NKG GNSS ANALYSIS CENTRE

ITRF2014 densification for the Nordic and Baltic countries

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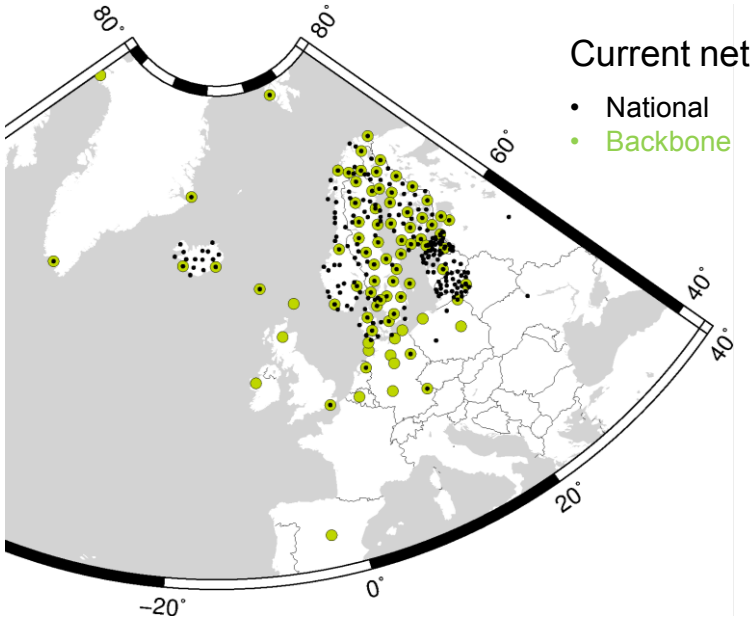
BACKGROUND

- Motivation
  - Dense and homogenous velocity field for Nordic and Baltic countries
  - For national reference frames related tasks
  - For geodynamic studies (land uplift etc.)
- NKG GNSS Analysis Centre
  - Launched in 2012
  - Started with operational processing on weekly basis in 2014
  - Continued with reprocessing
  - Finished a densified ITRF2014 position and velocity solution with uncertainties

METHODS OF NKG GNSS AC

- Backbone solution: NKG-EPN solutions
- Eight national analysis centres
  - Own national stations
  - EPN stations for combination
  - Reference station (IGS/ITRF14)
- Subnet solutions
  - All Bernese solutions
  - Followed EPN's guidelines for its ACs
- Combination of subnet solutions
  - Both using ADDNEQ2 (Bernese) and CATREF

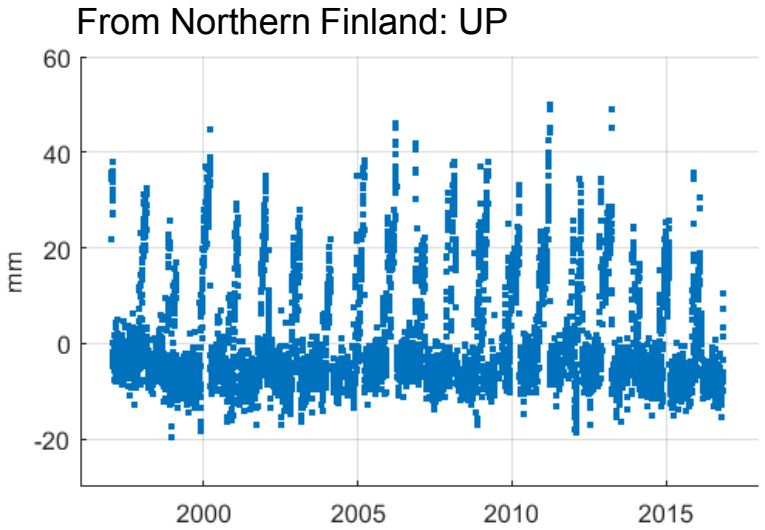


METHODS OF CUMULATIVE SOLUTION

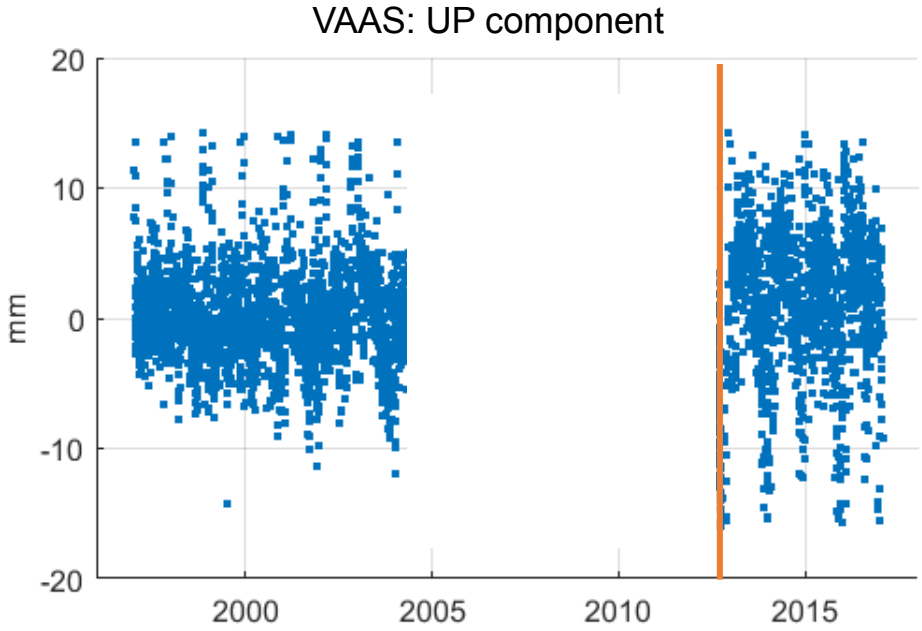
- Reprocessing RINEX data 1997.0–2017.1
  - Daily solutions with 3 and 10 degree cut-off angle
- Combination of subnets into daily solutions (CATREF)
- Time series analysis mainly manually utilising Tsview software
  - Bad data, discontinuities
  - Rejections into daily SNX files before combination
- Cumulative solution using CATREF
  - Both positions and velocities
  - Constraints between co-located stations (twin stations)
- Uncertainties for velocities using Hector

TIMESERIES PRE-ANALYSIS

- Roughly 300 stations
  - 8 analysis centres with local knowledge
  - Systematics due to snow
- Discontinuities
  - Antenna changes based on site logs or similar
  - Considered receiver/firmware change effects
  - Unknown changes most challenging

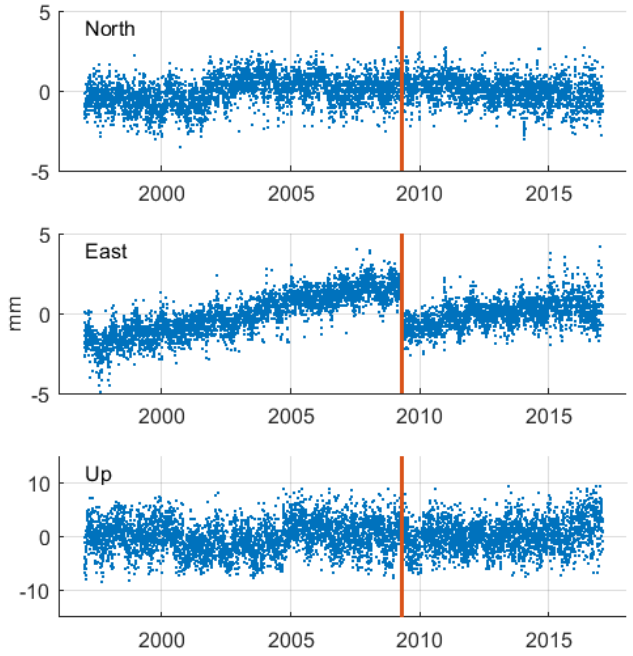


TREE-GROWTH EXAMPLE



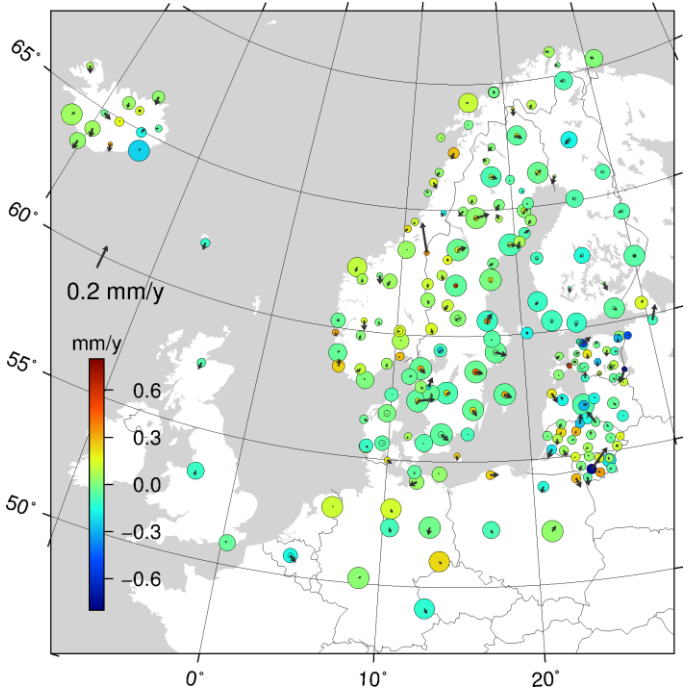
TWIN STATIONS DIFFERENCES

- Some of the Swedish twin stations had trends in horizontal residuals
  - Originating from velocity differences btw old (~20 years) and new (~6 years) station
  - Differences up to 0.3 mm/y
  - No link to the time span of the time series
  - Decided to remove constraints on all Swedish twin
- Similar size of differences at other twin?
  - Not observed yet



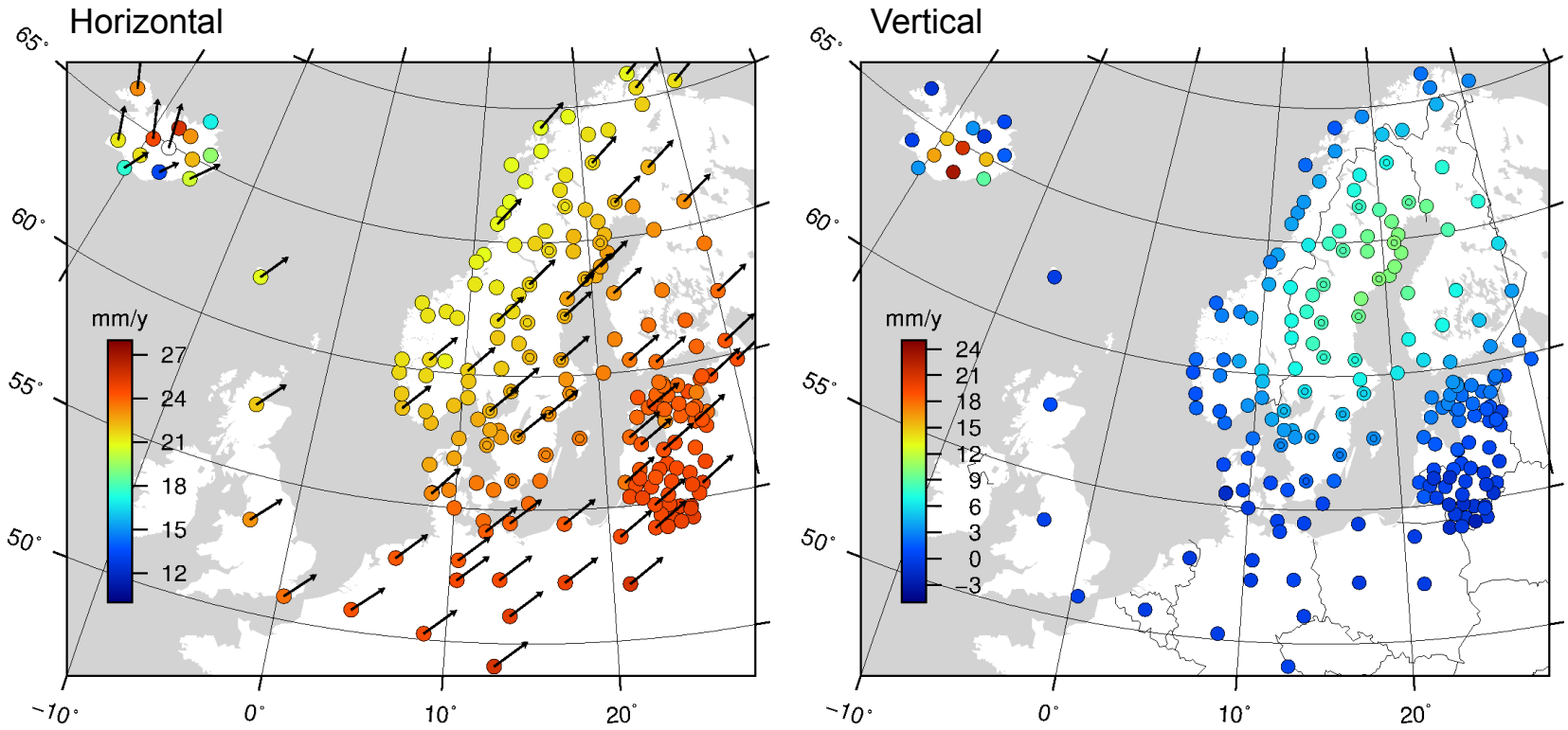
3 AND 10 DEGREE SOLUTIONS

- Can we see any effects of changing cut-off angle at sites during time span?
- Largest differences mostly in short time series
- No systematical differences
  - 3 deg solutions as final solution



Horizontal: arrows
Vertical: circles scaled by the time series length

FINAL ITRF2014 VELOCITIES

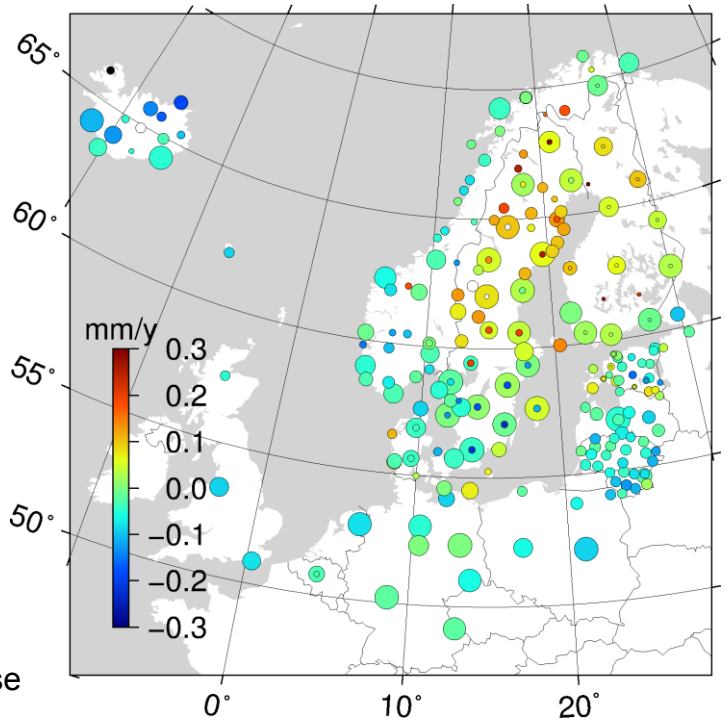


UNCERTAINTIES

- Realistic uncertainties needed for e.g. land uplift modelling
- Main alternative noise models
  - General power-law + white noise
  - Flicker noise + white noise
- Residuals of the CATREF solution as an input
  - Analysed individually for each station and its components (NEU)
  - Discontinuities as in CATREF solution
- Special case: uncertainties for the constrained twin stations
  - Final velocity a weighted mean of the two stations (approximately)
  - Final uncertainty using error propagation law
  - Time series length as weighted

DIFFERENCES: FLICKER VS POWER-LAW NOISE

- Horizontally roughly equal (less than 0.05 mm/y difference)
- Vertically power-law gives slightly larger near GIA maximum
  - But some overestimated uncertainties found if shorter time series
  - Power-law not fitting in power spectra density plot
- Flicker noise more robust to be used for all stations

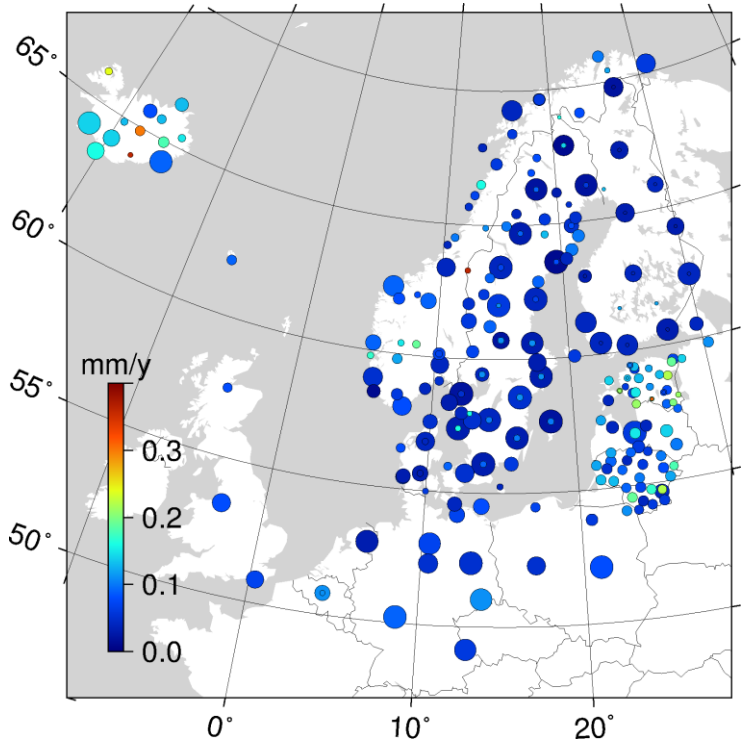


Vertical difference:
Powerlaw – Flicker noise

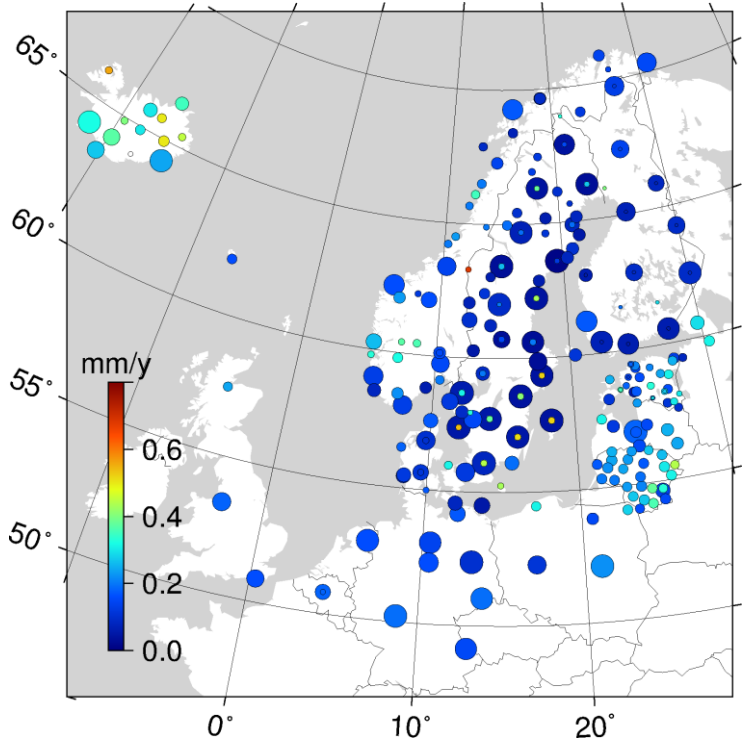
FINAL UNCERTAINTIES (1σ)

NLS FINNISH GEOSPATIAL RESEARCH INSTITUTE FGI

Horizontal



Vertical



OUTLOOK

- Produced a high quality solution
- Results will be published
  - Velocities for stations with min 3 years of data (epochs)
  - Manuscript submitted in April
- Continue the work by stacking new data
  - Quite many newly established stations
  - Some more automatic procedures especially for snow data