Vortex Detection Code (VDC)

version 1

User Manual

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1 Introduction

The Vortex Detection Code (VDC) version 1.0 (VDC v1.0, written in Mat-Lab) is designed to detect and identify the vortex flow motions in the 2D numerical or observational solar data. Code is based on implementation of Gamma functions Graftieaux, Michard, and Grosjean 2001 and new algorithm for more accurate tracking of the vortex boundary. The code is fully tested on the numerical data generated by SolarBox code.

2 Release note

June 2020 version 1.0

3 Usage

This manual includes the following parts:

(1) Software environment setting;
(2) Format of the input data;
(3) Examples of use.

3.1 Software environment setting

We recommend to use MatLab version 2018a or later to avoid any incompatible conflicts with software.

3.2 Format of the input data

VDC v1.0 process the velocity vector field in the .fits format. Typically, it requires taking three velocity field components as the input-longitudinal, latitude, and vertical components, respectively. The velocity field should be manually provided the ‘main’ function as well in the directory where user run the code.

```matlab
data_x = fitsread('B10_6x5Mm1z_Vx_nz#33_2980_3543_5s.fits');
data_y = fitsread('B10_6x5Mm1z_Vy_nz#33_2980_3543_5s.fits');
data_z = fitsread('B10_6x5Mm1z_Vz_nz#33_2980_3543_5s.fits');
```

Figure 1: Velocity field components
4 Examples of use

In this part, we show how to use VDC to detect vortex on velocity field.

Step 1: Open the main function
Step 2: Click the run button of MatLab
Step 3: Select the region of interest

Figure 2: The region of interest (ROI) is marked by rectangle.
Figure 3: The snapshot of the detected vortices boundaries and centers. Red colour corresponds to the clockwise rotated vortex and blue to the counterclockwise rotation.

**Step 4: Presentation of the results**

After processing, VDC automatically presents the detection result as follow. Results include the all detected vortex in ROIs (Figure 4a) and each vortex’s detailed information that considers assisting in vortex analysing (Figure 5). Figure 4a and b are the different view angles of the ROIs in that change in the time domain (frame index). Each colour corresponds to the individual vortex that evolves along with the time domain. Thus, the current 3D spatial detected 22 vortexes. Within each vortex, the color that differs from its boundary, represent its current vortex center. Beside present overall information shown within the figure, VDC isolates each
vortex and present it as shown in Figure 5. Figure 5a and b show two examples of the clockwise and counter-clockwise vortexes where the left panel present its boundary and center evolution and right panel record the Gamma 1 value of the center and area change versus time domain.

The user could also further explore each vortex by referring to the digital record true_vortex_list that records more detail information. Figure 6 shows the template of information of an Instantaneous vortex. In this table, VDC automatically records the coordinate of the vortex center, boundary, and angular velocity surrounding the current vortex, vorticity, direction, and other information.
Figure 4: The region of interest (ROI). The upper panel (a) and bottom panel (b) show all the detected vortices in ROI. The red lines correspond to the trajectory of the vortices centers.
Figure 5: Vortex boundary change as a function of time. The two isolated vortices No.16 and No.21 are shown on the upper and bottom panels respectively.
Figure 6: Representation of the detailed information of detected vortex.

5 Release notes

VDC version 1.0 (2020).

6 Queries

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7 Citation in the literature

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References