

# Space weather data service providing solar and geomagnetic indices in support of atmospheric drag calculation



# Outline

- Short project presentation
- SST/for (FORIND) - Space weather data service, provided by ISS, Romania
  - Summary of indices offered
  - Service structure
  - Usage examples
- SST/atm (ATMDEM) - Atmospheric neutral density modelling, provided by Met Office UK
  - Service details
  - Usage examples

# Introduction

- Our service (SST/for – FORIND) is part of the Space Weather P2-SWE-II ESA project, under the Space Situational Awareness program
- We provide easy access to 40 solar and geomagnetic indices, nowcasts and forecasts.
- Some indices provided by our service (FORIND) are used by the atmospheric modelling service (ATMDEN) which is part of the same project and provided by Met Office UK

# FORIND service description

- 40 Indices offered:
  - Solar nowcast: 1
  - Solar forecast: 14
  - Geomagnetic nowcast: 14
  - Geomagnetic forecast: 11
- Update periods: 1, 10 or 15 minute, daily, weekly, monthly
- Data providers:
  - CLS
  - BGS
  - GFZ
  - NOAA
  - UK SSDC
  - SIDC
  - World Data Center for Geomagnetism in Kyoto
  - IRF Lund

# Solar Indices offered

- Nowcast:
  - Sunspot number
- Forecast:
  - F10.7
  - F30
  - Sunspot number

# Geomagnetic Indices offered

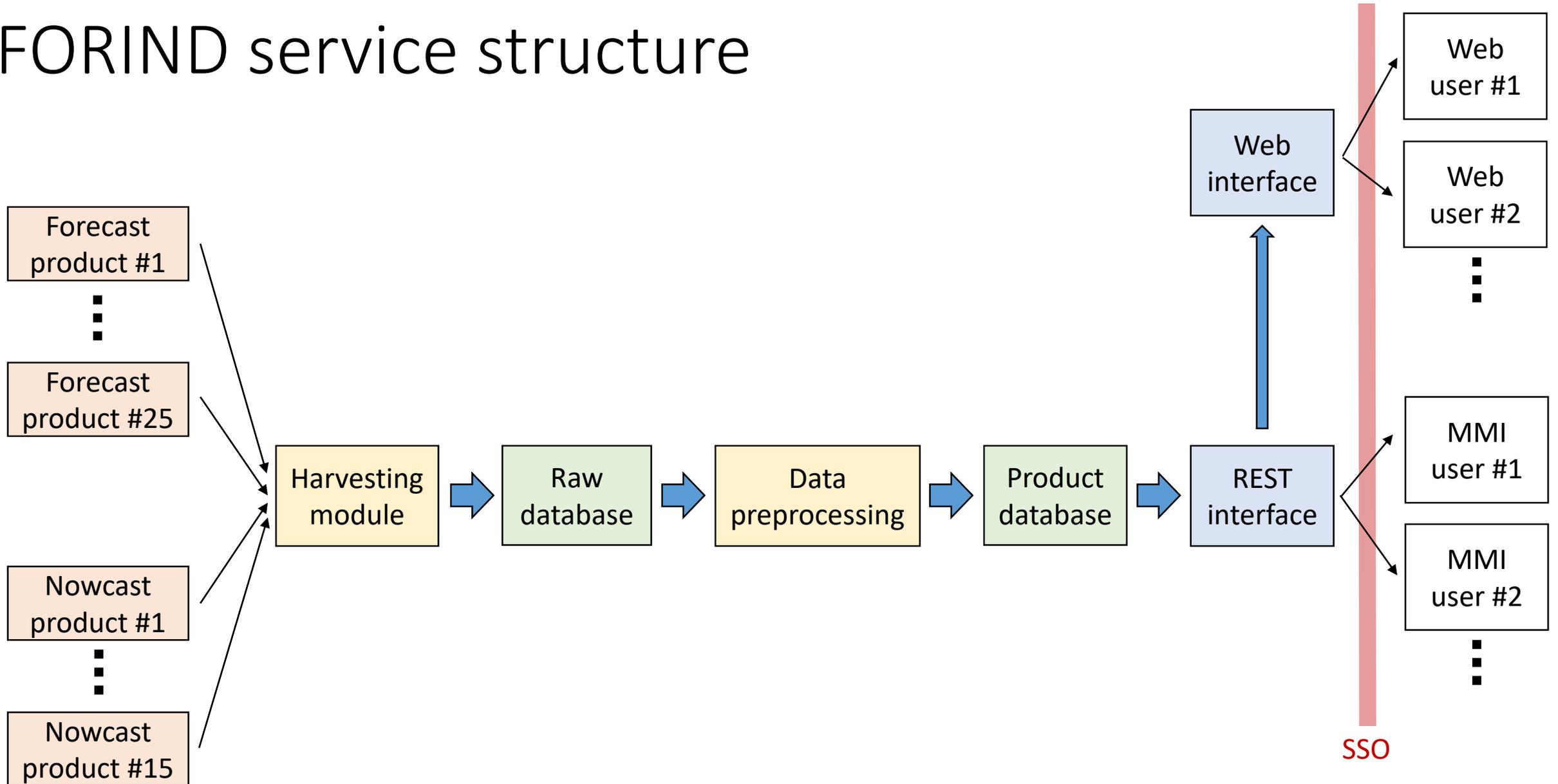
- Nowcast

- aa
- Aa
- ap
- Ap
- DST
- IMF
- Kp
- Cp
- C9

- Forecast

- Ap
- Kp
- ap
- DST
- IG12

# FORIND service structure



# SSO authentication

- The ESA Single Sign On (SSO) system offers the possibility to access all the federated products hosted by the SSA portal using a single username/password combination
- Once the user authenticates within the portal, access is granted to all areas for which he or she is authorized
- The FORIND service is part of the ESA Space Situational Awareness portal, on the ESC for Ionospheric Weather page.
- If one has access to the ESA SSA portal, but not to the FORIND service, a request should be made to ESA SSA in order to receive authorization (email to [helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int)).

# FORIND data presentation

- Machine-to-Machine interface: REST interface
- Human-Machine Interface: website
- Data format: JSON, CSV, PNG

# Web interface

- Available via the ESA SSA interface, on the Ionospheric Weather ESC page: <http://swe.ssa.esa.int/>
- Or directly at <http://ssa.space-science.ro/>
- User selection:
  - Product
  - Time frame
  - Data format (CSV,JSON,PNG)

# FORIND Website – product selection

Product category

Solar Geomag

Nowcast

Forecast

Specific product

- F10.7 Index Forecast 27-day (BGS)
- F10.7 Index Forecast Predicted multi-year (SWPC)
- F10.7 Index Forecast Outlook 27-day (SWPC)
- F10.7 Index Forecast 45-day (SWPC)
- F30 Index Forecast Absolute 30-day (CLS)
- F30 Index Forecast Adjusted 30-day (CLS)
- Sunspot Number Forecast Standard Curve 12-month (SIDC)
- Sunspot Number Forecast Combined Method 12-month (SIDC)
- Sunspot Number Forecast Improved Standard Method 12-month (SIDC)
- Sunspot Number Forecast Improved Combined Method 12-month (SIDC)
- Sunspot Number Forecast Improved McNish & Lincoln method 12-month (SIDC)
- Sunspot Number Forecast Predicted multi-year (SWPC)
- F10.7 Index Forecast Absolute 30-day (CLS)
- F10.7 Index Forecast Adjusted 30-day (CLS)

Time interval

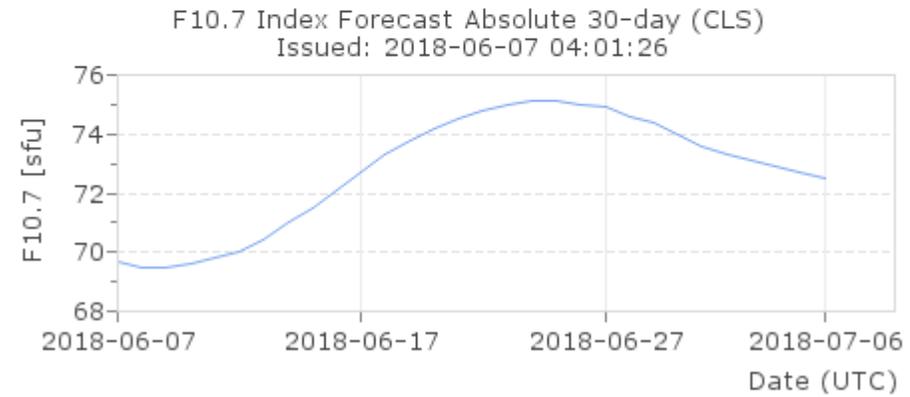
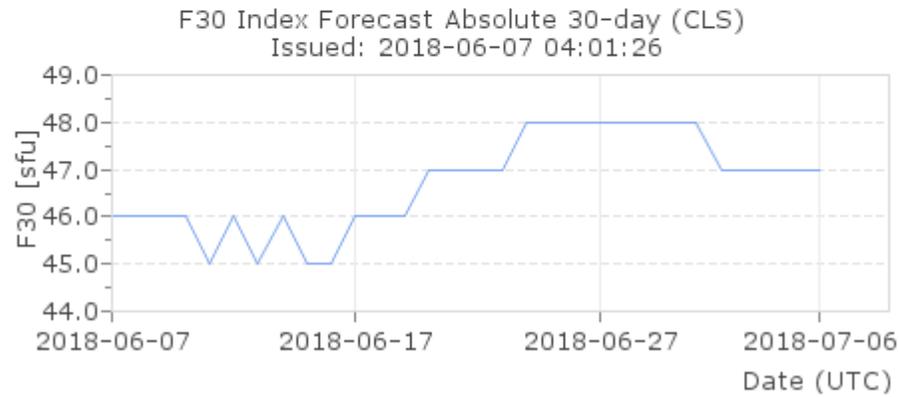
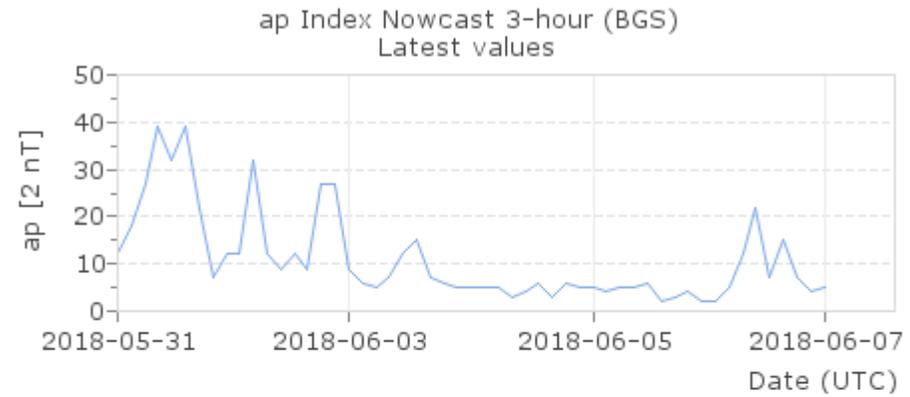
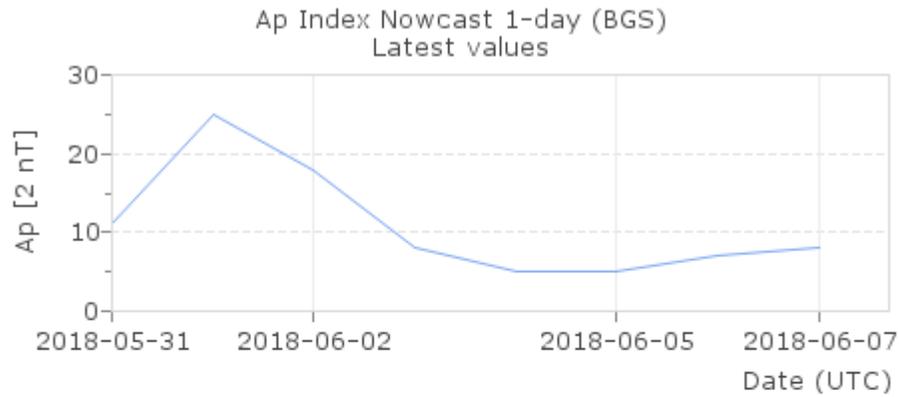
Selection time interval:

Start: 2018-05-31 00:00  End: 2018-06-07 00:00 

Format

Format:  JSON  CSV  PNG

# FORIND website – live product plots



# REST interface

- In the REST architecture, each request from a client contains all the necessary information
- Suitable for machine to machine interface – automated data retrieval
- Query example:

[http://ssa.spacescience.ro/forecast.php?end\\_date=2018-06-07+21:00&output\\_type=PNG&parameter=aa\\_NMH\\_nowcast&start\\_date=2018-05-31+21:00](http://ssa.spacescience.ro/forecast.php?end_date=2018-06-07+21:00&output_type=PNG&parameter=aa_NMH_nowcast&start_date=2018-05-31+21:00)

- Required REST parameters:
  - **end\_date**: end of the requested interval
  - **output\_type**: desired format (CVS,JSON or PNG)
  - **parameter**: name of the desired parameter
  - **start\_date**: start of the requested interval

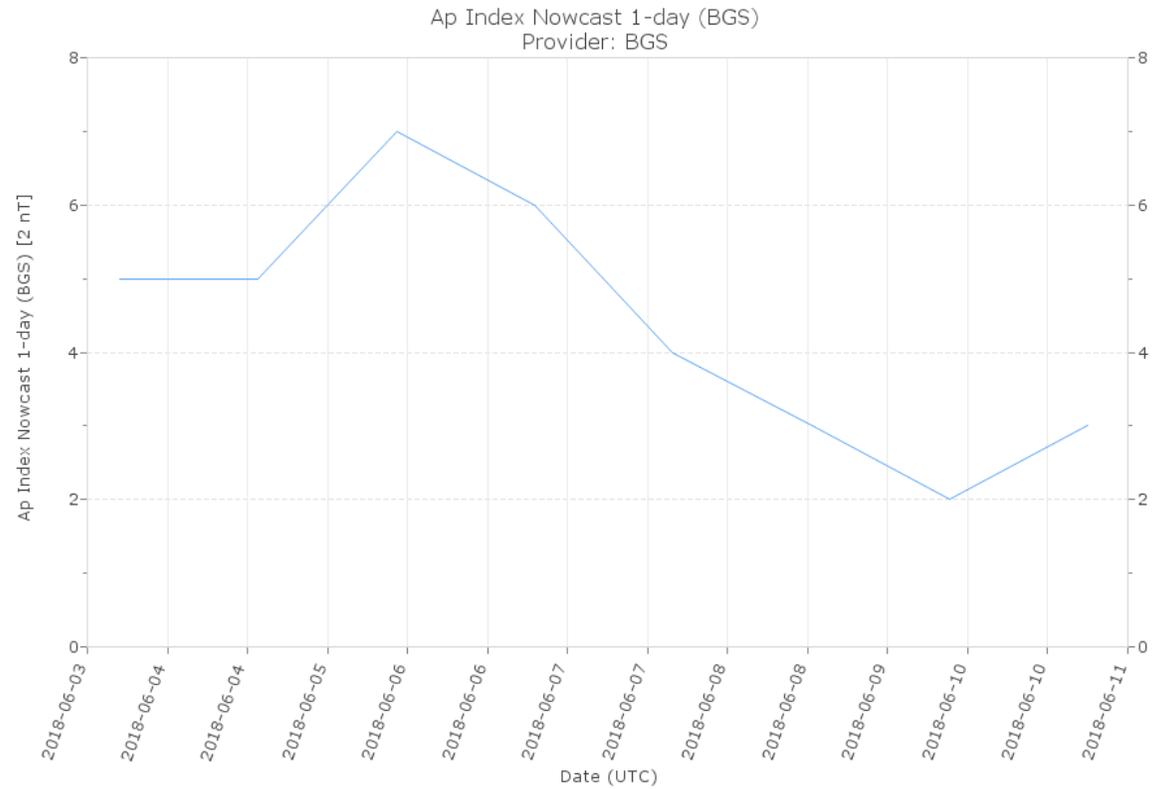
# FORIND CSV header

```
# Query parameters
# parameter: Ap_NMH_nowcast
# start_date: 2018-06-04 00:00
# end_date: 2018-06-11 00:00
# output_type: CSV
#
# Metadata
# Name : Ap Index
# Short name : Ap Index Nowcast 1-day (BGS)
# Originator: British Geological Survey
# Missing data value: 999
#
# Results
# number of rows: 8
# columns: Date, value
# units: UTC, 2 nT
#
# Acknowledgement
# This product is prepared within ESA SSA (P2-SWE-II Space Weather Service Developments under contract
4000116100/15/D/MRP)
```

# FORIND JSON example

```
{ "parameters":
  { "parameter": "Ap_NMH_nowcast",
    "start_date": "2018-06-04 00:00",
    "end_date": "2018-06-11 00:00",
    "output type": "JSON" },
  "metadata":
  { "name": "Ap Index",
    "short": "Ap Index Nowcast 1-day (BGS)",
    "columns": ["Date", "value"],
    "units": ["UTC", "2 nT"] },
  "acknowledgement":
  ["This product is prepared within ESA SSA (P2-SWE-II Space Weather Service Developments under contract 4000116100\15\D\MRP)"],
  "data":
  [ ["2018-06-04 00:00:00", "5"],
    ["2018-06-05 00:00:00", "5"],
    ["2018-06-06 00:00:00", "7"],
    ["2018-06-07 00:00:00", "6"],
    ["2018-06-08 00:00:00", "4"],
    ["2018-06-09 00:00:00", "3"],
    ["2018-06-10 00:00:00", "2"],
    ["2018-06-11 00:00:00", "3"] ] }
```

# FORIND plot example



# Atmospheric density

- Provided by Met Office UK
  - Via ESA SSA, Ionospheric Weather (ATMDEN)
  - <http://sst-atm.spaceweatherservices.com/index.php>
- Includes forecasts and prior-estimate fields of thermospheric neutral density using the output of the DTM2013 model
- Indices used:
  - From FORIND:
    - F30 index forecast 30-day
    - ap index forecast 3-day
    - Ap index forecast 27-day
  - From SGIarv:
    - F30 (absolute)
    - Definitive Ap

# Atmospheric density

- Products offered:
  - 1-3 day forecast (based on forecast 3-hourly ap and F30)
  - 1-27 day forecast (based on forecast daily Ap and F30)
  - 12 month prior estimate (based on measure Ap and F30)
- Altitude range: 120 – 1500 km
- Output formats:
  - Data file (all altitudes)
  - Plot (200km altitude)

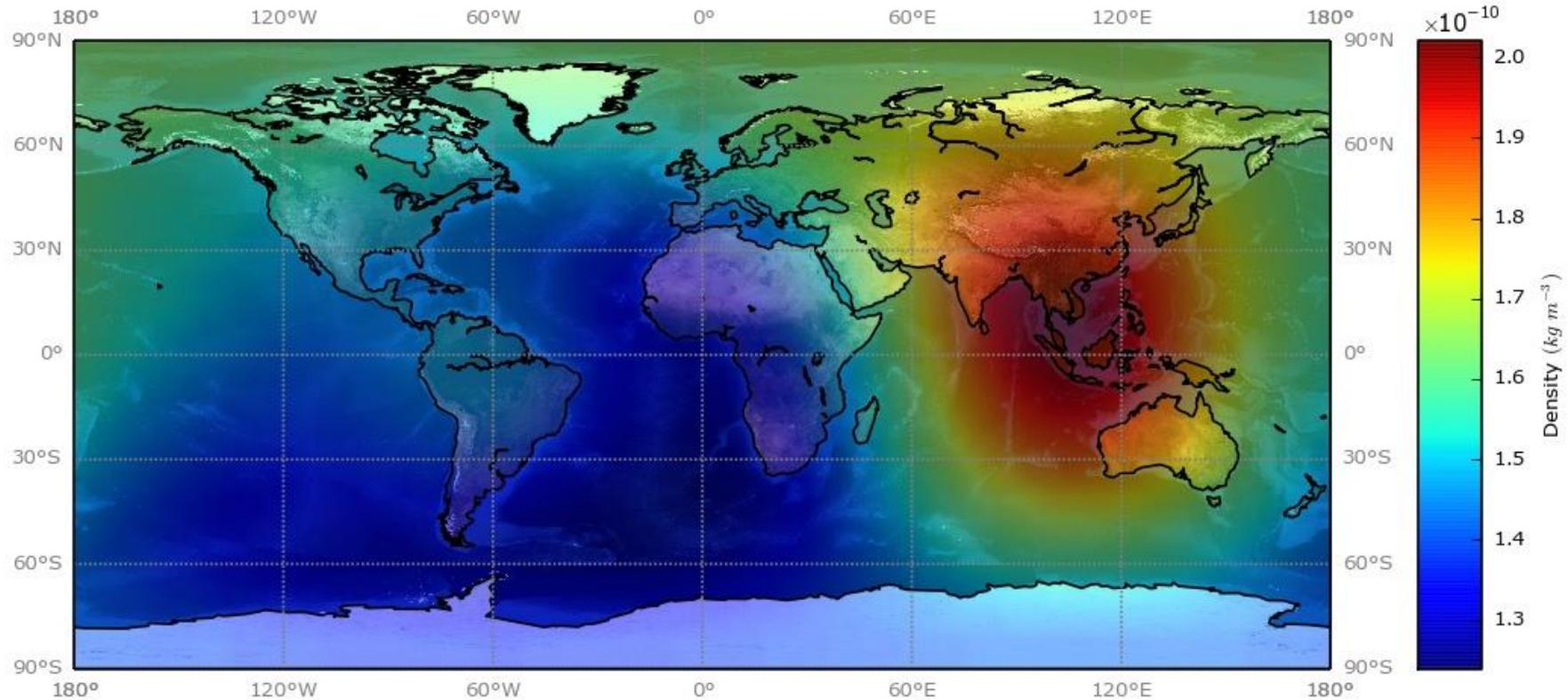
# Atmospheric density data file header

```
# Met Office Atmospheric Density Forecast
#-----
# Product Code: ATM_DAY_1-3_F
# DateTime (UTC)
# Forecast Reference DateTime (T0): 20180601T0000Z
# Forecast Period DateTime (T) : 2018-06-01 00:00:00
# Density units [kg m^-3]
#-----
# Input Solar Index (DateTime) : 48.9 (2018-05-31 00:00:00)
# Input Solar Index 81-day avg (DateTime): 44.6 (2018-06-01 00:00:00)
# Input Geo Index (DateTime) : 18.0 (2018-05-31 21:00:00)
# Input Geo Index 24-hr avg (DateTime) : 7.5 (2018-06-01 00:00:00)
#-----
# Angular resolution (deg): 5
# Longitude range (deg): [-180 - 175]
# Latitude range (deg) : [ 85 - -85]
# Altitudes (km): [ 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 350, 400, 450, 500, 550, 600,
700, 800, 1000, 1500]
# Array shape: ( 20, 35, 72) [Altitude, Latitude, Longitude]
#-----
# Altitude level (km): 120
```

# Atmospheric density forecast plot example



200 km Atmospheric neutral density for 11 Jun 2018 06:00:00 (UTC)  
at reference date 11 Jun 2018 00:00:00 (UTC)



Thank you