

# How can we improve results of VLBI analysis?

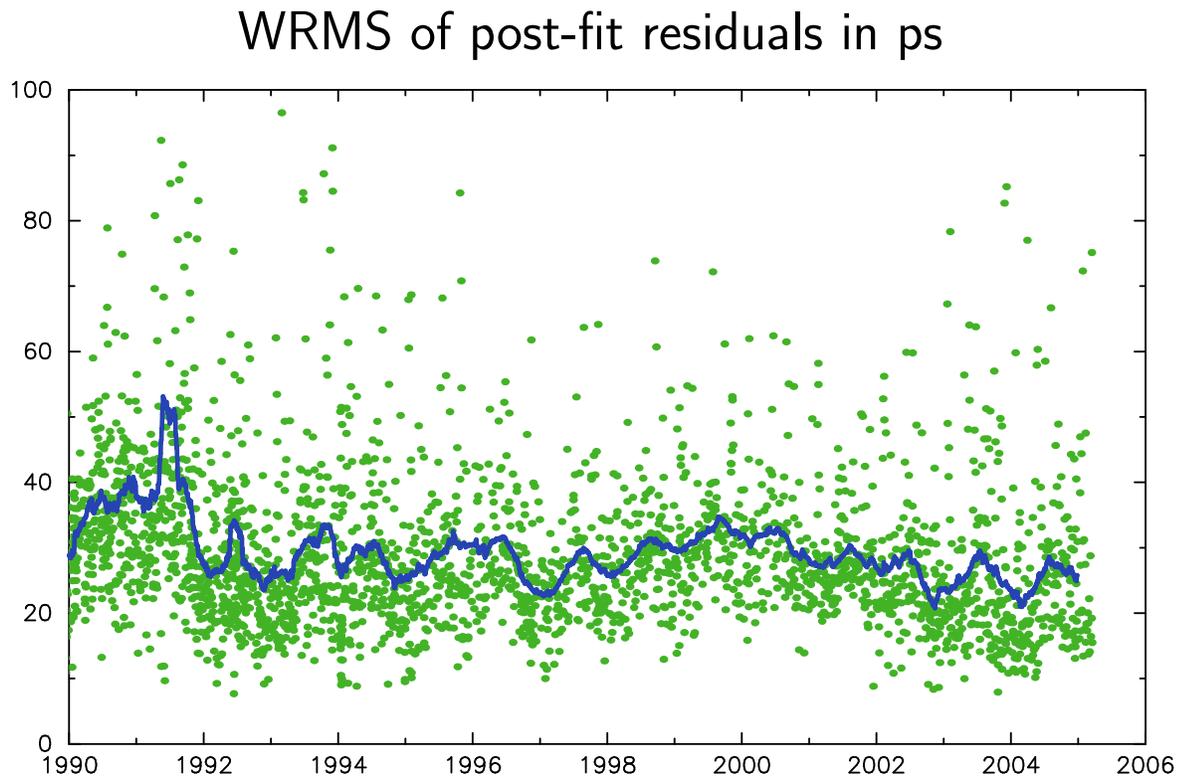
Leonid Petrov

[http://gemini.gsfc.nasa.gov/pet/discussion/vlbi\\_problems\\_2005.pdf](http://gemini.gsfc.nasa.gov/pet/discussion/vlbi_problems_2005.pdf)

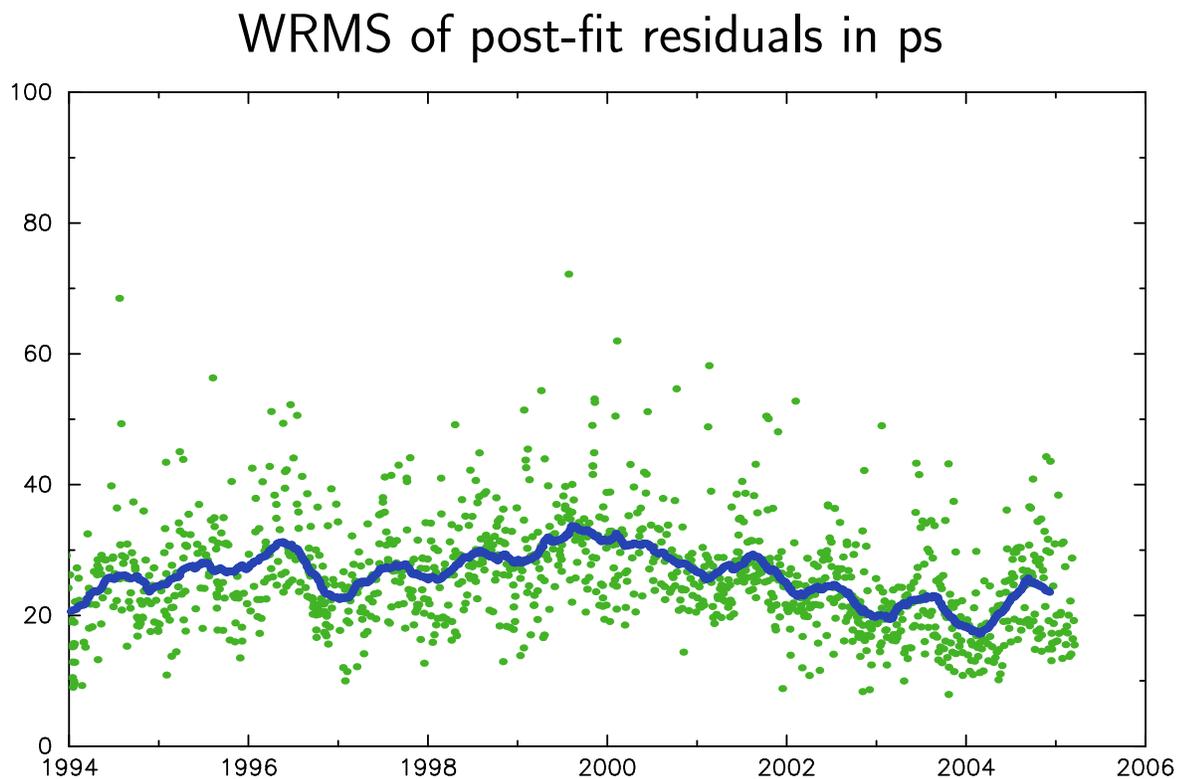
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# Were VLBI results improved in last 10 years?

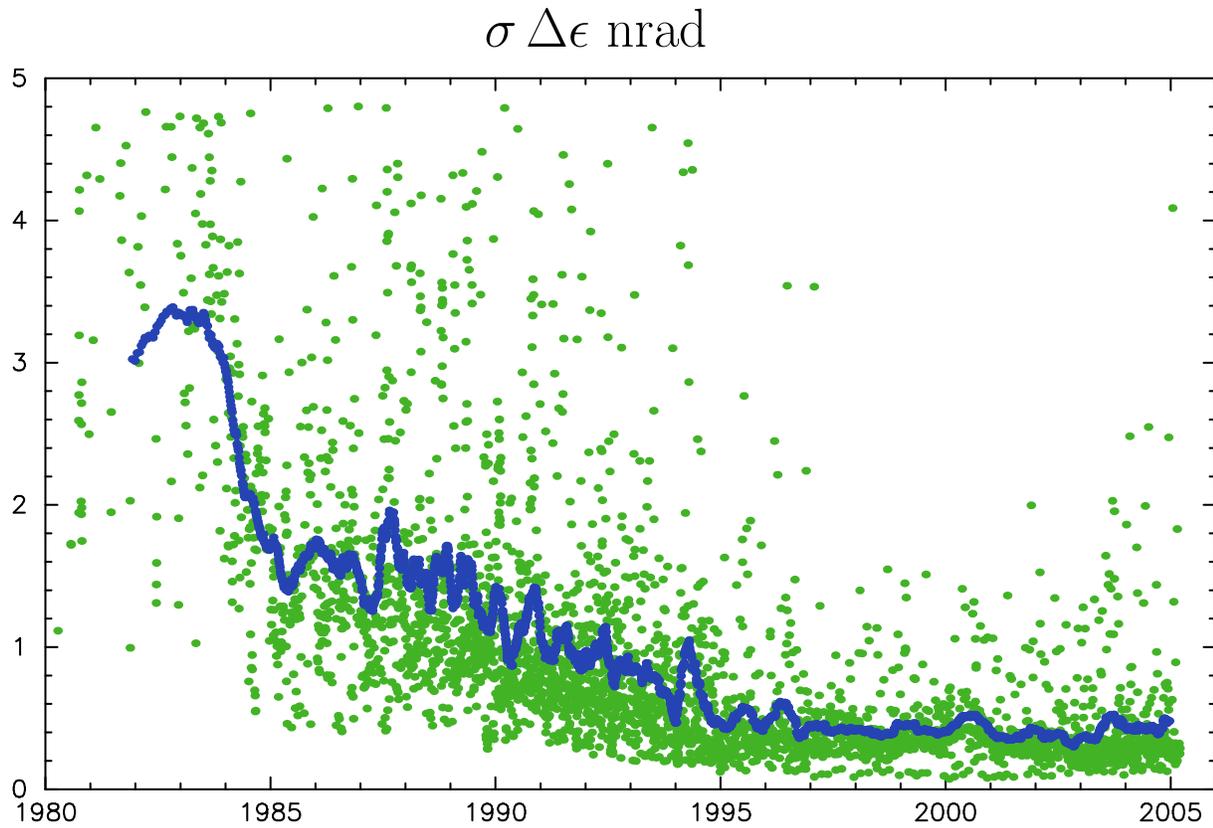
Evolution WRMS of post-fit residuals of individual experiments.  
**All data.**



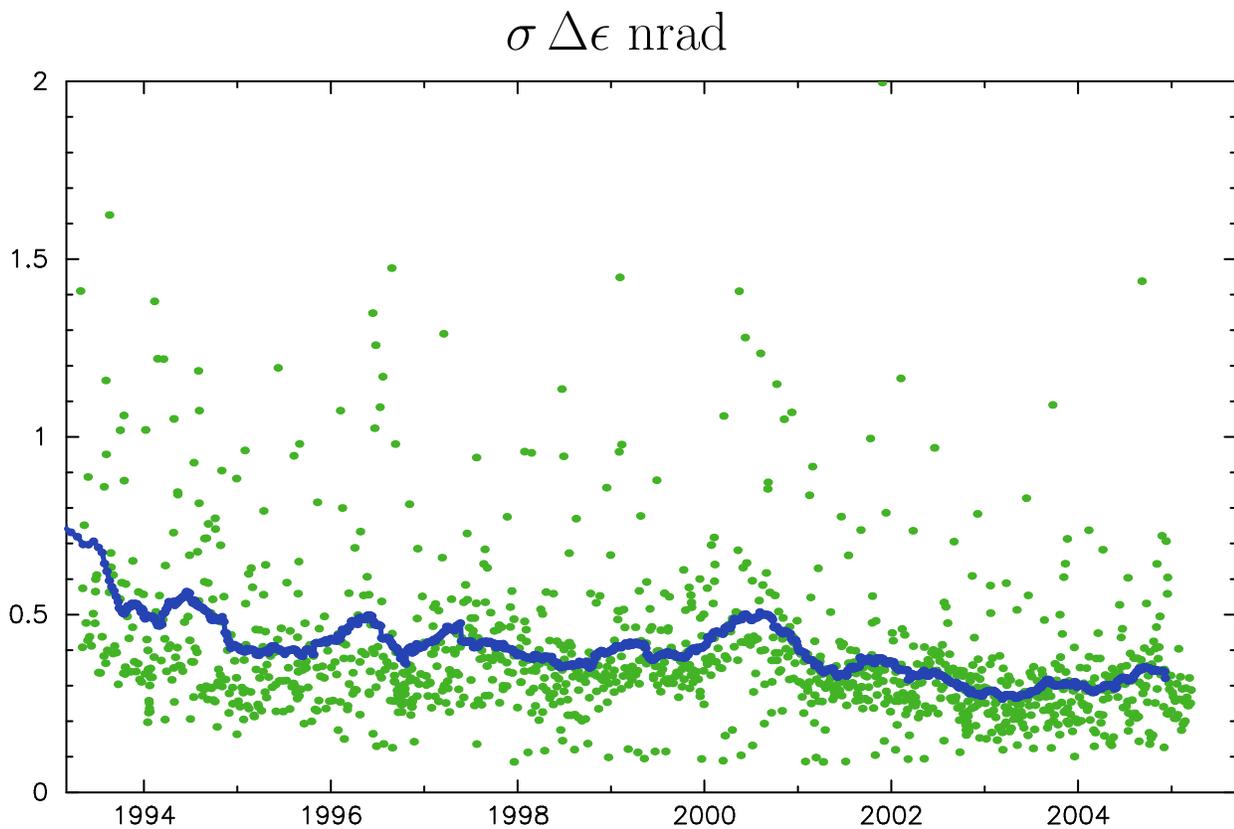
Evolution WRMS of post-fit residuals of individual experiments.  
**XA, XE data.**



# Evolution of formal uncertainties of daily estimates of $\Delta\epsilon$ All data.

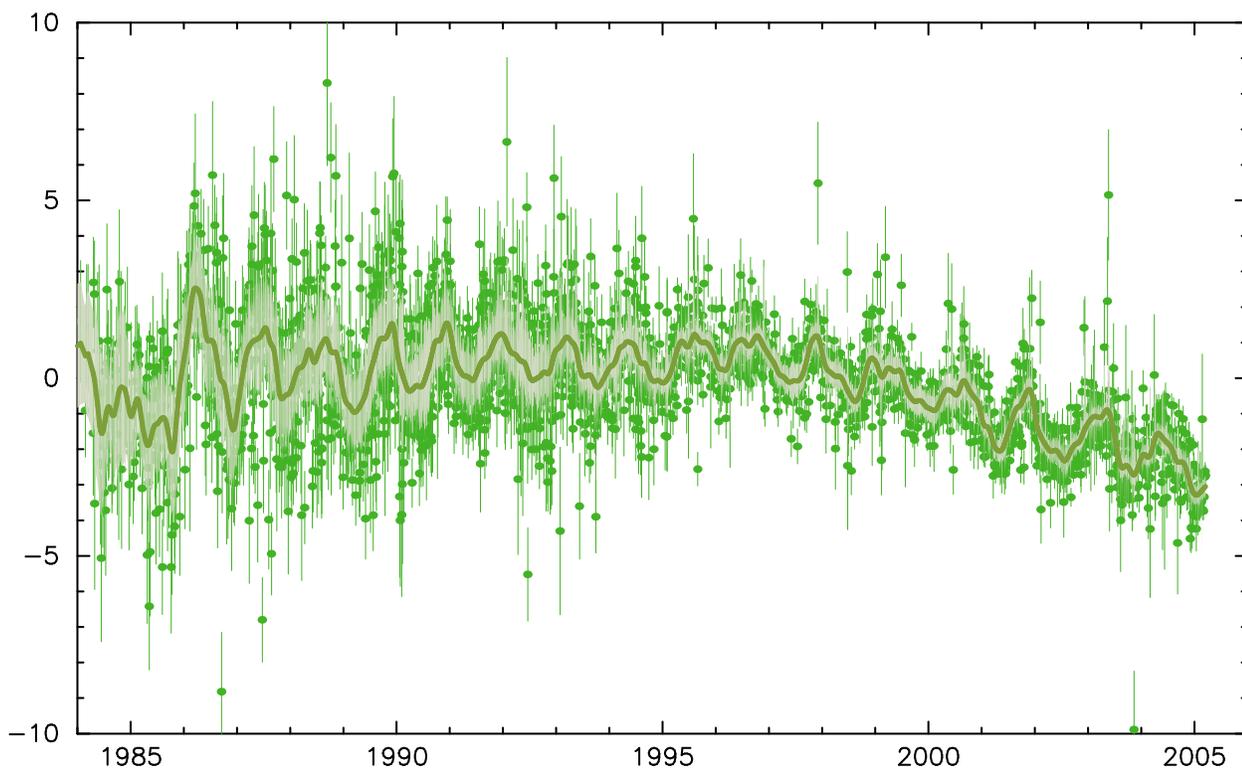


# Evolution of formal uncertainties of daily estimates of $\Delta\epsilon$ XA, XE data.

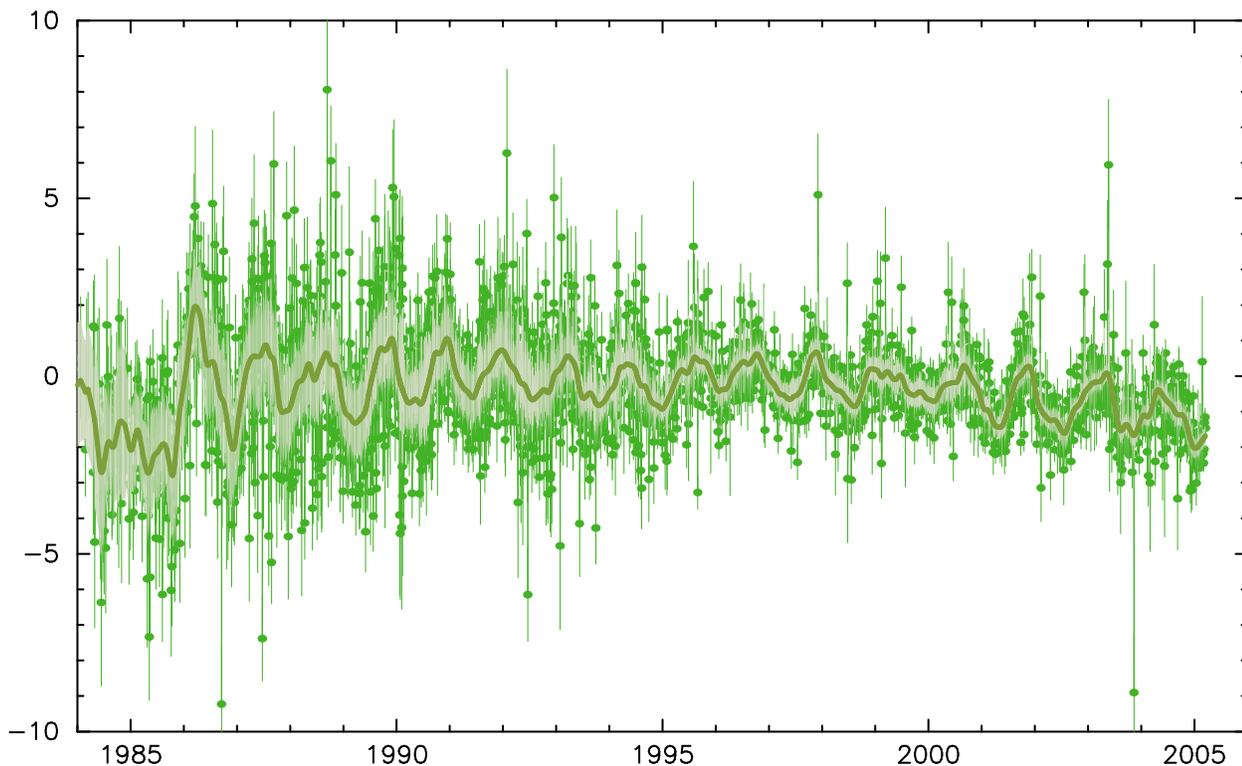


# Benchmark of VLBI precision: deviation of daily estimates of nutation angle $\Delta\epsilon$ from empirical nutation expansion.

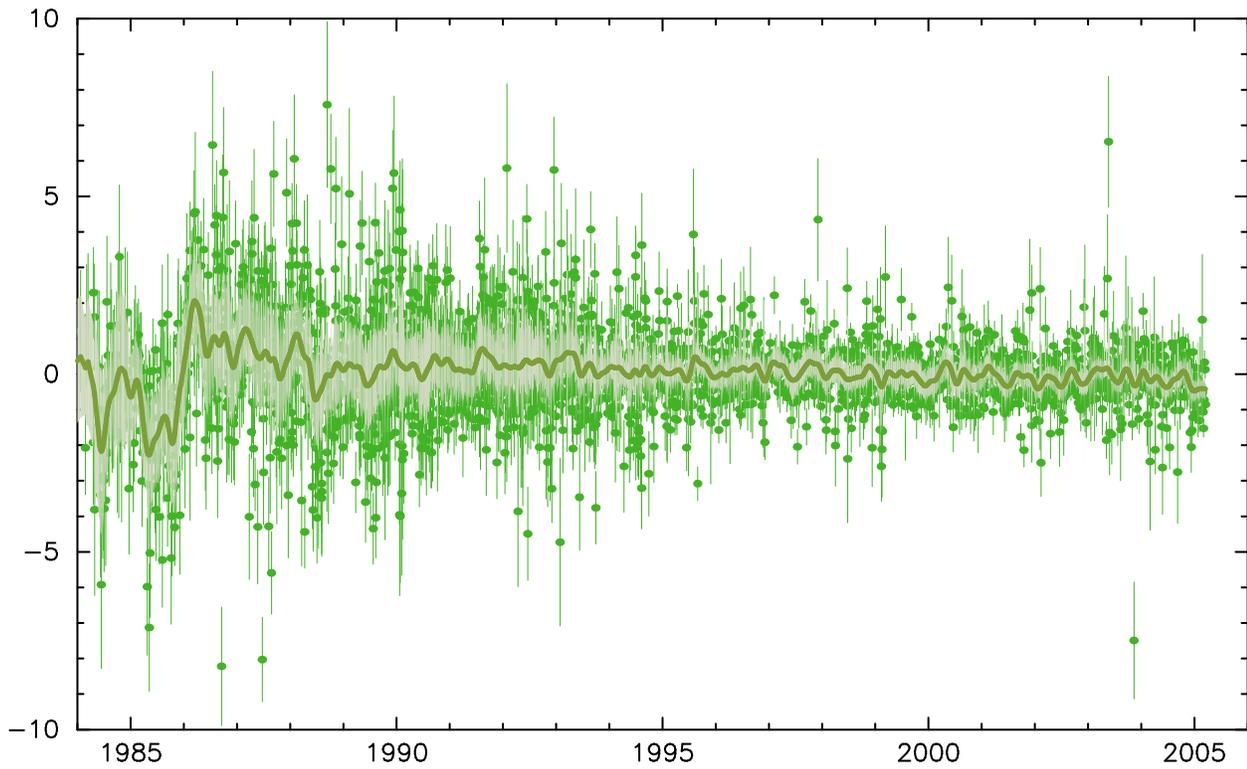
Differences: daily estimates of  $\Delta\epsilon$  versus IERS1996 in nrad.



Differences: daily estimates of  $\Delta\epsilon$  versus MHB2000 in nrad.



Differences: daily estimates of  $\Delta\epsilon$  versus heo\_05c in nrad.



WRMS of the deviation of daily estimates from the global model

Year	$\sigma$ nrad
1985–1987	1.80
1987–1989	1.68
1989–1991	1.15
1991–1993	0.83
1993–1995	0.70
1995–1997	0.56
1997–1999	0.49
1999–2001	0.45
2001–2003	0.46
2003–2005	0.47

# Can we move out of the plato of accuracy?

Before starting ...

- Are we perfect?
- Do we have courage to acknowledge that we do something not perfect (= inefficient, wrong)?
- Do we need to improve results? Is there a buyer?
- Do we have a will to improve results?
- Can we distinguish real problems from illusionary?
- Do we consider improvement of results as an priority goal?
- Do we have resources for that?
- Can we take a risk of possible missteps?
- Can we take resolve with other conflicting goals?

# Analysis of the problem

Improvement of data analysis ... technical aspect.

How it can be achieved?

- to use more data:
  1. raw data instead of pre-processed data, i.e. correlator output, AP-by-AP data, raw readings from the Field System.
  2. external data: f.e., pressure field from meteorological models, hydrology data, GRACE gravity field, etc.
- to use more sophisticated models of data reduction
- to use more sophisticated methods of parameter estimation
- to improve interface between the data and algorithms.

# Seeds of growth

## *List of unresolved problems:*

1. to overcome the gap between analysis made at the correctors and at the analysis centers. To use level 1 data in the process of estimation of end-user parameters.
  - to use fringe plots for problem diagnostics.
  - to resolve sub-ambiguities in a routine basis in similar was as group delay ambiguities.
  - to compute ionosphere contribution at the AP-by-AP basis.
  - to develop technology for dealing with the data with unequal amplitudes across the band (G-codes).
  - to develop LSQ methods for group delay refinement using fringe phases.
  - to develop methods for fringe phase reweighting when the group delay is computed.

Requires: [Level 1 data](#), interface to the level 2 software.

2. to calibrate the data for spurious signal in phase calibration.

Requires: [system temperature data](#)

3. to calibrate the data for polarization leakage.

Requires: [??](#)

4. to develop the model for contribution of source structure to group and phase delays.

Requires:

- [Level 1 VLBA data](http://gemini.gsfc.nasa.gov/raw_vlbi/vlba.html) **available** at VLBA site and at [http://gemini.gsfc.nasa.gov/raw\\_vlbi/vlba.html](http://gemini.gsfc.nasa.gov/raw_vlbi/vlba.html)
- [Level 2 digital VLBA source maps](#). Currently **available** on-line:
  - maps of 720 sources (Kovalaev)
  - maps of 120 sources (Pushkarev)
  - ??

5. to develop more robust methods for phase delay ambiguity resolution.

6. to develop methods for computation of the atmospheric path delay and its partial derivatives using numerical weather models:

- Regression methods (Niell, Boehm);
- Direct ray-tracing;

Requires: [Numerical weather models](#) **available at NCEP**.

7. to maintain fringe amplitude control.

Requires: [system temperature data](#), [source maps](#), [antenna gain measurements](#).

8. to develop estimation technique for dealing with non-linear site motion.