Estimation of IFOV inter-channel deviation for conical-scanning Microwave Radiation Imager

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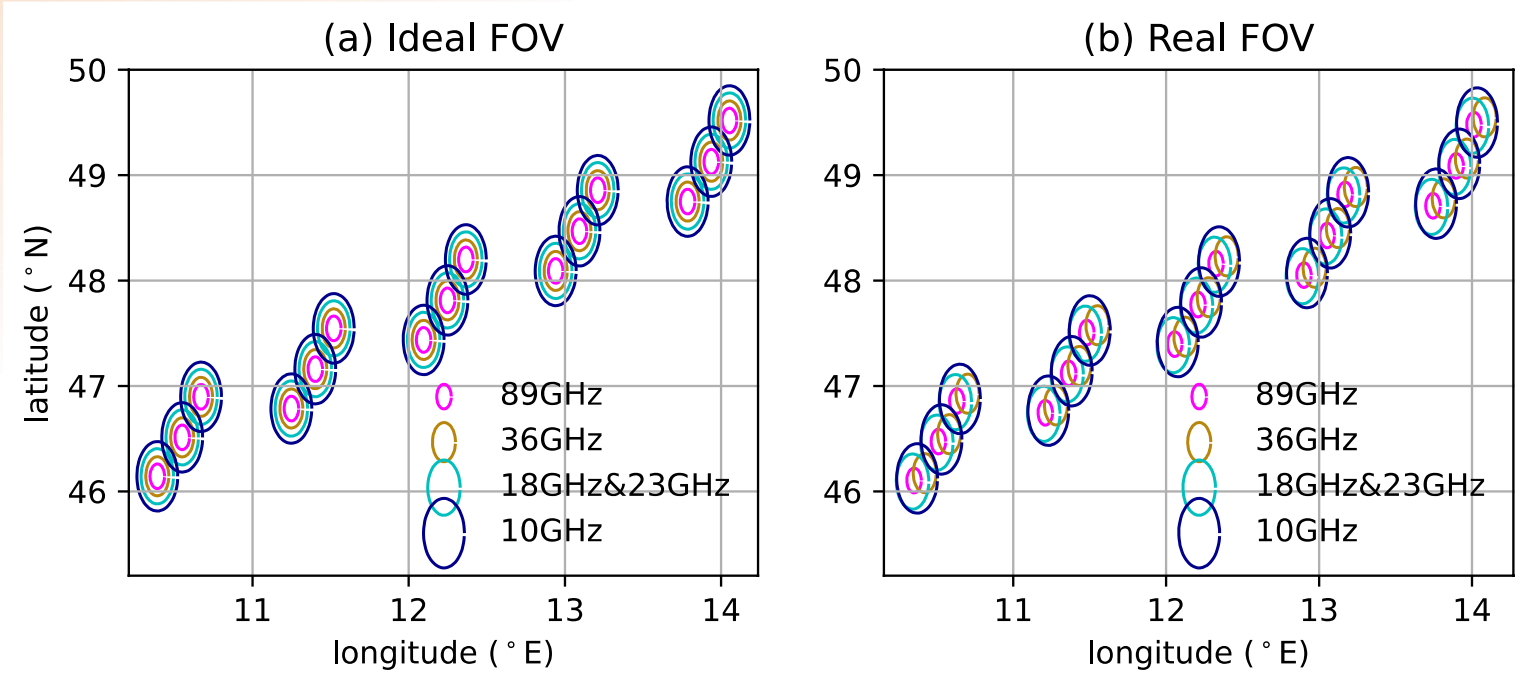
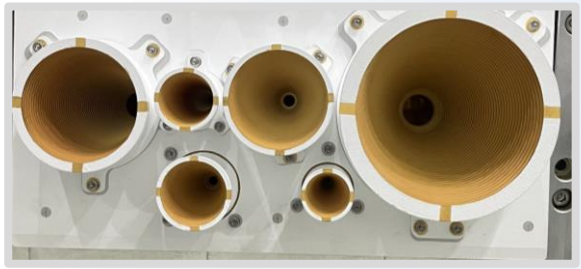
01 What: IFOV Inter-Channel Deviation

Actual IFOVs deviate from ideal concentric ellipses.





- Directly impacts the accuracy of the retrieved geophysical parameters and spatial matching between multiple platforms and payloads

- Structural assembly errors and measurement errors of feedhorn apertures could cause IFOV inter-channel deviation.

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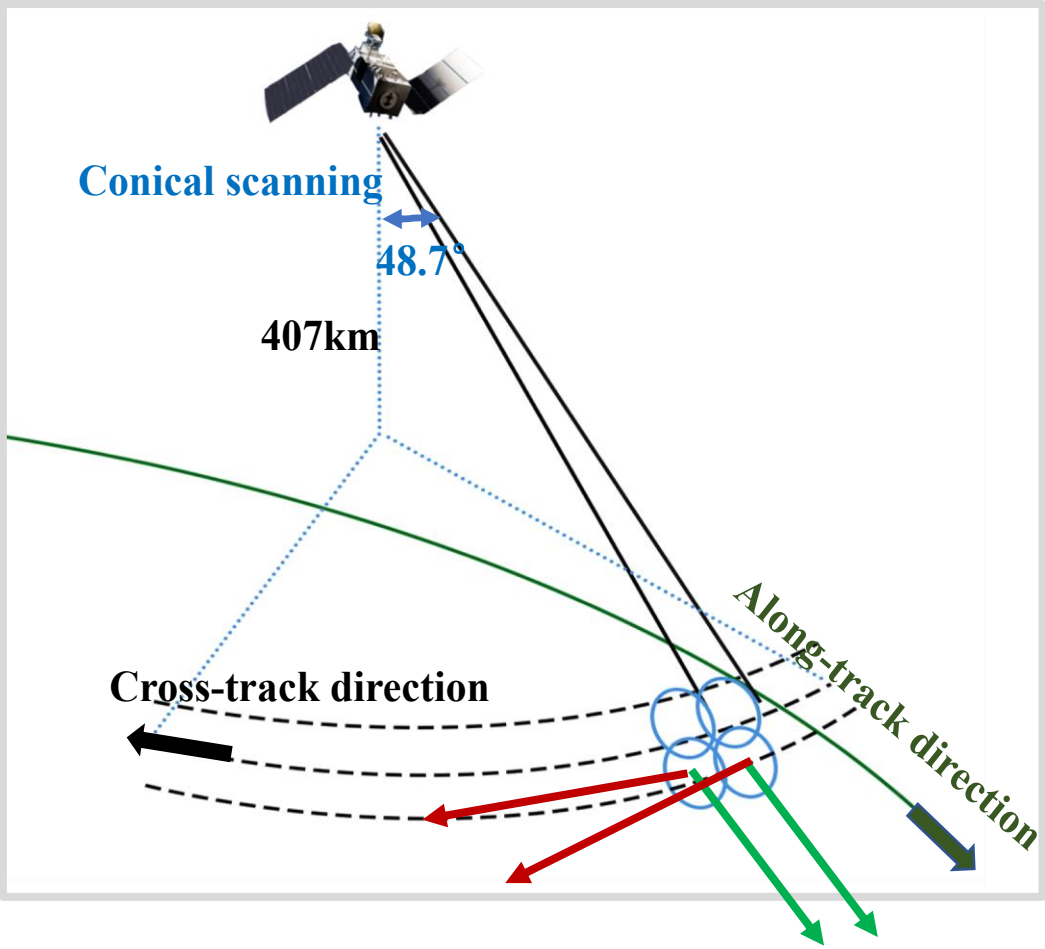
02 Why: Complexity in Conical-Scanning instrument



Traditional method

- Utilize physical property of brightness temperature abrupt change near coastline
- Analyze deviation distance of each channel relative to reference channel 89V
- Empirical selection of sampling areas

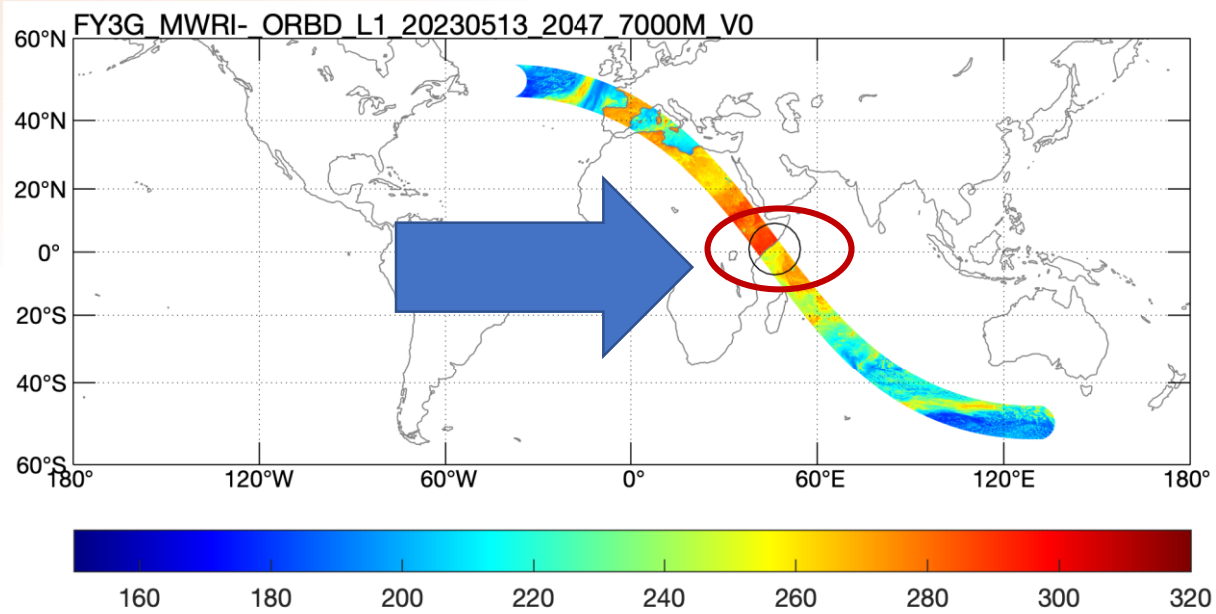
Key challenges

- Cross-track pointing variation in real time
- Elliptical FOV Misalignment——rotating footprint angle varies vs. fixed coastline

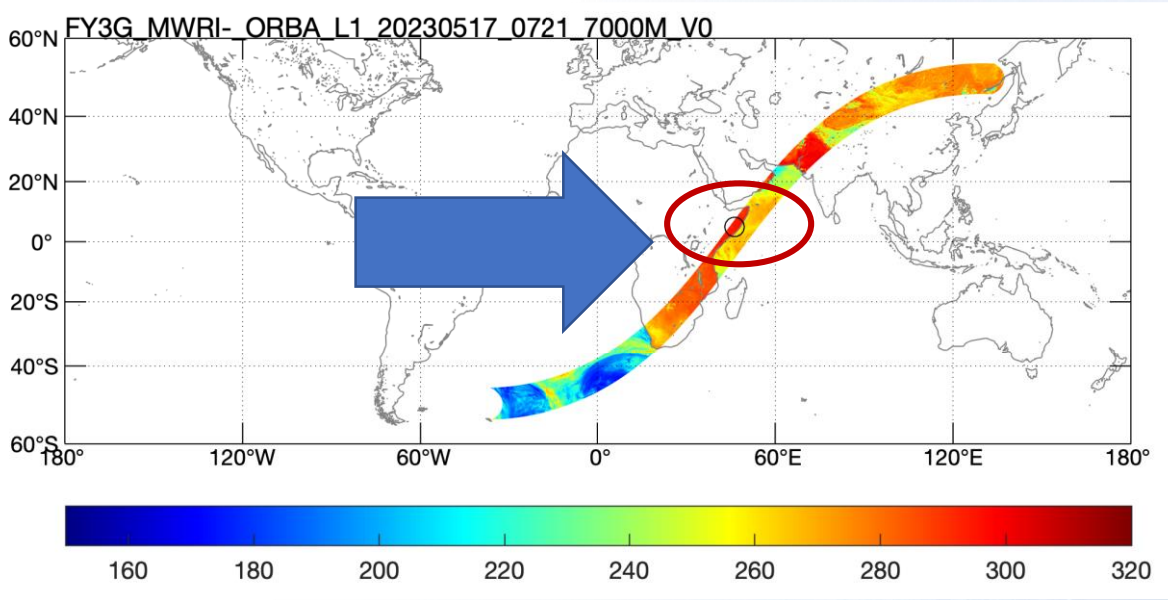
02 Why: Complexity in Conical-Scanning instrument

Estimate deviations separately in the along-track and cross-track directions.

- Sample for Cross-Track Deviation Estimation



- Sample for Cross-Track Deviation Estimation



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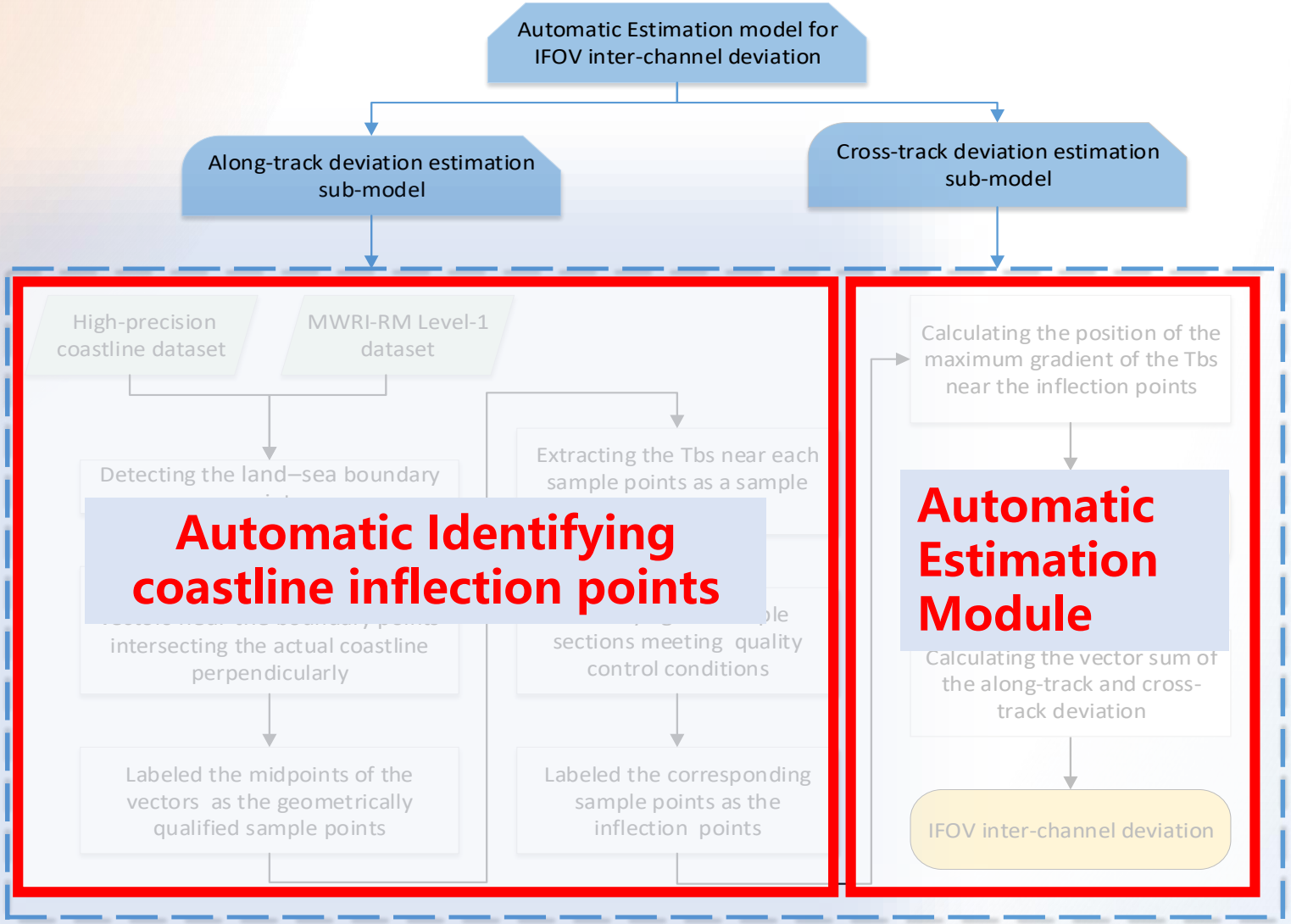
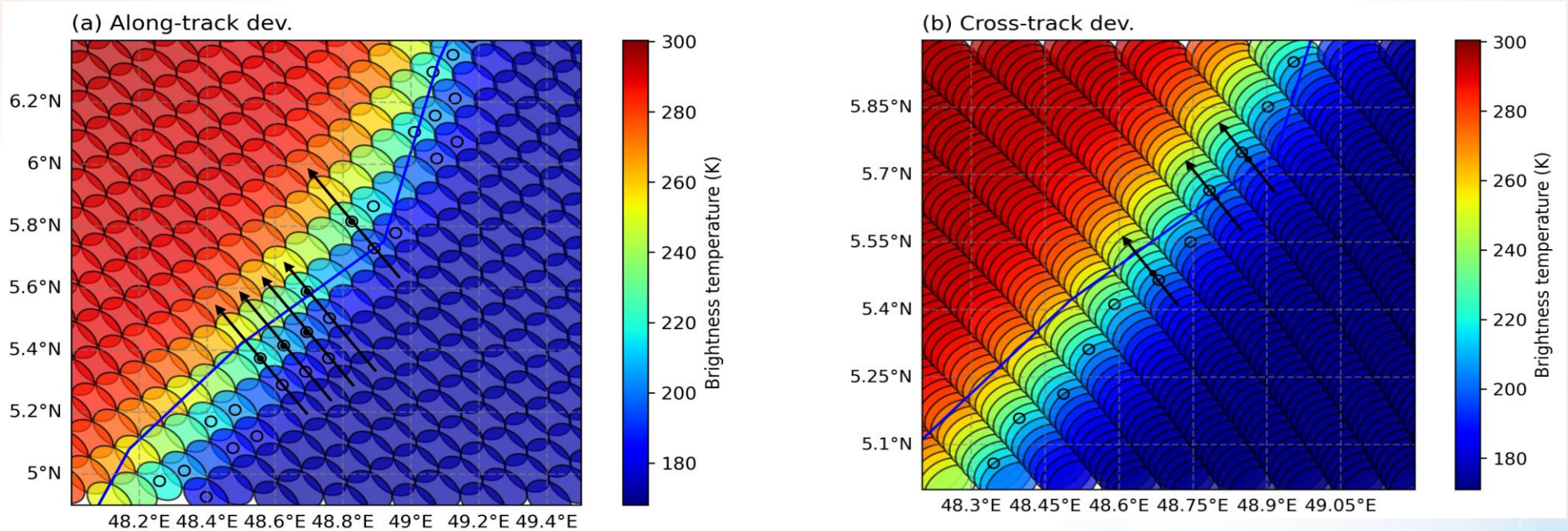
03 How: Model-Based Estimation



03 How: Model-Based Estimation

Automatic Identifying coastline inflection points:

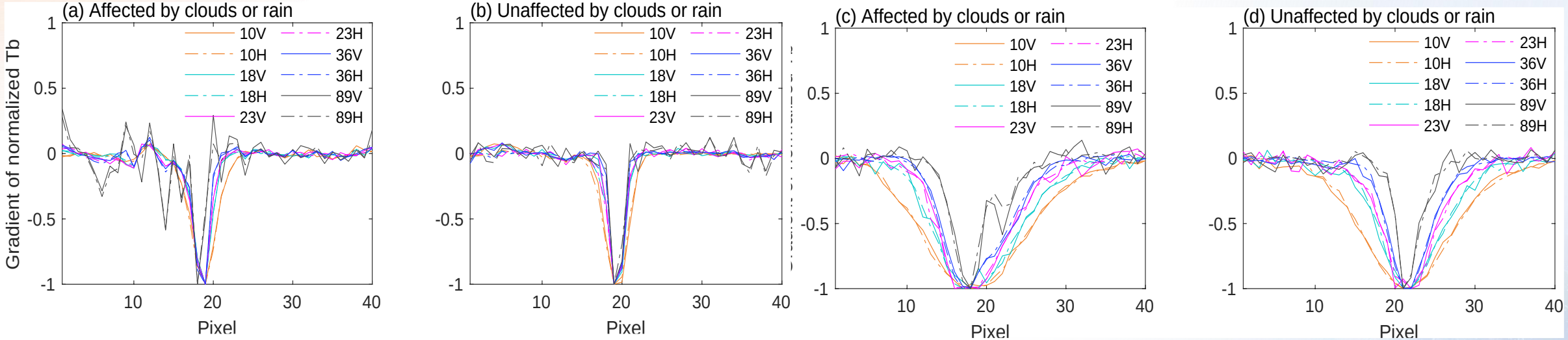
- Land-sea Boundary Buffer Zone Recognition
- TB inflection points perpendicular to & intersecting coastlines



03 How: Model-Based Estimation

Automatic Identifying coastline inflection points:

- **Cloud-free points only**

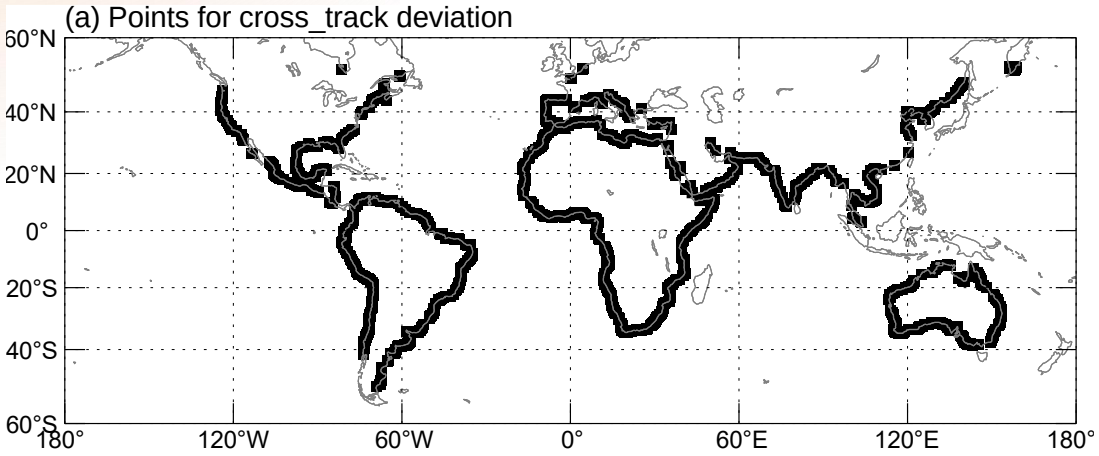


Gradient thresholds are used to mask out cloud/rain contamination

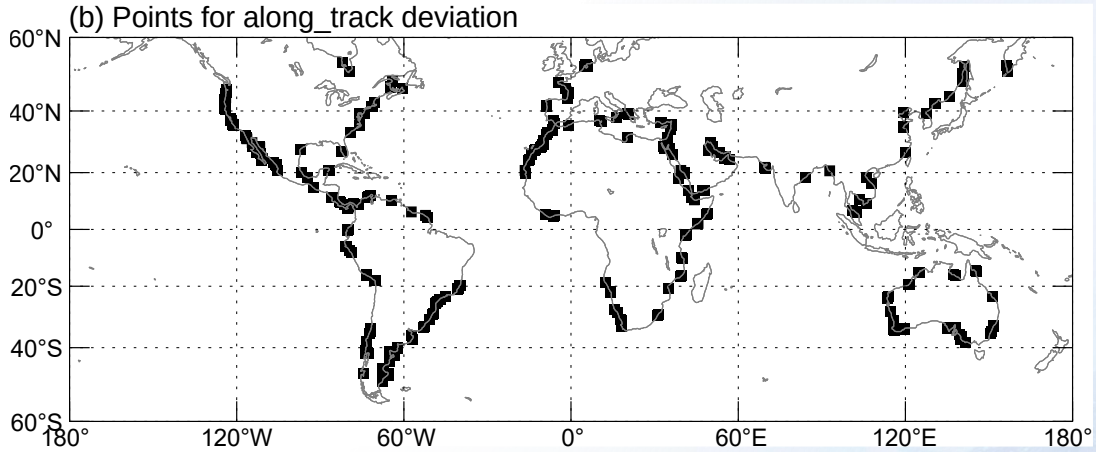
03 How: Model-Based Estimation

Samples span diverse latitude zones and greatly exceed empirical selection.

- Samples for Cross-Track deviation estimation



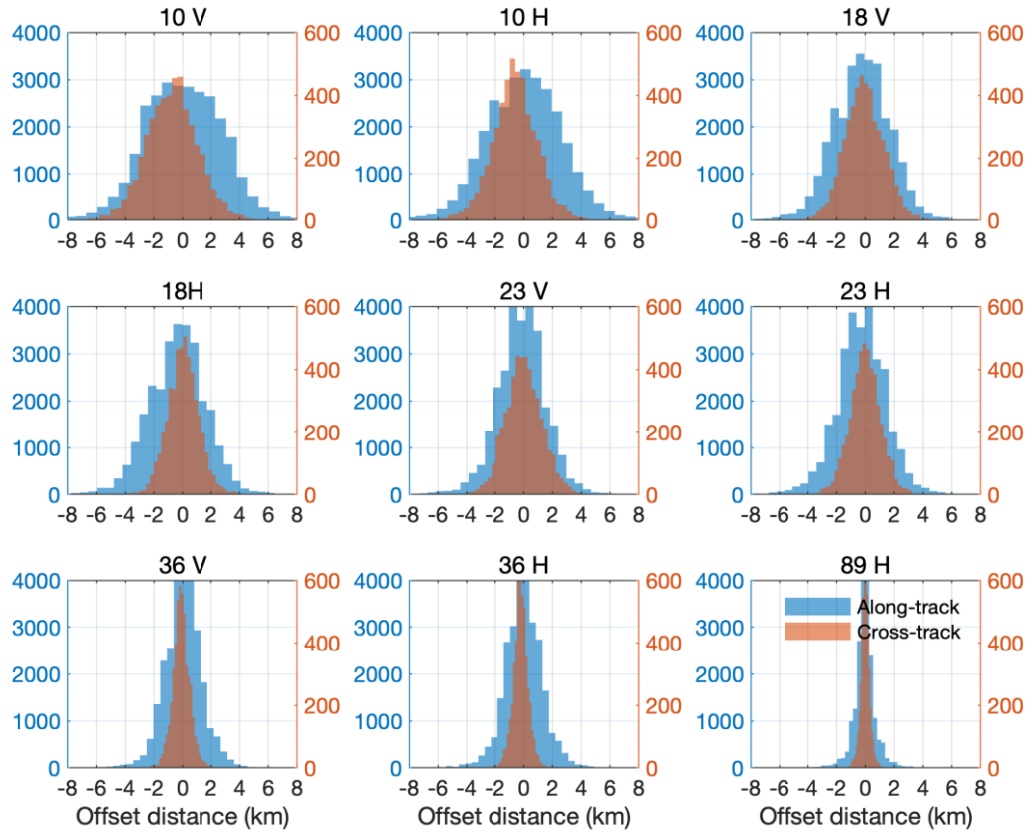
- Samples for Along-Track deviation estimation



03 How: Model-Based Estimation

Automatic Estimation Module:

- Coastline inflection method
- Cubic spline interpolation is used to achieve subpixel accuracy
- Symmetric distribution → accurate inflection point identification
- Lower frequencies : larger spread → wider beams → more uncertainty



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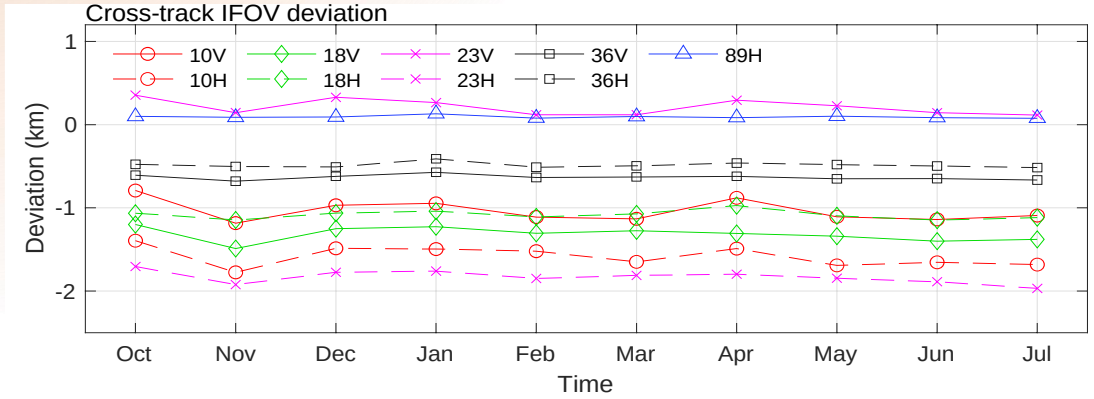
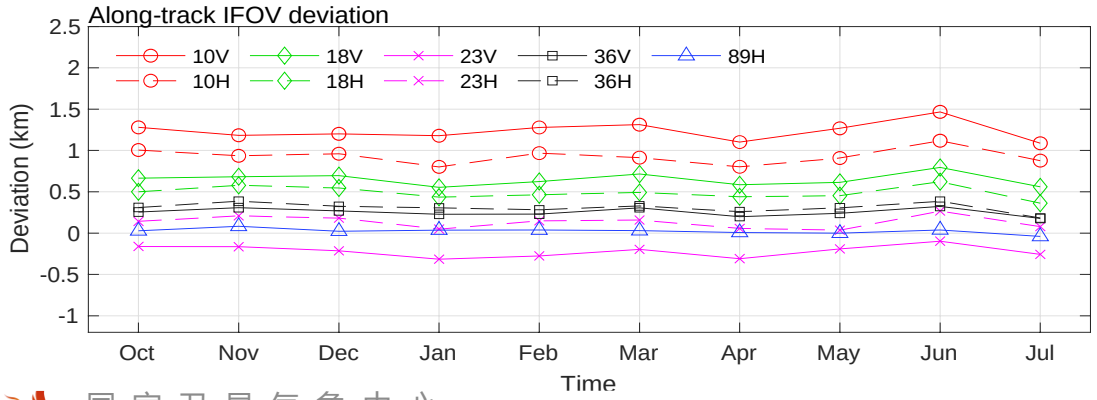
04 Results and Validation

Results

Composite deviation <2 km for FY3G/MWRI-RM and FY3F/MWRI-II





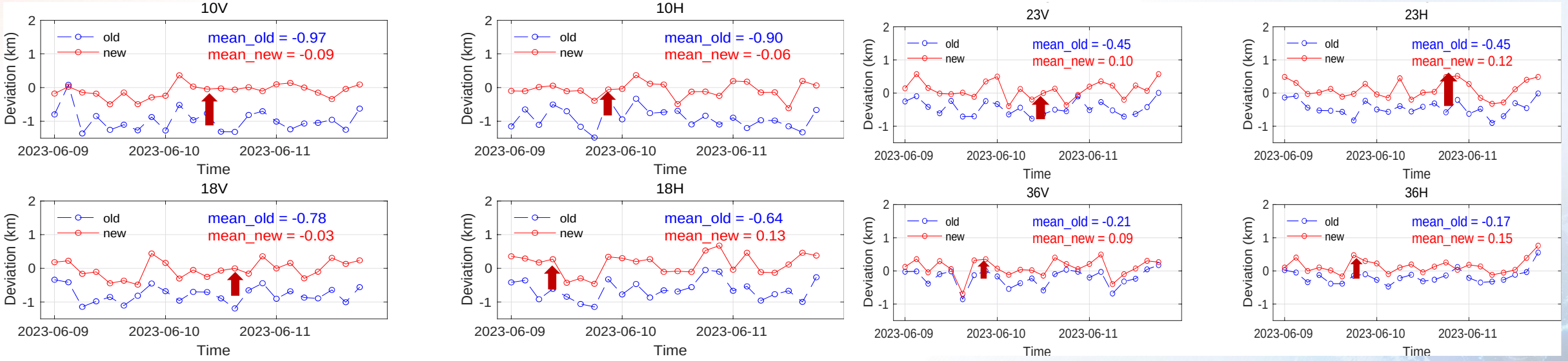
- The on-orbit composite deviation is less than 1 km for FY-3G and below 2 km for FY-3F.
- Monthly-based assessment accuracy reaches 90.1% over long-term monitoring.

04 Results and Validation

Validation

➢ Image matching-based verification

After re-geolocating using the estimated inter-channel deviations, the inter-channel misregistration was reduced to below 0.2 km.



04 Results and Validation

Validation

➢ Theoretical parameter uploading effect vs. model-estimated effect

- On August 22, 2023, telemetry uploading new timing sequence.
- Sub-0.2 km residuals confirm model precision.

Channel	FY-3F MWRI			FY-3G MWRI		
	Model-estimated effect (km)	Theoretical upload effect (km)	**Residual (km)**	**Model-estimated effect** (km)	Theoretical upload effect (km)	**Residual (km)**
10.65 V	-8.75	-8.56	**-0.19**	-5.38	-5.45	**0.07**
10.65 H	-9.03	-8.96	**-0.07**	-5.05	-5.16	**0.11**
18.7 V	-6.29	-6.38	**0.09**	-3.17	-3.16	**-0.01**
18.7 H	-5.89	-5.88	**-0.01**	-2.85	-2.87	**0.02**
23.8 V	-2.77	-2.80	**0.02**	-1.97	-2.01	**0.04**
23.8 H	-4.90	-4.82	**-0.08**	-2.02	-2.08	**0.06**
36.5V	-2.90	-2.99	**0.10**	-1.33	-1.36	**0.03**
36.5H	-2.77	-2.86	**0.09**	-1.35	-1.36	**0.01**
89 H	0.16	0.02	**0.14**	0.02	0.00	**0.02**

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05 Summary & Perspectives

- An Automated Inter-Channel Deviation Estimation Model has been designed for conical-scanning radiometers . The model is stable and reliable, with evaluation accuracy better than 0.2 km.

- MWRI inter-channel deviations on FY-3F and FY-3G: < 2 km.

- Evaluate inter-channel deviations of major global microwave radiometers, providing support for data matching across multiple sensors.

- Analyze the spatiotemporal characteristics and key drivers of deviation variability , offering a scientific basis for the optimization of future microwave instruments.

Speaker： Pengjuan Yao

Major : Calibration and validation for microwave radiometer

National Satellite Meteorological Center, CMA