

Terra/Aqua Orbit-Drift Update

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University of Maryland

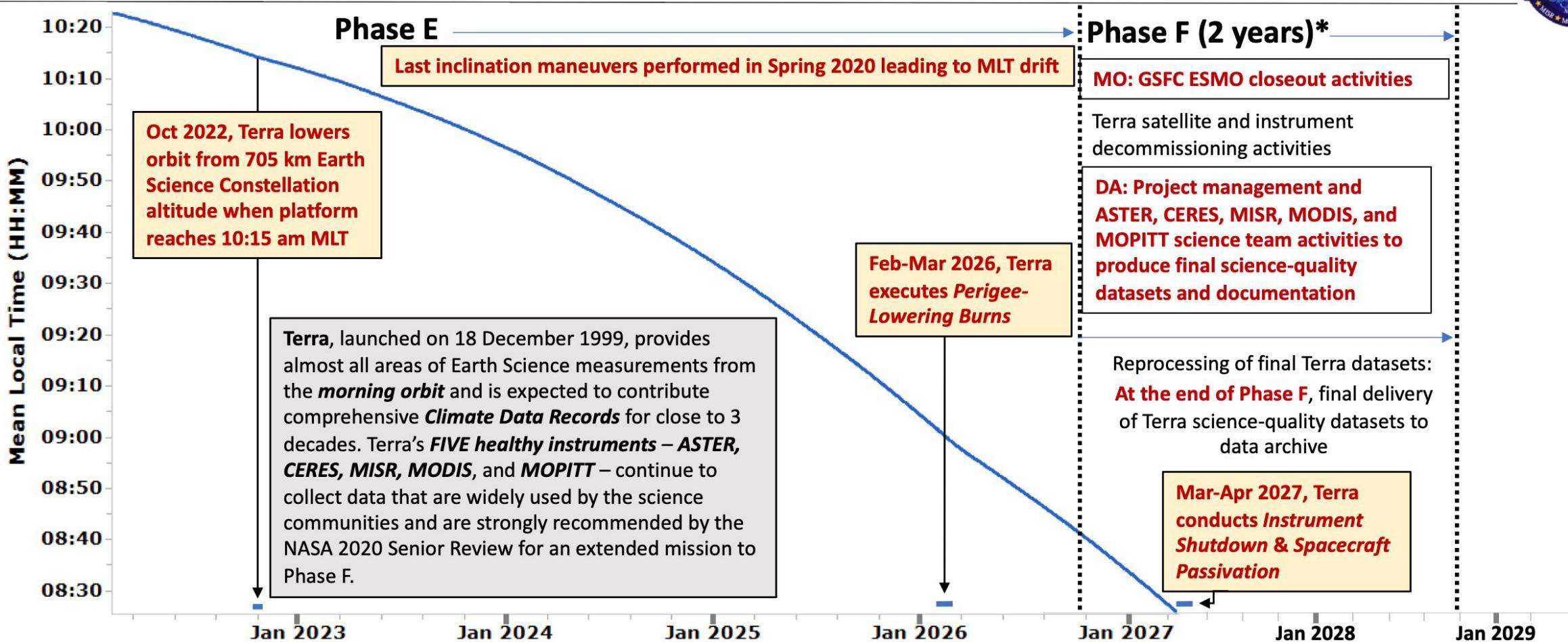
NASA's Land, Atmosphere Near Real-time Capability for EOS
User Working Group Meeting
May 2025

Relevant Dates

- Terra: Final inclination adjustment maneuver (IAM) + drag make-up (DMU) + 6-km altitude decrease in 2022
- Aqua: Final IAM + DMU in 2021

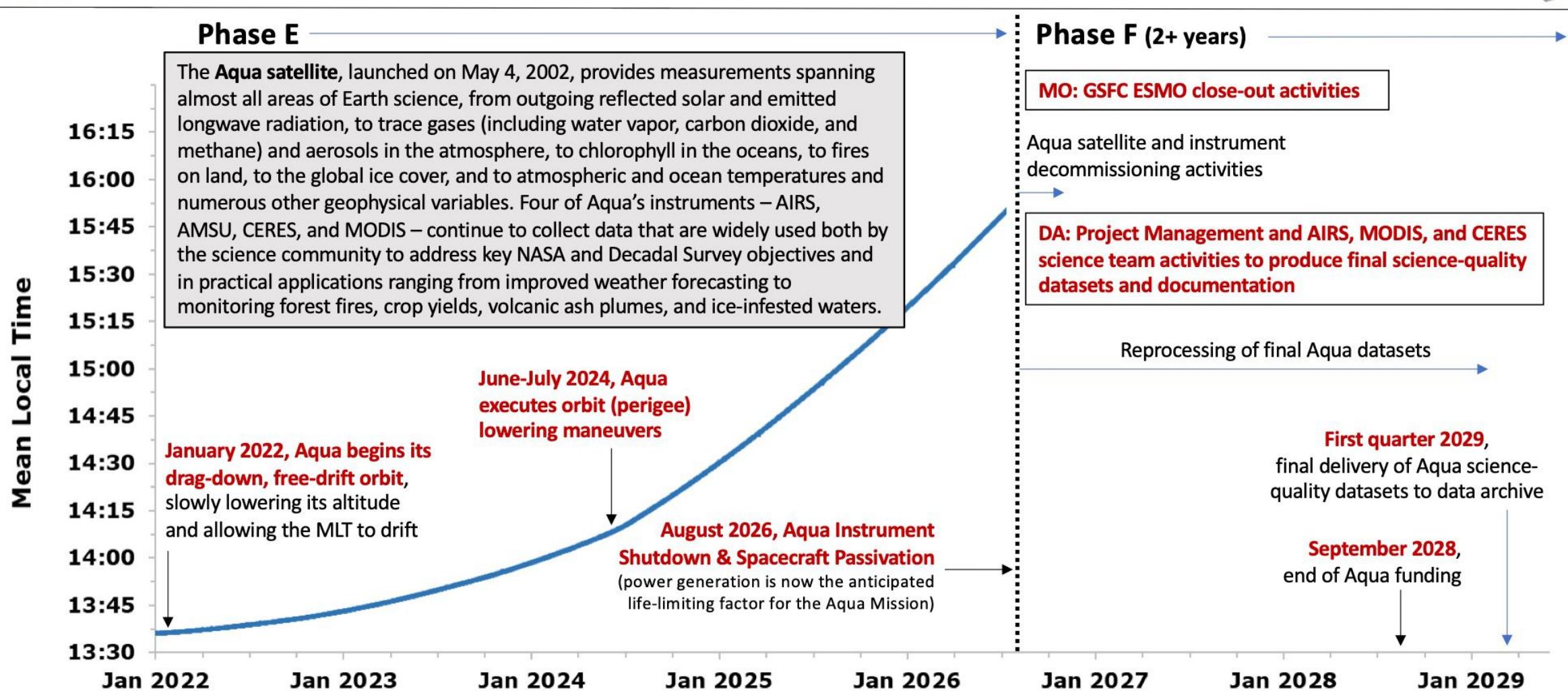
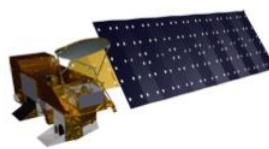


Terra Timeline if Maximally Extended





Aqua Timeline if Maximally Extended



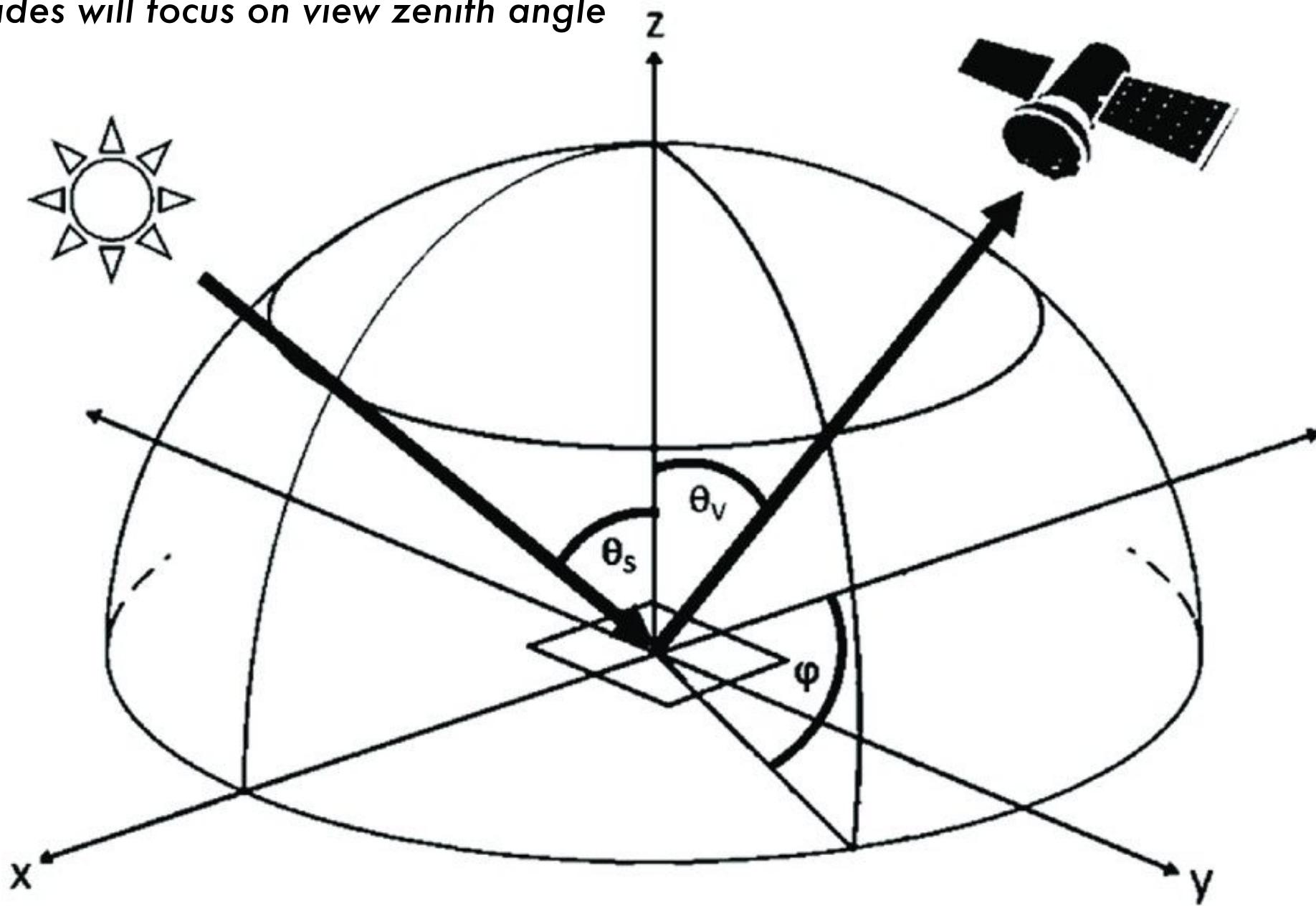
MODIS Orbit-Drift Impacts

- Sampling of diurnal cycle
- Pixel size and spacing
 - 1 km → ~970 m along-scan (spring 2025)
- Gap between successive scans
 - "MODIS maximal scan gaps at nadir widen from ~1/2 to ~1 1/4 [250-m] pixels (out of 40 [250-m] pixels per scan) in December 2026 for Terra and in July 2026..." (Lin et al., 2023)
- Bowtie overlap
- Patterns in spatial sampling
 - Due to narrowing of swath + faster spacecraft speed + factors above
- Other

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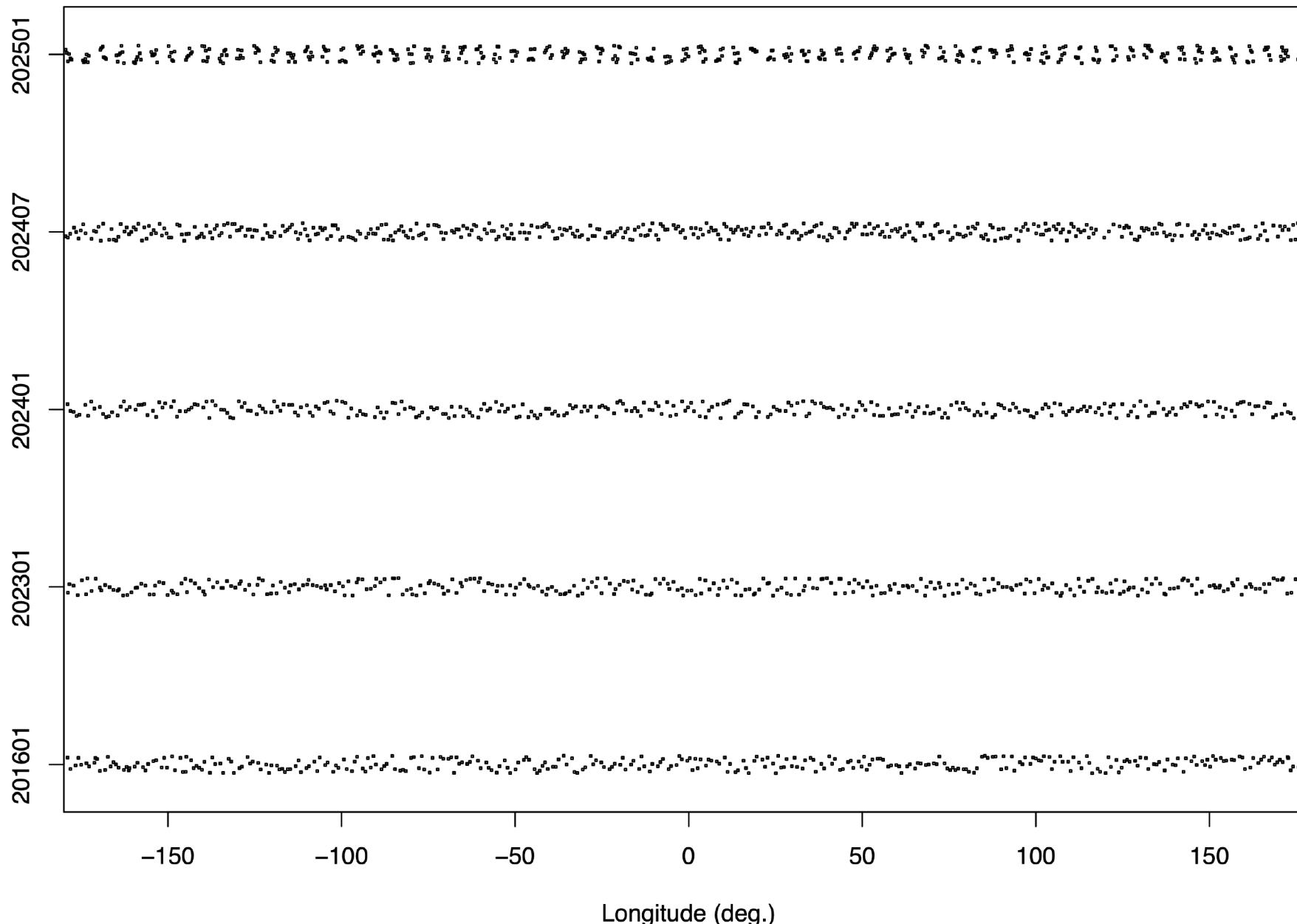
Remaining slides will focus on view zenith angle



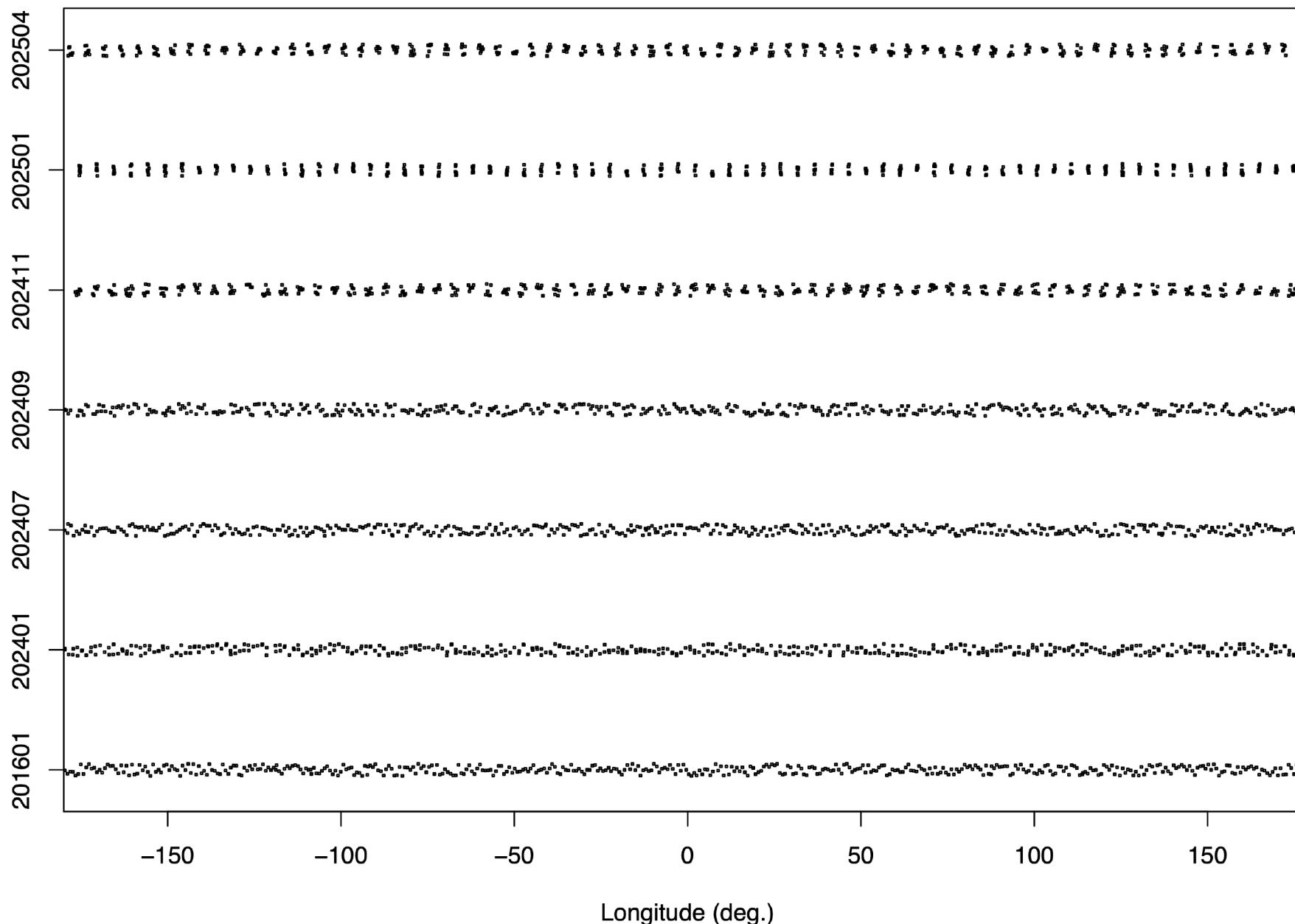
Nadir-Observation Spacing

Figures show locations of nearly-nadir ($VZA \leq 2^\circ$) views along the Equator during the first 16 days of selected calendar months.

Terra MODIS



Aqua MODIS



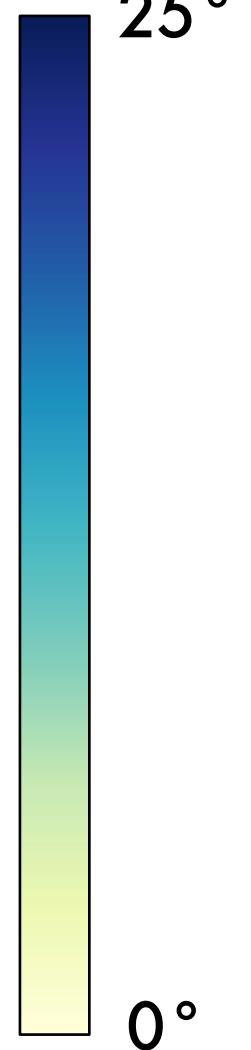
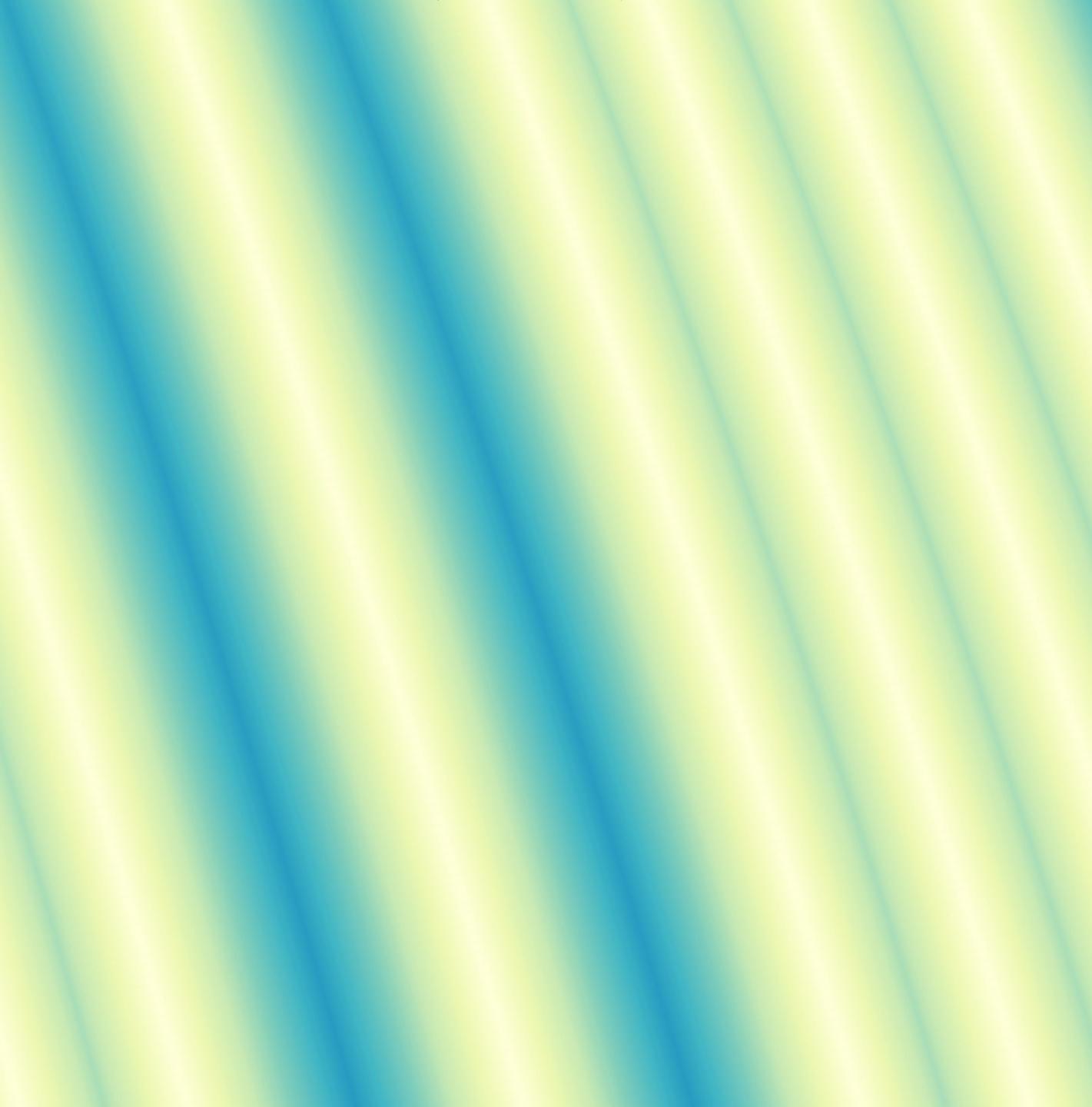
Tile-Level Composites

- Tile h20v07 (Africa, just above Equator)
- Derived from daily Aqua surface reflectance composites
 - Includes view zenith angle
- First 1612 days of each year (i.e., Jan. 1–1612)

Minimum View Zenith Angle

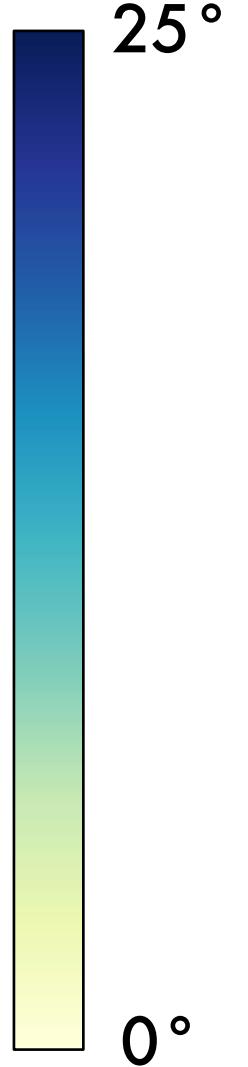
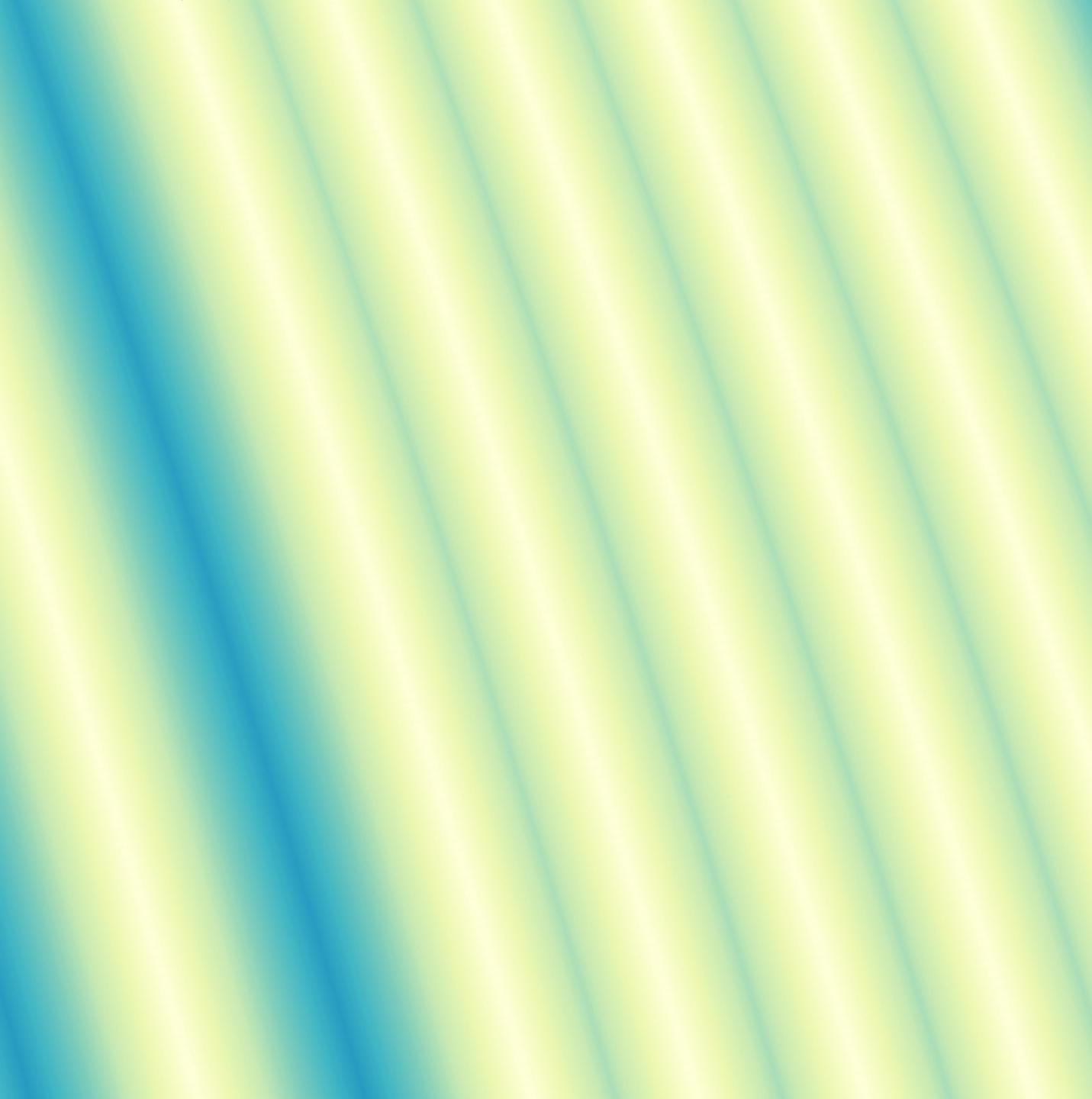
2010

Aqua



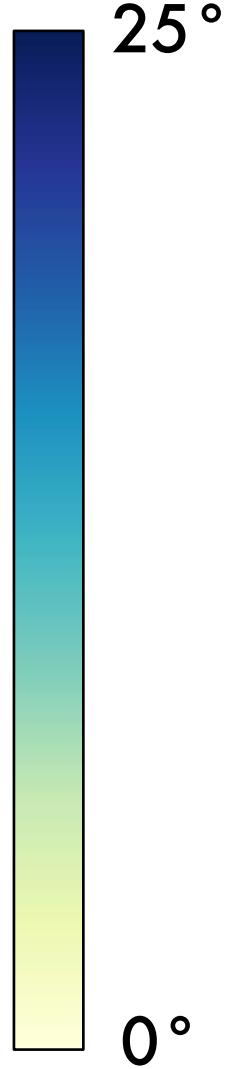
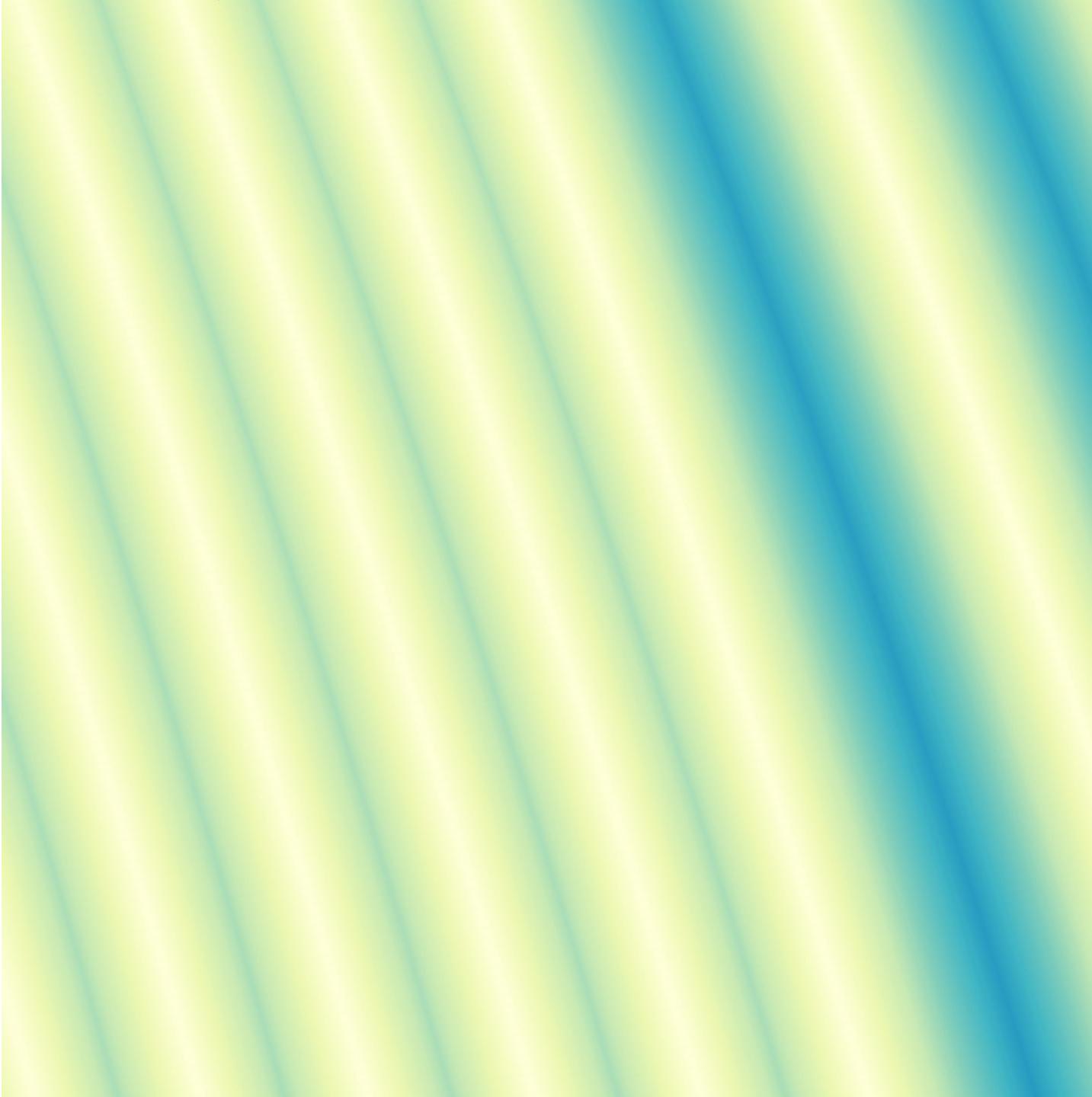
2016

Aqua



2020

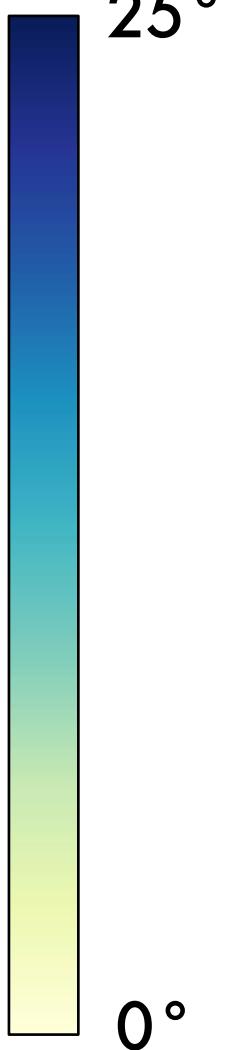
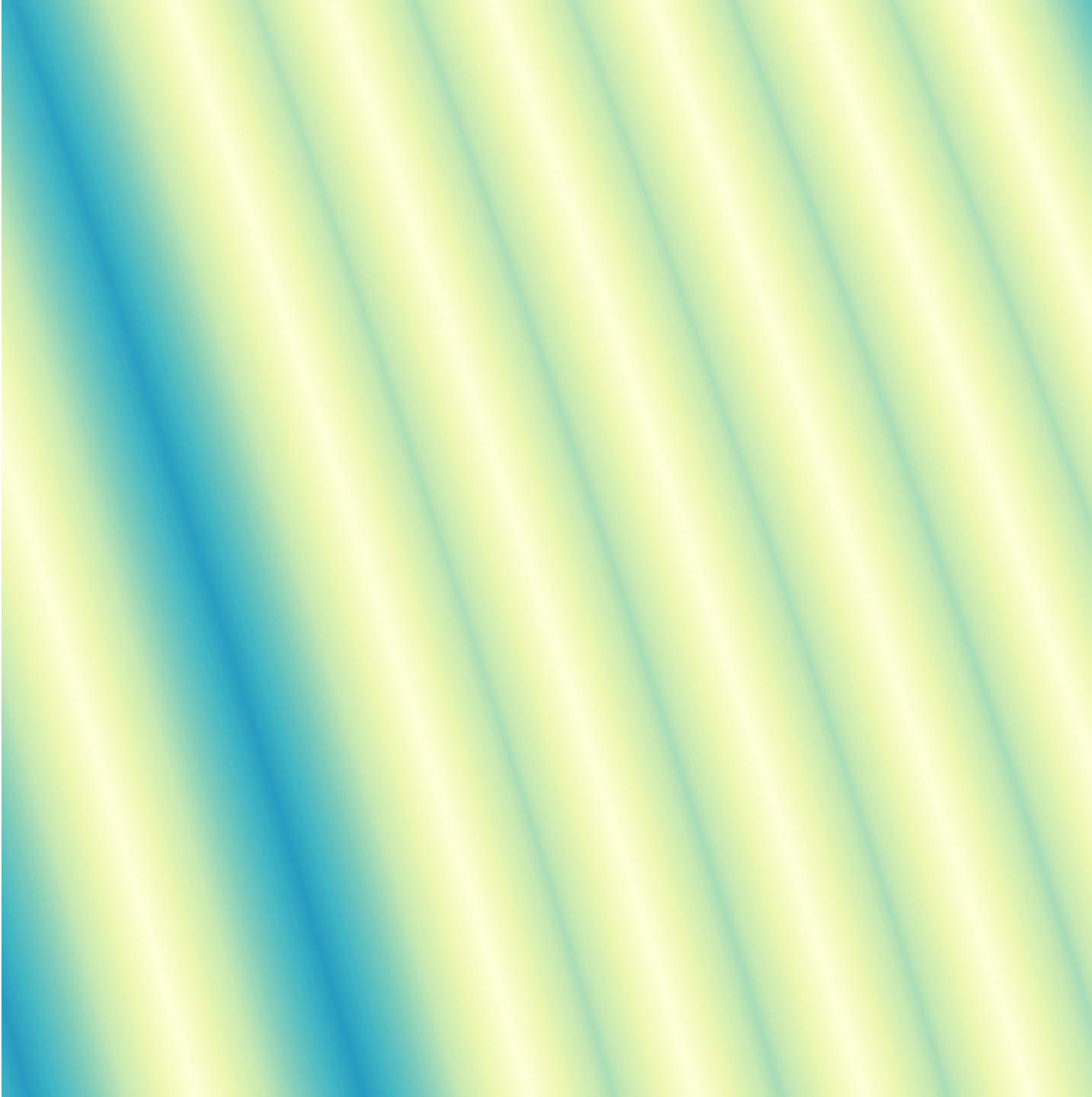
Aqua



15

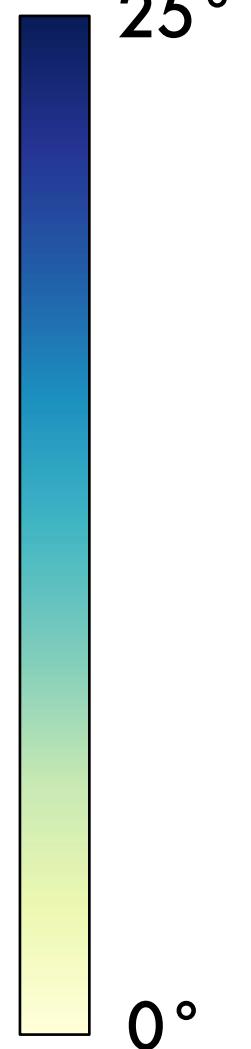
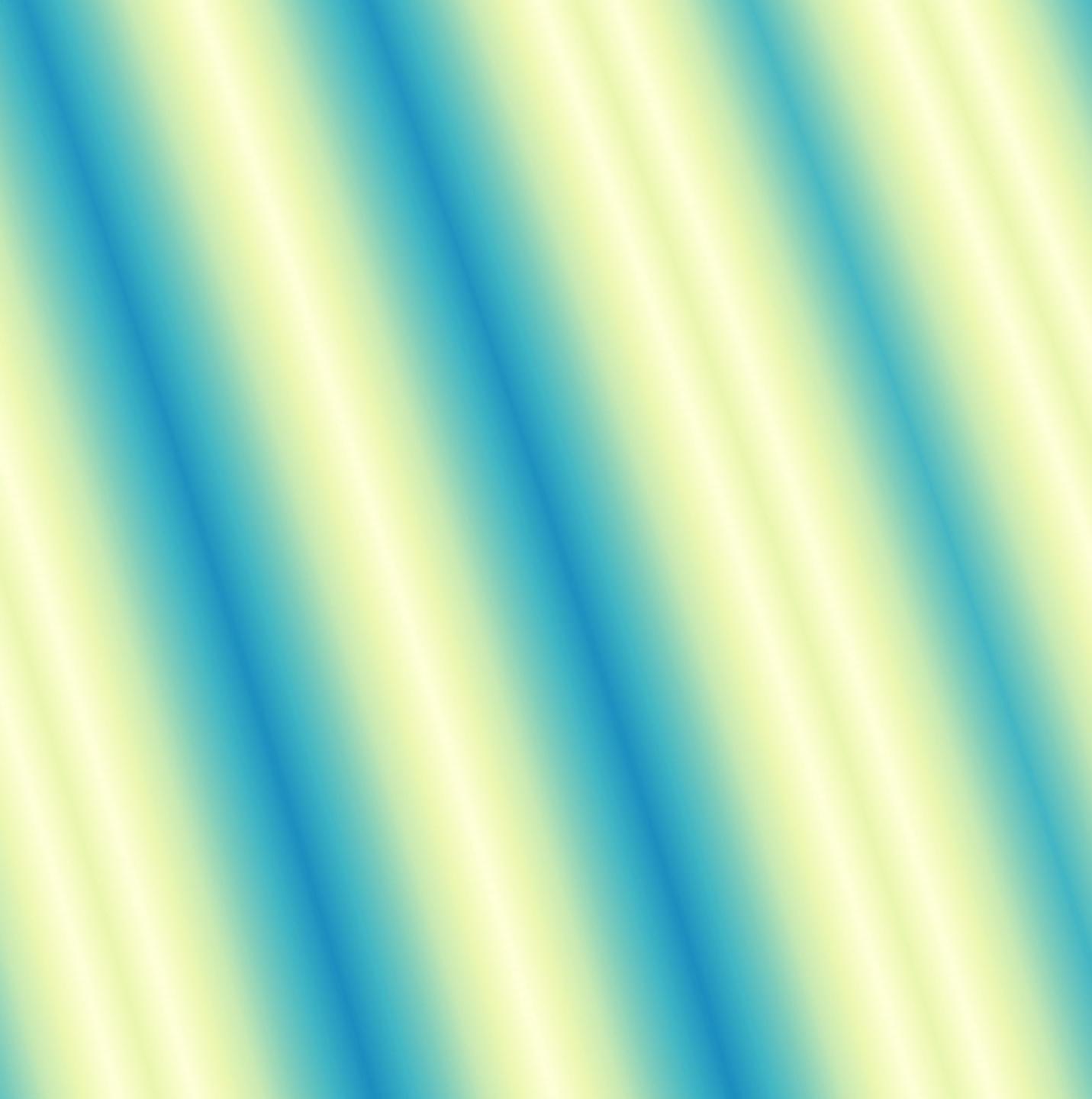
2022

Aqua



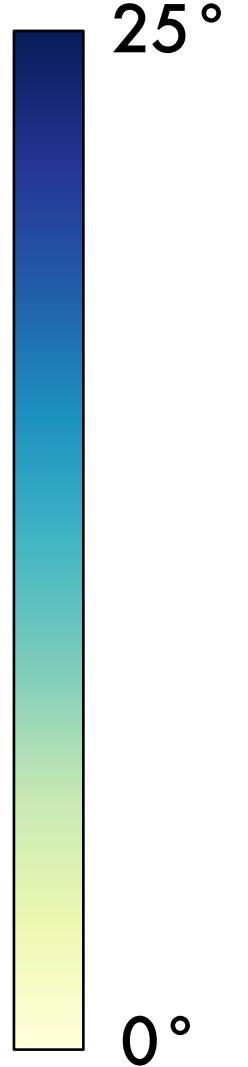
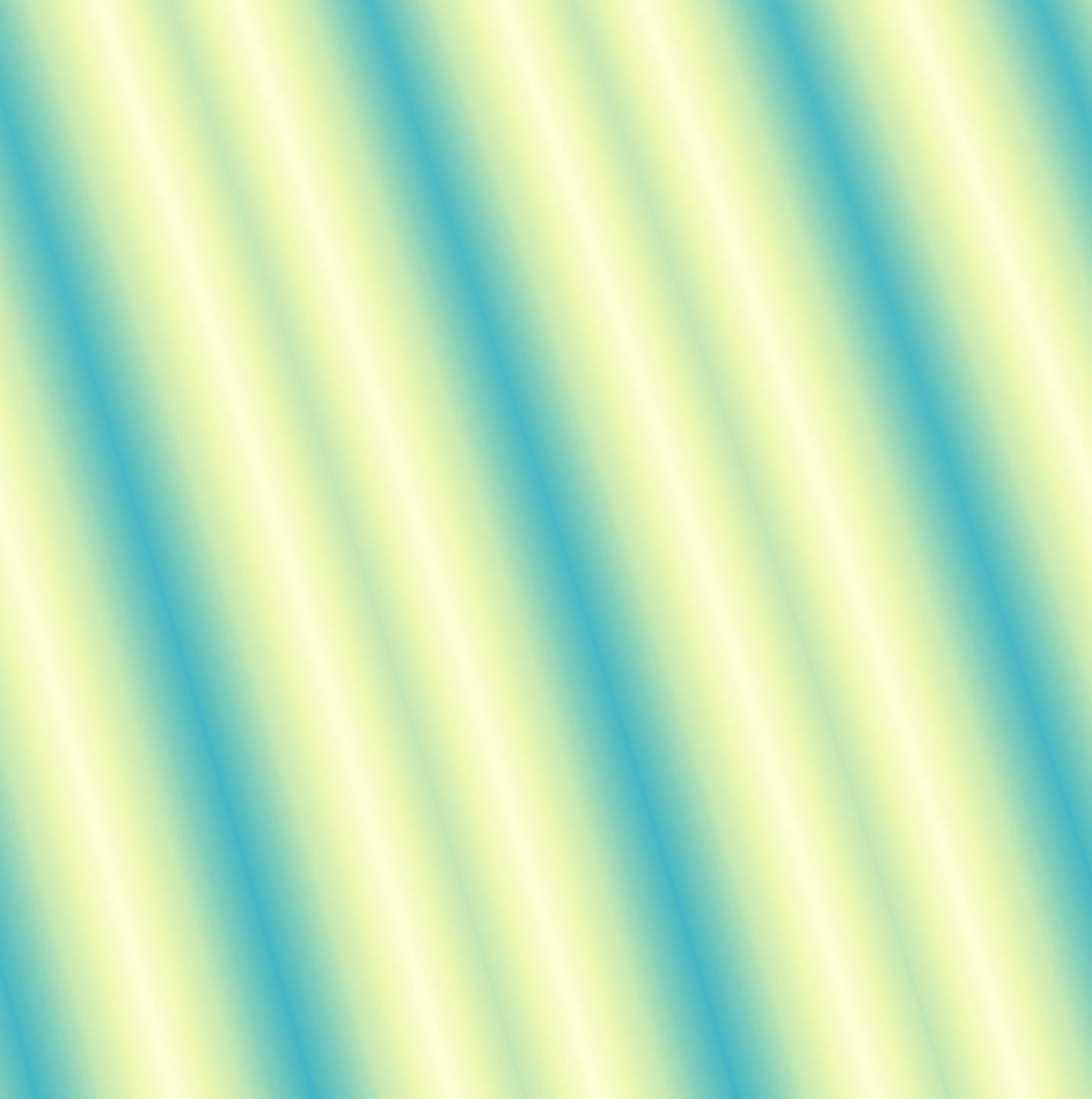
2023

Aqua



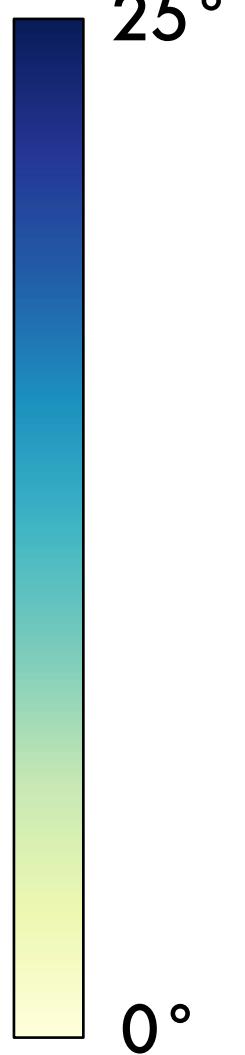
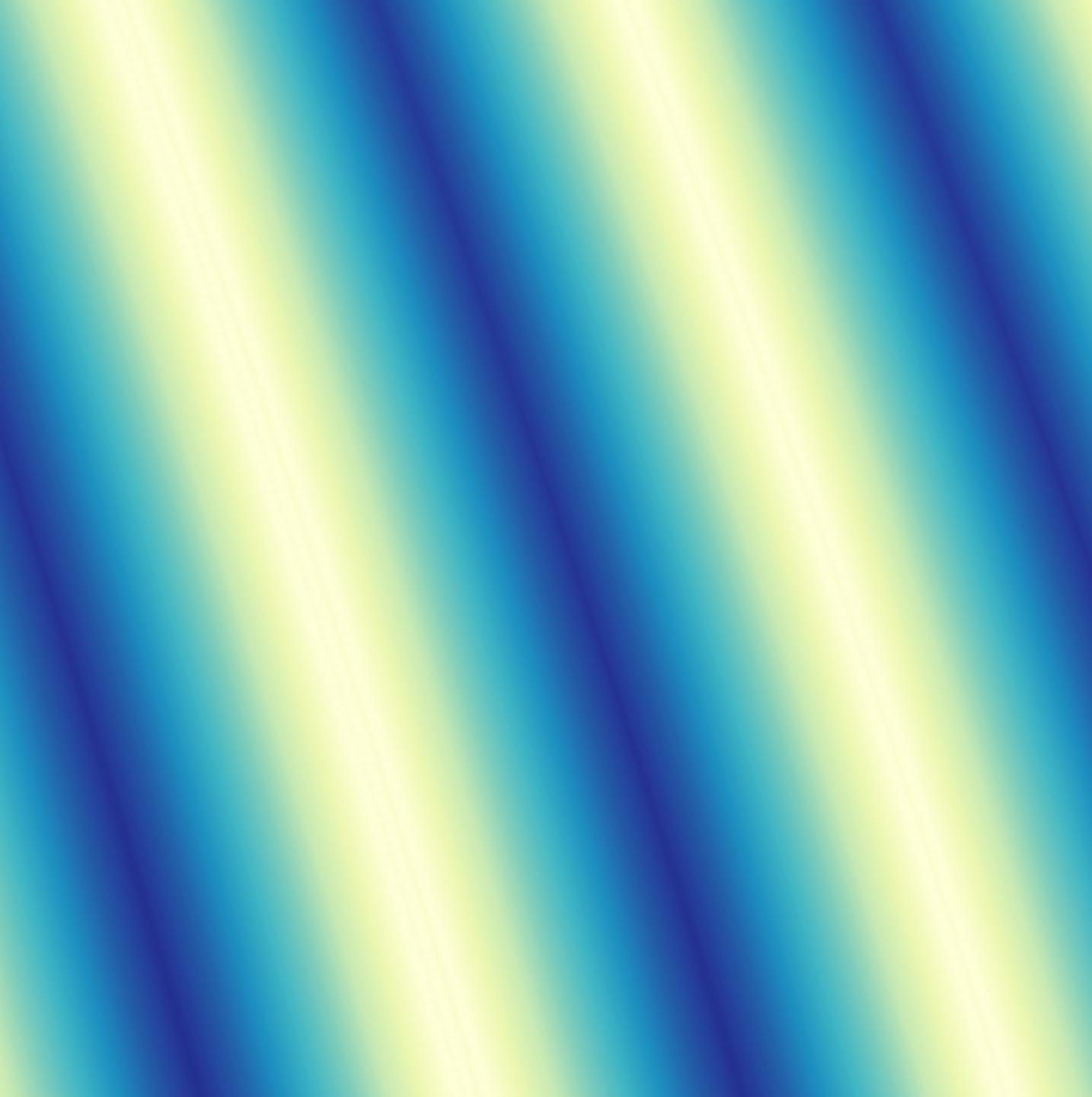
2024

Aqua



2025

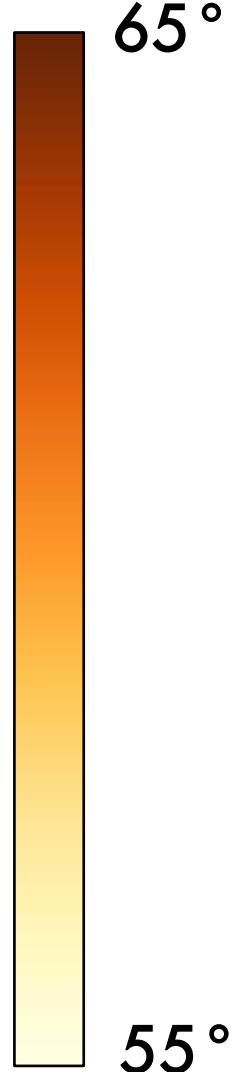
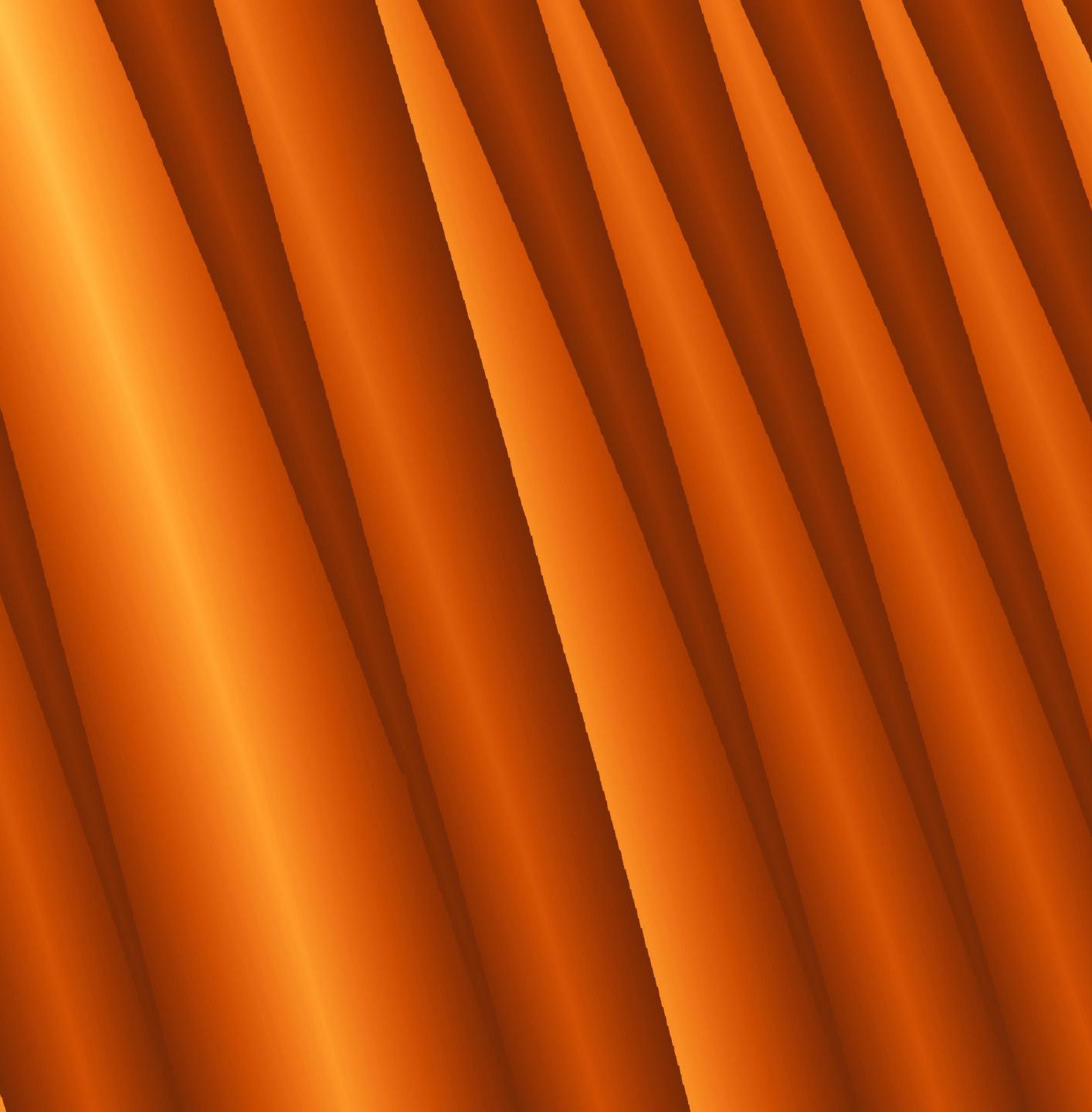
Aqua



Maximum View Zenith Angle

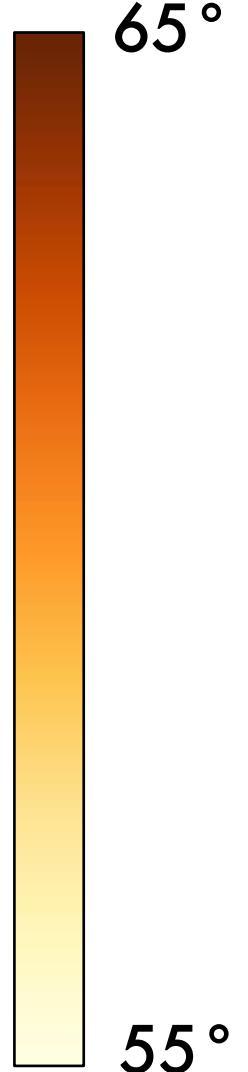
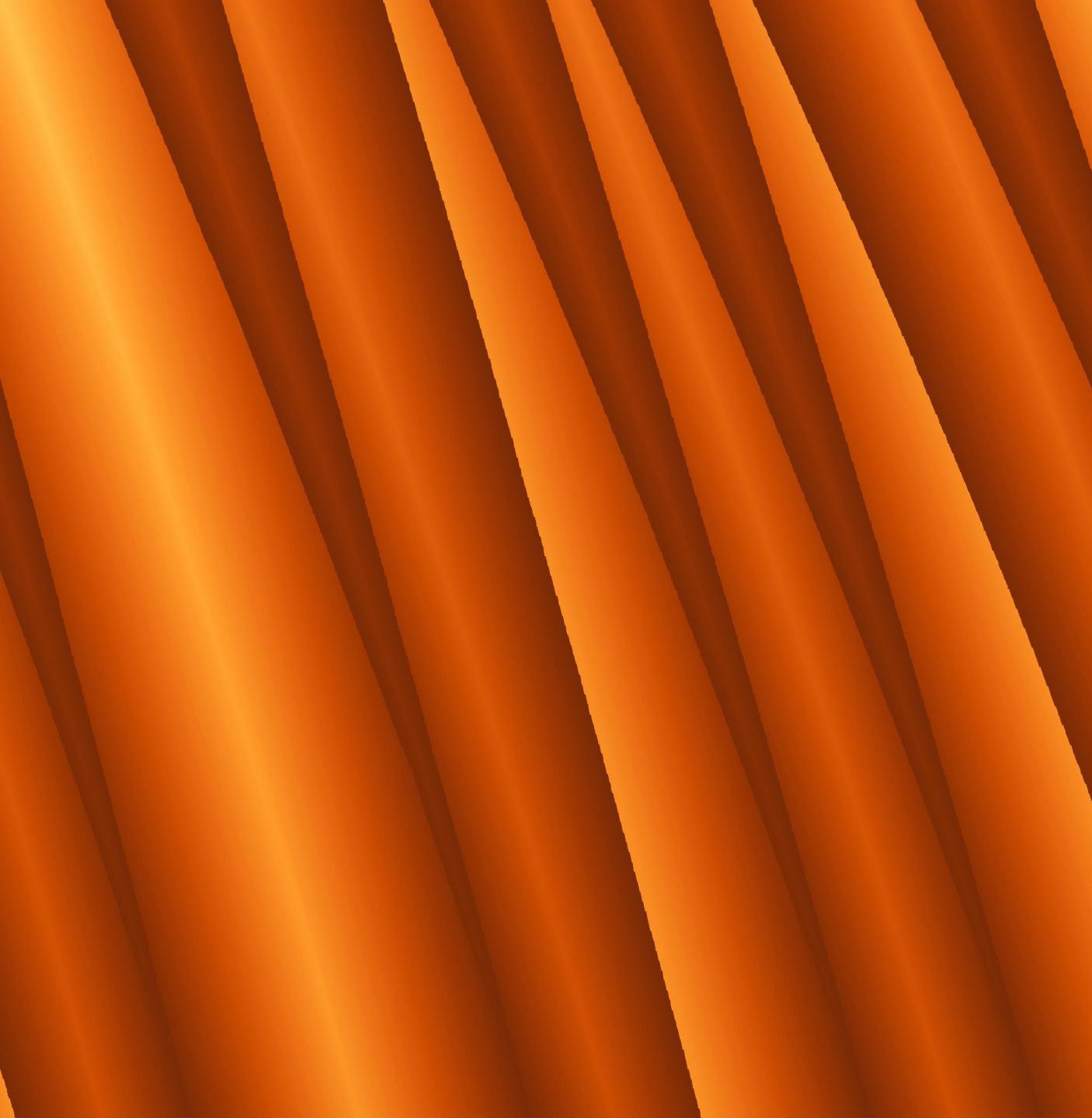
2010

Aqua



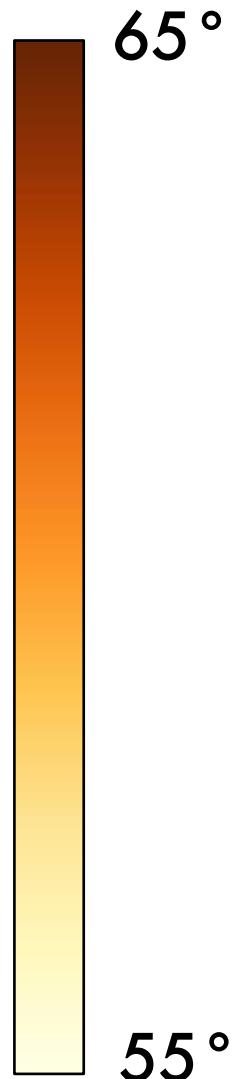
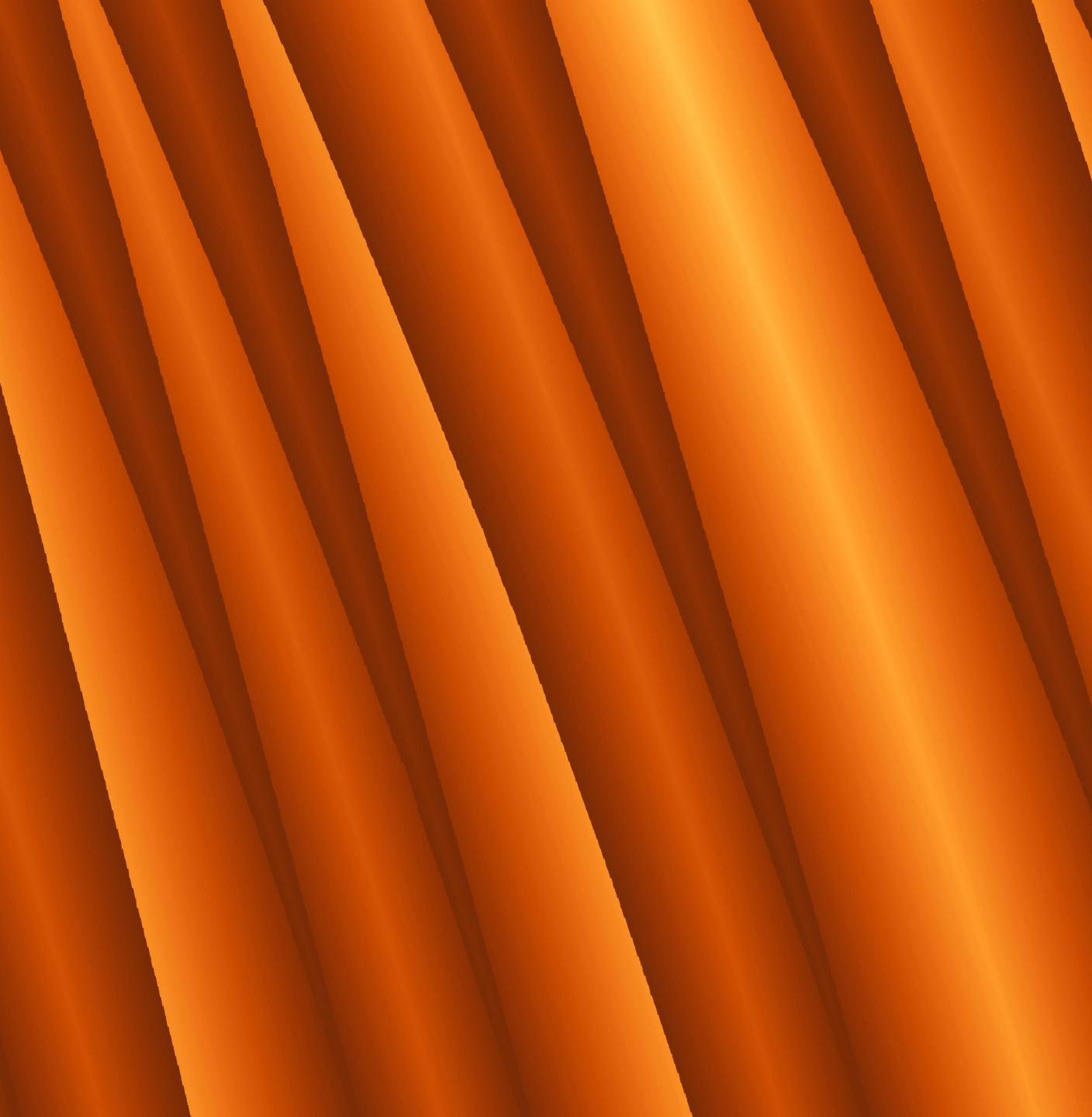
2016

Aqua



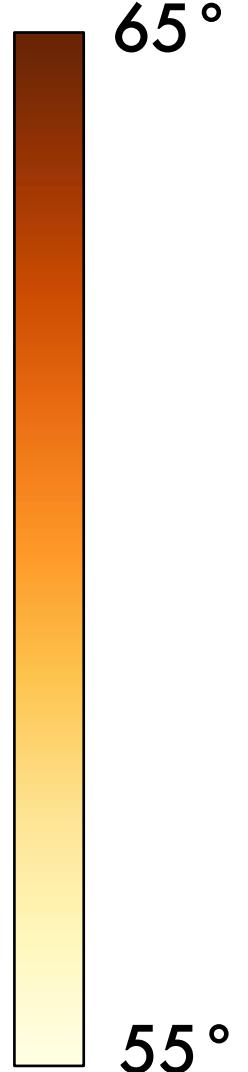
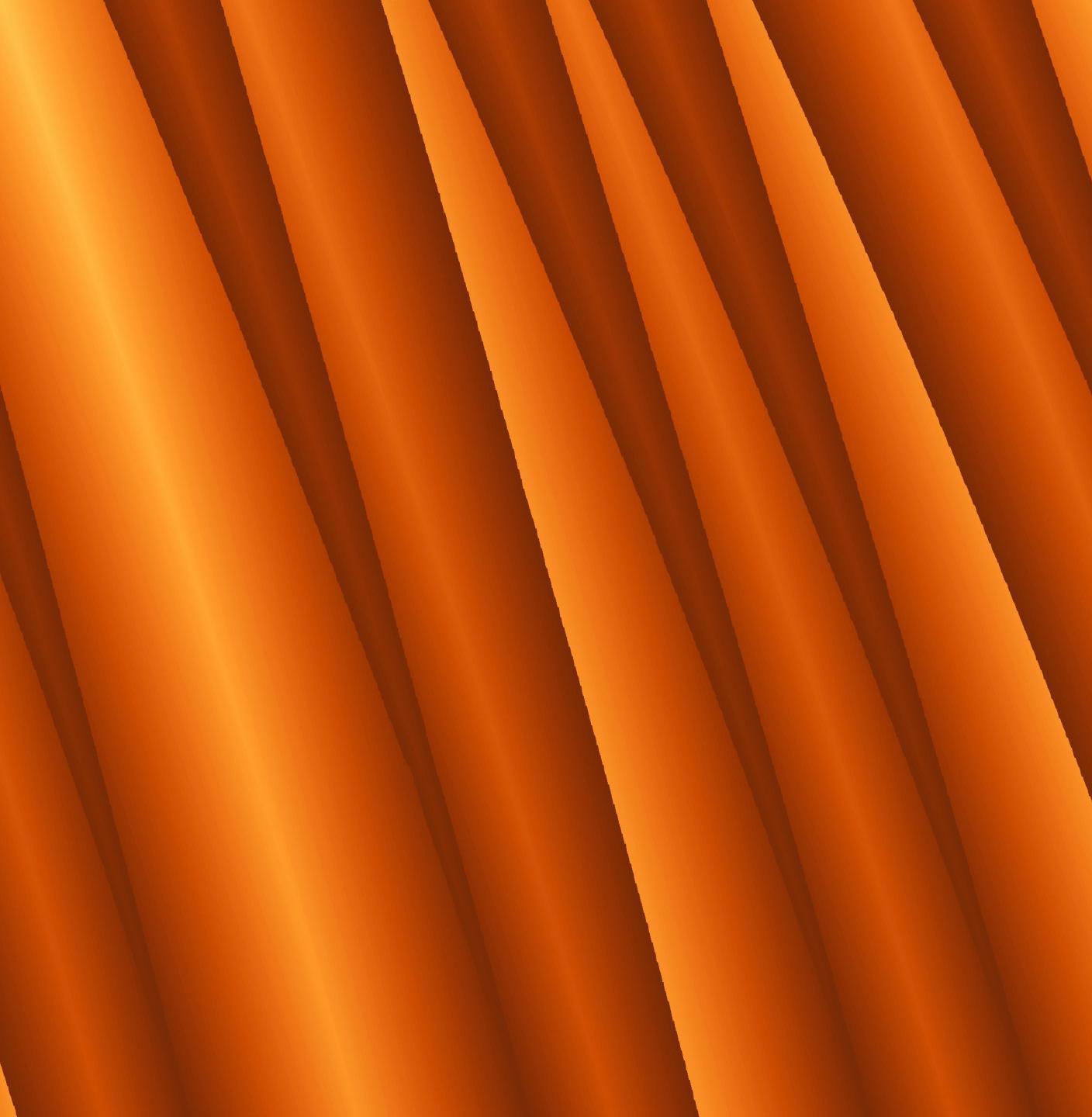
2020

Aqua



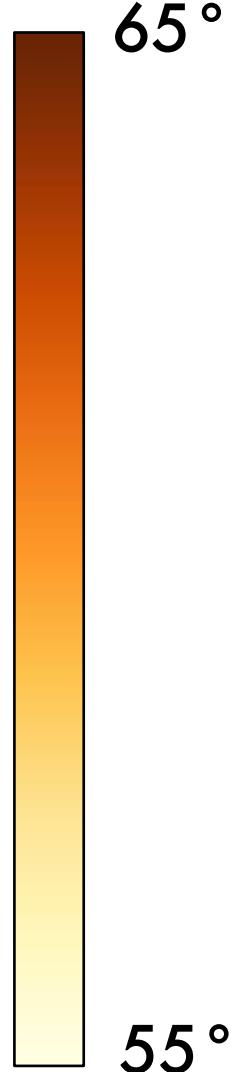
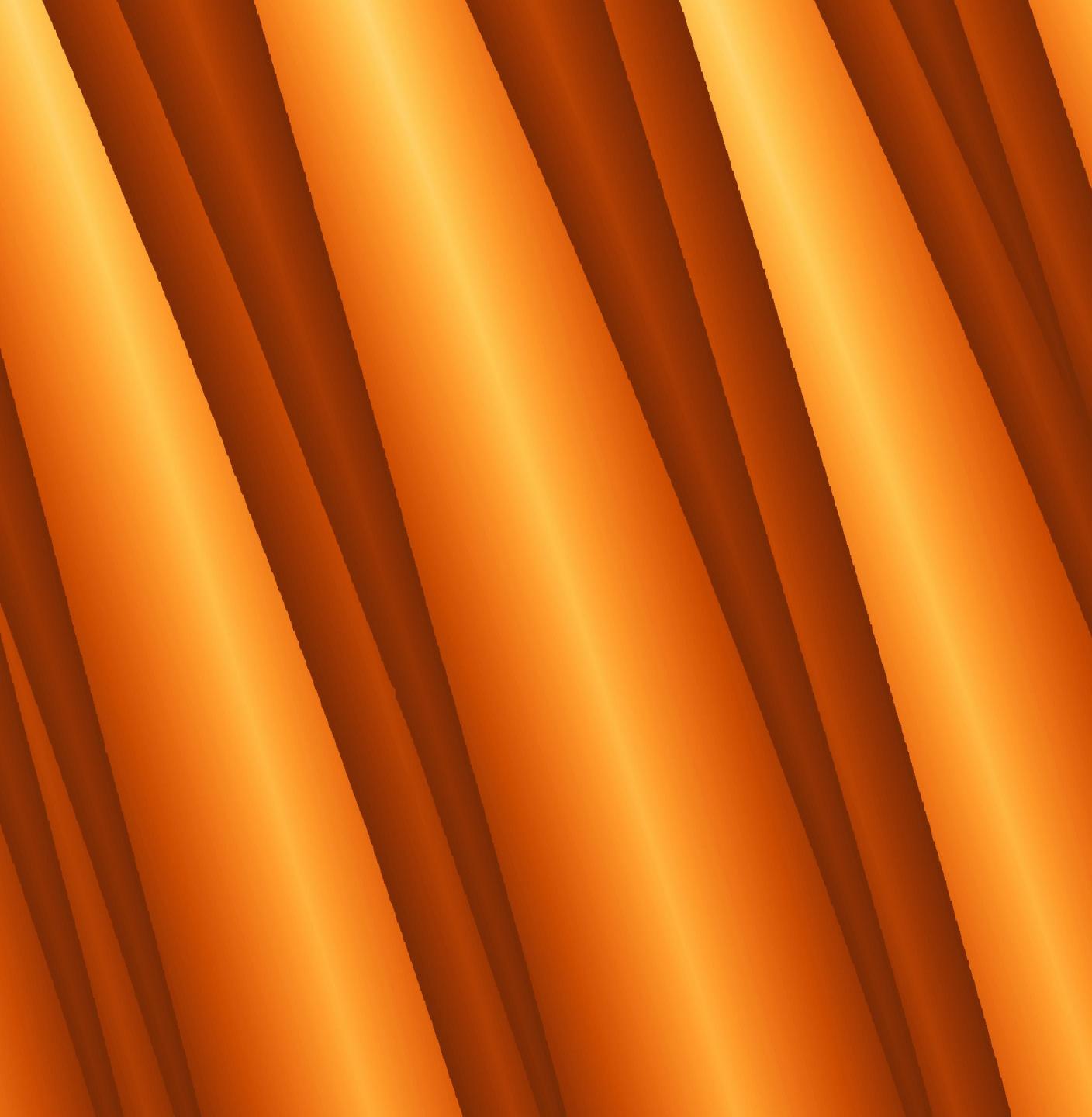
2022

Aqua



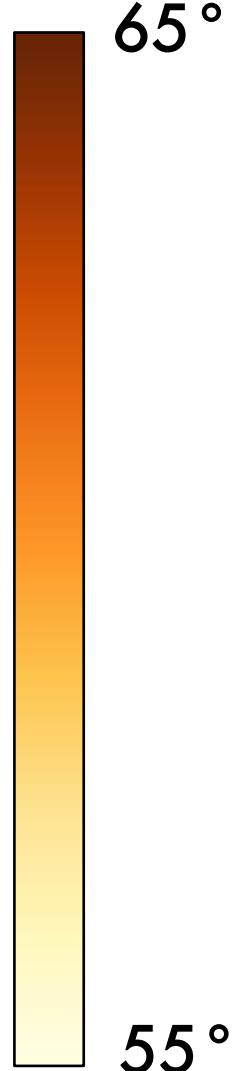
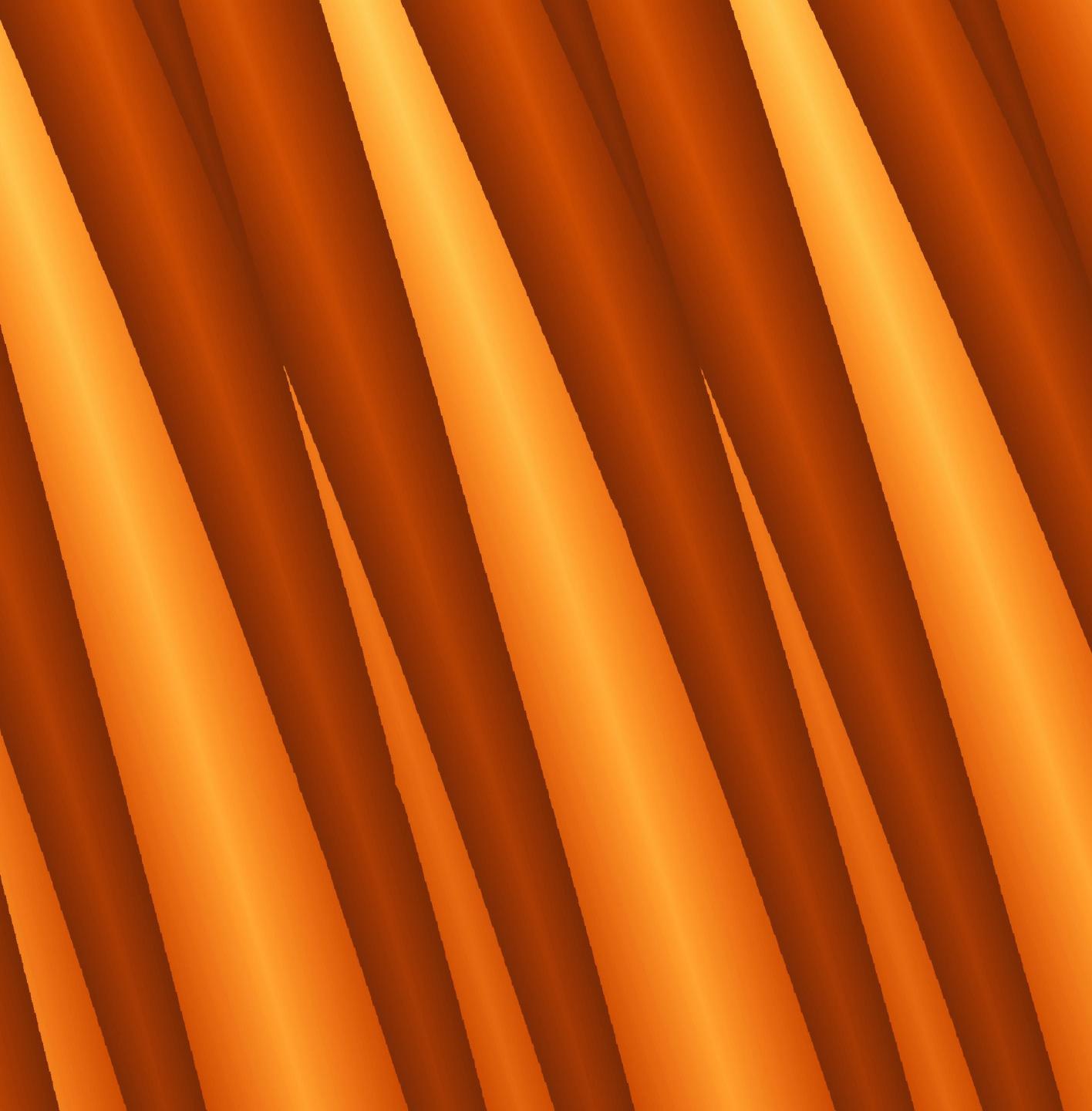
2023

Aqua



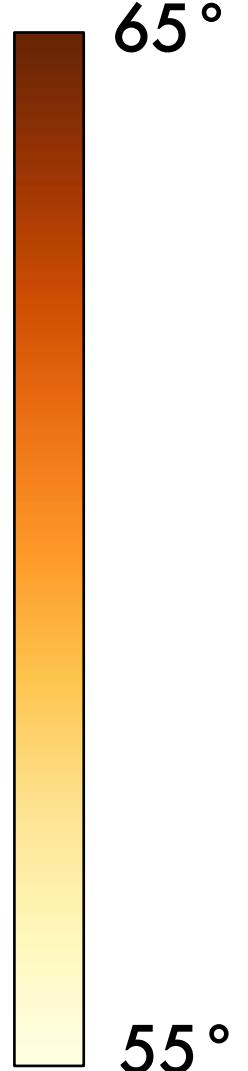
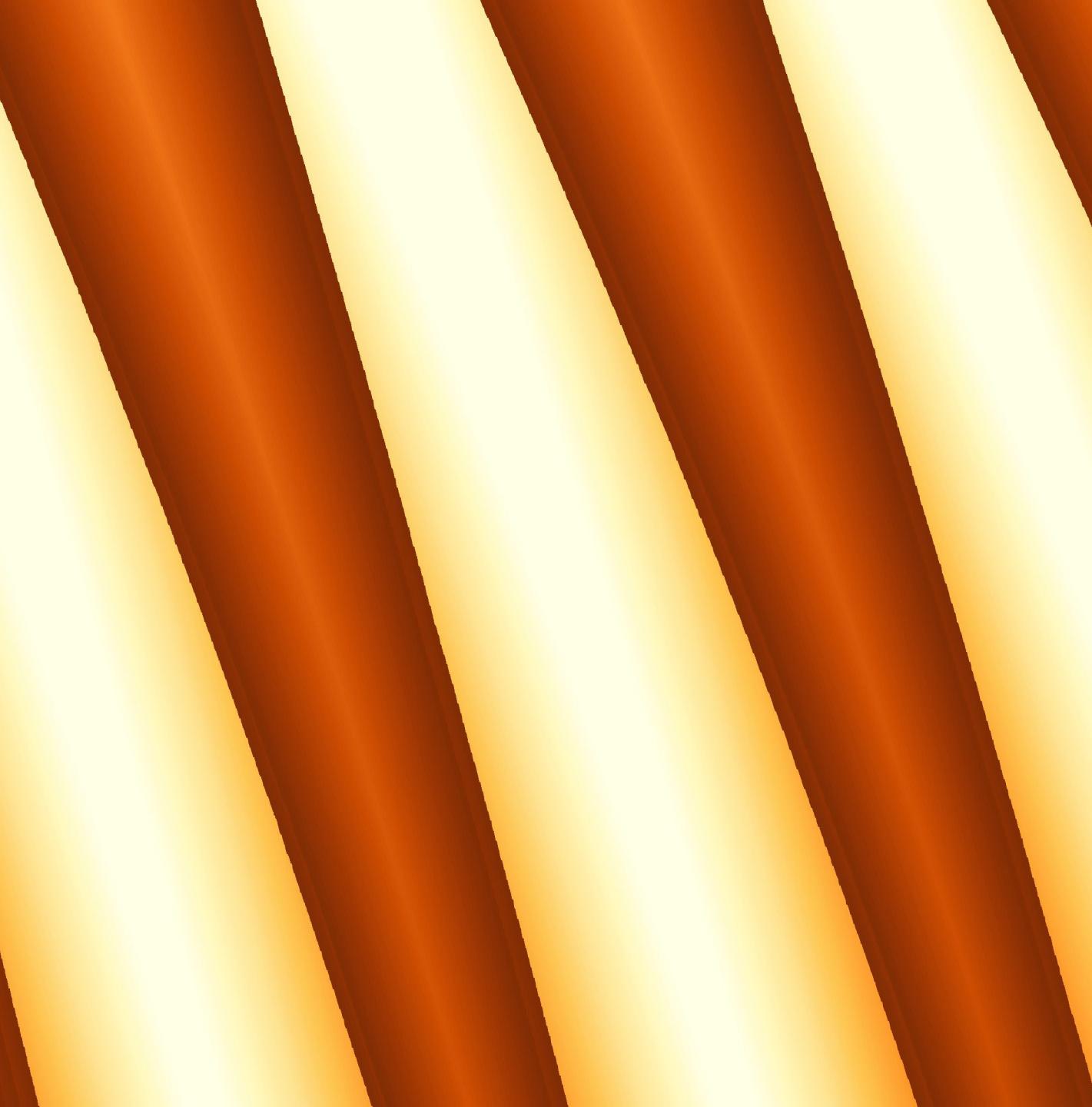
2024

Aqua



2025

Aqua

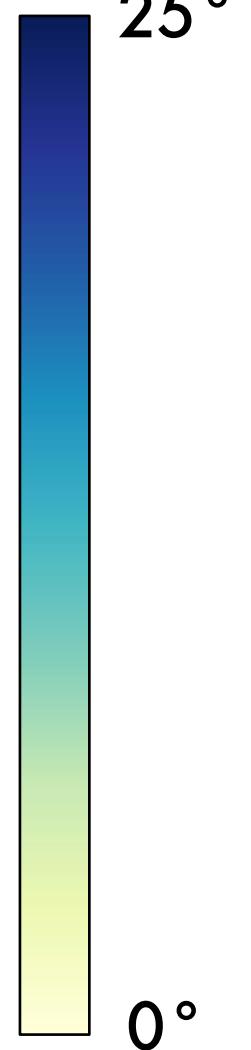
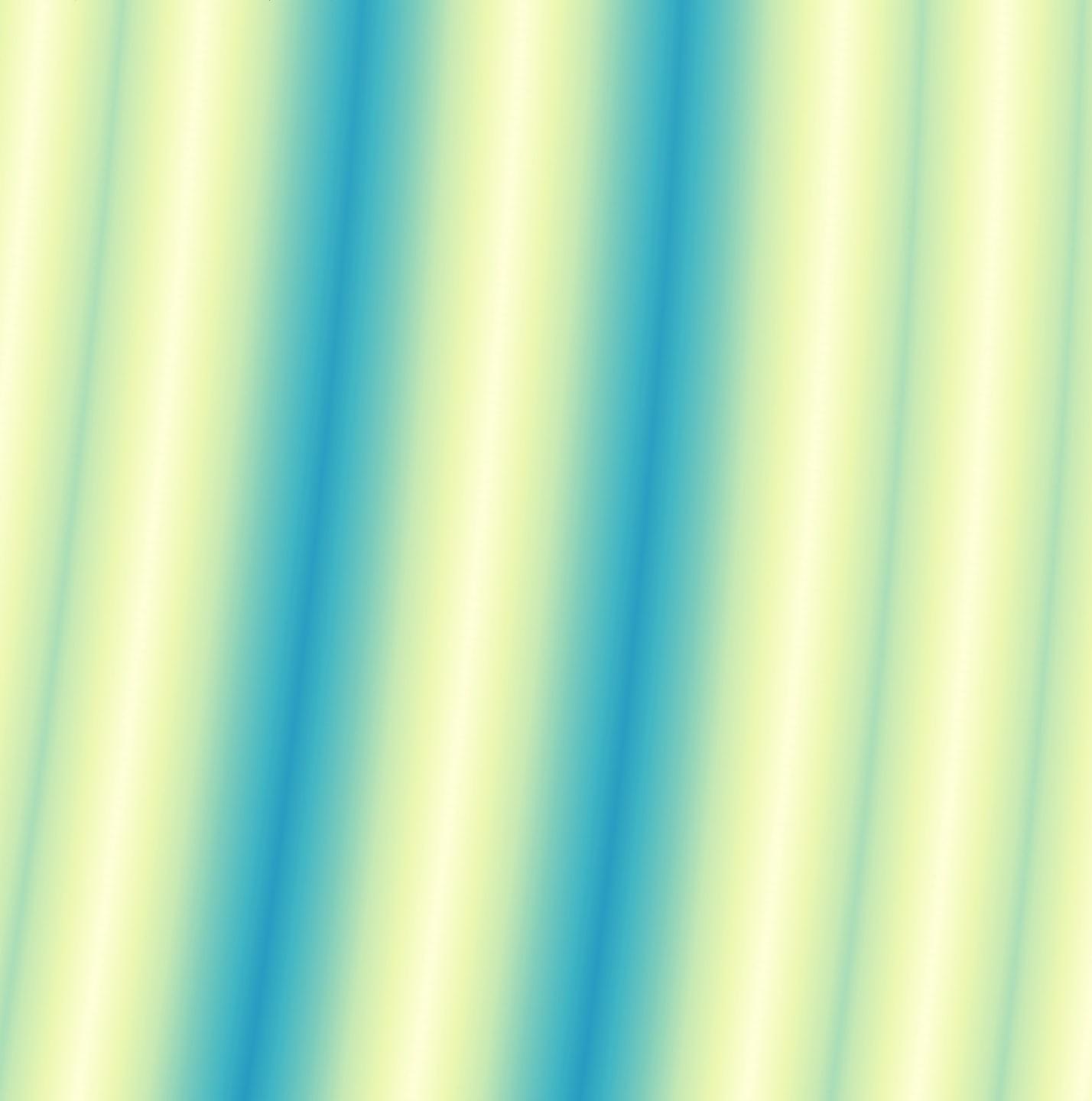


Tile-Level Composites

- Same as previous slides, but derived from daily Terra surface reflectance composites

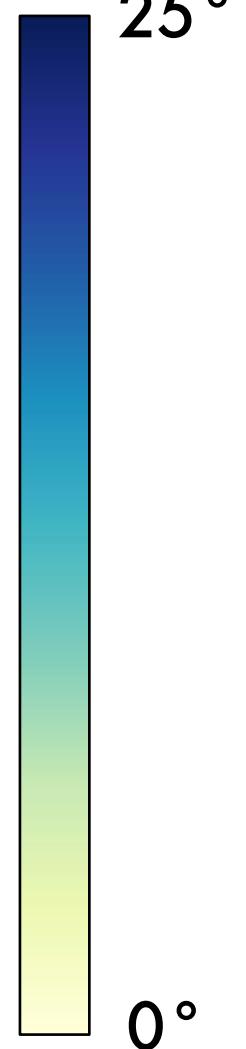
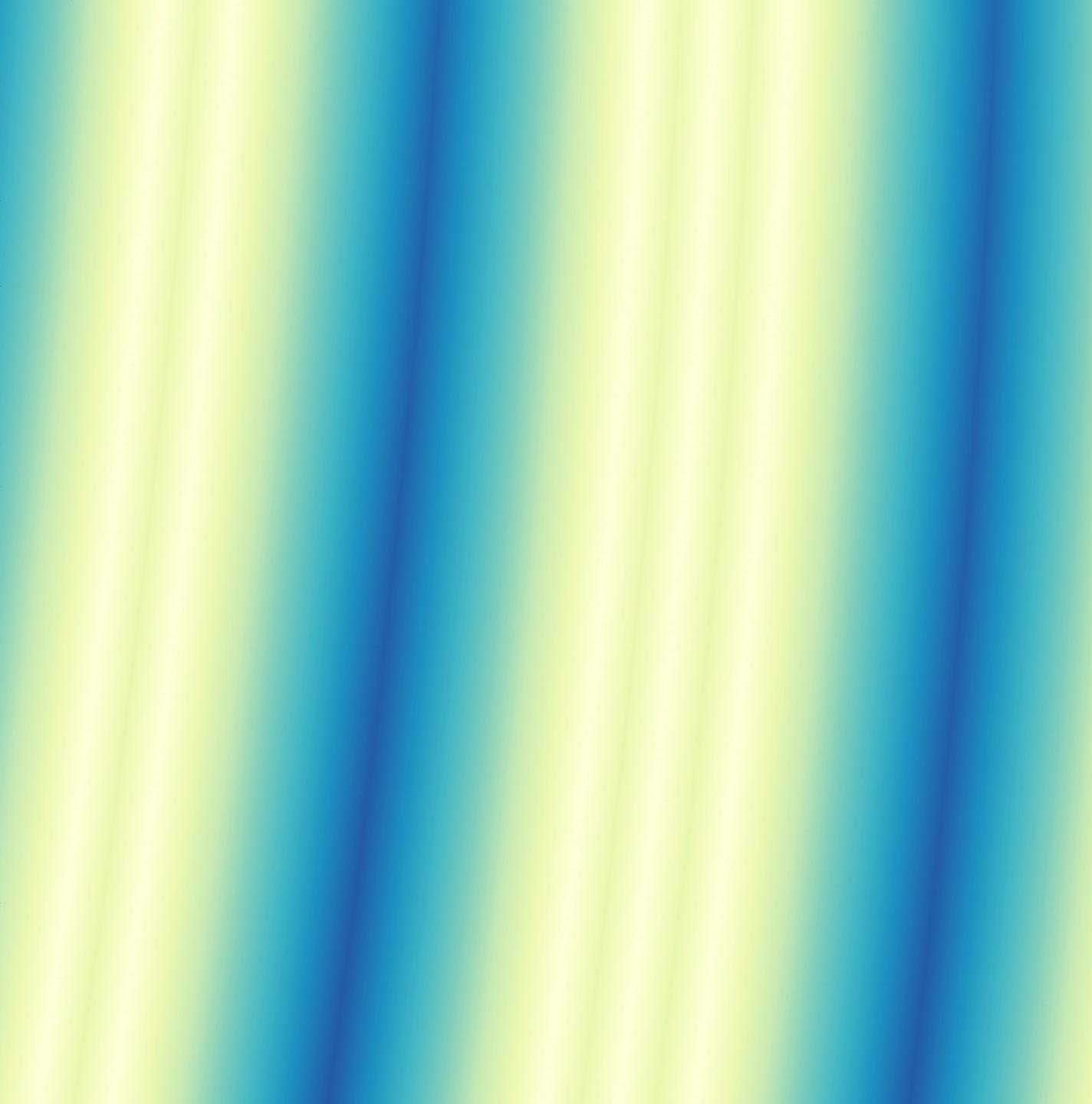
2016

Terra



2025

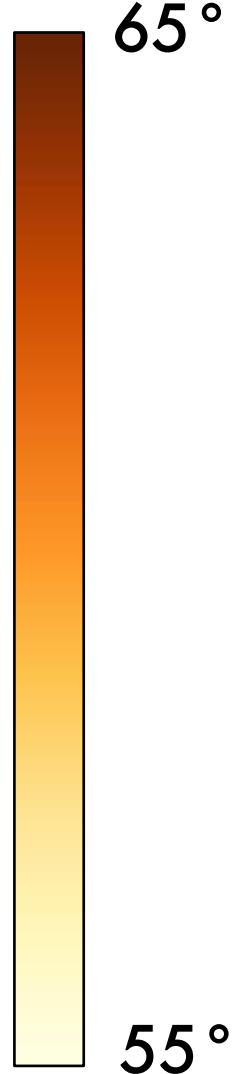
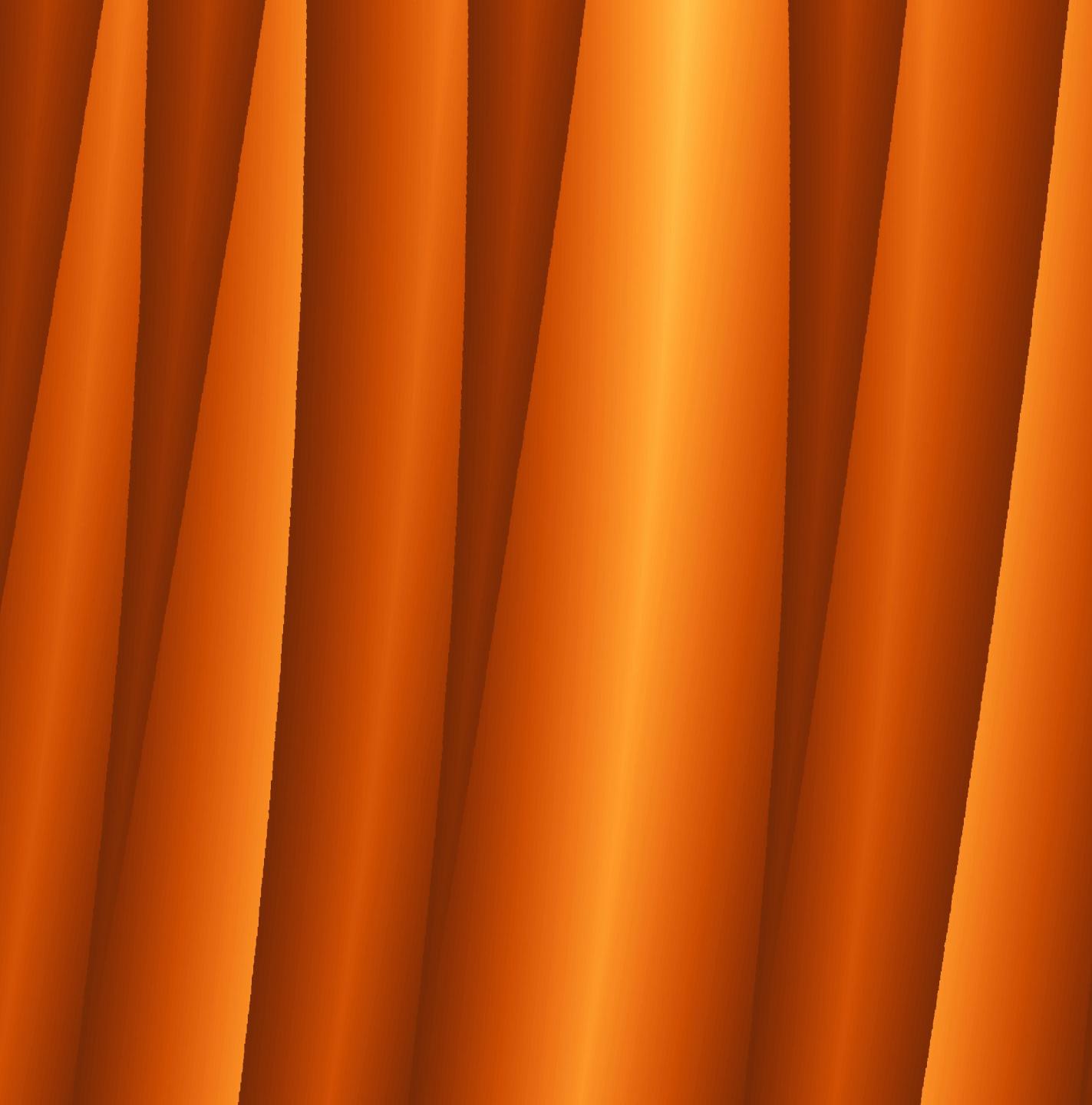
Terra



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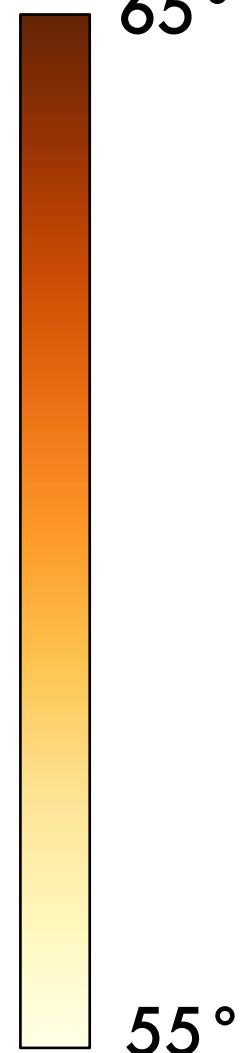
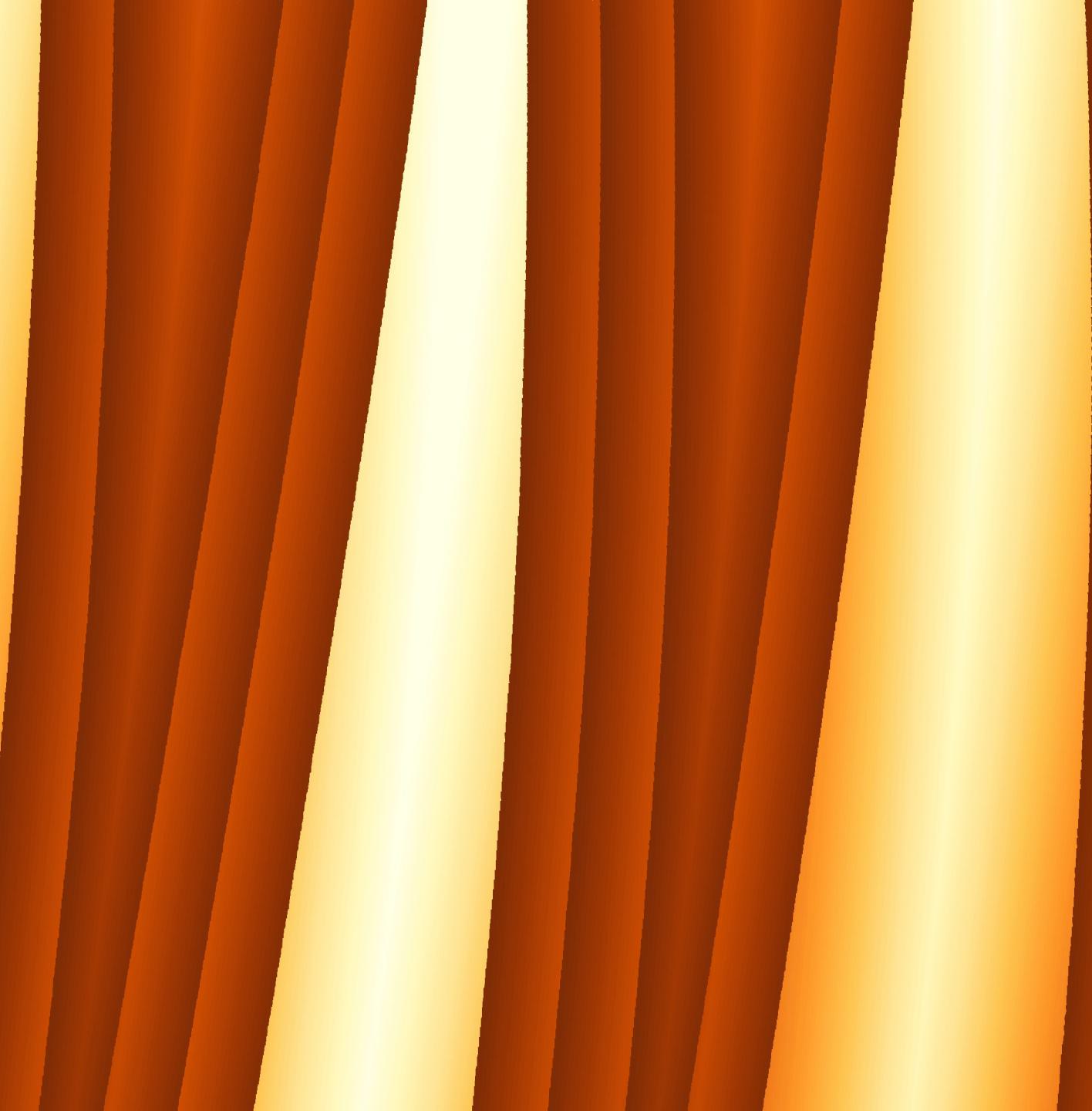
2016

Terra



2025

Terra



Summary

- Impact of Terra/Aqua orbit drift on MODIS fire products is under active investigation by my group
- Impact on broader product suite is under active investigation by the LDOPE
- MODIS pixel size, pixel spacing, scan gap, bowtie overlap, and sampling of diurnal cycle are most obviously affected
- Impacts on MODIS spatial sampling are more subtle but seem to have abruptly increased in magnitude in late 2024