Icelandic Met Office

The impact of climate change on glaciers and glacial runoff in Iceland

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Hydrology and glaciers of Iceland

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Meteorological conditions

- Maritime climate
  - Mild winters and cool summers
  - Frequent changes in meteorological conditions during all seasons
  - Relatively high precipitation

Glaciers

- 11% of the country covered with glaciers
- Glaciers store the equivalent of 15–20 years of annual average precipitation over the whole country
- Receive about 20% of the total annual precipitation of the country

Hydrology

- Snow storage during winter
- Spring floods
- Late summer glacier melt peak in glacier rivers
- Large groundwater effects

Effects of glaciers and hydrology on infrastructure and society

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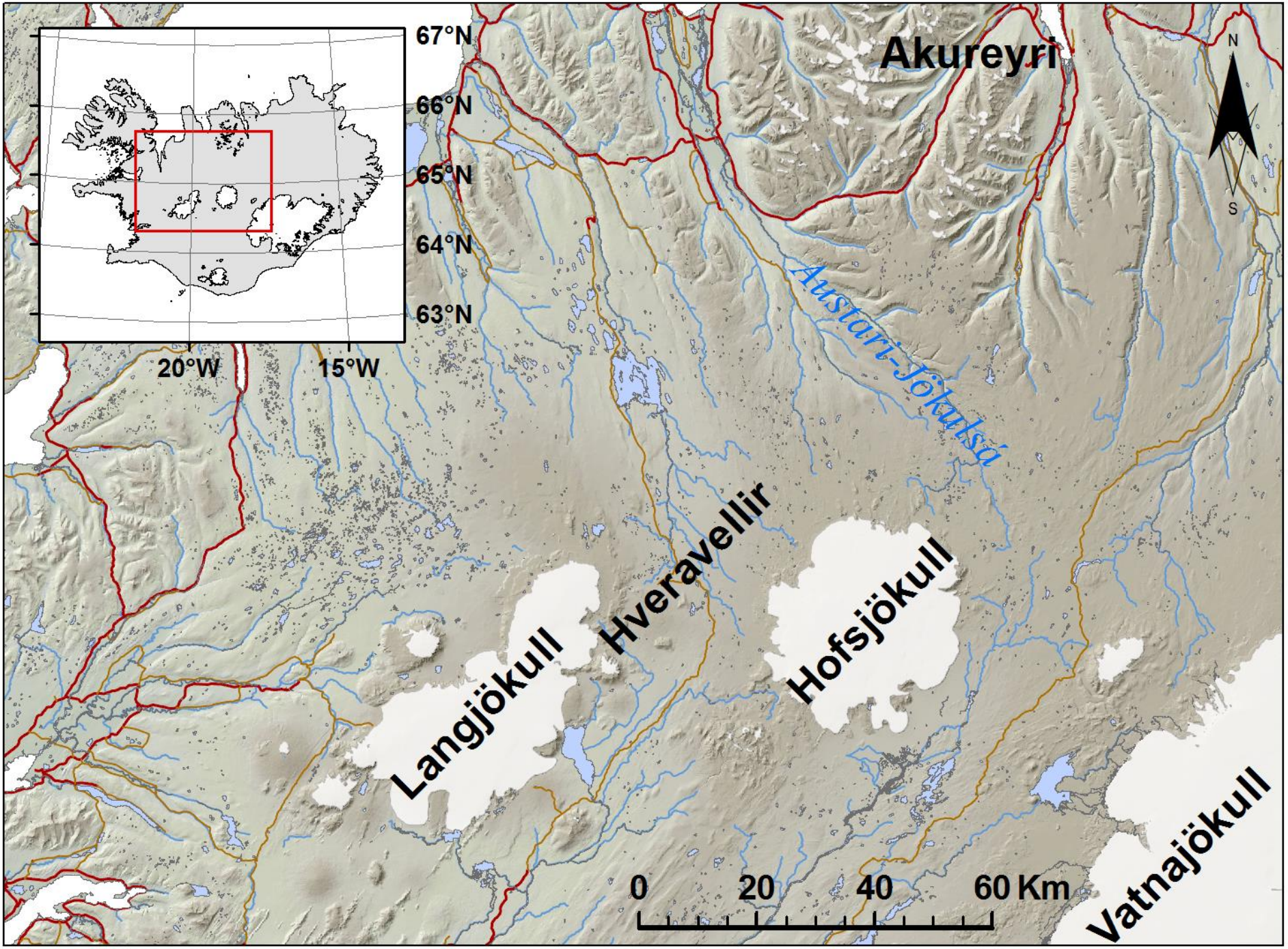
Runoff and glacier changes are important for the design and operation of:

- hydroelectric power plants
- transportation
- tourism
- other utilization of water

Impacts of climate change on glaciers, hydrology, hydro-resources and energy systems explored in:

- CES (Climate and Energy Systems), http://en.vedur.is/ces
- LOKS (Loftslagsbreytingar og áhrif þeirra á orkukerfi og samgöngur), http://www.vedur.is/loks
- SVALI (Stability and Variations of Artic Land Ice), http://www.ncoe-svali.org/


67°N
66°N
65°N
64°N
63°N
20°W
15°W
Akureyri
N
S
Austari-Jökulsá
Hveravellir
Langjökull
Hofsjökull
Vatnajökull
0
20
40
60 Km

Past temperatures and predicted climate changes

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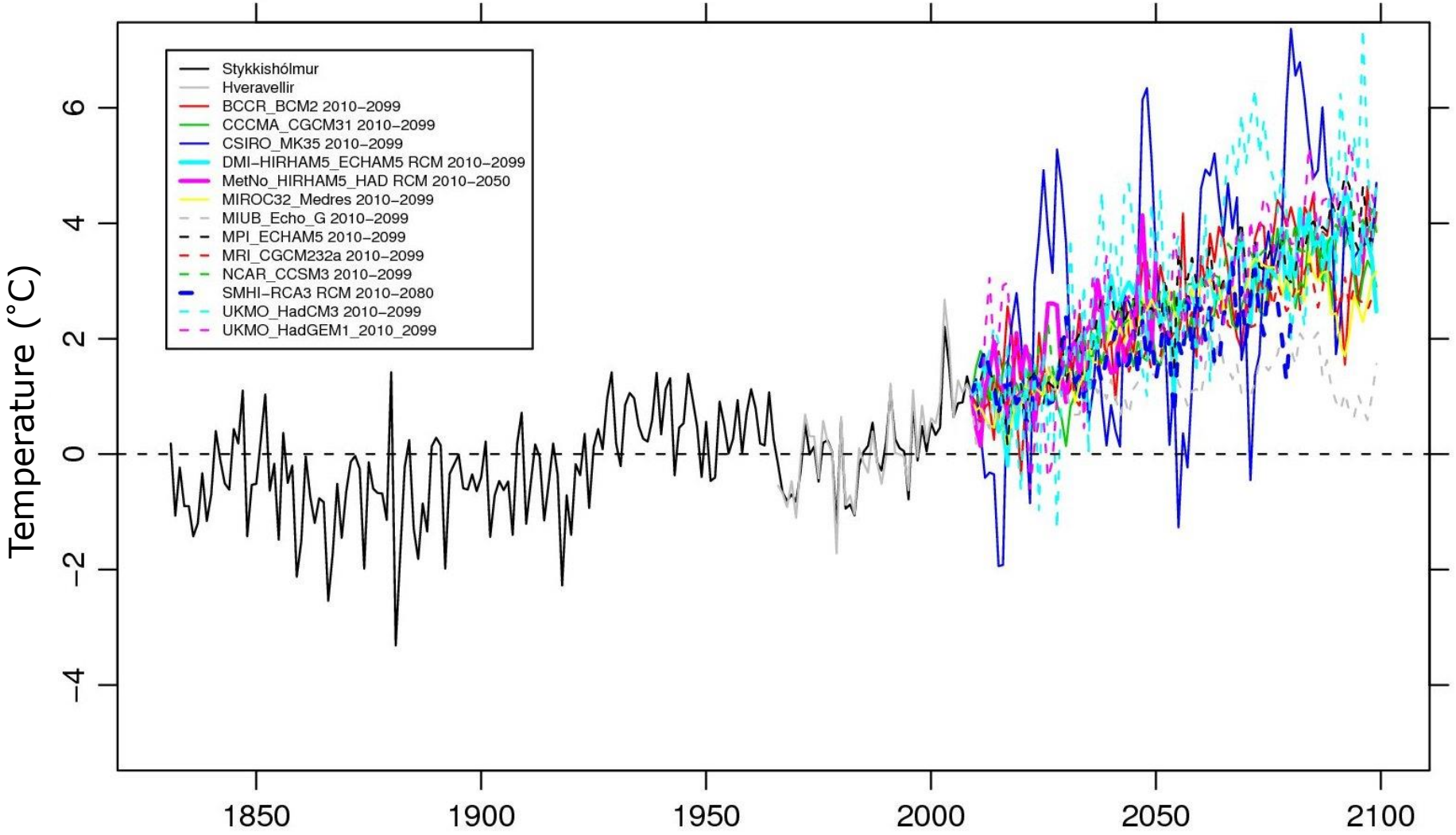

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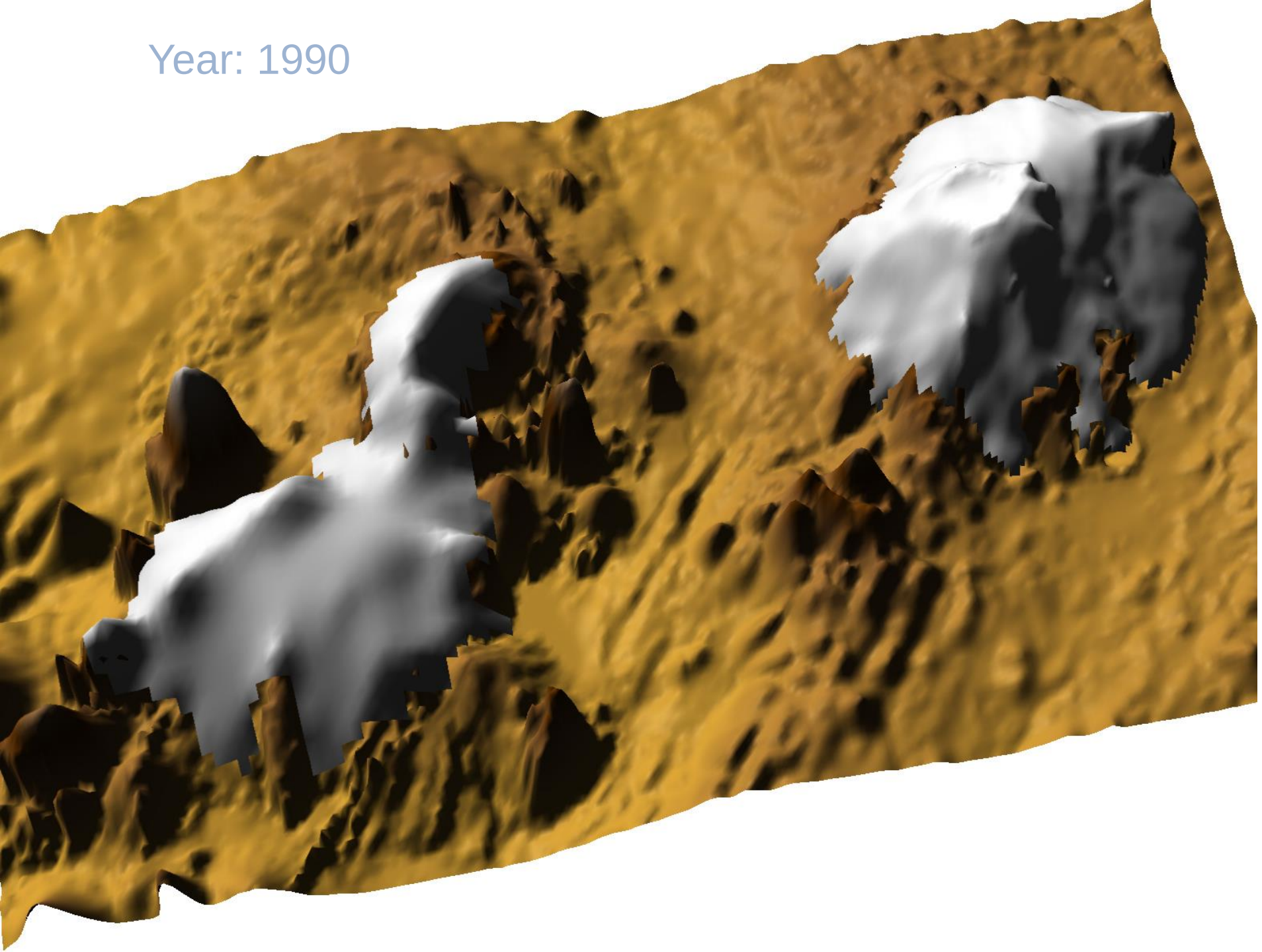

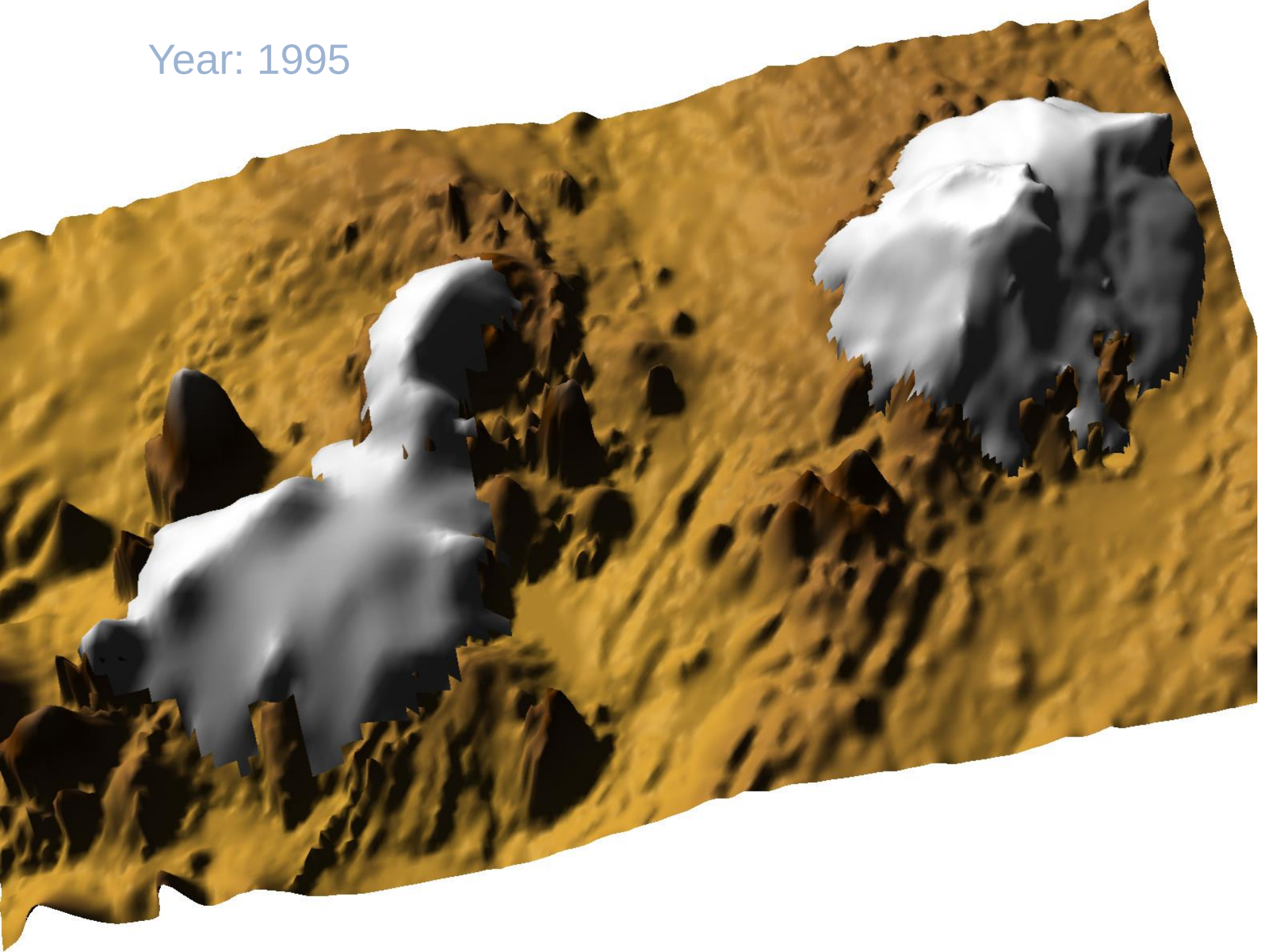
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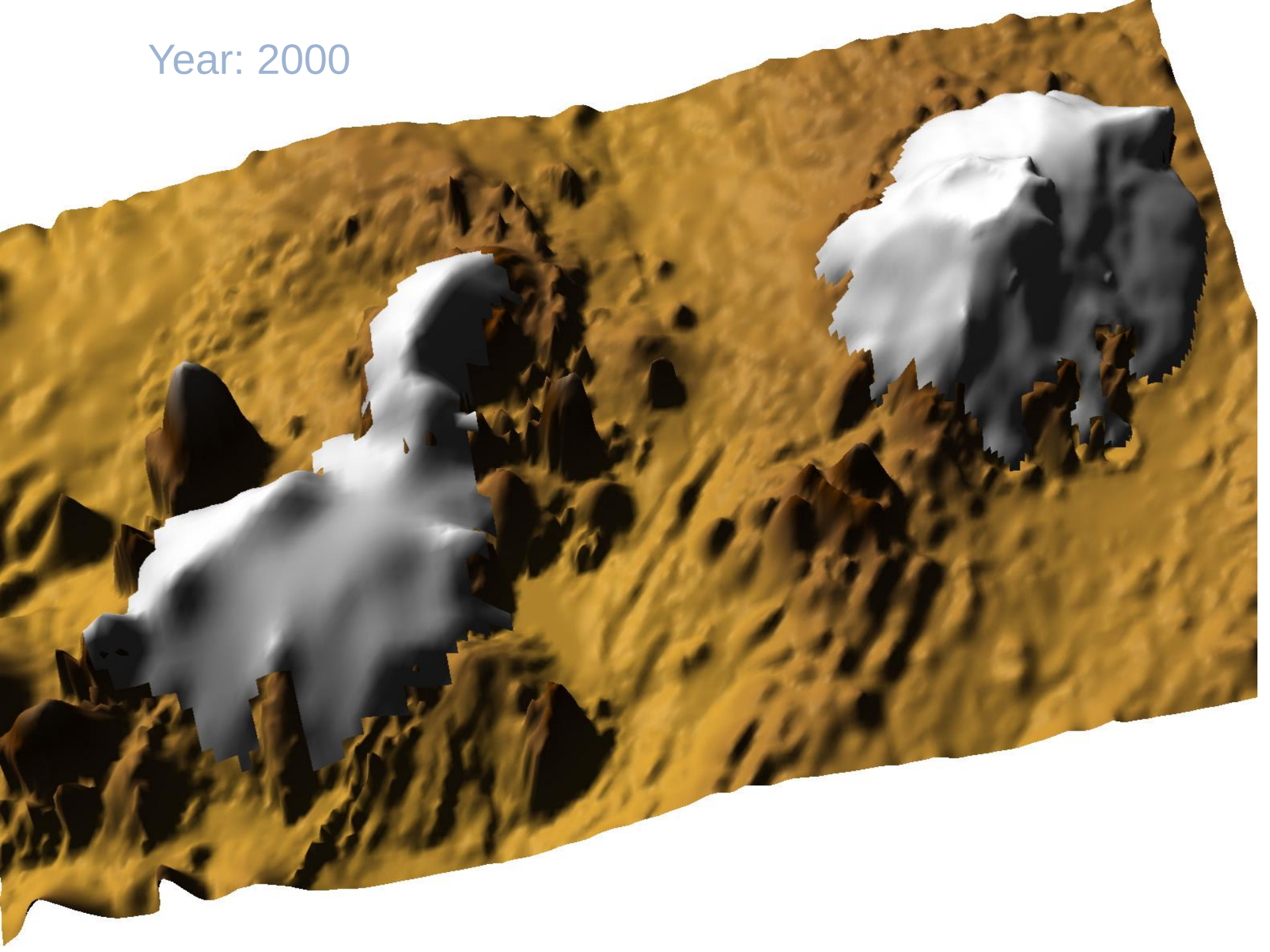
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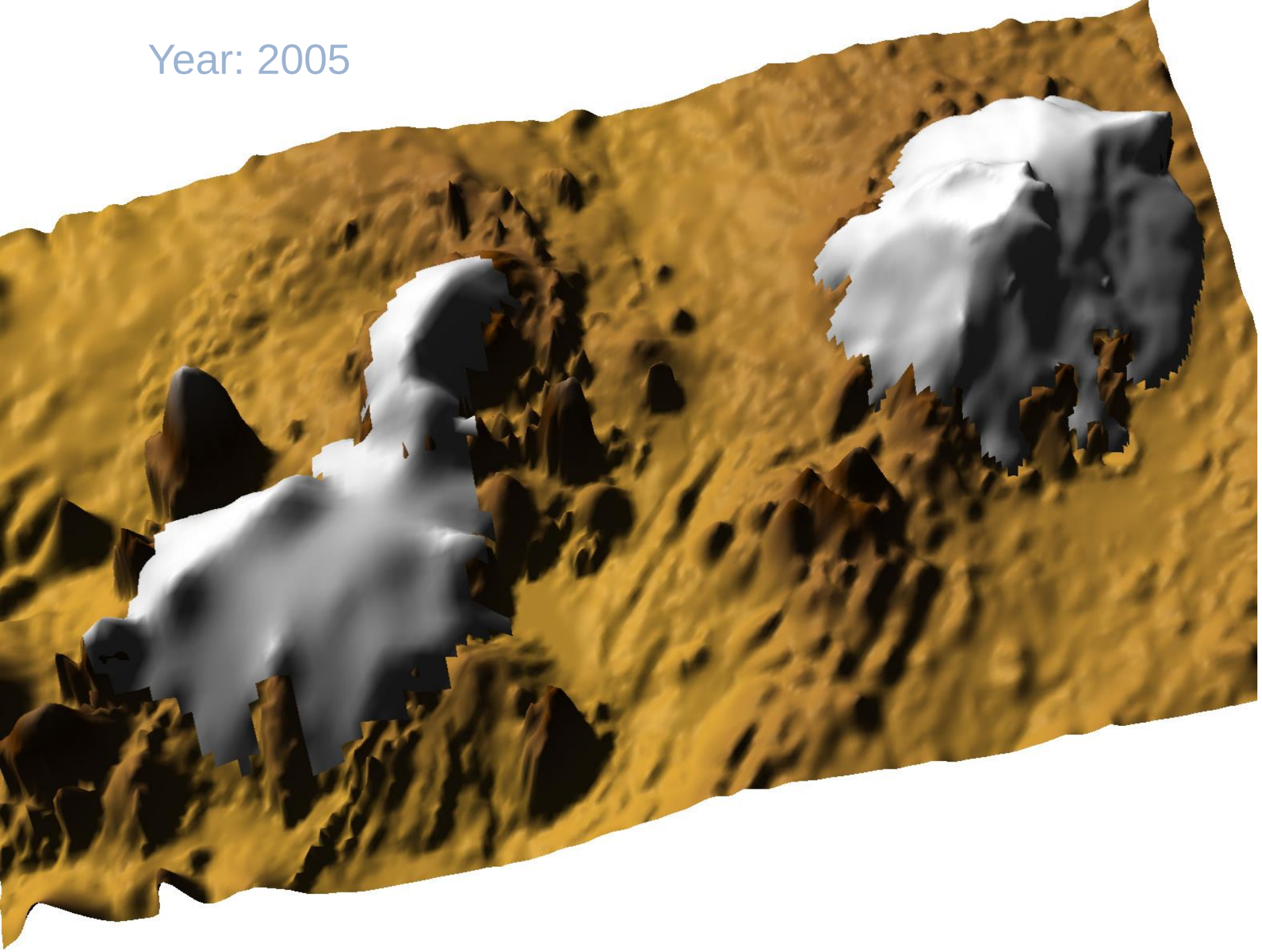

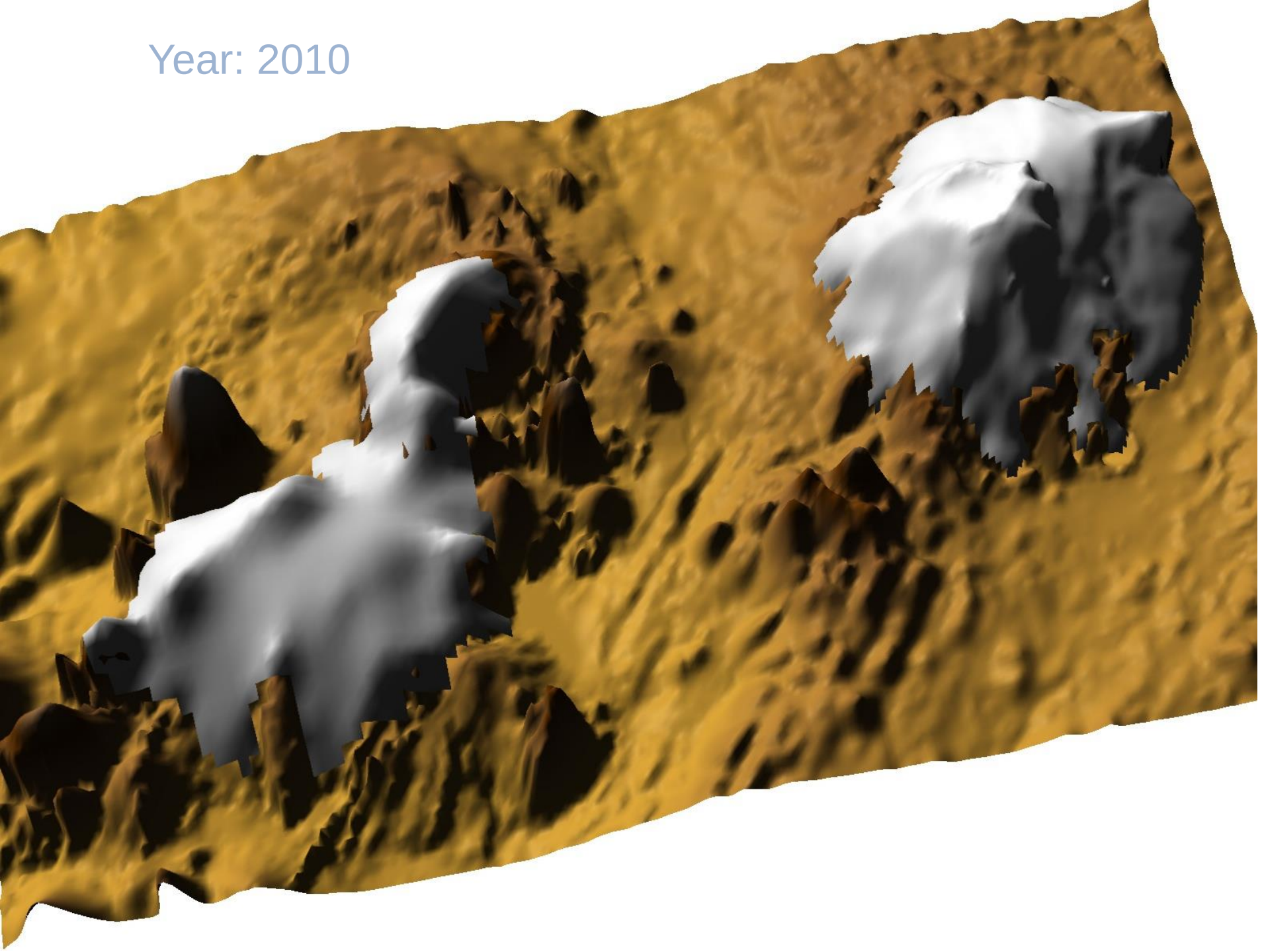
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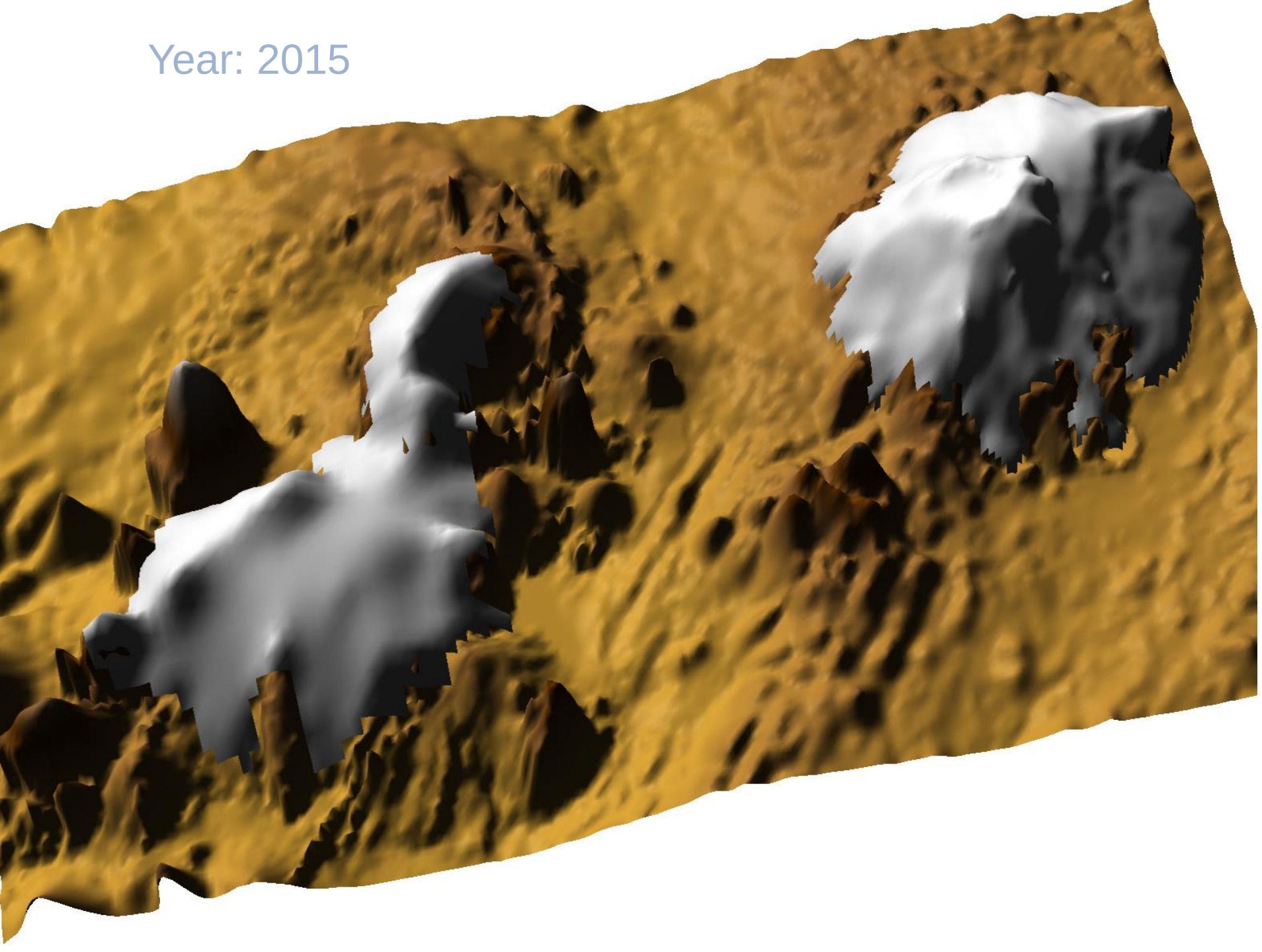

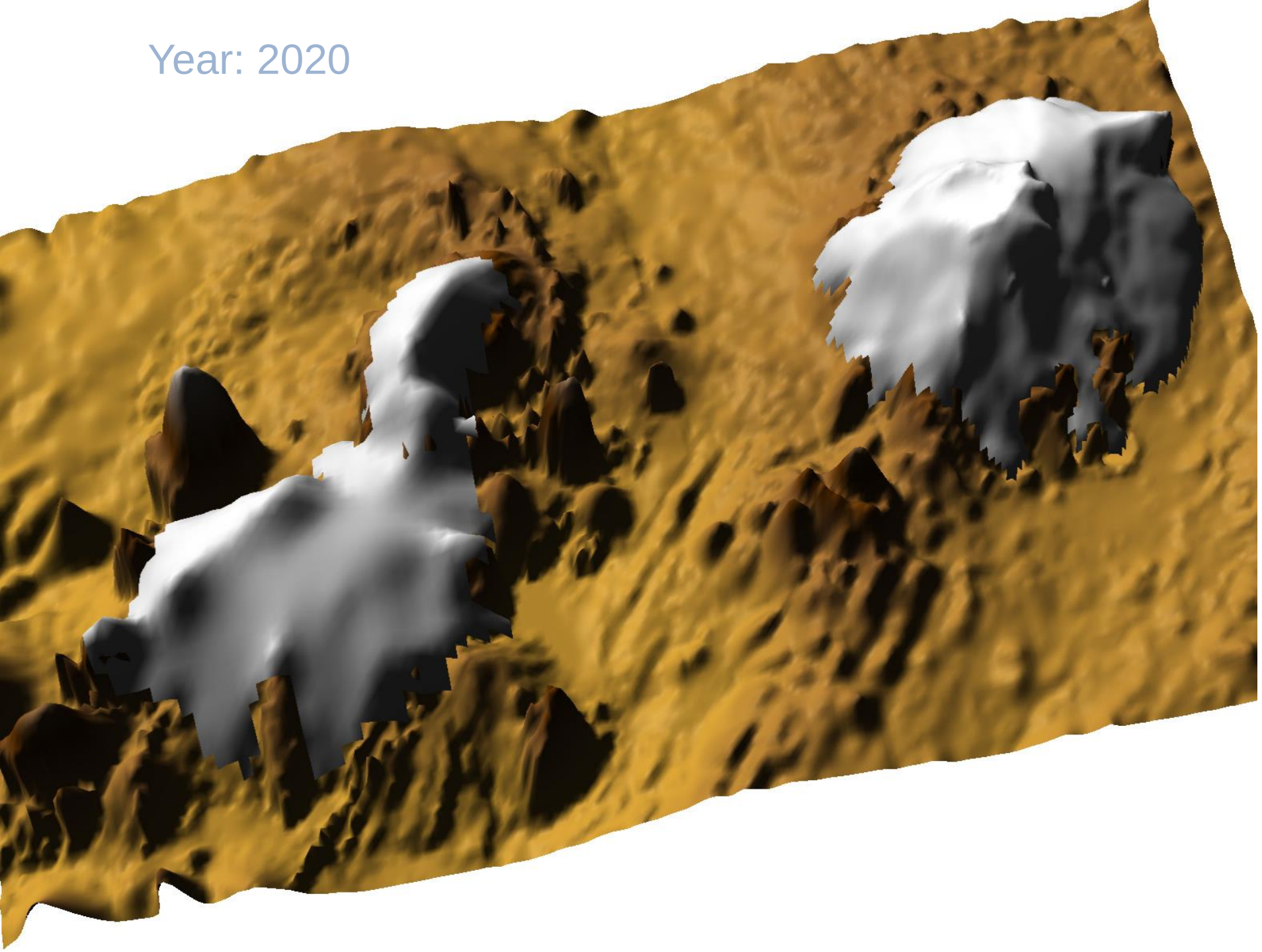
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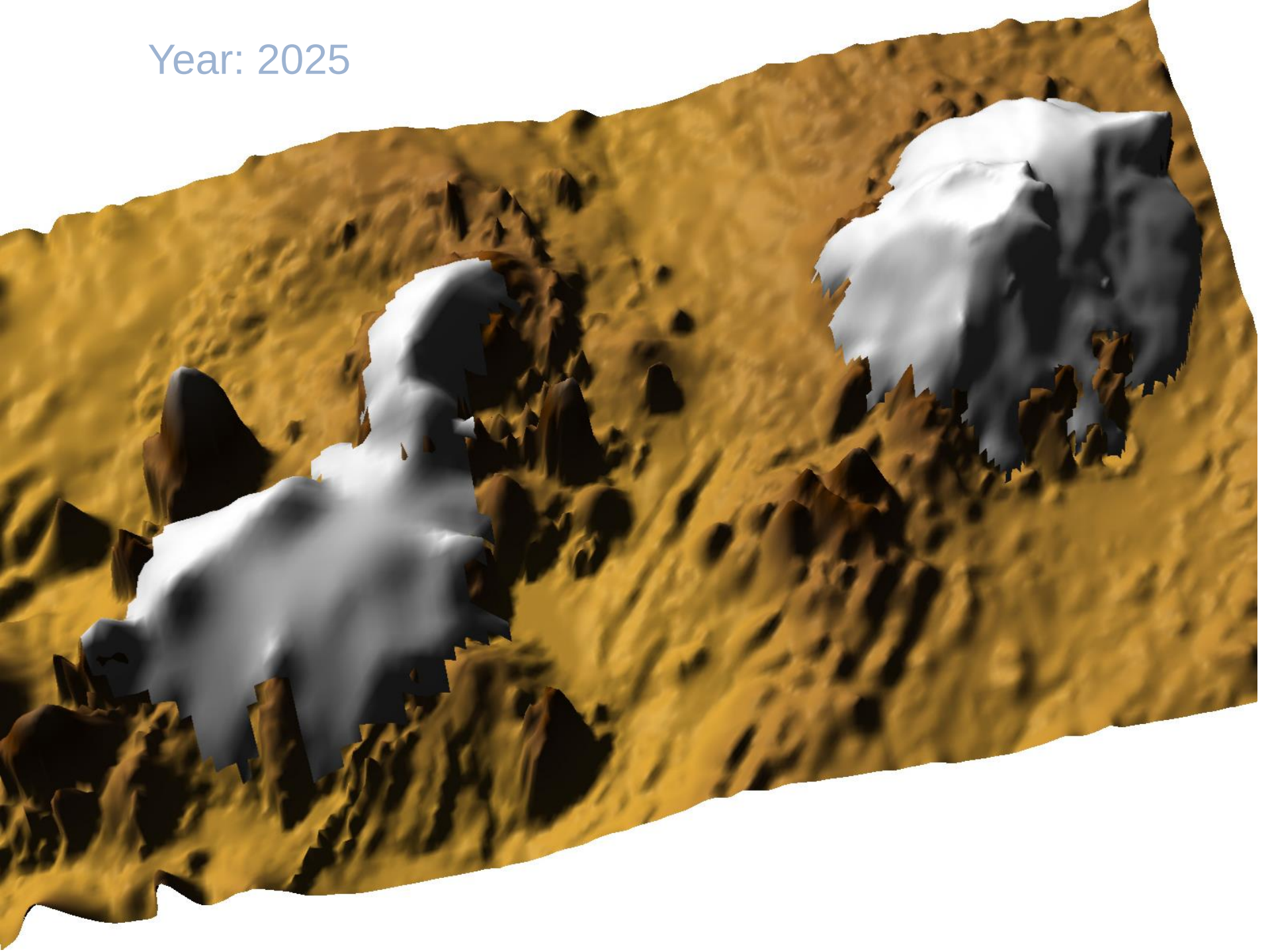
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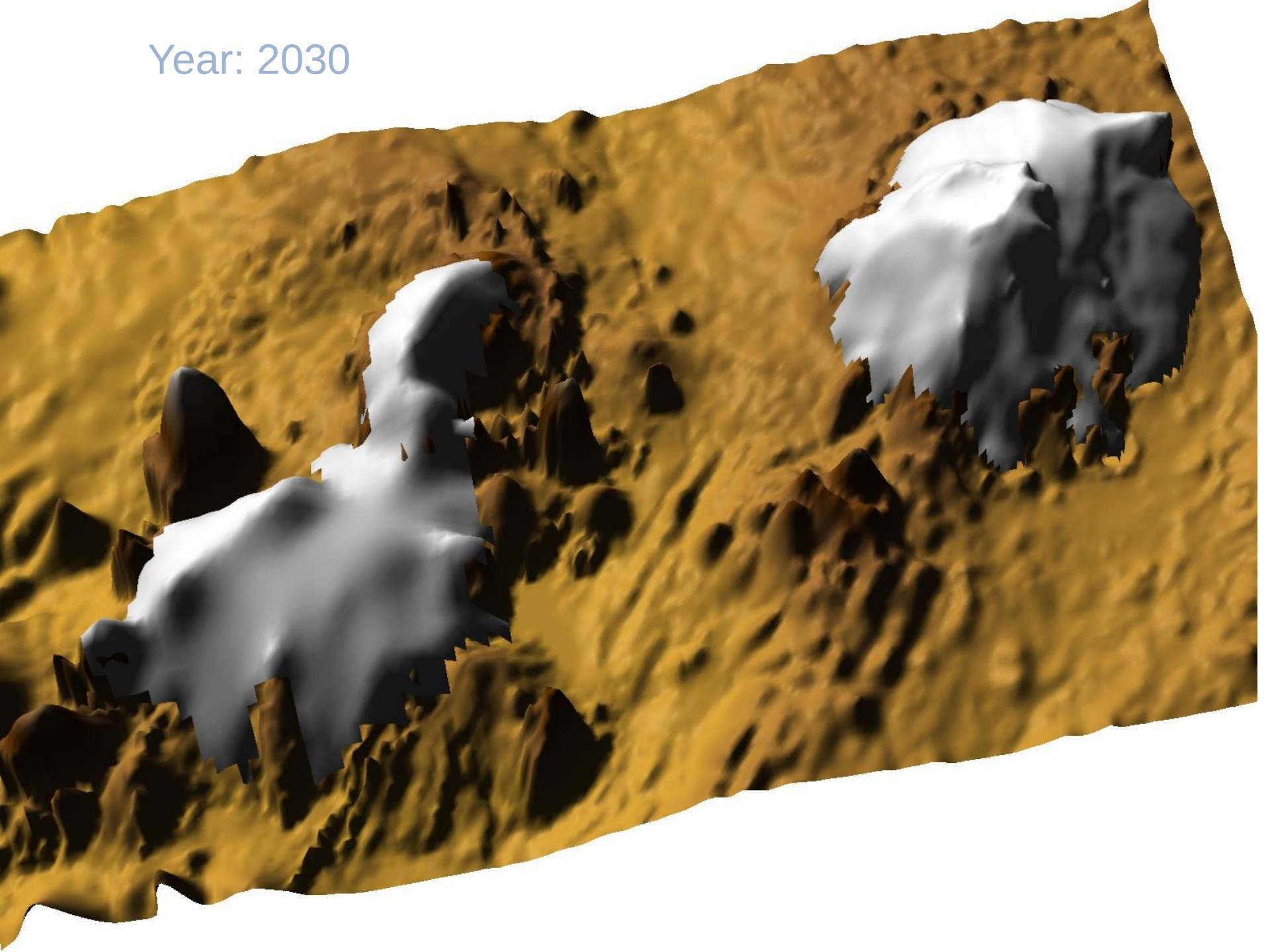
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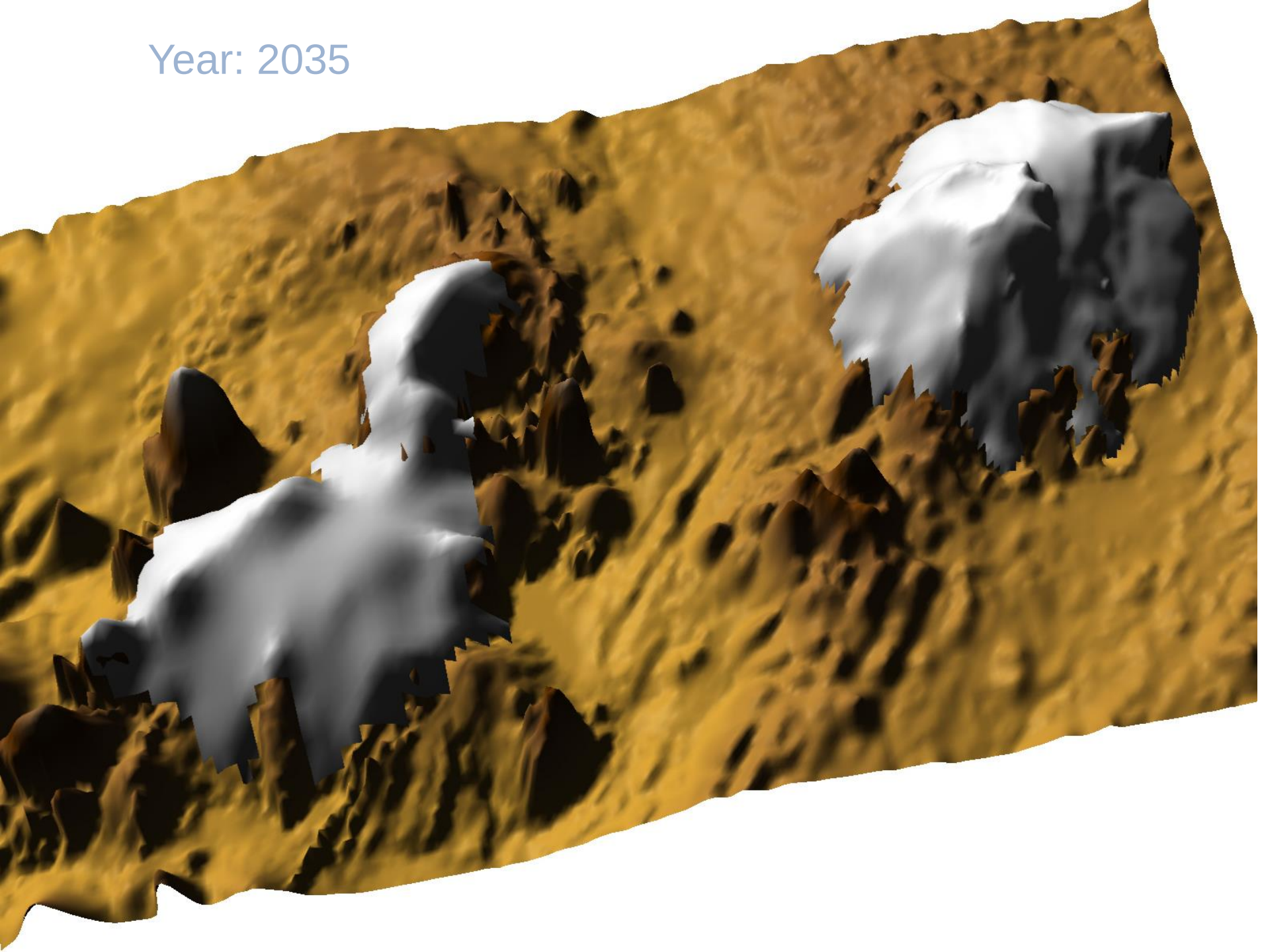

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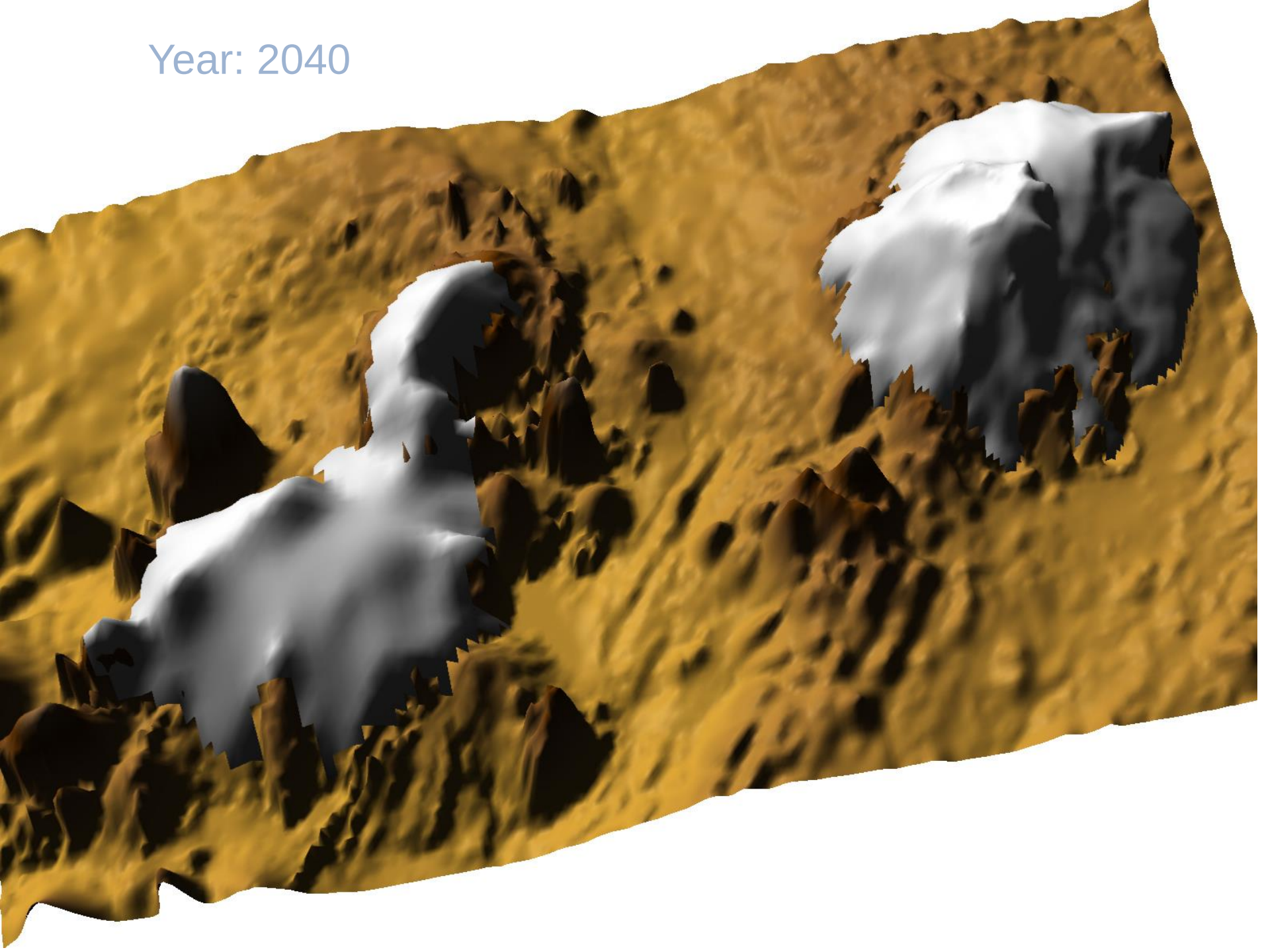

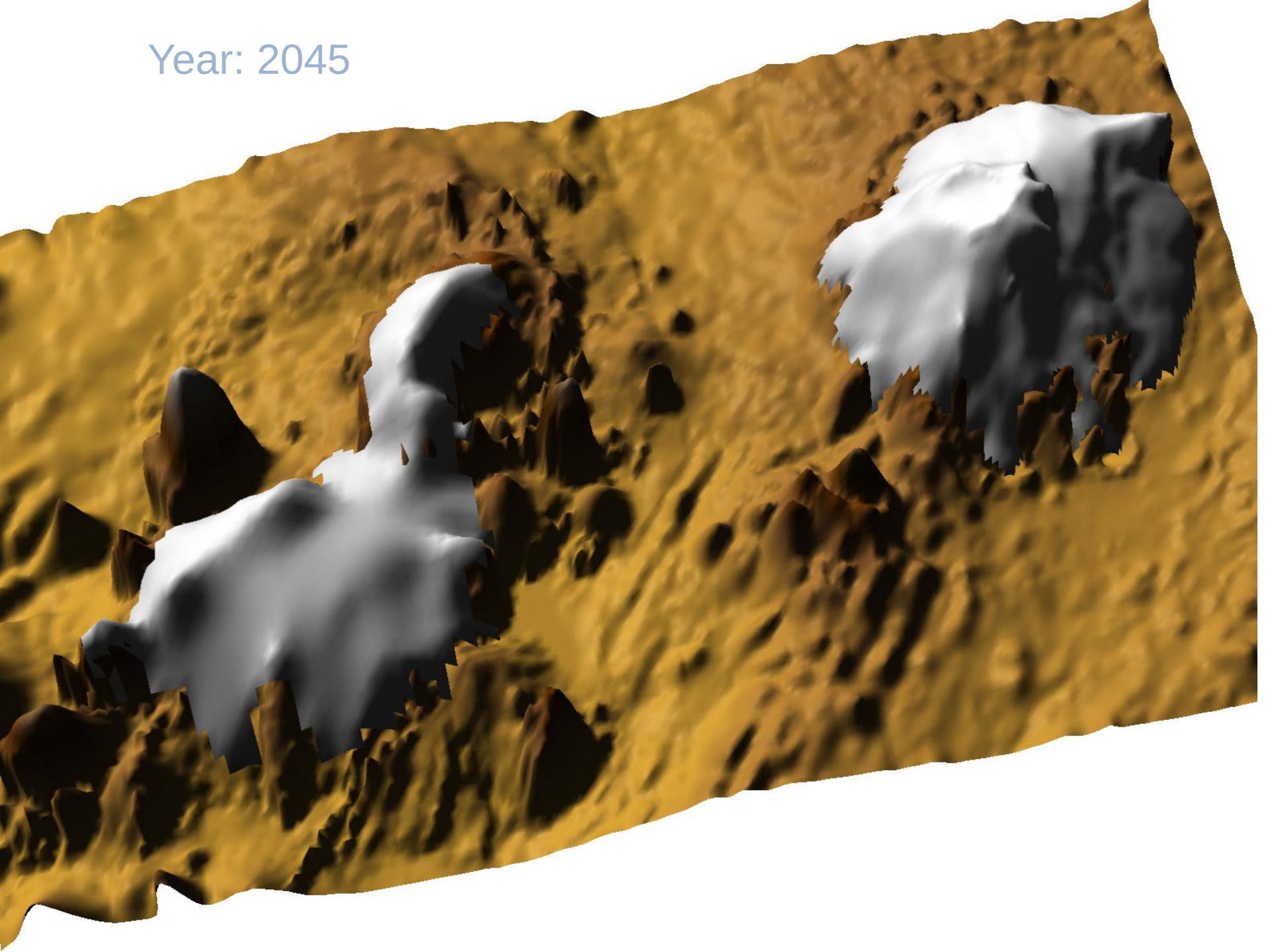
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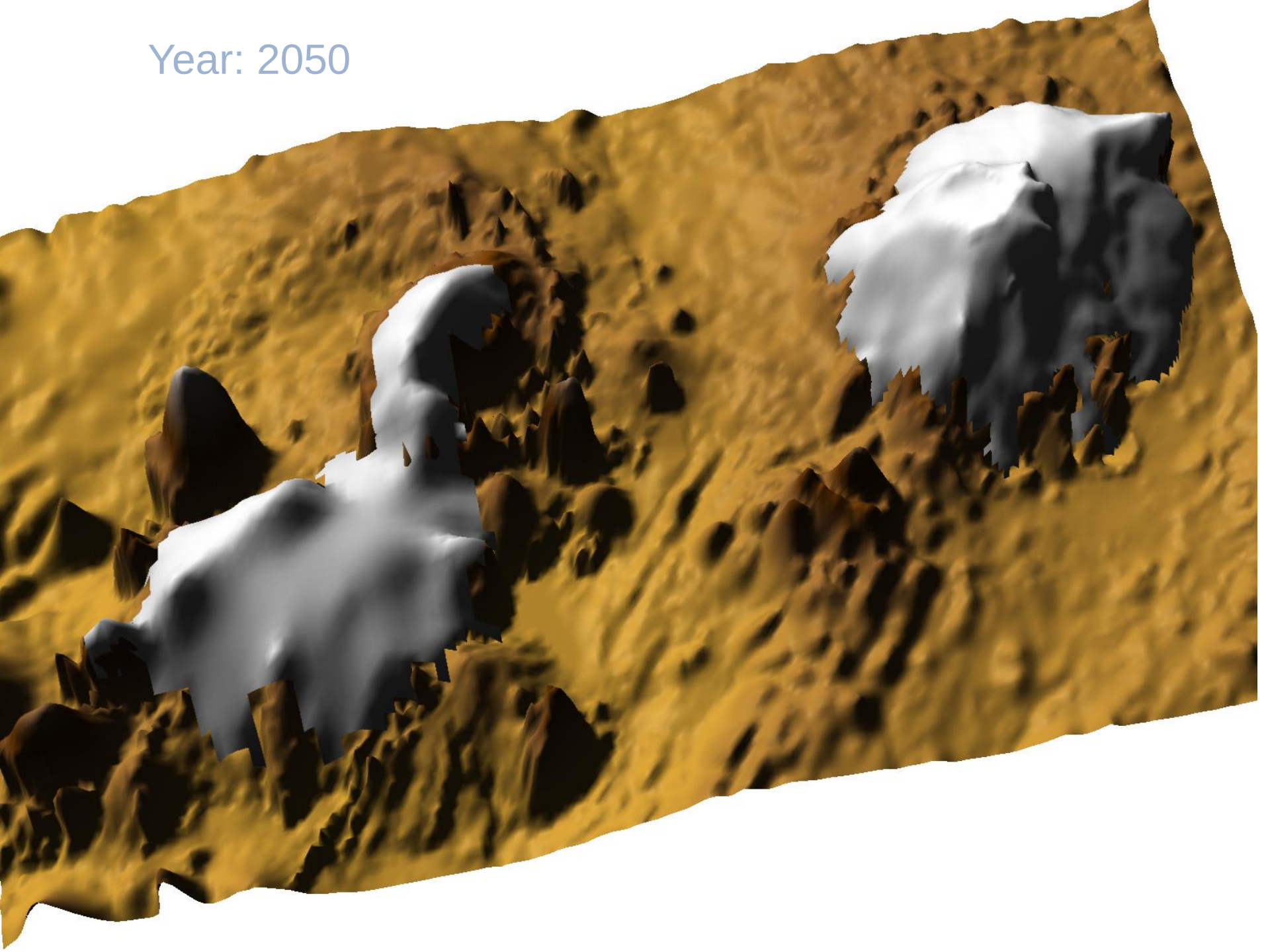
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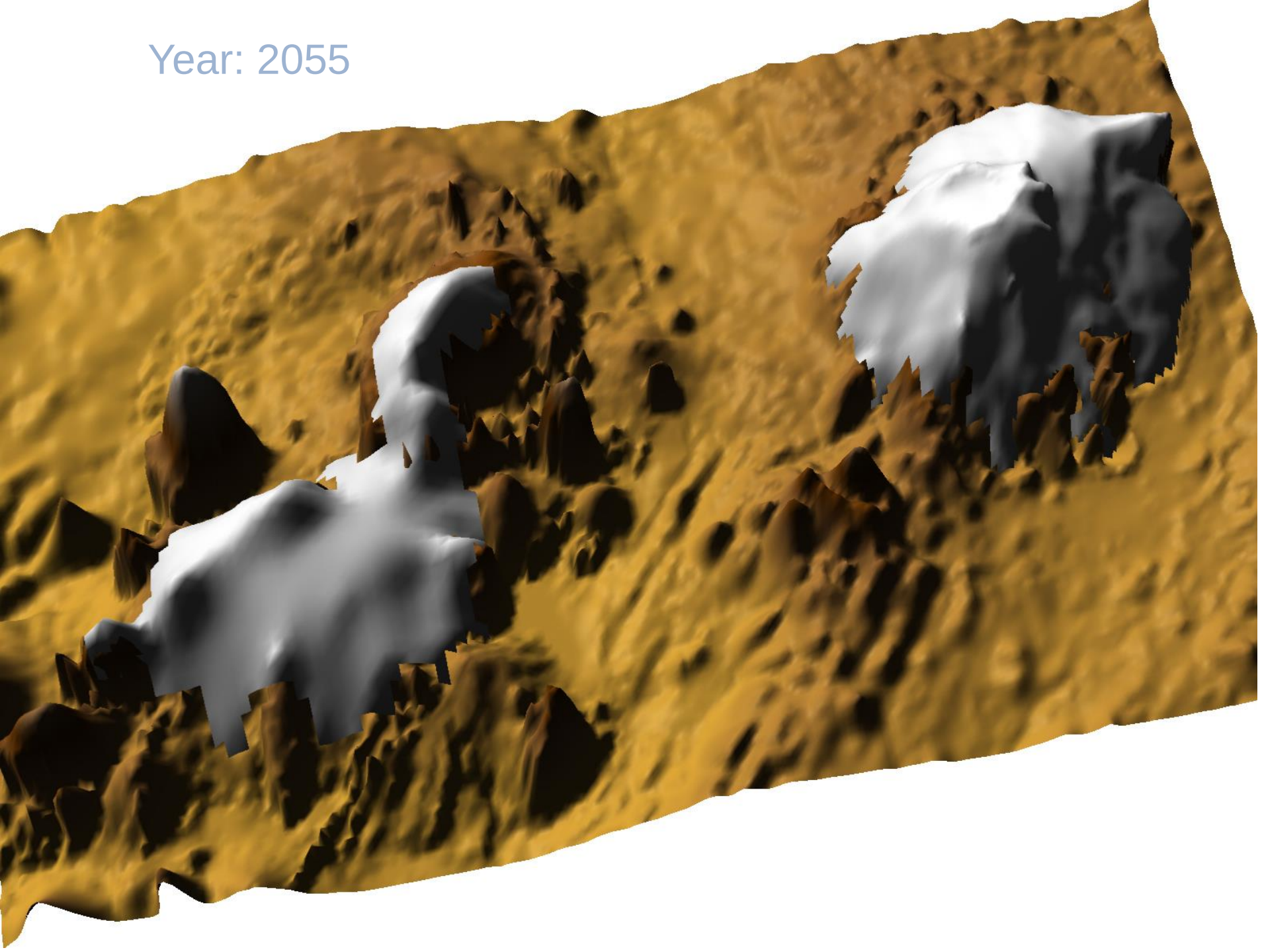
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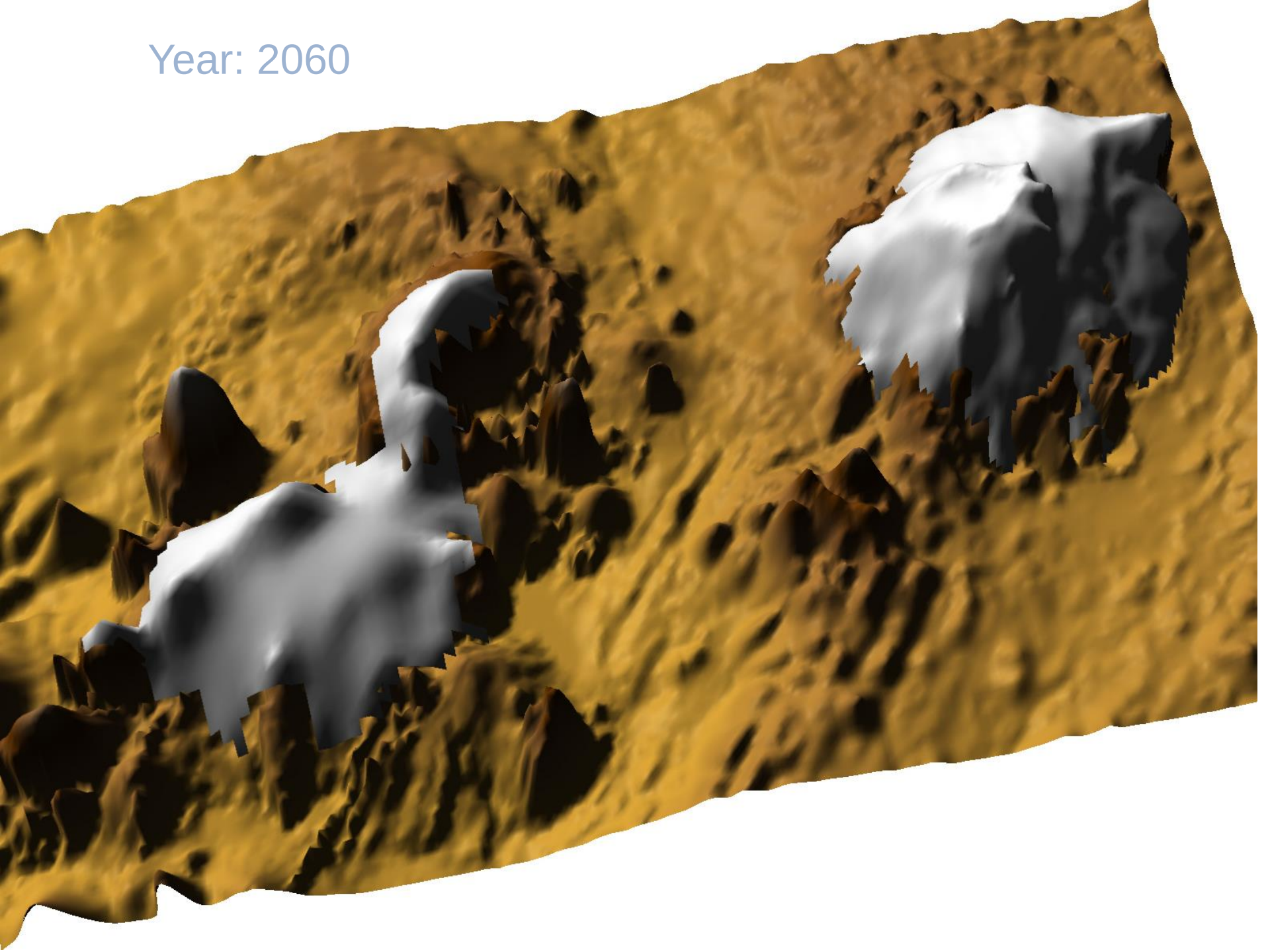
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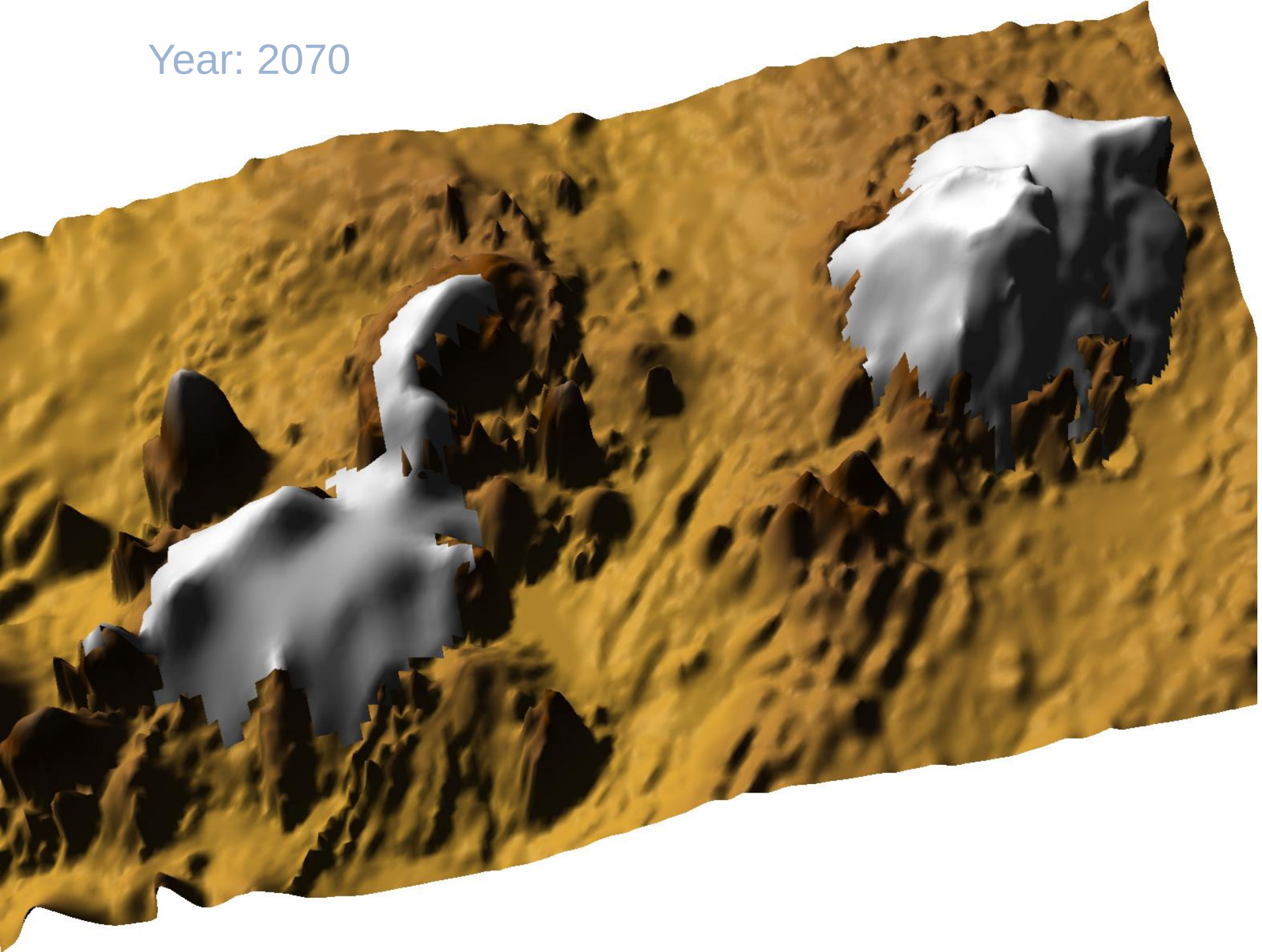
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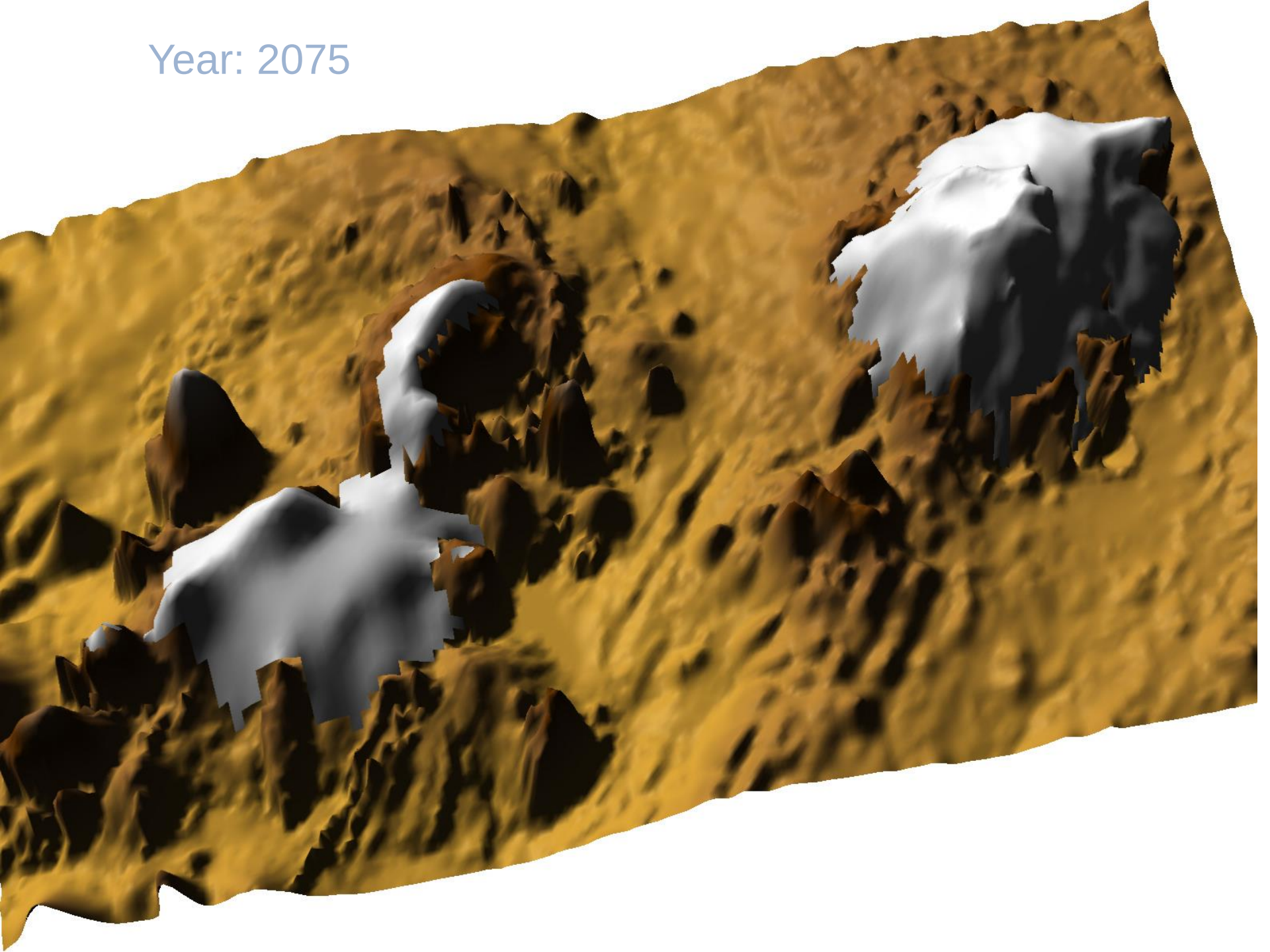
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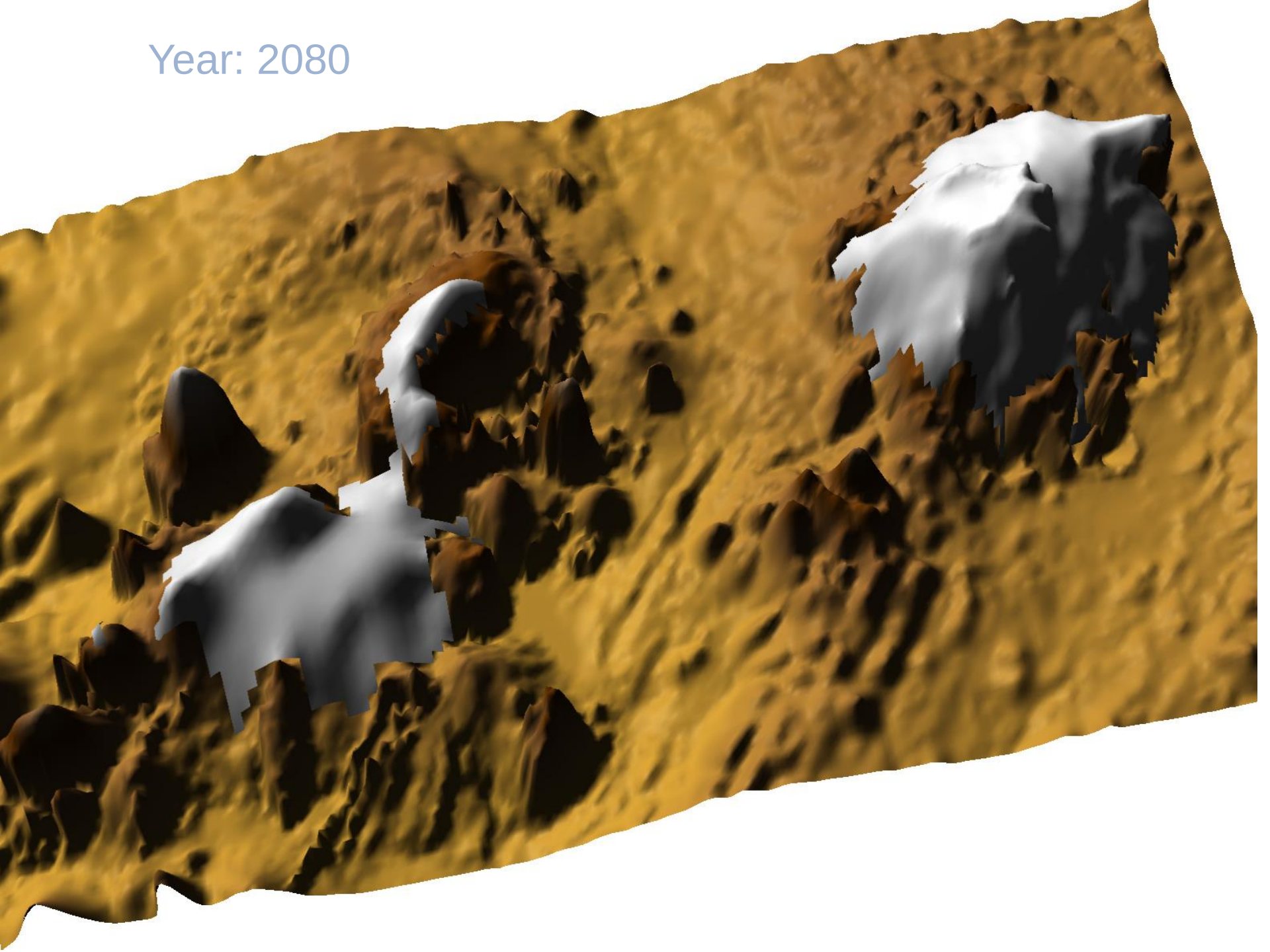
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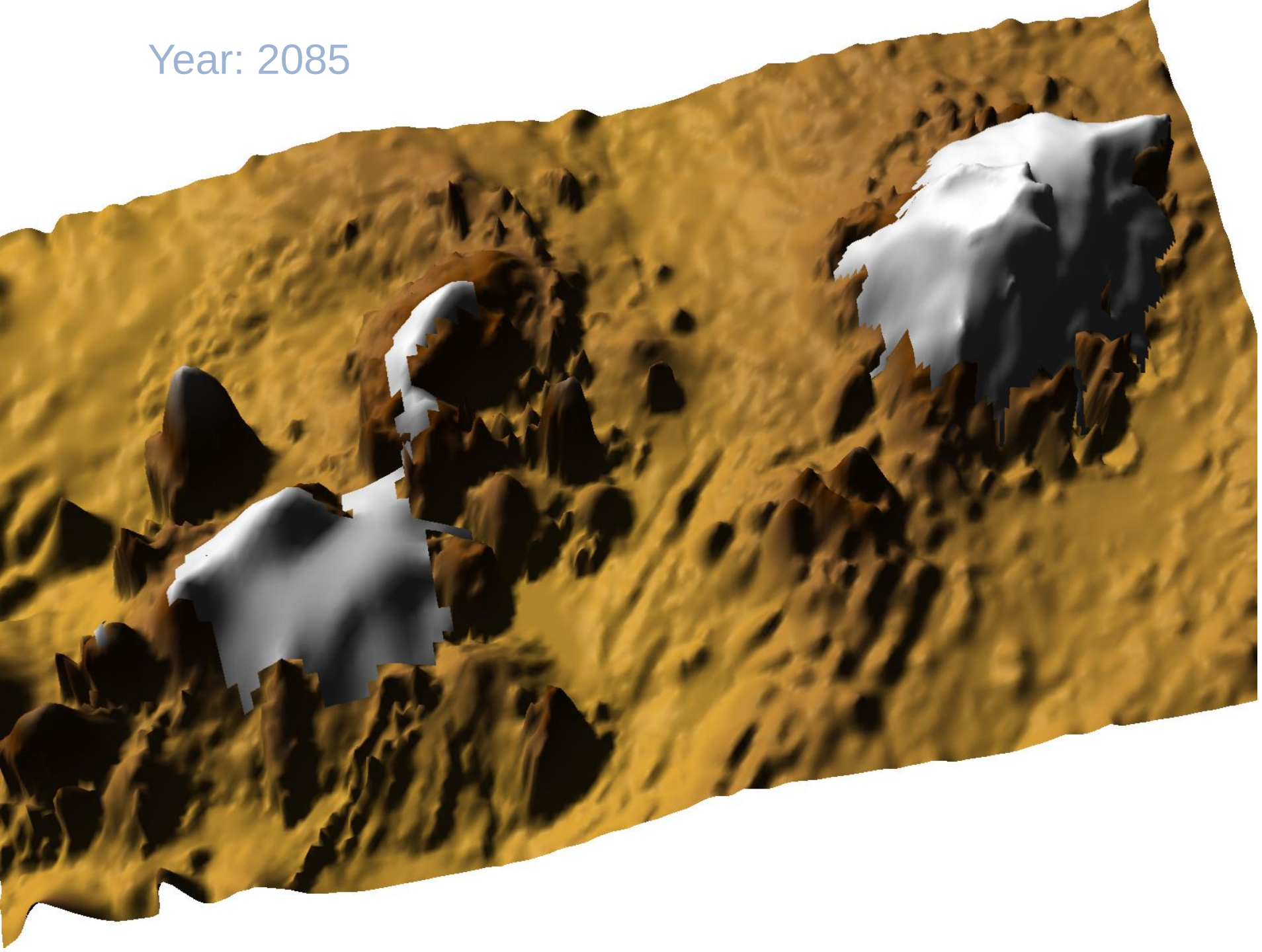

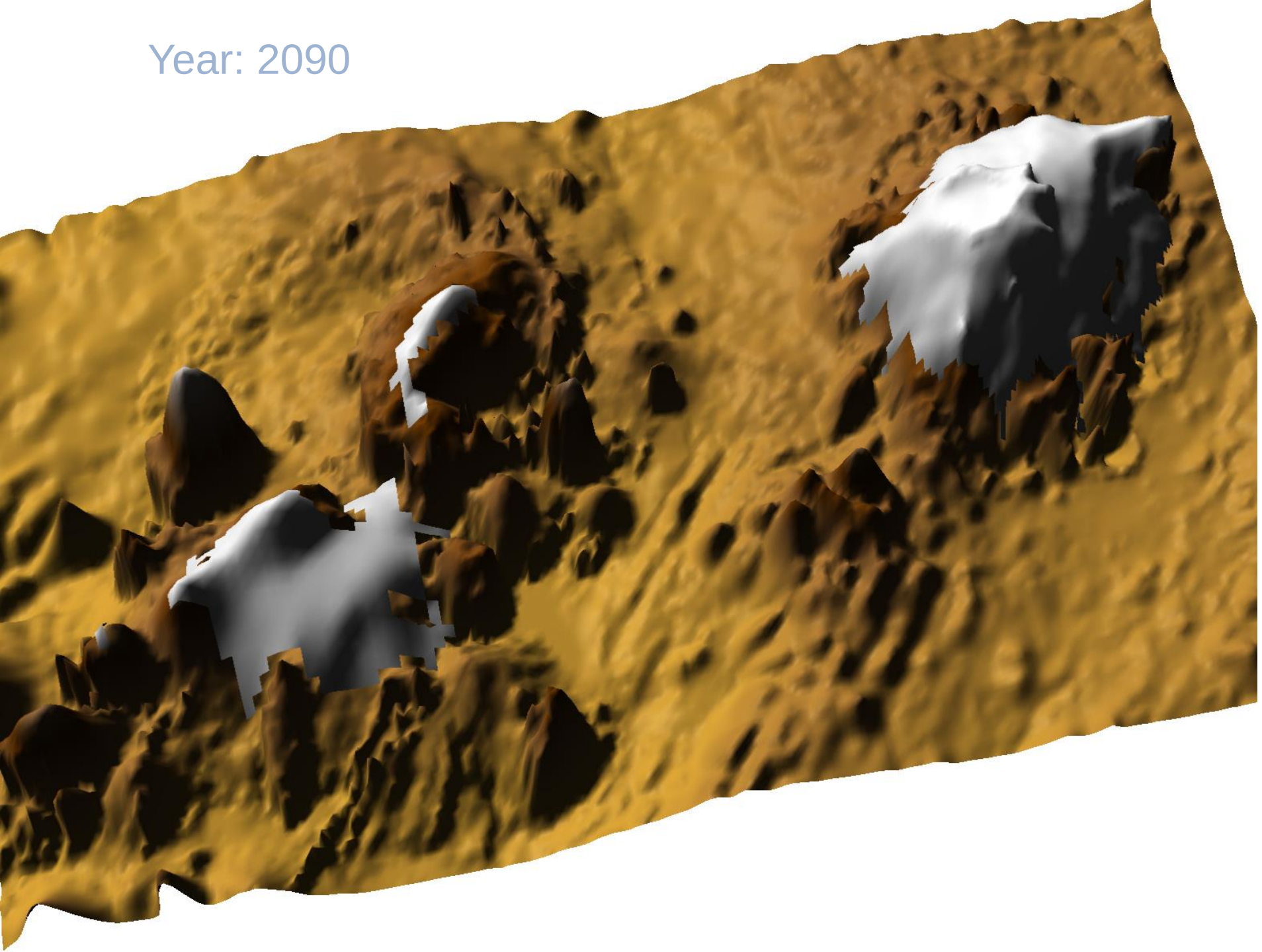
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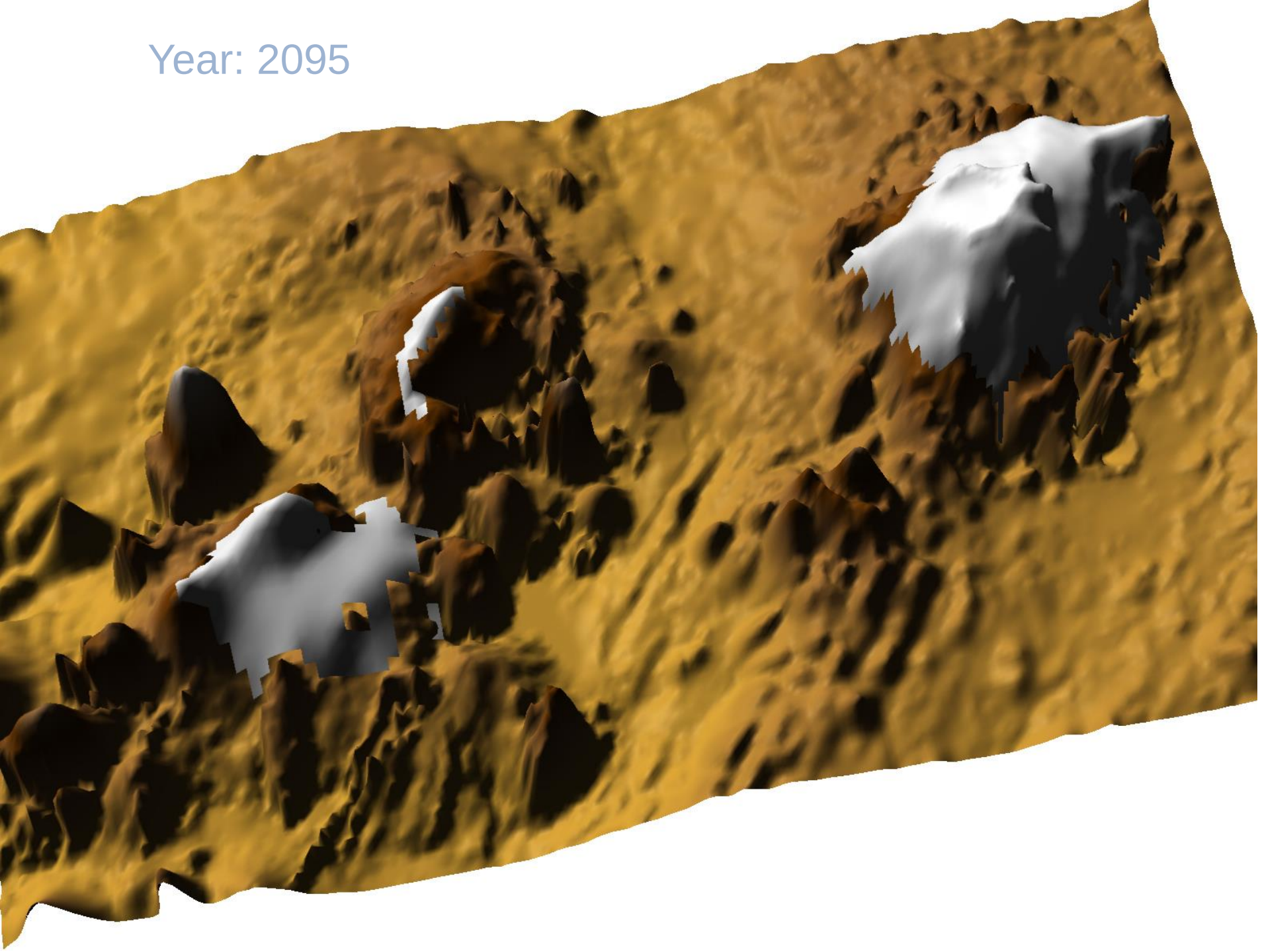

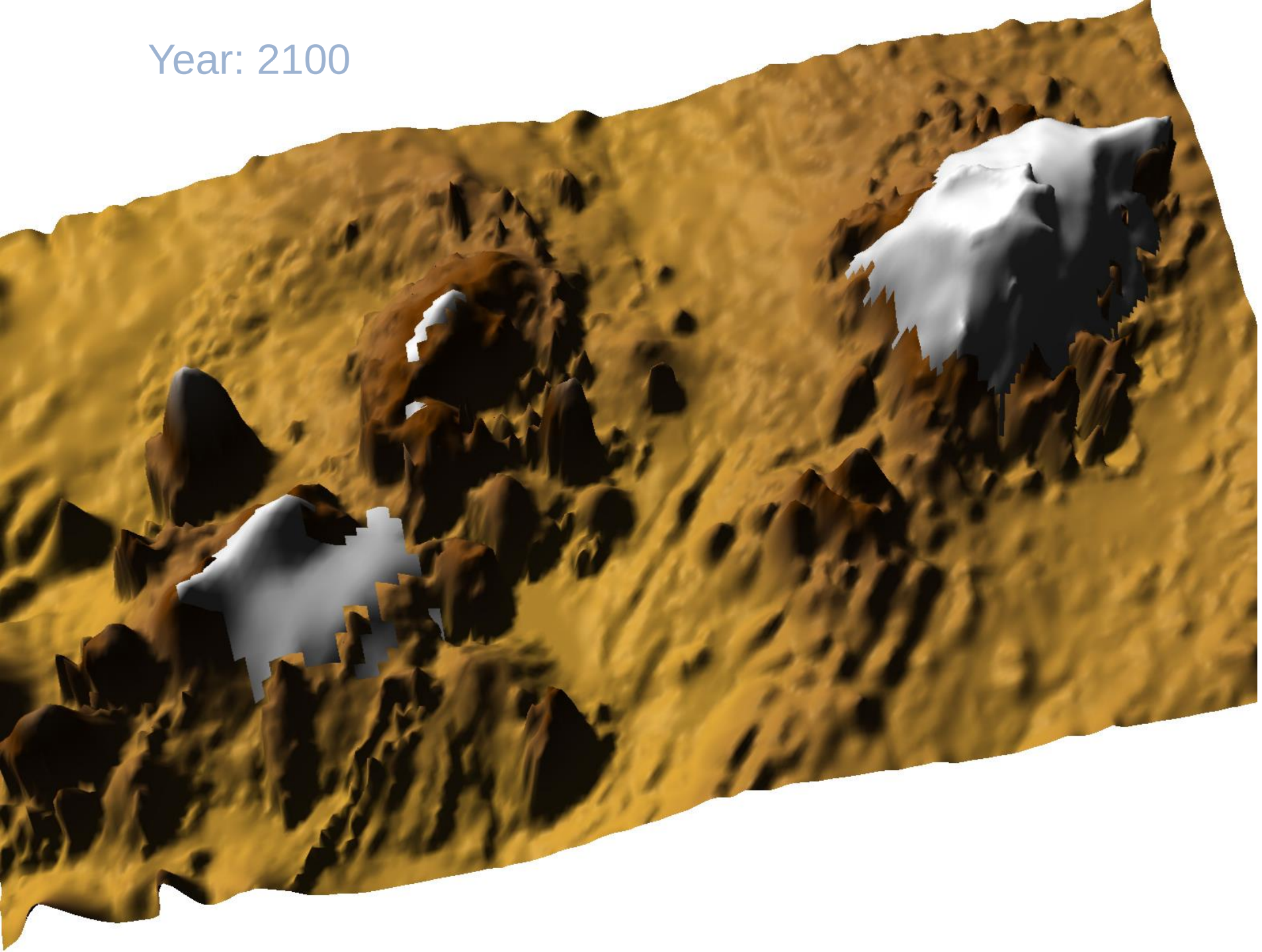
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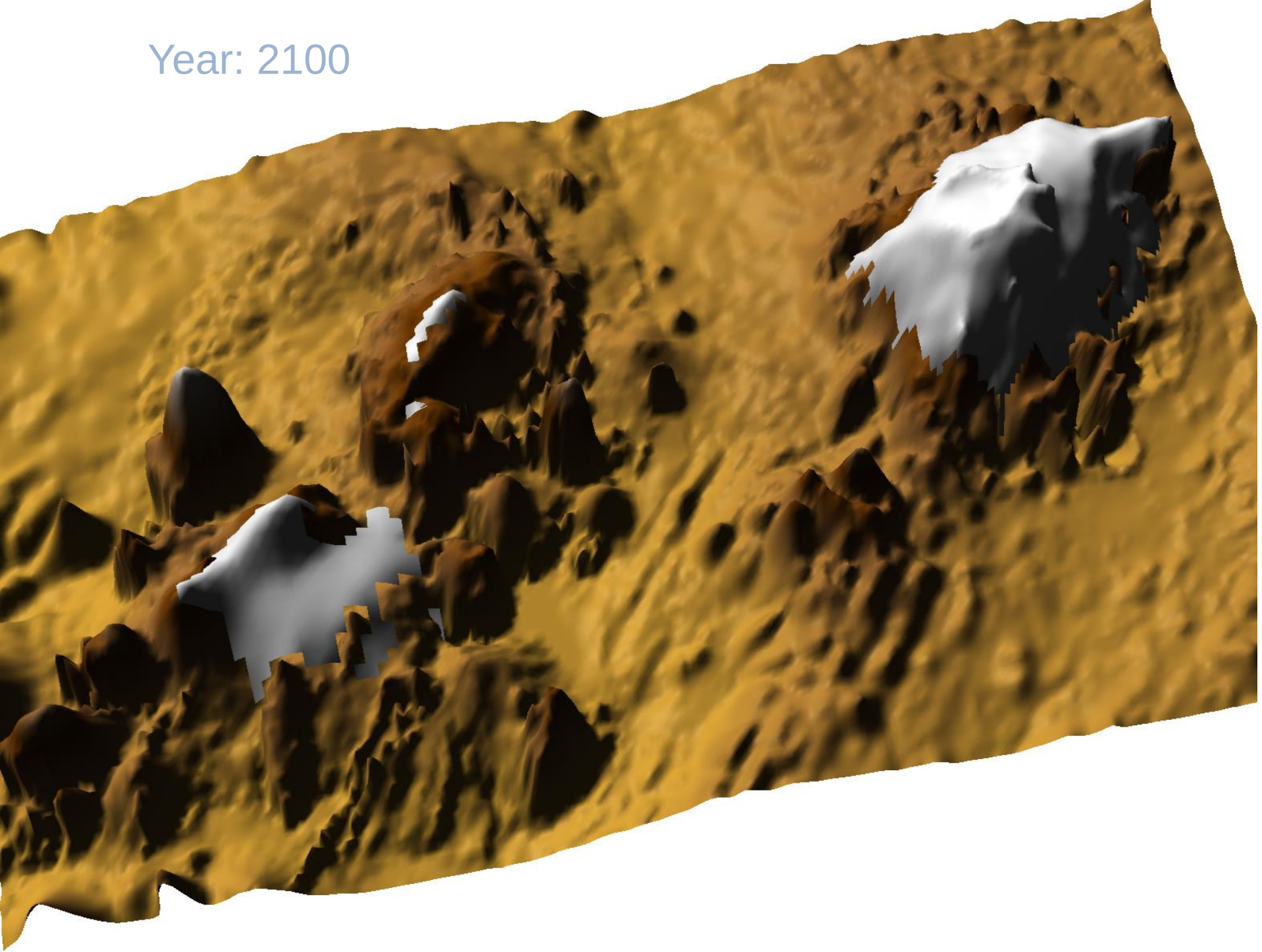
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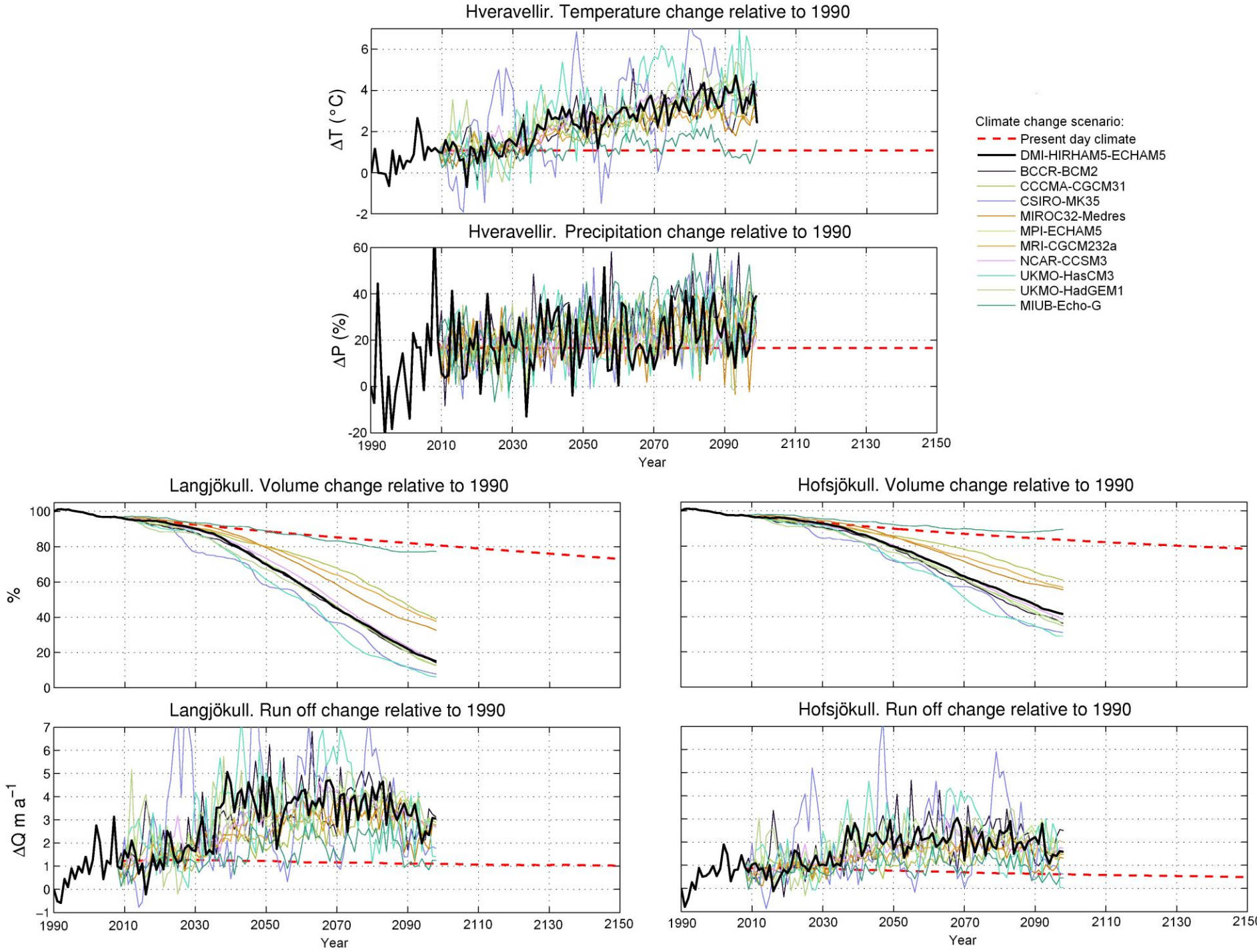
Hveravellir. Temperature change relative to 1990
ΔT (°C)
Hveravellir. Precipitation change relative to 1990
ΔP (%)
Year
Climate change scenario:
Present day climate
DMI-HIRHAM5-ECHAM5
BCCR-BCM2
CCCMA-CGCM31
CSIRO-MK35
MIROC32-Medres
MPI-ECHAM5
MRI-CGCM232a
NCAR-CCSM3
UKMO-HasCM3
UKMO-HadGEM1
MIUB-Echo-G
Langjökull. Volume change relative to 1990
%
Hofsjökull. Volume change relative to 1990
Langjökull. Run off change relative to 1990
ΔQ m a-1
Hofsjökull. Run off change relative to 1990
Year

Hydrological modelling

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The WaSiM hydrological model used to study the effects of these changes on runoff further

- Distributed model developed in Swiss at ETH, Zürich
- Accounts for:

WaSiM

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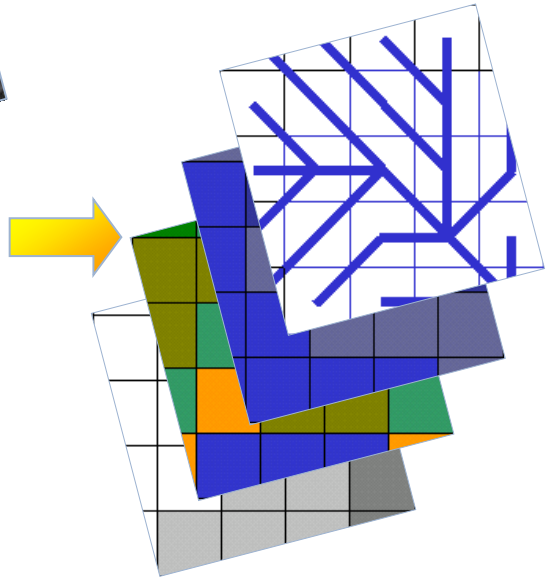
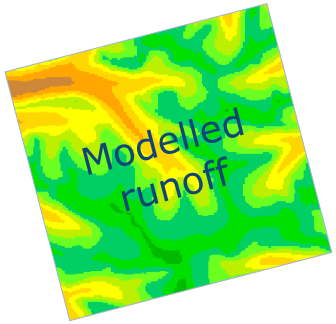
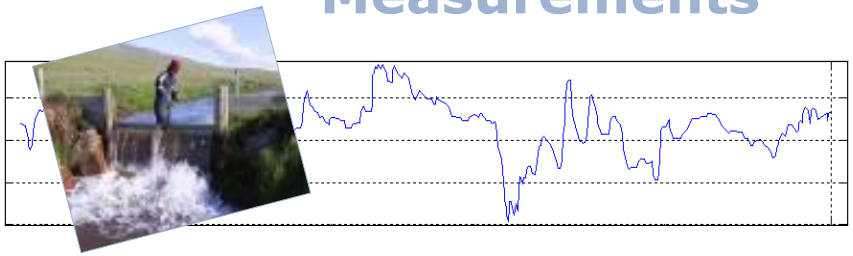


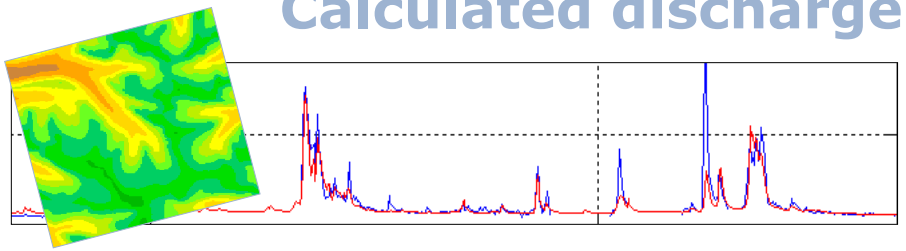
WaSiM-ETH



Measurements



Calculated discharge



The effect of climate change on runoff in Iceland

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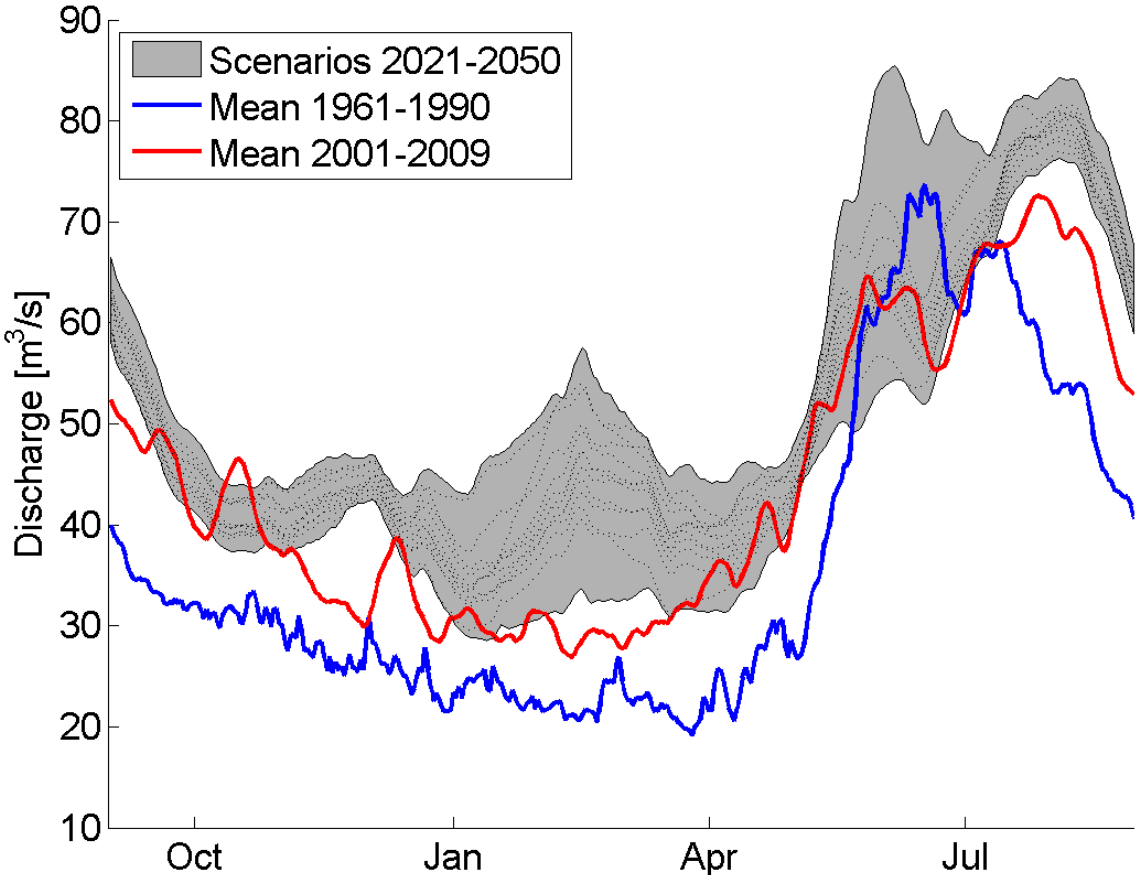
Changes in discharge seasonality for a glacier fed river, Austari-Jökulsá

- 2021–2050 compared to 1961–1990
- Temperature increase of ~2°C, dependent on scenario
- Precipitation increase of ~16%, dependent on scenario
- Considerable changes for 2001–2009 compared to 1961–1990



The effect of climate change on runoff in Iceland

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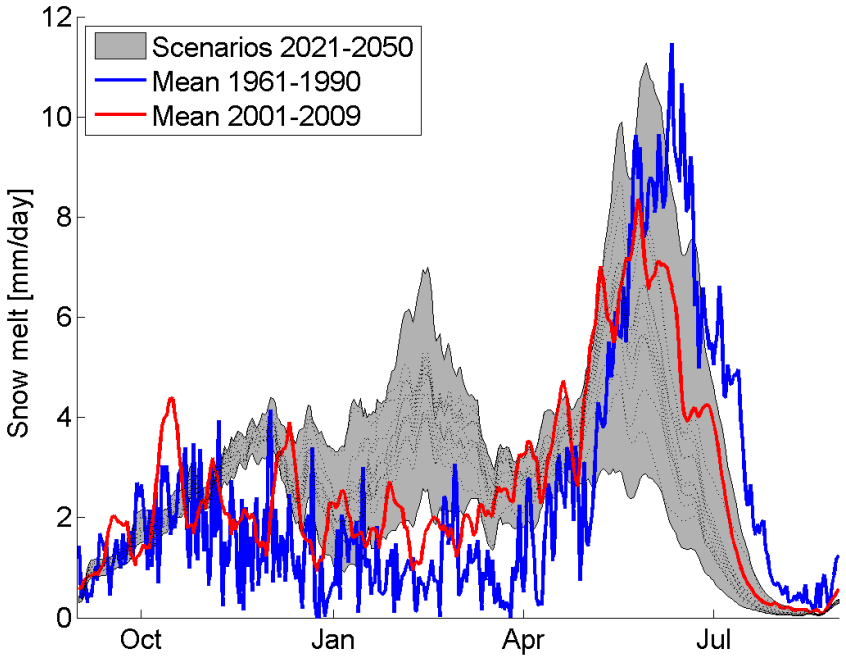
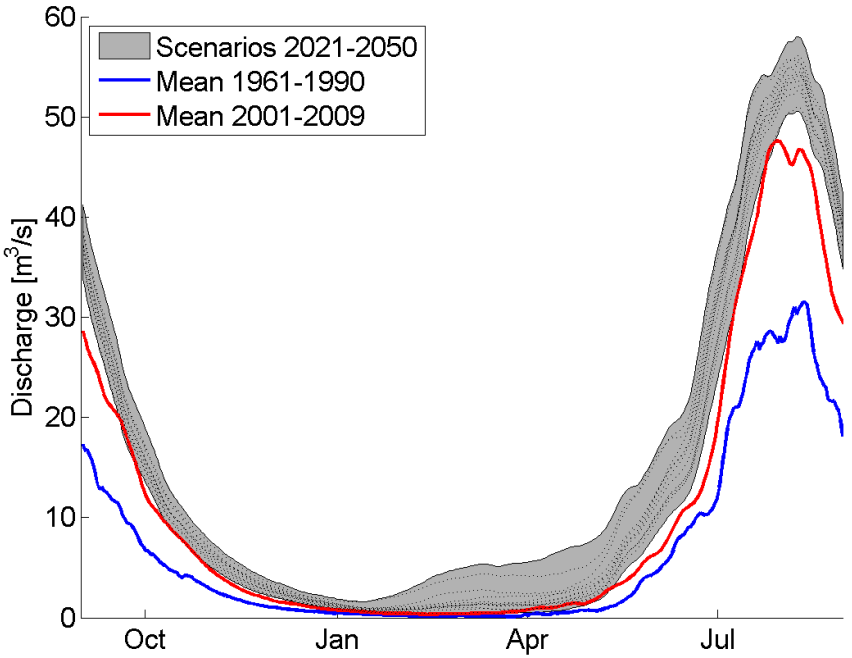
- Changed discharge seasonality for a glacier fed river is combined effect of changes in snowmelt and changes in glacier runoff



Mean snowmelt seasonality for Austari-Jökulsá



Mean glacier originated discharge seasonality for Austari-Jökulsá

Conclusions

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Runoff from the glaciers will increase substantially due to increased ice melting during the coming decades

- Duration of the glacier melt period is predicted to increase by nearly two months, reaching further into the spring and autumn
- The glacier melt peak becomes larger in volume and magnitude and will be a more dominant feature in the discharge

The increase is temporary and glacier runoff will decrease with decreased glacier volume in the last quarter of this century

- Present glacier rivers will not stop flowing but will become direct-runoff and groundwater fed rivers with a different seasonality

Changes in water divides and changes in river courses with changed glacier geometry and extent may, though, have important consequences


Photograph: Oddur Sigurðsson


Photograph: RAX

Conclusions

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These changes may affect the hydropower industry, transportation, tourism and many other sectors of society

Compared to the period 1961–1990, a warming of about 1°C has already been observed during the period 2001–2009

- Causing considerable discharge changes in the same direction as the predicted future changes

Glaciers and river runoff are already considerably affected by human-induced climate changes

- Glacier changes and runoff variations in the next few decades will nevertheless be much affected by natural climate variability as they have been in the past and predictability is, in addition, limited by scenario-related uncertainties.

Acknowledgments

- Climate and Energy Systems (CES), financed by The Nordic Energy Research and the Nordic energy sector
- "Loftslags-breytingar og áhrif þeirra á orkukerfi og samgöngur" (LOKS) funded by Landsvirkjun (the National Power Company of Iceland), the National Energy Authority, The Icelandic Road Administration and the Icelandic Meteorological Office

Múlajökull, Kerlingarfjöll and Þjórsá
Photograph: Oddur Sigurðsson