POLAR FIELD CORRECTION AND MAGNETIC CHARTS

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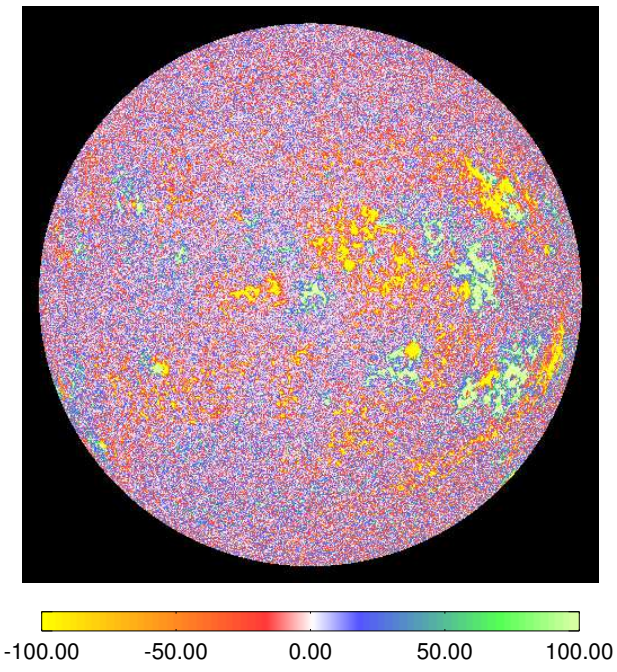
POLAR FIELD CORRECTION: MDI CASE

STEP #1

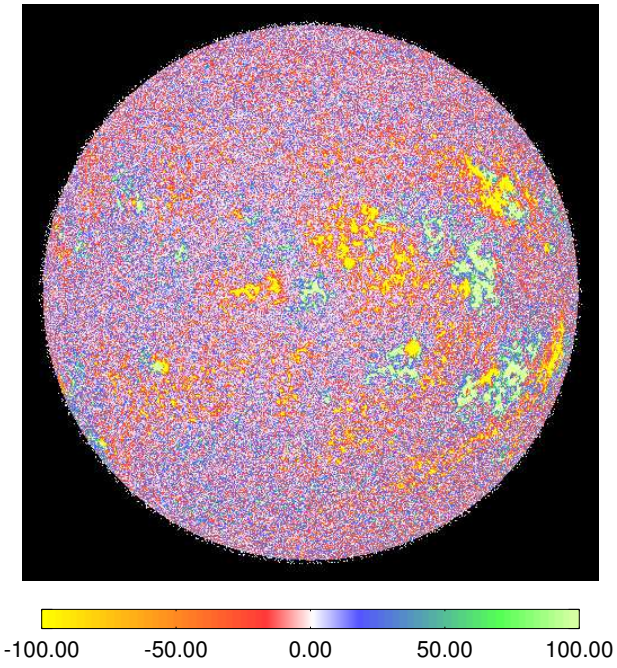
The original 1024×1024 magnetogram is rebinned (neighborhood averaging) into a new 512×512 image. Both scale factor (Tran et al. 2005, in ApJ Supp 156, p. 295), and zero offset masks are applied to the magnetogram. The saturation factor used in determining the scale factor mask is still the *old* formula: 4.5 - 2.5sin$^2(\rho)$

Date observed: 8/20/2000; $b_0 = 6.91°$; CR = 1966



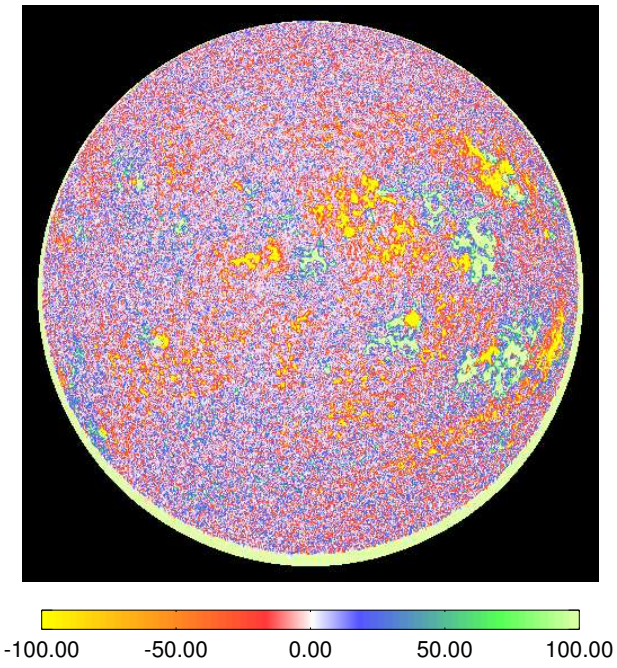
STEP #2

The pixels with center-to-limb angle (CLA) greater than 80° (near the limb) that have a $|B| > 5$ gauss are set to null. This step is necessary in order to produce a *good extrapolation* into the polar regions. It is not required when the MWO magnetograms are used.



STEP #3

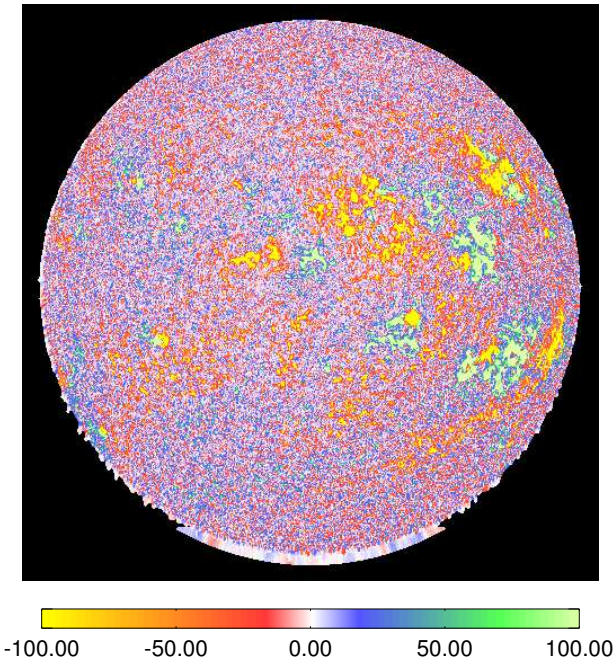
The magnetogram is transformed from the actual projection, defined by the corresponding value of b_0, to one with $b_0 = 0$. The green arc-shape shows the *missing* polar and limb pixels that need to be determined.



STEP #4

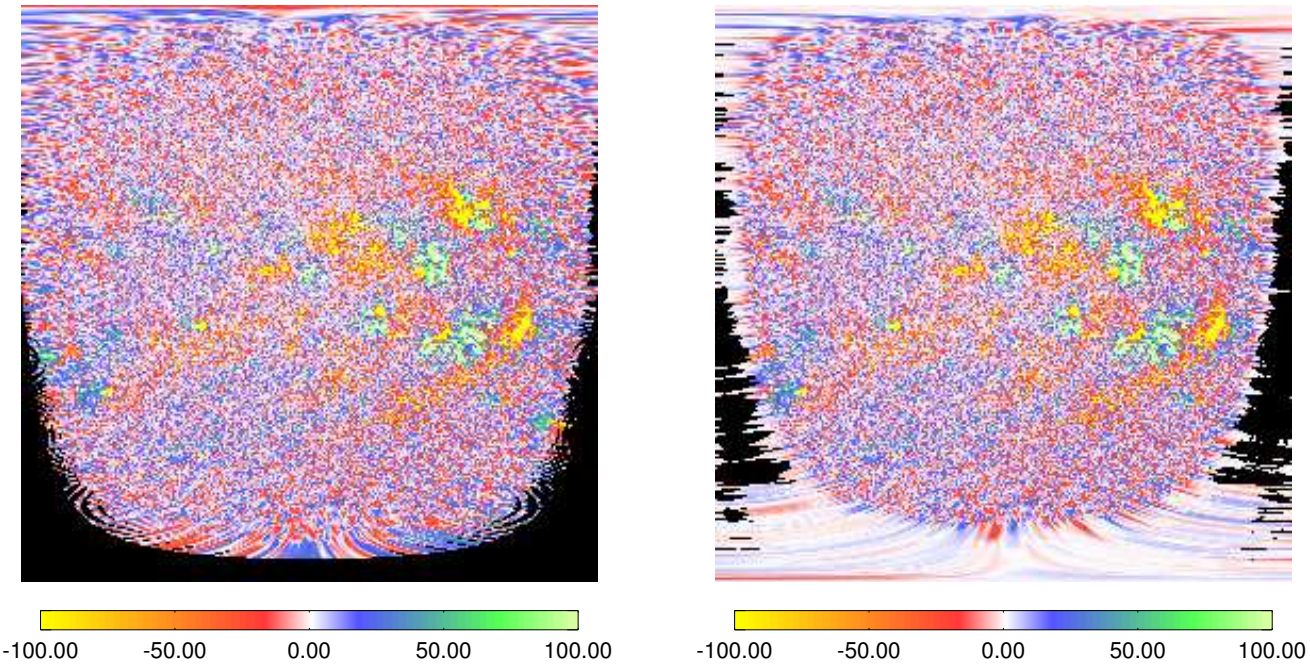
An elaborated extrapolation scheme is used to determine the value of the *missing* pixels.

1. For each missing pixel, we select 17 *good* pixels in the CLA range between 67° and 70° that are nearest to the missing pixel.
2. We use the weighted distance from the 17 pixels to estimate the missing pixel's value. The total weight is 1.0, and each individual weight is (1/distance).



STEP #5

The magnetogram is transformed into heliographic coordinates, longitude and latitude.



The image on the left is the type of magnetogram used in current magnetic charts, where only step #1 was applied. The image on the right shows the final magnetogram after all the steps have been applied.

MAPS CREATION: Meridional field maps

1. Collect a bunch of magnetograms for a desired CR

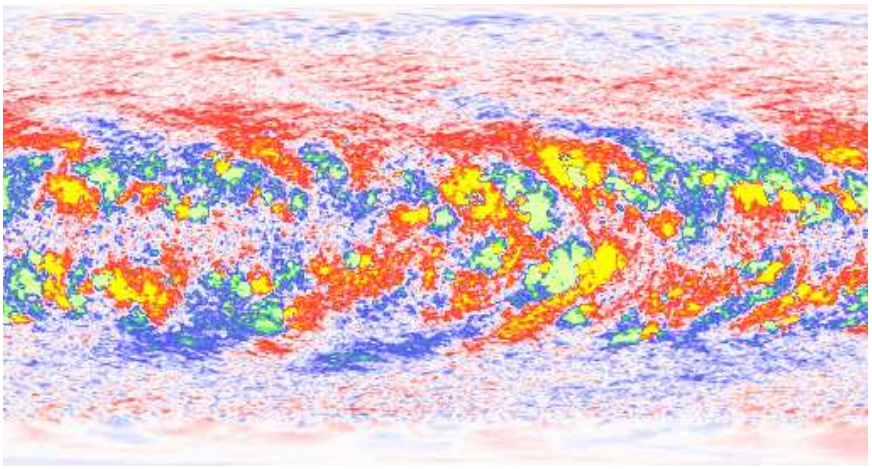
2. A single point (e.g.: Lon,Lat) in a magnetic chart (synoptic or snapshot) can be observed different times during a CR. If we label with B_i each measurement of the LOS component of this point on the surface we can use weighted averages of these observations to resolve the stationary part of the Sun's magnetic field into B_v (component of the field in the meridional plane) and B_t (transverse component in the east-west direction) using:

$$B_i = \cos(L_i)B_v + \sin(L_i)B_t,$$

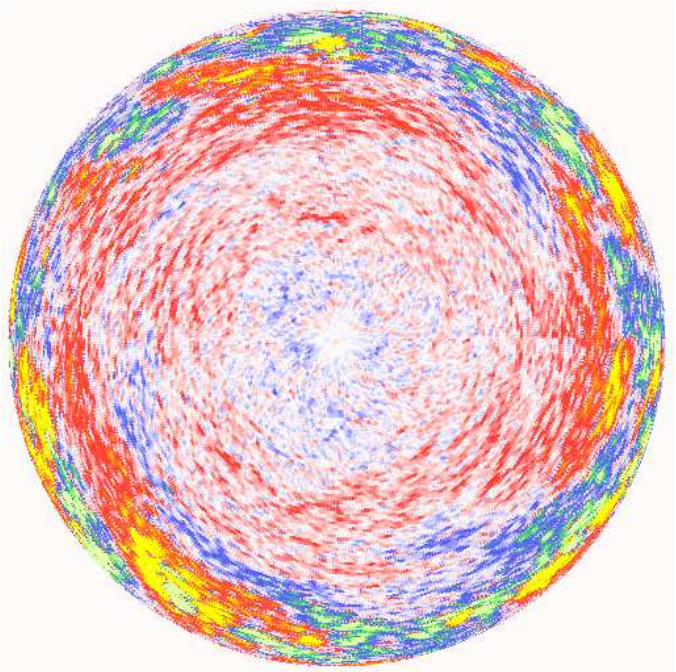
   where L is the central meridional angle (Ulrich et al. 2002, in ApJ Supp 139, p. 259).

3. We create two maps: synoptic and snapshot (Ulrich & Boyden 2006, in Solar Phys. 235, p. 17). We only use the B_v component of the field.

SNAPSHOT MAP, CR 1966, Average B0 = 6.88 degrees



NORTHERN HEMISPHERE



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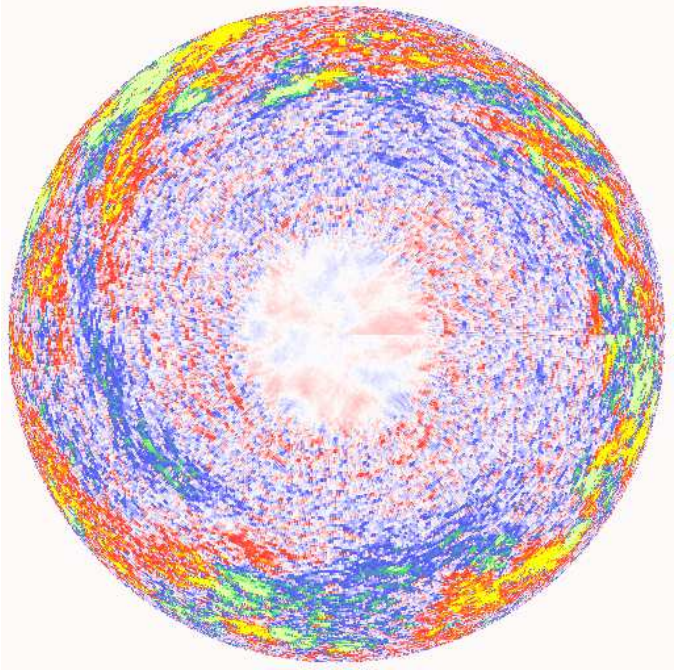
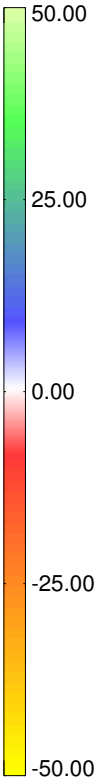
360



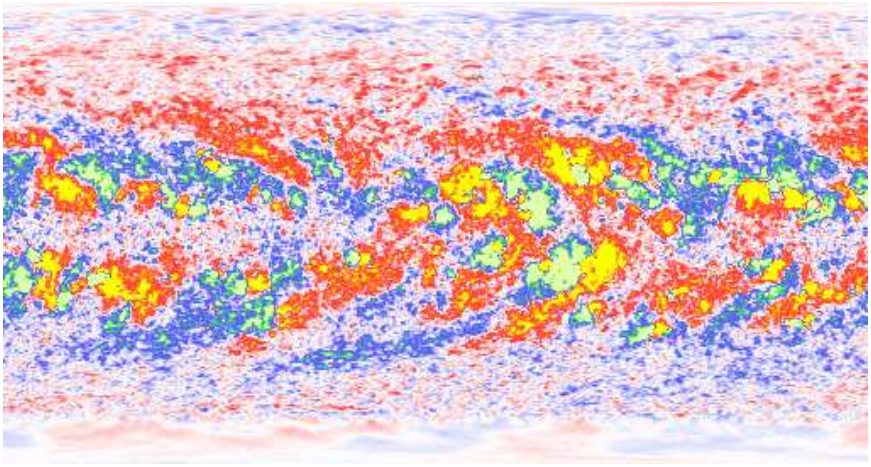
SOUTHERN HEMISPHERE

360
0

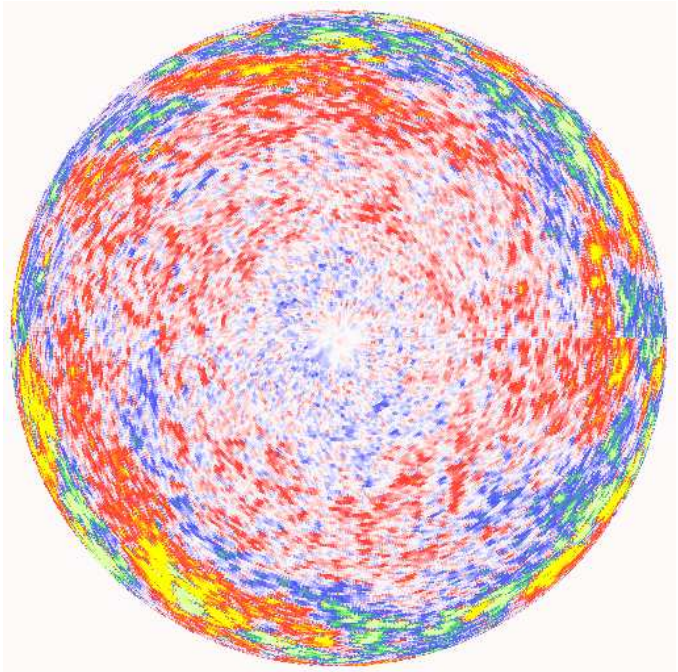


Gauss

SYNOPTIC MAP, CR 1966, Average B0 = 6.88 degrees



NORTHERN HEMISPHERE



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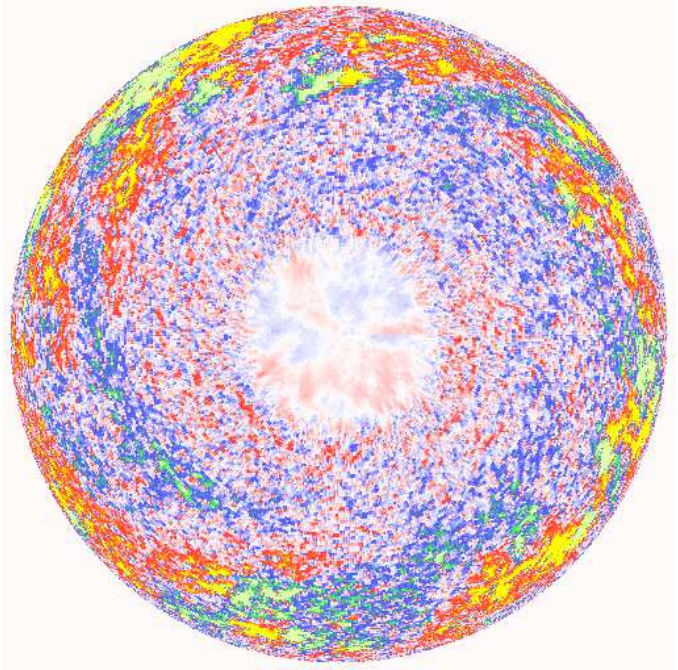
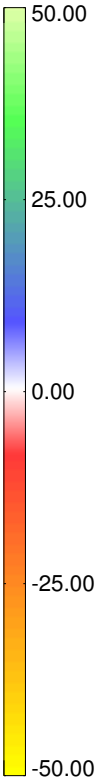


SOUTHERN HEMISPHERE

360
0



Gauss

MAPS CREATION: Radial maps

- We do not divide the observed LOS magnetic field by the factor cos(CMA)cos(latitude - b_0) to retrieve the radial component of the magnetic field!

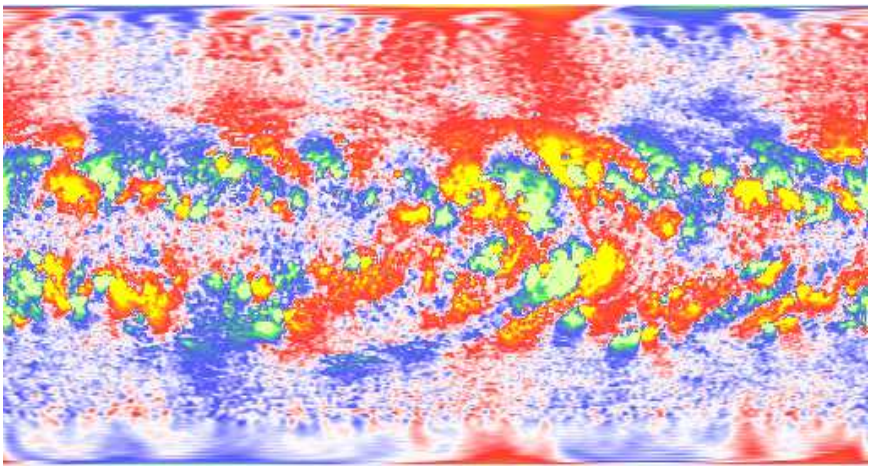
- The meridional field maps are used to create the radial maps

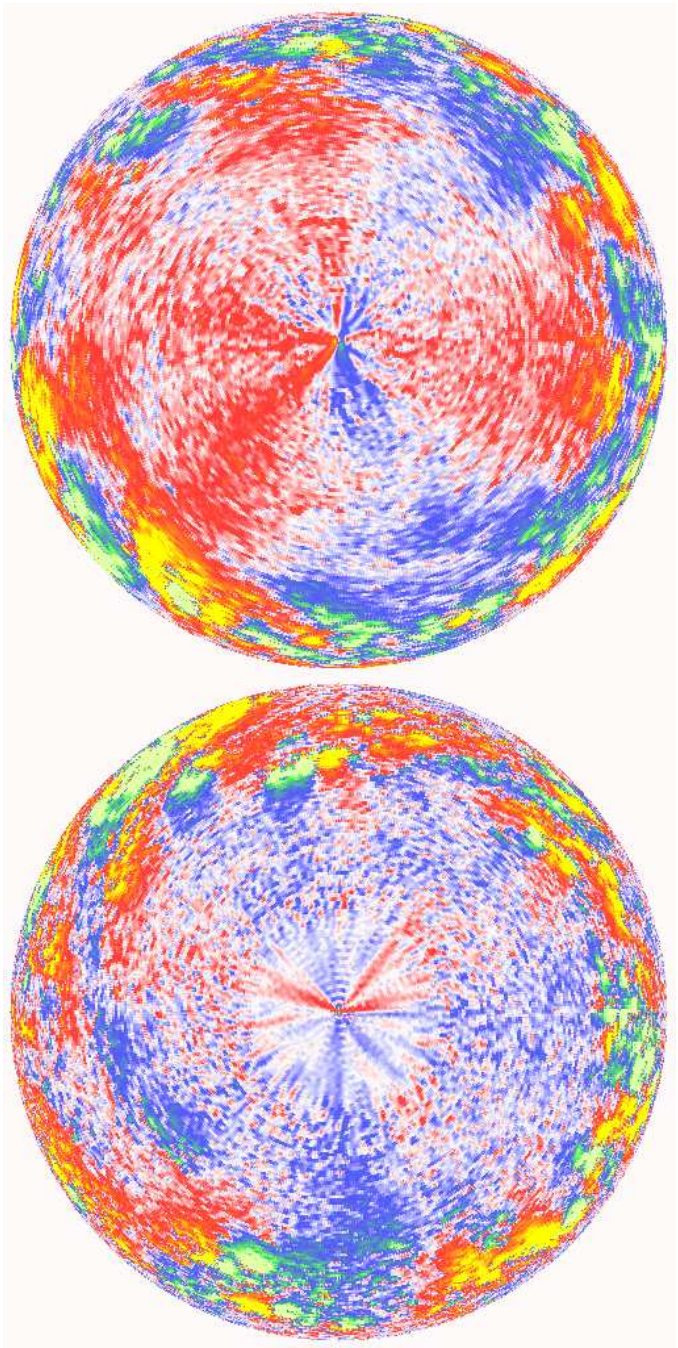
- We apply the method described in Altschuler et al. 1977, in Solar Phys. 51, p. 345, to the following decomposition:

$$B_v = B_r \cos(\text{latitude} - b_0) + B_\theta \sin(\text{latitude} - b_0),$$

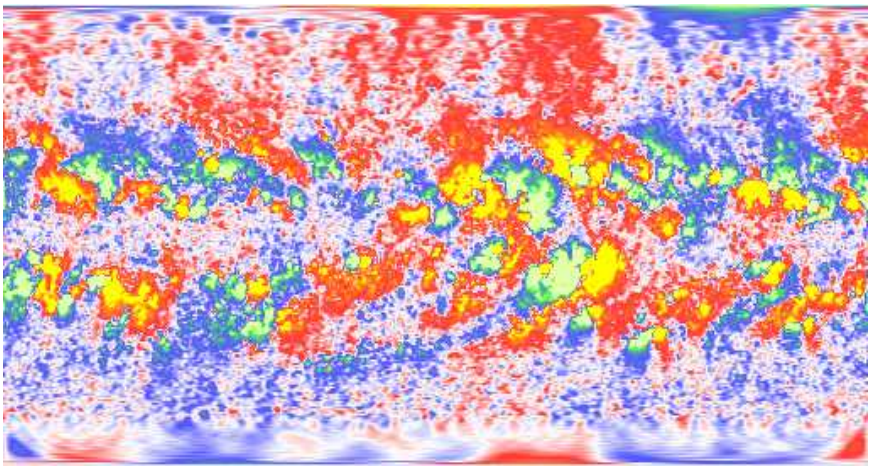
  We compute the spherical harmonic coefficients from the B_v map and we use these coefficients to determine B_r, and eventually B_θ.

SNAPSHOT MAP, CR 1966, Average B0 = 6.88 degrees
RADIAL FIELD

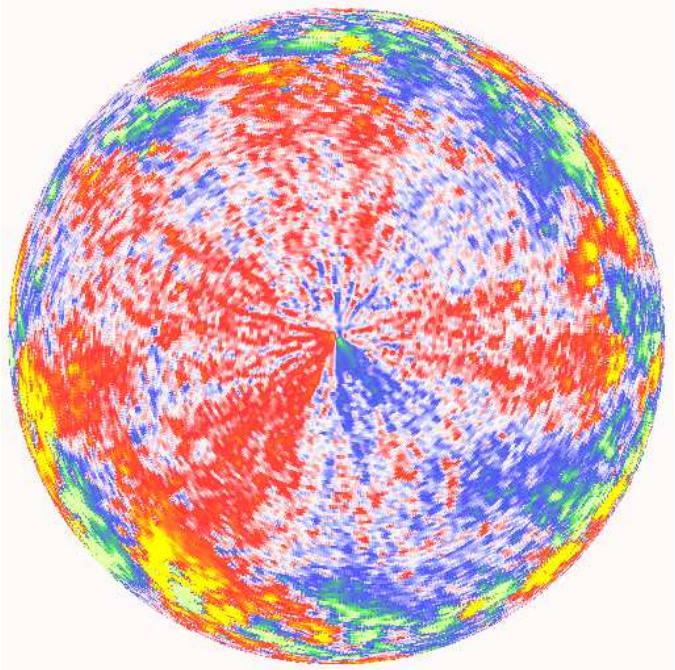




SYNOPTIC MAP, CR 1966, Average B0 = 6.88 degrees
RADIAL FIELD



NORTHERN HEMISPHERE



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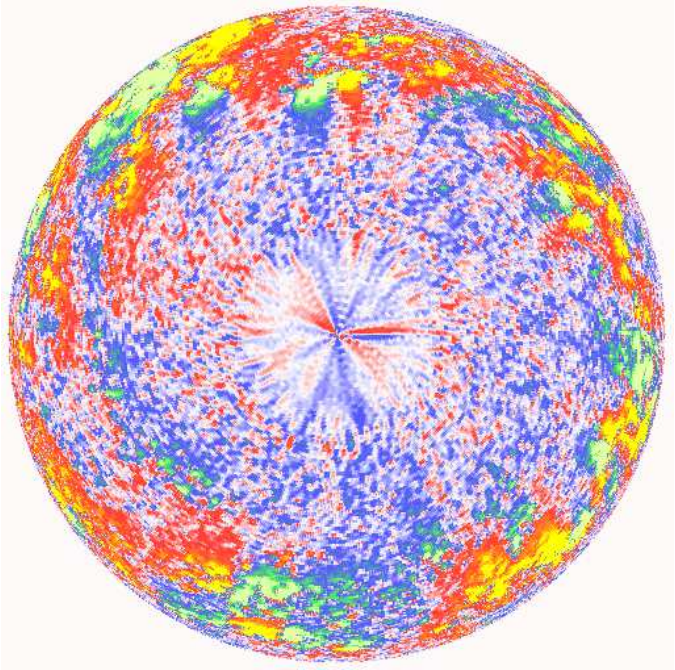
SOUTHERN HEMISPHERE



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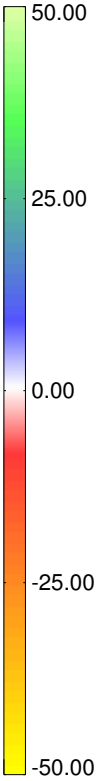
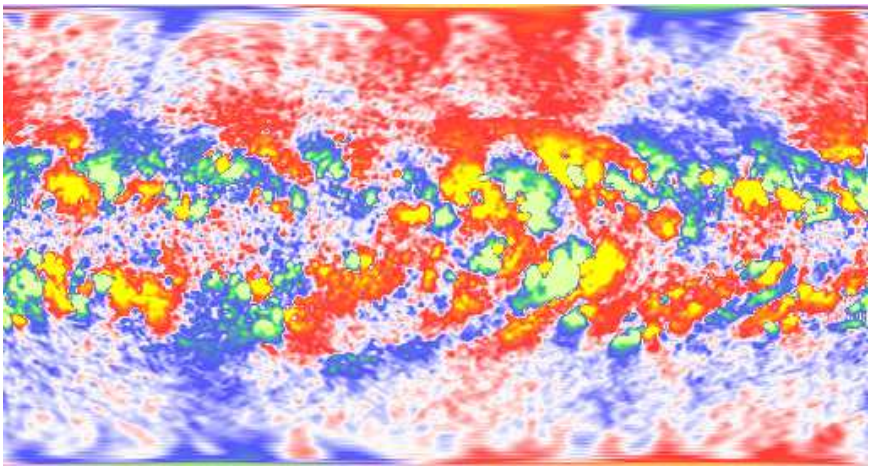


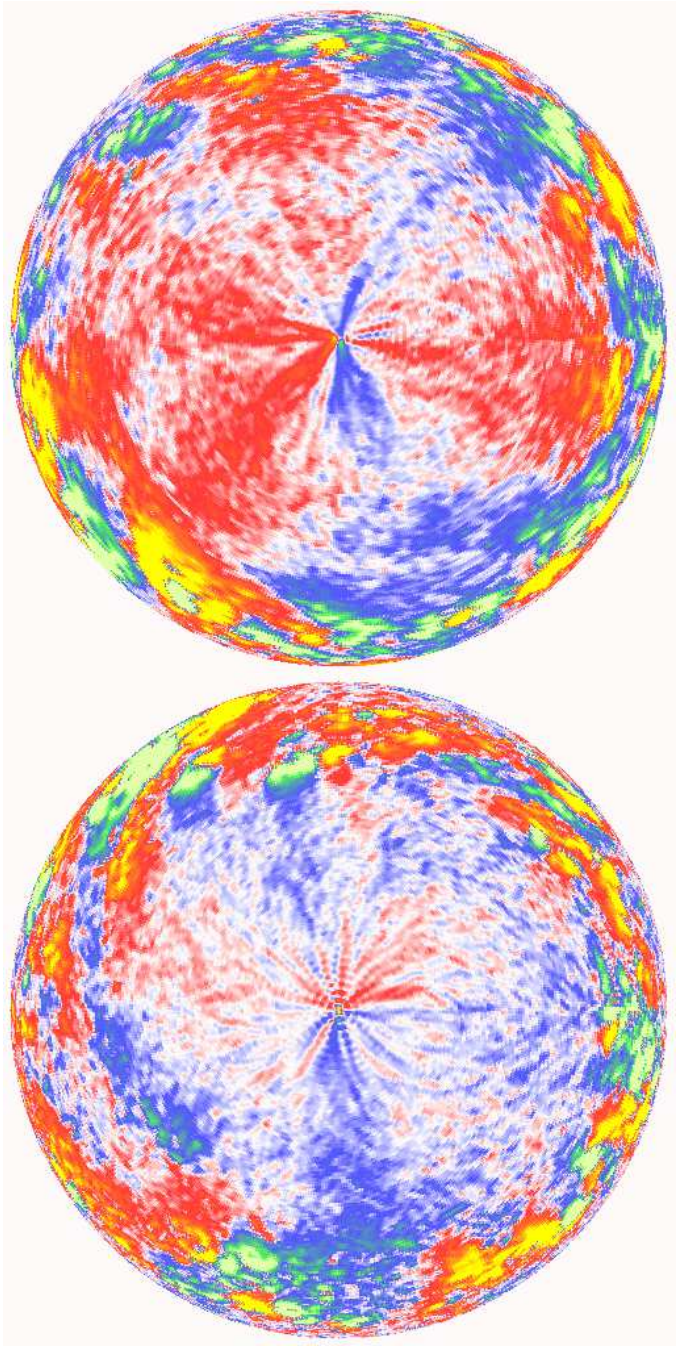
Gauss

MWO SNAPSHOT MAP, CR 1966, Average B0 = 6.88 degrees
RADIAL FIELD

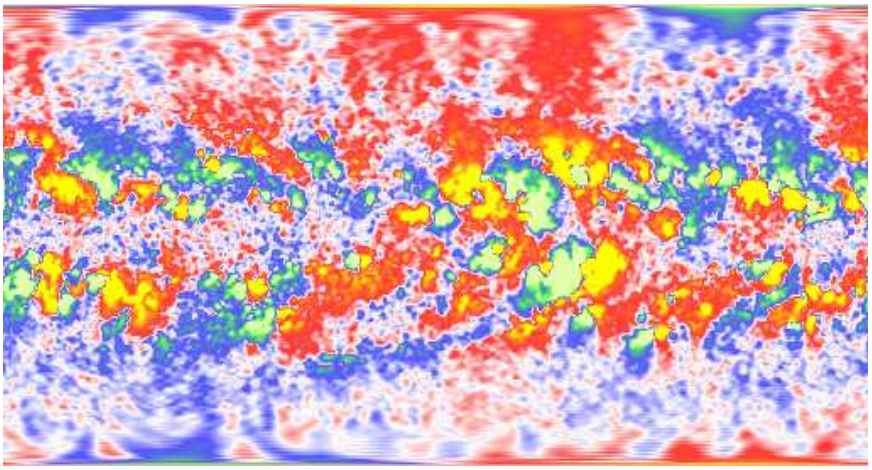


NORTHERN HEMISPHERE

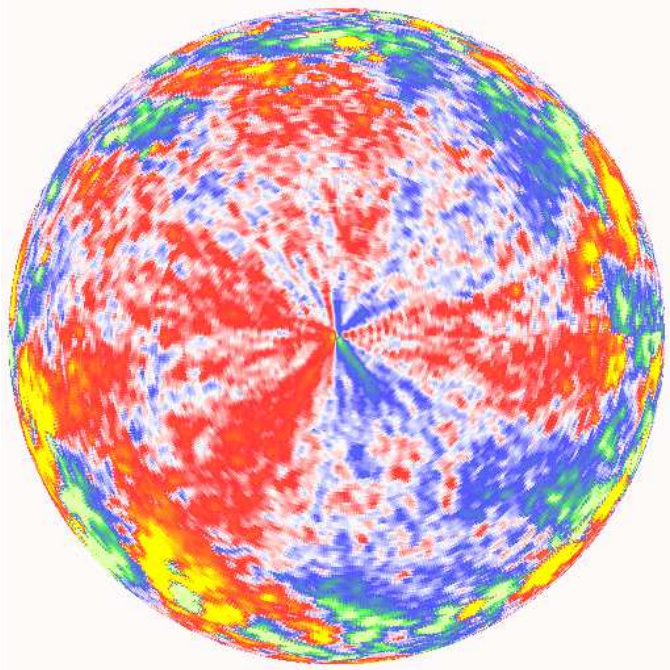
SOUTHERN HEMISPHERE



MWO SYNOPTIC MAP, CR 1966, Average B0 = 6.88 degrees
RADIAL FIELD



NORTHERN HEMISPHERE



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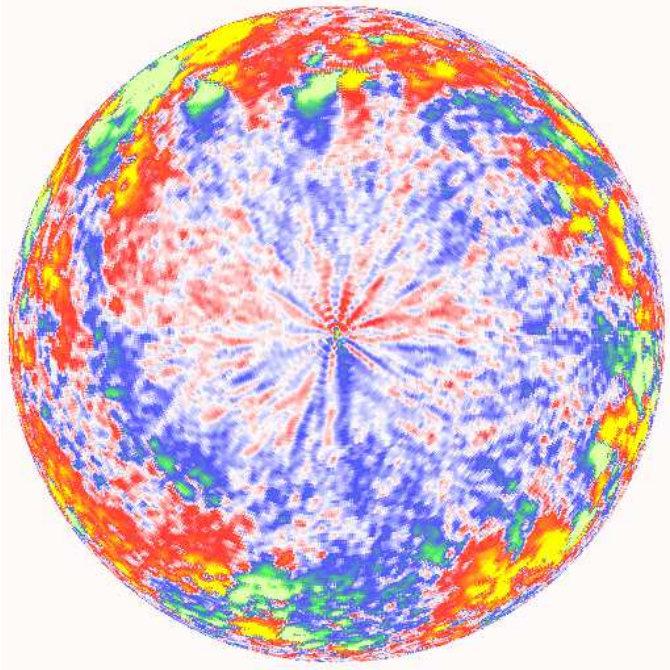
SOUTHERN HEMISPHERE



360
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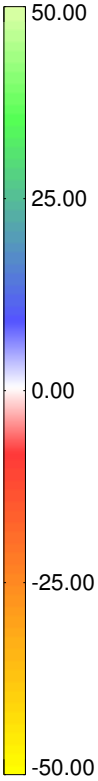

Gauss