ION GNSS 2015

Advanced GNSS Algorithms and Services Based on Highly-stable On-board Clocks

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SESSION E2b: Advanced Technologies in High Precision GNSS Positioning 2

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OUTLINE

- Introduction and objective
- Satellite clocks modelling
- Preliminary Results
- Conclusions

INTRODUCTION AND OBJECTIVE

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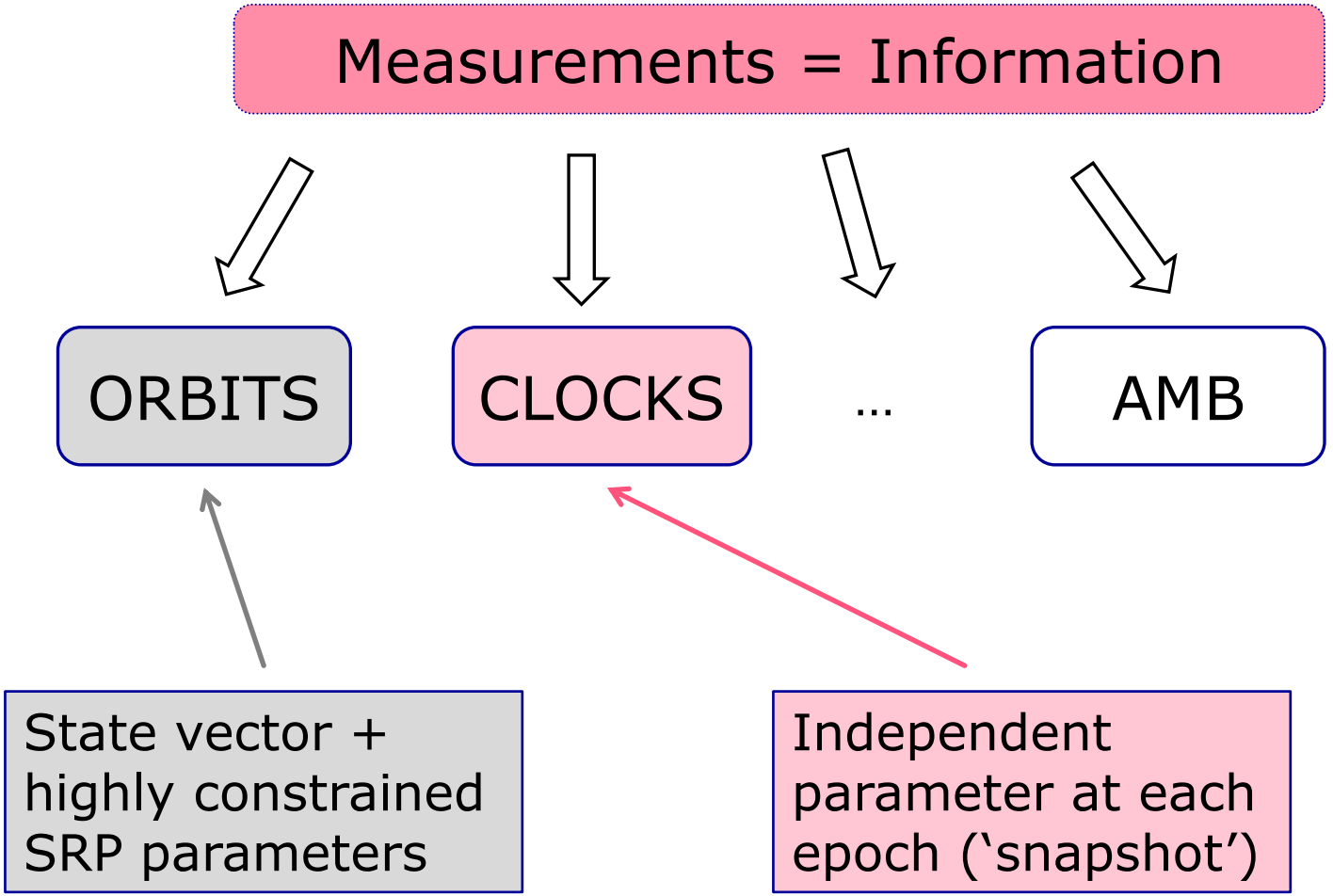
ORBIT AND CLOCK ESTIMATION



CONVENTIONAL OD&TS PROCESS

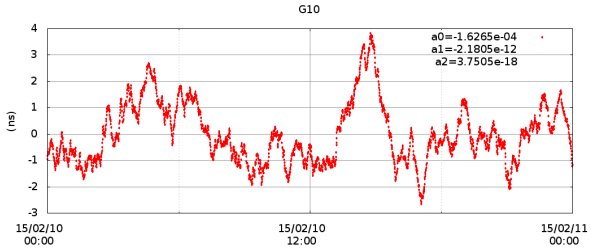
Snapshot estimation ➔ huge amount of information

Relatively large tracking station networks are needed

IGS Analysis Centre	Reference Network size
CODE	240
NRCan	80
ESOC	150
GFZ	200
JPL	80
MIT	300
NGS	200
SIO	290
Service Provider	**Reference Network size**
FUGRO	>100
TRIMBLE	100
VERIPOS	74

SATELLITE CLOCKS

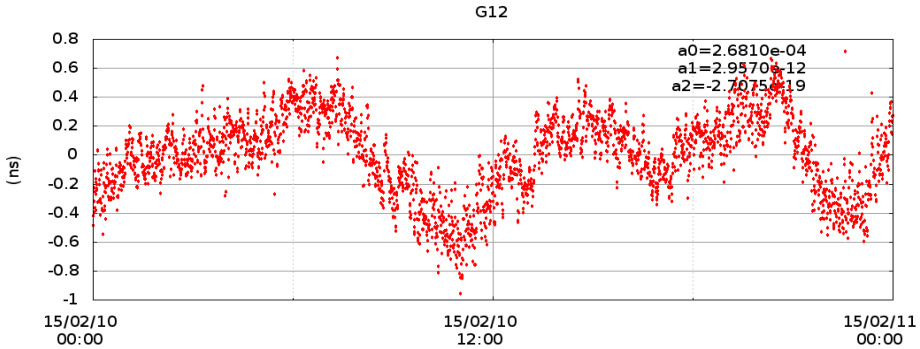
Atomic clocks on board satellites are highly stable

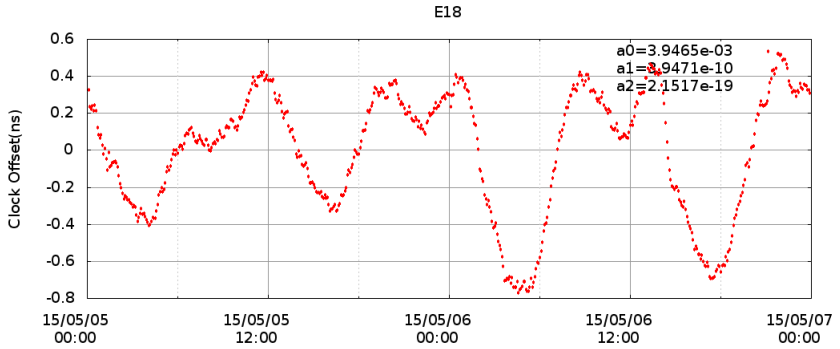


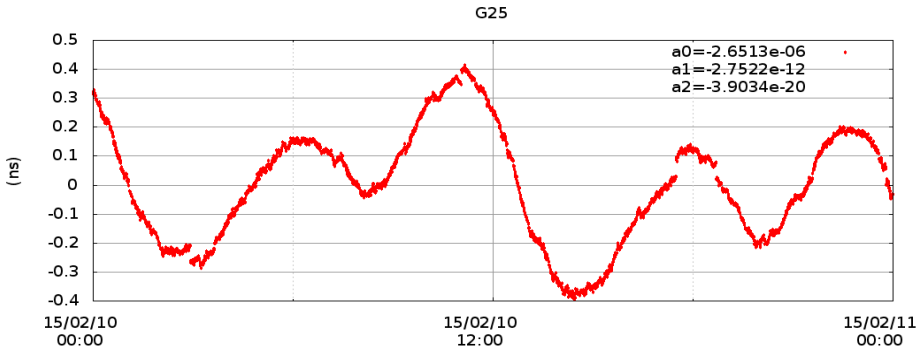
Behavior		Estimation
Random, no pattern	⇒	Snapshot
High stability, clear pattern	⇒	?

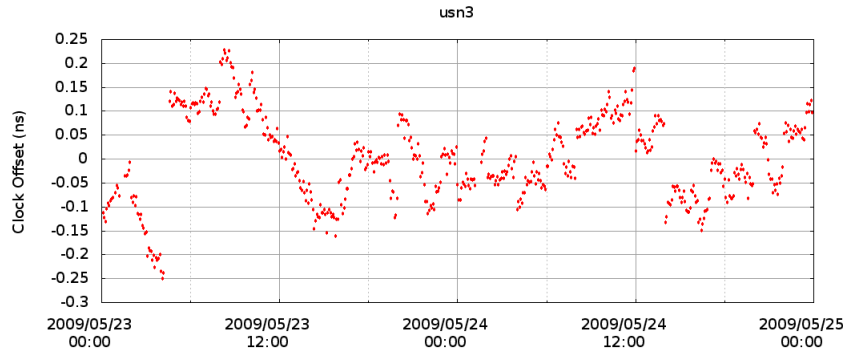
SATELLITE CLOCKS

Satellite clock stability keeps improving





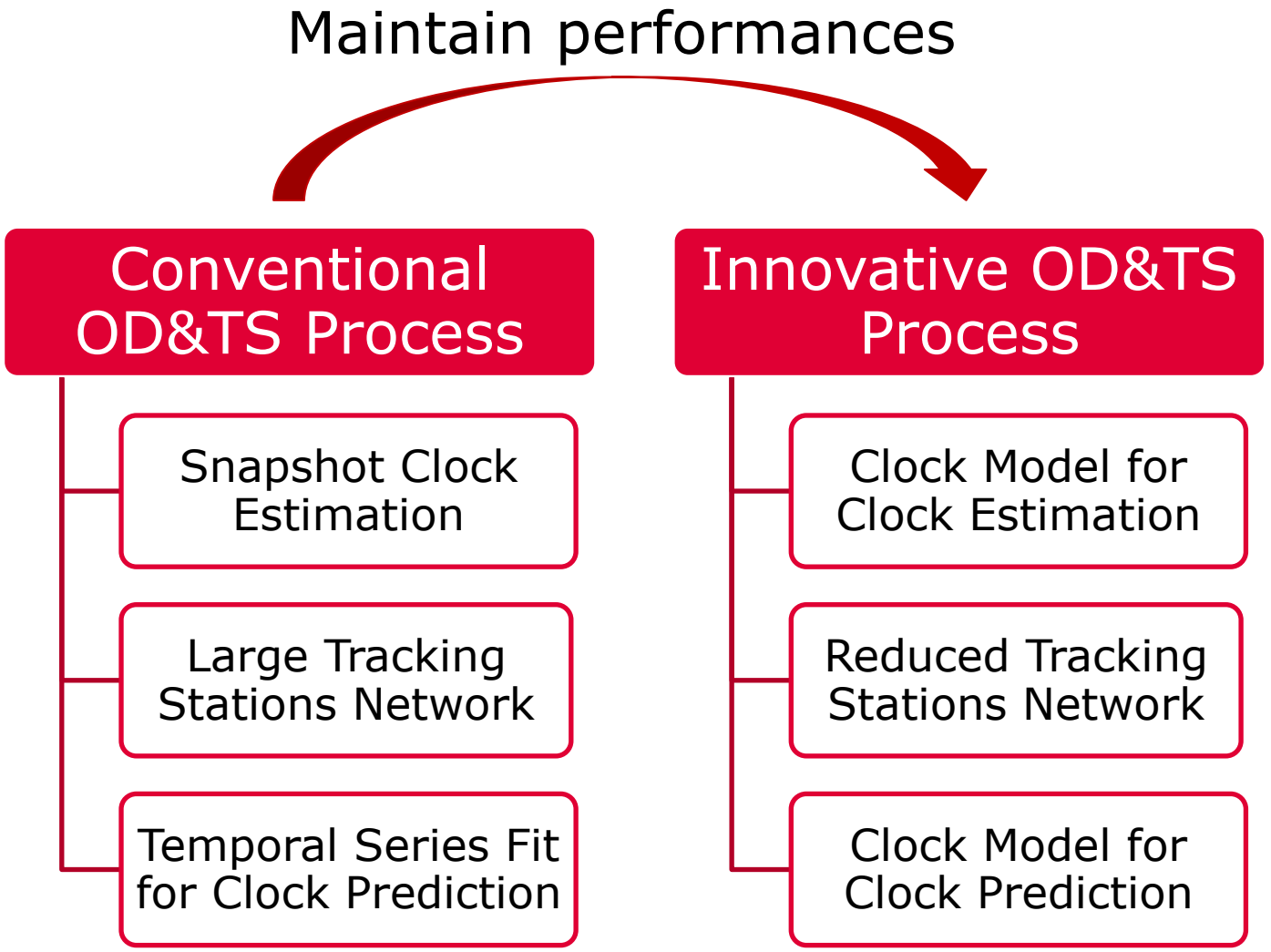




Rb

PHM

OBJECTIVE


Maintain performances
Conventional OD&TS Process
Snapshot Clock Estimation
Large Tracking Stations Network
Temporal Series Fit for Clock Prediction
Innovative OD&TS Process
Clock Model for Clock Estimation
Reduced Tracking Stations Network
Clock Model for Clock Prediction

SATELLITE CLOCKS MODELLING

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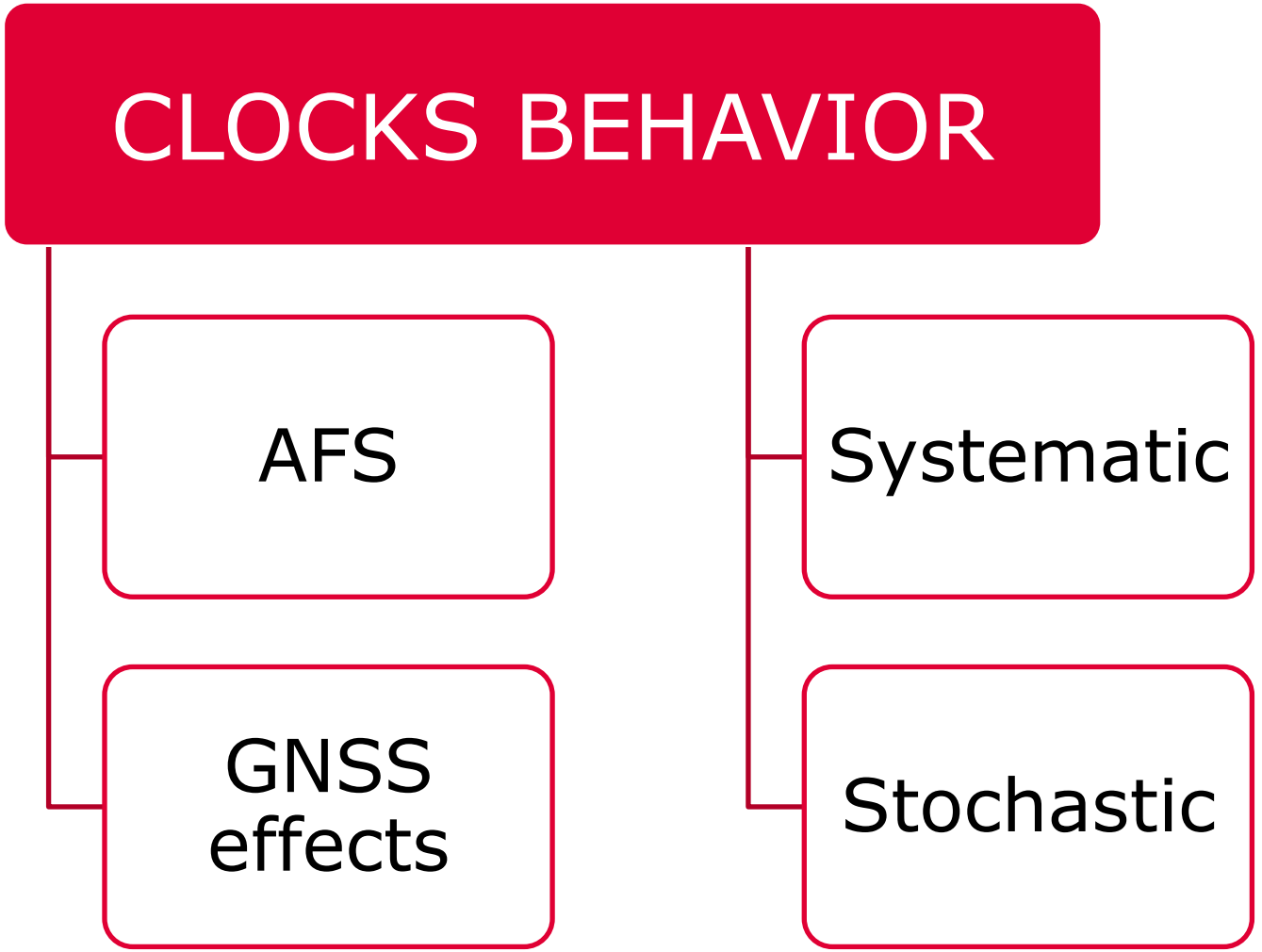
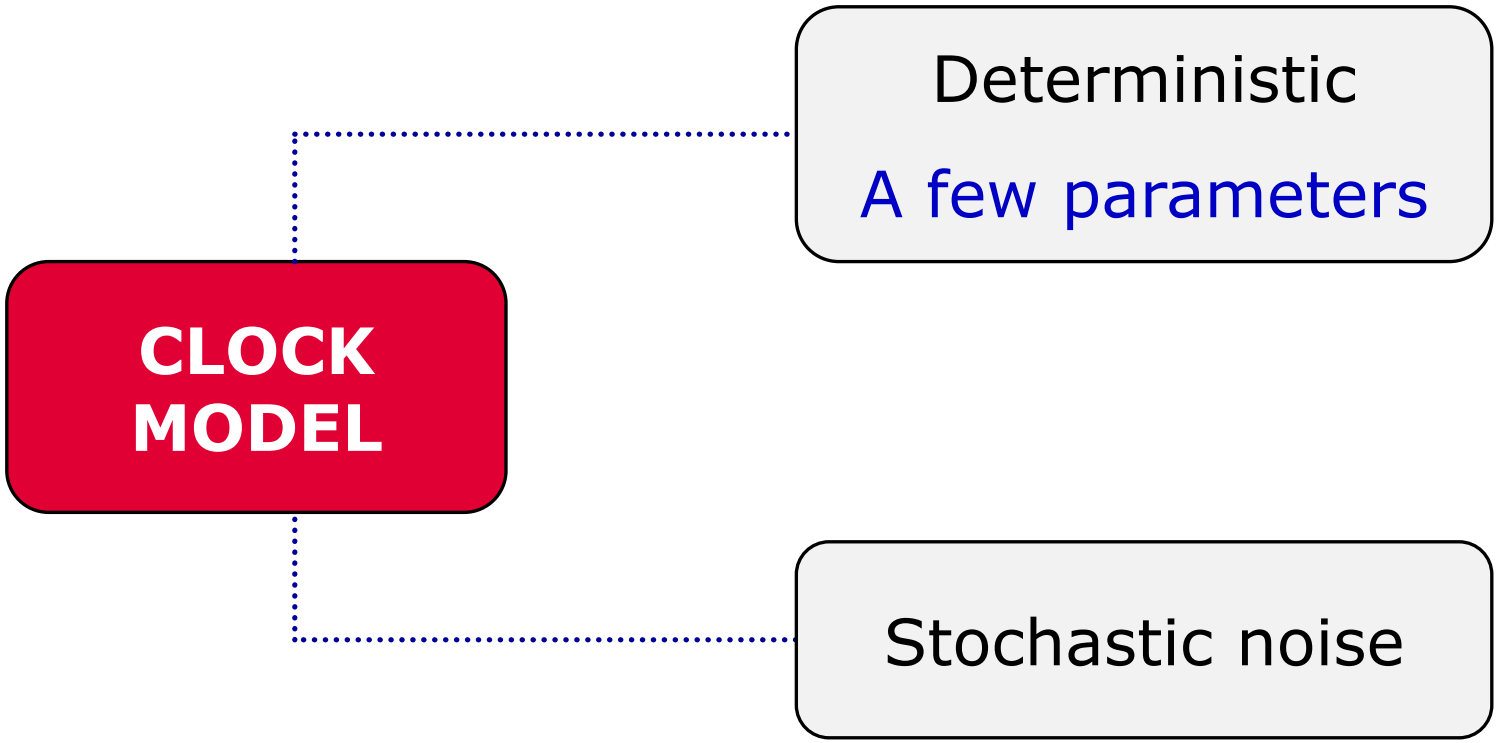
SATELLITE CLOCKS

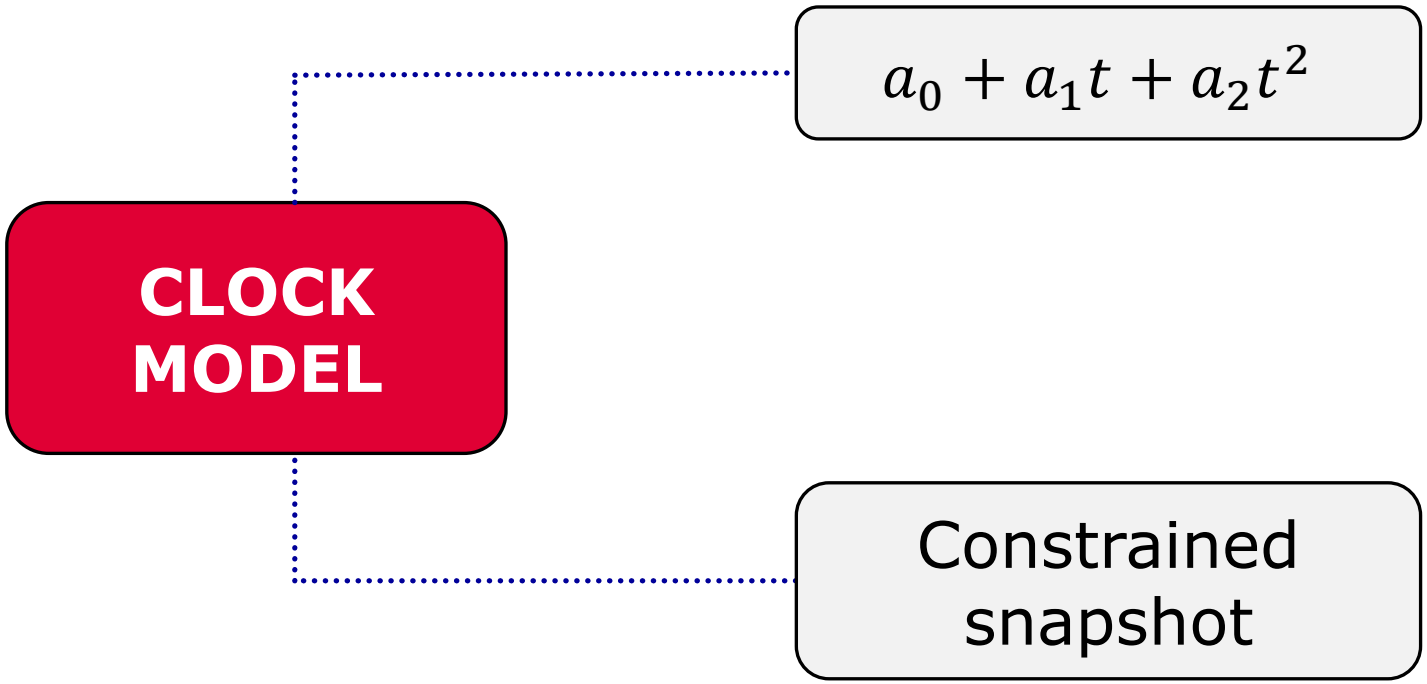


CLOCK MODELS IN ODTS



CLOCK MODELS IN magicODTS

magicOTDS enhanced with clock model est.



PRELIMINARY RESULTS

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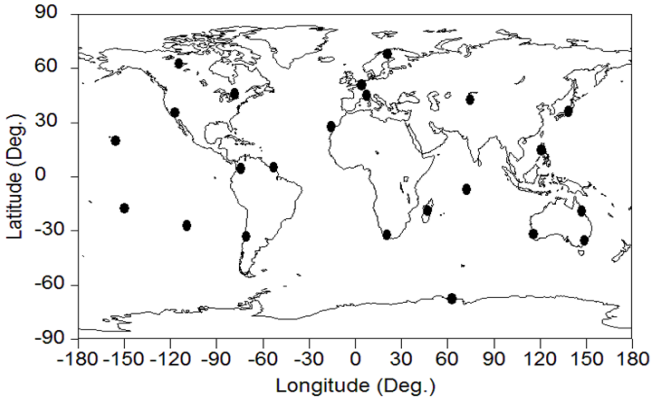
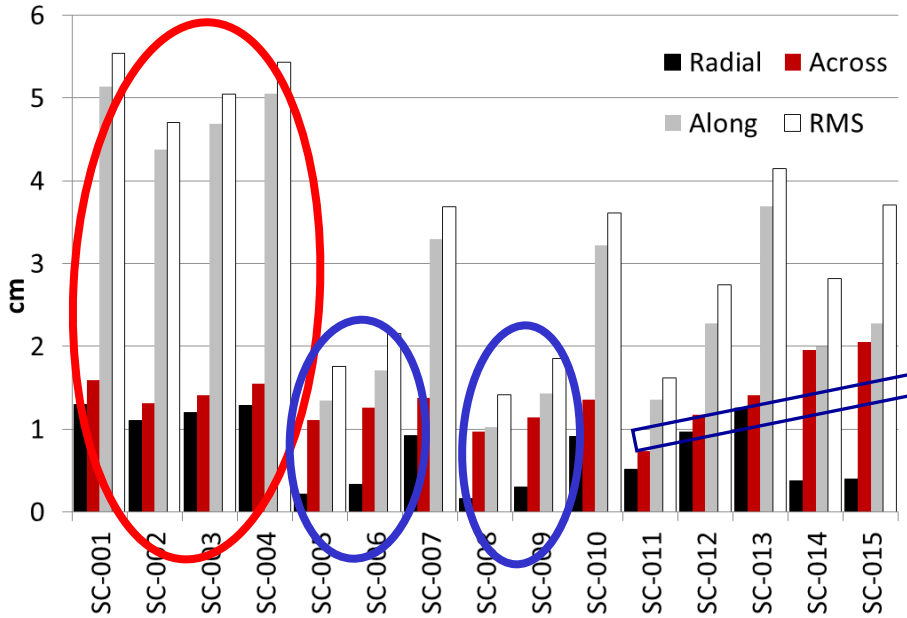
COVARIANCE ANALYSIS

- **Covariance analysis tool**
- 23 stations network
- Different scenarios tried



Fix GSS clocks



Fix SAT clocks

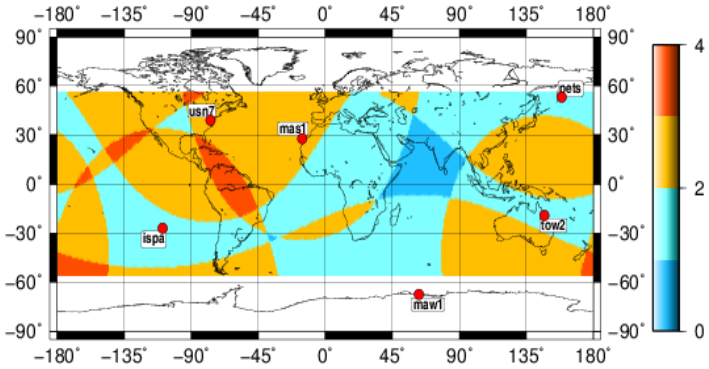
CLOCK MODELLING RESULTS

- magicODTS enhancement: each clock can be estimated as snapshot or clock model

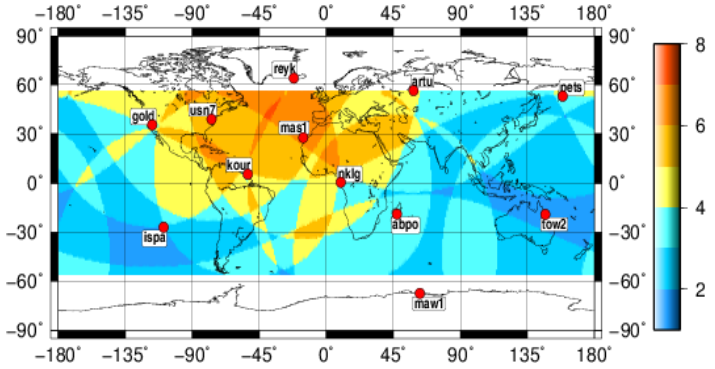
- Clock model made of two parts $b(t) = b_G(t) + b_S(t)$
  - A quadratic function, $b_G(t) = a_0 + a_1 t + a_2 t^2$
  - A constrained snapshot correction, $b_S(t)$

- ODTS with clock model proved feasible, performance improvements for small networks

CLOCK MODELLING RESULTS

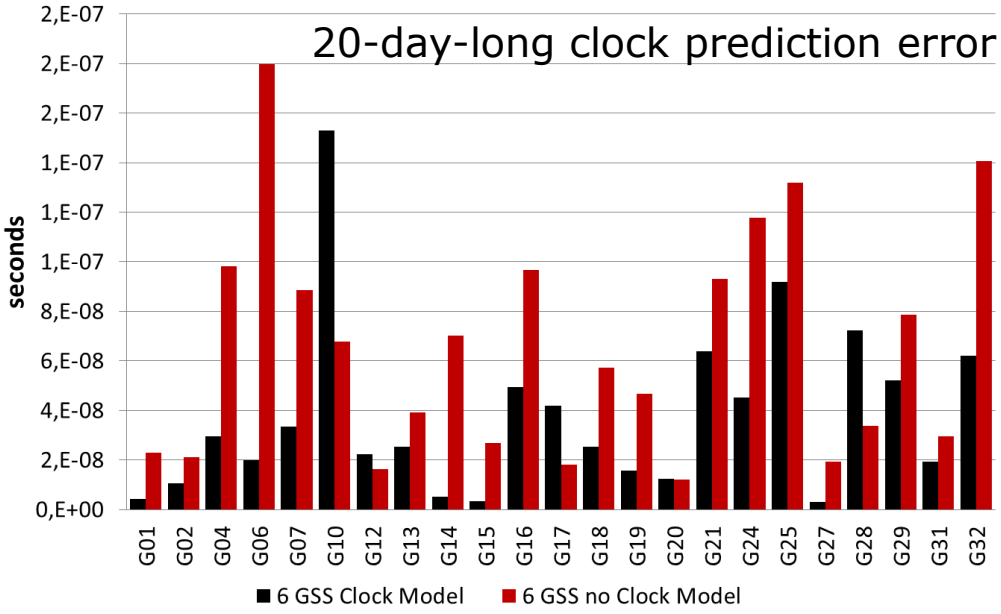


6 stations tracking network



12 stations tracking network

Orbit and Clock determination error wrt IGS				
Processing type	CLK (ns)		ORB (cm)	
	6	12	6	12
Snapshot	0.51	0.26	21.3	6.6
Model	0.43	0.26	16.5	5.6



CONCLUSIONS

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CONCLUSIONS

- Current GNSS clocks stability clears the path for potential performance improvements based on a tight modelling
- This would make possible to reduce tracking networks size
- Physical clock modelling in ODTS processing have shown positive results in reduced networks
- Systematic effects (e.g. thermal environment) need to be properly understood and modelled

Thank you

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