# BUOYANT FLAKE EXPERIMENT – Minicoy Island, India

## Introduction

This is the initial draft of a scientific experimental outline designed to establish whether buoyant flakes, carrying ultra-slow release nutrient minerals, can produce results that may be useful in addressing the environmental threats of global warming, ocean acidification, and food security.

The proposed graduated progression of experiments takes advantage of several previously under-appreciated concepts:

* That ocean fertilisation may be done using natural or waste products, similar in content to those that have safely fertilised the oceans by wind-blown dust for millennia;
* That nutrients held, and slowly released at the lighted ocean surface, are far more effective at developing a productive and balanced marine ecology than are nutrients that dissolve fast and sink rapidly away into the dark depths, largely unused;
* That surface waters, stratified either by temperature or salinity, are likely to become deficient in one or more essential nutrients;
* That heavy monsoon rainfall, as well as intense tropical sunlight, can produce such unproductive stratification;
* That some of the most productive diazotrophs (nitrogen-fixing organisms), such as *Trichodesmium* species, float on the ocean surface;
* That the ocean currents that run up and down India’s West coast reverse themselves seasonally;
* That the high seas of the Indian Ocean are some of the most nutrient-deficient in the global ocean, and that the well-offshore waters of India’s West coast are principally deficient in reactive nitrogen, iron, silica and phosphate, together with several other nutrients and trace elements; and
* That phytoplankton have a major effect upon the albedo (reflectiveness) of both the ocean surface and of the marine clouds nucleated and brightened (MCB) by the phytolanktonic emission of dimethyl sulphide (DMS), and hence upon the oceanic evaporation rate and upon both sea surface (SST) and global temperatures.

## Discussion

The Indian National Oceanography Institute (NOI), located in Goa halfway up India’s West coast, is both capable and supremely well-placed to conduct scientific experiments using buoyant flakes composed of rice husks, lignin glue and minerals. Due to the seasonal current reversal there, such experiments might be conducted entirely within India’s jurisdictional waters. Should initially small (less than a square kilometre), fortnightly disseminations of sparsely-distributed flakes covering <0.2% of ocean site surface, be made near to Minicoy Island at an appropriate time, then the separate disseminations could probably each be readily monitored by observation, beacon and sensor as they floated, in an expanding barcode array, offshore some 300km, both up and down the coastline over a total distance of some 2,000km, and over a duration of some months. Following results’ analyses of prior disseminations, each new dissemination might be of somewhat wider extent and/or greater flake concentration. Such a cautiously graduated series of experiments could be suspended at any point, or continued when the recent experimental outcomes warranted it.

## Objectives

Several objectives might be achieved by such experimentation. These might include:

* The determination and improvement of flake buoyancy and longevity
* The ease of flake plume trackability and morphological evolution
* The rates at which, and methods by which, nutrients are extracted from the flakes
* Flake colonisation and utilisation
* The effects of various degrees of flake-based supplementary nutrition on marine life, biodiversity and evolving surface water ecologies
* The effects of additional carbon biosequestration on pH and oxygenation in the photic water column
* The extent to which flake-enriched plumes attract pelagic marine life
* The degree and duration of ocean surface albedo effects
* The degree, if any, by which flakes and flake-induced populations affect temperatures in the photic water column.

What such limited-scale experiments are unlikely to determine are:

* The additional deep carbon flux caused by flake nutrients
* The additional amount of resulting marine biomass by species
* The extent of the reduction in global warming and extreme weather events caused by the increased oceanic and marine cloud albedos
* The smoothed change in rainfall patterns downwind caused by flake-induced evaporative and DMS concentration changes
* The effects upon the non-photic water column of flake-based nutrition.

## Strategy

Due to the topic’s history and sensitivity, some confirmatory laboratory, Earth Systems modelling, and flake formulation work is desirable to establish a modest scientific footing for the concept before going public beyond the authorities and scientists directly involved. Once this work indicates the likelihood of effectiveness, timeliness, acceptably-graduated risk and potential rewards, then the necessary levels of support, collaboration and social licence can be sought. It will be highly desirable to achieve support from Indian and UN policy-makers, both before and at the Paris Conference of Parties in December 2015.