Visible channel CMV from FengYun Geo. Stereo view – simulation and bias analysis

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Outline

1)Background

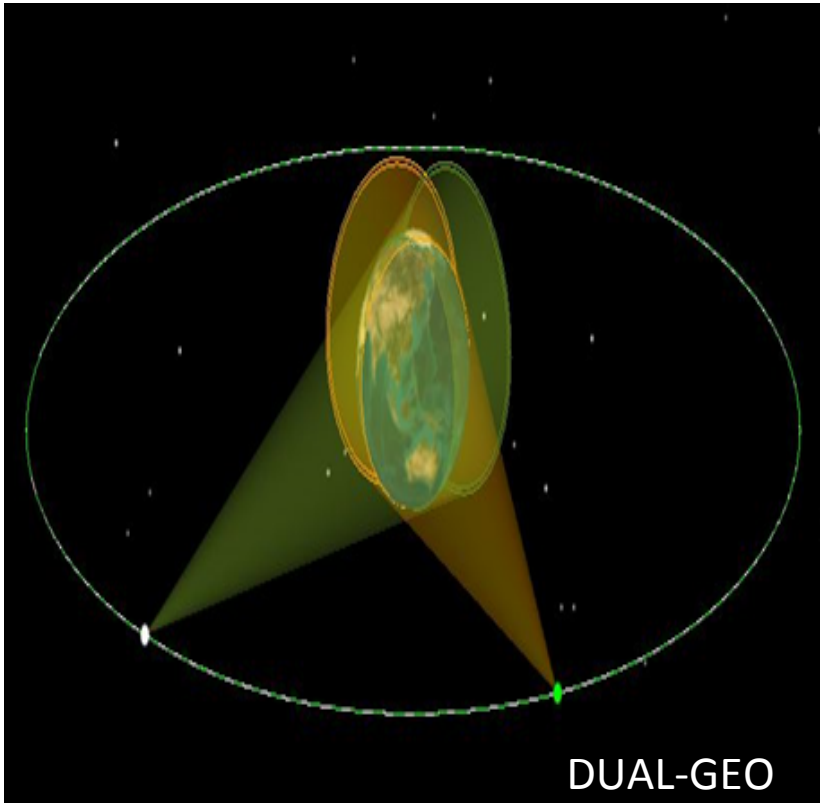
2)FengYun Geo. satellite settings

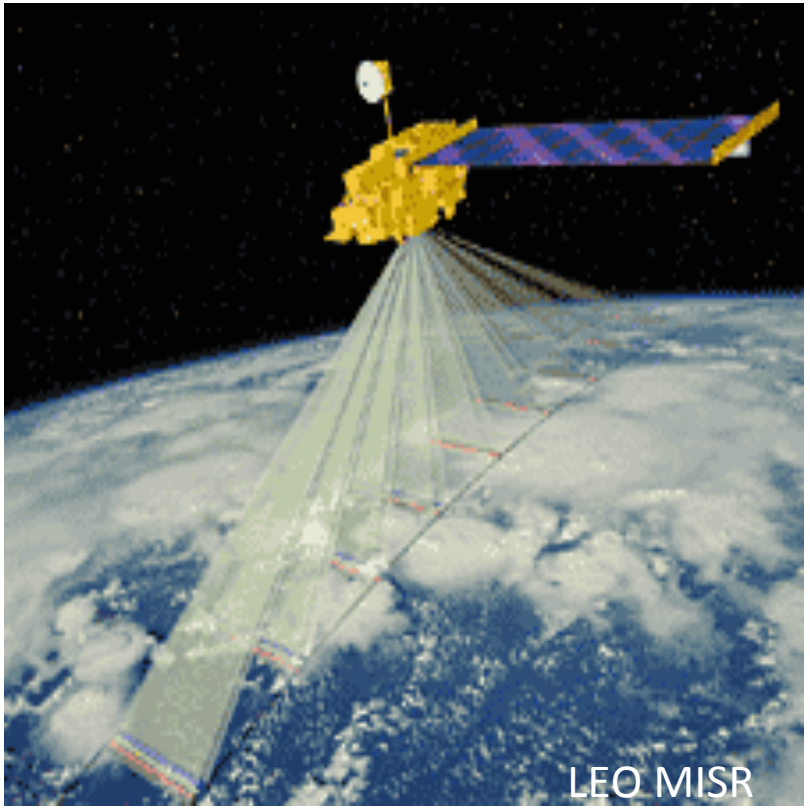
3)FengYun DUAL-GEO CMV Bias analysis

4)Future work

Parallax*

Apparent displacement, or difference in the apparent position, of an object, caused by actual change (or difference) of position of the point of observation; spec. the angular amount of such displacement or difference of position, being the angle contained between the two straight lines drawn to the object from the two different points of view, and constituting a measure of the distance of the object."



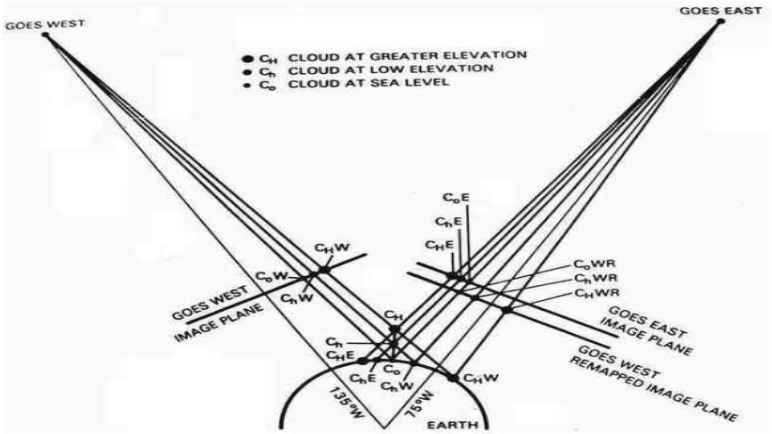


**Oxford English Dictionary* (Second Edition ed.). 1989.

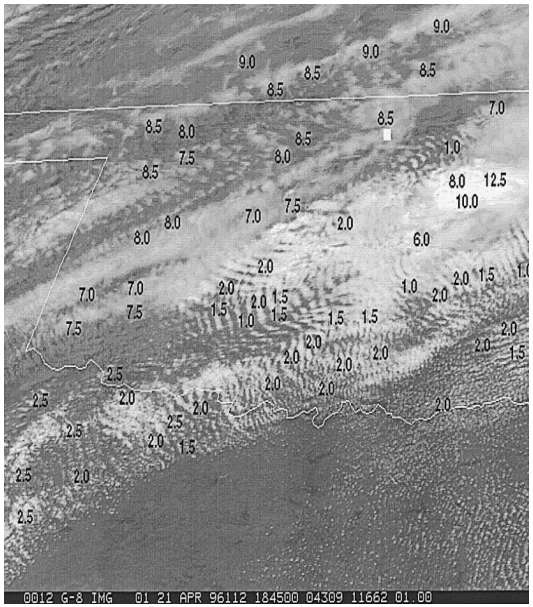
$$H = \frac{P}{P_{10}} \times 10\ km$$

H: cloud top height
P10: parallax while cloud height is 10Km
P: parallax offset observed in image pair

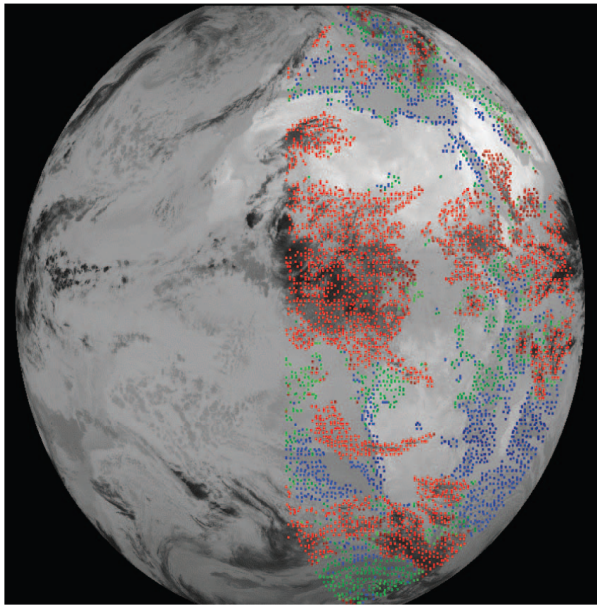
Fujita T.T., 1982: Principle of stereographic height computations and their and their applications to stratospheric cirrus over severe thunderstorms. *J. Meteor.Soc. of Japan*, **60**, 355-368.



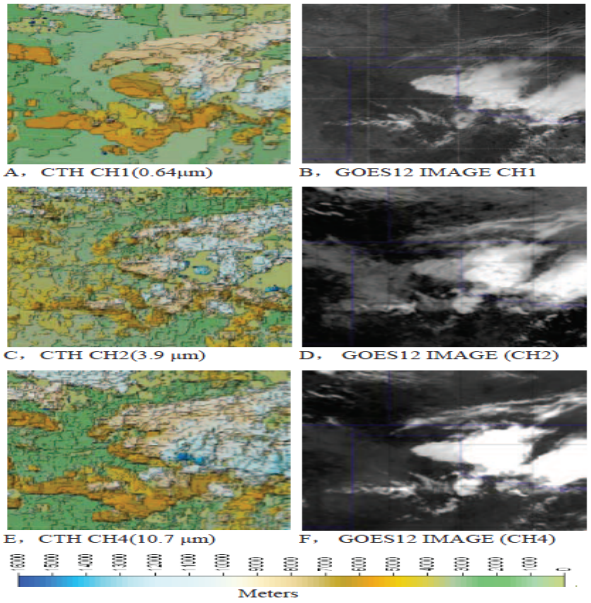
Automatic analysis of stereoscopic satellite image pairs for determination of cloud-top height structure (1991)
by A F Hasler, J Strong, R H Woodward, H Pierce, Journal of Applied Meteorology



Wylie, D. P. Santek, D. Starr, D. O. Cloud-top heights from GOES-8 and GOES-9 stereoscopic imagery, Journal of Applied Meteorology,1998 VOL37,4,p405-413



Geometric cloud heights from Meteosat，
G.G. G. CAMPBELL，K. HOLMLUND，INT. J. REMOTE SENSING, 10 NOVEMBER, 2004，VOL. 25, NO. 21, 4505－4519

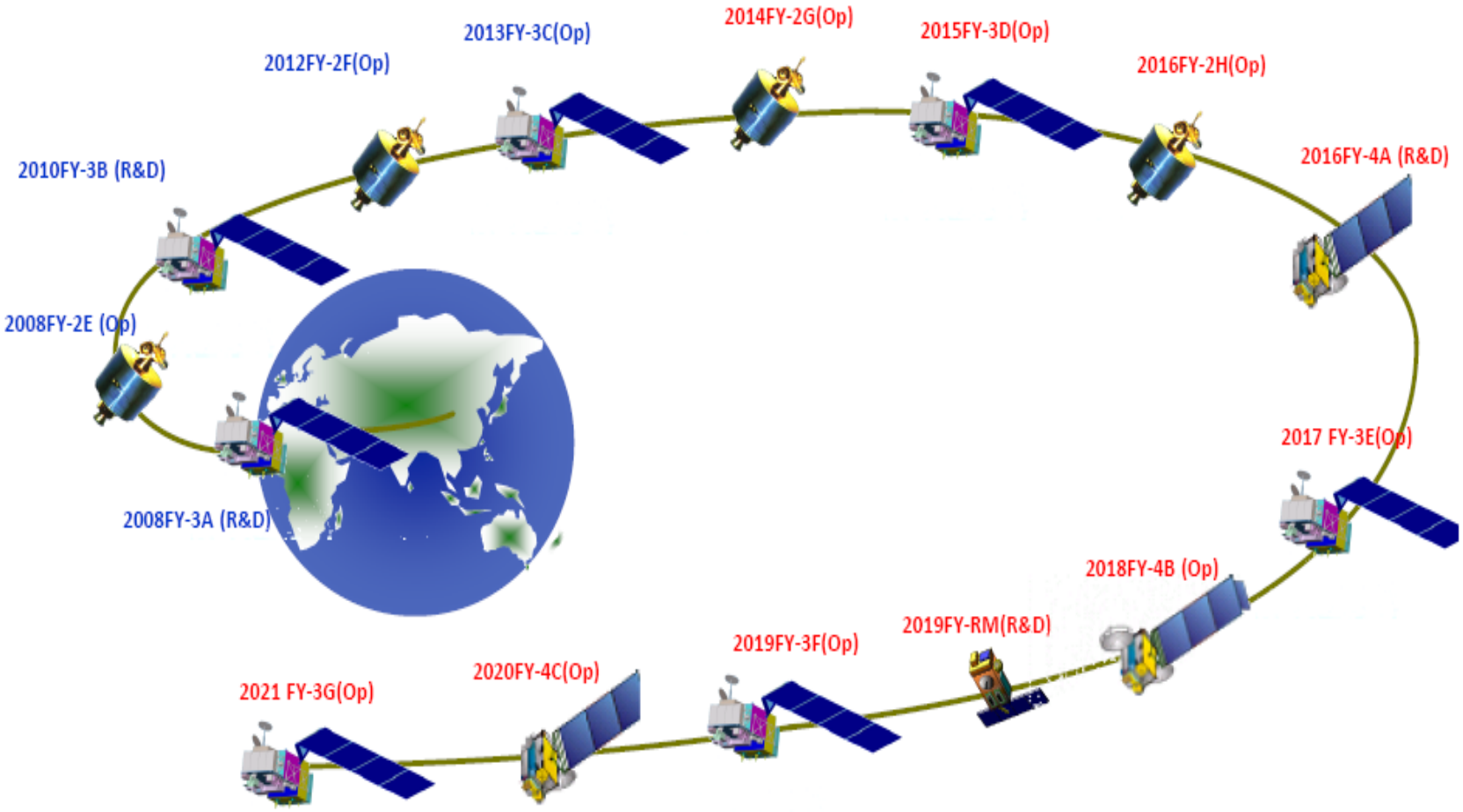


Feng Lu,Jianmin Xu,W. Paul Menzel,Christopher S. Velden, Geometric cloud top height assignment by geosychronous meteorological satellite images,2009,
2009 IEEE International Geoscience & Remote Sensing Symposium

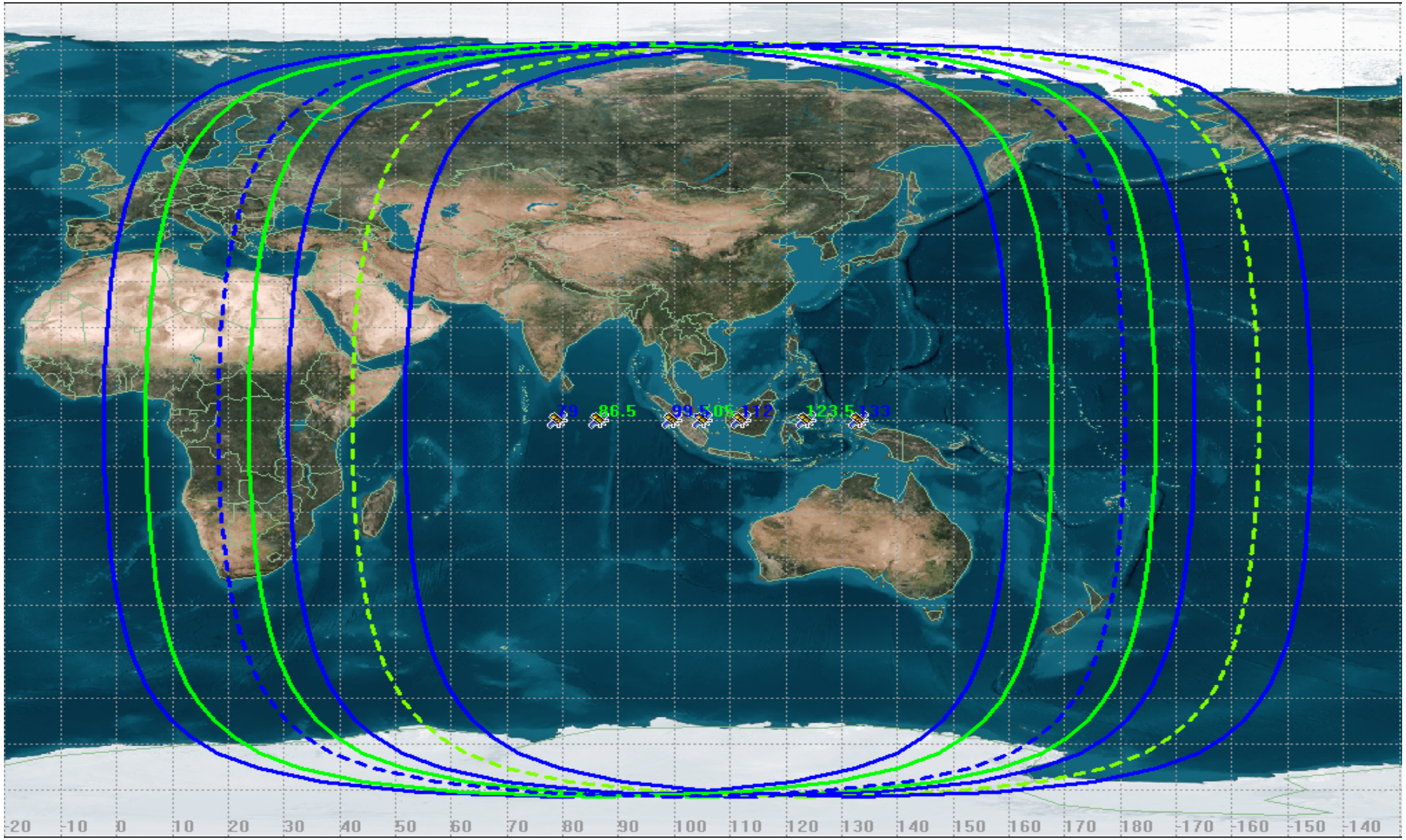
Benefits of Dual-Geo. In Visible CMV Retrieval

1) Not rely on NWP data for height assignment.
2) Good accuracy in cloud height assignment, especially for low level cloud.
3) Good temporal resolution.
4) Good spatial coverage.

Planning of CMA satellite systems by 2020.



Orbital positions for FengYun Geo.



Heritage positions from FY-2 86.5E,105E and 123.5E

New positions to apply 79E,99.5E,112E and 133E

Channel Setting of FengYun Geo.

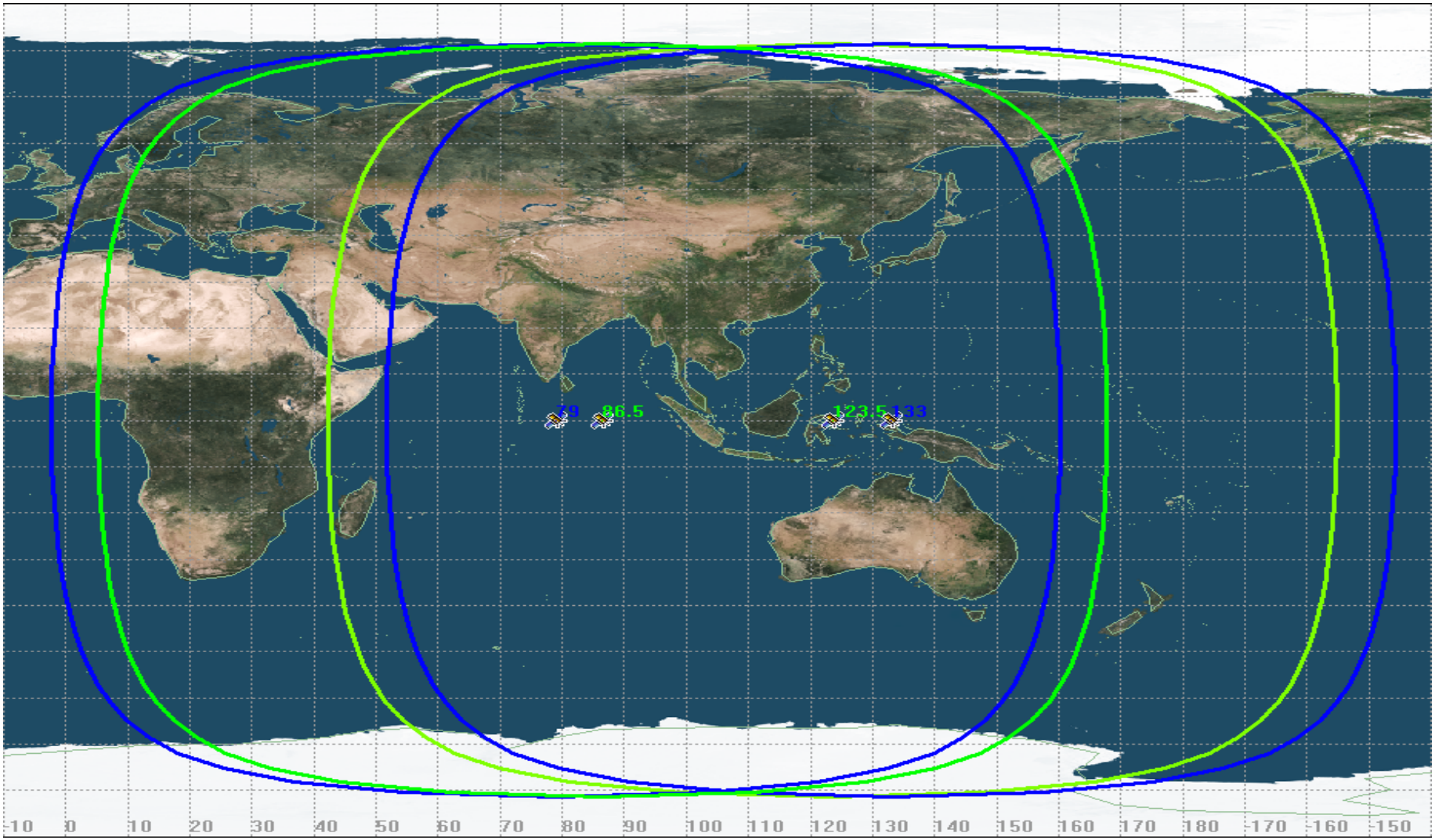
FY-2 VISSR

Channel	FY-2 C/D/E	FY-2 F/G/H	Spatial Resolution (Km)	Detection Sensitivity	Main Application
Visible	0.55～0.9	**0.55～0.75**	1.25		Fog Cloud Environment
Mid-wave Infrared	3.5-4.0	**3.5-4.0**	5	NEΔT≤0.7K(300K)	Fire, Cloud
Water Vapor	6.9～7.3	**6.9～7.3**	5	NEΔT≤0.3K(260K)	WV
Long-wave Infrared	10.3～11.3	**10.3～11.3**	5	NEΔT=0.2K(300K)	WV,Cloud SST
	11.5～12.5	**11.5～12.5**	5	NEΔT=0.2K(300K)	SST Cloud,WV

FY-4A AGRI

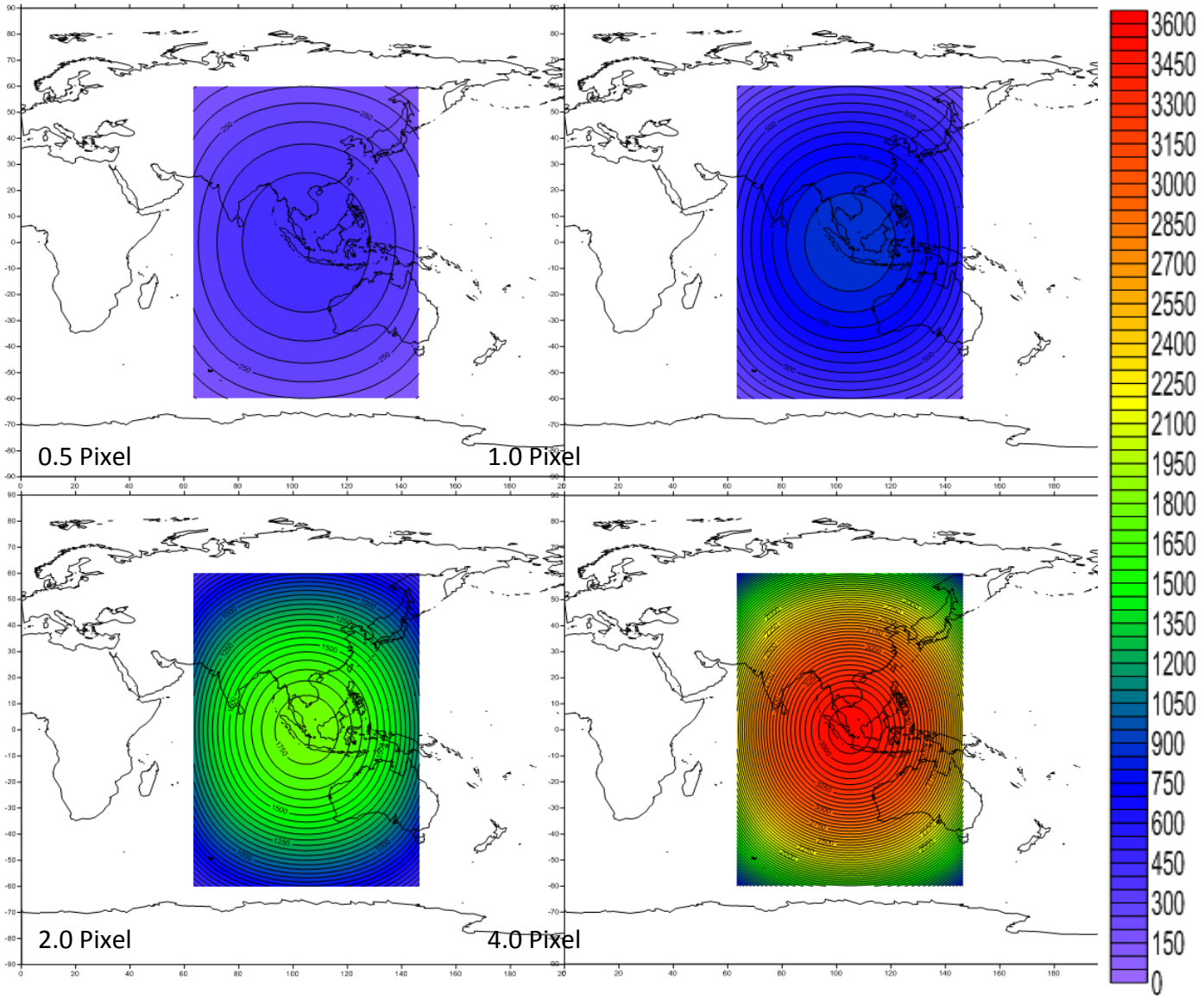
Channel	Band (*μm*)	Spatial Resolution (Km)	Detection Sensitivity		Main Application
Visible & Near-Infrared	0.45～0.49	**1**	S/N≥	70(ρ=100%)	Aerosol
	0.55～0.75	**0.5～1**		200(ρ=100%), 5(ρ=1%)@0.5Km	Fog,Clound
	0.75～0.90	**1**			Vegetation
Short-wave Infrared	1.36～1.39	**2**	S/N≥	200 (ρ=100%) 5 (ρ=1%)	Cirrus
	1.58～1.64	**2**			Cloud,Snow
	2.1～2.35	**2～4**			Cirrus,Aerosol
Mid-wave Infrared	3.5～4.0(high)	**2**	NEΔT≤0.7K(300K)		Fire
	3.5～4.0(low)	**4**	NEΔT≤0.2K(300K)		Land surface
Water Vapor	5.8～6.7	**4**	NEΔT≤0.3K(260K)		WV
	6.9～7.3	**4**	NEΔT≤0.3K(260K)		WV
Long-wave Infrared	8.0～9.0	**4**	NEΔT=0.2K(300K)		WV,Cloud
	10.3～11.3	**4**	NEΔT=0.2K(300K)		SST
	11.5～12.5	**4**	NEΔT=0.2K(300K)		SST
	13.2～13.8	**4**	NEΔT=0.5K(300K)		Cloud,WV

FengYun Geo. Overlap



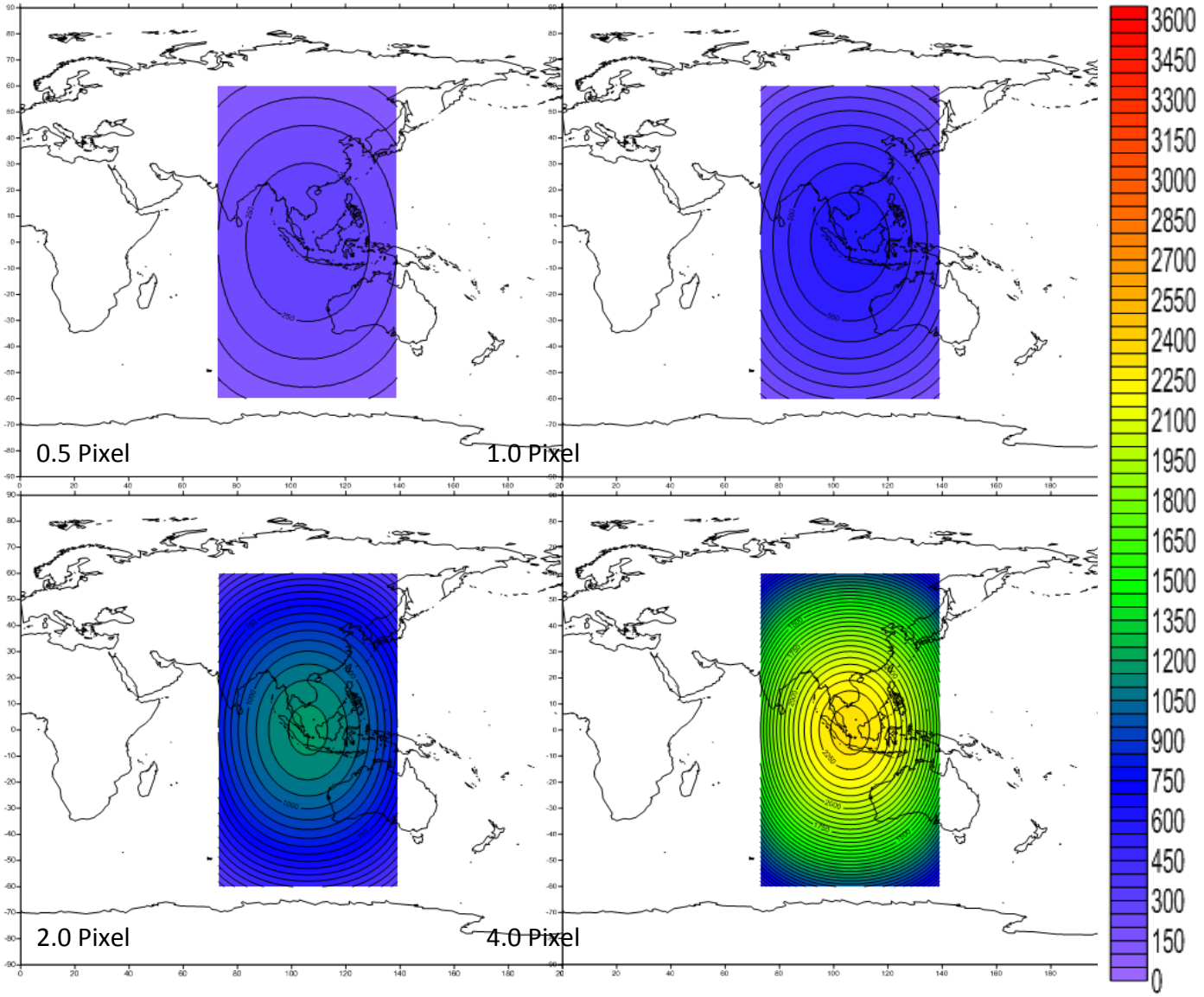
Operational Setting (86.5+123.5) Vs Potential Setting(79+133)

Parallax Corresponding CTH Analysis: FY-2 Dual-GEO Operational Setting



One FY-2 Visible Pixel =1.25Km SSP

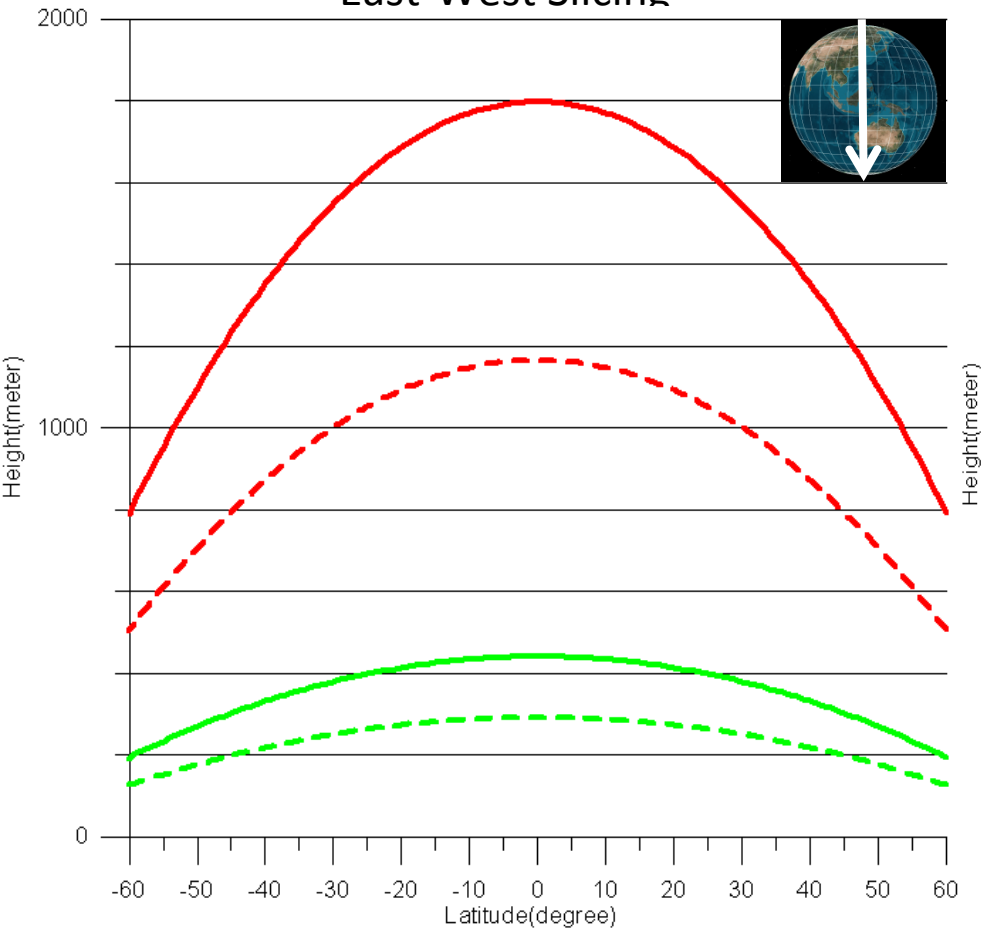
Parallax Corresponding CTH Analysis: FY-2 Dual-GEO Potential Setting



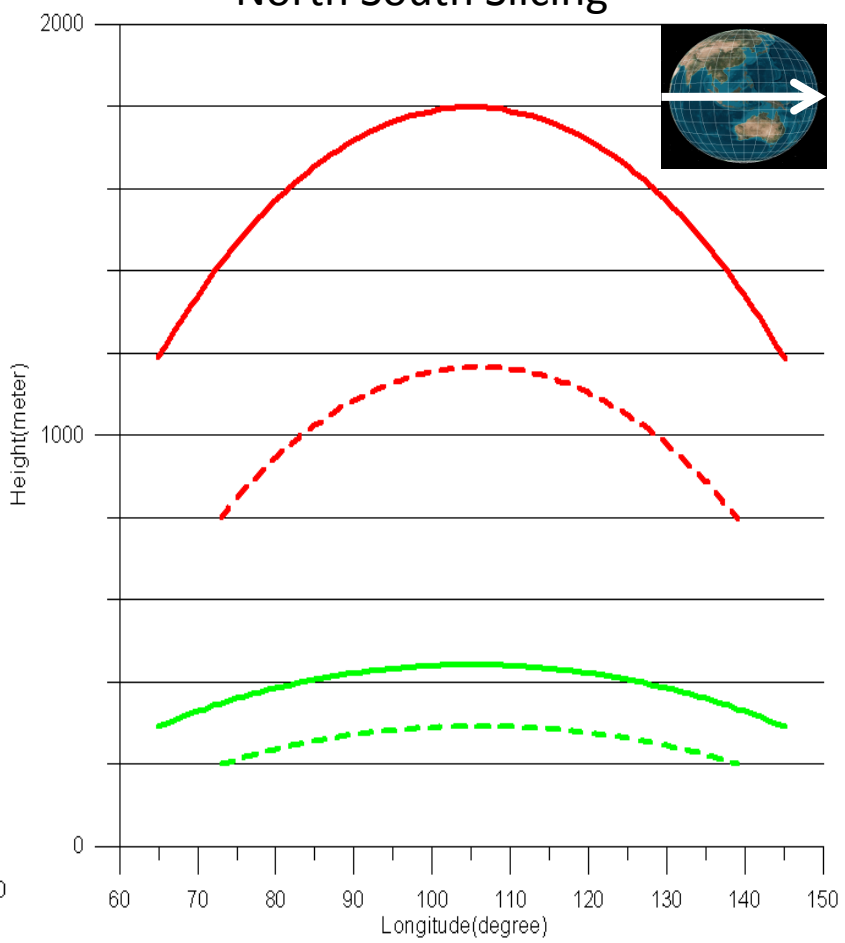
One FY-2 Visible Pixel =1.25Km SSP

Parallax Corresponding CTH Analysis: FY-2 Dual-GEO

East-West Slicing



North South Slicing



86.5+123.5 Half IR pixels
79+133 Half IR pixels
86.5+123.5 Half Vis pixel
79+133 Half Vis pixel

*Half pixels in FY-2 IR channel =2.5Km
*Half pixels in FY-2 Vis channel =0.625Km

1) FY-2 Dual-Geo CTH Capability

For FY-2 Vis channel,

86.5+123.5 dual-geo could recognize CTH >500 meters

79.0+133.0 dual-geo could recognize CTH >400 meters.

For FY-2 Ir channel,

86.5+123.5 dual-geo could recognize CTH >1800 meters

79.0+133.0 dual-geo could recognize CTH >1200 meters.

2) Coverage

86.5+123.5 dual-geo covers China and most of Asian-Pacific region

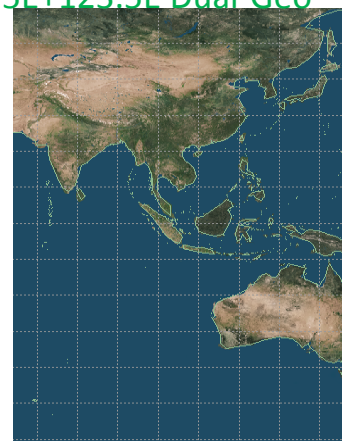
3)Operational Possibility

CMA have approved the 2014 FY-2 Maneuver plan,

FY-2F it will provide rapid scan on 123.5E from Q3 2014.

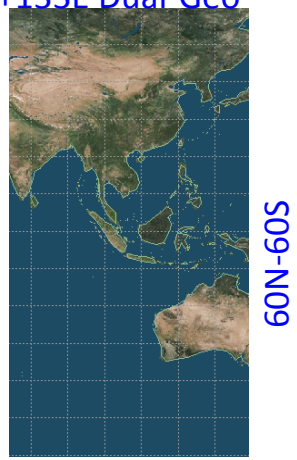
It could cooperate with current FY-2(86.5E) for Dual-Geo. Observations.

86.5E+123.5E Dual-Geo



63.5E-146.5E

79E+133E Dual-Geo



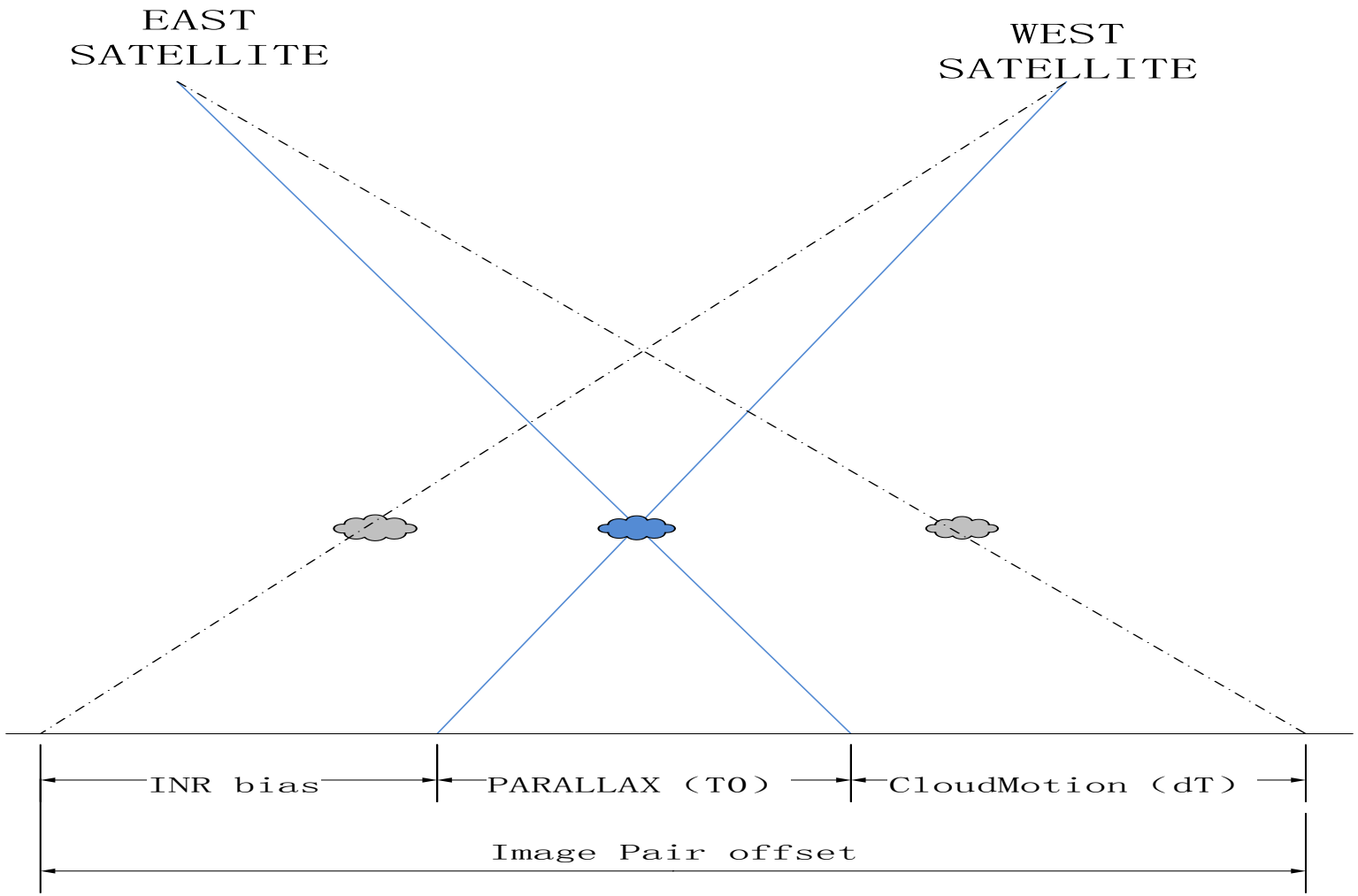
73E-139E

Operational Setting (86.5+123.5)

Potential Setting(79+133)

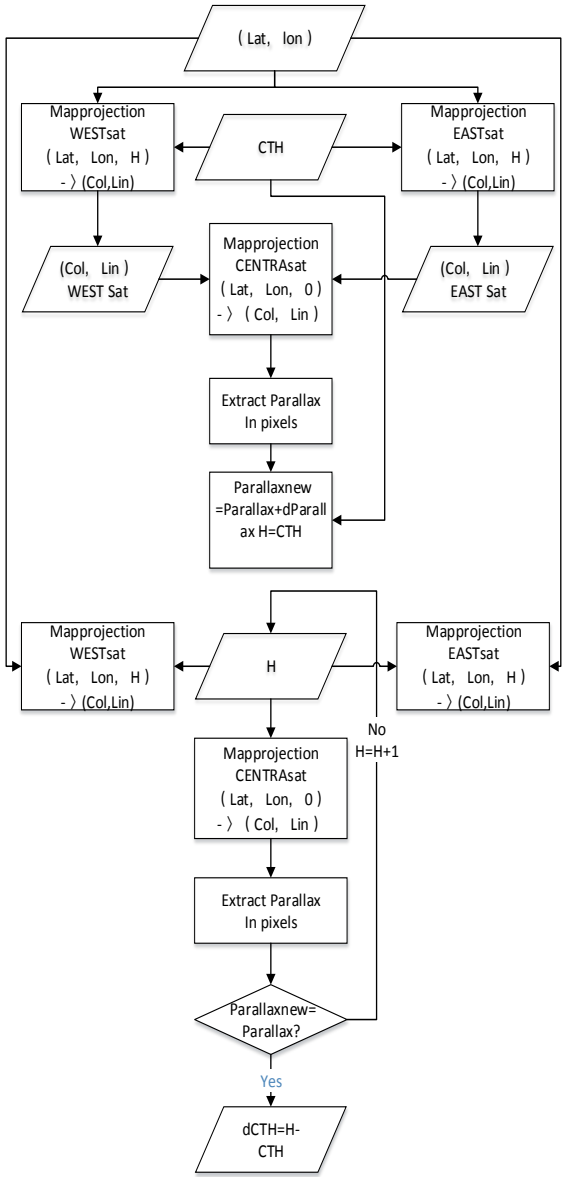
FengYun DUAL-Geo. CMV

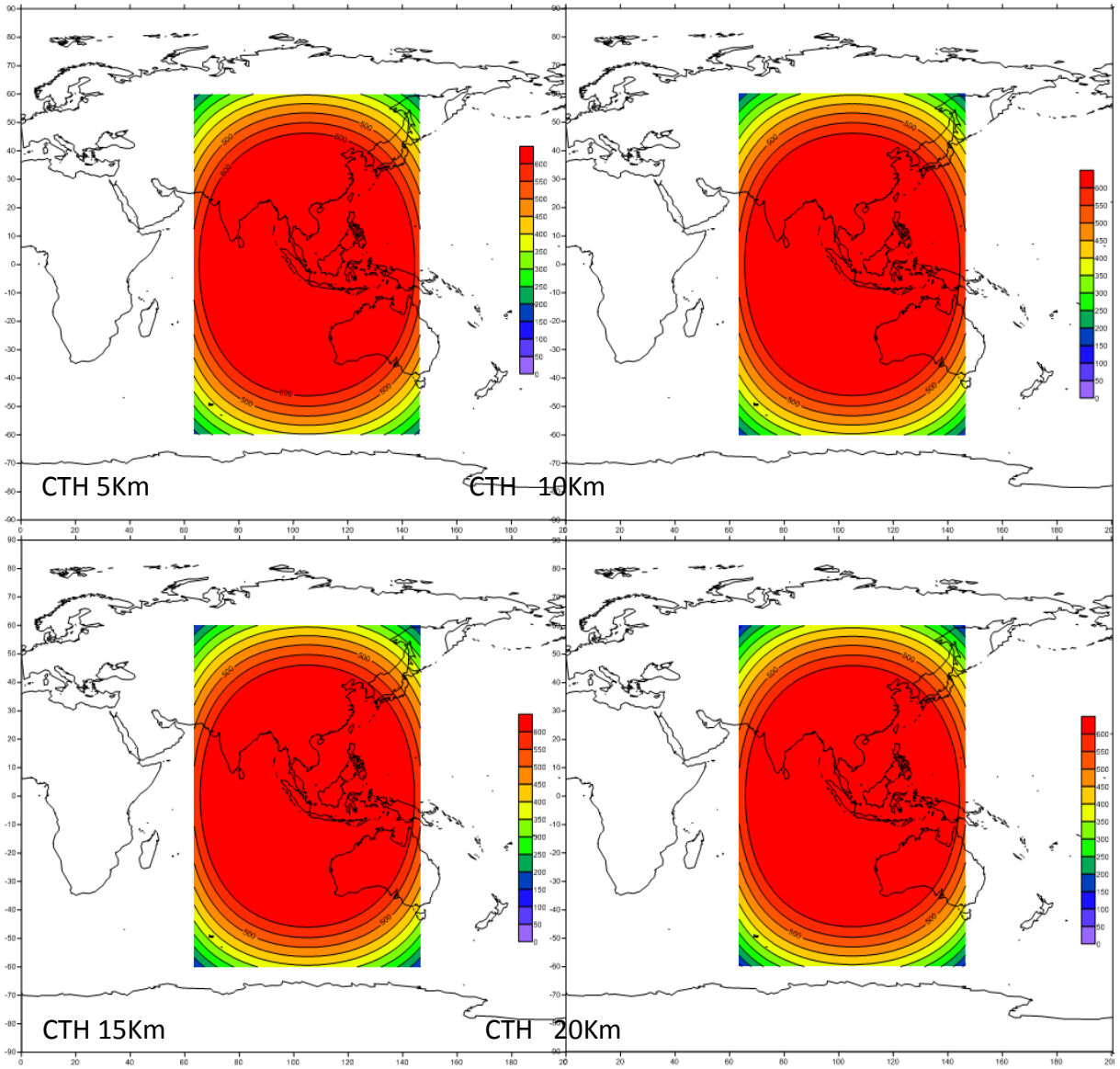
Image Pair Offset = INR Bias +Parallax (T0) +Cloud motion(dT)



! The two FengYun Geo. satellite make observation asynchronous

CTH errors related to INR bias





dINR=1pixels (FY-2 Vis)

FY-2 Dual-GEO 86.5E+123.5E

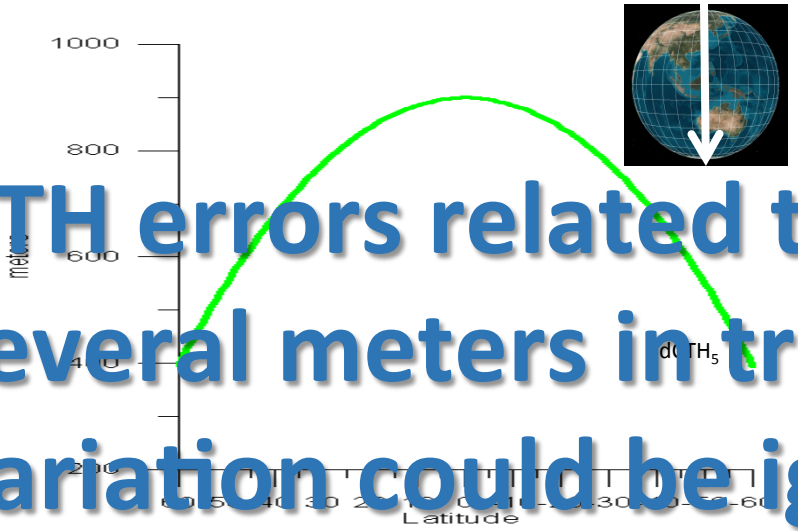
1）How does INR bias effect CTH,

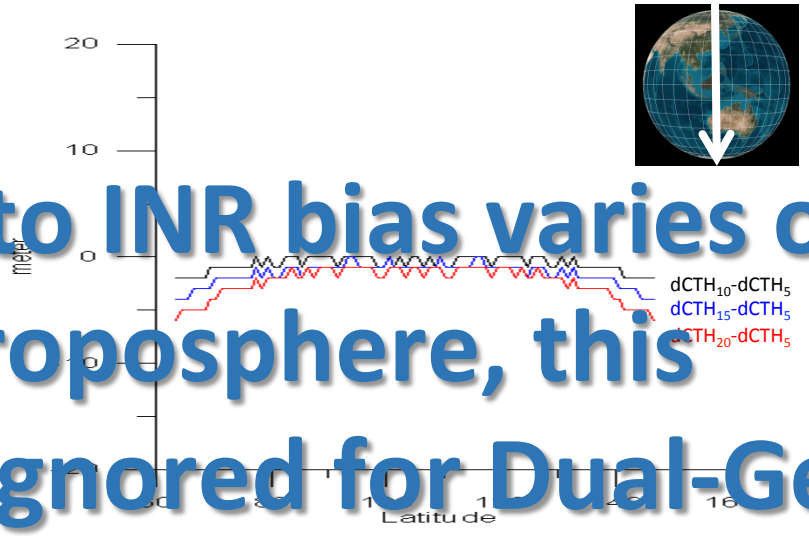
does it change with height?

2）How does cloud Motion effect on CTH,

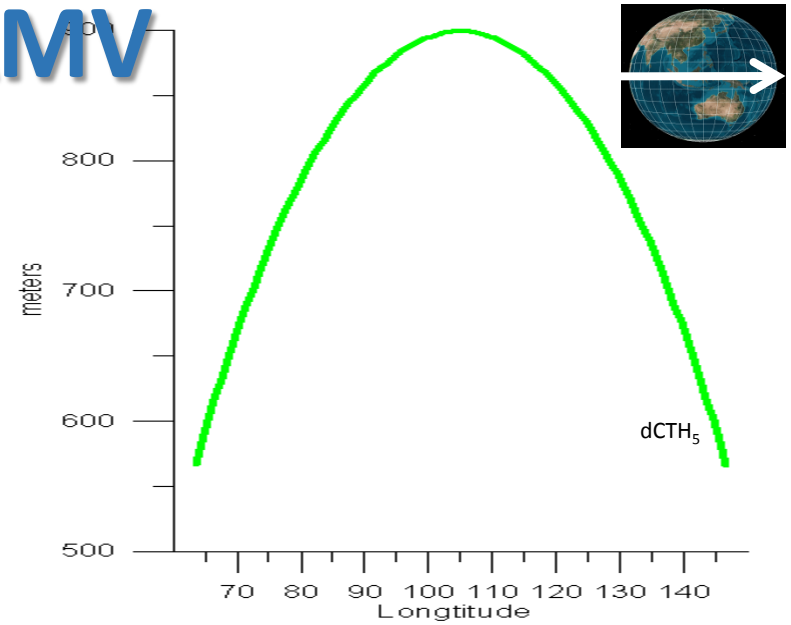
Is it a big error source?

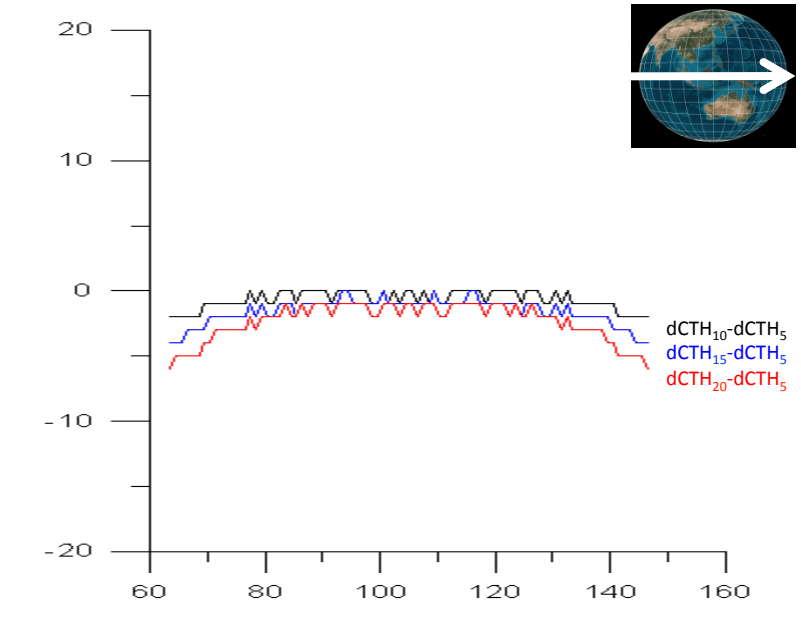
dCTH=CTH(with 1Pixel INR bias)-CTH



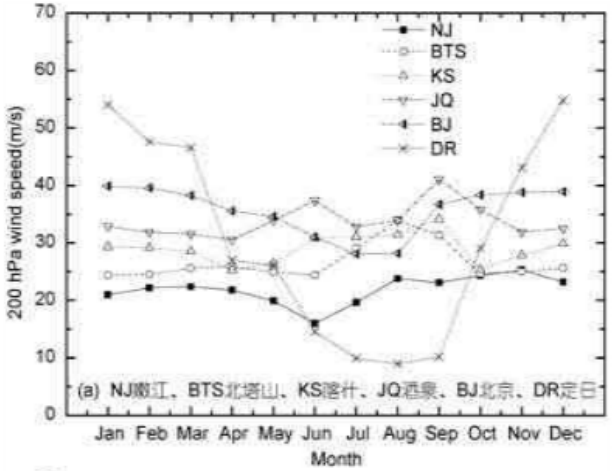


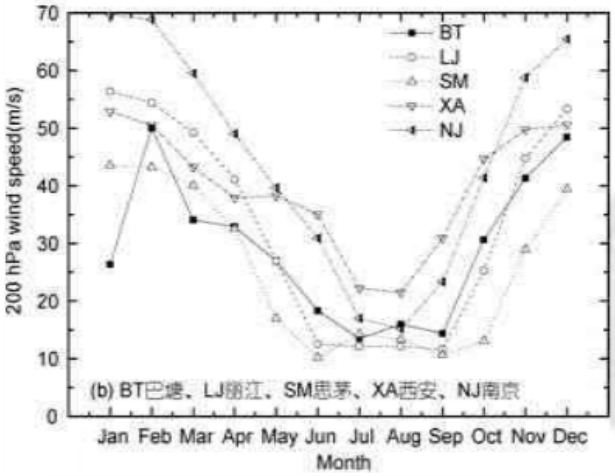
CTH errors related to INR bias varies only several meters in troposphere, this variation could be ignored for Dual-Geo AMV

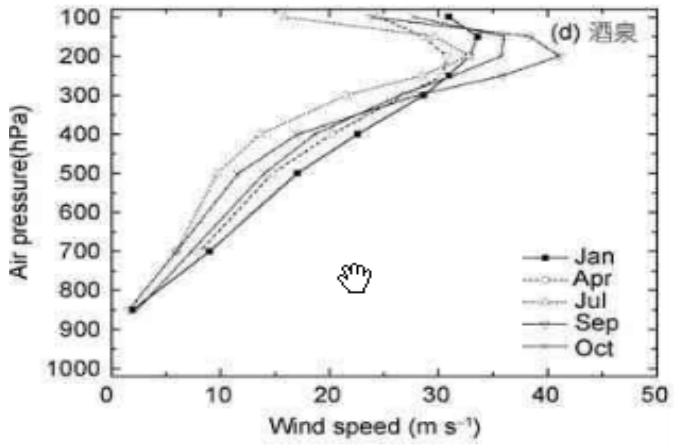


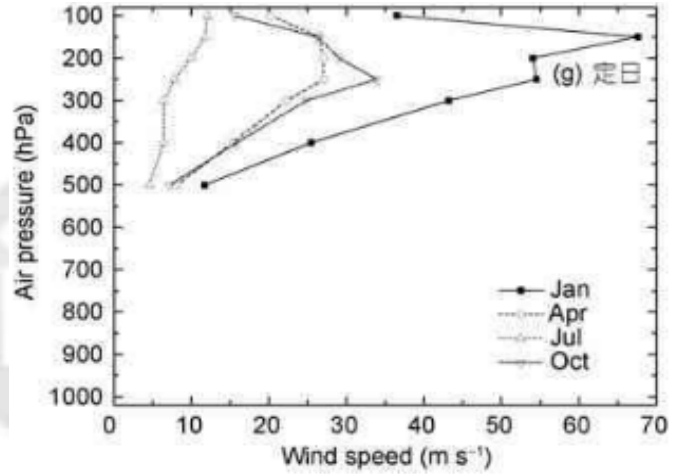


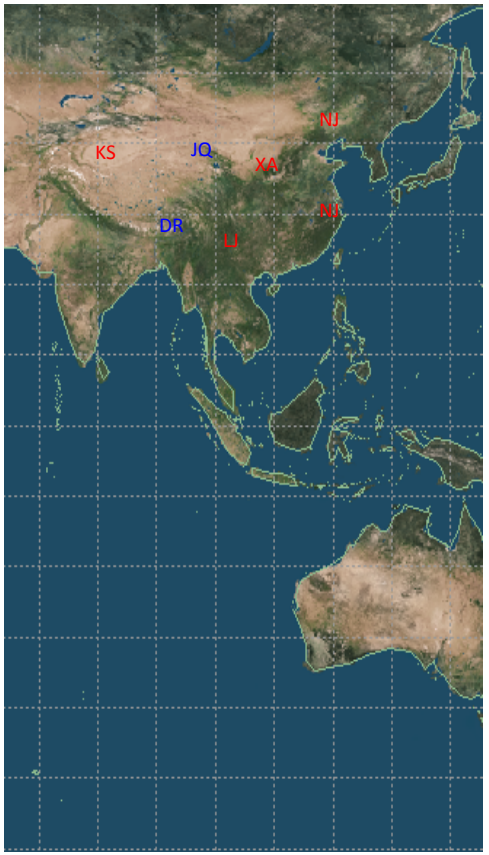
Tropospheric Wind Speed Over China











The annual variation of 200 hPa wind speed at representative stations. Wind speed unit is m s^{-1}. The abscissa is month, and the y-coordinate is 200 hPa wind speed.

*Research of upper-level wind for astronomical site survey. Zhang Yonhjing ,Yao YongQiang ,Qian Xuan. DOI: 10.1360/132011-348,Scientia SINICA Physica,Mechanica&Astronomica Vol.42 No.2 199-209,2012 Based on 1951-2008 upper-air station in China

Basic consideration on time asynchronous

FY-2 Full disk scan: 25 minutes

Time Different of Dual-Geo view =30 seconds

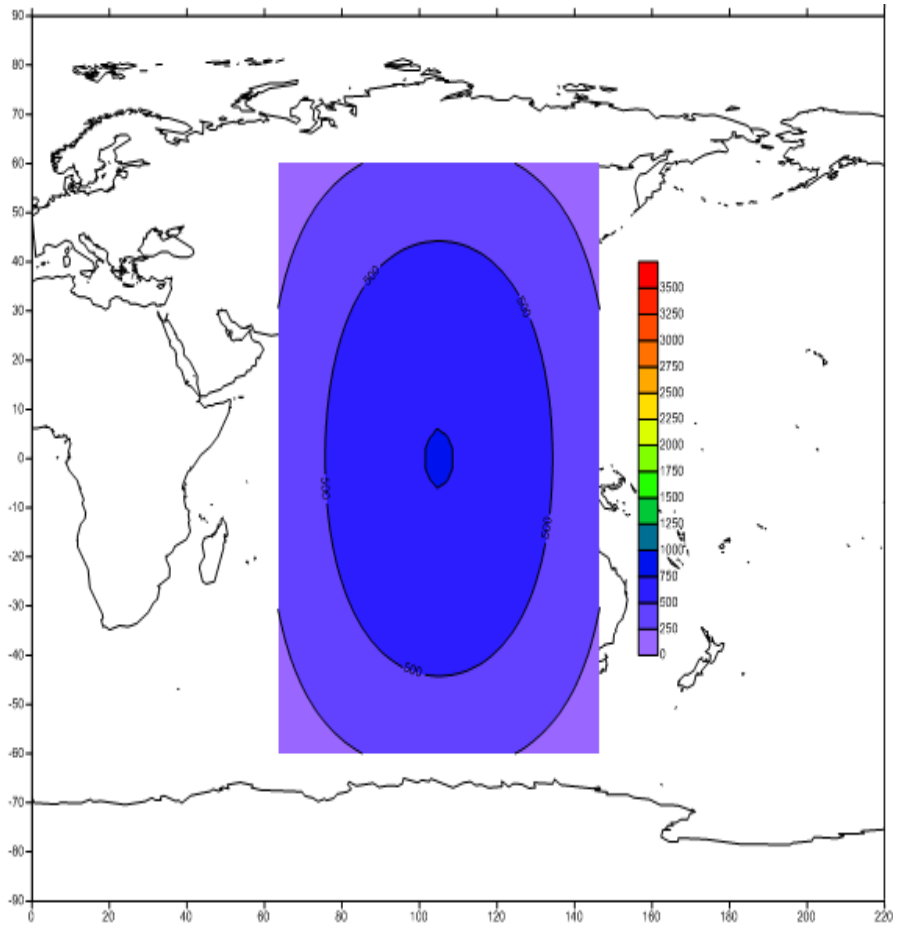
1）Middle level: 5.5km（500hPa） 20m/s

2）High Level: 12km（200hPa） 80m/s

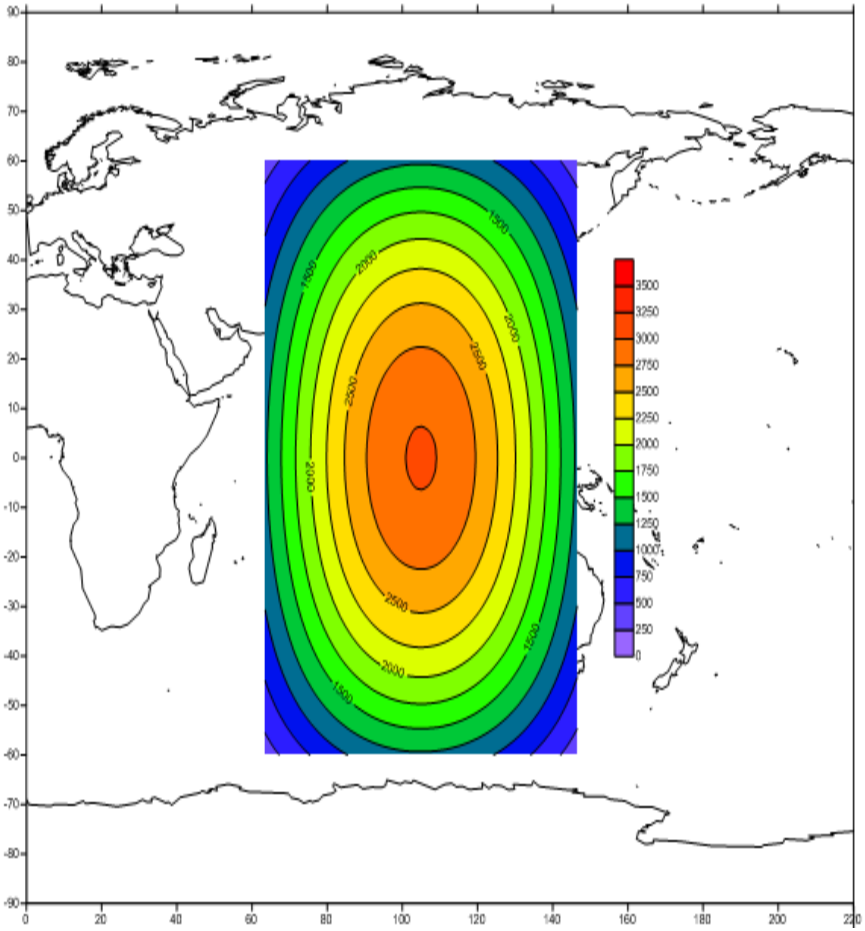
Cloud movement

- 30 seconds on 12Km height: 2400m
- 30 seconds on 5500m height: 600m

Time asynchronous effect on CTH

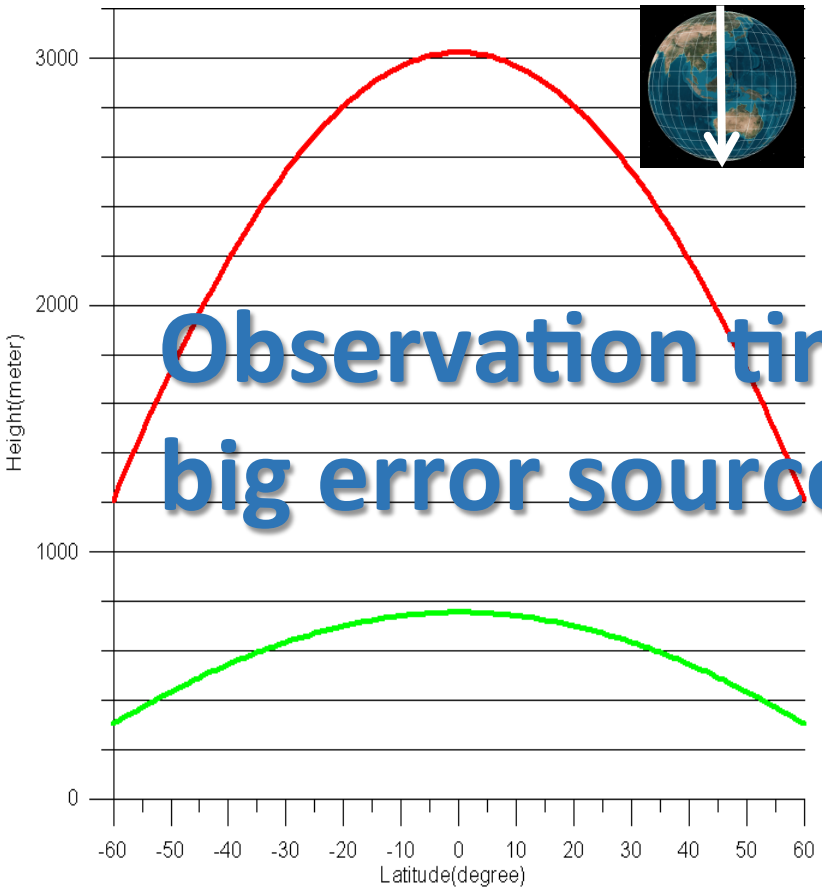


Middle Level: 5500m（500hPa） 80m/s
Time asynchronous :30 Second



High Level: 12km（200hPa） 80m/s
Time asynchronous :30 Second

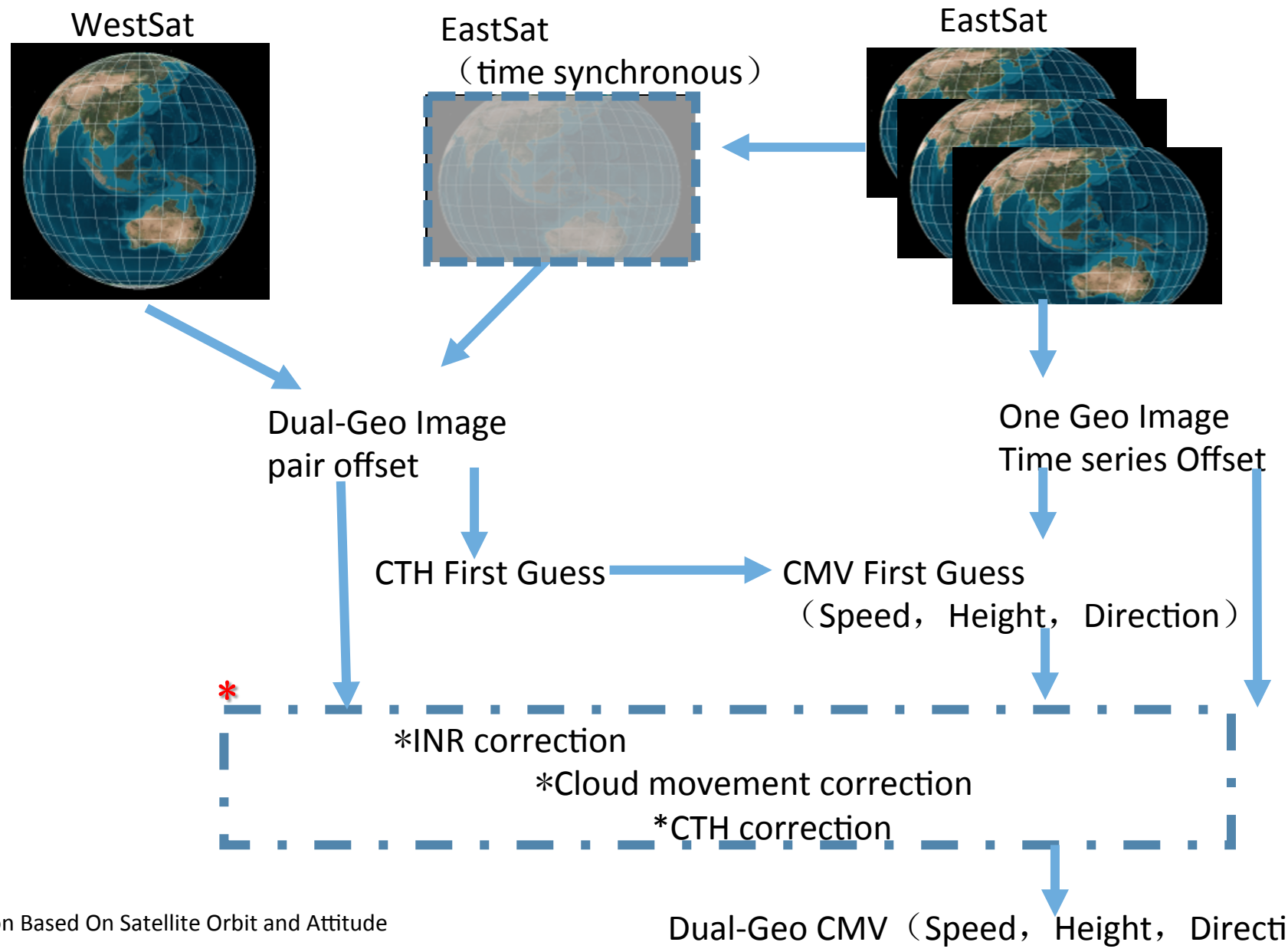
Time asynchronous
->Cloud Motion
->CTH Error



Observation time asynchronous is big error source for Stereo CMW.

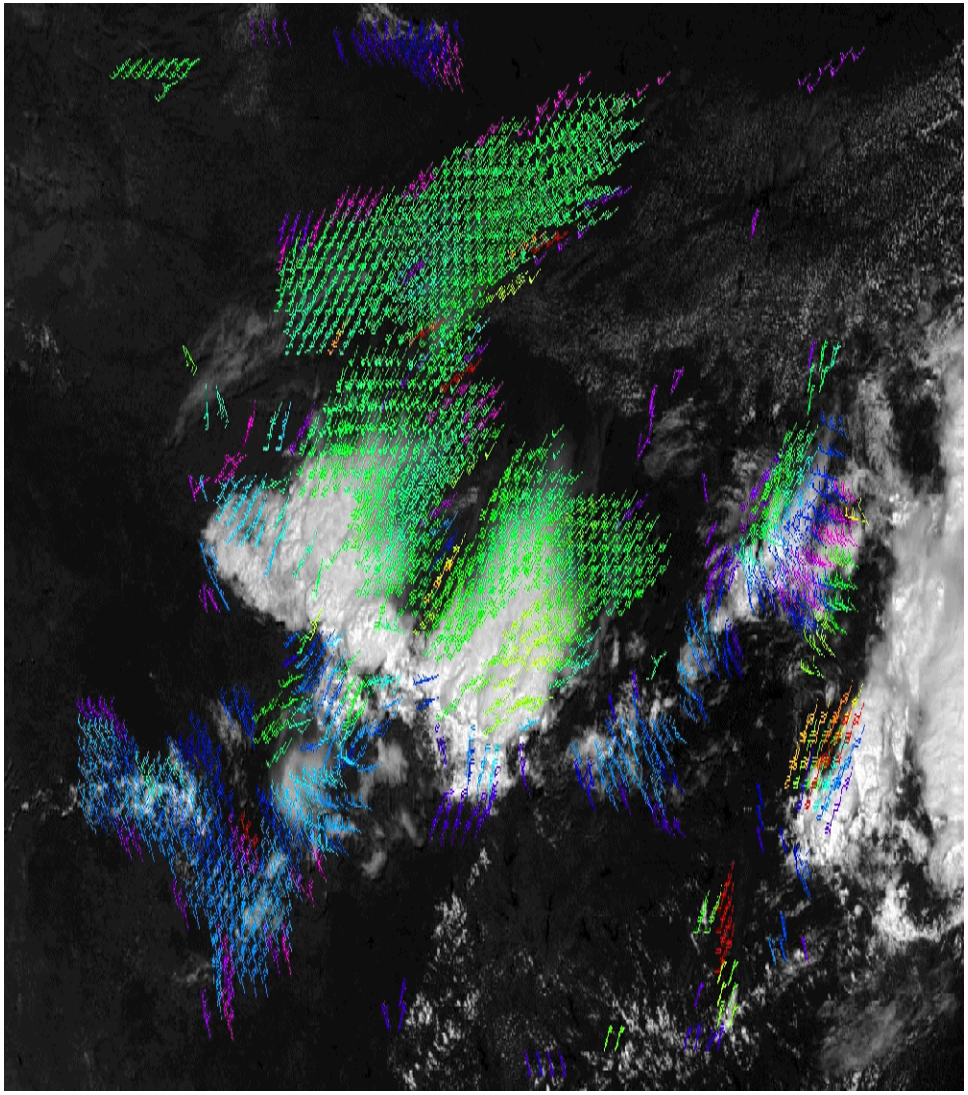
Middle Level: 5500m（500hPa） 80m/s
High Level: 12km（200hPa） 80m/s
Time asynchronous :30 Second

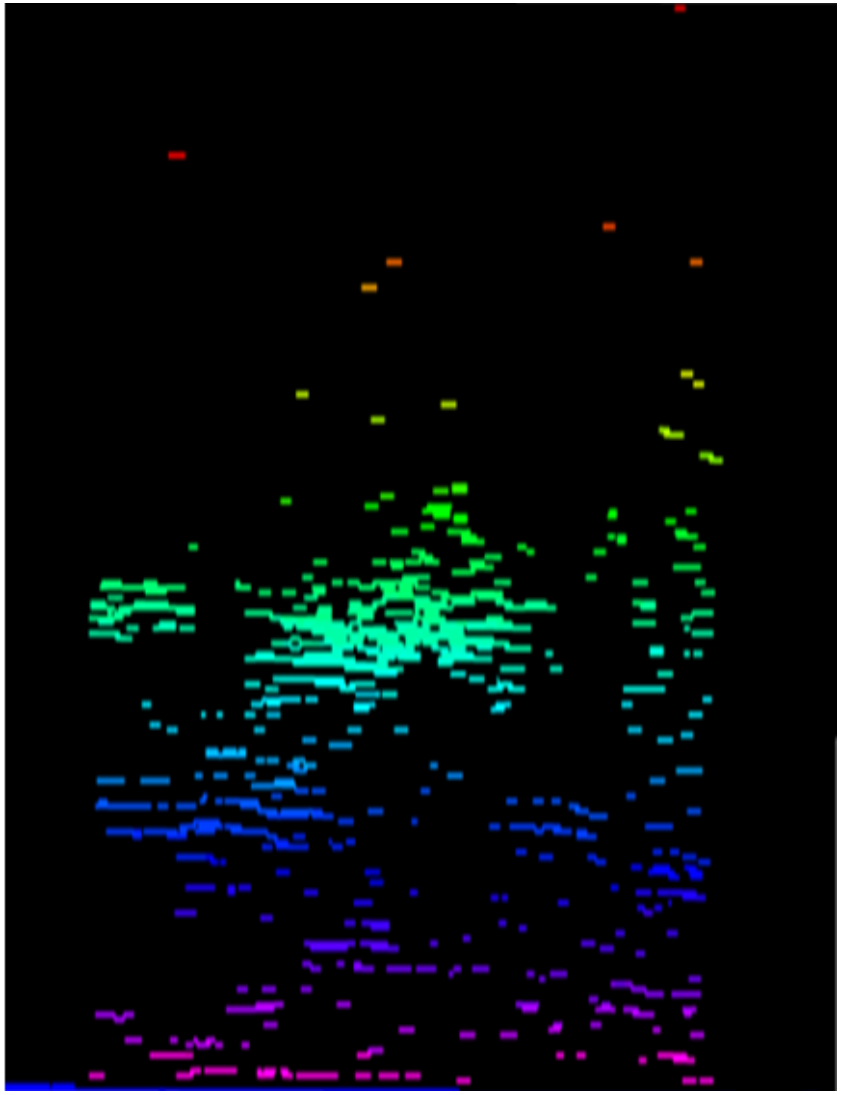
Diagram of FengYun Dual-Geo CMV



*Iteration Based On Satellite Orbit and Attitude

Prototype Algorithms have been finished





Future Work

1) FY-2F will move to 123.5 in Q3,2014 for Rapid Scan service, Combine FY-2(86.5E) and FY-2(123.5E) for FengYun Dual-Geo Vis CMV.

2) Build up FY-2 DUAL-GEO Vis CMV system.

3) CMV Validation

4) Extending the Dual-GEO observations.


Thank you
for your attention
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