Global Navigation Satellite Systems- A boon for Earth Science in 21st Century

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With the advent of Global Navigation Satellite Systems (GNSS) comprising of GPS by USA, GLONASS by Russia, GALILEO by European Union,COMPASS by China, Quazi-Zenith Satellite System (QZSS) by Japan, and Indian Regional Navigation Satellite System (IRNSS) by India, the gamut and usage of its applications to earth science have become very wide and have opened up new vistas. After the launches of modernized GPS Block II R-20 (M) satellites with the availability of Civilian signals like L1, L2, L2C, P2 and L5, two GIOVE-B GALILEO and two COMPASS/Beidou II satellites, the Space-Geodesy has acquired an augmented and modernized status facilitating more constellations, more satellites and more signals any time and anywhere in the planet. By the time all the other systems would be in vogue in the near future,the multiple constellations broadcasting interoperable open signals would result in improved observed geometry, integrity,and continuity, increasing end user accuracy everywhere and improving the service availability in environments where satellite visibility is often obscured. With this enormous leap in space-geodesy, the earth science would undergo a sea-change with improved position accuracy in the order of mm and satellite orbit accuracies of ~3-5cm 3-D WRMS GPS Solutions and ~ 10-20cm GLONASS Solutions, estimation of crustal deformations in the order of mm, and the plate velocities in the order of few mm/yr. Improving Earth observations with GNSS could provide early warning for natural disasters such as Tsunamis, sea level rise, earthquakes, climate changes, real-time responses and mitigate their effects. The stringent GNSS measurements and analysis also would reveal the strain accumulation very precisely in the areas outside the active deformation zones (intraplate earthquakes) and facts about the stress transients (where the future events of earthquakes would occur). National Geophysical Research Institute (NGRI), Hyderabad houses one such IGS Station (International GNSS Service), (HYDE), by having GNSS Receiver that acquires data from both GPS and GLONASS satellite systems and contributes hourly and daily data to IGS Data Center and also has been designated as IGS05 Reference Frame site. By virtue of all these, NGRI has become a member of International Committee on GNSS (ICG) under the aegis of United Nations Office for Outer Space Affairs (UNOOSA) thereby becoming an important global player in the future evolution and improvement of GNSS and its applications. NGRI has also become a steering committee member of Global Geodetic Observing System (GGOS), that integrates different geodetic techniques, and different models in order to ensure a

long-term monitoring of the geodetic observables, and the static as well as time-varying quantities thus finally benefiting the society and our changing planet.

Key words: GNSS, Compatibility and interoperability, ICG and GGOS