Magnetic Perturbations from Magnetosphere Models

COMMUNITY
COORDINATED
MODELING
CENTER

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http://ccmc.gsfc.nasa.gov
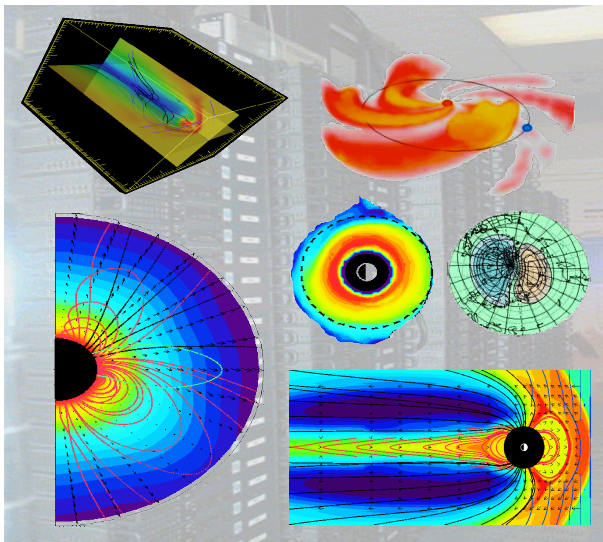
Contributors:

Models:

OpenGGCM:

    J. Raeder, A. Vapirev, U. New Hampshire

SWMF:

    A. Glocer, NASA GSFC, A. Ridley U. Michigan

CMIT:

    M. Wiltberger, P. Schmitt, NCAR,

    V. Merkin, JHU-APL

Data:

Intermagnet

Magnetic perturbations

δB at station location (x_{St}, y_{St}, z_{St}) at a number of high- and mid-latitude stations by Biot-Savart from different current systems:

Magnetosphere:

Distance **R**=(x-x_{St} , y-y_{St}, z-z_{St}) and

volume element dV.

R > 3 R_E.

Transform to SM coordinates.

$$\delta B = \left(\frac{\mu_0}{4\pi} \sum_{GM} \frac{\mathbf{J}x\mathbf{R}}{R^3} dV \right)_{SM}$$

Field-aligned currents:

Gap region between 110 km altitude and 3 RE.

120 (lon.) X 120 (lat.) x 60 (radial) positions.

Currents taken from magnetosphere, aligned with magnetic dipole field.

Magnetic perturbations (cont.)

Ionosphere:

Local grid centered around zenith axis at each station.

110 km altitude, positions spaced every 50 km on rings with up to 1500 km radius (to horizon).

Use height-integrated currents in ionosphere electrodynamics.

Many stations can be tracked at once.

Runs serially (with some vectorization within IDL).

Sample plots

SWMF has built-in capability:

- Biot-Savart on magnetosphere currents

- Field-aligned currents on 180x180x800 grid

- Ionosphere currents on IE grid (120x180)

- Runs massively parallel (magnetosphere and FAC contributions) during run execution

Event 1: |δB| at YKC (glon=245, glat=62.5)

B from observatory file: ykc_OBS_20031029.txt

Observation:
—ykc

Model runs:
—9_SWMF
—9_SWMF_C1
—9_SWMF_C2
—9_SWMF_C3
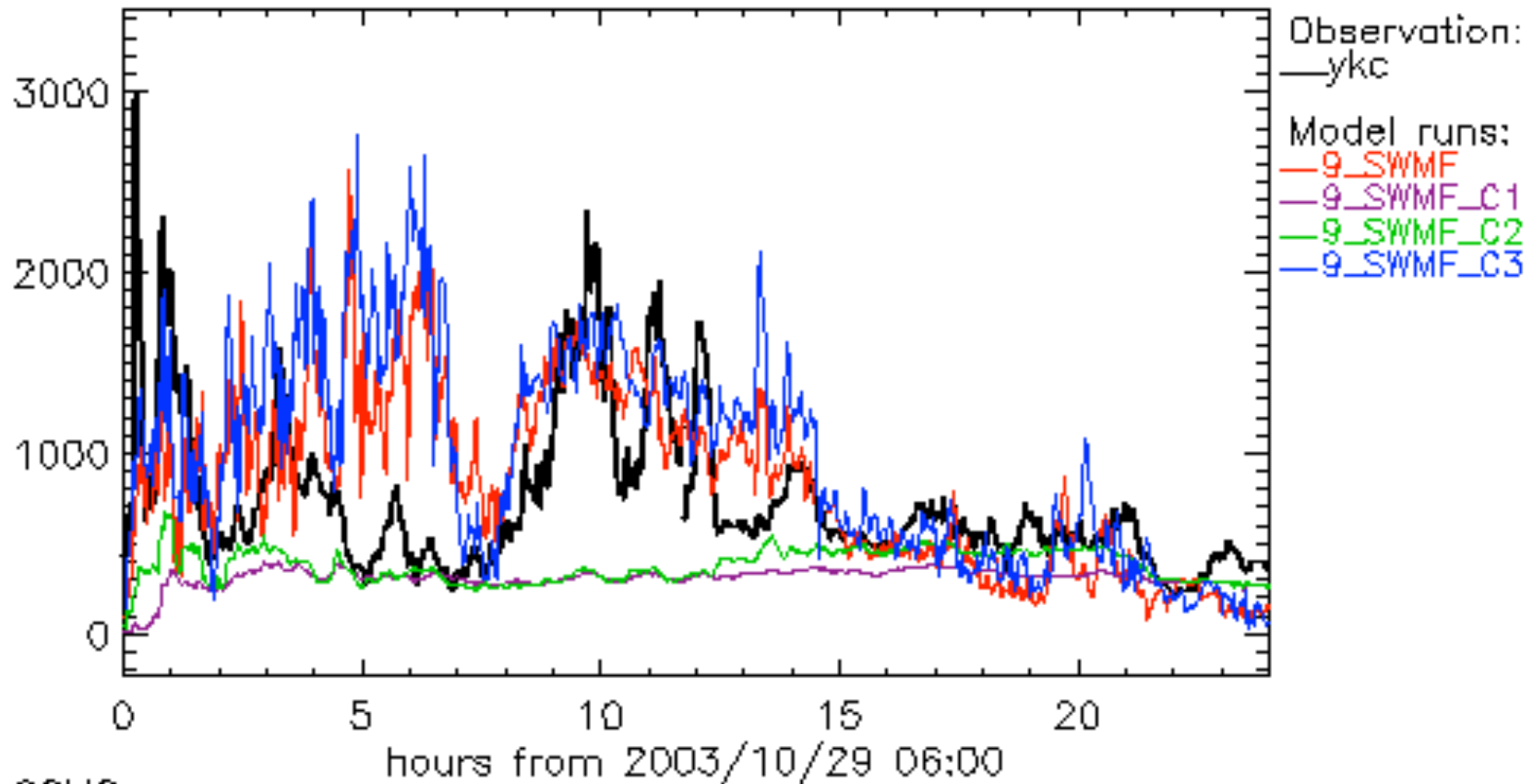
Plot: CCMC
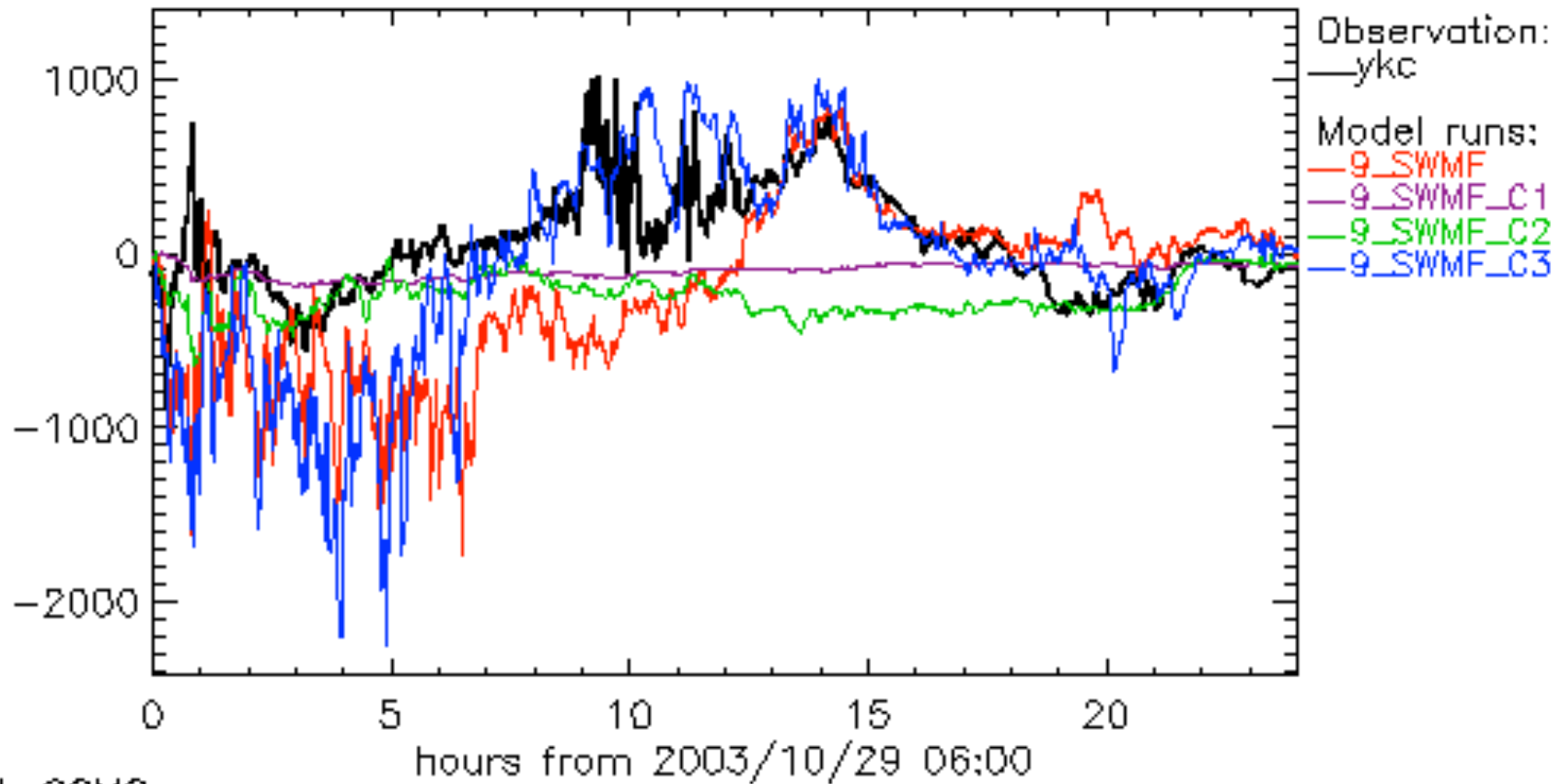
9_SWMF: SWMF built-in results
9_SWMF_C1: CCMC, magnetosphere
9_SWMF_C2: CCMC, magnetosphere+FAC
9_SWMF_C3: CCMC, magnetosphere, FAC and ionosphere currents

YKC: Yellowknife

δB$_{east}$ at same station

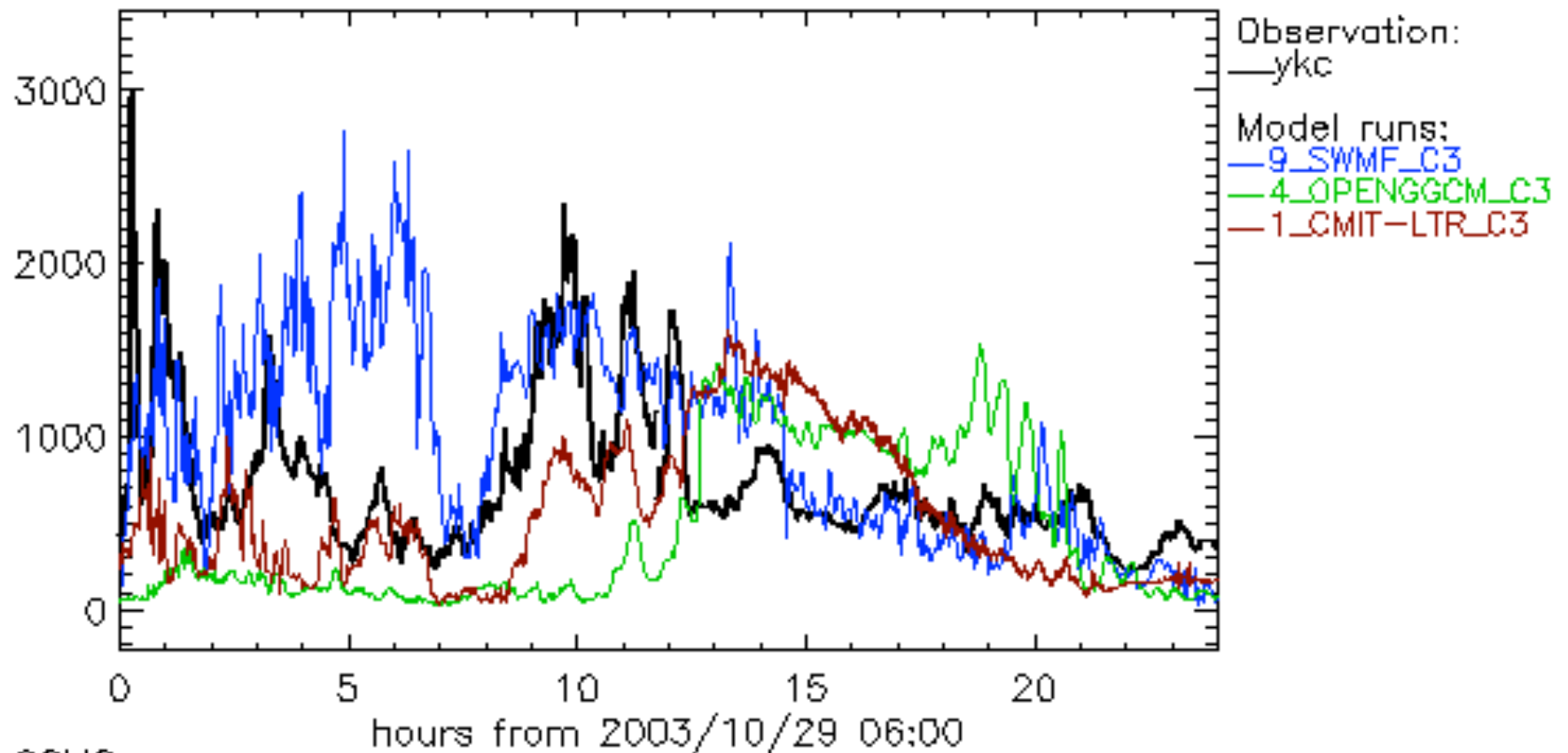B_East from observatory file: ykc_OBS_20031029.txt

Observation:
——ykc

Model runs:
——9_SWMF
——9_SWMF_C1
——9_SWMF_C2
——9_SWMF_C3

hours from 2003/10/29 06:00

Plot: CCMC

|B| at YKC
3 magnetosphere models

B from observatory file: ykc_OBS_20031029.txt

Observation:
——ykc

Model runs:
——9_SWMF_C3
——4_OPENGGCM_C3
——1_CMIT-LTR_C3

hours from 2003/10/29 06:00

Plot: CCMC

$|\delta B_{East}|$ at HRN (glon=15, glat=77) for Event 2 (3 magnetosphere models)

B_East from observatory file: hrn_OBS_20061214.txt

Observation:
— hrn
Model runs:
— 9_SWMF_C3
— 4_OPENGGCM_C3
— 1_CMIT−LTR_C3

hours from 2006/12/14 12:00
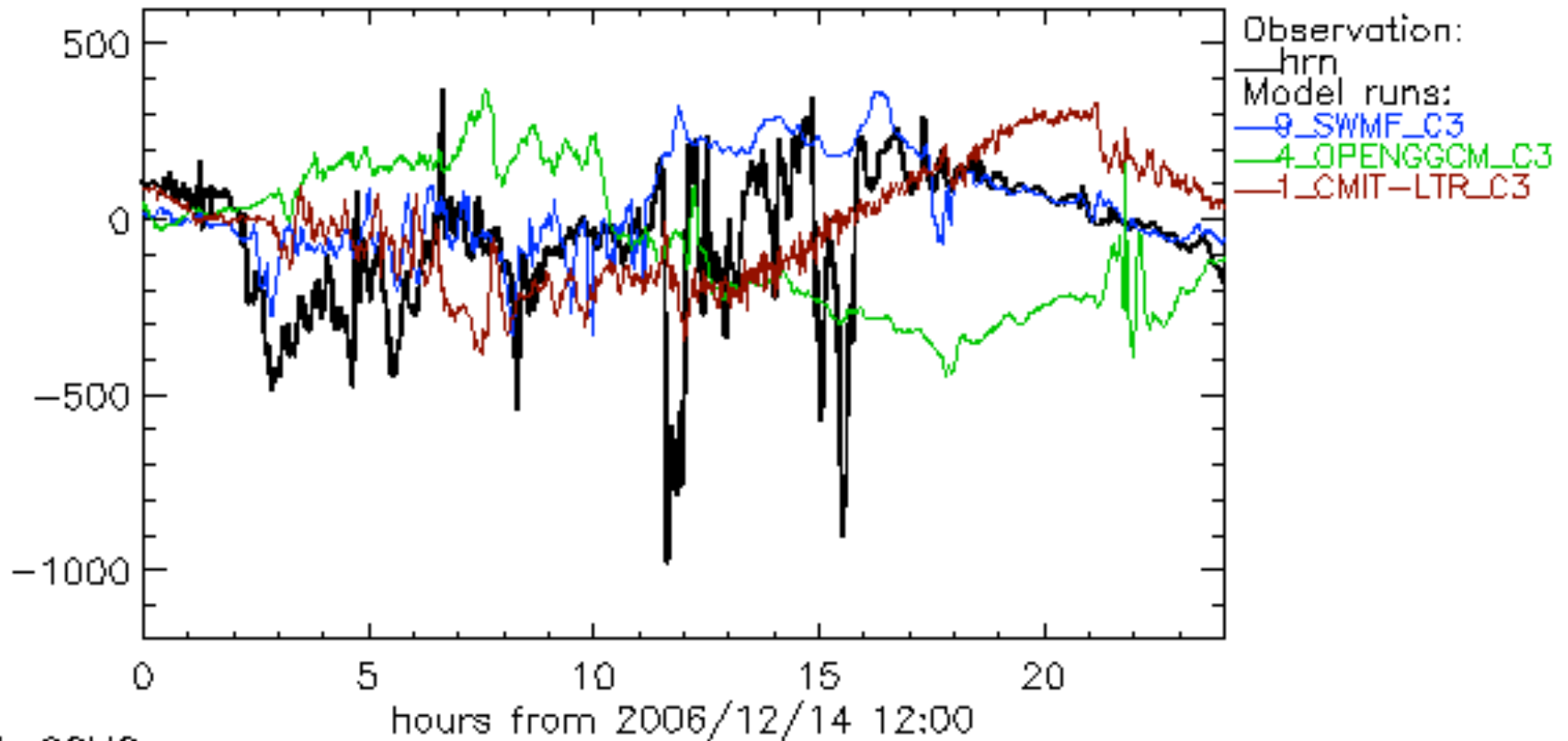
Plot: CCMC

HRN: Hornsund

Conclusions

- B-field perturbations can be computed from any model output (SWMF, OpenGGCM, LFM).

- Procedure can run in real-time after a model has written additional data.

- Procedure accumulates data from SWMF real-time run at CCMC for about 50 stations.