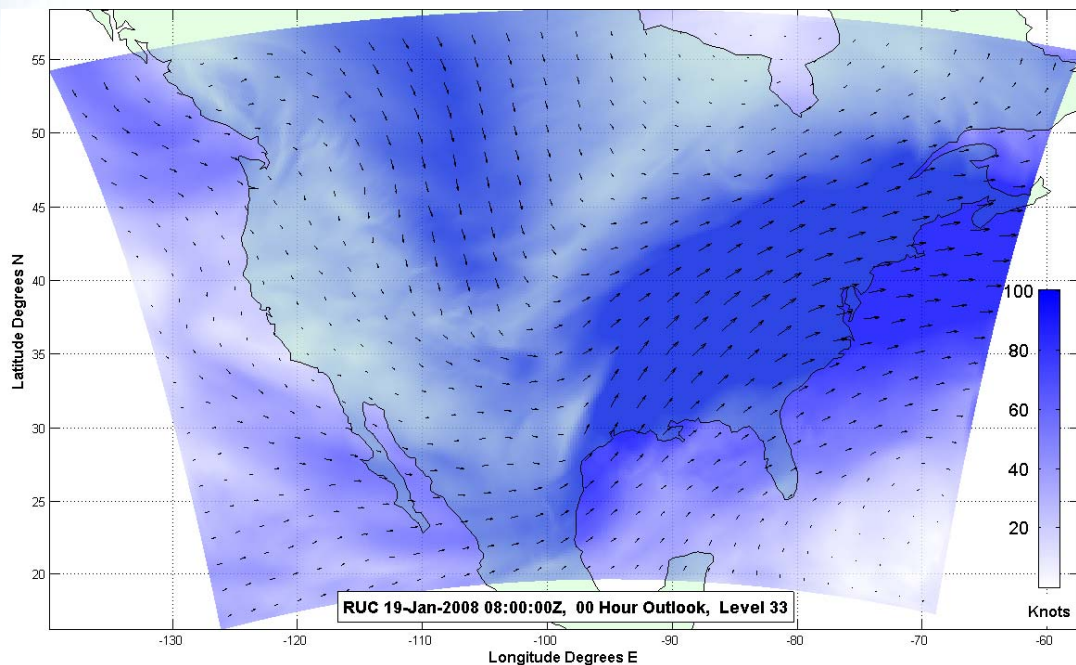




Wind Analysis in Aviation Applications



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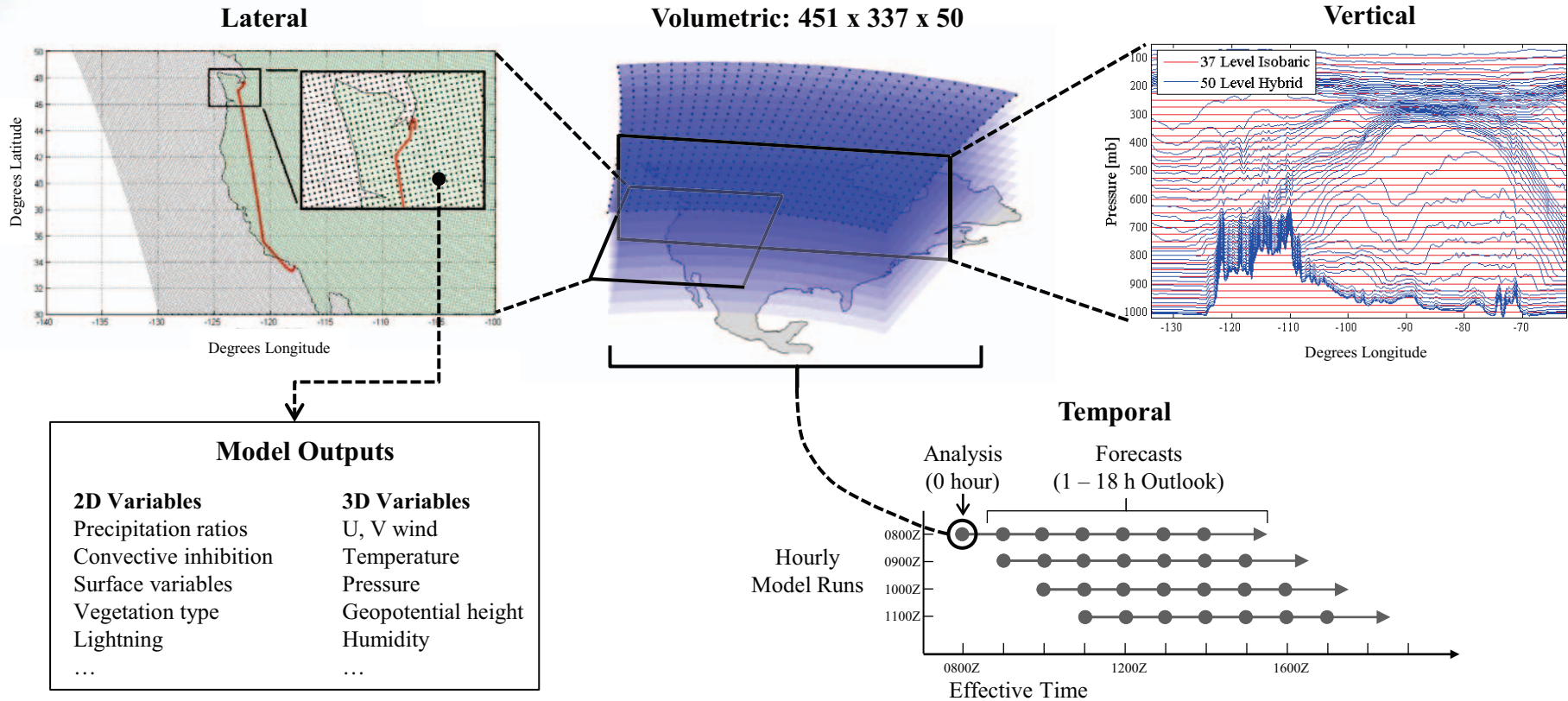
October 18th, 2012

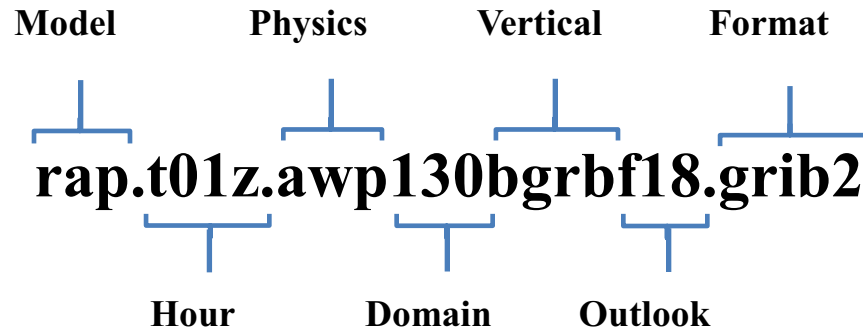


Overview



Rapid Update Cycle (RUC) Rapid Refresh (RAP)





Model

rap – Rapid Refresh
ruc – Rapid Update Cycle v1
ruc2 – Rapid Update Cycle v2

Physics

awp – Atlantic Warm Pool

Domain

130 – 13 km CONUS
252 – 20 km CONUS
236 – 40 km CONUS
242 – 11 km Alaska
221 – 32 km North America
200 – 16 km Puerto Rico

Vertical

bgrb – Native (50 Level)
pgrb – Isobaric (37 Level)
sgrb – Surface only

Hour

t00z - t23z – Hour, GMT

Outlook

f00 (anl) – Nowcast
f01 - f18 – Forecast

Format

grib (grb) – GRIB1 File
grib2 (grb2) – GRIB2 File



Methods



4D Interpolation

Steps

Lateral Transform

Altitude Conversion

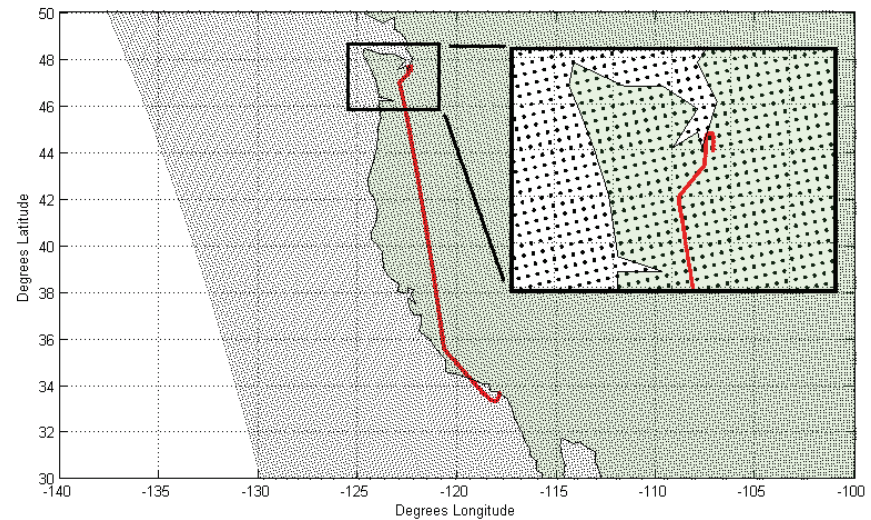
Wind Rotation

Vertical Interpolation

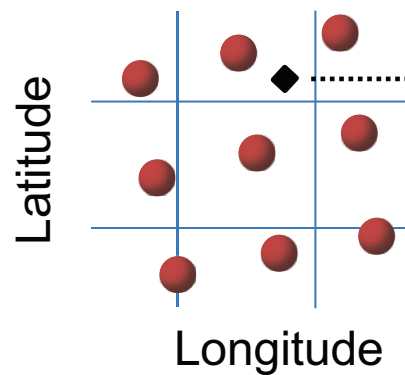
Lateral Interpolation

Temporal Interpolation

Map Reduce

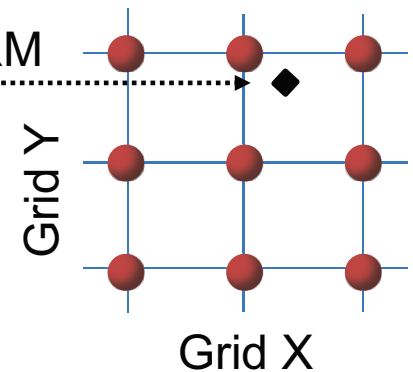


Cartesian Space



TRANSFORM

Lambertian Space





4D Interpolation

Steps

Lateral Transform

Altitude Conversion

Wind Rotation

Vertical Interpolation

Lateral Interpolation

Temporal Interpolation

Map Reduce

Convert Geopotential Height to Geometric Height

Select Vertical Index:

- Pressure
- Geometric Height
- Geopotential Height
- Pressure Altitude
- Corrected Pressure Altitude

Parameter	Symbol	Value
Geometric Height	h	(input)
Pressure Surface	P_S	(input)
Lapse Rate	λ_0	-6.5 K/km
Standard Temp.	T_0	288.15° K
Gravity	g	9.80665 m/sec ²
Gas-Constant	R	8.31432 J/mole-K
Pressure	P	(output)

$$\theta = 1 + \frac{h\lambda_0}{T_0}$$

$$P = P_S \theta^{\left(\frac{-g}{\lambda_0 R}\right)}$$



4D Interpolation

Steps

Lateral Transform

Altitude Conversion

Wind Rotation

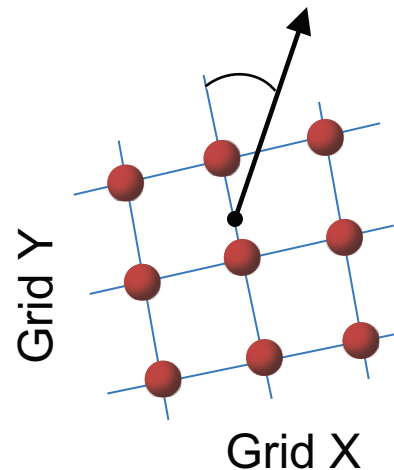
Vertical Interpolation

Lateral Interpolation

Temporal Interpolation

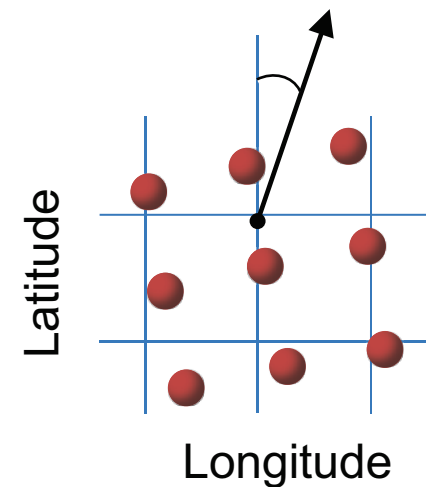
Map Reduce

**Wind Vector
Relative to
Lambertian Space**



GRID
ROTATION
→

**Wind Vector
Relative to
True North**



$$\alpha = \sin(\text{Latitude}_o) \cdot (\text{Longitude} - \text{Longitude}_o)$$

$$u_{\text{TrueNorth}} = \cos(\alpha) \cdot u_{\text{Lamb}} + \sin(\alpha) \cdot v_{\text{Lamb}}$$

$$v_{\text{TrueNorth}} = -\sin(\alpha) \cdot u_{\text{Lamb}} + \cos(\alpha) \cdot v_{\text{Lamb}}$$

$$\text{Latitude}_o = 25 \text{ degrees}$$

$$\text{Longitude}_o = -95 \text{ degrees}$$



4D Interpolation

Steps

Lateral Transform

Altitude Conversion

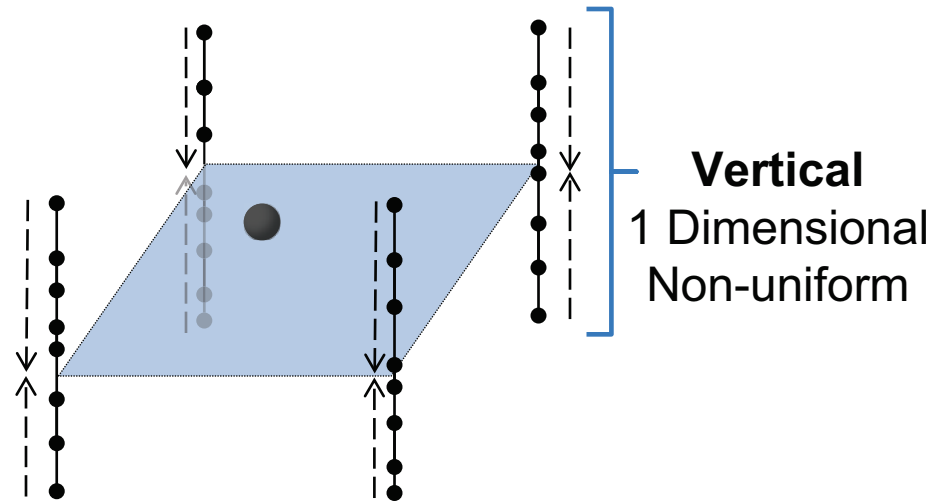
Wind Rotation

Vertical Interpolation

Lateral Interpolation

Temporal Interpolation

Map Reduce





4D Interpolation

Steps

Lateral Transform

Altitude Conversion

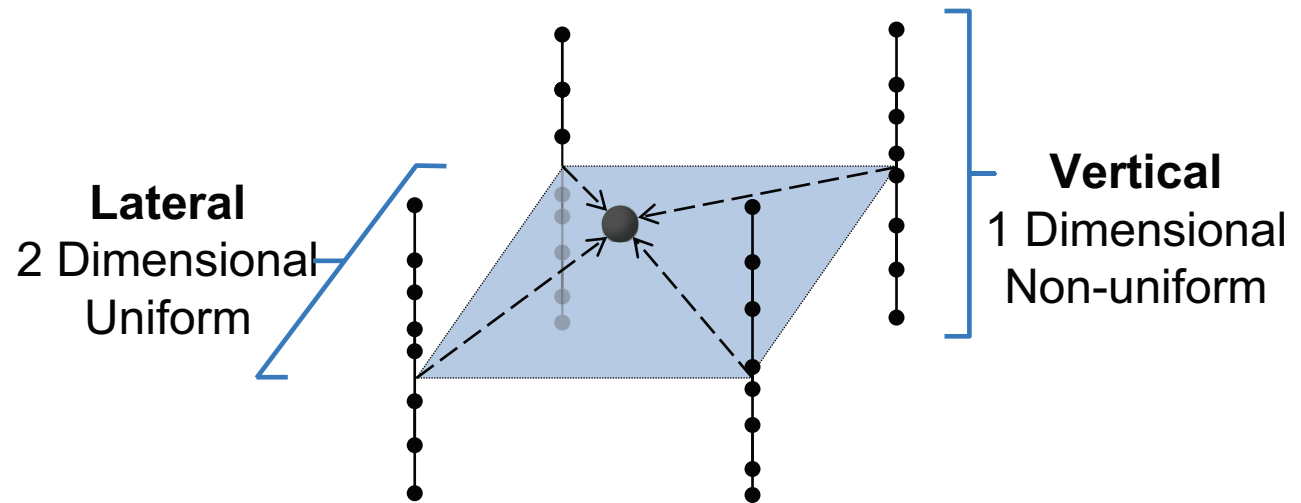
Wind Rotation

Vertical Interpolation

Lateral Interpolation

Temporal Interpolation

Map Reduce





4D Interpolation

Steps

Lateral Transform

Altitude Conversion

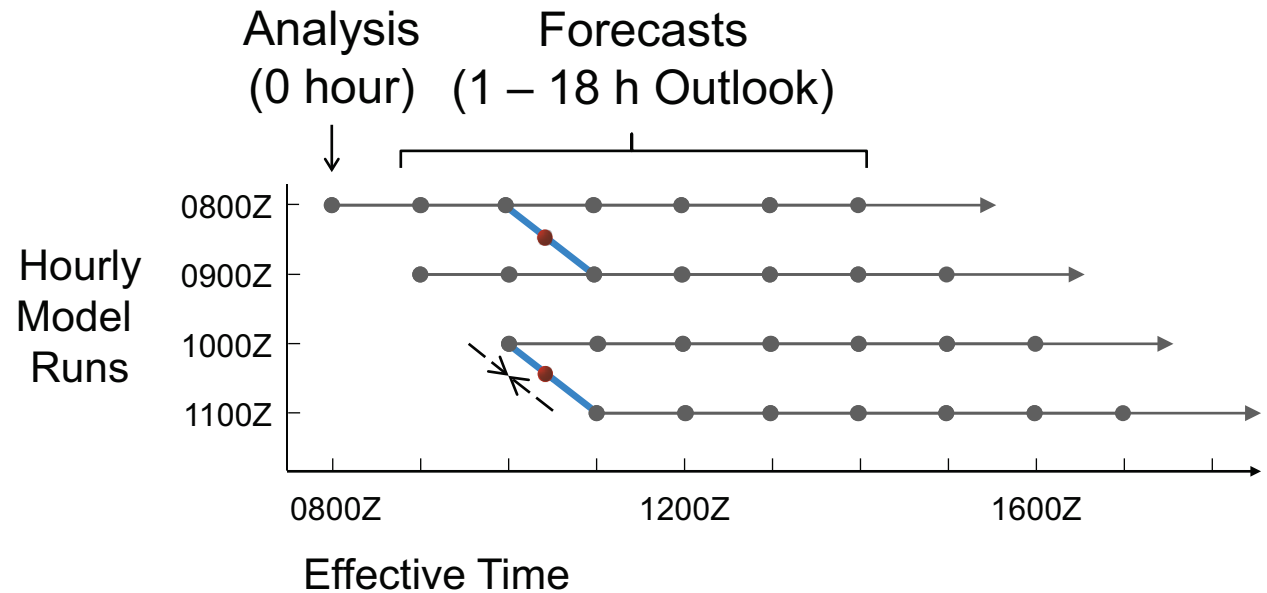
Wind Rotation

Vertical Interpolation

Lateral Interpolation

Temporal Interpolation

Map Reduce





4D Interpolation

Steps

Lateral Transform

Altitude Conversion

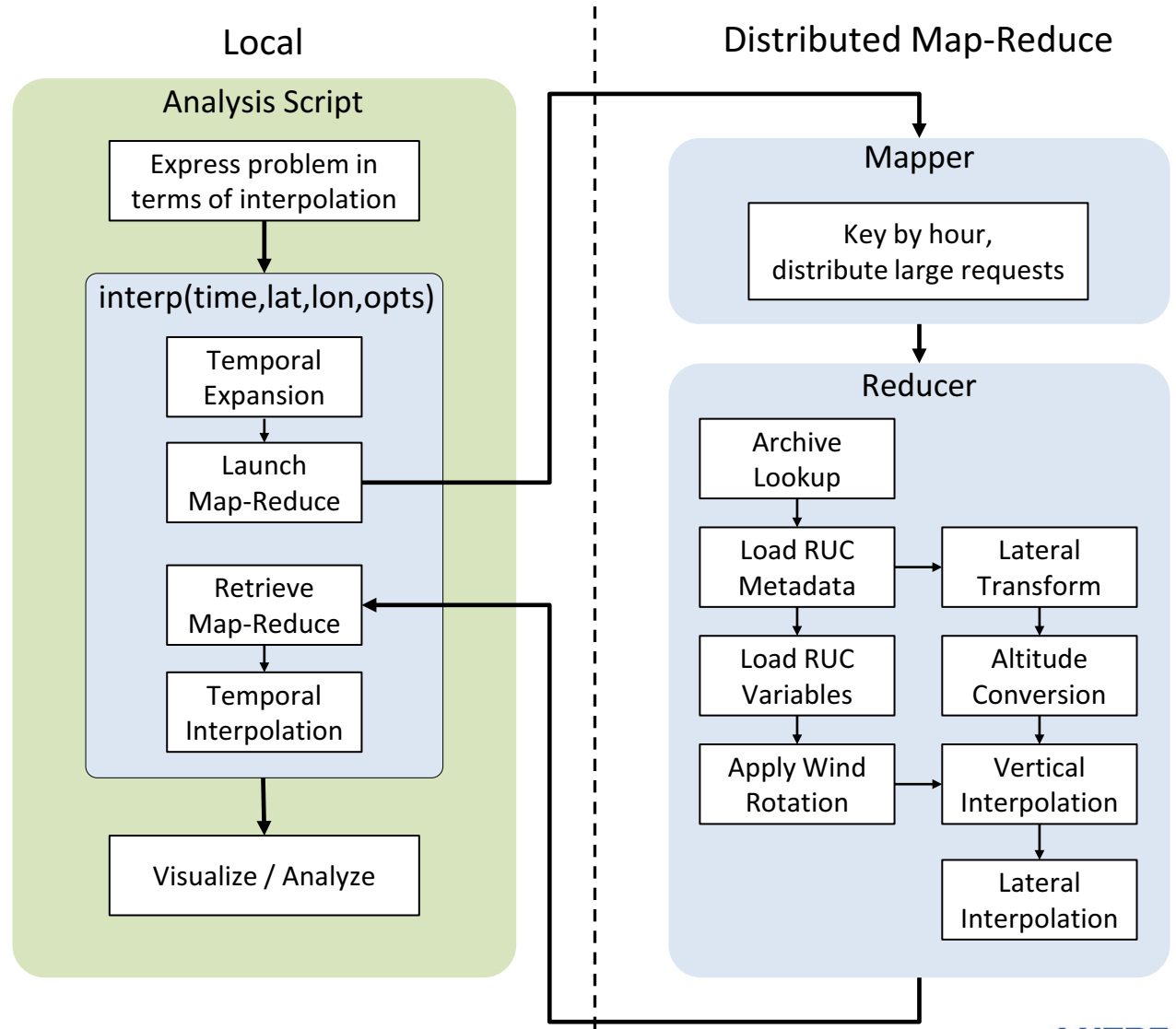
Wind Rotation

Vertical Interpolation

Lateral Interpolation

Temporal Interpolation

Map Reduce





Applications



Historic Winds for Procedure Design

STEP 1: Determine Ground Speed (V_{ground})

a = turn altitude in feet

f = MSL field elevation

V_{KTAS} = appropriate value from 8260.54A, table 2-3

$$(1) V_{KTAS} = \text{round} \left[\frac{V_{KTAS} \times 171233 \times \sqrt{303 - 0.00198 \times a}}{(288 - 0.00198 \times a)^{2.628}}, 0 \right]$$

$$(2) \text{ case } (a - f \leq 2000): V_{KTW} = 30$$

$$\text{ case } (a - f > 2000): V_{KTW} = \text{round} [a \times 0.00198 + 47, 0] \quad *$$

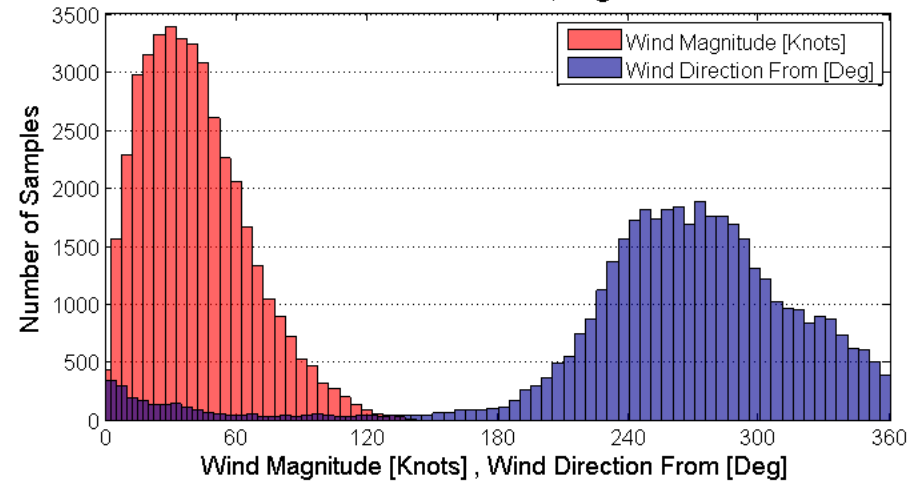
Note: Lower V_{KTW} values may be used if the last 5 year weather history at the turn fix location and turn altitude indicates the lower value maximum value is typical. Record the value used and justification in procedure documentation.

$$(3) \text{ case } (a \leq 19500): V_g = V_{KTAS} + V_{KTW}$$

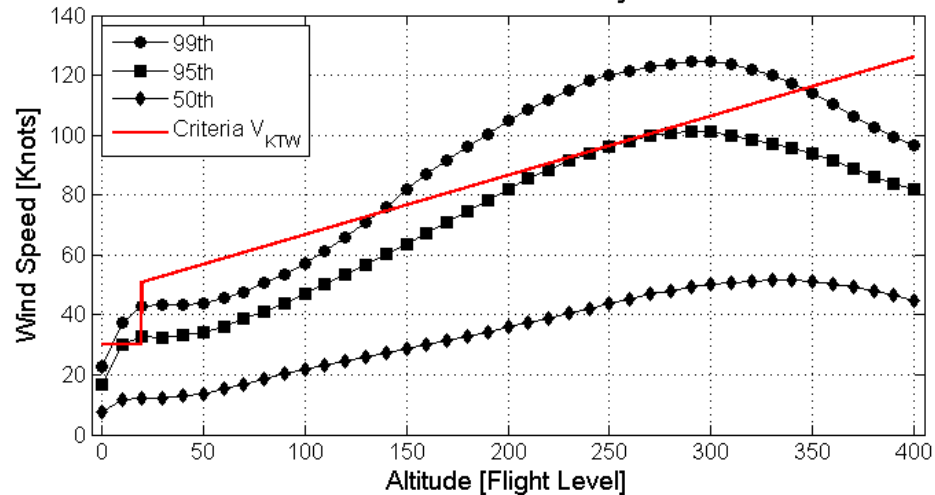
$$\text{ case } (a > 19500): V_g = \text{round} \left[0.9941 \times \frac{a}{100} + 287, 0 \right]$$

$$V_{ground} = \min [V_g, 570]$$

KDEN Wind Distributions, Flight Level 230

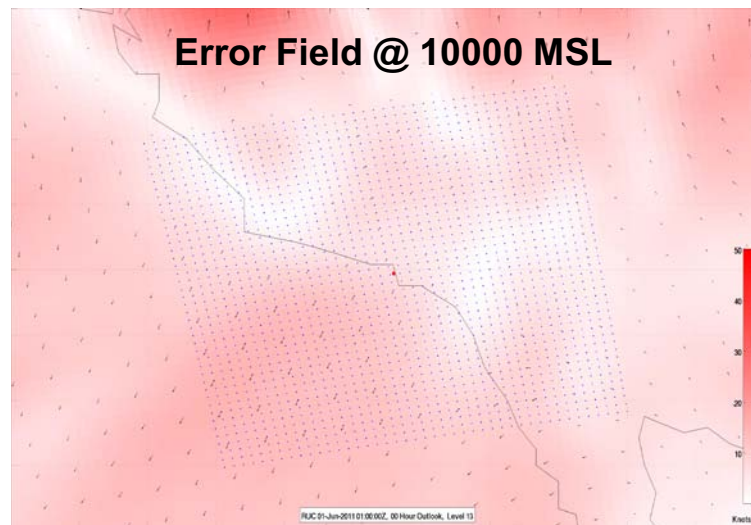
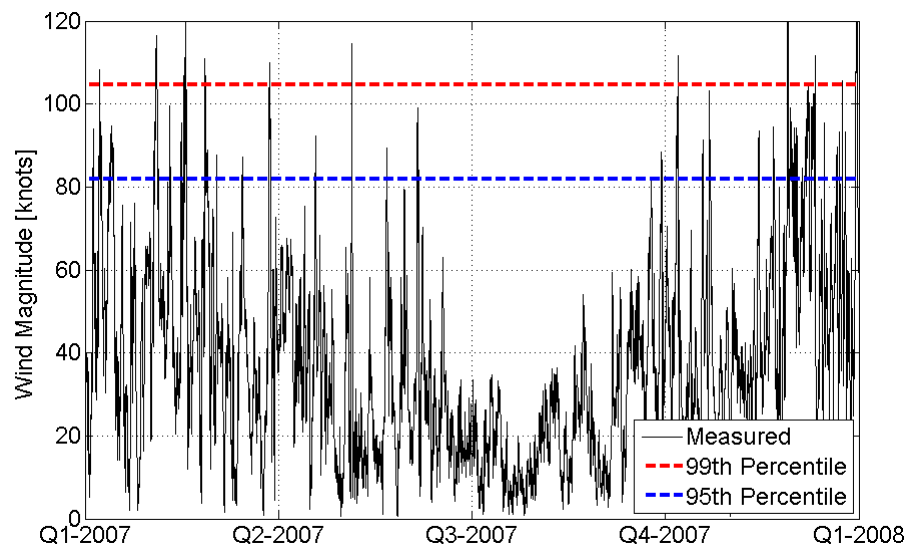
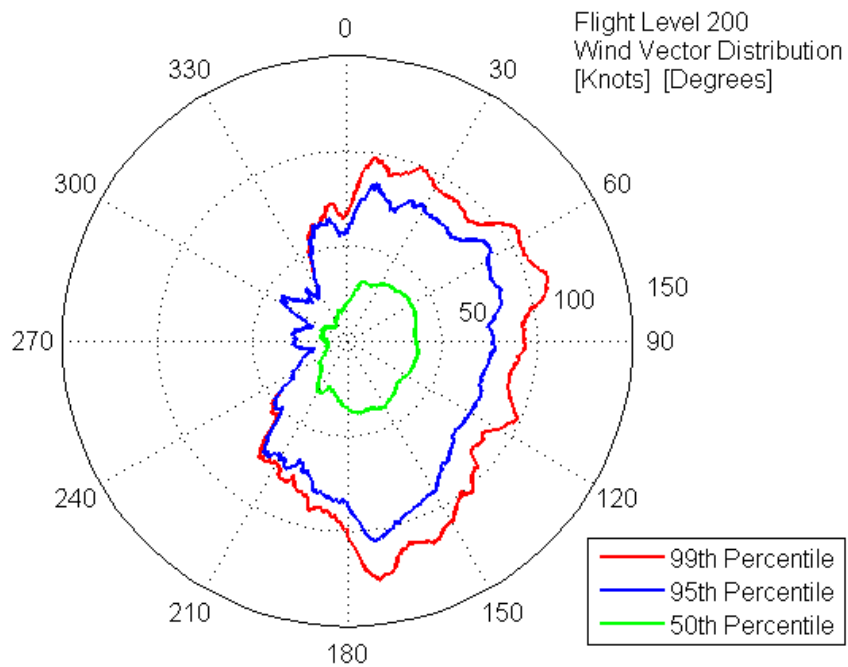


KDEN Wind Distribution by Altitude



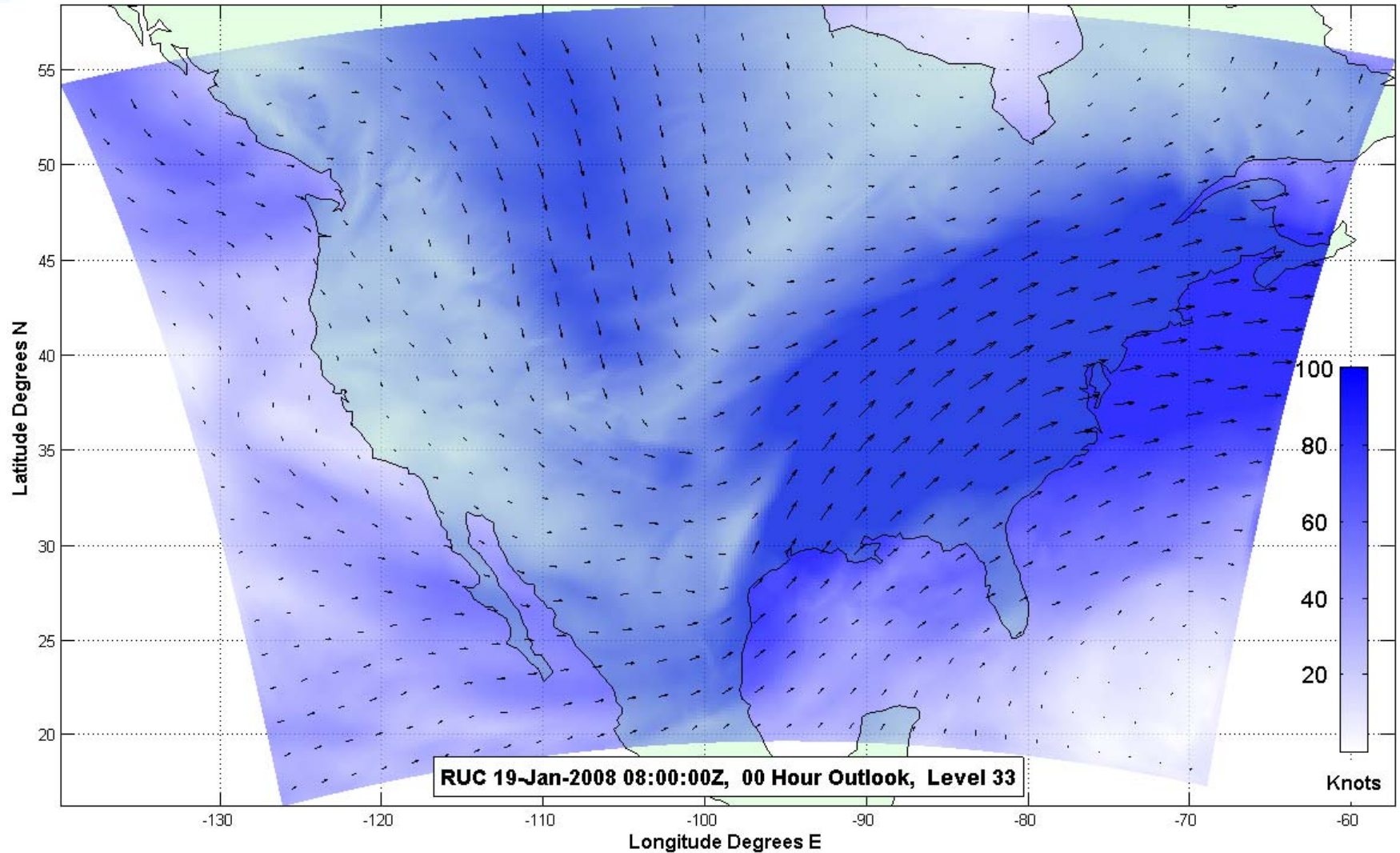


Visualization and Simulation



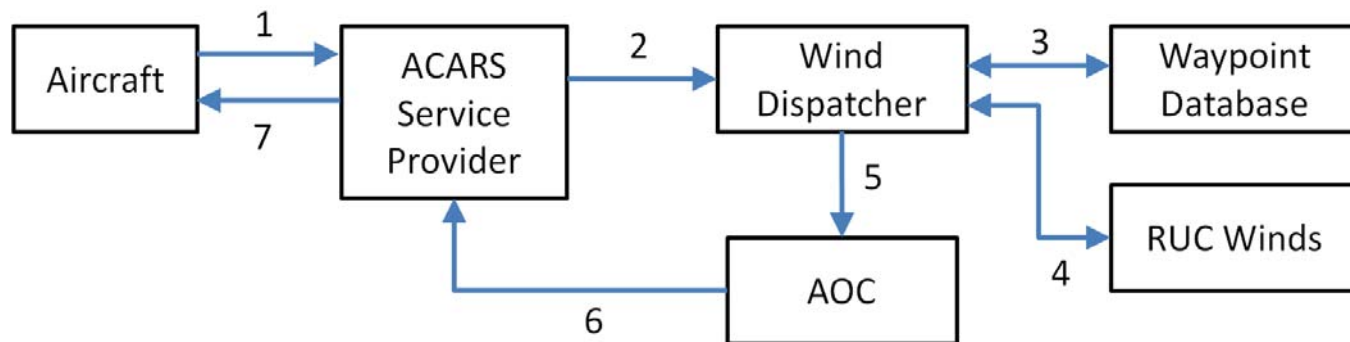
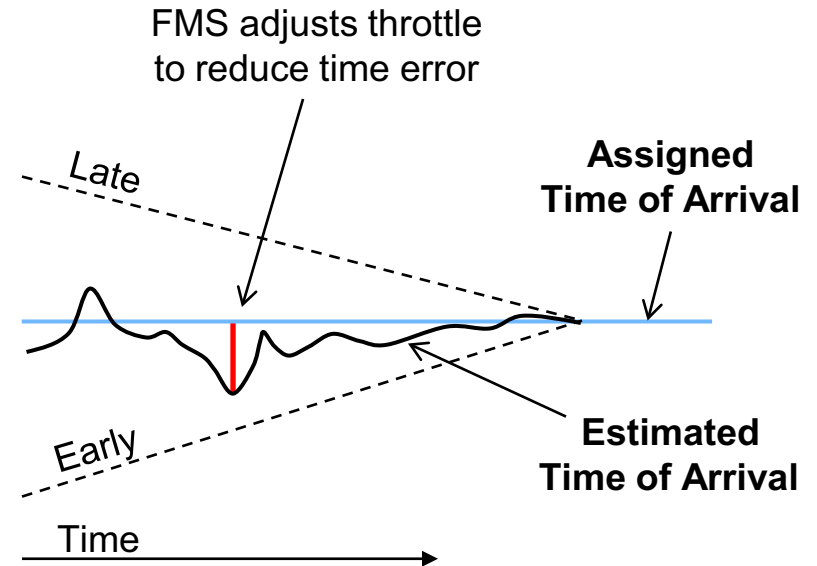
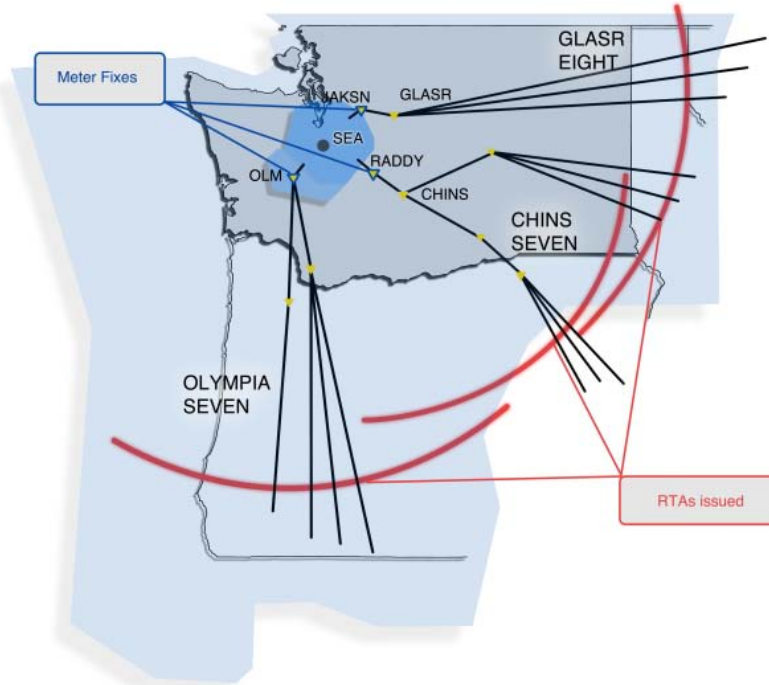


Visualization and Simulation





Winds for Trajectory Based Operations





Questions
