Reactive Transport

Reactive Transport

CE 40420, Spring 2016

Q: What is reactive transport?

A: When things move and react at the same time (duh)

Q: Why do you need to learn it?

A: This really puts a lot of ideas from past 4 years together

Q: What previous courses will come into play here?

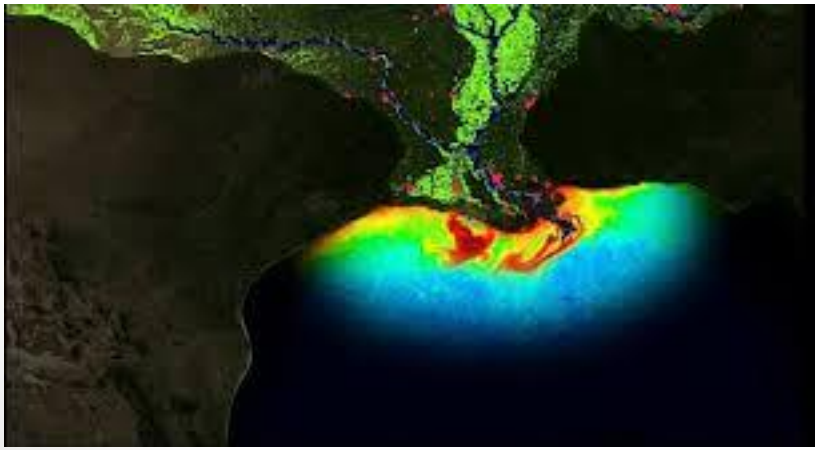
A: Aquatic chemistry, environmental eng., fluids, groundwater, hydrology, numerical methods

Motivation

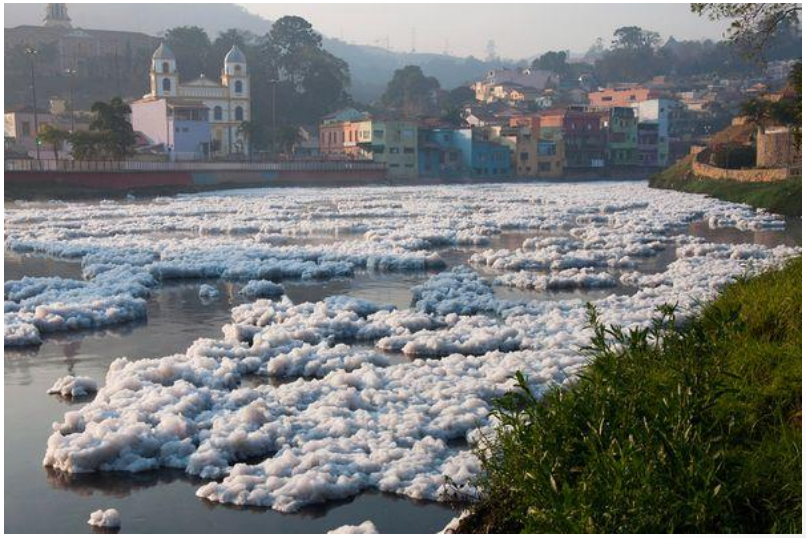
The National Research Council (NRC) has issued a report which concludes that for 10 percent of sites in the United States that require groundwater remediation, work is unlikely to be completed within the next 50 to 100 years. The report determines that at least 126,000 sites have contaminant levels in groundwater above those that would allow unlimited use and unrestricted exposure. It estimates that about 10 percent of those sites are complex from a hydrogeological and contaminant perspective. These include Department of Defense and Department of Energy sites as well as sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act. The report states that an estimated "cost to complete" of up to $127 billion for these contaminated groundwater sites "is likely to be an underestimate of future liabilities."

Motivation

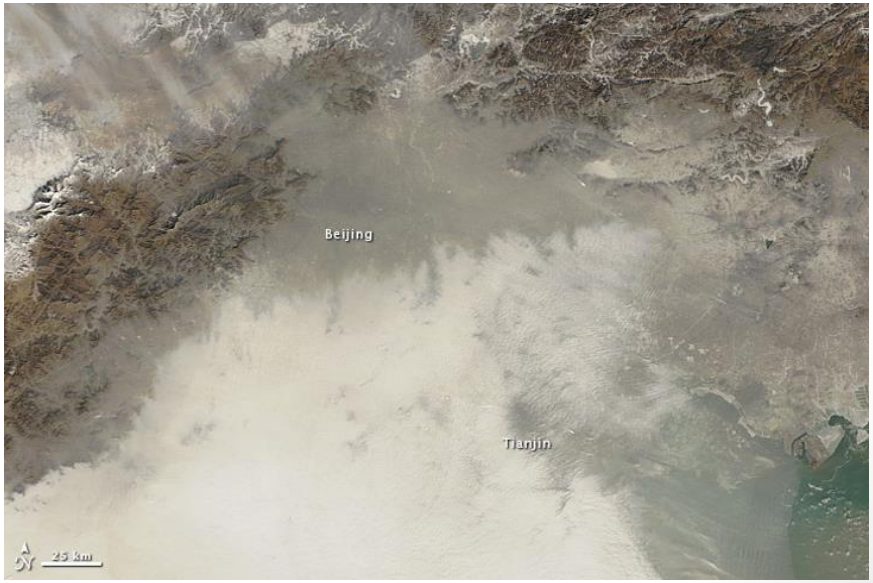

Upper Mississippi River Basin
Missouri River Basin
Arkansas - White River Basin
Ohio River Basin
Red River Basin
Lower Mississippi River Basin



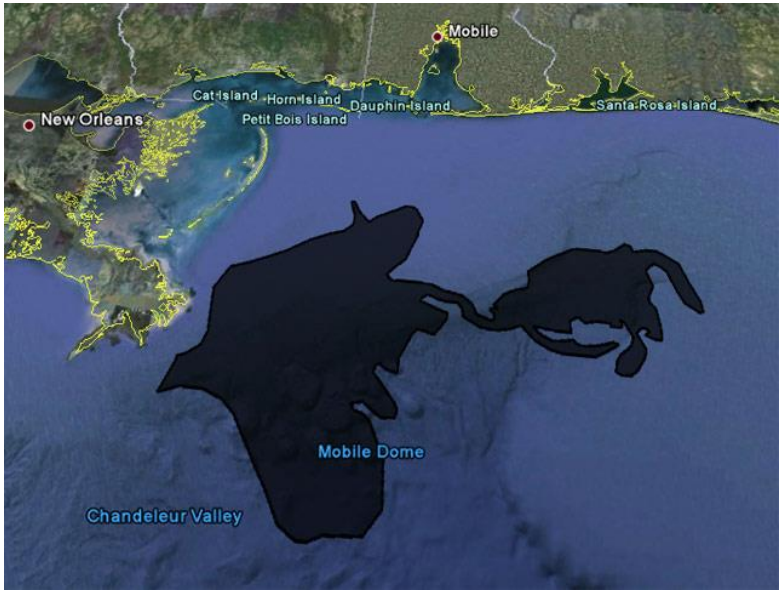
Motivation



Motivation



Motivation



Deepwater Horizon

Valdez Exxon

Impacts of considering reactive transport

Clean Water

Share of a Deep Well $100

Give one share of a deep well. A deep well can provide up to 2,800 gallons of clean water a day to benefit as many as 300 people. In addition, a deep well can cut a community's child death rate by as much as half! Clean water lies hundreds of feet below layers of hard rock in many communities....

Learn More

Give Now

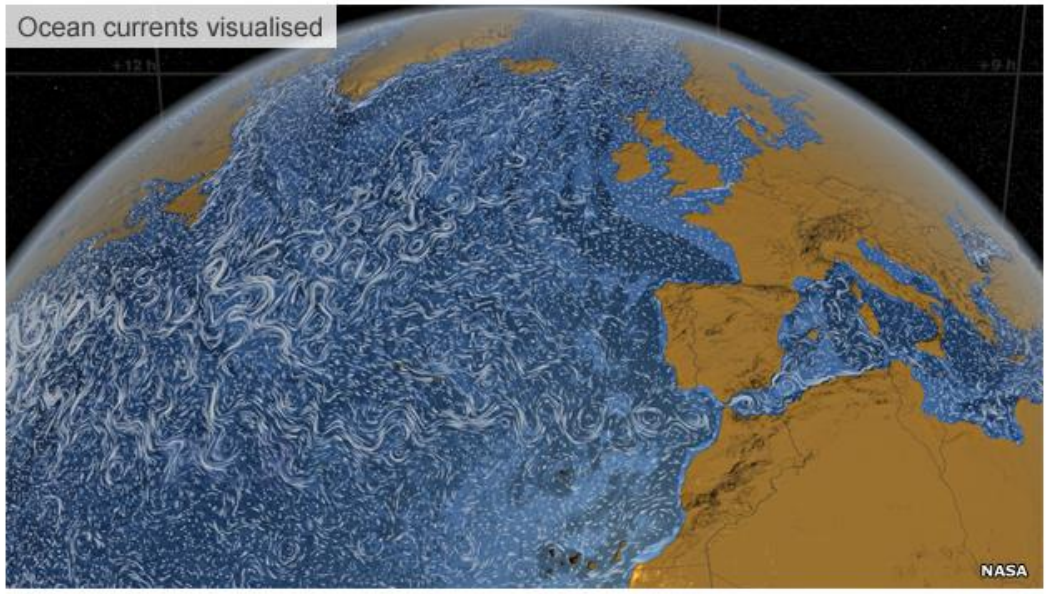
Impacts of considering reactive transport

Impacts of considering reactive transport

Even higher impact:

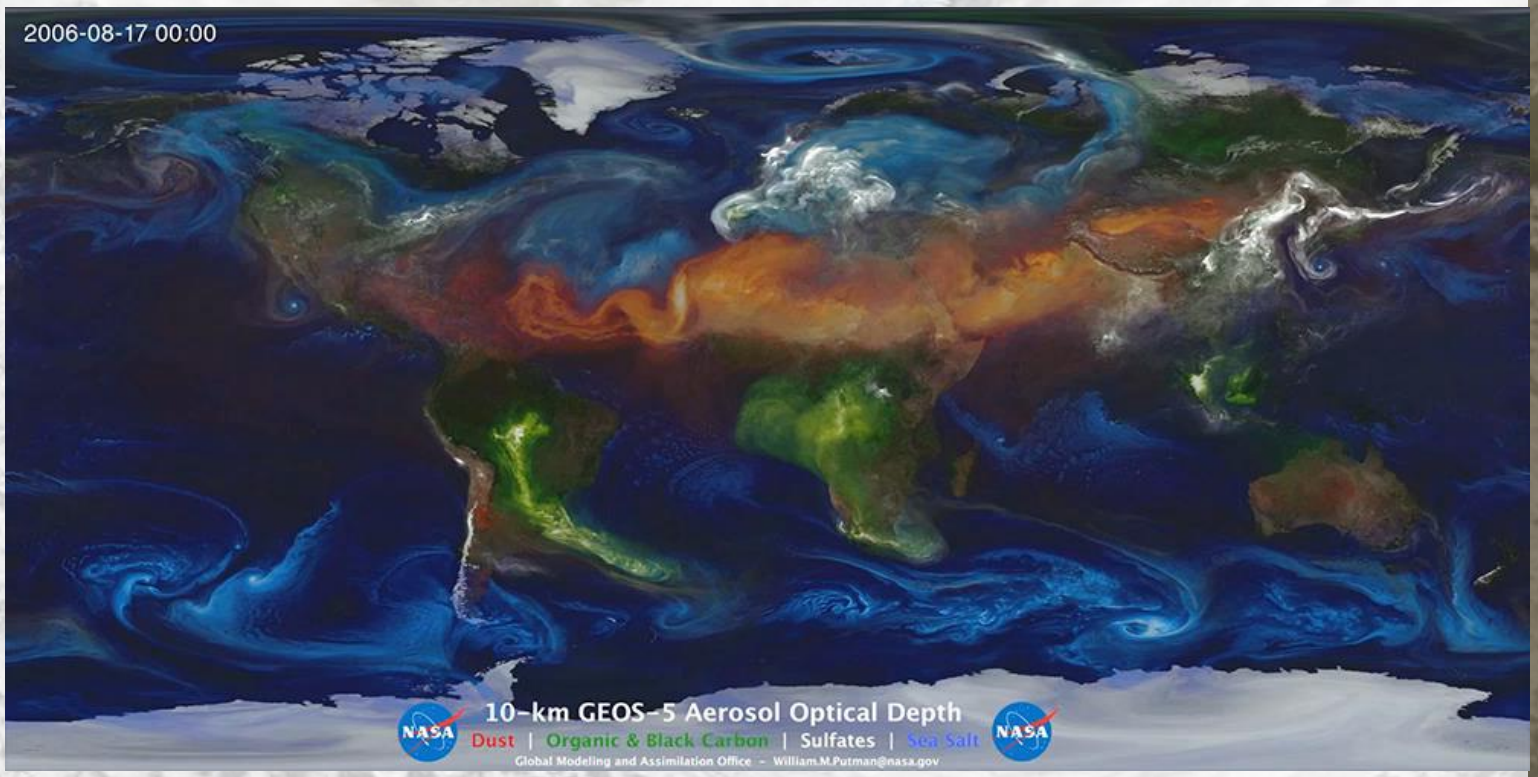
The Cornish beaches where Lego keeps washing up

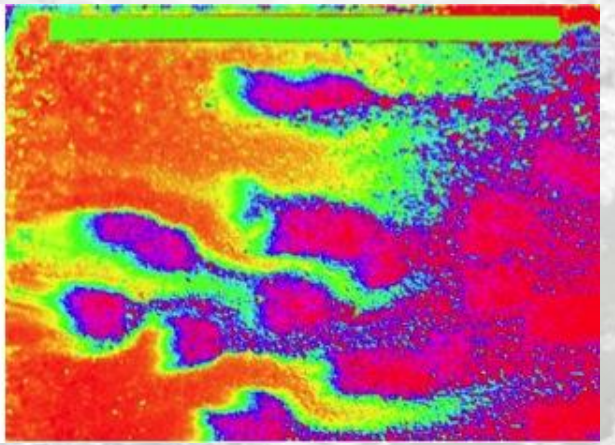
By Mario Cacciottolo
BBC News Magazine



http://www.bbc.com/news/magazine-28367198

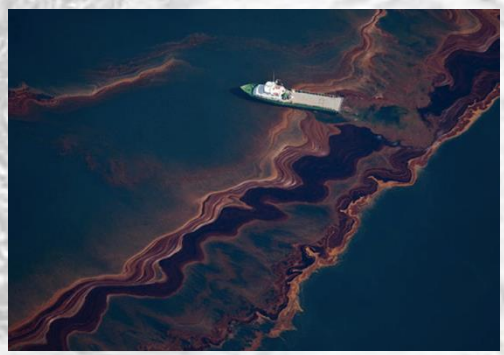
On what scales to you see reactive transport?





Some famous examples

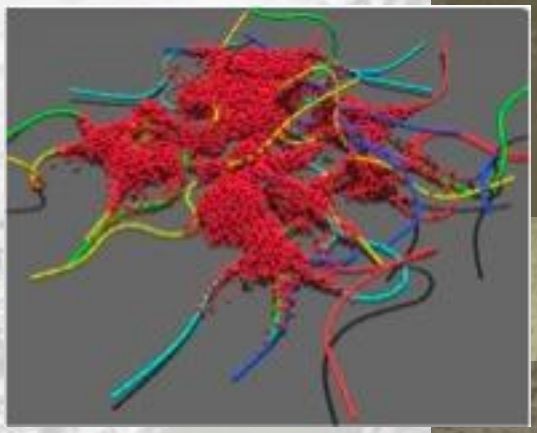
- Fukushima
  - Radioactive materials
- Deepwater horizon
  - Hydrocarbons
  - Biodegradation
- Minimata bay
  - Methylmercury
- Great London Smog of 1952
  - Soot and sulphur dioxide
- Gulf of Mexico dead zone
  - Biological decomposition
- Animas river
  - Heavy metals and mine waste



Some lesser known examples

- Garbage islands
  - Slow degradation (plastic)
- River transport
  - Diogo's research
- Arctic photochemistry
  - Rose Cory of UM
  - Degradation of organic matter
- Biofilm growth
  - Rob Nerenberg & C. Picioreanu
  - Good and bad biofilms
- Air-sea gas exchange
  - Byron Blomquist's HIWINGS
  - CO_2 and other trace gases

Figure 2. Plastic collected from the centers of ocean gyres is usually no more than a few millimeters across; an oceanic garbage patch is more like a plastic soup than a plastic island. (Photograph by Marilou Maglione, courtesy of the Sea Education Association.) The inset shows the location of the five subtropical ocean garbage patches (light green) and the gyres that encircle them. Also indicated are the poleward flowing currents (red) on the western boundaries of the gyres.



Goal of This Course

Education is not the filling of a pail, but the lighting of a fire.
- William Butler Yeats

The nature of this course will be mathematical. For some of you the maths may be easy, for some of you very hard. I promise to always be there to help you with it and teach it to you in as many different ways as needed and I can, so that you will succeed! My office is always open to you – I mean it when I say that the most satisfying part of my job is to have students come and chat with me – it brightens my day (even just to chat) and nothing is more satisfying than seeing the switch go 'Click' when a student gets it.

I am not interested in testing your mathematical skills, nor am I really interested in testing you at all, although I will to make sure that you are on track, which serves as useful feedback to me on what I am doing well and what I am doing poorly. A senior class like this one in my view is about exposing you to new ideas and details you are not aware of and as Yeats said best 'igniting a fire'.

My goal is to expose you to what I think are extremely elegant and beautiful methods for understanding very complex phenomena.

Struggle with me, work hard and be patient and you will find it very rewarding as you will start to see the equations and processes everywhere you look around you (as I do and know my grad students begin to also). I expect you to work hard and put in the hours needed to learn this, but that also means that you should expect me to work hard for you – hold me to the highest standard and expect nothing less than that from me – if I am failing you – let me know and I will do my best to rise to the occasion.

If it's easy for you – push yourself harder and try to take these concepts a level further by implementing more elegant approaches and solutions than those I teach you – I am happy to provide more challenging and interesting problems!

Once you get these things, as hard as they may seem right now, they become 'SIMPLE' and I believe that Simplicity is the root of Elegance in problem solving for Scientists and Engineers