



University
of Victoria

Converting and upgrading the Gemini Adaptive Queue Planning Tool Prototype



University of Victoria

Physics and Astronomy Co-op Program



Motivation

1. Part of an OCS upgrade
2. Working towards automatic scheduler
3. Increasing number of ToOs
4. Require a simulation environment to test options

Motivation

Currently:

- Daily plans are created manually.
- Night-time observers switch plans as conditions change.

Weaknesses:

- ToOs disrupt the plan
- Managing timing windows
- It is difficult to support complicated cadences (eg. observe every N days, logarithmic cadences)

Existing queue scheduling software

Gemini Queue Planning Tool [Computer software] – Bryan Miller 2005

IDL software for automated queue scheduling and simulations of long observing periods (week to months).

1. Determine highest priority observations in queue
2. Generate nightly plans for the appropriate sky conditions
3. Simulate several nights of observing w/ changing conditions



Contribution

1. Convert 2005 IDL prototype to Python
2. Develop new features

Tools in upgrade

1. Simulate long observing periods (weather, ToOs, etc.)
2. Examine new scheduling algorithms
3. Examine new observation weighting schemes
4. Framework for handling sequences, using time constraints

Stage 1: Converting to Python

1. Direct conversion
2. Refactoring
3. Experiment with data structures
4. Improve workflow and performance

Astroconda packages

astroplan.Observer

- get_moon
- get_sun
- moon_phase
- moon_illumination
- moon_rise_time
- moon_set_time
- sun_rise_time
- sun_set_time
- twilight_evening_nautical
- twilight_morning_nautical
- local_sidereal_time

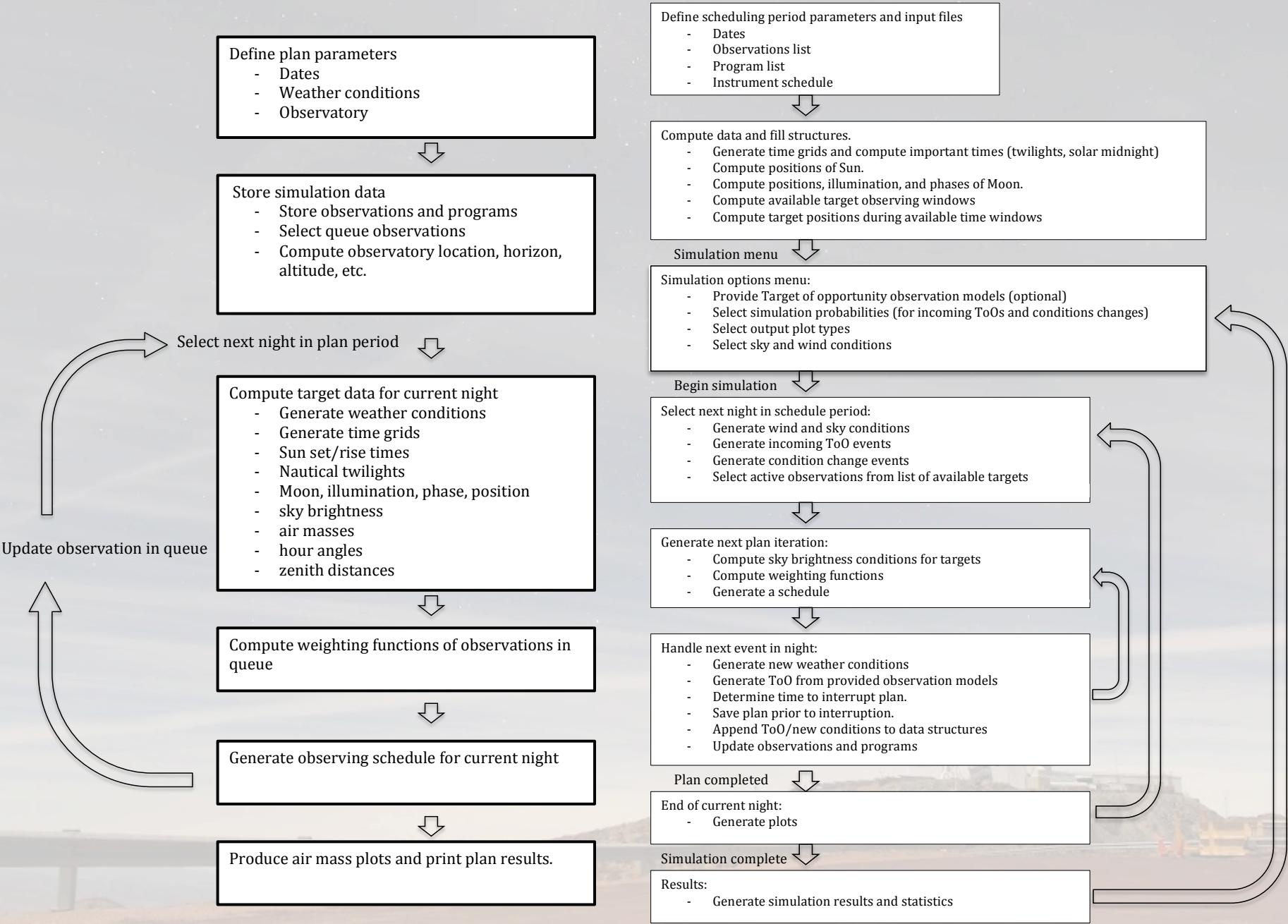
astropy.table.Table

astropy.time.Time

astropy.units

astropy.coordinates.SkyCoord

- transform_to



Stage 2: Developing new features

1. Gemini observation timing constraints
2. Instrument calendar
3. Target of opportunity simulator
4. Changing sky condition simulator
5. Program completion statistics
6. Weight function plotting program
7. Visuals for examining scheduling/simulator algorithms

Instrument schedule

1. Instruments
2. GMOS focal plan unit
3. GMOS disperser
4. F2 focal plane unit



Timing constraints

'[{start duration repeats period}, ...]'

1. Convert to time windows
2. Constrain within scheduling period boundaries
3. Constrain within nautical twilights
4. Check instrument availability
5. Constrain for elevation constraint (Airmass or Hourangle)



Examples

Prepare scheduling period

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Prepare scheduling period

```
>>> python gqpt.py observations.txt exechours.txt instschedule.txt
```

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```
>>> python gqpt.py observations.txt exechours.txt instschedule.txt
```

```
>>> python gqpt.py observations.txt exechours.txt instschedule.txt --start 2018-01-01
```

Examples

Prepare scheduling period

```
>>> python gqpt.py observations.txt exechours.txt instschedule.txt
```

```
>>> python gqpt.py observations.txt exechours.txt instschedule.txt --start 2018-01-01
```

```
>>> python gqpt.py observations.txt exechours.txt instschedule.txt --start 2018-01-01 --  
end 2018-06-01 --observatory MK
```

Gemini Adaptive Queue Planning Tool

Dates: 2018-06-01 to 2018-06-01

Number of nights: 1

Daylight savings time: False

Observatory:

Site: gemini_south
Height: 2750.0000 m
Longitude: -70.7367 deg
Latitude: -30.2407 deg

Options:

1.	Log file	gqpt01Jun18-19:57:56.log
2.	ToO file	None
3.	ToO probability	0.0
4.	Max. number of ToOs per night	4
5.	Conditions (iq,cc,wv)	(70%, 50%, Any)
6.	Conditions from distribution type	None
7.	Wind conditions (dir, vel)	(330.0deg, 5.0m/s)
8.	Generate random wind conditions	False
9.	Probability of condition change	0.0
10.	Max. number of condition changes per night	4
11.	Show plan plots	False
12.	Show airmass plot of each plan iteration	False
13.	Show airmass plots of plan building up	False
14.	Show sky conditions plots	False
15.	Show wind condition plots	False
dir	Show files in current directory	

Press enter to run or select an option:

-- Generating plan for night of 2018-06-01 --

Sky conditions (iq, cc, wv): (70%, 50%, Any)
Wind conditions (dir., vel.): 330.0 deg, 5.0 m / s

Solar midnight (UTC): 2018-06-02 04:40
Solar midnight (local): 2018-06-02 00:40

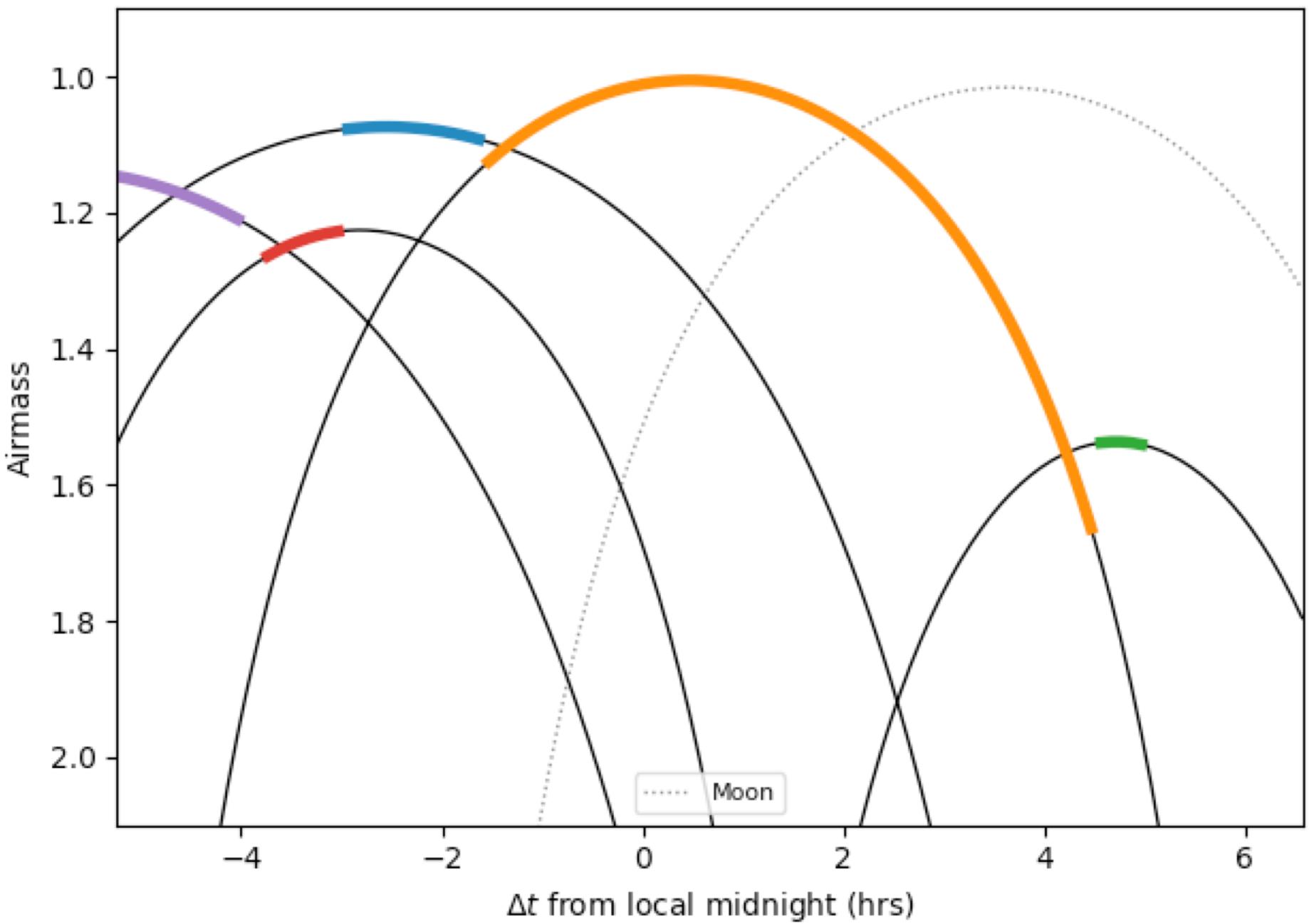
Sun ra: 69.82 deg
Sun dec: 22.14 deg

Moon ra: 293.24 deg
Moon dec: -20.17 deg
Moon fraction: 0.88
Moon phase: 0.69 rad

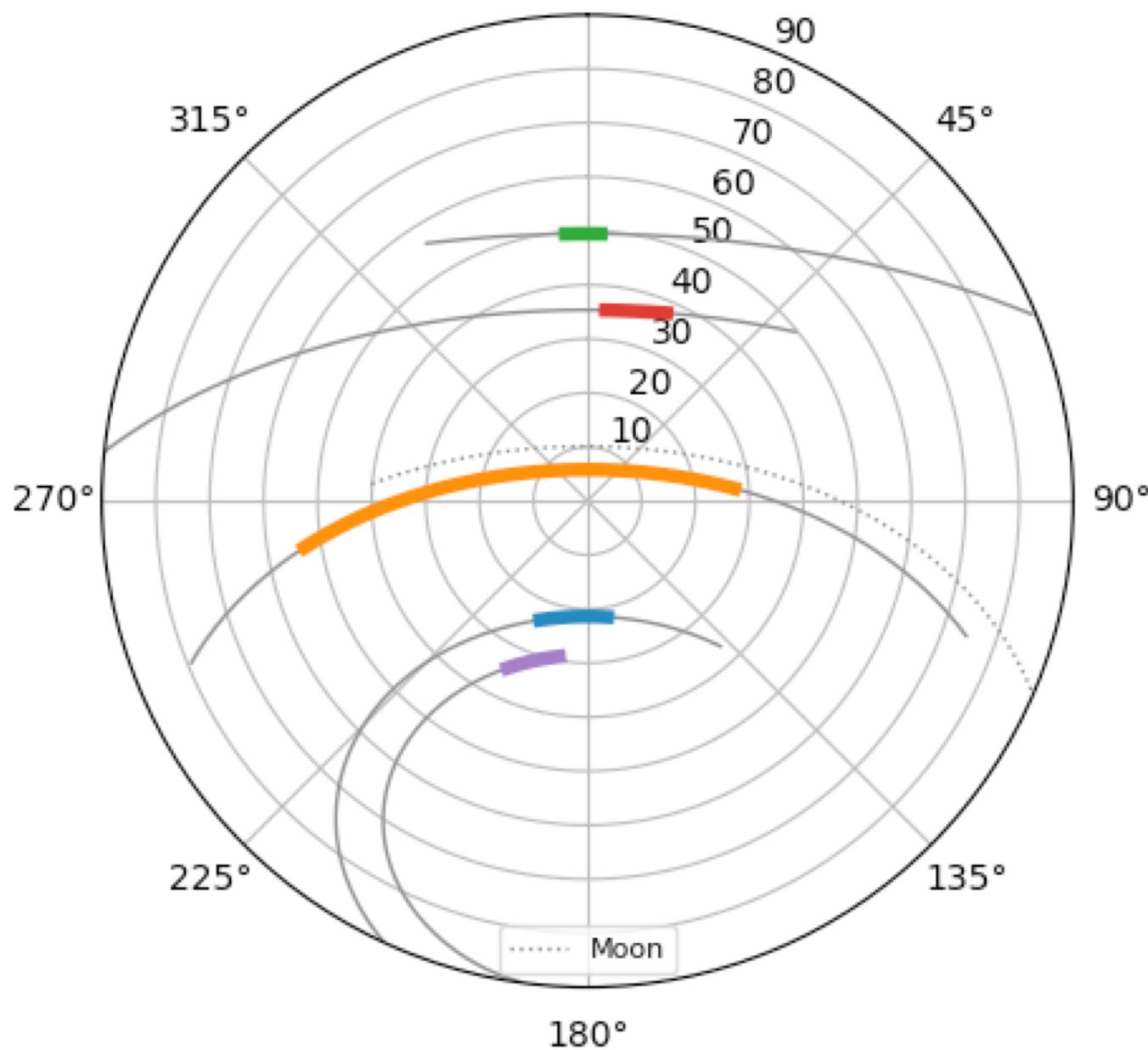
-- 2018-06-01 schedule --

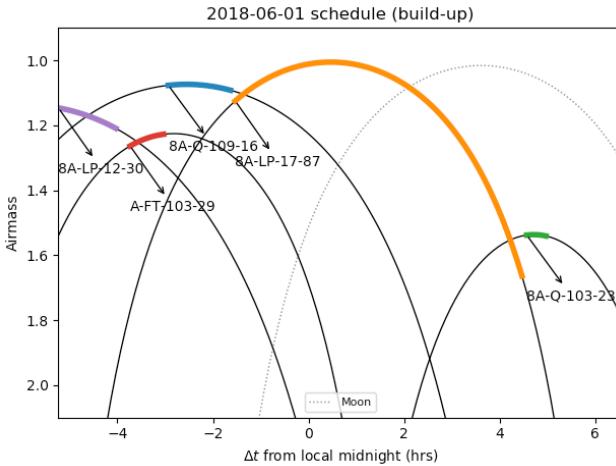
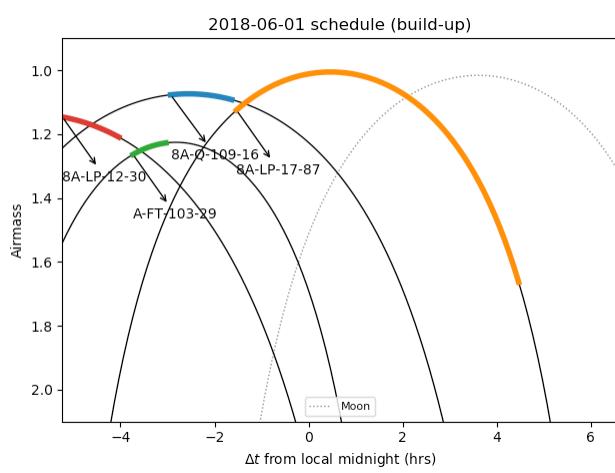
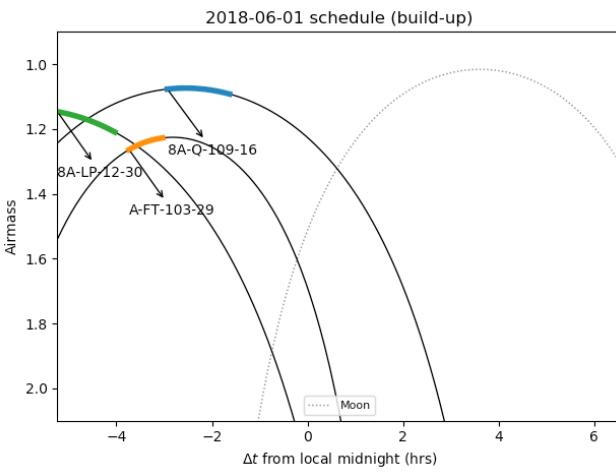
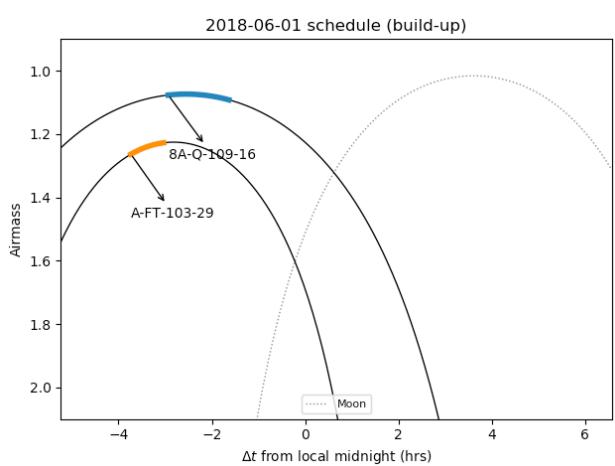
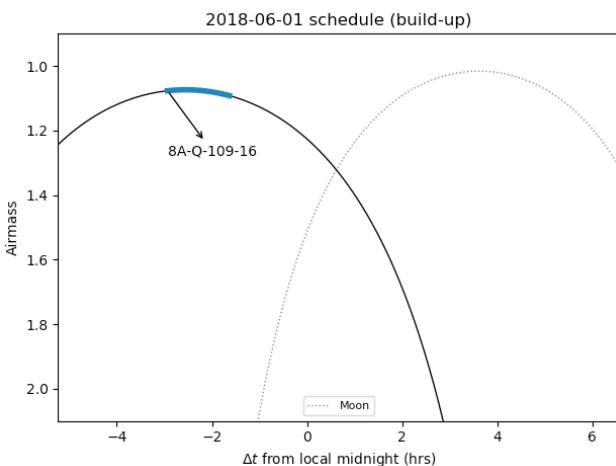
Obs. ID	Target	RA	Dec.	Instr	UTC	LST	Start	End	Dur.	AM	HA	Completed
12 deg.twi.					22:46	10.74	18:46					
A-LP-12-30				GPI	22:46	10.74	18:46	20:04	1.3 h	1.15	0.66	True
-FT-103-29				GPI	00:16	12.25	20:16	21:04	0.8 h	1.26	-0.92	True
A-Q-109-16				GPI	01:04	13.05	21:04	22:28	1.4 h	1.08	-0.38	True
A-LP-17-87				Visit	02:28	14.45	22:28	04:34	6.1 h	1.12	-2.01	True
A-Q-103-23				GMOS-	08:34	20.57	04:34	05:04	0.5 h	1.54	-0.15	True
12 deg. twi.					10:34	22.57	06:34					

2018-06-01 schedule



2018-06-01 schedule



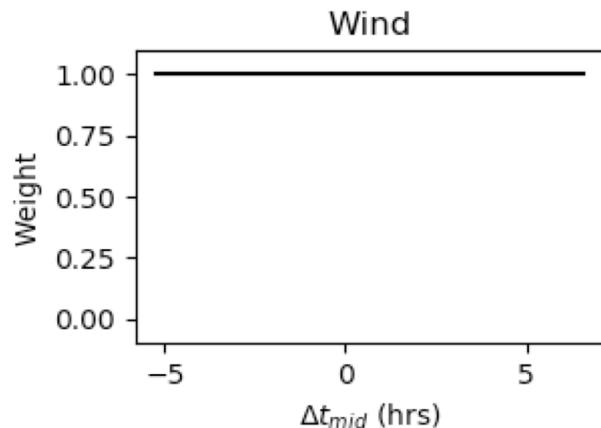
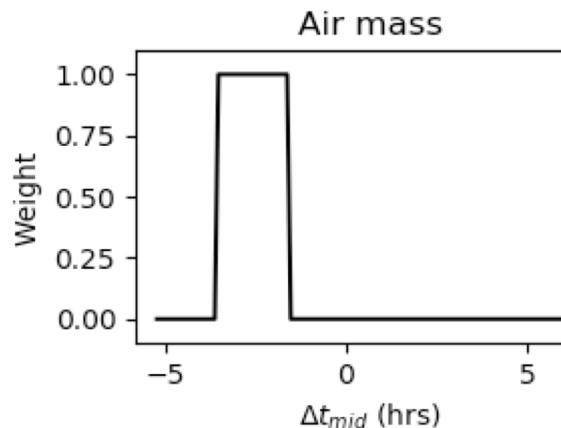
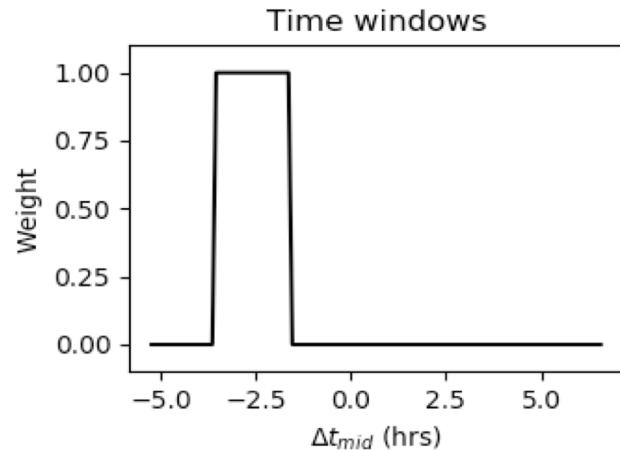
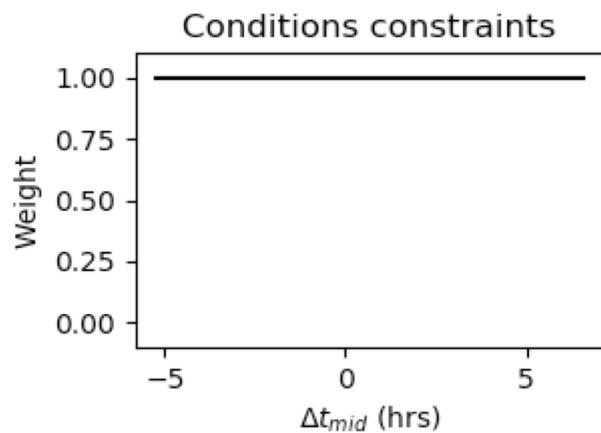
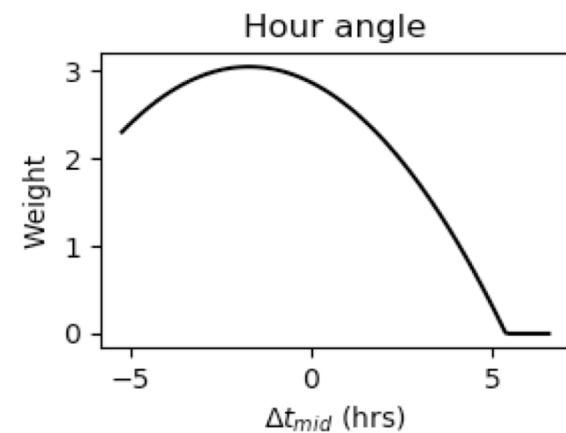


Weighting function

$\text{weight}(t) = (\text{condition constraints} + \text{status} * \text{hourangle}(t)$
 $+ \text{priority} + \text{band} + \text{partner} + \text{time distribution})$
 $* \text{viewing conditions}(t) * \text{wind} * \text{complete} * \text{timing}$
 $\text{constraint}(t)$

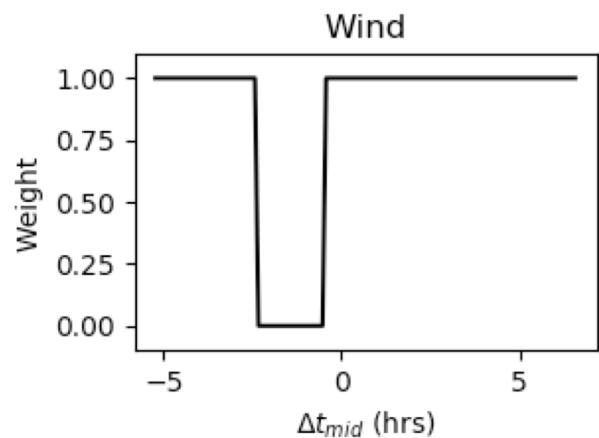
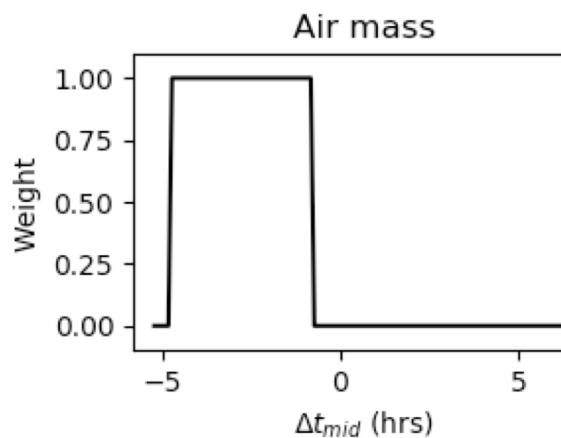
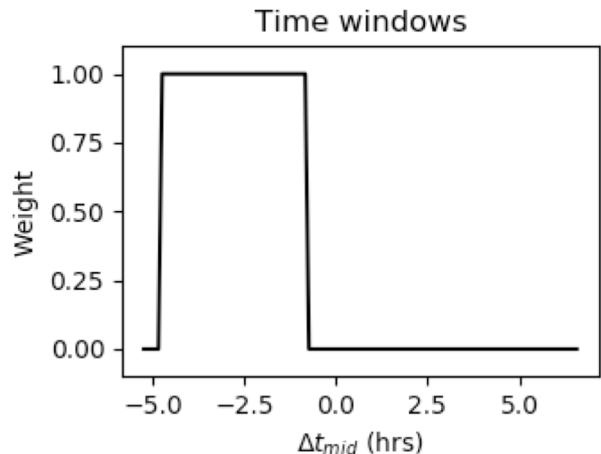
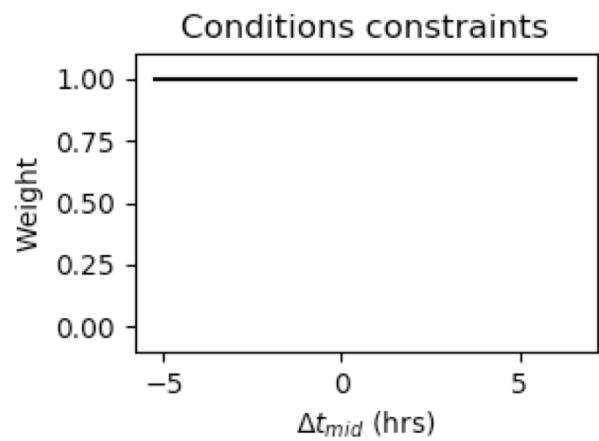
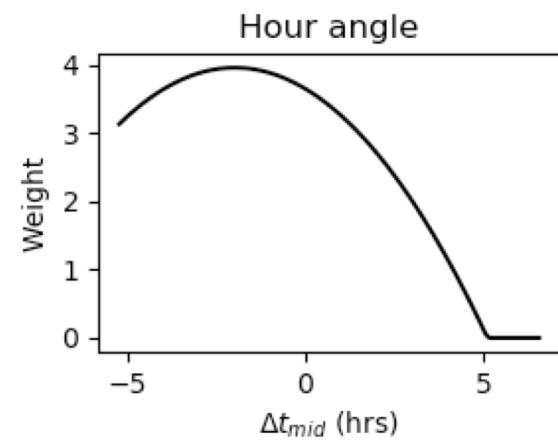
GS-2018A-Q-109-16 weights

Total cond: 12.915451895 (iq=0.7, cc=0.5, bg=1.0, wv=1.0)
RA: 7.757871808036047
Band: 3000.0 (Band 1)
User priority: 2.0 (High priority)
Status: 1.0 (Partially complete: prog=False, obs=False)

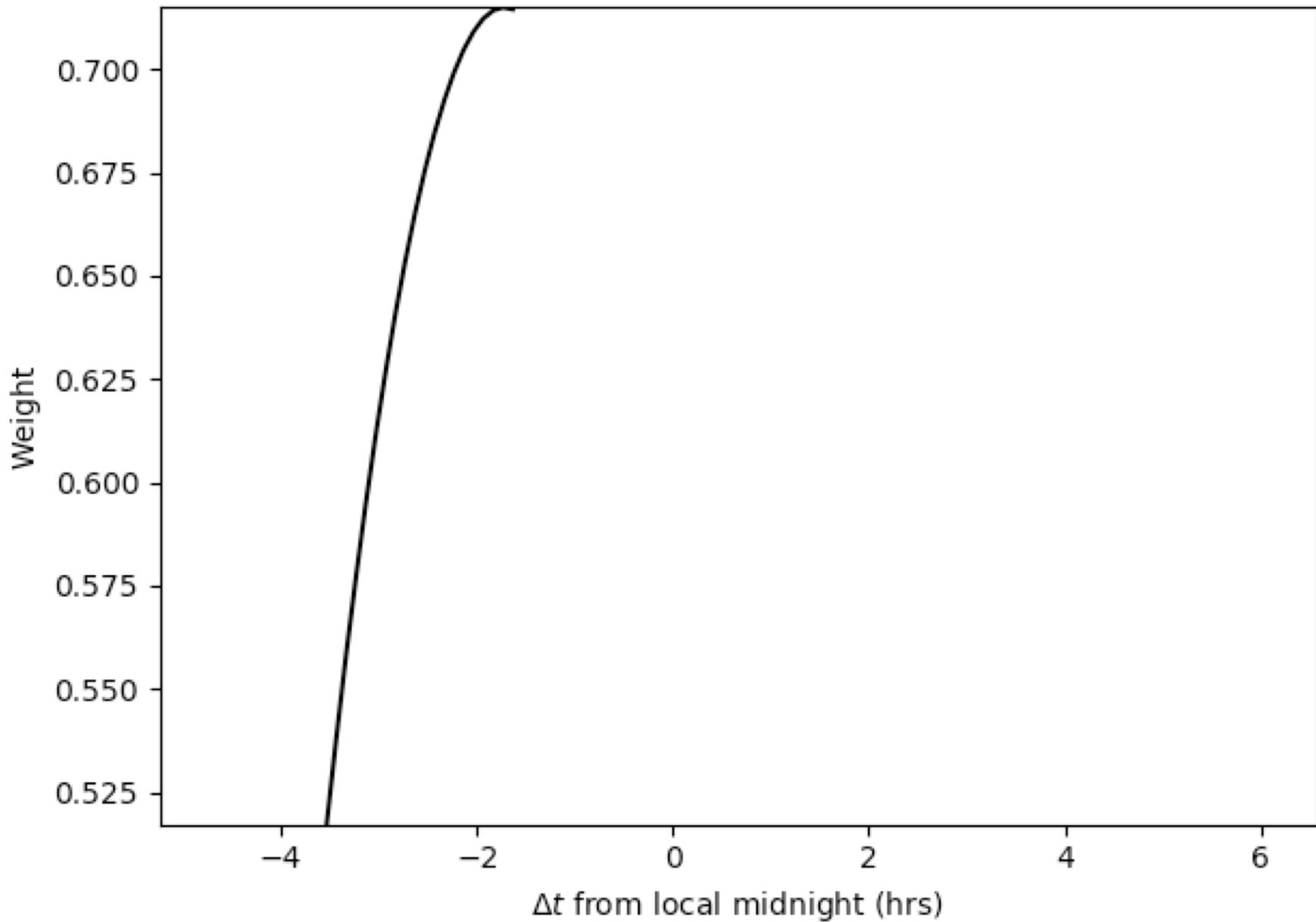


GS-2018A-FT-103-29 weights

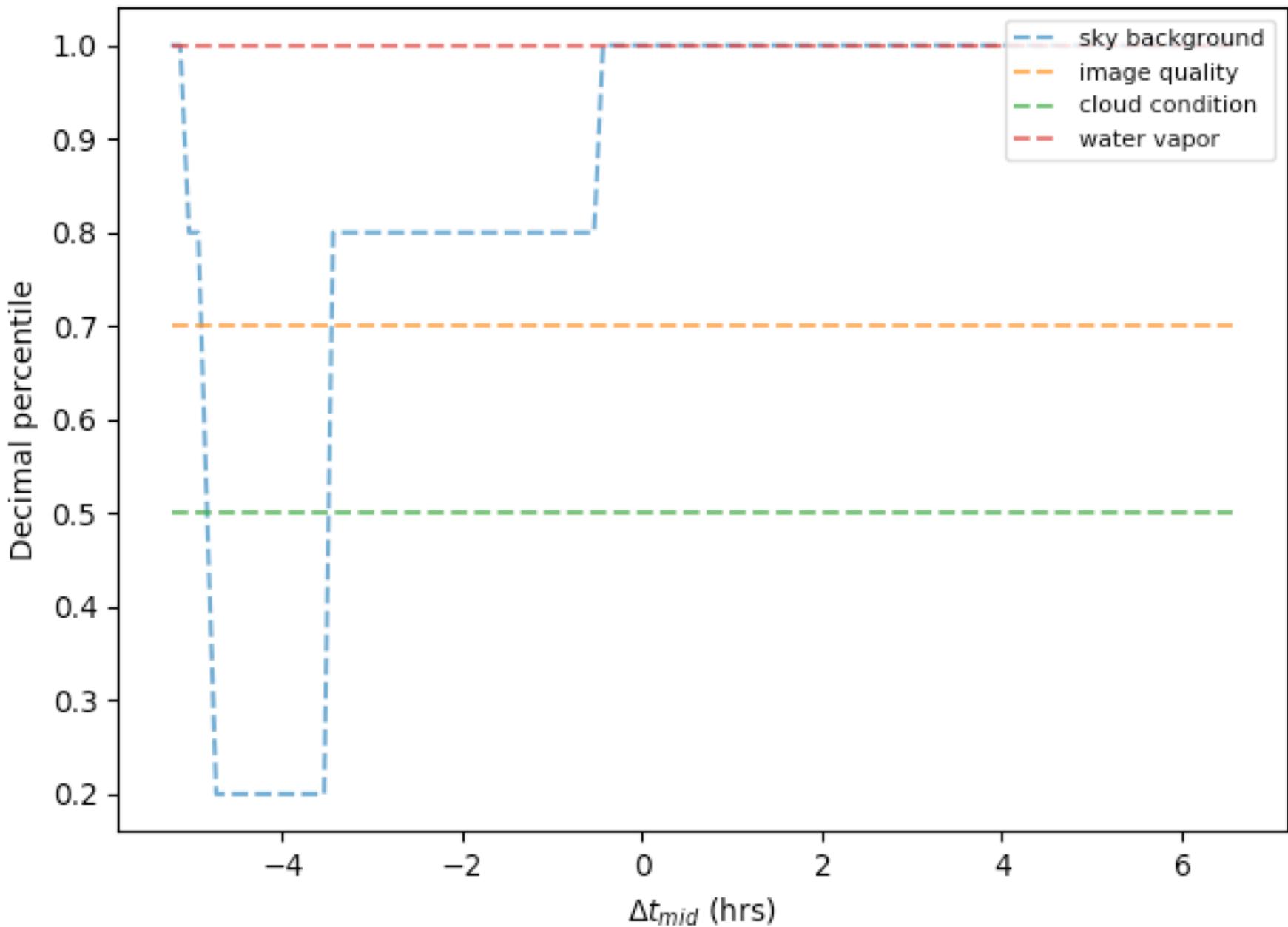
Total cond: 12.915451895 (iq=0.7, cc=0.5, bg=1.0, wv=1.0)
RA: 7.757871808036047
Band: 3000.0 (Band 1)
User priority: 1.0 (Medium priority)
Status: 1.0 (Partially complete: prog=False, obs=False)



+3.025e-5 Weight function: GS-2018A-Q-109-16 on 2018-06-01



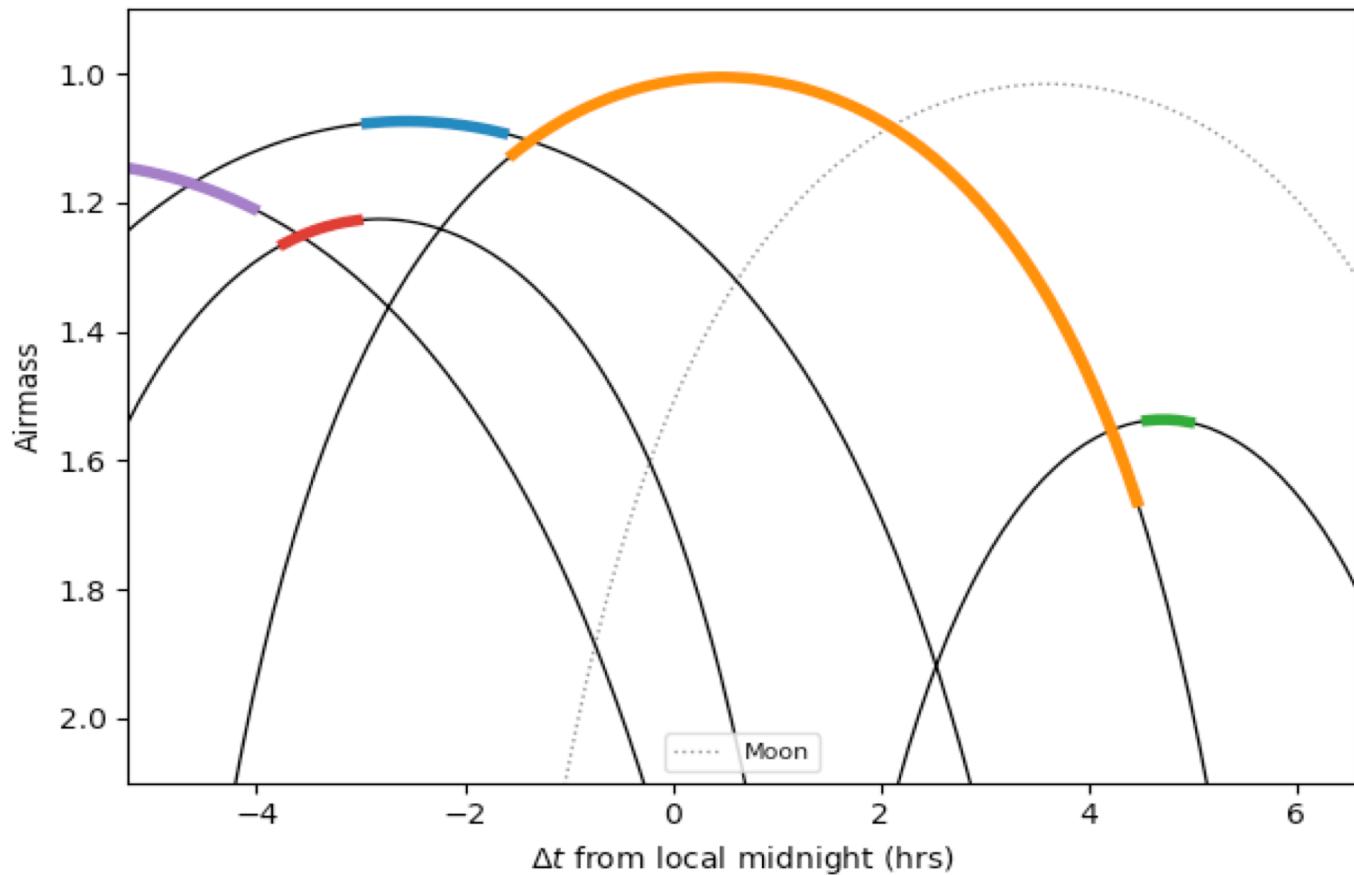
2018-06-01 sky conditions



Simulation events:

- Event type (ToO, viewing conditions change)
- Probability of event
- Maximum number per night
- Placed randomly throughout the night

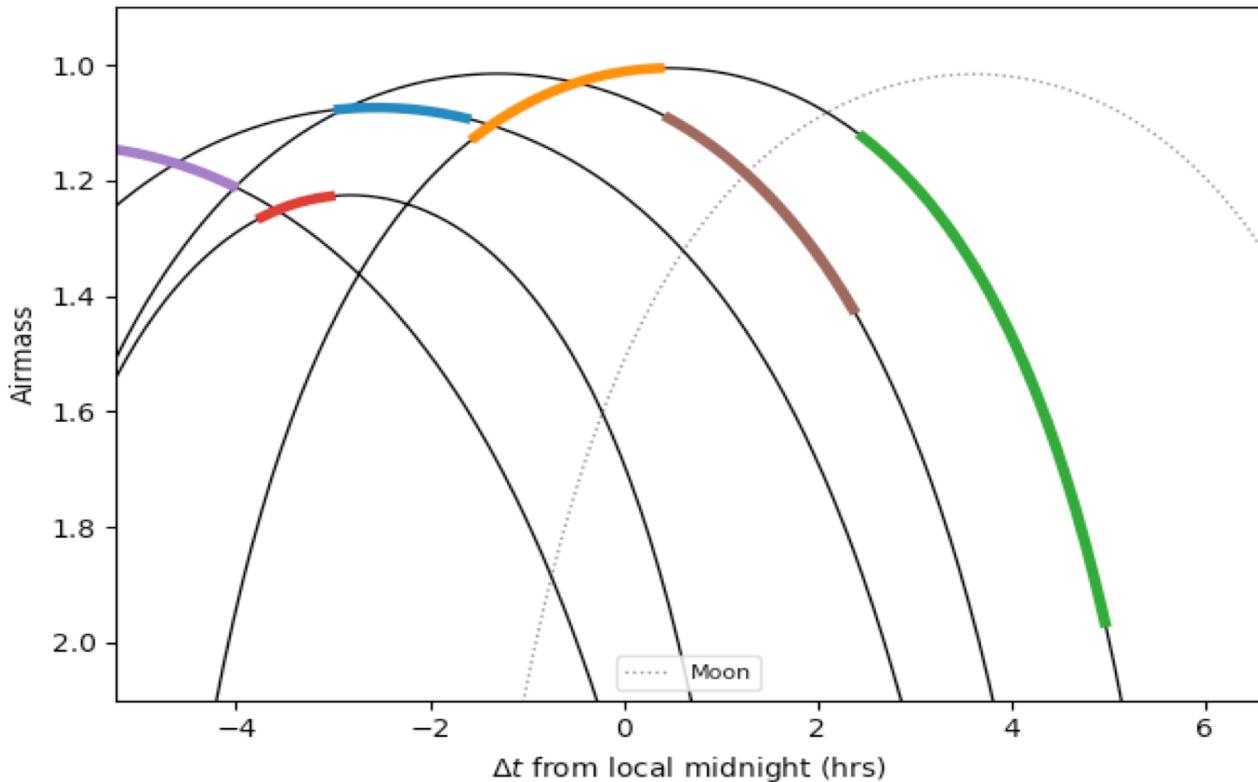
2018-06-01 schedule (iteration 1)



-- 2018-06-01 schedule (iteration 1) --

Obs. ID	Target	RA	Dec.	Instr	UTC	LST	Start	End	Dur.	AM	HA	Completed
12 deg.twi.		--	--		22:46	10.74	18:46					
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A-LP-17-87				Visit	02:28	14.45	22:28	04:34	6.1 h	1.12	-2.01	False
A-Q-103-23				GMOS-	08:34	20.57	04:34	05:04	0.5 h	1.54	-0.15	False
12 deg. twi.					10:34	22.57	06:34					

2018-06-01 schedule (iteration 2)



At 23:46 local time, Standard Target of Opportunity added to queue.

At 00:16 local time, Interrupt Target of Opportunity added to queue.

-- 2018-06-01 schedule (iteration 2) --

Obs. ID	Target	RA	Dec.	Instr	UTC	LST	Start	End	Dur.	AM	HA	Completed
-----	-----	--	---	-----	----	---	-----	---	---	--	--	-----
12 deg.twi.					22:46	10.74	18:46					
A-LP-12-30				GPI	22:46	10.74	18:46	20:04	1.3 h	1.15	0.66	True
-FT-103-29				GPI	00:16	12.25	20:16	21:04	0.8 h	1.26	-0.92	True
A-Q-109-16				GPI	01:04	13.05	21:04	22:28	1.4 h	1.08	-0.38	True
A-LP-17-87				Visit	02:28	14.45	22:28	00:28	2.0 h	1.12	-2.01	False
018A-T-1-2				GMOS-	04:28	16.46	00:28	02:28	2.0 h	1.09	1.77	False
A-LP-17-87				Visit	06:28	18.46	02:28	05:04	2.6 h	1.12	2.00	False
12 deg. twi.					10:34	22.57	06:34					

Summary: Moving forward

Basic framework in place to begin testing new policies

1. Use continuous ranking bands
2. Use physical conditions
3. How to handle long observations, timing constraints between observations
4. How to handle increase ToO fraction
5. How to schedule GS and GN together

Acknowledgments

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