

# Hourly Updated Precise Orbit Products of Quad-constellation Satellites in IGS Analysis Center at Wuhan University

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- ❑ **The Update of PANDA Software**
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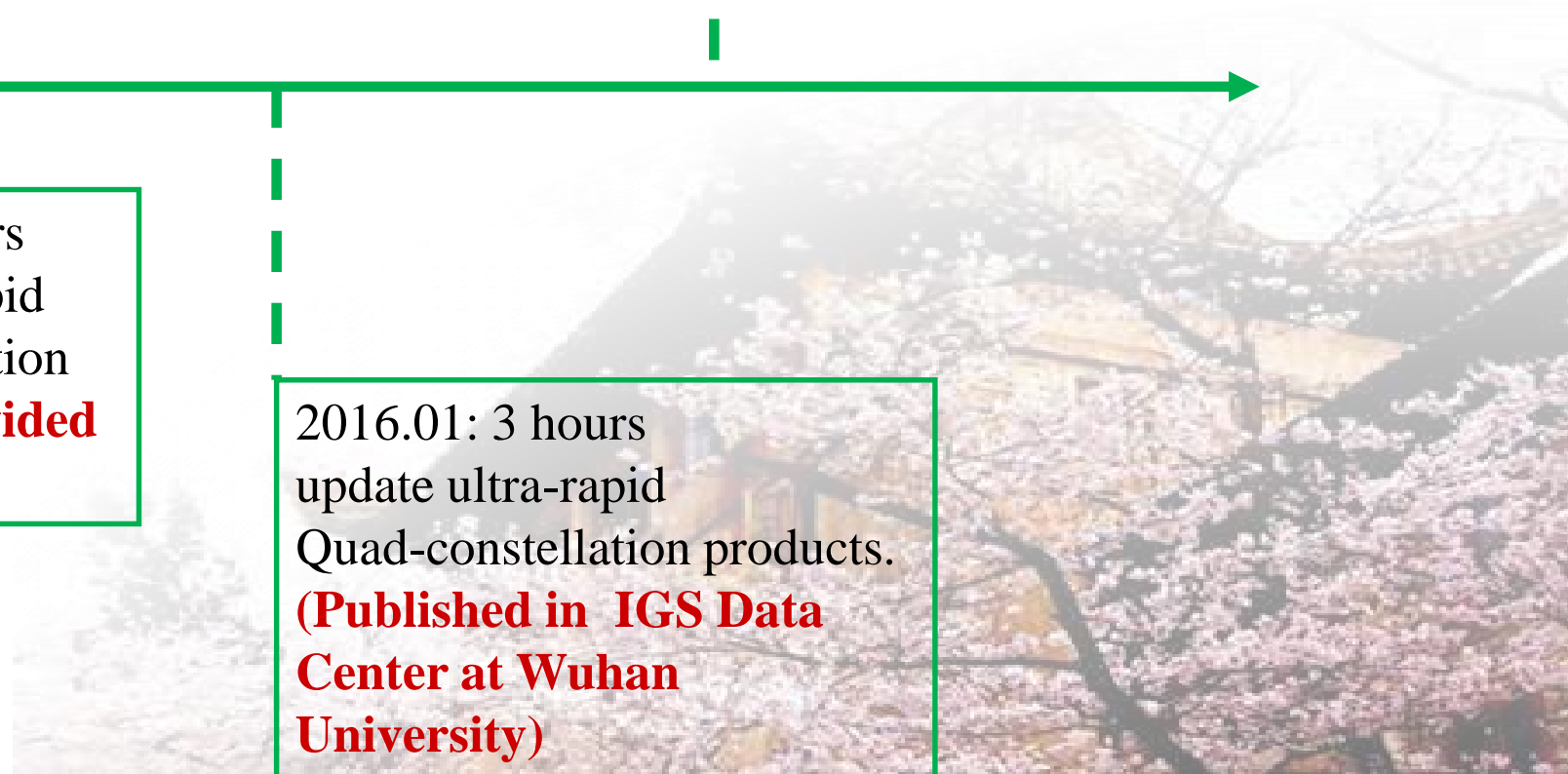
# Current Status of WHU ultra-rapid GNSS Products

2012.05: 6 hours  
update ultra-rapid  
GPS products.  
**(Provided to IGS)**

2013.09: 6 hours  
update ultra-rapid  
Quad-constellation  
products. **(Provided  
to iGMAS)**

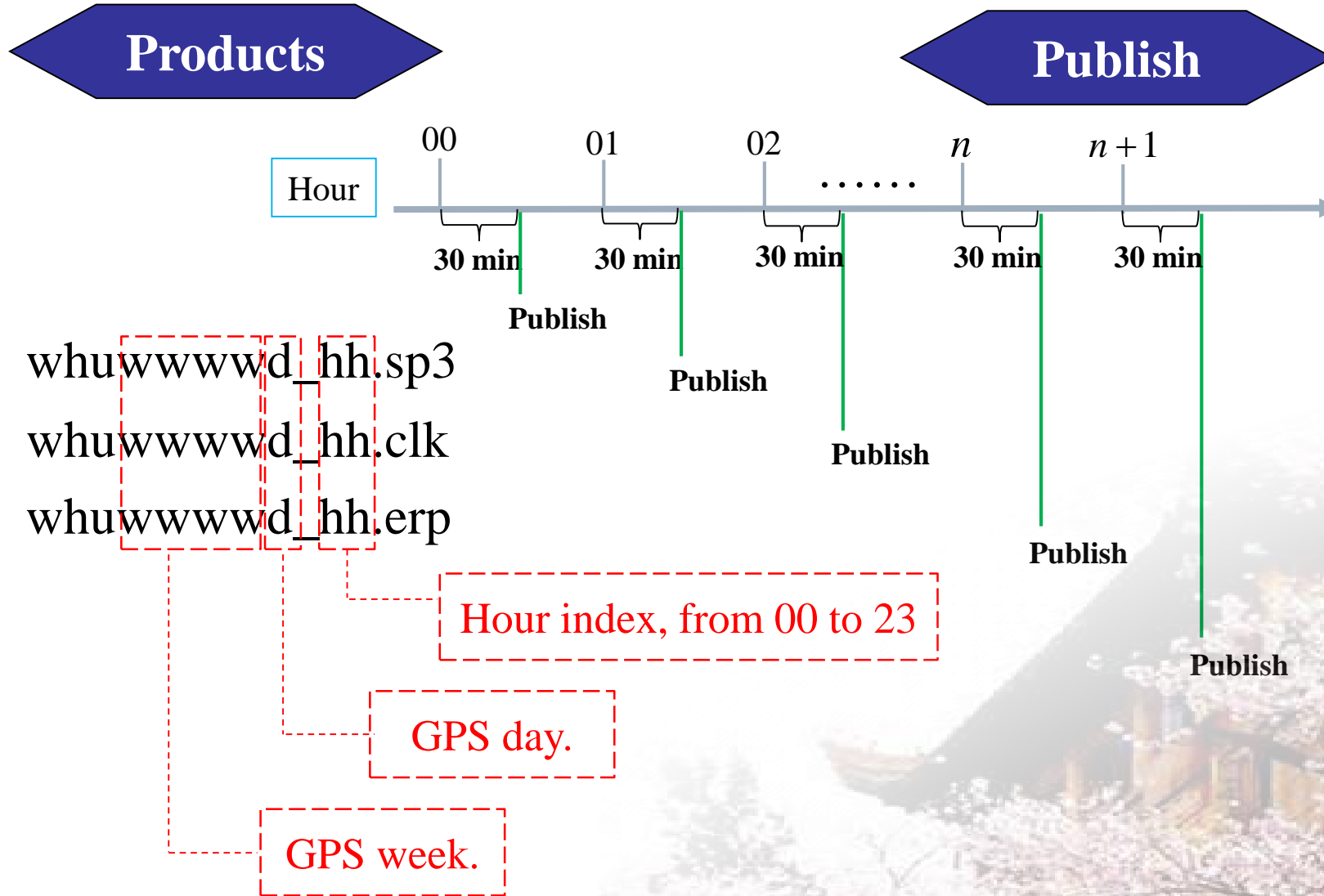
2016.01: 3 hours  
update ultra-rapid  
Quad-constellation products.  
**(Published in IGS Data  
Center at Wuhan  
University)**

2017.05: 1 hour update ultra-  
rapid Quad-constellation  
products. **(Published in IGS  
Data Center at Wuhan  
University)**

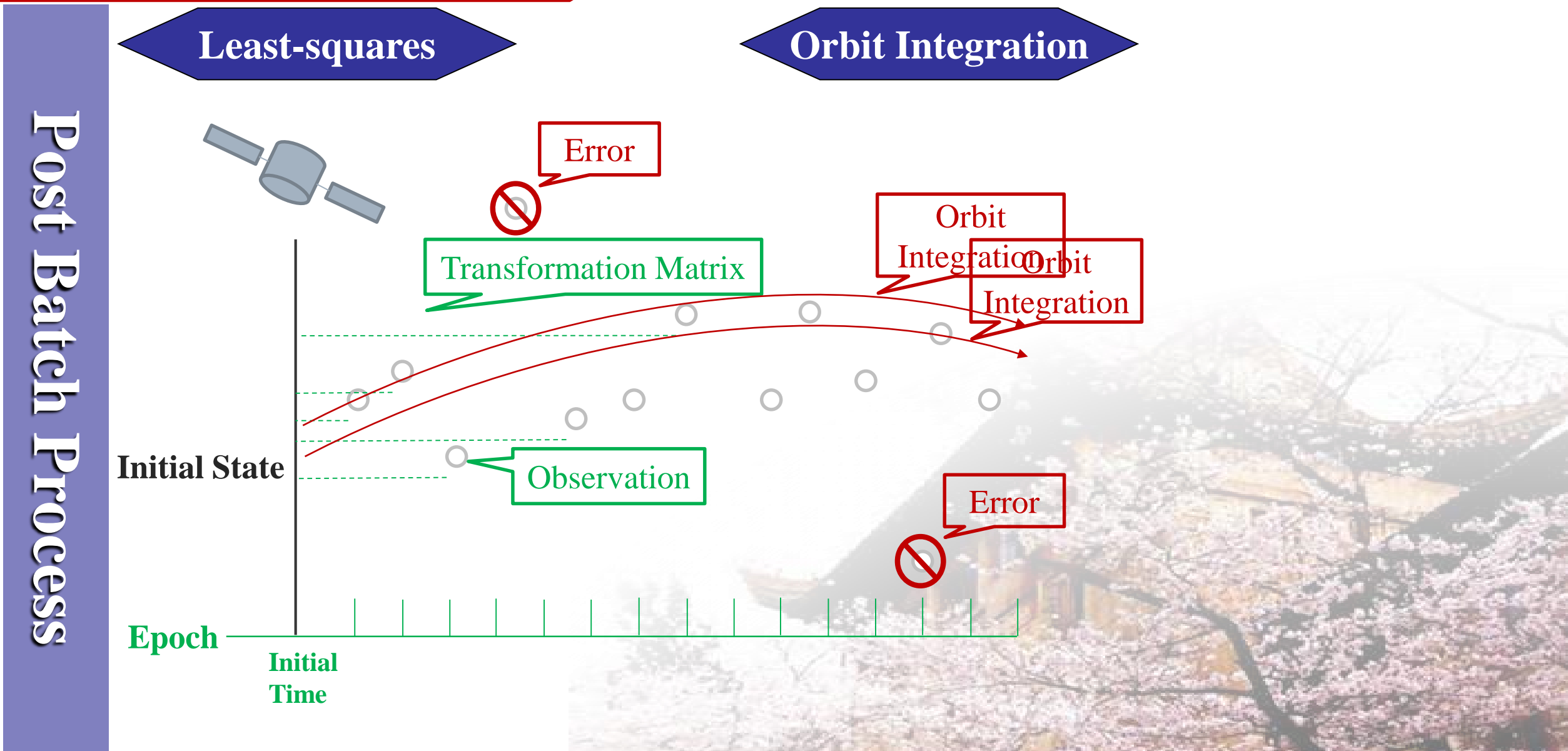


# Products

1 hour update products

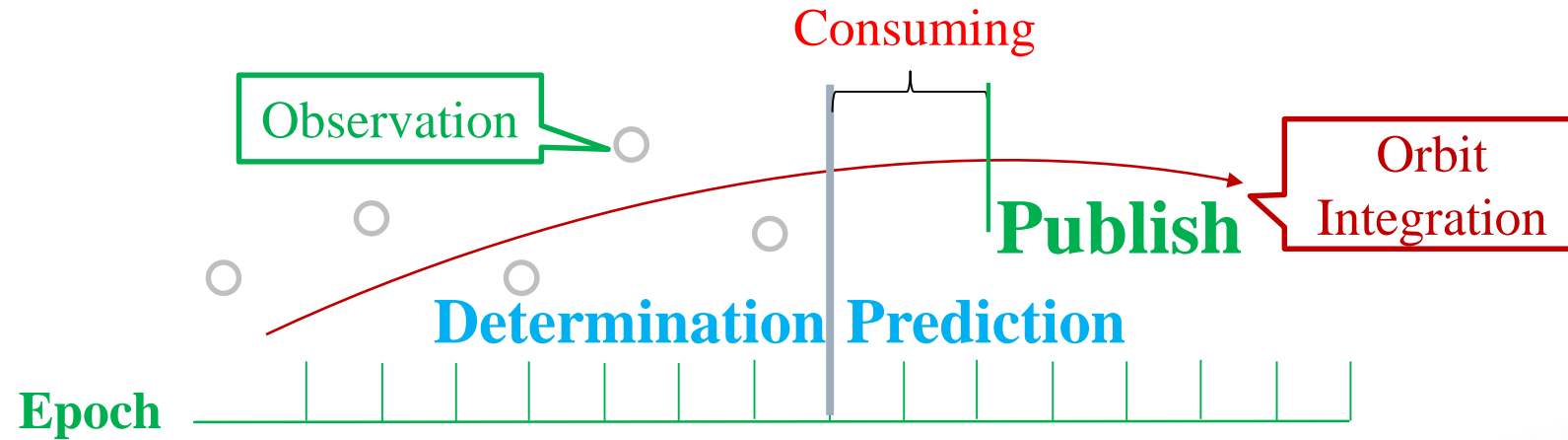


# 2. The Update of PANDA Software



## 2. The Update of PANDA Software

### Post Batch Process



Advantage

High precision

Disadvantage

Bad real-time performance.  
The precision of predicted orbits  
decreases rapidly over time.

## 2. The Update of PANDA Software

Post least-squares batch



Least-squares collocation method

Fast least-squares batch

&

Real-time filtering on each epoch

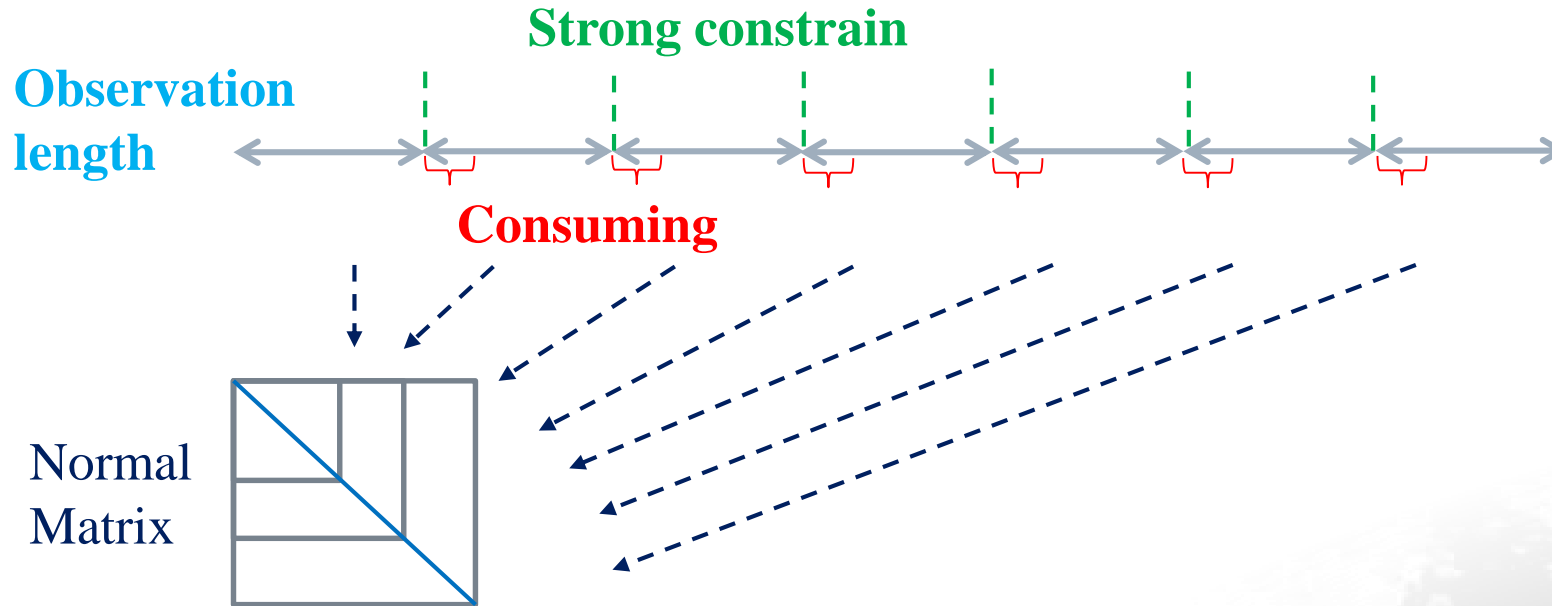
**Strong constrain** between epoch or observation length.  
Need the precise dynamic models for the GNSS satellite

**Variable constrain** between epoch or observation length.  
When enough real-time GNSS data are available

Update

# 2. The Update of PANDA Software

Fast least-squares batch



## Advantages

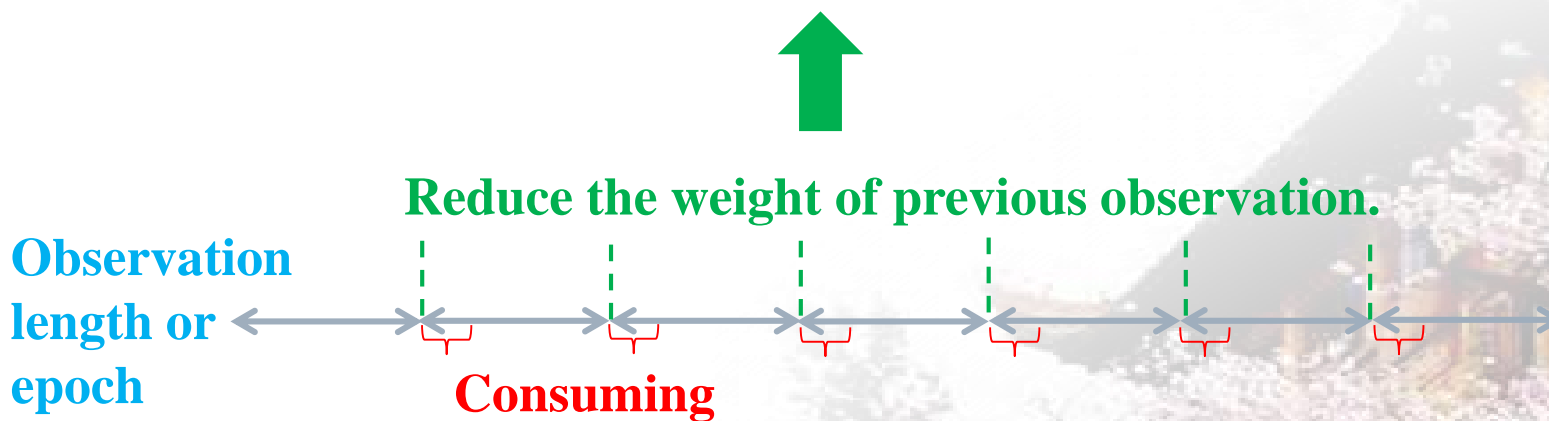
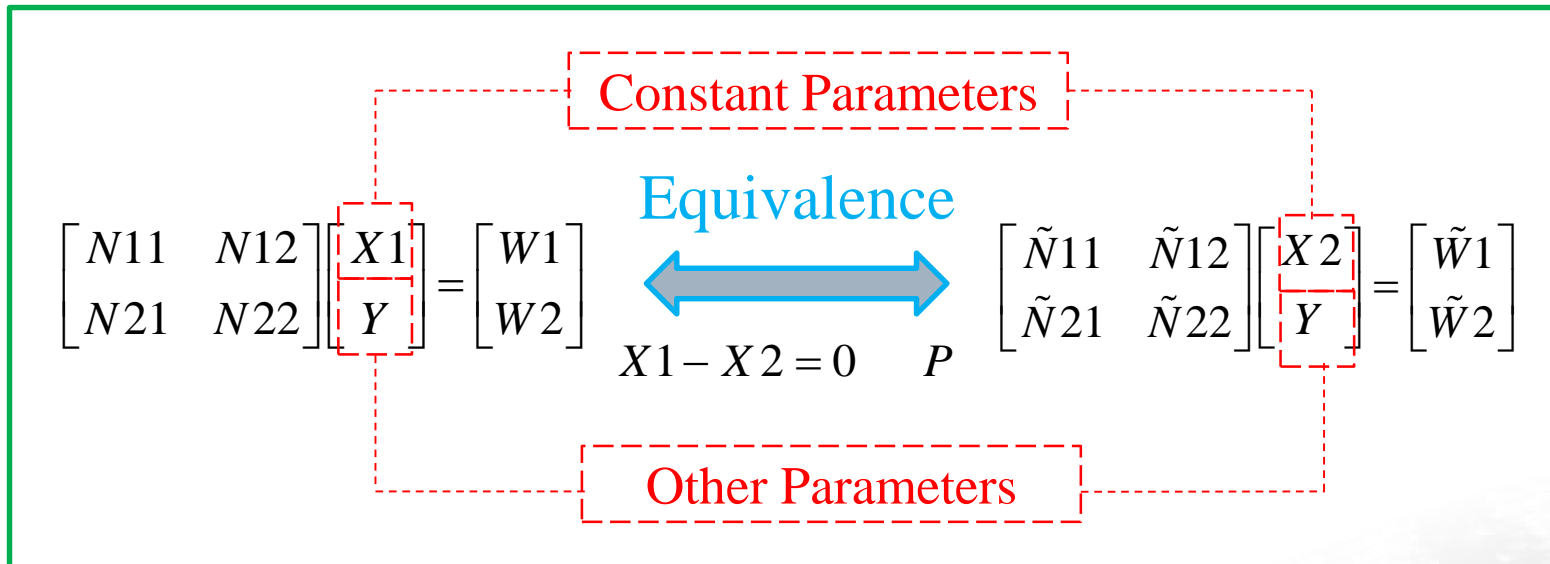
Observation Part: Approach or reach the precision of post batch process.

Prediction Part: Quick update, less consuming, high precision of user available part.



# 2. The Update of PANDA Software

Real-time filtering

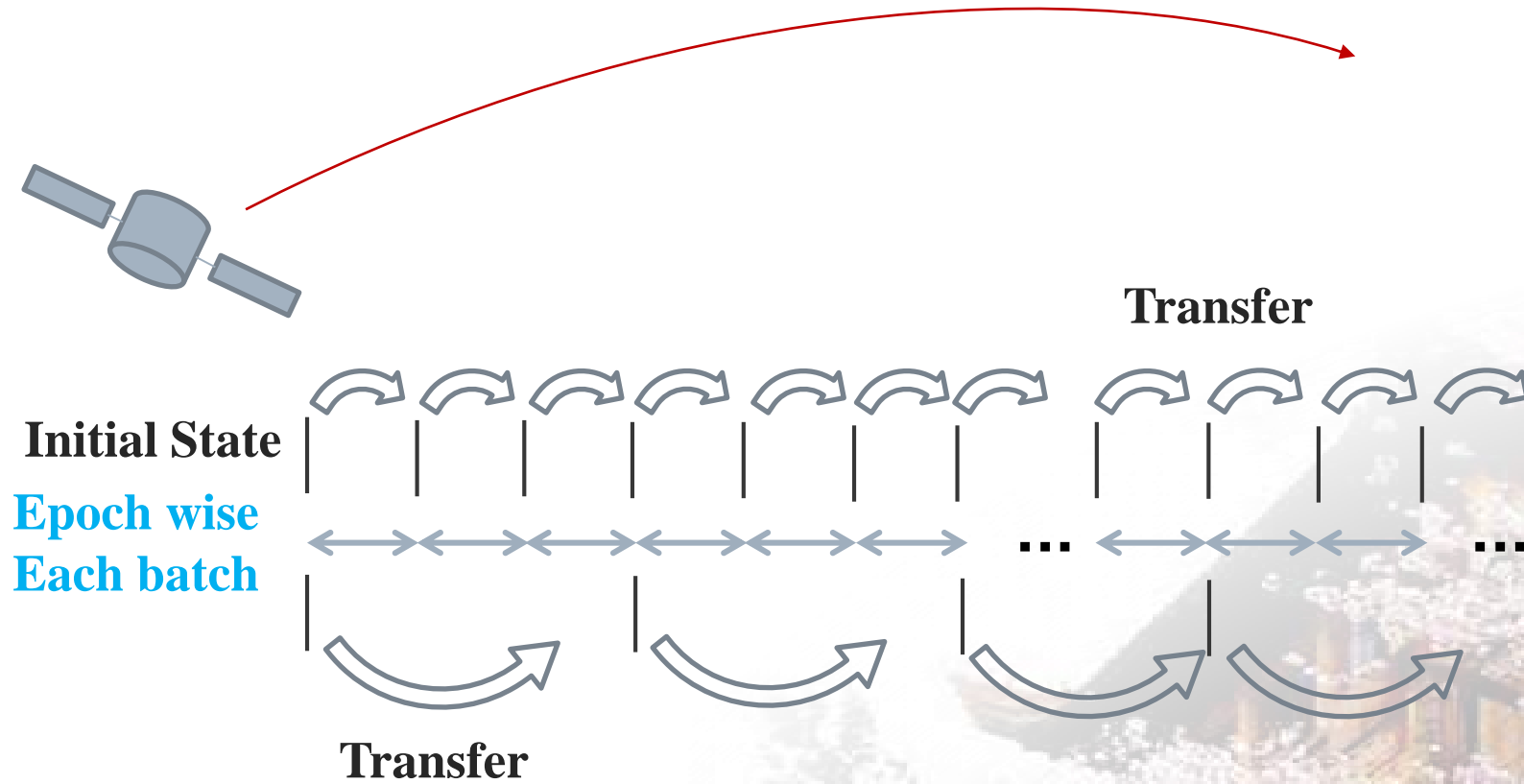


# 2. The Update of PANDA Software

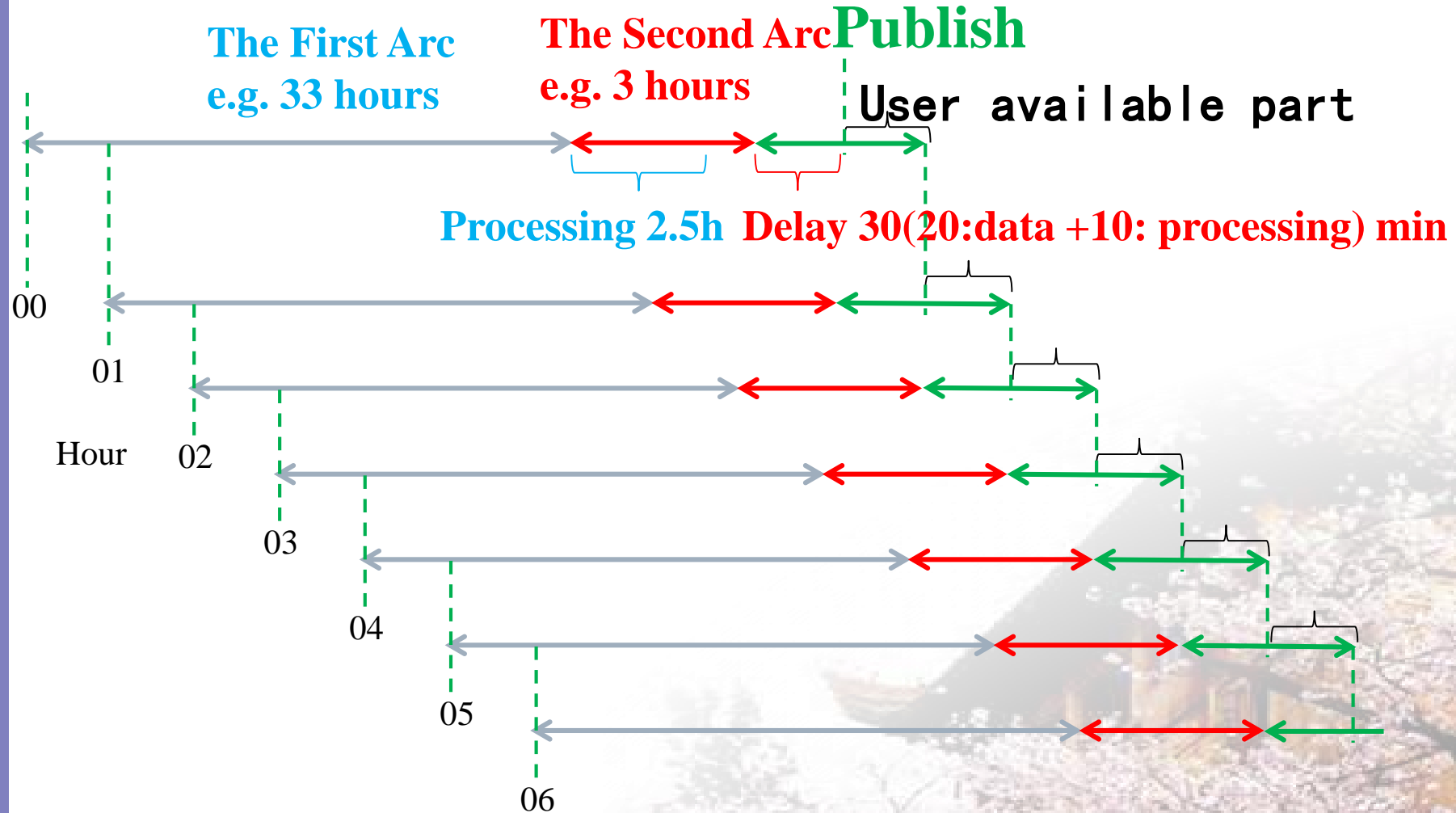
Initial state transformation

Fast least-squares batch

Real-time filtering on each epoch

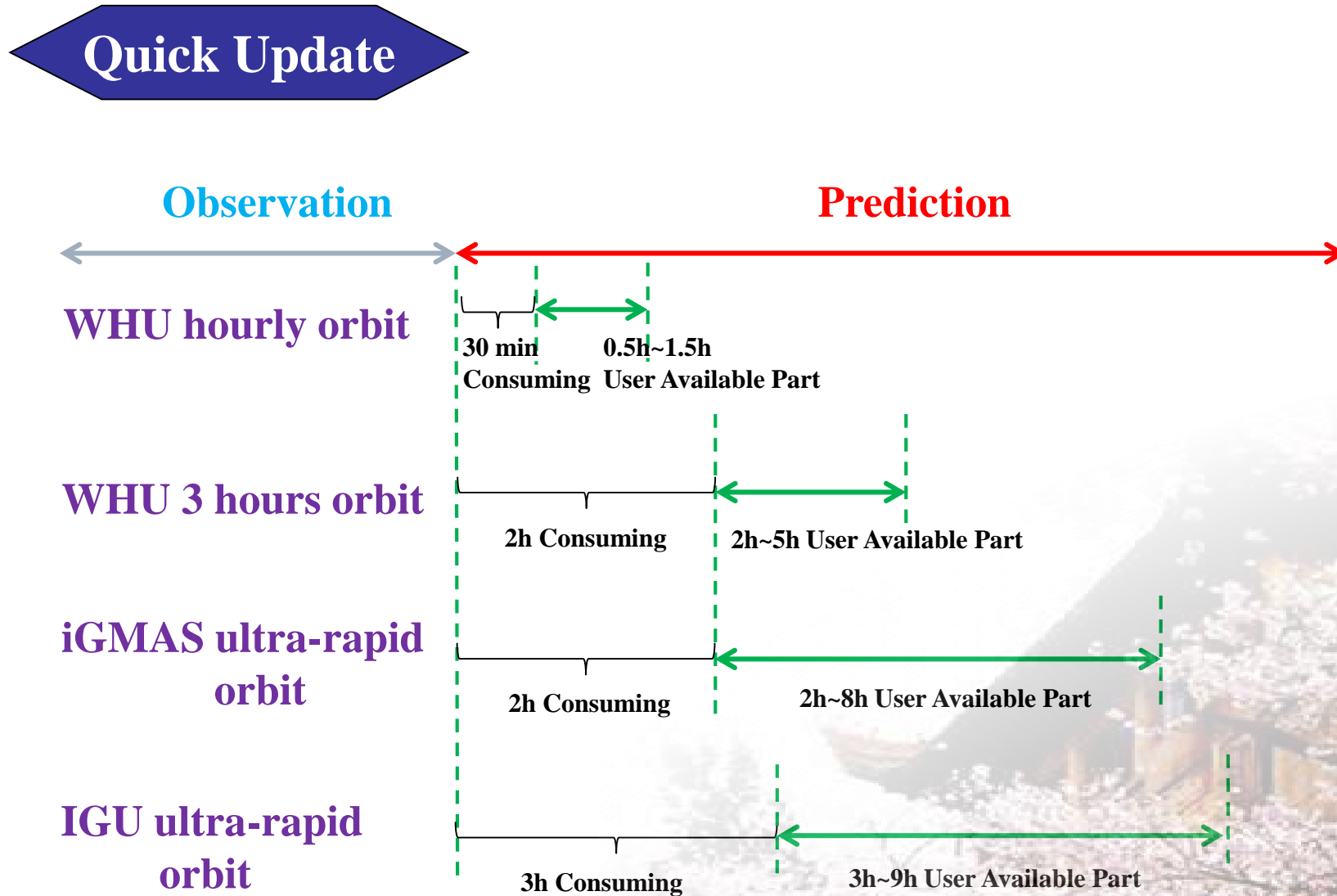


# 3. Hourly-updated Orbit



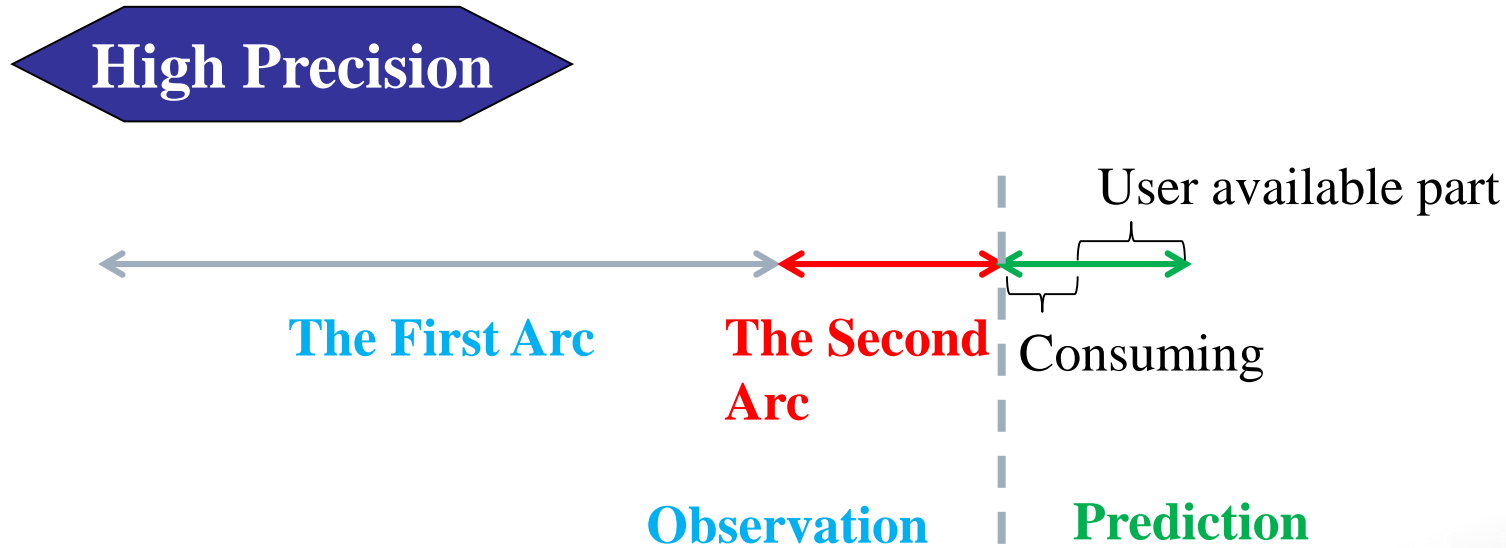
# 3. Hourly-updated Orbit

Advantage



# 3. Hourly-updated Orbit

Advantage



Observation Part: Approach or reach the precision of post batch process.

Prediction Part: Quick update, less consuming, high precision of user available part.

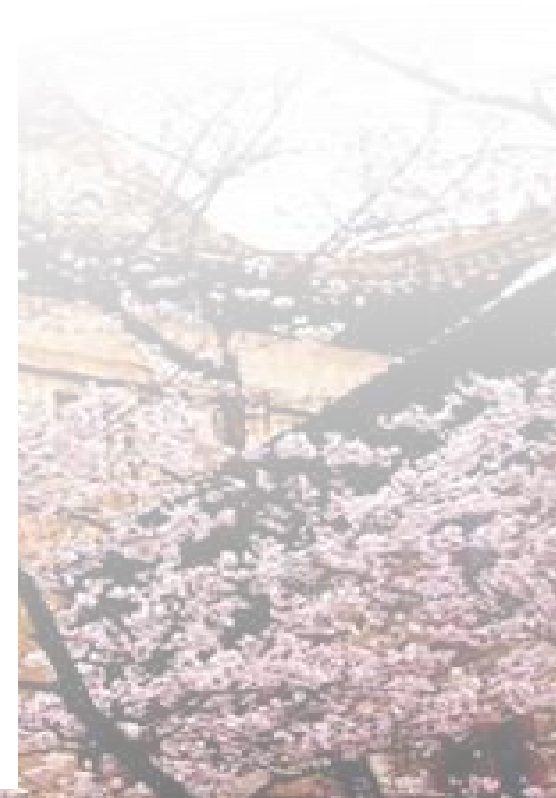
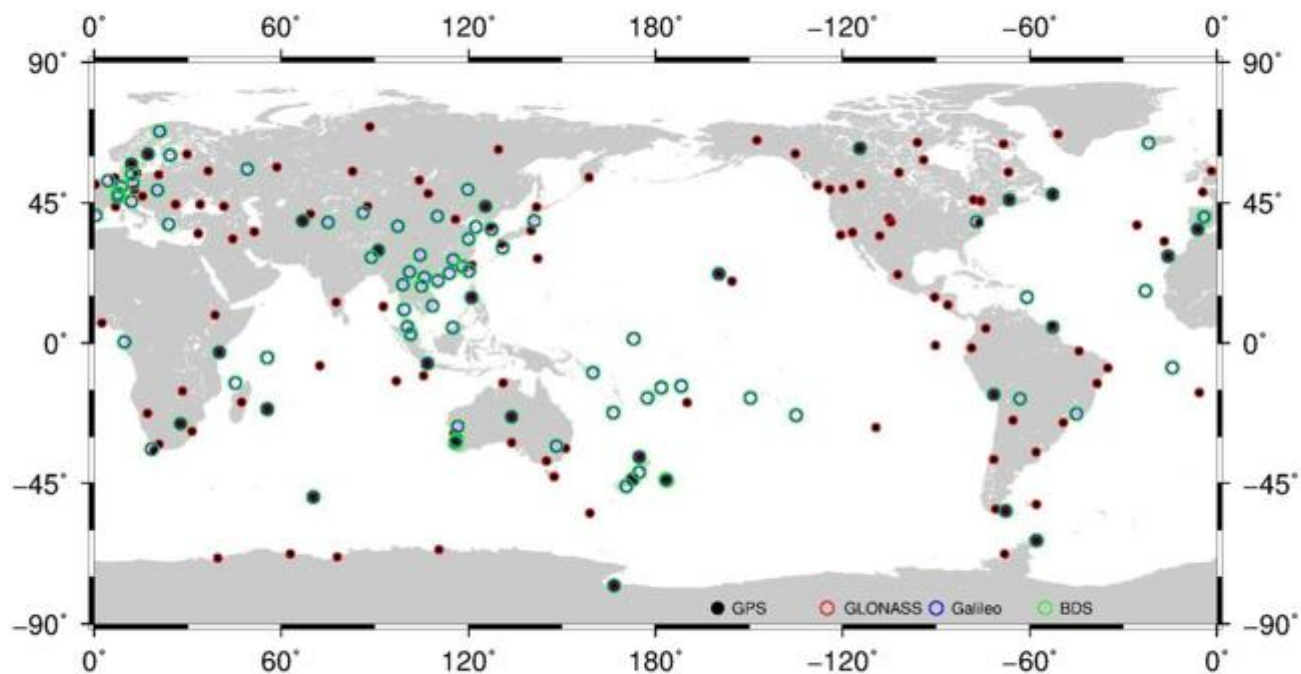
# 3. Hourly-updated Orbit

Item	Model
System	GPS GLONASS BDS GALILEO
Observation divided	33 hours + 3 hours
Observation	Un-difference Ionosphere-free combination
Frequency	L1&L2 G1&G2 B1&B2 E1&E5a
Sampling rate of data	30s
Sampling rate of parameter estimation	300s
Elevation	GPS/GLS: 7 degree BDS/GAL: 10 degree
Orbit parameter	3 initial position, 3 initial velocity, 5 BERN solar pressure
Integration step	60s
Perturbation	Non-spherical gravity, three body gravity, solid earth tide, Earth radiation, Solar radiation
Satellite phase center	GPS/GLS: igs08.atx BDS/GAL: WHU

# 3. Hourly-updated Orbit

WHU: IGS Data Center  
iGMAS Date Center

IGS data MGEX data  
iGMAS data BETS data  
CMONOC data .....



# 3. Hourly-updated Orbit

Test Date: DOY 106~112, 2017

Reference Orbit:

GPS	→	IGS Final Orbit
GLONASS	→	IGL Final Orbit
BDS	→	GBM Final Orbit
GALILEO	→	GBM Final Orbit

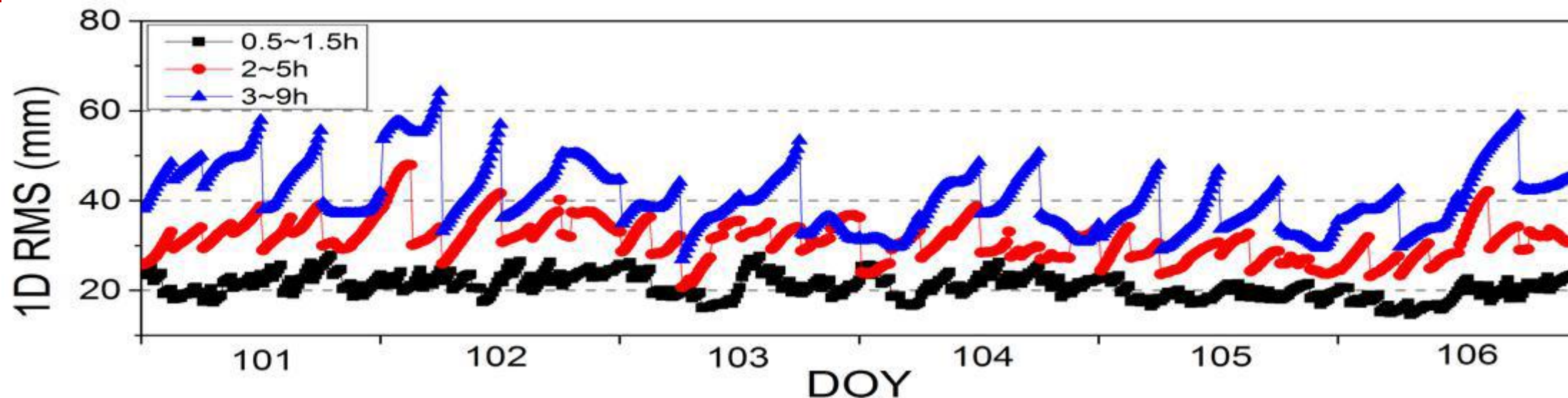
Arc Comparison:

Observation part  
0.5h~1.5h in prediction part  
2h~5h in prediction part  
3h~9h in prediction part



# 3. Hourly-updated Orbit

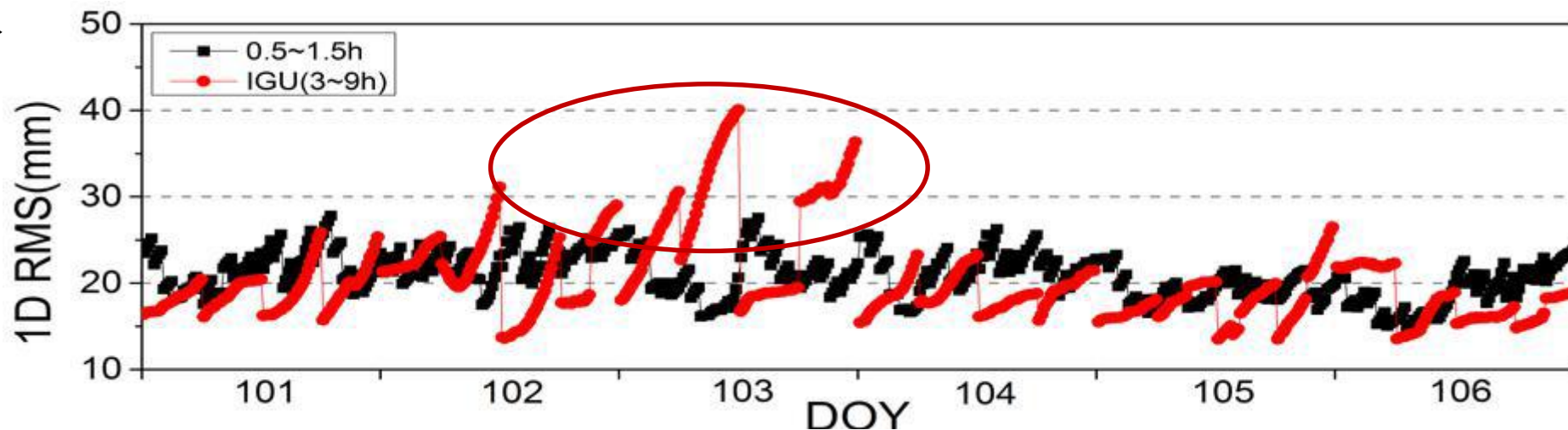
GPS



GPS 1D RMS (mm)						
DOY	0.5~1.5h		2~5h		3~9h	
	AVE	STD	AVE	STD	AVE	STD
101	21.73	4.00	32.45	5.14	44.52	9.39
102	22.61	3.18	35.37	8.27	47.35	12.65
103	21.05	4.77	31.43	6.59	38.15	8.66
104	21.70	3.96	29.97	5.80	37.65	10.25
105	19.31	2.63	27.53	4.51	35.91	8.06
106	19.03	4.18	29.95	7.05	41.59	11.99
AVERAGE	20.91	3.79	31.12	6.23	40.86	10.17

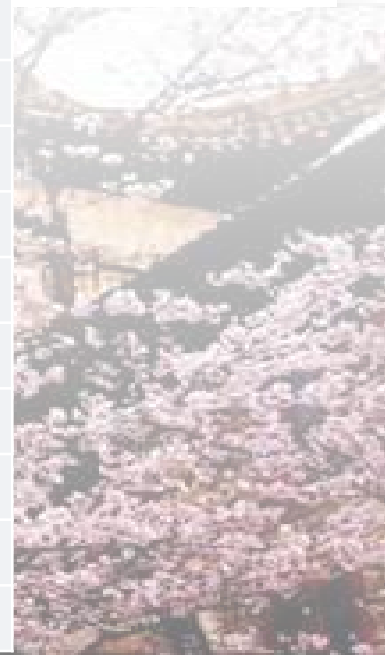
# 3. Hourly-updated Orbit

IGU



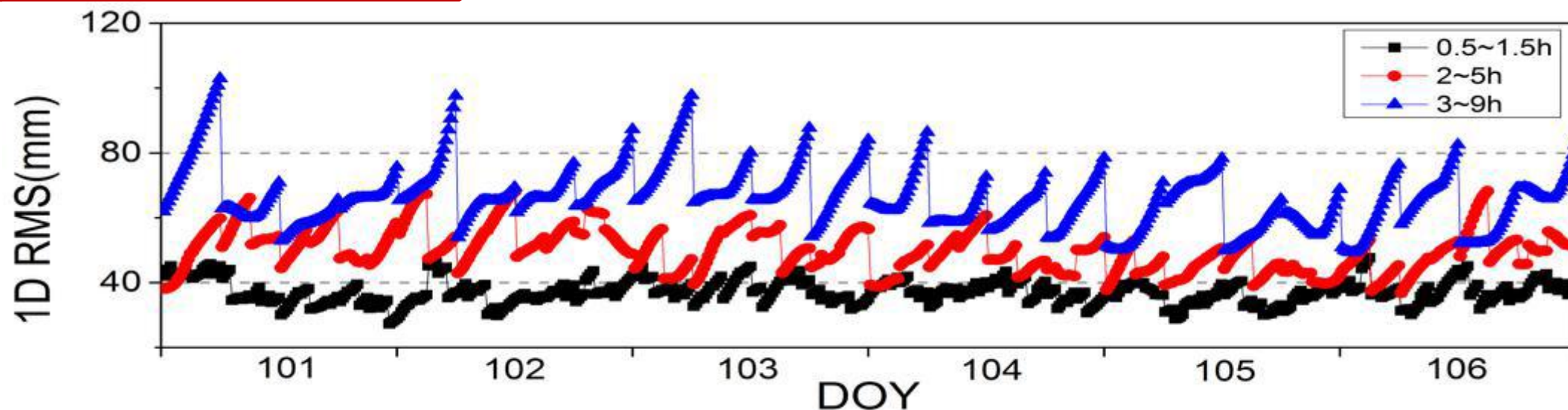
DOY	GPS 1D RMS (mm)			
	0.5~1.5h		IGU(3~9h)	
	AVE	STD	AVE	STD
101	21.73	4.00	18.98	3.87
102	22.61	3.18	21.40	7.23
103	21.05	4.77	26.62	11.43
104	21.70	3.96	18.89	3.32
105	19.31	2.63	17.11	5.27
106	19.03	4.18	17.81	4.82
AVERAGE	20.91	3.79	20.13	5.99

GPS



# 3. Hourly-updated Orbit

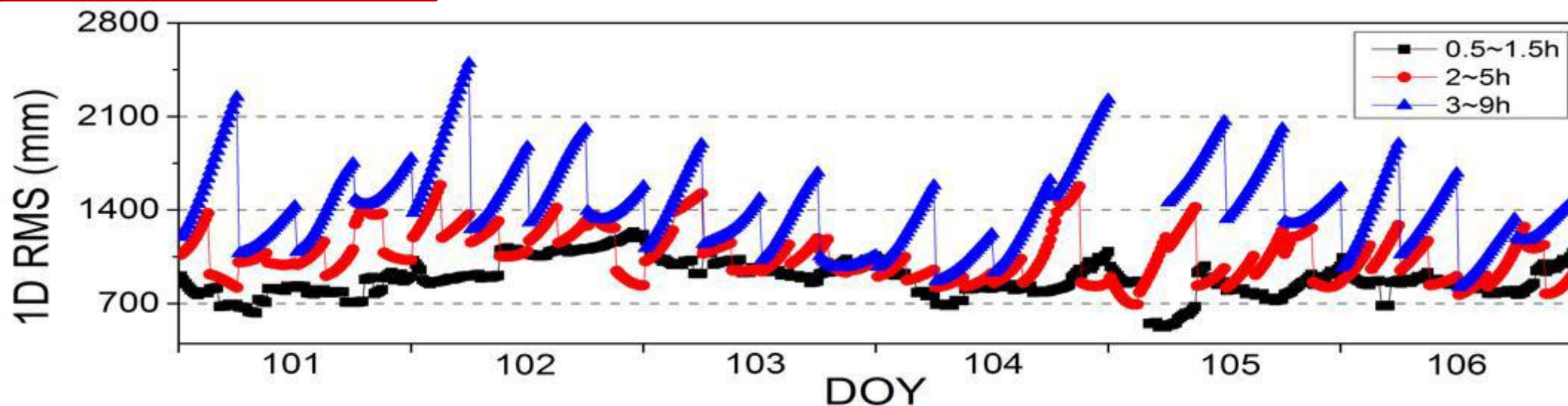
GLONASS



GLONASS 1D RMS (mm)						
DOY	0.5~1.5h		2~5h		3~9h	
	AVE	STD	AVE	STD	AVE	STD
101	36.99	7.82	51.86	10.55	67.60	18.25
102	36.90	6.22	55.38	10.52	69.62	12.87
103	38.07	5.79	49.69	11.54	71.90	14.91
104	37.38	4.70	47.55	8.81	64.11	11.65
105	35.56	5.27	44.38	6.57	60.67	13.38
106	37.85	5.99	49.22	10.77	63.41	15.15
AVERAGE	37.12	5.97	49.68	9.79	66.22	14.37

# 3. Hourly-updated Orbit

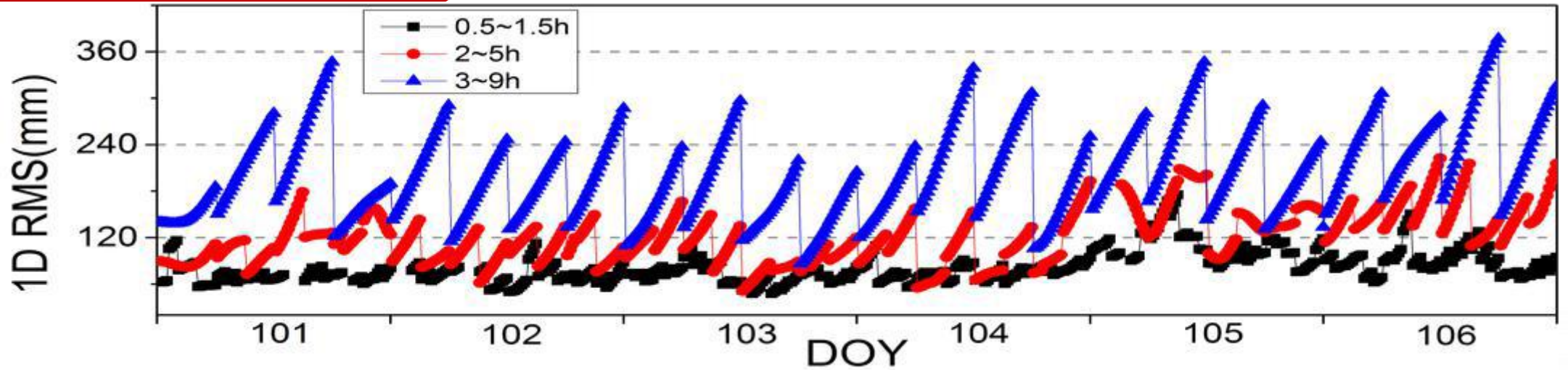
BDS GEO



DOY	BDS GEO 1D RMS (mm)					
	0.5~1.5h		2~5h		3~9h	
	AVE	STD	AVE	STD	AVE	STD
101	727.09	332.48	1068.84	285.20	1384.35	495.50
102	1035.18	224.04	1199.43	308.22	1540.13	539.22
103	979.12	115.53	1090.46	301.08	1206.47	438.54
104	844.76	182.68	972.63	368.34	1260.64	650.82
105	785.85	246.50	986.25	349.78	1504.78	400.75
106	866.45	158.23	968.77	262.39	1205.84	424.59
AVERAGE	873.08	209.91	1047.73	312.50	1350.37	491.57

# 3. Hourly-updated Orbit

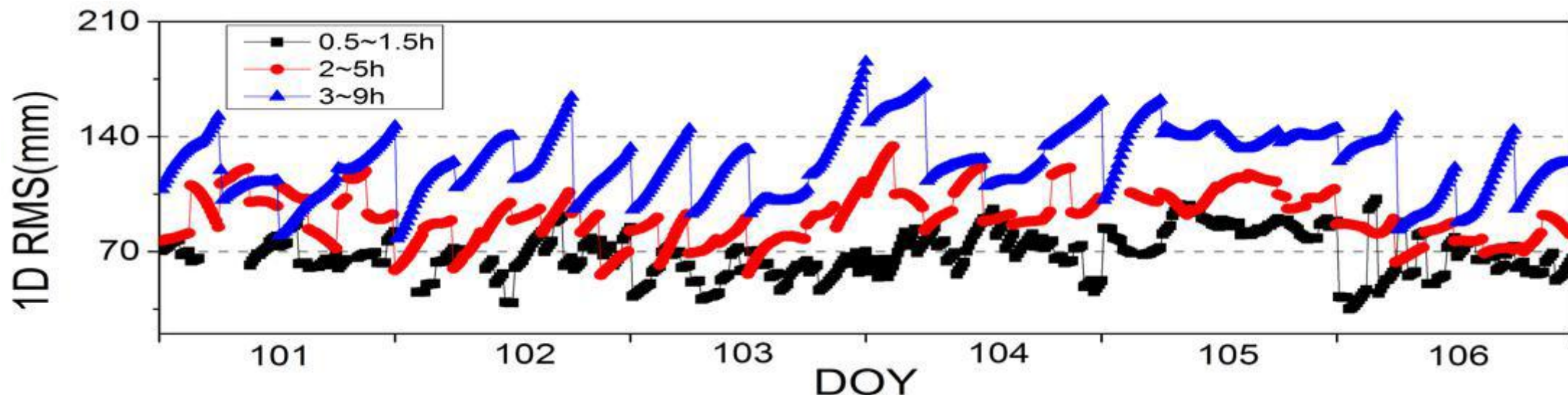
BDS I/M



DOY	BDS I/M 1D RMS (mm)					
	0.5~1.5h		2~5h		3~9h	
	AVE	STD	AVE	STD	AVE	STD
101	71.97	19.09	112.55	40.35	195.54	96.58
102	71.35	20.13	104.55	32.51	195.97	75.32
103	71.03	20.52	102.44	40.90	169.11	80.41
104	75.45	17.28	106.02	55.23	202.60	99.37
105	109.11	35.84	149.78	53.67	217.95	87.58
106	89.39	28.71	156.43	54.09	241.84	93.04
AVERAGE	81.38	23.59	121.96	46.13	203.83	88.72

# 3. Hourly-updated Orbit

GALILEO



GALILEO 1D RMS (mm)						
DOY	0.5~1.5h		2~5h		3~9h	
	AVE	STD	AVE	STD	AVE	STD
101	69.33	11.75	97.21	24.45	117.01	28.34
102	65.88	20.72	82.06	21.78	120.42	29.03
103	57.83	14.96	82.14	19.37	119.70	36.52
104	71.00	18.52	101.57	22.99	136.37	32.99
105	84.06	12.67	104.66	11.90	150.49	21.47
106	62.45	24.26	78.89	12.57	114.84	31.74
AVERAGE	68.43	17.15	91.09	18.84	126.47	30.02

# 3. Hourly-updated Orbit

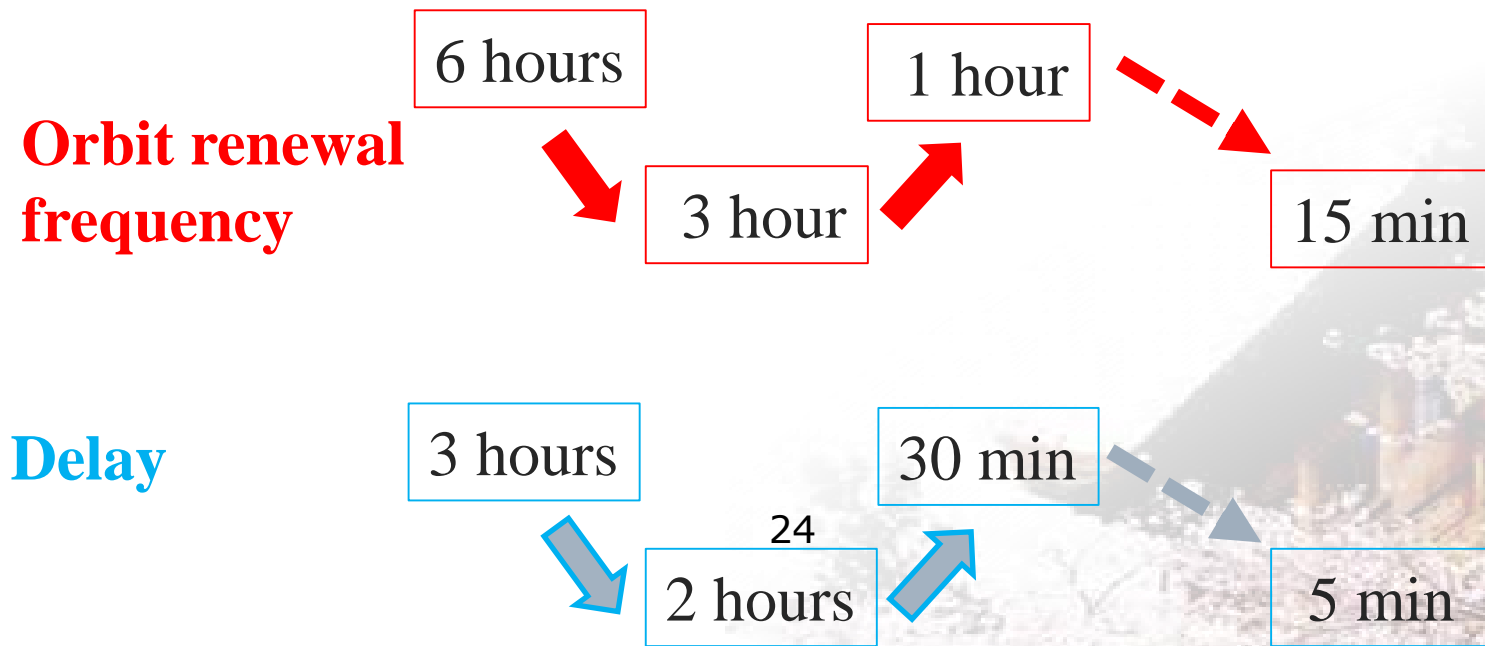
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<input type="checkbox"/>	<a href="#">whu19484_20.erp.Z</a>	281 B	17/5/12	下午5:30:00
<input type="checkbox"/>	<a href="#">whu19484_20.sp3.Z</a>	313 kB	17/5/12	下午5:30:00



# 4. Outlook

- ❑ More real-time data , and Data quality control
- ❑ New force models for each constellation, eg. GLONASS, BDS GEO
- ❑ Parallel computing







Thanks for your attention!



自强不息  
弘毅  
求是  
拓新