CLIMATE DIMENSIONS

Not definite or consensus but "climate" defined mostly in terms of time scales

-- near deterministic-to-probabilistic transition

-- > 1 week to century scales

-- Two broad time frames included: Seasonal to interannual forecasts

Multidecadal/trend scales of climate change

Major challenges/considerations:

What are the long-memory determinants/processes of climate variability & change? To what extent & how should these long-memory processes be incorporated into models (climate & hydro) and predictions?

e.g., Land-air interactions (including soil moisture, groundwater, land uses & cover); ocean-air interactions; cryospheric variability & change

e.g., internal climate modes (including MJO, PNA, ENSO, NAO, PDO, AMO, unnamed, …)

e.g., external forcings (including GHGs, anthropogenic land disturbance, solar, volcanoes, etc.)

Need to understand, initialize, simulate, and project most of these at regional scales with uncertainty envelopes.

Climate Dimensions Breakout Discussions ----------

Major challenges/considerations, continued:

Consideration of these long-memory processes is part of a broad need to included more coupling of land-air & hydrology-climate processes in models and forecasts.

Long-range vision includes coupling of (i) soil moisture-atmosphere (at both climate time scales), (ii) human disturbances & changes of land surface & cover and water availability (on both time scales, but perhaps more so on climate-change scales), and (iii) coevolution of climate/hydrology/vegetation/landscape with society (climate change scales), in climate & hydro models/forecasts.

What is required to produce useful AND defensible hydrologic predictions/ projections & scenarios from climate projections & models?

More resolution ("human scale"→basin scaleS), more processes, more coupling
Better internal modes especially at interdecadal time scales (→ 500 yr records)
ET & associated variables of increasing importance (espec in extreme conditions)

Note similar issues plague downscaling for seasonal forecasts but (a) downscaling is being done, and (b) seasonal forecasts are more limited by climate-forecast skill than by downscaling.

Major challenges/considerations, continued:

Future of hydrologic forecasts/projections

Distributed models/physically based needed to capture extremes & unusual conditions, to accommodate change (including landscape change), for coupling of land to atmosphere

Hydrologic initialization of climate models will be increasingly important

Dynamic vegetation is important, phenology for forecasts, coevolution for projections

Groundwater is important & NOAA is going to require help from outside

Human management of water & land is important & NOAA is going to require help from outside

Recalibration or dynamic-recovery parameterizations needed for accommodation of land change/disturbances in forecast models

Permafrost change (along with other cryospheric change) at seasonal to century time scales needs to be tracked & included in Arctic (and mountains)

What are appropriate scales for land-air coupling in models, for downscaling, for representing feedbacks?

Major challenges/considerations, continued:

Future of climate models/projections

Need to close water (& energy balances) associated with land hydrology in climate models

How will storm tracks change? How will synoptic conditions contributing to climate-scale processes & outcomes change?

Regional models could (?) be a learning ground for inclusion of additional processes & land-air coupling, but similar inclusions should begin in global models too

Climate-change hydrologic projections are irrelevant until brought to local (basin?) scales

** Explicitly characterize ALL uncertainties in our climate & hydro models (and their couplings): disentangling different sources of uncertainty is VERY difficult but promising avenues include multiphysics experimentation & heirarchical Bayesian approaches

** Propose establishment of NOAA tiger teams to evaluate selected real-world extreme events (climate & hydro), aiming to dissect causes and antecedents, determine how much forecst skill was there, & how much could/should it have been used, considering time scales from hours to weeks

Major challenges/considerations, continued:

Drought forecast/characterization

How well can we define what state we're in (drought-wise)? Need initialization soil moisture, groundwater, streamflow, snow, reservoir storage, irrigation, …, at HUC10-ish scales.

NASA & other agencies can help. What all can remote sensing add to w-c nowcasting?

More generally (in drought or not), WE DON'T KNOW WHERE THE WATER IS, WHEN, NOW & INTO FUTURE.

Need full & continuous distributions of climate modes like NAO/AO & their drought impacts.

On climate-change scale, how does climate elasticity of runoff depend on model parameters and parameterizations?

How to characterize (estimate) climate-change uncertainties and how to handle risk under nonstationary statistics?

On both time scales, is a downscaled ensemble of mechanistic climate/hydro models actually better than statistical methods for things like flood frequencies?

Major challenges/considerations, continued:

Are forecasts of numbers & cumulative effects of synoptic-based extreme events possible? Number of atmospheric events, and possibly cumulative hydrologic effects.

Analysis of records of past & attribution are still extremely fruitful but extreme challenges. Decadal forecasts are important investment area for NOAA and its partners.

Added processes/coupling/resolution all may run afoul of the challenge of piling on models that are already overparameterized.

Everything everywhere all the time is not something that NOAA can do...a challenge for NOAA is defining what the limits of what it is willing and able to do. The community really needs this and it would serve in many ways as a gold standard for us all.