Review:

HARIMAU Radar-Profiler Network over the Indonesian Maritime Continent: A GEOSS Early Achievement for Hydrological Cycle and Disaster Prevention

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The Hydrometeorological ARray for Isv-Monsoon AUtomonitoring (HARIMAU), a 5-year project under the Japan EOS Promotion Program (JEPP) contributing to the Global Earth Observation System of Systems (GEOSS), has begun in 2005 to set up a radar-profiler network for observing the world's most active convective activities over the Indonesian Maritime Continent (IMC). Rainfall and wind distributions are displayed in nearly real time on the internet. Both scientific understanding and practical concepts on intraseasonal variations (ISVs) interacting with larger (seasonal and interannual) and smaller (diurnal or local) scale phenomena will be established. These are expected to contribute greatly and directly to climatic disaster prevention over the IMC and to global climate change assessment through studies on the global effects of the IMC-induced variations such as El Niño, and through construction of the first climatic database over the IMC.

Keywords: meteorological disaster, maritime continent, radar network, wind profiler, GEOSS

1. Introduction

The Indonesian Archipelago, produced by tectonic activity or continental movement some 20 million years ago, continues to play the role of a "dam" across global ocean circulation flowing from the Pacific Ocean to the Indian Ocean, which interacts with a quasi-periodic change in global climate called glacial and inter-glacier periods. Such a changing climate compelled human beings to repeat evolutions and exterminations in the struggle against natural disasters and environmental change. In a glacier period the western part of the present Indonesian Archipelago was a true continent called Sundaland, in which our distant relative homo erectus (pithecanthropus, lived originally in Africa) established a major colony approximately a million years ago and survived until its extermination around 600,000 years ago, caused probably due to climatic changes.

In an inter-glacier period such as the last 10,000 years, the continent becomes a complex of large islands and inland seas called the Indonesian maritime continent (IMC) [1]. Very warm sea water in and around the IMC induces very intense convective activities playing the role of a major heat source driving atmospheric circulation [2, 3]. Atmosphere-ocean interactions near the IMC also generate interannual global climate variations such as the El Niño-southern oscillation (ENSO) [2, 4] and the Indian Ocean Dipole mode (IOD) [5]. Sea-land contrasts enforce local diurnal variations in wind, clouds and rainfall, which are quite dominant in the IMC [6, 7, 8, 9, 10, 11, 12, 13, 14]. Modifications and re-organization of intraseasonal variations (ISVs) also occur, passing over the IMC eastward from the Indian to Pacific Oceans [15, 16, 17, 18, 19, 20]. To understand and predict such phenomena, we must set up an observational network and coupled atmosphere-ocean dynamics over the IMC.

Our direct ancestors, earlier homo sapiens, started dispersing out over the globe (so-called great journey) some 200,000 years ago again from Africa and arrived in

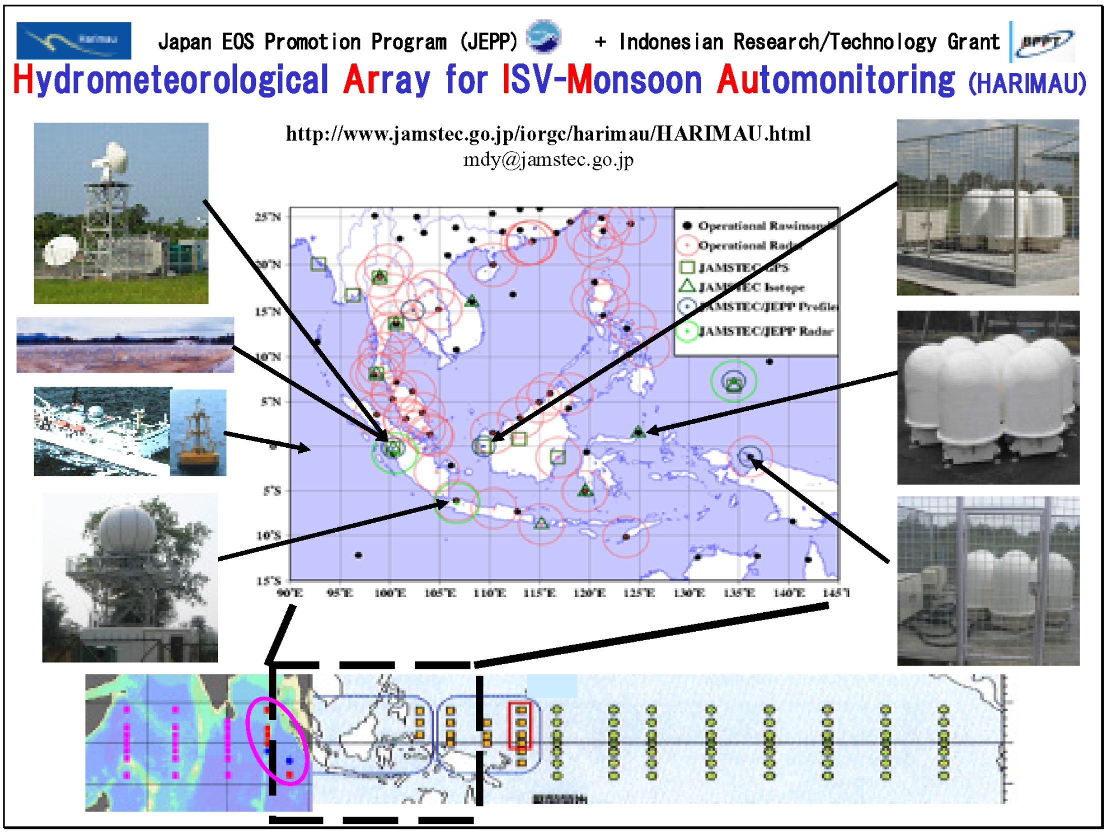

Fig. 1. The HARIMAU radar-profiler network: Green circles indicate locations of radars and wind profilers of which photos are also shown.

India, then in Sundaland. They encountered the biggest crisis of extermination after a super-volcano – which is now a large caldera lake Toba in Sumatera – erupted 74,000 years ago [21, 22, 23] and causing probably the world's biggest disaster in human history and ethnic separation between people living on the eastern (Mongoloid) and western (Indo-European) sides of Southeast Asia, but not directly due to volcanic but mainly climatic (volcanic-ash cloud-induced cooling) disaster. The damage of such volcanic-climatic disaster is governed by atmospheric circulation transporting ash, which is still not so well understood in particular in the low latitudes.

Volcanic and seismic disasters are indeed ruinous but usually limited in space and in time, as seen in the December 2004 wipeout of some 220,000 people along the coast of the Indian Ocean due to earthquakes and tsunamis near Sumatera. Climatic disasters, such as floods and droughts, hot and cold waves, and storms are more frequent in many areas, and they accumulate far more victims and sufferers than do volcanic or seismic disasters. The worst case we know of, occurring 74,000 years ago, combined the two categories, but the most important factor governing extension and duration of the disaster was wind or atmospheric circulation transporting volcanic ashes. Note, as will be detailed later, that the equatorial tropics are the pumping region for global atmospheric circulation. Because seismic and volcanic activity in and around the IMC remains active, we must understand atmospheric dynamics also for determining the extension and duration of volcanic-ash clouds due to super-eruptions in future.

The IMC is currently the region of the most intense convective activity and thus generates frequent torrential rainfall [24, 25, 26]. In January-February 2007, for example, the Indonesia's capital of Jakarta suffered serious flood damage leaving behind over 100 dead and over 300,000 affected [27]. To observe cloud systems, we must install instruments with high time and space resolution. Direct observations of three-dimensional (3D) wind velocity components with high time and vertical resolution are very important, particularly in the tropics, because geostrophic approximation (the indirect estimation of wind from a pressure field) is not useful and cloud systems with diurnal and shorter scales are dominant. These considerations make radar remote-sensing techniques important, although satellite cloud (hourly geostationary, or spatially high-resolution polar-orbit) and rawinsonde (operationally bidaily, daily, or 12-hourly; in special scientific use 3-hourly at a maximum) observations are still useful for obtaining information not detected by radar techniques.

Meteorological radars operated mainly in SHF-band measure the spatial distributions of raindrops and, if a Doppler capability is added, their radial velocity, and can be operated in a rainy atmosphere. Wind profilers