



Office of the VUSSP Head Director
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TO: VUSSP Assistant Director Jon Standley, Human Relations Director Troy Autry, JPL Director Sarah Littrell, Mission Control Operations Director Irene Komninou
From: VUSSP Head Director Kaimoni A. Sutton

Subject: Earth Weather Observation Satellite (EWOSAT) Program Proposal

Ladies and gentlemen,

The VUSSP has continued on with the observation of celestial bodies other than the Earth, but as we have seen by the atmospheric events that have occurred over the past two years and the world's inability to adequately track and monitor such events, more systems need to be in place to serve as an early warning and weather detection system. The EWOSAT program is the answer to those needs. This proposal will outline the system and requirements for ensuring the success of the satellite network. It is hoped that this proposal meets all requirements needed to pass investigation by the Executive Committee.

Signed,

Kaimoni A. Sutton

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Program Purpose

As was stated, the Earth Weather Observation Satellite or EWOSAT network is the world's answer to the call for global weather coverage, serving as an early warning and weather detection system that will allow the proper agencies to contact the governments of third-world countries who have poor communication resources in a more efficient and expedient fashion, giving them warning and ample evacuation time if confronted with severe storms and geological events.

As was seen in the past, little warning was given to third world countries in the Indian Ocean region when a super tsunami destroyed whole countries, killing over 110,000 men, women, and children. The world simply did not have the means for communicating with those countries to warn them of the oncoming danger presented by the seismic event, which produced the deadly tidal wave. In addition, the countries affected did not have the means or technology available that would allow them to monitor and track the events that caused the massive loss of life.

Background Information

There are many theories as to the cause of the world's steadily worsening weather conditions. The most logical explanation contributes the increased severity of major storms to global warming, which has already caused major drought throughout the world causing hunger, famine, and environmental problems to nations all over the world, especially third world countries.

Global warming is a direct result of an increase of greenhouse gases that are building up within our atmosphere causing earth's temperature to steadily rise. The most prominent greenhouse gas is Carbon Dioxide, or CO₂. It is estimated that between 1900 and 2000, the amount of carbon dioxide in our atmosphere has risen 82% according to various scientists in the meteorology field. Such an increase in CO₂ has indirectly led to the increase of severe and extreme weather conditions and events such as floods, droughts, heat waves, and hurricanes.

While it is still unclear just how exactly global warming affects the earth and why there have been worsening weather conditions world-wide, all we can do is try our best to study our earth and take any and all measurements to protect ourselves from the earth's steadily worsening weather conditions. The EWOSAT program is the answer to that call.

Mission Statement

The mission of the Earth Weather Observation Satellite network is to provide early warning and weather detection to nations who do not have the adequate technology needed to implement such a system. The network will also be tasked with studying the effects of global warming and evaluating regional and global climate shifts.



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Program Requirements

The requirements to maintain this program are as follows:

- 4 missions, one satellite per mission
- Own website to provide statistical data, up to date records, integrated weather information
- A single program manager who will run all four satellites once placed into orbit and deemed fully operational

Satellite Descriptions

1. EWOS-1

- Multispectral Electronic Self-Scanning Radiometer (MESSR)
- Visible and Thermal Infrared Radiometer (VTIR)
- Microwave Scanning Radiometer (MSR)

2. EWOS-2

- Advanced Microwave Scanning Radiometer (AMSR)
- Global Imager (GLI)
- Sea Winds (SeaWinds)
- Polarization and Directionality of the Earth's Reflectancies (POLDER)
- Improved Limb Atmospheric Spectrometer-II (ILAS-II)

3. EWOS-3

- Panchromatic Remote Sensing Instrument for Stereo Mapping (PRISM)
- Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2)
- Phased Array type L-band Synthetic Aperture Radar (PALSAR)

4. EWOS-4

- Ocean Color and Temperature Scanner (OCTS)
- Advanced Visible and Near Infrared Radiometer (AVNIR)
- VUSSP Scatterometer (VSCAT)
- Total Ozone Mapping Spectrometer (TOMS)
- Polarization and Directionality of Earth's Reflectancies (POLDER)
- Interferometric Monitor for Greenhouse Gases (IMG)
- Improved Limb Atmospheric Spectrometer (ILAS)



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Mission Information

1. EWOS-1
 - Launch Date- Saturday December 10, 2005
 - Launch Time- 5:00 pm EST
 - Inclination- 50°
 - Target Orbit- 1,500 x 1,600 km
 - Launch Vehicle- Delta IV 5.2 Medium+
 - Primary Flight Director/Team- Matthew Eby / White Team

2. EWOS-2
 - Launch Date- Saturday January 6, 2006
 - Launch Time- 5:30 pm EST
 - Inclination- 75°
 - Target Orbit- 500 x 500 km
 - Launch Vehicle- Delta IV 5.2 Medium+
 - Primary Flight Director/Team- Kaimoni Sutton / Red Team

3. EWOS-3
 - Launch Date- Sunday January 28, 2006
 - Launch Time- 12:00 pm EST
 - Inclination- 270°
 - Target Orbit- 900 x 950 km
 - Launch Vehicle- Delta IV 5.2 Medium+
 - Primary Flight Director/Team- Irene Komninou / Gold Team

4. EWOS-4
 - Launch Date- Saturday February 17, 2006
 - Launch Time- 6:30 pm EST
 - Inclination- 180°
 - Target Orbit- 450 x 450 km
 - Launch Vehicle- Delta IV 5.2 Medium+
 - Primary Flight Director/Team- Matthew Eby / White Team

Sensors Defined

Multispectral Electronic Self-Scanning Radiometer(MESSR)- Is an electronic scanning radiometer that observes solar light reflected from the earth surface. It is equipped with two camera systems that are set parallel to the satellite's flight direction.

Visual and Thermal Infrared Radiometer (VTIR)- Mechanically scans from right to left at a right angle to the satellite's flight direction.



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Microwave Scanning Radiometer (MSR)- A radio sensor scanning the earth surface along the flight path with its rotating dish antenna.

Advanced Microwave Scanning Radiometer (AMSR)- Will observe various physical content concerning water (H₂O) by receiving weak microwaves to be naturally radiated from the Earth's surface and atmosphere (for example, water vapor content, precipitation, sea surface temperature, sea surface wind, sea ice, etc.) and also regardless of day or night, the presence of cloud. These sensors aim at collecting energy.

AMSR is a radiometer to observe eight frequency bands from 6.9GHz to 89GHz bands respectively by the vertical and horizontal polarized waves except two frequency bands of 50GHz. It acquires radiance data by scanning the Earth's surface conically or mechanically rotating its antenna along the satellite flight path. Also, AMSR has the function and high-temperature calibration source to acquire radiance temperatures in deep space (about 2.7K) for calibrating observation data.

The aperture diameter of AMSR's antenna is 2m and its instant visual field is about 5km (89GHz). It scans conically an angle of incidence on the Earth's surface (a nominal angle:55deg) to be constant and minimizes the effect of sea surface wind upon observation data and accomplishes a swath width of about 1600km.

Global Imager (GLI)- An optical sensor aiming at observing globally and so frequently the reflected solar radiation from the earth's surface including land and ocean, and cloud or the infrared radiation for measuring the physical content such as chlorophyll, dissolved organic substance, surface temperature, vegetation distribution, vegetation biomass, distribution of snow and ice, and albedo of snow and ice, etc. These data may be used for grasping the global circulation of carbon, monitoring cloud, snow, ice, and sea surface temperature, and grasping the primary marine production. GLI is an advanced type of the mission of Ocean Color and Temperature Scanner (OCTS) on-board ADEOS for further expansion of observation.

GLI has 23 bands in visible and near-infrared region (VNIR), 6 bands in short-wave length infrared region (SWIR), and 7 bands in middle and thermal infrared region for its multispectral observation. Although the ground resolution is at the nadir of 1km, a part of the bands in VNIR and SWIR has a resolution of 250 m at the nadir which will be used for observing vegetation and cloud. The observation region by mechanically scanning is 12 picture elements (12 km) to the forward direction and 1600 km in the cross-track direction.

Sea Winds (SeaWinds)- Will provide high accuracy wind speed and direction measurements over at least 90% of the ice-free global oceans every 2 days. SeaWinds will provide a continuing set of long term wind data for studies of ocean circulation, climate, air-sea interaction and



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weather forecasting. SeaWinds is a follow on to the VUSSP Scatterometer (VSCAT) which is a sensor on ADEOS and will, like NSCAT, provides measurements of ocean surface winds in all weather and cloud conditions. The SeaWinds will use a one meter diameter dish antenna with two beams rotated about the satellite nadir axis at 18 RPM. SeaWinds radiates and receives microwave pulses at a frequency of 13.4 GHz across on 1800km wide swath.

Scatterometers use a highly indirect technique to measure wind velocity over the ocean. Changes in the wind velocity cause changes in ocean surface roughness, modifying the radar cross section of the ocean and the magnitude of the backscattered power. Multiple, collocated, measurements acquired from several directions can be used to solve wind speed and direction simultaneously.

Polarization and Directionality of the Earth's Reflectivity (POLDER)- Will observe the polarization, directional and spectral characteristics of the solar light reflected by aerosols, clouds, oceans and land surfaces.

POLDER is a push broom, wide field of view, multi-band imaging radiometer/polarimeter developed by CNES. Multi-angle viewing is achieved by the along-track migration at the spacecraft velocity of a quasi-square footprint intercepted by the total instantaneous 114-degree wide field of view. This footprint is partitioned into 242x274 elements of quasi-constant 7kmx6km resolution, imaged by a CCD matrix in the focal plane (fig).

Simultaneously, a filter/polariser wheel rotates and scans eight narrow spectral bands in the visible and near infrared (443,490,565,665,763,765,865 and 910 nm), and three polarization angles at 443,665 and 865 nm (fig).

Improved Limb Atmospheric Spectrometer-II (ILAS-II)- Developed by the Environment Agency of Japan (The present Ministry of Environment) is a sensor to monitor the high-latitude stratospheric ozone. The objectives of ILAS-II are to monitor and study changes in the stratosphere which are triggered by emissions of chlorofluorocarbons (CFC), and to evaluate the effectiveness of world-wide emission controls of CFCs. ILAS-II is a spectrometer which observes the atmospheric limb absorption spectrum from the upper troposphere to the stratosphere using sunlight as a light source (solar occultation technique).

The spectrometer covers the infrared region (2-13 μ m) and the near visible region (753 to 784nm). ILAS-II was designed to improve observation accuracy and cover wider spectral ranges than ILAS (aboard ADEOS planned for 1996 launch by NASDA) which was based on LAS aboard EXOS-C (Ohzora, ISAS, 1984). ILAS's observations are focused in the high latitude regions because of the geometrical relation of the solar occultation events with the sun-synchronous orbit. From these spectral observations, ILAS-II can measure the vertical profiles of species related to ozone hole phenomena: ozone (O₃), nitrogen dioxide (NO₂), aerosols, water vapor



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(H₂O), CFC11, methane (CH₄), nitrous oxide (N₂O), chlorine nitrate (ClONO₂), temperature, and pressure.

Panchromatic Remote Sensing Instrument for Stereo Mapping (PRISM)- Panchromatic radiometer with 2.5-meter spatial resolution. In order to obtain terrain data including elevation, PRISM has three optical systems for forward, nadir and backward view. Precise land information can be obtained frequently by PRISM.

Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2)- A visible and near-infrared radiometer for observing land and coastal zones and provides better spatial resolution than ADEOS's AVNIR. It will be used to provide land coverage maps and land-use classification maps for monitoring regional environment. The instrument has a cross track pointing capability for disaster monitoring.

Phased Array type L-band Synthetic Aperture Radar (PALSAR)- An active microwave sensor for cloud-free and day-and-night land observation and provides higher performance than JERS-1's SAR. This sensor has a beam steerable in elevation and the ScanSAR mode, which allows us to obtain a wider swath than conventional SARs. The development of PALSAR is a joint project between JAXA and the Japan Resources Observation System Organization (JAROS).

Ocean Color and Temperature Scanner (OCTS)- An optical radiometer devoted to the frequent global measurement of ocean color and sea surface temperature. OCTS will show the amount of chlorophyll and dissolved substances in the water, and temperature distribution. OCTS data will be used for determination of ocean primary production and carbon cycle, and be used for getting the information of ocean conditions for fishery and environment monitoring etc. OCTS is a successor to CZCS (Coastal Zone Color Scanner), the U.S. project, which was the first real optical sensor for ocean observation onboard NIMBUS-7 launched in 1978.

OCTS has 8 bands in visible and near-infrared region and 4 bands in thermal region, and achieves highly sensitive spectral measurement with these bands. The observation bands are determined on the characteristics of spectral reflectance of the object substances, atmospheric windows and atmospheric correction. The spatial resolution is about 700m. This is applicable to the observation of coastal zone and land, the feature of these area barriers quickly compared to the open ocean. As the swath width is about 1400km on the ground, OCTS can observe the same area every 3 days and can monitor rapidly changing phenomena. OCTS has optical calibration function using solar light and halogen lamp as the calibration source. OCTS has two data transmission modes. All raw pixel data are transmitted through X band with fine data transmission mode. One pixel data is sampled from every 6x6km area as typical data of the area and is transmitted at UHF band in coarse data transmission mode.



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OCTS consists of scanning radiometer unit, which contains optical system and detector module, and-electrical unit. OCTS adopts catoptric optical system and mechanical rotating scanning method using mirror. This is because OCTS covers wide range of wavelength and wide scanning angles. OCTS can tilt its line of sight along the track to prevent the sunglitter at the sea surface from interrupting the observation. For high sensitivity, each band has 10 pixels aligned to the track. The infrared detectors are cooled at 100K by a large radiant cooler facing the deep space.

VUSSP Scatterometer- Will measure wind speeds and directions over at least 90% of the ice-free global oceans every 2 days - under all weather and cloud conditions. Winds are a critical factor in determining regional weather patterns and global climate. At present, weather data can be acquired over land, but our only knowledge of surface winds over oceans comes from infrequent and sometimes inaccurate reports from ships. Since oceans cover approximately 70% of Earth's surface, VSCAT data will play a key role in scientists' efforts to understand and predict complex global weather patterns and climate systems.

Total Ozone Mapping Spectrometer (TOMS)- Changes in the ozone layer caused by release of CFC's in the atmosphere have the potential of producing biological damage through increased UVB radiation. While cloud cover provides protection on the ground against solar radiation in the visible and near UV wavelengths, biologically damaging radiation near 300 nm is controlled primarily by the total ozone content. Total ozone is highly variable on small spatial scales and short time scales. TOMS maps the spatial distribution of total ozone using high resolution, thus providing information for estimating the potential biological damage at any location.

A second capability is the detection of volcanic eruptions through measurement of sulfur dioxide contained in such eruptions. Large eruptions, such as the June 1991 eruption of Mount Pinatubo, are expected to have climatic effects. TOMS data can be used to make quantitative estimates of sulfur dioxide gas which is a precursor of stratospheric aerosol clouds that cool the earth.

TOMS measures the albedo of the earth's atmosphere at six narrow spectral bands in the nearultraviolet. Albedo is measured by comparing the reflectivity of the earth with the reflectivity of a calibrated on-board diffuser plate. Total ozone is derived from the differential albedo in three pairs of the spectral bands, which are selected to function at all latitudes and solar illumination conditions, and a measurement of the surface reflectivity at a longer non-absorbed wavelength band. The five shortest TOMS wavelengths are indicated at the top of Figure 2, which shows the absorption spectra of ozone and sulfur dioxide in the near ultraviolet. Sulfur dioxide, which normally is below the TOMS detection threshold, is measured using the same six wavelengths. The ozone and sulfur dioxide absorption spectra are sufficiently different that these two absorbing constituents can be separated by analysis.

Interferometric Monitor for Greenhouse Gases (IMG)- A sensor to monitor the earth's radiation balance, the temperature profile of the atmosphere, the temperature of the earth's



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surface, and physical properties of clouds. It was developed by the Japan Resources Observation System Organization (JAROS) for the Ministry of International Trade and Industry (MITI). IMG will obtain detailed spectra of thermal infrared radiation from the earth's surface and atmosphere. The detailed spectra measured by the IMG will be used to infer atmospheric concentrations of water vapor and other greenhouse gases. A global increase in tropospheric concentrations of trace gases, such as carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons (CFCs) has been noted. These increases have been brought about by human activities. Now however we have limited knowledge of the magnitude or distribution of the anthropogenic sources of these gases. Two sources whose magnitude must be investigated are deforestation and biomass burning. IMG will map the global and regional distribution of emission sources by measuring variations in the concentrations of trace gases. Moreover, natural sources and sink strengths of trace gases may vary widely with different terrestrial and oceanic ecosystems.

Improved Limb Atmospheric Spectrometer- Monitors and studies changes in the stratosphere which are triggered by emissions of Chloro Fluoro Carbons (CFC), and to check the effectiveness of world-wide emission controls of CFCs. ILAS is a spectrometer which observes the atmospheric limb absorption spectrum from the upper troposphere to the stratosphere using sunlight (solar occultation technique). This covers the infrared region (850-1610cm⁻¹) and the near visible region (753 to 781nm). ILAS is designed based on LAS (Limb Atmospheric infrared Spectrometer), which was aboard EXOS-C (Ohzora, ISAS). It was developed to improve observation accuracy and also to detect minor constituents related to ozone hole chemistry. ILAS's observations are focused on the high latitude regions because of the geometrical relation of the solar occultation events with the sun-synchronous orbit. From these spectral observations, ILAS can measure the vertical profile of ozone hole related components: ozone (O₃), nitrogen dioxide (NO₂), aerosols, water vapor (H₂O), CFC11, methane (CH₄), nitrous oxide (N₂O), temperature, and pressure. This dataset covers the key physical and chemical parameters which characterize ozone hole events: the cooling at the polar lower stratosphere, PSC formation, the removal of nitrogen reservoirs, and the ozone reduction by activated chemical chain reactions. ILAS will continue to contribute to research into stratospheric ozone changes into the late 1990's.

Retroreflector in Space (RIS)- A retroreflector for an earth-satellite-earth laser used in long-path absorption experiments. RIS has a corner-cube structure with an effective diameter of 50 cm. Measurements of ozone, CFC12, CO₂, CH₄, etc. are carried out using infrared pulsed lasers.