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To: ECGVM Workshop
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Subject: Using atmosphere error characteristics to improve analysis

1. Objective

Illustrate dependence of atmosphere error on latitude and elevation and suggest changes to analysis procedure.

2. Latitude dependence of mapping function error

The height error introduced by mapping function error varies with latitude and differs for hydrostatic and wet components. This dependence on latitude for the hydrostatic components of NMF, IMF (Niell 2001), and VMF (Boehm and Schuh 2004) are shown in Figure A.

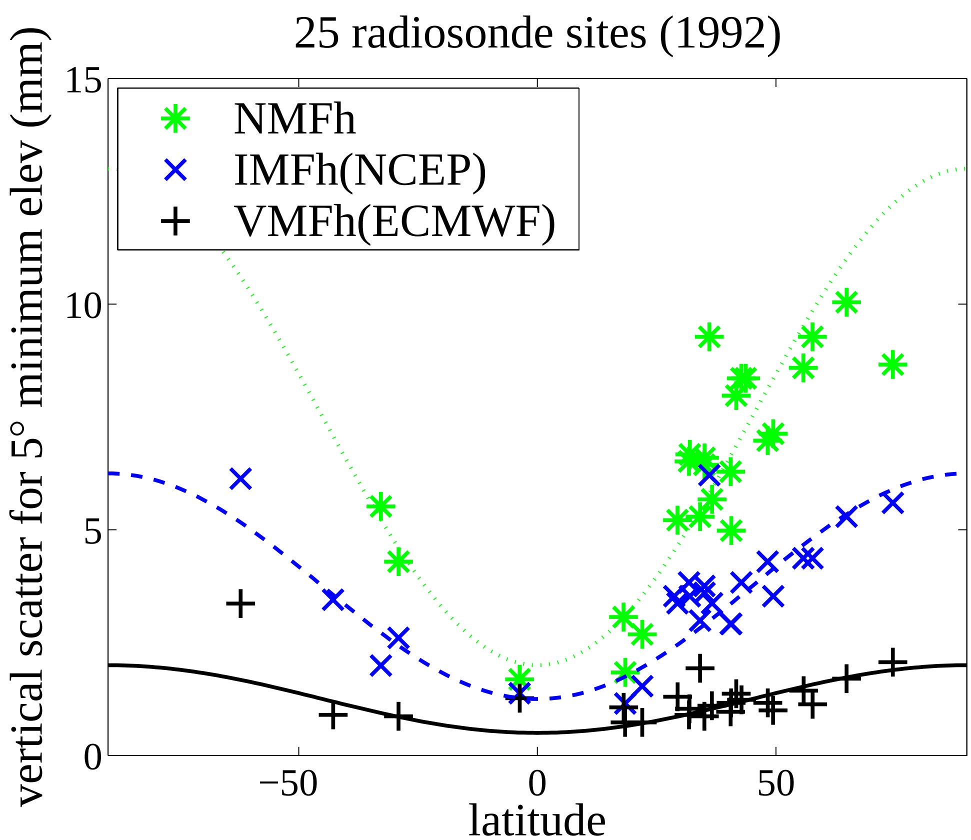

Figure A. Latitude dependence of hydrostatic mapping functions.

The height error for the wet mapping functions is shown in Figure B.

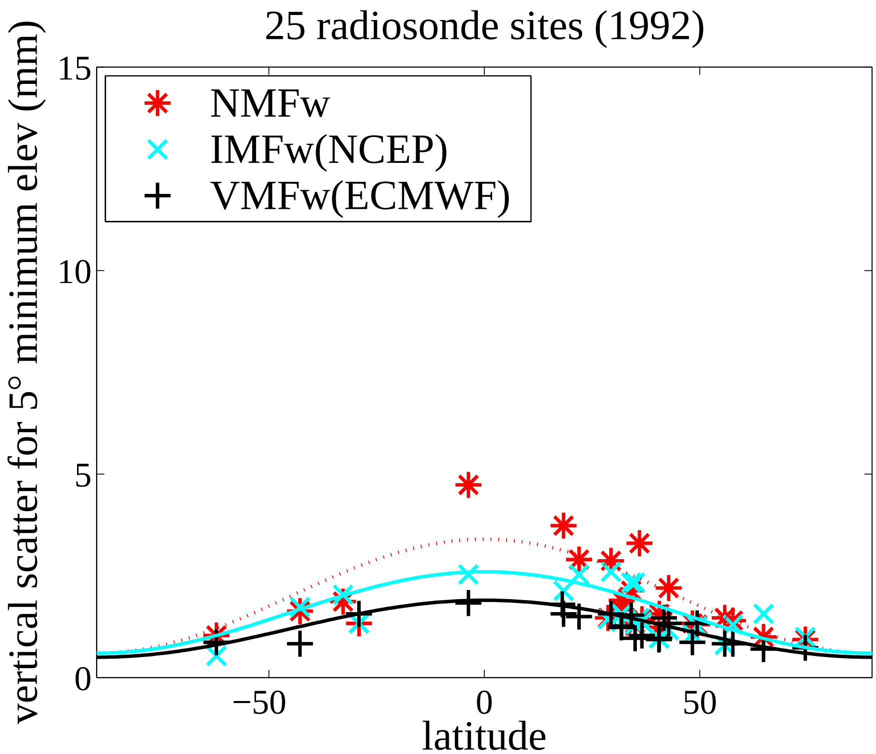

Figure B. Latitude dependence of wet mapping functions.

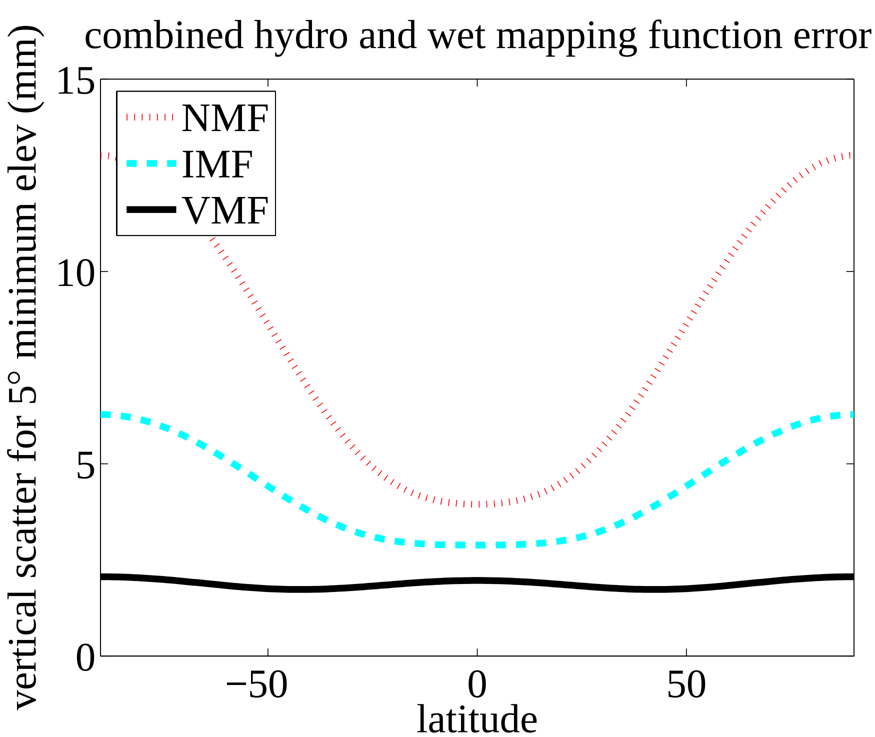

Figure C. Latitude dependence of combined hydrostatic and wet mapping functions for each of NMF, IMF, and VMF.

In Figure C is shown the quadratic sum for each of the three mapping functions The uncertainty on each curve could be as large as 25%, but the relative values should correspond better than this.

3. Minimum elevation dependence of mapping function error

The effect of a mapping function error is strongly dependent on the minimum elevation of the observations retained in the solution. The relative values are illustrated in Figure D, which happens to be for NMF, but, for relative values, should apply to all of the mapping functions. The error at 5° is reduced to about 1/3 for 7.5° and to about 1/5 for 15°. Other tests suggest even larger reduction in the sensitivity at 15°.

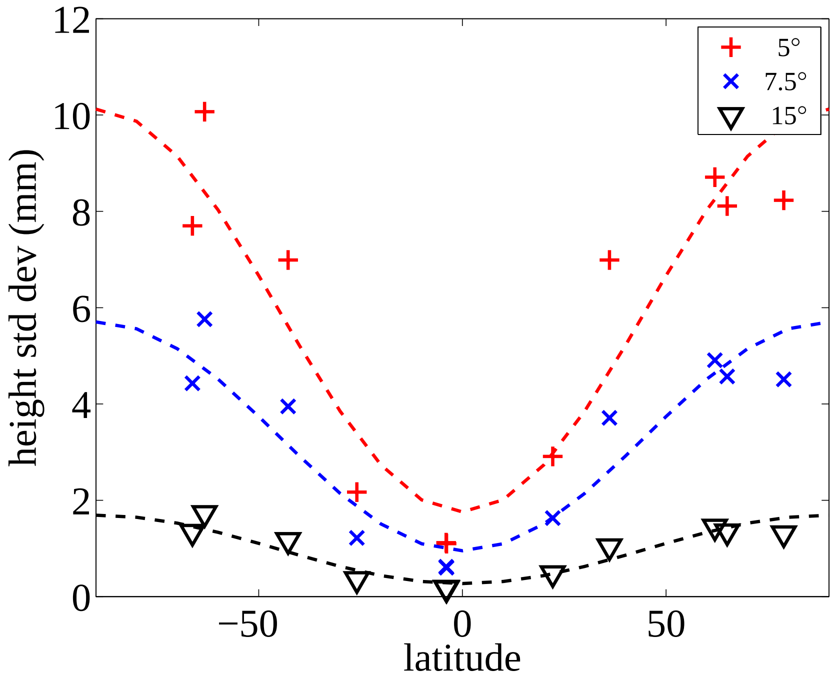

Figure D. Minimum elevation dependence of error in height due to mapping function error (from GPS simulations).

4. Combining the latitude and minimum elevation dependence

Since the geometric strength improves with lower minimum elevation, and thus reduces the height error, while the height error due to mapping function error increases with lower elevation, the optimum minimum elevation can be evaluated. An example obtained by using GPS observations is shown in Figure E.

This figure is representative for GPS sky coverage and mapping function error at mid-latitudes. It illustrates that the minimum elevation should be reduced from 10° to 7° as better mapping functions are adopted. At the same time the height uncertainty might improve by as much as 25%. For the GPS simulation, these numbers take into account correlations of the height, atmosphere, and clocks. From Figure C it is clear that when using NMF the minimum elevation should be a strong function of latitude. However, with IMF or VMF the benefit of latitude dependence is not so evident since the sky coverage of the antenna must also be taken into account.

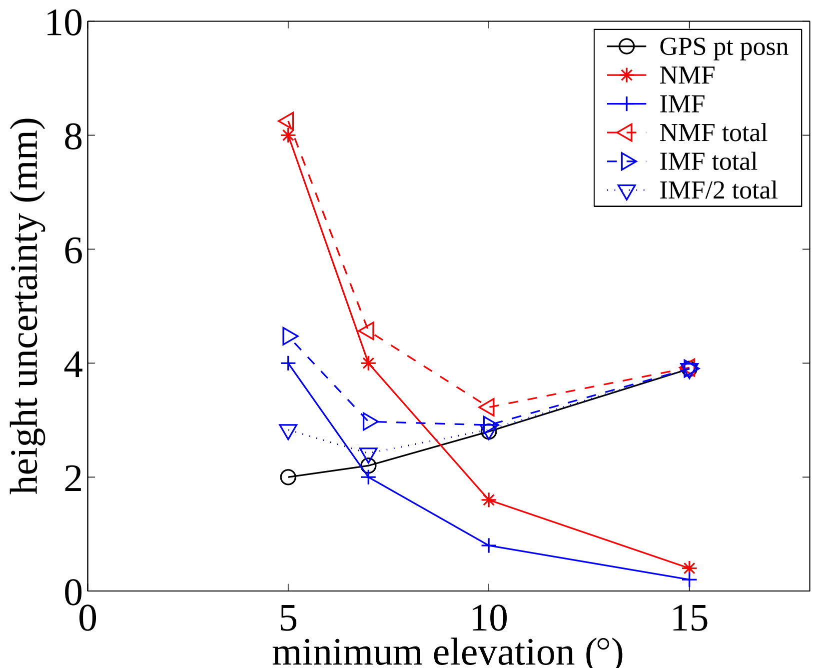

Figure E. Choosing the minimum elevation for observing based on error in height due to mapping function error and expected uncertainty due to other errors.

5. Comments

This note is intended only to illustrate that knowledge of the characteristics of an error source, in this case the atmosphere mapping functions, can potentially be used to improve the quality of the data analysis.