FORMOSAT-7/COSMIC-2
Neutral Atmosphere Initial Operating Capability
Data Release

March 6, 2020
FORMOSAT-7/COSMIC-2 Neutral Atmosphere IOC Data Release

Submitted by: Jan-Peter Weiss

Dr. Jan-Peter Weiss
FORMOSAT-7/COSMIC-2 Neutral Atmosphere Cal/Val Lead
Manager, COSMIC Data Analysis and Archive Center
University Corporation for Atmospheric Research

Concurred by: Bill Schreiner

Dr. William Schreiner
FORMOSAT-7/COSMIC-2 Mission Scientist
Director, COSMIC Program
University Corporation for Atmospheric Research
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Approved by:

Dr. Elsayed Talaat
Director, Office of Projects, Planning, and Analysis
National Environmental Satellite, Data, and Information Service
National Oceanic and Atmospheric Administration

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Approved by:

Chun-Liang Lin, Mar 6, 2020
Dr. Chun-Liang Lin
Director General
National Space Organization
1 Background

The US Air Force Space Test Program successfully launched six FORMOSAT-7/COSMIC-2 (F7C2) satellites into a 24 deg inclination low Earth orbit on June 25, 2019. The primary F7C2 mission objective is to continuously and uniformly collect atmospheric and ionospheric data as the inputs to daily near-real-time weather forecasts, climate studies, and space weather monitoring and forecasts. Following spacecraft system activation and checkout, instruments were first activated on July 16, 2019. Each F7C2 satellite has three instruments: the primary Tri-GNSS Radio-occultation System (TGRS) payload, Ion Velocity Meter, and Radio Frequency Beacon. The F7C2 team supporting calibration and validation of TGRS neutral atmosphere products consists of experts from Aerospace Corp., Central Weather Bureau (CWB), Jet Propulsion Laboratory (JPL), National Central University (NCU), National Oceanic and Atmospheric Administration (NOAA), National Space Organization (NSPO), and University Corporation for Atmospheric Research (UCAR). The team has worked intensively to evaluate instrument performance and optimize processing algorithms since launch. Provisional TGRS neutral atmosphere data were released December 10, 2019. The F7C2 Executive Steering Committee reviewed progress presented by the calibration and validation team and declared neutral atmosphere Initial Operating Capability (IOC) on February 26, 2020.

2 Datasets

This data release encompasses TGRS IOC neutral atmosphere products. TGRS data and neutral atmosphere products from October 1, 2019 and forward are included. This start date is chosen because all TGRS units operated using consistent flight software and configuration, and because radio occultation (RO) counts are relatively consistent. As such the dataset is useful for evaluation in numerical weather prediction (NWP) systems to assess quality and impacts of the F7C2 data [1]. All data are processed as-if or in near real-time. The US and Taiwan data processing centers will publish new data by 0200 UTC daily for the prior day. The following data types are released:

- Level 0
  Raw TGRS binary data files

- Level 1a
  Precise orbit determination antenna measurements (RINEX v2.11 format)
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Satellite attitude measurements (leoAtt format)
High rate RO measurements (opnGns format)

- Level 1b
  Precise orbit determination (POD) solutions (SP3 format)
  Atmospheric excess phase (conPhs format)

- Level 2
  Atmospheric profiles as atmPrf (RO retrieval), wetPf2 (1D-var retrieval), and BUFR

See Section 3 for the data download locations and file format descriptions. Ionospheric data and products will be released at a later date. UCAR plans to release a level 0-1 conversion tool in the future, and will update these release notes accordingly.

2.1 Updates Since Provisional Data Release

Relative to the provisional data release, the following updates are made:

- POD RINEX files correctly label L2 measurement types (e.g. C2, P2)
- BUFR files now consistent with atmPrf and wetPf2
- BUFR file instrument ID set to 104 for TGRS
- Improved quality controlled (QC) for GPS L2 P-code occultations

2.2 Caveats

We note the following caveats to data users:

- L2P occultations
  In NWP model comparisons, GPS L2P occultation bias and standard deviation remain higher than setting occultations from approximately 19-29km altitude. The QC improvement noted above reduces but does not eliminate this feature. The team continues to investigate future software updates to further address this issue.

- POD antenna phase center offset
  A POD antenna phase center offset error of up to a few cm in magnitude remains. Since this error most likely results in a bias in the orbit estimates it should not affect RO retrievals. This matter remains under investigation.
3 Links

- F7C2 data download
  https://data.cosmic.ucar.edu/gnss-ro/cosmic2/nrt
  https://tacc.cwb.gov.tw/v2/download.html

- COSMIC Data Analysis and Archive Center
  https://cdaac-www.cosmic.ucar.edu/

- Taiwan Analysis Center for COSMIC
  https://tacc.cwb.gov.tw

- CDAAC user support forum
  https://groups.google.com/a/ucar.edu/forum/#!forum/cdaac-users

- RINEX v2 format
  ftp://igs.org/pub/data/format/rinex211.txt

- leoAtt format
  https://cdaac-www.cosmic.ucar.edu/cdaac/cgi_bin/fileFormats.cgi?type=leoAtt
  https://tacc.cwb.gov.tw/cdaac/cgi_bin/fileFormats.cgi?type=leoAtt

- opnGns format
  https://cdaac-www.cosmic.ucar.edu/cdaac/cgi_bin/fileFormats.cgi?type=opnGns
  https://tacc.cwb.gov.tw/cdaac/cgi_bin/fileFormats.cgi?type=opnGns

- SP3 format
  ftp://igs.org/pub/data/format/sp3c.txt

- conPhs format (same as atmPhs, except nav bits have been applied)
  https://cdaac-www.cosmic.ucar.edu/cdaac/cgi_bin/fileFormats.cgi?type=atmPhs
  https://tacc.cwb.gov.tw/cdaac/cgi_bin/fileFormats.cgi?type=atmPhs

- atmPrf RO retrieval format
  https://cdaac-www.cosmic.ucar.edu/cdaac/cgi_bin/fileFormats.cgi?type=atmPrf
  https://tacc.cwb.gov.tw/cdaac/cgi_bin/fileFormats.cgi?type=atmPrf

- wetPf2 1D-var retrieval format (same as wetPrf)
  https://cdaac-www.cosmic.ucar.edu/cdaac/cgi_bin/fileFormats.cgi?type=wetPrf
  https://tacc.cwb.gov.tw/cdaac/cgi_bin/fileFormats.cgi?type=wetPrf
• BUFR format
  https://cdaac-www.cosmic.ucar.edu/cdaac/cgi_bin/fileFormats.cgi?type=bfrPrf
  https://tacc.cwb.gov.tw/cdaac/cgi_bin/fileFormats.cgi?type=bfrPrf

References


Acronyms

BUFR  binary universal form for the representation of meteorological data
CDAAC  COSMIC Data Analysis and Archive Center
CWB  Central Weather Bureau
F7C2  FORMOSAT-7/COSMIC-2
GPS  Global Positioning System (USA)
IOC  Initial Operating Capability
IVM  Ion Velocity Meter
JPL  Jet Propulsion Laboratory
NCU  National Central University
NOAA  National Oceanic and Atmospheric Administration
NSPO  National Space Organization
NWP  numerical weather prediction
POD  precise orbit determination
QC  quality controlled
RFB Radio Frequency Beacon
RO radio occultation
TACC Taiwan Analysis Center for COSMIC
TGRS Tri-GNSS Radio-occultation System
UCAR University Corporation for Atmospheric Research