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Storm surges prediction and sea level rise along the Danish North Sea coast from tide gauges and satellite altimetry

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Satellite altimetry can be used for storm surge application by assimilating sea surface height data in to operational models and for calibration purposes and in some regions this can improve storm surge warning capabilities quite dramatically. However, satellite altimetry is limited in both temporal and spatial sampling. Despite this, it is demonstrated that satellite altimetry in the North Sea captures all extreme water situation along the coast of Denmark and that that storm surge warning can be improved by incorporated satellite altimetry.
Based on GPS-measurements at permanent stations, long tide gauge secords (+100 y) and three national high-precision leveling campaigns performed over the last century absolute height changes at tide gauge show absolute land uplift rates between 0.61 mm/y at Esbjerg in the SW part of Denmark to 2.08 mm/y at Frederikshavn in the northern part. Rates of absolute SLR are close to the global average for the century with a mean value of 1.83 mm/y (1.64 - 2.21mm/y) from the ten tide gauge stations used. Correspondingly, rates of absolute sea level rise in the period 1990-2006 average 3.2 mm/y (0.98 mm/y – 4.91 mm/y).
Statistical return periods under projected sea level rise scenarios will differ greatly between stations. As an increase in extreme water level events at some stations in recent years cannot be ascribed to the meteorological conditions alone, the causes have been examined for selected stations.