Fine-mesh numerical weather models for modeling of GNSS troposphere slant delays

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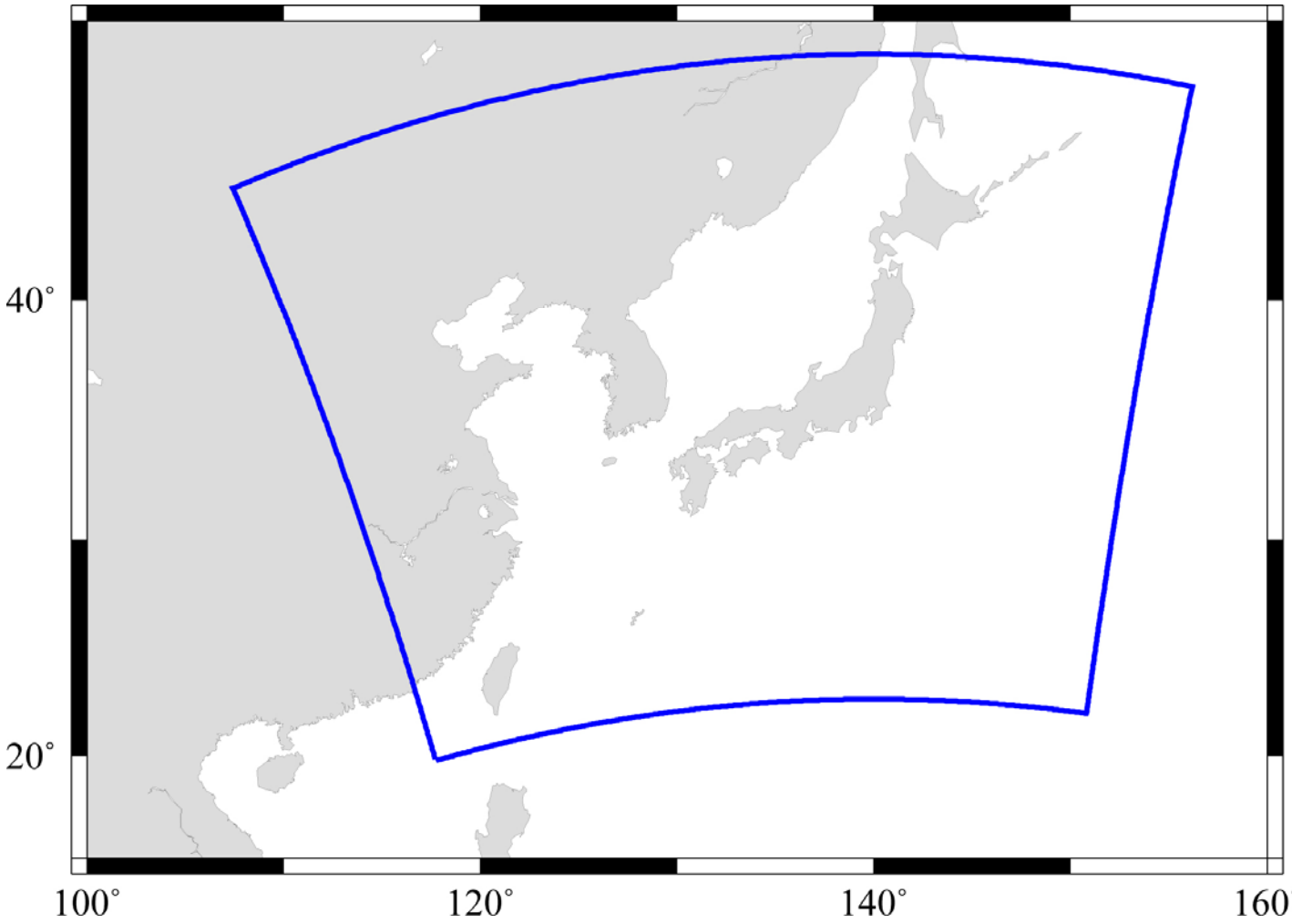
Content

- From meso-scale to fine-mesh models
- Ray-tracing with fine-mesh models
- Information content
- Zenith total delays - estimated vs. modeled
- Applying troposphere slant delay corrections to GNSS observations
- Results
- Conclusions

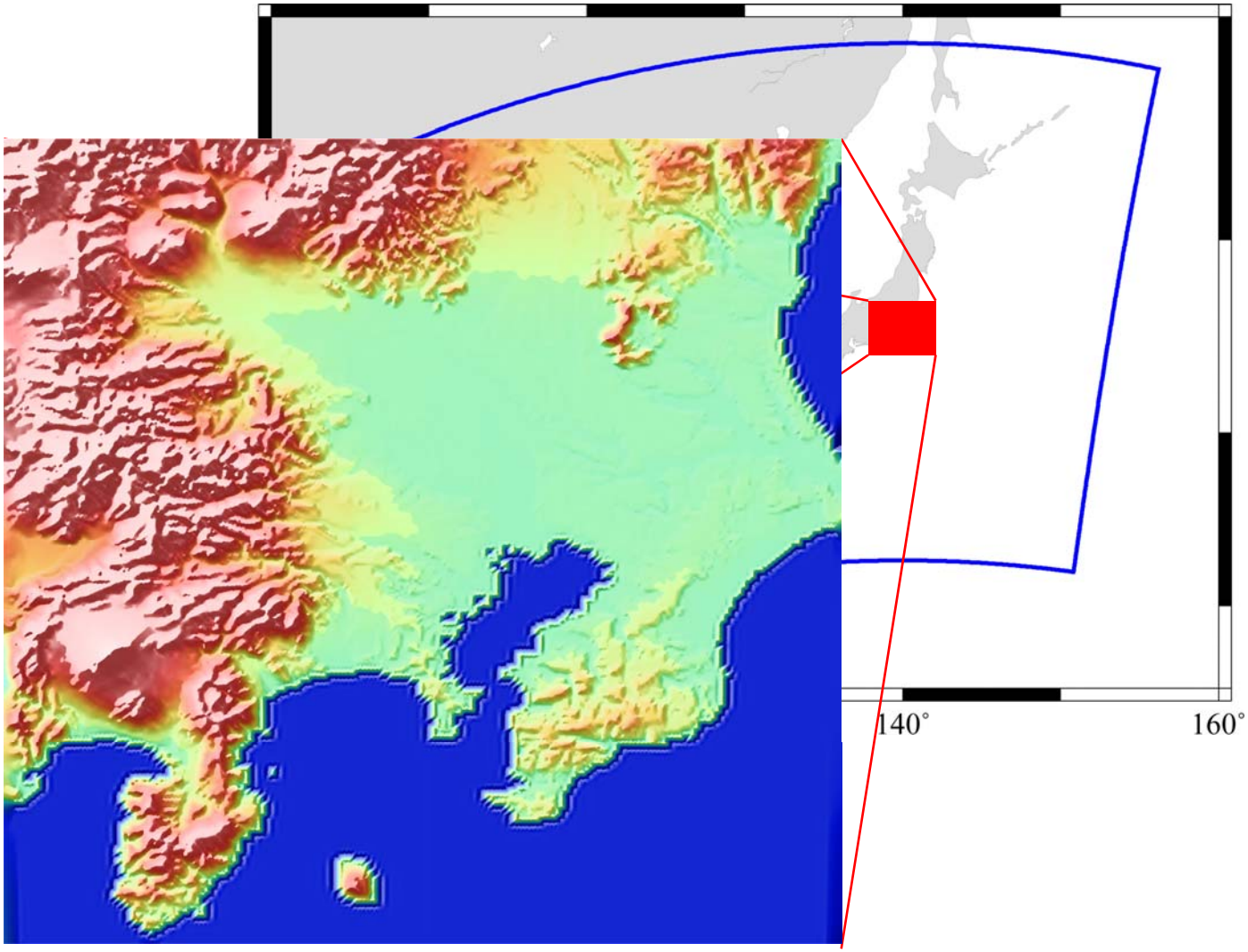
Meso-scale analysis model – Japanese meteorological agency (JMA)



Spatial resolution:
10 x 10 km
Temporal resolution:
3 hrs
Coverage:
Japan, Korea, Taiwan, parts of China and Russia

MANAL ray-traced slant delays + residual troposphere delay estimation useful for GNSS processing, see *Hobiger et al. (EPS, 2008)*

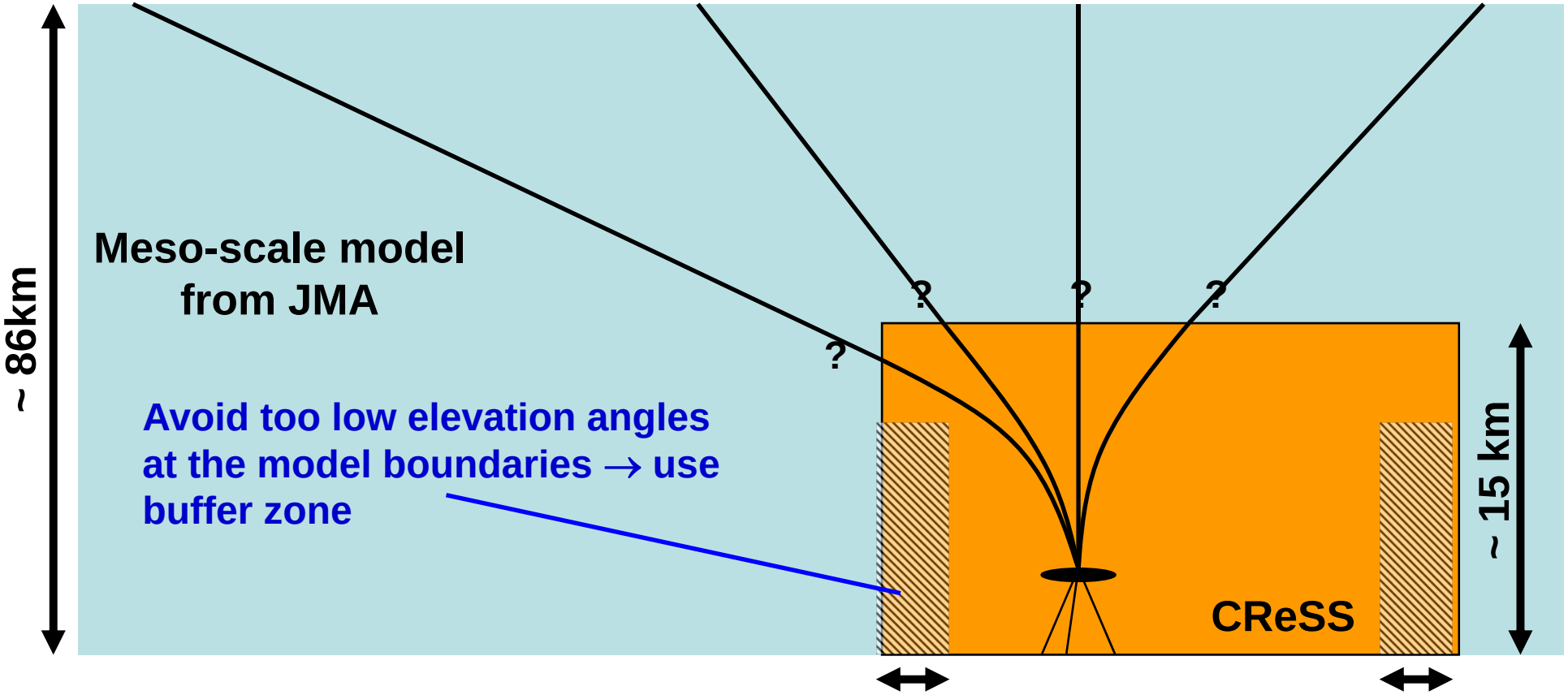
Cloud resolving storm simulator (CReSS) from NIED



Spatial resolution:
1 x 1 km
Temporal resolution:
1 hrs
Coverage:
Area around Tokyo,

Question:
To which extent can we model troposphere slant delays from such a high resolution weather model?

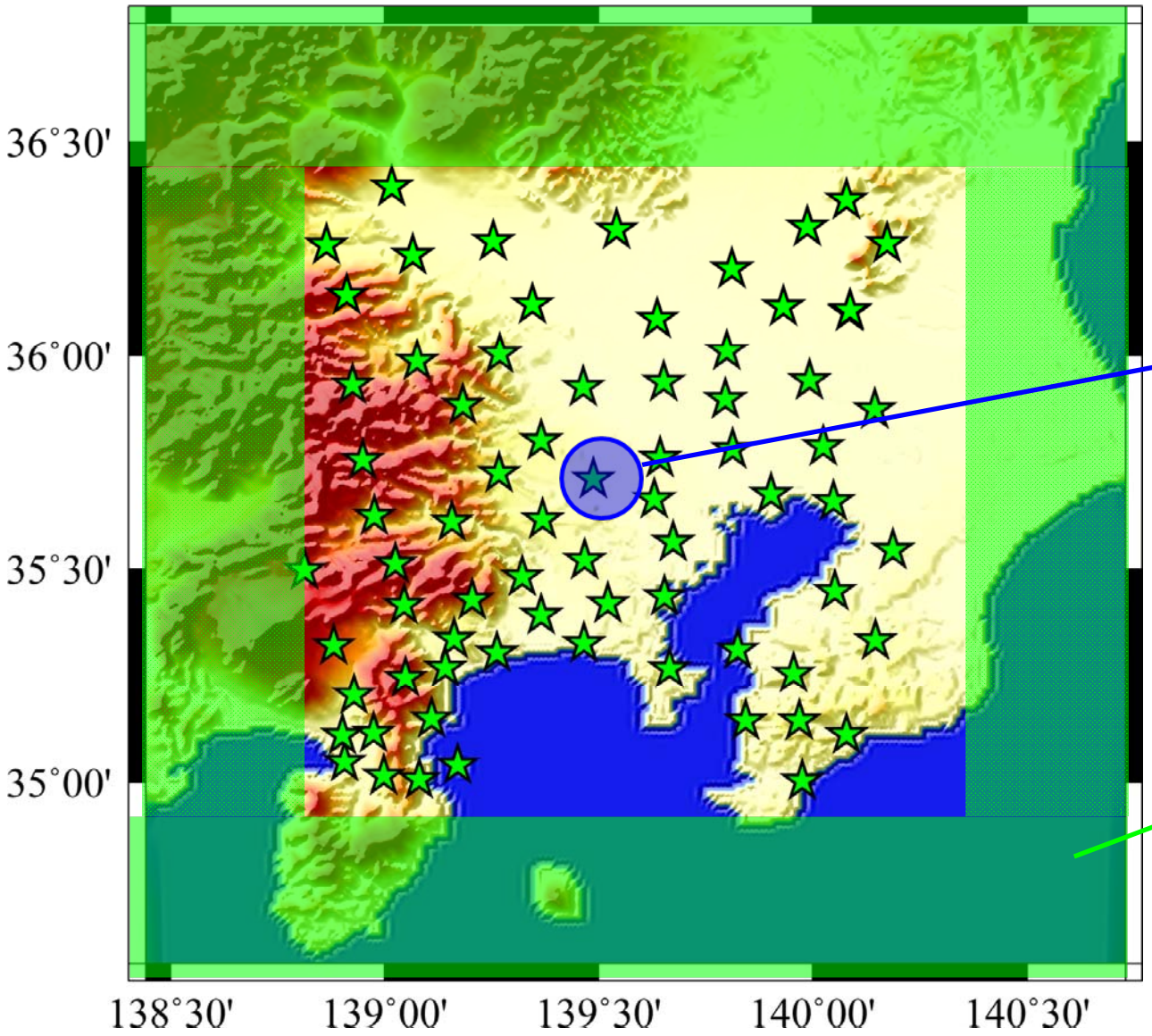
Ray-tracing considerations



Sep. 1st - 9th, 2007 (Typhoon passage)

Dedicated model run carried out by NIED: CReSS model initialized by MANAL model every 24 hours

GEONET receivers within the model boundaries

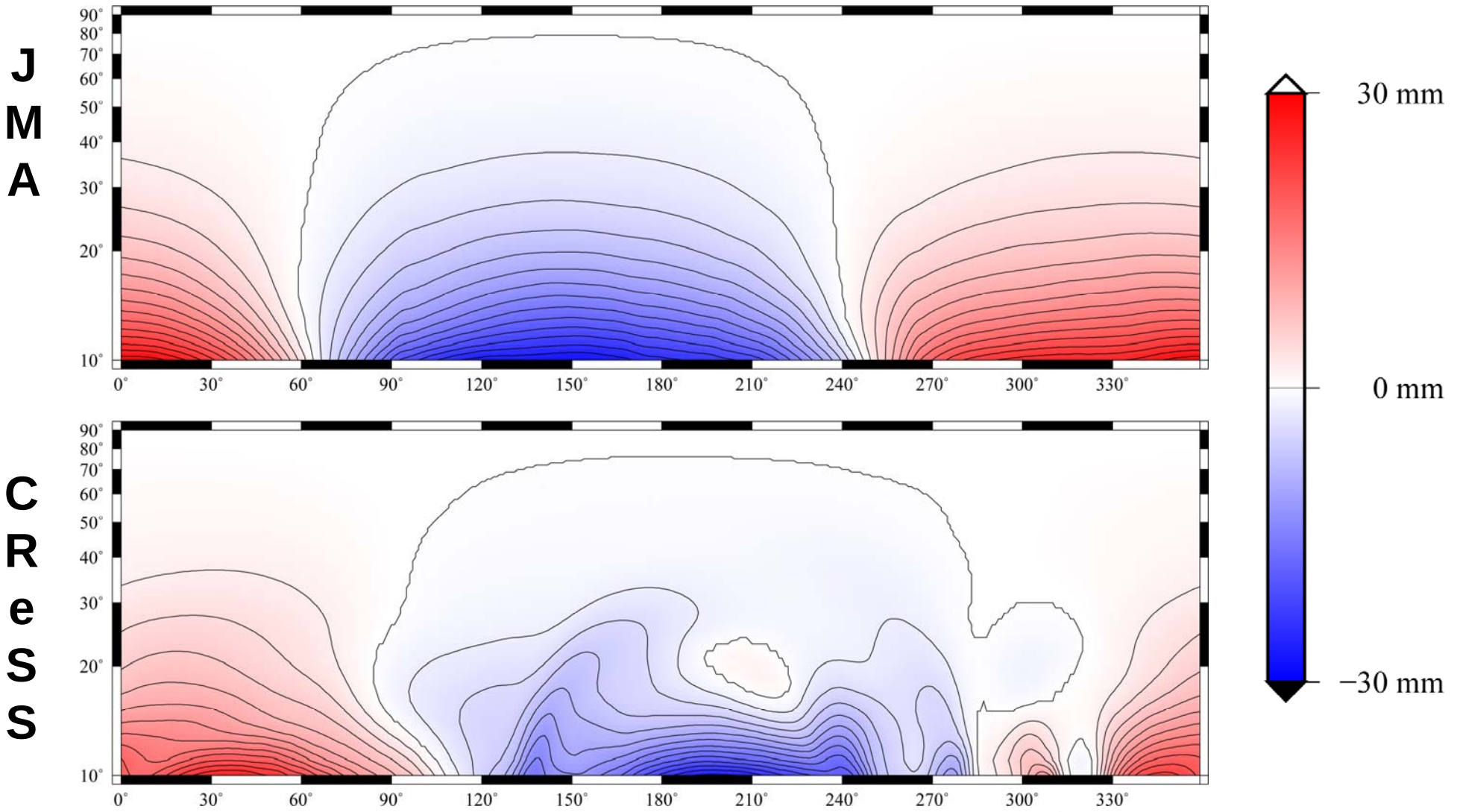


Totally:
72 GPS receivers

GEONET station 3017, will be shown on the next 2 slides

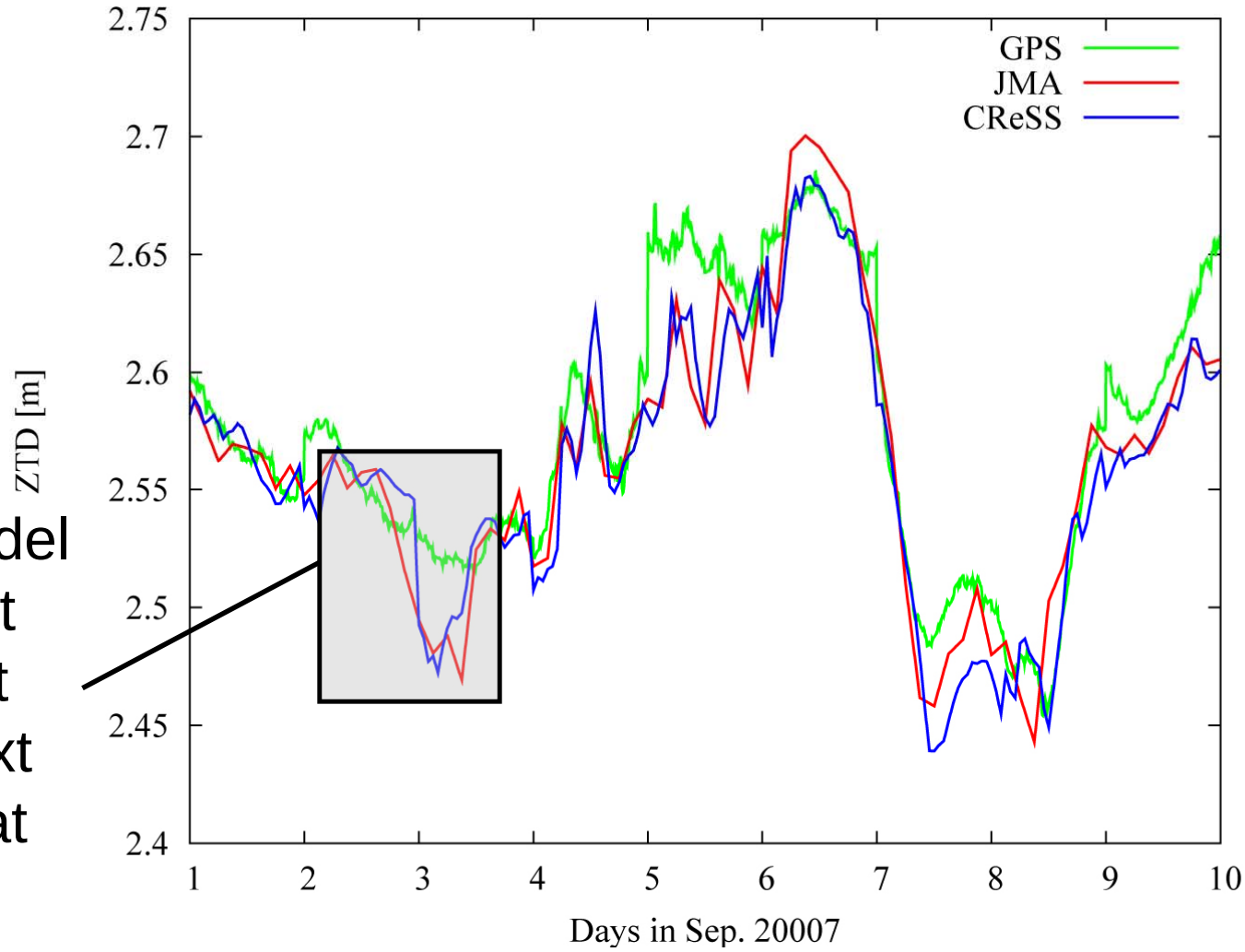
- Ensures that low elevation angles don't leave NWM laterally
- Avoids model deficits at the boundary

Information content: Sep. 7th, 2007 12h UT
Ray-traced asymmetric troposphere delay at site 3017

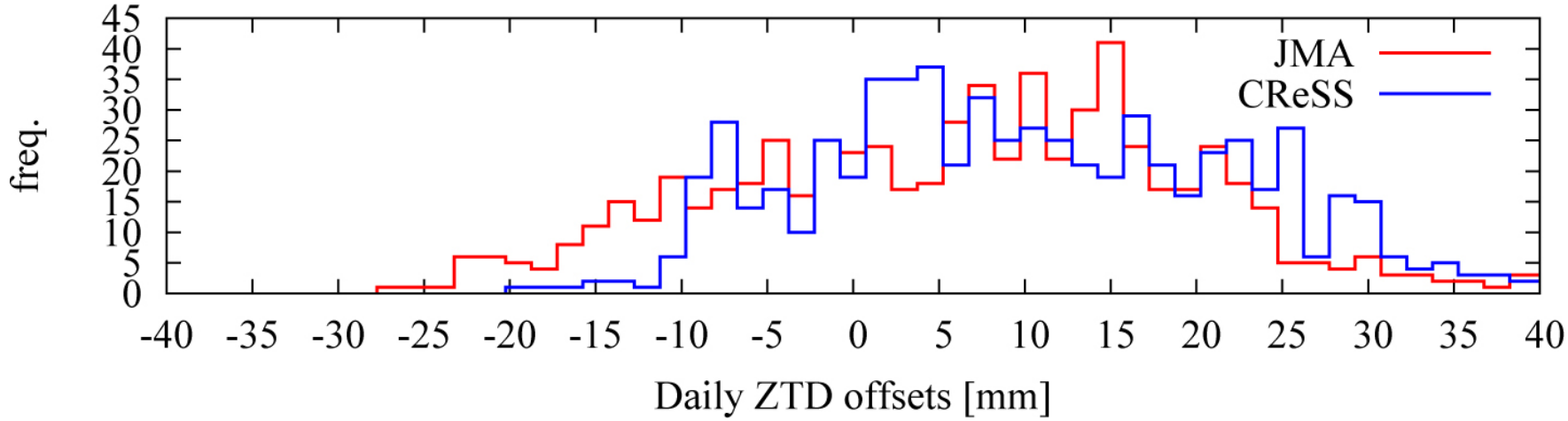


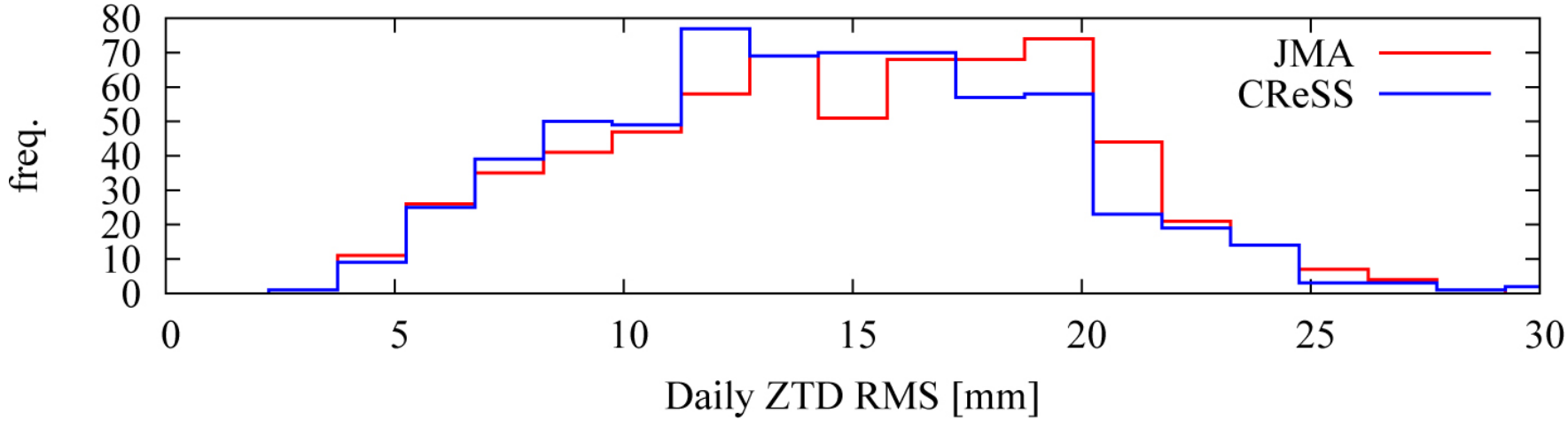
Comparison of (total) zenith delays at site 3017

Fine-mesh model would predict correctly, but biased by next initialization at 0UT



Comparison of ZTDs (Sep. 1-9, 2007, all sites)

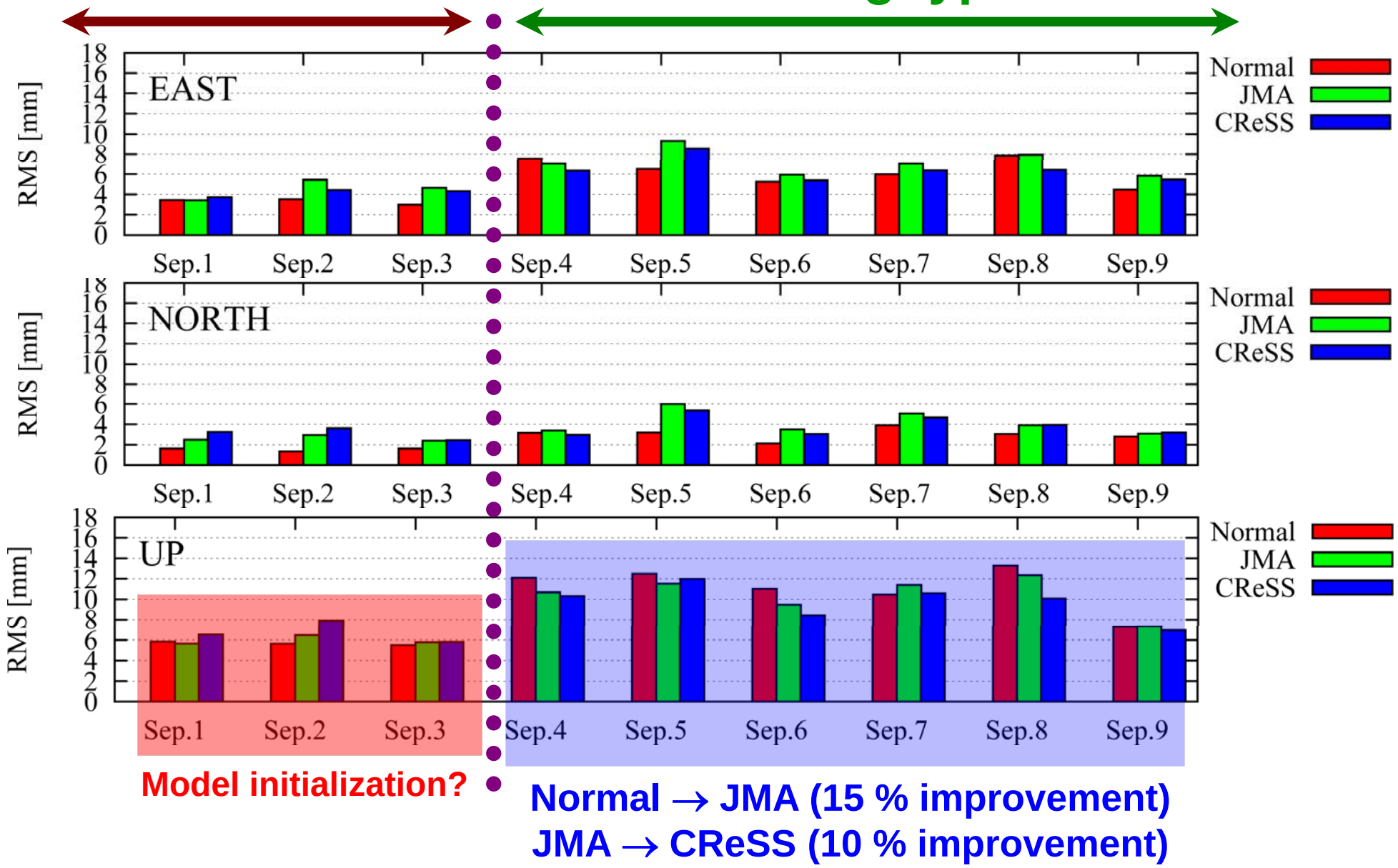




Fine-mesh models can provide more realistic troposphere corrections, but not accurate enough for correction of total troposphere delay → estimation of residual delays necessary

PPP solutions

- All estimations with GPSTOOLS v0.6.3
- "**Normal**" solution: GMF + gradients
- "**JMA**" solution: ray-traced slant delays from meso-scale model, residual delay estimation with 1/sin(el) mapping function
- "**CReSS**" solution: ray-traced slant delays from fine-mesh model, residual delay estimation with 1/sin(el) mapping function
- Mean RMS of daily station position variation (over all 72 stites)


Before typhoon
During typhoon
EAST
NORTH
UP
RMS [mm]
Normal
JMA
CReSS
Sep.1
Sep.2
Sep.3
Sep.4
Sep.5
Sep.6
Sep.7
Sep.8
Sep.9
Model initialization?
Normal → JMA (15 % improvement)
JMA → CReSS (10 % improvement)

Conclusions

- Fine-mesh weather models reveal complex weather situations, which can hardly be modeled by mapping functions and simple gradient approaches (see *Pany et al., poster on Friday in session G5*)
- Such models have the potential to improve GNSS positioning estimates significantly
- Residual troposphere delay estimation still necessary (using a simple mapping function)
- Model initialization is crucial !
- Spatial domain restricted, currently only feasible for local/regional studies

Outlook

- Improve model initialization
- Assimilate in-situ meteorological data and/or GNSS ZTDs
- Provide corrections for InSAR measurements
- Increase ray-tracing speed → *Hobiger et al., Computation of troposphere slant delays on a GPU, talk on Thursday, session G5*

Thank you very much for your attention !