Climate Data Analysis Tools (CDAT)

Overview

- ## Promote community wide sharing of:
  - Data access, handling, and manipulation
  - Diagnostic development
  - Analysis and visualization

- ## Originally developed to promote achieving and diagnosing of simulation data.

- ## Open-source based on Python
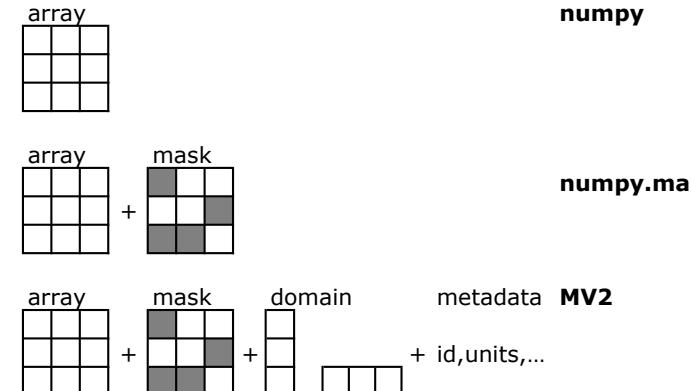
Data Handling and Management

- Core module: Climate Data Management System 2 (CDMS 2)
    - Multiple I/O formats: NetCDF, HDF, PP, GrADS-GRIB, ASCII, Binary

- Lies on top of strong numerical package but made metadata smart: MV2 – layer on top of Numpy which preserves metadata

- NetCDF Climate and Forecast (CF) convention – metadata designed to promote the processing and sharing of simulation and observation data

Climate Model Output Rewriter 2 (CMOR 2)

- The "Climate Model Output Rewriter" (CMOR) can be used to produce CF-compliant NetCDF files that fulfill the requirements of many of the climate community's standard model experiments and observations

- Used as the metadata schema for the Earth System Grid Federation (ESGF)

CMOR Table Amon: Monthly Mean Atmospheric Fields and Some Surface Fields				Amon	mon
(All Saved on the Atmospheric Grid)					

In CMOR Table Amon: 2-D fields on atmospheric grid

priority	long name	units	comment	questions	output variable name	standard name
1	Near-Surface Air Temperature	K	near-surface (usually, 2 meter) air temperature.		tas	air_temperature
1	Surface Temperature	K	"skin" temperature (i.e., SST for open ocean)		ts	surface_temperature
1	Daily Minimum Near-Surface Air Temperature	K	monthly mean of the daily-minimum near-surface (usually, 2 meter) air temperature.		tasmin	air_temperature
1	Daily Maximum Near-Surface Air Temperature	K	monthly mean of the daily-maximum near-surface (usually, 2 meter) air temperature.		tasmax	air_temperature
1	Sea Level Pressure	Pa	not, in general, the same as surface pressure		psl	air pressure at sea level
1	Surface Air Pressure	Pa	not, in general, the same as mean sea-level pressure		ps	surface_air_pressure
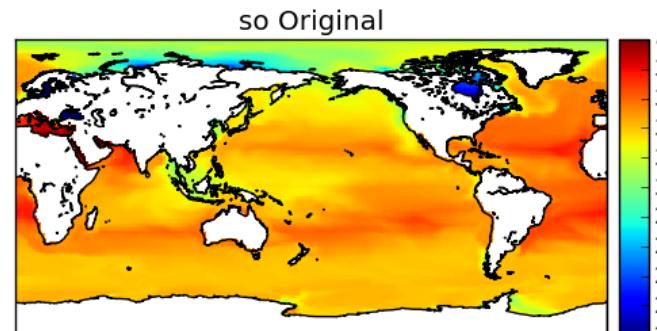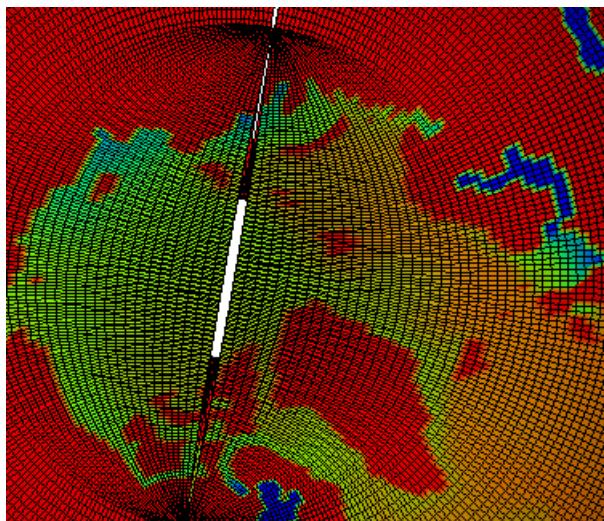
# Community Contributed Analysis Packages

- Numpy/MA/MV

- Genutil (developed at LLNL)
  - Commonly used functions to compute correlation, covariance, auto-correlation, auto-covariance, lagged correlation, lagged covariance, mean absolute difference, root mean square, standard deviation, variance, geometric mean, median, percentiles, linear regression, etc.

- Cdutil (developed at LLNL)
  - Climate data specific utilities such as spatial, area weighing, climatology diagnostics, departures, etc.

- Community contributed packages
  - Pyclimate
  - SciPy

- Over 100 software packages contributed from the climate community
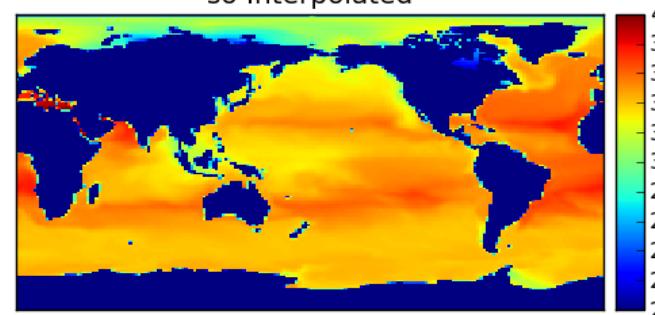
UV-CDAT Supports Multiple Regridding Tools

- ## UV-CDAT expands the choice of CDAT regridding tools by adding:
  - LibCF for nodal interpolation of curvilinear data in N-dimensions
  - ESMF for cell (conservative) or nodal (linear or quadratic) interpolation of curvilinear data in 2D or 3D
    - Leverages parallel ESMF library: domain decomposition performed on the fly by ESMF
    - Also supports regridding from and to unstructured grids
    - Handles well tripolar grid, displaced pole, and other types of grid warping

Tripolar of ocean model (detail)

Conservative regridding with ESMF

Valid fractional areas/volumes act as masking
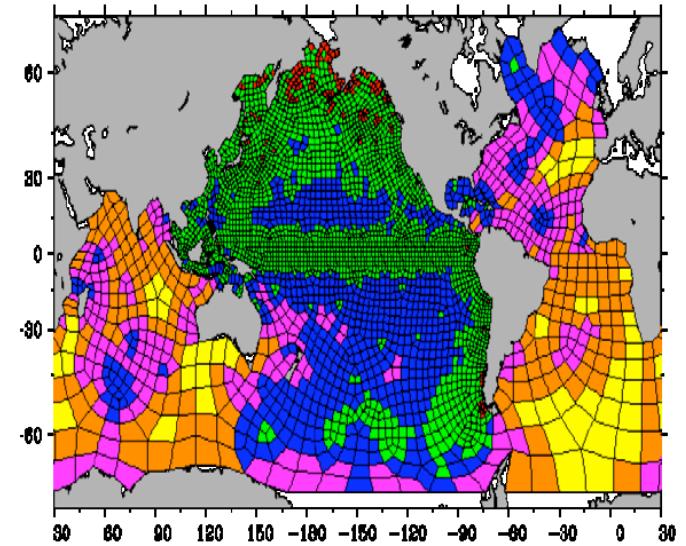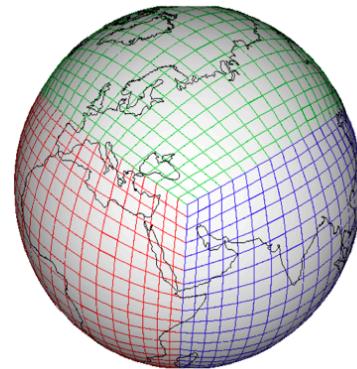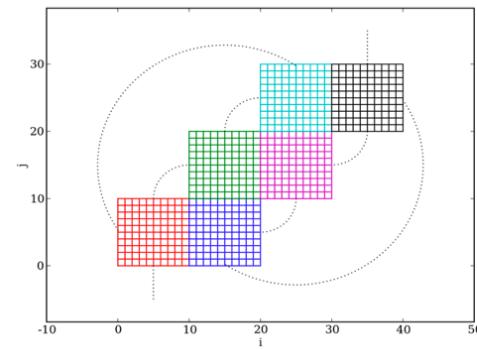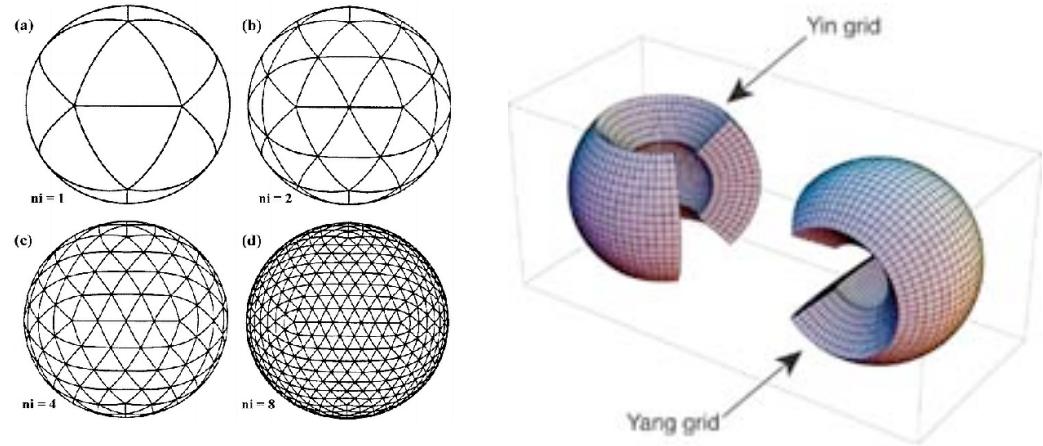
# Additional Grid Awareness

- Multiple grid software
  built-in: ESMF/ESMP,
  Gridspec, Ugrid,
  SCRIP, etc.
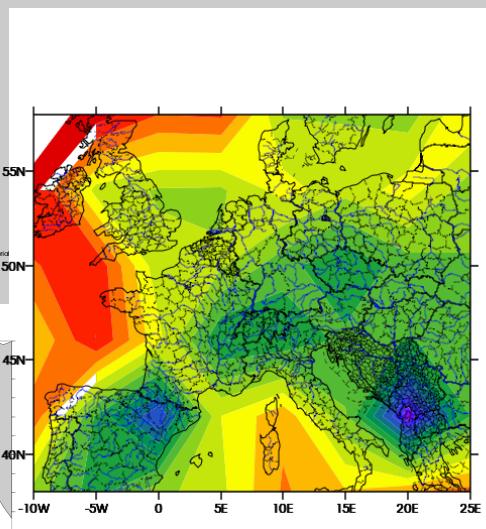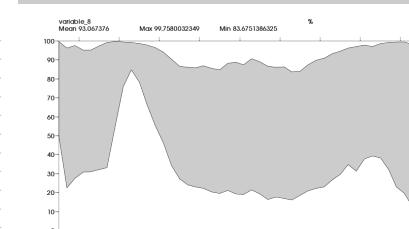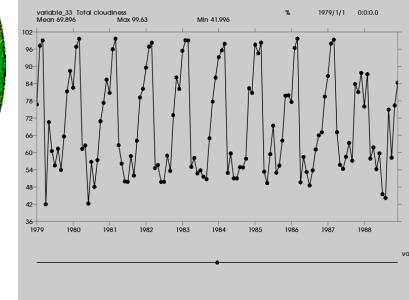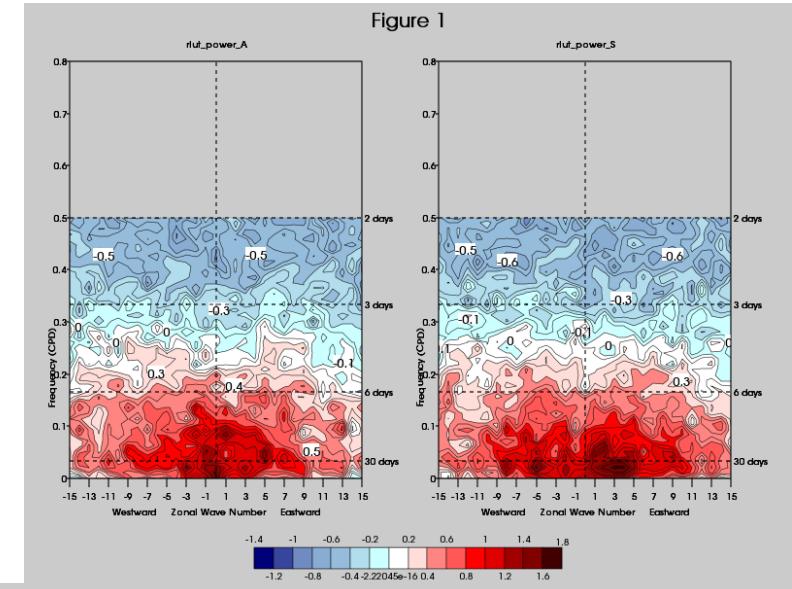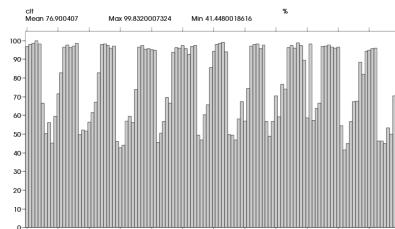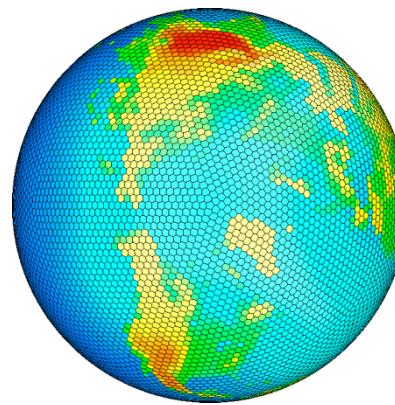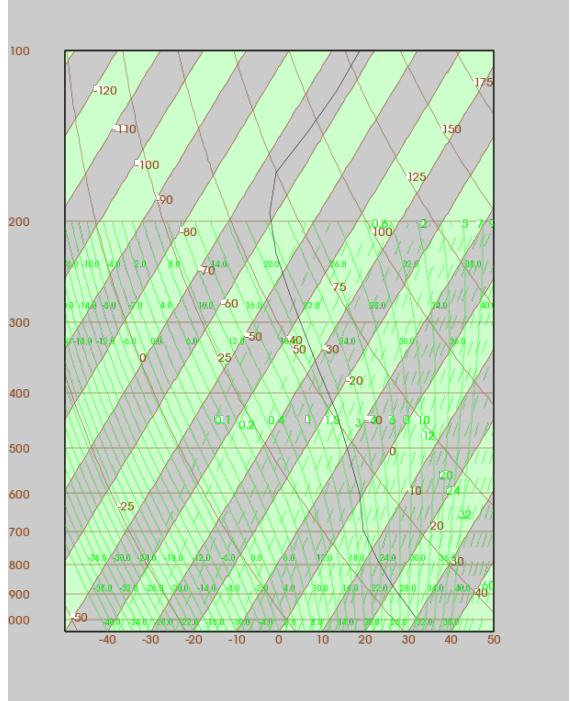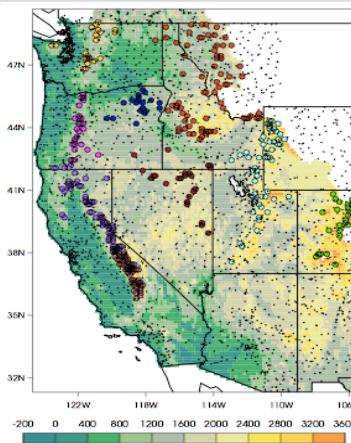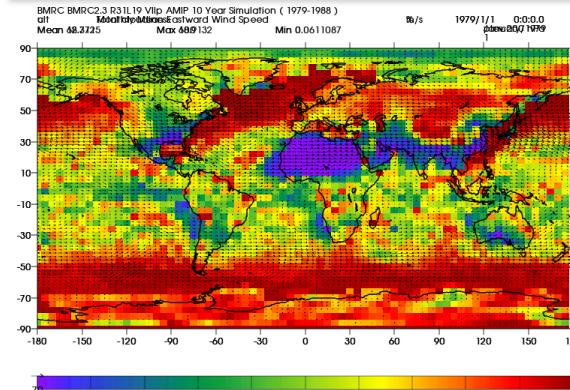
The Visualization and Control System (VCS)
1D and 2D Plots
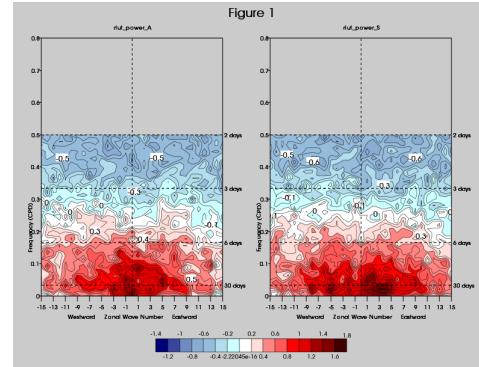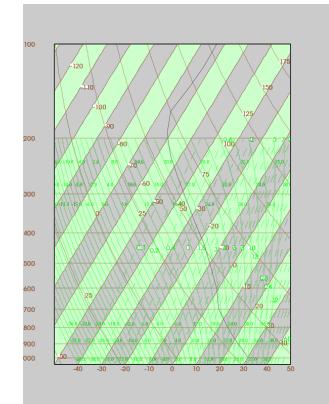
Diagnostics

- Constantly harvesting new diagnostics
- Some samples:
  - (a) WK
  - (b) Thermo
  - (c) Taylor-diagrams
  - (d) Performance plots

(a)

(b)

(c)

(d)