# Hydrology & Permafrost WG

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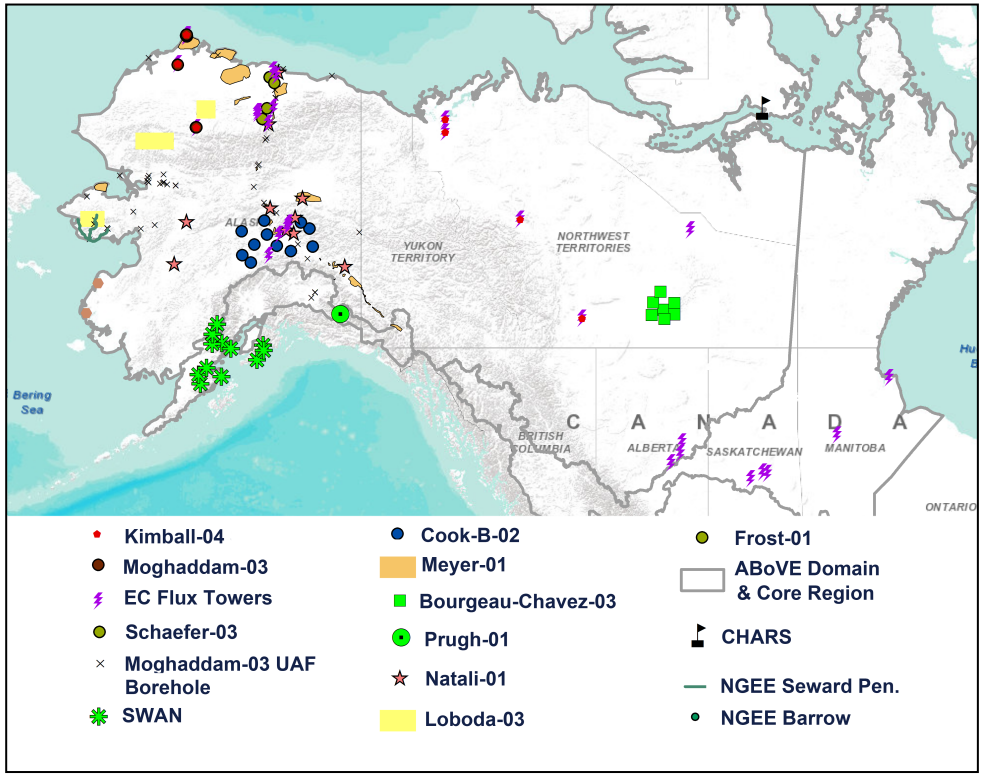
# Institutional Collaborations & Outreach

- Federal or state agencies
  - Multi-agency representation on HPWG: NASA, DOE, USGS, NPS, Env. CN, CHARS
  - Leverage regional monitoring networks (e.g. USArray, USCRN), infrastructure & outreach
  - Science value-added, including data products development, Cal/Val & process studies
- Local communities and Native groups
  - Local outreach from individual projects to communicate science objectives and findings
  - Outreach through HPWG member agencies & infrastructure
  - Opportunities to create "indicator" maps to aid land managers/community leaders
  - Other groups, activities TBD
- Other stakeholder organizations
  - Interagency Arctic Research Policy Committee (IARPC) Collaborations
  - Exchange for Local Observations and Knowledge of the Arctic (ELOKA)
  - Alaska Landscape Conservation Cooperative (ALCC)
  - Imiq Hydroclimate data portal
  - Coordinate activities with ABoVE Stakeholder Engagement & Public Outreach Working Group (Larson)

# HPWG Science Objectives

- Improve understanding of processes controlling changes in distribution and properties of permafrost and hydrologic systems, including spatial/temporal patterns and controls on:
  - Non-frozen season timing & duration
  - Active layer depth, permafrost thermal profile & thermokarst activity
  - Surface soil moisture, open water inundation and lake area
  - Snowcover properties & distribution
- Investigate how recent changes in non-frozen season, active layer depth and surface hydrology are influencing vegetation greening/browning patterns, land-atmosphere carbon exchange, animal habitat & migration, transportation networks & ecosystem services
- Develop HPWG Action Plans to promote integrated data collection and analyses for the ABoVE domain
- Identify opportunities for data compilations and "big-picture" meta-analyses; this will require interacting with other WGs and research communities outside of ABoVE

# Field Studies




## Field Measurements

| | | | |
|---|---|---|---|
| Active Layer | Relative Humidity | Lake Area Thickness | Organic Layer Thickness |
| Air Temp | Stream Flow | Precip. | $NO_3^-$ Isotopes |
| Soil Temp | Stream/Lake Temp | Snow Depth | H2O Isotopes |
| Soil Matric Potential | pH/Salinity | SWE | GPR |
| Pore Water EC | DOC/DIC | Surface Albedo | NMR |
| Water Table Depth | Aquatic $CH_4$ | Solar Radiation | ERT |

# Cross-WG Synergies

- Synergies with other WGs:
  - Coordinated modeling, parameterization, validation & data products (*Modeling Framework & Comparisons*)
  - Wildlife impacts from changing snow cover, winter thaw events & surface flooding (*Wildlife & Ecosystems*)
  - Fire disturbance interactions with surface wetting/drying trends, altered snow regimes & NF seasons (*Fire Disturbance*)
  - Impacts of changing surface hydrology, permafrost & ALD dynamics on NEP, C exchange & storage (*Carbon Dynamics*)
- Data gaps / needs:
  - Integrated field data collection of critical HP variables (e.g. ALD, SM, ST, Snow)
  - Lateral movement of surface/sub-surface water & materials (DOM, C species, N, sediment)
  - Lake & river ice phenology, incl. properties, timing, duration, trends & monitoring at relatively fine (</=100m Res.) spatial scales
  - Finer scale spatial Info. on snow cover properties (structure, depth, density, SWE) & regional snow monitoring
  - Comprehensive water budget characteristics (P, ET, Q, storages)
  - Coordination with other research activities & local knowledge: NASA Arctic-Colors (Arctic-Coastal Land Ocean inteRactions) campaign; The Arctic Landscape Conservation Cooperative (ALLC); PalEON (PaleoEcological Observatory Network); The Interagency Arctic Research Policy Committee (IARPC)

# Space/Airborne Remote Sensing

- Data products will target freeze/thaw (FT), active layer depth or thickness (ALD, ALT), thermokarst features, water table depth (WTD) surface water inundation, lake dynamics, soil moisture (SM), and snow properties.

| Project | Description | Spatial Extent | Temporal Coverage | Spatial Res. | Sensors Used |
|---|---|---|---|---|---|
| ***Surface Freeze/Thaw, PF and Active Layer Characteristics*** | | | | | |
| Kimball-04 | FT Trend and Anomaly Maps | ABoVE Domain | 1980-2017 | 6; 12; 25-km | AMSR; SMMR; SSMI/S; SMOS; SMAP |
| Kimball-04 | Annual ALD Maps | ABoVE Domain | 2003-2009 | 25-km | SMMR; SSMI/S; MODIS LST |
| Striegl-01 | Static ALD; sub-surface PF Maps | Alaska; Regional | 2011 | 30-m | Landsat; **NIAP; G-LiHT; Leica ALS60** |
| Schaefer-03 | Surface Subsidence; ALT Maps | Sub-region, North Slope | 1991-2010 | 30; 100-m | ERS-1/2; ALOS PALSAR |
| Moghaddam-03 | ALD; WTD; SM; OLT Maps | Alaska Transects | | 15; 90-m | **AirMOSS; UAVSAR** |
| Frost-01 | Thermokarst Maps | YK Delta Region | | | AVHRR; SSM/I; MODIS; Landsat; NGA; **Lidar?** |
| Loboda-03 | ALD; Soil Temp Maps | Regional | | | Landsat |
| Wullschleger-01 | Ground Ice; ALT; Soil Thermal Maps | Barrow; Seward Pen. | | | Landsat, etc. |
| Natali-01 | Multi-scale FT Maps | Regional | | | TBD |
| ***Surface Water Distribution & Soil Moisture*** | | | | | |
| Carroll-01 | Lake Extent & Change Maps | Alaska & Canada | 1991; 2001; 2011 | 30-m | Landsat; MODIS |
| Kimball-04 | Surface Inundation Maps | ABoVE Domain | 2003-2017 | 25; 5; 1-km | AMSR |
| Kimball-04/Moghaddam-03 | Soil Moisture Validation Maps | Regional | 2015 | 9-km; 15, 90-m | SMAP; **AirMOSS; UAVSAR** |
| Meyer-01 | Lake Change Maps; Ice Hazard Maps | Regional | | | ALOS PALSAR; ALOS-2; SAOCOM; **NISAR** |
| Cook-B-02 | Wetland/Surface Water Change Maps | Regional | | | Landsat; **HyspIRI** |
| Loboda-03 | Drainage & Soil Moisture Maps | Regional | | | Landsat; InSAR |
| Bourgeau-Chavez-01 | SM Maps (pre & post burn); ALD | Great Slave Lake Region | 2015-2018 | | PALSAR; Radarsat-2; ERS; Sentinel; SMOS; SMAP; Landsat; DigitalGlobe |
| ***Snow Cover Characteristics*** | | | | | |
| Prugh-01 | SCE; Depth; Hardness Maps | Wrangell St. Elias Region (Kennecott) | | 100-m | TBD |
| Loboda-03 | SCE; Onset; Duration Maps | Regional | | 1-km | Landsat; MODIS; ERS-1/2; Radarsat-1/2; ALOS PALSAR; ENVISAT |
| Kimball-04 | Snowpack Melt Maps | Regional | 1979-2016 | 25-km | AMSR; SMMR; SSMI/S |

*Text in **blue** indicates airborne

# Airborne Remote Sensing

Existing airborne remote sensing included in HPWG projects:

- **AirMOSS P-; UAVSAR L-band** (Moghaddam-03; Kimball-04)
  - detect seasonal ALD, SM, WTD, organic layer depth
  - data used as inputs in biogeochemical models (carbon flux maps)
- **HyspIRI** (Cook-B-02)
  - wetland/surface water change maps
    (mapping wetland species $CH_4$ emission control factors?)
- **NIAP; Leica ALS60** (Striegl-01; Frost-01)
  - thermokarst features, ALD, sub-surface PF features, landscape physical properties influencing hydro. & PF processes
- **G-LiHT** (Striegl-01)
  - detecting landscape physical properties influencing hydro. & PF properties
- Trail Valley Creek (NWT) airborne radar campaigns targeting SWE (Chris Derksen)
- NGEE and CHARS (TBD)

# Modeling

- **Datasets produced:** HPWG modeling activities will provide maps of key landscape indicators and parameters for SM, WTD, surface inundation, PF & lake ice properties, thermokarst activity, snow extent & characteristics (others TBD)

- **Models identified**: InSAR FZN Ground, ReSALT, SnowModel, SUTRA, PFLOTRAN, ATS, ED, TEM, ACME/ALM, CanFIRE, TCF-PWBM, various statistical approaches

  *The HPWG has started a model table list. This can be found under ABoVE Google Docs.*

- **Model input data:** (wide range of spatial/temporal res.) satellite & airborne RS, gridded surface met & in situ measurements

- **Data gaps/needs:** Airborne P- & L-band retrievals across project and flux tower sites; Airborne LiDAR and HF-radar along snow transects; Winter L-band SAR at select lake sites; Joint LiDAR, HyspIRI/AVIRIS+MASTER, airborne SAR and CARVE $CO_2$ & $CH_4$ retrievals at ABoVE core sites; Pre-ICESat-2 retrievals at ABoVE core sites; representation in YK Delta

# Completed AIP Input & Objectives for ABoVE 2A

- An initial AIP draft has been produced by HPWG members
- The following actions targeted during the 2A meeting:

**Mature draft:**

- field measurements table (additional input)
- field measurement location maps (spatial coordinates needed)
- expected datasets table (additional input)
- expected model(s) table (additional input)

**Identify:**

- timing & synergies between/among WG projects & HPWG members
- any data gaps/needs not yet included in draft AIP
- opportunities for "big-picture" meta-analyses and data synthesis
- opportunities for coordinated data sharing and community outreach

**Draft:**

- plans/requests for coordinated airborne observations (with C. Miller)