APP

Antarctic precipitation properties from ground-based instruments.

Principal investigator

Nicoletta Roberto

nicoletta.roberto@artov.isac.cnr.it

Institute of Atmospheric Sciences and Climate (ISAC) of the National Research Council of Italy (CNR)

Other contact

l.baldini@isac.cnr.it

Areas of contribution

Observations

Summary

The main focus of the project Antarctic precipitation properties from ground-based instruments (APP) is to set up an observatory for investigating precipitation in Antarctica. Characterization of effective precipitation that occurs at ground of Antarctica region, plays a crucial rules in defining and validating global climate models and numerical weather prediction model. The observatory is designed to be set up at the Italian Antarctic station Mario Zucchelli integrating the current instrumentation for weather measurements with other instruments specific for precipitation observations. In particular, a 24-GHz vertical pointing radar, Micro Rain Radar, and an optical disdrometer, Parsivel will be integrated with the advanced weather stations, radiosoundings and the ceilometer. The synergetic use of the set of instruments allows for characterizing precipitation and studying properties of Antarctic precipitation such as dimension, shapes, fall behavior, density of particles, particles size distribution, particles terminal velocity, reflectivity factor and including some information on their vertical extent. The project is for four years, it started in July 2017 and will be active until July 2020, covering the Special Observation Period (SOP) in the Southern Hemisphere of Year of Polar Predicition (YOPP) period. APP can be provide specific measurements for precipitation occurring over the Antarctic coast at high temporal resolution, in particular specific snow products such as snow rate, snow depth and their water equivalent.

Description

Improvements in the knowledge of the Antarctic hydrological cycle is fundamental to assess the control of future changes of the Antarctic surface mass balance (SMB), which is one of the factors responsible of global sea level rise. One of climatic variables of interest in Antarctic region is precipitation. Due to the extreme environment and climate conditions, precipitation measurements at ground in the Antarctica are scarce and not adequate to detail precipitation properties. The need of knowledge of microphysical characteristics of the precipitation and precipitation climatology in Antarctica is leading some stations, such as Princess Elizabeth in the South East and Dumont d'Urville, to equip observatories for cloud and precipitation with a set-up similar to what is proposed here.
At the moment, most of the precipitation measurements are based on satellite observations that can be improved by the knowledge of the microphysical characteristics of snow. In order to validate and to improve the performance of numerical weather prediction and climate models, and to constrain satellite-based measurements, it is necessary to establish and maintain some in-situ observation sites equipped with specific precipitation measurement devices. There is therefore the need, before anything else, for accurate measurements of precipitation, including at the very local scale.
The main objective of the proposed research is to set up an observatory at the Italian station, Mario Zucchelli Station (MZS), in order to characterize precipitation in Antarctica. MZS is selected for its position, within the Terra Nova Bay and the proximity to the ocean. Moreover, this site is characterized by numerous precipitation events of different type of precipitation and the precipitation cumulated from satellite estimation is between 100-150 mm/year. The meteorological instrumentation available at MZS will be integrated with specific instrumentation for precipitation observation. Proposed instrumentation includes a Metek Micro Rain Radar (MRR) and an OTT Parsivel2 (P2) laser disdrometer. The P2 provides size and fall velocity of particles passing through a laser matrix from which snow rate (SR) at ground and snow accumulation can be inferred. MRR is a 24 GHz fixed vertical pointing antenna, this frequency is barely attenuated by ice particles and allow for enough sensitivity to small particles. With respect to pulsed radar profilers, the use of CW-FM scheme allows higher resolution with low power transmission, and reduced cost for both purchasing (one order of magnitude lower) and operations. The instrument comes with a standardized software that implements a procedure to retrieve the particle size distribution (PSD). However, a different processing of reflectivity spectra needs to be developed to remove known artifacts such as spectra aliasing and range-Doppler ambiguity and to improve performance at low signal to noise ratio. MRR precipitation retrievals will be based on reflectivity spectra, i.e., the lowest level data available to users. From reflectivity spectra one can derive effective reflectivity (Ze), mean Doppler velocity of the falling particles, and spectral width. This pair of instruments has been used to measure the falling snow and its microphysical properties in different field campaigns of the GPM (Global Precipitation Measuring) GV (Ground Validation) programme, such as the Canadian CloudSat/Calipso Validation Project (and Cold Season Experiment.
The P2 and MRR as the Eneide station are designed to automatically operate and to be remotely controlled via a year-round satellite connection. Under this condition, these instruments are operational even during winter season when human controls are not available. The data collected by these instruments will be downloaded and stored in a dedicated server installed in Italy. Systematic collection of data for a long period are necessary to highlight interannual and seasonal variability of snow precipitation. The objectives of this proposal will be achieved in four years and at the end a database of snow precipitation products for four years of data will be available. The project started in July 2016. At the moment, it is financed until July 2018. However, we are confident that two year of extension will be approved. In the framework of the WMO Year Of Polar Prediction (YOPP), within the Polar Prediction Project (PPP), the APP project will contribute with a year of experiments on precipitation characterization providing specific products. In particular, during the Special Observing Period of YOPP-SH, we are planning to provide some specific precipitation products obtained by measurements

collected in MZS by the MRR and P2 and by the synergetic use of them. P2 measures PSD at ground every minute and MRR measures power spectra and radar reflectivity factor from the ground up to 6000 m every minute. After applying a specific processing to these measurements, the precipitation products that are more interesting from the point of view of prediction models, can be obtained. Although MRR measures the vertical profile of radar reflectivity from which snow fall can be derived, the snow fall at ground will be produced through the synergy with PSDs measured at ground by P2. In synthesis, products that will be made available to YOPP at hourly resolution are: mean snow rate at ground, snow depth and snow equivalent water at ground. The set up of instrumentation at MZS is ongoing. Since, MRR collects raw spectra file of the order of 100 Mb per day and the data will be processed in Italy, we presume that the lack of bandwidth of the data link at MZS does not allow to real-time deliver daily products. However, precipitation products collected during YOPP period will be delivered as soon as possible.

Timeline

2017-07-07 - 2020-07-07

Regional emphasis

Northern hemisphere: No

Southern hemisphere: Yes

Further specification

Mario Zucchelli station: 74°41'42" S, 164°07'23" E

Key project deliverables

- Set up an observatory to characterize precipitation on Antarctica coast;
- Development of a methodology to synergetic use Micro Rain Radar (MRR) and disdrometer (P2) measurements;
- Estimation of quantitative precipitation product, such as, snow rate, snow depth, snow water equivalent;
- Investigation on particles classification methodology based on MRR and P2 observations;
- Dissemination of experimetal dataset, i.e. four years of precipitation products.

Data management

In Italy at Institute of Atmospheric Sciences and Climate of the National Italian Research Council of Italy (ISAC-CNR) in Rome.

Is data provided to WMO Global Telecommunication System

No