1 Table S1: Description of the source regions in Fig. 1.

Acronym	Region	Latitude	Longitude	Notes
ARAB	Arabian Peninsula & surrounding regions	0 to 50ºN	37.5 to 67.5ºE	Southern border includes Horn of Africa to incorporate dust emissions from there that are not found at the same latitude westward (Luo et al., 2008).
ASIA	Asia	10ºS to 30ºN 30 to 50ºN 50 to 90ºN	67.5 to 180ºE 110 to 180ºE 52.5 to 180ºE	Excludes major desert regions.
AUS	Australia and New Zealand	10 to 90ºS	67.5 to 180ºE	Northern limit defined by general model ITCZ location.
CAF	Central Africa	0 to 15ºN	45ºW to 37.5ºE	Northern border separates dust and combustion emission sources.
CEAS	Central Asia	30 to 50ºN	67.5 to 110ºE	Major desert region.
EUR	Europe	30 to 50ºN 50 to 90ºN	45ºW to 37.5ºE 45ºW to 52.5ºE	The border between Europe and Asia is along the Volga River (forested land to the west and shrubland to the east (Loveland et al., 2000)).
NAF	North Africa	15 to 30ºN	45ºW to 37.5ºE	
NAM	North America	0 to 90ºN	45 to 180ºW	The eastern border extends through western Greenland to capture combustion emissions off the east coast of the United States.
SAF	South Africa	0 to 90ºS	30ºW to 67.5ºE	Northern limit defined by general model ITCZ location.
SAM	South America	0 to 90ºS	30 to 180ºW	Northern limit defined by general model ITCZ location.

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Table S2. Dust atmospheric lifetime (days) in BAM-Fe (CAM4) and MIMI (CAM5). Global annual total emissions of dust also shown under model name.

	Dust lifetime /days	
	BAM-Fe (1800 Tg /a)	MIMI (3200 Tg /a)
Fine/Accumulation	10	6.5
Coarse	3.8	2.0
Fine/Accumulation + Coarse	3.9	2.1

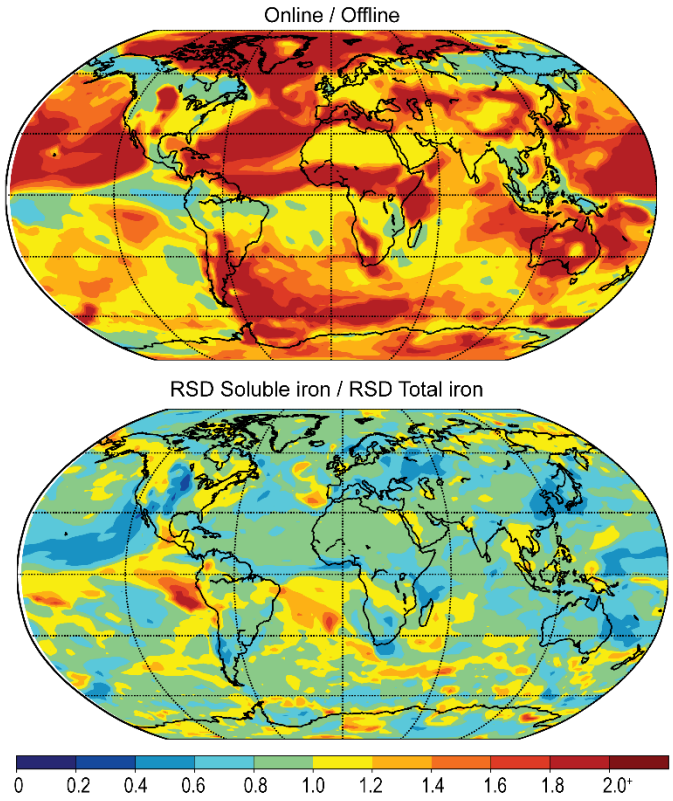


Figure S1. **Top:** Ratio of the online and offline calculation for iron solubility. **Bottom:** Ratio of relative standard deviation (RSD) of soluble and total iron.

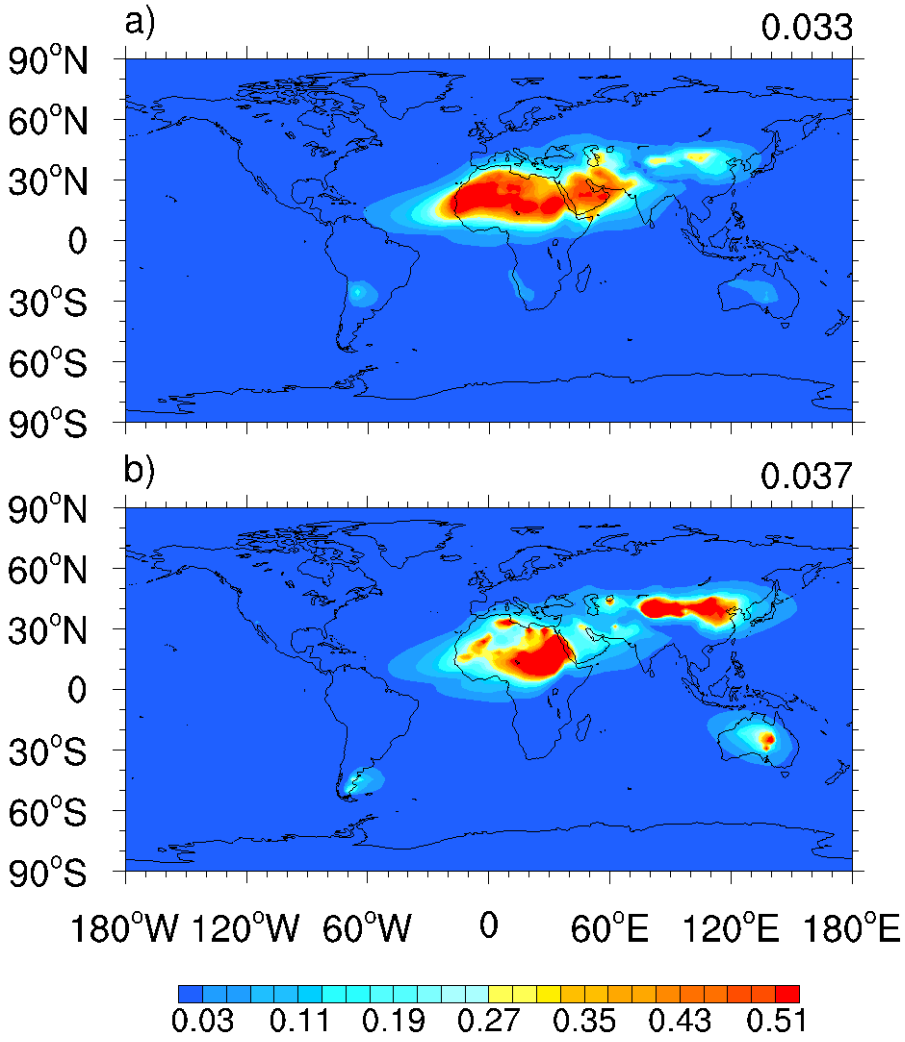
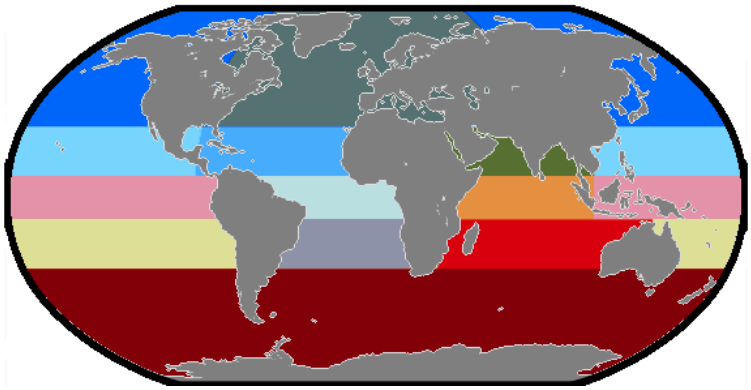


Figure S2. Dust aerosol optical depth within CAM5 MAM4 using the Kok et al. (a), and DEAD (b) schemes. Numbers on the top right of each panel represent the globally means.



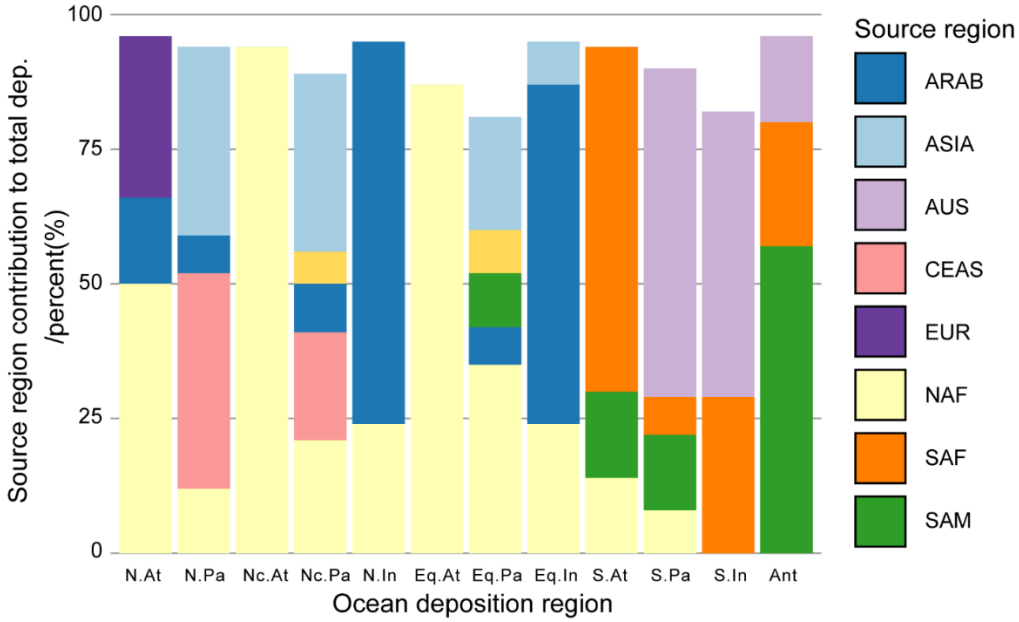
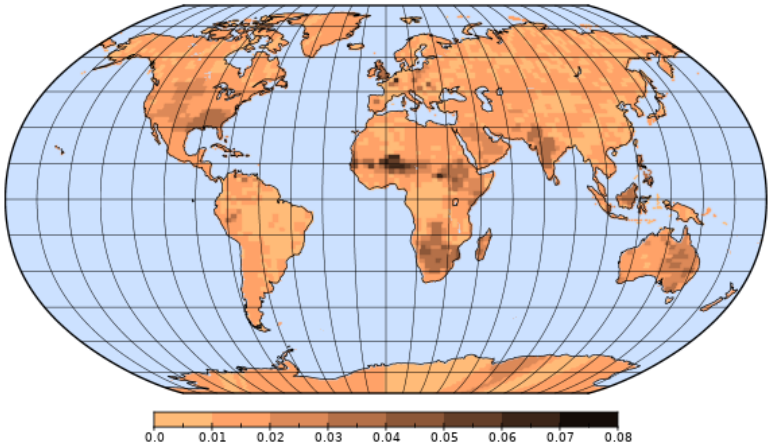


Figure S3. **Top:** Boundary of each ocean regions as defined in Gregg et al. (2003). Note that colours bear no relationship to any other figure. **Bottom:** Contribution of each emission source region (Fig. 1) to the total iron deposition across the region as defined in Gregg et al. (2003). Regions contributing <5% filtered out.



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29 **Figure S4.** Fraction of the soil mineral which is hematite in MIMI**.**

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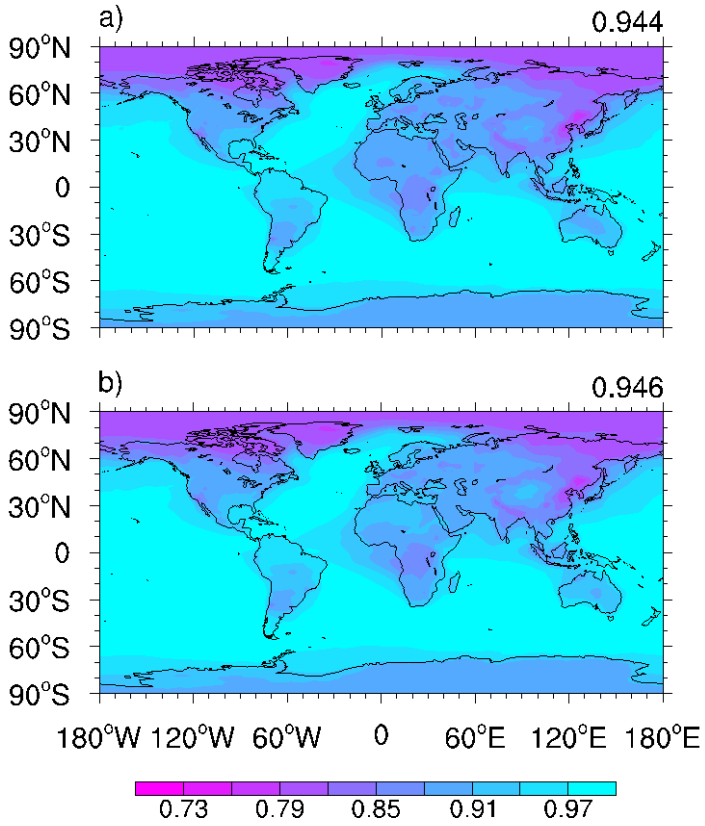

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33 **Figure S5**. Single scattering albedo with hematite from both clay and silt minerals (a), and solely

34 from clay minerals (b). Numbers on the top right of each panel represent the globally means.