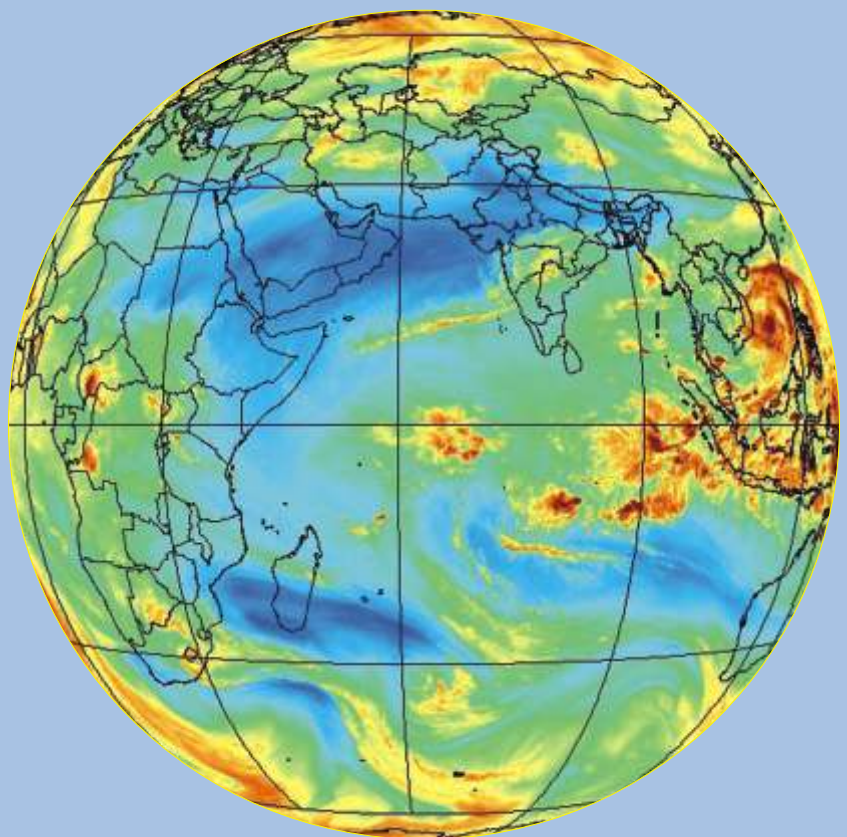
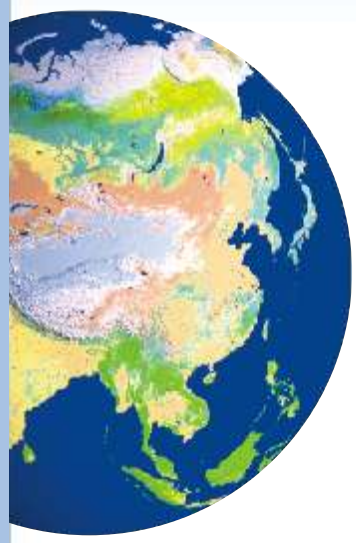
PILOT PROJECT ABSTRACT

Satellite Meteorology & Global Climate (SATMET)
PG Course (Phase-I)





Rainfall estimation over Bangladesh and adjoining Bay of Bengal by Arkin's method

Mr. Md. Abdur Rahman
Bangladesh meteorological Department
Dhaka, Bangladesh

Supervisor
Dr. R.M. Gairola, MOG
SAC, Ahmedabad, India

Rainfall is one of the most important meteorological parameters but also one of the most difficult to monitor because of its high variability in both time and space. In this project work rainfall using INSAT (VHRR) images through Arkin's method over Bangladesh and adjoining Bay of Bengal area has been estimated. Every three hourly INSAT (VHRR) thermal IR band images over 85º E -95ºE longitude and 10º N -28º N latitude region for the month of July 96 were utilized. Monthly average brightness temperature (Tb) over the selected region are divided into grids of 2º * 2º Latitude/longitude and grid wise rainfall has been estimated. The INSAT derived mean weekly and monthly rainfall are in qualitative agreement with the simultaneous ground truth observations over the land masses of Bangladesh. In the present study applicability of 3 hourly observations of INSAT (VHRR) for weekly and monthly rainfall estimation has been successfully demonstrated.

Normalized Differential Vegetation Index (NDVI) and estimation of soil moisture over Bangladesh using NOAA-AVHRR Data

Mr. M H Sarker
Bangladesh Space Research and
Remote Sensing Organization (SPARRSO)
Dhaka, Bangladesh

Supervisor
Dr. V.K. Dadhwal, ARG
SAC, Ahmedabad, India

A spatio-temporal analysis of rainfall, soil moisture and Normalized Differential Vegetation Index (NDVI) derived over agricultural sites in Bangladesh is being carried out. Arc/Info GIS is used for creating monthly climatic layers for rainfall and minimum and maximum temperature and district boundaries of administrative regions. The NDVI is derived from GAC multiple year data sets at biweekly and 10 day intervals. The relationship between integrated NDVI and rainfall with 1 to 3 month lag would be explored. Model based soil moisture estimates would be compared against NDVI and slope of NDVI versus land surface temperature derived from channel 4 and 5 of NOAA-AVHRR data. The relationship of NDVI and soil moisture with crop yield in the study years would be investigated.

Validation of NWP model output with the satellite derived products VIS-À-VIS conventional meteorological observations

Mr. R.M. Kahaldkar
Indian Institute of Tropical Meteorology
Pune, India

Supervisor
Dr. P.K. Pal, MOG
SAC, Ahmedabad, India

India being agricultural country, forecast of weather for a period of 3-8 days is very crucial for monitoring the crop production activities. Such forecast is provided by numerical weather prediction (NWP) model at National Center for Medium Range Weather Forecast (NCMRWF), New Delhi. The farmers can be provided with the useful information when performance of the model is satisfactory. As NWP is an initial value problem, along with the model characteristics, the performance of the model depends upon accuracy meteorological observations over the entire globe. So far as the conventional observations are concerned, most of the vast global oceanic regions are data void. Therefore, the satellite derived products play a vital role in providing the necessary input to the model. The model output, in turn, is very important for improving the quality of the satellite derived products. However, as the satellites probe the atmosphere from space at quite a large distance, there are inherent limitations for the accuracy of the derived products. In the present study, the weather forecast is produced by above model for a period of three days generating the output for every 12 hours. The output parameters like the winds, temperatures at different levels, humidity, rainfall etc are analyzed. These parameters are validated with the satellite derived products as well as the conventional meteorological observations during 1-6 June 1996.

Ocean circulation modelling using satellite data

Mr. Aftab A Can
Department of Marine Sciences and
Marine Biotechnology, Goa University
Goa, India

Supervisor
Dr. S. K. Basu, MOG
SAC, Ahmedabad, India

The atmosphere overlying the north Indian Ocean (NIO) has a profound effect on the circulation of NIO. The present work aims at using the satellite derived wind data in a reduced gravity ocean circulation model to determine the impact of satellite data in studying the ocean surface circulation. The results of the model run using the climatological winds obtained from Florida State University are presented. The results show a high resemblance of surface features with those of the climatology of the region. The study reveals that the changing atmospheric circulation, in general, change the surface circulation of the NIO. The satellite derived wind data is interpolated as per the grid requirements of the model.

Rainfall estimation over Indonesian region

Mr. Wahyu Subektiyo
Meteorological and Geophysical Agency
Jakarta, Indonesia

Supervisor
Mr. A.K. Varma, MOG
SAC, Ahmedabad, India

The study aims to estimate weekly to monthly scale rainfall by Arkin's technique and diurnal distribution of rainfall/ cloudiness based on 3 hourly INSAT data over Indian region over 2.50 * 2.50 latitude/ longitude grid. The weekly and monthly rainfall maps are generated and diurnal variability of rainfall is obtained by analyzing 3 hourly fractional cloud cover maps. The comparison of rain maps is done with Indian Meteorological Department ground based rain measurements, weather reports and SSM/I derived monthly rain maps.

Study of coastal upwelling in Persian Gulf and Oman sea

Mr. H.R. Moradi
Meteorological Organisation of Iran (IRIMO)
Tehran, Iran

Supervisor
Dr. M.M. Ali, MOG
SAC, Ahmedabad, India

Coastal upwelling is a well known phenomenon in the sea. It is induced by the wind action under suitable conditions which causes the upward movement of water from deeper layer to the surface. The upwelled water has higher concentration of nutrients and hence regions of upwelling usually have high biological productivity. This upwelling phenomenon has both spatial and temporal variations. In this study the location and periods of upwelling closer to the Persian Gulf and Oman Sea are being investigated. Upwelling is estimated using ERS-2 wind vectors. Besides, Sea Surface Temperature derived from NOAA is also being analyzed. Since upwelling is associated with divergence of water, sea level goes down at regions of upwelling and has cooler Sea Surface Temperature. The enclosed figure shows low sea surface height at around 250 N 610 E obtained from TOPEX observations corresponding to the upwelling computed from ERS-2 wind vectors for the period 18-27 September 1997.

Cloud analysis of western disturbances

Ms. Aisulu Darbekova
Agency of Hydrometeorology
Almaty, Kazakhstan

Supervisors
Dr. V.K. Agarwal,
Mr. B.M. Rao, MOG
SAC, Ahmedabad, India

The North West India and the adjoining regions experience Western disturbances during the North-East Monsoon period (November to March). The Western Disturbances over these areas during January 1996 are studied. The distribution and classification of clouds associated with these disturbances have been analyzed using cloud images, Outgoing Longwave Radiation (OLR) and synoptic charts for the above period. The life cycle of Western disturbances using INSAT data at 3 and 9 GMT hours have been studied. The speed of its movement and intensity (in terms of Cloud Top Temperature) have also been characterized.

Wildfire danger estimation, detection and monitoring using NOAA-AVHRR, IRS and GIS techniques

Mr. B Erdene Ochir
Research Institute of Geo-ecology
Ulaanbaatar, Mongolia

Supervisor
Dr. M.M. Kimothi, FLUPG
SAC, Ahmedabad, India

Mongolia is located in the frontier zone of East Asia. Climate is considered as sharp continental, marked by four seasons. About 12% of land surface is covered by various types of forests, which contribute to about 10% of GNP of the country. Extreme dry and continental climate causes many natural disasters. Among these the occurrence of frequent forest and grassland fire is main disaster, which needs much attention to develop real time monitoring system of fire suppression. In the present study various spatio-temporal satellite data viz. NOAA-AVHRR, IRS 1C/1D (WiFS, LISS III), IRS-1B (LISS-I, LISS-II) of pre and fire duration along with meteorological and other ancillary data were analyzed over Mongolian and part of Indian region. The study has helped in understanding the detection of wild fire, extent of damage, real time monitoring of large scale fire and fire risk area mapping. Attempt has also been made to develop procedure using spatial and non-spatial information derived through remote sensing satellite data like IRS and other sources for generating fire risk model using Geographical Information System.

Retrieval, validation and application of atmospheric temperature and humidity profiles from NOAA/TOVS satellite sounding data over Mongolia

Mr. Nergui Tesngel
Institute of Meteorology & Hydrology,
Ministry for Nature & Environment
Mongolia

Supervisor
Mr. B Simon, MOG
SAC, Ahmedabad, India

Atmospheric and surface parameters retrieved using NOAA/TOVS satellite data provide valuable information for meteorological investigations in the data-spare regions. Retrieved atmospheric temperature and water vapour profiles over Mongolia and Indian regions will be compared with collocated radiosonde observations. Comparisons will show the accuracy of soundings retrieved from satellite-measured radiance data over Mongolia and Indian regions. This is useful for synoptic forecasting and Numerical Weather Predictions. We have used ITPP5.01 package of Wisconsin University to process the TIP data which was downloaded at Space Application Centre on 28-31 July 98, to retrieve air temperature and humidity profiles. One such comparison between radiosonde and TOVS profile is shown in the figure.

Vegetation and soil moisture tendency estimation using Normalized Difference Vegetation Index (NDVI) from NOAA/AVHRR data over Mongolia

Ms. Azzaya Dologosurengiin
National University of Mongolia
Ulaanbaatar, Mongolia

Supervisor
Dr. V.K. Dadhwal, ARG
SAC, Ahmedabad, India

Mongolia is an agricultural country, which has 5 agricultural regions. This study will concentrate on the central agricultural region of Mongolia which is located in the northern part of Mongolia. In Mongolia the limiting factor for agricultural crops is water (moisture) availability during vegetative period (April-October). Therefore assessment of vegetation and soil moisture estimation is highly useful for agriculture of Mongolia. NOAA-AVHRR derived NDVI will be used for assessing vegetation and in conjunction with land surface temperature also used for assessing soil moisture tendency. Global NDVI data sets of GAC data would be used to compare NDVI over good and deficit rainfall years to develop an understanding of the response. A detailed study with full resolution data would be carried in the second phase and results compared with field measured soil moisture. The information will be useful to estimate trend of the crop yields and pasture crops and condition of arable land pasture in Mongolia.

Onset of monsoon over Nepal using satellite data

Mr. Saraju Kumar Baidya
Department of Hydrology & Meteorology
Kathmandu, Nepal

Supervisor
Dr. P.C. Joshi, MOG
SAC, Ahmedabad, India

The prediction of the onset of monsoon is a very complex problem. The onset of monsoon over Kerala Coast is comparatively well understood and well defined problem. Its advancement to Nepal requires the monitoring through satellite based inputs. There are many of meteorological factors which affects the monsoon onset. The satellite based observations important for ascertaining the onset are Outgoing Longwave Radiation (OLR), temperature, humidity and wind profile. The present study uses INSAT-VHRR estimated OLR and NOAA-TOVS estimated temperature and humidity profiles. The OLR field shows that the band of low OLR (which corresponds to the Maximum Cloudiness Zone) <200 Wm-2 over Kerala and <220 Wm-2 over Nepal may be used as one of the monsoon onset criteria. Year to year variation of OLR during 1994-1998 are analysed with respect to the onset of monsoon. The characteristics moisture fields at upper levels for onset of monsoon are also studied. The temperature profile over Tibetan plateau and other regions are studied for prediction of onset of monsoon. Long term dates of onset over Kerala and Nepal are studied to examine the relationship between them.

Break and active monsoon over Nepal

Mr. Rajendra Prasad Shrestha
Department of Hydrology & Meteorology
Meteorological Forecasting Division
Tribhuvan International Airport
Kathmandu, Nepal

Supervisor
Dr. B Manikiam, MOG
SAC, Ahmedabad, India

Using INSAT and ground truth data for the four years (1994-1997) of 12 stations of Nepal and 18 subdivisions of India, an attempt has been made to establish a relationship between Nepal and three different regions selected of India on break and active monsoon over Nepal. The three different meteorologically homogeneous regions of India west central, peninsular and northeast India have been selected for the present study. Generally these three regions of India are more related to Nepal's monsoon especially during break monsoon conditions. Weekly rainfall data of the area have been analysed statistically. Similarly satellite imageries and synoptic charts have also been used to study the movement cloud and trough line. The nature of the weekly variations over the different regions in four representative months of the year is discussed.

Tropical cyclone track prediction using cloud top temperature analysis and chaos theory approach

Mr. Renato M De Leon
Philippine Atmospheris Gepphysical and
astronomical Services Administration
Quezon City, Philippines

Supervisor
Mr. B.M. Rao, MOG
SAC, Ahmedabad, India

Using 3 hourly INSATVHRR IR imageries, three cyclones are analyzed in the Indian region with an aim of improving cyclone track prediction not only in the Indian region but also in the Philippines. Cloud top temperature maps were prepared to know the time and the turning angle of the track of cyclones. Chaos theory approach was utilized to know the future deflection of the tropical cyclone. It was observed that the major structural cloud feature as seen from cloud top temperature maps associated with these cyclones follow a change in the direction of their movement. The limitation of this method is that it is effective only when the major cloud features persist for a reasonably longer period. This research work shows that Cloud Top Temperature and Chaos Track analyses is better than Climatology and Persistence when it comes to predicting cyclone track particularly in the case of recurving cyclones.

Rainfall estimation over a cyclone using cloud indexing technique

Mr. Roy A Badilla
FFB/WFFC/PAGASA
Quezon City, Philippines

Supervisor
Dr. Winston J Prakash, MOG
SAC, Ahmedabad, India

A methodology to estimate rainfall over a cyclone from geosynchronous meteorological satellite using both visible and infrared data has been developed. Cloud classification was done using bispectral method and cloud indices were assigned for each cloud type. In bispectral method, rain rate corresponding to cloud brightness and cloud top temperature values were adjusted to fit to the rainfall distribution pattern over the cyclone in the DMSP-SSM/I data. Sun angle correction, in the visible image, has also been taken into consideration. Area per cloud type was known by histogram method and the total rain rate over the cyclone has been computed. Data used in this research are INSAT visible and infrared data for the 1992 Bangladesh cyclone, from November 14 to 20, 1992 and the corresponding DMSP-SSM/I rainfall data.

Retrieval, validation and applications of sea surface temperatures around Sri-lanka using NOAA-AVHRR and ERS-ATSR data

Mr. Ranjith Jayasekera
Dept. of Meteorology
Colombo, Sri Lanka

Supervisor
Mr. A.K. Mathur, MOG
SAC, Ahmedabad, India

The major input of energy into atmosphere (thermal radiation, sensible and latent heat) originate at the sea surface and is controlled by the sea surface temperature. However, a regular monitoring of sea surface temperature can be performed by satellite data. As Meteorological Department of Sri-Lanka is receiving NOAA-AVHRR data at present and is expecting to receive INSAT data in near future, hands on experience on satellite data handling is very important. The SST retrieval techniques have been studied in this project using the data sets in Indian Ocean and limited period validation has been performed to asses accuracy levels of the algorithms. This project is later to be carried out on larger spatial and temporal scale during the one year study phase.

Temperature and humidity profile over Uzbekistan using NOAA/TOVS sounding data

Mr. Dmitriy Shulgin
Central Asian Research Hydrometeorological Institute
Tashkent, Uzbekistan

Supervisor
Mr. P.K. Thapliyal, MOG
SAC, Ahmedabad, India

Information of temperature and moisture distribution in the vertical is useful in aviation meteorology, synoptic forecasting and numerical weather prediction (NWP). Sounding of the atmosphere by balloon-borne radiosonde instruments has increased our knowledge about the vertical structure of the atmosphere. However, these soundings are available on a limited scale over land areas and are practically absent over vast oceanic areas. On the other hand, satellites can provide repetitive globally consistent sounding on land and ocean areas alike. Satellite soundings are average over a large grid (approx 80 * 80 Km). In this study vertical profile of temperature and humidity are being derived from TOVS-TIP data onboard NOAA satellite. ITTP5.01 package of Wisconsin University is used to process TIP data and hence to retrieve the vertical profile of temperature and humidity. Surface data is included in the retrieval process to improve the profile. These profiles are compared with the nearest radiosonde station data for validation purpose. A sample result of temperature profile over India (latitude = 23.3, longitude = 85.3), using the TOVS-TIP data recorded at Space Applications Centre, Ahmedabad, for July 28 1998 is shown in figure.

Rainfall estimation using cloud indexing

Ms. Matveycheva Natalya
Central Asian Research Hydrometeorological Institute
Tashkent, Uzbekistan

Supervisors
Dr. V.K. Agarwal,
Dr. W.J. Prakash, MOG
SAC, Ahmedabad, India

Using INSAT visible and infrared data rainfall rate has been estimated using cloud indexing technique. Cloud indexing involves characterizing a cloudy area by an index number which includes features of the satellite imaged cloud fields and Outgoing Long Wave Radiation (OLR) values. Rainfall and OLR have a high degree of negative correlation. The cloud types include cloud top temperature, brightness, texture information and cloud cover. These indexes are indicative of cloud potential rain rate. Empirical relationships has been established between the calculated rain rate using INSAT images and in-situ data. The project would be continued during next one year period using eight time in a day images from NOAA-AVHRR over Uzbekistan.

Tropical cyclone track prediction by using INSAT-VHRR data

Mr. Md. Abdur Rahman
Meteorological Office
Cox's Bazar, Bangladesh

Supervisor
Mr. B.M. Rao, ASD/MOG
SAC, Ahmedabad, India

Three hourly INSAT VHREE-IR imageries of three cyclones formed in the Bay of Bengal an the Arabian sea (North Indian Ocean) during the period 1992-1999 were analyzed. This region is an ideal breeding ground for tropical cyclones. So, the present study was carried out with a view to improve the cyclone track prediction in this region. Cloud top temperature maps were prepared to know the time and the turning angle of the track of the cyclone. It was observed that the rotation in the major structural cloud features as seen from the cloud top temperature maps associated with these cyclones in the North Indian ocean is followed with a change in direction of their movement. But this method is effective only when the cyclone is severe and when the major cloud features persist for a reasonably longer time. In this study, only the direction of movement is forecast considering a uniform speed of the cyclone.

Monitoring of crops in DPR Korea using muti-date NOAA AVHRR satellite data

Mr. Jo Myong Son
Central Information agency for Science & Technology (CIAST)
Pyongyang, DPR Korea

Supervisor
Dr. V.K. Sehgal, ARG
SAC, Ahmedabad, India

DPR Korea has been continuously affected by drought from 1994 onwards which has resulted in the drastic decrease in production of major crops especially rice, maize and potato. This study deals with the development of methodology of monitoring the country level crop area and condition/yield of major crops using LAC/NOAA-AVHRR channel 1 and 2 data. For the year 1998 multi-date AVHRR data was downloaded from internet, screened and preprocessed for analysis. The preprocessing involved radiometric calibration and sun angle correction of images followed by geometric correction and registration using ERDAS IMAGINE image processing software. The province boundaries of DPR Korea were generated in ARC/INFO GIS and overlaid on images to extract the area of interest. For four dates AVHRR data, NDVI images were computed from channel 1 and 2 and scaled from 0 to 200. Using hierarchical decision rule based classification, the features of cloud, water, built up. Sand and forest features were classified. The remaining features of crop types were classified using unsupervised classification. The clusters were assigned to rice, maize and potato-soyabean mixed crop types. The areas of rice, maize and potato-soyabean for the 1998 crop season were found to be 580.4, 658.2 nad 523.1000 has respectively. For each of the individual crop types, the mean NDVI profiles were generated for the country as well as the major crop growing provinces. The shape and area under the NDVI profile curves of the crops over the years can indicate the state of crop production in comparison to reference year.

Vegetation and land surface temperature monitoring using multi-temporal NOAA/AVHRR coarse resolution data over Korean peninsula

Mr. Han Chol Hun
Institute of Remote Sensing and Geoinformatics (ISRG)
Academy of Sciences
Pyongyang, DPR Korea

Supervisor
Dr. V.K. Dadhwal, RESA
SAC, Ahmedabad, India

Vegetation condition and Land Surface Environmental parameters such as Land Surface Temperature and Soil Moisture are very important parameters for agricultural monitoring, forest management, and study of climate variables such as drought and natural disasters such as flood and hurricane. Especially in mid 1990's there has been large decrease of crop production in DPR Korea. NOAA/AVHRR data derived NDVI and LST studied and analyzed for the inter-year and infra-year vegetation index and soil moisture in different regions over Korean Peninsula during period 1993-2000. Mean NDVI value for 1993 is higher than that of NDVI for 1997 by 0.2, while LST value for 1993 is lower than that of 1997 by 10º K. the results showed a very strong correlation between NDVI, LST and Climate variables, particularly, during critical period of crop growth.

The diurnal cycle of rainfall during Asian summer monsoon using TRMM observations

Mr. H. Narendra Singh
C & H Division, Indian Institute of Tropical Meteorology
Pune, India

Supervisor
Dr. C.M. Kishtawal, ASD/MOG
SAC, Ahmedabad, India

In present study, the rainfall observations from TRMM Microwave Instruments (TMI) for understanding the diurnal variation of rainfall during Asian Summer Monsoon are used. Due to its unique orbital characteristics, TRMM satellite can provide valuable information about the diurnal variation of rainfall over the global tropics. Our analysis for the July, 1999 indicates that the mean diurnal variation of precipitation over land shows a bimodal maxima; one in the morning hour (~0600 LT) and the other in the afternoon hour (~1800LT) against the unimodal maximum in the case of oceanic regime at around 1000LT as sampled by TRMM. By region, a coastal area where the ITCZ intersects the large continents and the maritime continent exhibits a strong diurnal variation due to the low level convergence between the land breeze and large scale wind system. The rainfall during morning hours is significantly higher over the Tropical Ocean in general and ITCZ than that during evening hours. The mean diurnal variation variation of convective precipitation over oceanic region for 2º * 2º lat-long grid for 2 hourly local time interval during the Asian Summer Monsoon contribute approximately 50% of the total mean precipitation. Observations show that the more intense the oceanic convection, the larger the diurnal variation of convection. Weak oceanic convection shows little diurnal variation.

A study of sea surface temperatures and sea surface winds over the Indian seas during monsoon using TRMM microwave imager and IRS-P4 MSMR

Lt. Cdr. V Senthil Kumar
Command Met. Office
Mumbai, India

Supervisor
Dr. M.S Narayanan, MOG
SAC, Ahmedabad, India

One of the objectives of Indian Climate Research Programme (ICRP) is better understanding of the physical processes responsible for the variability of oceanic parameters, specially over Indian seas (Arabian Sea, Bay of Bengal and equatorial Indian Ocean). The Indian seas remain predominantly cloudy during the Southwest Monsoon season. The microwave observations of sea surface temperatures and sea surface winds by the radiometers onboard TRMM and IRS P4 Satellites provide useful data for Oceanic and atmospheric applications irrespective of the cloud cover. In the present study on attempts has been made to study/analyse the large scale features of sea surface temperatures and sea surface winds during July 1999 using data from the above mentioned two platforms. The zonal and temporal variations of the two parameters are also studies/analyzed. Beside this, a comparative statistical analysis has been made to bring out the IRS-P4 MSMR accuracies and its potential utility for studying the physical processes over Indian Seas, for e.g. the occurrence of warm pool over Southeast Arabian Sea.

A comparative study of sea state estimated by satellite data and conventional feet forecast over Arabian sea

Lt. Cdr. D Vijayakumar
Oceanographic Forecasting Cell (OFC),
Naval Base
Kochi, India

Supervisor
Dr. Abhijit Sarkar, MOG
SAC, Ahmedabad, India

Knowledge of the ocean winds, waves and the resulting sea state is very important for operational deployment of ships at sea as well as for planning, design and execution of deep water/off-shore projects. For the ships and other platforms at sea, the operational sea state forecast (wind and wave height) is issued twice a day with a validity period of 12 hours. These forecasts are primarily based on sparse in-situ observations and empirical methods. With the advent of satellites, using the advanced remote sensing techniques, satellite sensors like radar altimeter onboard TOPEX/ Poseidon Scatterometer/SAR onboard ERS or Quicksat and Radiometers (MSMR) onboard Oceansat-1 (IRS-P4) are now capable of providing the crucial wind/wave height data with a very high spatial coverage and temporal resolutions. Thus, it is now feasible to exploit the voluminous satellite derived data over an otherwise data sparse oceanic region for assimilation in day-to-day operational sea state forecasting methods. This work aims at the validation and assessment of satellite derived sea state (wind and wave height) by comparing them with the available in-situ measurements/ fleet forecast.

The study would be further extended to develop an assimilation technique for generating an integrated sea state forecast scheme blending all the synoptic, in-situ as well as the satellite derived data sets.

Rainfall estimation over Indian region derived from DMSP-SSM/I and IRS P-4 MSMR

Mr. Eddy Hermawan
Atmospheric Research Division of LAPAN Bandung
Bandung, Indonesia

Supervisor
Dr. A.K. Varma, MOG
SAC, Ahmedabad, India

Rainfall one of the most important processes in the hydrological cycle, but also one of the most difficult in monitor. Since last couple of decades, researchers have attempted to derive techniques for the estimation of rainfall from visible/ infrared and microwave observations. In this project, an application of passive microwave technique in estimating rain-rate over Indian region (0º - 30º N and 40º E- 100º E) period September 1-30, 1999 is presented. Pentad and monthly rain-rate over study area has been derived from DMSP (Defence Metetorological Satellite Program) SSM/I (Special Sensor Microwave/Imager) (F13 and F14) and IRS (Indian Remote Sensing) Satellite P-4 MSMR (Multichannel Scanning Microwave Radiometer). The MSMR monthly rain-rates are reasonably well matched, both qualitatively and quantitatively, with SMM/I derived rain rates. All major rain events as presented by INSAT images of the same period are nicely picked up by MSMR and SSM/I F13 & F14.

SST monitoring in EL NINO region from satellite and Linkage with rainfall over Indonesia

Mr. Hartoyo A. S.
Meteorological and Geophysical Agency
Jakarta, Indonesia

Supervisor
Dr. V.K. Agarwal, ASD/MOG
SAC, Ahmedabad, India

Every year, extreme climatic problems occur around the globe, with droughts in some places and floods in others. Recently, we have come to recognize that some of these widely dispersed climatic extremes might have a common origin in the periodic warning of the sea surface water in central and eastern equatorial Pacific Ocean. In some years, El Nino Lingers, and seems to be connected with droughts in Australia, Indonesia, Brazil or India. Reduced incidence of tropical hurricanes on the east coast of the USA, and floods in Peru. This report attempts to analyze incidences of El Nino and la Nina as observe by satellite image and seek thus influence over weather activities over Indonesia. The data used is MSMR Oceansat-I. The data analysis methods develop have good sensitivity to study small changes. However, during this period no event of significance was observers over Pacific.

Snow cover monitoring over Western Himalayas

Mr. Reza Ghaemi
Meteorological Organisation of Iran (IRIMO)
Tehran, Iran

Supervisor
Dr. A.V. Kulkarni, MWRG/RESA
SAC, Ahmedabad, India

Lack of water in the next decades will be the most important issue of many countries in different aspect. Therefore investigation on the water resources has the major role in water supply. Snow is the reservoir of the most fresh water of earth. Most of the snow-covered areas are difficult to assess and having insitu measurement for the whole area is not possible. Satellites are the best to furnish us with these data. In this regard we used the satellite IRS-WiFS data to monitor the snow area over the western Himalayas, to find out the trends of accumulation and ablation from December 1999 to May 2000 and in each month of the Year, which altitude zone contribute water into run off. For this purpose snow deflection in four altitude zone from 1500-5100 M were studied. This study shows that the accumulations are taking place in late winter and the ablation in early summer mostly in the 2700 to 3900 altitude zone with a change of 65%. In the altitude zone of 3900 to 5100 the range of changes 55%. In the altitude zone of > 5100 the changes are very few through out the year, with a change of 10%. The altitude zone of 1500 to 2700 is only cover by snow by maximum 13% in late winter. This study has shown that in early months of winter, i.e. in December snow cover has depleted. This is possibly due to higher temperature (anomaly) during this period. In February and March snow cover was increased and then it started to decrease in late March. Reduction of snow cover in December is usual and mostly contributed from altitude ranges of Himalayas snow-melt runoff contributed mostly from this altitude range in the month of December. In addition, from March to April, most of the runoff is contributed from 2700-3900m.

Study of MSMR brightness temperature data over India and Kazakhstan and its potential for large area soil moisture estimation

Ms. Amankulova Svetlana
RSO, "Kazhydromet
Kazakhstan

Supervisor
Mr. B.M. Rao, ASD/MOG
SAC, Ahmedabad, India

Soil moisture is a very important land-surface variable. Estimation of soil moisture over large areas is useful in meteorology, hydrology and agriculture. Satellite microwave sensors have all-weather capabilities, can provide rapid and repetitive observations over the whole globe, can provide temporal and spatial observations of surface Soil Moisture over large areas and it can observe Soil Moisture conditions under moderate levels of vegetation cover. In this study Brightness Temperature data obtained from Multichannel Scanning Microwave Radiometer (MSMR) aboard IRS-P4 have been used. Global MSMR data of

Brightness Temperature at 6 and 10 GHz were analyzed over India and Kazakhstan during July and August 1999. Potential of MSMR data for possible estimation of Soil Moisture over these large areas is demonstrated. Weekly Brightness Temperature data over India and Kazakhstan have shown spatial and temporal variations in Soil Moisture. Time series Brightness Temperature data plots have shown changes of Brightness Temperature response to rainfall both for India and Kazakhstan.

Verification of different model forecasts over Kazakhstan with analysis and satellite data

Mr. Kalelova Anargul
RSO Kazhydromet
Kazakhstan

Supervisor
Mr. P.K. Thapliyal, ASD/MOG
SAC, Ahmedabad, India

Kazakhstan is located in the center of Eurasian continent and its climate is marked by four seasons. Medium Range Forecast (MRF) of the weather is a very crucial for predicting sudden changes like snowfall, drop in temperature etc., which affect agricultural production severly during bloom crop and growth period. MRFs are provided by Numerical Weather Prediction (NWP) models at different centers like National Center for Medium Weather Forecasting (NCMRWF, India) and national Center for Environmental Prediction (NCEP, USA). In the present study an attempt has been made to validate the weather forecasts produced by NCMRWF and NCEP models over Kazakhstan region during the period 11-17 February 2001 with analysed fields and satellite images. The following important parameters like precipitation, wind field, geopotential height and surface pressure were analysed. The forecast charts for 24, 48, 72, 96, 120 hours from both the models for 850, 700 and 500 mb levels were compared and verified with respective analysed charts. A few cases were studied for comparing different time-scale forecasts viz. 4 and 3 cases for 48 and 72 hours respectively. Besides this, a particular case study of a frontal system (Western Disturbance) over Kazakhstan, which initially formed as a deformation zone over Persian Gulf neighbourhood is presented. The analysis revealed that the forecast fields of geopotential heights at 850, 700 & 500mb from NCEP and 700mb winds from NCMRWF were in agreement mostly. In the analysis of the case study it was found that the NCEP forecasts for msl pressure and geopotential heights at 500mb could simulate the development, intensification and movement of the frontal system.

Qualitative rainfall estimation using VIRS and TMI observation using artificial neural network (ANN) approach

Ms. K Mahbuba
The State Enterprise of The Hydrometeorology
Bishkek, Kyrgyz Republic

Supervisor
Dr. C.M. Kishtawal, ASD/MOG
SAC, Ahmedabad, India

In this project, study has been carried out at assess the feasibility of using Visible/IR observations for estimation of qualitative rainfall index on instantaneous time scales. For this study we used the data form Tropical Rainfall Measuring Mission (TRMM), which provide multispectral (Vis+IR) observations of clouds along with instantaneous rainfall rates based an microwave observations. For developing a qualitative rainfall estimation tool based on visible and IR data alone, we used a number of cloud features seen in Visible/IR images and used them in the input layer of an artificial Neural Network (ANN), which was trained to provide qualitative rain index as output. We used rainfall rates from TRMM Microwave instruments (TMI) to train the network. The accuracy of the trained Network was estimated to be 74% for a large verification data set.

Climatology of Mongolia using NCEP/NCAR data

Ms. T Chantsaldulam
Aeronautical Meteorological Center
Ulaanbaatar, Mongolia

Supervisor
Dr. M.S. Narayanan, MOG
SAC, Ahmedabad, India

The underlying cause of climate variation is heat exchange, whose intensity is largely determined by geographical latitude, altitude and distance from ocean. Mongolia is a land locked country that is situated in the interior of Asian continent. Variabilities of temperature, humidity and wind over the whole Mongolia and the four natural zones in Mongolia from daily to annual time scales, in surface and at three vertical levels (in our case 850 mb, 500mb, 200mb) were examined using ten years (1982-1991) monthly some daily NCEP/NCAR reanalysis data. Comparisons of NCEP climatology with available conventional climatology have been carried out. Also, a few samples of NCEP profiles for selected days were compared with TOVS operational products of NOAA. NCEP/NCAR reanalysis outputs were available in four classes that are dependent on the relative influence of observational data and the model on the gridded variable. In this study, the parameters used were of type "A" (e.g. upper air temperature, and winds) and type "B" (e.g., humidity and surface temperature) which indicates that the analysis variable is strongly influenced by observed data and less dependent on the model. It was found out that NCEP data could be used for climatological studies as well as on the daily basis over Mongolia.

Retrieval of temperature and humidity profiles from NOAA/TOVS satellite data and its comparison with radiosonde and NCEP data

Ms. Tsatsral Batmunkh
Institute of meteorology & Hydrology,
Khudaldaanii Gudamj 5
Ulaanbaatar, Mongolia

Supervisor
Mr. B Simon, ASD/MOG
SAC, Ahmedabad, India

Retrieval of temperature and humidity profiles are very important for synoptic forecasting and Numerical Weather Prediction. There are several methods to retrieve both the parameters from satellite data. In this study, we have used the ITPP-5.01 software (international TOVS Processing Package) developed by the University of Wisconsin, USA. We have analyzed NOAA/TOVS TIP (TIROS Information Proccessor) data downloaded at Space Application Centre (SAC) From July 29-31, 1998 and compared it conincident radiosonde data. Similarly, TOVS data for January 8-12, 2001 were processed and compared with NCEP data. These data were analyzed particularly over Indian region. We have compared the retrieval processes using four different options of ITPP-5.01 software. We have found that the "Reg_tigr" option gives more accurate and stable soundings profile. By a statistical analysis, we found that RMS error is of the order of 1.53º Kat 850mb for data from July 29-31, 1998 over Indian region. While for specific humidity profiles we have found 0.006-0.021 kg/kg (6-21 g/kg) retrieved from NOAA/TOVS data. Comparison temperature & dew point temperature retrieval of TOVS & radiosonde data.

Study of western disturbances using satellite data

Mr. Keshav Das Shrestha
Department of Hydrology & Meteorology
Kathmandu, Nepal

Supervisor
Dr. M Mohan, ASD/MOG
SAC, Ahmedabad, India

Western disturbances are the extra tropical weather phenomena which move from west to east across Iran, Afghanistan, North Pakistan, Northwest India and the adjoining regions during the winter months (November to March). This project report presents the results of Pilot study carried out on the western disturbances that occurred during November 28th and METEOSAT satellite data and the NCMRWF and NCEP analyses and medium range forecasts. The study is based on the analysis of the physical features, areal extent, intensities of cloudiness and rainfall associated with the western disturbances using the visible, short wave and thermal infrared satellite data. The spatial distribution of different parameters such as surface temperature, surface precipitation, geopotential heights at 500 hPa, total column precipitable water, Outgoing Long wave Radiation (OLR), ant the eastward propagation of the cloud masses western disturbances of the two cases have been examined in detail using

the image sequences. A comparison has been made between the NCMRWF predicted positions and the actual positions of the western disturbances as revealed by the analyses fields and the satellite images. The possibility of using NCMRWF forecasts for the prediction of the arrival of western disturbance over Nepal has been explored. Using the 2EINSAT CCD data (VIS and SWIR) the ice top of the tall thick clouds were identified and their correspondence with surface rainfall obtained from NCEP analysis have been compared.

Verification of extended range model outputs with Oceansat 1 Data

Mr. Ramendra Kumar Jha
Central Department of Hydrology & Meteorology,
Tribhuvan University
Kathmandu, Nepal

Supervisor
Dr. Pradip K. Pal, MOG
SAC, Ahmedabad, India

For the proper planning of agricultural and water management activities in the country like Nepal, extended range forecasts of fortnightly and monthly averages are of much use. In the present study, Extended Range Monsoon Prediction (ERMP) model outputs for first fortnight of August 2000 are compared for verification with MSMR finished products averaged during the same period over Summer Monsoon region. ERMP model forecast of average wind speed and total water vapor with MSMR derived average sea surface wind and total water vapor for August first fortnight, 2000 are in good agreement with comparatively higher RMSE for wind speed. Out of these twp parameters, wind speed from model seems to be slightly underestimated but total water vapor is very well simulated having excellent correlation with the observed from MSMR. ERMP average wind speed in different regions, viz., Bay of Bengal, Arabian Sea, and Indian Ocean, is showing high RMSE and low correlation with MSMR wind, whereas total water vapor is having low RMSE and high correlation.

Movement of tropical cyclones near Philippines using GMS water vapor imagery

Mr. Jorie J Loiz
PAGASA Weather Bureau
Quezon City, Philippines

Supervisor
Dr. P.C. Joshi, ASD/MOG
SAC, Ahmedabad, India

The essentiality of accurate track prediction is extremely crucial since the Philippines is located in a region which is recognized as having the greatest frequency of tropical cyclones in the world. Large number of subjective and objective techniques are employed in track prediction which in many cases produces different forecast and highly divergent tracks. This report attempts to use the water vapor imagery to study the tropical cyclone motion near Philippines particularly Typhoon Bebinca nad Xangsane, Three-hourly water vapor GMS data from October 23-November 5, 2000 are analyzed. NCEP/ NCAR reanalysis charts of wind

vectors and geopotential height in layer 850, 700, 500 and 200 hPa was incorporated in the analysis for the identification of approaching systems like troughs, ridges etc. A brief history of GMS satellites and the special features of water vapor imagery in relation to IR/VIS imagery are also described. The usefulness of water vapor imagery in depicting the influences of synoptic systems altering the course of the typhoon was clearly shown. Results reveal that for Typhoon Xangsane, the moisture envelope build-up northeastward depicts the possible recurvature of the typhoon one day before that actual recurvature. The water vapor imagery also shows the approaching dark band which influences the track of Bebinca days ahead before the actual interaction and westward turn. Analysis of cyclone motion using water vapor imagery can be an effective and useful tool in predicting tropical cyclone motion.

Humidity profiles over the arabian sea and the Bay of Bengal using MSMR total precipitable water

Mr. Wilfredo H Tuazon
PAGASA Weather Bureau
Quezon City, Philippines

Supervisor
Dr. Sujit K Basu, MOG
SAC, Ahmedabad, India

The method of empirical orthogonal function has been applied for analyzing large numbers of radiosonde observed vertical humidity profiles in the Arabian Sea and Bay of Bengal. It has been found that the dominant variability in the vertical is governed by positive correlations between all layers. Based on this analysis mathematical relations were established for deriving vertical humidity profiles in the Arabian Sea and Bay of Bengal from observations of total precipitable water by the passive microwave radiometer MSMR onboard the Indian satellite Oceansat 1. The derived profiles compare reasonably well with collected radiosonde observations in the Bay of Bengal. Humidity profiles were derived over the Arabian Sea and Bay of Bengal using MSMR observations in monsoon as well as non-monsoon months and contours showing two-day average humidity at four vertical levels were produced.

Identification of the oceanic features using NOAA/AVHRR data

Mr. Malavige Don Dayananda
Dept. of Meteorology, Bauddhaloka Mawatha
Colombo, Sri Lanka

Supervisor
Dr. M.M. Ali, MOG
SAC, Ahmedabad, India

The weather over Sri Lanka is mainly depend on wind pattern and weather systems which develop over the surrounding sea area. Besides that oceanic features like eddies, oceanic circulation, upwelling/ downwelling, fronts and wedge of cold water effect

Sri Lanka weather, but this relationship is not Yet Studied. Department of Meteorology in Sri Lanka is having ground satellite receiving facility and process HRPT. Level 1B data has been stored on CDROM. But because of lack of expertise in the department those, data are not fully utilized. The main idea behind this project is to familiarize with handing of NOAA-AVHRR data. In March 1997, two days NOAA level 1B data were used to create the SST image over north of Indian Ocean. Oceanic eddy, warm waters and cold water tongs were identified and eddy was observed to move in south-east direction with a speed of 1.8km/hour. Weekly average finished products of SST from NOAA data for the year 1999 were also analyzed. Equatorial region SST gradually increased from January to May and highest SST over this area occurred in May. By the end of May, monsoon starts and the temperature cools down. Both Bay of Bengal and Arabian Sea (above equator) SST distribution show annual bi-modal maxima.

Humidity and temperature profile from NOAA/TOVS package and the comparison with NCEP and METEOSAT data

Mr. Anapashsha Rajabova
Department of Aviation
Uzbekistan

Supervisor
Mr. P.K. Thapliyal, MOG
SAC, Ahmedabad, India

Synoptic forecasting and Numerical Weather Prediction play an important role in planning day to day activities, aviation, agricultural, sports planning etc. For better predictions of weather we require accurate information about prevailing weather conditions in the atmosphere. Upper air observations of temperature, humidity, pressure wind etc. are very important parameters in the forecasting of weather phenomenon. Ground measurements of these parameters are very spares due to the cost/manpower involved in the launching of Radiosonde. Satellite data plays an important role in providing these informations at regular interval over whole globe. TIROS Operational Vertical Sounder (TOVS) onboard NOAA series of satellite gives information about vertical profile of atmospheric parameters such as temperature and humidity profiles . In this pilot project ITTP5.01 package developed by Wisconsin University, USA, is used to process the TOVS-TIP data, recorded at Ahmedabad Earth station (AES) and hence to retrieve the vertical profiles of atmospheric parameters temperature, humidity, etc. these retrievals are compared with the NCEP analyzed products. Meteosat/Insat satellite imagery of Water Vapor, infrared are used to identify and compare the regions of high cloudiness/ water vapor.

Satellite cloud top temperature method for cyclone track prediction over Vietnam

Ms. Nguyen Thi Hoai Thu
Satellite Group, NCHMF
Hydro-Met. Services of Vietnam
Hanoi, Vietnam

Supervisor
Dr. B.S. Gohil, MOG
SAC, Ahmedabad, India

GMS visible and infrared imageries of two cyclones in the Vietnam region: Saomai (05-11 Sep), Xangsane (26 Oct-1 Nov), 2000 were analyzed with a view to improve the cyclone track prediction. It was observed that the rotation in the major structural cloud features as seen from the cloud top temperatures maps associated with these cyclones in the region is followed with a change in direction of their movement. This method is seen to be particularly effective when the cyclone is severe and when the major cloud features persist for a reasonably longer time. Even though it has limitations but this method can be used as an aid to the tropical cyclone track forecasting in major turning cases. The result of forecast should be better if combine this method with others methods.

Rainfall features of Bay of Bengal cyclones observed by satellite data and their comparison with surface observations

Ms. Farah Deeba
Main Meteorological Office
Chittagong, Bangladesh

Supervisor
Dr. C.M. Kishtawal, MOG
SAC, Ahmedabad, India

In the present study from TRMM Microwave instruments TMI and PR for understanding the vertical rain rate features and the comparison of rain from satellite and ground over Bay of Bengal during May 1998, October 1999 and 2000. due to its orbital characteristics, TRMM can provide better information about the evolution of tropical cyclones. This paper focuses on the observational aspects of the vertical rain and the comparison of rainfall events during cyclone. The TRMM TMI 2A12 and PR 2A25 geophysical parameters along with the surface observations have been used for the study. TMI 2A12 algorithm shows a relatively better performance with respect to the surface observations. PR 2A12 algorithm also used to study the vertical profile of rainfall, which gives better results about the rain features during cyclone intensifications. Over ocean TMI and PR algorithm gives better correlation of 0.70 and bias of 0.71, but the point measurements of TRMM with Rain gauge does not perform well as they show no correlation. Areal comparison shows better results for estimation of rainfall. Regarding with TRMM where only a limited number of observations were available during cyclone, the analysis indicates that the spatial probability of rainfall, as well as the fractional coverage by TRMM are the important factor to be considered while comparing the features of rainfall. The consistent bias between these two sensors without clear guidance from the ground-based data reinforces the need for better understanding of the physical assumptions going into these retrievals.

Re-estimation of surface winds in the neighbourhood of cyclones in the Bay of Bengal using TOPEX/POSEIDON Altimeter data

Mr. Shaikh Shahjahan Alam
Bangladesh Meteorological Dept.
Dhaka, Bangladesh

Supervisor
Dr. Abhijit Sarkar, MOG
SAC, Ahmedabad, India

This study addresses the problem of estimation of surface wind speed from space borne altimeter. An algorithm developed earlier for Geosat has been suitably modified for Topes/Poseidon and has been applied to some cases of cyclones in the Bay of Bengal during 1999 and 2000. Though the satellite passes in this cases were in the periphery of the systems, the winds estimated in this study are found to be more realistic. The re-estimated winds were found to be well correlated to the significant wave height values measured by Topex/Poseidon. Because of lack of proper space/time collocation, the re-estimated winds for the case here could not be compared with buoy data. There is a potential to extend the study to large data set and validate them with insitu data.

Use of vegetation index and thermal channels for assessing soil moisture availability

Mr. Chol Yong Kim
Institute of Remote Sensing and Geoinformatics (ISRG),
Academy of Sciences
Pyongyang, DPR Korea

Supervisor
Dr. B.K. Bhattacharya, CMD/ASD
SAC, Ahmedabad, India

Soil moisture availability is one of the most important variables to assess the crop conditions and crop monitoring. The spatial mapping of this parameter is highly required for regional applications of crop simulation models, different climate prediction and forecasting models. An attempt has been made to generate soil moisture availability map over Central-North-Western India (20-25º N, 72-78º E) using NOAA AVHRR (PAL) 8 km 10 day composite datasets of normalized difference vegetation index (NDVI), channel 4 and 5 brightness temperatures during May to October, 1997-2000. A total of 72 subscenes for each of three products were analyzed for the study. A simple approach using Temperature-Vegetation Dryness Index (TVDI) based on parameterization of the triangular relationship between surface temperature (Ts) and vegetation index (NDVI) was applied. This index was also tested elsewhere to characterize extent of land (soil-vegetation cover complex) dryness. Soil moisture availability map was generated from TVDI map using 100% availability conditions at maximum TVDI (=0.0) and zero availability at minimum TVDI (=1.0). The seasonal changes in 10-day composite soil moisture availability were compared with the 10-day cumulative measured rainfall for the corresponding period at 4 rain gauges within the study area. The result indicated that the effect of rainfall was evident at low soil moisture availability conditions than at near saturation conditions.

Temporal and spatial variation of aerosol optical depth over Indian ocean using satellite data

Mr. Song Min Chae
Oesong-dong Central District
Pyongyang, DPR Korea

Supervisor
Dr. M. Mohan, MSCED
SAC, Ahmedabad, India

Aerosols play an important role in the radiation budget of the atmosphere. A number of attempts have been made in the recent years to assess the impact of aerosols on the earth's weather and climate with the help of numerical prediction models. Even thought eh direct and indirect radiative forcing by aerosols in the atmospheric dynamics widely recognized one still does not have definite, quantitative assessment of their influence on the weather climate of the Earth. This is mainly due to the lack of realistic information on the aerosol parameters on global scales at frequent intervals. Satellites, with their capability for large area coverage and frequent receptivity are the most ideal means for acquiring aerosols

information on local, regional and global scale.The atmospheric correction bands of ocean colour sensors like IRS P3 MOS-B, IRS P4 OCM, IRS P3 MOS-A, Sea WiFS, MODIS etc can detect atmospheric aerosols over synoptic areas with high receptivity.In this study, the algorithm developed at SAC was used to detect marine aerosol optical depth (AOD) from OCM data over a selected area in the Arabian sea of Gujarat coast of India for the month of January for 3 years: 2000, 2001 and 2002. The aerosol variability within each of these months as well as the variability from one year to the next was studies. Comparison between OCM derived AOD and the NOAA operational AOD were carried out to get the relation between them. The relationship between AOD distribution and the NCEP reanalysis wind fields at different atmospheric altitudes are also investigated.

Assimilation of Quickscat data into a Mesoscale modeling system

Lt. Cdr. G Rambabu
Met Office, INS Garuda, Naval Air Station
Kochi, India

Supervisor
Dr. P.K. Pal, MOG, SAC
SAC, Ahmedabad, India

MM5 is known as fifth generation NCAR/Penn State Mesoscale model (MM5), which is the non-hydrostatic version of the model. Using the data of QuickSCAT, an impact study is performed with the MM% modeling system. QuickSCAT derived winds have been used to diagnose the motion of the cyclone that formed over Bay of Bengal during the year 2001. For a cyclonic situation, data of few ships of opportunity and of some coastal or island stations are only available. For the assimilation of observed data into MM5, a few passes of QuickSCAT at different times are available. These additional data strengthen the initial data the initial field with the inclusion of scatterometer data was nearer to the actual situation. In the prediction experiment, it was also shown that the inclusion of satellite data improved the prediction up to 48 hrs. However, more number of cases need to be analysed to assess the bias and other forecast skill scores of wind, temperature and rainfall fields compared to observations and MM5 control run.

Cloud radiative forcing over the Indian region during 1987 EL NINO event

Mr. S.D. Patil
Indian Institute of Tropical Meteorology, C & H Division
Pune, India

Supervisor
Dr. V. Sathiyamoorthy, ASD/MOG
SAC, Ahmedabad, India

Cloud radiative forcing is a good tool to diagnose the role of clouds on climate. It is well known that the cooling and the warming effects of the clouds nearly cancel each other in the deep convective regions of the tropics. But in the Indian monsoon region during June to September, this balance is found to be invalid, due to the presence of unusually large amount of high clouds with high optical depth. Earlier studies demonstrated that the EI Nino events affect the cloud radiative forcing in the Pacific Ocean by modifying the cloud physical

properties. In this work, an attempt has been made to study the spatiotemporal variability of cloud radiative forcing in the Indian region during the drought monsoon year 1987 in the present work, satellite measured cloud radiative forcing from Earth Radiation Budget Experiment and cloud data from International Satellite Cloud Climatology Project have been used. Large scale reduction in the magnitude of SWCRF, LWCRF and NCRF are found in 1987 over the Arabian Sea and the high cloud amount, total cloud optical depth and cloud top height in the regions where the magnitude of the cloud radiative forcing is less. It is likely that weak upward motion / subsidence might have reduced the magnitude of cloud radiative forcing by modifying the cloud physical properties and the cloud growth/information.

MODIS atmospheric data validation and application for MESO-scale processes studies

Lt. Cdr. SMU Athar
School of Naval Oceanography and Meteorology
Kerala, India

Supervisor
Dr. Baby Simon, MOG
SAC, Ahmedabad, India

The atmospheric profile product data from recently launched MODIS sensor on board Terra and Aqua Satellites was used to study the meso scale processes embedded in the large scale atmospheric systems, in the South East Arabian Sea. This satellite data was processed for validation of Temperature and Humidity profiles with concurrent ARMEX Radiosonde data. It was found that the RMS error of Temperature below 500hPa was in the range 1-2.5º K which is very encouraging considering the level 2 product grid is of 5 KM resolution. In the case of Dew Point Temperature the RMS error upto 780 hPa was in the range of 1.5-3.5º K. the results obtained for specific humidity profiles were most encouraging as the RMS error was less than 2g/ kg even in the lower levels. These have wide implications for meso scale models as the level 1 data is available at a grid of 1 km. Similarly the comparisons of stability index (Total totals index) showed encouraging results. The maps of various parameters and stability indices were able to reveal the convective regions in the South East Arabian Sea. The MODIS data can give an insight into the thermodynamic structure of the meso scale systems, something which was not possible with the earlier satellite data.

Study of IRS-P4 MSMR brightness temperature data over Iran and its potential for drought monitoring through soil moisture estimation

Mr. Mohsen Araghizadeh
Kerman Meteorological office
Iran

Supervisor
Dr. B.M. Rao, MOG
SAC, Ahmedabad, India

Soil moisture is one of the parameter that helps to study the drought. Soil moisture at different temporal and spatial scales is very important for various applications. At smaller scales it has importance in the Agro-meteorological application, whereas at large scales it is

an important boundary parameter in the numerical prediction models of atmosphere for monthly to seasonal time-scale integrations. Monitoring soil moisture changes by remote means requires timely and repetitive sensor coverage. Microwave sensors have weather capabilities. Also it can observe soil moisture conditions under moderate levels of vegetation cover. The ability of microwave sensors to detect soil moisture is based upon the difference in dielectric constant of dry soil (less than 2.5) and of water (higher than 80). This contrast causes variations in soil's emissivity from about 0.95 when dry to less than 0.6 when wet. In this study brightness temperature data obtained from MSMR aboard IRS-P4 that was launched in 1999 have been used. MSMR has four frequencies at 6, 10, 18 and 21 GHz in both horizontal and vertical polarizations. Global MSMR data of brightness temperature at 6 and 10 GHz were analyzed over Iran during June 1999 to December 2000. Potential of MSMR data for possible estimation of soil moisture over this large area is demonstrated. Monthly average brightness temperature data at 6 GHz horizontal polarization over Iran shows spatial and temporal variabilities in soil moisture (drought). Time series of brightness temperature data and rainfall plots shows changes of brightness temperature in response to rainfall.

Exploration of linkage between the Kazakhstan climate and the polar sea ice

Ms. Farida Muratova
RSO Kazhydromet
Almaty, Republic of Kazakhstan

Supervisor
Dr. N.K. Vyas, MOG
SAC, Ahmedabad, India

The cold waves coming from the Artic do affect the north and central Asian climate. The aim of the present study is to investigate any correlation/teleconnection existing between the Artic sea ice and the Kazakhstan climate. We also investigate any lead lag relationship between the anomaly of sea ice extent in the European and Asian part of the Artic and the anomaly of the monthly mean temperatures and precipitation in Kazakhstan. The lead lag relation has been studies for a time difference upto 12 months in step of one month. The most important aspect of this study is the exploration of linkage between sea ice extent and Kazakhstan climate. It has been analyzed using cross correlation coefficient of temperatures anomaly and precipitation anomaly in Kazakhstan with the sea ice extent anomaly in the Eurasian part of the Artic. The goodness of fit parameter R has been used as the key parameter for calculation of any possible relationship. The monthly average temperature anomaly for February for most of the stations (4 stations out of 5 considered) in Kazakhstan show a good cross correlation coefficient 60-70% with the February (previous) sea ice anomaly in the Eurasian Artic. The goodness of fit is also found in the range 42-65%. Some of the stations (e.g., Atyrau and Oskemen) show some kind of tele link between the precipitation anomaly and the sea ice extent anomaly. Atyrau precipitation for July has a cross correlation of 73.9% (goodness of fit 61%) with the sea ice extent anomaly for February in the Eurasian Artic. Similarly Oskemen precipitation anomaly in March has a cross correlation of 72.6% (goodness of fit of 54%) with the sea ice extent anomaly in February.

Internnual variability of boundary layer heat fluxes and related parameters over Caspian sea using SSM/I and AVHRR

Ms. Manzura Nassyrova
RSO Kazhydromet
Almaty, Republic of Kazakhstan

Supervisor
Mr. Randhir Singh, MOG
SAC, Ahmedabad, India

The surface air sea fluxes link oceanic and atmospheric processes, the knowledge of their variability on different space-time scales is crucial for understanding ocean-atmospheric interaction. Air-sea interaction play a pivotal role in regulation the Earth's climate and there are now urgent requirements in meteorological research for quality estimates of large scale air sea fluxes of heat, momentum and fresh water. Surface fluxes derived from satellite are becoming increasing promising. The study focuses on the remote sensing of boundary layer heat (latent and sensible) fluxes and their interannual variability over Caspian Sea. Monthly heat fluxes are estimated using stability dependent bulk formulate applied to SSM/I and AVHRR marine data over 1988-1998. Analyses focus on interannual variability of seasonal and annual mean heat fluxes. Autumn and winter season shows the maximum interannual variability. Mean annual heat fluxes show a trend towards increased heat fluxes. The remotely sensed heat fluxes are compared with NCEP reanalysis heat fluxes. The satellite derived and NCEP reanalysis heat fluxes compares well. The latent and sensible heat fluxes could be derived with an RMSE of 13 and 8 Wm^{-2} respectively. The pattern and seasonal variability of satellite derived heat fluxes are in good agreement with those of NCEP reanalysis heat fluxes during 1988.

Validation of NOAA AVHRR pathfinder SST over Malaysian waters

Mr. Santhira Seraran Singaravelu
Malaysian Meteorological service
Selangor, Malaysia

Supervisor
Mr. A.K Mathur, MOG
SAC, Ahmedabad, India

Marine influences are one of the main controllers of Malaysian weather and climate. Land sea temperature differences result in daily weather activity and long terms changes in sea surface temperature (SSTs) may influence seasonal variations in rainfall. A study of SST anomalies in relation to rainfall anomalies may provide some insight as to the degree of such influences. As a prelude, this study attempts to validate the NOAA/AVHRR pathfinder SST with insitu SST data for the years 2000 and 2001. The equal angle best pathfinder SST data provides one of the most accurate retrievals of satellite SST. Buoy oil platform and mostly ship reports, although sparse, provided a means of this validation. The RMS error of the satellite SST with respect to input SST for the year 2000 was found to be 0.88^0 C for the day pass and 0.64^0 C for the night pass. RMS error for the night pass. RMS errors

for the night passes were significantly lower than day passes. Also RMS error for spatial thresholds of 0.1 to 1 degree were found to be not large, of the order of 0.2^0 C to 0.5^0 C, and for purposes of comparison satellite and ship data separated by 1 degree can be considered to be concurrent. Future work will encompass correction on bias, if any, of Pathfinder SST data with respect to insitu data over the region, which will enable it to be used to study the influence on long term SST variations on regional rainfall.

Intra and Inter season Variation in vegetation index over Mongolia

Mr. Luvsan Bayarbaatar
Institute of Meteorology & Hydrology
Ulaanbaatar, Mongolia

Supervisor
Mr. M.R. Pandya, ARG
SAC, Ahmedabad, India

Vegetation is an important land cover influencing the energy balanced, climate, hydrology and biogeochemical cycles. Vegetation condition over the season and over the years is an indicator of ecosystem properties. Satellite remote sensing provides the opportunity to regularly monitor the vegetation condition over large areas. This report summarizes the analysis of SPOT VEGETATION sensor based data set that spans the period April 1998 to October 2002. The time series of VEGETATION normalized difference vegetation index (NDVI) data was studied for land areas of Mongolia particularly over the grasslands, broadleaf and needle leaf forests. The temperature and precipitation for the same period were also studied along with the NDVI for the station in different natural zones of Mongolia. The interannual and intra season variation in NDVI for mountain zone grassland, desert zone grassland, desert steppe zone grassland, desert zone grassland and broadleaf and needle leaf forests have also been reported. The grassland of mountain zone showed shift in peak-NDVI from August to July. The NDVI profiles for grassland of desert steppe zone and dessert zone showed significant decrease over the years. Broadleaf forest did not show much variation, while needle forest showed a drastic reduction in yearly profile. The profiles could characterize the growing period very well, specially the greening peak vegetation phase and senescene. On a decadal scale the NDVI was related to temperature as well as precipitation.

Climatic variability of mountain valley glacier: A case study of Parbati Glacier, Himachal Pradesh

Mr. Suresh Maharjan
Central Department of Hydrology and Meteorology
Kirtipur, Kathmandu, Nepal

Supervisor
Dr. Anil V. Kulkarni, MWRG
SAC, Ahmedabad, India

The Himalayas has undergone significant shrinkage in the last century in response to climatic warming. Some of this warming is part of a natural climatic cycle, although over the last 50 years or so probably about half of the warning is due to human sources (greenhouse gases). Fresh water is finite and vulnerable resource, which is essential for sustaining life and development. Glaciers are a part of natural water resources in the Himalayas, which is the largest body of ice out side the polar region. These resources support mighty perennial rivers and life of the millions of people in this region. Monitoring Himalayas Glacier is normally difficult due to the rugged mountainous terrain and inclement weather conditions in high altitude glaciated regions. Remote sensing is an excellent technique tool that can be used to assess glacial retreat. Glacier retreat was estimated using topographic map of survey of India, Landsat images of 1990 and Indian Remote Sensing satellite images of 2000. Initially glacier boundary was delineated from topographic map and digitized using ARC/INFO software. Glacier boundary of 1990 and 2000 were obtained using digital analysis technique. Panchromatic (PAN) Linear imaging self scanning (LISS) III data of year 2000 was merged with to obtain better interpretation. Glacier area cover estimated as 45.85 sq. km, 39.63 sq.km. and 38.56 sq.km in 1962, 1990 and 2000, respectively. This indicates a total loss of 7.05 sq.km from 1962 to 2000. in addition mean glacial length was reduced 6.80km. it was also obtained secular retreat from 1962-90 is 209 m/year is reduced to 113 m/year. This is possibly because glacier snout is shifted from 4135 m to 4800m from 1962 to 2000. in addition, the temperature data (1972-1992) shows that yearly average maximum and minimum temperature is in increasing trend. Mass balance is negative in year 2002. this investigation suggests the Parbati Glacier is retreating and in future it will influence availability of water in the Parbati stream.

Studying the variability of the 1990's El NINO using the derived satellite parameters

Ms. Edna t. Seachon
Pagasa central Office Blg, Agham Road
Quezon City, Philippines

Supervisor
Dr. Rashmi Sharma, MOG
SAC, Ahmedabad, India

The El Nino events in the 1990s were investigated using sea surface height (SSH) from TOPEX/POSEIDON Altimeter and sea surface temperature (SST) data from the Reynolds analyses in the East and West tropical pacific region from October 1992 to December 1999. The time series analysis of both the parameters could reveal series of warm events (positive sea level anomaly and SST anomaly) in the Pacific. The first half of 1990's was characterized by a weak and short lived warm periods while the 1997 warm event was as large or larger than the event in 1983. The sea level anomaly reached upto 20-25 cm above the normal and SST was 4^{0} C more than the normal in the east pacific. The opposite signs characterized West Pacific, but magnitudes were much weaker. The timing of the sea surface height anomaly (SSHA) and sea surface temperature anomaly (SSTA) correlates with each other. There were no phase lead/lag between the two parameters. To enhance the signal and to interpret the results objectively, Morlet wavelet transform was applied to both the time series. This analysis helped in getting the exact time frequency information of the El Nino event. A very strong positive (negative) SSHA and SSTA was brought out in the eastern (western) pacific with the periodicity of 48 months and the duration was from may 1997 to April 1998. The spatial maps of both the parameters also provide with much insight into the evolution and the extent of 1997-98 El Nino.

Rainfall from TRMM-RADAR and radiometer

Mr. Koung Won Park
Institute of satellite information science,
Pukong national University
Busan, Republic of Korea

Supervisor
Dr. R.M Gairola, MOG
SAC, Ahmedabad, India

Some of the studies carried for estimation of rainfall over land and oceanic regions in and around South Korea are presented. We use active and passive microwave measurements from TRMM TMI and Precipitation Radar (PR) respectively during a typhoon even named RUSA that took place on 30 Aug. 2002. We have followed the approach by Yao et al 2002 and examined the performance of their algorithm using two main predictor variable named as scattering Index (SI) and polarization corrected brightness temperatures (PCT) while using TMI data. The rainfall flux estimated using PCT and SI shows some under estimation as compared to the 2A25 rainfall products from the PR in common area of overlap. A larger database thus would be used in future to establish a new rate algorithm over Korean region based on the present case study.

Analysis of SSM/I derived meteorological parameters for southwest monsoon studies over Sri Lanka

Ms. Shiromani Jayawardena
Department of Meteorology
Colombo, Sri Lanka

Supervisor
Mr. P.K Thapliyal, MOG
SAC, Ahmedabad, India

Atmospheric parameters retrieved from the data of Special Sensor Microwave Imager (SSM/I) onboard DMSP satellites have been used to study the main features of the summer monsoon over and around Sri Lanka. Daily data of integrated water vapor,cloud liquid water and sea surface wind speed have been analyzed for the period of May-September of two contrasting monsoon years, 1999 (good/normal) and 2002 (poor). These data have been used to study the onset and active/break phases of the monsoon over Sri Lanka. Difference in the monthly means of these parameters during summer monsoon season have been analyzed for these two years. Further a time series analysis of these parameters over different regions in the Indian ocean and Arabian sea have been analyzed to study the intra seasonal oscillations of the summer monsoon. This is achieved by performing spectral and wavelet transform on the time series. Different modes of oscillations have been analyzed in relation to the different phases of monsoon and the relative performance of monsoons in two different years. Further the atmospheric parameters over west Sri Lanka sea have been correlated with the in-situ rainfall over few land stations to study the potential predictability of rainfall over Sri Lanka using satellite derived parameters with a lag of few days.

Study of variations in thermal structure of Indian ocean using a limited area ocean model

Mr. Boonthum Tanglumlead
Thai Meteorological Department
Bangkok, Thailand

Supervisor
Dr. V.K. Agarwal, MOG
SAC, Ahmedabad, India

The Indian Ocean underwent substantial changes in 1994-1995. Using 1-D limited area ocean model to study the thermal structure of Indian Ocean during El Nino and La Ninia years 1994-95. The observations show un-even distribution of winds over Indian continent over this period. Hence the forced mechanism on Upper Ocean will be of different. This feature is analyzed by means of temperature profile transacts at three latitudinal belt using a limited area ocean model. Results found twice yearly warming occurred over the study area i.e. during Nov-Dec-Jan and the following April-May June and were phase locked to the Indian ocean seasonal cycle. The changes of temperature profile are more closely

depends to the region as well as to the surface and sub-surface physical parameters. Moreover in the equatorial ocean they were related to a coupled interaction between the atmosphere and the ocean. Oceanic up welling in the east and down welling in the west played a major role in giving rise to the latent heat flux associated with the dipole mode structure and hence a variation in the thermal behavior of sea water. The up welling of the coast of Sumatra elevated the regional thermocline by more than 80 m in December 1995. During boreal fall winter of 1994 the southeasterly trades were displayed and abnormally prolonged in their northernmost equatorial position. This shifts the centre of the trades towards the equator, weakened the winds in the central southern ocean, reduced the latent heat flux in the region and subsequently induced a surface warming. The cross-basin upper ocean temperature sections show that the extra tropical warming was rather uniformly distributed in the upper 60m, further supporting the role of mixed layer processes in the warming.

Movement of tropical cyclone using GMS water vapour and NCEP data

Mrs. To Le Thu
Southern Regional Hydrometeorological
Centre in Ho Chi Minh City
Ho chi Minh City, Vietnam

Supervisor
Dr. P.C. Joshi, MOG
SAC, Ahmedabad, India

Vietnam is a country that experiences a number of tropical cyclones each year that cause a considerable loss of life and property. In the present study we have analyzed the environmental factors influencing the track of tropical cyclones in South China Sea One of the basic objectives of the present thesis is to assess how the satellite observations can be helpful in providing the information about the deep layer mean circulation, and hence can be helpful in cyclone track prediction. We have analyzed one tropical cyclone, named "Faith" that persisted over the South China Sea during 8-15 December 1998, and moved along a curved path particularly during the last two days before its landfall. We used the data from water vapor channel (6.7μm) of Geostationary Meteorological Satellite (GMS-5) of Japan along with the high quality wind analysis (i.e. NCEP Reanalysis) of an operational weather forecast model for this study. A continuous buildup of moisture on the fore side and a continuous drying up of the atmosphere on the left side of the location of cyclone were observed throughout the life cycle of this cyclone, suggesting the formation of trough and subsidence zones in the vicinity of the storm. Since the water vapor images represent the mid-tropospheric circulation ($\sim$ 500 hPa), we also analyzed the relationship between deep layer mean winds and circulation at 500 hPa level using the NCEP reanalysis, and observed that the circulation features derived from water vapor images provide a reasonable representation of deep layer mean circulation, and hence can be helpful in the study of the environmental influence on the motion of cyclone. This analysis indicates that the direction of 500hPa wind approximately 15 west-north-west of the cyclone location is best correlated with the direction of the movement of the cyclone 12 hours later.

Wave modelling over the south China sea

Mr. Viret Van Luong
Centre for Hydrometeorology of South Vietnam
Ho Chi Minh City, Vietnam

Supervisor
Dr. Raj Kumar, MOG
SAC, Ahmedabad, India

At present, the WAM model is used operationally in global; and regional applications to make forecasts of the sea state, which can be used for many applications such as ship routing and offshore activities, and for the validation and interpretation of satellite observations. Progress has also been made on the assimilation of satellite observations into wave models. Deviations between predicted and observed waves are normally indicators of errors in the driving wind fields so that effective wave data assimilation procedures correct both wind and wave fields. The relationship between wave-model development and satellite remote sensing is much closer than one might expect at first sight. Satellite observations (Altimeter, Scattero meter and Synthetic Aperture Radar (SAR) are being used to derive the model and also to validate the model forecast. In this pilot project, I have run WAM model for two months of year 2001, summer monsoon conditions of July and winter monsoon conditions of December. To derive the wave model for the above periods, satellite wind data of Quickscat scattero meter has been process. The comparison of hind cast model parameters has been done with Topex radar altimeter derived parameters. For the comparison, in-situ data of the Oilrig in the China Sea has also been utilized. The pilot project results show quite good agreement between model derived parameters and other data sets. This study will be extended for the whole year of 2001 for the Project with more data sets.

Validation of TRMM-Meteosat merged daily rainfall over Bangladesh

Md. Azizur Rahman
Bangladesh Meteorological Department (BMD)
Abhawa Bhavan, Agargoan,
Dhaka, Bangladesh

Supervisors
Dr. M.S. Narayanan,
Ms. Shivani Shah, MOG
SAC, Ahmedabad, India

A validation study on daily scale has been conducted over Bangladesh using the satellite derived rainfall with conventional Rain gauge observation for the monsoon seasons of 1998 to 2003. The merged daily rain product (3B42) at 1x1 grid, produced from the instantaneous rain rate from TRMM microwave imager instrument and Meteosat infrared imager has been used for this study for the monsoon months June to September. For ground truth, 34 rain gauge stations distributed over Bangladesh has been used. Comparison has been made at large spatial (over the whole domain of Bangladesh) and temporal scales (seasonal and monthly). The merged satellite products are seen to be underestimated the total rainfall of the season. The intraseasonal variations seem to be picked up by satellite satisfactorily. At this time and spatial scales the correlations range between 0.68 to 0.79 and RMSE 8.08 mm to 10.21 mm for the different years. Comparison with climatology shows that TRMM merged product underestimated rainfall between 3%-15% during the study period except 1999 where satellite overestimated by 5%. On smaller time and spatial scales, viz specific grid boxes of 1x1 size, the correlations are poorer. An attempt has also been made to study the dominant intraseasonal periodicities using the wavelet technique. The 30-50 day mode is seen to be prominent along with the other high modes.

Storm surge prediction and inundation along Bangladesh coast using satellite data and model

Mr. S.M.Quamrul Hassan
Bangladesh Meteorological Department (BMD)
Abhawa Bhavan, Agargoan
Dhaka, Bangladesh

Supervisors
Dr. Raj Kumar,
Dr. S K Basu, MOG
SAC, Ahmedabad, India

Storm surge associated with severe tropical cyclonic storm is one of the most destructive natural disasters. Due to the long continental shelf, shallow bathymetry, complex coastal geometry with lots of kinks, islands and long tidal range between east and west coasts of Bangladesh, very high and long duration surges occur in this region. In the present study, we have performed experiments using a storm surge model for the analysis area extending from 84°E to 95°E and from 16°N to the southern coast of Bangladesh. The storm surge model used in this study is based on shallow water equations and the factors affecting storm surge

prediction are the wind forcing and bathymetry. We have performed various simulation experiments with actual cyclone track data during the year 1997-2002 occurring in the Bay of Bengal area and heading towards Bangladesh coast. We have also performed numerous sensitivity experiments to study the sensitivity of the surge height and location of the peak surge to the error in predicting landfall position of the cyclone. In our experiments it has been observed that the error of up to 100 km in landfall position does not have any influence on the location of highest storm surge. In the experiments it has been observed that higher storm surge is generally at Chittagong coast. In the present storm surge model, the wind has been generated at each grid point using Rmax (radius of maximum wind) and Vmax (maximum wind speed) using standard analytical formula. We have also tried to simulate the storm surge using the winds predicted by a regional atmospheric model (MM5). Satellite altimeter data is able to provide sea surface height with a good accuracy in the open ocean and in the coastal area (up to 10 km from the coast).

Analysis of the impact of ground surface reflectance on the aerosol optical depth using Terra and Aqua MODIS and ground-truth data over Ahmedabad

Ms. Xiaoying Wang
Institute of Atmospheric Environment,
China Meteorological Administration
Shenyang, Liaoning Province, China

Supervisor
Prof. A. Jayaraman
PRL, Ahmedabad, India

Satellite retrieval of aerosol optical depth (AOD) over land remains a difficult task because of the need to separate the surface reflectance from total measured radiance. The dark target approach for MODIS data has shown excellent competence at retrieving the aerosol distribution and properties. However, this algorithm works better for surfaces of low reflectance, such as water bodies and dense vegetation. In this project, we attempt to derive AOD over Ahmedabad using the synergy of TERRA and AQUA MODIS data (SYNTAM) (Tang et al., 2005), which can be used for various ground surfaces, including high-reflective surface. Preliminary validation results by comparing with ground truth data show good accuracy. Further improvement, such as the incorporation of changes in the ratio of the morning and afternoon surface reflection values, wavelength dependence of AOD are attempted and their effects on the accuracy of the derived results are discussed.

Determination of the height of atmospheric motion vector winds using Geostationary satellite images

Mr. M. Mahakur
Forecasting Research Division
Indian Institute of Tropical Meteorology
Pune, India

Supervisor
Dr. C.M. Kistawal, ASD/MOG
SAC, Ahmedabad, India

Atmospheric Motion Vector (AMV) wind derived from geostationary satellite observations is an important parameter that is used for several operational meteorological applications viz. synoptic and numerical prediction of weather systems. Determination of correct height of the derived AMVs is still an operational challenge, and a large part of errors in AMV fields can be attributed to errors in height assignment alone due to the presence of semi-transparent and sub-pixel size cloud in the satellite field of view. In this pilot project attempt has been made to determine the height of the AMVs using imageries from Kalpana-1 satellite of India. This satellite radiometer is having visible, infrared (IR) as well as water vapor (WV) channels. Water vapor-infrared channel intercept method is employed using WV and IR observed radiances to assign the height (isobaric level) to the AMVs, derived using image triplet. Satna Barbara DISORT Atmospheric Radiative Transfer (SBDART) model is used as a tool to simulate the total upwelling radiances at the top of the atmosphere for both IR and WV channels for opaque clouds of different heights using analysed temperature and moisture profiles from NCEP during first week of November 2004. These theoretically simulated radiances were used to determine the heights of the derived AMVs. This technique is primarily tested for the METEOSAT-5 images and the results were validated using the cloud heights derived operationally by EUMETSAT. The same technique later will be applied for assigning heights to AMVs derived using Kalpana-1 satellite images.

Detection and dynamical modeling of forest fire spread

Mr. Dadang Subarna
Climate model Division,
LAPAN, Indonesia

Supervisor
Dr M.M. Kimothi, RESIPA
SAC, Ahmedabad, India

Forest fires, whether of human or natural origin, have profound effects on land cover, land use, production, local economies, global trace gas emissions, and health. Uncontrolled wildfires can have an immense impact on the human population and the environment. Forest Fire in Uttaranchal region of Northern India was detected by using IRS WiFS and MODIS satellite. Satellite data used from both satellite in April 2003 and April 2004. IRS WiFS 188 meters spatial resolution images were used to map the burnt areas after the fire season in Uttaranchal region. However, the lack of a short-wave infrared band is in certain cases a limitation for the detectability of the burnt areas. Integration of IRS-WiFS with MODIS 500 meters spatial resolution images, that has short-wave infrared bands, could improve the mapping of burned areas. We present results on the data integration of both images over the Uttaranchal region on 27th April of 2003 and 2004. The preliminary results show a good potential to improve the burned area mapping in Northern India by using IRS-WiFS higher spatial resolution in integration with the MODIS short-wave infrared bands.

Rainfall climatology over Indonesia using TRMM data

Mr. Nanang Purnadi
Meteorology and Geophysical Agency,
Statiun Meteorologi Kelas I
Cengkareng, Indonesia

Supervisor
Dr R.M.Gariola, MOG
SAC, Ahmedabad, India

The rainfall observation from TRMM image for understanding rainfall climatology over Indonesia for the years 1998 to 2004 have been studied to know characteristics of rainfall during that period. Monthly and inter-annual variations of rainfall over Indonesia have been attempted from the TRMM data over Indonesia. The prominent El Nino and La Nina impact are observed during 1997-1999 clearly from TRMM data, which lead to the forest fire over Indonesia. During El Nino rainfall over Indonesia dropped 160 mm which was less (70 mm) than average rainfall in this period and after the La Nina replaced the El Nino rainfall from June 1998 to January 1999, In 2002 rainfall less than average was similar with performance of monsoon 2002 over Indian regions and thus can be categorized as drought over Indonesia. The depression in rainfall during July 2002 has been very low (below 120 mm compare to a range of 180 to 220 mm in other years). Again similar to the good monsoon in India, 2003 shows the good rain patterns over Indonesia during the complete period. Due to large land-sea variations, the 5 representative zones were fixed for analysis the 2002, 2003 rainfall. Only west of Indonesia (box 1) has almost similar rainfall amounts in both the years. The time longitude plots for two successive monsoons are shown to represent the good and bad performance very clearly. In addition, the longer time series data of GPCP (1986-2004) also support our observations of drought and good monsoon years and makes a relatively better database to analyze the trend of rainfall over the area of study.

Analysis and verification of T-80 model temperature forecast and NCEP data over Kazakhstan region with MODIS and in situ data

Ms. Irina Kalyamova
Engineer Weather-Forecaster category 1
Hydromet Center
Astana, Republic of Kazakhstan

Supervisor
Dr. B. Simon, MOG
SAC, Ahmedabad, India

Kazakhstan is the ninth largest country in the world with 2.1million km^2 area. It territory covers a wide range of ecoclimatological zones. Reliable extended range weather forecast is very important for a large country like Kazakhstan. At present extended range weather forecast is based on climatology. Increased interest, computing power, and evidence of modest skill at fortnight to monthly time scales are all leading to a better

extended range forecasting using global models. T80 is one of such global model, which can be used for this purpose. In this study MODIS temperature field, surface observations and radiosonde observations are used to verify the model results. Only eight radiosonde stations are available which are operational at 00 GMT (i.e. 6 a.m. local time). In this aspect radiosonde profile is not enough either to validate the model or made forecast. The relative scarcity of conventional data gives an added importance to remote sensing observations particularly the temperature and humidity sounding data. Comparison between the NCEP and T80 model output especially in the temperature and wind field have been compared with model performance. Limited validation of observed temperature with MODIS and NCEP was carried out for different vegetation zones. The model results, in general, were matching with NCEP and MODIS derived temperature. However at 1000 mb the difference in temperature is maximum. This may be due to high diurnal variability at the lower level. The difference of temperature for 500 mb NCEP-MODIS: 0.4 - 0.9^0 C and NCEP-T80: 0.7 2.8^0 C. Since T80 is a course resolution model it can not capture some details of the mountain part of Kazakhstan.

Temperature and moisture profiles with radiosonde and NCEP analysis over Kazakhstan

Ms. Kussainova Marzhan
Engineer Weather-Forecaster category 2
RSO Kazhydromet
Almaty, Republic of Kazakhstan

Supervisor
Dr. R. Singh, MOG
SAC, Ahmedabad, India

In weather prediction, knowledge of vertical distribution of temperature and moisture is crucial to successful nowcasting and forecasting. The standard instrument for obtaining the vertical profiles of temperature and moisture is the balloonborne radiosonde. The temporal and spatial resolution of these radiosonde-based observations is limited. One of the most important applications of satellite measurements is atmospheric sounding that is retrieving vertical profiles of temperature and moisture. Compared to radiosonde, the satellites sounding have higher spatial and temporal resolution and hence best suited for initializing the numerical weather prediction models. However, if the satellite data are to be used in initializing the numerical weather prediction models, the quality and behavior of data must be understood. In this study level-II MODIS temperature and moisture profiles are evaluated by examining various statistics with respect to the radiosonde and NCEP analysis over Kazakhstan. Because of limited upperair stations in Kazakhstan, there is a data gap to correctly simulate the atmospheric condition. Hence the satellite sounding can be used to fill the data gap in observations during initializing the model. For this purpose the MODIS temperature and moisture profiles are compared during four seasons during year 2004. The root mean square errors for temperature and moisture are 4.3 K and 0.6 gkg^{-1}, respectively.

Estimation of global insolation at surface using METEOSAT 1.0 coverage

Ms. Natalia Kim
Meteorology and Geophysical Agency,
Ecology and Environment Protection,
Kyrgyz-Russian Slavic University
Bishkek, Kyrgyzstan

Supervisor
Dr. Bimal K. Bhattacharya, CMD/ARG/RESIPA
SAC, Ahmedabad, India

The need for radiation data for solar energy and other applications is becoming increasingly apparent. However, the availability of solar radiation is limited by sparsity of both the existing measurement network and the meteorological data required by conventional numerical models. As a consequence, during the last few decades much work has been directed toward the developing and improving methods for determining the solar irradiance at the earth's surface using satellite observations. Only the satellites can provide the global as well as regional coverage for solar radiation estimates. In this study data from visible, near infra red and water vapor channels of Meteosat-5 satellite have been used in this work for retrieving the global insolation at the surface in all-sky conditions during the period from July 1999 to June 2000. The physical retrieval scheme called Tanahashi algorithm which was developed by Japanese scientists and applied for GMS satellite data has been used with some modifications. Instantaneous, daily total, daily average, dekad average values of insolation have been obtained. These results have been compared with ground truth measurements of insolation by pyronometer and also with the insolation data from another algorithm developed by EARS (Netherlands). Further the seasonal and diurnal variations in global insolation over the Indian region have been studied. It was found that Tanahashi algorithm overestimates the clear-sky values of insolation, but in comparison with EARS method it better captures the cloudy-sky insolation variations. Comparison with ground truth data gave correlation coefficient for daily average values of insolation about 0.7-0.8, root mean square error 5-6 Wm^{-2}.

Climatology of sea surface temperature, surface winds, significant wave height and sea surface height anomaly (SSHA) using satellite and island-station data over and around Maldives islands

Mr. Yazeed Ahmed
Department of Meteorology,
Male, Maldives

Supervisors
Dr. Abhijit Sarkar,
Dr. K. Satheesan, MOG
SAC, Ahmedabad, India

Maldives, a group of 1200 islands in the Indian Ocean, with mean elevation less than 2m, is located close to the equator aligned around 73°E. The atmospheric and oceanic conditions exhibit features of equatorial Indian Ocean like equatorial Jet and

seasonally reversing winds. Since observations over the area are sparse, studying such parameters is challenging. Data from microwave sensors onboard the satellites are used to study the climatology of SST, SW, SWH and SSHA for the region enclosed by latitude 10°S to 10°N and Longitude 65° to 80°E.Data from QuikSCAT was used to study the variation of SW, TOPEX altimeter for SSHA and SWH, and TMI radiometer for SST. The climatology of these parameters, and time series were analyzed. The season over the Indian Ocean was conventionally divided in to Southwest and Northeast Monsoons. However, analysis of winds clearly shows the two monsoons as West and Northeast. The Wind Rose shows winds to be zonal in most of the months, especially in the West monsoon. Comparison with station data shows that the estimation of these parameters for this region from the satellite observations is quite good. A few representative results are shown here.

Verification of extended range forecast over Mongolia

Mr. Batbold Altangerel
Institute of Meteorology and Hydrology
Ulaanbaatar, Mongolia

Supervisor
Mr. V.Sathyamoorthy, MOG
SAC, Ahmedabad, India

The Numerical Weather Prediction models (NWPs) are useful tools to make short-term weather predictions (a few days), but they unfortunately loose all ability beyond 5 to 10 days. In other words, it is impossible to predict the day to day weather for the next month. Still there is possibility of predicting average behaviour. In the present work, extended range weather forecast from National Center for Medium Range Weather Forecast (NCMRWF, India) T-80 model forced by observed Sea Surface Temperature (SST) for July 2001, 2002 and 2003 are compared with satellite, reanalysis and radiozonde observations over Mongolian region. Temperature and humidity data from MODIS, wind data from National Center for Environmental Prediction (NCEP) reanalysis, precipitation data from NOAA NCEP Climate Prediction Center Merged Analysis of Precipitation (CMAP) and radiosonde observations from Mongolia and few Russian and Chinese stations are used for the verification study. Comparisons suggest that T-80 model simulates the general circulation of earth very well. The locations and intensity of the sub-tropical westerly jets of both Hemispheres and tropical easterly jet over Asian monsoon region are simulated well by the model when compared to the NCEP reanalysis data. Rainfall patterns simulated by the model over Mongolia are also matching well with the CMAP data. Monthly averaged temperatures simulated by model at standard levels are compared with monthly mean temperature obtained from MODIS. Model Simulates the temperature over Mongolia well.

Drought assessment using remote sensing and meteorological data

Ms. Bat-Oyun Tserenpurev
Institute of Meteorology and Hydrology
Ulaanbaatar, Mongolia

Supervisor
Dr. R.P. Singh, ARG/RESIPA
SAC, Ahmedabad, India

Drought monitoring and assessment of its impact on pasture biomass are very important in Mongolia, whose economy strongly depends on livestock production. Remote Sensing from satellite platform helps in regular monitoring of land surface conditions (drought and flood etc) over large area. The study was carried out using both optical (NDVI) and microwave (wetness index) data for a drought (2002) and non-drought (1998, 2003) years. The vegetation dynamics at different locations in Mongolia were analyzed in 2002 and 2003. Surface moisture condition, which is an important input in detecting drought, affected areas were analyzed using wetness index derived from SSM/I data for the four years (1988, 1998, 2000, 2002). Impact of drought and non-drought situation in 2002, 2003 was estimated using NPP data derived from SPOT-VEGETATION sensor. The results were validated using ground observations of pasture conditions data as well as rainfall data available from meteorological station in study area. It was observed that profile of NDVI showed distinct behavior in drought and non-drought conditions. It was found that good summer condition (high pasture biomass and rainfall) were associated with high NDVI as compared to drought condition (low pasture biomass and rainfall). A high correlation (>0.86) was found between NDVI and precipitation of June to August. The wetness Index of 1998 was found highest in most of the study sites as compared to 1988, 2000, and 2002. A high correlation (0.92 for Arvaiheer and 0.76 for Uliastai) between wetness index and precipitation of April to September was found in Mongolia. Overall study indicates that remote sensing observations along with meteorological data provide a very good tool for quantification and assessment of drought.

Large area characterization of dust aerosols from satellite remote sensing data

Ms. Sumyasuren Jamiyan
National Agency for Meteorology,
Hydrology and Environment Monitoring
Ulaanbaatar, Mongolia

Supervisor
Dr. M.B. Potdar, TSDD/ARG/RESIPA
SAC, Ahmedabad, India

Dust storm is a meteorological phenomenon common in the Gobi desert of Mongolia other arid and semiarid regions. In Mongolia, the dust storms are quite frequent from March to August; the peak activity being in May. Torres and colleagues (1998) showed that the Aerosol Index (AI) derived from Total Ozone Mapping Spectrometer (TOMS) SBU data; the radiative properties of aerosols can be derived to estimate the Single Scattering Albedo,

which is a property of the aerosol types. This is based on multispectral measurements in the UV wavelengths and the interaction between aerosols and the strong molecular scattering in the near ultraviolet produces spectral variations of the backscattered radiances that can be used to separate aerosol absorption from scattering effects using Aerosol Index. For dust storm aerosol studies EP-TOMS derived AI and UV Irradiance data encompassing the Mongolia on known dates of dust storm are used. By averaging the AI and UV Irradiance data over 15 (latitude) x 5 (longitude) degree grids, the attenuation of 380 nm UV irradiance as a function of AI is derived for different storms. This property is dependent on the dominant type of aerosols and their source regions; which is characterized by Single Scattering Albedo (SSA), a ratio of scattering cross section to total attenuation cross section. The SSA is then retrieved from the plots of the Irradiance ratio Irr324/Irr380 nm vs. Irr380 nm. It is shown that the SSA of storm dust aerosols decreases from March to May indicating that the aerosols are of more scattering type in early in the season and more absorbing type in late season.

Impact of MODIS data in Meso-scale model (MM5) to predict rainfall over Nepal

Mr. Rishi Ram Sharma
Department of Hydrology and Meteorology
Kathmandu, Nepal

Supervisor
Dr. Pradeep K. Pal, MOG
SAC, Ahmedabad, India

Weather forecasting in Nepal is challenging because of not only mountainous topography but also lack of upper air data, insufficient synoptic station and lack of modern tools and technology. In Nepal natural disaster directly coincides with extreme weather events which ultimately bring a lot of damage in life and property each year. Before adopting any Numerical Weather Prediction (NWP) model for operational weather forecasting such model should be validated to see the model behavior in different situation than the situation where model is originally developed and validated. In this study, Pennsylvania State University, NCAR MM5 mesocale model is validated to see the model performance in a complex terrain of Nepal. Overall prediction power of NWP model depends upon the accurate representation of its initial condition. National Centre or Environment Prediction (NCEP) AVN global data is used to initialize the MM5 model to predict the rainfall over Nepal. Temperature and moisture profile derived from Moderate Resolution Imaging Spectro-radiometer (MODIS) instrument of the Terra and Aqua satellites is used to initialize the model in experiment run. The MM5 model is run for two times for two different cases, control and experiment run, during active monsoon period of 2004. Ground measured point data (rain gauge data) and Tropical Rainfall Measuring Mission (TRMM) satellite derived rainfall data is also used to validate the model performance. With subjective selection of parameterisation schemes, available in the model, model generally able to predict rainfall locations for next 48 hours but its response, specially, in extreme rainfall events is poor when compared with the rain gauge data.

Oceanic thermal response to tropical cyclones around the Philippines using satellite data

Mr. Noel Sarmiento Pregonero
Weather Specialist II,
PAGASA Central office
Quezon city, Philippines

Supervisors
Dr. A.K. Mathur,
Dr. B.M. Rao, MOG
SAC, Ahmedabad, India

Tropical Cyclone track prediction skill has shown steady improvement with better numerical models and high quality observations, but intensity prediction skill falls short of expectations. Once a tropical cyclone reaches moderate intensity, the prediction of its further intensification requires observations of the ocean's thermal structure ahead of the storm. An attempt has been made to establish relationships between the TRMM TMI SST anomaly and Maximum Sustained Winds (MSW) and Minimum Central Pressure (MCP) for 10 TC formed in 2004. The average daily SST data and the JMA best track position have been used to compute SST anomaly, which provides information on the cooling wake generated during the passage of a Tropical Cyclone. However, it is seen that SST alone is not a good predictor and knowledge of vertical thermal structure is needed particularly to predict the sudden intensification of tropical cyclones. Near-real time fields of Tropical Cyclone Heat Potential (TCHP) are available over major ocean basins and have been used to investigate the potential of these data in predicting the sudden (explosive) intensification of the cyclones. It is seen that TCHP values during calm periods are around 20 kJ/cm^2, however this increases many times and reaches around 120-140 kJ/cm^2 during intensification. This provides enormous energy for tropical cyclones, which leads to its sudden intensification. Typhoon "Dianmu" (13-21 June 2004) experienced such sudden intensification within 12-hours, the TCHP values were able to provide crucial information on this. Relationships between the SST anomaly and MCP & MSW have been seen developed, the correlation of the order of 0.78 to -0.69 have been notice, however combining all data sets did not provide good correlation and are being investigated further.