Supplementary Materials

**Table S1.** Quality assessment conditions for each pixel based on QA Pixel quality band.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| QA interpretation | d.q | QA interpretation | d.q | QA interpretation | d.q |
| fill | 0 | clear\_water\_snow | 0 | fill\_clear\_cloudShadow\_cloud\_ccMedium | 0 |
| clear | 1 | fill\_clear\_water\_snow | 0 | water\_cloudShadow\_cloud\_ccMedium | 0 |
| fill\_clear | 1 | cloudShadow\_snow\_ccLow | 0 | fill\_water\_cloudShadow\_cloud\_ccMedium | 0 |
| water | 1 | fill\_cloudShadow\_snow\_ccLow | 0 | clear\_water\_cloudShadow\_cloud\_ccMedium | 0 |
| fill\_water | 1 | clear\_cloudShadow\_snow\_ccLow | 0 | fill\_clear\_water\_cloudShadow\_cloud\_ccMedium | 0 |
| clear\_water | 1 | fill\_clear\_cloudShadow\_snow\_ccLow | 0 | snow\_cloud\_ccMedium | 0 |
| fill\_clear\_water | 1 | water\_cloudShadow\_snow\_ccLow | 0 | fill\_snow\_cloud\_ccMedium | 0 |
| cloudShadow\_ccNone | 1 | fill\_water\_cloudShadow\_snow\_ccLow | 0 | clear\_snow\_cloud\_ccMedium | 0 |
| fill\_cloudShadow\_ccNone | 1 | clear\_water\_cloudShadow\_snow\_ccLow | 0 | fill\_clear\_snow\_cloud\_ccMedium | 0 |
| clear\_cloudShadow\_ccNone | 1 | fill\_clear\_water\_cloudShadow\_snow\_ccLow | 0 | water\_snow\_cloud\_ccMedium | 0 |
| fill\_clear\_cloudShadow\_ccNone | 1 | cloud\_ccLow | 1 | fill\_water\_snow\_cloud\_ccMedium | 0 |
| water\_cloudShadow\_ccNone | 0 | fill\_cloud\_ccLow | 1 | clear\_water\_snow\_cloud\_ccMedium | 0 |
| fill\_water\_cloudShadow\_ccNone | 0 | clear\_cloud\_ccLow | 1 | fill\_clear\_water\_snow\_cloud\_ccMedium | 0 |
| clear\_water\_cloudShadow\_ccNone | 1 | fill\_clear\_cloud\_ccLow | 1 | cloudShadow\_snow\_cloud\_ccMedium | 0 |
| fill\_clear\_water\_cloudShadow\_ccNone | 1 | water\_cloud\_ccLow | 1 | fill\_cloudShadow\_snow\_cloud\_ccMedium | 0 |
| snow | 0 | fill\_water\_cloud\_ccLow | 1 | clear\_cloudShadow\_snow\_cloud\_ccMedium | 0 |
| fill\_snow | 0 | clear\_water\_cloud\_ccLow | 1 | fill\_clear\_cloudShadow\_snow\_cloud\_ccMedium | 0 |
| clear\_snow | 0 | fill\_clear\_water\_cloud\_ccLow | 1 | water\_cloudShadow\_snow\_cloud\_ccMedium | 0 |
| fill\_clear\_snow | 0 | cloudShadow\_cloud\_ccLow | 0 | fill\_water\_cloudShadow\_snow\_cloud\_ccMedium | 0 |
| water\_snow | 0 | fill\_cloudShadow\_cloud\_ccLow | 0 | clear\_water\_cloudShadow\_snow\_cloud | 0 |
| fill\_water\_snow | 0 | clear\_cloudShadow\_cloud\_ccLow | 1 | fill\_clear\_water\_cloudShadow\_snow\_cloud\_ccMedium | 0 |
| clear\_water\_snow | 0 | fill\_clear\_cloudShadow\_cloud\_ccLow | 1 | ccHigh | 0 |
| fill\_clear\_water\_snow | 0 | water\_cloudShadow\_cloud\_ccLow | 0 | fill\_ccHigh | 0 |
| cloudShadow\_snow\_ccNone | 0 | fill\_water\_cloudShadow\_cloud\_ccLow | 0 | clear\_ccHigh | 1 |
| fill\_cloudShadow\_snow\_ccNone | 0 | clear\_water\_cloudShadow\_cloud\_ccLow | 1 | fill\_clear\_ccHigh | 1 |
| clear\_cloudShadow\_snow\_ccNone | 0 | fill\_clear\_water\_cloudShadow\_cloud\_ccLow | 1 | water\_ccHigh | 0 |
| fill\_clear\_cloudShadow\_snow\_ccNone | 0 | snow\_cloud\_ccLow | 0 | fill\_water\_ccHigh | 0 |
| water\_cloudShadow\_snow\_ccNone | 0 | fill\_snow\_cloud\_ccLow | 0 | clear\_water\_ccHigh | 1 |
| fill\_water\_cloudShadow\_snow\_ccNone | 0 | clear\_snow\_cloud\_ccLow | 0 | fill\_clear\_water\_ccHigh | 1 |
| clear\_water\_cloudShadow\_snow\_ccNone | 0 | fill\_clear\_snow\_cloud\_ccLow | 0 | cloudShadow\_ccHigh | 0 |
| fill\_clear\_water\_cloudShadow\_snow\_ccNone | 0 | water\_snow\_cloud\_ccLow | 0 | fill\_cloudShadow\_ccHigh | 0 |
| cloud\_ccNone | 1 | fill\_water\_snow\_cloud\_ccLow | 0 | clear\_cloudShadow\_ccHigh | 0 |
| fill\_cloud\_ccNone | 1 | clear\_water\_snow\_cloud\_ccLow | 0 | fill\_clear\_cloudShadow\_ccHigh | 0 |
| clear\_cloud\_ccNone | 1 | fill\_clear\_water\_snow\_cloud\_ccLow | 0 | water\_cloudShadow\_ccHigh | 0 |
| fill\_clear\_cloud\_ccNone | 1 | cloudShadow\_snow\_cloud\_ccLow | 0 | fill\_water\_cloudShadow\_ccHigh | 0 |
| water\_cloud\_ccNone | 1 | fill\_cloudShadow\_snow\_cloud\_ccLow | 0 | clear\_water\_cloudShadow\_ccHigh | 0 |
| fill\_water\_cloud\_ccNone | 1 | clear\_cloudShadow\_snow\_cloud\_ccLow | 0 | fill\_clear\_water\_cloudShadow\_ccHigh | 0 |
| clear\_water\_cloud\_ccNone | 1 | fill\_clear\_cloudShadow\_snow\_cloud\_ccLow | 0 | snow\_ccHigh | 0 |
| fill\_clear\_water\_cloud\_ccNone | 1 | water\_cloudShadow\_snow\_cloud\_ccLow | 0 | fill\_snow\_ccHigh | 0 |
| cloudShadow\_cloud\_ccNone | 0 | fill\_water\_cloudShadow\_snow\_cloud\_cloudConf | 0 | clear\_snow\_ccHigh | 0 |
| fill\_cloudShadow\_cloud\_ccNone | 0 | clear\_water\_cloudShadow\_snow\_cloud\_ccLow | 0 | fill\_clear\_snow\_ccHigh | 0 |
| clear\_cloudShadow\_cloud\_ccNone | 1 | fill\_clear\_water\_cloudShadow\_snow\_cloud\_ccLow | 0 | water\_snow\_ccHigh | 0 |
| fill\_clear\_cloudShadow\_cloud\_ccNone | 1 | ccMedium | 0 | fill\_water\_snow\_ccHigh | 0 |
| water\_cloudShadow\_cloud\_ccNone | 0 | fill\_ccMedium | 0 | clear\_water\_snow\_ccHigh | 0 |
| fill\_water\_cloudShadow\_cloud\_ccNone | 0 | clear\_ccMedium | 1 | fill\_clear\_water\_snow\_ccHigh | 0 |
| clear\_water\_cloudShadow\_cloud\_ccNone | 1 | fill\_clear\_ccMedium | 1 | cloudShadow\_snow\_ccHigh | 0 |
| fill\_clear\_water\_cloudShadow\_cloud\_ccNone | 1 | water\_ccMedium | 0 | fill\_cloudShadow\_snow\_ccHigh | 0 |
| snow\_cloud\_ccNone | 0 | fill\_water\_ccMedium | 0 | clear\_cloudShadow\_snow\_ccHigh | 0 |
| fill\_snow\_cloud\_ccNone | 0 | clear\_water\_ccMedium | 1 | fill\_clear\_cloudShadow\_snow\_ccHigh | 0 |
| clear\_snow\_cloud\_ccNone | 0 | fill\_clear\_water\_ccMedium | 1 | water\_cloudShadow\_snow\_ccHigh | 0 |
| fill\_clear\_snow\_cloud\_ccNone | 0 | cloudShadow\_ccMedium | 0 | fill\_water\_cloudShadow\_snow\_ccHigh | 0 |
| water\_snow\_cloud\_ccNone | 0 | fill\_cloudShadow\_ccMedium | 0 | clear\_water\_cloudShadow\_snow\_ccHigh | 0 |
| fill\_water\_snow\_cloud\_ccNone | 0 | clear\_cloudShadow\_ccMedium | 0 | fill\_clear\_water\_cloudShadow\_snow\_ccHigh | 0 |
| clear\_water\_snow\_cloud\_ccNone | 0 | fill\_clear\_cloudShadow\_ccMedium | 0 | cloud\_ccHigh | 0 |
| fill\_clear\_water\_snow\_cloud\_ccNone | 0 | water\_cloudShadow\_ccMedium | 0 | fill\_cloud\_ccHigh | 0 |
| cloudShadow\_snow\_cloud\_ccNone | 0 | fill\_water\_cloudShadow\_ccMedium | 0 | clear\_cloud\_ccHigh | 0 |
| fill\_cloudShadow\_snow\_cloud\_ccNone | 0 | clear\_water\_cloudShadow\_ccMedium | 0 | fill\_clear\_cloud\_ccHigh | 0 |
| clear\_cloudShadow\_snow\_cloud\_ccNone | 0 | fill\_clear\_water\_cloudShadow\_ccMedium | 0 | water\_cloud\_ccHigh | 0 |
| fill\_clear\_cloudShadow\_snow\_cloud\_ccNone | 0 | snow\_ccMedium | 0 | fill\_water\_cloud\_ccHigh | 0 |
| water\_cloudShadow\_snow\_cloud\_ccNone | 0 | fill\_snow\_ccMedium | 0 | clear\_water\_cloud\_ccHigh | 0 |
| fill\_water\_cloudShadow\_snow\_cloud\_ccNone | 0 | clear\_snow\_ccMedium | 0 | fill\_clear\_water\_cloud\_ccHigh | 0 |
| clear\_water\_cloudShadow\_snow\_cloud\_ccNone | 0 | fill\_clear\_snow\_ccMedium | 0 | cloudShadow\_cloud\_ccHigh | 0 |
| fill\_clear\_water\_cloudShadow\_snow\_cloud\_ccNone | 0 | water\_snow\_ccMedium | 0 | fill\_cloudShadow\_cloud\_ccHigh | 0 |
| ccLow | 1 | fill\_water\_snow\_ccMedium | 0 | clear\_cloudShadow\_cloud\_ccHigh | 0 |
| fill\_ccLow | 1 | clear\_water\_snow\_ccMedium | 0 | fill\_clear\_cloudShadow\_cloud\_ccHigh | 0 |
| clear\_ccLow | 1 | fill\_clear\_water\_snow\_ccMedium | 0 | water\_cloudShadow\_cloud\_ccHigh | 0 |
| fill\_clear\_ccLow | 1 | cloudShadow\_snow\_ccMedium | 0 | fill\_water\_cloudShadow\_cloud\_ccHigh | 0 |
| water\_ccLow | 1 | fill\_cloudShadow\_snow\_ccMedium | 0 | clear\_water\_cloudShadow\_cloud\_ccHigh | 0 |
| fill\_water\_ccLow | 1 | clear\_cloudShadow\_snow\_ccMedium | 0 | fill\_clear\_water\_cloudShadow\_cloud\_ccHigh | 0 |
| clear\_water\_ccLow | 1 | fill\_clear\_cloudShadow\_snow\_ccMedium | 0 | snow\_cloud\_ccHigh | 0 |
| fill\_clear\_water\_ccLow | 1 | water\_cloudShadow\_snow\_ccMedium | 0 | fill\_snow\_cloud\_ccHigh | 0 |
| cloudShadow\_ccLow | 0 | fill\_water\_cloudShadow\_snow\_ccMedium | 0 | clear\_snow\_cloud\_ccHigh | 0 |
| fill\_cloudShadow\_ccLow | 0 | clear\_water\_cloudShadow\_snow\_ccMedium | 0 | fill\_clear\_snow\_cloud\_ccHigh | 0 |
| clear\_cloudShadow\_ccLow | 1 | fill\_clear\_water\_cloudShadow\_snow\_ccMedium | 0 | water\_snow\_cloud\_ccHigh | 0 |
| fill\_clear\_cloudShadow\_ccLow | 1 | cloud\_ccMedium | 0 | fill\_water\_snow\_cloud\_ccHigh | 0 |
| water\_cloudShadow\_ccLow | 0 | fill\_cloud\_ccMedium | 0 | clear\_water\_snow\_cloud\_ccHigh | 0 |
| fill\_water\_cloudShadow\_ccLow | 0 | clear\_cloud\_ccMedium | 1 | fill\_clear\_water\_snow\_cloud\_ccHigh | 0 |
| clear\_water\_cloudShadow\_ccLow | 1 | fill\_clear\_cloud\_ccMedium | 1 | cloudShadow\_snow\_cloud\_ccHigh | 0 |
| fill\_clear\_water\_cloudShadow\_ccLow | 1 | water\_cloud\_ccMedium | 0 | fill\_cloudShadow\_snow\_cloud\_ccHigh | 0 |
| snow | 0 | fill\_water\_cloud\_ccMedium | 0 | clear\_cloudShadow\_snow\_cloud\_ccHigh | 0 |
| fill\_snow | 0 | clear\_water\_cloud\_ccMedium | 0 | fill\_clear\_cloudShadow\_snow\_cloud\_ccHigh | 0 |
| clear\_snow | 0 | fill\_clear\_water\_cloud\_ccMedium | 0 | water\_cloudShadow\_snow\_cloud\_ccHigh | 0 |
| fill\_clear\_snow | 0 | cloudShadow\_cloud\_ccMedium | 0 | fill\_water\_cloudShadow\_snow\_cloud\_ccHigh | 0 |
| water\_snow | 0 | fill\_cloudShadow\_cloud\_ccMedium | 0 | clear\_water\_cloudShadow\_snow\_cloud\_ccHigh | 0 |
| fill\_water\_snow | 0 | clear\_cloudShadow\_cloud\_ccMedium | 0 | fill\_clear\_water\_cloudShadow\_snow\_cloud\_ccHigh | 0 |

**\*Notes:** “\_” = and, dq = Desired quality of pixel, cloudShadow = Cloud shadow confidence, ccHigh = Cloud confidence high, ccMedium = Cloud confidence medium, ccLow = Cloud confidence low, ccNone = No cloud confidence, cloud = Cloud in pixel snow = snow/ice confidence, clear = Clear terrain, fill = Designated fill, water = Waterbody. Here the desired quality value “0” means this condition did not exist and “1” means this condition exists in our case (Table 2).