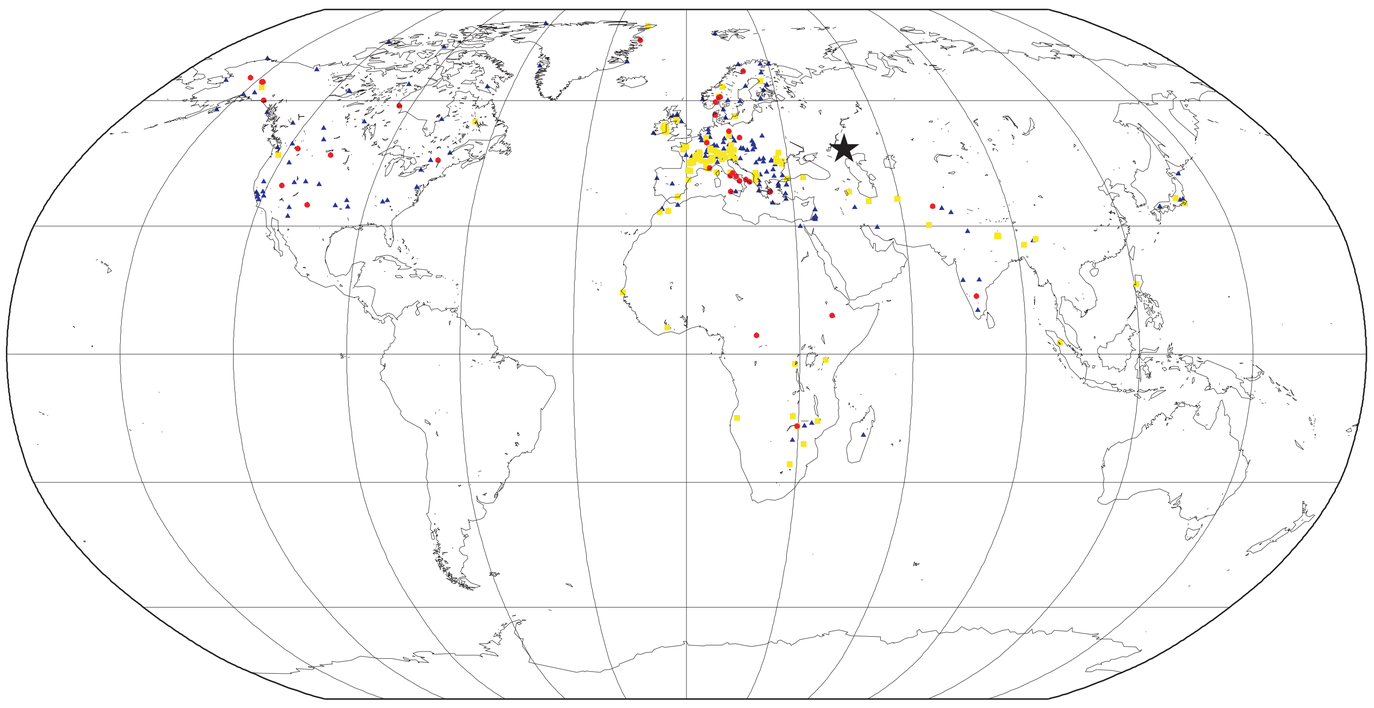
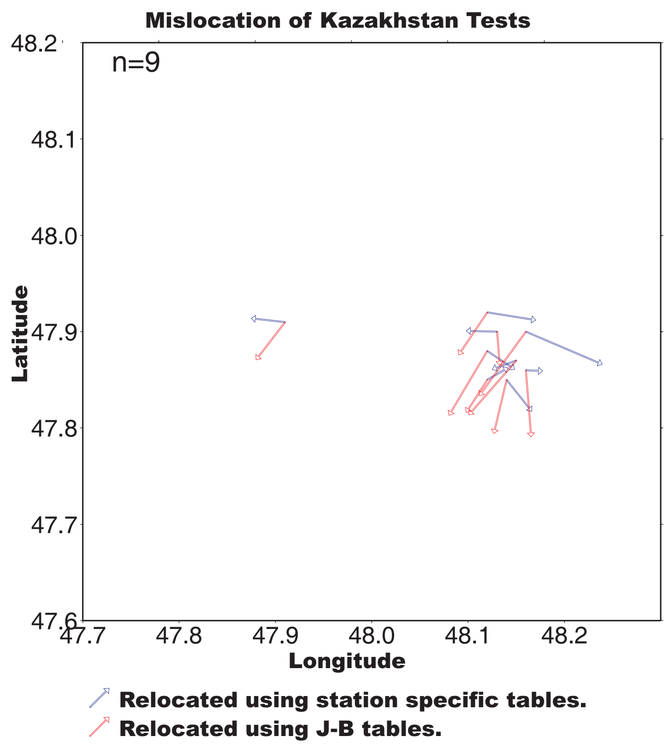
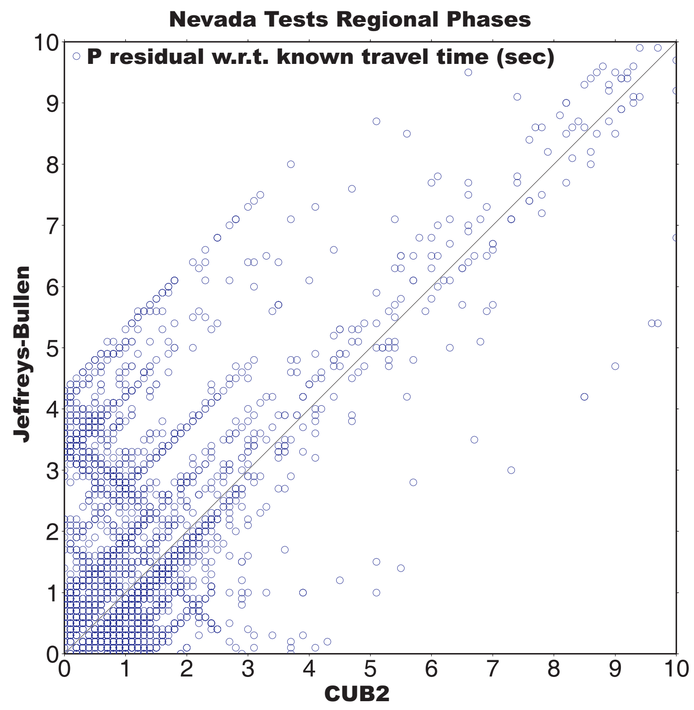


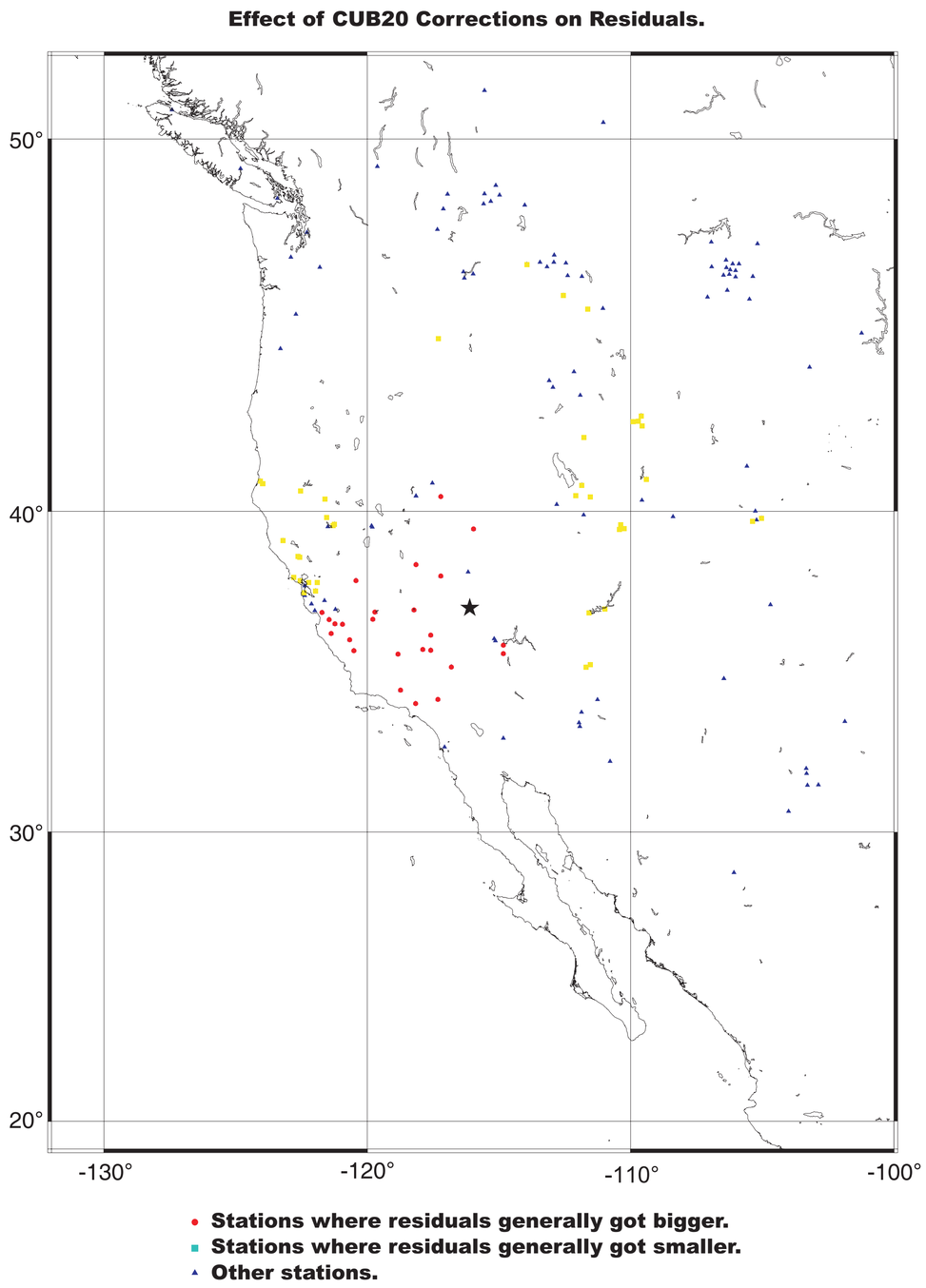
The residuals for the new travel time tables are better than Jeffreys-Bullen residuals for most stations reporting the Kazakhstan tests. There are however cases where the opposite is true and it would be interesting if there was a pattern as to which stations improved and which didn't. This map shows stations that contributed P phases to at least 3 of the test events and they are coloured to indicate whether the residuals for these phases are generally better or worse than they are using J-B. The green stations are those where residuals are better for more than 74% of events. The red stations are those where residuals are worse for more than 74% of events. Other stations are plotted in blue. No obvious geographical pattern can be seen in the distribution of stations although it is clear how few local stations there are in the ISC database that contribute to several of these tests. These tests are a better for testing the Harvard model we are using for distances greater than 20 degrees and do not contribute much data for consideration of the CUB2 model used for regional phases.



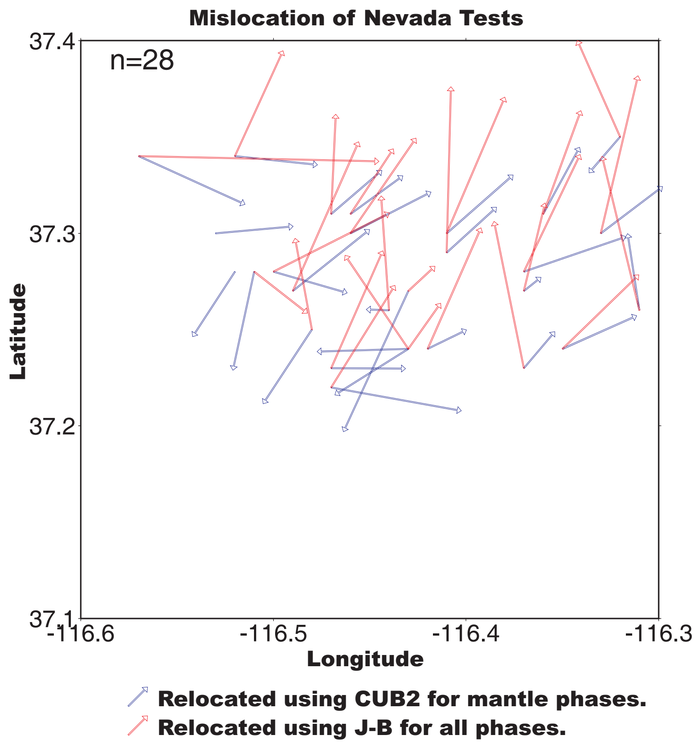
The majority of residuals with respect to known travel times for ground truth locations are smaller using the new travel time tables than when using Jeffreys-Bullen tables, as the ISC does now. One would thus expect more accurate results when free locations are carried out using the new tables. This is confirmed here where the two solutions are plotted as mislocation vectors in relation to the actual origins of one group of the Kazakhstan tests. The vectors for the new locations are shorter in every case than those for the current ISC solutions.



More than one source region needs to be considered when testing source specific travel time tables and the second set of ground truth events considered here is the nuclear tests in Nevada. So far the ISC has not calculated the travel times required to create tables for all of the stations that recorded teleseismic phases from these tests. Instead only regional stations are examined and so only the CUB2 model is being tested. It can be seen that residuals for the new travel time tables are smaller more often than the Jeffreys-Bullen residuals.



This map shows stations that contributed regional P phases to at least 3 of the Nevada test events. The green stations are those where residuals are better for the new travel time tables for more than 74% of events. The red stations are those where residuals are better for Jeffreys-Bullen tables for more than 74% of events. Other stations are plotted in blue. The stations very close to the events are missing because travel time correction tables have not been calculated for Pg. Doing so would be a challenge because of the abrupt discontinuities in the crustal model. This may also be the reason that most of the nearest stations investigated have residuals that are worse using CUB2 than using Jeffreys-Bullen, Pn waves travelling along the Moho will have been modelled over some sharp steps in Moho depth to calculate these travel times. One way to remedy this problem may be to replace the crustal part of CUB2 with a simple two layer crust for small delta and we are experimenting along these lines at the moment.



Despite the problems with nearby stations, residuals from the CUB2 tables are generally smaller than those from Jeffreys-Bullen and so one would expect locations to be more accurate using the new tables. This is shown to be true here for one group of the Nevada test events. The two blue vectors on their own indicate events where a solution was not achieved using J-B travel times but where a convergence was reached using the new travel time tables.

Conclusion

The use of travel time tables calculated for each station using detailed earth models has been shown to improve relocations of ground truth events in Kazakhstan and Nevada. This indicates a possible avenue for the ISC to pursue to make their reloctaions more accurate. However, it would be necessary to calculate and store a set of travel time tables for over 2000 stations for at least P, S and crustal phases. Even at a reasonably coarse spacing in azimuth and delta and at a limited selection of depths this would require over 3000 Mbytes of data. Currently, travel time tables are held in memory by the relocation program but this strategy would have to be reassessed for such large amounts of data. One solution would be to populate the tables sparsely with only those areas of the globe where events have actually been recorded by a given station having travel times included.

If the ISC decide to adopt these type of travel time tables then much more testing is necessary before they can be included in normal procedures, both to prove that a significant improvement in earthquake location is achieved in comparison with the use of existing travel time tables and to fine tune the way that the new methods are applied. Potential problems such as inaccuracies at small delta will have to be addressed. A workshop is planned at the IASPEI general assembly in autumn 2005 to discuss recent developments in earthquake location. This will be an ideal forum to discuss which global models are at that time best for ISC purposes, as well as to consider solutions to possible problems.