Modeling Ocean Atmosphere Exchange:

Ozone & Iodine

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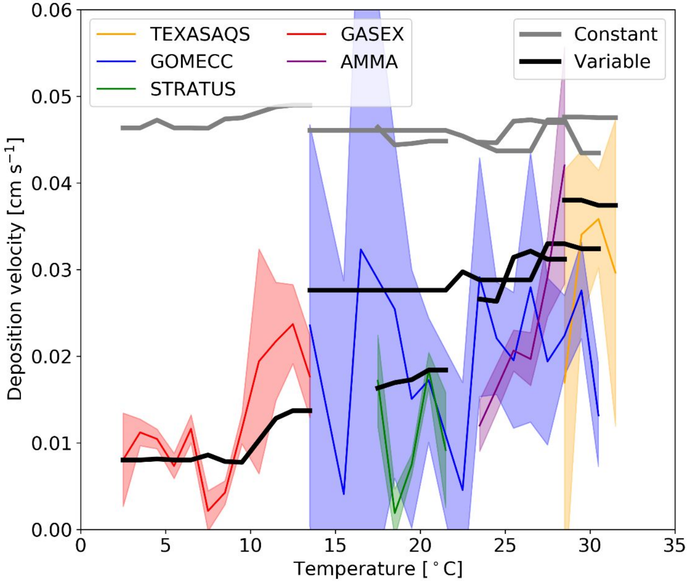
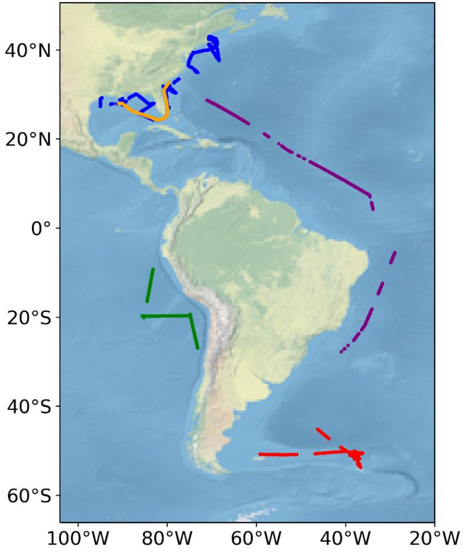
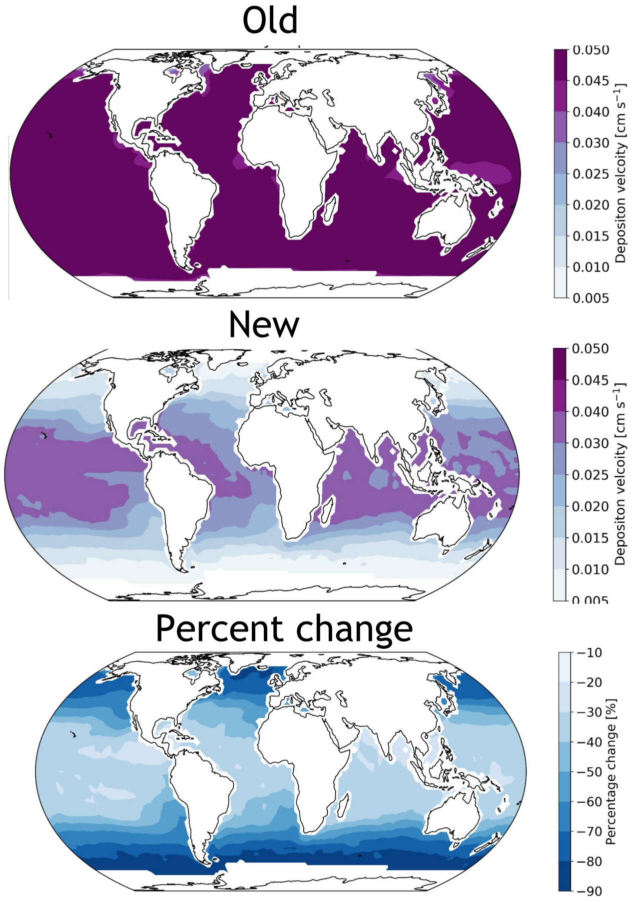
Oceanic O_3 dry deposition



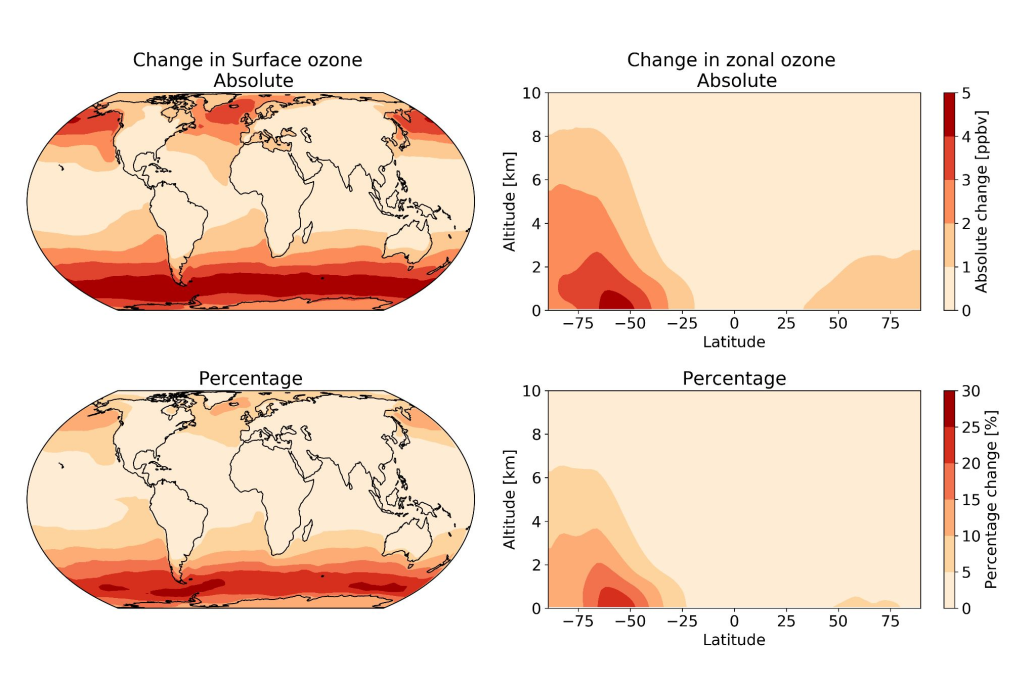




Pound et.al 2020

O_3 dry deposition

More accurate O_3 dry deposition modelling saw increase in Tropospheric O_3



+1.2% tropospheric O_3

(included in iodine's impact)

GEOS-Chem

Pound et.al 2020

Oceanic iodine emissions - current picture

Dependencies on:

- 10m wind speed
- $[I^-]$
- Surface O_3

$$Flux_{HOI} = [O_{3(g)}] * \sqrt{[I^-(aq)]} * \left(\frac{3.56\times10^5}{ws} - 2.16\times10^4 \right)$$

$$Flux_{I_2} = [O_{3(g)}] * [I^-(aq)]^{1.3} * \left(1.74\times10^9 - 6.54\times10^8 * \ln(ws)\right)$$

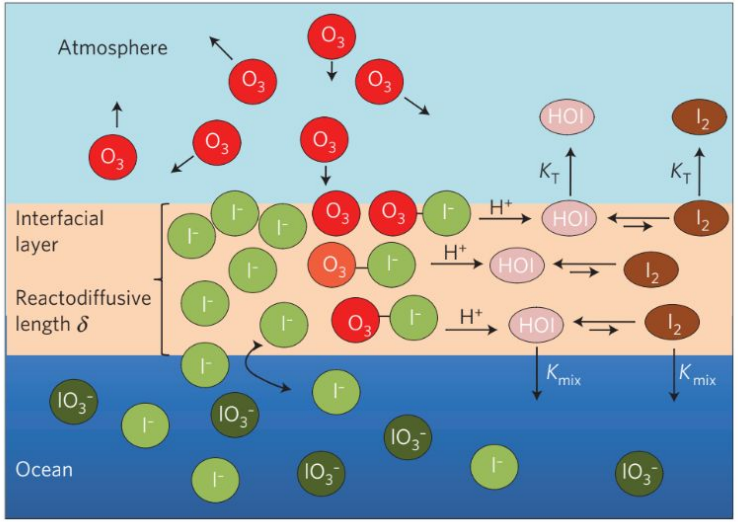
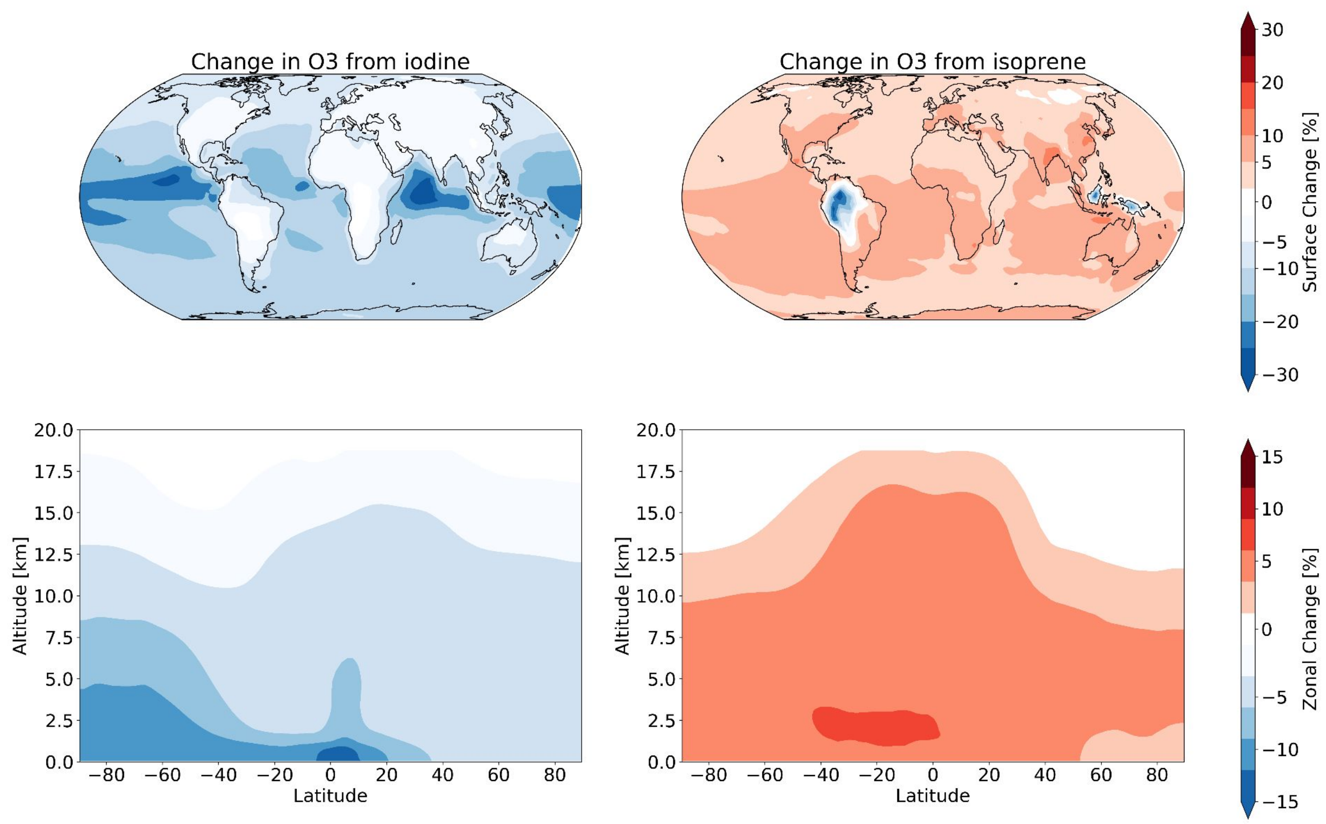


Figure 2 | Schematic of HOI and I_2 production following the reaction of O_3 with I^- at the air–sea interface. Mass transfer from the aqueous to gas phase is denoted by K_T and mixing from the interfacial layer to bulk sea water is denoted by K_{mix}.

Carpenter et.al (2013). Atmospheric iodine levels influenced by sea surface emissions of inorganic iodine. Nature Geoscience, 6 , 108–111

Iodine and tropospheric O_3

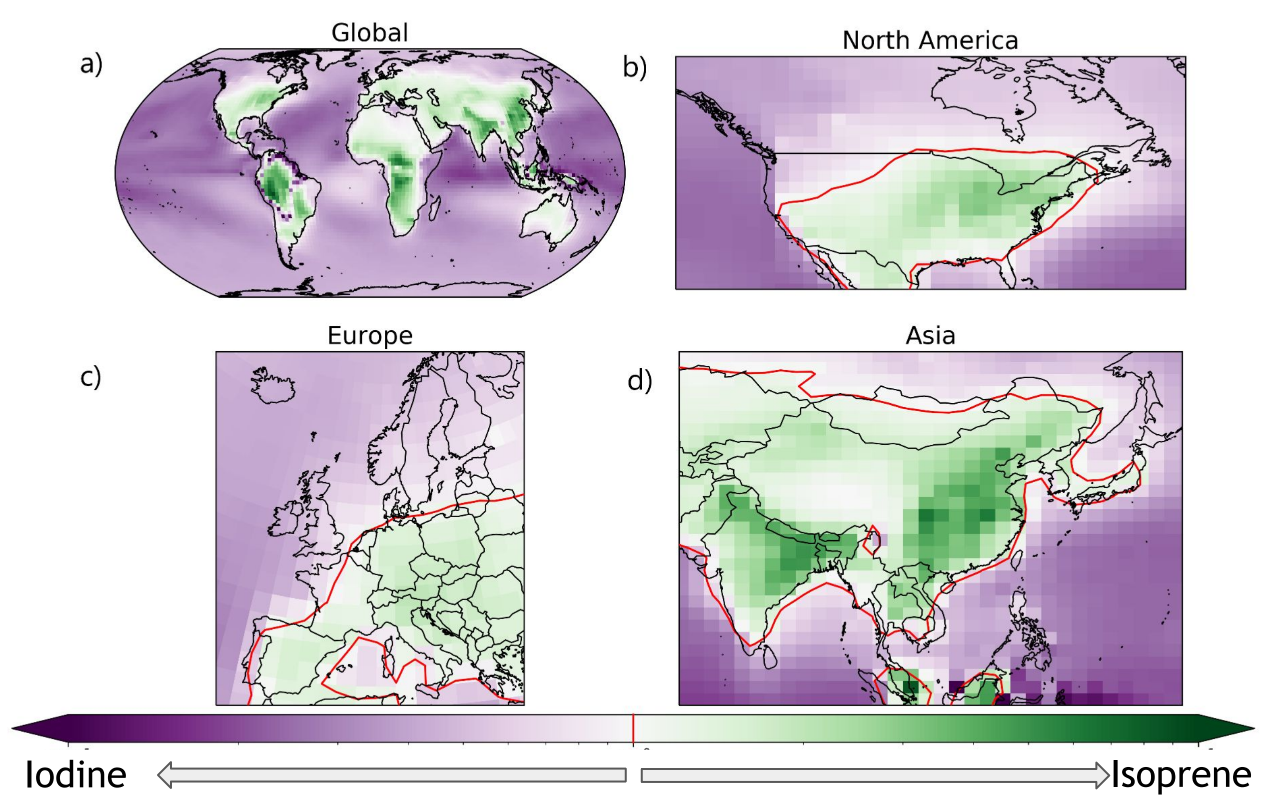


Iodine **-5.7%** tropospheric O_3

Isoprene **+4.4%** tropospheric O_3

Pound et.al 2022 in review

Iodine and tropospheric O_3



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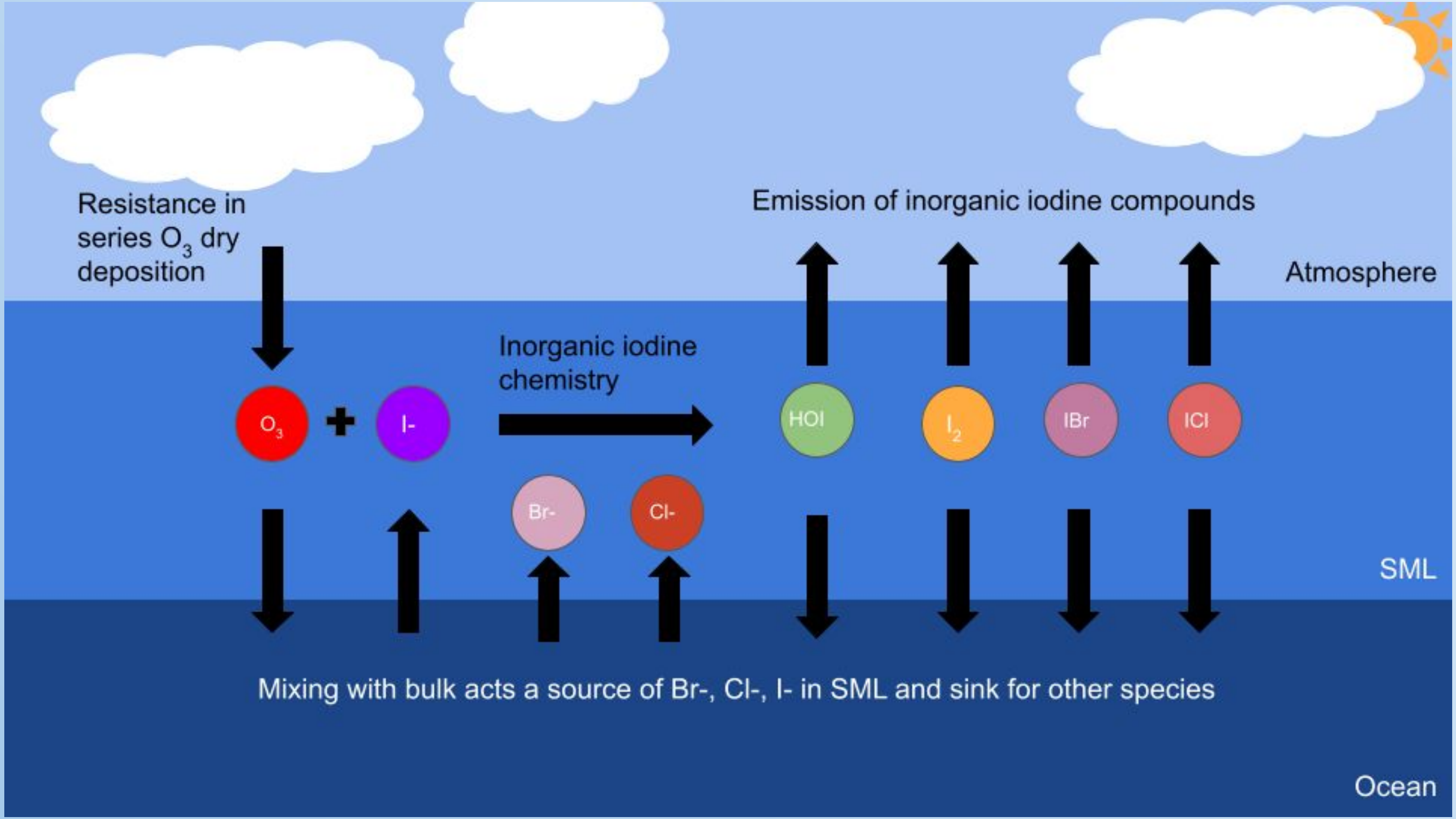
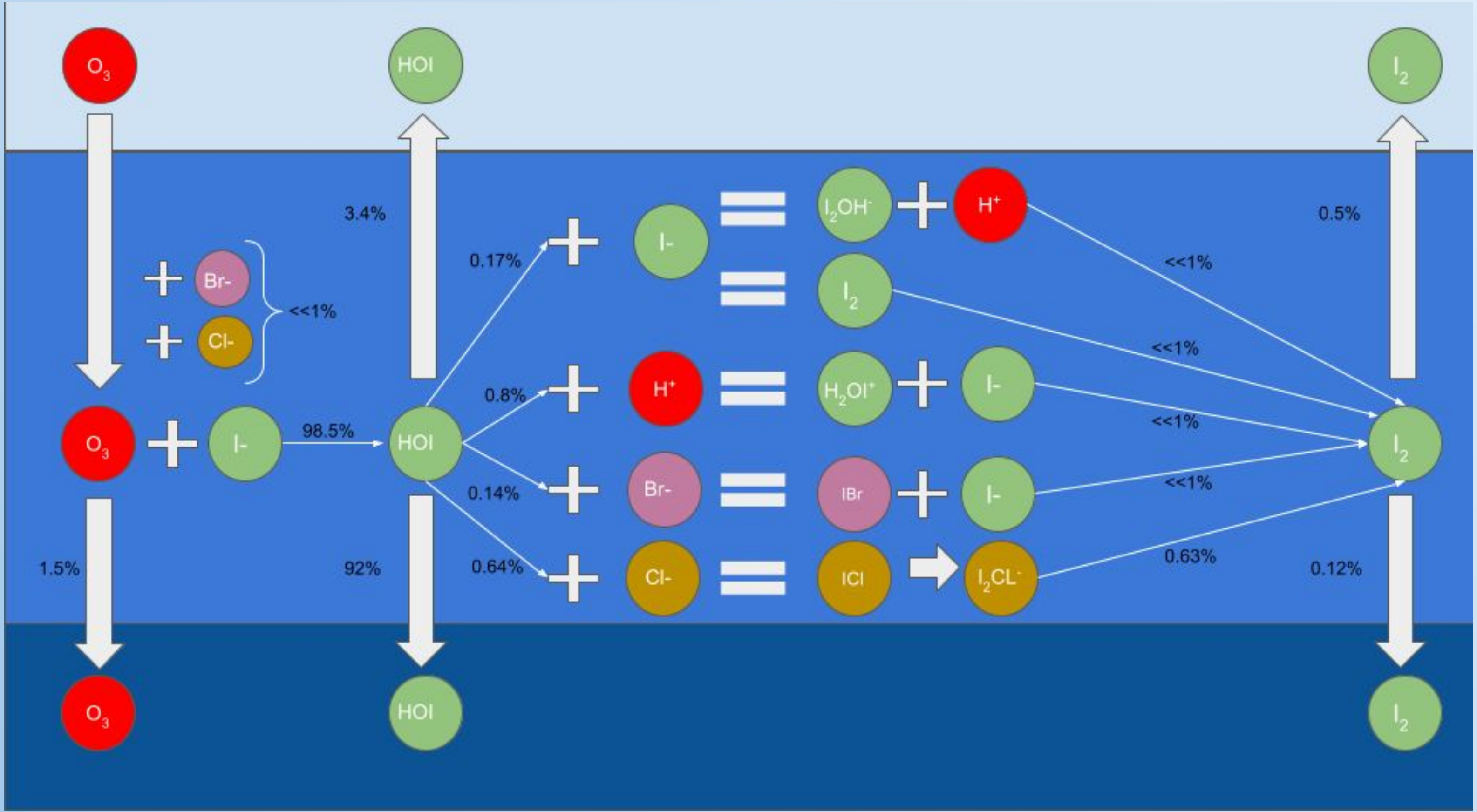
Pound et.al 2022 in review

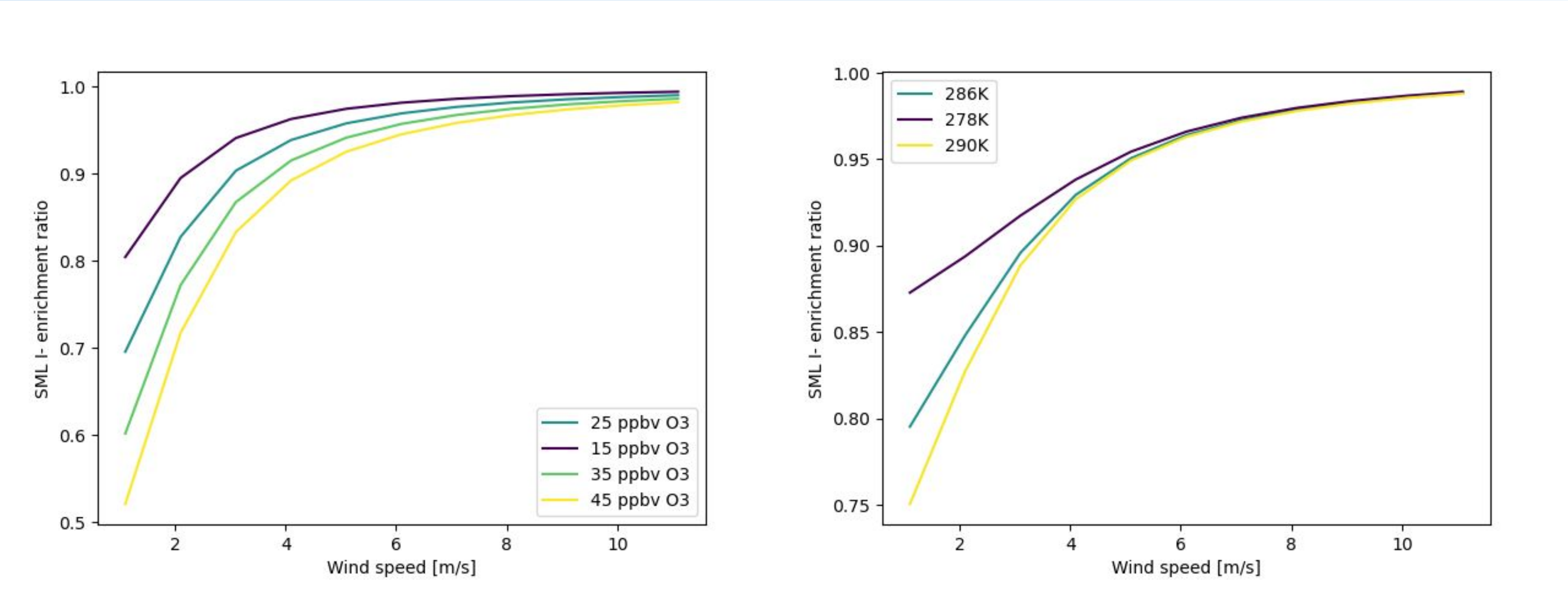
A model of ocean-atmosphere exchange



Overview of SML system



One key result - SML iodide depletion



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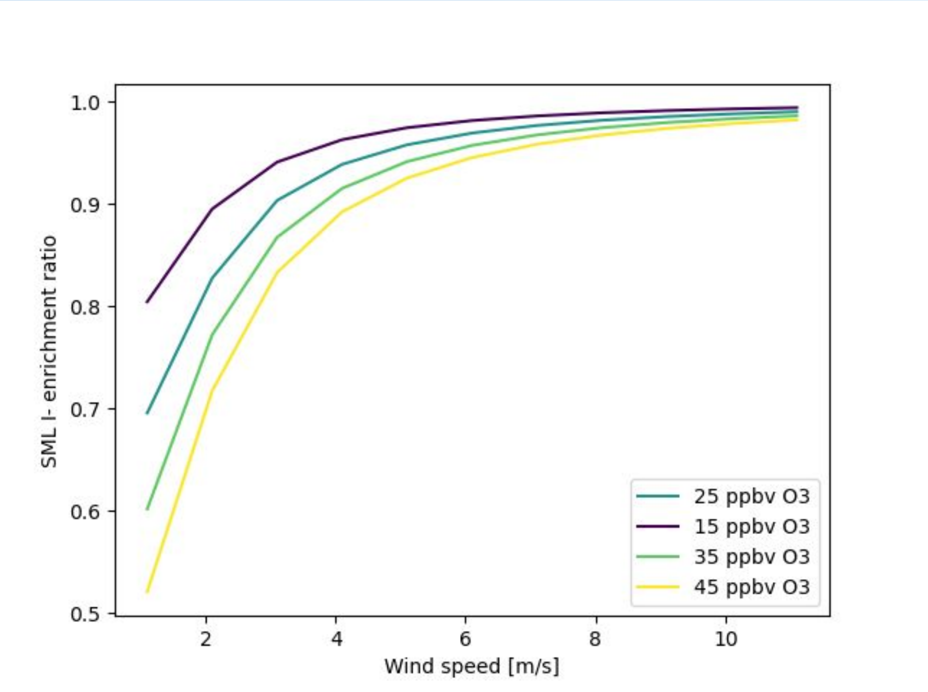
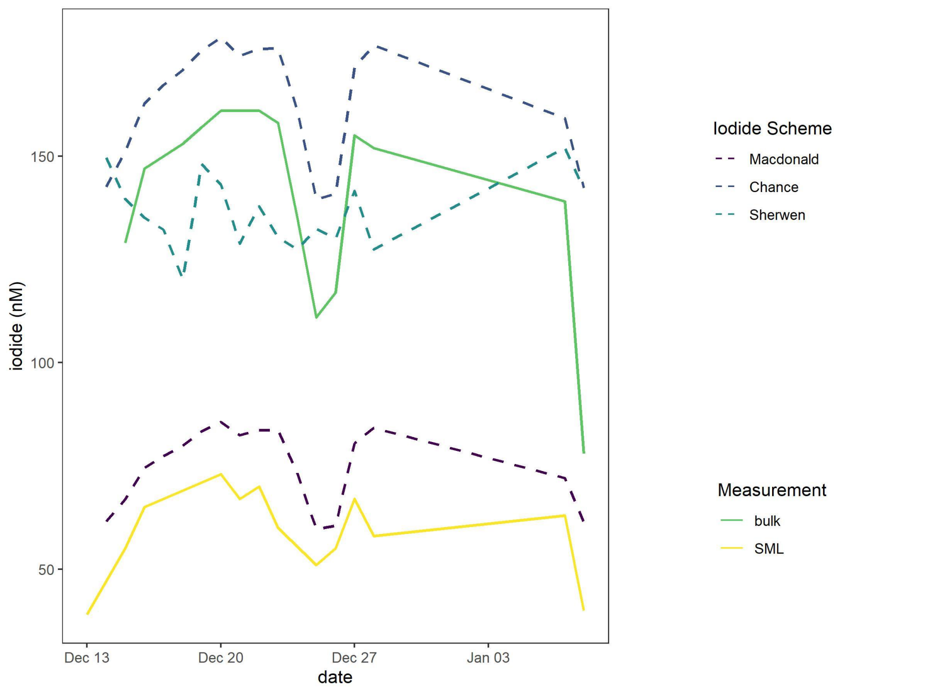
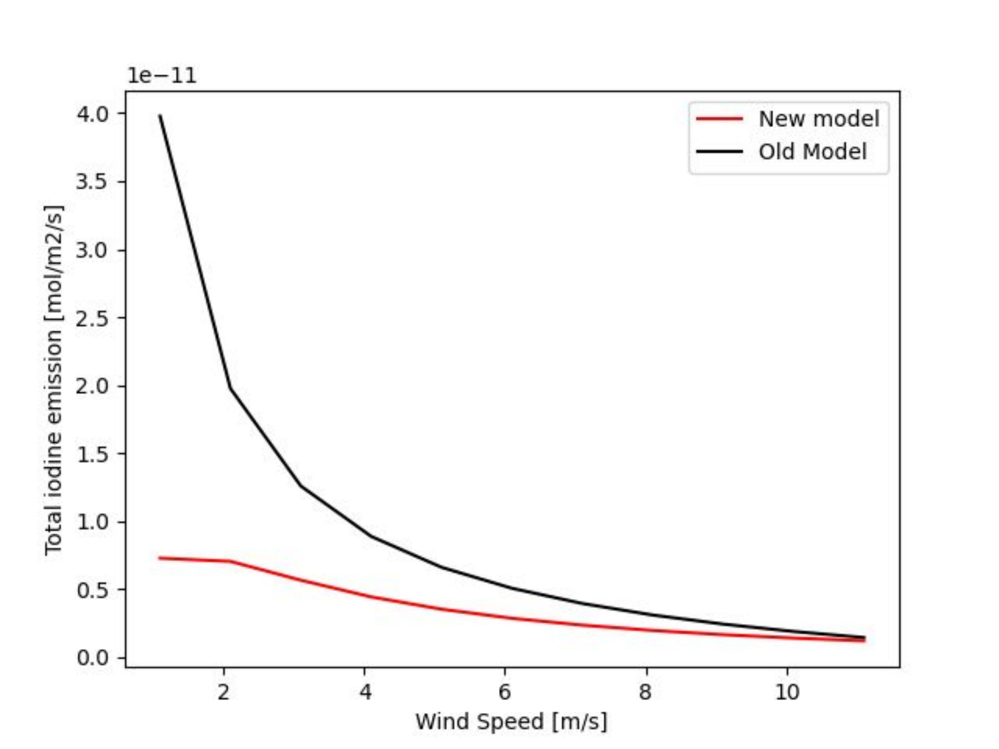




Model comparison



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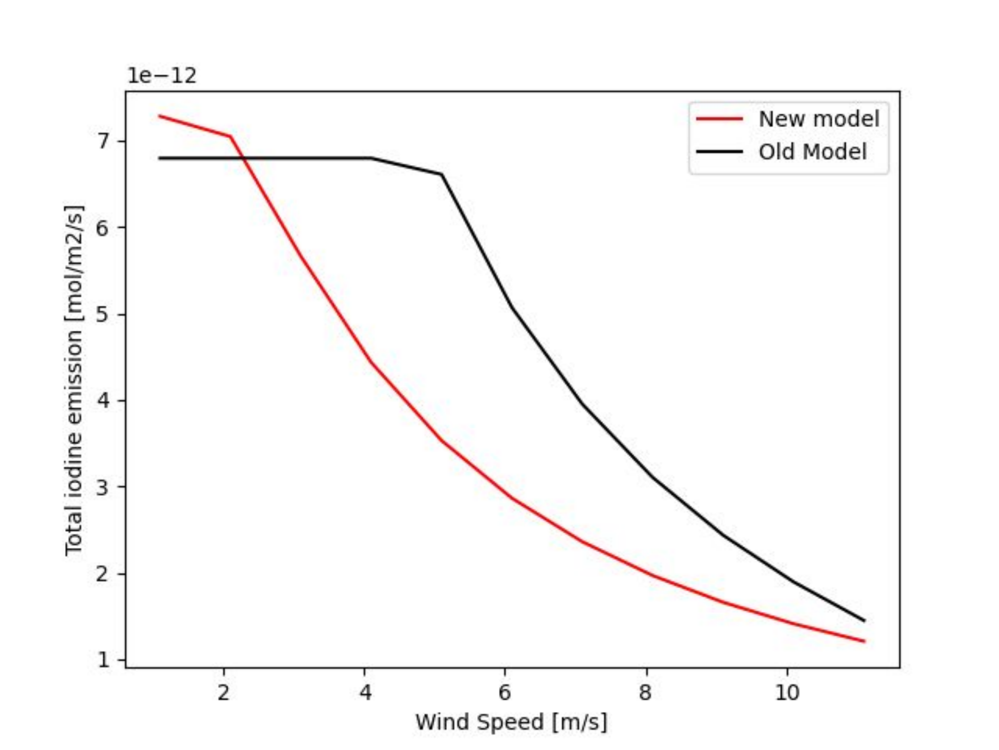

With minimum wind speed of 5 m/s on old model

$$Flux_{HOI} = \left[O_{3(g)}\right] * \sqrt{\left[I^{-}_{(aq)}\right]} * \left(\frac{3.56\times10^{5}}{ws} - 2.16\times10^{4}\right)$$

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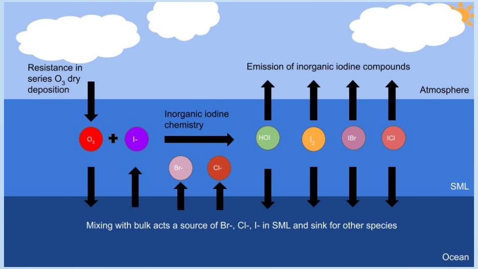
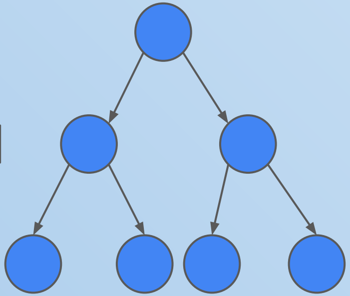
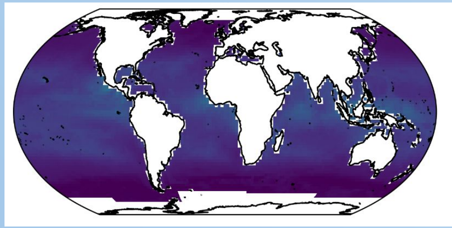
Moving from box to global

$[O_3]$
$[I^-]$
ws
T

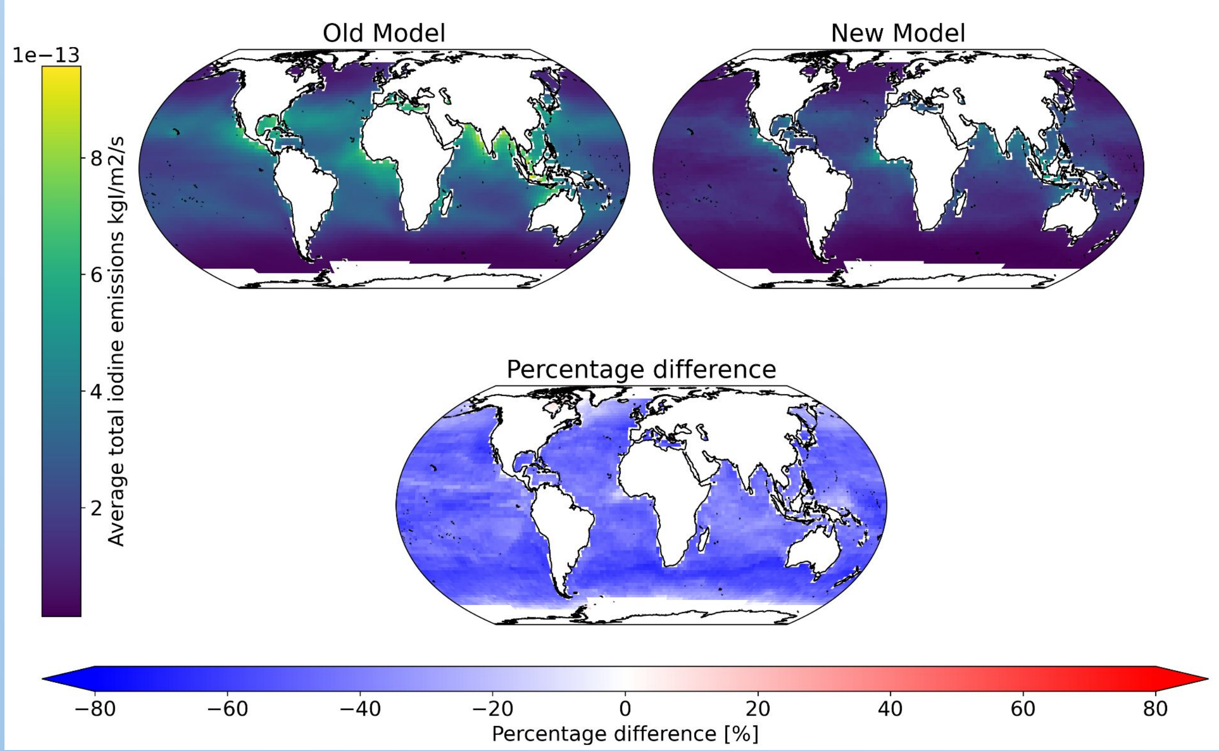




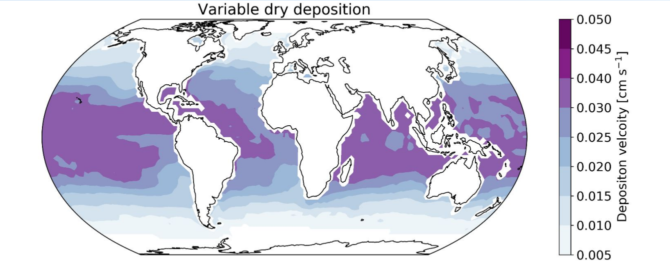


- Sweeping range of $[O_3]$, $[I^-]$, ws & T values
- Use these results to train a Random Forest Regression model
- Use global inputs to predict global emissions

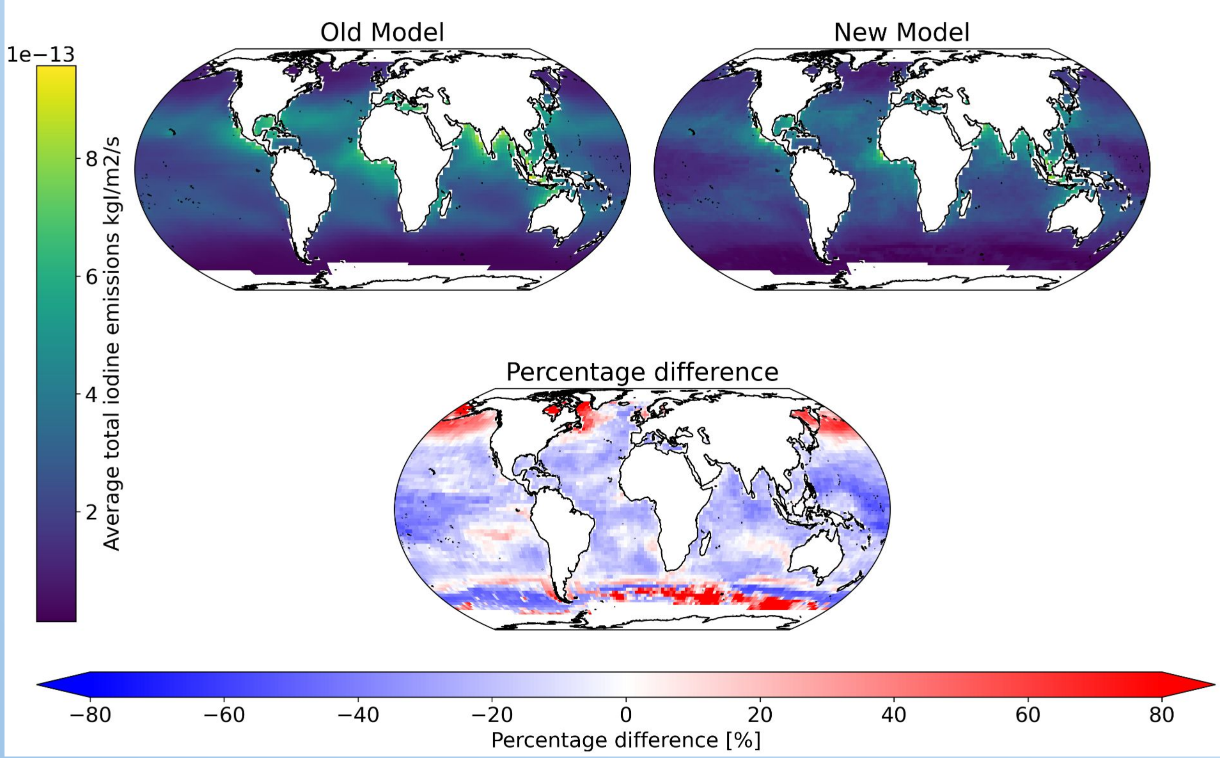
Comparing to current emissions



- Macdonald et.al 2014 iodide
- Global decrease in total inorganic iodine emissions **-43%**
- Different Iodide field to O_3 dry deposition



Comparing to current emissions



- Using Sherwen et.al 2019 iodide (same as O_3 dry deposition)
- Decrease in global total iodine emissions of **-13%**

Summary + future work

- Iodine plays an important role in controlling tropospheric O_3
- Developed a new box model coupling O_3 dry deposition & iodine emissions
- Further input from experimental work + expand to organic reactions
- How much of this detail needs to be in global scale models?

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