NOOS Meeting on 'Exchange of transports'

8 March 2013, BSH Hamburg

BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

NOOS

North West European Shelf Operational Oceanographic System

NOOS Exchange of transports
Meeting on 8 March 2013, Hamburg

AGENDA

1. Welcome and introduction
2. New NOOS web pages
3. Evaluation and developments within MyOcean
4. Discussion on new file contents and formats for the exchange
5. Discussion on heat fluxes
6. Further evaluation and developments
   (e.g. ensemble modelling)

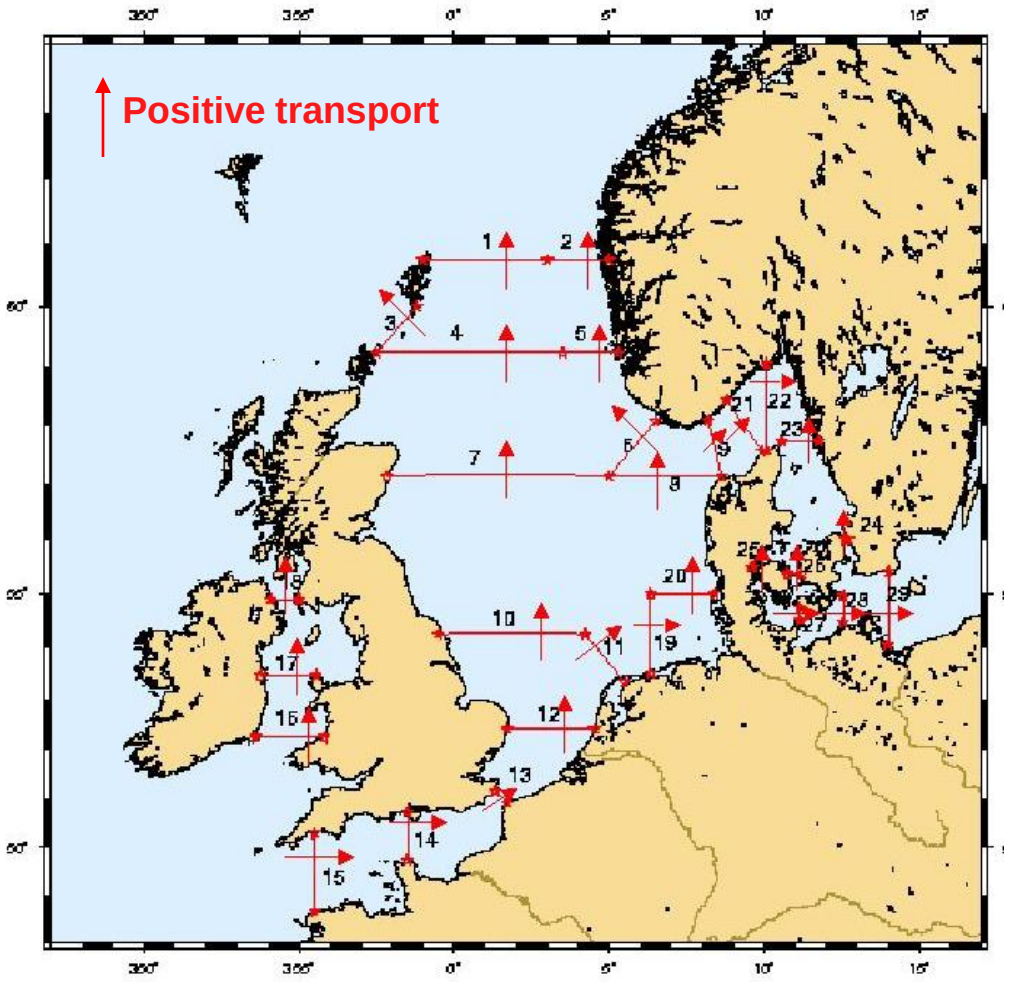
NOOS Exchange of transports

Project task:
Exchange computed water, salt, and heat transports across selected transects in the North West European Shelf Sea

Lead agency: BSH

Access via: http://www.noos.cc

Forecasts: provided by
BSH (since 2004),
MUMM (since 2006)
DMI (since 2009)
Met.Office (since 2012)
DCOO (since 2013)



NOOS Exchange of transports

Aims:

- **characterization of the current hydrodynamic situation**
- **better understanding of dispersion of pollutants or the development of ecological parameters**
- **model inter-comparison using data from different models**
- **model validation by transports derived from measurements (if available)**
- **forcing data at open boundaries**

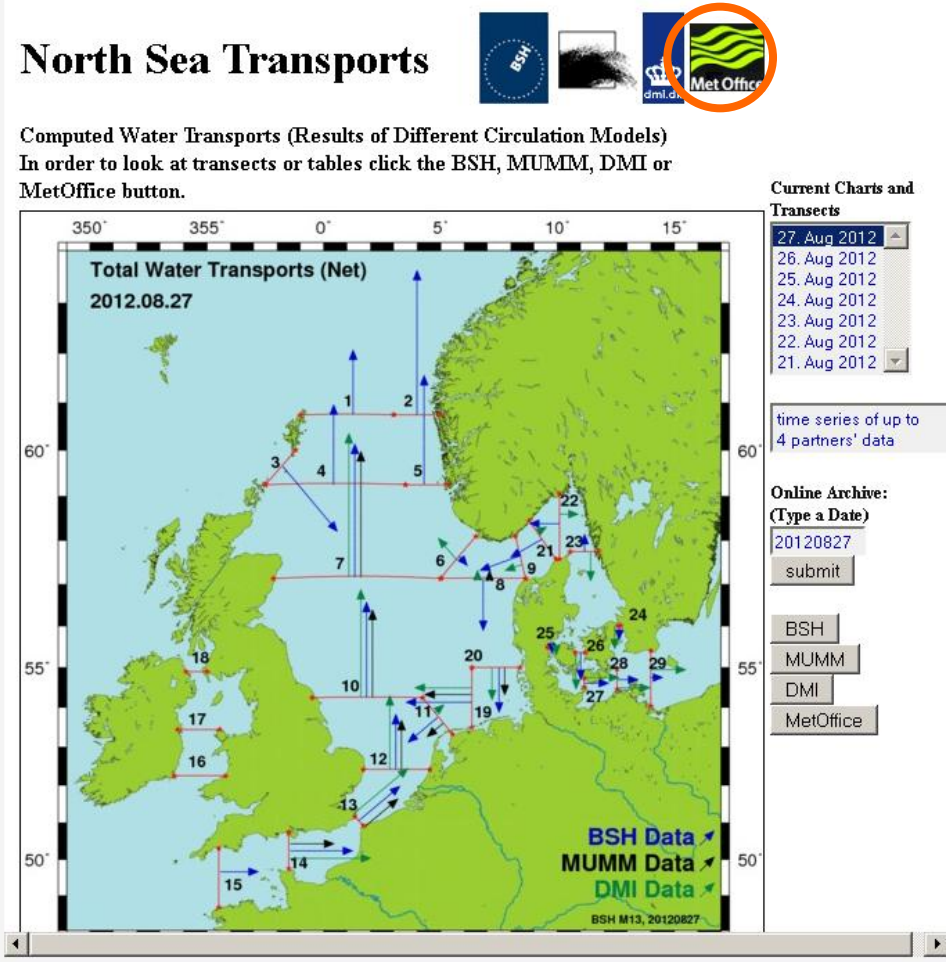
Present status:

- **calculation of tidal mean values of water, heat and salt transports** (vertical mean + 10 layers) **for 29 transects** (+ 25 in Baltic)
- **provision of compressed data sets on ftp server**
- **presentation of water transports on NOOS web pages**

NOOS transports

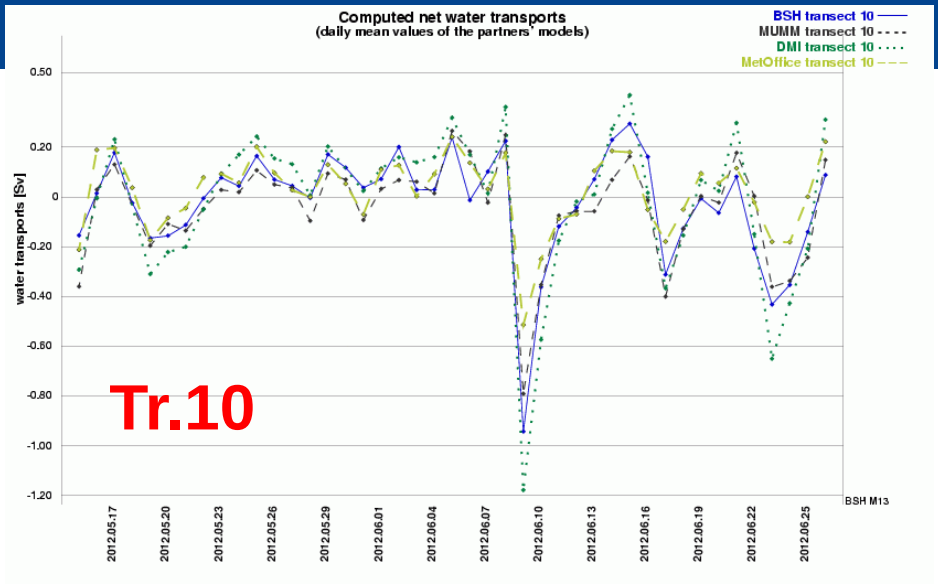
What is new?

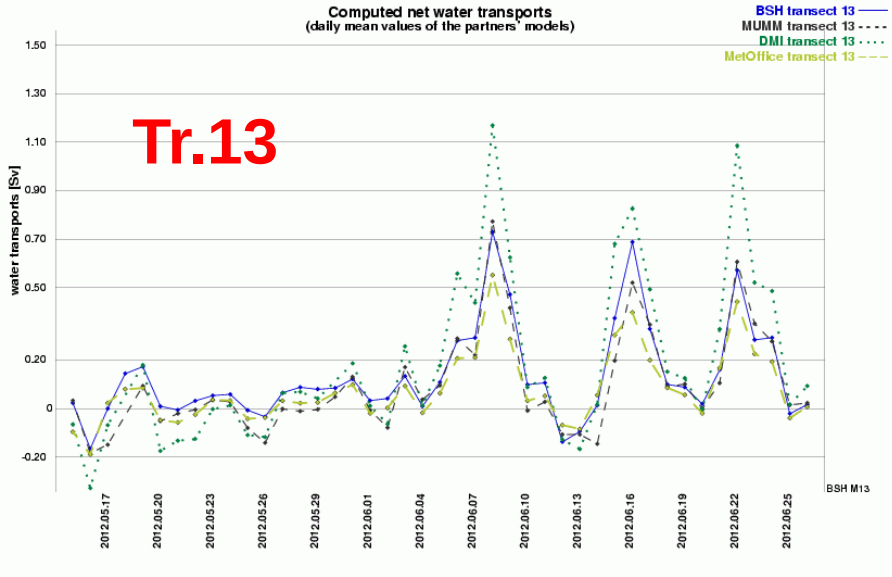
- new participants: UK Met.Office (2012) and DCOO (2013)
- model intercomparison and validation activities in MyOcean => QUID (Quality Validation Document V1) and Scientific Val. Rep. V2 for Baltic MFC (2012)
- comparison of water, salt and heat transports
- strong interest of other partners

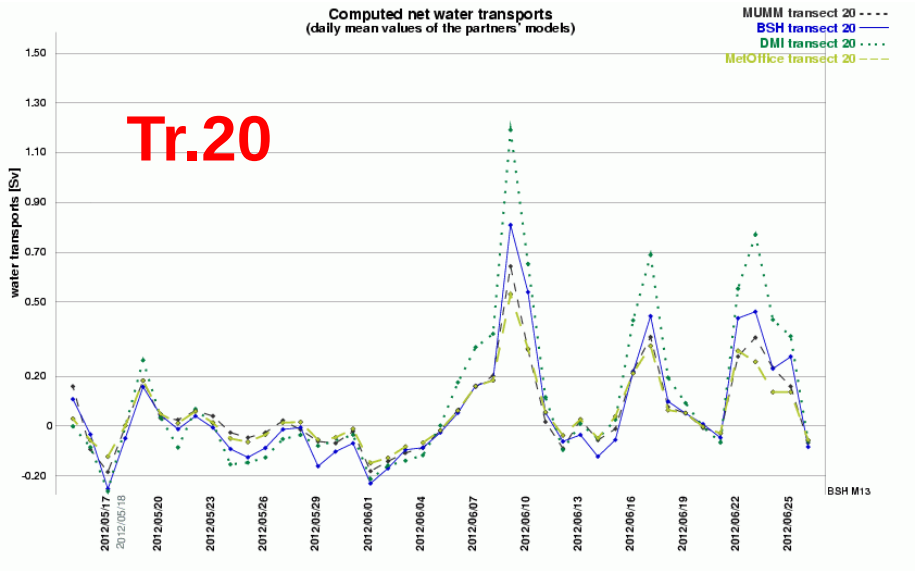


NOOS transports

- **good agreement for most transects**







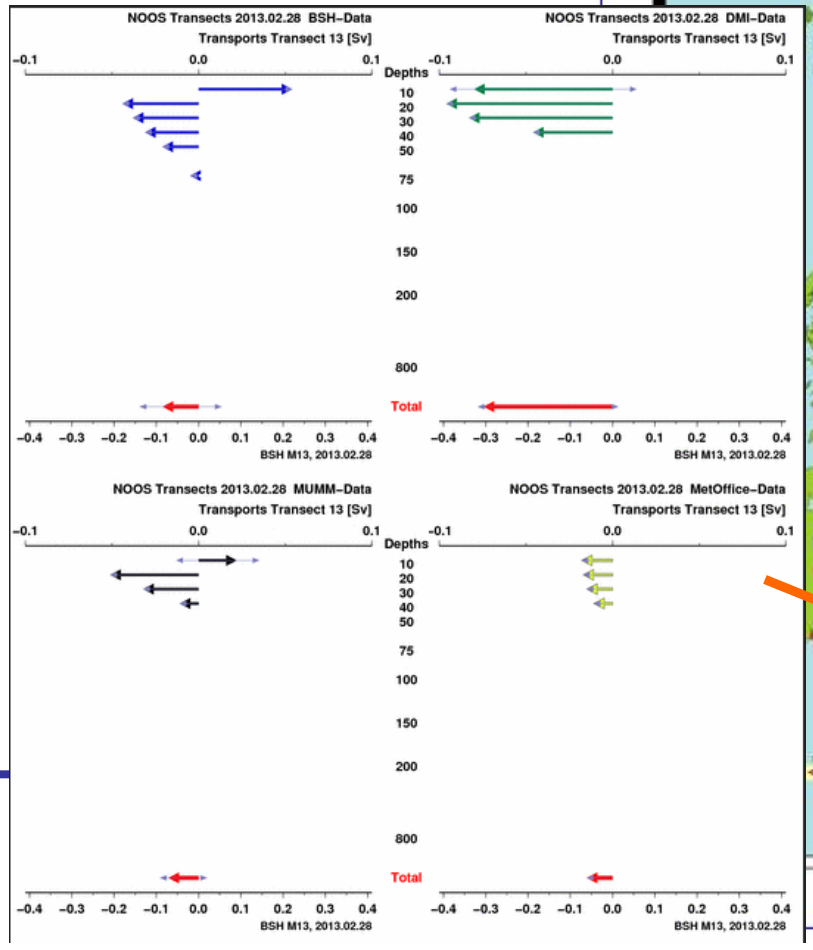
2. Update of web pages

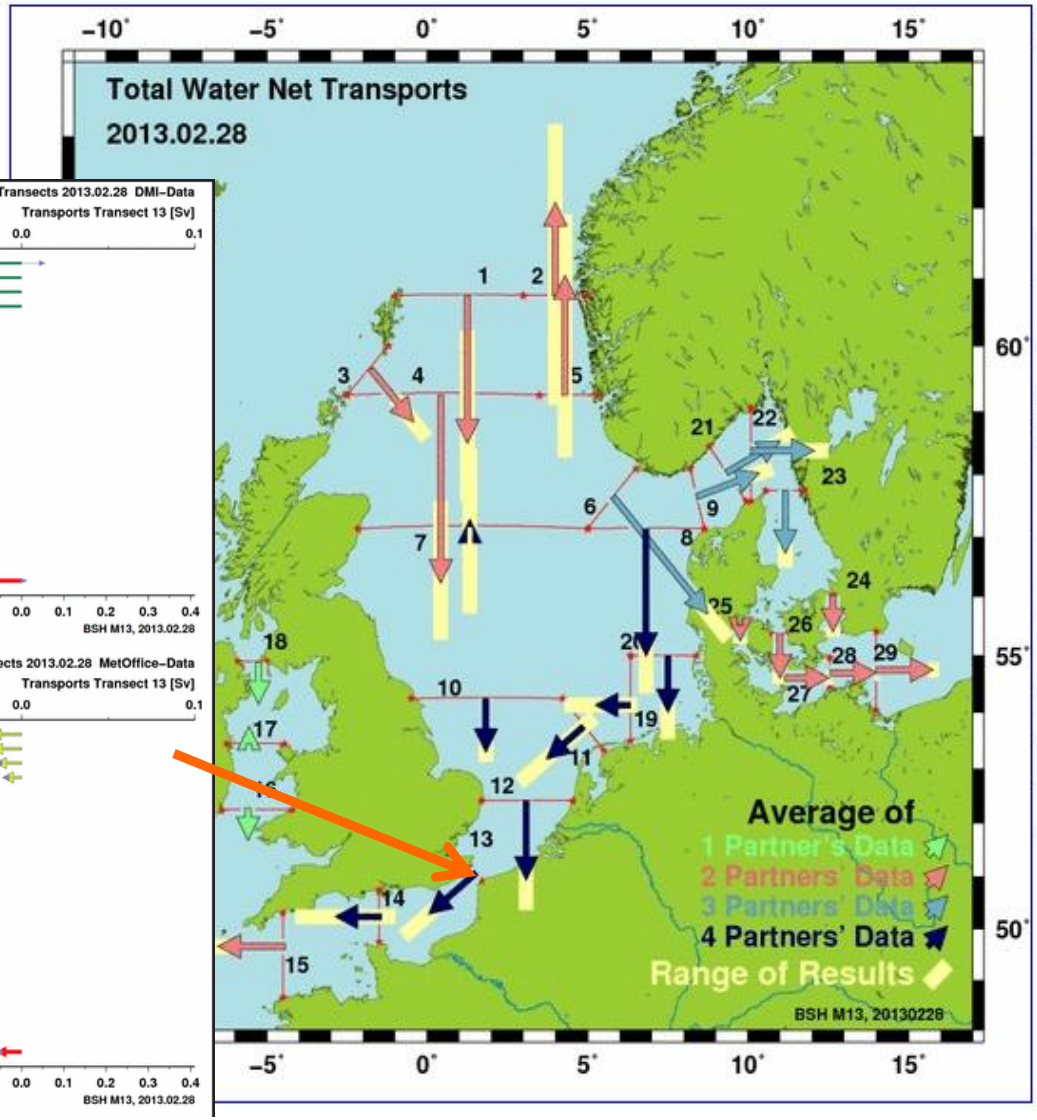
- Improved layout of front page
- New figures (e.g. display of surface transports)

http://www.bsh.de/aktdat/modell/stroemungen/transports_neu/html/all_avg.htm

NOOS transports

2. Update of web page





North Sea Transports

Computed Water Transports (Average Results of the BSH, MUMM, DMI and MetOffice Circulation Models)

Current Charts and Transects

28. Feb 2013
27. Feb 2013
26. Feb 2013
25. Feb 2013
24. Feb 2013
23. Feb 2013
22. Feb 2013

time series of 4 partners' data

Online Archive: (Type a Date)

20130228

submit

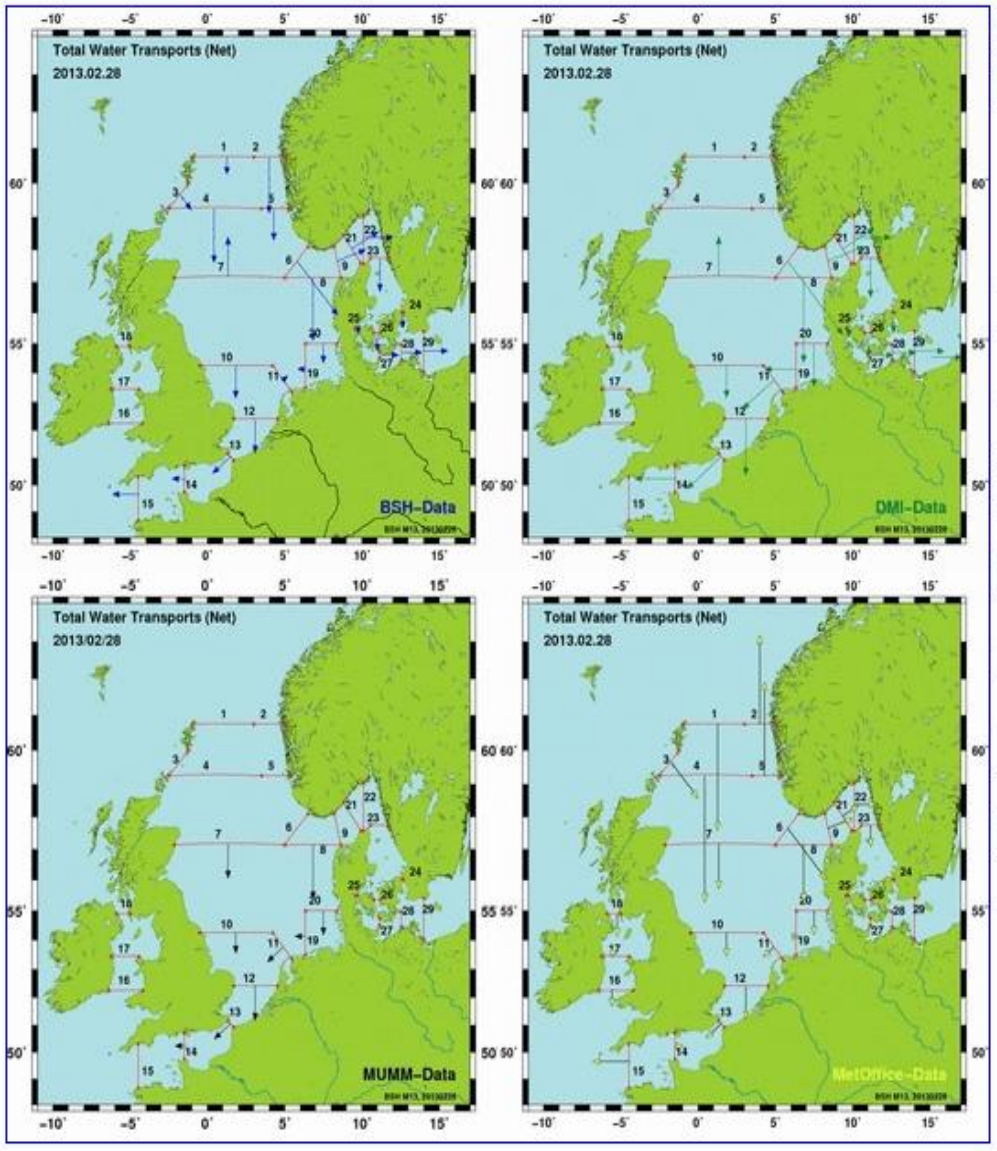
Overview

BSH
MUMM
DMI
MetOffice

NOOS transports

2. Update of web page

– Overview



NOOS/BOOS Diagramm-Auswahl - Mozilla Firefox

www.bsh.de/aktdat/modell/stroemungen/transports_neu/html/wdiagramm_neu.htm

North

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partners (fir

BSH (2

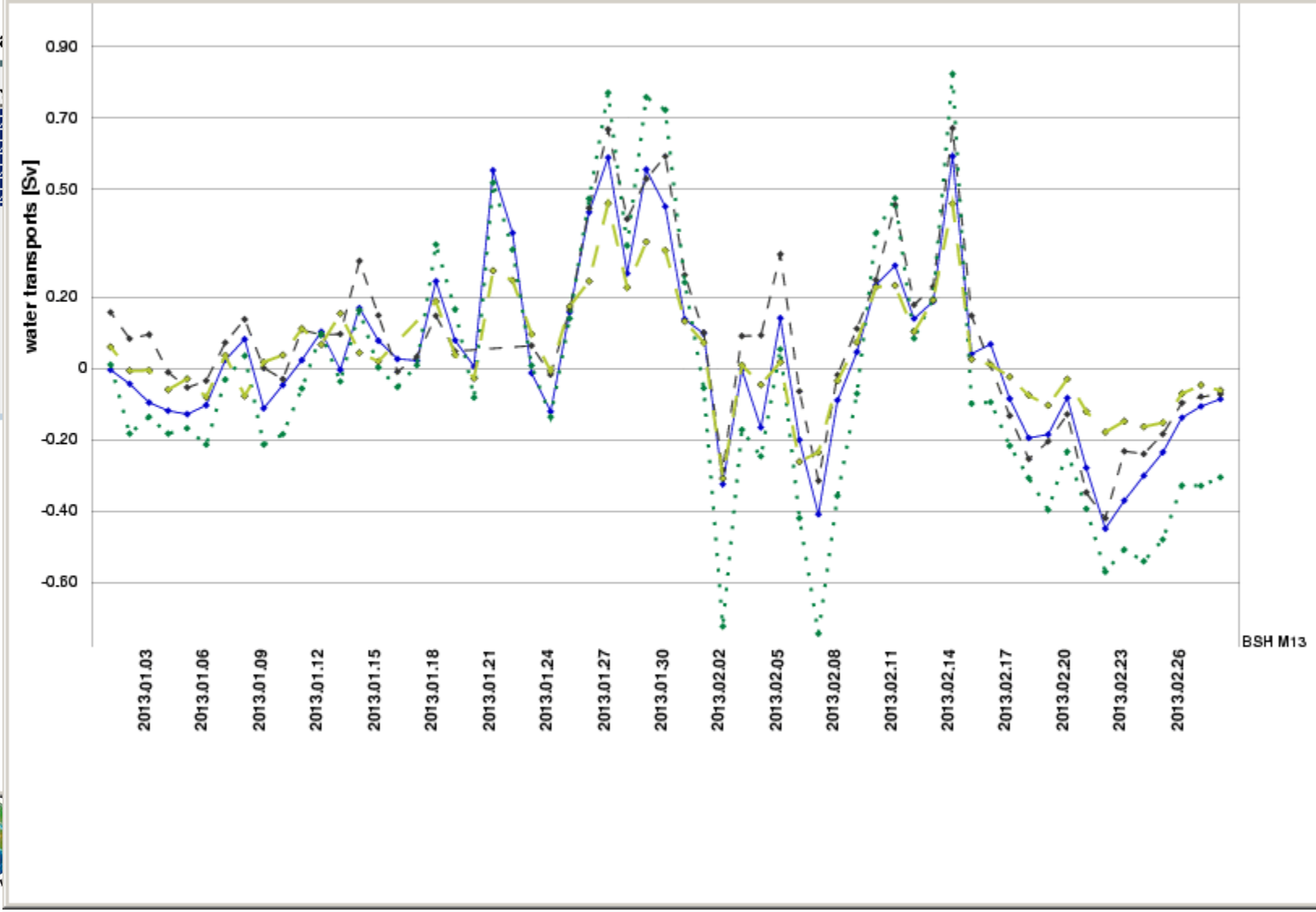
MUMM (2

DMI (2

MetOffice (2

mach_wasser_reihen_neu.pl (GIF-Grafik, 842 × 1190 Pixel) - Mozilla Firefox

gotland.bsh.de/Cgi-noos/mach_wasser_reihen_neu.pl



Global Ocean Obser

3. Evaluation and developments within MyOcean/MyOcean2

4. Discussion on new file contents and formats for the exchange

NOOS transports

What do we have?

- **Calculation of tidal mean values for 10 fixed z-layers**
- **Calculation of positive and negative transports**
- **Integration/sum of positive, negative and net transports**
- **Output (format description):**

first line: header (date and transect No.)

```
      write(iweg,'(a10,a12,i3,a17,i3)')date(1:10),
     + '   Transect:',itr,'   No. of layers:',ktra(itr)
```

second line: vertically integrated transports (= total mean transport)

```
      write(iweg,'(9e12.4E2)')(water(i3),i3=1,3),
     +  (heat(i3),i3=1,3),(salt(i3),i3=1,3)
```

i3=1: net transport, i3=2: positive transport, i3=3: negative transport

next 1 to ktra(itr) lines: transports for each NOOS layer

NOOS transports

Example of BSH model output for transects 3 to 5:
(from file 'tr_20040213_bsh'):

Format: 9e12.4E2

```
2004.02.13   Transect:  3   No. of layers:  0
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
2004.02.13   Transect:  4   No. of layers:  8
  0.2867E+06  0.4486E+06 -0.1619E+06  0.3398E+15  0.5379E+15 -0.1980E+15  0.4498E+07  0.1374E+08 -0.9245E+07
  0.2916E+05  0.5846E+05 -0.2930E+05  0.3450E+14  0.7010E+14 -0.3560E+14  0.4767E+06  0.1872E+07 -0.1395E+07
  0.4890E+05  0.6632E+05 -0.1742E+05  0.5830E+14  0.7952E+14 -0.2123E+14  0.1208E+07  0.2112E+07 -0.9041E+06
  0.4769E+05  0.6177E+05 -0.1407E+05  0.5689E+14  0.7401E+14 -0.1712E+14  0.1200E+07  0.1885E+07 -0.6853E+06
  0.4166E+05  0.5461E+05 -0.1295E+05  0.4968E+14  0.6543E+14 -0.1575E+14  0.1023E+07  0.1657E+07 -0.6349E+06
  0.4166E+05  0.5461E+05 -0.1295E+05  0.4968E+14  0.6543E+14 -0.1575E+14  0.1023E+07  0.1657E+07 -0.6349E+06
  0.4662E+05  0.6940E+05 -0.2277E+05  0.5519E+14  0.8325E+14 -0.2806E+14  0.5477E+06  0.2093E+07 -0.1545E+07
  0.4662E+05  0.6940E+05 -0.2277E+05  0.5519E+14  0.8325E+14 -0.2806E+14  0.5477E+06  0.2093E+07 -0.1545E+07
 -0.1562E+05  0.1409E+05 -0.2971E+05 -0.1961E+14  0.1687E+14 -0.3647E+14 -0.1527E+07  0.3734E+06 -0.1901E+07
2004.02.13   Transect:  5   No. of layers: 10
 -0.3488E+06  0.1117E+06 -0.4605E+06 -0.4223E+15  0.1339E+15 -0.5562E+15 -0.1483E+08  0.3272E+07 -0.1810E+08
 -0.4635E+04  0.4191E+04 -0.8826E+04 -0.5684E+13  0.4988E+13 -0.1067E+14 -0.3058E+06  0.9567E+05 -0.4015E+06
  0.5756E+03  0.6099E+04 -0.5523E+04  0.5684E+12  0.7264E+13 -0.6695E+13 -0.1244E+06  0.1482E+06 -0.2727E+06
  0.2156E+03  0.7438E+04 -0.7223E+04  0.1435E+12  0.8868E+13 -0.8725E+13 -0.1319E+06  0.1882E+06 -0.3200E+06
 -0.6515E+02  0.7838E+04 -0.7903E+04 -0.1842E+12  0.9346E+13 -0.9530E+13 -0.1330E+06  0.1966E+06 -0.3296E+06
 -0.6515E+02  0.7838E+04 -0.7903E+04 -0.1842E+12  0.9346E+13 -0.9530E+13 -0.1330E+06  0.1966E+06 -0.3296E+06
 -0.9927E+04  0.2391E+05 -0.3383E+05 -0.1216E+14  0.2870E+14 -0.4086E+14 -0.6338E+06  0.7263E+06 -0.1360E+07
 -0.9927E+04  0.2391E+05 -0.3383E+05 -0.1216E+14  0.2870E+14 -0.4086E+14 -0.6338E+06  0.7263E+06 -0.1360E+07
 -0.7026E+05  0.3045E+05 -0.1007E+06 -0.8510E+14  0.3665E+14 -0.1217E+15 -0.2962E+07  0.9943E+06 -0.3956E+07
 -0.1200E+06  0.0000E+00 -0.1200E+06 -0.1449E+15  0.0000E+00 -0.1449E+15 -0.4679E+07  0.0000E+00 -0.4679E+07
 -0.1348E+06  0.0000E+00 -0.1348E+06 -0.1626E+15  0.0000E+00 -0.1626E+15 -0.5094E+07  0.0000E+00 -0.5094E+07
```

NOOS transports

Advantage

- short and rather compact files
- tidal signal removed -> good characterization of circulation
- all use same layer thicknesses -> good intercomparison

Disadvantage

- problem with mass conservation (e.g. 2 M2 tidal cycles averaged can't be converted into monthly/annual mean
- 4 digits format is not the most appropriate
- different transects have different accuracy
- only coarse (and diffuse) representation of vertical structure

Problem with heat fluxes

- heat fluxes in °K, better in °C ?
- constant heat capacity

NOOS transports

New and different kind of output

for correct (mass conserving) calculation of long term means and for further analyses

Suggestion:

- Use existing data (mean over 2 M2 tidal cycles) as before

- Introduce new (additional) output with:
  - high temporal resolution (e.g. hourly data - integrated)
  - only net water, heat and salt transports
  - new format: REAL with more digits (e.g. m^3/s as F12.1)

or:

- provide information for each grid cell

5. Discussion on heat fluxes

- **heat fluxes in °K, better in °C ?**
- **constant heat capacity**

Heat transport [J/s = W]:

$q_n = tr_n * c_p * \rho * T$

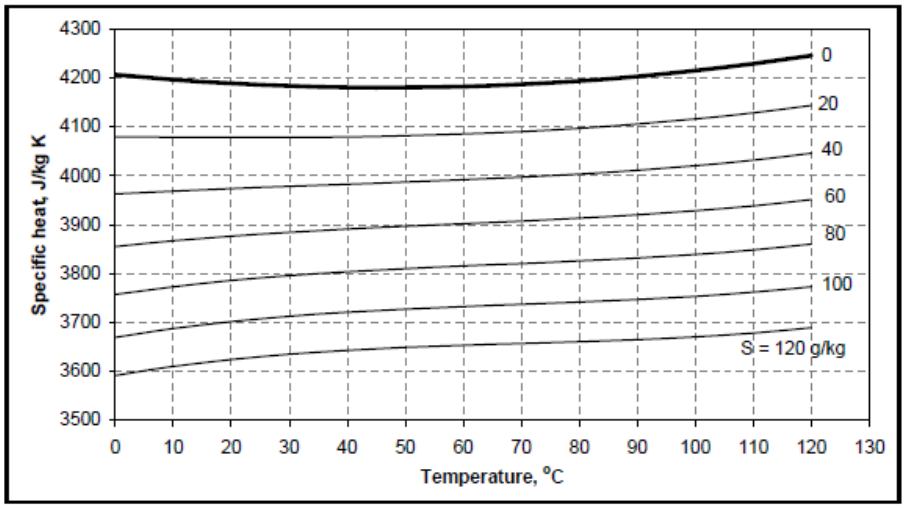
with
- tr_n water transport [m^3/s]:
- c_p heat capacity of ocean = $4.190*10^3$ J/kg/K
- ρ density of water (~1026 kg/m^3)
- T temperature in K

NOOS transports

Constant heat capacity: values vary between 3985 and 4200 J/(kg K)

Specific heat at constant pressure, J/kg K

	Salinity, g/kg												
Temp, °C	0	10	20	30	40	50	60	70	80	90	100	110	120
0	4206.8	4142.1	4079.9	4020.1	3962.7	3907.8	3855.3	3805.2	3757.6	3712.4	3669.7	3629.3	3591.5
10	4196.7	4136.7	4078.8	4022.8	3968.9	3916.9	3867.1	3819.2	3773.3	3729.5	3687.7	3647.9	3610.1
20	4189.1	4132.8	4078.2	4025.3	3974.1	3924.5	3876.6	3830.4	3785.9	3743.0	3701.8	3662.3	3624.5
30	4183.9	4130.5	4078.5	4027.8	3978.6	3930.8	3884.4	3839.4	3795.8	3753.6	3712.7	3673.3	3635.3
40	4181.0	4129.7	4079.6	4030.7	3982.9	3936.4	3891.0	3846.7	3803.7	3761.8	3721.1	3681.6	3643.2
50	4180.6	4130.8	4081.9	4034.1	3987.3	3941.5	3896.6	3852.9	3810.1	3768.3	3727.5	3687.8	3649.0
60	4182.7	4133.7	4085.5	4038.3	3992.0	3946.5	3902.0	3858.3	3815.5	3773.7	3732.7	3692.6	3653.4
70	4187.1	4138.5	4090.6	4043.6	3997.3	3951.9	3907.4	3863.6	3820.6	3778.5	3737.2	3696.7	3657.0
80	4194.0	4145.3	4097.3	4050.1	4003.7	3958.1	3913.3	3869.2	3825.9	3783.5	3741.7	3700.8	3660.7
90	4203.4	4154.2	4105.9	4058.3	4011.5	3965.4	3920.2	3875.7	3832.0	3789.1	3746.9	3705.6	3665.0
100	4215.2	4165.4	4116.4	4068.2	4020.9	3974.3	3928.5	3883.6	3839.4	3796.0	3753.5	3711.7	3670.8
110	4229.4	4178.8	4129.1	4080.2	4032.2	3985.1	3938.7	3893.3	3848.6	3804.9	3761.9	3719.9	3678.6
120	4246.1	4194.7	4144.2	4094.6	4045.9	3998.2	3951.3	3905.4	3860.3	3816.2	3773.0	3730.7	3689.4



Accuracy ±0.28%

Mostafa H. Sharqawy, John H. Lienhard V and Syed M. Zubair, Thermophysical Properties of Seawater: A Review of Existing Correlations and Data, Desalination and Water Treatment, 2010

NOOS transports

Equations for the specific heat at constant pressure are given in the paper:

Mostafa H. Sharqawy, John H. Lienhard V, and Syed M. Zubair, "Thermophysical properties of seawater: A review of existing correlations and data," Desalination and Water Treatment, Vol. 16, pp.354-380, April 2010.

http://web.mit.edu/lienhard/www/Thermophysical_properties_of_seawater-DWT-16-354-2010.pdf

Table 3
Seawater specific heat correlations.

Correlation
$c_{sw} = A + B\,T_{68} + C\,T_{68}^2 + D\,T_{68}^3$ (9)
where
$A = 5.328 - 9.76 \times 10^{-2} S_P + 4.04 \times 10^{-4} S_P^2$
$B = -6.913 \times 10^{-3} + 7.351 \times 10^{-4} S_P - 3.15 \times 10^{-6} S_P^2$
$C = 9.6 \times 10^{-6} - 1.927 \times 10^{-6} S_P + 8.23 \times 10^{-9} S_P^2$
$D = 2.5 \times 10^{-9} + 1.666 \times 10^{-9} S_P - 7.125 \times 10^{-12} S_P^2$
Validity: c_{sw} in (kJ/kg K); $273.15 < T_{68} < 453.15$ K; $0 < S_P < 180$ g/kg Accuracy: ±0.28 %

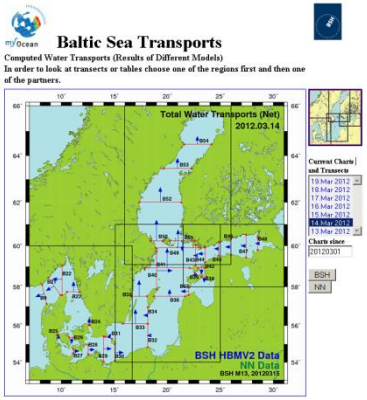
NOOS transports

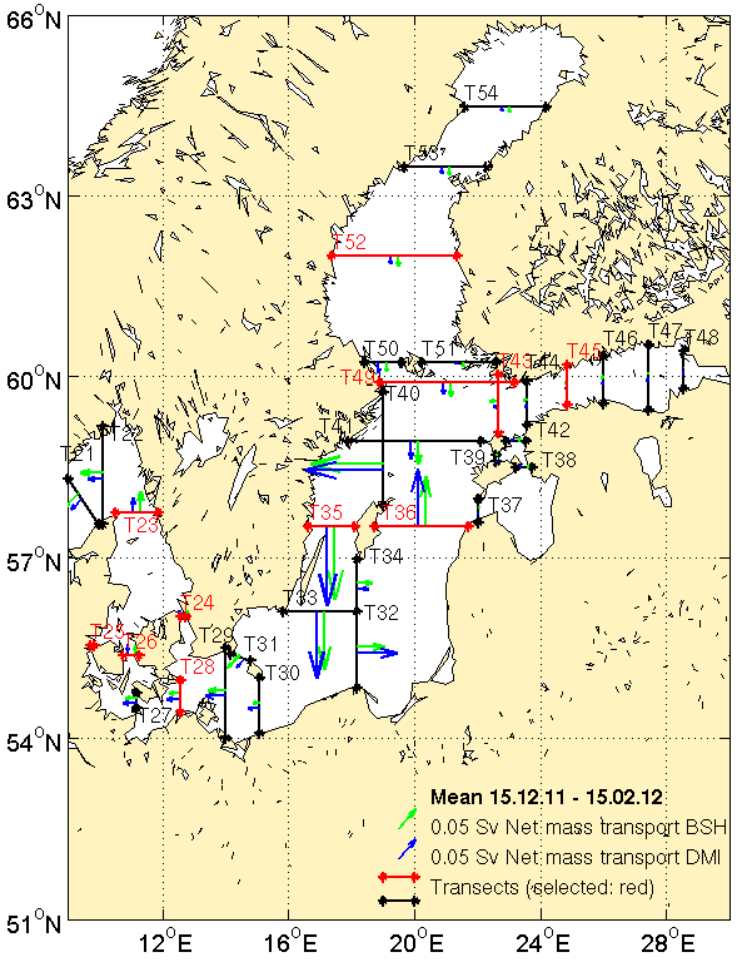
Thank You!

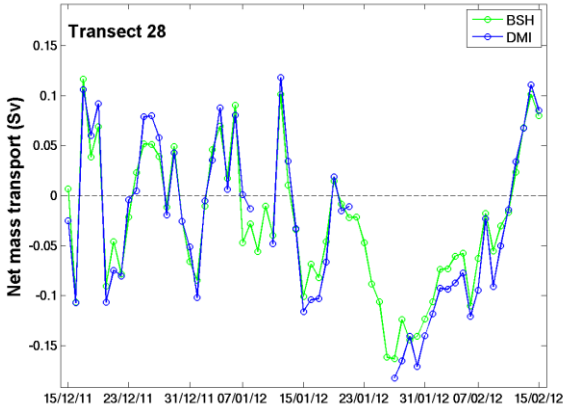
NOOS transports

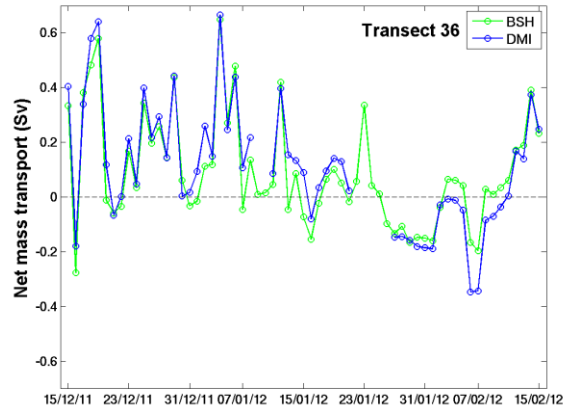
MyOcean ScVR V2

- HBM code of BSH and DMI
- 15.12.11 - 15.02.12
- **volume**, heat, salinity transport
- reflecting main circulation pattern





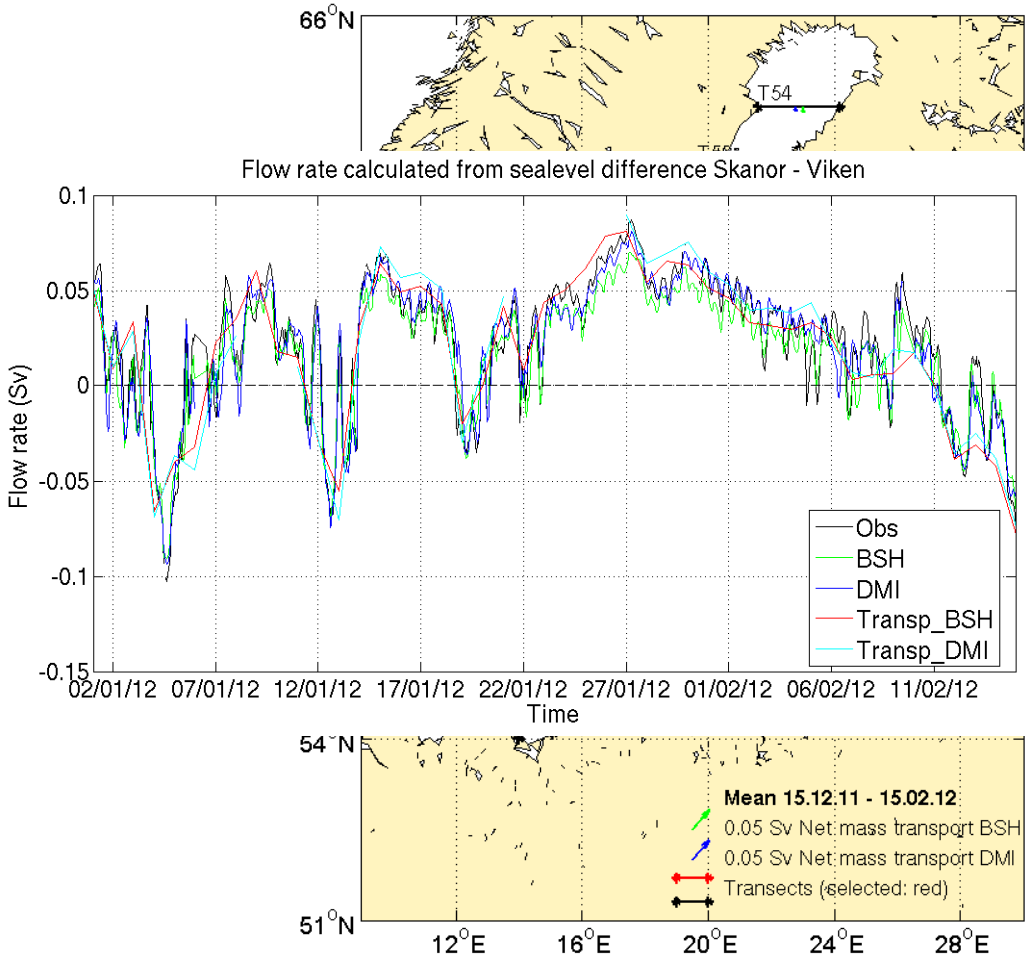




NOOS transports

MyOcean ScVR V2

- Comparison with observations for transect 24 (Öresund)
- Empirical formula (Mattson 1996) based on differences in sea level between Skanör and Viken
- Calculation of flows from
  - sea level data (measurements)
  - sea level data (DMI model)
  - sea level data (BSH model)
  - transport data (DMI model)
  - transport data (BSH model



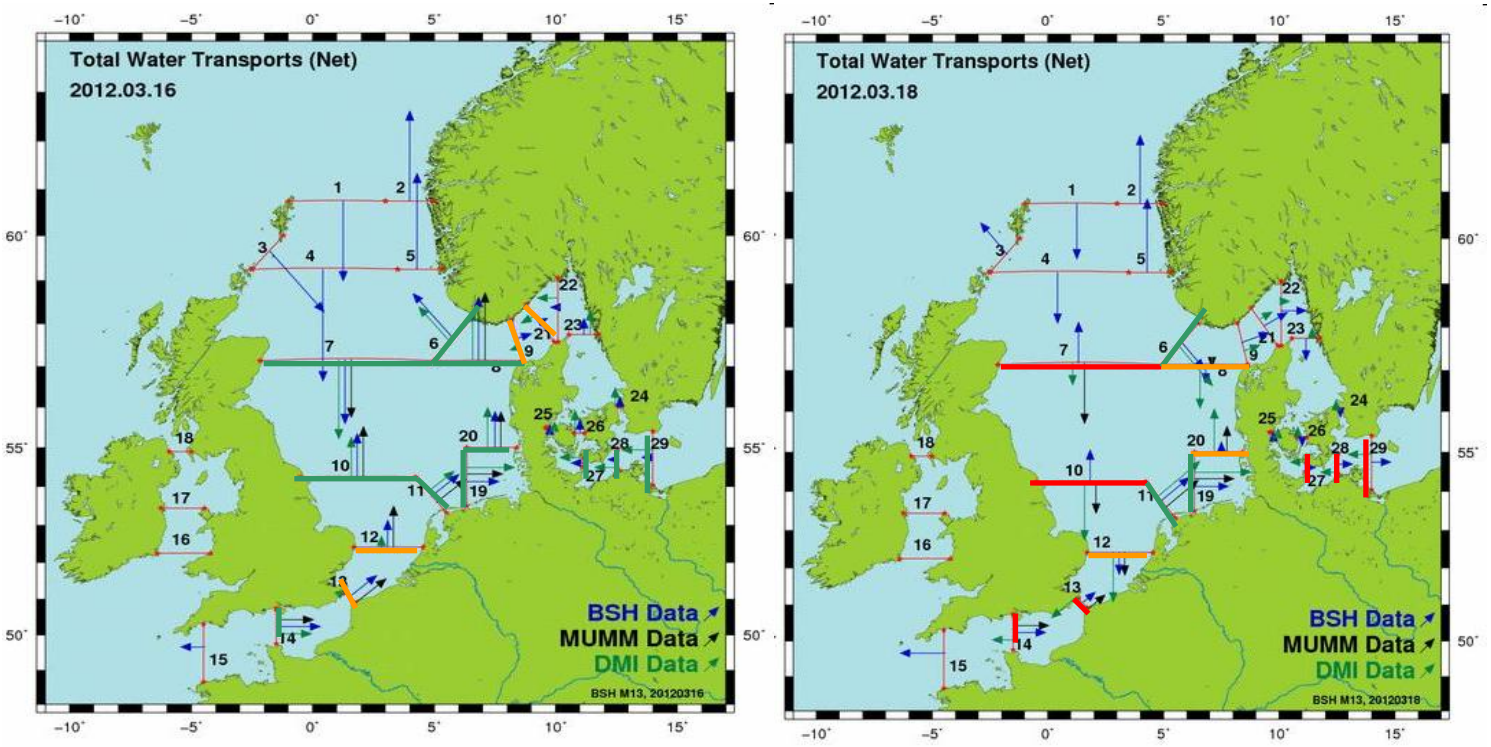
NOOS transports

2. Activities in MyOcean-2

- Measure for consistency of models - (“warning system”)

Example:

Colour of transects indicate differences between model results
green: good agreement
yellow: some differences
red: larger range

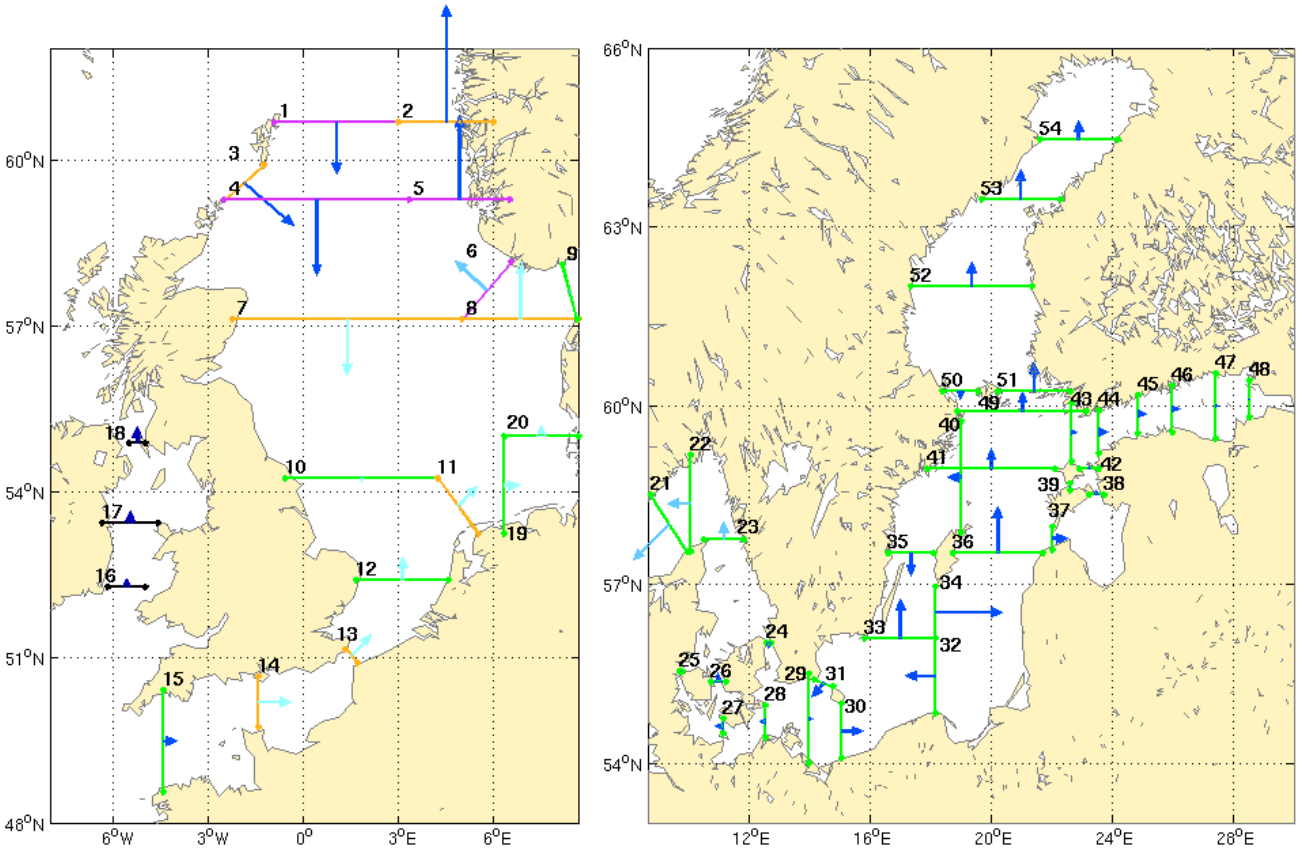


NOOS transports
MyO Meeting 2012

Plans for MyOcean II

- Measure for consistency of models - (“warning system”)

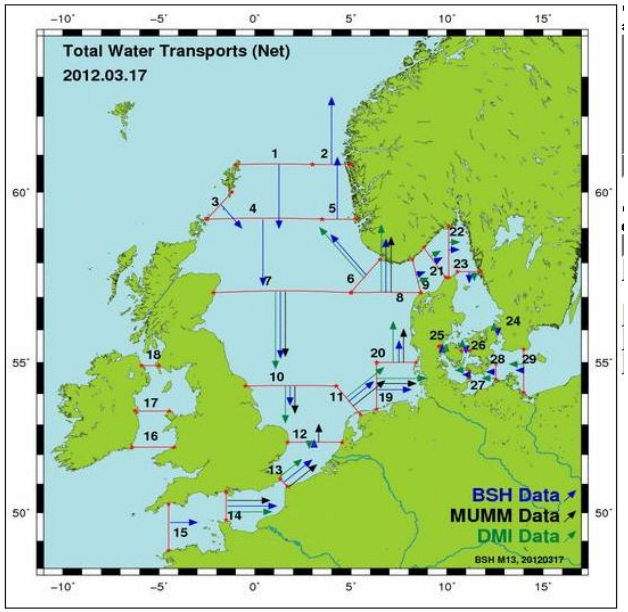
- Arrow colour shows No. of models used for calculation of mean values (light blue=1 model - dark blue =4 models)
- Colour of transects shows standard deviation of data (green < 0.1 yellow 0.1<=x<0.5 purple >=0.5).

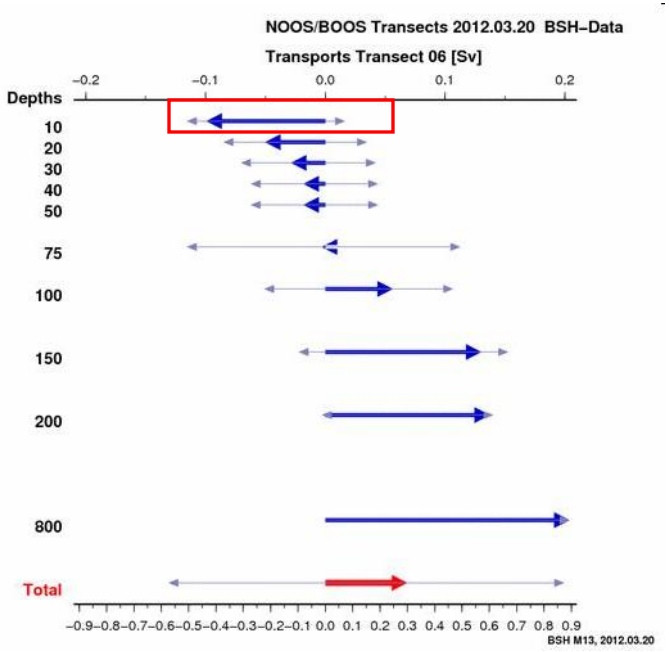


NOOS transports
MyO Meeting 2012

Plans for MyOcean II

- Online calculation of transports for all models
- Insert figure of transport through transects in hydrodynamic important areas i.e. Norwegian Trench, English Channel
- Display surface transports





NOOS transports

Things, still to do

- Mass Conservation:

  2 M2 tidal cycles averaged can't really be converted into yearly mean. Should we move to daily mean or something else? (save data)
- Is the used format (4 digits) the most appropriate?
- How to deal with heat fluxes? K or °C
- Is the Boussinesq approximation applied in all models? (time/space dependent ρ_w in UKMO (heat only?) fluxes; constant value in MUMM)
- How to improve layout of NOOS website when more models implemented?

NOOS transports