Long-term high-resolution hydrodynamical model simulation in the Gulf of Finland

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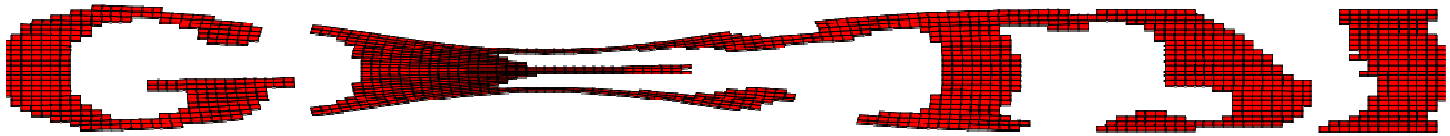
Introduction

- Model implementation , description & setup
- Results
  - Salinity and temperature stratification in two sites
  - Mean surface and barotropic circulation
- Validation
  - Temporal variability of salinity and temperature
  - Statistical analysis, Taylor diagram for Mom and Getm models
- Conclusion

General Estuarine Transport Model



3D hydrodynamical model

- primitive ocean equations
- hydrostatic and Bossinesq approximations
- eddy-viscosity assumptions
- spherical horizontal coordinate system
- vertical sigma coordinate system
- Arakawa C grid
- free surface
- mode-splitting into barotropic and baroclinic mode
- high order-TVD advection schemes with directional split
- coupled with GOTM for turbulence parametrization and biochemical models
- parallel computing, sub-domains sharing halo-zones
- NetCDF I/O

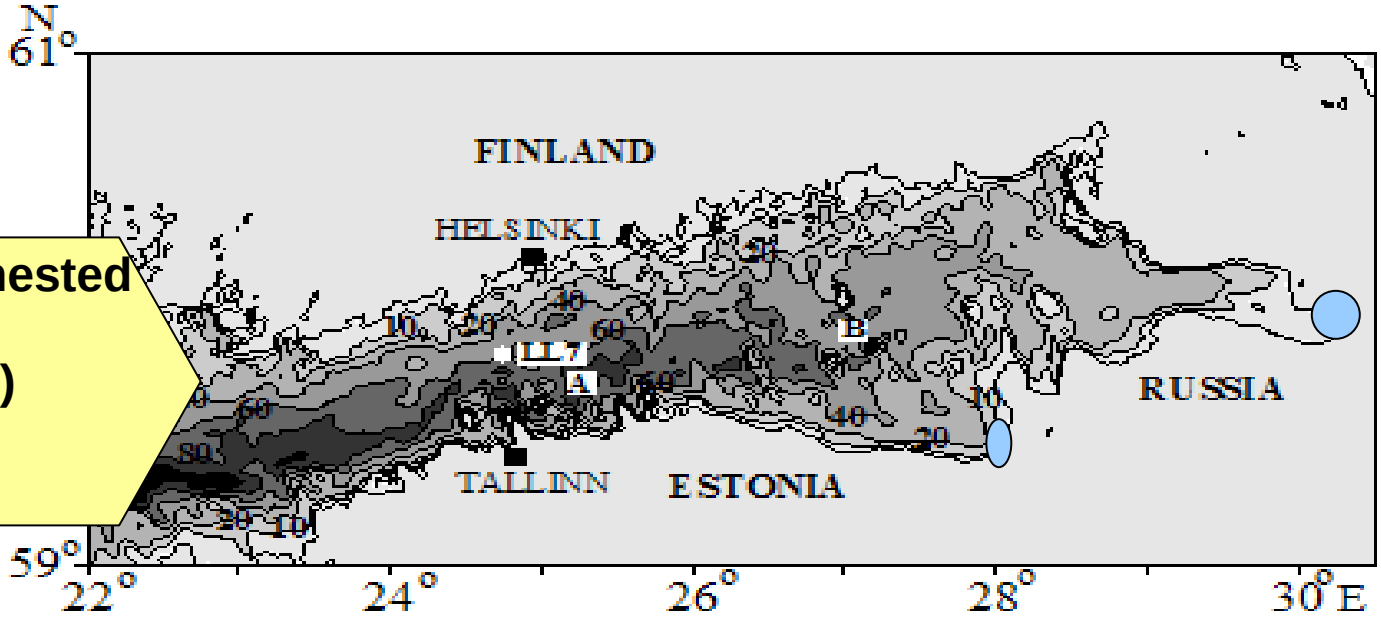
Developed by GETM community

Public domain: http://getm.eu/

Setup for the Gulf of Finland

- 0.5 nautical mile bathymetry (from Seifert topography).
- 25 vertical sigma-layers
- Initial salinity and temperature fields are interpolated from MoM run
- Rivers have been adopted from T. Neumann
- Atmosphere forcing from improved RCA output

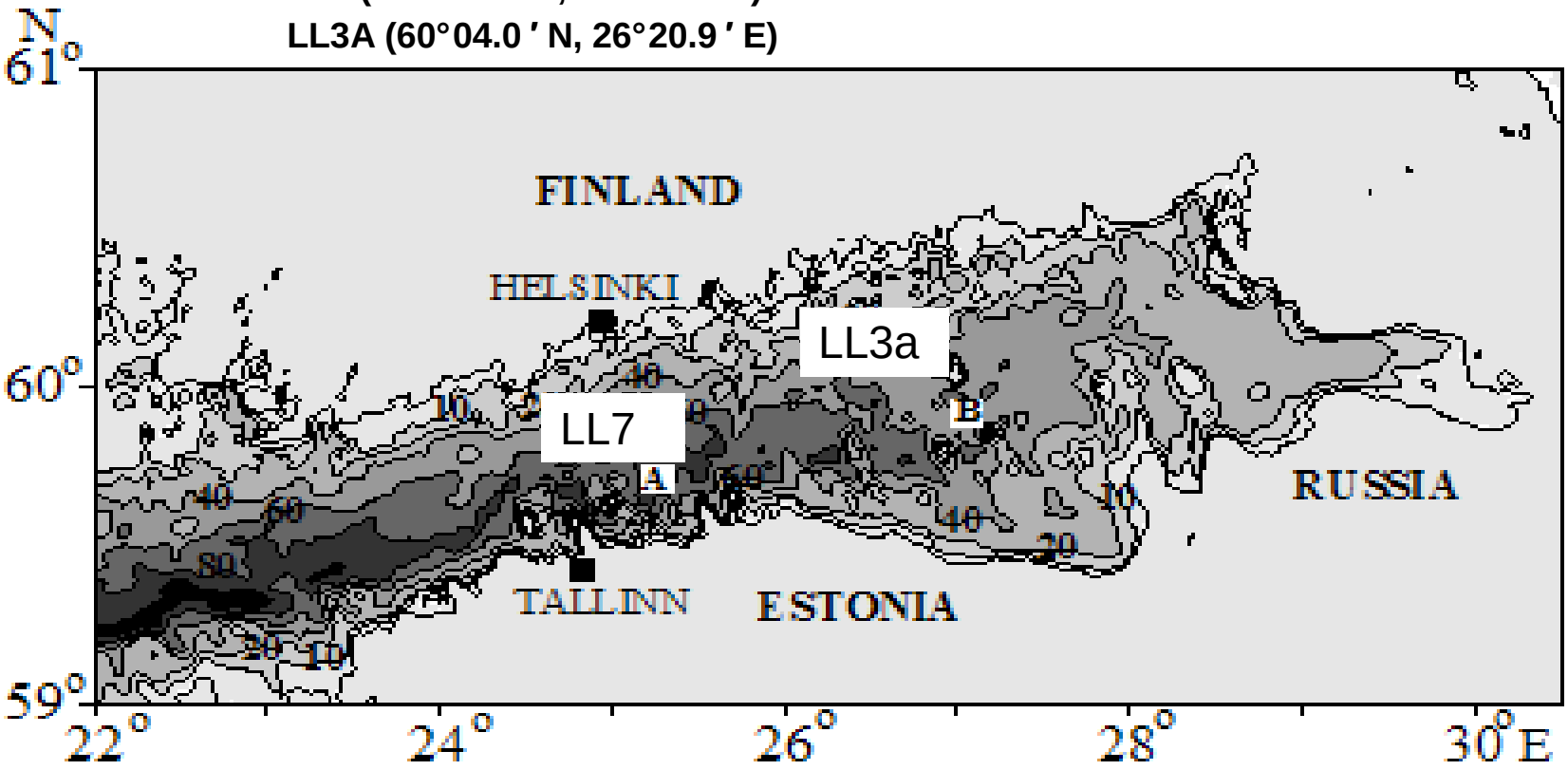
Boundary 1 way nested From 2nm setup elevations (30min) salinity & temperature (3h)



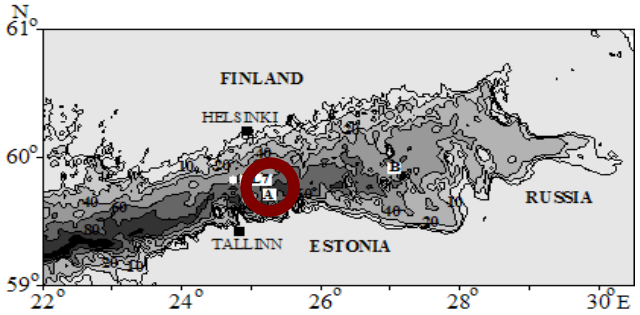
Results

- Salinity and Temperature time-depth profiles at two sites :
  - Site A , depth ~ 90 m , central part of the Gulf
  - Site B , depth ~ 60 m , eastern part of the Gulf

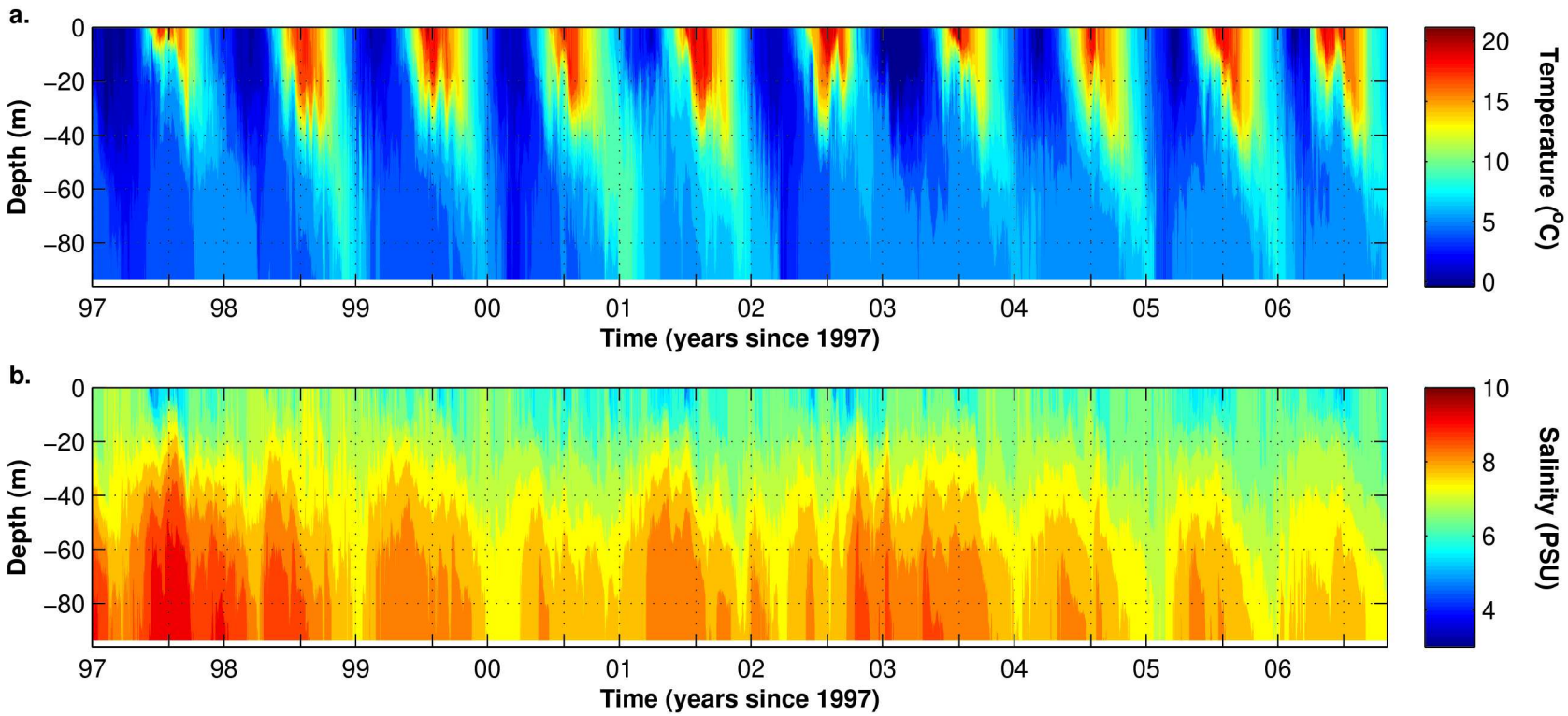
Locations of hydrographic stations
LL7 (59°51.0′ N, 24°49.6′ E)
LL3A (60°04.0′ N, 26°20.9′ E)



Site A

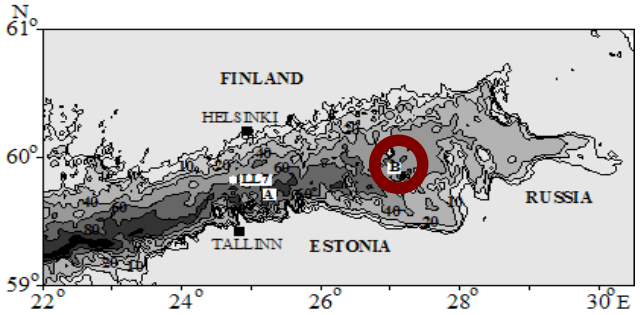


- seasonal temperature evolution was reproduced
- high mixing causes weak stratification
- high seasonal and inter-annual variability

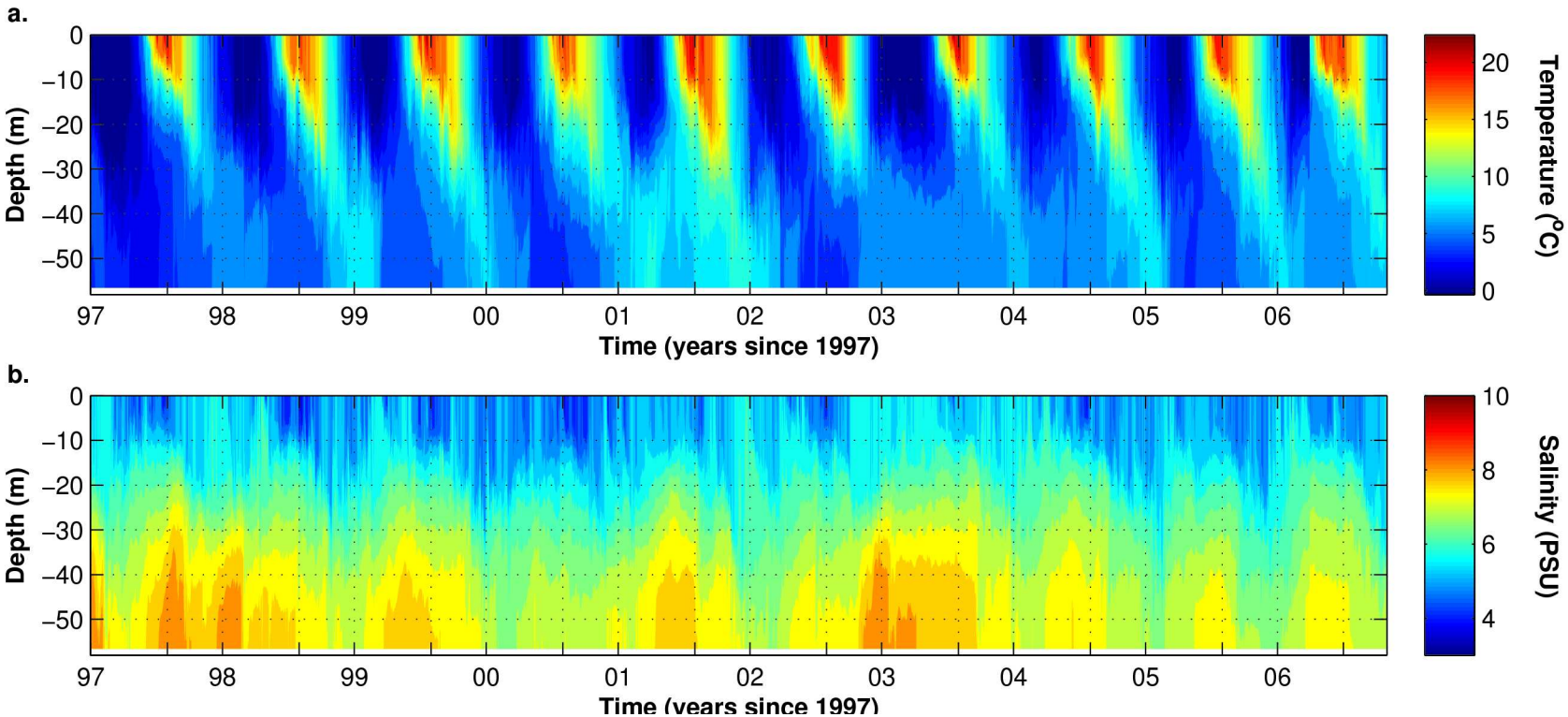


Temporal course of vertical distribution of temperature (a) and salinity (b)

Site B

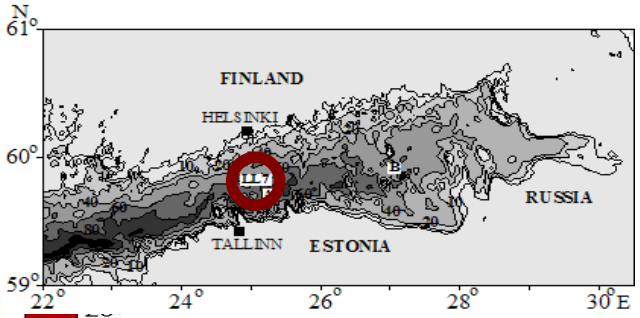


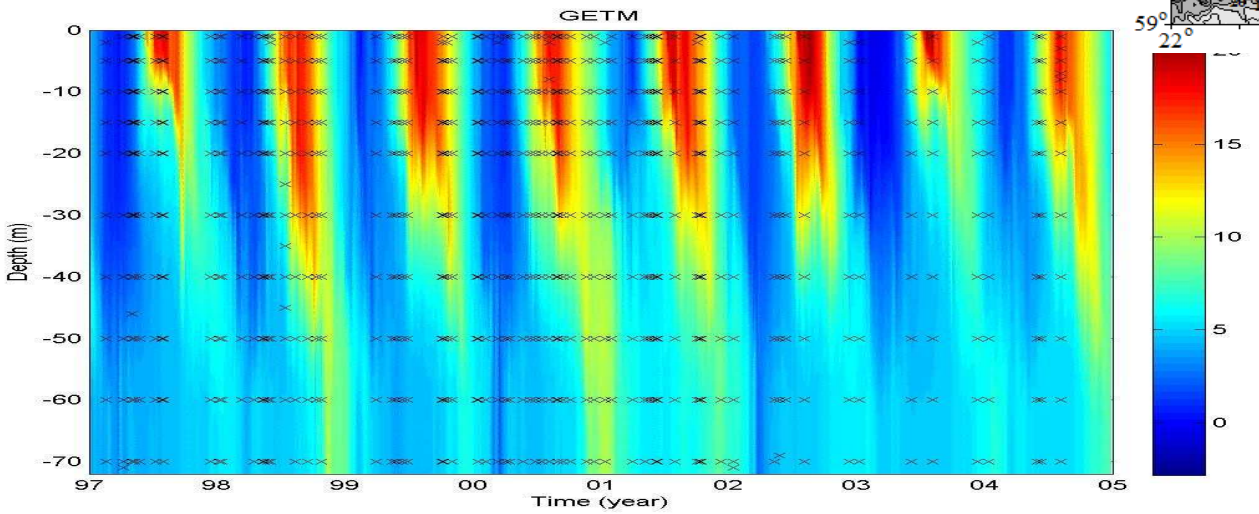
- temperature follows same seasonal and inter-annual variability as site A
- stratification is more stable – site is away from active upwelling areas
- riverine influence causing lower salinity in surface

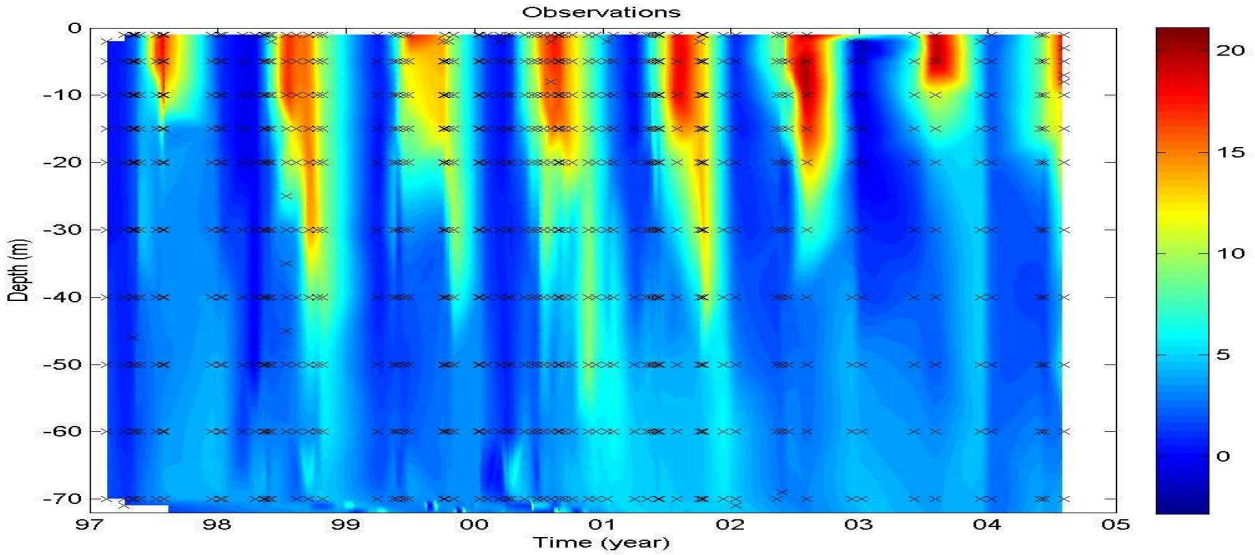


Temporal course of vertical distribution of temperature (a) and salinity (b)

LL7 Temperature

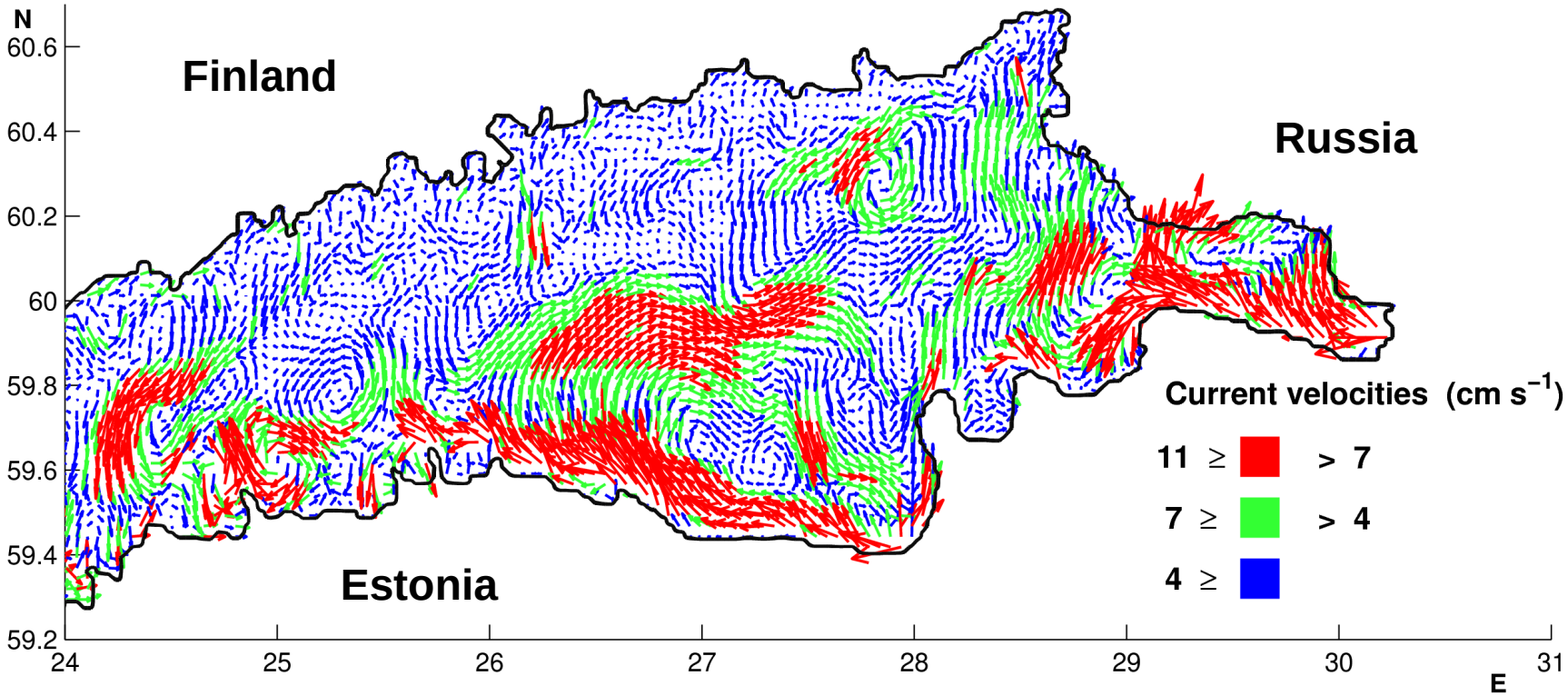






Temperature time-depth plot from model in upper plot and from interpolated plot from observations at LL7 .

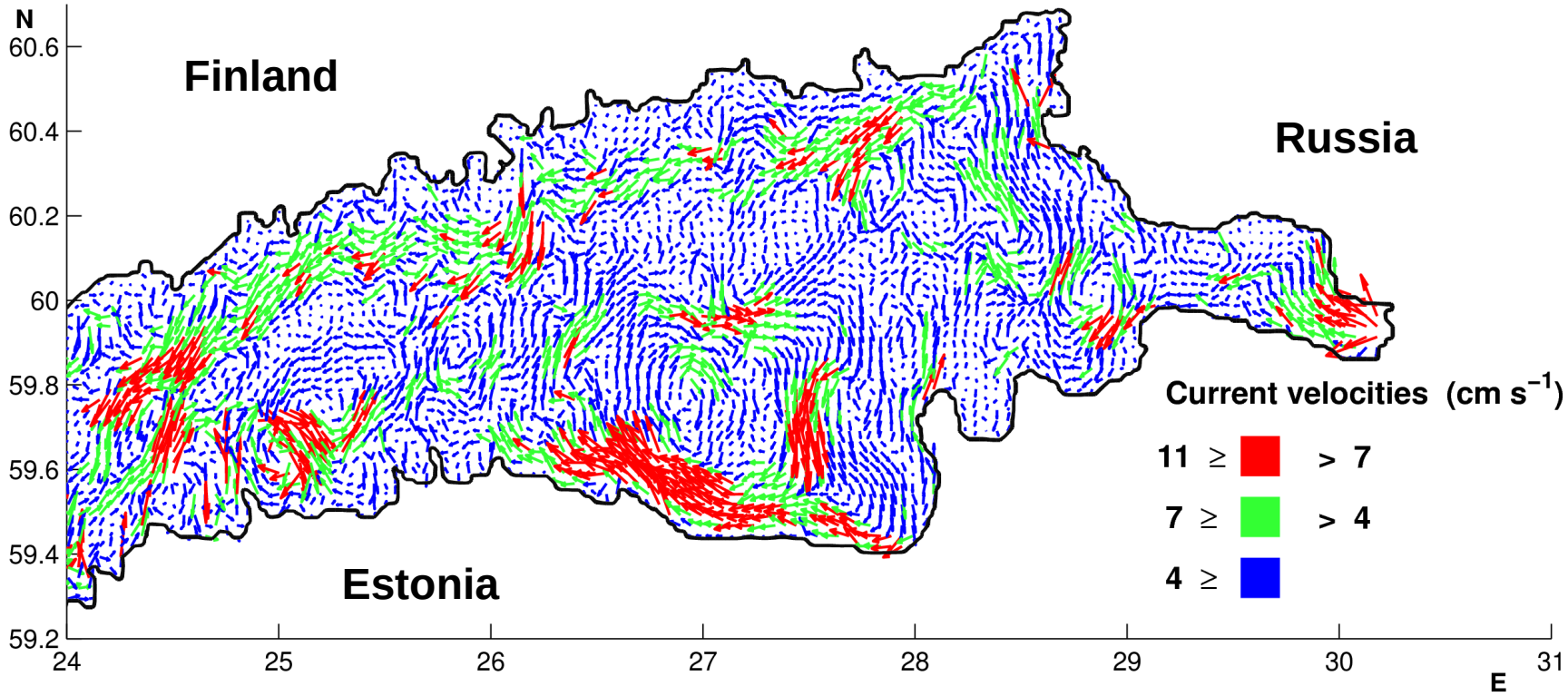
Mean surface velocities



Spatially variable circulation pattern for with numerous eddies all over the Gulf

- Persistent currents and jets near the southern shore and also in center of the gulf
- Finnish side of the Gulf is characterized by multiple eddies with average diameter 15 - 20 km
- Due to complicated coastline, many along shore coastal jets and eddies are forming in the western part of Estonian coastal sea area

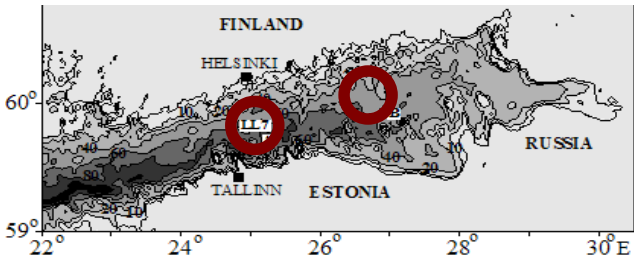
Mean barotropic velocities



Mean barotropic circulation patern has better agreement with previous studies

- Overall cyclonic circulation
- Presistent strong westward subsurface current near Finnish coast
- Inflow near Estonian coast

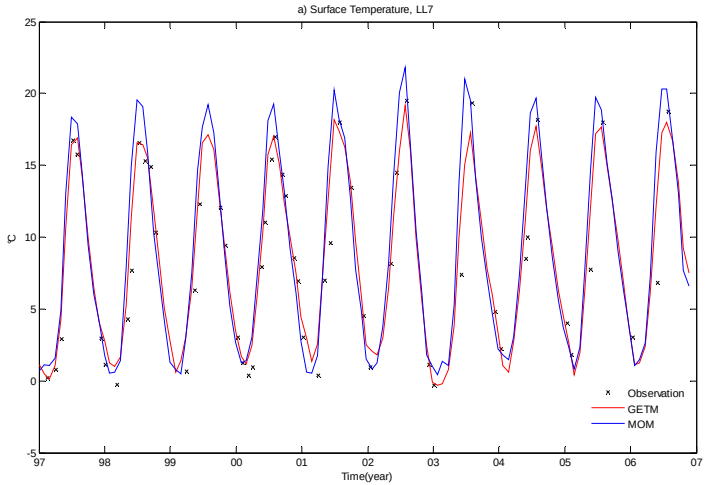
Temporal variability of temperature

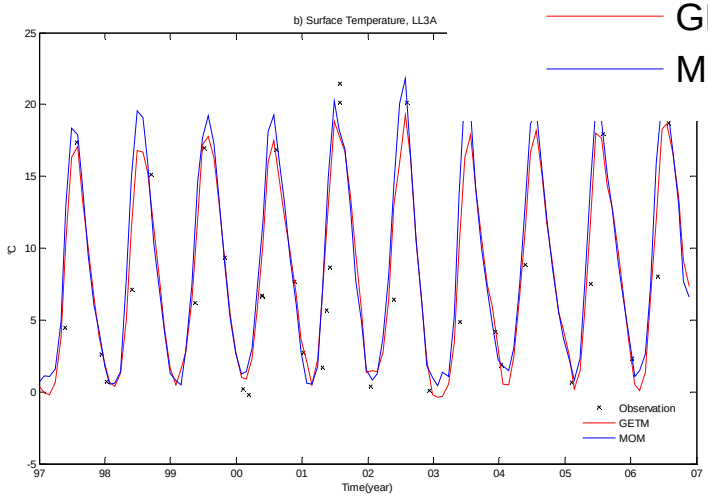


LL7 **LL3a**

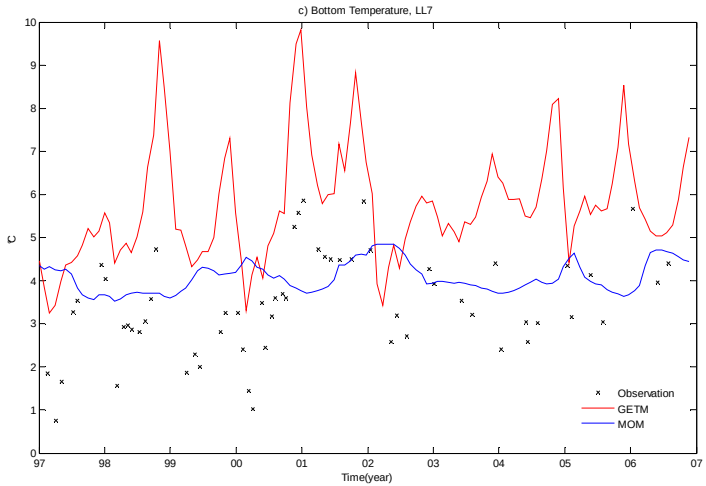
Observation
GETM
MOM

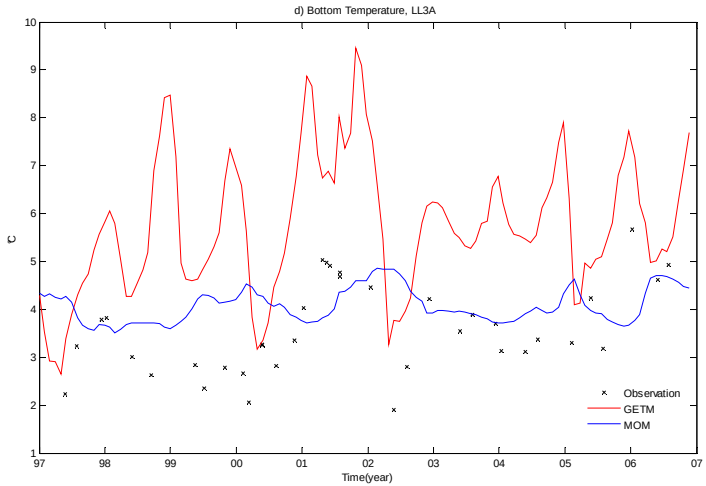
Surface 5 m



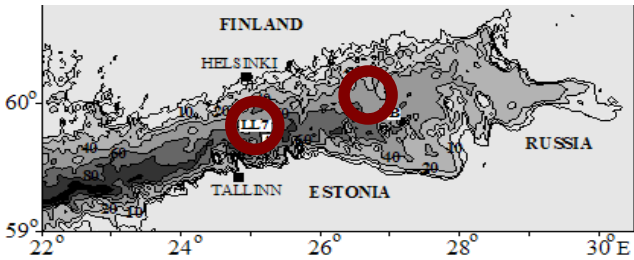


Bottom 60 m





Temporal variability of salinity



LL7 **LL3a**

× Observation
GETM
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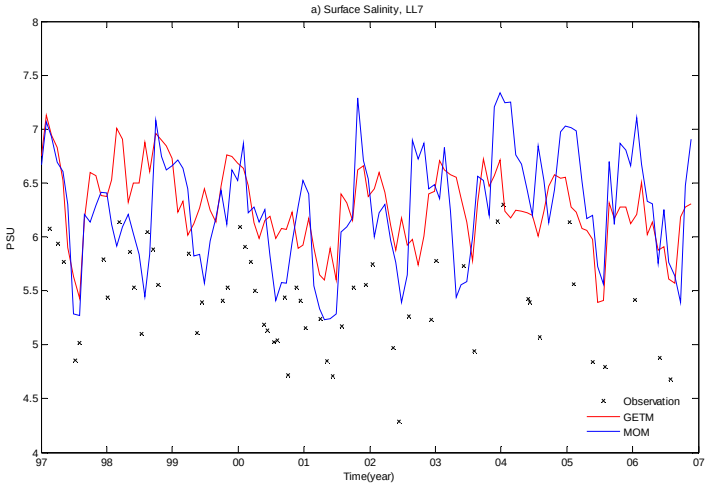
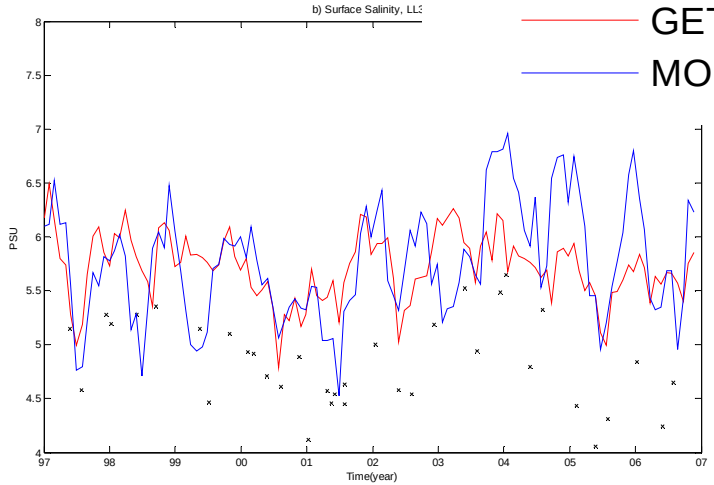
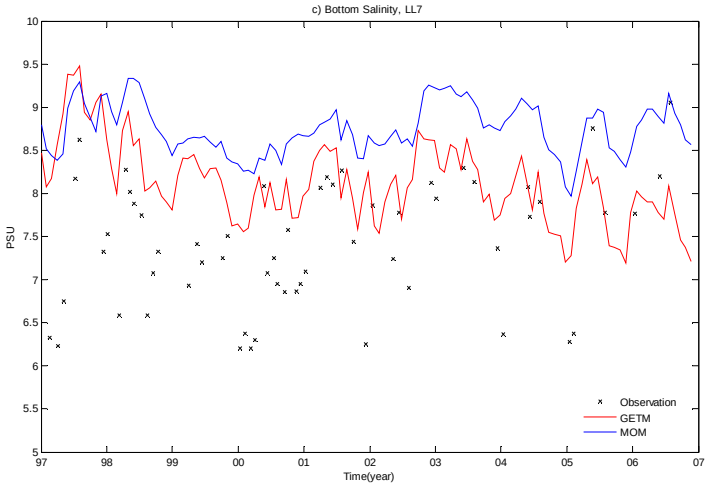
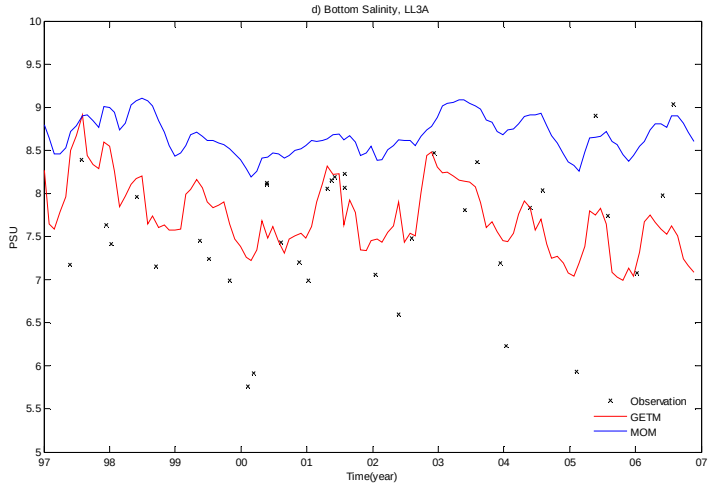
Surface 5 m





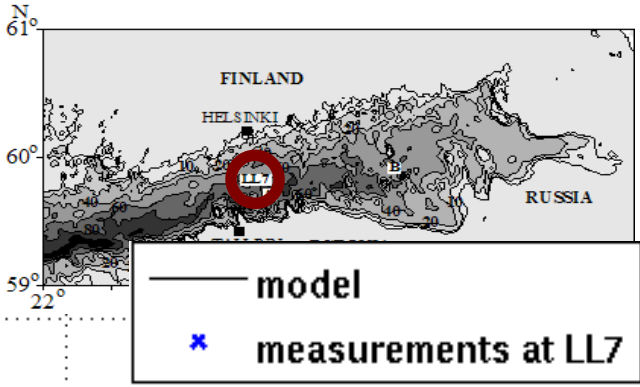
Bottom 60 m

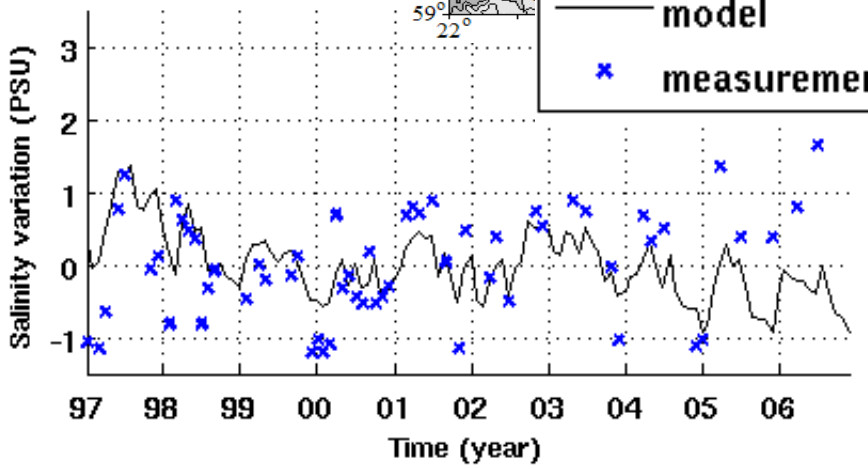




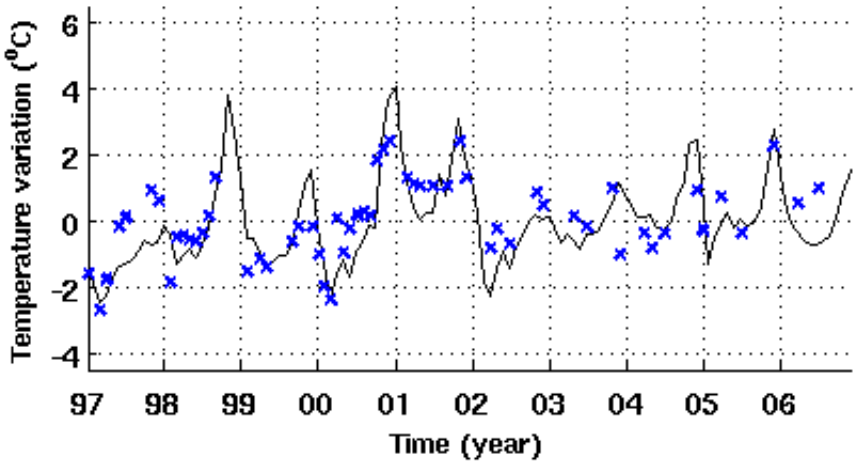
Deviation from mean

Model and observational data averaged over month and mean values were subtracted from both datasets.
i.e. deviation from mean

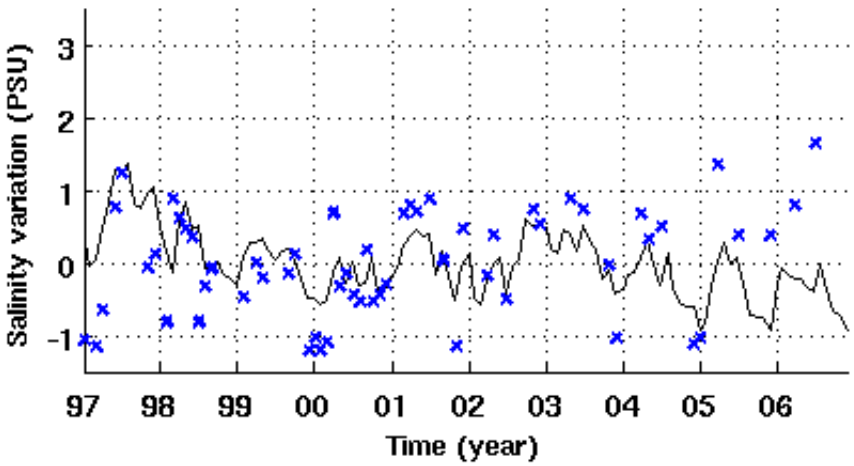




Variability of surface salinity



Bottom temperature

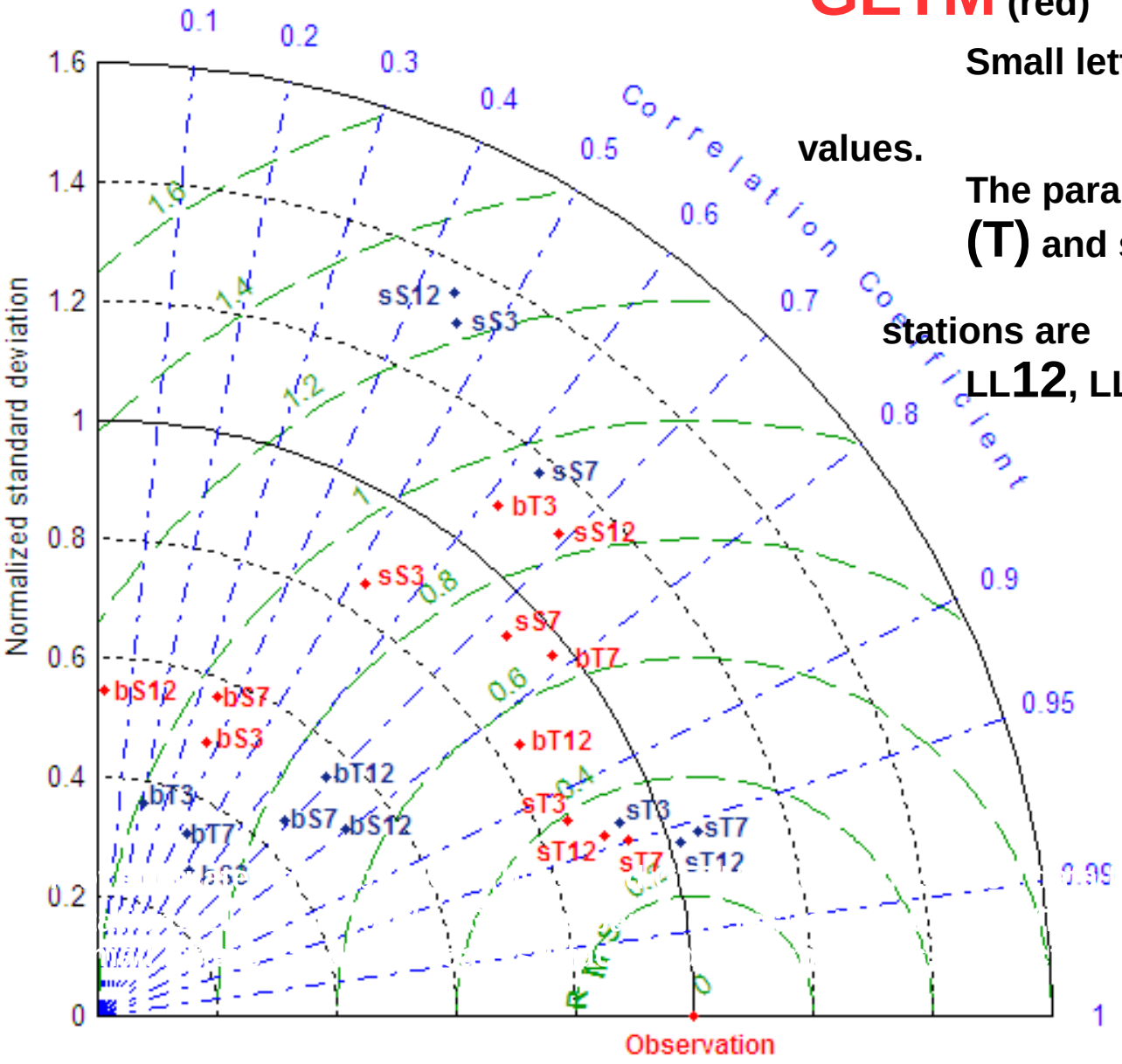


Variability of bottom salinity

Statistical comparison of model results and data

- Monthly averaged data (observed and modeled)
- GETM 0.5 nm, GETM 2 nm and MOM
- CTD Temperature and salinity from depths 5m and 60m
- Statistical parameters: STD, RMSE and Correlation coefficient plotted to the Taylor diagram

Statistical comparison



Comparison of simulated data by

MOM (blue) and

GETM (red)

Small letters *s* and *b* indicate surface and bottom values.

The parameters are temperature (T) and salinity (S).

Monitoring stations are LL12, LL7 and LL3a.

Conclusions

- Temporal variability of surface and near-bottom temperature was simulated well by the models
- Results at the station LL7 are simulated with higher accuracy
- Modeled surface temperature showed good agreement with observed data in all three stations.
- The model MOM gave slightly more accurate results in surface temperature distributions, whereas the results of the GETM model were better in near-bottom distributions.
- Temperature seasonal cycles in the upper layer were reproduced well. Bottom temperatures and surface and bottom salinities were reproduced with lower quality
- Bottom temperatures were better reproduced in the western and central Gulf than in the eastern Gulf
- Surface salinity was simulated with the same quality in all stations by GETM, while MOM reproduced salinity better in the central Gulf compared to the eastern and western part
- Bottom salinities were better simulated by MOM than by GETM
- Models overestimates observed bottom salinities for about 0.5-2 PSU

Thank You for Your attention.