Environnement Canada
Centre météorologique canadien

Environment Canada
Canadian Meteorological Centre

Processing of GPSRO Observations at the Canadian Meteorological Centre

Version 1.0

February 2009

Revision history		
Version	**Date**	**Remarks**
1.0	2009/02/28	First version: February 2009 implementations details
1.1	2013/05/07	Addition of METOP-1 (or METOP-B) satellite

Table of Contents

1. Introduction

The document is a simple summary of the processing of GPSRO observations in the CMC.

A Radio Occultation occurs when a transmitting GNSS satellite (i.e. GPS constellation), setting or rising behind the Earth's limb(edge), is viewed by a LEO(LOW EARTH ORBITER) satellite

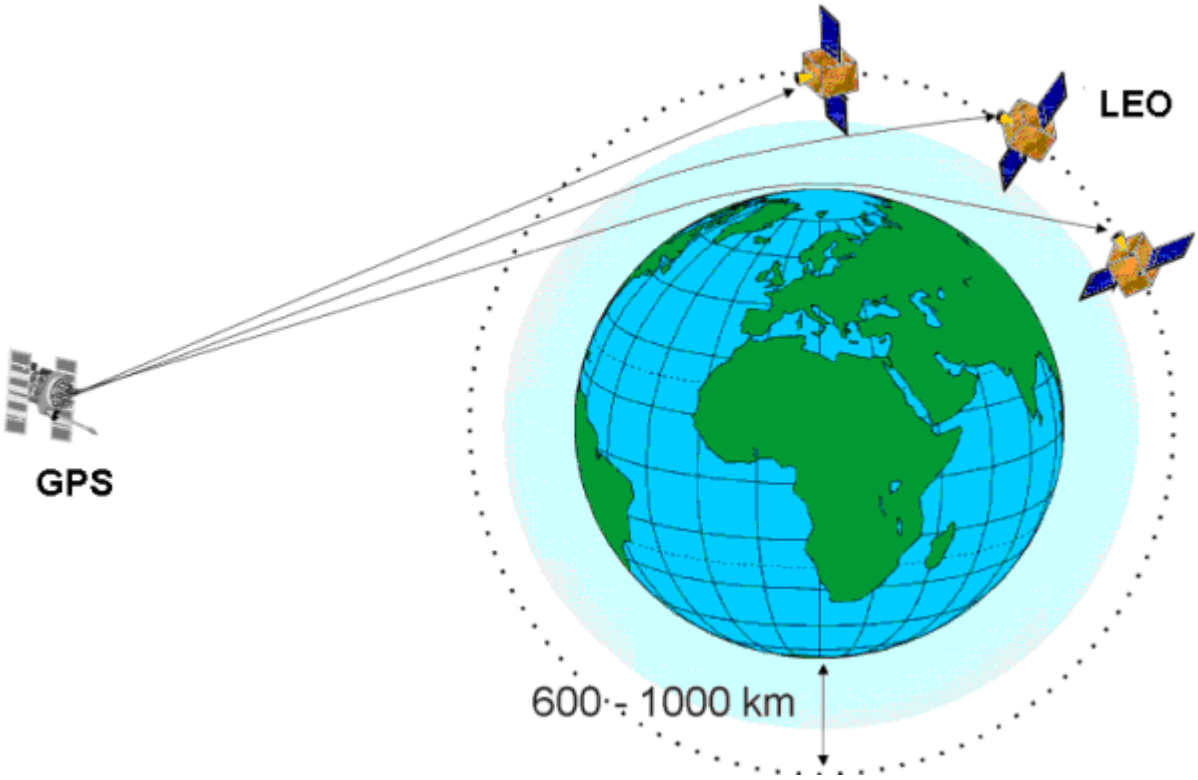


Figure 1. Principles of RO measurement

The relative motion between the GPS and a LEO provides a vertical scanning of the atmosphere. In the geometrical optics approximation and considering the spherical symmetry, a ray passing through the atmosphere is refracted and delayed due to the vertical gradient of density. As the satellites geometry changes (figure 1), the radio waves sample successively layers of the atmosphere. By the phase variation of the GPS signal, these limb sounding measurements are used to retrieve a vertical profile of bending angle and transformed into profiles of refraction index n (Figure 2.) .

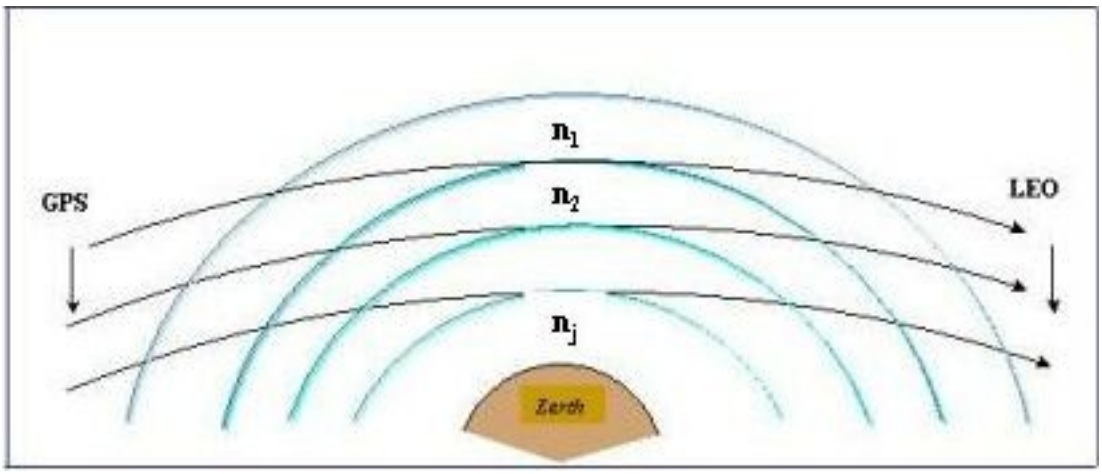
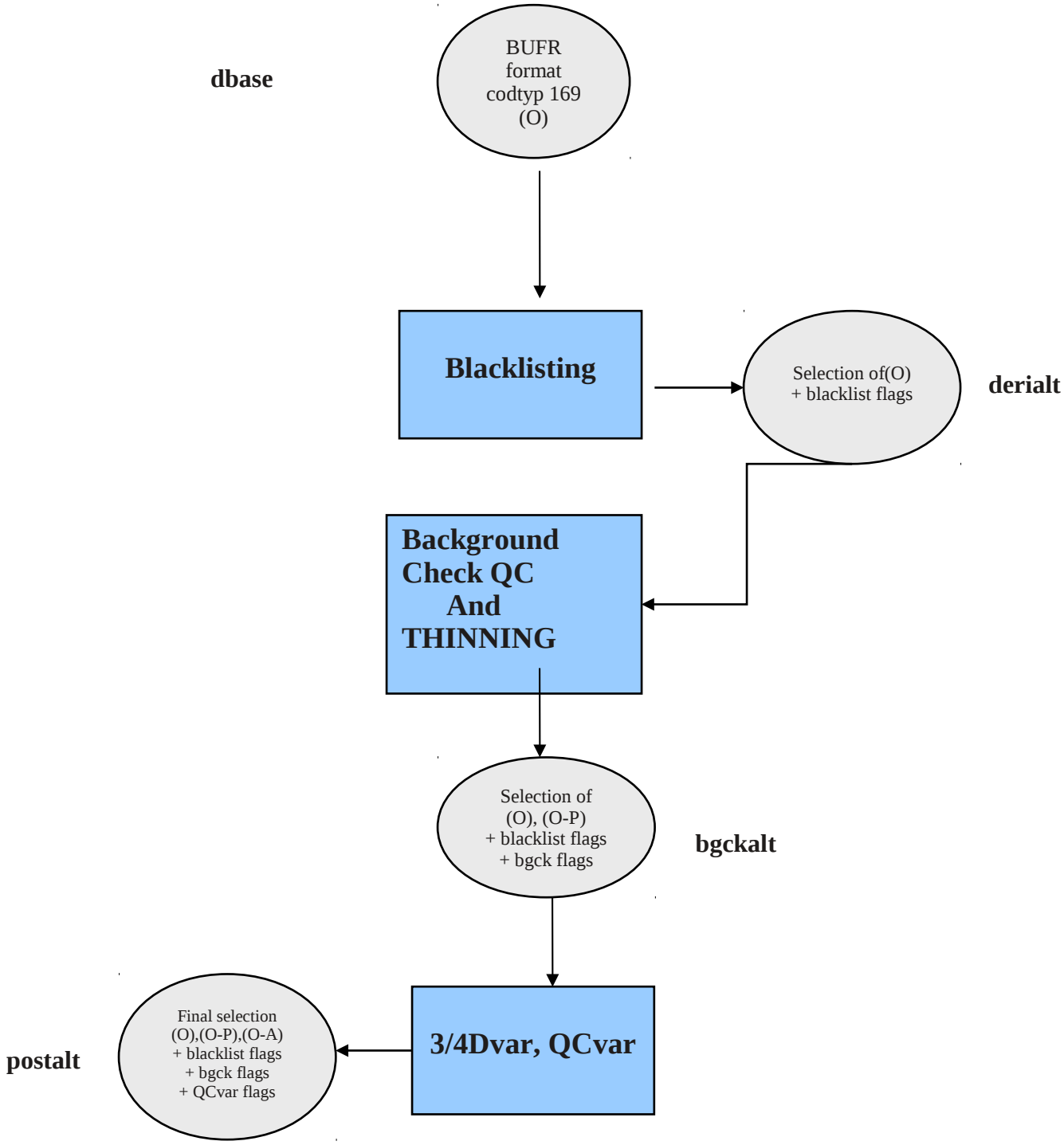
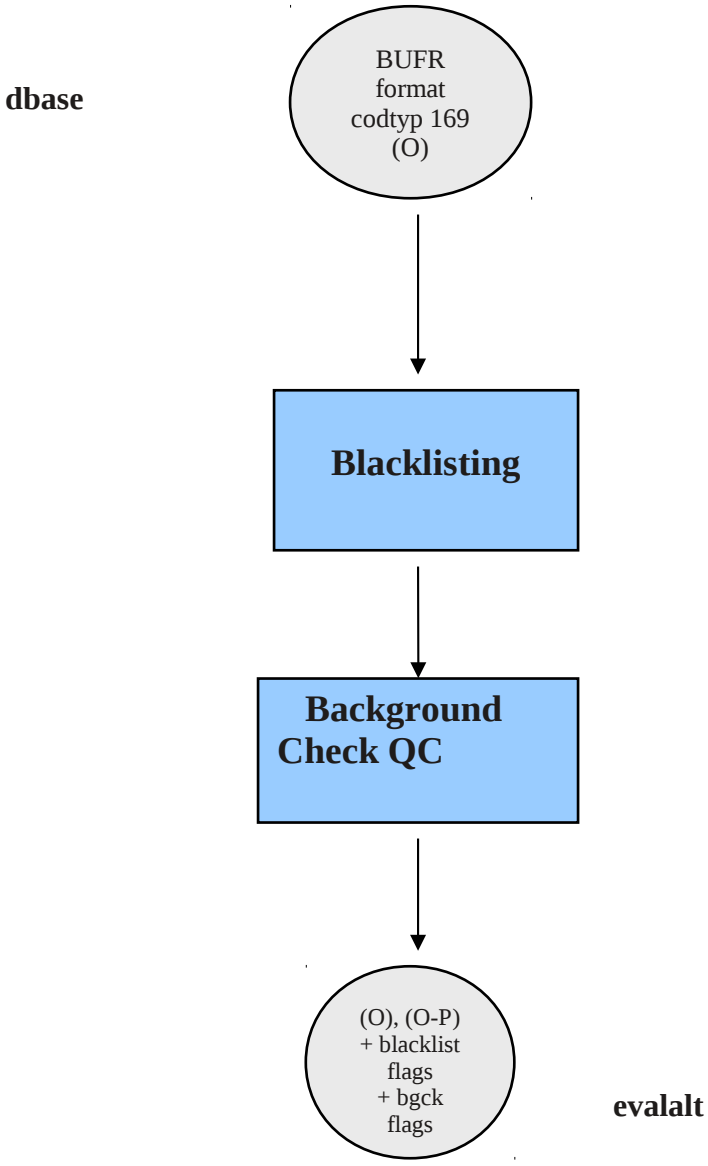


Figure 2. RO event geometry

2. Flowchart of of gpsro observations processing




dbase
BUFR
format
codtyp 169
(O)
Blacklisting
Background
Check QC
(O), (O-P)
+ blacklist
flags
+ bgck
flags
evalalt

3. Observation details

Code type 169 GPSRO

GPSRO data is distributed with several levels of processing. Data is presented as an ensemble of profiles of an observable related to refraction index, as a function of altitude, in several places on Earth.

Table 1 describes the details and BUFR/BURP codes:

Processing Level	**Vertical coordinate**	**Observable**
Bending angle	7040 (Impact parameter)	15037 (Bending angle)
Refractivity	7007 (Geometric height)	15036 (Refractivity)
Temperature & moisture	7009 (Geopotential height)	10004 (Pressure) 12001 (Temperature) 13001 (Specific moisture)

GPSRO data is being received at MSC in near-real-time from several sources, currently:

- CHAMP: Data processed by GFZ (Germany), encoded in BUFR by UKMO, and distributed from there.
- GRACE: Data processed by GFZ (Germany), encoded in BUFR by UKMO, and distributed from there.
- COSMIC(1/2/3/4/5/6): Data processed by UCAR (US), encoded by themselves in BUFR and distributed from there.
- METOP(1 & 2): Data processed by EUMETSAT, encoded by GRAS SAF in BUFR and distributed from DMI.
-

The level selected for the current implementation is the second: (refractivity profiles).

On average, there are about 3000 profiles received at CMC per 24hrs.

4. Processing details

BLACKLISTING

The data is first blacklisted according to a list of satellites This list is updated according to the daily monitoring done the data .

BACKGROUND CHECK

The objective of the background check is to identify observations with gross errors. It is a comparison between the observed elements and the same elements from the analysis first guess (6-hour forecast) interpolated at the observation location.

A background check is then performed on all data and data is rejected if the absolute value of (O-P)/P < .05

THINNING

GPSRO data is distributed with a formal vertical resolution of 200m. Actual resolution is believed to range between 500m (troposphere) and 1000m (stratosphere). Data from the very low

troposphere is known to present occasionally some important biases, especially related to low level layers of moisture.
For these two reasons, data must be vertically thinned to a lower formal resolution, and low level data must be rejected. High level data is also rejected.

- Thin to 830m vertical resolution
- Discard data below certain altitude MSL (default 1 km MSL)
- Discard data below certain altitude over the surface (default 1 km over background model topography)
- Discard data above what the model can describe (default model lid)
- Discard data above estimated limit of GPSRO technology (default 40 km)
- Discard an observation if all the elements in the observation (REFRACTIVITY) block are on the blacklist

A filter has been implemented with all these thresholds.