

ECASA - Model description template

NAME of model: <i>FjordEnv</i>	Reporter/institute (a): <i>Carina P. Erlandsson, Address: University of Gothenburg, Box 450, 405 30 Gothenburg, Sweden</i> <i>Phone no: +46317862854</i> <i>Email:caer@gvc.gu.se</i> (b)Ander Stigebrandt <i>Address: University of Gothenburg, Box 450, 405 30 Gothenburg, Sweden</i> <i>Phone no:+46317862851</i> <i>Email:anst@gvc.gu.se</i>
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Short DESCRIPTION of model (b)

general description: *The FjordEnv model can be used to calculate environmental effects of fish farming and municipal and industrial wastewater on fjords and other inshore areas. It can also be used to calculate environmental effects of dredging and building road-banks in sea straits and changing runoff.*

Environmental change in the surface water due to nutrient input is expressed as change in Secchi depth. Environmental change in the basin water is calculated as change of oxygen consumption and minimum oxygen concentration.

Calculated water exchange and the resulting residence times of the surface and basin waters are important factors influencing the results. The model calculates the three major contributions to water exchange; the estuarine circulation driven by freshwater input and wind, the intermediary circulation driven by density fluctuations in the coastal water, and the tidal pumping driven by the amplitude and the period of the local tide. The residence time of the basin water is calculated from the variability of the offshore density field at sill level and local mixing in the basin water.

main state variables (c): *Secchi depth, oxygen concentration*

scale to which applicable (d): *Regional model for inshore waters (B)*

forcing data needed (e):

Topography:

-Fjord surface area at several depths (i.e. the hypsography) for calculation of volumes above and below sill level

-Entrance width at several depths for calculation of the cross-sectional area

Forcing:

Intermediary circulation:

- ΔM is the integrated standard deviation of the density (kg m^{-2}) in the coastal water, from the sea surface and down to the maximum depth of the entrance. This is calculated from salinity and temperature profiles in the coastal water. The observations may be scattered over time or time series.

Tidal pumping:

-Tidal amplitude (M_2+S_2)

-Tidal period (hours)

-The efficiency factor ($0 \leq f_i \leq 1$) telling how large part of the tidal pumping that is not recycled in the bay/fjord

Estuarine circulation:

- S_2 is the salinity of the "sea water", beneath the surface layer

-Mean value of freshwater input

-Mean wind velocity

Deepwater exchange:

- $\sigma\rho$, a measure of the variability of the density field, calculated as the standard deviation of the density at sill level (kg m^{-3})

Optic and Biochemical input parameters:

-Typical Secchi depth during the productive season

-Primary production in the coastal water

-Local input of nutrients

-Oxygen concentration of the inflowing new basin water

possibly relevant INDICATORS (f)

driver:

pressure:

state: surface water: Secchi depth, chlorophyll a concentrations, biodiversity

basin water: oxygen concentration and oxygen consumption, biodiversity

impact:

Response:

STATUS of model (g)

origin(ator), present development state (has been tested, under development, etc)

present use, claimed robustness and scientific basis of this:

The model was developed during the Møre project in the 80-ies. The project involved 30 different fjords along a relatively small area of the Norwegian coast. Measurements of salinity, temperature, oxygen, and a number of biochemical variables were obtained. The characteristics of the fjords differed widely with respect to surface area (1-48 km²), volume (0.01-1.7 km³), maximum depth (30-170 m), sill depth (4-50 m), number of sill basins (1-4), and local supply of freshwater and nutrients. The model is based on a number of papers of which several are based on data from this project. The model of the estuarine circulation is described in Stigebrandt (1975, 1981). The formula used to estimate the mean rate of intermediary circulation was derived and developed in Stigebrandt (1990), Stigebrandt & Aure (1990), and Aure et al. (1997). The residence time of the basin water below sill level is in FjordEnv estimated as described in Aure & Stigebrandt (1989a, 1990). The formulation of the transport of organic matter is in the present version partly based on findings presented in Aure & Stigebrandt (1989b) and Stigebrandt et al. (1996), and Stigebrandt (2001). The present version of FjordEnv is described in Stigebrandt 2001. Regional data of offshore forcing are stored in a database connected to the program making it easy to apply the model to regions where the offshore data field has already been established.

FjordEnv has been applied to numerous fjords all over Norway during more than a decade and is used in the MOM-system (Ervik et al., 1993., Hansen et al., 2001, Stigebrandt et al., 2004), which is the Norwegian environmental regulations for fish farming.

Recent research on 1) how transport of organic matter is effected by fjord topography (Erlandsson 2006), 2) the influence of freshwater on the Secchi depth (Erlandsson and Stigebrandt 2006), and 3) the influence of different length of the periods of variability of the coastal density field on the stagnation period of the basin water in fjords (Stigebrandt and Erlandsson 2006), have increased the knowledge of important factors influencing the water quality in fjords and other inshore waters and will be implemented in the model.

FjordEnv will be run on the few inshore sites involved in the ECASA project, and also on the Thau lagoon in southern France. The results will be compared with local data, and an analysis of these results plus the results from some OAERRE, and Norwegian sites will be

presented in a paper.

If possible, a validation of the new Secchi depth formula including the effect of freshwater and wind speed will also be validated for some of the inshore sites.

IMPLEMENTATION OF MODEL

state of implementation (*h*): *The implementation of above mentioned recent research result have not yet begun.*

state of documentation: *The version 3.1 of the model FjordEnv is described in Stigebrandt (2001) and this version is also available as a PC-program on CD-disk. Recent research that will be used to improve the model is published (Erlandsson and Stigebrandt 2006) or is submitted (Erlandsson 2006, Stigebrandt and Erlandsson 2006) to scientific journals.*

intellectual property concerns (*i*): *The equations included in the present and the improved version of FjordEnv will be available in published papers. The present and also the next version of the PC program of the model will be available from ANCYLUS (www.....) .*

TESTING

summary of conditions and measurements needed - including critical forcing data (*j*)
criteria for model rejection

OTHER models

Used with this model (*k*): *The MOM model*

Similar models (*l*): *The CSTT model (for the surface layer)*

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