Cumulus and Aerosol Semi-Direct Effects (CASE):
An exploration of atmospheric dynamics, clouds and aerosols over the Tropical Indian Ocean

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Likely: Herman Bange & Christa Marandino (GEOMAR, Helmholtz, Germany)

Proposed Time: Start Date March/April of 2016/2017 for one year

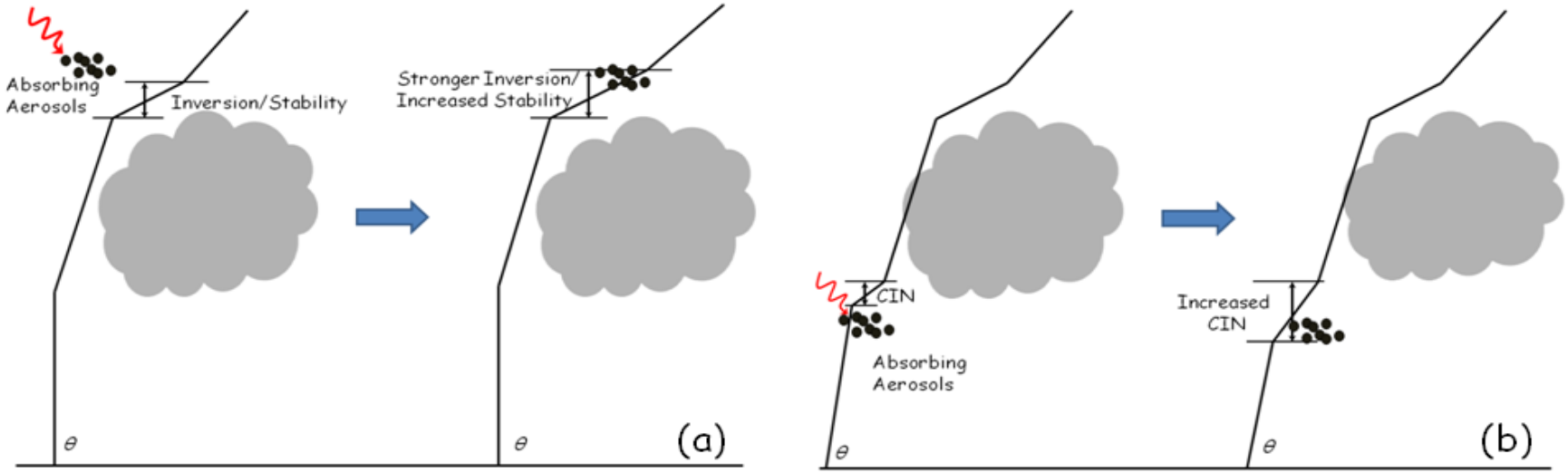
Objectives and Goals

Goal: The primary goal of the project is *to evaluate the semi-direct effects of aerosols on the trade-wind cumulus cloud systems that are abundant over the tropical Indian Ocean*.

The experiment will test the following hypotheses:

- That the spatio-temporal distribution of aerosols influence cloud liquid water content, radiative properties, and lifecycle of low level clouds
- That the absorbing /scattering aerosols perturb the surface energy and moist exchange rates
- That the changes in the surface energy and moisture budgets alter the vertical mixing rates and the planetary boundary layer heights
- That the changes in PBL height influence the formation and lifecycle of low-level clouds.

Semi – Direct Effects



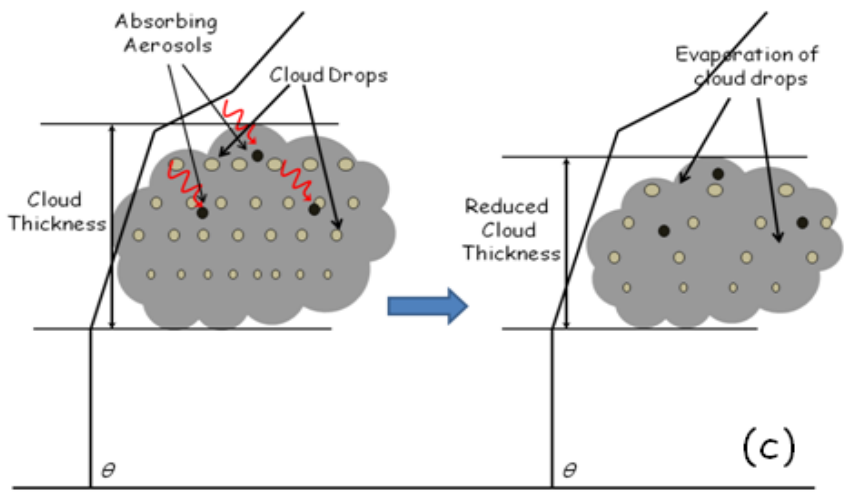
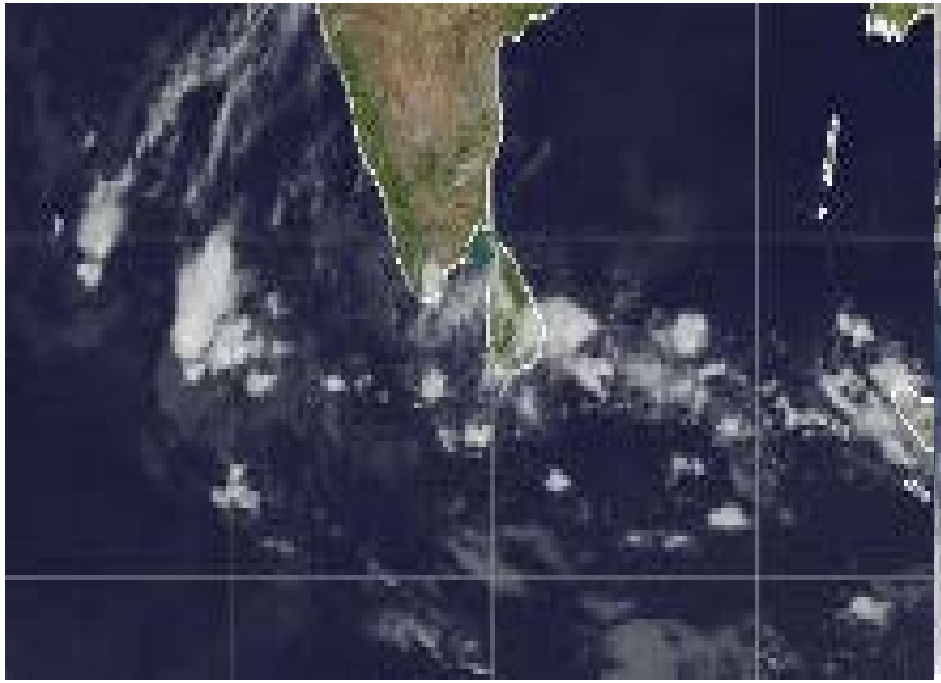


Fig 3: Schematic showing the hypothesized (a) Impact of absorbing aerosols on boundary layer inversion; (b) Impact of absorbing aerosols on Covective Inhibition (CIN); (c) Impact of absorbing aerosols on cloud size and drops.

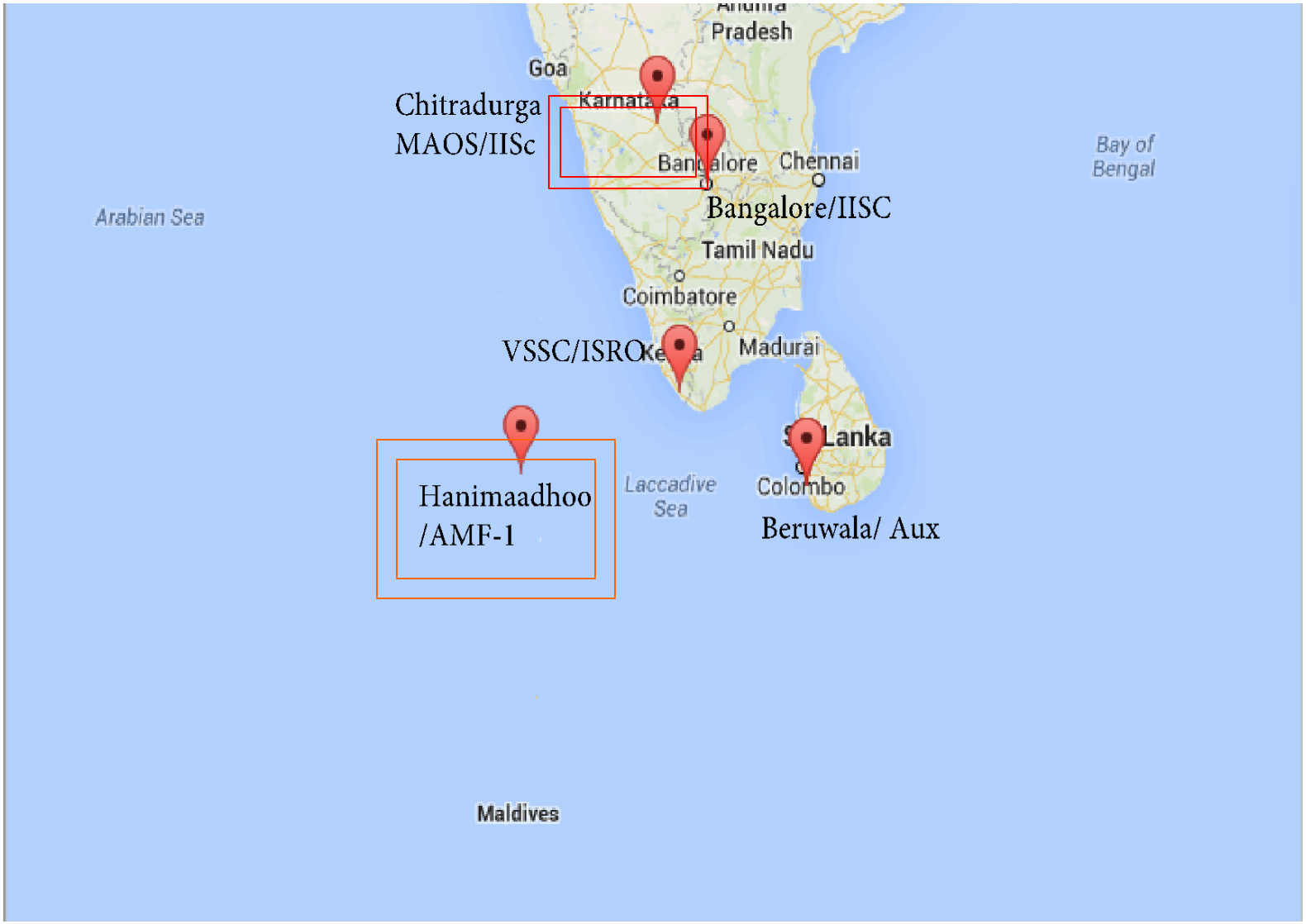
Clouds and Aerosols over the Northern Indian Ocean



Low Level Clouds

Aerosols

Location


Pradesh
Goa
Chitradurga
MAOS/IISc
Chennai
Bay of
Bengal
Arabian Sea
Bangalore/IISC
Tamil Nadu
Coimbatore
Madurai
VSSC/ISRO
Lanka
Hanimaadhoo
/AMF-1
Laccadive
Sea
Colombo
Beruwala/ Aux
Maldives

Sites and Resources

- **MAOS at a site in Southern India (Chitradurga, India)**
- **AMF-1 remote sensing and cloud observing capabilities at Northern Maldives (Hanimaadhoo, Maldives). AMF-1 for deployment in Maldives with specific emphasis on the AOS, cloud radars, water vapor profiling, aerosol vertical characterization using MPL and HSRL (from AMF-2), and instrumentation to measure energy, radiation and moisture budgets**
- limited deployment of meteorological, cloud and aerosol measurements at an auxiliary site located in Sri Lanka (Beruwala), where one of our Co-I's (Prof. Joe Fernando) is operating a site (**most likely funded by Navy**)
- Site at VSSC, Trivandrum, India. This is already operational and **funded by ISRO, India.** Need to agree on a data sharing protocol (**No ARM funding)**
- Auxiliary site in Bangalore, India (Operated by **IISc and funded by DST, India**)

ASIRI – Fluxes, Waves and Energy Budgets (Sponsored by Naval Research Laboratory - NRL)

Measurements at one to three locations:

Suggested sites are: light houses, towers, and atolls off the coast (e.g. Pigeon Island off Trinco and Great Bases Light house off Yala National Park)

Potential Collaborations

- Prof. Dr. Christa Marandino (marine biogeochemistry) at GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany has conducted an OASIS study (**O**rg**A**nic very short-lived **S**ubstances (VSLS) and their air/sea exchange from the **I**ndian Ocean to the **S**tratosphere) in 2013.
- Herman Bange & Christa Marandino of GEOMAR are planning another study funded by EU and expressed interest in collaborating
- The surface site at Maldives will be co-located at the MCOH (Maldives Climate Observatory at Hanimaadhoo) operated by Orjan Gustafsson (Stockholm University, Sweden) and Prof. Satheesh (IISc) (funded by Swedish Government and ISRO India)
- Naval Research laboratory most likely will continue funding for another three years the site in Sri Lanka and make flux measurements over the ocean around Sri Lanka and South using RV Roger Revelle.
- This study named ASIRI- RAWI is now operational. Indian and Sri Lankan scientists working on RV Roger Revells making flux measurements and they have installed about 30 deep water buoys east of Sri Lanka in deep water.
- International Indian Ocean Expedition, sponsored by WMO has just launched a five year study in this region.

Welcome Other Ideas, Collaborations and Suggestions

- Aircraft G-1?
- Ramanathan has a few UAV's (needs a pilot)
- NSF interest ?
- NASA will be in Korea, 2016
- NCAR also will be in Korea in 2016
- Collaboration with Navy

Ram's UAV