Transition from Research to Operation for GNSS Radio Occultation

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NOAA Satellite & Information Service (NESDIS)

- **Mission:** To provide timely access to global environmental data and information services from satellites and other sources in support of the larger NOAA mission.

- **Major Programs...**
  - Geostationary Operational Environmental Satellite (GOES)
  - Polar-orbiting Operational Environmental Satellite (POES)
  - Joint Polar Satellite System (JPSS)
  - Environmental Satellite Observing Services
  - Environmental Data Management
NOAA Satellite and Information Service
An End-to-End Responsibility

Requirements & Planning
System Acquisition
Launch
Command & Control
Real-Time Product Development & Distribution
Data Archive & Access
Products & Services

NOAA Data and Information are Essential for…
Hazard, Severe Weather, Watches, Warnings
Climate
Transportation
Defense
Agriculture

Ocean
Industry
Environment Monitoring
Commerce
GNSS Radio Occultations

COSMIC/FROMOST-3 – the first Radio Occultation Constellation that demonstrates the value of GPSRO in weather, climate and space weather.

GNSS RO Application Area Examples

- Storms / Severe Weather
  - NWP
    - AVERAGE FOR 00Z/23APR2008 - 00Z/20APR2008
  - Storms / Severe Weather
    - 30-Hour Forecast Track Error
    - COSMIC Demonstration
    - Hurricane Lili
    - Track Error Improvement

- Climate
  - GNSS RO can measure:
    - ENSO Signal
      (El Niño - Southern Oscillation – dominant tropospheric variability)
    - Global QBO
      (Quasi-Biennial Oscillation - dominant signal in stratosphere)

- Space Weather
  - 3-D Maps Global Electron Distribution
    - From Electron Density Profiles Updated at Five Minutes Combined Tomographically (Randel et al. 2009)

From Bill Randel (UCAR)
Six (6) COSMIC GPS RO Satellites
Significant Impact on Weather Service Forecast Skill

- Proven significant forecast accuracy improvement
- 40-day experiments:
  - Black line - No COSMIC
  - Red line - COSMIC Initial Operations
  - Green line - Current COSMIC

COSMIC provides significant improvement in Weather forecast skill
8 hours improvement at Forecast Day 4 and
>15 hours improvement during Forecast Day 7
- Particularly significant improvement over the oceans and in Southern Hemisphere
- Analysis – COSMIC satellite loss causes significant NOAA forecast skill loss

NCAR 4-Day Ernesto (2006) Forecasts

The Actual Storm
Forecast with GPS
Forecast without GPS

Y.-H. Kuo (NCAR), 2007
Impact of Various Observing Systems

GEOS-5.6.1 28 Jan – 05 March 2010 00z

FORMOSAT-3
Ranked #3 in Impact Per Observation

Adjoint-based estimate of 24-hr global forecast error reduction in wind, temperature and surface pressure combined as energy (J/kg)

From Ron Gelaro, NASA, GMAO

FORMOSAT-7/COSMIC-2 GNSS RO
Notional Architecture [USA-Taiwan]
FORMOSAT-3/COSMIC vs FORMOSAT-7/COSMIC-2

3 hrs Coverage

12 Satellites - 2 inclinations
Data are distributed more homogeneously

COSMIC Occultations – 3 Hrs Coverage

COSMIC-2 Occultations – 3 Hrs Coverage

The Future of GNSS RO

CALENDAR YEAR

GPS
FOC 28-30 MEO S/C

GLONASS
FOC 24-30 MEO S/C

Galileo
FOC 27-30 MEO S/C

COMPASS
FOC 27 MEO, 5 GEO, 3 IGSO S/C

FOC = Full Operational Capability

[Diagram showing satellite coverage and operational status for GPS, GLONASS, Galileo, and COMPASS]
Happy 5th Anniversary FORMOSAT-3/COSMIC!
NOAA is proud to be your partner!