

25 Years of DPW Grids: A Retrospective from 2001 through 2026

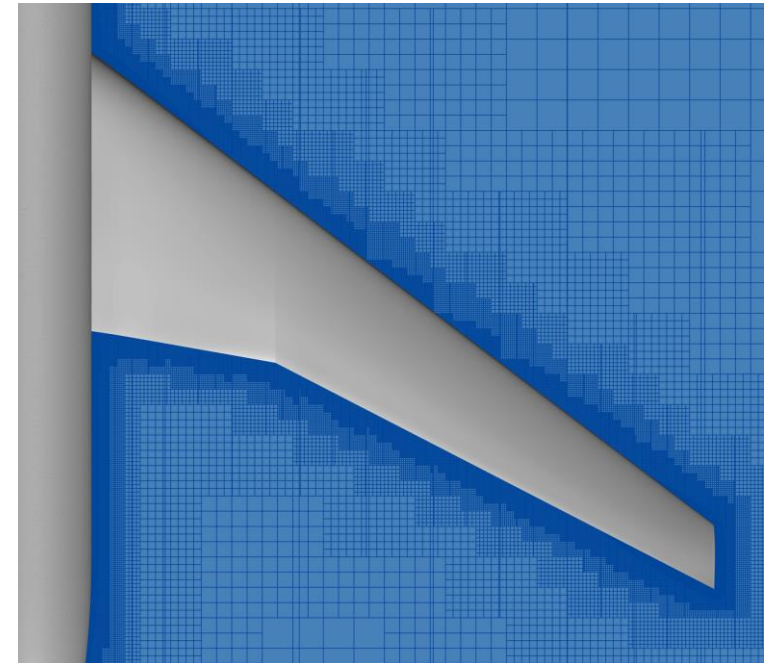
Brent Pomeroy

NASA Langley Research Center
Configuration Aerodynamics Branch
Emeritus Langley Associate



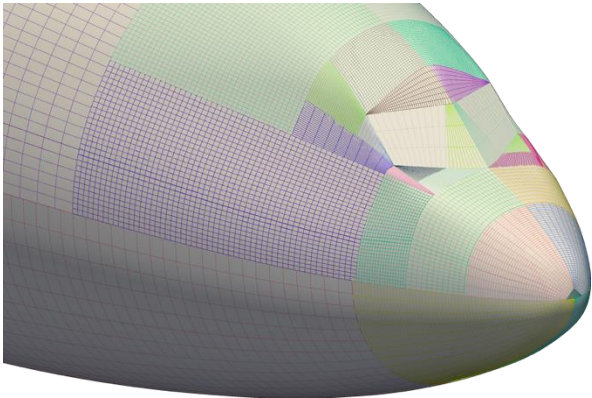
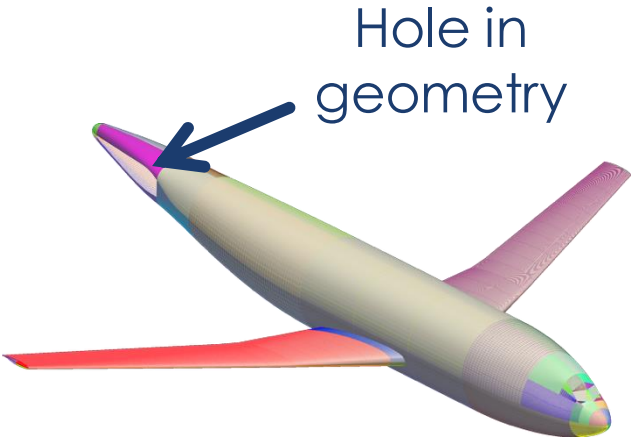
- **DPW has a deep history of committee-supplied grids**
 - Common grids (structured and unstructured) first provided for DPW-1
 - Strong dependency upon grids found in DPW-3 and afterwards
- **Improvements relative to DPW-1 (“CFD Drag Prediction Workshop”)**
 - RANS, middle-of-the-envelope transonic analysis has matured to a useful capability
 - Field has a good understanding of grid requirements to capture flowfield features
 - Increased ability to assess grid sensitivity (but has it reduced uncertainty?)
- **Some major efforts since DPW-1**
 - Adaptive mesh refinement
 - HRLES, LES, WMLES, etc. grid topologies
 - Some historic data files cannot be read by modern tools!

- **Guidelines have been carefully developed**
 - Developed from previous experience in workshops
 - Includes recommendations for surface and volume grids
 - Component-specific settings capture relevant flow physics
- **Good understanding of RANS, but no consensus yet for unsteady schemes (discussed tomorrow)**
 - DPW-8 has informed differences between RANS and URANS
 - DES/LES require very-dense spanwise and chordwise spacing; users have numerous different philosophies
- **Representative of the committee-supplied grids for the workshops (sources listed at the end)**

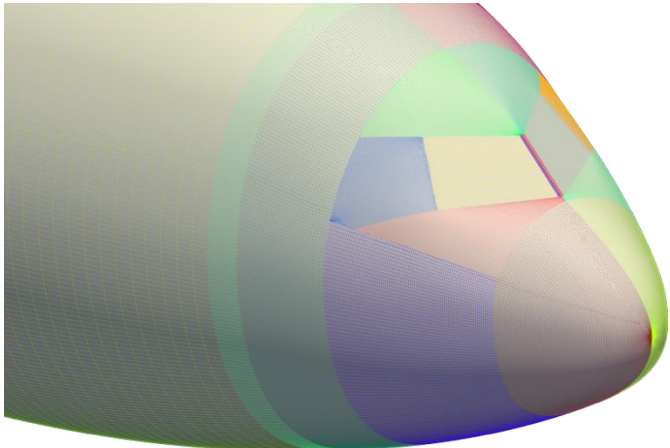
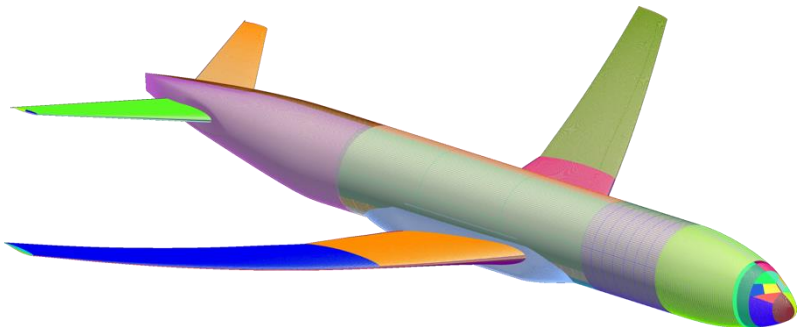


DPW-1

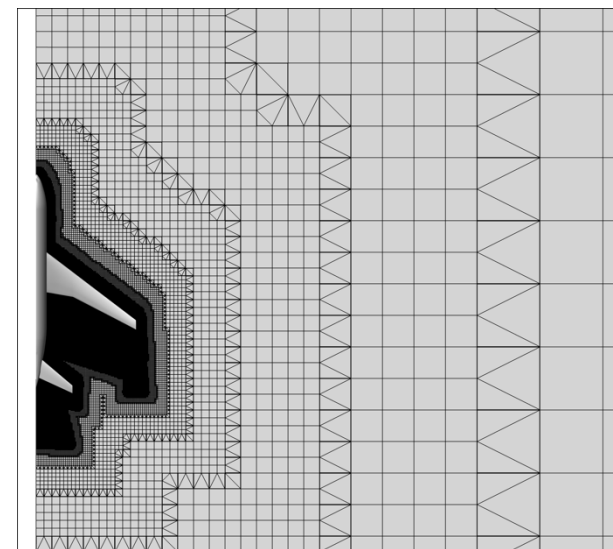
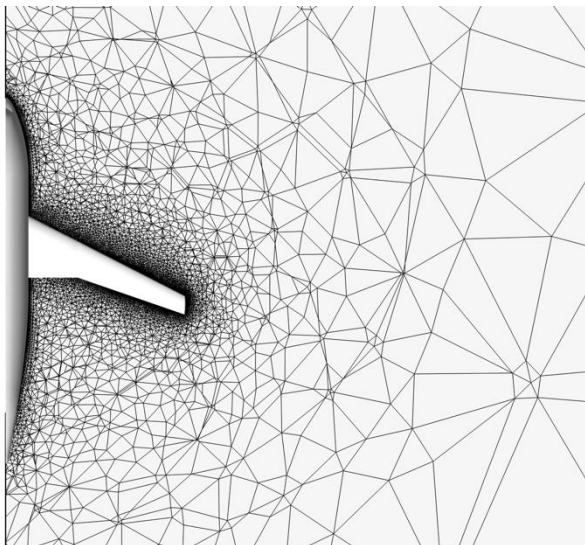
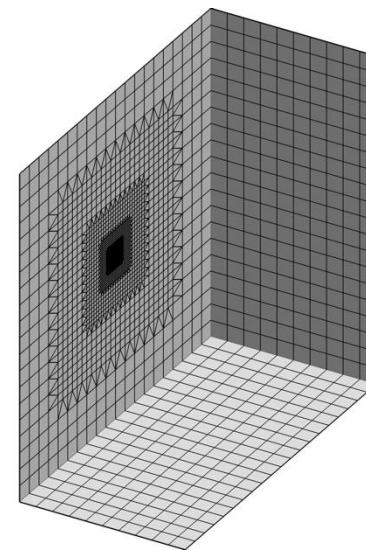
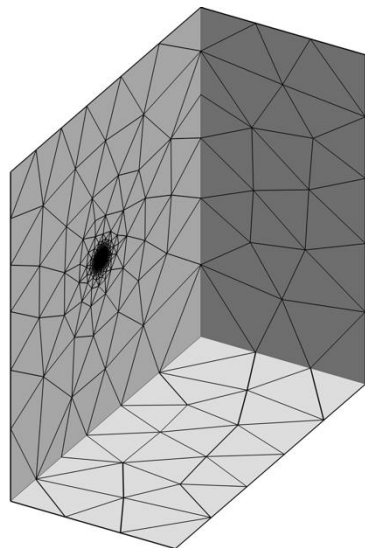
F4-wing		DEF1
y = 74.21084 mm		
	upper side	lower side
x (mm)	z (mm)	z (mm)
37.97545	8.86741	8.86741
37.98555	9.54780	8.39685
37.99565	9.85686	8.12685
38.02597	10.22070	7.85685
38.07651	10.65029	7.51685
38.17758	11.14957	7.02685
38.37971	11.88937	6.40685
38.58185	12.39876	5.93991
38.78400	12.81923	5.54991
38.98613	13.18307	5.21235
39.18826	13.50243	4.91235
39.39041	13.78544	4.63945
39.59254	14.03406	4.38445
39.79468	14.25035	4.13851
39.99683	14.44239	3.90083
40.19896	14.61016	3.66538
40.40109	14.77273	3.43468
40.60323	14.92636	3.21195
40.80537	15.06886	3.00015
41.00751	15.20228	2.80211



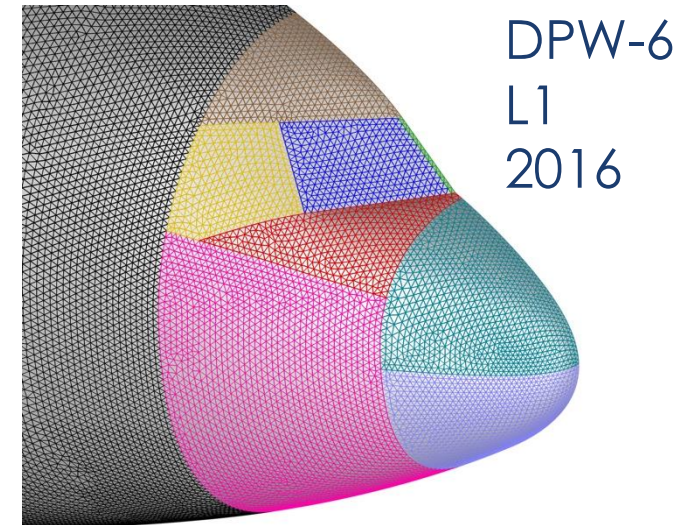
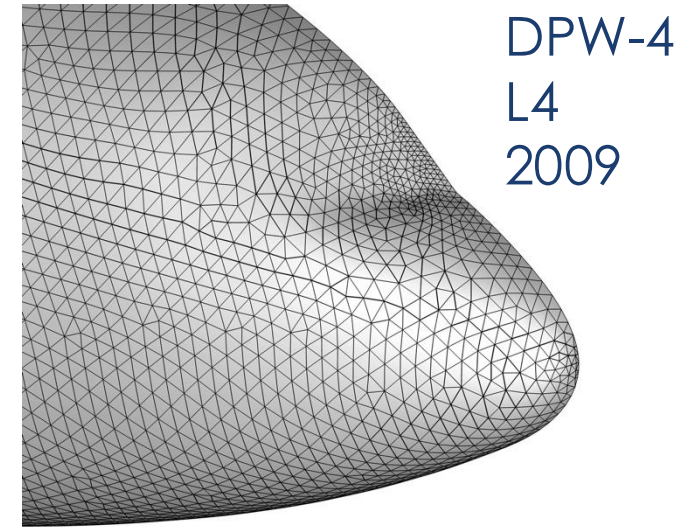
DPW-8



Outer Domain Comparisons (DPW-1 and DPW-8)

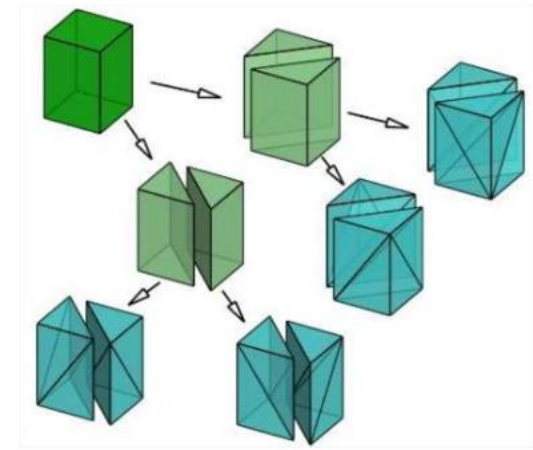
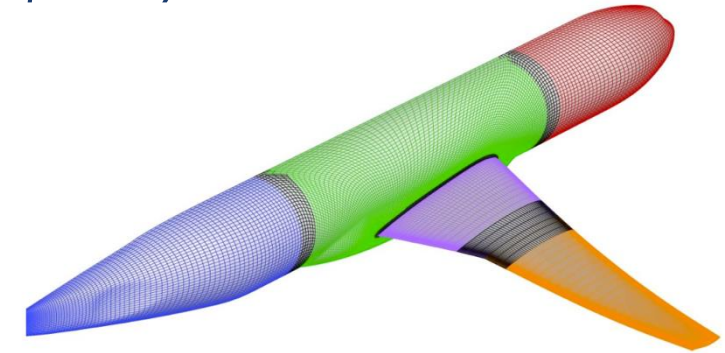


- **Baseline CRM geometry utilized a simplified flight deck window layout**
 - Improved surface modeling for DPW-6
 - Grids (regardless of topology) can more accurately represent the cockpit
- **Geometry was updated for subsequent DPWs and on the CRM website**



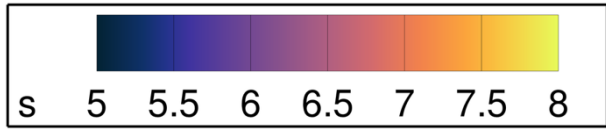
“After three workshops, the organizing committee recognized that a recurring theme of the workshop series was related to grid quality and resolution” (Vassberg, et al.; DPW-4 summary paper)

- **Gridding guidelines developed for DPW-4 and beyond**
- **Detailed study for DPW-5**
 - One family of committee-supplied common grids
 - Consistent point cloud of nodes for all topologies
 - Points extracted from a five-block multiblock grid
 - Converted into overset and unstructured topologies
 - Significant reduction in scatter

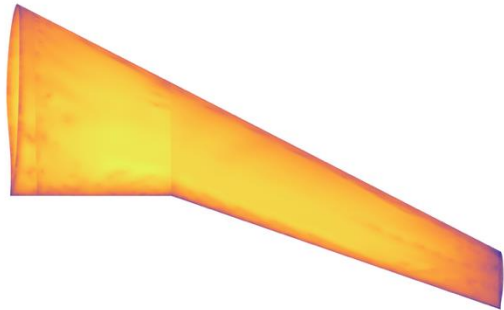


Levy, et al. "Summary of Data from the Fifth AIAA CFD Drag Prediction Workshop," AIAA Paper 2013-0046. 2013 Aerospace Sciences Meeting, Grapevine, TX. 2013.

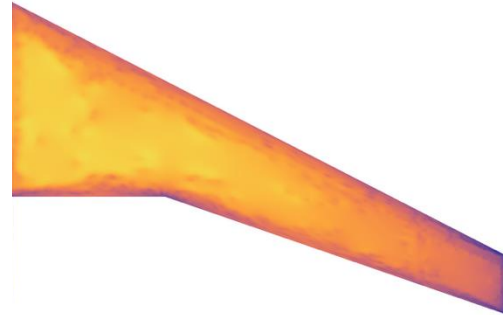
Representative Unstructured Grids: Cell Area



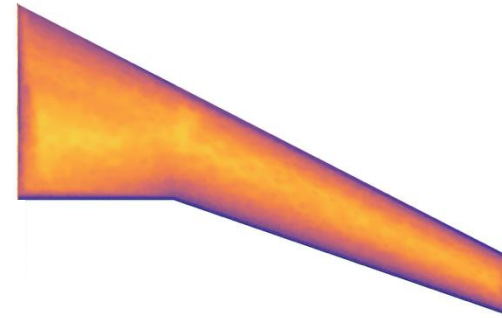
$s = \log(A + \Delta) - \log(\Delta)$ in which $\Delta = 10^{-12}$ and A = surface area



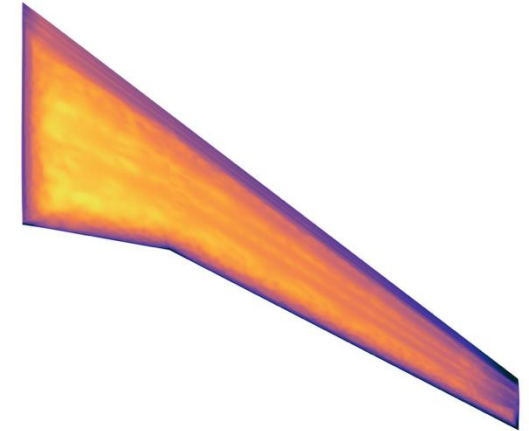
DPW-1



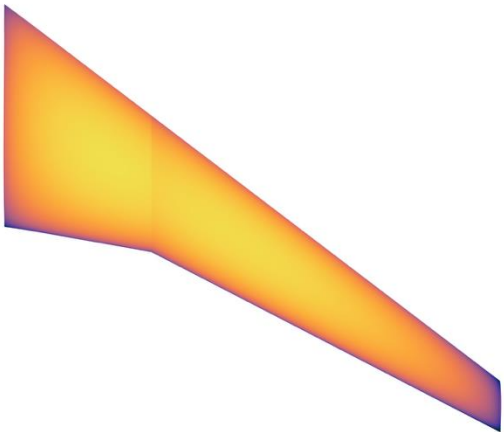
DPW-2



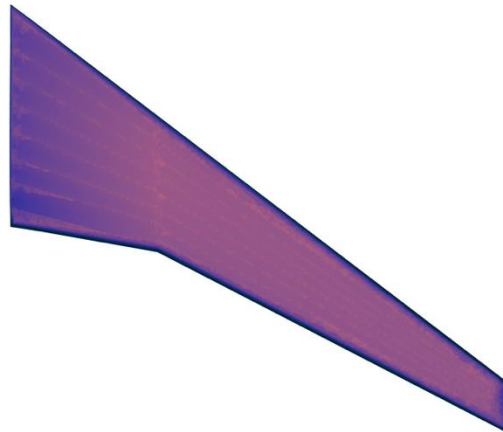
DPW-3



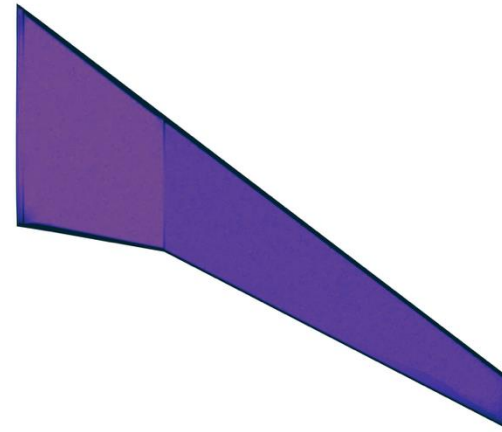
DPW-4



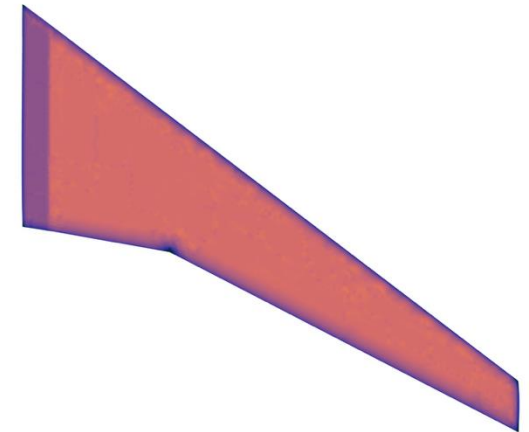
DPW-5



DPW-6

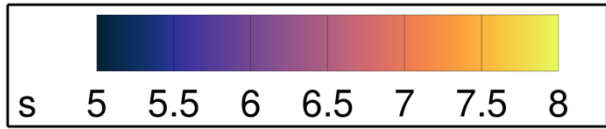


DPW-7

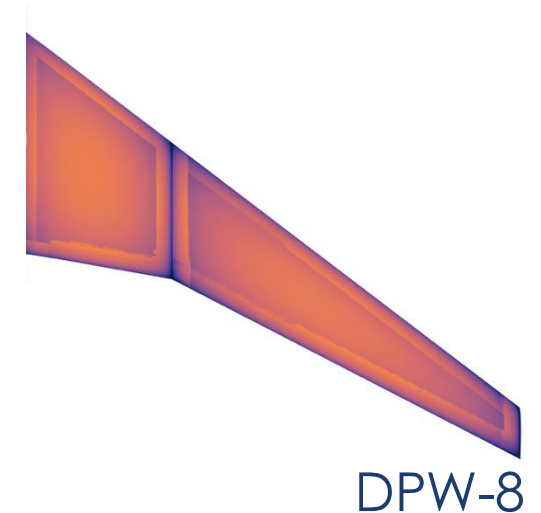
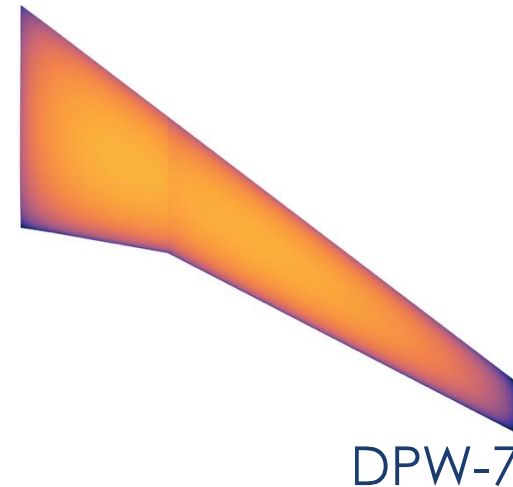
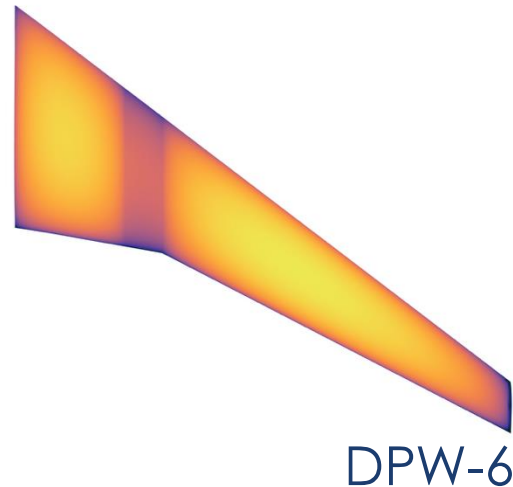
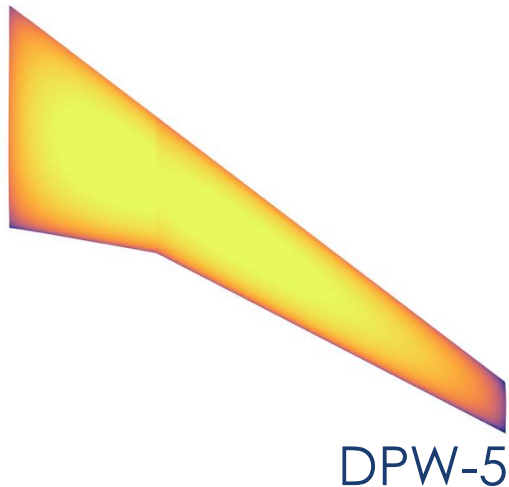
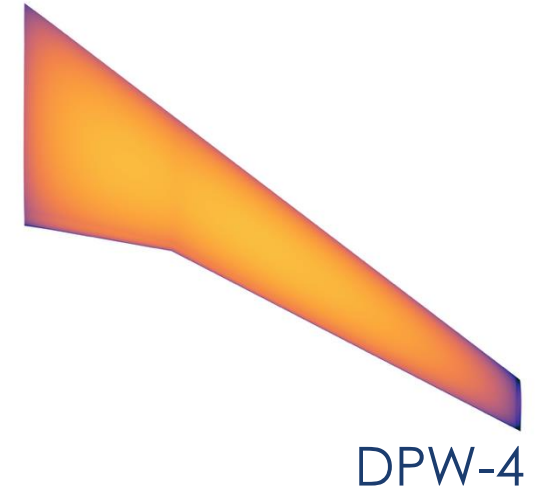
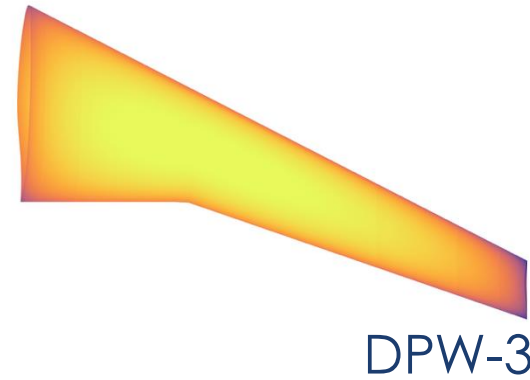
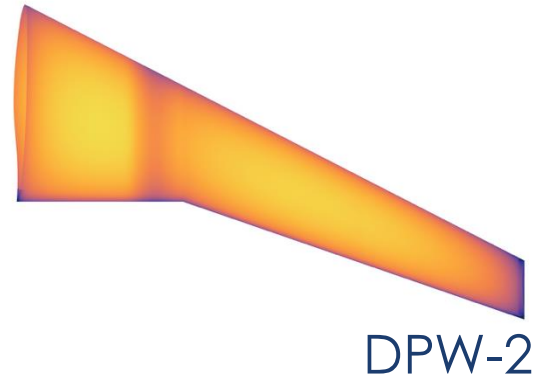
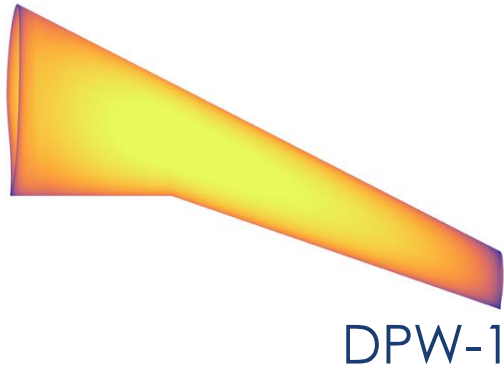


DPW-8

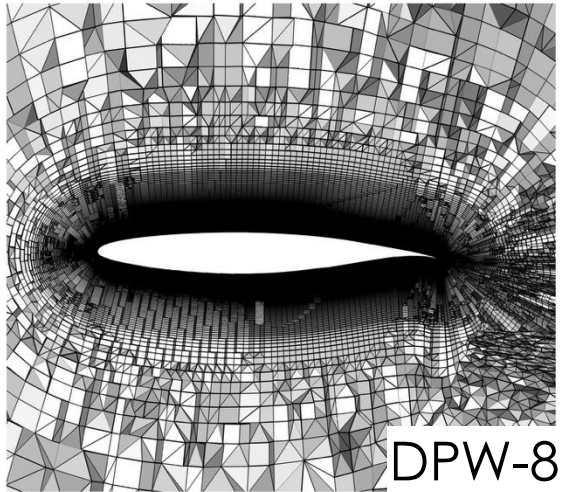
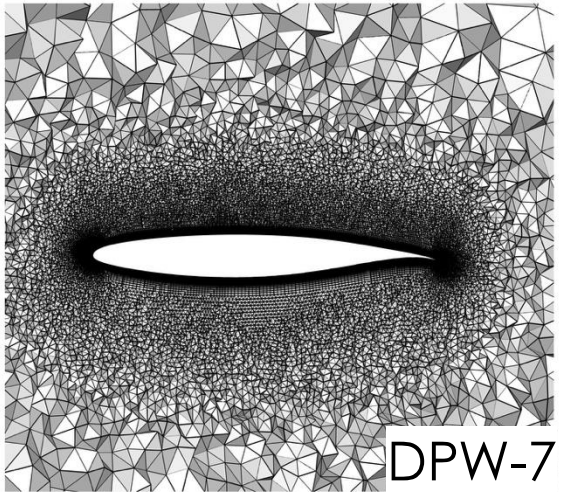
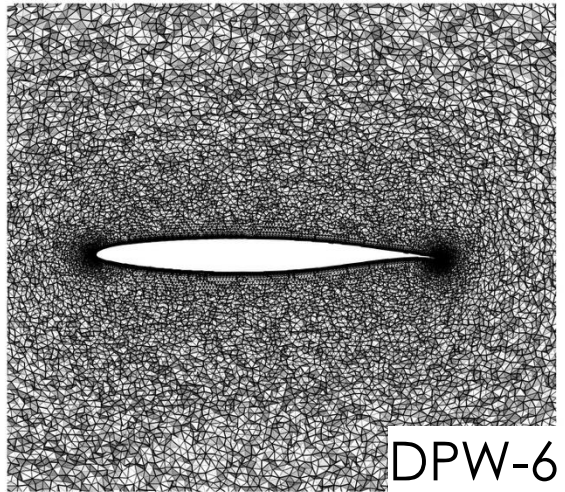
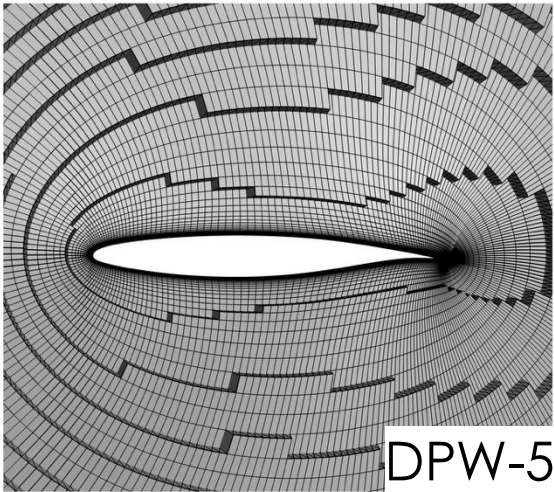
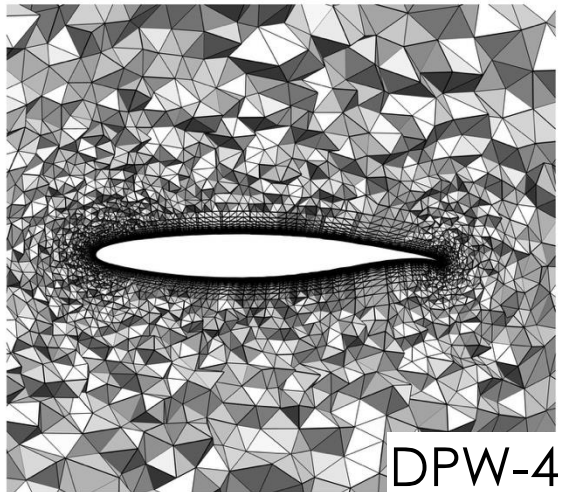
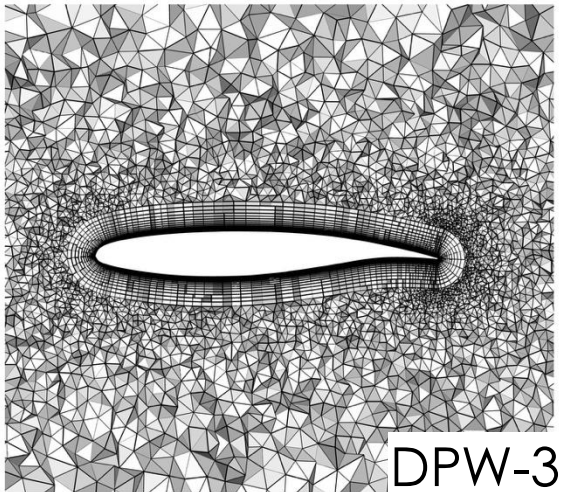
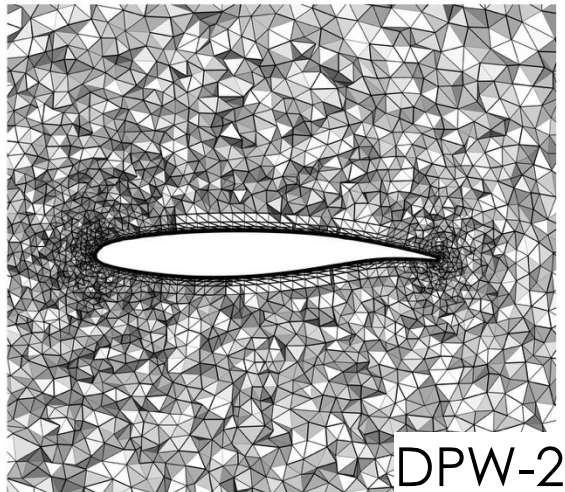
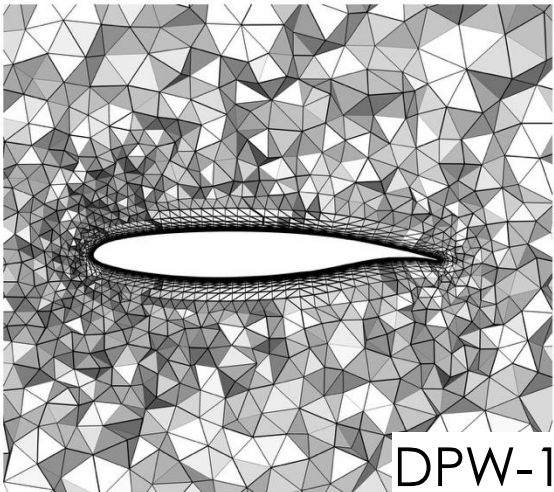
Representative Structured Grids: Cell Area



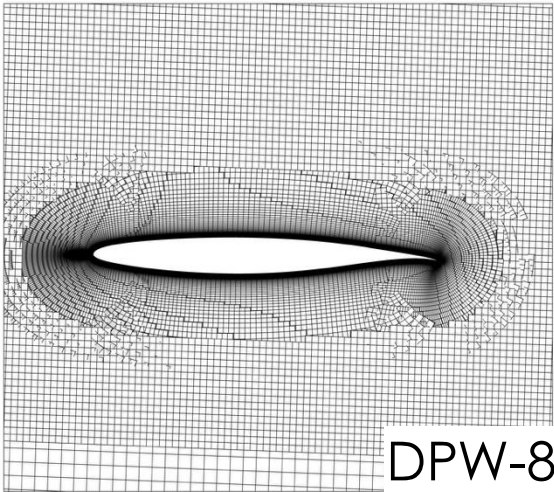
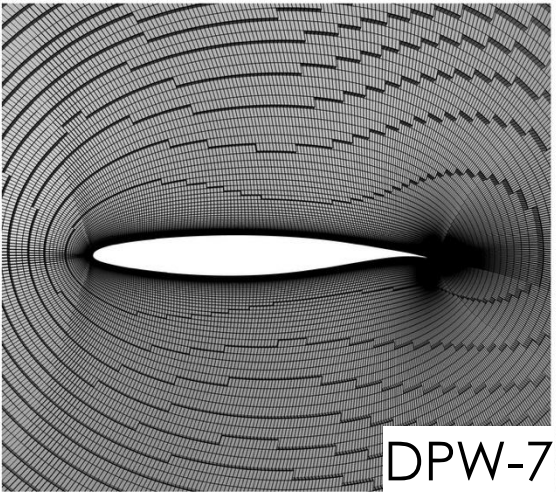
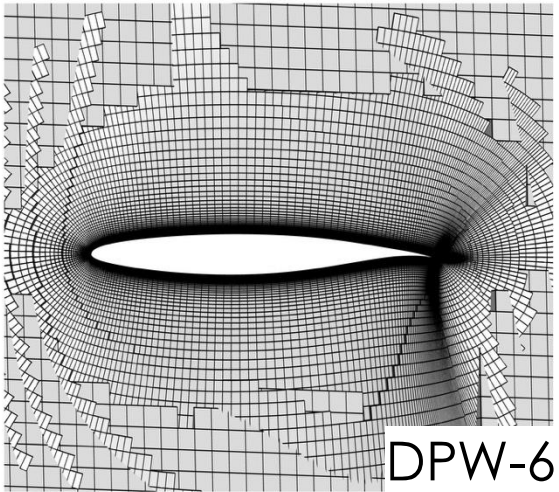
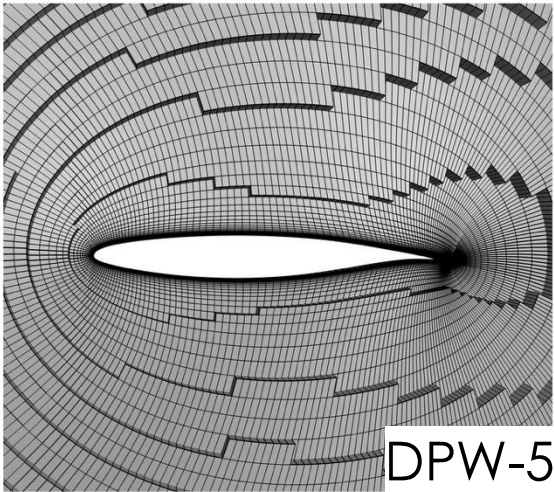
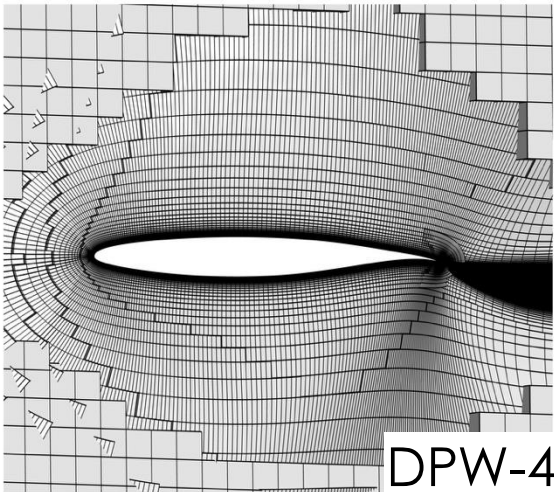
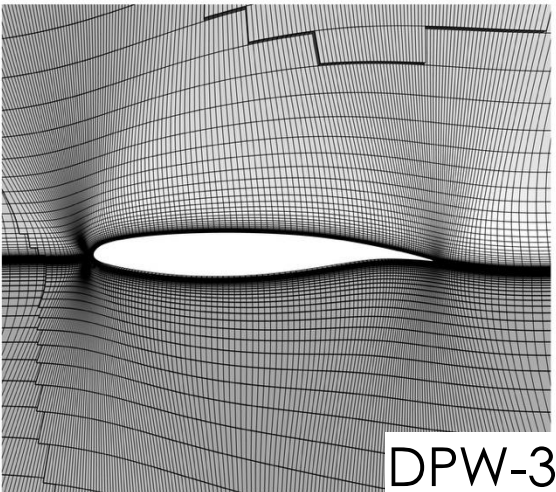
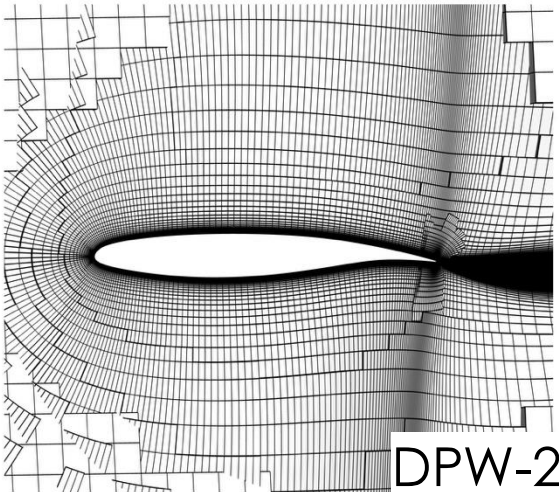
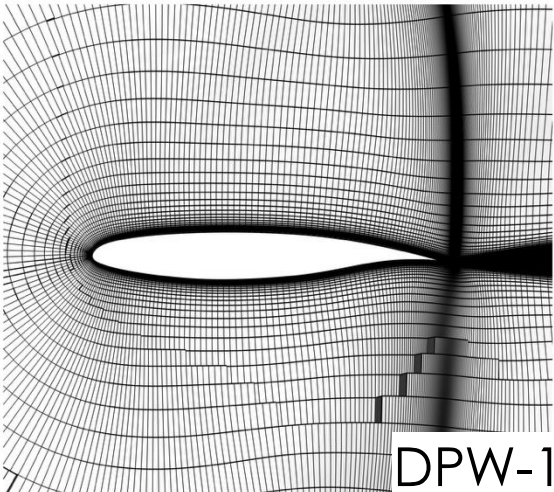
$s = \log(A + \Delta) - \log(\Delta)$ in which $\Delta = 10^{-12}$ and s = a metric of surface cell area



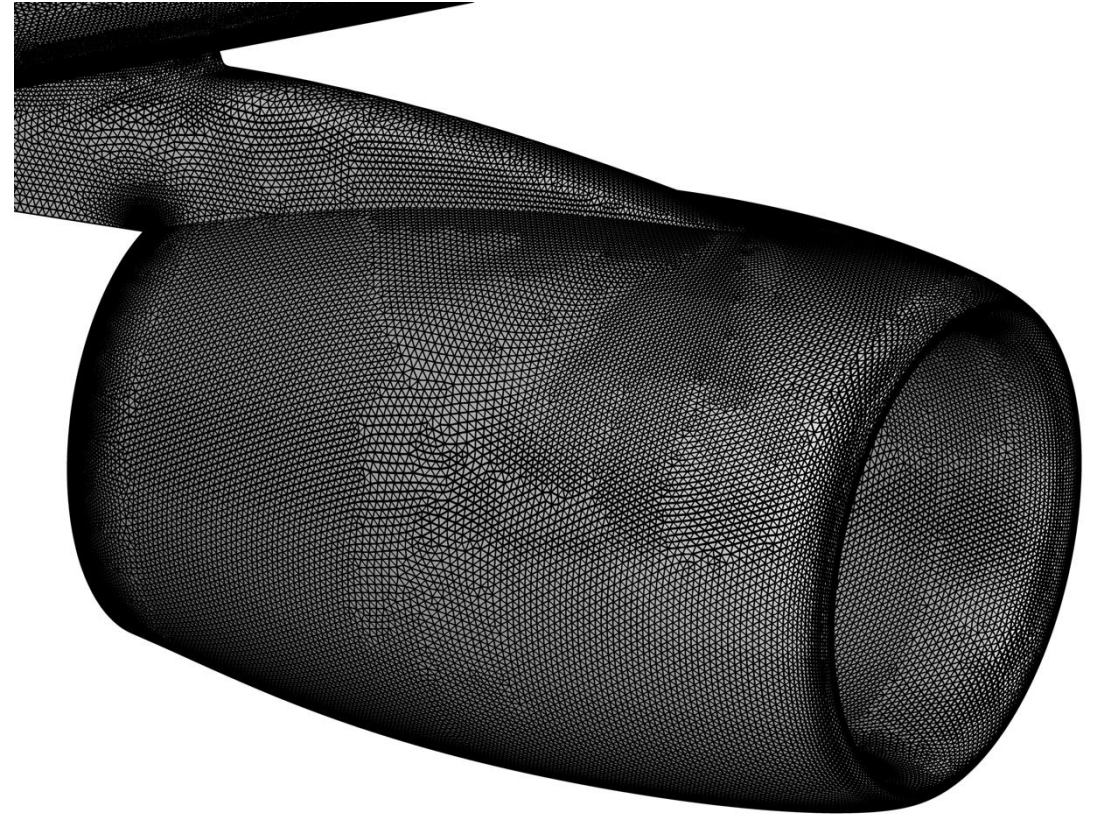
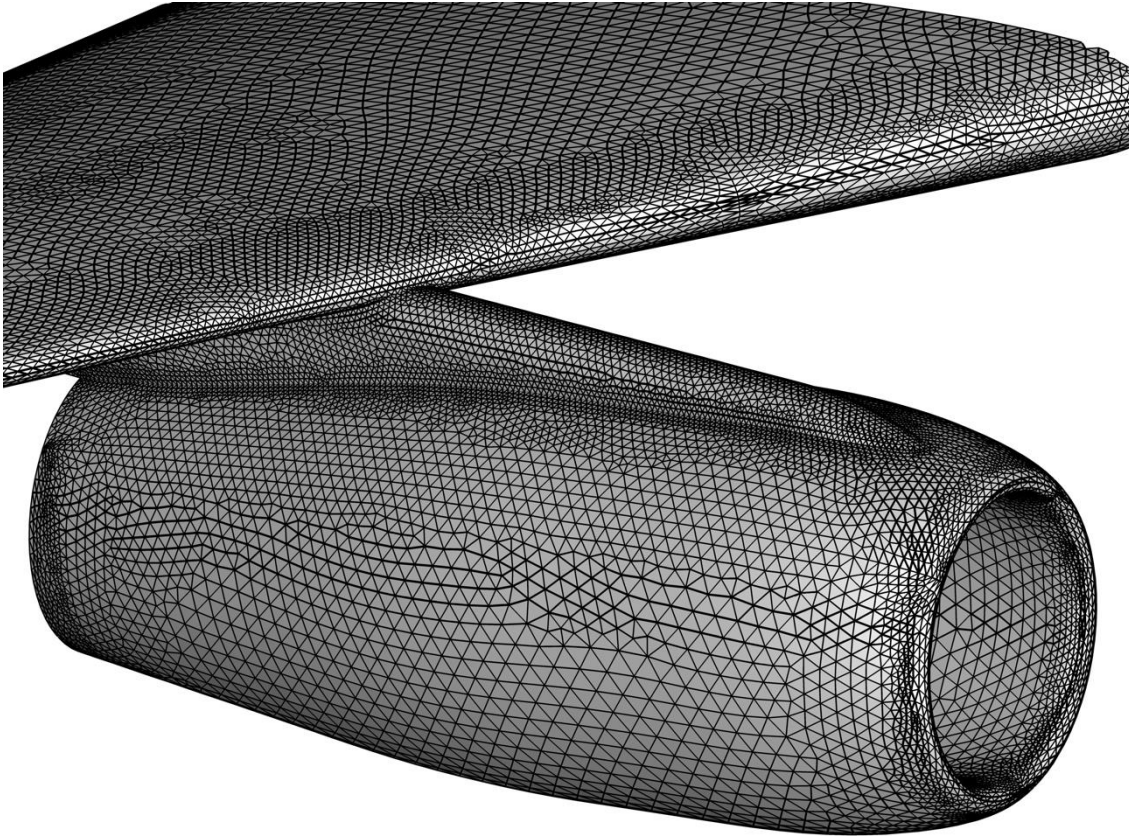
Representative Unstructured Grids: 50% Span



Representative Structured Grids: 50% Span



DPW-2 and DPW-6 Nacelle/Pylon



DPW-1

DPW1/DPW-I/original-grids/USG_Cell_Based

DPW1/DPW-I/original-grids/SG_Overset

DPW-2

DPW2/unst-CC-larc/wb/medium

DPW2/overset-mad/wb/medium

DPW-3

DPW3/hybrid_DLR/f6wb/L2

DPW3/multiblock_Boeing_CGNS/F6wb_struct_boeing/L2

DPW-4

DPW4/unstructured_Larc/CellBase/L3

DPW4/overset_Boeing/wbh_ih0_medium

DPW-5

DPW5/unstructured_grids.REV01/L3

DPW5/overset_grids.REV01/L3

DPW-6

DPW6/unstructured_NASA_GeoLab.REV01/WB_AE2.75_REV01/L3

DPW6/overset_grids_Boeing_Serrano.REV00/WB_ae2p75_medium/UPLOAD_wb-ae2p75-medium

DPW-7

DPW7/JAXA_Grids.REV00/L3

DPW7/Vassberg_Grids.REV00/LoQ/L3

DPW-8

DPW8/Buffer/Test_Case_2/Helden_Grids.REV00/alpha_1.22/b8/L3

DPW8/Scatter/Test_Case_2/Ames_Grids.REV00/alpha_2.50/L3

