

# Summit Station Clean Air Management Plan

## 1. Purpose of this Plan

The pristine environment of the ice sheet surrounding Summit Station, and the historical context of the GISP 2 paleoclimate record, has made Summit Station an ongoing research site for investigating high latitude physical processes, atmospheric and snow science, ice core interpretation, and climate change. Summit Station's high altitude, northern latitude, and isolation have attracted research projects in astrophysics. In addition, as it is the only such year-round facility located on the ice sheet, Summit Station has an expanding role as an access point for international science activities in the region.

As the station has grown over the last 30 years, so too have the local impacts of human activities. Many of the research projects at Summit Station can be significantly impacted by local pollution sources. This document provides context and guidelines to assist station staff, researchers, and other interested parties in minimizing impacts on sensitive science activities.

## 2. Managing Clean Air Operations

Because winds transport local emissions between station locations, managing clean air operations requires an understanding of both wind direction (Figure 1) and station layout (Figure 2). Prevailing winds at Summit are from the south ( $180^\circ$ ), with winds out of the southeast ( $135^\circ$ ) to southwest ( $225^\circ$ ) range 47% of the time during September to May but only 31% of the time during June – August. To minimize the impact of local human activities on sensitive science, most science activity is located to the south of station, or upwind under prevailing wind conditions.

The physical separation of sensitive science activities is reinforced by the designation of a large area south of station as the clean air zone (CAZ). The CAZ is itself sub-divided by science application:

**Clean Air Sector:** designated for the experiments most sensitive to combustion emissions, such as trace gas chemistry, snow composition, or aerosol research. Delineated by an east-west line passing through the Temporary Atmospheric Watch Observatory (TAWO).

**Clean Campaign Sector:** designated for temporary campaign projects with clean air/snow requirements, but tolerant of minimal authorized foot traffic. Consists of  $15^\circ$  wedges to the north of the Clean Air Sector, on both east and west sides, with its apex 200 m to the east of TAWO.

**Undisturbed Snow Sector:** designated for projects that require undisturbed snow but tolerate more frequent windborne combustion emissions. Consists of a wedge between the eastern Clean Campaign Sector and the main station, with the boundary passing through the snow profiler tower, east of the Mobile Science Facility (MSF).

The science sectors that make up the CAZ have been oriented to minimize the likelihood that winds carry station combustion and other emissions into these sensitive areas. However, when winds blow from the north, or are light and variable, contaminated air can drift into the CAZ. As this situation is detrimental to Summit Station’s science mission, special actions are taken by station users during these ‘north wind’ periods.

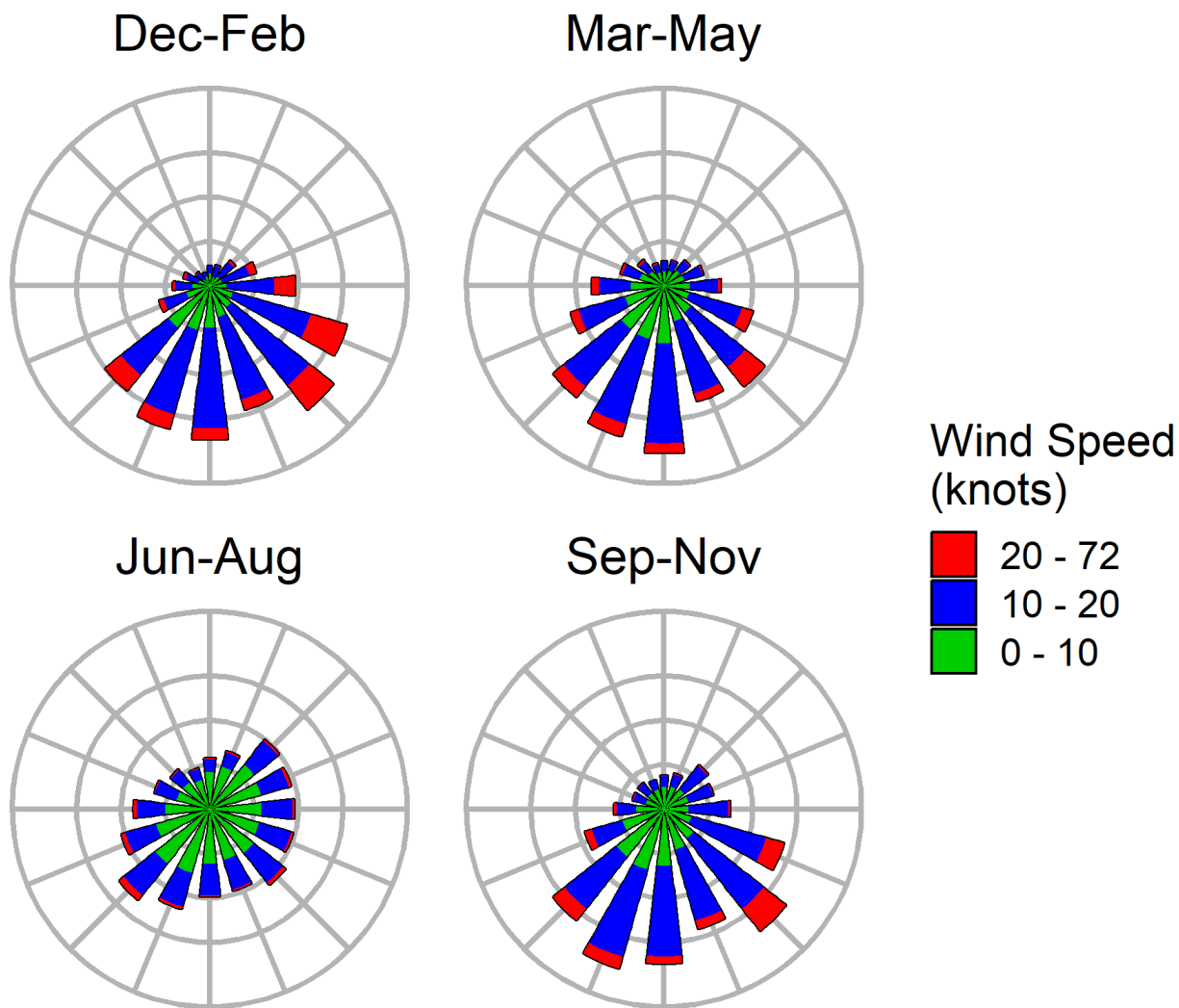
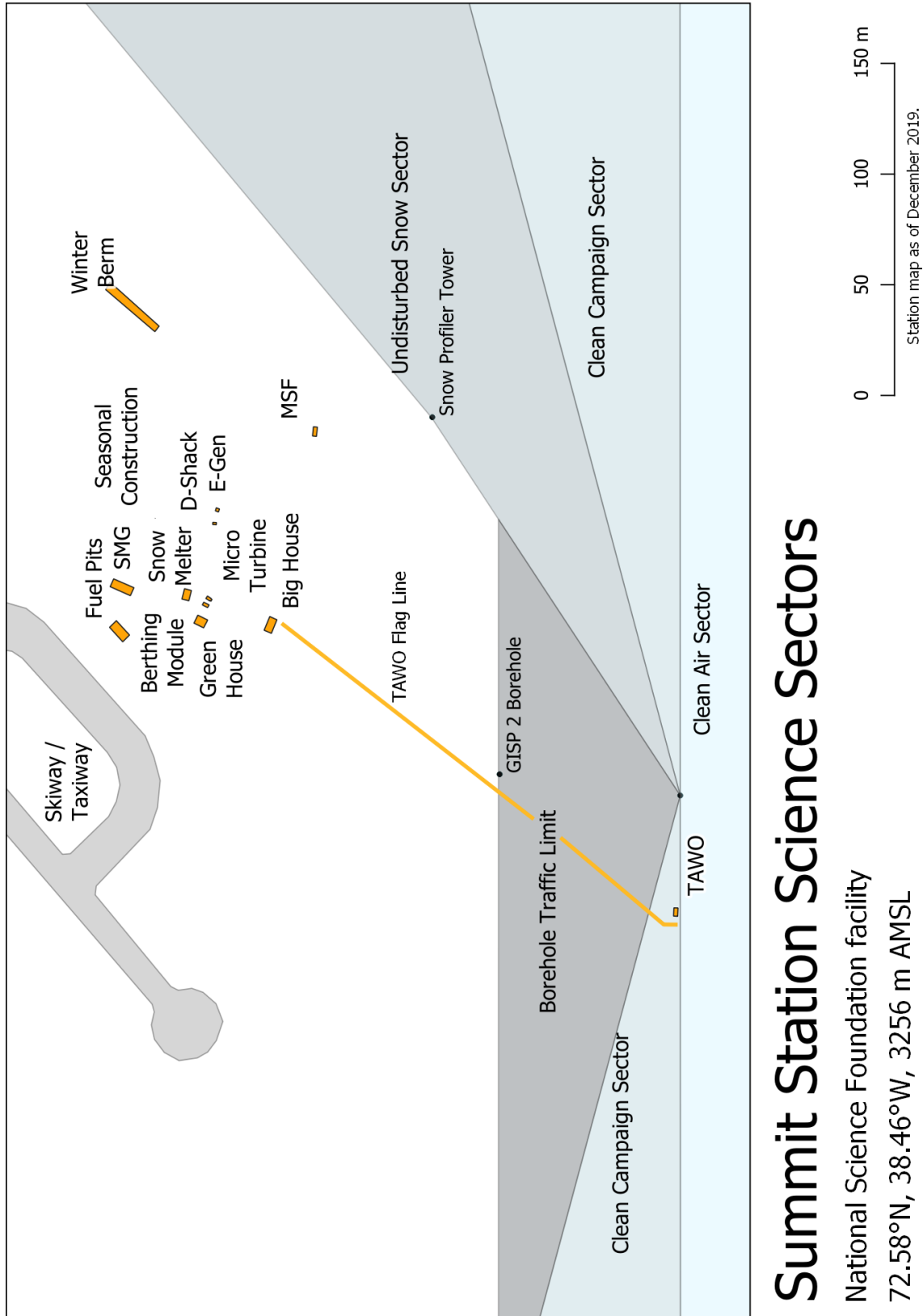


Figure 1: Summit wind rose by 3-month season, based on NOAA ESRL 1-minute average measurements.



# Summit Station Science Sectors

National Science Foundation facility

72.58°N, 38.46°W, 3256 m AMSL

Figure 2: Map of Summit Station science sectors and primary landmarks as of 2020-07-16.

### 3. North Wind Operations

When winds are from the north or wind speeds are low, special guidelines apply to activities at Summit Station. These periods of northerly or low winds are collectively known as ‘north winds’, and are formally defined by these criteria:

**Wind direction is between 342° and 72° (i.e. wind from NNE, 27° +/- 45°)**  
**AND/OR**  
**Wind speed is less than 2 knots, exclusive**

Wind speed and direction can be accessed via any computer or observed on fixed displays around station. Any individual who observes that north wind criteria are met should make a station notification via radio, or as appropriate for the time of day.

When north winds are present, the following procedures must be followed. Stop the use of most internal combustion sources (as summarized in Table 1). No internal combustion rolling stock is used unless: A) required for life safety, B) required for flight operations, C) required for snow melting due to depleted station water reserves, or D) consistent with a variance approved by the NSF for critical camp and/or science operations. Equipment in active use when north wind conditions begin should be driven to its parking place and shut down as soon as feasible but does not need to be shut down in place. Equipment use, even under approved circumstances, must be minimized. These exceptions are discussed in detail:

- A. While most activities at Summit have a bearing on life safety, the life safety exception is intended to address urgent threats, such as medical emergencies. In most cases, clearing egress, etc., should be addressed through the standard variance process.
- B. When water reserves fall to less than 600 gallons, the use of equipment for water-making in north winds can be considered by the field team, considering current north winds forecast, water usage rate, and other factors. An effort should be made to fill the water reserves prior to forecast north winds events.
- C. On flight days, internal combustion equipment can be used for two hours before an aircraft lands and for two hours after an aircraft departs. When just the winter crew (4-6 staff) is present, the preparatory time is extended to 4 hours before aircraft arrival. In all cases, only equipment use related to flight operations is approved.
- D. Some urgent circumstances may justify the use of combustion equipment during north wind conditions. These circumstances are considered on a case-by-case basis by the NSF, as outlined in the section below.

Operators of snowmobiles or heavy equipment record all north winds equipment use (time, type, duration, location) on the ‘clean air log’ clipboard in the Big House office. All equipment traffic on the skiway, regardless of wind direction, is recorded by the operator; this includes skiway grooming and crossings of the skiway to access the ICESat Traverse line or other science sites. The site supervisor records all flight activity (e.g., LC-130 or Twin Otter) on the clipboard.

Once a week, science technicians collect the clean air log clipboard from the Big House office and use it to update the electronic log, prior to the weekly science report.

Table 1: Guidelines for use of internal combustion sources.

<b>Source</b>	<b>North Winds</b>	<b>Non-north Winds</b>
Aircraft	As Scheduled	As Scheduled
Core generators (SMG, E-Gen, D-shack)	Continuous	Continuous
Aux. Generators	Prohibited*	Minimized
Heavy Equipment	Prohibited*	Minimized
Light Equipment (e.g., snowmobiles)	Prohibited*	Minimized

\*Except during medical emergency, flight operations, or after consultation with the SCO and NSF.

## 4. North Winds Variance Process

Outside of life-safety situations, the decision to approve north winds equipment usage can only be made by NSF representatives. When urgent circumstances arise, the site supervisor or their designated representative (such as construction foreman) prepares a variance request. This document presents justification for the variance to the NSF representatives, including a description of proposed work, impacts of delays, and alternative options. This document is submitted to pre-defined contacts at the NSF, Summit Science Coordination Office (SCO), and PFS. Although members of SCO typically comment on variance requests, they are not authorized to approve or deny requests—this is solely the responsibility of the NSF representatives. The variance request template is maintained by the site supervisor.

All variance requests must be: A) need-based, B) sent at least 24 hours in advance of the work activity, C) and include a reference to the two-day weather forecast from the DMI. Need-based equipment operation implies that the safety/well-being of those at Summit will be compromised and/or a critical schedule slip will result from delaying operations. The weather forecast should indicate a persistent pattern of north or light variable winds.

A weather forecast is reviewed at the daily morning meeting. The presence of north winds in the forecast should trigger a scheduling discussion to avoid the need for variance requests.

While NSF-approved variances permit combustion equipment to operate, they do not mitigate the impact of the work on science activities. The duration of equipment work must be minimized, and the scope of work limited to those activities described in the variance.

## 5. Physical Entry into the Clean Air Zone

The science sectors that make up the CAZ are off-limits to most physical entry, including on foot, skis, snowmobiles or heavy equipment. Access is allowed only under the following circumstances:

In the event of a medical emergency.

Well-defined science tasking, such as accessing the Bamboo Forest, Met Tower, seismometer, magnetometer, or raising the science sector flag lines. This routine science work does not require approval or additional documentation, if travel is limited to designated routes and performed on foot.

Pre-coordinated science or construction activities (e.g., raising approach markers or research sites), with the approval of the Summit Station Science Project Manager and the SCO.

Any approved traffic should be along designated flag lines and walking paths. Any deviations from this policy must be documented with photographs and GPS coordinates and reported to the SCO and Summit Station Science Project Manager.

Outside of the CAZ, no snowmobile or heavy equipment traffic is permitted south of the GISP 2 borehole site without prior approval from the Summit Station Science Project Manager and SCO. All combustion activities to the south of the main station should be minimized.

## 6. Access to Off-Station Sites

North-winds limitations do not apply to off-station locations, such as along the ICESat Traverse line and at temporary science research sites. For instance, snowmobile traffic during ICESat Traverse can continue if north winds conditions develop after the party departs station.

However, north-winds limitations do apply to traffic between Summit Station and off-station sites.

**Outbound travel:** No non-emergency equipment travel may depart Summit during north wind conditions.

**Return travel:** Individuals not equipped to remain off station (such as technicians on the ICESat Traverse or members of a science group residing at Summit and off station for a daytrip), may return to Summit regardless of wind conditions. Groups safely equipped for overnight stays (such as traverse parties or groups at off-station overnight locations) should remain at those sites until north wind conditions end.

Parking snowmobiles on the far side of the skiway does not circumvent this policy, as the resulting emissions still may impact local science.

## 7. Documenting Impacts both Authorized and Unauthorized

Impacts on the science sectors must be documented. This includes approved operations during north winds (e.g., NSF variances, flight ops, snow melting, life safety), science campaign incursions into the CAZ, low altitude aircraft flights over the CAZ, and any deviations from the clean air management policies. The Summit Station science technicians are the point of contact (POC) for this documentation and should be informed of any relevant events. The technicians maintain a file on the public Summit FTP site:

[http://isr.sri.com/mirror/summit/ftp/science/clean\\_air\\_traffic/](http://isr.sri.com/mirror/summit/ftp/science/clean_air_traffic/)

## 8. This Document

The Summit Station clean air management plan is maintained by the Summit Station Science Project Manager, Sam Dorsi ([sam@polarfield.com](mailto:sam@polarfield.com)), in cooperation with the Summit SCO ([sco@summitcamp.org](mailto:sco@summitcamp.org)).

The science community should be notified of any changes to this management plan:  
[cps-summit-science@transport.sri.com](mailto:cps-summit-science@transport.sri.com)