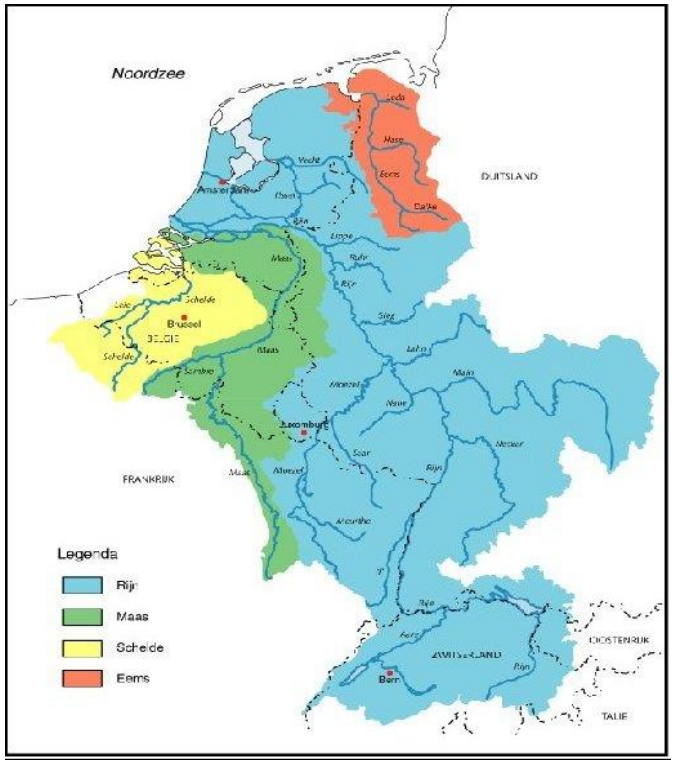
Rijkswaterstaat
Ministry of Infrastructure and the Environment



A future Rhine model for accidental spills?

RPS-ASA model Chemmap

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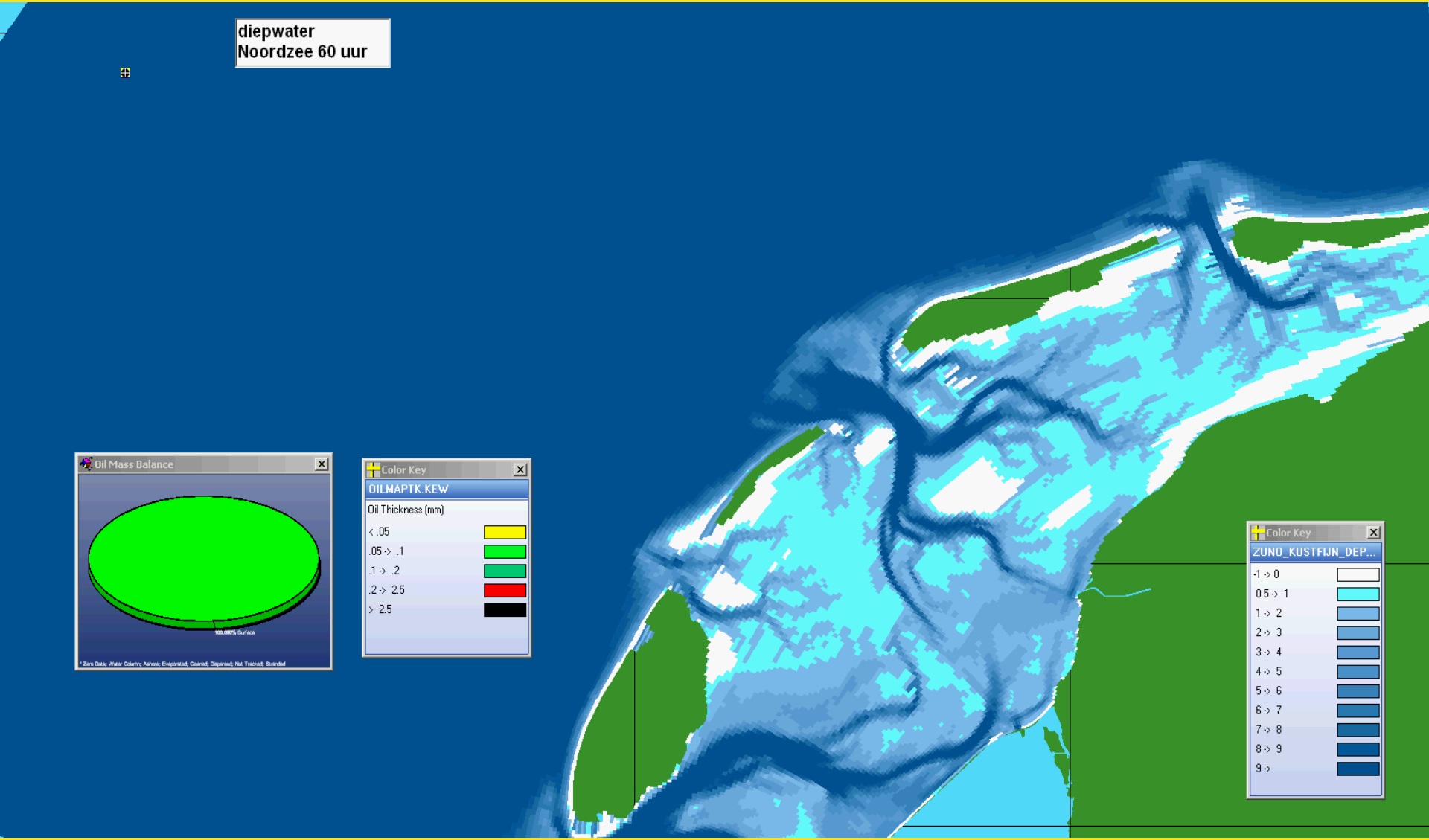
Rudi Heymen.

Supported by RPS-ASA and Deltares

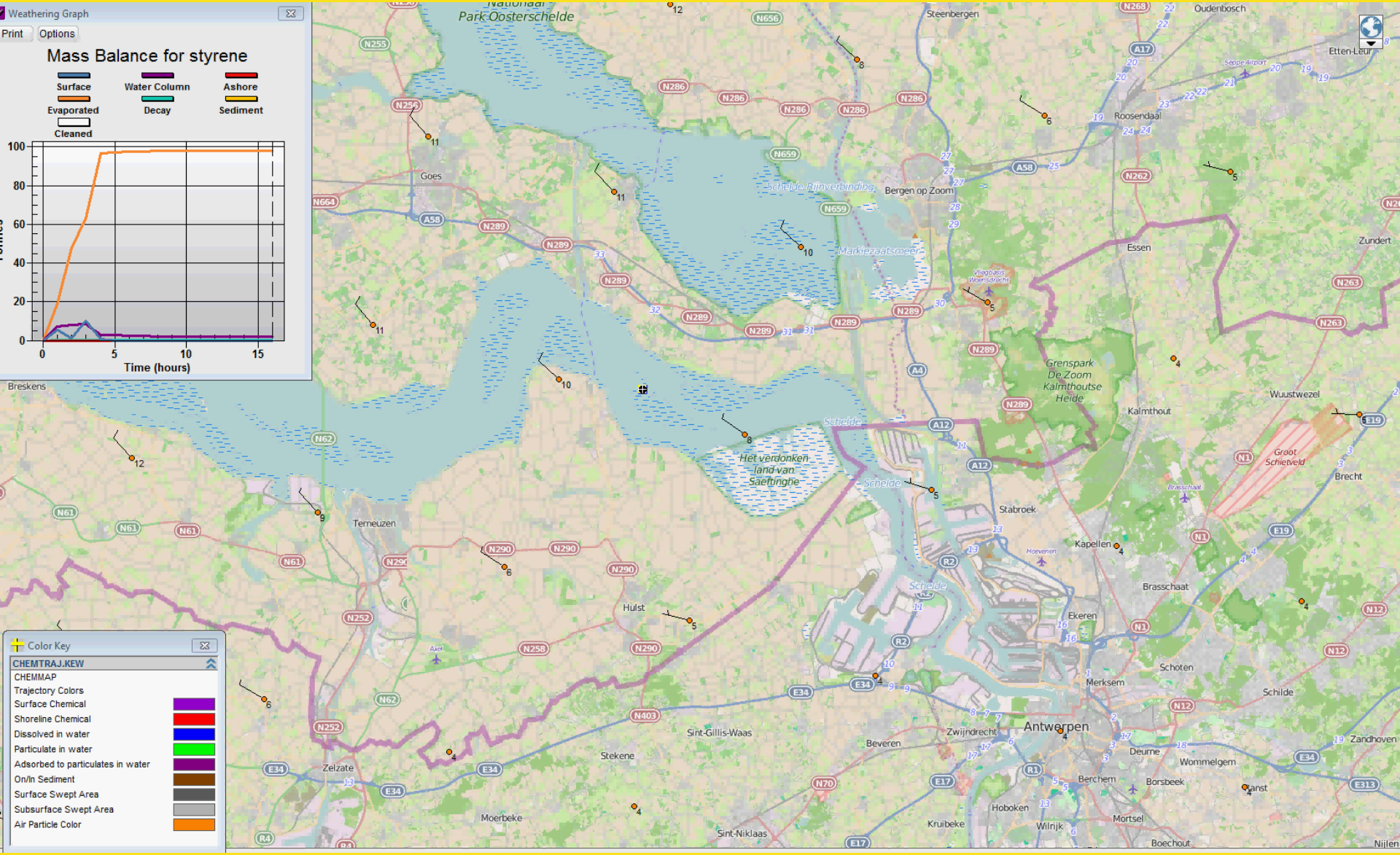
Modeling environmental incidents

- In case of an incident with chemicals we want to know how substances spread out in environment and there effects.
- So Rijkswaterstaat (RWS) has models for paths and fate of oils and chemicals in our water environment.
- We use the hydrodynamic information from the models that calculate the water levels and flows.
- Our Meteorological institute delivers a wind field for modelling drifting and volatile substances
- Few examples:
  - Oil in the North sea
  - Styrene in the Western Scheldt


diepwater
Noordzee 60 uur
Oil Mass Balance
Color Key
OILMAPTK.KEW
Oil Thickness (mm)
< .05
.05 -> .1
.1 -> .2
.2 -> 2.5
> 2.5
Color Key
ZUNO_KUSTFIJN_DEP...
-1 -> 0
0.5 -> 1
1 -> 2
2 -> 3
3 -> 4
4 -> 5
5 -> 6
6 -> 7
7 -> 8
8 -> 9
9 ->

Collision January 17 2015

spill 140 m3 (?)
Styreen/ethylbenzene



Project scope

- In the past various departments of RWS used different software's. We started in 2007 with harmonization.
- For salt waters, notably North Sea and Waddensea RWS adopted ASA's software suite (Oilmap, Chemmap). Chemmap uses particle tracking to forecast fate and transport of such spills.
- The model framework combines operational forecast results of 2Dsimulation models.
- RWS strives for harmonization with freshwater lakes and rivers. Main motivation: a uniform working environment which is highly relevant during "stressful" situations.

RPS ASA Role – Model/data integration

- **RPS ASA Role**: to provide tools to predict the movement and fate of Oil and Chemical spills, and to support Search & Rescue operations (SAR-Coast Guard).

- **How**: customizing RPS tools (OILMAP, CHEMMAP, SARMAP), using MATROOS database whit operational forecasting of water and wind.

- **Tools**: OIL/SAR/CHEMMAP have same User Interface (> ease of use) but have different inputs and outputs (> challenge).
  - Oil & SAR has been customized to take into account varying water depths (flooding/drying)
  - Chemmap has been adjusted to operate in rivers.

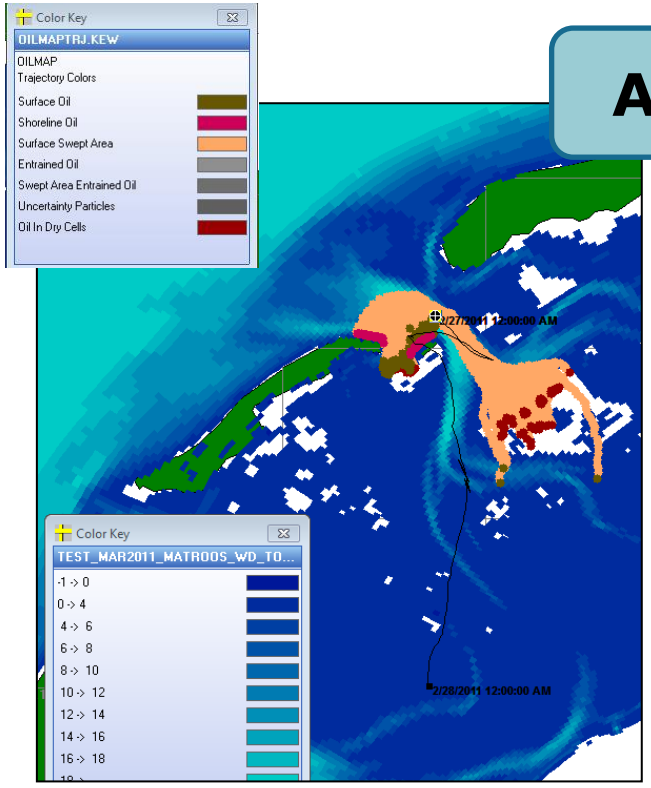
Oil Spill & SAR models (OIL/SARMAP)

Emergency Response:

User creates spill/SAR scenario and ask inputs to MATROOS database

HTTP / XML

MATROOS



ASA-MAP

Database:

Bathymetry for Area of Interest +

- Wind file
- Current file
- Surface elevation

Static data File

Total water depth

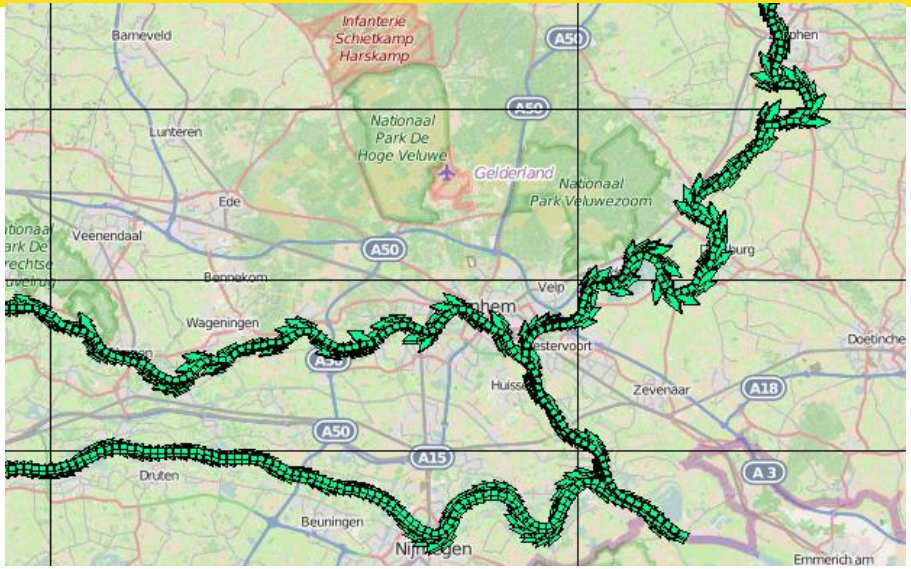
Used by the model to **"strand"** and **"float"** the oil or SAR object

{t, xyz}

Chemical Spill Model

•CHEMMAP is a 3D chemical pollutant transport model. It requires 2/3D currents and interacts with coast & sea/river-floor.

•River models provides 1D River points and those get converted to a 2D currents field to be used in CHEMMAP.



Script in CHEMMAP simplifies the workflow (“point and click”), no external steps required. Use of MATROOS server request (html/xml).

Coastline (river shoreline) and Bathymetry imported into CHEMMAP on-the-fly

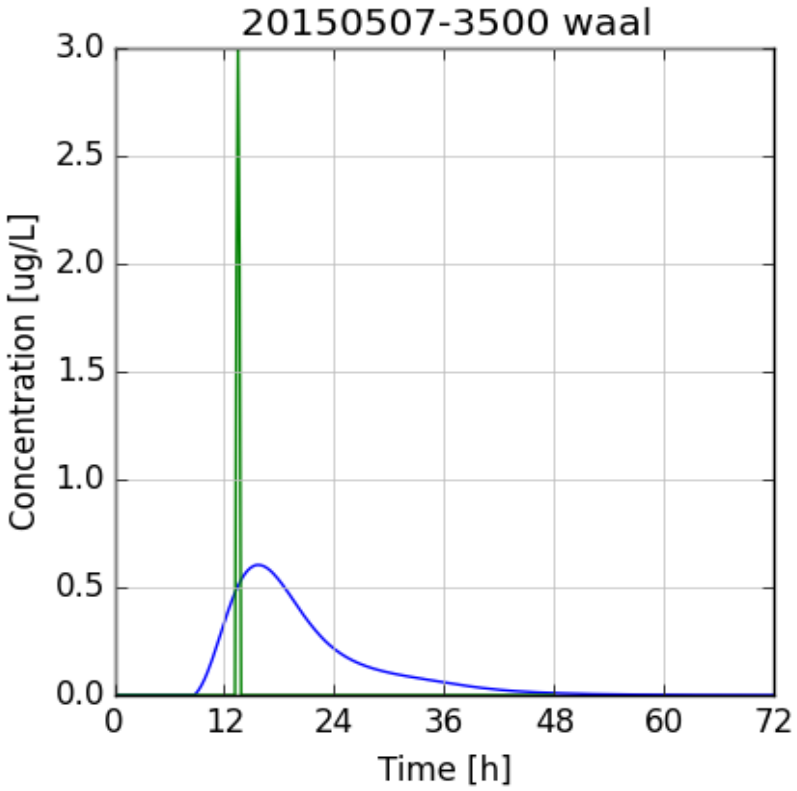
Output 1D-Sobek -> 2D-currents

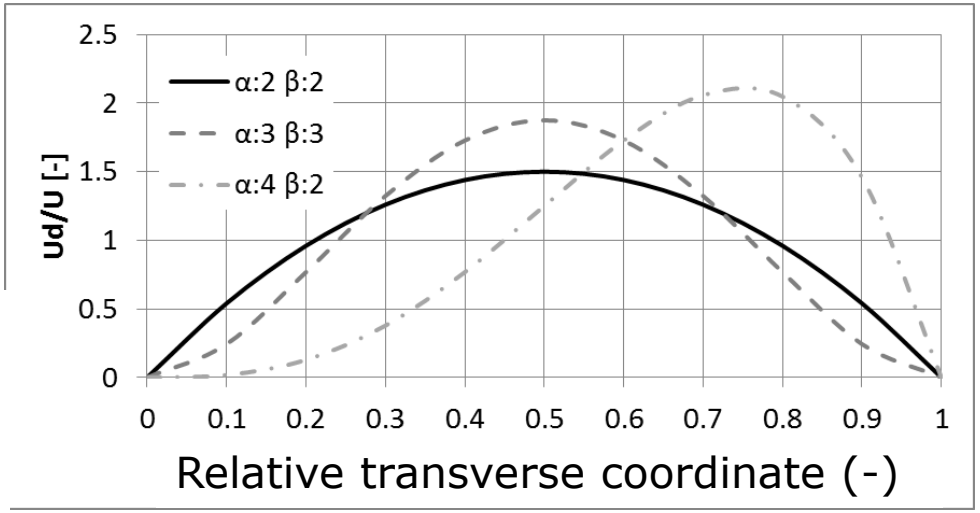
- SOBEK calculation points having dynamic flow results (Q_{1D})
- 2D section on basis of $Width_{1D}$ and loction of other points.
- $V_{2D} = f(Q_{1D}, W_{1D}, A_{1D})$
- Direction: towards next section
- CHEMMAP uses average of 4 corners → extra sections required to prevent particles from sticking to the wall.

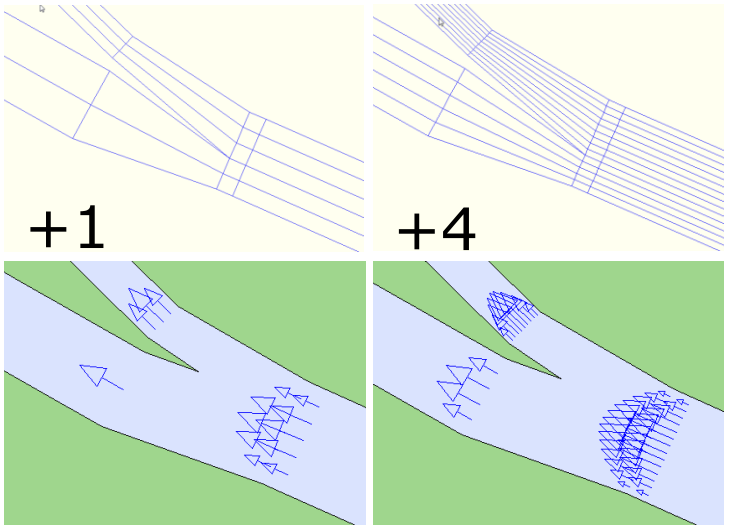
Adequate longitudinal mixing

1D river flow + uniform dispersion =

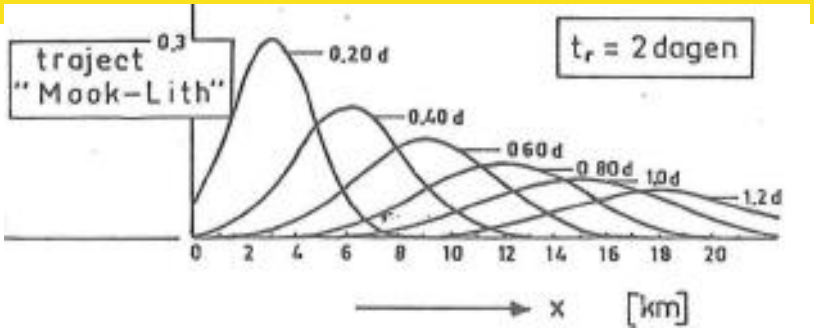
too low longitudinal mixing!

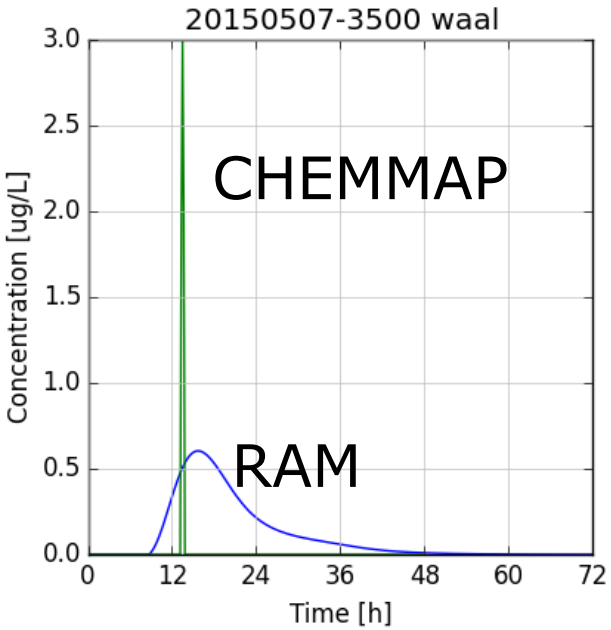


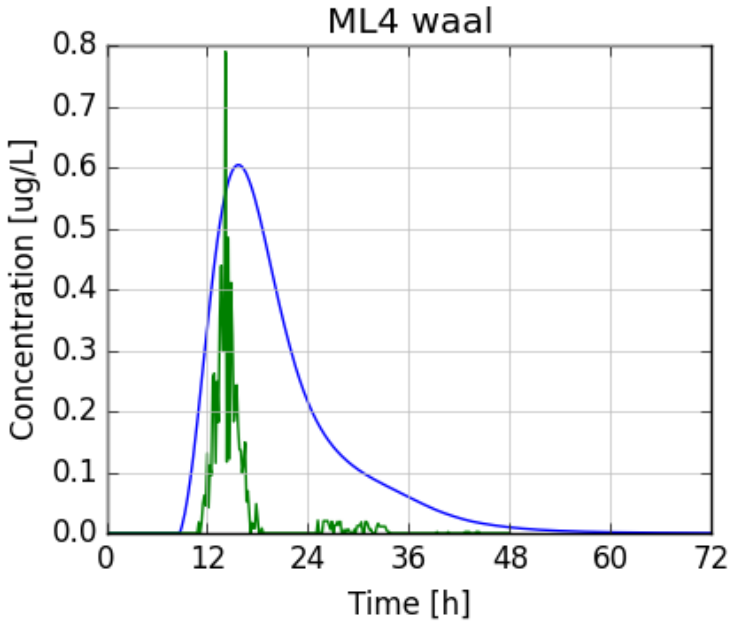




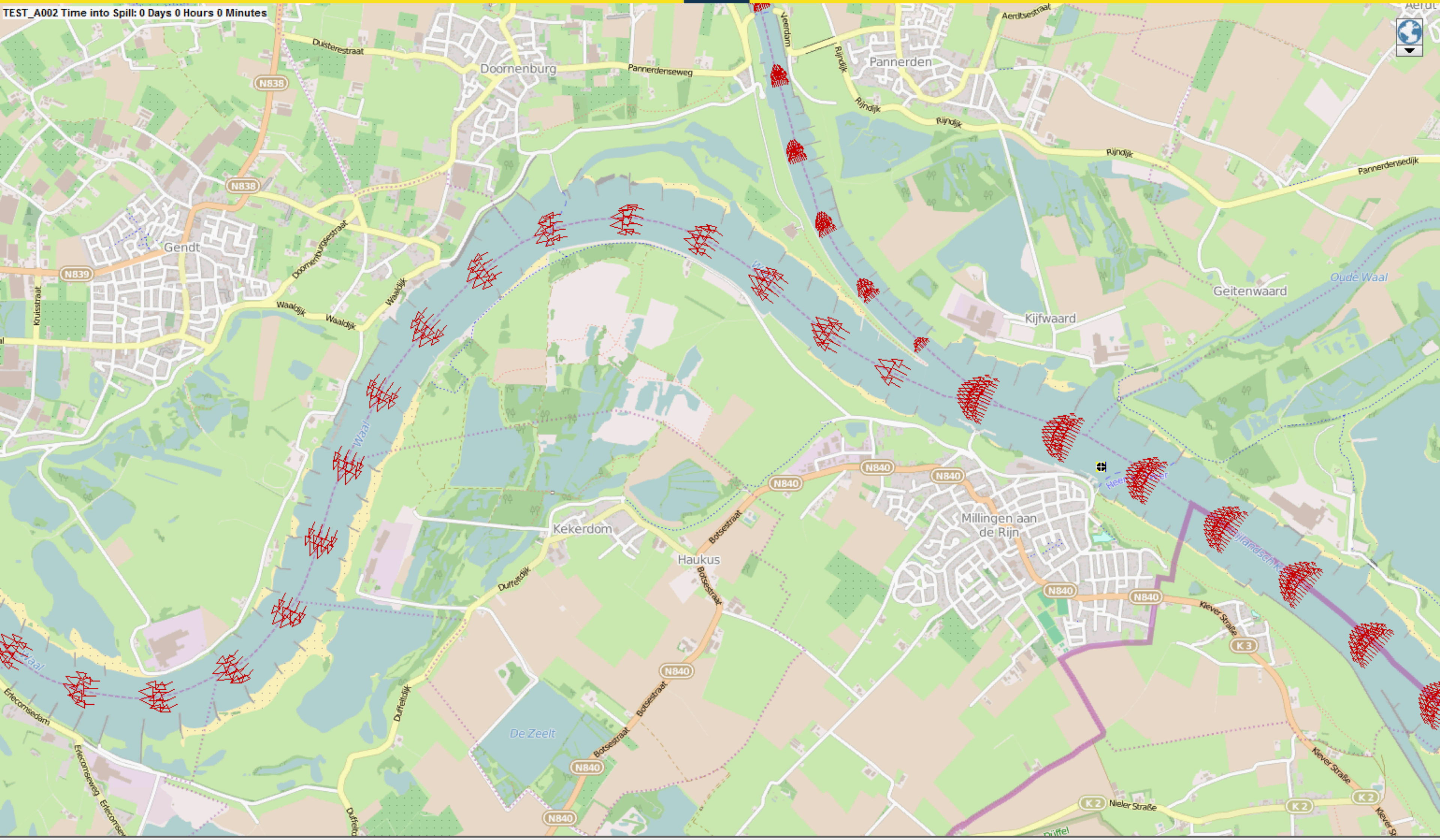
Calibration options







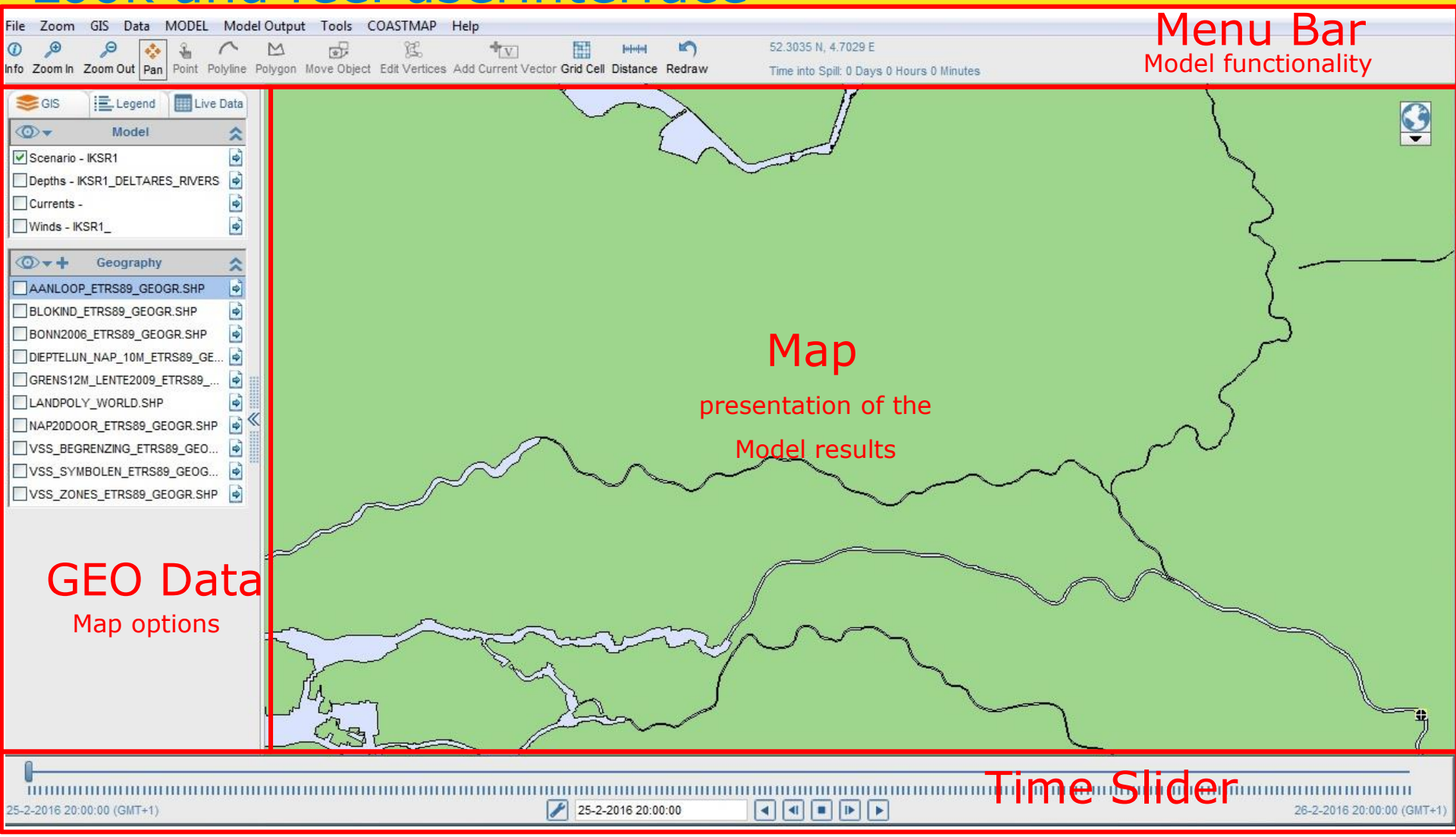
RAM: Accidental Spill Model for river Rhine


TEST_A002 Time into Spill: 0 Days 0 Hours 0 Minutes
Doornenburg
Pannerden
Gendt
Geitenwaard
Kijfwaard
Oude Waal
Kekerdom
Haukus
Millingen aan de Rijn
De Zeelt
Waal
N838
N839
N840
K 3
K 2
Duisterestraat
Pannerdenseweg
Pannerdensedijk
Rijndijk
Veerdam
Aerdtsestraat
Doornenburgsestraat
Waaldijk
Kruisstraat
Botsestraat
Duffeltdijk
Erlecomsedam
Erlecomseweg
Kiever Straße
Nieler Straße

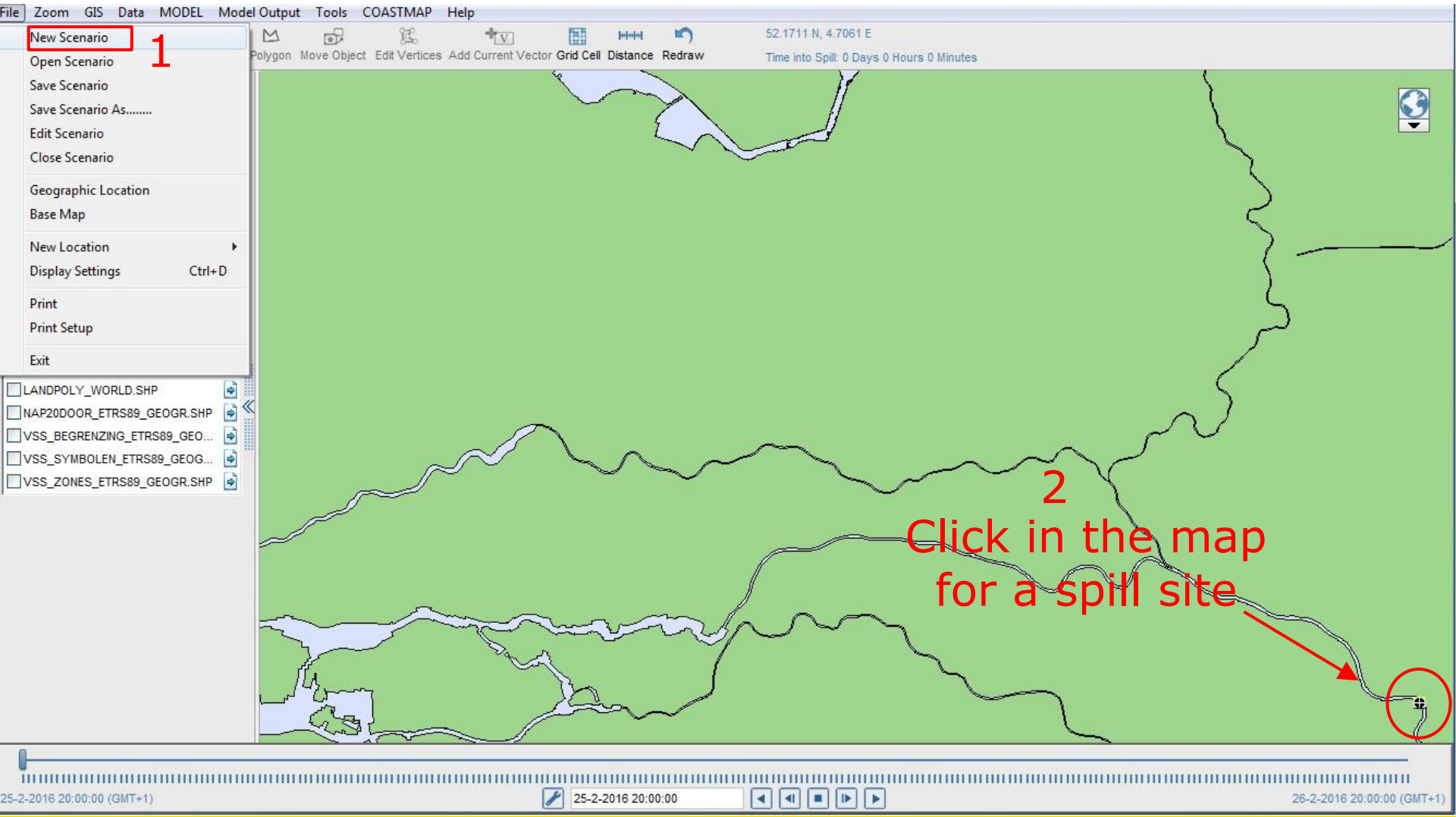
Conclusions

1. The model framework for the sea is expandable with river systems and covers the full domain of interest: catchment to coast.
2. Using existing operational hydrodynamic models
3. RWS has extended the model of the Rhine till Maxau
4. Extension to Bodensee, side branches is possible
    1. If hydrological data is available
5. Transport in water and in the air (volatile compounds)
6. Database with chemicals (CHEMMAP) and crude oils (OILMAP) available.
7. Uniform approach minimises operation & maintenance costs for RWS

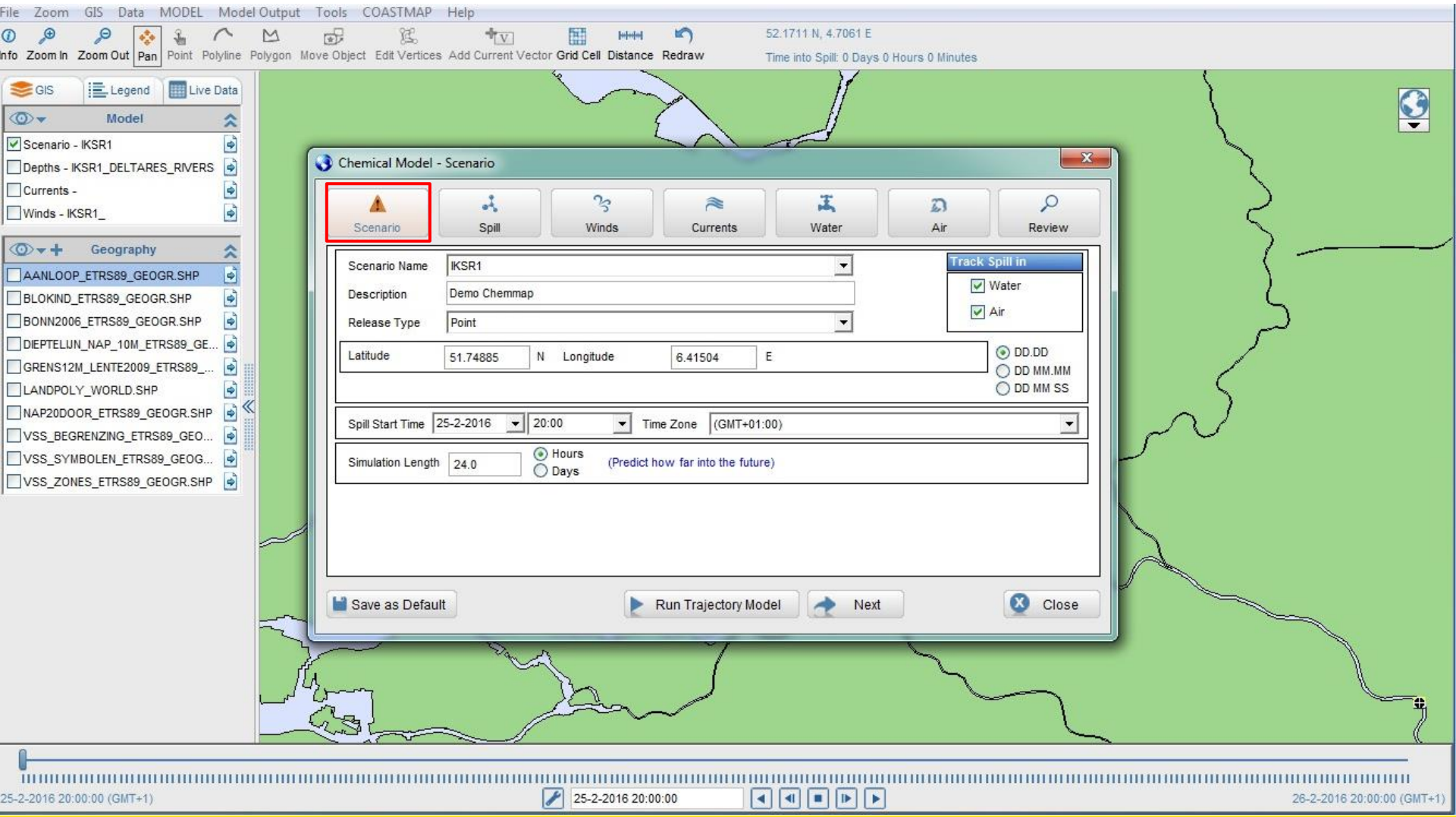
Chemmap main screen
Look and feel userinterface



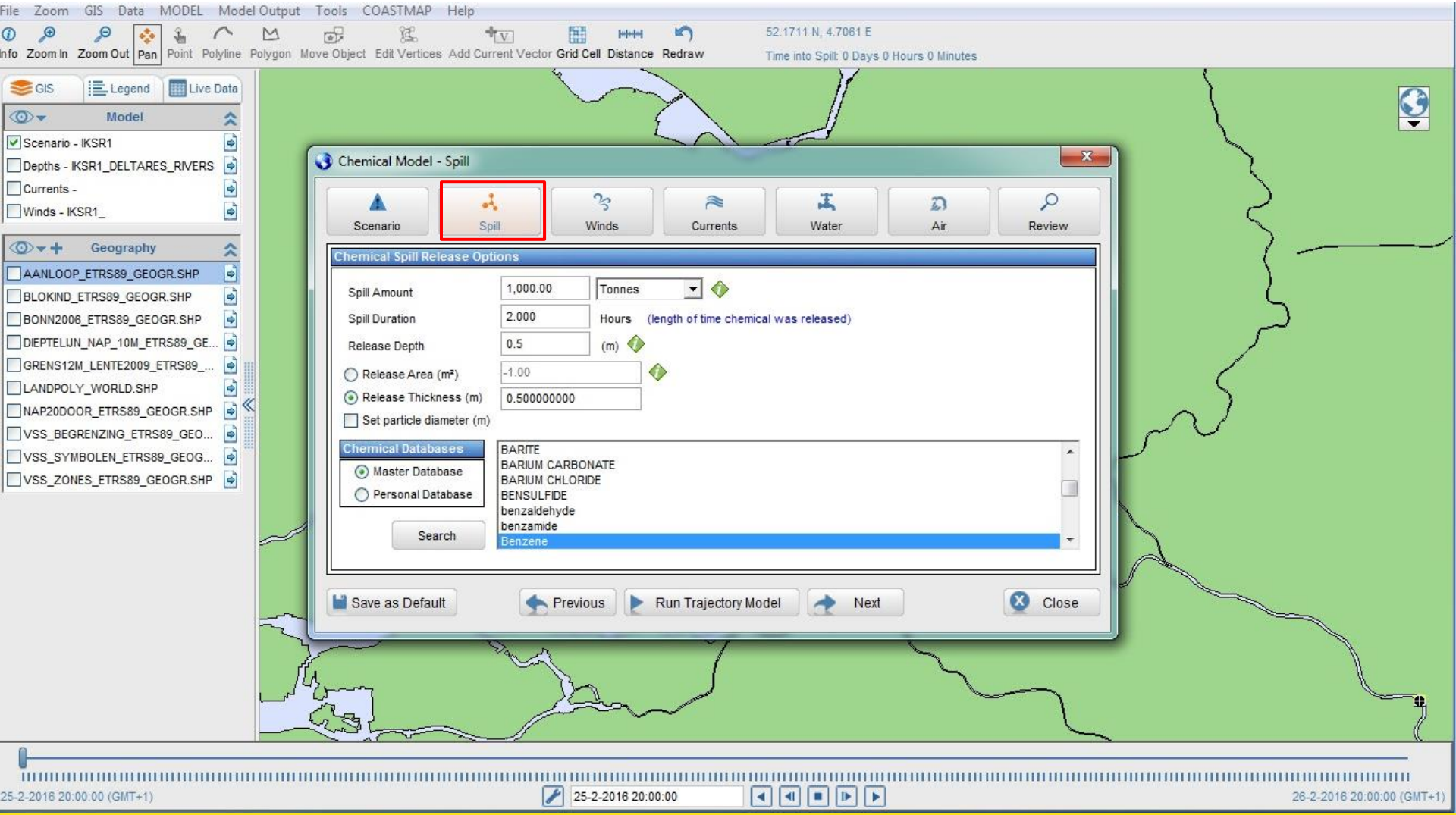
Create New Scenario



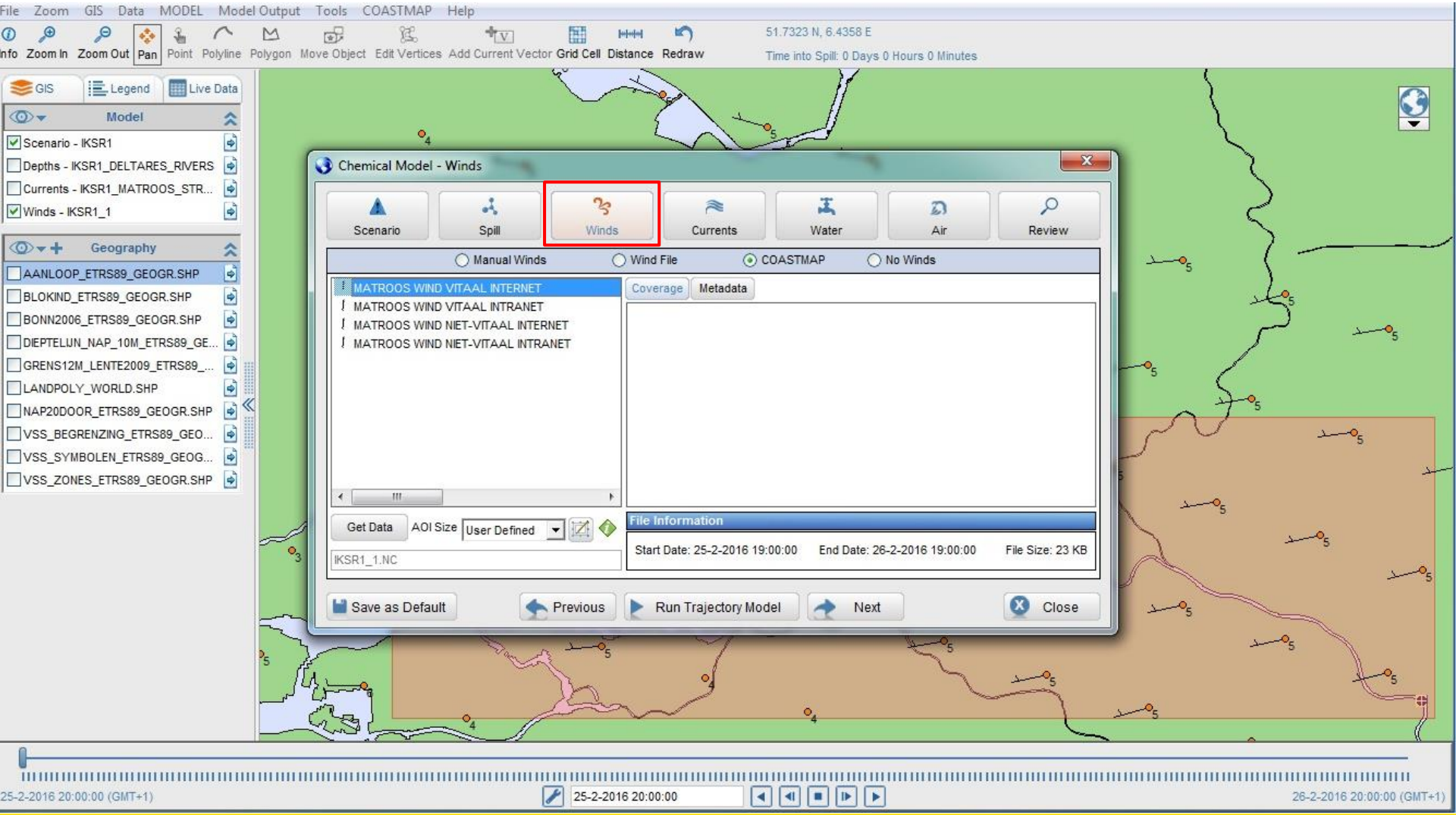
New Scenario



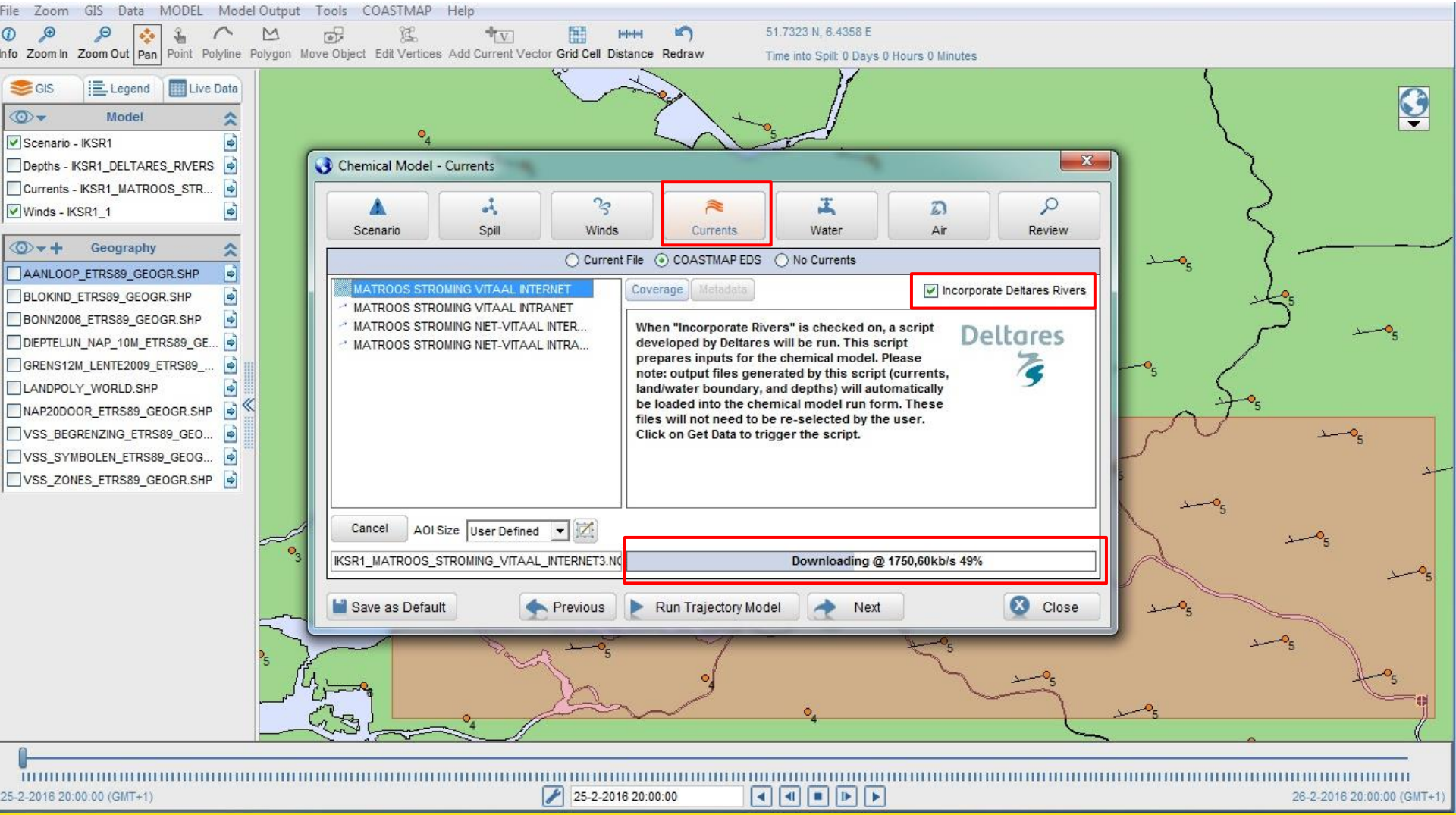
Benzene Spill



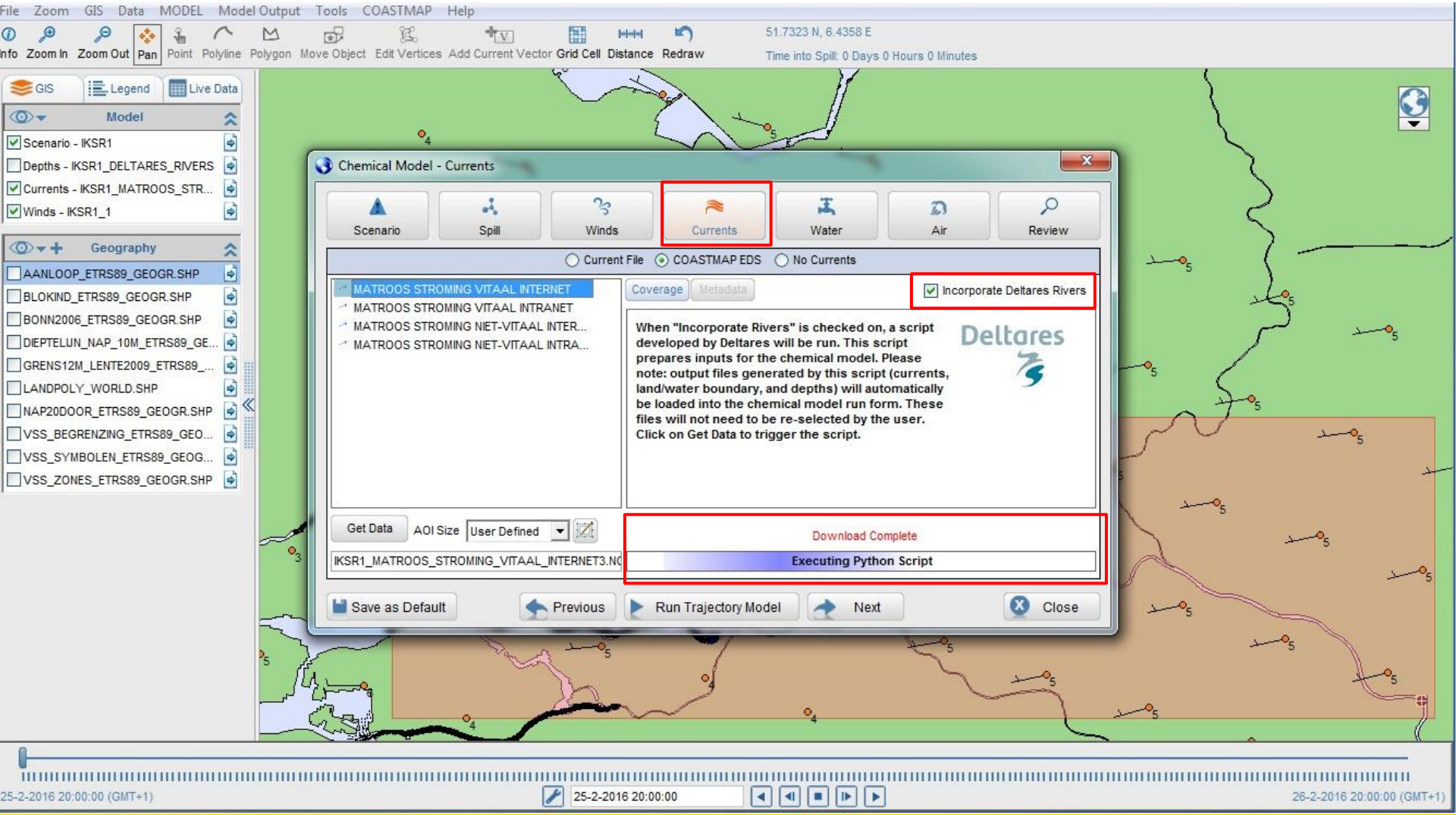
Get Wind Data



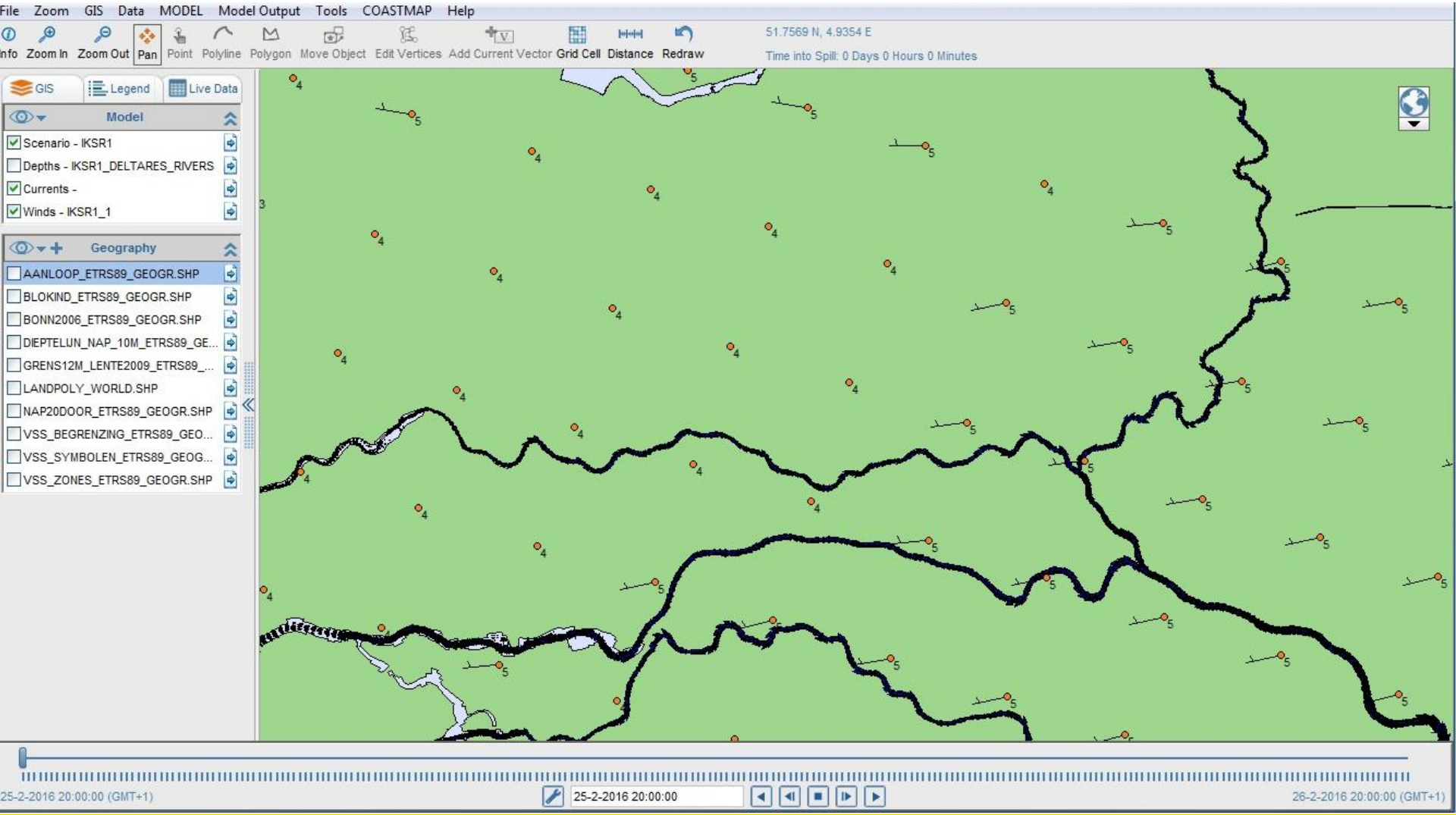
Get Current Data



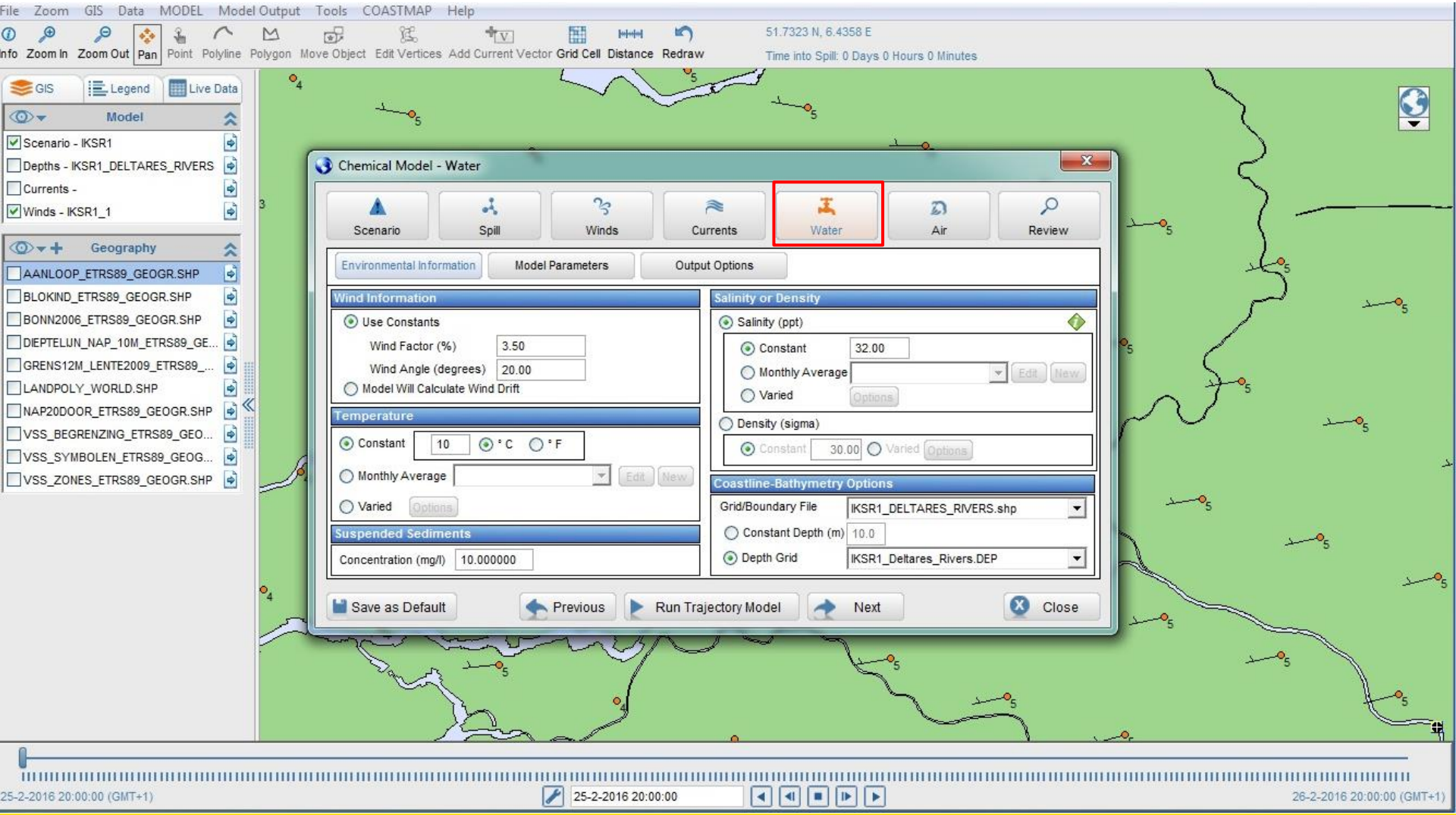
Executing River Script



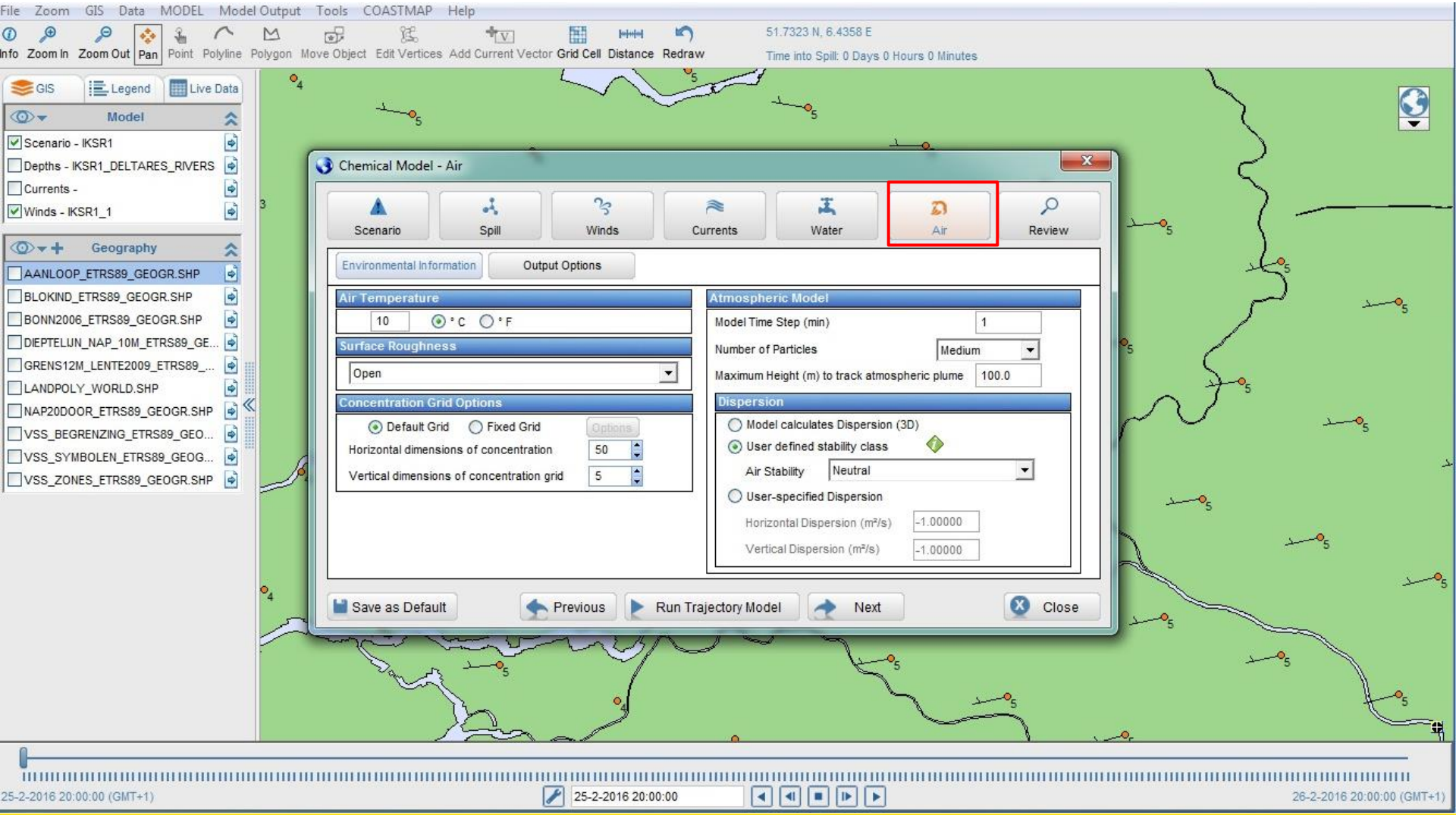
Wind and Current Data



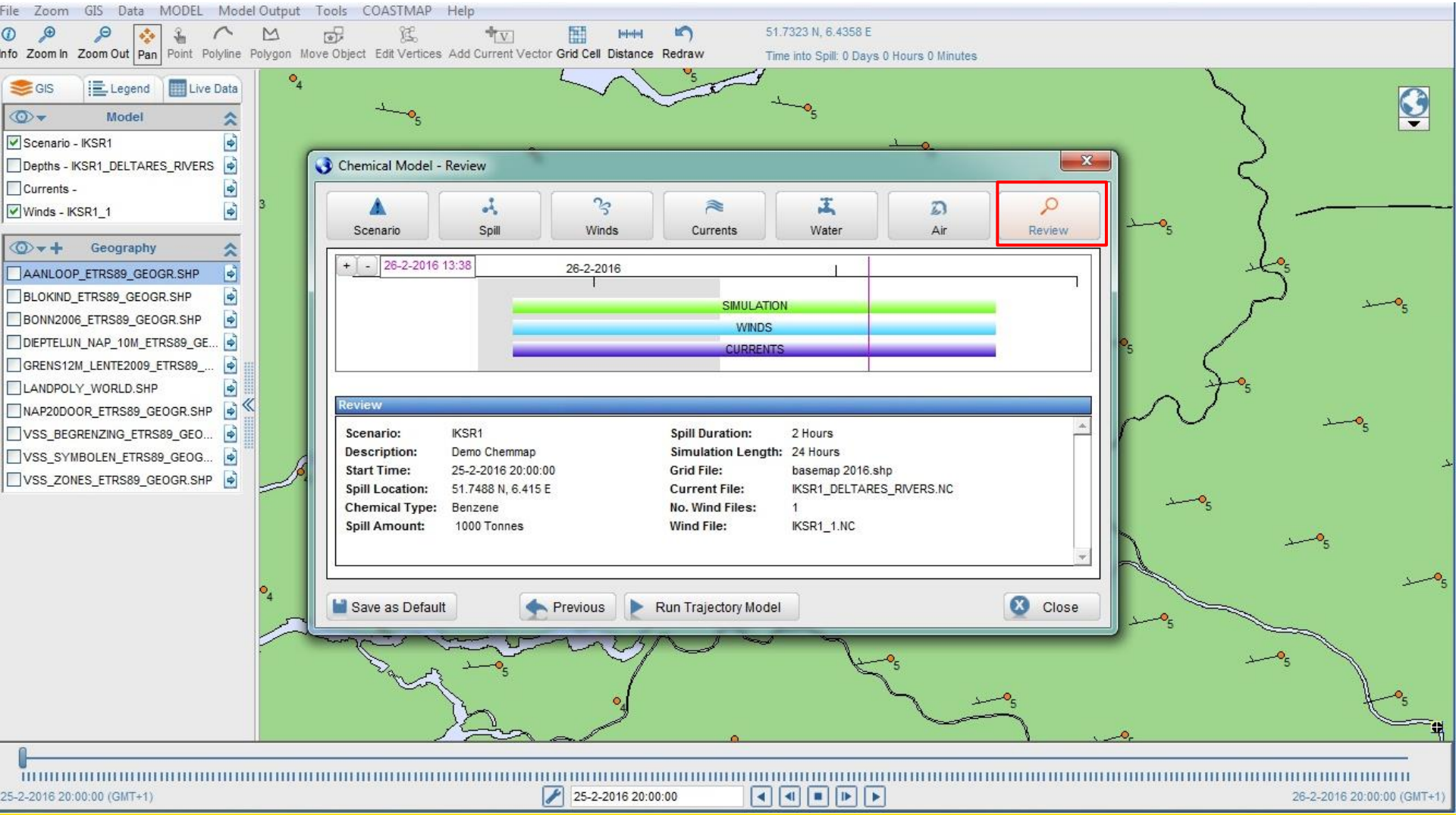
Water Parameters



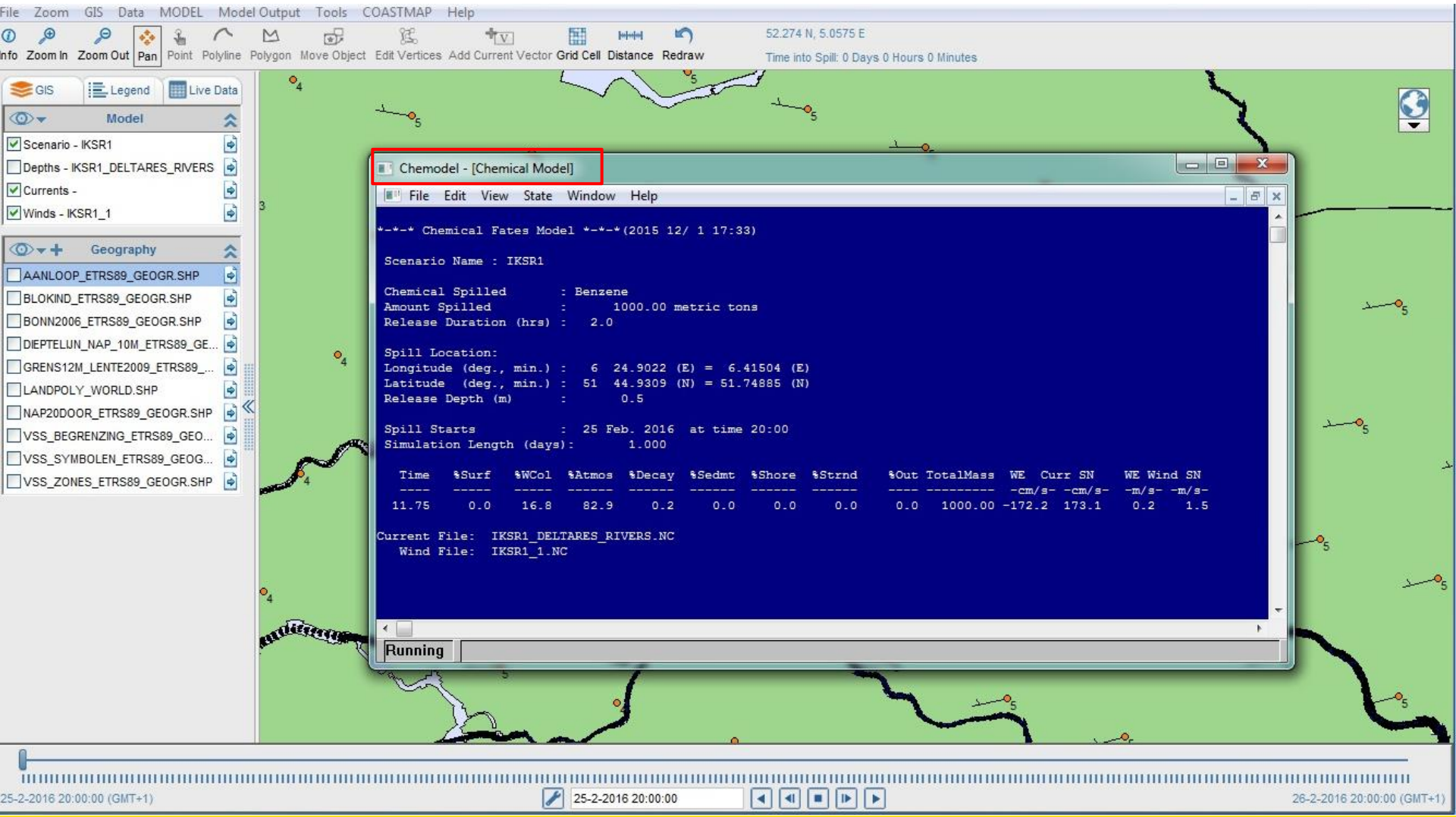
Air Parameters



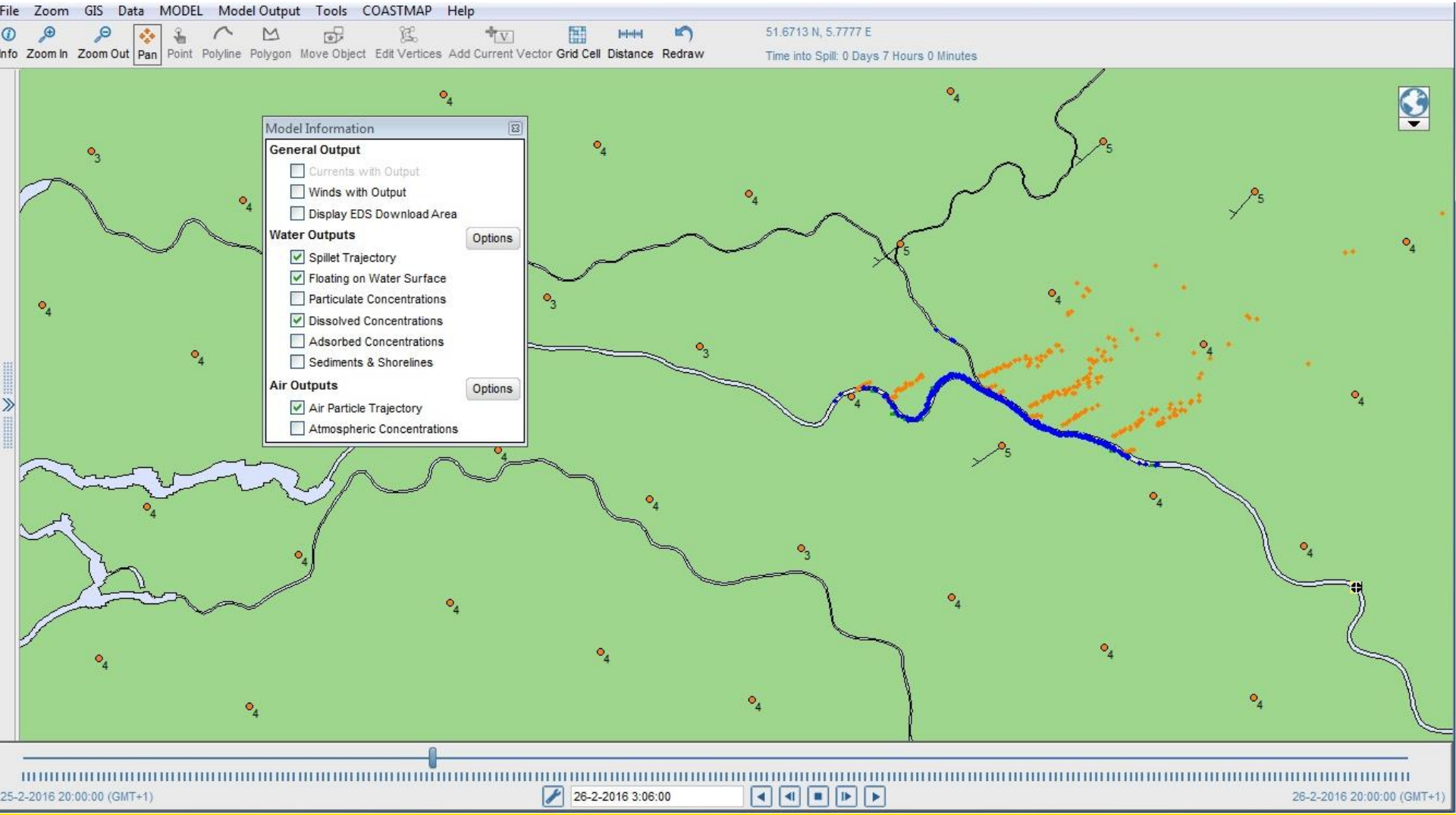
Review Spill and Data



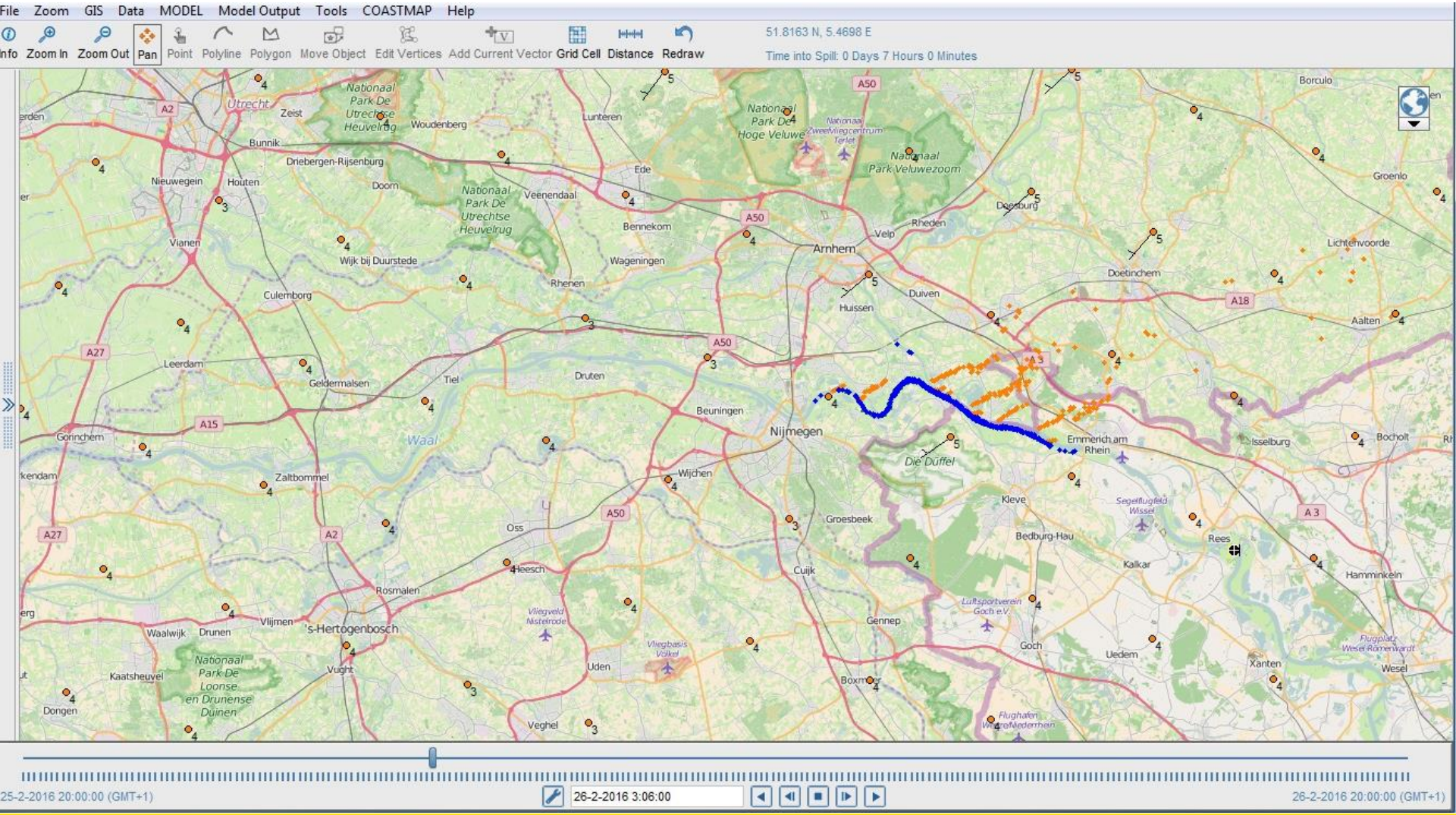
Chemical Model



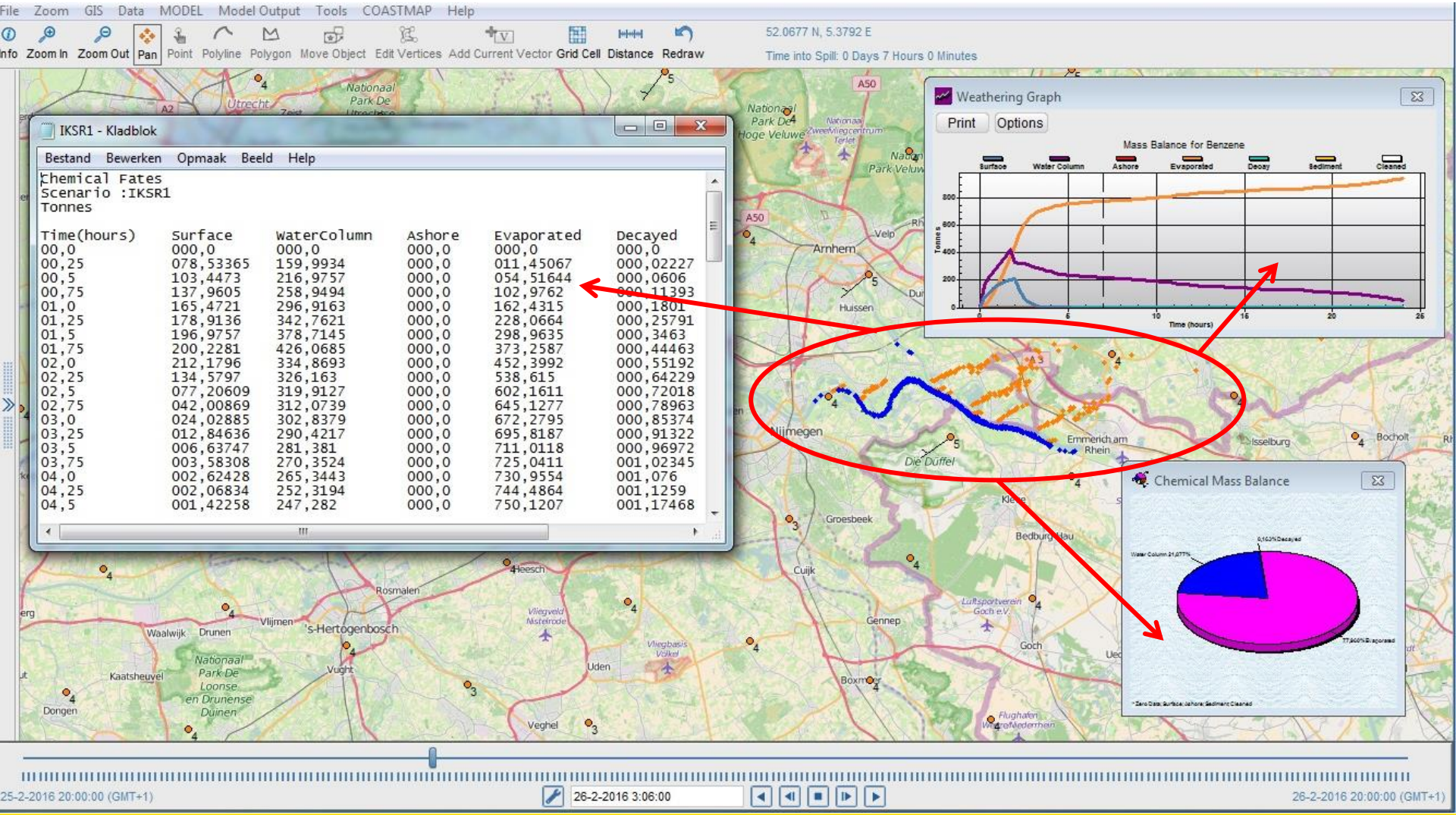
Model Results (base map)



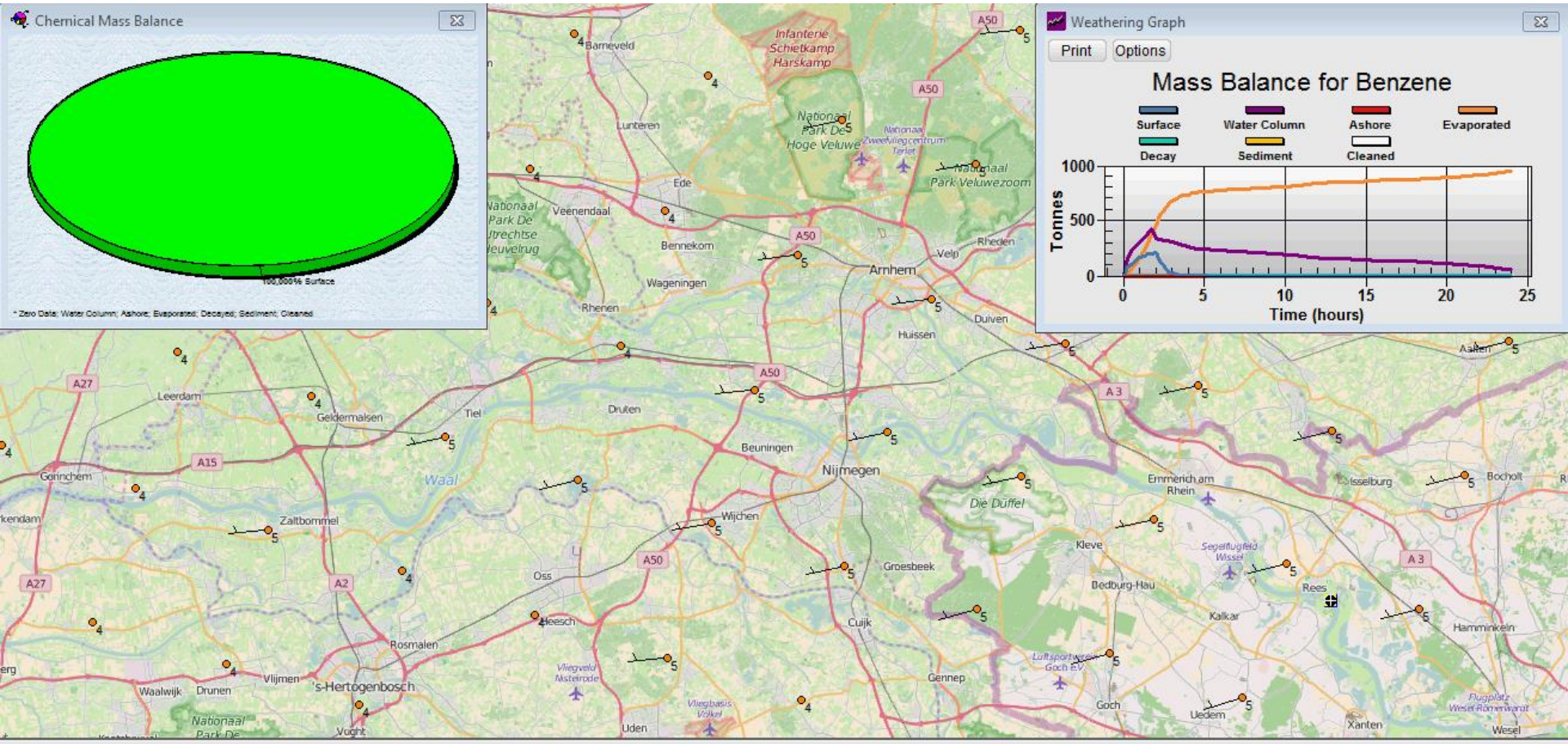
Model Results (open street map)



Model Display Options



Model Results (movie)



Thank you for your attention

2020 > ????