中文題目：北印度洋中人為的氮輸入及其對海洋中一氧化二氮通量的影響：
結合觀測與模式方法的必要性
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## Abstract

Anthropogenically-derived nitrogen input to the northern Indian Ocean has increased significantly in recent decades, based on both observational and model-derived estimates. This external nutrient source is supplied by atmospheric deposition and riverine fluxes, and has the potential to affect the vulnerable biogeochemical systems of the Arabian Sea and Bay of Bengal, influencing productivity and oceanic production of the greenhouse gas nitrous-oxide ($N_2O$). We summarize current estimates of this external nitrogen source to the northern Indian Ocean from observations and models, highlight implications for regional marine $N_2O$ emissions using model based analyses, and make recommendations for measurement and model needs to improve current estimates and future predictions of this impact. Current observationally-derived estimates of deposition and riverine nitrogen inputs are limited by sparse measurements and uncertainties on accurate characterization of nitrogen species composition. Ocean model assessments of the impact of external nitrogen sources on regional marine $N_2O$ production in the northern Indian Ocean estimate potentially significant changes but also have large associated uncertainties. We recommend an integrated program of basin-wide measurements combined with high-resolution modeling and more detailed characterization of nitrogen-cycle process to address these uncertainties and improve current estimates and predictions.

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## 專題討論

## 摘要

根據近幾十年來通過量測和模式所估算得出的資料，得知北印度洋中人為氮源輸入量明顯增加。此海域的氮源輸入量主要是由大氣沉降和河流輸入所提供的，並且有可能影響阿拉伯海和孟加拉灣脆弱的生地化系統，進而影響溫室效應氣體——一氧化二氮（N$_2$O）的產生。此研究整合了目前的量測資料，並以模式估算出北印度洋外部的氮源輸入量，強調該海域 N$_2$O 的排放量應該應用不一樣的模式分析，並結合測量和模型資料的需求提出建議以改善模式的準確度，使模式對未來的預測估算更為精準。目前量測得出的大氣沉降和河流氮的輸入量，受到測量數據缺乏和氮物質組成不確定性的限制。以修正後的區域性海洋模式評估，得出外部氮源對北印度洋一氧化二氮產量有重大的的影響，且其不確定性也很大。我們建議成立一個綜和的計劃，測量全流域範圍並將其資料納入高解析度的模式，以對氮循環過程進行更詳細的探討，描述當前的不確定性和改善估計和預測。

## 參考資料

Parvadha Suntharalingam et al. (2019) "Anthropogenic nitrogen inputs and impacts on oceanic N$_2$O fluxes in the northern Indian Ocean: The need for an integrated observation and modelling approach" Deep Sea Research Part II: Topical Studies in Oceanography Volume 166, August 2019, Pages 104-113