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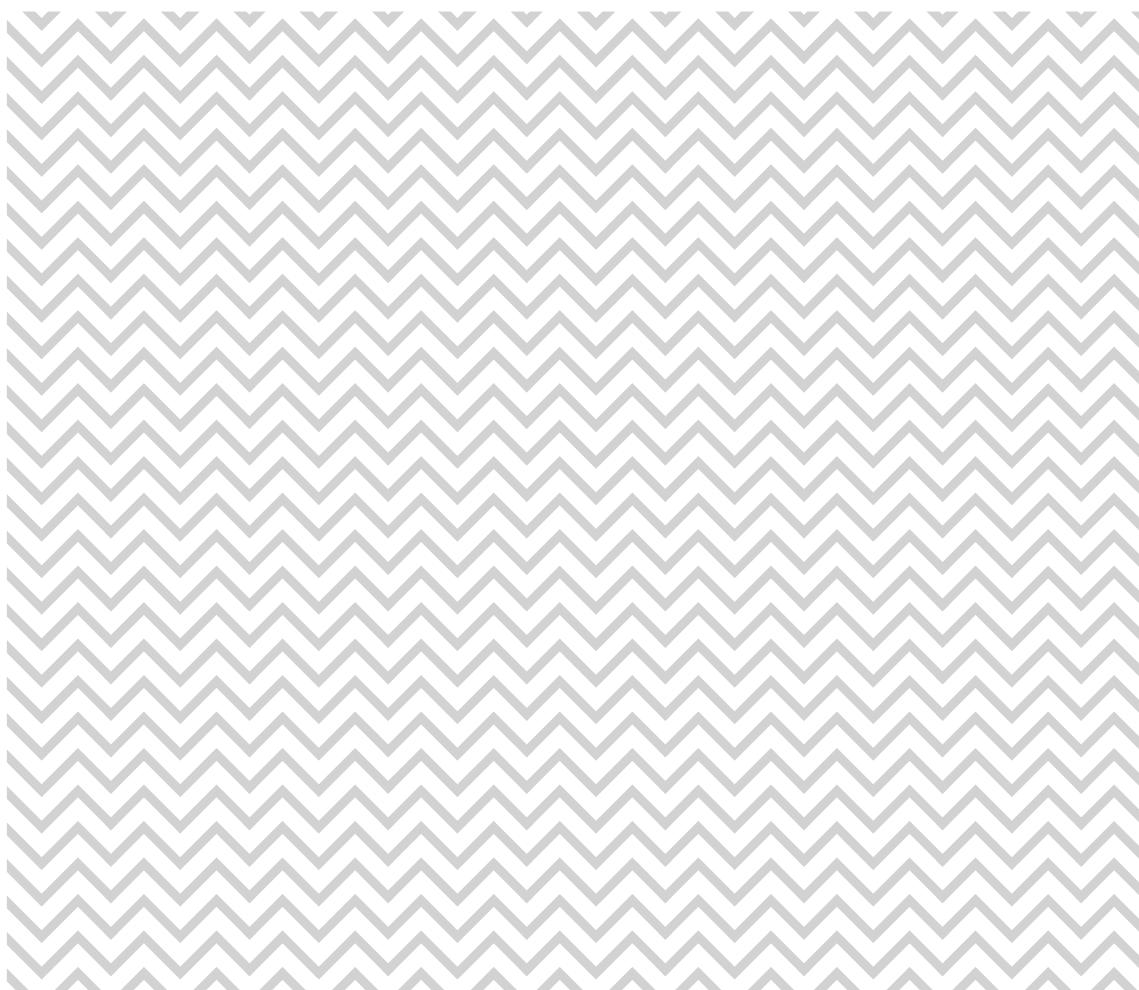
Category

**METreport**

# Evaluation of the FjordOs-model

January 2016

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# METreport

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# Abstract

Abstract text...

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Figure 1: The simulation area. (Karina: Marker posisjoner for observasjoner)

## 1 Introduction - André

Provided is an evaluation of the FjordOs-model (ref. teknisk rapport).

To be continued...

## 2 Model - Karina

Kort om modellen. Vise til teknisk rapport.

## 3 Data

Hvilke observasjoner har vi?

Figur som viser modelområdet samt alle relevante posisjoner der vi har observasjoner som vi bruker i rapporten.

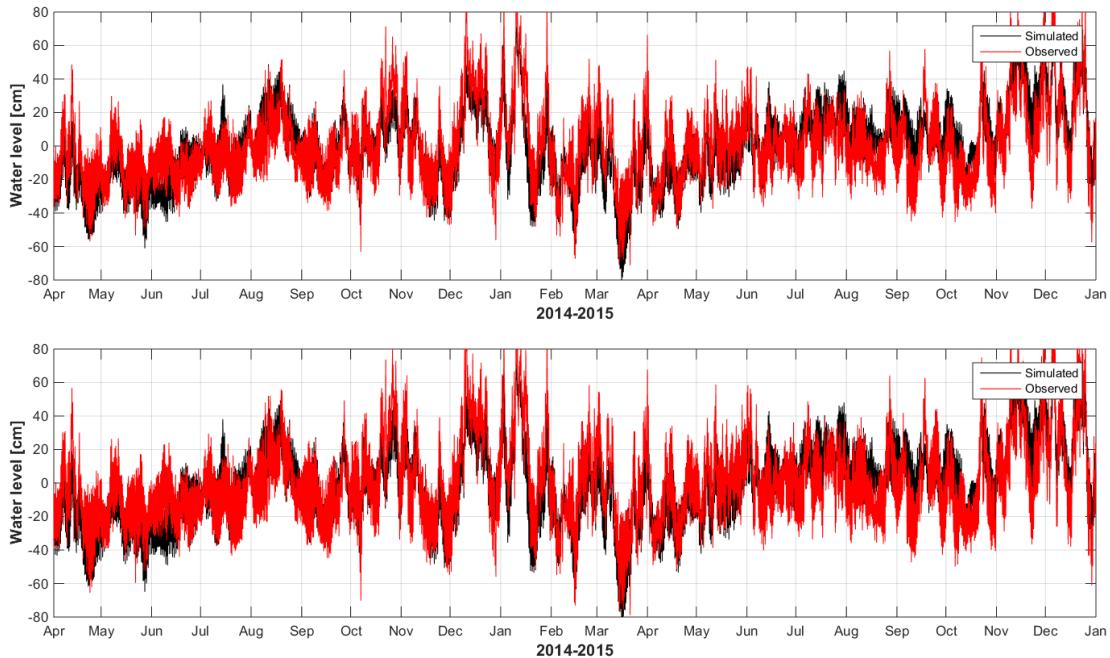


Figure 2: Observed and simulated water level for Viker (upper) and Oscarsborg (lower)

## 4 Evaluation

### 4.1 Water level and tide - Karina

The Norwegian Mapping Authority has three permanent stations measuring sea level in the area of interest. Time series from these three stations have been analysed and compared with simulated time series of waterlevel from the same period in time.

Tides are included in the model at the southern open boundary in two ways. The FjordOs model is nested into NorKyst800 through daily mean forced on the boundary. This forcing includes the tidal components with longer periods. In addition 11 components with shorter periods are introduced explicitly using their corresponding amplitudes and phases for both depth integrated currents and water level (ref. tidevannsartikkelen?). The timeseries of tides originating from explicit tidal forcing are in fairly good agreement (Fig. 3, upper, and Fig. 4, upper). The main characteristics of the remaining tidal components are present in both the observed and the simulated timeseries (Fig. 3, lower).

To be continued... Karina (Figurer og tabeller er laget og satt inn, men en del tekster mangler fortsatt)

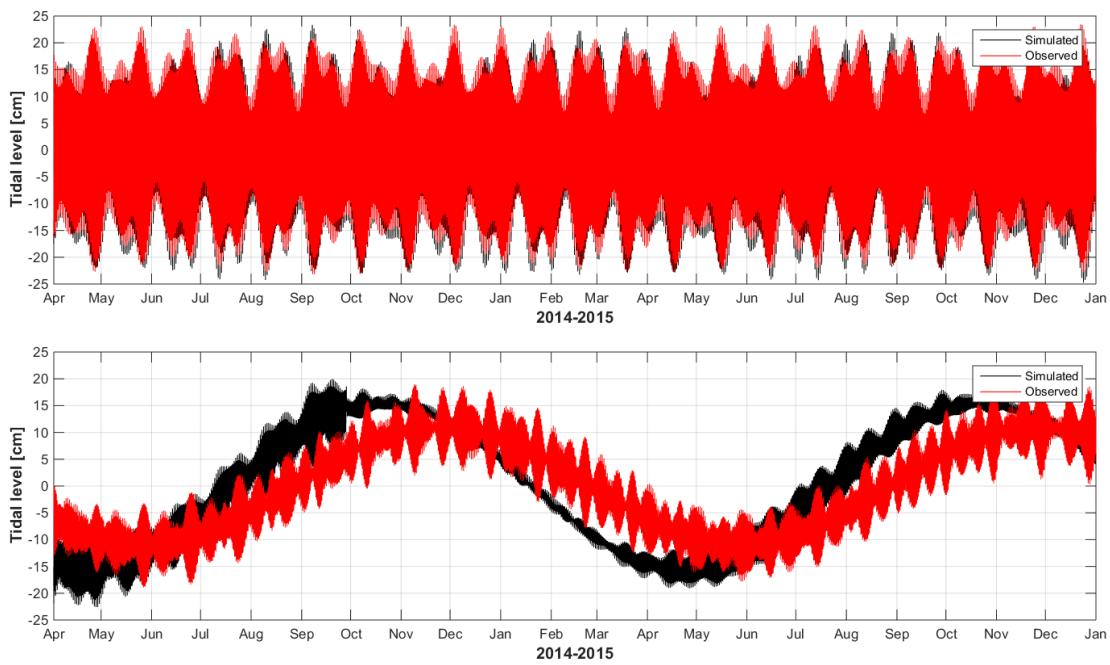


Figure 3: Timeseries at Oscarsborg of the tidal components included (upper) and not included (lower) in the explicit tidal forcing.

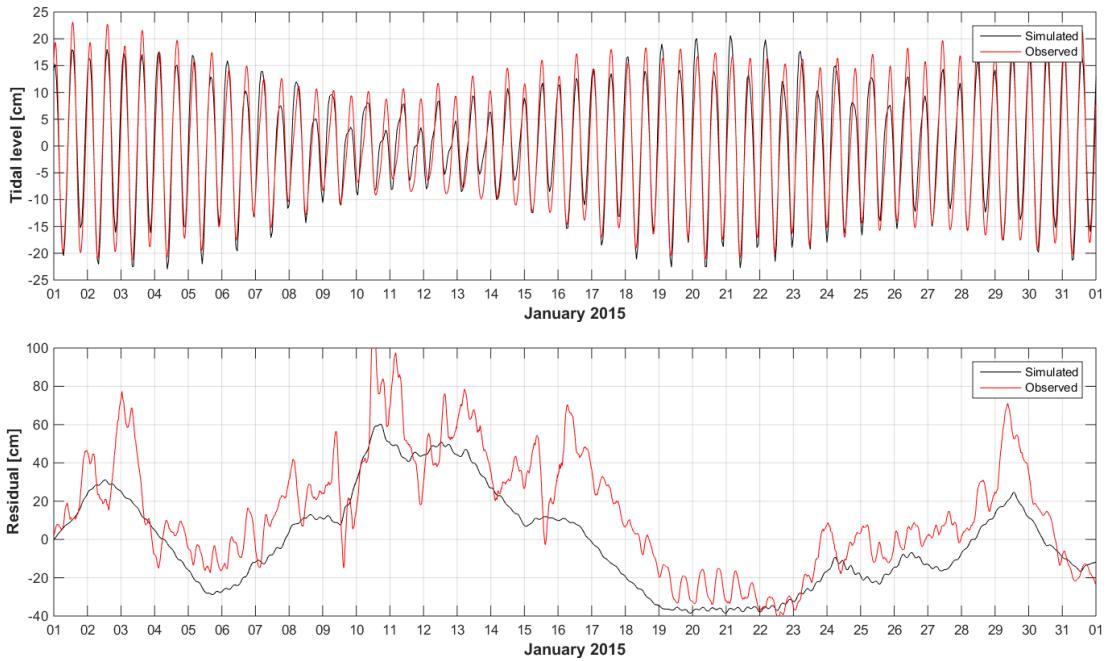


Figure 4: Timeseries of tides originating from explicit tidal forcing (upper) and the residual (lower) at Oscarsborg

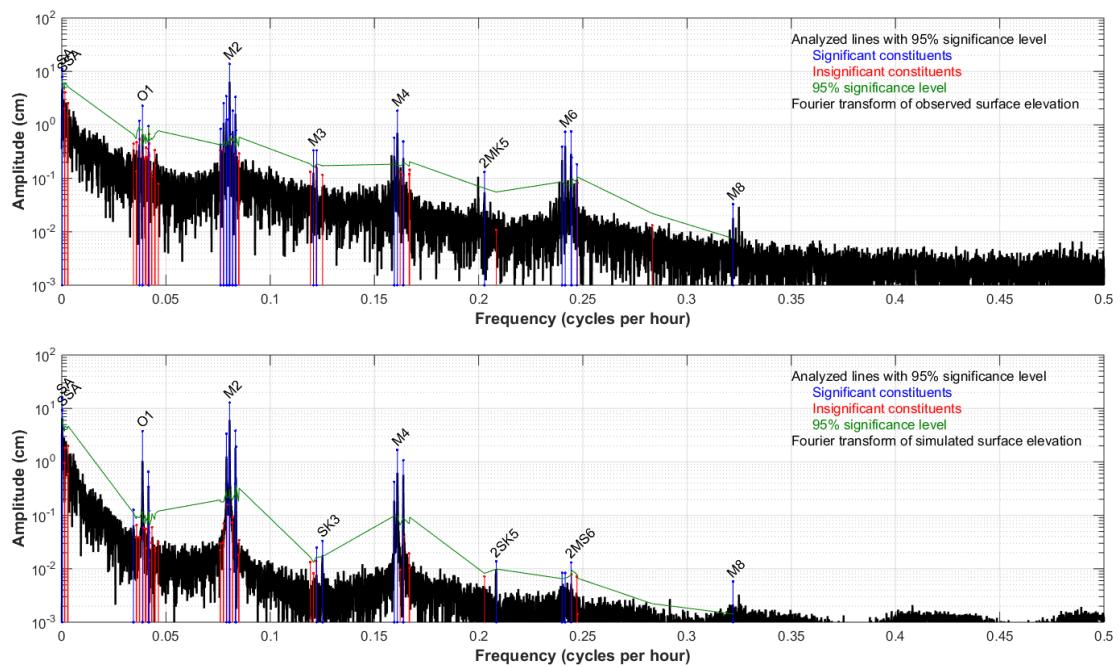


Figure 5: Frequency series of Fourier transformed observed (upper) and simulated (lower) water levels at Oscarsborg

Table 1: Simulated and observed tidal amplitude and phase for selected tidal components.

Comp.	Period [h]	sim/ obs	Viker		Oscarsborg		Oslo		Included in tidal forcing
			amp. [cm]	phase. [deg]	amp. [cm]	phase. [deg]	amp. [cm]	phase. [deg]	
SA	365 days	sim	15.5	284	15.5	286	15.2	286	no
		obs	10	319	11	322	11.3	324	
SSA	182 days	sim	8.8	198	9.2	199	9.3	200	no
		obs	7.5	188	7.9	188	8.2	190	
K2	11.9672	sim	1.6	32	1.9	35	2.1	37	yes
		obs	0.7	46	0.8	66	0.9	67	
S2	12.0000	sim	3.3	87	3.8	91	4.1	92	yes
		obs	2.9	46	3.3	65	3.5	69	
M2	12.4206	sim	11.2	127	12.9	134	13.6	135	yes
		obs	11.9	105	13.8	121	14.4	125	
N2	12.6584	sim	2.9	91	3.4	96	3.6	98	yes
		obs	3	60	3.4	76	3.6	80	
K1	23.9345	sim	0.2	194	0.1	185	0.1	165	yes
		obs	0.4	125	0.7	128	0.8	129	
P1	24.0659	sim	0.6	335	0.7	346	0.7	352	yes
		obs	0.2	123	0.4	100	0.4	95	
O1	25.8193	sim	3.5	347	3.8	348	3.8	349	yes
		obs	2.3	276	2.3	281	2.4	282	
Q1	26.8684	sim	0	177	0	188	0.1	201	no
		obs	1.1	189	1.2	197	1.3	199	
MN4	6.2692	sim	0.2	50	0.4	76	0.6	78	yes
		obs	0.4	249	0.6	289	0.7	297	
M4	6.2103	sim	0.9	37	1.7	61	2.2	65	yes
		obs	1.2	281	1.8	324	2.3	332	
MS4	6.1033	sim	0.5	123	1.1	150	1.4	154	yes
		obs	0.3	360	0.5	44	0.7	56	

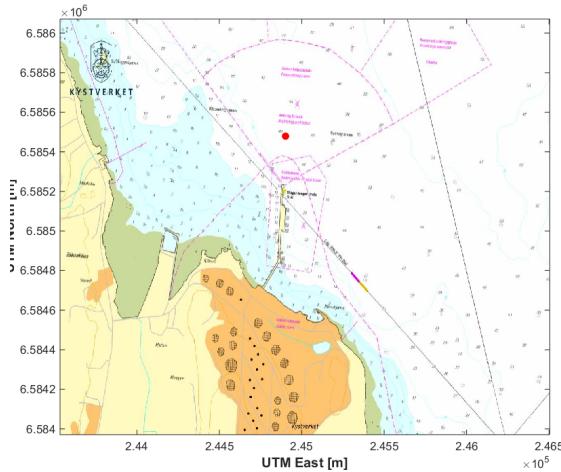


Figure 6: Map retrieved from the Norwegian Coastal Administration. The red dot marks the position corresponding to the extracted simulated data.

## 4.2 Current

### 4.2.1 Current measurements performed by Statnett - André/Karina ?

To be continued... André?

### 4.2.2 Current measurements performed by Exxonmobil AS - Karina

Using a bottom-mounted doppler Exxonmobil has measured the currents in two depths since 1997. The device is placed 50-80 meters northwest of Turning Dolphin at the Slagen Refinery (Fig. 6). The observations are compared with simulated data from 1st October 2014 until 30th November 2015 at approximately the same location and depth.

Time series show that the observed velocities varies and follows no striking pattern (Fig. 7). Current roses show that both the observed and the simulated velocities are stronger in the upper layer (Fig. 8). The simulated velocities are stronger than the observed velocities. This is in accordance with the probability density functions (Fig. 9). The maximum velocities are approximately 0.8 and 1.1 knots at 10 and 2.5 meters depth respectively (Tab. 2). During 2014 and 2015 maximum observed velocity at 2.5 meters depth was 1.07 knots in southeast direction ( $143^\circ\text{N}$ ) the 26th of March 2014. The velocity at 10 meters depth was 0.15 knot at the time of maximum velocity at 2.5 meters depth indicating that the velocities are different in the two layers.

The mean directions are to the south east. At approximately 2.5 meters depth the

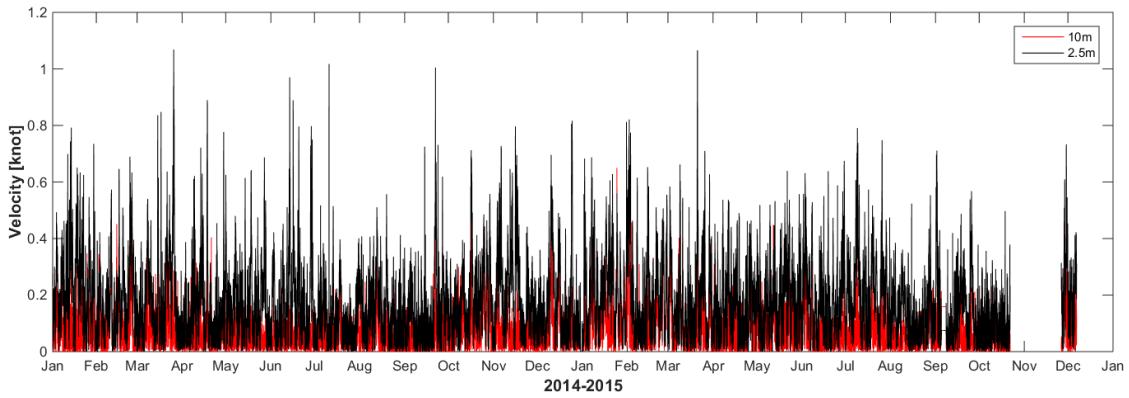


Figure 7: Timeseries of observed velocities at Slagen from 1st of January 2014 to 31st of December 2015.

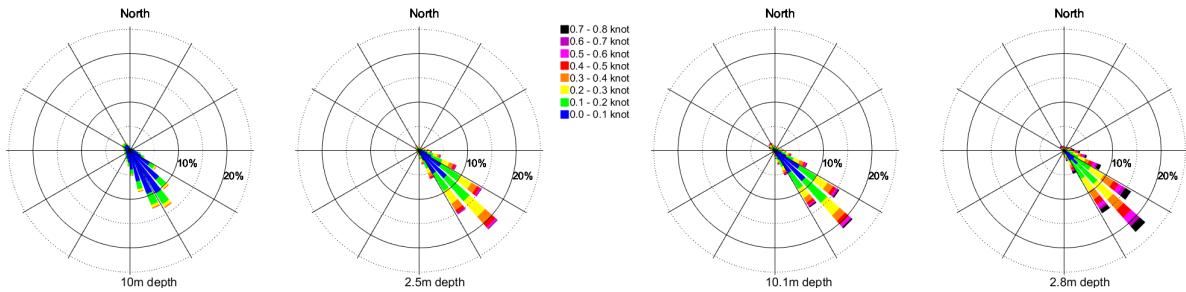


Figure 8: Current roses for observed (left) and simulated (right) velocities at two depths from 1st of October 2014 to 1st of October 2015.

mean directions are  $146^\circ\text{N}$  and  $141^\circ\text{N}$  for observed and simulated directions respectively which is in fairly good agreement. At approximately 10 meters depth the observed mean direction shifts to  $170^\circ\text{N}$  while the simulated mean direction is  $149^\circ\text{N}$ . The probability density functions reveals that the model captures the distribution of directions in the upper layer, but does not capture the change in direction between the two depths (Fig. 9). The standard deviations at 2.5 and 10 meters are 55 and 66 degrees respectively for the observed directions, and 58 and 65 for the simulated directions.

The scatter plots reveal that the correlation in time is not satisfying (Fig. 10). The model seen to have difficulties with capturing the right phenomena influencing the currents to the right time. This is a well known problem when it comes to forecasting currents. The QQ-plots also confirms that the simulated currents are stronger than the observed currents.

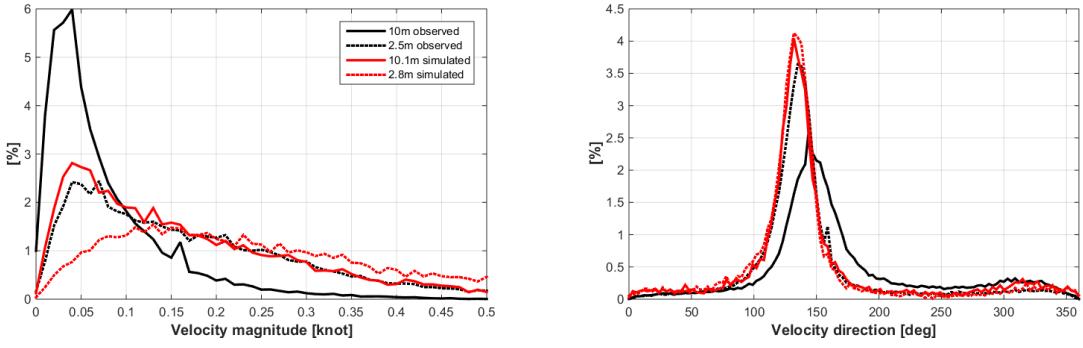


Figure 9: Probability density functions of velocities and directions at Slagen for 1st of October 2014 to 1st of October 2015. The bin width is 0.01 knots for velocity and 3 degrees for direction.

Table 2: Maximum oberved velocity at Slagen.

Year	Max. velocity at 10m depth			Max. velocity at 2.5m depth		
	Date	[knots]	[deg]	Date	[knots]	[deg]
2006	21 January	0.81	139	31 Octotber	1.10	140
2007	14 January	0.81	172	21 August	2.00	359
2008	22 March	0.70	149	19 December	1.10	160
2009	17 December	0.87	142	24 March	1.10	139
2010	09 November	0.81	138	09 November	1.05	138
2011	01 January	0.76	146	30 March	1.21	185
2012	05 December	0.75	138	29 May	1.11	140
2013	10 October	0.82	143	10 Octotber	0.95	144
2014	18 April	0.85	147	26 March	1.07	143
2015	24 January	0.65	128	21 March	1.07	141

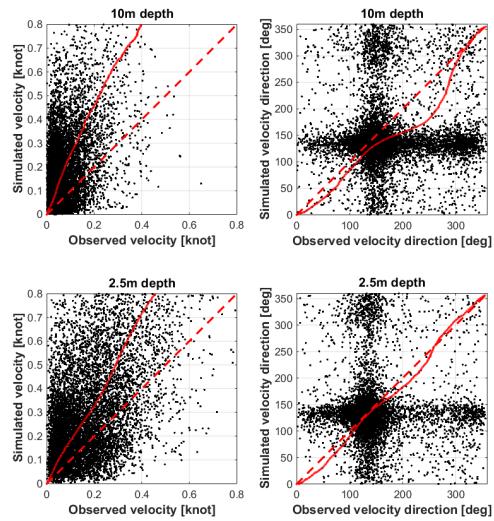


Figure 10: Combined QQ- and scatterplot of observed and simulated current at Slagen from 1st of October 2014 to 1st of October 2015.

## **4.3 Temperature and Salinity**

### **4.3.1 CTD-measurements - André?**

To be continued... André?

#### **4.3.2 Temperature measurements performed by Scanmar AS - Karina**

Hourly temperaturmeasurements at one meter depth for the last 10 years have been measured by Scanmar AS located south of Åsgårdstrand. The device has an accuracy of  $\pm 0.15^{\circ}\text{C}$  in the range from -5 to  $+30^{\circ}\text{C}$ . The observations are compared with simulated data from 1st October 2014 until 30th November 2015 at the same location at 1.15 meters depth.

Timeseries show that the simulated temperatures are between 2 and 8 degrees lower than the observed temperatures 11. The model captures the variations in temperature fairly good (Fig. 12). Notice for example the variations in January with around three days period, and the local minimum around 1st of August. (Karina: Her bør det nevnes hva som forårsaker disse variasjonene.)

The probability density functions reveals that not only are the simulated temperatures lower than the observed temperatures, but the variation is larger in the observed temperatures (Fig. 13). The mean of the observed and simulated temperatures are  $10.1^{\circ}\text{C}$  and  $5.5^{\circ}\text{C}$  respectively, while the variances are  $27.2^{\circ}\text{C}$  and  $16.4^{\circ}\text{C}$  respectively.

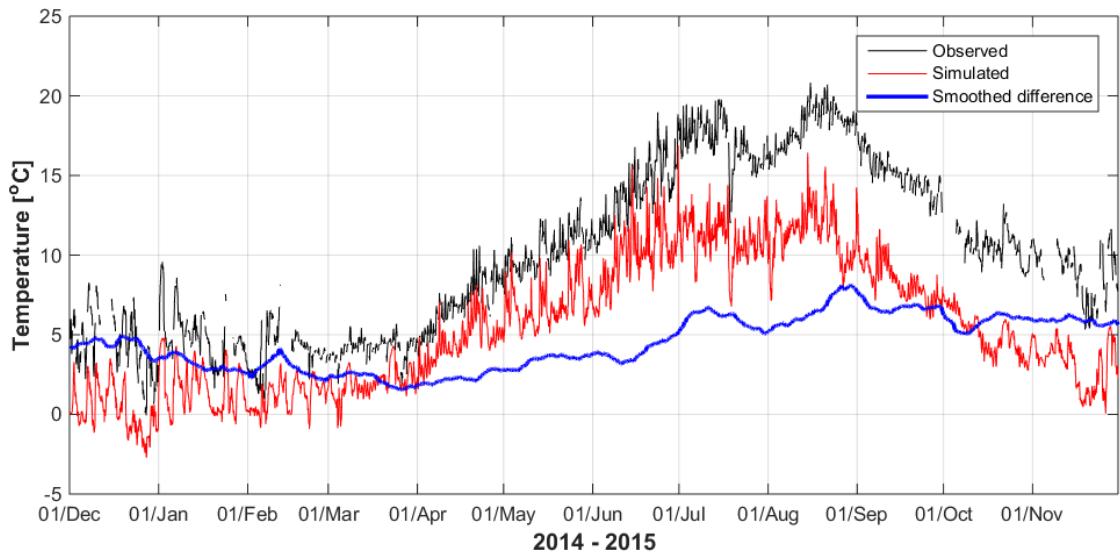


Figure 11: Timeseries of observed and simulated temperature at Åsgådstrand from 1st of December 2014 to 1st of December 2015. The difference is smoothed over 10 days.

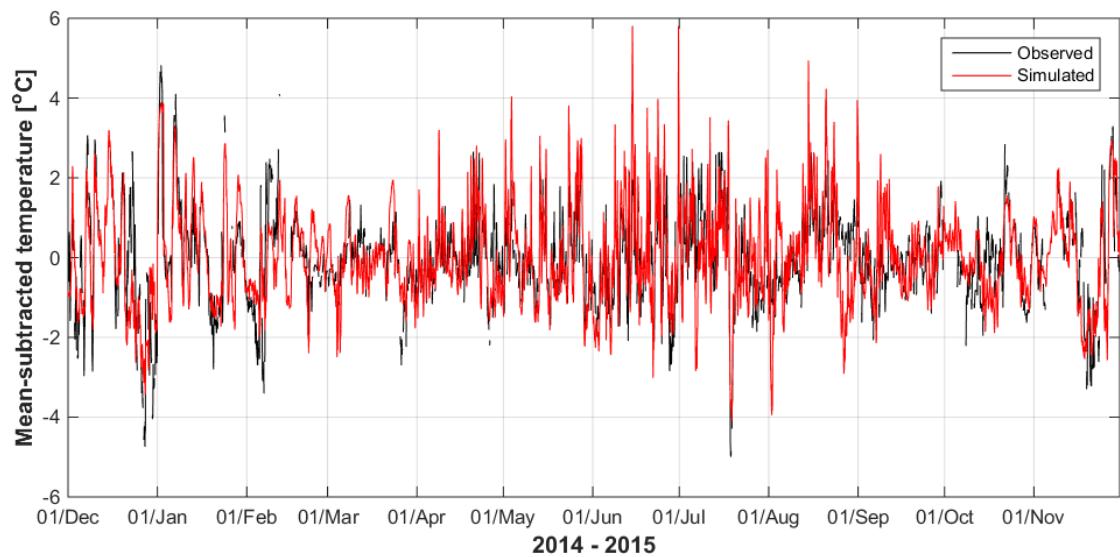


Figure 12: Mean-subtracted timeseries of observed and simulated temperature using a gliding mean of one month.

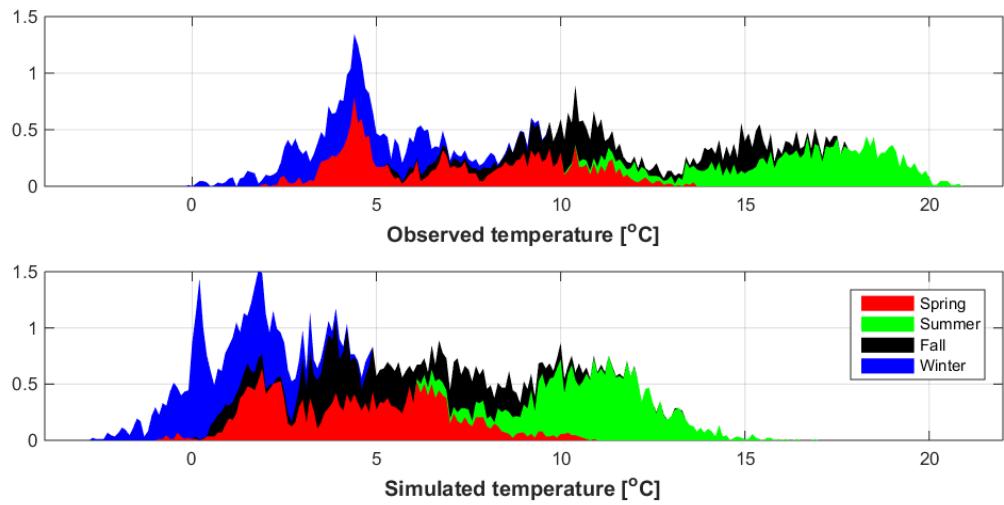


Figure 13: Probability density functions of observed and simulated temperature at Åsgådstrand from 1st of December 2014 to 1st of December 2015.

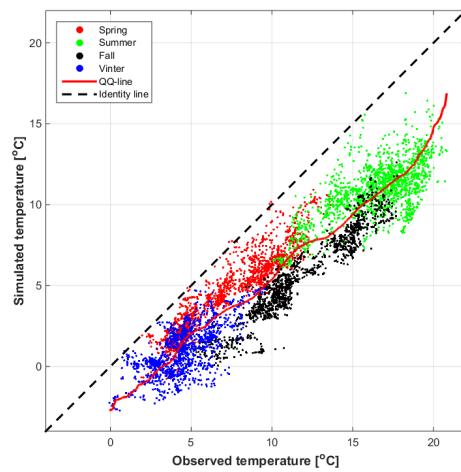


Figure 14: Combined QQ- and scatterplot of observed and simulated temperature at Åsgådstrand from 1st of December 2014 to 1st of December 2015.

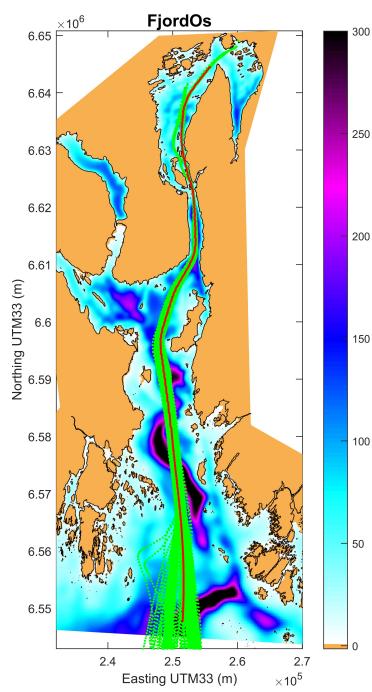


Figure 15: The track of Color Fantasy.

#### 4.3.3 Ferrybox - André?

To be continued... André?

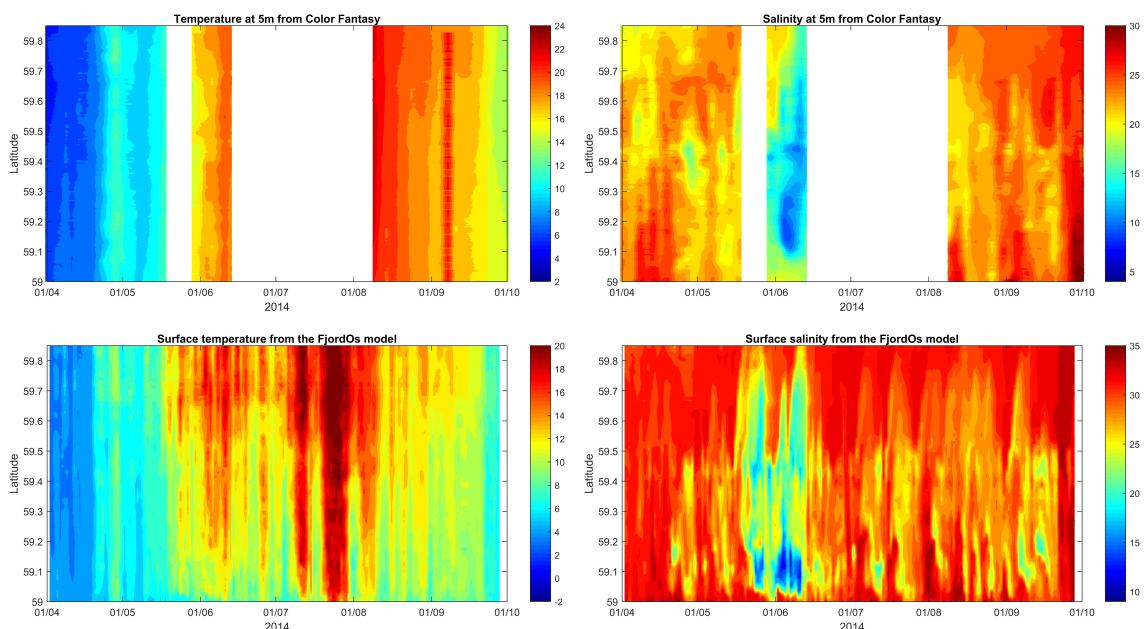


Figure 16: Simulated daily mean compared with observations from ferryboxes for temperature (left) and salinity (right).

## **5 Summary and final remarks**

## Acknowledgements

## Appendix