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ANSIR AUSTRALIAN NATIONAL SEISMIC IMAGING RESOURCE

The role of reference models and misfit criteria in event location

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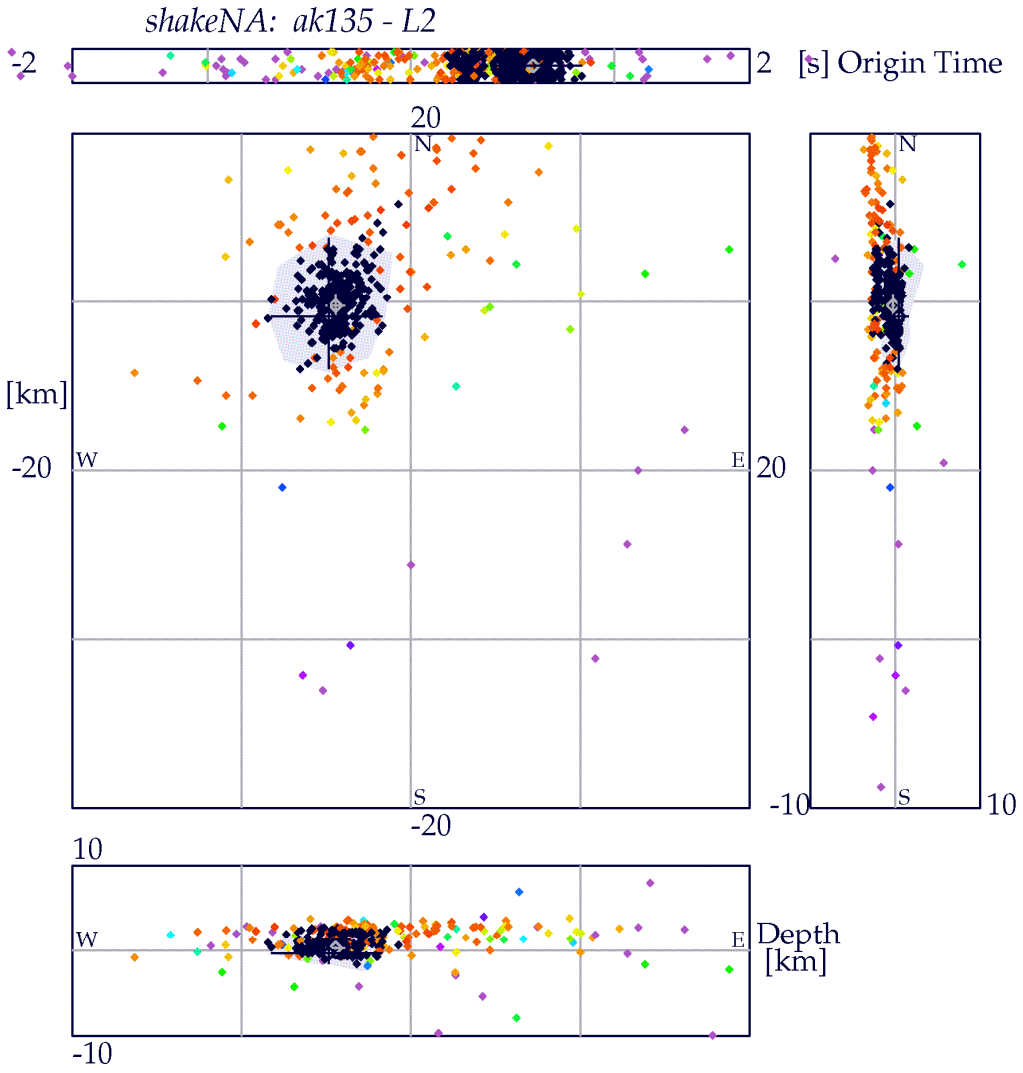
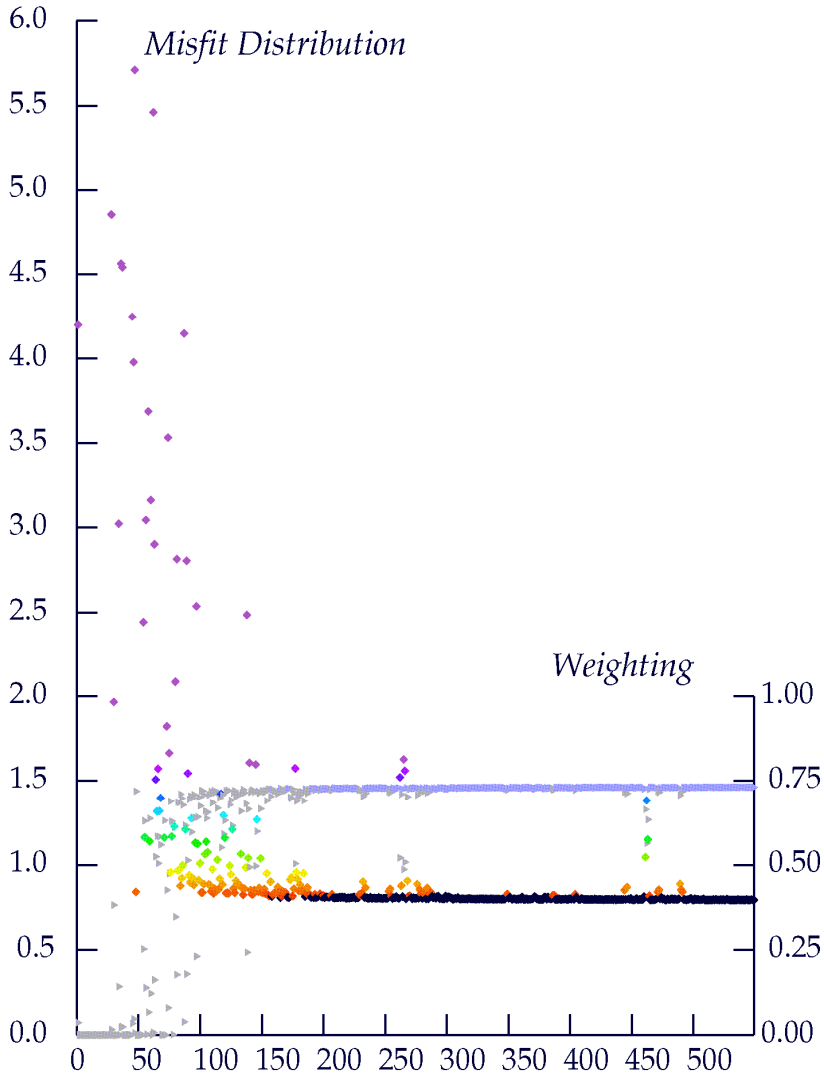
Location Procedure I

- The entire set of reference events has been relocated using a fully non-linear scheme: the *shakeNA* program of Sambridge & Kennett (2001), which exploits the properties of the 4-D hypocentral space to seek the best-fitting solutions for some prescribed misfit function
- No differentiation is required, just the ability to compute the arrival times for a proposed hypocentre
- This means that robust criteria such as an L1 representation can be used, with any suitable velocity model, and the initial domain does not have to be small (e.g. 5x5 deg x100 km x 30s)
- The ***ak135*** model has been employed, since this provides a good global representation for a wide range of phases.

Location Procedure II





Example of shakeNA convergence and definition of consistency region

Location Procedure III

- Rather than reject any arrivals, all data have been employed with a systematic weighting scheme via an expected error
- Assigned errors (s)

  iP: 1.0, eP: 1.5, P: 2.0;

  ipP:1.5, e/−pP: 2.5; isP: 2.0, e/−sP: 3.5;

  iPKP: 2.0 ePKP: 3.0, PKP: 4.0;

  iPcP: 4.0 ePcP: 6.0, PcP: 8.0 (also ScP)

  PP: 10.0

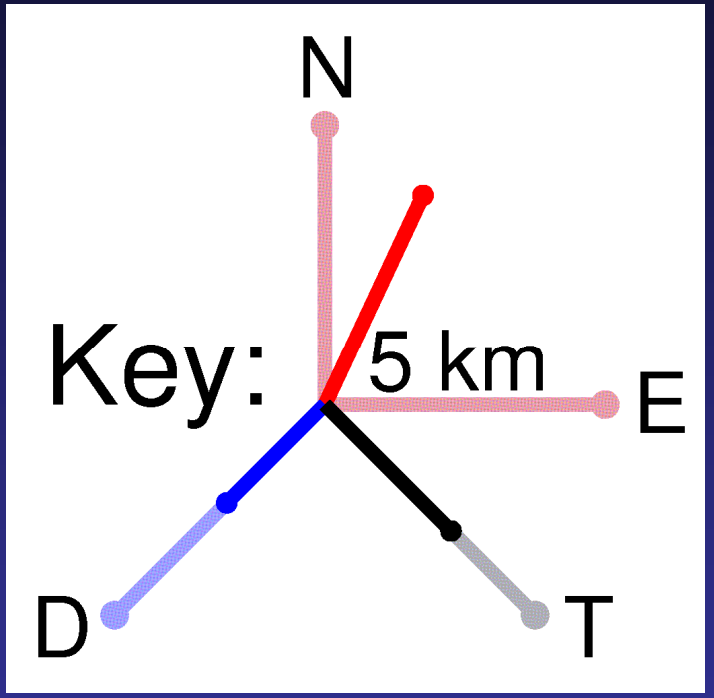
  iS: 3.0, eS: 4.5, S: 6.0
- The shakeNA scheme can be used with azimuth and slowness information but was not for these tests

Location Procedure IV

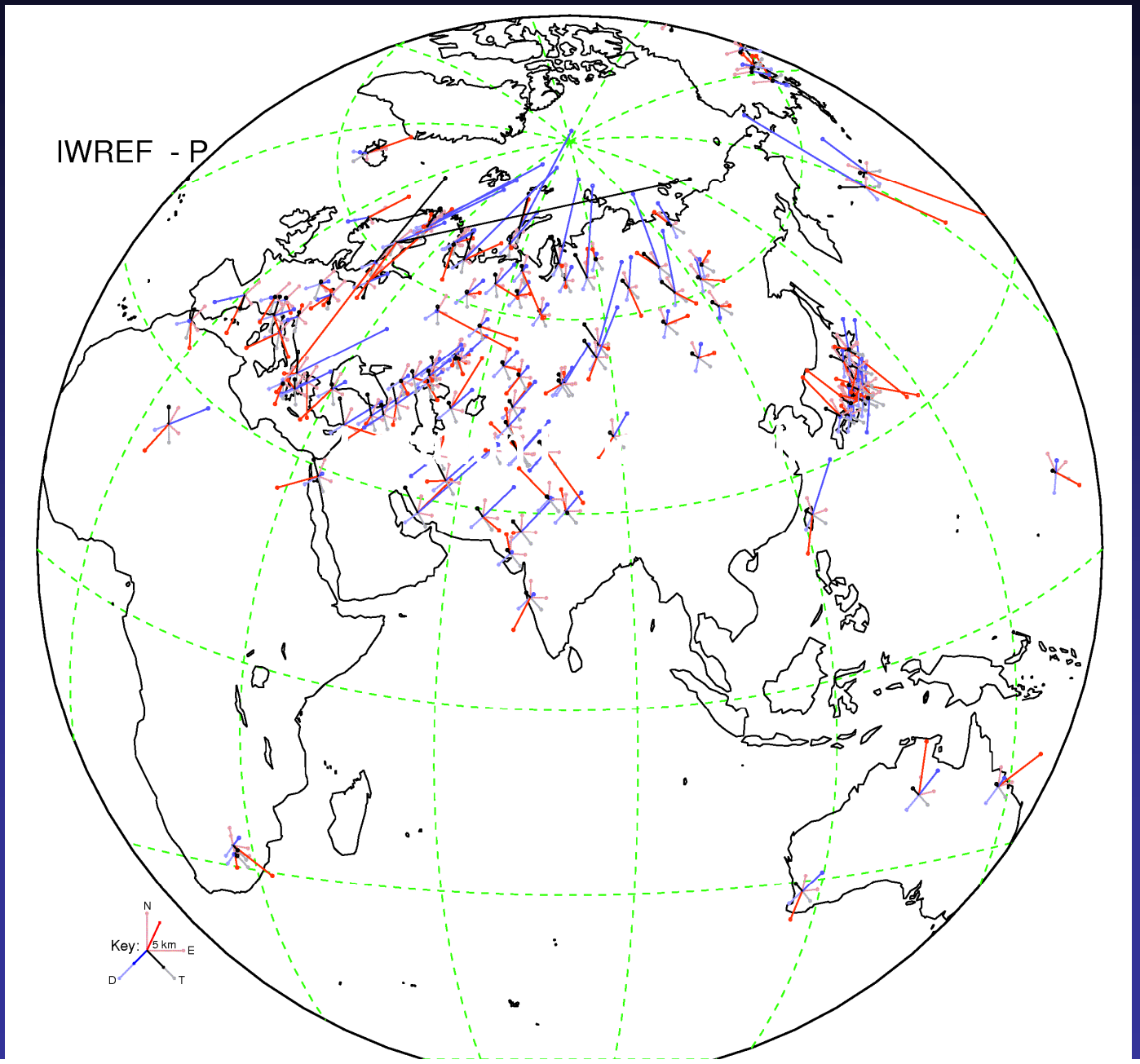
- The L1 measure of misfit is the sum of the absolute value of the weighted residuals (thus the influence of blunders is minimised)
- All events were processed with the same domain (+/- 2 deg in latitude and longitude, +/- 60 km in depth (where possible), +/- 20 s in origin time
- The centre of the domain was the ISC1 location (except in depth), but this can be moved by 1 deg with no ill effects
- 30 iterations of the NA inversion scheme were used, i.e., 279 locations tested with 9 new trials per iteration into the best 2 voronoi cells
- Inversions were carried out using just P phases and including S information as well

Display of results

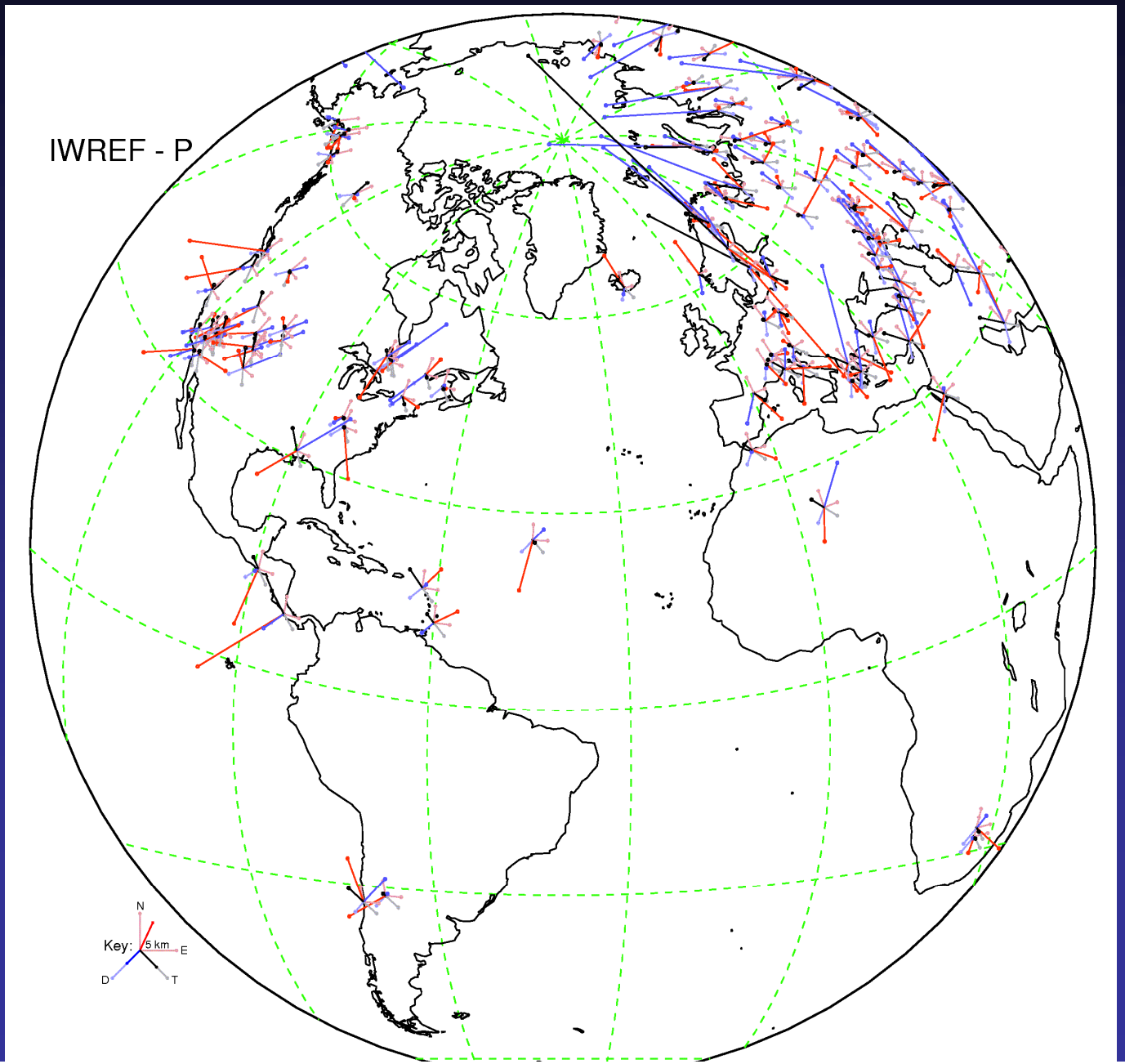
- It is always difficult to convey the 4-D attributes of a hypocentre in a 2-D plot.
- In the plots a projective axis system is used so that horizontal and vertical displacements from the reference location can be seen, as well as time shifts



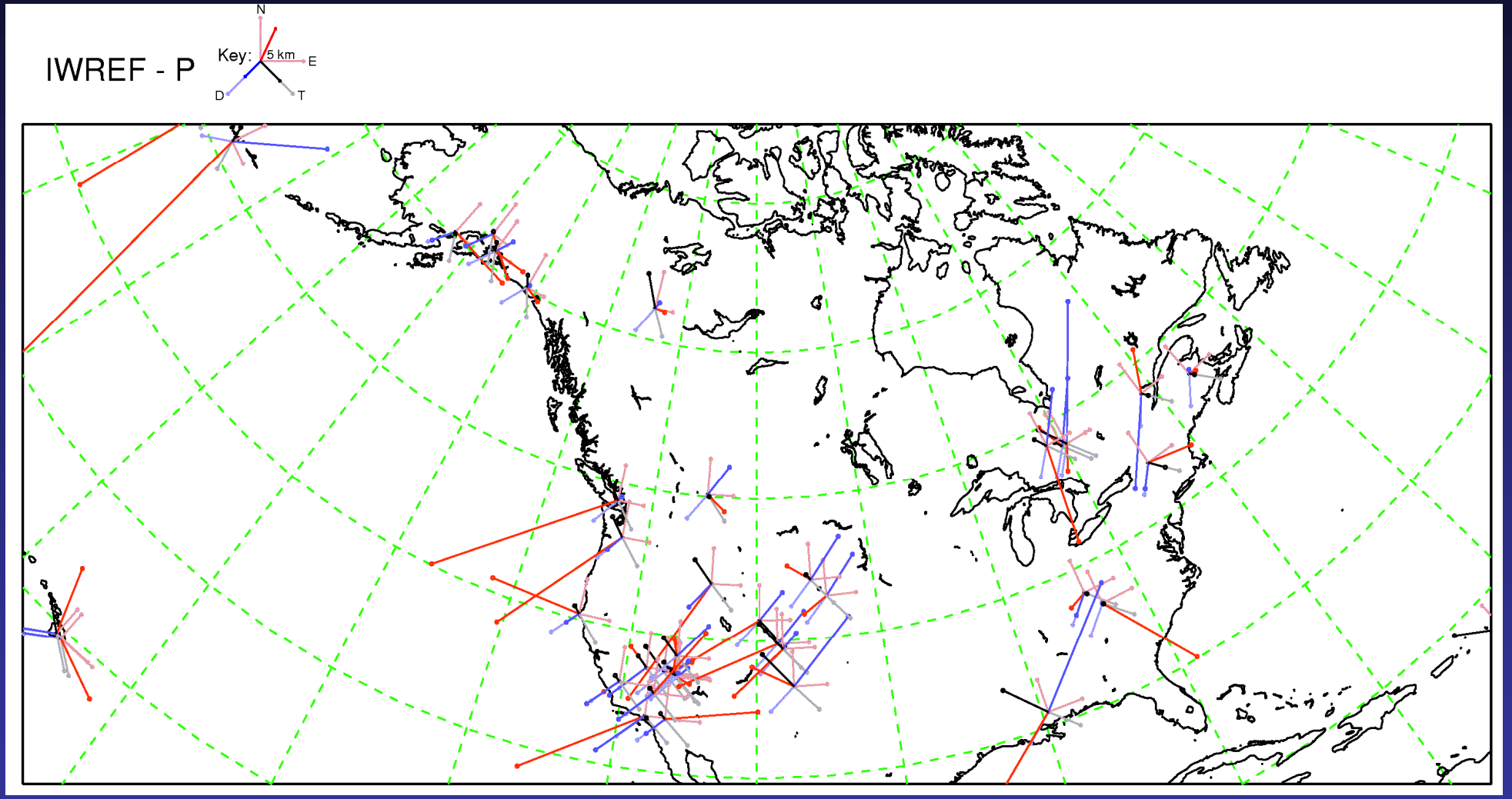
shakeNA compared to IWREF I



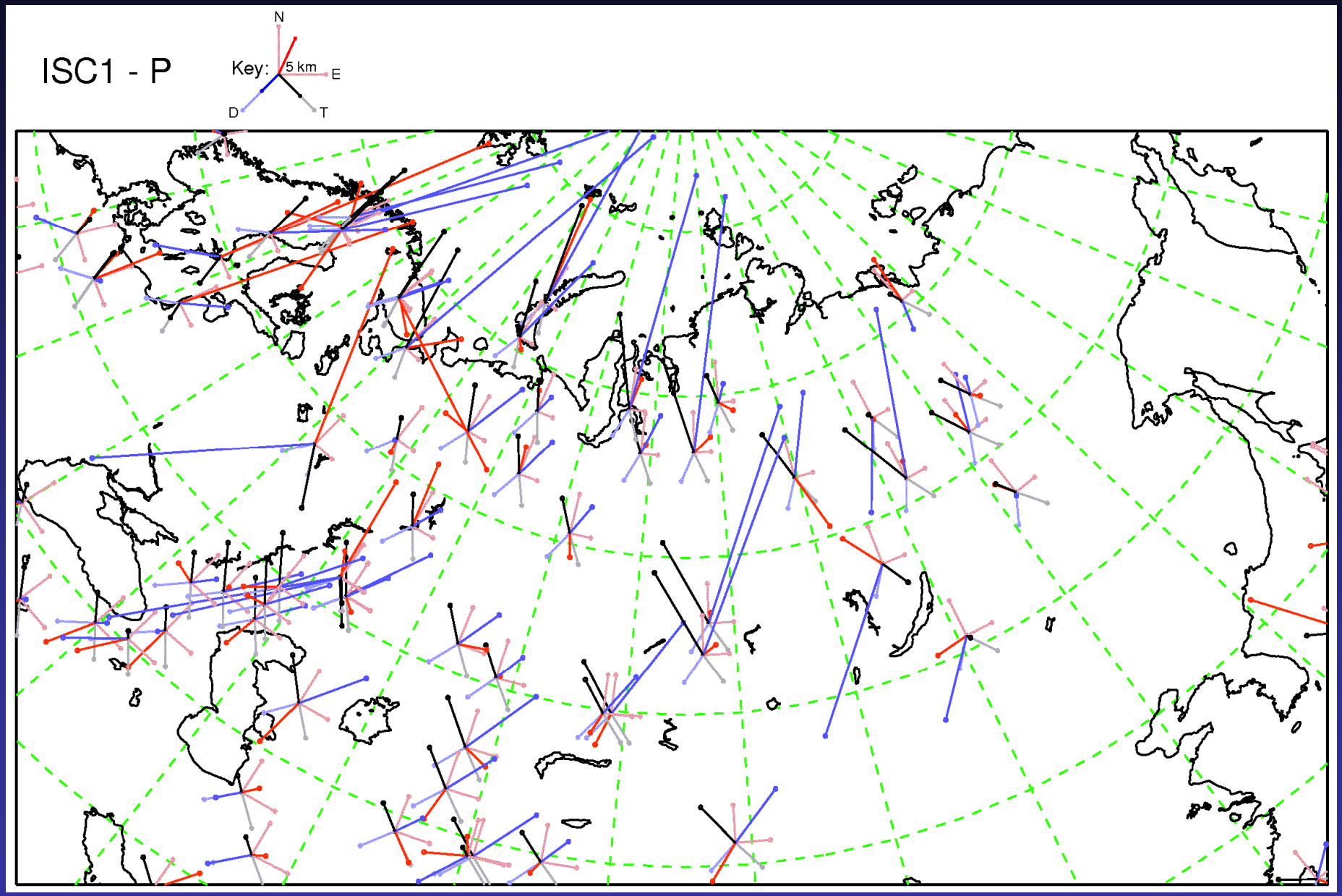
shakeNA compared to IWREF II



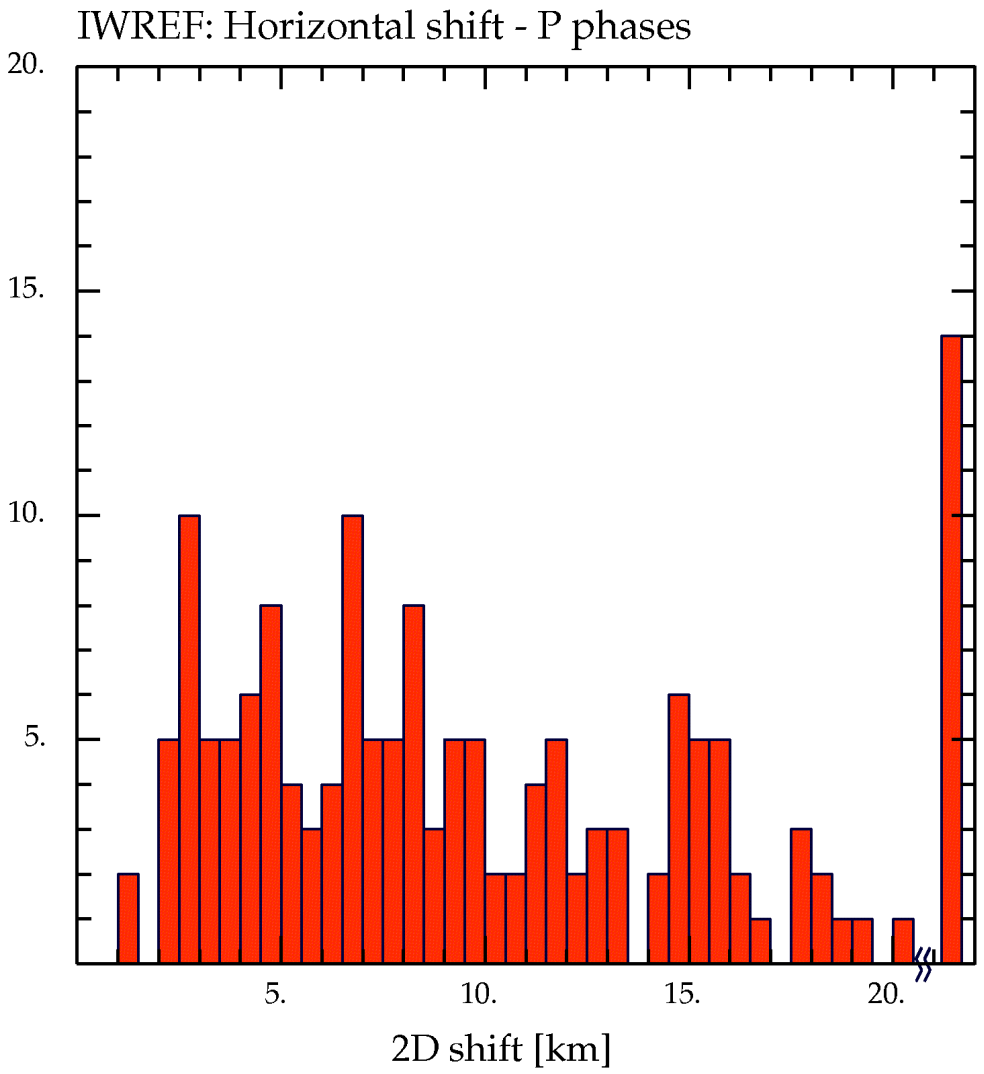
shakeNA compared to IWREF III

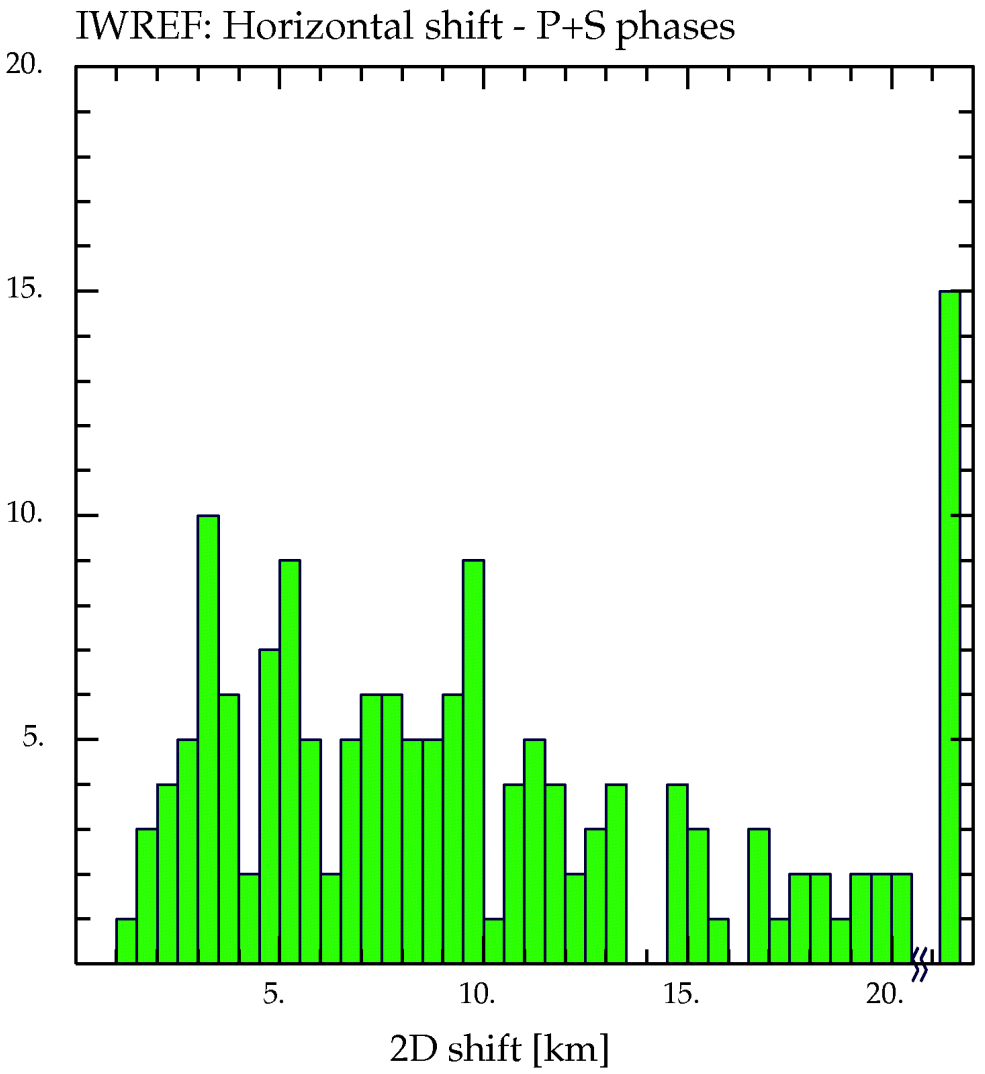


shakeNA compared to IWREF IV



Horizontal Shift





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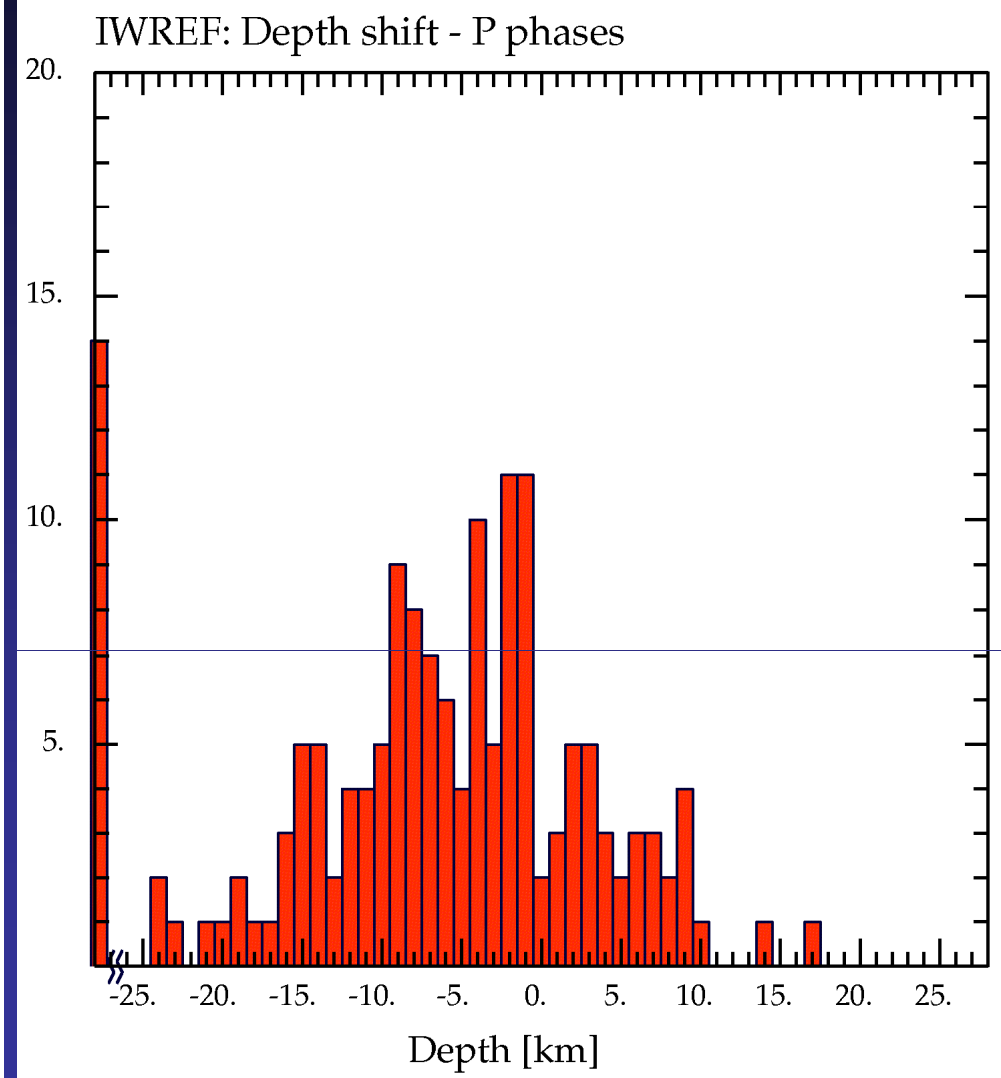
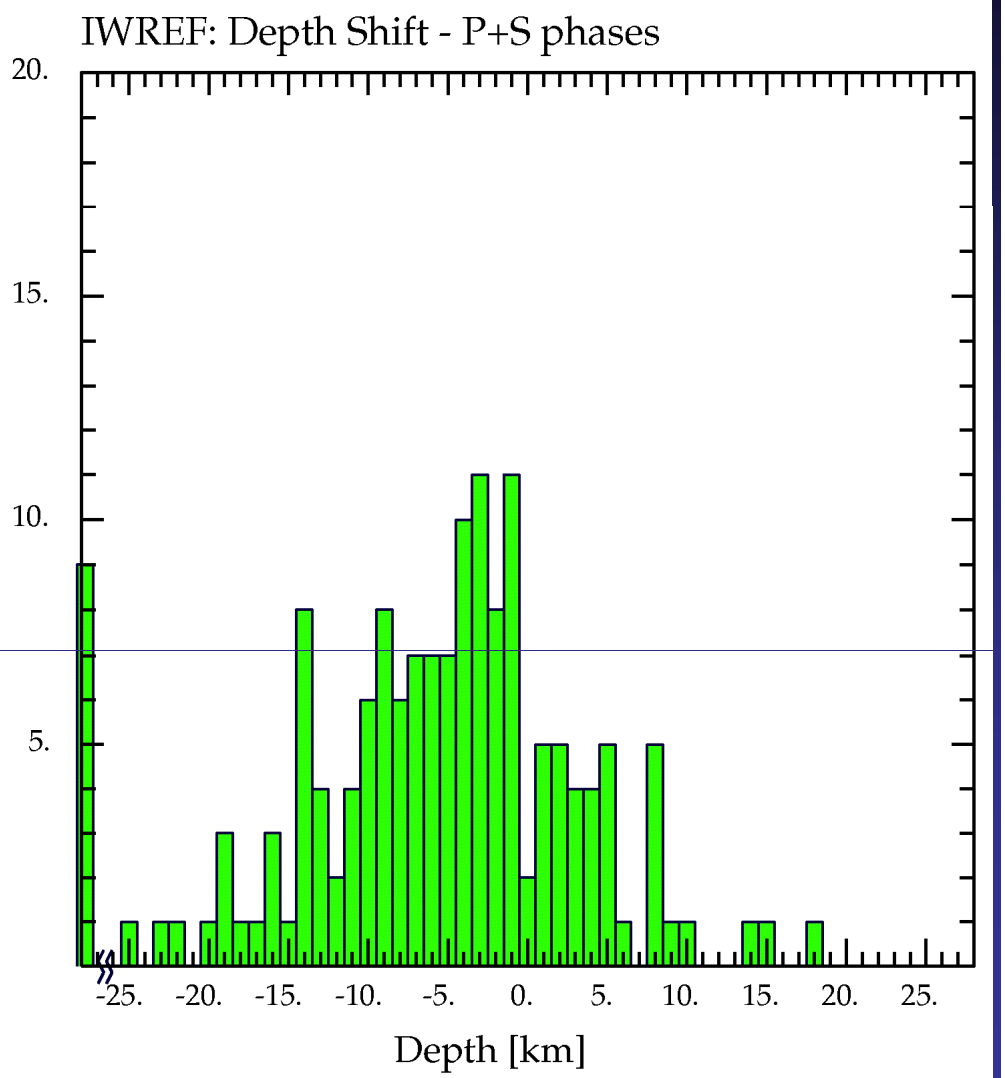
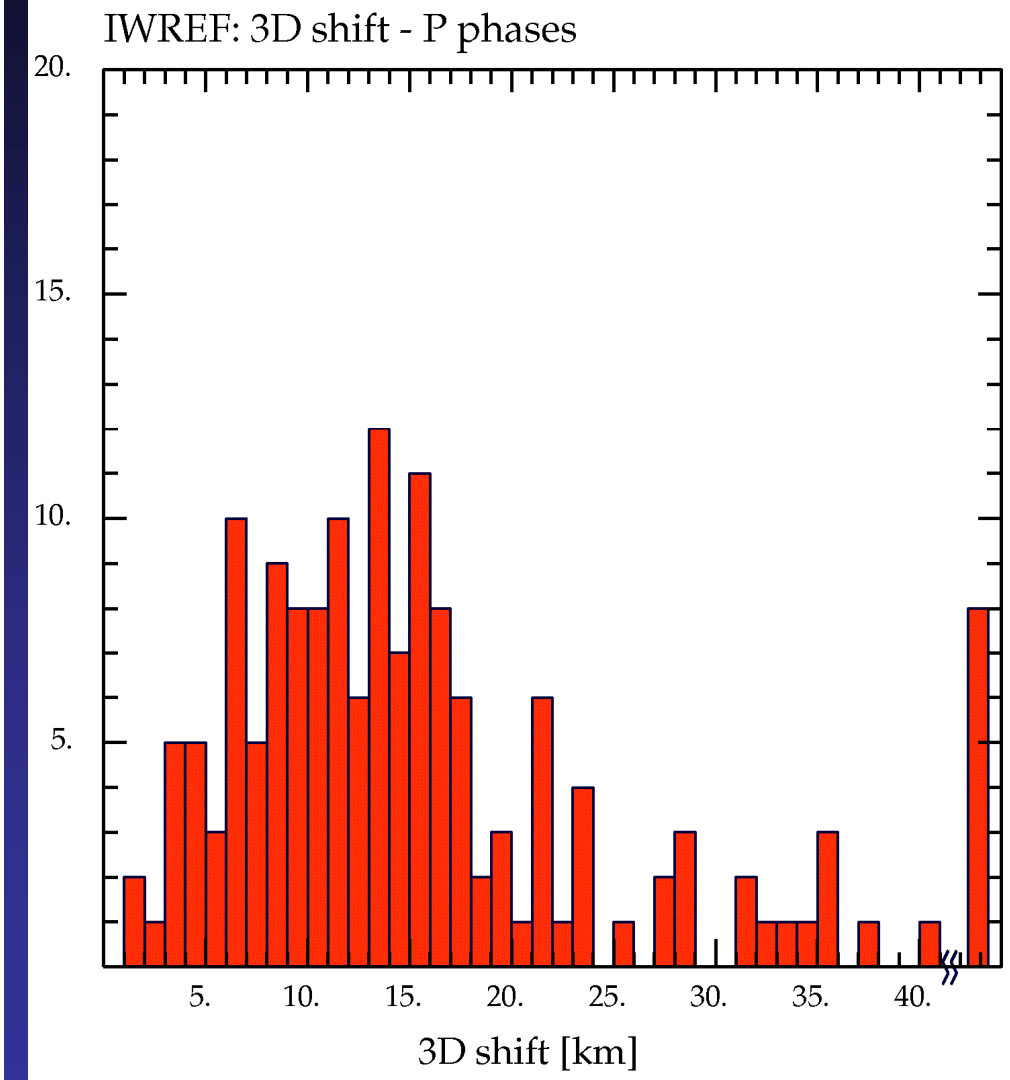
Vertical Shift





3-D shift


IWREF: 3D shift - P phases
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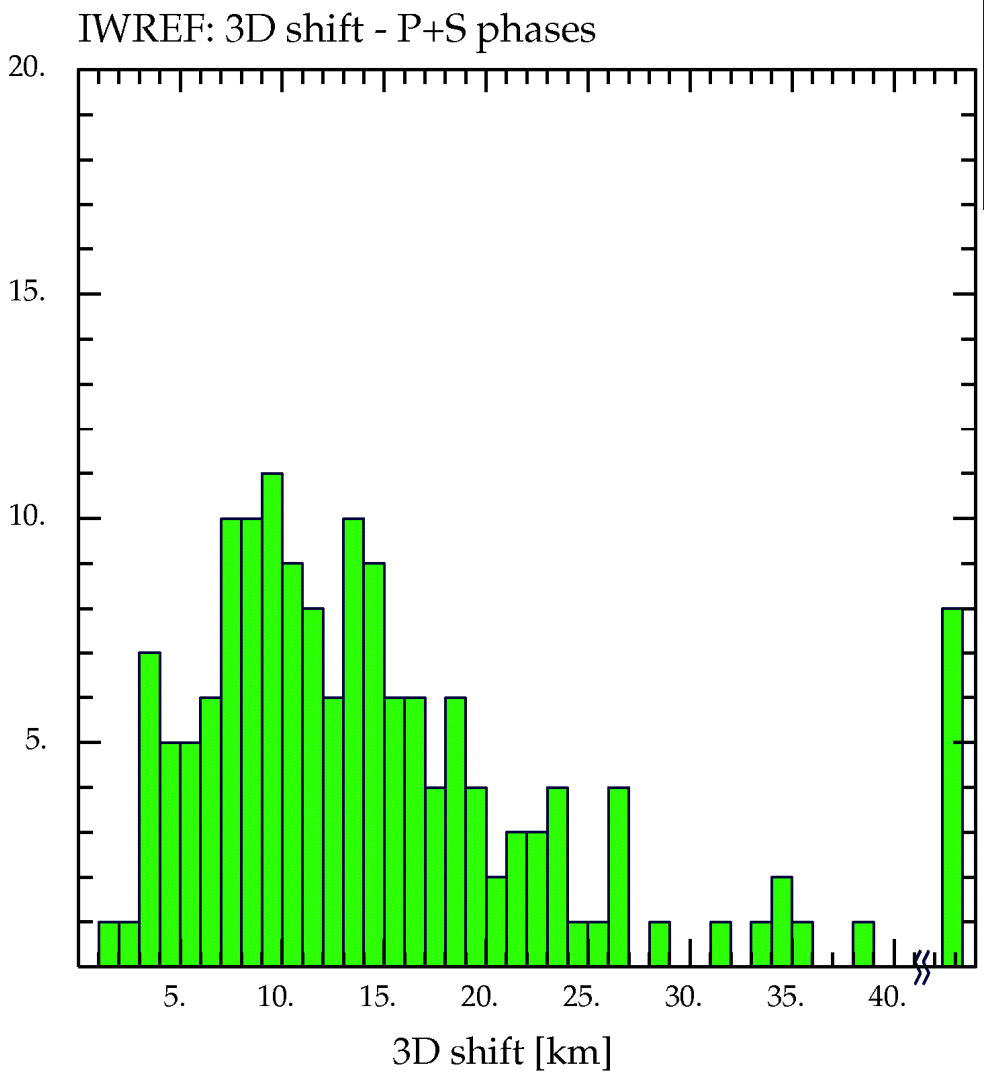
40.
3D shift [km]


IWREF: 3D shift - P+S phases
20.
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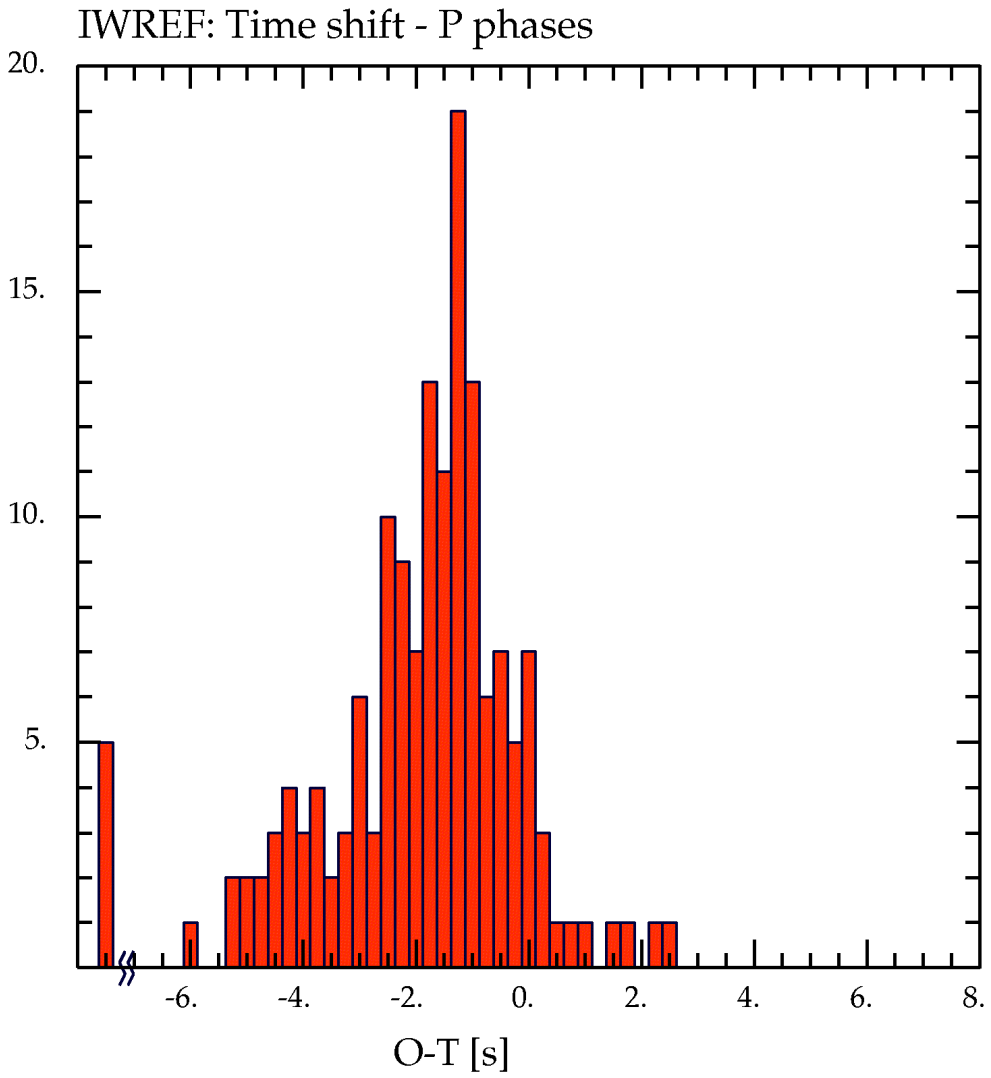
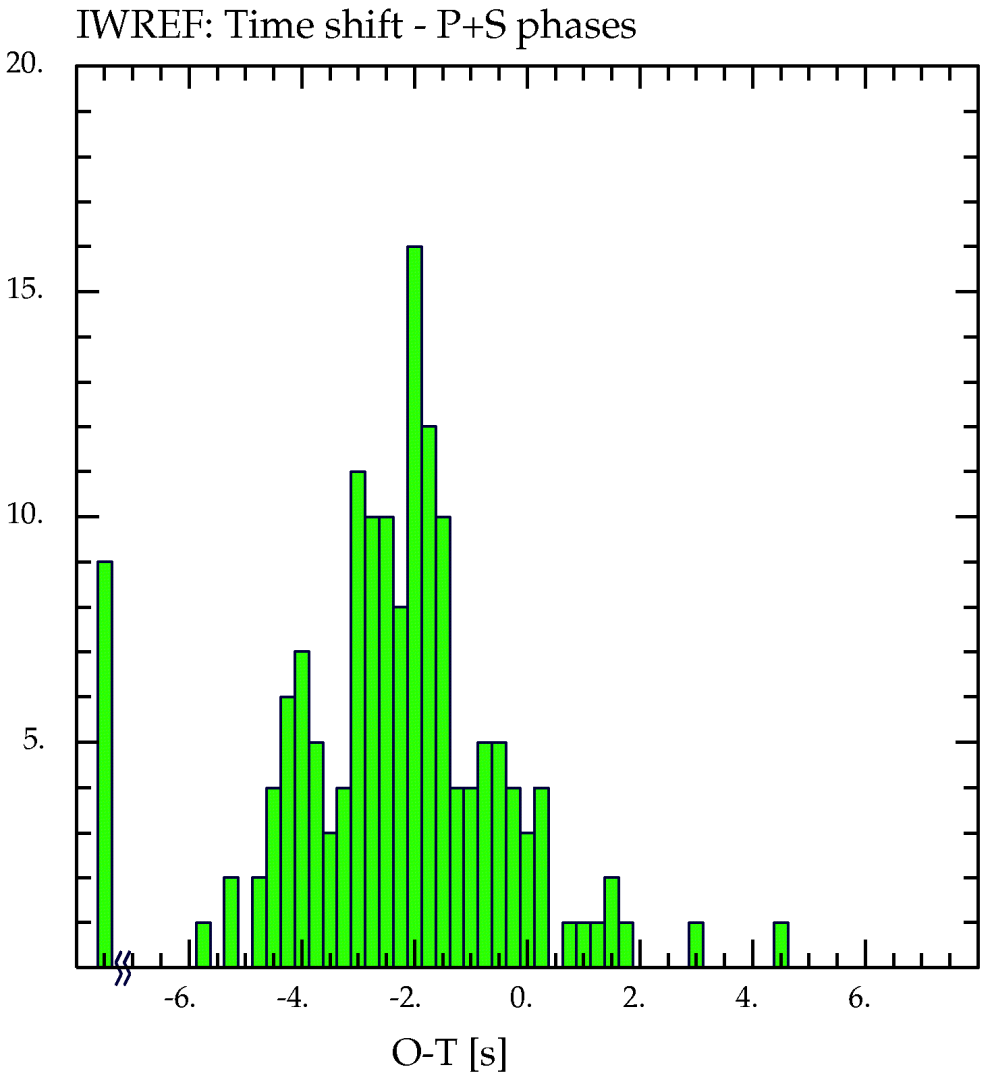
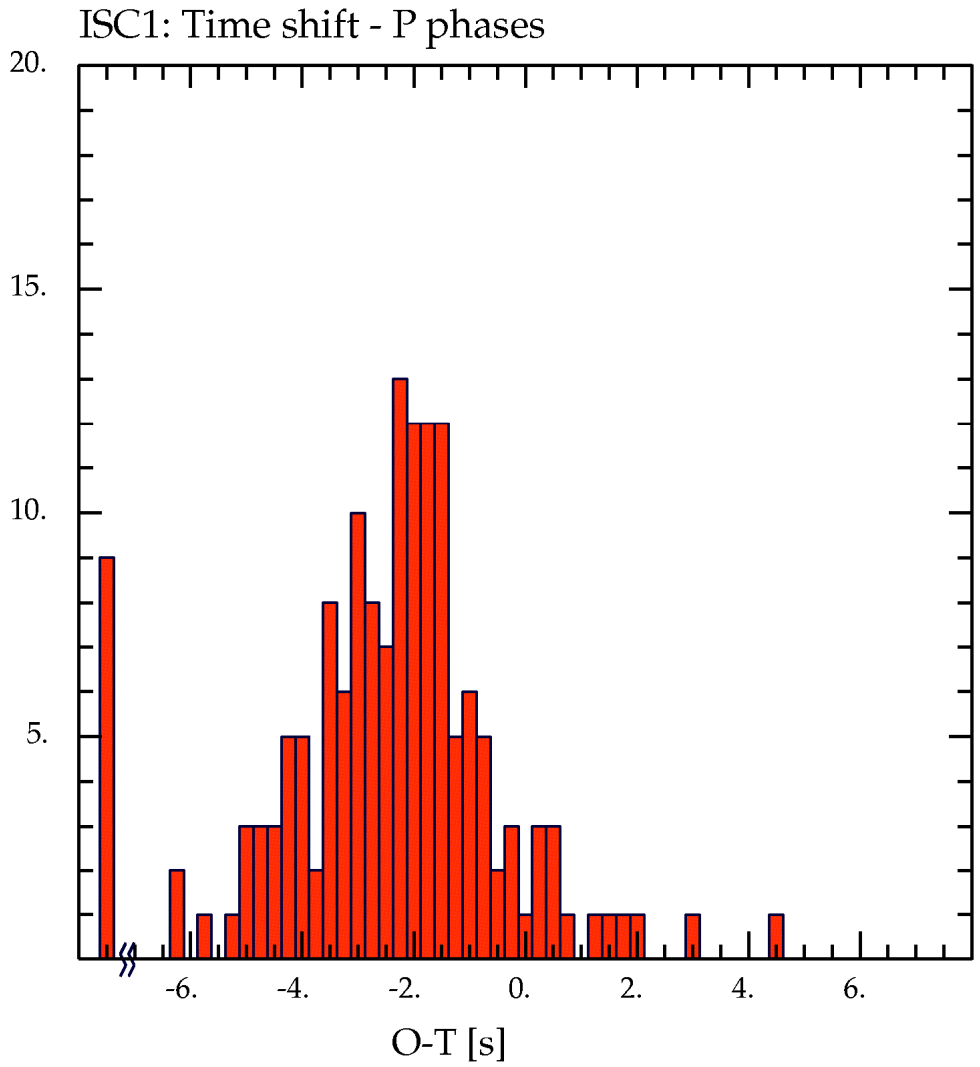
35.
40.
3D shift [km]

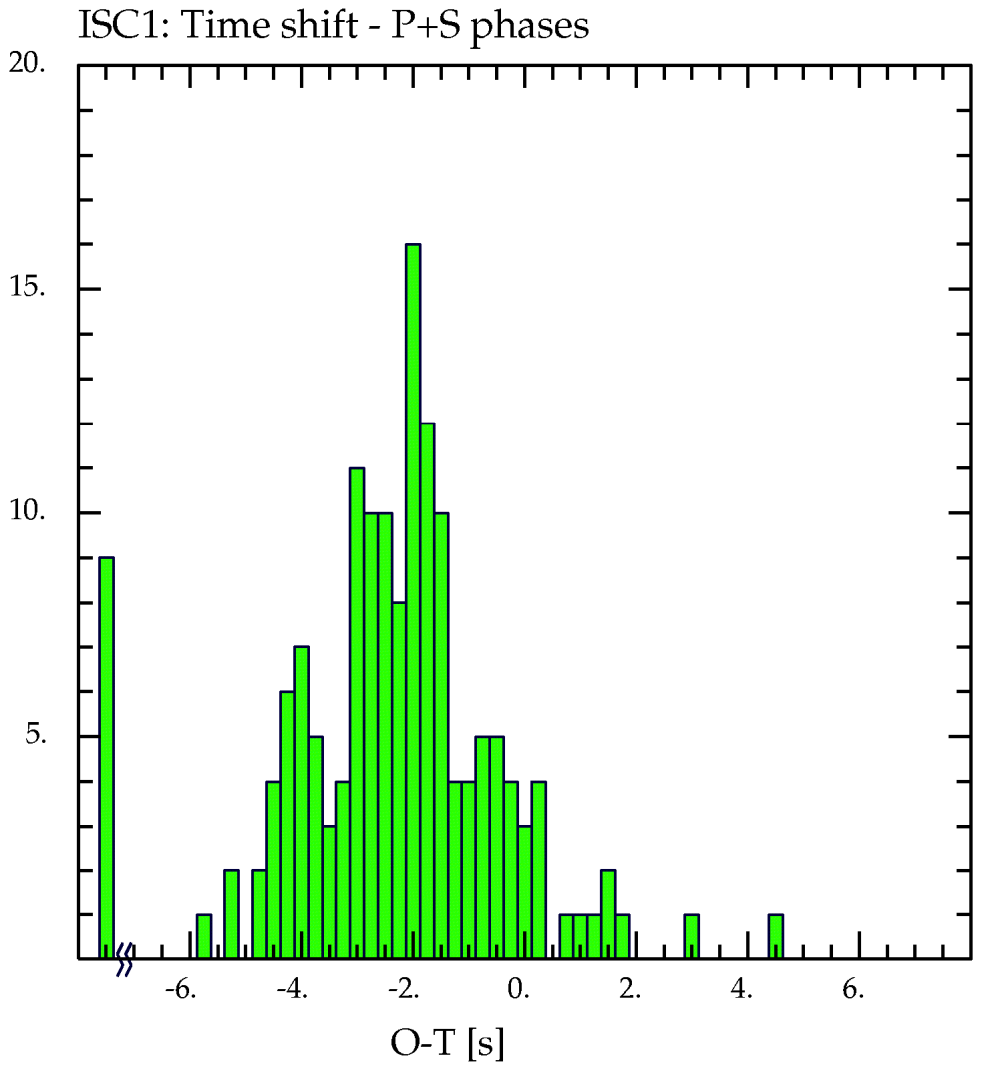
Origin Time shift



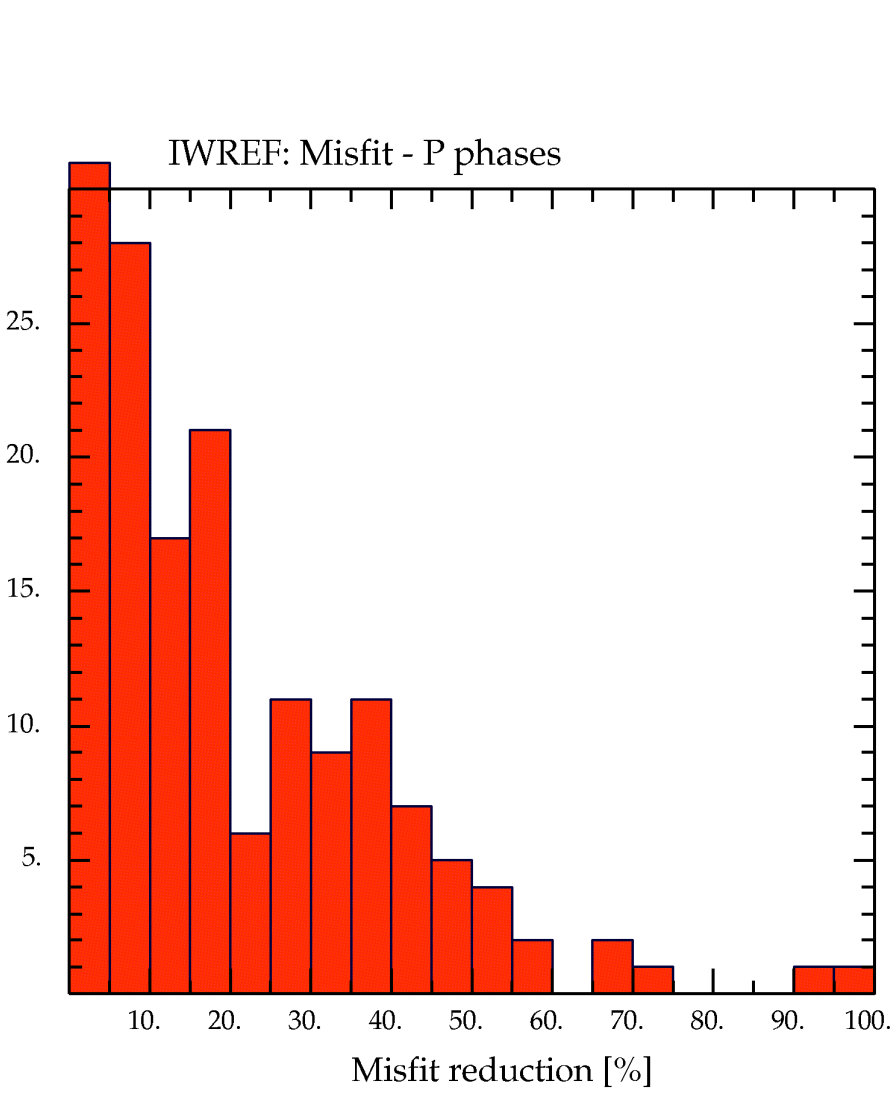


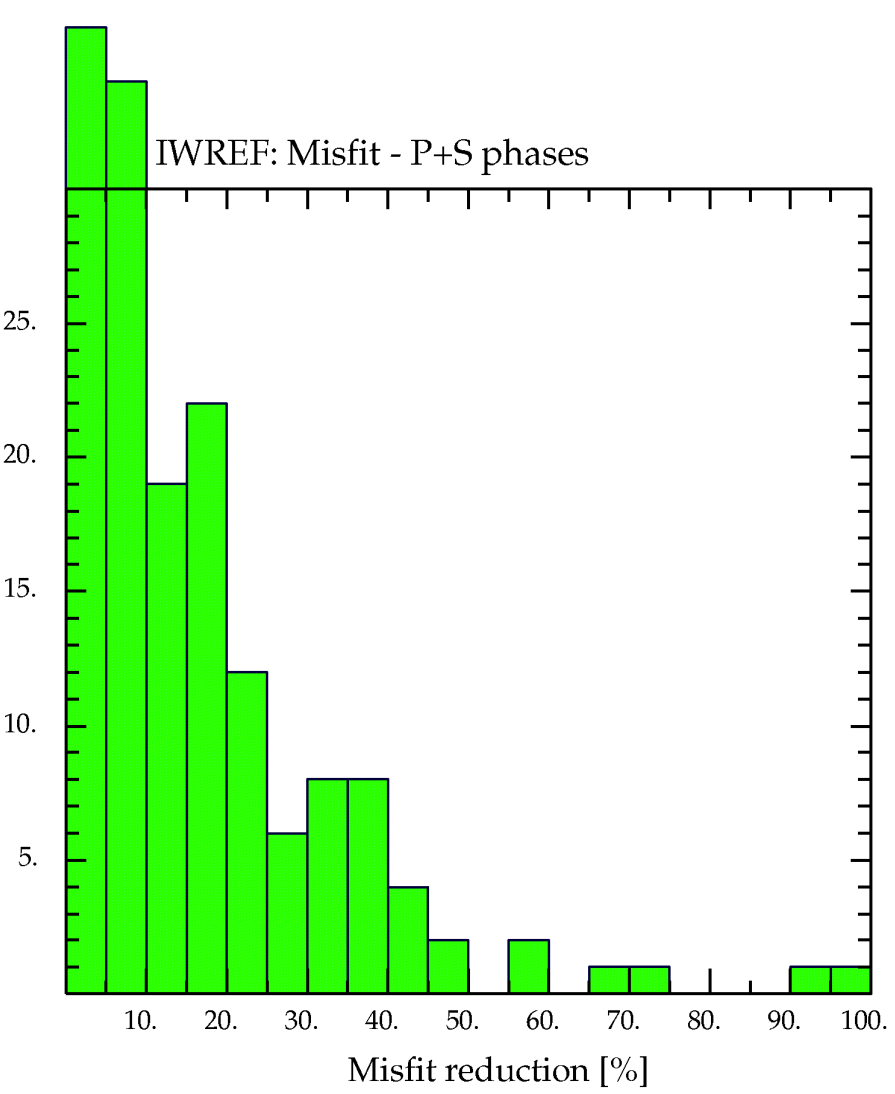
ISC1 – Origin Time shift





Misfit reduction (relative to IWREF)





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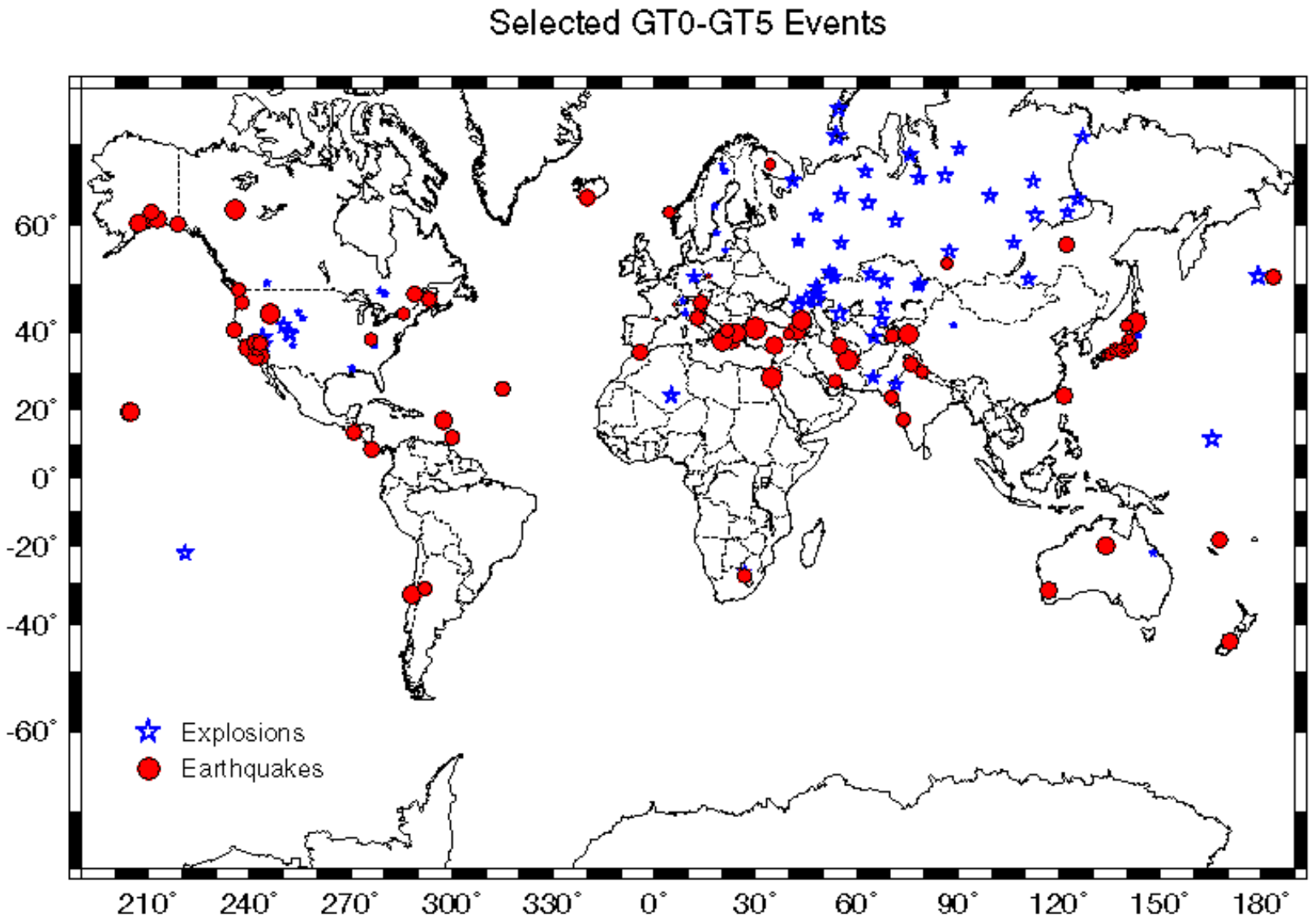
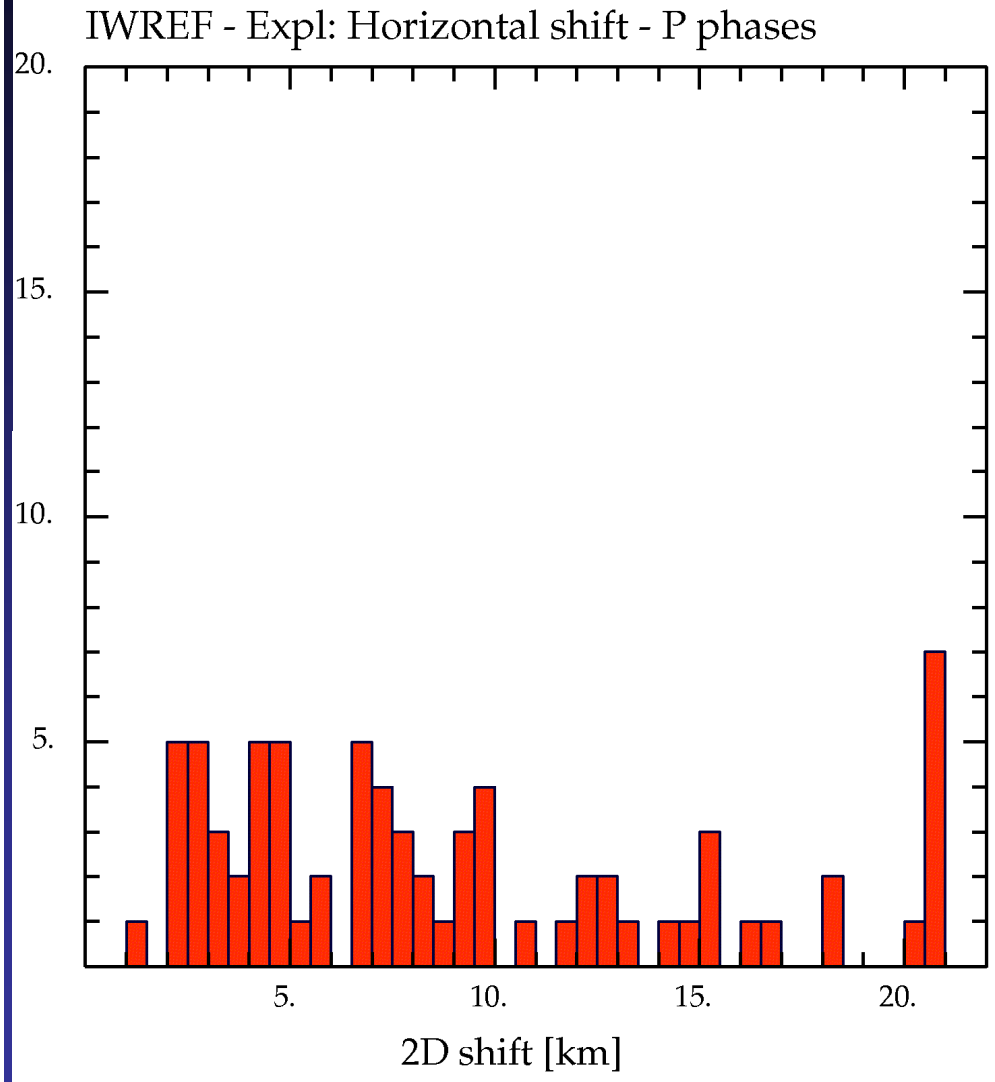
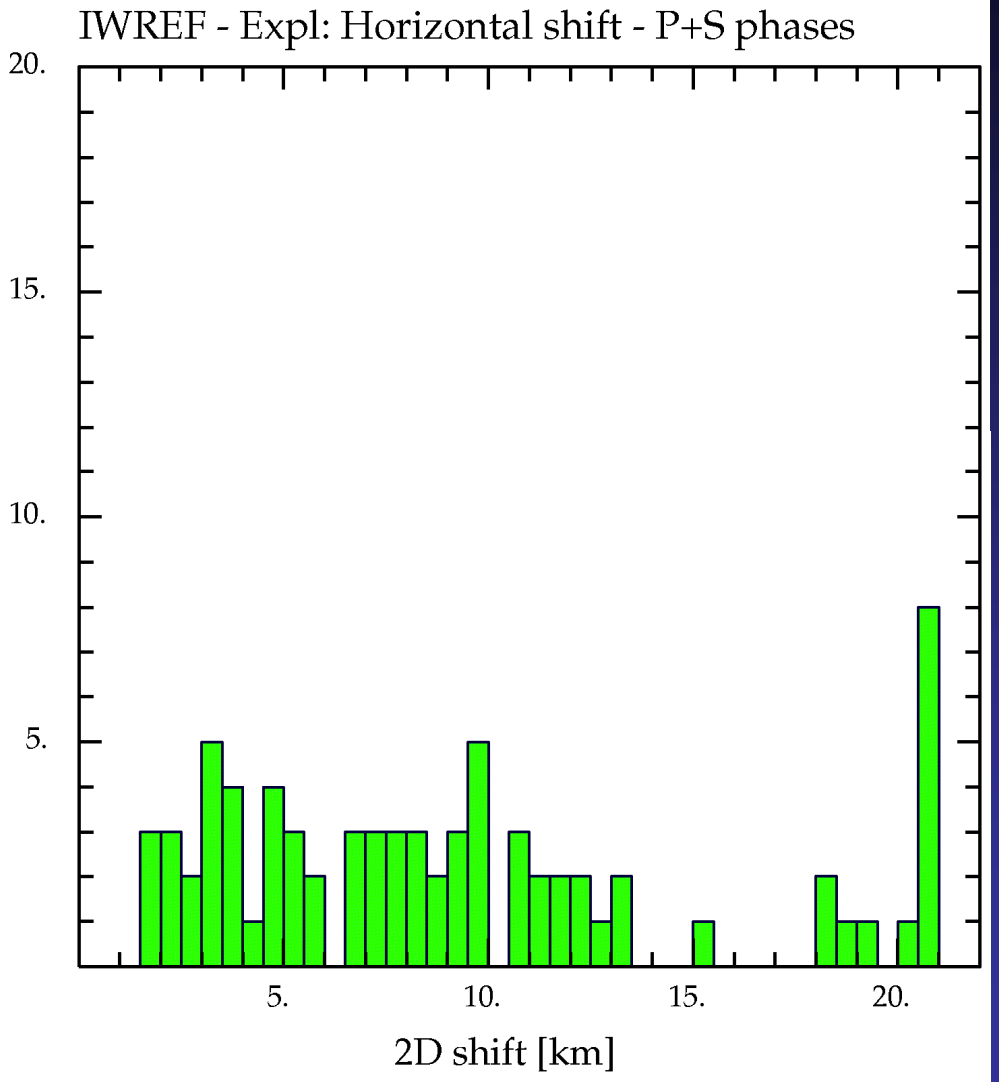
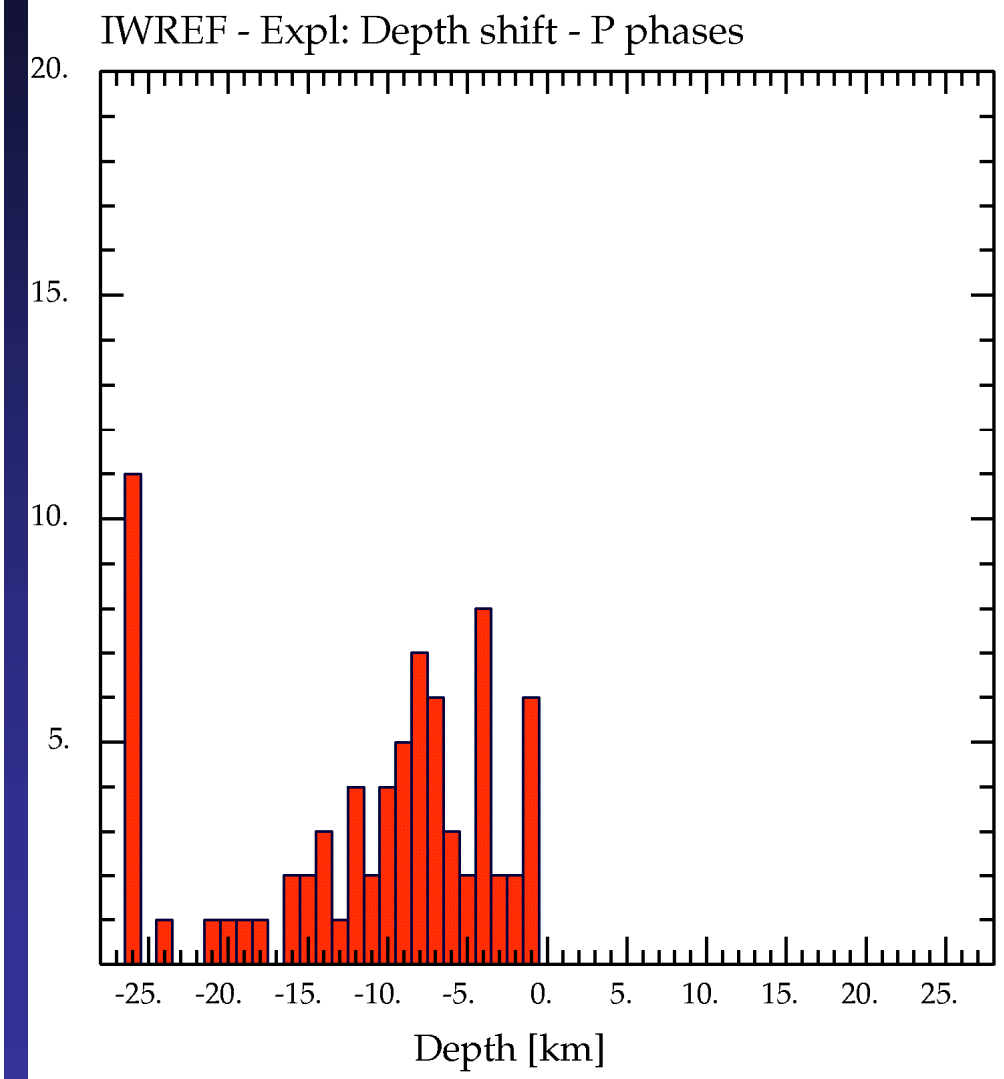


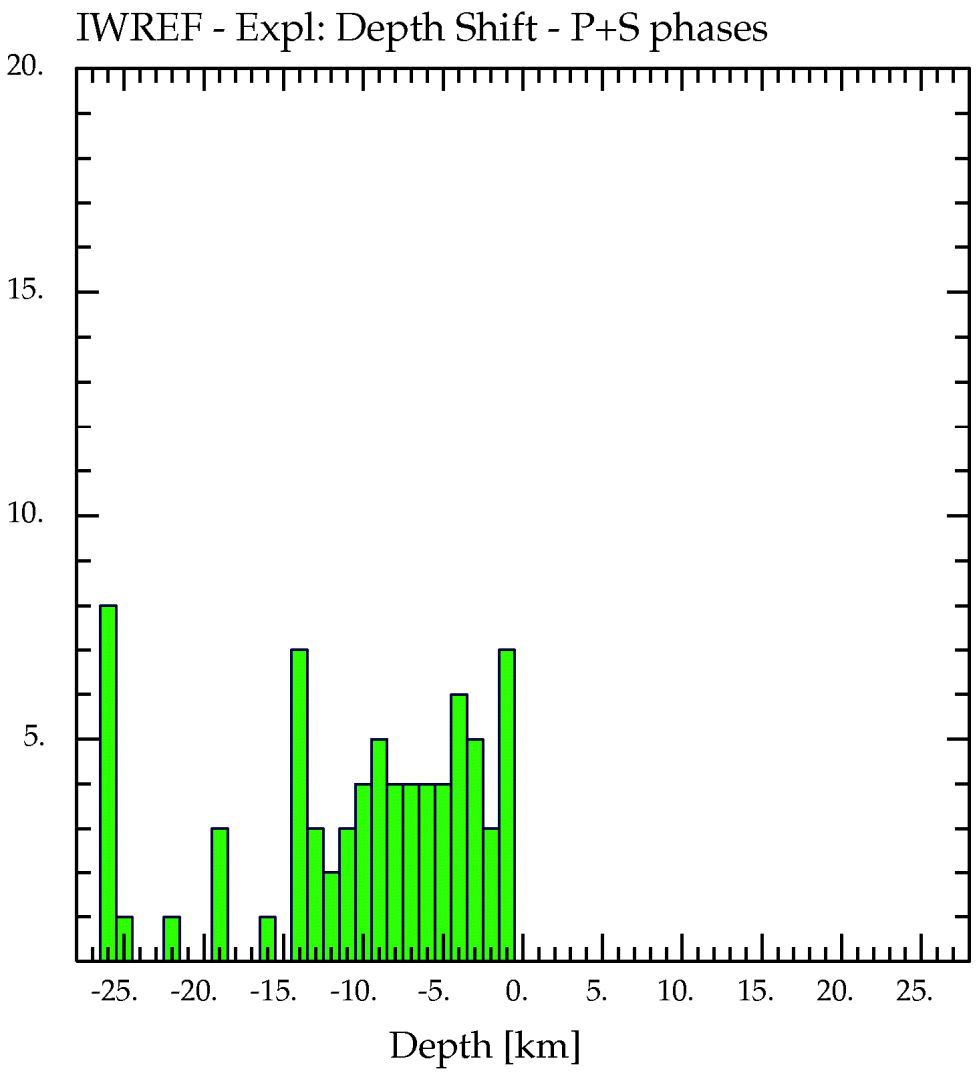
Explosions – Horizontal



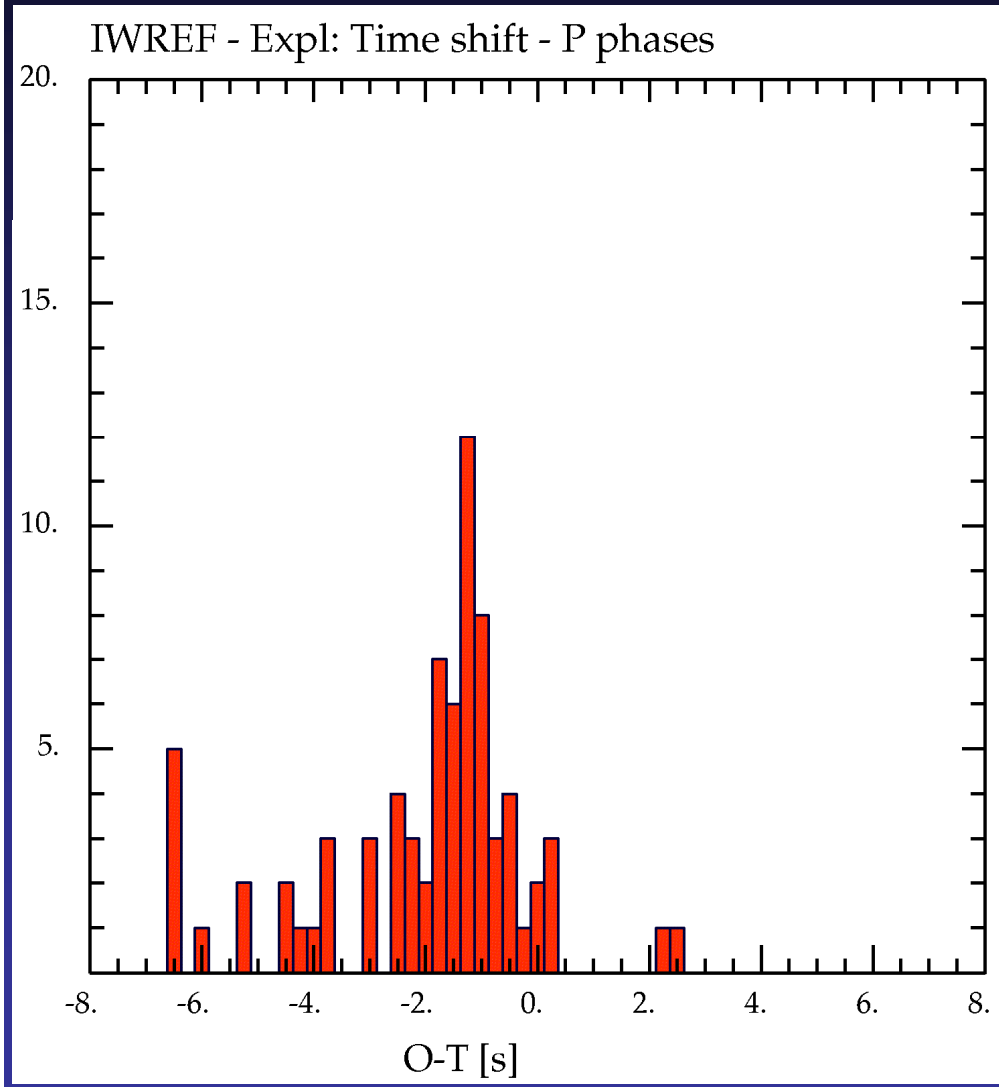


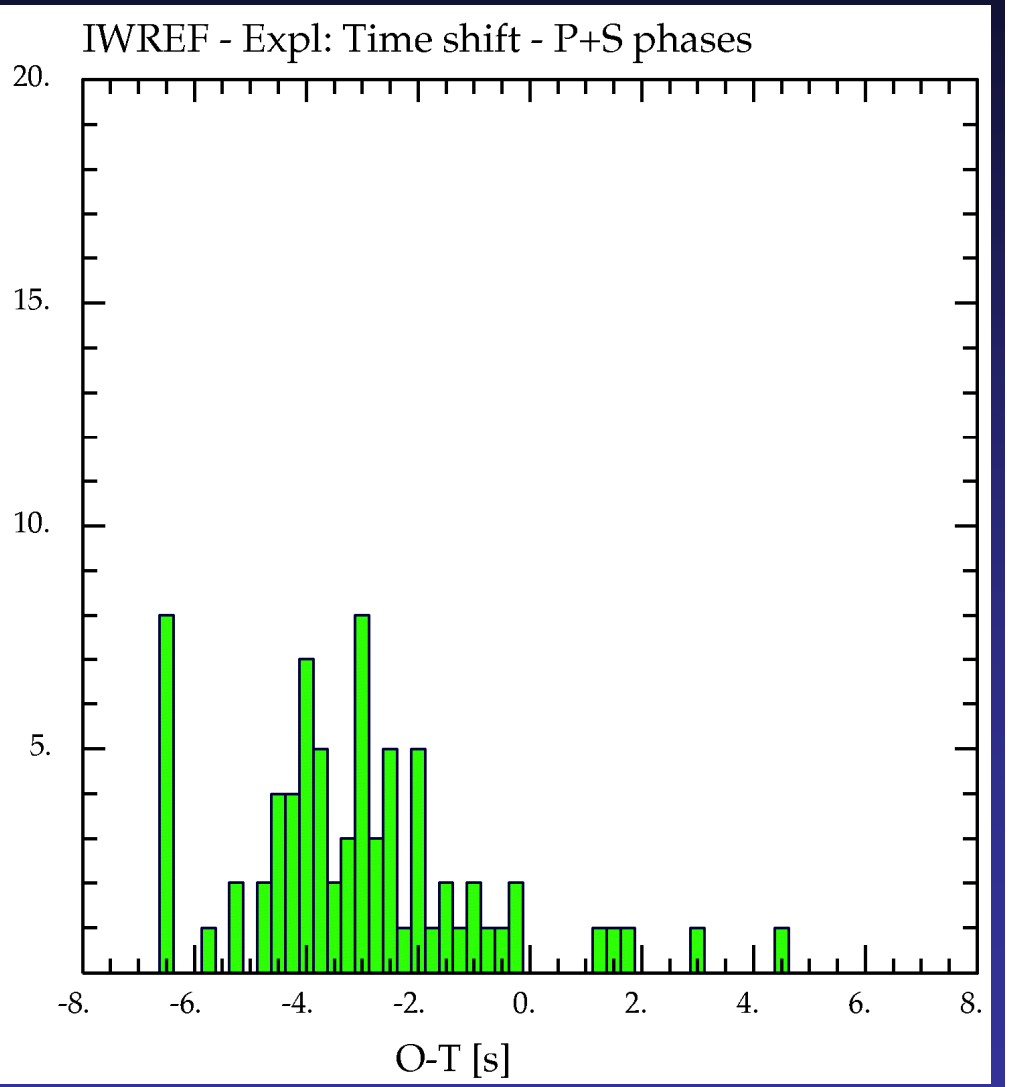
Explosions – Vertical





Explosions – origin time





Locations with ak135

- In the unconstrained inversions we can see the influence of heterogeneity and trade-off between depth and origin time even with nonlinear inversion
- *ak135* times are consistent between P, S and their depth phases so such readings can be directly incorporated
- Presumed explosions should be located with P phases
- Robust nonlinear inversion without need for phase selection could be a good starting point for later event refinement

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- Thanks to the staff at ISC for help with handling the ISF format!
- The shakeNA program is freely available for UNIX and Linux systems
- ak135 tables are now available from the IASPEI website

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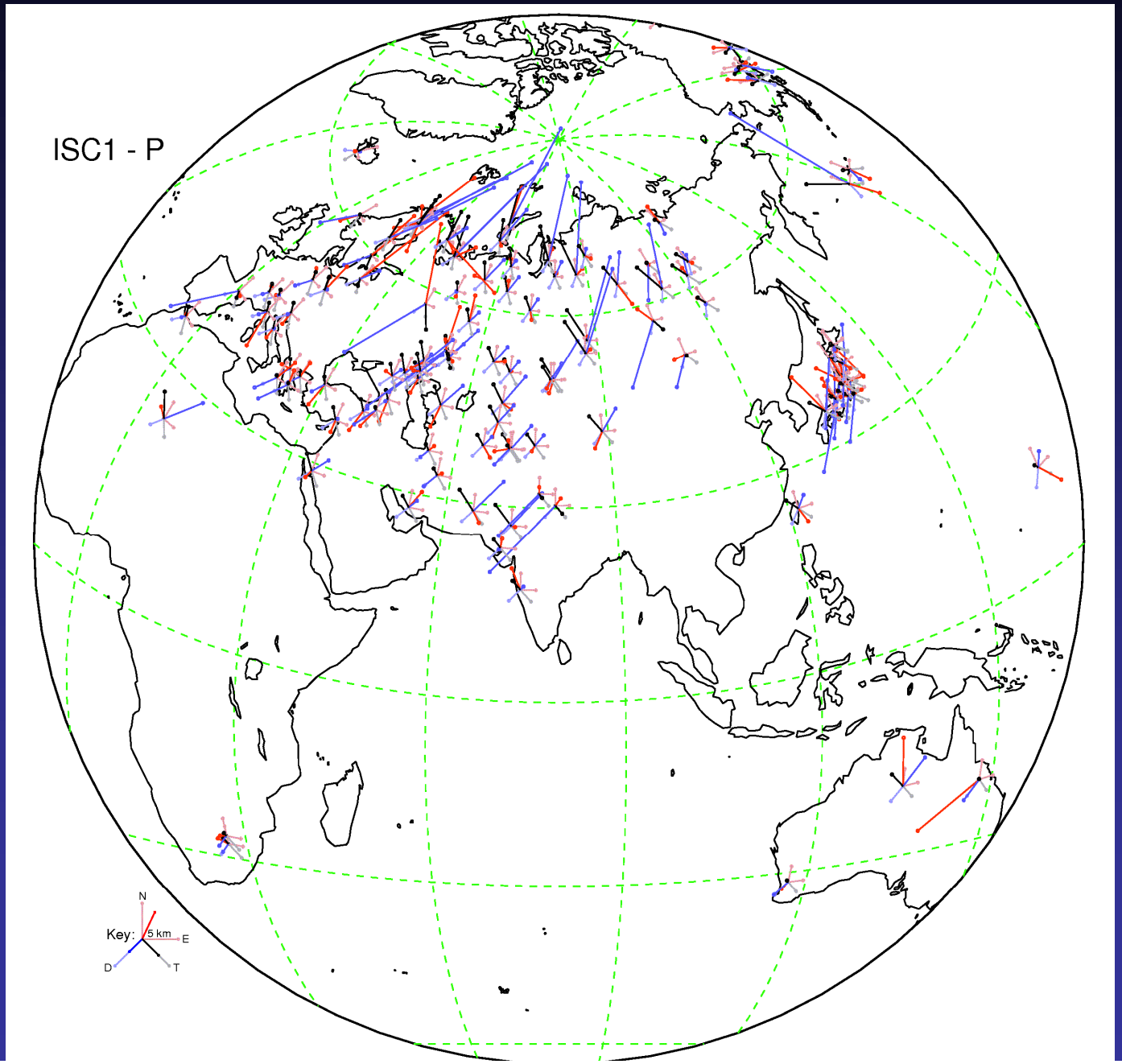
ISC1



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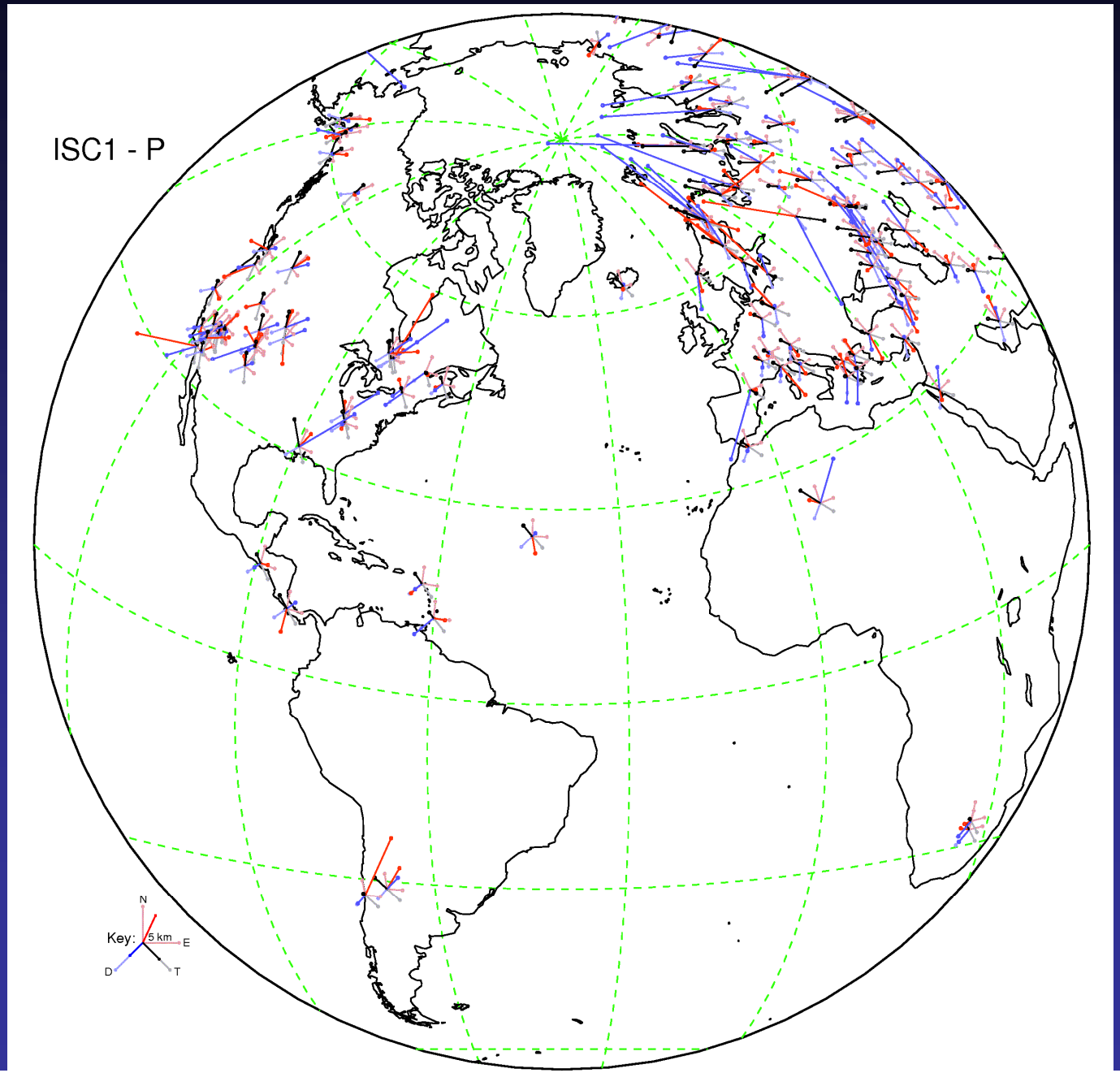

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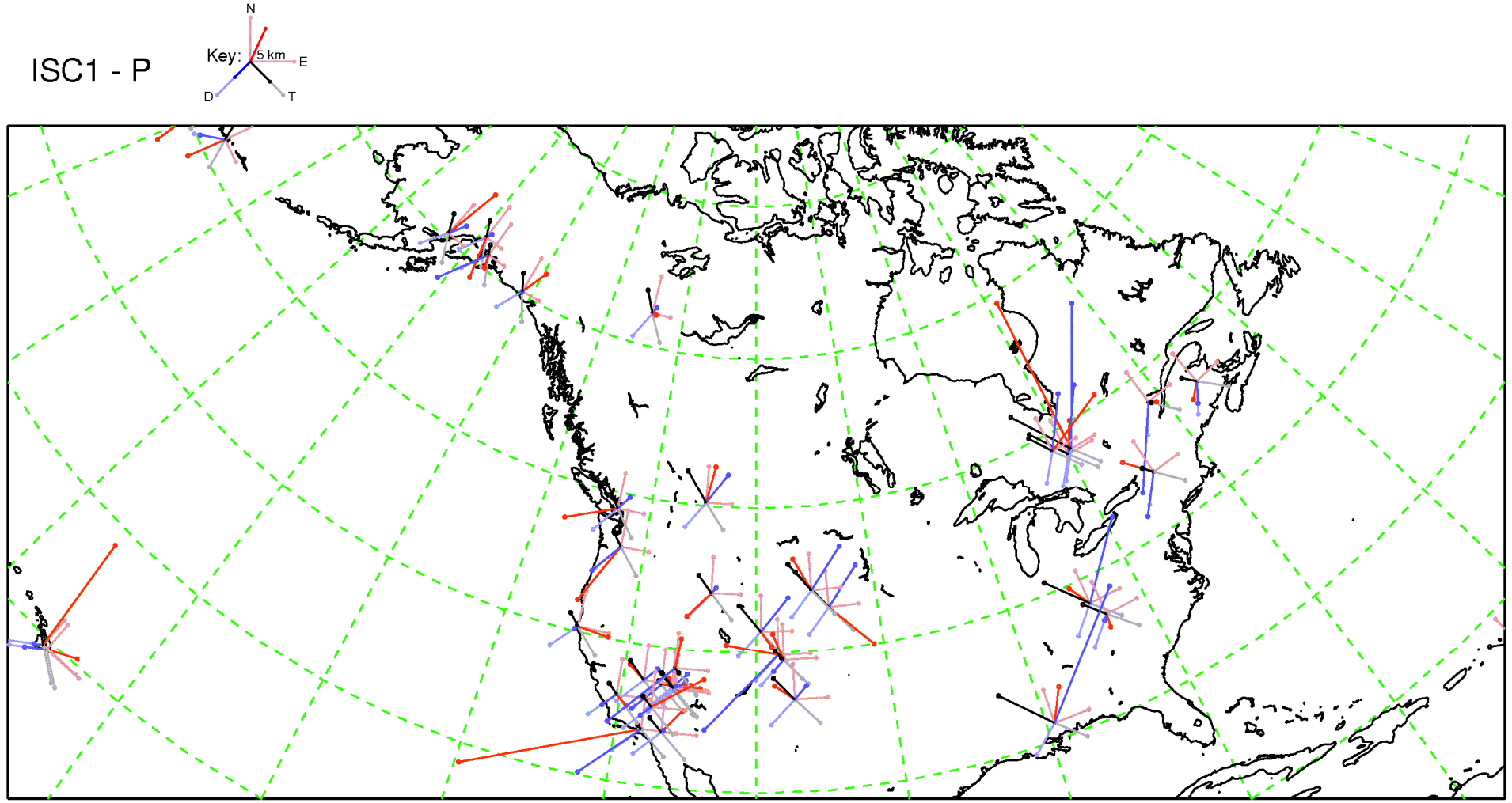

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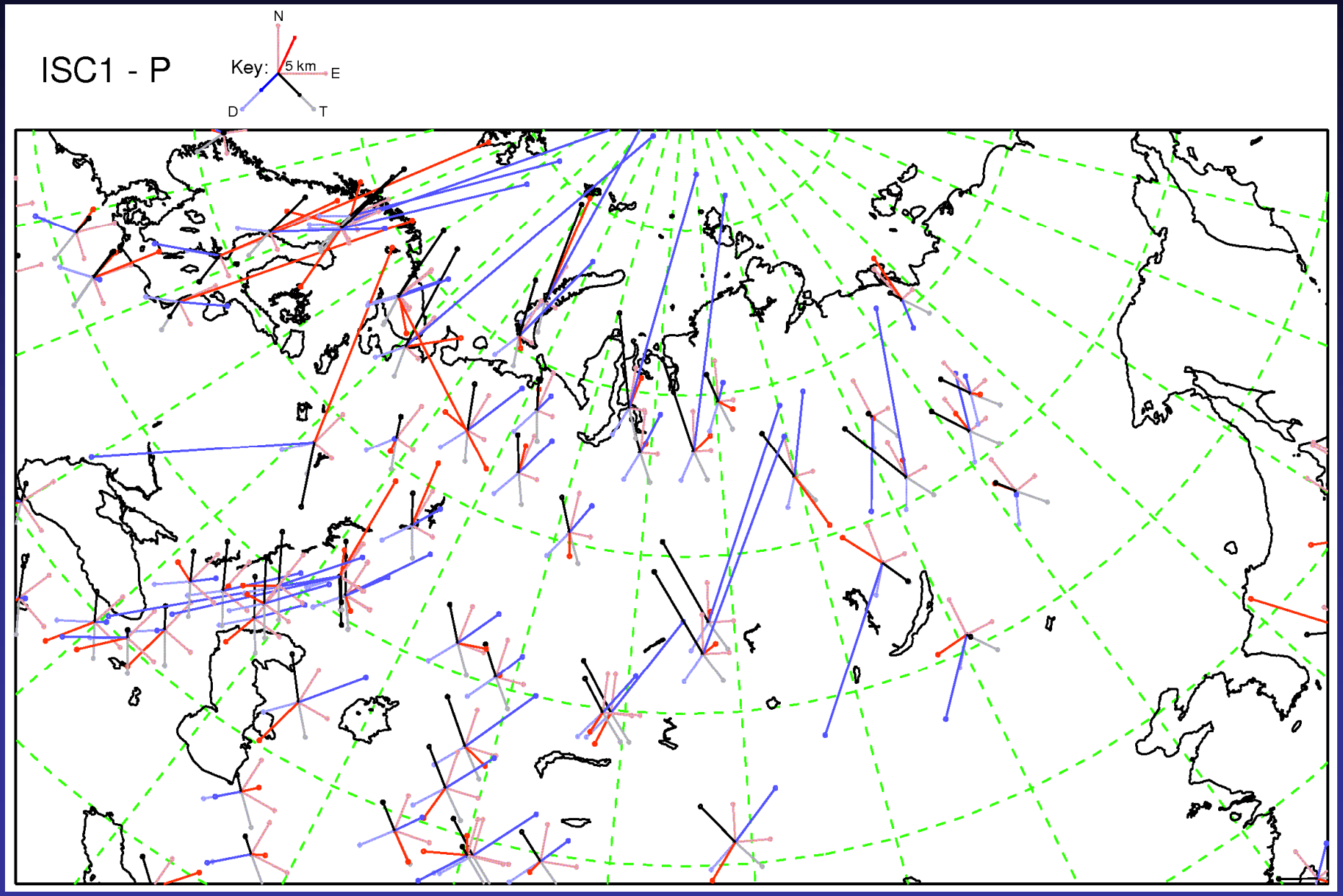

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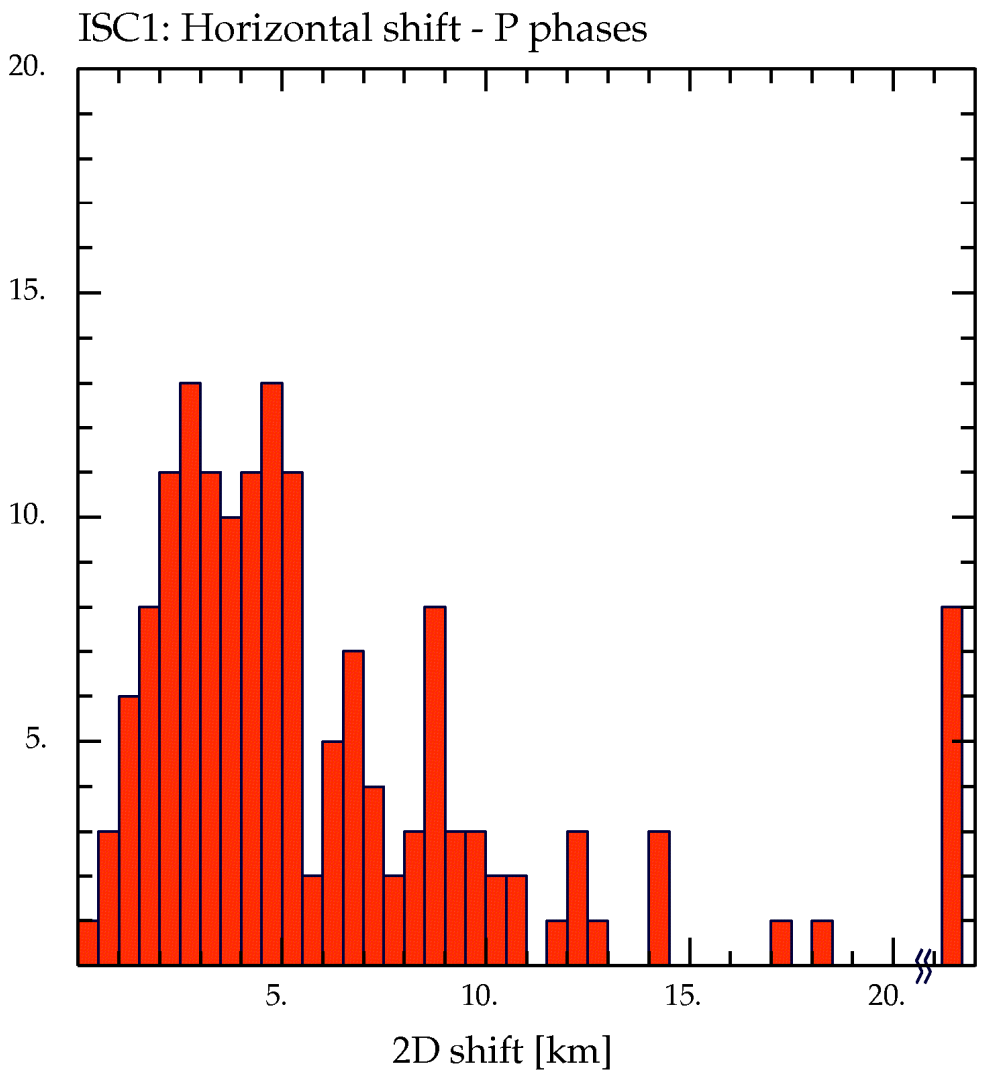

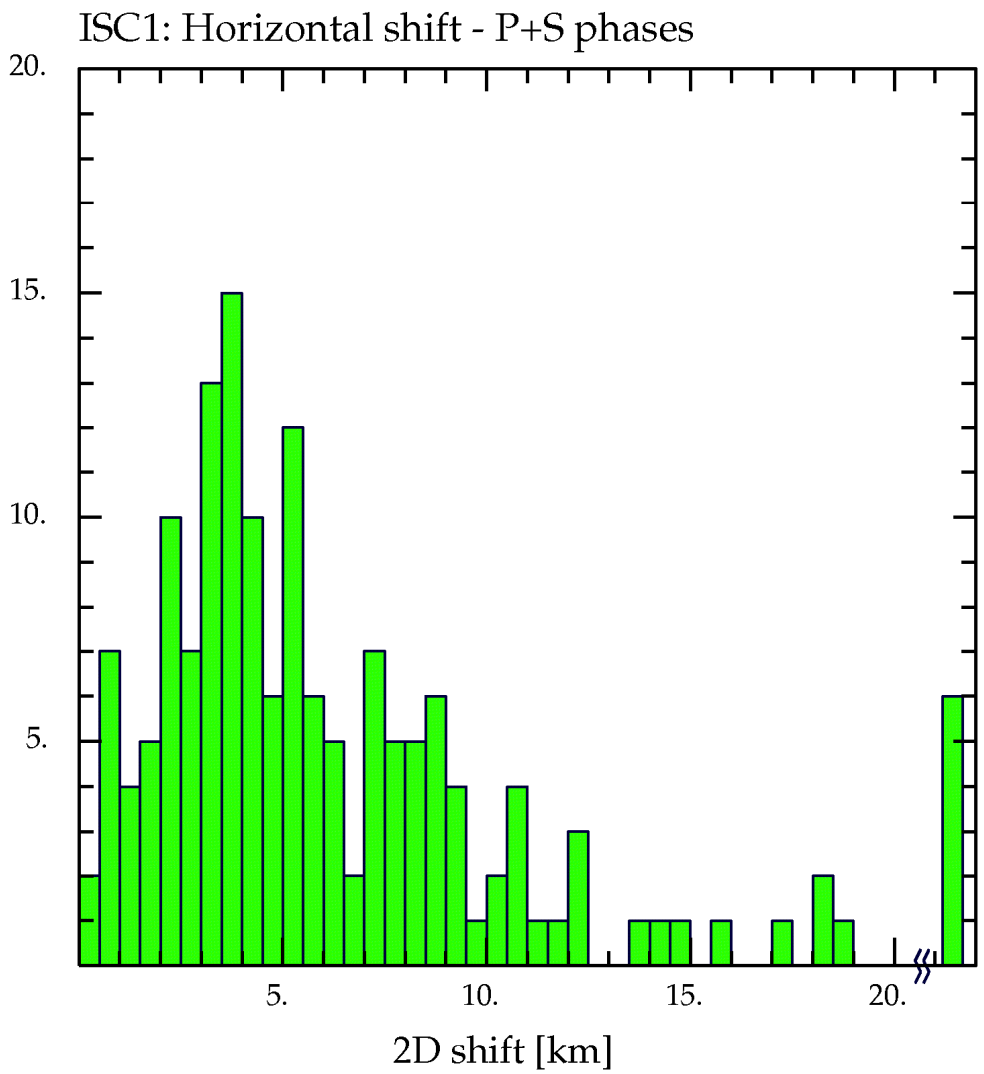

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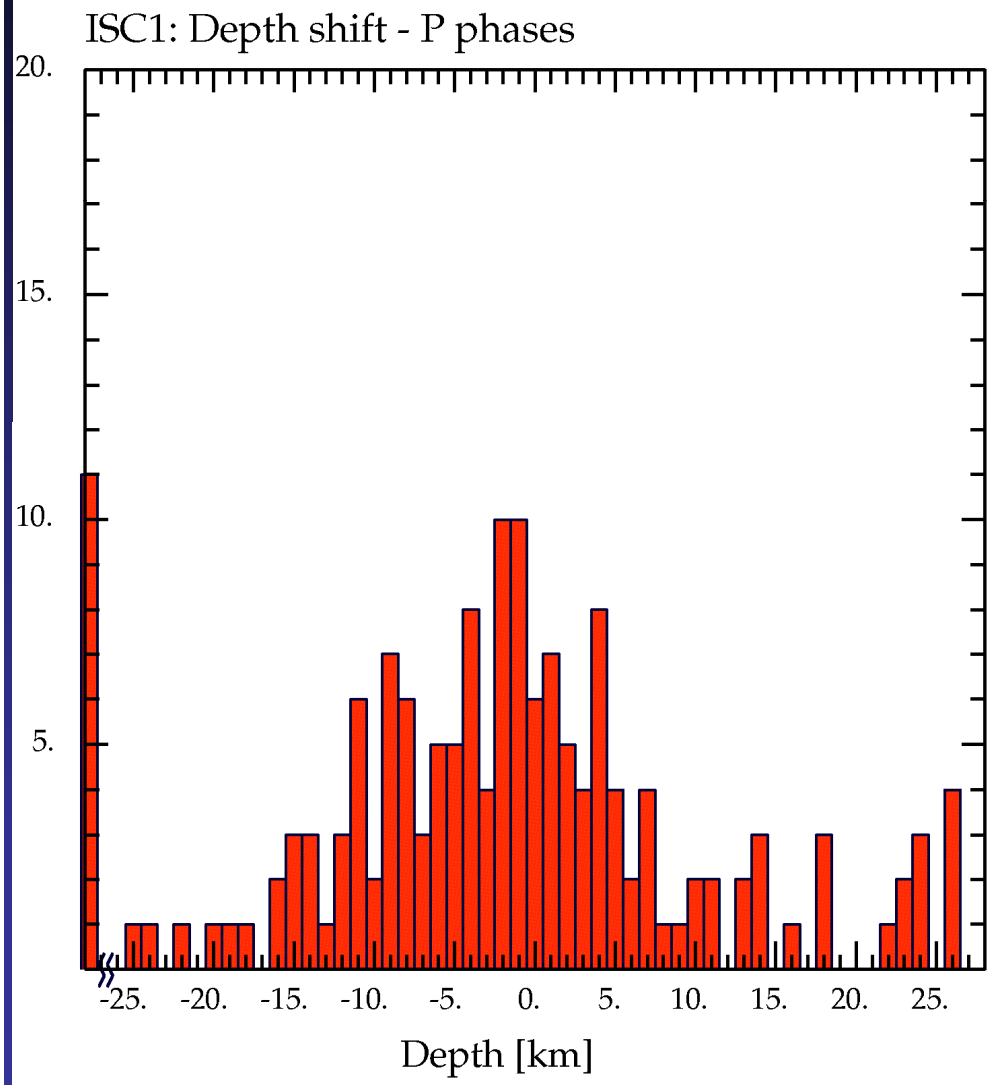

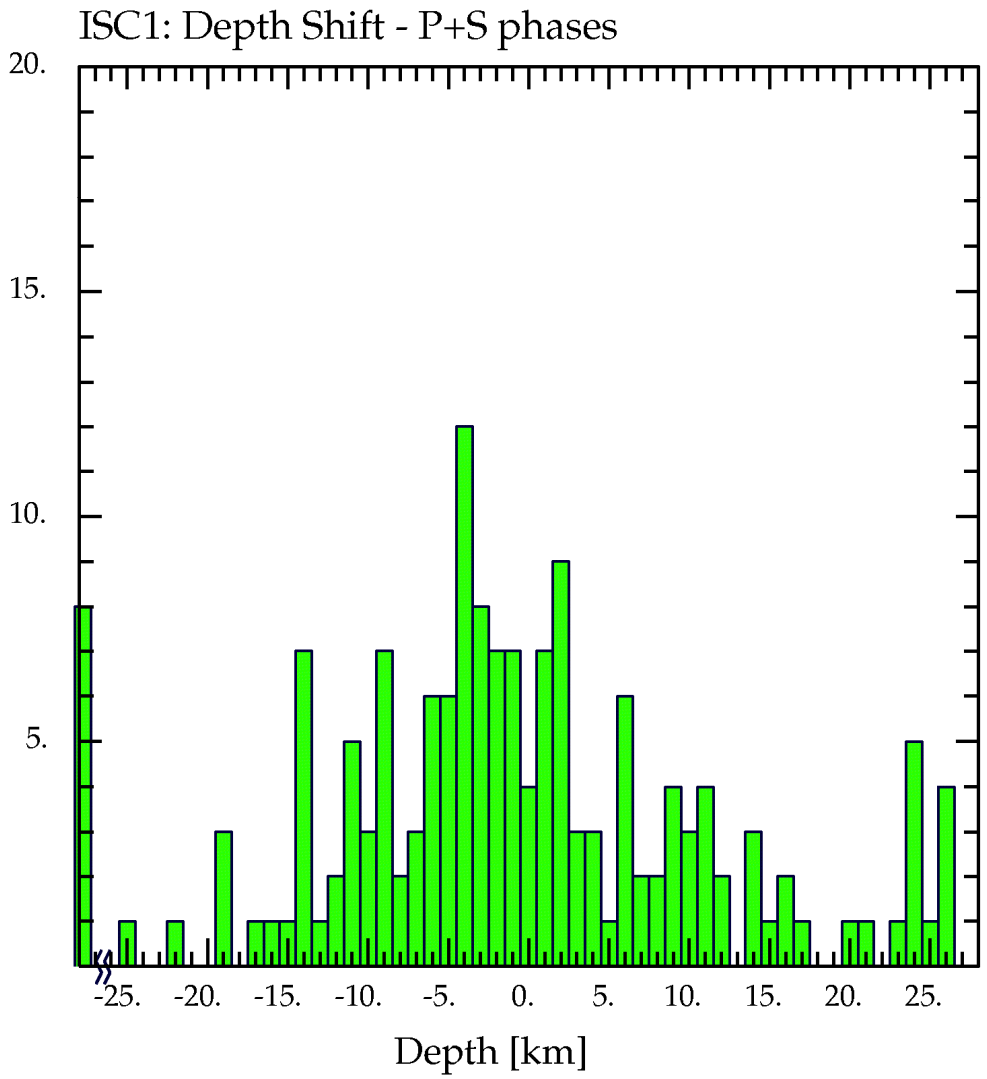

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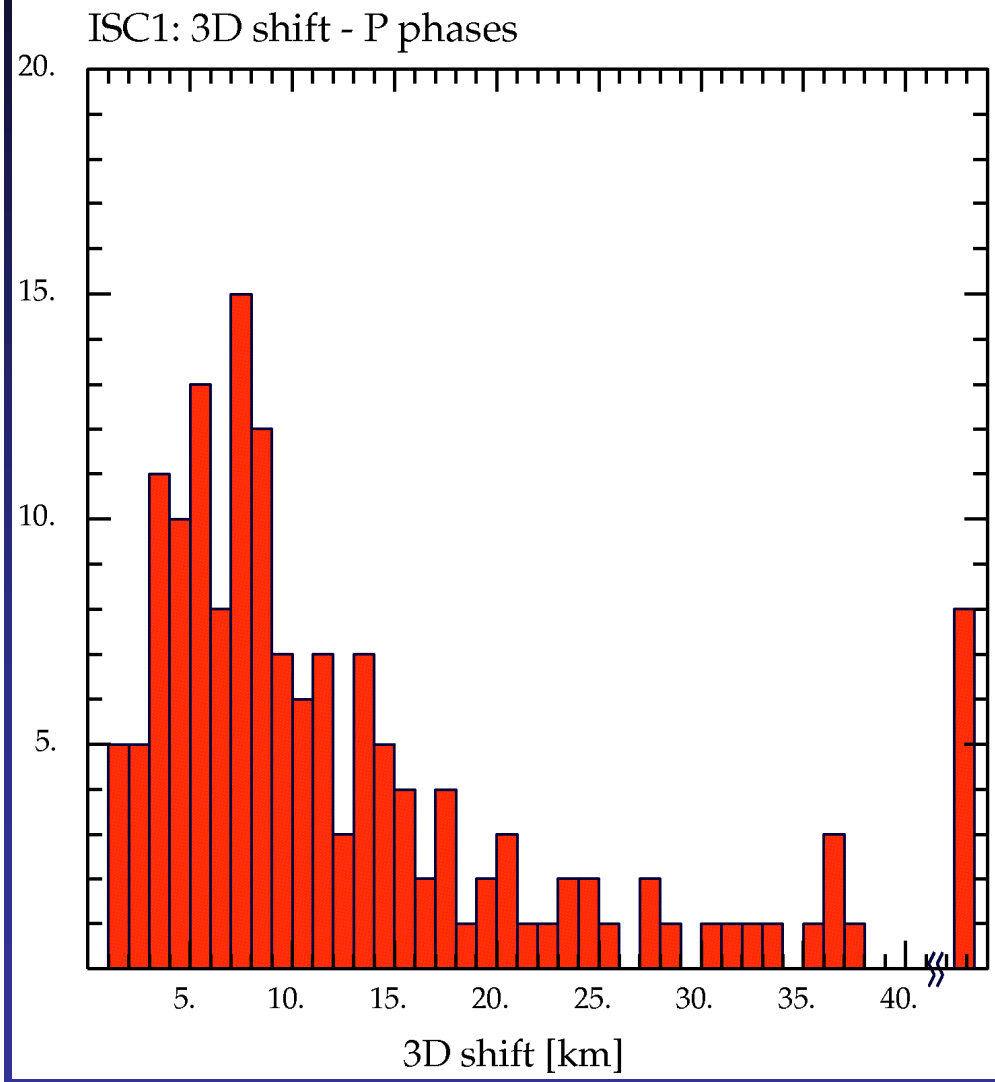

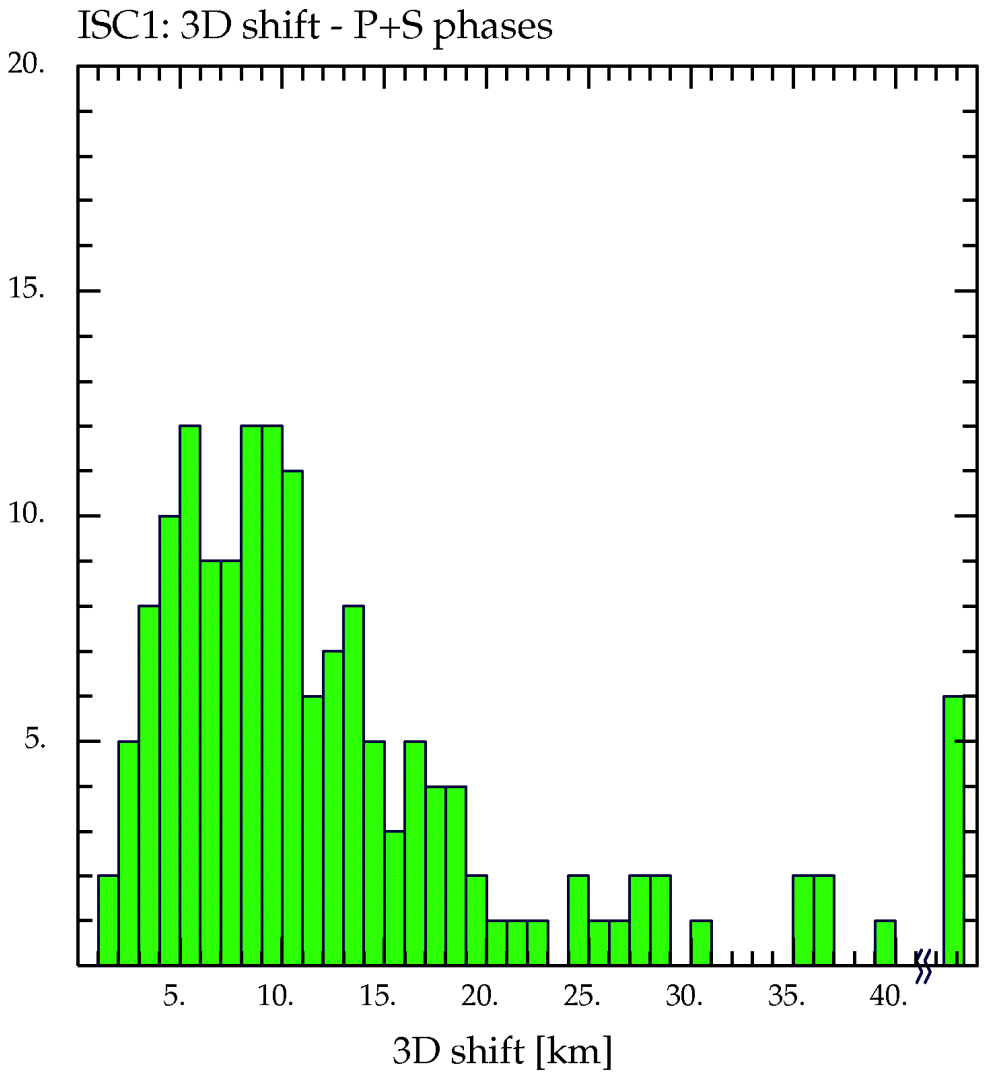

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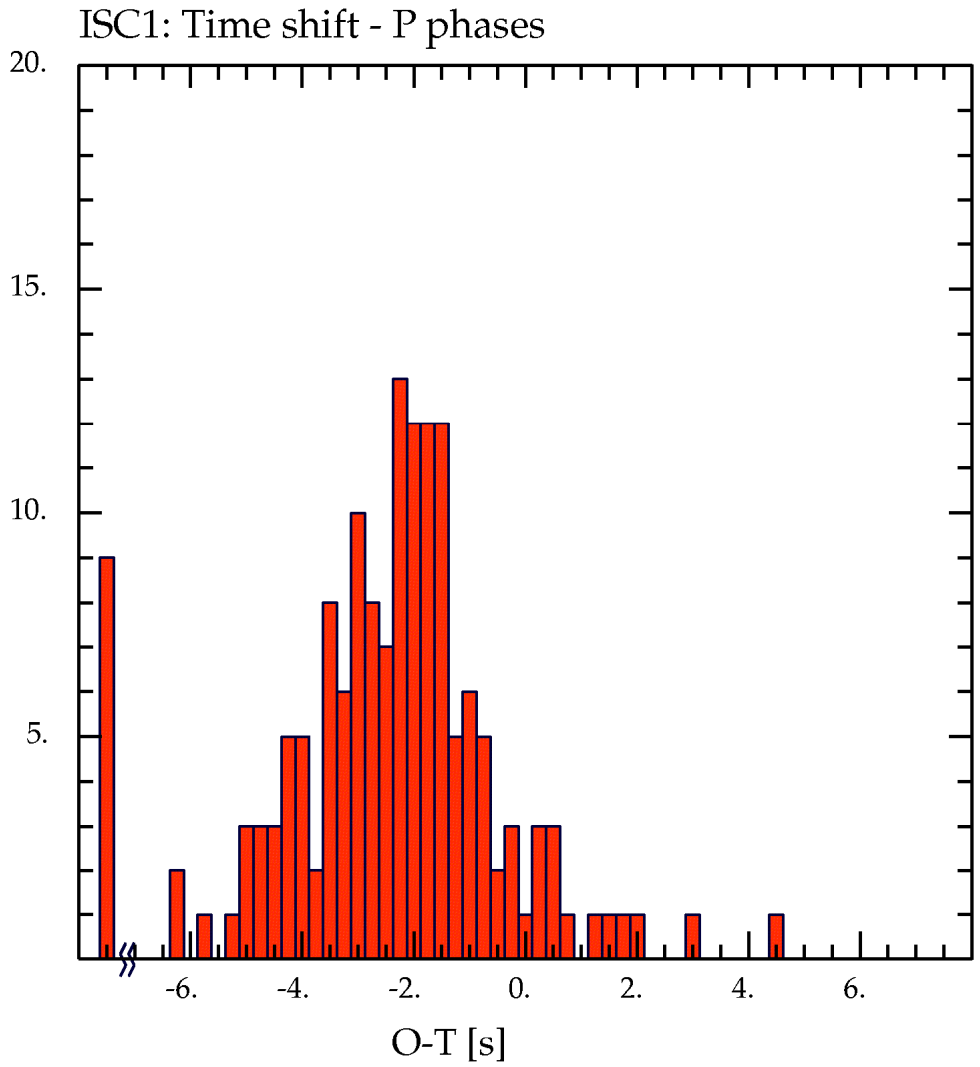

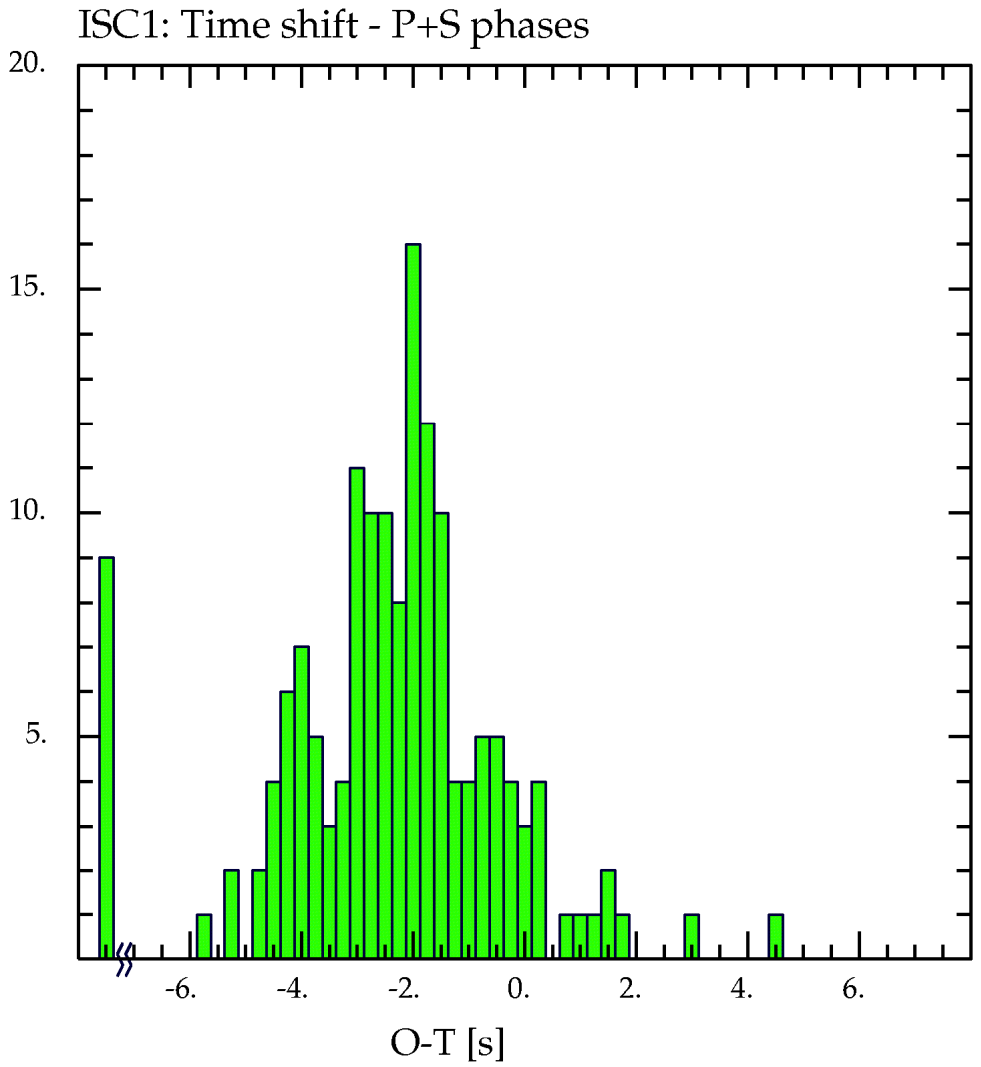

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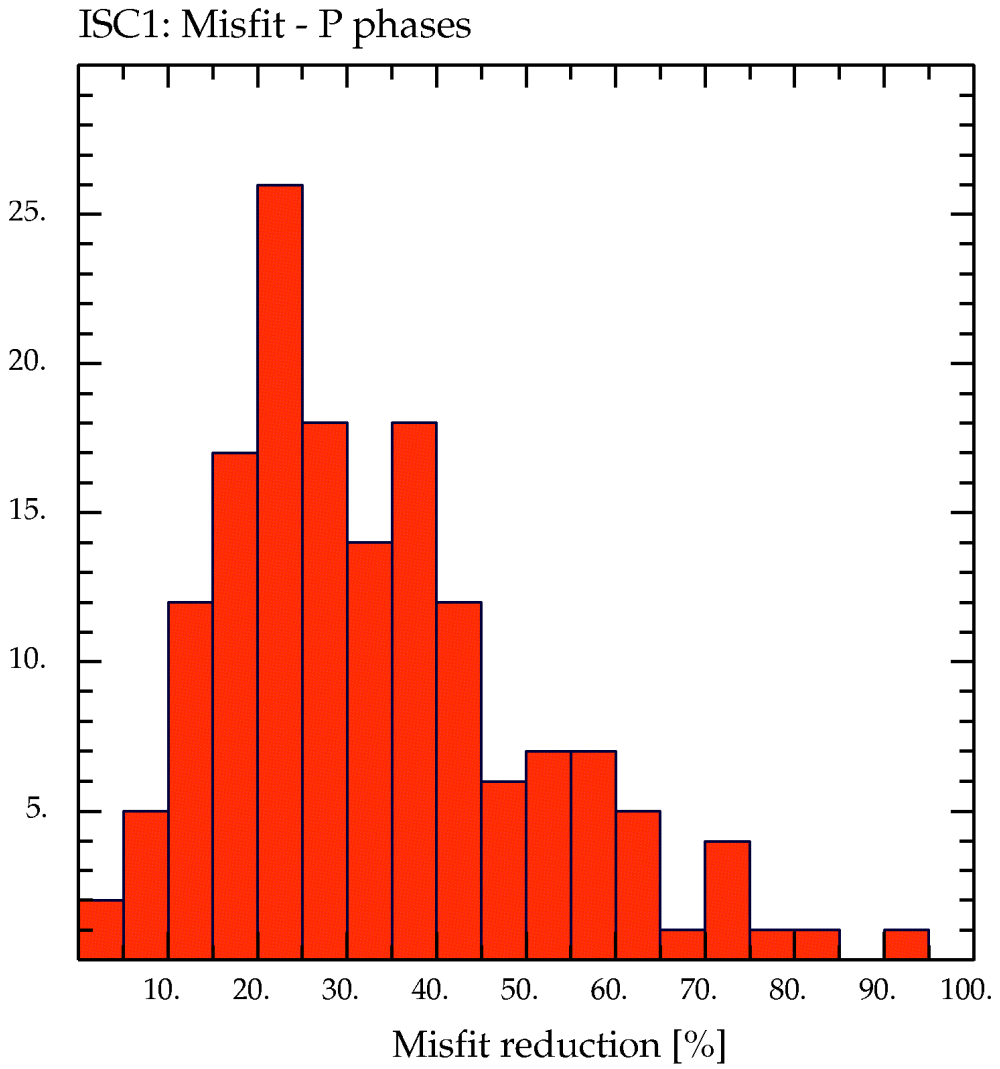
ISC1: Misfit - P phases
25.
20.
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30.
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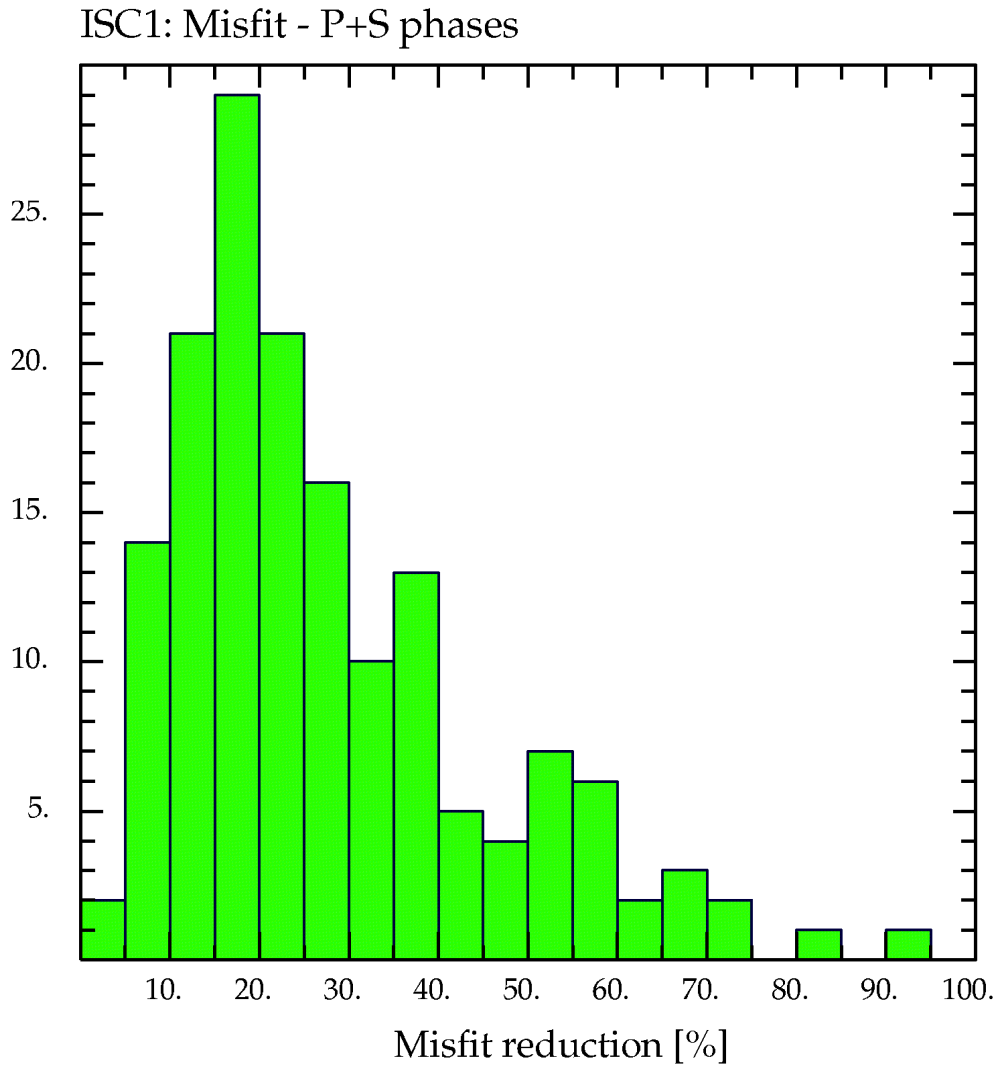
50.
60.
70.
80.
90.
100.
Misfit reduction [%]


ISC1: Misfit - P+S phases
25.
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70.
80.
90.
100.
Misfit reduction [%]