Long-term ZTD and ZWD series and climate normals using NCEP1

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Objective

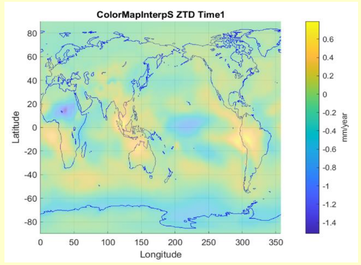
Assess the impact of using normals of different length in zenith total delay (ZTD) and zenith wet delay (ZWD). For this purpose, we used ZTD and ZWD generated by the UNB Vienna Mapping Function service alimented with data from National Centers for Environmental Prediction (NCEP1). The NCEP1 contain data since 1948 and is thus a database that will allow us to detect temporal changes over a time frame longer than those of other reanalysis centers. We computed and compared normals using time periods equal to 1 year, 5 years, 10 years, 15 years, 20 years and 30 years.

Methodology

The methodology used in this work is portrayed by the flowchart in Figure 1. It shows the flow starting from the extraction and stacking of the ZTD and ZWD values from the VMF1 grids, quality control following criteria suggested by the WMO, and the computation of the trends either ignoring annual trends or removing them.

The annual component was removed by a simple removal of a sine wave with a period of approximately one year. Our initial expectation was that the removal of the annual component would be mostly visible in the short averaging windows, 1 year and 5 years, because of the characteristics of the process of averaging, which can be considered a low pass filter, tends to eliminate the effect of the seasonal component as the window increases. Colour maps were also built, with and without the seasonal component, to visualize the results.

Trend in ZTD



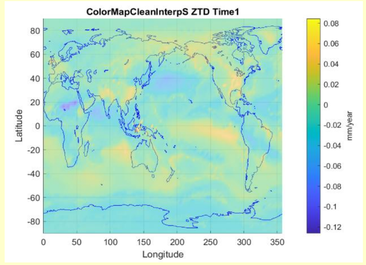
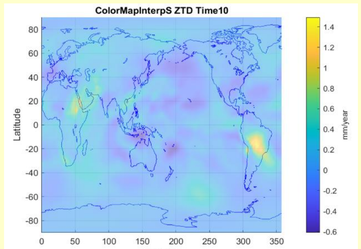


Figure 1 – 1-year normals; left (with annual component); right (annual removed)



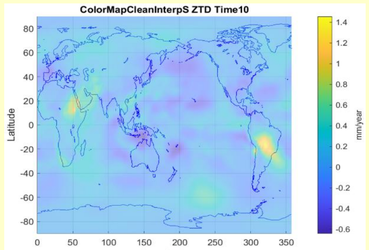
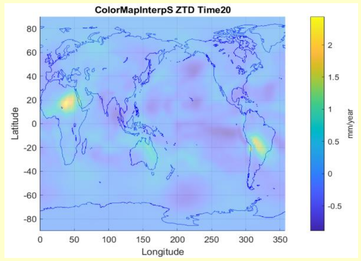


Figure 2 – 10-year normals; left (with annual component); right (annual removed)



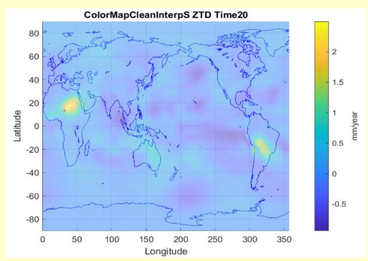
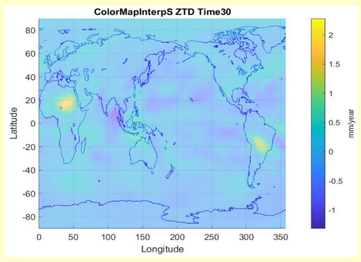


Figure 3 – 20-year normals; left (with annual component); right (annual removed)



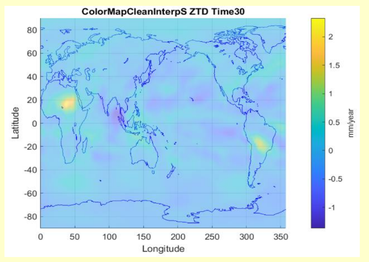
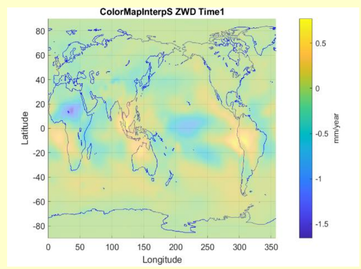


Figure 4 – 30-year normals; left (with annual component); right (annual removed)

From the 10-year window onward the difference between maps with and without the seasonal component becomes less and less noticeable.

Trend in ZWD



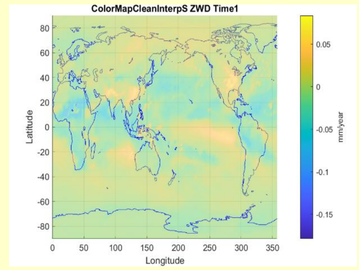
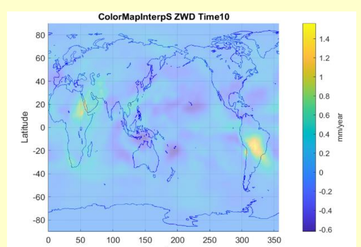


Figure 5 – 1-year normals; left (with annual component); right (annual removed)



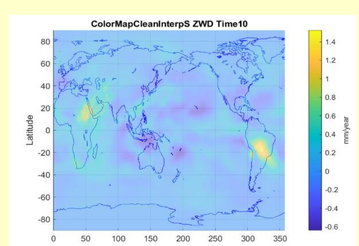
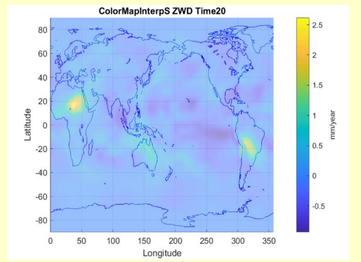


Figure 6 – 10-year normals; left (with annual component); right (annual removed)



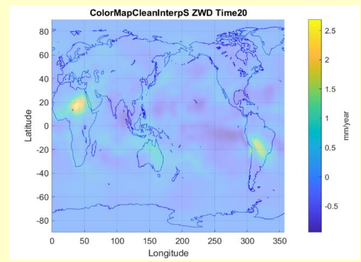
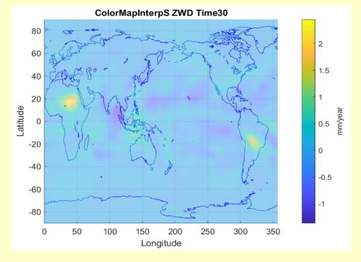


Figure 7 – 20-year normals; left (with annual component); right (annual removed)



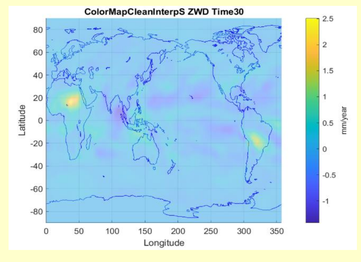


Figure 8 – 30-year normals; left (with annual component); right (annual removed)

It seems contribution from water vapour is dominant in ZTD.

Future comparisons with trends computed from GNSS-derived ZTD and ZWD series to be included (with the caveat that time period for such comparisons must be shorter).

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