
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

esa

UNIVERSITY OF Southampton

# Spatial variability of the annual cycle in coastal sea level: a regional study

Marcello Passaro[1,2], Paolo Cipollini[3], Jérôme Benveniste[2]

[1] School of Ocean and Earth Science, Univ. of Southampton, U.K.
[2] European Space Agency/ESRIN, Frascati, Italy.
[3] National Oceanography Centre, Southampton, U.K.

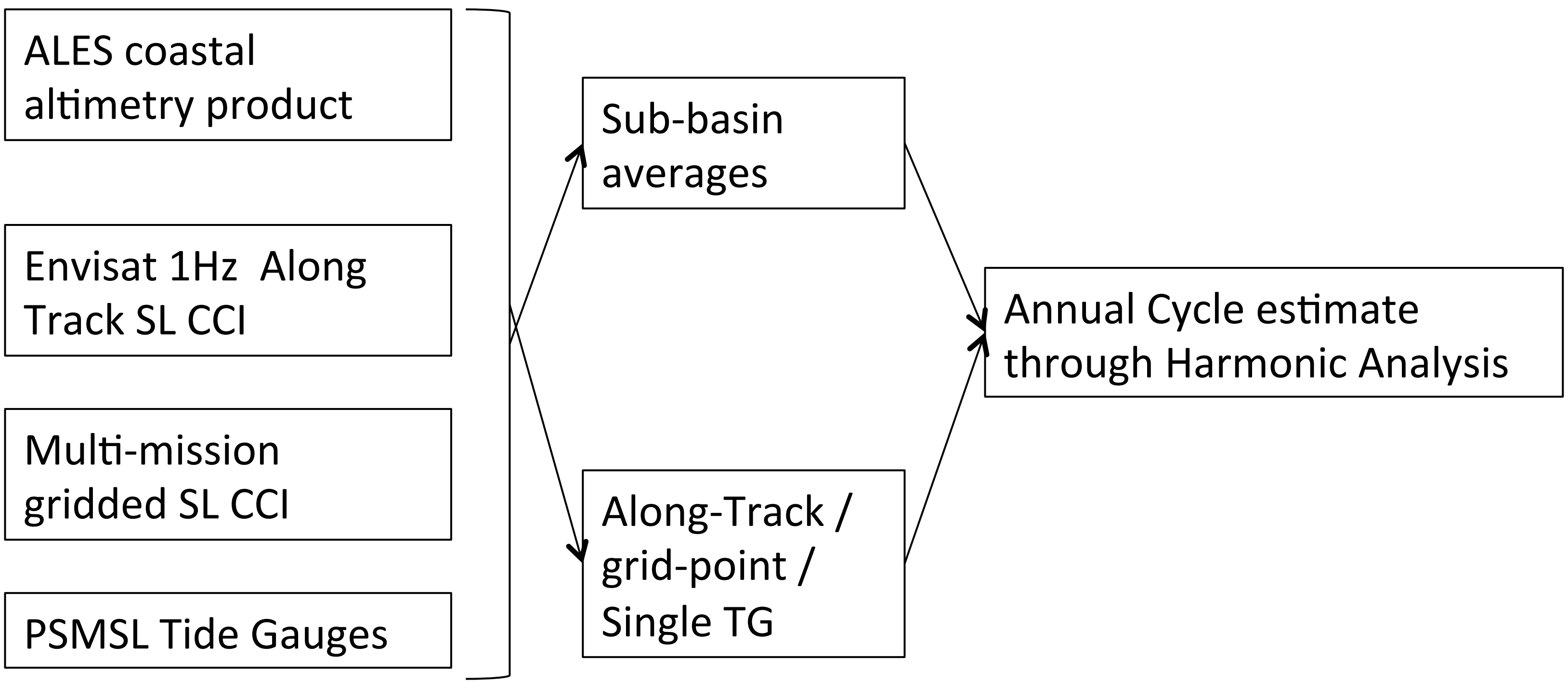
CAN WE TRUST SATELLITE ALTIMETRY FOR THE ANALYSIS OF REGIONAL SEA LEVEL SEASONAL VARIABILITY IN THE COASTAL OCEAN?

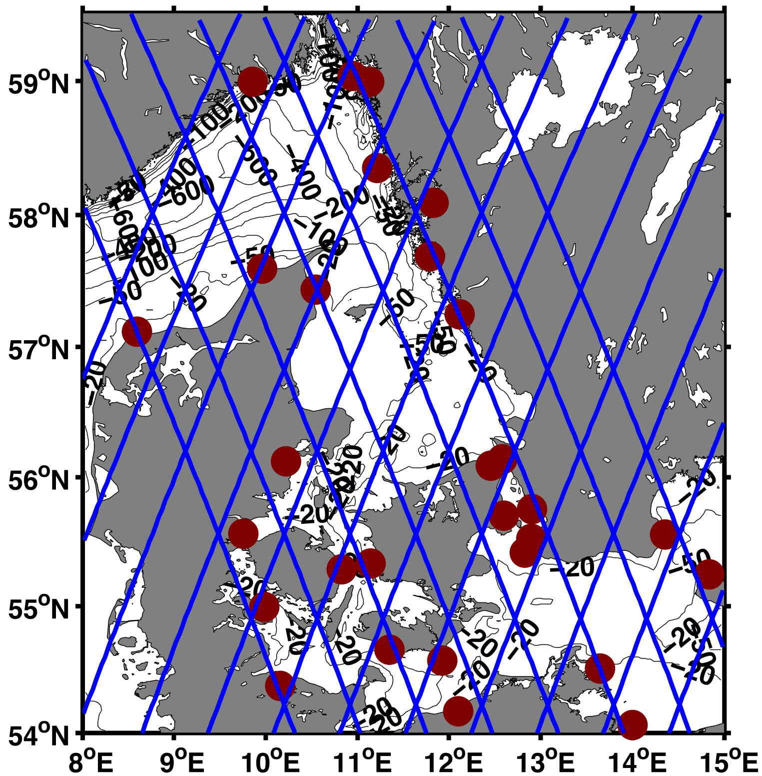
CAN WE IMPROVE THE CURRENT STATE-OF-THE-ART SEA LEVEL PRODUCT?

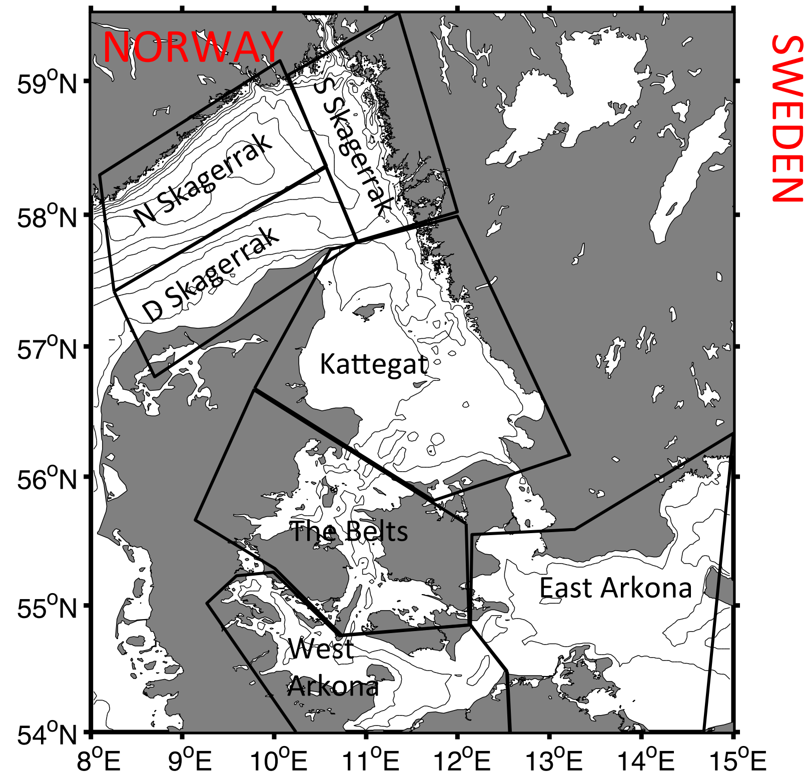
CAN WE PERFORM AN INTEGRATED ANALYSIS OF SEASONAL VARIABILITY?

Updated “corrections” to obtain sea surface height anomaly (SSHA):

- DTU10 tide model and mean sea surface
- GPD Wet Tropospheric Correction
- ECMWF-operational-based Dynamic Atmosphere Correction





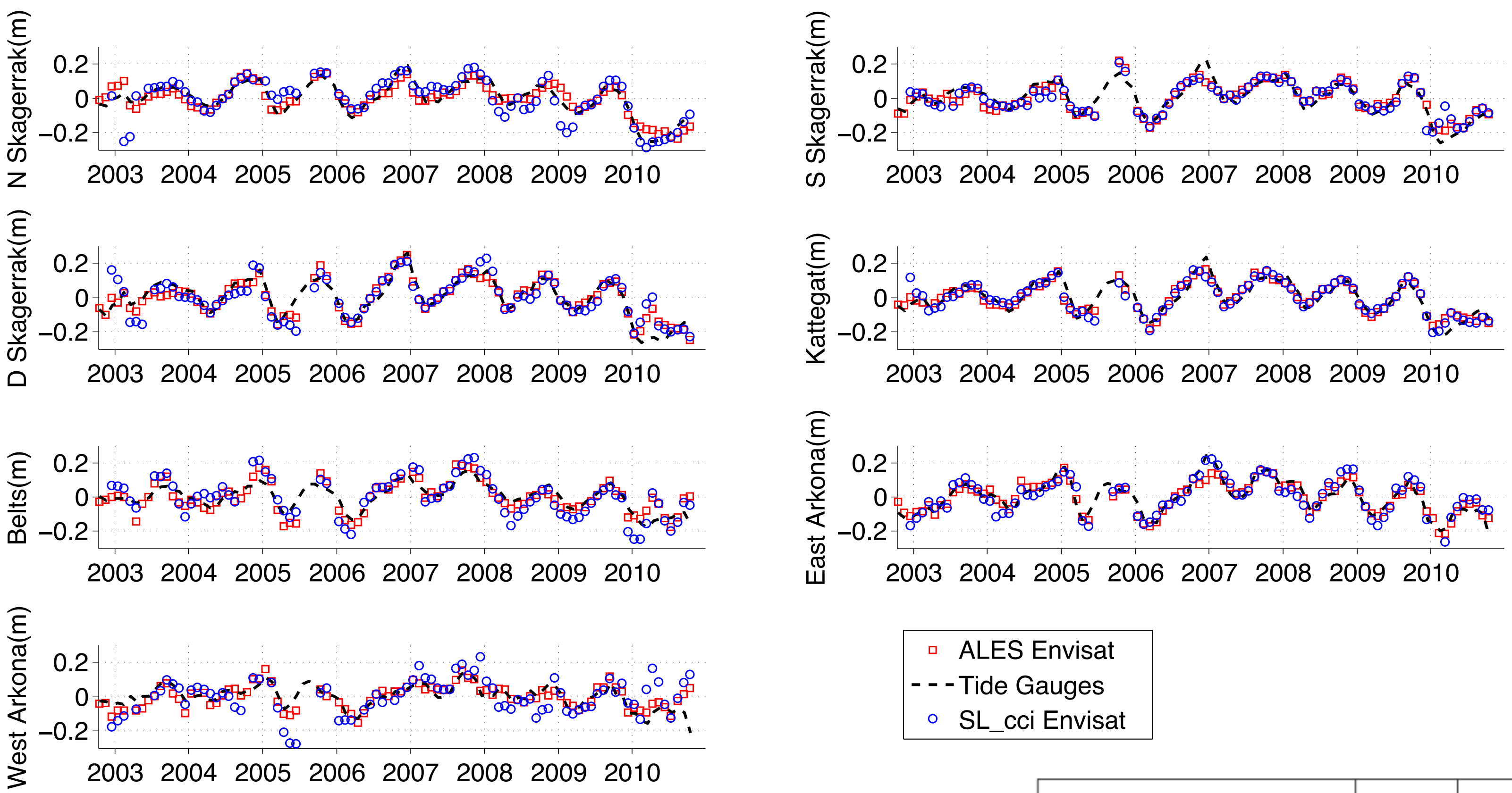




AREA OF STUDY: North Sea/Baltic Sea Transition

- challenging for altimetry (small scales, shallow water, jagged coastline)
- several tide-gauges (TGs) for coastal validation

CIRCULATION CHARACTERISTICS:

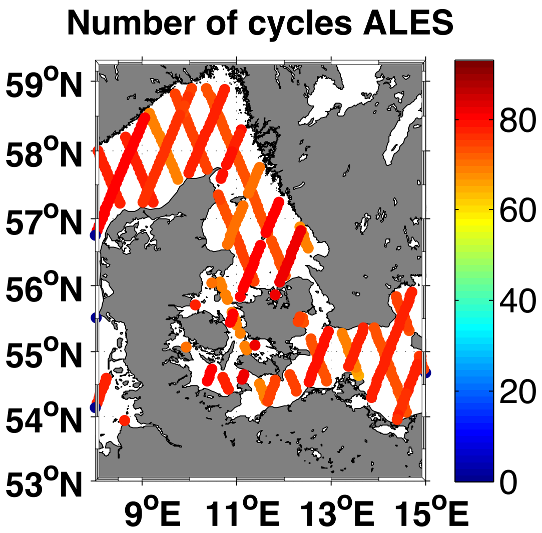
- Outflow/Inflow: Brackish waters in the Arkona Basin vs warmer and saline waters from Atlantic
- Atlantic waters enter through the Jutland Current (D Skagerrak) and exit through the Norwegian Current (N. Skagerrak)




| CORR COEFFICIENT | ALES | SL CCI Env |
|---|---|---|
| Kattegat | 0.92 | 0.90 |
| Norway Skagerrak | 0.91 | 0.85 |
| Denmark Skagerrak | 0.92 | 0.83 |
| Sweden Skagerrak | 0.91 | 0.86 |
| West Arkona | 0.81 | 0.46 |
| East Arkona | 0.92 | 0.89 |
| Belts | 0.85 | 0.82 |

- Time series dominated by the annual cycle

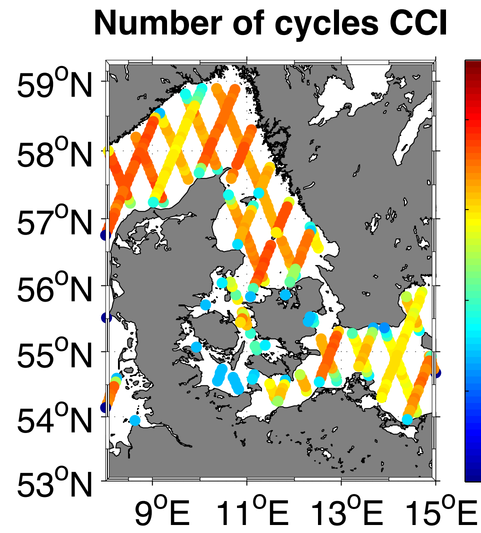
- Coastal data are reliable!

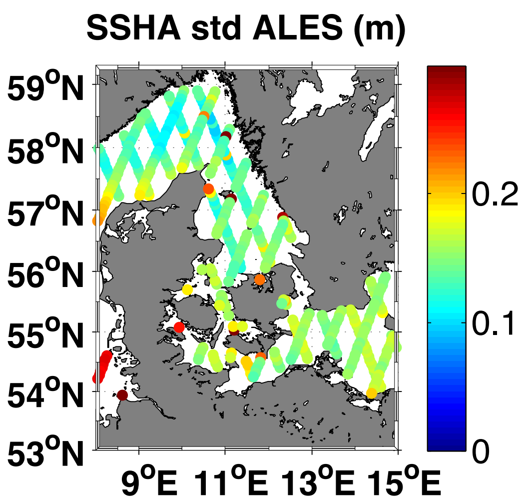



ALES

=

MORE DATA

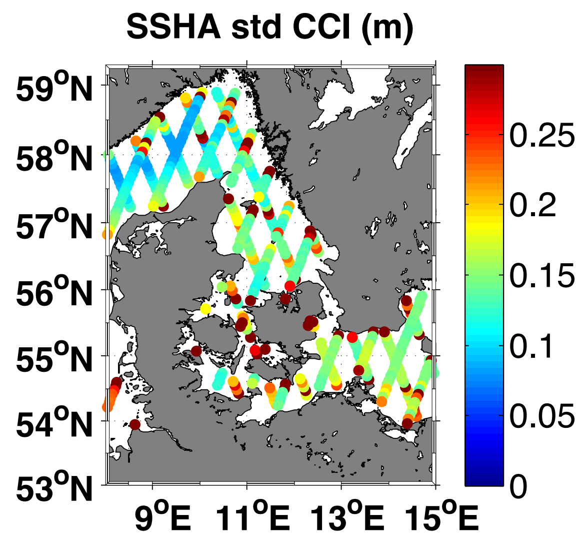


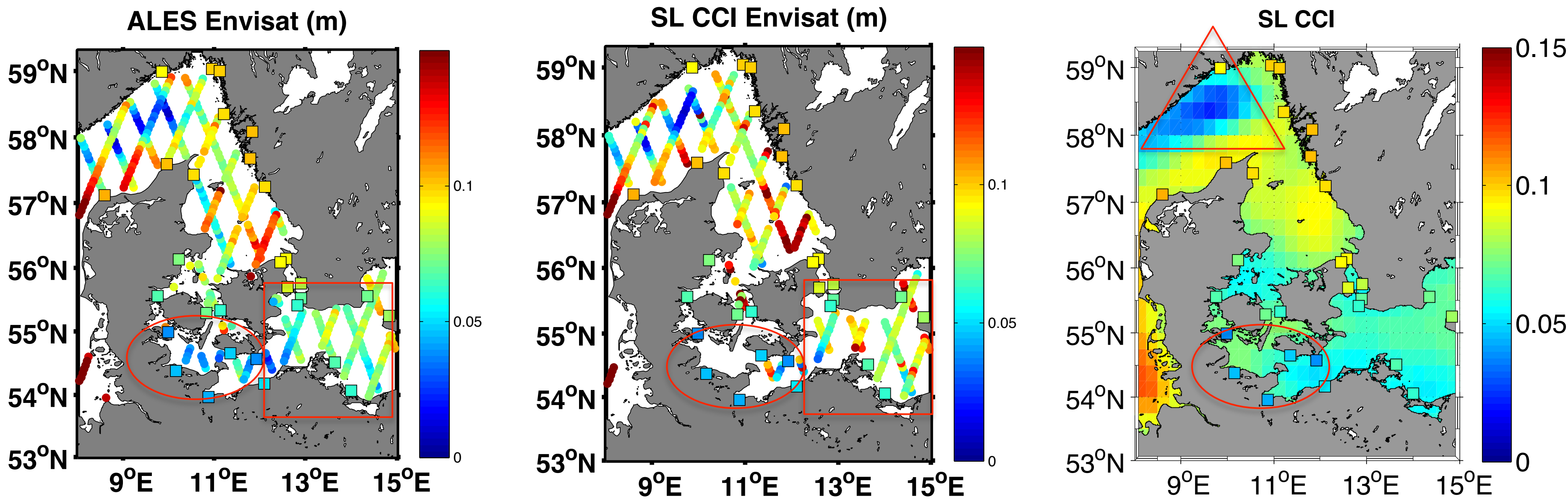

ALES

=

BETTER DATA

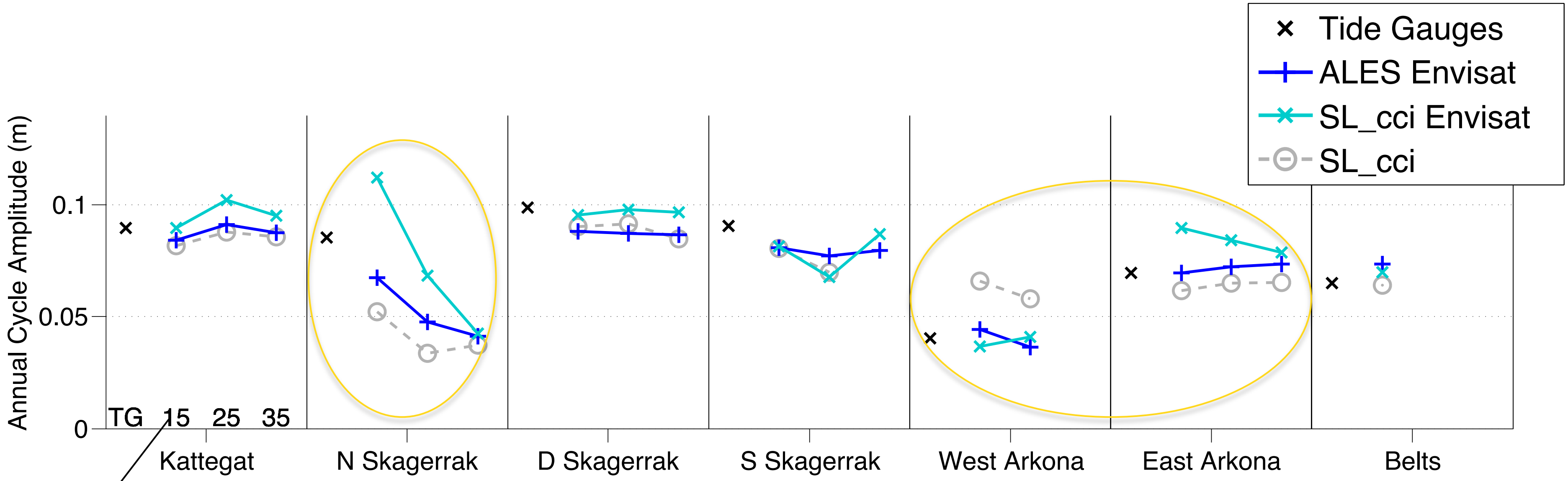


# ALONG TRACK ANNUAL CYCLE AMPLITUDE




- Only estimations with at least 5 years of data available (~50 Envisat cycles) are shown

- SL CCI inconsistencies in the Arkona Basin (square & circle) and Norwegian Skagerrak (triangle)



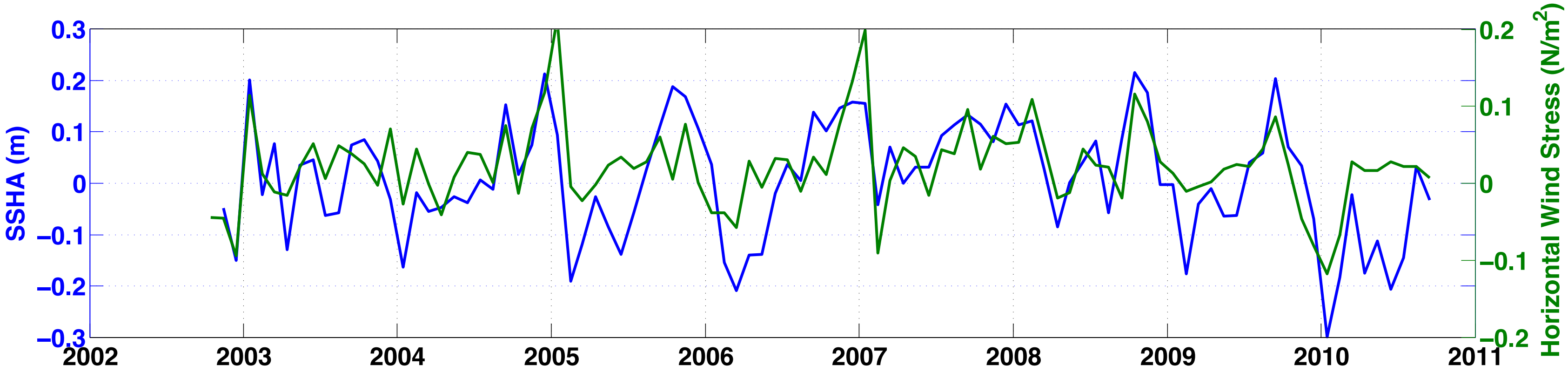

Km from the coast

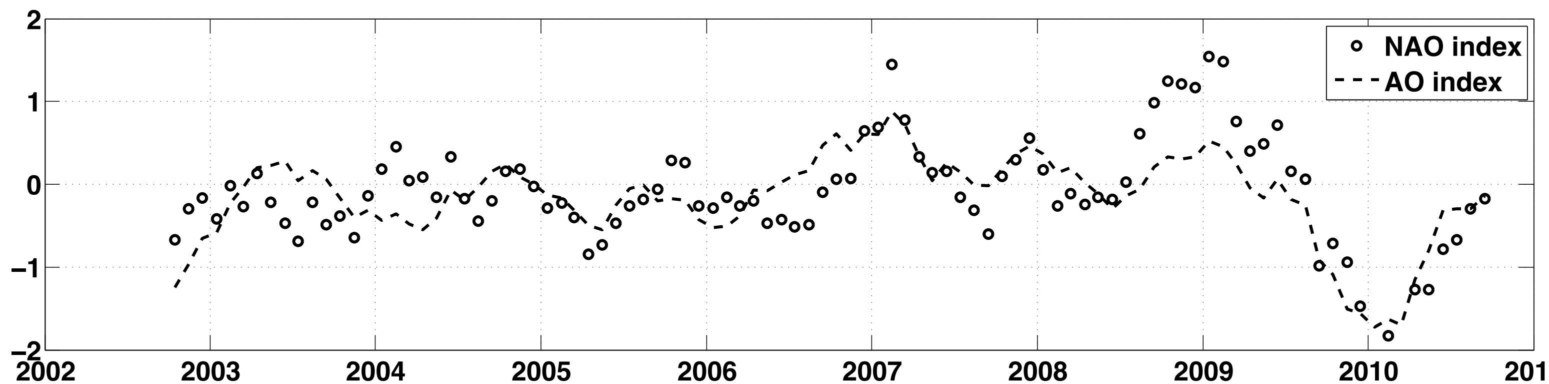
1) ALES Envisat coastal estimates agree within 1 cm with Tide Gauges FOR EACH SUB-BASIN

2) Slope in N Skagerrak -> Norwegian Current circulation & Bathymetry

PHASE (not shown): peak SSHA between November and December

SEA LEVEL – MASS COMPONENT

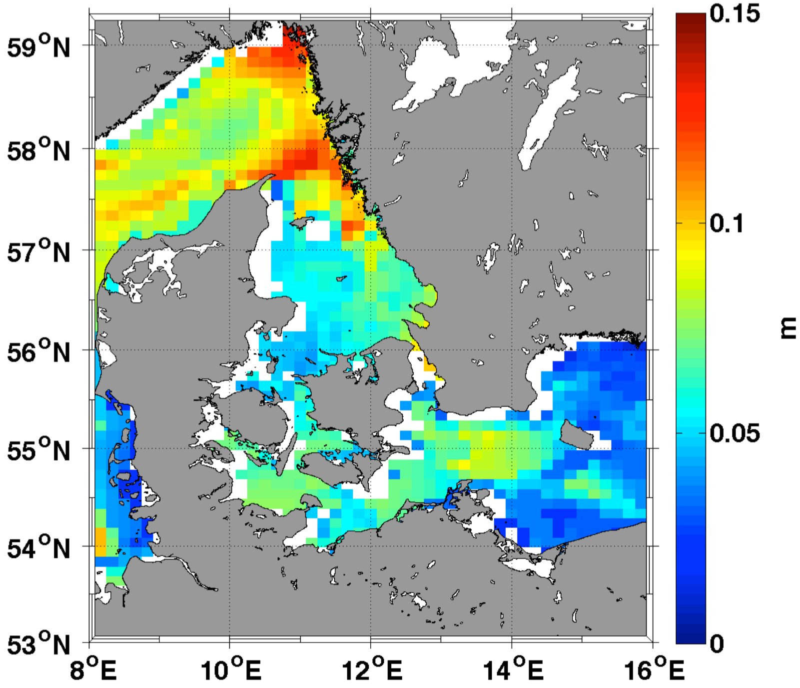


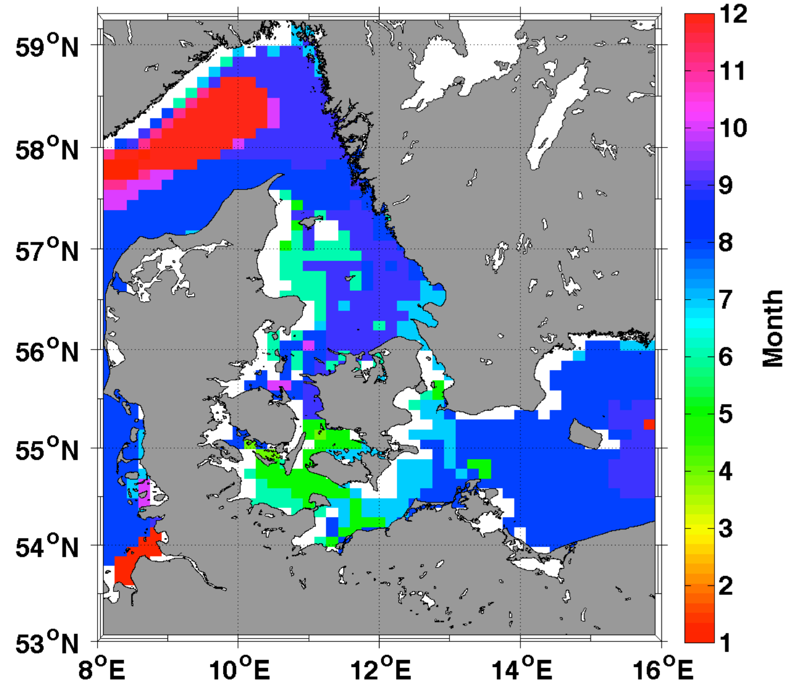

- Wind is the main driver: MAX SSHA -> STRONGEST WESTERLIES; NEGATIVE SSHA -> LOW WINDS OR EASTERLIES
- Large atmospheric circulation patterns influence wind direction and intensity

SEA LEVEL – STERIC COMPONENT

ANNUAL CYCLE AMPLITUDE




ANNUAL CYCLE MAXIMUM




- Shallow waters: maximum in late summer (due to maximum water temperature)
- Norwegian Trench (deep waters): maximum in winter due to penetration of warmer Atlantic water below the thermocline
- In West Arkona Basin the maximum is in May-June (opposite phase w.r.t. mass component), due to strong salinity differences (min salinity in May)

# ACT LOCAL…

Integration with climatology and wind information demonstrates that wind is the main driver of the annual cycle in the area, while steric components and circulation explain differences among the sub-basins.

# THINK GLOBAL…

ALES-reprocessed coastal altimetry data increase the reliability of sea level analysis. We believe that the next versions of Sea Level CCI products should include a coastal altimetry product.

**Data Sources**

Sensor Geophysical Data Records (SGDR): Earth Online (EO) User Services.

Dynamic Atmosphere Correction from http://www.aviso.altimetry.fr.

GPD Wet Tropospheric Correction courtesy of J. Fernandes.

DTU10 tide model and mean sea surface from http://www.space.dtu.dk/

ESA SL CCI products from http://www.esa-sealevel-cci.org.

Tide gauges data from http://www.psmsl.org.

Wind stress from (SODA) reanalysis version 2.2.4 downloaded from http://dsrs.atmos.umd.edu/.

Local climatology courtesy of K.Madsen (DMI)

# QUESTIONS?

**References**

[1] Passaro, M., Cipollini, P., Vignudelli, S., Quartly, G., Snaith, H. ALES: a multi-mission adaptive sub-waveform retracker for coastal and open ocean altimetry. *Remote Sensing of Environment*, 145, 173-189 (2014).