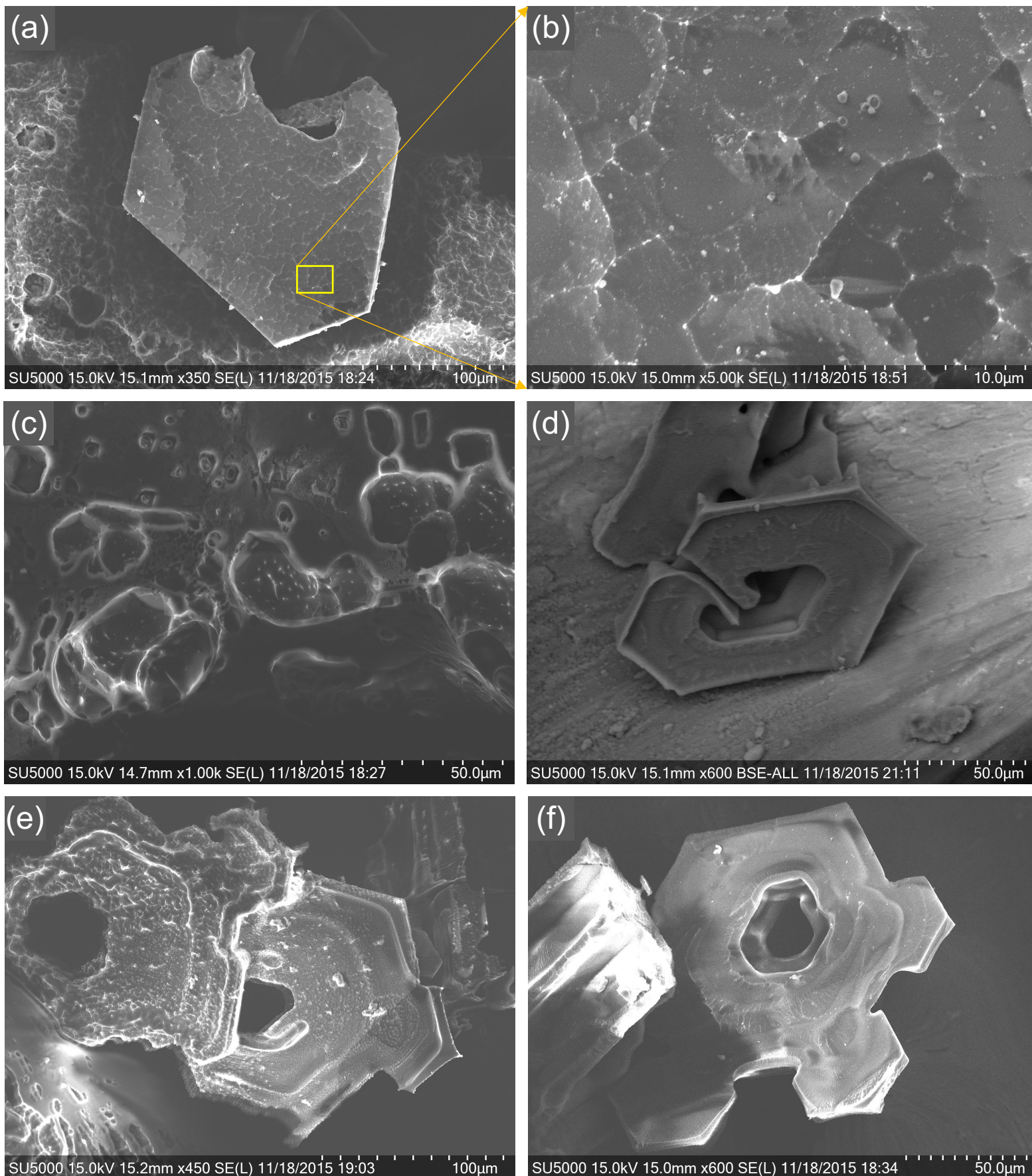


## A. ICE-Ball Flight: Nov. 18, 2015

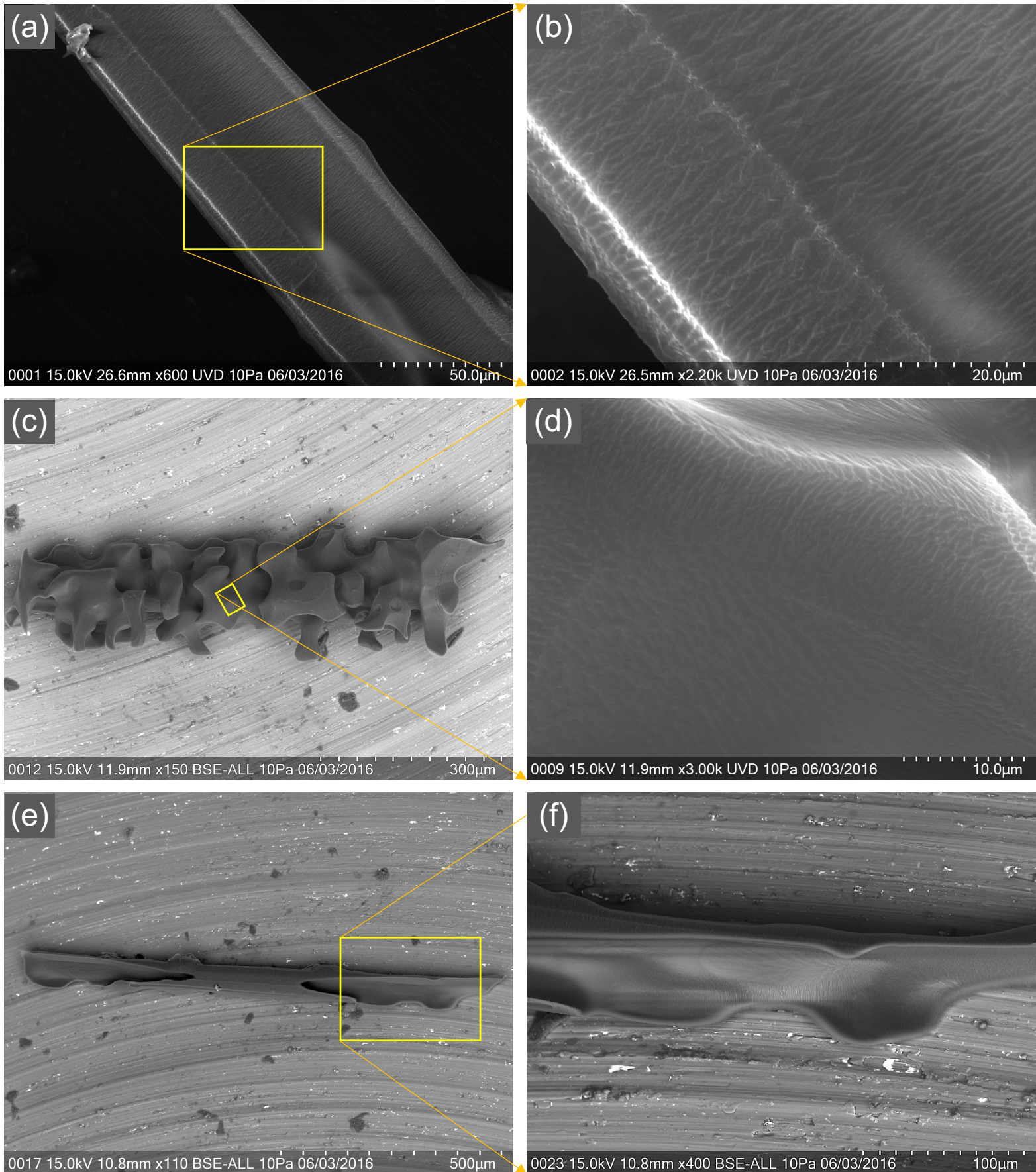
Atmospheric conditions and particle collection context: First successful Ice-Ball flight sample through multi-layered mixed-phase altostratus (5-7 km height, -20 to -30 C) and overlying cirrus (9-11 km height, -40 to -50 C) over Newtown, PA. IceBall was collecting in cloud between 1830 – 1905Z. Approximately 15 ice particles collected, showing a mix of sectored plates, truncated triangular plates and several columnar habits and partial bullets (not shown). Most, but not all particles showed evidence of sublimation. Most also show surface aerosol scavenging and multi-mode roughening. Panel f. is an unusual scrolled plate, with evidence of aero-finning and basal roughening.





## B. ICE-Ball Flight: June 3, 2016

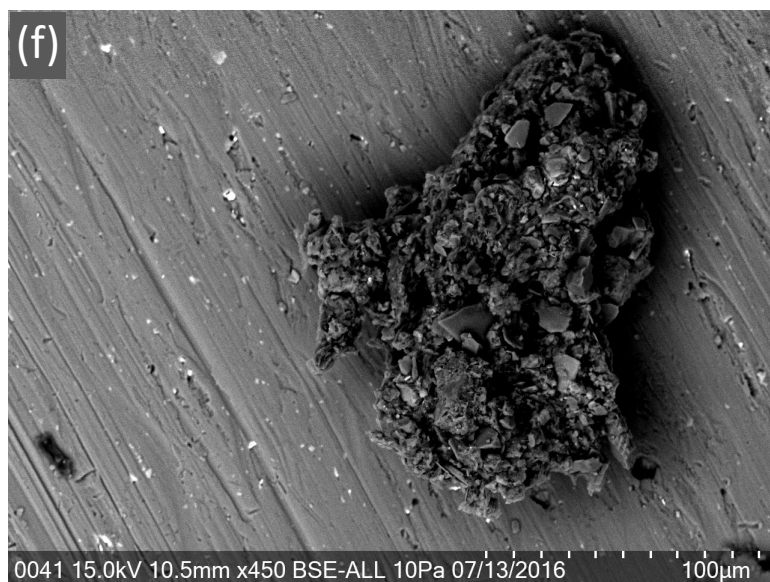
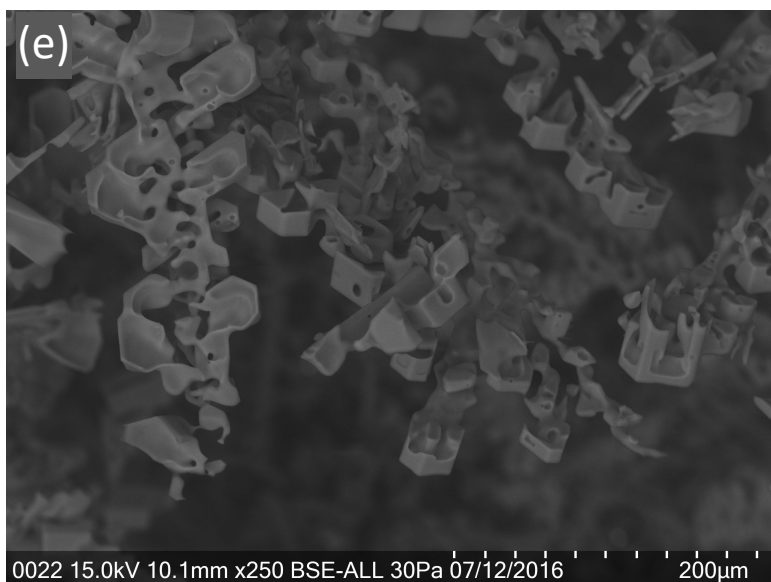
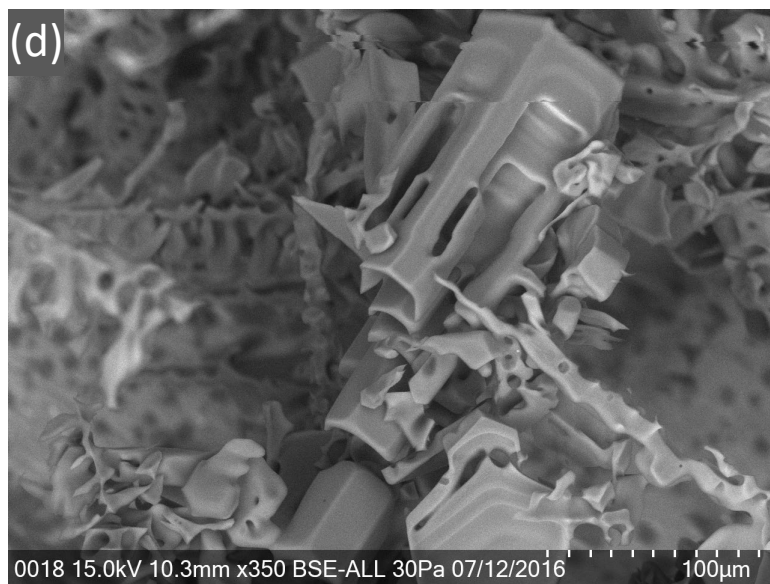
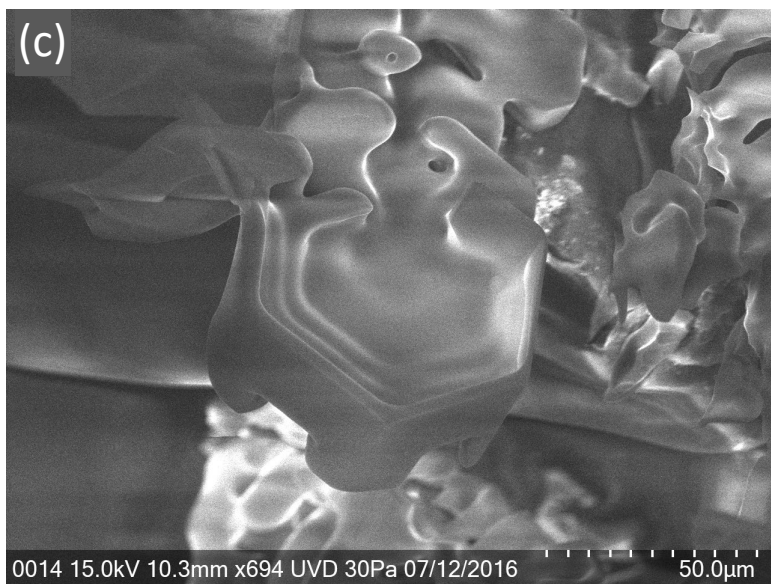
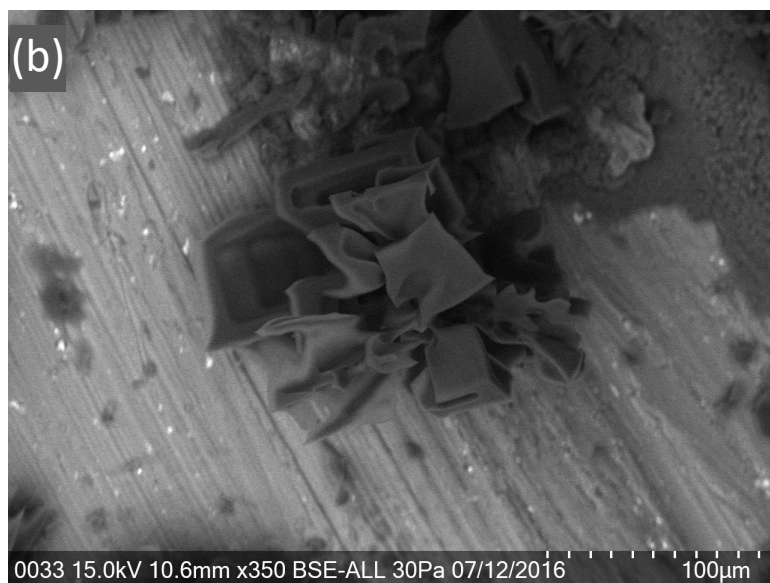
**Atmospheric conditions and particle collection context:** This ICE-Ball flight was collected through scattered cirrus uncinus, including cirrus spreading from contrails (10-12 km height, -45 to -60 C) over New Hope, PA. ICE-Ball was collecting in cirrus between 1920 – 1925Z. Five very long (500+ micron) columnar ice particles and many dry aerosol particles were collected. Three ice particles were moderately sublimated (panels a, b, e, f) and 2 others particles were highly sublimated (panels c, d). All ice particles showed very distinct mesoscopic roughening, including linear ridges along prism facets and complex and dendritic roughening patterns on scroll interiors and highly sublimated surfaces.





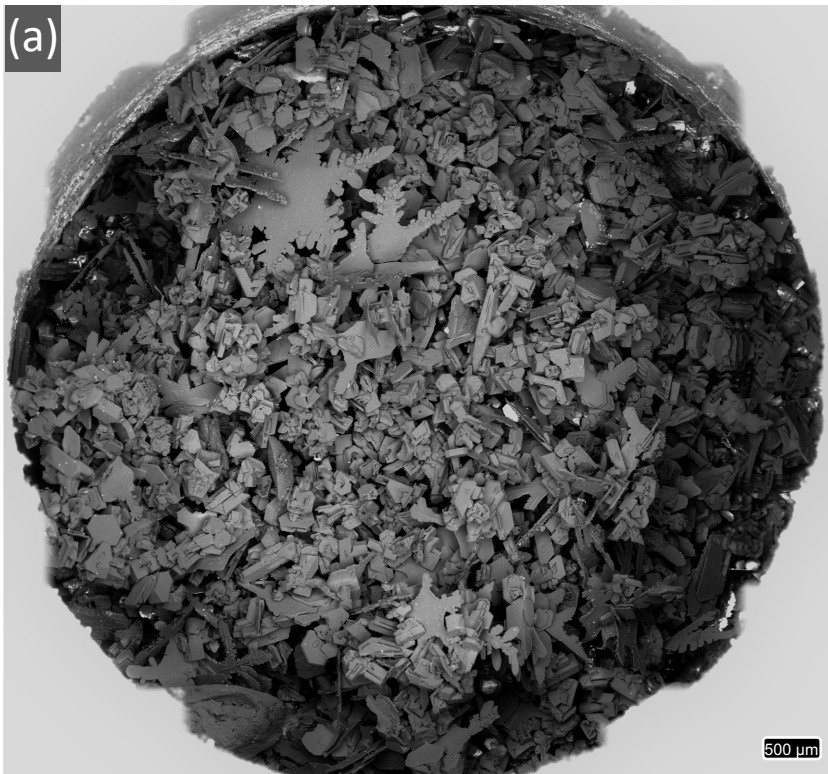
## C. ICE-Ball Flight: July 7, 2016

**Atmospheric conditions and particle collection context:** Ice-Ball flight sample #3. Collected in SE Pennsylvania, adjacent to moderate low-topped convection and overlying cirrus strands. Collection between 8 and 11 km, -30 to -45 C. Textured spheres (a), non-bulleted rosettes (b & e), corner-prortusions (c), tiered sheaths (d), and complex mineral aerosol particles were representative observations.



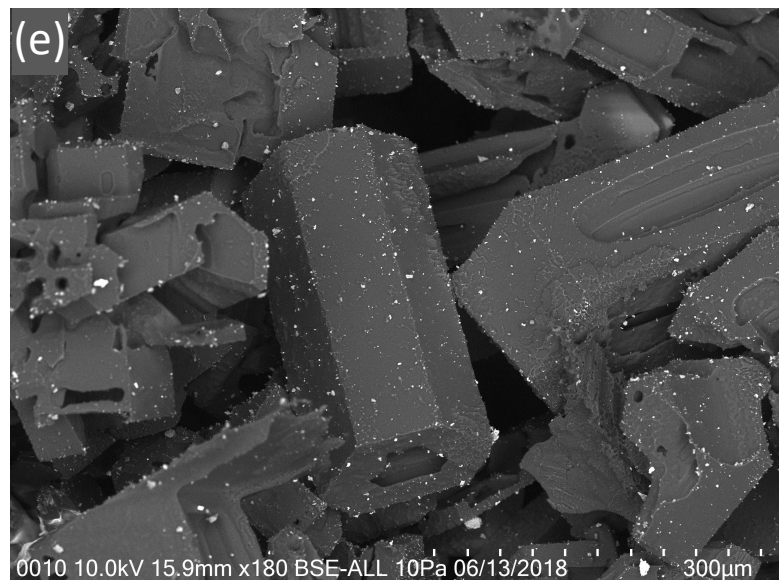
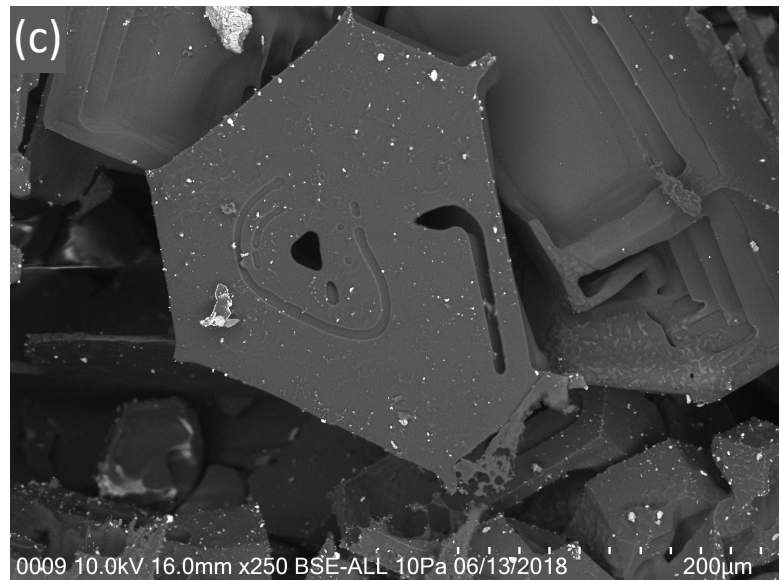


## D. ICE-Ball Flight: June 13, 2018



### Atmospheric conditions and particle collection context:

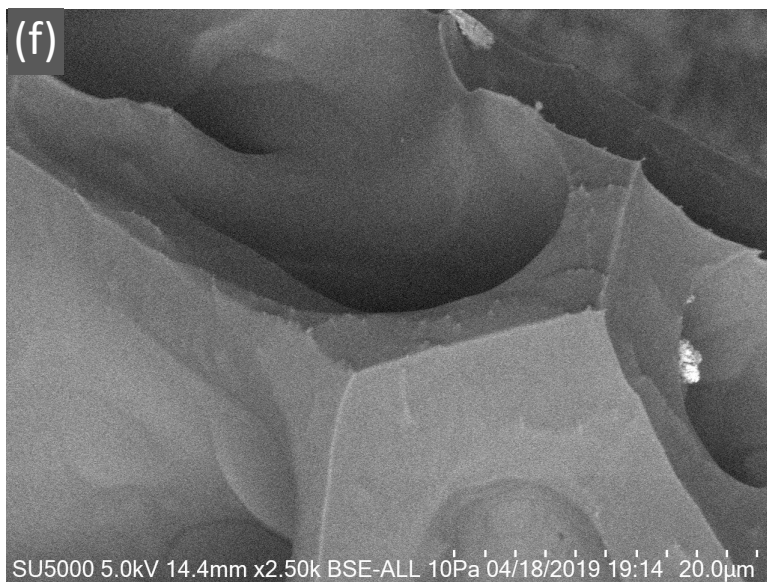
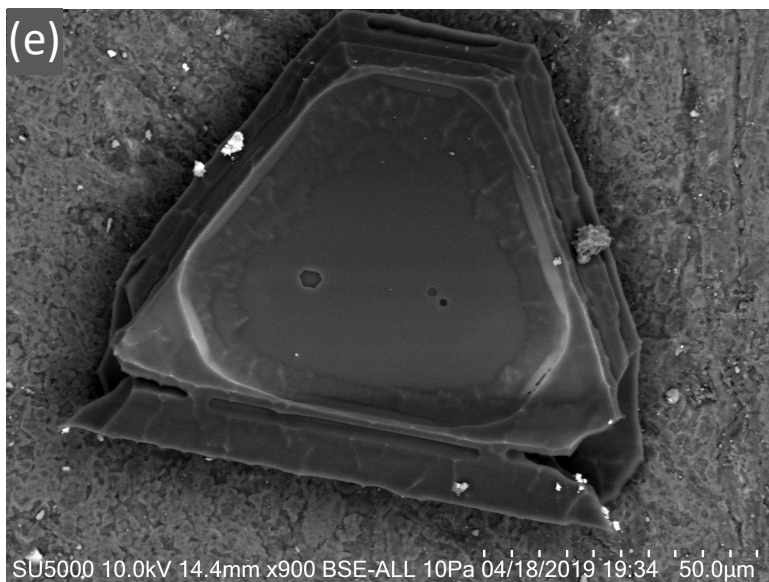
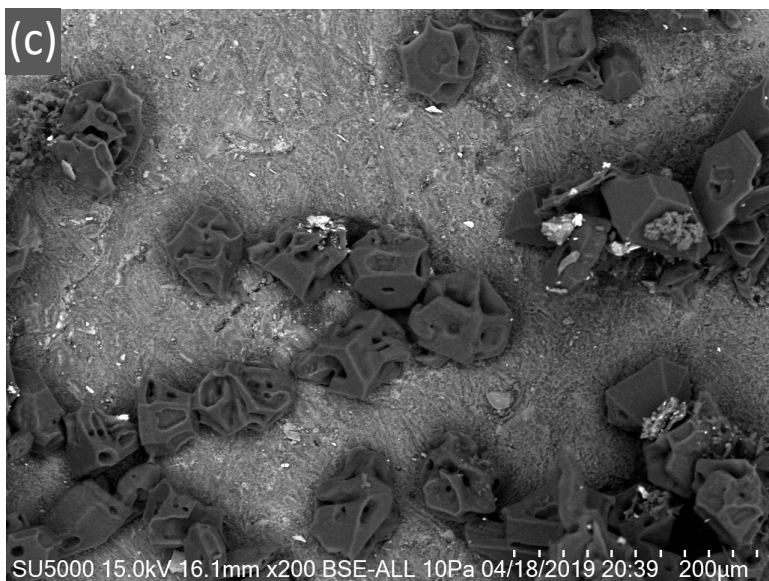
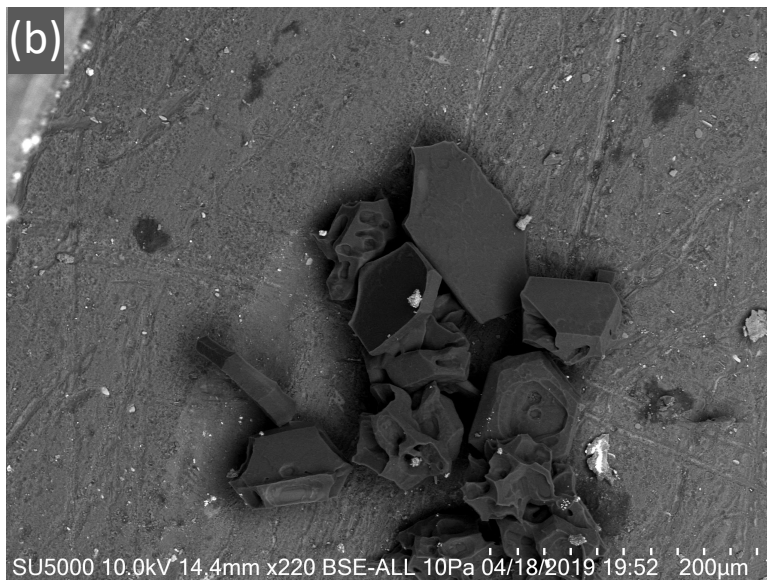
Ice-Ball flight ice sample #4. Collected from altostratus and cirrostratus layers, 6-10 km altitude over Levittown, PA. Instrument was in collection zone from Cloud temperatures from  $-18$  to  $-40^{\circ}\text{C}$ . An estimated  $10^5$  ice particles were collected in two separate capsules. Most particles show preferential plate-like aspect ratios and multi-angular polycrystals are common, though a few columnar crystals and several dendrites are present. Some crystals show evidence of regrown microfacets (eg see dendrite arm on panel b) Many particles show extensive coverage of aerosol particulate coverage (especially panels c, d, and e.). Air mass back trajectory and collection zone coincided with Ohio Valley and urban corridor of SE Pennsylvania.





## E. ICE-Ball Flight: April 18, 2019

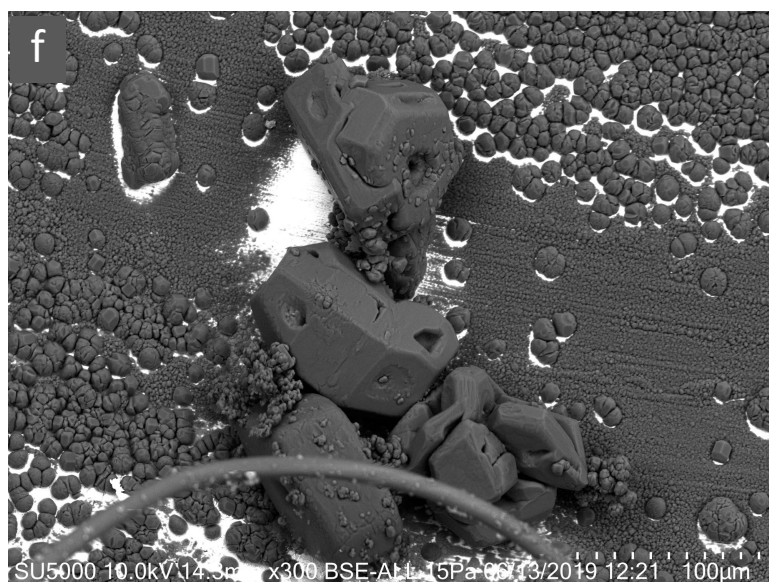
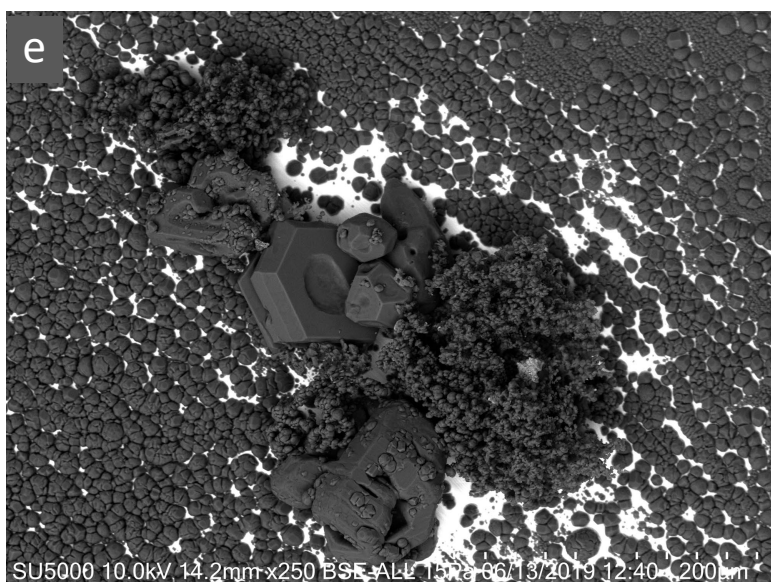
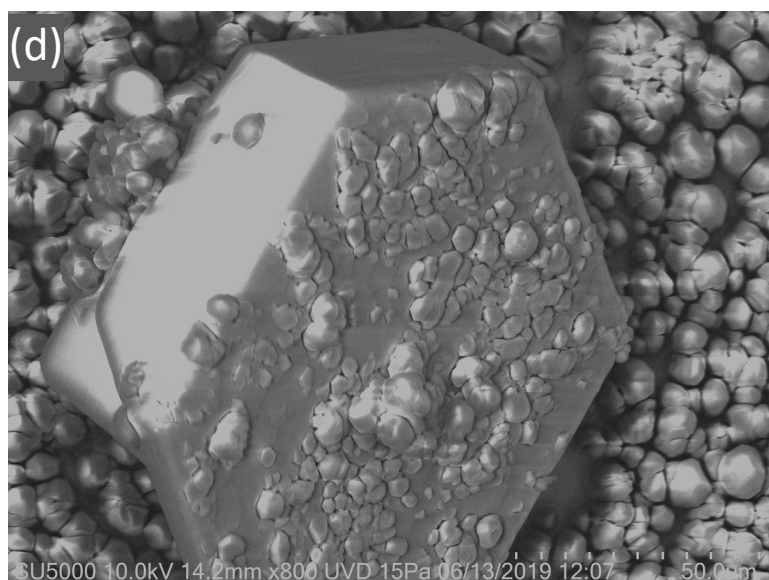
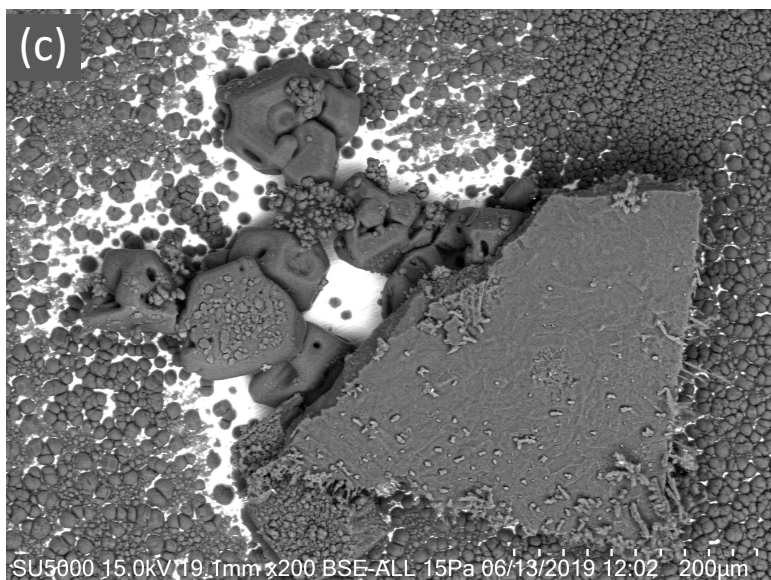
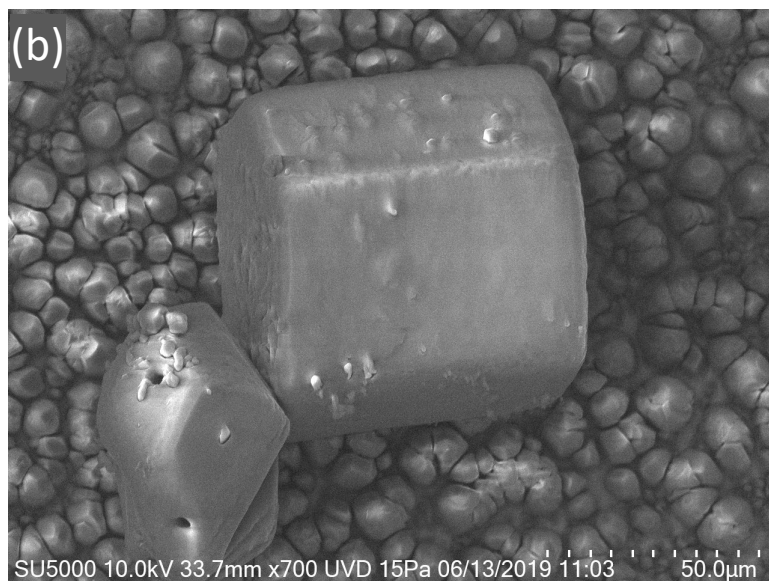
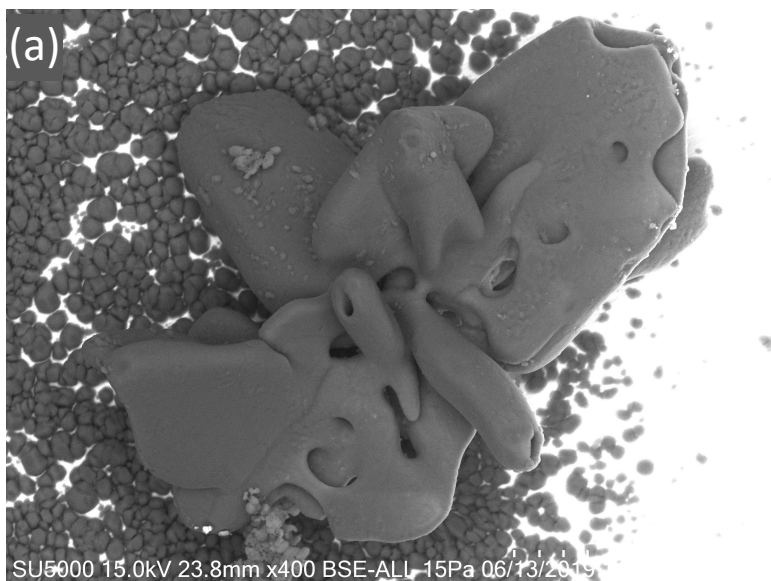
**Atmospheric conditions and particle collection context:** This ICE-Ball flight collected particles from a high, very thin ( $\tau < 1$ ) cirrostratus layer between 11-13 km and temperature of -55 to -65°C. Particle shapes are mostly compact single crystals, but the particles facets complex geometric angles that are typically not in simple hexagonal form. Facets also show evidence of sublimation, hollowing, and pitting, including mesoscopic roughening with no regular linear ridges (e.g. panels e and f).





## F. ICE-Ball Flight: June 6, 2019

**Atmospheric conditions and particle collection context:** This flight collected ice particles in very thin cirrus ( $\tau < 1$ ) at 9-11 km altitude in temperatures of -40 to -55°C over Norristown PA. Captured ice particles are primarily compact single crystals, though plate-like, columnar, pyramidal, and rosette forms are also seen. The transfer procedure accidentally exposed crystals to supersaturated vapor for several seconds, which resulted deposition of frost nodules on the stage background and some particle surfaces. This artifact prevents analysis of mesoscopic surface details on ice particles, but particle-scale morphology and complexity appears to be unaffected.





## G. ICE-Ball Flight: June 25, 2019

**Atmospheric conditions and particle collection context:** This ICE-Ball flight collected numerous ice particles through thin post-frontal cirrus at 1730-1735Z over Newtown, PA at an altitude of 11.5 –12.5 km and a temperature range from -40°C to -50°C. Approximately 2000 ice particles were collected in two separate capsules. This sample includes a mixture of rosettes, columns, and plates, including compact forms and others with moderately large aspect ratios. Notably, this sample appears to include several chain-like aggregates (e.g. panel b). The transfer procedure accidentally exposed crystals to supersaturated vapor for several seconds, which resulted in small deposition nodules on the stage background and some particle surfaces. This artifact prevents analysis of mesoscopic surface details on ice particles, but particle-scale morphology and complexity appears to be unaffected.

