Enabling API Access to the Space Weather Services at the Community Coordinated Modeling Center

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Community Coordinated Modeling Center

CCMC hosts a unique collection of over 100 contributed models that cover the entire domain from the solar corona to the Earth's upper atmosphere aiming to:

- Provide the scientific community with an access to modern space research models
  - Customized model runs
  - Online analysis and visualization of model results
  - Conversion of model result files to standard data formats

- Provide a platform for unbiased model testing and evaluation
- Support space weather forecasters through Research-to-Operation (R2O) activities
- Support space weather education
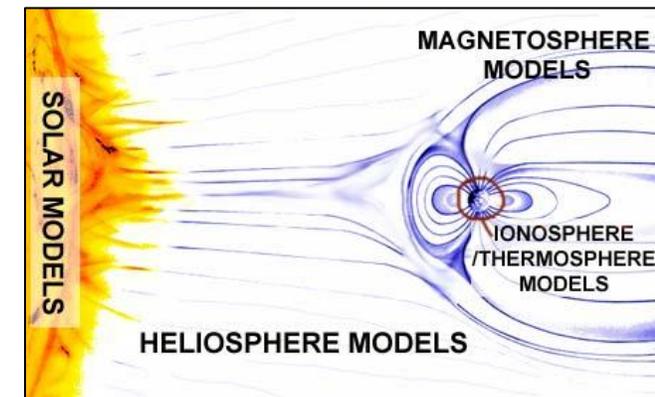
Collaborative API Access to Services at CCMC

iSWA (space weather data streams acquisition and display tool)

- Most data streams are available through HTTP archive, time series data streams available through HAPI

Scoreboards (model intercomparing tools)

- SEP Scoreboard - all data presented in interactive scoreboards can also be downloaded in its original form from the HTTP archive

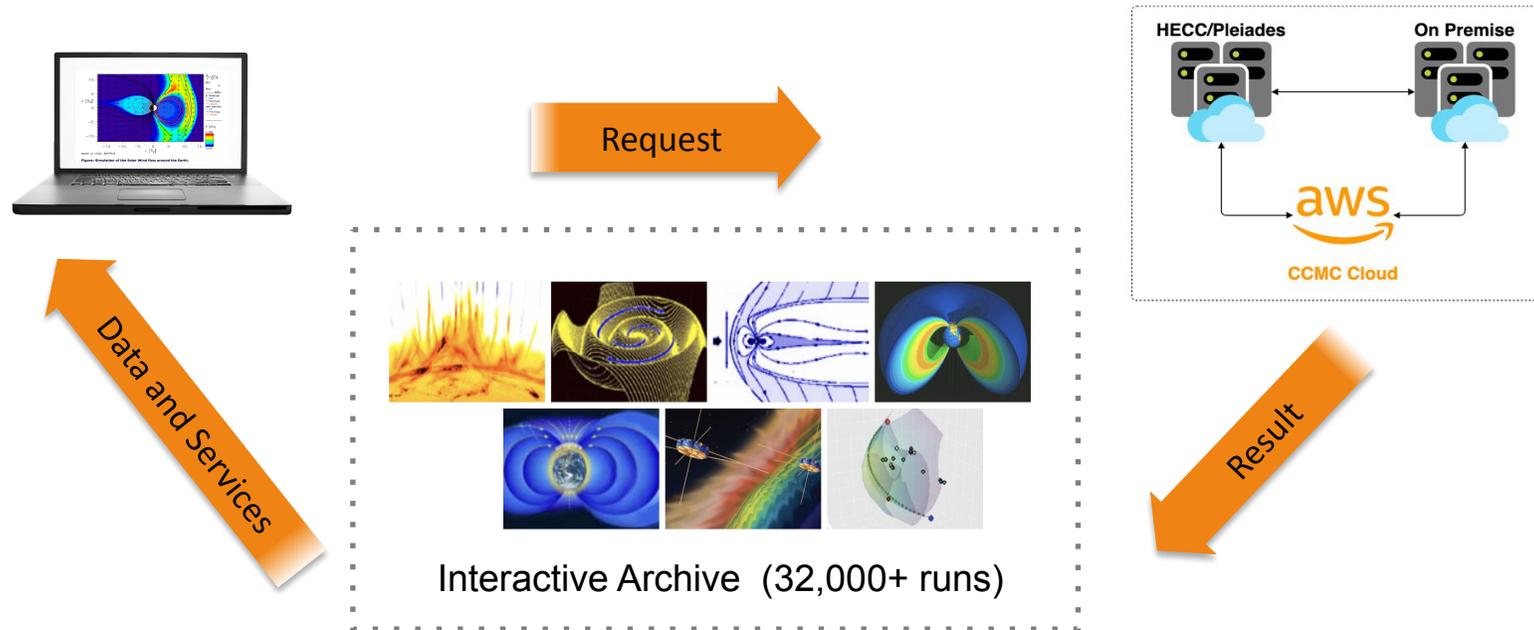- Flare scoreboard - presented data available through HAPI

DONKI (online database of space weather events)
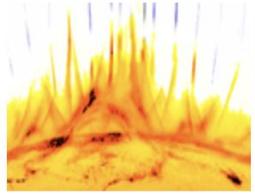
- Comprehensive Web Service API

Runs on Request System (ROR) at CCMC

Request

Data and Services

Result

HECC/Pleiades   On Premise

aws
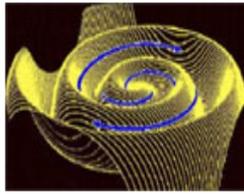
CCMC Cloud

Interactive Archive (32,000+ runs)

Model run requests are submitted to ROR using a web form, processed by CCMC, and published to an online archive for a subsequent interactive data analysis

- Open and Free system enabling Space Weather and Helio R2O

- Test drive ~60 state-of-the-art models without cost of entry barriers

- Opportunity for model evaluations by the entire community
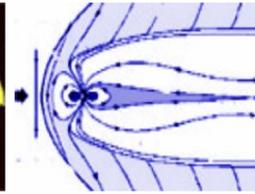
- Expert CCMC guidance and support for advanced requests

https://ccmc.gsfc.nasa.gov/models/?services=Runs-on-Request
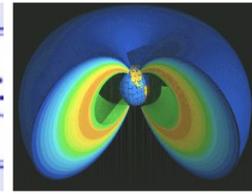https://ccmc.gsfc.nasa.gov/simulations/
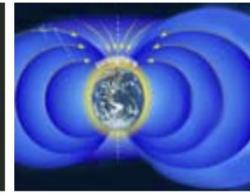
ROR Run Results Archive

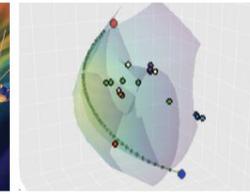Solar Models Results · Heliosphere Models Results · Global Magnetosphere Models Results · Inner Magnetosphere Models Results · Ionosphere / Thermosphere Models Results · Local Physics Models Results · Post Processing Request Results

Open archive of over 32,000 complete runs (~3PB) integrated with extensive data analysis services - visualization, run chaining, format conversion, etc…

ROR Archive Includes:

- Runs performed by ROR users

- Curated runs performed by CCMC (e.g., >150 geostorms)

- Model validation campaigns

- Outside simulations delivered to CCMC

- Simulations performed through the partners, e.g., VSWMC

Guided User Experience: Pros and Cons

- Highly interactive user interfaces in ROR offer guidance to the users, but become a tedious bottleneck when working with more than a handful of simulations

- Rigid workflow makes the system and data opaque for both the users and the operators

Sample Run Request Page

Sample Run Result Page

Sample Model Outputs Page

Opening up ROR via REST APIs: Goals

- Provide easy and uniform automated management of runs series

- Make system, data, and metadata more transparent and observable

- Support online access to individual run result data files
  - Client applications can be built on top of URL-accessible results
  - Don't need to download and store everything if data are readily accessible

- Enable client applications and data pipelines without forcing users to scrape web site for metadata

- Simplify interconnection between ROR services

- Connect to partner organizations through open and reusable interfaces

Machine Discovery

- Entire ROR archive can be now searched both interactively and through API

0:
  run_num: "Bernhard_Haas_052424_IM_1"
  link: "https://ccmc.gsfc.nasa.gov/results/viewrun.php?runnumber=Bernhard_Haas_052424_IM_1"
  metadata: "https://ccmc.gsfc.nasa.gov/results/api/run_metadata.php?runnumber=Bernhard_Haas_052424_IM_1"
  files: "https://ccmc.gsfc.nasa.gov/results/run_files.php?runnumber=Bernhard_Haas_052424_IM_1&format=json"
  request_date: "2024-05-24"
  domain: "IM"
  keyword: "First run of Super Storm"
  title: "Mother Day Storm"
  model: "VERB"
  meta_string: "VERB 2.5"
  start: "2024/05/08 00:00"
  end: "2024/05/15 00:00"
1:
  run_num: "Edith_Botek_101824_IM_5"
  link: "https://ccmc.gsfc.nasa.gov/results/viewrun.php?runnumber=Edith_Botek_101824_IM_5"
  metadata: "https://ccmc.gsfc.nasa.gov/results/api/run_metadata.php?runnumber=Edith_Botek_101824_IM_5"
  files: "https://ccmc.gsfc.nasa.gov/results/run_files.php?runnumber=Edith_Botek_101824_IM_5&format=json"
  request_date: "2024-10-18"
  domain: "IM"
  keyword: "MotherDay"
  title: ""
  model: "BSPM"
  meta_string: "BSPM 2021"
  start: "2024/05/11 15:00:00"
  end: "2024/05/11 16:00:00"
2:
  run_num: "Josh_Pettit_061124_IT_1"
  link: "https://ccmc.gsfc.nasa.gov/results/viewrun.php?runnumber=Josh_Pettit_061124_IT_1"
  metadata: "https://ccmc.gsfc.nasa.gov/results/api/run_metadata.php?runnumber=Josh_Pettit_061124_IT_1"
  files: "https://ccmc.gsfc.nasa.gov/results/run_files.php?runnumber=Josh_Pettit_061124_IT_1&format=json"
  request_date: "2024-06-11"
  domain: "IT"
  keyword: "Mothers Day Super Storm"
  title: ""
  model: "GITM"
  meta_string: "GITM 21.11"
  start: "2019-05-09"
  end: "2019-05-12"
3:
  run_num: "Balazs_Heilig_100124_IT_1"
  link: "https://ccmc.gsfc.nasa.gov/results/viewrun.php?runnumber=Balazs_Heilig_100124_IT_1"
  metadata: "https://ccmc.gsfc.nasa.gov/results/api/run_metadata.php?runnumber=Balazs_Heilig_100124_IT_1"
  files: "https://ccmc.gsfc.nasa.gov/results/run_files.php?runnumber=Balazs_Heilig_100124_IT_1&format=json"
  request_date: "2024-10-01"
  domain: "IT"
  keyword: "Mother\\s Day"
  title: ""
  model: "WAMIPE"
  meta_string: "WAMIPE 1.2.4"
  start: "2024-05-10"
  end: "2024-05-12"
4:
  run_num: "RAJESH_BARAD_082824_IT_1"
  link: "https://ccmc.gsfc.nasa.gov/results/viewrun.php?runnumber=RAJESH_BARAD_082824_IT_1"
  metadata: "https://ccmc.gsfc.nasa.gov/results/api/run_metadata.php?runnumber=RAJESH_BARAD_082824_IT_1"
  files: "https://ccmc.gsfc.nasa.gov/results/run_files.php?runnumber=RAJESH_BARAD_082824_IT_1&format=json"
  request_date: "2024-08-28"
  domain: "IT"
  keyword: "MOTHER\\S DAY STORM"
  title: ""
  model: "TIE-GCM"
  meta_string: "TIE-GCM 2.0"
  start: "2024-05-08"
  end: "2024-05-17"

https://ccmc.gsfc.nasa.gov/results/api/find_runs.php?search=mother

Metadata and Provenance

- Runs on Request tabulates metadata on each result page and now provides metadata for all runs in both SPASE and a simple JSON formats

- There are several 'known' clients

  - Virtual Model Repository (VMR) tools
  (started by scraping ROR pages)
  - Flux fly-by-tool
  - ROR itself is a client!

Nilam_Bhosale_092424_1

Run Status: Run Complete
Status updated: 2024-09-28T22:59:41+0000

Run Metadata

Metadata Record:	View Full Run Metadata in the CCMC Metadata Registry (CMR)
Metadata as JSON:	View Full Run Metadata as JSON
Model Domain:	GM
Model Name:	SWMF
Model Version:	v20180525
Title/Introduction:	Storm_origina
Key Word:	Storm_origina
Run type:	Real event sin
Inflow Boundary Conditions:	Time-depende
Start Time:	2004/11/04 00
End Time:	2004/11/04 23
Dipole Tilt at Start in X-Z Plane:	-19.23 °
Dipole Tilt in Y-Z GSE Plane:	-7.84 °
Dipole Update With Time:	yes
Ionospheric Conductance:	auroral
Radio Flux 10.7 cm:	133.7
Co-rotation:	Corotation pot
Grid:	overview grid
Coordinate System for the Output:	GSM
Solar wind input source:	OMNI
Ring current model:	RCM

Magnetosphere Run Parameters:

GM solver:	Sokolov
GM limiter name:	mc3
GM limiter beta:	1.2
GM implicit:	part-implicit
GM timestep:	2.0
GM Boris clight factor:	0.01

Input Data

- View solar wind input data
- List solar wind input data in ASCII format (see

domain: "GM"
status: "Run Complete (Status updated: 2024-09-28T22:59:41+0000)"
progress: 100
filesJSON: "https://ccmc.gsfc.nasa.gov/results/run_files.php?runnumber=Nilam_Bho...
model: "SWMF"
modelVersion: "20180525"
description: "CCMC ROR run for SWMF 20180525 with RORID Nilam_Bhosale_092424_1"
runSubmissionTime: "2024-09-24T05:05:35+00:00"
runExecutionStartTime: "2024-09-28T19:10:43+00:00"
runPublicationTime: "2024-09-28T22:59:41+00:00"
nprocs: ""
simulationStartTime: "2004-11-04T00:00:00+00:00"
simulationEndTime: "2004-11-04T23:59:00+00:00"
outfreq: "60"
keyword: "Storm_original"
inputParameters:
    Run_Ring_Current_Model_or_Not: "False"
    Calculate_Oval_Position_or_Not: "True"
    withRCM: "True"
    withCIMI: "False"
    withCRCM: "False"
    withRBE: "True"
    Provide_Output_Along_Satellite_Trajectory: "False"
    Provide_CDF_Output_files: "False"
    Provide_HDF_Output_files: "False"
    Provide_MAGNETOMETER_Output_Files: "True"
    EXO: "0"
    satellite_names: ""
    SSCWeb_satellite_names: ""
    satellite_output_time_interval: "5"
    solarwind: "var"
    sw_source: "OMNI"
    despike_solar_wind_data: "True"
    despike.threshold: "3"
    despike.number_of_samples: "5"
    setting_option_for_Bx: "user"
    constant-Bx: "0"
    By-coefficient: "0"
    Bz-coefficient: "0"
    b_abs: "8.44"
    b_angle: "-34.35"
    Bx: "0"
    By: "-4.765"
    Bz: "6.972"
    Vx: "-403.613"
    Vy: "-33.138"
    Vz: "13.625"
    N: "22.725"
    T: "41462.1"

Accessibility

- Result files can be downloaded in bulk or individually

- 'Quick-look' graphics and interactive visualization are available for most models

- Data conversion services make data accessible in familiar formats

- API access streamlines access to multiple runs and large outputs on slower connections

- CCMC leads a number of tools for working with the data

Current State

Benefits

- Made the system more open and transparent
- Exposing metadata through an API allowed for a more straightforward interconnection between highly distributed services in ROR
- Public API opened up doors for external clients and collaborations
- A dedicated API allows changing the front end and implementing new features without breaking downstream clients

Challenges

- Rethinking legacy code is hard
- API takes away some flexibility
- Opening the system invites more use, putting a strain on existing infrastructure
- Hard to gauge user interest

Future Work

Development and priorities in ROR are largely driven by the community. Some of our near-future plans for the API features in the Runs on Request include:

- Conform to the popular standards (OpenAPI, Schema.org)

- Document the API and write up examples

- Continue integration with partner services, such as VSWMC and HDRL

- Implement run submission API

- Implement support for other popular interfaces, e.g. HAPI

Questions?