

Simple box modeling of mercury cycling in the Indian environment.

Possible impacts of control scenarios and need for data (preliminary)

July 27, 2016

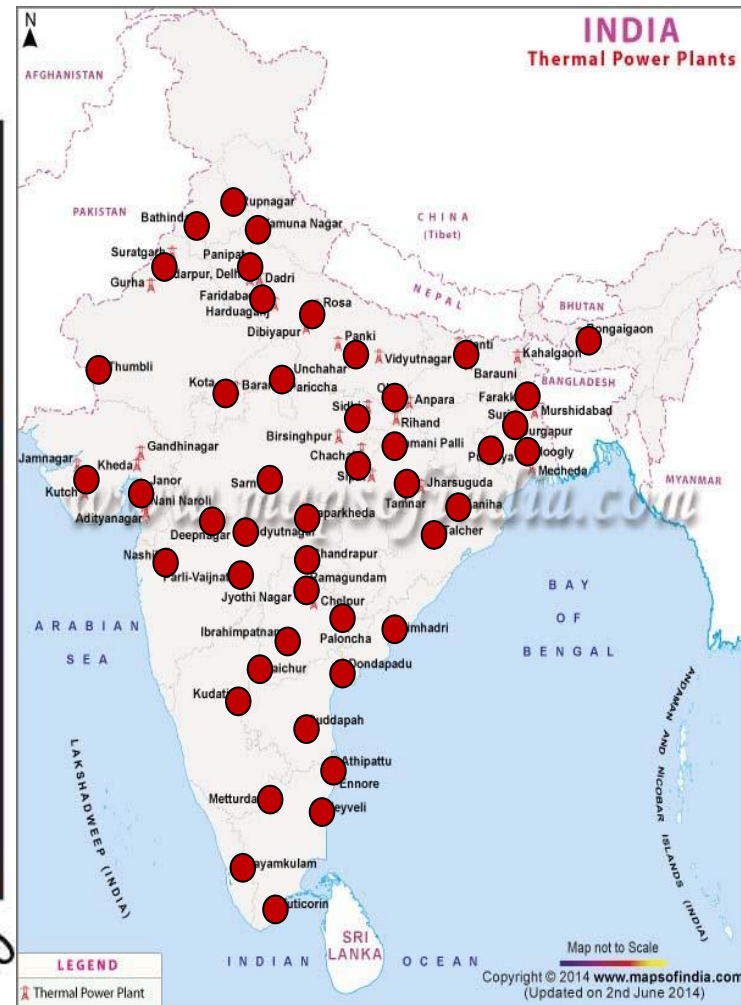
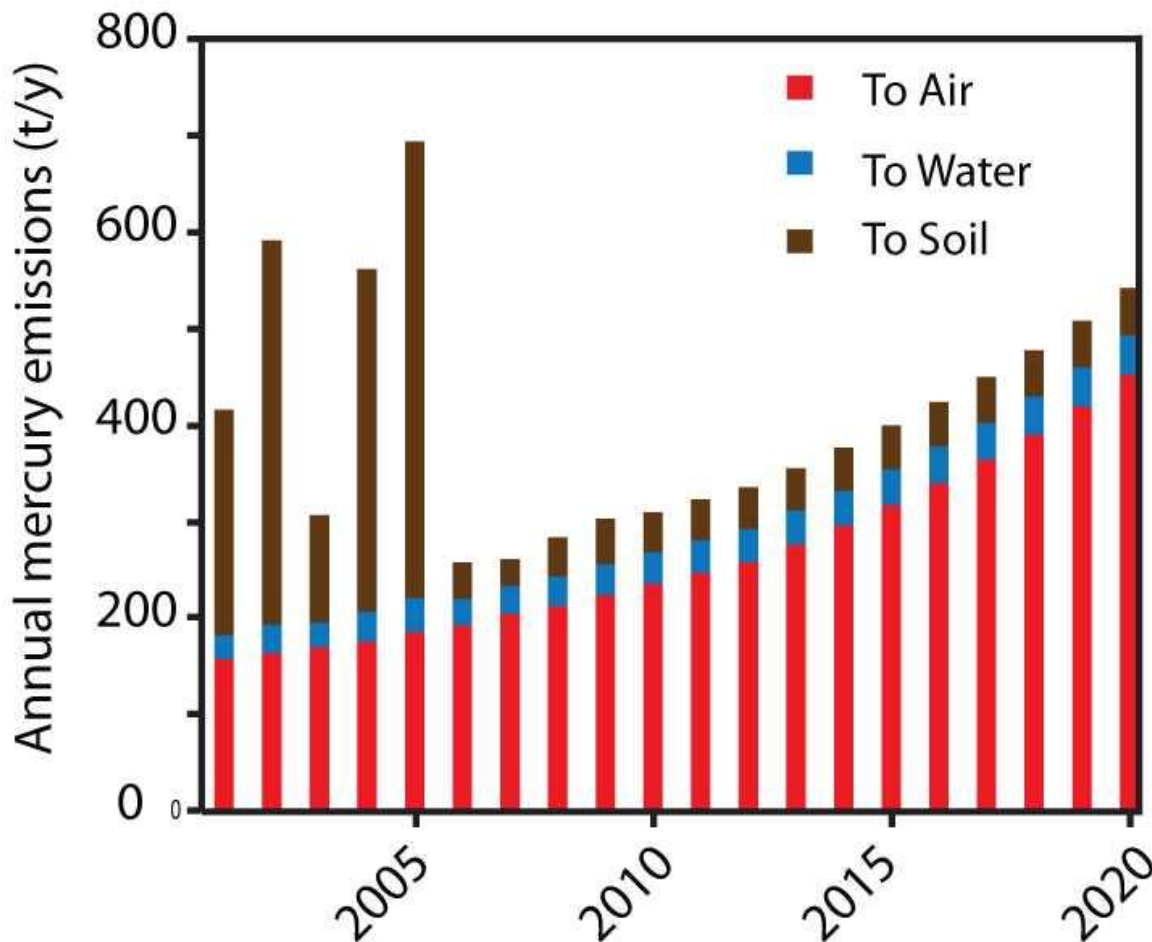
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Emissions projections¹



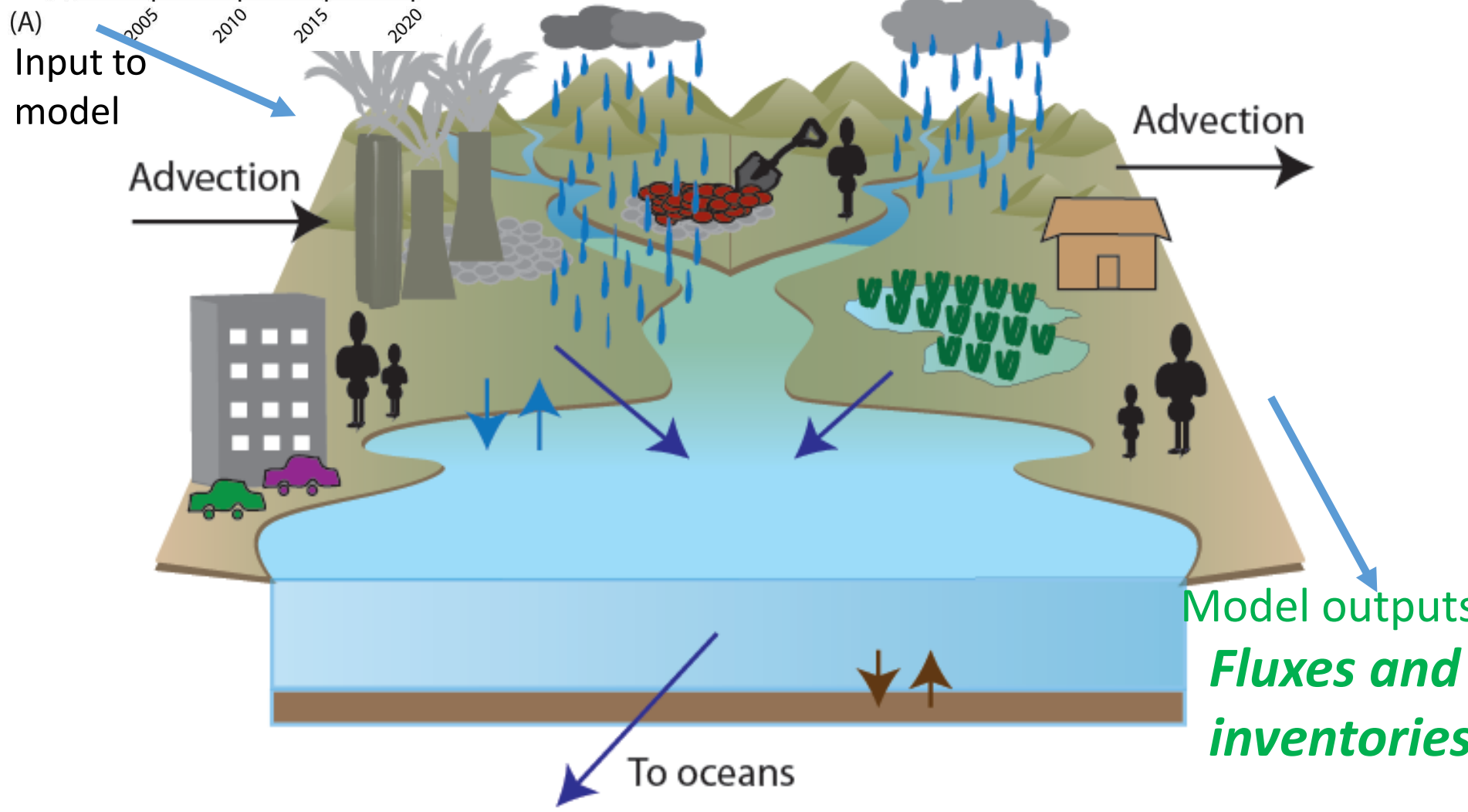
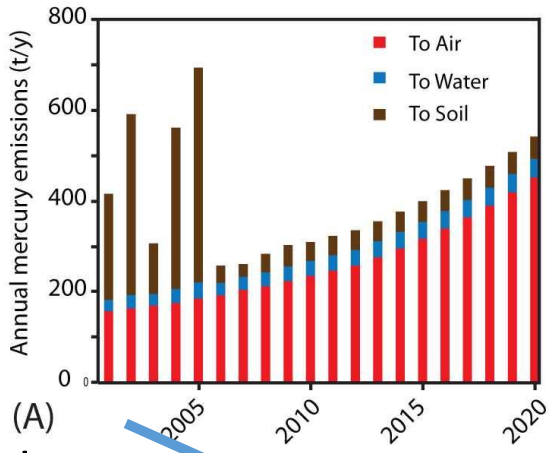
<http://www.mapsofindia.com/maps/india/thermalpowerplants.htm>

1: Chakraborty et al. (2013) *Environ. Sci. Technol.*,47,8105-8113.

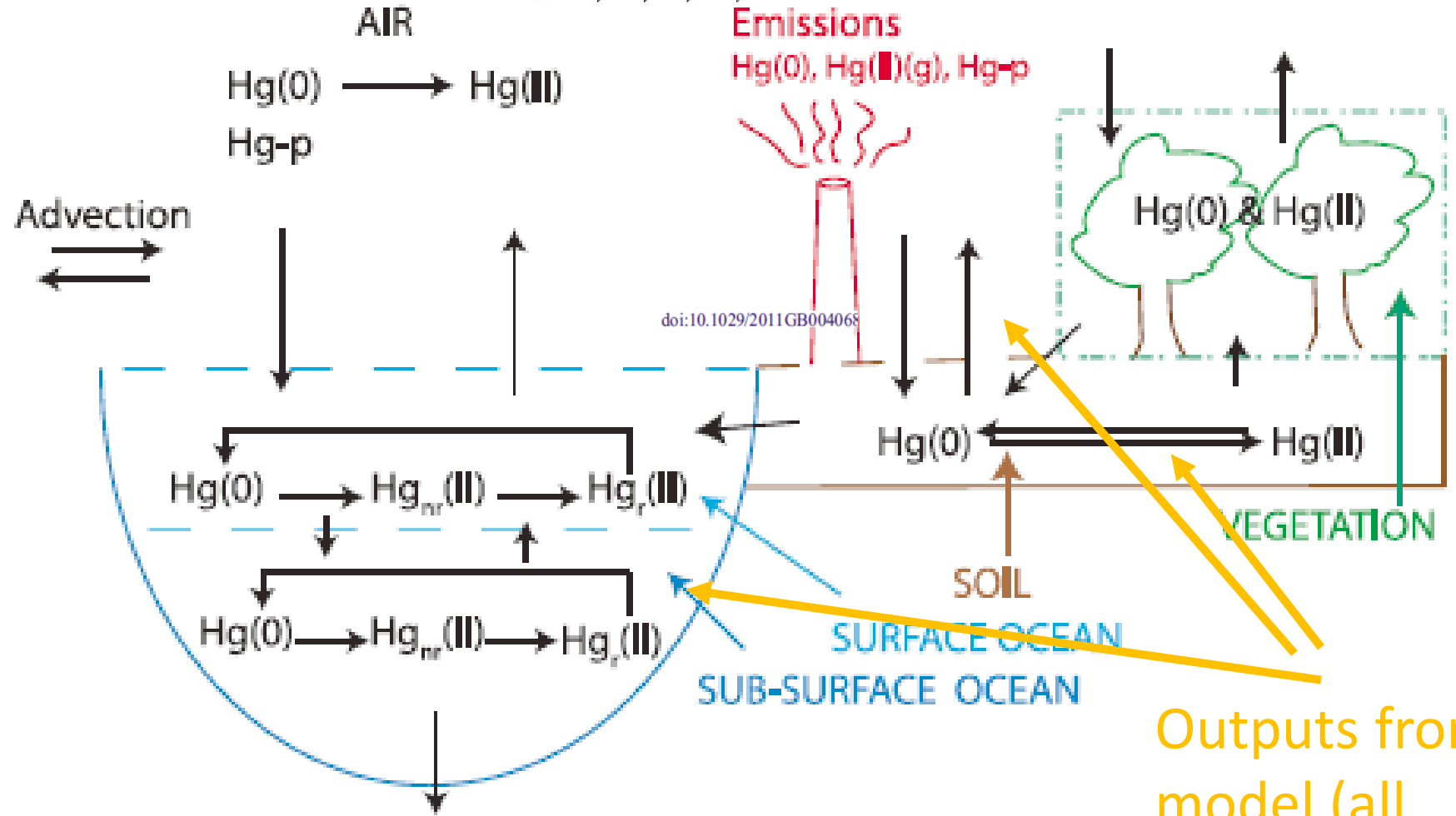
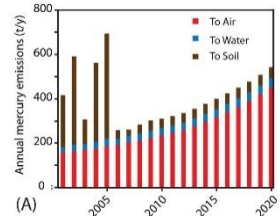
Some questions of interest:

- (1) How does this information translates to fluxes of mercury in the environment?
- (2) If one changes the emissions, what are the implications to
 - (i) local deposition
 - (ii) trans-boundary pollution
 - (iii) human health

Simplified model environment



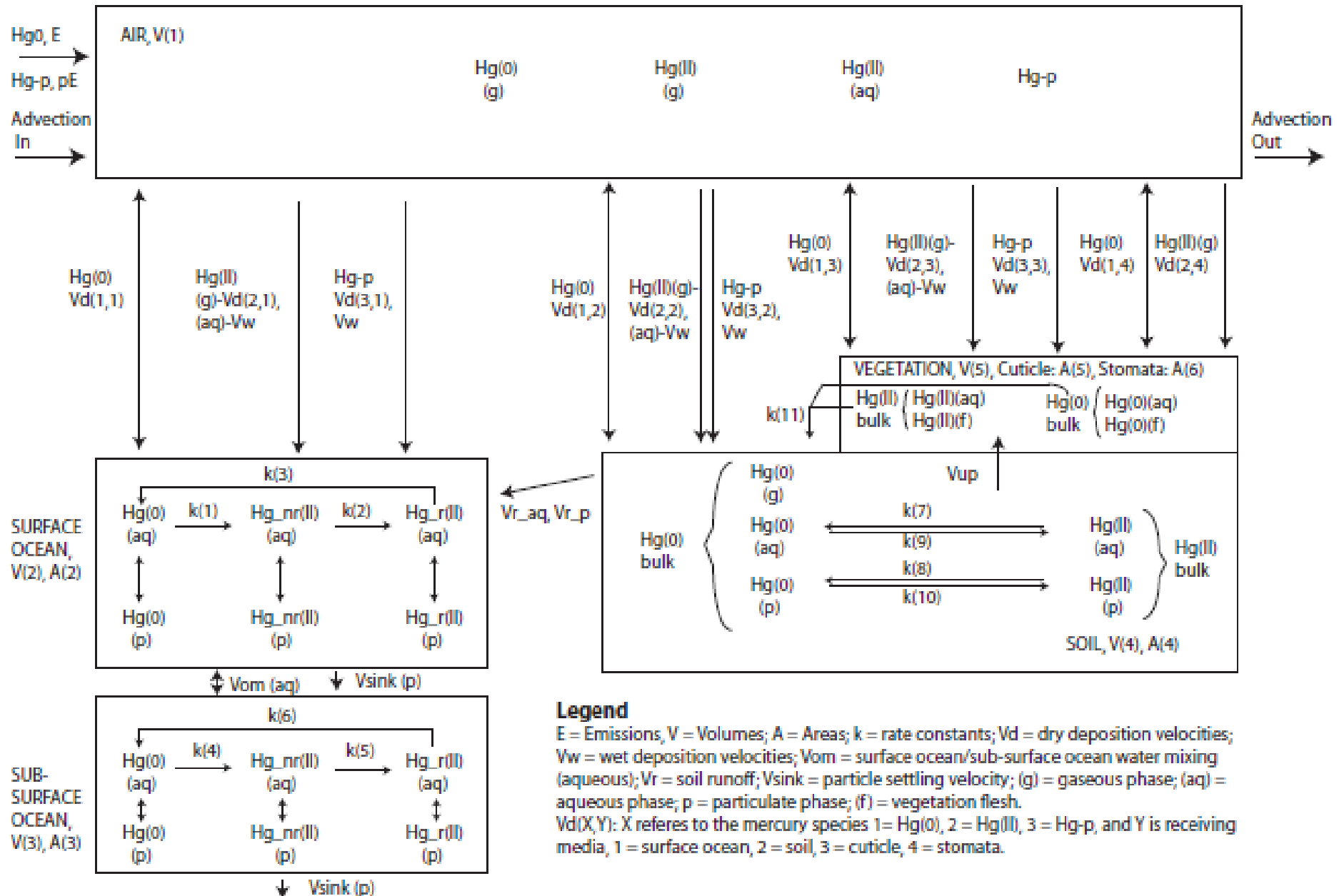
Less-simplified model environment



Outputs from model (all arrows, +)

1: Qureshi et al. (2011) *Global Biogeochem. Cycles.*, doi: 10.1029/2011GB004068.

Not-that-simplified model environment



After model: compare model results with observations

	Model	Observations (<i>min – max</i>)
Air (ng/m³)	1.43	1.9 ± 0.6; 2.7 ± 0.5
Dissolved Water (pM)	13.6	1.15 ± 2.4 (0 – 19)*
Sediments (µg/g)	0.017	0.07 ± 0.09 (0.01 – 0.3)*

* *Uncontaminated/ Less contaminated region*

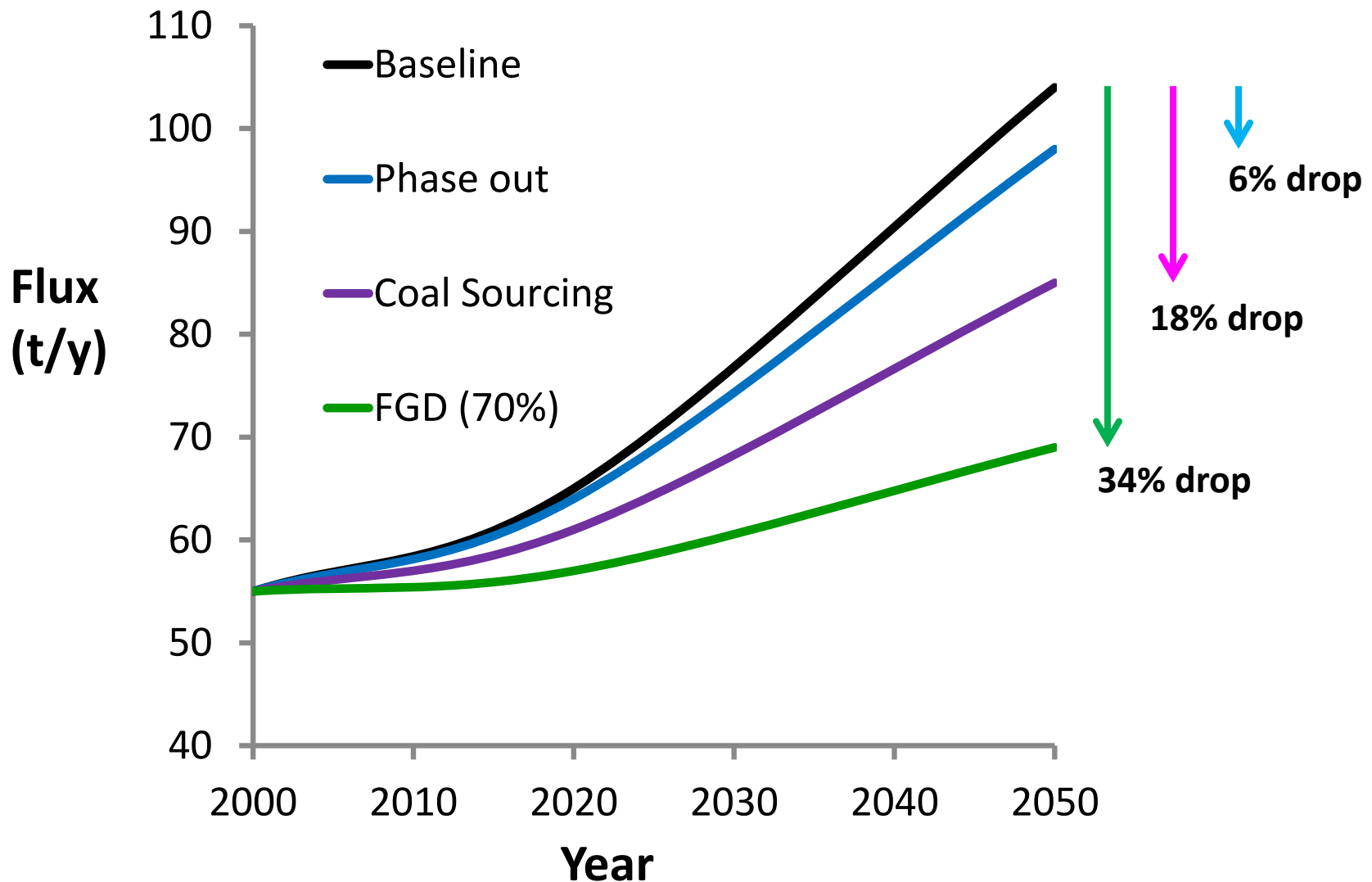
Evaluate effects of different emission control scenarios

control measure	air	water	soil	land-fills	ash structures	total to environment
phase-out	-12 (-29)	-49 (-16)	-66 (-27)	-36 (-21)	0 (0)	-23 (-73)
coal sourcing	-38 (-89)	0 (0)	0 (0)	-17 (-10)	-35 (-5)	-29 (-90)
coal washing	-10 (-24)	0 (0)	1 (0)	26 (15)	62 (9)	-8 (-24)
FGD 40% efficiency	-16 (-38)	0 (0)	1 (0)	40 (23)	96 (14)	-12 (-37)
FGD 70% efficiency	-33 (-76)	1 (0)	2 (1)	81 (47)	195 (29)	-24 (-75)
recovery ^b	-13 (-31)	0 (0)	0 (0)	-4 (-2)	-10 (-1)	-10 (-31)
recycling ^b	-7 (-17)	-9 (-3)	-2 (-1)	-43 (-25)	0 (0)	-7 (-21)
coal sourcing + phase-out	-51 (-119)	-49 (-16)	-66 (-27)	-53 (-31)	-35 (-5)	-53 (-162)
coal sourcing + FGD 70% efficiency	-51 (-120)	0 (0)	1 (0)	16 (9)	44 (7)	-39 (-120)

Numbers are as % (tonnes)

Reduction scenarios & 2000–2050 trends

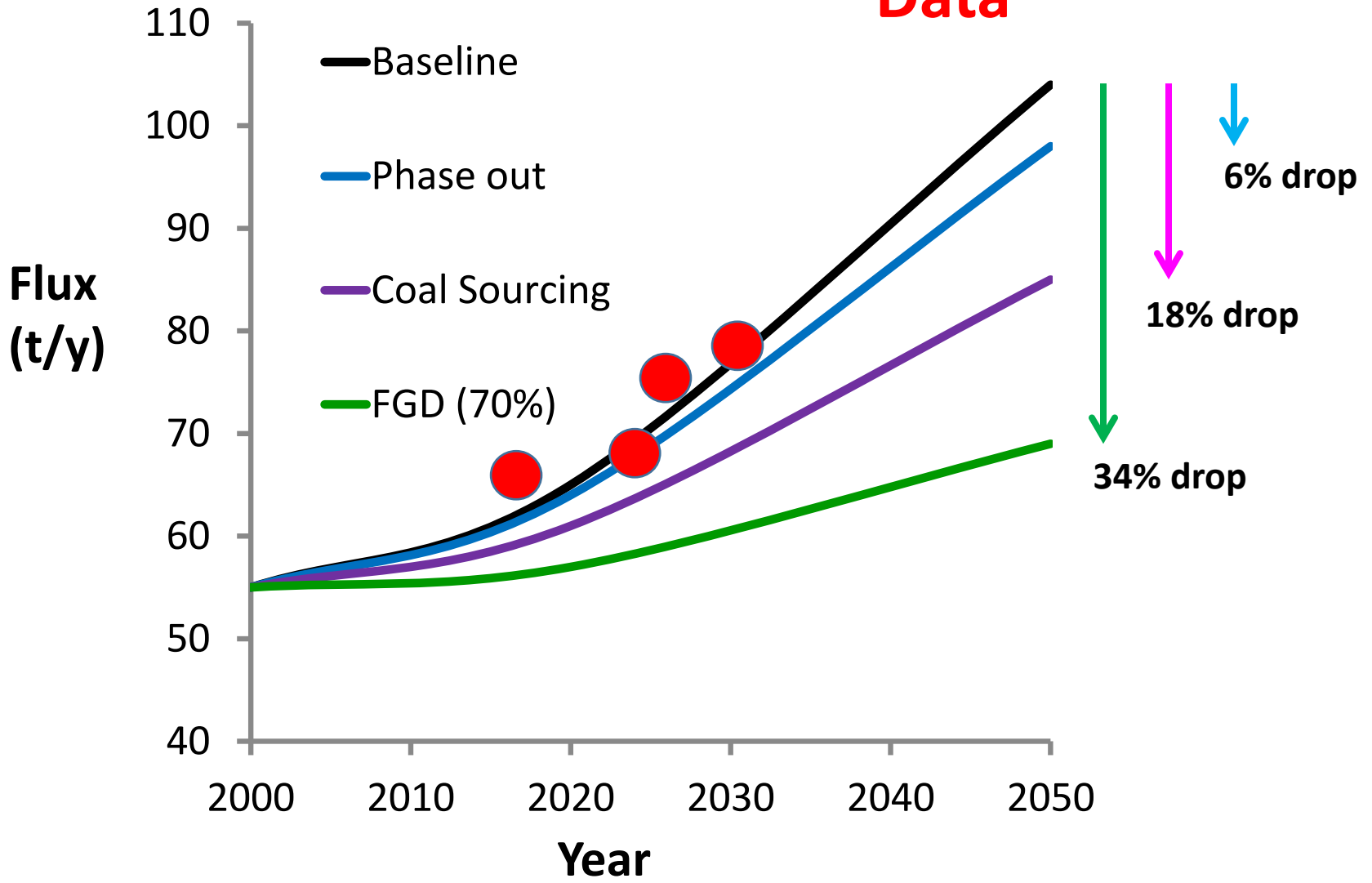
Total Hg deposition to Land (t/y)



Confidence increases with observations

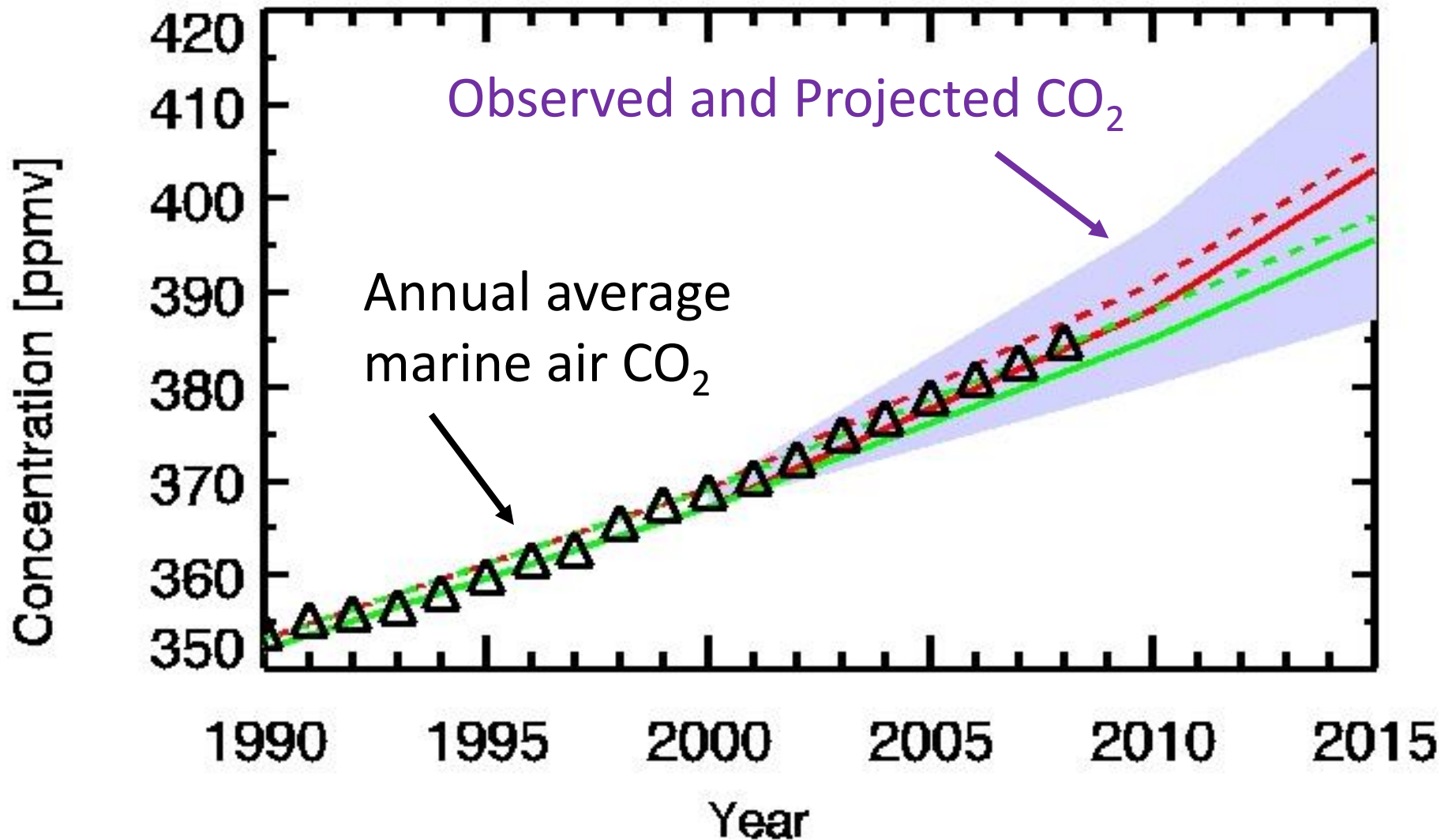
Total Hg deposition to Land (t/y)

● = Hypothetical Field Data



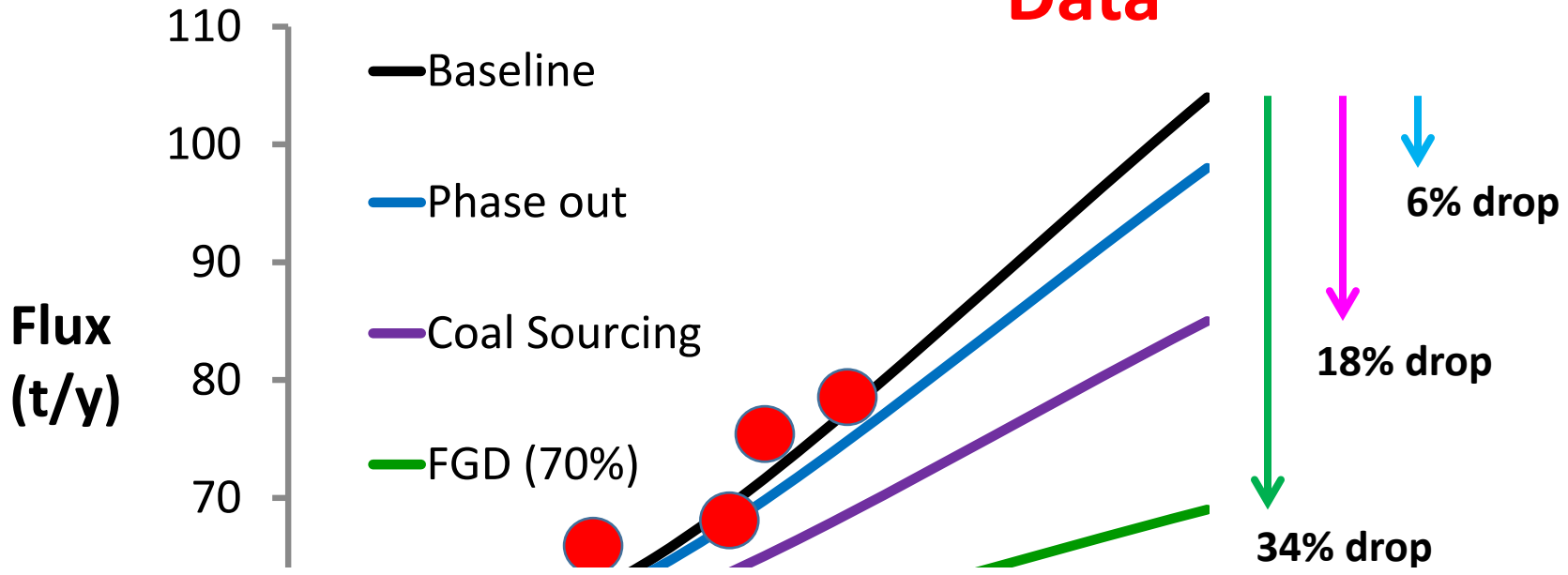
Note the analogy with CO₂

From IPCC: http://www.ipcc-data.org/observ/ddc_co2.html



Confidence increases with observations

Total Hg deposition to Land (t/y) ● = Hypothetical Field Data

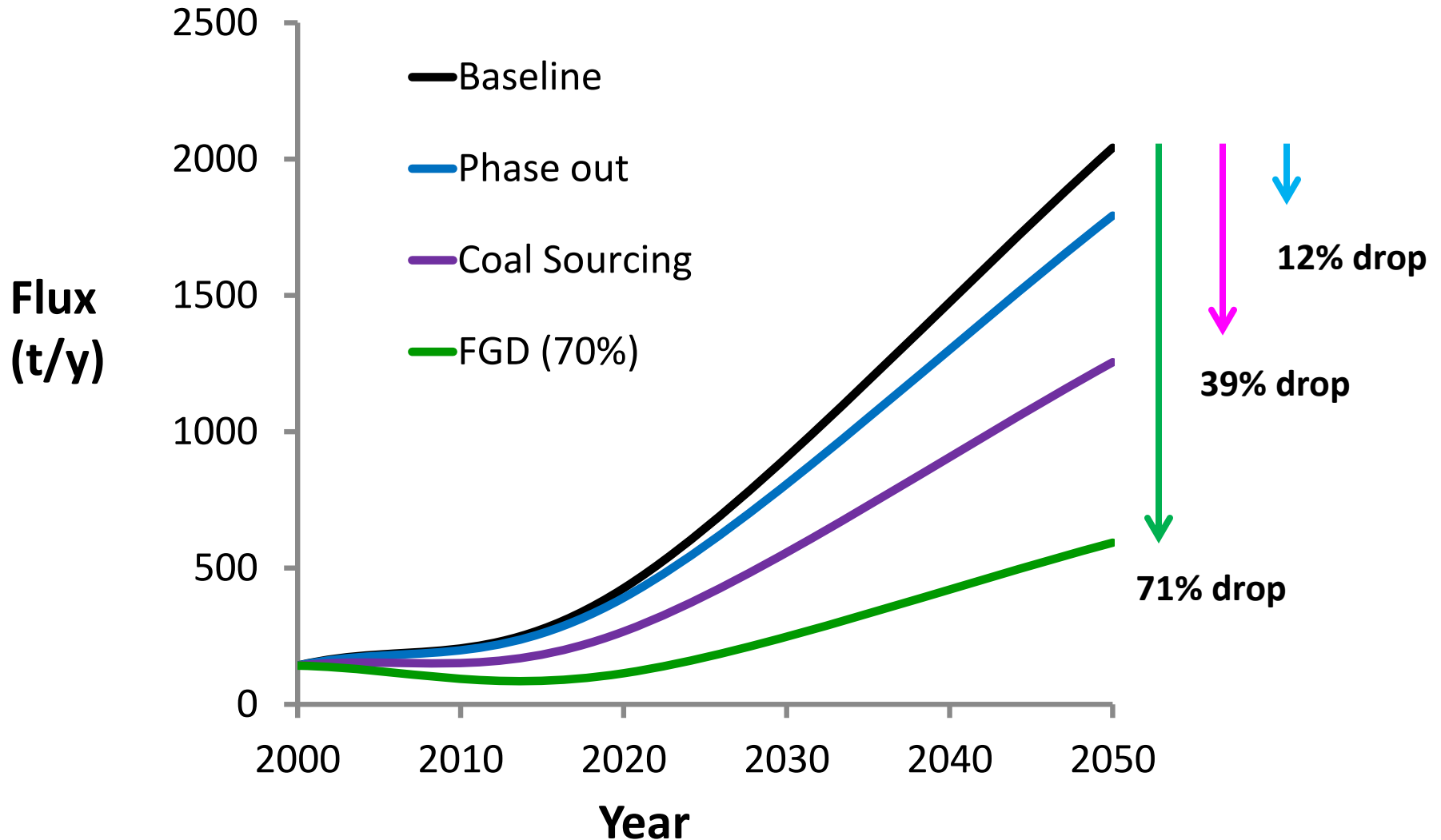


One can:

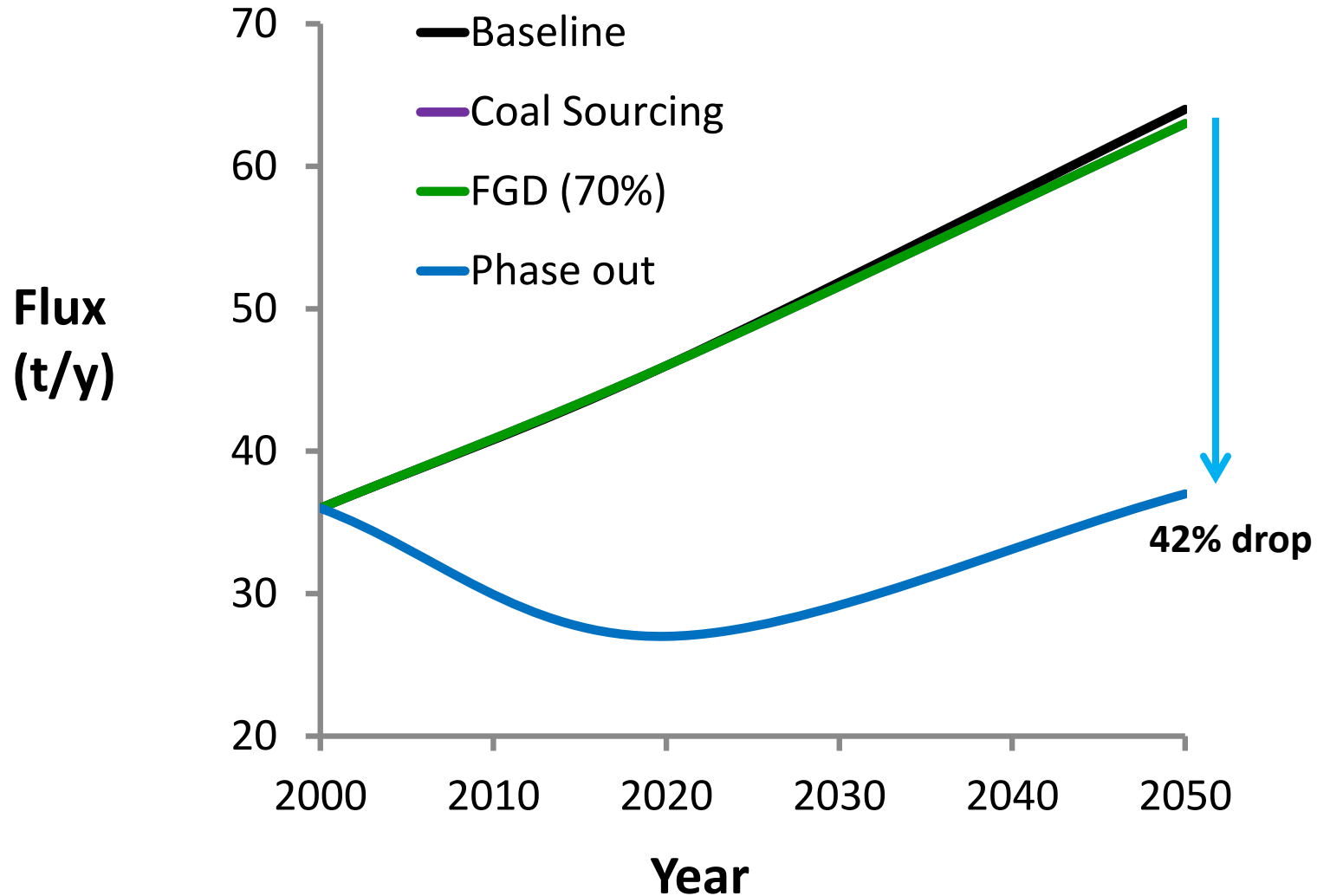
- (1) Evaluate whether anticipated impacts are being observed
- (2) Parameterize model for better prediction
- (3) If (1) and (2) are good, further project future trends

Example of other parameters of interest

Net Hg out of country via atmospheric transport (t/y)



Runoff to oceans (t/y)



Summary

- Modeling allows for understanding of system as a whole
- Allows for projection of trends

Baseline, and Routine field data is necessary to corroborate model and increase their predictive power!

Thank you