2018 Summit Year-round Measurements –

ICECAPS CONTACTS –
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- ICECAPS Radiosondes – twice daily (00Z & 12Z) Vaisala RS41-SG/SGP model sondes measuring vertical profiles to ~25km altitude at ~5m resolution of:
    - winds
    - temperature
    - humidity
- ICECAPS Polar Atmospheric Emitted Radiance Interferometer (PAERI) – passive calibrated infrared interferometer in the 3.3-25 micron window at 0.5 cm-1 resolution measuring spectral IR sky brightness temperatures and radiances to derive:
    - cloud ice/water content
    - cloud optical depth
    - cloud particle size
    - cloud radiative forcing
    - cloud temperature
    - cloud occurrence
- ICECAPS Millimeter Cloud Radar (MMCR) – multimode 35 GHz Ka band, pulsed Doppler radar sensing signal from -50 to +20 dBZ measuring radar Doppler spectra and moments (reflectivity, mean Doppler velocity, spectrum width) of detected hydrometeors to derive:
    - cloud vertical boundaries
    - cloud occurrence
    - atmospheric winds
    - cloud particle size
    - cloud ice/water content
    - atmospheric turbulence
- ICECAPS Microwave Radiometers (MWR) – two scanning passive radiometers measuring downwelling radiance at 22-31, 51-58, 90, and 150 GHz absorption lines to derive:
    - atmospheric moisture
    - atmospheric temperature
    - cloud ice/water content
- ICECAPS Cloud Aerosol Polarization and Backscatter LIDAR (CAPABL) – Tiltable non-scanning multiple linear polarization sensitive lidar at 532 nm measuring backscatter, depolarization ratio of detected targets to derive:
    - cloud vertical boundaries
    - cloud occurrence
    - cloud phase
    - cloud optical depth
- ICECAPS Ceilometer -non-scanning vertically pointing lidar at 1064 nm measuring backscatter of detected targets to derive:

    - cloud vertical boundaries
    - cloud occurrence
    - cloud phase
    - cloud optical depth
- ICECAPS Micropulse Lidar (MPL) – non-scanning polarization sensitive vertically pointing lidar at 532 nm measuring backscatter, depolarization ratio of detected targets to derive:
    - cloud vertical boundaries
    - cloud occurrence
    - cloud phase
    - cloud optical depth
- ICECAPS Precipitation Occurrence Sensor System (POSS) – x-band Doppler radar mounted on a 2-3m tall mast to measure reflectivity and mean Doppler velocity of detected hydrometeors to derive:
    - precipitation occurrence
    - precipitation type
    - precipitation intensity
- ICECAPS Multi-Angle Snowflake Camera (MASC) – multi-camera automatic sensing high resolution snowflake imaging system mounted 1-2m above surface to automatically capture images of snow type and structure.
- ICECAPS Hotplate – two horizontal, heated plates mounted ~2m above surface set to maintain a constant temperature with one exposed to precipitation. Differential heating during precipitation provides an inferred measurement of precipitation mass.
- ICECAPS IcePic – manually captured digital images of snowflake structure and type utilizing microscope stage, lenses, and slides to image precipitation in very high resolution.
- ICECAPS SODAR – bi-static audible acoustic sodar measuring sonic backscatter from density variations to infer depth and stability of the boundary layer
- ICECAPS Total Sky Imager (TSI) – hemispheric digital sky imager used to monitor cloud fraction from captured images. Operates in daylight conditions above -40C.
- UC Davis DRUM Sampler – impact sampler with a through-wall inlet at TAWO measuring aerosols including:
    - Contacts – Thomas Cahill (PI) tomandginny12@gmail.com; Nicolas Spada (Co-I) njspada@ucdavis.edu
    - Sizing in 8 modes from ~15 µm to 0.09 µm
    - 8 wavelengths of optical absorption (350 to 720 nm)
    - Composition of up to 32 elements to sub-picograms/m3 levels
    - 12 hour resolution from 2003
- NOAA Meteorology; minute data records of following parameters –
    - Contact – NOAA GMD Met group; gmd.met@noaa.gov
    - Wind Speed/Direction (10m); Lufft Ventus-UMB sonic anemometer
    - Temperature (2m); Logan RTD
    - Relative Humidity (2m); Vaisala HMP155
    - Ambient pressure; Setra and Honeywell pressure transducers (2 instruments)
- NOAA Carbon Cycle Greenhouse Gas (CCGG); weekly in-situ flask samples taken in the clean air sector with a portable sampling unit; flasks are analyzed for:
    - CCGG Contact – Don Neff don.neff@noaa.gov
    - Carbon dioxide (CO2)
    - Methane (CH4)

    - Carbon monoxide (CO)
    - Nitrous oxide (NO)
    - Sulfur hexafluoride (SF6)
    - C13/C12 in CO2
    - O18/O16 in CO2
    - C13/C12 in CH4
    - Ethane (C2H6)
    - Propane (C3H8)
    - i-butane – (C4H10)
    - n-butane – (C4H10)
    - i-pentane – (C5H12)
    - n-pentane – (C5H12)
    - isoprene (C5H8)
    - Molecular Hydrogen
    - n-hexane
    - Acetylene
    - Toluene (C7H8)
    - Ethene (C2H4)
    - Propene (C3H6)
- NOAA Halocarbon and Atmospheric Trace Species (HATS) in-situ flask samples: weekly (Jul-Sept), biweekly (Oct-Jun) taken from inlet above TAWO roof; HATS flask data that are regularly updated to the NOAA/GMD ftp site from the analysis of SUMMIT flasks are listed below. The data are from measurements on a GCMS and with a GC/ECD instrument (results on ftp site supplied by ECD are indicated with an asterisk, although those gases are also measured by GCMS):
    - HATS Contacts – Steve Montzka Stephen.a.montzka@noaa.gov; Ben Miller ben.r.miller@noaa.gov; James Elkins james.w.elkins@noaa.gov
    - CFC-11 *
    - CFC-12 *
    - CFC-113
    - H-1211
    - H-2402
    - CH3CCl3
    - CCl4 *
    - CH2Cl2
    - C2Cl4
    - CH3Br
    - CH3Cl
    - HCFC-22
    - HCFC-141b
    - HCFC-142b
    - HFC-134a
    - HFC-152a
    - HFC-365mfc
    - HFC-227ea
    - Carbonyl Sulfide (COS)
    - N2O * (but stopped due to ECD instrument problems)
    - SF6 * (but stopped due to ECD instrument problems)

- 2) Additional gases are measured by the HATS group, but the data haven't necessarily been through the QA/QC associated with the publication process, so although measurements are made and results are thought to be reliable, they aren't regularly posted. Data for these gases could be made available upon request from NOAA GMD HATS group.
    - CFC-112
    - HCFC-133a
    - HCFC-21
    - CH2Br2
    - CHBr3
    - CHCl3
    - CH3I
    - 1,2-dichloroethane
    - 1,1-dichloroethane
    - CH2BrCl
    - CHBr2Cl
    - CHBrCl2
    - CH2ClI (chloro-iodo-methane)
    - Benzene
    - C3H4
    - n-pentane
    - n-hexane
- 3) Ben Miller also analyzes for the following species on his PERSEUS instrument (GCMS) and are available up request:
    - CF4 CF4
    - NF3 NF3
    - C2H6 ethane
    - PFC-116 CF3CF3
    - SF6 SF6
    - CFC-13 CClF3
    - HFC-23 CHF3
    - C2H2 ethyne
    - OCS carbonyl sulfide
    - HFC-32 CH2F2
    - SO2F2 sulfuryl fluoride
    - H-1301 CF3Br
    - PFC-218 Perfluoropropane
    - C3H8 propane
    - CFC-115 CFC-115
    - HFC-125 HFC-125
    - HFC-143a HFC-143a
    - HCFC-22 HCFC-22
    - CFC-12 CFC-12
    - HFC-134a HFC-134a
    - HFO-1234yf HFO-1234yf
    - CH3Cl methyl chloride
    - HFC-152a HFC-152a
    - HFO-1234ze HFO-1234ze

    - i-butane iso-butane
    - HFC-227ea HFC-227ea
    - H-1211 Halon-1211
    - nC4H10 n-butane
    - CH3Br methyl bromide
    - HCFC-142b HCFC-142b
    - HFC-236fa HFC-236fa
    - CFC-114 CFC-114 and CFC-114a (combined)
    - HCFC-133a HCFC-133a
    - CFC-11 CFC-11
    - CH3I methyl iodide
    - CH2Cl2 dichloromethane
    - iC5H12 i-pentane
    - nC5H12 n-pentane
    - HCFC-141b HCFC-141b
    - CFC-113 CFC-113
    - H-2402 Halon 2402
    - HFC-365mfc HFC-365mfc (ion 65)
    - CHCl3 chloroform
    - n-hexane n-hexane
    - CCl4 carbon tetrachloride
    - C2HCl3 C2HCl3
    - CH2Br2 dibromomethane
    - CH3CCl3 methyl chloroform (ion 97)
    - C6H6 benzene
    - C2Cl4 tetrachloroethylene
- NOAA Aerosol properties in hourly resolution including light absorption, light scattering, and particle number concentration from the following instruments:
    - Contacts – Patrick Sheridan Patrick.sheridan@noaa.gov; Besty Andrews betsy.andrews@noaa.gov
    - nephelometer – light scattering and back-scattering measurement at 3 wavelengths
    - continuous light absorption photometer (CLAP) – light absorption measurement at 3 wavelengths
    - aethalometer –equivalent black carbon concentration/light absorption at 7 wavelengths
- NOAA Surface Ozone – minute average of surface atmospheric ozone concentrations
    - Contact Irina Petropavlovskikh; irina.petro@noaa.gov; Audra McClure audra.mcclure@noaa.gov
- NASA ICESat – monthly traverse to take GPS ground-truth measurements for space borne and airborne laser and radar altimetry systems used to interpret ice-sheet topography and associated temporal changes. Accumulation at ~120 stakes is also taken during the transect.
    - Contact Thomas Neumann (PI) – Thomas.neumann@nasa.gov; Kelly Brunt (Co-I) Kelly.m.brunt@nasa.gov
- NASA Bamboo Stake array – weekly manual measurements of accumulation in a 121 stake bamboo stake array located ~700m east of station.
    - Contact Thomas Neumann (PI) – Thomas.neumann@nasa.gov; Kelly Brunt (Co-I) Kelly.m.brunt@nasa.gov
- NASA Steffen GC-NET –

    - Contact Konrad Steffen (PI) konrad.steffen@wsl.ch; Guido Muller guido.mueller@env.ethz.ch; Stephan Nyeki Stephan.nyeki@pmodwrc.ch; Dany Pfiffner dpfiffner@owel-swiss.ch
    - Solar Tracking instruments – shaded pyranometer and pyrgeometer instruments and seasonal precision filter radiometer (PFR)
    - Fixed Arm measurements – Upwelling pyranometer and pyrgeometer and downwelling unshaded pyranometer
    - Pyranometers measure shortwave solar radiation in mV with applied calibration factors and correction values to provide W/m2 values
    - Pyrgeometers measure longwave solar radiation in mV with applied calibration factors and correction values to provide W/m2 values
    - upGPR instrument – an upward looking GPR buried in the snow gathers snow accumulation and compaction information
    - Temperature, sonic snow depth, and 10m snow temperature profile measurements
- NASA Howatt SnowFox – insitu cosmic ray sensing instrument measuring neutron impacts over time to derive snow water equivalency (SWE) of accumulated precipitation. Manual physical sampling done weekly to provide direct density and SWE measurements.
    - Contact Ian Howat (PI) – howat.4@osu.edu
- GFZ Potsdam Seismometer – two broadband seismometers monitoring activity as part of a global network of instruments. Seismic signal can be used to derive ice calving events amongst other seismic activities.
    - Contact Angelo Strollo (PI) strollo@gfz-potsdam.de; Thomas Zieke tzieke@gfz-postdam.de
- DTU Magnetometer – Part of a network of magnetometers around Greenland providing full vector geomagnetic field information at 1 Hz resolution
    - Contact Rico Behlke (PI) rico.behlke@space.dtu.dk
- UNH Radionuclide Filter – filter samples collected with approximately 48 hour resolution and analyzed offsite for concentrations of Be-7 and Pb-210.
    - Contact Jack Dibb jack.dibb@unh.edu

Automated Measurements at and near Summit

- Steffen GC-NET AWS
    - Contact Konrad Steffen (PI) konrad.steffen@wsl.ch;
    - Measured parameters include wind speed and direction, temperature and humidity profiles, barometric pressure, snow temperature profile, sonic snow depth, and short and all wave solar radiation.
- DMI AWS
    - Contact Jens Hansen (PI) jqh@dmi.dk
- Abdalati Firn FirnCover – Automated continuous measurement of firn densification using a draw-wire sensor connected to an anchor at depth in the firn.
- Measurements and contact information include:
    - Contact Waleed Abdalati (PI) waleed.abdalati@colorado.edu; Mike MacFerrin (Co-PI) michael.macferrin@colorado.edu
    - Snow accumulation
    - Temperature
    - Firn stratigraphy and density profiles