Atmospheric Dispersion Simulation using HYSPLIT with Real-time Weather Forecasts

5th Annual Meeting of ASEAN NPSR, 26-28 Oct 2022, Singapore

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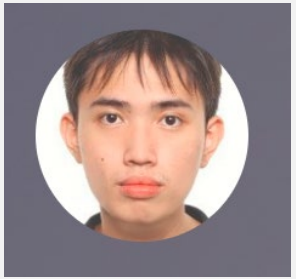
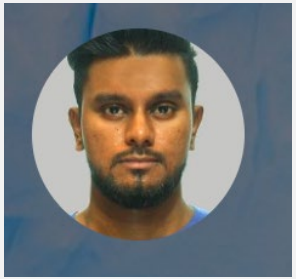
Singapore Nuclear Research & Safety Initiative

Team

- Full time on atmospheric dispersion

- Part time on risk analysis and MACCS

HYbrid

Single-**P**article

Lagrangian

Integrated

Trajectory model

- https://www.ready.noaa.gov/documents/Tutorial/html/index.html
- Windows/Linux/Mac OS/Web

HYSPLIT Implementation Requirement

- Software
  - Windows (v5.2.2)
    - Tcl/Tk
    - Ghostscript
    - Ghostview
    - ImageMagick
  - Linux (v5.2.3)
    - Fortran 90 compiler (serial and/or parallel)
    - C compiler
    - eccodes library
    - NetCDF library
- Hardware
  - Multiple-core 64-bit architecture
  - Large memory (8G/CPU)

Before running HYSPLIT

- Prepare meteorological data
  - Single station data (wind, stability, etc.)
  - GFS gridded data
- Setup HYSPLIT
  - Source term (release rate, duration…)
  - Grid (domain, grid spacing, vertical levels…)
  - Species (half-life, form, deposition parms…)
  - Simulations (run mode/length, # particles…)

GFS Data

- Global Forecast System (GFS)
  - National Centers for Environmental Prediction
  - Operational 4 times a day, 16-day forecasts
  - Global domain (0.25º/0.5º)
  - GRIB2 format

```
461:343224539:d=2022101800:HGT:850 mb:48 hour fcst:
462:344124422:d=2022101800:TMP:850 mb:48 hour fcst:
463:344968437:d=2022101800:RH:850 mb:48 hour fcst:
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466:347719226:d=2022101800:VVEL:850 mb:48 hour fcst:
467:348946802:d=2022101800:DZDT:850 mb:48 hour fcst:
468:350116239:d=2022101800:UGRD:850 mb:48 hour fcst:
469:351064436:d=2022101800:VGRD:850 mb:48 hour fcst:
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471:352972659:d=2022101800:CLWMR:850 mb:48 hour fcst:
472:353347247:d=2022101800:ICMR:850 mb:48 hour fcst:
473:353678968:d=2022101800:RWMR:850 mb:48 hour fcst:
474:353912202:d=2022101800:SNMR:850 mb:48 hour fcst:
475:354090630:d=2022101800:GRLE:850 mb:48 hour fcst:
476:354185646:d=2022101800:O3MR:850 mb:48 hour fcst:
477:355408835:d=2022101800:HGT:900 mb:48 hour fcst:
```
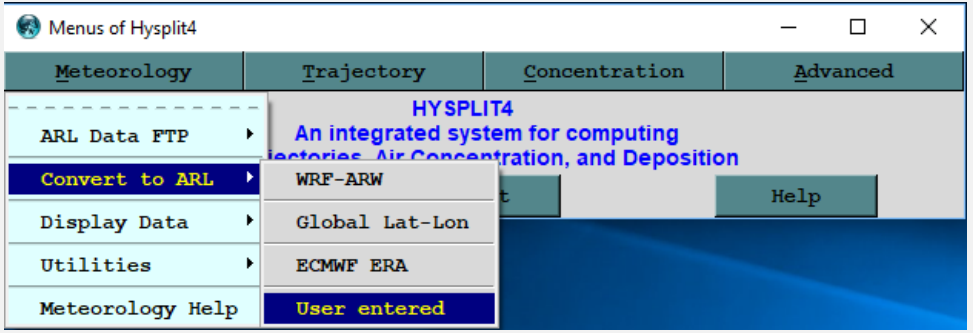

Format conversion GRIB2 → ARL

- ftp://ftp.ncep.noaa.gov/pub/data/nccf/com/gfs/v16.2/gfs.20220806/00/atmos/*gfs.t00z.pgrb2.0p50.f024*

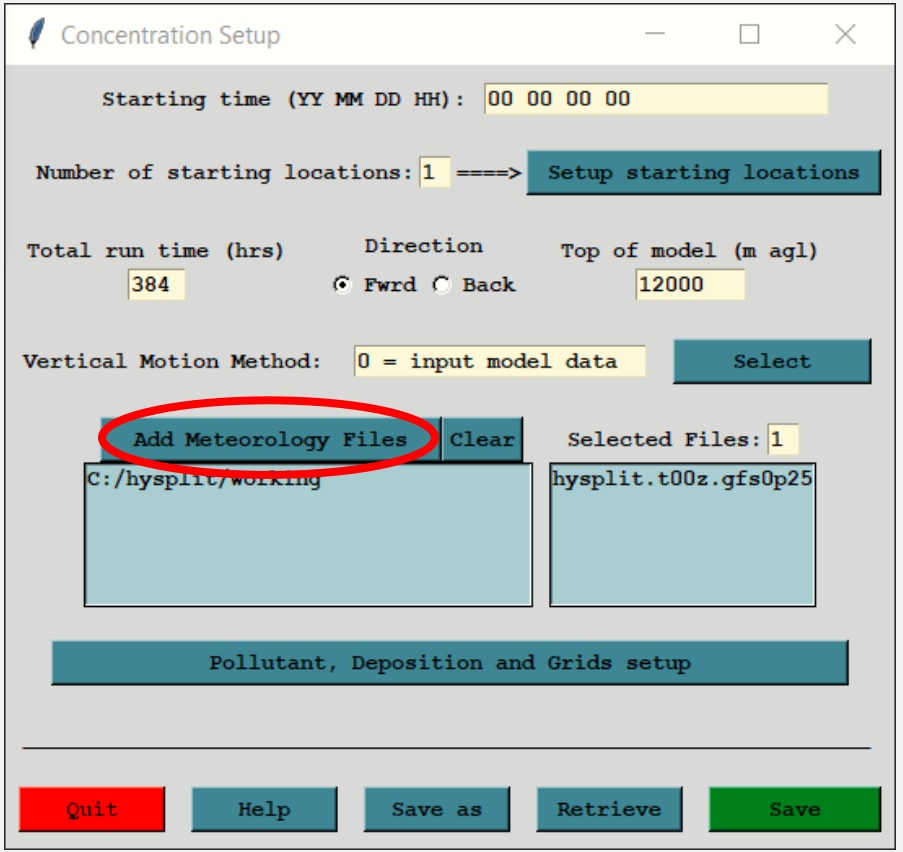
```
api2arl_v1 -igfs.t00z.pgrb2.0p50.f000 -of000
api2arl_v1 -igfs.t00z.pgrb2.0p50.f003 -of003
        …
api2arl_v1 -igfs.t00z.pgrb2.0p50.f024 -of024
cat f* > hysplit.t00z.gfs0p25f024
```



- https://nomads.ncep.noaa.gov/pub/data/nccf/com/hysplit/prod/hysplit.20221001/*hysplit.t00z.gfs0p25f072*

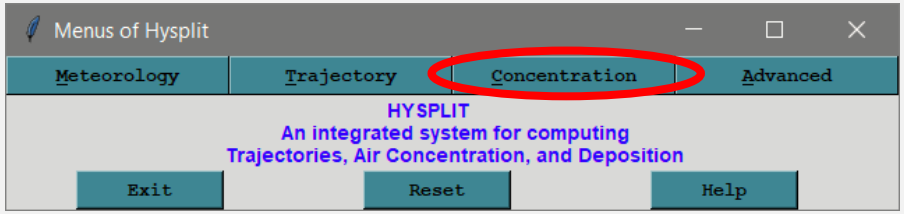
Setup HYSPLIT

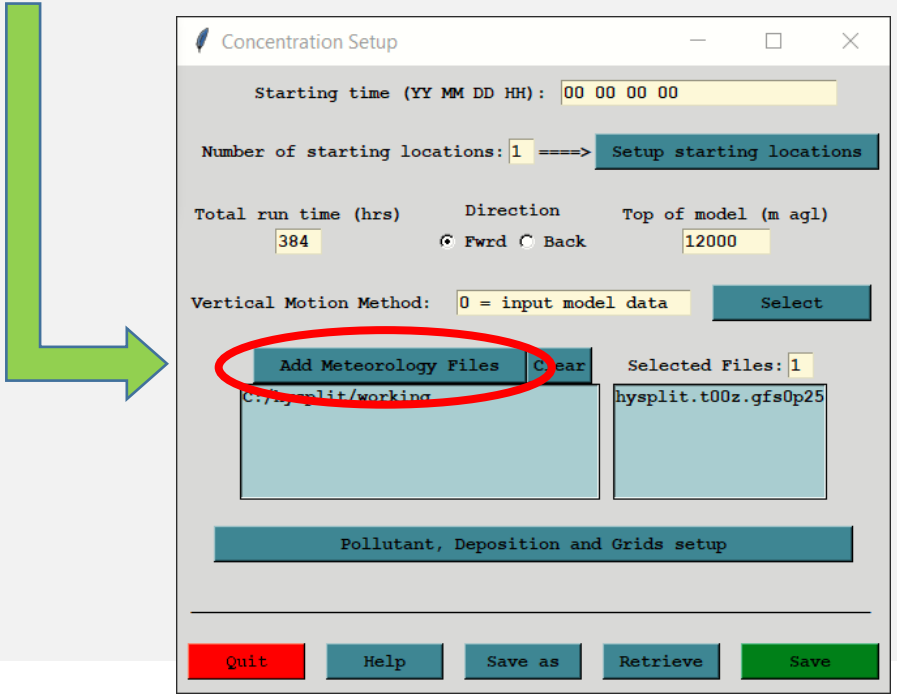
- Menu Concentration → Setup Run



Setup HYSPLIT (continued)

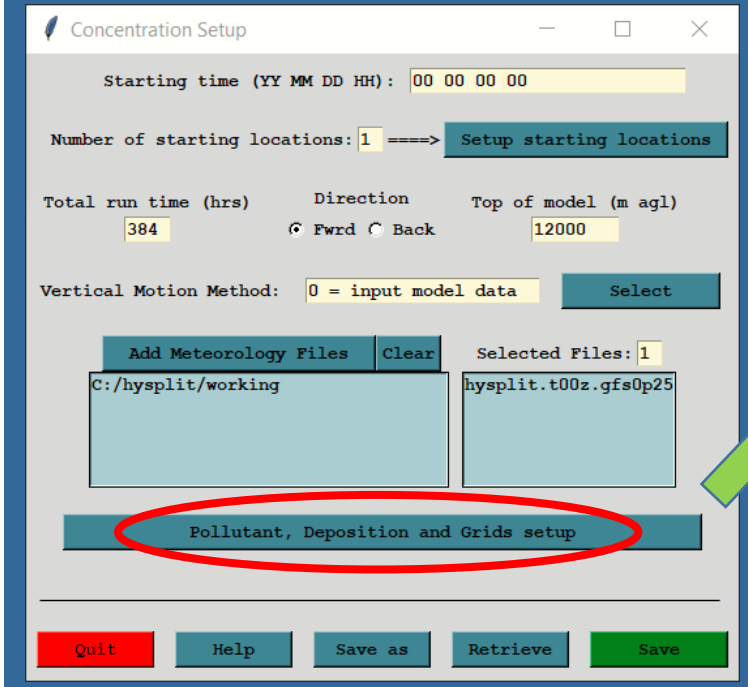
- Menu → Concentration [or Trajectory] → Setup Run

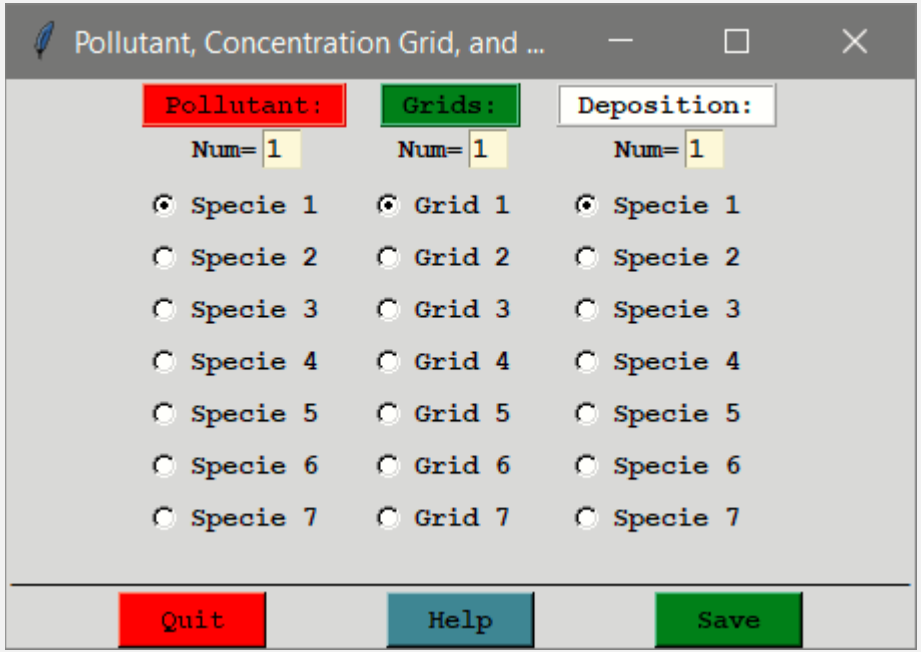




Setup HYSPLIT (continued)

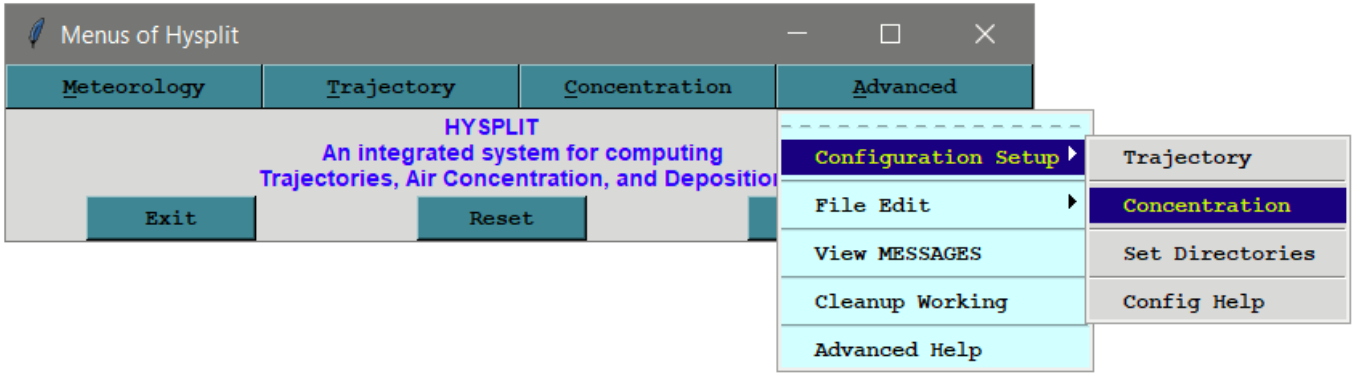
- Menu → Concentration → Setup Run → Pollutant, Deposition and Grids setup



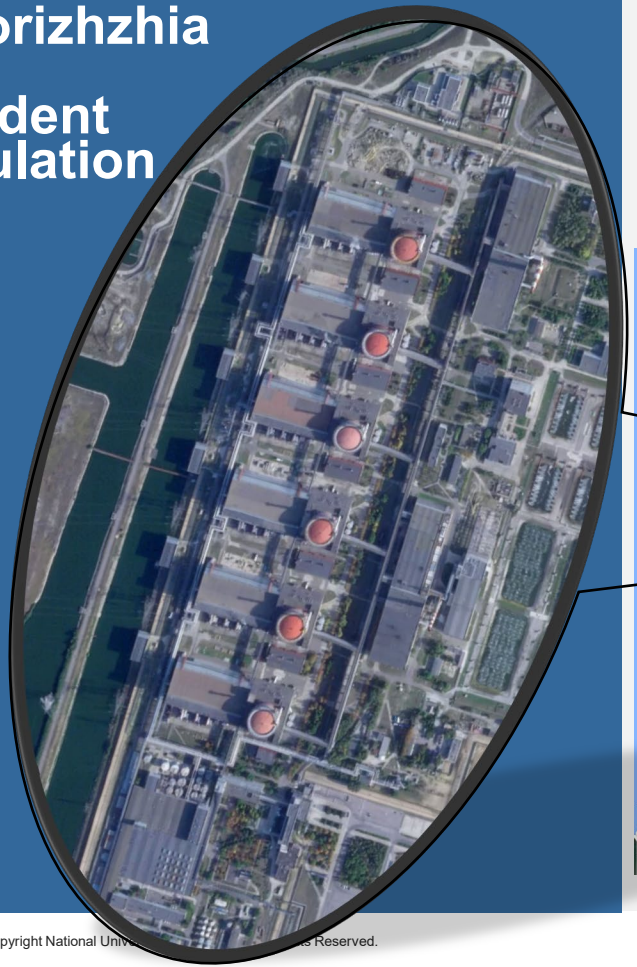


Setup HYSPLIT (advanced)

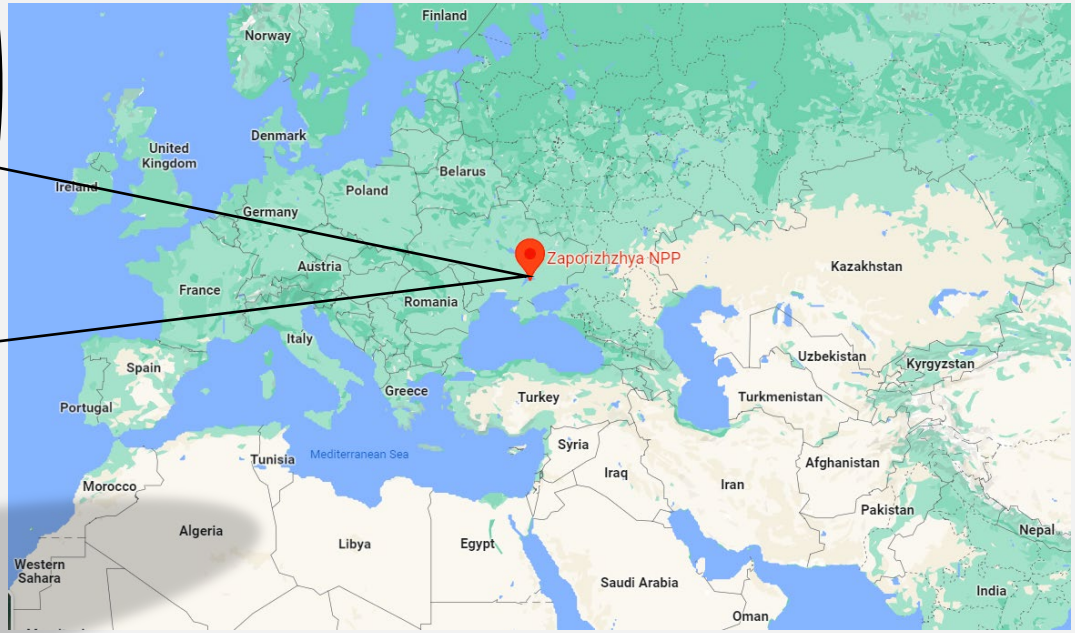
- Menu → Advanced → Configuration Setup → Concentration
  - Time step
  - Number of particles
  - Puff or particles running mode
  - Advanced emission scenario
  - Ensemble simulations



Hypothetical Zaporizhzhia NPP Accident Simulation

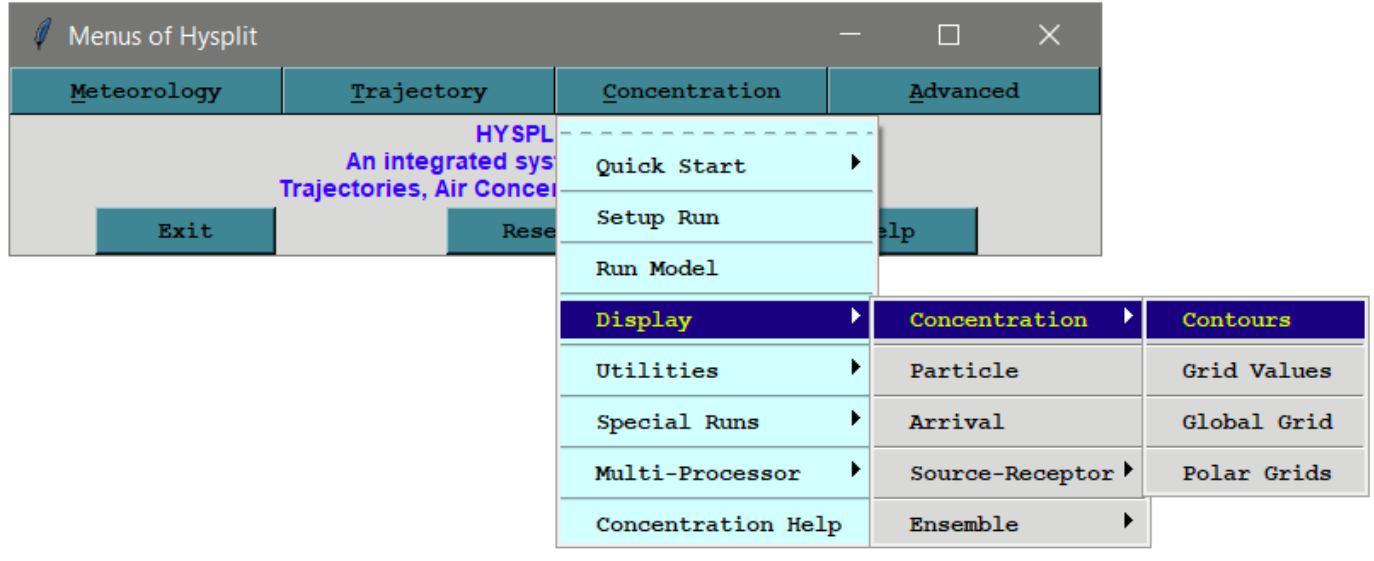


- GFS 0.5º 3-hourly 16-day forecasts
- Cs-137 released for 7 days at $1x10^{13}$ Bq/h
- Grid spacing 0.5º
- Dry deposition only

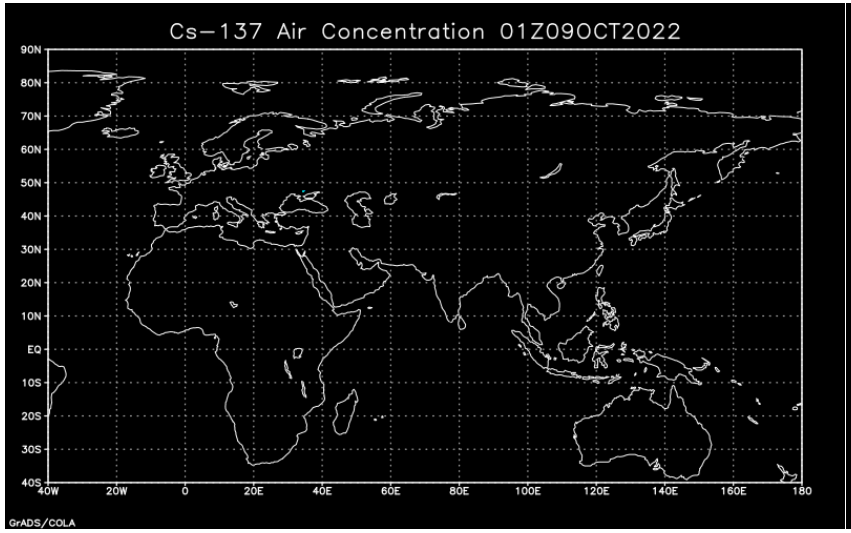


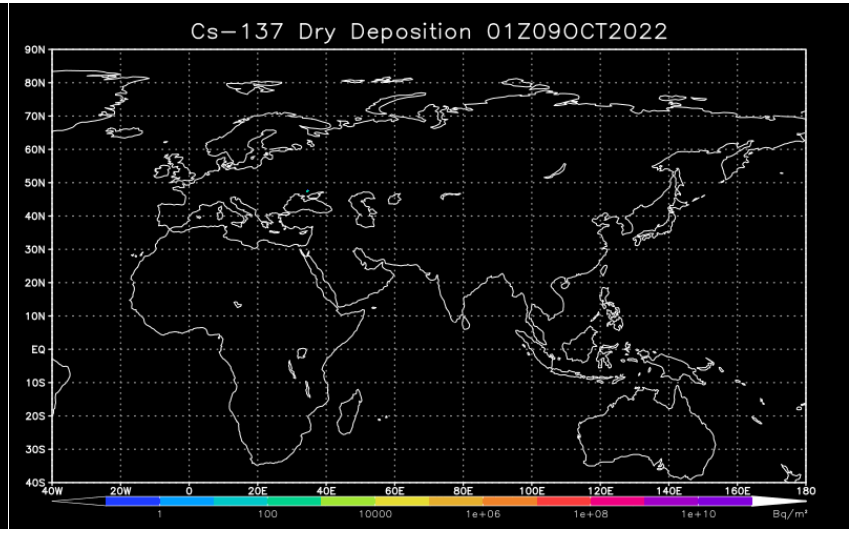
Postprocessing

- cdump
  - con2asc.exe -i*cdump* -o*cdump.txt*
  - con2grad.exe *cdump*
  - con2grib.exe -i*cdump* -o*cdump.grib* (Linux)
  - integrated visualisation functions

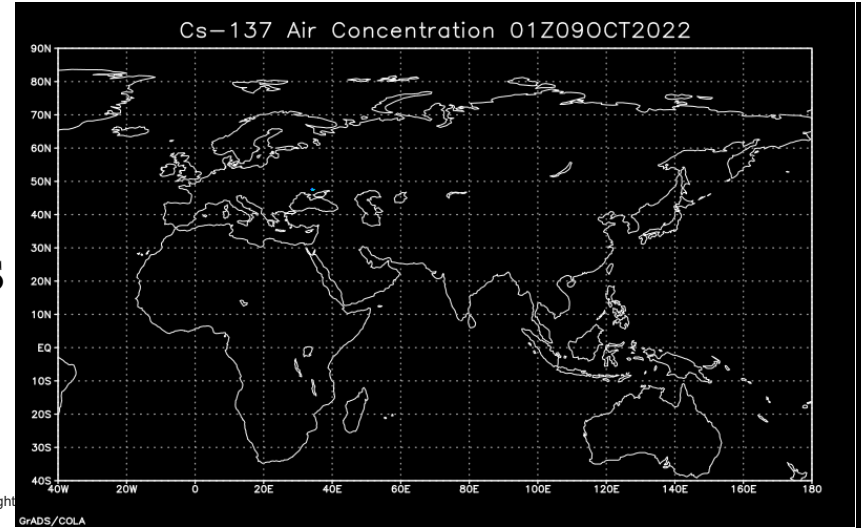


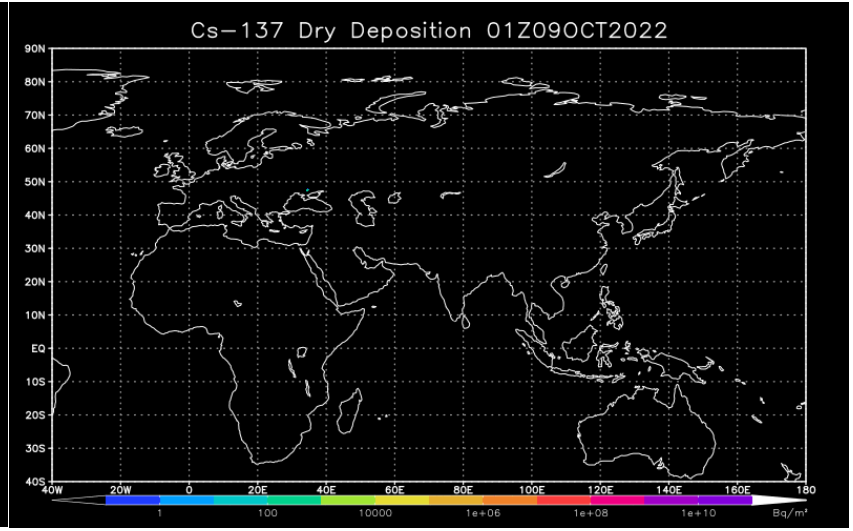
0.5º GFS





0.25º GFS





THANK YOU

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