A Dense Global Velocity Field based on GNSS Observations: Preliminary Results

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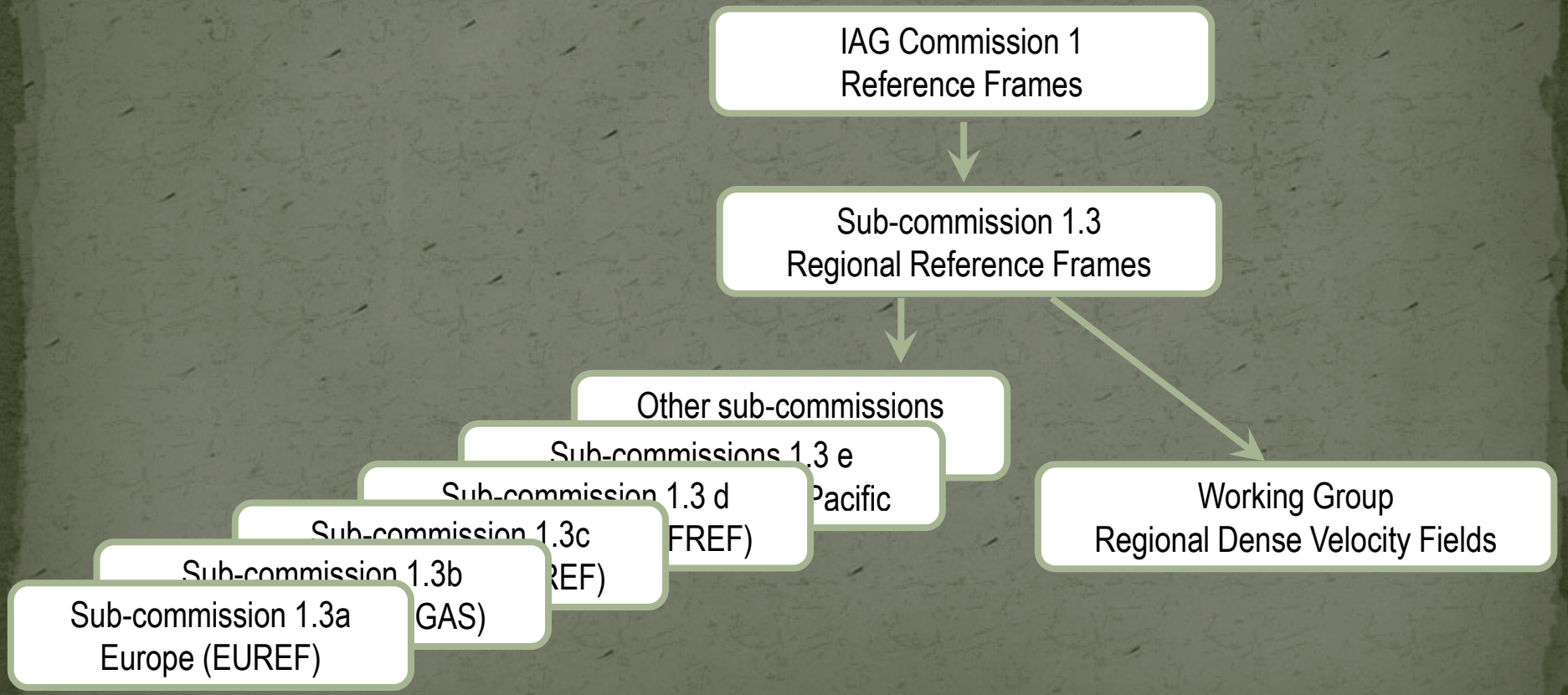
IAG 2009, Buenos Aires, Aug. 31- Sept. 4, 2009

IAG Working Group "Regional Dense Velocity Fields", 2007-2011

- Created at IUGG 2007 in Perugia



Objective

"To provide a globally referenced dense velocity field based on GNSS observations"

- Collect GNSS-based SINEX solutions and their meta-data,
- Define specifications and quality standards for the submitted SINEX solutions,
- Study the strengths and shortcomings of local/regional and continuous/epoch GNSS solutions to determine site velocities,
- Define optimal strategies for the combination of regional and global SINEX solutions,
- Provide the densification of the ITRF2005 (or its successor)

Workplan

2007-2009: Gather first experiences and learn lessons for future

- Set up initial strategy & submission guidelines
- Collect solutions (outreach, web site)
- First preliminary combination
- Conclusions & future steps

First results presented here…

2009-2011: Computation of dense velocity field

- Define new strategy & submission guidelines
- Collect solutions (outreach, web site)
- Dense velocity field
- Conclusions & future steps

Initial Strategy

Question 1

Role of regional sub-commissions (Africa, Antarctica, Asia&Pacific, EUREF, NAREF, and SIRGAS)?

- Take advantage of coordination role of sub-commissions within their region
- Region coordinators from regional sub-commission
  - Gather reliable velocity solutions from their own region
  - Combine these solutions with the sub-commission solutions to produce a regional combined velocity solution
  - Meta-data management & outlier detection done at regional level
- Combination coordinators
  - Combine the regional velocity solutions and global solutions at tie them to ITRFyy

World Regions

Region and Combination Coordinators

Region coordinators

- Africa: R. Fernandes & L. Combrink
- Antarctica: R. Dietrich
- Asia & Pacific: J. Dawson
- Europe: A. Kenyeres
- North America: M. Craymer
- Latin America & Caribbean: L. Sánchez

Combination coordinators

- D. Lavallée
- T. Herring

Initial Strategy — Question 2

Role of GNSS campaigns ?

- Precision of estimated velocities
  - Influence of periodic signals
  - Marker instability and antenna offsets
- A lot of information !
  - Include them, but under certain conditions → guidelines

Initial Strategy

Question 3

Stack weekly regional and global SINEX to compute velocities

or

Combine cumulative regional and global (position + velocity) SINEX?

- Many velocity solutions without access to weekly SINEX
- Allows to combine if necessary only velocities (without the coordinates)
- Step-wise combination of global and regional solutions
- But:
  - No coordinate time series available to the WG
  - Need to have a consistent handling of discontinuities, especially on frame-attachment sites

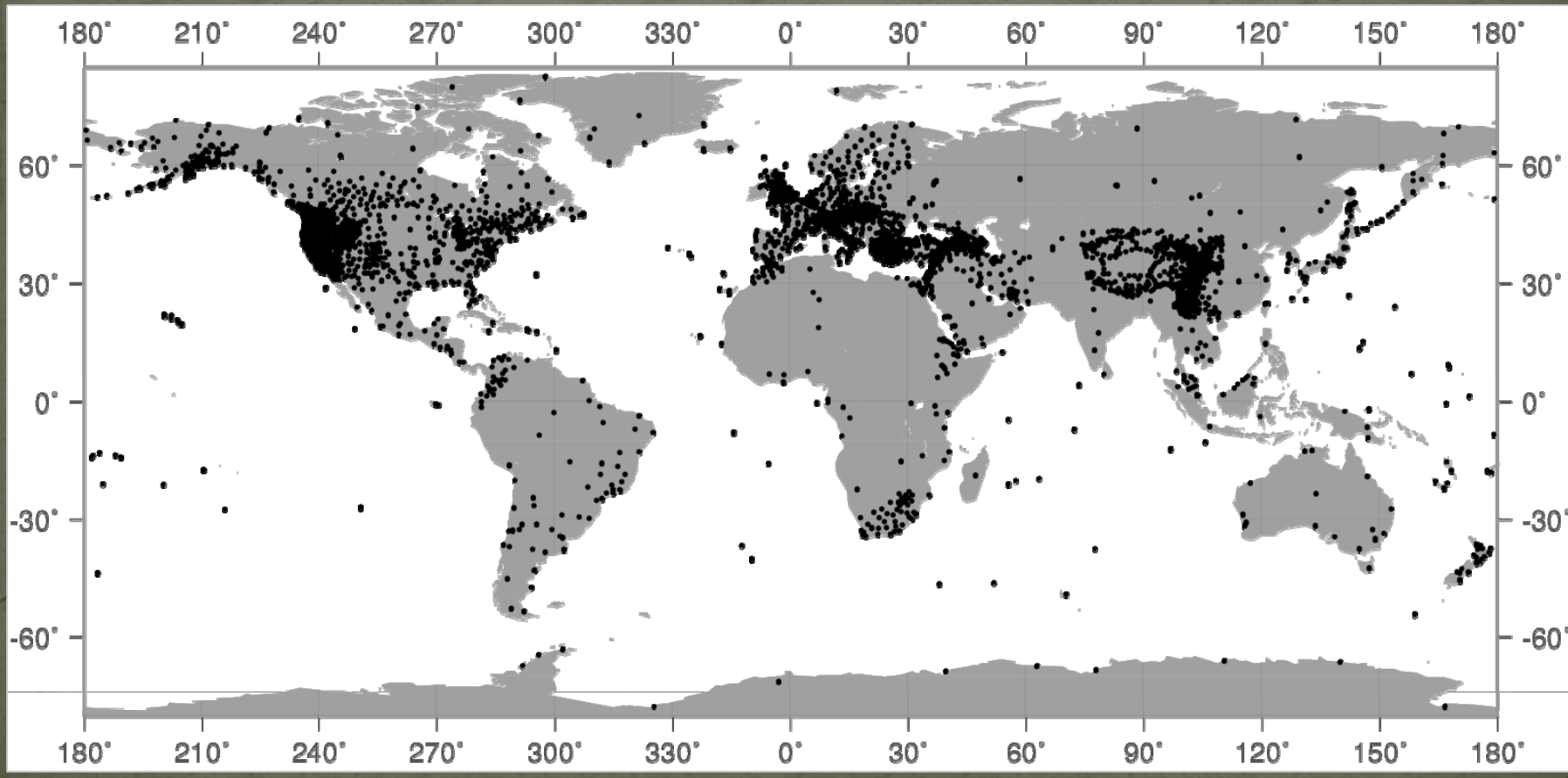
Submission Guidelines

Not too strict to allow inclusion of a maximum number of solutions

- Minimum 2 years of continuous data or 2 campaign epochs over a 4 year period
- Minimum 2,5 years of data if significant seasonal signals
- Velocity constraints should be minimal or removable
- Significant number of “frame-attachment” sites (> 5 years)
- Discontinuities identical to the ones used by the IGS
- SINEX format

Call for Participation Issued Nov. 2008

About 6000 sites proposed to the WG



Received so far

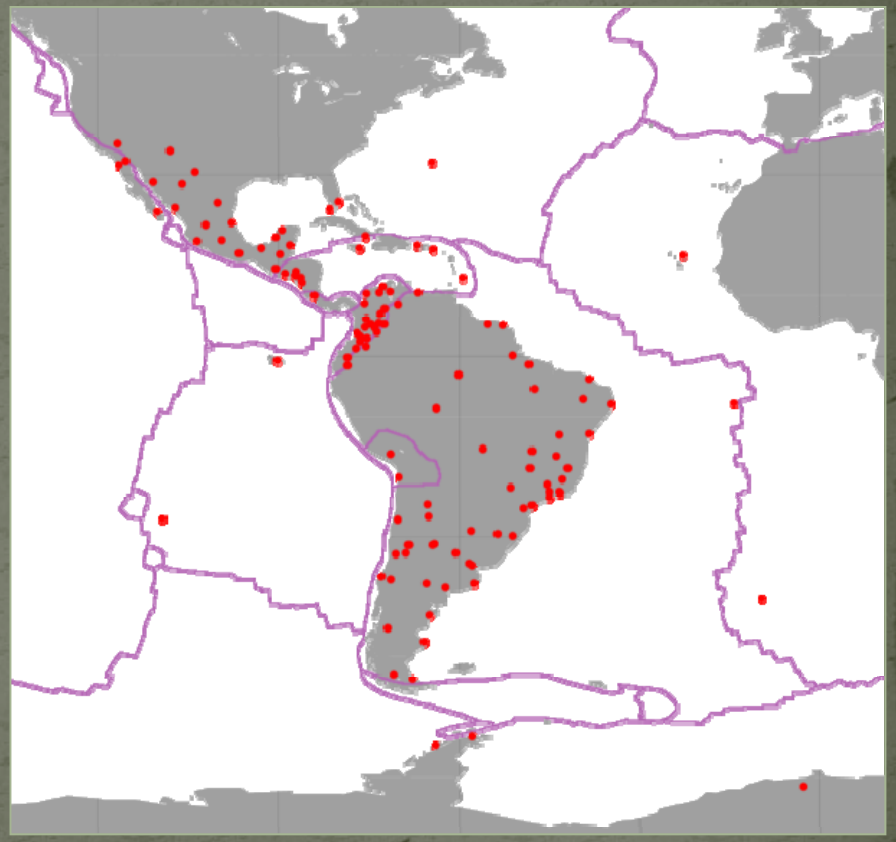
- Regional networks
  - Africa, Europe, Latin America & Caribbean, Asia & South Pacific
  - North America: solution not ready in time
  - Antarctica: solution expected for end 2009
- Global network
  - ULR

Latin America & Caribbean

Bernese 5.0 - 120 stations

Full SINEX:

Reprocessed SIRGAS (00-'09)

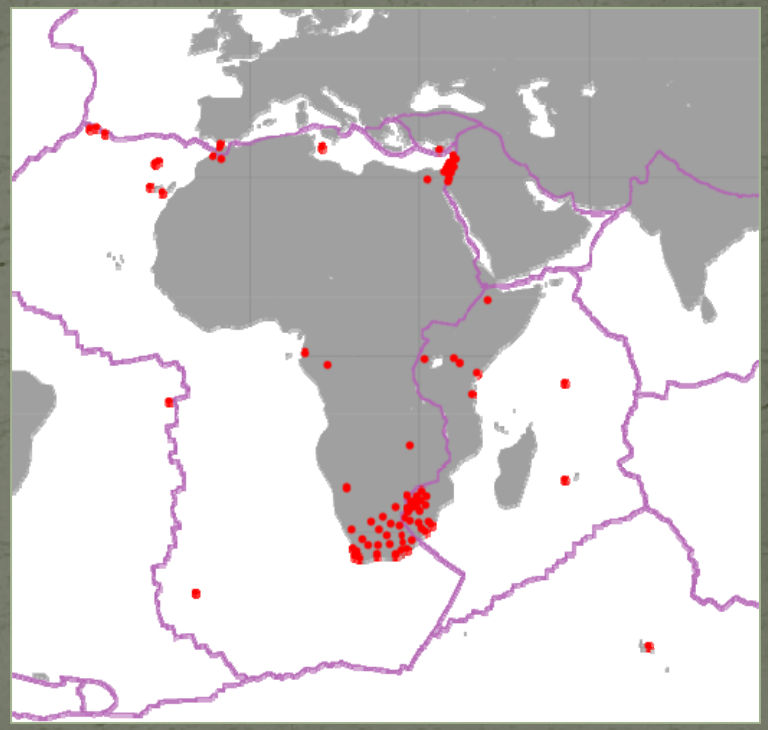


Africa

GIPSY - 93 stations

Full SINEX:

CGPS (‘96-’09)



Asia & Pacific

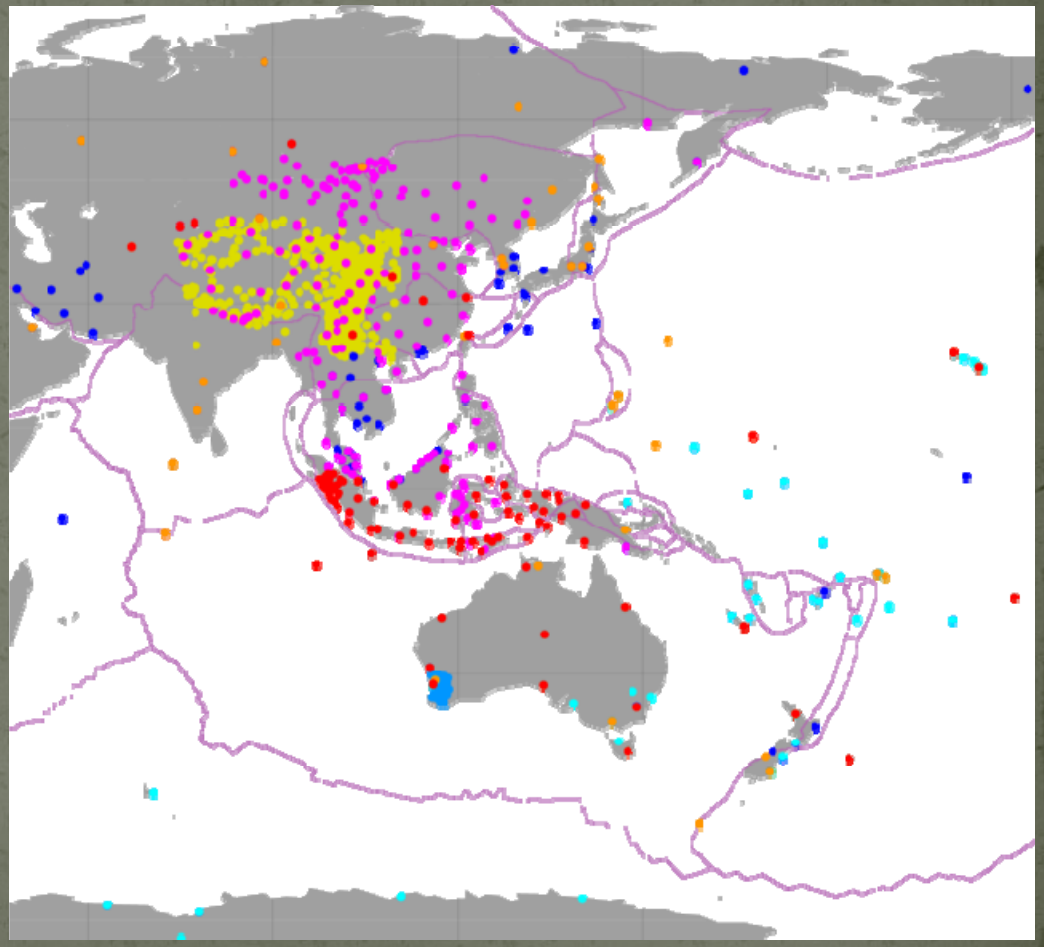
CATREF - 1156 stations

Full SINEX:

PCGIAP (‘97-’06) – camp,
SW Austr. seism. zone (‘02-’06) – camp,
GeoScience Australia
TIGA (‘97-’09)

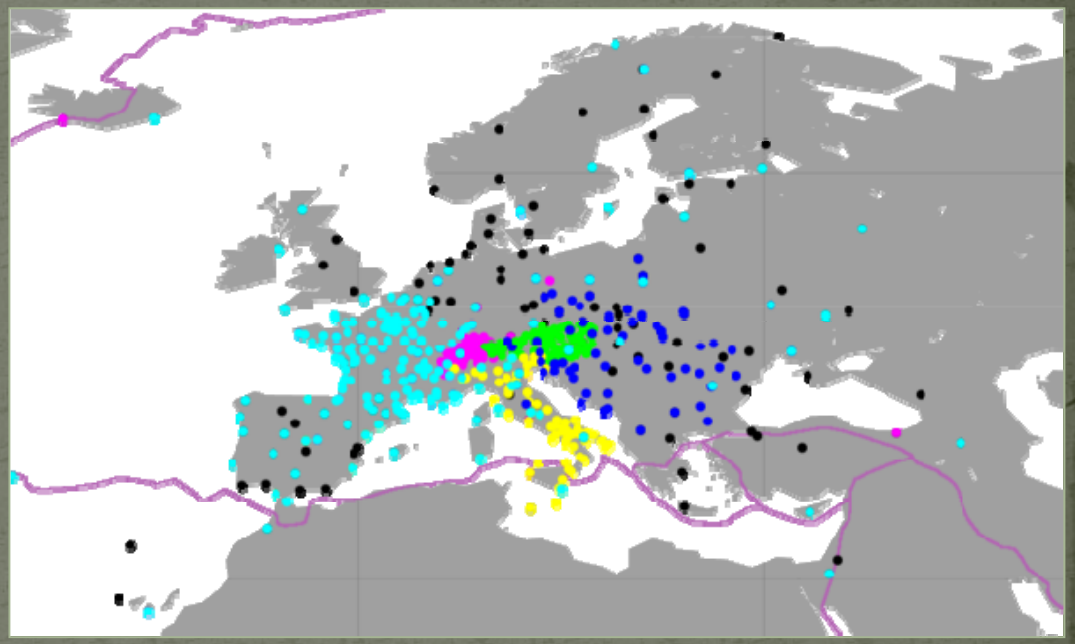
Velocity only:

Tibet (‘98-’04), Asia (‘94-04), Global (‘95-’07), Indonesia (‘91-’01)



Europe

CATREF - 525 stations



Full SINEX:

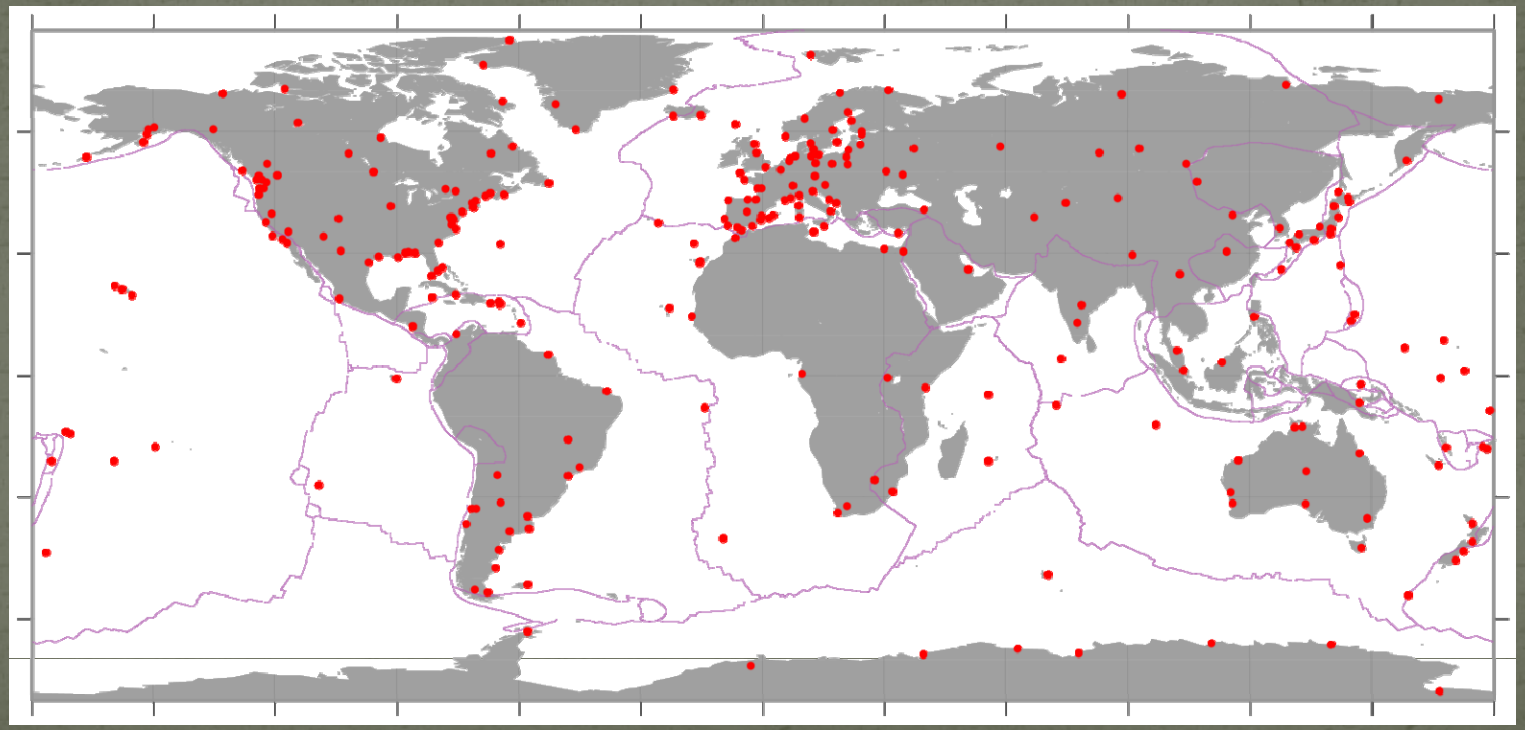
- Reprocessed EPN ('96-'09)
- AGNES ('98-09')
- AMON ('01-'09)
- ASI ('97-'09)
- IGN ('98-'09)
- CEGRN ('94-'07) - camp

Received, but not yet included: BKG, INGV, Nardo

Global - ULR

CATREF - 274 stations

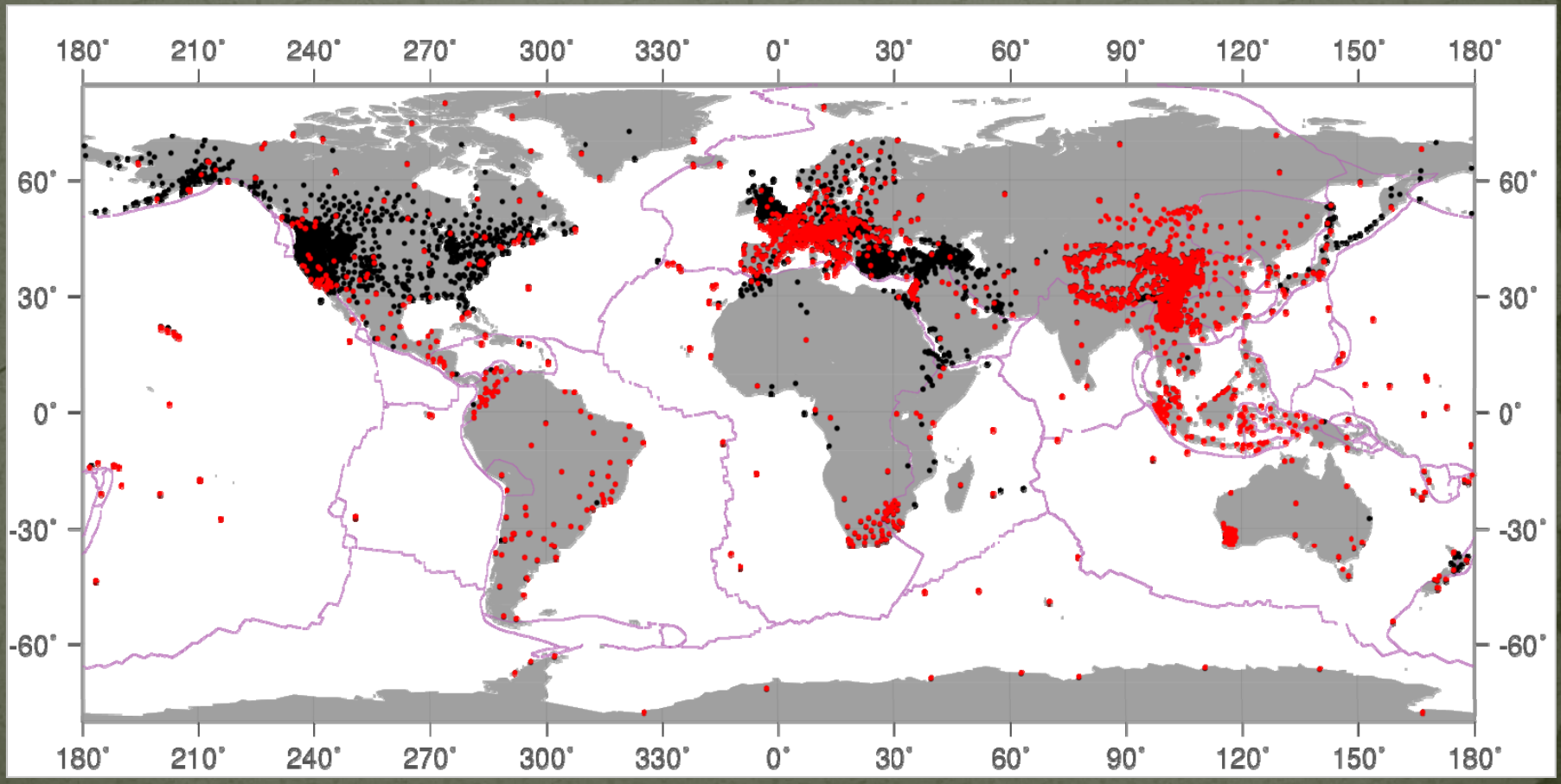
‘95-’08



Promised versus received/used

Promised

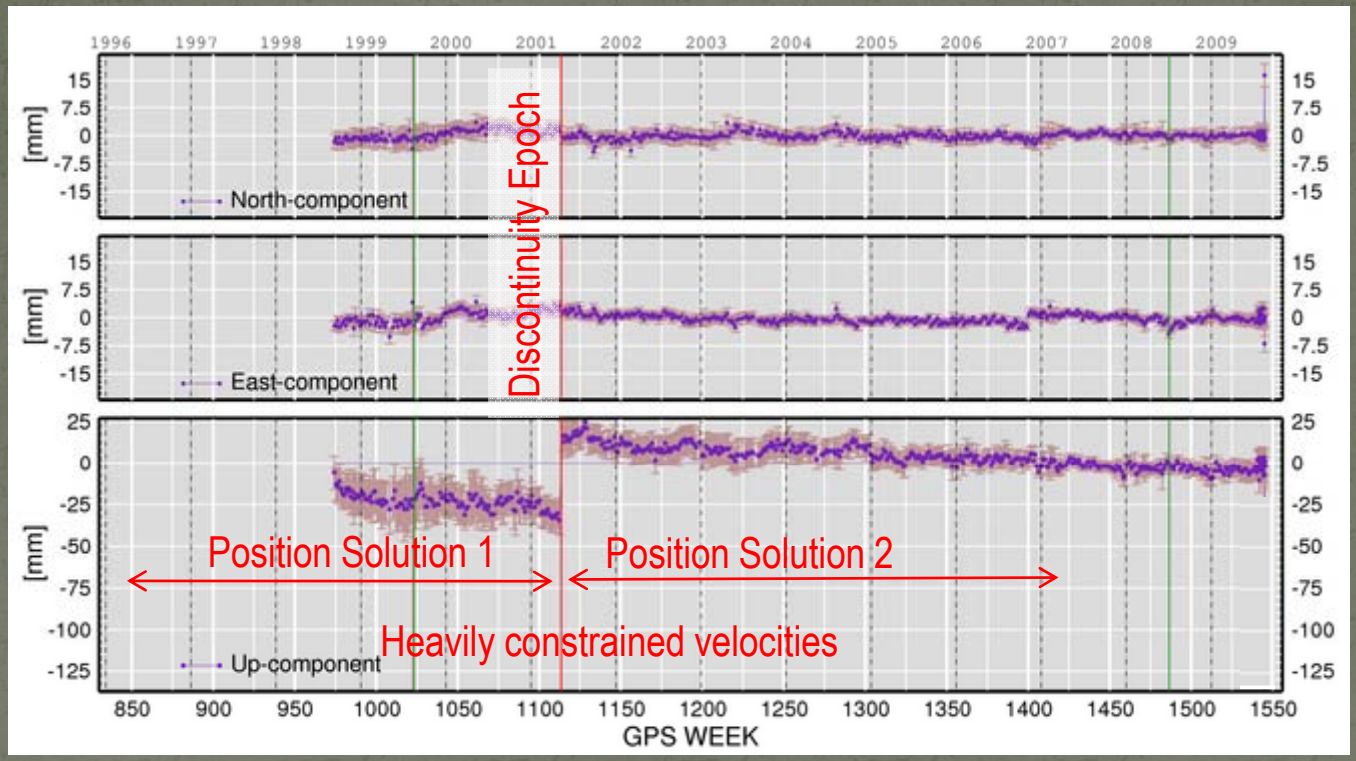
Received and included in this excercise



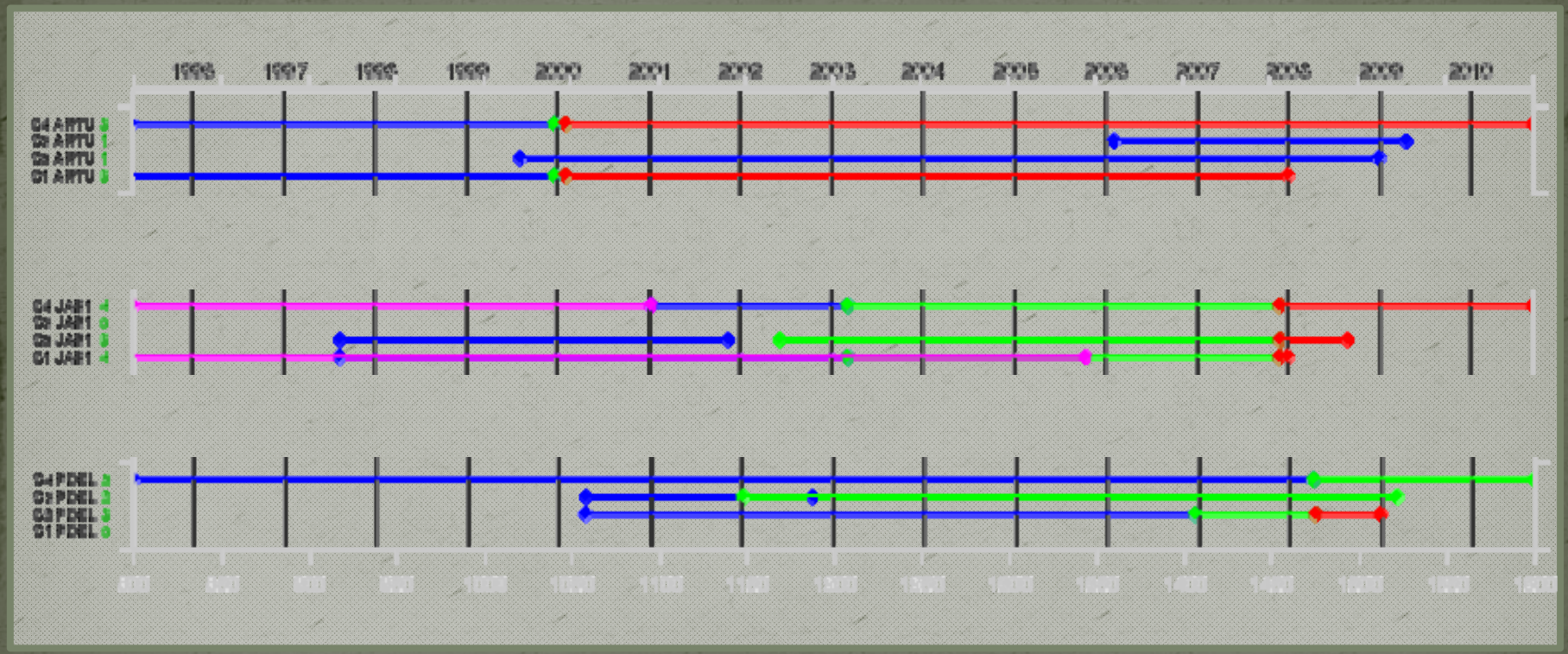
Problems Encountered during Combination

- Need to recognize identical stations when doing the combination
  - Inconsistent station naming and DOMES numbers
  - Duplicate station names, missing DOMES numbers
- Inclusion of young or low quality sites → eliminated during regional combination
- Numerical instabilities due to equating (or heavily constraining) of velocities before and after a position jump
- Inconsistent handling of the solution numbers and discontinuity epochs

Discontinuity Epochs & Solution Numbers



Comparison with IGS Solution Numbers



How did we deal with these problems?

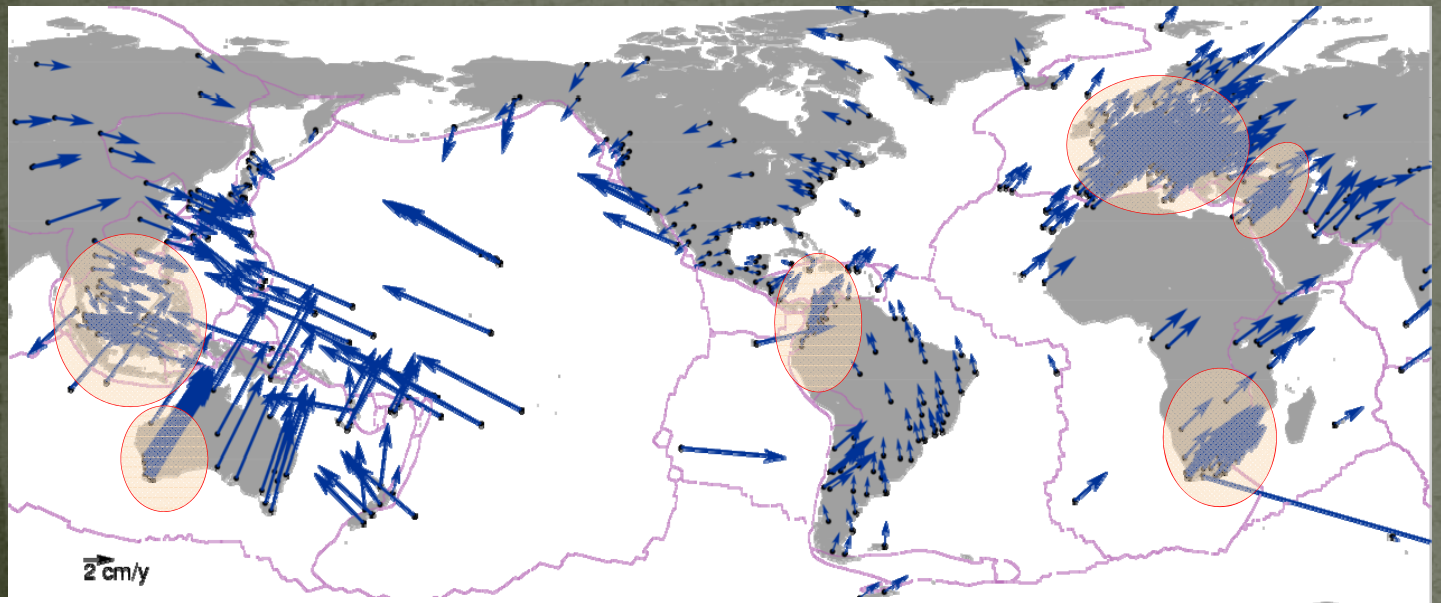
- First attempt to set up WG data base for site discontinuity epochs and solution numbers
  - BUT: not ready to be used at this point
- WG data base for confirmed DOMES numbers, including virtual DOMES numbers
  - Basis: IERS DOMES number list
    - Missing (IGS) stations, typos, duplicate DOMES numbers
  - Iterations with coordinators and ITRF technique center
    - Updated IERS DOMES number list is under preparation
- Problems are NOT solved at all !

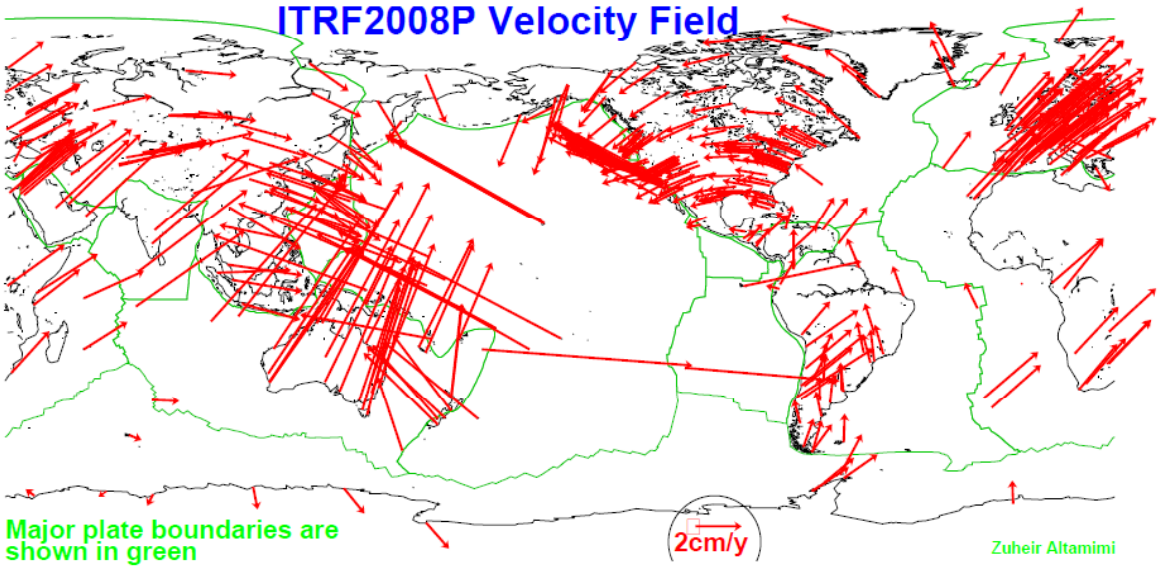
Combination

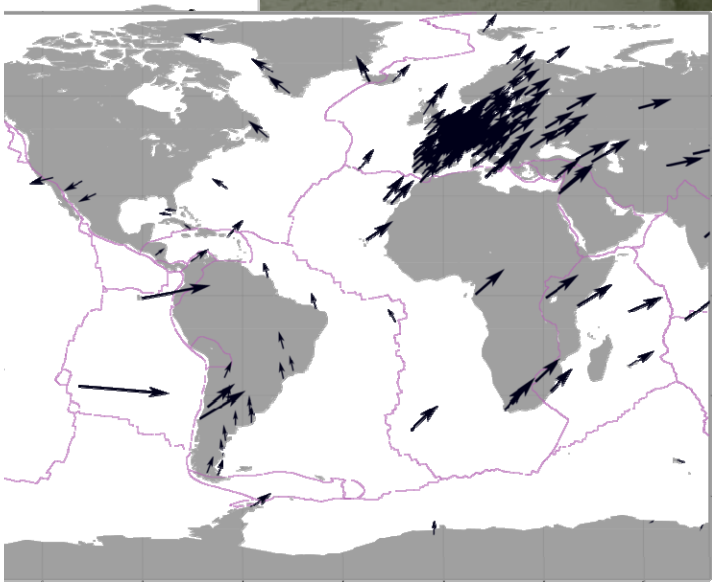
Two different approaches:

- Combination of solutions using weight factors
- Regional networks attached to global network (ULR) without perturbing global network (Davies & Blewitt, JGR, 2000)
  - Can be used later to densify the ITRF2008 without altering it

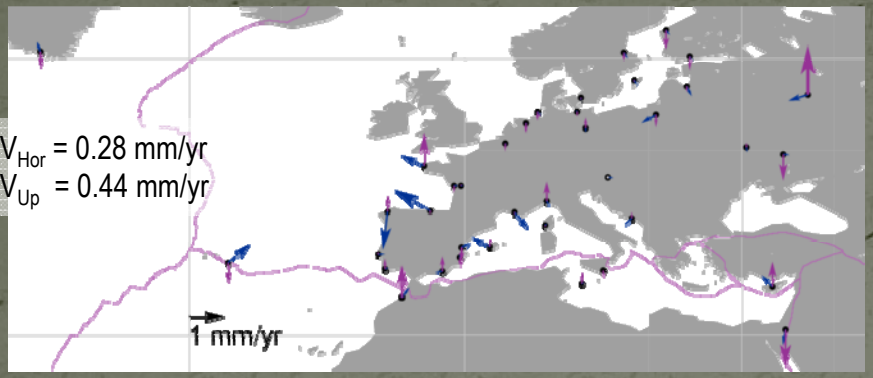
The Velocities so far

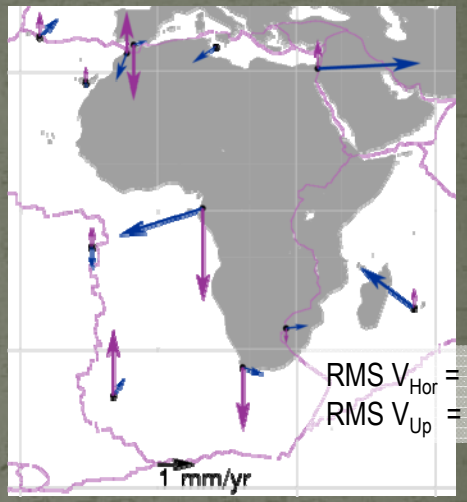


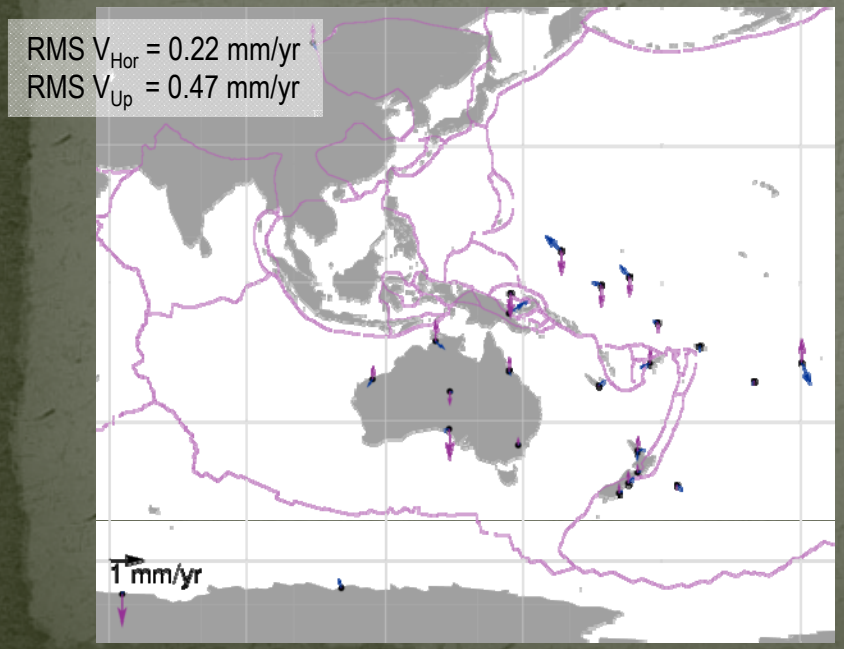




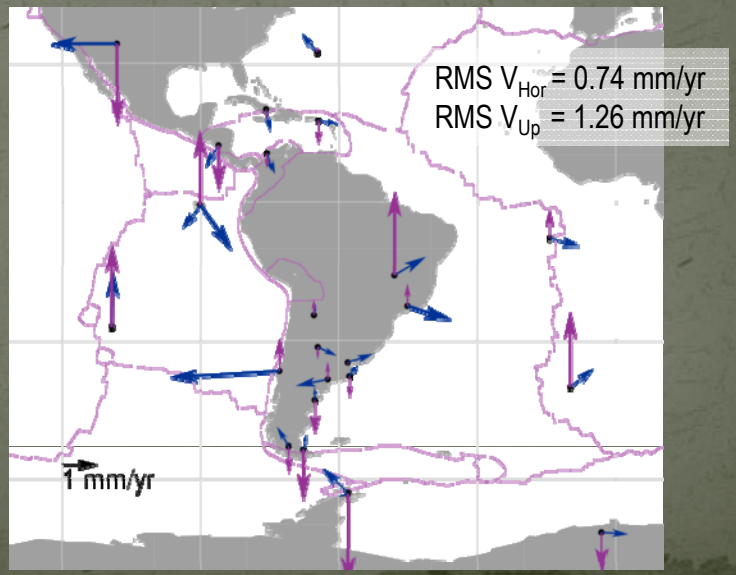
Agreement of Velocity Solutions wrt ULR







V_{Hor}
V_{Up}



Lessons Learned and Future Steps

- Need find a way to have a common discontinuity file for all ITRF and IGS activities involving participation/agreement by all groups
  - WG will need to set up procedure to deal with this (2009-2010)
- Education/outreach
  - Gather more velocity solutions
  - Importance of usage of COMMON discontinuity epochs and solution numbers for ALL networks
- 2010-2011
  - New strategy, guidelines and combined velocity solution

More Information http://www.epncb.oma.be/IAG/

iagwg@oma.be

Working Group on Regional Dense Velocity Fields, 2007-2011

International Association of Geodesy
Subcommission 1.3 on Regional Reference Frames

Guidelines

Jul 10, 2009

The following contains the guidelines for solutions submitted to the Working Group.

INSTRUCTIONS

- Check the submission guidelines (see below)
- Upload the solution to ftp://omaftp.oma.be/incoming/astro/Bruyninx.C/WG_DENSE_VELOCITY_FIELDS/ in the subdirectory referring to the region of the solution
- Notify the region coordinator and iagwg@oma.be by email. Include in your email references to papers/presentations acknowledging the authors of the solution.

SUBMISSION GUIDELINES

Analysists wishing to contribute to the WG are recommended to follow the submission guidelines.

The submission should at least contain the following files:

- Estimated station coordinates and velocities, in SINEX format. Use the SINEX format checker.
- List of discontinuities (solution numbers), in SINEX format. More details are given below.
- A text file with a short description of the solution, including the method (and software) used to compute it. For combined solutions, add a description of the solutions used to generate the combined solution.

EPOCHS OF DISCONTINUITIES

Acknowledgements

AFRICA

AFREF: Fernandes R.M.S., Kamamya C.M., Farah H., Hunja E. W., Combrink, A.Z.A., Combrinck L., and Miranda J.M.

MON: Haslinger C., Krauss S. , Stangl G.

NORTH AMERICA

calais_nov06: Calais E., Han J.Y., DeMets C., and Nocquet J.M.

NAREF: Craymer M., Piraszewski M., and Henton J.

PBO: Plate Bounderary Observatory, http://pboweb.unavco.org

PNW: McCaffrey et al.

SCEC CMM 4.0: Shen et al.

EUROPE

AMON: Stangl G.

AGNES: Brockmann E.

ASI: Ferraro L.

BELG: Bruyninx C.

BIFROST: Lidberg M., Johansson J. M., and Scherneck H-G

BKG: P. Franke

CEGRN: CEGRN Consortium, http://www.fomi.hu/CEGRN/default.htm

EPN_MUT: Figurski M.

EUREF: EUREF Permanent Network, http://epncb.oma.be/

EMED: Bendick, R., McClusky S., Bilham R., Asfaw L., and Klemper S

Greece: Rontogianni S., Clarke P. J., King M. , Lavallée D.A., England P., Parsons B., and Floyd M

HUN: Kenyeres A.

IGN: Harmel A., Garayt B.

INGV: Devoti R.

SK: Droscak B.

UK: Teferle N.

LATIC AMERICA & CARIBBEAN

SIRGAS: SIRGAS, http://www.sirgas.com/, Seemüller W., Krügel M., and Sánchez L.

ASIA-PACIFIC

Asia: Calais E., Dong L., Wang M., Shen Z., Vergnolle M.

GEOSCIENCE AUSTRALIA TIGA: Jia M.

Global: Kogan M.G., Steblov G.M.

PCGIAP: Dawson J., Hu G.

Indonesia: Bock Y., Prawirodirdjo L., Genrich J.F., Stevens C;W., McCaffrey R., Subarya C., Puntodewo S.S.O., Calais E.

SW Australia seismic zone: Dawson J., Hu G.

SW China: Chen, Z., Burchfiel B.C., Liu Y., King R.W., Royden L.H., Tang W., Wang E., Zhao J., and Zhang X.

Tibet: Shen ZK, Niu Z. Wang M., Wan Y., Zhou D. Cheng J.

GLOBAL

URL4TIGA: Wöppelmann G., Martin Miguez B., Bouin M-N, and Altamimi Z.

COAST: King M.

Solutions included in the test presented today.

Solutions included in the future (we hope).