CAgM Expert Team 3.1 Update

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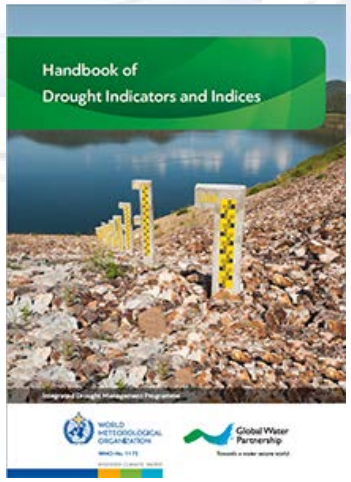
Sept 6, 2017



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Expert Team 3.1 Drought: Terms of Reference

a) Review the definition of drought. Conduct a comprehensive review of the definitions and phases of drought e.g. onset, duration, recovery and the 'end point' of drought in all regions.

b) Identify case studies and conduct a literature review of the socio-economic impacts of drought for regions or countries with successful* mitigation and preparedness programs and policies.

c) Report on existing material on likely drought changes under future climate variability and change

d) Conduct a literature review of the climate science to identify the main mechanisms behind drought onset and persistence in order to develop guidance material for drought preparedness.

e) Report and make recommendations to CAgM on existing drought indices and potential new drought indices in consultation with the Integrated Drought Management Programme (IDMP).

f) Engage with the GEO groups on global drought information systems, NIDIS, and other relevant groups (incl. GEOGLAM, EDO, South Pacific Drought Group), and report on changes.

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Results/Recommendations

- The needs for a definition of drought are contradictory
  - Societal understanding is broad; policy and planning needs to work with a broad concept
  - For research and analysis it should be narrowly defined and standardized

- Two options are available:

1. If drought is rooted in ppt shortages, then use SPI< 0 over a specified time period
   - All other aspects of drought (soil moisture deficit, etc) are impacts
   - Will not be consistent with societal understanding of drought

2. If we keep the broader concept for *drought,* should we incorporate new terms?
   - For example: *drought event* to represent period of ppt shortage
   - We would remain in line with societal understanding; use multiple indices
   - We need to rethink the premise that drought is based on precipitation shortages;
     - What is the role for heat, especially in onset; how will heat stress be factored in?

★ Report is based on this approach

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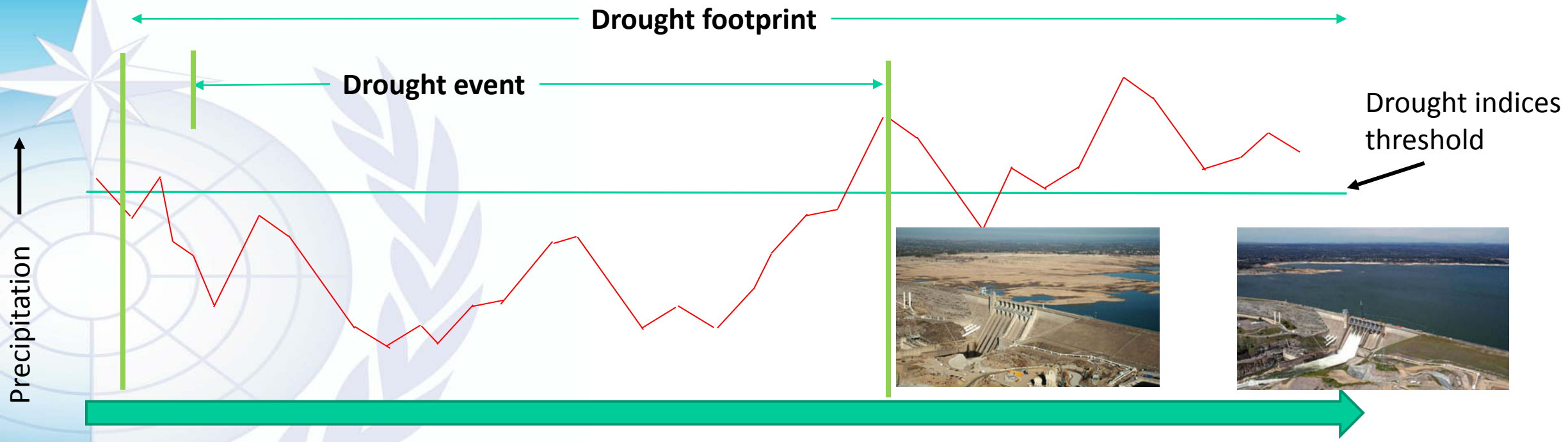
Results/Recommendations (Cont'd)

- Need to more clearly separate drought from aridity
  - Also more clearly articulate differences in terminology (e.g. drought vs water scarcity)
- Socioeconomic metrics must go beyond dollar values for costs and should measure the degree of hardship endured by the people
- Consistent weather monitoring needs to be in place in order to better understand exceptional circumstances (e.g. heat waves) surrounding drought
- New evaporative demand indices offer improved resolution of drought and need to be evaluated for operational use.
- Develop unique databases for drought footprints
  - Include systematic comprehensive record of all droughts (impacts, severity, duration, costs, & collateral effects)

What is a Drought Lifecycle?



Onset

- Abnormally dry (Level 0)
- Soil moisture levels are low, crop & pasture growth delayed
- Water alerts are issued

Drought Event

Intensification

- Moderate (Level 1 - 2
- Some crop & pasture damage
- Fire risk moderate - high
- Water conservation measures activated
- Socioeconomic impacts are mild to moderate

Persistence

- Level 2 – 4 drought
- Water shortages crop damage, and fires are widespread
- Fire risk high to extreme
- Socioeconomic impacts are moderate to severe and widespread

Recovery

- Meteorological indices have returned to normal
- Soil moisture is restored in cultivated land
- Pasture growth re-establishes
- Forest growth re-establishes
- Reservoirs and lakes refill

Drought Endpoint

- Agricultural and Natural ecosystem productivity returns to average pre-drought conditions
- Lake and reservoir levels return to average pre-drought conditions
- Socioeconomic conditions:
  - Do they return or stabilize?
- In some cases we hit a “new normal”

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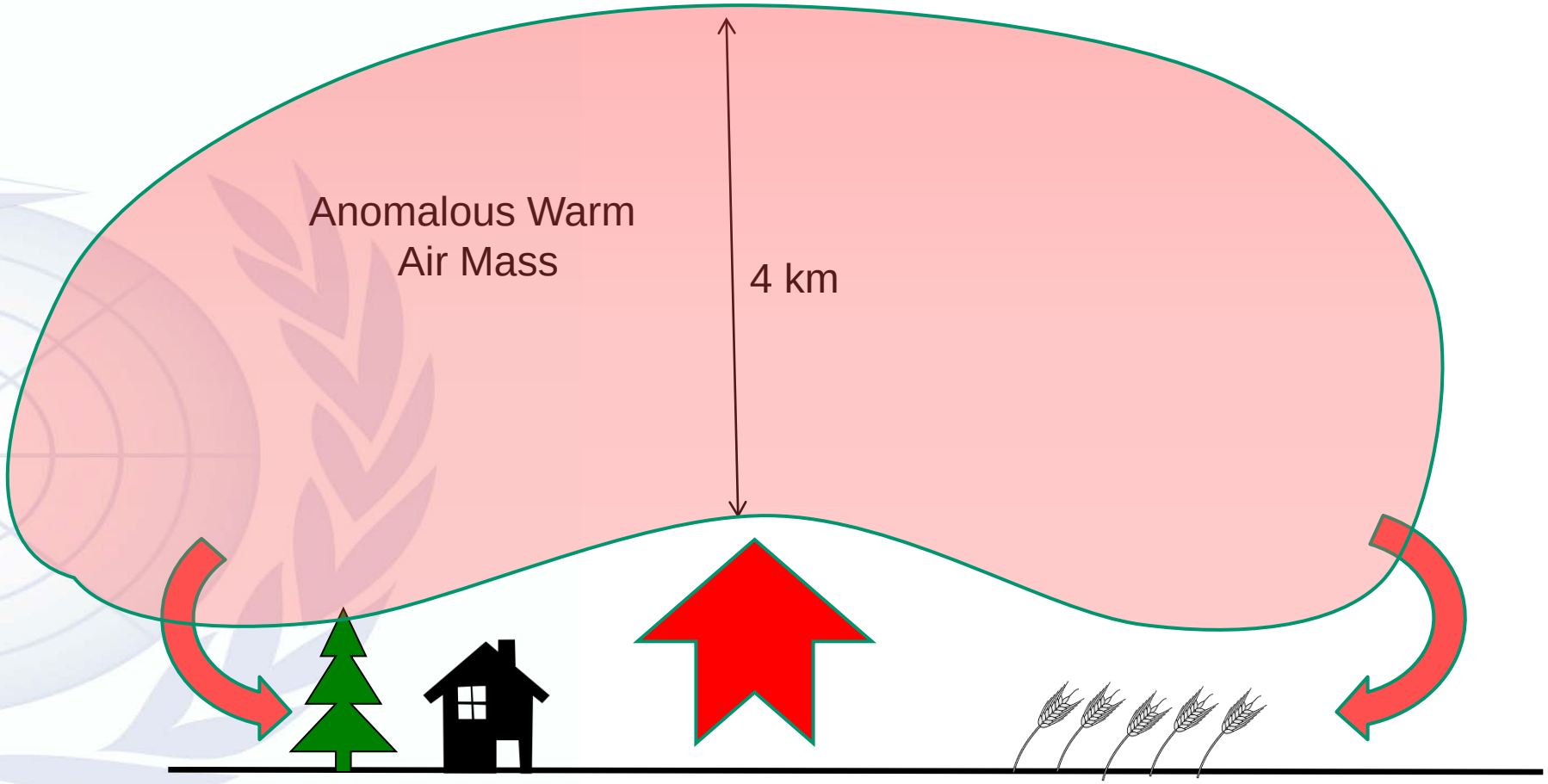
Influence of heat

- Solar radiation will be absorbed as latent heat as moisture is removed from the soil
- As soil moisture is depleted a larger portion of the solar radiation is converted to sensible heat
  - Consequence: land temperature rises; air temperature rises and evaporative demand for water (potential evapotranspiration, E_0) rises; actual evapotranspiration (ET) decreases; humidity decreases.
  - Leads to decreased cloud formation and increased solar radiation
  - Describes a “classic” or sustained drought event
- In Rapid Onset Drought (Flash Drought)
  - ET does not necessarily decrease as E_0 increases
  - Other factors (esp. high temperatures) drive the increase in E_0
  - Precipitation reductions are not always evident

European (2003) Russian (2010) Heat Waves



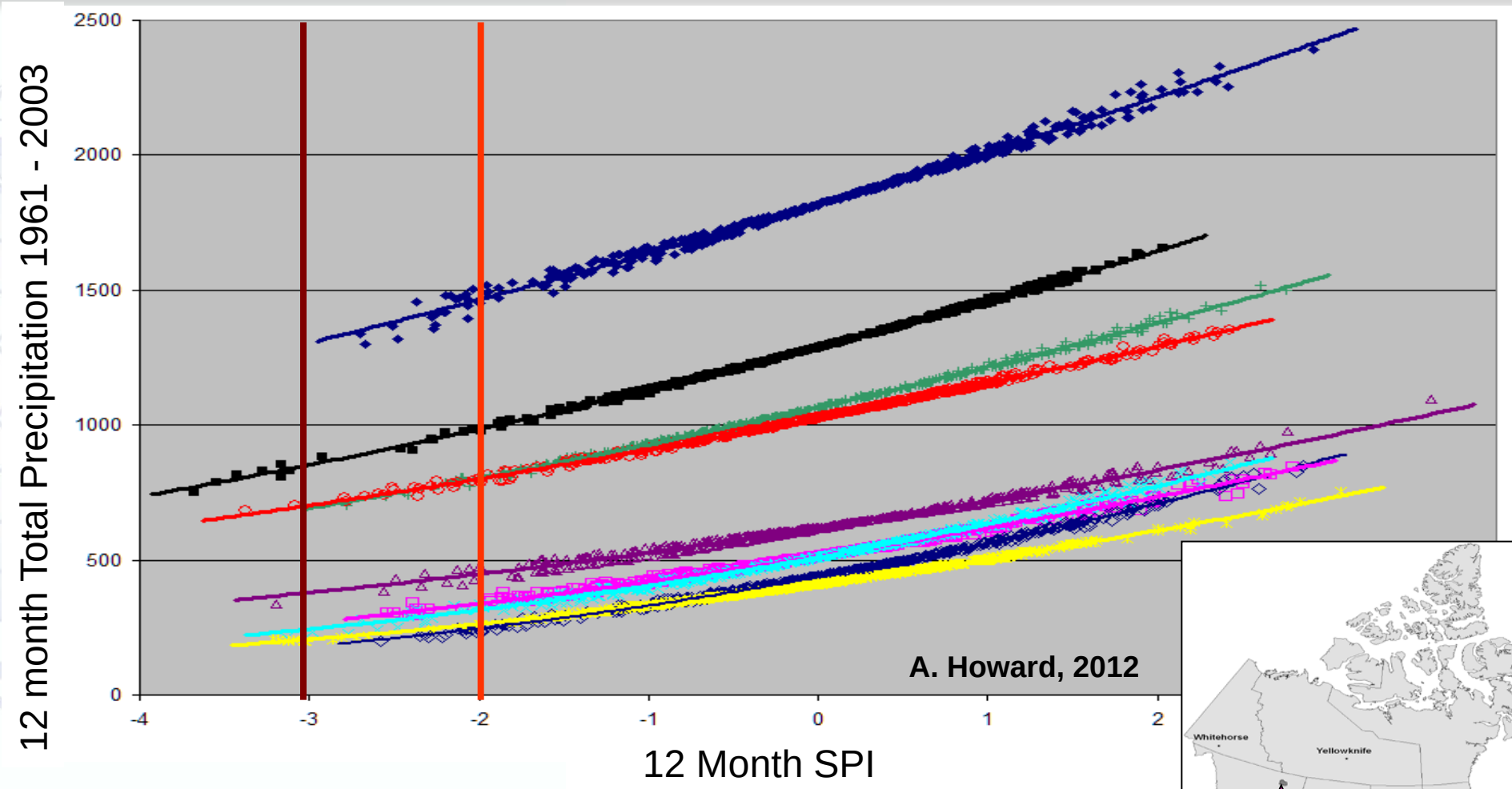
Miralles et al., 2014

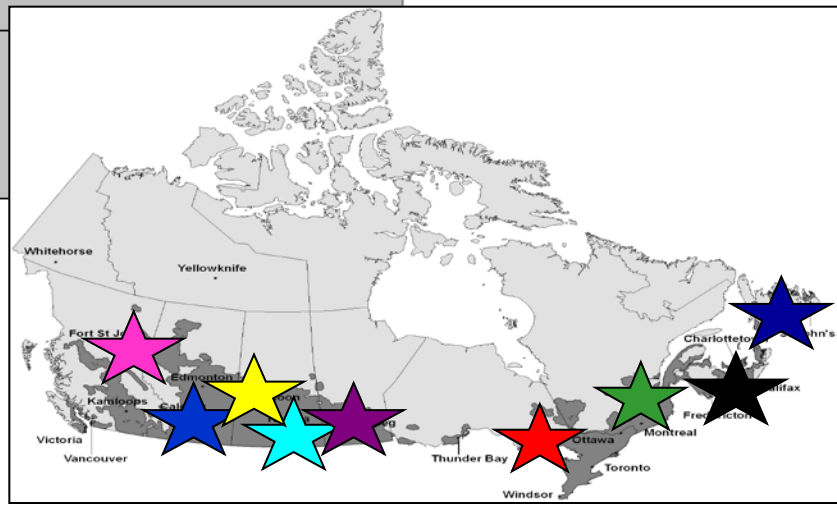
Drought Indices

Most commonly used Indices

- SPI and SPEI
  - Flexible timescale make them suitable for wide range of drought and pluvial periods
  - SPEI has been found to be slightly better correlated to drought that SPI
- PDSI
  - PDSI has recently gained popularity as an index for drought
    - Self-Calibrated version
    - Improved modeling of ET (Penman-Monteith)
  - Better suited to mid and long term duration droughts; insensitive to short duration drought
- These indices are data driven: need appropriate data coverage
- They have not been well suited to detecting flash droughts

Regional variation of precipitation associated with SPI





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Drought Indices (Cont'd)

Demand based indices

- **Evaporative Stress Index (ESI)**
  - Uses GOES and MODIS thermal IR bands to determine rate of warming of land surface
  - E_0 and ET can be calculated from warming rate using a land surface model ALEXI
  - E_0:ET anomalies since yr 2000 used to determine the index.
  - Fast, responsive, can identify flash droughts; not operable in cloudy conditions

- **Evaporative Demand Drought Index (EDDI)**
  - Input data is from the North American Land Data Assimilation System; PoR is from 1979
  - E_0 is the central element; if $E_0 > 0$, then drier than climatological median; if $E_0 <$ then wetter
  - Flexible timescale make it suitable for flash droughts, short, mid and long term droughts
  - Experimental, needs validation especially in non US areas.
- **Both indices can be used in data-sparse areas**

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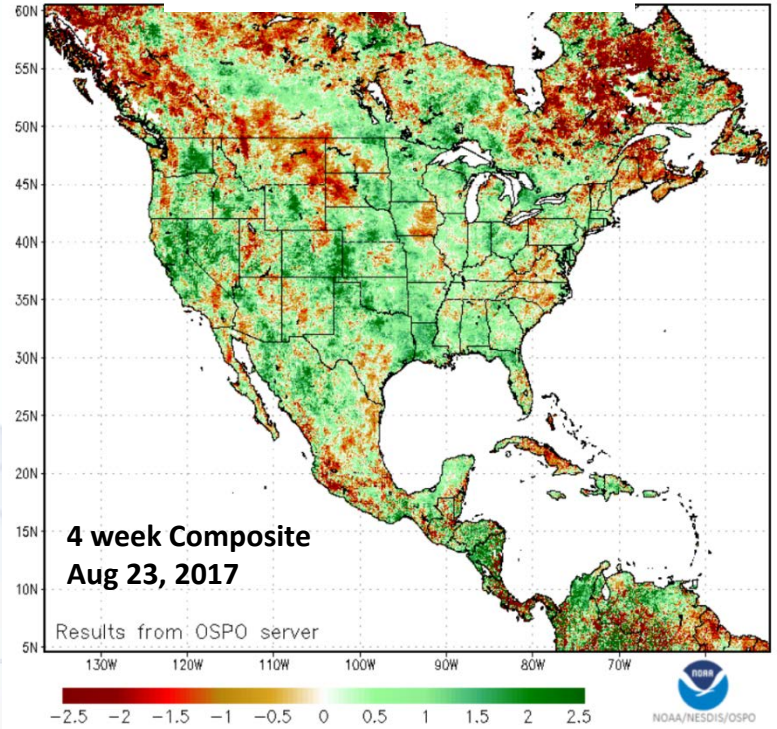
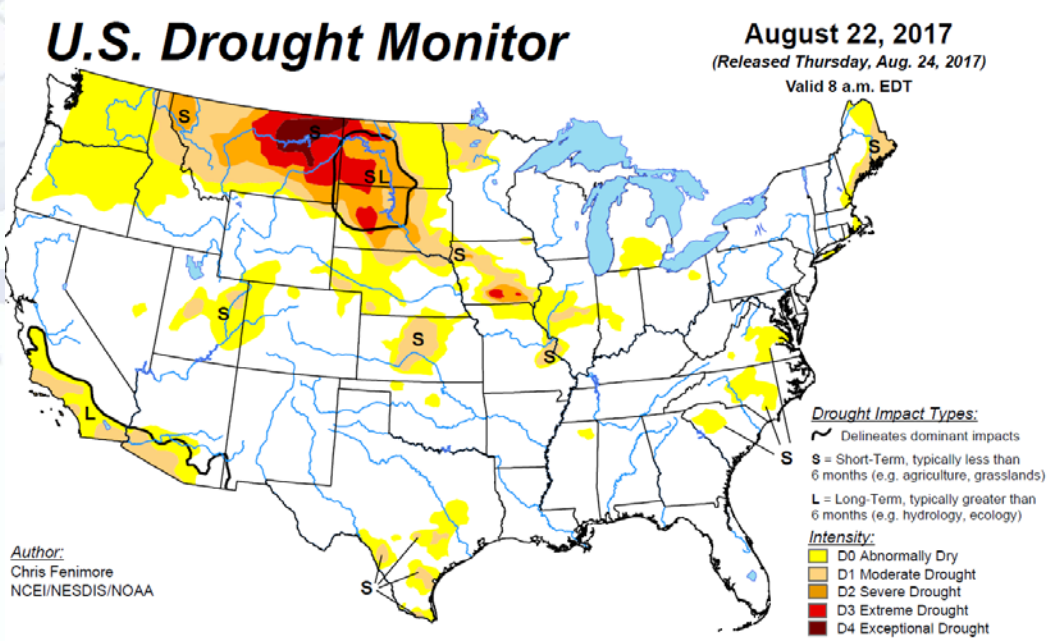
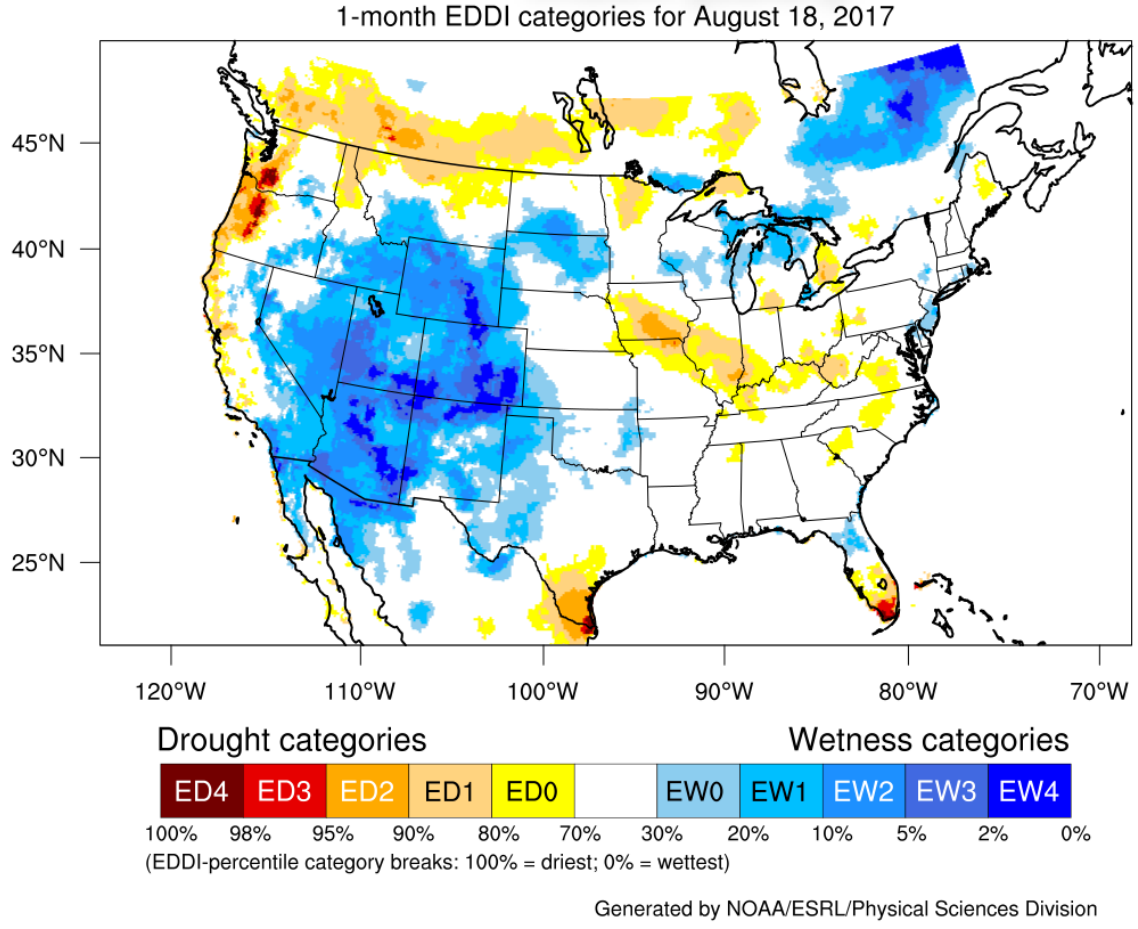
Drought Indices

Evaporative Stress Index





Evaporative Demand Drought Index (EDDI)



Next Steps

- Looking for feedback
  - Team is reviewing it
  - Feedback from IDMP, especially on the indices, would be appreciated
- Some information from contributors yet to come in
- TOR (f) will be a summary of team participation through 2016 -17
- Intent is to publish some in scientific journals jointly with Expert Team 3.3

THANK YOU !

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