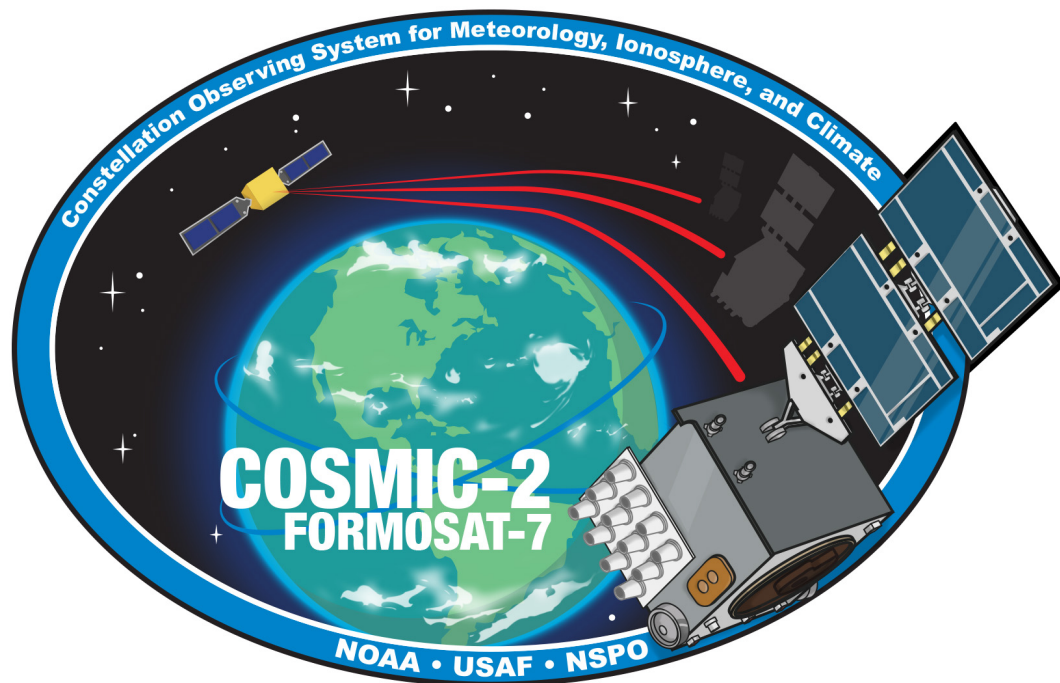

FORMOSAT-7/COSMIC-2
Neutral Atmosphere Initial Operating Capability
Data Release

March 6, 2020



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FORMOSAT-7/COSMIC-2 Neutral Atmosphere IOC Data Release

Approved by:

Chun-Liang Lin, Mar 6, 2020

Dr. Chun-Liang Lin

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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)

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

- [1] Schreiner, W. S., Weiss, J. P., Anthes, R. A., Braun, J., Chu, V., Fong, J., Hunt, D., Kuo, Y.-H., Meehan, T., Serafino, W., Sjoberg, J., Sokolovskiy, S., Talaat, E., Wee, T.K., Zeng, Z. (2020), *COSMIC-2 radio occultation constellation: First results*, Geophysical Research Letters, 47, e2019GL086841, <https://doi.org/10.1029/2019GL086841>

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