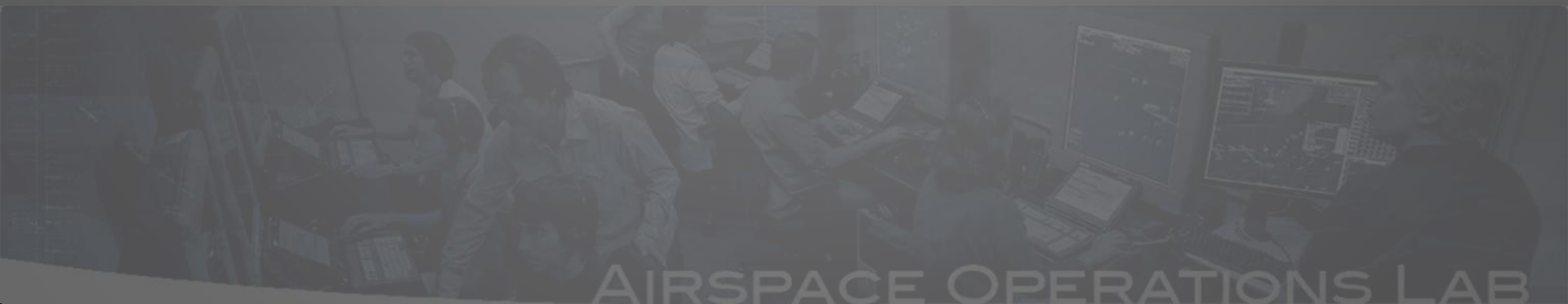
Scenario Generation in MACS

Chris Cabrall

Slides by Jeff Homola



Outline

- Introduction
- Traffic scenario generation
  - Getting started
  - AC Table Editor
  - Scenario Editor
- Going forward and final notes

Scenario Generation

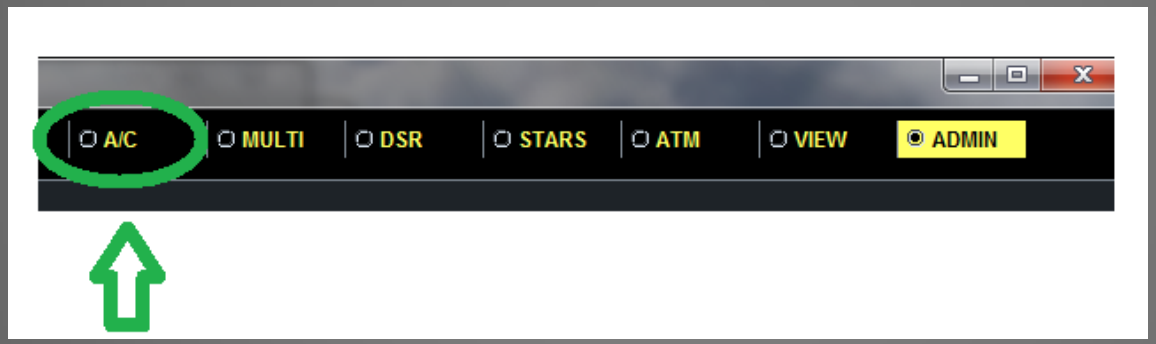
- The scenario generation and editing functions in MACS are the primary means by which traffic scenarios are created for use in simulations and testing
- The scenario generation tools allow for a great deal of flexibility in what can be tested
- To date, a variety of traffic situations have been created that simulated current day operations both in the terminal and en route domains as well as far-term environments with 2-3 times current traffic levels and different levels of aircraft equipage

Typical questions that guide the process

- What is the airspace of concern?
- What are the targeted traffic loads for that airspace?
- What is the duration and scope of the problem?
- What are the equipage assumptions?
- How structured does the traffic need to be?
- What, if any, are the desired interactions of the traffic?
  - Conflicts, arrival/departure flows, metering

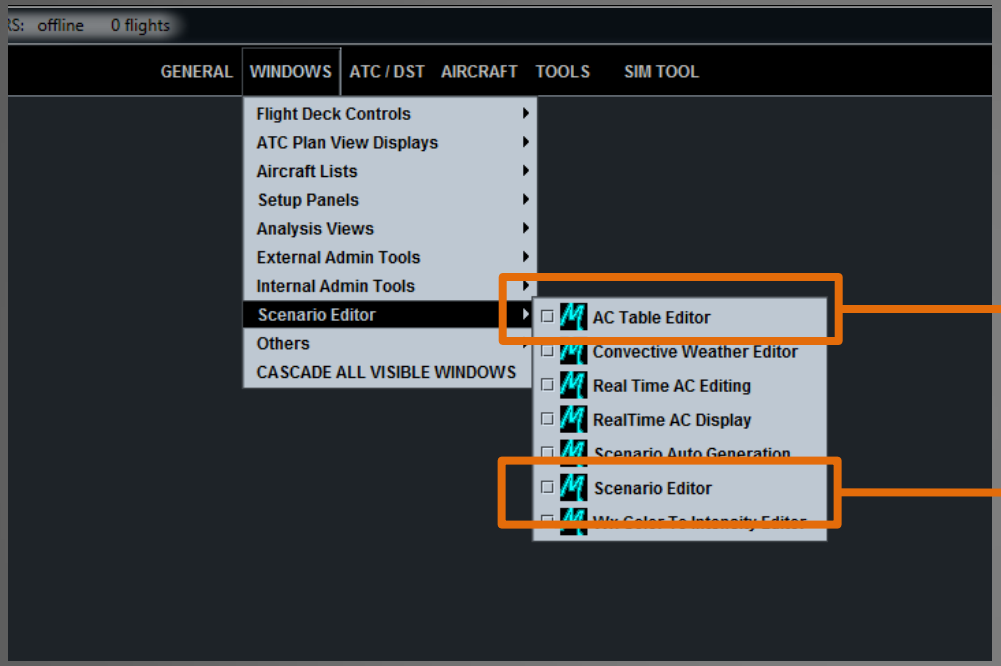
Getting Started

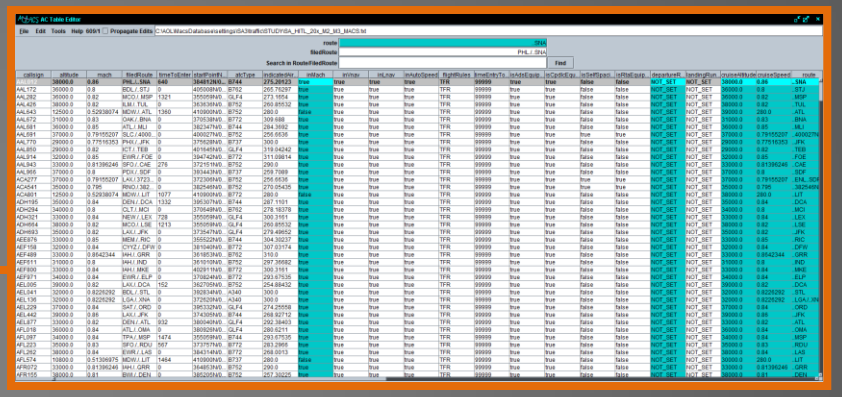
- **Open MACS via double-clicking the Example_ZOB "Developer.bat" shortcut**
  - C:\Experiments\Example_ZOB\MacsStart\Admin

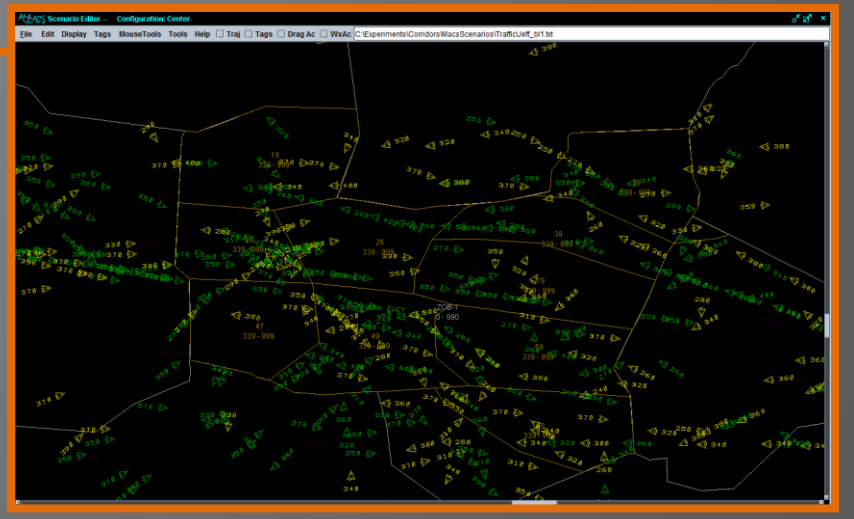


  - **Switch to the A/C "tab", and close and re-open the windows there:**
    - **Scenario Editor, AC Table Editor, SIM TOOL**

Common Tools







- The two most common tools used for traffic development and editing are the AC Table Editor spreadsheet and the graphical Scenario Editor.

- They are often used in tandem and interface with one another, so it is useful to have them both up together.

MACS modes

1. MACS initializes in Simulation mode by default. Editing can only be done in the Editor mode. To switch modes, first enable the SimTool by clicking on its item in the title bar.

2. **Click on the SimTool's drop-down menu that is currently set to Simulation.**

3. **Select Editor from the menu to enter the Editing mode.**

Opening Traffic Files

•Multiple places to switch between Traffic files

- Different “synched” locations to select traffic file from

  - **Sim Tool: “Browse” button**

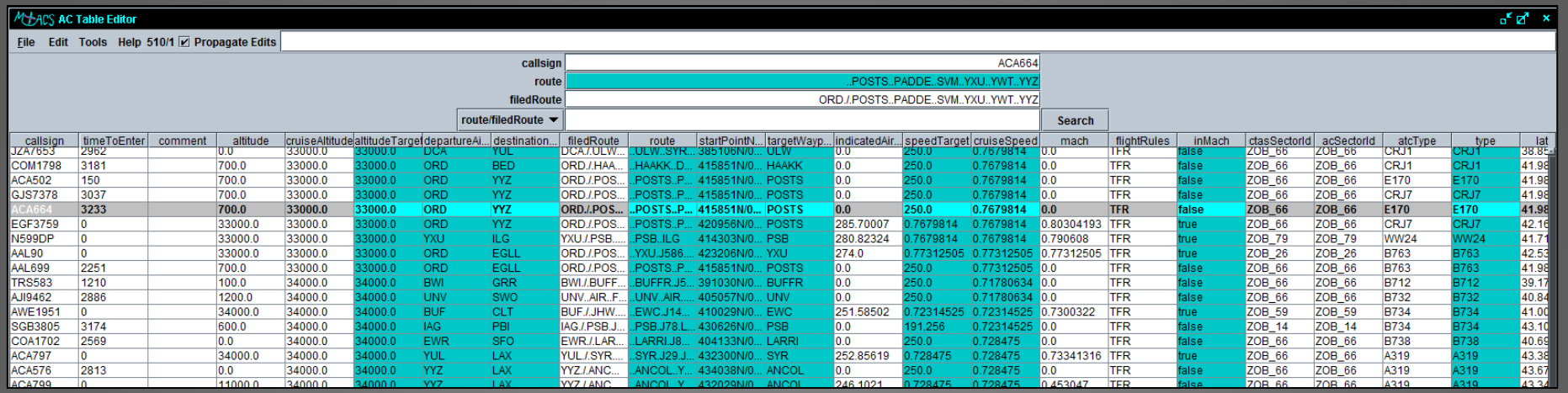
  - **AC Table Editor, Scenario Editor: “File -> open”**

**note: Sim Tool not updating when Scenario Editor “File -> open” is used

- **Change from “10_AC_Sample_Traffic.txt” to “SA5_Sample_Traffic.txt” (and then back)**

**note: The number of aircraft total/selected, load times, etc.

AC Table Editor

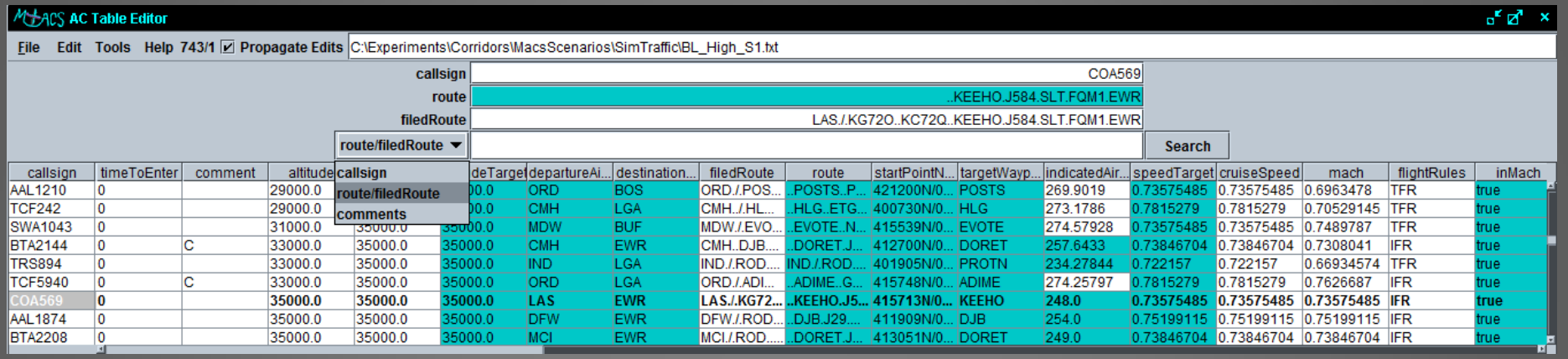


callsign	timeToEnter	comment	altitude	cruiseAltitude	altitudeTarget	departureAi...	destination...	filedRoute	route	startPointN...	targetWayp...	indicatedAir...	speedTarget	cruiseSpeed	mach	flightRules	inMach	ctasSectorId	acSectorId	atcType	type	lat
JZA7653	2962		0.0	33000.0	33000.0	DCA	YUL	DCA./.ULW...	..ULW..SYR...	385106N/0...	ULW	0.0	250.0	0.7679814	0.0	TFR	false	ZOB_66	ZOB_66	CRJ1	CRJ1	38.85
COM1798	3181		700.0	33000.0	33000.0	ORD	BED	ORD./.HAA...	..HAAKK..D...	415851N/0...	HAAKK	0.0	250.0	0.7679814	0.0	TFR	false	ZOB_66	ZOB_66	CRJ1	CRJ1	41.98
ACA502	150		700.0	33000.0	33000.0	ORD	YYZ	ORD./.POS...	..POSTS..P...	415851N/0...	POSTS	0.0	250.0	0.7679814	0.0	TFR	false	ZOB_66	ZOB_66	E170	E170	41.98
GJS7378	3037		700.0	33000.0	33000.0	ORD	YYZ	ORD./.POS...	..POSTS..P...	415851N/0...	POSTS	0.0	250.0	0.7679814	0.0	TFR	false	ZOB_66	ZOB_66	CRJ7	CRJ7	41.98
ACA664	3233		700.0	33000.0	33000.0	ORD	YYZ	ORD./.POS...	..POSTS..P...	415851N/0...	POSTS	0.0	250.0	0.7679814	0.0	TFR	false	ZOB_66	ZOB_66	E170	E170	41.98
EGF3759	0		33000.0	33000.0	33000.0	ORD	YYZ	ORD./.POS...	..POSTS..P...	420956N/0...	POSTS	285.70007	0.7679814	0.7679814	0.80304193	TFR	true	ZOB_66	ZOB_66	CRJ7	CRJ7	42.16
N599DP	0		33000.0	33000.0	33000.0	YXU	ILG	YXU./.PSB.....	..PSB..ILG	414303N/0...	PSB	280.82324	0.7679814	0.7679814	0.790608	TFR	true	ZOB_79	ZOB_79	WW24	WW24	41.71
AAL90	0		33000.0	33000.0	33000.0	ORD	EGLL	ORD./.POS...	..YXU.J586....	423206N/0...	YXU	274.0	0.77312505	0.77312505	0.77312505	TFR	true	ZOB_26	ZOB_26	B763	B763	42.53
AAL699	2251		700.0	33000.0	33000.0	ORD	EGLL	ORD./.POS...	..POSTS..P...	415851N/0...	POSTS	0.0	250.0	0.77312505	0.0	TFR	false	ZOB_66	ZOB_66	B763	B763	41.98
TRS583	1210		100.0	34000.0	34000.0	BWI	GRR	BWI./.BUFF...	..BUFFR.J5...	391030N/0...	BUFFR	0.0	250.0	0.71780634	0.0	TFR	false	ZOB_66	ZOB_66	B712	B712	39.17
AJI9462	2886		1200.0	34000.0	34000.0	UNV	SWO	UNV..AIR..F...	..UNV..AIR.....	405057N/0...	UNV	0.0	250.0	0.71780634	0.0	TFR	false	ZOB_66	ZOB_66	B732	B732	40.84
AWE1951	0		34000.0	34000.0	34000.0	BUF	CLT	BUF./.JHW....	..EWC.J14...	410029N/0...	EWC	251.58502	0.72314525	0.72314525	0.7300322	TFR	true	ZOB_59	ZOB_59	B734	B734	41.00
SGB3805	3174		600.0	34000.0	34000.0	IAG	PBI	IAG./.PSB.J...	..PSB.J78.L...	430626N/0...	PSB	0.0	191.256	0.72314525	0.0	TFR	false	ZOB_14	ZOB_14	B734	B734	43.10
COA1702	2569		0.0	34000.0	34000.0	EWR	SFO	EWR./.LAR...	..LARRI.J8...	404133N/0...	LARRI	0.0	250.0	0.728475	0.0	TFR	false	ZOB_66	ZOB_66	B738	B738	40.69
ACA797	0		34000.0	34000.0	34000.0	YUL	LAX	YUL./.SYR....	..SYR.J29.J...	432300N/0...	SYR	252.85619	0.728475	0.728475	0.73341316	TFR	true	ZOB_66	ZOB_66	A319	A319	43.38
ACA576	2813		0.0	34000.0	34000.0	YYZ	LAX	YYZ./.ANC...	..ANCOL..Y...	434038N/0...	ANCOL	0.0	250.0	0.728475	0.0	TFR	false	ZOB_66	ZOB_66	A319	A319	43.67
ACA799	0		11000.0	34000.0	34000.0	YYZ	LAX	YYZ./.ANC...	..ANCOL..Y...	432029N/0...	ANCOL	246.1021	0.728475	0.728475	0.453047	TFR	false	ZOB_66	ZOB_66	A319	A319	43.34

- The AC Table Editor displays the loaded traffic file as a spreadsheet and can be used as such.

- The columns of values **can be arranged according to preference by clicking and dragging the heading cell of a column to its desired location**. This is a useful feature as it is often helpful to group certain columns together for review.

AC Table Editor



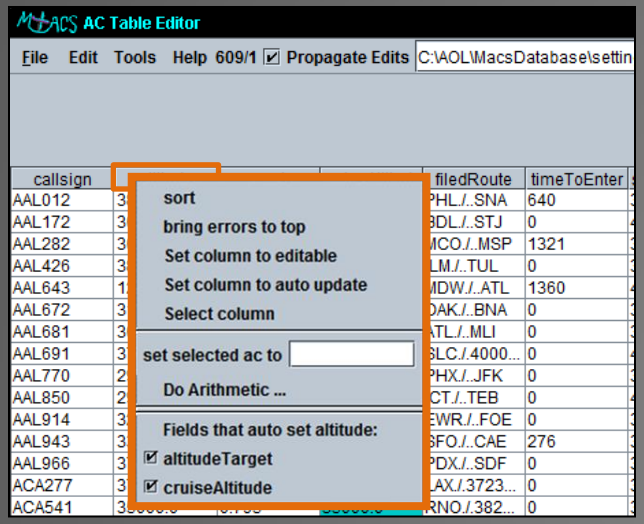
- **Selecting a single aircraft in the table will display its associated text in bold for reference**.

- Its *callsign*, *route*, and *filedRoute* will be displayed in the respective text windows as shown.

- The *callsign, route, and filedRoute* can be edited from the upper windows without the need to do so in the individual table cells. (e.g. as a shortcut/quick access point)

- The AC Table Editor has a search function that allows the user to search the entire file for specific callsigns, certain strings within a route/filedRoute, or strings within comment entries.

AC Table Editor: Column Headings



Each column has a fly-out menu that can be accessed by right clicking the column's heading cell.

Selecting each option will have the following results:

sort Sorts the file in ascending order of the column's values.

bring errors to top The editor has error checking for each field, with errors displayed in red text. Selecting this will bring all rows with errors in the selected column to the top.

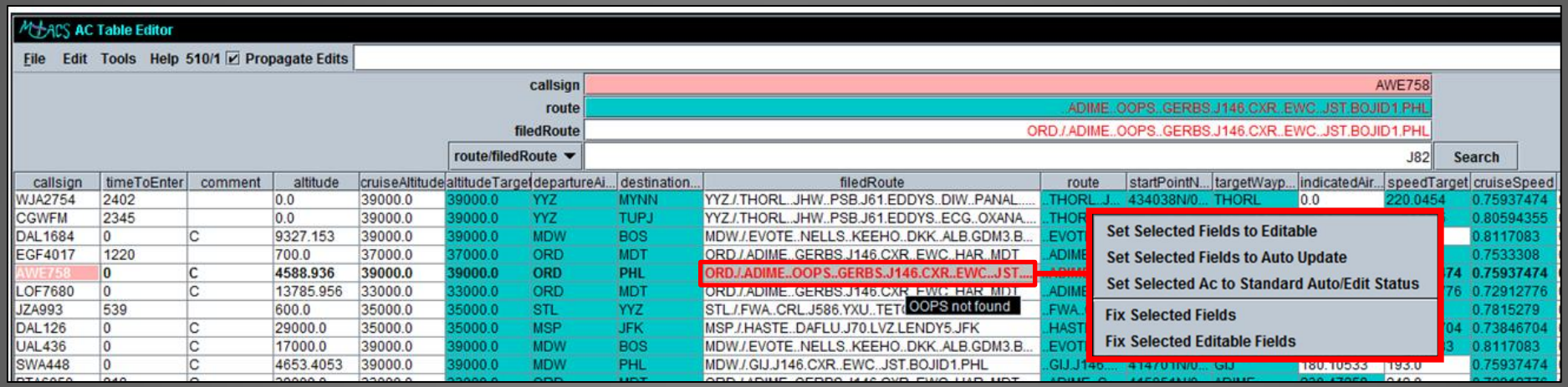
Set column to editable Changes made in other columns will not affect values in this column.

Set column to auto update Changes made within an associated column will propagate to the column set to auto update. For example, setting the altitudeTarget or cruiseAltitude to 35000 will update the corresponding altitude cell to 35000.*

set selected ac to Sets the column value of all selected aircraft to the text box entry.

**Updates will only propagate if the "Propagate Edits" checkbox is checked*

AC Table Editor: Error Checking



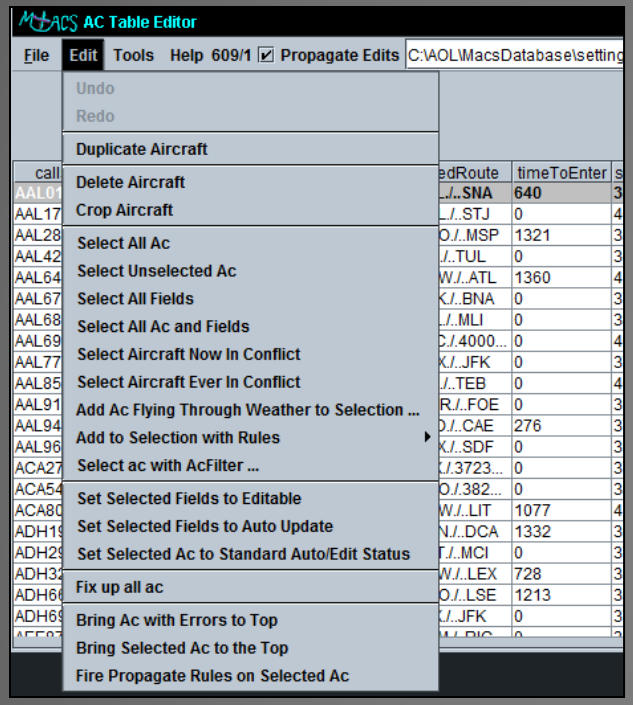
AWE758 Each aircraft with an error in any field has its callsign highlighted.

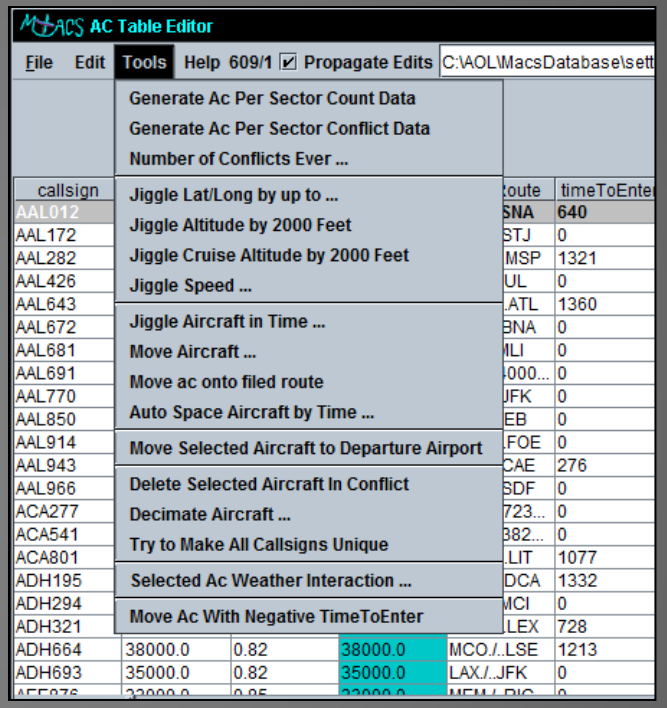
ORD./.ADIME. Text in the field(s) containing errors are shown in red.

OOPS not found The filedRoute and route fields have tool tips displayed when hovered over that identify what is causing the specific error.

Fix Selected Fields Selecting this option from the flyout menu will “fix” the error. Exercise some caution when using this feature as some changes may not reflect your intent.

AC Table Editor Features



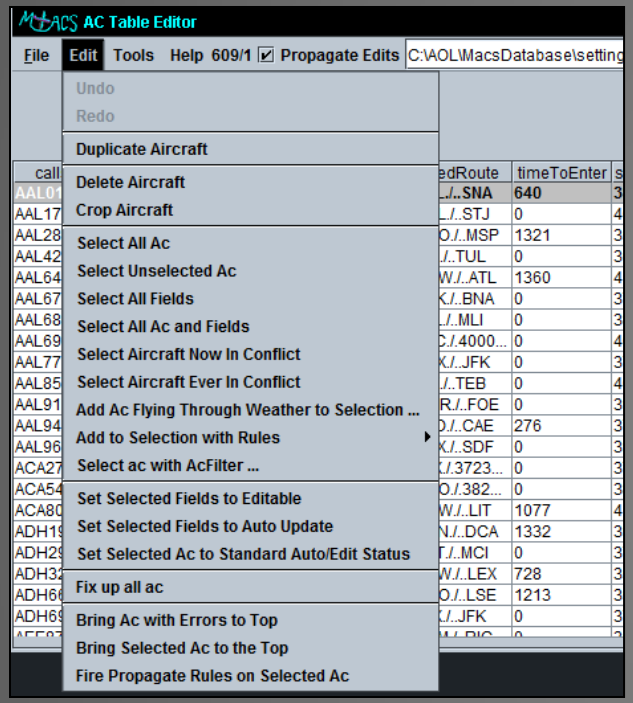


For the purposes of these slides, the Edit and Tools functions are too numerous to go into detail. It is recommended to simply try these out and get a feel for how the different options will best suit your needs.

The following slides cover a small selection of **frequently used features** in each of the menus.

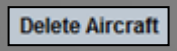
Short sample activity/task to follow after I review a few of these.

AC Table Editor: Select Edit Functions

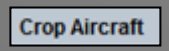


Undo returns to the previous state prior to the last change. Redo reincorporates the previous change.

Makes exact duplicates of selected aircraft with the exception of new, unique callsigns. Can be performed on one or multiple selections.

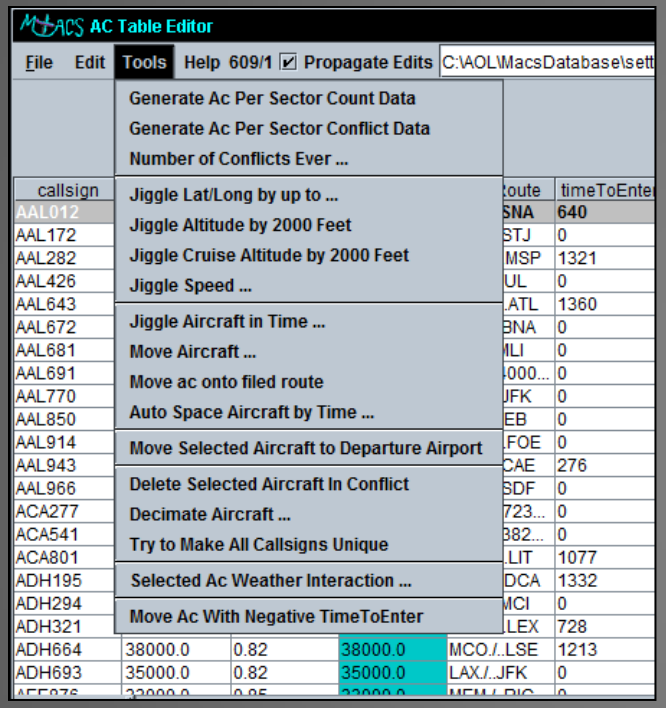


Removes the selected aircraft from the scenario file.



Removes all non-selected aircraft. Only the selected aircraft remain following this action.

AC Table Editor: Select Tools Functions



Generate Ac Per Sector Count Data

Displays the predicted sector load counts based on the traffic. Requires the ***Load Graph Window*** to be properly setup and displayed.

Move Aircraft ...

Activates a pop-up window through which an aircraft's position can be moved forward or backward along its route according to a specified time (in seconds).

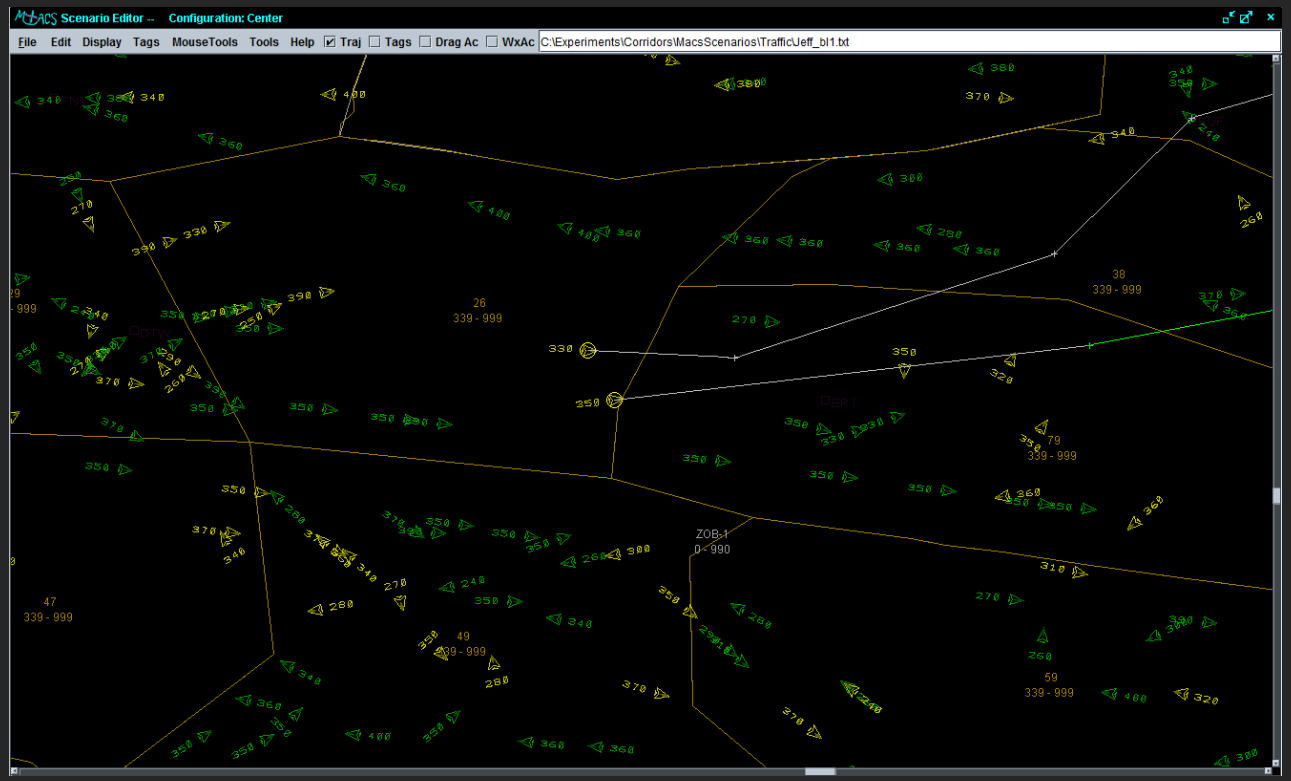
Move ac onto filed route

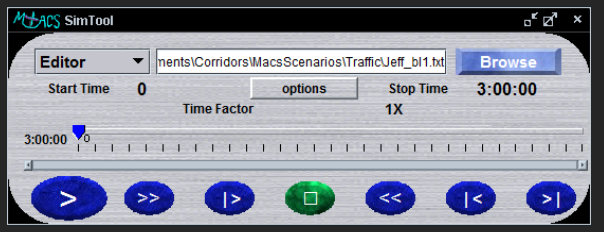
Occassionally changes can force an aircraft off of its route, which would mean it would be "free track" during the run. This feature attempts to place all selected aircraft back onto their route.

Decimate Aircraft ...

Activates a pop-up window through which the user can specify a percentage of the selected aircraft to remove from the file.

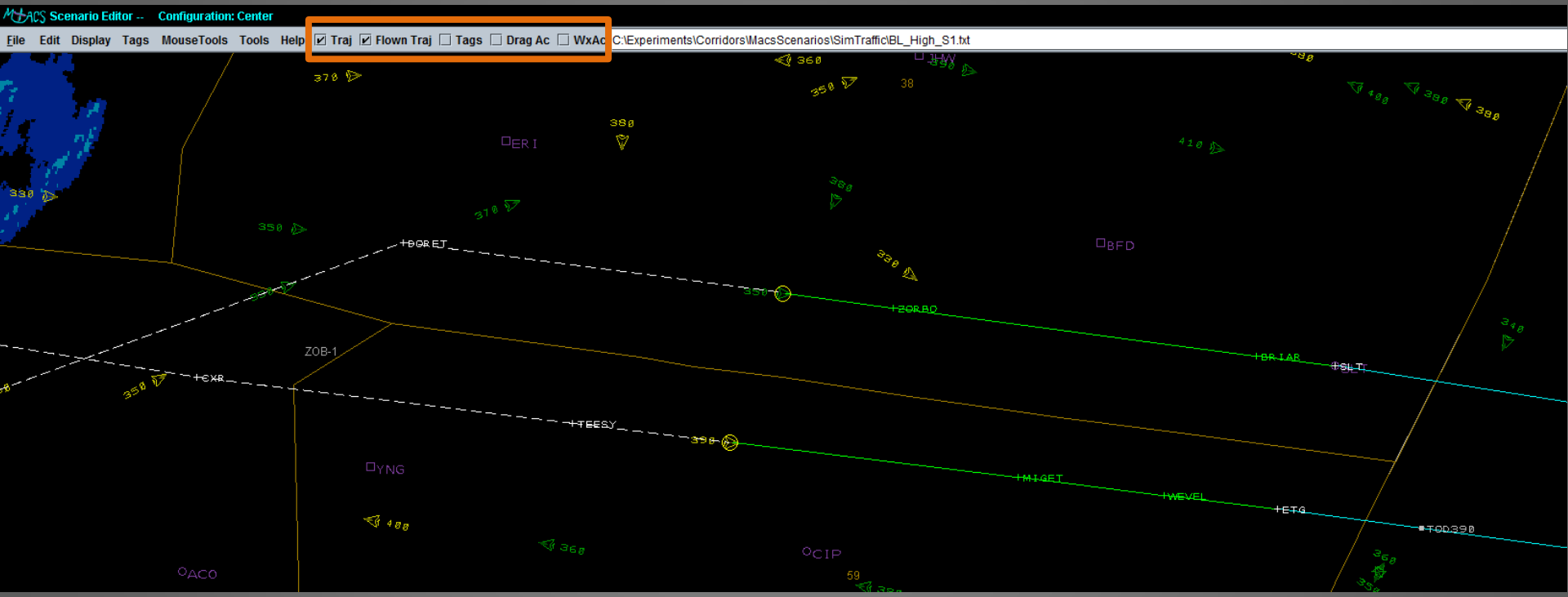
Scenario Editor





- The Scenario Editor allows the user to load and graphically manipulate aircraft within the file.
- It is often used in conjunction with the **SimTool**.
- **Dragging the SimTool's time slider (while in Editor mode)** will update the aircraft positions to reflect their predicted positions at the given time.

Scenario Editor: Display



Traj Displays a solid line for the selected aircraft's trajectory to be flown from scenario start.

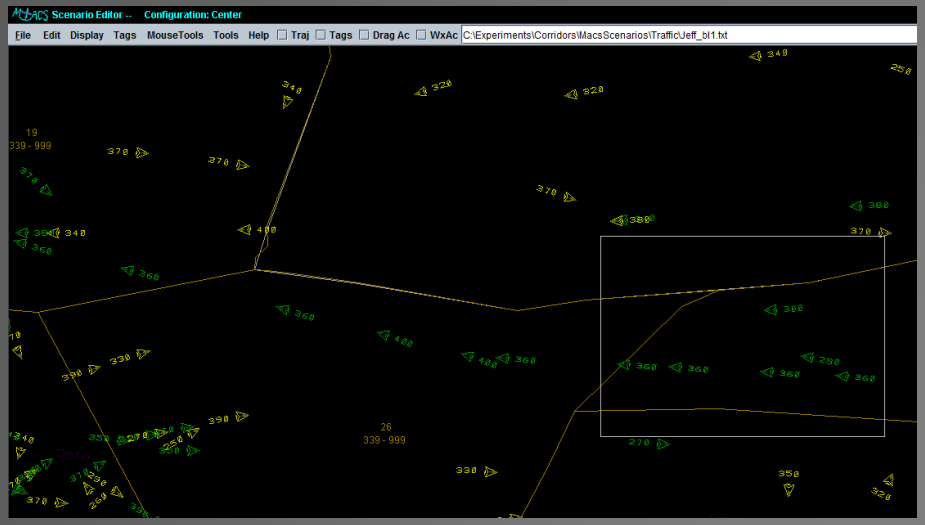
Flown Traj Displays a dashed line for the "flown" portion of the selected aircraft's trajectory.

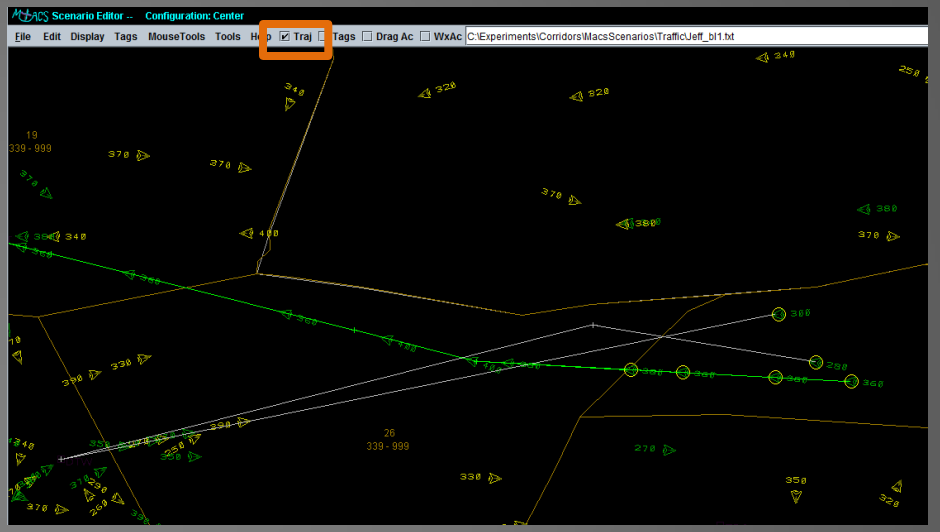
Tags Displays the data tags for selected aircraft (dependent upon data tag rule settings).

Drag Ac Allows aircraft to be dragged anywhere, regardless of route. *Sets editor time to zero*.

WxAc Displays the points at which an aircraft will penetrate convective weather.

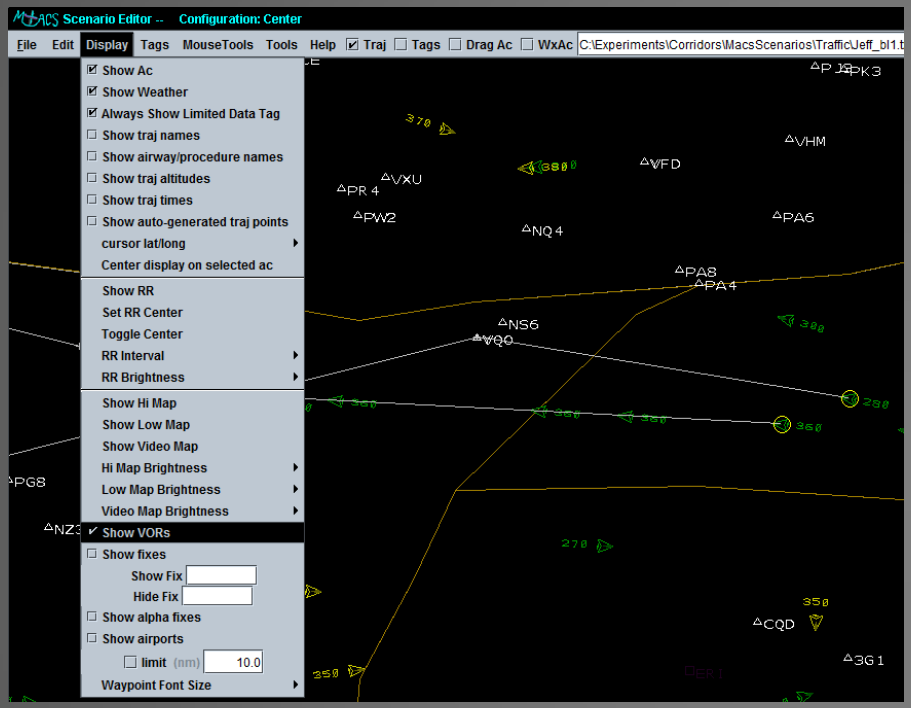
Scenario Editor: Aircraft Selection

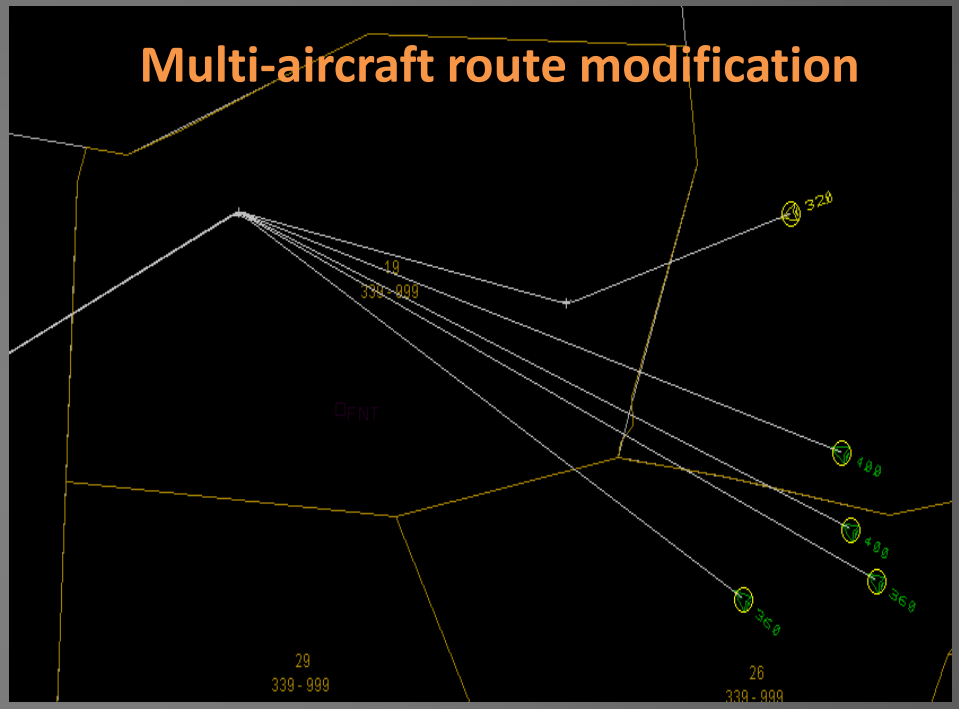




- Individual aircraft can be selected in the Scenario Editor **by left-clicking on the target symbol**.
- Multiple aircraft can be selected together **by left-clicking and dragging a box around the desired aircraft (as shown on the left).**
- To add aircraft to the selection, **hold down the Shift key and left-click on the additional aircraft or draw another box**.
- To remove aircraft from the selection, **hold down the Shift key and left-click on the selected aircraft**.
- Routes for selected aircraft can be displayed (see right panel) **by selecting the Traj checkbox in the menu bar**.

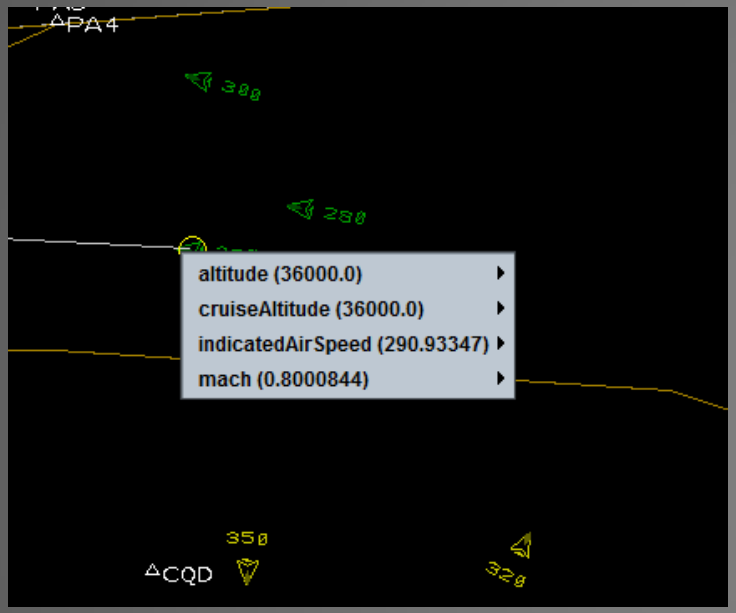
Scenario Editor: Route Modifications

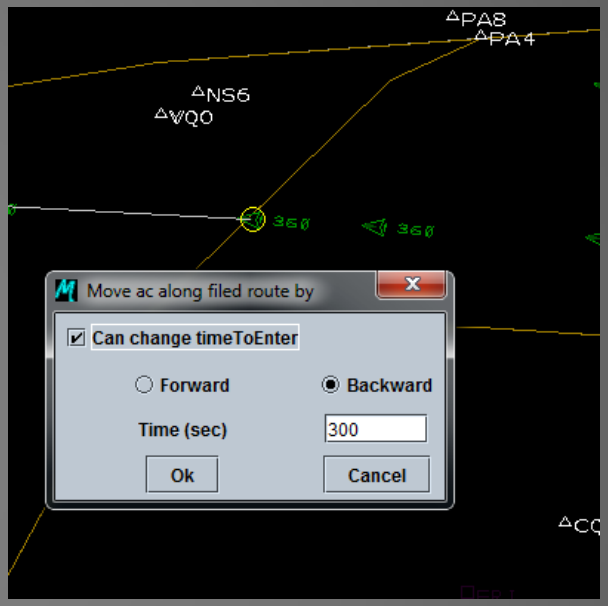




- Aircraft routes can be modified by left-clicking anywhere along the route line and dragging the point to the desired location. Multiple routes can be modified by selecting overlapping/common points.
- If VORs or Fixes are not displayed, or if the point being moved is placed in an unnamed location, that point will be defined by a lat-long position.
- Dragging a point to a named location will snap it to the location and the name of the VOR or Fix will appear in the aircraft's route.
- To display named locations, **(un)check the *Show VORs* or *Show Fixes* boxes in the Display** menu.
- To remove a point on the route simply right-click the point.

Scenario Editor: Aircraft Properties

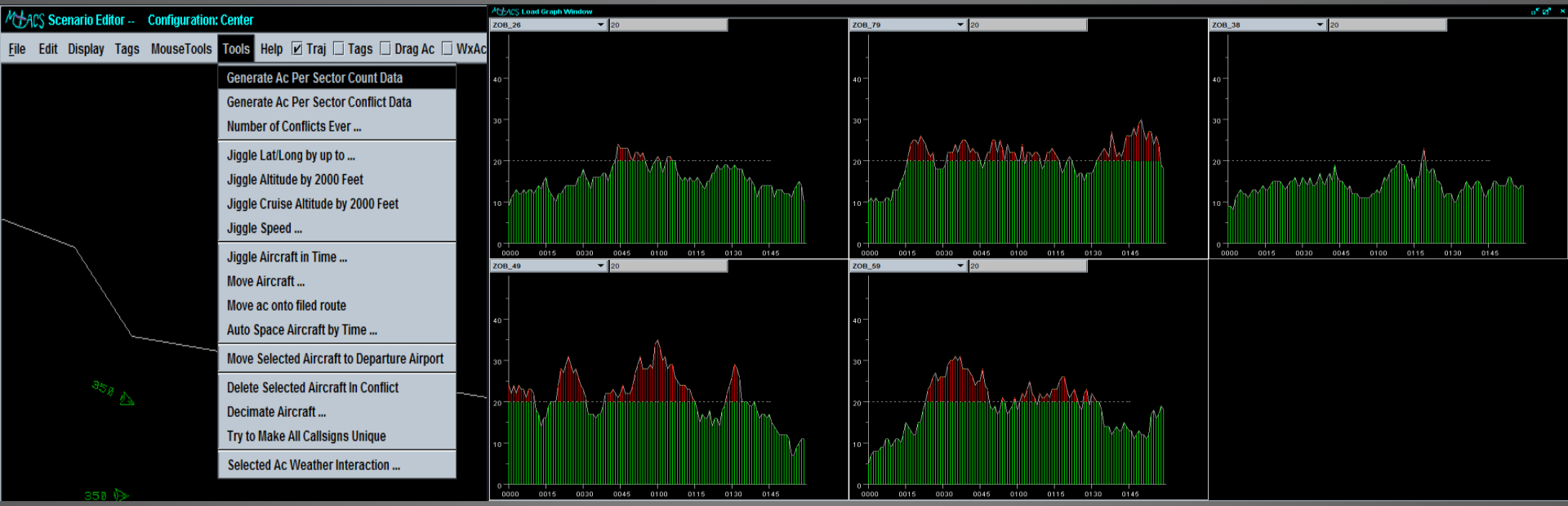




- Right-clicking on an individual aircraft will open a flyout menu.
- The menu options displayed can be updated through additional menu options by dwelling the mouse pointer over the desired field.

- The position of one or more selected aircraft can be moved forward or backward along the route by navigating to the **Tools** menu and selecting *Move Aircraft…*
- The desired time and direction can be entered into the resulting window.
- A shortcut is to select the aircraft and then hit any number between 1-9 and it will move forward that number of seconds * 100 (e.g., 5 = 500 seconds). To move backward, hold the Ctrl key down while pressing the number.

Scenario Editor: Load Assessment



- The traffic loads for particular sectors can be viewed through the Load Graph Window.
- To display the window: in MACS' main menu bar navigate to **Windows → Analysis Views →** and select ***Load Graph Window***.
- The sectors to view in the Load Graph and the specifications for the window must first be defined in the traffic load setup file.
- To view the loads, in the AC Table Editor or Scenario Editor select *Generate AC Per Sector Count Data* in the **Tools** dropdown menu as shown above.

Going Forward

- The preceding slides covered a small subset of the scenario development capabilities available in MACS.
- The best way to learn is to just try out the different tools and develop your own style and strategy.
- The scenario development tools are a work in progress. Let us know of serious errors that you uncover or any ideas for improvement that you may have.

Final Note

Scenario development is an iterative process. Using the editing and development tools offline only gets you part of the way to the final product. It is critical to play the scenarios in Simulation mode, in real-time, in exactly the same way that the final study will be conducted. There are always differences that arise due to a variety of reasons that will only be noticeable when doing so.

Hands-on Sample Activity

Create a new flight AAL123 from PHL to MSP via PSB, YNG, GRR at cruise alt 36,000

- **duplicate SWA1790, in "callsign" column rename to AAL123**
- **In "filedRoute" column, change from "PHL./.PSB.j60.IOW..LBF..DEN" into "PHL./..PSB..YNG..GRR..MSP" (press enter)**
  - Auto propagation updates "route" and "destination"
  - Note change in displayed route in Scenario Editor
- Change "filedRoute" to avoid sector 26.
  - **Insert "CLE" between "YNG" and "GRR"**

Hands-on Sample Activity

Change the cruise altitude

- **Set “altitude” and “altitudeTarget” columns to “auto update”**
- **Change “cruiseAltitude” to 36000**

Start just before sector 59

- **Tools -> Move Aircraft …**
  - Uncheck change to timetoEnter
- **Move aircraft backward by 700 seconds**
  - Note the plane travel backwards along the dashed line

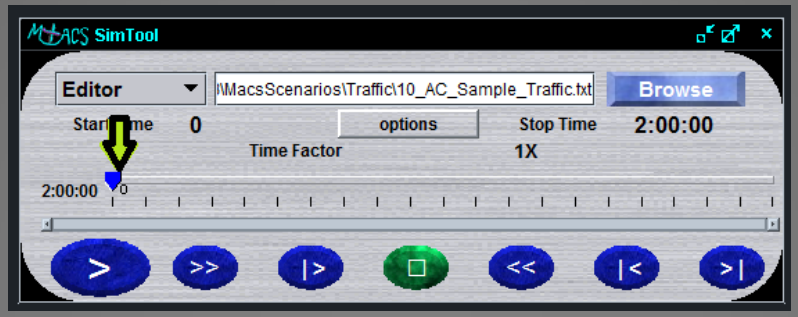
YOU TRY:

New plane AAL999, PHL to MSP, start just before sector 79 (go via 79 and 26), altitude 34000

Hands-on Sample Activity

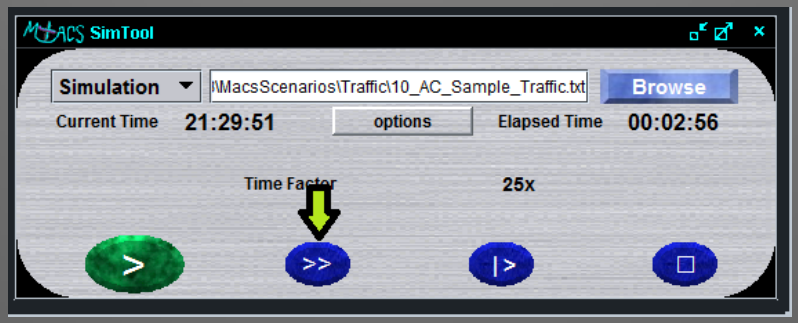
View the traffic

- In "Editor Mode" drag the scenario editor time slider
  note: observe the Scenario Editor display



DON'T FORGET TO SAVE BETWEEN SWITCHING FROM EDITOR TO SIMULATION MODE

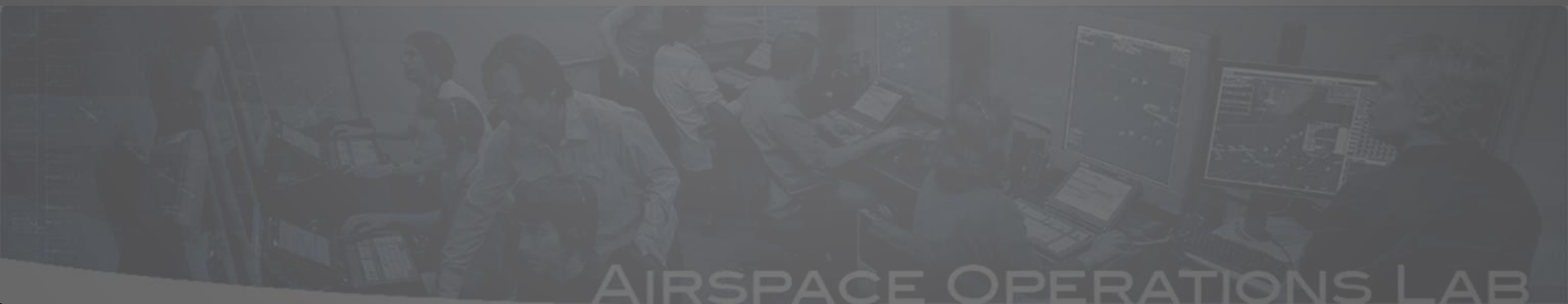
- In "Simulation Mode" play in real or accelerated times
  note: observe in the DSR or TSD air traffic controller displays



Generating Convective Weather with the Convective Weather Editor

Chris Cabrall

Slides by Matt Mainini



Outline

- What is the goal?
- What is the Convective Weather Editor?
- What are the capabilities and assumptions of the Weather Editor?
- What is the general process?
- Overview of Convective Weather Editor features

What is the goal?

The main goal of the Convective Weather Editor is to generate realistic convective weather to display on the DSR or TSD in which the operator may view and interact with.

What is the Convective Weather Editor?

The Convective Weather Editor is a tool within MACS that enables the user to sequentially combine convective weather images that appear as realistic weather formations in real time.

What are the capabilities and assumptions of the Weather Editor?

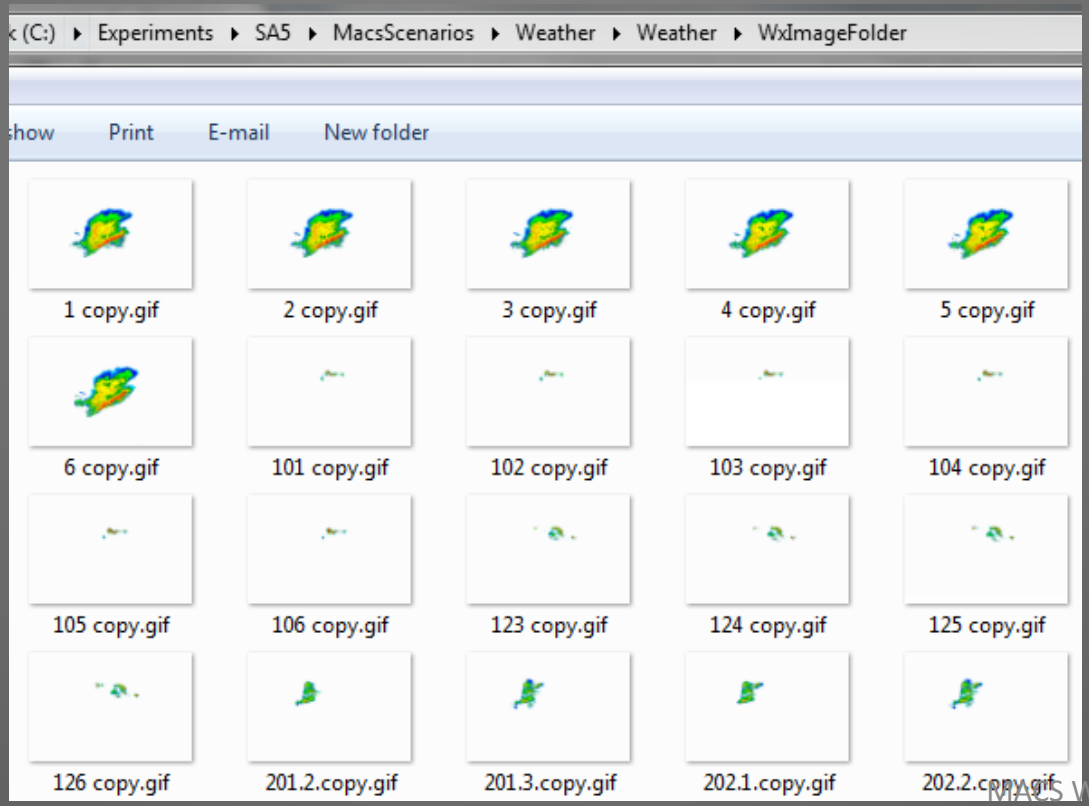
- Capabilities
  - Generate realistic weather cells
  - Multiple simultaneous weather cells
  - Weather looping
  - Predicted future weather
  - Displayed on DSR and/or TSD
  - Weather probe
- Assumptions
  - Weather images have been prepared for MACS read-in
  - The general location, size, direction, and number of cells have been considered

The process of generating MACS weather

- The basic process
  - Weather images are captured from NOAA
  - Images are prepared for MACS with Photoshop
  - **Images are loaded in Convective Weather Editor window**
  - **Images, or “patterns,” are stitched together and edited in time, or “steps,” to create morphing convective weather cells, or “paths”**
  - **The “paths” are saved as an .xml and are played back as realistic weather cells on the DSR or TSD**

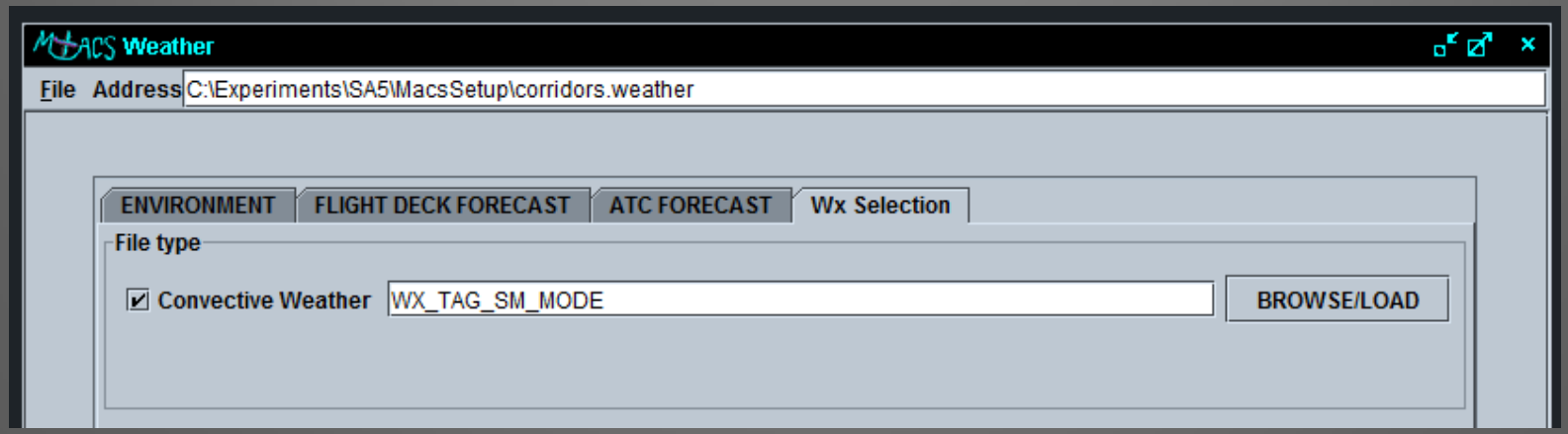
Relevant Files/Folders

- Wx Image folder C:\Experiments\SA5\MacsScenarios\Weather\Weather\WxImageFolder\
- WX_TAG_SM_MODE file C:\Experiments\SA5\MacsSetup\ WX_TAG_SM_MODE.xml



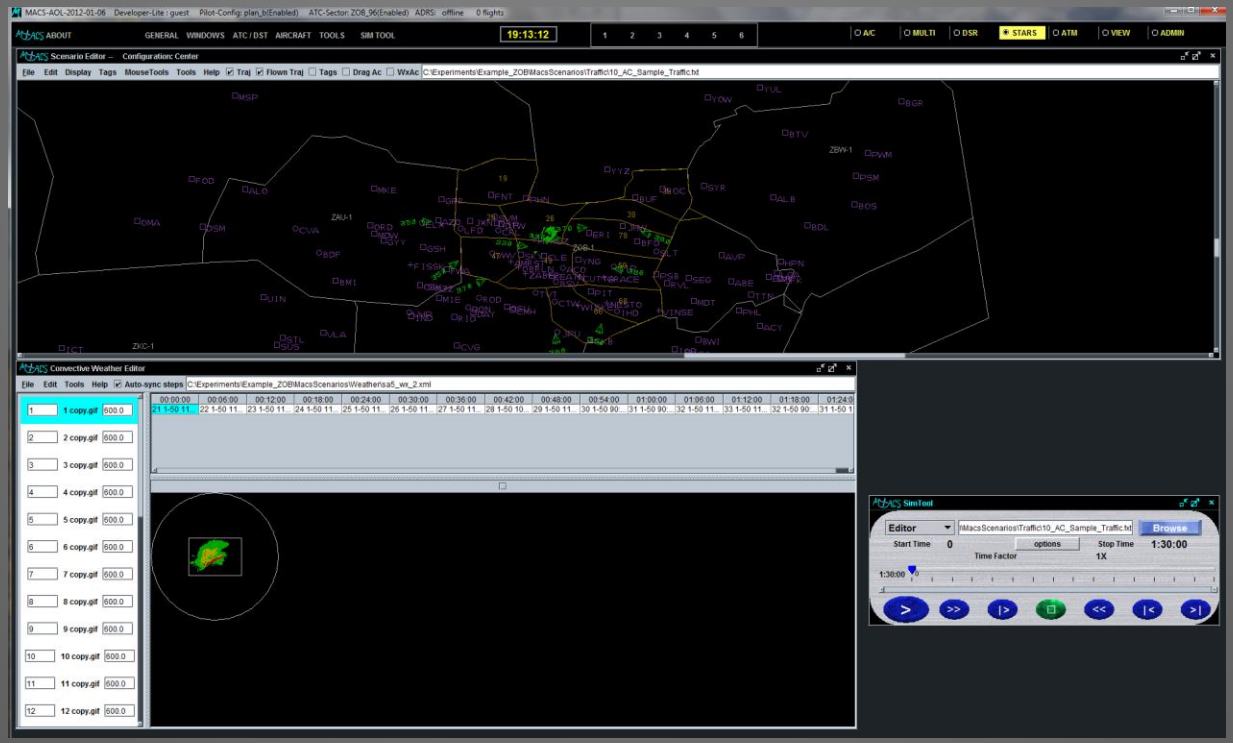
Setup the Weather Editing Environment

- **Open MACS in developer-lite mode**
  (e.g. with the Example_ZOB “developer.bat” file)
- **Places MACS into “editor” mode**
  (i.e. not “simulation” or “playback” mode)
- **Go to Windows/Setup Panels/Weather -> “Wx Selection tab” and check the box next to “Convective Weather”**
- **Press “Browse/Load” button, find, and select the sa5_wx_2.xml file**
  - C:/Experiments/Example_ZOB/MacsScenarios/Weather/sa5_wx_2.xml



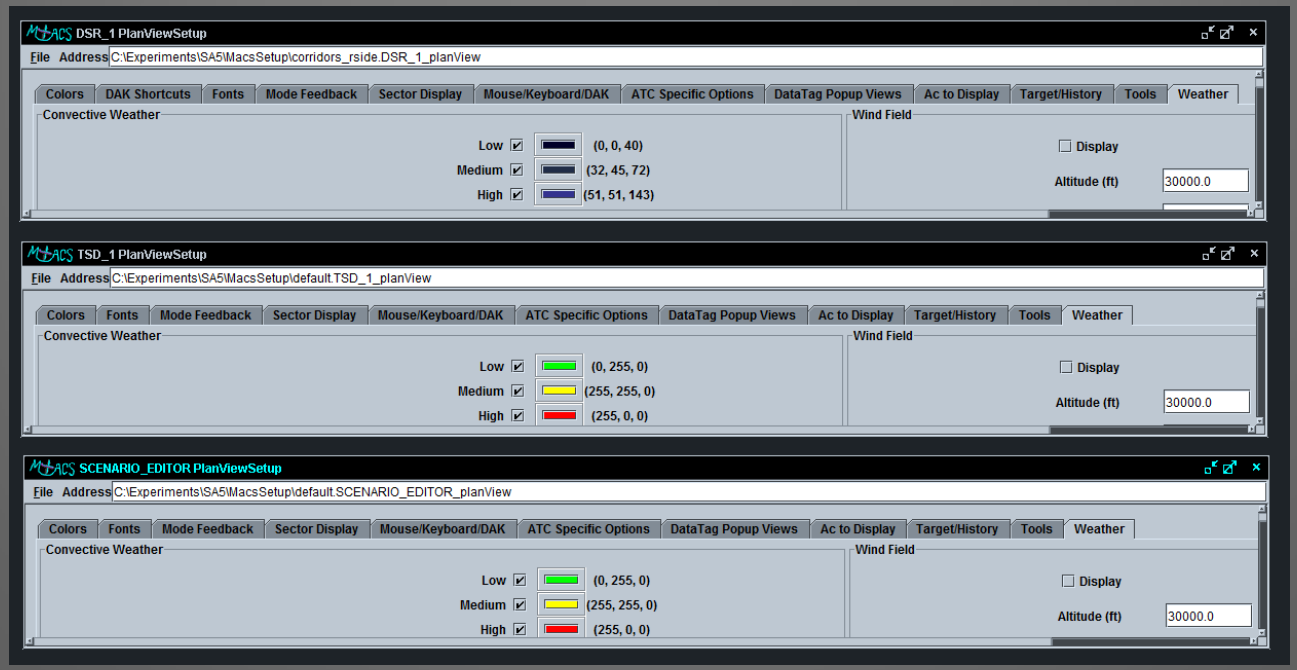
Setup the Weather Editing Environment

- **Open the "STARS" tab and on it place:**
- Windows\Scenario Editor\Scenario Editor
- Windows\Scenario Editor\Convective Weather Editor
- SimTool

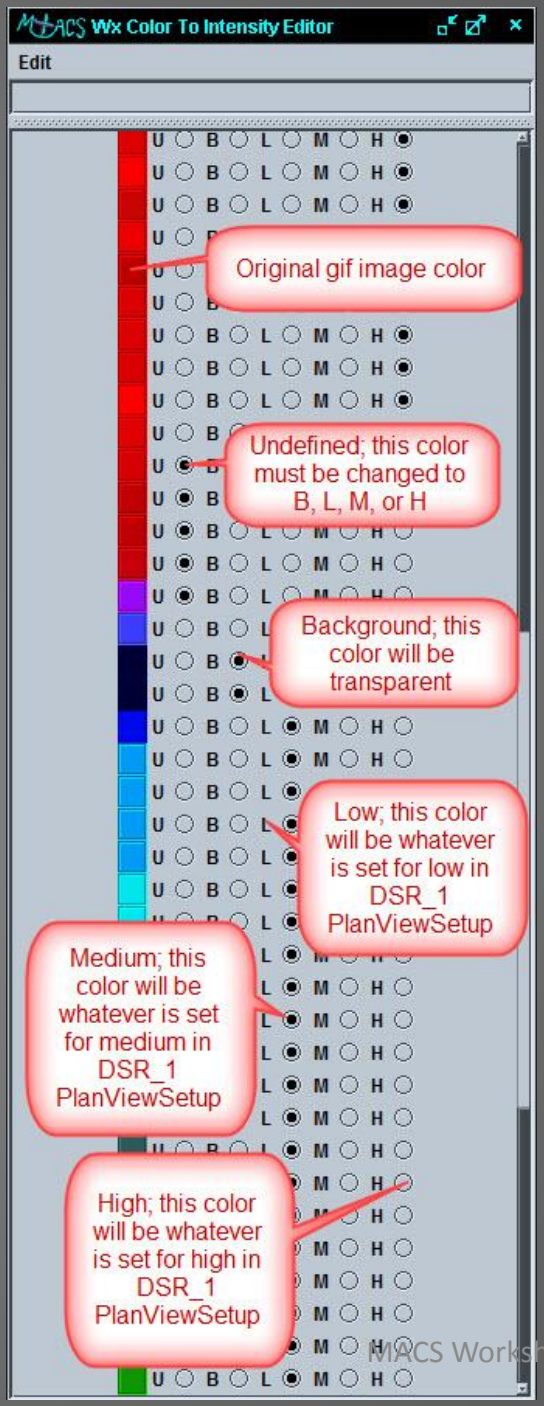


Setup the Weather Editing Environment

- **Ensure weather viewing on various ATC station displays is turned "on"**
  - Windows\Setup Panels\DSR_1**DSR_1 PlanViewSetup**
  - Windows\Setup Panels\TSD_1**TSD_1 PlanViewSetup**
  - Windows\Setup Panels**Scenario_Editor PlanViewSetup**
- Can display different levels (low, medium, high) in different colors on different displays

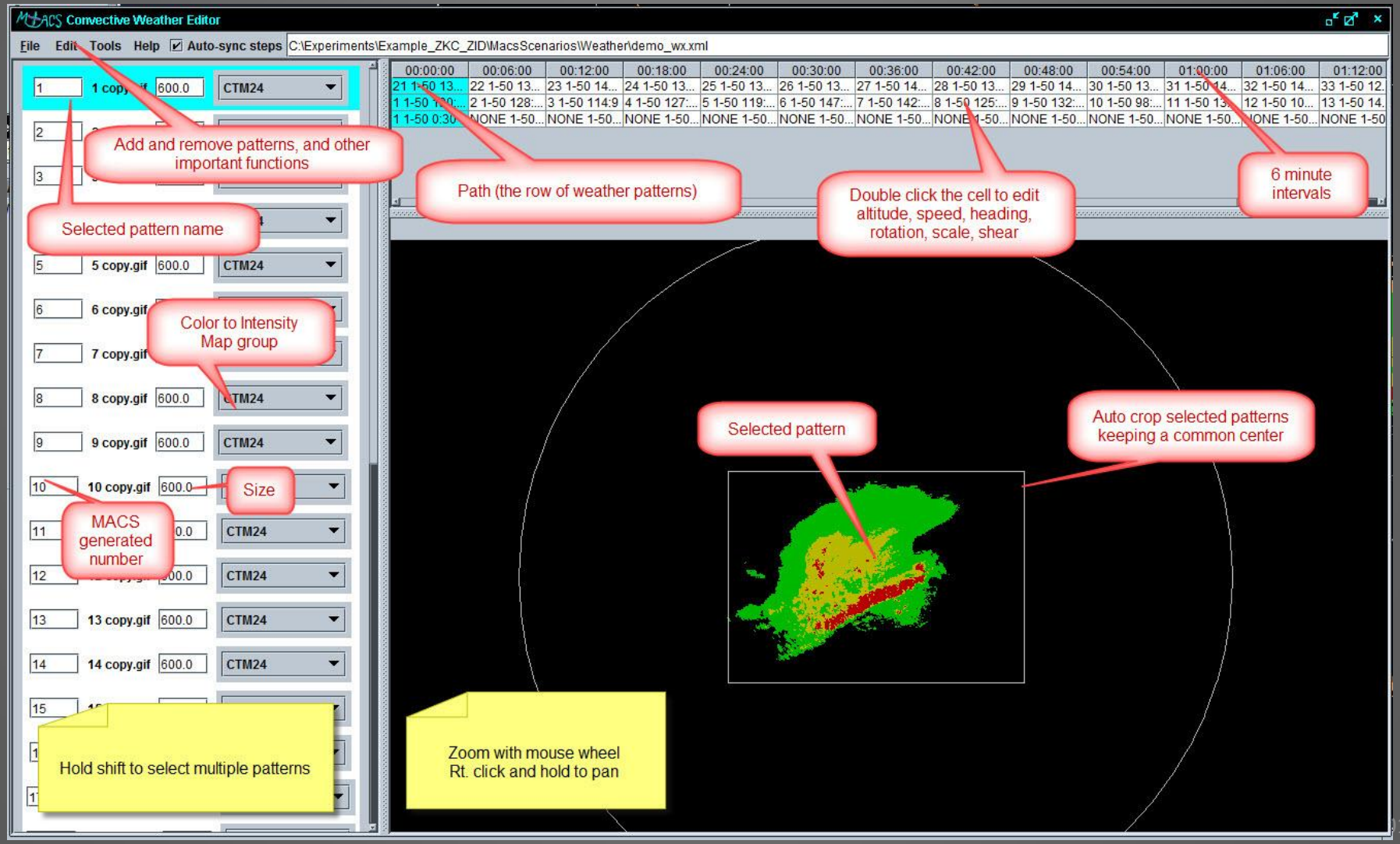


Wx Color to Intensity Editor



Convective Weather Editor

- Windows\Scenario Editor\Convective Weather Editor



Hands-on Sample Activity

Extend the weather pattern for another half hour, have it continue to move eastward , but die out.

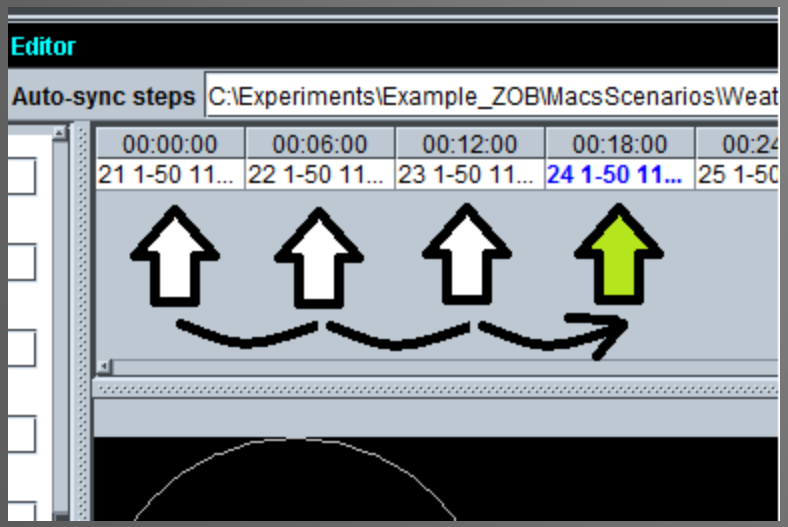
- Save the .xml weather file with new name
  - **Convective Weather Editor "File -> Save as …"**
    - Note: the folder location where it's being saved
  - **Save as "SampleWxActivity.xml" under C:/Experiments/Example_ZOB/MacsScenarios/Weather/**
    - Note: the file name may have changed when browsing.

- Change the length from 1.5 to 2 hrs
  - **Convective Weather Editor "Edit -> Edit Properties"**
  - **Change number of steps from 15 to 20, press "OK"**

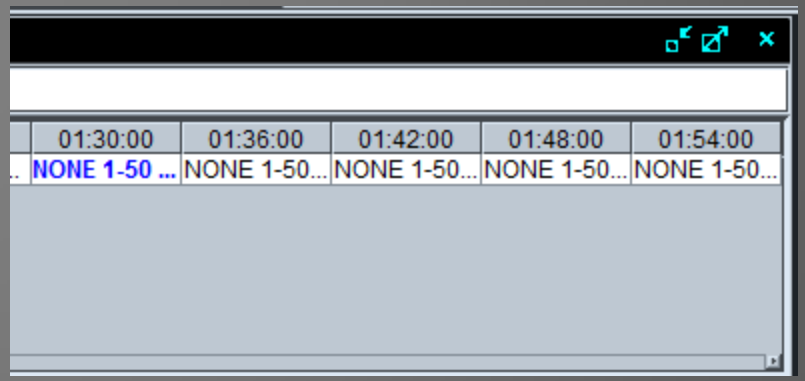
Hands-on Sample Activity

Review each “step” (cell) in the “path” (row) in the Convective Weather Editor

- **In order from left to right, left click each “step”**
  - Note: the time slider advances on the Sim Tool
  - Note: the planes advance in the Scenario Editor
  - Note: the “pattern” (image) changes in the Convective Weather Editor; also note the “names” of each pattern



… … …

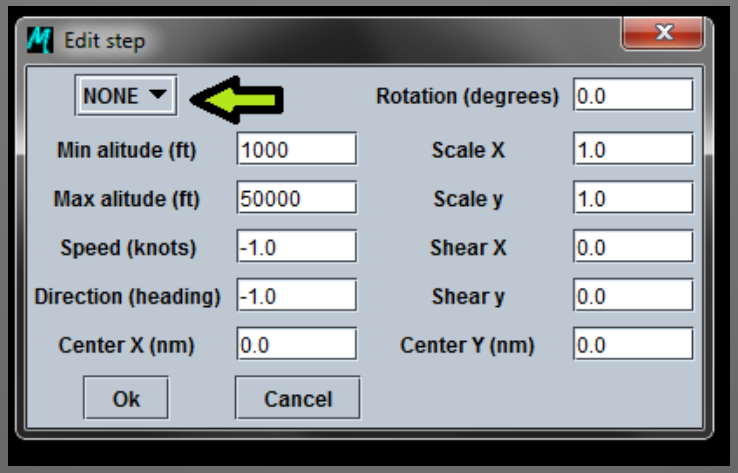


Note: we have not yet loaded “patterns” into the newly created last 5 “steps” of the “path”

Hands-on Sample Activity

Load pattern “30” into the 01:30:00 step

- **Double left click on the “step” (cell) beneath “01:30:00” column heading**
  - Note: the “edit step” window opens
- **Click the pattern selection drop down box (it is currently set to “none”) and select pattern “30” and press OK**

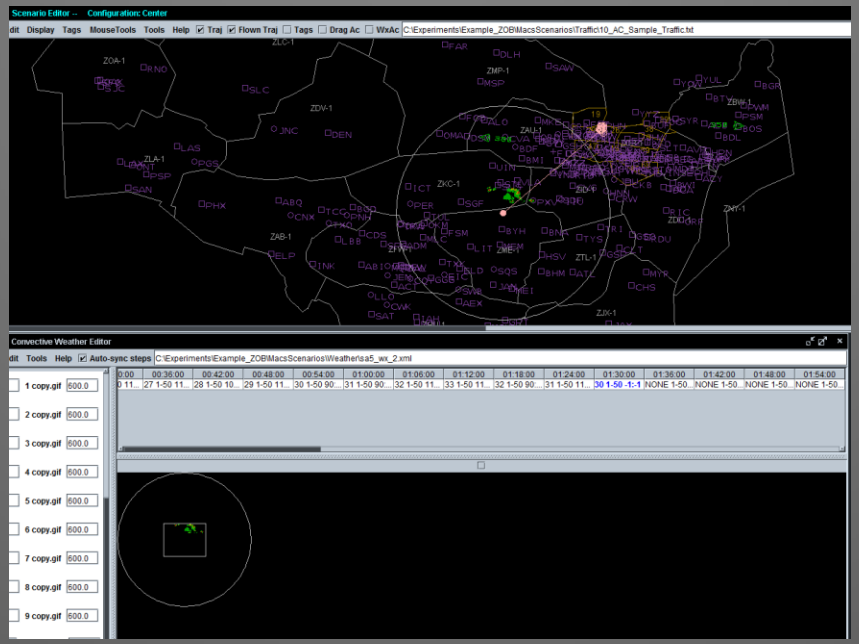


Hands-on Sample Activity

Compare the loaded pattern “30” at 01:30:00 with the previous step loaded pattern “31”at 01:24:00

- Note: the location of the white circle (boundaries) and pink dot (center) of each step
- Note: the Scenario Editor white circle corresponds to the Convective Weather Editor white circle…

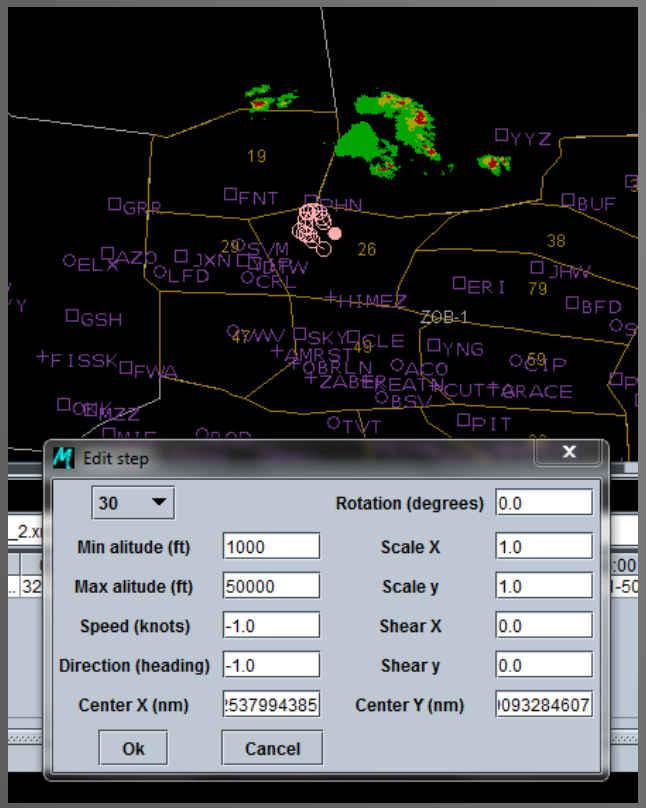
- **In the scenario editor, left click the pink dot “center” of the 01:30:00 pattern and drag it up near to the other step’s centers**

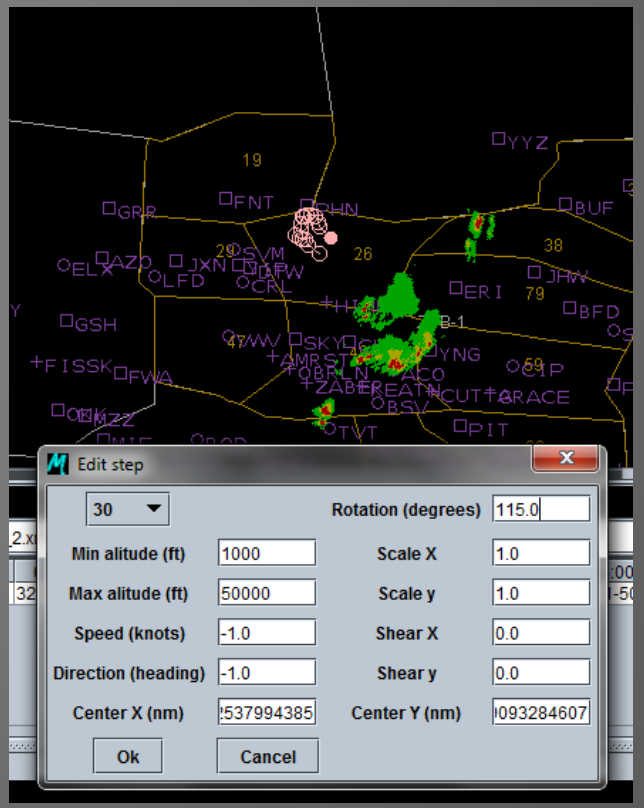


Hands-on Sample Activity

Note: the rotation is “off” in regards to the previous steps, with the weather to the north of the dot and not to the south-east…

- **Double left click the 01:30:00 step in the Convective Weather Editor table to open the Edit step window, and enter “115.0” for the pattern image “Rotation (degrees)” setting**

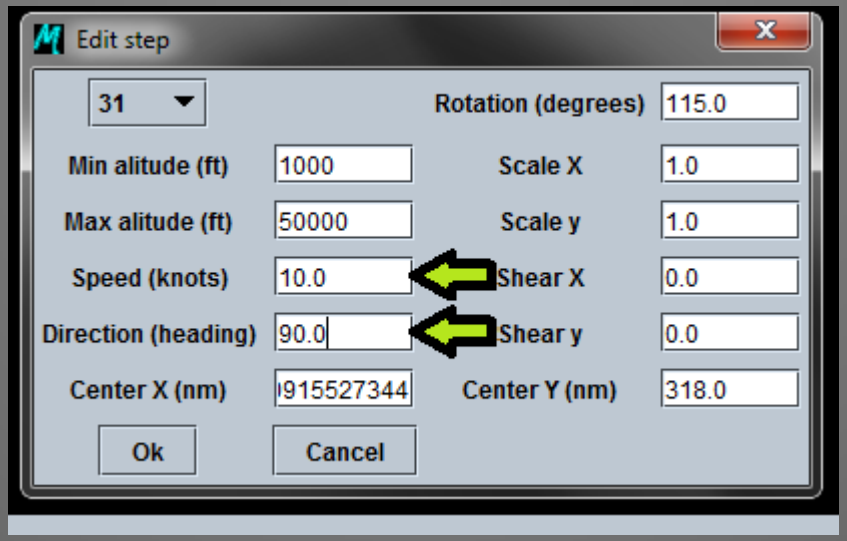




Hands-on Sample Activity

With the initial placement (center/pink dot) and rotation of the pattern image set for the step at 01:30:00, now update its direction and speed of travel for how it is to progress across its 6 minute time slot.

- **Double left click the 01:30:00 step in the Convective Weather Editor table to open the Edit step window, and enter “10.0” for Speed (knots) and enter 90.0 for Direction (heading) , and press OK**



Hands-on Sample Activity

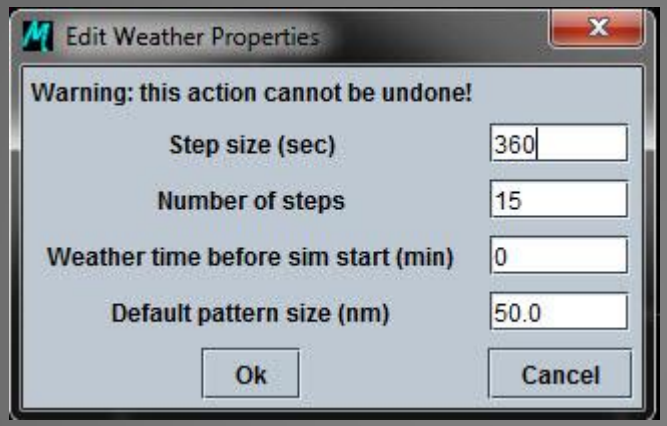
Continue with the last 4 time slots to fill the remaining steps with patterns “29”, “28”, “27”, and “26”

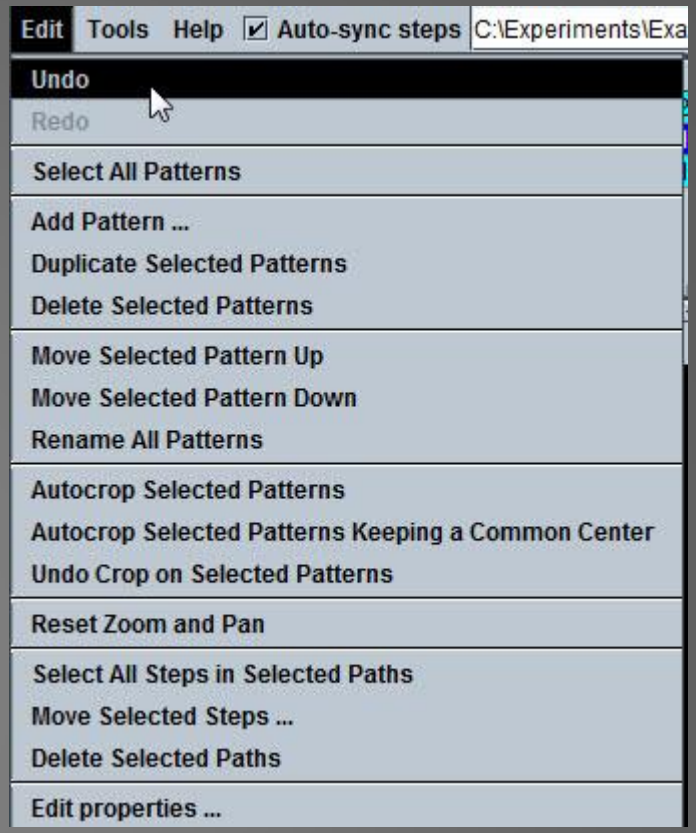
- **Double-click the desired step in the Convective Weather Editor**
- **Use the “Edit Step” window’s pull-down menu to select the desired pattern**
- **Left click on pink dot in Scenario editor to move the center of the pattern rotate**
- **Adjust rotation, speed, heading settings under “Edit Step” window**

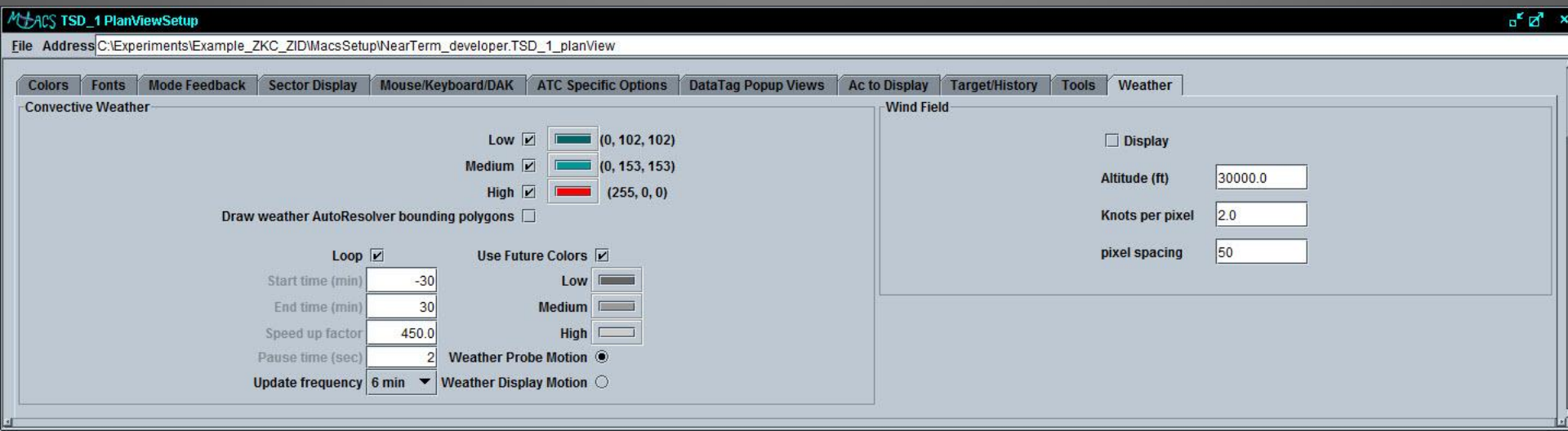
Other things to try:

- **Re-scale the pattern image in each progressive step to “reduce” the weather so it gets smaller and “dies out” in this last half-hour**
- **Choose or create and place in new pattern images with less severity (less red, more green, etc.)**

Other Important Menu Options



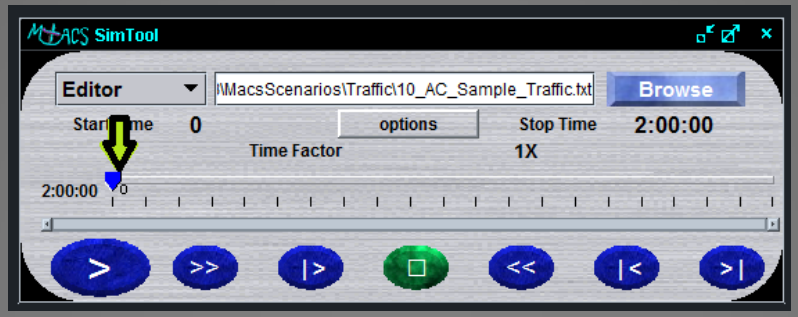




Hands-on Sample Activity

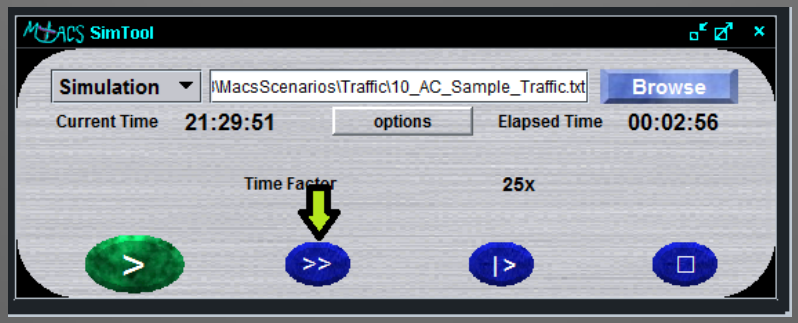
View the weather

- In "Editor Mode" drag the scenario editor time slider
  note: observe the Scenario Editor display



DON'T FORGET TO SAVE BETWEEN SWITCHING FROM EDITOR TO SIMULATION MODE

- In "Simulation Mode" play in real or accelerated times
  note: observe in the DSR or TSD air traffic controller displays



Contacts and References

Jeff Homola: jeffrey.r.homola@nasa.gov (650) 604-4603

Hwasoo Lee: hwasoo.lee@nasa.gov (650) 604-0764

Christopher Cabrall: christopher.d.cabrall@nasa.gov (650) 604-2165

Related guides on the MACS wiki:

Traffic generation:
https://aol1.arc.nasa.gov:8443/display/macs/Scenario+Editor+User+Guide

Convective weather generation:

https://aol1.arc.nasa.gov:8443/display/macs/Weather+1+-+Overview+and+how+to+create+weather+patterns+to+be+loaded+in+MACS

https://aol1.arc.nasa.gov:8443/display/macs/Weather+2+-+How+to+Photoshop+weather+images+prior+to+MACS

https://aol1.arc.nasa.gov:8443/display/macs/Weather+3+-+How+to+use+the+MACS+Convective+Weather+Editor