Report on the 2nd COSPAR Symposium "Water and Life in the Universe"

Othon Cabo Winter (Chair of the Symposium)

From 9 to 13 of November 2015 occurred the *2nd COSPAR Symposium "Water and Life in the Universe"* in Foz do Iguaçu, Brazil. About 187 participants from 23 countries attended the meeting. The venue was a splendid place with its *Cataratas do Iguaçu* water falls, the huge *ITAIPU* hydroelectric power plant, and the magnificent bird sanctuary *Parque das Aves,* among other attractions.

Just after the Opening Ceremony there were two keynote speeches. The first, by Prof. Paulo Artaxo (USP, Brazil) on "Amazonia: The close links betweenwater. Biological activity and Climate Change" and the second by Prof. Fabrizio Capaccioni (INAF/IAPS, Italy) on "Water in the Solar System: Results from ROSETTA". Following happened the *Space Agencies Round Table*, chaired by Prof. Lenard Fisk (President of COSPAR), with the presence of representatives from the Brazilian Space Agency (AEB), the National Institute of Space Research (INPE), the Argentinian Space Agency (CONAE), the Italian Space Agency, (ASI), the French Space Agency (CNES), the Japanese Space Agency (JAXA), the European Space Agency (ESA) and the USA Space Agency (NASA).

Opening the activities of the first two afternoons there was a Plenary Talk. On Monday it was given by Dr. Eduardo Janot Pacheco (USP, Brazil) on "The PLATO 2.0 Mission". In the next day Dr. Silvia Maria Giuliatti Winter (UNESP, Brazil) talked on "Pluto System Dynamics & the New Horizons Mission". There was an *Invited Lecture* opening each morning activities. The first one on "The ASTER Mission: Exploring for the First Time a Triple System Asteroid" delivered by Dr. Elbert Macau (INPE, Brazil). On Wednesday Dr. Dara Entekhabi (JPL, USA) talked on "The NASA Soil Moisture Active Passive (SMAP) Mission Status and Early Results". In the following day, Dr. Masaki Fujimoto (JAXA/ISAS, Japan) talked on "Formation of the Solar System, Terrestrial Water and Life: Sample Returns of Hydrated Dust and Organics from Small Bodies". Finally, on Friday there was a lecture on "Exploration and Sample Return from Other Shores: Planetary Protection for the Water Worlds" by John D. Rummel (McGill Univ., Canada).

The Symposium was composed of oral and poster presentations distributed into nine sessions, described as follows.

Session 1 - Space astronomy missions to detect ingredients for life and exoplanets in the universe: status of current and future approved missions and new proposals.
This session presented results from space missions and ground observatories to study water, ices, organics in the galaxy, interstellar medium, around stars and on exoplanets. They reviewed the status of exoplanets research, in particular in the new context of habitability. They discussed the potential of upcoming space mission, and proposed observatories for the future.

Session 2 - Water and life in the universe and on Earth: impact on human consciousness and societies.
An interdisciplinary (and even trans-disciplinary) session connecting hard and social sciences, and even the society, in the tradition of the education and outreach session at the COSPAR. The idea was to have lectures/contributions from scientists involved in astrophysics, geophysics, and environmental sciences, but also in geography, economy, sociology, history, health sciences, etc. and may be an artist view to get a picture of the impact of water both on Earth and in the cosmos on life, on the society(ies), and on the human.

Session 3 - Satellite and probe missions for water remote sensing on Earth, planets, and other celestial bodies.
The main goal of the session was: 1- to show achievements of especially dedicated satellite water missions such as: ESA`s water mission SMOS (Soil Moisture and Ocean Salinity); NASA`s SMAP (Soil Moisture Active and Passive Mission); pioneering missions based on GNSS-R signals also transmitting information on soil moisture (ESA`s PARIS (Passive Reflectometry and Interferometry System) In orbit-demonstrator, may be GRACE (Gravity Recovery and Climate Experiment). 2- to show how the GPM and TRMM missions (NASA-JAXA) are helping to advance our understanding of Earth`s water and energy cycle, improving forecasting of extremes events that causes natural hazard and disaster, and extend current capabilities in using accurate and timely information to directly benefit society.

Session 4 - Water and Life in the Solar System.
Solar system research has revealed evidences of present water both inside and outside the snow line, from Mercury, Moon, Mars to Europa, Ganymede, Enceladus and beyond. The “habitable zone” concept has been expanding from surface habitats on the terrestrial planets in close heliocentric orbits to deep habitats, like thermal vent eco-system on the Earth, underneath the satellites affected by strong tidal forces of giant planets. Organics and volatiles are also discovered by meteoritic analysis, space missions and astronomical observations of asteroids, comets, and icy bodies. Cosmic dust plays a major role as delivery vehicle of water and organics to the Earth.

Extra terrestrial water resource is also expected as a future exploitation target to support future deep space human exploration.

Session 5 - Water from chemical, biological, and physical perspectives.
Water use and reuse for life support, sources (combustion/propulsion reaction by-product; celestial bodies; organic decomposition; …). There have been very important theoretical & experimental developments in the mystery of water such as: (i) Constructions & prototypes of water batteries; (ii) Low frequency phenomena in water & their impact on the bio-system; (iii) Ferro-electric ordered domains in water leading to a superphase of water; (iv) Low frequency magnetic phenomena in water; (v) Electromagnetic signals from DNA in water (vi); Coherence & non-transient effects in water.

Session 6 - Role of water from the ground to the upper atmosphere.
Water in the Earth`s middle atmosphere is very small, in amount, but play important roles. It is recently known that latent heat released by cumulus convection in the troposphere play important role in generating atmospheric waves, such as gravity wave and tides, which go up to the mesosphere and even thermosphere and ionosphere up to a few hundred km above ground, transporting momentum and energy, and driving the atmosphere circulation and variations of ionosphere. Water vapor is also one of greenhouse gases and the trend in the middle atmosphere is of interest. At mesopause, water becomes ice in summer polar region and forms noctiluscent clouds or PMC. The increasing trend of such clouds is a hot issue related to the global warming. Molecules related to water, such as OH, are also used for remote sensing of the mesosphere lower thermosphere region. This session treats various aspects of phenomena above ground up to the upper atmosphere related to water.

Session 7 - Astrobiology: habitability, synthesis of organics in ice, and prebiotic chemistry in liquid water.
The session covered three topics: i) Habitability: defining the motion of habitability related to the nature of the stars, then, expanding to habitability on Mars, icy satellites and possible exoplanets; ii) Synthesis of Organics in Ice: reports on laboratory work to synthesize organic molecules related to astrobiology in Ices (water + CO + NH3 + …); iii) Prebiotic Chemistry in Liquid Water: could early prebiotic chemistry develop on surfaces of Mars or in Icy satellite of giant planets?

Session 8 - Water and life support for human exploration in low Earth orbit, Moon and beyond.
The session discussed the use and recycling of water and organics for human missions and their reuse for life support on the ISS and beyond. The possibility of using water and organics resources on lunar sites (including poles), asteroids and Mars was discussed for life support, propulsion fuel, in-situ manufacturing and other by-products enabling human exploration. The session included talks and posters on terrestrial simulation analogue

campaigns, and precursor robotic space experiments to survey these materials, to demonstrate their use for supporting biological and technical investigations, and provide lessons for future life support systems in human bases on the Moon and beyond.

Session 9 - SWOT altimetry mission for hydrology;
This was a session dedicated to SWOT, the altimeter mission for hydrology.

On the 12th of November happened a special session to celebrate one year of the landing of *Philae,* a small lander, on the surface of comet 67P/Churyumov-Gerasimenko.

The Program Committee counted with the participation of COSPAR members from Commissions A, B, C, E, F and Panels PSD, PPP, PE and PEX. The local organization of the Symposium was made by the University of the State of São Paulo (UNESP) and the National Institute of Space Research (INPE).

Simultaneously to the Symposium there were organized some other events as a *Public Lecture*, a *Training Teachers* for local school teachers with lectures, hands-on activities and a planetarium session, and also a *Drawing Contest* for kids (8-11 years old) on the theme “Water and Life in the Universe”. In the two weeks preceding the Symposium, a *Capacity Building Workshop (CBW)* on "Data Analysis from Space Missions" was organized in the city of Guaratinguetá, Brazil, and some of the works developed by the participants of the CBW were presented in the Symposium as well.

PHOTOS (follow in separated files)

1- ROUND TABLE

2- OFFICIAL PHOTO

3- DRAWINGS CONTEST AWARDS (2 photos)

4- TRAINING TEACHERS

5- LOC