
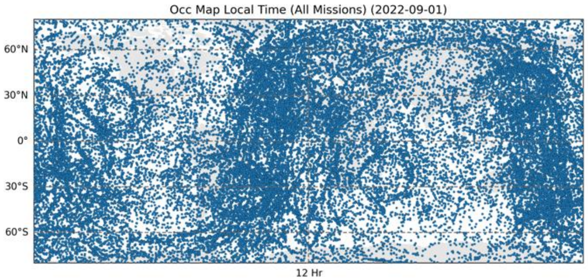

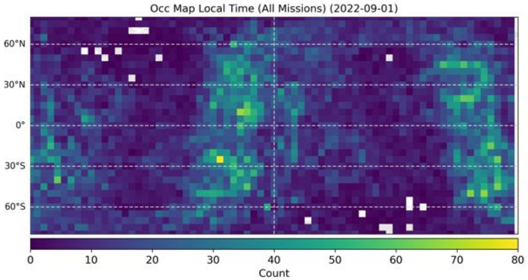

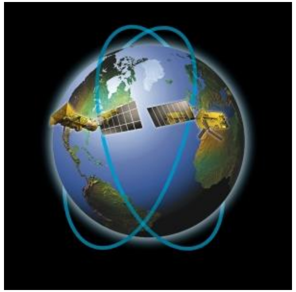

Results from CDAAC Processing of the ROMEX Excess Phase Data

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M. Sleziak-Sallee, S. Sokolovskiy, T. VanHove, H. Veitel, Z. Zeng

COSMIC/JCSDA Workshop and IROWG-10
September 13, 2024

Thanks to all the data providers and EUMETSAT. Thanks to NOAA’s Commercial Data Program for supporting this work.

Outline

- Motivations
- ROMEX processing updates and quality control
- A few metrics
  - – Counts and coverage
  - – Bending angle statistics
  - – 3CH error estimates
  - – STDV (high altitude bending angle noise)
  - – Local spectral width
- Summary

Motivations

- Most missions contributing to ROMEX already processed in near real-time or post-processing modes
- Gain initial experience processing new missions (for us)
  - Feng-Yun 3
  - Sentinel-6A
  - Tianmu
  - Yunyao
- For ROMEX effort, processing retrievals only starting from excess phase, so processing not independent of core EUMETSAT dataset
- For main goal of ROMEX to conduct NWP experiments, choice of data processing center is probably not important
- CDAAC provides local spectral width observation error estimates for each profile, which is not available from other centers

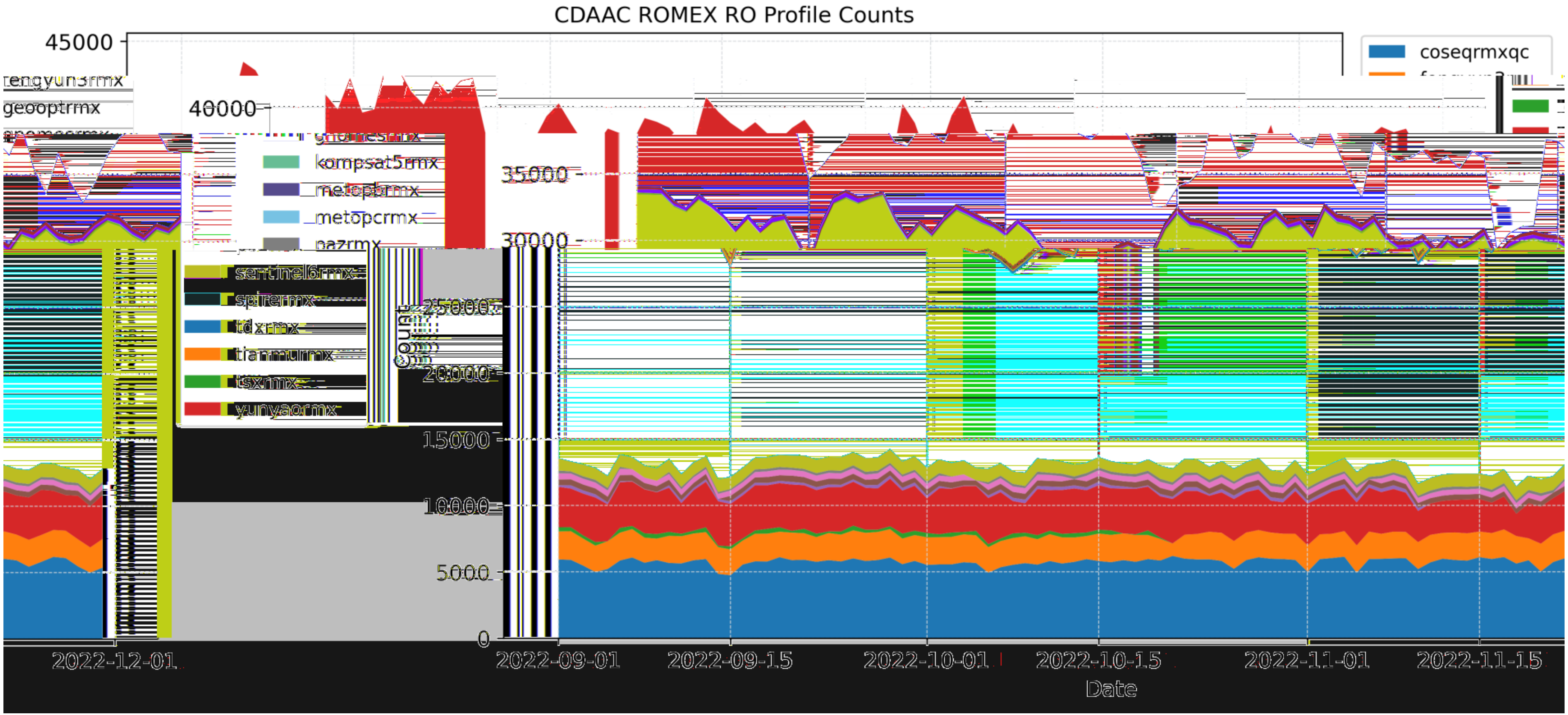
Quality Control for ROMEX Data

- Providing the usual “bad” flag with each ROMEX profile
- Quality control (QC) parameters for ROMEX are the same across all missions with exception of L1 SNR mean from 40-80 km
- SNR is measured differently depending on receiver, so tuned threshold used for each mission
- Some COSMIC-2 QC parameters were relaxed relative to operational processing in order to be consistent with other ROMEX missions
  - Impact on bending angle statistics appears negligible
  - In future we will evaluate using these parameters in operations
- QC parameters summarized on next slide

Quality Control for ROMEX Data

Global Attribute in atmPrf	Definition of Attribute	QC Threshold COSMIC-2 Ops	QC Threshold All ROMEX
reldevmax (fraction)	Maximum of abs value of fractional difference of retrieved BA from climatology between 25 - 40 km	reldevmax <= 0.25	<= 0.3
difmaxref (fraction)	Maximum of abs value of fractional difference of retrieved N from climatology between 10 - 60 km	difmaxref <= 0.5	Same
qcl2d (m/sample)	Maximum of abs value of difference of raw L1 - L2 Dopplers between 20 - 40 km	qcl2d <= 0.1	Same
stdv (mcrad)	standard deviation of retrieved BA from climatology between 60 - 80 km	stdv <= 150	Same
smean (mcrad)	mean deviation of retrieved BA from climatology between 60 - 80 km	|smean| <= 100	<= 300
snr1avg (V/V)	L1 SNR averaged between 40 - 80 km	snr1avg >= 200	Depends on mission

- Average = 37614/day



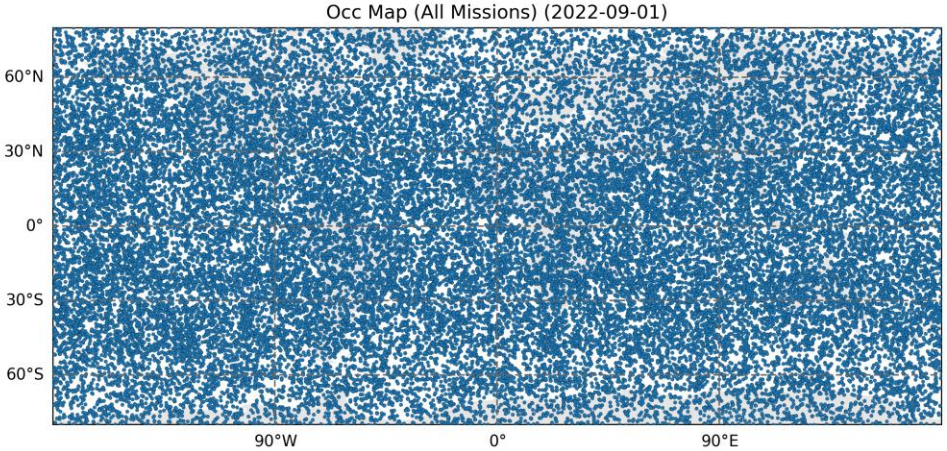
CDAAC ROMEX RO Profile Counts

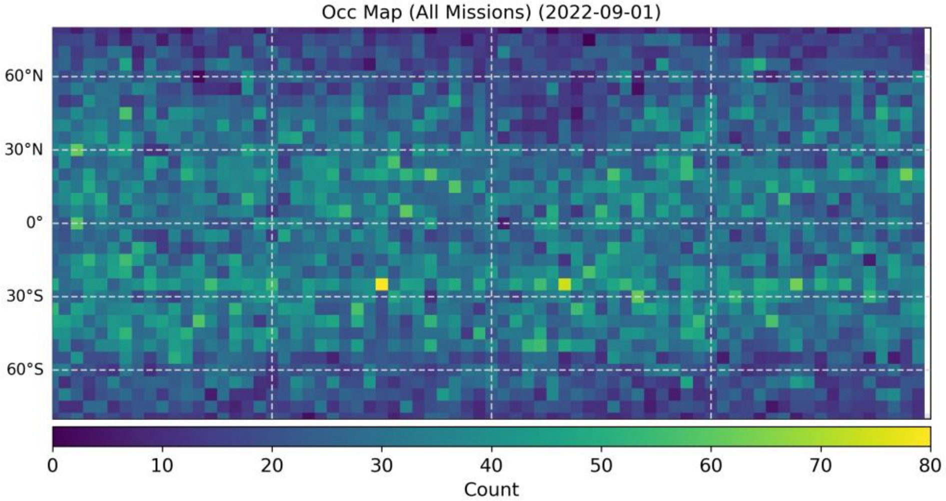
Mission	Total Profiles	Average Profiles/Day
COSMIC-2	522811	5745
FY3	180858	1988
GeoOptics	12564	138
GNOMES (PlanetIQ)	279410	3070
KOMPSAT-5	13930	153
MetOp-B	37695	414
MetOp-C	36239	398
PAZ	16281	179
Sentinel-6A	85987	945
Spire (Full Dataset)	1208807	17777
TanDEM-X	12315	135
TianMu	20822	229
TerraSAR-X	18087	199
Yunyao	568173	6244

"Big 4"

Geographic Coverage (All Missions)

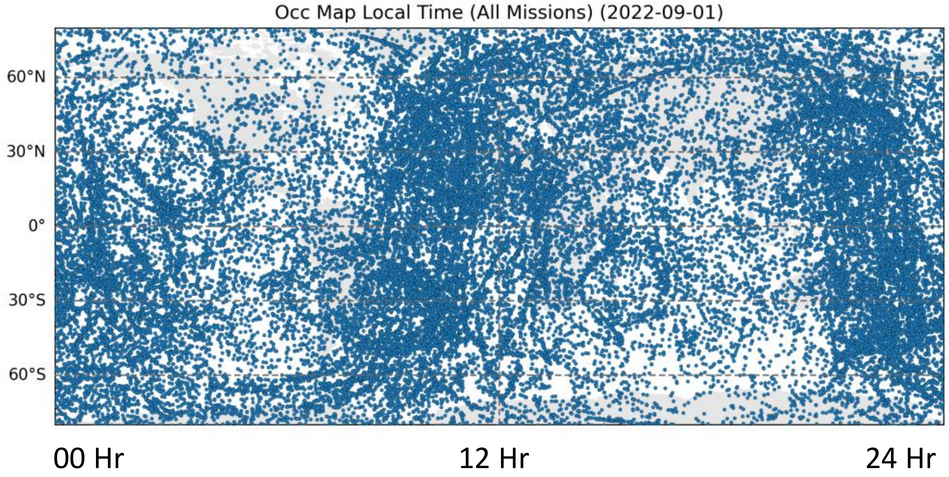
- Showing daily occultation locations (left) and daily count in 5x5 deg lat/lon bins (right)

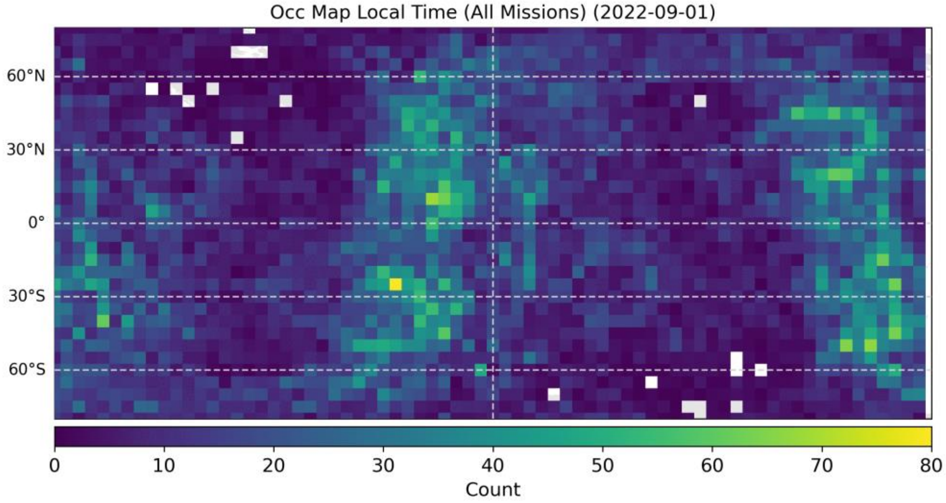




Local Time Coverage (All Missions)

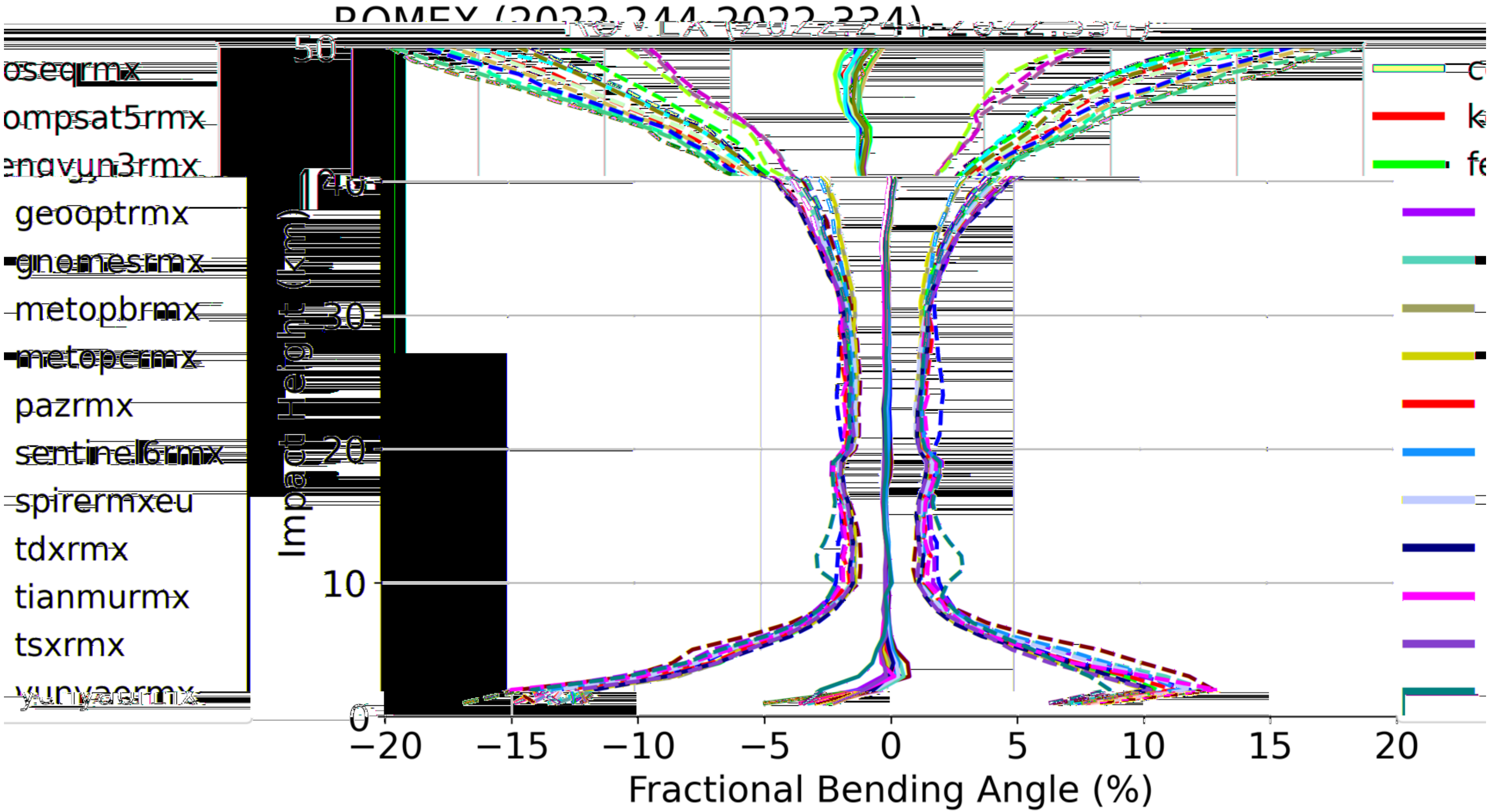
- Showing daily occultation locations (left) and daily count in 5x5 deg lat/lon bins (right)





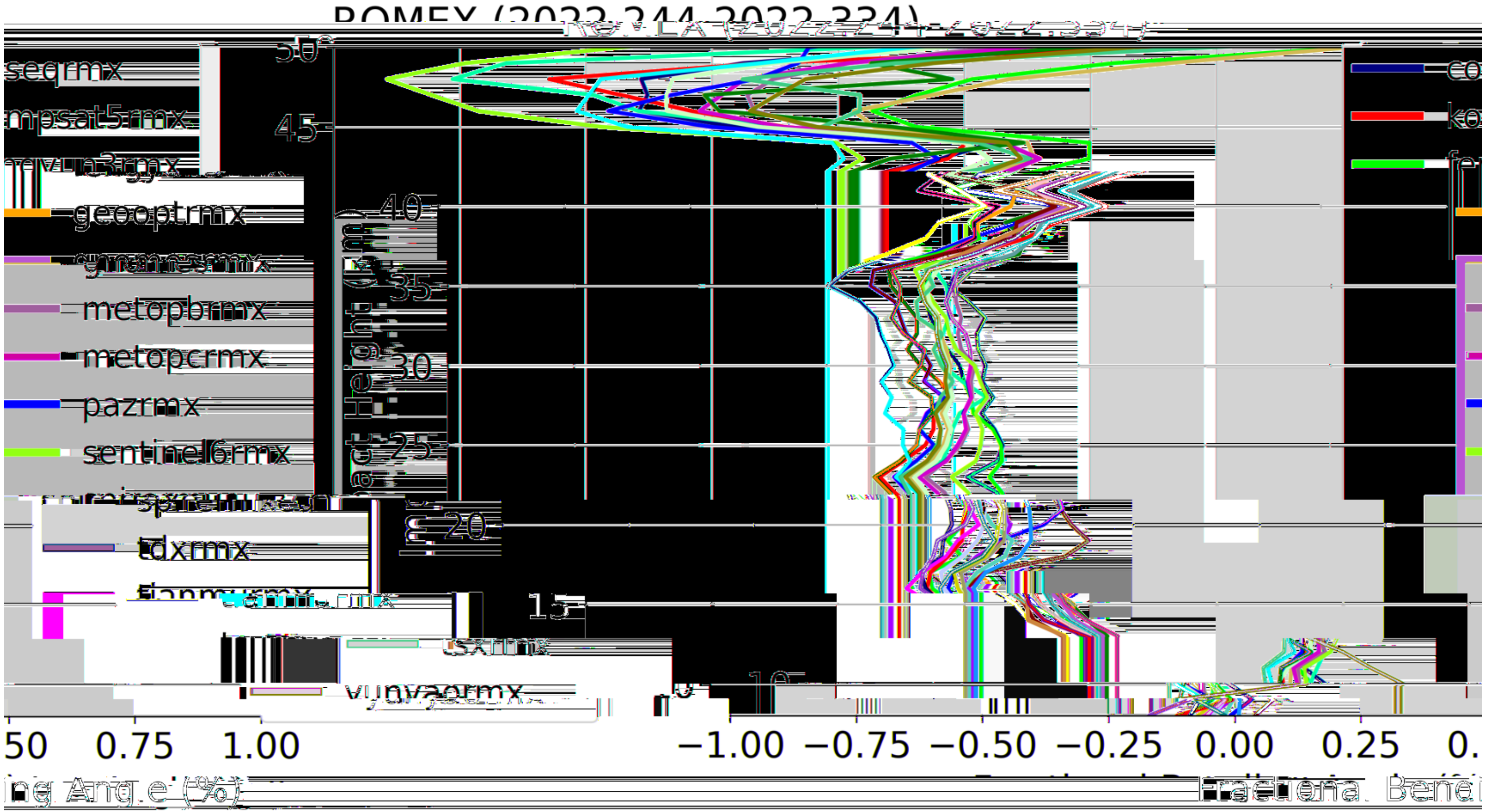
Global Bending Angle vs. ECMWF (All Missions)

- Generally consistent mean and st dev vs. altitude across missions



Global Bending Angle vs. ECMWF (All Missions)

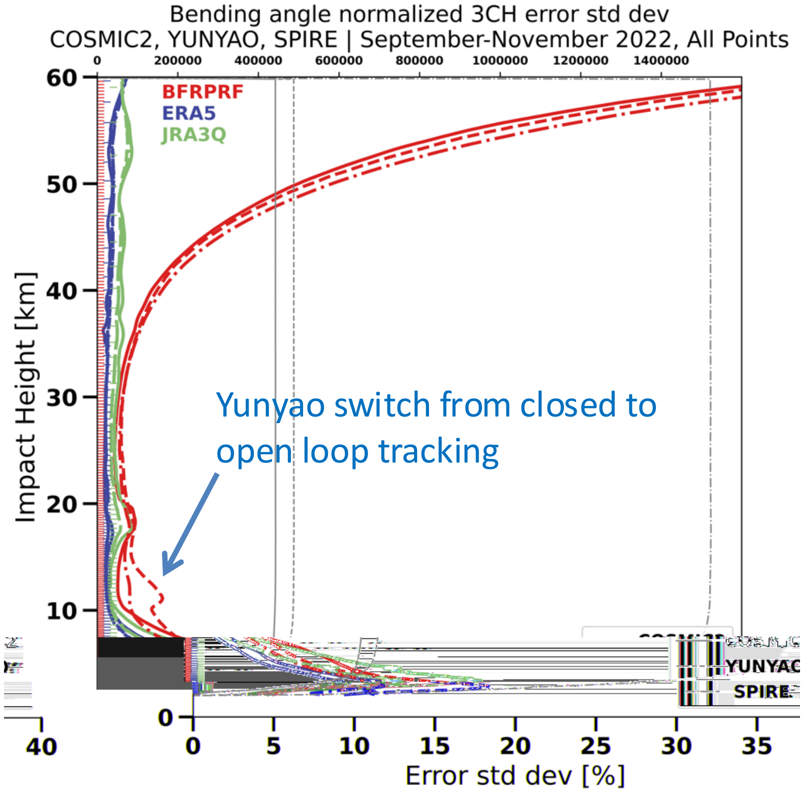
- Zoom in on biases

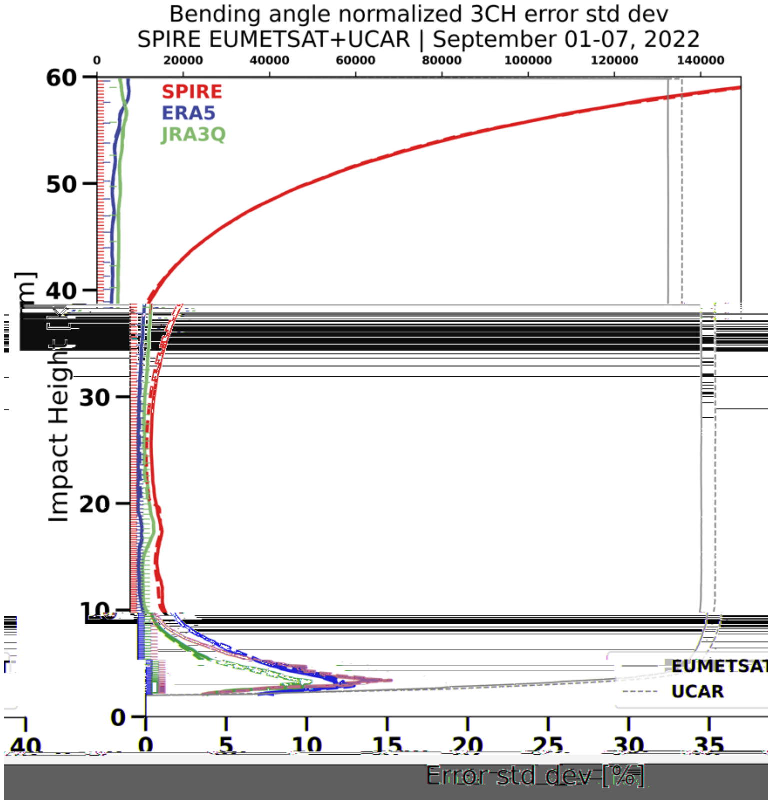


3-Cornered Hat (3CH) Obs Error Analyses

- Left: 3CH analysis of UCAR COSMIC-2, YunYao, Spire
- Right: 3CH analysis of UCAR and EUMETSAT processed Spire data

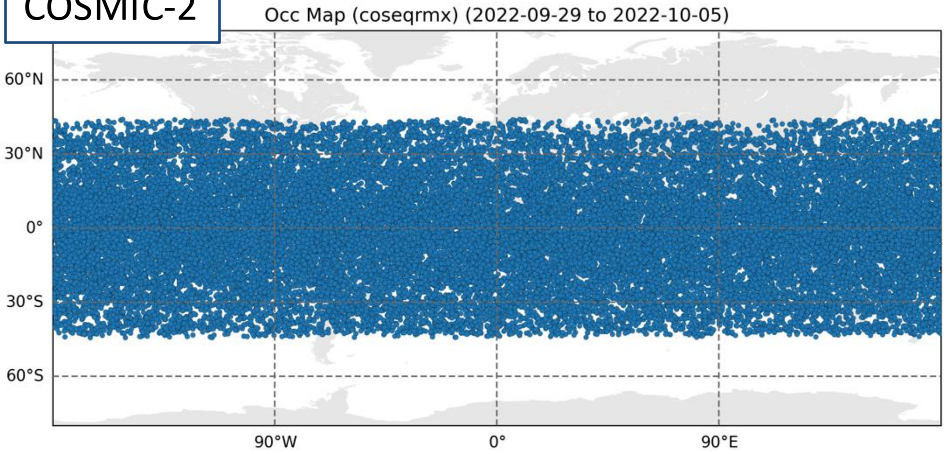
Courtesy R. Anthes and J. Sjoberg, UCAR



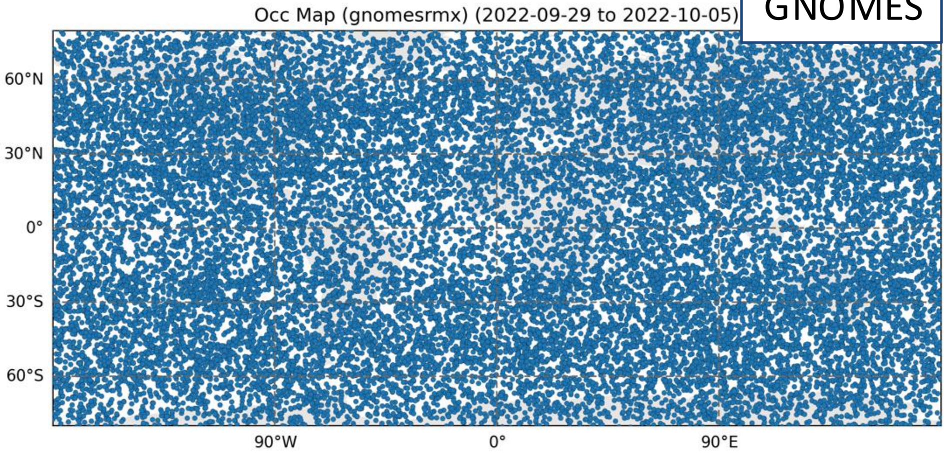


Geographic Coverage (4 Missions, 1 Week)

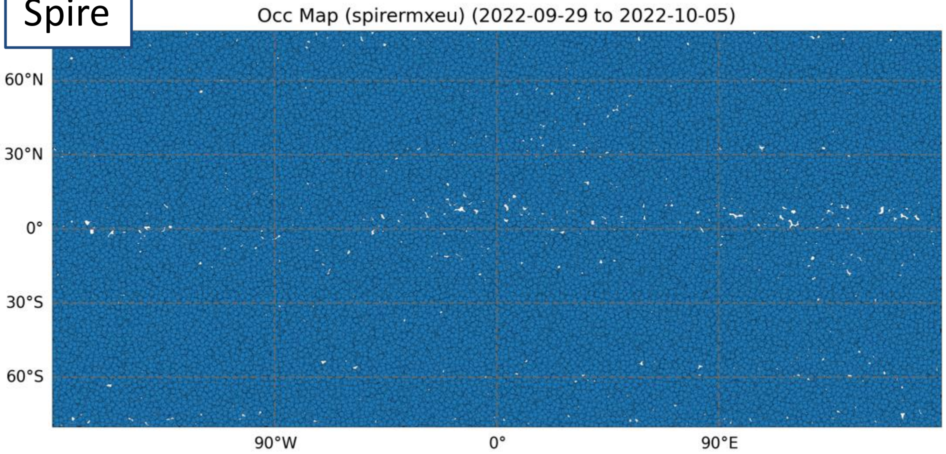
COSMIC-2



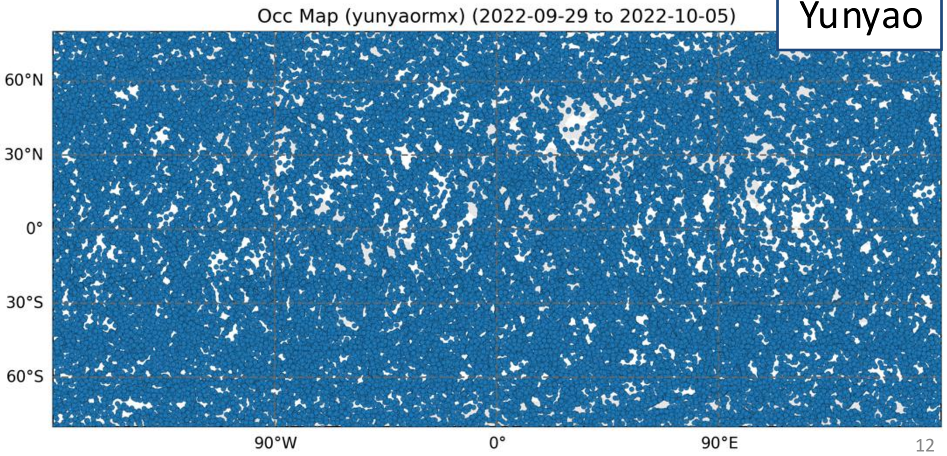
GNOMES



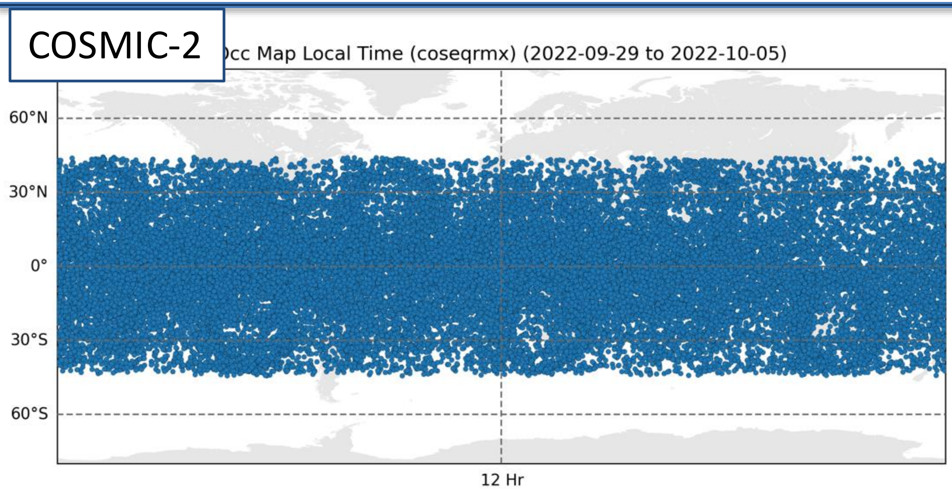
Spire

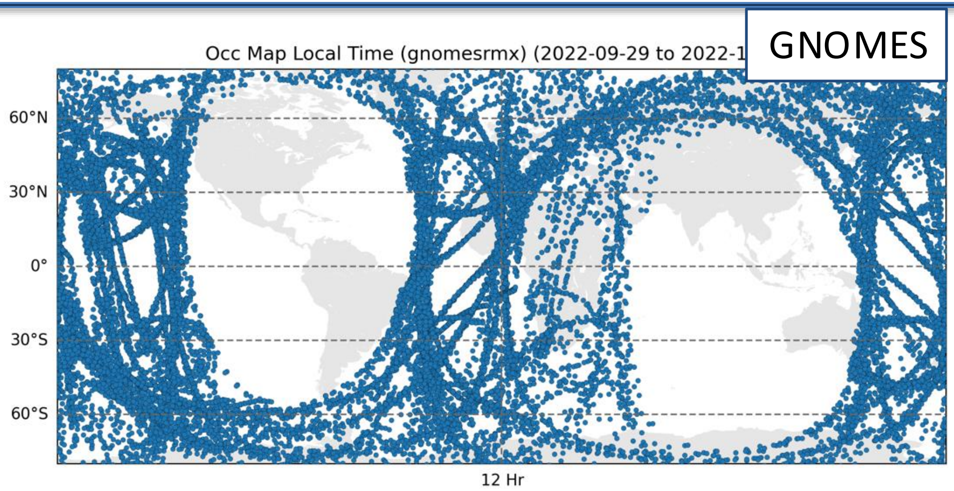


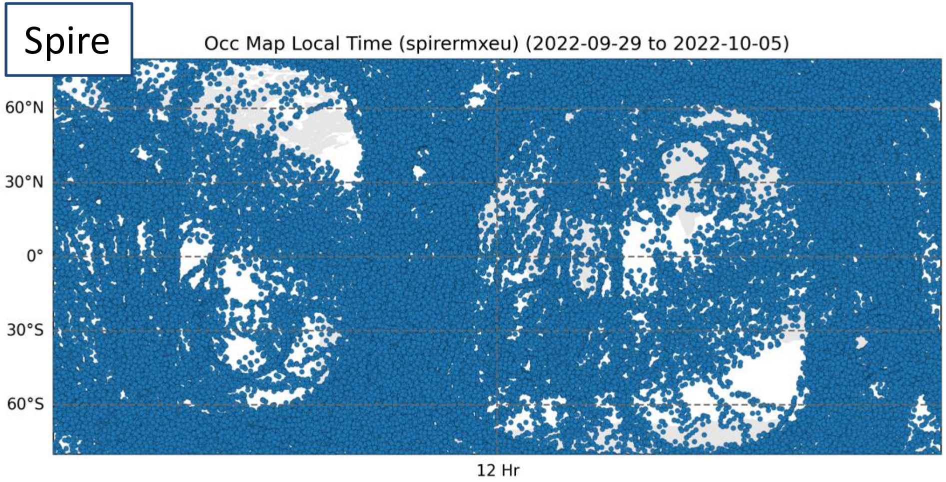
Yunyao

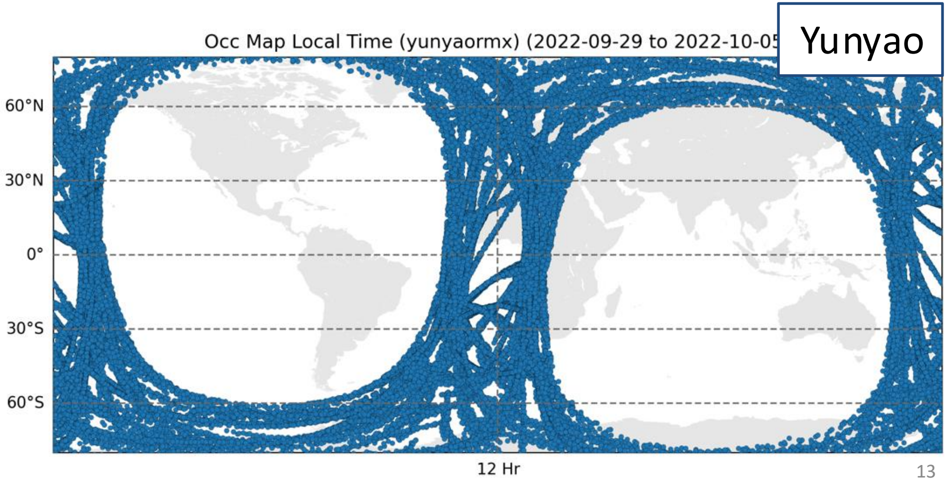


Local Time Coverage (4 Missions, 1 Week)



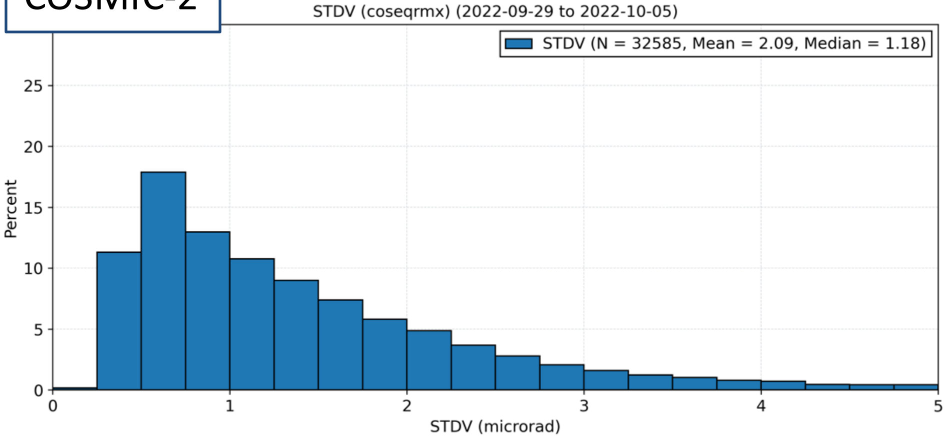




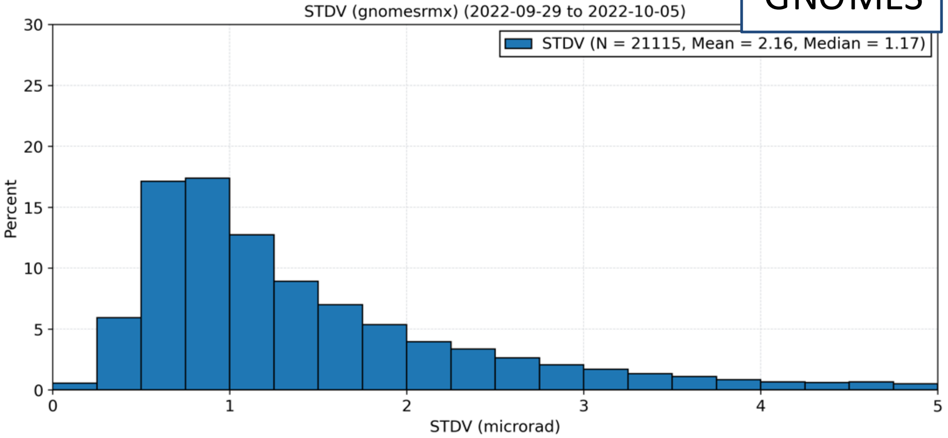


Global STDV (60-80 km BA Noise) (4 Missions, 1 Week)

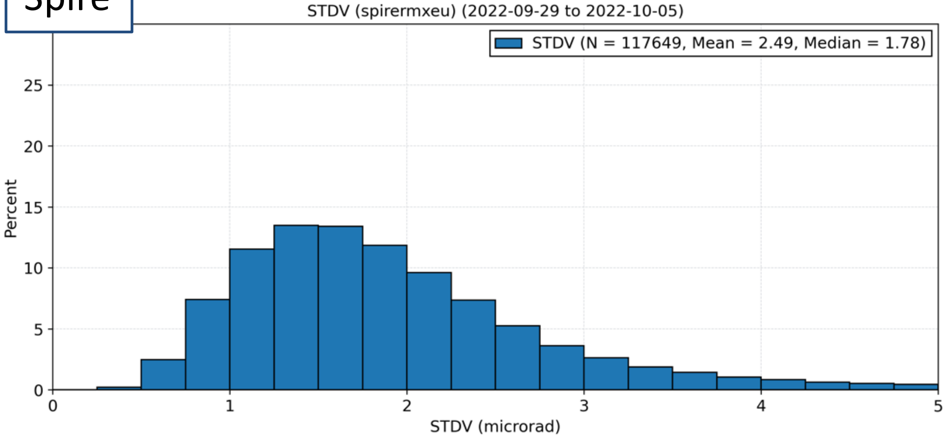
COSMIC-2



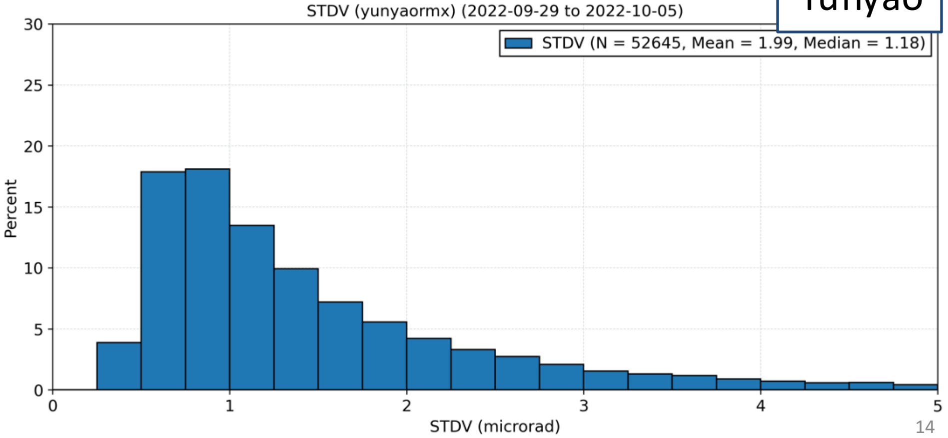
GNOMES



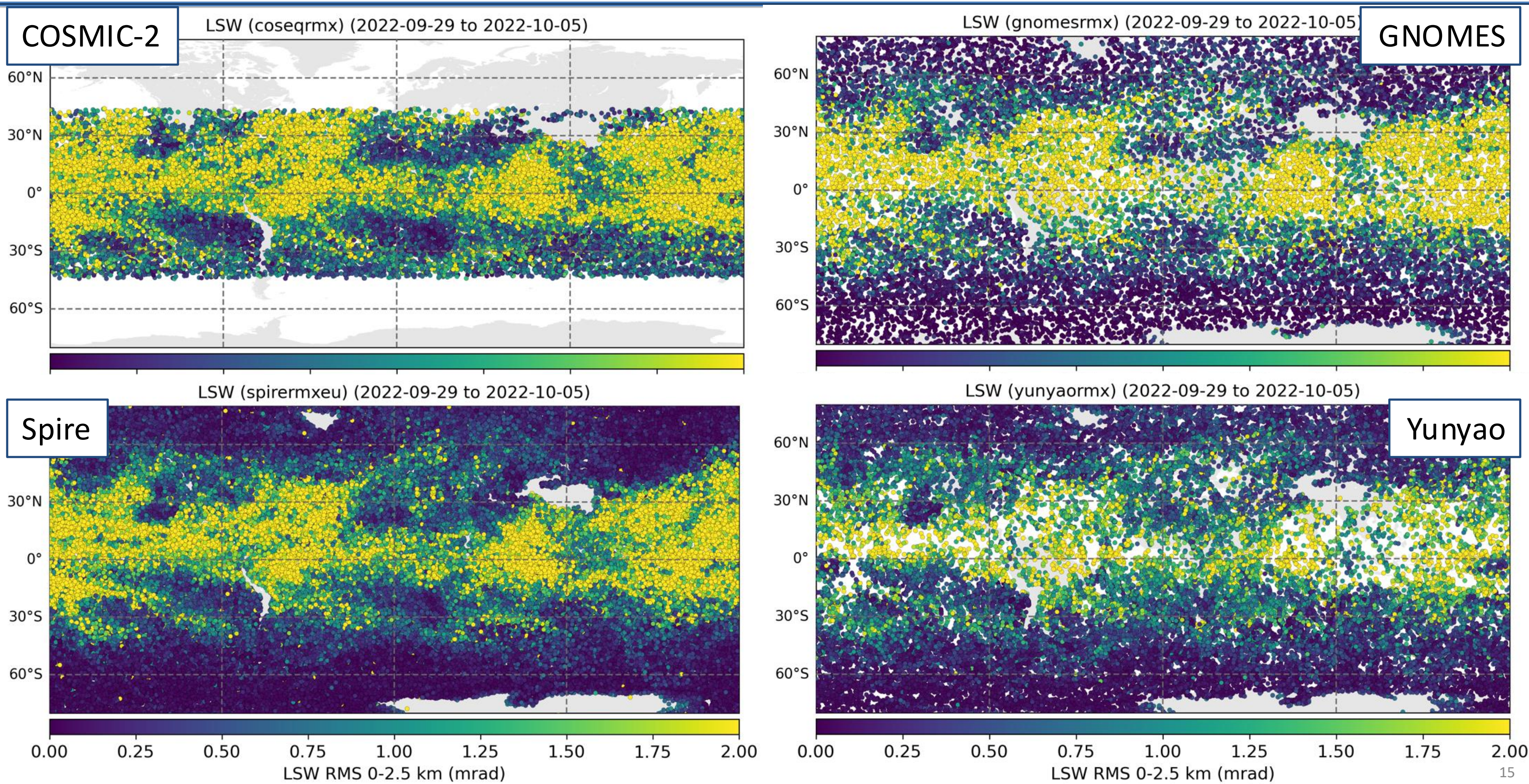
Spire



Yunyao



Local Spectral Width (4 Missions, 1 Week)



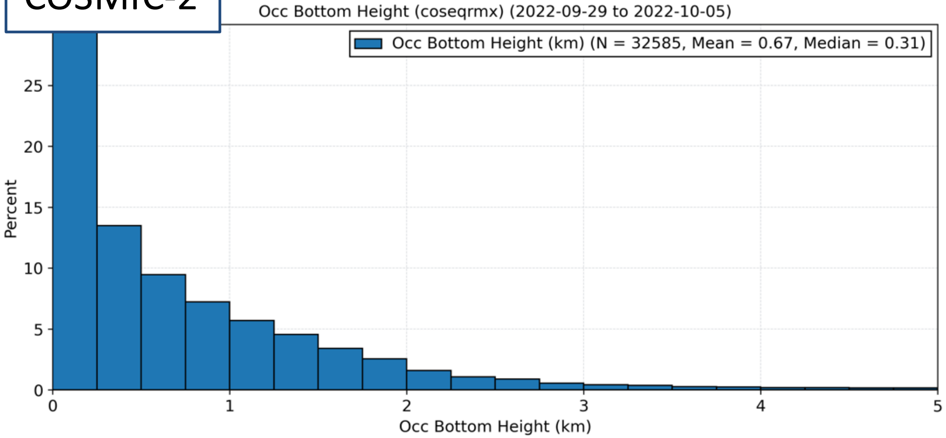
Summary and Next Steps

- CDAAC team completed processing of the ROMEX dataset
- Using consistent software, processing strategy, and QC
- Results appear generally reasonable and consistent with operational processing
- UCAR and EUMETSAT processing results show remarkable consistency
- Evaluations of C2 bias relative ongoing, working with JPL team
- Looking forward to NWP center experiments
- Thanks to all the partners supporting this international collaboration
- ROMEX datasets will enable many interesting NWP and science studies

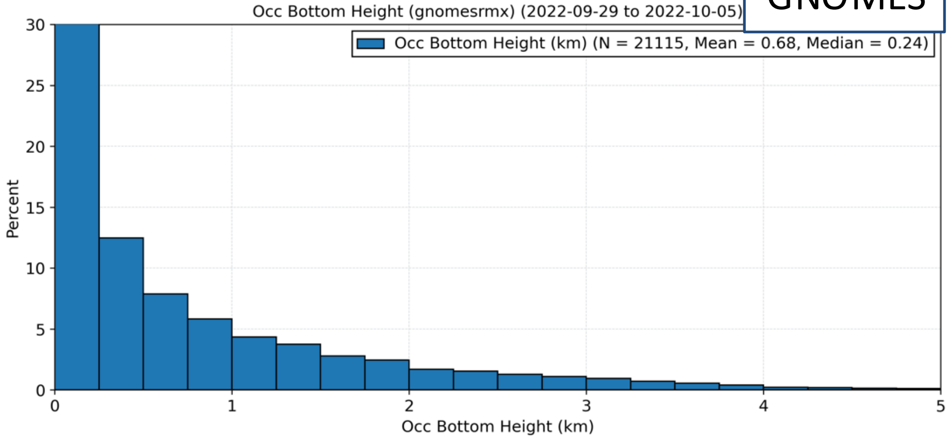
Backup

Global Profile Bottom Height (4 Missions, 1 Week)

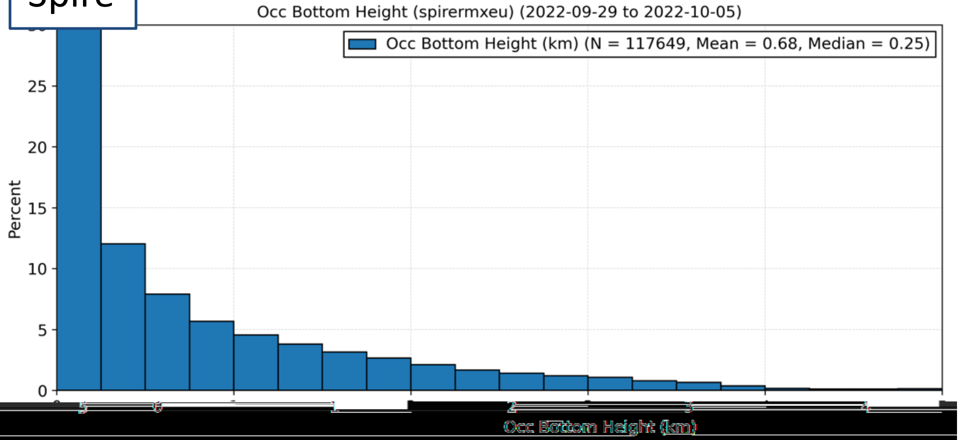
COSMIC-2



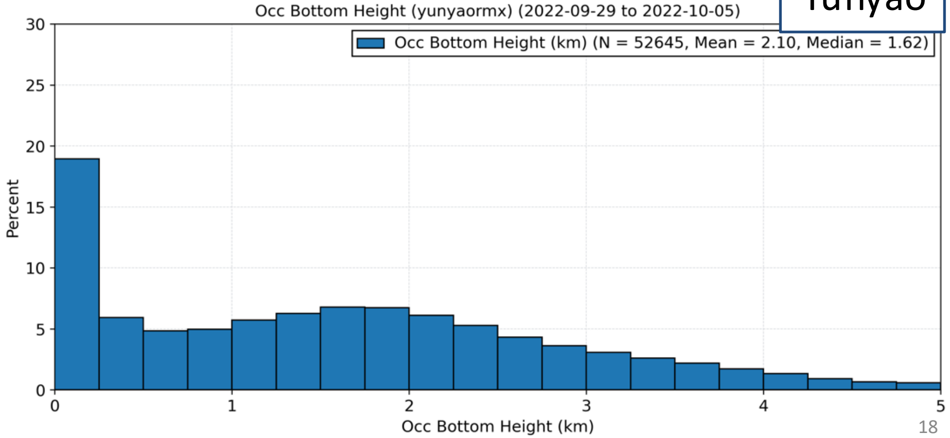
GNOMES



Spire

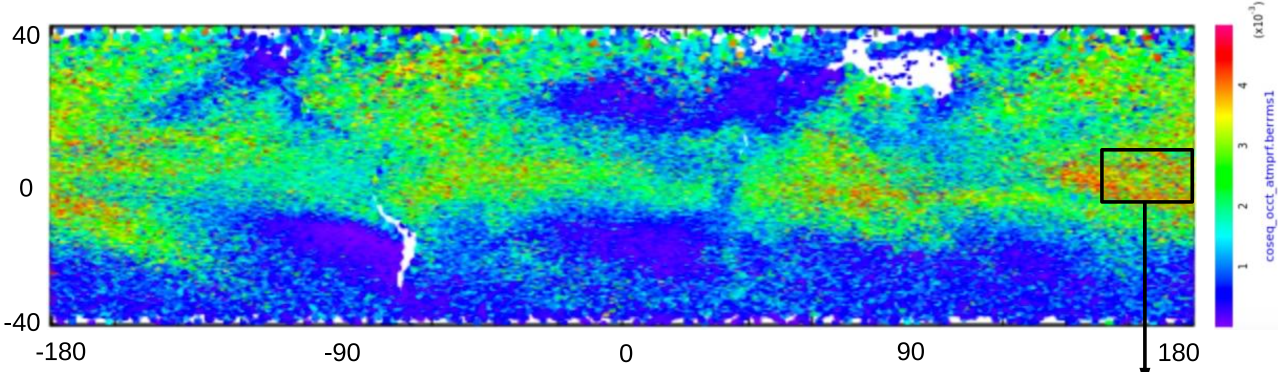


Yunyao

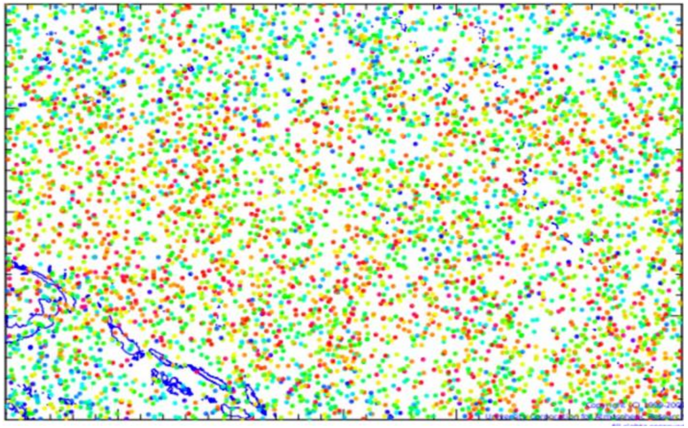


Bending Angle Uncertainty (BAU) Discussion

- Map shows global distribution of COSMIC-2 BAU based on local spectral width RMS from 0-2.5 km; can be used for development of the error model for DA, which depends on latitude, longitude



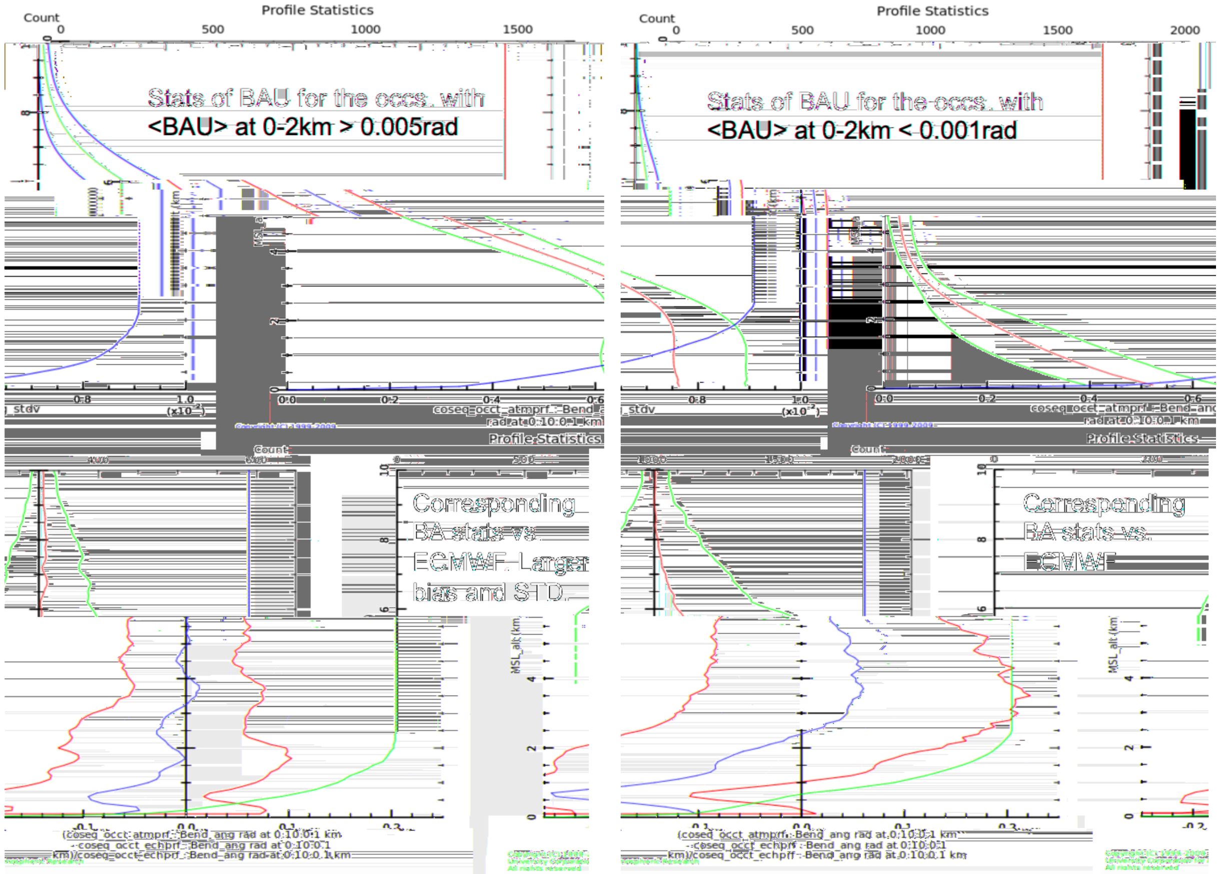
- However, even in the regions with statistically homogeneous distribution of BAU, the difference of BAU between different occultations may be significant
- Sub-sets of occultations with different BAU have different random errors and biases (see next slide)
- This suggest using BAU for changing weights of individual occultations in DA



Region of deep moist convection

Bending Angle Uncertainty Discussion

- BAU and BA statistics in the region of deep moist convection from previous slide



Data Processing Updates for ROMEX

- For FY3, we needed to
  - Add necessary attributes and rename certain variables (occfreq1, occfreq2, startTime, stopTime, [xyz]Gps, [xd,yd,zd]Gps)
  - Fill in variables (xmdl and xmdl2) which tell when open/closed loop data begin and end
  - Phase connect open loop data; we were unable to get navigation bits to apply correctly due to some time tag errors in the data, so we performed 2 quadrant phase connection
- For Spire, we needed to
  - Add necessary attributes to data (occfreq1, occfreq2)
  - Connect first and second frequency phases, using external nav bits when necessary
- For Tianmu, we needed to
  - Add necessary attributes to data (occfreq1, occfreq2, startTime, stopTime)
  - Connect first and second frequency phases with 2 quadrant phase connection; we did not have the nav bits necessary for the BeiDou signals tracked