Airborne Snow Observatory 2018 Recap & 2019 Plans

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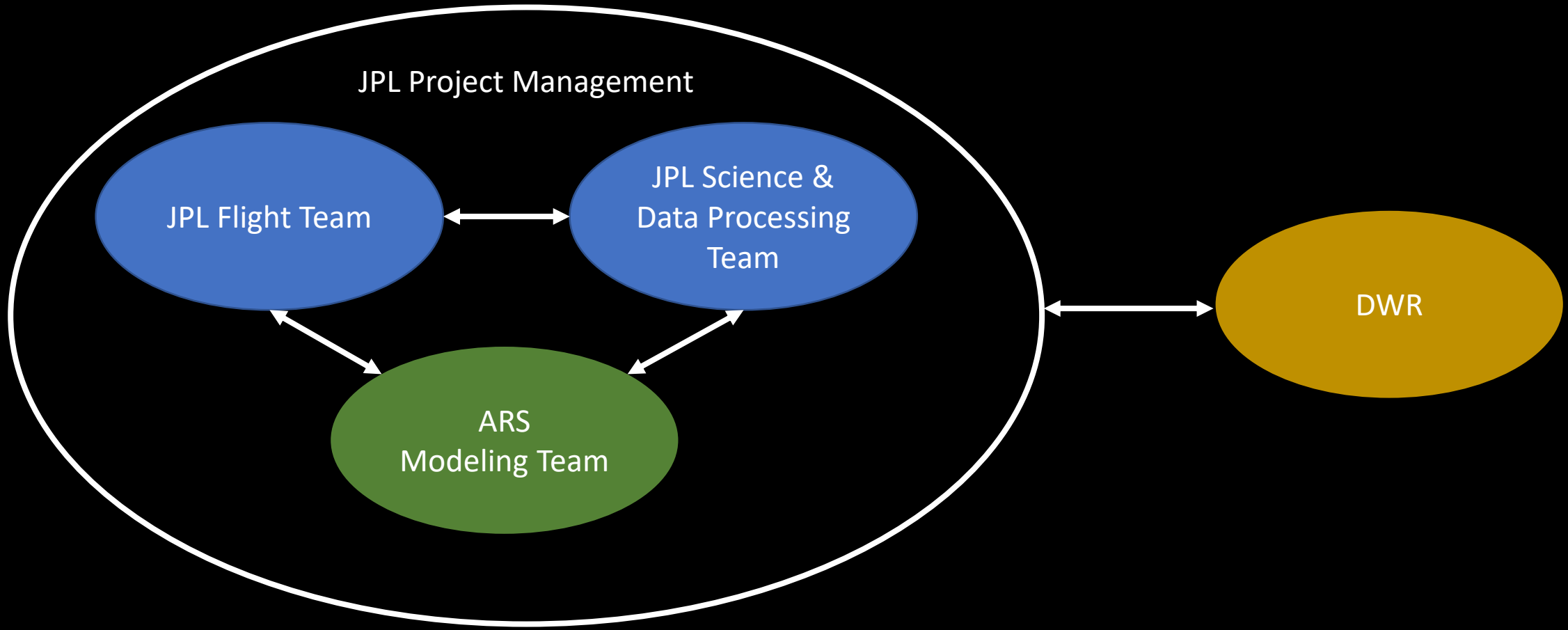
History of ASO program

- Considered in 2009
- Startup commitment by JPL in 2010
- Partnership with DWR initiated in 2011
- Funding committed by NASA in 2012
- First snow-free flights Aug 2012 (Tuolumne)
- First snow-on acquisition Apr 3 2013 (Tuolumne)
- First 24 hour turnaround late April 2013
- Expansion of California to include Lakes, Merced, Kings, Rush in 2014
- Expansion to include Cherry/Eleanor (2016) and San Joaquin (2017)
- 50th full Tuolumne acquisition (2018)
- 240 snow-on acquisitions by ASO (2013-2018)

ASO Team

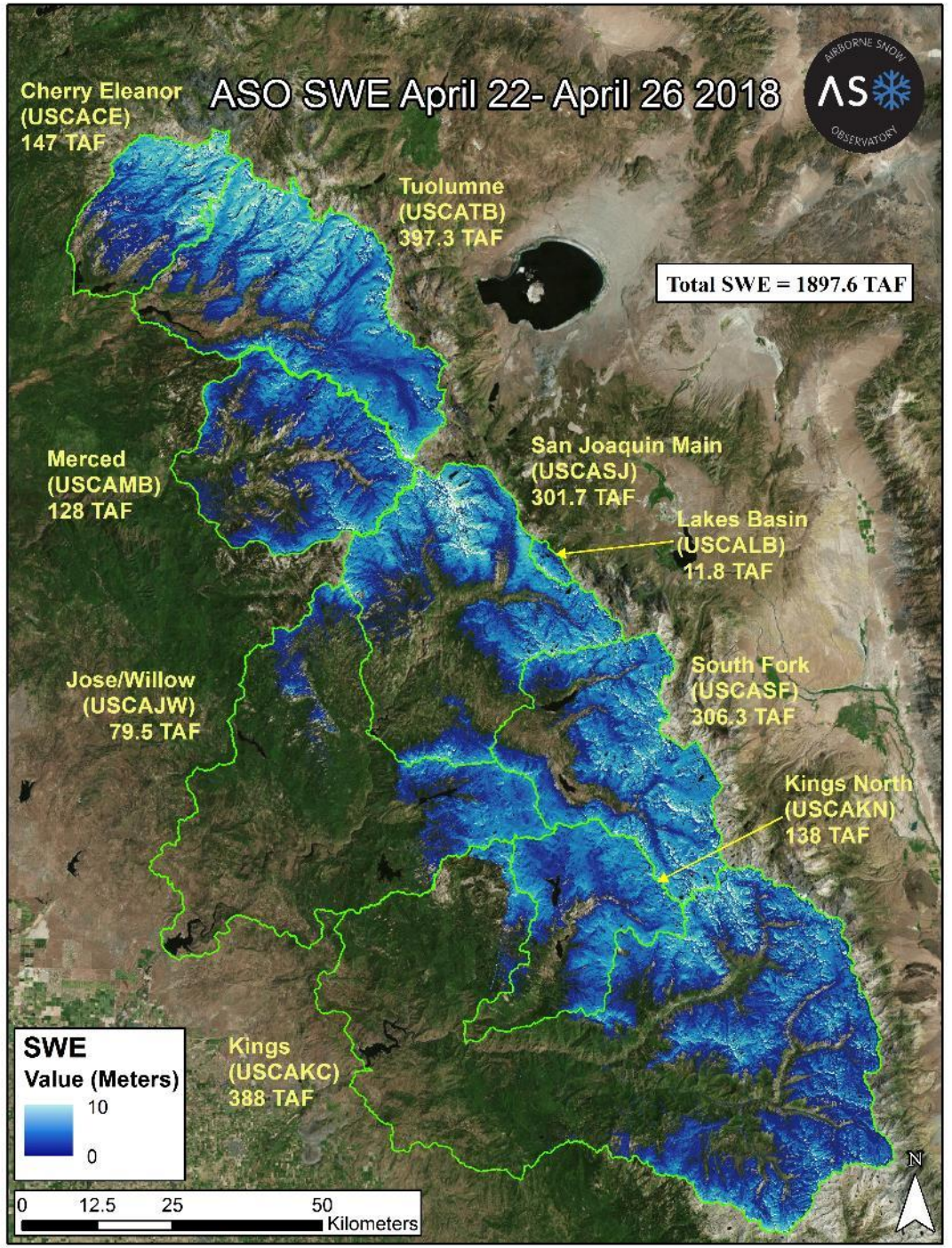
ASO is a partnership between NASA-Jet Propulsion Lab (JPL) and USDA Agricultural Research Service (ARS)



ASO California 2018

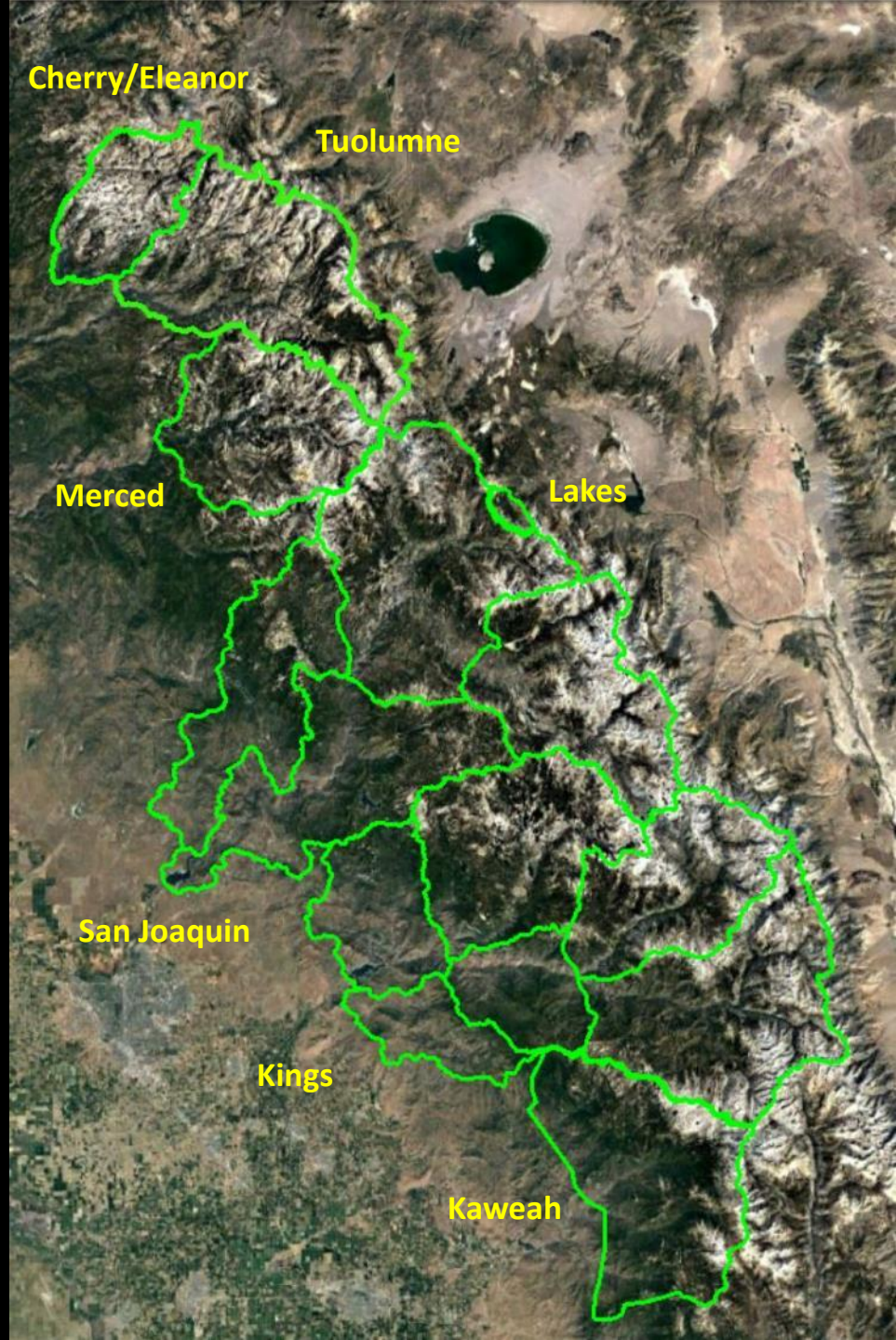
- 23 operational flights:
  - San Joaquin (March, April, June)
  - Tuolumne/Cherry/Eleanor (April, June)
  - Lakes (March, April, June)
  - Kings (Late April)
  - Merced (Late April)
- Data delivered in 2-7 days (average ~3-4 days)

- Other ASO 2018 work:
  - Kaweah bare-earth survey (September)
  - Gunnison, CO (April, late May)
  - High-resolution bare-earth surveys for US Forest Service Remote Sensing Lab
    - Plumas National Forest
    - Lake Tahoe Basin
    - Portions of Shasta-Trinity NF and Klamath NF

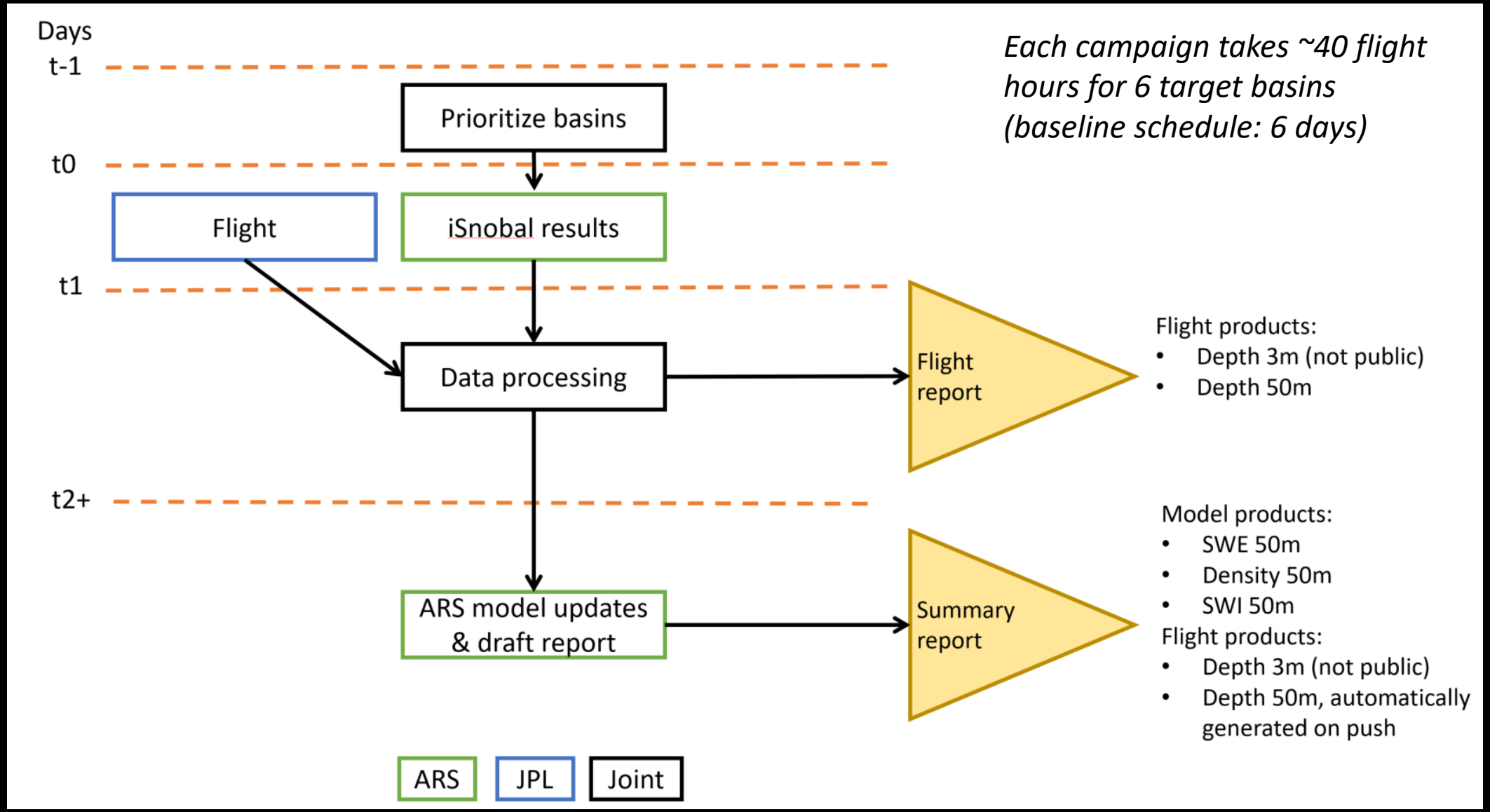


2019 Plans

- Targeted basins:
  - San Joaquin
  - Tuolumne/Cherry/Eleanor
  - Lakes
  - Kings
  - Merced
  - Kaweah (New for 2019)
- 4 monthly surveys (Feb 1, March 1, April 1, May 1) plus 2 “optional” flights
- Data delivery latency target: 2-3 days
- Scalability and real-time operations of ARS Automated Water Supply Model (AWSM)
- Evaluate hydrologic models for simulating streamflow given snowmelt from AWSM iSnobal
- Streamlined data delivery to CDEC and FERIX



2019 Workflow



Each campaign takes ~40 flight hours for 6 target basins (baseline schedule: 6 days)

Flight products:
- Depth 3m (not public)
- Depth 50m

Model products:
- SWE 50m
- Density 50m
- SWI 50m

Flight products:
- Depth 3m (not public)
- Depth 50m, automatically generated on push

Additional Developments

- ASO will begin flying a Ka-band radar altimeter in 2019 to provide snow depth measurement capability during cloud cover
- ASO team funded to explore utility of ASO data in the NOAA Colorado Basin River Forecast Center Snow-17 snowmelt runoff modeling
- NASA Snow Experiment (SnowEx) 2019 will be hosted in the Sierra Nevada to piggyback on the ASO program with CA DWR and the California Cooperative Snow Survey program + the Colorado Rockies to piggyback the program with Colorado Water Conservation Board work in the Gunnison and Uncompahgre and potentially the Blue River above Dillon Reservoir