2022 Online
HYSPLIT Workshop
Wrap-Up

Workshop Web Page:

https://www.ready.noaa.gov/register/HYSPLIT_hyagenda.php

NOAA Air Resources Laboratory
June 14-17, 2022
### 2022 HYSPLIT Workshop Schedule

*Subject to change, depending on the progression of the course and at the discretion of the instructors*

<table>
<thead>
<tr>
<th>UTC</th>
<th>Eastern Daylight Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:00 - 14:00</td>
<td>9:00 - 10:00</td>
<td>OPTIONAL* 1a. Installing HYSPLIT on Windows PC</td>
<td>Introduction</td>
<td>Introduction</td>
<td>Introduction</td>
<td>Introduction</td>
</tr>
<tr>
<td>Break</td>
<td>14:00 - 15:00</td>
<td>OPTIONAL* 1b. Installing HYSPLIT on MAC</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
</tr>
<tr>
<td>15:00 - 16:00</td>
<td>11:00 - 12:00</td>
<td>One-on-one virtual installation sessions, by appointment</td>
<td>4. Trajectory Calculations</td>
<td>Break</td>
<td>12. Air Concentration Uncertainty</td>
<td>Break</td>
</tr>
<tr>
<td>Break</td>
<td>16:00 - 17:00</td>
<td>One-on-one virtual installation sessions, by appointment</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
</tr>
<tr>
<td>17:00 - 18:00</td>
<td>13:00 - 14:00</td>
<td>One-on-one virtual installation sessions, by appointment</td>
<td>5. Trajectory Options</td>
<td>Break</td>
<td>13. Source Attribution Methods</td>
<td>Break</td>
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<tr>
<td>Break</td>
<td>18:00 - 19:00</td>
<td>One-on-one virtual installation sessions, by appointment</td>
<td>6. Trajectory Statistics</td>
<td>Break</td>
<td>14. Wildfire Smoke</td>
<td>Break</td>
</tr>
<tr>
<td>19:00 - 20:00</td>
<td>15:00 - 16:00</td>
<td>One-on-one virtual installation sessions, by appointment</td>
<td>Break</td>
<td>10. Alternate display options</td>
<td>14b. Dust Storms</td>
<td>Break</td>
</tr>
<tr>
<td>20:00 - 21:00</td>
<td>16:00 - 17:00</td>
<td>One-on-one virtual installation sessions, by appointment</td>
<td>Day 1 Wrap-Up</td>
<td>Day 2 Wrap-Up</td>
<td>Day 3 Wrap-Up</td>
<td>Break</td>
</tr>
</tbody>
</table>

*Break times are marked in orange.*

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**Day 1**
- **9:00 - 10:00** **9:00 - 10:00**
  - Optional: Installing HYSPLIT on Windows PC
- **11:00 - 12:00** **11:00 - 12:00**
  - Optional: Installing HYSPLIT on MAC
- **12:00 - 13:00** **12:00 - 13:00**
  - One-on-one virtual installation sessions, by appointment
- **13:00 - 14:00** **13:00 - 14:00**
  - One-on-one virtual installation sessions, by appointment
- **14:00 - 15:00** **14:00 - 15:00**
  - One-on-one virtual installation sessions, by appointment
- **15:00 - 16:00** **15:00 - 16:00**
  - One-on-one virtual installation sessions, by appointment
- **16:00 - 17:00** **16:00 - 17:00**
  - One-on-one virtual installation sessions, by appointment
- **17:00 - 18:00** **17:00 - 18:00**
  - One-on-one virtual installation sessions, by appointment
- **18:00 - 19:00** **18:00 - 19:00**
  - One-on-one virtual installation sessions, by appointment
- **19:00 - 20:00** **19:00 - 20:00**
  - One-on-one virtual installation sessions, by appointment
- **20:00 - 21:00** **20:00 - 21:00**
  - One-on-one virtual installation sessions, by appointment

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**Day 2**
- **9:00 - 10:00** **9:00 - 10:00**
  - Optional: Installing HYSPLIT on Windows PC
- **11:00 - 12:00** **11:00 - 12:00**
  - Optional: Installing HYSPLIT on MAC
- **12:00 - 13:00** **12:00 - 13:00**
  - One-on-one virtual installation sessions, by appointment
- **13:00 - 14:00** **13:00 - 14:00**
  - One-on-one virtual installation sessions, by appointment
- **14:00 - 15:00** **14:00 - 15:00**
  - One-on-one virtual installation sessions, by appointment
- **15:00 - 16:00** **15:00 - 16:00**
  - One-on-one virtual installation sessions, by appointment
- **16:00 - 17:00** **16:00 - 17:00**
  - One-on-one virtual installation sessions, by appointment
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  - One-on-one virtual installation sessions, by appointment
- **20:00 - 21:00** **20:00 - 21:00**
  - One-on-one virtual installation sessions, by appointment

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**Day 3**
- **9:00 - 10:00** **9:00 - 10:00**
  - Optional: Installing HYSPLIT on Windows PC
- **11:00 - 12:00** **11:00 - 12:00**
  - Optional: Installing HYSPLIT on MAC
- **12:00 - 13:00** **12:00 - 13:00**
  - One-on-one virtual installation sessions, by appointment
- **13:00 - 14:00** **13:00 - 14:00**
  - One-on-one virtual installation sessions, by appointment
- **14:00 - 15:00** **14:00 - 15:00**
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- **15:00 - 16:00** **15:00 - 16:00**
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  - One-on-one virtual installation sessions, by appointment
HYSPLIT Model

- **Continuous development** at NOAA Air Resources Laboratory (ARL) for more than 40 years
- **ARL HYSPLIT modeling group** (~10 scientists)
- **Trajectories** and **Dispersion**
- **Forward** and **Backward**
- **3-D Dispersion (generally > ~1 km):**
  - Puffs (top-hat or Gaussian)
  - “Particles” (i.e., computational points)
  - Eulerian grid
- **Dry** and **Wet deposition**
- **Chemical** and **Radiological Transformations**
- **Simulation Modes:**
  - Run online (**READY**)
  - **Download** – run via Graphical User Interface
  - **Download** – run via command line and scripts
  - Windows, Mac, Linux
- **Users:**
  - Emergency response & science at NOAA
  - Emergency response & science - other agencies (e.g., MACCS)
  - Scientific community: e.g., Stein et al. 2015 ~ 3000 citations
Extensive use of HYSPLIT by the research community


+ ~80 other publications by ARL ATD group scientists from 2016-2021
HYSPLIT Resolution Overview

- HYSPLIT is driven by gridded meteorological data, generally supplied as an “input”
  - This gridded met data will have a temporal and spatial resolution that will affect the accuracy of the transport and dispersion simulation
- HYSPLIT interpolates in time and space between met model data grid points to try to estimate the met data at any location/time in the simulation domain
- HYSPLIT simulations will have one or more concentration grids that are specified by the user
  - These conc grids each have their own user-defined temporal, horizontal, and vertical resolution
  - Resolution of the conc grids are independent and completely separate from the resolution of the met data grids
  - Note – the same concentration grids are also used to track deposition
- Minimum time step in HYSPLIT is 1 minute
  - this governs transport & dispersion; deposition; and concentration outputs
  - 3 m/sec wind → 180 meters in 1 minute
  - Interpolation routine in output algorithm fills in space between starting and ending position to avoid leap-frogging over concentration grid squares
  - But, no met data finer than 1 minute is used
  - In most cases, we do not have met data with temporal resolution of less than 1 minute… (exception: HYSPLIT in-line with WRF)
- We are considering decreasing the minimum time step down to 1 second; this may offer some advantages for very near-field simulations
You can define more than one grid, each with its own specifications.

Depending on where the grid is and which way the wind is blowing during the simulation, you might not get any computational point particles in the grid, and all concentrations in the grid will be zero.

If a grid has very fine spacing, you might need to increase the number of computational point particles released in the simulation.

The particles are “discrete” and if there are too few of them, you aren’t really representing the continuous plume, and you can get very blotchy results.
- Intentional Tracers
  - Past tracer experiments → DATEM system

<table>
<thead>
<tr>
<th>Experiments</th>
<th>Range (km)</th>
<th>Range (log km)</th>
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<tbody>
<tr>
<td>ACURATE</td>
<td>1000</td>
<td>3.0</td>
</tr>
<tr>
<td>ANATEX</td>
<td>500-2800</td>
<td>2.7-3.4</td>
</tr>
<tr>
<td>CAPTEX</td>
<td>800-1000</td>
<td>2.9-3.0</td>
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<tr>
<td>OKC80</td>
<td>100-600</td>
<td>2.0-2.8</td>
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<tr>
<td>METREX</td>
<td>20-30</td>
<td>1.3-1.5</td>
</tr>
<tr>
<td>COSTEX</td>
<td>10-50</td>
<td>1-1.7</td>
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<tr>
<td>IFX</td>
<td>10</td>
<td>1</td>
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<tr>
<td>ASCOT</td>
<td>10</td>
<td>1</td>
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<tr>
<td>PSB1</td>
<td>0.2-3.2</td>
<td>-0.7-0.5</td>
</tr>
</tbody>
</table>
Random numbers – turbulence treatments
- (2019) - Changed how turbulent velocity is initialized. New namelist variable VINIT = 1 (default) initializes turbulent velocity by drawing from distribution; VINIT = 0 initializes turbulent velocity to zero

Random numbers – non dispersion procedures
- (2020) new KRAND options for more user control over initial seeds for random number generation

Model vertical structures
- (2020) - Increased compatibility with WRF hybrid vertical coordinate system
- (2021) - More user control over model vertical levels

Buoyancy-driven plume-rise algorithms
- Existing: Briggs (based on point source observations)
- (2020) - New for wildfires: Sofiev
- (2022) - Upcoming for wildfires: Freitas

Dust emissions
- (2022) – Upcoming: FENGSHA algorithm

HYSPTEST program
- (2019) - Pre-processing program to test inputs and configuration to diagnose common errors

Center-of-Mass Trajectory option
- (2020) - Trajectory created based on center-of-mass of emitted computational particles (CMTFN)

Python post-processing graphics programs
- (2020) - Python versions have increased functionality, e.g., different map backgrounds, zooming features

SVG graphics outputs – as an alternative to postscript
- (2021) - Workaround for increasingly difficult Ghostscript / Ghostview compatibility issues

Density estimation via Gaussian Mixture Models
The NOAA Air Resources Laboratory recently had its 5-year science review

https://www.arl.noaa.gov/about/lab-reviews/2022-lab-review/2022-arl-review-topic-presentations/
Atmospheric Transport and Dispersion Theme Overview, Mark Cohen [PDF]

YouTube Playlist for Atmospheric Transport and Dispersion

<table>
<thead>
<tr>
<th>Topic</th>
<th>Presenter</th>
<th>Format</th>
<th>Type</th>
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<tbody>
<tr>
<td>Nuclear Applications and Emergency Response</td>
<td>Tianfeng Chai</td>
<td>PDF</td>
<td>Movie</td>
</tr>
<tr>
<td>Wildfire Applications and Emergency Response</td>
<td>HyunCheol Kim</td>
<td>PDF</td>
<td>Movie</td>
</tr>
<tr>
<td>Volcano Applications and Emergency Response</td>
<td>Alice Crawford</td>
<td>PDF</td>
<td>Movie</td>
</tr>
<tr>
<td>Chemical Applications and Emergency Response</td>
<td>Sonny Zinn</td>
<td>PDF</td>
<td>Movie</td>
</tr>
<tr>
<td>Model Evaluation / Improvement with Tracers</td>
<td>Fantine Ngan</td>
<td>PDF</td>
<td>Movie</td>
</tr>
<tr>
<td>Source Estimation using Inversions</td>
<td>Chris Loughner</td>
<td>PDF</td>
<td>Movie</td>
</tr>
</tbody>
</table>
HYSPLIT Tips

- **CONTROL file**: Look at this file if you are having a problem – sometimes you can see obvious errors
- **GUI**: When you are using the GUI, most input and output files will be in `hysplit\working\`
- **Scripts**: usually create a new working directory, e.g., `hysplit\working_nuclear`  
- **Met File(s)**: Correct directory and name; encompass time & spatial domain of your desired simulation
- **Ascii text**: `CONTROL`, `SETUP.CFG`, `MESSAGE`, `TDUMP files` (trajectory output files), scripts
- **Binary**: `Met data files`, `CDUMP files` (concentration output files)
- **Options**: Not all available from GUI; can type executable name from command line to see options
- **Many other HYSPLIT programs** in the HYSPLIT exec directory (e.g., met data analysis programs); some are available in the GUI, but not all
- **Graphics**: HYSPLIT has some graphical capabilities – including some new Python and SVG graphics – but you can also display your model outputs using other graphics platforms (Google Earth, GIS, Python, Matlab...)
- **Numerical Experiments**:
  - Do you have enough particles in your simulation? Increase the number and see if your answers change. Keep increasing until the answers level off. The finer the grid you use, the more particles you need.
  - Do the same simulation with different met data sets to evaluate sensitivity to met data uncertainties
  - And you can do other sensitivity tests for other parameters
HYSPLIT Documentation and Learning Resources

- **HYSPLIT Tutorial**: detailed instructions on using the GUI + example scripts; can be run online or downloaded to local computer.
- The GUI is a great way to learn HYSPLIT:
  - even experienced users use it when trying something new
  - can create a run in the GUI, and then look at associated input/output files to tell you how to create a script to do similar simulations
  - you can do some relatively complicated procedures (e.g., trajectory clustering)
- **HYSPLIT Users Guide**: online (and also in hysplit/documents directory)
- Download HYSPLIT and other resources: [https://www.ready.noaa.gov/HYSPLIT.php](https://www.ready.noaa.gov/HYSPLIT.php)
- **HYSPLIT Cheat Sheet**
- **Model Overview**: [https://www.arl.noaa.gov/hysplit/hysplit/](https://www.arl.noaa.gov/hysplit/hysplit/)
- **HYSPLIT Forum**: [https://hysplitbbs.arl.noaa.gov/](https://hysplitbbs.arl.noaa.gov/)
- **HYSPLIT FAQ’s**: [https://www.arl.noaa.gov/hysplit/hysplit-frequently-asked-questions-FAQs/](https://www.arl.noaa.gov/hysplit/hysplit-frequently-asked-questions-FAQs/)
- Stein et al., 2015: NOAA’s HYSPLIT atmospheric transport and dispersion modeling system, *Bull. Amer. Meteor. Soc.*, 96, 2059-2077, [http://dx.doi.org/10.1175/BAMS-D-14-00110.1](http://dx.doi.org/10.1175/BAMS-D-14-00110.1)
- Rolph et al., 2017: Real-time Environmental Applications and Display sYstem: READY. *Environmental Modelling & Software*, 95, 210-228, [https://doi.org/10.1016/j.envsoft.2017.06.025](https://doi.org/10.1016/j.envsoft.2017.06.025)
Workshop guidance
and resources posted at
Workshop Web Page

https://www.ready.noaa.gov/register/HYSPLIT_hyagenda.php

*We will update this page to include any new materials or links that are relevant to the Workshop*
https://www.ready.noaa.gov/register/HYSPLIT_hyagenda.php

**Workshop Day 3 (Thr, June 16)**
The exec/statmain executable in HYSPLIT v5.2.1 does not work correctly. Please update it by downloading statmain to your HYSPLIT exec directory.

- **Windows users** - fix_win10.zip (zip, 0.5 MB). Three executable files (including txt2dbf.exe and dbf2xls.exe) in the HYSPLIT v5.2.1 distribution for Windows are found to be defective.
- **macOS users** - fix_macOS.zip (zip, 0.3 MB).
- **Ubuntu 20.04 users** - fix_UbuntuOS20.04.zip (zip, 29 KB).
- **Red Hat Enterprise Linux 8 / CentOS 8 users** - fix_RHEL8.5.zip (zip, 29 KB).
- **Red Hat Enterprise Linux 7 / CentOS 7 users** - fix_CentOS7.9.zip (zip, 28 KB).
- **Day 3 handout** (pdf, 1.0 MB).
- **Day 3 wrap-up** (pdf, 1.3 MB) or Day 3 wrap-up (pptx, 1.0 MB).
- **Transformation and deposition slides** (pdf, 1.1 MB).
- **HYSPLIT Simulation Parameters for ALOHA Chemicals** (pdf, 7.8 MB).
- **Wildfire applications** (pdf, 0.8 MB).
- **Source attribution methods** (pdf, 1.2 MB).
- **Workshop video recording for day 3** (mp4, 1.4 GB) and unfinished transcript (txt, 228 KB). The transcripts can be downloaded from the above link. See the above on how to download the video file.
Course Certificates

- Course certificates will be made available to all participants
- You will receive an email (probably next week) asking if you would like a certificate and letting you know how to obtain it
We will be sending out a course survey soon, and we hope you will return it.

It can be anonymous, or you can provide your name – it is up to you.

We will really appreciate hearing your feedback, about what went well and what we can try to improve.
Please feel free to continue to ask any questions that you have in the HYSPLIT Forum.

You can ask them in the 2022 Workshop section of the Forum, or you can ask them in another section of the Forum if it seems more relevant.

Wherever you ask the question, we will try to answer it.
# HYSLIT Forum

https://hysplitbbs.arl.noaa.gov/index.php

<table>
<thead>
<tr>
<th>HYSLIT PLATFORM SPECIFIC</th>
<th>TOPICS</th>
<th>POSTS</th>
<th>LAST POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYSLIT for PCs</td>
<td>150</td>
<td>503</td>
<td>How to run daily ensembles by dominch116 May 24th, 2022, 9:17 am</td>
</tr>
<tr>
<td>HYSLIT for Mac OS X</td>
<td>13</td>
<td>87</td>
<td>Re: Hysplit installation by demoran June 17th, 2022, 10:42 am</td>
</tr>
<tr>
<td>HYSLIT for LINUX</td>
<td>74</td>
<td>321</td>
<td>Re: How to run hysplit on linux by Fantine March 1st, 2022, 11:20 am</td>
</tr>
<tr>
<td>HYSLIT on the READY Server</td>
<td>12</td>
<td>14</td>
<td>Re: Best meteorological data ... by alicec April 20th, 2022, 5:38 am</td>
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<table>
<thead>
<tr>
<th>METHODOLOGICAL DATA</th>
<th>TOPICS</th>
<th>POSTS</th>
<th>LAST POST</th>
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<tbody>
<tr>
<td>General questions on meteorological data needed for HYSLIT</td>
<td>125</td>
<td>420</td>
<td>Re: Use of a customized netcd... by Fantine June 10th, 2022, 11:30 am</td>
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<tr>
<td>Conversion programs</td>
<td>108</td>
<td>453</td>
<td>unnamed---custom made netcdfile---... by faruk April 30th, 2022, 1:50 pm</td>
</tr>
<tr>
<td>Repositories of HYSLIT formatted data</td>
<td>22</td>
<td>65</td>
<td>Re: Corrupt Hysplit format HK... by sonny.zinn April 1st, 2022, 10:21 am</td>
</tr>
<tr>
<td>Meteoinfo Software</td>
<td>52</td>
<td>120</td>
<td>Plot trajectories on 3D earth by yaqing January 6th, 2022, 2:13 am</td>
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# HYSPLIT Forum

https://hysplitbbs.arl.noaa.gov/index.php

<table>
<thead>
<tr>
<th>RESEARCH</th>
<th>TOPICS</th>
<th>POSTS</th>
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<tbody>
<tr>
<td>Volcanic Ash</td>
<td>9</td>
<td>16</td>
<td>I saw a program on TV that st... by sonny_zinn on July 22nd, 2021, 11:28 pm</td>
</tr>
<tr>
<td>Wildfire Smoke</td>
<td>5</td>
<td>9</td>
<td>Wildfire Smoke SplitR Dispers... by cs7va on July 22nd, 2021, 10:24 am</td>
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<tr>
<td>Dust</td>
<td>20</td>
<td>58</td>
<td>Re: Transport of Saharan Dust... by murphy1 on June 21st, 2021, 2:14 pm</td>
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<tr>
<td>Chemicals</td>
<td>9</td>
<td>24</td>
<td>Re: K2 diffusivity by gva on May 18th, 2021, 6:16 pm</td>
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<tr>
<td>Radiological</td>
<td>14</td>
<td>44</td>
<td>Re: Differences between result... by IPPiquet on November 10th, 2020, 5:50 pm</td>
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<tr>
<td>Cluster Analysis</td>
<td>37</td>
<td>162</td>
<td>Re: Program code to cluster a... by alicecc on October 5th, 2021, 9:01 am</td>
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<table>
<thead>
<tr>
<th>FORUM</th>
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<tbody>
<tr>
<td>HYSPLIT Workshop</td>
<td>192</td>
<td>733</td>
<td>Re: EMITTIMES character limits by Fantino on June 17th, 2022, 12:15 pm</td>
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### HYSPLIT Workshop

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<tbody>
<tr>
<td>2022 HYSPLIT Workshop Questions</td>
<td>27</td>
<td>92</td>
<td>Creating a consistent CONUS g... by dmv_fe @</td>
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<td></td>
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<td>June 17th, 2022, 1:16 pm</td>
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<tr>
<td>2021 HYSPLIT Workshop Questions</td>
<td>59</td>
<td>234</td>
<td>Re: daily concentration conta... by davidglain @</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>August 11th, 2021, 11:25 am</td>
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<tr>
<td>2020 HYSPLIT Workshop Questions</td>
<td>88</td>
<td>349</td>
<td>Re: ImageMagick version - up ... by nobella @</td>
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<tr>
<td>Questions from the 2020 Online HYSPLIT Workshop.</td>
<td></td>
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<td>April 14th, 2021, 12:22 am</td>
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<tr>
<td>2019 HYSPLIT Workshop Questions</td>
<td>3</td>
<td>5</td>
<td>Re: Depositions calculated w... by arielstein @</td>
</tr>
<tr>
<td>During the four weeks of the 2019 HYSPLIT Workshop, users will be able to post questions on the week's topics to this Forum and model developers will try to answer them as soon as possible.</td>
<td></td>
<td></td>
<td>June 17th, 2019, 3:58 pm</td>
</tr>
</tbody>
</table>
The 26th Annual George Mason University Conference on Atmospheric Transport and Dispersion Modeling will be held on July 26-28, 2022.

The deadline for submitting abstracts is **July 16, 2022**. Please send your abstracts to Joe Chang (gmu.atd.conference@gmail.com) and Zafer Boybeyi (zboybeyi@gmu.edu).

If there are enough HYSPLIT-related abstracts submitted, there will be special section on HYSPLIT applications.
Thanks for your participation and for your interest in HYSPLIT!