Updating ozone deposition to the ocean

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Ozone in the troposphere

Transport from Stratosphere

443 Tg/yr
Ozone in the troposphere

Transport from Stratosphere
443 Tg/yr

Chemical production
4897 Tg/yr

Chemical loss
4529 Tg/yr

Net +368 Tg
Ozone in the troposphere

Transport from Stratosphere
443 Tg/yr

Chemical production
4897 Tg/yr
Net +368 Tg

Chemical loss
4529 Tg/yr

811 Tg/yr
Ozone in the troposphere

Ozone burden: 326 Tg

Transport from Stratosphere
443 Tg/yr

Chemical production
4897 Tg/yr

Chemical loss
4529 Tg/yr

Net +368 Tg

811 Tg/yr
Ozone in the troposphere

Ozone burden: 326 Tg

Transport from Stratosphere
443 Tg/yr

Chemical production
4897 Tg/yr

Chemical loss
4529 Tg/yr

Net +368 Tg

595 Tg/yr
Ozone in the troposphere

Ozone burden: 326 Tg

Transport from Stratosphere
443 Tg/yr

Chemical production
4897 Tg/yr

Chemical loss
4529 Tg/yr

Net +368 Tg

595 Tg/yr

215 Tg/yr
Ozone in the troposphere

Ozone burden: 326 Tg

Transport from Stratosphere
443 Tg/yr

Chemical production
4897 Tg/yr
Chemical loss
4529 Tg/yr
Net +368 Tg

215 Tg/yr

595 Tg/yr
Calculating a deposition velocity

Rate of loss to surface

Meteorology

Laminar flow

Ocean surface

Ocean
Calculating a deposition velocity

Meteorology

Rate of loss to surface

Laminar flow

Constant

Ocean
Model vs Measurements

Helmig et al. 2012
Model vs Measurements

![Graph showing deposition velocity vs temperature for different models: TEXASAQS, STRATUS, GOMECC, GASEX, AMMA. Each model is represented by a different color, and temperature is shown on the x-axis, while deposition velocity is shown on the y-axis.]

Helmig et al. 2012
Model vs Measurements

![Graph showing deposition velocity vs temperature for different models: TEXASQAQS, STRATUS, GOMECC, GASEX, AMMA, and Base. The graph indicates variations in deposition velocity across different temperature ranges.]

Helmig et al. 2012
Ocean surface uptake - New

Garland et al. 1980
Fairall et al. 2007
Luhar et al. 2017, 2018

Surface Microlayer

Turbulent Surface Layer

‘Bulk’ Ocean

~ micrometers

~ millimeters

~ meters
Ocean surface uptake - New

Surface resistance to dry deposition

\[ v_{dw} = (a D)^{1/2} \left[ \frac{\psi K_1(\xi_\delta) \cosh(\lambda) + K_0(\xi_\delta) \sinh(\lambda)}{\psi K_1(\xi_\delta) \sinh(\lambda) + K_0(\xi_\delta) \cosh(\lambda)} \right] \]
Ocean surface uptake - New

Surface resistance to dry deposition

\[ v_{dw} = (\alpha D)^{1/2} \left[ \frac{\psi K_1(\xi_\delta)\cosh(\lambda) + K_0(\xi_\delta)\sinh(\lambda)}{\psi K_1(\xi_\delta)\sinh(\lambda) + K_0(\xi_\delta)\cosh(\lambda)} \right] \]

Rate of ozone reaction with iodide

Luhar et al.
2018
Ocean surface uptake - New

Surface resistance to dry deposition

Diffusion of ozone in water

Rate of ozone reaction with iodide

\[ v_{dw} = (aD)^{1/2} \left[ \frac{\psi K_1 (\xi_\delta) \cosh(\lambda) + K_0 (\xi_\delta) \sinh(\lambda)}{\psi K_1 (\xi_\delta) \sinh(\lambda) + K_0 (\xi_\delta) \cosh(\lambda)} \right] \]

Luhar et al.
2018
Ocean surface uptake - New

Surface resistance to dry deposition

Diffusion of ozone in water

Rate of ozone reaction with iodide

Wind

Depth of surface layer

\[ v_{dw} = (a D)^{1/2} \left[ \frac{\psi K_1(\xi_\delta) \cosh(\lambda) + K_0(\xi_\delta) \sinh(\lambda)}{\psi K_1(\xi_\delta) \sinh(\lambda) + K_0(\xi_\delta) \cosh(\lambda)} \right] \]

Luhar et al. 2018
Ocean surface uptake - New

Sea-surface iodide concentration

See Tomás' poster (B13, Poster Session B, 4:30-6:30)
Global Ozone deposition to Ocean
Global Ozone deposition to Ocean
Model vs Measurements

Helmig et al. 2012
Model vs Measurements

[Helmig et al. 2012]
Changes in annual mean surface ozone
Changes in annual mean zonal ozone
Comparisons to GAW sites
Comparisons to GAW sites

Mace Head - Ireland

Surface Ozone (ppb)

Month of year

Ozone Change [%]
Comparisons to GAW sites

Trinidad Head - California

[Graph showing observed and predicted ozone levels compared to actual data.]
Comparisons to GAW sites
Comparisons to GAW sites
Comparisons to GAW sites
Comparisons to GAW sites
Ozone in the troposphere - before

Transport from Stratosphere

443 Tg/yr

Chemical production
4897 Tg/yr

Chemical loss
4529 Tg/yr

Net +368 Tg

In troposphere: 326 Tg

215 Tg/yr

590 Tg/yr
Ozone in the troposphere - after

Transport from Stratosphere:
- Transport from Stratosphere: 442 Tg/yr
- Chemical production: 4864 Tg/yr
- Chemical loss: 4589 Tg/yr
- Net: +275 Tg - 93 Tg

Net +275 Tg - 93 Tg

In troposphere:
- In troposphere: 330 Tg + 4 Tg
- 125 Tg/yr
- -90 Tg/yr

595 Tg/yr
- +5 Tg/yr