Calibration and Application of FY-3H IPM

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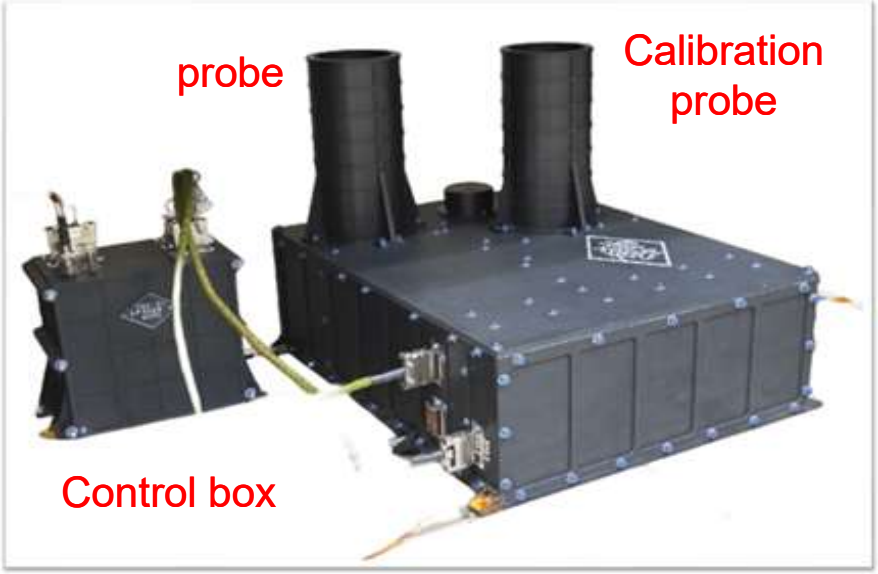
Introduction

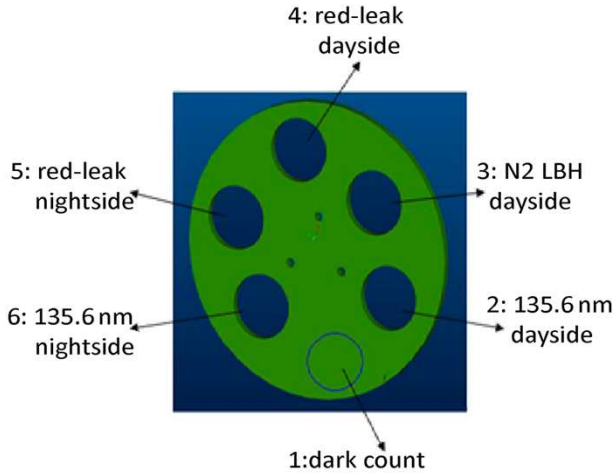
- The Feng Yun 3-H (FY3H) is an afternoon Sun-synchronous satellite with an orbit altitude of 836 km, an inclination of 98.75°, and orbit period of about 101.5 min.
- The Ionospheric PhotoMeter (IPM) is carried on the FY3H meteorological satellite to image the earth's far-ultraviolet (FUV) airglow.
- The IPM on satellite H will succeed the overdue-service IPM on satellite D.



Introduction

- IPM monitors OI 135.6 nm emissions in the nighttime and OI 135.6 nm and N_2 LBH emissions in the daytime by employing a filter wheel.
- Day mode: 4 observations of channel 2 and channel 3 + 2 observations of channel 4 + 1 observation of channel 1 in each frame.
- Night mode: 8 observations of channel 6 + 1 observation of channel 5 + 1 observation of channel 1 in each frame.

Number	Channel	Filter
1	Dark count channel	None
2	OI 135.6 nm dayside channel	BaF_2 + bandpass
3	N_2 LBH dayside channel	BaF_2 + bandpass
4	Red-leak dayside channel	BaF_2 + bandpass + quartz
5	Red-leak nightside channel	BaF_2 + quartz
6	OI 135.6 nm nightside channel	BaF_2



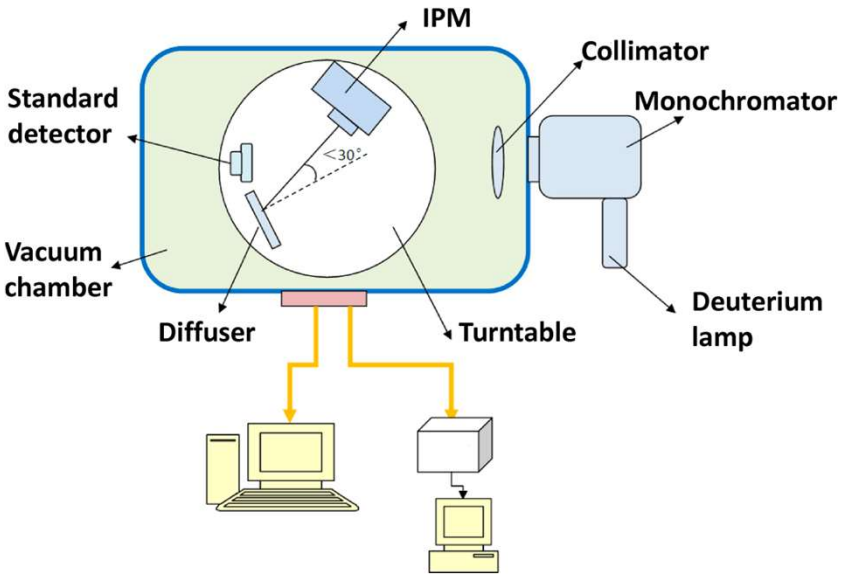
Introduction

- IPM instrument requirements

Parameter	Value
Wavelength	Night mode: OI 135.6 nm Day mode: OI 135.6 nm and N_2 LBH
Field of view	~3.5^o (along orbit) x 1.6^o (cross orbit)
Responsivity	Day mode: >=1 counts/s/Rayleigh Night mode: >=150 counts/s/Rayleigh
Radiometric accuracy	15% (minimum requirement), 10% (expected)
Spatial resolution	~ 30 km at ionosphere (300 km)
Time resolution	Day mode: 2 s Night mode: 10s

Laboratory Calibration

- The IPM was calibrated at ground laboratory prior to flight.
- The responsivities of the probe A and the calibration probe A2 reaches the instrument requirements.

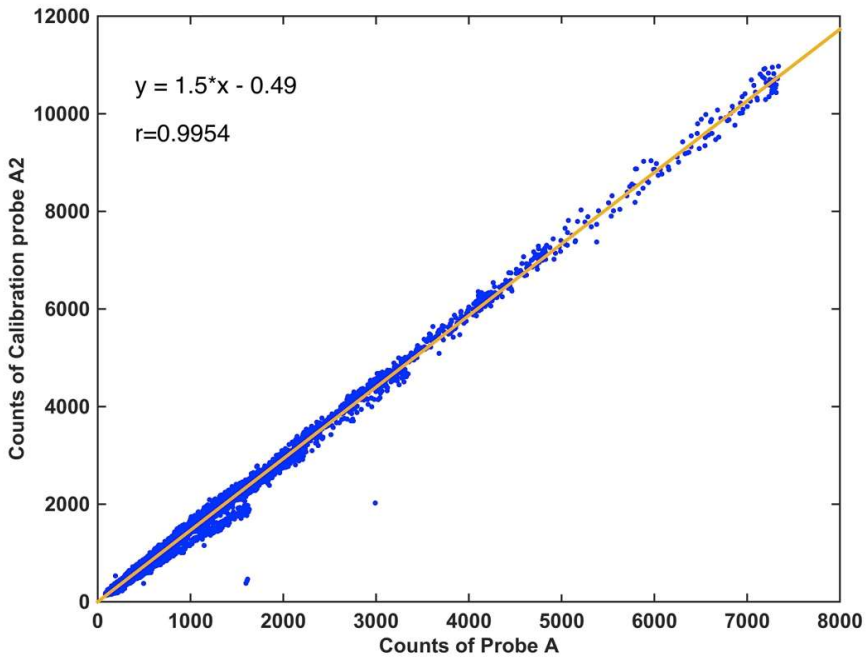


Wavelength	Responsivity of probe A (counts/s/R)	Responsivity of calibration probe A2 (counts/s/R)
Nighttime 135.6 ± 0.5 nm	201	225.3
Daytime 135.6 ± 0.5 nm	3.363	/
Daytime LBH	4.178	/

On-orbit Calibration

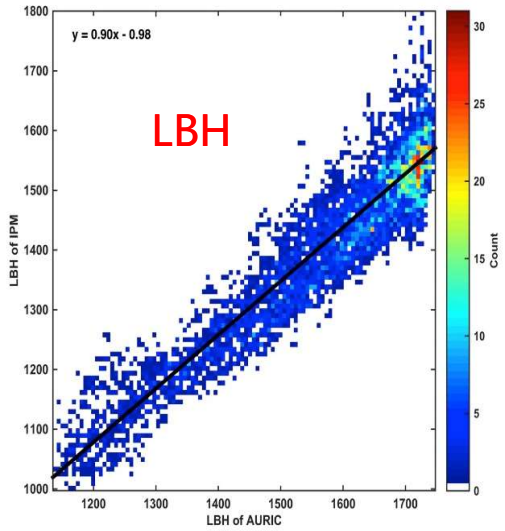
- Calibration probe A2 points to the direction of probe A to observe the consistency of the detective probe.
- IPM carried out three on-orbit calibration operations on November 10, December 10, 2025, and February 8, 2026 with four orbits for each operation.

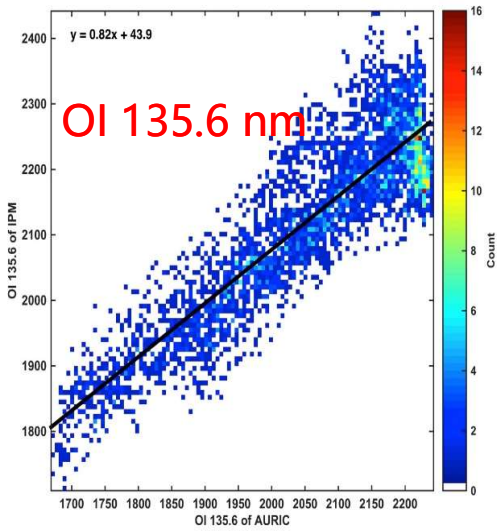
FY3H_IPM--_ORBT_1A_20251110_0459_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20251110_0640_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20251110_0822_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20251110_1003_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20251210_0849_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20251210_1031_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20251210_1212_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20251210_1354_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20260208_1629_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20260208_1811_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20260208_1952_OBC--_V0.HDF
FY3H_IPM--_ORBT_1A_20260208_2134_OBC--_V0.HDF



Validation

- Comparison with AURIC model.
- The scatter plots of irradiances of OI 135.6 nm and N_2 LBH of probe A versus the corresponding results derived from AURIC model from 11-13 Nov 2025.

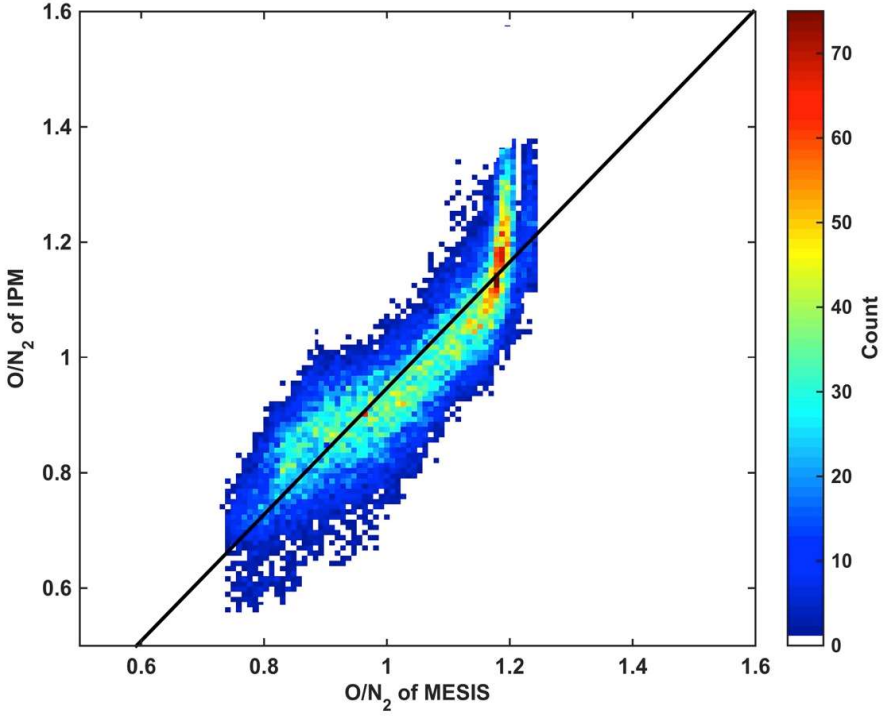




Sample		Root Mean Square Error (RMSE)		Correlation coefficient (R)	
OI 135.6 nm	LBH	OI 135.6 nm	LBH	OI 135.6 nm	LBH
3681	6500	14.58%	11.28%	0.89	0.93

Validation

- Comparison with MSIS-00 model
- The level 2 product of the IPM – O/N_2 versus the corresponding results derived from the MSIS-00 model on 23-28 Nov 2025.



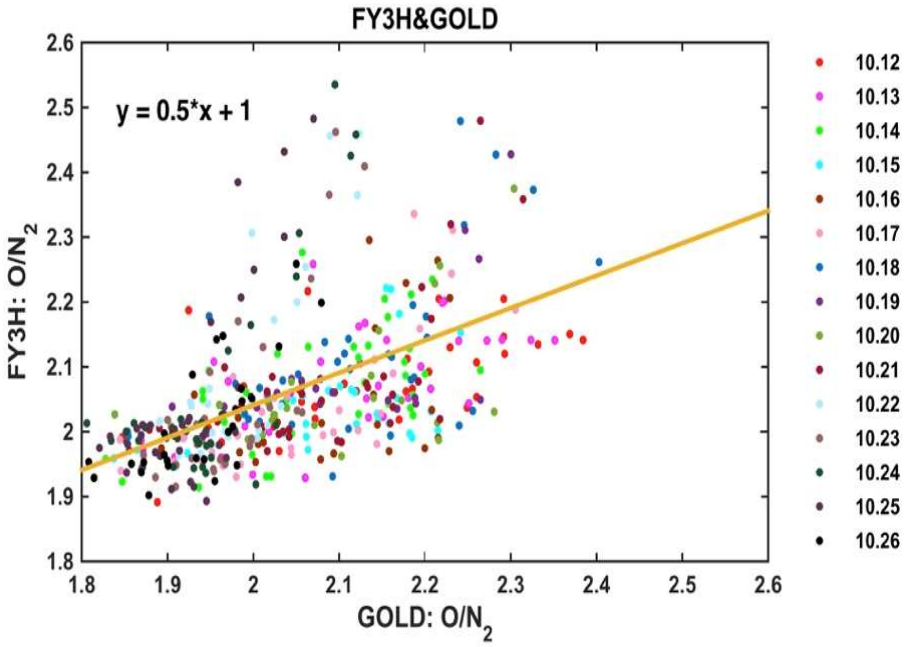
- Validation data: November 23-28, 2025
- Accuracy requirement: correlation coefficientr>0.7

  relative root mean square error<20%

sample	Root Mean Square Error (RMSE)	Correlation coefficient (R)
32594	12.58%	0.91

Validation

- Comparison with GOLD
- The level 2 product of the IPM – O/N_2 versus the corresponding results observed from GOLD on 12-26 Oct 2025.

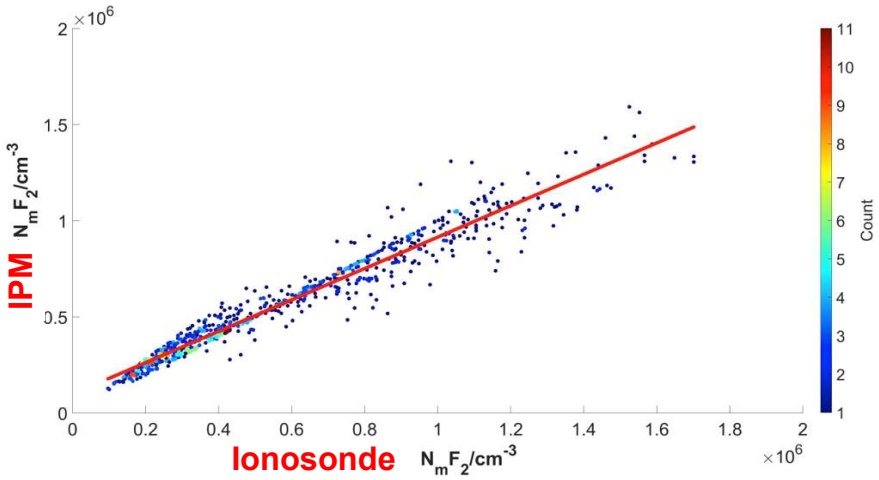


- Validation data: October 12-26, 2025
- Spatial matching resolution: 2°×2° (longitude×latitude)
- Temporal matching resolution:
- Accuracy requirement: correlation coefficientr>0.7
  relative root mean square error<20%

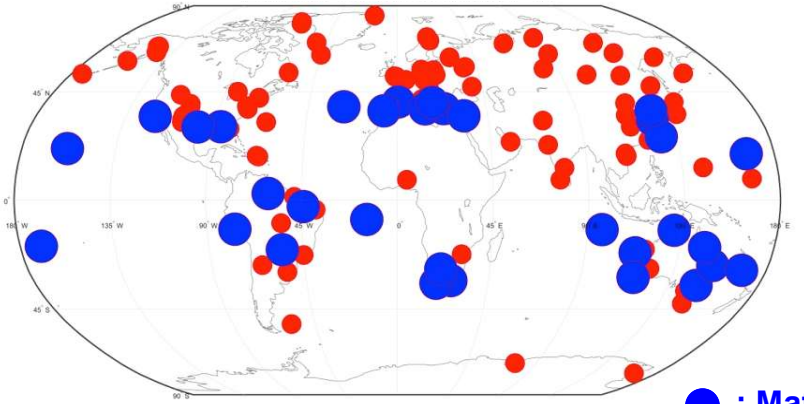
sample	Correlation coefficient (R)
458	0.73

Validation

- Comparison with global ionosonde
- The level 2 product of the IPM – NmF2 versus the corresponding results observed from the global ionosonde from October-December 2025.



Matched ionosonde station distribution



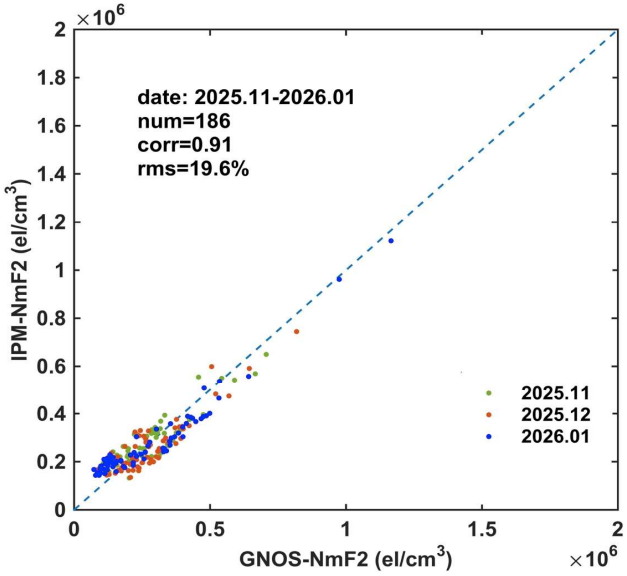
● : Matched stations

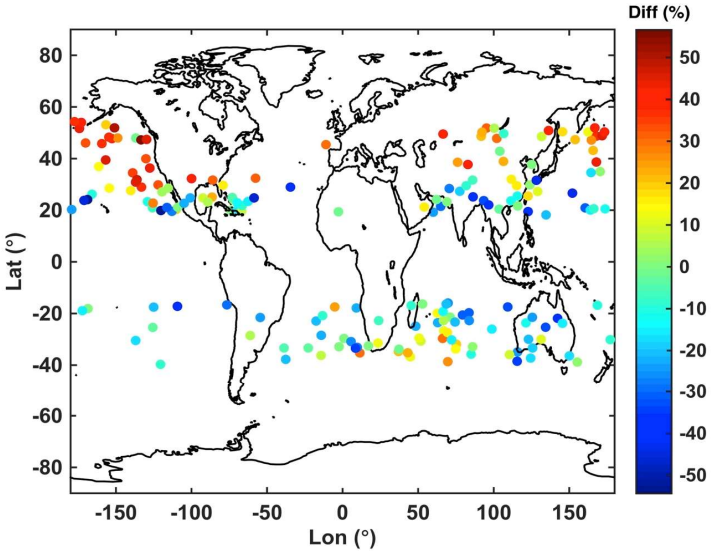
- Validation data: October-December 2025
- Spatial matching resolution: 5°×2.5° (longitude×latitude)
- Temporal matching resolution: 30 mins
- Accuracy requirement: correlation coefficientr>0.7
  relative root mean square error<20%

sample	Root Mean Square Error (RMSE)	Correlation coefficient (R)
779	16.57%	0.97

Validation

- Comparison with global ionosonde
- The level 2 product of the IPM – NmF2 versus the corresponding results derived from the FY3H GNOS from November 2025 to January 2026 .





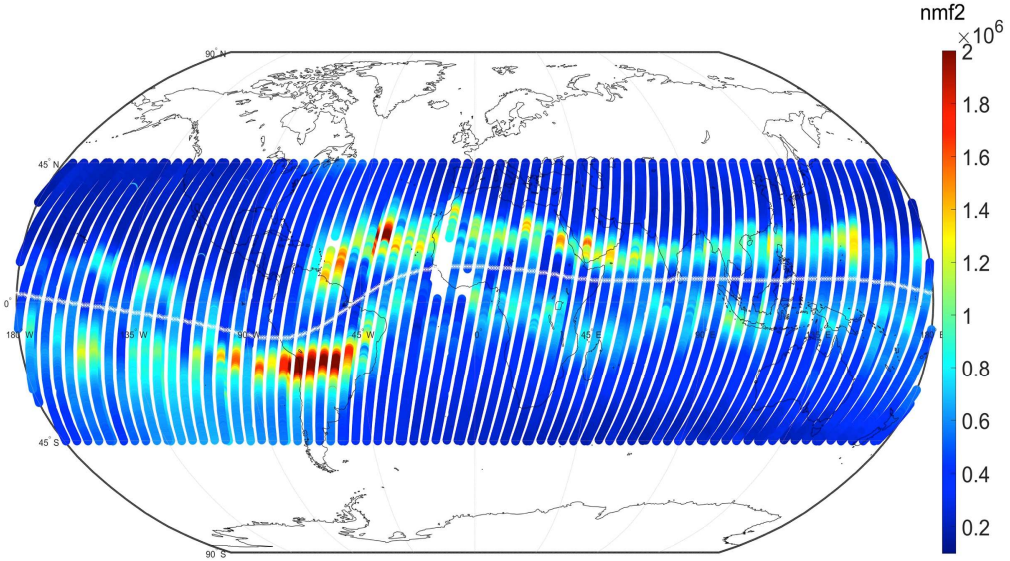
- Validation data: November 2025-January 2026
- Spatial matching resolution: 1°×1° (longitude×latitude)
- Temporal matching resolution: 30 mins
- Accuracy requirement: correlation coefficientr>0.7
  relative root mean square error<20%

sample	Root Mean Square Error (RMSE)	Correlation coefficient (R)
186	19.64%	0.91

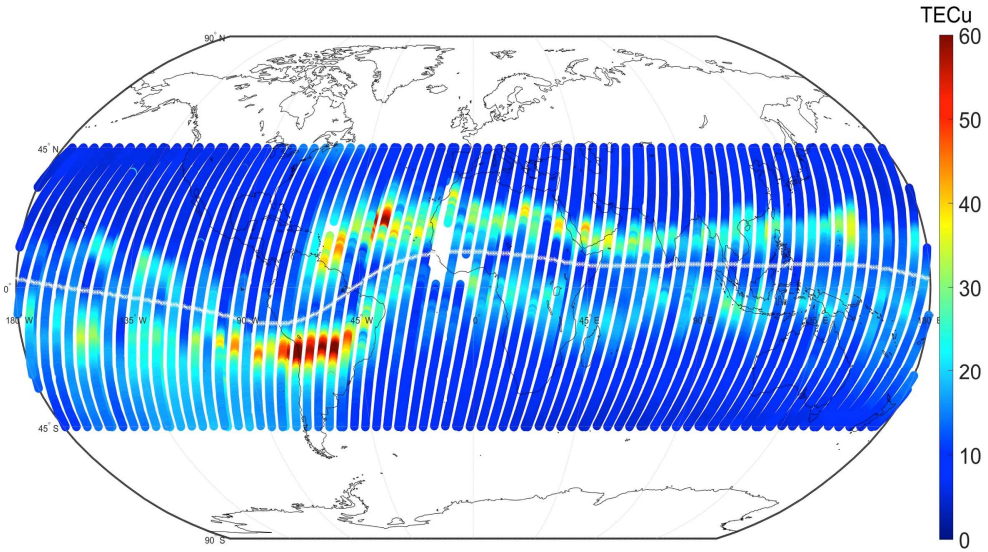
Application: Equatorial Ionization Anomaly

- Merged map of IPM Level-2 products **NmF2** and **TEC** for all orbits from 21 to 26 October 2025.
- Both nighttime products are physically reasonable and effectively capture the nighttime Equatorial Ionization Anomaly (EIA).

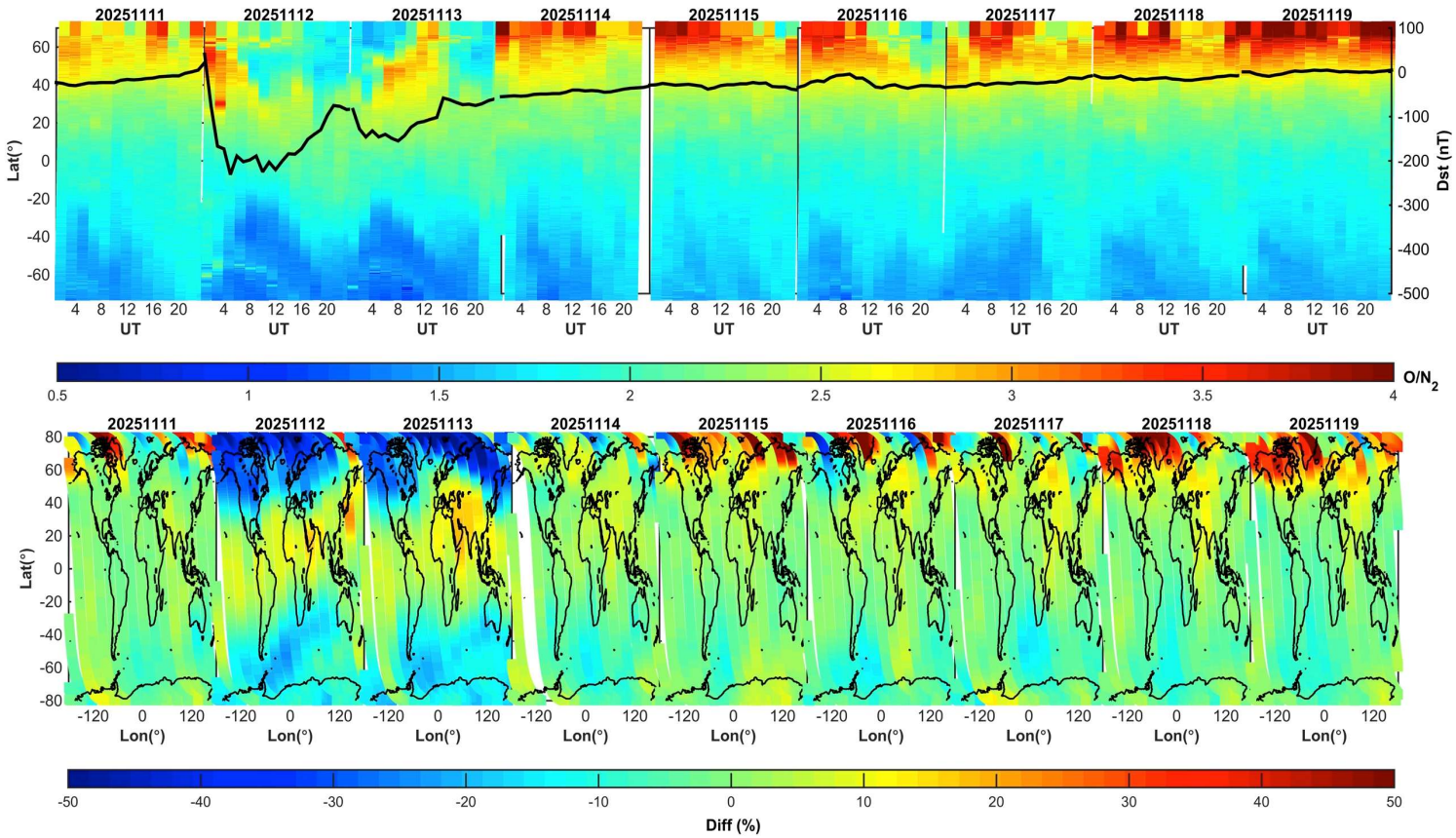
Nighttime L2 Level-2 product NmF2



Nighttime L2 Level-2 product TEC



Application: disturbed time



- Capture the initial storm perturbations using the delay time between Dst drop and obvious O/N_2 product changes, and determine the response speed.
- Judge the integrity of the response process by analyzing O/N_2 amplitude variations (quiet vs. storm time O/N_2) and their correlation with the Dst index trend.

Conclusion

- The calibration results demonstrate that the IPM meets the design requirements.
- The IPM observations agree well with the AURICA models.
- The level 2 products of IPM agree well with the MSIS00 model and the observations of GOLD, FY3H GNOS, and the global ionosondes.
- The IPM level 2 products-NmF2 and TEC can effectively capture the nighttime Equatorial Ionization Anomaly, while the O/N_2 can track the evolution of magnetic storm-induced perturbations of the atmosphere during disturb time.
- The set of analyses demonstrate the value of the FY3H IPM instrument for the study of the thermosphere and ionosphere in the future.

Thank you!