



CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)

Weather Translation Examples

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*Friends and Partner of Aviation Weather
(FPAW)*



Weather Translation – Definition

- ***Weather Translation*** is comprised of one or more functions which ingest weather observations, analyses, and forecasts...and automatically produce relevant, standardized threshold events and/or characterizations of weather-related NAS constraints. This is accomplished through a framework of aviation operations filters such as Federal Aviation Regulations (FARs), flight standards, aircraft limitations and standard operating procedures (SOPs). The results of Weather Translation can be in the form of 4-D depictions that are spatially and temporally relevant to the affected NAS element (e.g. airport, terminal area, region of en route airspace).



Weather Translation – Non-Aviation Wind Chill and Heat Index



NWS Windchill Chart



		Temperature (°F)																	
		40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Wind (mph)	5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
	10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
	15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
	20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
	25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
	30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
	35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
	40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
	45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95	
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97	
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98	

Frostbite Times: 30 minutes (light blue), 10 minutes (medium blue), 5 minutes (dark blue)

$Wind\ Chill\ (°F) = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$
 Where, T= Air Temperature (°F) V= Wind Speed (mph) Effective 11/01/01

Wind chill and heat index are derived from multiple observable weather parameters

Wind chill and heat index themselves are not directly observable or measurable

Heat Index Chart

		Temperature (°F)															
		80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
Relative Humidity (%)	40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
	45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
	50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
	55	81	84	86	89	93	97	101	106	112	117	124	130	137			
	60	82	84	88	91	95	100	105	110	116	123	129	137				
	65	82	85	89	93	98	103	108	114	121	128	136					
	70	83	86	90	95	100	105	112	119	126	134						
	75	84	88	92	97	103	109	116	124	132							
	80	84	89	94	100	106	113	121	129								
	85	85	90	96	102	110	117	126	135								
	90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127											
100	87	95	103	112	121	132											

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

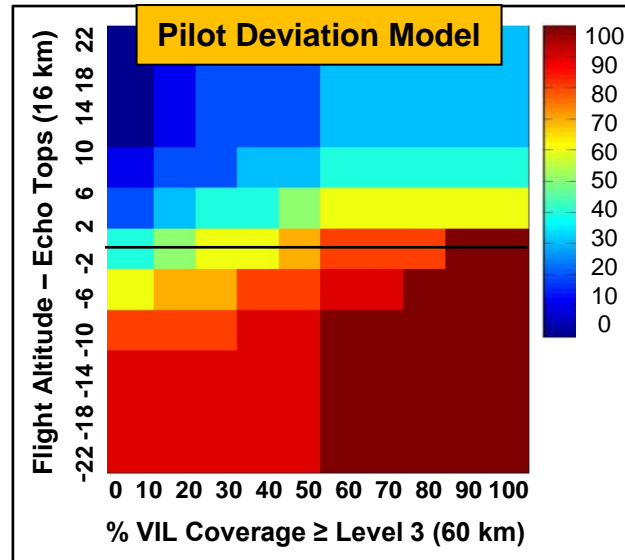
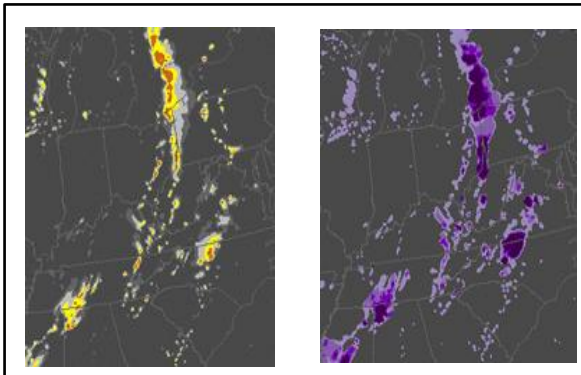
■ Caution ■ Extreme Caution ■ Danger ■ Extreme Danger



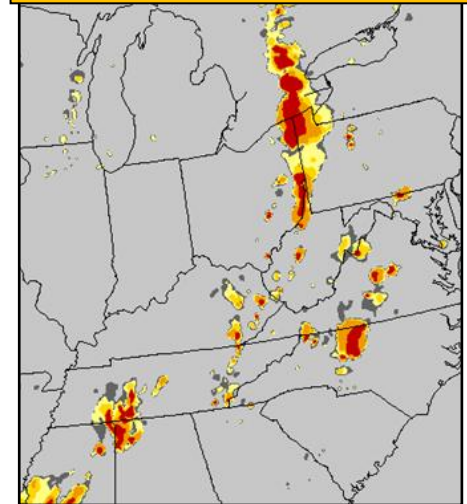
Weather Translation – Aviation Convection

Weather Avoidance Field (WAF)

Precipitation & Echo Tops Forecasts



Forecasted Pilot Avoidance Regions

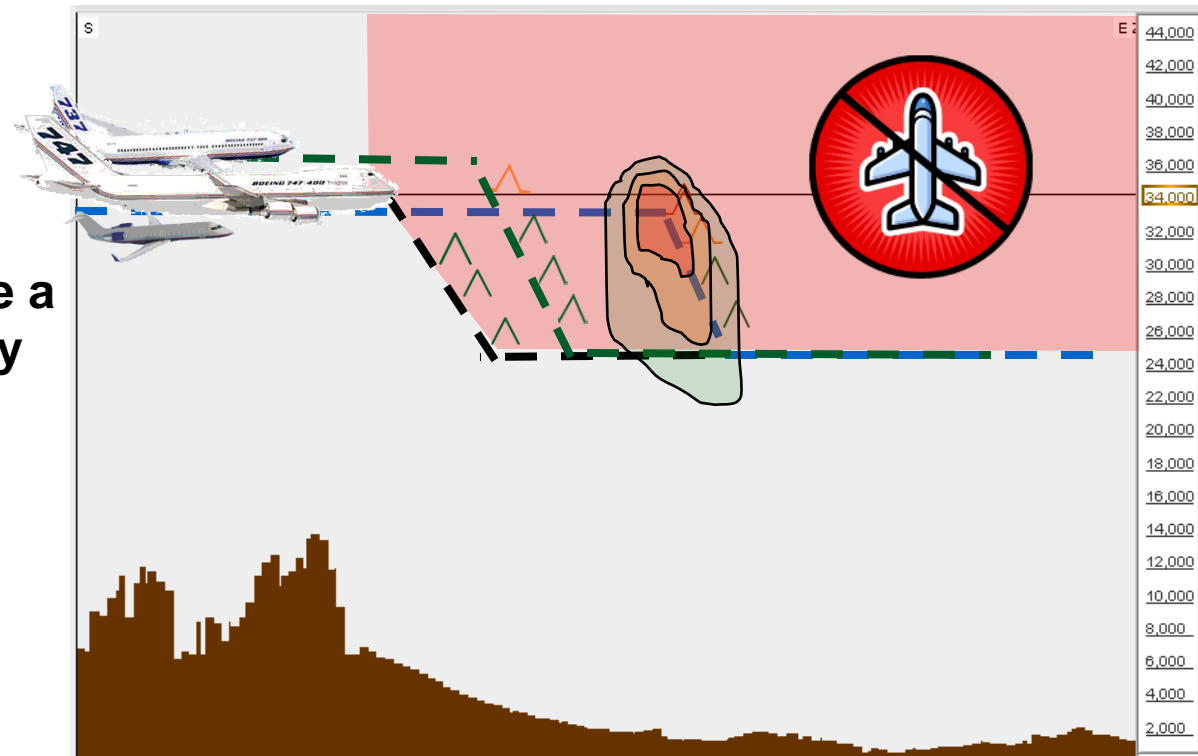


Weather → Filter → Constraint



Turbulence – Current Operations

- Multiple aircraft, all in the same flow at different altitudes, end up flying at the same inefficient altitude in the same sector based on the subjective turbulence report from the smallest aircraft in the flow
- As additional aircraft hear the ride reports from ATC, requests for lower altitude will be made, and the flow will continue to be compressed into a narrow range of altitudes in the same sector, in effect sterilizing altitudes above
- ATC does not have a way to strategically anticipate the reactions of individual aircraft



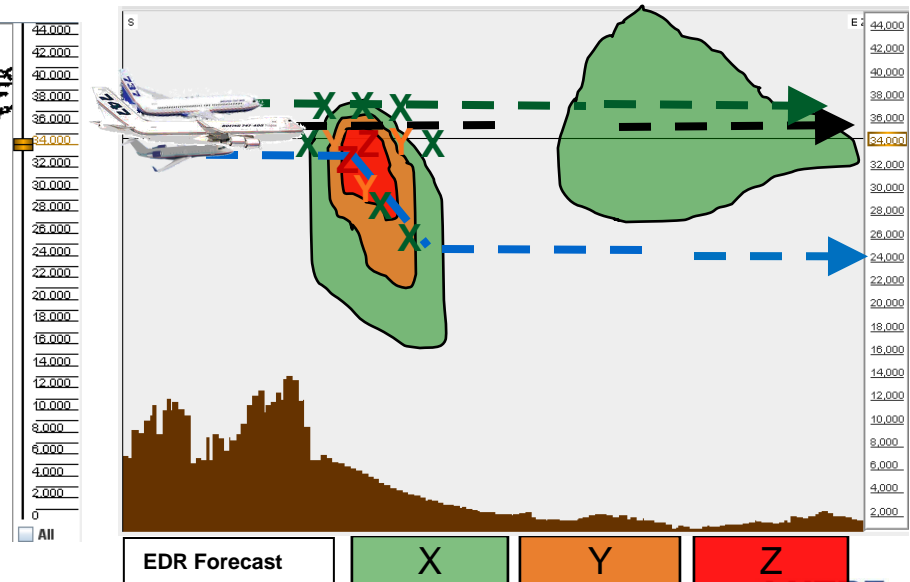
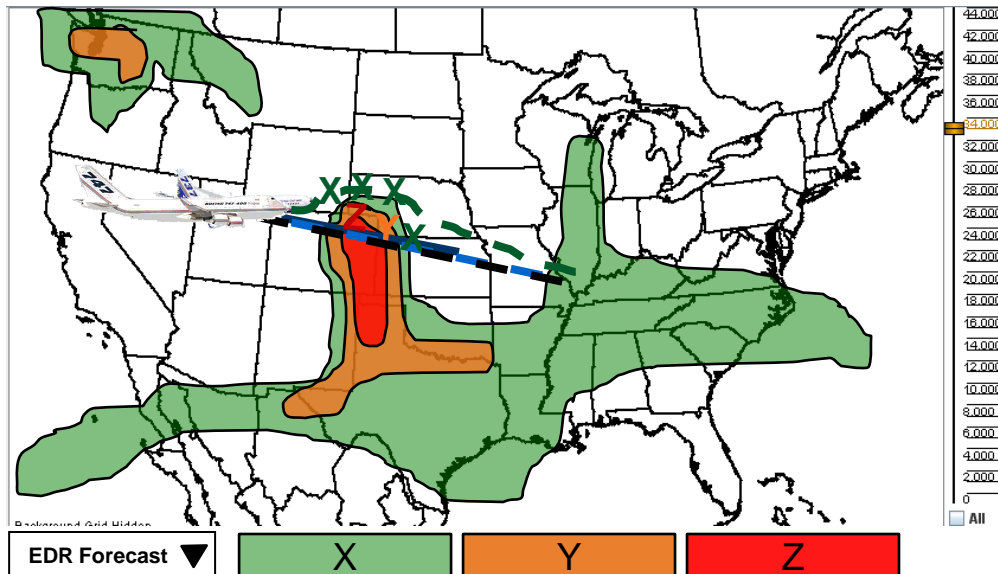
Key:

- ▲ Light Turbulence
- ▲ Moderate Turbulence
- ▲ Severe Turbulence



Turbulence – Future Operations

- Multiple aircraft, which have been in same flow at different altitudes, have crossed the turbulence-constrained area and are still altitude-segregated
- Likely actions of the aircraft have been anticipated by TM due to the availability of turbulence constraint information in realtime, and user-preferred flight plan route options; mitigation plans are put in place, and reroutes can be made well in advance of the turbulence, if desired
- Tactical actions at the sector level to assist pilots in avoiding turbulence have been minimized due to the advance actions taken to re-route affected aircraft
- Airspace has not been unnecessarily sterilized
- Capacity has not been unnecessarily reduced





Weather Translation – Aviation Turbulence (Notional)

Turbulence Translation Table (Notional)

Aircraft Type	MTOW [metric tons]	EDR Value										
		0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
		Aircraft Response										
		N/A			X				Y			Z
Antonov An-225	640	N/A	N/A	N/A	X	X	X	X	Y	Y	Y	Z
Airbus A380-800	560	N/A	N/A	N/A	X	X	X	X	Y	Y	Y	Z
Boeing 747-8I	440	N/A	N/A	N/A	X	X	X	X	Y	Y	Y	Z
Antonov An-124	405	N/A	N/A	N/A	X	X	X	X	Y	Y	Y	Z
Boeing 747-400	397	N/A	N/A	N/A	X	X	X	X	Y	Y	Y	Z
Boeing 747-200	378	N/A	N/A	N/A	X	X	X	X	Y	Y	Y	Z
Boeing 747-300	378	N/A	N/A	N/A	X	X	X	X	Y	Y	Y	Z
Airbus A340-500	368	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Airbus A340-600	365	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Boeing 777-300ER	352	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Boeing 747-100	333	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Boeing 777-300	299	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Airbus A340-200	275	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
MD-11	273	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Ilyushin IL-96M	270	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Boeing 777-200	263	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Airbus A340-300	254	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Boeing 787-9	245	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
L-1011-500	232	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Airbus A330-300	231	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Airbus A330-200	231	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Boeing 787-8	220	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Ilyushin IL-96-300	216	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Ilyushin IL-86	215	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Boeing 767-400ER	204	N/A	N/A	X	X	X	X	Y	Y	Y	Z	Z
Boeing 767-300ER	181	N/A	X	X	X	X	X	Y	Y	Y	Z	Z
Airbus A300-600R	171	N/A	X	X	X	X	Y	Y	Y	Z	Z	Z
Airbus A300-600	165	N/A	X	X	X	X	Y	Y	Y	Z	Z	Z
Airbus A310-300	164	N/A	X	X	X	X	Y	Y	Y	Z	Z	Z
Boeing 787-3	164	N/A	X	X	X	X	Y	Y	Y	Z	Z	Z
Boeing 767-300	156	N/A	X	X	X	X	Y	Y	Y	Z	Z	Z
Airbus A310-200	142	N/A	X	X	X	X	Y	Y	Y	Z	Z	Z
Airbus A400M	141	N/A	X	X	X	X	Y	Y	Y	Z	Z	Z



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Questions?

MITRE