Development of deformation models to support Dynamic and semi-dynamic Datums

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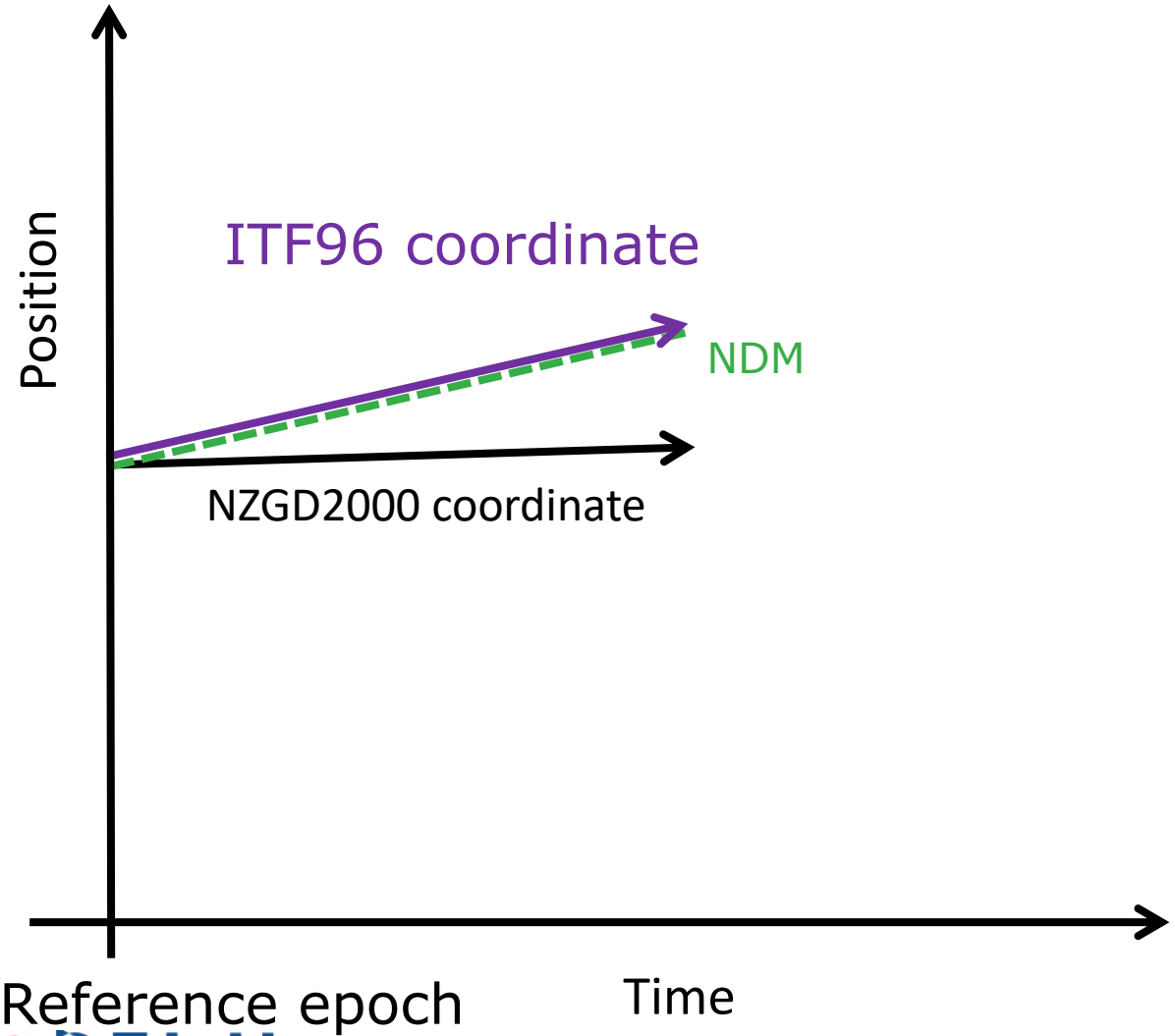
Deformation Models

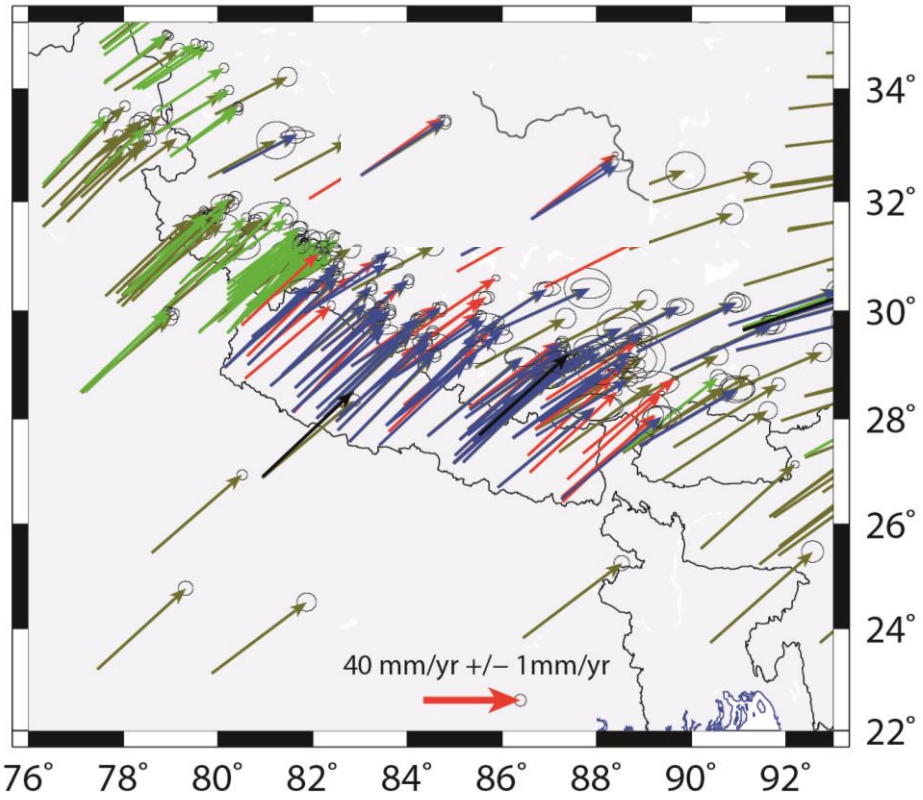
- Models of the secular or inter-seismic velocity field
  - Assumed to be constant
  - Grid containing Ve, Vn and possibly Vu
- Patches or displacement grids for significant earthquakes that have effected the area in question
  - Grid file containing De, Dn and Du
- Possibly models of post seismic relaxation
  - Grid of coefficients for exponential decay functions

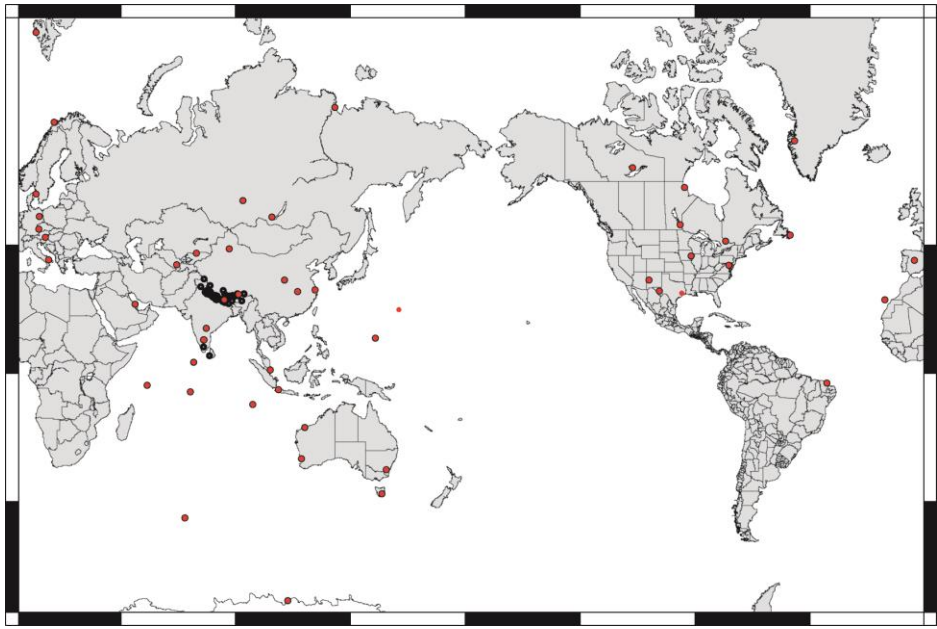
Secular deformation



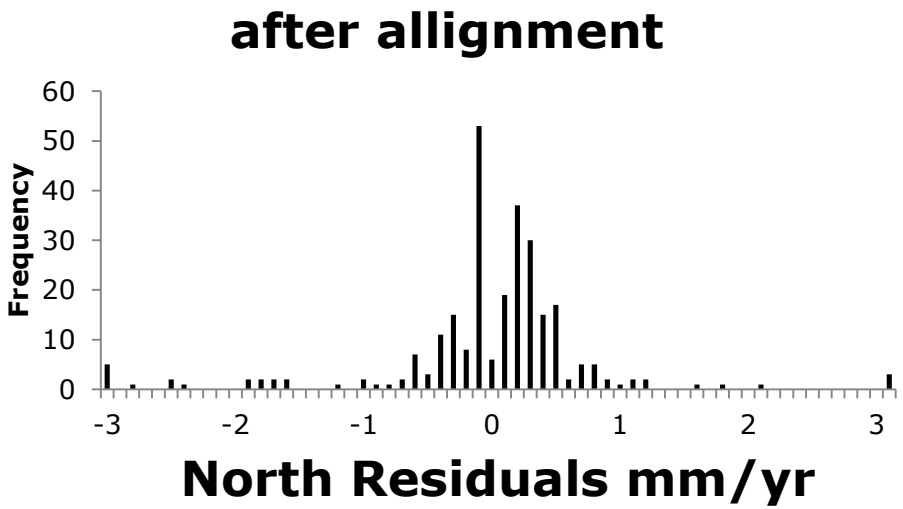
Secular velocity field

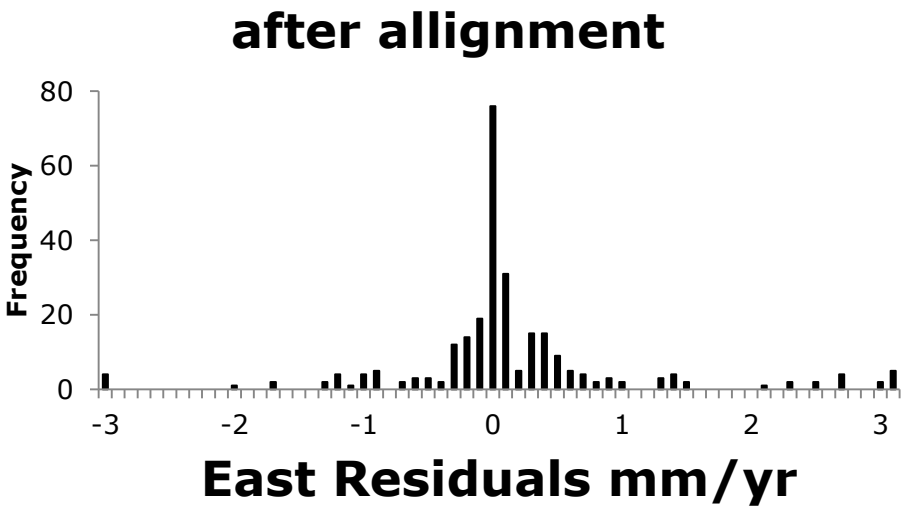
- Velocity from four recent studies were aligned with the ITRF2014 velocities
- The combined velocity field was used to produce a grid file with a density of 20 points/degree

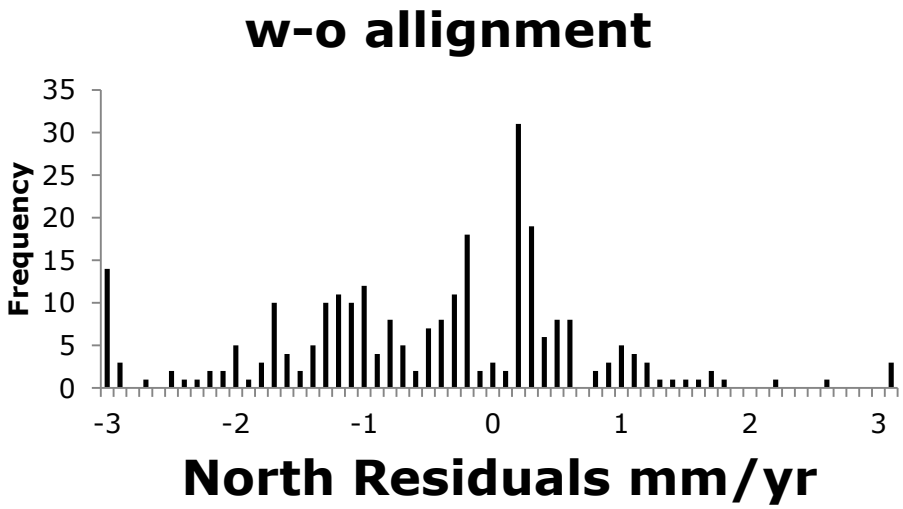


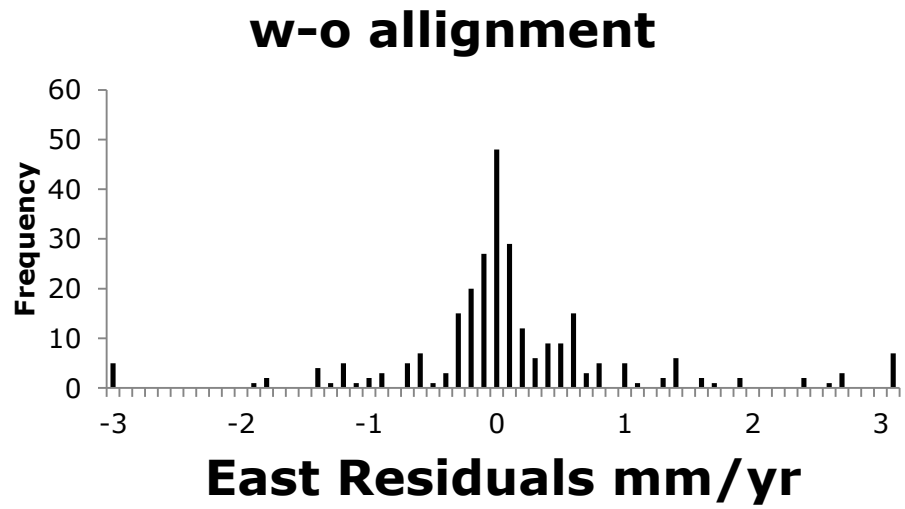


Residuals from alignment









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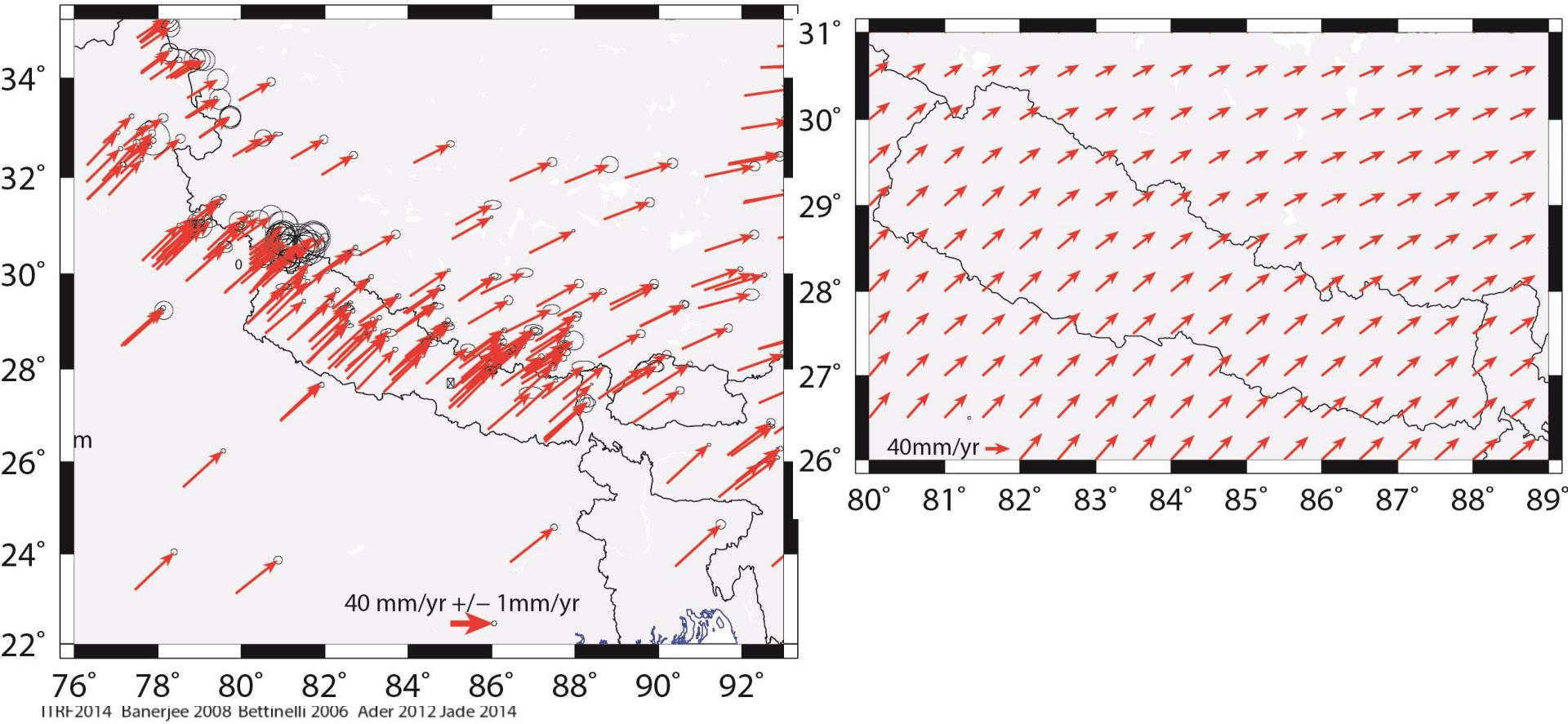
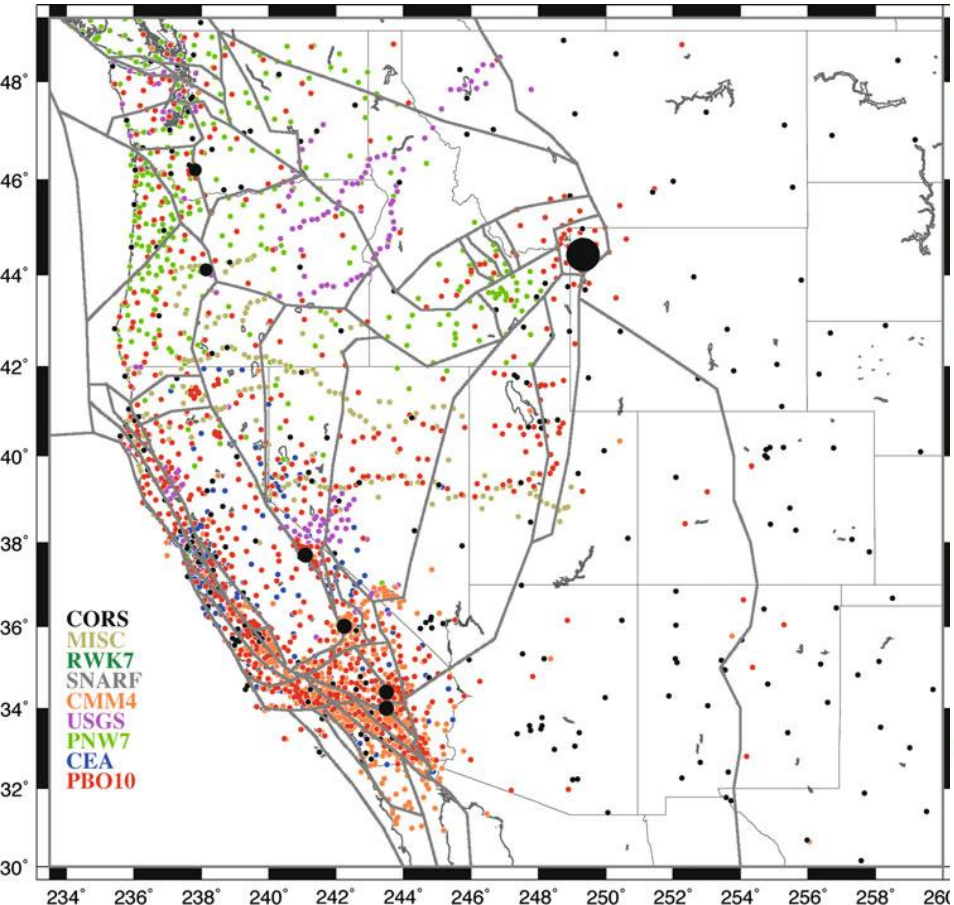
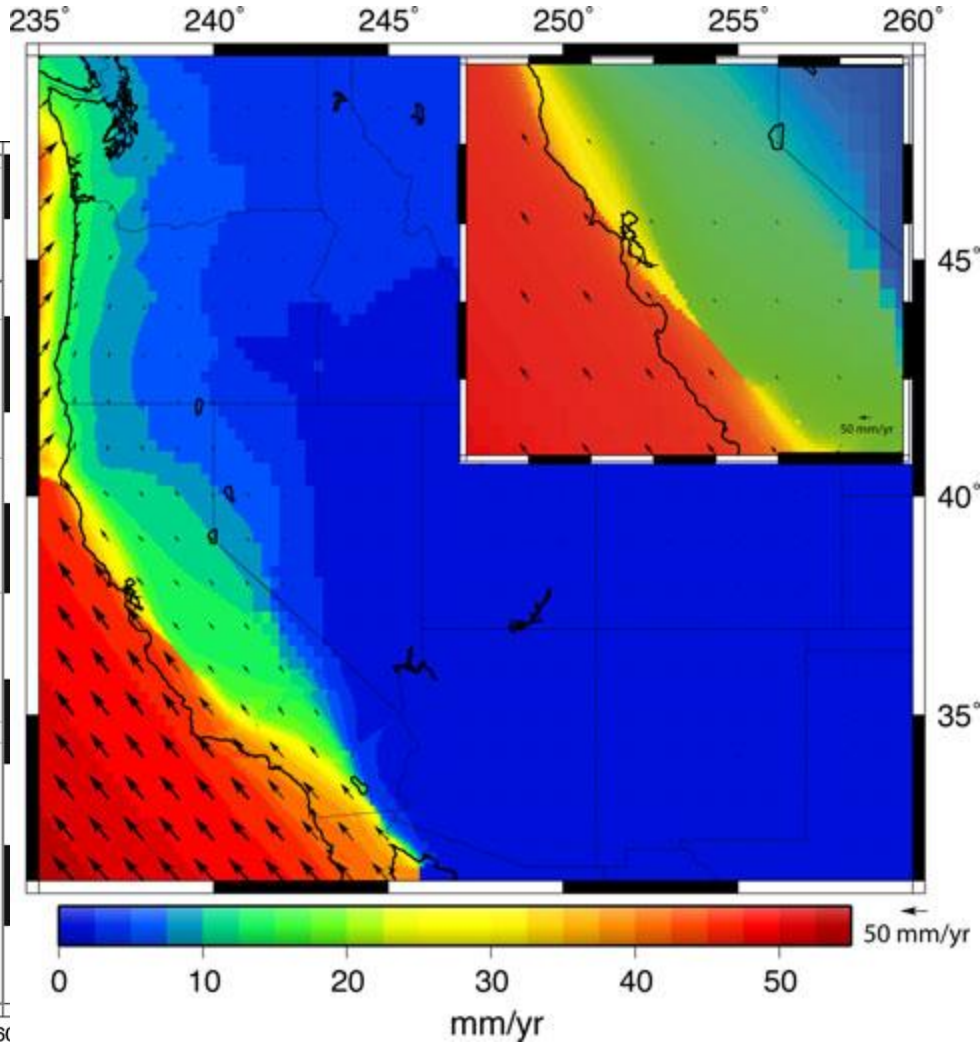


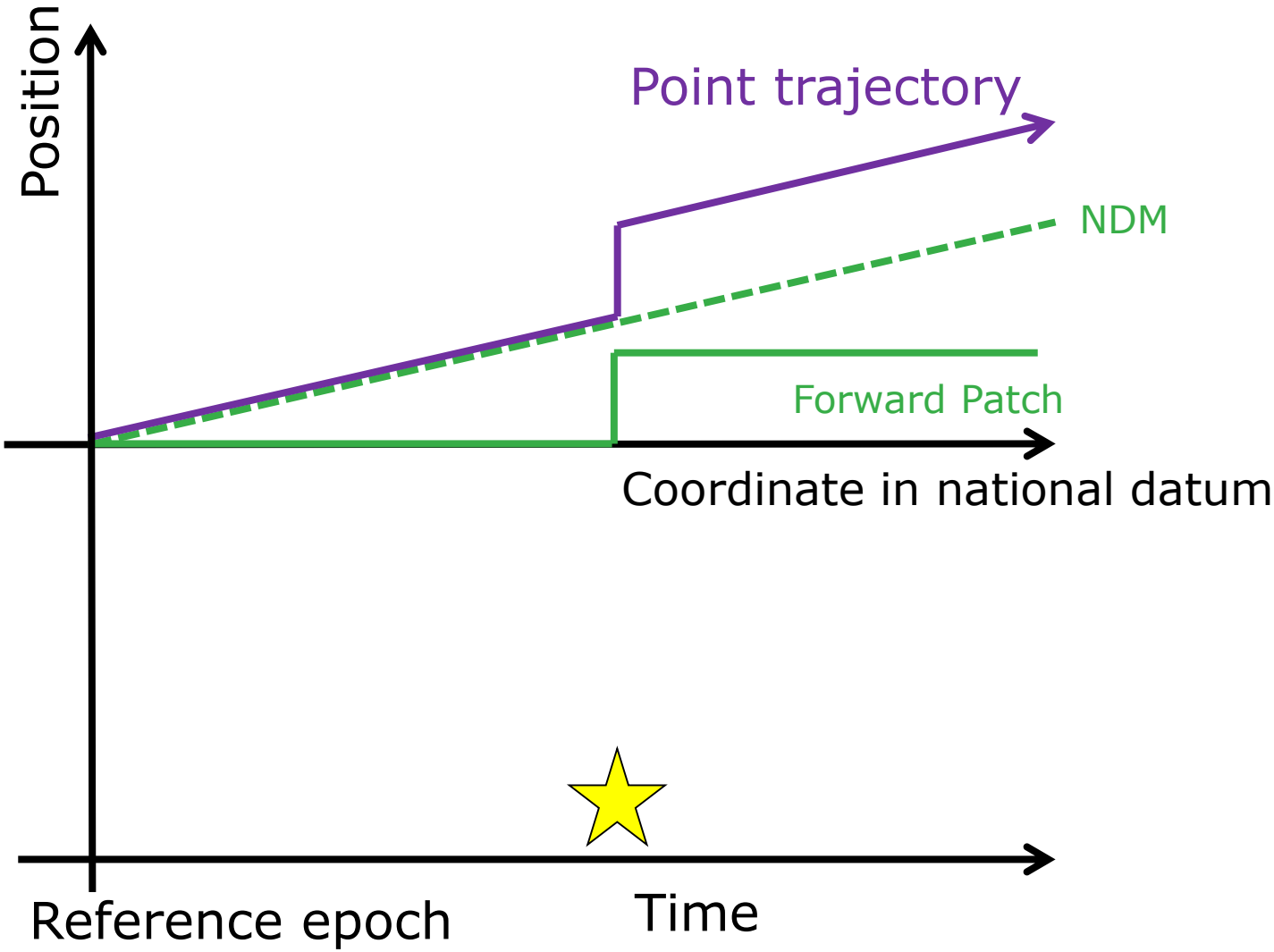
Block models

- Block models can be used to develop velocity grids
- Useful where measured velocities are sparse or velocity field is rapidly changing



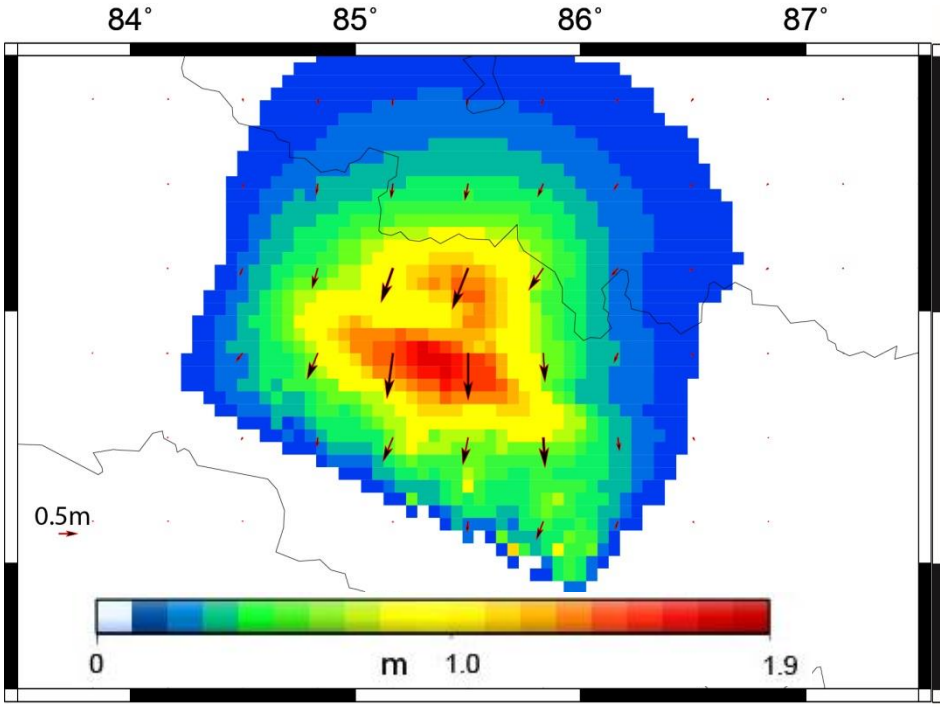


“Forward” patch

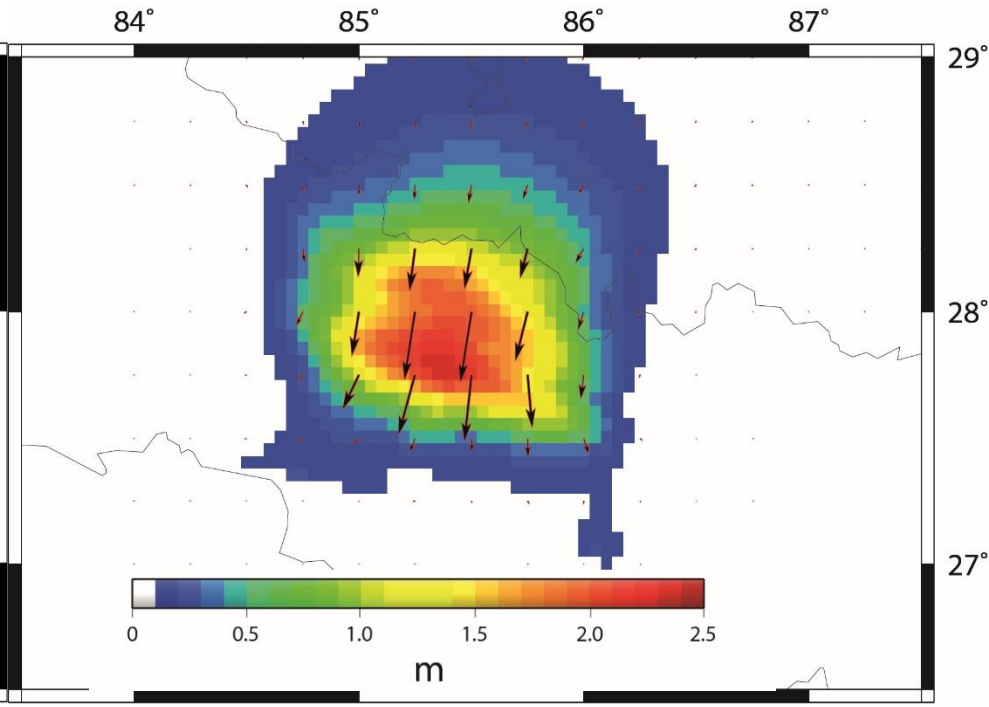


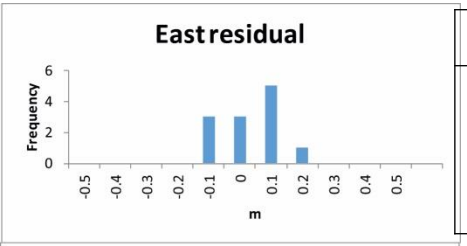
Two possible models for Gorka Earthquake

Galetzka et al. 2015 (JPL)

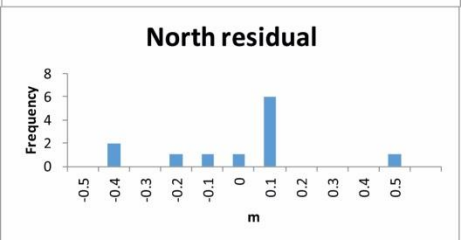


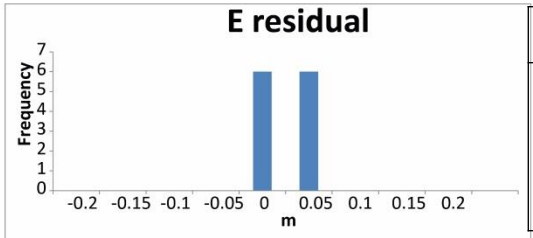
Wang et al in prep (SOPAC)



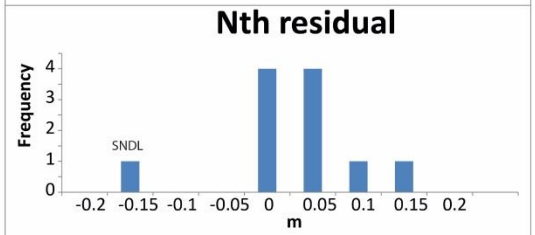


RMS	Galetzka
E m	0.21
N m	0.11
U m	0.08



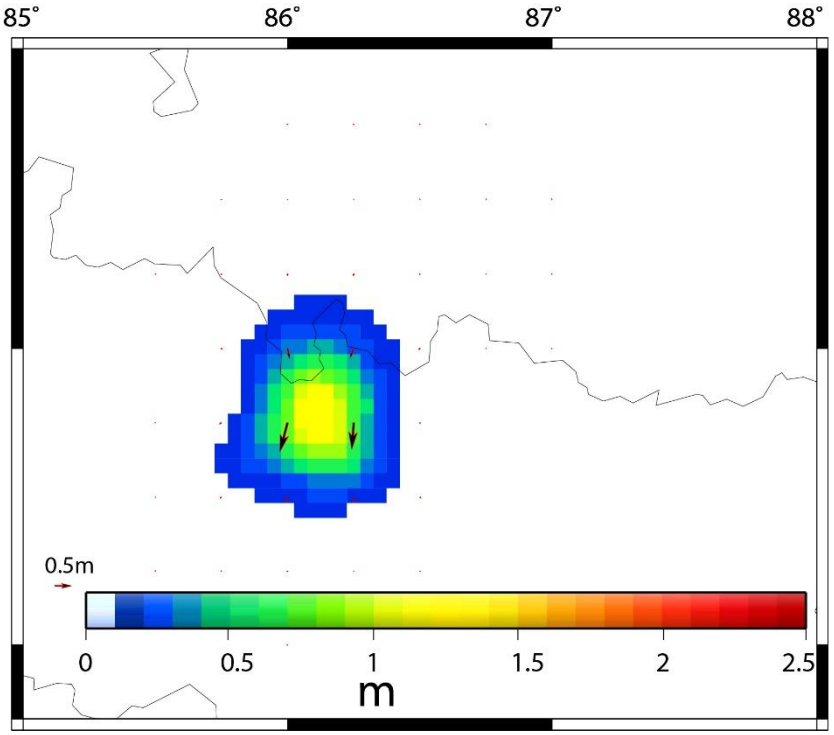


RMS	Wang
E m	0.07
N m	0.02
U m	0.03

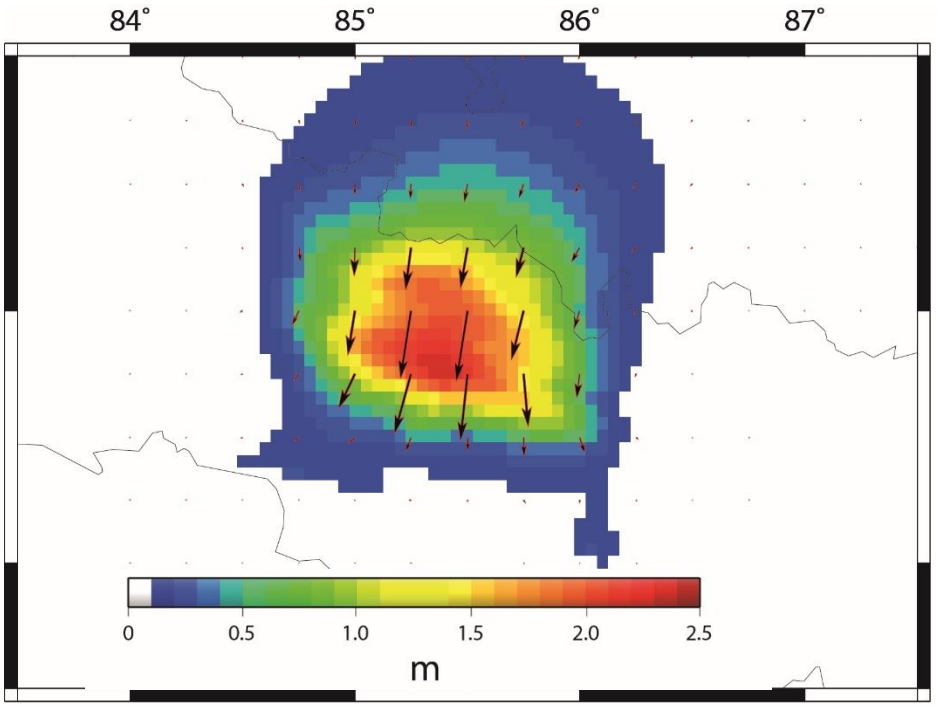


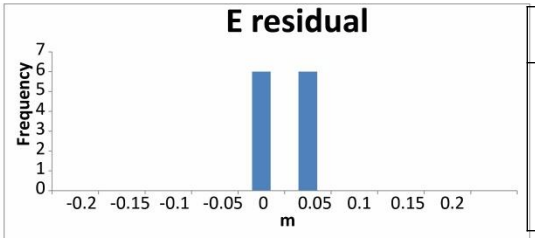
models for 2015 Earthquake & aftershock

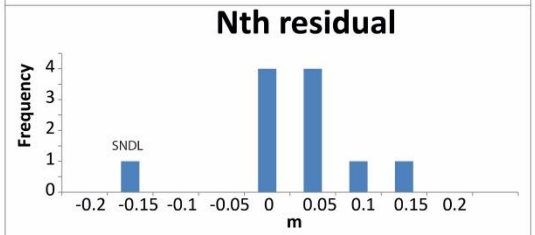
May 15 afteshock



April 2015 Gorka Earthquake







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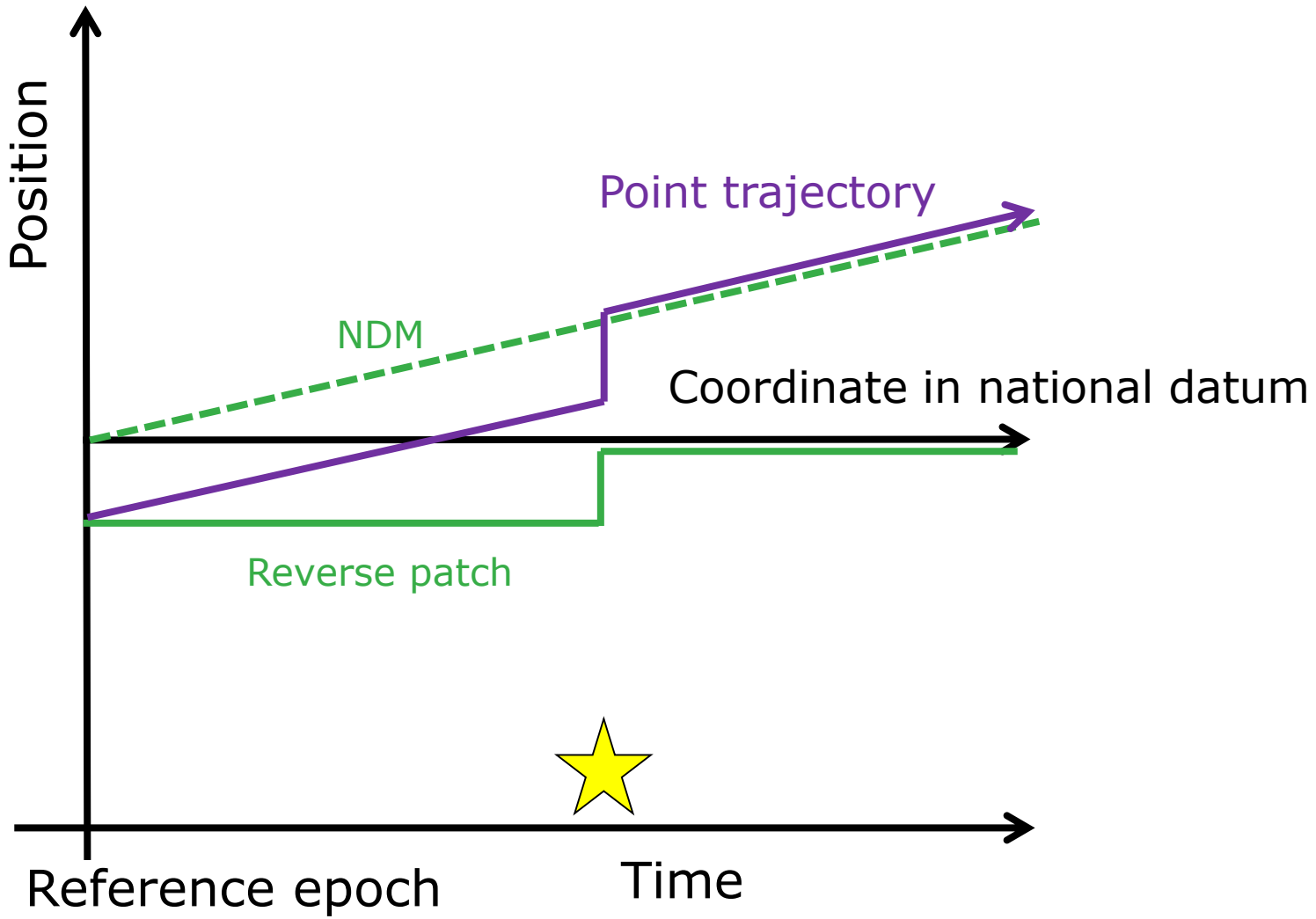
Wang et (SOPAC)

“Reverse” patch



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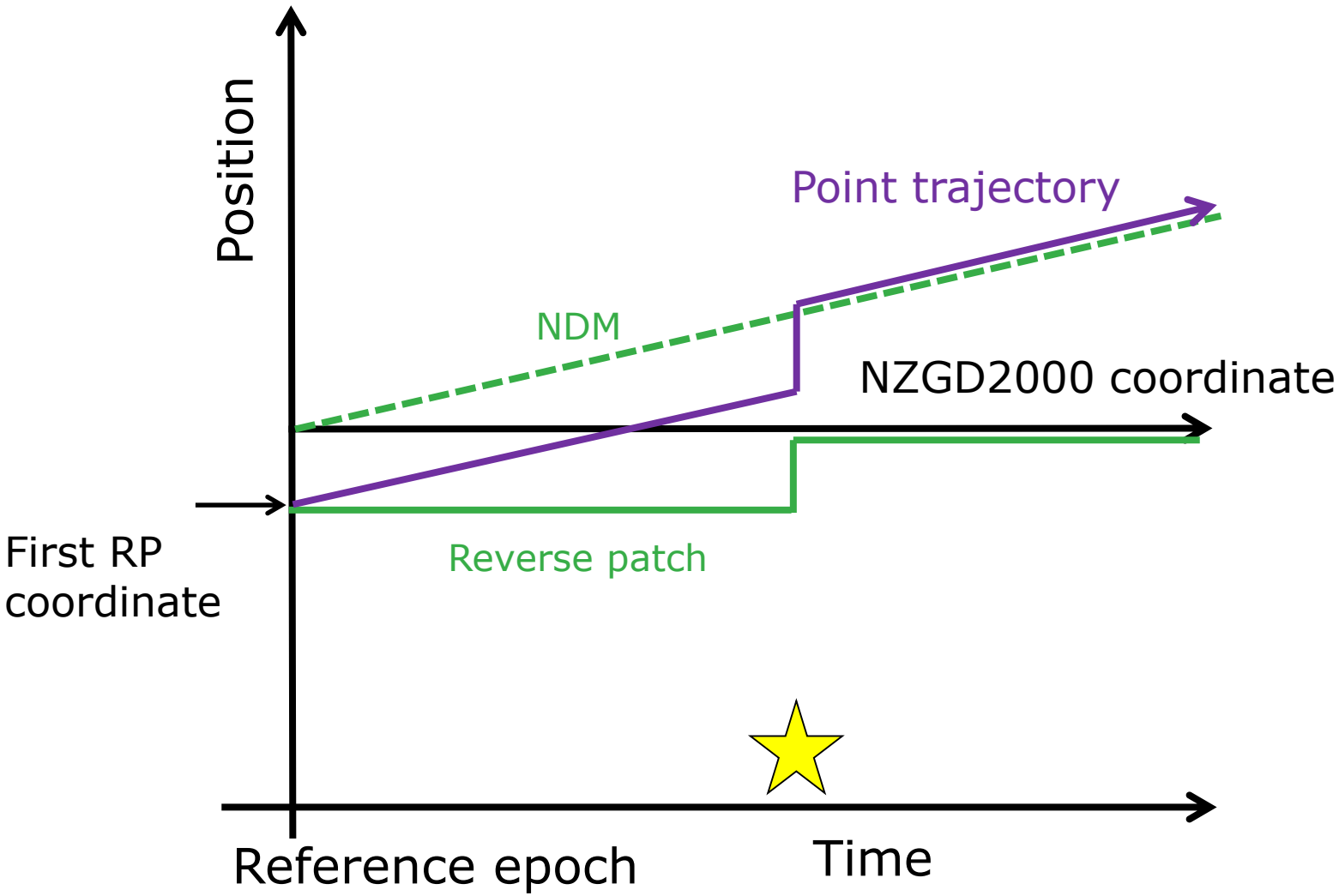
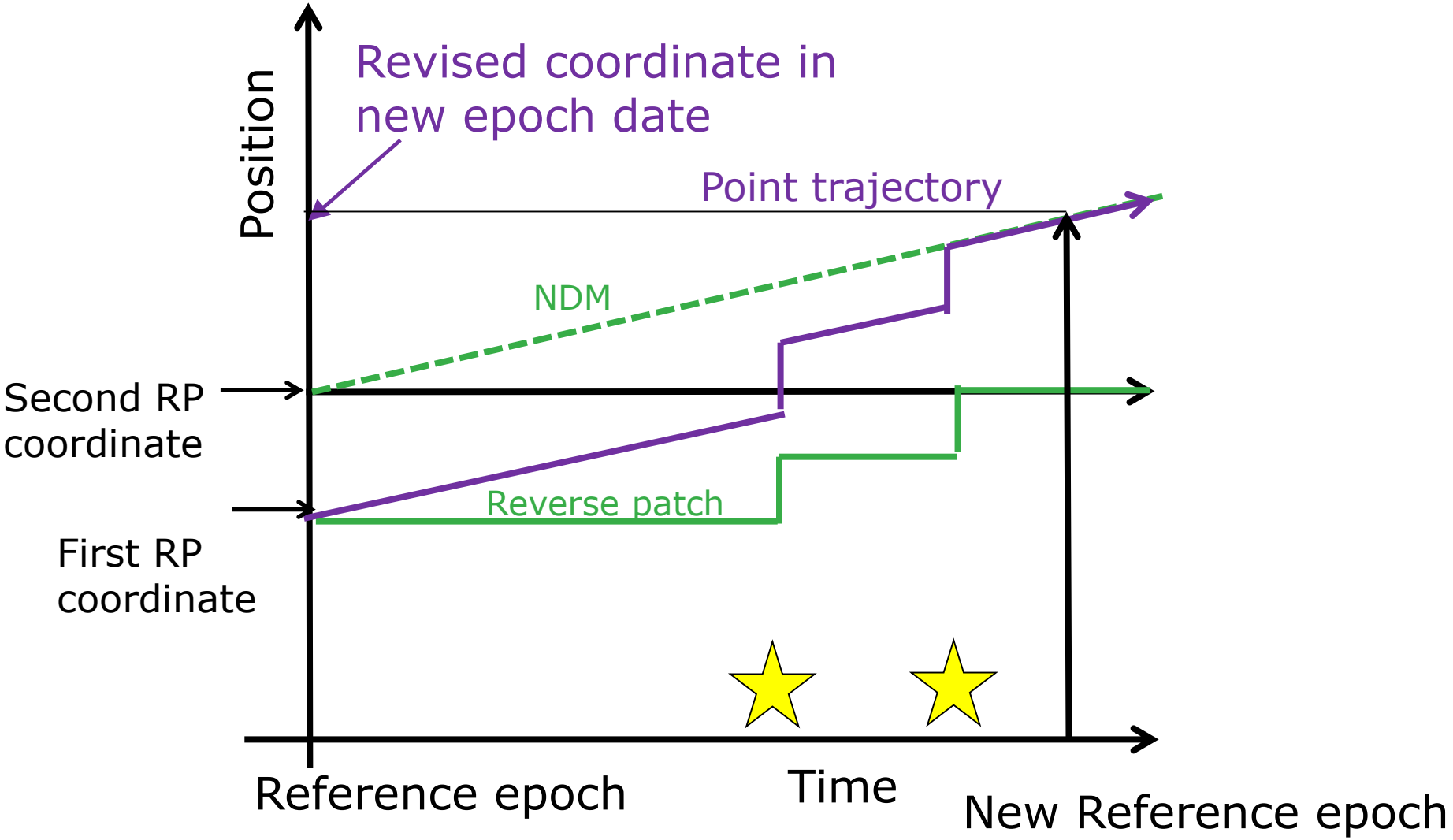
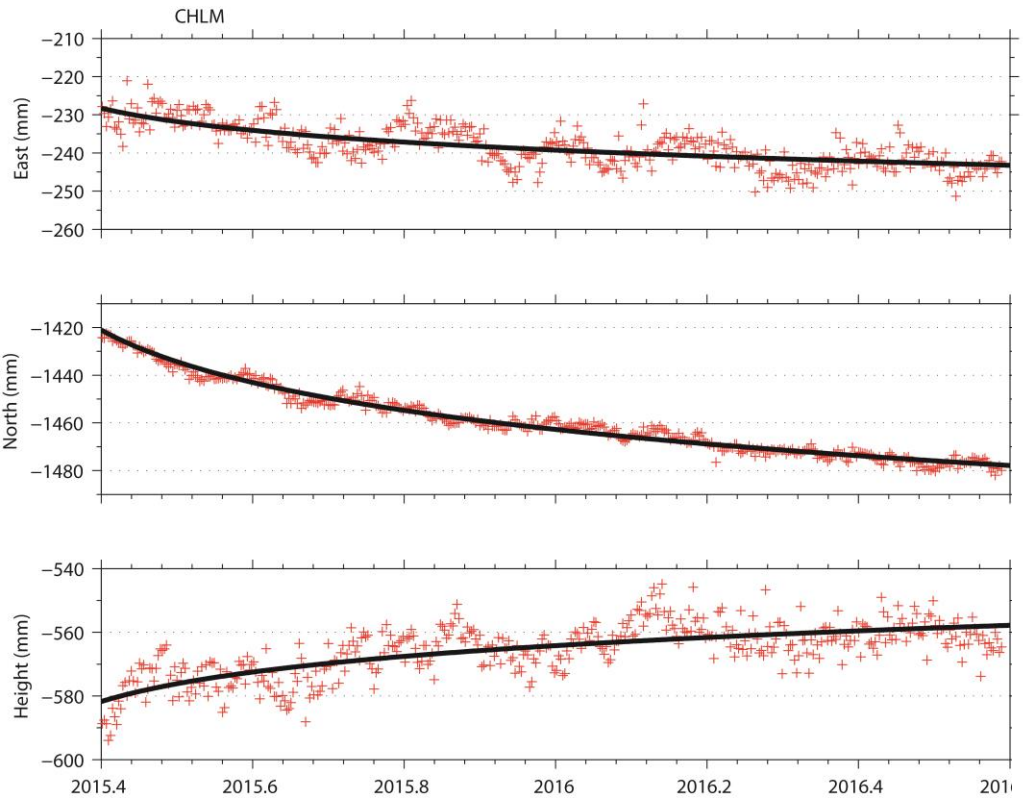


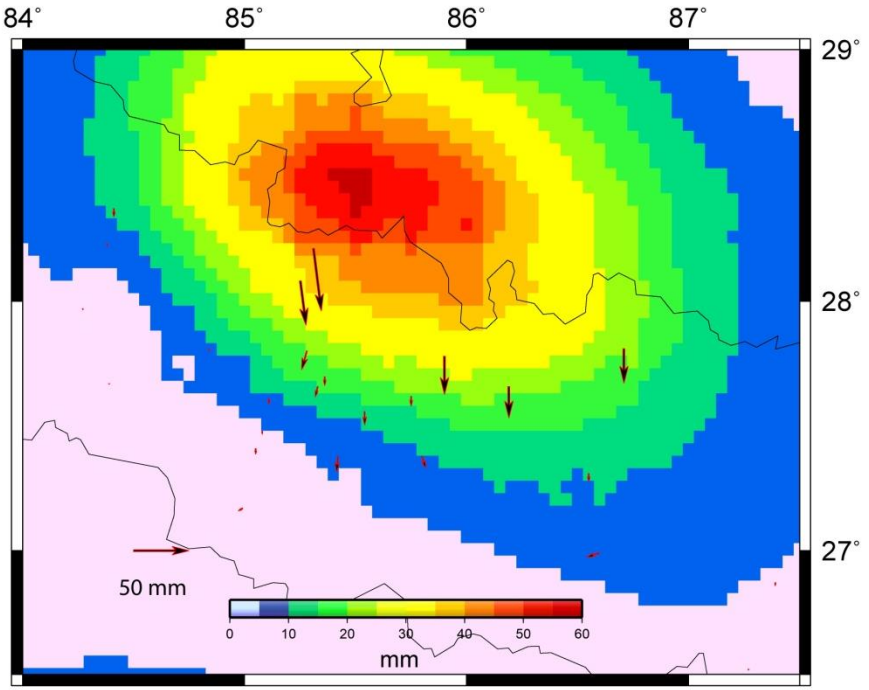
“Reverse” patch



Post seismic relexation

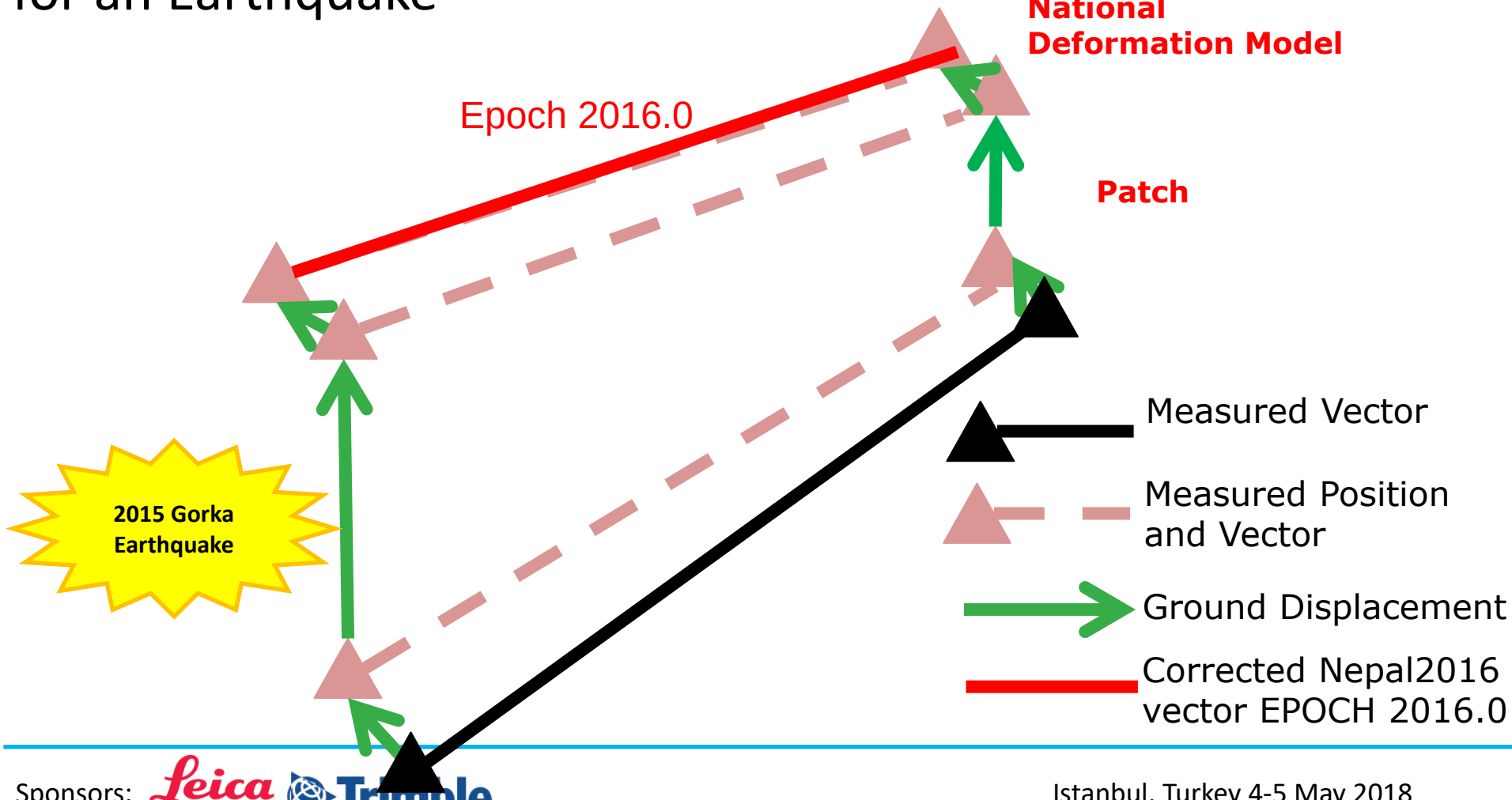


Mencin et al
Nature Geosciences 2016

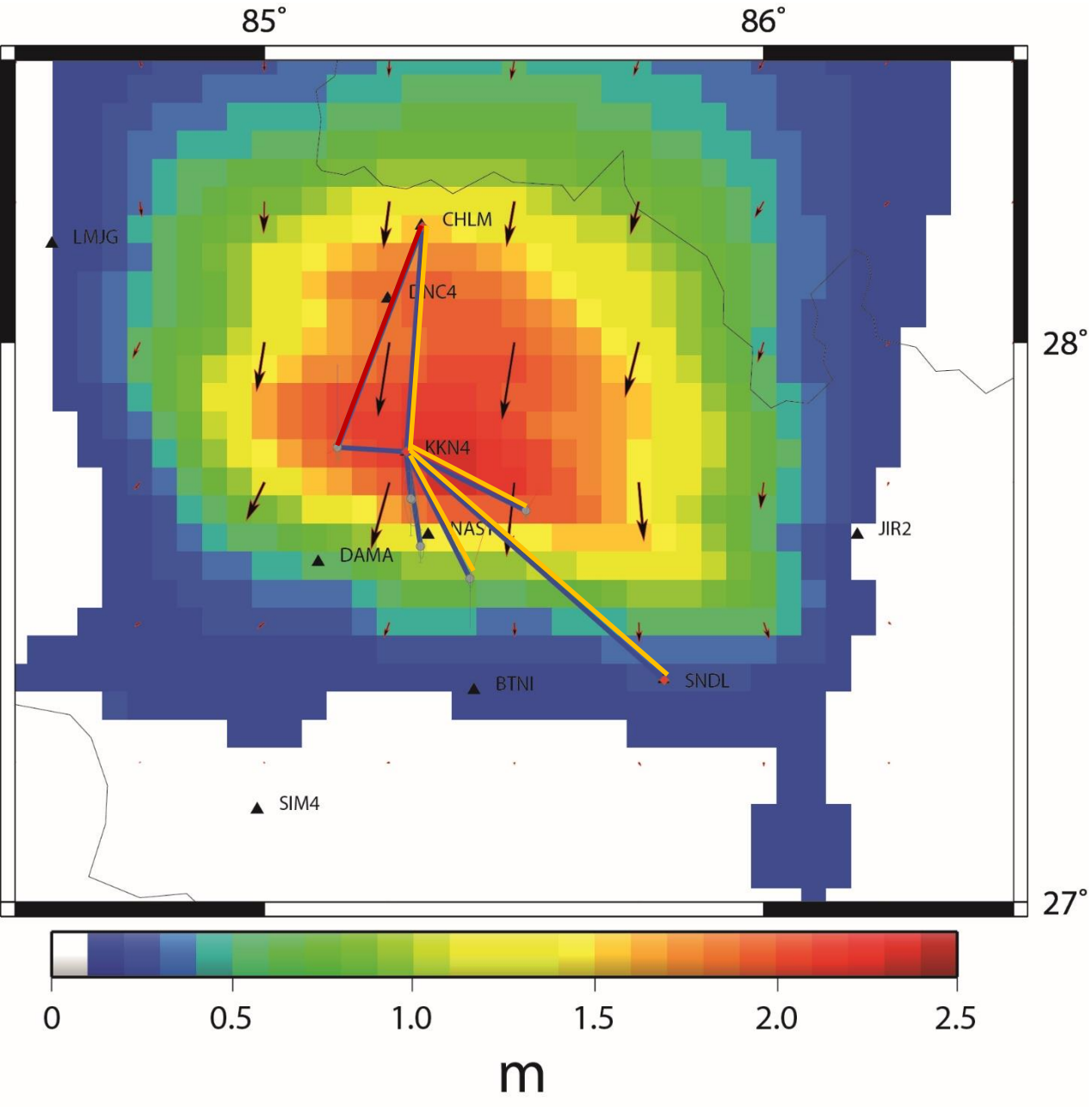


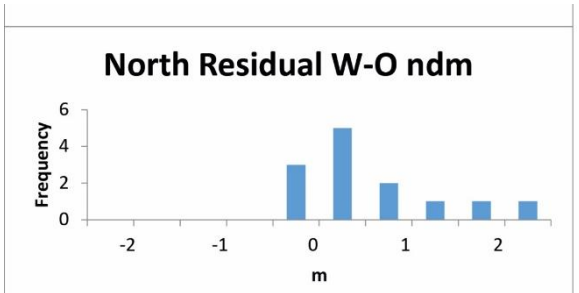
$$m_k(t) = v_k t + E_k H(t - t_i) + P_k H(t - t_i)\left(1 - e^{(t-t_i)/43}\right)$$

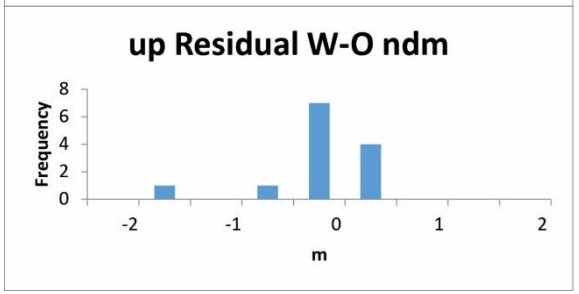
Deformation models in survey adjustments Example: Patch for an Earthquake

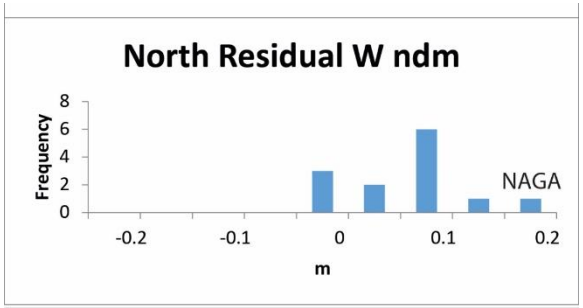


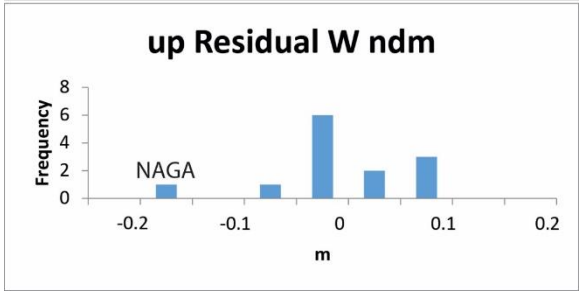
Adjustment of GPS before and after the Gorkha Earthquake











Conclusions

- Deformation models involve:
  - Secular velocity field
    - Alignment is critical!
  - Earthquake displacements
    - reverse patches simplify NDM for users but cause a sequence of coordinate shifts
    - Consider changing the epoch date after the earthquake sequence.
  - Post seismic displacement
- Patches always have significant errors
  - Particularly where displacement changes suddenly
  - Consider temporarily reducing order of control marks In these areas.

4 September 2010 Darfield Earthquake