

Absolute Baltic Sea Level Trends in the Satellite Altimetry Era: A Revisit

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Climate change and other drivers of environmental change: Developments, interlinkages and impacts in regional seas and coastal regions.



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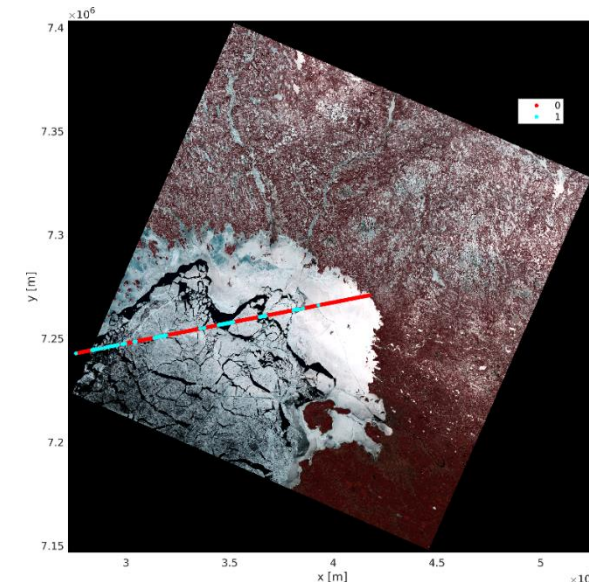
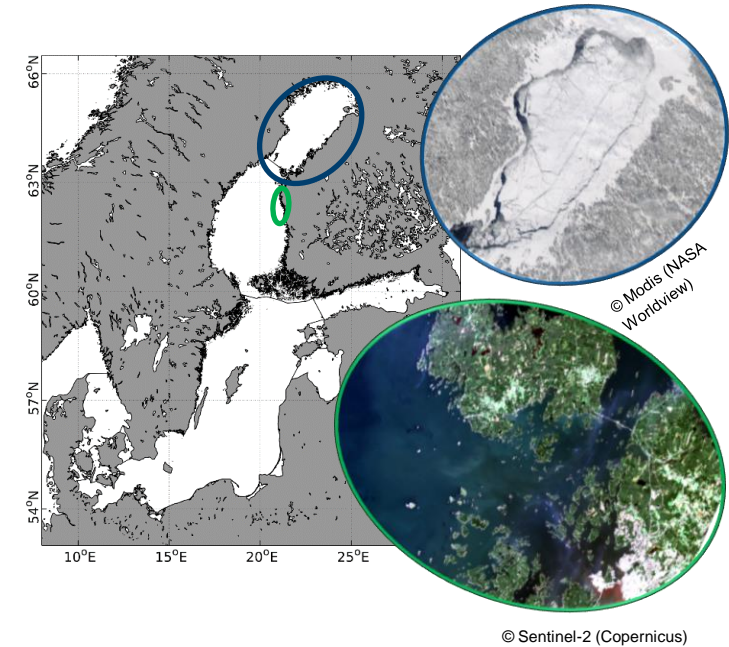


Why the Baltic Sea

- Previous sea-level products do not include information from the sea-ice covered surface and from the coastal zone
- Ideal test environment for developing advanced sea-level products
 - Complex coastlines
 - Seasonal sea-ice formation
 - High abundance of in-situ observations and long data records
- Improvements in retracking solutions (closer to the coast), geophysical corrections etc.

Aim:

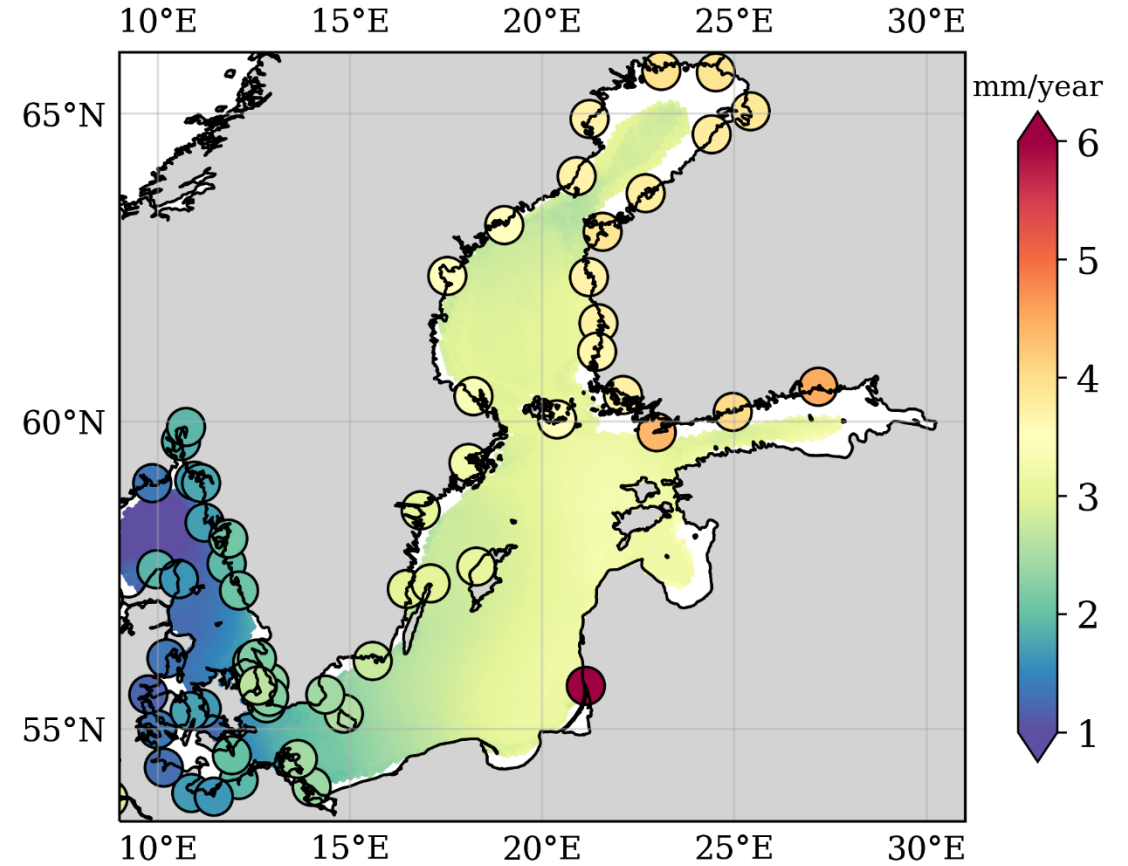
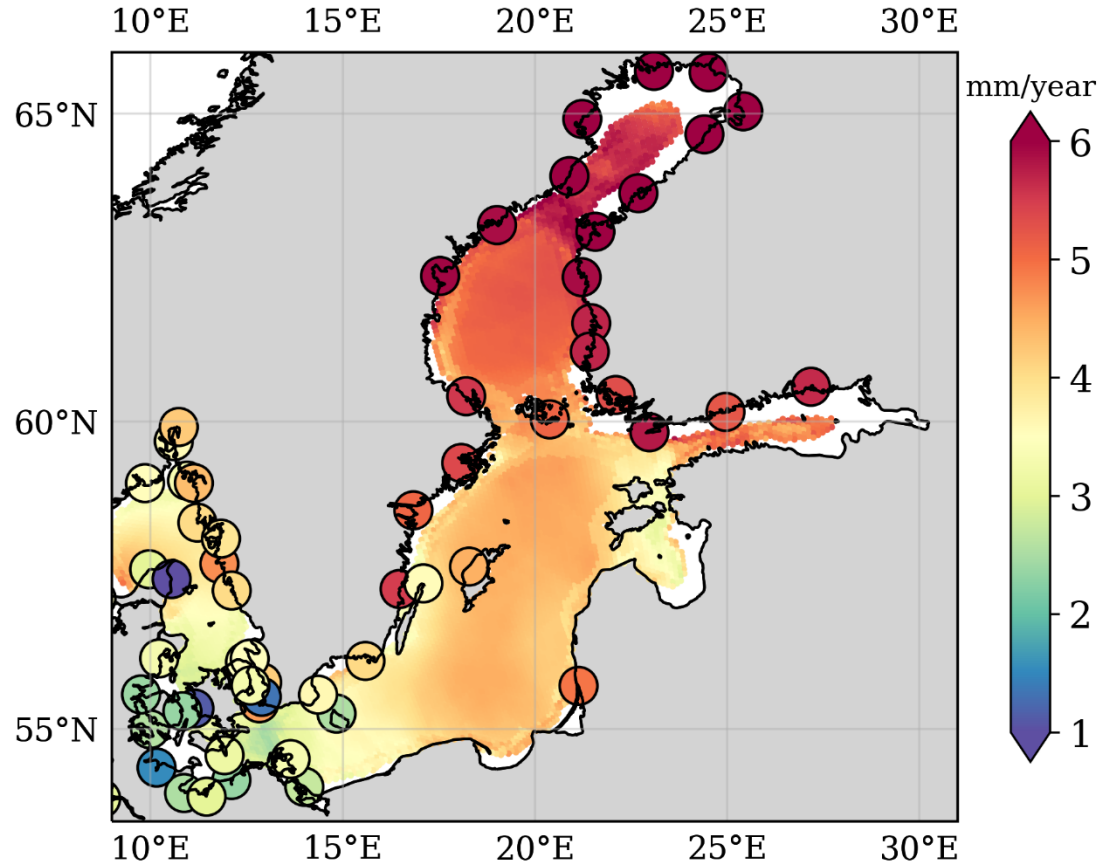
- Generation of novel long-term multi-mission along-track and gridded sea level products (monthly SL, mean sea surface, sea level trends)



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a) SAT and TG trends (NKG2016 corrected)

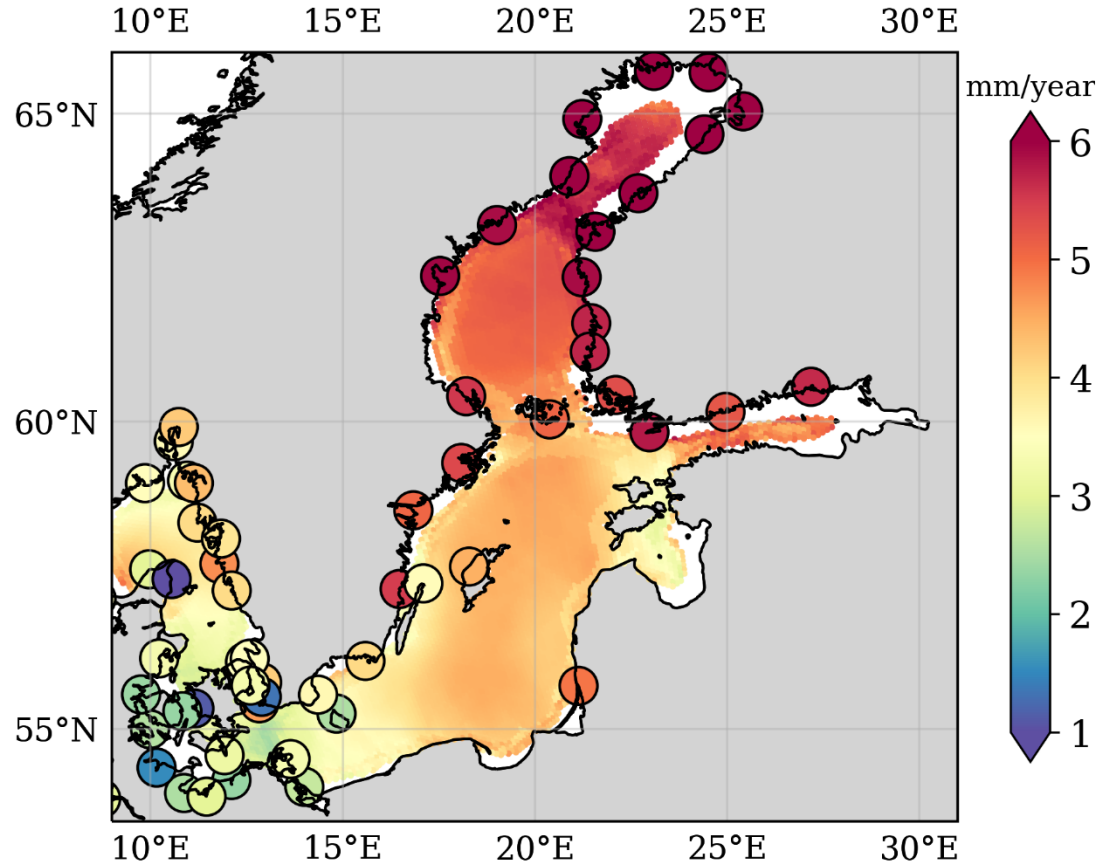
b) Trend uncertainties, AR1 (CI: 95%)



Mean Trend: 4.27 ± 3.58 mm/year (during 1995-2019)

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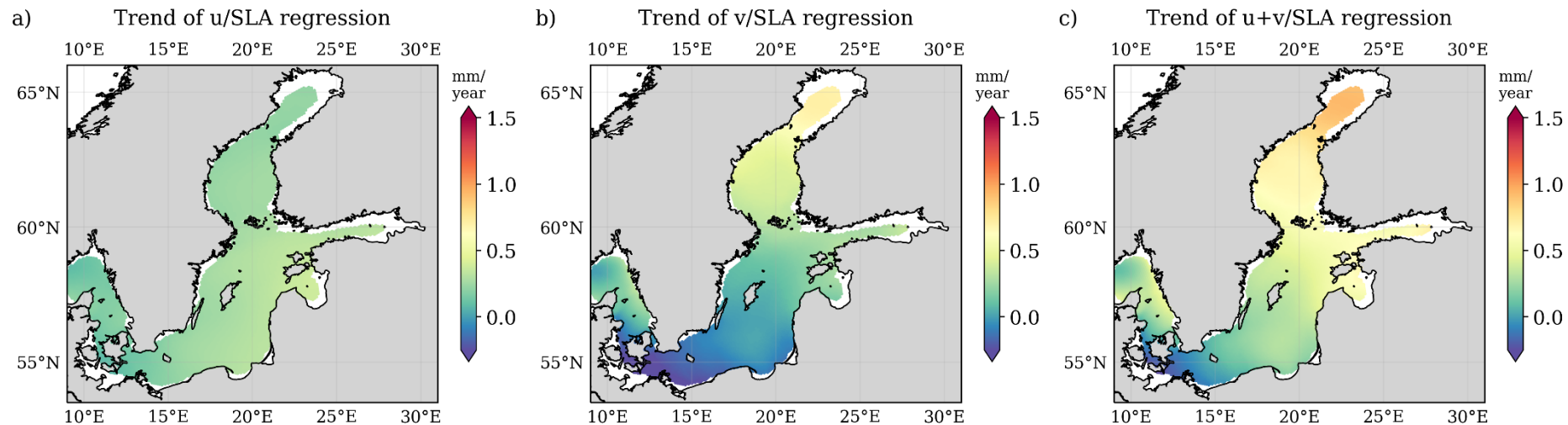


Mean Trend: 4.27 ± 3.58 mm/year (during 1995-2019)

- What causes the spatial variations in absolute sea level trends in the altimetry era (in particular the pronounced SW-NE trend gradient)?
- What are the underlying dynamics and driver of the spatio-temporal monthly and interannual SL variations?
- Investigations on the influence of atmospheric forcing on Baltic SL

The impact of surface winds on sea level trends

- Trends (+ uncertainties) of regressions of u- and v-wind anomalies on SLAs
- Strengthening southerly winds during (1995-2019) explain a fraction (~1 mm/year) of the observed (SW-NE) trend gradient over the domain



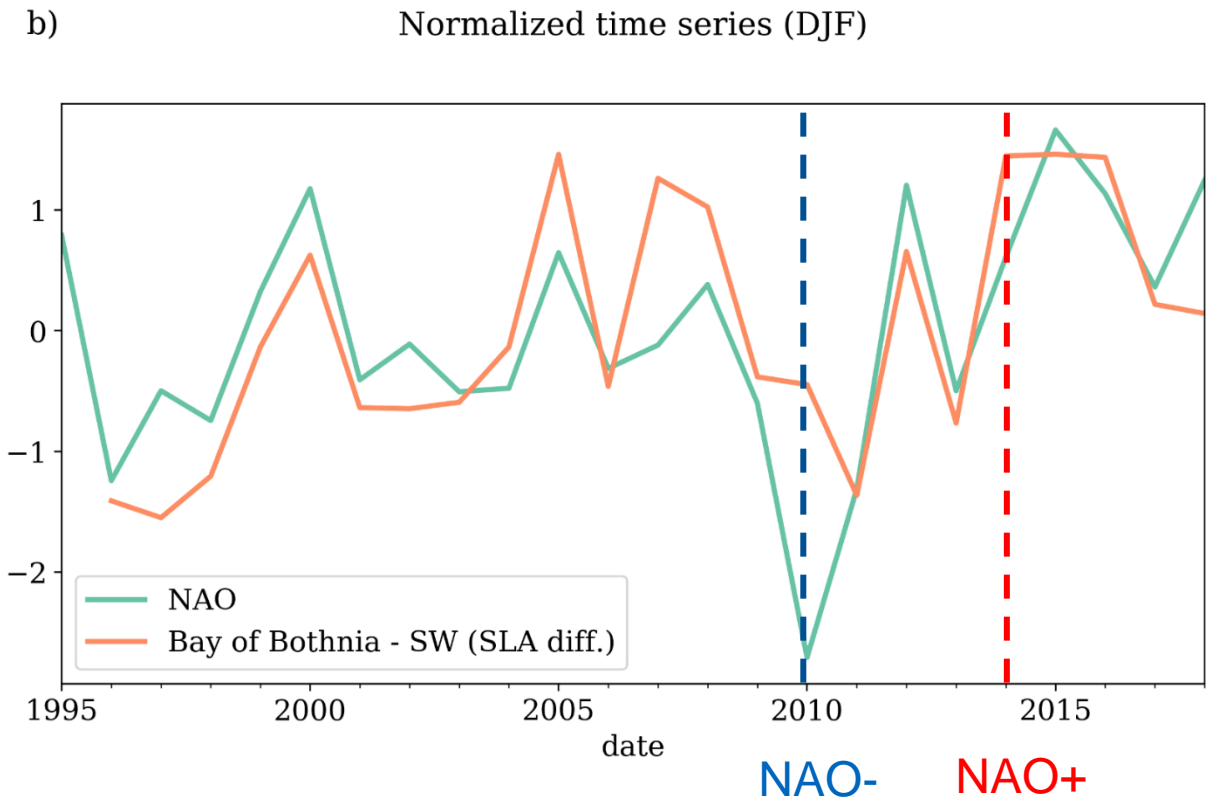
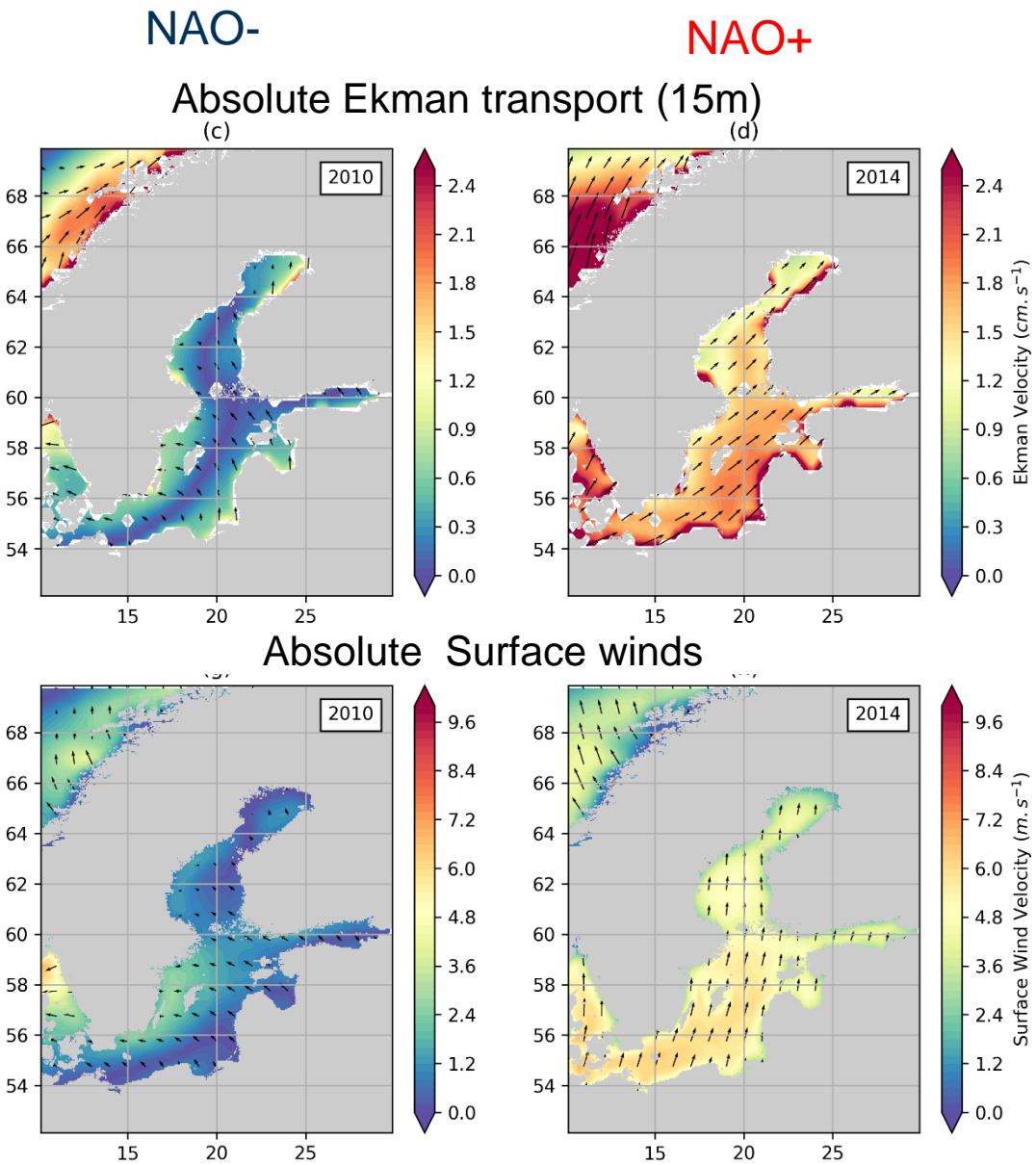
Trend explained by: Zonal wind component

Meridional wind component

Combined surface winds

NAO+: Southerly winds + stronger ekman transport towards the N-E

Reduced southerly winds + reduced ekman transport towards the N-E



➤ NAO related surface wind variations shape the anticorrelated SL variations (in the NE and SW domain) via their influence on Ekman transport

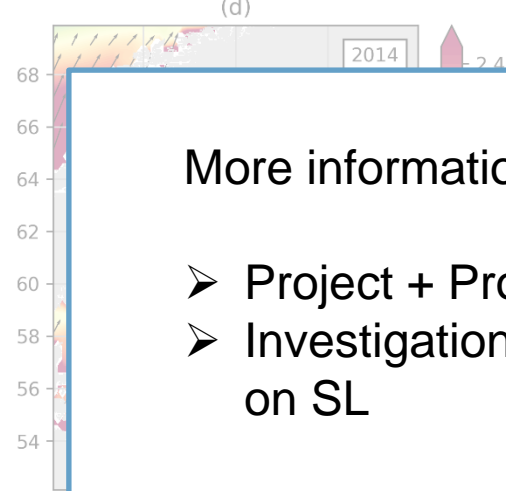
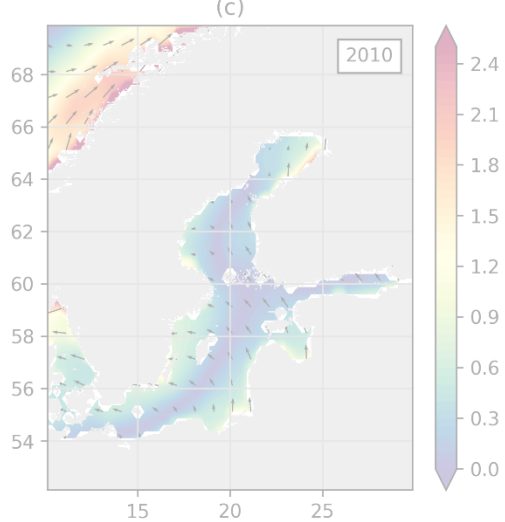
NAO+: Southerly winds + stronger Ekman transport towards the N-E

Reduced southerly winds + reduced Ekman transport towards the N-E

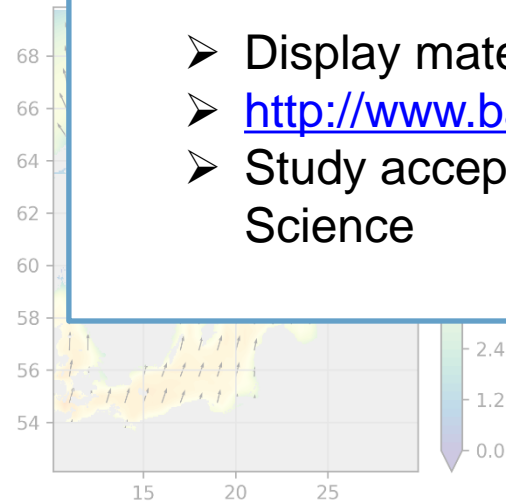
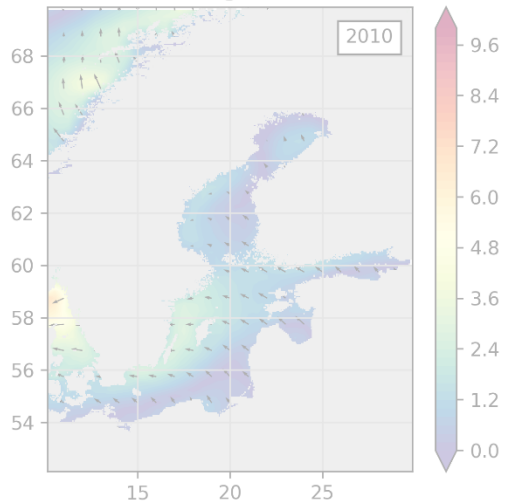
NAO-

NAO+

Absolute Ekman transport (15m)



Absolute Surface



More information on the

- Project + Products + Methods
- Investigations of the atmospheric impact on SL

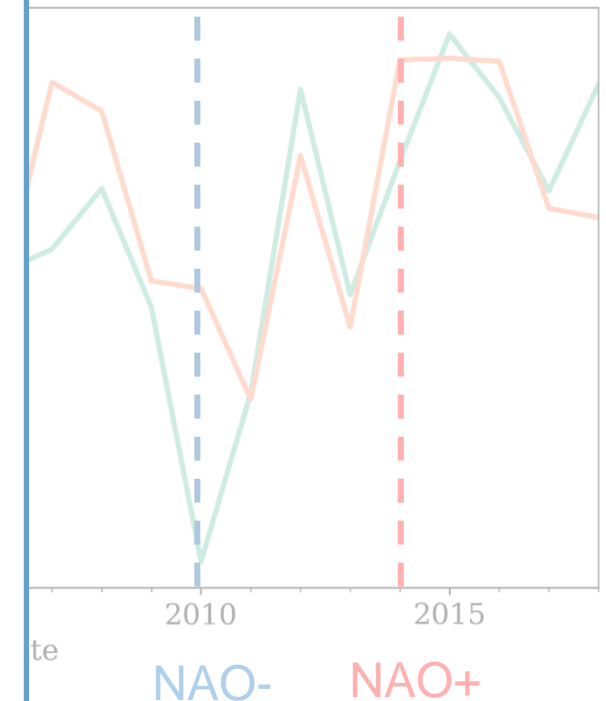


Can be found in the

- Display material
- <http://www.balticseal.eu>
- Study accepted by Frontiers in Marine Science

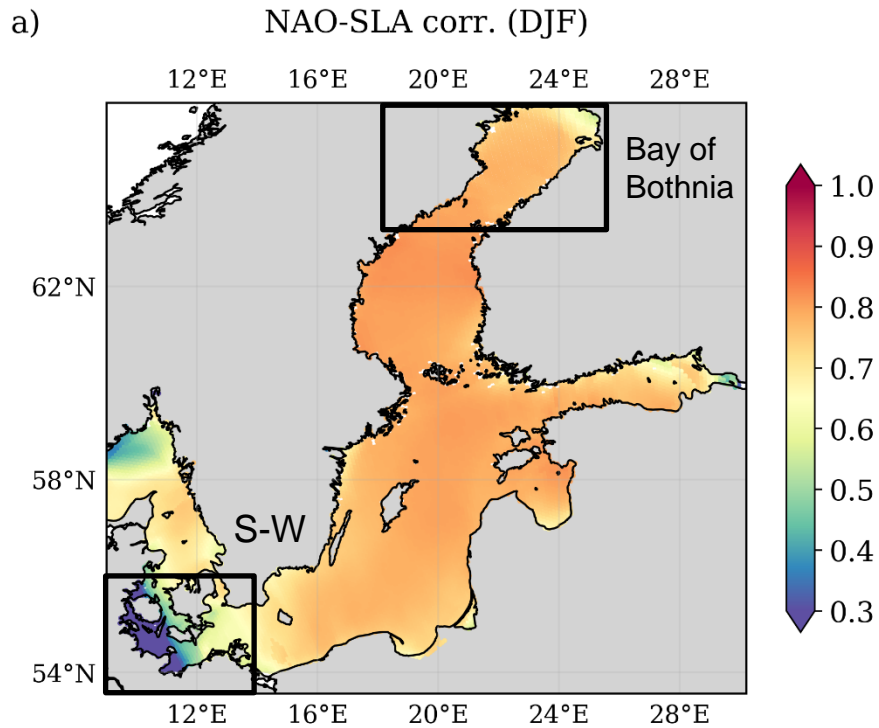
- NAO related surface wind variations shape the anticorrelated SL variations (in the NE and SW domain) via their influence on Ekman transport

the series (DJF)

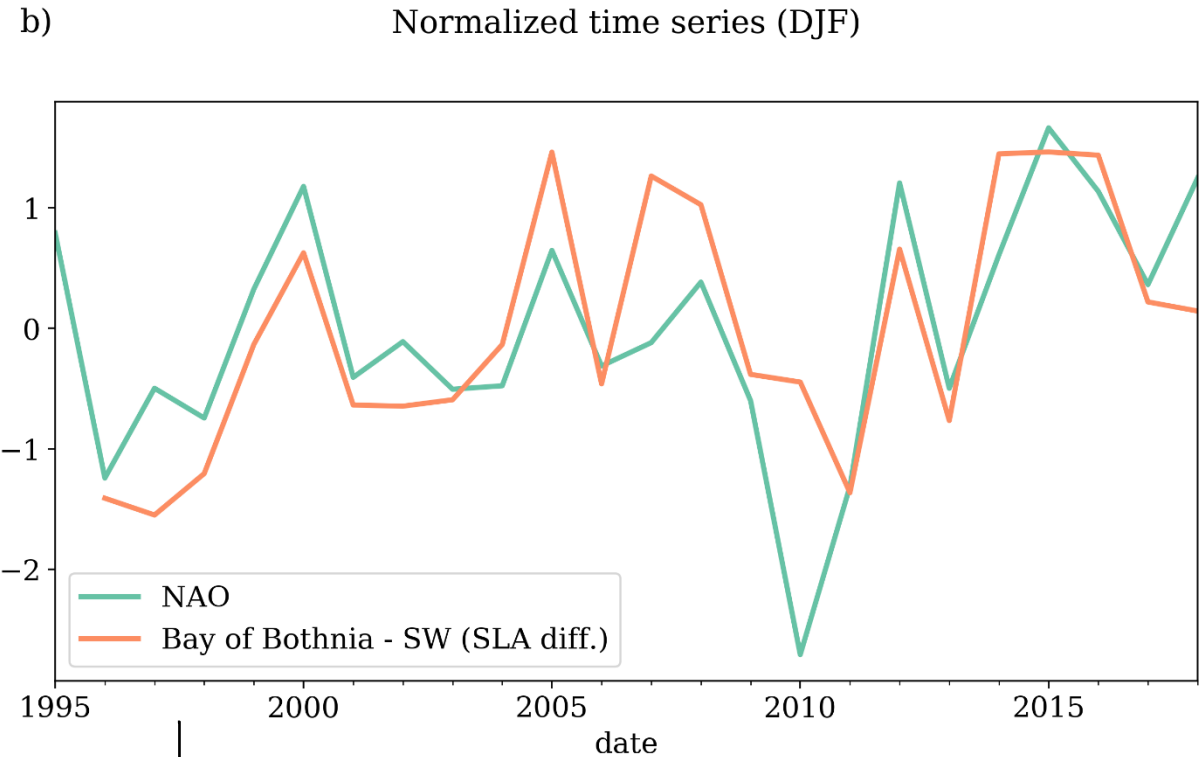


End of vPICO

The role of the NAO in shaping Baltic SL-variability (winter season)



(see also e.g. Jevrejeva et al. 2005; Hünicke and Zorita 2006; Karabil et al. 2018; Gräwe et al. 2019)



Correlation of NAO with differences of SLAs averaged over the Bay of Bothnia and the SW is 0.7

Trends and variability analysis - Conclusion

- ❑ The regionalized Baltic+ SL- dataset provides more reliable estimates of absolute SL trends in the Baltic Sea than comparable products

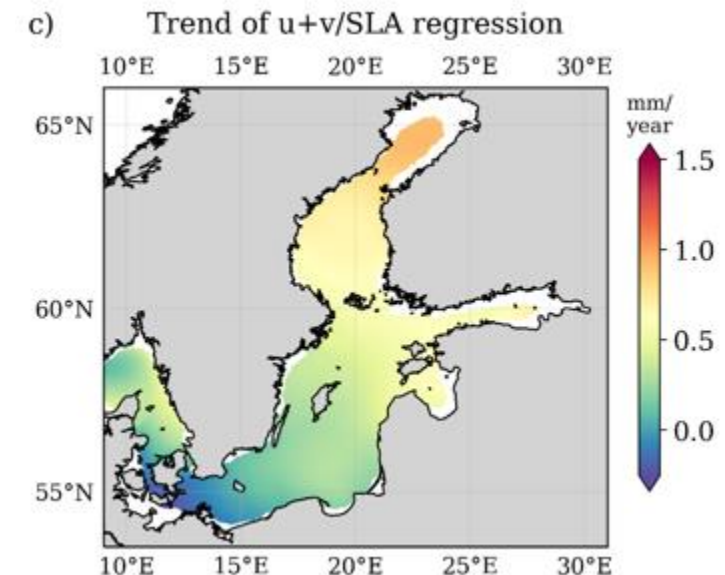
- ❑ A strong SL-trend gradient from S-W to N-E was found

- Monthly Baltic SL-variability is dominated by 2-major modes of variability, which are characterized by
 1. spatially homogeneous SL variations and
 2. by inversely correlated SL-variations in the S-W and N-E domain

- Southerly surface wind anomalies cause anomalous Ekman transport to the N-E, which can explain a trend gradient of ~ 1 mm/year over the domain

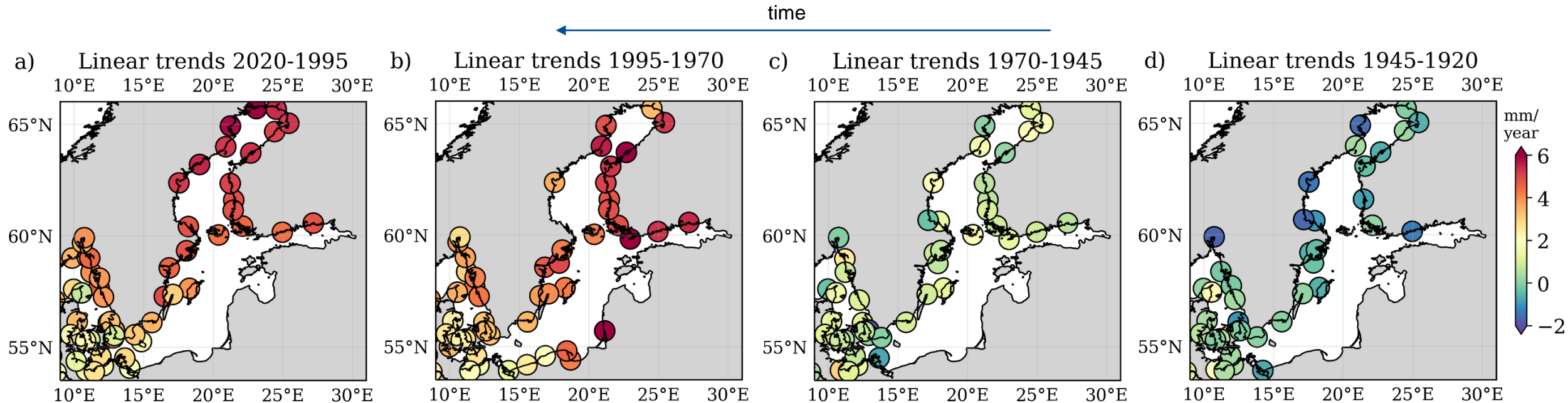
- Next to a strong basin-wide influence, positive NAO phases are associated with increased southerly winds and water accumulation in the Bay of Bothnia

- ✓ Study accepted at *Frontiers in Marine Science*



Trends and variability analysis - Outlook

How has sea level changed over the last century in the Baltic Sea?



- The observed SW-NE trend gradient is most pronounced during 1970-present, but is not present in the period before (1920 - 1945)
- Motivation to further study other factors of past and present Baltic Sea level change!



Thank you for
reading/listening!

For further information, go to
<http://www.balticseal.eu>, or contact
info@balticseal.eu

Product download and documentation is available via the Baltic SEAL website. This includes the requirements analysis, validation reports, algorithm theoretical basis documents, and impact assessment reports. The scientific roadmap is also made available, charting a course forward for the various scientific advances made by the Baltic SEAL team.

The Product Handbook describing the dataset is:

Passaro, M., Müller, F., Dettmering, D., Abulaitjiang, A., Rautiainen, L., Scarrott, R.G., Chalençon, E., Sweeney, M., (2021). Baltic SEAL: Product Handbook, Version 1.1. Report delivered under the BalticSEAL project (ESA contract no. 000126590/19/I/BG). DOI: <http://doi.org/10.5270/esa.BalticSEAL.PH1.1>

For further information, go to <http://www.balticseal.eu>, or contact info@balticseal.eu

An article has been accepted by Frontiers in Marine Science:

Passaro M., Müller F.L., Oelsmann J., Rautiainen L., Dettmering D., Hart-Davis M.G., Abulaitjiang A., Andersen O.B., Høyer J.L., Madsen K.S., Ringgaard I.M., Särkkä J., Scarrott R., Schwatke S., Seitz F., Tuomi L., Restano M., Benveniste J.: Absolute Baltic Sea Level Trends in the Satellite Altimetry Era: A Revisit, Frontiers in Marine Science, under review.

