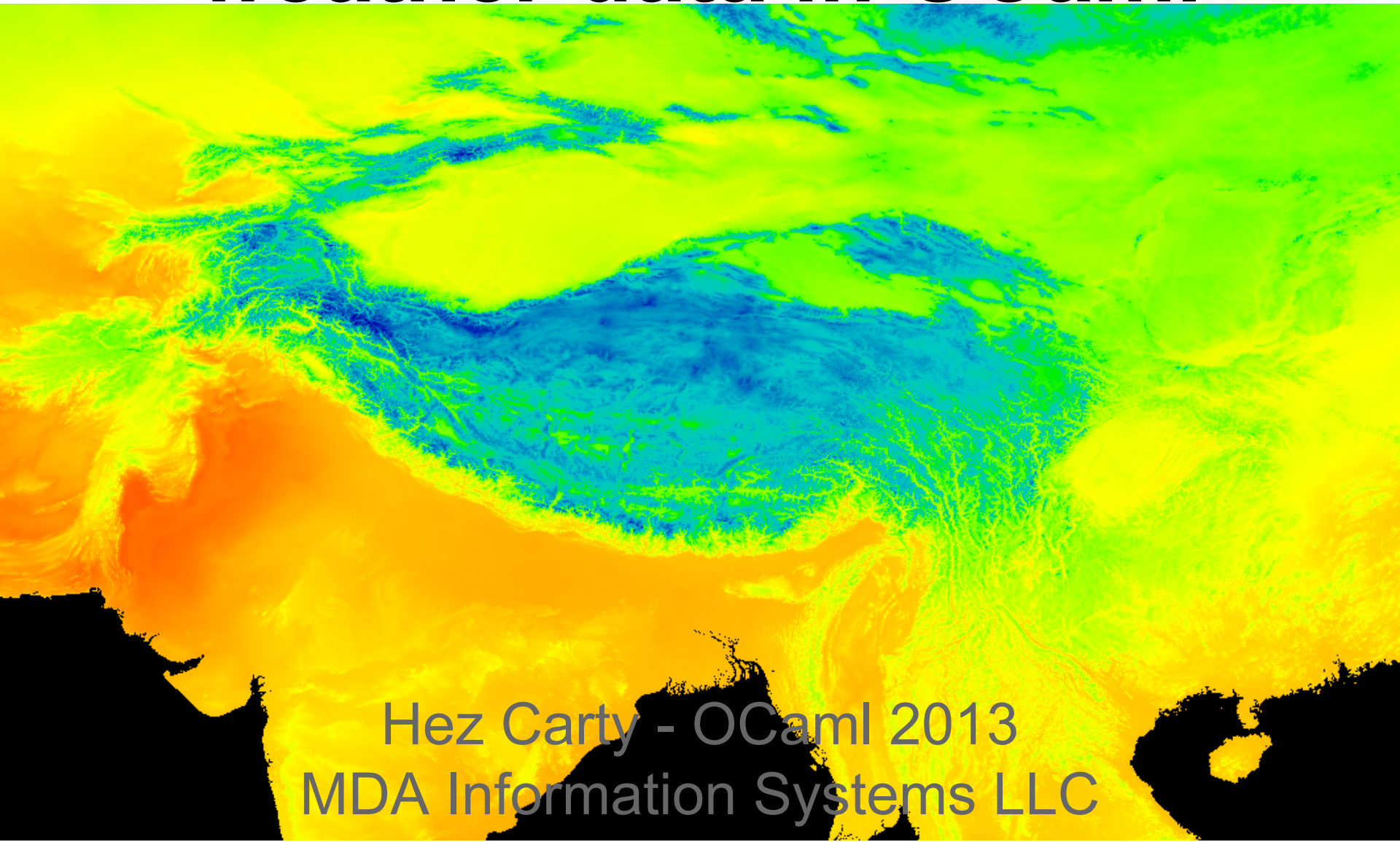
Accessing and using weather data in OCaml



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Weather and OCaml

- OCaml - why and where?
- Library bindings
- Highs and lows

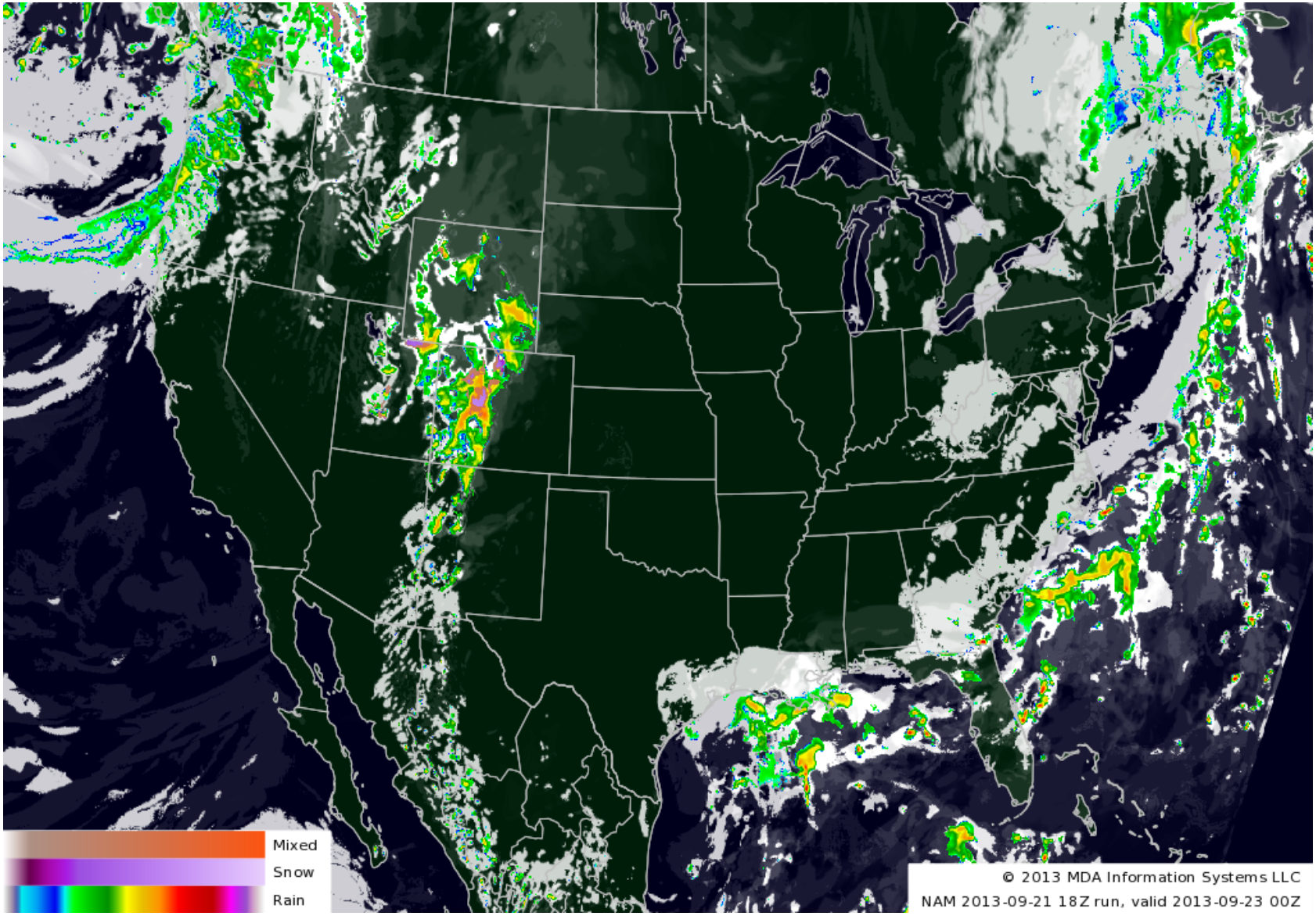
Why OCaml

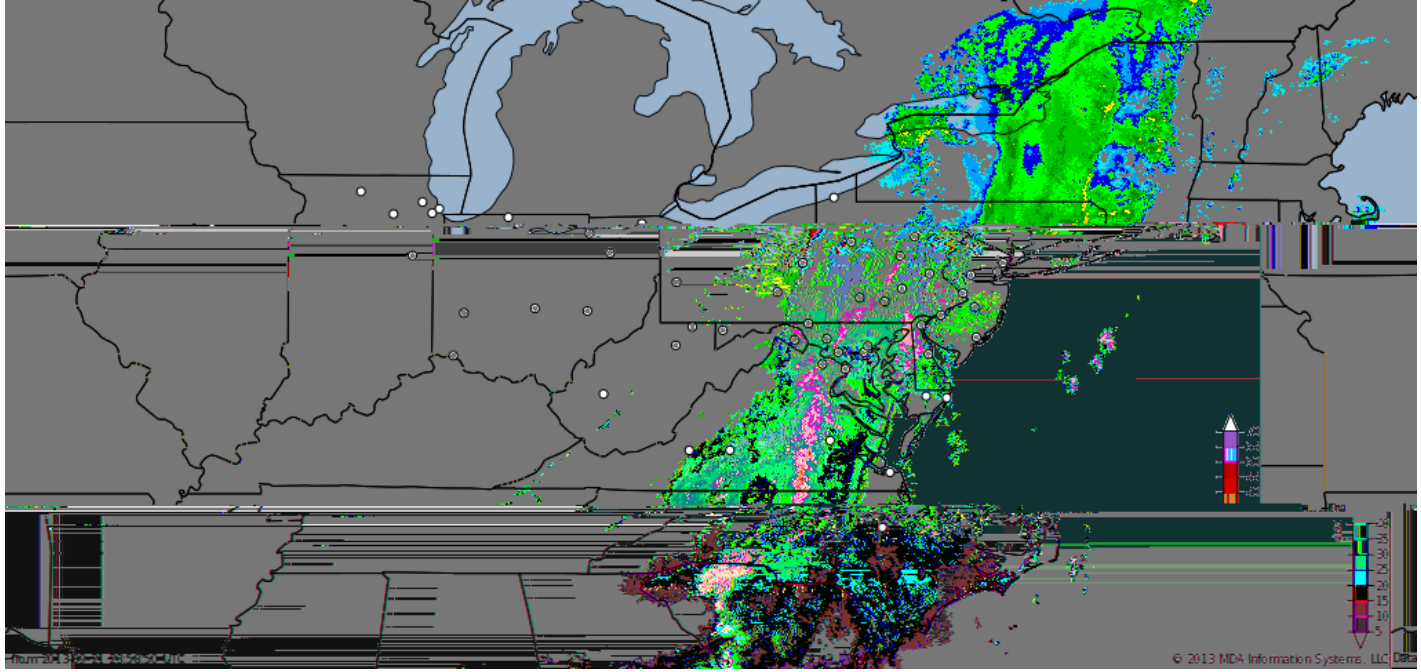
- The usual reasons
  - Functional (when you want to be)
  - Type safe and expressive
  - Native code (fast), bytecode (REPL)
  - Predictable
- Relatively simple FFI
  - Bigarrays, C-friendly float arrays
- Reasonable selection of native and bound libraries

What OCaml

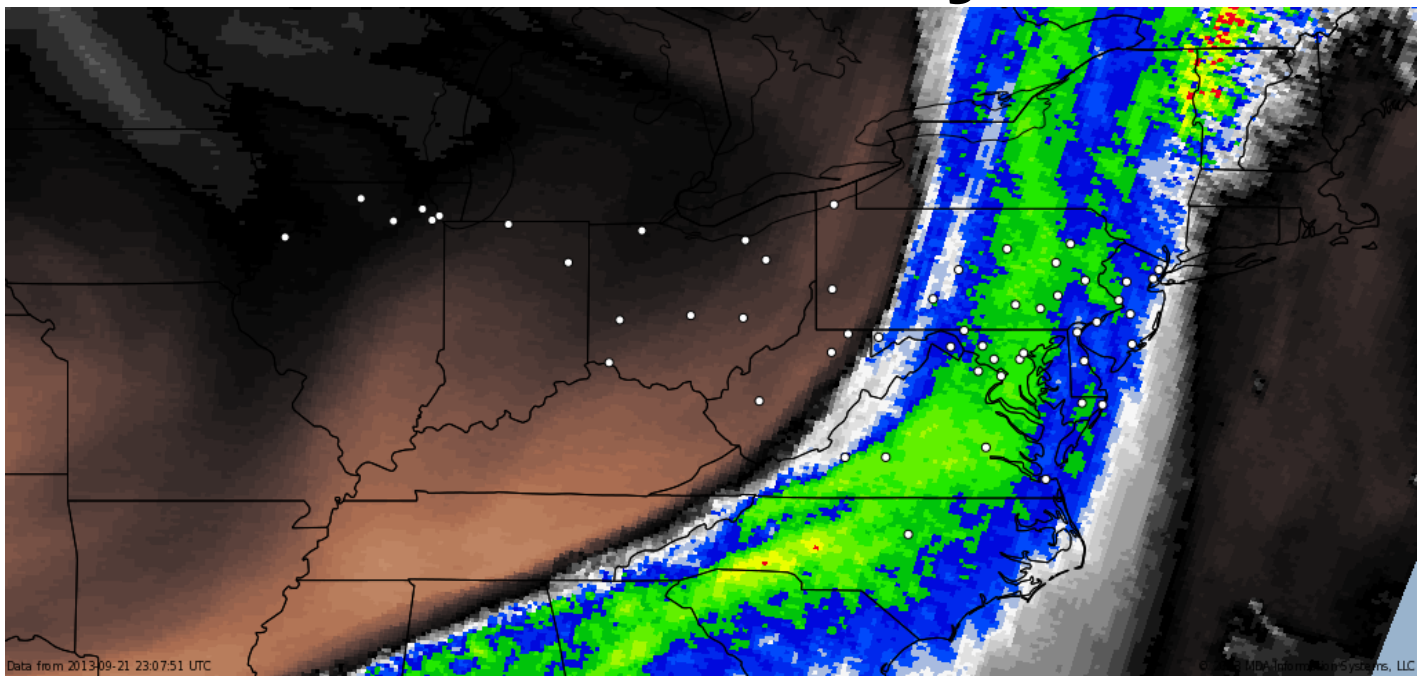
- Weather data retrieval and validation
- Services
  - HTTP, zeromq
  - Task/workflow management
- Data analysis and reduction
  - Teleconnections (PCA, plotting)
  - Precipitation probability model (Monte Carlo simulation with a first order Markov chain)
  - General data processing and preparation
    - Climatology
    - Data extraction/insertion

NAM forecast



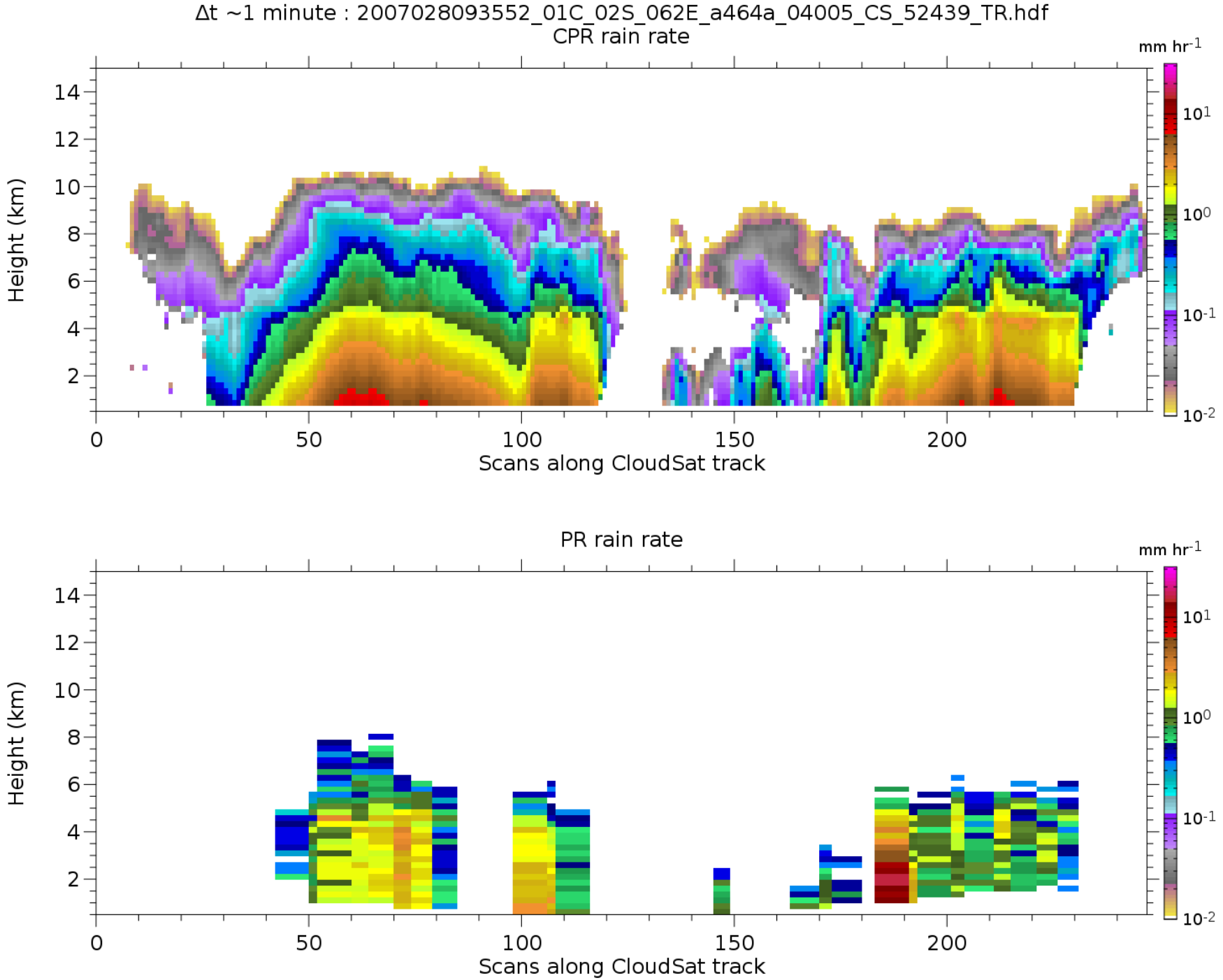


Raw bits and bytes

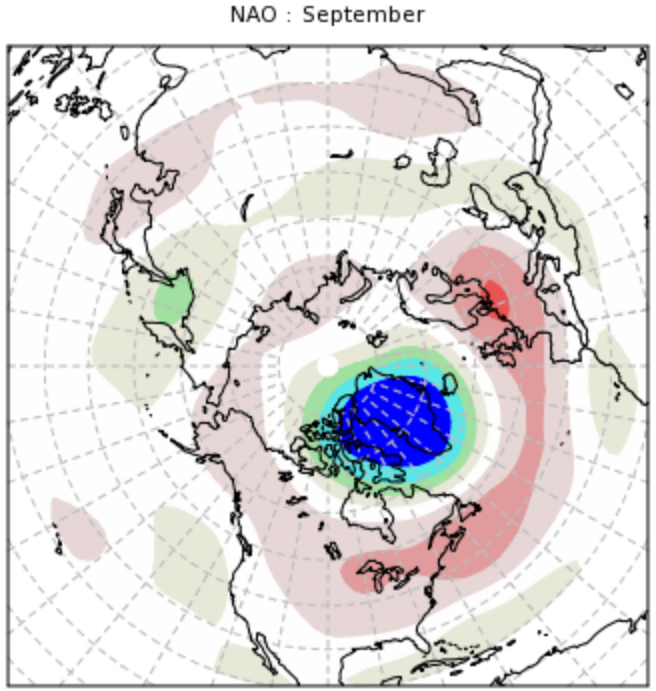


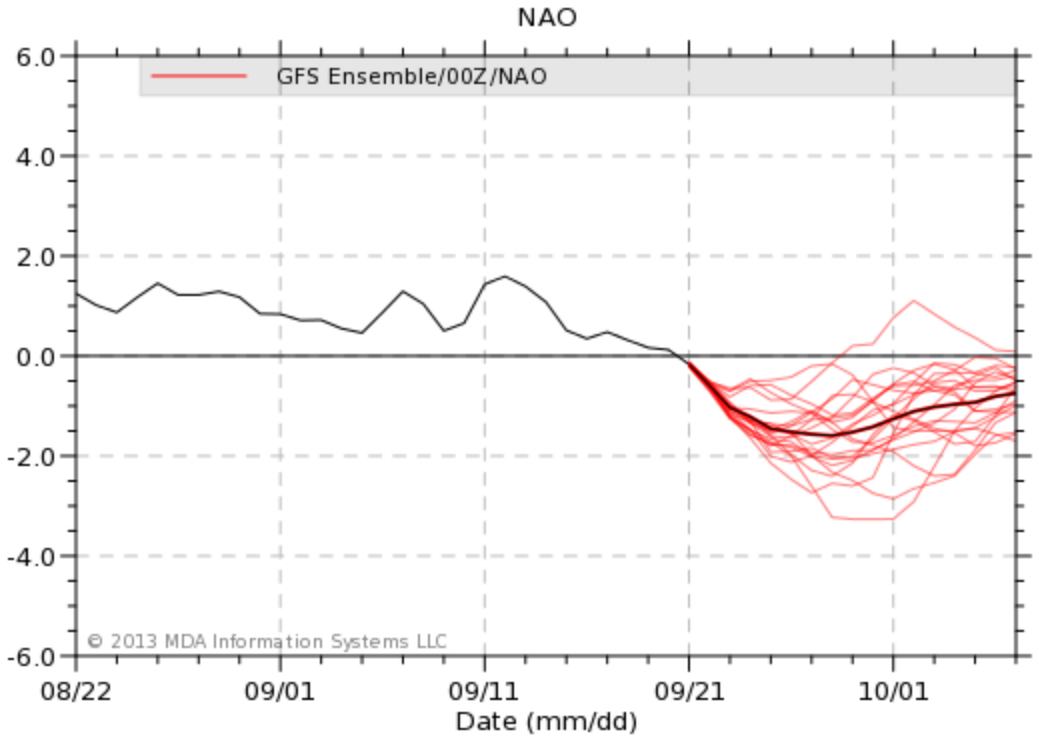
HDF4 and GRIB

- Binary data formats used in Earth sciences
- C libraries, lots of analysis tools
- Multi-dimensional data
- HDF4 bindings
  - Bigarrays wrapped in a variant + converters
  - Mixture of hand-written and camlidl
  - Low level and OCaml-friendly interfaces
- GRIB bindings
  - ints, floats, float arrays
  - Bindings are entirely hand-written
  - Only exposes an OCaml-friendly interface


Δt ~1 minute : 2007028093552_01C_02S_062E_a464a_04005_CS_52439_TR.hdf
CPR rain rate
mm hr-1
10^1
10^0
10^-1
10^-2
Height (km)
14
12
10
8
6
4
2
0
50
100
150
200
Scans along CloudSat track
PR rain rate
mm hr-1
10^1
10^0
10^-1
10^-2
Height (km)
14
12
10
8
6
4
2
0
50
100
150
200
Scans along CloudSat track

Derived data - Teleconnections





Challenges

- Standard issues when interfacing with C
  - Type mismatches between C and OCaml, void *
  - Share vs copy?
- Balancing elegance, purity with potential speed + memory savings of mutation
- Development environments other than emacs and vim
- Accessibility and exposure to people outside of the community

Successes

- HDF4 and GRIB API bindings are/have been used to process terabytes of data per day
- Bigarrays with mmap + the FFI makes getting up and running quick and easy
- opam with local repositories
  - GODI, odb/oasis-db before that
- utop, merlin, ocamlbrowser
- ocp-indent
- Lwt, Batteries, cohttp, GSL, atdgen

Thanks!

Other related bindings

- UDUNITS
  - Unit conversion
- PROJ.4
  - Coordinate projections
- PLplot
  - Various kinds of plots and maps
- Proper/official opam packages coming
- Until then:
  - http://github.com/hcarty/
  - http://0ok.org/ocaml/repo/ - opam repository