South East European Virtual Climate Change Center

DATABASE OF MINERAL COMPOSITION IN ERODIBLE SOILS AND ITS APPLICATION ON NUMERICAL MODELING OF ATMOSPHERIC IRON TRANSPORT

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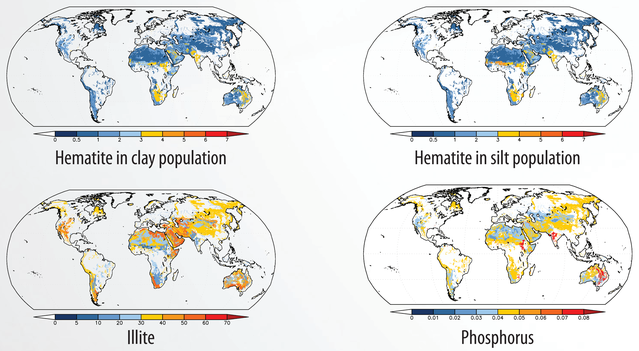
INTRODUCTION

Dust aerosol has a significant influence on climate and environment. It affects climate dynamics through its effects on radiation forcing and cloud formation and its properties. Dust is a major primary nutrient for the marine ecosystem over open ocean and it also could have an important impact to human health. Composition of dust aerosol strongly depends on mineralogy of surface soils in regions of its origin. Therefore, in order to predict its environmental influence, it is necessary to know mineral composition of potentially erodible soils and to numerically simulate atmospheric transport of mineral aerosol. For that purpose we develop 30 arc-seconds resolution global database of surface mineralogy of most frequent minerals in potentially erodible soils, called GMINER30. GMINER30 is incorporated in DREAM-Iron model and is used in a case study simulation to assess atmospheric transport and deposition of iron embedded in dust aerosol.

DATABASE OF SOIL MINERALOGY

Following Claqiun et al. (1999) we have developed a high-resolution global database of mineral composition in potentially erodible soils GMINER30 is on 30-seconds grid (~1km), the resolution appropriate to be used for dust emission process parameterization in fine-resolution atmospheric dust numerical models. Selected minerals (illite, kaolinite, smectite, feldspars, quartz, calcite, hematite and gypsum) are divided into clay and silt size populations with some of minerals contributing to the both groups. We supplement Claquin's mineral list with phosphorus and broaden their choice of soils with several additional FAO soil categories, covering relatively large area that is arid and bare, and thus potentially dust productive (Nickovic et al., 2010).
The database is available for download at: www.seevccc.rs/GMINER30



Hematite in clay population | Hematite in silt population

Illite | Phosphorus

Figure 1. Mineral fractions in potentially erodible soils: Examples from GMINER30

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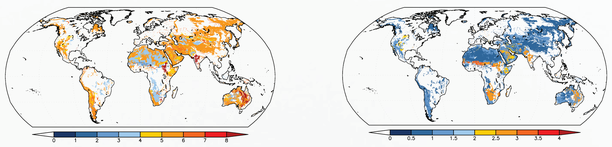
IMPLEMENTATION OF GMINER30 INTO DREAM-IRON

GMINER30 database is implemented into DREAM model in order to simulate atmospheric cycle of iron embedded into dust aerosol. First step in the implementation is to select minerals from GMINER30 that contain different amount of iron (Journet et al., 2008) and add their fractions within respective size population. Iron percentage is obtained by multiplying iron fraction with clay and silt content in each point, providing the model with an information on how much iron is available for uptake. Finally, as a common practice in atmospheric dust models, this matrix is multiplied with a dust sources mask that is in this cased based on choice of USGS land cover categories that characterize arid and bare soils.



Iron in clay population | Iron in silt population

Figure 2. Iron fractions in potentially erodible soils

Both soluble and total (consisting of soluble and non-soluble) iron concentrations are calculated in the model, along with standard dust aerosol concentration. There are 24 particle size bins in total, 8 of them for each category of aerosol (dust, total iron and soluble iron).

	clay population bins					silt population bins		
effective radius (μm)	0.15	0.25	0.47	0.8	1.36	2.29	3.53	7.24

CONCLUSIONS

We report on the development of high-resolution global database GMINER30 on mineral composition of potentially dust productive soils (www.seevccc.rs/GMINER30). GMINER30 could be used in a wide range of multidisciplinary research and numerical simulations. It is successfully implemented into DREAM-Iron model that simulates atmospheric transport of iron embedded into dust aerosol. We simulate a dust storm event, followed by a chlorophyll bloom, near Canary Islands. According to preliminary results, location of observed maximum in chlorophyll a concentration coincide well with an area of increased surface concentration of soluble iron. Such results are in favor of the iron hypothesis arguing for an essential role of iron in ocean productivity.

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CASE STUDY

Dust storm induced chlorophyll bloom near Canary Islands, July 2004

During July and August 2004, numerous dust storms occurred in northwestern part of Africa during which Saharan dust was blown towards the Atlantic ocean. Mineral rich dust aerosol was deposited mainly along the northwest African shelf, supplying the ocean with nutrient necessary for phytoplankton growth. During August, a massive occurrence of cyanobacteria was reported near Canary Islands (Ramos et al., 2005).
According to the iron hypothesis (Martin, 1994), the deposition of iron, along with dust aerosol, might increase biological productivity of the ocean and might enhance chlorophyll concentration. Therefore, we simulated this event using DREAM-Iron. The integration covers the period between 15th and 31st of July. Here we present preliminary results for dust load and iron deposition and surface concentration which is in good agreement with observed pattern of chlorophyll a concentration, observed with MODIS Aqua satellite.

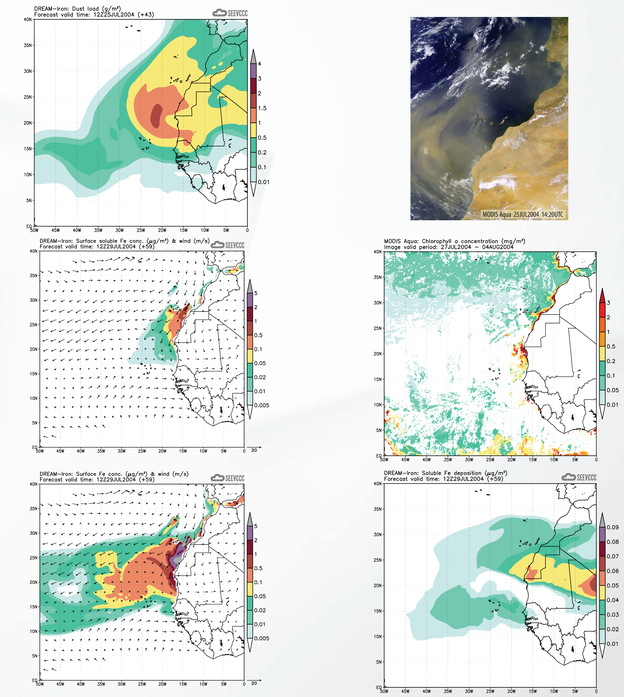

Figure 3. DREAM-Iron case study results and sattelite images