Sustained, Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring

- Aims to provide an international basis for the provision of high-quality long-term datasets of ECV’s
- www.scope-cm.org
- One of 10 projects is the collaboration of EUMETSAT, JMA, and NOAA “Land surface albedo from geostationary satellites”

**Introduction**

Geostationary constellation fields of view (above) and available time series (right).

**Motivation**

Spatial-Temporal Data Fusion Algorithm benefits:

1. Provides a superior product leveraging the better temporal resolution of the geostationary product and the better spatial resolution of the polar-orbiting product
2. Provides a framework for comparison of products on equal spatial and temporal footprints

Example of general flow for one year of data over a 50 km x 50 km region

**Methodology**

Consider two datasets: GSA (j = 1), MODIS (j = 2)
- Observations of type \( j \) represent spatial averages over spatial regions: \( B_1, \ldots, B_{1,1} \) (i.e., \( B_1, \ldots, B_{1,250} \)).
- Observations of type \( j \) represent temporal averages over days: \( A_1, \ldots, A_{2,1} \) (i.e., \( A_1, \ldots, A_{2,1000} \)).
- Let \( Y_{s,t} \) be the observed value of data type \( j \) for region \( B_t \) and day \( A_t \). Let \( \mu(s,t) \) be the true albedo at spatial location \( s \) on day \( t \).

\[
E(Y_{s,t}) - \mu(s,t) = \frac{1}{|B_t|} \sum_{j=1}^{1000} Y_{s,j}
\]

The true process is taken to be a linear combination of spatial and temporal basis functions:

\[
\mu(s,t) = \sum_{j=1}^{U} \sum_{k=1}^{V} \theta_{jk} G_j(s) H_k(t)
\]

This can be written in matrix form (\( U = \# \) spatial basis functions, \( V = \# \) temporal basis functions):

\[
Y_{s,t} = \Theta(j, k) G_j(s) H_k(t)
\]

Theta is a matrix of spatial and temporal basis coefficients estimated via a penalized regression approach.

**Results**

As a pilot study we chose the 50 km x 50 km region surrounding the Niwot Ridge Ameriflux site in Colorado for the month of January 2003.

A thin plate spline spatial basis algorithm is utilized.

**MODIS (MCD43A3):**
- Jan 9, 2003 data (includes acquisition between days 9–24)
- 500-m spatial resolution
- Shortwave WSA
- Filtered for quality, using only full inversion data

**GSA:**
- Jan 9, 2003 data (daily)
- 2-km spatial resolution
- Shortwave WSA

A temporal-distance weighting structure is used for the temporal basis functions.

**Summary**

- Fused product demonstrates the ability to leverage the spatial resolution advantages of the polar-orbiting-based product with the temporal resolution advantages of the geostationary-based product
- Fused product fills spatial and temporal gaps of missing data in either dataset
- The choice of basis function complexity balances computational efficiency with smoothing effects
- Validation can be performed with in situ measurements