

Humanism in Girish Karnad's Plays



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Abstract

People relate God nature and world in terms of power and might. God is omnipotent and omnipresent. People think that God is someone to whom one turn when one is in trouble and needs help, someone who might invoked upon to aid one in seeking revenge against enemy. People are running behind material prosperity and glamorous life. No one is worried about the needs of the poor, low and downtrodden. Girish Karnad is a man who asserts that drama is meant for the *demos* i.e. common people. In his plays, it seems, he wants to break the age-old stereotypes in order to instruct, elevate and liberate ordinary humanity. His basic concern is human spirit. He castigates blind worship and idolatry in the name of caste and creed and upholds the cause of the humble and lowly who are denied the sacred rights of man, especially women, children and oppressed. The present paper concentrates on humanistic concerns in the plays of Girish Karnad.

Introduction

*"O my unfortunate country, those whom you have debased, they shall drag you down to their own level till their shame is yours; Those whom you have deprived of their human right, who stand before you but find no room in your lap, they shall drag you down to their own level till their shame is yours."*¹

Girish Karnad is a leading and the most active playwright of the contemporary Indian stage. His ideas and notions are startlingly new. Indian drama through the centuries has been one of the means of finding out as how a human being can achieve an optimal human existence—cultural, social, political, material and spiritual. He is a fine social critic. His humanistic approach asserts itself against all religious orthodoxy. He throws light on every aspect of the society. He has vividly selected the subject matter of his plays which have the social relevance and meanings. His plays present the life of the oppressed and offer glimpses of the oppressors. He used the myths, histories and folk-stories for personal reasons. This self reflexive note is evident in *Yayati*, *Tughlaq* and *Hayavadana*. They reveal his deep humanism. Thus in his hands the plays become an instrument of his humanism, an instrument for the enlightenment of man, and a means for the expression of his love, sympathy and compassion.

*"Girish Karnad is a humanist in the sense that he has a profound concern for both men and women, especially the oppressed and downtrodden."*²

Girish Karnad as a humanist has deep insight into the present social and political issues, which are eternally relevant to mankind. He does not openly suggest any pragmatic solutions for them. No doubt his humanistic solutions are there in his plays. His humanism is tinged with a sense of loss, pain, suffering, incomprehension and helplessness. As a revolutionary humanist, he succeeds in making his voice heard. His humanistic vision is multidimensional and complex. "He has been a bitter critic in recent years of the rise of religious fundamentalism in India. He publicly condemned the destruction of the Babri Masjid in 1992. When religious fundamentalism tried to whip up communal tensions over the controversy about the Idgah Maidan in Hubli, Karnad (who hails from Dharwad) strongly opposed them. More recently, he has publicly opposed the threats made by the Sangh Parivar of stopping the Tipu Bicentennial celebration."³

Karnad has realized what life meant to the down trodden people. How they lived and suffered. What he aimed was to present the miserable condition of the poor, of the outcaste and the woman before the people of India as well as the people of the world. They suffered every kind of humiliation and suffering. Karnad's very soul revolted against the narrow religious outlook. He condemns castes and creeds which divide mankind and points out those narrow religious outlooks, which are against the oneness of mankind. All human beings are equal to the Creator. There is no untouchable in the great body of God. Karnad's sympathy can be seen towards the poor, lowly and the lost. His profound humanistic concerns are mirrored in all his plays. According to Subhash Bisaria the salient features of Karnad's humanism in his plays are as follows—

1. Deep concern for man, especially the weak and oppressed.
2. Return to the past and reinterpretation of the past mythical, historical and oral stories.
3. A determined demystification of the dominant beliefs and practices.
4. A sympathetic understanding and affirmation of this ephemeral life.
5. Contemporary social relevance.⁴

He wrote *Yayati* as an escape from his stressful situation, when he was going to England for higher study. *Tughlaq*, also reflects a fear of failure that Karnad himself suffered. *Hayavadana*, too has a personal strain that he has acquainted with. The important characteristics is that all his plays have a direct social relevance. This is his humanistic vision.

Hayavadana occupies an important place in the humanistic world of Karnad. *Hayavadana* becomes the mouthpiece of the playwright to get across the point that gods and celestial beings often delight in giving pains to humans; visit to holy places, temples, places, gods and goddesses for the fulfillment of wishes can be futile. It encompasses the three worlds, the human, the divine and the animal. *Hayavadana* represents the third. By his conscious and penetrating observation and insight he questions the established norms to demystify the dominant beliefs and practices. Karnad shows his sympathy for *Hayavadana*, who becomes a horse, and the child (Padmini's child) that learns to laugh. The tragedy of the adults is left behind and the comedy of the children is looked forward to. It is pertinent to quote Dr. Punam Pandey - "Though the irony is felt but the iron will of Karnad asserts itself giving the colour of hope to Karnad's humanistic vision. Being a thorough going humanist, Karnad suggests that transcendence is possible only in immanence and believes that the generous acceptance of the tantalizing reality will be meaningful, even if the world remains terribly incomprehensible and inexplicable."⁵

In *Naga-Mandala* and *Hayavadana* Karnad tries to show how women are plaything in the hands of men. In *Naga-Mandala*, Rani is married to Appanna, but is deprived of her sexual, personal and familial needs. She is even treated like a maid servant. She is confined in locked house. She is not permitted to talk anybody or contact. She is, worse still, not allowed to speak with her husband. When tries to correspond with Kurudavva, first dog and then a mangoose guards in her house. The husband lives with a concubine instead of living with her. By the strange magic of Kurudava's roots, however, Rani gets the love and affection of Naga unknowingly. Naga also finally releases her from the tyrannical clutches after the snake ordeal afflicted by the elders, sitting in the chair of judgement. The playwright is of the view that women cannot be confined in safety lockers, while the men can be thieves elsewhere. Perhaps the matriarchal order may be conducive to male as well as female. He raises many feminine questions out of his humanism. A man can keep

as many wives as he likes but a woman is denied such privileges. In *Hayavadana*, Kapila proposed to Padmini and Devadatta is noteworthy—"Could not we all three live together like the Pandavas and Draupadi?"⁶ Padmini shows her agreement but shows her negligence and disagreement. It means that a woman does not have a desire to have more husbands than one. The play presents it affirmatively.

As a humanist, Karnad has raised many questions related to caste, religion, family and society. In *Naga-Mandala*, he raises numerous questions regarding the relationship between husband and wife and the crisis of human values. Rani is acceptable either as a slave or a whore or as a goddess by her husband and society both, but not as a human being. Appanna devotes his day and night to the concubine; but no one questions him for his extra-marital relationship with a concubine. In *Hayavadana*, no one takes the proper care of the children. *Hayavadana* is left alone after the dispute between his parents. The child of Padmini is also left alone in the end. They are deprived of the love and affection that a child gets in a joint family. In *Tale Danda*, the playwright has a humanistic vision with an appeal of social justice. Human being should be accepted as human being and there should be no division on the basis of caste and creed. There are many scenes that highlight the pitiable condition of the downtrodden people. The playwright exposes the age old rituals by Brahmins and their maintaining distance from the untouchables. They proclaimed their superiority and established a patterned hierarchy in the society. Sharanas demolished the boundaries of the caste and class for the sake of equality, humanity and social change. Their firm faith in Lord Shiva inspired them to believe in the equality of sexes and hard dedicated work.

In *the Fire and the Rain* misbehavior of male gender towards female gender is presented through the character of Nittilai and Vishakha. Nittilai is killed by her husband when she walks out on him. The gender discrimination and the oppression of women by the patriarchal society and the sympathy of the playwright can be seen in his plays. In most plays of the playwright, "the worst sufferers are women.....who are caught up in a whirlpool of Hindu patriarchy and are sucked down helplessly."⁷ The expectations and desires of a woman are always suppressed in a patriarchal society, whether she belongs to a higher or lower caste. In *Yayati* Chitralakha belongs to an Aryan family, in *Bali: the Sacrifice* the protagonist is a queen and Vishakha in *the Fire and the Rain* is a Brahmin, all these characters are from a higher social order but suffer at the hands of unjust patriarchal society. It seems that society had forced Padmini in *Hayavadana* to perform *Sati*. Nittilai in *the Fire and the Rain* is murdered and the queen in *Bali: the Sacrifice* is sacrificed herself.

Karnad believes that the world has not been created for man to conquer and abuse it. What he aims at is an ecological vision in which animate as well as inanimate

objects would live in harmony. He emphasizes that man cannot live by ill will, enmity, destruction, hatred and so forth. Keeping this view in his mind Karnad has focused his attention on the downtrodden, oppressed, exploited and poor fellow of the society. His plays consistently favour for the female, children and the people at grass root level. In brief, we can say that Karnad as a playwright exposes the chain of tradition, caste discrimination, gender inequality, social injustice and political problems in his plays with an appeal of humanistic approach. It is evident by its glory.

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Dr. B.R. Ambedkar and his Annihilation of Caste



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Abstract

Dr. Bhim Rao Ambedkar (14th April 1891-6th December 1956) known as Baba Saheb, was a Dalit Political leader, Indian nationalist, editor, economist, historian, activist, philosopher, scholar, revolutionary, revivalist of Buddhism in India, jurist, thinker, anthropologist, orator and prolific writer. He is regarded as the maker of the Indian Constitution. He was born in a poor untouchable *Mahar* family. He spent his whole life fighting against social injustice, caste-discrimination based on the system of *Chaturvarna*- the Hindu categorization of human society into four Varnas- Brahmin, Kshatriya, Vaisya and Shudra. Dr. Ambedkar believes that the existence of caste in India is due to the notion of inequality imposed by religion. 'Annihilation of Caste' is a famous book written by him in which he asserts that if the social and cultural practices cease, caste could be annihilated. As a leading Dalit scholar, Ambedkar had received his education in India, America, England and Germany. As a writer he had written so many articles, reports, theses, speeches, critical notes and books. His 'Annihilation of Caste' is a speech-note prepared for Jat-Pat-Todak Mandal, Lahore in 1936. Unfortunately, it could not be delivered due to certain reasons. Later, Dr. Ambedkar published it in a book form in December 1944 in order to serve the purpose for which it was intended.

Introduction

Value His 'Rise and Fall of Hindu Women', 'Who were the Shudras?', 'What Have Gandhi and Congress Done to Untouchables?', 'The Thoughts on Pakistan', and 'The Buddha and His Dhamma' are the most famous books in prose. Dr. Ambedkar was a highly studious man. About his reading habit, Devidayal writes:

"Dr. Ambedkar read leaving his bed in the morning; he read in the toilet, he read while he ate, while he moved, while travelling by a car, train or aeroplane. He read even when relaxed, lying or sitting and before going to bed."¹

Dr. Ambedkar himself said:

"I always study difficult subjects. I never read simple, recreational literature like novels and short stories. I am always busy with difficult literature"²

Annihilation of Caste is a speech prepared by Dr. B.R. Ambedkar in 1936 for annual conference of the Jat-Pat-Todak Mandal of Lahore, but it could not be delivered owing to the cancellation of the conference by the Reception Committee on the ground that the views expressed in the Speech would be unbearable to the Conference. In this book, Dr. Ambedkar has focused on caste-system in India and its bad effects. Being born into an untouchable caste (Mahar), he had faced its clutches and remained always a miserable victim of caste system yet he did not lose courage and fought against orthodox Hindus and untouchability. He criticized them in his writings and speeches on social occasions. For this, he was also criticized by a large number of Hindu activists. Speaking at the 'Yeola Conversion Conference' on October 13, 1935 near Nasikh, he had announced his intention to convert to a different religion and exhorted his followers to leave Hinduism. In a thesis, on the origins of untouchability, Dr. Ambedkar wrote:

"The Hindu civilization...is a diabolical contrivance to suppress and enslave humanity. Its proper name would be infamy. What else can be said of a civilization which has produced a mass of people...who are treated as an entity beyond human intercourse and whose mere touch is enough to cause pollution?"³

As a social reformer, he wanted to establish a casteless society in India as he thought that only such a society could establish peace and prosperity in the nation. He wrote:

"The path of social reform like the path of heaven at any rate in India is strewn with many difficulties. Social reformers in India have few friends and many critics. The critics fall into two distinct classes; one class consists of political reformers and the other of the socialists."⁴

It means that it is difficult to make India casteless where most of the people feel pride in their castes. In 'Annihilation of Caste', Dr. Ambedkar has drawn our attention towards the contemporary society in which the untouchables were victims of so-called religious rules of Hindus.

The writer has quoted a number of incidents, times and places when, where and how the lower castes people were treated mercilessly by the upper castes people. He quotes a report of 'Times of India' (4th January 1928) in which the correspondent of 'Times of India' reported that high caste Hindus in Indore district (of the Indore state) informed the Balais (Lower castes people) that they could live in the village only when they were ready to follow these rules:

1. Balais must not wear gold –lace-bordered pugrees.
2. They must not wear dhotis with coloured or fancy borders.
3. They must convey intimation of the death of any Hindu to relatives of the deceased- no matter how far these relatives may be living.
4. In all Hindu marriages, Balais must play music before the procession and during the marriage.
5. Balais women must not wear gold or silver ornaments: They must not wear fancy gowns or jackets."⁵

But the Balais did not follow these rules, so Hindus proceeded against them. Balais were prohibited from getting water from the wells. They were beaten bitterly. The Balais submitted their petitions to the Durbar against these persecutions but there was no positive result. The poor Balais had to run away from their villages to Dhar, Dewas, Bagli, Bhopal, Gwalior and other states.

A most pathetic incident has been reported from the village Chakwara in Jaipur state. It was also mentioned in newspaper that an untouchable of Chakwara arranged a dinner to his fellow untouchables. The guests were gathered, food was served. Actually, food was prepared with ghee and butter so Hindus did not like this because untouchables were fully prohibited from taking such delicious food. The Hindus were having their hundred lathis, reached among the untouchables and despoiled their food. Untouchable ran away for their lives. Dr. Ambedkar writes criticizing this incident:

"This means that an untouchable must not use ghee even if he can afford to buy it, since it is an act of arrogance towards the Hindus. This happened on or about the 1st of April 1936."⁶

In those days, India was burning in the fire of slavery. Mr. W.C. Bonnerji was a leader of rebellions against the British Government. Indians, under the directions of Mr. Bonnerji were trying to achieve political power. Dr. Ambedkar asks the political-minded Hindus:

"Are you fit for political power even though you do not allow a large class of your own countrymen like the untouchables to use public school? Are you fit for political power even though you do not allow them the use of public wells? Are you fit for political power even though you do not allow them the use of Public Street? Are you fit for political power even though you do not allow them to wear what apparel or ornaments they like? Are you fit for political power even though you do not allow eating any food they like?"⁷

Further Dr. Ambedkar writes:

"I am sure no sensible man will have the courage to give an affirmative answer. Every Congress man who

repeats the dogma of mill that one country is not fit to rule another country must admit that one class is not fit to rule another class."⁸

Dr. Ambedkar tells about the reason why these types of injustices are prevalent in Indian Society. Its one and the only reason is **Chaturvarna Vyavastha**. He writes:

"I contend that it is the most vicious system. That the Brahmins should cultivate knowledge that Kshatriya should bear arms, that the Vaisyas should trade and the Shudra should serve sounds as though it was a system of division of labour."⁹

It is regretting that in India, this bad and vicious system is considered to be religious system. The book in which these so-called rules are written systematically is regarded as the religious book of Hindus. Not only have these Hindus supported this **Chaturvarna** saying:

"Why should the Shudra need trouble to acquire wealth, when the three Varnas are there to support him? Why need the Shudra bother to take to education, when there is the Brahmin to whom he can go when the occasion for reading or writing arises? Why need the Shudra worry to arm himself because there is the Kshatriya to protect him?"¹⁰

Here, it is clear that the defenders of **Chaturvarna** do not have human- feeling. Their hearts are hollows. The theory of **Chaturvarna** treats Shudra as the ward and the three Varnas as his guardians. Dr. Ambedkar attacks this system and he also criticizes its defenders. He suggests a way to all Indians that we must change this so-called social system. Without changing it, we can not make desirable progress. He warns us that on the foundations of caste we can not build any nation.

Hence, Dr. B.R. Ambedkar is a great writer of prose. His **Annihilation of Caste** is a famous book. It has many tragic incidents relating to the exploitation of the depressed classes. This small book may be summed up as the black history of untouchables in India. It also reflects the real picture of so-called religious Hindus that they might be sympathetic and kind towards the dogs and cats but remained always merciless and cruel towards human beings whom they treated as untouchables.

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Philosophical Leanings of Shiv K. Kumar on Various Aspects of Life, Expressed through Proverbial Type of Statements and Generalizations in his Poetry

Abstract

Shiv K.Kumar, a stalwart Indian-English litterateur, being a professor-poet, is basically a thinker who has keenly observed and deeply speculated on almost all the important aspects of human life and made certain generalizations which beautifully comprehend human psychology and behaviour and they are transcendental as they leap beyond the ramparts of their contextual interpretations. Throughout his writings, such generalizations keep coming up time and again. The paper is focussed on all such proverbial type of statements and generalized remarks in his poems, published in his eight volumes, which, quite remarkably, unfold the philosophical leanings of Kumar.



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Introduction

Shiv k. Kumar, born and brought up in the family of shri Bishan dass kumar, a teacher, a theologian knowing several languages, an erudite scholar and hence a rationalist and the intuitive, religious and caring mother, Smt. Ishwar Kaur. As a Poet, novelist, playwright, short story writer and critic, he has played a pivotal role to bring about a poetical renaissance from decadent nineteenth century Romanticism. He covers a wide range of human experiences and has fabricated a well articulated imaginative world into which he resolves the contradictions of self and society. He is deeply influenced by the famous philosopher Bergson who believes in the supremacy of intuition over reason. He thinks that reason and intellect can never help us understand the reality. The only way to know it is intuition. Further he is also influenced by Romantic literature, Stream of Consciousness Novel, D.H. Lawrence, T.S. Eliot, and the Bhagwad Gita and hence as a thinker he has developed his personal confirmed viewpoints and concepts and these concepts intermittently keep coming up time and again in the form of proverbial statements and generalizations. All such passages taken from the eight volumes of his poetry have been organized and presented in the following data -

1. Articulate Silences

- 1.1. Better it is to remain busy with companions and friends because secluded moments are extremely painful-
*-- loneliness's frenzied -
search for companionship. (Waiting.13)*
- 1.2. Doubt, which, no doubt can create crevices even in the strongest bonds, also provides an opportunity to the other alternates-
*Doubt's stylus
can wedge into granite sandstone,
showing hairbreadth crevices.
The wrinkled triangle
between the agitate eyebrows
is both a three pronged
jab into affirmation
and a release into
fresh openings. (The Face.15)*
- 1.3. Memories keep on haunting a person throughout the life. However, to avoid the tension generated by the recollection of undesirable, painful memories, it is advisable that one should keep one's memory's cells paralysed-
*The easiest path to renunciation
is to paralyse memory's cells,*

- so that when confronted with a face
from the reservoir of time,
the mind blinks like an idiot,
lacking recognition. (Renunciation.18)*
- 1.4. Perceptions received through sense organs are generally incomplete and illusive-
*The dull ears hear only
the eidolons of proration
whizzing past on invisible wings,
dropping deprivation
in the starveling's bowl. (Sounds of Hunger.21)*
- 1.5. Commenting on 'Images', the poet says-
*Images drafted into action
are always dodgers,
snarling restively
like circus lions
when rudely jabbed,
showing their dragon teeth,
brandishing their
monstrous paws. (Images.30)*
- ## 2. Cobwebs in the Sun
- 2.1. Without the 'soul', anything is a dead matter, and intuitive urges are the very soul in human life. Hence the poet says –
*Denuded of incense
or gesture
the flower may sear
into a papier-mâché. (Lear to Cordelia.5)*
- 2.2. Any intellectual exercise at the time of copulation must shatter the whole pleasure-
*Nudity feels stripped
When the mind plays at
catching its own tail. (Cerebral Love.11)*
- 2.3. Perversion sometimes also leads to perception-
Perversion too is perception.(The Unbeliever.17)
- 2.4. Half-hearted endeavour to perform generally leads to inutility-
*Beyond the flame's nervous leap
chafing at the fringes of endeavour,
the smoke writhes
in coiled inutility. (Limitations.20)*
- 2.5. One should clearly identify one's competence and capabilities and then alone, one should move ahead-
*Don't let the music's
impassioned blare
deflect the stillness
of our reflections
in the black coffee.
What you can't, you can't. (Limitations.20)*
- 2.6. Flow and flux, not the stagnancy leads to immortality-
Immortality is born of flux. (Flux.21)
- 2.7. Precaution is needed to prevent the past, unhappy moments to revive and mar the present and future both-
*---the first ray
from the old sun
may decide the next eclipse.(Returning Home.28)*
- 2.8. Man should not leave efforts even in adverse circumstances and remain hopeful because -
*---- there are saplings
that may grow
out of season and clime
if the mulching is rich
and hope shields stems and tendrils*

- from borers. (Reclamation.35)*
- 2.9. Positive attitude is the most important thing in life. We should not feel depressed or dejected-
*Deep in the earth's bowels
there are seeds
that may have lain
untouched by moisture
awaiting reclamation. (Reclamation.35)*
- 2.10. Age does not spare anyone living; it must leave its marks on all living beings -
*Age brands its indelible marks
on humans only-
how can a gold- fish conceal
its sagging face,
its drooping jaws? (Reclamation.35)*
- 2.11. It is not possible to shoot the dart of logic and reason on the shadow, as it must dodge it -
*The shadow always dodges the dart.
(Patient Number Eleven Ward C,36)*
- 2.12. Sometimes crabwise movements are better -
*---the easiest way to hit
the destination was to
march crabwise. (Pilgrimage.41)*
- 2.13. A woman should be approached by a man as a whole, with total devotion and surrender-
*A man should come to his woman whole-
not when the mind
is a perverted sunflower
turning face to darkness.(A Dark Mood.43)*
- ## 3. Subterfuges
- 3.1. May be, it is a proverb 'Speech is silver, silence is gold', but it is not always true as silence sometimes may prove to be fatal-
---and silence is no virtue. (Broken Columns-6.14)
- 3.2. Sense organs like eyes, ears have their own limitations and nothing can prevent the free flow of imaginative, intuitive perceptions-
*Subterfuges can cloak only the turret
not the stereobate anchored in certitude.
And no blinkers can hoodwink
the albino glow in your third eye
(Broken Columns-7.15)*
- 3.3. Commenting upon the most frequently emphasised value in India i.e. 'self control', placed against the intuitive upsurge of sex feelings, after the father takes the son to the priest as he has sniffed the danger of love letter, the poet, through the mouth of the priest, pleads for it, though, in the context, it is satire-
*'Self control is the force
that keeps the sky's circus- tent
staid above the multitude.(Broken Columns-7.16)*
- 3.4. It is not at all a sin to review one's past carefully and safely because any act done with utmost care is not harmful-
*Gloved hands leave no fingerprints.
And a brisk review of all your yesterdays is no sin.
(A Letter from New York.18)*
- 3.5. Actually it is cheaper to have a live-in relationship than engaging in a ritual of marriage-
*It's cheaper
to take a woman to live with
than breed mammals after
a brief church ritual,*

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*only to be betrayed by the
uncanny grocery mirror,
the scourge of all shoplifters.*

(A Letter from New York.20)

- 3.6. It is necessary to always remain hopeful and pour all one's energy and devotion to a work and the success is sure-

*Like the sunset's parting
thrust at the mirror's retina
words may glow even from
faded dog-eared parchments.*

(My Grandfather's Love Letters.26)

- 3.7. Affirmation is always the result of perfect logos-
---the perfect logos
is the act

of affirmation. (The Sun Temple, Konark.28)

- 3.8. There can be two ways to interpret and analyse anything-rational and intuitive and one can easily discover and reach the truth-

*You can always kill
a thing twice-
in light and shade -
wash its bones
to primordial whiteness
till you can not tell*

(Coromandel Beach.42)

4-Woodpeckers

- 4.1. Love, sex and consummation need totally undisturbed moments -

*Is there a point at which
even parallel lines meet?*

out of sheer exhaustion? (Broken Columns III.3)

- 4.2. The poet has beautifully used the proverbial line in his poem -

*When gold rusts
what can iron do? (Broken Columns V.5)*

- 4.4. The poet quotes the idea from the scriptures that self control in terms of relationship with a woman is necessary-

*Where a woman's body creases
at the core of existence
a sever runs through the dark
foliage (Broken Columns VII.8)*

- 4.5. Misuse of freedom often leads to disaster-

*'Freedom is the demon
that devours its own brood.*

(Broken Columns VIII.11)

- 4.6. Children are like clean slates. It is the way of grooming them which shapes their future personality -

*The creepers on the wall
have no clear concept of truth.*

*If fed on cactus milk, they
may grow into pythons*

to stifle the church. (Broken Columns IX.12)

- 4.7. Sometimes it becomes hazardous to cross the boundaries without appropriate knowledge and equipments-

*The bird that stretches its wing
beyond the water's brink
often lands on some insidious rock.*

(Broken Columns X.14)

- 4.8. Every work requires appropriate person, time and tools. Everybody can not do every work at any time-

*How could a zebra be yoked to carry
cabbages to the market place?*

(Broken Columns XII.16)

- 4.9. Inanimate objects are not supposed to procreate-

procreation is for the living only.

(Flower-pot in my Study.18)

- 4.10. Love does not lend to any kind of legal or moral restraint-

*No emperor's law now prohibits
Love's parody. (The Taj.21)*

- 4.11. Even the bad people have some soft corners and instincts to do good and -

Even impostors have some graces— (My Son.23)

- 4.12. All what we hope to happen may not take place because destiny plays its own role-

*Resilience is not for everybody-
perish in the womb*

before sunrise. (An Old Dry Well.26)

- 4.13. Language of gestures and body movements is sometimes more powerful than words-

*A mere smile can be a ritual
and a frank swivel of the hips
send gazelles capering*

through infinite space (Young Maidservant.30)

- 4.14. Pointing towards the fact, the poet says that there is no difference between one woman and another-

*What's it that one woman has
and the other hasn't ?*

(Love Letter.33)

- 4.15. Sometimes even very petty object can prove to be highly useful-

*A mere scrap of paper
can be one's undoing.*

(Love Letter.33)

- 4.16. Exposing the hypocrisy in religion, the poet, sarcastically comments on it-

All prayer is dual.

(Thanksgiving.35)

- 4.17. It is very difficult to resist an onslaught from an invisible invader and it also hurts more deeply and fatally-

The invisible always hurts more. (A Dead Bird

on an Electric Pole.36)

- 4.18. Man made mechanical and technical devices/equipments are unable to discriminate between what is good and what is bad-

The electric is neutral

to bird, assassin and saint.

(A Dead Bird on an Electric Pole.36)

- 4.19. It totally depends upon a person to sustain his secret a secret or share it with everybody-

*One may consolidate the gains discreetly
or share the night's secret in the market-place.*

(A Pregnant Woman in the Queue.37)

- 4.20. To keep on moving consistently up to a long distance is not possible with weak feet-

*How much can you carry
on your petite feet?*

(A Pregnant Woman in the Queue.37)

- 4.21. Depression and despair can overpower anybody, any time, without any consideration of time, place and age -

*The moment of despair
has no age*

no discretion.

(Midnight Musings.39)

5. Trapfalls in the Sky

- 5.1. Muteness and silence is a gift for love as it is with this muteness that one can perform wonders-
*When in love
go mute like pebbles under crystal
water, wear white silk, or take
the veil. Your eyes will then glow like fire-
flies, your footsteps fall like dew-
drops on banana leaves on a summer morn.
You may then leap through a ring of fire, kiss
a cobra's hood, work miracles with sand,
for you are then the Virgin's bridesmaid-
only half mortal like lotus.*

(Mother Teresa Feeds her Lepers at her Home for the Destitute, Calcutta.13)

- 5.2. Any argument or verbalisation during the moments of surrender must shatter the whole experience-
*Don't ever argue
at the moment of surrender
for the end is ineluctable.*

(An Indian Mother's Advice to her Daughter Before Marriage.14)

- 5.3. Memories of human beings are short and myopic; they forget all in due course of time-
*A man's memory is myopic
like a sparrow's; once filled up
he hardens into a rock.*

(An Indian Mother's Advice to her Daughter Before Marriage.14)

- 5.4. It is not possible for a man to simultaneously do the contradictory jobs and try to obtain both the goals-
----- *a man
can not swallow both ends of rainbow.*

(An Indian Mother's Advice to her Daughter Before Marriage.14)

- 5.5. Verbalisation and excessive use of rhetoric often creates suspicion-
-----*rhetoric
often deepens the suspicion,-----.*

(An Indian Mother's Advice to her Daughter Before Marriage.14)

- 5.6. An adolescent must believe in and have full faith, confidence and control on his nascent power and then, nothing can deprive him of success-
-----; *if you can tame
the genie of your nascent power, the
pyramids will give out their mysteries
and the moon craters fill up with ambrosia.*

(Adolescence.17)

- 5.7. Joy and mirth is the feeling that may be derived from any source- physical or spiritual-

*sleeping on a spiked bed
like a yogi, or letting your coffee
nipples dirk into my breast.*

Either way leads to nirvana. (At a Whorehouse.18)

- 5.8. It takes time to convince a raw hand or a person who is going to do anything first time-
-----*A new convert
needs time to intone an exotic chant.*

(At a Whorehouse.18)

- 5.9. As a matter of fact, it is not the final punishment or doom but the excessively long wait which causes harassment and pain-
It's the long wait that kills

the lover, the cancer-patient

- 5.10. Tears are not the permanent solace to one's sufferings and despairs, but the headstone-
*Often the moment of pain seeks solace
in a headstone, not in tears. (Solid Objects.27)*

- 5.11. Horoscopes, stars and movements of planets, particularly at the time of one's nativity often play important role to decide one's fate and it is through the study of this horoscope that one can foresee one's death-
*And how can you foresee your death
without knowing the configuration
of stars and moon
at your nativity? (Death of a Dog.28)*

- 5.12. Dogmatically speaking, night and darkness have their own negative effects, side effects and after effects-
*Burial at night may sometimes cause
a lunar eclipse- and darkness
is always a lone whiner. (Death of a Dog.28)*

- 5.13. One should not feel disheartened due to adversities as there are always the chances to resurrect-
*But to fade away is not to die
for there's always resurrection. (Clouds.30)*

- 5.14. Earlier part of life or childhood of almost all the creatures is always holy, pious and innocent-
*At nativity all creatures are chaste, like breast-milk-
the downy chick, pecking its way out
of the shell's prison,
the littlum calf, gravitating on tottering
legs to its mother's udders
and the undiapered babe, thumped
and thrashed into primal consciousness.*

(Cleansing Ganga.35)

- 5.15. There is hardly any difference between the sense perceptions of an ordinary woman and a whore-
Even a whore has some in-built censors—

(O! Delhi.37)

- 5.16. All preparations are to be made in advance and all efforts, to be poured into, before we start a work-
*One must be stripped,
bathed in one's perspiration,
and robed in pallid white
before confronting the unknown. (Refugees.39)*

- 5.17. To remain sticking to one's past is no more needed. Confident movement with full force is rather more helpful-

*There are no horizons here
to prolong the ceremony of retreat.*

*Just one dip behind the hilltop
and its done.*

(Sunset Over Simla Hills.41)

- 5.18. Raw materials are always anonymous; it is the sculpting, finishing and polishing of a stone alone which can convert it into a piece of art, or even god-
*Anonymity shrouds every rock
until the sun's chisels sculpt
it into a god. (A Wayside Shiva Temple.45)*

- 5.19. Any kind of involvement in any sinful act or any collaboration and connivance with a person involved in such an act or to hold somebody trafficking in sin must invoke hatred and punishment-

*It's only when you stray into the crossroads
of life and hold someone
trafficking in sin*

- that you may get poked in the sides
and shooed away with a brusque 'tut' 'tut!'.*
(A Stray Cow.48)
- 5.20. Some physical gestures like the movement of hips, thighs and calves are certainly an invitation-
If hips, thighs and calves sway to some rhythm, it must be a sort of love-play that knows how to leap across a pot-hole in the side-walk, an arc of the sky and also swing in bed.
(A Young Female Jogger.55)
- 5.21. Hunger and starvation pinch the soul-
-----*hunger scrunches like gravel under the feet.* (The Holocaust Survivor.58)
- 5.22. Full blooded liveliness is needed for any kind of success-
The only way to vanquish the sun is to glower back into the vitals (The Holocaust Survivor.59)
- 5.23. Sheer verbalisation and self praise does not attract commendation. It is rather the actions done which speak more loudly-
'Actions speak louder than words.'
(A Reminiscence.62)
- 5.24. Sex instinct does not have any relationship with age of a person; it can upsurge anytime, anywhere and at any point of age-
But the eyes-----, has no age, no discretion for even the wrinkled hands are smoothed by a rabbit's caress.
(Shakespeare Seminar: Fall 1981.64)
- 5.25. The generation gap is a universal phenomenon and hence, the clash between parents and children is imminent-
And isn't every parent an easy prey to revolt? (Birth of Adam.70)
- 5.26. Exceptions and derivations are more important than the rule because it is these which expose the truth-
-----*It's always the exception that exposes the lie, not the rule that squirms its way through the wet sand like a snail blindfolded.*
(Serpent to Eve.73)
- 5.27. In order to grow, cooperation and collaboration are the basic requirements and for any construction, destruction is also needed-
-----*to multiply is to seek confluence with another tributary, ----to replenish the earth is to first ravage it*
(Adam to Eve.75)
- 5.28. Without axis it is impossible for any creature to move-
-----*every creature that moves has a still axis, ----* (Adam to Eve.75)
- 5.29. One may have to face indifference if one is aware of one's own downfall-

When the sunrise knows how and when it will meet its grey end, even the cypresses lapse into indifference.
(After the Departure of Adam and Eve from Eden.77)
- 5.30. Eyes have got their own limitations and sometimes fail to comprehend the reality-
--to the naked eye

any rudy, round object carries the succulence of life.

(After the Departure of Adam and Eve from Eden.77)

6. Woolgathering

- 6.1. Pre-dawn hours in Indian scriptures and mythology are supposed to be the sacrosanct hours as it is the time when gods and goddesses pour their blessings upon human beings-
Predawn is the hour when gods relish their nectar in conclave.
(Dew-drops on Lotus Leaves, Nagina Lake, Srinagar.7)
- 6.2. Debunking religion, the poet puts the words into the mouth of the priest who prays to god to give him enough courage not to deny his flesh as --
----- *the spirit is always a whiplash.*
(Dew-drops on Lotus Leaves, Nagina Lake, Srinagar.7)
- 6.3. Death is a great leveller which closes all-
But once the last rites are over there'll be deep silence---
(The Death of my Father.13)
- 6.4. What is visible to the naked eyes or what is projected by someone may be illusive and away from reality-
But isn't each plain statement a heresy, just as each resume is a perversity, like a foetus with two heads or three legs?
(I Say it on Oath, Your Lordship.14)
- 6.5. Courts are the places where people are put on oath to speak the truth and nothing but the truth. However it is a great embarrassment to speak out one's mind there-
Speaking out one's mind in an open court is always an embarrassment---
(I Say it on Oath, Your Lordship.14)
- 6.6. Duality between rough and soft, gentle and rude is astringent-
There is an astringent duality, ----- between stone and water, an owl's hoot and a bird's warble.
(I Say it on Oath, Your Lordship.15)
- 6.7. 'Well begun is half done' and hence small beginnings may be teasing-
Small beginnings are teasers when they herald an event that doesn't take place.
(Drizzle.18)
- 6.8. Life is a consistent struggle. Therefore, to seek shelter every time under a tree or a temple's cupola is not desirable-
But is it life to always seek shelter under a tree or a temple's cupola.
(Drizzle.18)
- 6.9. Light, even though for a moment is significant and powerful enough to devour the darkness and make the truth least hurting -
But after the lightning's grin even the truth ceases to hurt.
(After the Rain.19)
- 6.10. Some of the dreams keep coming up, 'recycling themselves eternally' time and again-
----- *there are some dreams that recycle themselves eternally because love forges its own scriptures to defy time's scoffing.* (Golconda Fort.21)

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- 6.11. The poet, here points out that the day, specifically for the poor, is meant for hard menial work and labour-
*Day is for sweating-
for shoe-shining foraging for crumbs from dust-bins,
for pan-handling, or wiping the windscreens of cars
as the traffic freezes at the red signal.*
(Pavement-sleepers of Bombay.22)
- 6.12. Even the church and ecclesiastical institutions have got their limitations-
----- *priest's vespers
never rise beyond the cathedral's dome.*
(Pavement-sleepers of Bombay.22)
- 6.13. Any kind of restraint or taboo is unable to totally control the basic instincts-
*How long the soul's breath vanquish
the red flame?*
(Khajuraho.24)
- 6.14. Forcefully created distance between the objects which have natural tendency to remain sticking together is sure to increase the appetite further-
----*any distance
between leaf and bud, bone and flesh
hand and breast, only whets appetite---*
(Khajuraho.24)
- 6.15. Time plays an important role in life. If any work is not done in time, it will definitely conclude in nothingness-
*Disaster comes too soon to those
who converse with water at dusk
when the blood loses its immunity
against amnesia,
and the past and present eddy around each other
reinforcing nothingness*
(Walking by the Riverside.30,31)
- 6.16. To provide outlet to suppressed emotions is necessary as silence must choke the soul and loneliness; sometimes it is also fatal -
*Silence can choke the soul
like grey fog, and loneliness
may breed only white ants that could bring
even a citadel down to its knees.*
(The Lemon Tree in my Backyard.33)
- 6.17. To remain anonymous is not always fruitful; it may rather turn into a curse-
Anonymity can be a curse.
(A Subway Railway Station.35)
- 6.18. Darkness, in its own way has the power to absolve all the sins-
--*darkness can absolve one of all sins.*
(A Stray Bitch abandons her Litter at dusk.37)
- 6.19. It is not possible for the weak objects like wood, water and statement to resist steel, oil and counter respectively-
*How can wood stand up against steel,
water against oil,
statement against its counter?*
(Felling a Tree.39)
- 6.20. To humiliate anybody when he is devoid of any defence weapon makes the humiliation more lethal-
*Humiliation is lethal
when the victim has no weapons for defence,
when you have to carry your own cross
and you are your own pyre-
fuel, flame and ashes* (Felling a Tree.39)
- 6.21. We are sometimes quite helpless before destiny. There are certain compulsions which do not succumb to any degree of resistance-
*One cannot always claim dominion over a candid sky
for compulsions have their own logic.
Horoscopes are never governed
by terrestrial laws.*
(On Moving into a Complex of Apartments.40)
- 6.22. The parameters of darkness are set by darkness itself-
Darkness has its own norms.
(Blackout.42)
- 6.23. Animals, according to Kumar, as they have been depicted in his works, have more evolved and broad-based powers of perception-
*If an animal does not articulate
like a preacher or a soothsayer,
it's because his eyes can laser through
wood, iron, mortar, subterfuge or dissimulation;
he can sniff the presence in the atmosphere
of a spirit just risen from the flaming pyre-
or even of someone who has dipped his feet
into the dark river to be ferried
across to a land
where sleeping or waking are the same
where the truth is revealed to any one
who can come back home after sleeping with a courtesan,
or who is listless during day
but vigilant at night to hear the sounds of silence
lost to those who are trapped in dreams.*
(Sleep-walking.43)
- 6.24. We cannot shut our eyes and disassociate ourselves from our past as it can resurge any time, specifically during the moments of complacency-
*You cannot dodge the past all the time;
it resurges more sinisterly
during moments of complacency
reminding you
that you may see your doom
even in still waters.* (Shadow Lines.44)
- 6.25. The moment to enjoy sex relationship requires complete surrender with no thought at all. Simply making a material change is not going to help-

Mauji Ram- 13
*To change a bed's locus-standi
each autumn
may not retrieve anything
when the mind is still shadowed by the bat's wings.*
(Shadow Lines.44)
- 6.26. Marital relationship needs frequent recurrences and revivals after perishing together in the debris of past-
*May be it'd help if the ceiling could climb
down the walls to smother the floor's crust
since, often, the only way to union
is to perish together in a rubble
of mortar, wood
and marital rancour.* (Shadow Lines.44)
- 6.27. Making a comment on the creation of a poem, the poet says that the process is quite intuitive, requiring complete freedom for recollection and creation-
In any case, writing a poem is like breaking

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- a genie into doing a tantric ritual.*
(To a Young Beautiful Woman Aspiring to be a Poet.48)
- 6.28. Evening and night are the times when sinful activities take place-
*Evening is always a carouser
mimicking the orgy of ghosts
under the moon
till the cock's first crow
proclaims the end.* **(End of the Party.49)**
- 6.29. Power does not lend to any kind of resistance and hence all the weak objects surrender quietly as they know that no effort to resist will ever succeed-
-----*To the wind's dirge
a lamp-post bows its head,
a tree drops a tear
a stone lies stoically on the side-walk,
knowing that all discourse
must end in the silence
of the moss, spawning in a dry well.*
(The Ambulance.50)
- 6.30. What appears to be the truth to the eyes may be a subterfuge while the reality is something else-
*Like a nun's retreat
flatness can be a subterfuge
for the breasts may grow inwards.
The sculptor's hammer and file
never reach the quarry's heart
and that's where the soul dances
under the iron-lid.* **(Norman, Oklahoma.54)**
- 6.31. Innuendoes can bring one to nowhere but to inquisition-
Innuendoes only bring one to inquisition.
(The Computer.55)
- 6.32. Natural instinctive calls can not be kept suppressed for a long time-
*Somewhere down the dark passage way,
one has to redeem one's manliness.*
(The Computer.55)
- 6.33. Language of love does not require any verbalisation or rhetoric; it has got its own language through which it can express itself in a very powerful way-
*Each icon of love speaks
its own language-
husky cooing in a thistle-
down bed, eye that seeks the meaning
of pollen wafting from one blue-bell
to another- and fingers that weave
occult patterns around brown nipples,
till even stone melts into benediction.*
(Rape.61)
- 6.34. Virtue and merit can not be overtaken by vice and evil-
*How could virtue be sullied
by a night's brief affair?*
(The Ring.62)
- 6.35. High spirits and mural is required for doing miracles-
---*it's rider's swing through
space that works the miracle.*
(My Little Grandson on his Rocking Chair.63)
- 6.36. All the mortals on the earth must suffer the stings of destiny; fantasies are meant for gods and goddesses-
-----*fantasies
are only for the moon and stars,
not for the mortals who are prone to chills and
fevers.* **(Walking through the Woods.64)**

- 6.37. For copulation and orgasm, both, physical, as well as mental strength, with hundred percent involvement is a must-
*But what can you do when the roots
under the yellow soil are paralysed
and will not stir up.* **(Even at my Age.65)**
- 6.38. Old age and ripeness must bring sufferings and pains-
-----*ripeness is a cruel mentor.*
(Even at my Age.65)
- 6.39. To regain strength, rest and sleep are needed for a fresh start-
*But how can you confront the sun
if you don't seek rebirth after each death?*
(Sunrise.67)
- 6.40. It is the great people alone who enjoy the privileges; the poor are destined to suffer and suffer alone-
*Marble graves are for the scion
of royalty-roses and lilies-
not for the commoners who are swept off by history
into a mass grave, where they lie for centuries
till they become manure for the new-born.*
(A Requiem for Autumn Leaves.71)

7. Thus Spake the Buddha

- 7.1. Kumar, depicting the death of a poet, describes his verses (his own verses) as jumble of ambiguities. The lines, he quotes to support his viewpoint are marvellous pieces of generalization-

*that a flower's eye has a better
perception than the human retina
that even in the fraternity of stars
there are feuds, but they close up
their ranks when it comes to challenging
the moon's suzerainty-----.* **(Death of a Poet.3)**
- 7.2. Desire, an unbridled stallion and body's appetite need restraint as-
*Body's appetite like a crocodile's belly,
can hold rock, metal
and a virgin's thigh.* **(Thus Spake the Buddha.5)**
- 7.3. Yearnings, if satiated, may sublimate-
*The way to satiate a yearning
is to sublimate it.* **(Thus Spake the Buddha.5)**
- 7.4. All the mysteries cannot be revealed; even soothsayers can not unfold them-
*But darkness guards all mysteries
even beyond the ken of a soothsayer.*
(I was Old Before my Death.6)
- 7.5. Any kind of hoarding is a sin while sharing it with others may lead to the emancipation of the soul-
*If hoarding is a sin,
sharing emancipates the soul.*
(Inside the Womb.10)
- 7.6. One can not remain confined and unnoticed for long; the laser of the sun must detect him one day-
*How long can one remain fortified
inside, unscathed by the sun?*
(Inside the Womb.10)
- 7.7. Death is imminent and no safeguard is impregnable for the man in mask-
-----*there's no shield
against the man in mask.*
(Putting an Old Sick Dog to Sleep.11)
- 7.8. Waterfalls are the testimony to their invincible strength and hence the poet says-

- water
is more potent than rock,
more lethal than a woman's fangs.
(Niagara Falls.25)
- 7.9. Any confession without penance is meaningless-
But if confession without penance
could work, a parrot would claim
rebirth as a bird of paradise.
(A Temple atop a Hill.26)
- 7.10. Anger, the biggest enemy, as described in our
scriptures can wreck havoc, if not controlled in
time-
Tempered in the oven of a sizzling
throat. even human teeth may grow
into tusks, charging at giant windmills. (Anger.27)
- 7.11. Any causality in the family must mar the happiness
of the celebration of a festival-
A happy Diwali is for those who had
an unblemished year-
no death in the family-
of man, animal or sapling. (A Damp Diwali.31)
- 7.12. External natural environment, no doubt contributes
to the sustenance of a seed, fruit and flower but
without love and care it is not at all possible-
Love, not the sun, is real
sustenance to seed, fruit flower
and the soul. (The Himalayas.34)
- 7.13. One has to face the hard realities in life; no one can
survive on mere reflections-
How long can one live
on mere reflections?
(The Himalayas.35-36)
- 7.14. There is no one-to-one relationship between desire
and consummation-
Too much or too little,
but never the scale between
desire and consummation.
(Lake Gandipet, Hyderabad.37)
- 7.15. Juxtapositions and paradoxes have two faces -
The way inside is the way out
to understanding-
that each paradox carries two faces :
fruit and worm, beginning and end.(Meditation.44)
- 7.16. Frequent occurring of the reminiscences from the
past are sure to destroy one's present and future-
Phantoms from the past, you know,
can ambush the present and hold the future
to ransom.----- (A Letter to Sharad.47)
- 7.17. Pain is the inseparable part of life; it comes with the
birth and goes with death-
Pain -----is born
in the mother's womb, and ends only
when the ashes are silenced-
by a sprinkling of milk. (Renunciation.56)
- 7.18. With poise and passivity between body and mind,
intuition and reason, one can perform wonders-
It is possible even on
a slender branch if one can balance
both body and mind.----- .
(Birds' Homecoming at Sunset.57)
- 7.19. The crude fact of life is that neighbours, friends,
relatives, all change with the passage of time and
we must reconcile to it and make continuous efforts
to minimise the attachment which causes nothing but pain-
-----Neighbours

of yesterday might have migrated
to some other land. And no one from
one's progeny ever returns home.

The kaleidoscope changes its pattern
each evening to remind one that
attachment generates only anguish.

(Birds' Homecoming at Sunset.57)

8. Losing My way

- 8.1. Offspring of words which lay eggs on paper, never
die-
-----Only words which
lay eggs on paper and whose
offspring never die. (Hamlet.3)
- 8.2. There is nothing like purity of blood; it is only a
myth which prevails in our society-
Purity of blood - the thin line
that divides Bermuda grass from
weeds - is a myth created by
those whose vision is impaired
by jaundice. (Weeds.4)
- 8.3. Bidding of Adam to God unveils Kumar's views on
God and the earth-
We know the journey down to earth
is fraught with danger. Nightmares, disease
and death. Animals, birds and humans
eating up their own progenitors.
But, inspite of the enveloping gloom,
we know your compassion would
impel you to call us back someday.
Because divine grace punishes
to forgive and kills to regenerate.
Doesn't sinning carry within its womb
the seeds of redemption? (Adam to God.7)
- 8.4. To conclude the poem 'Vandana Weds Ramesh',
the Indian father's promise never to forget her
though she is going abroad, to a distant place,
Kumar generalizes and writes-
Time and distance are only
for unbelievers. (Vandana Weds Ramesh.11)
- 8.5. The poet still can recall the visage of the river easily
because-
Faces don't change. Only lineaments
deepen into grooves
and the complexion turns sallow.

It's the heartache that snaps
the bond between fruit and branch. (Déjà Vu.14)
- 8.6. Anonymity is perhaps the best camouflage-
Anonymity is a chador that covers
up all pimples on the soul.
(Two Strangers on a Train.17)
- 8.7. Freedom is availed and enjoyed by a few chosen
people in this world-
----- A leash on the
soul only impoverishes it. But freedom
too is not meant for everyone.
(Whisperings of Immortality.18)
- 8.8. Commenting on the taboos regimented against all
what is instinctive and intuitive, Kumar writes-
Pain is born when the honey-
bee returns to the belly-button
of the same flower,
again and again. (Peacocks mating.28)

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- 8.9. Experience for Kumar is more authentic even than divinity-
Isn't the voice of experience more authentic than even divinity's, which often sounds like a matron's?
(Bhishmpitamah to Yudhishter Dharmaraj.31)
- 8.10. Truth can only be perceived through the eyes of the pain, not through those of luxury and joy-
-----*it's only through pain's eye that you can perceive truth-*
-----*The way to see is to go blind, and the way to fly is to crawl on your belly.*
(Bhishmpitamah to Yudhishter Dharmaraj.33)
- 8.11. The poet's comment on window shopping subtly expands into a generalization-
With no silver in hands, you may still look at the earth's treasures through the slits of a cloud. Distance shields on from the flame of touch. Inside the glass-house, images look larger than life. -----

glass windows are such stuff as dreams are made off. **(Window-shopping.36)**
- 8.12. Destinations are generally far away from reality-
A destination is often a mirage. **(Lying Low.P.40)**
- 8.13. Describing street children as 'born of cyclone, earthquake and drought', Kumar generalizes and writes-
Identity is for those who are lullabied in cradles, and fed on honey and dreams. **(Street Children.41)**
- 8.14. It does not matter whether it is burial or cremation, after death-
Does it matter at the end of the day, it's burial or cremation? the dust eats it all up - bone, flesh and dreams. **(Street Children.41)**
- 8.15. What the underground man says to Lisa transcends the limits of time and space-
In each soul there are corridors - dark, wet, narrow and circuitous. But at every curve stands a Moses to lead one to Mount Sinai.
(On Reading Dostoevsky's 'Notes from Underground'.42)
- 8.16. He further admits that though she is extremely beautiful yet all physical beauty is short-lived. What survives is only divine love -
But beauty is a whiff of lavender, a freak drizzle on a broiling day. What will survive beyond the tombstone is only divine love.
(On Reading Dostoevsky's 'Notes from Underground'.42)
- 8.17. Darkness and music represent intuition while daylight, reason, and hence the poet says-
Darkness has an ear for music while daylight is only for polemics.
(In Memory of Begum Akhtar.45)
- 8.18. To keep the spirits high in order to lead a full, vibrant life and get success is necessary-
'The way to live is not to crawl or whimper, but charge into the stone wall.'
(Riding a horse.49)
- 8.19. The insurgent tidal waves of undesirable desires must be tamed-
-----*the insurgent tidal waves must be tamed, and the wind's bowl muzzled to silence.* **(Telling Beads.50)**
- 8.20. About the creation of a poem, the poet says-
A poem is born when words wing down from the sky, chorusing like nightingales with holes in their throats. **(Words.55)**
- 8.21. Foresight has got its own limitations and it cannot help one to penetrate all the mystery-
There's no bourn between street and pavement, truth and perjury, gesture and intent. It's all the same. Your foresight can not carry you beyond the next step **(The Mist.56)**
- 8.22. Definitions of love and life, given by the poet, in the poem 'A Poets' Meet' carry the undertones of generalization-
-----*Love-----*
is a yellow creeper with ambrosia dripping from its poppy flowers.

---Life-----is a river that circles back to its origin, like a snake catching its own tail.
(A Poets' Meet.57)
- 8.23. It is victory alone which is celebrated; no one cares for the vanquished and defeated-
-----*No resurrection*
for the vanquished. **(A Cock-fight.61)**
- 8.24. The ways of temptation are sly and in order to catch a star, it is necessary to keep one's palm open-
Sly are the ways of temptation.

The way to catch a star is to keep your palm open.
(Feeding the Pigeons.62)

Interpretation

As the above data clearly shows, Kumar's major focus is there on the dichotomy between intuition and reason and he stands for intuition's supremacy. That is why the maximum number of generalized statements (31) -1.4, 2.1, 2.2, 2.11, 3.2, 3.8, 4.13, 4.18, 5.1, 5.2, 5.5, 5.20, 5.23, 5.26, 5.30, 6.4, 6.13, 6.14, 6.24, 6.27, 6.30, 6.32, 6.33, 7.1, 7.3, 7.12, 7.18, 8.3, 8.8, 8.10, 8.17 dwell upon this juxtaposition. Eleven citations above - 2.4, 2.5, 4.7, 4.8, 4.20, 5.16, 5.17, 5.22, 6.19, 6.35 and 8.18 are based on the theme of the significance of devotion hard work and full blooded endeavour in order to perform a work successfully. It is also important that before taking up a task in hand one should be sure of one's competence and capacity to do it. Half-hearted endeavours always lead to failures. Further, the moments of love require total surrender to each other, with no hypocrisy, no verbalization, no arguments, and no discussion. Any rational, mathematical approach is sure to mar the total experience. The generalizations based on this theme are - 4.1, 4.10, 5.1, 5.24, 6.25, and 6.37. The poet has also generalized the concept of recollections, specifically the painful ones and advises to keep oneself away from them. However it is these recollections which play a vital role in the creation of art. -1.3, 2.7, 3.4, 6.10, 7.13, 7.16. He also talks of hopefulness in 2.8, 3.6, and 5.13. Destiny plays a pivotal role in human life. Sometimes we are left in a fix in front of it. -4.12, 4.17, 5.11, 6.21,

6.36, 640, 8.13. Darkness and night in Kumar represent intuition, but it is also the time when crime and sin takes place. -6.18, 6.22, 6.28. He expresses his views on anonymity in 6.17, 7.6, 8.6, and on juxtapositions in 6.6 and 7.15. Death has been focussed in 6.3, 7.7, and 8.14 while 7.2 and 8.19 dwell upon desire and restraint. 7.4, and 8.21 talk of unlimited mysteries. True love does not surrender to the limits of time and space which are meant for unbelievers. – 8.4, 8.5. 4.4, and 5.6 focus on self-control while 4.5 and 8.7, on freedom.

Besides 1.1, dwells upon loneliness, 1.2, doubt, 2.3, perversion, 2.6, flux and immortality, 2.9, On positive attitude, 2.10, age factor, 2.11, crabwise movements, 3.1, silence, 3.3, self control, 3.5, live-in relationship and marriage, 3.7, affirmation, 4.6, children, 4.9, production, 4.10, good instincts in bad people, 4.14, women, 4.15, love letter, 4.16, hypocrisy in religion, 4.19, instinct, 4.21, depression, 5.3, memories, 5.4, doublemindedness, 5.7, joy and mirth, 5.8, convincing a raw hand or a new convert, 5.10, tears and solace, 5.12, night, 5.14, innocence and piousness of childhood, 5.15, ordinary woman and whore, 5.18, raw materials and art, 5.19, sin and punishment, 5.21, hunger, 5.25, generation gap, 5.27, destruction and reconstruction, 5.28, importance of axis, 5.27, downfall and indifference, 6.1, sanctity of pre-dawn hours, 6.2, debunking of religion, 6.5, embarrassment in courts, 6.7, significance of good beginning, 6.8, consistent struggle in life, 6.9, value of light, 6.11, labour and hard work for the poor during the day, 6.12, limitations of religion, 6.15, importance of time, 6.16, silence v/s expression of emotions, 6.19, weak defence and humiliation, 6.23, animals, 6.26, value of recurrences and revivals for the sustenance of marriage, 6.29, powerful v/s weak, 6.31, innuendoes and inquisitions, 6.34, virtue and good v/s vice and evil, 6.38, old age and suffering, 6.39, sleep rest and good start, 7.5, hoarding, 7.8, potency of water against rocks, 7.9, confession and penance, 7.10, anger and havoc, 7.11, causalities and celebrations, 7.17, pain as part of life, 7.19, change, attachments and reconciliations, 8.1, words art and immortality, 8.2, purity of blood as myth, 8.9, experiences and authenticity, 8.11, window-shopping, 8.12, destinations and mirages, 8.15, weaknesses, hopefulness and help from gods, 8.16, physical beauty v/s divine love, 8.20, creation of a poem, 8.22, definitions of love and life, 8.23, importance of victory and 8.24, temptations.

Conclusion – In this way, all the aforesaid proverbial statements and generalized remarks cover a wide range of thinking by the poet on human behaviour. He has pondered over modern life very deeply and presented his beautiful thoughts in the form a type of definitions. Almost all the aspects of internal and external behaviour of human beings along with so many instinctive urges and intuitive perceptions and expressions have been taken into account.

The poet has succeeded to comprehend an elaborate discussion on the predominating controversy between intuition and reason. Through different generalizations, he has also presented his views on love, sex, marriage, and consummation, role of destiny, significance of hard work, labour and devotion, positive attitude, self control, freedom, anonymity, darkness and night, desire and restraint, mysteries of life and even on the creation of a poem etc. As a whole, these expressions, thus,

give a candid glimpse of kumar's views on various topics and comprehend his thinking.

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Sustainable Development with Optimizing Quantity of Soil Pollutants from Industries: A Goal Programming Approach

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Abstract

Soil is a basic resource and plays a vital role in sustenance of all kinds of life on the planet. It is most valuable but unfortunately non renewable resource. If we will tame it wisely, it will provide a healthy and good life to us and if it is abused it will collapse and take life away with it. Now-a- days due to ignorance and selfish motives under the influence of ethics of development we are neglecting the maintenance of quality and life of our soil. This paper is trying to present a Weighted Goal Programming (WGP) model on six different soil pollutants coming from different type of industries. Also we are trying to optimize quantity of pollutants by treatment and the yield of industries to satisfy both ecosystem and development process. The model may be helpful to both environment planners and industrialists while facing soil pollution problems.

Key Words: Weighted Goal Programming (WGP), soil pollutant, treatment of pollutants, ecosystem and yield of industries.

Introduction

Soil is a sustainable resource which supports life of flora and fauna of each and every ecosystem of this planet. It is a very basic and non renewable resource. In this race of development we are continuously spoiling the natural quality of our soil by throwing xenobiotic chemicals into it. Today we are standing on the cross roads of development and ecological balance, so it becomes our humble duty to think on both the aspects of the problem.

Soil is mixture of both organic and inorganic components derived from transformation of rocks. The inorganic part is composed of rock fragments and very fine mineral particles. The organic part is composed of dead and decaying remains of plants and animals. Whenever there is any imbalance in quantity of these parts or some foreign material gets mixed into the soil, it leads to contamination or pollution of soil. Thus, the process of buildup of toxic compounds, chemicals, salts, radioactive materials, plastic, disease causing agents into the soil which alter the quality or composition of soil and further affects the growth of plants and health of human beings adversely is termed as soil pollution.

It is an issue of serious concern because it is the soil on which we live and get our food supply. It is not actually a result of a single human activity but it is a complex outcome of number of activities like mining, oil and fuels dumping, leaching, discharge of industrial waste, drainage of contaminated water and sewage sludge in soil, etc. During this process of soil pollution build up, the pollutants get accumulated in soil and further are absorbed by plants, micro and small organisms. The organisms get poisoned and die due to which the organic activities inside the soil gets obstructed and gradually soil loses its fertility. When these pollutants are absorbed by plants then they enter the food chain and adversely affect the animal metabolism. Some amount of pollutants are naturally disposed by micro-organisms but due to high industrialization the amount of pollutants has risen up to a critical level where natural agents become helpless so it has to be treated well before disposal. Apart from it yield of industries is an important aspect as we cannot ignore development.

Thus in this paper we are presenting a WGP model which can be helpful in reducing soil pollution with maintain the pace of development.

Goal Programming

Goal programming (GP) is an important analytical approach devised to solve many real world problems, where targets have been assigned to all attributes and where decision makers (DM) are interested in minimizing the non achievement the corresponding goal. [Chin Nung Laio]. GP was first introduced by Charnes and Cooper (1961) and further developed by Lee (1972), Ignizio (1976), Tamiz et.al. (1998), etc.

Generally GP minimizes undesired deviations from target values. In this method the DM can consider many goals simultaneously during the search for compromise solution and is supported by Mathematical Programming Optimization Potential (Martel and Aouni, 1998). GP is a powerful tool which draws upon the highly developed and tested techniques of LP but provides a simultaneous solution to a complex system of competing objectives (Banashri Sinha and N Sen, 2011).

GP is a mathematical programming technique which treats the constraints of linear programming problem as their goal. Linear programming as a goal in the objective function, optimization means coming as close as possible to achieve these goals in order of priority by the decision maker. Goal programming is applicable to single or multiple goal although it is a greater usefulness occurs when the multiple goal are conflicting and cannot satisfied simultaneously.

Weighted Goal Programming (WGP) is also known as Archimedean GP. Its achievement function consists of both the unwanted deviation variables associated with rigid constraints and flexible constraints each weighted according to priority. As long as the unwanted deviations are minimized, we achieve a satisfactory solution. The mathematical of a WGP model is as:

Minimize $\sum (\alpha_i d_i^+ + \beta_i d_i^-)$, $i = 1, 2, 3, \dots, n$.

Subject to: $f_i(X) + d_i^+ - d_i^- = g_i$, $i = 1, 2, \dots, n$.

$d_i^+, d_i^- \geq 0$, $i = 1, 2, \dots, n$.

$X \in F$ (F is a feasible set). [Chin Nung Laio, 2008]

Our Pollutants

In this paper we are considering six different pollutants namely red mud coming out from aluminum industries, lime sludge the byproduct of paper industry, basic slag produced by steel industry, press mud a waste from sugar industry, fly ash waste from thermal power plants and sewage sludge from municipal areas.

- 1. Red mud:** It is an alkali effluent which is discharged from alumina industry during the process of melting of bauxite. It makes soil alkaline, increases salt and metal content and vast area of land is unnecessarily consumed during disposal.
- 2. Lime sludge:** It is the main byproduct from paper industry which contains calcium carbonate and sodium. It makes soil alkaline and gets deposited in plants which affects adversely in large quantities.
- 3. Basic Slag:** It is the waste produced from steel and allied industries. It is largely lime stone or dolomite which has absorbed phosphate from the iron ore. It is highly alkaline in nature and phosphates in large quantity adversely affect plant and animal health.
- 4. Fly ash:** It is one of the residues generated in combustion of coal and wood. It is highly toxic and considerably increases the pH of soil. Also it causes accumulation of heavy metals in plants and animals causing serious diseases.
- 5. Press Mud:** It is one of the byproducts of sugar industry. Although it is a good fertilizer but its accumulation in large quantities leads to increased salinity of the soil. Also if used in large quantities causes introduction of metals in food chain which is harmful to human health.
- 6. Sewage Sludge:** It is a big problem as it is unavoidable waste of human and animals. It contains heavy metals like lead, cadmium, chromium, zinc and

mercury which can cause serious health hazards. [S.K.Sahu, K.C.Pradhan, D.Sarangi, 2004].

Goal Programming Model

Considering the minimization of the six pollutants and maximization of waste treatment along with industrial yield as our priority we can formulate the model as:

Minimize $Z = W_R d_1^+ + W_P d_2^+ + W_{BS} d_3^+ + W_{PM} d_4^+ + W_R d_1^- + W_F d_5^+ + W_{SS} d_6^+ + W_T d_7^- + W_Y d_8^-$

Subject to:

$$\sum R_i x_a + d_1^- - d_1^+ = \alpha$$

$$\sum L_i x_p + d_2^- - d_2^+ = \beta$$

$$\sum B_i x_1 + d_3^- - d_3^+ = \gamma$$

$$\sum P_i x_s + d_4^- - d_4^+ = \delta$$

$$\sum F_i x_t + d_5^- - d_5^+ = \lambda$$

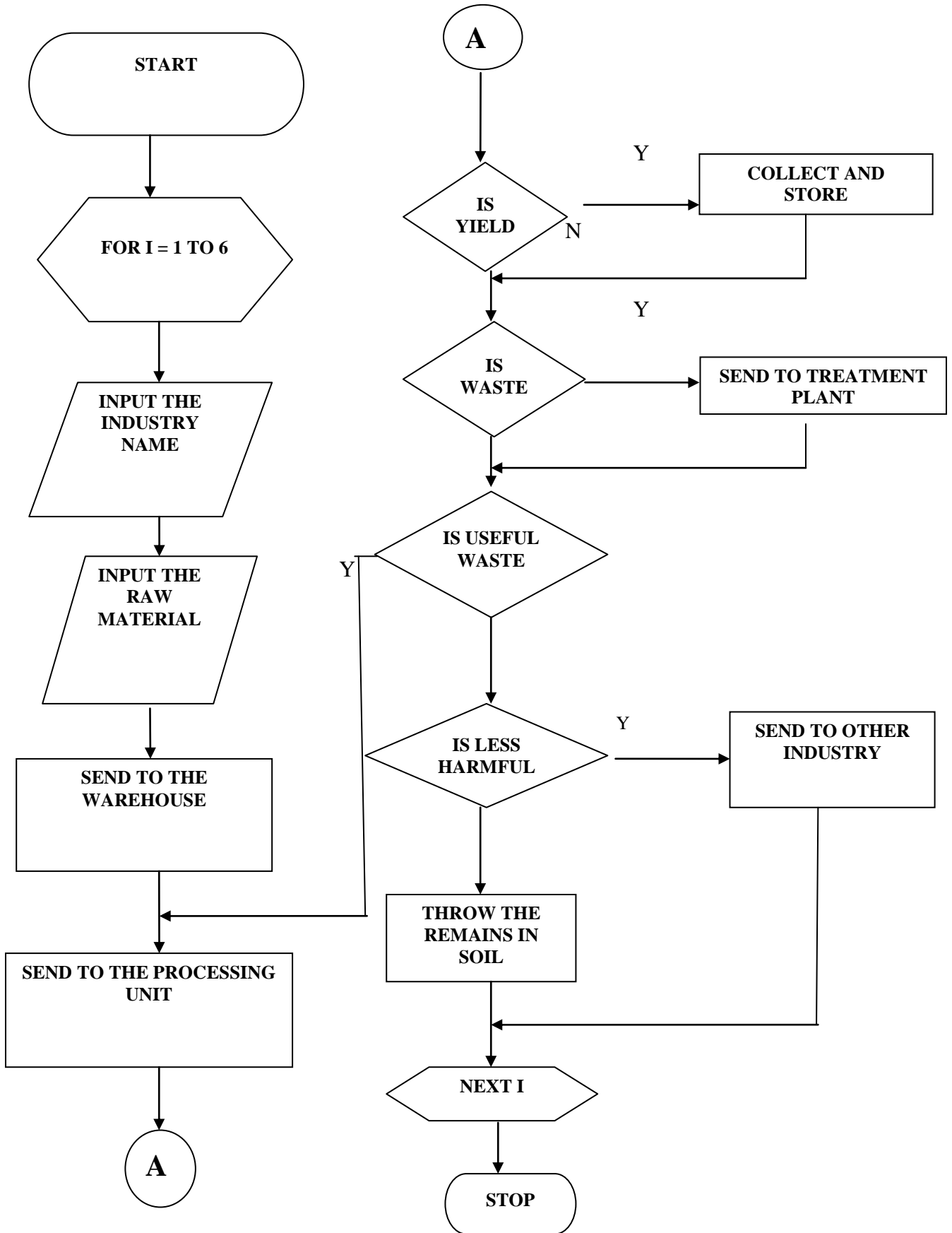
$$\sum S_i x_m + d_6^- - d_6^+ = \mu$$

$$(\sum TR_{ij} + \sum TR_{ij} + \sum TR_{ij} + \sum TR_{ij} + \sum TR_{ij} + \sum TR_{ij}) t_j + d_7^- - d_7^+ \geq \sum \xi_j^{\max}$$

$$(\sum Y_i^A + \sum Y_i^P + \sum Y_i^I + \sum Y_i^S + \sum Y_i^T + \sum Y_i^M) t_j + d_8^- - d_8^+ \geq \sum \psi_j^{\max}$$

(Flow Chart given on next page)

Flow Chart



Symbols and Notations

R_i = Unit amount of red mud from i^{th} aluminum industry.
 L_i = Unit amount of lime sludge from i^{th} paper industry.
 B_i = Unit amount of slag from i^{th} iron and steel industry.
 P_i = Unit amount of press mud from i^{th} sugar industry.
 F_i = Unit amount of fly ash from i^{th} thermal power plant.
 S_i = Unit amount of sewage sludge from i^{th} municipal area.
 x_a = number of aluminum industries in the area.
 x_p = number of paper industries in the area.
 x_1 = number of iron and steel industries in the area.
 x_s = number of sugar industries in the area.
 x_t = number of thermal power plants in the area.
 x_m = number of municipalities in the area.
 $\alpha, \beta, \gamma, \delta, \lambda$ and μ = maximum amount of pollutant that can be accepted by a given soil.
 TR_{ij} = Amount of red mud from i^{th} industry treated in j^{th} plant per hour.
 TL_{ij} = Amount of lime sludge from i^{th} industry treated in j^{th} plant per hour.
 TB_{ij} = Amount of basic slag from i^{th} industry treated in j^{th} plant per hour.
 TP_{ij} = Amount of press mud from i^{th} industry treated in j^{th} plant per hour.
 TF_{ij} = Amount of fly ash from i^{th} thermal power plant treated in j^{th} plant per hour.
 TS_{ij} = Amount of sewage sludge from i^{th} municipality treated in j^{th} plant per hour.
 t_j = Number of working hours of j^{th} treatment plant.
 ξ_j^{max} = Maximum capacity of j^{th} plant to treat waste.
 Note: Values of j ranges from 1 to 6 as different treatment plants are required to treat different kind of waste.
 Y_i^A = Yield of i^{th} aluminum industry which gives profit.
 Y_i^P = Yield of i^{th} paper industry which gives profit.
 Y_i^I = Yield of i^{th} iron and steel industry which gives profit.
 Y_i^S = Yield of i^{th} sugar industry which gives profit.
 Y_i^T = Yield of i^{th} thermal power plant which gives profit.
 Y_i^M = Yield of i^{th} municipality which gives profit.
 t_i = Number of working hours of i^{th} industry.
 ψ_j^{max} = maximum yield expected from i^{th} industry.
 $W_R, W_P, W_{BS}, W_{PM}, W_F, W_{SS}, W_T, W_Y$ are weights associated with the deviational variables.
 d_i^+, d_i^- are the deviational variables.

Conclusion

The model has been developed by taking both ecosystem conservation and industrial development into consideration. The priority has been given to different goals but it would be better option if priority is given according to nature of soil and industries present in the area of study. Data collected from various areas can be applied and solved using softwares like LINDO, LINGO, etc. It is quite possible that the decision variables presented in this study satisfy maximum possible factors responsible for changing the aspiration levels. Thus, this paper can be taken as a basic study and use of more constraints can bring improvement in it.

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Highly Geo-effective Solar Transients and Their associated Geomagnetic Activities



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Abstract

The solar Cycle 23 has shown some peculiar features, i.e. slow and prolonged decline phase. It is when combined with the ascending phase of Cycle 24, it provides us a long phase during which the overall magnetic activity was very low. During this interval the average sunspot number appeared on the solar disk were very low and signifies the weak polar magnetic fields, and solar wind streams mainly originating from coronal holes. The study investigate the relationship between magnetic structure of coronal holes and/or coronal mass ejection (CME) source region and their influence on Earth's geomagnetic field, i.e. storms and sub storms. Mainly considering very intense geomagnetic storms that occurred during Solar Cycle 23. The disturbance storm time index Dst is taken as an indicator of geomagnetic activity by setting a value of $Dst_{min} \leq -200$ nT as threshold. By examining halo CMEs that erupted between 2000 to 2008. We selected 07 events associated with M-class and X-class solar flares. Furthermore, as the geomagnetic field (B_{Geomag}) puts a lower cutoff rigidity (R_c) to the entry of cosmic particles in to the earth, depending upon the geomagnetic activity. Sometimes when this entry of charged particles exhibits very sudden sharp and short lived increases in cosmic ray intensities, registered by neutron monitor, it is termed as Ground-level enhancement (GLEs). These enhancements are known to take place during the result of powerful solar eruption. In this present investigation we also studied GLE events associated with solar flare and coronal mass ejection (CMEs). The spacecraft data acquired by STEREO mission and those provided by SOHO, ACE and geomagnetic stations like WDC-Kyoto are utilized in the study. It is found that the GLE's are well associated to X-class solar flares. The average speed (1674.2 Km/s) of GLE associated CME was much faster than the average speed (306.9 Km/s) of non GLE associated CMEs.

Introduction

One of the main objectives in space weather research is to predict the occurrence of geomagnetic storm based on real time solar observations. A severe geomagnetic storm may produce many harmful effects on earth, such as radiation hazards to humans, especially to astronauts, disruption of communication, navigation and satellite control systems, damage of electric power grid and so on [1]. Geo-magnetic storms generally occurred due to abnormal conditions in the interplanetary magnetic field (IMF) and solar wind plasma emissions caused due the various transient phenomenon occurring on the surface of Sun [2]. The occurrence of prominences and flares are also associated with varying phases of sunspot cycle leading to the geomagnetic storms. The strength of interplanetary magnetic field (IMF) and its fluctuations have also shown to be most important parameter affecting the geomagnetic field condition. It is now a well established fact that the southward direction of interplanetary magnetic field, allows sufficient energy transfer from the solar wind into the Earth's magnetosphere through the magnetic reconnection process [3-5].

A solar flare is a sudden brightening observed over the Sun surface or the solar limb, which is interpreted as a large energy release of up to 6×10^{25} joules of energy (about a sixth of the total energy output of the Sun each second). Solar flares affect all layers of the solar atmosphere (photosphere, chromosphere, and corona), when the medium plasma is heated to tens of millions of kelvins and electrons, protons, and heavier ions are accelerated to near the speed of light. They produce radiation across the electromagnetic spectrum at all wavelengths, from radio waves to gamma rays, although most of the energy goes to frequencies outside the visual range and for this reason the majority of the flares are not visible to the naked eye and must be observed with special instruments. Flares occur in active regions around sunspots, where intense magnetic fields penetrate the photosphere to link the corona to the solar interior. Flares are powered by the sudden (timescales of minutes to tens of minutes) release of magnetic energy stored in the corona. The same energy releases may produce coronal mass ejections (CME), although the relation between CMEs and flares is still not well

established. The frequency of occurrence of solar flares varies, from several per day when the Sun is particularly "active" to less than one every week when the Sun is "quiet", following the 11-year cycle (the solar cycle). Large flares are less frequent than smaller ones. Solar activities vary with an 11-year cycle there are typically more sunspots on the sun, and hence more solar flare [16].

A coronal mass ejection (CME) is a massive burst of solar wind, other light isotope plasma, and magnetic fields rising above the solar corona or being released into space. Recent scientific research has shown that the phenomenon of magnetic reconnection is responsible for CME and solar flares. When the ejection is directed towards the Earth and reaches it as an interplanetary CME (ICME), the shock wave of the traveling mass of Solar Energetic Particles causes a geomagnetic storm that may disrupt the Earth's magnetosphere, compressing it on the day side and extending the night-side magnetic tail. When the magnetosphere reconnects on the nightside, it releases power on the order of terawatt scale, which is directed back toward the Earth's upper atmosphere [17]. The relationship between solar flares and Coronal Mass Ejections (CMEs) is a big issue in solar physics (e.g., Gosling 1993; Hudson et al. 1995). Both of these phenomena often occur in conjunction but the relationship is not one to one; the exact nature of the flare and CME triggers and the relationship between the cause and consequence is still open and quite puzzling. Kahler (1992) pointed out that if the CME is associated with a flare then the CME originates in the explosive phase of the flare and such flares are long-decay events (LDEs); but the relationship of CMEs with impulsive flares is still unknown [18].

Solar flare and CME's are produced in sporadic solar eruptions. Solar flares and CME are in the larger ones. The distinction between solar flare and CME is that a solar flare is a sudden flash of electromagnetic radiation, whereas a CME is a mass motion in the solar corona that can be seen in a coronagraph. The spatial relationship between flare and CME depend on the magnetic field configuration involved in the solar eruption process. Flares are perhaps photospheric and CME and CME are chromospheric [19]. The flares erupt from the intensely luminous area of the sun, whereas the CMEs are ejected from an incandescent and transparent layer of gas lying above and surrounding the photosphere. So flares can presumably trigger CMEs. However, there are also arguments that both phenomena might originate from the same active region of the solar disk even though they have different manifestation. Detailed explanations can be found in several studies [e.g., Kahler et al., 2001; Dorman, 2004; Yashiro et al., 2008; Belov, 2009]. Intense solar flares and fast CMEs consisting of entrained magnetic fields have enough potential to create turmoil in the earth's atmosphere [e.g., Manchester et al., 2005; Wang and Wang, 2006]. Namely, electromagnetic emissions produced by solar flares penetrate the Earth's atmosphere and change particle environment on the Earth, consequently disrupting radio transmissions. X-ray flares and CMEs may also cause sharp rise in cosmic ray intensities in the Earth. So, a study on characteristics of GLE- associate SEPs, X-ray flares, and CMEs can be useful for the understanding of cosmic rays and space weather. This is our motivation to pursue this study [20]. In this paper the statistical study has been performed to analyze these geomagnetic storms recorded by various geomagnetic observatories identified with the help of

Disturbance storm time index (Dst). This Dst index is taken as an indicator of geomagnetically disturbed condition, as it represents the depressions in the ring current as a result of its interaction with the plasma signatures having their roots originated at solar surface or from some other exotic environment. We investigated various solar parameters/ interplanetary magnetic field components which were potentially geo- effective and occurred during the solar activity period of solar cycle-23.

II. Selection criteria and Data analysis

Disturbances in the geomagnetic field are caused by fluctuation in the solar wind impinging on the earth. The disturbances may be limited to the high-latitude polar region, unless the interplanetary magnetic field (IMF) carried by the solar wind has long periods (several hours or more) of southward component ($B_z < 0$) with large magnitudes. The occurrence of such a period stresses the magnetosphere continuously, causing the magnetic field disturbance to reach the equatorial region. The degree of the equatorial magnetic field deviation is usually given by the Dst index. This is the hourly average of the deviation of H (horizontal) component of the magnetic field measured by several ground stations in mid to low-latitudes. Dst = 0 means no deviation from the quiet condition, and Dst \leq -50nT means magnetic storms. We have analyzed the events represented by maximum Dst decrease and selected by using the selection procedure of Loewe and Prolos (1997). A list of magnetic storms, based on the Dst indices had been compiled for this study for the period 2000-2008. The Disturbance storm time index (Dst) is provided by the World Data Center for Geomagnetism at the University of Kyoto, Japan database (<http://www.swdc.kugi.kyoto-u.ac.jp/dstdir>). The study period refers to the interval solar cycle 23. We have used the Omni Web Data Results provided by the National Space Science Data Center (NSSDC) (<http://www.omniweb.gsfc.nasa.gov/>). Where the solar wind data have been compiled since 1963, using the observed data from 7 space satellites including the ACE, WIND and IMP. The Coronal Mass Ejection data used for the present study was adopted from the SOHO LASCO CME catalogue being maintained and provided by CDaw (http://cdaw.gsfc.nasa.gov/cme_list/halo/halo.html). The flares observed by PRL's "Solar X-ray Spectrometer (SOXS) were also used, the data of which is obtained from the SOXS's homepage website URL link at <http://www.prl.res.in/~soxs-data/> the link provide solar data of various activities, Earth's atmosphere and geo-space disturbances and data for other planets. The Solar X-ray Spectrometer provides solar flare observations in X-ray waveband in the energy range of 4-56 keV and it was launched onboard GSAT-2 Indian spacecraft in 2003 using GSLV-D2 rocket.

II. Observations

The fact that the solar activity is directly related to space weather and geomagnetic activity does rise and fall along with the solar activity. We study the period (2000-2008) of solar cycle 23, and find seven events associated with solar flare and coronal mass ejection. We selected 07 events associated with M-class and X-class solar flares. Ground-level enhancement (GLEs) is sudden sharp and short lived increases in cosmic ray intensities registered by neutron monitor. These enhancements are known to take place during powerful solar eruption. In this present

investigation we also studied 02 GLE event associated with solar flare and coronal mass ejection (CMEs). Both the GLE are as a result of X-class solar flares. The average speed (1674.2 Km/s) of GLE associated CME was much faster than the average speed (306.9 Km/s) of non GLE associated CMEs. In which one GLE event occurred on 14 July and second occurred on 29 October. On July 14, 2000, an X5 class flare erupted on the Sun and a coronal mass ejection was launched directly at the Earth. A geomagnetic super storm occurred on July 15-17 which caused an S3 radiation storm on Earth fifteen minutes later as energetic

protons bombarded the ionosphere. It was the biggest solar radiation event since 1989.^[24] The proton event was four times more intense than any previously recorded since the launches of SOHO in 1995 and ACE in 1997 [25]; the minimum of the Dst index was -301 nT. Despite the strength of the geomagnetic storm, no electrical power distribution failures were reported. The Bastille Day event was observed by Voyager I and Voyager II, [20] thus it is the farthest out in the solar system that a solar storm has been observed.

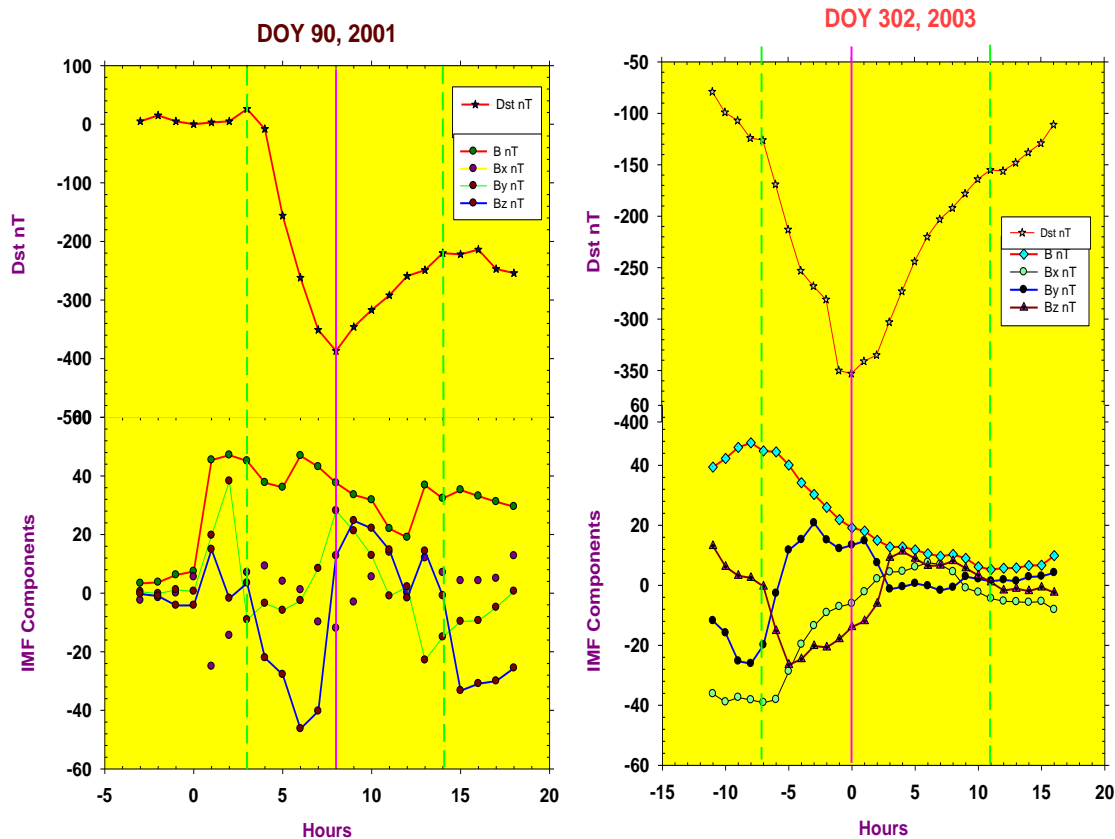


Figure 1: This figure depicts the geomagnetic field variation profile and the respective variation of interplanetary magnetic field (IMF) parameters, i.e. B_x , B_y , B_z and B_t observed during the selected events. Here Dst index has been taken as an indicator of geomagnetic activities and its values has been obtained from the World Data Center, Kyoto, Japan. The 0 on the X-axis represents the event onset, while the negative and positive values indicate the preceding and onward values.

IV. Results & Discussion

It is suggested that geomagnetic activity is related to variety of interplanetary plasma/ field parameters, e.g. Solar wind velocity V , interplanetary magnetic field (IMF) B and B_z [2]. Furthermore, the strong geomagnetic disturbance is associated with passage of magnetic cloud, which causes intense and severe geomagnetic storms [17, 21]. Recently, it is observed that geomagnetic activity during the declining phase of solar activity is highly related to high value of the product of solar wind velocity (V) and interplanetary magnetic field (IMF) strength B i.e., $V \times B$ leading to geomagnetic disturbances causing GMSs [21]. The electromagnetic and corpuscular radiations produce extra ionization in the sunlit part of the Earth and produce geomagnetic disturbances are observed and represented by different geomagnetic indices a_p , equatorial index, Dst and AE etc. Geomagnetic disturbances are driven by the

interaction of solar wind with geomagnetosphere and the strength of this interaction depends on the solar wind parameters. AE measures primarily the variations in the auroral electrojets. It is based on 1-min values of the H-Component trace from auroral - zone observatories located around the world. The data of these observatories are plotted as a function of universal time. The upper and lower envelopes are defined as AU and AL indices, respectively, and are believed to represent the maximum eastward and westward electrojets currents. The sum of the absolute values of AL and AU is called AE. Introduced in 1964, the ring-current index Dst measures primarily the ring-current magnetic field. It is based on hourly averages of the H component recorded at four low-latitude observatories, subtracting the average S_q and the permanent field from the disturbed magnetic field. Schwenn (2006) reviewed in details the solar processes associated with space weather

phenomena Dameris and Pawson (2002) reviewed the effects of solar activity on the middle atmosphere and found controversial results since no clear physical mechanism existed to explain the interactions. Further, it is extremely difficult to isolate any solar-induced variability, since the dominant influence on the middle atmosphere appears to be tropospheric forcing. Experiments with two types of numerical model used to examine the atmospheric response to changes in solar forcing were reviewed by them. Firstly, mechanistic-model simulations of the solar-induced 27- and 13-day oscillations show that weak perturbations generated in the upper stratosphere can lead to detectable oscillations in the lower atmosphere. Secondly, a general circulation model shows that the modulation of the middle atmosphere dynamics by solar activity and the equatorial quasi-biennial oscillation is feasible. There are limitations to the studies. Thus, it is utmost important to improve our current understanding on the identifying the solar disturbances and their interaction with atmosphere as a function of altitude. This will lead to understand the coupling process among magnetosphere, ionosphere and thermosphere of the Earth.

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Identification of solar features causing GMSs during solar cycle 21-22.



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Abstract

The effect of H α , X-ray- solar flares, Active Prominences and Disappearing Filaments (APDFs), Coronal Intensity (CI) on geo sphere has been investigated for solar cycle 21-22. In all 176 geomagnetic storms (GMSs) of Severe (S), Moderately Severe (MS) and Moderate (M) type with Ap \geq 20 have been considered. It is observed that H α and X-ray solar flare occurring over the western limb of the solar disk will cause the larger disturbances in magnetosphere leading to occurrence of S, M and Total (i.e., S + M + MS) GMSs; whereas, those solar flares which occur on the eastern limb of the solar disk will lead to occurrence of MS GMSs. Similarly the APDFs occurring over the western limb will cause S, M and Total GMSs where as APDFs occurring over the eastern limb will cause M GMSs. It is observed that maximum numbers of GMSs are associated with CI followed by individual H α and X-ray solar flare events. However, when the accumulated effect of H α and X-ray solar flare events are considered, in that case these solar flares become more dominant than CI to cause GMSs. It is observed that CI is found to possess a very good correlation with the occurrence of GMSs. It is observed that maximum numbers of GMSs are associated with importance of solar flares (SF) and closely associated with CI.

Keywords: GMSs, solar flares, APDFs, CI.

Introduction

PVP Geomagnetic disturbances are generally represented by geomagnetic storms. The geo space environment is dominated by disturbances directly by the Sun, such as solar flares, APDFs, and coronal mass ejections which are responsible for some large geomagnetic storms or else by disturbances, e.g. sub storm, occurring within the magnetosphere that are ultimately caused by solar wind variations (Gonzalez et al., 1994; Kumar and Yadav, 2003). The intense disturbances in geomagnetic field are known as GMSs. The large variations in the geomagnetic field are mostly caused by the disturbances on the solar atmosphere, which reaches on the Earth in the form of plasma and field through interplanetary medium. There are many solar activities eg, solar flares, APDFs, coronal mass ejections etc in the solar atmosphere, so a unique solar source for these geomagnetic activities (Kumar and Yadav, 2002).

Solar activity phenomenon exhibits some form of spatial asymmetry, especially North-South (N-S) asymmetry. The spatial asymmetries of the solar flares and APDFs are investigated by many workers (Verma, 1987; Atac and Ozguc, 2001; Kumar and Yadav, 2002). Most of the papers reveal the existence of a N-S asymmetry; however, there are different outcomes if the evolution of the N-S asymmetry is correlated with the solar cycle.

The solar corona is the outermost layer of the sun's atmosphere-a very hot halo (millions of degrees) that, in the form of the solar wind, extends well past the Earth's orbit. Coronal holes are the darker regions of lower density and temperature than the rest of solar corona. Data spanning 21 years made it possible to recognize some of the coronal holes are almost permanently visible on solar poles, except at the time of the maximum of the solar cycle. Solar wind in the form of plasma embedded with the solar magnetic field, causes disturbances in the geospheric sporadic phenomenon have been observed on solar disk which affect the geospheric condition and cause geomagnetic disturbance. GMSs are more associated with coronal holes than solar flares (Hewish and Bravo, 1986). Data available from sky lab mission suggest that coronal holes, APDFs have causal link with solar activity and produces GMSs. The coronal intensities are given in millionths of intensity of the solar disk (coronal units) and converted to the photometrical scale of Lomnický Stit Station at a height of 40" above the solar limb. The daily coronal intensity observations, with measurements taken every 5 degrees around the solar disk (counterclockwise).

In recent years, a number of investigations have been carried out to understand the solar-terrestrial relationship and to ascertain factors that are

responsible for geomagnetic storms (Feynman et al., 2000; Plunkett et al., 2001; Kumar et al., 2002). In the present analysis, geomagnetic storm events are characterized by horizontal component of earth's magnetic field (H) with index $A_p \geq 20$ during the period 1978-95. A storm is said to be Severe (S) if $H \geq 400$ n T; Moderately Severe (MS) if $250 \leq H \leq 400$ n T) and Moderate (M) if $H \leq 250$ n T.

2. Data Analysis

The Solar causes of geomagnetic storms with $A_p \geq 20$ during the period 1978-1995 total 176 GMSs have been investigated. For this solar wind plasma (SWP), Interplanetary magnetic field (IMF) data compiled by King and Couzens in different volumes of interplanetary medium data book from NSSDC and coronal intensity data provided by Dr. V. Rusin, Astronomical Institute, Slovak Academy of Sciences were used. For association of GMSs with solar features Solar Geophysical Data is being used (1978-1995).

3. Results and Discussion

The $H\alpha$, X-ray- solar flares, APDFs, CI and accumulated solar features are associated with S (37), MS (48), M (91) and Total GMSs have been investigated from the period Jan 1978 to Dec 1995 of the solar cycle 21-22. The associations of S, MS, M and Total GMSs with different solar features have been plotted in Table 1. It is observed that maximum numbers of GMSs are associated with CI followed by individual $H\alpha$ and X-ray solar flare events. However, when the accumulated effect of $H\alpha$ and X-ray solar flare events are considered, in that case these solar flares become more dominant than CI to cause GMSs.

It is observed from the Figure 1. that 56%, 65% and 100% of Total GMSs are associated with $H\alpha$ solar flares, X-ray solar flares, APDFs and CI respectively.

Further, the correlation coefficient between the yearly occurrence of GMSs and solar features such as $H\alpha$, X-ray solar flares, $H\alpha$ + X-ray solar flares, APDFs and CI has been calculated and found to be 0.82, 0.96, 0.94, 0.95 and 1.0. Further, it is observed that correlation is better in the case of Moderate GMSs followed by Moderately Severe and Severe GMSs. The solar coronal intensity is found to possess a very good correlation. It is observed from the Figure 2 and Figure 3 that no $H\alpha$, X-ray- solar flares have occurred beyond 40° N and 40° S. Further, it is observed from the Figure 4 that APDFs have occurred within 30° N and 30° S heliolatitudes. These results are in agreement with Kumar and Yadav (2002).

For the entire period of investigation the $H\alpha$, X-ray- solar flares and APDFs distribution in heliographic latitude for all types of GMSs have been observed and the results indicate that the $H\alpha$, X-ray- solar flares and APDFs in the northern hemisphere are more numerous than those in the southern hemisphere (except the $H\alpha$ solar flares causing S and M GMSs). Garcia and Dryer (1987) got the northern predominance of the solar flares in the 20 and 21 solar cycles. Temmer (2002) analyze the solar flares for the solar cycles 21 and 22 and reveals a slight (51.0%) and solar cycle 22 a distinct (56.2%) excess of flare events in the southern hemisphere. The longitude asymmetry of the $H\alpha$, X-ray-solar flares and APDFs distribution has also been investigated during the period under consideration. It is observed from the Figure 2 and Figure 3 that the distribution $H\alpha$, X-ray solar flares has been observed throughout from 0° to 90° East to 0° to 90° West. It is observed that $H\alpha$ and X ray solar flare occurring over the western limb of the solar disk will cause the larger disturbances in magnetosphere leading to occurrence of S.

M and Total GMSs; where as those solar flares which occur on the eastern limb of the solar disk will lead to occurrence of MS GMSs. Joshi (1995) using $H\alpha$ solar flares found no E-W asymmetry for solar cycle 21 and a small asymmetry for the solar cycle 22. Temmer (2002) found slight eastern excess both for solar cycle 21(51.2%) and solar cycle 22 (50.8%). It is observed from the Figure 4 that APDFs observed to be more effective when located at the extreme heliolongitudinally i.e., 80° to 90° East and West. Further, it is observed that APDFs occurring over the western limb will cause S, M and Total GMSs; where as APDFs occurring over the eastern limb will cause M GMSs. It is observed from the Figure 5 that maximum number of GMSs are associated with importance of SF, SN, IN, IB of each $H\alpha$ and X-ray solar flares. Further, the importance of SB of X-ray solar flares cannot be ignored. It is observed that importance of SF is more associated with all kinds of GMSs.

The coronal intensities are given in millionths of intensity of the solar disk (coronal units) streaming towards the earth results in to striking the Earth's magnetic field and triggering the geomagnetic storms. It has been observed from the Figure 6 that CI and solar wind velocity do not possess better correlation. Further more, it is observed that there are many occasions when eruptive streams and shock are unaccompanied by flare or filament activity anywhere on the disk. Somehow, the CI is being observed during this interval. Thus, it is concluded that CI have much greater ability to produce GMSs. It has been observed that maximum number of GMSs occurred in the year 1989 during the entire period of considerations, i.e. 1978-95. Further, it is observed that cosmic ray intensity shows decrease, few hours earlier than the occurrence of GMSs. It is also observed that maximum number of coronal intensity events took place in between 60° to 70° PA.

Conclusions

- (1) It is observed that $H\alpha$ and X ray solar flare occurring over the western limb of the solar disk will cause the larger disturbances in magnetosphere leading to occurrence of S, M and Total GMSs; whereas, those solar flares which occur on the eastern limb of the solar disk will lead to occurrence of MS GMSs. Similarly the APDFs occurring over the western limb will cause S, M and Total GMSs; whereas APDFs occurring over the eastern limb will cause M GMSs.
- (2) It is observed that maximum numbers of GMSs are associated with coronal intensity followed by individual $H\alpha$ and X-ray solar flare events. However, when the accumulated effects of $H\alpha$ and X-ray solar flare events are considered, in that case these solar flares become more dominant than coronal intensity to cause GMSs.
- (3) The solar feature maximum coronal intensity is found to possess a very good correlation with the occurrence of GMSs.
- (4) No $H\alpha$, X-ray solar flares have occurred beyond 40° N and 40° S whereas, the distribution of $H\alpha$, X ray Solar flares has been observed throughout from 0° to 90° East to 0° to 90° West.
- (5) $H\alpha$, X-ray solar flares and APDFs in the northern hemisphere are more numerous than those in the southern hemisphere (except the $H\alpha$ solar flares causing S and M GMSs).
- (6) Maximum number of GMSs are associated with importance of SF.

- (7) GMSs of all kind are closely associated with CI.
- (8) Maximum number of CI events took place in between 60° to 70° PA.

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Table: Different solar origin and their association causing Severe (S), Moderately Severe (MS), Moderate (M) and Total (S+MS+M) GMSs during the period 1978-1995.

| S.No. | Solar Features | S (37) | MS (48) | M (91) | Total (S+MS+M) |
|-------|--|--------|---------|--------|----------------|
| 1. | H α Solar flares | 28 | 30 | 56 | 114 |
| 2. | X-ray solar flares | 22 | 29 | 47 | 98 |
| 3. | APDFs | 29 | 30 | 91 | 127 |
| 4. | CI | 37 | 48 | 30 | 176 |
| 5. | H α , X-ray solar flares | 20 | 20 | 103 | 70 |
| 6. | APDFs, CI | 29 | 30 | 68 | 127 |
| 7. | H α solar flares, CI | 28 | 07 | 56 | 91 |
| 8. | H α X-ray solar flares, CI | 20 | 20 | 11 | 51 |
| 9. | H α , X-ray solar flares, APDFs | 17 | 17 | 24 | 58 |
| 10. | H α , X-ray solar flares, APDFs, CI | 17 | 17 | 24 | 58 |

Figure 1. Occurrence frequency of Total (S + MS + M) type GMSs with their associated solar

features such as H α -, X-ray- solar flares, APDFs, CI and their accumulated effects during the period 1978-95.

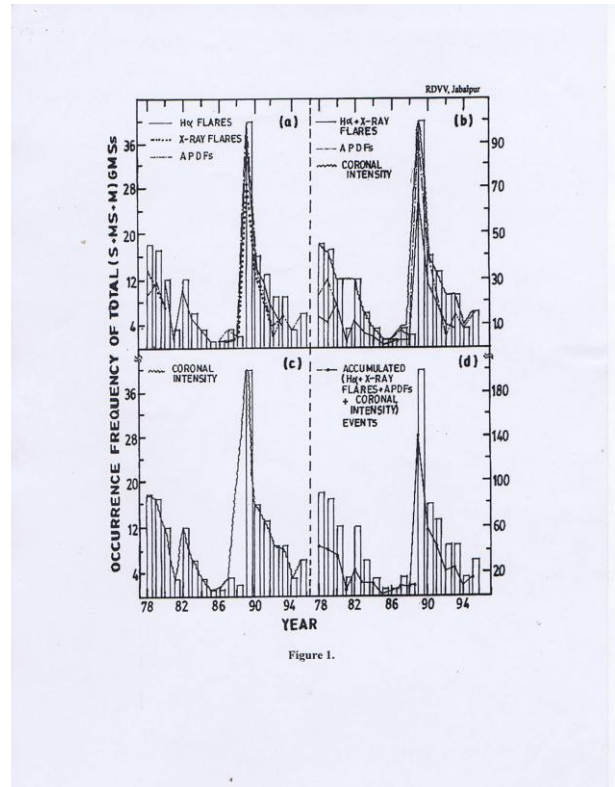


Figure 2. Occurrence frequency of H α solar flares (a) Helio-latitude and (b) Helio-longitude associated with Total (S + MS + M) type GMSs with their associated solar features during the period 1978-95.

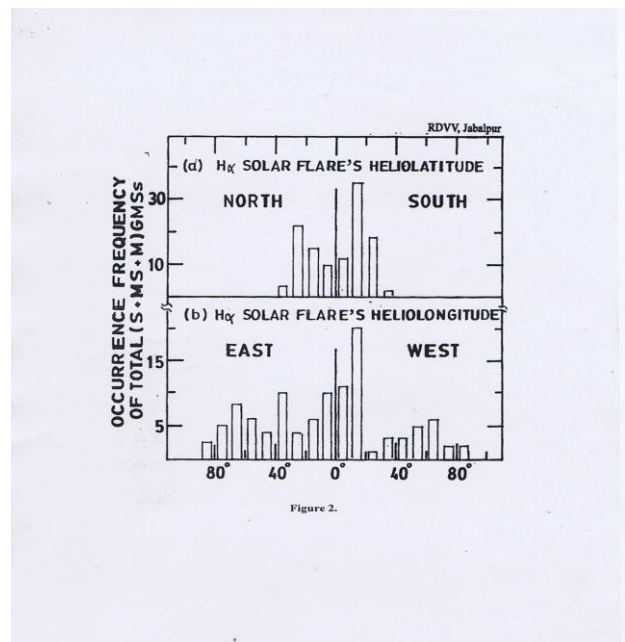


Figure 3. Occurrence frequency of X-ray solar flares (a) Helio-latitude and (b) Helio-longitude associated

with Total (S + MS + M) type GMSs with their associated solar features during the period 1978-95.

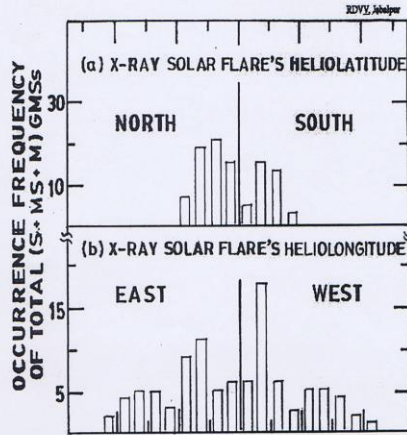


Figure 3.

Figure 4. Occurrence frequency of APDFs (a) Heliolatitude and (b) Heliolongitude associated with Total (S + MS + M) type GMSs with their associated solar features during the period 1978-95.

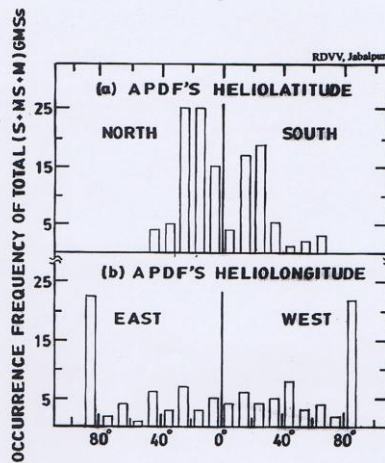


Figure 4.

Figure 5. Occurrence frequency of the importance of (a) H α solar flares (b) X-ray solar flares associated with Total (S + MS + M) type GMSs have been plotted histographically during the period 1978-95.

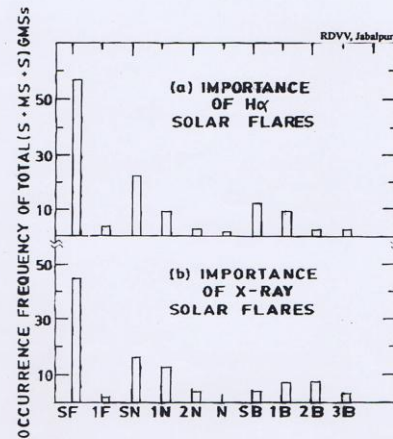


Figure 5.

Figure 6. Plot for Vsw and CI for Severe, Moderately Severe and Moderate type GMSs during the period 1978-95.

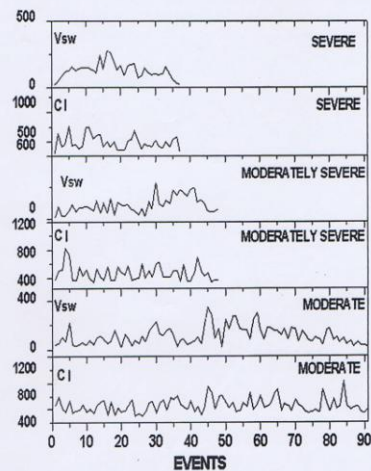


Figure 6.

Solar Wind Transient Plasma Events and their Characteristics Features



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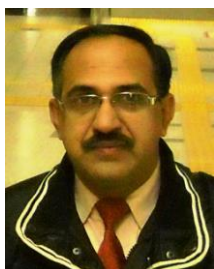
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Abstract

A geomagnetic storm is a global disturbance in Earth's magnetic field usually occurred due to abnormal conditions in the interplanetary magnetic field (IMF) and solar wind plasma emissions caused by various solar phenomenon. Furthermore the magnitudes of these geomagnetic effects largely depend upon the configuration and strength of potentially geo-effective solar/interplanetary features. In the present study the identification of 220 geomagnetic storms associated with disturbance storm time (Dst) decrease of more than -50 nT to -300 nT, have been made, which are observed during 1996-2007, the time period spanning over solar cycle 23. The study is made statistically between the Dst strength (used as an indicator of the geomagnetic activity) and the peak value obtained by solar wind plasma parameters and IMF B as well as its components. We have used the hourly values of Dst index and the wind measurements taken by various satellites. Our results inferred that yearly occurrences of geomagnetic storms are strongly correlated with 11-year sunspot cycle. We observed that IMF B is highly geo-effective during the main phase of magnetic storms, while it more significant at the time of storm peak, which is further contributed by southward component of IMF Bz, substantiating earlier findings. The correlation between Dst and wind velocity is higher, as compared with IMF Bz and ion density. It has been verified that geomagnetic storm intensity is correlated well with the total magnetic field strength of IMF better than with its southward component.

Introduction

Geo-magnetic storms generally occurred due to abnormal conditions in the interplanetary magnetic field (IMF) and solar wind plasma emissions caused by various solar phenomenon [1,2]. The study of these worldwide disturbances of Earth's magnetic field are important in understanding the dynamics of solar-terrestrial environment and furthermore because such storms can cause life threatening power outages, satellite damage, communication failure and navigational problems [2-4]. Since the beginning of the space age, the cause of geomagnetic activity has been sought in a number of correlative studies [1]. It is suggested that geomagnetic, activity is related to variety of interplanetary plasma/ field parameters, e.g. Solar wind velocity V , interplanetary magnetic field (IMF) B and B_z [1, 2, 4]. Furthermore, the strong geomagnetic disturbance is associated with passage of magnetic cloud [3, 4], which causes intense and sever geomagnetic storms [5, 6]. It is well established fact that solar wind is continuously emanating from the sun's outer corona and engulf the entire heliosphere. It mainly consists of hot electrons and protons flowing supersonically and caused due to extremely high coronal temperature helping ionized plasma to overcome the gravitation attraction of the Sun. The density and speed of this flow is highly variable and depends solely upon the conditions which has caused it to eject. The solar wind carries with it the magnetic field of Sun, which when enters to the interplanetary medium is termed as Interplanetary Magnetic Field (IMF). The strength and orientation of this magnetic field associated with solar wind depends up on its interaction between slow and fast solar wind originating from coronal holes and leads to create co-rotating interaction region (CIR) [1,5,7].

Geomagnetic disturbance are generally represented by geomagnetic storms and sudden ionosphere disturbance (SIDs). These are caused by the disturbances originated at solar atmosphere, interplanetary (IP) shocks and / or stream interfaces associated with high speed solar

wind streams (HSSWS) [8, 9]. These are associated with Coronal holes, which occur in Polar Regions or higher latitude. Fast CME produce transient IP shocks, which cause storm sudden commencement at earth. Geomagnetic storms are associated with isolated disappearing filaments [3,10,11]. The occurrence of prominences and flares are also associated with varying phases of sunspot cycle leading to the geomagnetic storms. The strength of IMF and its fluctuations have also shown to be most important parameter affecting the geomagnetic field condition. South direction of IMF, allows sufficient energy transfer from the solar wind into the Earth magnetosphere through magnetic reconnection [12-14]. As a geomagnetic storm lasts usually a few to several days in duration. However, sometimes the recovery phase of a geomagnetic storm lasts one to two weeks or even for longer durations. These kind of long-duration events were termed as High-Intensity Long-Duration Continuous AE Activity events (HILDCAA events). In a study of such events made by Tsurutani and Gonzalez (1987), it was suggested that continuous injections to the ring current take place during these events in such manner that the ring current does not, or cannot, decay rapidly [15-18]. Various studies have reported that these geo-effective events are further associated with CME's, solar flares, SEPs and also with other solar wind transients [19-22]. Which not only significantly produce the depressions in the earth's ring current but also modulates the cosmic ray intensity, causes Forbush decrease events, and produce ground level enhancement events too [23-24]. In this paper the statistical study has been performed to analyze these geomagnetic storms recorded by various geomagnetic observatories identified with the help of Disturbance storm time index (Dst). This Dst index is taken as an indicator of geomagnetically disturbed condition, as it represents the depressions in the ring current as a result of its interaction with the plasma signatures having their roots originated at solar surface or from some other exotic environment. We investigated various solar parameters/ interplanetary magnetic field components which were potentially geo-effective and occurred during the solar activity period of solar cycle-23.

Selection criteria and Data

The disturbances in the geomagnetic field are caused by fluctuation in the solar wind impinging on the earth. The disturbances may be limited to the high-latitude polar region, unless the interplanetary magnetic field (IMF) carried by the solar wind has long periods (several hours or more) of southward component ($B_z < 0$) with large magnitudes [2-4]. The occurrence of such a period stresses the magnetosphere continuously, causing the magnetic field disturbance to reach the equatorial region. The degree of the equatorial magnetic field deviation is usually given by the Dst index. This is the hourly average of the deviation of H (horizontal) component of the magnetic field measured by several ground stations in mid to low-latitudes. $Dst = 0$ means no deviation from the quiet condition, and $Dst \leq -50$ nT means magnetic storms [3,4]. We have analyzed the events represented by maximum Dst decrease and selected by using the selection procedure of Loewe and Prohss [9]. A list of magnetic storms, based on the Dst indices provided by the World Data Center for Geomagnetism, Kyoto, Japan through its world wide web (and also from the Omni web data source maintained by National Geophysical Data Center (NGDC) : (<http://www.ngdc.noaa.gov/stp/SOLAR/ftpsatenvir.html>) is being compiled for this

study for the period 1996-2007. As the study period refers to the interval solar cycle 23. We have used the Omni Web Data Results (www.omniweb.gsfc.nasa.gov) [10- 12, 25-26].

We deal with the sudden, sharp and short-lived depressions in the magnetospheric ring current and simultaneous solar parameters to understand the relationship. It is known that the intensity of solar parameters (e.g., solar flare, SEP flux etc.) is registered by satellite at the geostationary orbit in the near Earth space whereas the magnetic field variation and ring current depressions are recorded by a network of observatories well located all over the world. The data being compiled the world data center Kyoto and distributed to world scientific community. Ultimately, there is a time-delay between the registration of Dst and the registration of solar parameters. To find out the time-delay, we availed cross-correlation analysis. We used cross-correlation function because it shows correlations at different points of two waveforms thereby exhibiting all correlations between every two signals of the waveforms. The time-delay is then calculated as the time-length with respect to the specific wave point where the highest correlation is found. Cross-correlation analysis provides correlations between data of two time series or waveforms. The observations of one data series are correlated with the observations of another data series at various lags and leads. Cross-correlations help identify variables which are leading indicators of other variables or how much one variable is predicted to change in relation with the other variable. The cross-correlation test of two time-series data sets involves many calculations of the coefficient (r) by time-shifting the one data set relative to the other data set. Each shift is called a 'lag' and the lag time is simply the sampling period of the two time-series data sets. A typical cross-correlation graph shows enough lags in both negative and positive directions to show the cyclical relationship of the two sets of data. Detailed explanations on cross-correlation theorem, mathematical expressions and computation process can be studied in several books and papers e.g., Kuglin and Hines, 1975; Goshtasby et al., 1984; Mitra and Kaiser, 1993; Lewis, 1995; Qureshi, 2003 [32-36].

Result and Discussion

Electromagnetic fields and currents connect various regions of the Earth's near space environment extending up to the magnetopause. Realization of this fact has lead to the concept of Global Electric Circuit (GEC) to describe the electromagnetic environment of the Earth's atmosphere. Solar wind - magnetosphere - ionosphere coupling forms a vital component of GEC. Magnetospheric sub-storms represent a global interaction between the solar wind, the magnetosphere, and the ionosphere. Lakhina (1994) reviewed the solar wind - magnetosphere-ionosphere coupling processes with emphasis on the nonlinear particle dynamics in the magnetotail [3]. Those aspects of the sub-storm processes which involve the chaotic dynamics are highlighted. Various methods based on nonlinear particle dynamics, linear prediction filtering techniques, phase space reconstruction techniques, and dynamical analogue models of geomagnetic activity are reviewed. It is shown that the solar wind - magnetosphere - ionosphere system behaves as a strongly coupled nonlinear dynamical system which could be driven from regular to chaotic behavior with low dimensionality when the solar wind forcing is strong enough. Figure 1 presents maximum

values reached by the solar wind speed V versus negative Dst (max.). The scatter is larger, with a wide range of velocities varying between 400 and 900 kms^{-1} . The more intense geomagnetic storms (peak Dst < -350 nT) are not associated with greater values of solar wind velocities. The

correlation coefficient between V and peak Dst has been found to be -0.39. Figure presents the Interplanetary magnetic field versus the maximum of negative Dst. Statistically, the occurrence of more intense geomagnetic storms (negative Dst magnitudes

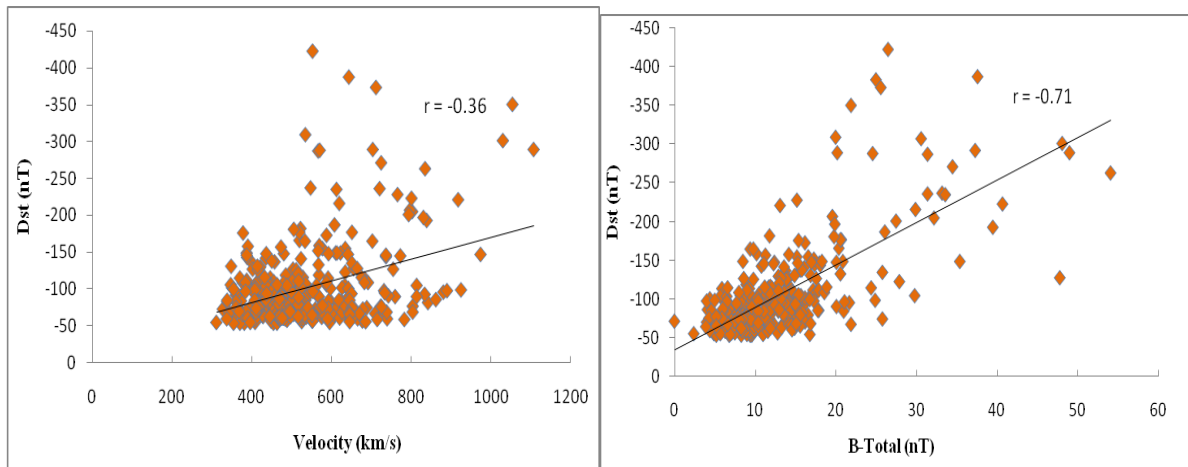


Fig1. Presents maximum values reached by the solar wind speed V and Interplanetary magnetic field versus maximum of negative Dst.

~250 nT or less) is lower (~10% of the storms considered). In this figure, a linear correlation between B_{total} and Dst can be seen, that is, the strength of the geomagnetic storm is strongly dependent on the total magnetic field B_{total} . The correlation coefficient has been found to be reasonably high (-0.71). Figure 2 presents the maximum of interplanetary negative B_z (southward) versus the maximum of negative Dst. In this figure, a linear correlation between B_z and Dst can be seen, that is, according to previous studies the strength of the geomagnetic storm is strongly dependent on the southward component B_z . But in present study the correlation coefficient has been found to be low (0.24). This result may be obvious Solar wind Southward magnetic field component B_z has significant growth mainly during (or before) the initial phase of geomagnetic storm (not during the main phase, tested here). Absence of high linear correlation between density and Dst during the main phase does not mean that solar wind Southward magnetic field component B_z is not a geo-effective parameter, which is considered above. Studies shows the delay between the peak negative Dst and the negative B_z (at the time of Dst peak). Figure 2 shows the peak proton density versus the maximum Dst (negative). No definite relationship between both these parameters is found. It can be seen the greater intensity geomagnetic storms are not necessarily associated with greater values of solar wind density. This means that there is a high probability that intensity of a geomagnetic storm is not determined by the increased density. The correlation coefficient between both these parameters is -0.24. The maximum phase of solar cycle-23 has been measured during the year 2000 whereas the periods 1996-99 and 2001-07 are the periods of minimum phase of solar activity. Which clearly follow the phase of sunspots cycle. It is evident that in the year 1996 (solar minimum year) only 2 geomagnetic storm have occurred. It is also found that maximum number of geomagnetic storm have occurred in year 2002 while year 2000 is the maxima of the solar

cycle-23, the year 2007 represent minimum sunspot activity during the descending phase of solar cycle-23. The largest geomagnetic storm of solar cycle-23 occurred on 20 November 2003, with a Dst index of -472 nT and the large numbers of geomagnetic storm have occurred in the year 2003 and 2005, which do not exactly follow the phase of solar cycle and show complex behavior. It is believed that the majority of intense geomagnetic storm occur during the maximum phase of sunspot cycle because many solar active region appear during this time while a few of the geomagnetic storms are observed during the minimum phase of sunspot cycle, which do not exactly follow the phase of solar cycle and show complex behavior.

Summary and Results

The present paper has considered the peak values of the various parameters which are further correlated with the peak depression in the geo-magnetic perturbed conditions. It is widely recognized that the solar and interplanetary causes produce geomagnetic disturbances. In present study, a linear correlation between B_{total} and Dst can be seen, that is, the strength of the geomagnetic storm is strongly dependent on the total magnetic field B_{total} . The correlation coefficient has been found to be reasonably high (-0.71). According to previous studies the strength of the geomagnetic storm is strongly dependent on the southward component B_z . But in present study the correlation coefficient has been found to be low (0.24). This result may be obvious Solar wind Southward magnetic field component B_z has significant growth mainly during (or before) the initial phase of geomagnetic storm (not during the main phase, tested here). Thus, in this study period had something special which need to be understood, B_z is not essentially peak at the time of dst peak value. This shows time delay between B_z and Dst peak. It has been verified that geomagnetic storm intensity is correlated well with the total magnetic field of IMF better than southward

component Bz of the IMF, density and solar wind velocity. However, it is clear that present analysis should be considered preliminary, mainly because of the uncertainty

in time delay, which should be investigated in detail for prediction purposes.

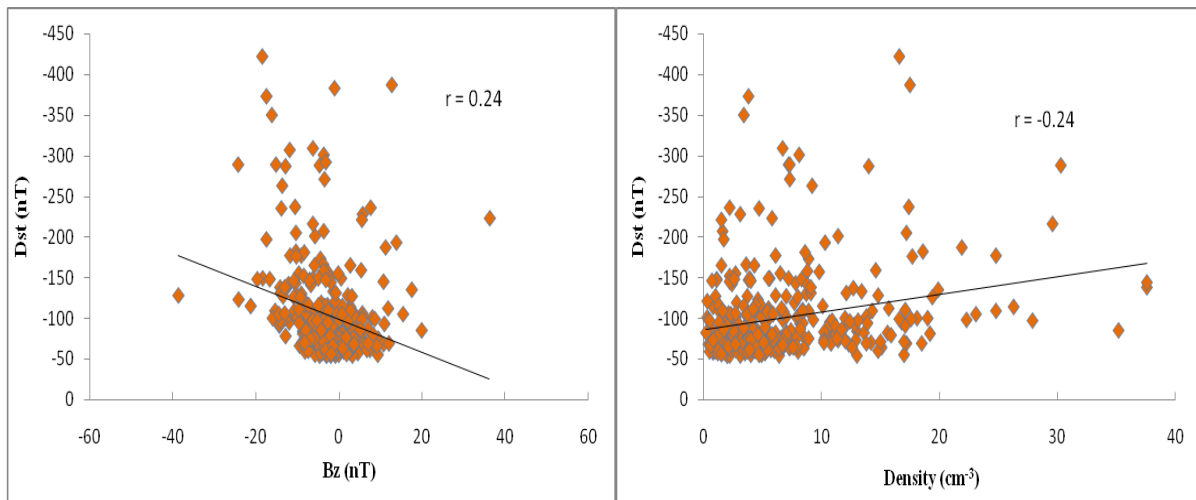


Fig.2: It presents the maximum of interplanetary negative and peak proton density versus the Bz (southward) versus the maximum of negative Dst

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Interplanetary Plasma Flows and Associated Forbush Decrease



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Abstract

In this study we discuss the behavior of cosmic rays during the phase of highly intense or ultra intense geomagnetic storms, as shocks driven by energetic coronal mass ejections (CME's) and other interplanetary (IP) transients are mainly responsible for initiating large and intense geomagnetic storms. Observational results indicate that galactic cosmic rays (CR) coming from deep surface interact with these abnormal solar and IP conditions and suffer modulation effects. In this paper a systematic study has been performed to analyze the CRI variation during super storms i.e. very intense geomagnetic storms with Dst index ≥ -100 nT. The neutron monitor data of three stations Oulu ($R_c = 0.77$ GV), Climax ($R_c = 2.97$ GV) and Huancayo ($R_c = 13.01$ GV) well distributed over different latitudes and hourly values of IMF parameters derived from satellite observations near Earth IP medium from OMNI Data base is used for the period spanning over solar cycles 20, 21, 22 and 23. It is found that AP and AE indices show rise before the forward turnings of IMF, while the Dst index shows a classic storm time decrease. The analysis indicates that the magnitude of all the responses depends on BZ component of IMF being well correlated with solar maximum and minimum periods. Transient decrease in CRI with slow recovery is observed during the storm phase duration.

Keywords: Coronal mass ejection, magnetic cloud, Forbush decrease.

Introduction

Geo The kind of interaction between solar wind and terrestrial magnetosphere depends up on the structures present in the solar wind. The magnetic cloud is a kind of large scale interplanetary structure resulted as a transient ejection of the solar plasma in the solar wind. Its characteristics were first time reported in 1981 by a group of scientists[1] . According to their studies performed on the basis of the systematic variation of interplanetary magnetic field component (IMF B) in a flow behind an interplanetary shock using the spacecraft data between 1 and 2 AU, it was reported that the magnetic field strength in the cloud was high while the intensity and the temperature were low. To investigate the relationship of these magnetic clouds with other parameters of the interplanetary medium, a number of classification schemes have been introduced. According to first classification scheme given in 1982 (a) clouds following shocks, (b) clouds preceding interaction regions and (c) clouds associated with cold magnetic enhancements [2]. During 1988 some investigators have given another classification considering the magnetic field direction as a primary discrimination, according to which a magnetic cloud is termed as a 'positive magnetic cloud' if at spacecraft onset, the magnetic field vector is rotating in a direction directed northward. If this direction of rotation is directed towards the south than such type of magnetic cloud are 'negative magnetic cloud'[3].

Magnetic clouds are ideal objects for solar- terrestrial studies because of their simplicity and extended intervals of southward and northward magnetic fields [4]. On the solar side the rope- like field configuration of the cloud generated interest to ascertain whether it would be the manifestation of a coronal mass ejection (CME) [5,6] or of a disappearing filament [7]. On the terrestrial side, the immersion of the Earth in to the cloud may provide a long lasting period with a southward interplanetary magnetic field that is favorable for the formation a strong geomagnetic storm [8]. As a magnetic cloud is a transient ejection of solar plasma in the solar wind defined by relatively strong and rotating magnetic field associated with them, where a large and smooth rotation of the magnetic field direction takes place over the distances of approximately 0.25 AU at 1 AU. These are further having a low proton temperature coefficient defined by plasma beta (β) [9]. Soon after the discovery of these magnetic clouds several studies have been performed to observe their association with geomagnetic activity. Large disturbances in geomagnetic field with arrival of a magnetic cloud have been noticed and a strong association between the initiation of geomagnetic storms and

the onset of magnetic cloud at earth was observed [1, 10]. This result was ascertained by a number of investigators [5, 11]. We have analyzed the influence of two types of magnetic clouds namely positive and negative, on geomagnetic activity, measured by *Dst* index and also on various interplanetary features solar wind velocity, temperature, density, B , B_x , B_y and B_z component of interplanetary magnetic field. We have listed both kinds of the magnetic clouds along with some of their coefficients studied during this research period in table 1 and 2 for positive and negative magnetic clouds respectively. These tables consists of estimated start and end times of the clouds based on the result of the magnetic field model given by Burlaga et al. which assumes that the field within the magnetic cloud is force free, i.e. the electrical current and the magnetic field are parallel and proportional in strength everywhere within its volume. [4]

Data and method of analysis

We have applied superposed epoch analysis to study the short-term effects of magnetic clouds with various solar and interplanetary features. By this statistical technique one can detect the periodic or recurrent, and non-periodic variation. In the present analysis data event position having special features are taken as zero position or zero epoch day. Then average value of each time interval is calculated and their deviations from average values of relevant day (zero epoch day) are also calculated. The value of deviation for each day is plotted against the column number of both sides of the zero epoch time and a curve is obtained. The curve depicts the expected variations in the values of a particular physical quantity with respect to time. In order to increase the number of epochs, we have identified 21 magnetic clouds on the basis of criteria adopted in earlier studies [1]. We have taken the time period from Feb. 1995 to Nov. 1998. We have used the magnetic field and solar wind plasma measurements from IMP 8 and ISEE 3 spacecrafts provided by the National Space Science data Center [12, 13], and considered all the 34 possible magnetic clouds events during the above mentioned period.

Results and discussion

Relations between solar wind parameters and magnetic clouds are examined using superposed epoch analysis. In figure 3 the time dependent behavior of the bulk solar wind speed V , proton density, NP and proton temperature, TP for the intervals, believed to contain magnetic cloud at the spacecraft are compared. The error bars shown in the figures establish the quantitative nature of this study and also support our results in statistical framework. This figure is divided in to two panels for the two cases of clouds with southward directed magnetic field at spacecraft onset – a negative magnetic cloud (left panel) and the northward directed magnetic field at spacecraft onset – a positive magnetic cloud (right panel). Inspection of figure shows distinctly higher solar wind velocity than elsewhere in the vicinity of the negative magnetic cloud comparing to the case of positive magnetic clouds where velocity goes on increasing and reach its maximum after 24 hours of onset of the clouds. Furthermore, one can easily observe that average background density level is much higher for positive clouds than for negative clouds, while the velocity in this case (for negative clouds) remained higher and constant during and after the passage of clouds. The temperature is higher comparing to its surrounding in case of negative

clouds, where it starts decreasing and goes minimum after 12 hours of the onset of the clouds and later it remains higher. For positive clouds temperature is lower at the onset time, during the passage of cloud it shows some transients fluctuations.

Similar superposed analysis has been done for interplanetary magnetic field (IMF) B and all its three components B_x , B_y , B_z . It is seen from figure 4 that the variation of the magnetic field B for both positive and negative clouds is similar though the peak is shifted closer to the onset time of the magnetic clouds. For B_x and B_y components there is a little difference between the plots for two types of clouds. If we compare the B_x and B_y curves with those in figure 3, there is no apparent evidence for any significance except the NP curve of the clouds. This appears to show a strong density enhancements associated with the positive clouds that contradicts previous studies, which associate lower densities with magnetic enhancements [3]. In case of B_z component of IMF, as it is seen that the IMF B_z for negative clouds becomes more southward after the passage of the cloud and then becomes northward (after 12 hours) whereas in the case of positive clouds, IMF B_z , which is initially northward becomes weakly southward. Results obtained for negative clouds are found quite different from the results of positive clouds. This behavior significantly indicates different interplanetary conditions during the passage of these two types of magnetic clouds substantiating the previous results [14, 15]. In an earlier theory it is said that the higher solar wind speed and the density is noted during the passage of the negative magnetic clouds, due to its association with interplanetary shocks.

However, the geomagnetic responses to magnetic clouds have been reported in earlier work [4]. In this context further analysis has been done to observe the effects of these two types of clouds on earth's magnetosphere. We have taken *Dst* as a geomagnetic index assumed to be primarily due to the equatorial ring current in the earth's magnetosphere. Figure 5 depicts superposed epoch analysis plots of the *Dst* geomagnetic index that is shown in right and left panels respectively. For the negative clouds the *Dst* index decreased just after the onset time of clouds and further increased during the passage of the clouds, whereas, for the positive clouds maximum decrease is found after 24 hours of arrival of clouds. These results substantiate the hypothesis that predicts the fact that geomagnetic activity is greater when the magnetic field is southward rather than when it is northward [7, 16]. Speed of the solar wind to be well correlated with the geomagnetic activity, hence we observe minimum *Dst* values during the passage of negative magnetic clouds. From the figure 5, we see that minimum *Dst* was -80 nT for the negative clouds and -57 nT for positive clouds. It is noted that the difference cannot be attributed to the strength of the maximum southward component of the magnetic field, which was nearly the same for these two classes of the magnetic clouds. We know that all the clouds are not responsible for generating a geomagnetic storm, even though all clouds had a large southward component of the magnetic field at some point during their duration. Now it is proposed that the difference in *Dst* is related to the differences in the plasma parameters for the two classes of magnetic clouds. The average behavior of *Dst* and B_z for intervals of time containing

magnetic cloud is very suggestive that when a magnetic cloud has a southward BZ at earth, coupling between the magnetosphere and the solar wind occurs and energy enters the magnetosphere resulting in increased geomagnetic activity. When a cloud has a northern BZ at earth, coupling between the magnetosphere and the solar wind is inhibited and no energy enters the magnetosphere. In another mechanism it is stated that the solar wind streams interaction with the magnetic cloud may have directly discontinuous field arise [15]. The magnetic cloud stream interaction region is unusual and its nature is not likely to be determined fully from single spacecraft observations. Here we speculate several possibilities, one is a compound stream follows by the magnetic clouds and the two streams interfaces would correspond to the corresponding streams. Second possibility is this that corotating streams were interacting with the heliospheric plasma sheet in which the multiple directional discontinuities might represent crossing of the heliospheric current sheet. A third possibility is that a single corotating stream interacted with magnetic cloud and produced instabilities that formed a complex boundary. In 1990 occurrence of coronal mass ejections (CME's) in terms of ejecta are investigated as magnetic cloud related disturbance in interplanetary space[17]. Recently it has been explained that magnetic clouds are substructure of ejecta and the field structure observed depends upon where the ejecta is intercepted, the investigator also demonstrated close association between ejecta (as defined for example by regions of depressed solar wind proton temperature) and short-term particle decrease [18]. Ejecta are produced as the result of a gas dynamical explosion, in which magnetic field is carried positively. The radial speed gradient across the CME and the resulting expansion of the CME as it propagates antisunward are viewed as a resulting dynamical effect in the interplanetary space and momentum exchange with ambient medium.

Conclusions

This study has inferred that negative magnetic clouds are more responsible for the depression in the BZ component of the interplanetary magnetic field, while the positive magnetic cloud produce large decrease in BZ component after the 24 hours of onset time of clouds. The decrease in Dst values show different variational pattern for positive and negative clouds, it is greater for clouds with higher speed than for clouds with lower speeds. As here, Negative clouds show large decrease just after arrival of clouds onset with early recovery, on the other hand positive clouds show maximum decrease in D_{st} values after 24 hours of onset with late recovery taking 72 hours of time span.

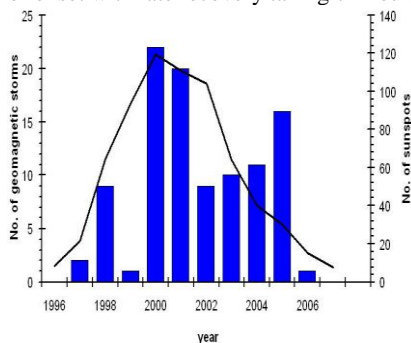


Figure 1 Distribution of the yearly occurrence rate of intense geomagnetic storms ($D_{st} > 100nT$) in relation to sun-spot numbers (shown by the solid line).

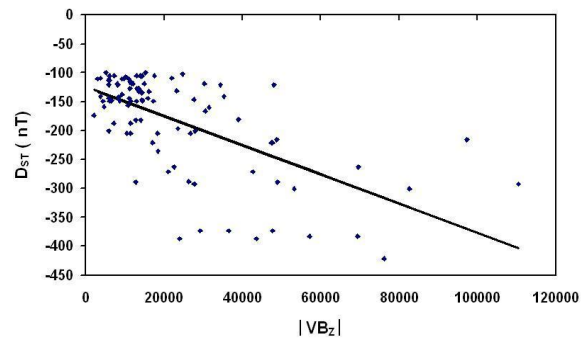


Figure 2: Relation between D_{ST} index and $|VB_Z|$ values of the geoeffective CMEs. Where V is the initial speed of CME and B_Z is IMF.

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Cosmic Rays during Intense Geomagnetic Conditions and Their Solar / Interplanetary Causes



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Abstract

The present study aim to analyze the cosmic ray intensity during the phase of intense geo-conditions. It is known that energetic coronal mass ejections and other transient interplanetary features are mainly responsible for large disturbances in geomagnetic field of earth and play a key role in producing a geomagnetic storm or substorms. As well as they are responsible to modulate the cosmic ray intensities. Identifying intense geomagnetic storms with Dst decrease more than or equal to 300 nT occurred during solar cycle 23, a correlative study has been performed to analyze the behavior of cosmic ray intensity and associated solar and interplanetary causes of these events using solar wind plasma, interplanetary magnetic field (IMF) and solar geophysical data. We have used neutron monitor the oulu cosmic ray data. It is observed statistically that 55% storms have occurred during solar maximum and 45% occurred during minimum phase of solar cycles. The correlative plots between various indices provide some interesting results being discussed in detailed paper. Further, study reveals that 97% intense storms are associated with coronal mass ejections (CME's), which confirms earlier findings. Sharp transient decreases in cosmic rays are evident for short term durations. **Keywords:** cosmic ray, geomagnetic storm, interplanetary magnetic field (IMF).

Introduction

Shocks driven by energetic coronal mass ejections (CME's) and other interplanetary (IP) transients are mainly responsible for initiating large and intense geomagnetic storms. Observational results indicate that galactic cosmic rays (GR) coming from deep surface interact with these abnormal solar and interplanetary conditions and suffer modulation effects.

Investigators have revealed that various activities taking place on Sun and other interplanetary proxies of coronal mass ejection's (CME's) lead to cosmic ray (CR) modulations at neutron monitor energies. This heliospheric modulation process reflects the dominant role played by solar wind parameters (bulk speed and the IMF intensity). Which further play the key role in initiating the various space weather activities involving variety of phenomena such as sub-storms, magnetic storms, acceleration of relativistic electrons etc.¹⁻² It is well known fact that solar wind velocity plays an important role to produce short-terms as well as long-terms modulation of cosmic rays and Forbush decreases (Fd's) are produced by perturbation in interplanetary conditions¹. These perturbations originate from shock waves, CME's, solar flares, high speed solar wind streams. As solar wind consists of various plasma and magnetic field characteristics, these plasma signatures in interplanetary medium produce disturbances in Earth's magnetic field whose intensity/ strength depending upon the nature of ejecta³⁻⁵. Interplanetary plasma data obtained from spacecraft's observations allowed rapid progress in relating cosmic rays variation with other solar and interplanetary characteristics. Investigators have reported two possible sources responsible for the decrease from high-speed plasma streams observed in ecliptic plane. One kind of which is associated with ejection of solar flares in solar active region while another depends up on the coronal holes. Furthermore, flare generated streams and coronal hole-associated streams have been defined⁴⁻⁶.

Data

We have analyzed the events represented by maximum Dst decrease. The study has been performed to analyze the cosmic ray intensity variation during this prescribed period 1996-2010. The neutron monitor data from Oulu stations

($R_c=0.77$ GV). We have used hourly averaged IMF components and solar wind plasma data at 1 AU obtained from satellite observations provided by National Space Science Data Center (NSSDC) through its OMNIWEB (<http://www.nssdc.gsfc.nasa.com/omniweb.html>)⁷⁻⁸. Introduced in 1964, the ring current index Dst measures primarily ring current magnetic field, using which one can investigate low latitude effects. Here Dst is used as an indicator of geomagnetic activity to derive the possible relationship between cosmic rays intensity with geomagnetic activity⁹.

Discussion

A geomagnetic storm is the response of the magnetosphere to the interplanetary phenomena arising as a sequence of activities taking place on the solar surface. The magnitude of these events further depends up on the nature of ejecta and the possible interplanetary circumstances present at the time of occurrence. Investigators have observed a common association between solar and interplanetary events assumed as interplanetary CME's, co-rotating interaction regions (CIR's)⁵⁻⁹⁻¹⁰. As the aim of this study is to analyze the events which are highly geoeffective and than to find possible correlation between geomagnetic indices and cosmic ray intensity variation; to perform the study hourly averaged values of solar and geomagnetic indices is obtained from NSSDC⁷⁻⁸⁻⁹. The results are shown in figure 1 and 2. Cosmic ray intensity is shown in the lower panel of figure 1, while the geomagnetic indices Dst shown in upper panels.

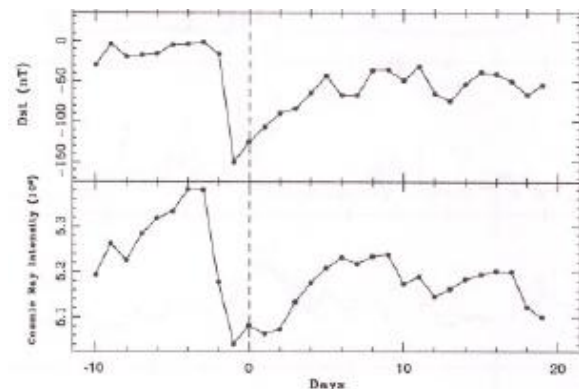


Figure 1. Shows cosmic ray intensity variation, Disturbance Storm Time (Dst) index during the event period.

Figure 2 represents the bulk speed, ion density and ion temperature in respective panels. On comparing the averaged behavior of parameters shown in figure 1, it is found that geomagnetic Dst index follows the same decrease pattern as that of cosmic ray particles. Dst index produce a significant decrease profile. As we know most of the storms have been associated with coronal mass ejections. These events are large-scale structure and become highly geoeffective while travelling towards Earth. As in the case of Halo- CME's, they are supposed to play the key role in originating the geomagnetic activities in the magnetosphere. In the ejecta magnetic field varies very slowly and the magnetic field strength increases. At the same time plasma proton's temperature and thermal pressure decrease, while the solar wind speed also decreases as the ejecta passes through the interplanetary medium. In some cases the ejecta also present smooth rotation of magnetic field vector, resulting in to the interaction of this compressed plasma high speed flow with preceding slow solar wind. As a consequence the proton

temperature, magnetic field strength increases while the solar wind speed rises¹¹⁻¹². This is seen in figure 2 as immediately after the occurrence of event the bulk speed enhances. These compressed streams produce modulation effects in cosmic ray particles responsible for the significant decrease pattern as observed in figure 1. Observations indicate the strong association between super geomagnetic storms with CME's. Which is obvious as these solar events are large scale ejecta eruptions of solar wind plasma, that are further responsible for effectively modulating the cosmic ray intensity.

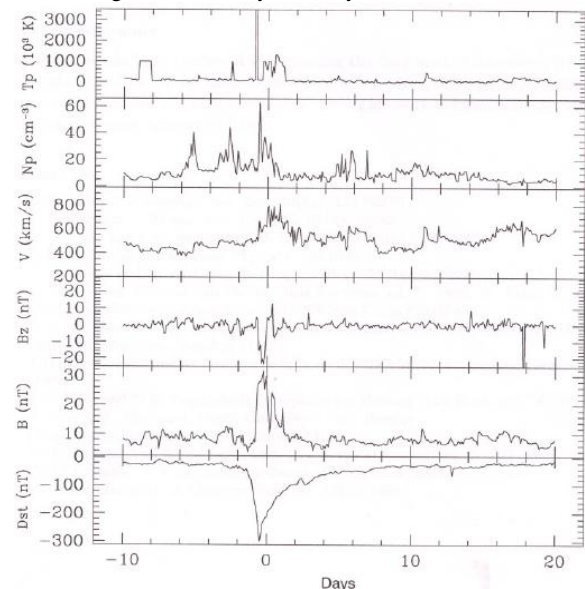


Figure 2. It shows the solar and interplanetary parameter corresponding to intense geomagnetic storms with $Dst \leq -300$ nT. The geomagnetic Dst index and other feature are plotted on day to day basis.

In this paper we also correlated various interplanetary parameters with Dst indices less than 300 nT, intense geomagnetic storm.

| S. No. | Date | Dst nT | B nT | Bz nT | V km/s | Np cm ⁻³ |
|--------|-------------|--------|------|-------|--------|---------------------|
| 1 | 16 Jul 2000 | -301 | 48.1 | -3.7 | 1030 | 8.1 |
| 2 | 31 Mar 2001 | -387 | 37.6 | -12.7 | 644 | 17.5 |
| 3 | 30 Oct 2003 | -383 | 25 | -1.1 | - | - |
| 4 | 20 Nov 2003 | -422 | 26.6 | -18.5 | 553 | 15.6 |
| 5 | 08 Nov 2004 | -373 | 25.6 | -17.5 | 712 | 3.5 |

Table 1. Details of interplanetary plasma parameters.

In table 1 shows details of interplanetary plasma parameters. The peak values of the parameters were used at the onset time of corresponding peak value of Dst index. On the basis of values given in table 1 we calculate the correlation coefficients between Dst and various IMF parameter. The correlation between Dst and total magnetic field B, Southward component Bz and plasma velocity V are 0.79, 0.58 and 0.58 respectively. We have not found a significant correlation between Dst and plasma density Np.

Conclusions

The relation of Dst index with interplanetary plasma parameters have been studied from 1996 to 2010 and the following conclusion have been drawn:

The occurrence of most of the events is dominant during the high value of total magnetic field B and southward turning of Bz component of IMF that leads to the significant decrease in Dst index as well as in the cosmic

ray intensity. Most of the events are associated with transient decreases in cosmic ray intensity. Intense storms are having their well defined solar origin as during solar maximum the occurrence rate is 55% while it is only 45% during solar minimum phase of solar cycle.

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