7 May, morning. Very light snowfall is expected on 10May F/N which may increase towards night of 10May.
- 2) Weather is expected to be mainly clear and worship/summit of the Mt. Dhaulagiri peak may be planned during afternoon of 7May to 9May night/very early morning of 10May.
- 3) Clear weather window after 10 May would be intimated in the subsequent forecast.
- 4) Please find meteogram also

With best of wishes to all
warm regards
(J.V.Singh)
Scientist E , Ph:9868105010

4.b)

Date: Wed, 6 May 2009 18:42:46 +0630
From: "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
To: Mt Dhaulagiri Expedition <dhaulagiri2009@gmail.com>
CC: akbohra@ncmrwf.gov.in; ashok@ncmrwf.gov.in; jvsingh21@gmail.com
Subject: Re: Weather reports

Dear Col Chauhan

Pl. find meteogram as discussed

- 1) No moderate to heavy snowfall is expected during 7-10may
- 2) Out of these days, winds speed are likely to be more around 9 AM of 8May
give a call tomorrow around 5PM also,

with best wishes
JV.Singh

----- Original Message -----

From: Mt Dhaulagiri Expedition <dhaulagiri2009@gmail.com>
To: jvsingh <jvsingh@ncmrwf.gov.in>
Sent: Wed, 6 May 2009 14:56:44 +0530
Subject: Weather reports

> MS Chauhan
> Leader, Mt Dhaulagiri Expedition Team 2009

4. c)

From: Mt Dhaulagiri Expedition <dhaulagiri2009@gmail.com>
To: jvsingh <jvsingh@ncmrwf.gov.in>
Sent: Fri, 8 May 2009 15:15:35 +0530
Subject: Summit achieved, weather report attached

> Dear Mr JV Singh,
> Thank You very much for all your support, even attending phone at odd
> times. We would like to congratulate you as well. The first Indians to

- > summit Mt Dhaulagiri have been successful on 8 may 09 at 1130h, and
 - > with the help of your forecasts...!!!
 - > I am attaching weather report for today. the teams are still up on the mountain.
 - >
 - > Thank You again
 - > Capt Dr Inam Danish Khan
 - > Expedition Doctor
5. a)

Date: Mon, 31 Aug 2009 11:31:48 +0630
 From: "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
 To: "Dr. A. K. Bohra" <akbohra@ncmrwf.gov.in>
 Subject: Re: Fw: expedition indian army

Sir

- A) There was phone call from Maj. Harish yesterday morniong, follwing is the briefing provided to him.
- 1) There is an eastnortheast - westsouthwest oreintted westerly trough. Under its influence moderate to heavy precipitation is expected today followed by strong winds in next 24Hrs.
 - 2) 2Sept and subsequently, both the precipitaipn and winds are expected to reduce significantly. May plan to perform final summit, accordingly.
- B) One other Army's expedition led by Maj. Vishal at Lat ~ 31N/79E has been provided briefings during last 15 days. Yesterday morning, there was message of successful expedition by the team.

Thanking you,
 With best regards
 (Jagvir Singh)

----- Original Message -----

From: "Dr. A. K. Bohra" <akbohra@ncmrwf.gov.in>
 To: jvsingh@ncmrwf.gov.in
 Sent: Sun, 30 Aug 2009 14:36:56 +0530
 Subject: Fw: expedition indian army

> ----- Forwarded Message -----

> From: Harish Sharma <harshgso2@yahoo.in>
 > To: akbohra@ncmrwf.gov.in
 > Sent: Sun, 30 Aug 2009 08:41:53 +0530 (IST)
 > Subject: expedition indian army

- >
- > Respected Sir
- > Indian Army is conducting a joint army mountaineering expedition with Kazak
- > army in Kazakshtan to Marble Wall Peak.
- > Its Lat & Lon are as under:
- > N 42 DEGREE 18 MIN 29 SEC
- > E 80 DEGREE 16 MIN 11 SEC
- > Request,if possible,to provide the weather forecast of the peak.Team is at
- > camp 3 and will attempt to summit the peak on 30/31 Aug subject to weather
- > conditions.
- > Regards.... Maj HARISH, gso1,aaw

5. b)

Date: Thu, 3 Sep 2009 10:41:17 +0630
 From: "jvsingh" <jvsingh@mail.ncmrwf.gov.in>
 To: ranjeet@ncmrwf.gov.in
 Subject: Fw: Athiya please see, its urgent

----- Forwarded Message -----

From: "jvsingh" <jvsingh@ncmrwf.gov.in>
To: athiyab@gmail.com
Cc: akbohra@ncmrwf.gov.in;ashok@ncmrwf.gov.in;jvsingh@ncmrwf.gov.in;;;
Sent: Wed, 2 Sep 2009 11:20:53 +0630
Subject: Athiya please see, its urgent

Dear Athiya,

A) I require next 8 days forecast of winds speed and precipitation for lat 42 N/Lon 81E; height 6500 meters (Kazakhstan). One of Indian Army's expedition team is there, waiting for 48 Hrs clear weather window from now to 16 September.

As you are new to the system, may be any of Mr. B.P. Yadav and Mr. SC Bhan will be able to tell you as they would have gone through the forecast system there.

B) I am finding frequent western disturbances (intense) moving across the region till 8 Sept. Only clear weather window available is from today Noon to tomorrow evening which is insufficient.

Thanking you

With best of wishes and warm regards

(J.V.Singh)

5. c)

Date: Mon, 7 Sep 2009 20:15:11 +0530 (IST)
From: Harish Sharma <harshgso2@yahoo.in>
To: jvsingh <jvsingh@ncmrwf.gov.in>
Subject: Re: Congrats for successful Wall of Marble Peak Kazakh THANKS ! IT WAS only possible because of the uninterrupted and accurate info by you.

(Major Harish Sharma)

From: jvsingh <jvsingh@ncmrwf.gov.in>
To: harshgso2@yahoo.in
Cc: akbohra@ncmrwf.gov.in
Sent: Monday, 7 September, 2009 1:49:18 PM
Subject: Congrats for successful Wall of Marble Peak Kazakh

Dear Col. Soni / Maj Harish

HEARTILY CONGRATULATIONS FOR YOUR SUCCESSFUL WALL OF MARBLE PEAK EXPEDITION

I received Col Shekhawat phone from Kazakhstan about success of the joint Indo-Kazakhstan Army expedition of Marble Wall peak. Having seen weather systems of the location closely since 30 August 09, I can understand difficulty and risk involved. As, there was no 48 Hrs. clear weather window available required for the expedition till 9 September. The way your team made summit with very narrow clear weather windows amidst stormy weather (western depressions) and even after they got trapped in bad weather for 3 hours, is marvelous.

Wishing many more grand and safe successes.

With best of wishes and warm regards

Yours truly

(Jagvir Singh)

Scientist E / Director

Ministry of Earth Sciences, National Centre For Medium Range Weather Forecasting
Ph: 9868105010 M, 0120-2403913 (O), 011-24528010 R1, 011-26266576 R2



**Customized Weather Forecast For
Mountaineering Expeditions In India**

Technical Report No. NMRF/TR/01/01/2011

Ministry of Earth Sciences

National Centre For Medium Range Weather Forecasting
A-50, Sector-62, Noida-201309